

New Enhancement of the Taipei Metro Signaling System

Alstom Company

Abstract

Throughout the history of the Taipei metro system, Alstom Signaling has been the signaling company of choice to provide signaling systems for DORTS. All of the Taipei Metro lines, with the exception of the Muzha line, are signaled by Alstom systems.

A modern mass transit Automatic Train Control (ATC) signaling system is comprised of three fundamental sub-systems: Automatic Train Protection (ATP), Automatic Train Operation (ATO), and Automatic Train Supervision (ATS). These sub-systems work together to ensure safe and efficient train operation.

Many new enhancements are currently being introduced to improve the reliability and efficiency of the Taipei Metro signaling system. We will briefly introduce four of these new developments: Video Display Unit (VDU) control panels, the GM4000A switch machine, redundant Vital Processor Interlocking (VPI) installations and the Platform Screen Doors subsystem.

Key Words : Automatic Train Control, Automatic Train Protection, Automatic Train Operation, Automatic Train Supervision, Video Display Unit, Platform Screen Doors

臺北捷運號誌系統設備升級

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摘要

臺北都會區捷運的號誌系統除中運量木柵線之外，高運量捷運號誌系統都是由美商亞世通號誌公司承製。

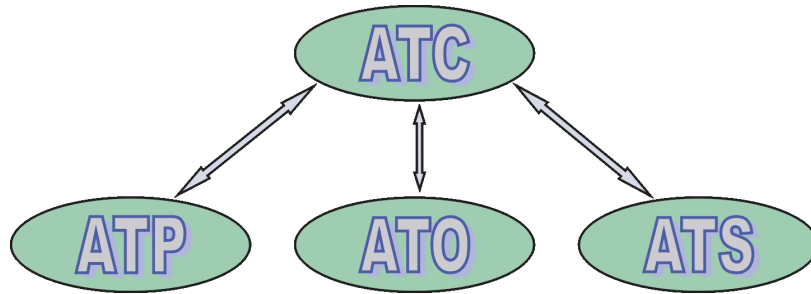
現代化的高運量列車自動控制系統 ATC (Automatic Train Control) 包括三個重要的子系統所組成：列車自動保護系統 ATP (Automatic Train Protection)，列車自動操作系統 ATO (Automatic Train Operation)，列車自動監督系統 ATS (Automatic Train Supervision)，這三個子系統一起運作以確保列車運轉時的安全與效率。

為提昇臺北捷運號誌系統的可靠及效率，目前正逐步引進許多升級的設備。這裡簡單的介紹 4 種新發展：具視訊顯示功能的控制、GM4000A 的轉轍器、雙套 VPI 設備裝置、以及月台門子系統。

關鍵詞：列車自動控制系統、列車自動保證系統、列車自動操作系統、列車自動監督系統、視訊顯示單元、月台門

Throughout the history of the Taipei metro system, Alstom Signaling has been the signaling company of choice to provide signaling systems for DORTS. All of the Taipei Metro lines, with the exception of the Muzha line, are signaled by Alstom systems. Alstom Signaling continues to provide safe and reliable ATC signaling systems for the Taipei Metro with new and improved features added to the Orange and Blue line extension (OBLEX) project. For those unfamiliar with the basics of a metro signaling system, we shall first provide a brief summary.

A modern mass transit ATC signaling system is comprised of three fundamental sub-systems: ATP, ATO, and ATS. These sub-systems work together to ensure safe and efficient train operation.



Automatic Train Control System

The ATP system is primarily responsible for ensuring safe separation between the trains. The entire length of the main train track is divided up into sections called Blocks. The basic premise is that no two trains should occupy the same block at the same time in order to avoid a collision. Additionally, faster moving trains need greater separation from the trains ahead due to increased stopping distance required. The ATP system is informed of which blocks are occupied by means of track circuits. Each block of track is supplied with an electrical signal, at a specific frequency, that runs through the rails and through the bonds (a large transformer at each end of the track circuit). When a train occupies the track circuit, the signal is interrupted and a track relay (in the signal equipment room) will be de-energized. The de-energized contacts of the track relay are used to inform the ATP system that the block is occupied.

Speed commands to the trains are also supplied to the trains by means of signals injected into the rails through the bonds. When the ATP sub-system senses that a track circuit is occupied, it will automatically adjust the speed commands for trains approaching that section of track. By this method, the ATP system can ensure safe separation of trains while allowing the maximum speed for efficient train operations.

The second part of the ATC signaling system is the Automatic Train Operation sub-system. When the train receives a permissive speed command (a speed command above 0 Kph), the ATO computers aboard the train command it to smoothly accelerate to the maximum allowable speed. As the train approaches the next station, it passes over wayside markers which electronically inform the ATO system what distance remains to the next station. The ATO computers then begin to smoothly decelerate the train so that it will stop precisely at the station. When the train is stopped correctly at the station, the ATO system will be able to communicate with the station's berthing system. This communication allows the train doors to open properly. When the station dwell time expires, the doors will close and the train accelerates to make its run to the next station. All these functions are controlled by the ATO system.

The ATS system allows Central Control Room (CCR) personnel to monitor and control metro

system operations. The CCR communicates with the trains by means of the Train to Wayside Communications (TWC) system. The TWC is a bi-directional communications system. The CCR is informed of train location, identification and routing information. In turn, the CCR can send information to the train such as performance levels (acceleration limits), modifications of station dwell times and changes in routing. The CCR communicates to the stations via a standard network communications system. The station electronic signaling equipment then passes the information to and from the trains via special bonds at the stations.

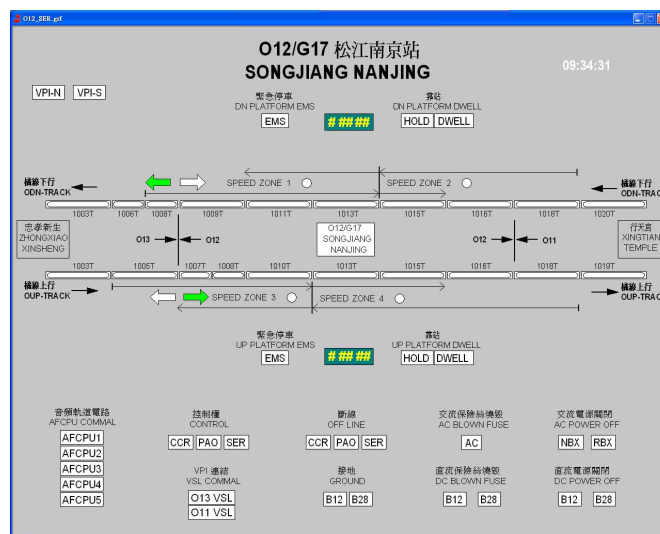
All the communications and logic of the three sub-systems above are controlled and integrated by special purpose computers within the signal equipment rooms. These special purpose computers are called VPIs. The VPIs are composed of modular components. This feature provides the flexibility to read inputs, set outputs and process logic for a wide variety of applications as demanded by the particular conditions required by the section of tracks which they control.

Many new enhancements are currently being introduced to improve the reliability and efficiency of the Taipei Metro signaling system. We will briefly introduce four of these new developments: VDU control panels, the GM400A switch machine, redundant VPI installations and the Platform Screen Doors subsystem.

The VDU control panels provide operators with state of the art control and indication of the metro system. These systems are provided by our local signaling partner ACSI. They consist of IBM compatible personal computer systems equipped with LCD screens and special software. They display the status of the controlled tracks and provide intuitive control of all available functions. These systems replace the electro-mechanical Local Control Panels previously used to accomplish these functions. The VDUs are more reliable, less expensive to operate and maintain, and are much easier to upgrade if required due to changes in metro system design.

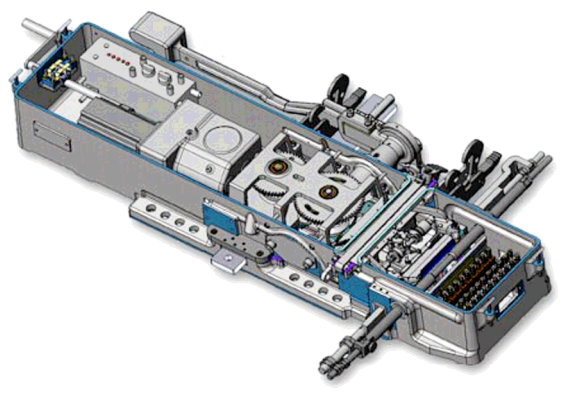


Typical Signal Equipment Room



Typical VDU Screen

The new GM4000A switch machine will replace the previously supplied Model 5E switch machines. The GM4000A uses 50% fewer parts than traditional switch machines and incorporates a Brushless DC motor along with a solid-state amplifier. This improved design enhances reliability and maintainability. Field obstruction testing and adjustments are also simplified with the help of LEDs and a point-detector adjusting nut that is exposed and easy to adjust.



GM4000A Switch Machine

Redundant VPI units are being installed to maximize reliability and allow uninterrupted operations during routine or un-scheduled maintenance. In a redundant VPI system, two identical VPI units are installed within a signal equipment room. Normally, both VPI systems read all inputs and process the logic simultaneously. However, only one of the VPI's will have its outputs energized. This allows only one VPI to control the interlocking while the other is always ready to take over automatically if needed. Also, control of the interlocking can be transferred manually if desired so that routine maintenance or testing can be performed on the other VPI. Maintainers and controllers will certainly welcome this new feature.

One of the new features that will be most visible to the passengers will be the integration of Platform Screen Doors (PSD) sub-system. The PSD sub-system will consist of a set of sliding doors separating the platform from the train track at the stations. The doors will remain closed except when there is a train parked at the platform. When a train arrives at the platform, and is safely stopped, the PSD will open to load and unload passengers. The PSD will then close before the train departs. The separation of the tracks from the platform with PSD will be an obvious improvement to the safety and comfort of the passengers.

The new and improved systems described above are already in the design, build and installation stages. We will be able to see them in operation in the very near future. However, in order to maintain a world-class metro system, one cannot rest on their laurels. The creative engineers at Alstom Signaling are already hard at work designing the signaling systems of the future. Some of the innovations that are being designed include improved electronic diagnostic systems, enhanced passenger information systems, and more robust wayside hardware. Alstom Signaling will always be hard at work to make sure our passengers arrive safely at their destination in the most efficient and reliable way.