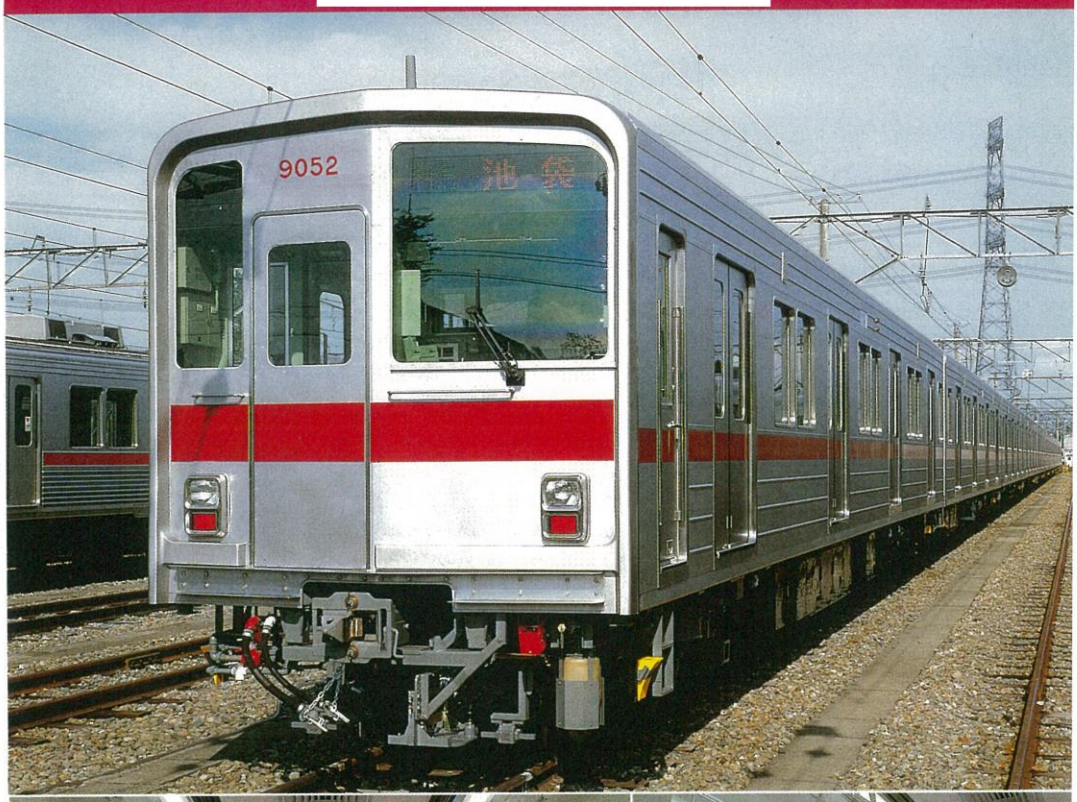
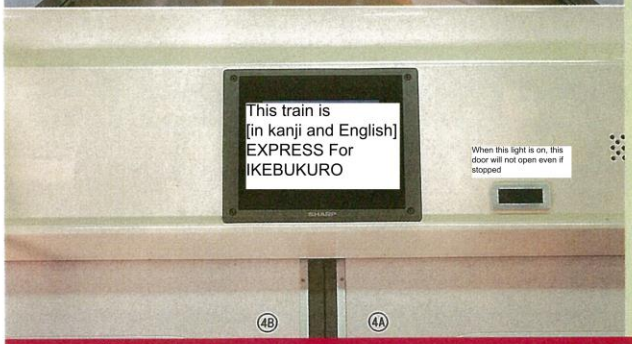
Tobu Railway 9050 Series Railroad Car





Upper left: passenger compartment
Upper right: wheelchair area
Lower left, lower right: LCD device in car

For details, see pages 26 to 29

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Tobu Railway

9050 Series Railroad Car

1. Introduction

Through service between our Tojo Line and the Tokyo Metro Yurakucho Line began in August 1987, and straight-through operation is underway between the city of Kawagoe (in part, forest parks) on the Tojo Line and Shin Kiba on the Tokyo Metro Yurakucho Line. The Tojo Line is a section that is used by many passengers, mainly for commuting to work or school in the morning and evening, and on the weekends for sightseeing trips to the city of Kawagoe and Musashino Ridge Forest Park etc. Recently, with the opening of Ikebukuro station on the new line, the train schedule has been revised to provide greater transportation capacity, and we have introduced double 9050 series trains with 20 cars. The following is an overview of these changes.

2. Basic concept

The 9000 series railroad car, which was the predecessor of the 9050 series railroad car, was our first all-stainless-steel railroad car, beginning in 1981 as a prototype single-car train, and it is currently in operation as an eight-car train. It is a railroad car made for lighter weight, energy conservation, and improved riding comfort, notable as the foundation for the current plans for general commuting railroad cars. The 9050 series railroad car, which inherits the design concept and knowhow of the 9000 series railroad car, emphasizes the basic concepts of “brightness” and “urban feeling” along with the provision of modern services in a more-pleasant railroad car, with LCD in-car displays, automatic broadcasting equipment, and space for a wheelchair etc. In addition, VVVF inverter controllers, IGBT SIV devices, AC compressors, and other devices have been adopted for further energy saving and maintenance-free operation.

3. Main specifications

The composition is fixed at ten cars, and as in the 9000 series, [the MT ratio] has been set to 6M4T. VVVF controllers are aboard cars M_5 and M_7. IGBT SIV devices, two of 140 kVA and one of 120 kVA, are aboard cars M_6, M_8, and M_9, and three AC compressors are also installed on these same cars, for proper load balance. Tight lock couplers (rotor type) are present between T_3 and M_7 and between M_8 and T_4 for scheduled inspections at the factory. The front coupler was made a rotor-type coupler, which under the train-changing agreement is not used by our company, so in order to allow cars that have an automatic coupler to be connected together in the event of an abnormality, a simpler coupler is provided under the floor of both leading cars. In addition, to be ready for a case in which railroad cars that have different brake systems are to be operated joined together, an emergency brake conversion device and an emergency coupling plug are mounted on both so that continuous braking can be used.

4. Structure of the car body

The frame is made mostly of stainless steel (SUS301L-H). And for rigidity and lowering the center of gravity, concave material of a thickness 4.5 mm and a height 175 mm is used for the side beams. The structure is a stainless steel structure of reduced weight, a double finish process (pearskin finish) is applied to the surface of the side external plates, and a bead-formed worked material is used for the wainscot paneling and frieze boards. For the roof structure, 0.6-mm-thick bead-formed material is effectively used, so by eliminating the vertical through material, the weight is reduced and the center of gravity is lowered. Providing a royal maroon strip on the external panels below the windows, together with the use of bead-formed material, results in a composition with a clean look. At the front, considering the front field of view, as much of the front window area as possible is taken for the driver’s seat, resulting in an appearance that is asymmetrical left and right, and an accent strip is shown with the same color as on the side, matching the angular headlights to convey a modern feeling.

5. Passenger compartment

In the passenger compartment, decorative panels of a basically white tone and the matching brown tones of the flooring and bench upholstery combine to create a bright, soft feeling. The very comfortable seats are delineated with a seating pattern that gives each passenger a roomy width of 450 mm. The flooring is two color tones, with marble-like brown in the middle and solid-brown foot lines on the sides. To help passengers who have difficulty in getting around, the silver upholstery of priority seats distinguishes them from ordinary seats. And each train has two areas to accommodate wheelchairs. Each such area is equipped with an interactive emergency information device for talking with the train crew, who when something abnormal happens will be able to correctly ascertain the situation and take prompt and proper action.

The cooling equipment is of concentrated dispersion system in which four units of 10,500 kcal/h each are positioned in each car in the longitudinal direction of the car body, with a sweep fan grill in the middle and, on its left and right, two grills that blow out cool air, so as to obtain an even distribution of air, coordinated with the fluorescent

lighting, the grab-strap bars, and the pipe-type storage racks, for a clean look. The cooling equipment has roll filters, for better serviceability. By changing the height of the floor surface from the former 1,175 mm to 1,150 mm, the ceiling has been raised by 25 mm, giving the railroad car an open feeling. The side entrances were raised by 30 mm to 1,830 mm, thereby accommodating the taller physique of today's passengers; also, better measures were taken to prevent drafts from the gaps in door pockets.

The side windows are of unit construction in which one pane is lowered, and the former schlieren method balancer type has been changed to a spiral balancer type for improved serviceability. Also, for safety, for the window in the wheelchair area, the window opening dimension was set to 1,400 mm from the floor level, to fit the subway specifications.

6. Crew compartment

For the crew compartment, much attention was given to crew comfort, operability, and visibility, adopting an appearance in which the front window is larger, and asymmetrical left and right. Thus, to ensure a good field of view, a large windshield wiper with a built-in washer has been installed. The various equipment was mounted concentrated together as much as possible, thus improving the appearance, and oriental green was uniformly adopted for the color of the various equipment and the applied cosmetic color.

The main controller and brake controller are attached to a console table, and arranged in the middle of the table are a clock stand and switches that are frequently used by the crew. For clear visibility, the front clock face and display lights are painted with a matte dark-gray color.

7. Main equipment

(1) Controller

A VVVF inverter has been adopted as the controller for better riding comfort due to smooth acceleration and deceleration, maintenance-free operation due to the absence of contacts, improved reliability, and lower power consumption due to high-efficiency regenerative brake. The main constituent parts include an inverter, a line breaker box, a filter reactor, and a control relay box and the like. In the main control elements, eight induction motors are controlled by a PWM inverter for each voltage-type, which uses 4,500-V, 4,000-A high-voltage-resistant, large-current GTO thyristors. Cooling of the semiconductors for the main circuitry is done with a heat pipe cooling system that makes use of the wind caused by the motion of the train,

Main specifications

Item	Content
Type of car	ordinary railroad passenger car, DC 1500 V, control car, motor car, add-on car
Train composition (10 cars fixed, 6M4T)	TC3 M5 M6 T3 M7 M8 T4 M7 M9 TC4 + 9150 9250 9350 9450 + 9550 9650 9750 9850 9950 9050 rotor type tight lock automatic coupler rod type coupler
Between tracks Electrical system Weight (tons) and capacity (number of persons)	1067 mm DC 1500 V, overhead wire type TC3 M5 M6 T3 M7 M8 T4 M7 M9 TC4 Total 30.0 37.5 36.5 26.0 37.5 36.0 26.5 37.5 36.5 30.0 334 141 152 152 152 152 152 152 152 152 141 1498
Acceleration and deceleration	acceleration 3.3 km/h/s, deceleration (usual) 3.7 km/h/s, (emergency) 4.5 km/h/s
Top speed	110 km/h
Maximum dimensions	20000 mm (distance between coupling planes) x 2800 mm (width of car) x 4040 mm (height) 4145 mm (pantograph-folded height) 2878 mm (distance between side lights)
Distance between bogie centers	13800 mm
Platform car	bolsterless air spring platform car (SU type axle box suspension type) pulling device: Z-link system TRS-94M (SS141) type treading surface single brake system TRS-94T (SS041) type treading surface single brake system
Coupling devices	rotor type tight lock automatic coupler and rod type coupler, each with rubber shock absorber
Main motor	three-phase squirrel-cage induction motor, model TM-92 150 kW, 1100 V, 102 A, 1430 rpm, frequency 48.8 Hz
Drive unit	solid-shaft parallel cardan system (TD coupling type) model TD-88 gear ratio: 87/14 = 6.21, cog width 85 mm, modules 7, pressure angle 26 degrees, helix angle 18.5 degrees
Controller	VVVF inverter control system, (with regenerative brake, with variable load)
Brake devices	all-electric command type electromagnetic straight-through air brake, model HRD-2A also uses regenerative brake, with safety brake and pressure suppression brake device
Electric air compressor	AC compressor (with starting controller) model SIM-HS20-12 (with dehumidifier, dehumidifier heater) AC 220 V, 15 kW, 50.5 A, 1765 rpm, 2180 Q/min, 3 units/train
Current-collecting equipment	underframe crossing type model PT-4815, slide plate made of alloy (also using a lubricant) spring rising type, with pneumatic lifting device, pneumatic lowering type, 3 units/train
Auxiliary power source	stationary three-phase inverter (IGBT-SIV) system, with electricity receiving and supplying device 190 kVA x 2 units, 120 kVA x 1 unit
Spare power source	plastic bond type storage batteries, 100 V, 56 AH x 2 units, 37 AH x 1 unit
Door closing device	double-action door closer (biparting mechanism) model DP-45DS with non-contact door closing detector, door closing safety device, reopening and -closing device, middle door closing device
Lighting equipment	Lights inside the car: alternating current fluorescent lamps, AC 220 V-40 W, or direct current fluorescent lamps DC 100 V-40 W Lead car: 23 lamps (including 4 lamps in each compartment that also serve as spare lamps, and 1 lamp for the operation compartment) Middle cars: 24 lamps (including 4 lamps in each compartment that also serve as spare lamps) Headlights: sealed-beam lamps, DC 100 V, 200 W/150 W, 2 lamps, with non-contact controller Rear lights: LED type
Cooling equipment	concentration-dispersion type, 10500 kcal/h/unit (model RPU-3002AJ, B), 4 units/car with combined switching circuit for heating and cooling, with roll filter
Heating equipment	Passenger compartment low-voltage reflecting type sheath heater Lead car: AC 220 V-900 W x 14 units Middle cars: AC 220 V-900 W x 16 units Car with wheelchair: AC 220 V, 900 W x 12 units, 1300 W x 3 units Crew compartment: far-infrared heater 250 W x 1 unit, sheath heaters 500 W x 2 units far-infrared heater 500 W x 1 unit (near conductor)
ATC/S equipment	Multi-information variable frequency type ATS and high-frequency continuous track circuit type, ATC responsive integrated type triple system
Wireless equipment	Train radio: space wave wireless system (interactive and preventive), inductance wireless (for Tokyo Metro lines): (interactive and preventive)
Broadcast equipment	Dispersed amplification type to deal with background noise, speakers within car, 3S2P With automatic broadcast equipment, outside-of-car speakers 4 units/car, door-closing buzzers 8 units/car
Monitors	Microcomputer control system, with matrix display
Emergency communication equipment	pushbutton system, interactive system (wheelchair area only) monitor display linkage
Display lamps at side of car	4 lamps/car, LED type with 2 lamps on one side (car side lamps and emergency indication lamps)
Displays for type and destination	LED display type, SPC control system
In-car displays	LCD display type, SBC system, 8 units/car display content (type, destination, next-station information, train-changing information, etc.)
Electric couplers	Multi-core type, 144 cores, 19 cores, and YH connector system

and a [CFC-free] cooling medium is used in order to deal with environmental problems. The GTO drive device adopts a system without a pulse transformer, for smaller size and lighter weight, and for signal transmission from the microprocessor amplifier, optical fiber is used, which offers superior noise insulation and high-voltage insulation, for better reliability. A modulation pulse number switchover system is adopted in order to reduce the unpleasant electromagnetic sounds and changes in timbre caused during pulse mode modulation upon startup. This makes it possible to suppress the transient torque fluctuations that occur when pulse mode switching is done, and produces better riding comfort as well.

Used for the main motor is a 150-kW high-output induction motor, in consideration of the high acceleration on the Tokyo Metro lines and the high travel speed on our company's lines. Also, by choosing the same VVVF devices and main motors as in the 20050 series, it has been possible to reduce the need for spare parts.

(2) Brake equipment

What is adopted for the brakes are all-electric command electromagnetic straight-through air brakes with supplementary air brakes also used for regenerative braking. Four types of brakes are provided: off valve type ordinary brakes, emergency brakes, safety brakes, and suppression brakes. They are made up of parts such as a brake controller, a brake command unit, a brake control device, an electropneumatic amplifier, and a brake relay. The brake controllers are of non-contact type, which improves operability, and a brake command unit is provided under the floor as the output unit. In the ordinary brake, normally three pressure-applying command lines are controlled by a digital command with a pure binary ON-OFF choice, providing seven levels of braking. In the emergency brake, normally two pressure-applying lines, + and -, are pulled through in reciprocation, to prevent touching together and to improve reliability. The safety brake, which normally is made up of pressure-applying circuitry, is constituted independently of the ordinary and emergency brake systems, and only if this is impossible after operation of the emergency brake does it operate automatically independently in each car as a backup brake. For improved reliability, as brake monitoring circuitry, various circuits are provided for detection of braking failure, detection of failure to release the brake, a function for forcibly releasing the brake if it fails to be released, detection of reduction in basic air pressure, and the like.

(3) Motor-driven air compressor

What was adopted for the motor-driven air compressor is a low-noise air compressor that runs on an AC 220 V power source and employs a shim-type three-phase induction motor having easy startup control. Using a shim-type motor is meant to improve reliability and serviceability. Reliability is also improved because an after-cooler and dehumidifier are both provided, and the brake is supplied with compressed air, without a drain.

(4) Auxiliary power unit

Adopted for this device is an IGBT (insulated-gate bipolar transistor) type SIV device that uses an IGBT as its main control element. It is made up of an inverter, a starter, a reactor transformer box, etc. The inverter part can be made smaller, lighter, and simpler because with the IGBT element being of the voltage drive type, the gate control power is low and the circuitry can be simplified, it can be turned on and off at high frequency and thus the output waveform is nearly a sine wave, allowing the waveform rectification circuitry to be simplified, and being a molded element, it can be built in to easily make a cooling structure. The starter is of the type in which the job of cutting off the current in an accident is done by a thyristor, so the circuit breaker is no longer responsible for blocking large currents, and therefore a small electromagnetic contactor can be used, allowing a smaller size. The magnetic noise of the transformer is reduced by inserting a filter for inverter output waveform rectification in a prior stage of the output transformer inside the reactor and transformer box.

A power receiving and supplying device is a device that supplies power only to the important loads from the normal side when power generation becomes impossible due to a breakdown of an SIV device; power is supplied semi-automatically by operating a power receiving and supplying switch that is provided behind the operator's seat.

(5) Displays and automatic broadcasting equipment

The destination displays on the front and side that display the type of train and the destination have changed from the former motor-wound type to the high-brightness LED type, for better visibility. To save energy and prolong useful life, the destination displays on the side have been given the function of automatically turning off their display between stations, where the need for such display is questionable.

As an in-car guidance device, a nine-inch liquid crystal monitor is provided above the side doors in each car; visually, they provide improved service by displaying the destination, the type of train, the stations the train will stop at, and other information. Consideration has been given to making this monitor easy to see from the seats as well, by mounting on the lintel inspection cover, which is formed from fiber-reinforced plastic (FRP), and tilting it at an angle of 30 degrees from the vertical.

The broadcast device is of automatic broadcast type; besides the basic broadcasting of announcements about the destination, the stations where the train stops, and information about changing trains, it also broadcasts warnings when the emergency brake operates. Also, the broadcast device adopts an automatic volume control system that can vary the loudness to correspond to changes in the background noise, making it possible to make announcements at the right volume for the noise inside each car. The opening and closing of doors is given a relatively large weight among matters concerning the safety of passengers and the railroad car, and consideration has been given to further reducing accidents when doors are opened and closed; functions have been added with which, when the doors are closed,

the conductor's voluntary operation of a departure signal switch sounds a departure signal buzzer and the announcement, from a speaker outside the car, that the doors are about to close, and when the doors are about to open or close, a corresponding chime is sounded from the door speakers.

A combined control system from the display device command unit is used for the destination display devices, the in-car [passenger] guidance devices, and the automatic broadcasting devices. In addition, the display device command unit and the train information device command unit are made compact, to improve operability and to ensure [adequate] space for attaching the equipment.

(6) Emergency reporting device

Besides putting two emergency reporting devices of the same buzzer type as previously in each car, an interactive emergency reporting device has been put in the wheelchair area, making it possible to communicate with the crew. In this operation method, upon pressing a reporting button (with a clacker plate) in the reporting device, an emergency reporting buzzer sounds in the caller's car and in the crew compartment. Then, upon pressing a confirmation button on the report receiving device in the crew compartment, the buzzer stops, a communication display light lights up, and two-way communication can be conducted. Resetting when the conversation has ended can be done from the crew compartment.

(7) Platform cars

A bolsterless platform car having no bolsters was made, to lighten the weight and provide maintenance-free operation. A Z-link type pulling device was adopted, to improve riding comfort.

In the axle-box suspension, two horizontal flat springs are attached above and below between the axle-box and the platform car frame, and with the proper degree of left-right rigidity, with respect to the front-rear rigidity, excellent properties can be maintained. In addition, U-shaped shock absorbing rubber can suppress front-rear and left-right rocking while maintaining high-speed stability

8. Conclusion

The 9050 series railroad car was introduced on operating rail lines in December of last year. We expect that providing passengers with these pleasant cars will enhance the image of Tobu Railway. And we hope that everyone will continue to favor us with their patronage.

Finally, we wish to express our gratitude to everyone in the supervisory agencies and in related positions for their guidance and unstinting efforts in the design and production.

(Toshiya Yoshino, Car Section, Operation Car Department, Tobu Railway (Ltd.))

Housing and Urban Maintenance Public Corporation

The Model 9100 Railroad Car

1. Introduction

The Housing and Urban Maintenance Public Corporation, together with beginning operation on part of the corporation's second-period line in spring of 1995 (planned) (a 4.7-km stretch between Chiba-Newtown Central station and Insei Makinohara station), has created a new type of railroad car, the model 9100 (double 8 car train, totaling 16 cars). The new car is affectionately called the "C-Flyer". The C is the first letter of Chiba-Newtown, Comfortable, Clean, and Culture and the like, and "Flyer" means a rapid train or express train.

It was designed and produced to enhance the image of Chiba-Newtown and to provide functions as a railroad car in the pursuit of convenience and comfort. Since the public corporation railway began operations in 1984 between Komuro and Chiba-Newtown Central (4.0 km), we have worked to ensure transportation for the residents of Chiba-Newtown, and in November 1992 we are beginning construction of a new line between the sections that are now in operation.

2. Basic design concept

The model 9100 railroad car was designed with the following points in mind.

(1) Enhancing the image of Chiba-Newtown

(2) Because maintenance and other operations will be entrusted to the Hokuso Development Railway, the underfloor and other equipment will be shared with the Hokuso model 7300.

(3) Nonstop service will become possible among the Hokuso, Keisei, Toei Asakusa, and Keihin express lines.

(4) Labor and energy will be saved, and high reliability will be achieved.

(5) Riding comfort will be improved, and noise will be reduced.

(6) Passenger service will be improved.

3. Train composition and main specifications

With an eight-car 6M2T fixed train composition, the performance is as follows.

(1) Acceleration: 3.5 km/h/s

(2) Deceleration: 4.0 km/h/s normally, 4.5 km/h/s in an emergency

(3) Designed maximum speed of car: 120 km/h

4. Car body

Except for the front part of the lead car and part of the frame, a lightweight all-stainless-steel structure was adopted (SUS301L, SUS304 steel) for the train body. The outer plates are given a dull finish that suppresses gloss, and there is a blue stripe on the hairline material in the edge on the side. The front part has a black and a silver metallic paint coating, and the paint on the side doors is blue in the wheelchair area and yellow in the cross-seat part, with the color of the door indicating the functions that that car has, so as to give a vivid impression.

To convey mellowness with a feeling of speed, the front of the lead car, with ordinary steel […]

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