4. Infrastructure Systems

4.1 Battery-Based Self-Traction System for Validation Test Vehicles for Next-Generation N700S Shinkansen Train of Central Japan Railway Company

Toshiba Infrastructure Systems & Solutions Corporation and Central Japan Railway Company ("JR Central") have jointly developed a battery-based self-traction system utilizing the SCiB™ lithium-ion rechargeable battery, targeted at the validation test vehicles for the N700S Shinkansen trains of JR Central. We have also jointly developed a system to recharge the battery unit from an auxiliary power supply unit.

As a result of tests conducted in July 2019 at JR Central's Mishima Railway Yard, we confirmed that the newly developed self-traction system delivers the required performance. This is the world's first battery-based self-traction system for high-speed railway vehicles(*).

It was necessary to comply with severe dimensional and weight constraints in order to install the self-traction system in the underfloor area of the N700S validation test vehicle. We therefore reduced the size and weight of the main circuit and other underfloor equipment, making it possible to optimize the arrangement of the underfloor equipment and thereby contribute to vehicle standardization. As a consequence, the number of N700S car types was reduced from eight to four. In addition to the 16-car formation for the Tokaido Shinkansen, the N700S now supports 8-car, 12-car, and other train formations without any need to change the basic design.

The battery-based self-traction system is normally charged from the pantograph through an auxiliary power supply unit. However, in the event of a power loss such as overhead line failure, a contactor disconnects the self-traction system from the auxiliary power supply unit so that electricity is supplied to the traction system from the self-traction battery system.

Even in the event of a prolonged power failure due to a natural disaster, etc., the Shinkansen train can run with the battery-based self-traction system to a location where passengers can easily evacuate. This will greatly contribute to improvement of the safety of the Tokaido Shinkansen in the case of abnormalities.

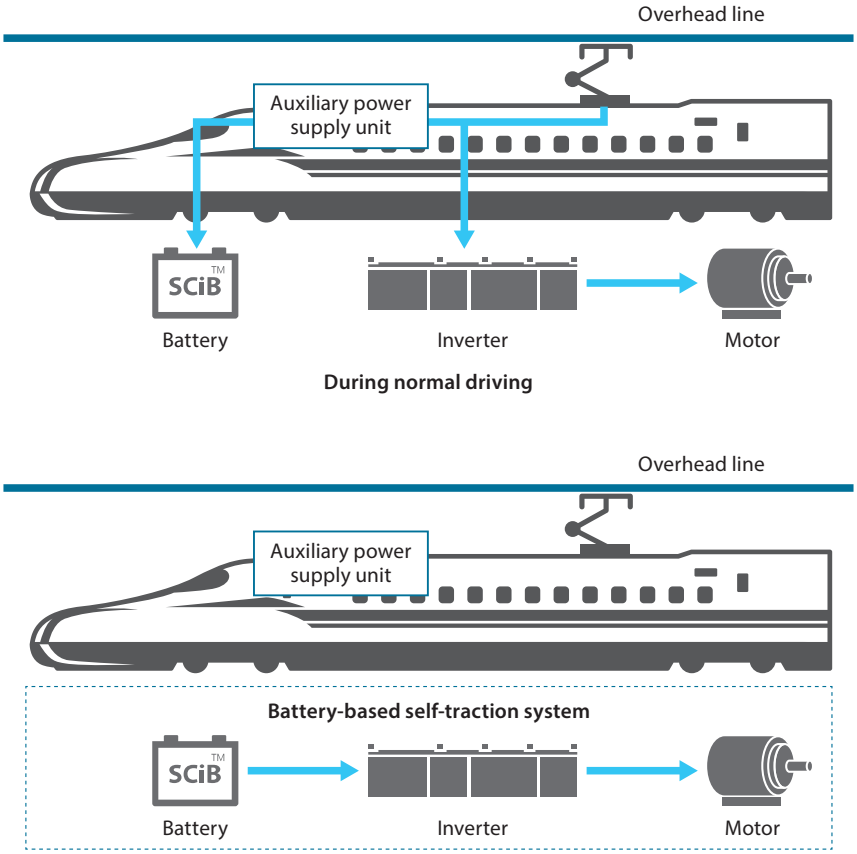
The battery-based self-traction system is planned to be utilized for mass-produced N700S cars, which will be put into commercial operation in July 2020.

(*) As of July 2019 (as researched by Toshiba Infrastructure Systems & Solutions Corporation)

Courtesy Central Japan Railway Company

Validation test vehicles for N700S Shinkansen of Central Japan Railway Company

Battery unit of battery-based self-traction system



Outline of battery-based self-traction system

4.2 Interconnected Operation of Multiple Traction Energy Storage Systems of Okinawa Urban Monorail, Inc.

On October 1, 2019, Okinawa Urban Monorail, Inc. extended its operating line by 4.1 km to Urasoe City. Accompanying this extension, two additional sets of traction energy storage systems (TESS), each with a rated power of 500 kW (maximum instantaneous power of 1 000 kW), were installed.

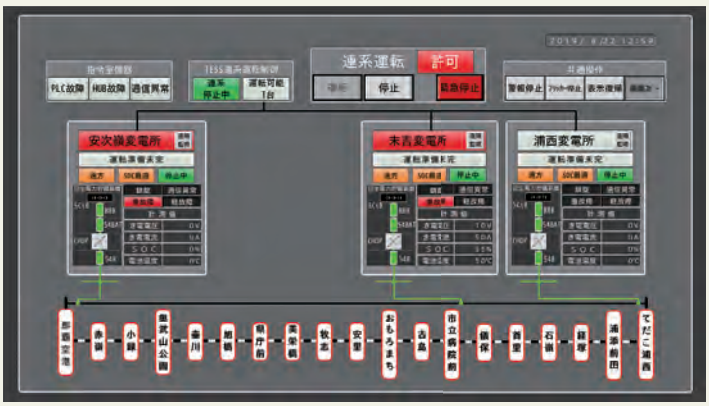
In the event of a wide-area power outage around the Okinawa Urban Monorail line, passengers need to be safely disembarked from trains stuck on elevated tracks between stations. The TESS supplies emergency power to the trains so that passengers can travel to the nearest station in the shortest possible time. Prior to the extension of the Okinawa Urban Monorail line, one set of TESS was sufficient to accommodate emergency train operations. However, with the line extension and an increase in the number of trains operated, three sets of TESS became necessary to increase the amount of emergency power supply. To realize the interconnected operation of all the TESS sets, it is necessary to switch the operation mode and start each TESS at each site. It is important to perform these multiple procedures accurately and quickly in an emergency situation.

To address this requirement, Toshiba Infrastructure Systems & Solutions Corporation has developed a remote controller incorporating an industrial computer and a programmable logic controller (PLC), which provides a simple and safe operating environment. The remote controller allows simultaneous monitoring of all the TESS sets on one screen and interconnected operation of all the TESS sets via a single button. During normal operation, the remote controller can be used as monitoring equipment for maintenance.

To further improve the reliability of the TESS during power outages, we have also developed and delivered an auxiliary power unit (APU) for TESS. The APU supplies control power using the battery of the TESS. Conventionally, DC control power is supplied from an external power source such as a lead-acid battery. However, the APU allows the TESS to generate a control power supply on its own, eliminating the need for an external control power source. This reduces the maintenance work required and achieves independent operation of the TESS.

We will continue to develop products that satisfy our customers' requirements and provide greater value to them.

4. Infrastructure Systems



Screen display

Equipment appearance

Remote controller

Traction energy storage system of Okinawa Urban Monorail, Inc.

Auxiliary power unit

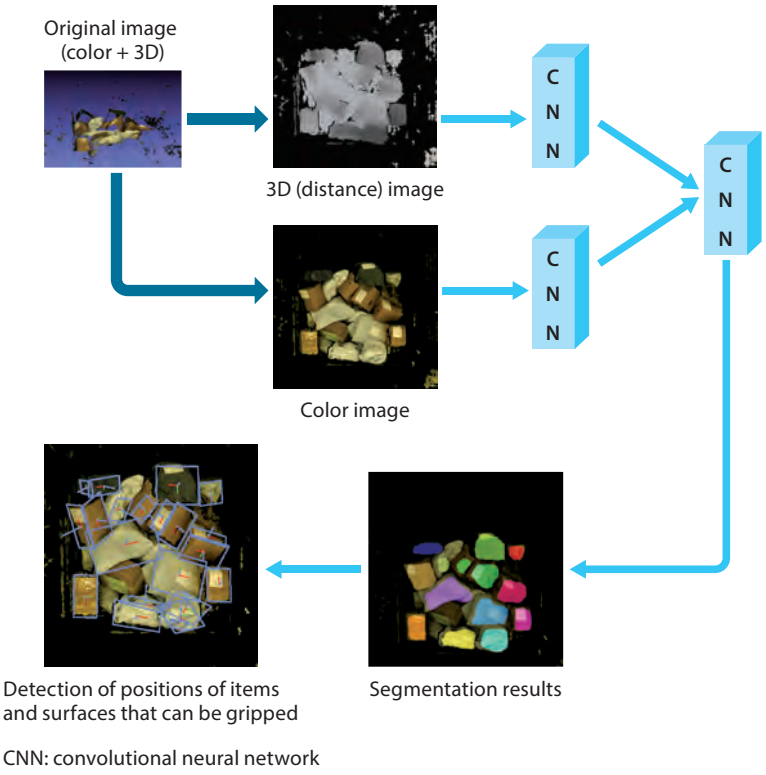
4.3 Depalletizer for Randomly Stacked Packages of Various Shapes

Depalletizer capable of handling randomly stacked parcels

Robotic process automation (RPA) has been increasingly deployed at factories and other manufacturing sites in recent years to compensate for labor shortages due to the declining birthrate and aging population. At the same time, the amount of cargo handled by the logistics industry has been increasing because of the rapid growth of e-commerce, making labor shortages even more serious. However, an obstacle to the application of RPA to logistics is the vast variety in the sizes, shapes, and weights of the packages to be handled.

Toshiba Infrastructure Systems & Solutions Corporation has been applying mechatronics and image recognition technologies to logistics and postal sorting machines for many years, to contribute to labor saving and meet customers' needs. In the field of logistics, we previously commercialized a depalletizer for neatly stacked packages. We have now developed a robot capable of unloading packages of mixed sizes, shapes, and weights without pre-training, with the aim of further enhancing efficiency.

Three technologies are essential for the robotic handling of such varied packages: (1) gripping technologies for securely holding packages, (2) planning and control technologies for accurate and efficient unloading, and (3) image recognition technologies for accurately grasping the position and posture of each package.

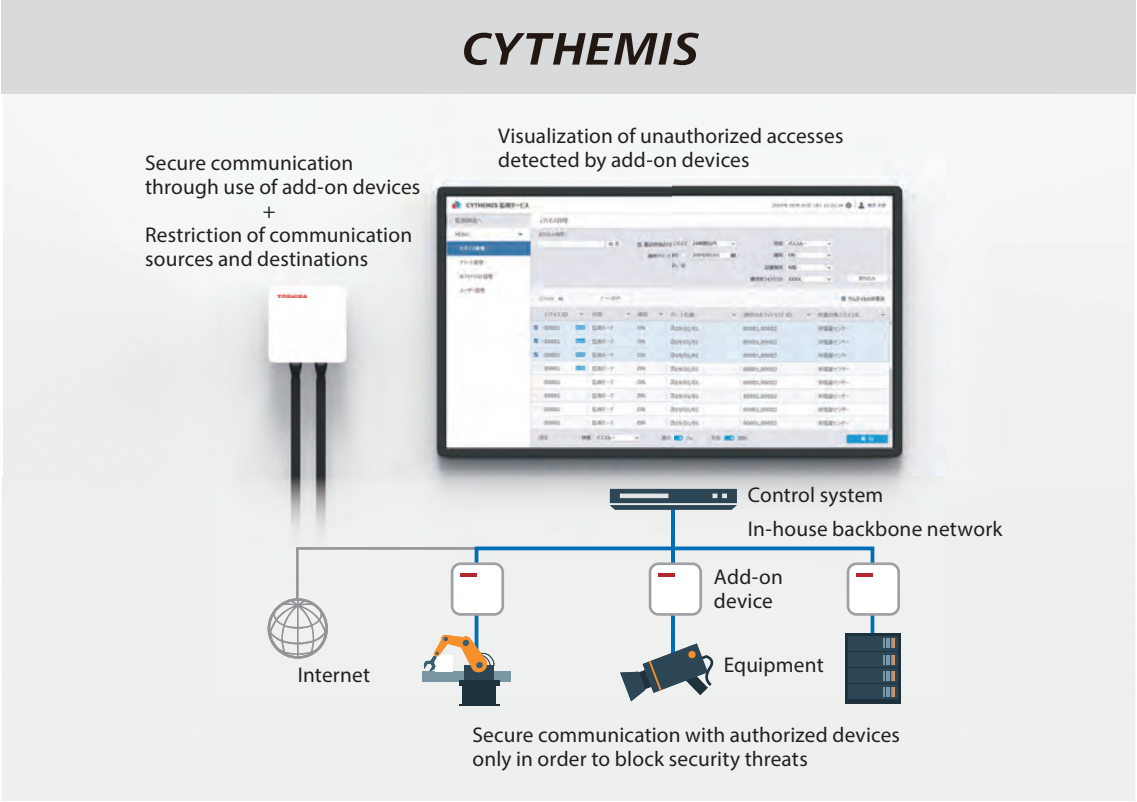


Algorithm to recognize individual parcels

To enhance gripping, we have developed a gripping hand that can reduce the stroke of suction pads and control them individually in order to handle inclined packages as well as packages of various sizes. As a result, the new gripping hand can handle packages inclined up to 15 degrees and with a maximum weight of 30 kg. In addition, we have developed planning and control technologies for the appropriate handling of packages, such as a technology to control suction pads according to the sizes and conditions of packages and a technology to prevent packages from being crushed. To improve the accuracy of image recognition, we have utilized color and three-dimensional (3D) cameras so as to combine color information from the color camera with spatial (distance) information from the 3D camera, increasing the amount of features acquired from the packages handled.

We will continue to develop robots that meet the needs of the market and contribute to RPA and labor saving in the logistics field.

4.4 CYTHEMIS to Add IoT Capability to In-House Standalone Devices



Configuration of CYTHEMIS IoT security solution

Many R&D systems operate in a standalone environment. For these systems, it is often impossible to update the operating system or apply security patches. Since such R&D systems might contain security vulnerabilities, they cannot be connected to the internal backbone network, making it difficult for them to communicate and cooperate with other devices.

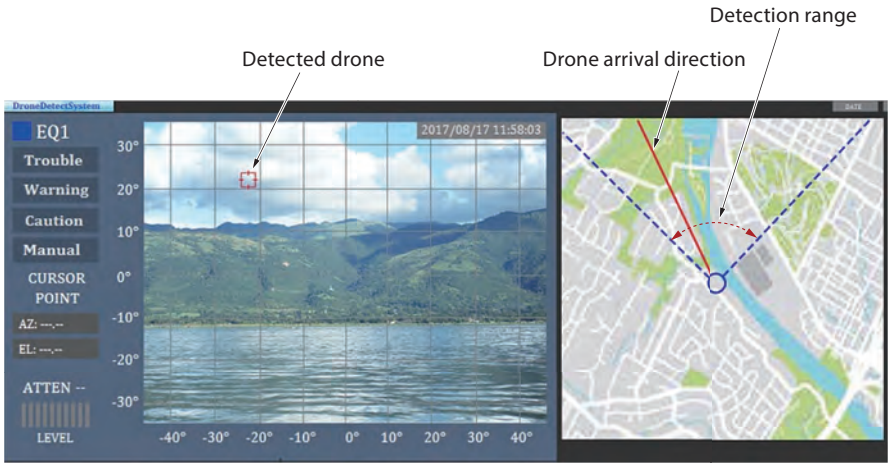
To solve this problem, Toshiba Infrastructure Systems & Solutions Corporation provides CYTHEMIS, an Internet-of-Things (IoT) security solution that consists of add-on devices for R&D systems and a central control system. CYTHEMIS provides an encrypted mutual authentication function and a communication whitelist function. We have now added an enhancement to CYTHEMIS that enables multicast communication.

CYTHEMIS makes it possible for R&D systems to be securely connected only to specific devices on the backbone network. It therefore prevents R&D systems with security vulnerabilities from making the backbone network vulnerable to malware, and conversely prevents a backbone network infected with malware from affecting R&D systems.

We have already received orders for CYTHEMIS from customers, and will promote the adoption of CYTHEMIS to other companies and organizations having similar problems.

4.5 Drone Detection System Utilizing Radio Signal Visualization Technology

Sensing device



Example of monitoring control terminal display

Toshiba Electronic Systems Corporation has developed a drone detection system applying a technology for radio signal visualization jointly developed by Toshiba Infrastructure Systems & Solutions Corporation and the Ministry of Internal Affairs and Communications of Japan.

The newly developed drone detection system consists of a sensing device equipped with an array antenna and a camera, and a monitoring control terminal. The array antenna can detect the direction of radio signals emitted by a drone. When a drone is detected, the drone detection system shows the direction of the drone on the monitoring control terminal by combining the radio signal position with a video image captured by the camera and issues an alarm, warning the operator of the presence of the drone. This system can also show the direction of the drone on a map.

Since the drone detection system provides a horizontal detection range of 90 degrees, four units can cover the entire circumference of a facility.

We will continue to enhance this detection technology to contribute to the reduction of the increasing threat of hostile drones.

4.6 Commencement of Commercial Operation of Mega Solar Farm Connected to 220 kV Grid Line

GNE Togo Mega Solar Farm of Global New Energy Togo Co., Ltd.

220 kV substation

The 25 MW GNE Togo Mega Solar Farm of Global New Energy Togo Co., Ltd. in Togo in the city of Hyuga, Miyazaki Prefecture, commenced commercial operation in January 2020. Serving as the prime contractor for this project, Toshiba Infrastructure Systems & Solutions Corporation completed the turnkey construction of the solar farm, including the site preparation, delivery and installation of power generation equipment, and electrical engineering work.

Since the planned site was located in a mountainous region, we blasted the hard bedrock and leveled the land for use as a solar farm site. Furthermore, we employed a crawler drill to drill holes in the hard ground in order to secure the solar cell stands to the ground.

This solar farm is the first one to be connected to a 220 kV grid line in the service area of Kyushu Electric Power Co., Inc. To realize the grid connection, we utilized a 220 kV gas-insulated switchgear, oil-immersed transformer, and digital protection relay supplied by the Toshiba Group.

Leveraging our experience in this project, we will continue to contribute to the expansion of renewable energy.

4.7 Flyaway VSAT Providing Improved Setup and Operability

New flyaway VSATs

Example of display supporting satellite look-angle adjustment

Conventional flyaway very small aperture terminals (VSATs) require a complex on-site uplink access test (UAT)(*1) prior to the commencement of operation.

We have now developed a flyaway VSAT that eliminates the need for the UAT. The newly developed UAT-free VSAT simplifies the setup procedure, facilitating the deployment and operation of satellite communications. In order to eliminate the need for the UAT, the VSAT had to have the capability to measure the correct polarization angle of the satellite radio wave. This was achieved by means of a display showing the three angles necessary for setup, namely, the azimuth, elevation, and polarization, calculated from the latitude and longitude acquired from a built-in global positioning system (GPS). The UAT is consequently no longer required, simplifying satellite acquisition.

The new VSAT also features a built-in modem commonly used for time-division multiple access (TDMA)(*2) systems, allowing its use to be expanded to various customers.

(∗1) The UAT ensures that the antenna polarization has no leakage from the cross-polarized beam as well as the correct transmission power level and transmission frequency.

(∗2) A type of channel access method that allows multiple users to share the same frequency channel for transmission by dividing a signal into different time slots

4.8 Commencement of Production of Fourth-Generation Motor and Generator for Hybrid Electric Vehicles

HEV equipped with newly developed motor and generator
(Courtesy Ford Motor Company)

Fourth-generation motor

Fourth-generation generator

Main specifications

Item	Specification	
	Motor	Generator
Maximum torque (Nm)	235	65
Maximum power (kW)	96	78
Maximum speed (rpm)	15 500	13 500

* Performance of each product in the unmounted condition

Motor and generator for hybrid electric vehicles (HEVs) manufactured by Ford Motor Company and their main specifications

In April 2019, Toshiba International Corporation commenced mass production of the fourth-generation motor and generator (hereafter motor-generator) for hybrid electric vehicles (HEVs) from Ford Motor Company.

The first- and second-generation motor-generators were manufactured in Japan, while the third-generation motor-generators are currently manufactured by Toshiba International Corporation.

As a result of design improvements, the fourth generation delivers a more than 20% reduction in energy loss under highway driving conditions compared with the third generation. Leveraging the experience and expertise acquired through the manufacturing of the previous motor-generators, we have also achieved a 20% increase in production efficiency while maintaining high-quality production with zero market defects.

The growth of the HEV and electric vehicle (EV) market will further spur demand for motor-generators. Our fourth-generation motor-generator is expected to be one of the key components for HEVs as well as a key product for our automotive business.

4.9 Unified Controller Vm series typeS

Name	Module	Specification
Power module	PSB11	Input: 100–240 VAC Output: 5 V–15 A, 12 V–6.7 A
Fan unit	FAB11	Single chassis fans × 2 Backside installation
CPU module	PUB11	typeS controller equipped with computer function (Linux)
Expansion interface module	ILB21	TC-net I/O loop (optical fiber cable, loop network, single bus)
	TNB22	TC-net 100 (optical fiber cable, star network, duplex, 1 system)
Blank module	SPB11	1 slot

CPU: central processing unit

Unified Controller Vm series typeS

Toshiba Infrastructure Systems & Solutions Corporation has developed the Unified Controller Vm series typeS as a successor to the nv series type1 high-speed sequence controller with a programmable logic controller (PLC). The Vm series typeS is designed to utilize data from manufacturing sites to accommodate the requirements of edge-rich cyber-physical systems (CPS).

To realize edge-rich CPS, it is necessary to collect, store, and analyze large volumes of data, including operating logs, in addition to those used for control purposes. Therefore, the typeS incorporates a new virtualization technology to provide computer functions capable of running applications on Windows or inside a Linux container. The engineering tool, input/output (I/O) unit, and user programs of the existing series also work in the typeS. Similarly to the type1, the typeS has a modular design, which simplifies replacement of an existing controller with the typeS.

The typeS will be used as a platform for the next-generation control system.

4.10 CP30 Model 300 Small Embedded Industrial Computer

Toshiba Infrastructure Systems & Solutions Corporation released the CP30 model 300, the latest model in its range of small embedded industrial computers, in December 2019. The concepts of our industrial computers are as follows:

- High-reliability design
  High processing performance combined with environmental ruggedness to withstand harsh temperature environments, static electricity, electromagnetic radiation, vibration, and dust
- Reduced downtime
  Robustness to withstand 24/7 operation and long-term service
- Long-term maintenance
  Support for early recovery from abnormal conditions and periodic maintenance.

In addition, the CP30 model 300 provides the following enhancements over the conventional model:

- The CP30 model 300 incorporates an Intel Atom system-on-a-chip (SoC) processor, which provides a roughly 1.5-fold increase in computational performance and an eightfold increase in auxiliary memory capacity.
- The use of a fanless structure and a solid-state drive (SSD) eliminates the need for a spindle, thereby achieving high environment-resistant performance and maintainability.
- The use of an optional battery allows safe shutdown of the operating system (OS) without loss of data in the event of a power failure.
- The CP30 model 300 is available as DC- and AC-powered models according to the installation requirements.

As a result of these features, the CP30 model 300 can be installed as an edge computer near remote field devices, contributing to the construction of advanced cyber-physical systems (CPS).

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Without OS shutdown battery　　With OS shutdown battery

CP30 model 300 small embedded industrial computers

Main specifications of CP30 model 300

Item			Main specifications	
			Without OS shutdown battery	With OS shutdown battery
Processor (SoC)			Intel Atom x5-E3940 (1.6 GHz, quad core)	
Main memory			4 to 8 GB DDR3L-SDRAM (DDR3-1600) with ECC function	
Extended interface			Low profile size PCI Express (×1): 1 slot*1	
Auxiliary storage device			2.5-inch SATA SSD (unit type): 1 unit (128 or 512 GB)	
Power supply	DC power		Rated voltage: 24 VDC Allowable voltage range: 20.4 to 26.4 VDC	
	AC power		Rated voltage: 100 to 240 VAC Allowable voltage range: 85 to 264 VAC	
Dimensions*2			114 (W) × 164 (H) × 174 (D) mm	114 (W) × 222 (H) × 174 (D) mm
Installation environment	Temperature	Operating	0 to 50°C When main memory is 8 GB: 0 to 45°C	0 to 40°C
		Storage	-10 to 60°C	-10 to 50°C
	Vibration (during operation)		Less than 4.9 m/s^2	
	Shock (during operation)		Less than 19.6 m/s^2	

DDR3L: Double Data Rate 3 Low Voltage
SDRAM: synchronous dynamic random-access memory
ECC: error check and correct
PCI: Peripheral Component Interconnect
SATA: Serial Advanced Technology Attachment

∗1　The connector has four PCI Express sockets.
∗2　The CP30 model 300 can be placed in a horizonal orientation.
　　The dimensions do not include rubber feet and protrusions.

4.11 Design Method for High-Efficiency Synchronous Reluctance Motors

In order to realize an environmentally friendly sustainable society, it is necessary not only to develop energy-efficient motors but also to reduce the amounts of rare metals and other resources required for their production. Toshiba Infrastructure Systems & Solutions Corporation has been developing synchronous reluctance motors (SynRMs) as a next-generation motor to achieve both energy and resource savings. In order to provide a lineup of SynRMs with various capacities, it was previously necessary to design numerous rotors with different cross-sectional shapes according to the capacity. To solve this problem, we have developed a new design method that makes it easy to determine the rotor's cross-sectional shape, mainly focusing on the two points described below.

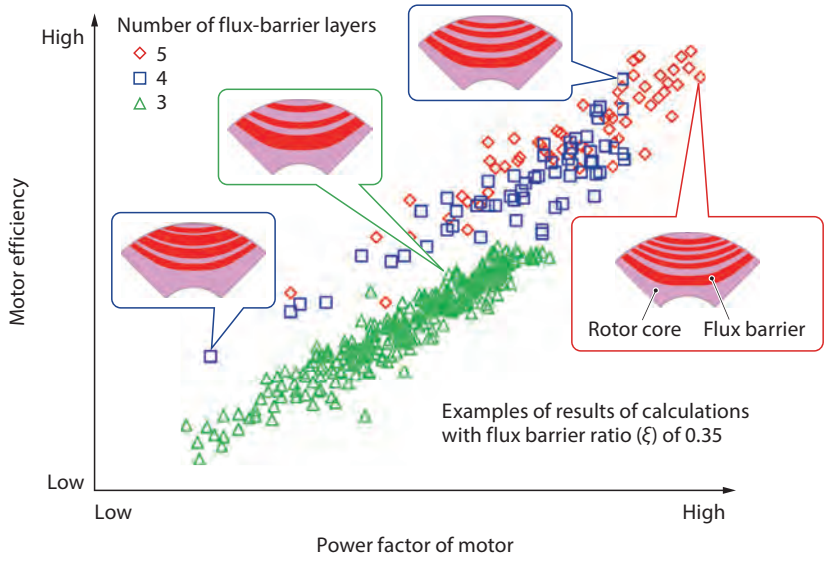
It is known that the performance of SynRMs depends on the magnetic saliency of the rotor. The stronger the magnetic saliency, the higher the motor's performance. Therefore, the first point is the use of a rotor's flux-barrier ratio (ξ)(*1) to quantify the relationship between the magnetic saliency and the rotor shape. The newly developed method determines an appropriate ξ value according to the capacity of the motor. However, a rotor with a given ξ value can be designed in many shapes because of the freedom of the position, thickness, and layer count of the flux barrier. The second point is the use of a randomized algorithm for the determination of ξ to generate multiple rotor shapes with an equal ξ and calculate their characteristics (such as motor efficiency and power factor) in search of an optimal shape.

We have employed the new method to design and prototype small- and medium-capacity SynRMs for industrial applications. Our measurements show that these SynRMs meet the IE5(*2) efficiency class requirements with the same frame size as conventional induction motors (IMs) of IE3 efficiency class. In addition, because of their high power factor, these SynRMs can be driven with an inverter of the same capacity as that for an IM.

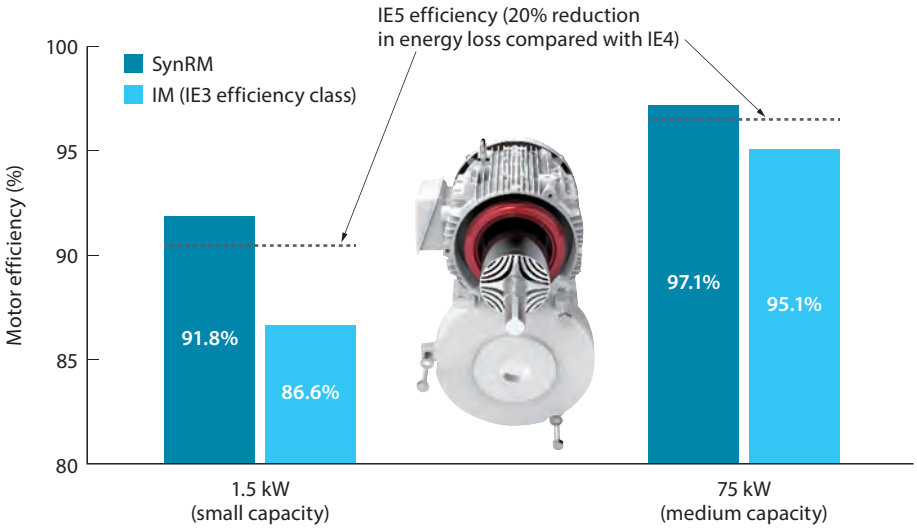
Our next step is to expand the lineup of industrial SynRMs and broaden their application to various fields including electric vehicles and railways.

(*1) The ratio of the area occupied by the flux barrier to the total cross-sectional area of the rotor core

(*2) The IE (International Efficiency) code of the International Electrotechnical Commission (IEC) stipulates energy efficiency classes for industrial motors. IE classes with a higher number require higher energy efficiency. The IE5 class is defined as an efficiency that provides a 20% lower energy loss than IE4.



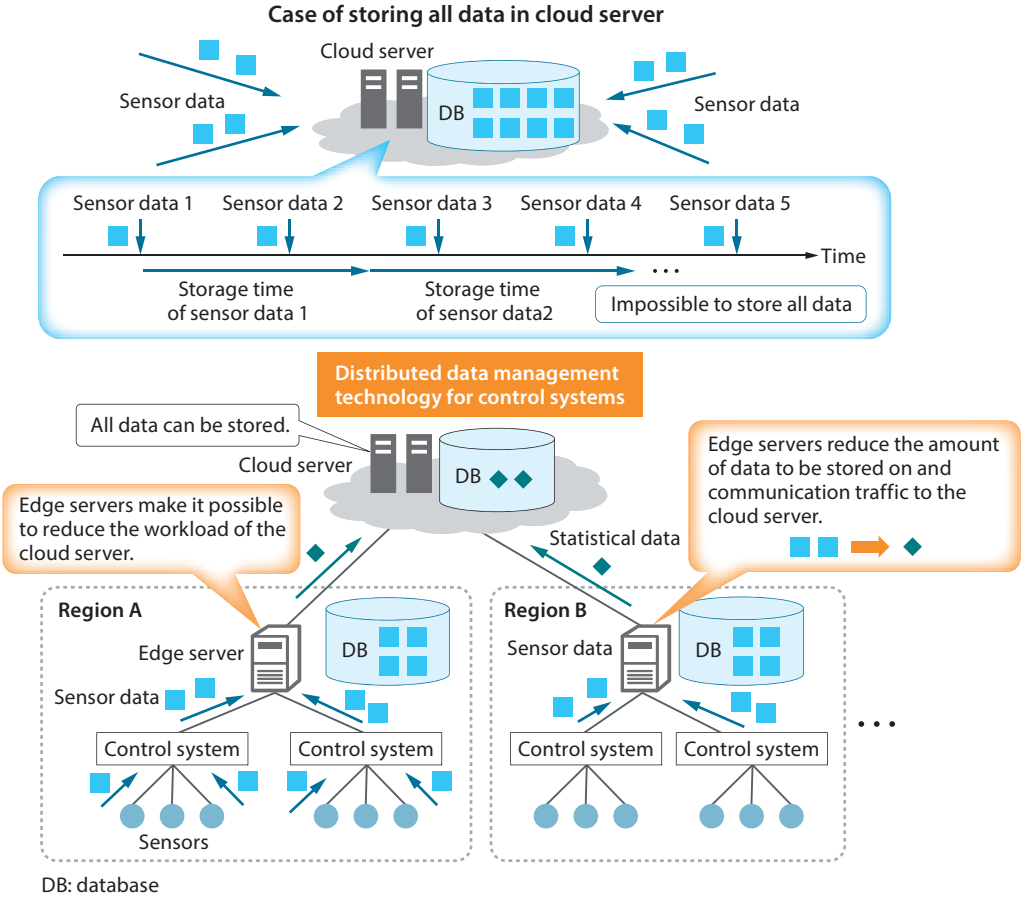
Relationship between rotor shape and efficiency and power factor of synchronous reluctance motors (SynRMs)



* Examples for typical small- and medium-capacity motors

Comparison of efficiency of conventional induction motors (IMs) and newly developed SynRMs

4.12 Distributed Data Management Technology for Control Systems Using Cloud Server and Multiple Edge Servers



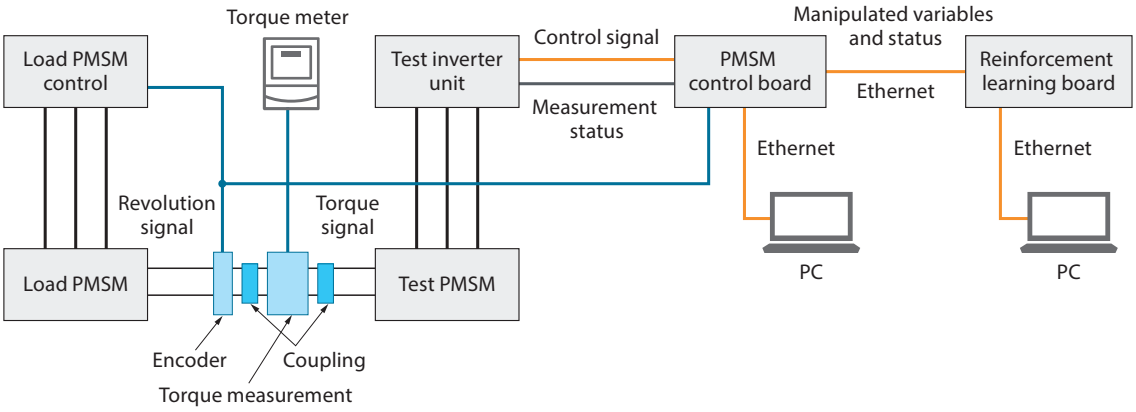
Distributed data management technology for control systems using multiple edge servers in addition to cloud server

In cases where social infrastructure control systems are installed at geographically dispersed locations, centralized management of sensor data is necessary to perform failure diagnosis and control optimization. One possible data management approach is to store all sensor data on a cloud server. With this approach, however, it is impossible to store all of the sensor data on the cloud server if the transaction time required for cloud storage exceeds the interval of sensing.

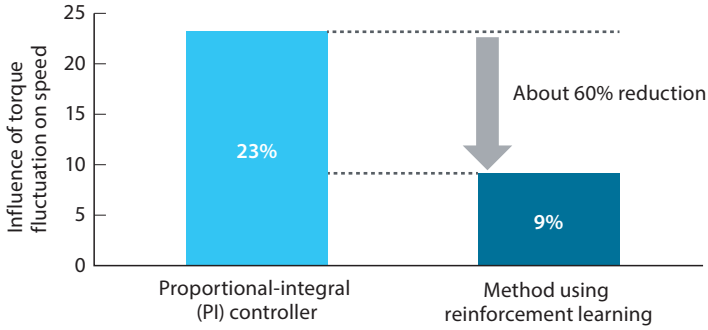
To resolve this issue, Toshiba Infrastructure Systems & Solutions Corporation has developed a distributed data management technology for control systems using multiple edge servers in addition to a cloud server. In a distributed system, original sensor data are stored in databases on edge servers located near the control systems, and statistical data are generated from the original sensor data. Only the statistical data are transferred to the cloud server together with reference information for the original sensor data.

This technology makes it possible to reduce computational and communication workloads on the cloud server for the centralized management of sensor data. Our prototype system has achieved real-time processing of 9.6 million data points per second.

4.13 Automatic Generation of PMSM Speed Control Model Using Reinforcement Learning



Configuration of actual machine verification tests on automatic construction of PMSM speed controller using reinforcement learning



Reduction of speed fluctuation ratio when driving pulsating load

Reinforcement learning (RL), an area of artificial intelligence (AI), is a technique to automatically obtain parameters that provide better performance for a target machine through trial and error. RL is expected to have extensive applications because of its potential to automatically generate control logic without any knowledge of the target machine.

Toshiba Infrastructure Systems & Solutions Corporation has employed RL to automatically generate speed control models for permanent magnet synchronous motors (PMSMs), minimizing the need to consider motor types and their load conditions in the development process. The speed control logic tuned by RL has achieved performance equivalent to that of a proportional-integral (PI) controller under constant load. In addition, RL-based control logic has achieved a 60% reduction in the effect of torque fluctuations under a periodically changing load condition, compared with PI control.

In the future, we will evaluate various motor drive conditions such as torque and speed while exploring the application of RL to other fields.

4.14 Ultracompact, Lightweight A3 Monochrome Multifunctional Peripherals Achieving High Speed and Reliability

e-STUDIO2329A/2829A series A3 monochrome multifunctional peripheral (MFP)

e-STUDIO2822AM/2822AF series A3 output capable monochrome MFP with A4 footprint

Toshiba Tec Corporation has commercialized eight new models in the third-generation series of ultracompact, lightweight A3 monochrome multifunctional peripherals (MFPs), including the e-STUDIO2329A, together with paper feed and system options. The new models incorporate a total of 115 newly developed items based on ideas and requests from users and dealers in the Chinese market, achieving further improvements in performance and quality.

Performance enhancements include (1) an 8% reduction in warmup time (compared with the previous models), (2) a reduction in print waiting time through the effective use of Printer Command Language (PCL™)(*1), and (3) an increase in printing speed from 23 pages per minute (ppm) to 25 ppm.

Environmental enhancements include (1) a reduction in standby power consumption through the use of a highly efficient low-voltage power supply, (2) a reduction in active power consumption achieved by the use of a highly efficient toner fusing lamp with an improved control method, and (3) compliance with ENERGY STAR® Version 3.0(*2), a new program to promote energy-efficient products.

Functional enhancements include (1) support for an application that enables printing and scanning from mobile devices; (2) support for the access point mode(*3) of wireless LAN, which improves compatibility with tablets and smartphones; (3) management of MFPs via a network, improving their serviceability and usability; and (4) a Universal Series Bus (USB) port that allows models without wireless LAN connectivity to print data from mobile devices.

Quality enhancements include (1) a further improvement in reliability achieved through a focus on quality assurance from early in the development cycle, and (2) a resulting reduction in downtime compared with the current models.

(∗1) A page description language developed by Hewlett-Packard Company
(∗2) An international energy efficiency standard for office equipment
(∗3) A mode that allows an MFP to be used as an access point to connect to wireless clients such as PCs and smartphones

4.15 IS-200 Series On-Counter and Cart-Mounted Compact Scanners for Retail Stores

IS-200-G-24S-S compact general-purpose scanner

IS-200-C-S compact scanner for self-checkout shopping carts

Self-checkout shopping carts, which allow customers to scan the items they have purchased, are attracting attention in Japan because of the serious labor shortage in the retail industry. In addition, various proximity-based services using customers' smartphones such as mobile payment and advertising are spurring demand for compatible point-of-sale (POS) peripheral devices.

To meet these requirements, Toshiba Tec Corporation has developed the IS-200 series of compact scanners, which can be used as stationary scanners or mounted on a shopping cart.

The IS-200-C-S, a compact scanner for mounting on a self-checkout shopping cart, enables customers to scan their purchases efficiently with hands-free operation.

The IS-200-G-24S-S, a compact general-purpose scanner, supports an adjustable tilt angle ranging from -15 degrees to 30 degrees. The IS-200-G-24S-S can also lie flat when detached from its stand. This scanner can therefore be used to scan not only purchased items but also a payment code displayed on a smartphone screen.

The IS-200 series can identify various types of codes at any angle, including the European Article Number (EAN), Universal Product Code (UPC), Code 39, Code 93, Code 128, Interleaved 2 of 5 (ITF), and two-dimensional (2D) barcodes. In addition to a beep sound, the IS-200 series indicates a successful scan with a blink of a light-emitting diode (LED).

4.16 BA400 Series Label Printers Contributing to Efficient Operations

BA410 barcode label printer with high-durability metal body for manufacturing industries

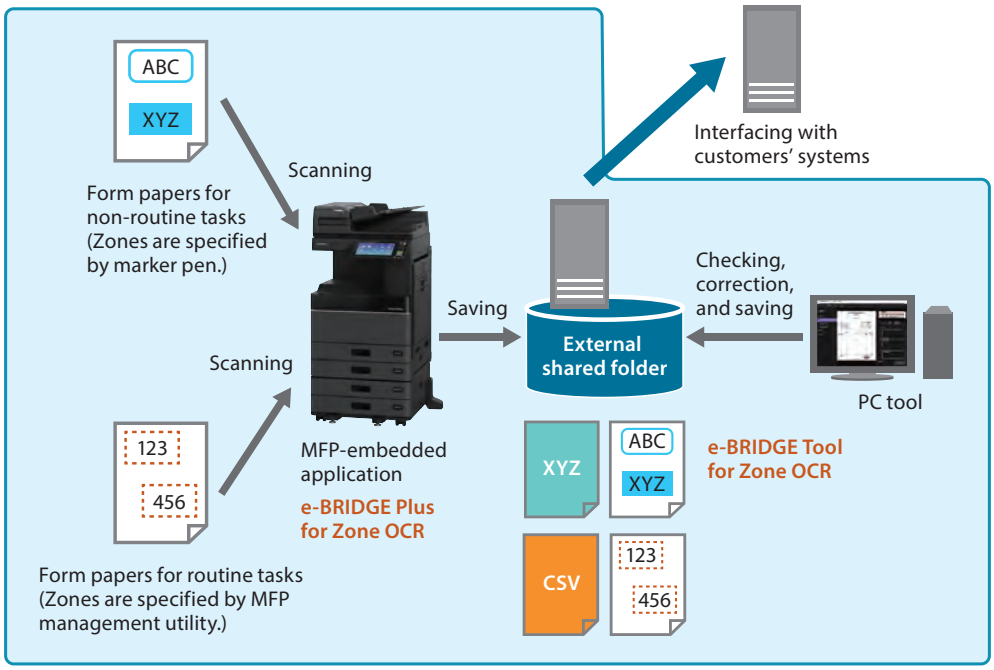
BA420 barcode label printer with plastic body for distribution industries

Toshiba Tec Corporation has developed the BA400 series of medium-speed label printers, comprising the BA410 model with a high-durability metal body for manufacturing industries and the BA420 model with a plastic body for distribution industries. The BA400 series inherits the unique structure of predecessor models that allows all operations including daily maintenance work to be performed from the front side so as to improve space utilization, as well as simplifying setting procedures by means of a graphic liquid crystal display (LCD) mounted on the front panel. This series also delivers a 30% increase in maximum printing speed and provides various functions including a smartphone setting tool that simplifies printer setting procedures in the field, a function that indicates when consumables are running low so that the user's operations will not be interrupted, and a new radio-frequency identification (RFID) tag read-write function.

Dual-band wireless LAN connectivity is optionally available in addition to various standard interfaces, including USB, LAN, and Bluetooth™. The BA400 series also incorporates extensive emulation functions to ensure compatibility with existing label printers as well as Windows™, Linux™, and SAP™ drivers, to provide connectivity with various systems.

We are aiming to further expand sales by offering products that deliver functions superior to those of printers in the same price range from other companies.

4.17 e-BRIDGE Plus for Zone OCR Application Embedded in MFPs for Efficient Paper Form Operations



Overview of e-BRIDGE Plus for Zone OCR application to perform OCR in specific areas of documents scanned by e-STUDIO series MFPs

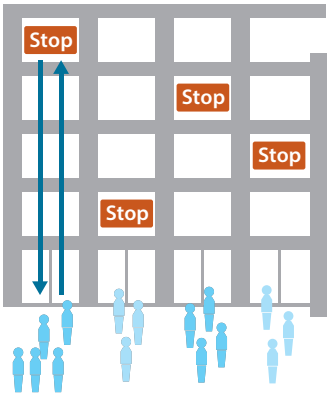
At logistics and manufacturing workplaces, human operators still enter order numbers, part numbers, and prices manually. To help improve the efficiency of these operations, Toshiba Tec Corporation has developed e-BRIDGE Plus for Zone OCR, an application that uses optical character recognition (OCR) to analyze the specified areas (zones) of a document captured by an MFP and passes the extracted meta-information to the subsequent system.

This application provides excellent operability for specification of the zones to be scanned and correction of the OCR results. Using e-BRIDGE Plus for Zone OCR, the user can specify target zones not only by entering their coordinates but also by surrounding or filling them with a marker pen. In addition, e-BRIDGE Tool for Zone OCR is also provided as a user-friendly application that runs on a PC, making it easy to identify and correct the scanned areas and OCR results.

4.18 Expansion of Lineup of FLOORNAVI™ Elevator Destination Control System

Considerable reduction in waiting and travel times

DCS uses an advanced algorithm to optimally schedule elevator operations based on the selected destination floors and thereby provides a comfortable elevator ride experience.



Floor selection entry terminal

FLOORNAVI™ elevator destination control system

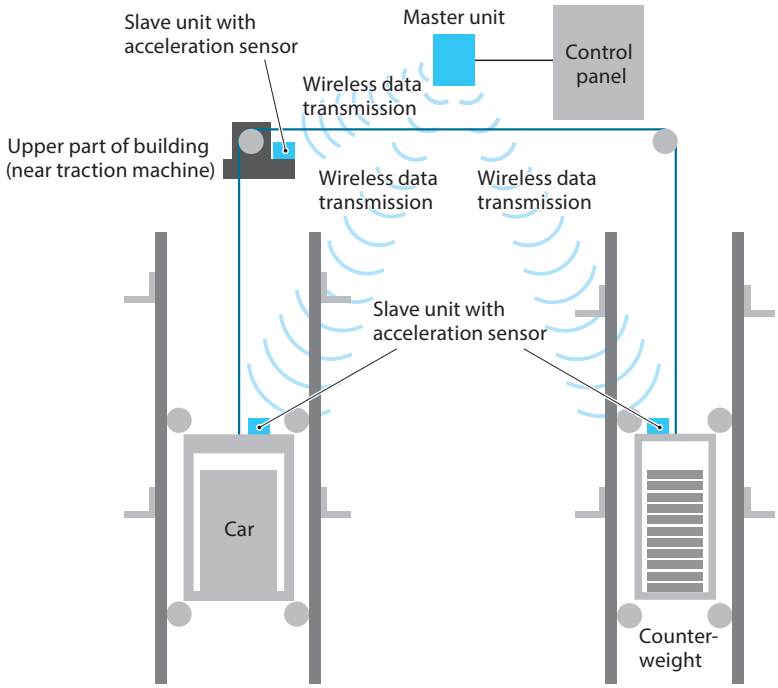
Toshiba Elevator and Building Systems Corporation has commercialized new models of the FLOORNAVI™ elevator destination control system. This system facilitates the efficient operation of elevators by replacing the up and down buttons in elevator halls with floor selection entry terminals that allow passengers to select their destination floor. This makes it possible for FLOORNAVI™ to grasp the number of waiting passengers and their destinations in advance.

The new models support two modes of operation: FULL-DCS (Destination Control System), in which floor selection entry terminals are installed on all floors, and HYBRID-DCS, in which such terminals are installed only on some floors and up and down buttons are used on the other floors.

The floor selection entry terminal has a fully redesigned aesthetic appearance and incorporates various functional enhancements to improve the display and audio announcement functions, including smooth animated screen displays, support for the Japanese, English, and Chinese languages, and an increase in the number of digits for floor and car number displays.

The new models will satisfy the increasingly diverse needs of customers in Japan and abroad.

4.19 Enhancement of Automatic Operation Restoration Function for Elevators Following Earthquake



Outline of enhanced automatic operation restoration function for elevator systems

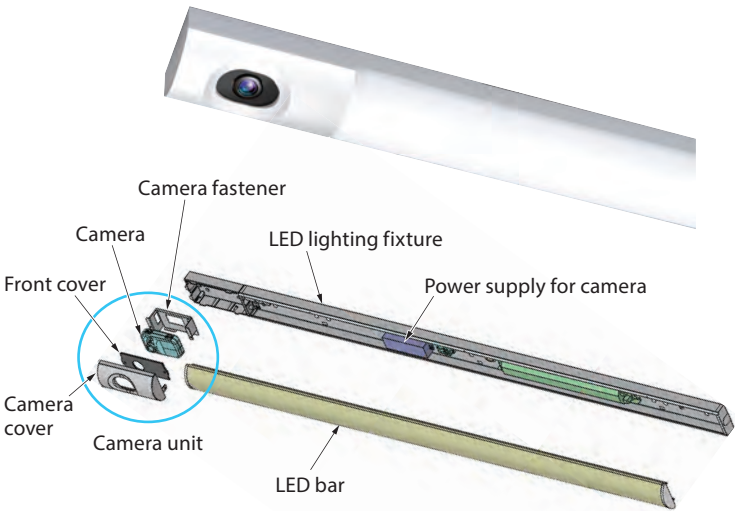
Toshiba Elevator and Building Systems Corporation has already commercialized an automatic operation restoration function for elevator systems that is activated following an earthquake, performing a self-diagnosis to tentatively restore elevators to normal service and eliminating the need for an inspection by field engineers.

Conventionally, this system has incorporated a seismic detector in the machine room or hoistway to indirectly determine whether a self-diagnosis operation is possible. As a result, restarting of the elevator might be delayed in some situations regardless of whether the elevator equipment has actually been damaged and whether a self-diagnosis operation can be safely performed.

We have now enhanced this system by positioning seismic detectors in the vicinity of the car, counterweight, traction machine, and other major components in order to directly measure seismic waves for comparison with the seismic design criteria of the equipment.The seismic detectors incorporate a wireless data transmitter because it is difficult to run electric wires to the sensors, particularly that for the counterweight. This helps to shorten the installation time and makes it possible to attach seismic detectors to existing elevators.

In the case of a tremor smaller than the seismic design standard, the new system facilitates the provision of a field service for temporary and safe restoration of the elevator if the automatic self-diagnosis operation detects no anomaly.

4.20 ViewLED LED Lighting Fixture Equipped with Camera



Configuration of ViewLED LED lighting fixture equipped with camera

Specifications of camera unit

Item	Specification
Model name	LEDX-CAM-T200
Number of pixels	CMOS 2 Mpixels
Angular field	Horizontal 140°, vertical 70°
Recording media	microSD memory card
Recording method	5 min/file, loop overwriting method
Manufacturer warranty	2 years

CMOS: complementary metal-oxide semiconductor

Specifications of power supply for camera unit

Item	Specification
Product name	JD038
Input voltage	100–242 VAC
Output voltage	7.2 VDC (-0.35 V, +0.55 V)
Output current	350 mA max.
Life	60 000 hours

In recent years, there has been an increasing need to record video images in various applications for safety and other purposes. However, since camera systems require additional installation work, are constrained by restrictions on installation, and incur extra costs, many customers have had to give up on the installation of such a system.

Under these circumstances, Toshiba Lighting & Technology Corporation has developed and commercialized ViewLED, the industry's first LED lighting fixture equipped with a camera(*), which is installed in a position that provides a view of the entire room. The electric wires for the light can be used to simplify the installation of a camera system with a recording function.

The ViewLED consists of an LED bar, an LED light fixture, and a camera unit. Recording is enabled only when the light is on. The camera unit comes with a warranty of two years. Since this is shorter than the lifetime of 60 000 hours of the light fixture, the ViewLED is designed to allow the replacement of the camera unit. In addition, the camera unit is aesthetically designed in such a manner that its cross-sectional shape and external color match those of the lighting fixture so that its appearance is not intimidating. The image quality can be set as either high definition (HD) or full HD (FHD) using a smartphone. Five-minute video recordings of a room taken from the ceiling are stored in succession as files on a microSD card with a capacity of up to 64 GB. When the card becomes full, the older recordings are automatically overwritten.

The name *ViewLED* was selected from the answers to questionnaires given to all our employees, as it expresses the "sense of the fusion of an LED light and a ceiling-mounted video camera recorder." We will continue to expand the lineup of this camera series utilizing lighting infrastructure.

(*) As of June 2019 for base lights and LED-integrated light bars available in the Japanese facility lighting market (as researched by Toshiba Lighting & Technology Corporation)

4.21 PROCOOL Condensing Unit Equipped with Large-Capacity Twin-Rotary Compressors and DC Inverter

PROCOOL condensing unit equipped with large-capacity twin-rotary compressors and DC inverter for commercial freezing and refrigeration use

Food processing factories, refrigerated warehouses, supermarkets, and drugstores need compact, large-capacity, and high-efficiency condensing units for large refrigeration equipment.

In response, Toshiba Carrier Corporation has developed the PROCOOL compact, high-efficiency condensing units (available in 20, 25, and 30 hp models) that incorporate newly developed DC inverter twin-rotary compressors. To support operations under high-pressure conditions, the new twin-rotary compressor is designed with a liquid injection system(*1), an optimized internal refrigerant flow channel, and components made of new materials. We have verified its durability through repeated tests.

The 20 hp model has achieved the industry's highest-class coefficient of performance (COP) of 2.42(*2) and a reduced power consumption under partial load conditions, which account for most of the operating time of a condensing unit. As a result, the 20 hp model has 11.2% lower annual power consumption than products from other companies equipped with scroll compressors(*3).

The 30 hp model has a 17% smaller footprint per unit capacity than the current 8 hp model.

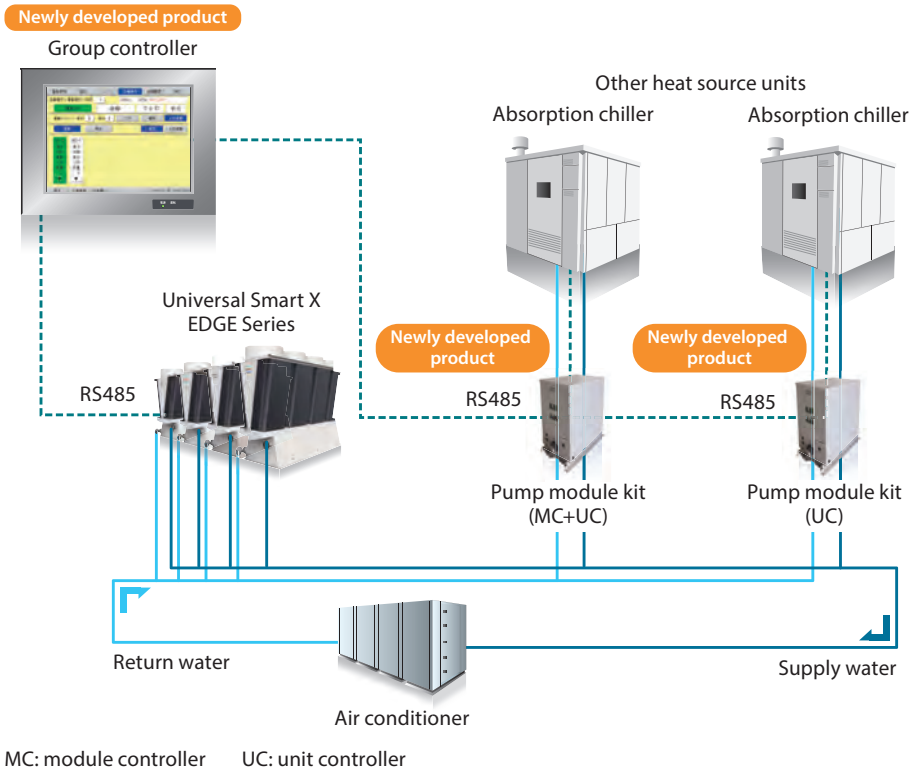
PROCOOL is the industry's first condensing unit equipped with a harmonics suppression function. PROCOOL is expected to be used for large-capacity refrigeration equipment, contributing to a reduction in the environmental load of such equipment.

(*1) A system cooled by a liquid refrigerant because the compressor temperature becomes high when it operates at a high compression ratio

(*2) As of November 2019 (as researched by Toshiba Carrier Corporation)

(*3) Calculated using weather data for the Kanto region (the area covering Tokyo and nearby prefectures) for FY 2018

4.22 USX+ New Value Proposal Activities



Example of flexible water pipe system combining other heat source units controlled by group controller and pump module kits

Toshiba Carrier Corporation is promoting a project entitled USX+, comprising activities for the proposal of new value to customers using various heat solutions in order to optimize their overall chiller systems. As part of the USX+ project, we have developed and commercialized a group controller and a pump module kit that simplify the combined operation of the Universal Smart X 3 Series and the Universal Smart X EDGE Series air-cooled heat pump chillers with other heat source units in a flexible manner.

The newly developed group controller and pump module kit reduce the energy consumption of the water pumps based on information on the opening of the valves of the air-handling units (AHUs). In addition, valveless control can be adopted in situations where the system load on each AHU tends to be almost equal, eliminating the need for AHU valves as well as temperature and pressure sensors and further reducing energy consumption and costs.

Moreover, with the evolution of our heat source unit, the Universal Smart X EDGE Series has achieved a reduction of up to 62% in standby power and an increase of up to 109% in cooling performance in low outdoor temperature conditions compared with the conventional model.

We will continue to implement USX+ activities to satisfy various customer needs.

4.23 Super Power Eco DANTARO HRP1 Series Air Conditioners for Cold Regions

3–4 hp　　5–6 hp

Outdoor units of Super Power Eco DANTARO HRP1 series air-conditioning system for cold regions of Japan

Toshiba Carrier Corporation has developed the Super Power Eco DANTARO HRP1 series of air conditioners featuring superior heating capability even at low outdoor temperatures, designed for use in offices and retail stores in the cold regions of Japan. The main focus of the Super Power Eco DANTARO HRP1 series is on delivering adequate heating and combating frost on the outdoor unit. With the use of a liquid-injection twin-rotary compressor and operation optimized for the low global warming potential (GWP) R32 refrigerant, the Super Power Eco DANTARO HRP1 series has achieved the industry's top-class annual performance factor (APF) and heating capacity at -20°C(*).

The freezing of defrost water in the drainage section is one of the main issues for air conditioners operating in cold regions. The Super Power Eco DANTARO HRP1 series provides enhanced resistance to frost through a newly developed icicle prevention defrosting control function and frost prevention plate, which increase the temperature of the defrost water and thereby prevent freezing before the defrost water is drained.

Moreover, the addition of an 8°C heating function that provides low-energy-consumption heating prevents an excessive drop in the indoor temperature after hours. Coupled with a 12-hour continuous heating function, which maintains the indoor temperature at the desired temperature, the 8°C heating function provides a comfortable environment even when the outdoor temperature is sub-zero.

We have also reduced the weight of the 3 to 6 hp outdoor units, making them the lightest models in the industry(*). The 3–4 hp model in particular allows for even easier installation because of the reduced chassis size.

(*) As of September 2019 (as researched by Toshiba Carrier Corporation)

4.24 13 and 14 hp Side-Blow Type Outdoor Units of MiNi-SMMS Series VRF Air-Conditioning System for Chinese Market

13/14 hp side-blow type outdoor unit of MiNi-SMMS series variable-refrigerant-flow (VRF) air-conditioning system for Chinese market

Toshiba Carrier Corporation has released 13 and 14 hp side-blow type outdoor units of the MiNi-SMMS series variable-refrigerant-flow (VRF) air-conditioning system for the Chinese market, which provides high capacity and energy efficiency despite the slim chassis to achieve flexible installation. To increase the cooling and heating capacity, we have developed a new compressor with a 20% larger displacement volume than that of the conventional model without changing the dimensions. We have also increased the number of discharge valves in the compressor from two to four to reduce the loss of refrigerant pressure at each discharge valve, while optimizing the thickness of the compressor stator core to improve the motor efficiency. As a result, the new compressor realizes a 17% increase in cooling and heating capacity and a 5% increase in operating efficiency.

We have also utilized new technologies such as oil management control to control the amount of refrigerating machine oil and the dilution of the oil with refrigerant in the compressor, a low-pressure-loss accumulator without internal piping, and a chassis design that improves heat exchange efficiency. As a result, the MiNi-SMMS series has achieved an IPLVc (integrated part load value, cooling) of 7.1, the industry's highest class for a side-blow type outdoor unit(*), realizing both high capacity and energy efficiency.

(*) As of July 2019 (as researched by Toshiba Carrier Corporation)