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भारत सरकार रेल मंत्रालय

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

डीजल इलेक्ट्रिक लोकोमोटिव के 1 किलोवाट डीसी डीसी
कनवर्टर हेतु विशिष्टि
SPECIFICATION FOR 1 KW DC/DC CONVERTER
FOR DIESEL ELECTRIC LOCOMOTIVE

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**SPECIFICATION No:MP.0.04.00.06, Rev.'0', FOR 1 KW DC/DC
CONVERTER FOR DIESEL ELECTRIC LOCOMOTIVE**

1.0 FOREWORD

1.1 RDSO had issued a specification for DC-DC converter for electric & diesel electric locomotive no. ELRS/SPEC/DC-DC Converter/0021 Rev. 0, July'2002 for supplying power to ALCO locomotive head light system as well as instrument lamp load. A need has been felt to provide O.K. signal lamps and fog lights on ALCO locos and a common specification to cater for GM locos. In view of above, this specification for DC-DC converter is prepared for diesel loco application.

1.2 This specification requires reference to following standard specifications :

- (i) IS: 616 - Safety requirements for mains operated electronics or related apparatus for household and similar general use.
- (ii) IEC:60571 - Rules for electronic equipments used on Rail Vehicles.
- (iii) ELRS/SPEC/SI/0015- Reliability of Electronics used in Rolling Stock application.

2.0 SCOPE

2.1 This specification is meant for specifying technical requirements of DC-DC converter to be used for supplying power to locomotive headlight systems for ALCO or GM loco and O.K. signal lamps and fog lamps as well as instrument panel load of locomotive. It also specifies prototype and acceptance test methods to ensure consistency of quality of equipment.

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

3.0 CLIMATIC, ENVIRONMENTAL AND SERVICE CONDITIONS

Equipment shall be designed to work / withstand satisfactorily under climatic, environment & service conditions as mentioned below:

- 3.1 Max. Temperature : 70 deg. c.
- 3.2 Humidity : 100%.

- 3.3 Altitude : 1200 m above mean sea level.
- 3.4 Atmosphere : Extremely dusty. Hot weather desert terrain in certain areas.
- 3.5 Coastal area : Equipment shall be designed to work in coastal areas in humid and salt-laden and corrosive atmosphere.

4.0 Vibrations and Shocks

The DC-DC converter shall withstand satisfactorily vibrations and shocks normally encountered in service as indicated below: -

- a) Maximum vertical acceleration : 3.0 g
 - b) Maximum lateral acceleration : 3.0 g
 - c) Maximum longitudinal acceleration : 3.0 g
- ('g' being the value of acceleration due to gravity).

The vibrations are of sine wave form and the frequency of vibrations is between 1 Hz and 50 Hz. The amplitude 'a' expressed in mm is given as a function of 'f' by $a = 25/f$ for value of 'f' from 1 to 10 Hz. and $a = 250/f^2$ for the value of 'f' exceeding 10 Hz and up to 50 Hz.

5.0 GENERAL REQUIREMENTS

- 5.1 Headlight and other associated light system of the locomotive shall use a common DC/DC converter housing having 2 separate converters each designed for minimum continuous load of 1000 W for Diesel Electric locomotives but only one working at a time and other acting as standby. The input nominal voltage shall be 72 V DC and regulated output shall be $25.5V \pm 1 \%DC$ to meet the photometric standards, considering voltage drop in cables from DC-DC converter to Headlight.
- 5.2 MOS 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 aluminium section and black anodized. All steel parts shall be given suitable anti-corrosive treatment.

- 5.3 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.
- 5.4 In order to ensure high reliability of electronic components, the guidelines indicated in the RDSO Reliability Assurance Specification No. ELRS/Spec/SI/0015 should be implemented. A mention be made in the tender offer to the relevant clauses, which are not followed, and relaxation is required.
- 5.5 Any deviations to this specification considered necessary to improve performance, reliability of the unit or for any other reason, should be furnished by manufacturer 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

6.0 TECHNICAL REQUIREMENTS

6.1 DC-DC converter shall be designed for taking a continuous load of 1000 Watt under specified input and output conditions. The converter shall be designed to withstand starting in rush current of 50 ampere.

6.2 **Input supply :**

The input dc voltage to dc-dc converter shall be as under :

	Diesel Electric loco.
Nominal input voltage	72 V
Variation in input voltage	50V to 85V
Ripple content	up to 30% peak to peak

6.3 **Output supply :**

The output voltage shall be regulated and the voltage shall be maintained at 25.5± 1% dc.

6.4 **Output, Efficiency & Dimensions.**

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

	Output Wattage	1000 Watt.
(b)	Efficiency	Not less than 85 % .
(c)	Dimensions	360 (H) x 360 (W) x 200 (L)
(d)	System	(i). Suitable for (-)ve earthed battery system. (ii). Control must be on positive side.

6.5 **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 coupled together MCB shall be provided in the converter to selector either of the converter.

6.6 **PROTECTION**

- 6.6.1 Input fuses Individual HRC fuses for each of the twin converters shall be provided on positive side.
- 6.6.2 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.
- 6.6.3 Surge protection Protection against surges shall be provided in both the converters. Surges of 2 KV are expected in the system.
- 6.6.4 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 50 V. The system shall go into hiccup mode so as to immediately recover as the voltage improves.
- 6.6.5 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 wrong connection of battery voltage (72 V) at output terminals.

6.7 Indications and Terminals :

6.7.1 **Indications** : Indications shall be provided to indicate input present and output present for both the converters.

6.7.2 **Terminals** : 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.

7.0 **General Guidelines:**

- (a) The equipment shall be mounted in machine room on locomotive.
- (b) 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.
- (c) 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.
- (d) The use of Industrial grade components will be used for which a necessary certificate will be produced by the tenderer.
- (e) 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.
- (f) The use of jumper wire/fuse wire on PCB, soldered glass fuse base, rewirable fuse is not acceptable. The use of HRC fuse with proper mounting, arrangement is recommended.
- (g) 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.

- (h) The equipment shall not malfunction or be damaged when spikes or voltage surges are applied as indicated under surge test.
- (i) 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.
- (j) 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.
- (k) Equipment housing / exposed metal work shall be connected to vehicle frame for safety. Mounting arrangement shall not be treated as earthing and earthing-tinned pad with brass bolt shall be provided.
- (l) Equipment shall be designed such that regular / periodic maintenance shall not be necessary. Special maintenance if required shall be stated at the time of tendering.
- (m) The equipment (DC-DC converter) shall be burn-in after manufacture as per clause 7.7 & 12.2 of RDSO spec. No. ELRS/SPEC/SI/0015, Oct.'2001 keeping temp. limit from –10 deg. C to 75 deg. C.

8.0 Testing Facilities

The manufacturer shall offer all the testing facilities free of charge, to the inspecting authority for all the tests conducted at his premises.

9.0 TESTS FOR DC-DC CONVERTER

The offered equipment shall be subjected to the following Type, Routine and Acceptance tests. These tests shall be conducted as per the clause no. mentioned below:

List of tests to be performed are given below:

Sl.No.	Test description	Type	Routine	Acceptance	Clause No.
1.	Visual inspection 1	Y	Y	Y	Cl. 10.1
2	Visual inspection 2	Y	Y	Y	Cl.10.2

3. Dielectric and Insulation test.	Y	Y	Y	Cl. 10.3
4. Performance test-1	Y	Y	Y	Cl.10.4.1
5. Performance Test-2	Y	Y	Y	Cl.10.4.2
6. Temp. rise test (Dry heat test)	Y	-	-	Cl.10.6
7. Temp. rise test (Damp heat test)	Y	-	-	Cl.10.7.1
8. Surge and transient test.	Y	-	-	Cl.10.8
9. Vibration test	Y	-	-	Cl.10.9
10. Dust test	Y	-	-	Cl.10.10
11. Reliability test	Y	Y	Y*	Cl.10.11
12. Efficiency test	Y	-	-	Cl.10.12
13. Other tests				
- Temp. rise test	Y	-	-	Cl.10.7
- Performance check	Y	-	-	Cl.10.5
14. Salt mist test	Y	-	-	Cl.10.13
15. Low temp. storage test	Y	-	-	Cl.10.14
16. Burn-in test	Y	-	-	Cl.10.15

Legend: Y : Test to be conducted as per IS 2500 Pt.-1.

- : Test not to be conducted.

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

10. TEST METHODS FOR DC-DC CONVERTER

10.1 Visual Inspection (1):- (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 peeling 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 has 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.

10.2 VISUAL INSPECTION (2):

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/peeling 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.

10.3 DIELECTRIC AND INSULATION TEST:

10.3.1 INSULATION TEST:

The test shall be conducted on fully assembled equipment ready for inspection.

Insulation resistance measurement and dielectric test shall be conducted on:-

- i) Each circuit where galvanic isolation has been provided.
- ii) Each circuit of this type and earth, individual circuit may be connected together electrically for the purpose of this test.
- iii) For board assemblies with a metallic support frame the test shall be performed between all short-circuited connections of the plug connector and the metallic-supporting frame.
The test shall be conducted with 500 V megger and the insulation resistance shall not be less than 20 mega ohms.

10.3.2 Dielectric test:

The test shall be conducted corresponding to 1500V rms, 50 Hz for 1 min applied between shorted connections and the metallic supporting frame. The test shall be considered as unsatisfactory if either a disruption, discharge or flashover occur or dielectric equipment trips before one minute during the test.

10.4 Performance Test - 1

10.4.1 The performance test shall be conducted to determine that the unit is capable to meet the operating requirements specified in the specification. The following tests shall be conducted under performance Test -1

- (a) Each dc-dc converter with rated load of 1000 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 0-85V and note the input and output voltage and current with lamp in circuit. Note the readings accurately when the output voltage becomes 25 V at the minimum nominal and maximum voltage. Now load the DC-DC converter at its full capacity and observe the input & output current at minimum, normal and maximum input voltage. Repeat this test three times.

Repeat the above test at 25%, 50% and 75% rated 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 check the current limit circuit by overloading the output. The maximum in-rush current shall not be more than 50 A. Repeat the test at maximum input voltage of 85 V.
- (c) Set the input voltage at nominal voltage and connect 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.

10.4.2 Performance Test 2

The performance test 2 shall be at nominal voltage to determine whether any deterioration has occurred due to the previous tests.

10.5 Performance Check

The performance check is a short form performance test, which is performed during and after environmental tests and before performance test (1) and (2) to prove that the equipment under test is within its operational limits and that it has survived on environmental test.

10.6 Temperature Rise Test (Dry heat Run Test)

The test shall be carried out as per clause 10.2.4 of IEC-60571 on the complete electronic assembly as in normal operation at full load.

At the end of this test, a performance check as per clause 10.5 of this specification shall be conducted.

10.7 Temperature Rise Tests .

The test shall be carried out at room temperature with power supply 'ON' and output fully loaded for worst condition of input voltage at 50V and the temperature rise of critical components is measured to ensure that is within the limit agreed by RDSO.

10.7.1 Temperature Rise Test (Damp Heat Test)

The test shall be conducted as per clause 10.2.5 of IEC-60571 and performance test (2) as per clause 10.4.2 of this specification after the damp heat test.

10.8 Surge and Transient Test

Test shall be conducted as per clause 10.2.26 of IEC 60571 and performance check after the test.

10.9 Vibration test

The test shall be carried out as per clause 10.2.11 of IEC 60571 i.e. 8 hours in each direction.

10.10 Dust Test

In case the facilities are available, it is preferable to conduct combined dust, humidity and heat test as per clause 27 of IEC-571. If the facilities do not exist for combined test, the dust test alone may be conducted against combined test.

10.11 Reliability Test.

The equipment shall be operated at rated resistive load of 1000W and nominal voltage of 72 V and placed in a chamber for 100 hours. During the

test the temperature in the test chamber shall be maintained at 70 deg C \pm 2°C.

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.

10.12 Efficiency Test

The efficiency of dc-dc converter shall be calculated based on readings 25%, 50%, 75% and 100% load. The full load efficiency shall not be less than 85 %.

10.13 Salt Mist Test

This test shall be carried out as per IEC-60571 clause 10.2.10.

10.14 Low Temperature Storage Test

This test shall be carried out as per IEC-60571 clause 10.2.14.

10.15 Burn-in Test

After mounting of the components, the populated PCB cards kept in proper chassis in energized condition shall be burn-in for minimum 45 hours at 75 deg. C and -10 deg. C as per the cycle at Annexure I of spec. No. ELRS/SPEC/SI/0015, Oct.'2001. The PCB will be tested functionality to the extent possible during the burn in test.

11.0 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.

12.0 Design Manual

After the prototype is approved, design manual consisting of the following shall be supplied along with each supply order of dc-dc converter.

- a) Circuit diagram, component nos., rating of components and data sheets of all components.
- b) Drawing of the converter assembly along with part drawings.

13.0 Maintenance Manual

A maintenance manual shall be supplied with each dc-dc converter. It shall consist of the following:

- i) Trouble shooting procedures of DC-DC converter
- ii) Spare parts list as given in assembly drawing and component no. as given in the circuit diagram.

14.0 Marking

An anodized aluminium plate carrying following markings shall be fitted on the casing of DC-DC converter at a suitable place :-

- (i) Maker's name and trade mark
- (ii) Maker's serial number and year of manufacture.
- (iii) Specification No....
- (iv) System Voltage.
- (vi) Rating of converter.

15.0 Packing

The complete assembly shall be wrapped in polythene packing and placed in a craft board box and then packed in a wooden box (having adequate strength) in such a manner that there shall be no damage during transit.

16.0 Guarantee.

The DC/DC converter shall be guaranteed for a period of one year from the date of commissioning. Any component found defective within one year shall be repaired or replaced by the manufacturer free of cost.

17.0 INFRINGEMENT OF PATENT RIGHTS:

Indian Railways shall not be responsible for infringement of patent rights arising due to similarity in design, manufacturing process, use of components used in design and manufacturing of DC-DC converter and any other factor, which may cause such dispute. The responsibility to settle any issue rests with the manufacturer.

18.0 TYPE APPROVAL

18.1 Complete design details along with set of drawings shall be submitted to RDSO for approval. Material details for various items shall also be

furnished before the design is approved. Outer dimensions of the fittings can be finalised by actual mounting of the prototype on a locomotive in a loco shed of Indian railways. Only after the drawings and material details are finalised and approved by RDSO, the prototype unit shall be manufactured and offered for prototype tests. Type tests on one unit shall be carried out by the representatives of RDSO at the manufacturer's works. Type approval shall be granted by RDSO in case all the tests are successful. In the event of satisfactory type tests it will be fitted on few locomotives and performance shall be monitored for six months. After satisfactory performance, their provision may be extended on more locomotives.

- 18.2** Any modification considered necessary shall be carried out by the manufacturers free of cost. Authority for finalising the modification, if necessary, shall be RDSO.
- 18.3** After the units work satisfactorily in service, no modification in design shall be carried out without prior approval of RDSO.
- 18.4** Prototype tests shall be repeated by RDSO after a period of two years or earlier for revalidation of the design.
- 18.5** The tenderer may suggest superior design features if any which can be considered by RDSO/Purchaser based on overall cost benefit and technical superiority of the design proposals, simplicity in design, construction and operational reliability etc.

**Technical details of DC-DC converter to be furnished
by the Tenderer along with Tender :**

1. Input voltage : a) Minimum.....V
: b) NominalV
: c) Maximum.....V
2. Input current : a) 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.