DIGITAL ISSN 3008-9409
RSO - Safety Journal
(may-jul, 2023): [51 - 57]
ark:/s29534739/8qa06vfk8

DOSSIER

Advanced Signaling at Level Crossings: Elixs Controller on the Roca Line

Engineer Pablo Cosentino
Alstom Field & Operation Manager,
Railway Engineering Coordinator
National Technological University
(UTN) Haedo.

pablo.cosentino@alstomgroup.com

Keywords: *Transportation - Safety - Railway - Control Systems - Signaling System*

Received: 22/02/23
Approved: 22/03/23

Abstract

As part of the project to modernize the signaling system on the Roca line, Alstom1 is implementing new technology by installing level crossing control equipment, whose characteristics are described herein.

The ELIXS device, implemented by Alstom, controls light and sound signaling and the activation of barriers at level crossings. It also communicates with the interlocking system. It is a modern and robust piece of equipment that offers a wide range of configuration and performance options.

DIGITAL ISSN 3008-9409
RSO - Safety Journal
(may-jul, 2023): [51 - 57]
ark:/s29534739/8qa06vfk8

Introduction

The Buenos Aires Metropolitan Area (AMBA) has several urban railway lines, with their terminal stations located in the Autonomous City of Buenos Aires (CABA), extending an average of 60 kilometers into Gran Buenos Aires (GBA). Additionally, suburban, freight, and regional rail services extend across much of the national territory.

The railway networks also have a significant number of level crossings, many of which are equipped with electro-mechanical barrier mechanisms that operate automatically, known as automatic level crossings.

Historically, the control of automatic level crossings has been implemented using electro-mechanical relays. The relays gather information on track occupancy (the system's input data) and provide operational commands to the active components of the level crossings: barrier mechanisms, vehicle traffic lights, bells, and warning signals for the train driver.

As part of the modernization project for the signaling system on the Roca Line, the company Alstom[1] is implementing new technology through the installation of level crossing control equipment, whose characteristics are described below.

ElectrologIXS VLC–ELIXS

The ElectrologIXS (hereinafter ELIXS) is a fail-safe, high-availability controller, designed in accordance with the parameters and recommendations defined by the American Railway Engineering and Maintenance of Way Association (AREMA). It has a projected service life of 30 years and is certified at Safety Integrity Level 4 (SIL 4), according to EN 50129.

The ELIXS device controls the signaling lights, sound alerts, and barrier mechanisms at level crossings. It also communicates with the interlocking system.

It has a modular design, both in terms of hardware and interlocking logic, allowing it to be configured not only to control level crossings but also any type of small or medium-scale interlocking system.

This equipment is expandable through the addition of new hardware modules, enabling the control of more level crossings or other devices, depending on operational needs.

More than 30,000 ELIXS units are installed worldwide, performing railway safety functions.

The ELIXS system for the Roca Line project controls barrier mechanisms, road signals, bells, train warning signals, equipment diagnostics, and communicates with the interlocking system via an Ethernet link. According to contract specifications, train detection is carried out using the track circuits of the interlocking system. In this application, the responsibility for informing the ELIXS that a train is approaching lies with the Smartlock interlocking system (also manufactured by Alstom).

The equipment consists of a chassis, a motherboard, a Control Display Unit (CDU), and interface modules with terminal blocks (personality) for wiring external elements. All modules have indicators on the front panel, displaying the operating status of the module, as well as function indicators for monitoring active input and output signals.

> ***"The ELIXS device controls the signaling lights, sound alerts, and barrier mechanisms at level crossings."***

The VPM-3 web-based Graphical User Interface (GUI), the CDU, or a computer/terminal connected to the diagnostic port serve as the human-machine interface for system installation/configuration, parameter adjustment, and system testing/troubleshooting. The web GUI is operated through an independent computer/device running an Internet Explorer (or compatible) web browser.

For the Roca Line project, the modules that make up the ELIXS system are:

- VPM-3 (Vital Peripheral Master)
- CPS-3 (Central Power Supply)
- UCI-3 (Universal Chassis Information)
- CDU (Control Display Unit)
- GFD-1 (Ground Fault Detector)
- VIO12-86S (Vital Input/Output)

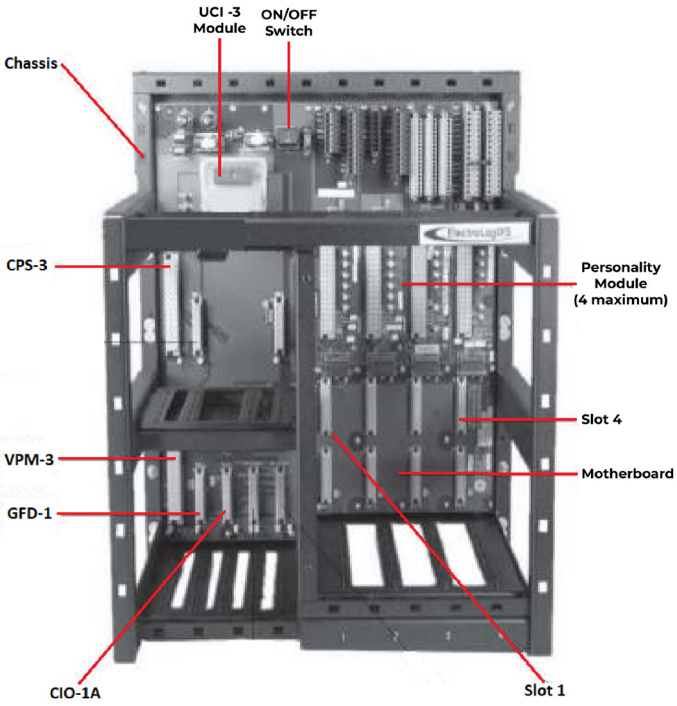
1. Alstom. A company that promotes sustainable mobility, focused on the development and development and commercialisation of systems, equipment and services for the transport sector for the transport sector in the world. It works on solutions for passenger solutions, personalised services (maintenance, modernisation), infrastructure issues, signalling and digital mobility.

DIGITAL ISSN 3008-9409
RSO - Safety Journal
(may-jul, 2023): [51 - 57]
ark:/s29534739/8qa06vfk8

Figure 1. ElectroLogIXS VLC–ELIXS with 4 modules

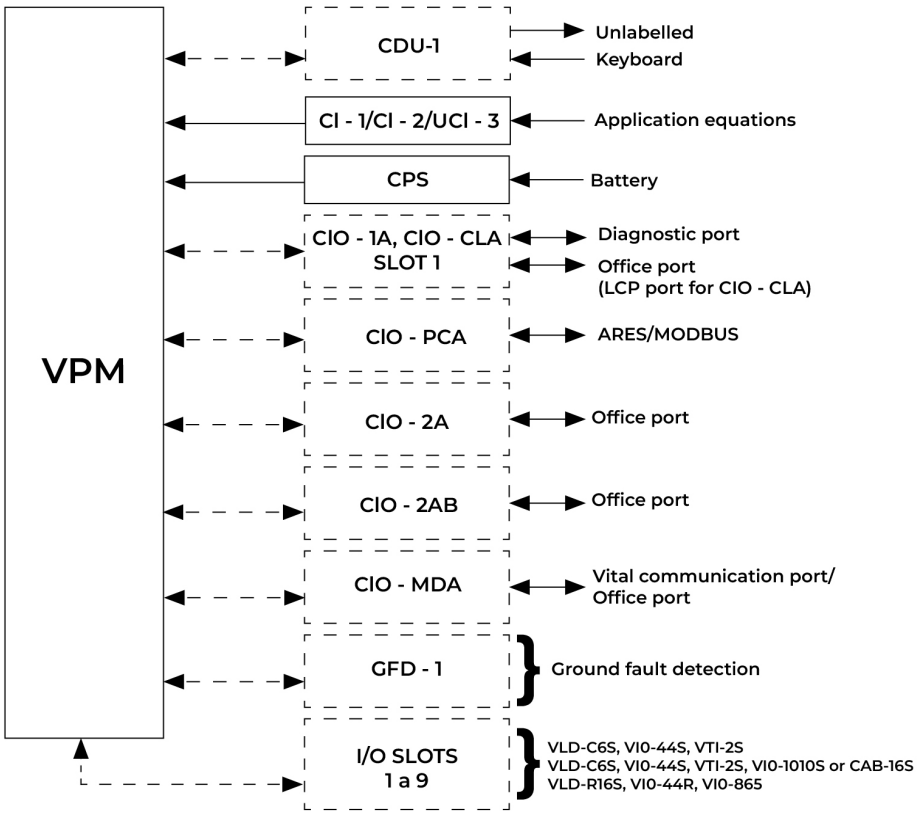
Source: Alstom.

Figure 2. ELIXS chassis with 4 modules



Source: Alstom.

Figure 3. Block diagram for ELIXS (generic)



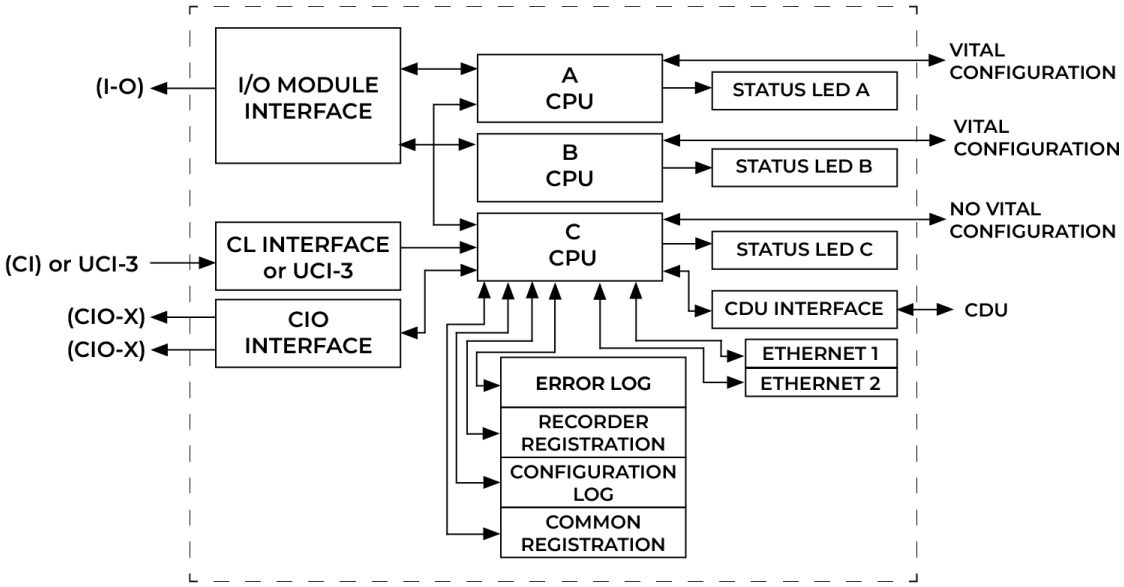
Source: Alstom.

DIGITAL ISSN 3008-9409
RSO - Safety Journal
(may-jul, 2023): [51 - 57]
ark:/s29534739/8qa06vfk8

VPM 3-Vital Peripheral Master

The VPM-3 is a microprocessor-based module consisting of three CPUs (A, B, and C) that control the operation of the ELIXS system. The VPM-3 is responsible for downloading the selected vital and non-vital applications from the UCI module and executing the applications, while also maintaining system safety checks and providing diagnostic functions.

Figure 4. VPM-3. Block diagram

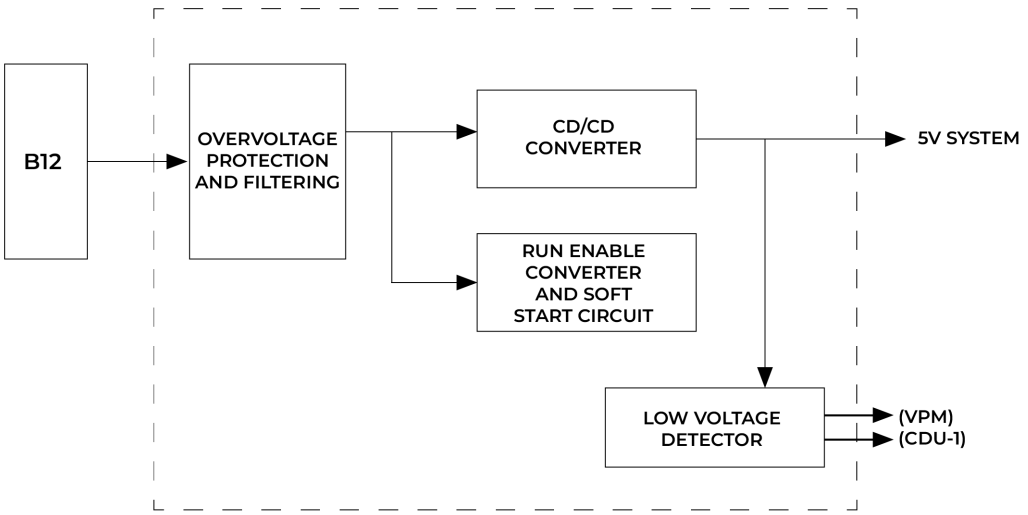


Source: Alstom.

CPS 3-Central Power Supply

The CPS-3 module (central power supply) provides +5 V CC for all components in the ELIXS system that require a non-isolated 5-volt power source. Components that need isolated 5-volt power have their own power supplies. The CPS-3 can be used in applications requiring up to 70 watts of 5 V CC power.

Figure 5. CPS-3. Block diagram



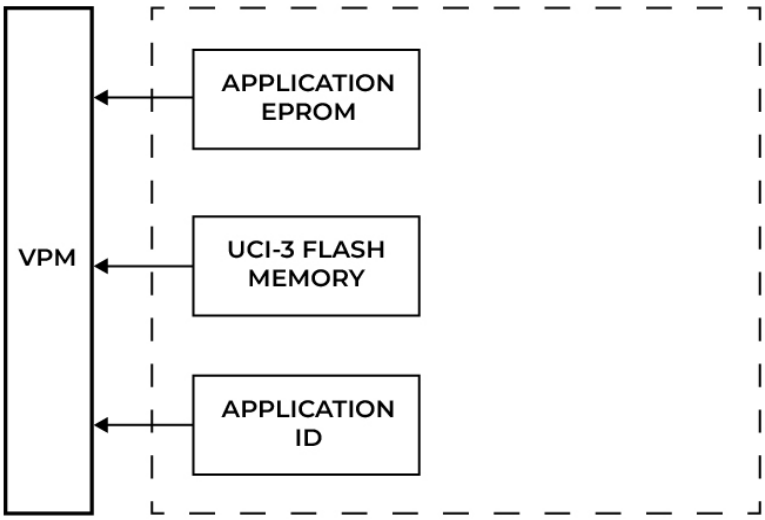
Source: Alstom.

DIGITAL ISSN 3008-9409
RSO - Safety Journal
(may-jul, 2023): [51 - 57]
ark:/s29534739/8qa06vfk8

UCI 3-Universal Chassis Information

The UCI-3 module provides non-volatile storage for the ELIXS system. It includes a removable non-volatile memory device (EPROM), which stores the application equations and has two DIP switch sockets to set the application ID value. Additionally, the UCI-3 module has 8 MBytes of non-volatile memory that can be used for application storage. If an EPROM with a valid application equation file is installed in the UCI-3, the equations from the EPROM are used. If no EPROM is installed, the UCI-3's non-volatile memory is used for the application equations.

Figure 6. UCI-3. Block diagram

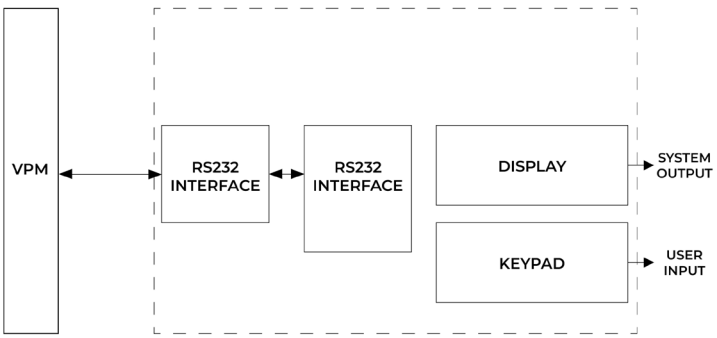


Source: Alstom.

Control Display Unit

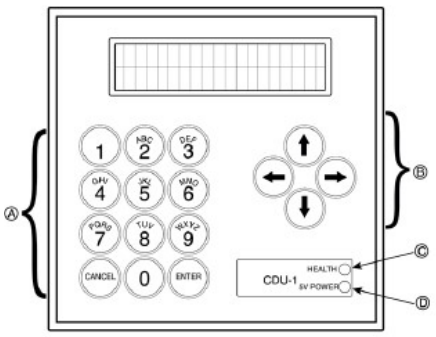
The CDU-1 provides a user interface for the system and serves as the primary interface for VPM-based ELIXS systems. It features a two-line, 20-character vacuum fluorescent display, a 16-button keypad, and two LED indicators for system status and 5V power status. The CDU connects to the VPM through an RJ45 modular connector and uses RS-232 signaling.

Figure 7. CDU. Block diagram



Source: Alstom.

Figure 8. CDU module



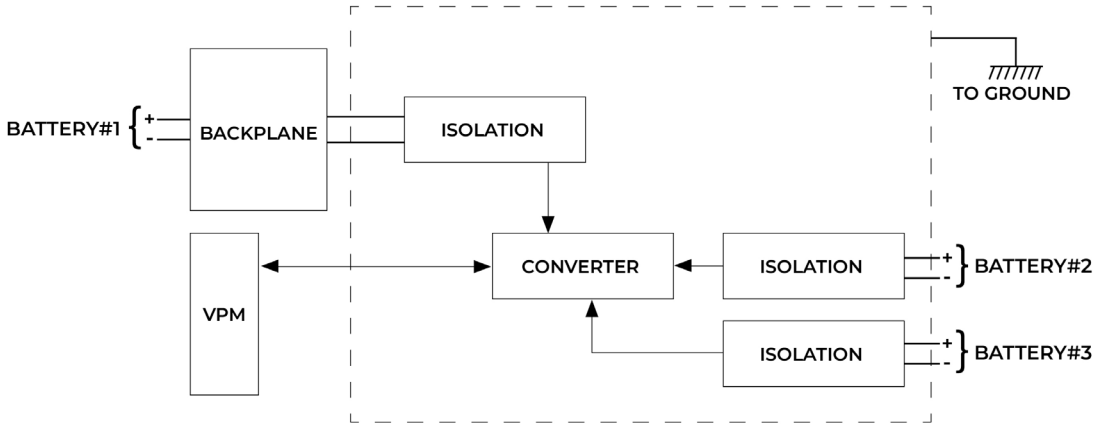
Source: Alstom.

DIGITAL ISSN 3008-9409
RSO - Safety Journal
(may-jul, 2023): [51 - 57]
ark:/s29534739/8qa06vfk8

GFD-1 Ground Fault Detector

The GFD-1 module (ground fault detector) monitors up to three battery banks to detect ground faults. It can detect faults in both the positive and negative poles of the battery. The GFD monitors the battery connection to the ELIXS through the motherboard and has a front-panel field connector for connecting up to two external batteries. The ELIXS user can program the fault threshold and ground fault time through the CDU-1. The GFD can only be installed in the dedicated GFD-1 slot on the backplane.

Figure 9. GFD-1. Block diagram

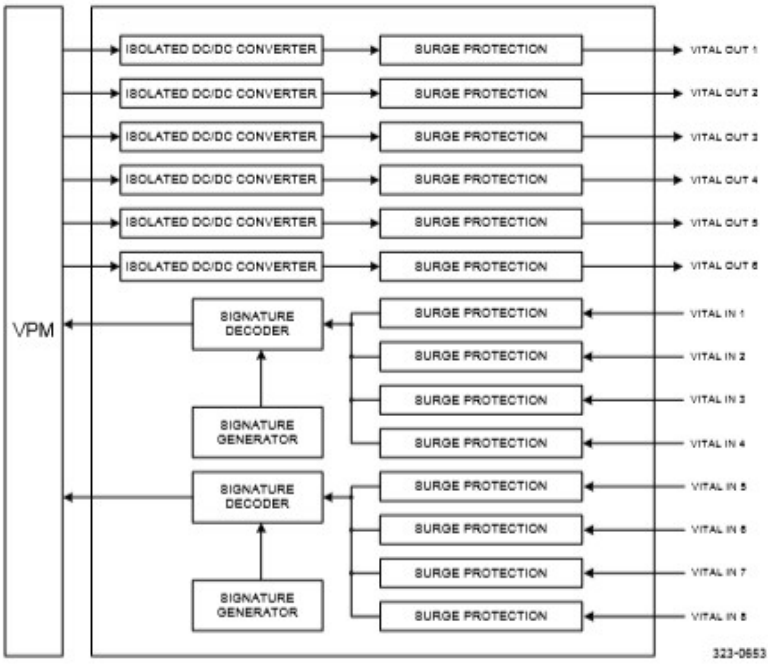


Source: Alstom.

VIO12-86S-Vital Input/Output

The module includes eight vital two-wire general-purpose inputs and six vital two-wire general-purpose outputs. It is used for the vital control of the system by monitoring vital inputs and providing vital outputs in accordance with the application equations.

Figure 10. VIO12-86S. Block diagram



Source: Alstom.

DIGITAL ISSN 3008-9409
RSO - Safety Journal
(may-jul, 2023): [51 - 57]
ark:/s29534739/8qa06vfk8

ELIXS as Interlocking System

Due to its great flexibility and expandability, the ELIXS system can be used to control low and medium-complexity interlockings, whether isolated or interconnected with neighboring systems. For applications in passenger transport networks, if the neighboring interlockings are also ELIXS systems, communication between them (for exchanging information such as track status, signals, and traffic direction) is established through fiber optic links or digital radio.

For applications in freight transport networks (with more distant interlockings and typically non-electrified tracks), if the neighboring interlockings are ELIXS systems, communication between them can even be established through the rails. This is achieved using a specific communication protocol called ElectroCode 5, which was first put into operation in the 1970s in the United States.

In addition to enabling communication between neighboring ELIXS interlockings through the rails, ElectroCode 5 allows the implementation of track circuits over 5 kilometers in length (depending on ballast conditions).

The interface with various control systems, whether local (CTL) or centralized (CTC), is also facilitated.

ELIXS can communicate with these systems (whether from Alstom or third parties) using a wide range of communication protocols.

Modifications to the interlocking logic, whether due to changes in track layout or other needs, are not an issue. These can be easily implemented using the ACE application. The graphical interface of this tool allows for the creation and modification of logic by visualizing it as relay contact diagrams, Ladder logic, or even XML.

ELIXS as a Level Crossing Controller

In applications where it is not desirable to link the level crossing to an interlocking system and the tracks are non-electrified, the ELIXS can independently detect the presence of trains. For this function, a specific module is available that enables train detection in the form of simple track circuit occupancy, movement detection, and speed prediction.

In the case of electrified tracks, train detection can be implemented through axle counting. The interface between the axle counting equipment and the ELIXS can be implemented using discrete inputs and outputs or through a communication link, depending on the model of the axle counter.

CONCLUSIONS

The implementation of the ELIXS controller represents a significant improvement in the technical standard for level crossing control. It is a reliable, robust, and flexible system that poses no issues for operation and maintenance. Furthermore, familiarization with equipment like the ELIXS provides a new product for considering signaling logic solutions beyond just level crossing control, offering extensive operational capabilities and communication options between devices.