Government of India
Ministry of Railways
(Railway Board)

INDIAN RAILWAY STANDARD SPECIFICATION FOR DC-DC Converter For Railway S&T Installations

Serial No. S 96-2000

0. FOREWORD

0.1 This specification is issued under the fixed Serial No. S 74 followed by the year of adoption as standard or in case of revision the year of latest revision.

ADOPTED 1989

0.2 This specification require reference to the following Indian Railway Standards (IRS) and Indian Standards (IS).

IRS: S 23	Electrical Signalling & Interlocking Equipment.
IRS: S 76/89	Indoor Signalling Cable
IRS: S 78	Non-deteriorating type fuses.
IRS: S 86	Battery charger for Railway S&T installations.
IRS: S 93 (B)	Valve Regulated (Sealed) Lead Acid Stationary Battery charger for S&T Installations.
IS: 1248	Direct Acting Analogue Indicating Electrical Measuring Instruments & their accessories.
IS: 2147	Degrees of protection provided by enclosure for low voltage switch gear and control gear.
IS: 2149	Dimensions for panel mounted indicating and recording Electrical Instruments.
IS: 3985	Monocrystalline/Semi conductor rectifier cells and stacks.
IS: 9000	Basic environmental testing procedures for electronics and electric items.
IS: 13947(Pt.3)	Air break switches. Air break disconnectors. Air break switch disconnectors and fuse combination units for voltages not exceeding 1000V AC or 1200V DC.

0.3 Whenever in this specification, any of the above mentioned specification is referred by number only, without mentioning the year of issue, the latest issue of that specification is implied, otherwise the particular issue referred to is meant.

0.4 This specification is intended chiefly to cover the technical provisions and does not include all the necessary provisions of contract.

1. SCOPE

1.1 This specification lays down the requirements and tests for DC-DC Converter for use in Railway Signalling installations.

1.2 The DC-DC Converter covered in this specification are suitable to operate from battery on float/boost charge with battery chargers as per specification IRS:S 86 & IRS:S 93 (B).

1.3 The DC-DC Converter covered under this specification shall work satisfactorily meeting all the prescribed parameters as long as the DC input voltage is within -10% to +20% of nominal input voltage.

1.4 This specification covers converters of output current up to 20Ams. The nominal input voltage, nominal output voltae & output current are required to be specified by the purchaser.

The recommended nominal input and nominal output voltage ratings are as under:

a) Nominal input voltage 24,60, 110V DC
b) Nominal output Voltage
   i) 5,10,12,60,110V DC
   ii) 24-30V DC (in a step of 2V)
   iii) 12-24V, 24-40V, 40-60V DC (in step of 4V)
   iv) 60-110V, 110-150V DC (in a step of 10V

1.5 Converters of multiple outputs are also covered in this specification.

1.6 Converters of modular structure with either n+1 or n+n configuration are also covered in this specification.

2. TERMINOLOGY

2.1 For the purpose of this specification the terminology given in IRS :S 23 (as applicable) shall apply.

3. CONSTRUCTION

3.1 The DC-DC Converter shall conform to the drawings, dimensions and layout, if any, specified by the purchaser.

3.1.1 Layout of back panel of cabinet type DC-DC converter shall be as per Drg. No. SDO/DC-DC/001.

3.2 The DC-DC Converter shall be of natural air cooled type and shall be suitable for indoor use in the cabins where the maximum ambient temperature may reach 60 deg.C. The converter shall be of shelf or floor or card mounting type as specified by the purchaser.

3.3 The DC-DC Converter shall be of robust construction. They shall be housed in a self supporting cubicle made of cold rolled closed annealed mild steel sheet o thickens not less than 1.5mm. The cubicle shall be adequately ventilated. Ventilating openings shall be less than 3mm of size for protection against entry of lizards etc. Cubicle shall be protected against ingress of water. The cubicle shall conform to IP-31 type of protection as specified in table - 1 of specification no. IS: 2147.

3.4 The DC-DC Converter cubicles where provided shall be treated with zinc chromate primer followed by electrostatic epoxy powder coating paint finish, passivation shall be done through seven stage process. Small metal parts such as nuts, bolts and washers shall be either galvanized or chrome plated. All other metal parts of the converter shall be plated for protection against corrosion.

3.5 The layout of the components and wiring shall be such that all parts are easily accessible for inspection, repairs and replacement.

3.6 All cables and wires used for wiring shall conform to specification no.IRS:S 76/IS: 694 of 1100V grading and shall be procured from RDSO approved suppliers. The cables and wires used shall be neatly secured in position by bunching and strapping. Aluminum wires shall not be used. The gauge of wiring shall be such that the current density does not exceed 3Amps/mm Sq. The colour scheme used for wiring shall conform to normal conventions and shall be shown in the instruction manual.

3.7 All connections shall be made through crimped eyelets and shall be numbered with PVC cable marker rings corresponding to the numbers/letters shown in the schematic wiring diagrams. Soldering shall be used only where use of crimped eyelets is not possible.

3.8 The schematic wiring diagram referred in clause 3.7 shall show al wiring used for inter connecting the main components of the converter. This diagram shall be drawn on the anodized aluminium plate of thickness not less than 1 mm and size not less than 150mm x 100 mm and shall be firmly fixed on the inside of the cover of the converter.

3.9 The components used for making the converter units such as transistors, diodes, SCRs, Linear ICs, Digital ICs. Power MOSFETS, Resistors, Capacitors, Switches, MCBs, Meters. Terminals, Fuses etc shall be minimum of industrial grade and shall be procured frm RDSO approved sources only.

3.10 All non-current carrying metal parts shall be bonded together and earthed. An earth terminal suitable for taking minimum 4mm dia wire and with suitable marking shall be provided.

4. COMPONENTS

4.1 Semi-conductor Devices

4.1.1 The DC-DC Converter shall use diodes/SCRs/Power transistors, Power MOSFETS, Linear & Digital Integrated circuits for achieving conversion from high DC voltage to low DC voltage. The rectifier cells and stacks, if used, shall comply with IS: 3895. The temperature rise for the semi-conductor devices above ambient shall not exceed 50 deg.C. The current rating of the power components such as diodes, SCRs, Transistors etc shall be more than twice the rated value of the converter.

4.1.2 The manufacturer shall declare the peak reverse voltage, current rating and working temperature of the rectifier element under ambient conditions, the number of elements used and the manner of their connection. The peak reverse voltage rating should not be less than two times the expected reverse voltage across the devices.

4.2 Printed circuit cards and components

4.2.1 The material for printed circuit board shall be copper clad, glass epoxy of grade FR-4 or equivalent. The nominal board thickness shall be minimum 1.6mm and thickness of the motherboard shall be minimum 2.4mm. Thickness of copper cladding shall be minimum 70 microns. The track width shall be 0.5mm nominal. In no case it should be less than 0.3mm. The spacing between tracks shall be 0.5mm nominal and in no case it shall be less than 0.3mm.

4.2.2 The printed circuit cards shall be fitted with plug in arrangement by using Male-Female, gold plated, harp/Euro/hartings connectors. No extra wires shall be used for interconnection of components on the PC card. Soldering of components shall be done with meticulous care so that joints are not dry.

4.2.3 The maker's name or trademark shall be engraved or printed on the cards.

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

4.2.5 Assembled printed boards should be given a conformal coating of Acrylic Varnish to enable them for functioning under adverse environmental conditions. The coating material should protect the assembly from the following hazards:

a) Humidity
b) Dust and Dirt
c) Air borne contaminates like smoke and chemical vaporous
d) Conducting particles like metal clips and filings
e) Accidental short circuit by dropped tools, fasteners etc
f) Abrasion damage

4.3 Meters

4.3.1 Each Converter shall be provided with a DC Ammeter to indicate the total current delivered by the unit. The Ammeter shall be of moving coil type mounted flush with the casing on the front panel. The range of the Ammeter scale shall be of 150% of the rated maximum output current of the unit.

4.3.2 Each converter shall be provided with a DC Voltmeter to indicate the output voltage of the unit. The Voltmeter shall be of moving coil type mounted flush with the casing on the front panel. The range of the Ammeter scale shall be of 150% of the rated maximum output voltage of the converter.

4.3.3 The meters shall conform to clause 1.1.1 (c) of IS: 2419 and shall be of accuracy class 1.0 or better of IS: 1248.

4.3.4 In case of DC-DC Converter of card module, the meters are not required to be provided.

4.4 Switches, Terminals, Indicators and Fuses

4.4.1 The converter shall be provided with non-deteriorating type fuses conforming to IRS:S 78 for the DC input and output circuits.

4.4.2 Each converter shall be provided with an ON/OFF rotary switch as per IS: 13947 Pt. 3. The rating of the switch shall be at least twice the maximum input current.

4.4.3 A selector switch shall be provided to select output voltages in case the converter is for giving more than one output voltages.

4.5 Indications

The converter shall be provided with means for protection and visual indication for the following indications.

4.5.1 Input power ON indication

4.5.2 Reverse polarity of DC input

4.5.3 Under voltage of DC input

4.5.4 Over voltage of DC input

4.5.5 Over load/short circuit of DC output

4.6 The converters of output ratings more than 150VA shall be provided with both audible and visual alarm for conditions mentioned at 4.5.1 to 4.5.5. Visual indications shall be provided for all the units irrespective of output rating.

5. PERFORMANCE REQUIREMENTS

5.1 Output must be isolated from input. Wherever multiple outputs are provided in single converter all output shall be isolated from each other unless specified by the purchaser.

5.2 Voltage regulation at full load shall not be worse than ±1% for all output ranges, for input supply variation from -10% to +20% of nominal input voltage indicated in para 1.4 above.

5.3 The output shall be free from over-shoot on account of turn 'ON/OFF' or power failure or when the battery charger is switched ON/OFF.

5.4 It shall work in the temperature range of 0 deg.C to 60 deg.C and relative humidity up to 95%.

5.5 The unit shall be provided with over-load protection, over-voltage protection and output short circuit protection with fold back characteristics. The over-load protection shall be effective at 135% of the nominal output rating.

5.6 The no load input current shall not be more than 10% of the rated input current at maximum full load for all setting of output voltage and input voltage variation from -10% to +20% of nominal input voltage.

5.7 The overall efficiency of the converter at full load shall not be less than 65% for converters of less than 50VA rated output, 75% for converters rating from 50VA to less than 150VA rated output and 85% for converters of 150VA or more rated output at -10% to +20% of nominal input voltage.

5.8 All components used such as transistors, diodes, FETS, Integrated circuits etc shall meet the relevant IS specification or JSS specification.

5.9 All indications and fuses shall be provided on the front panel. The ON/OFF switch shall also be provided on the front panel.

5.10 The noise spikes on the input side shall be attenuated by atleast 60 db when measured at the output side. For test purposes the noise spikes will be of 10V amplitude, 50 micro seconds pulse width with a repetition rate of 20Hz.

5.11 The additional requirements of DC-DC Converter for analog axle counter installation are as under;

i) The converter shall operate from 24V DC input.
ii) It shall have 5V/5A and 10V/1A outputs with common ground and isolated output 10V/0.5A.
iii) Output regulation of common ground output shall be 0.1% and for isolated output it shall be 1%.
iv) Glass fuses of 3.5A and 0.75A shall be provided in the input and isolated output respectively.
v) 5V/5A output shall have crow bar protection operating in the range of 5.8V ±0.2V to act within 20 micro seconds.
vi) Ripple shall not exceed 40mV peak to peak.
vii) Output monitoring sockets and indications shall be provided for all outputs and trimming potentiometer control shall be provided for 5V/5A and 10V/1A.
viii) Indications for nominal, under and over voltage of input shall be provided.
ix) Meters are not required to be provided
x) ON/OFF Toggle switch shall be provided in the input side.
xi) The pin configuration of connector for card and cabinet module shall be as per Annexure.

5.12 The converter shall have self re-setting type protection from under voltage of DC input, over voltage of DC input, over load of DC output and short circuit of DC output. The converter shall be adequately protected against surges/lightening at the input.

5.13 The output ripple (peak to peak) of the converter shall not be more than 1% of the rated output voltage at full load.

6. MARKING

6.1 All markings/identifications shall be easily legible and durable. Where the marking is by use of labels, labels shall be metallic or screen-printed and shall be firmly fixed and shall not be capable of being removed by hand. Durability of marking shall be checked by rubbing the marking by hand for 15 seconds with a piece of cloth soaked with petroleum spirit. This requirement shall also be met after meeting all climatic tests.

6.2 All markings/identifications shall be placed in the vicinity of the components to which they refer and shall not be placed on removable parts, if thee parts, if these parts can be replaced in such a way that the markings become misleading.

6.3 Each converter shall be provided with a rating plate fixed outside at a conspicuous position. The rating plate shall be anodized/engraved and shall show the following information.

a) Name of the manufacturer
b) IRS No.S.96
c) Nominal DC output voltage
d) Rated output DC current
e) Nominal DC input voltage
f) Serial No. and year of manufacture.

6.4 The word 'INDIAN RAILWAY PROPERTY' shall be indelibly etched or engraved on the converter at a conspicuous position. The size of letter shall be chosen depending upon the size of the converter cubicle but shall not be less than 5 mm high in any case.

7. INSTRUCTION MANUAL

Two copies of instruction manual duly approved by RDSO shall be supplied with each converter. The manual shall include the following information.

i) Installation instructions
ii) Guaranteed performance data and technical and other particulars of the converter.
iii) Detailed wiring diagram showing all components and their values. This should include, transformers, chokes, SCRs, Diodes, Transistors, FETs, ICs, Capacitors, Potentiometers etc.
iv) Schematic block diagram showing general maintenance arrangement of various components.
v) Operating instructions including detailed procedure for various settings and functions of switches and other accessories provided on the front panel. This should include Maintenance instructions also.
vi) Trouble-shooting procedure.
vii) Any other information which the manufacturer may like to give.

8. TESTS AND REQUIREMENTS

8.1 Conditions of Tests - Unless otherwise specified, all tests shall be carried out at ambient atmospheric conditions.

8.1.1 For inspection of material, relevant clauses of this specification shall apply.

8.2 Test Equipment - The ammeters and voltmeters used in the tests shall be of an accuracy class equal to at least 0.5 of IS: 124 (or 4-1/2 digit display digital multimeters).

8.3 Type tests - The following shall constitute type tests and shall be carried out once in three years in the sequence given below.

a)	Visual inspection	(Cl 8.6)
b)	Applied high voltage test	(Cl. 8.7)
c)	Insulation resistance test	(Cl. 8.8)
d)	Performance test	Cl. 8.9)
e)	Tests on protective devices	(Cl.8.10)
f)	Tests for continuous operation	(Cl. 8.11)
g)	Overload and In-rush current test	(Cl. 8.12)
viii)	Vibration test	(Cl.8.13)
ix)	Climatic tests	(Cl. 8.14)

8.3.1 Only one converter of each type and output rating shall be tested for this purpose. The unit shall successfully pass all the type tests for proving conformity with this specification. If the unit fails in any of the type tests, the purchaser or his nominee at his discretion may call for another converter unit of the same type and output rating and subject to all tests or to test(s) in which failure(s) had occurred. No failure shall be permitted in the repeat test(s).

8.3.2 At the end of the validity period for type test or earlier, if necessary, the testing authority may call for fresh samples for type tests.

8.4 Acceptance Test

The following shall constitute acceptance tests:

a)	Visual inspection	(Cl 8.6)
b)	Applied high voltage test	(Cl. 8.7)
c)	Insulation resistance test	(Cl. 8.8)
d)	Performance test	Cl. 8.9)
e)	Tests on protective devices	(Cl.8.10)
f)	Overload and In-rush current test	(Cl. 8.12)

8.4.1 Visual inspection, applied high voltage test, insulation resistance test and performance test shall be carried out on all converters. The following sampling plan shall be adopted for the remaining tests:

Lot Size	Sample size	Lot size	Sample size
2-8	2	51-100	13
9-15	3	101-150	20
16-25	5	151-200	32
26-50	8		

For acceptance of the lot, there shall be no failures.

8.5 Routine test

The following shall constitute routine tests and shall be carried out on every converter and test results will be submitted by manufacturer to the inspecting authority at the time of inspection.

a)	Visual inspection	(Cl 8.6)
b)	Applied high voltage test	(Cl. 8.7)
c)	Insulation resistance test	(Cl. 8.8)
d)	Performance test	Cl. 8.9)
e)	Tests on protective devices	(Cl.8.10)
f)	Tests for continuous operation	(Cl. 8.11)

8.6 Visual Inspection

The converter shall be examined for provisions of all facilities stipulated in this specification, correct wiring, proper mounting of components, marking, workmanship and finish for which no tests have been specified.

8.7 Applied High Voltage test

The converter shall withstand for one minute without puncture and arching a test voltage of 1000V AC rms applied between power components and the body of the unit, which shall be earthed. The test voltage shall be approximately sine wave form and of any frequency between 50 and 100 Hz. Any electronic components(s), which are likely to get damaged by the application of high voltage, shall be disconnected during the test.

8.8 Insulation Resistance test

This test shall be carried out

a) Before the high voltage test
b) After the high voltage test
c) After the climatic test have been completed.

The measurements shall be made at potential of not less than 500V DC. The insulation resistance shall be measure between;

a) Input line terminals and the body of the equipment.
b) Output line terminals and the body of the equipment.

Value of the insulation resistance shall not be less than 10 Mega ohm for the equipment and 100 M.ohms for the transformers and inductors if any used in the equipment, measure at a temperature of 40 deg. C and Relative Humidity of 60%. There shall not be more than 5% change in the values measured before and after high voltage test.

After the completion of climatic tests, the value shall not be less than 5 M. Ohms for the equipment and 50 M. ohms for transformers and inductors measured at a temperature of 40 deg.C and Relative Humidity of 60%. In case the prevalent values of temperature and RH at the time of measurement are different from those specified above, the IR values shall be obtained from Table 'A' or 8.8.1.

8.8.1 **Table 'A'**

RH	25 Deg C	30 Deg C	35 Deg.C	40 Deg. C
60%	100 M.Ohms	100 M.Ohms	100 M.Ohms	100 M.Ohms
65%	100 M.Ohms	90 M.Ohms	85 M.Ohms	80 M.Ohms
70%	80 M.Ohms	70 M.Ohms	65 M.Ohms	60 M.Ohms
75%	60 M.Ohms	53 M.Ohms	47 M.Ohms	43 M.Ohms
80%	42 M.Ohms	36 M.Ohms	33 M.Ohms	30 M.Ohms
85%	29 M.Ohms	25 M.Ohms	22 M.Ohms	18 M.Ohms
90%	20 M.Ohms	16 M.Ohms	13 M.Ohms	10 M.Ohms
95%	15 M.Ohms	10 M.Ohms	7 M.Ohms	5 M.Ohms
100%	10 M.Ohms	6 M.Ohms	3 M.Ohms	1 M.Ohms

Note 1) The value of insulation resistance has been taken as 100 M.ohms at a temperature of 40 deg.C and RH of 60%. Values of IR at different temperature and RH may be obtained from the table.

2) To obtain the value of IR, corresponding to 50 M.ohms or 10 M.ohms or 5 M.ohms at 40 deg. C and 60% RH, a multiplying factor of 0.5 or 0.1 or 0.05 respectively may be used.

3) The value of insulation resistance for extreme conditions of temperature and humidity shall not be less than 1 M. ohms even if the IR value of 60% RH and 40 deg. C temperature is less than 100 M. ohms.

8.9 Performance Test

The converter shall be tested for its electrical performance as per clause 5 of the specification. At least one sample shall be tested at an environment temperature of 60 deg.C during acceptance/type tests. Tests as per para 5.10 are to be carried out during type test only.

8.10 Test for Protective Devices

The converter unit shall be tested for output short circuit protection, over load protection, input reverse polarity protection and crow-bar protection if required in terms of requirements brought out in para 5.

8.11 Test for Continuous operation

The converter shall be subjected to a continuous run for 72 hours at rated input voltage and rated output load. After this test the unit shall satisfy the requirement of clause 5.

8.12 Overload and In-rush current test

The converter shall be capable of delivering 125% of rated full load at any ambient condition specified in clause 5.4 for a period of 4 hours. It should be capable of delivering 200% of the rated full load for a period of 300 milli sec in order to cater for the high inrush current at the time of switching 'ON' of the converter.

8.13 Vibration test

The charger shall be subjected to the vibration test (sinusoidal) as per IS:9000 Pt. VIII with following severities.

i)	Frequency range	1-35Hz
ii)	Amplitude	0.35 or 5g
iii)	No. of Axes	3
iv)	No. of sweep cycle	10
v)	Total duration	1 hour 45 minutes
vi)	If resonance is observed, vibration test at resonant frequency at each resonant frequency.	10 Minutes

After the test the charger shall be visually inspected for any mechanical damages. The electrical parameters shall be measured as per Cl. 8.9.

8.14 Climatic Test

8.14.1 Climatic tests shall consist of:

i) Dry heat test at 60 deg. C ± 2 deg C at full rated output for 16 hours duration as per IS:9000 (Pt.III) Section 5, during which the maximum temperature rise shall not exceed 50 deg.C. During last half an hour of this test, the converter shall be checked to meet the requirements of clauses 5 at a controlled oven temperature of 55 deg. C.

ii) Damp heat (cycle) tests for variant 1 for 7 cyles at upper temperature range of 40 deg C ± 2 deg. C as per IS:9000 Pt. V Section. 2.

iii) Cold test at 0 deg. C for two hours duration as per IS:9000 (Pt.III) during last half an hour of this test, the converter shall be checked to meet the requirements of clauses 5.

9. PACKING AND LEBELING

9.1 The complete unit shall be packed in suitable strong boxes/crates to prevent damage or loss of the unit during transit. Loose space inside the box/crate shall be filled with suitable packing material.

9.2 Each box shall be legibly marked at one end with code numbers, contents, quantity and name of manufacturer/supplier.

10. INFORMATION TO BE SUPPLIED BY THE PURCHASER

a) The nominal input voltage (Clause 1.4)
b) Nominal output voltage (Clause 1.4)
c) Rate output current (Clause 1.4)
d) Drawing dimensions and layout (Clause 3.1)
e) Type of mounting required - shelf/floor/card mounting (Clause 3.2)
f) Whether required for signalling/axle counter (Clause 5.11)