GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(Railway Board)

INDIAN RAILWAY STANDARD SPECIFICATION FOR BATTERY CHARGERS FOR RAILWAY S&T INSTALLATIONS

Serial No. 86-2000

0. FOREWORD

0.1 This specification is issued under the fixed serial No.S-86 followed by the year of adoption as standard or in the case of revision, the year of latest revision.

ADOPTED - 92

REVISED - 2000

0.2 This specification requires reference to the following specifications:

IRS: S 76-89	Specification for PVC insulated cables and wires for Indoor Railway Signalling.
IRS:S 23	Electrical Signalling & Interlocking Equipment.
IS: 694	PVC insulated cables for working voltage upto and Including 1100V.
IS: 1248	Direct Acting Analogue Indicating Electrical Measuring Instruments and their accessories.
IS: 2026	Power Transformers
IS: 2208	HRC Cartridge fuse links upto 650V
IS: 2419	Dimensions for panel mounted indicating and recording Electrical Instruments.
IS: 2628	Rotary Wafer Switches
IS: 2736	Ceramic Dielectric Capacitors, type 2
IS: 2959	Contactors for voltage not exceeding 1000V A.C or 1200V D.C.
IS: 4064	Air break switches, air-break disconnectors, air-break Switch-disconnectors and fuse combination units for Voltages not exceeding 1000V ac or 1200V dc
IS: 5786	Fixed resistors general purpose low power

IS 6297 (pt. I & II)	Transformers and inductors (power audio pulse and switching) for electric equipment.
IS: 8083	Ceramic Dielectric Capacitors of the plate type.
IS: 8823	Miniature air-break circuit breaker for A.C circuits for Voltage not exceeding 1000V.
IS: 2147-1962	Degrees of protection provided by enclosure for low Voltage switch gear and control gear.
IS: 8909	Fixed resistors, general purpose power
IS: 9000	Basic environmental testing procedures for electronics and Electric items.
IS: 9224	Low Voltage fuses.
IS: 9633	Fixed polyester film-dielectric capacitors for direct current.
IS: 10249	Voltage dependent resistors (variators)
RDSO/SPN/144/2006–	Specification for Safety and Reliability requirement of Electronic Signalling equipment.

0.3 Whenever in this specification, any of the above mentioned specifications 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 a contract.

1. SCOPE

1.1 This specification lays down the requirements and tests for battery chargers for use in Railway S&T installations.

1.2 The battery chargers covered in this specification are self-regulating type and are suitable for charging of lead acid stationary secondary batteries. In auto mode of working the charger will automatically change over from auto float to auto boost mode of working if the batteries are discharged and will switch back to auto float mode after the batteries get charged. A provision is also made to switch over to manual mode in case failure of auto mode. However, chargers with manual mode alone are not covered by this specification.

1.3 The battery charger covered under this specification shall work satisfactorily meeting all the prescribed parameters as long as the AC input voltage is within 160V-270V range. In case the AC input voltage goes below ‘160V’ or goes above ‘270V’ use of a separate AC voltage stabilizer in conjunction with the charger is recommended.

1.4 The nominal output voltage and the rated output current of the charger are required to be specified by the purchaser.

Note 1) : The nominal voltage of a lead acid secondary cell will be taken as 2.0 volts and nominal output voltage of the charger will be calculated accordingly.

Recommended capacity of chargers for some of the standard capacity secondary cells in use on Railways are given below:

S.No	Cell Cap (Amps. Hrs)	C/10 Rate	Maximum permissible load (A)	Minimum current rating of charger (A)	Recommended current rating charger (A)
1.	40	4	4	8	10
2.	80	8	8	16	20
3.	120	12	12	24	30
4.	200	20	20	40	40
5	300	30	30	60	60
6	400	40	40	80	80
7	500	50	50	100	100

Note –2: The nominal voltage ratings of 12, 24, 36, 48, 60, 110 & 120 volts are recommended for adoption by Railways. This will help in standardizing the equipment and ultimately in testing and maintenance.

Note – 3: In case, the charger is required for input voltages other than standard 230V AC, the same shall be specified by the purchaser. Special requirements, if any, shall be specified by the purchaser.

1.5 The charger of 12, 24, 60 & 110 volts output shall have a provision for charging number of cells as mentioned below:

Output Voltage	Provision for charging No. of cells
12	6,7,8
24	12,13,14
60	30,31,32
110	55, 56, 57

LED Indication shall be provided for indication of number of cell selected.

1.6 One set of spare control card shall be supplied along with each battery charger and shall be kept inside the charger at conspicuous position to avoid any kind of damage.

2. TERMINOLOGY

For the purpose of this specification, the terminology given in IRS:S 23 shall apply.

3. CONSTRUCTION

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

3.2 The chargers shall be of natural air cooled type and shall be suitable for indoor use in the cabins where the maximum ambient temperature may reach 55º C. The chargers shall be of shelf or floor mounting type as specified by the purchaser.

3.3 The charger shall be of robust construction they shall be housed in self supporting cubicles made of cold rolled closed annealed mild steel sheet of thickness not less than 1.6 mm ± 0.12mm as specified in IS: 513-1994. The cubicles shall be adequately ventilated. Ventilating openings shall be less than 3mm size for protection against entry of lizards etc. The cubical shall confirm to IP-31 type of protection as specified in table 1 of Specification no IS: 2147-1962.

3.4 The charger cubicles 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 charger 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 The AC input portion shall be clearly isolated and protected to prevent accidental contact.

3.7 All cables and wires used for wiring shall conform to Specification No. IRS:S 76-89/IS 694 (1100V grade) and shall be procured from RDSO approved sources. The cables and wires used shall be neatly secured in position by bunching and strapping. Aluminium wires shall not be used. The gauge of wiring shall be such that the current density does not exceed 3 amps/mm^2. The colour scheme used for wiring shall conform to normal conventions and shall be shown in the instruction manual.

3.8 All connections shall be made through crimped eyelet 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.

3.9 The schematic-wiring diagram referred in clause 3.8 shall show all wiring used for interconnecting the main components of the charger. This diagram shall be drawn on an anodised aluminium plate of thickness not less than 1 mm and size not less than 150 mm x 100 mm and shall be firmly fixed on the inside of the cover of the charger.

3.10 The components provided on the front panel shall be as per drawing No. SDO/RDSO/LM/BC/001.

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

3.12 The charger unit shall have separate battery and load terminals for all ratings.

3.13 All cable entry holes should be provided with rubber grommets.

3.14 All wire terminations shall be provided with spring washers, locking washers etc to avoid cases of loose connection. All the wires/ cables shall be properly held with cable ties.

4. COMPONENTS

ICs and other components used in the equipment shall be of industrial grade with operating temperature range -25 deg.C to +85 deg.C and shall conform to HIREL programme of CDIL or equivalent. Capacitor used should be certified for atleast +105^{o} C.

4.1 Transformers and Chokes

4.1.1 The main transformer shall be double wound and shall conform to Category 3 (clause 3.1) of IS: 6297 (Pt. 1) – 1971 and Grade 2 (Table 1) of IS: 6297 (Pt.II) – 1973. Class B or higher grade insulating material shall be used.

4.1.2 The transformers and chokes shall be vacuum impregnated.

4.1.3 When tested in accordance with clause 6.2.1.6 of IS:6297 (Pt.I)-71, the main transformer shall show an insulation resistance of not less than 1000 meg. ohms. This value shall not fall below 500 megohms at the end of climatic tests.

4.1.4 The maximum permissible rise in temperature above ambient shall be 65ºC for transformers and chokes.

4.1.5 The gauge of winding copper wire shall be such that the current density does not exceed 2 Amps/sq. mm

4.2 Rectifying elements

4.2.1 The chargers shall use silicon diodes and/or silicon controlled rectifier for rectification. The rectifier cells and stacks shall comply with IS:3895-66. They shall be suitably protected against surges.

4.2.2 The rectifier stacks shall be connected for full wave rectification. The stacks shall be of robust construction and of adequate rating. The temperature rise above ambient shall not exceed 50ºC or 20ºC less than that specified by the manufacturer whichever is less. The current rating of power components such as diodes, SCRs etc. shall be rated more than twice the current flowing through them.

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

4.2.4 All resistors used shall be at least double the power capacity, which is supposed to be dissipated in them. The voltage rating of capacitor shall be at least 50% above peak value. The resistors and capacitors used in control cards, firing cards and comparator cards etc. shall be of tolerances not more than 5% and 10% respectively. The resistors and capacitors used elsewhere in the charger shall be of tolerance not more than 10% & 20% respectively.

4.3 Printed Circuit Cards

4.3.1 **PCB material**: Material for the printed circuit board shall be copper clad glass epoxy of grade FR-4 or equivalent. PCB shall be of standard size.

4.3.2 **Outline dimensions**: PCB's shall be of standard size.

4.3.3 **Board thickness**: The thickness of PCB cards and motherboard shall be as per currently available technology. There should be no deformity in the PCB cards or the motherboard due to mounting of heavy components or due to ageing effect.

4.3.4 **Track Width**: The track width shall be 0.5 mm nominal. In no case it should be less than 0.3 mm.

4.3.5 **Spacing between Tracks**: Spacing between tracks shall be 0.5mm nominal and in no case it shall be less than 0.3 mm.

4.3.6 The printed circuit cards shall be specifically designed to suit the circuitry used and no extra wires or jumpers shall be used for interconnection of components on the PCB. No piggy-back PCB shall be connected to any PCB. The components shall be soldered with wave-soldering machine. Any exception to wave-soldering machine shall have specific approval of RDSO, Lucknow.

4.3.7 The cards shall be provided with testing points and the corresponding voltages / waveforms shall be indicated in the fault diagnostic procedure and service manual to facilitate testing and fault tracing.

4.3.8 CONFORMAL COATINGS: Assembled & tested printed boards should be given a conformal coating to enable them for functioning under adverse environmental conditions. The coating material should be properly chosen to protect the assembly from the following hazards:

(a) Humidity;
(b) Dust and dirt;
(c) Airborne contaminants like smoke and chemical vapours;
(d) Conducting particles like metal clips and filings;
(e) Accidental short circuit by dropped tools, fasteners etc.;
(f) Abrasion damage and
(g) Vibration and shock (to a certain extent).

4.3.9 The solder masks shall be applied on the solder side and component side of the card.

4.3.10 Following description shall be etched on the component side of the PCB:

i) Component outline in the proximity of the component.
(ii) Manufacturer's name.
(iii) PCB name.
(iv) Equipment name.
(v) Part number.

4.3.11 Following description shall be engraved / marked with permanent marker on the PCB

(i) The manufacturing serial number.
(ii) Month and year of manufacture.

1.3.12 Printed circuit cards shall be fitted with gold plated Euro/ D type plug in connectors with locking arrangement. Mechanical arrangement e.g. a clip or a screw to hold the PCB in inserted position shall be provided. Screws should be countersunk and held on PCB when it is plugged out. The PCB shall be mechanically polarized so

that it is not possible to insert the PCB into wrong slot. Suitable mechanical arrangement shall be provided against wrong insertion of connectors.

4.3.13 **Heat Dissipating Components**: All components dissipating 3W or more power shall be mounted so that its body is not in contact with the board unless a clamp, heat sink or other means are used for proper heat dissipation.

4.3.14 **Burning in**- After mounting of components the populated PCB cards kept in proper chassis in energised condition shall be burnt in for 168 hours at 60 deg.C.

4.3.15 The distribution of the power supply on the cards should be such that different voltage tracks (0, 5V etc.) follow the same route as far as possible. The track of power supplies should be as thick and wide as possible.

4.4 Meters:

4.4.1 Each charger shall be provided with a DC ammeter to indicate the total current delivered by the charger/battery charging/discharging current. The ammeter shall be of the moving coil center zero type mounted flush with the casing on the front panel. The range of the ammeter scale shall be 125% to 150% of the rated output current of the charger. The rated output current of the charger shall be indicated on the meter scale by a distinct green marking.

4.4.2 An arrangement shall be provided so that it may be possible to read an ammeter either the total current of the charger or current drawn by the battery set.

4.4.3 Each charger shall be provided with a d.c voltmeter to indicate the output voltage of the charger. The voltmeter shall be of the moving coil type mounted flush with the casing on the front panel. The range of the voltmeter scale shall be 150% to 175% of the nominal output voltage of the charger. The limits of voltage in float mode of working as specified in clause 5.6.1 shall be indicated on the meter scale by a green band.

4.4.4 The meters shall conform to clause 1.1. 1(c) of IS: 2419 and shall be of accuracy class 1.5 or better of IS: 1248.

4.4.5 The minimum scale length of the meters shall be 60mm for chargers of nominal output voltage upto 24V and rated output current upto 20A. For chargers, where either the voltage or the current exceeds these limits, the scale length shall be minimum 90 mm for both meters.

4.5 **Switches and Terminals**:

4.5.1 Each charger shall be provided with ON/OFF-ON/OFF rotary switch as per IS:4064 (Pt-I) and a fuse on AC side with matching current capacity. Holding clamps for sliding type fuses shall be provided.

4.5.2 A two-position rotary switch designated as ‘ Mode selector switch’ conforming to IS: 4064 (Pt-I) shall be provided for selecting Auto/Manual mode of working.

4.5.3 A selector switch conforming to IS: 4064 (Pt.I) shall be provided to select the various pre-designated voltages, when the charger is working in manual mode. Consequent upon failure of automatic mode of working/or otherwise as described in Clause 5.6.3.

4.5.4 A pre set designated as '*current control'* shall be provided on the PCB to set the charging rate. The control shall permit continuous variation of the current from 25% to 100% of the rated current.

4.5.5 A pre set control designated as '*voltage control'* shall be provided on the PCB to adjust the output voltage over a range of 2.12 to 2.3V per cell under float mode of working.

4.5.6 The input, output and earth terminals shall be provided inside the cubicle and shall be accessible only when the cover is removed. The sizes of terminals shall be commensurate with the current rating of the charger.

4.5.7 All current carrying terminals shall be of brass and shall be plated for protectin against corrosion.

4.5.8 Analogue switches are to be provided on the PCB for selection of cells as detailed in Clause 1.5. The cell selection shall be achieved through resistance divided network and analogue switch. The position of three different selection of cell shall be clearly marked on PCB itself.

4.5.9 Switches used in the charger shall be at least more than 50% of the rated value.

4.6 Indication & Protective Devices

4.6.1 A green LED to indicate that the input supply is ON shall be prominently provided.

4.6.2 LED indications to indicate the mode of working of the charger (Auto Float or Auto Boost or Manual).

4.6.3 A red visual indication shall be available to indicate reverse connection to the battery. The indication shall be located near output/battery terminals. The charger shall also be protected against damage due to reverse battery connection.

4.6.4 Red visual indication shall be provided to indicate short circuit condition.

4.6.5 HRC fuses conforming to IS: 2208 shall be provided in the DC output circuit.

4.6.6 In addition to fuses, protection against short circuit and overload at output terminals shall be available as envisaged in clause 5.5.

4.6.7 Chargers shall be provided with means of protection against spikes in line voltage by providing line surge suppressor (MOVRs) on input side. For chargers meant for Telecom/Axle Counter/SSI applications, RFI, EMI filters shall also be provided both on input & output sides.

4.6.8 In case any fault occurs within the charger, the output DC voltage in Automode shall not exceed 2.4 volts/cell.

4.6.9 Chargers of output current rating of 50 Amps and above shall be provided with extra fuses and alarms (visual and audible) as given below:

A) <u>Fuses</u>

1. Rectifier Elements
2. Smoothening Condenser

B) Alarms

1. Main fuse blown
2. Output fuse blow
3. Rectifier element fuse blown
4. Equipment overload/ short circuit
5. Smoothening condenser fuse blown

The alarms shall be provided with a resetting button for cutting off the alarm. Attention Lamp, which will light up when the fault persists and the audible alarm shall only be reset. Facility shall be provided for a single contact, which will make for any of these conditions.

4.6.10 Red LED to indicate that the AC supply is out of range (160 to 270V).

5. PERFORMANCE REQUIREMENTS

5.1 Unless otherwise specified, the chargers shall be suitable for operating on single phase AC supply mains of 230 volts nominal and of frequency 50Hz. Input AC voltage may vary from 160V to 270V.

5.1.1 a) Red LED indication shall appear with audible alarm (re-settable) when no charger output voltage is available although AC supply is available. At 1.9V/cell, red indication (Run DG set) shall appear with audible alarm (non-resettable type). This indication shall appear in both auto and manual mode of working. The potential free contact shall be provided on the front panel of the charger cabinet to allow easy access for its use at site. The alarm /indications shall remain lit until the AC supply restored.

b) Alarm / indication shall work even if mains fail.

5.1.2 Relay / contactor shall not be used in the input side of the transformer.

5.2 Nominal output voltage and rated output current of the chargers shall be as specified by the purchaser. The charger shall be rated for continuous output.

5.3 The DC output of the charger shall be smoothed such that the r.m.s. ripple content of the output voltage when delivering the rated output current through a resistive load measured by an oscilloscope /true r.m.s multimeter shall not be more than 5%. The requirement shall be met in all modes of working.

5.4 Additional requirements of Ripple.

5.4.1 Additional requirement for battery chargers for telecommunication installations: -

The output of the chargers shall not contain psophometric noise voltage of more than 2 mV rms, when delivering rated output current in the float mode or set value of current in boost through resistive load.

5.4.2 Additional requirements for battery charger for axle counter installations

PARD value (Peak average random deviation of ripple and noise) of output voltage is specified as under:

a) rms ripple shall be less than 10mV
b) Peak to peak noise voltage shall be less than 50mV

measured by means of storage type 50MHz oscilloscope when delivering rated output current in float mode or set value of current in boost mode.

5.5 The chargers shall be designed to deliver continuously the rated output current without damage to or deterioration of the components of the chargers. Beyond the rated load, arrangement shall be such that the current is automatically limited to the rated current with drooping output voltage (or upto the pre-selected value of current as per setting of the c.c. preset).

5.6 The charger shall be capable of float/boost charging the batteries in “Auto” mode by sensing the current across battery terminals and automatically adjusting its output voltage/current to float/boost levels.

5.6.1 Normally the output voltage of the charger shall be 2.15V/cell adjustable between 2.12 to 2.3V/cell by the voltage control preset. The value of the output voltage shall be maintained within ± 0.05V/cell of the set value over the entire range of AC input supply (Cl.5.1)

5.6.2 If the current across battery terminals increases by 8-12% of the rated current, the output voltage of the charger shall automatically change to 2.4V/cell (boost mode). It shall continue to give this output till the batteries get fully charged and the current drawn by batteries is less than 5% of the rated current value. The output current during boost charging shall be maintained constant (within ±5% of the selected value) with input voltage varying between the limits mentioned in Cl. 5.1 and the DC terminal voltage varying from 1.8V to 2.4V/cell.

If there is no output voltage, the indication LED against “Auto” mode will start flashing with an audible alarm.

5.6.3 Manual Mode

Selector switch as per clause 4.5.2 shall be provided to select manual mode of working. Another selector switch as per clause 4.5.3 shall be provided for selecting voltages as given below:

Charger Output (Volts)	**Manual mode of working**		
	Position – 1 (Volts)	**Position – 2 (Volts)**	**Position – 3 (Volts)**
12	13.5	15.75	18
24	27	29.25	31.5
60	67.5	69.75	72
110	123.75	126	128.25

The manual mode voltages shall be achieved through a separate full wave rectifier bridge. The output voltage shall be measured at rated load at nominal input of 230V with variation of ± 0.1V per cell for the selected taping.

5.7 The overall watt efficiency and power factor shall be calculated at the nominal input voltage and at the rated output current (through a resistive load) at the following output voltages:

Float mode 2.15 V/cell
Boost charging 2.4V/cell

5.7.1 The overall watt efficiency shall not be less than 70% for chargers of 500 watts or more rated output power & 65% for chargers of less than 500 watts rated output power in all modes of working. For chargers of 12V, current upto 40A, the overall watt efficiency shall not be less than 60%.

5.7.2 The power factor shall not be less than 0.7 lagging in all modes of working. It shall be measured using VI COS Ø method at rated input AC.

5.8 The no-load current of the charger shall not be more than 10% of the rated input current under float mode with input voltage variation as specified in clause 5.1.

5.9 In case of AC mains failure, the reverse leakage current from battery through the charger should not exceed 50 mA without any interruption to load. The relay/Contactor/solid state devices provided for protection of reverse leakage current shall not provide any delay/interruption while extending load to battery.

The measurements shall be taken after disconnecting the meter and protection circuit on the output side.

5.10 Control circuit shall be so designed so as to avoid hunting of charger between float and boost modes in automatic mode of working.

5.11 The charger should have soft start feature whereby on energisation, the output voltage should build up slowly in less than 30 seconds, eliminating all starting surges.

5.12 The output voltage in auto mode with different position of cell selector switch shall be as under:

Volts	**Auto mode of working**					
	Float mode			**Boost mode**		
	(2.15* No. of cells)			**(2.4* No. of cells)**		
12	12.9	15.05	17.2	14.4	16.8	19.2
24	25.8	27.95	30.1	28.8	31.2	33.6
60	64.5	66.65	68.8	72	74.4	76.8
110	118.3	120.4	122.6	132	134.4	136.8

The output voltage in auto float should be maintained as per Cl. 5.6.1

6. MARKING

6.1 All markings/indications shall be easily legible and durable. Where the marking is by use of labels, the labels shall be metallic and shall be firmly fixed and shall not be capable of being removed by hand. Durability of a 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 completion of climatic tests.

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

6.3 The words “Indian Railway Property” shall be indelibly etched, engraved or embossed on the charger at a conspicuous position. For it the size of letters shall be chosen depending upon the size of the charger cubicle but shall not be less than 20 mm high in any case.

6.4 Each charger shall be provided with a rating plate fixed outside at a conspicuous position. The rating plate shall be anodized and shall show the following information:

a) Name or trade mark of the manufacturer
b) IRS number
c) Nominal a.c. input voltage and frequency
d) Nominal D.C. output voltage
e) Rated DC output current
f) Serial No.
g) Installation for which meant i.e. signal/telecom/axle counter
h) Year of manufacture

6.5 The AC line terminal shall be indicated by the letter 'L' and the neutral terminal by the letter 'N'. Earth terminal shall be indicated by letter 'E'.

6.6 The designation of the components mounted on the front panel and their operating positions shall be indelibly indicated by figures, letters or other visual means. The direction of rotation in which voltage/current controlled by the control switches increases shall be indicated by use of ascending numbers or by arrows. The ratings of the fuses to be used shall be clearly marked on their base plates. When the removable fuse carriers are interchangeable, they must also be individually identified.

6.7 The main components inside the charger, and the input and output terminals shall be clearly marked and identified.

7. INSTRUCTION MANUAL

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

a) Installation instructions
b) Guaranteed performance data, technical and other particulars of the charger.
c) Detailed wiring diagram showing all components and their values. This should include transformers, chokes, SCRs diodes, transistors, resistors, capacitors, potentiometers, integrated circuits etc.
d) Schematic block diagram showing general mounting arrangements of various components.
e) Operating instructions including detailed procedure for various settings and function of switches and other accessories provided on the front panel. This should include maintenance instructions.
f) Trouble shooting procedures along with test, voltages and waveforms at various test points in the PCBs.
g) Any other information which the manufacturer may like to give.

7.2 Each charger shall have an anodized aluminium sheet of thickness not less than 1 mm and of size not less than 125 mm x 100mm on which instructions for operation of battery charger shall be printed. The anodized aluminium instruction sheet shall be fixed either on back or side cover of the battery charger.

7.3 The instruction and Maintenance manual should be tied up on the inner side of the cover, which shall be opened at the site for cable termination.

8. TESTS AND REQUIREMENTS

8.1 **Conditions of Tests** – Unless otherwise specified, all tests shall be carried out at ambient atmospheric condition.

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

8.2 **Test Equipment** – The ammeter, Voltmeter & Watt meter used in the tests shall be of an accuracy class of 0.5 or better of IS: 1248 – 1968.

8.3 **Type tests**: The following shall comprise type tests and shall be carried out in the given sequence:

a) Visual inspection	(Clause 8.6)
b) Insulation Resistance test	(Clause 8.7)
c) Applied High Voltage test	(Clause 8.8)
d) Induced high voltage test	(Clause 8.9)
e) Temperature rise test	(Clause 8.10)
f) Performance test	(Clause 8.11)
g) Test for protective devices	(Clause 8.12)
h) Vibration test	(Clause 8.13)
i) Climatic tests	(Clause 8.14)
j) Endurance test	(Clause 8.15)

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

8.3.2 The initial performance test as per Cl. 8.11 shall be carried out with main & spare cards for all the cell positions of the battery charger. The observation after vibration and climatic test shall be carried out at mid position of cell selector with main control card only.

8.3.3 The manufacturer shall furnish following information at the time of type approval.

a) Details of components i.e. semiconductor devices, capacitors etc used alongwith data sheets.
b) Bill of material for PCB cards i.e. control, power supply & annunciation cards etc and charger unit.
c) Compliance toCl. 4.2.2, 4.2.3 & 4.2.4 for safety margin withvoltage and current ratings of the components.
d) Clause wise compliance report of the product as per specification for verification by the inspecting authority.

8.4 **Acceptance Tests** – The following shall comprise acceptance tests:

a) Visual inspection	(Clause 8.6)
b) Insulation resistance test	(Clause 8.7)
c) Applied High voltage test	(Clause 8.8)
d) Induced high voltage test	(Clause 8.9)
e) Temperature rise test	(Clause 8.10)
f) Performance test	(Clause 8.11)
g) Test for protective devices	(Clause 8.12)

8.4.1 The following sampling plan shall be adopted. There shall not be any failure during acceptance test

Lot size	Sample size for performance test as per Cl. 8.11.	Sample size for other than performance test.
2-8	2	1
9-15	3	1
16-25	5	2
26-50	8	2
51-100	13	3
101-150	20	3
151-200	32	3

8.4.2 The performance test as per Cl. 8.11 shall be carried out at mid position of selection switch with main control card, for example, for 24V charger having cell selection of 12, 13 & 14 cells, the testing shall be carried out at 13 cells position.

8.4.3 The overall efficiency test at rated input and output shall also be repeated on charger with spare control card at mid position of the cell selection in case of acceptance test.

8.5 **Routine Tests** – Following shall constitute routine tests and shall be conducted by manufacturer on every battery charger and test results will be submitted during the inspection:

a) Visual inspection (Cl. 8.6)
b) Insulation resistance test (Cl. 8.7)
c) Applied High voltage test (Cl. 8.8)
d) Induced high voltage test (Cl. 8.9)
e) Performance test (Cl. 8.11)
f) Continuous operation test (Cl. 8.15.1)

8.5.1 The performance test may be carried out only at normal input voltage during the routine test.

8.6 **Visual Inspection** – The chargers shall be visually inspected to ensure compliance with the relevant requirements of clause 3,4, and 6.

8.7 **Insulation Resistance Test** – This test shall be carried out –

a) Before the high voltage test
b) After the high voltage test
c) After induced high voltage test (for main transformer only)
d) After the temperature rise test when the charger has attained ambient temperature and
e) After the climatic tests have been completed.

The measurement shall be made at a potential of not less than 500 volts dc. The insulation shall be measured between –

a) AC line terminals and earth
b) DC terminals and earth
c) AC terminals and DC terminals

When measured at a temperature of 40ºC and relative humidity of 60%, the value of the insulation resistance shall not be less than 10 Megohms for the complete

battery charger and shall not be less than 1000 Megohms for the main transformer. There shall not be any appreciable change in the measured value of insulation resistance before and after induced high voltage test and after induced high voltage test. When measured after the battery charger has attained ambient temperature after completion of the temperature rise test, the insulation resistance will not be less than the limits mentioned above. When the test is repeated after the climatic tests, these values shall not be less than 5 Megohms and 500 Megohms respectively, when measured at a temperature of 40ºC and relative humidity of 60%.

Note: In case the prevalent values of temp. & R.H. at the time of measurement are different from those specified above the IR values shall be obtained from table 'A' of Cl.8.7.1.

8.7.1 Table 'A'

Value of Insulation Resistance at different temperature and relative humidity

R.H	25ºC	30ºC	35ºC	40ºC
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 at 100 M.ohms at a temp. of 40ºC and R.H. of 60%. Values of I.R. at different temp. and R.H. may be obtained from the table.

2. To obtain the value of I.R., corresponding to 500 M.ohms or 1000 M.Ohms or 50 M.ohms at 40ºC and 60% RH, a multiplying factor of 5.0, 10 and 0.5 respectively may be used.

3. The value of insulation resistance for extreme conditions of temperature and humidity shall not be less than 1 M.Ohm even if the value at 60% R.H and 40ºC temperature is less than 100 M.ohms.

8.8 **Applied High Voltage Test** – The charger shall withstand for one minute without puncture and arcing a test voltage of 2000 volts rms applied between:

a) AC line terminals and earth
b) DC line terminals and earth
c) Primary and secondary windings of charger transformer

The test voltage shall be alternating, of approximately sinusoidal wave form and of any frequency between 50 and 100 Hz. Printed circuit cards shall be removed and all four terminals of rectifier bridge shall be connected together during this test.

8.9 **Induced High Voltage Test** – The main transformer of the charger with no load shall be connected to a voltage equal to two times nominal supply voltage, the

frequency being equal to two times the rated frequency. The voltages shall be raised from 1/3rd of the maximum value of full value as is consistent with accurate reading of the instrument. Full test voltage shall be maintained for one minute and shall then be rapidly reduced to 1/3rd of the value before being switched off. At the end of the test the transformer shall be tested for the following:

a) Insulation Resistance (Clause 8.7)
b) No load current

The value of IR shall not differ from the specified value. No load current of the transformer shall not be more than 10% of the full load input current.

8.10 **Temperature Rise Test** – The cold resistance of transformer and choke winding shall be measured after conditioning the charger until three consecutive temperature readings taken at 30 minutes interval are constant and the constant temperature shall be taken as reference Temp. T1.

The charger shall be connected to the ac supply mains and setting the input voltage at 270V. A resistive load shall be connected such that the rated dc current flows through the load and output terminal voltage remains at 2.4V per cell. The charger shall continue to draw the rated output current till such time the temperature equilibrium is reached i.e the temperature variation between 3 successive readings taken at an interval of 30 minutes is less than 1ºC. Throughout the test, the rated load current shall be maintained. Once the temperature equilibrium has been reached the temperature of the rectifying diodes, resistors, thyristor, zener diodes, electric junction (carrying more than 5 amps current) shall be measured by means of thermometer (thermo couple type) without disconnecting the load. The thermo couple used for determining the temperature rise of the different components shall be attached to the back of a small blackened disc of copper or brass 15 mm in diameter and 1 mm thick which is flush with the surface of component. Then the charger shall be switched off and hot resistance of the windings of main transformer/chokes shall be measured within one minute of switching off.

The temperature rise of the winding shall be computed by the following formulae:

$$\Delta T = \frac{R1 - R2}{R1}(234.8 + T1) - (T2 - T1)$$

ΔT is the temperature rise.
R1 is the resistance at the beginning of the test.
R2 is the resistance at the end of the test.
T1 is the room temperature at the beginning of the test.
T2 is the room temperature at the end of the test.

Maximum temperature rise above ambient (T2) of different components shall be as per Table-1.

Table -1

SN	Components	Maximum permissible temperature rise above ambient temperature
1.	Transformer & Choke	65ºC
2.	Silicon diodes, Zener diodes	50ºC or 20ºC less than specified by manufacturer whichever is less.
3.	Electric junctions (terminals, switches etc.)	15ºC
4.	Resistors	50ºC

During the test, the charger shall be protected from draughts and radiation from warmer objects. After completion of test and re-attaining ambient temperature, charger shall meet the requirements as given in Clause 8.7 and 8.8.

8.11 **Performance test** – The charger shall be tested for its output performance (Watt efficiency, load & voltage regulation, no load current, power factor and ripple content, auto/manual changeover. In addition, psophometric noise voltage shall be tested for Telecom. Chargers and PARD value for axle counter chargers) by connecting a variable resistive load across the output terminals. The test shall be carried out at AC input voltages of 160V, 230V & 270V.

'At least one sample shall be tested at an environment temperature of 55ºC.'

8.11.1 Automatic mode of working

Switch on the charger and set the mode selector switch (Cl. 4.5.2) to "Auto" mode. Connect a variable resistance across the output/load terminal such that it can draw 0 to 90% of the rated current/as selected by the cc preset. Connect another variable resistance across the battery terminals so that the charger is giving float output of 2.15V/cell (adjustable between 2.12 to 2.3V by voltage control preset). Gradually change the value of resistance across the battery terminal so that the current drawn by battery terminal reaches 8-12% of the rated current. The charger should switch over to boost mode and its output voltage changes to i.e. 1.8 to 2.4V/cell with constant current as per Cl.5.6.2.

Now increase the value of the resistance connected across the load / output terminals and check that the charger continues in boost mode. Due to increase in current fed to battery terminals, the voltage across battery terminals increases. As soon as the voltage across the variable resistance in battery terminals increases to 2.4V/cell and the current drawn by battery becomes less than 5% of the rated current and the charger reverts back to float mode (2.15V/cell)

Now set the mode selector switch to "Manual mode". Connect rated load across the load terminal and set input AC voltage at 230V AC. With the selector switch (Cl.4.5.3) in positions 1, 2 & 3 the output voltages shall be as per Cl.5.6.3.

8.11.2 The charger shall fulfil the requirements of no load current, power factor, efficiency, ripple voltage, voltage stability under float mode of working and current stability under boost mode of working as given in different clauses of this specification.

8.12 Test for protective devices

8.12.1 Short circuit protection

During this all fuses of the charger shall be short-circuited. Charger shall be connected to AC input voltage of 270V and output terminals shall be short circuited through a suitable arrangement. Steady short circuit current shall be measured. It should not exceed rated current +10%. There shall not be any damage to charger. Working of short circuit indication/alarm will also be checked. This shall be achieved by controlling output current and voltage under short circuit condition and not by switching off the input/output voltage under such condition.

8.12.2 Overload protection

As soon as the output current increases to 102% of rated current, the O/P voltage shall droop.

8.12.3 Reverse battery connection

A fully charged battery set when connected in reverse polarity across the output terminals for a period of two minutes of the charger (both when the charger is ON and OFF) shall not cause any damage to the charger. There shall be no emission of smoke or undue temperature rise of any component of the charger. During this test, the working of corresponding alarm/indications shall also be checked.

8.12.4 All the protection/alarms shall be within tolerance of ± 0.02V/cell for voltage and ± 1% in case of current. Tolerance for voltage protection /alarm shall be verified at mid position of the cell selector switlch.

8.13 The charger shall be subjected to vibration test as per RDSO/SPN/144/2004.

	Upto & including 75 Kg weight	**Over 75 KG weight**
Freq. Range	05-350Hz	5-150 Hz
Amplitude	± 6 mm constant displacement or 15m/ sec.^{2} constant acceleration	± 6 mm constant displacement or 15m/ sec.^{2} constant acceleration
No. of axis	3	3
No of sweep cycle	20	10
Total duration	105 min	105 min
If resonance is observed	10 min at each resonant freq.	10 min at each resonant freq.
Condition	After this test, electrical parameters shall be monitored in addition to physical checks. As per Cl. 8.11	

8.14 Climatic tests

8.14.1 The climatic test shall consist of –

i) **Change in temperature test** IS: 9000 Part XIV Section II

Low temperature	-5^{o}C ± 3^{o}C
High temperature	+70 ^{o}C ± 2^{o}C
Rate of change in temp	1^{o}C/min.
Duration	3 hrs at each temp.-5^{o}C &+ 70^{o}C
Cycle	3
Condition	Fully functional during test

ii) Dry Heat Test - Dry heat test as per IS 9000 Part III Section 3

Temperature	+70^{o}C
Duration	16 hrs
Condition	Fully functional during test

(iii) **Cold Test** - IS 9000 Part II Section 3

Temperature	-5°C ± 3°C
Duration	2 hrs
Condition	Fully functional during test

(iv) **Damp Heat test (Cyclic)** As per IS 9000 Part V Section 1 & 2

Upper temperature	40°C ± 2°C
Humidity	95% max
Cycles	6
Condition	Fully functional during one hour period towards end of each cycle

(v) **Damp Heat (Steady state Storage)** as per IS:9000 Part IV

Temperature	40°C ± 2°C
Humidity	93% (+2%,-3%)
Cycles	4 days
Condition	Fully functional during test

(vi) **Dust test** as per IS 9000 Part XII

Duration	**1 hour**
Condition	After this test, electrical parameters shall be monitored in addition to physical checks

(vii) **Bump test** as per IS 9000 Part VII Sec.2

No. of bumps	1000
Peak acceleration	400m/Sec Sq.
Pulse duration	6 mS
No. of axes	03
Condition	After this test parameters shall be monitored in addition to physical test

(viii) **Thermal cycling test**

(a) The PCB shall be subjected to thermal cycling as per the procedure given below. The assembled boards are to be subjected to rapid temperature cycling as mentioned below in the power off condition.

(b) This temperature cycling from 0 deg C to 70 deg. C, 1/2 hours at each temperature for 9 cycles and 1 hour at each temperature for the 10^{th} cycle. Dwell time of 1 hour is provided for the last cycle in order to oxidize defective solder joints exposed through thermal stress.The rate of rise/ fall of temperature shall be min 10 deg. C per minute

(c) In addition to physical checks, the electrical parameters are also to be monitored after this test.

(d) Power cycling: The power supply modules shall be subjected to 60 ON-OFF cycles for 1 hour. The ON-OFF switch usually provided in the modules may not be used for this purpose.

8.14.2 The climatic tests shall be carried out by setting the chargers in Auto mode of operation & connecting the load on battery terminals in such a way that charger goes to boost mode. During the period of exposure in each test the chargers shall be connected to supply mains of nominal input voltage and shall deliver the rated output current at output voltage of 2.4V/cell to a resistive load.

8.14.3 Immediately after the damp heat test, the insulation resistance of the main transformer shall not go below 100 Meg.ohms and for the complete charger not below 5 Meg.ohms, which shall improve, to 500 Meg.ohms and 8 Meg.ohms respectively after complete recovery.

8.14.4 During the last half hour of exposure under dry heat test insulation resistance shall not go below 5 Meg.ohms.

8.14.5 At the end of each test and after recovery, the charger shall not show sign of any apparent damage or deterioration. The charger shall then satisfy the requirement of clause 8.7 and no load current shall not vary more than 5% of the initial value before test. Requirement of clause 6.1 will also be ensured.

8.15 Endurance Test: The charger shall be subjected to a continuous operation for 1000 hours at commercial input voltage and rated output current. After this test, the charger shall not show any deterioration in its performance as specified in Cl.8.11.

8.15.1 **Continuous operation test during routine test**: During routine test the charger shall be subjected to continuous operation test for 8 hours at commercial input supply and rated load. It shall changeover to the boost and float mode alternately after every 30 minutes. Proper records shall be maintained.

9. Packing and Labeling

9.1 Charger units complete shall be packed in suitable boxes/crates, strong enough, without additional packing to prevent damage or loss to the unit during transit. Loose space inside the box/crate shall be filled up with suitable packing material.

9.2 The fragile components such as meters and P.C cards shall be separately and individually packed to prevent damage.

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

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'Appendix –A'

Information to be supplied by the Purchaser

A-1 Nominal output voltage and rated output current (Clause 1.4)

A-2 Drawings, Dimensions and layout if desired (Clause 3.1)

A-3 Type of mounting required - shelf mounting or floor mounting (Clause 3.2)

A-4 Whether the charger is being procured for signalling or Telecom. or Axle Counter installations.

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