

SAFETY AND RELIABILITY REQUIREMENT OF ELECTRONIC SIGNALLING EQUIPMENT

SPECIFICATION No. RDSO/ SPN/ 144/2006

(Draft)

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**SIGNAL DIRECTORATE
RESEARCH DESIGN & STANDARDS
ORGANISATION
LUCKNOW – 226 011**

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Abstract This document defines Safety and Reliability Requirement of Electronic Signalling Equipment.		

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NAME	ORGANIZATION	FUNCTION	LEVEL
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AMENDMENTS

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**GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)**

**INDIAN RAILWAY
STANDARD SPECIFICATION
FOR
SAFETY AND RELIABILITY REQUIREMENT OF
ELECTRONIC SIGNALLING EQUIPMENT**

(DRAFT)

Serial No. RDSO/ SPN/ 144/2006

0.0 FOREWORD

- 0.1 This specification is issued under the fixed serial no. RDSO/ SPN/ 144 followed by the year of original adoption as standard or in the case of revision, the year of last revision.
- 0.2 This specification requires reference to the following Indian Railway Standards specification (IRS) and Indian Standards Specification (IS). It shall also be complied to the extent applicable.
- (i) IRS: S 96 for DC-DC converters.
 - (ii) IRS: S 88 for Low maintenance Lead Acid Batteries.
 - (iii) IRS: S 93 for Valve Regulated Lead Acid Batteries.
 - (iv) IRS: S 86 for battery chargers.
 - (v) IS: 9000 for Basic Environmental Testing procedure for electronic and electrical items.
 - (vi) IS: 9001 Guidance for Environmental Testing.

- (vii) IS: 2147 for Degrees of protection provided by enclosure for low voltage switch gear and control gear.
 - (viii) IEC: 947/7/1 terminal blocks for copper conductors.
- 0.3 Whenever in this specification, any of the above mentioned specifications are referred to by number only without mentioning the year of issue, the latest issue of that specification is implied, otherwise particular issue referred to is meant.
- 0.4 This specification is intended chiefly to cover the technical provisions and does not include all the necessary provisions of a contract.

1.0 SCOPE

- 1.1 This specification covers the **reliability and safety requirements for electronic (including microprocessor / micro-controller/ processor based) fail safe signalling equipment.**
- 1.2 This specification shall be read with the main specification of the equipment.
- 1.3 Any special requirement specified in the main specification of the equipment shall override the requirements laid down in this specification.

2.0 GENERAL

- 2.1 The equipment shall be manufactured as per best engineering practices.
- 2.2 The cabinet shall be powder coated and good aesthetic appearance. It shall conform to **IP-31** class of protection as specified in table-I of IS: 2147.
- 2.3 The power portion of the equipment shall be clearly isolated and protected to prevent accidental contact.
- 2.4 **All non-current carrying metals parts including shields and screens shall be bonded together and earthed.** An earth terminal suitable for taking upto 4 mm dia copper wire shall be provided. The earth terminal shall be indicated by letter 'E'. Maximum earth resistance shall be 2 ohms.
- 2.5 Outsourcing, if any, of any sub-modules or PCB shall be indicated in the 'Quality Assurance Plan' and approval of RDSO, Lucknow shall be obtained. Any outsourcing of safety related sub-module or PCB shall be from ISO-9001 or ISO-9002 certified manufacturers only.

2.6 Necessary provision shall be made in the hardware and software for modular expansion of the equipment.

2.7 Version Control:

2.7.1 The version number of any equipment shall be as per the format given below:

DXXSXXXHXX

DXX	SXXX	HXX
Basic Design	Software	Hardware
D: Design, S: Software, H: Hardware		
XX and XXX are numeric two and three digit numbers respectively.		
Thus the initial version of any equipment will be D01S001H01 .		
In every case of modification/ upgradation/ improvement of Basic Design, DXX will increment by one.		
In every case of modification/ upgradation/ improvement of system Software (executive software), SXXX will increment by one.		
In every case of modification/ upgradation/ improvement of Hardware, HXX will increment by one.		

2.7.2 **Version number** shall be engraved on each **printed circuit board** and will also be displayed in the name plate of the equipment.

2.7.3 The **software version number** shall appear on the LCD display board immediately after power ON and shall be displayed for **10 seconds**. The system shall display version number of the software for 10 seconds either by giving suitable command or by pressing a button.

2.7.4 Each document/ manual of the manufacturer shall contain the **history** of the changes in version along with accompanying changes in the manual, if any.

2.7.5 Signalling equipments which do not have any embedded software shall follow the following format for version number.

DXXHXX

DXX	HXX
Basic Design Change	Hardware Change
D: Design, H: Hardware XX are numeric two digit numbers.	
Thus the initial version of any equipment will be D01H01 .	
In every case of modification/ upgradation/ improvement of Basic Design, DXX will increment by one.	
In every case of modification/ upgradation/ improvement of Hardware, HXX will increment by one.	

2.8 Change of system software

2.8.1 The **system software** and **application software** shall be stored in **separate EPROMs**.

2.8.2 Any supply or installation of modified/ upgraded / improved system software by a firm for an equipment shall only be done with prior approval of Signal Directorate of RDSO, Lucknow. RDSO, while approving the upgraded/ modified/ improved software with new version number, shall verify the checksum of the system software as given by the manufacturer and indicate the same along with version number of the equipment.

2.8.3 The Director (Q.A.)/ S&T will check the version number and also the checksum of new version of the software before passing the same in the acceptance test.

2.8.4 Version number and checksum of new version shall form part of acceptance and routine tests also.

2.8.5 After the acceptance test by Director (Q.A.)/ S&T, stickers with software version no. will be stuck/ pasted on the EPROMs. In case EPROMs carrying new software version are to be supplied separately for replacing in already supplied equipment, these will be sealed in a proper package and stamped with RDSO's seal and stamp before the same are dispatched to the consignee for installation. The version number and the checksum will be clearly typed or written on the sealed cover and signed by the inspecting authority.

2.8.6 Firms shall supply and install only the latest approved version of the equipment and software.

3.0 REQUIREMENTS OF SIGNAL ENGINEERING MANUAL

The equipment and its accessories shall comply with the requirements pertaining to signalling circuits using electronic equipment as laid down in Signal Engineering Manual (Para 7.121 to 7.130) which is reproduced below:

- 3.1 **Component failure shall be self-detecting by way of causing a signal to display a most restrictive aspect as far as practicable.**
- 3.2 Failure of components which are not self-detecting shall not cause any **unsafe** failure of the equipment. Even simultaneous failures in different components which are not self-detecting shall not cause any unsafe failure of the equipment.
- 3.3 **All fail-safe circuits shall work on continuous energisation principle** such that open circuits in wiring, relay contacts, etc., or loss of power supply shall not cause unsafe conditions.
- 3.4 **Common return shall not be used for vital circuits.** In vital circuits, the final stage shall use **fail-safe signalling relays**. A transformer isolation shall be provided between the final stage fail-safe signalling relay and the electronic device preceding it. The DC power supply shall not have any galvanic connection with the coil of the final stage signalling relay.
- 3.5 All electronic equipment shall have a Mean Time Between Failures (MTBF) as specified in the relevant equipment specification. Duplication of components and parts of equipment or modules may be resorted to for improvement of the reliability where necessary. Where components / parts modules are duplicated, it is desirable that provision may be made for cross checking the performance of one set by the other set and vice-versa.
- 3.6 Due consideration shall be given to the effects of faults in fail-safe electronic equipment to allow **open or short circuit or earthing** conditions and variation in component values due to ageing, replacement of faulty component with new components of specified tolerance, etc.. Safety shall not be impaired as a result of multi-terminal devices failing - either open

circuit, short circuit or with partial short circuit between any pair of terminals or earthing.

- 3.7 Special care shall be taken in the design of amplifier circuit to eliminate the possibility of self-oscillation. It is desirable that loss of safety requirements is not caused should the amplifier go into self-oscillation due to any unforeseen contingency.
- 3.8 Where specific frequencies are used for safety circuits, particular care shall be taken to ensure that the frequency generating equipment is producing only the **desired frequency signal**. Verification shall be carried out using passive tuned filters in series with each frequency source.
- 3.9 The physical construction of fail-safe equipment shall be designed to eliminate the possibility of **external objects** causing short circuits between combinations of terminals in vital circuits. This may be achieved for example, by adequate separation of terminals and by the fitting of protective shrouds where necessary.
- 3.10 For the consideration of the fail-safe feature of an electronic safety signalling device, failure of one component for all the modes of probable faults indicated in paragraph 3.6, one at a time shall be considered. If the failure of the component under examination is not self-detecting, then simultaneous failure of other associated components shall be considered.

4.0 FAIL-SAFETY REQUIREMENT

- 4.1 The system shall be designed on fail safe principles. In case of any failure whether in the hardware, software or any part of the equipment, the system and the equipments controlled by it should fail on the safe side and the system should change over to a **more restrictive state**.
- 4.2 **No single failure shall result in an unsafe condition** i.e. the system shall be brought to a safe state as soon as a failure occurs.
- 4.3 It must be ensured that if a failure of equipment occurs which by itself does not result in unsafe condition, but which in combination with a second or subsequent failure could result in an unsafe condition, then the design of the equipment must be such that the first failure is detected and negated. The probability of occurrence of a second failure, while the first failure has not been detected and negated, should be negligible so that mean time between wrong side failures (**MTBWSF**) is more than **10⁹** hours.

- 4.4 The design of the equipment shall cater for detection and restoration of system to a safer state in case of following faults if these are likely to result in unsafe condition:
- (i) **Variation in power supply** beyond its tolerance limits including its momentary or prolonged failure;
 - (ii) **Spikes** in the power supply system, stray fields caused by traction vehicles or standby diesel generator sets;
 - (iii) **Insertion of PCBs in wrong card slots;**
 - (iv) **Earthing of any component or wire** or a combination of such earthing faults; and
 - (v) **Broken wires, damaged or dirty contacts, failure of a component to energise, loss of power supply or blown fuses** etc.
- 4.5 The equipment shall be so constructed as to prevent unauthorized access.
- 4.6 Whenever power of the equipment is switched on, the equipment should wait for a **manual system reset** before assuming normal operational mode.
- 4.7 System reset arrangement shall be provided as specified in relevant specification. Manual reset switch, if provided, must have an **non-resettable electro-mechanical counter** which should be incremented every time a reset operation is performed. System reset switch must have a locking arrangement to prevent unauthorised operation.
- 4.8 All vital relays, including the safe shutdown relays, shall be of approved type for use in railway signalling.

5.0 HARDWARE

5.1 COMPONENT TYPES

- 5.1.1 ICs and other components used in the equipment shall be of such grade that these can work satisfactorily in **-40⁰ to +85⁰ C temperature** range. Capacitors used should be certified for atleast **+105 deg. C**. Source of procurement of components shall be given in the Quality Assurance Plan.
- 5.1.2 Discrete components like diodes, transistors, SCRs etc. should conform to HIREL program of CDIL or equivalent.

5.1.3 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%. Tolerances of capacitors shall be as under:

Metallised polycarbonate (MPCAR)-	5%
Polypropylene (PPSAR/ PSAR)	- 5%
Polysterine (PFD)	- 2%
Electrolytic	- 20%

5.1.4 Where ICs are used, all power supplies on cards should be locally decoupled using a capacitor with good high frequency characteristics. The value of chip decoupler ceramic capacitor shall be 0.1 to 1 μ F. The value of board decoupler electrolytic capacitor shall be 10 to 100 μ F placed near to where power supply enters PC board.

5.2 PROTECTION AGAINST ELECTROMAGNETIC INTERFERENCE

To protect against the **electromagnetic interference**, at least the following two levels of shielding should be provided:

- (i) **Shielding** at card level by providing a metallic plate over the cards;
- (ii) Shielding at chassis/ rack level.

5.3 DIAGNOSTIC FACILITY

In case of microprocessor based equipment, the system shall be provided with a **front-panel alpha numeric LED/ LCD display unit** indicating various failures. The **error code** should indicate type of the failure.

5.3.1 A **trouble-shooting chart** should be provided indicating the action required to be taken for repair of the equipment corresponding to each error code.

5.3.2 **Audiovisual alarm** shall be provided to indicate failure. The audio alarm should stop when acknowledged but the visual alarm should continue till the fault is rectified.

5.3.3 If required by the purchaser, **data logging facilities** shall be provided as per IRS: S-99 for on-line storage of data. It should be possible to retrieve the logged data either on the VDU terminal or as a hard copy on a printer

5.4 HOUSING RACK

- 5.4.1 **19 " rack** mountable and 3/4/6U high cabinets made of aluminum of minimum thickness 2mm shall be used for housing the PCB cards. The cabinet shall be powder coated. The front & back sides of the cabinets shall have facility for completely locking the equipment. The rack should have provision for natural ventilation. If required, provision for forced cooling shall be made.
- 5.4.2 **Connectors from WAGO, PHOENIX** or any other firm recommended by RDSO and confirming to IEC: 947/7/1 shall be provided. This should include signaling inputs/output, data input/output and power supply connections with in-built arrangement for connecting fuses where required.
- 5.4.3 The equipment shall be housed in a rack with a **transparent front panel**. The rack shall have provision for natural ventilation. Ventilation openings shall be louvers of less than 3mm size covered with wire mesh for protection against entry of rodents, lizards etc. The protection shall conform to IP-31 type protection as specified in table 1 of specification NO. IS: 2147.
- 5.4.4 **Rack shall be earthed.**
- 5.4.5 The layout of the components and wiring shall be such that all parts are easily accessible for inspection, repairs and replacement.
- 5.4.6 The AC input portion shall be clearly isolated and protected to prevent accidental contact.
- 5.4.7 Dummy slots for inserting spare PCBs shall be provided if space is available in the rack.

6.0 PRINTED CIRCUIT BOARD

- 6.1 **PCB MATERIAL:** Material for the printed circuit board shall be copper clad glass epoxy of grade FR-4 or equivalent. PCB shall normally be of standard size (e.g.3/4/6U).
- 6.2 **OUTLINE DIMENSIONS:** PCBs shall be of standard size.
- 6.3 **BOARD THICKNESS:** The thickness of PCB cards and motherboard shall be as per currently available technology. There should be no deformity in the PCB cards or the motherboard due to mounting of heavy components or due to ageing effect.

- 6.4 TRACK WIDTH: The track width shall be 0.5 mm nominal. In no case it should be less than 0.3 mm. Lesser width for use of SMD technology may be considered.
- 6.5 SPACING BETWEEN TRACKS: Spacing between tracks shall be 0.5mm nominal and in no case it shall be less than 0.3 mm. Lesser spacing for use of SMD technology may be considered.
- 6.6 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 piggy-back 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.
- 6.7 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.
- 6.8 CONFORMAL COATINGS: Assembled & tested printed boards 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:
- (a) Humidity;
 - (b) Dust and dirt;
 - (c) Airborne contaminants like smoke and chemical vapours;
 - (d) Conducting particles like metal clips and filings;
 - (e) Accidental short circuit by dropped tools, fasteners etc.;
 - (f) Abrasion damage and
 - (g) Vibration and shock (to a certain extent).
- 6.9 The solder masks shall be applied on the solder side and component side of the card.
- 6.10 Following description shall be etched on the component side of the PCB:
- (i) Component outline in the proximity of the component.
 - (ii) Manufacturer's name.

(iii) PCB name.

(iv) Equipment name.

(v) Part number.

6.11 Following description shall be engraved on the PCB

(i) The manufacturing serial number.

(ii) Month and year of manufacture.

(iii) Version number.

6.12 Printed circuit cards shall be fitted with gold plated Euro/ D type plug in connectors with locking arrangement. Mechanical arrangements 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 PCBs.

6.13 HEAT DISSIPATING COMPONENTS: All components dissipating 3W or more power shall be mounted so that its body is not in contact with the board unless a clamp, heat sink or other means are used for proper heat dissipation.

6.14 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.

7.0 SOFTWARE REQUIREMENTS

7.1 Software should be written in **structured format**. It should be developed in such a way that it is possible to test and validate each module independently.

7.2 The software shall be such that in case of variable data, the possibility of using incorrect data does not exist. Further, the software should check and reject –

- (a) Use of data which is obsolete or meant for some earlier state of the system, and
 - (b) Corruption of the data.
- 7.3 As far as possible, program flow should be independent of the input data. The program should preferably execute the same sequence of instructions in each cycle.

7.4 The use of interrupts should be kept to a bare minimum.

7.5 SELF CHECK PROCEDURES

Software should include self check procedures to detect faults in the hardware. The self check should include the following procedures:

- (i) Memory containing the vital software and data should be checked periodically so that probability of corrupted software jeopardizing the safety of the equipment is minimized.
 - (ii) Components of the CPU, such as general purpose registers, program counters, stack pointers, instruction register, instruction decoder, ALU, etc., should be checked periodically as far as practicable.
- 7.6 Self check of the associated functional hardware as required by the hardware design should be performed periodically.
- 7.7 Critical and non-critical software should be segregated in the memory area so that special procedures to check the program flow may be adopted during the self check process for the critical software.

8.0 TRANSMISSION OF SIGNALLING INFORMATION

In the systems requiring transmission of vital safety information, the following requirements shall be fulfilled:

- 8.1 It shall be possible to transmit the safety information over commercial voice channels / cables through use of proper multiplexers, unless other modes of transmission are specified by the purchaser.
- 8.2 The transmission protocol shall ensure required integrity of safety related information irrespective of transmission medium.

- 8.3 The overall system design must ensure that if the transmission link becomes inactive for more than a specified period, the safety information drain (user) will assume a restrictive and fail-safe state.
- 8.4 For systems relying on error prevention, all transmission equipment such as filters and amplifiers must be designated to meet specified fail safety standards.
- 8.5 Errors introduced or not detected at a given level in the transmission system must be detected at higher levels. Error detection methods used at any level must take into account the characteristics of the lower levels.
- 8.6 Error detection techniques should permit the use of standard telecommunication technology, which offers much more economic solutions than the special hardware needed to implement error prevention techniques.
- 8.7 Error detecting coding should not form the sole means of protection of transmitted information, but should be combined with other methods such as higher level procedures and protocols, and hardware redundancy or diversity.
- 8.8 Forward error correcting coding should not be used unless precautions are taken at the higher level to prevent invalid corrections from being accepted at the higher level.

9.0 ENVIRONMENTAL/ CLIMATIC REQUIREMENTS

- 9.1 The equipment shall be capable of working in non-air conditioned environment in the field.
- 9.2 The equipment shall be suitable for installation on AC/ DC electrified and non-electrified sections. It shall be suitable in all areas including where locomotives having thyristor controlled single phase or 3-phase induction motors haul passenger or freight trains and where chopper controlled EMU stocks are operated.

Repetition
Parity Bits
Checksums
CRC
Hash

If Error Detected,
ARQ or
ECC / FEC

9.3 The equipment shall meet the following climatic and environmental requirements:

S. No	Test		Reference	Electronic Equipment				
				Indoor	Out-door		On board	
					On Track	Track side	Inside Cab	Outside Cab
1.	Change of temp test		IS 9000 Part XIV Sect. II	Yes	Yes	Yes	Yes	Yes
	Low temp	-10°C ± 3°C						
	High temp	+70°C ± 2°C						
	Rate of change in temperature	1°C / min						
	Duration	7hrs at each temp. - 10°C & +70°C						
	Cycle	3						
	Condition	Fully functional during test						

S. No	Test		Reference	Electronic Equipment				
				Indoor	Out-door		On board	
					On Track	Track side	Inside Cab	Outside Cab
2.	Dry heat test		IEC-571; IS:9000 Part-III Sect 3	Yes	Yes	Yes	Yes	Yes
	Temp	+70°C						
	Duration	16 hrs						
	Condition	Fully functional during test						
3.	Cold test		IS 9000 Part II Sect. III	Yes	Yes	Yes	Yes	Yes
	Temp	-10°C ± 3°C						
	Duration	2 hours						
	Condition	Fully functional during test.						
4.	Damp heat test (Cyclic)		IS 9000 Part V Sect. 2 Variant 1	Yes	Yes	Yes	Yes	Yes
	Upper temp	40°C ± 2°C						
	Humidity	95% (+1%, -5%)						
	Cycles	6						
	Condition	Fully functional during one hour period towards end of each cycle. Stabilization shall be done at 25°C ± 3°C						
5.	Damp heat test (Steady state storage)		IS 9000 Part IV	Yes	Yes	Yes	Yes	Yes
	Temp	40°C ± 2°C						
	Humidity	93% (+2% , -3%)						
	Severity	4 days						
	Condition	Fully functional during test.						

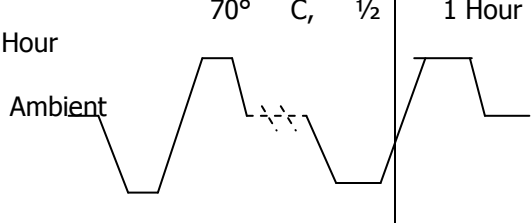
S. No	Test		Reference	Electronic Equipment				
				Indoor	Out-door		On board	
					On Track	Track side	Inside Cab	Outside Cab
6.	Salt mist test		IS 9000 Part XI procedure 3	Yes Procedu re 3	Yes Proce- dure 2	Yes Proce- dure 2	Yes Proce- dure 3	Yes Proce- dure 2
	Mist + Damp heat	Procedure 2: 2 hours + 7 days Procedure 3: 2 hours + 22 hours						
	Temp	35° ± 3° C						
	Humidity	93% (+2%, -3%)						
	Hours	22						
	Cycle	3						
	Condition	After this test, electrical parameters shall be monitored in addition to physical checks.						
7.	Dust test		IS 9000 Part XII	Yes	Yes	Yes	Yes	Yes
	Duration	1hour						
	Condition	After this test, electrical parameters shall be monitored in addition to physical checks.						
8.	Water Immersion test		IS 9000 Part XV Sect. 7	No	Yes	No	No	No
	Head of water	0.4 m						
	Duration	24 hours						

S. No	Test		Reference	Electronic Equipment				
				Indoor	Out-door		On board	
					On Track	Track side	Inside Cab	Outside Cab
	Condition	After this test, electrical parameters shall be monitored in addition to physical checks (Ingress of water).						
9	Driving Rain test		IS 9000 Part XVI Test condition 'c'	No	Yes	No	No	Yes
	Water spray for 1 hour							
	Condition	After this test, electrical parameters shall be monitored in addition to physical checks.						
10	Bump test		IS 9000 Part VII, Sec. 2	Yes	Yes	Yes	Yes	Yes
	PCBs/Modules/units in packed condition shall be subjected to bump test as under:							
	No of bumps	1000						
	Peak acceleration	400 m/s ²						
	Pulse duration	6 ms						
	No of axes	3						
	Condition	After this test, electrical parameters shall be monitored in addition to physical checks.						

S. No	Test		Reference	Electronic Equipment					
				Indoor	Out-door		On board		
					On Track	Track side	Inside Cab	Outside Cab	
11	Shock test (to simulate the effect of shunting shock)		IS 9000 Part VII Sec. 1	No	Yes Severity 2	Yes Severity 1	Yes Severity 1	Yes Severity 1	
	Severity 1: The equipment in operation shall be subjected for 2 minutes to 50 Hz vibration of such nature that the maximum acceleration is equal to 30 m/s ² (amplitude a=0.3 mm). At the end of the test, the assembly shall be subjected to performance test as specified in relevant specification.								
	Severity 2: 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.		IS 9000 Part VII Sec. 1 Clause 9						
12	Vibration test		TEC (IPT 1001A- revised)	Yes	Yes	Yes	Yes	Yes	
		Up to & including 75 Kgs. weight							Over 75 Kgs.
	Freq. Range	05-350 Hz							5-150 Hz

S. No	Test		Reference	Electronic Equipment				
				Indoor	Out-door		On board	
					On Track	Track side	Inside Cab	Outside Cab
	Amplitude	± 6 mm constant displacement or 15m/Sec. ² constant acceleration.	± 6 mm constant displacement or 15m/Sec. ² constant acceleration.					
	No. of axes	3	3					
	No of sweep cycle	20	10					
	Total duration	105 min	105 min					
	If resonance is observed	10 min at each resonant freq.	10 min at each resonant freq.					
	Condition	After this test, electrical parameters shall be monitored in addition to physical checks.						

S. No	Test	Reference	Electronic Equipment				
			Indoor	Out-door		On board	
				On Track	Track side	Inside Cab	Outside Cab
13.	<p>Environmental Stress Screening tests (ESS) for Printed Circuit Boards (PCB) & sub systems</p> <p><i>(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.)</i></p>		Yes	Yes	Yes	Yes	Yes
13.1	<p>Thermal cycling</p> <p>The PCBs shall be subjected to thermal cycling as per the procedure given below.</p> <p>The assembled boards are to be subjected to rapid temperature cycling as mentioned below in the power off condition.</p>		Yes	Yes	Yes	Yes	Yes
	<p>❖ This temperature cycling from 0° C to 70°C, ½ Hours at each temperature for 9 cycles and 1 hour at each temp. 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.</p>						

	<p>Hour</p>  <p>70° C, 1/2</p> <p>1 Hour</p> <p>Ambient</p> <p>r</p> <p>0° C, 1/2 Hour</p> <ul style="list-style-type: none"> ❖ The rate of rise / fall of temp. shall be minimum 10° C per minute. ❖ In addition to physical checks, the electrical parameters are also to be monitored after this test. 						
13.2	Power cycling: The power supply modules shall be subjected to 60 ON-OFF cycles for 1 hour. The ON-OFF switch usually provided in the modules may not be used for this purpose.		Yes	Yes	Yes	Yes	Yes

9.4 The system operation and its safety should not be affected by EMI encountered in 25 KV AC electrified areas. For those outdoor equipment which are used in 25 KV AC electrified areas and whose working is susceptible to the effect of electrostatic and electromagnetic induction, the following tests may be performed as given in relevant specification.

9.4.1 One sample of the test equipment shall be subjected to **static discharge** test of 7 KV AC. Methodology of test is given below:

- a) The equipment shall be functional and the chassis of the equipment shall be firmly grounded.
- b) A charged capacitor of 7 KV should be discharged by touching the chassis by testing probe through 330Ω resistance and 150 pF capacitor.
- c) The above discharge test should be repeated minimum 3 times.
- d) After completion of the test, the equipment shall be able to continue its normal operation.
- e) If given in the relevant specification, the discharge test should be carried out on individual card/ module also.

For conducting 7 KV static discharge test, the NSG 200 Interference Simulator equipment with plug-in NSG 222 module or its equivalent equipment may be used.

- 9.4.2 Pantograph Interference Test: One prototype of the equipment shall be installed in the actual field condition in AC electrified traction area. An AC electric loco shall be placed in a position on the track such that distance between nearest face of the equipment and point of catenary where pantograph is touching, is about 4.0 meters.

The equipment shall be tested for its normal working during raising and lowering of the pantograph. This test will be repeated for sufficient number of times. The equipment will be tested for its normal operation after completion of the test.

- 9.5 Insulation Resistance Test: This test shall be carried out –

- (a) Before the high voltage test
- (b) After the high voltage test
- (c) After completion of the climatic test

There shall be no appreciable change (value more than 10 Mega ohms and variation within 10%) 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 40⁰ C and relative humidity 60%. The measurement shall be made at a potential of 500V DC.

- 9.6 Applied High Voltage Test: The equipment shall withstand for one minute without puncture and arcing a test voltage of 2000 volts rms applied between:

- (a) AC line terminals and earth
- (b) DC line terminals and earth

The test voltage shall be alternating of approximately sinusoidal wave form of any frequency between 50 Hz. and 100 Hz. Printed circuit cards shall be removed.

10.0 POWER SUPPLY REQUIREMENTS

- 10.1 The equipment shall work on nominal voltage **24V DC** (+20%, -30%) power supply or as specified in the relevant equipment specification or as approved by the purchaser.
- 10.2 Where separate **DC-DC converters** are used to derive the required DC voltages from the DC main input, these should conform to IRS specification no. IRS: S-96 for axle counter.
- 10.3 The battery shall be used in **float charge mode** from the AC mains at 230V. The battery charger shall be of low ripple voltage output type as specified in IRS: S-86 for axle counter.
- 10.4 A **surge suppresser** shall be provided in the battery charger to protect against transient voltages, spikes etc.

11.0 LIGHTNING AND SURGE PROTECTION FOR ELECTRONIC SIGNALLING EQUIPMENTS

- 11.1 The equipment shall be suitably protected against atmospheric voltage surges both for common mode (voltage that appears between phase conductors and earth) and differential mode (voltage that appears between neutral & earth) in order to limit the harmful effects of lightning.
- 11.2 The IEC standards 61312, 61024, 61643, **62305** and VDE 0100-534 pertaining to protection against lightning and surges shall apply for all electronic equipment to withstand static electricity, electric fast transient and surge voltage.

IEC 60364

Earthing

Arrangements

TT

TN -C -S

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The power line of electronic signalling equipment shall have Class B & C type 2-stage protection in **TT configuration**. **Stage 3 protection** is also required for protection of power/signalling/data lines. Class B & class C type protection devices shall preferably be pluggable type to facilitate easy replacement.

11.3 Stage 1 Protection (Power line protection at Distribution Level)

The protection of class 'B' type, against Lightning Electromagnetic Pulse (LEMP) & other high surges shall be provided at the power distribution panel. Wherever available, the modules shall have an indication function to indicate the prospective life and failure mode to facilitate the replacement of failed SPDs. The device shall be spark gap type and certified as per the VDE 0675 A1/A2 & IEC 61643. It shall be provided

with a 63 Amp fuse in phase line. The protection shall be in compliance of IEC 61312, IEC 61024 & VDE 0100-534 with the following characteristics:

SN	Parameters	Limits	
		Line & Neutral	Neutral & Earth
1	Nominal Voltage (U_0)	230V	230V
2	Maximum continuous operating voltage (U_c)	$\geq 255V$	$\geq 255V$
3	Lightning Impulse current between R, Y, B & N (I_{mp})	$\geq 50KA$, 10/350 μs for each phase	--
4	Lightning Impulse current between N & E (I_{mp})	--	$\geq 100KA$, 10/350 μs
5	Response time (T_r)	≤ 100 ñs	≤ 100 ñs
6	Voltage protection level (U_p) between L & N	/	/
7	Voltage protection level (U_p) N & PE	/	/
8	Short circuit withstand and follow up current extinguishing capacity without back up fuse (I_{sc})		
9	Operating temperature / RH	95%	95%
10	Mounted on		

11.4 **Stage 2 Protection (Power line protection at Equipment Level)**

The protection of class 'C' type against low voltage surges shall be provided at the equipment input level connected between line & neutral. This shall have an indication function to indicate the prospective life and failure mode to facilitate the replacement of failed SPDs. This shall be thermal disconnecting type and equipped with potential free contact for remote monitoring. The device shall be a single compact varistor of proper rating and in no case a number of varistors shall be provided in parallel. This protection shall be in compliance of IEC 61643-12, 61312 & 61024 and VDE 0100-534 with the following characteristics:

SN	Parameters	Limits
1	Nominal Voltage (U_0)	230V
2	Maximum continuous operating voltage (U_c)	$\geq 300V$
3	Nominal discharge current between R, Y, B & N (I_n)	$\geq 10KA$, 8/20 μs for each phase
4	Maximum discharge current between L & N (I_{max})	$\geq 40KA$, 8/20 μs
5	Response time (T_r)	≤ 25 ñs
6	Voltage protection level (U_p) at I_n	≤ 1.6 KV
7	Operating temperature / RH	95%
8	Mounted on	

11.5 **Stage 3 protection (Protection for Power /signalling / data lines)**

All external Power/signalling/data lines (AC/DC) shall be protected by using preferably pluggable stage 3 surge protection devices which consists of a combination of varistors/suppressor diodes and GD tube with voltage and current limiting facilities.

11.5.1 Power line Protection (Class D)

The device for power line protection shall be of Class D type. This shall have an indication function to indicate the prospective life and failure mode to facilitate the replacement of failed SPDs. This shall be thermal disconnecting type and equipped with potential free contact for remote monitoring. This protection shall be in compliance to IEC 61643-1 and VDE -0675 Pt. 6 with following characteristics:

Nominal Voltage (U_0)	24V	48V	60V	110V	230V
Max. continuous operating voltage (U_C)	30V	60V	75V	150V	253V
Rated load current (I_L)	16A	16A	16A	16A	16A
Nominal discharge current (I_n) 8/20 μ s	$\geq 700A$	$\geq 700A$	$\geq 700A$	$\geq 2.0KA$	$\geq 2.5KA$
Max discharge current (I_{max}) 8/20 μ s	$\geq 2KA$	$\geq 2KA$	$\geq 2KA$	$\geq 5KA$	$\geq 5KA$
Voltage protection level (U_P)	$\leq 200V$	$\leq 350V$	$\leq 500V$	$\leq 700V$	$\leq 1100V$
Response time (T_r)	≤ 25 ns	≤ 25 ns	≤ 25 ns	≤ 25 ns	≤ 25 ns

Note: Minor variations from above given parameters shall be acceptable.

11.5.2 Signalling/Data line protection

These devices shall preferably have an indication function to indicate the prospective life and failure mode to facilitate the replacement of failed SPDs. If the device has any component which comes in series with data/signalling lines, the module shall have "make before break" feature so that taking out of pluggable module does not disconnect the line. This protection shall be in compliance to IEC 61643-21 & VDE 0845 Pt. 3 with the following characteristics:

Nominal Voltage(U_0)	5V	12V	24V	48V
Arrester Rated Voltage(U_C)	6V	13V	28V	50V
Rated load current(I_L)	$\geq 250\text{mA}$	$\geq 250\text{mA}$	$\geq 250\text{mA}$	$\geq 250\text{mA}$
Total discharge current, 8/20 μs (I_n)	$\geq 20\text{KA}$	$\geq 20\text{KA}$	$\geq 20\text{KA}$	$\geq 20\text{KA}$
Lightning test current 10/350 μs	$\geq 2.5\text{KA}$	$\geq 2.5\text{KA}$	$\geq 2.5\text{KA}$	$\geq 2.5\text{KA}$
Voltage protection level (U_p)	$\leq 10\text{V}$	$\leq 18\text{V}$	$\leq 30\text{V}$	$\leq 70\text{V}$

Note: Minor variations from above given parameters shall be acceptable.

- 11.5.3 If power supply /data / signalling lines (AC/DC) are carried through overhead wires or cables above ground to any nearby building or any location outside the equipment room, additional protection of Stage 2 (Class C) type shall be used at such locations for power supply lines and Stage 3 protection for signal / data lines.
- 11.6 Coordinated type Class B & C arrester shall be provided in a separate enclosure adjacent to each other. This enclosure should be wall-mounting type.
- 11.7 Length of all cable connection from input supply and earth busbar to SPDs shall be minimum possible. This shall be ensured at installation time.
- 11.8 Stage 1 & Stage 2 (Class B & C) protection should be from the same manufacturer/supplier. Manufacturer shall provide Stage 1 & Stage 2 protection. Stage 3 protection shall be got provided by Railways separately.
- 11.9 The cross sectional area of the copper conductor for first stage protection shall not be $< 16 \text{ mm}^2$ and for second stage shall not be $< 10 \text{ mm}^2$
- 11.10 Batch test report of OEM should be submitted by the manufacturer /supplier of Lightning & Surge protection devices to the IPS manufacturer at the time of supply of these devices. Copy of the same shall be submitted by manufacturer to RDSO at the time of acceptance test of equipment.

12.0 MARKING

- 12.1 All markings/ indications shall be easily legible and durable. Where the marking is by use of labels, the labels shall be metallic and shall be firmly fixed and shall not be capable of being removed by hand. Durability of marking shall be checked by rubbing the marking by hand with a piece of cloth soaked with petroleum spirit. This requirement shall also be met after completion of climatic test.

- 12.2 All markings/ indications shall be placed in the vicinity of the components to which these refer and shall not be placed on removable parts, if these parts can be replaced in such a way that the marking / indications can become misleading.
- 12.3 The words 'Indian Railway Property' shall be etched, engraved or embossed on the equipment at a conspicuous position. For it, the size of the letters shall be chosen depending upon the equipment but shall not be less than 20mm high in any case.
- 12.4 The anodized name plate shall be firmly attached to the equipment and shall show the following information:
- (a) Name or trade mark of the manufacturer.
 - (b) IRS number.
 - (c) Serial number of the equipment.
 - (d) Installation for which meant.
 - (e) Month and year of manufacture.
 - (f) Version number.

13.0 DOCUMENTATION

Two copies of the following manuals shall be supplied:

- 13.1 Instruction Manual
- 13.2 Installation and Maintenance Manual including Dos & Don'ts.
- 13.3 Mechanical drawings of each sub-system/ rack.
- 13.4 Guaranteed performance data, technical & other particulars of the equipment.
- 13.5 Schematic block diagram showing mounting arrangement of various components & details of each type of assembled PCB.
- 13.6 Trouble shooting procedures along with test voltages and waveforms at various test points in the PCBs.
- 13.7 Details of software viz. Source code, algorithm, flow chart, machine code along with test/ validation procedure used and the results thereof.
- 13.8 Details of Hardware e.g. schematic diagrams of the system circuits/ components, details for each type of assembled PCB and part-list.
- 13.9 Pre-commissioning check list.

14.0 PACKING

- 14.1 The equipment and its sub assemblies shall be wrapped in bubble sheet and then packed in thermocole boxes and the empty spaces shall be filled with suitable filling material. All PCBs shall be enclosed in anti-static shield cover. The equipment shall be finally packed in a wooden case of sufficient strength so that it can withstand bumps and jerks encountered in a road/ rail journey.
- 14.2 Each box shall be marked with code numbers, contents and name of manufacturer. The upside shall be indicated with an arrow. Boxes should have standard signages to indicate the correct position and precaution "Handle with Care" with necessary instructions.
- 14.3 Printed circuit boards shall be separately and individually packed to prevent damage.

15.0 OPTIONS TO BE SPECIFIED BY THE PURCHASER

- 15.1 Whether on line data logging facility is required. (Cl. 5.3.3).
- 15.2 Location of use of equipment so that applicability of various climatic and environmental tests as per clause 9.3 is clear.
- 15.3 Whether 7 KV static discharge test & pantograph interference test is required to be performed on the equipment or not. (Cl. 9.4).
- 15.4 Whether for use in RE area.
- 15.5 Operating voltage. (Cl 10.1)
