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Branka Krsmanovica 20, 11000 Belgrade, Serbia

1. EI – ELECTRONIC INTERLOCKING

EI - Main characteristics

• EI (Electronic Interlocking) – Electronic station interlocking system is a HIMA HiMax PLC based controlling system of the highest safety integrity level - SIL4 in accordance with CENELEC European railway standards.

• It is dedicated to cover all types of the railway stations and lines between the stations (automatic blocks or permissive inter-station dependency).

• EI is realized as a modular and scalable system, which can cover all types of various stations track configurations and signalling arrangements, from simple (small) to very complex (large), for various county practices and various railway authorities.

• EI represents an economical system, which is very competitive to other Computer-based Interlocking - CBI systems, as well as, to the conventional Relay Interlocking – RI systems.

• Directorate for Railways of the Republic of Serbia issued the permanent approval for use of the EI on the Serbian Railways, I-01-1 No.: 340-142-3/2016, from 09.03.2016.y.

EI Hardware – Architecture of the system

- Level 1: HMI - Operator console (single or duplicated for availability, typically SIL0.
- Level 2: Central safety controlling system (SIL4) realized with HIMA PLC family HiMax.
- Level 3: Safety controlling sub-systems (SIL4) realized with HIMA PLC family HiMatrix.
- Level 4: Interfaces for the control of signalling elements are realized as standardized modules (SM - signal module, PM - points module, DIM – digital input module, DOM – digital output module).
- Level 5: Signallling elements (outside and inside).

EI – Prototype for Serbian Railways

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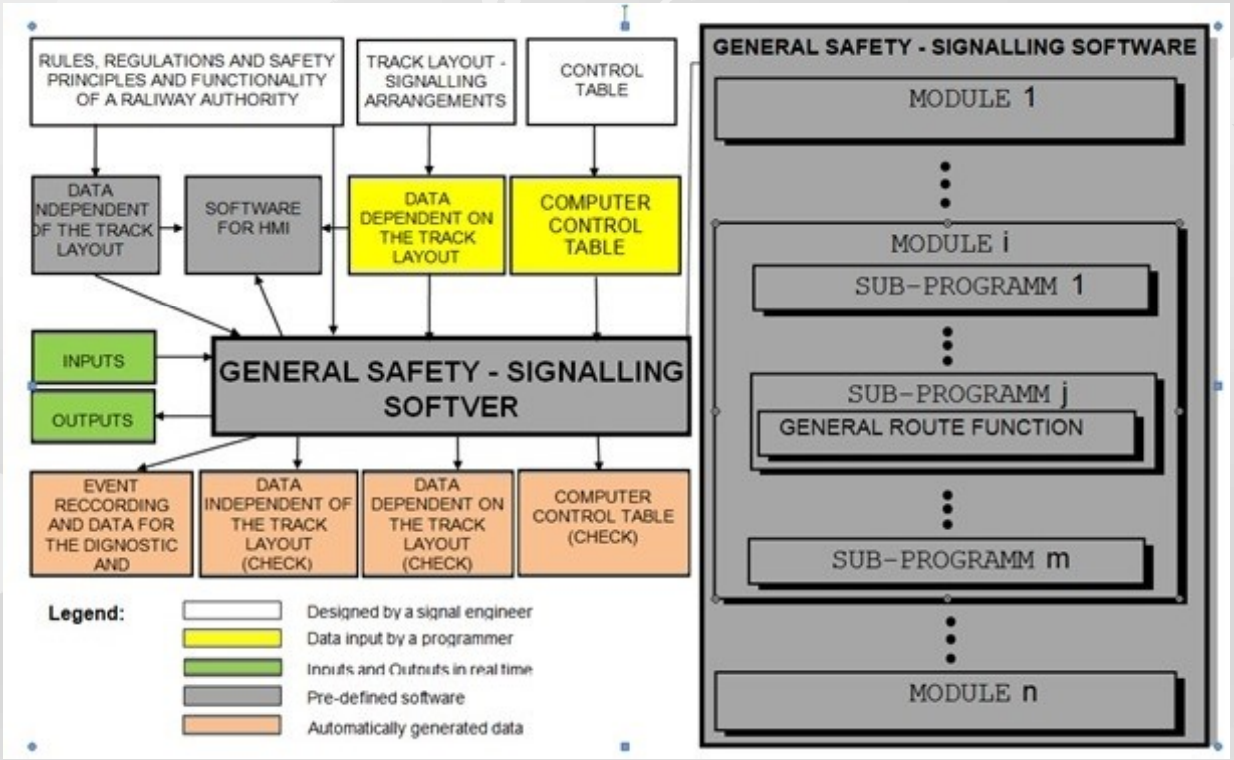
EI - Software

• EI software is realized on the bases of the PhD dissertation of Dr. Dejan Lutovac: "Universal Computer-Based System for Railway Interlocking Control".

• Software is realized as an integrated package that contains all necessary data and functional modules.

• It covers complete safety principles and functionality of the railway authority, independently of the station track layout.



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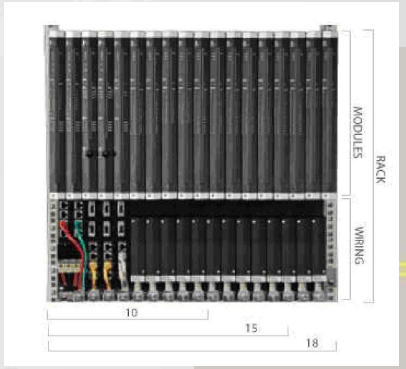
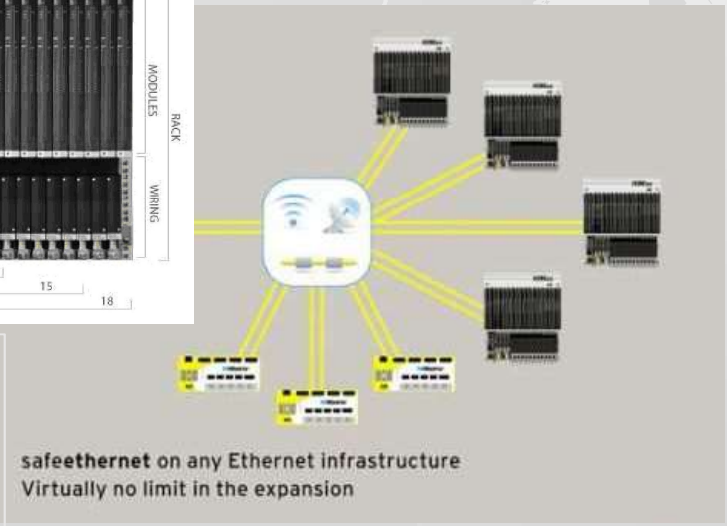
EI - Modular and scalable system

- Minimum configuration: 10 modules inside a single housing (rack).
- Maximum configuration: 16 housings (racks) with total 288 modules.
- Mixture of HiMax (SIL4) and HiMatrix (SIL4) depending on the requirements and complexity.





EI Communication (duplicated for the availability)

- Ethernet (non-vital): HMI (SIL0) with HiMax(SIL4).
- Safe-Ethernet (vital): HiMax (SIL4) with HiMatrix (SIL4).

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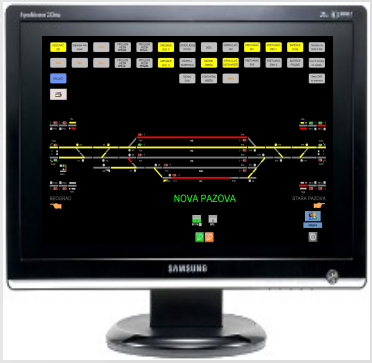
Level 1: HMI - Operator console (single or duplicated for availability), typically SIL0.

- HMI (Human Machine Interface) is an electronic system that allows the interactive communication between the operator and the central EI system.
- The software package WinCC (Siemens) on the PC is used as a base for the realization of the HMI.
- Communication with HiMax PLC is realized over the Ethernet using the HIMA XOPC server.
- HMI is typically realized as a single SIL0 system and can be duplicated for the availability.
- It can also be connected to other computer-based interlocking systems via appropriate communication protocols.



HMI – Interface to the relay interlocking system

• This subsystem is realized as an independent system that can be used with relay interlocking system or an other computer-based interlocking.

• The same HMI operating console, with the appropriate communication protocol, uses for this purpose.

• The HMI interface for relay interlocking system SpDrS64-JZ (Siemens), with Simatic S7 communication protocol and Simatic S7 PLC family (Siemens) is shown on the picture.

• Directorate for Railways of the Republic of Serbia issued the permanent approval for use of the EMMI - Electronic Man Machine Interface on the Serbian Railways, I-01-1 No. 6/08, from 19.01.2009.y.

EMMI – Interface to SpDrS64-JZ, Nova Pazova

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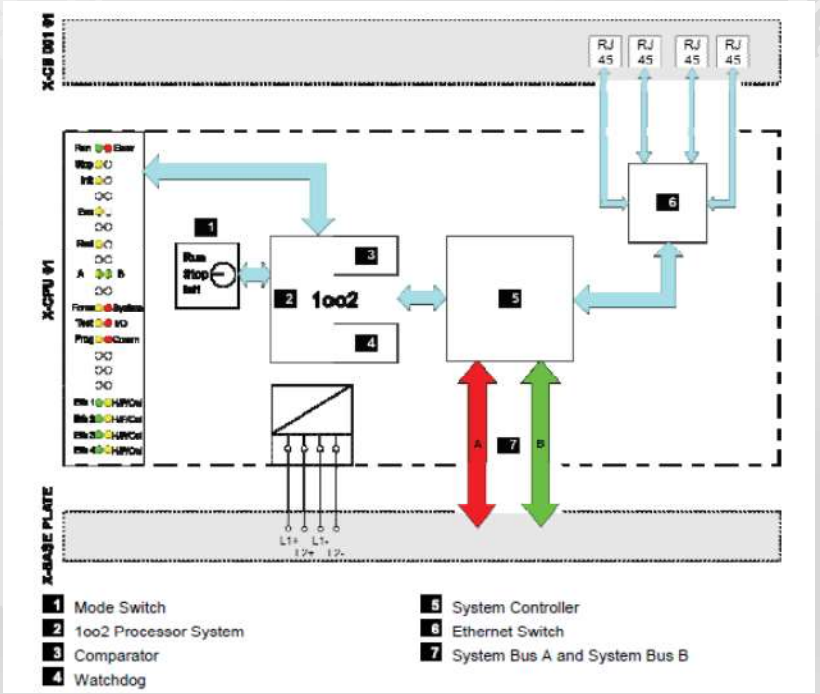
Level 2: Central safety controlling system (SIL4) realized via HIMA PLC family HiMax

• Central computer controlling system is realized by use of the safety HIMA PLC family HiMax (SIL4), which is also highly reliable and highly available system.

• Each safety module individually is realized in the safety architecture - "2 out of 2".

• HiMax PLC for EI application is typically realized in the architecture - "2 times 2 out of 2" with hot swap-ability feature for the failed modules (worm replacement of the failed module).



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Level 3: Safety controlling sub-systems realized via HIMA PLC family HiMatrix (SIL4)

• Safety sub-systems of the EI are individual safety computer controlled systems, which are realized by use of the safety HIMA PLC family HiMatrix (SIL4):

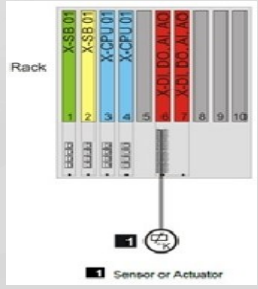
• ELC – Electronic Level Crossing System
• EAC – Electronic Axle Counter System
• Electronic Interfaces

• The sub-systems are typically connected to EI via Safe-Ethernet, but they can, also, be connected to the EI (or the other relay or computer-based interlockings) via DIO (hardware connection)

ELC - Electronic Level Crossing

EAC - Electronic Axle Counter

Electronic Interface with HiMatrix



Wiring of DIO modules

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Level 4: Interfaces for the control of the signalling elements

Interface modules are realized as standardized functional modules:

- SM - signal module
- PM - points module
- DIM - digital input module
- DOM - digital output module

Additional functional modules:

- EFL – Electronic Flasher
- ECD – Electronic Current Detector
- RM – Relay Interface
- IP – Indication panel
- GSM – SMS diagnostic
- LPM – Lighting Protection
- TERM – Electronic Thermostat
- ETIM – Electronic Timer
- EODT – Electronic Off-Delay Timer