

Railway Power Supply Systems

Find out more on <http://toshiba-railway.com>

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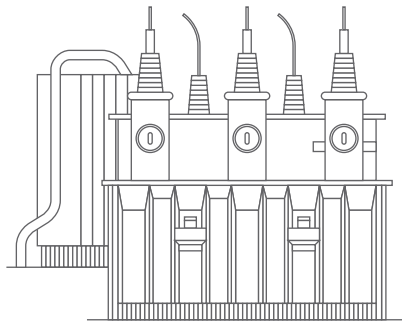


Railway Power Supply Systems

Rail transport has been evaluated as an environment-friendly transportation system, helping to solve environmental pollution, energy resources shortage, and chronic traffic congestion problems in developing countries. Since Toshiba started manufacturing traction motor and propulsion systems in 1899, we have made continuous technological innovations which led to the creation of new transportation systems, including power supply systems. We have now expanded our business to supply advanced technologies on a global scale. In the pursuit of technological innovation, global environmental issues are important, and demand is high for the creation of a new product value aimed at reducing environmental impact while ensuring safety and comfort. We offer products and systems to support your organization's activities aimed at protecting the environment, thus contributing to the creation of a sustainable, eco-friendly society.

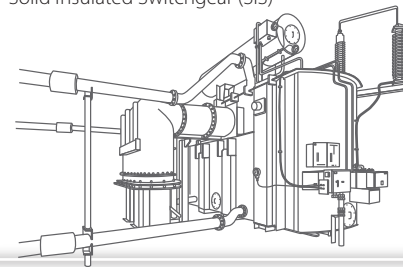
AC Electrification Systems

- Traction Transformer
- Auto-transformer
- Feeding Circuit Breaker
- Feeding Switchgear(GIS,C-GIS,SIS)
- Changeover Switch
- Control / Relay Panel
- AC Feeding Protection Relay



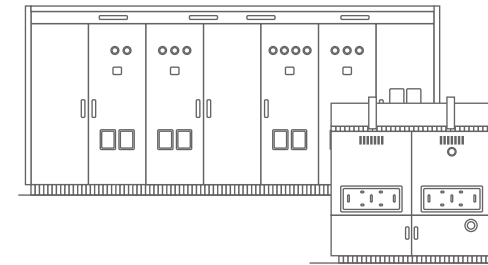
Transmission Systems

- Gas Insulated Switchgear (GIS)
- Gas Insulated Transformer (GIT)
- Gas Circuit Breaker (GCB)
- Cubicle Type Gas Insulated Switchgear (C-GIS)
- Solid Insulated Switchgear (SIS)



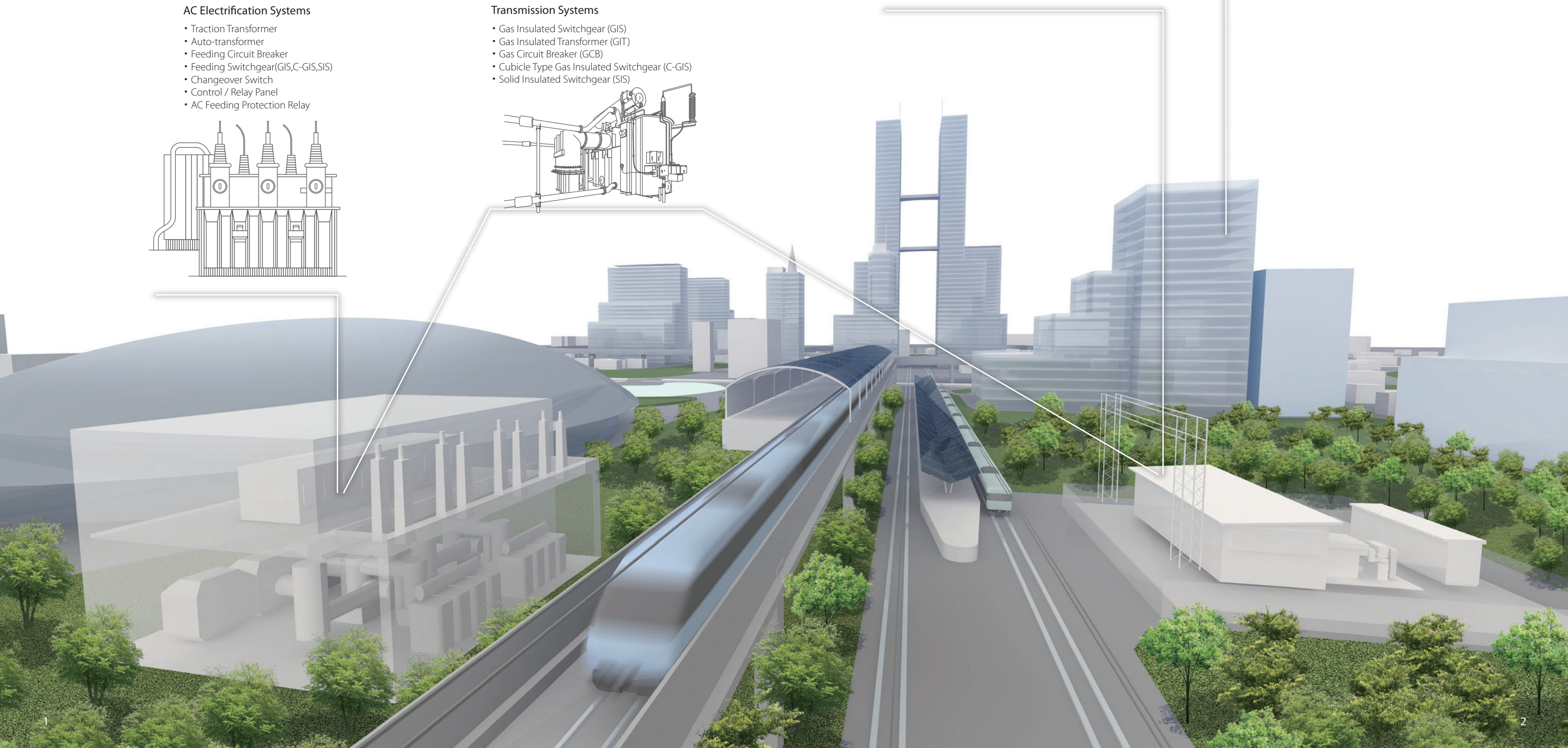
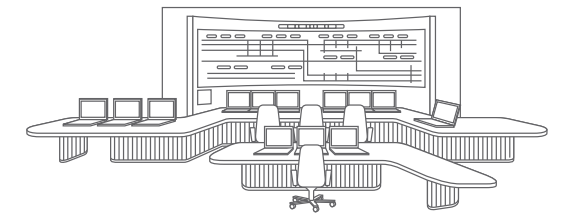
DC Electrification Systems

- Rectifier Transformer
- Traction Rectifier
- Regenerative Inverter
- DC Switchgear
- Protection Relay
- HSVCB
- Package-Type DC Substation
- SCIB™ Traction Energy Storage System



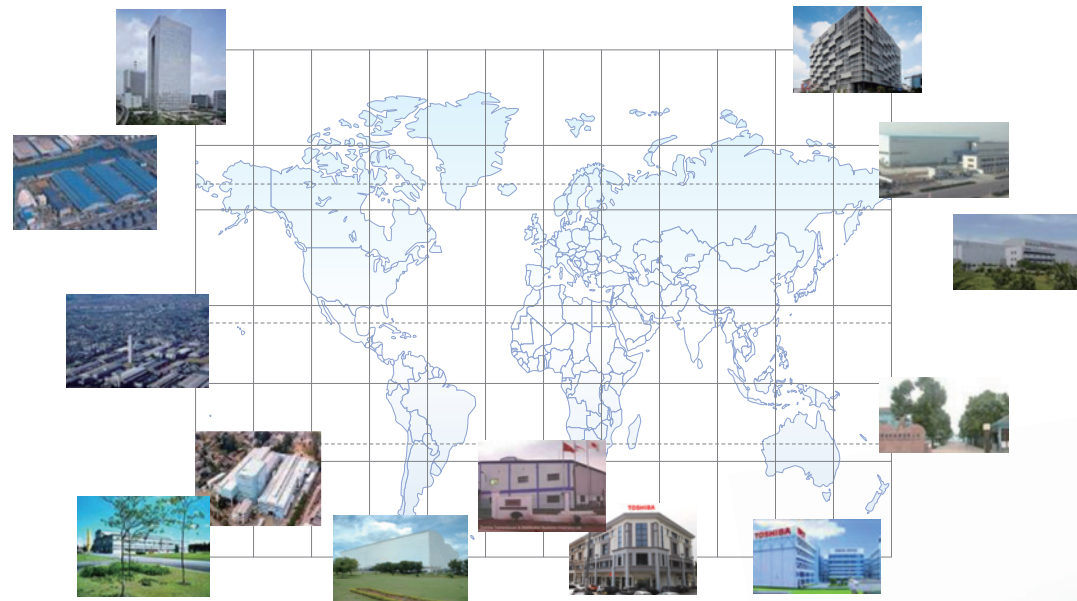
Control Center

- Supervisory Control And Data Acquisition (SCADA)

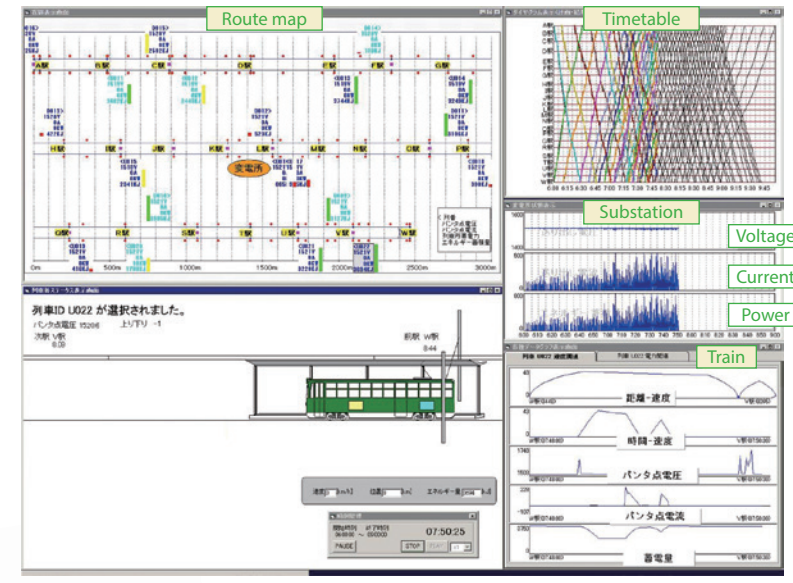


System Integration

Toshiba has been continuously striving to provide customers with advanced, optimal solutions. We are able to provide not only the latest environmentally-friendly products from all over the world but also consulting services like energy simulation and construction works as well.



Toshiba is able to supply transmission and distribution products from our bases all over the world, using our worldwide distributors to offer customer-oriented solutions at a competitive price.



Example of Power Supply Simulation

Our long history of engineering railway system projects has given us extensive expertise in designing railway power supply systems. Our in-house simulator is able to calculate various railway system conditions with remarkable accuracy. Our experienced engineers are also there to provide consultation and offer customer-oriented solutions.

Engineering



Construction



Taiwan High Speed Railway Project

Procurement & Manufacturing



Solid Insulated Switchgear



Vegetable Oil Transformer



SCiB™ Traction Energy Storage System



Having started in the transportation business in 1899, Toshiba has extensive experience in offering innovative railway system products. For power supply systems, our current products such as the Solid Insulated Switchgear, Vegetable Oil Transformer and SCiB™ Traction Energy Storage System, are environment friendly solutions which contribute to a more sustainable environment.

In addition to supplying products, Toshiba also provides customers with FTK solutions. One representative example of our FTK is the Taiwan High Speed Railway, wherein Toshiba built and supplied essential products for railway electrification.

Transmission Systems

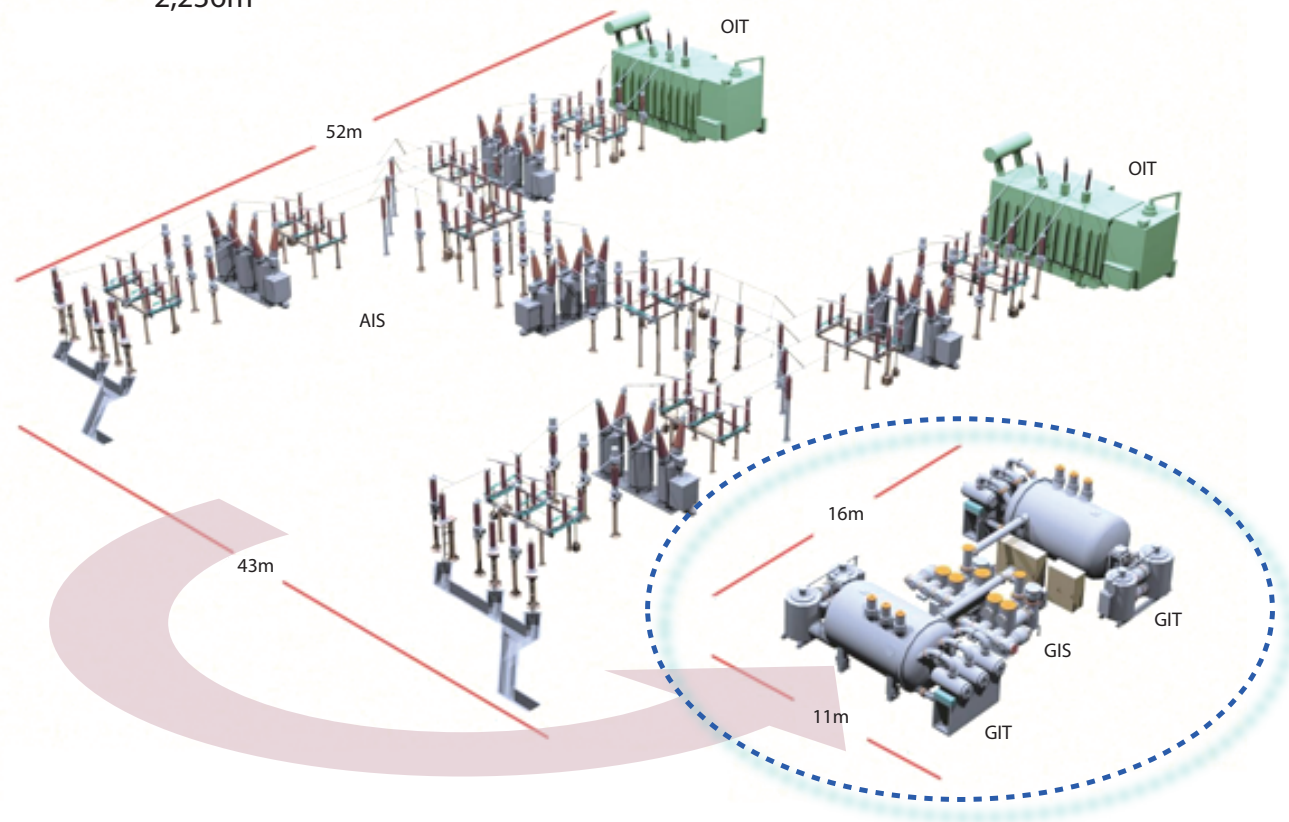
Railway Power Supply equipment must be highly reliable and safe. In addition, today's equipment must also be economically efficient to accommodate installation in limited space and in a short period of time. Therefore, Toshiba developed the highly reliable SF₆ Gas Insulated Switchgear (GIS) which can simplify site work and reduce land footprint by up to 92%. For the main transformer, Toshiba offers a non-flammable Gas Insulated Transformer (GIT) for a more compact substation solution. As for Toshiba's product line-up for middle voltage switchgears, we developed the Cubicle type Gas Insulated Switchgear (C-GIS) and SF₆ gas free Solid Insulated Switchgear (SIS).



Transmission Systems

As for Toshiba's product line-up for middle voltage switchgears, we developed the Cubicle type Gas Insulated Switchgear (C-GIS) and SF₆ gas free Solid Insulated Switchgear (SIS).

Typical space for AIS+OIT
2,236m²



A compact solution with GIS and GIT

AIS : Air Insulated Switchgear
OIT : Oil Insulated Transformer
GIS : Gas Insulated Switchgear
GIT : Gas Insulated Transformer

Our GIS+GIT - Sample Layout
176m² (8% of AIS + OIT land footprint)

Gas Insulated Switchgear (GIS)

The Gas Insulated Switchgear (GIS) is an integrated switchgear which uses SF₆ insulation gas. It is used mainly in 72.5kV or higher systems. Toshiba has a long history for developing and manufacturing GIS.



168kV GIS



170kV GIS

Ratings

Rated Voltage [kV]	72.5 ~ 252
Rated Interrupting Current [kA]	25 ~ 63
Rated Lightning Impulse Withstand Voltage [kV]	325 ~ 1050
Rated Power Frequency Withstand Voltage [kV]	140 ~ 460
Rated Gas Pressure	0.7(GCB) / 0.7(GIS)
Applicable Standards	JEC / IEC

Features

- **Compact Design**
Can be installed in indoor and underground substations
- **Outdoor Compatibility**
Protection against pollution
- **Safe Operation**
Electrified parts are enclosed in the earthed tank
- **Low Maintenance**

Gas Insulated Transformer (GIT)

The Gas Insulated Transformer (GIT) uses SF₆ gas for insulation and cooling instead of mineral oil and is suitable for indoor and underground substations. GIT development and manufacturing at Toshiba also has a long history.



GIT

Features

- **Non-flammability**
SF₆ gas is used instead of mineral oil, alleviating the need for a fire fighting system. This also allows the installation in the same room with the GIS for a more compact substation layout.
- **Non-explosive**
No pressure relief device is needed.
- **Compact Design**
Conservator and pressure relief device are not required thus lowering the height to less than that of OITs.

3-3

Gas Circuit Breaker (GCB)

Toshiba supplies many types of Gas Circuit Breakers (GCB) for 72kV or higher voltage.



240kV GCB



72kV GCB



145kV 3-Phase GCB

Ratings

	GSR	GSM / GSP	GSPF
Rated Voltage [kV]	240 / 300	72 / 84 / 168	145
Method of Operation	Hydraulic	Motor Spring	Motor Spring
Tank	Dead Tank		Live Tank
Rated Withstand Voltage	Lightning Impulse [kV]	900 / 1050	350 / 400 / 750
	Power Frequency [kV]	200-265-200(1min)/250-330-250(1min)	140 / 160 / 325
Applicable Standards	JEC / IEC		

Features

- Good Breaking Ability
- Easy Installation
- Low Noise

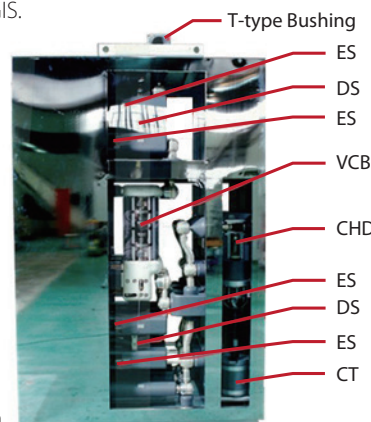
3-4

Cubicle Type Gas Insulated Switchgear (C-GIS)

The Cubicle Type Gas Insulated Switchgear (C-GIS) is an integrated switchgear which uses SF₆ insulation gas. It is used mainly in 36kV to 84kV systems. Toshiba spent many years developing and manufacturing high quality C-GIS. Vacuum circuit breakers (VCB) are used for the C-GIS.



72kV C-GIS



Cross-section

Ratings

	36	40.5	72	84
Rated Voltage [kV]	36	40.5	72	84
Rated Withstand Voltage	Lightning Impulse [kV]	170	185	350
	Power Frequency [kV]	70	95	140
Rated Current [A]	630 / 1250 / 2500	630 / 1250 / 2000	800 / 1250	800 / 1250
Rated Short Time Withstand Current [kA]	25 / 31.5	25 / 31.5	20 / 25 / 31.5	20 / 25 / 31.5
Applicable Standards	JEC / IEC			

Features

- Compact Design
- Outdoor Compatibility
- Safe Operation
- Low Maintenance
- Easy Withstand Voltage Test

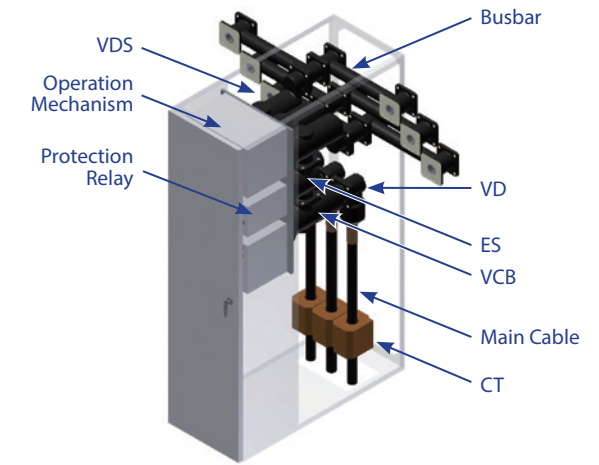
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Solid Insulated Switchgear (SIS)

Toshiba developed Solid Insulated Switchgear (SIS), which utilizes high-performance epoxy resin independently developed as insulating material for SIS. Our epoxy resin provides a remarkable improvement in strength, flexibility, heat-resistance and dielectric strength. By using this material for switchgear insulation, we are able to reduce the size while maintaining the equipment's high reliability. Installation space required for the 72/82kV SIS is smaller than our conventional 72kV air-insulated switchgear. For the 24/36kV SIS, the new Balanced Magnetic Actuator (BMA) for the VCB is utilized which further reduces the size and weight of the SIS without compromising its performance.



24kV SIS



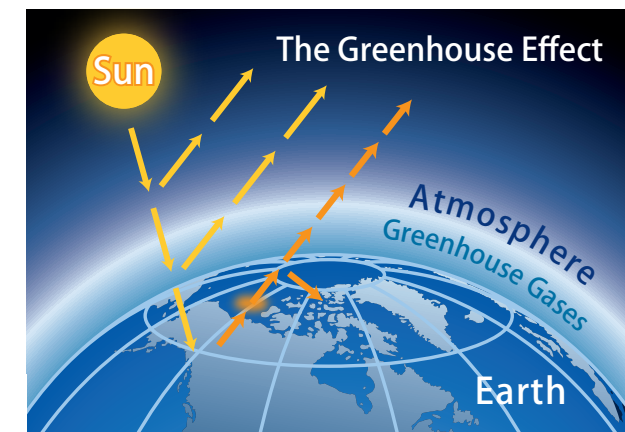
Ratings

Rated Voltage [kV]	24	36	40.5	72	84
Rated Withstand Voltage	Lightning Impulse [kV]	125	170	185	350
	Power Frequency [kV]	50	70	95	140
Rated Current [A]	630 / 1250 / 2000		1250 / 2000	800 / 1250	
Rated Short Time Withstand Current [kA]	25 / 31.5				
Applicable Standard	JEC / IEC / GB				

Features

- SF₆ gas-less due to epoxy-resin coating
- Compact Design
- Outdoor Compatibility
- Safe Operation
- Low Maintenance
- High Reliability

Eco-Friendly Design



SF₆ gas is evaluated as the most potent greenhouse gas and it poses negative effects in the environment. As part of Toshiba's drive for the development of more eco-friendly products, Toshiba introduced a new material which possesses high dielectric strength.

Safe Design



SIS Busbar Compartment

SIS has an "Internal arc-free" feature which promotes safe operation. Busbar and devices in each phase of the main circuit are completely insulated with earthed layer of Toshiba's unique epoxy resin mold coating.

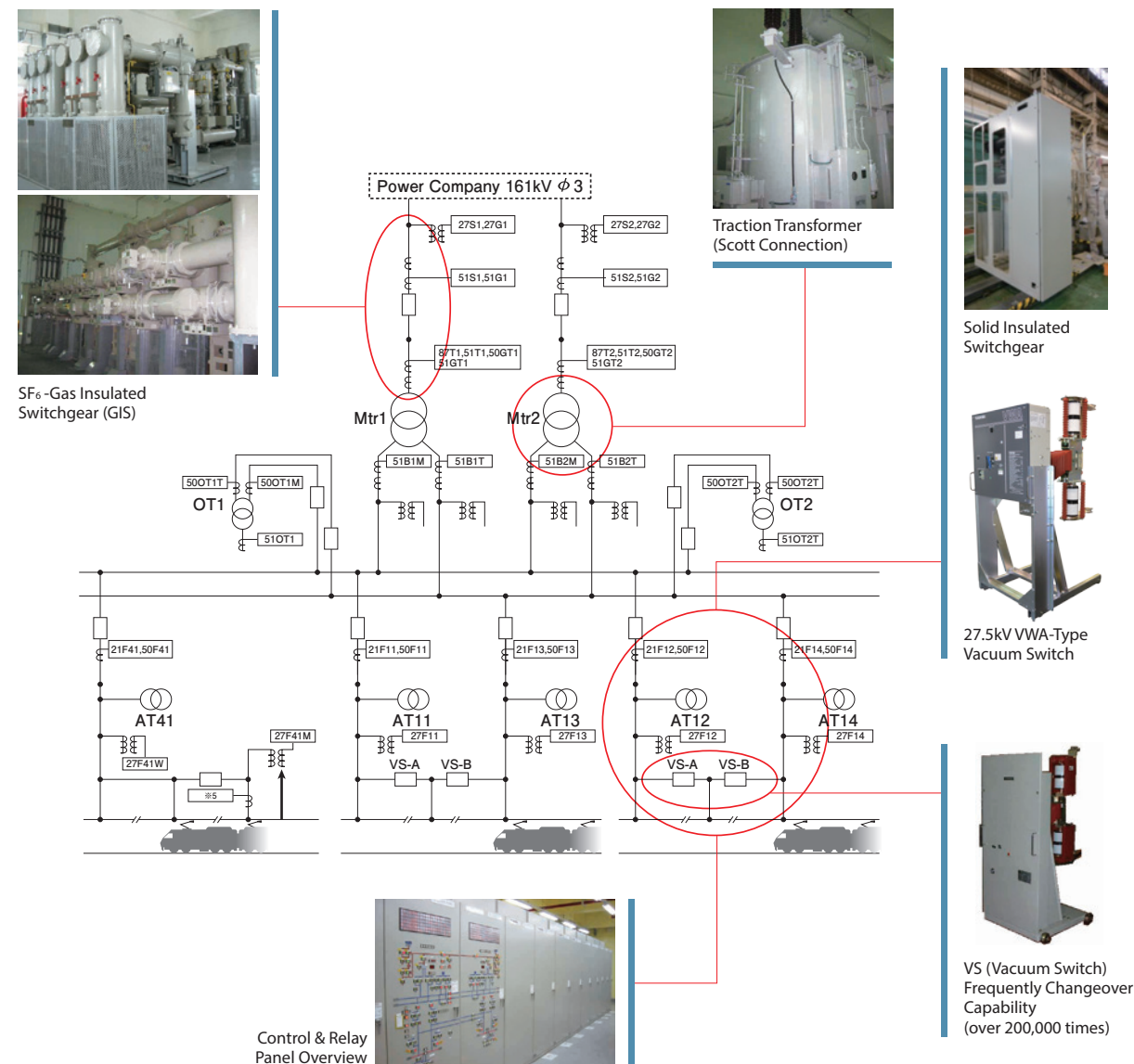
AC Electrification Systems

Toshiba provides a highly-reliable and modernized AC electrification system which consists of elements such as large capacity of traction transformers, single phase circuit breakers, surge arrestors, and changeover switches. Our products are designed with the advance technology based on our long history of development. It contributes to a safe, stable and cost-minimized system operation for a long term.

Features

- Toshiba can supply various types of transformers and propose the most suitable type of transformer according to customer specification such as voltage, capacity, loss, installation condition, etc.
- The changeover switches are used for the phase break point of high speed railway system. Our product is designed for long time operation under the harsh conditions of high voltages and repeating surges.
- The control and relay panels supplied by Toshiba are designed with the advance digital technologies. They integrate all required functions such as protection, control and monitoring by the intelligent digital relays, PLCs and the LAN connection network.

TOSHIBA's POWER SUPPLY SYSTEMS for AC Feeding Substation



4-1

AC Traction Transformer

AC feeding power for rolling stock is single-phase power. The AC feeding substation should therefore convert the commercial AC 3-phase into AC single-phase. However in this case, it will cause three phase voltage unbalance at the primary side. The Scott-connection and the Roof-delta connection transformer below are used for the AC traction transformer which can reduce the 3-phase voltage unbalance induced in the primary side.



Scott Connection Transformer

Ratings

Application	Feeding System for High Speed Railway
Rated Voltage [kV]	220 / 25x 2 ; 161 / 60x 2 ; 132 / 27.5x 2
Cooling Type	ONAN / ONAF / OFAF
Rated Power [MVA]	84 / 60
Overload	200% 5mins
Connection	Scott
Applicable Standard	JEC / IEC



Roof-delta Connection Transformer

Ratings

Example of Roof-delta Connection Transformer

Utility	Feeding System for High Speed Railway
Rated Voltage [kV]	220kV / 60kVx2
Cooling Type	ONAN
Rated Power [MVA]	60
Overload	300% 2min
Connection	Roof-delta
Applicable Standard	JEC / IEC

4-2

Auto-transformer

The Auto-transformer is used for the AT Feeding System (25kV x 2) which reduces catenary voltage drops and electro-magnetic interference. It should be designed with low impedance and to withstand the high short circuit current.



Auto-transformer

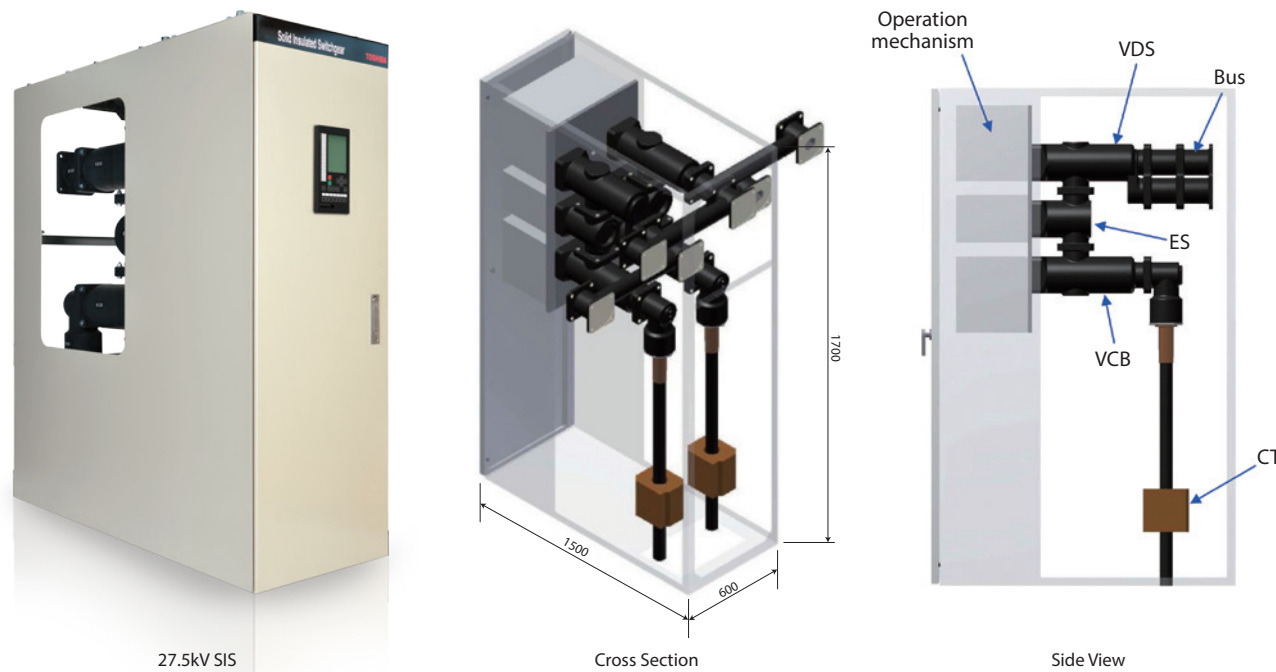
Ratings

Rated Voltage [kV]	55 / 27.5	
Type	ONAN	
Rated Power	Self Capacity [MVA]	4 / 5 / 7.5 / 10
	Line Capacity [MVA]	8 / 10 / 15 / 20
Overload	300% 2min	
Short Circuit Intensity	Can withstand thermally and mechanically for 25 or 35 times of the rated current	
Applicable Standard	JEC / IEC	

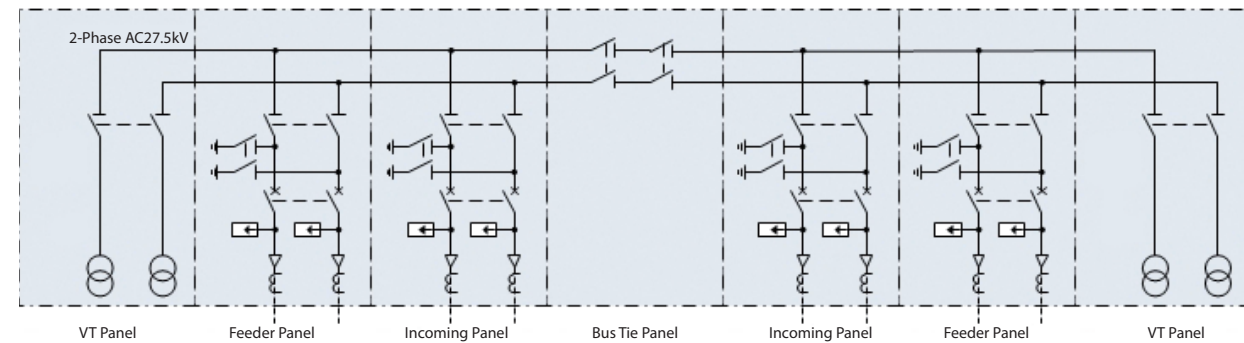
4-3

Feeding Circuit Breaker / Switchgear (Solid Insulated Switchgear)

Toshiba developed a single-phase SIS for AC Feeding System. This next generation switchgear uses an improved insulation material in place of the conventional SF₆ gas which further enhances its functionality and reliability. Using epoxy resin material for insulation also allows both installation even in harsh environment and drastic reduction in space requirement. Furthermore, SIS has a modular composition which enables easier replacement, maintenance and customization.



Single Line Diagram



Ratings

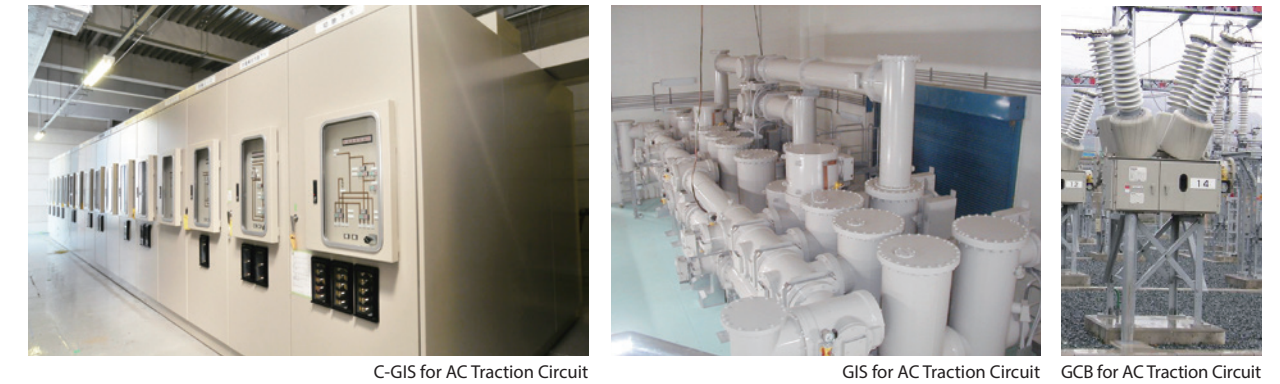
Rated Voltage [kV]	27.5	
Rated Withstand Voltage (Line to Earth)	Lightning Impulse [kV]	200 (to earth and across open contacts) 220 (across isolating distance)
	Power Frequency [kV]	95 (to earth and across open contacts) 110 (across isolating distance)
Rated Current [A]	1250	
Rated Short Time Withstand Current [kA]	31.5	
Applicable Standard	IEC	

Features	<ul style="list-style-type: none"> • SF₆ gas-less due to epoxy-resin coating • Compact Design • Outdoor Compatibility • Safe Operation • Low Maintenance • High Reliability
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4-4

Feeding Circuit Breaker / Switchgear (Gas Insulated Switchgear)

Dual or single-pole circuit breakers are used for AC outgoing feeders. These must demonstrate a long operating life and have a reclosing function. Individual gas circuit breakers (GCB), gas insulated switchgears (GIS), or cubicle type gas insulated switchgears (C-GIS) are used.



Ratings (C-GIS)

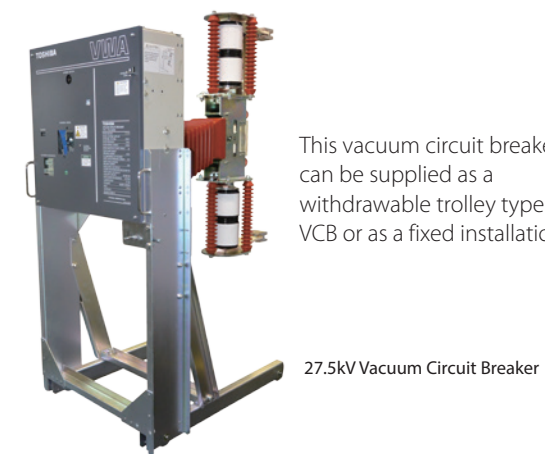
Rated Voltage [kV]	36 / 72	
Rated Bus Current [A]	1200	
Rated Breaking Current [kA]	16 / 25	
Rated Withstand Voltage	Lightning Impulse [kV]	200 / 350
	Power Frequency [kV]	70 / 140
Rated Gas Pressure [MPa·G]	0.05 (at 20°C)	

Features	<ul style="list-style-type: none"> • Compact Design • Outdoor Compatibility • Safe Operation • Low Maintenance
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4-5

Single Phase Vacuum Circuit Breaker

Toshiba's VCB designed for 27.5kV single phase AC feeding system uses high performance vacuum switches that are able to withstand high voltages and extensive switching cycles.



This vacuum circuit breaker can be supplied as a withdrawable trolley type VCB or as a fixed installation.

27.5kV Vacuum Circuit Breaker

Features	<ul style="list-style-type: none"> • High Voltage Withstand Capability In order to withstand the excessive voltage at the phase break point, two vacuum interrupters are provided in series for the switch. • Long Life Operation Aiming at long life operation, a simple electro-magnetic operation mechanism is used.
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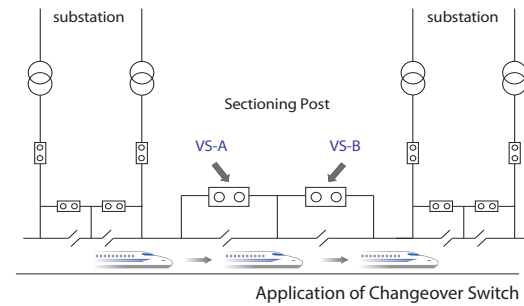
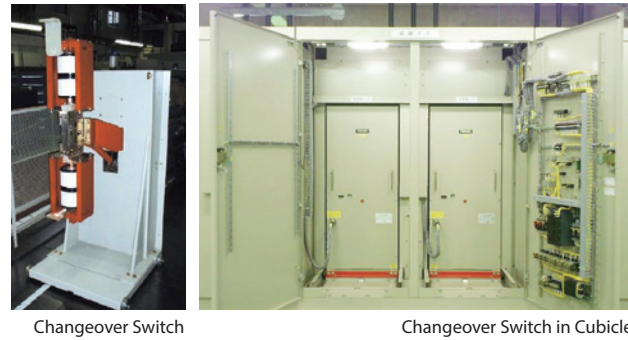
Ratings

Rated Voltage [kV]	27.5	
Rated Current [A]	1250	
Rated Withstand Voltage	Lightning Impulse [kV]	250
	Power Frequency [kV]	95
Rated Short Time Withstand Current [kA]	25	

4-6

Changeover Switch

Single pole vacuum switches (VS) are used for power switching at phase break points for AC high speed railway systems. Toshiba is a leading company in manufacturing changeover switches equipment for railways.



Ratings

Rated Voltage [kV]	36	
Rated Current [A]	1200	
Rated Withstand Voltage	Lightning Impulse [kV]	Between Main Circuit and Earth 200 Between Main Circuit Terminals 250
	Power Frequency [kV]	Between Main Circuit and Earth 70 - 1min. Between Main Circuit Terminals 100 - 10min.
Rated Short Time Withstand Current [kA]	12.5 - 2sec.	
Switching Lifetime	Mechanical	200,000 times
	Electrical	100,000 times

Features

- High Voltage Withstand Capability**
In order to withstand the excessive voltage at the phase break point, two vacuum interrupters are provided in series for the switch.
- Long Life Operation**
Aiming for long life operation, a simple electro-magnetic operation mechanism is used.

4-8

Control / Relay Panel

The integrated control and relay panels are provided for AC feeding substations. They are designed with the advanced digital technology and consist of elements such as a digital protection relay, programmable logic controller (PLC), colored LCD touch screen, Ethernet LAN connection.



Control/Relay Panel

Features

- Colored LCD Touch Screen for Human Interface
- Redundant System
- Self-monitoring and Self-diagnosis Function
- Alarms and Commands Logs Function
- Measuring Data (voltage, current, power, power factor etc.)
- Connection with Remote Control Center (SCADA)

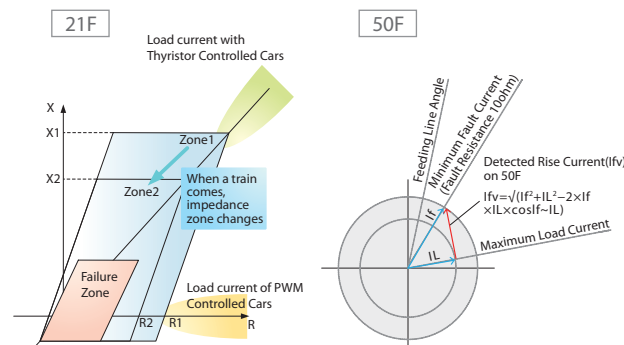
4-7

AC Feeding Protection Relay(GRY-200 Series)

Toshiba's AC feeding protection relay provides mainly 2 protection functions called "Distance Relay (21F)", and "Instantaneous Overcurrent Relay (50F)". If failure is detected, it will isolate failure circuit quickly.

Ratings

Protection Function	21F	Distance Protection
	51F	Overcurrent Protection
	27F	Voltage Protection
	79	Automatic Reclose
	50F	Instantaneous Overcurrent Protection
Control Function	Multi-shots auto-reclosing function	
	Inter breaking function *	
	Controlling function (SWGR, CB)	
Metering Function	I, V, W, +Wh, Impedance	
Monitoring Function	Event records	
	Fault records	
	Disturbance records	
Record Function	CB and DS status	
	CB and DS response monitoring	
	Trip circuit supervision	
	Trip counter monitoring categorized by breaking level	
Self-supervision		

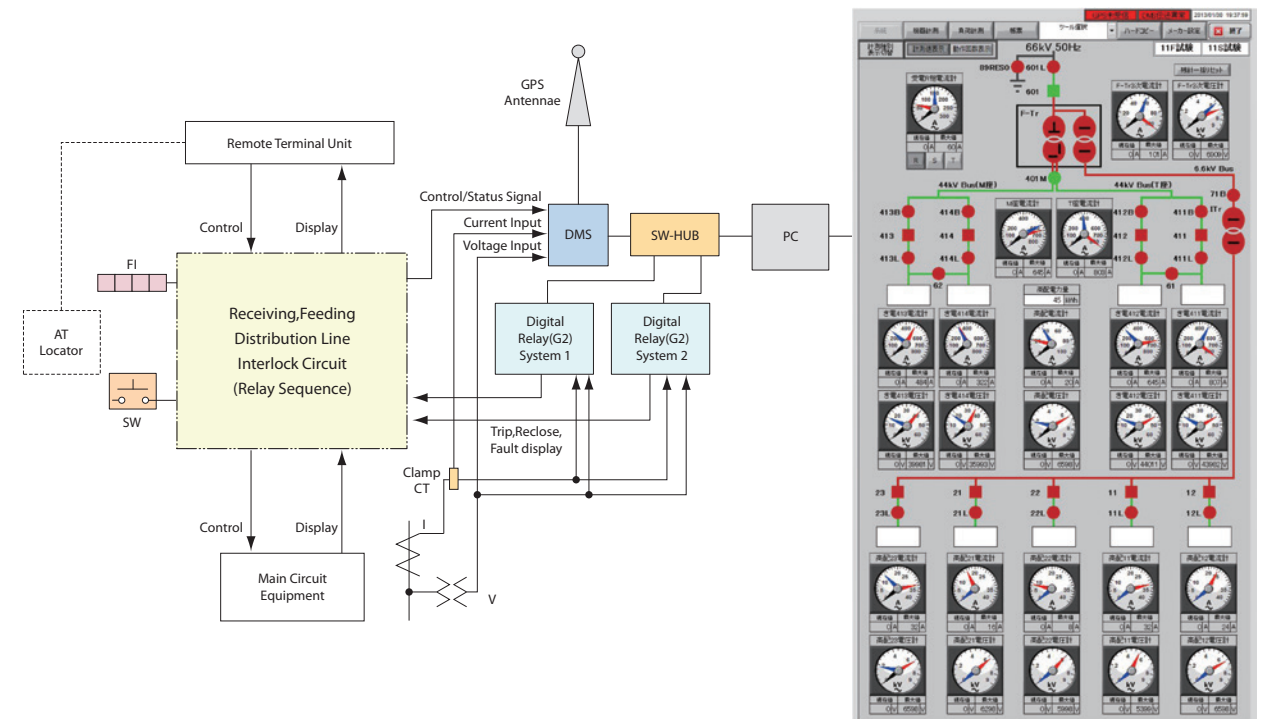


Features

- Compact Design
- Colored LCD touch screen for human interface
- Flexible Installation (The touch panel and the main unit are separated.)
- Support a wide range of communication protocol

Substation Monitoring System

This Control/Relay Panel for AC Receiving Substations is installed with G2 Relay and monitoring system that utilizes DMS (Digital Monitoring System). Hence, it can flexibly deal with both distributed and clustered systems. G2 Relay's features include fault waveform collection, transmission functions and a user-friendly LCD interface. System monitoring results such as daily and monthly energy status reports and fault history can be displayed through its large LCD.



LCD panel (31.5 inch)

*Communication lines between the substations are required.

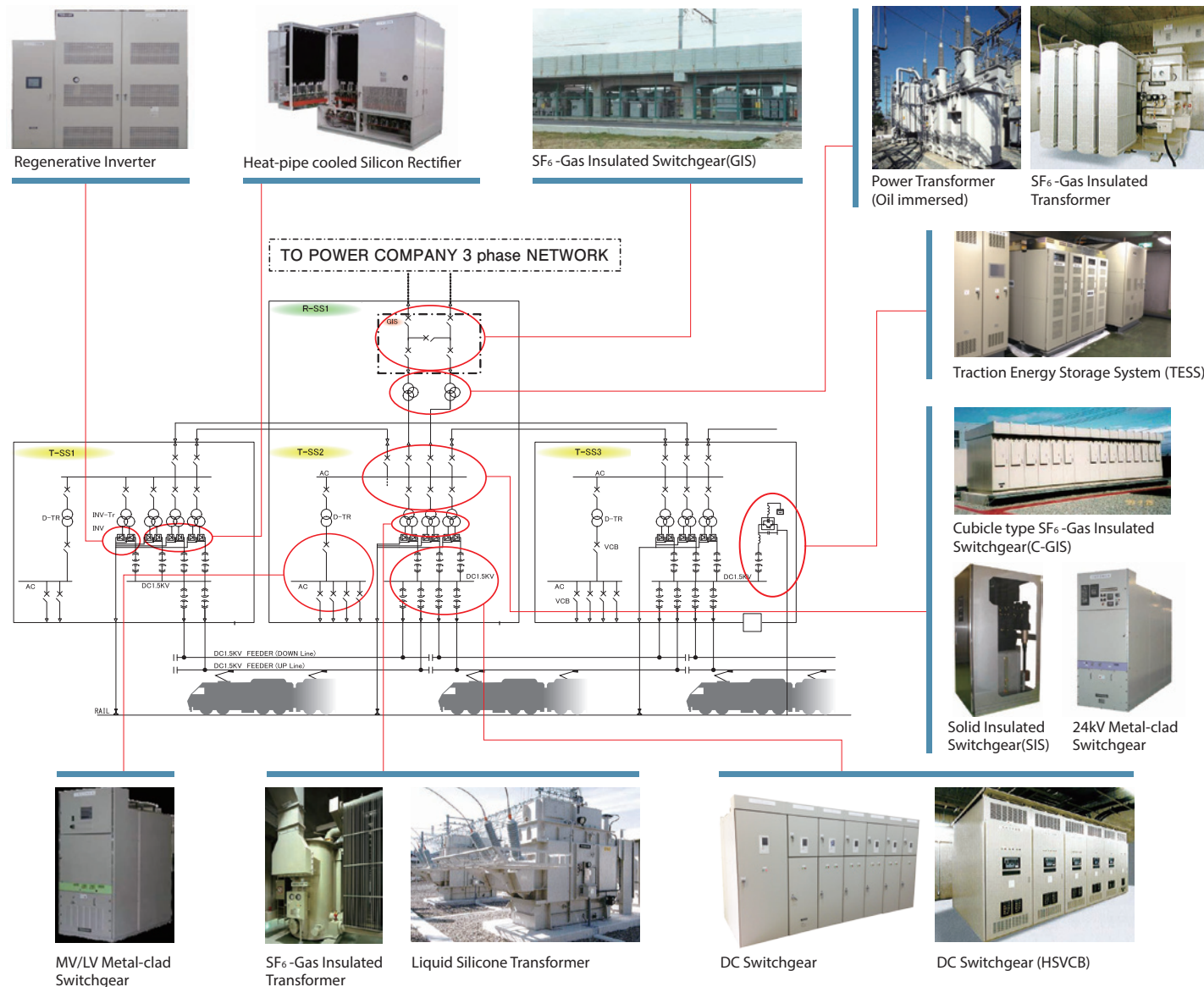
DC Electrification Systems

Toshiba also provides a highly-reliable and modernized DC electrification system. In addition to conventional equipment like rectifier transformers, rectifiers, and high speed circuit breaker (HSCB), a lot of new equipment has been developed with power electronics and digital technology. Toshiba presents innovative solutions to meet customers' needs.

Features

- For better environmental friendliness, a liquid silicone transformer or vegetable oil transformer can be used for the rectifier transformer.
- Heat pipe Rectifier has a very high thermal efficiency and can be installed outdoors.
- High Speed Vacuum Circuit Breaker (HSVCB) has high reliability, safety and can reduce maintenance
- Regenerative Inverter is a good energy saving solution for the efficient use of regenerative braking power from rolling stocks.
- SCiB™ Traction Energy Storage System is an energy saving solution which is not only useful for storage of regenerative energy but also for promoting power peak cut, feeder voltage compensation and emergency power supply.
- Package Type Substation saves space and construction works.

TOSHIBA's POWER SUPPLY SYSTEMS for DC Feeding Substation



Rectifier Transformer



Features

- Nonflammable SF₆ Gas Insulated Transformer is suitable for indoor use.
- Noncombustible liquid silicone transformer and vegetable oil transformer are friendly to environment.

Ratings

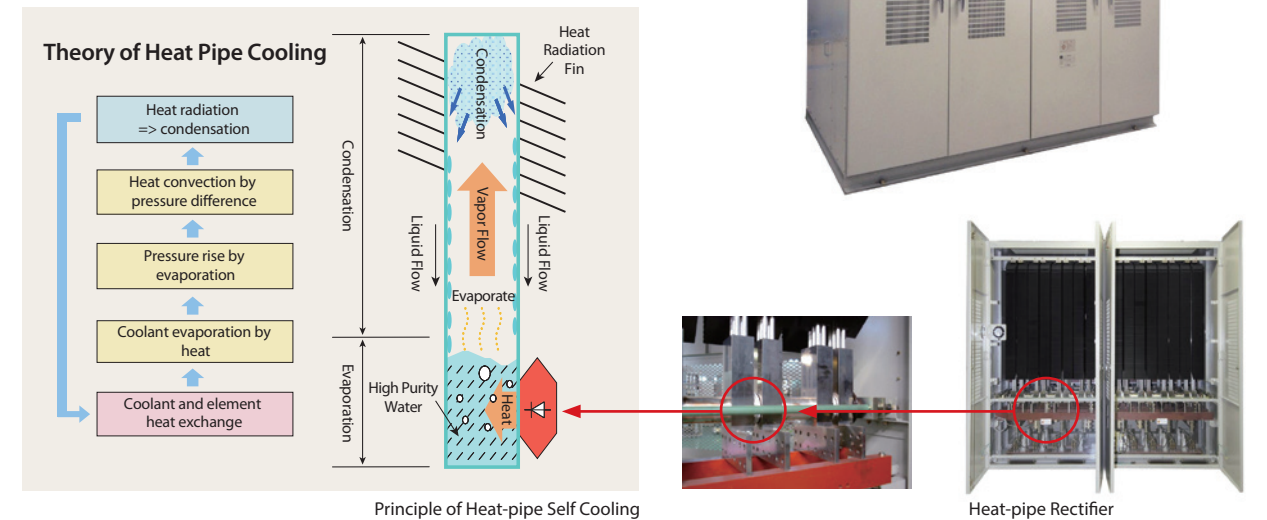
Cooling and Insulating Method	Gas	Mineral Oil	Liquid Silicone	Vegetable Oil	Epoxy Resin
Rated Power	Applicable for up to 6MW Rectifier				
Rated Voltage	Primary	~ 77kV			~ 35kV
	Secondary	Applicable for DC600V / 750V / 1500V / 3000V			
Applicable Standard	JEC / IEC				

Traction Rectifier

Toshiba has a long history of manufacturing rectifiers (diode, thyristor, and IGBT type). Our current Rectifier has a heat pipe cooling system using high purity water. It is suitable for repeated overload current and has large cooling capacity and it can be installed outdoor.

Ratings

Cooling Method	Vertical heat-pipe self cooling
Rated Power	~ 6 MW
Rated Voltage	DC 600V / 750V / 1500V / 3000V
Applicable Standard	JEC / IEC



DC Switchgear

Based on a strong experience and know-how on the supply of highly quality DC High Speed Circuit Breakers and DC Switchgears since the 1970's, Toshiba developed the HS5 DC Switchgear with our own DC Protection Relay which satisfies current global market requirements. This highly reliable DC Switchgear can efficiently undertake its critical role in railway power supply systems such as detection and breaking of fault currents at a very high speed.

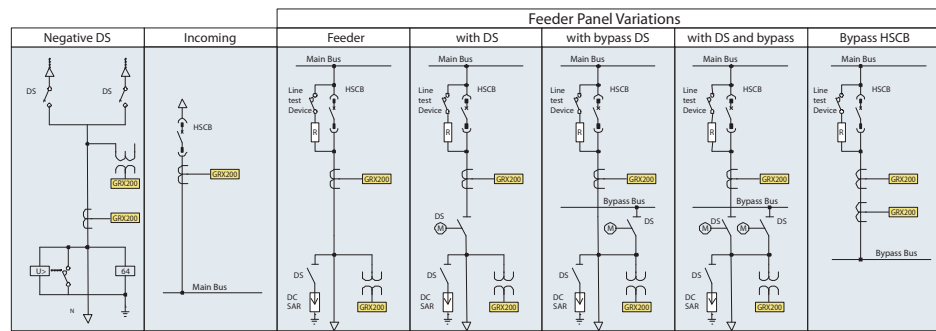
Ratings

Rated Voltage [V]	DC900 / 1800	
Rated Bus Current [A]	4000 ~ 12000	
Rated Short-circuit Making and Breaking Current [kA]	80	
Rated Withstand Voltage	Lightning Impulse [kV]	20
	Power Frequency [kV]	9.2
Applicable Standard	JIS / IEC	

Features

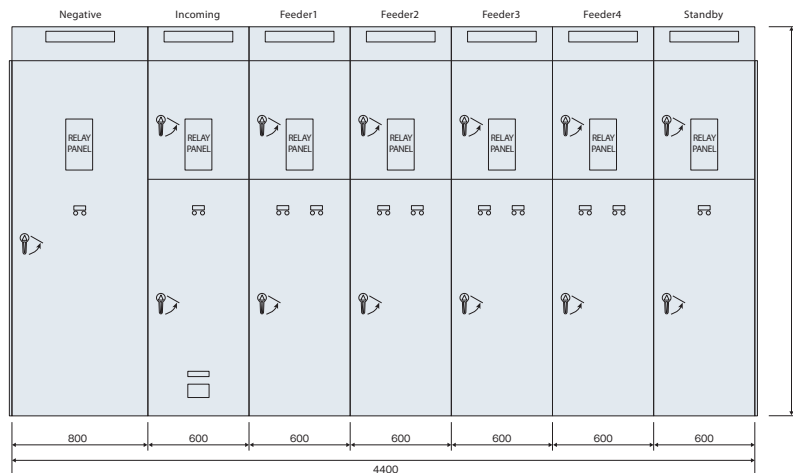
- Compact Design
- Combined with DC Protection Relay
- User-friendly Human Interface

Typical Configuration

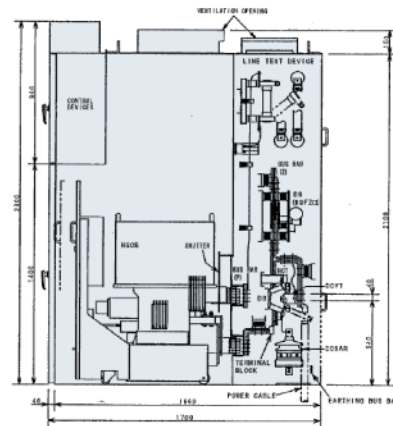


Toshiba's DC Switchgear can be configured into various common panel configurations such as feeder panels with DS, bypass DS, DS and bypass and bypass HSCB.

Front View



Side View of Feeder Panel



1500V DC Switchgear

Back View



Protection Relay (GRX-200 Series)

Ratings

Power Supply Ranges	100 ~ 250 Vdc
Communication Protocol & Interface	Modbus / IEC61850 / IEC60870-5-103 / Web browser / DNP3.0 etc
LCD Language	English / Chinese / Japanese



GRX-200 Relay

Protection	ΔI	Delta I protection
	di / dt	Current rate of rise protection
	50	Over current protection (4 stages)
	49	Thermal overload protection (3 stages)
	32	Reverse Overcurrent protection (4 stages)
	64	Grounding overvoltage protection (2 stages)
Control	59	Over voltage protection (2 stages)
	27	Under voltage protection (2 stages)
Metering	Multi-shots auto-reclosing function	
	Line test function	
	Inter breaking function *	
Record	Controlling function (SWGR, CB)	
	Section compensation function	
Monitoring	I, V, W, +Wh, -Wh, Impedance	
	Event records	
	Fault records	
	Disturbance records	
Monitoring	CB and DS status	
	CB and DS response monitoring	
	Trip circuit supervision	
	Trip counter monitoring categorized by breaking level	
	Self-supervision	

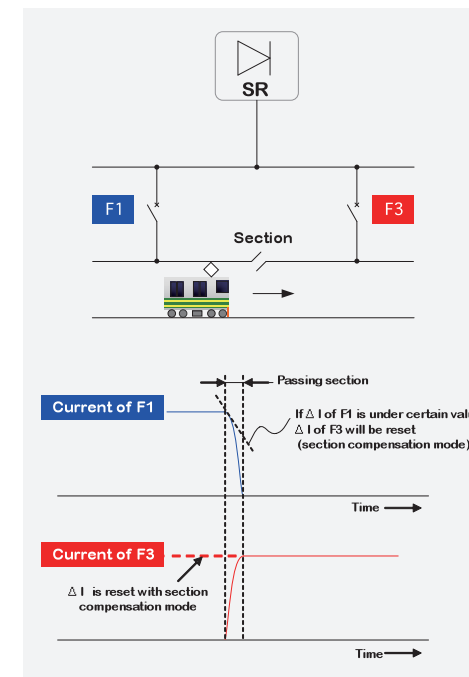
* Communication lines between the substations are required.

Features

- Compact Design
- Colored LCD Touch Screen for Human Interface
- Flexible Installation (The touch panel and the main unit are separate.)
- Wide Range of Communication Protocol Supported
- Various Protection Elements

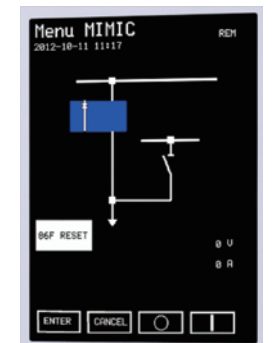
Section Compensation Function

When the train passes the section, sudden change of current might cause unnecessary trip. In order to avoid this situation, section compensation function is provided.



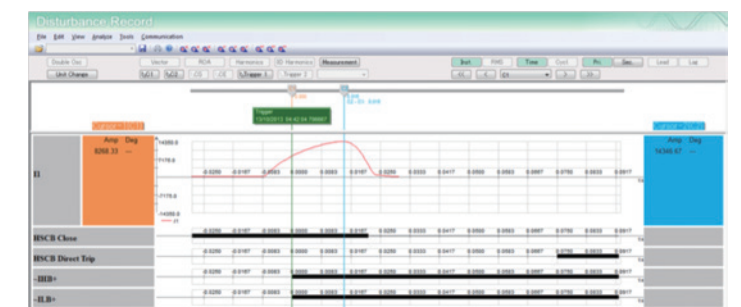
Section Compensation Principle

Through the relay's user-friendly HMI screen the circuit breaker can be operated and switchgear conditions can be checked.



Feeder Relay Mimic

This protection relay can generate, monitor and record wave forms during failure occurrences. Through this, detailed fault analysis can be performed.

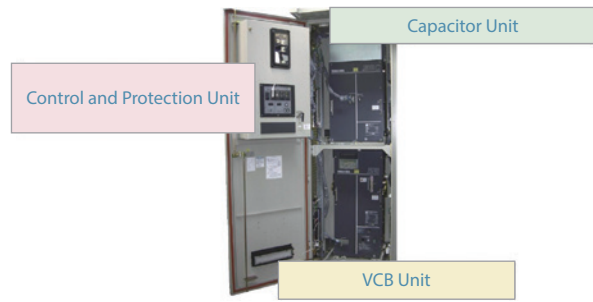


PC Tool for Fault Waveform Function

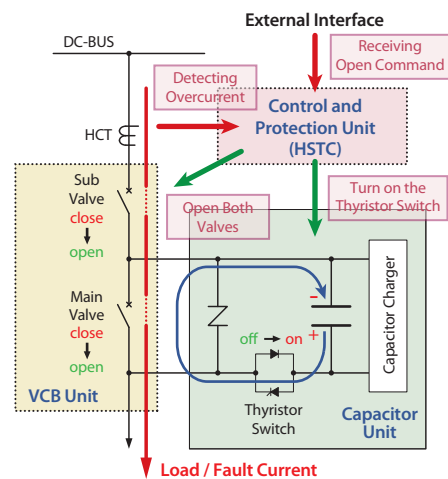
5-5

High Speed Vacuum Circuit Breaker (HSVCB)

Toshiba has developed the innovative HSVCB. The HSVCB consists of the VCB, Capacitor, Control and Protection units. The aerial arc chute and the contactor for the conventional HSCB are not used for the HSVCB. It contributes to safe operation and easy maintenance.



Outline of HSVCB



Principle of Cutting off DC Current by HSVCB

Features

- **Safe Operation**
No arc occurs during current breaking due to VCB application.
- **Low Noise**
VCB application allows low noise.
- **Low Maintenance**
Maintenance is free from aerial arc chute and the contactor.

Ratings

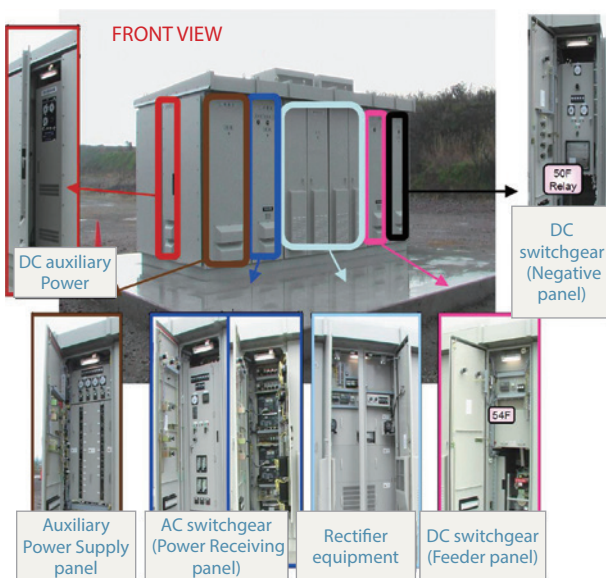
Rated Voltage [V]	DC 750 , 1500
Rated Current [A]	3000 , 4000
Rated Breaking Capacity [kA]	50 (at 3x10 ⁴ A / sec), 100 (at 10x10 ⁴ A / sec)
Rated Short Time Current [kA]	50-1sec , 100-1sec
Applicable Standard	JIS (To be developed for IEC)

When control and protection unit detects the over current or receives open command from external devices, the both valves trip and the thyristor switch of capacitor unit is turned on. Since the current of capacitor unit is in the opposite direction of the load/fault current, the zero-cross point of DC current can be achieved. Therefore, the DC load/fault current can be broken with high reliability and safety.

5-6

Package-Type DC Substation

Toshiba has developed the compact "Package-Type DC Substation". It is suitable for small-capacity substations and temporary substations during rehabilitation work, and it reduces substation space.



Outline of Package-Type DC Substation

Features

- Compactness
- Flexible Layout
- Short Construction Period

Ratings

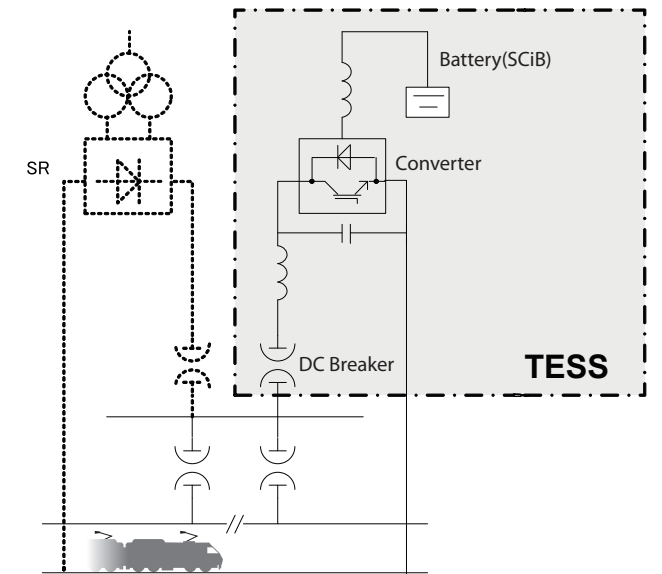
	Specifications	Applicable equipments
MV Switchgear Unit	7.2 / 24 / 36kV	Air Insulated type or Solid Insulated type
12-Pulse Rectifier Unit	Up to 2,000kW	TR : Epoxy Resin Molded Dry / Liquid Silicone SR : Heat-pipe Self-cooling
DC Switchgear Unit	DC 600V, DC 1500V	HSCB or HSVCB
Auxiliary Power Supply Unit	DC 110V, AC 105V / 210V	Lead Storage Battery





5-7

Traction Energy Storage System with SCiB™

System Overview

Toshiba developed Traction Energy Storage System (TESS) with SCiB™, an energy saving solution with Toshiba's own battery technology of high quality. TESS efficiently charges and discharges surplus regenerative energy to/from SCiB™. TESS is installed with Toshiba's patented advance V-SOC (Voltage-State-of-Charge) control system which allows flexible control of charge-discharge characteristics in accordance to the battery's State-of-Charge (SOC). This allows significant increase in battery lifetime. This system is useful not only for energy saving, but for various purposes such as regenerated energy absorption, peak cut, feeder voltage compensation and emergency power supply.

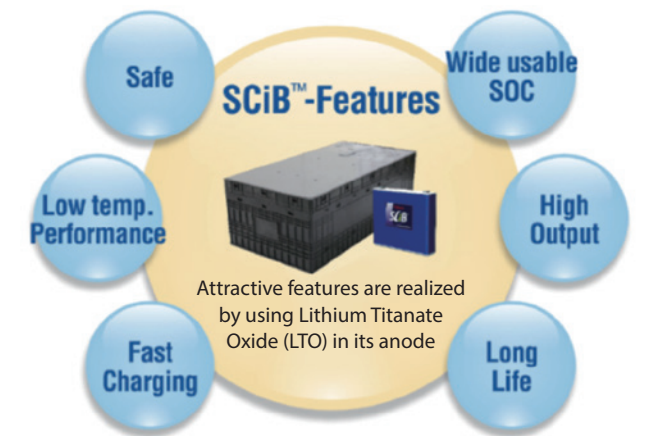


Converter 1800W×2380D×2300H 	Battery Panel 600W×650D×2100H×8 panels 
DC Breaker 600W×1700D×2100H×2 panels 	Control Panel 500W×600D×2100H×2 panels 

Structure at Rated Power 500kW (mm)

Ratings

Rated Power	500kW~2000kW
Battery Capacity	200kWh~800kWh
Rated Voltage for Feeder side	1500V(950V~2000V)
Rated Voltage for Battery side	600V(500V~713V)
Load Pattern	1p.u.(1min.)~0.5p.u.(4min.) or 0.5p.u.~continuous



* Results of cell level tests under certain conditions. Not a guaranteed performance.

SCiB™

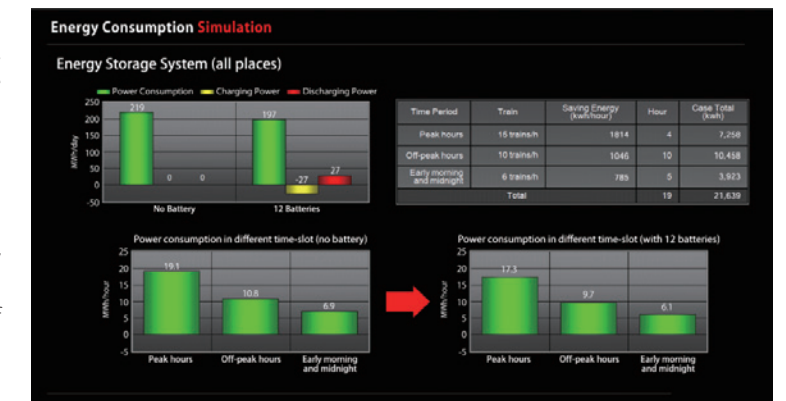
SCiB™ is a rechargeable battery which uses Lithium Titanate Oxide (LTO). Its features include safety, long life, rapid charging, high power output performance, and good cryogenic operation.

System Design

In the introduction of TESS in a railway system, it is important to do an accurate and reliable simulation of the traction power system during the design stage.

Toshiba has many experience and consultation know-how for such energy simulation required in designing a highly efficient total energy saving solution for the customer.

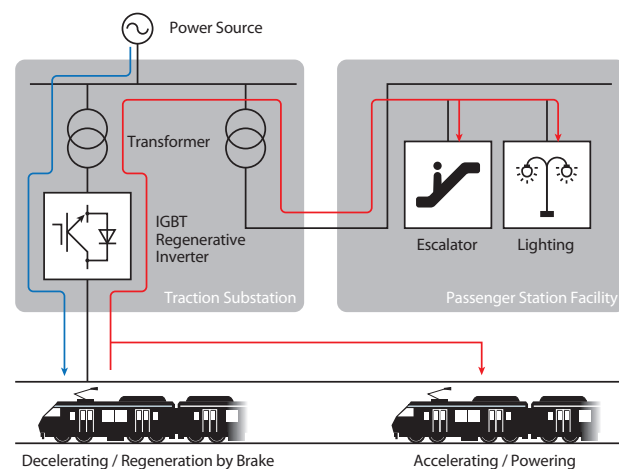
This simulation leads to a more suitable design of the TESS in terms of efficiency and cost as well.



5-8

Regenerative Inverter

The regenerative inverter is an ideal solution for regenerative braking power from rolling stocks. It converts the DC regenerative power back to AC power and supplies it to the auxiliary system for passenger stations. Toshiba supplies the IGBT inverters with heat pipe cooling systems.



Regenerative Inverter

Features

The performance of the IGBT inverters has been upgraded in comparison with conventional thyristor inverters.

- **Reduces Harmonics**
Harmonics distortion can be reduced due to the advanced gate control.
- **High Power Factor**
The power factor is close to 1.0.
- **Low Loss**
- **Easy Operation and Maintenance**
A touch screen on the panel for operation and maintenance.

Ratings

Capacity	Regenerating Inverter mode	1,000kW-continuous rating
	Powering Converter mode	3,000kW-1minute or 4,500kW-30seconds
Rated Input Voltage	1,500VDC	
Rated Output Voltage	Output control mode (Make a selection for your operation)	
	-1) Load control: To 6% or 8% output regulation -2) Constant voltage control	1,200VAC
Main Circuit Configuration	1Series * 2Parallel * 6Arm * 2Bridge Double bridge parallel configuration by Transformer	
Device	IGBT (3,300V-1,200A) / MG1200FXF1US53(P)	
Device Cooling System	Heat-pipe in pure water (natural cooling type)	
Dimension	Inverter	2,700W * 2,200D * 2,900H
	Control Panel of Inverter	800W * 1,000D * 2,300H
	DC Reactor	2,800W * 2,000D * 2,500H

6

Power SCADA

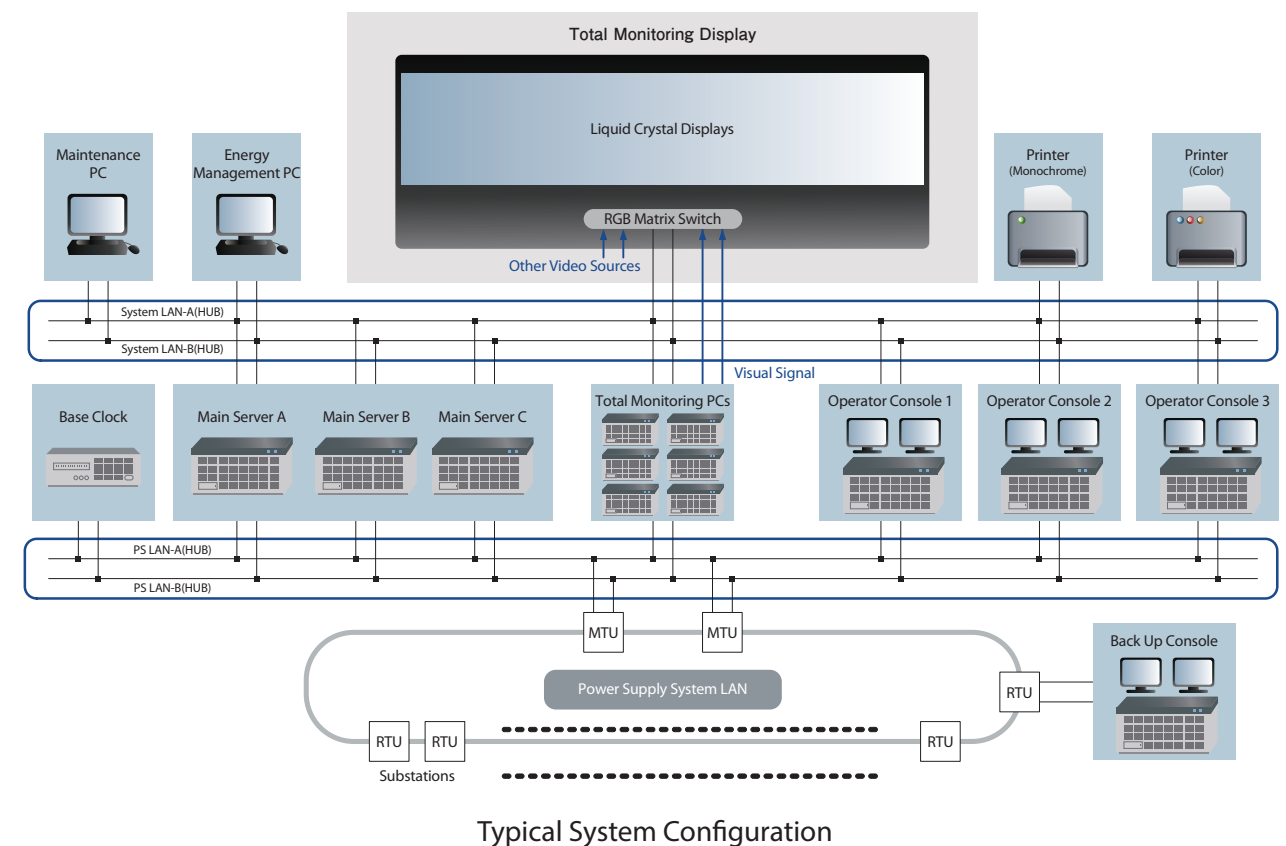
Overview

Toshiba produces Supervisory Control And Data Acquisition (SCADA) systems for railway power supply systems with ICT which enables stable and highly-reliable train operations. Toshiba's abundant expertise allows for production of user-friendly systems. For instance, when a fault occurs on the distribution network, many fault signals will be sent simultaneously from some substations to the SCADA server in the Control Center. The operator would subsequently become confused by the many faults and alarms. Our system therefore collects related information and displays what originally happened, and then activates recovery control or shows the recovery procedure to the operator. In addition, the simulation function provides training for immediate and exact recovery. Toshiba takes customers requirements into account in its flexible approach to producing SCADA systems.



Features

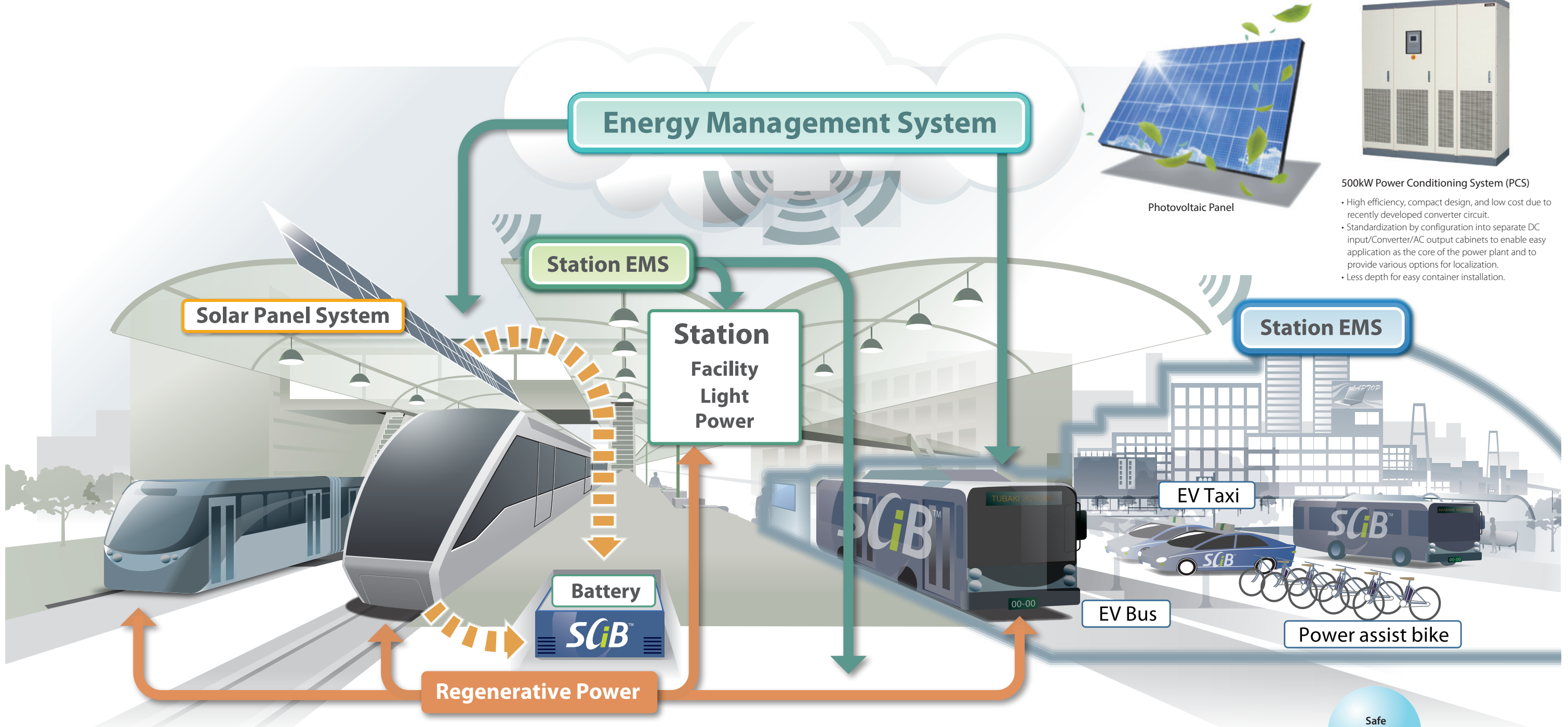
- 1. High Reliability by Triple Servers**
The triple-server system enables highly reliable operation. It can allow duplex servers operation even while maintenance and training. Of course, each of the three servers can be changed automatically or manually to service, standby or simulation mode.
- 2. Server-less Manual Control on Console**
The substation monitoring and the individual manual control functions are installed in the Console PC. These functions are therefore available even if the connection between the servers and Remote Terminal Unit (RTU) fails.
- 3. Remote Back-up Console for Emergencies**
Installing the Console PC in the substation makes remote back up control possible from the substations.
- 4. Registered Sequential Control**
This function controls multiple local equipment sequentially with one action. The operator can define and register the condition, equipment to be controlled, and sequence depending on their usability.
- 5. Fault Recovery Control**
In case of a fault in some substations or the distribution network, the fault recovery control (consisting of reclosing tripped circuit breakers, fault location control, etc.) will be done automatically or manually while displaying recovery procedure to facilitate immediate and exact recovery.
- 6. Simulation (Training)**
This function provides training for operators and conducts test for maintenance with a pair of servers and with the operator console in off-line status with all substations. Playing the "Simulation Scenario" which can be made from actual event logs simulates faults and circuit breakers tripped as if actual accidents had happened. This allows the operator to experience training that is effective for immediate and exact recovery.



Typical System Configuration

Toshiba's Station Energy Solution

Toshiba proposes the new idea of Station Energy Solution. It will realize the effective utilization of energy and contribute to environment friendly society. This solution consists of photovoltaic system, regenerative inverter system, battery system and total energy management system.



Photovoltaic Systems

Toshiba is capable of devising photovoltaic power and energy solutions that fit specific projects. Engineering know-how, expertise in system development and construction, and a seamless service network that spans the globe are crucial requisites. Toshiba has the experience and technology to make solar a successful strategy.



- 500kW Power Conditioning System (PCS)**
- High efficiency, compact design, and low cost due to recently developed converter circuit.
 - Standardization by configuration into separate DC input/Converter/AC output cabinets to enable easy application as the core of the power plant and to provide various options for localization.
 - Less depth for easy container installation.

Regenerative Inverter System

Regenerative DC power from an electronic train converted to AC power via a Regenerative Power Inverter. The AC power is then supplied to nearby passenger stations for auxiliary power (e.g. Lighting, Escalators, etc.)



Regenerative Inverter

Traction Energy Storage System with SCiB™

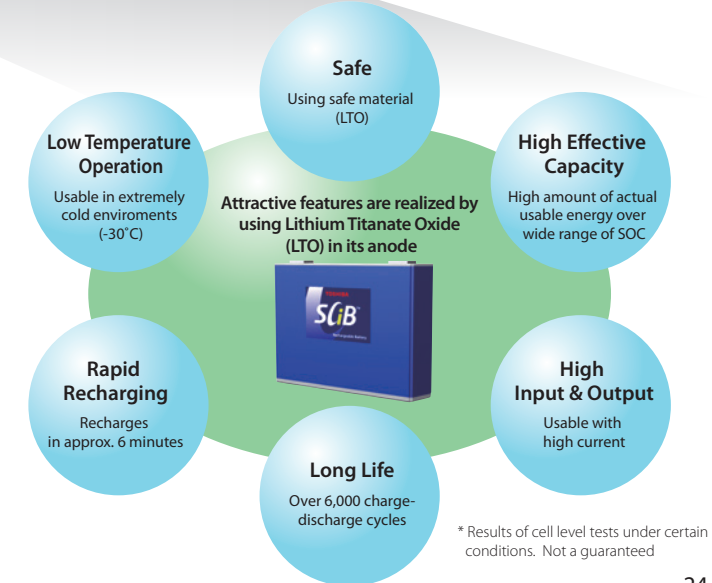
Regenerative DC power can now be stored in Toshiba's Traction Energy Storage System which utilizes high performance SCiB™ batteries. It is controlled using a special control system with Toshiba's own propriety technology that promotes batteries' longer lifetime. With the use of this equipment, each substation can not only save regenerative power but it can also help promote power peak cut, compensate voltage unbalance and be used as emergency power system.



SCiB™ Battery Panel

Super Charge Ion Battery (SCiB™)

SCiB™ is a rechargeable battery. By using unique oxide materials, SCiB™ holds high resistance toward thermal runaway resulting from short circuiting caused by physical stress. SCiB™ also has good characteristics such as, long life with small capacity loss even after 6,000 full charge-discharge cycles, rapid charging capability with ability to charge 80% of the capacity in as fast as approx. 6 minutes. High power output with performance equivalent to that of an EDLC (Electric Double-Layer Capacitors), and good cryogenic performance with ability to function even at -30°C.

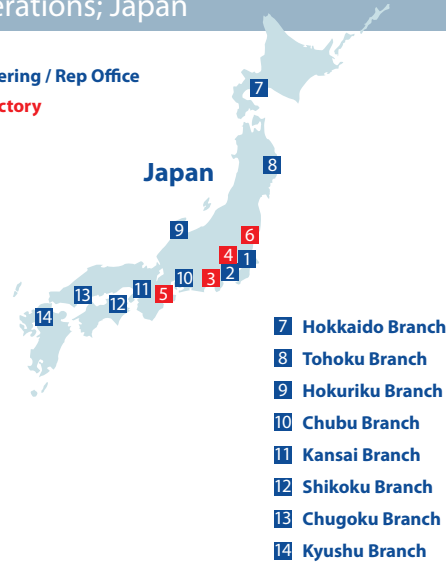


* Results of cell level tests under certain conditions. Not a guaranteed

Global Network

Global operations; Japan

X Sales / Engineering / Rep Office
Y Production Factory



1 Head Office (Tokyo, Japan)	<ul style="list-style-type: none"> Corporate Staff Sales Engineering 	
2 Smart Community Center (Kawasaki, Japan)	<ul style="list-style-type: none"> Corporate Staff Sales Engineering 	
3 Hamakawasaki Operations	<ul style="list-style-type: none"> Transformers Switchgears Surge Arresters On Line Monitoring Systems 	
4 Fuchu Complex	<ul style="list-style-type: none"> Protection System Substation Automation System System Solution Medium Voltage Switchgears 	
5 Mie Operations	<ul style="list-style-type: none"> Distribution Transformers Power Transformers Protection Equipment 	
6 Kitashiba Electric Co., Ltd.	<ul style="list-style-type: none"> Distribution Transformers Power Transformers 	

Global operations; China

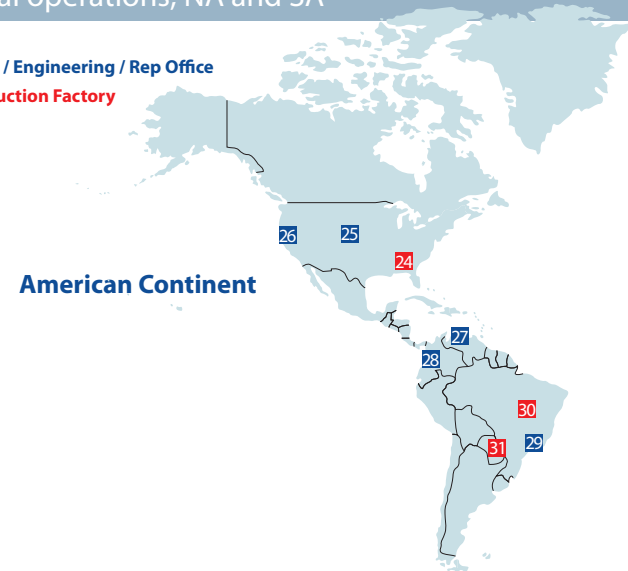
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15 (TBV) Toshiba Baiyun Vacuum Interrupters (Jinzhou) Co., Ltd.	<ul style="list-style-type: none"> Vacuum Circuit Breakers 	
16 (ETA) EPRI Toshiba Arrester Co., Ltd.	<ul style="list-style-type: none"> Surge Arresters (~1,100kV) 	
17 (PTC) Henan Pinggao Toshiba High-Voltage Switchgear Co., Ltd.	<ul style="list-style-type: none"> High Voltage Switchgears (110~1,100kV) 	
18 (CTC) Changzhou Toshiba Transformer Co., Ltd.	<ul style="list-style-type: none"> Large Capacity Transformers (~1,100kV) 	
19 (CTS) Changzhou Toshiba Shuidian Transformer Co., Ltd.	<ul style="list-style-type: none"> Distribution Transformers 	
20 (THC) CET Toshiba (Henan) Switchgear Components Manufacturing Co., Ltd.	<ul style="list-style-type: none"> High Voltage Switchgear Parts 	
21 (GTBS) Guangzhou Toshiba Baiyun Electrical Equipment Co., Ltd.	<ul style="list-style-type: none"> MV Switchgears 	
22 (JPC) Zhuhai Xujizhi Power System Automation Co., Ltd.	<ul style="list-style-type: none"> Distribution Automation System (DAS) 	
23 (TCH) Toshiba China Co., Ltd.	<ul style="list-style-type: none"> 1 Headquarter in Beijing and 7 Branch Offices in Shanghai, Guangzhou, Chengdu, Jinan, Xian, Wuhan and Hargzhou 	

Global operations; NA and SA

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Y Production Factory

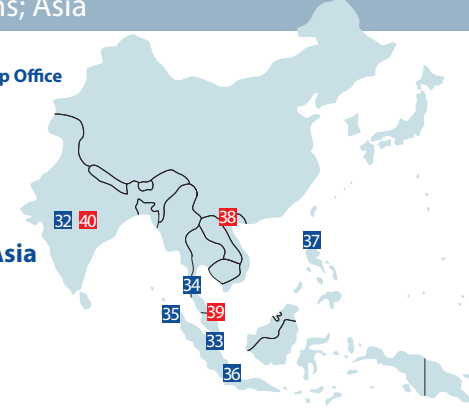


24 (TIC-US) Toshiba International Corp. (Houston)	<ul style="list-style-type: none"> Headquarters Power conditioner, Battery Energy Storage 	
25 (TIC-US) Toshiba Int'l Corp. (Denver)		
26 (TIC-US) Toshiba Int'l Corp. (San Francisco)		
27 (TDV) Toshiba de Venezuela C.A.		
28 (TDV) Toshiba de Venezuela C.A. - Columbia		
29 (TIC-SA) Toshiba Infrastructure Systems South America Ltd. Headquarters (São Paulo)		
30 (TIC-SA) Transformer Factory	<ul style="list-style-type: none"> Power Transformers Distribution Transformers 	
31 (TIC-SA) Switchgear Factory	<ul style="list-style-type: none"> Air Insulated Switchgears Surge Arresters Protection Relay Turn-Key Engineering 	

Global operations; Asia

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India, South East Asia



32 (TIPL) Toshiba India Private Ltd.		
33 (TAPL) Toshiba Asia Pacific Pte., Ltd. (Singapore)		
34 (TAPL) Toshiba Asia Pacific Pte., Ltd. (Bangkok)		
35 (TAPL) Toshiba Asia Pacific Pte., Ltd. (Kuala Lumpur)		
36 (TAPL) Toshiba Asia Pacific Pte., Ltd. (Jakarta)		
37 (TAPL) Toshiba Asia Pacific Pte., Ltd. (Manila)		
38 (TTDV) Toshiba Transmission & Distribution Vietnam	<ul style="list-style-type: none"> Protection Relays Substation Automation Systems 	
39 (TTDA) Toshiba Transmission & Distribution Systems Asia Sdn. Bhd.	<ul style="list-style-type: none"> Medium Voltage Switchgears vacuum Circuit Breakers Ring Main Units, Compact Substations, EPC of T&D Systems 	
40 (TTDI) Toshiba Transmission & Distribution Systems India	<ul style="list-style-type: none"> EHV, UV, Transformers Medium Voltage Switchgears Power Distribution Equipment 	

Global operations; EMEA and Russia

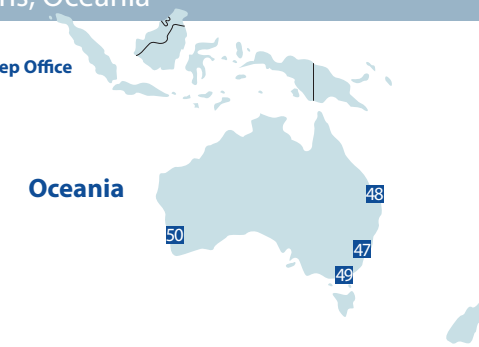
X Sales / Engineering / Rep Office
Y Production Factory



41 (TIL) Toshiba International (Europe) Ltd. (Durham)		
42 (TTDE) Toshiba Transmission & Distribution Europe	<ul style="list-style-type: none"> EPC of substations EPC of PV plants 	
43 (JHB) Toshiba Johannesburg Rep. Office		
44 (TTDG) Toshiba T&D Systems Gulf SPC. (Abu Dhabi)		
45 (TTDG) Toshiba T&D Systems Gulf SPC. (Bahrain)		
46 (TCIS) Toshiba CIS LLC (Moscow)		

Global operations; Oceania

X Sales / Engineering / Rep Office
Y Production Factory



47 (TIC AUS) Toshiba Int'l Corp. (Sydney)		
48 (TIC AUS) Toshiba Int'l Corp. (Brisbane)		
49 (TIC AUS) Toshiba Int'l Corp. (Melbourne)		
50 (TIC AUS) Toshiba Int'l Corp. (Perth)		