KAVACH PROJECT
(The Indian Railway Automatic Train Protection System)
PACKAGE DETAILS Development of KAVACH System

DOCUMENT DESCRIPTION:

Specification of Ethernet Switch (For Railway Onboard Applications) for KAVACH Application of Indian Railways

APPLICATION : Onboard KAVACH System

OEM/VENDOR : Bharat Heavy Electricals Limited

END CLIENT : Indian Railways

		GC / Indian Railway APPROVAL	
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History

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1 INTRODUCTION

KAVACH is an indigenously developed Automatic Train Protection (ATP) system meant to provide protection to the trains against Signal Passing at Danger (SPAD), excessive speed and collisions. KAVACH provides protection to the trains against Signal Passing at Danger (SPAD), excessive speed and collisions. KAVACH provides continuous update of Movement Authority (distance up to which the train is permitted to travel without danger). Hence during unsafe situations when brake application is necessitated, and the crew has either failed to do so, or is not in position to do so, automatic brake application shall take place. KAVACH has additional features to display information like speed, location, distance to signal ahead, Signal aspects etc. in Locomotive cab and generation of Auto and Manual SOS messages (Distress messages) from Locomotive as well as from the Station unit in case of emergency situation. The Communication between Stationary KAVACH and Loco KAVACH units shall be Safety Integrity Level-4(SIL4) certified as per the CENELEC standards for railways.

1.1 Purpose of This Document

The purpose of this document is to define the detailed technical specifications, compliance requirements, quality standards, and deliverables for a rugged managed Ethernet switch intended for integration within the Onboard KAVACH Automatic Train Protection (ATP) system. It ensures that the supplied equipment meets railway-specific safety, reliability, environmental, and interoperability standards, enabling secure and resilient communication between vital onboard subsystems.

1.2 General Instructions

The supplier shall submit the offer / bids in two parts:

Part 1: Techno-commercial bid (without pricing). Unpriced price bid to be enclosed in the technical bid.

Part 2: Price bid

1.3 Scope of The Project

This specification applies to the procurement, inspection, testing & supply of managed Ethernet switches for onboard railway applications under the Onboard KAVACH system.

The scope covers:

- Hardware, firmware, and accessories required for Ethernet Switch.
- Compliance with EN 50155, EN 61373, EN 45545-2, EN 50121-3-2/-4, and related standards.
- Quality documentation, type test certificates, and reliability data.
- Integration of the switch with the Onboard KAVACH vital controller and associated networks.
- Warranty, service, and long-term support commitments by the OEM/vendor.

1.3.1 Norms and Standards

Table 1: Norms and Standards

Reference	Title	Edition
IRS: S23	Electrical signalling and interlocking equipment	
RDSO/SPN/144	Safety and reliability requirement of electronic signalling equipment	
IS: 9000	Basic environmental testing procedures for electronic and electrical items	
EN 50155	Electronic equipment used on rolling stock—covers operating conditions like temperature, humidity, power supply, EMC, shock, vibration, and reliability	
EN 61373	Shock and vibration testing standard for equipment installed on railway vehicles (defined categories and classes based on mounting location)	_
EN 45545-2	Fire protection standard—maintenance of fire behavior for materials and components used in railway vehicles; defines hazard levels and requirement sets	_
EN 50121-3-2	EMC standard: electromagnetic compatibility for rolling-stock apparatus (emissions and immunity)	_
EN 50121-4	EMC standard: emission and immunity requirements for signalling and telecommunications apparatus used trackside	
EN 50124-1	Standard for insulation coordination—specifies clearances and creepage distances for electrical/electronic equipment in railway installations	

1.3.2 Input Documents

Table 2: Input Documents

Title
SRS: System Requirement Specification of KAVACH (The Indian Railway Automatic Train Protection System) - RDSO/SPN/196/2020 Version 4.0 d3 or its latest along with its associated annexures

1.3.3 Referenced Documents

Table 3: Referenced Documents

Title	Version
System Requirement Specification of KAVACH (The Indian Railway Automatic Train Protection System) - RDSO/SPN/196/2020 Version 4.0 d3 or its latest along with its associated annexures	4.0 Amdt -3

1.4 Abbreviations and Acronyms

Table 4: Abbreviations and Acronyms

Abbreviation/ Acronym	Definition/Description
TCAS	Train collision avoidance system
ATP	Automatic Train Protection
EN	European Norm (European Standard)
IEC	International Electrotechnical Commission
EMC	Electromagnetic Compatibility
IP	Ingress Protection
DC	Direct Current
MTBF	Mean Time Between Failures
M12 D-coded	4-pin M12 connector for 10/100 Mbps Ethernet
M12 X-coded	8-pin M12 connector for 1 Gbps Ethernet
VLAN	Virtual Local Area Network
RSTP	Rapid Spanning Tree Protocol

Abbreviation/ Acronym	Definition/Description
MRP	Media Redundancy Protocol
HTTPS	Hypertext Transfer Protocol Secure
SSH	Secure Shell
SNMP	Simple Network Management Protocol
NTP	Network Time Protocol
CLI	Command Line Interface
GUI	Graphical User Interface
OEM	Original Equipment Manufacturer
BHEL	Bharat Heavy Electricals Limited
RDSO	Research Designs and Standards Organisation

1.5 Terms and Definitions

The following table describes or defines terms which are used within this document to get a better understanding or if the term is used in a specific way to avoid misunderstandings.

Table 5: Terms and Definitions

Term	Definition/Description
PM	Project manager
RQM	Requirements manager
DES	Designer
VER	Verifier
VAL	Validator
TST	Tester
INT	Integrator
IMP	Implementor

1.6 Imperative Terms

Use of the words **'shall', 'should', 'may'** and **'will'** within this document observe the following rules: The word **'shall'** in a text expresses a mandatory definition. The words **'should'** and **'may'** in a text express a non-mandatory definition. 'Should' is used, when a non-mandatory provision is recommended, otherwise 'may' is used. The word **'will'** in a text expresses a definition in cases a simple futurity is required. 'Will' is also used to express a task (done by an individual or an organization), which is not controlled by this document.

2 DETAILED TECHNICAL FEATURES

The equipment shall be a rugged, managed Ethernet switch for onboard railway applications, compliant with EN 50155, EN 61373, EN 45545-2 and EN 50121-3-2/-4; it shall operate from rated voltage of 24–110 VDC with power-interruption performance per EN 50155, provide a minimum of twelve (12) M12 Ethernet ports (M12 D-coded), be housed in minimum IP42 metal enclosure suitable for harsh onboard locations, and support standard Layer-2 features.

2.1 General Requirement

2.1.1 The device shall be a managed industrial Ethernet switch intended for onboard use on rolling stock railway applications.

2.1.2 The device shall provide twelve (12) M12 Ethernet ports of 10/100BASE-T(X) D-coded.

2.1.3 The device shall support creation of segmented onboard networks (e.g., Vital Controller network, DMI/console network, diagnostics/service network) using IEEE 802.1Q VLANs.

2.1.4 The device shall support rapid network resiliency for ring or mesh topologies using standardized protocols (e.g., RSTP/MSTP, MRP) or vendor-specific fast ring mechanisms with optimised recovery time for a single fault.

2.1.5 The device shall provide secure management via HTTPS Web GUI and SSH CLI; SNMP shall be supported for monitoring, with remote syslog and NTP time sync.

2.1.6 The device shall provide at least one service/console interface (e.g., M12 serial/USB or equivalent robust service port) for local commissioning and backup/restore of configuration without network connectivity.

2.1.7 The device shall support configuration backup/restore to removable media (e.g., USB) and provide a mechanism to restore factory defaults locally.

2.1.8 The device shall boot to forwarding/management availability within a practically short time; the OEM shall state typical boot time.

2.1.9 The device shall support user/role-based access control with at least admin/operator/read-only roles and password policy controls.

2.1.10 Where offered, L3 functionality (optional) (static routing, VRRP and/or OSPF) shall be licensable/model-dependent; absence of L3 shall not affect compliance with mandatory L2 requirements.

2.1.11 The device shall be interoperable with third-party industrial switches and standard Ethernet hosts using IEEE 802.3/802.1 standards without proprietary lock-in.

2.1.12 The device shall be firmware-upgradable in the field without specialized hardware; the OEM shall provide digitally signed firmware and a documented vulnerability disclosure process.

2.1.13 The OEM shall provide a published software maintenance policy covering security patches and critical bug-fixes for not less than two (2) years from supply.

2.1.14 The device shall provide visual status via front-panel LEDs (per-port link/activity, device power/status, ring/alarm state) visible in typical cabinet mounting orientations.

2.1.15 The OEM shall declare MTBF per IEC 62380 or MIL-HDBK-217F at 25 °C and at 40 °C; a minimum MTBF of 300,000 hours at 25 °C shall be met.

2.1.16 The equipment shall be supplied with mounting accessories, mating power connector(s), and OEM installation/commissioning manuals in English.

2.1.17 The OEM shall provide a conformity/compliance matrix against this specification, identifying model/option codes used to meet each requirement and any deviations/alternates.

2.1.18 The device shall be RoHS compliant; WEEE/EoL and obsolescence policy shall be declared.

2.1.19 The OEM shall confirm availability of technical support and warranty service in India.

2.2 SAFETY AND COMPLIANCES

2.2.1 The device shall comply with EN 50155 for railway rolling-stock electronic equipment, including applicable classes for temperature, power interruptions and transients.

2.2.2 The device shall comply with EN 61373 for shock and vibration (Category 1, Class B or better).

2.2.3 The device shall comply with EN 45545-2 for fire protection of railway rolling stock materials/components (minimum requirement aligned to the device's installation location).

2.2.4 The device shall comply with EMC standards EN 50121-3-2 (rolling stock apparatus) and/or EN 50121-4 (trackside, if applicable) and relevant IEC 61000-6-2/-6-4 industrial immunity/emission.

2.2.5 The device shall meet insulation coordination per EN 50124-1 appropriate to the installation environment and supply class.

2.2.6 The ethernet switch shall provide ingress protection of minimum IP42 and above.

2.2.7 All compliance shall be evidenced by type-test certificates and/or ISO/IEC 17025 test reports or summaries supplied with the bid.

2.3 ELECTRICAL REQUIREMENTS

2.3.1 The device shall accept DC input suitable for rolling-stock auxiliaries with a nominal range of 24–110 VDC; the OEM shall declare the exact permissible operating range and transient withstand levels as per EN 50155.

2.3.2 The device shall meet EN 50155 power interruption class S2 (or better), with internal hold-up ensuring uninterrupted operation through specified supply dips.

2.3.3 The device shall provide reverse-polarity and over-voltage protection appropriate to the stated input range.

2.3.4 The device shall provide functional earthing/PE connection and include surge/ESD protection on interfaces consistent with railway EMC requirements.

2.3.5 The device shall declare input current at 24 VDC and 110 VDC and the maximum power consumption at full port load.

2.3.6 All Ethernet user ports shall be galvanically isolated from the power input to the extent required by EN 50155/EN 50124-1.

2.4 MECHANICAL REQUIREMENTS

2.4.1 The device shall be housed in a corrosion-resistant metal enclosure, at least IP54, suitable for installation in harsh railway onboard applications.

2.4.2 All data ports shall use vibration-resistant M12 connectors: D-coded for 10/100 Mbps connector coding shall be per IEC standards.

2.4.3 The power input shall use a ruggedized connector suitable for rolling-stock.

2.4.4 The device shall support secure mounting (e.g., wall/panel or bracket) and withstand vibration per EN 61373 without loss of function.

2.4.5 The device shall operate over −30°C to +70°C continuous; short-duration temperature excursions per EN 50155 TX class shall be tolerated as declared by the OEM.

2.4.6 The device shall tolerate 5–95% RH, non-condensing, and shall incorporate design measures to mitigate condensation and pressure equalization.

2.4.7 The device’s size and weight shall be declared; compact and lighter designs are acceptable if all requirements are met.

2.5 ENVIRONMENTAL & RELIABILITY

2.5.1 The device shall meet EN 50155 environmental classes (temperature class TX or equivalent), including thermal cycling and damp heat tests.

2.5.2 The device shall resist corrosion appropriate to onboard locations; where applicable, salt-mist testing per IEC 60068-2-52 or equivalent shall be declared.

2.5.3 The device shall operate at altitudes up to at least 2000 m without derating; any derating beyond this shall be stated.

2.5.4 The device shall support conformal coating or equivalent protective measures on PCBs, as per the OEM's standard for rolling-stock products.

2.5.5 The device shall provide alarm outputs/logs for over-temperature, power faults, ring failures and major events for maintenance diagnostics.

2.5.6 The OEM shall declare MTBF figures and the methodology used; predictive reliability data shall accompany the bid.

2.5.7 The standard warranty shall be not less than two (2) years from the date of supply.

2.6 DOCUMENTATION, TESTS & DELIVERABLES

2.6.1 The vendor shall supply a filled compliance for this specification referencing datasheet/manual sections against each clause of this specification and list all deviations.

2.6.2 The vendor shall supply type-test certificates and/or accredited reports for EN 50155, EN 50121-3-2/-4, 61010-1 (and other as mentioned above and applicable), Ingress Protection, and insulation coordination.

2.6.3 The vendor shall supply installation and commissioning manuals, management/CLI guides, MIB files, dimensional drawings, connector pinouts, and wiring instructions.

2.6.4 The vendor shall supply reliability documentation (MTBF calculation note and method), software maintenance policy, and end-of-life/obsolescence policy.

2.6.5 The vendor shall provide test and integration support and recommended procedures for successful implementation of Onboard KAVACH application.

2.6.6 The vendor shall declare local service capability, Regional person of contact and typical turnaround time for warranty repairs.

3 QUALITY, INSPECTION AND ACCEPTANCE

Phase 1: The supplier must submit the following for approval:

- 2D drawings
- 3D models (STEP files)
- Bill of Materials (BOM)
- Quality and Inspection plan
- Mounting and fixing guidelines
- Type test certificates/Declaration
- Any additional technical documentation or MTBF calculations.

Phase 2: Upon review and approval of the documents, the supplier must submit a Certificate of Conformance (COC) for dispatch clearance from BHEL MM department.

Phase 3: The supplier shall visit BHEL SBD premises to perform functional testing of the Ethernet switch as per BHEL protocols and ensure successful integration with the Onboard KAVACH vital controller unit in the KAVACH system. Final approved versions of:

- Software (if applicable)
- Firmware (if applicable)
- Graphical interfaces (if any)
- Supporting application files (if any) must be submitted to BHEL.

Phase 4: A joint inspection and acceptance report, signed by both BHEL and the supplier/OEM, must be submitted to the MM department for final acceptance.

3.1 Specification Compliance

The OEM or vendor must submit a clause-by-clause compliance sheet with their bid, in line with the requirements mentioned in Clause 2,3,4 and 6.

3.2 Documentation Required before Dispatch

The OEM or vendor shall submit the Equipment 2D drawings, 3D models (STEP files), Bill of Materials (BOM), Configuration and testing procedures, Quality and inspection plan, Mounting and fixing guidelines, Type test certificates, any additional technical documentation and required MTBF calculations.

- Detailed dimensional drawings indicating mounting arrangements.
- Commissioning instructions of Ethernet switch and its interface with Kavach.
- Submission of MTBF (Mean Time Between Failures) document.
- Periodic maintenance instructions along with equipment overhaul schedule and troubleshooting instructions.
- Operation and Maintenance Manual covering description, operation of complete system and individual components, disassembly and assembly, trouble shooting, test specification of individual items, spare parts catalogue shall be submitted. The Hardware & Software documentation of the manual must be in line with Clause No-11 of IEC 60571.

- Warranty Certificate. If Item is BOI, the warranty certificate of OEM shall also be submitted
- All the above said documents shall be provided in Hard copy (2 Sets) and Soft Copy.

4 DELIVERABLES

The supplier must provide a complete set of Ethernet Switch for Rolling stock applications for integration and testing with the onboard KAVACH system, as per the technical specifications in Sections 2 and 3.

Each set must include:

- One Ethernet switch for rolling stock applications
- One configuration tool, if applicable, for switch configuration
- All required accessories: cables, connectors, mounting hardware (nuts, bolts, brackets, etc.)

Please refer the Deliverable Reference Table.

Sr. No	Description	Price Per set in INR
1	Supply of Ethernet Gateway Switch as per specification	Bidder to quote
2	GST @ Actuals	Bidder to quote
3	Total cost excluding Taxes	Bidder to quote
4	Total cost including Taxes	Bidder to quote

5 WARRANTY

- A minimum 24-month warranty must be provided from the date of successful installation, commissioning, and acceptance at BHEL.
- The warranty must cover on Hardware (against material and manufacturing defects) and Software components or embedded electronics (if any), against performance issues, bugs, or failures
- Repair or replacement of defective ethernet switch (including labour, logistics) must be performed at no cost during the warranty period.
- Any failure reported by BHEL must be addressed and resolved within 15 working days.
- The supplier must ensure proper integration of the Ethernet Switch with the Onboard KAVACH system provided by BHEL and successfully demonstrate full functionality to the satisfaction of RDSO and BHEL.

6 PRE-QUALIFICATION CRITERIA

Table 6: Pre-qualification Criteria

SL	BHEL Qualification requirement	Documents to be submitted for evaluation
1 2 3	Vendor shall have supplied Ethernet switches to **BHEL** for any Railway Rolling stock Applications. **(OR)** Vendor shall have supplied Ethernet Switches to **Railways and Metro signalling OEMs** for any Onboard Signalling, TCMS, Railway Onboard Applications for ATPS(KAVACH) /ETCS/ CBTC in India. **(OR)** Vendor shall have supplied Ethernet Switches to RDSO approved Kavach/DPWCS **OEMs** for Railway Rolling stock Applications.	1) Purchase Order copy 2) Proof of delivery – ***Tax Invoice along with*** ***1. Receipted LR copy (***or) ***2. Material Dispatch Clearance Certificate (MDCC) from customer*** (or) ***3. Material Receipt Certificate from the customer*** (or) ***4. Completion certificate from Customer*** 3) Contact Details – (Name, Phone number, email) – of the customer associated with Purchase Order and Proof of delivery (Proof of delivery shall be dated within 10 years before the date of opening of bid) Note: ❖ Railway OEM means vendors/Agencies/Manufacturers supplying Onboard Signalling, TCMS, Railway Onboard Applications for ATPS(KAVACH) /ETCS/ CBTC / TCMS systems.