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सत्यमेव जयते

Draft

FUNCTIONAL REQUIREMENT SPECIFICATION
of
SMPS BASED POWER PLANT SUITABLE FOR LITHIUM-ION BATTERIES

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अअमासं RDSO
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SIGNAL AND TELECOM DIRECTORATE (TELECOM WING)

1. Background:

1.1 Railway Board has approved 42nd TCSC meeting Agenda no. 337(3) for adoption of TEC specification for SMPS based Power Plant on Lithium-Ion batteries and their inclusion in railway after field trials.

1.2 WCR and SR were nominated for field trial of Lithium ion battery based SMPS power plant. This Functional Requirement Specification (FRS) prepared for field trial of SMPS based Power Plant suitable for Lithium-Ion batteries only.

1.3 This document has been prepared based on the recommendation of the 42nd Telecom Standard Committee (TCSC) duly approved by Railway Board vide letter number 2020/Tele/9(2)/1 dated 04.01.2025.

2. Objectives:

2.1 Indian Railways is constantly striving to enhance the quality of service so as to ensure better experience with the adoption of new age technology for enhancing train operation in this digital world. As, it is the need of the hour that the railways should also keep pace with the latest technology.

2.2 Railway Board advised to RDSO to issue TAN/Revised specification/new specification by Telecom Directorate of RDSO for SMPS Charger as well as Li-ion Battery compatible based on industries practices and in line with TEC specification for using in Telecom equipments.

3. Technical Requirements

3.1 This document covers the technical requirements of 48 V DC Power Plant based on High Frequency Switch Mode Techniques for the use by Indian Railways for Telecom Equipments i.e. Exchanges, Multiplexing Equipments, Microwave Radio Equipments, GSM-R Equipments, TETRA Equipments, OFC Equipments etc..

3.2 Power Plant shall consist of a Distribution-Switching-Control-Alarm Arrangement (DSCA) and Float Rectifier-cum-Chargers (FR-FCs) or Float Rectifier cum Boost Chargers (FR-BCs).

3.3 Lithium-Ion batteries suitable for SMPS based power plant consist of Battery Management System (BMS) & set of battery module (having 15 cells of 3.2V each). If higher voltage rating is used the configuration should be such that 48V over all voltage is achieved.

3.4 The Power Plant shall be capable of meeting the load requirement (equipment and battery bank) for various telecom equipments. The system shall be expandable at rack level itself, using the basic modules of the same rating.

3.5 The Power Plant including FR-FC or FR-BC modules shall be suitable for operation from AC Mains or from a DG Set.

3.6 230V AC/48V DC SMPS based Power Plant should be work for single phase incoming power supply range from 165V AC to 260V AC.

4. SMPS based Power Plant-Functional Requirements

4.1 Nominal Input AC Power supply shall be 230VAC, single phase, voltage range 165V-260V.

4.2 Battery type: Lithium-ion in the form of battery module having 15cells of 3.2V each module. If higher voltage rating is used the configuration should be such that 48V over all voltage is achieved.

4.3 Battery module rating should be 50AH or higher. However 100AH battery module is recommended. Minimum battery modules shall be two numbers in load sharing with one in hot stand by (Load sharing with N+1 Configuration)

4.4 The SMPS based power plant using FR/FC modules of 25A rating each with N+1 configuration shall operate from single phase AC input. Ultimate expandable capacity of Power Plant shall be 50A or higher as per purchaser requirements.

4.6 Power Plant using FR-FC or FR-BC module shall work either Constant Current (CC) mode or Constant Voltage (CV) mode as per Zonal Railway requirements.

4.7 Constant Current (CC) mode should be C/5 or lower charging rate/ Constant Voltage (CV) mode should be 54V/module(battery) in constant voltage charging mode.

4.8 Nominal input frequency should be 50Hz (variation allow within limit 48Hz to 52Hz)

4.9 Output DC Power Supply should be 48VDC (variation allow within limit 42V to 54V)

4.10. Over Voltage Protection of module/battery shall be less than or equal to 56V

4.11 Efficiency at 230VAC input, 48VDC output & 100% load should be >85%

4.12 Power Factor at 230VAC, 48VDC & rated load should be >0.98 and 75% to 100% load should be >0.95

4.13 Total Voltage/Current harmonic distortion shall not be more than 10%

4.14 Psophometric noise shall be <4mv when battery is not connected

4.15 Peak to Peak Ripple Voltage at full load should be <300mv when battery is not connected

4.16 Voltage overshoot/Undershoot within +/- 5% of set voltage when battery is not connected

4.17 Parallel operation (Current sharing/Load sharing) variation shall be within +/- 10% between the battery modules to be ensured

4.18 Battery Path current is kept at 10% to 50% of battery AH capacity; actual battery path current will be decided by the purchaser.

4.19 Applied HV 1500V/50Hz for one minutes

4.19.1 between earth & output

4.19.2 between input & output

4.20 IR Test

4.20.1 IR >2M Ohm between AC input & Earth

4.20.2 IR >1M Ohm between DC output & Earth

4.20.3 IR >5M Ohm between AC input & DC output

4.21 Alarm Indication in SMR Modules

4.21.1 Healthy/OK

4.21.2 Minor Alarm such as Temperature Alarm, Cell Voltage Low/High, Battery Voltage Low/High, Fan Fail, etc.

4.21.3 Major Alarm such as Battery Fail, Mains Fail, Discharge >80%

4.22 Function Indications in DSCA Panel

4.22.1 Main Available

4.22.2 FR-FC Mode (CC/CV)

4.23 Alarm Indications in DSCA Panel

4.23.1 Load Voltage High (Above 56V) & Low (Below 45.6V)

4.24 Additional Alarms on SMR Modules

4.24.1 Mains out of Range

4.24.2 System over Load

4.24.3 Mains "ON" / Battery Discharge

4.24.4 Fan Fail (in case of fan provided)

4.24.5 Battery Fail or No Battery (Separate for each Battery)

4.24.6 Battery isolated from the load

4.24.7 Lightning and surge Protection Fail

4.25 Audio/Visual alarm & indication of all parameters of battery charger, each battery module & each battery cell (i.e. main available, charging mode, AC/DC over voltage & under voltage,

System/Module over load (voltage drop), Module Fail/Fan Fail/Temp. sensor fail, Mains out of Range, Battery Fail/Isolated, AC/DC input/output voltage & current, charging/dis-charging rate, charging/dis-charging cycle count, State of Charge (SOC)/Depth of Discharge (DOD) and over all State of Health (SOH) shall be monitor at BMS & DSCA Panel and at Test Room through Bi-directional SNMP over Ethernet or E1

4.26 Battery Charger shall be protected for short circuit, reverse battery connection, AD/DC current & voltage limit and lightning & surge protection.

4.27 Surge Protection in input side of Charger and industrial grade MOV should be provided internally for protection of each module

4.28 All components/parts of battery charger shall be Industrial grade

4.29 Potential free contact for AC and Module Failure to be provided for connection with Data logger

5. Lithium-Ion Battery-Functional Requirements

5.1 Normal voltage of each battery cell shall be greater than or equal to 3.2V, however 3.2V/cell recommended with combination of 15cell/battery. If higher voltage rating is used the configuration should be such that 48V over all voltage is achieved.

5.2 Exhausted condition of battery 2.8V/Cell or 42V/Module

5.3 Working condition of battery 3.2V/Cell or 48V/Module

5.4 Charging of Battery at the rate 3.6V/Cell or 54V/Module

5.5 Lower voltage range of each cell 2.8V(DOD) & Upper voltage range of each cell 3.6(Full charge)

5.6 Normally One battery Module have 15 battery cells (15Cell x 3.2V = 48VDC). If higher voltage rating is used the configuration should be such that 48V over all voltage is achieved.

5.7 DC output lower cutoff voltage 42V & DC output upper cut off voltage 54V

5.8 Temperature range for charging shall be 0 deg C to 55 deg C

5.9 Temperature range for dis-charging shall be -20 deg C to 60 deg C

5.10 Relative Humidity operation should be >90%

5.11 Relative Humidity Storage should be >95%

5.12 Life Cycle : at 25 deg C & at charge/discharge rate C/5, Number of cycle shall be 3500

5.13 Ampere Hour (Ah) efficiency shall be >95%

5.14 Each cell connected in series & each module connected in parallel

5.15 Charge time should be maximum 8 Hrs to charge 100% battery, accordingly charge rate to be set from C/5 to lower rate.

5.16 The back-up time should be minimum 8 Hrs to dis-charge upto 80% of battery capacity, according battery capacity should be installed for telecom equipments.

6. Battery Management System(BMS)-Functional Requirements

6.1 BMS Consisting of following components

6.1.1 Solid-state switch for disconnecting charging path and current limiter circuit to regulate charging current.

6.1.2 Solid-state switch for disconnecting discharging path that is disconnecting the battery discharging circuit to prevent a total discharge.

6.1.3 The current sensor to measure the charging/discharging- currents.

6.1.4 The BMS cell board or the central box that are monitoring and balancing the single cells.

6.1.5 The power supply for the energy supply of the BMS.

6.1.6 Four nos. of cells temperature sensors for monitoring of cell temperature.

6.1.7 BMS with LCD is required to display critical parameters.

6.2 BMS collect all information from module/cell – individual voltage of each cell and total Battery voltage

6.3 BMS communicate to the power plant

6.4 BMS Monitor- Voltage, Temperature & Current other function- Cell balancing

6.5 BMS should calculate maximum charge current as a charge current limit (CCL)
6.6 BMS should calculate maximum dis-charge current as a dis-charge current limit (DCL)
6.7 BMS count total number of cycles & charge/dis-charge cycle count
6.8 BMS indicate battery charge level in % called State of Charge (SOC) or Depth of Discharge (DOD)
6.9 BMS measure overall condition of the battery called State of Health (SOH)
6.10 BMS should be provided following protection:-
6.10.1 Over charge protection
6.10.2 Over discharge protection
6.10.3 Short circuit protection
6.10.4 Overload protection
6.10.5 Temperature protection
6.11 BMS ensured that all the cells that compose the battery are kept at the same voltage or State of Charge to prevent under-charging or over-charging.
6.12 Natural/forced air cooling will be provided such that the cells/module/batteries always operate within the safe temperature limits.
6.13 Battery supply not interrupted due to failure of any one battery module. The system shall be able to provide uninterrupted rated power to the load.
6.14 The manufacturer shall provide Modbus RS485 port for connectivity with SMPS power plant and shall also provide any other additional communication port(s) such as RS232, Ethernet or USB, CAN, wireless communications etc., as per the requirement of the purchaser.

7. General Requirements

7.1 Same 19" U Rack shall be used to house both SMPS Battery Charger and lithium ion battery.
7.2 Sufficient spacing shall be given between lithium ion battery and SMPS battery charger.
7.3 All battery data i.e. individual cell voltage, battery voltage, SOH, SOC, over voltage, under voltage etc. shall be available on an LCD panel of BMS.
7.4 All Charger data i.e. Load Voltage High, Alarms on FR/FC, Mains out of range, System over load, Main ON/Battery discharge, Battery Fail or No Battery (Separate for each battery), Battery isolated from the load, Lighting and surge protection stage II Fail etc. shall be available on an LCD panel of DSCA.
7.5 Audio Visual alarm shall be generated at dashboard/NMS located at test room for all parameters of DSCA and BMS.
7.6 Pop up facility should be provided by firm on dashboard/NMS to find out failure history.
7.7 Auto refresh should be provided in every 2 second to see current status of asset on dashboard.
7.8 Necessary Declaration/Undertaking/Datasheet to be provided by firm at the time of testing.
7.9 Compliance of local content as per laid down Make in India policy of Government should be ensured by firm.
7.10 Undertaking on Codal life of Lithium-Ion battery should be submitted by firm at the time of system testing.
7.11 All data on DSCA and BMS shall be sent to NMS and display at dashboard located at Test Room as per the drawing attached as **Annexure-1**

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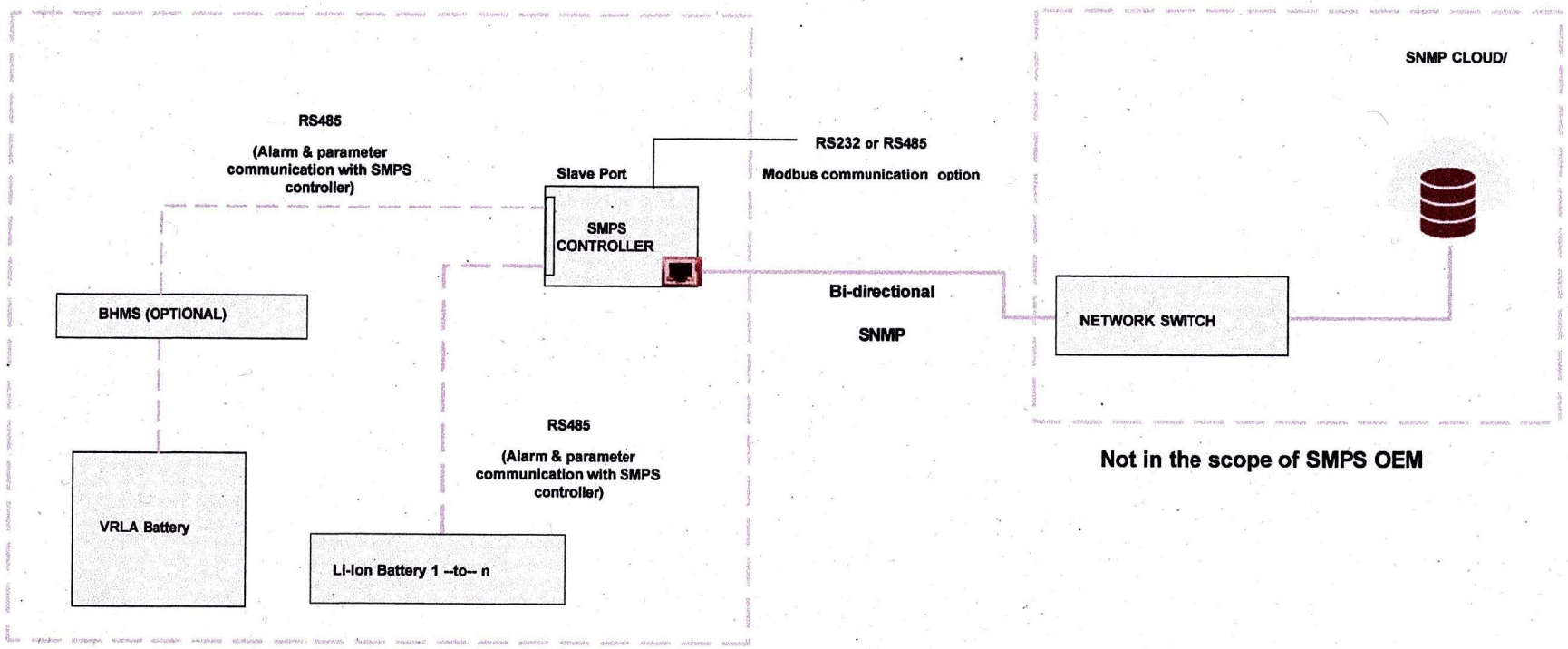
Annexure-1


RS485
(Alarm & parameter communication with SMPS controller)
Slave Port
RS232 or RS485
Modbus communication option
SMPS CONTROLLER
BHMS (OPTIONAL)
Bi-directional
SNMP
SNMP CLOUD/
NETWORK SWITCH
RS485
(Alarm & parameter communication with SMPS controller)
VRLA Battery
Li-Ion Battery 1 --to-- n
Scope of SMPS OEM
Not in the scope of SMPS OEM