Toshiba’s transportation system technology is widely-used all over the world.

Toshiba Infrastructure Systems & Solutions Corporation

Find out more about Toshiba transportation solutions on http://toshiba-railway.com

Railway Power Supply Systems

Toshiba's transportation system technology is widely-used all over the world.
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.
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.

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 Traction Energy Storage System (TESS) with SCiB™, 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, the Taiwan High Speed Railway, wherein Toshiba built and supplied essential products for railway electrification.

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.
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).

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.

<table>
<thead>
<tr>
<th>Ratings</th>
<th>72.5 ~ 242</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Voltage (kV)</td>
<td>25 ~ 63</td>
</tr>
<tr>
<td>Rated Lightning impulse Withstand Voltage (kV)</td>
<td>325 ~ 1050</td>
</tr>
<tr>
<td>Rated Power Frequency Withstand Voltage (kV)</td>
<td>140 ~ 450</td>
</tr>
<tr>
<td>Applicable Standards</td>
<td>JEC / IEC</td>
</tr>
</tbody>
</table>

Features

- Compact Design
- Can be installed in indoor and underground substations
- Outdoor Compatibility
- Protection against pollution
- Safe Operation
- Enclosed with tank in 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.

<table>
<thead>
<tr>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-flammability</td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td>Non-explosive</td>
</tr>
<tr>
<td>No pressure relief device is needed</td>
</tr>
<tr>
<td>Compact Design</td>
</tr>
<tr>
<td>Conservator and pressure relief device are not required thus lowering the height to less than that of OITs.</td>
</tr>
</tbody>
</table>

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

2,236m² (8% of AIS + OIT land footprint)
3-3 Gas Circuit Breaker (GCB)

Toshiba supplies many types of Gas Circuit Breakers (GCB) for 12kV or higher voltage.

![24kV GCB](Image)

### Ratings

<table>
<thead>
<tr>
<th>Voltage [kV]</th>
<th>GCB</th>
<th>GCB / GSP</th>
</tr>
</thead>
<tbody>
<tr>
<td>240 / 310</td>
<td>72 / 84 / 160</td>
<td></td>
</tr>
</tbody>
</table>

**Methods of Operation**
- Hydraulic
- Water Spring

**Tank**
- Dielectric Tank

**Rated Voltage** [kV]
- 300 / 2min

**Rated Current** [A]
- 120

**Rated Voltage** [kV]
- 220 / 60kV×2

**Rated Power Frequency** [kV]
- 50 / 70 / 95 / 140 / 160

**Applicable Standards**
- IEC / JEC

### Features
- 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.

![24kV C-GIS](Image)

### Ratings

<table>
<thead>
<tr>
<th>Voltage [kV]</th>
<th>36</th>
<th>40.5</th>
<th>72</th>
<th>94</th>
</tr>
</thead>
<tbody>
<tr>
<td>720 / 1200</td>
<td>315</td>
<td>315</td>
<td>31.5</td>
<td>31.5</td>
</tr>
</tbody>
</table>

**Rated Current** [A]
- 20 / 10 / 20 / 30 / 50 / 100 / 200 / 300 / 500 / 1000 / 2000 / 3000 / 5000 / 10000

**Rated Short Time Withstand Voltage Test**
- 100% (at 3×10 6 A / sec), 100 (at 10×10 6 A / sec)

**Applicable Standards**
- JEC / IEC

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

3-5 Solid Insulated Switchgear (SIS)

Solid Insulated Switchgear (SIS) utilizes high-performance epoxy resin independently developed as the insulating material for SIS. This epoxy resin provides remarkable improvement in strength, flexibility, heat-resistance and dielectric strength. With the use of this material for switchgear insulation, size was reduced while maintaining the equipment’s high reliability. Installation space required for SIS is smaller than our conventional air-insulated switchgear. For the 24/36kV SIS, 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](Image)

### Ratings

<table>
<thead>
<tr>
<th>Voltage [kV]</th>
<th>24</th>
<th>36</th>
<th>40.5</th>
<th>72</th>
<th>94</th>
</tr>
</thead>
<tbody>
<tr>
<td>620 / 1200</td>
<td>315</td>
<td>315</td>
<td>31.5</td>
<td>31.5</td>
<td></td>
</tr>
<tr>
<td>315 / 630</td>
<td>315</td>
<td>315</td>
<td>31.5</td>
<td>31.5</td>
<td></td>
</tr>
</tbody>
</table>

**Rated Current** [A]
- 630 / 1250 / 2000 / 3150 / 4200 / 6300 / 9000 / 12500

**Rated Short Time Withstand Voltage Test**
- 100% (at 3×10 6 A / sec), 100 (at 10×10 6 A / sec)

**Applicable Standards**
- JEC / IEC / GAB

### 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 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 sags.
- 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. Scott Connected and Roof-Delta Connected transformers are used for the AC traction transformer which can reduce the 3-phase voltage unbalance induced in the primary side.

Ratings

<table>
<thead>
<tr>
<th>Example of Scott Connected Transformer</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Voltage [kV]</td>
<td>220/27.5 x 2, 132/27.5 x 2</td>
</tr>
<tr>
<td>Cooling Type</td>
<td>ONAN / ONAF / GIGAF</td>
</tr>
<tr>
<td>Rated Power [MVA]</td>
<td>63 / 80 / 100</td>
</tr>
<tr>
<td>Overload</td>
<td>150% (5 minutes), 200% (5 minutes) @ONAN Rating</td>
</tr>
<tr>
<td>Connection</td>
<td>Scott</td>
</tr>
<tr>
<td>Applicable Standard</td>
<td>IEC</td>
</tr>
<tr>
<td>Note: JEC Standards is also applicable</td>
<td></td>
</tr>
</tbody>
</table>

Ratings

<table>
<thead>
<tr>
<th>Example of Roof-delta Connected Transformer</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Voltage [kV]</td>
<td>220kV / 600kV x 2</td>
</tr>
<tr>
<td>Cooling Type</td>
<td>ONAN</td>
</tr>
<tr>
<td>Rated Power [MVA]</td>
<td>120</td>
</tr>
<tr>
<td>Overload</td>
<td>100% / 3min</td>
</tr>
<tr>
<td>Connection</td>
<td>Roof-delta</td>
</tr>
<tr>
<td>Applicable Standard</td>
<td>JEC</td>
</tr>
<tr>
<td>Note: IEC Standards is also applicable</td>
<td></td>
</tr>
</tbody>
</table>

4-2 Autotransformer

Autotransformer is used for the AT Feeding System which reduces catenary voltage drops and electro-magnetic interference. It is designed with low impedance and to withstand the high short circuit current.

Ratings

<table>
<thead>
<tr>
<th>Example of Autotransformer</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Voltage [kV]</td>
<td>60/30</td>
</tr>
<tr>
<td>Type</td>
<td>ONAN</td>
</tr>
<tr>
<td>Rated Self Capacity [MVA]</td>
<td>10</td>
</tr>
</tbody>
</table>
| Rated Power                | 100%
| Rated Line Capacity [MVA]  | 20 |
| Overload                   | 100% / 3min |
| Short Circuit Intensity    | Can withstand thermally and mechanically for 25 or 30 times of the rated current |
| Applicable Standard        | JEC / IEC |
| Note: IEC Standards is also applicable |  |
Feeding Circuit Breaker / Switchgear (Solid Insulated Switchgear)

Toshiba offers 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.

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.

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.

### Ratings (C-GIS)

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</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>35 / 25</td>
</tr>
<tr>
<td>Rated Withstand Voltage</td>
<td>200 / 350</td>
</tr>
<tr>
<td>Lightning Impulse (kV)</td>
<td>70 / 140</td>
</tr>
<tr>
<td>Power Frequency (kV)</td>
<td></td>
</tr>
<tr>
<td>Applicable Standards</td>
<td>IEC</td>
</tr>
</tbody>
</table>

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

This vacuum circuit breaker can be supplied with or without withdrawable trolley.

### Ratings

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</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>Lightning Impulse (kV)</td>
<td>95</td>
</tr>
<tr>
<td>Power Frequency (kV)</td>
<td></td>
</tr>
<tr>
<td>Applicable Standard</td>
<td>IEC</td>
</tr>
</tbody>
</table>

### Features
- High Voltage Withstand Capability
- Long Life Operation
- Aiming at long life operation, a simple electro-magnetic operation mechanism is used.
### Changeover Switch

Toshiba manufactures single pole vacuum switches (VS) for power switching at phase break points in AC high speed railway systems.

![Changeover Switch](image)

**Ratings**

<table>
<thead>
<tr>
<th>parameter</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Voltage [kV]</td>
<td>42</td>
</tr>
<tr>
<td>Rated Current [A]</td>
<td>1200</td>
</tr>
<tr>
<td>Rated Lightning Impulse Voltage [kA] (Between Main Circuit and Earth)</td>
<td>250</td>
</tr>
<tr>
<td>Rated Power Frequency [kHz]</td>
<td>70 - 1.5m</td>
</tr>
<tr>
<td>Rated Short Time Withstand Current [kA] (Between Main Circuit Terminals)</td>
<td>100 - 1.5m</td>
</tr>
<tr>
<td>Switching Lifetime</td>
<td>Mechanical: 200,000 times, Electrical: 100,000 times</td>
</tr>
</tbody>
</table>

### AC Feeding Protection Relay (GRY-200 Series)

GRY-200 Protection Relay is part of Toshiba’s latest IED series specifically designed to meet global market requirement. It boasts of high functionality and flexibility. Furthermore, this relay also includes protection functions applied in highly reliable Japanese high-speed railway systems.

**Ratings**

<table>
<thead>
<tr>
<th>function</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protection Function</td>
<td>21F Distance Protection, 51F Overcurrent Protection, 71F Voltage Protection, 10F Automatic Reclose, 5DF Instantaneous Overcurrent Protection, 50F Overcurrent Protection</td>
</tr>
<tr>
<td>Control Function</td>
<td>10F Interlocking function, 51F CB and DS status, 51F Voltage Protection, 51F CB and DS response monitoring</td>
</tr>
<tr>
<td>Monitoring Function</td>
<td>51F Event records, 51F Disturbance records</td>
</tr>
<tr>
<td>Record Function</td>
<td>51F CB and DS response monitoring, 51F Trip circuit supervision, 51F Trip counter monitoring categorized by breaking level, 51F Self-supervision</td>
</tr>
</tbody>
</table>

*Communication lines between the substations are required.

### 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

Toshiba offers Substation Monitoring System by DMS (Digital Monitoring System) for Control/Relay systems. DMS stores and displays data of current, voltage, operation count, fault waveform, etc. System monitoring helps maintenance planning activities by utilizing tendency information of equipment in substations such as daily and monthly energy status reports, fault history, etc.
## 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 (HVCB) 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 stacks.
- Traction Energy Storage System (TESS) with SCiB™ is a regenerative energy storage solution which is not only useful for energy saving, but also for promoting power peak cut, line voltage compensation and emergency power supply.
- Package Type Substation saves space and construction works.

### Toshiba’s POWER SUPPLY SYSTEMS for DC Feeding Substation

![Image of Toshiba’s POWER SUPPLY SYSTEMS for DC Feeding Substation](image-url)

### Ratings

<table>
<thead>
<tr>
<th>Cooling and Insulating Method</th>
<th>Gas</th>
<th>Mineral Oil</th>
<th>Liquid Silicone</th>
<th>Vegetable Oil</th>
<th>Epoxy Resin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Power</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated Voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Applicable Standard</td>
<td>JEC/IEC</td>
<td>JEC/IEC</td>
<td>JEC/IEC</td>
<td>JEC/IEC</td>
<td>JEC/IEC</td>
</tr>
</tbody>
</table>

### 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.

### Traction Rectifier

Toshiba manufactures vertical heat pipe self-cooling rectifiers. This rectifier has a large cooling capacity which makes it suitable for systems with repetitive overload current and for outdoor installation.

### Ratings

<table>
<thead>
<tr>
<th>Cooling Method</th>
<th>Vertical heat pipe self-cooling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Power</td>
<td>~ 6 MW</td>
</tr>
<tr>
<td>Rated Voltage</td>
<td>DC 600V / 750V / 1500V</td>
</tr>
<tr>
<td>Applicable Standard</td>
<td>JEC/IEC</td>
</tr>
</tbody>
</table>

### Theory of Heat Pipe Cooling

![Diagram of Heat Pipe Cooling](image-url)
DC Switchgear

Toshiba offers H6 Type DC Switchgear with its own DC Protection Relay which satisfies global market requirements. This highly reliable DC Switchgear efficiently undertakes its critical role in railway power supply systems while ensuring user safety and easy maintenance.

Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Voltage (V)</td>
<td>DC400 / 1600</td>
</tr>
<tr>
<td>Rated DC Current (A)</td>
<td>4000 ~ 13000</td>
</tr>
<tr>
<td>Rated Short-circuit Making and Breaking Current (kA)</td>
<td>80</td>
</tr>
<tr>
<td>Rated Withstand Voltage</td>
<td>Lightning Impulse 3kV</td>
</tr>
<tr>
<td>Power Frequency (Hz)</td>
<td>50.2</td>
</tr>
<tr>
<td>Applicable Standard</td>
<td>JS / IEC</td>
</tr>
</tbody>
</table>

Features

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

Typical Configuration

Various panel configurations such as feeder panels with DS, bypass DS and bypass HSCB, can be manufactured.

Protection Relay (GRX-200 Series)

Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply Ranges</td>
<td>100 ~ 250 Vdc</td>
</tr>
<tr>
<td>Communication Protocol &amp; Interface</td>
<td>Modbus / EIC61850 / EIC60870-5-103 / Web browser / DNP3.0 etc.</td>
</tr>
<tr>
<td>LCD Language</td>
<td>English / Chinese / Japanese</td>
</tr>
<tr>
<td>Applicable Standard</td>
<td>IEC</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)
- 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.

Human Interface

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

Fault waveforms can be recorded, monitored and generated using the PC tool. This data can be used for detailed fault analysis during fault occurrences.

Section Compensation Principle
High Speed Vacuum Circuit Breaker (HSVCB)

The HSVCB consists of VCB, Capacitor, Control and Protection units. HSVCB configuration eliminates the use of arc chute and contactor promoting 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 arc chute and the contactor.

Outline of HSVCB

Control and Protection Unit

Load Fault Current

Outline of HSVCB

DC-Rating

External Interface

Principle of cutting off DC Current by HSVCB

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 with 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, line voltage compensation and emergency power supply.

High performance SCiB™

TESS utilizes Toshiba’s own high performance SCiB™. This battery has various outstanding characteristics. By using unique cathode materials, SCiB™ holds high resistance against thermal runaway caused by internal short circuiting brought about by physical stress.

Ratings and Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>Rating / Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Line Voltage</td>
<td>DC 750V, AC 1,000V</td>
</tr>
<tr>
<td>Rated Power</td>
<td>DC 1,500V</td>
</tr>
<tr>
<td>Applicable Standard</td>
<td>JEC / IEC</td>
</tr>
<tr>
<td>Voltage</td>
<td>1,500V</td>
</tr>
<tr>
<td>Rated Short Time Withstand Current [kA]</td>
<td>25 / 31.5</td>
</tr>
<tr>
<td>Rated Short Time Current [kA]</td>
<td>630 / 1,250 / 2,500</td>
</tr>
<tr>
<td>Rated Withstand Voltage Lightning Impulse [kV]</td>
<td>200 / 350 / 630</td>
</tr>
</tbody>
</table>

Features

- **Compactness**
- **Flexible Layout**
- **Short Construction Period**

Package-Type DC Substation

Toshiba has developed the compact “Package-Type DC Substation”, suitable for small-capacity substations and temporary substations during rehabilitation work, and it reduces substation space.
Regenerative Inverter

The regenerative inverter is a 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>Powering Converter mode</td>
<td>1,000kW - continuous rating only</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rated Input Voltage</th>
<th>1,500VDC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output control mode</td>
<td>(Make a selection for your operation:)</td>
</tr>
<tr>
<td>Load control mode</td>
<td>-1 Load control: To 6% or 8% output regulation</td>
</tr>
<tr>
<td>Constant voltage control</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rated Output Voltage</th>
<th>1,200VAC</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Main Circuit Configuration</th>
<th>1Series * 2Parallel &quot;A&quot;Side * 2Bridge Double bridge parallel configuration by Transformer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device</td>
<td>IGBT/1,200V * 1,200A / MOS1000V H101151P</td>
</tr>
<tr>
<td>Device Cooling System</td>
<td>Heat-pipe in pure water (natural cooling type)</td>
</tr>
<tr>
<td>Dimension</td>
<td>Inverter: 7,000W * 2,000A * 3,000Hz</td>
</tr>
<tr>
<td></td>
<td>Control Panel: 6,000W * 1,200A * 2,000Hz</td>
</tr>
<tr>
<td></td>
<td>DC Reactor: 2,000W * 2,000A * 2,500Hz</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 reducing tripped circuit-breakers, back 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 offline status with all substations and the real-time power supply system. "Simulating the Faults" which can be made from actual event logs simulates faults and circuit breakers tripped as if actual accidents had happened. This allows users to experience the training that is effective for immediate and exact recovery.

Typical System Configuration

Total Monitoring Display

- Liquid Crystal Displays
- Maintenance PC
- Energy Management PC
- Fault Lights Switch
- Other Visual M hurt

Other Monitoring Display

- Main Server A
- Main Server B
- Main Server C
- Operator Console
- Operator Console
- Operator Console
- Operator Console
- Power Supply System LAN
- Subst"ates

Base Clock

- LMN
- GRX200
- GRX200
- GRX200
- Back Up Console

Energy Test

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU

- Device

- Line

- RTU