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Document Title: Specification For Multi Section Digital Axle Counter			



**RESEARCH DESIGNS & STANDARDS ORGANIZATION
MANAK NAGAR, LUCKNOW – 226011**

**MULTI SECTION DIGITAL AXLE COUNTER
SPECIFICATION NO. RDSO/SPN/176/2013**

Version 3.0

Number of pages 29

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Abstract This document defines Multi Section Digital Axle Counter Specification.	

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AMENDMENTS

Version	Chapter/ Annexes	Amendments	Effective Date
1.0	-	First issue	13.09.2002
2.0	-	Second issue	15.05.2005
3.0	-	Revised to incorporate 81st SSC Recommendations	31.03.2014

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SPECIFICATION FOR MULTI SECTION DIGITAL AXLE COUNTER

0.0 Foreword:

- 0.1 This specification is issued under the fixed serial No. RDSO/SPN/176/2013 followed by the year of original adoption as standard or in case of revision, the year of latest revision

1.0 Objective and Scope

- 1.1 This document sets forth general, operational, technical, performance & type tests requirements of Multi Section Digital Axle counter.
- 1.2 This specification does not cover the specification of external cable and protective devices to be used in conjunction with Multi Section Digital Axle Counter for its installation.
- 1.3 Axle Counter shall use amplitude/phase change techniques or any other fail safe techniques for safe and reliable wheel detection functions

2.0 Terminology & Abbreviations

2.1 Terminology

- 2.1.1 The terminology referred to in the specification is covered by the definitions given in IRS Specification no. S-23, IS Specification No. 9000 and as given below.
- 2.1.2 **Axle detector:** The track device comprising of the coils fixed in cover mounted on the rail. It will detect the wheel (rolling stock axle) passing over the device.
- 2.1.3 **Counting device/Digital Axle Counter field unit (track side):** Counting device/digital axle counter field unit is the track side electronic assembly that energizes the axle detectors for detecting the passing wheels determining the direction of movement and keeping the count of wheels. It transmits the count and health information to the Central Evaluator at regular intervals.
- 2.1.4 **Detection Point:** Detection point comprises of one axle detector and the field unit connected to it.
- 2.1.5 **Track Section:** The portion of track confined by associated axle detectors & field units. The axle counter is checking the occupancy of this section.
- 2.1.6 **Section Balancing:** Axle counter determines whether the track section in question is clear / occupied, based on the information on detected (in counts and out counts) numbers of axles, which is received from the axle detectors confining the section in question.
- 2.1.7 **Resetting:** Resetting commands the setting to zero the records of counted axles.
- 2.1.8 **Preparatory Reset:** After resetting, axle counter shall continue to show occupied until one train movement in the section carries out correct balancing of track section.
- 2.1.9 **Conditional Hard Reset:** The reset is activated after physical verification of a condition from different location like the clearance of the track section from site using line verification box. The axle counter will show clear after the conditional reset .
- 2.1.10 **Event Logger:** Logs the events occurring in axle counter system with date and time stamping.

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2.1.11 Central Evaluator (Indoor): The Central Evaluator receives count and health information from Digital Axle Counter Field units. It evaluates the counts received from the digital axle counter field units to generate relay-driving signals for individual track-sections.

2.2 Abbreviations

2.2.1	dB	Decibel
2.2.2	AWS	Auxiliary Warning System
2.2.3	TPWS	Train Protection & Warning System
2.2.4	TX	Transmitter
2.2.5	RX	Receiver
2.2.6	KHz	Kilo Hertz
2.2.7	LED	Light Emitting Diode
2.2.8	LCD	Liquid Cristal Display
2.2.9	VF	Voice Frequency
2.2.10	AFTC	Audio Frequency Track Circuit
2.2.11	DACFU	Digital Axle Counter Field Unit

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3.0 Applicable documents/drawings:

3.0.1	IS: 9000	Basic environmental testing procedures for electronic and electrical items.
3.0.2	IRS-S-23	Electric Signaling and Interlocking Equipment
3.0.3	ISO 9001	Quality systems – model for quality assurance in design, development, production, installation and serving.
3.0.4	IEC529/EN 60529	Specification for degree of protection provided by enclosures (IP code).
3.0.5	EN 61000.4.2	Electromagnetic compatibility (EMC) – testing and measurement techniques- electrostatic discharge immunity test and basic EMC
3.0.6	EN 61000.4.4	Electromagnetic compatibility – testing and measurement techniques- electrical fast transient/burst immunity test and basic EMC publication
3.0.7	EN 61000.4.5	Electromagnetic compatibility – testing and measurement techniques – surge and immunity test
3.0.8	PrEN50126	Railway applications - specification and demonstration of - reliability, availability, maintainability and safety
3.0.9	PrEN50128	Railway applications – Signalling and Communications – Software for Railway Control and Protection system
3.0.10	PrEN50129	Railway application: Safety related electronic systems for signaling
3.0.11	EN 50159-1 & 2	Railway Application: Signalling and Communication Safety related communication in closed and open Transmission system
3.0.12	IRS: S TC-30	Underground Railway Jelly filled Quad Cables for Special purposes in Electrified Area.
3.0.13	RDSO/SPN/165	SMPS based IPS.
3.0.14	IRS: S- 86	Battery Charger-Self Regulating.
3.0.15	IRS: TC 41	PIJF Telephone Cable.
3.0.16	RDSO/SPN/144	Safety and Reliability Requirement of Electronic Signalling Equipment.
3.0.17	RDSO/S/20001	Drawing for Reset – Box and Reset Panel
3.0.18	RDSO/SPN/99	Data Logger
3.0.19	RDSO/SPN/192	Electronic Interlocking
3.0.20	RDSO/S/20002	Drawing for line verification box.

3.1 Wherever in this specification, any of the above-mentioned specification is referred; the latest issue of the same is implied.

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4.0 System Requirements

The MSDAC system comprises of Axle Detectors, Track side electronics/DAC field units, Central Evaluator, Reset unit, Relay unit, Event Logger and diagnostic terminal.. MSDAC system should be scalable and support detection points & generate vital relay outputs for requisite track sections as per user's requirement. The Central Evaluator shall be connected to Track side electronics/ DAC field units in star configuration through 2wire or if track side electronics are to be reduced then 4 wire arrangements can be used to transmit information from field unit to central unit.. Each track section can be reset independently from the Reset Box/Reset Module of Reset Panel/Visual Display Unit (VDU). The Event Logger shall record all the events occurring in the multiple sections of axle counter.

5.0 General Requirements:

- 5.0.1 Multi section digital Axle counter consists of axle detectors & field units scalable upto user's requirement shall be configured for desired track sections as per user's requirement/site specific conditions. It is capable of counting axles, count comparison, finding direction of axle movement, supervision, relay drive and transmission of counts and health of axle detectors & field units. The field units are connected to the Central Evaluator by a transmission medium where transmission is in VF range or Central Evaluator may be connected to detection point through track side electronics on 2 wire arrangements or 4 wire arrangements may be used to reduce the track side electronics considerably
- 5.0.2 Track clear indication shall only be given when IN count and OUT count are equal and equipment is functioning all right. This implies that until all axles that enter a section are completely counted out, the section concerned shall not show as clear.
- 5.0.3 Axle counter shall show occupied the moment any of the axle counter sub-assemblies belonging to the section is damaged, missing or has become faulty.
- 5.0.4 The axle counter shall use Amplitude/ Phase change techniques or any other fail safe techniques for safe & reliable wheel detection function
- 5.0.5 Axle counter shall have arrangement so that wheels of push trolleys, dip lorry, rail dollies etc. are not counted by it. Trolley protection track circuit shall not be required with phase detection.
- 5.0.6 Axle counter operation shall be independent of wear & tear of wheels as permitted vide Indian Railway's Schedule of Dimension, lateral displacement of wheels on rails etc. The manufacturer shall specify the minimum diameter of the wheels, condition of wheels etc., to which the performance of equipment shall not be affected.
- 5.0.7 Axle Counter operation must be independent of type of sleepers in the section such as wooden, RCC, or steel etc. and shall work on all types of rail profiles and construction such as welded or non-welded rails of 52 kg / 60 kg / 90 lbs etc. Axle counter shall operate up to the vertical **limit for worn-out rail as given below:**

Sl. No.	Rail section	Vertical wear in mm.
1.	60 Kg / metre	13.00
2.	52 Kg / metre	8.00
3.	90 R	5.00

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- 5.0.8 Axle counter shall be suitable for train speed from 0 to 250 Km/h.
- 5.0.9 Axle counter system shall be designed for ease of maintainability and testability.
- 5.0.10 The equipment shall be robust in construction and shall work on the permanently energized principle. Any defect occurring in the equipment shall not result in a condition that will lead to unsafe situation.
- 5.0.11 The equipment (central evaluator & field unit) shall be of continuously self-checking type and shall have separate indication to show conditions of track clear and track occupied (including fault). Any disturbance or failure in the equipment including power supply failure shall result in withdrawal of clear indication and occupied indication shall be lit. . Disturbance /failure related to a track section shall not influence the normal working of other track sections.
- 5.0.12 Card wise failure indication shall be provided in Central Evaluator & Field Unit. It is desirable to give suitable indication of the nature of failure. Also total system failure and O.K. indications shall be provided.
- 5.0.13 Axle detector & field unit shall have no moving parts and shall require little maintenance.
- 5.0.14 The equipment (central evaluator & field unit) shall be so constructed as to prevent unauthorized/irregular access to sub-assemblies of the system. Authorized persons should, however, have access to these sub-assemblies for the purpose of installation and maintenance by unlocking the outer cover/breaking of seal provided on the outer cover.
- 5.0.15 The central evaluator & field units shall be provided with testing, measuring and adjusting facilities for indicating proper functioning of equipment and for facility of maintenance.
- 5.0.16 The equipment shall be fully solid-state using carefully chosen industrial grade components.
- 5.0.17 The system shall provide for continuous supervision of field units including cables connecting the field units with central evaluator and detectors with field units. Any defect in these shall be immediately detected, error code displayed and the system / section should go to error mode.
- 5.0.18 The maximum axle count, each track section can handle, should be ≥ 1024 .
- 5.0.19 Response time of train occupancy for any track section shall be less than 1.0 second.
- 5.0.20 Clearance time of any track section after train leaves the section shall be less than 2.5 sec.
- 5.0.21 Axle counter system design shall take into consideration system growth capability and architecture of digital axle counter shall be such that it is fit to be used on all the sections of Indian Railways including suburban sections.
- 5.0.22 Environmentally slight moisture condensation shall not lead to malfunction or failure of equipment.
- 5.0.23 The design of axle counter shall take into account switching transients that may occur either inside or outside the system and of any magnitude upto and including interruption of full short circuit current.

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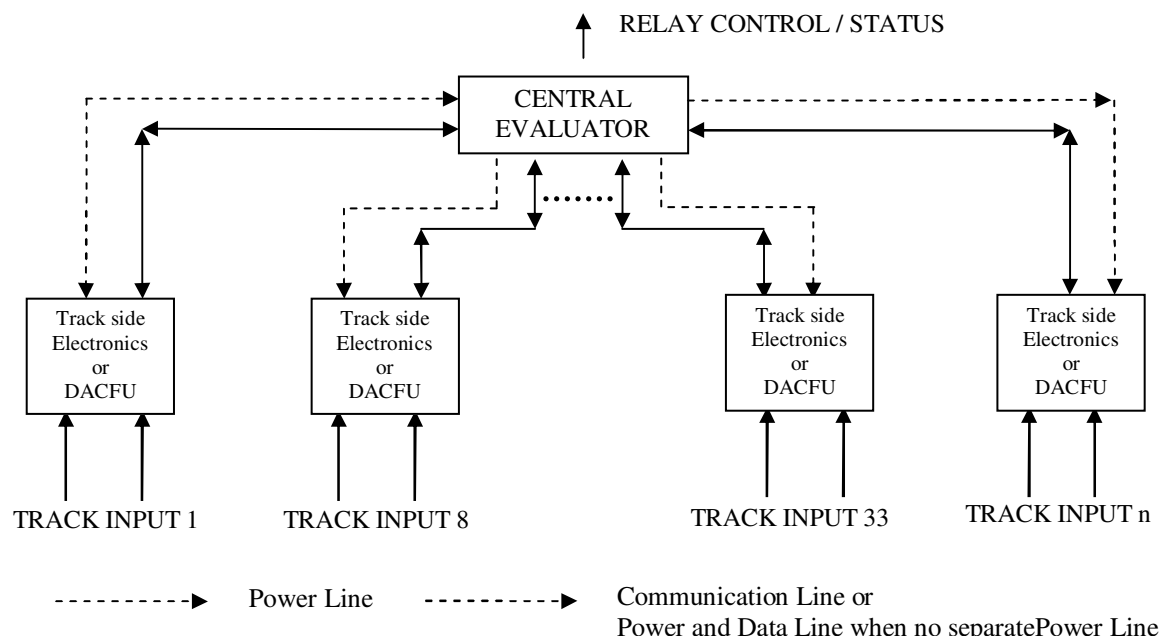
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- 5.0.24 Axle counter shall withstand the effect of lightning & surges incorporating lightning and surge protection as per RDSO/SPN/144.
- 5.0.25 The equipment shall conform to the Safety Integrity Level 4 as per CENELEC Standard and as per Clause 3 of this specification i.e. Applicable Documents/drawings.
- 5.0.26 The axle counter should not affect the operation of other wayside signalling equipments.
- 5.0.27 The axle counter shall neither affect nor be affected by presence in vicinity of other trackside signaling equipments like AFTC, TPWS, AWS, DC track circuit, 50Hz and 83-1/3 AC track circuit etc and Telecommunication equipments.
- 5.0.28 Error rate should not be more than 2 errors per 1 million correctly counted axles, and if there is error, it should not result in unsafe condition.
- 5.0.29 The equipment shall be capable of simultaneously counting in and / or counting out from the ends of any track section.
- 5.0.30 Response of rocking of wheels on Axle Detector: If any sensor is influenced two or more times consecutively without a proper count pulse, the system should go to error. If both sensors are influenced four or more times consecutively without a proper count pulse, the system should go to error.
- 5.0.31 Axle counter should tolerate induced voltage of at least 400V AC, 50Hz on the quad cable.
- 5.0.32 It shall fulfill fail safety requirement as per RDSO/SPN/144.
- 5.0.33 It shall fulfill the requirement of Signal Engineering Manual as per RDSO/SPN/144.
- 5.0.34 The software shall fulfill the software requirements as per RDSO/SPN/144.
- 5.0.35 Axle counter system shall adopt a structured design process including but not limited to the System architecture, Software requirements specification, software architecture, flow charts, Man machine Interface for prototypes, verification and test approach.
- 5.0.36 Detection point at the junction of two consecutive sections shall be capable of giving feed to both the monitoring sections.
- 5.0.37 Both hardware and software functions will be partitioned to ensure that integrity of certified design will not be compromised though routine software and hardware upgrades.
- 5.0.38 Design of the axle counter will maximize the use of vendor independent implementations.

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5.0.39 Digital axle counter interconnection diagram is shown in figure 1.



System (Scalable) with Trackside Electronics Interconnection (Network Mode)

5.0.40 Digital Axle Counter system should be provided with a spare set of application/configuration data which should be site specific and labeled accordingly, wherever such requirement is applicable.

5.1 **Configuration:** Multi section axle counter shall be easily configurable as per yard layout in different track sections as given below:

5.1.1 One detection point Single section: In terminal lines / siding.

5.1.2 Two detection points Single section: In straight line.

5.1.3 Three detection points Single section: In point zone.

5.1.4 Four detection points Single section: In point zone.

5.1.5 Multiple detection points single section: In ladder.

5.1.6 Consecutive single section in a straight line.

5.2 **Vital Relay Drive& Relay Unit**

5.2.1 Free and occupied indication of an axle counter section (track section) shall be available in the form of vital relay pick up and drop contact respectively. Vital relay/s will be driven by central evaluator.

5.2.2 The vital relay shall be 24V DC, 1000-ohm plug-in type. In section clear condition, the relay driver output shall be more than 20V DC and in occupied condition, it should be less than 2.0V DC.

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5.2.3 The design should incorporate fail safety feature such that when the vital relay is in dropped condition as per status of the track section, if any external voltage appears across the vital relay coil which can pick up the vital relay, then the system should detect it and the concerned axle counter section/track section will go to error state.

5.2.4 The relay unit shall provide housing for all vital relays.

5.2.5 The relay unit shall have enough space for mounting vital relays for max. no. of track sections supported by MSDAC.

5.3 **Axle detector:**

5.3.1 It comprises of two sets of TX/RX coils / sensors.

5.3.2 The TX/RX coils shall operate at frequencies above 20 KHz.

5.3.3 Different frequencies shall be used for each set of TX/RX coils.

5.3.4 These shall be capable of withstanding environmental conditions given and specified later. The inductance of axle detectors shall not vary more than $\pm 6\%$ within the specified temperature range.

5.3.5 The transmitter/receiver coils in the track shall be of web mounted type. The fasteners should be tightened at specified torque using torque wrench.

5.3.6 Axle counter performance shall not be affected by the flooding of track.

5.3.7 The axle detector shall be actuated only by wheel flanges and not by other parts of trains e.g. rail brakes, toilet pipes, suspended chains, electrical inductors in locomotives, air-conditioning equipment and other electrical /electronic equipment in train /engine.

5.3.8 One set of axle detector shall not influence another set of detector mounted ≥ 2 meters away.

5.3.9 The axle detector should not infringe with the Schedule of Dimensions of Indian Railways.

5.3.10 The length of inbuilt cable with Axle Detector shall be 5 / 10 / 15 mtr. only.

5.4 **Resetting:**

5.4.1 User input track section wise reset shall be possible.

5.4.2 Whenever any yard is provided with MSDAC, reset boxes/Visual Display Unit (VDU) shall be incorporated in a panel depicting yard layout so that respective reset boxes are easily co-related with the track section they pertain to. Refer drawing No. RDSO/S/20001 for details.

5.4.3 Track section wise resetting shall be easily configurable as preparatory reset or conditional hard reset.

5.4.4 Resetting of a track-section shall not disturb other track-sections in any way.

5.4.5 The resetting of the track section shall be recorded in the event logger.

5.4.6 A voltage sensitive feature shall ensure that without the operation of re-setting key, the system will not come back to initial or original condition for the following cases:

5.4.6.1 Power fails and restores back in field unit and/or central evaluator.

5.4.6.2 Voltage fluctuation beyond upper and lower limits in field unit and/or central evaluator.

5.4.6.3 Removal of printed circuit cards from the system (field unit and/or central evaluator.)

5.4.6.4 In case OUT count has been registered before any IN count.

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- 5.4.7 It shall be possible to reset each track section from reset box/reset module of reset panel only.
- 5.4.8 Provision shall be made for recording every operation of resetting by means of non-resettable counter. For one reset operation, the counter should not increment by more than one.
- 5.4.9 For track section on a straight line confined by two detection points, when reset is applied, the axle counter section shall go to “preparatory reset mode”. The preparatory reset LED in reset box/reset module of reset panel shall glow and reset counter shall increment. The axle counter section will be still in occupied state. The axle counter section will become clear only after more than one incout from one end and same number of outcount from the other end have taken place.
- 5.4.10 For track section on a terminating line/siding line, point zone and ladder, the reset command from reset box/reset module of reset panel will be transmitted only after verifying that verification switch have been pressed & turned in the line verification box at site as a proof of the axle counter section being clear physically. On availability of reset command, the section will reset and show clear and counter shall increment.
- 5.4.11 The reset box./reset module of reset panel should work from 24V DC supply. The following should be provided in the reset box/reset module of reset panel (as per Reset Box drawing no. RDSO/S/20001).
- 5.4.11.1 A six-digit (min.) non-resettable type counter.
- 5.4.11.2 Reset switch with key.
- 5.4.11.3 Reset push button – Red.
- 5.4.11.4 Axle counter section clear indication (LED- minimum 5mm) –Green
- 5.4.11.5 Axle counter section occupied indication (LED-minimum 5mm)-Red
- 5.4.11.6 Power OK indication (LED-3mm)-Yellow
- 5.4.11.7 Preparatory reset indication (LED-3mm) –Green or
- 5.4.11.8 Line verification indication (LED-3mm)-Yellow
- 5.4.12 The possibility of reset will be as per table below:

S.No.	Conditions	Whether reset permitted (Yes/No)
1.	No in count, No out count, section clear & healthy.	No
2.	No in count, No out count, Error has occurred.	Yes
3.	Only in count, No out count, System healthy	No
4.	Only in count, No out count, Error has occurred.	Yes
5.	In count & out count, registered System healthy	Yes
6.	In count & Out count started, Error has occurred	Yes
7.	No in count, but only out counts, system goes to error.	Yes
8.	System in preparatory mode	No

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5.4.13 There shall be provision of sealing in the reset box.

5.4.14 The line verification box shall be as per RDSO Drg. No. RDSO/S/20002.

5.5 Central Evaluator

5.5.1 The Central Evaluator Unit shall be housed in a pre-fabricated rack to be supplied along with the system.

5.5.2 The Central Evaluator shall be based on 2 out of 3 logic.

5.5.3 Central Evaluator based on 2 out of 2 logic may be considered through cross acceptance/ approval.

5.5.4 The Central Evaluator shall be able to connect up to 40 detection points.

5.5.5 The Central Evaluator shall connect to Digital Axle Counter field units in star configuration.

5.5.6 The Central Evaluator shall communicate with the Digital Axle Counter field units at minimum 1200 Baud.

5.5.7 The Central Evaluator will provide one vital relay output for each track section.

5.5.8 The Central Evaluator shall be able to generate relay outputs for upto 39 track sections.

5.5.9 The Evaluator should be configurable as per site specific requirements to handle the associated DPs for a track section.

5.5.10 The Central Evaluator shall be able to receive the reset command generated from Reset unit for section wise resetting of track section(s).

5.5.11 The Central Evaluator shall provide input to the Event Logger for registration and recording of events occurring in the multiple section digital axle counter.

5.5.12 The Central Evaluator will have an RS-232 port to interface with Electronic Interlocking (EI) system as per RDSO/SPN/192.

5.5.13 The Central Evaluator will have a separate port to connect to the station data logger for monitoring the section wise clear/occupied information. Standard Data Logger protocol as specified in RDSO/SPN/99 shall be used for this purpose.

5.5.13.1 The following information shall be sent to station data logger:

5.5.13.1.1 Track section nomenclature as per signalling plan.

5.5.13.1.2 Status of track section i.e. clear, occupied, failed or preparatory reset.

5.5.13.1.3 Application of reset command track section wise

5.5.14 Provision should be there for lightning & surge protection in the central evaluator power supply input and communication line input/output.

5.5.15 The field units should be able to communicate with central evaluator for transmission loss upto 20dB.

5.5.16 Suitable arrangements shall be made for providing electrical isolation between external relay circuits and internal circuits.

5.6 Digital Axle Counter field Unit

5.6.1 It shall have 2 out of 2 architecture.

5.6.2 It shall detect and count axles passing over the axle detector.

5.6.3 It shall determine the direction of passing of axles.

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- 5.6.4 Provision should be there for lightning & surge protection in the field unit power supply input and communication line input/output.
- 5.6.5 The field units should be able to communicate with central evaluator for transmission loss upto 20dB.
- 5.6.6 It shall identify and communicate in the following conditions to the Central Evaluator:
- 5.6.6.1 Power fails and restores back
- 5.6.6.2 Voltage fluctuation beyond upper and lower limits
- 5.6.6.3 Removal of printed circuit card(s) from the unit
- 5.6.6.4 In case out count has been registered before any in count.
- 5.6.7 It shall transmit axle counts and health status to Central Evaluator at regular intervals
- 5.6.8 It shall have provision for setting unique address of each field unit. The address shall be minimum 8 bit.
- 5.7 Communication:**
- 5.7.1 It shall be possible to use copper cable or voice channel in optical fiber communication for transmission of data between field units and central evaluator. The copper cable will be quad cable as per IRS: TC: 30-97 (0.9 mm dia) or PIJF Telecom Cable as per IRS: TC 41/97 (0.9 mm dia.) No separate external interface should be required for using any of these two transmission mediums.
- 5.7.2 Impedance matching between communication channel and modem shall be provided.
- 5.7.3 It shall be capable of transmission of axle counts, health status and other information between field units & central evaluator on a transmission link. The transmission link, in case of copper cable, shall be ½ quad telecom cable or 1 pair in PIJF cable or use 2 pairs of cable to reduce the trackside electronics or one 2-wire voice channel in case of OFC. The rate of transmission should be minimum 1200 baud.
- 5.7.4 Fault tolerant telegrams shall be used for transmission of axle counts and other information between field units and central evaluator. CRC to be used for error detection and the hamming distance of the message protocol shall be at least 5. The code transmission should be safety validated. Communication should be as per CCITT standard.
- 5.7.5 Minimum 2 (two) consecutive telegrams will be required to verify the integrity of the status of direction and counts transmitted. However, for the information that in count has started, action may be taken after receiving first telegram itself to take the axle counter section to occupied state (a safe state). The manufacturer shall specify the minimum length of the axle counter section for which the axle counter section shall work properly for train running at maximum speed as specified.
- 5.8 Earthing:**
- 5.8.1 Provision of earthing should be there in the central evaluator, field unit and reset box. The earth terminal shall be suitable for taking upto 4mm dia. copper wire with lug.

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5.9 Event Logger

- 5.9.1 The Event Logger shall be inbuilt in the Central Evaluator.
- 5.9.2 The event logger should work automatically without any other input required to be given by staff.
- 5.9.3 Digital Axle Counter failures shall not affect in any way the correctness of the information recorded in the Event Logger. Neither shall it cause its loss or change.
- 5.9.4 The data registered in the event logger must be secured against erasing by unauthorized persons.
- 5.9.5 It should be possible to download logged events to a commercial computer/Pen Drive through standard port.
- 5.9.6 The process of event logging and downloading of logged events should not hamper the normal working of axle counter in any manner.
- 5.9.7 The event logger shall record following events at the minimum:
 - 5.9.7.1 Resetting of a track-section, field unit or central evaluator.
 - 5.9.7.2 Failures/errors in field units or central evaluator.
 - 5.9.7.3 Breakdown of communication link (s).
 - 5.9.7.4 Change in relay status for section occupied / clear.
 - 5.9.7.5 Changes in 5 V output of DC-DC converter beyond limits.
 - 5.9.7.6 Change in date / time.
- 5.9.8 Provision should be there to log minimum 40,000 events. In case of its memory becoming full, the event logging should be on first in first out principle.
- 5.9.9 All data will be recorded in a user-friendly form with date & time stamp in English Language.
- 5.9.10 It shall be possible to download the data for a user-selected time interval or it should be possible to generate report for a user selectable date/period.

6. Diagnostics

- 6.1 Diagnostic system of the axle counter shall provide-
 - 6.1.1 Local and remote diagnostics and testing of system through a serial connection.
 - 6.1.2 Self-detection of errors and display through error codes and brief description in diagnostic terminal. The same display should normally show in count / out count detection point wise and section wise and software version no. when the system is switched on initially.
- 6.2 Diagnostic information should not be considered vital.
- 6.3 Diagnostic functions shall be carried out on a permanent basis without disturbing normal operation of the equipment.
- 6.4 Information on the state of the equipment in failure situations and on operations performed by the staff shall be registered with time stamping.

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7. Traction and supply

- 7.1 Axle Counter system shall be capable of working in all sections including non-electrified, 25 kV 50 Hz AC, 1500 VDC & 750V DC electrified areas.
- 7.2 The axle counter should operate correctly under traction return currents of up to following magnitudes
- 7.2.1 25 kV / 50Hz 1000 A
- 7.2.2 1.5kV/dc 6000 A
- 7.2.3 750V/ dc 3000 A
- 7.3 The currents or their harmonics flowing in the rolling stock & rails shall not affect the digital axle counter.
- 7.4 The equipment shall be insensitive to extraneous magnetic or electric fields such as due to traction return currents on electrified sections, traction motor failures, vehicle magnetism or due to any other source.
- 7.5 The electromagnetic brakes in both on and off states should not affect the axle counter.

8. DC Input Power Supply

- 8.1 The field unit shall work with power supply of 24V DC fed from a remote location. The input voltage range is +24V DC (+20% to -30%) & will have a maximum ripple as per Para 5.4.23 of RDSO/SPN/165 or Para 5.4.2 of IRS: S 86/2000.
- 8.2 The Central Evaluator shall work with same type of power supply as mentioned in Para 8.1 but range will be 24V+ 20%, -10%.
- 8.3 The power consumption in the equipment shall be low. It should be less than 0.75A for field unit at 24VDC (nominal).
- 8.4 There should be protection of over voltage, under voltage and polarity reversal.

9.0 Hardware Standards

9.1 Component types

- 9.1.1 The ICs used in the equipment shall be of industrial grade.
- 9.1.2 The discrete components like diodes, transistors, SCRs etc., should conform to HIREL program of CDIL or equivalent.
- 9.1.3 All resistors used shall be rated for at least double the power, which is supposed to be dissipated in them. The voltage rating of the capacitor shall be at least 50% above peak value. The resistors shall be of tolerance not more than 5%. Tolerance of capacitors shall be as under:

Metallised Polycarbonate (MPCAR) : 5%

Polypropylene (PPSAR/PSAR) : 5%

Polystyrene (PFD) : 2%

Electrolytic : 20%

These shall be procured from RDSO approved sources, wherever specified.

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- 9.1.4 All power supplies on cards should be locally decoupled where digital ICs are used using a capacitor with good high frequency characteristics. Recommended value of capacitor is 0.01 μ f.
- 9.1.5 Shielding at card level by providing a metallic plate over the cards.
- 9.1.6 Shielding at chassis/rack level.
- 9.1.7 Terminals provided for cable connections shall be of cage clamp type of Wago or Phoenix make.
- 9.1.8 Screw type couplers used for any connections shall be of MIL grade.
- 9.2 Printed Circuit Board**
- 9.2.1 PCB material: Material for the PCB shall be copper clad glass epoxy of grade FR-4 or equivalent.
- 9.2.2 Outline Dimensions: PCBs shall be of standard Euro extended size.
- 9.2.3 Track Width: The track width shall be 0.5mm nominal. In no case it should be less than 0.3mm.
- 9.2.4 **Spacing between tracks:** Spacing between tracks shall be 0.5mm nominal and in no case it shall be less than 0.3mm.
- 9.2.5 Printed circuit cards shall be fitted with gold plated Euro/ D type plug in connectors with locking arrangement. Mechanical arrangement e.g. a clip or a screw to hold the PCB in inserted position shall be provided. Screws should be countersunk and held on PCB when it is pulled out. The PCB shall be mechanically polarized so that it is not possible to insert the PCB into wrong slot. Suitable mechanical arrangement shall be provided against wrong insertion of connections.
- 9.2.6 The printed circuit cards shall be specifically designed to suit the circuitry used and no extra wires or jumpers shall be used for interconnection of components on the PCB. No piggyback PCB shall be connected to any PCB. The components shall be soldered with wave-soldering machine. Any exception to wave-soldering machine shall have specific approval of RDSO, Lucknow.
- 9.2.7 The cards shall be provided with testing points and the corresponding voltages / waveforms shall be indicated in the fault diagnostic procedure and service manual to facilitate testing and fault tracing.
- 9.2.8 **Heat Dissipating Components:** All components dissipating 3 W or more power shall be mounted in such a manner that the body is not in contact with the board unless a suitable heat sink is provided.
- 9.2.9 **Conformal Coatings:** Assembled PCBs should be given a conformal coating to enable them for functioning under adverse environmental conditions. The coating material should be properly chosen to protect the assembly from the following hazards:
- 9.2.9.1 Humidity
- 9.2.9.2 Dust and dirt
- 9.2.9.3 Airborne contaminates like smoke and chemical vapours
- 9.2.9.4 Conducting particles like metal clips and filings
- 9.2.9.5 Accidental short circuit by dropped tools, fasteners etc

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9.2.9.6 Abrasion damage and

9.2.9.7 Vibration and shock (to a certain extent)

9.2.10 **Burning in Test**

9.2.10.1 All the electronic components used in the equipment shall be subjected to “Burn-in” test for 48±1 hours at temperature of 65°C. Record of failed components in this test should be maintained.

9.2.10.2 After mounting of components, the populated PCB cards kept in proper chassis in energized condition shall be burnt in for 168 hrs at 60°C. Record of failed PCB Cards in this test should be maintained.

9.2.11 Following description shall be screen printed on the component side of the PCB:

9.2.11.1 Component outline in the proximity of the component.

9.2.11.2 Manufacturer’s name.

9.2.11.3 PCB name.

9.2.11.4 Equipment name.

9.2.11.5 Part number.

9.2.12 Following description shall be marked on the PCB:

9.2.12.1 The manufacturing serial number.

9.2.12.2 Month and year of manufacture.

9.2.13 **Solder Mask:** Solder mask shall be applied on solder side and component side of the board.

9.2.14 The distribution of the power supply on the cards should be such that different voltage tracks (0, 5V etc) follow the same route as far as possible. The track of power supplies should be as thick and wide as possible.

9.2.15 Housing rack shall be as per RDSO/SPN/144.

10.0 **Performance**

10.1 Time for failure detection: Failure indication shall occur not later than after the passage of the first train over the relevant track section.

10.2 Occurrence of any failure or error of operation in the axle counter component parts must not lead to any hazards but can solely result in transition to a distinguished safe state.

10.3 The Axle counter service life shall not be less than 20 years.

10.4 The Axle Counter (equipment only) shall have MTBF of not lower than 70,000 hrs.

11.0 **Inspections and Testing**

11.1 **General**

11.1.1 Inspection and tests shall be carried out to ensure that requirements of this specification are complied. Conditions of tests – Unless otherwise specified, all tests shall be carried out at ambient atmospheric conditions. For inspection of material, relevant clauses of IRS: S 23 and RDSO/SPN/144 shall also apply.

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11.2 Type Approval

11.2.1 Initial Type Approval

11.2.1.1 Manufacturer shall furnish following information at the time of initial type approval:

11.2.1.1.1 Design approach for the system and Salient feature through which fail-safety has been achieved

11.2.1.1.2 Proof of safety report or its equivalent giving complete tests and their results that have been undertaken by manufacturer or independent safety assessor

11.2.1.1.3 The system shall conform to the CENELEC standards for SIL-4 Railway Signalling. Software & hardware validation shall be done by accredited / reputed independent third party. The agency to be engaged for validation shall be got approved by RDSO.

11.2.1.2 While granting initial type approval it shall be ensured that the system conforms to all the clauses & passes all type tests as mentioned in clause 10.3.

11.2.2 Maintenance Type Approval

At the end of validity period, RDSO may call for fresh samples for type testing for the purpose of maintenance of Type Approval as per the provisions of Directorate Operating Procedure. The sample must pass all type tests as per Clause 11.3.

11.3 Type tests

11.3.1 The following shall comprise type tests:

11.3.1.1 Visual inspection (Cl.11.5.1)

11.3.1.2 Performance test (Cl.11.5.2)

11.3.1.3 Applied high voltage test (Cl.11.5.3)

11.3.1.4 Insulation resistance (Cl.11.5.4)

11.3.1.5 Climatic tests (Cl.11.5.5)

11.3.1.6 Shock tests (Cl. 11.5.6)

11.3.1.7 7 KV static discharge test (Cl. 11.5.7)

11.3.1.8 Vibration Test (Cl. 11.5.8)

11.3.1.9 Fail safety tests (Cl 11.5.9)

11.3.1.10 The test for Software check–sum (Cl.11.5.11)

11.3.2 One equipment shall be tested for this purpose. The equipment shall successfully pass the entire type test for proving conformity with this specification. If the equipment fails in any of the tests, the purchaser or his nominee at his discretion, may call for another equipment of the same type and subject it to all tests or to the test(s) in which failures occurred. No failure shall be permitted in the repeat test.

11.3.3 To obtain a type approval certificate, the manufacturer or supplier shall submit to the testing authority two numbers of samples, for conducting all the tests mentioned. In case of maintenance type approval, the samples shall be selected at random from regular production lots so as to be as representative as possible of the type under consideration. A Type approval certificate shall be issued to a manufacturer if samples pass all the prescribed tests in accordance with this specification.

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11.3.4 A type approval certificate once issued shall not be valid if a change in design, construction, material used or manufacturing process is made subsequently, unless this change has the approval of the Purchaser or his nominee.

11.4 **Acceptance Test& Routine Test**

11.4.1 **Acceptance Test**

11.4.1.1 Inspecting authority shall carry out acceptance tests on all the equipment/sub units. The following shall comprise acceptance tests:

11.4.1.1.1 Visual inspection (Cl.11.5.1)

11.4.1.1.2 Performance test (Cl.11.5.2)

11.4.1.1.3 Insulation resistance (Cl.11.5.4)

11.4.1.1.4 Records of Environmental Stress Screening Tests (ESS) (Cl. 11.5.10)

11.4.1.1.5 The test for Software check–sum (Cl.11.5.11)

11.4.1.2 A complete test report of all the tests conducted shall be submitted by inspecting authority giving the detailed observations made in every case and actual values recorded. Specific mention shall be made whenever the equipment has failed to comply with the requirements and indicating as to how far it has failed to comply.

11.4.1.3 Disposal of samples: Sample equipment, which has been subjected to type tests, shall not form part of supply.

11.4.2 **Routine test**

11.4.2.1 Following shall constitute routine tests and shall be conducted by manufacturer on every equipment/sub units and test results shall be submitted during the inspection.

11.4.2.1.1 Visual inspection (Cl.11.5.1)

11.4.2.1.2 Performance test (Cl.11.5.2)

11.4.2.1.3 Insulation resistance (Cl.11.5.4)

11.4.2.1.4 Environmental Stress Screening Tests (ESS) (Cl. 11.5.10)

11.4.2.1.5 The test for Software check–sum (Cl.11.5.11)

11.5 **Test Procedure**

11.5.1 **Visual Inspection**

The equipment/sub units shall be examined for provisions of all facilities stipulated in this specification such as correct wiring, proper mounting and marking of components, marking, workmanship and finish for which no tests have been specified.

11.5.2 **Performance tests**

11.5.2.1 **Equipment sub units**

DC-DC converter	No load current Output load Line regulation Effect of frequency variation
Signal conditioner card	
CPU	
Modem	
Relay driver	
Software	Functional tests

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11.5.2.2 System level checking

11.5.2.2.1 Constructional detail

11.5.2.2.2 Dimensional check

11.5.2.2.3 General workmanship

11.5.2.2.4 Configuration

11.5.2.2.5 Functional tests

11.5.2.3 Card level checking

11.5.2.3.1 PCB laminate thickness

11.5.2.3.2 Quality of soldering

11.5.2.3.3 General track layout

11.5.2.3.4 Conformal coating and shielding

11.5.2.3.5 Legend printing

11.5.2.3.6 Green masking

11.5.2.3.7 Mechanical polarization

11.5.2.3.8 General shielding arrangement of individual cards

11.5.2.3.9 Indication and display

11.5.2.3.10 Mounting and clamping of connectors

11.5.2.3.11 Proper housing of cards

11.5.3 Applied High voltage test

The equipment shall withstand for one minute without puncture and arcing at a test voltage of 2000 AC, rms applied between power components and the body of equipment, which shall be earthed. The test voltage shall be approximately sine wave of any frequency between 50 and 100 Hz. Any electronic component, which is likely to get damaged by the application of high voltage, shall be disconnected during the test.

11.5.4 Insulation Resistance Test

11.5.4.1 This test shall be carried out:

11.5.4.1.1 Before the high voltage test

11.5.4.1.2 After the high voltage test

11.5.4.1.3 After completion of the each climatic test/severities in type test.

There shall be no appreciable change in the values measured before and after high voltage test. After the completion of climatic test, the values shall not be less than 10 Mega ohms for the equipment at a temperature of 40 deg. C and relative humidity 60%. The measurement shall be made at a potential of 500V DC. During acceptance test, high voltage test and climatic test will not be done.

11.5.5 Climatic Test

Climatic Test shall be done as per the sub clauses mentioned below. After completion of all the tests, high voltage test (**Clause 11.5.3**) & insulation resistance test (Clause 10.5.4) shall be repeated.

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11.5.5.1 Change of Temperature Test:

11.5.5.1.1 The equipment shall be tested as per IS-9000/Pt.XIV Sec-2.

11.5.5.1.2 The test severity shall be -

i) Lower Temperature: $-10^{\circ}\text{C} \pm 3^{\circ}\text{C}$

ii) High Temp: $70^{\circ}\text{C} \pm 2^{\circ}\text{C}$

Rate of cooling and heating 1 degree per minute. Duration of test: 3 cycles of 3 hrs each (after stability in the chamber has been reached). The equipment shall be kept energized during the test and status of relay shall be recorded. After completion of test, the equipment shall be subjected for standard recovery of 2 hours (15 - 35 degree C, RH 45 -75 %), After recovery, the equipment shall be checked visually for any damage and its insulation resistance shall be measured which shall not be less than 10 Mega ohms at 40 degree C and 60 % RH.

11.5.5.2 Dry Heat test:

The equipment shall be tested as per IS-9000/Pt.III Sec. 5. The test severity shall be $+ 70 \pm 2$ deg.C and duration of exposure 16 hrs. (After stability in the chamber has been reached). Rate of change of temperature shall be 1 degree per minute. The equipment shall be switched ON when the temperature in the chamber has stabilized and remained active during the above tests and status of relay shall be recorded. After completion of test, the equipment shall be subjected for standard recovery of 2 hours (15 - 35 degree C, RH 45 -75 %), After recovery, the equipment shall be checked visually for any apparent damage or deterioration and insulation resistance shall be measured which shall not be less than 10 Mega ohms at 40 degree C and 60 % RH.

11.5.5.3 Cold test:

The equipment shall be tested as per IS-9000/Pt.II Sec. 3. The test severity shall be $- 10 \pm 2$ deg.C and duration of exposure 2 hrs. (After stability in the chamber has been reached). Rate of change of temperature shall be 1 degree per minute. The equipment shall be switched ON when the temperature in the chamber has stabilized and remained active during the above tests and status of relay shall be recorded. After completion of test, the equipment shall be subjected for standard recovery of 2 hours (15 - 35 degree C, RH 45 -75 %), After recovery, the equipment shall be checked visually for any apparent damage or deterioration and insulation resistance shall be measured which shall not be less than 10 Mega ohms at 40 degree C and 60 % RH.

11.5.5.4 Damp Heat Test (Cyclic):

The equipment shall be tested as per IS-9000 / Pt.V Sec-2. The upper temperature shall be $+ 40$ deg C, lower temperature $+ 25$ degree C, RH 95 %, Variant 1, 1 cycle 12 + 12 hours and 6 number of cycles. The equipment shall be kept energized during the test. No intermediate measurements required only relay status to be recorded. After standard recovery of 2 hours, the equipment shall be checked visually for any apparent damage or deterioration and insulation resistance shall be measured which shall not be less than 10 Meg ohms at 40 degree C and 60 % RH.

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11.5.5.5 Damp Heat Test (Steady state):

The equipment shall be tested as per IS-9000 / Pt.IV. The temperature shall be maintained $+ 40 \pm 2$ deg C, and relative humidity 95 %, (+2% -3%). The duration of the test is 4 days. The equipment shall be kept energized during the test. No intermediate measurements required only relay status to be recorded. After standard recovery of 2 hours, the equipment shall be checked visually for any apparent damage or deterioration and insulation resistance shall be measured which shall not be less than 10 Meg ohms at 40 degree C and 60 % RH.

11.5.5.6 Salt Mist Test:

This test shall be carried out as per RDSO/SPN/144.

11.5.5.7 Driving Rain Test (for Axle Detectors):

The unit shall be subjected to this test for 1 hr. as per IS: 9000 Pt. XVI/should comply the requirements of IP 66 and shall withstand the same. The equipment shall be kept de-energized during the test and in its normal operational position. The item shall be sprayed from eight showerheads, four of them being directed at an angle of 45 degree on each of the uppermost corners of the item and remaining four being directed horizontally at the center of the area of each of the four sides of the item. After standard recovery, the equipment shall be checked for any deterioration and insulation resistance shall be measured which shall not be less than 10 Meg ohms at 40 degree C and 60% RH.

11.5.5.8 Water Immersion Test (for Axle Detectors):

The equipment shall be subjected to this test for 24 hrs as per IS: 9000 Pt.-XV Section 7/ should comply the requirement of IP 68. Water head shall be 40 cm above the highest point of item under test. The equipment shall be kept in the chamber in its normal operational position and in de energized state. After the completion of the test external surface of the item shall be dried by wiping or by applying a blast of air at room temperature. After standard recovery of 2 hours, the equipment shall be checked visually for undue penetration of water and for any apparent damage or deterioration. Insulation resistance shall be measured which shall not be less than 10 Meg ohms at 40 degree C and 60 % RH.

11.5.5.9 Dust Test:

The equipment shall be tested as per IS-9000 Pt. XII./ It should comply the requirement of IP 60 The item shall be subjected in the chamber at laboratory temperature in switched off condition. The temperature of the chamber shall then be raised to a value of $40 \text{ deg C} \pm 3 \text{ deg C}$ with a relative humidity not exceeding 50% shall be maintained in the test chamber. When the temperature stability has been attained, the test item shall then be subjected to a stream of dust-laden air for a period of one hour. After standard recovery of 2 hours, the equipment shall be checked for any deterioration and insulation resistance shall be measured which shall not be less than 10 Meg ohms at 40 deg C and 60% RH.

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11.5.6 Shock Test: (on axle detectors only)

Axle detectors shall be tested for this test.

Shock test as per IS 9000 Pt. VII Sec. 1 Clause 9	Peak acceleration	40 g.
	Duration of the pulse	11 m. sec.
	No. of shocks	18
	Velocity change	Half sine pulse
	Equipment in unpacked condition shall be subjected to Bump test. In addition to physical checks, the assembly shall be subjected to performance test.	

11.5.7 7 KV Static Discharge Test:

11.5.7.1 The test shall be done as per RDSO/SPN/144 except for diagnostic terminal, external event logger, reset box/panel.

11.5.8 Vibration Test:

The equipment shall be subjected to vibration test as per IS: 9000 (Part VIII).

Specification Details.	Severities		Observation /Remarks
Vibration test as per IS 9000 Pt. VIII	Frequency range	10 Hz – 55 Hz	Equipment shall be visually examined for any apparent damage.
	Amplitude	0.35mm (0 to peak) or 5g	
	No. of axis	3	
	No. of sweep cycles	20	
	Total duration for the 20 sweep cycles	1 hour 45 minutes when frequency of vibration is changed as per clause 6.3 of IS-9001 Pt.XIII-81 during each sweep	After completion of the test the equipment shall be tested for its normal operation.
	If resonance is observed, endurance tests at resonant frequency.	10 minutes at each resonant frequency	

11.5.9 Fail-safety test:

Fail safety tests shall be carried out as per RDSO/SPN /144/2004 as covered under the clause 4.0 and as per CENELEC EN50129.

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11.5.10 Environmental Stress Screening Tests (ESS) for Printed Assembly Boards (PAB) and Subsystems

The manufacturer shall carry out the following ESS tests on all modules on 100% basis (except bump test) during production/testing in the sequence as follows. Suitable records shall be maintained regarding the compliance of these tests.

11.5.10.1 Vibration Test

PCBs in unpacked condition shall be subjected to vibration test for 10 minutes at the resonant frequency/frequencies at 3.0 g minimum acceleration in the axis /axes perpendicular to the mounting of components. In addition to physical checks, the electrical parameters are also to be monitored after the vibration test.

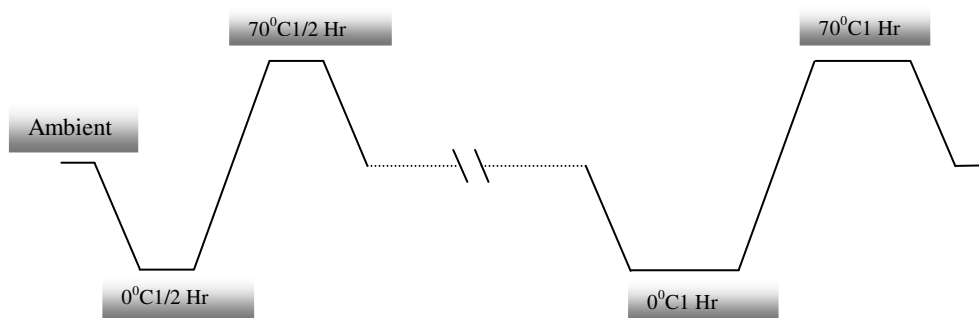
11.5.10.2 Bump Test

PCBs /modules/units in packed condition shall be subjected to bump test at 40 g for 1000 bumps. This test shall be carried out as per sampling plan given in Clause 7.2.5, 7.2.6 & 7.2.7 of IRS:S 42/85 for Axle Counter Equipment. In addition to physical checks, electrical parameters are also to be monitored after the bump test.

11.5.10.3 Thermal Cycling

The PCBs shall be subjected to thermal cycling as per the procedure given below:

The Assembled Boards are to be subjected to the Rapid Temperature Cycling as mentioned below in the power OFF condition. This temperature cycling is from 0 to 70°C, ½ hour at each temperature for 9 cycles and 1 hour at each temperature for the 10th cycle. Dwell time of 1 hour is provided for the last cycle in order to oxidize defective solder joints exposed through thermal stress.



The rate of rise /fall of temperature shall be minimum 10°C/minute.

In addition to physical checks, the electrical parameters are also to be monitored after this test.

11.5.10.4 Power Cycling

The power supply modules shall be subjected to 60 (sixty) ON-OFF cycles for one hour. (The ON-OFF) switch usually provided in the modules may not be used for this purpose.

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11.5.11 The test for Software check–sum

Through suitable means, the total size of the software of each sub-system shall be measured and recorded. The manufacturer shall specify the size of software with version number of each sub-system at the time of applying for type approval.

12.0 Quality assurance

- 12.1 All materials shall be of the best quality and the workmanship shall be of the highest class as per QAP standards laid down by RDSO.
- 12.2 The equipment shall be manufactured as per quality assurance procedure laid down so as to meet the requirement of the specification.
- 12.3 Along with other requirement of the specification, validation and system of monitoring of QA procedure shall form a part of type approval. The required plant machinery and test instruments as per RDSO's Standards shall be available with the manufacturer.

13.0 Marking and Identification

- 13.1 It shall conform to the clause of marking given in RDSO/SPN/144.
- 13.2 Terminals, which are to be connected to track, power supply etc., shall be marked clearly.
- 13.3 A nameplate shall be provided in a conspicuous position giving manufacturer's name, specification reference, serial no of the equipment, date of manufacture, version no., local address, remote address etc.
- 13.4 A plate indicating the configuration to be adopted for entry point unit and exit point unit shall be provided in a conspicuous position on the equipment.
- 13.5 Proper marking should be on Tx/Rx coil.

14.0 Packing

Packing shall be done to RDSO/SPN/144/2006 or latest.

15.0 Warranty

The warranty of the equipment shall be in accordance with IRS Specification No. S- 23.

16.0 Documentation

- 16.1 Documents shall be prepared to meet EN 50128 and EN 50129 requirements.
- 16.2 Safety case documents as per CENELEC standards for SIL-4 Railway Signalling to be submitted for type approval.
- 16.3 Guaranteed performance data, technical & other particulars of the equipment to be submitted for type approval.
- 16.4 Details of hardware e.g. schematic diagrams of the system circuits / components, details for each type of assembled PCB and part list to be submitted for type approval.
- 16.5 The manufacturer shall provide report containing detailed analysis of hardware and software of axle counter verifications and validation documents approved from accredited validation agency.

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17.0 Purchaser's Responsibility

- 17.1 The commissioning of the equipment shall be done under the supervision of the manufacturer. However, purchaser, at his own discretion may waive off this clause by specifying so in the tender conditions.

18.0 Supply of documents:

- 18.1 Two copies of the following shall be supplied during type approval and one copy each shall be supplied along with each equipment. Documents shall be approved by RDSO.
- 18.1.1 Instruction Manual.
 - 18.1.2 Installation & maintenance manual including Dos & Don'ts.
 - 18.1.3 Mechanical drawings of each sub-system/rack.
 - 18.1.4 Schematic block diagram showing mounting arrangement of various components & details of each type of assembled PCB.
 - 18.1.5 Trouble shooting procedures along with test voltages and waveforms at various test points in the PCBs.
 - 18.1.6 Pre-commissioning checklist.

19.0 Purchaser should specify:

- 19.1 Number of detection points and track sections required.
- 19.2 The length of cable required with each track device (Refer Cl. 5.3.10).
- 19.3 Specialized tools and measuring instruments required.

20.0 Tools for maintenance:

- 20.1 The manufacturer shall indicate special maintenance instruments and tools that may be necessary for safe and reliable adjustment and maintenance of equipment and supply these, if so required by the purchaser

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