




**GOVERNMENT OF INDIA  
MINISTRY OF RAILWAYS**



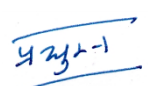
**TECHNICAL SPECIFICATION OF  
GPS DEVICE FOR  
ELECTRIC LOCOMOTIVES**

**SPECIFICATION No. RDSO/2018/EL/SPEC/0132 / Rev. '0'**

**Issued on: 09.01.2018**



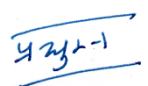
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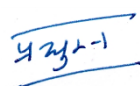
### STATUS OF REVISION

S. N.	Date of Revision	Page No.	Revision	Reasons for Revision
1.	-	All	0	New

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## SPECIFICATION OF GPS DEVICE FOR ELECTRIC LOCOMOTIVES IN INDIAN RAILWAYS

### Chapter I

#### GENERAL

#### 1.1 Introduction

**1.1.1** This specification covers constructional features, technical requirements and testing procedure for GPS Device for Electric Locomotives.

**1.1.2** It is proposed to install GPS device in all types of Electric locomotives for transmitting location and speed information along with loco number and train number to a server. This information can be accessed by authorized users through a website using desktop/laptop/mobile.



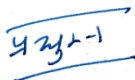
#### 1.2 Terminology

For the purpose of this specification, following terminology shall apply:

- |        |              |   |
|--------|--------------|---|
| (i)    | <b>GPS</b>   | : Global Positioning System                   |
| (ii)   | <b>GSM</b>   | : Global System for Mobile                    |
| (iii)  | <b>GPRS</b>  | : General Packet Radio Service                |
| (iv)   | <b>RDSO</b>  | : Research Designs and Standards Organisation |
| (v)    | <b>API</b>   | : Application Program Interface               |
| (vi)   | <b>IR</b>    | : Indian Railways                             |
| (vii)  | <b>SMS</b>   | : Short Message Service                       |
| (viii) | <b>MMD</b>   | : Maximum Moving Dimensions                   |
| (ix)   | <b>AMC</b>   | : Annual Maintenance Contract                 |
| (x)    | <b>APN</b>   | : Access Point Name                           |
| (xi)   | <b>TC</b>    | : Technical Circular                          |
| (xii)  | <b>GNSS</b>  | : Global Navigation Satellite System          |
| (xiii) | <b>SBAS</b>  | : Satellite-Based Augmentation System         |
| (xiv)  | <b>GAGAN</b> | : GPS Aided Geo Augmented Navigation          |

#### 1.3 Scope Of Supply:

This specification covers design, development, manufacturing, testing, supply, installation and commissioning of GPS device for use in 25 kV Electric locomotives. The detailed scope of supply is given in Chapter IV.

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**1.4 Vendor's Responsibility:**

Vendor shall supply the equipment and depute his representatives to CLW/Sheds/workshops for installation and commissioning of the equipment on locomotive.

**1.5 Warranty:**

- 1.5.1** The vendor shall be responsible for carrying out improvements and modifications at his own expense on all the equipments during the period of warranty provided such modifications/improvements are decided to be necessary for meeting the requirements of reliability, performance and safety etc.
- 1.5.2** The firm is required to give root cause analysis of all the failures and their corrective actions. In case of any modification (hardware and software), the necessary approval shall be obtained from RDSO.
- 1.5.3** For the purpose of technical decisions on improvements/modifications etc. on equipment, the final authority from the purchaser's side will be RDSO.
- 1.5.4** During warranty period all charges related to server, data transfer etc. shall be paid by vendor.
- 1.5.5** Charges for AMC beyond warranty period shall also be specified by the vendor and shall include the charges related to server, data transfer etc.



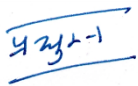
**1.6 Approval For Design:**

The design shall be developed based on the requirements given in this specification and sound engineering practice. Approval of design means the approval of general design features. Notwithstanding the approval, the vendor shall be wholly responsible for the performance and reliability of the complete system.

**1.7 Documentation:**

The firm shall submit following information for the design approval in printed form and in digital format:

- (a) Technical specification of GPS module, Antenna module, GSM module & power supply module
- (b) System design
- (c) Schematic Circuit/Block diagram
- (d) Functional Description
- (e) Protection scheme
- (f) BOM (Bill of Material), Data sheets for components/devices and other equipment proposed for use.
- (g) Mechanical interface diagram (Outline General Arrangement), assembly drawings of complete unit, mounting arrangement and weight.

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- (h) Clause by clause compliance of specification.
- (i) Test protocol with procedure of testing.
- (j) Details of Backup data memory size and battery backup size along with calculations.

### 1.8 Important Documents Referred In This Specification:



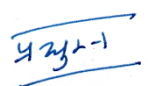
1.	IEC-60571: 2012-09 (or latest)	General requirements and tests for electronic equipment used on Rail vehicles.
2.	IEC-60077-1: 1999-10 (or latest)	Railway applications – electric equipment for rolling stock
3.	IEC-60529: 2013-08 (or latest)	Degrees of protection provided by enclosures (Code IP)
4.	IEC-61373: 2010-05 (or latest)	Railway applications – Rolling stock equipment – Shock and vibration tests
5.	RDSO/2018/EL/TC/0143 Rev. '0' (or latest)	Technical Circular for GPS device for Electric Locomotives in Indian Railways.

### 1.9 Infringement Of Patent Rights:

Indian Railway shall not be responsible for infringement of patent rights arising due to similarity in design, manufacturing process, use of similar components used in design, development and manufacturing of GPS device and any other factor not mentioned here in which may cause such a dispute. The entire responsibility to settle any such dispute/matters lies with the vendor.

Details/design/documents given by the vendors are not infringing any IPR (Intellectual Property Rule) and they are responsible in absolute and full measures instead of Indian Railways for any such violations. Data specifications and other IP (Intellectual Property) as generated out of interactions with Indian Railways shall not be unilaterally used without consent of RDSO and right of Indian railways/RDSO on such IP is acceptable to them.

**1.10** All the provisions contained in RDSOs ISO procedures laid down its Document No. QO-D-7.1-11 dated 9.6.2017 (titled “Vendor Changes in approved status”) and subsequent versions/ amendments thereof, shall be binding and applicable on the successful vendor/ vendors in the contracts floated by Railways to maintain quality of products supplied to Railways.


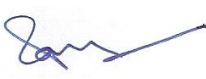
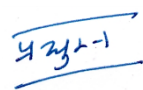
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## CHAPTER II

### TECHNICAL DETAILS

#### 2.1 General technical requirements & Specification:

- 2.1.1 Location of installation of GPS device shall be finalized and standardized by RDSO based on the size of GPS device developed.
- 2.1.2 GPS device shall include a GPS receiver, display and keyboard, two sim card modules, power card module, battery backup module with appropriate internal or external combo antenna for getting the GPS location information and transmitting the data. Antenna used shall be suitable for working under 25 kV AC traction system and shall be within MMD of the loco. External Antenna module shall have IP 66 protection, if used.
- 2.1.3 GPS location information, time stamp and speed will be included in GPS data packets along with loco number and train number.
- 2.1.4 The GPS device shall have position accuracy of approximately 15 meter.
- 2.1.5 The GPS device shall support Multi GNSS and SBAS (GAGAN).
- 2.1.6 Adequate provisions shall be made in the design for suppression of internal transients, spikes and to withstand external transients, spikes and surges as per limits laid down in IEC-60571 ed-3 or latest.
- 2.1.7 In the electronic equipments to be supplied to this specification, the vendors shall use industrial grade components, backup battery and systems of high reliability, suitable in every way for the application on rolling stock. In this connection, vendor is advised to refer to "Rules for Electronic Equipments used on Rail Vehicles IEC Publication 60571"
- 2.1.8 Minor deviations from the specification if any, can be mutually sorted out with RDSO during development stage if supported by justification on ground of cost and/or technical superiority.
- 2.1.9 All electronic components and ICs used shall be selected after proper burn in and screening tests and shall be adequately rated to withstand the service requirements. A quality assurance scheme shall be submitted by the vendor for approval of RDSO. All the connecting wires, cables used on PCB in the sub units should be properly laid out with suitable connector. The cable used inside the sub unit shall be properly supported with stiffeners. No soldering shall be done on the PCB for inter connection.
- 2.1.10 System shall have real time clock for recording date & time which is updated from GPS system.
- 2.1.11 The device shall function satisfactorily under 25 kV ac electric traction. It shall not be susceptible to malfunction due to interference from overhead traction power supply lines or under abnormal conditions such as overloads and faults in the electrical traction circuits of the locomotives.

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**2.1.12** The GPS device shall have the facility of enter the loco number and train number by a keypad and viewed on 2 line 16 character alphanumeric LCD display. Details are given in technical circular number TC-0143 (latest version).

## 2.2 Configuration parameter setting:

**2.2.1** GPS device of each locomotive shall be identified by the unique locomotive number.

**2.2.2** It shall be possible to configure locomotive number associated with GPS device through its own keypad by authorized persons.

**2.2.3** IP address to which GPS devices shall transmit its data shall also be configured through its own keypad/Over the air (OTA) by authorized persons.

## 2.3 Vendor Server & website:

**2.3.1** Vendor shall have its own server which will located in India for safety and security reasons with specific static IP address. There shall be flexibility in upgrading the server configuration such that more locomotives can be added to the system as and when more locomotives are fitted with GPS Devices. GPS device shall be configured to communicate with the vendor server.

**2.3.2** Webpage layout of the vendor server for accessing the GPS data will also be approved by RDSO. Dashboard approach will be followed to list all the locomotives at a glance. Filtering based on the Holding Railway/Shed and working Railway/sheds shall be possible. Detailed information will be available after selecting a particular locomotive. Details are given in TC-0143 (latest version).

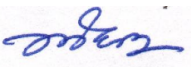

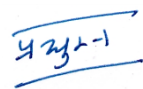
**2.3.3** Locomotive position shall also be displayed on map. Details are given in TC-0143 (latest version).

**2.3.4** Webpage will have some colour coding for identifying the locomotives which are running, stopped and in dead condition. Details are given in TC-0143 (latest version).

**2.3.5** Authorized users can access the GPS device information through internet by connecting to vendor server through desktop/laptop/mobile devices.

## 2.4 Railway Server

Railway may decide to setup its own server for accessing the GPS information of locomotives. It shall be possible to configure the GPS device to transmit data to Railway server if required. Vendor shall provide communication protocol from GPS device to server and other necessary details to transfer GPS data from device to Railway server. It shall also be possible to transfer GPS data to Railway server and stopping the data transmission to vendor server if required by Railways.

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**2.5 Transfer of GPS data from locomotive to server:**

For transferring GPS data from device to server, device shall be equipped with APN configured SIM cards and use 3G/4G technology for data transfer. Two SIM cards of different operator shall be used for data transfer.

**2.6 Capturing and transmission of GPS data by GPS Device****2.6.1 When Locomotive battery supply is available (HBA is in ON)**

**2.6.1.1** GPS data shall be captured every 05 seconds by the GPS device.

**2.6.1.2** Data transfer shall be every 10 seconds or less to the server.

**2.6.1.3** If due to any reason, data transfer to server is not successful, the data shall be stored in the GPS device memory and will be transferred to the server at the earliest opportunity.

**2.6.2 When Locomotive battery supply is not available (HBA is in OFF)**

**2.6.2.1** GPS data shall be captured every 20 minutes by the GPS device and transferred to the server.

**2.6.2.2** If due to any reason, data transfer to server is not successful, the data shall be stored in the GPS device memory and will be transferred to the server at the earliest opportunity.

**2.6.2.3** For the remaining period GPS device will be in sleep mode for conserving the battery and will wake up every 20 minutes to capture and transfer GPS data. During sleep mode GPS will be active but no data transfer shall be carried out.

**2.7 Memory for the system :**

**2.7.1** GPS Device shall have the capacity to store GPS data for at least 30 days.

**2.7.2** Vendor server shall have capacity to store GPS data for at least 90 days.



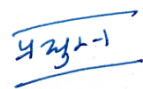
**2.7.3** Calculations of data packet size to be provided by the vendor.

**2.8 GPS device internal battery backup**

**2.8.1** Battery backup of the GPS device shall be adequate such that it can work for at least 20 days when locomotive is in dead condition (HBA in OFF condition).

**2.8.2** Messages indicating battery condition shall also be transferred to server periodically when device battery is less than 50%. These messages will be displayed on the webpage/dashboard every hour.

**2.8.3** Internal battery of GPS device shall be charged from locomotive battery when HBA is in ON condition. Suitable protections like overvoltage, over current, short circuit, over charge & over discharge, surge, incorrect insertion of connector, over temperature etc. shall be provided in charging/discharging circuit.

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## 2.9 Enclosure for GPS device

Suitable Tamper Proof, Vandal Proof and Water Proof enclosure for GPS device will be provided.

## 2.10 Power supply:

**2.10.1** The battery supply at 110V DC varying from 70V to 137.5V will be available in the locomotive. Since memory storage are to be catered for, an internal battery back up as a part of the GPS device shall also be provided.

The operating voltage of the locomotive battery is as follows:

Minimum voltage = 70 V DC

Nominal voltage = 110 V DC

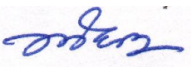

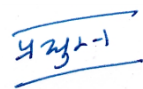
Maximum Voltage = 137.5 V DC

**2.10.2** The device shall be designed considering the fact that surges do appear in the locomotive power supply. Suitable protection shall be incorporated.

## 2.11 Marking:

An anodized aluminium plate carrying following markings shall be fitted on the GPS device at a suitable place:-

- (i) Maker's name and trade mark
- (ii) Name of the equipment
- (iii) Type, Model and version of equipment
- (iv) Manufacturer address with email ID.
- (v) Maker's serial number and year of manufacture.
- (vi) Specification No.
- (vii) System Voltage.

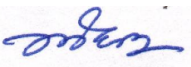

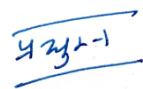
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### CHAPTER III

#### ENVIRONMENTAL CONDITIONS

**3.1** The climatic and environmental conditions prevailing in India in the area of operations are the following:

A. Atmospheric temperature	<ul style="list-style-type: none"> <li>• Maximum temperature: 50 °C</li> <li>• Maximum touch temperature of metallic surface under the Sun: 75 °C and in shade: 55 °C</li> <li>• Maximum temperature near electronic cards in un-energised condition of locomotive standing under direct sunlight during summer: 70 °C</li> <li>• Maximum temperature near electronic cards in working condition of locomotive during summer: 65 °C</li> <li>• Minimum temperature: - 10 °C</li> </ul> <p>( Also snow fall in certain areas during winter season)</p>
B. Solar radiation	1 kW/m <sup>2</sup>
C. Humidity	100% saturation during rainy season
D. Altitude:	1776 m above mean sea level
E. Rain fall:	Very heavy in certain areas.
F. Wind speed	High wind speed in certain areas, with wind pressure reaching 150 kg/m <sup>2</sup>
G. Atmospheric conditions	Extremely dusty and desert terrain in certain areas. The dust concentration in air may reach a high value of 1.6 mg/m <sup>3</sup> . In many iron ore and coal mine areas, the dust concentration is very high affecting the filter and air ventilation system. The system shall be able to work at the maximum specified ambient temperature inside the locomotive without any pre-cooling requirement.
H. Coastal area	<ul style="list-style-type: none"> <li>• Humid and salt laden atmosphere with maximum pH value of 8.5,</li> <li>• Sulphate of 7 mg per liter,</li> <li>• Maximum concentration of chlorine 6 mg per liters and</li> <li>• Maximum conductivity of 130 micro siemens / cm</li> </ul>
I. Vibration & Shock	The equipment shall be designed to withstand the vibrations and shock encountered in service satisfactorily as specified in IEC -61373 (latest) Publication for Shock & Vibration on Rolling-stock vehicle. The vibration test shall be done as mounted in the actual operating condition.

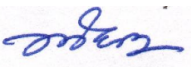

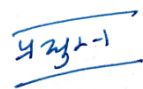
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## CHAPTER IV

### SCOPE OF SUPPLY

- 4.1** Scope of the specification is Supply, installation and commissioning of the GPS device along with associated wiring.
- 4.2** Supply of two GSM SIM of commercial mobile internet provider, their activation / registration and payment of data charges are in the scope of supply for Vendor.
- 4.3** Installation, commissioning and maintenance (during warranty period) are in the scope of supply.
- 4.4** The following will be the scope of supply:-

SN	Items	Quantity per locomotive
I.	GPS device along with activated two SIM Cards	01 set
II.	Cables for connecting GPS device to loco battery	01 set
III.	Antenna and cables for connecting Antenna unit to GPS device (if applicable, in case of external antenna).	01 set
IV.	Installation & Maintenance Manual	02 set



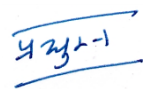
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## CHAPTER V

### INSPECTION & TESTING

#### 5.1 INSPECTION:

- 5.1.1** The system shall be tested generally in accordance with the IEC: 60571:2012-09 (or latest). Dry Heat test of the Electronics shall be carried out at 70° C as per IEC: 60571. All optional tests mentioned in various standards shall also be carried out. Details shall be worked out during design approval. Type tests shall be carried out by the vendor at his own responsibility and cost.
- 5.1.2** The vendor shall formulate and submit a type test protocol / plan at design approval stage for approval of RDSO before undertaking manufacturing. It shall, however, be open for RDSO to waive some of tests in case of equipment and sub-assemblies, where the vendor can establish it for the requirements of this specification that such tests have already been carried out earlier on the same equipment and where equipment has been proved in prolonged service.
- 5.1.3** Modifications found necessary as a result of the tests/trials shall be incorporated by the vendor at his own cost in the locomotives in a manner approved by the Purchaser. Drawings incorporating the modifications found necessary, as a result of tests and trials, shall be submitted to RDSO for final approval.
- 5.1.4** The vendor shall offer all the testing facilities free of charge to inspecting authority. Testing of equipment and fittings shall, as far as possible be carried out at the works of the vendors. Testing of bought out components may also be carried out at sub-vendor's premises, if so required. The vendor shall provide free of charge, such materials or fittings as may be required for testing whether at his own or his sub vendor's premises. The test for which facilities are not available may be carried out at RDSO or any other approved laboratory for which the testing charges shall be payable by the vendor.
- 5.1.5** All the equipments and the fittings required for testing shall be selected by the inspecting officer and the tests shall be carried out in his presence.
- 5.1.6** No material shall be packed or dispatched until it has been passed by the inspecting officer but the vendor's responsibility for its efficiency in every way, shall remain the same as if the work had been manufactured and tested by himself.
- 5.1.7** Should any part require alteration or any defect appear during the testing or trial, the vendor shall without any extra charges make such alteration or rectify the defects to the satisfaction of the inspecting authority.
- 5.1.8** Copies of Maker's test certificate, guarantee the performance of the equipment shall be supplied in duplicated along with the delivery of each unit.
- 5.1.9** The inspecting authority shall:-
- 5.1.9.1** Visit at any reasonable time and without previous notice, either vendor's works or his sub-vendor's works to inspect the vendors and the quality of the work at any stage.
- 5.1.9.2** Reject any materials or fittings that does not conform to the relevant standard/ specifications or have not been manufactured in accordance with

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the approved practices. The rejected materials or fittings shall be marked in a distinguishable manner and shall be disposed on in such manner as the inspecting officer may direct to avoid its inadvertent use in the product order as per this specification.

## 5.2 CATEGORIES OF TEST:

### 5.2.1 Type test:

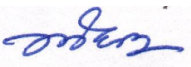

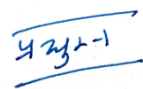
- 5.2.1.1** Type test shall be carried out on equipment of the approved design. If there is any change in design or source of supply of any components/sub-components/ assembly, units made to the changed design or from new source shall be treated as new item for the purpose of conducting type tests.
- 5.2.1.2** Type tests are to be repeated in case of any major change is made. In case of minor changes, i.e. change in type, rating of component etc., special test/tests as agreed by user and vendor are to be conducted to ensure their suitability and effectiveness of the modifications.
- 5.2.1.3** Tests will be carried out on the prototype unit as per relevant IEC specifications or mutually agreed test program. Vendor will bear the expenses of the tests.

### 5.2.2 Routine test:

Routine test shall be carried out on every equipment of each order.

The tests to be carried out are given in the following table, together with the clause number of IEC 60571 ed-3 2012-09 (or latest).

SN	TESTS	IEC CLAUSE NO.	TYPE TEST	ROUTINE TEST
I.	Visual Inspection	12.2.2	✓	✓
II.	Performance test	12.2.3	✓	✓
III.	Voltage variation test	12.2.3	✓	--
IV.	Cooling Test (Cold Start Test)	12.2.4	✓	--
V.	Temperature rise test (Dry heat)	12.2.5	✓	--
VI.	Temperature rise (damp heat cyclic)	12.2.6	✓	--
VII.	Supply over voltage test	12.2.7	✓	--
VIII.	Surges test	12.2.8.1	✓	--
IX.	Insulation test	12.2.10.2	✓	✓
X.	Voltage withstand (Dielectric) test	12.2.10.3	✓	✓
XI.	Vibration and shock test	12.2.12	✓	--
XII.	Water tightness test for external antenna, if provided.	12.2.13	✓	✓

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### 5.2.3 DETAILS OF TESTS:

#### 5.2.3.1 VISUAL INSPECTION:

The object of visual inspection is to check that the equipment is free from defects and the equipment is as per approved drawing. Bill of materials will be submitted. The make, rating of equipment, subassemblies will be checked with the details as per approved design document. If a change is needed in make or rating of important equipment, sub-assemblies, it should be intimated and should have proper approval of RDSO. GPS device with modified equipment, subassemblies will be given separate revision number. All the important dimensions will be measured and should be in permissible tolerance. Visual inspection is to mainly verify cable marking, cable clearance, creepage distance etc. Bill of material is also to be verified.

#### 5.2.3.2 PERFORMANCE TEST:

Measurements shall be carried out at the ambient temperature.

The performance test shall consist of a comprehensive series of measurements of the characteristics of the equipment to check that its performance is in accordance with the functional requirements of the particular equipment concerned, including any special requirements of its individual specification, and general requirements of this standard. Performance test procedure will be submitted by the vendor for approval.

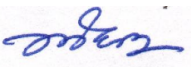

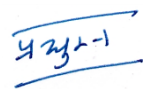
These tests are carried out to check and ensure that the performance of the equipment is in order.

#### 5.2.3.3 VOLTAGE VARIATION TEST:

This test shall be carried out as per clause 12.2.3 of IEC 60571. During the test, system voltage shall be as per clause 2.10.

#### 5.2.3.4 COOLING TEST:

This test shall be carried out as per clause 12.2.4 of IEC 60571. Bring down the temperature of the equipment to  $-10\text{ }^{\circ}\text{C} \pm 2$  and keep it at the temperature for 2 hours. In this test equipment shall be in energised condition and the working of the system will be checked. Insulation test, Dielectric test at 85% voltage of the previous test and performance test will be carried out after the recovery period of 3 hrs.

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**5.2.3.5 TEMPERATURE RISE TEST (DRY HEAT):**

This test shall be carried out as per clause 12.2.5 of IEC 60571. The temperature of the equipment will be raised to 70 °C at the rate of 1° c at 1.5 minute and to be kept at that temperature for 6 hours. In this test equipment shall be in energised condition and working of the system will be checked. Insulation test, Dielectric test at 85% voltage of the previous test and performance test will be carried out after the recovery period of 3 hrs.

**5.2.3.6 TEMPERATURE RISE (DAMP HEAT):**

This test shall be carried out as per clause 12.2.6 of IEC 60571. Damp heat test shall be done keeping the equipment in de-energised condition. It is to be ensured that the RH of the oven should be between 80 to 100% during the above test. The temperature of the equipment is to be raised from ambient to 55°C in 2 hours and kept at that temperature for 6 hours. The temperature of the equipment 55°C should be brought down to ambient (recovery period) in 3 hours. The cycle is to be repeated at least two times and carry out insulation test, Dielectric test at 85% voltage of the previous test and performance test.

**5.2.3.7 SUPPLY OVER VOLTAGE & SURGES TEST:**

The test shall be conducted as per IEC-60571 latest.

**5.2.3.7.1 OVER VOLTAGE TEST:**

The test shall be conducted as per clause 12.2.7 of IEC-60571.

**5.2.3.7.2 SURGE TEST:**

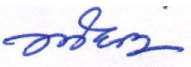

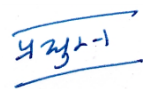
The test shall be conducted as per clause 12.2.8.1 of IEC-60571. The surge pulse shall be 2 kV, 1.2/50 micro Second.

**5.2.3.8 INSULATION TEST:**

This test shall be carried out as per clause 12.2.10 of IEC-60571. Insulation resistance shall be measured with megger of 500V. The time of the meggering shall not be less than 60 Sec.

**5.2.3.9 Voltage Withstand Test (DIELECTRIC TEST):**

The test shall be carried out as per clause 12.2.10.3 of IEC-60571. Applied voltage shall be of sine wave, 50 or 60 Hz for one minute between the terminals that interface with locomotive short circuited and the metallic frame of the assembly box.

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### 5.2.3.10 VIBRATION AND SHOCK TEST

The test is to be carried out as per clause 12.2.12 of IEC-60571.

Random vibration & shock test is recommended as per IEC 61373 for rolling stock application

The vibration and shocks tests shall be carried out as per category 1, class B of IEC 61373 latest for rolling stock equipment for Railway application. The following test should be carried out.

- a) Functional random test as per clause no. 8.0 of IEC 61373.
- b) Simulated long life testing as per clause no. 9.0 of IEC 61373.
- c) Shock testing as per clause no. 10.0 of IEC 61373.

After the test there shall be no resulting damage, abnormality in the operation of equipment. After completion of mechanical endurance test, vibration and shock tests, the equipment shall again be subjected to dielectric test and performance test.

### 5.2.3.11 WATERTIGHTNESS TEST:

This test will be done for external antenna (if provided) of GPS device as per IEC-60529.

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