KYOSAN

MACAU LRT TAIPA LINE

Communications-Based Train Control

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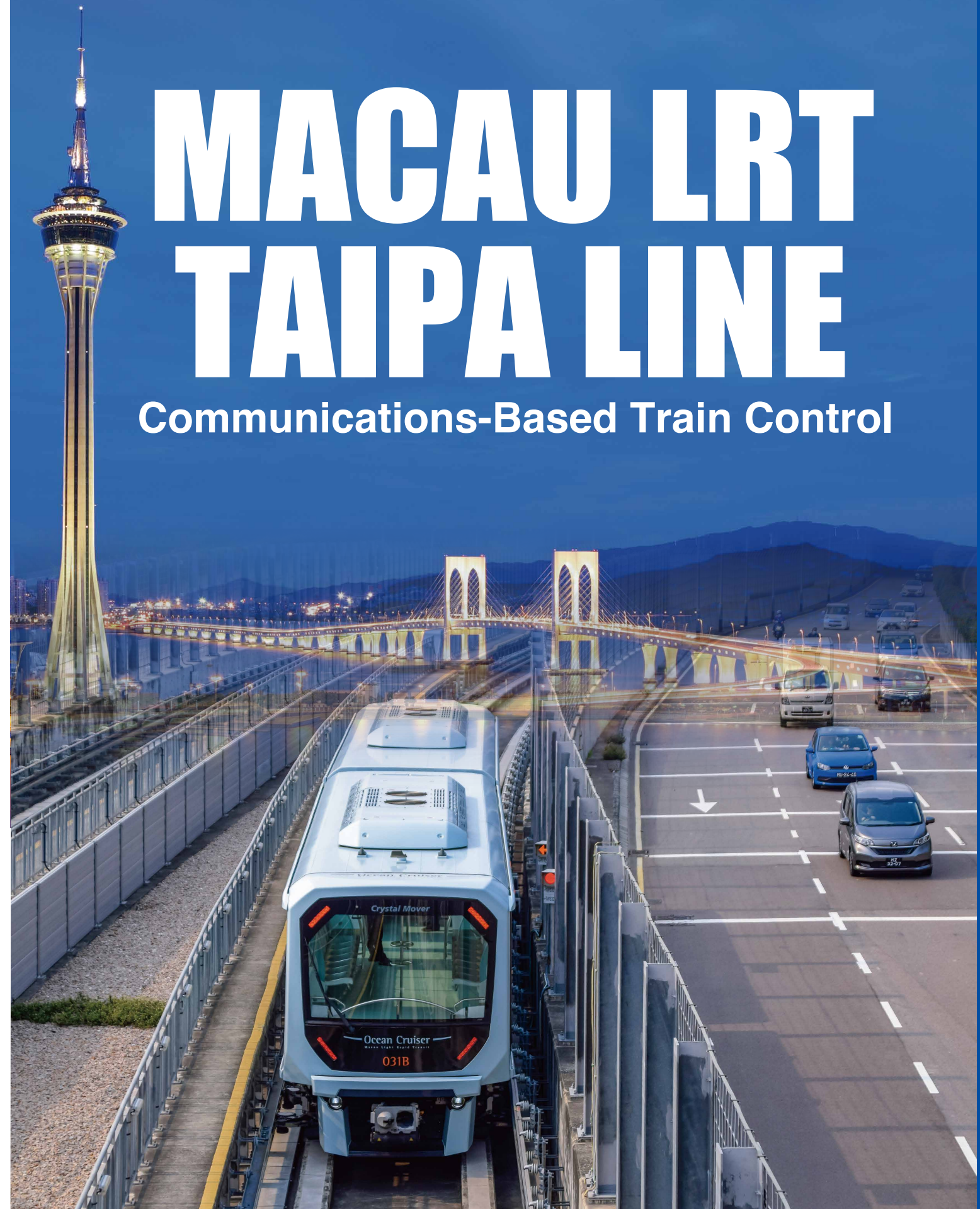
Communications-Based Train Control
(Fully-Automatic and Unattended Train Operation)
Achieved in Macau

**Supplied CBTC for
Mitsubishi Heavy Industies, Ltd.**

Macau, a special administrative region of the People's Republic of China, and, with a historical background of being a Portuguese colony, has an atmosphere of Eastern and Western cultures.

In addition, since many entertainment facilities exist, the region is regularly crowded with tourists. However, due to its small land area, there was no railway, and Macau have become overdependant on road transport, which lead to high traffic congestion all the time. The Macau government propose a railway plan, to construct a Light Rapid Transit (LRT), fully-automated and communications-based controlled, in Taipa Island, where an airport and ferry terminal are already built. In this response to the Macau government and its citizens' will : introduce new technology, Kyosan participated in this Macau LRT project, with the latest technology CBTC.

In December, 2019, Taipa line (11 stations, 9.3 km x 2) started operation. Then, from Ocean station, the west end, Extend to Barra (1 station added, 3.2 km) opened in December, 2023. At present (October, 2024) Taipa Island, where large resort hotels are built, and, Macau Peninsula, where the City Centre exists, are connected.

Moreover, 2 additional lines are planned: Seac Pai Van branch line (2 stations + With transfer station, 1.6 km) and Hengqin branch line (2 stations, 2.2km).
The Seac Pai Van line connects to Seac Pai Van district, a new residential area. The Hengqin line spans to the University of Macau in Hengqin Island, opposite of Macau Peninsula. Further improvement in transport convenience and less traffic congestion are expected.

Topics

- CBTC (Communications-Based Train Control) System with GoA4 (Grade of Automation) (Unattended Train Operation)
- Total Track Length : 31km (Taipa Independent Commissioning (TIC) 9.3 km x 2 (Double-Track) + Depot 6km / Barra : 3.2 km x 2)

※Extension Plan Seac Pai Van (SPV) : 1.6 km × 2 / Hengqin (HQ) : 2.2 km - 55 Trains

Features

Kyosan's CBTC system, adopted in Macau LRT satisfies the following features:
- Highly-Accurate Train-Position Detection without track circuits
- Continuous, Bidirectional High-Speed Communication of train control and status information
- Continuous Train Control using fail-safe CPUs for on-board and wayside equipment

Aside from fundamental functions※ This system has other functions as below:
- Centralized Control Function at Operation Control Centre (OCC) – possible to check train operation status on main line and depot at Operation Control Centre (OCC)
- Accurate Train Automatic Stop Control (TASC) in accordance with the number of train cars
- Energy-Saving Operation Function – possible to run trains by ATO eco-profile and automatically power ON/OFF parking trains
- Automatic, Unattended Coupling Function for the Purpose of Failure Train Rescue on main line – coupling function with Maintenance Recovery Vehicles
- Trainset Reformation by Automatic, Unattended Coupling/Decoupling Function

※Fundamental functions include train-position detection, train interval control, speed restriction, rolling prevention, backward detection, trainset protection, zero-speed detection, and terminal protection.

Table: Data Sheet of Macau LRT

Items	Macau LRT Line
Operation Area	Taipa Island and Cotai Area (Macau Special Administrative Region of the People's Republic of China)
Opened	10th December, 2019
Total Track Length	31km (9.3km×2 (Double-Track) + 6km (Depot) / 3.2km×2 (Barra)) Extension Plan Seac Pai Van (SPV) : 1.6km×2 / Hengqin (HQ) : 2.2km
Number of Stations	11 Stations + Depot / Barra Station
Track Type	Automated guideway Transit (AGT)
Vehicle Type	Rubber Tire
Number of Trainsets	2 Cars×55 Sets (Maximum：4-Car Set)+Maintenance Recovery Vehicle (MRV)×2 Sets
Grades of Automation (GoA)	GoA 4 (Unattended Train Operation)
Maximum Speed	80 km/h
Minimum Time Interval	95 sec
Coupling/Decoupling	Automatic or Manual

System Configuration

All centralized signalling equipment, the Operation Control Centre (OCC) and the Backup Control Centre (BCC), apply dual system. This makes the system highly reliable and safe.
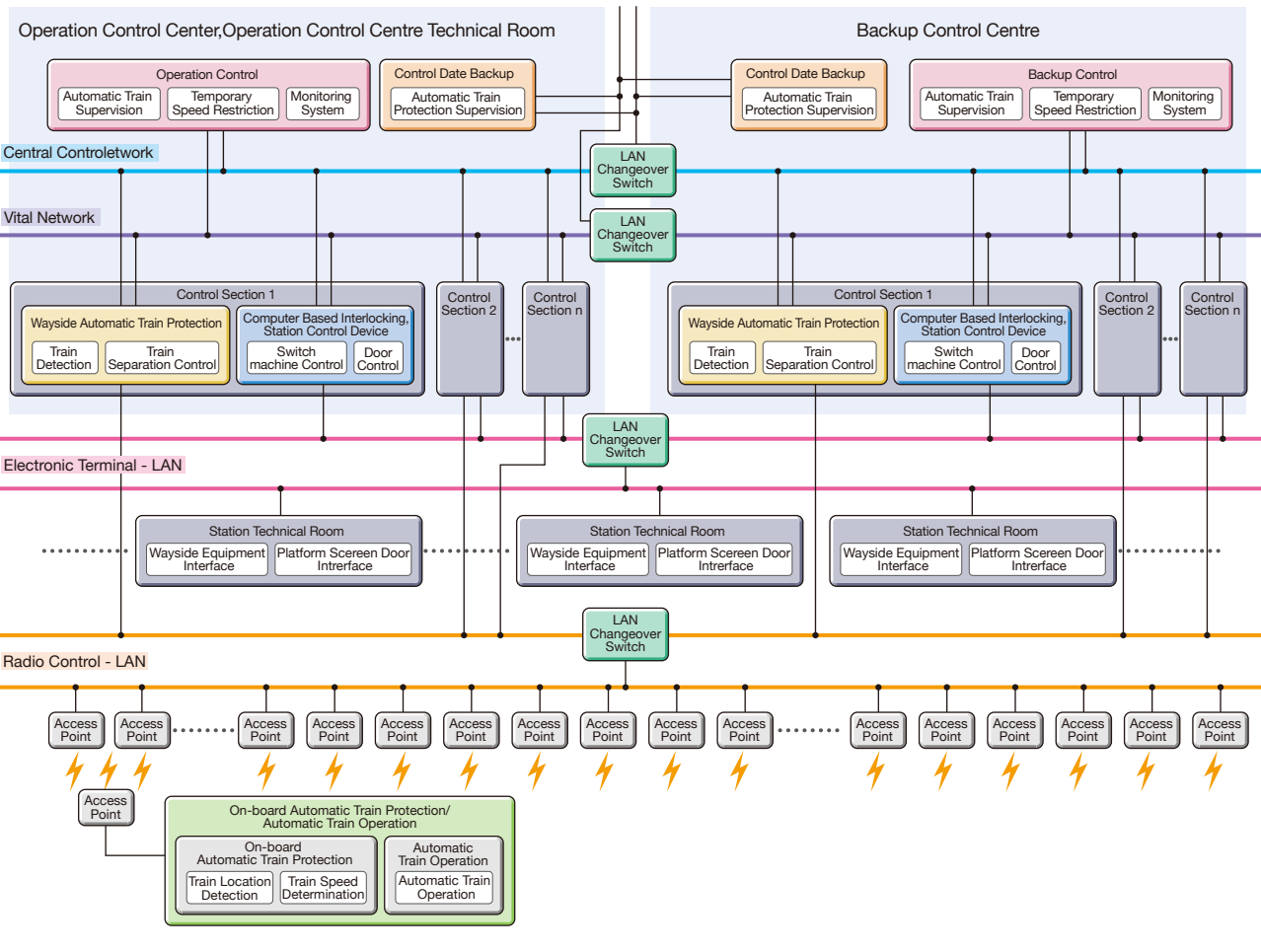
ATP (Automatic Train Protection) Wayside Equipment

This system determines train occupancy by transmitting position information, detected with on-board equipment, to wayside equipment through radio communication.
This equipment does not require additional equipment such as wayside track circuits, loop coils, or axle counters.

Functions

- Train Position Detection
- Train Interval Control
- Speed Restriction
- Rolling Prevention
  To prevent stopping trains from moving spontaneously. Apply service brake when trains shall not move (number of track clear sections = 1).
- Backward Detection
- Trainset Protection
- Zero-Speed Detection

This system adopts ISM (Industrial, Scientific, and Medical) radio bands, in which radio station license is not required for radio network along the lines.

ATP Wayside Equipment

ATP/ATO (Automatic Train Operation) On-board Equipment

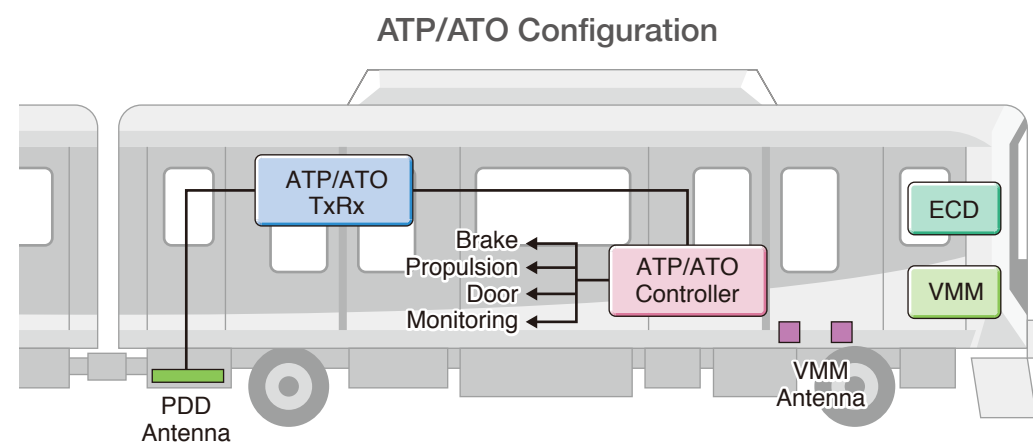This equipment integrates ATP and ATO On-board functions.
It automatically controls train departure from a station, running between stations, arrival at determined position in the next station, and opening and closing train doors/platform screen doors.

ATP/ATO On-board Equipment

Functions

- Automatic Train Operation: Accelerate, decelerate, coast, or run trains at constant speed, in line with target speed in operation plan.
- Train Automatic Stop Control: Apply brakes to make trains stop at predetermined positions.
- Door Open/Close: Open train doors after a train stops.

ATP/ATO Configuration

- ATP/ATO TxRx
- Brake
- Propulsion
- Door
- Monitoring
- ATP/ATO Controller
- ECD
- VMM
- VMM Antenna
- PDD Antenna

Computer Based Interlocking (CBI)

This equipment ensures safe train operation by controlling trains in station yards and train routes, linking signals and point machines on software using computer.

Station Control Device (SCD)

This equipment controls opening/closing of platform screen gates, according to train stop information from ATP/ATO On-board equipment.

Automatic Train Supervision (ATS)

CBI Equipment

This equipment controls signals and routes automatically in accordance with train timetable data, in order to efficiently operate the large number of trains within the railway area. In addition, so as to be able to conduct operation staff work correctly, this equipment also has train rescheduling and passenger guidance functions.

Functions

- Operation Supervision: assists operation staff work by supervising train operation based on train timetable, and posing alarm of train being late. Also, it sends an alert to the equipment that is the cause of train being affected, such as signals.
- Automatic Operation Control: automatically controls routes and passenger guidance in line with train timetable.

媽閣 Barra
海洋 Ocean
馬會 Jockey Club
運動場 Stadium
排角 Pai Kok
路氹西 Cotai West
橫琴口岸 Hengqin Control Point
蓮花 Lotus
氹仔碼頭 Taipa Ferry Terminal
機場 Airport
科大 MUST
路氹東 Cotai East
東亞運 East Asian Games
協和醫院 Union Hospital
石排灣 Seac Pai Van

— Taipa Line
— Seac Pai Van Line
— Hengqin Line