

Railway Systems



1 Class 385 exterior (top) and interior (bottom)

1 Class 385 for the International Market

In March 2015, the Hitachi Group won a contract for the provision of 234 Class 385 railcars (46 train sets of three cars each and 24 train sets of four cars each, for a total of 70 train sets), including 10 years of maintenance, from railway operator Abellio. The contract is being financed by UK-based Caledonian Rail Leasing Limited.

The Class 385 was originally developed as the AT-200 commuter train platform, which is part of the global A-train series of rolling stock. The Class 385 will operate on all services in Scotland run by Abellio under a franchise deal, including lines under the Edinburgh Glasgow Improvement Programme (EGIP).

By further expanding the global A-train semi-made to order series of rolling stock and providing rolling stock that meets the needs of railway operators while maintaining competitive lead times, the Hitachi Group plans to expand sales of the new Class 385s and other rolling stock not only in the UK market but also in the EU and emerging markets.

2 Use of Stationary Energy Storage System to Propel Trains in an Emergency

Since the Great East Japan Earthquake, railway operators have been examining how to evacuate passengers safely in the event of power interruption. In trials run in collaboration with Tokyo Metro, Co., Ltd. in 2014,



2 Stationary energy storage system chopper panel and new auxiliary power supply panel (far right)

Hitachi demonstrated the ability of a train to propel itself to the nearest station using only lithium-ion batteries in an emergency.

Based on the results of these trials and after exhaustive consultation and examination with Tokyo Metro, Co., Ltd., Hitachi has developed a stationary energy storage system that can also be used to propel a train in an emergency. The new system combines a self-sufficient power supply system needed to propel the train in an emergency, a function for switching to emergency travel mode, and an improved charging/discharging direct current (DC) to DC converter.

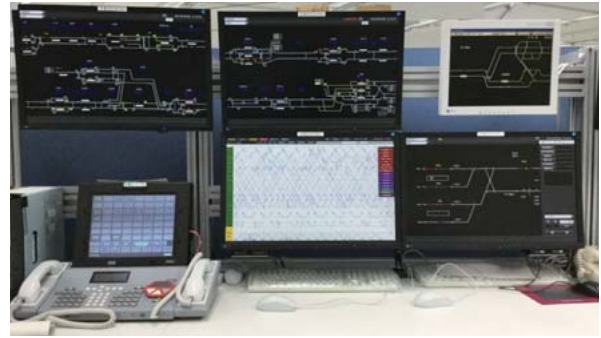
The system was delivered to the Kasai substation on the Tokyo Metro Co., Ltd. Tozai Line and went into operation in March 2016. Consequently, Hitachi's stationary energy storage system product line-up now includes a new system that can be used to propel a train in an emergency in addition to an energy-saving system and a system to prevent regeneration lapses.

In meeting various requirements for improvement in functions, Hitachi plans to further develop the stationary energy storage systems so that they can be used both to save energy and to evacuate passengers safely in an emergency.

3 Adoption of ATOS on the Keiyo Line

East Japan Railway Company's autonomous decentralized transport operation control system (ATOS) is a railway operation control system adopted on high density railway lines in the Tokyo region.

ATOS was installed on the Keiyo Line between Tokyo Station and Soga Station in September 2016. Adoption of ATOS on the Keiyo Line linked the systems of the Keiyo Line and the ATOS-enabled Musashino Line made it easier for controllers to input operation arrangements, speeded up train rescheduling through



3 Control desk for Keiyo Line

the use of forecast schedules (information about the status of services in the future having delays, etc. into account), and automated operations for notifying train crews and stations and managing maintenance work. Adoption of ATOS also improved passenger information services, making it possible to display more detailed information on train departure boards.

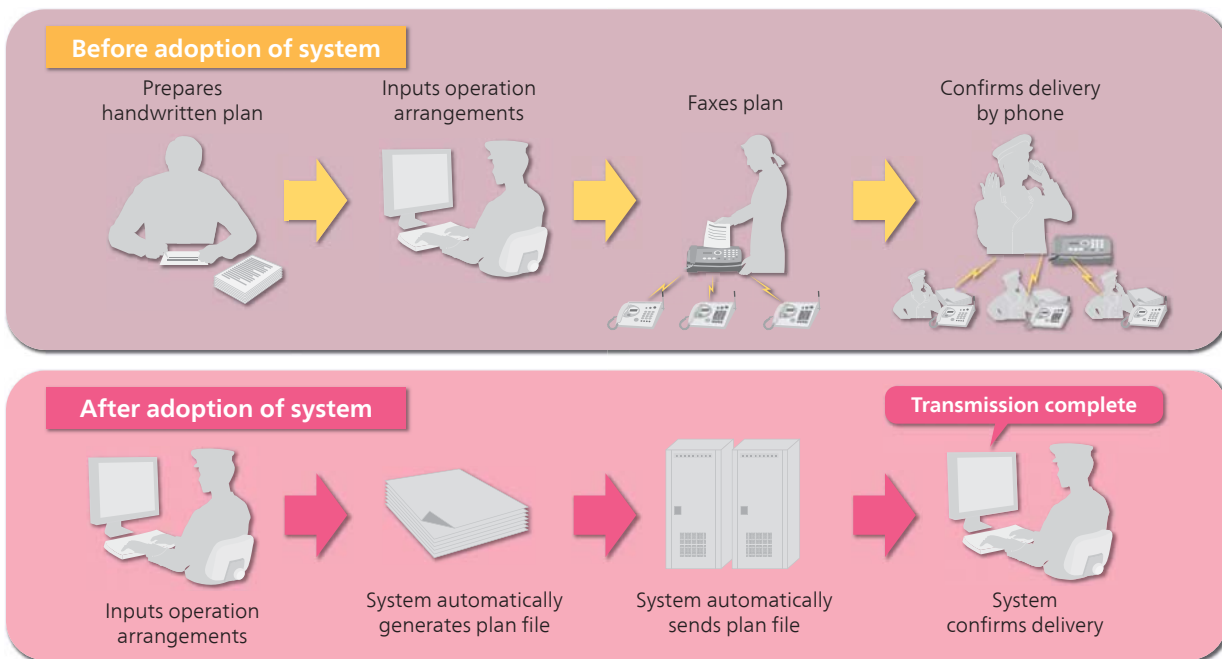
The ATOS installed on the Keiyo Line also has a new function that uses forecast schedules in passenger information, making it possible to display an estimated time of departure for example "Approx. 08:40" on departure boards even when schedules are disrupted.

4 East Japan Railway Company Operation Arrangement Plan Communication System

In October 2016, an operation arrangement plan communication system was installed in the ATOS of East Japan Railway Company with the aim of increasing the efficiency of control operations. In the event of transport disruption, controllers set out details of planned operation arrangements in operation arrangement plans, which serve as a tool for communicating planned operation arrangements to stations and other relevant sites.

The new system automatically generates operation arrangement plans following the input of operation arrangements into information terminals. It automatically sends the plans to recipients selected based on the input data, and can also confirm delivery of the plans to senders' information terminals. Before the introduction of the system, controllers prepared handwritten plans, selected recipients by themselves and manually faxed the plans. Its delivery was confirmed by controller phone. Adoption of the new system has significantly reduced the workload of controllers and enabled fast, accurate information communication that does not depend on the proficiency of controllers.

East Japan Railway Company adopted the new system on the Yokohama Line initially and plans to roll out the plan to the Keiyo Line and other lines in the future.



4 Comparison of operations performed by controllers before and after adoption of the operation arrangement plan communication system

Hitachi will continue helping to improve transport control operations based on a detailed understanding of customer needs.

5 Visual Information System for the New E235 Yamanote Line EMU

East Japan Railway Company has added the new E235 electric multiple units (EMU) for the Yamanote Line into service.



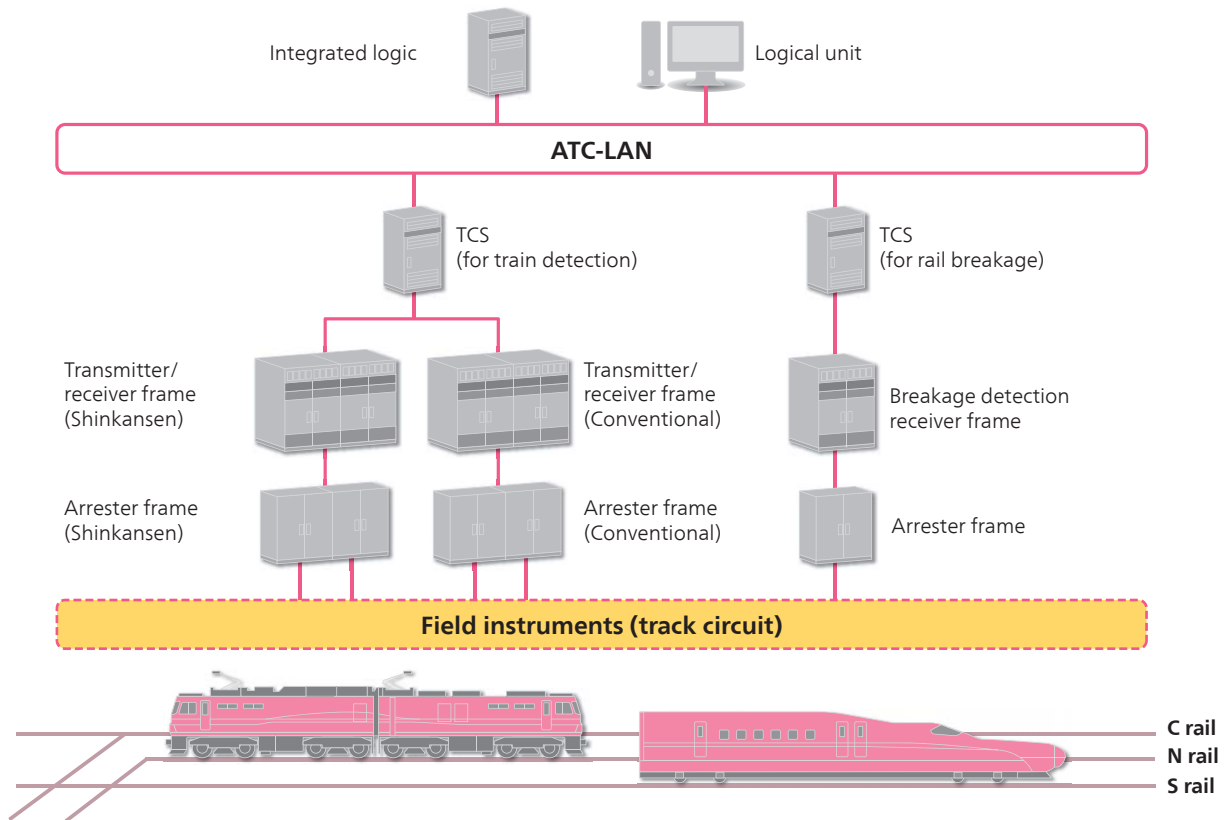
5 Display device with content stretched across three screens (top) and display of passenger information for Yamanote Line inner loop train (bottom)

Hitachi developed a new visual information system (VIS) for the digital signage installed at stations, etc. and produced and supplied the system for the prototype E235 Yamanote Line EMU. Based on the specifications and service functions of the previous system, this new VIS has improved digital signage functions, with three-screen display devices above the windows as well as display devices at the end of cars. Using software that simultaneously processes displayed images, these display devices can simultaneously display train ads, and the content stretches across the three screens. The passenger information shows the loop line and is designed so that passengers can tell at a glance whether the train they have boarded is an inner loop train or an outer loop train. The VIS also uses 3D icons for station facilities, which is proving popular. This new E235 series with enhanced digital signage functions will be phased into Yamanote Line services from FY2017.

6 Hokkaido Shinkansen Signal System

On March 26, 2016, when the Hokkaido Shinkansen opened, digital communication and control for Shinkansen automatic train control (DS-ATC) system appropriate for the three tracks of the Hokkaido Shinkansen, which Hitachi supplied to Hokkaido Railway Company, entered service.

The Hokkaido Shinkansen between Shin-Aomori and Shin-Hakodate-Hokuto stretches 148.8 km and around 82 km of this is dual-gauge using both Shinkansen and conventional lines. This dual-gauge section adopts a



GW: gateway, TCS: track communication server, LAN: local area network

6 Configuration of DS-ATC system for three tracks

special three-rail configuration with an S (standard) rail, an N (narrow) rail, and a C (common) rail. The Shinkansen runs on standard-gauge track (S rail and C rail) while conventional trains run on narrow-gauge track (N rail and C rail). However, the following technological challenges had to be overcome to achieve this.

- (1) Attenuation of signal current and deterioration of train detection characteristics of track circuits that detect trains due to interaction of the three rails.
- (2) Increase in interference noise arising from asymmetric track circuit configuration.
- (3) Development of a new system to detect breakage of the common rail, which is not needed in a two-rail configuration.

Based on the DS-ATC system supplied to East Japan Railway Company, the new system overcomes the above technological challenges and is the first signal system in the world to enable services on both Shinkansen and conventional lines.

7 AC BEMUs for Kyushu Railway Company and East Japan Railway Company

Kyushu Railway Company put battery electric multiple units (BEMUs), which are powered via overhead alternating current (AC) power lines, into operation in

October 2016, as the next generation of trains to replace diesel trains. Equipped with storage batteries, the AC



7 AC BEMU (top) and main circuit storage battery (bottom)

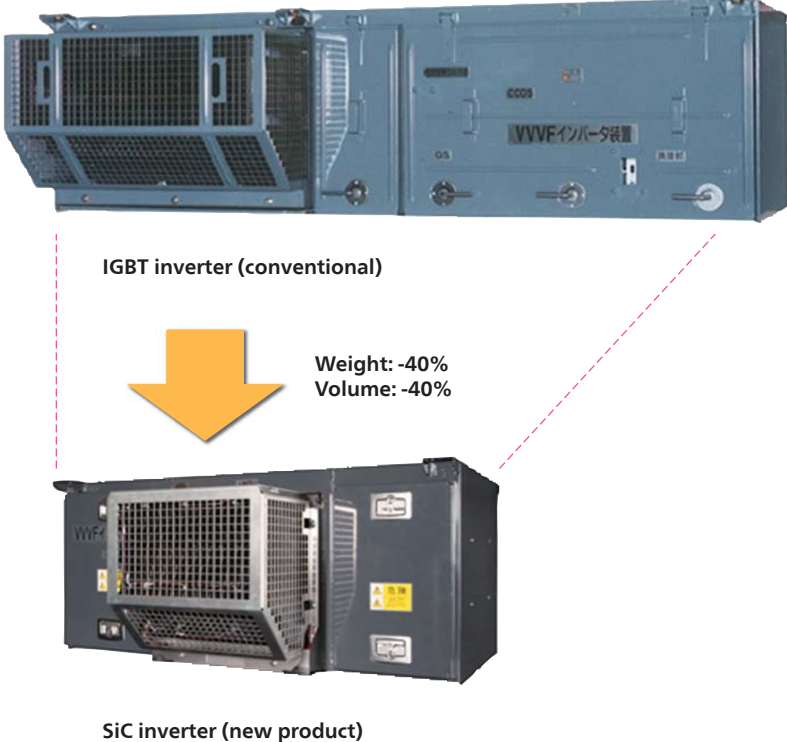
BEMUs are more efficient and quieter than conventional diesel trains and also require less maintenance. The AC BEMUs run in the same way as conventional AC electric trains on electrified sections and use the energy obtained by charging their batteries from AC overhead power lines to run on non-electrified sections. Besides charging their batteries through the overhead power lines, the AC BEMUs also use regenerative braking to charge their batteries. A totally enclosed fan cooled motor is used as the main motor to minimize noise and maintenance, while Synaptra using Ethernet communication is adopted as the train information control system. Through the standardization of basic operation functions, the AC BEMUs operate in the same way as electric trains even on non-electrified sections and can run on sections that are going to be electrified in the future. The car design is based on the design concept “friendly to people, the earth, and the future.”

AC BEMUs based on those operated by Kyushu Railway Company and customized to withstand cold and snowy conditions are expected to be introduced to East Japan Railway Company’s Oga Line in the spring of 2017.

8 SiC Inverters for Rolling Stock

By adopting silicon carbide (SiC) power devices, Hitachi has reduced the size of SiC modules and cut power loss. A 3.3 kV/1200 A SiC module was developed, achieving approximately two-thirds the size of a conventional insulated gate bipolar transistor (IGBT) with the same output power density. Meanwhile, Hitachi has also developed a cooling system that improves the cooling efficiency of the power device and reduced the weight of the inverter by 40% compared to a conventional IGBT inverter through the use of fewer components.

By extending the regenerative braking area, thus minimizing the use of air brakes, and reducing energy consumption rate by reducing energy loss, Hitachi has succeeded in developing a high efficiency propulsion system. With a focus on harmonic losses of the induction motor, which account for a large percentage of total energy loss, Hitachi developed the optimal induction motor structure for reducing these losses and the optimal pulse width modulation (PWM) control system, thus reducing energy consumption. Field testing on commuter lines demonstrated that the developed system reduced energy consumption rate by 37.1% per unit compared with conventional systems.



8 Conventional IGBT inverter and new SiC inverter