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GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)

SPECIFICATION AND TEST SCHEDULE
FOR
DC-DC CONVERTER
FOR
DIESEL ELECTRIC LOCOMOTIVE HEAD LIGHT

SPECIFICATION NO.MP.0.2362.01
JULY 1993 ✓

Issued by
MOTIVE POWER DIRECTORATE
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Clause - 3

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NO.SD.DFM.Headlight

Date : 10/11-04-1996

The General Managers (Mech.),

1. Central Railway, Bombay VI-400 001.
 2. Eastern Railway, Faillie Place, Calcutta-700 001.
 3. Northern Railway, Banoda House, New Delhi-110 001.
 4. N.S.Railway, Gorakhpur-278 001.
 5. N.F.Railway, Maligaon, Guwahati-781 011.
 6. Southern Railway, Park Town, Madras-600 003.
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 8. S.E.Railway, Garden Reach, Calcutta-700 043.
 9. Western Railway, Churchgate, Bombay-400 020.
 - 10 Diesel Locomotive Works, Varanasi-221 004.
- Chief Mech.Engineer, Diesel Components Works, Patiala-147 001.

Sub : Amendment to RDSO specification No.MP.0.2362 of July 1993 for DC-DC converter for Diesel Electric locomotive head light.

Following clause of the above specification has been amended as under :

Cl.3.11"The test shall be conducted as per Clause 27 of IEC-571. The unit shall be placed after dust is settled in the unit in a chamber where the temperature is progressively raised from the ambient to 70 ± 2 deg. over a period of time between 1.5 to 2.5 hours with relative humidity of 95 to 100%. The unit shall be kept for 4 hours. The preparation of dust shall be done as per Clause 27 of IEC-571. At the end of this period, the performance test-2 shall be carried out after allowing for a recovery time of 2 hours".

Clause-3 : List of tests
item 14
Soak test deleted for "routine tests".

Encl : Nil.

(B.P.Gupta)
for Director General (MP).

Copy to :

1. Executive Director (Development), Railway Board, Rail Bhavan, New Delhi-110 001,
2. M/s. Bharat Heavy Electrical Ltd,Pvt., Piplani, Bhopal-462 022.

Encl : Nil.

B.P.Gupta
12/04/96
(B.P.Gupta)
for Director General (MP).

**Specification for DC-DC converter
for Head Light of Diesel locomotive**

1.1 Scope

This specification covers the design, and testing of DC-DC converter equipment for diesel electric locomotive head light in lieu of head light power resistor (HLPR).

1.2 Warrantee

The converter unit shall be guaranteed for satisfactory working for a period of 12 months from the date of commissioning or 24 months from the date of supply whichever is earlier. The period of out of commission on account of failure of the equipment during warrantee shall be excluded for the purpose of calculating period of warrantee.

DESIGN

- 1.3 The converter shall use power transistor employing pulse width modulation for voltage control. The output voltage and current shall be regulated by means of voltage and current feed back. 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, wiring connections and surges that may occur in course of locomotive working.

Heat sinks shall be of extruded anodised section and mat black powder paint coated. All steel parts shall be given suitable anticorrosive treatment.

1.4 Training

The supplier shall undertake to train free of cost concerned shed staff for installation, operation and maintenance of the equipment.

1.5 General requirements

- 1.5.1 The tenderer shall take into consideration the following factors in developing a suitable design to meet the specific requirement.

- 1.5.2 The offered equipment shall be suitable for the climatic environmental and service condition as given below:

Ambient temperature	Max - 70 deg.C
	Min- 0 deg/C
Humidity	Upto 95%
Altitude	160 m above MSL

Atmospheric condition

- extremely dusty upto 1.6 mg/m cube
- The equipment shall be required to work in coastal area in humid salt ladden corrosive atmosphere having
 - . maximum pH value - 8.5
 - . Sulphated - 7 mg/litre
 - . Max. chlorine concen - 6 mg/litre

Vibration shock

- 3 g (in each direction)

2.0 Equipment data

The equipment is to feed 250 watt 32V head light of diesel electric locomotive with dimming arrangement for 16 v. The brief data for the equipment are given below:

Input voltage

- . Nominal 72V DC
- . variation 50V to 85V DC

Input ripple

upto 15% (peak to peak)

Output voltage

- . Nominal 32V + 1% DC
- . Dim 16V + 1% DC (selected by an external switch)

Capacity

500 W at 70 deg.C continuous at 32V output.

Efficiency

Not less than 87% at rated input voltage and rated load.

Dimensions

Preferably within 250 mm x 175 mm x 135 mm including mounting arrangement.

System

Negative common electrical system exists on diesel electric locomotive.

Protections-

Short circuit

Suitable for sudden output short circuit for indefinite period. The equipment should restore after removal of short.

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to	. Over voltage	shall be suitable for operation upto 100V for 5 minute.
1 Be in humid osive	. Under voltage	The equipment shall function without any consequential damage at any lower voltage, the output voltage however shall be lower.
- 8.5 litre ten -	. Reverse polarity	Will not operate for reverse polarity input. No damage shall occur.
	. Terminals	The equipment shall be suitable for adopting standard control wire 48/.020" suitable with terminal lugs.
1)	Dielectric strength	1 KV max between any of the terminals and the casing for one minute.
esel The	Insulation resistance	Not less than 10 mega ohm with 500 V megger.

2.1 General Guidelines

- (i) Components designed for soldering shall be soldered properly. Flexible conductors, metallic braiding designed for carrying current shall not be soldered but fitted with crimped lugs and strain relieved. If Soldered lugs are used then not more than one wire shall be soldered to any one lug.
- (ii) Track to track, track to pad and pad to pad spacing shall be as wide as possible but subject to the absolute minimum design widths as given below:

Maximum voltage between adjacent conductors	Minimum spacing
Upto 15V	0.254 mm when solder mask is provided. 0.762 mm if solder mask is not used.
16V to 30V	0.762 mm
31V to 120V	4.064 mm
121V to 500V	6.350 mm

- (iii) The minimum clearance between track to board edge/ metal fixing shall be ensured for the voltages given below:

Voltage between conductor to earth	Minimum spacing
Upto 30V	3.18 mm
30V to 120V	4.1 mm.
121V to 500V	6.35 mm

- (iv) All printed board assemblies shall be protected on both sides with a flame retardant protective transparent coating in order to prevent deterioration or damages due to moisture and atmospheric contaminants. The protective coating shall not be applied on high temperature components, IC sockets, test points, connector contact mating surface etc.
- (v) Erasing or defacing of manufacturers markings on components will be treated as point for rejection.
- (vi) The use of burnt in industrial grade components is recommended.
- (vii) All the terminal, indications, switches shall be marked for easy identification and connection. The rating plate with manufacturers name, serial number etc. shall be fixed on the equipment.
- (viii) The use of jumper wire/fuse wire on PCB, soldered glass fuse, rewirable fuse is not acceptable. The use of HRC fuse with proper arrangement /fuse carrier is recommended.

2.2 Quality assurance programme

The supplier shall submit their internal quality assurance programme to the RDSO/purchaser. In this, frequency of various checks, details of nature of work involved in the checks and record maintained regarding these checks shall be indicated.

The supplier shall on demand by RDSO/purchaser make the records of check carried out during internal quality assurance available for scrutiny.

2.3 Maintenance

The supplier shall supply, free of cost, sufficient copies of the maintenance manual for trouble shooting purpose to the concerned diesel shed.

edge/
given

2.4 Field trial and product approval

After successful completion of type test, field trial of the prototype unit shall be carried out on a diesel locomotive for a period of six months before clearance for bulk supply is given. Any modification/improvement felt necessary during the field trials shall be carried out by manufacturer.

Based on performance evaluation after completion of one year of field trial, the manufacturer shall be approved for a limited period by RDSO/purchaser. Final approval shall only be given after extensive use on locomotives. However, RDSO/purchaser reserves the right to repeat the type test should it be felt necessary.

2.5 Packing and marking

The unit shall be suitably packed in shock and water proof boxes as to permit convenient handling and to protect against loss or damage during transit and storage.

The equipment shall be provided with a suitable rating plate for identification giving following:

- i. Manufacturer's name
- ii. Type and serial no.
- iii. Date of manufacture
- iv. Rating.

3. Testing

The offered equipment shall be tested for following three categories :

- Type Test
- Routine Test
- Acceptance Test

List of test to be performed are given below :

LIST OF TESTS

Sl. No.	Test Description	Type	Routine	Acceptance	Clause
1.	Visual inspection	*	*	*	3.1
2.	Insulation resistance test	*	*	*	3.2
3.	Di electric test	*	*	*	3.3
4.	Earth continuity test	*	*	*	3.4
5.	Performance test-1	*	*	*	3.5
6.	Performance test-2	*	*	*	3.6
7.	Temp.rise test(Dry heat)	*	-	-	3.7
8.	Temp.rise test:(At room temp.)	*	-	-	3.8
9.	Temp.rise test:(Damp heat)	*	-	-	3.9
10.	Cooling test(low temp.)	*	-	-	3.10
11.	Combined dust humidity & heat test	*	-	-	3.11
12.	Surge test	*	-	-	3.12
13.	Vibration test:	*	-	-	3.13
14.	Soak test	*	*	-	3.14
15.	Burn in test	*	*	-	3.15
16.	Efficiency test:	*	*	-	3.16

See Amendment 00
SD. 000. 14. 196.

3.1 Visual inspection

The initial visual inspection shall be carried out to ensure that the equipment is of sound construction, good workmanship, free from defects and meet all the specification requirements including dimensional check, mounting and fastening arrangement etc.

The second visual inspection shall be carried out to check whether any damage or deterioration has occurred resulting from the test/tests performed. It should be checked that no crack has developed, 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 roots of components leads, flashover mark, sparking etc.

3.2 Insulation Resistance test

The insulation resistance of the converter shall be measured with a 500 V megger. The measurement will be between the input terminals shorted together and the casing. The IR value measured thus shall not be less than 10 mega ohm.

3.3 Dielectric test

An externally produced sinusoidal voltage of 1500V, 50 C/S shall be connected for one minute between all the input/output terminals shorted together and all exposed

metal parts. The test voltage shall be applied gradually by stepless control to the specific value within 30 Sec. No flash over or sparking should occur during this test. Any earth connection shall be disconnected before conducting this test. IR value shall again be measured after dielectric test.

3.4 Earth continuity test

The test shall be performed to ensure that there is no break in specified earth circuit provided. The continuity resistance shall not exceed 100 milli ohms.

3.5 Performance test

The performance tests 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.

The unit shall be connected to the DC power supply (variable) and the output shall be connected to a resistive load which will draw 500 W at 32 V. Voltmeters and ammeter shall be connected to measure the input and the output.

The input voltage shall be gradually varied from 0 to 100V DC. The output voltage increases till it reaches $32V \pm 1\%$. Record the input and output voltage and current with load in circuit. The output voltage must be within the specified range of $32V \pm (i.e. 31.7 + 32.3V)$ when the input voltage is between 50V to 90V.

3.5.1 Open circuit test

The unit shall be subjected to open circuit test at 64V and shall be kept in this condition for one hour. The input current shall be measured.

3.5.2 Short circuit test

Set the input voltage at 64V DC and a contactor across 500W load. Suddenly close the contactor to create short circuit condition. Record the input/output voltage and current. This condition shall be maintained for one hour.

3.5.3 Over voltage test

An input DC voltage of 100V shall be applied for 5 minutes.

3.5.4 Under voltage test

The unit shall be subjected to under voltage test at 30V DC input. This condition shall be maintained for one hour.

3.5.5 Reverse polarity test

The unit shall be subjected to reverse polarity at 100V DC input and maintained for one hour.

3.5.6 Dimming test

Operate the dimming switch and vary the input voltage from 50V to 90V keeping the same load connected. The output voltage must be $16V \pm 1\%$ with a consequent decrease in the load current.

3.6 Performance test-2

The performance tests-2 shall be conducted at input voltages of 50V, 64V and 100V to determine whether any deterioration has occurred due to the previous tests.

3.7 Temperature rise test (Dry heat)

The test shall be carried out as per clause 24 of IEC-571. The unit shall be placed in a test chamber where the temperature is progressively raised from the ambient to $75 \text{ deg.C} \pm 2$ instead of 70 deg.C mentioned in IEC-571 over a period of half hour. The unit shall be kept in this condition for 6 hours. After this period the performance test-2 shall be carried out.

3.8 Temperature rise test (at room temp.)

The converter when operating at 72V DC input with full load shall be subjected to temperature rise continuously till the temperature gets stabilized. The temperature of heat sink, the indicator and the power semiconductor casing shall be measured. The working temperature computed for 70 deg.C ambient must be within the temperature limit of components as declared.

3.9 Temperature rise test (Damp heat)

The test shall be conducted as per clause 25 of IEC-571. The unit shall be placed in a chamber where the temperature is progressively raised from the ambient to $55 \pm 2 \text{ deg.C}$ over a period of 1 to 2 hours, the relative humidity being between 95% and 100%. The unit shall be kept in this condition for 10 hours. After this period the temperature is lowered to the ambient over a period of 3 hrs., relative humidity being 95 to 100%. After this the performance test-2 shall be carried out.

3.10 Cooling test

The test shall be carried out as per clause 23 of IEC-571. The unit shall be placed in a chamber where the temperature is progressively lowered from the ambient to -10 deg.C over a period of at least half hour. The unit shall be kept in this condition for 2 hours. After this, the performance test-2 shall be carried out.

3.11 Combined dust humidity and heat test

The test shall be conducted as per clause 27 of IEC-571. The unit shall be placed after dust is settled in the unit in a chamber where the temperature is progressively raised from the ambient to 75 ± 2 deg/C over a period of time between 1.5 to 2.5 hours with relative humidity of 95 to 100%. The unit shall be kept for 4 hours. The preparation of dust shall be done as per clause 27 of IEC-571. At the end of this period, the performance test-2 shall be carried out after allowing for a recovery time of 2 hours.

3.12 Surge test

A surge of 1.8 KV amplitude and 45 micro second width shall be applied to the equipment as per clause 22 of IEC-571. After this, the performance test-2 shall be carried out.

3.13 Vibration test

The test shall be carried out as per clause 28 (28.1 to 28.4) including investigation test as per clause 28.2 of IEC-571. After vibration test, the performance test-2 shall be carried out.

3.14 Soak test

The test shall be performed at ambient temperature. The unit shall be set up at 72V input DC and at full load for a period of 100 hours. After completion of test, the performance test -2 shall be carried out.

3.15 Burn in test

The equipment shall be energised at 72V with 500W load resistor and placed in a chamber at temperature 70 ± 2 deg.C for a period of 48 hours. Performance test-2 shall be conducted at ambient temperature on completion of 48 hours to ensure that there is no deterioration in performance or any failure.

3.16 Efficiency test

The efficiency of the unit shall be calculated from the readings of the input and output voltage and currents recorded during the performance test at no load and full load at rated voltage. No load loss shall not exceed 10W and full load efficiency not less than 87%. The losses shall not exceed 10% from the declared value.