Every step brings the world closer to a brighter future.

**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 antennas, laser scanners, and cameras mounted on a vehicle, the MMS can acquire 3D position data including buildings, road contours, and other mobile data while driving. It has diverse applications such as public survey projects and infrastructure management.

**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 continuously contribute to the advancement of manufacturing; from next generation PLCs, “the brains behind the production line”, to advanced robotics and precision sensors and motion control. Mitsubishi Electric is delivering manufacturing technologies that are one step ahead of the times.

**Ultra-high-speed elevator in Shanghai Tower**
- Completed in 2015, three ultra-high-speed elevators serve the Observation Deck (119 floors above the ground); one of them, The ultra-high-speed passenger elevators with a world-class speed of 1,230m/min.

**Autonomous Control Technologies for Spacecraft**
- Featuring advanced guidance, communications, data processing and power-supply technologies, our autonomous control module pilots Japan’s first unmanned automated supply vehicle to the International Space Station. *Pictures of the ISS and HTV have been provided by JAXA*

**Every step brings the world closer to a brighter future.**

**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.”
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 manifacturer to create rail systems in close involvement with customers.

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 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.

CMMI certification

<table>
<thead>
<tr>
<th>Subject of certification</th>
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<tbody>
<tr>
<td>Brake control unit</td>
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<tr>
<td>Train propulsion control equipment</td>
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<td>Train information equipment</td>
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SIL certification (Level 4 – 2)

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International Rail Industry Standard (IRIS) certification

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</tr>
<tr>
<td>Plant Works: Power supply systems, Auxillary Power Supply and Train Control and Management System (TCMS)</td>
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</tbody>
</table>
A system integrator that realizes “Powering,” “Braking,” “Control” and “Comfort” functions in a single company.

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

We support safe train operation via 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

Powering trains safely and stably

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

We contribute to improve passenger services with air conditioning, incorporating both people and the environment, and image display, incorporating the latest information technology. We also work to enhance indoor security.

Convenience and comfort / Providing spaces in which passengers can feel safety and secure

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Contributes to realizing further increases in efficiency and reductions in size and weight in train devices.

Hybrid SiC power module for traction applications

Optimization of switching frequency realizes a 30% reduction in power loss and 20% reduced volume and mass.

SiC auxiliary power supply

Operation of switching frequency realizes a 30% reduction in power loss and 20% reduced volume and mass.

Train Control and
Management System (TCMS)

Employs high-speed and high-volume Ethernet as its network bus, conforming to international standards. Allows control to be maintained online, ensuring reliability even in case of出轨.

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Integrated security device

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

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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.
The combination of advanced digital control technology and a self-diagnostic function results in a high-reliability system that also reduces maintenance manpower.

Control and protection equipment
We supply shell-type rectifiers employing a dense layout of silicon rectifiers incorporating shell-type transformers and high-voltage elements. The units save space and reduce loss.

Transformer rectifier
Large-capacity (100kA) DC breaker with high-speed breaking capability.

DC Breaker
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.

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

Power-receiving switchgear
*6 Light Rail Vehicle

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 it has been applied to urban lines and LRV™ in AC catenary systems. Together with our air conditioning systems that create a comfortable onboard space, the application of these technologies continues to expand.

Converter-Inverter
The use of SiC module reduces size and increases efficiency.

Traction transformers for high speed railways
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.

Shinkansen

From leading-edge power management systems to environmentally-conscious equipment. Cooperation between onboard equipment and wayside equipment makes it possible to use regenerative energy more effectively, enabling energy to be saved throughout the entire railway system.
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 wayside 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**
We employ torsion bar spring-operated equipment with excellent energy transmission efficiency from 145kV to 552kV.

**Feeding transformer**
We have realized practical use of roof delta (RD) connected transformer for simple connection and a simple configuration. The equipment is also lightweight and saves space.

**Control and protection equipment**
The employment of an ME-type distributing board boosts reliability and operability, in addition to reducing the expenditure of labor power in maintenance.

**DC substations**

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**DC Breaker**
Large-capacity (100kA) DC breaker with high-speed breaking capability.

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**Station**

**S-EIV® (Station Energy Saving Inverter)**
Supplies the surplus regenerative energy created by train’s breaking to station electrical equipment.

**7.2kV composite insulated switchgear**
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.

*Condition-Based Maintenance

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**Substation**

**S-EIV**

Supplies the surplus regenerative energy created by train’s breaking to station electrical equipment.

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**Remote power monitoring and control system**

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**Power control center**

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**Power company**

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**Train**

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**Flow of regenerative energy**

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**Brake**

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**Station**

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**Power company**

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**Train**

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**Substation**

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**S-EIV**

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**7.2kV composite insulated switchgear**

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**AC substations**

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**DC substations**

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**Regenerative inverter**

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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*/CBTC**)

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.

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*1 Advanced Train Administration and Communications System
*2 Communication-Based Train Control System

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**Automatic Train Supervision (ATS)**

- Operation monitoring screen
- Operation control screen
- Schedule planning screen
- Crew scheduling support screen

**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 train control systems (ATACS*/CBTC**)

- Wayside radio unit
- Automatic Train Supervision (ATS)
- Traffic operation network
- Power management
- Solid State Interlocking (SSI)
- Automatic Train Operation (ATO)
- Onboard controller
- Onboard radio unit
- Automatic Train Operation (ATO)
- Train Vision
- TCMS
- DRSS (Doppler Radar Speed Sensor)
- Semi-conductor speed sensor

**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.

- Onboard radio unit
- Wayside radio unit
- Antenna

**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 fail-safe processor ensures a high level of safety.

- Control unit
- Solid State Interlocking (SSI)
- Wayside Zone Controller (WZC)

**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.

- Onboard controller
- Automatic Train Operation (ATO)
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.

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 knowhow obtained towards the realization of condition-based maintenance (CBM).

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.

Image systems

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

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.

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.
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.

Measurement and analysis of wayside equipment.

Mitsubishi’s MMSTM 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 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.

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.

⑤ Formulation of 3D CAD data
Enables 3D CAD data to be formulated from 3D shape data.

Introduction to Overseas Bases

Servicing and Maintenance Systems

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.

Mitsubishi’s MMSTM infrastructure monitoring system
Using measurement cars

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Overseas bases

- Sales and maintenance bases: New York, Mexico City, São Paulo, Sydney, Singapore, Hong Kong, London, Beijing, Bengaluru, Düsseldorf, and Milan
- Manufacturing bases: Pittsburgh, San Juan del Rio, Zhuzhou, Bengaluru, and Padua
- Research bases: Boston, Rennes, and Livingston
- Capital participation: Warsaw

Measurement car

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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.

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

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- World’s first* mass production and delivery of chopper control system

#### 1960
- Commencement of sale of automatic train supervision
- OFC evaporative cooling rectifier
- Regenerative inverter

#### 1970
- Delivery of Japan’s first* VVVF inverter for 1500V catenary
- VVVF inverter for 1500V catenary
- Flywheel-type train line power storage equipment
- Converter-inverter applying IPM semiconductors (First for Shinkansen*)

#### 1980
- Delivery of converter-inverter applying IPM semiconductors
- Power devices (IGBT modules, IPM, SiC power modules, etc.)
- Chopper control system
- CFC evaporative cooling rectifier
- Regenerative inverter

#### 1990
- Delivery of converter-inverter applying IPM semiconductors
- Totally enclosed induction motor
- Station Energy Saving Inverter (S-EIV)

#### 2000
- 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
- Train Vision

#### 2010
- Marketing of world’s first* VVVF inverter using SiC
- WVF Inverter using SiC
- Auxiliary power supply using SiC
- Station Energy Saving Inverter (S-EIV)

*According to in-house survey conducted in March 2017