TRANSPORTATION SYSTEMS

Changefor the Better

Mitsubishi Electric

for a Greener Tomorrow
MITSUBISHI ELECTRIC CORPORATION
Innovating your world for over 90 years.

As Mitsubishi Electric nears its 100th anniversary, our mission is clear — apply our technologies to contribute to society and enhance the quality of life around the globe. We are working to create a brighter future through innovation and ensure a more sustainable world. We are extending our global reach and pioneering developments in fields ranging from home appliances to satellites, introducing breakthrough after breakthrough for the benefit of society, industry, and individuals. Our path to the future is built on an untarnished record of innovation and excellence, and our tradition of “changes for the better.”

JUST A FEW OF OUR ACHIEVEMENTS

Power Semiconductor Devices
Power semiconductor devices are essential for making various kinds of power electronics equipment more energy-efficient, from traction and Electric Vehicle (EV) / Hybrid Electric Vehicle (HEV) to industrial robots and air conditioning systems.

Transformer Equipment Development Technologies
We verify the reliability of our transformers utilizing the largest environmental testing facilities capable of simulating severe natural environments, including extreme cold, heat, lightning, and earthquakes.

Micro-via-laser Drilling Technologies for Printed Circuit Boards
High-speed and high-accuracy, precise laser processing enables printed circuit boards to be pierced at 6,000 holes per second, an FA technology supporting the evolution of smartphones.

Mobile Mapping System (MMS)
Consisting of equipment such as GPS antenna, laser scanners and cameras mounted on a vehicle, the MMS can acquire 3D position data including buildings, road contours, and other roadside data while driving. It has diverse applications such as public survey projects and infrastructure management.

Autonomous Control Technologies for Spacecraft
Featuring advanced guidance, communications, data processing and power-supply technologies, our autonomous control module piloted Japan’s first unmanned automated supply vehicle to the International Space Station.

SiC Train Circuit Systems
Ushering in an age of greener rail infrastructure, our silicon carbide (SiC) traction inverters, together with our regenerative braking systems and other technologies, are delivering unprecedented energy savings.

Continuous Industrial Revolution
While we are in the midst of the 4th industrial revolution, Mitsubishi Electric automation products have and will continue to contribute to the advancement of manufacturing from next generation PLCs, “micro-brains” within the production line, to advanced robotics and precise servo and motion control. Mitsubishi Electric is delivering manufacturing know-how that’s a step ahead of the times.

The World’s Fastest Elevator
Completed in 2015, Shanghai Tower has the fastest elevator in the world. Our aerodynamic elevator cars rocket from the basement to the 119th floor in 53 seconds at more than 70 km/h in smooth, safe comfort.

Every step brings the world closer to a brighter future.
Towards next generation safety, stability, comfort and energy conservation. Advanced rail solutions that only Mitsubishi Electric can offer.

**Safety**
The pursuit of safety is an important task in the world of rail no matter what the era. Mitsubishi Electric’s diverse array of advanced technologies, including automated technologies such as the Train Control and Management System (TCMS) and safety systems – which are able to monitor the status of a situation and apply control automatically – are supporting the creation of transportation systems that all passengers can feel secure.

**Stability**
Mitsubishi Electric supports to realize to maintain the punctuality of transportation services through the provision of highly flexible solutions in response to diverse transportation needs.

**Comfortable**
We strive to create transportation systems that are both easy to use and offer a high level of comfort to all users. Wide-ranging technologies that can only be realized by a comprehensive electrical manufacturer enable integrated, high-quality transportation services that offer comfortable trains and convenience and timely access to the necessary information when in the station.

**Ecology**
For the sake of the sustainable development of society and our future ways of life, we propose environmentally-conscious transportation systems. Bringing together monitoring and control technologies and energy-saving technologies, we are able to realize comprehensive, advanced environmental performance in the four domains of train, station, depot and line.
We have introduced 3D design in pursuit of even higher-quality development, enabling us to achieve high quality from the initial stage. We have CMMI and SIL certification and certification through third-party certification organizations including IRIS, and are able to respond to overseas projects.

Customer Engineering

Leveraging the technological power of a comprehensive electrical manufacturer to create rail systems in close involvement with customers.

Mitsubishi Electric’s proposal-based sales system, which allows us to grasp our customers’ real needs face-to-face, ensures sincere and speedy responses. Offering backup via a comprehensive range of support systems, from the stage of formulation of the customer’s introduction plan to post-introduction maintenance and management, we work with you to create optimal rail transport systems.

Evaluation tests / Verification

Actual train environment simulator
We are constantly working to improve the quality of our software in order to ensure exact reproduction of an operating train in the test environments employed in our factories.

Feeding network simulator
We conduct power simulations incorporating large-scale and complex feed circuit networks.

3D simulation
We have introduced 3D design in pursuit of even higher-quality development, enabling us to achieve high quality from the initial stage.

Test verification equipment
Verification in combination with traction systems
We conduct verification by applying inertial loads to propulsion control systems and traction motors.

Vibration test equipment
We verify vibration resistance using equipment conforming to international standards (IEC).

International certification
We have CMMI and SIL certification and certification through third-party certification organizations including IRIS, and are able to respond to overseas projects.

International Rail Industry Standard (IRIS) certification

CMMI certification
- [Subject of certification]
  - Brake control unit
  - Train propulsion control equipment
  - Train information equipment
  - Train depot systems

SIL certification (Level 4–2)
- [Subject of certification]
  - Brake control unit
  - CBTC

IRIS certification
- [Subject of certification]
  - Nagasaki Works: Train air conditioning equipment
  - Ako Plant, Transmission and Distribution Systems Center: Train traction transformers

Digital mockup based on 3D design
Thermal distribution on motor
Train operating mode distribution

Propulsion control and power supply unit that incorporates leading-edge inverter control. We support safe and comfortable operation with proven AC motors and drive equipment in addition to the latest technologies.

Brake control unit manufacture with a history of more than 90 years standing behind it, reliable failsafe technologies, and automatic operation technologies.

Safe and secure braking / Automatic control
Brake control unit / Security equipment / Automatic Train operation

*3 Automatic Train Stop    * 4 Automatic Train Control

Train Systems
A system integrator that realizes “Powering,” “Braking,” “Control” and “Comfort” functions in a single company.

Propulsion safety and stably
Propulsion control and power supply unit that incorporates leading edge inverter control. We support safe and comfortable operation with proven AC motors and drive equipment in addition to the latest technologies.

HVAC (Air conditioning): Multiple temperature sensors detect the ambient temperature to control a comfortable air-conditioned temperature.

40% reduction in traction motor loss and reduced noise; elimination of necessity for cleaning and use of cartridge bearings reduces maintenance time by 3/4.

High-definition videos and animation displays boost advertising value; power consumption has also been reduced by 22%.

Traction motor
The use of cylindrical roller bearings and a vertical axis arrangement simplifies maintenance and assembly. High-speed output and smooth output are achieved even at the lowest speeds, realizing low noise.

Full-SiC*2 VVVF inverter
Using the next-generation material SiC, we have realized a 40% reduction in power consumption, in addition to 40% reduced volume and mass.

Onboard crime prevention systems
A learning function increases ride comfort and the precision of stops, while predictive control for busy periods realizes energy-saving operation.

Train Control and Management System (TCMS)
Employs high-speed and high-volume Ethernet to realize stable communication between trains and wayside equipment.

Train Control and Management System (TCMS)

Wayside equipment
A configuration that integrates electrical and pneumatic brake control sections reduces volume and mass by 80% against conventional systems.

Brake control unit
Apply to multiple signal systems like ATS*3, ATC*4 and communications-based train control (CBTC), etc.

Integrated security device
A learning function increases ride comfort and the precision of stops, while predictive control for busy periods realizes energy-saving operation.

Automatic Train Operation (ATO)
A learning function increases ride comfort and the precision of stops, while predictive control for busy periods realizes energy-saving operation.

Powering trains safely and stably
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Automatic Train Operation (ATO)
A learning function increases ride comfort and the precision of stops, while predictive control for busy periods realizes energy-saving operation.
Contributing to the creation of more environmentally-friendly railway systems with diverse energy technologies.

From leading-edge power management systems to environmentally-conscious equipment. Cooperation between onboard equipment and station equipment makes it possible to use regenerative energy more effectively, enabling energy to be saved throughout the entire railway system.

Shinkansen

Today, “Shinkansen” is a word that the entire world knows. Mitsubishi Electric traction transformers and Converter-Inverter support the operation of the Shinkansen network. The advanced technologies that we cultivated during development for the Shinkansen, a domain in which limit performance is demanded, are highly regarded. Now if has been applied to urban lines and AC catenary systems. Together with our air conditioning systems that create a comfortable onboard space, the application of these technologies continues to expand.

Regenerative inverter

These units conserve energy by converting train regenerative energy into AC and enabling it to be used for ancillary equipment. They enable stable operation even in response to rapid changes in regenerative energy.

Converter-Inverter

A proprietary configuration reduces oil use in addition to realizing reductions in size and weight; we have also worked to reduce the necessary maintenance.

HVAC (Air conditioning) (Shinkansen)

Compressor controlled by inverter enables fine control of onboard temperature.

Power supply system

Station

Power switching equipment that employs dry air composite insulation and uses no greenhouse gases. A CBM* function enables abnormalities to be detected at an early stage.

Transformer rectifier

Large-capacity (100kA) DC breaker with high-speed breaking capability. This enables use of all M-CB breaker area, leading to a further reduction in space in addition to reducing the expenditure of labor power in maintenance.

Feeding transformer

Latest IEC Standard complied, compact size cubicle type gas insulated switchgear (C-GIS).

Power-receiving switchgear

Traction transformers for high speed railways

Transformer for high-speed railings

HVAC (Air conditioning) (Shinkansen)

Compressor controlled by inverter enables fine control of onboard temperature.

65kV (Station Energy Saving Inverter)

Power switching equipment that employs dry air composite insulation and uses no greenhouse gases. A CBM function enables abnormalities to be detected at an early stage.

Shinkansen

From leading-edge power management systems to environmentally-conscious equipment. Cooperation between onboard equipment and station equipment makes it possible to use regenerative energy more effectively, enabling energy to be saved throughout the entire railway system.

AC substations

Power-receiving switchgear

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Train Operation Systems

Rising to the challenge of new forms of transportation in the ICT era.

Ensuring safe and stable transportation through the optimization of trainset operation and operation control. In addition, precise train control realized via cooperation between onboard and wayside equipment optimizes energy consumption throughout the entire transportation system.

Automatic Train Supervision (ATS)

These systems enable centralized monitoring and control of train operation. User interfaces that offer superior visibility and operability enable accurate understanding of the status of train operation and rapid and precise command decisions. Diverse functions also assist in the formulation of operation plans.

Radio train control systems (ATACS*1/CBTC*2)

These systems enable trains to detect their own position, and enable control via two-way radio transmission between onboard and wayside equipment. In addition to making it possible to streamline wayside equipment (doing away with signals, etc.), cooperation between onboard and wayside equipment using advanced radio technology enables high-density operation, automatic operation and power-saving operation.

Passenger Information Control (PIC)

LCD panels display train departure and arrival information, line information, advertisements, etc. Videos, still images and information in letters and characters can be freely combined.

Radio equipment

A full lineup of radio equipment tailored to train control using the radio LAN band, the train radio band, etc. Ensures stable communication quality.

Wayside equipment

Wireless technology enables position data and control data for each train to be exchanged, and control to be applied to the distance between trains, speed, route, etc. The use of a failsafe processor ensures a high level of safety.

Onboard equipment

Obtains control data related to the interval between trains while transmitting position data for the subject train to wayside zone controller via radio communications, enabling ATO to be applied within a restricted speed.

*1 Advanced Train Administration and Communications System: A signal security system developed by JR East
*2 Communication-Based Train-Control System
Creating next-generation information infrastructure by offering various products.

Voice communication between wayside systems and onboard systems and the deployment of communications systems in areas including signals and power are essential to train operations. Leveraging the technologies that we have cultivated over many years, we are able to supply systems of the highest reliability.

Radio systems

Train radio systems

Employing the latest digital radio technologies, we realize high-quality two-way information and communication infrastructure between wayside equipment and onboard equipment, supporting train traffic management procedures and enabling fast and accurate provision of information to users.

Onboard LCX digital wireless systems for high-speed trains

The use of LCX laid along the tracks and technologies to boost radio quality enables the realization of stable radio communications across all lines, even at 360km/h.

LCX: Leaky Coaxial Cable

Making stations even more comfortable with facilities offering absolute safety and security and abundant information services.

Today, in the ongoing diversification of the services provided by rail operators, stations are no longer place simply to take a train; they form part of our living space in which people come together. Mitsubishi Electric supplies a range of products and systems that assist in making stations safe and comfortable spaces that respond to the needs of their diverse users.

Improve your customers’ experience by offering services that maximize safety and security.

Image systems

High-impact Diamond Vision and high-resolution DLP Multi-Vision make stations more vibrant and enjoyable.

Safety and security

Elevators and escalators

Seeking to realize shared spaces that everyone can use together, we provide elevators and escalators for platforms and concourses that are both easy to use and welcoming to all users.

Servicing and Maintenance Systems

Increasing the efficiency of maintenance via a sufficient support system and unique technologies.

Contributing to reducing lifecycle costs by providing support for CBM. A full range of maintenance services also offer rapid response to malfunctions and increase the efficiency of inspection procedures.

Train lifecycle management solutions.

Creating platforms for systems that collect and utilize train monitoring data by integrating the Train Control and Management System (TCMS) with wayside equipment. The sharing and use of monitoring data and related data enables rapid response to malfunctions (breakdown maintenance) and increased efficiency in inspection procedures (time-based maintenance). It also allows monitoring data analysis techniques to be honed and knowledge obtained towards the realization of condition-based maintenance (CBM).

Maintenance services

Mitsubishi Electric provides comprehensive maintenance services that respond to our customers’ needs, from onsite responses to handover-related services. We always respond with honest maintenance services that consider the customer.
Measurement and analysis of wayside equipment.

Mitsubishi’s MMSD™ infrastructure monitoring system enables measurement and analysis of wayside equipment using measurement cars.

Using high-precision 3D measurement and a range of sensing technologies, we are able to automate social infrastructure inspections and equipment measurements, reducing the expenditure of manpower and increasing precision. Conducting measurements in motion using road-rail vehicles and similar equipment makes it possible to conduct precise 3D measurements in a short period. Analysis and processing of 3D shape data enables its use in a variety of fields and applications.

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Measurement car

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Examples of analysis

1. **Measurement of structure gauge**
   - Enables measurement of structure gauge for tunnels, etc.

2. **Tunnel wall status analysis**
   - Internal changes in tunnels are displayed as differently-colored areas.

3. **Beacon and signal location measurement**
   - Enables measurement of absolute position of beacon, equipment management based on absolute position.

4. **Measurement of deviation of contact wires**
   - Enables measurement of distance from central position of catenaries.

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**Train depot systems**

**Maintenance information management system (MIMS)**

Centralized management of train equipment logs and train data, including maintenance data and malfunction data, in a database. Supports expansion to use in malfunction prediction and improvement of maintenance procedures.

**Depot information management system (DIMS)**

Formulates train operation (allocation) plans based on main line timetables and train maintenance plans. Can also be used in the formulation of depot work plans and route control.

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**Introduction to Overseas Bases**

Reinforcing relationships with local railway operators and car builders by expanding global manufacturing and services.

New rail projects are getting underway one after another throughout the world. Attention is being focused on rail and expectations on this modality are increasing as an environmentally-friendly form of transportation. Mitsubishi Electric is working to establish joint ventures and add to its range of local manufacturing and servicing bases. Integrating with local communities and contributing to local regions, we advance our activities every day with the goal of forming close local partnerships.

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**Overseas bases**

- **Sales and maintenance bases**: New York, Mexico City, São Paulo, Sydney, Singapore, Hong Kong, London, Beijing, Gurgaon, Düsseldorf, and Milano.
- **Manufacturing bases**: Pittsburgh, San Juan del Río, Sydney, Zhuhou, Bengaluru, and Paulus.
- **Research bases**: Boston, Rennes, and Livingston.
- **Capital participation**: Warsaw.

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Main Domestic Manufacturing and Research Bases

Meeting the needs of the present age with uncompromising high-quality manufacturing and cutting-edge technologies.

With an absolute commitment to quality, we adopt a total approach to manufacturing in order to enable us to offer products of ever-higher quality. We are working to strengthen cooperation between our manufacturing bases and research centers, always striving to resolve a range of difficult issues with a view towards the future of the rail industry.

Milestones in Mitsubishi Electric’s Transport Systems Business

1940
- First advance into overseas markets: Delivery of electrical components to Indian Railways

1950
- Advance into European market: Delivery of electrical components for the Spanish National Railway Network
- Completion of traction motors for Shinkansen production cars
- Marketing of Japan’s first* Automatic Train Control (ATC) and Automatic Train Operation (ATO) equipment
- World’s first* mass production and delivery of chopper control system

1960
- Commencement of sale of automatic train supervision

1970
- Delivery of Japan’s first* VVVF inverter for 1500V catenary

1980
- Delivery of converter inverter applying IPM semiconductors (First for Shinkansen*)

1990
- Delivery of Japan’s first* Train Integrated Management System (TIMS)
- Delivery of Japan’s first passenger information system (Train Vision)
- Delivery of totally enclosed induction motor
- Marketing of air conditioning using substitute refrigerant
- Marketing of Station Energy Saving Inverter (S-EIV)

2000
- Delivery of Japan’s first* VVVF inverter using SIC
- Delivery of world’s first* auxiliary power supply using SIC
- Marketing of Station Energy Saving Inverter (S-EIV)

2010
- Marketing of world’s first* VVVF inverter using SIC

*According to in-house survey conducted in March 2017

Itami Works
- Rolling stock systems
- Signal control systems

Transmission & Distribution Systems Center
- Switchgear
- Lightning arresters

Kobe Works
- Automatic Train Supervision
- Transportation power supply system
- Optical network systems
- Disaster prevention systems, etc.

Nagasaki Works
- Train air conditioning
- Platform screen doors
- Passenger information display (Full-color LED)
- Onboard display (Full-color LED)

Power Device Works (Fukuoka, Kumamoto Prefecture)
- Power devices (IGBT modules, IPM, SiC power modules, etc.)

Advanced Technology R&D Center
- SiC power modules
- Computer platforms for traffic data control (traffic management, transportation planning, support for command) systems

Information Technology R&D Center
- Train radio system (LOC, millimeter-wave)
- Train dynamics monitoring systems

Industrial Design Center
- Passenger Information System (Concept/Screen)
- Screens for train information systems
- Screens for automatic train supervision (Including Operation Control Center design)

Design Systems Engineering Center
- Manufacturing Engineering Center
- Component Manufacturing Technology Center

Chopper control system
- Regenerative inverter
- CFC evaporative cooling rectifier
- Train Vision
- Totally enclosed induction motor
- AU726A-G4 air conditioning
- VVVF inverter for 1500V catenary
- Flywheel-type train first power storage equipment
- Converter-inverter applying IPM semiconductors
- VVVF inverter using 1500V catenary
- Station Energy Saving Inverter (S-EIV)