

## General Brochure of the Railway Systems Division

Rolling Stock Systems  
Locomotives



Information Systems



Global Supply Record



Full Turn Key



Power Supply Systems



# Further beyond, steadily and thoughtfully

## Toshiba's railway technologies that contribute to individuals, society, and the environment

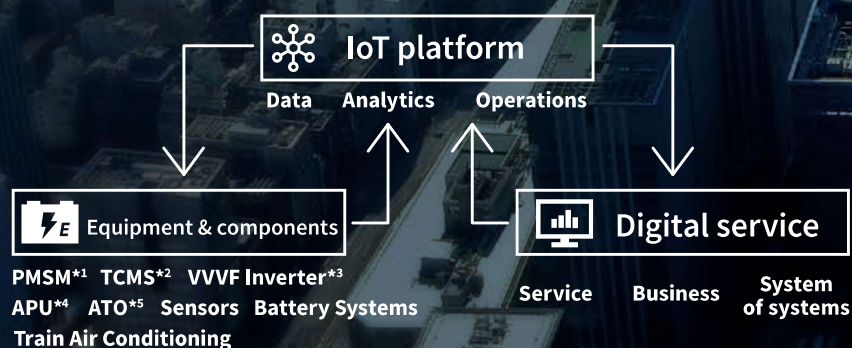
Toshiba has supported domestic and foreign railway systems in areas such as electric components for rolling stock, locomotives, electric power supply, and information technology.

In addition, based on customer expectations, we are endeavoring to reduce life cycle costs, improve safety, accuracy, and comfortability and develop environmental-friendly products.

We are also trying to create new values by combining competitive Toshiba products with IoT and AI-related advanced technologies and proven railway system technologies.

Toshiba will continue to use its technologies to achieve the future vision of high-quality and reliable railway systems.

### World-wide Experience



## SCiB™, Toshiba's rechargeable battery with superior safety



SCiB™ provides a long life of over 20,000\*6 charge/discharge cycles, rapid charging, high input/output power performance and excellent low-temperature operation, all while maintaining a high level of safety.



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\*1 PMSM : Permanent Magnet Synchronous Motor \*2 TCMS : Train Control Monitoring System

\*3 VVVF Inverter : Variable Voltage Variable Frequency Inverter \*4 APU : Auxiliary Power Unit

\*5 ATO : Automatic Train Operation Equipment

\*6 Results of cell level tests under certain conditions. Not a guaranteed performance.

Achieving energy-saving and improving passenger comfort through technology

# Rolling Stock Systems

## Solutions for rolling stock systems that evolve to achieve safe transportation and energy-saving.

Toshiba initiated the transport system business in 1899 and started to manufacture traction motors for electric railcars, control equipment, and bogies. Since then, we have been designing and manufacturing rolling stock systems to solve the challenges that our clients face while always seeking innovation. We combine advanced technology and energy-saving technology for various systems such as the propulsion system, auxiliary power supply system, air conditioning system and train information system; seek improvement in safety, security, and stability, which are fundamental requirements for railway transportation; and provide solutions with superior environmental performance and maintainability.

### Remote monitoring service

This system consists of IoT terminals and the wayside server that are connected via radio communication to monitor the condition of rolling stock. The data obtained by this system are used to improve the efficiency and sophistication of operation and maintenance of rolling stock. It transmits and stores the data from the IoT terminal to the wayside server to allow monitoring of the condition of train in real time. The data can be displayed on standard computers or tablets using a web browser.

Toshiba  
IoT Cloud

Operation data

Failure data

## Traction battery system

The lithium ion rechargeable battery developed by Toshiba (SCiB™) is structured to suppress risks of explosion and fire. It boasts a long life of more than 20,000<sup>\*1</sup> cycles of charge and discharge and has superior characteristics for operation in low temperatures.

The rapid charge capabilities makes it suitable to store energy generated in the regenerative brakes and reuse the energy to accelerate the train. The battery system is also used as an emergency power source for transporting passengers to a safe place when the power supply from the catenary is stopped.



## Train information system / Train safety system

Toshiba provides train information system employing a highly reliable CPU and rapid transmission system. The system is integrated with functions for highly efficient control, safe operation, and improved guidance services for passengers. We adopt highly reliable and fail-safe CPUs for the safety systems such as, to provide automatic train control (ATC) devices, automatic train stop (ATS) devices, and automatic train operation (ATO) devices. It is structured as a redundant system to support stable operation.



## Propulsion system

Our propulsion system adopts a permanent magnet synchronous motor and contributes to decreases power consumption by 39% compared to conventional induction motors<sup>\*2</sup>, and also reduces the maintenance time. The traction converter that uses the state-of-the-art SiC device achieves 38% downsizing and weight reduction compared to conventional equipment<sup>\*3</sup>.



## Air conditioning system

Toshiba adopts a highly efficient compressor to operate air conditioning system, and by employing inverter control it achieves optimized operation to reduce power consumption and improve comfortability.



## Auxiliary power supply system

Toshiba provides various auxiliary power supply system for supplying power to the air conditioning system, lighting system and etc. in the train while taking redundancy into consideration.



<sup>\*1</sup> Results of cell level tests under certain conditions. Not a guaranteed performance.

<sup>\*2</sup> From test results based on JIS E6102 (PMSM manufactured in 2010 and measured in May of 2012, and IM manufactured in 1992 and measured in April of 2012). Calculation conditions: Includes the regenerative brake performance improvement effect from control that used adhesion limit relaxation and regenerative braking power as a train unit.

<sup>\*3</sup> Based on comparison between existing equipment and new equipment in the 02 series for Tokyo Metro Marunouchi Line.

Innovative products adopted worldwide

# Locomotive Systems

**Toshiba provides solutions for locomotive systems that lead the world market based on years of experience and superior technological ability.**

Toshiba has been providing various locomotives that are indispensable for personnel and freight transportation since we started manufacturing electric locomotives in 1923. Toshiba's locomotive technologies are used worldwide to operate hybrid locomotives driven by both the high-performance lithium ion battery and the engine, advanced locomotives that adopt permanent magnet synchronous motors, and large capacity locomotives that use large capacity induction motors in combination with the water-cooled main traction converter.



**Standardized Hybrid Locomotive for European market**  
(under development)

## Accumulated experience



## Hybrid system

The hybrid system uses an engine generator and the high-performance lithium ion battery (SCiB™) as the power source. Various combinations of systems can be adopted for each purpose. Using the power supplied via the catenary as the power source is also possible by installing a pantograph as an option.

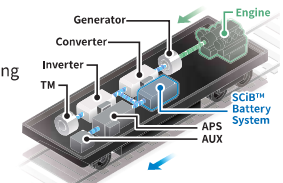
This system reduces fuel consumption and suppresses the emission of CO<sub>2</sub> and NO<sub>x</sub>.



\* Safety Integrity Level 4

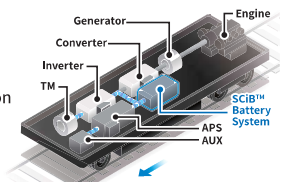
### Hybrid driving

The locomotive is driven by using both the engine generator and SCiB™ Battery System as the power source.



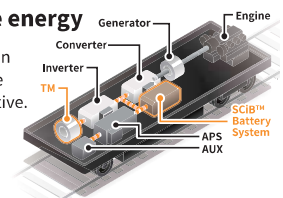
### Battery driving

Suitable for low-speed operation and freight shunting



### Reuse of regenerative energy

Regenerative energy is stored in SCiB™ Battery System when the brake is applied on the locomotive. The stored energy is reused for acceleration.



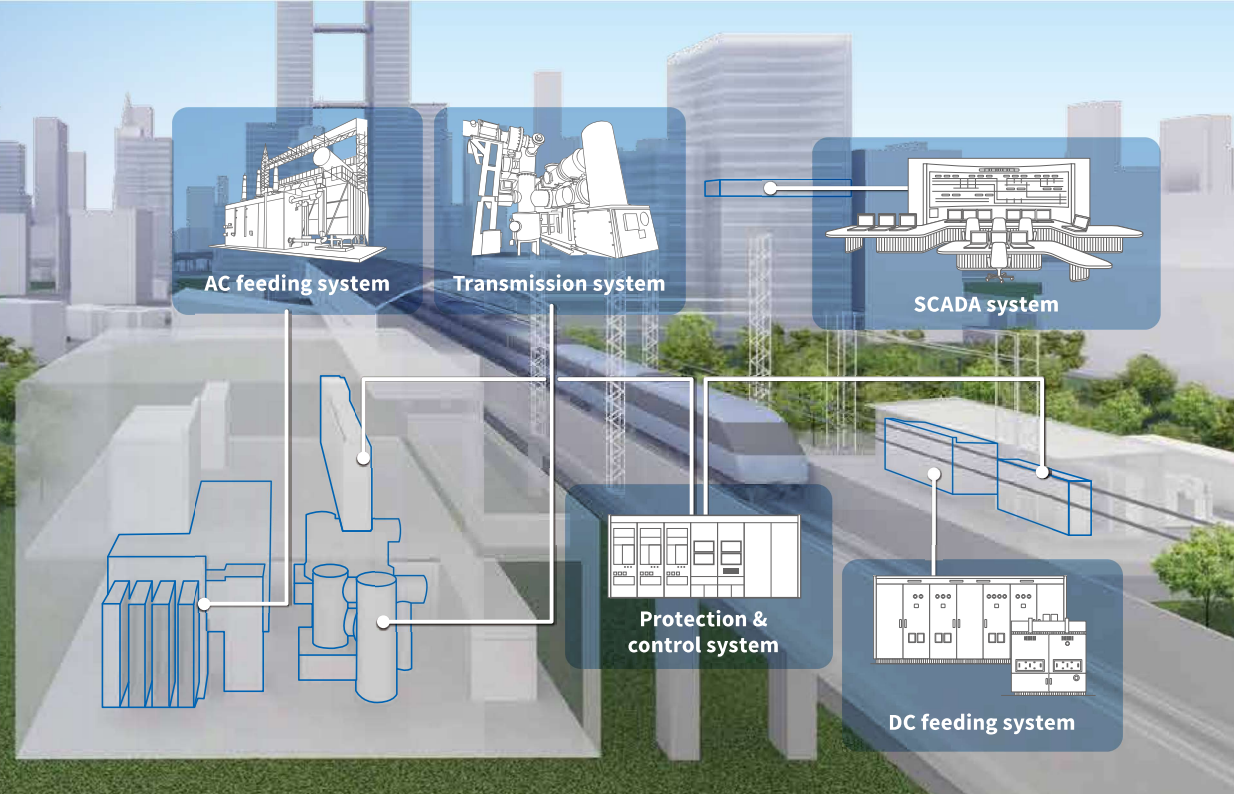
Electric power supply,  
the core of railway transport

# Power Supply Systems

**Stable supply of power to railway systems through the use of highly reliable equipment based on energy efficient and environment-friendly technologies.**

Toshiba provides highly reliable DC and AC feeding substation equipment, as well as SCADA system, in various railway systems such as Shinkansen, suburban and subway lines.

Toshiba also provides environment-friendly products and energy saving solutions based on advance technology to support stable power supply in railway infrastructure.

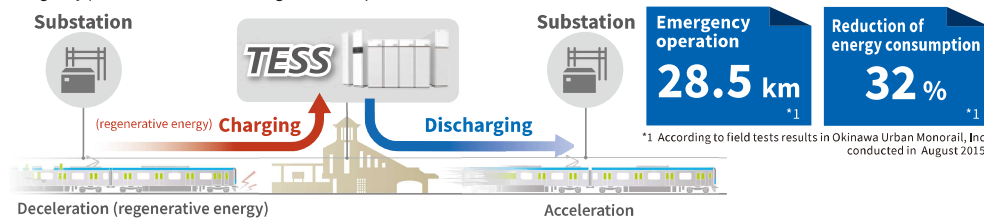


## Traction Energy Storage System (TESS)

TESS can be used not only for energy saving purposes, but also as an alternative solution to building new substation and as emergency power supply system in case of power failures.

Using Toshiba's rechargeable battery SCIB™, TESS charges surplus regenerative energy from decelerating trains and discharges it to accelerating trains. This contributes to energy saving in railway systems. In addition, by adopting TESS as an independent battery substation, a simpler power supply system with significant reduction in space footprint compared to conventional substations, can be achieved.

Furthermore, TESS contributes to the improvement of safety and reliability in railway operation through its ability to provide emergency power to the trains during wide area power failures.



- Energy saving & peak shaving**  
Enables energy saving and peak shaving of power consumption by using regenerative power.
- Alternative to substations**  
By adopting TESS as an independent battery substation, a simpler and more compact power supply system can be realized.

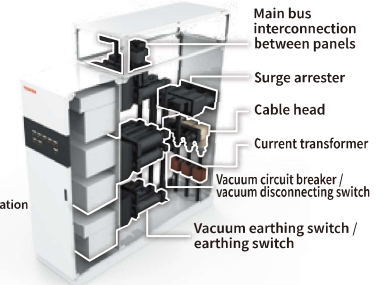
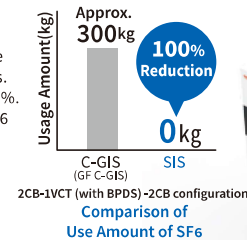
- Emergency power supply**  
In case of wide area power failures, TESS enables train operation in emergency mode.
- Storage of regenerative energy during braking operation**  
Effectively reuses regenerative power instead of wasting it as heat through resistors in conventional systems.

## Solid Insulated Switchgear (SIS)

**Greenhouse gases are not used.**

SIS utilizes high-performance epoxy resin to insulate the main circuit conductor and the main circuit components. It reduces SF6 gas, which causes global warming, by 100%. The amount of SF6 that is used for the cubicle type of SF6 gas insulated switchgear (C-GIS) is reduced from approximately 300 kg / system\*2 to 0 kg.

\*2 Comparison with Toshiba's GF type C-GIS. Excluding cases wherein VCT, which requires connection interface of SF6, is used.

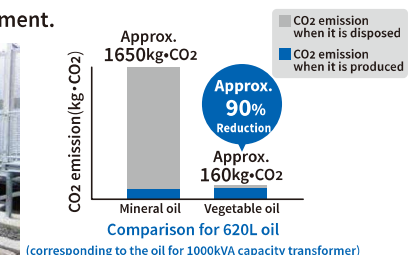


## Vegetable oil transformer

**Contributing to the society with environment-friendly equipment.**

Transformer for which vegetable oil that is certified in the Eco Mark program is used as the insulating oil. It contributes to the decrease of environmental load with a carbon-neutral\*3 design.

\*3 Carbon dioxide (CO2) generated when oil is incinerated for disposal is offset by the absorbed amount during rapeseed plant growth.

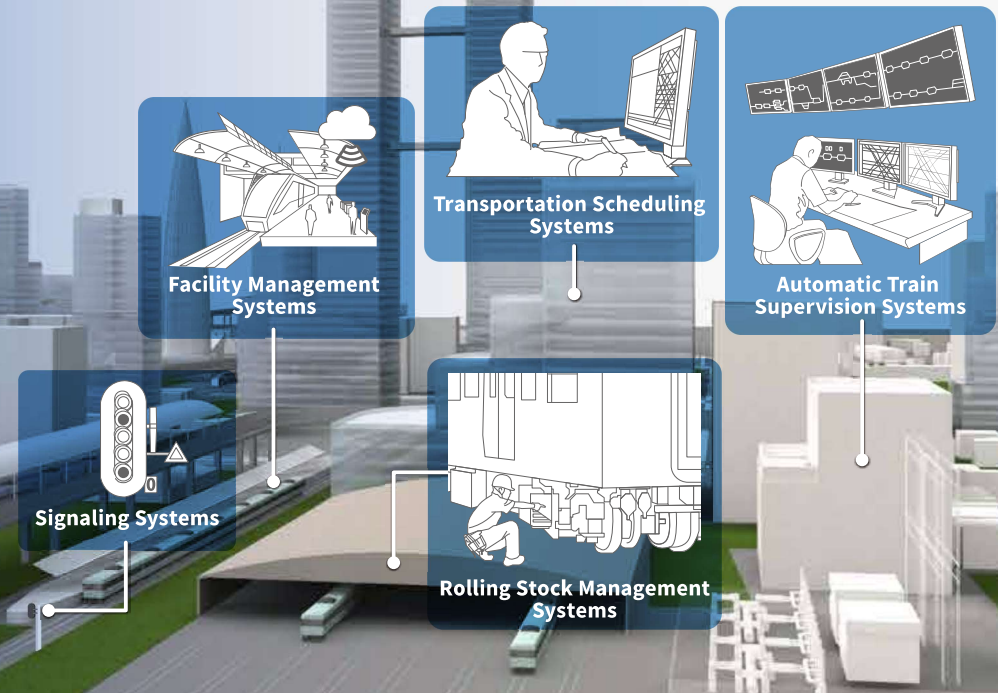


Creates new value with a combination of technologies and knowledge

# Information Systems

Achieves the advanced railway system by using IoT technologies and supports safe, stable, and accurate operation.

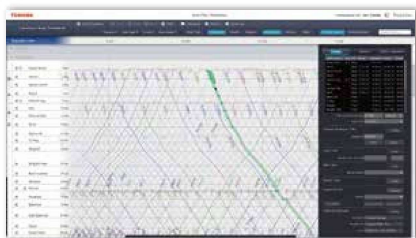
Toshiba establishes control and information systems for areas of train operation, transportation scheduling, rolling stock & crew management, facility management and signaling by combining advanced information-communication technologies and the accumulated knowledge of railway operation. In addition, we offer total solutions that improve the efficiency in railway operation based on the integrated railway information system with advanced technologies such as IoT.



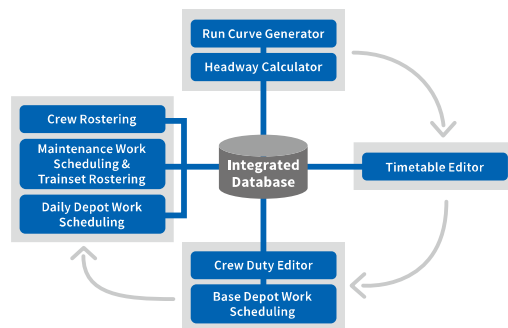
## Transportation Scheduling Systems

Toshiba provides solutions to improve the efficiency of overall transportation scheduling tasks, such as train timetabling, rolling stock operation & maintenance scheduling and crew duty scheduling.

SaaS, the only one that features  
all the basic functions for transportation scheduling.\*  
**TrueLine™** \* As of September 1, 2019.



TrueLine™ is a registered trademark of Toshiba Digital Solutions Corporation that represents a co-developed product.



**Saving** | Available through monthly subscription for only necessary functions from your PC connected to the Internet.

**Simple** | The award-winning user interface supports an intuitive look and feel.


**Secure** | The data center protected by robust security maintains and operates 24 hours a day, 365 days a year.

**Seamless** | Collectively manages the data to contribute to achieving the seamless cooperation among tasks and functions.

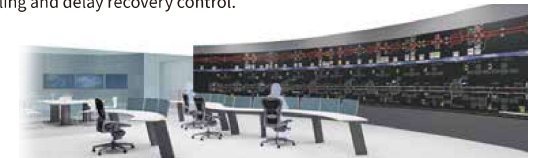
We have experiences in the provision of on-premise systems specifically designed for each operator.

## Automatic Train Supervision Systems

Toshiba provides solutions to improve railway's operational efficiency such as train tracking, operation monitoring, automatic route control, and in case of traffic disruption, train rescheduling and delay recovery control.

 Available for high-density train timetable and complex operation modes.

 Uses AI and IoT technologies to efficiently support train operation control tasks.



## IoT Solutions

Our IoT solutions thoroughly connect devices and users in operation control center, stations, substations, depots and crew offices, and utilize the collected data to contribute to achieving an integrated railway system.



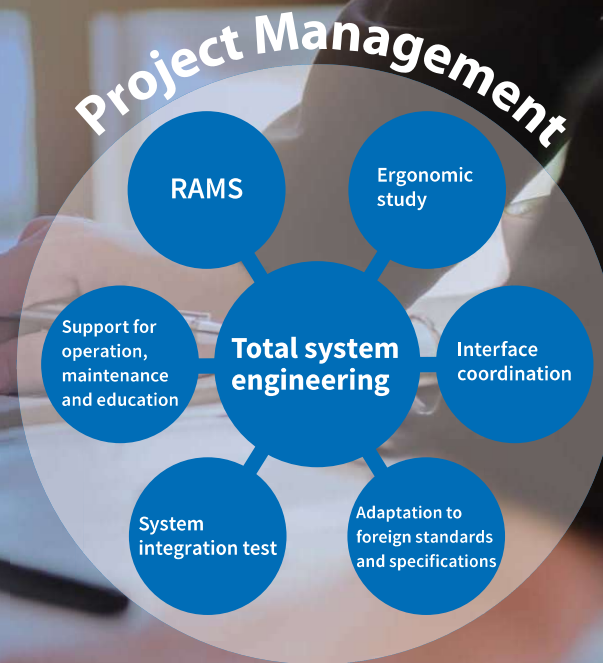
Combination of foreseeability, response capability,  
and resourcefulness

# Full Turn Key Solution

**Toshiba cooperates with domestic and foreign partners while focusing on technologies and contributes to establishing integrated railway systems abroad.**

Toshiba develops full turn key business that generally deals with design, procurement, construction and various support after the inauguration for areas such as rolling stock, signaling and communication facilities and electric facilities. Based on technologies that we have developed, we provide various services and products for railway business such as RAMS\* analysis for the project, adaptation for international/foreign standards, operation test and maintenance that are established while considering both the engineering and management aspects.

\* RAMS : Reliability, Availability, Maintainability and Safety



## Purple Line (Thailand)

### First Japanese rolling stock running in metropolitan area in Thailand.

The Purple Line, an urban railway line with 16 stations that runs about 23 km between north western area of Bangkok and Nonthaburi Province was inaugurated in August 2016. The joint Venture that Toshiba established with partner company got a bulk order for a whole railway system (rolling stock, substations, signaling, platform screen door system, communication system, automatic fare collection system, rolling stock depot facilities, etc.). After submission of proposals and negotiation for about 3 years, we made full endeavors to meet requirements such as completion and inauguration within 34 months after we got the order and compliance with European standards and specifications. Then finally we managed to introduce the railway system produced by Japanese enterprises for the first time in the urban transport market in Thailand that was occupied only by European enterprises. In addition, the joint venture is awarded the 10-year maintenance contract to contribute to stable operation of the Purple Line.



## Taiwan High Speed Rail (Taiwan)

### First export case of Japanese Shinkansen

Taiwan High Speed Rail of which the section of approximately 350 km from Taipei to Zuoying was inaugurated in January 2007 as a main artery in the north-south direction is the first export case of Japanese Shinkansen System. Toshiba joined the consortium of 7 Japanese companies that tried for the project and provided electric units for rolling stock, substation and power receiving facilities, operation management/maintenance management systems, communication facilities, and dispatcher's desk facilities. Even after the inauguration, Toshiba provided additional facilities for 4 stations including the extended section to Nangang Station, additional rolling stock, and IT system updates. Even now we are contributing to the development of the high speed railway infrastructure in Taiwan while adopting our rich experience in the area of maintenance and operation of Japanese Shinkansen and advanced technologies.



## Global Network

We rapidly support our customers from worldwide locations.



**Toshiba Infrastructure Systems & Solutions Corporation**  
72-34, Horikawa-cho, Saiwai-ku, Kawasaki-shi, Kanagawa

### Major Manufacturing Facilities

Fuchu Complex	Mie Operations	Fuji Operations	Hamakawasaki Operations	Kashiwazaki Operations
Manufacturing products	Manufacturing products	Manufacturing products	Manufacturing products	Manufacturing products
Locomotive Systems, Rolling Stock Systems(Driving, Power Source, Vehicle Information, Vehicle Driving Battery), Power Supply System(Switchgear, Rectifier, TESS, Protection Relay)	Rolling Stock Systems(Transformer, Power Supply System(Transformer)	Rolling Stock Systems (Air Conditioning System)	Power Supply System (Transformer, Switchgear)	Rechargeable Battery (SCIB™)

Oversea bases The bases from 1 to 3 are manufacturing & engineering base; and 4 is an engineering base.



### Toshiba International Corporation

13131 West Little York Rd., Houston, TX 77041, U.S.A.

Manufacturing products	Rolling Stock Systems (Driving, Power Source, Vehicle Information)
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### Toshiba Transmission & Distribution Systems (India) Private Limited

Rudraram, Patancheru Mandal, Sangareddy District, Telangana-502329, the Republic of India

Manufacturing products	Rolling Stock Systems(Driving), Power Supply System (Transformer, Switchgear)
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### Dalian Toshiba Locomotive Electric Equipment Co., Ltd.

Dalian Free Trade Zone ID-35, China

Manufacturing products	Rolling Stock Systems (Driving, Power Source, Vehicle Information)
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### Toshiba Railway Europe GmbH

Bunsenstrasse 29, 24145 Kiel, Germany

\* Engineering only

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6	<b>Toshiba (China) Co., Ltd.</b>	Dalian Free Trade Zone ID-36, Northeast 6th Street, Jinzhouqu District Dalian, 116600, China
7	<b>Toshiba Asia Pacific Pty Ltd</b>	20 Pasir Panjang Road, #13-27/28 Mapletree Business City, Singapore 117439
8	<b>Toshiba Electronic Components Taiwan Corporation</b>	4F, No.168, Sec.3, Nanjing E. Rd., Taipei City 10488, Taiwan
9	<b>Toshiba Africa (Pty) Ltd</b>	10th Floor, Sandton Office Towers, Corner 5th Street & Rivonia Road, Sandhurst Extension 3, Sandton, Republic of South Africa
10	<b>Toshiba International Corporation Pty., Ltd.</b>	11a Gibbon Rd, WINSTON HILLS, NSW 2153, Australia
11	<b>Toshiba Railway Europe GmbH</b>	Marienstrasse 8, 40212 Dusseldorf Germany

## World-wide Experience

Toshiba's products have been used worldwide for more than 60 years in over 30 countries.



### DB Cargo HELMS (2 prototypes)

Germany

Aiming to achieve high efficiency and high reliability by applying the hybrid technology compliant with European standard.

- Hybridization of existing 1,000kW class diesel shunting locomotive
- Toshiba series-parallel hybrid technology with SciB™



### SMRT C151 Series

Singapore

Equipped with our PMSM driving system. Since it was introduced in commercial operation in 2015, it brings superior energy savings compared to existing equipment systems and delivers safe operation with high reliability.

- Refurbishment of existing drive system
- PMSM drive system for 750Vdc



### KORAIL 8500 series

South Korea

Thanks to our reliability that has been cultivated for more than 20 years in the Korean market and locomotive technologies, we delivered electric equipment for 56 units of large capacity electric locomotives. It has maintained high quality since delivery in 2011 and delivers stable freight transport.

- Driving system and power source system for large capacity (6,600kW) electric locomotives



### WMATA 7000 series

United States

WMATA7000 series car includes Buy America compliant Propulsion and Vehicle Information System for 748 cars manufactured in Houston Texas. Toshiba's highly reliable system contributes to stable operation in the Washington metropolitan area since the start of revenue service in 2015.

- Driving system and Vehicle Information System for 750Vdc

## Global supply records (after 2005)

Country name	Client name	Delivery year
India	<b>Delhi Metro Rail Corporation Ltd</b>	2017
Brazil	<b>Rio de Janeiro State Company of Engineering of Transport and Logistics(CENTRAL)</b>	2011
Indonesia	<b>Companha de Transporte de Salvador</b>	2007
Canada	<b>Companha do Metropolitano de São Paulo</b>	2010
China	<b>Metrolinx</b>	2015
Singapore	<b>Wuhan Metro Group Co Ltd</b>	2013
South Africa	<b>Chongqing Rail Transit (Group) Co Ltd</b>	2005
South Korea	<b>Dalian Modern Rail Transit Co.,Ltd.</b>	2007, 2012
Taiwan	<b>Tianjin BinhaiMass Transit DevelopmentCo.,Ltd.</b>	2007
Egypt	<b>China Railway</b>	2006~
Venezuela	<b>National Authority For Tunnels (NAT)</b>	2010~2016
Thailand	<b>Delhi Metro Rail Corporation Ltd</b>	2017
Turkey	<b>Dedicated Freight Corridor Corporation of India Limited</b>	2016~2018
United Arab Emirates	<b>Indonesian Railways</b>	2008
United States	<b>Directorate General of Railways</b>	2016
Malaysia	<b>Companha de Transporte de Salvador</b>	2007
Singapore	<b>Malaysia Railways Limited (KTMB)</b>	2005
South Africa	<b>Land Transport Authority</b>	2010~
South Korea	<b>Transnet</b>	2010
Taiwan	<b>Incheon International Airport Corporation</b>	2006
Venezuela	<b>Yong In Rapid Transit Corporation</b>	2008
Thailand	<b>Taiwan Railway Administration</b>	2007~2008, 2012~2016
Turkey	<b>Taiwan High Speed Rail Corporation</b>	2006, 2015~2016
United Arab Emirates	<b>Bangkok Expressway and Metro Limited</b>	2016
United States	<b>Turkish State Railways(TCDD)</b>	2009
Venezuela	<b>Dubai Airport Company</b>	2006
Thailand	<b>Roads &amp; Transport Authority</b>	2007~2009
United States	<b>New York City Transit Authority</b>	~2013
South Korea	<b>Northern Indiana Commuter Transportation District</b>	2008
Taiwan	<b>Metra</b>	2012
Venezuela	<b>Sonoma Marin Area Rail Transit</b>	2013
Thailand	<b>Metropolitan Washington Airports Authority</b>	2007
United States	<b>City of Atlanta, Department of Aviation</b>	2007

# History of our railway business

Toshiba's transport business started with manufacturing of main motors, control equipment, and bogies for electric railcars in 1899 and has recorded about 120 years of history since then. Toshiba has continuously delivered various cutting-edge products to clients such as the JR group, private railway companies, and foreign railway users. Toshiba will continue to deliver railway solutions with an increasingly complicated society.

- 1875** Tanaka Seizo-sho, the predecessor of Toshiba Corporation, was established.
- 1899** Started to manufacture control equipment and main motors for electric railcars. This year is commemorated as the start of the transport business for Toshiba.
- 1901** Delivered first main motor and bogie in Japan to Daishi Railway (predecessor of Keikyu Corporation).
- 1923** Completion of our first electric locomotive with the delivery of 6 Deki 1 vehicles (40 tons, B-B) to Ina Electric Railway (predecessor operator of a part of the Iida Line of Central Japan Railway Company.)
- 1928** Delivered electric locomotive EF52 for the Tokaido Line to Japan Railways (predecessor of the Central Japan Railway Company).
- 1940** Fuchu Plant (predecessor of Fuchu Complex) was completed and started operation as a railcars factory.
- 1945** Toshiba Sharyo (predecessor of our division) was established.
- 1956** Exported electric railcars for the Sarmiento Line of Argentina National Railways for the first time as a Japanese company.
- 1965** First export of AC electric locomotives (85t, 2,400kW), 15 vehicles to Indian National Railways.
- 2007** Taiwan High Speed Rail inauguration of the section between Taipei and Zuoying, for which we are engaged in as a member of the main contractor.
- 2010** Started to provide the PMSM for subway lines and its control devices for the Marunouchi Line of Tokyo Metro Co., Ltd.
- 2012** Delivered the HD300, the first Japanese mass production hybrid locomotive, to JR Freight Railway Company.
- 2018** The world's first delivery driving system using three advanced technologies together (All-SiC, PMSM and SCiB™) on the Marunouchi Line of Tokyo Metro Co Ltd.

## Toshiba Corporation

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\*The information contained herein is subject to change without notice.

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