

Railway Facilities and Systems



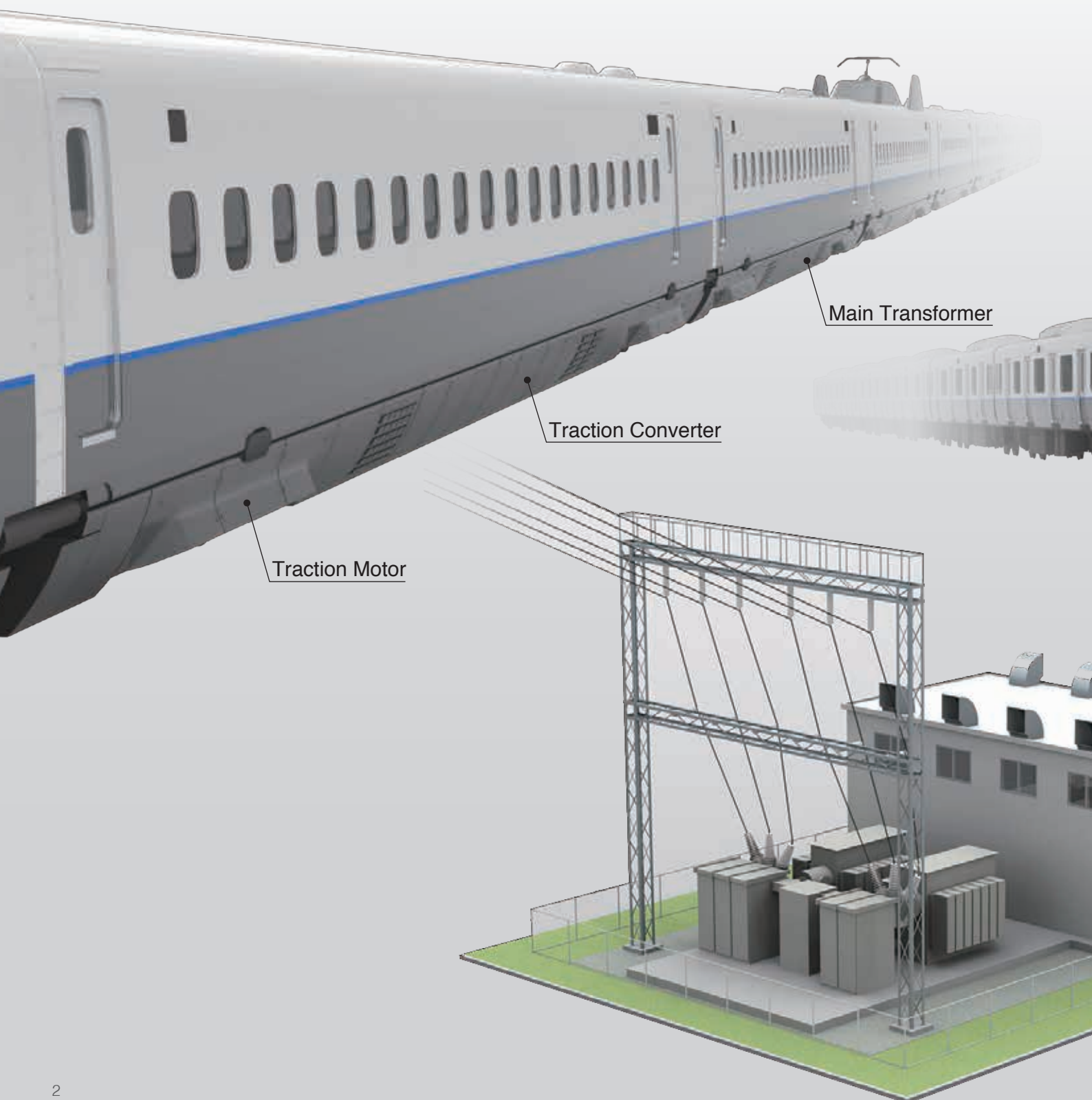
Fuji Electric's great reliability assure safety,
stable, and comfortable operation

Fuji Electric's Railway Facilities and Systems

Fuji Electric improves convenience and quality of the society by contributing eco-friendly railway facilities and systems.

Electrical Equipment for High Speed Railcars

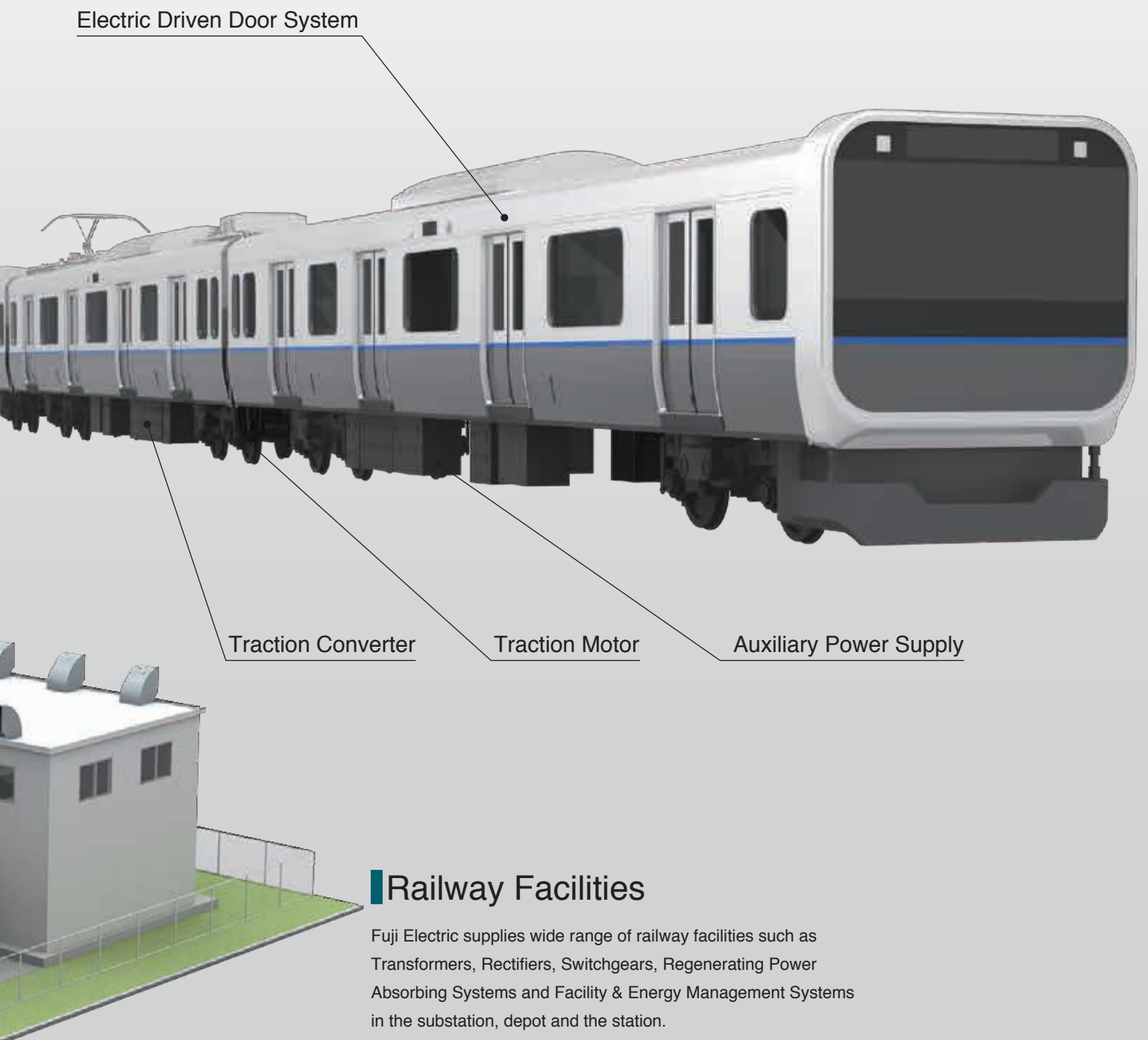
Fuji Electric's various and state-of-the-art technologies contribute to the stable and high speed operation.





■ Electrical Equipment for Commuters, Metro and Local Railcars

Fuji Electric's strong engineering abilities will meet your high-demand requirements.



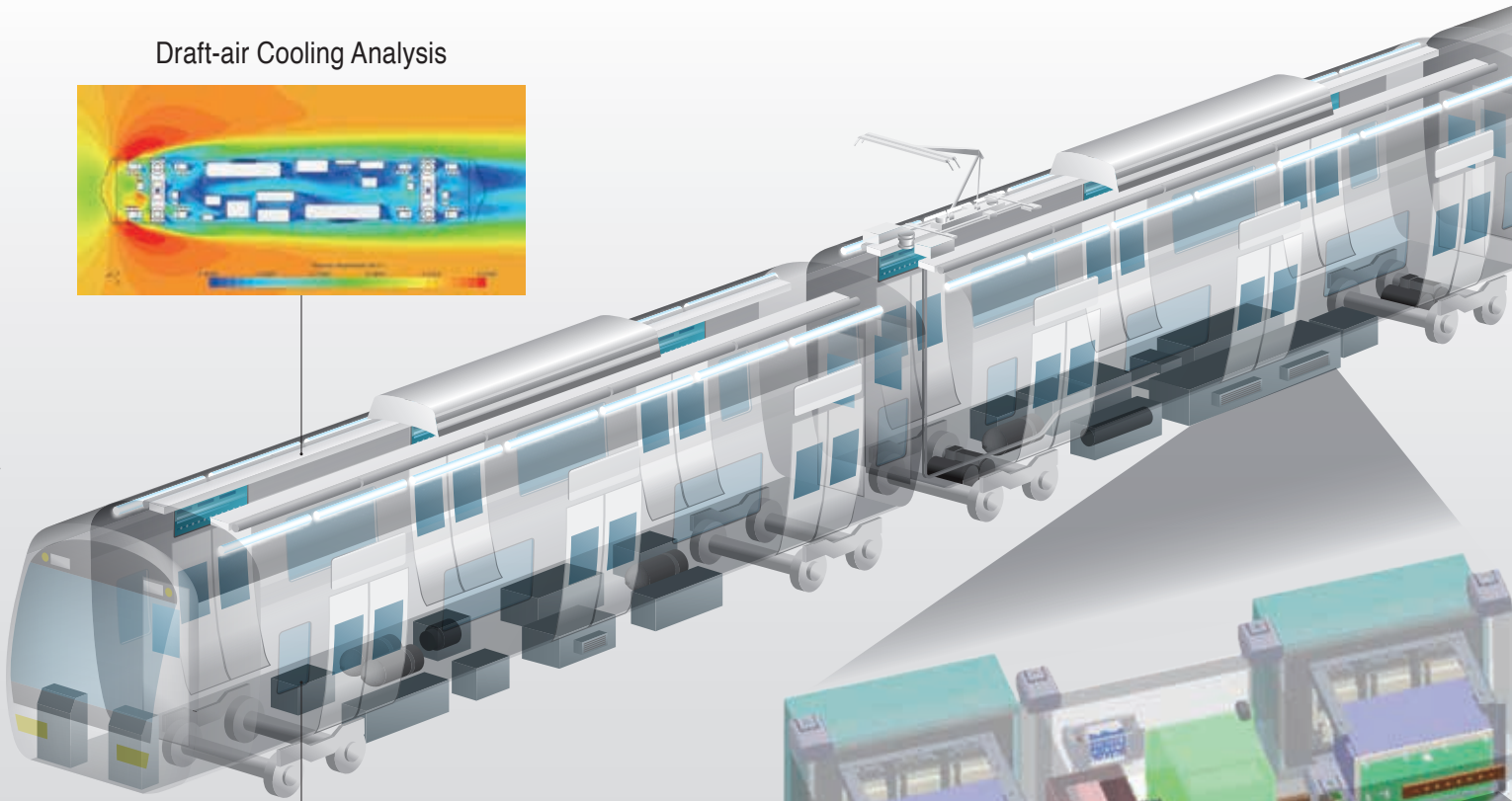
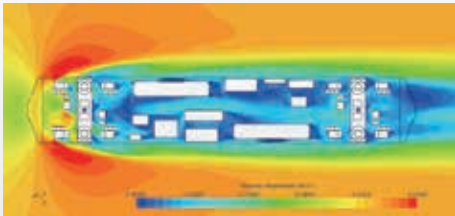
■ Railway Facilities

Fuji Electric supplies wide range of railway facilities such as Transformers, Rectifiers, Switchgears, Regenerating Power Absorbing Systems and Facility & Energy Management Systems in the substation, depot and the station.

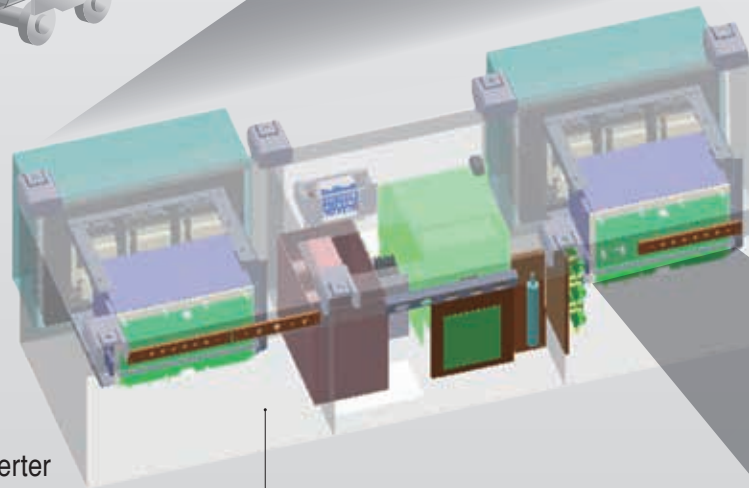
Advanced Technologies and Total Engineering

Fuji Electric supplies a total range of power semiconductors that are key components of power electronics equipment, and the range of railcars equipment such as the propulsion systems, auxiliary power supplies (APS) and door systems, as well as the substation, depot and station facilities.

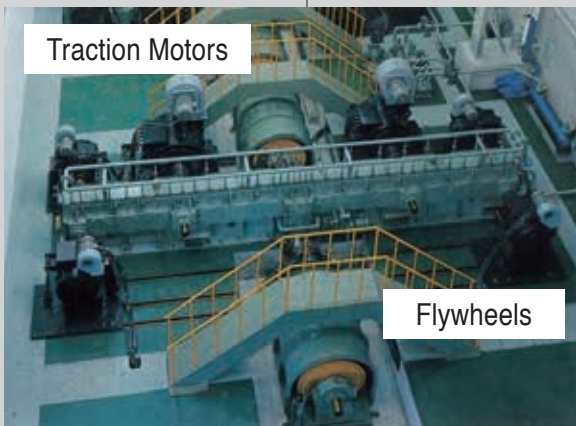
Draft-air Cooling Analysis



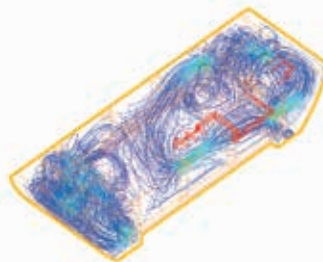
Power Converter



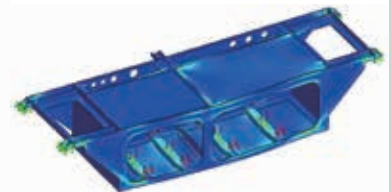
Traction Motors



Dynamic Simulator



Inner Air-flow Analysis



Structural Analysis

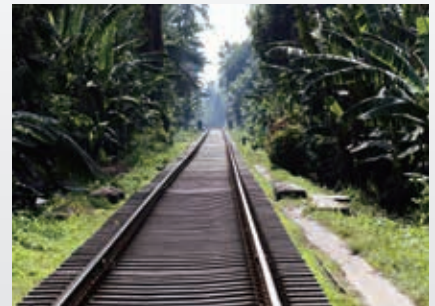
Abilities

Fuji Electric's products have been in service over the years under diverse environment.

Since Fuji Electric has strong engineering abilities as a general electric manufacturer, Fuji Electric can integrate various technologies suitable for the environment of operation and Fuji's self developed power semiconductors, and can realize wide range of environmental capability.



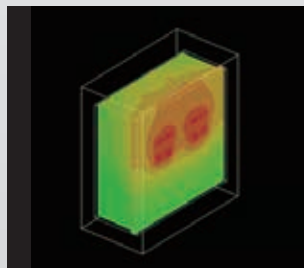
Cold Region



High Temperature & Humidity



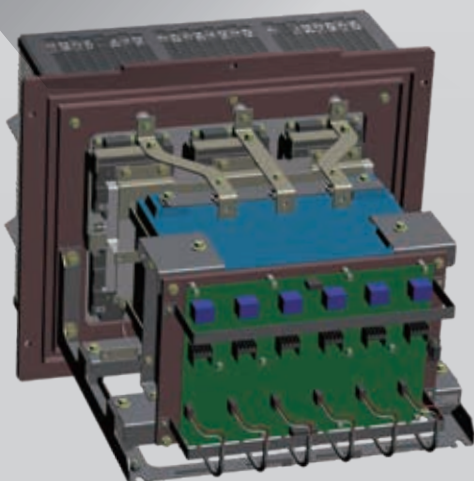
Electro-Magnetic Analysis



Heat Conduction Analysis



Dry Climate



Power Unit

Self Developed Power Semiconductors



SiC Hybrid Module



All SiC Module



HPnC Module

Supply Record for Railway Facilities and Equipment

Fuji Electric's electrical equipment contributes to the safety and stable transportation.

New York City Transit (NYCT)
R160 (U.S.A.)

Door System

Long Island Rail Road and
Metro North Railroad M9 (U.S.A.)

Door System

Sonoma Marine Area Rail Transit
(U.S.A.)

Door System

Washington Metropolitan
Area Transit Authority 7000 (U.S.A.)

Door System
APS

Metrolinx
(Canada)

Door System

Business Locations for Railway Equipment

Japan
Tokyo



TOKYO Factory &
Multidiscipline R&D Center

Mie



SUZUKA Power Electronics
Technical Center and
Railcar equipment Factory

Nagano



MATSUMOTO Electronics
Semiconductor Devices
R&D Center

Thailand



Fuji Manufacturing Thailand



Fuji TUSCO



**Chongqing MetroLine 2
(China)**

APS



**East Japan Railway Company
E235 (Japan)**

Door System
APS



**Transportation Bureau of Tokyo
Metropolitan Government 330 (Japan)**

Door System



**Taipei Rapid Transit Corporation
(Taiwan)**

Door System



**Central Japan Railway Company
N700A (Japan)**

Traction Converter
Traction Motor
Main Transformer



**Manila LRTA Line -1
(Philippines)**

APS



**Singapore Mass Rapid Transit C151,
C151A, C151B, C751B(Singapore)**

Traction Motor
APS
Propulsion Inverter
Door System



**RailCorp, Sydney
(Australia)**

APS

Canada

Montreal



Fuji SEMEC Railcar
equipment Factory

USA

Edison, New Jersey



Fuji Electric Corp. of
America Office

Virginia



Fuji Electric Corp. of
America Virginia Railcar
equipment Factory

Plattsburg, New York City

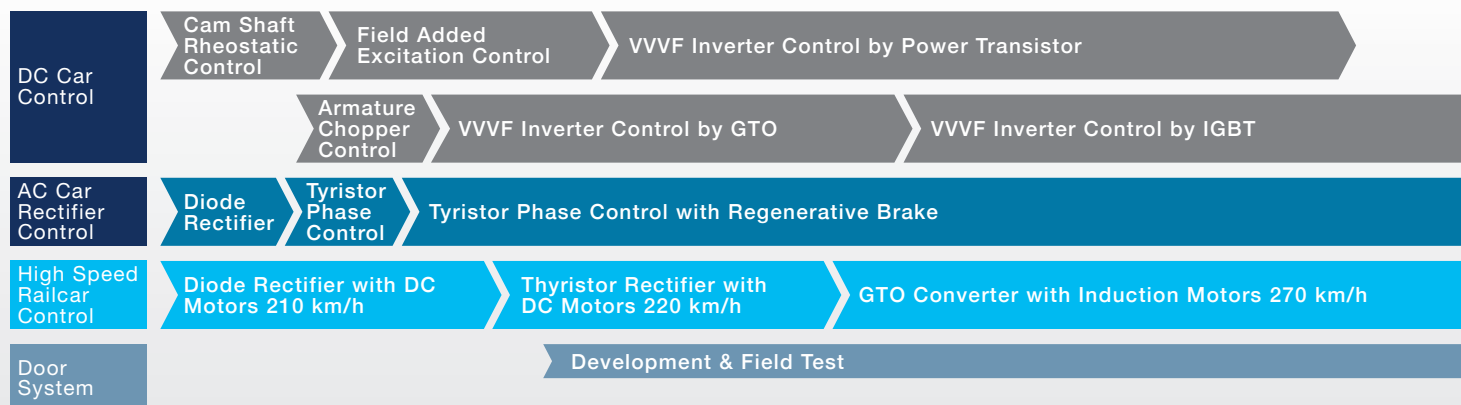


Fuji SEMEC Railcar
equipment Factory

Fuji Electric's Railway Businesses History

We are engaged in a product of railway systems for 110 years.

Technical Advancement



Fixed Facilities on Ground

1960 Dry Air-Cooled Silicon Rectifier

1977 Chlorofluorocarbon Ebullient Cooled Silicon Rectifier

1986 Regenerative Power Absorbing equipment

1988 Perfluorocarbon Ebullient Cooled Silicon Rectifier

Railcar Equipment

1996 Regenerative Power Inverter equipment

1964 JNR HSR Shinkansen series 0 cars Propulsion system by diode rectifier



1978 JNR series 781 AC/DC multiple source cars
Propulsion system by thyristor phase control

1981 JNR series 201 cars Propulsion system
by armature chopper control

1983 Sanyo Electric Railway series 3000 cars APS with GTO

1985 JNR series 205 cars Propulsion system
by field added excitation control

1985 JNR HSR Shinkansen series 100 cars
Propulsion system by Thyristor Rectifier

1986 Singapore Metro series C151 cars APS

1992 JR-Central HSR Shinkansen series 300 cars
Propulsion system by GTO

Siemens

1923 Fuji Electric Manufacturing

1984 Fuji Electric

Furukawa Electric



Electric propulsion system fitted to antarctic exploration ship "Fuji"



Started manufacturing general-purpose inverters



Developed 1,000 kW phosphoric acid fuel cell



Completed an ozone-based water treatment system



Delivered 100 kW phosphoric acid fuel cell

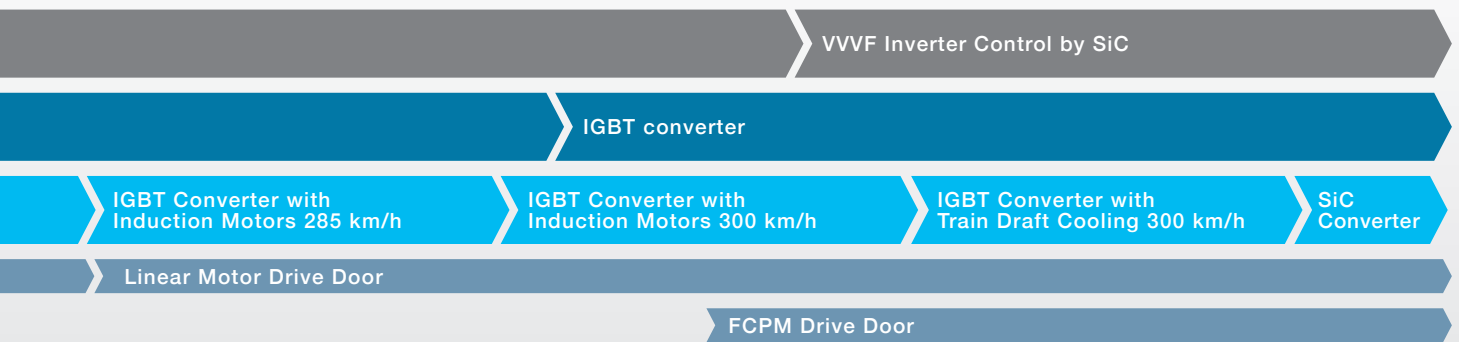
1960

1970

1980

1990

Note: ■ Fixed Facilities on Ground ■ JNR: Japanese National Railways
 ■ Propulsion System ■ JR: Japan Railways
 ■ HSR System ■ *HSR: High Speed Rail
 ■ APS System
 ■ Door System



2001 Cubicle type 24 kV Sulfur Hexafluoride Gas Insulated Switchgear

2001 Pure water ebullient Cooled Silicon Rectifier

2011 Plant oil insulated Transformer

2014 Cubicle type 72 kV
Sulfur Hexafluoride Gas
Insulated Switchgear

1998 DC High Speed Vacuum Circuit Breaker

1999 JR-Central HSR Shinkansen series 700 cars Propulsion system by IGBT

1999 SINGAPORE Metro series C751B cars
Propulsion system with IGBT

2009 JR-East series E233 cars Door



1999 JR-East series E231 cars Door



2007 JR-Central HSR Shinkansen series N700 cars
Propulsion system by IGBT

2002 NEW YORK R143 cars Door trial

2005 NEW YORK R160B cars Door



2013 Washington D.C. RC7000 cars Door

2013 JR-Central HSR Shinkansen series N700A cars
Propulsion system by IGBT



2011 Metro North Railroad USA M8 AC/DC multiple source cars
APS with IGBT



Delivered micro-grid system to outlying islands, and took part in installation and verification testing



High-speed electric vehicle battery charger went on sale



140 MW geothermal power plant, the largest single-unit capacity in the world, started operation (New Zealand "Nga Awa Purua Power Station")



Development of next-generation SiC module power semiconductor

2000

2010

2020

Propulsion System for High Speed Railcars

Power electronics and advanced control technology realize high performance and functionality

Features

- Superior performance, functions and efficiency
- Superior stability at high-speed operation
- Outstanding reliability
- Low-noise level
- Smaller size
- Minimal maintenance work

SiC Devices Usage

- Central Japan Railways and Fuji Electric jointly have developed and evaluated propulsion converter with SiC devices for High Speed Train in main line test run toward actual utilization

Traction Converter



Traction Motor



Main Transformer



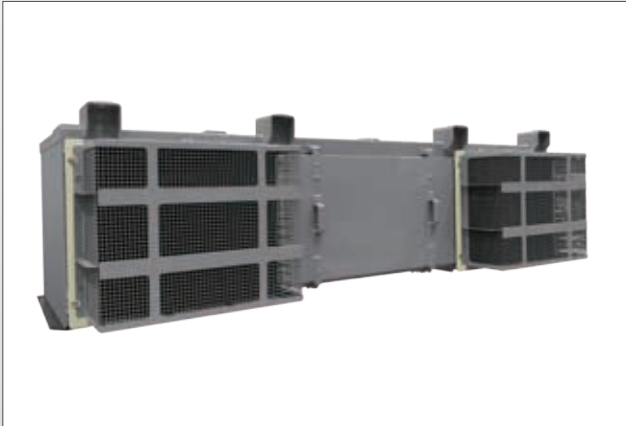
Propulsion System for Commuters, Metro and Local Railcars

Fuji Electric's various technologies realize comfortable rail service.

Features

- Smooth acceleration/deceleration by stator-flux-based vector control for greater passenger comfort
- Minimal maintenance work
- Superior functions at low-cost

Traction converter



Traction motor



Master controller



Filter reactor



Line breaker box



Switch box



Auxiliary Power Supply System

Fuji's APS will be satisfied with various requirement.

Line-up

Large Capacity APS for DC Cars with 3-Level Inverter



- Less acoustic noise and less EMI with 3-level inverter
- Larger capacity with small size

Input voltage	DC1500 V			
Output voltage	AC440 V 3φ 50/60 Hz			
Output capacity	120 kVA	180 kVA	210 kVA	260 kVA

APS for AC Cars with IGBT PWM Converter



- More stable DC link voltage by using IGBT PWM converter

Input voltage	AC440 V	DC1500 V
Output voltage	AC100 V 1φ 50/60 Hz	AC440 V 3φ 50/60 Hz
Output capacity	20 kVA	180 kVA

Small Size and Light Weight APS for Small Cars



- Medium frequency isolation system with forced-air cooling makes equipment smaller and lighter

Input voltage	DC750 V		
Output voltage	AC440 V 3φ 50/60 Hz, DC100 V		
Output capacity	70 kVA	110 kVA	140 kVA

Ultra High Reliability APS with Stand-by Power Unit



- APS with stand-by spare power unit. If the power unit fails, the equipment switches to the stand-by power unit and continue to supply auxiliary power

Input voltage	DC1500 V			
Output voltage	AC440 V 3φ 50/60 Hz			
Output capacity	120 kVA	180 kVA	210 kVA	260 kVA

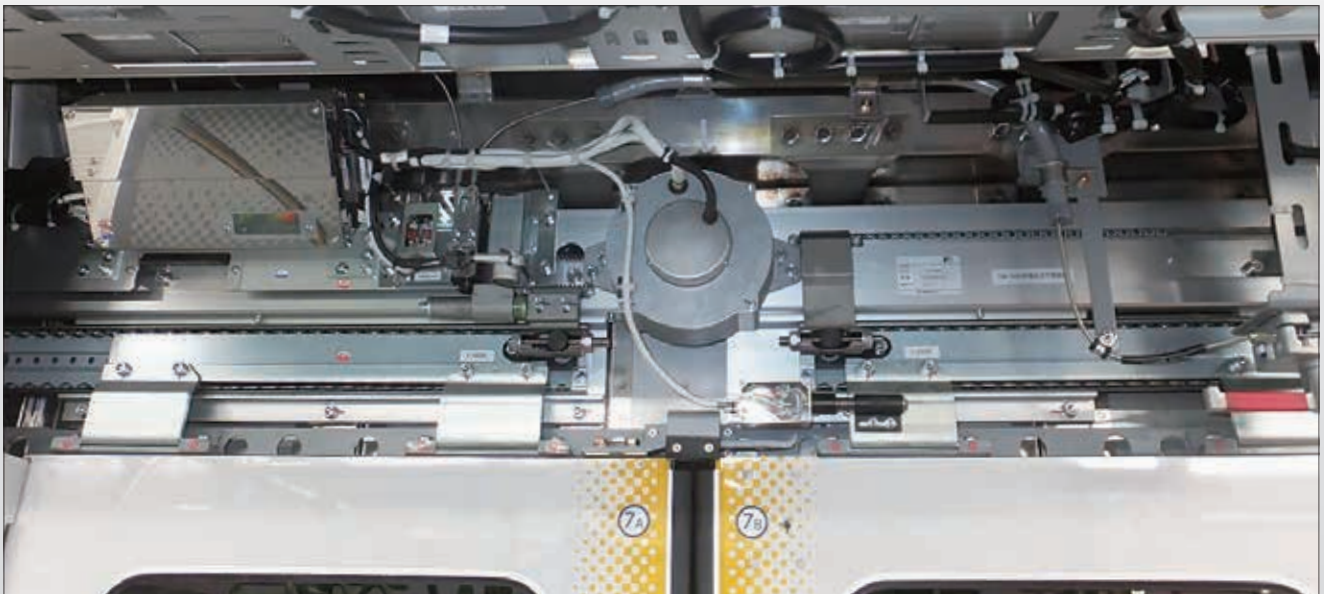
Electric Driven Door System

Fuji Electric contributes to the safety and comfort of the transportation system by supplying electric driven door systems for railcars with state-of-the-art power electronics technologies.

Features

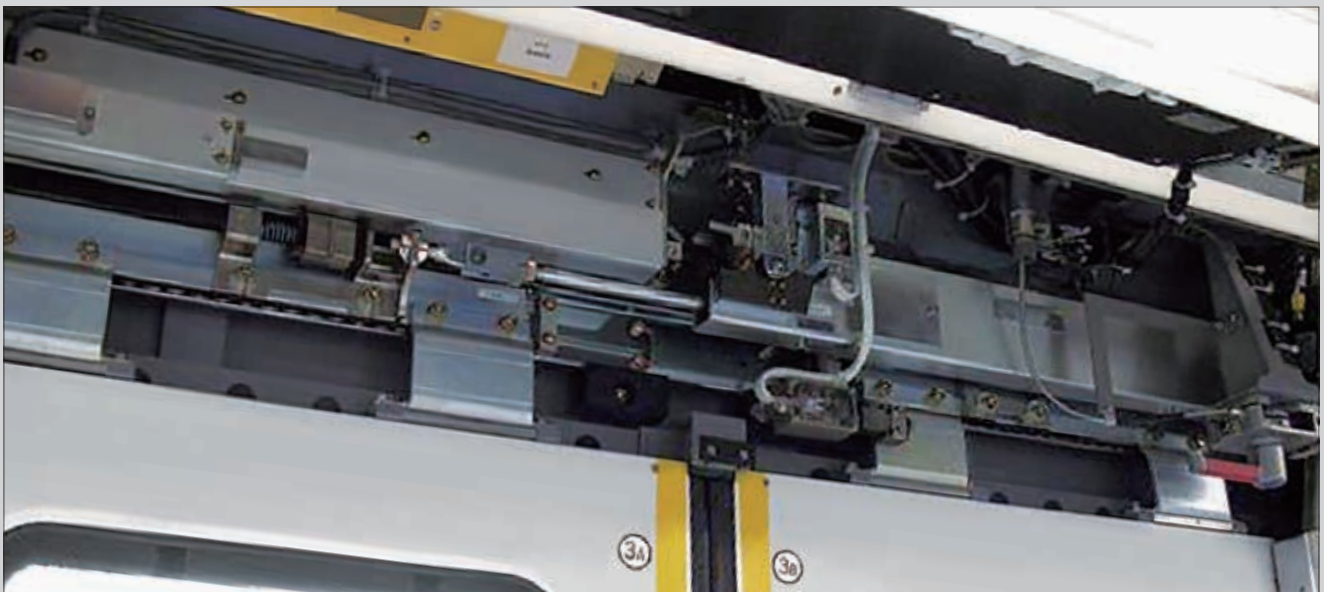
- Advanced power electronics and software technology to integrate safety design
- Accurate and intelligent performance in obstruction detection
- Small and light equipment with flat motor to simplify the refurbishment compared to a pneumatic system
- Simplified installation and easy maintenance and inspection provided by eliminating pneumatic pipings
- Direct drive mechanism to provide high reliability compared to the ball screw mechanism
- Low Maintenance

FCPM Drive



Small and light-weight equipment to save the installation space

Linear Motor Direct Drive



Direct drive mechanism to establish super high reliability

Power Semiconductor for Rail System

Fuji Electric power semiconductors contributing energy management for rail system.

All-SiC Modules



Configuration	Chip	Rated Voltage	Rated Current	Package Size
2 in 1	SiC MOSFET SiC SBD	1200 V	600 A	62 mm × 108 mm
		1700 V	300 A	

Package: Compatible with Fuji conventional standard IGBT module




Chip: SiC MOSFET + SiC SBD / High frequency switching / Lower power loss operation

SiC Hybrid Modules



Package: Highly reliable package (AlSiC base + AlN isolation sub.)

Chip combination: IGBT + SiC-SBD

	Configuration	Chip	Rated Voltage	Rated Current	Package Size
	2 in 1	Si IGBT SiC SBD	1700 V	1200 A	130 mm × 140 mm
	1 in 1		3300 V	1200 A	130 mm × 140 mm
			3300 V	1800 A	190 mm × 140 mm

HPnC Modules (High Power next Core)



Configuration	Chip	Rated Voltage	Rated Current	Package Size
2 in 1	Si IGBT Si Diode	1700 V	1000 A	100 mm × 140 mm
		3300 V	450 A	
	SiC MOSFET SiC SBD	1700 V	TBD	
		3300 V	750 A	

RoHS: RoHS Solder(under chip and DCB) and Ultra sonic welded terminals

Tj(op) is 175deg.C: With latest X series and 7G package technology

High long-term reliability: Resin with CTI>600 for higher anti-tracking high thermal cycling capability with ultra sonic welded terminals

Substations, Depot and Station Facilities

Fuji realizes minimizing environmental load, simplified compact systems and saving energy consumptions.



Fuji “MOLTRA”, Cast-Resin Dry Type Transformers

- Fuji Electric developed our first cast-resin transformers in Japan in 1974
- Third party certification of IEC60076-11 was obtained in 2006
- Secured top market share in Japan for 22 consecutive years in 2010



Features

- Standard design
- Rated voltage; up to 36 kV, Rated power; up to 24,000 kVA
- Insulation system temperature; 155°C(F)
- Type of cooling; AN (Naturally-Cooled), AF (Forced-air-Cooled)
- Maximum ambient temperature; 40°C, yearly average temperature; 20°C
- Utilizing aluminum for winding and copper for terminal
- Climatic, environmental and fire behavior classes C2, E2 and F1

Technical data

- Optional design
- Insulation system temperature; 180°C(H)
- High & Super-high efficiency type
- Low noise type
- Maximum ambient temperature 50°C
- Rectifier transformer (provision for harmonics)
- In-rush current reduced design to standard value 15~20 times
- Winding temperature rise reduced design for higher ambient temperature site

Supply Record Examples

Approximately 170units delivered to the railway substations in the Middle East in 2009

Sulfur Hexafluoride Gas Insulated Switchgear

The number of application for SF gas insulated switchgear has been tremendously growing all over the world, because it has many advantageous features as below:

Features

- Small space requirement
- High reliability
- Safety
- Good harmony with environment
- Long maintenance interval
- Short erection period at site



Pure Water Vaporization-cooling Silicon Rectifier

- 70% of size than conventional silicon rectifier
- Environmental friendly by using pure water
- High reliability by reducing parts using Fuji's own high withstanding voltage and large capacity power devices
- High safety by earthing whole equipment by fin ceramic
- Clean panel by double dust proof configuration
- Applicable Standard : JEC2410



Arc-less High Speed Vacuum Circuit Breaker

Innovating for future railway substations

- Minimizing maintenance cost by arc-less mechanism
- 50% of size than conventional air circuit breaker
- Saving Energy consumption
- Environmental friendly by non Sulfur Hexafluoride gas
- Applicable Standard : JIS E 2501-1,2 (Type:H2)



FUJI's HIGH QUALITY SPIRITS

This column focuses on the highly refined skills developed by employees involved in manufacturing. Also examined are the ways in which they approach their work.

Quality Control of Electronic Components

Shigeru Fukuyama

Transportation Testing Section, Quality Assurance Department,
Kobe Factory, Production Management Division,
Power Electronics Business Group

The Quality Assurance Department is the final gate through which products pass to be tested before delivery to customers. In this department, Shigeru Fukuyama is in charge of inspecting the quality of all conversion equipment and auxiliary power supply units for railroad cars such as bullet trains, special express trains, and commuter trains. Because the construction and painting processes, for example, differ depending on the weather of the region where they will be used, and because of varying customer specifications, inspection covers a wide spectrum of activities, including bolt tightening, the painting process, welding, and wiring. Fukuyama painstakingly compares each part to the design drawings by eyesight and by using tools to check the parts. In addition, his accumulated knowledge and experience drives his intuition on whether or not something is wrong with a color or shape in the product.

For example, when inspecting bolt tightening, he uses a hammer to tap the bolt and can determine whether or not it has been tightened correctly from the small sound it makes. Fukuyama says, "From the pitch of the sound you can tell how loose a bolt is or if it has been over tightened." Since he started this job, he has hit hundreds of bolts every day. Usually, learning the difference in sounds takes years. However, Fukuyama's concentration made it possible to learn whether a bolt was too loose or too tight within the first year, and exactly how much it needed to be adjusted by the second year.



Shigeru Fukuyama from a Colleague's Perspective

At the factory, Fukuyama is fire captain and is a real leader. His sense of pitch is excellent, letting him discern the different sounds in bolt tightening and making him really good at karaoke, especially the songs of Japanese singer-songwriter Masaharu Fukuyama.

He says, "Right ahead of us is the customer. If we miss a flaw here, it could interfere with train operation and have significant social repercussions." When carrying out an inspection, every nerve is focused in the five senses. Other than design drawings, the inspection must clear JIS and pass internal regulations checks. "There's no such thing as a perfect product. You have to carry out inspections with the thought in mind that anything made by people is imperfect. Otherwise there is the chance you will miss some minor flaw," states Fukuyama.

Currently, the Kobe Factory produces many products for Japanese and overseas markets, especially parts of Asia. He mentions, "It is my job to make sure that all shipped products are of the same quality. To achieve this goal, I need to keep learning and growing."

FE Fuji Electric Co., Ltd.

Gate City Ohsaki, East Tower, 11-2, Osaki 1-chome, Shinagawa-ku, Tokyo 141-0032, Japan
Phone : (03)5435-7111

Internet address : www.fujielectric.co.jp

Information in this catalog is subject to change without notice.

2020-3(C2020b/I2017)5MS Printed in Japan