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Document Title: SPECIFICATION FOR ELECTRONIC INTERLOCKING			



RESEARCH DESIGNS & STANDARDS ORGANIZATION
Manak Nagar, Lucknow – 226011

RDSO/SPN/192/2019

ELECTRONIC INTERLOCKING

(FORMELY KNOWN AS SOLID STATE INTERLOCKING)



NUMBER OF PAGES 30

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Abstract This document defines technical requirements of Electronic Interlocking.			

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0. FOREWORD:

- 0.1 This specification is issued under the fixed serial No. RDSO/ SPN/192/2019 followed by the year of original adoption as standard or in case of revision, the year of latest revision.
- 0.2 This specification requires reference to the latest version of following specifications: –

1.	IRS: S 36	Relay interlocking systems
2.	IRS: S23*	Electrical signalling and interlocking equipment
3.	RDSO/SPN/144	Safety and reliability requirement of electronic signalling equipment.
4.	IS: 9000*	Basic environmental testing procedures for electronic and electrical items.
5.	IS 2147-62*	Degrees of protection provided by enclosure for low voltage switchgear and control gear.
6.	ISO 9001	Quality Systems- model for quality assurance in design, development, production, installation and serving.
7.	EN 50121*	Railway Applications - Characteristics of Railway Systems that affect EMC behaviour
8.	EN50126	Railway applications- specification and demonstration of reliability, availability, maintainability and safety.
9.	EN50128	Railway applications- signaling and communication- Software for Railway control and protection system.
10.	EN50129	Railway applications- Safety related electronic systems for signaling.
11.	EN50159	Railway applications- Signaling and Communication Safety related communication in closed and open transmission system.
12.	IEC 529/EN 60529	Specification for degree of protection provided by enclosures (IP code).
13.	EN 61000.4.2	Electromagnetic compatibility (EMC) - testing and measurement techniques- electrostatic discharge immunity test and basic EMC.
14.	EN 61000.4.4	Electromagnetic compatibility - testing and measurement techniques- electrostatic fast transient/ burst immunity test and basic EMC publication.

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15.	EN 61000.4.5	Electromagnetic compatibility - testing and measurement techniques- surge and immunity test.
16.	IRS: S-99	Data Logger System.
17.	RDSO/SPN/186	Domino Type Control Panel for Railway Signalling
18.	RDSO/SPN/197	Code of Practice for Earthing and Bonding System for Signalling Equipments.
19.	IRS: S-24	Electric Point Machine
20.	RDSO SPN 153	LED Signal
21.	IRS : S-57	Electric Lamp for Railway Signalling
22.	RDSO SPN 146	Audio Frequency Track Circuit
23.	RDSO SPN 175	Solid State Block Proving by Digital Axle Counter
24.	RDSO SPN 176	Multi-section Digital Axle Counter
25.	IRS TC 55	24F Armored Optical Fiber Cable
26.	RDSO/SPN/177	Single section Digital Axle Counter
27.	IRS: :S 63	PVC insulated underground unscreened cable for Railway signalling
28.	IRS: S 76	PVC insulated indoor cables for Railway signaling
29.	RDSO/SPN/183	Train Protection Warning System
30.	IRS : S 96	DC-DC Converter for Railway S&T Installations.

* Or equivalent Recognized International standard. The supplier shall submit a copy of the same for verification.

** Whenever, reference to any specification appears in this document, it shall be taken as a reference to the latest version of that specification.

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0.3 ABBREVIATIONS :

SNO.	Abbreviation	Expanded Form
1.	ABS	Automatic Block Signalling
2.	ATP	Automatic Train Protection
3.	CA	Cross Acceptance
4.	CCIP	Control Cum Indication Panel
5.	CD	Compact Disc
6.	CENELEC	European Committee for Electro Technical Standardization
7.	CPU	Central Processing Unit
8.	CMU	Central Monitoring Unit
9.	CTC	Centralised Train Control
10.	EI	Electronic Interlocking
11.	EMU	Electrical Multiple Unit
12.	EPROM	Erasable Programmable Read Only Memory
13.	IBS	Intermediate Block Signalling
14.	I/O	Input/output
15.	ISA	Independent Safety Auditor/Assessor
16.	MTBF	Mean Time Between Failure
17.	MTBWSF	Mean Time Between Wrong Side Failure
18.	MTTR	Mean Time to Repair
19.	MT	Maintenance Terminal
20.	OC	Object Controller
21.	OFC	Optical Fiber Cable
22.	PC	Personal Computer
23.	PCB	Printed Circuit Board
24.	QA	Quality Assurance
25.	QAP	Quality Assurance Program
26.	SEM	Signal Engineering Manual
27.	SIL	Safety Integrity Level
28.	STR	Schedule of Technical Requirements
29.	TOT	Transfer of Technology
30.	UV	Ultra Violet
31.	VDU	Visual Display Unit/ VDU Control Terminal
32.	VGA	Video Graphic Array
33.	TPWS	Train Protection Warning System
34.	ETCS	European Train Control System
35.	RTC	Real Time Clock
36.	BOM	Bill of Material
37.	FOM	Fiber Optic Modem
38.	OS	Operating System

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0.4 DEFINITIONS:

ABSOLUTE BLOCK SIGNALLING: Absolute Block signaling is to facilitate the safe operation of a Railway by preventing more than one train from occupying a defined block section at the same time with the use of block instruments, block proving through axle counter etc.

AUTOMATIC BLOCK SIGNALLING: A system of block working where auto signals in the block section control the train movements to achieve the headway requirements.

AUTOMATIC TRAIN PROTECTION: Automatic Train Protection System is to help prevent collisions through a driver's failure to observe a signal or speed restriction. It consists of two parts – one part is on-board equipment to protect the train and the second is trackside equipment to transmit the interlocking information to the on-board equipment.

CENTRAL PROCESSING UNIT: Central Processing unit is a microprocessor based interlocking system, which holds the firmware and the station specific application logic for an interlocking. It processes the station specific application logic based on the vital inputs received from the field and non-vital commands given by user in fail safe manner and generates vital outputs to control the field gears. The CPU may be connected to object controllers to control the field gears in a distributed interlocking environment.

CENTRALISED TRAIN CONTROL: Centralised train control system is used in places where more than one stations are controlled from a central place. The command to an interlocking can be given from a central place and after the commands are executed by the interlocking in the station, the field status is updated on the CTC screen. It shall also manage the traffic schedules and plans.

DATA LOGGER: It is a RDSO approved software based system to log events of a station in chronological manner pertaining to signalling gears.

CENTRAL MONITORING UNIT OF DATA LOGGER: A remote centralized system for monitoring the status of signalling gears and systems through data loggers located at wayside stations.

OBJECT CONTROLLER (OC): Object controller is an intermediary system between CPU & field gears that will be placed close to the field gears. The object controller will communicate with CPU to get the commands to drive out-

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puts directly or through RDSO approved fail safe relay and send the status of field gears back to CPU.

Real Time Clock (RTC): -Real Time Clock of the EI System

1.0 SCOPE :

- 1.1 This specification covers the technical requirements of Electronic Interlocking.
- 1.2 The Electronic Interlocking covered in this specification shall be a microprocessor based equipment used for the operation of points, signals, level crossing gates, block working with adjacent station, releasing of crank handle for manual operation of points and other controls like slots etc. through a control cum indication panel or VDU based control terminal. It shall be capable of future interfacing with ATP & CTC systems, TPWS, ETCS, Radio Block Centre & other advanced systems.
- 1.3 A typical Electronic Interlocking installation shall consist of VDU Control Terminal and/or CCIP, Central Processing Unit, Object Controller and/or relay driver circuit, Maintenance Terminal & Data logger, etc. The command is generated from the VDU Control Terminal/CCIP and given to central processing unit which performs all the interlocking and fail safety functions. After processing the command, the necessary output is given to object controller /or Relay driver circuit to drive the output relays. The object controller if available gives command to signalling gears directly or through interface relays. After the given command is executed, the inputs from the field are read back and transmitted to CPU for further process and for display at VDU Control Terminal/CCIP as acknowledgement.
- 1.4 The whole interlocking of a yard shall be controlled either by central operation or Distributed operation.

2. TERMINOLOGY:

- 2.1 For the purpose of this specification, the terminology given in latest version of IRS: S 23 and RDSO/SPN/144 shall apply. However in case of conflict between this specification & RDSO/SPN/144, the terminology defined in this specification for Electronic Interlocking system shall be followed.

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3. GENERAL REQUIREMENTS:

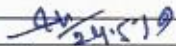
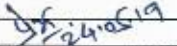
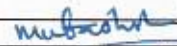
- 3.1 The system shall provide all the interlocking, control and indication functions as per approved interlocking plan, selection table and panel diagram of the station.
- 3.2 The system shall have facility of logging of internal variables as well as status of I/O.
- 3.3 It shall be possible to connect EI with Central Diagnostic Unit kept at Head quarter or any other suitable place. MT shall be used to diagnose faults/events related to hardware and software of EI. EI system shall have facility for automatic data transfer to a central diagnostic unit.
- 3.4 RDSO approved external data logger of suitable capacity shall be supplied with EI unless specified otherwise by the purchaser.
- 3.5 EI shall be connected to data logger through protocol converter having protocol as defined in IRS: S-99, amnd.3 or latest.
- 3.6 The system shall be suitable for working on sections having 25 kV AC traction and where passenger/freight trains hauled by single phase/three phase thyristor, IGBT or chopper based propulsion system for controlled EMU& AC Locomotives are operated.
- 3.7 The system shall be capable of working with the Control cum indication panel (CCIP) with VDU Control Terminal or with duplicated VDU Control Terminal as required by Railways. The CCIP is optional and needs to be specified by the purchaser.
- 3.8 The system should have capability to interface with Block Working. It should also be capable of interfacing with, IBS, ABS including interfacing with outlying yards and sidings.
- 3.9 The system should be capable of interfacing with all signalling gears available on Indian Railways required for train operation directly or through RDSO approved fail safe relays.
- 3.10 The system shall be capable for working in non-air-conditioned environment and ambient temperature range between -10° C to 70° C and Relative Humidity upto 95% at 40° C.
- 3.11 The system shall be provided in dust protected cabinet. If forced cooling is required, the cooling fans shall operate on separate power supply with over

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current protection arrangement. The failure of any one fan shall give an alarm to the operator.

- 3.12 The equipment shall be so constructed as to prevent unauthorized access (through hard keys on equipment cabinet, CCIP & password on VDU) to the system.
- 3.13 Necessary provision shall be made in the hardware and software for modular expansion of the system.
- 3.14 The communication provided between EI-EI & between EI to OC shall be on redundant network/switches using fiber Optic cable arrangement if equipments are placed in different locations with facility to identify fault and easy restoration using NMS or equivalent system. The system shall adopt duplicated/redundant network if placed at multiple locations, the OFC paths should also be on diversified routes. The vital protocol shall be complying to CENELEC normative EN 50159, or relevant.
- 3.15 EI shall have user-friendly graphic based design tool to generate station specific application software to carry out future yard modifications. All the software tools required for yard modification shall be provided by supplier. It shall be possible for Railway to carryout yard modifications without the help of firm and the training shall be imparted by the supplier to Railway signalling staff for the same as per agreement with the Railway.
- 3.16 Either OFC or twisted pair cable shall be used for all vital connections.
- 3.17 The RTC of Central processing Unit system(s) should be updated/ synchronized with the External Data logger. And it shall be possible to log the events in chronological order in case of use of either single/multiple Central processing Unit with Data logger
- 3.18 In case any peripheral equipment (such as MT, Data logger etc.) needs to be connected to the EI through serial ports. Then EI system shall be isolated from the peripheral systems, and suitable isolators shall be used for connecting the peripheral devices.
- 3.19 LED/LCD indication/display shall be provided on all the modules of EIs to indicate status/ errors of the module.
- 3.20 Requirement of spare parts of each type for the first line maintenance shall be indicated to meet system availability with Mean time to repair (MTTR) as required by the user railways.

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3.21 REQUIREMENT OF ELECTRONIC INTERLOCKING:

- 3.21.1 Both hardware & executive software of EI must meet SIL-4 as defined in CENELEC Standards. If the system is developed using any equivalent International Standard other than CENELEC, a copy of the standard followed shall be submitted with application. The certificate of Independent safety assessor certifying that the system is equivalent to SIL-4 compliant shall also be submitted to RDSO.
- 3.21.2 The EI system executive software as well as hot standby changeover software should have been independently verified and validated including its offered configuration by third party. User Railway shall verify application software pertaining to yard data.
- 3.21.3 The system shall have the capability to log events like Emergency Route cancellation, Calling On signal, Emergency Point operation, Overlap release operation etc. It shall be possible to read events as and when required. Supplier shall provide a counter box having non-resettable counters to log above events or any other means to achieve the same.
- 3.21.4 The firm manufacturing EI, when applying for type approval or cross – acceptance approval shall submit documentary proof of independent validation as per CENELEC Standards or equivalent standards, along with complete safety case.
- 3.21.5 The firm shall give details of all modifications carried out in the system after initial validation/ approval. Date of each modification with brief reasons for undertaking modifications shall be given. All modifications must have got approval of internationally recognized validating agency/ approving agency.
- 3.21.6 The next level Signal control circuits like Cascading of Signal aspects, Red lamp protection etc shall be achievable through Software only.
- 3.21.7 The audio-visual alarm shall be available for Approach locking, Button sticking etc .as specified by the user railway.
- 3.21.8 The system shall have back up information on log of minimum one month data or 10,00,000 events (whichever is higher) for all internal variables. The log shall be stored for complete system either in CPU(s) or MT. In case the complete logging is dependent on MT, the MT shall be suitable for 24x7 operation to ensure backup of log.

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3.21.9 The system shall have facility for automatic data transfer to a central monitoring unit through data logger. The protocol for this communication shall be as per latest Data Logger specification No. IRS: S-99

3.21.10 Cycle time and response time to read and process the input shall be fast enough to ensure safety and avoid any apparent delay. Cycle time and response time of the system shall be clearly indicated. The longest route for which all points are in favour shall not take more than 10 seconds from initiation of command to display of lowered signal aspect on control panel.

3.22 The supplier shall supply the earthing arrangement for EI installation as per the latest guidelines issued by the Railway Authority.

4. INTERLOCKING REQUIREMENTS:

4.1 The system shall meet the interlocking requirements as specified in Cl.4.0 of IRS: S 36.

4.2 The system shall meet the interlocking requirements of the station as per the approved Interlocking plan and approved selection/control table provided by Zonal Railway.

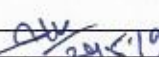
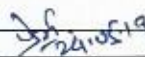
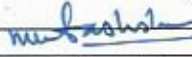
5. SYSTEM COMPOSITION:

5.1 The EI system shall consist of the following:

5.1.1 Microprocessor based interlocking equipment to read input from the yard and from CCIP/VDU Control Terminal and process them in a fail-safe manner as per the selection table and generate required outputs.

5.1.2 Duplicated VDU Control Terminal or VDU Control Terminal with Domino type Control Cum Indication Panel (CCIP) used with Panel Processor as required by purchaser. Panel Processor shall always be placed in same room as CCIP and connected through duplicated/redundant OFC with CPU.

5.1.3 CCIP shall be used as optional and shall conform to relevant clauses of IRS: S 36 and RDSO/SPN/186. It shall be provided with push buttons/ control switches for individual operation of points, clearing of signals, releasing of crank handle/ground lever frame/ gate controls, cancellation of routes and other functions as covered by IRS: S 36 including block signalling, auto signal, IB signal, adjacent yard layout, to facilitate indication or operation cum indication as per requirement.

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5.1.4 Maintenance terminal (MT) with display, keyboard, printer and event logging facility for minimum 10,00,000 events or one month data (whichever is larger) of its own.

5.1.5 Relay racks along with required number of approved type of relays or OCs.

5.1.6 EI shall either have object controllers having solid state Point & Signal modules to drive signals and points directly or it shall be possible to interface EI or object controller to drive points and signals using RDSO approved relays.

5.1.7 Power supply requirement shall be as per Clause 9.

5.2 OBJECT CONTROLLER (Optional) :

5.2.1 OC shall be a Processor based system. It shall work as slave unit of CPU through duplicated OFC communication and placed within 15 Km. radius from CPU. The OC shall drive the field gears (Points, Signals & Relays) and take feedback (Inputs) from various field gears without any modification/ change in the design of outdoor Signalling equipment.

5.2.2 Both hardware & executive software of OC must meet SIL-4 as defined in CENELEC Standards.

5.2.3 The OC shall be able to drive the signalling gears directly or through RDSO approved fail safe relay. The purchaser shall give the details of interface requirements with outdoor gears.

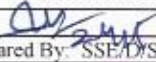
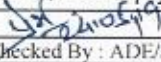
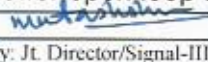
5.2.4 OC shall be normally placed in field locations. The location shall be strategically selected to reduce requirement of signalling cables and interface relays.

5.2.5 The medium of communication between CPU and OCs shall be OFC provided on a redundant/duplicated basis. In case of communication failure between CPU & OC, all the outputs of OCs shall be brought to safe state.

5.2.6 All the inputs and outputs of OCs shall be isolated.

5.2.7 OC shall carry out the supervisory function to check the proper level of its own voltages at critical points to ensure proper working of the system and its own health.

5.2.8 OCs when placed at multiple locations shall be connected through diversified/duplicated OFC ring and the protocol shall comply to EN-50159 for closed loop transmission. Additionally Vital Radio link as per the Indian telecom standards to connect between Object controllers and CPU can also be used which should comply with EN-50159 for open loop transmissions.

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5.2.9 Occurrence of any error in any OC or hardware fault leading to unsafe condition shall immediately withdraw all output commands and remove the source supply to outputs. Functionally, each OC should be independent from other OC. Error in one OC should not affect the working of other OCs.

5.3 VIDEO DISPLAY UNIT CONTROL TERMINAL or VDU Control Terminal :

5.3.1 Requirements:

- It shall have Ethernet/OFC communication with the CPU either on copper cable or OFC, with suitable isolators.
- It shall have required level of security features & access control i.e logging (the ports & application provided on unit shall be password protected) for the operator/maintainer.
- It shall have key board/mouse operation.
- It shall be possible to have either entry/exit like CCIP or pop up menu based operation as required by Railways.
- It shall be possible to disable the menus in case of emergency.
- It shall support buzzers/alarms as in CCIP
- Embedded Industrial grade fan-less (commercial-off-the-shelf-COTS) PC with latest PC configuration shall be provided and suitable Compact Flash Disc memory space shall be catered for the backup requirements.
- In case of big yards, it shall be possible to display the yard in more than one monitor of thin edge type/ bezel type

5.3.2 The following minimum requirements shall be catered for the both VDU Control Terminal/ maintenance terminals (but it is not limited to).

It shall have minimum of two serial ports. The serial ports shall have inbuilt isolation or external isolation shall be provided

Minimum Requirements for Embedded PC For VDU Control Terminal of Electronic Interlocking (EI)

CPU	AMD T52R 1.5GHz or Intel Atom N270 1.6 GHz processor or Intel® Atom™ Z530 / 1.6GHz or above or as required by OEM.
OS (pre-installed)	Linux or Windows Embedded Standard or above or as required by OEM.
System Memory	1 x 200-pin DDR2 SODIMM socket support DDR2 533 up to 2GB, built-in 1 GB
Storage	
Built-in	10 GB onboard industrial DOM to store OS minimum or above as required by OEM.
Other Peripherals	

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Key Board/Mouse	As required by OEM.
Audio	Line-in, line-out interface
Display	A good quality of commercial display monitor of size minimum 42 inch up to 6-7 line yard, multiple display monitor with thin/bezel edge for large yards.
Ethernet Interface	
LAN	2 auto-sensing 10/100 Mbps ports (M12)
Serial Interface	
Serial Standards	4 RS-232/422/USB/485 ports as required by the OEM.
Environmental Limits	
Operating Temperature	Wide temperature range models: -10 to 70°C
Ambient Relative Humidity	5 to 95% (non-condensing)
Power Requirements	
Input Voltage	9-36 or 12 to 48 VDC
Standards and Certifications	
EMC	EN 50121/ EN 61000-3-3/ EN 55024 or FCC Part 15 subpart B class A
Warranty	
Warranty Period	Purchaser will specify the warranty period from the date of commissioning of complete system.
Fan less	Yes

A flashing indication shall be provided on the VDU Control Terminal to indicate healthy condition of the main system and communication channel.

Three dot markers in Red, Blue & Green colours respectively shall also be displayed prominently at conspicuous location on the VDU Control Terminal to indicate that the colour monitor is healthy and all the three colours (Red, Blue & Green) are present in right proportion.

It shall be possible to display the status of the yard by distinguishing with two different colours (i.e., system active and system inactive)

- 5.3.3 It shall be possible to display the complete yard layout including the section on the monitor. It shall also have facility for displaying a portion of the yard or section in an enlarged mode or with scrolling arrangement, if required.
- 5.3.4 The current position/ status of various field equipments and track circuits shall be displayed on the VDU Control Terminal using different colors/ symbols, as desired by the purchaser.

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- 5.3.5 The system shall have suitable interface to receive and process the information for displaying the status of field equipment on the VDU control terminal. This interface shall be of standard Ethernet based communication or any other approved type.
- 5.3.6 Availability of communication channel shall be indicated by a constantly flashing indication. Whenever the communication channel goes faulty, a suitable error message shall be displayed on the terminal.
- 5.3.7 Blocking of functions (points, signals, track circuits etc.) shall be possible through VDU Control Terminal. The blocking operations shall be achieved in fail-safe manner.
- 5.3.8 If VDU Control Terminal and CPU are in separate building, then they shall be interfaced using FOM (Fiber Optic Modem) to protect against lightning and surges.
- 5.3.9 Operation of signalling gears shall not be possible simultaneously through both VDU Control Terminals. In case of VDU Control Terminal's used in Hot standby, VDU Control Terminal switch over is required in the following conditions:
- a) VDU Control Terminal to EI communication failure,
 - b) VDU Control Terminal computer failure,
 - c) VDU Control Terminal monitor's failure,
 - d) One VDU Control Terminal is not controllable due to mouse failure.
- It should be possible to switch over control from any of the working VDU Control Terminal without co-operation from VDU Control Terminal which is having above mentioned failures.

6. HARDWARE AND FAIL-SAFETY:

- 6.1 Requirements of SEM as laid down in relevant clause of latest version of RDSO/SPN/144 or CENELEC or equivalent international standard shall be complied.

6.2 COMPONENTS:

Components used shall comply with relevant clause of latest version of RDSO/SPN/144 and should be commercially available.

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6.3 PROTECTION AGAINST ELECTROMAGNETIC AND ELECTROSTATIC INTERFERENCE:

The requirements laid down in relevant clause of latest version of RDSO/SPN/144 shall be complied or relevant CENELEC standard as required by RDSO. The equipment chassis shall be connected to suitable earth.

6.4 FAIL-SAFETY:

The requirements laid down in relevant clause of latest version of RDSO/SPN/144 or CENELEC or equivalent international standard shall be complied.

6.4.1 Either or both of hardware and software redundancy shall be provided to ensure that any single fault does not lead to unsafe failure.

6.5 MTBWSF should be minimum 10^9 hours.

6.6 The system shall have provision for accommodating additional 15% of I/O in future.

7.0 SYSTEM ARCHITECTURE:

7.1 One of the following architectures shall be employed in the system.

- (a) Single Hardware architecture with diverse software. In addition, hot standby processor(s) /system shall be provided with facility of automatic changeover.

The train operation shall not be affected and there shall be no unsafe occurrence due to switching over from main system to standby system. It should also be ensured that the fault, which affected the main processor/ system, does not affect the hot standby processor/ system.

- (b) Two out of two hardware architecture with identical hardware and identical or diverse software. In addition, hot standby processor(s) / system using similar 2 out of 2 hardware and software architecture shall be provided with facility of automatic changeover.

The train operation shall not be affected and there shall be no unsafe occurrence due to switching over from main system to standby system. It should also be ensured that the fault, which affected the main processor/ system, does not affect the hot standby processor/ system.

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- (c) Two out of three hardware architecture with identical hardware and identical or diverse software.

7.1.1 One of the following arrangements. shall be used during the commissioning of EI in the Railways :

- i) Centralized arrangement.
 - ii) Distributed arrangement with object controllers.
- a) The Object controllers shall have only function as input/output gatherer and interlocking logic shall not be contained in any of Object controller.
 - b) Provision of local as well Centralized operation for stations shall be provided to facilitate CTC operation in future.
 - c) The Architecture and Distribution of Object Controllers may be made Line/Zone-wise so as to result in minimum repercussion to traffic in case of failure of any Object Control Module or the power supply or its connectivity to Electronic interlocking.
 - d) Complete redundancy from power supply to communication, including communication system shall be provided for connection of object controllers to main Central processing unit. It shall be ensured that no single failure shall result in shut down of system or object controllers.
 - e) The connections of object controllers shall be only on duplicated OFC with diversified path and redundant switches/modems. A comprehensive NMS or other equivalent system for monitoring of communication links as well equipments shall be provided for easy maintenance and restoration of faults.
 - f) It shall be possible to interlock All Level crossing gates in block section, IBS, Automatic Block Signals and BPAC using Distributed architecture with Object Controller.

7.2 MAINTENANCE AND DIAGNOSTIC AIDS:

7.2.1 MT consisting of a PC (Industrial grade or commercial as required by purchaser) with printer from a reputed manufacturer shall be provided for following Operations: -

- i) Display of the current status of points, signals, controls etc. of the yard.
- ii) Storage of minimum one month data or 10,00,000 events whichever is larger for complete system which shall be recorded continuously by MT.
- iii) Display of recorded events and

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- iv) Data transfer to pen drive, flash memory or any other storage media.
- v) Generation of exception reports shall be possible on MT for analysis purpose and past events simulation on yard layout etc.
- vi) The soft copy of Signalling circuits/manuals provide at the station shall also be loaded on MT for ready reckoner of ESM in simple/local language.
- vii) MT shall be preferably connected to EI through OFC. If copper cable is used for connectivity the MT port shall be isolated from the port of EI. At both ends RS232 isolator/industrial grade opto-isolators shall be used.

7.2.2 The failure of any card/module in active or standby system should be clearly indicated. The supplier should also indicate process of replacing such defective cards / modules.

MT shall be user friendly and the displays on MT shall be self-guiding type for identifications of faults as well as for maintenance of system.

7.2.3 Control operation of yard functions shall not be possible from the maintenance terminal. It shall be possible to scroll the yard layout for the big yards.

7.2.4 In case of any module/ card becoming faulty, this fact should be displayed on MT with diagnostic facility to identify faulty module/ card.

8.0 SOFTWARE REQUIREMENTS:

8.1 The software of system should have two layers :

(a) Executive Software or System Software

This Executive Software shall define what the system can do and how the various parts of the system operate together. It shall include all start up and operational safety tests (including checking the Executive Software itself) that are the parts of the processor for continual assurance of safety operation.

(b) Application Software

It shall be containing the logic that defines how the inputs and outputs for a particular station are related. This shall be station specific.

It shall not be possible to modify Executive Software. However, Application engineers should have the facility to modify application software as and when required. It should be possible to prevent unauthorized access for modifying the application software through a password protection.

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- 8.1.1 The Application data of station shall be submitted by the OEM to the railways
- 8.2 Software used in EI should have been developed in conformity with a software engineering standard issued by recognized standards body such as CENELEC with special relevance to safety critical applications. Particular software engineering standards used shall be specified and one complete set of such standards shall be made available to RDSO.
- 8.3 The selected EI executive Software should have been independently verified and validated. As specified in the software Engineering Standards, full documentation on Quality Assurance Program specially the Verification and Validation (V&V) procedures carried out in-house or by any independent agency, should be made available to RDSO to check their conformity to the standards. If the procedure and documentation for V & V is considered inadequate, RDSO reserves the right to get the verification and validation of software and hardware done by an independent agency at the cost of the supplier.
- 8.4 The system shall conform to software requirements and self-check procedures as laid down in relevant clause of latest version of RDSO/SPN/144 or CENELEC standards.
- 8.5 **SELF CHECK PROCEDURES:**
- 8.5.1 Self-check of the associated functional hardware as required by the hardware design should be performed periodically as laid down in relevant clause of latest version of RDSO/SPN/144.
- Sufficient self-check should be built into the system to detect possible hardware faults.
- 8.5.2 Integrity of the final vital output of the system for control of the field equipment should be continuously monitored by failsafe hardware and software along with reading front (in case of Metal to carbon relay) or both contacts (in case of Metal to Metal relay) of relays to guard against inadvertent operation of the equipment.
9. **POWER SUPPLY REQUIREMENTS:**
- 9.1 The EI shall work with the 110 VDC power supply from common IPS or any other reliable 110 V DC power supply. Provision of reliable 110 V DC power supply shall be made available by Zonal Railways

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- 9.2 The terminals through which common positive or negative supply of 110V DC is provided to EI, must be duplicated, this shall also require duplicated power supply cables from 110V DC power supply source to EI.
- 9.3 Two different voltages shall be used, one to drive EI equipment and the other for receiving the inputs from the field gears.
- 9.4 All the DC-DC converters used to provide the different supply to the EI shall be provided for main and standby EI system separately.
- 9.5 DC-DC converters shall be capable for working in non-air conditional environment and ambient temperature range between -10°C to 70°C and Relative Humidity upto 95% at 40°C . It should be possible to indicate failure of DC-DC converter through potential free contact
- 9.6 The short circuit & over voltage protection of self-restoring type shall be provided.
- 9.7 The required protection shall be provided to protect from any malfunctioning due to false/ spurious feed.
- 9.8 Suitable surge protection and proper earthing arrangement shall be provided in the power supply system to protect against transient voltages, lightning & spikes etc. as per IEC normative. Also the above shall be implemented suitably in the field for the Indian Railways environment but firm shall provide a document capturing the installation / maintenance methods / work instruction prior to installation.
- 9.9 A detailed Power supply arrangement diagram/ circuit shall be provided.
- 9.10 Power supply arrangement for individual processor should be such that, in case of fault in power supply of one processor, all processors should not cease to function simultaneously. It should be possible to switch off and take out faulty processor for repairing/replacement without affecting working of the balance system.
10. **Information to be furnished by the manufacturer / supplier(at the time of type test or cross approval to RDSO):**
 - 10.1 The manufacturer shall supply the following information.
 - a) Design approach for the system.
 - b) Functions achieved in hardware & software.
 - c) Mode of interaction between hardware & software.

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- d) Salient feature through which fail safety has been achieved e.g. use of a watchdog timer, automatic shutdown etc.
- e) Proof of safety in the form of process adopted for safety analysis and result thereof.
- f) Full documentation of Software Engineering followed during development.
- g) Full documentation of verification and validation procedure, Quality Assurance Program along with report and certificate from in-house Quality Assurance (QA) Group or an Independent Safety Auditor (ISA).
- h) If the RDSO consider software validation necessary, the manufacturer/supplier will supply all the documents etc. to the Validator nominated by the RDSO.
- i) Complete application software with facility for Non-volatile Memory programming for entering yard data.

In case of Cross-Acceptance, the conditions postulated by RDSO for cross acceptance policy shall be followed.

10.2 The manufacturer shall supply the following documentation/ manuals:

- i) Installation & Maintenance Manual with pre-commissioning check list.
- ii) Diagnostic aids including troubleshooting charts: A trouble-shooting chart shall also be provided to indicate the step-by-step actions to be taken in case of failure of the equipment. It shall be possible to rectify the fault by replacement of defective PCB card by the maintainer at site.
- iii) Details of Hardware e.g. schematic diagrams of the system circuits/components, details for each type of assembled PCB or details of IPR (Intellectual property right).
- iv) Details of software algorithm flow chart along with test/validation procedure used and the results thereof for details of IPR (Intellectual property right).
- v) Version No. of Signalling equipment shall be as per RDSO/SPN/ 144. In case of Cross-acceptance, Version No. as per manufacturer's practice may be accepted.
- vi) Software checksum of Non-Volatile Memory(s) shall be provided as per RDSO/SPN/144.
- vii) System design and proposed configuration for the station.
- viii) EMI/EMC Test undergone by system to be submitted to RDSO.
- ix) Detailed power supply arrangement of EI.
- x) Wiring/Cable plan for the interconnectivity of EI sub-system and its interface.
- xi) Type of relays to be used with EI.

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10.3 The manufacturer shall provide the following certifications from approved validation agency at the time of cross approval or type testing:

- i) Correctness and safety of the software.
- ii) Reliability and fail-safety of the interlocking system.
- iii) Details of modifications carried out in the system and its subsequent validation.
- iv) Expected MTBF.
- v) Expected MTBWSF.
- vi) Expected MTTR.

11. ENVIRONMENTAL/CLIMATIC REQUIREMENTS:

The requirements of Environmental/ climatic tests as per relevant clause of latest version of RDSO/SPN/144 (Indoor Equipment) shall be complied.

12. WARRANTY REQUIREMENTS:

12.1 The EI system including its equipment and subsystems shall be under warranty from the date of commissioning of complete system. Purchaser will specify the warranty period.

12.2 Requirement of spare parts of each type for the first line maintenance shall be indicated for better system availability.

12.3 The MTBF of all vital modules shall comply with MTBF for the product as covered by CENELEC standard.

13. TESTS AND REQUIREMENTS:

13.1 Conditions of Tests:

Unless otherwise specified all tests shall be carried out at ambient atmospheric conditions.

13.2 For inspection of material, relevant clauses of IRS: S 23 and RDSO/SPN/144 shall apply.

13.3 TEST EQUIPMENT:

The firm should have all essential Testing Equipments as per latest STR.

13.4 TYPE TESTS:

13.4.1 Standard RDSO layout shall be used for conducting type tests.

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The following tests shall constitute type tests:

- a) Visual inspection as per Clause 14.1
- b) Insulation Resistance tests as per Clause 14.2
- c) Card-level functional tests on all the cards and fail-safety tests on one card of each type.
- d) System level functional and fail-safety tests.
- e) Computerised testing for minimum two hundred thousand permutations and combinations as per Clause 14.3.
- f) Environmental/ climatic tests as per Clause No. 9.0 of RDSO/SPN/144, Revision 1 (Indoor Equipment).
- g) System Diagnostics test as per Clause 14.4.
- h) System Software tests as per Clause 14.5.

13.4.2 Any other tests shall be carried out as considered necessary by RDSO.

13.4.3 Only one EI shall be tested for this purpose. The equipment shall successfully pass all the type tests for proving conformity with this specification.

13.5 ACCEPTANCE TEST:

13.5.1 The following shall comprise acceptance tests:

- a) Visual inspection (Clause 14.1)
- b) Insulation Resistance tests (Clause 14.2)
- c) Card level functional test on all the cards.
- d) System level functional tests.
- e) System Diagnostics test (Clause 14.4)
- f) Verification of application software vis-a-vis selection table (This shall be done by user Railway).

* Submission of SIL 4 certificate for generic product is not required for acceptance test.

13.5.2 Any other tests shall be carried out as considered necessary by the purchaser.

13.6 ROUTINE TEST:

13.6.1 The following shall comprise the routine tests and shall be conducted by manufacturer on every EI and the test results will be submitted to the inspection authority before inspection. The application software in proper format shall also be submitted to the inspection authority in advance.

- a) Visual inspection (Clause 14.1)
- b) Insulation Resistance tests (Clause 14.2)
- c) Card level functional test on all the cards.
- d) System level functional test.

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- e) System diagnostics test as per Cl. 14.4.

Any other tests shall be carried out as considered necessary by the purchaser.

14 TEST PROCEDURE:

The test procedure shall be based on the system design. The methodologies to be adopted for various tests shall be decided taking into account the system design/ configuration and shall be approved by the purchaser.

14.1 VISUAL INSPECTION:

The equipment shall be visually inspected to ensure compliance with the requirement of Clauses 3 to 7 of this specification. The visual inspection will broadly include –

- i) **System level checking:**
 - Constructional details
 - Dimensional check
 - General workmanship
 - Configuration
- ii) **Card level checking**
 - General track layout
 - Quality of soldering and component mounting
 - Conformal coating
 - Legend printing
 - Green masking
- iii) **Module level checking**
 - Mechanical polarisation
 - General shielding arrangement of individual cards
 - Indications and displays
 - Mounting and clamping of connectors.
 - Proper housing of cards

14.2 INSULATION RESISTANCE TEST:

This test shall be conducted between the equipment power supply line terminals and the earth. If there is a possibility of the Meggering voltage reaching the cards, these will be taken out before starting the IR test.

This test shall also be carried out after the climatic tests. The measurement shall be made at a potential of not less than 500 V DC.

The IR value shall not be less than 10 Mega ohms. After the climatic tests, this value shall not be less than 10 mega ohms.

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14.3 COMPUTERIZED TESTING:

The manufacturer shall provide a computer-based test set up with the required software for automatic testing.

The following tests shall be conducted with the help of this set up.

14.3.1 FUNCTIONAL TESTING:

The system shall be tested functionally for all the signals with all routes, point operation, emergency point operation, route cancellation, emergency route cancellation, operation of Ground Frame control points, level crossings and crank handle as per the selection table of the yard provided by the purchaser.

14.3.2 OPERATIONAL FAIL SAFETY TESTS:

These tests are conducted as per procedure given below:

- i) After setting of points in main route & desired overlap, signal is cleared. Back locking of the route and overlap should be verified. It should also be checked that other yard functions are free.

The track circuit of the route should be dropped one by one and it should be verified that it is not possible to clear the signal. All the routes are checked one by one.

- ii) Conditions required for route setting should be disturbed in various permutations and combinations and it should be verified that it is not possible to set the route with the disturbed conditions. Similarly, conditions required only for signal clearance (such as track circuits) should also be disturbed and it should be verified that the route is set but the signal is not cleared.

14.4 SYSTEM DIAGNOSTICS TEST:

14.4.1 These tests shall be conducted by automatic test procedure through a PC. The diagnostic tests on the system shall be performed to test the integrity of the system software by verifying the checksum.

14.4.2 It shall be possible to verify the application program vis-a-vis the selection table by the user, preferably through regeneration of the locking table from yard data.

14.4.3 The PC at the end of the test shall print out summary of the tests conducted.

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14.5 SYSTEM SOFTWARE TEST:

Checksum of system software and format of the application software shall be verified. Online Checksum view facility shall be provided either in MT or front display of CPU. In case of any change in the system software/ format of application software, the same shall be validated.

15. TOOL KIT:

The following tools shall be provided by the manufacturer at the time of supply of the equipment:

- True RMS digital multimeters-4 ½ digits suitable upto 50 Hz, high accuracy.
- Earth Resistance meter.
- Insulation Resistance tester, Etc. and other tools as required by Purchaser/user Railway.

16.0 CONDITIONS IN CASE OF CROSS ACCEPTANCE:

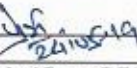
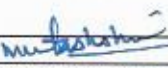
16.1 The latest cross approval policy "PROCEDURE ORDER FOR CROSS ACCEPTANCE/APPROVAL OF SOFTWARE EMBEDDED ELECTRONICS SYSTEMS AND NEW/IMPORTED TECHNOLOGY PRODUCTS FOR RAILWAY SIGNALLING" shall be followed for firm applying under cross approval policy

16.2 The firm has to submit following documents to ensure that the system meets all requirements as mentioned in cross approval policy to RDSO.

- Certificates of Type tests done earlier at the time of development of the system as required by international standards.
- List of Routine tests done and sample copy of results to be submitted.
- Acceptance tests to be done at the time of inspection of equipment to be supplied. Routine tests reports to be submitted to RDSO before offering the system for acceptance test.
- Performance feedback reports from user Railways.
- To assess the configuration and architecture of the system, a team of RDSO officials may visit the manufacturing facility of manufacturer in its respective Country(s) on the approval of Railway Board. Sample tests shall be carried out if found necessary. Details of cross acceptance procedure may be referred to in concerned document of RDSO

17. QUALITY ASSURANCE:

17.1 All materials & workmanship shall be of good quality.

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- 17.2 Since the quality of the equipment bears a direct relationship to the manufacturing process and the environment under which it is manufactured, the manufacturer shall ensure QAP of adequate standard.
- 17.3 Validation and system of monitoring of QAP procedure of the firm including software loading precautions/procedures in addition to other system procedures to ensure quality of the product shall form a part of type approval. The necessary Plant, Machinery and Test instruments as per STR shall be available with the manufacturer.
- 17.4 Along with the prototype sample for type test, the manufacturer shall submit the Quality Assurance Manual.
- 18 **PLANT AND MACHINERY:**
The firm should have all essential Plant & Machinery as per latest STR. In case of cross approval acceptance, the firm shall follow the latest guidelines in cross approval policy issued by RDSO.
19. **PACKING:**
As per relevant clause of latest version of RDSO/SPN/144.
20. **INFORMATION TO BE FURNISHED BY THE PURCHASER:**
- Approved interlocking plan, selection table and panel diagram of the station (Cl. 3.1) and the station data such as old or new room, size of the room, station layout details etc.
 - Station codes followed by Railways.
 - Type of block instrument to be interfaced with EI.
 - Type of Signal LED or filament type lamps
 - Location of lamp proving relays either in equipment room or at location boxes.
 - If LED signals are used then HMUs are required or not.
 - In case of relay interface, type of point interface (through QBCA1 point contactors or Siemens/Integra point group or any other approved type).
 - Type of VDU control terminal and whether CCIP is required or not.
 - System output required to drive field gears – relay interface or direct driving of approved type (Cl 3.9).
 - Whether Centralized arrangement or Distributed arrangement with Object Controllers is required (Cl 7.1.1)
 - Type of relays to be used with EI Metal to carbon relay or Metal to Metal relay.
 - 110V AC or DC usage for signal lamp lighting.
 - Minimum size of VDU Control Terminal monitor screen is defined in clause no 5.3.2, however in specific case if bigger size screen is required then purchaser may specify the size as per requirement.

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- n) Requirement of spares as per CI 5.1.3
- o) Whether entry-exit or pop up menu based operation is required in VDU (CI 5.3.1)
- p) Warranty requirement for system as per CI 12.1.
- q) Details of audio visual alarms as per CI 3.20.7
- r) Requirement of external Datalogger (CI 3.4)
- s) Toolkit details as per CI. 15



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