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MINISTRY OF RAILWAYS

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TECHNICAL SPECIFICATION FOR STATIC BATTERY CHARGER FOR AC AND TL COACHES

lo vkj-Mh-,l-vk-@ih-b-@,l-ih-b-lh-@,-lh-@0008&2010**(**l'kk-2**)**
No. RDSO/PE/SPEC/AC/0008- 2010(Rev.2)

SN	Date of amendment	Revision	Page no.	Remarks
1	NIL	Rev.0	N/A	First Issue
2	01.07.04	1	N/A	During design and inspection stage, RDSO gained knowledge for standardizing the product even to device level. This revision has been proposed incorporating the requirement for standardization, better efficiency, power factor and THD.
3		2	19	IGBT based with DSP control to improve performance parameters

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APPROVED

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I N D E X

SPECIFICATION FOR STATIC BATTERY CHARGER FOR AC AND TL COACHES

At present railways are using Valve Regulated Lead Acid (VRLA) and Low Maintenance Lead Acid (LMLA) cell batteries. VRLA batteries are very much sensitive to ripple content and voltage regulation. With the wide range of voltage variation in the 3-phase power supply system available; uncontrolled rectification is detrimental for the VRLA batteries. Further AC to DC rectification can add to the inherent power line disturbances by distorting the waveform due to harmonic current injected into the power supply network. In addition to the above, appreciable amount of energy is wasted in workshops during discharging of batteries through resistors. Keeping in view the energy conservation there is also a need of efficient discharging system which can help batteries to discharge energy back to power supply network. Therefore, Digital Signal Processing (DSP) controlled IGBT based AC to DC rectification (converter) with active power factor correction with fine control on voltage regulation, ripple, THD and improved efficiency with re-generative feature is issued for charging the batteries of TL & AC coaches. The unit will work satisfactorily for conventional low maintenance lead acid battery also.

1.0 SCOPE

This specification covers the design, manufacture and supply of DSP controlled IGBT based charge/discharge equipment with active power factor correction, which can charge the rolling stock batteries and feed power back to the power supply network during discharging mode. The unit shall be designed for charging of VRLA and LMLA batteries.

2.0 SYSTEM OPERATING DETAILS

The unit shall be designed in such a way that it neither affects nor damages the nearby electrical equipments. The required charging characteristics of the two batteries (VRLA & LMLA) are listed below: -

A. VRLA Batteries

The VRLA batteries are normally charged in constant voltage mode and partially charged in constant current mode. Maximum charging current is allowed to 20% of the rated 10 hr capacity of the battery and 7% in constant current mode. The recommended voltage of charging is 2.3V per cell during boost mode and 2.25V per cell during float mode. The trip shall be set at 2.35 V per cell for boost charging and 2.30 v per cell for float charging. Auto mode charging has been explained later in the specification.

B. Low Maintenance LEAD Acid cell batteries:

These types of batteries are charged in constant current mode with charging current of 10 % of the rated AH capacities of the batteries. Charging current shall not exceed the set value by more than 1%.

2.1 PROPOSED SCHEME DETAILS

The three phase 415V, 50 Hz supply is converted to desired voltage level by using DSP controlled IGBT with active power factor correction controller and high frequency transformer. While designing the unit, care shall be taken to ensure that p.f at input side shall not be less than 0.98, at all load conditions at nominal, minimum and maximum AC input voltage. Total Harmonic Distortion (THD) contribution by the unit does not cross the limit of 8 % for the AC line current and voltage. All the power devices shall be provided with suitable snubbers. Necessary filter, shielding, coupling, grounding, etc may be provided to control the interference by conduction or radiation which may affect the power supply, telecommunications, signaling system and other nearby equipments.

3.0 GOVERNING SPECIFICATIONS:

The following publications are applicable to the equipment in general: -

IGBT / Diode	IEC 60747
Semiconductor fuses	IEC 60269-4
Meters	IS: 1248
Hardware	IS: 1363
Paint	IS: 8662
Degree of protection	IEC 60529
Danger Notice Plate	IS:2551
Steel for general purpose	IS:2062
Method of random sampling	IS: 4905
Low voltage switch	IS:8623
Basic environmental testing procedure for electrical & electronic items	IS:9000
Power inductors	IEC 60310
Power capacitor	IEC 61071
Power converter	IEC 61287
Thin walled flexible Electrometric cable	IS:9968
Guide for equipment reliability testing	IS:8161
EMI/EMC compatibility	IEC 61000

Note: Latest version of the above specifications/IEC shall be applicable

4.0 SERVICE CONDITIONS:

The equipment shall be sturdy and suitable for the following service conditions normally to be met in service.

4.1 Environmental conditions

Ambient temperature	-5 to 55 °C
Humidity	Up to 98% during rainy seasons
Altitude	Max. 1200 m above mean sea level.
Annual Rainfall	Ranging between 1750 to 6250 mm with thunder storm.
Dust	Extremely dusty and desert weather and desert terrain in certain areas. The dust contents in air may reach as high values as 1.6 mg/m^3
Coastal areas	The equipment shall be designed to work in coastal area in Humidity salt laden and corrosive atmosphere. The maximum value of the condition will be as under:-

Max. PH value	: 8.5
Sulphate	: 7mg/liter
Max. concentration of chlorine	: 6 mg/liter
Max. conductivity	: 130micro semen/CM

5.0 TECHNICAL SPECIFICATION:

5.1 The Unit shall be designed for the following rating and other particulars:

	Type	Constant current and Constant voltage with current limiting
1.	During charging mode	
	• Input voltage (AC side)	
	i) Nominal	415V AC,50Hz, 3 phase, 4 wire system
	ii) Operating range	350Vto 480V AC, 50 Hz
	• Output Voltage (DC side)	As per annexure 'A'
	• Output current dc	As per annexure 'A'
2.	During discharging mode	
	• Input voltage (DC side)	As per annexure 'A'
	• Output Voltage (AC side)	415V AC,50Hz, 3 phase, 4 wire system
3.	Operating Modes	The unit shall be suitable to work either in constant voltage or constant current mode while charging the Battery. When the unit is used for discharging purpose, it will act on constant current mode and discharging the battery into AC input mains (power supply system) at a constant preset current. Separate mode selections for discharging mode, battery charging in constant current / constant voltage are to be provided.

5.2 REGULATION:

5.2.1 Constant Voltage

Under this mode of working the charger shall give a DC output voltage adjustable over a range of 2V to 2.75 V per cell by suitable means. The value of output voltage shall be maintained within ±1 % of the set value over the entire range of input AC supply variation and the output load variation from 10% to 100% of rated capacity.

5.2.2 Constant Current:

Under this mode of working the unit shall be capable of delivering the output current whose magnitude shall be selected by suitable means.. The current shall be maintained within ±1% of the set value at 35% to 100% load with the input voltage varying from 350 volt to 480 volt.

5.3 EFFICIENCY:

The efficiency of the unit shall not be less than 85% at half load and 93% for full load for entire input voltage range during charging and discharging mode.

5.4 RIPPLE CONTENTS:

The unit shall be designed in such a way that the output voltage ripple content shall be less than 2% r.m.s. of the rated value of voltage and current at all loads when measured across a resistive load.

5.5 HARMONIC CONTENTS:

Voltage and current harmonics shall be measured on AC side of the unit. Total Harmonic Distortion (THD) contributed by the unit shall not be more than 8% at full load. During charging mode, measurement shall be done at 415V AC input with resistive load at output and during discharging, measurement shall be done at 110V DC input and power supply network as output.

5.6 POWER FACTOR:

Power factor at input side shall not fall below 0.98 in charging mode at full load condition at nominal, maximum and minimum input AC voltage.

5. 7 AUTO MODE CHARGING:

The unit shall be provided with arrangement to charge the VRLA battery either in float or boost mode automatically under constant voltage mode. It shall go to boost mode whenever the charging current exceeds 5-6% of ampere-hr capacity (max charging current allowed is 20% of AH capacity of the battery) and to float mode when the charging current reduces to 3-4% of ampere hour capacity. For boost mode, voltage per cell shall not be more than 2.3 V/cell and for float mode it shall not be more than 2.25 V/Cell.

5.7 COOLING

The battery charger shall be natural air cooled.

5. 9 PROTECTIONS:

5. 9.1 Over voltage

Necessary protection shall be provided to avoid the unit developing high voltage beyond the set level by blocking the firing pulses. Release of pulses shall be possible only when the unit is switched OFF and made ON again .The trip shall be set at 2.35V per cell for boost charging and 2.30V per cell for float charging for VRLA batteries. In case of Low Maintenance Lead Acid (LMLA) cell, the trip shall be set at 2.75 V per cell.

5. 9.2 Current limit

During constant current charging mode, the unit output current shall be limited to ±1% of the set charging current by dropping the output voltage. During constant voltage charging mode, current shall be limited to 20% of Ah capacity of battery.

5. 9.3 Over current protection:

The unit shall be protected against over current at DC output by tripping the unit if output current exceeds 115% of its set current in charging mode

5. 9.4 AC side fuse:

A reliable HRC fuse of suitable rating shall be provided at AC side with suitable circuit breaker.

5.9.5 DC side fuses:

The DC side of the unit shall be protected with HRC fuse of suitable rating.

5. 9.6 AC under / over voltage protection

5.9.6.1 During charging mode, there shall an arrangement to sense the AC input voltage and cut off the unit when the voltage is less than 350 V or more than 480 V AC with an audio visual alarm. The unit shall be automatically switched ON when the AC voltage is within 350 V to 480V.

5.9.6.2 During discharging mode, DC under voltage trip shall be settable from 1.7 to 2.0 Volt/cell through key pad

5. 9.7 Controls:

The unit shall be provided with the following minimum controls:

i) AC circuit breaker for emergency shut down.
ii) Output circuit breaker.
iii) Unit ON/OFF
iv) Trip reset push button
v) Mode selection for charging /discharging /OFF.
vi) Mode selection for boost charge/ auto mode charge
vii) Mode selection for constant current/constant voltage charge
viii) Current setting arrangement
ix) Voltage setting arrangement

6.0 GENERAL REQUIREMENT

6.1 Transformer/Choke may be provided in a separate compartment/cubicle, which can be permitted without IP 54 protection provided that water if entered, shall not affect the performance once drain and dried but the above cubicle shall form an integral part of the unit within over all size.

6.2 High frequency transformer with H-class insulation of adequate capacity shall be used to step down the voltage and to provide isolation. Only virgin core shall be used in high frequency transformer. Released core shall not be used in any condition.

6.3 Power devices (IGBT) to be used shall be of Industrial Grade and above. The device shall be selected in such a way that it meets the requirement of battery charger as mentioned at annexure 'A'.

6.4 All the electronic control circuits components, PCBs, power supplies etc. except snubbers circuits shall be placed in a totally enclosed natural air cooled module provided with IP-54 protection. All the connectors used in this module shall have IP65 protection. The rest of the panel shall be provided with IP-32 protection conforming to IEC 60529. Adequate number of louvers with suitable wire mash can be used for natural ventilation.

6.5 All material used in manufacturing of unit shall be fire retardant. Metalised polypropylene capacitors shall be used of extra long life category.

6.6 Components/equipments rating, type and makes as mentioned in the specification shall be used.

6.7 All the studs for fuses and terminals shall be provided on a FRP/DMC terminal board made with adequate clearance and creepage distances. All insulating boards used shall not be less than 5mm thick. There shall be proper insulating barrier between transformer and other sections so that heat generated by the transformer does not affect the working of semi-conductor devices.

6.8 Minimum values of adequate creepage distance and clearance shall be maintained from the live terminals to earth and between live parts as per IS: 13947.

6.9 PCBs used shall be of FR4 grade or higher. Use of silicon coated wire wound resistors and metal film resistors are recommended. All the PCBs used shall be of good workmanship and assembled by using automatic wave soldering machines.

6.10 Anti corrosive protection coating on PCB shall be applied to avoid corrosion in service. The protective coating shall be transparent, So that type/rating of components are readable. The protective coating on trackside of PCB shall be solderable type.

6.11 Control circuit shall be protected against the spikes in the line voltage/transient by providing line surge suppressor at input side.

6.12 A potential free contact of rating 230V AC, 2 Amps for charger failed conditions shall be made available for use of indication/interlocking by users.

6.13 The charger shall have soft start feature (ramp-up) whereby on energization, the output voltage shall build up slowly within 6 seconds, eliminating starting surges considerably.

6.14 a) Terminal markings shall be engraved on Terminal board. The termination of internal connections shall facilitate palm-to-palm connections.

b) AC line terminals shall be indicated by the letter R, Y, B and neutral terminal by letter N. Earthing terminal may be indicated either by letter E or earthing symbol. DC output positive terminal shall be indicated by the symbol positive by (+) and negative by (–).

6.15 The equipment shall be reliable and shall conform to IS:8161. The enclosure shall be designed for better air-cooling. Cooling fins shall be as welded/ mounted to the enclosure that these shall be in close contact with enclosure and will not loose contact due to corrosion in service. The charger shall be housed in a robust sheet metal cubicle suitable for mounting on the shop floor and provided with easily accessible screwed covers for facility of connection/replacement etc. The front cover shall be made into two parts- one with meters, indications, control switches etc. and MCBs having the knobs protruded outside the cover so that hinged on one side and other side provided with adequate captive screws and the other part of bottom portion shall be fixed with adequate captive screws. All the other covers shall be fixed with hexagonal screws and tapped pads, which are duly welded inside the frame member. The cubicle shall be provided with suitable forged eyebolts for lifting purpose.

6.16 All the replaceable components such as fuses, indicating LED and switch modules etc. shall be mounted at the front side of the unit for easy maintenance.

6.17 Manufacturer shall provide a screen-printed single line diagram inside the front opening cover at suitable place.

6.18 Two earthing bosses with M10 tapped holes shall be welded on each side of the enclosure for earthing the metallic enclosure. The size of bosses shall be of dia 25 x 20 mm material conforming to IS: 2062 and two nos. of 300 mm long 35 sq. mm bare copper braided cables duly crimped on both ends to be supplied with each unit.

6.19 The thickness of the sheet steel used for enclosures shall not be less than 2 mm. The design of the enclosure shall be such as to prevent ingress of iron dust liable to get attracted by the magnetized components of the equipment. Suitable gaskets of neoprene rubber shall be provided for covers to prevent ingress of dust and moisture. The enclosure shall meet the requirement of hose proof test as per IEC 60529.

6.20 Charger cubicle shall be cleaned by using seven-tank process and powder coated with aircraft gray colour. Coating thickness shall be minimum 60 microns.

6.21 Cable entry holes shall be provided on the top/bottom of the cubicle as required by the user.

6.22 Cooling fins shall be provided to meet the requirements specified.

6.23 All the hardware including those used for electrical terminals shall be hexagonal head screws and hexagonal nuts conforming to IS: 1363. Plain and spring washers shall be used as per the requirements of fastening arrangement. Screws used for mounting of the components shall preferably be on tapped holes, wherever necessary. Hardwires shall be zinc plated with passivation. All the copper links/plates shall be electro-tinned.

6.24 Caution plate as per IS: 2551 made out of 1 mm thick aluminum sheet shall also be riveted to the inspection cover of the unit worded as approved by the purchaser with letter etched and painted white in red back ground.

6.25 A rating plate made out of 1 mm thick aluminum sheet shall be riveted to the inspection cover of the unit with letter etched painted white in black background.

6.26 A label of size 275x210 mm indicating the operating instructions on aluminum anodized plate of 1 mm thick with letters engraved by embossing/etched and painted white in black background shall be displayed.

6.27 The complete unit shall be maintenance free except cleaning of heat sink.

7.0 PROTECTIONS & INDICATIONS

a. The unit shall include the following minimum protective features:

- Protection against ingress of dust and water
- Input /output fuses with fuse blown indication
- AC over voltage set at 480±1 V with audio visual alarm
- AC under voltage set at 350±1 V with audio visual alarm
- Output short circuit protection
- DC output over voltage set at 2.35 V per cell for boost changing and 2.30V per cell for float charging incase of VRLA batteries and for LMLA batteries, it shall be set at 2.75V
- Over load protection and single phase protection
- Earth fault on AC side.
- Voltage surge suppression
- Capacity to withstand input of 510VAC without any damage to any part of the unit
- Protection towards wrong phase sequence
- DC under voltage

b. The unit shall have the provision of following indications:

- Input AC ON (3 Phase)
- Constant voltage charging "ON"
- Constant Current charging "ON"
- Fuse failure (for input and output fuses)
- Earth Fault
- AC over voltage
- AC under voltage
- Boost charging "ON"
- Float charging "ON"
- Discharging "ON"
- Auto charging "ON"
- Wrong phase sequence
- Single phasing
- DC under voltage

c. Indicating Instruments

DC digital voltmeter and ammeter suitable to measure/indicate voltage and current upto two decimal places during charging/discharging cycle shall be provided to monitor either the charger output dc current /voltage or battery voltage current by means of a toggle switch. Similarly on ac side, ac digital voltmeter and ammeter shall be provided to measure/indicate ac voltage, current and KWH meter with facility to measure input and output energy separately.

8.0 CABLES

8.1 The number of wires/cables to be used shall be reduced to minimum. The use of insulated copper busbar is preferable. The wires/cables below 10 Sq.mm. shall be PTFE and higher than 10 Sq.mm. e-beam thin walled halogen free cables as per relevant specification shall be used. The use of PVC cables/wires is not acceptable. Outer sleeves, if used, for bunching the control wiring shall be low smoke halogen free fire retardant. Fire retardant heat shrinkable sleeves shall be provided at the termination point of the cable.

8.2 All the connections including incoming and outgoing connections of transformer shall be of crimped type sockets and numbered/ferruled with cable markers corresponding to the wire numbers of the schematic diagram and neatly bunched over suitable insulated stiffeners with fire retardant ties.

8.3 Power & control cable bunches shall have separate routes. Colour scheme for wiring shall conform to normal conventions and shall be shown in the instruction manual.

9.0 TESTS:

Separate type, acceptance, routine and investigation tests for battery charger assembly and complete unit will be conducted. Resistive load of adequate capacity shall be arranged at the manufacturers' premises by the manufacturer for the purpose of testing. Various tests shall be performed by simulating the combination of resistive loads of adequate capacity matching the rating of the battery charger

RDSO may conduct surprise check on manufacturing process and quality control along with any of the test to ensure quality of product and its conformance to RDSO's specification.

9.1 PROTOTYPE TEST

Prototype units will be inspected / tested by RDSO at manufacturer's premises. All the tests shall be carried out on one prototype sample (first unit) of battery charger developed by the prospective manufacturer in the presence of representative from RDSO to establish the conformity of the product with the specification. This prototype sample shall not be commissioned in the field; the same shall be kept in the premises of the manufacturer for future references.

9.2 TYPE TESTS

Type tests shall be carried out on one battery charger unit of given design to verify that product to meet the requirements specified and agreed upon between user and manufacturer. Subject to agreement between user and manufacturer some or all the type tests shall be repeated whenever required by RDSO on sample basis, so as to confirm the quality of the product to meet the specified requirements. In addition, the manufacturer shall repeat the type test to be witnessed by representative of RDSO or purchaser either totally or in part in following cases without any additional cost: -

- Modification of equipment likely to affect its function.
- Repeated failure of equipment or variations established during routine tests
- Resumption of production after an interruption of more than two years.
- In any other condition where RDSO/Purchaser felt necessity of the type test.

9.3 ACCEPTANCE TESTS

The acceptance tests are to be conducted in the presence of railways nominated representative on the samples selected at random or on all as agreed between purchaser and manufacturer, to establish conformity of the lot to be supplied with the requirements of the specification. Purchaser has the right to insist acceptance tests on each unit in the presence of his nominated representative.

9.4 ROUTINE TESTS

These tests are to be carried out to verify that properties of the product corresponding to those measured during prototype/type tests. Routine tests are to be performed by the manufacturer on each equipment and all the records of test results shall be maintained with traceability. The same shall be produced before the railway inspecting officer/representative to verify the routine test results.

9.5 INVESTIGATIVE TESTS

Based on the performance, field experience, in case of critical failures in the system or in view of the improvement measures, investigation tests shall be carried out at no extra cost. These tests shall be specially requested either by RDSO or user or by the manufacturer.

10.0 DETAILS OF TESTS:

10.1 Visual inspection:

The various approved drawings, QAP, Bill of Material (BOM) of the assembly/sub-assembly components used in the equipment and approved after prototype tests shall be checked along with aesthetics, design, workmanship and general construction of the unit.

10.2 Performance Test

Connect the unit to the supply and record the following parameters at low, nominal and high input voltages of 350 V, 415V and 480 V respectively for 10%, 50% and 100% loads. Record input Watts, input pf, dc output Volts, dc amps, rms & peak to peak ripple for voltage and current, % regulation and efficiency in constant voltage, constant current and discharging mode.

(i) Constant voltage:

Set the unit to constant voltage working mode and set voltage to 2.3V /cell and record parameters mentioned above for line and load variations at 350V, 415 V and 480V and at 10% load, 50% load and at full load.

(ii) Constant current:

Set the unit to constant current mode set the output voltage to 2.75V /Cell and load the unit to full capacity without disturbing the load, reduce the output current to 80%, 50% and 35% of the rated capacity and record the change in output current for the input voltage variation of 350V, 415V and 480 V AC and record the parameters mentioned at Para 10.2 (a). The variation in set current shall not exceed by ± 1% of the set value.

(iii) Discharging Mode:

Constant Current: Set the under voltage setting as required (1.70 or 2.0 V/Cell) depending upon number of cells by adjusting low voltage adjusting arrangement. Keep the unit in discharging mode and mode selector switch in constant current mode. By connecting a battery or an external charger to the unit, record the variation in discharge current for an input voltage variation of 350 to 480 VAC. The variation in set current shall not vary by 6 1% of the set value. This test may be conducted for the output current of 25%, 50% and 100% of the rated output current.

10.3 Short Circuit Test

10.3.1 Charging mode: Short the output terminals and switch 'ON' the unit at high input AC voltage and measures the short circuit currents. On removal of short, the charger shall start automatically.

10.3.2 Discharging mode: Short the output terminals (AC side) and switch 'ON' the unit measures the short circuit currents. On removal of short, the charger shall start automatically.

10.4 Surge Test

This test shall be conducted as per IEC-60571 and record the waveforms through storage oscilloscope.

10.5 Dielectric Test

When the unit is cold, dielectric test shall be carried out after disconnecting capacitors and shorting power semiconductor devices, primaries of trigger equipment, pulse transformers earthed and disconnecting special card, if necessary, before applying dielectric voltage corresponding to the voltage given below: -

i) 415V ac circuits, 2000V r.m.s, sine wave, 50 Hz for 1 minute.
ii) 110V dc circuits, 1500V r.m.s, sine wave, 50 Hz for 1 minute.

Test is considered satisfactory if there is no flash over or tripping of dielectric test equipment set at 50 mA leakage current.

This test shall also be repeated after temperature rise test.

10.6 Insulation Resistance

This shall be done with the help of 500V megger prior to the starting of all the tests and after heat run. Insulation resistance shall not be less than 10 M-Ohms for all circuits.

10.7 Weight

Weight of the charger unit shall be kept as minimum as possible.

10.8 Output Current/ Voltage Limit Test:

10.8.1 Set the required current limit as per annexure-A and Load the unit at nominal AC input Voltage to its 100% capacity. Note down DC Voltage. Load the unit beyond 100% and record the droop in output voltage.

10.8.2 Set the required voltage per annexure-A and Load the unit at nominal AC input Voltage to its 100% capacity. Note down DC Voltage. Load the unit from 25% to 115% of full capacity and record the output voltage.

10.9 Ripple Measurement

Measure the ripple of the output by using a true RMS multi-meter. It shall not be more than 2% r.m.s for voltage and 3% r.m.s for current.

The Waveform shall be recorded through storage Oscilloscope (having suitable interface with PC or printer for recording the waveform) across precision shunt for 10%, 50%, 100% load at max, min & nominal input voltage. Record r.m.s and peak to peak ripple.

10.10 Dry Heat and Damp Heat Test

The dry heat and damp heat test shall be conducted as per IEC60571 on all the electronic modules used in the system.

10.11 Salt Mist:

Salt mist test shall be conducted as per IEC 60571 on all the electronic modules used in the system.

10.12 Efficiency Test

The efficiency shall be measured soon after temperature rise test. The efficiency of the unit shall be measured with wattmeter at full and half load at input supply of 415 V, 50 Hz with a resistive load. The output voltage shall also be recorded. During discharging, efficiency shall be measured at input of 110V DC and at half and full rated current.

10.13 Temperature Rise:

This test shall be conducted at full load with 350V AC input supply. The unit shall be set on charging mode during this test.

The temperature rise shall be recorded with the help of temperature recorder having at least 12-14 sensors mounted at the specified reference points (by using thermal imaging camera to detect hot spot) on the body of semiconductors, transformer, filter capacitors and other components. The maximum-recorded temperature under worst loading conditions shall be corrected for 55ºC and compared with maximum permissible temperature (for power devices at junction). The thermal margin available shall be compared with the safety margin declared by the manufacturer. Under loading conditions as specified above, the corrected temperature of the power devices shall have a safety margin of minimum 10^0 C.

Temperature of Transformers shall not exceed 155ºC when corrected to 55^0 C. The unit shall also be subjected for short time rating after continuous loading to ensure the temperature rise is within the permissible limit.

The maximum temperature rise of the electronics devices on the PCBs shall not exceed approximately 20^0C for industrial grade components suitable for 85^0C environment, when measured at half inch away from identified critical components. In case, it is exceeding this limit, use of mil-grade component can be considered keeping RDSO informed.

The temperature rise in the inductors/choke windings shall also be measured by resistance method. The charger unit shall be deemed to have reached thermal stability when three consecutive readings of temperature are more or less same.

10.14 Test for Ingress of Protection

The purpose of this test is to verify the effectiveness of the means provided to reduce ingress of dust and water as per protection for enclosure. The test shall be conducted as per IEC-60529.

10.15 Trigger Equipment Test

The object of this test is to verify that the firing pulses comply with the design and the manufacturers shall furnish the details. The blocking of firing pulses as mentioned in clause 4.9.8 for output short circuit shall also to be checked.

10.16 Load Break Test

A contactor shall be connected in series with the full load. After the rated current has been flowing in load for 1 min. the load shall be broken through the contactor. The test shall be repeated three times.. No damage shall occur to any part of the unit.

10.17 Input under Voltage/ Over Voltage and Transient Test

The input voltage shall be reduced below 350V and check that unit switches "OFF" prior to 345 volts and automatically switches "ON" after the input voltage exceed 352 volts. The input voltage shall be increased beyond 480 V AC and check that unit switches "OFF" at 482 Volts and the voltage shall further raised to 510V AC and maintained for two minutes.. There shall be no damage of any nature to any of the components of the unit. The unit shall automatically switch "ON' when the voltage reduces to 475 V.

The design shall incorporate necessary feature of suitable time delay/ hysteresis of 5V to avoid hunting for both under voltage and over voltage tripping. Transient voltage test shall be conducted as per IEC-60571.

10.18 Acoustic Noise Measurement

The sound pressure level shall be measured in order to ensure that it is not exceeding the limit value of 60 dB (A) at a distance of 1 meter away from the equipment in all the directions. Tests shall be performed at no load, 50%load and full load.

10.19 Harmonic Content Measurement

Voltage and current harmonics shall be measured at the AC side of the unit. THD contributed by the unit shall not be more than 8% at full load at nominal, maximum and minimum input ac voltage during discharging with constant voltage and constant current and discharging mode.

10.20 Tests on High Frequency Transformer

Temperature-rise and efficiency at operating frequency shall be conducted. Necessary test results shall be submitted at the time of testing.

10.21 BURN-IN TEST

a. To ensure the reliability of the components, Burn-in tests cycle as per Annexure-B for reliability of electronics used in the battery charger shall be conducted on every card in energised condition.

b. All the controller cards fitted with components used in the charger are subjected to 45 Hrs. at 55ºC in energised condition. Records of the tests shall be maintained with traceability for all the cards and shall be produced before the representative of the inspecting agency at the time of testing. This test may be conducted randomly by the RDSO on the selected cards from the running lot.

10.22 EMI/EMC Test

EMI/EMC test shall be conducted as per relevant clauses as mentioned in the IEC 61000 for the following:-

i. RFI RADIATED TEST: as per IEC 61000 – 4 – 3
ii. RFI CONDUCTED TEST: as per IEC 61000 – 4 – 6
iii. ELECTRICAL FAST TRANSIENTS TEST: as per IEC 61000 – 4 – 4
iv. POWER FREQUENCY MAGNETIC FIELD: as per IEC 61000 – 4 – 8

No degradation of the system & malfunctioning shall be allowed during or after the test.

10.23 MARKING:

The unit shall be marked/screen printed with the following information:

- Type Make
- Contract No.
- Month & Year of manufacture
- Input operating voltage range
- Output voltage range
- Wattage
- Output current

In addition to this the make shall also be embossed on cubicle which shall be legible and lasting till equipment life.

11.0 TEST SCHEMES:

S. No.	Type of Test	Clause No.	Proto Type Test	Type Test	Routine Test	Acceptance test
1	Visual Inspection	10.1	Yes	Yes	Yes	Yes
2	Verification of protection	7.0 a	Yes	Yes	Yes	Yes
3	Verification of indication	7.0 b	Yes	Yes	Yes	Yes
4	Indicating instruments	7.0 c	Yes	Yes	Yes	Yes
5	Performance test	10.2	Yes	Yes	Yes	Yes
6	Short circuit test	10.3	Yes	Yes	Yes	Yes
7	Surge test	10.4	Yes	Yes	Yes	Yes
8	Dielectric test	10.5	Yes	Yes	Yes	Yes
9	Insulation resistance	10.6	Yes	Yes	Yes	Yes
10	Weight	10.7	Yes	No	No	No
11	Output current / Voltage limit	10.8	Yes	Yes	Yes	Yes
12	Ripple measurement	10.9	Yes	Yes	Yes	Yes
13	Dry heat & damp heat	10.10	Yes	No	No	No
14	Salt mist test	10.11	Yes	No	No	No
15	Efficiency test	10.12	Yes	Yes	No	Yes
16	Temperature rise test	10.13	Yes	Yes	No	No
17	Test for IP	10.14	Yes	No	No	No
18	Trigger equipment test	10.15	Yes	Yes	No	No
19	Load break test	10.16	Yes	Yes	Yes	Yes
20	Input U/V - O/V & transient	10.17	Yes	Yes	Yes	Yes(except transient)
21	Acoustic noise measurement	10.18	Yes	Yes	No	No
22	Harmonic content	10.19	Yes	Yes	Yes	Yes
23	Tests on Transformer	10.20	Yes	Yes	No	No
24	Burn-in test	10.21a	Yes	No	No	No
25	Burn-in test	10.21b	No	Yes	Yes	Yes
26	EMI/EMC	10.22	Yes	No	No	No
27	Marking	10.23	Yes	Yes	Yes	Yes

12.0 TESTING FACILITIES

Testing facilities are considered desirable in the premises of the manufacturer for quality and reliable product as per RDSO STR no. RDSO/PE/STR/AC/0013-2004 (Rev '0') dated 01.11.2004.

13.0 PRE-COMMISSIONING AND COMMISSIONING TESTS

Unpack the battery charger unit and check that it is not damaged. Energise the unit and check for performance tests by energizing the unit and connecting resistive load before fitment on the coach. Mount the assemblies of the unit on the coach and conduct the following: -

- Proper mounting of cubicle and its rigidity
- Insulation and dielectric Test.
- Performance Test at nominal voltage and full load.
- Proper functioning of protections, indications meters by simulation method and operating switches.
- Ensure operation of earth fault

14.0 SAMPLING

The sampling and rejection shall be done as per IS: 4905.

15.0 GUARANTEE

The battery charger unit complete with high frequency transformer/choke and controls shall be guaranteed for a period of 60 months from the date of commissioning or 72months from the date of supply whichever is earlier. Any design defect, defective material, under rated component used etc. have to be corrected and merely replacement of defective parts will not be considered adequate. Complete investigation report along with remedial measure taken to avoid re-occurrence of similar failure in future for each defect/failure shall be submitted to RDSO and purchaser for each case.

16.0 SPARES AND MAINTENANCE MANUAL

A list of spares required for a period of five years maintenance shall be submitted in printed form and neatly compiled in a booklet form.

The operating and maintenance manual giving instructions for installation, maintenance and circuit diagram with voltages at salient points to locate faults, list of components with brief specifications and manufacturers etc. Trouble shooting and after repair testing procedure of major assemblies and electronic cards shall be supplied. In addition to above, working principle, precautions to be taken, fault diagnostic up to component level, component testing before its fitment, component handling etc. shall be included in the maintenance manual. The original numbers on IC, transistors and other components shall not be erased or painted.

17.0 INFORMATIONS TO BE SUBMITTED

The manufacturer must submit the following information at the time of offering for witnessing the prototype test along with in-house test results in printed form and neatly compiled in a booklet form.

a) Detailed specification of the offered battery charger along with all the components fitted.
b) Details of protections provided and their effectiveness/proposed set values and range and working principle.
c) Details of semi-conductor devices used and their specification and data sheets.
d) Circuit diagrams along with bill of material, and circuit description and working principle.
e) Safety margins in voltage, current, thermal (for junction temperature) along with the limit values for power devices, inductors and transformer etc.
f) Declared output voltage wave-form power factor and regulation.
g) Drawings and details of dimensions, mounting arrangement and weight.
h) Details of operating panel and function of each switch, indications and fault diagnostic features.
i) Detailed description/explanation of circuit adopted and its salient advantages.
j) Burn-in procedure followed for components/assembled cards.
k) Duty cycle considered for battery charger design for continuous and short time ratings.
l) Service experience for the developed unit or similar units.
m) A set of different coloured photographs of the battery charger unit, which clearly shows the outside, and inside details in different photographs.
n) Quality assurance plan for the product.

18.0 APPROVAL OF DESIGN/DRAWINGS BEFORE MANUFACTURING OF PROTOTYPE

The manufacturer shall submit working principle, schematic diagrams, detailed design calculations, specification of components and dimensional & fitment drawings proposed to be used in the system to RDSO for provisional approval before manufacturing the prototype unit.

Based on provisional approval of design/drawings, prototype unit shall be manufactured after incorporating all the modifications found necessary during inspection / testing without any additional charges.

The manufacturer shall also submit details like make, type, reliability, grade, rating and loading of various electronic components used in the circuit along with reliability prediction, calculations based on actual loading of various components. The temperature rise of the various components under the most adverse conditions shall also be declared. The battery charger shall be accepted for prototype test only, if the reliability prediction calculations show that MTBF is not less than $4x10^4$.

19.0 FAILURES DURING GUARANTEE PERIOD OR UNDER MAINTENANCE CONTRACT

The details of failures, action taken, action taken to arrest re occurrence of similar failure in future, failure report, investigation report and failure analysis are to be submitted to RDSO and purchaser railways.

In case of repeated failures, necessary changes in design on the units put in service or in production line are to be made by the manufactures. Investigation tests, if considered necessary, are to be arranged / conducted by the manufacturer.

20.0 TRAINING

The contractor shall undertake to train, free of cost the supervisors of the Indian Railways for operation, maintenance, fault finding, repair of the offered equipment under guidance of skilled engineers, during the first year of the service of the equipment. The purchaser shall pay the wages and allowances of each Railway Supervisor nominated for training. The purchaser shall bear the cost of the passage to and fro from the place of training for the railway supervisors.

21.0 DEVIATIONS:

Clause wise comments shall be submitted and deviations, if any, shall be brought out clearly while offering for witnessing the prototype testing.

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ANNEXURE – A

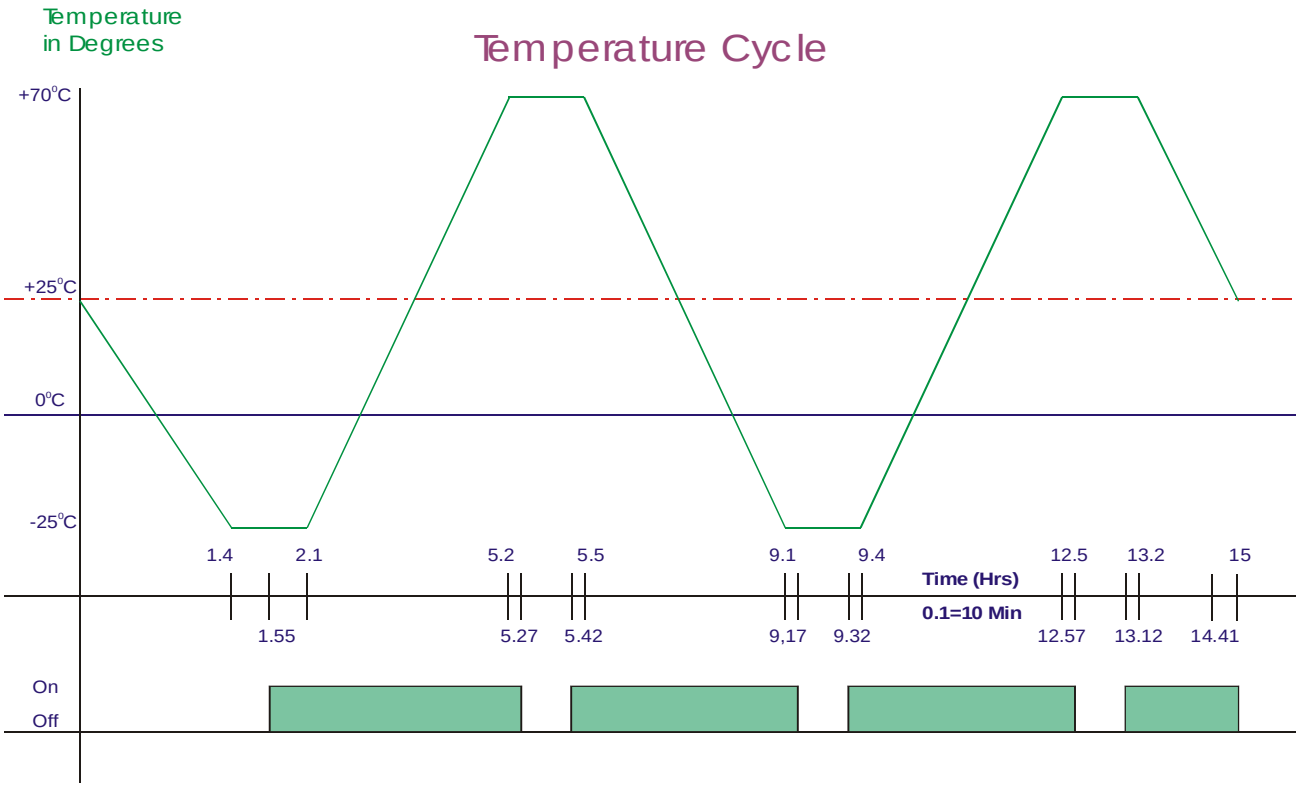
DETAILS OF BATTERY CHARGER FOR VARIOUS TYPE OF TL/AC COACHES

Type	CELL Capacity in Ah	No. of Cells	UNIT O/P VOLTAGE	O/p volt Variation	UNIT O/P CURRENT	APPLICATION
TYPE-1	120/90/75 /70	20-56	155V	40-155V	0-25 A	Train lighting
TYPE-2	1100/800/ 650/ 525	20-56	155V	40-155 V	0-220 A	Air conditioning
TYPE-3	120/90/75 /70	30-112	310V	60-310 V	0-25A	Train lighting (2 Coaches in series)
TYPE 4	1100/800/ 650/525	30-112	310V	60-310 V	0-220 A	Air conditioning (2 coaches in series)
TYPE-5	1100/800/ 650/525	5-10	30V	10-30 V	0-180A	Weak cell charging
TYPE-6	120	5-10	30V	10-30 V	0-25 A	Weak cell charging

Note: In case, the unit is for output voltage and current other than the above ratings, the same shall be specified by the purchaser.

ANNEXURE – B

BURN-IN TEST



Note: The above temperature cycle is for industrial grade electronics components suitable for 85^0C. In case of higher grade components are used, this test shall be conducted as per the cycle mutually agreed between the user and manufacturer.

ANNEXURE-C

BILL OF MATERIAL FOR REGULATED BATTERY CHARGER

SN	Item Description	Make	Remarks
1	DSP (Digital Signaling Processor) designed for motor control/ Battery charger/Converter application	Texas USA/ Microchip/Motorola	-
2	Capacitor for load life of 10,000 hrs at 105^0 C	EPCOS/ALCON/ Hittachi / Nippon/ Philips	
3	IGBT (High Frequency)	Semikron/ Mitsubishi / Infineon	-
4	Gate driver card	It shall be from IGBT vendors or from the sources approved from RDSO.	Type test report shall be submitted along with internal test result which shall be examined by RDSO
5	Input/ Out put Connectors (All type)	Hypertac, Harting, Amphenol & Allied	
6	Electronic Components	-	Industrial Grade suitable for 85ºC or above
7	PCBs	-	FR-4 or better
8	Contactor	GE/ABB/C&S	-
9	MCB/MCCB	GE/Siemens/L&T/ MDS	-
10	DC filter choke	EPI/ ARYA/Bhurji or from the sources approved from RDSO.	-
11	Thermal switch	Mikron/Honywell	-
12	DC/DC converter card/Booster card	-	Type test report shall be submitted along with internal test result which shall be examined by RDSO
13	Battery charger card	-	
14	Cables/ wires	-	As per relevant specification

Note: i) For other items (not mentioned above), Type test report of the components shall be submitted along with design details for examination.

ii) Items for which RDSO approved sources are available, only approved sources/ make shall be used.

xxxxxxxxx

Prepared by	Checked by
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