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)
- Chargerower 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)
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.

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.

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.

In addition to supplying products, Toshiba also provides customers with FTK solutions. One representative example of our FTK comes the Taiwan High-Speed Railway project 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 medium voltage switchgear, we developed the Cubic type Gas Insulated Switchgear (C-GIS) and SF₆ gas free Solid Insulated Switchgear (SIS).

3-1 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.

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

3-2 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.

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 required.
- Compact Design
  No heat exchanger or other accessories are required thus lowering the height to less than that of OITs.
### Gas Circuit Breaker (GCB)

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

#### Ratings

<table>
<thead>
<tr>
<th>GSR</th>
<th>GS / GSP</th>
<th>GSPT</th>
</tr>
</thead>
<tbody>
<tr>
<td>240 / 300</td>
<td>72 / 84 / 168</td>
<td>145</td>
</tr>
</tbody>
</table>

- **Tank**: Dead Tank
- **Live Tank**: 900 / 1050 (100-750 / 150-300 / 450-600) 650
- **Power Frequency Power [V]**: 200-250-300 / 250-300 / 350-500 / 540-160 / 325 275
- **Applicable Standard**: JEC / IEC

#### Features
- Good Breaking Ability
- Easy Installation
- Low Noise

**24kV GCB**

![24kV GCB](image1)

**145kV 3-Phase GCB**

![145kV 3-Phase GCB](image2)

### 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.

#### Ratings

<table>
<thead>
<tr>
<th>Rated Voltage [kV]</th>
<th>36</th>
<th>40.5</th>
<th>72</th>
<th>84</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Withstanding Voltage [kV]</td>
<td>170</td>
<td>185</td>
<td>350</td>
<td>400</td>
</tr>
<tr>
<td>Power Frequency Power [V]</td>
<td>70</td>
<td>95</td>
<td>140</td>
<td>180</td>
</tr>
</tbody>
</table>

- **Rated Short Time Withstand Current [kA]**: 25 / 31.5
- **Applicable Standards**: JEC / IEC

**72kV C-GIS**

![72kV C-GIS](image3)

### 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.

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

**24kV SIS**

![24kV SIS](image4)

#### Ratings

<table>
<thead>
<tr>
<th>Rated Voltage [kV]</th>
<th>24</th>
<th>36</th>
<th>40.5</th>
<th>72</th>
<th>84</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Withstanding Voltage [kV]</td>
<td>125</td>
<td>170</td>
<td>185</td>
<td>350</td>
<td>400</td>
</tr>
<tr>
<td>Power Frequency Power [V]</td>
<td>50</td>
<td>70</td>
<td>95</td>
<td>140</td>
<td>180</td>
</tr>
<tr>
<td>Rated Short Time Withstand Current [kA]</td>
<td>25 / 31.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Applicable Standards</td>
<td>JEC / IEC / GB</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**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 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.

**SiS Busbar Compartment**

![SiS Busbar Compartment](image5)
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.

- 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.

TOSHIKA’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.

<table>
<thead>
<tr>
<th>Application</th>
<th>Feeding System for High Speed Railway</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling Type</td>
<td>ONAN / ONAF / OFAF</td>
</tr>
<tr>
<td>Rated Power (MVA)</td>
<td>84 / 80</td>
</tr>
<tr>
<td>Overload</td>
<td>300% 2min</td>
</tr>
<tr>
<td>Connection</td>
<td>Scott</td>
</tr>
<tr>
<td>Applicable Standard</td>
<td>IEC / JEC</td>
</tr>
</tbody>
</table>

4-2

Auto-transformer

The Auto-transformer is used for the AT Feeding System (25kV × 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.

<table>
<thead>
<tr>
<th>Rated Voltage [kV]</th>
<th>55 / 27.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>ONAN</td>
</tr>
<tr>
<td>Rated Power [MVA]</td>
<td>4 / 5 / 7.5 / 10</td>
</tr>
<tr>
<td>Line Capacity [MVA]</td>
<td>8 / 10 / 15 / 20</td>
</tr>
<tr>
<td>Overload</td>
<td>300% 2min</td>
</tr>
<tr>
<td>Short Circuit Intensity</td>
<td>Can withstand thermally and mechanically for 25 or 30 times of the rated current</td>
</tr>
<tr>
<td>Applicable Standard</td>
<td>IEC / JEC</td>
</tr>
</tbody>
</table>
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

![27.5kV SIS]

#### Ratings

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Voltage [kV]</td>
<td>27.5</td>
</tr>
<tr>
<td>Rated Lightning Impulse</td>
<td>200 (to earth and across open contacts)</td>
</tr>
<tr>
<td>Voltage [kV]</td>
<td>220 (across isolating distance)</td>
</tr>
<tr>
<td>Rated Current [A]</td>
<td>1250</td>
</tr>
<tr>
<td>Rated Short Time Withstand Current [kA]</td>
<td>31.5</td>
</tr>
<tr>
<td>Applicable Standard</td>
<td>IEC</td>
</tr>
</tbody>
</table>

#### Features

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

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 switchgear (GIS), or cubicle type gas insulated switchgear (C-GIS) are used.

### Ratings (C-GIS)

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Voltage [kV]</td>
<td>36 / 72</td>
</tr>
<tr>
<td>Rated Bus Current [A]</td>
<td>1250</td>
</tr>
<tr>
<td>Rated Breaking Current [kA]</td>
<td>16 / 25</td>
</tr>
<tr>
<td>Rated Withstand Voltage</td>
<td>200 / 350</td>
</tr>
<tr>
<td>Power Frequency [kV]</td>
<td>70 / 140</td>
</tr>
<tr>
<td>Rated Gas Pressure [MPaG]</td>
<td>0.45 (at 20°C)</td>
</tr>
</tbody>
</table>

#### Features

- Compact Design
- Outdoor Compatibility
- Safe Operation
- Low Maintenance

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.

#### 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 at long life operation, a simple electro-magnetic operation mechanism is used.

### Ratings

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Voltage [kV]</td>
<td>27.5</td>
</tr>
<tr>
<td>Rated Current [A]</td>
<td>1250</td>
</tr>
<tr>
<td>Rated Withstand Voltage</td>
<td>250</td>
</tr>
<tr>
<td>Power Frequency [kV]</td>
<td>95</td>
</tr>
<tr>
<td>Rated Short Time Withstand Current [kA]</td>
<td>25</td>
</tr>
</tbody>
</table>
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.

![Changeover Switch](image1)

**Ratings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Voltage [kV]</td>
<td>36</td>
</tr>
<tr>
<td>Rated Current [A]</td>
<td>1200</td>
</tr>
<tr>
<td>Rated Lightning Impulse [kV]</td>
<td>Between Main Circuit and Earth: 250</td>
</tr>
<tr>
<td></td>
<td>Between Main Circuit Terminals: 250</td>
</tr>
<tr>
<td>Rated Power Frequency [kV]</td>
<td>Between Main Circuit and Earth: 70 - 1min.</td>
</tr>
<tr>
<td></td>
<td>Between Main Circuit Terminals: 100 - 10min.</td>
</tr>
<tr>
<td>Rated Short Time Withstand Current [kA]</td>
<td>12.5 - 2sec.</td>
</tr>
<tr>
<td>Switching Lifetime</td>
<td>Mechanical: 200,000 times</td>
</tr>
<tr>
<td></td>
<td>Electromagnetic: 100,000 times</td>
</tr>
</tbody>
</table>

**Features**

- **High Voltage Withstand Capability**
  In order to withstand the excessive voltage at the phase break points, 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.

4-7 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.

![AC Feeding Protection Relay](image2)

**Ratings**

<table>
<thead>
<tr>
<th>Protection Function</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>21F Distance Protection</td>
<td></td>
</tr>
<tr>
<td>31F Overcurrent Protection</td>
<td></td>
</tr>
<tr>
<td>29F Voltage Protection</td>
<td></td>
</tr>
<tr>
<td>79 Automatic Reclose</td>
<td></td>
</tr>
<tr>
<td>50F Instantaneous Overcurrent Protection</td>
<td></td>
</tr>
</tbody>
</table>

**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

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.

**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)

**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.

![Control/Relay Panel](image3)
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 (HSCB) 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. |

TOSIBA’S POWER SUPPLY SYSTEMS for DC Feeding Substation

**Rectifier Transformer**

- **Gas Insulated Transformer**
- **Liquid Silicone Transformer**
- **Epoxy Resin Molded Dry Transformer**
- **Vegetable Oil 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 Voltage**
  - Primary: ~ 35kV  
  - Secondary: Applicable for 220kV / 250kV / 350kV / 300kV

- **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

**Theory of Heat Pipe Cooling**

- Heat transfer by conduction  
- Heat convection by pressure difference  
- Evaporation and condensation  
- Condensation  
- Condensation and heat exchange
Based on a strong experience and know-how on the supply of highly-quality DC High Speed Circuit Breakers and DC Switchgears since the 1978, Toshiba developed the HSS 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.

**DC Switchgear**

**Ratings**
- Rated Voltage (V): DC600 / 1600
- Rated Inlet Current (A): 4000 ~ 12000
- Rated Short-circuit Making and Breaking Current (kA): 80
- Rated Withstand Voltage: Lightning impulse (kV): 20
- Power Frequency (Hz): 50 / 60
- 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.

**Protection Relay (GRX-200 Series)**

**Ratings**
- Power Supply Ranges: 100 ~ 250 Vdc
- Communication Protocols & Interface: Modbus / EGS 1810 / EC60870-5-103 / Web Browser / EPRI 52 etc.
- LCD Language: English / Chinese / Japanese

**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.

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

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

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 3×106A/sec, 150 at 10×106A/sec
- Rated Short-Time Current (kA) DC 100, 150
- Applicable Standard JEC / IEC

When control and protection unit detects the overcurrent or receives an open command from external devices, the break 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 breakвал current, the zero-cross point of DC current can be achieved. Therefore, the DC breakвал current can be broken with high reliability and safety.

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.

Features
- Compactness
- Flexible Layout
- Short Construction Period

Ratings
- Specifications
  - MV Switchgear Unit: 7.2 / 34 / 36kV
  - 12-Pulse Rectifier Unit: Up to 2.0MW
  - DC Switchgear Unit: 500V, DC1500V
- Applicable equipments
  - Air Insulated type or Solid Insulated type
  - TR: Epoxy Resin Molded Dry / Liquid Silicone
  - SR: Heat pipe Self-cooling
  - MSCB or FVSCB

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.

Structure at Rated Power 500kW

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 cyclic performance.

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.
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.

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

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Regenerating Inverter mode</th>
<th>1,000kW-continuous rating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1,000kW-continuous rating only</td>
</tr>
<tr>
<td>Rated Input Voltage</td>
<td>1,500VDC</td>
<td>Output control mode (Make a selection for your operation)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-1 Load control: To 6% or 8% output regulation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-2 Constant voltage control</td>
</tr>
<tr>
<td>Rated Output Voltage</td>
<td>1,200VDC</td>
<td>Powering Converter mode</td>
</tr>
<tr>
<td>Main Circuit Configuration</td>
<td>1Series × 3Parallel = “6Arm” × 2Bridge</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Double bridge parallel configuration by Transformer</td>
</tr>
<tr>
<td>Device</td>
<td>IGBT (15,500V × 7,200A / 15,500V × 5,100A)</td>
<td></td>
</tr>
<tr>
<td>Device Cooling System</td>
<td>Heat pipe in pure water (natural cooling type)</td>
<td></td>
</tr>
<tr>
<td>Dimension</td>
<td>Inverter: 2,580W × 2,080W × 2,808H</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control Panel of Inverter: 600W × 1,200W × 1,356H</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DC Reactor: 2,800W × 2,000W × 1,580H</td>
<td></td>
</tr>
</tbody>
</table>

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 duplicate 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 recovering 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 simulate faults and circuit breakers tripped as if actual accidents had happened. This enables the operator to experience training that is effective for immediate and exact recovery.
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.

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.

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.)

Traction Energy Storage System with SCiB™

Regenerative DC power can now be stored in Toshiba 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.

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.

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.

Photovoltaic Panel

• 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.

Super Charge Ion Battery (SCiB™)