भारत सरकार, रेल मंत्रालय

GOVERNMENT OF INDIA

MINISTRY OF RAILWAYS

कर्षण संस्थापन निदेशालय

Traction Installation Directorate

TECHNICAL SPECIFICATION

FOR

BATTERY CHARGER FOR
110 VOLT BATTERY, 150 AH (FOR 2X25 KV)/40AH (FOR 25KV) AT SP/SSP FOR ELECTRIC TRACTION INSTALLATION

SPECIFICATION NO. TI/SPC/PSI/40-150/CHGR/1210

Revised in: , 2021

(Effective from:)

ISSUED BY

GOVERNMENT OF INDIA: MINISTRY OF RAILWAYS
RESEARCH DESIGNS & STANDARDS ORGANISATION
MANAK NAGAR, LUCKNOW-226011

SPECIFICATION FOR: Battery charger for 110 Volt battery, 150 Ah (for 2x25 kV)/40Ah (for 25kV) at SP/SSP for electric traction installation

SPECIFICATION NUMBER: TI/SPC/PSI/40-150CHGR/1210

Amendment Number	Revision	Total pages including drawings
0	TI/SPC/PSI/40-150/CHGR/1210	14

	PREPARED BY	CHECKED BY	APPROVED BY
SIGNATURES			
DATE			
DESIGNATION	SSE/PR	DTI/ III	EDTI

1.0 Scope

1.1 The specification applies to the design, manufacture, supply and erection & commissioning of battery chargers for charging 110 V, 150 Ah lead acid batteries installed at unattended 2X25 kV traction switching stations (SSP/SP/AT) and 40 Ah lead acid batteries installed at unattended 25 kV traction switching stations (SSP/SP). Separate battery charger shall be developed for 40Ah & 150Ah lead acid batteries.

1.2 The battery chargers shall be complete with all parts and accessories necessary for their efficient operation. All such parts and accessories shall be deemed to be within the scope of this specification whether specifically mentioned or not.

1.3 The "Make in India" Policy of Government of India shall be applicable.

1.4 This specification supersedes specification no. ETI/PSI/1 (06/81).

2.0 Service conditions:

2.1 The battery chargers are intended for use in moist tropical climate in India, with following atmospheric conditions:

SN	Description	Value
i.	Maximum ambient air Temperature	55^0C
ii.	Minimum ambient air Temperature	-10^0C
iii.	Maximum relative humidity	100% saturation during raining season
iv.	Maximum number of thunder storm days per annum	85 days
v.	Maximum Number of dust storms days per annum	35 days
vi.	Altitude	Not exceeding 2000 meters.

2.2 The battery chargers are required for installation in control rooms of unattended 25 & 2x25 kV switching station (SSP/SP). The charger shall also be suitable for effecting quick charge of a discharged battery. The steady super-imposed load on the battery charger will be maximum 2 Amp 40Ah battery charger and 4 Amp for 150 Ah battery. Steady superimposed load will vary depend on type of SSP/SP and number of lines. The control room cubicles are situated close to the Railway tracks and hence the Panels are subjected to vibrations due to running trains.

2.3 The battery charger shall be suitable for operation on 240Volt single phase, 50 Hz supply obtained from 25 kV / 240volts, 10 kVA LT supply transformer, the primary of which is connected to the 25 kV switching station bus bars at one end and to earth at the other. The 240V ac supply is, therefore, subject to fluctuations of voltage between 170V and 270Volt.

3.0 Governing specification:

3.1 The battery charger and its main components shall comply with the following specifications which shall be applied in the manner, altered, amended or supplemented by this specification and the Indian Electricity Rules, where applicable.: -

i.	Mono-crystalline semiconductor rectifier assemblies and equipment.	IS: 4540-1968 IS: 6619-1972
ii.	Rectifier transformer	IS: 2026-1977
iii.	Mono crystalline semi-conductor rectifier cells and	IS: 3895-1966

	stacks.	
iv.	Electrical indicating instruments	IS: 1248-1968
v.	Miniature circuit breaker	IS: 8828-1978
vi.	Specification for HRC fuses	IS:2208
vii.	Specification for wiring	IS:375/1963
viii.	Air break contactor/switch	IS:13947/1993
ix.	Printed circuit board	IS:5421/1981, IS: 5921
x.	Safety code for semiconductor rectifier equipment	IS:6619
xi.	AC contactors for voltage not exceeding 1000V	IS:2959

3.2 Any deviation from this specification calculated to improve the performance, utility and efficiency of the equipment, proposed by the vendor, will be given due consideration, provided, full particulars with justification thereof, are furnished. In such a case the vendor shall quote according to this specification and the deviations proposed by him shall be quoted as an alternative proposal.

4.0 Rating and other particulars:

4.1 The battery charger shall be designed for the following rating and other particulars:

i) Type	Two-rate, mono crystalline semi-conductor Silicon controlled rectifier type, suitable for floor mounting.
ii) Nominal primary voltage	240V 50 Hz ac, subject to variation from 170 to 270V.
iii)Nominal output voltage.	110 V dc
iv) Charging characteristics: a. Trickle charge	**Battery charger for 40Ah**: The output voltage of the charger shall be adjustable between 115 to 127 V (2.1 to 2.3 V per Cell) by a potentiometer provided on the PCB for smooth step less control of trickle voltage. In this mode the charger will operate in constant potential mode with current limit. **Battery charger for 150Ah**: The output voltage of the charger shall be adjustable between 115 to 127 V (2.1 to 2.3 V per Cell) by a potentiometer provided on the PCB for smooth step less control of trickle voltage. In this mode the charger will operate in constant potential mode with current limit.
b. Boost charge:	**Battery charger for 40Ah** Two rate of charging current shall be adjustable between 0.5 to 5 A through the potentiometers provided on PCB. Starting rate of charging shall be run up to 130V (2.35 V/cell) and then with reduced current, finishing rate of charging shall be up to 151V (2.75V/cell). After that the charger shall be back in trickle mode. In trickle mode, if trickle current goes upto 8 to 12 % of the rated current excluding steady load current (super-imposed load) on battery, then the charger shall be change its mode from trickle to boost. In this mode the charger shall be operated in constant current mode. **Battery charger for 150Ah** Two rate of charging current shall be adjustable between 5 to 20 A through the potentiometers provided on PCB.

	Starting rate of charging shall be run up to 130V (2.35 V/cell) and then with reduced current, finishing rate of charging shall be up to 151V (2.75V/cell). After that the charger shall be back in trickle mode. In trickle mode, if trickle current goes upto 8 to 12 % of the rated current excluding steady load current (super-imposed load) on battery, then the charger shall be change its mode from trickle to boost. In this mode the charger shall be operated in constant current mode.
v) Total current while boost charging	7A continuously for 40 Ah charger, 24A continuously for 150 Ah charger,

4.2 The battery charger shall be equipped with suitable filter circuits on the output side to reduce the ripple factor of output voltage to less than five per cent at maximum current rating, when measured across a resistance load. Superimposed AC to be measured using an oscilloscope. Ripple to be measured at 7A & 24A.

Ripple factor = Superimposed AC rms voltage / D.C. voltage (average)

4.3 The battery charger shall be designed in such a way that input supply variation in the entire range of 170 to 270 V the output for both trickle and boost charge condition shall not result in an increase or decrease by more than ± 2.5 % of the preset value.

4.4 During Float charging or Boost charging, voltage across the battery terminal may go higher. The higher output voltage of battery charger may damage the equipment connected across load terminal. A suitable automatic solid state transistorized dropping device shall be implemented in battery charger to maintain output voltage 110V±5 Volt DC across load terminal in any case.

5.0 Construction:

5.1 The equipment shall be housed in a suitable cubicle fabricated as angle iron framework fitted with mild steel sheet panels of thickness not less than 1.6 mm. The side and rear panels shall be provided with louvers to provide adequate ventilation. Perforated sheet / Wire mesh with opening not more than 3 mm shall be provided on the inner side of the louvers for protection against entry of lizards, vermin etc.

5.2 The sheet steel as well as other steel works shall be properly treated and then an under coat suitable to serve as base and binder for the finishing coat shall be applied. The exterior, interior and base frame of the panel shall be epoxy powder coated with industrially accepted Siemens gray shade followed by at least 180-degree bake ovening. The finish shall be virtually scratchproof with all metal surfaces coated to a uniform thickness on the powder coat line. To avoid rusting of the panels during service, the following pre-treatment through seven-tank process shall be ensured prior to painting:

- Degreasing
- Rinsing (Water wash)
- Pickling (Acid pickling)
- Rinsing (Water wash)

- Zinc Phosphating
- Rinsing (Water wash)
- Drying
- Powder coating & curing

If any painted surface gets damaged during transit, the surface finish shall be restored at site after erection by vendor.

5.3 The components of the battery chargers shall be appropriately mounted and identified with identification labels. The layout of major components shall permit easy access for maintenance. The charger shall be of robust construction. The assembly shall be such that it will not be affected adversely by the vibrations induced from nearby railway tracks. The clearances and creepage distances shall be in accordance with clause 4 of IS: 6619-1972. The noise level shall be kept to the minimum.

5.4 The rectifier transformer shall be double wound, vacuum impregnated, natural air cooled and liberally rated. The core shall be made of low loss silicon steel laminations. The winding shall be of copper with class F insulation.

5.5 Chokes shall be of copper winding with class-F insulation and shall be vacuum impregnated.

5.6 The rectifier shall be of the half or full controlled bridge connection using silicon thyristors or silicon thyristors and diodes with liberal ratings. The rectifier shall be suitably protected against overloading due to short time heavy currents drawn during closing of the circuit breakers, short circuits, over voltages and against inrush currents when charging full discharged batteries.

5.7 The switches meters and fuses shall be flush mounted on the front panel and shall be purchased from reputed manufacturers. These shall conform to relevant Indian Standards specifications.

5.8 The volt meters and ammeters shall be of flush mounted type of accuracy class 2.5 as per IS: 1248-1968 or latest. Latest digital or Analog meter for each with better accuracy shall be provided.

5.9 The control wiring inside the charger shall be with 1100 V grade PVC insulated copper cable having a minimum cross-section of 2.5 sq. mm for current carrying, 0.75 sq. mm voltage sensing and 0.5 sq. mm for electronic portion confirming to lS: 694-2010. The size of wire for power circuit shall be as per battery charger rating. The cables shall be suitably supported and provided with identification ferrules the connecting points.

5.10 The AC input and the DC output terminals shall be of robust design and shall be suitable for PVC copper cable connections. The polarity of output DC terminals shall be clearly marked.

5.11 (i) The battery charger shall be provided with facility for both automatic and manual control – which shall control both Float & Boost functions as to be installed at unattended 25 kV & 2x25 kV switching stations

(ii) It shall have current limiting facility, if the voltage control is in an automatic

mode and shall cause a gradual lowering of the output voltage when the DC load current exceeds the load limiting setting.

(iii) The charger shall have an adjustable current limiting facility-brought about by changing the charging voltage in gradual manner, also for safe guarding the Battery.

(iv) Uniform and smooth adjustments of voltage setting (in both manual and automatic modes) shall be provided.

(v) During Boost charging Battery Charger shall be in constant current mode and operation shall be smooth and stepless.

(vi) The current limiting characteristics shall be such that any overload or short circuit in the DC system shall not damage the charger, and will lower the output voltage immediately to avoid blowing of any of the charger fuses. To prevent any failures of the automation platform creating hazards in the field, it is recommended that fuses blow rather than risk life and high voltage output.

(vii) A lead acid battery charger should switch to float charge when fully saturated when operating in automatic mode.

(viii) Soft start feature shall be provided in the system.

5.12 Battery Charger shall have feature to communicate on MODBUS with SCADA system for control (ON/OFF) battery charger, status monitoring, faults i.e. Battery charger fail, input mains fail, input fuse fail/MCB trip, output MCB/MCCB trip/fuse fail, DC over voltage, DC under voltage, earth leakage at RCC through SCADA systems. The input and output voltage (Battery terminal and load terminal) of battery charger shall also be communicated to RCC through SCADA.

6.0 Fittings and Accessories:

The following fittings and accessories shall be provided on the battery charger:

i) LED indication for input ON and out put ON
ii) LED indication for trickle status ON/OFF, Boost status ON/OFF
iii) A double pole miniature circuit breaker along with a backup slide lock type HRC fuse on ac side.
iv) Two numbers slide lock type HRC fuses/MCB/MCCB of suitable rating on DC side (Battery terminal).
v) Two numbers slide lock type HRC fuses /MCB/MCCB of suitable rating on DC side (Load terminal)
vi) Analog or digital voltmeter 0-200 V on DC side.
vii) Analog or digital ammeter (0-5A/0-10A with 40 Ah battery charger or 0-15A/0-30A with 150 Ah battery charger) separately or dual range for trickle and boost current.
viii) Analog or Digital voltmeter 0-300 V on AC side.
ix) Auto/Manual selector switch
x) Step less smooth control through potentiometer for trickle voltage adjustment in auto mode.
xi) Step less smooth control through potentiometer for Boost charge current adjustment in auto mode.

xii) Solid state automatic load voltage regulator to maintain the load voltage of 110V±5 Volt DC. The rating of solid state transistorized dropping device shall be 5A continuous and 20A for 30 Sec for 40Ah and 10A continuous and 30A for 30 Sec for 150Ah.

xiii) Rating and diagram plate.

xiv) Two earthing terminals suitable for taking 8 SWG GI wires.

xv) RS 485 port for communication with SCADA to control, status and fault alarm display at RCC

xvi) Fuse fail/MCB/MCCB trip LED indication load and battery terminal

xvii) PVC insulated PVC sheathed 1100 V grade 3 core cable with copper conductors having a suitable cross section and conforming to IS: 694-2010 of suitable length fitted with a suitable 3 pin plug for connection to 240V ac supply.

As battery charger is manual and automatic, accessories accordingly shall be given in detail in the design drawing document submitted to RDSO for approval.

7.0 Type tests:

Following type tests shall be carried out on the prototype complete charger.

7.1 Tests on complete charger:

7.1.1 Visual inspection:

The proper layout, mounting, identification, connections and construction shall be checked.

7.1.2 No load test:

The test shall be carried out at input minimum voltage i.e. 170V and maximum input voltage i.e. 270V adjusted through a variac at input side..

7.1.3 Load test with resistance load:

The test shall be carried out by applying the minimum input voltage i.e. 170 V and maximum input voltage i.e. 270 Volts at input terminal through a variac at input side. An adjustable resistance load shall be connected across the output terminals. Load current shall be adjusted to the set value as nearly as possible at both minimum and maximum input voltage. The tests shall be carried out individually for specific current values specified under trickle and boost charge conditions.

7.1.4 Measurement of Ripple factor:

Ripple voltage on DC side shall also be measured during the load test (cl. 7.1.3) and the percentage ripple content shall be calculated.

7.1.5 Efficiency Test:

This test can be combined with no load test and load test for which details have been indicated in Cl. 7.1.2 and 7.1.3 respectively. For this test, input current, voltage and power on the AC side shall also be recorded at the minimum and maximum output voltages. The efficiency and the power factor shall then be computed from the test results.

7.1.6 Stability test:

Test shall be carried out to ascertain that the battery charger satisfies the requirements indicated in cl. 4.3 of this specification. It shall be sufficient to carry out the test at any input voltage, however, 240V AC input voltage shall be preferred for this test. At nominal voltage 240V AC input, the output voltage and current shall be adjusted through resistance load for setting required value. ln this condition, note down the output voltage and current in respect of nominal voltage i.e., 240V AC input. Then increase the input supply voltage upto 270V AC by adjusting input manual variance, the output voltage and current shall again be noted down. The test shall be separately carried out for trickle and boost charge condition and percentage increase in charging current on account of 270V AC supply voltage shall not exceed 2.5%.

7.1.7 Temperature rise test:

The test shall be carried out with charger in boost charge position and output voltage set to maximum. A suitable resistance load shall be connected across the output and load current shall be adjusted to the maximum rated current under boost charge. The ambient temperature, surface temperature of transformer, chokes, SCR and diode base etc. shall be recorded every half an hour till such time the temperature is stabilised (i.e., the temp. rise will not be more than 1 deg. C between consecutive hourly readings). The temp. rise of transformer winding, choke measured by the resistance method shall not exceed 50 deg. C. The diode/SCR base temp. rise shall be within the prescribed value recommended by the manufacturer.

7.1.8 Insulation Resistance Test:

Insulation resistance shall be measured by using 500 V dc megger between-

a) AC line lead to earth.
b) DC output terminals to earth.
c) Between line lead and DC output terminals.

These values shall be measured before and after the high voltage test and there shall not be any appreciable change in the measured values. The value of insulation resistance shall not be less than 50 mega Ohms in any case.

7.1.9 High voltage test:

The charger shall successfully withstand the test voltage of 2000 V ac rms 50 Hz for one minute applied between-

a) DC output terminals and earth.
b) AC leads and earth

7.1.10 Test 7.1.2 to 7.1.7 shall be carried out separately for manual and auto mode. Recreate all failure cases of clause no. 5.12 and check proper functionality.

7.1.11 Checking of automatic operation Float to Boost, Boost to Float mode as per battery condition.

7.1.12 Checking of automatic connection of battery to load in case of mains failure or charger trip condition.

7.2 Test on rectifier transformer:

Following tests shall be carried out on the rectifier transformer:

7.2.1 Measurement of resistance:

Resistance of primary and secondary windings shall be measured, preferably with a bridge instrument, at ambient temperature and recorded.

7.2.2 Open circuit test:

Rated primary voltage shall be applied to the primary of the transformer and the primary and secondary voltages and no-load losses shall be recorded keeping potentiometer at maximum and minimum positions.

7.2.3 Short circuit test:

With the control switches (potentiometer) set to the max. voltages and the secondary shorted, suitable voltage shall be applied to primary to pass the maximum rated current in the primary and the primary voltage, current and power shall be recorded and the full load losses calculated. This shall not exceed the guaranteed value by more than 10%.

8.0 Routine test:

The following routine tests shall be carried out on the complete charger.

8.1 Visual inspection: The proper layout, mounting, identification, connections and construction shall be checked.

8.2 No load test: The test shall be carried out in accordance with the cl. 7.1.2 except that the tests shall be carried out only at the rated input voltage of 240 V ac.

8.3 Load test with resistance load: The tests shall be carried out in accordance with cl. 7.1.3 except that tests shall be carried out only at the rated input voltage of 240 V ac.

8.4 Insulation resistance tests: Tests shall be carried out in accordance with cl. 7.1.8.

8.5 High voltage test: The tests shall be carried out in accordance with cl. 7.1.9.

8.6 Test 8.2 & 8.3 shall also be repeated in auto mode.

9.0 Technical data and drawings:

9.1 The vendor shall furnish guaranteed performance data, technical and other particulars for the equipment offered in the proforma attached as Annexure -A.

9.2 The vendor shall indicate their compliance or otherwise against each clause and sub-clause of the technical specification. The vendor shall for this purpose enclose a separate statement, if necessary, indicating the annexure and clause reference and compliance or otherwise. Wherever the vendor deviates from the provisions of the clause, he shall furnish his detailed. Remarks. Any clause or sub- clause of the specification not included in the statement shall be deemed to have been accepted by the vendor.

9.3 Successful vendor shall be required to submit the following detailed

dimensioned drawings for the equipment offered as per Railways standard size of 210 mm x 297 mm or any integral multiple thereof for approval by the purchaser along with soft copy:

i) Outline general arrangement drawing (in three views) along with mounting dimensions.
ii) Schematic diagram of connections along with technical details of components.
iii) Cross –sectional views (showing location of major components).
iv) Table of guaranteed and other technical particulars.

After approval, six copies of approved drawings along with 2 sets of reproducible copies shall be supplied to the purchaser.

9.4 Successful vendor shall also be required to furnish the design calculations for the rectifier transformer rating, rectifier ratings and filter circuits for approval by the purchaser.

Annexure -A to the Specification No. TI/SPC/PSI/40-150/CHGR/1210

SCHEDULE OF GUARANTEED PERFORMANCE, TECHNICAL AND OTHER PARTICULARS.

S. No.	Description	Units of measurement	Remarks
1.	Name of manufacturer		
2.	Country of origin.		
3.	Governing Specification.		
4.	Manufacturers type designation.		
5.	Rated primary voltage.		
6.	Nominal output voltage.		
7.	Designed capacity for charging battery of		
8.	Rated output:		
	a) At trickle charge for constant voltage varying from 115V to 127V battery charger.		
	b) At boost charge for charging current varying from 0.5 A to 5 for 40Ah battery and 5 to 20 for 150Ah battery.		
	c) 7A continuously for 40 Ah charger, d) 24A continuously for 150 Ah chargers		
9.	Declared values:		
	a. No load loss of complete charger under i. Trickle ii. Boost		
	b. Full load loss of complete charger under: i. Trickle ii. Boost		
	c. Overall efficiency of charger at full load under: i. Trickle ii. Boost		
	d. Variation in max. Charging current to battery with 10 increase in supply voltage under: i. Trickle ii. Boost.		
	e. Percentage ripple content in output voltage at full load with battery connected under: i. Trickle ii. Boost		
10.	Size and type of 240 V ac incoming lead.		
11.	Thickness of sheet steel for charger cubicle.		

12.	Total weight		
13.	Rectifier transformer particulars:		
	a. name of manufacturer		
	b. Governing specification		
	c. Rated input voltage. i. Taps provided for variation in input voltage. ii. Rated kVA.		
	d. Type of winding		
	e. Type of impregnated of the winding conductors.		
	f. Type of cooling		
	g. Class of insulation.		
	h. Iron loss at 100 % rated input voltage.		
	i. Copper loss at full load.		
	j. Maximum temp. rise on boost charge (7A) for 40 Ah and 24A for 150Ah over ambient.		
14.	Rectifier Particulars: a) Name of manufacturer. b) Governing specification c) Manufacturer's type designation. d) Total number of rectifier cells used. e) Method of connections. f) Repetitive peak inverse voltage. g) Rated average forward current h) Temperature rise over ambient on boost charge.		
15.	Devices used for protection of rectifier cells against: i. Over current ii. Over voltage.		
16.	Type of smooth filter.		
17.	Ammeter particulars.		
	a. Name of manufacturer.		
	b. Governing specification.		
	c. Dial size and range or Digits i. For AC ii. For DC		
	d. Accuracy class. i. For AC ii. For DC		
	e. Type of mounting.		
18.	Fittings and accessories. a) Miniature circuit breaker. i) make ii) Rating iii) No. of poles. iv) Governing specification. b) Slide lock type fuses/MCB/MCCB; i) Make ii) Rating		

	c) Rotary control switches: i) Main ii) Rating iii) Type designation.		
19.	Voltmeter particulars:		
	a. Name of manufacturer.		
	b. Governing specification.		
	c. Dial size and range or Digits i. For AC ii. For DC		
	d. Accuracy class: i. For AC ii. For DC		
	e. Type of mounting		
20.	Fittings and accessories.		
	a. Miniature circuit breaker.		
	i. make		
	ii. Rating		
	iii. No. of poles.		
	iv. Governing specification.		
	b. Slide lock type fuses;		
	i. Make		
	ii. Rating		
	c. Rotary control switches:		
	i. Main		
	ii. Rating		
	iii. Type designation.		