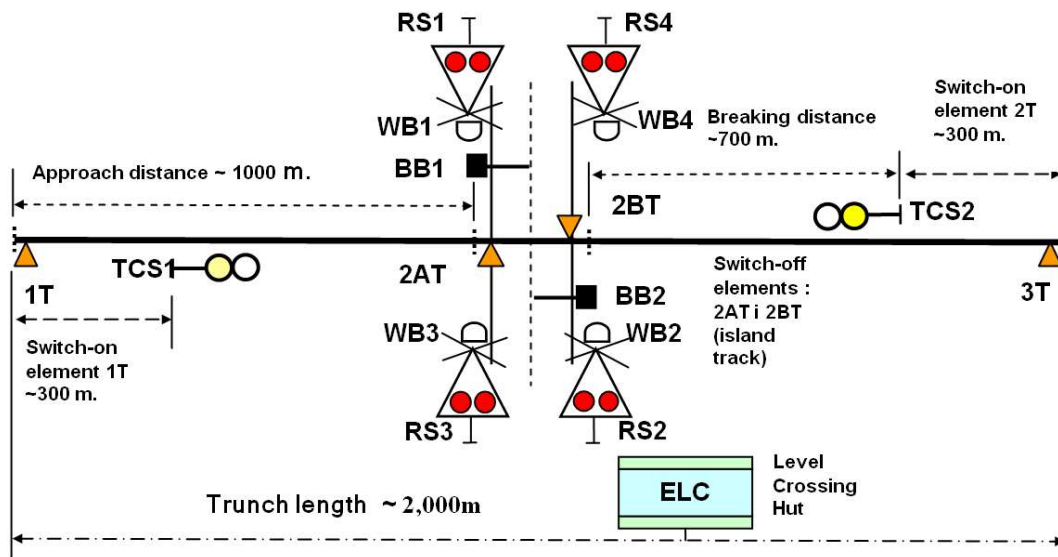


## ELC - ELECTRONIC LEVEL CROSSING

**ELC – Electronic Level Crossing** is a computer-based controlling and monitoring system of the highest safety integrity level (SIL4 in accordance with CENELEC Railway Standards) for the all types of the level crossings (on the open line, on the line with automatic block and in the station area). ELC is realised as modular and scalable system with possibilities for the applications on various signalling arrangements and for different railway administrations. ELC is an economical system, highly competitive with both computer-based and conventional, relay-based, level crossing controlling systems.

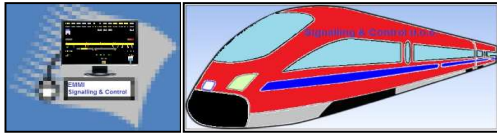
ELC is realised as a safety controller of universal type, which covers functionality of an automatic level crossing for all types of the track layouts and various types of the outside equipment.



**Typical signalling arrangement of the ELC system on a single line with a bi-directional traffic.**

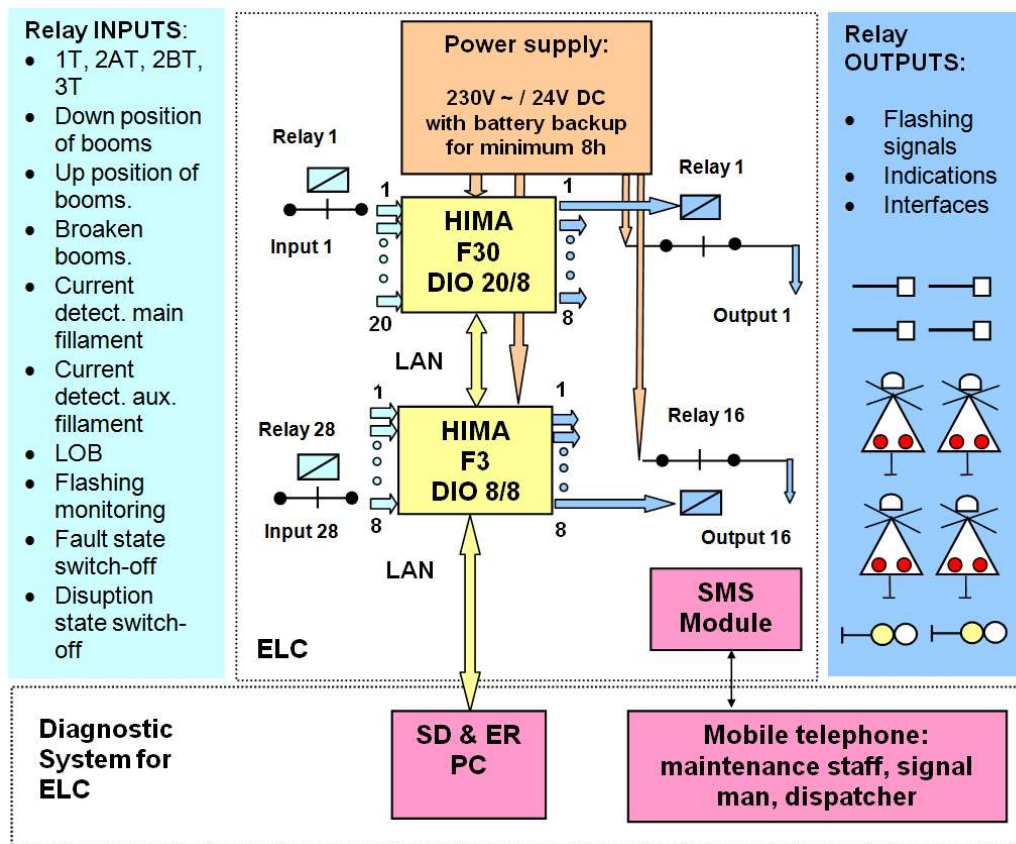
ELC is an automatic controller operated by the train. ELC gets activated by the approaching train, which occupies of the switch on element (1T or 3T) and gets deactivated by the passing by train, which occupies and releases of a pair of the switch off elements 2AT and 2BT. Beside switch-on and switch-off elements (1T, 2AT, 2BT and 3T), ELC controls and detects states of the following outside elements: red flashing lights of the **RS - Road Signals**: RS1, RS2, RS3 and RS4, motors, lights and positions of boom barriers of **BB - Boom Barrier mechanisms**: BB1 and BB2, **WB - Warning Bells**: WB1, WB2, WB3 and WB4 and both yellow steady and white flashing lights of the **TCS - Train Control Signals**: TCS1 and TCS2.

**Note:** Above example represent a typical example of the Level Crossings protection system on Serbian Railways – **SŽ**, for speeds up to 100 km/h with service braking distance of 700m (in accordance with Instructions 412, **ZJŽ** - Community of Yugoslavian Railways). The concept is general, but the approach distance and positions of the TCS will depend on the required maximum line speed and braking characteristics of the running trains.



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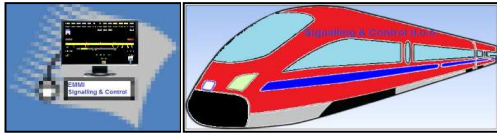
**Block diagram of the architecture of a standard ELC system.**

ELC is based on fail-safe **PLC** – *Programmable Logic Controller* of **HIMA** (HIMA Paul Hildebrandt GmbH + Co KG, Germany), type HiMatrix F30 and F3, which are certified for the highest safety integrity level SIL4 in accordance with CENELEC railway standards.

For increasing number of digital inputs and outputs safety PLC HiMatrix F3, which has 8 inputs and 8 outputs, is used. Inputs and outputs are galvanic isolated. They are obtained via voltage free contacts and coils of the miniature safety relays. States of the relevant output of the miniature safety relays are checked by the safety PLC-s. Current detection function for main and auxiliary filament of light modules of the RS and TCS is performed by electronic current detection modules (produced by the Signalling & Control ltd.).

As a switch-on and switch-off elements practically all known devices for this purpose, such as: electronic rail contacts, inductive while detectors, inductive loops, short range track circuits, long range track circuits, conventional track circuits, axle counters, etc, can be used. It is enough that the used element provides information about its state through a voltage free contact that can be used by the ELC system. Depending on the signalling arrangement, beside the automatic switching-on and switching-off, it is possible to have manual activation and deactivation of the ELC system by use of the appropriate push-buttons at the railway station, as well as, the local activation and deactivation at the level crossing hut. Various combinations of the automatic and manual activations and deactivations are possible as well. The use of ELC inside semi-automatic and automatic blocks with accomplishment of the all necessary interfaces with relevant signals is also supported.





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ELC can use various types of the boom barrier mechanisms, which are approved for use from the relevant railway administrations. It is necessary to provide for the ELC system information about the up and down position and broken state of a boom barrier. The information shall be provided by the appropriate voltage free contacts. The technical information about way of lowering and rising of boom barriers with the appropriate time durations and requirements shall be supplied as well.

ELC supports use of various types of the light modules for RS and TCS, such as conventional bulbs and LED modules. ELC system uses current detection modules with adjustable current levels for detection of the main and the auxiliary filaments of the used light modules.

Typical power supply for the ELC system is 230V, 50Hz from the distribution or dedicated railway network. ELC system has its own power supply system with battery backup of minimum 8h for full functionality. Long life batteries without maintenance are used. Extended backup time can be realised on request. Internal and external power supply circuits are separated and realised by a number of high quality DC/DC converters. Maximum power consumption of the ELC system is relatively low. It depends on the track layout and type of the used outside equipment. For given typical example for Serbian Railways it is about 500 VA. Due to small power consumption ELC can be powered by solar collectors where economically justified.

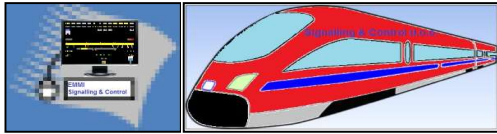
Electronic flasher is realised as an external, high reliable hardware module with solid-state relay output with adjustable light and dark phase (typically 50% / 50%). It is continuously monitored by safety PLC. Flasher is realised as a modular and scalable unit. Hence, number and current rate of the output solid-state relays can be optimised by the required consumption.

ELC is typically realised for the applications in the extended temperature range from -25°C to +70 °C. It is designed for typical enclosure for inside mounting (level crossing hut). Where necessary it can be also placed in the appropriate enclosure for the outside mounting. If the environment temperature conditions are savvier from declared for the ELC system then the required conditions shall be met by the enclosure or the equipment house (insulation, heating, etc.).

ELC is realised using high degree of modularity. For the realisation modules produced by Signalling & Control Ltd. and other eminent producers are used. Most of the used modules are commercially available. They represent independent functional units that are tested and approved for their purpose. Together they form the simple and low-cost hardware structure of the ELC, contributing to the generality, maintainability, higher reliability and safety.

ELC is developed to be generally applicable. The standard ELC system covers majority of the known level crossing applications and it is optimised from the cost benefits point of view. But, the ELC system does not exclude possibility of upgrading with the additional I/O modules to cover for more complex applications such as multi-track configurations with implementation of the down-holding function, for example. In that case, both software and hardware additions will be needed (ones for a country). A country (Railway Authority) specific differences shall be handled mostly by the application software. For the majority of applications, software adjustments will be related to the selection of the required functions from the available set of application functions and adjusting the timer values. Only very small hardware alterations are expected. For example, interfaces for the specific outside equipment and interfaces for block applications.





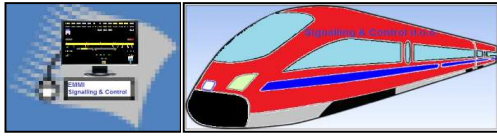
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If the complexity of the application requires additional inputs and outputs, the use of additional safety PLC HiMatrix F3 is anticipated. Number of F3 PLC modules that can be added is limited but it is sufficient to cover practically all known level crossing applications. If there is a requirement for the realisation of a special function (for example AD conversion etc.) other safety PLC modules (produced by HIMA) can be used, retaining the safety integrity level of the system.



**Layout of the standard ELC system.**

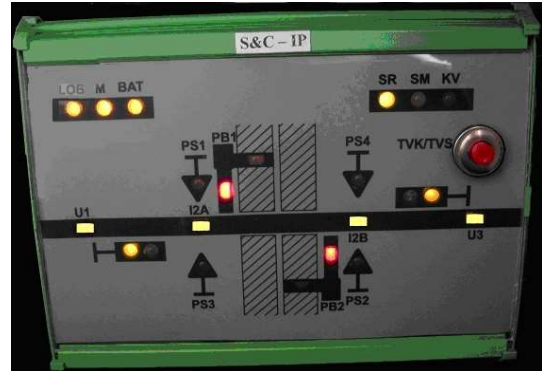


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## INDICATION PANNEL

The Indication Panel (either conventional or PC-based) can be placed locally and / or at the remote place. All indications are typically provided through the voltage free contacts of the miniature safety relays.



## SMS MODULE

Purpose of the SMS module is to provide immediate information to the relevant subjects (signalman, maintenance staff, dispatcher, etc.) about detected fault or disruption on the level crossing. SMS module is realised on the basis of GSM module, which collects states from the ELC via appropriate inputs. Selected states of the ELC system (fault, disruption and broken boom) are sent via SMS messages and delivered to three mobile telephones, which are selected in advance. Every SMS message contains identification of the level crossing.

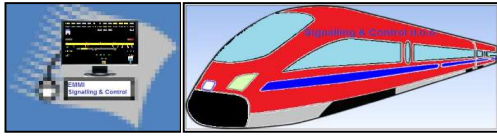
After receive of the SMS messages the authorised personnel is able to undertake necessary activities in the aim to efficiently repair failures at the level crossing. Due to the fact that failures are reported immediately, i.e. without delay, total time period while the level crossing system is in a failure state is significantly reduced. Hence, efficiency of the maintenance response is enhanced and availability of the level crossing protection system is significantly increased.

## REGISTRATION OF EVENTS, DIAGNOSTIC AND MAINTENANCE

ELS system is supported by **SD&ER** – *Service, Diagnostic and Event Recording* system. SD&ER consists of central and local part. Local part of the SD&ER system is part of the ELC system at the level crossing. It consists of local diagnostic database and SMS module. Conventional or GSM modem for communication with central part can be provided as an option if remote diagnostic is required. Local database is filed in by the software of the fail-safe ELC system, on the base of standard input data collected during the normal work of the ELC system. Hence, the diagnostic data are provided by the fail-safe system itself. Therefore, the diagnostic data are very trustable and reliable. Central part represents a PC with special SD&ER software and central database for level crossings. PC also contains commercial software packages: Microsoft Windows and Microsoft Excel. The PC can be used locally (basic solution), or remotely. For remote use it is required to provide appropriate modems or the appropriate means of communications between a remote place and the ELC (remote diagnostic solution).

Central database contains data about every level crossing including: unique identification of the level crossing (i.e. ELC system), registered events (regular events, disruptions and faults) with date and time of their appearance (day, month, year, hour, minute and second), as well as appropriate instructions for the maintenance and repair (for disruptions and faults). Data from the central database are used for maintenance support (preventive and current in case of detected disruptions and fault), as well as for the preventive and post incidental analyses of the registered events in a case of the irregular event (an incident).

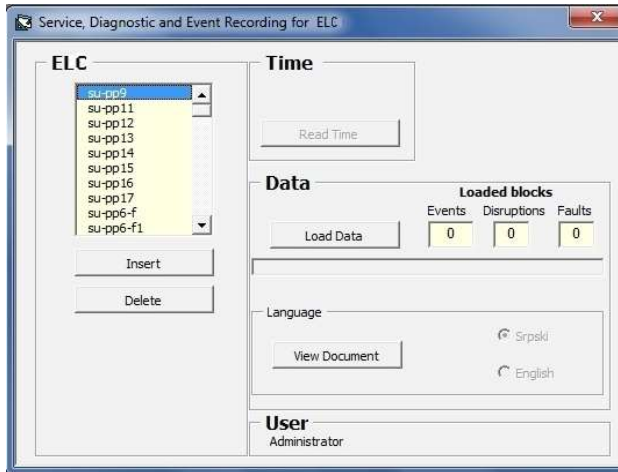




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SD&ER software runs on the PC as an independent package under Windows operating system. SD&ER software does the following:



- Provides authorisation of the access with administration of users;
- Supports communication with a selected level crossing system;
- Reads diagnostic data from the local database of a selected level crossing system;
- Analyses the diagnostic data and carries out further processing of the data;
- Updates central level crossings database;
- Generates appropriate maintenance instructions;
- Presents the diagnostic information on the screen in two languages, English and a user-defined language (Serbian for SR).

**Typical layout of the main window of SD&ER system.**

System SD&ER gives to the maintenance staff precise description of the types and locations of the failures and direct instructions how to repair them. Analyses of the regular events, also offers advance maintenance possibilities. Hence, it is possible to detect trends of behaviour, or critical time durations in performing certain functions that could go towards fulfilment of the conditions for disruption or fault to happen. In this case, it is possible to carry out preventive adjustments of the performances of the modules in the aim to get them in the optimal state and thus, avoid appearance of the disruptions or faults. This considerably shortens detection time of the failures and contributes to the more efficient complete maintenance process.

SD&ER software carries out a simple statistical analysis of the registered events. This allows for the maintenance personnel to follow the types and numbers of failures, to identify required time for the maintenance activities and to do more accurate planning of necessary spare parts. As a result, maintenance processes can be optimised and the yearly and lifetime maintenance cost of the level crossings can be significantly reduced.

Beside the SD&ER software PC also contains the documentation for the maintenance support, which includes: installation project of ELC system, signalling arrangement with the track layout, cable plan, instructions for the installation, handling and maintenance for both ELC and outside equipment.

Registered data of the SD&ER system can be used, also as an Event Recorder (Black Box), so a separate device for this purpose is not needed. Registered events offer a possibility of monitoring of the traffic (regular and after the incident) over the level crossing and hence, make possible supervision of the behaviour of the relevant subjects (signalman, driver, maintenance personnel, road vehicles and the level crossing signalling equipment). As a result, it is possible to undertake preventive measures in the aim to improve behaviour and avoid accidents, or to establish responsibility for an eventual irregular event (accident).

SD&ER system allows Centralised Maintenance for all ELC and Centralised Event Recording.