Specification No: ELRS/SPEC/DC-DC CONVERTER/0021

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

सत्यमेव जयते

"SPECIFICATION FOR DC/DC CONVERTER FOR ELECTRIC & DIESEL ELECTRIC LOCOMOTIVE."

Specification No: ELRS/SPEC/DC-DC CONVERTER/0021 Rev.'1'
Issue Date/Year - Sep 2004

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CONTANTS

CHAPTER - I

GENERAL

1.0 INTRODUCTION

1.1 Locomotives on Indian Railways have traditionally been provided with a headlight with single reflector and 32V, 250 W incandescent lamps on either end of Locomotives to RDSO specification No. EL/TL/41-1984. For this headlight power feed is from a regulated step down transformer (RTPR) on electric locomotives and HLPR in Diesel Electric locomotives. In the recent years there has been considerable development in the field of energy efficient light sources and twin beam headlight to RDSO Specification No.ELPS/Spec/HL/01for Electric locomotives and RDSO/PE/Spec/Genl/007 for Diesel Electric locomotives with 24 V halogen lamps, used in automobile headlights were adopted on locos for improving its performance and reliability. This system needed 24V DC supply for which DC-DC Converter of 110/24V DC was provided and its specification also included in twin beam headlight specification.

However, since Headlight is mainly a light device involving optics and DC-DC converter is a device involving electronics, the supplies of Headlight and DC-DC converter are not necessarily required to be obtained together. Therefore, specification of DC-DC converter has been separated, so that it can be procured separately and not along with headlight.

1.2 This specification is meant for specifying technical requirements of DC-DC converter to be used for supplying power to locomotive headlight systems as well as instrument lamp load of locomotive. It also specifies prototype and acceptance test methods to ensure consistency of quality of equipment.

1.3 This specification covers construction features, technical requirements and testing procedure for DC - DC converter suitable for feeding power to headlight system of Electric and Diesel Electric locomotives.

1.4 This revision is being issued to ensure better quality of PCB alongwith interchangability of Dc-Dc converter.

1.5 SUPPLIER'S RESPONSIBILITY:

The supplier's responsibility will extend to the following.

1.5.1 Supply of detailed instructions for installation of the equipment on the locomotive. Supplier shall also depute his representative for ensuring correct installation of first two equipments in the locomotive at each location (shed / CLW).

1.5.2 Supplier shall arrange Commissioning, testing & field trials of the prototype equipment in service jointly with RDSO and will depute team of engineers to Railway field units for this purpose.

1.5.3 The Dc Dc converter is required to service a life of 10 years. The supplier shall quote for spares, which may be required for satisfactory maintenance of the unit for a period of 3 years after completion of warranty period.

1.5.4 The supplier will be required to enter into a contract with the user railway for repair of electronic cards employed (if any) and shall indicate repair charges for the cards. The repaired card will have warranty of one year.

1.5.5 The design shall be developed as per requirement given in the specification. The detailed design shall be submitted to RDSO for scrutiny and approval of the design features before commencing of the manufacturing. The suppliers shall, however, be responsible for performance of complete system.

1.5.6 **Warranty:** The supplier shall be responsible for any damage to equipment provided in the locomotive due to defective design, materials, workmanship upto a period of 18 months after commissioning on the locomotive or 24 months from the date of supply, which ever is earlier. The supplier shall replace within one month, such equipment during the warranty period at his cost. The period of warranty will be extendable in case of recurring problems attributable to defective design, material or manufacturing. The supplier's liability in this respect of any complaints, defects and /or claim shall be limited to the supply and installation of replaced parts free of cost.

1.5.7 The supplier shall be responsible for carrying out all the modifications at his cost on any part of the equipment during the period of warranty required for satisfactory operation of the equipment as per technical specification. For any technical decision the final authority from the purchaser's side is RDSO

1.5.8 **Training:** The supplier shall arrange training to IR personnel in maintenance and trouble shooting of the system supplied. One day training for three persons per location is to be arranged by the supplier in the field of maintenance and troubleshooting. The supplier shall furnish the syllabus and schedule of training programme to RDSO as part of design proposal. Training will be arranged free of cost. Suitable training material will be supplied to the participants.

1.5.9 The supplier shall supply the write up and the elaborate manual for maintenance and trouble shooting free of cost to IR for easy maintenance. Two set of manuals will be supplied each shed/shop or one set per 10 nos. of equipment supplied.

1.6 RAILWAYS' RESPONSIBILITY:

Railway will be responsible for following:

1.6.1 Labour, consumables and electrical energy required for erection, testing & commissioning of the equipment.

1.6.2 The wages and allowances as well as the cost of the passage to and from the place of training for railway personnel only.

1.6.3 For installation of Dc Dc converter, interconnecting cables shall be supplied by Railways.

1.7 DOCUMENTATION:

1.7.1 Documents to be submitted with offer: The tenderer shall submit the following information with the offer in printed form and digital format and compiled in a booklet. Offer with incomplete information may not be considered.

(a) System design, Salient features and advantages of the offered system, Schematic Circuit, Functional Description, Protection scheme. A summary sheet of important data required is placed at Annexure-A.

(b) Man-machine interface: Details of switches, indications and fault diagnostic feature.

(c) BOM (Bill Of Material), Data sheets for components/devices and other equipment proposed for use

(d) Mechanical interface diagram (Outline General Arrangement), assembly drawings of complete unit, mounting arrangement and weight.

(e) Clause by clause compliance

(f) Details of technical support and training offered

(g) Supply experience, Logistics proposed for warranty support

(h) Recommended list of spares with cost for 3 years maintenance after warranty

(i) List of special tools, jigs and fixtures needed for assembly, testing, commissioning, maintenance and repair.

(j) QAM (Quality Assurance Manual), QAP (Quality Assurance Plan)

(k) Test protocol with procedure of testing.

(l) ISO 9000 certification.

(m)Details of infrastructure, manufacturing and testing activities in line with guidelines issued vide RDSO spec no.- ELRS/SPEC/SI/0015 (Latest).

Sub vendors supplying critical components such as toggle / rotary switches, cables, thimbles, MOSFETs, Choke/transformer, terminal strips/blocks of DMC/epoxy etc may also be got cleared by RDSO.

1.7.2 The successful tenderer shall submit Following documents after award of contract.

(a) Technical documentation explaining the complete scheme, characteristics, diagnostics, protection and control etc.

(b) Detailed drawings of each system/sub-system with interface details in CAD format.

(c) Vendor list for subsystems

(d) Operation and Maintenance manual

(e) Spares catalogue

1.7.3 DOCUMENTS FOR FUTURE REFERENCE: The tenderer shall submit 4 set of final design, BOM (Bill Of Material), mechanical drawing, approved test procedure etc. to RDSO, incorporating corrections, if any, during the design approval process. one set duly approved will be returned to the tenderer. These documents will require to be shown to the inspecting authorities/ railway representative on demand.

1.8 PROTOTYPE APPROVAL AND PERMISSION FOR BULK MANUFACTURING:

1.8.1 The successful tenderer shall submit a prototype sample for inspection/testing and approval by RDSO before undertaking the bulk manufacture whenever he is either executing order for the first time or against an order where change / revision of specification/ design is involved. A copy of internal test results should accompany the inspection call.

1.8.2 The supplier shall undertake bulk manufacturing incorporating modifications/ improvements as may be considered necessary in course of service trials and as directed by RDSO within the framework of the specification. In case of major change, the unit shall be type tested again.

1.9 Any deviations to this specification considered necessary to improve performance, reliability of the unit or for any other reason, should be furnished by tenderer with details and full particulars for consideration of purchaser. Unless such deviations are accepted in final contract, the provision of this specification will be binding on the contractor.

1.10 FIELD TRIALS:

After successful completion of type tests, the equipments shall be subjected to field service trials for a minimum period of six months. The number of trial equipments and venue shall be as agreed between the purchaser and the supplier. The installation and commissioning of the equipments for field trials shall be carried out by the supplier.

1.11 INFRINGEMENT OF PATENT RIGHTS:

Indian Railway shall not be responsible for infringement of patent rights arising due to similarity in design, manufacturing process, components used in design, development and manufacturing equipment and any other factor,

which may cause such dispute. The responsibility to settle any issue lies with the supplier.

1.12 INFRASTRUCTURAL REQUIREMENTS:

The manufacturer should have following minimum infrastructure for the manufacturing and supply of DC to DC converter

i) Dust free environment for the assembly of PCBs.

ii) Component lead forming machines/fixture.

iii) Temperature controlled wave soldering machine with auto-fluxing and legs cutting facilities.

iv) SMD component soldering workstation with repair facility.

v) Temperature controlled Dry heat test chamber.

vi) Automatic/manual (light guided manual placement) component placement machine for PCBs

vii) Multi-channel temperature scanner.

viii) Functional testing of PCBs.

ix) Electro static discharge protection in line with IS:10087-1981. Work procedure for following ESD practices needs to be submitted.

x) .Testing jigs for checking the correctness of component in PCBs.

xi) ISO 9001 : 2000 Certification.

However, supplier can avail Facilities from serial No. (ii) to (vi) from sub vender cleared by RDSO. In this regard supplier should submit along with offer the MOU with sub vendors for undertaking above operation from S. No.(ii) to (vi)

1.13 IMPORTANT DOCUMENTS REFERRED IN THIS SPECIFICATION

1.	IEC-60571	Rules for electronic equipment on rail vehicle
2.	IEC 61287	For power converters used in rolling stock application
3.	IS: 616	Safety requirements for mains operated electronics or related apparatus for household and similar general use.
4.	IEC-61000	Electromagnetic compatibility for industrial process measurement and control equipment.
	IEC-77	Rules for electric traction equipment
5.	ELRS/SPEC/SI/ 0015 (latest) OCT '2001	Reliability of electronics used in rolling stock application

CHAPTER II

TECHNICAL DETAILS

2.0 System Requirements

2.1 DC-DC converter shall be designed for taking a continuous load of 400/500 Watt under specified input and output conditions. The converter shall be designed to work with 2X 100 W Halogen lamps.

2.1.1 Headlight system of the locomotive shall use a common DC/DC converter housing having 2 independent separate converters each designed for minimum continuous load of 400W for electric loco and 500W for Diesel Electric locomotives but only one working at a time and other acting as standby. The input nominal voltage shall be as per clause no. 2.2 and regulated output shall be 25.5V ±1 % DC to meet the photometric standards, considering voltage drop in cables from DC-DC converter to Headlight.

2.1.2 MOSFET devices shall be used to achieve higher efficiency and low heat generation. Protective circuits shall be provided to prevent damages due to accidental short circuits, reversal of input supply wiring connections and surges that may occur in course of locomotive working. Heat sinks shall be of extruded anodized aluminium section and matt black powder coated. All steel parts shall be given suitable anti-corrosive treatment.

2.1.3 MOSFET on the PCBs shall be properly fitted to take care of vibrations in service. Overhang for heavier equipment is not permitted. These shall be mounted with suitable clamps

2.2 Input supply :

The input dc voltage to dc-dc converter for electric and diesel electric locomotives shall be as under :

	Electric loco	Diesel Electric loco
Nominal input voltage	110V	72 V
Variation in input voltage	70 V to 136V	50V to 85V
Ripple content	upto 30%	upto 30%

2.3 Output supply requirements:

a) The rated output of each converter for electric and diesel electric locomotives shall be as under :

	Electric loco	Diesel Electric loco
Output regulated voltage	25.5± 1% dc	25.5± 1% dc
Output Wattage	400 Watt	500 Watt
Efficiency	Not less than 85 %	Not less than 85 %

b) System should be :

(i) **Suitable for (–)ve earthed battery system**

(ii) Control must be on (+)ve side.

2.4 Selection of converter

The main and standby converters shall not be energised simultaneously. Arrangements will be provided to ensure that only one converter is energised at a time. Two way rotary/toggle switch capable to make/break 20A dc current on load and 110V dc voltage shall be provided on converter assembly to select either of the converter.

2.5 Size, mountings and colour of the Equipment

The converter box is proposed to be mounted in the cab-1 inside the locker on locomotive for retro fitment and below baby compressor in WAP4 locos/ new locos. Colour of the units should be gray colour (code-631 of IS-5). The maximum dimension of the converter box should not exceed following :-

Height	Width	Length
240 mm	240 mm	300 mm

Mounting should be provided through 4 holes diameter 10 mm. with centralised distance of 222mm +/- 2 and 150 mm +/- 1 as indicated in Annexure-B

2.6 PROTECTION

2.6.1 Input fuses — Individual fuses for each of the twin converters shall be provided on positive side.

2.6.2 Output short circuit — The converter shall be suitable for output short circuit for indefinite period. The equipment should restore to its normal working condition after removal of short circuit.

2.6.3 Surge protection — Protection against surges shall be provided in both the converters. Surges of 2 KV are expected in the system.

2.6.4 Under Voltage — The equipment shall function without any consequential damage at lower voltage. However it shall be able to prevent discharge to loco batteries at voltage below 70 V for electric locomotive and 50V for diesel locomotives. The system shall go into hiccup mode so as to immediately recover as the voltage improves.

2.6.5 Reverse polarity — Reverse polarity protection shall be provided to ensure no damage under reverse polarity connection at input. Measures shall also be taken to ensure no damage to converter in case of accidental application

of battery voltage at output terminals.

2.7 Indications and Terminals :

2.7.1 Indications shall be provided to indicate switching on and off of input and output voltages.

2.7.2 The input/output terminal board shall be located separately and shall be of fire retardant type, preferably SMC/DMC moulded type with partition in between terminals and have provision for fitment of standard crimped type lugs. The DC input terminals shall be on left side and black in colour and the output terminals shall be on right side and red in colour. The dimensions of input and output terminals shall be different for easy identification. The input and output shall be clearly marked.

2.8 MARKING:

The following shall be punched on each of the unit on the anodised aluminium plate on unit.

1. Manufacturer's Name
2. Serial Number
3. Year of built.
4. Input/output voltage & current on converter unit.
5. Wattage of the each converter

2.9 GENERAL DESIGN REQUIREMENTS:

2.9.1 PTFE cables should be used in the system.

2.9.2 All printed board assemblies shall be protected on both sides with a flame retardant protective transparent coating in order to prevent deterioration or damage due to moisture and atmospheric contaminants. It shall be possible to repair coated printed board assembly without the need for complete removal of coating.

2.9.3 Erasing of identification numbers/marks of components such as diodes, transistors, I C chips etc. is not permissible. All components shall be used with their identity marked on their body.

2.9.4 Industrial grade components will be used for which a necessary certificate will be produced by the tenderer.

2.9.5 All the terminals, indications, switches, shall be marked for easy identification and connections. The rating plate with manufacturers' name, serial number, contract number shall be fixed on the equipment.

2.9.6 The use of jumper wire/fuse wire on PCB, soldered glass fuse base, rewireable fuse is not acceptable. The use of HRC / Glass fuse with proper mounting, arrangement is recommended.

2.9.7 The use of assembly/sub-assembly with resistors/ capacitors/semi-conductors devices etc. mounted on PCB and moulded in housing/epoxy potted are not acceptable.

2.9.8 The equipment shall not malfunction or be damaged when spikes or voltage surges are applied as indicated under surge type test.

2.9.9 The equipment shall not generate voltage spikes or surges during normal and switching operation so as to have interference with other electronic equipment on the Locomotives. Suitable measures shall be taken to suppress such surges.

2.9.10 The rating of components shall be based on case component tolerances and environmental conditions. The safety margin calculations shall be based on derated ratings of components and load under worst conditions. The Vendor shall provide details of electronic components with tolerances and circuit diagrams.

2.9.11 Equipment housing / exposed metal work shall be connected to vehicle frame for safety. Mounting arrangement shall not be treated as earthling and earthling tinned pad with flexible and bolted connection shall be provided.

2.9.12 Equipment shall be designed such that regular / periodic maintenance shall not be necessary. Special maintenance required shall be stated at the time of tendering.

2.9.13 Electromagnetic compatibility of the entire system shall comply with provisions of *IEC 61000*. The equipment should withstand surge & spikes as specified in IEC 60571.

2.9.14 In the electronic equipments to be supplied to this specification, the suppliers shall use components and systems of high reliability, suitable in every way for the application on rolling stock. In this connection, supplier is well advised to refer to "Rules for Electronic Equipments used on Rail Vehicles IEC Publication 60571"

2.9.15 Any deviations to this specification considered necessary to improve performance, reliability of the unit or for any other reason, should be furnished by tenderer with details and full particulars for consideration of purchaser. Unless such deviations are accepted in final contract, the provision of this specification will be binding on the contractor.

2.9.16 All the components on PCBs should be wave soldered / surface mounted devices should be mounted using SMT workstation and complied with clause no. 7 of specification no. ELRS/SPEC/ SI/0015.

2.9.17 All ICs if mounted on the bases should be mounted on heavy duty sockets and provision should be made for tightening of the ICs on the base also complied with clause no. 6.1.3 of specification no. ELRS/SPEC/ SI/0015.

2.9.18 All electronic components and ICs used shall be selected after proper burn in and screening tests and shall be adequately rated to withstand the service requirements. A quality assurance scheme should be submitted by the supplier for approval of RDSO. It should be provided as per specification no. ELRS/SPEC/ SI/0015.

2.9.19 The equipment should function satisfactorily under 25 kV ac electric traction. It should not be susceptible to malfunction due to interference from overhead traction power supply lines or under abnormal conditions such as overloads and faults in the electrical traction circuits of the locomotives.

2.9.20 The equipment should be burn in after manufacturing as per clause 7.9 and 12.2 of RDSO specification no. ELRS/SPEC/ SI/0015.

2.10 SAFETY FEATURE:

2.10.1 In case of malfunction of one converter or its associated hardware, it should be detected and give a LED indication should be given. The head light operation should continue by selecting other converter.

2.10.2 The supplier should make an arrangement for protection of the equipment from fire.

CHAPTER III

ENVIRONMENTAL CONDITIONS

3.1 The equipment should function satisfactorily under the following environmental conditions. Which are encountered where equipment will be expected to work.

3.1.1

a) Maximum temperature
} Stabled Locomotive under sun : 70 deg. C
} On board Working loco under sun. : 55 deg. C
b) Minimum temperature : 0 deg. C
c) Average temperature : 47 deg. C

3.2 **Humidity:** Up to 100% during rainy season.

3.3 **Altitude:** Up to 1200 m above mean sea level.

3.4 **Rainfall:** Very heavy in certain areas. The loco equipment shall be designed suitably.

3.5 **Environment:** Extremely dusty and desert terrain in certain areas. The dust concentration in air may reach a high value of 1.6 mg/cm^3. In many iron ore and coalmine areas, the dust concentration is very high affecting the filter and air ventilation system.

3.6. **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

3.7 **Vibration and shocks:** The equipment shall be designed to withstand without damage, vibration and shock as generally encountered in the locomotives and shall confirm to the standards as per tests specified in IEC-60571 and are as under:-

{i} Max. vertical acceleration: - 1.0g.
(ii) Max. longitudinal acceleration: - 3.0g.
(iii) Max. transverse acceleration: - 2.0g.

The vibrations are of the sine wave and the frequency of the vibration is between 1Hz and 5OHz. The amplitude 'a' expressed in mm is given as a function of 'f' by the equation.

a= 25/f for values of 'f' from 1 Hz to 10 Hz.
a= 250/f square, for values of 'f' exceeding 10 Hz and up to 50 Hz.

3.7.1 In the direction corresponding to longitudinal movement of the vehicle, the equipment is subjected for two minutes to 50Hz vibrations of such a value that the maximum acceleration is equal to 3g (amplitude a= 0.3mm)

3.8 **Electromagnetic and Radio Frequency Interference Pollution** – High degree of electromagnetic pollution is anticipated in locomotive through high voltage contactor operation and RFI produced through walkee talkee hand set of the driver's, where the equipment will be mounted. Necessary precaution should be taken in this regard.

CHAPTER IV

SCOPE OF SUPPLY

4.1 Scope of work

4.1.1 The scope under this specification covers design, development manufacture, supply, training and commissioning of the "Dc to DC converter for head light" of electric and diesel electric locomotives.

4.1.2 The following will be scope of supply.

Sl no.	Items	Qty.
1.	Dc to DC converter	1 no.
2.	One set of additional fuses	As required

a) One set per 5 units subject to minimum two sets of users maintenance & troubleshooting manual.

b) Assurance to give backup support for supply of cards for 5 years after the warranty period.

c) List of spare parts along with cost for maintenance of system for 3 years. (Optional)

d) Cost of annual maintenance contract. (Optional)

e) Cost of card repair. (Optional)

CHAPTER V

INSPECTION

5.1 The whole of the material or fittings used in the construction of the equipment shall be subjected to inspection by the Inspecting authority and shall be to his entire satisfaction.

5.2 The inspecting authority shall have the power to :-

5.2.1 Adopt any means he may consider necessary to satisfy himself that all the materials or fittings specified are actually used throughout the construction.

5.2.2 Visit at any reasonable time and without previous notice, either contractors works or his sub-contractor's works to inspect the manufacturers and the quality of the work at any stage.

5.2.3 To reject any materials or fittings that does not conform to the relevant standard specifications or have not been manufactured in accordance with the approved practices. The rejected materials or fittings shall be marked in a distinguishable manner and shall be disposed on in such manner as the inspecting officer may direct to avoid its inadvertent use in the product order as per this specification.

5.3 The manufacturer shall offer all the testing facilities free of charge to inspecting authority. Testing of equipment and fittings shall, as far as possible be carried out at the works of the manufacturers. Testing of bought out components may also be carried out at sub-contractor's premises, if so required. The contractor shall provide free of charge, such materials or fittings as may be required for testing whether at his own or his subcontractor's premises. The test for which facilities are not available may be carried out at RDSO or any other approved laboratory for which the testing charges shall be payable by the supplier.

5.4 All the equipments and the fittings required for test shall be selected by the inspecting officer and the tests shall be carried out in his presence.

5.5 No material shall be packed or despatched until it has been passed by the inspecting officer but the contractors responsibility for its efficiency in every way, shall remain the same as if the work had been manufactured and tested by himself.

5.6 Should any part required alteration or any defect appear during the test or trial the contractor shall without any extra charges make such alteration or rectify the defects to the satisfaction of the inspecting authority.

5.7 Copies of Maker's test certificate, guarantee the performance of the equipment shall be supplied in duplicated along with the delivery of each unit.

CHAPTER VI

TESTS

6.1 CATEGORIES OF TEST

6.1.1 **TYPE TEST:** Type test shall be carried out on equipment of the approved design. If there is any change in design or source of supply of any components/sub-components/assembly, units made to the changed design or from new source shall be treated as new item for the purpose of conducting type tests.

6.1.1.1 Type tests are to be repeated in case of any major change is made. In case of minor changes, i.e. change in type, rating of component etc., special test/tests as agreed by user and manufacturer are to be conducted to ensure their suitability and effectiveness of the modifications.

6.1.1.2 The type tests shall be repeated once in three years by RDSO

6.1.2 **ROUTINE TEST:** Routine test shall be carried out in every equipment of each order.

6.1.3 **ACCEPTENCE TEST:** Acceptance Test shall be carried on 10% of batch quantity subject to minimum of 5 nos. as per table given below.

6.2 Tests will be carried out on the prototype unit as per relevant IEC specification or mutually agreed test program. Manufacturer will bear the expenses of the tests.

6.2.1 The tests to be carried out on complete unit are given in the following table, together with the clause number of IEC 60571 to which reference should be made.

Sl. No.	TESTS	IEC CLAUSE NO.	SPEC. CLAUSE NO.	TYPE TEST	ROUTINE TEST	ACCEPT. TEST
1.	Visual Inspection	10.2.1	6.3.1	✓	✓	✓
2.	Performance test	10.2.2	6.3.2	✓	✓	✓
3.	Cooling Test	10.2.3	6.3.3	✓		
4.	Temperature rise test (Dry heat)	10.2.4	6.3.4	✓		
5.	Temperature rise (damp heat)	10.2.5	6.3.5	✓		
6.	Supply over voltage, Surges and electrostatic discharge test	10.2.6	6.3.6	✓		✓
7.	Transient burst susceptibility test	10.2.7	6.3.7	✓		
8.	Radio Interference test	10.2.8	6.3.8	✓		

9.	Insulation test	10.2.9	6.3.9	✓	✓	✓
10.	Dielectric test	10.2.10	6.3.10	✓	✓	✓
11.	Vibration and shock test	10.2.11	6.3.11	✓		
12.	Reverse polarity test		6.3.12	✓	✓	✓
13.	Output short circuit test		6.3.13	✓	✓	✓
14.	Dust test		6.3.14	✓		
15.	Reliability test		6.3.15	✓	✓	✓*
16.	Efficiency test		6.3.16	✓		✓

* On 5% of the lot offered or a minimum of 2 nos.

6.3 TESTS:

6.3.1 VISUAL INSPECTION:

(a) The initial visual inspection shall be carried out to ensure that the equipment is of sound construction, good workmanship, free from defect and meet the specification requirements. The inspecting authority is free to point out defects /checks. However, for guidance some checks are given below: -

(b) Dimensional check, mounting dimensions fastening arrangement, knob, terminals, switches, indications, serial numbers, type numbers, terminal marking etc. are correct as per approved drawings and free from defects i.e. missing nuts/bolts, sharp edges, cracks/broken terminals/knobs, worn screws/ too tight, dents, scratches, deformation of fins, fixing holes too close to edges, loose screws etc.

(c) Main component i.e. diodes, transistor, power transistor, IC's etc. are as per approved drawings and material.

(d) The protective-cum-adhesive coating used on PCB's is clear, transparent, not affecting colour code of electronic components and type number of devices and is in dry conditions. Heavy components are properly tied or fixed. The soldered connections are with good finish, no pealing off copper connecting circuit path/ repaired by solder or jumper and the surface is coated with solderable protection coating.

(e) All the resistors, capacitors, semi-conductor devices and other components mounted on PCB's are with round bend instead of sharp 90 deg bends, the height of components is uniform and minimum to avoid breakage, overhang/cantilever mountings of components has been avoided, heavy components are tied down with PCB's, resistors of more than 5 watts are provided with heat resistant sheet below to avoid burning of PCB's and heat dissipating components are separately mounted.

(f) Standard and good code of practice has been followed i.e. wiring are properly laid, tied, terminated, colour code followed, mounting pads have been used for IC's/transistors where necessary, no repaired PCB's have been used. No hylam PCB has been used.

(g) Check that all nuts, bolts, spring washers, washers and other parts used are galvanised or plated. Hexagonal head bolts provided with slot for screw driving have been used. Welded nut construction is preferable instead of threads in housing sheet metal.

(h) Anodised rating plate, engraved terminal marking have been provided, indications, switches, terminal etc. are marked as per drawing.

(i) Normally the manufacturer have a check list to avoid mistakes/missing of any item etc. a copy of the same should be obtained and left over points included in visual inspection.

(j) In case the samples did not pass the visual inspection, no further tests shall be conducted and the firm may be asked to screen the offered lot.

The second visual inspection (2) shall be carried out to check whether any damage or deterioration has occurred resulting from the test/tests performed. Under visual inspection(2) mainly it should be checked that there are no cracks, loosening of components, loosening of nut/bolts, buckling of PCB, deterioration of surface finish of components PCB/pealing of copper paths, damage to protective coating, developing dry solder, components lead breakage/crack, corrosion at the root of components leads, flash over mark, sparking etc.

6.3.2 PERFORMANCE TEST:

These tests are carried out to check and ensure that the performance of the equipment is in order and meets the specification requirements. These tests shall be carried out at the room temperature and magnetic field not significantly different from that of earth. The operating voltage should be as per clause no. 2.2

(a) Each dc-dc converter with rated load of 400/500 W, ammeters, voltmeters and variable voltage power supply shall be connected to measure input and output parameters under the following conditions:-

Vary the input voltage gradually from 0 to 140 V for electric locomotive and 0-85V for diesel electric locomotive and note the input and output voltage and current with lamp in circuit. Note the readings accurately when the output voltage becomes 24 V at the minimum nominal and maximum voltage. The test shall be done at minimum nominal and maximum input voltages for 3 times respectively.

Repeat the above test at no load.

(b) Set the input voltage at nominal voltage and switch it `ON' and `OFF' at least 5 times from input side and 25 times from output side and see that the current limit circuit is effective and the inrush current is not more than 20 A on output side for 400 Watt and 23A for 500 Watt unit. Repeat the test at maximum input voltage as specified in clause 2.2 of this specification.

(c) Set the input voltage at nominal voltage and a contactor across the load. Close the contactor to create the short circuit condition. Note the input, output voltage and current readings .The unit shall be kept shorted for two hours and the current limit circuit shall limit the current satisfactorily.

6.3.2.1 The performance test shall be at nominal voltage to determine whether any deterioration has occurred due to the previous tests. This is performed during and after environmental tests to prove that the equipment under test is within its operational limits and that it has survived on environmental test.

6.3.2.2 VOLTAGE VARIATION TEST:

This test should carried out as per 10.2.2 (a) IEC 60571. During the test system voltage shall be as per clause no. 2.2

6.3.2.3 A test shall be done to verify that when the display unit has a clear audio indication at the time of fault occur and keys operating condition in the working cab to attract the attention of the driver.

6.3.3 COOLING TEST:

Bring down the temperature of the equipment to $0^{o} \pm 2$ and keep it at the temperature for 2 hours and the carried out insulation test, Dielectric test at 85% voltage of the previous test and performance test after the recovery period of 3 hrs.

6.3.4 TEMPERATURE RISE TEST (DRY HEAT):

The temperature of the equipment is to be raised to 75°C at the rate of 1° c at 1.5 minute and to be kept at that temperature for 6 hours. In this test equipment should be in energised condition and check the working of the system. Cool it to the room temperature (recovery period 3 hrs) and carried out insulation test, Dielectric test at 85% voltage of the previous test and performance test.

6.3.5 TEMPERATURE RISE (DAMP HEAT):

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

6.3.6 SUPPLY OVER VOLTAGE, SURGES AND ELECTROSTATIC DISCHARGE TEST:

6.3.6.1 OVER VOLTAGE TEST:

The test shall be conducted as per IEC-60571, clause 10.2.6.1 at 200V.

1.8 times of the nominal system voltage (clause 2.2) shall be passed for two minute and the unit shall work satisfactory after the test.

6.3.6.2 SURGE TEST:

The test shall be conducted as per IEC-60571, clause 10.2.6.2. The surge pulse shall be 1.8 kV, 1.2/50 micro Sec

6.3.7 TRANSIENT BURST SUSCEPTIBILITY TEST:

This test shall be conducted as per IEC 1000 – 4 – 4.The complete s m in simulated installed condition shall be p he test as specified in The recommended test severity level is leve 4 with Dire Coupling f Power Lines & with Capacitive Coupling for Communication & Signal Li es. he EFT of defined severity shall be applied on C nication line, Ana g and digital input lines as follows:

Severity for Level 4		
	Power Lines	signal Lines
Repetition rate	2.5 kHz	5 kHz
Applied voltage	4 KV	2 KV

Rise time	5 ns+/- 30%	5 ns+/- 30%
Impulse duration	50 ns +/- 30%	50 ns +/- 30%
Burst duration	15 ms +/- 20%	15 ms +/- 20%
Burst Period	300 ms +/- 20%	300 ms +/- 20%
Connections / period	Direct Coupling both positive & negative side for 60 seconds each sides	Capacitive Coupling both positive & negative side for 60 seconds each sides

During test the equipment shall be watched for malfunctioning or any erratic behaviour. Data recorded in the memory of the system during test shall also be downloaded & evaluated through Evaluation Software for the performance of the system as well as Data Recording & Downloading system.

No degradation of the system & malfunctioning should be allowed during or after the test. For more details refer IEC 1000 – 4 – 4

6.3.8 RADIO INTERFERENCE TEST:

6.3.8.1 RFI RADIATED/RADIATED SUSCEPTIBILITY:

This test shall be conducted as per IEC 1000 – 4 – 3. The complete system in simulated installed condition shall be put in to the Radiation Chamber & desired Radiation as defined bellow shall be applied:

Freq. Range: 80 to 1000 MHz

Field Strength: 10V/m

Amplitude Modulation: 80% at 1kHz Sinusoidal

During test the equipment shall be watched for malfunctioning or any erratic behaviour. Data recorded in the memory of the system during test shall also be downloaded & evaluated through Evaluation Software for the performance of the system as well as Data Recording & Downloading system.

No degradation of the system & malfunctioning should be allowed during or after the test. For more details refer IEC 1000 – 4 – 3.

6.3.8.2 INDUCED RF FIELD CONDUCTED/ CONDUCTED RF SUSCEPTIBILITY:

This test shall be conducted as per IEC 1000 – 4 – 6. The complete system in simulated installed condition shall be put for the test specified in IEC. The desired Radiation as defined below shall be applied on DC power in lines of Recorder cum Indicator & analog and digital input lines of equipment:

Freq. Range: 0.15 to 80 MHz

Amplitude: 10V/rms

Modulation: 80% Amplitude Modulation

During test the equipment shall be watched for malfunctioning or any erratic behaviour. Data recorded in the memory of the system during test shall also be downloaded & evaluated through Evaluation Software for the performance of the system as well as Data Recording & Downloading system.

No degradation of the system & malfunctioning should be allowed during or after the test. For more details refer IEC 1000 – 4 – 6.

6.3.9 INSULATION TEST:

Megger the electronics circuit with respect to earth and check the insulation level with 500V megger range and ensure that the insulation resistances are greater than the following minimum requirements and record the actual values obtained: The time of the meggering shall not less then 60 Sec.

- 110 V circuit and earth : 20 M ohms.
- Control and Electronics to earth : 10 M ohms.
- Screen to earth : 10 M ohms.
- Input/Output to earth : 10 M ohms.

6.3.10 DIELECTRIC TEST:

The test shall be conducted corresponding to 1500 V rms, 50 Hz for 1 minute applied between shorted connections and metallic supporting frame the test shall be considered as un satisfactory if either a disruption discharge of flash over occur are dielectric equipment trips before 1 minute during the test.

6.3.11 VIBRATION AND SHOCK TEST

6.3.11.1 Vibration test:

The test is to carry out as per IEC-60571, clause 10.2.11.

The complete unit together with its mounting arrangements including shock absorbing devices if provided shall be subject to the following tests:

The unit under test shall be secured in a suitable position to a vibration machine producing vibrations of sinusoidal form with adjustable amplitude and frequency. The test frequency lowers than 5Hz may be omitted. The unit shall be tests in energized condition at no load with the following parameter

Vertical acc	= 1 g at 2 h
Longitudinal acc.	= 3 g at 2 h
Transverse acc	= 2 g at 2 h

Resonance search at 10 to 100 Hz. If resonance is not meet than 10 Hz at 15 min in each direction.

6.3.11.2 Shock test:

The complete unit shall be subjected to a series of three successive shoks each corresponding to 50Hz at 3 g duration 2 min in all the three direction

The tests are considered to be satisfactory in case there is no resulting damage, loosening of connections/components/sub-assemblies, abnormality in operation. The unit shall be able to pass electrical performance tests after this test.

6.3.12 REVERSE POLARITY TEST:

The equipment shall be tested to verify the reverse polarity protection by making the connection to reverse polarity and unit shall function normal after restoring the connection to correct polarity.

6.3.13 OUTPUT SHORT CIRCUIT TEST:

The unit shall be tested by connecting a outputs, working at normal voltage short circuit shall be created at output through a switch of suitable rating and keep the unit for 2 minutes. Unit shall perform normal after the test.

6.3.14 Dust test:

In case the facilities are available, it is preferable to conduct combined dust, humidity and heat test as per given parameters.

Ambient temperature	25°C +10°C
Raised upto	70°C ±2°C (for 2 hrs)
humidity of	more than 80% (say 90%)
Spraying of Dust	The quantity and method of application are subject to an agreement between user and manufacturer (as per IEC-571 cl no.27)

If the facilities do not exists for combined test, the dust test alone may be conducted against combined test. After this test insulation test and Dielectric test are carried out at 85% voltage of the previous test

6.3.15 Reliability Test:

The equipment shall be operated at rated resistive load of 400W for electric loco and 500W for Diesel Electric loco and nominal voltage of 110V for electric locomotive and 72 V for diesel locomotive and placed in a chamber for 100 hours. During the test the temperature in the test chamber shall be maintained at 70 deg C ± 2°C. After this test insulation test and Dielectric test are carried out at 85% voltage of the previous test.

Performance tests shall be conducted at ambient temperature on completion of 100 hour period to ensure that there is no deterioration in performance of converter

6.3.16 **Efficiency test:**

The efficiency of dc-dc converter at no load and full load shall be calculated based on readings at no load and full load. The full load efficiency shall not be less than 85 %

6.3.17 **Prototype Test Report:-**

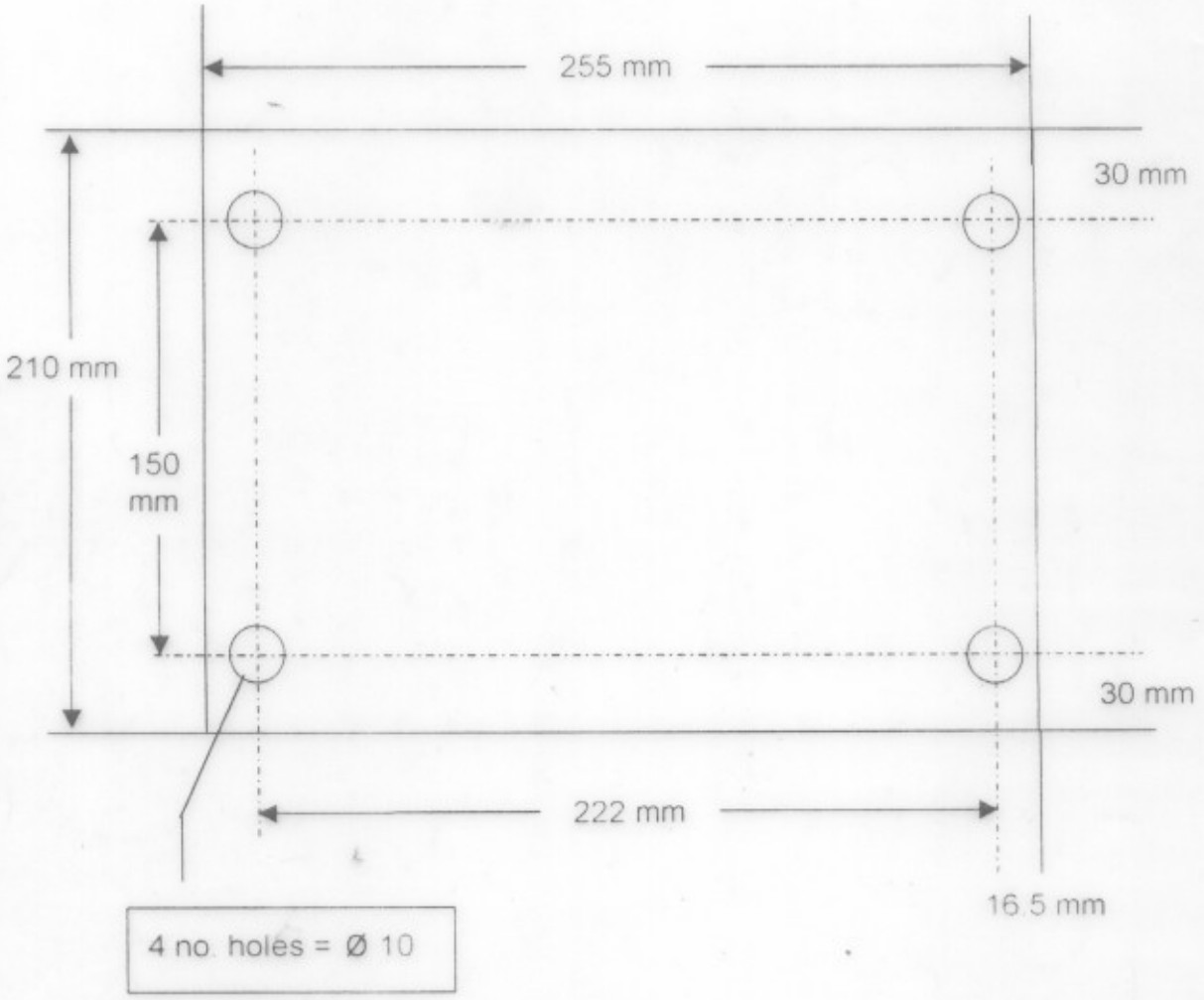
Complete prototype test report along-with test program circuit diagram, component details, working of the circuit etc. shall be bounded in booklet form and two copies of booklet shall be submitted to RDSO for record.,

Annexure - A

Technical details of DC-DC converter to be furnished by the Tenderer alongwith Tender :

1. Input voltage	:	a)	Minimum.....V
	:	b)	Nominal V
	:	c)	Maximum.....V
2. Input current	:	a)	At 110 V DC input...A (For electric locomotives)
	:	b)	At 72 V DC input....A (For diesel electric locomotives)
3. Output voltage	:		Nominal setting....V
4. Rating of each converter	:		W
5. Dimensions	:	a)	Length.....mm
	:	b)	Breadth....mm
	:	c)	Height.....mm
6. Weight of assembly	:		....Kg
7. Mounting arrangement	:		.....
8. Details of each component	:	a)	Type No.....
	:	b)	Rating with tolerance..
	:	c)	Junction temp. of diodes, transistors,thyristors etc..
	:	d)	Heat sinks details.

Annexure -B



Mounting details of Dc-Dc converter

Chief electrical Engineers:

1. Central Railway, Mumbai, CST-400 001.
2. East Central Railway, Hazipur-844101.
3. East Coast Railway, Chandrashekharpur, Bhubaneshwar-751016.
4. Eastern Railway, Fairlie Place, Calcutta-700001.
5. North Central Railway, Hastings Road, Allahabad- 211001.
6. Northern Railway, Baroda House, New Delhi-110001.
7. South Central Railway, Secunderabad-500 071.
8. South East Central Railway, Bilaspur-495004.
9. South Eastern Railway, Garden Reach, Calcutta-700 043.
10. Southern Railway, Park Town, Chennai-600 003.
11. West Central Railway, Jabalpur-482001.
12. Western Railway, Churchgate, Mumbai-400 020.
13. Chittaranjan Locomotive Works, Chittaranjan-713331 (WB)
14. Rail Coach Factory, PO: Hussainpur, Kapurthala-144 602(Punjab).
15. Integral Coach Factory, Perambur, Chennai-600 038.

(Ram Prakash)
for Director General Std/Elect

EL/6.11.1

Dated16.12.2004

Amendment no. 1

Sub : Amendment in the specification No. ELRS/SPEC/Dc-Dc Converter/0021 Rev-1 Sep 2004 of and DC-DC converter.

The specification No. ELRS/SPEC/Dc-Dc Converter/0021 Rev-1 Sep 2004 for Dc-Dc converter sent vide letter no. EL 6.11.1 date 22.9.04 does not include some of the parameters of diesel loco, EMU's & DMU's. The details of these parameters are given below.

Clause No	Existing	Amended
2.5	..... gray colour (code-631 of IS-5).	..... gray colour (code-631 of IS-5) *for electric loco and siemens gray for diesel locos.*
3.7	(i) Max. vertical acceleration - 1.*0g* (ii) Max. longitudinal acceleration - 3.0g (iii) Max. transverse acceleration - 2.*0g*	(i) Max. vertical acceleration - 3.*0g* (ii) Max. longitudinal acceleration - 3.0g (iii) Max. transverse acceleration - 3.*0g*
6.3.9	IR test -110V circuit and earth : 20 M Ohms -Control Electronics and earth : 10 M Ohms -Screen to earth : *10* M Ohms -Lamp unit to earth : *10* M Ohms	IR test - Control circuit and earth : 20 M Ohms - Electronics and earth : *20* M Ohms -Screen to earth : *20* M Ohms -Lamp unit to earth : *20* M Ohms
6.3.11.1	Vertical acc. = 1.0g at 2h Longitudinal acc. = 3.0g at 2h Transverse acc. = 2.0g at 2h	Vertical acc. = 3.0g at 8 hours Longitudinal acc. = 3.0g at 8 hours Transverse acc. = 3.0g at 8 hours

These amendments should be read along with above specifications

(Ram Prakash)
For DG/Electrical

Copy to: Dir/MP

Distribution: As per Attached list