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SINGLE SECTION DIGITAL AXLE COUNTER
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Abstract **This document defines Single Section Digital Axle Counter Specification.**			

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Director/Signal	**RDSO**	**Member**	**Prepare**
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AMENDMENTS

Version	Chapter/ Annexes	Amendments	Effective Date
1.0	-	First issue	14.01.2003
1.0 with Amendment 1		Clause 10 modified for Typographical errors, regrouping/inclusion of tests etc.	10.02.2003
1.0 with Amendment 2	-	(i) Clause 4.8, 4.13, 5.2, 5.10, 10.3.1, 10.4.1.1, 10.4.2.1, 10.5.11.2 (ii) New addition of clause 10.5.12.	1.7.2003
2.0	-	-	15.04.2005
2.0 with Amendment 1	-	(i) Cl. 4.0.23, 4.0.27, 4.0.28, 4.4.6, 4.4.7, 4.6.5, 5.1.2, 10.5.5.6 modified. (ii) New addition of clauses – 3.0.18, 4.0.35, 4.0.36, 4.2.5, 4.4.12, 4.5.7 & 18.1.	
3.0		(i) Cl. 4.04 Inclusion of SSC comments. (ii) Inclusion of ver-2.0, amndt-1 (iii) New addition of clauses inclusion of High availability system (iv) Cl. 4.0.31, Cl. 4.5.5 Cl. 18 & 19 modified. (v) Inclusion of Annexure I & II	10.09.2012

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SPECIFICATION FOR SINGLE SECTION DIGITAL AXLE COUNTER

1.0 Scope

1.1 This document sets forth general, operational, technical, performance & type tests requirements of Single Section Digital Axle counter.

1.2 This specification does not cover requirements of external cable and protective devices to be used in conjunction with Digital Axle Counter for its installation.

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/Track Device: The track device comprising of the coils sealed in a cover mounted on the rail. It will detect the wheel of 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 energise the axle detectors for detecting the passing wheels determining the direction of movement and supervision of track section or occupancy/output device, keeping the count of wheels. It is capable of communicating with other counting device at the other end of the track section.

2.1.4 Detection Point: Detection point comprises of one axle detector/track device and the field unit connected to it.

2.1.5 Track Section: The portion of track confined by associated axle detectors & field units. The occupancy of this section being supervised by the axle detectors.

2.1.6 Section Balancing: Axle counter determines whether the track section in question is clear / occupied, based on the information of 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 results in bringing 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 through 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 the field unit with date and time stamping.

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 Crystal Display

2.2.9 AFTC - Audio Frequency Track Circuit

3.0 Applicable documents/drawings:

1	IS: 9000	Basic environmental testing procedures for electronic and electrical items.
2	IRS-S-23	Electric Signaling and Interlocking Equipment
3	ISO 9001	Quality systems – model for quality assurance in design, development, production, installation and serving.
4	IEC529/ EN 60529	Specification for degree of protection provided by enclosures (IP code).
5	EN 61000.4.2	Electromagnetic compatibility (EMC) – testing and measurement techniques- electrostatic discharge immunity test and basic EMC
6	EN 61000.4.4	Electromagnetic compatibility – testing and measurement techniques- electrical fast transient/burst immunity test and basic EMC publication
7	EN 61000.4.5	Electromagnetic compatibility – testing and measurement techniques – surge and immunity test
8	PrEN50126	Railway applications - specification and demonstration of - reliability, availability, maintainability and safety

9	PrEN50128	Railway applications – Signalling and Communications – Software for Railway Control and Protection system
10	PrEN50129	Railway application: Safety related electronic systems for signalling
11	EN 50159-1 & 2	Railway Application: Signalling and Communication Safety related communication in closed and open Transmission system
12	IRS: S TC-30	Underground Railway Jelly filled Quad Cables for S&T installations.
13	RDSO/SPN/TC/72	1.4mm dia Copper conductor 4/6 Quad cable
14	IRS S 99	Datalogger system
15	RDSO/SPN/165	SMPS based IPS.
16	IRS: S 86	Battery Charger-Self Regulating.
17	IRS: TC 41	PIJF Telephone Cable.
18	RDSO/SPN/144	Safety and Reliability Requirement of Electronic Signalling Equipment.
19	RDSO/S/20003	Drawing for Digital Axle Counter Reset Box with display (fascia)
20	RDSO/TM/05/10	Wheel for Inspection (Push) trolley
21	RDSO/S/20002	Drawing for Verification Box

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

4.0 **General Requirements:**

4.0.1 Single section digital Axle counter consists of axle detectors & associated electronics (1 or 2 or 3 or 4) confining a track section connected together by a transmission medium where transmission is in VF range. It is capable of counting axles, doing count comparison, finding direction of axle movement, supervision, relay drive and transmission of counts and health of axle detectors & field units.

4.0.2 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.

4.0.3 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.

4.0.4 Axle Counter shall use amplitude/phase change techniques or any other fail safe techniques for safe and reliable wheel detection functions.

4.0.5 Axle counter shall have arrangement so that wheels of push trolleys, dip lorry, rail dollies etc. are not counted by it. These wheels shall not result in axle counter going to error. Trolley protection track circuit shall not be required with phase detection. (RDSO drawing no. RDSO/TM/05/10 for push trolley).

4.0.6 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.

4.0.7 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 / 90R etc. Axle counter shall operate up to the **limit for wornout 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

4.0.8 Axle counter shall be suitable for train speeds up to 250 Km/h.

4.0.9 Axle counter system shall be designed for ease of maintainability and testability.

4.0.10 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.

4.0.11 The equipment 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.

4.0.12 Card wise failure indication shall be provided. It is desirable to give suitable indication of the nature of failure. Also total system failure and O.K. indications shall be provided.

4.0.13 Axle detector/Track Device & field units shall have no moving parts and shall require negligible maintenance.

4.0.14 The equipment 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.

4.0.15 The field unit shall be provided with testing, measuring and adjusting facilities for maintenance.

4.0.16 The equipment shall be fully solid-state using carefully chosen components of grade as per details given in SPN/144.

4.0.17 The system shall provide for continuous supervision of axle detector including the cable connecting the counting device and axle detector. Any defect in these shall be immediately detected, error code displayed and the system should go in error mode.

4.0.18 The maximum axle count, the axle counter can handle should be $\geq$ 1024.

4.0.19 Response time of train occupancy for any track section shall be less than 1.0 second.

4.0.20 Clearance time of any track section after train leaves the section shall be less than 2.5 sec.

4.0.21 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.

4.0.22 Environmentally, slight moisture condensation shall not lead to malfunction or failure of equipment.

4.0.23 The design of axle counter shall take into account switching transients that may occur either inside or outside the system and of any magnitude., up to and including interruption of full short circuit current.

4.0.24 Axle counter shall withstand the effect of lightning & surges incorporating lightning & surge protection as per RDSO/SPN/144.

4.0.25 The equipment shall conform to the Safety Integrity Level 4 as per CENELEC Standard.

4.0.26 The axle counter should not affect the operation of other wayside signalling equipments.

4.0.27 The axle counter shall neither affect or be affected by presence in vicinity of track side signalling equipments like AFTC, TPWS, AWS etc. 4.0.28 Error rate should not be more than 2 errors per million correctly counted axles, and if there is error, it should not result in unsafe condition.

4.0.29 The equipment shall be capable of simultaneously counting in and / or counting out from the ends of the monitored section.

4.0.30 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.

4.0.31 Axle counter should tolerate induced voltage of at least 150V AC, 50Hz on the quad cable. Any external surge protection device required to achieve this shall be part of SSDAC supply.

4.0.32 It shall fulfill fail safety requirements as per RDSO/SPN/144.

4.0.33 It shall fulfill the requirements of Signal Engineering Manual as per RDSO/SPN/144.

4.0.34 The software shall fulfil the software requirements as per RDSO/SPN/144.

4.0.35 Both hardware and software functions will be partitioned to ensure that integrity of certified design will not be compromised through routine software and hardware upgrades.

4.0.36 Design of axle counter will maximize the use of vendor independent implementations.

4.1 **Configuration:** Single section axle counter will work in following configurations:

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

4.1.2 Two detection points Single section: In straight line.

4.1.3 Three detection points Single section: In point zone.

4.1.4 Four detection points Single section: In point zone.

4.1.5 Three-detection points two sections and also scalable for consecutive sections in a straight line.

4.1.6 Use as High Availability SSDAC system (HA-SSDAC) (e.g. for BPAC applications): High availability system uses proven electronic circuits of standard SSDAC, duplicated on same board/card. This system also facilitates use of redundant communication channels by using quad/OFC to overcome common mode failures. System provides two vital relay outputs from two channels that are used in 'OR' mode to interface with interlocking/block circuits. System uses 'Auto-reset Feature' to reset the failed channel of system by correctly working channel under steady state conditions. Complete electronics of high availability SSDAC system is integrated in the same chassis of a standard single channel SSDAC. Interfaces for the operator still remains the same and he is required to manually reset the system only when both channels of the systems have failed. Single reset interface will send reset command to both the channels and the reset command is extended to electronic via drop contact of vital relay of concerned channel. The High Availability SSDAC system can be provided with

4.1.6.1 Single track sensor input fed to both channels of HA-SSDAC **(Annexure – I Drg:2012/SSDAC/001 sheet 1of 2 attached)**

4.1.6.2 Dual track sensor inputs fed to different channels of HA SSDAC**. (Annexure I Drg:2012/SSDAC/001 sheet 2 of 2 attached)**

4.1.7 The option [selection] of single track sensor/dual track sensor can be exercised by the ordering authority based on density of traffic and considering MTBF requirements.

4.2 Vital Relay Drive

4.2.1 Free and occupied indications of the axle counter section shall be available in the form of vital relay pick up and drop contacts.

4.2.2 For one detection point single section and two detection point single section configurations, each field unit shall drive its vital relay. The field unit of the common detection point mentioned in para 4.1.5 shall drive two relays of adjacent sections.

4.2.3 For three detection point single section and four detection point single section configuration, vital relay may be provided in any one of the field units.

4.2.4 The relay to be used is 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.

4.2.5 The design should incorporate fail safety feature such that when the vital relay is in drop 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.

Spark quenching arrangement should be provided across vital relay coil operated by the field unit.

4.3 Axle detector:

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

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

4. 3.3 Different frequencies shall be used for each set of TX/RX coils.

4.3.4 These shall be capable of withstan**ding environmental con**ditions given and specified later. The inductance of axle detectors shall not vary more than ±6% within the specified temperature range.

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

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

4.3.7 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 equipments and other electrical /electronic equipment in train /engine.

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

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

4.3.10 The length of inbuilt cable with Axle Detector shall be 5 / 10 / 15 Mtr. Only.

4.3.11 Only shielded cable is to be used to carry track device signal to field unit.

4.4 **Resetting:**

4.4.1 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:

4.4.1.1 Power fails and restores back

4.4.1.2 Voltage fluctuation beyond upper and lower limits

4.4.1.3 Removal of printed circuit cards from the system.

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

4.4.2 It shall be possible to reset each field unit from reset box only. For HA-SSDAC auto resetting module will send reset automatically if one channel only has failed.

4.4.3 If all the field units of an axle counter section are placed in the same station, same/one reset box can be used to reset all the field units of one section in parallel.

4.4.4 If any field unit of an axle counter section is placed in different station, then separate reset box shall be used for resetting that field unit.

4.4.5 If reset is applied to only one field unit, the axle counter section will not reset and will continue in occupied condition.

4.4.6 In two detection point single section and three detection point two section configuration, when reset is applied to both the field units the axle counter section should go in “preparatory reset mode”. The preparatory reset LED in both reset boxes should glow and reset counter should increment. The axle counter section will be still in **occupied state** although the axle counts of individual field units will become zero. The axle counter section will become clear only after more than one in count from one end and same number of out count from the other end have taken place. The common field unit in three detection point two section configuration shall accept reset command from two separate reset boxes for adjacent sections.

4.4.7 In one detection point single section, three detection point single section and in four detection point single section configuration, the reset command from reset

box will be transmitted only after verifying that verification switch have been pressed & turned in the verification box at site as a proof of the axle counter section being clear physically. On availability of reset command to all the field units of a section, the section will reset and show clear and reset counter should increment.

4.4.8 The reset box with LCD display should work from 24V DC supply. The following should be provided in the reset box (as per Reset Box drawing no. RDSO/S/ 20003.

4.4.8.1 A six-digit (min.) non-resettable type counter

4.4.8.2 Reset switch with key Reset push button – Red

4.4.8.3 Axle counter section clear indication (LED-10mm) –Green

4.4.8.4 Axle counter section occupied indication (LED-10mm)-Red

4.4.8.5 Power OK indication (LED-3mm)-Yellow

4.4.8.6 Preparatory state indication (LED-3mm) –Green

4.4.8.7 Line verification indication (LED-3mm)-Yellow

4.4.8.8 Reset box shall have provision for a data download port along with necessary memory to store last thousand events.

4.4.9 The possibility of reset will be as per table below. This shall be controlled by software:

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 started, 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

4.4.10 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.

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

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

4.4.13 Auto reset modules (either separate entity or inbuilt in the main reset module) shall be part of high availability SSDAC for both ends of a SSDAC system. Auto reset module will generate reset pulse whenever there is a steady state mismatch in VR/VPR's for more than 10 seconds of two channels of high availability system. Reset pulse will be connected to system in the field through drop contact of VR/VPR's of respective systems.

4.5 Digital Axle Counter field Unit.

4.5.1 It shall have 2 out of 2 architecture.

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

4.5.3 It shall determine the direction of passing of axles.

4.5.4 Provision should be there for lightning & surge protection in the field unit power supply input and communication line input/output.

4.5.5 The field units should be able to communicate with each other for transmission loss up to 30dB.

4.5.6 Suitable arrangements shall be made for providing electrical isolation between external relay circuit and internal circuit.

4.5.7 It shall have provision for setting unique address of each field unit. The address shall be of minimum 8 bits.

4.6 **Communication:**

4.6.1 It shall be possible to use copper cable or voice channel in optical fibre cable communication for transmission of data between field units. The copper cable will be quad cable as per IRS: TC: 30-2005 (0.9 mm dia) or quad cable as per RDSO/SPN/TC/72/2007 (1.4 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.

4.6.2 Impedance matching between communication channel and modem shall be provided.

4.6.3 It shall be capable of transmission of axle counts, health status and other information between connected field units 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 one 2-wire voice channel in case of OFC. The rate of transmission should be minimum1200 baud.

4.6.4 Fault tolerant telegrams shall be used for transmission of axle counts and other information between field units. 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.

4.6.5 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.

4.7 Earthing:

4.7.1 Provision of earthing should be there in the field unit and reset box. The earth terminal shall be suitable for taking upto 4mm dia. copper wire with lug.

4.8 Event Logger

4.8.1 Each field unit should be provided with in-built event logger.

4.8.2 The event logger should work automatically without any other input required to be given by staff.

4.8.3 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 nor change.

4.8.4 The event logger shall record events happening in the axle counter system.

4.8.5 The data registered in the event logger must be secured against erasing by unauthorized persons.

4.8.6 Event logged should be date/time stamped.

4.8.7 It should be possible to download logged events to a commercial computer through standard port.

4.8.8 The process of event logging and downloading of logged events should not hamper the normal working of axle counters in any manner.

4.8.9 The event logger shall record following events as the minimum:

4.8.9.1 Resetting of a track-section, field unit.

4.8.9.2 Failures/errors in field units.

4.8.9.3 Breakdown of communication link (s).

4.8.9.4 Change in relay status for section occupied / clear.

4.8.9.5 Changes in 5 V output of DC-DC converter beyond limits.

4.8.9.6 Change in date / time.

4.8.10 Provision should be there to log minimum 1000 events. In case of its memory becoming full, the event deletion should be on first in first out principle.

5. Diagnostics

5.1 Diagnostic system of the axle counter shall provide the following :-

5.1.1 Local and remote diagnostics and testing of system through a serial connection

5.1.2 Self-detection of errors and display through error codes and brief description in reset box through alphanumeric LED/LCD display. The same display should normally show in count / out count and software version no. when the system is switched on initially

5.2 Diagnostic information should not be considered vital.

5.3 Diagnostic functions shall be carried out on a permanent basis without disturbing normal operation of the equipment.

5.4 Information on the state of the equipment in failure mode and on operations performed by the staff shall be registered.

6. **Traction and supply**

6.1 Axle Counter system shall be capable of working in all sections including non-electrified, 25 kV 50 Hz AC, 1500 V DC & 750V DC electrified areas.

6.2 The axle counter should operate correctly under traction return currents of up to following magnitudes

6.2.1 25 kV / 50Hz 1000 A

6.2.2 1.5kV/dc 6000 A

6.2.3 750V/ dc 3000 A

6.3 The currents or their harmonics flowing in the rolling stock & rails shall not affect the digital axle counter.

6.4 The equipment shall be immune 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.

6.5 The electromagnetic brakes in its both on and off states should not affect the axle counter.

7. DC Input Power Supply:

7.1 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 of 50mV peak to peak/10 mV rms.

7.2 The power consumption in the equipment shall be low. It should be less than 1.0A for SSDAC and less than 1.25A for HA-SSDAC system having display for field unit at 24VDC (nominal).

7.3 There should be protection of over voltage, under voltage and polarity reversal.

8.0 Hardware Standards

8.1 Component types

8.1.1 The ICs used in the equipment shall be of industrial grade.

8.1.2 The discrete components like diodes, transistors, SCRs etc., should conform to HIREL program of CDIL or equivalent.

8.1.3 All resistors and rectifiers 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 tolerances not more than 5%. Tolerance of capacitors shall be as under:

Metallised Polycarbonate (MPCAR) : 5%

Polypropylene (PPSAR/PSAR) : 5%

Polystyrene (PFD) : 2%

Electrolytic : 20%.

8.1.4 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 uf.

8.1.5 Shielding at card level by providing a metallic plate over the cards.

8.1.6 Shielding at chassis/rack level.

8.1.7 Terminals provided for cable connections shall be of cage clamp type of Wago or Phoenix or any other reputed make.

8.1.8 Screw type couplers used for any connections shall be of MIL grade.

8.2 Printed Circuit Board

8.2.1 PCB material: Material for the PCB shall be copper clad glass epoxy of grade FR-4 or equivalent.

8.2.2 Outline Dimensions: PCBs shall be of standard Euro extended size.

8.2.3 Track Width: The track width shall be as per current industrial standards .

8.2.4 **Spacing between tracks**: Spacing between tracks shall be as per current industrial standards .

8.2.5 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..

8.2.6 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.

8.2.7 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.

8.2.8 **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 clamp, heat sink or other means are used for proper heat dissipation.

8.2.9 **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:

8.2.9.1 Humidity

8.2.9.2 Dust and dirt

8.2.9.3 Airborne contaminates like smoke and chemical vapours

8.2.9.4 Conducting particles like metal clips and filings

8.2.9.5 Accidental short circuit by dropped tools, fasteners etc

8.2.9.6 Abrasion damage and

8.2.9.7 Vibration and shock (to a certain extent)

8.2.10 **Burning in Test**

8.2.10.1 All the electronic components used in the equipment shall be subjected to "Burn-in" test for 48±1 hours at temperature of 65ºC. Record of failed components in this test should be maintained.

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

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

8.2.11.1 Component outline in the proximity of the component.

8.2.11.2 Manufacturer's name.

8.2.11.3 PCB name.

8.2.11.4 Equipment name.

8.2.11.5 Part number.

8.2.12 Following description shall be marked on the PCB:

8.2.12.1 The manufacturing serial number.

8.2.12.2 Month and year of manufacture.

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

8.2.14 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.

8.2.15 Housing Rack shall be as per RDSO/SPN/144.

9.0 Performance

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

9.2 Occurrence of any failure or error of operation in the axle counter component parts must not lead to any hazards. It may slowly result in transition to a safe state.

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

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

10.0 Inspections and Testing

10.1 General

10.1.1 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.

10.2 Type Approval

10.2.1 Initial Type Approval

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

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

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

10.2.1.1.3 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.

10.2.1.2 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.

10.2.2 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 10.3.

10.3 Type tests

10.3.1 The following shall comprise type tests:

10.3.1.1 Visual inspection (Cl.10.5.1)

10.3.1.2 Performance test (Cl.10.5.2)

10.3.1.3 Applied high voltage test (Cl.10.5.3)

10.3.1.4 Insulation resistance (Cl.10.5.4)

10.3.1.5 Climatic tests (Cl.10.5.5)

10.3.1.6 Shock tests (Cl. 10.5.6)

10.3.1.7 7 KV static discharge test (Cl. 10.5.7)

10.3.1.8 Vibration Test (Cl. 10.5.8)

10.3.1.9 Fail safety tests (Cl. 10.5.9)

10.3.1.10 The test for Software check–sum (Cl.10.5.11)

10.3.2 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, RDSO at their 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.

10.3.2 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.

10.3.4 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 RDSO.

10.4 Acceptance Test & Routine Test

10.4.1 Acceptance Test

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

10.4.1.1.1 Visual inspection (Cl.10.5.1)

10.4.1.1.2 Performance test (Cl.10.5.2)

10.4.1.1.3 Insulation resistance (Cl.10.5.4)

10.4.1.1.4 Records of Environmental Stress Screening Tests (ESS) (Cl. 10.5.10)

10.4.1.1.5 The test for Software check–sum (Cl.10.5.11)

10.4.1.2 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.

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

10.4.2 Routine test

10.4.2.1 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.

10.4.2.1.1 Visual inspection (Cl.10.5.1)

10.4.2.1.2 Performance test (Cl.10.5.2)

10.4.2.1.3 Insulation resistance (Cl.10.5.4)

10.4.2.1.4 Environmental Stress Screening Tests (ESS) (Cl. 10.5.10)

10.4.2.1.5 The test for Software check–sum (Cl.10.5.11)

10.5 Test Procedure

10.5.1 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.

10.5.2 Performance tests

10.5.2.1 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

10.5.2.2 System level checking

10.5.2.2.1 Constructional detail

10.5.2.2.2 Dimensional check

10.5.2.2.3 General workmanship

10.5.2.2.4 Configuration

10.5.2.2.5 Functional tests

10.5.2.3 Card level checking

10.5.2.3.1 PCB laminate thickness

10.5.2.3.2 Quality of soldering

10.5.2.3.3 General track layout

10.5.2.3.4 Conformal coating and shielding

10.5.2.3.5 Legend printing

10.5.2.3.6 Green masking

10.5.2.3.7 Mechanical polarization

10.5.2.3.8 General shielding arrangement of individual cards

10.5.2.3.9 Indication and display

10.5.2.3.10 Mounting and clamping of connectors

10.5.2.3.11 Proper housing of cards

10.5.3 Applied High voltage test

The equipment shall withstand for one minute without puncture and arcing at a test voltage of 2000 AC, r.m.s 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.

10.5.4 Insulation Resistance Test

10.5.4.1 This test shall be carried out:

10.5.4.1.1 Before the high voltage test

10.5.4.1.2 After the high voltage test

10.5.4.1.3 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.

10.5.5 Climatic Test

Climatic Test shall be done as per the sub clauses mentioned below. After completion of all the tests, high voltage test (**Clause 10.5.3**) & insulation resistance test (Clause 10.5.4) shall be repeated.

10.5.5.1 Change of Temperature Test:

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

10.5.5.1.2 The test severity shall be -

i) Lower Temperature: -10ºC ± 3ºC

ii) Higher Temperature: +70ºC ±2ºC

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.

10.5.5.2 Dry Heat test:

The equipment shall be tested as per IS-9000/Pt.III Sec. 5. The test severity shall be + 70 ± 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.

10.5.5.3 Cold test:

The equipment shall be tested as per IS-9000/Pt.II Sec. 3. The test severity shall be - 10 ± 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.

10.5.5.4 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.

10.5.5.5 Damp Heat Test (Steady state):

The equipment shall be tested as per IS-9000 / Pt.IV. The temperature shall be maintained + 40 ± 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.

10.5.5.6 Salt Mist Test:

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

10.5.5.7 Driving Rain Test (for Axle Detectors):

The unit shall be subjected to this test for 1 hr. as per IS: 9000 Pt. XVI 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.

10.5.5.8 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. Water head shall be 40 cms 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.

10.5.5.9 Dust Test:

The equipment shall be tested as per IS-9000 Pt. XII. 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 deg C ± 3 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.

10.5.6 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.	

10.5.7 7 KV Static Discharge Test:

10.5.7.1 The test shall be done as per RDSO/SPN/144.

10.5.8 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. After completion of the test the equipment shall be tested for its normal operation.
	Amplitude	0.35mm (0 to peak) or 5g	
	No. of axis	3	
	No. of sweep cycles	20 sweep cycle per axis	
	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	
	If resonance is observed, endurance tests at resonant frequency.	10 minutes at each resonant frequency	

10.5.9 Fail-safety test:

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

10.5.10 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.

10.5.10.1 Vibration Test

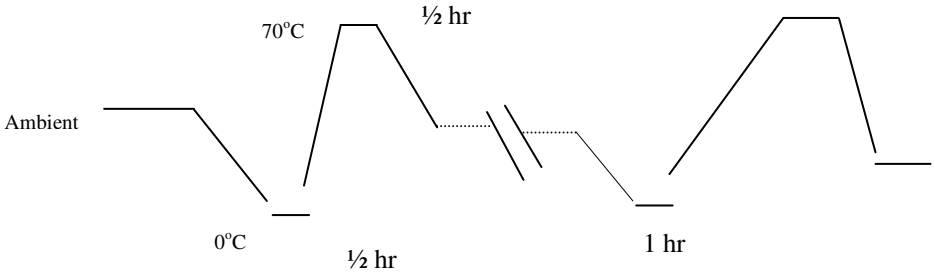
PCBs in unpacked condition shall be subjected to vibration test for 10 minutes at the resonant frequency/frequencies at 3.0 g minimum acceleration in the axis /axes perpendicular to the mounting of components. In addition to physical checks, the electrical parameters are also to be monitored after the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

10.5.10.2 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.

10.5.10.3 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 70ºC, ½ hour at each temperature for 9 cycles and 1 hour at each temperature for the 10^{th} 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 10ºC/minute.
In addition to physical checks, the electrical parameters are also to be monitored after this test.

10.5.10.4 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.

10.5.11 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.

11.0 Quality Assurance

11.1 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.

11.2 The equipment shall be manufactured as per quality assurance procedure laid down so as to meet the requirement of the specification.

11.3 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.

12.0 Marking and Identification

12.1 It shall conform to the clause on Marking given in RDSO/SPN/144.

12.2 Terminals, which are to be connected to track, power supply etc., shall be marked clearly.

12.3 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.

12.4 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.

12.5 Proper marking should be on Tx/Rx coil.

13.0 Packing

Packing shall be done to RDSO/SPN/144.

14.0 Warranty

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

15.0 Documentation

15.1 Documents shall be prepared to meet EN 50128 and EN 50129 requirements.

15.2 Safety case documents as per CENELEC standards for SIL-4 Railway Signalling to be submitted for type approval.

15.3 Guaranteed performance data, technical & other particulars of the equipment to be submitted for type approval.

15.4 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. Purchaser's Responsibility

16.1 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.

17. Supply of documents:

17.1 Two copies of the following shall be supplied during type approval and one copy each shall be supplied along with each equipment. Documents have to be approved by RDSO.

17.1.1 Instruction Manual.

17.1.2 Installation & maintenance manual including Dos & Don'ts.

17.1.3 Mechanical drawings of each sub-system/rack.

17.1.4 Schematic block diagram showing mounting arrangement of various components & details of each type of assembled PCB.

17.1.5 Trouble shooting procedures along with test voltages and waveforms at various test points in the PCBs.

17.1.6 Pre-commissioning checklist.

18. Item to be specified by Purchaser:

18.1 The configuration of which SSDAC's (by default 2 DP 1 section) are required.

18.2 The length of cable (5/10/15 m) required with each track device. Default length is 10m.

18.3 Supply option i.e.

18.3.1 Standard SSDAC or high availability SSDAC system using

18.3.1.1With Single track sensor device or

18.3.1.2 With Dual track sensor devices

19. **Tools for maintenance**:

19.1 The manufacturer shall indicate special maintenance instruments and tools like marking Jig for drilling & mounting of wheel sensors etc that may be necessary for proper adjustment and maintenance of equipment and supply these, if so required by the purchaser

…….

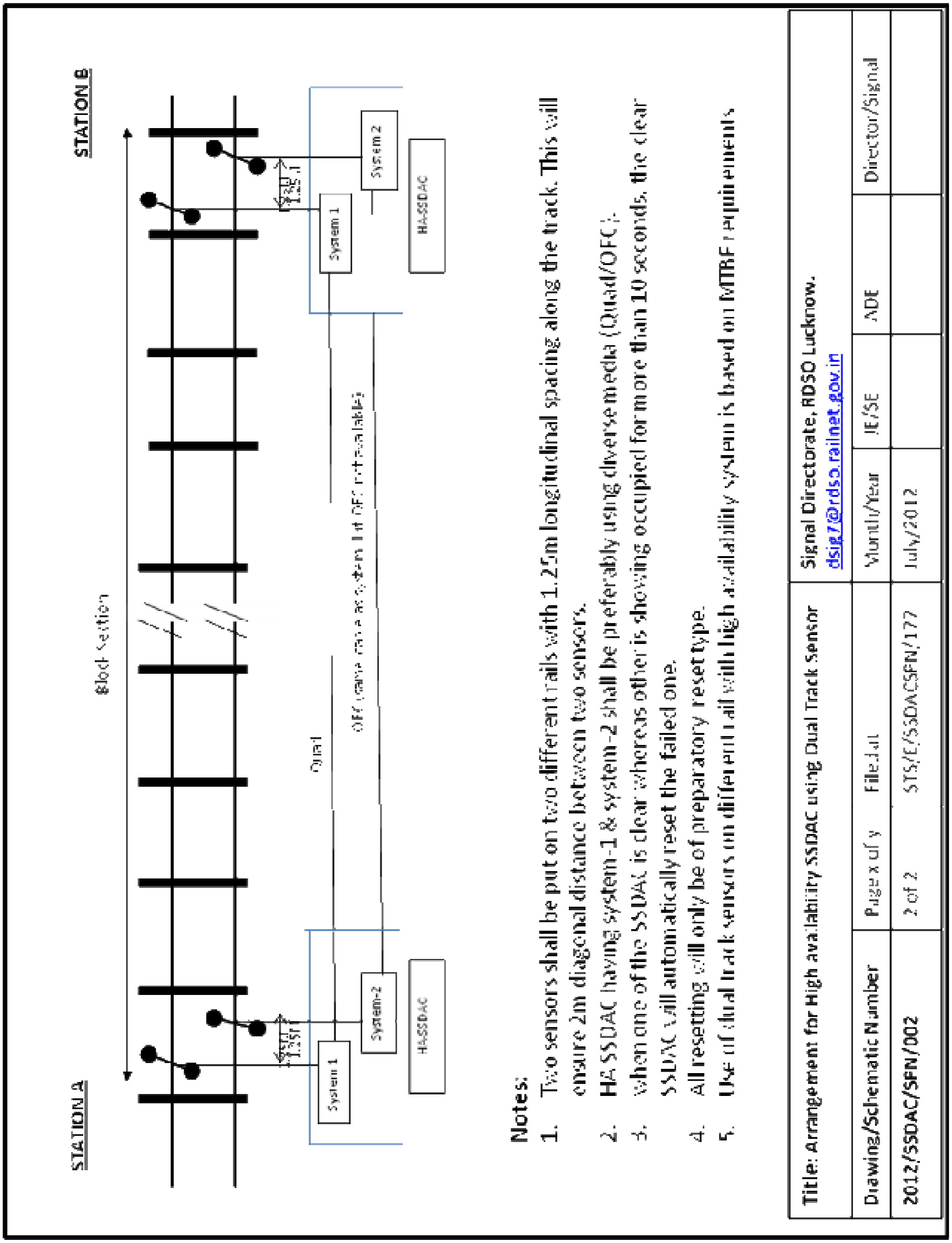
Annexure- I

Notes:

1. Sensors shall be put on any one of the rails (track). It should be ensured that sensor should preferably be deployed on the inner rail at the curvature of track for better reliability.
2. Communication from duplicated SSDAC modules shall be preferably using diverse media (Quad/OFC).
3. When one of the output is showing clear whereas other is showing occupied for more than 10 seconds, the unit/module showing clear will automatically reset the failed one. Reset arrangement shown in next sheet.
4. All resetting will only be of preparatory reset type.
5. A high availability SSDAC system having redundant modules i.e Processor card, Modem card & Relay Driver card within a single chassis is developed, details shall be advised once approved.
6. Maximum distance is actual circuit length (including tail cables length) between SSDAC units and not just the block section length.
7. SSDAC can work up to a maximum distance of 18 Kms on 0.9 mm quad cable and 28 Kms on 1.4 mm quad cable
8. Maximum circuit length of 18/28 Kms is based on a 30 dB max. attenuation limit @2 Khz.

Title: Arrangement for High availability SSDAC using single track sensor (for BPAC application)			Signal Directorate, RDSO Lucknow. dsig7@rdso.railnet.gov.in			
Drawing/Schematic Number	Page x of y	Filed at	Month/Year	JE/SE	ADE	Director/Signal
2012/SSDAC/SPN/001	1 of 2	STS/E/AC/SPN/177	July/2012			

Annexure – II


STATION A
STATION B
Block Section
System 1
System-2
System 2
HA-SSDAC
1.25m
Quad
Notes:
1. Two sensors shall be put on two different rails with 1.25m longitudinal spacing along the track. This will ensure 2m diagonal distance between two sensors.
2. HA SSDAC having system-1 & system-2 shall be preferably using diverse media (Quad/OFC).
3. when one of the SSDAC is clear whereas other is showing occupied for more than 10 seconds, the clear SSDAC will automatically reset the failed one.
4. All resetting will only be of preparatory reset type.
5. Use of dual track sensors on different rail with high availability system is based on MTRF requirements
Title: Arrangement for High availability SSDAC using Dual Track Sensor
Signal Directorate, RDSO Lucknow.
dsig7@rdso.railnet.gov.in
Drawing/Schematic Number
2012/SSDAC/SFN/002
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JE/SE
ADE
Director/Signal