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GOVERNMENT OF INDIA

MINISTRY OF RAILWAYS

SPECIFICATION
FOR

RELIABILITY OF ELECTRONICS USED IN ROLLING STOCK APPLICATION

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RESEARCH DESIGNS AND STANDARDS ORGANISATION

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RELIABILITY OF ELECTRONICS USED IN ROLLING STOCK APPLICATION

0. FOREWORD :

There has been a dramatic increase in electronics based applications on Indian Railways over the years. The newly acquired 3-phase locomotives and EMUs have complete microprocessor based control. A very high degree of reliability is required for these electronic equipments. The environmental conditions are very stringent. Reliability assurance requirements have to be supplemented for the main specification, which is generally performance oriented, to ensure high reliability under the heavily adverse working conditions. Though, there are International standards, addressing to the performance requirements of electronic equipment for rolling stock application, need is felt to specify requirements as per the service conditions on Indian Railways.

This specification replaces the existing RDSO specification bearing Sl.No. SPEC/E-16/1 (Revision A) of May'84. Since, electronics is a field where rapid advancements are taking place on day-to-day basis, the existing specification needs drastic changes. The thrust of the new specification is on the final performance as well as on quality assurance techniques during manufacturing and testing. This specification also addresses the issues related to integrity, maintainability and support to the software supplied as a part of the electronics system. It also addresses the important aspect of electromagnetic compliance.

1. SCOPE:

1.1 This specification covers the reliability requirements for electronics (including microprocessor/micro-controller based) used in rolling stock application.

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 REFERENCE TO OTHER SPECIFICATIONS:

2.1 This specification requires reference to the following specification, which should also be complied with to the extent applicable.

1. IEC-60571 : 1998
2. IEC-61000 : 1995
3. IEC-60249
4. IEC-60326
5. IEC-60529:1989
6. IS-10087:1981

2.2 Wherever in this specification, any of the above mentioned Specification is referred by number only, the latest issue of the Specification is implied, whenever the year of issue is mentioned, the particular issue referred to is meant,

3.0 GENERAL :

3.1 The equipment shall be manufactured as per best engineering practices.

3.2 The cabinet shall have Poly-urethane/ powder coating paint finish and good aesthetic appearance.

3.3 The power portion of the equipment shall be clearly isolated and protected to prevent accidental contact.

3.4 The shields and screens provided shall be properly earthed.

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

3.6 All vital relays including the safe shutdown relays shall be of approved type for use in railway rolling stock.

4.0 CLIMATIC & ENVIRONMENTAL CONDITION

4.1 The electronics will be fitted in a location in the rolling stock where the temperature will be

Maximum temperature	: 70 deg. C
Minimum temperature	: 0 deg. C
Average temperature.	: 47 deg. C

4.2 Humidity: Upto 100% during rainy season.

4.3 Altitude: Upto 1200 m above mean Sea level.

4.4 Rainfall: Very heavy in certain areas. The equipment shall be designed suitably.

4.5 Atmosphere during hot weather: Extremely dusty and desert terrain in certain areas. The dust concentration in air may reach a high value of 1.6 mg/cub.

4.6. Coastal area: The equipment shall be designed to work in coastal area in humidity and salt laden and corrosive atmosphere. The maximum values of the condition will be as follows:

a) Maximum pH value : 8.5.
b) Sulphate : 7 mg per litre.
c) Max. Concentration of chlorine : 6 mg per litre.
d) Maximum conductivity : 130 micro siemens /CM

4.7 Vibration: The equipment shall be designed to withstand the vibrations and shock encountered in service satisfactorily as specified in 60571 for the electronic equipment.

4.8 Electromagnetic Pollution – High degree of electromagnetic pollution is anticipated in areas, where the equipment will be mounted.

4.9 Signal and Telecommunication Installation: The tracks over which the rolling stock will run may be equipped with 83-1/3 Hz track circuits as well as track circuits at higher frequencies. Similarly, other devices like axle counters, block instruments, point machines, etc., may also be employed. On the communication network, control circuit, tele-printer circuit, as well as VHF/UHF and micro-wave circuits is employed.

5. INFRASTRUCTURE FOR QUALITY ASSURANCE :

The following facilities are considered desirable for the manufacture of quality and reliable product.

i) Dust free environment for the assembly of PCBs.
ii) Component lead forming machines/fixture.
iii) Electro static discharge protection in line with IS: 10087-1981. Work procedure for following ESD practices needs to be submitted.
iv) Automatic/light beam guided component insertion machine for PCBs.
v) Temperature controlled wave-soldering machine with auto-fluxing facilities for Through Hole Technology (THT) components.
vi) Burn in test chamber.
vii) Multi-channel temperature scanner.
viii) Functional testing of PCBs preferably with computer.
ix) In circuit testing machine for checking the correctness of component inserted in PCBs.
x) ISO 9001 Certification,

Facilities from serial No. (i) to (vii) are considered essential at developmental stage.

Use of all the above facilities are considered necessary during the bulk production and requires verification by RDSO before placing the firm as a regular source. The firm will advice the facilities as existing on date with details along with the proposed plan for augmentation of the short fall with expected duration along with the offer. Duration in any case shall not exceed one year from the date of the first order as per this specification. Non-compliance after this date will debar the firm for further order.

This shall generally form a criteria for evaluating/grading of the firms at the tender evaluation stage.

* Note: Infrared reflow soldering oven for top end Surface Mounted Technology (SMT) components and double wave soldering for bottom end. SMDs are considered essential whenever SMDs are used. If this facility is not available, off-loading to sub-vendor may be carried out with prior approval of RDSO.

6. HARDWARE

6.1 COMPONENT TYPES:

6.1.1 The components used in the equipment shall be of industrial grade or higher. These should be procured from reputed manufacturer.

6.1.2 The resistors and capacitors used shall conform to the relevant IS specifications and of tolerance not more than 5% for resistance.

6.1.3 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 micro farad.

6.2 PROTECTION AGAINST ELECTROMAGNETIC INTERFERENCE

Shielding should be provided to protect against electromagnetic interference at card level by providing a metallic plate over the cards or at chassis/rack level. The requirements & particular areas for its application shall be declared in the main specification of the equipment.

6.3 ENCLOSURE CLASS: IP 54

6.4 DIAGNOSTIC FACILITY.

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

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

6.4.2 Audiovisual alarm shall be provided in case of a failure wherever specified in the main specification, the audio alarm should stop when acknowledged but it should be recorded in non-volatile memory (NVM) of the system.

6.4.3 If required by the purchaser, data logging facilities shall be provided for online 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. It should also be possible to down load it into the computer using a handhold terminal or laptop PC.

6.4.4 At least ten (10) faults should be logged in NVM.

Built in diagnostic should be provided as per Cl.4.5 of IEC 60571.

6.5 FAULT PROTECTION:

Wherever the fuses are used for protection, they should have LED indications to communicate their status.

7. PRINTED CIRCUIT BOARD

PCBs will be manufactured as per the relevant IECs. General guidelines are given below. Deviation, if any, should be with prior approval of RDSO.

7.1 PCB MATERIAL: Material for the printed circuit board shall be copper clad glass epoxy of grade FR-4 or equivalent.

7.2 OUTLINE DIMENSIONS: PCBs shall be of standard size.

7.3 BOARD THICKNESS: The nominal board thickness shall be 1.6mm and Thickness of the motherboard shall be 2.4 mm. Thickness of the copper cladding shall be 70 micron.

7.4 TRACK WIDTH: The track width shall be 0.5mm nominal in no case it should be less than 0.3mm.

7.5 SPACING BETWEEN TRACKS: Spacing between tracks shall be 0.5mm nominal. It must not be less than 0.3mm.

7.6 CONFORMAL COATING: Assembled 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 vapour;
d) Conducting particles like metal chips and filings;
e) Accidental short circuit by dropped tools, fasteners etc.
f) Abrasion damage; and
g) Vibration and shock (to a certain extent)
h) Corrosion

The protective coating on trackside of PCB shall be transparent so that type/rating of components are readable. The protective coating on trackside of PCB shall be of solderable type.

7.7 BURN-IN: After mounting of components, the populated PCB cards kept in proper chassis in energized condition shall be burnt in for minimum 45 hrs at +75 deg. C and - 25 deg C as per the cycle at annexure-1, wherever specified in the main specification. The PCBs will be tested for functionality to the extent possible during the burn-in test. This will be mutually decided.

7.8 LEGEND PRINTING: Component outline shall be screen-printed on the components side of the board, Type and designation of the PCB shall also be screen-printed.

7.9 SOLDER MASK: Solder mask shall be applied on solder side and component side of the board.

7.10 POLARISATION: The PCBs shall be mechanically polarised so that it is not possible to insert the PCB into the wrong slot.

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

8.0 **SOFTWARE REQUIREMENTS**:

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

8.2 SOFTWARE VALIDATION:
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.

8.3 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.

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

8.5 SELF CHECK PROCEDURE- Software should include self-check procedure to detect faults in the hardware. The self check should include the following procedures:

a) 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:
b) 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.

8.6 Self check of the associated functional hardware as required by the hardware design should be performed periodically

8.7 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.

9.0 DEVELOPMENT PLATFORM :

The hardware and software should be designed on open platform to ensure integration with other microprocessor based system.

10. POWER SUPPLY REQUIREMENTS:

10.1 The equipment shall operate at 24V dc (+20%,-10%), 110 V dc (76-136V) or 230V ac (160-270V, 50Hz) supply, as specified in the main specification of the equipment.

10.2 A surge arrestor shall be provided in the battery charger to protect against transient voltages; spikes etc.

10.3 Electric service condition-As per IEC-60571. It is to be noted that one pole of battery of the vehicle is connected to the vehicle body,

11. RELIABILITY, MAINTAINABILITY AND EXPECTED USEFUL LIFE :

The manufacturer is required to mention the reliability figure. The method of calculation shall be agreed at the time of tendering between the manufacturer and the user and shall be in accordance with a recognized standard. The relevant paras of IEC 60571 will be applicable regarding useful life and maintainability.

12. TESTING

12.1 The electronic equipment should be tested in accordance with IEC 60571 and EMC compliance will be as per IEC 61000, level 3.

12.1 The list of tests to be carried out is as follow :

SL NO	TEST	CLAUSE	Type Test	Routine Test
1.	Visual inspection	IEC 60571 clause 10.2.1	✓	✓
2.	Performance test	IEC 60571 clause 10.2.2	✓	✓
3.	Cooling test	IEC 60571 clause 10.2.3	✓	-
4.	Dry heat test	IEC 60571 clause 10.2.4	✓	-
5	Damp heat test (Cyclic)	IEC 60571 clause 10.2.5	-	-
6	Supply Over Voltages, surges & electrostatic discharge test	IEC 60571 clause 10.2.6	✓	-
7	Transient burst susceptibility test	IEC 60571 clause 10.2.7	✓	-
8	Radio interference test	IEC 60571 clause 10.2.8	-	-
9	Insulation test	IEC 60571 clause 10.2.9	✓	✓
10	Salt mist test	IEC 60571 clause 10.2.10	-	-
11	Vibration, shock & bump test	IEC 60571 clause 10.2.11	✓	-
12	Water tightness test	IEC 60571 clause 10.2.12	-	-
13	Equipment stress screening	IEC 60571 clause 10.2.13	-	-
14	Low temperature storage test	IEC 60571 clause 10.2.14	-	-
15	Burn – in test	Annexure 1 of this spec.	*	*

Note : Test marked "-" to be carried out subject to mutually agreement between User & Manufacturer.
Test marked "*" is part of the quality assurance as per mutual agreement between user and manufacturer.

12.3 RDSO may decide to carry out certain special tests on the equipment, which are not covered by above IEC specification. Manufacturer will carry out the test as per mutually agreed test Programme at his own cost.

12.4 The equipment will be inspected & tested by the engineers of RDSO at the factory premises where all the facilities should be made available for carrying out the prototype test. The tests for which special facilities are required may be carried out at recognised test houses as per mutual agreement. The equipments will be kept in field trials for a period of six months. The RDSO engineers will associate and witness the tests in the rolling stock also till they are successfully completed. Any defects noticed / design improvement found necessary as a result of the test / trial shall be carried out by the supplier in the least possible time.

12.5 The individual equipments, system and sub-system as may be necessary shall be type tested and routine tested in accordance with relevant IECs.

12.6 Type test will be performed on one unit of given design to verify that the product meets the requirements specified and agreed upon between users & manufacturer. Subject to agreement between user and manufacturer some or all the type tests shall be repeated once in two years by RDSO and purchaser on sample basis so as to confirm the quality of the product. This will be part of revalidation of vendor approval. In addition, the manufacturer shall repeat all the type tests after 5 years without any additional cost. Type test will also be repeated in following cases.

- Modification of equipment, which is likely to effect its function.
- Failure or variations established during type or routine test.
- Resumption of production after an interruption of more than two years.
- At the time of indigenisation, if the firm has supplied with foreign collaboration in product originally.

" The type test will be carried out for the equipment/sub-assembly indigenised. The type test on the full unit in the case of indigenisation will be considered only if there is major design change."

12.7 Routine tests are to be carried out to verify that properties of the product corresponding to those measured during type tests. Routine test are to be carried out by the manufacturer on each equipments.

12.8 Investigation tests are intended to obtain additional information regarding the performance of the product. They shall be specially requested either by the user or the manufacturer.

12.9 RDSO may conduct surprise check on manufacturing process and quality control along with any of the test to ensure quality of product and its conformance to RDSO's specification.

13. DOCUMENTATION

Following documents should be supplied along with the system:

13.1 Mechanical drawings of each sub-system/rack.

13.2 Trouble shooting chart.

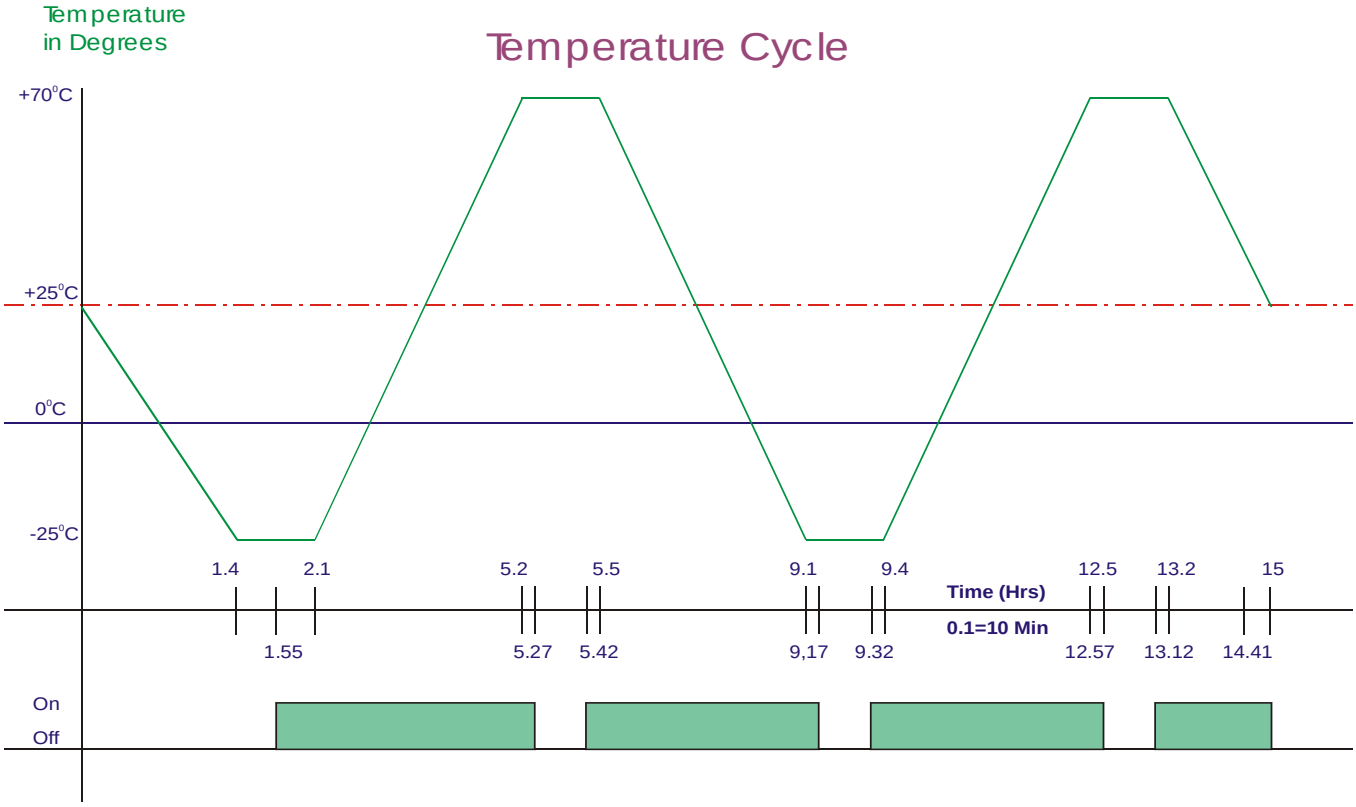
13.3 Installation and maintenance manual.

13.4.1 Details of Hardware e.g. schematic diagrams of the system circuits/components, functional block description for each type of assembled PCB.

13.5 Details of software e.g., algorithm flow chart along with test/validation procedure used and the results thereof.

13.6 Clause by clause compliance to this specification, variations, if any, should be brought out clearly.

BURN-IN TEST


Temperature
in Degrees
Temperature Cycle
+70°C
+25°C
0°C
-25°C
1.4
2.1
5.2
5.5
9.1
9.4
12.5
13.2
15
Time (Hrs)
0.1=10 Min
1.55
5.27
5.42
9,17
9.32
12.57
13.12
14.41
On
Off