Template for submitting comments/inputs on Draft GR "SOLAR PHOTO VOLTAIC (SPV) BASED STANDALONE/ HYBRID POWER SUPPLY FOR Wi Fi TERMINALS & OTHER SIMILAR TELECOM TERMINALS, (Draft GR TEC 66100:2026)"-

Name of Manufacturer/Stakeholder:
Organization:
Contact details:

Clause No.	Clause Description	Comments, if any	Remarks, if any

Note: The comments/inputs on the draft GR TEC 66100:2026 may be furnished in the above format through email to adgfa-tec-dot@gov.in with copy to dirfa.tec@gov.in and ddgfla.tec@gov.in at the earliest and within prescribed time period.

Annexure -1

वर्गीय आवश्यकताएँ के लिए मानक

टीईसी ६६१००:२०२६

(सं: टीईसी ६६१००:२०१७ को अधिक्रमित करता है)

~~वर्गीय आवश्यकताएँ सं:टीईसी/जीआर/टीएक्स/एचपीएस-001/01/माचच-17~~ STANDARD FOR GENERIC REQUIREMENTS

No.: TEC 66100:2026~~5TEC/GR/TX/HPS-001/01/MAR-17~~

(Supersedes No.TEC 66100:2017~~TEC/GR/TX/HPS-001/01/MAR-17~~)

सोलर फोटो वोल्टाइक बेस्ड स्टैंडअलोन /हाइब्रिड पावर सप्लाई फॉर वाई फ़ाई टर्मिनल्स एंड अदर सिमिलर टेलीकॉम टर्मिनल्स

SOLAR PHOTO VOLTAIC (SPV) BASED STANDALONE/ HYBRID POWER SUPPLY FOR Wi Fi TERMINALS & OTHER SIMILAR TELECOM TERMINALS

ISO 9001:2015

दूरसंचार अभियांत्रिकी केंद्र

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Release 2: XXXX, 2026

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FOREWORD

Telecommunication Engineering Centre(TEC) functions under Department of Telecommunications (DOT), Government of India. Its activities include:

- Issue of Generic Requirements (GR), Interface Requirements (IR), Service Requirements (SR) and Standards for Telecom Products and Services
- Field evaluation of products and Systems
- National Fundamental Plans
- Support to DOT on technology issues
- Testing & Certification of Telecom products

For the purpose of testing, four Regional Telecom Engineering Centers (RTECs) have been established which are located at New Delhi, Bangalore, Mumbai, and Kolkata.

ABSTRACT

This document contains the generic requirements of standalone and Hybrid power supply using Solar Photo Voltaic (SPV) for powering ONTs, Wireless terminals(WTs), Fixed Wireless terminals(FWTs), low power BTSs and similar Telecommunication equipment deployed to provide two-way communication in rural areas.

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HISTORY SHEET

S. No.	GR No.	Title	Remarks
1.	TEC/GR/TX/HPS-001/01/MAR-17	Generic Requirement for Solar Photo Voltaic based standalone/ Hybrid Power Supply for Wi Fi Terminals & Other Similar Telecom Terminals	First issue:: Requirements in respect of some of the parameters have been changed in the relevant clauses to accommodate advancements, more optional features for the purchaser and for better clarity
2.	TEC 66100:2026	Generic Requirement for Solar Photo Voltaic based standalone/ Hybrid Power Supply for Wi Fi Terminals & Other Similar Telecom Terminals	Second Issue:: Requirements in respect of some of the parameters have been changed in the relevant clauses to accommodate advancements, more optional features for the purchaser and for better clarity

REFERENCES

S. No.	*Document No.*	*Title/Document Name*
1	CISPR 32 (2015) with A1(2019)	Electromagnetic compatibility of multimedia equipment - Emission requirements
2~~1.~~	QM-115	Quality standard for calculation/verification of MTBF
3~~2.~~	QM-118	Quality reliability in product design.
4~~3.~~	QM-202	Pictorial guidelines for Visual assessment of quality of printed board assemblies (PBA) & discrete terminal assemblies.
5~~4.~~	QM-204	Guidelines for workmanship standards for repair & modification of printed wiring board assemblies.
6~~5.~~	QM-205	Guidelines for standard of workmanship for printed boards.
7~~6.~~	QM-206	Guidelines for standard of workmanship for printed boards assemblies.
8~~7.~~	QM-207	Guidelines for soft solder and fluxes for Telecom Equipments.
9~~8.~~	QM 210	Guidelines for standard of workmanship for surface Mounting Devices.
10~~9.~~	TEC 14016:2010 (old no. QM-333)~~QM-333~~	Standard for Environmental Testing of Telecommunication Equipments~~Specification for Environmental Testing of Electronic Equipments for Transmission and Switching use.~~
11	IS 5	Standard on colours & shades.
12	IS 101	Methods of Sampling & Test for Paints, Varnishes & Related Products
13	IS 168	Ready Mixed Paint, Air Drying, For General PurposeSpecification.

14	IS 1554 Amend -1 (June 1994)	Standard for Cables & Wires.
15~~0.~~	IS 2062:1992	Steel for General Structural purposes-Specification.
16~~1.~~	IS 4759	Specification for Hot-Dip Zink coatings on Structural Steel & Other Allied Products.
~~12.~~	~~IS 613~~	~~Copper Rods And Bars For Electrical Purposes -~~
~~13.~~	~~IS 10437(1986)~~	~~Safety requirements of radio transmitting equipments~~
~~14.~~	~~IS 13252 {2010}~~	~~Safety of information technology equipment including electrical business equipment~~
17~~5.~~	ISO-9001-2015 (latest issue) ~~00~~	Quality Management Systems Requirements.
18~~6.~~	ISO 14001:2015 (latest issue)	Pertaining to environmental requirements.
19~~17.~~	IEC-68-2-38 Test Bb	Environmental Requirements for SPV Generating Modules/panels
20~~18.~~	IEC-68-2-1 Test Ab	-do-
~~19~~21~~.~~	IEC-68-2-14	-do-
22~~0~~.	IEC-68-2-38	-do-
23~~1.~~	IS 9000(PART16)	-do-
24~~2.~~	IEC 61215	standard "Crystalline silicium terrestrial photovoltaic (PV) Modules - Design qualification and type approval"
25~~3.~~	IEC 60215	Safety requirements for radio transmitting equipment
26~~4.~~	IEC Publication 60950 (2001)	Information technology equipment –Safety
27~~5.~~	IEC publication 60479-1{1894}	Effects of current passing through the human body

28~~6.~~	IEC Publication 61000-4-2	Testing and measurement techniques of Electrostatic discharge immunity test
29~~27.~~	IEC Publication 61000-4-3	Radiated RF electromagnetic field immunity test
30~~28.~~	IEC Publication 61000-4-4	Testing and measurement techniques of electrical fast transients/burst immunity test
31~~29.~~	IEC Publication 61000-4-5	Test & Measurement techniques for surge immunity tests
32~~0.~~	IEC Publication 61000-4-6	Immunity to conducted disturbances
33~~1.~~	IEC 62368-1 IEC 950(UL-1950)	Safety of information technology equipment including electrical business equipment~~UL Standard for Safety Safety of Information Technology Equipment, Including Electrical Business Equipment~~
34~~2.~~	ITU-T Rec. O.41	Psophomeric noise requirements.
35~~3.~~	TEC67010:2011 (Old No. GR/Tx/BAT01/04.JUN.2011)	GR for VRLA Batteries
36~~4.~~	TEC 66079:2015~~GL/SPV-05/02.MAR.2015~~	Planning and Maintenance Guidelines for SPV supply
37~~5.~~	TEC 66130:2025~~TEC/GR/FLA/LSP-001/01/June.2010~~	GR on Lightening and Surge Protection of Telecom Sites
38	IEC-61000-4-x	Electromagnetic compatibility: Testing and measurement techniques
39	IEC 62305-1	Protection of Structures against Lightening: General Principle
40	IEC 61701	Salt Mist Corrosion Testing Of Photovoltaic (PV) Module
41	TEC10009: 2024	SAFETY REQUIREMENTS OF TELECOMMUNICATION EQUIPMENT
42	TEC 66110:2025	SMPS BASED POWER PLANTS

43	IEC 61643-31	Low-voltage surge protective devices - Part 31: Requirements and test methods for SPDs for photovoltaic installations
44	IEEE C62.41- 1991	IEEE Recommended Practice on Surge Voltages in LowVoltage AC Power Circuits
45	IEC 60529	Degrees of protection provided by enclosures(IP Code)
46	BIS 613	Copper rods and bars for electrical purposes
4	IS 1359: 1992	Electroplated Coatings of Tin: Specification

Note:

Unless otherwise explicitly stated, the latest approved issue of the standard/GR/IR, with all amendments in force listed in this References Table, on the issuance date of this GR/IR applies".

CHAPTER-1

1.0 Introduction

1.1 This document contains the generic requirements of standalone and Hybrid power supply using Solar Photo Voltaic (SPV) for powering ONTs, Wireless terminals(WTs), Fixed Wireless terminals(FWTs), low power BTSs and similar Telecommunication equipment deployed to provide two- way communication in rural areas.

1.2 These power supplies are capable of catering to load requirements of 60W, 5A continuous or up to 120 AH per day for 12V telecom equipments, 240W, 10A continuous or up to 240 AH per day for 24V telecom equipments and up to, 480W, 10A continuous or up to 240 AH per day for 48V telecom equipments.

1.3 SPV Power supply specified in this document may be of two types:

a) Standalone SPV Power Supply: Standalone SPV power supply has only provision for SPV Power generating source. This type of power supply has a larger battery bank to provide the higher autonomy. SPV Array in this case is also bigger than hybrid power supply (described below) because all the load requirements are to be met by SPV power source only. Rating and the voltage of the power supply will depend on the operating voltage and power requirement of the telecom equipment to be fed. A Block-schematic showing different component of the power supply is given in annexure -1.

b) **Hybrid SPV Power Supply:** Hybrid SPV Power Supply works on both SPV power source and Switch Mode Power supply (SMPS). This type of power supply is so designed that 50% to 100% of the load requirement is met by SPV and the remaining by the SMPS,

the SMPS may be required for occasional topping up of the batteries in case of unfavourable weather conditions. The hybrid power supply may as well be configured and used in Grid only mode in space constrained environments (no suitable space available for solar panels) where grid is available for more than 8 Hours a day. The percentage of load to be met by SPV power source is required to decide the size of the SPV array. Rating and the voltage of the power supply will depend on the operating voltage and power requirement of the telecom equipment to be fed. Hybrid SPV power supply shall be of two types **(i) Non- integrated SMPS Hybrid SPV power supply, (ii) Integrated SMPS hybrid SPV power supply**, as explained in clause 1.5.

1.3.1 This hybrid type of power supply shall have provision, so that, when both the output of SMPS and SPV power source are available, they shall take the load collectively. SPV power source shall deliver the load as per its available power and rest of the load shall be taken care of by SMPS. For proper load sharing of the two power sources, it shall be ensured that voltage of the SPV power source, even in worst working conditions (high SPV cell temperature) is higher than that of the SMPS.

1.4 The SPV Power Source is a non-conventional energy source, comprised of a SPV Modules, which convert Solar Energy (Sun light) directly into DC electricity to charge the battery, through a charge controller. The Charge Controller is used to control the charging process.

~~1.4~~1.5 SMPS is comprised of FR-FC (Float Rectifiers - cum - Float Chargers), which converters AC in regulated DC and its control circuitry. Output of the SMPS is used to cater to the load and simultaneously charge the battery. Hybrid SPV power supply shall be of two types:

1. **Non-integrated SMPS Hybrid SPV power supply:** SMPS shall be designed as standalone system and gets integrated to SPV Charge controller through the switch. A Block-schematic showing different component of this power supply is given in annexure -2a.

2. **Integrated SMPS Hybrid SPV power supply:** SMPS shall be fully integrated within the Hybrid power supply that accepts AC mains

power and SPV power as inputs. A Block-schematic showing different component of this power supply is given in annexure -2b.

~~2.~~

2.0 Description

2.1 Power Supply Configuration: The major components of the SPV Power Supply are as follows:

~~**2.1 Major components of the System :**~~

2.1.1 Solar Photo-voltaic Generating Source: SPV generating source is constituted of the following building blocks:

2.1.1.1 **SPV Module:** SPV Module is the basic building block of the SPV power supply, which consists of a number of Solar Cells (a Semi Conductor Device which when exposed to sun light produces DC electricity) connected in series or in series -parallel configuration and hermetically sealed with a toughened and highly transparent front glass cover. These modules are connected in series and parallel to get the desired power and voltage. Two rating of these modules, as per this document, have been specified as 12V/50Wp to 12V/300Wp and 24V/250Wp to 24V/550Wp and above~~24V/125Wp to 24V/300Wp~~. However, purchaser may specify power '300Wp or higher' as per the requirement.

~~2.1.1.2~~ **SPV Panel:** SPV Modules of same rating are connected in series to form a SPV panel to get the desired voltage. For example for a 12V equipment, the module itself becomes a panel, while for 48V equipment, four 12V SPV modules are connected in series to form a

48V SPV panel and two 24V modules are to be connected in series to form a 48V SPV panel.

~~2.1.1.3~~2.1.1.2

If required by **purchaser**, for a 48V equipment, less than four or four or more than four(in case of MPPT based CCU)12V SPV modules may be connected in series to form a 48V SPV panel and less than two or two or more than two(in case of MPPT based CCU) 24V modules (for standalone application only) may be connected in series to form a 48V SPV panel. However, higher voltage thus generated shall not be hazardous and all possible protection arrangement shall be made from safety point of view. (as per IEC 60950-1{2005}).

If desired by Purchaser/User, the advantages of PWM control techniques may be taken.

~~2.1.1.4~~2.1.1.3 **SPV Array:** A number of panels are connected in parallel or series to get the desired power. This whole combination is called an array. The SPV array is so designed that, it provided the necessary battery charging current and simultaneously meets the load demand, when sufficient sunshine is available.

~~2.1.2~~ **Charge Controller Unit (CCU):** Charge controller unit should have common MPPT Charge Controller module ~~shall be common~~ for both standalone SPV power supply and non-integrated SMPS Hybrid SPV power supply. ~~However for integrated SMPS Hybrid SPV power supply, CCU shall be fully intergrate with SMPS.~~

2.1.2 ~~Purchaser may choose to buy the Hybrid Charge Controller for 100% solar only applications, considering the future site requirements~~

2.1.2.1 It~~The unit~~ shall provide for the necessary DC power supply to the load and battery and also protect battery bank from over charge, deep discharge, reverse polarity and short circuit, thereby ensuring that the electrical characteristics are met for optimum performance and reliability. It monitors all the functions of SPV power source and SMPS through common DSCA (some on charge controller along with SMPS and all other on the SMPS). CCU shall also monitor all the functionalities of integrated SMPS based hybrid SPV system, while in case of non-integrated SMPS based hybrid SPV system, SMPS module shall have its own monitoring functions. It provides for termination for output of the SPV array, output of the SMPS (through a switch), load and battery. It shall house all the necessary alarms, monitoring and control circuits. It shall also provide for the mounting of the lightning and surge protection devices (SPV side on the charge controller itself or some external box/unit, while SMPS side lightning and surge protective devices on the SMPS or some external box/unit.) The system should have Stage – I & II SPD as per TEC GR No. TEC 66130:2025~~TEC/GR/FLA/LSP-001/01/June 2010~~. In case of small 12 V SPV power supplies using mono-blocks up to 50AH, the battery may be accommodated inside the charge controller.

The CCU shall compose the following features:

(i) Accommodating the charge controller and battery in same enclosure may reduce life and performance of charge controller. There should be adequate arrangement such that the rise in the temperature of one unit should not impact the temperature of the other. However purchaser may specify the requirement to have charge controller and battery to be kept in same enclosure or separate enclosures.

(ii) SMPS output shall not be terminated at the input of charge controller unit. It shall be connected in parallel with charge controller output internally or externally. There shall be provision to switch off SMPS output. This can be done using a control signal from Charge controller which controls SMPS or a switch. There shall be provision of load sharing as per clause 1.3b whenever Solar Power is available.

(iii) Charge controller shall be capable of working in extreme temperatures of -15°C to +55°C ambient without any de-rating in its power handling capabilities as Indian locations have extreme temperatures and any temperature related de-rating of power or performance will not be effect system performance.

(iv) The Solar Charge Controller shall be based on MPPT technology which can charges battery from Solar panels arrays of higher or lower voltage. It should utilize the maximum possible energy from the solar panels so that more energy can be harvested from same Solar panels. However, higher voltage thus generated shall not be hazardous and all possible protection arrangement as per IEC 60950-1(2005) shall be made from safety point of view.

~~The requirement of MPPT technology for Solar Charge Controller may be decided by purchaser.~~

~~(v) The Solar Charge Controller with MPPT feature shall have suitable protection to protect the Telecom Load from any potential hazards owing to short circuits at the primary levels.~~

~~(vi)~~(v) The Solar Charge Controller more than 60 V shall have the galvanic isolation and telecom equipment should never be allowed to get exposed to the un-isolated source of power.

Note: Charge controller should not allow any reverse current flow from the SPV power source into the FC, the CCU should prioritise SPV power over FC, and FC over battery power.

2.1.3 **Float Charger (FC)** : In hybrid Power supply, float charger(FC) can be modular or integrated depending upon non-integrated or integrate type SMPS based hybrid power supply and FC shall provide DC power supply to the load and battery when the AC commercial main are available.

2.1.4 **Battery Bank:** It stores the energy generated by SPV Generating source or SMPS. The Battery capacity will depend on the load and autonomy.

If required by the purchaser, Battery cabinet may have physical security system in place. Security system may be battery operated/AC powered for:

(i) Need based access control ensuring authorized personnel to have access when required.

(ii) Thermal management that ensures controlled fans and can be connected to a fire suppression system.

(iii) Complete data and audit trail to understand all operations about the site and door status.

(iv) Online/offline communication.

2.1.4.1 **12V SPV Power Supply:** For 12V SPV power supply either a six cell battery of 2V cells or 12V mono-block is used. Mono-blocks of rating up to 12V/150AH are permissible for this purpose. For higher battery capacity only 2V cells shall be used.

2.1.4.2 **24V SPV Power Supply:** For 24V SPV power supply, a 12 cell battery formed by 2V cells is used. 12 V Mono-blocks of rating up to 150AH are permissible for this purpose. For higher battery capacity only 2V cells shall be used.

2.1.4.3 **48V SPV Power Supply:** For 48V SPV power supply, a 24 cell battery formed by 2V cells is used. Mono-blocks of rating up to 12V/150AH are permissible for this purpose. For higher battery capacity only 2V cells shall be used~~Battery AH Capacity depend upon load requirement & autonomy~~ .

~~2.1.5~~ **The Module Mounting Structure :** SPV Modules /panels/arrays are mounted on a specially designed ~~hot dip~~ galvanized iron support structure .It shall also provide for ~~(with corrosion resistant paint) that can be installed either on the roof or on the ground at an~~ angle of tilt with horizontal in accordance with the latitude of the place of installation. ~~Also a vented metallic/plastic/wooden box with acid proof corrosion resistance paint for housing the storage battery indoors should be provided.~~

2.1.5

2.1.6 Interconnecting Cables : Interconnecting cables are used for providing interconnection between:

— SPV modules, panels

— SPV Generating Source (array) and Charge Controller

— Charge controller and SMPS (Hybrid power supplies)) (If required)

— Charge controller and battery

— Charge controller and load.

The Length of the interconnecting cables shall be as per the requirement of the site. The gauge of the cable shall be so chosen that the total voltage drop across the whole length of cable shall be less than 340mV (2% of voltage at peak power) for 12V SPV power generating source , 680 mV for 24 V SPV power generating source and 1.36V for 48V SPV power generating source. It shall also be capable of taking load without overheating. The termination of the cables shall be through lugs of suitable gauge. Further, the rating of the cables to be used may be decided in accordance with the guidelines given in the "Planning and Maintenance Guidelines for SPV supply No. . TEC 66079:2015 ~~GL/SPV-05/02.MAR.2015"~~ issued by TEC. The cables used shall be fire retardant and weather proof.

2.2 Power Supply Classification~~Types of Systems~~ : These Power Supplies are classified as:

2.2.1 Standalone SPV Power Supply: These are further classified as:

A.12V Standalone SPV Power supply: Depending on the Charge Controller unit capacity and load requirements, the 12V SPV power supplies are further classified as follows:

i) **12V/100W Standalone SPV Power supply**: Composed of 12V/100W SPV power Generating source, with 12V/100W Charge controller.

ii) **12V/200W Standalone SPV Power supply**: Composed of 12V/200W SPV power Generating source, with 12V/200W Charge controller.

iii) **12V/400W Standalone SPV Power Supply:** Composed of 12V/400W SPV Power Generating source, with 12V/400W Charge controller.

B 24V SPV Power Supply: Depending on the Charge Controller unit capacity and load requirements the 24V SPV power supplies are classified as follows:

i) **24V/500W Standalone SPV Power Supply:** Composed of 24V/500W SPV Power generating source, with 24V/500W Charge controller.

ii) **24V/1KW Standalone SPV Power Supply:** Composed of 24V/1000W SPV Power generating source, with 24V/1000W Charge controller.

iii) **24V/2KW Standalone SPV Power Supply:** Composed of 24V/2KW SPV Power Generating Source, with 24V/2KW Charge controller.

C. 48V SPV Power Supply: Depending on the Charge Controller unit capacity and load requirements the 48V SPV power supplies are classified as follows:

~~(i)~~

~~(ii)~~(i) **48V/100W Standalone SPV Power Supply:** It shall be composed of 48V/100W SPV Power Generating source with 48V/100W Charge controller.

~~(iii)~~(ii) **48V/200W Standalone SPV Power Supply**: It shall be composed of 48V/200W SPV Power Generating Source with 48V/200W Charge controller.

~~(iv)~~(iii) **48V/500W Standalone SPV Power Supply:** Composed of 48V/500W SPV Power generating source, with 48V/500W Charge controller.

~~(v)~~(iv) **48V/1KW Standalone SPV Power Supply:** Composed of 48V/1KW SPV Power generating source, with 48V/1KW Charge controller

~~(vi)~~(v) **48V/2KW Standalone SPV Power Supply:** Composed of 48V/2KW SPV Power generating source, with 48V/2KW Charge controller

~~(vii)~~(vi) **48V/4KW Standalone SPV Power Supply:** Composed of 48V/4KW SPV Power Generating Source, with 48V/4KW Charge controller.

2.2.2 Hybrid SPV Power Supply: "Purchaser may specify overall redundancy for the power supply including the Charge controller & SMPS". These are further classified as:

A. 12V Hybrid SPV Power supply: Depending on the Charge Controller unit capacity and load requirements the 12V Hybrid SPV power supply is classified as

a) **12V/100W Hybrid SPV Power Supply:** It shall be composed of:

(i) 12V/100W SPV Power Generating source with 12V/100W Charge controller.

(ii) SMPS (based on 12V/ 6.25A FR/FC modules) with ultimate capacity of 12.5A(two FR/FC modules 12V/ 6.25A (1 for load and one for redundancy)).

b) **12V/200W Hybrid SPV Power Supply**: It shall be composed of:

(i) 12V/200W SPV Power Generating Source with 12V/200W Charge controller

(ii) SMPS (based on 12V/ 6.25A FR/FC modules) with ultimate capacity of 12.5A (two FR/FC modules 12V/ 6.25A (one for load and one for redundancy)).

c) **12V/400W Hybrid SPV Power Supply**: It shall be composed of:

(i) 12V/400W SPV Power Generating Source with 12V/400W Charge controller

(ii) SMPS (based on 12V/ 6.25A FR/FC modules) with ultimate capacity of 18.75A (three FR/FC modules 12V/ 6.25A (two for load and one for redundancy))

Or

SMPS (based on 12V/ 12.5A FR/FC modules) with ultimate capacity of

25A (two FR/FC modules 12V/ 12.5A (one for load and one for redundancy))

Note: Purchaser may decide for procurement of 12V Hybrid SPV Power Supply based on their requirement.

B. 48V Hybrid SPV Power Supply: Depending on the Charge Controller unit capacity and load requirements the 48V Hybrid SPV power supply is classified as:

a) **48V/100W Hybrid SPV Power Supply:** It shall be composed of:

(i) 48V/100W SPV Power Generating source with 48V/100W Charge controller.

(ii) SMPS (based on 48V/ 6.25A FR/FC modules) with ultimate capacity of 12.5A(two FR/FC modules 48V/ 6.25A (1 for load and one for redundancy)).

b) **48V/200W Hybrid SPV Power Supply**: It shall be composed of:

(i) 48V/200W SPV Power Generating Source with 48V/200W Charge controller

(ii) SMPS (based on 48V/ 6.25A FR/FC modules) with ultimate capacity of 12.5A (two FR/FC modules 48V/ 6.25A (one for load and one for redundancy)).

a) 48V/500W Hybrid SPV Power Supply:

(i) 48V/500W SPV Power Generating Source with 48V/500W Charge controller.

(ii) SMPS (based on 48V/6.25A FR/FC modules) with ultimate capacity of 12.5A (Two FR/FC modules 48V/6.25A (1 for load and one redundancy)).

b) 48V/1KW Hybrid SPV Power Supply:

(i) 48V/1KW SPV Power Generating Source with 48V/1KW Charge controller.

(ii) SMPS (based on 48V/ 6.25A FR/FC modules) with ultimate capacity of 12.5A (two FR/FC modules 48V/ 6.25A (one for load and one redundancy)).

c) 48V/2KW Hybrid SPV Power Supply:

(i) 48V/2KW SPV Power Generating Source with 48V/2KW Charge controller.

(ii) SMPS (based on 48V/6.25A FR/FC modules) with ultimate capacity of 18.75A(three FR/FC modules 48V/6.25A (two for load and one redundancy)).

OR

SMPS (based on 48V/ 12.5A FR/FC modules) with ultimate capacity of 25A (two FR/FC modules 48V/ 12.5A (one for load and one for redundancy)).

d) 48V/4KW Hybrid SPV Power Supply: It shall be composed of:

i) 48V/4KW SPV Power Generating Source with 48V4KW Charge controller.

ii) SMPS (based on 48V/ 6.25A FR/FC modules) with ultimate capacity of 31.25A (Five FR/FC modules 48V/ 6.25A (four for load and one for redundancy)).

Or

SMPS (based on 48V/ 12.5A FR/FC modules) with ultimate capacity of 37.5A (three FR/FC modules 48V/ 12.5A (two for load and one for redundancy))

2.2.3 Charge controller module (MPPT module) for both Standalone and Hybrid SPV power supplies is common, hence a stand alone power supply can be converted into hybrid power supply and vice-versa functionally by adding or removing the SMPS. Connections scheme/block diagram to convert Standalone SPV system into hybrid system is given at Annexure (2a).

2.3 Power Supply~~System~~ **Sizing** :The capacity of the SPV power generating source, SMPS and battery will depend upon the actual load (Off-hook current and Continuous current) of the telecom equipment and additional loads, if any. Equipment load may differ from manufacturer to manufacturer and its traffic in Erlangs. The other loads include fans lighting, soldering and inverter etc. For the calculation of the equipment load, the duty cycle has been assumed as follows:

Daily Duty Cycle: Off Hook Current

Continuous Current Traffic

in Erlangs

Depending upon the power consumption by the telecom equipment during the talk time and idle time, the actual load per day may be worked out. The other loads may be arrived at from the consumption data of each utility. The total load requirement is the additions of all the loads to be fed by the SPV power supply. On the basis of the actual load and other factors such as availability of AC mains, autonomy etc., one of the configurations as given in clause 2.2 above may be selected. It shall be clearly highlighted at the time of ordering. (Refer Ordering information at chapter 2 of this document). In case of hybrid power supply, in addition to SPV power generating system, the SMPS rating shall also be worked out. The voltage and capacity of the battery will depend on load voltage, the optimum load and `autonomy'. The size of SPV array, Charge controller, SMPS, battery, interconnecting cables may be calculated in accordance with "Planning and maintenance guidelines for SPV power supply No. TEC 66079:2015(Old No TEC/GL/TX/SPV-05/02.MAR.2015"). Rating of each components, viz., SPV Power source, SMPS, charge controller etc. may be clearly stated in the Ordering information.

The power supply shall be designed to work within specified limits under any of the environmental conditions and shall occupy minimum space for mounting the required SPV array.

3.0 **Functional Requirements:** The SPV Power Generating System comprises mainly of a SPV Module - a non conventional source of power - that converts Solar Energy (Sun light) directly into DC Electricity which in turn charges battery bank through a Solar charge controller. The solar charge controller, in this case of Hybrid Power Supply shall have an in-built FC (float charger) that shall provide a regulated DC Power Supply to the load and the battery bank when the AC commercial mains are available.

Hybrid power supply for the above fixed wireless terminals shall be one single combined unit that shall be capable of working on both AC commercial mains as well as SPV power generating system. Whenever the Solar supply is available, the priority selection shall be SPV first and AC second. The system should so function always, that it should charge the battery and deliver power to the load through charge controller/Rectifier and on condition by using either Solar or AC. AC Power should come into picture from standby mode to parallel working mode

~~3.1~~ 3.1 SPV Power Source (Modules, Panels/Arrays): The SPV power source shall be able to charge a 12V battery for 12V SPV power supply, 24V Battery for 24V power supply (for standalone application only) and 48 volt battery for 48V power supply through the necessary protection arrangement against the discharge of the battery through SPV panels/array during sunless period, while simultaneously feeding load. ~~SPV Generating Modules & Panels :~~

3.1.1 The SPV generating module & panel, during the sunny period, shall through the SPV panels -feed load as well as simultaneously charge battery (through the necessary protection arrangement against the discharge of the battery by reverse flow). The cells shall be fully encapsulated and mounted behind a toughened low iron high transmission glass surface of thickness not less than 3mm to protect the cells from moisture, dust and external environment. The contacts should be corrosion resistant. Crane/scrim glass shall be used inside the SPV module in order to help the evacuation process. Standard practice of using crane/scrim glass (not up to the edges) shall be adopted. The leads must be weather protected.

3.1.1.1 SPV modules shall be constructed of materials and component, which are known to be resistant to damage or deleterious change when exposed outdoors for a period of 15 years in any of the climatic conditions prevailing in India and provide mechanical and environmental protection to the encapsulated components.

3.1.1.2 The modules shall have proven laminate construction. The laminates shall be sealed in a frame of light-weight anodised aluminium, with a suitable edge gasket/silicon rubber sealant to provide shock resistance and a further moisture barrier. The back surface shall be of impermeable aluminium foil/polyester and white refractive plastic material such as TEDLAR. The back surface can be Glass, Transparent and white refractive backsheet.

3.1.1.3 The sealing of edges of glass on the frames shall be hermetically tight so that rain water and dew do not enter into the cell compartment.

3.1.1.4 A terminal box shall be attached to the SPV module frame. The terminal box should be resistant to moisture ingress and shall include integral by-pass diode to protect cell overheating due to localised shading.

3.1.1.5 The design of the solar module shall be multi-cell and modular in construction to provide the required output.

~~3.1.1.1~~ 3.1.1.6 The solar photo-voltaic cell module is for use in terrestrial application and is to comprise of mono-crystalline/poly-crystalline PERC, TOPCon, HJT, or other advanced silicon-based technologies, ~~silicon solar cells to be~~ connected in appropriate series or series-parallel configuration to achieve the desired output~~arrangement~~. Each module shall be fully~~completely~~ encapsulated using advanced materials (such as multi-layer polymer backsheet or glass-glass construction)~~and sealed to provide reliable operation under adverse climatic conditions.~~

3.1.1.7 The SPV modules, being used for Telecom supply, need to be characterised at NPL (National Physical Laboratory) or any BIS/ NABL /TEC recognised Test Lab~~other recognised Test Lab~~.

~~In association with QA, BSNL for each type of cells used. The manufacturer will give the spread- in of silicon cells used by him.~~

3.1.1.8 The module must deliver full current at a load voltage corresponding to the terminal voltage of range 13.5V to 13.8 V plus the diode drop & cable drop at the maximum expected cell temperature (55 deg. C).

3.1.1.9 Suitable arrangement should be made to reduce the possibility of Bird menance, no sitting places for birds should be available above the solar panel area.

3.1.1.10

~~3.1.1.2~~ The module shall have positive tolerance of power.

3.1.2 **Panel/ Array configuration :** The panel shall be modular in configuration, consisting of one module for 12V SPV power source and 4 modules connected in series for 48V SPV power source. The rating of the 12V SPV power generating modules shall be 12V/50Wp to 12V/300Wp or any other rating. The module may be selected as per the load requirements and availability of space. In case of 24V (for Standalone Application only), the rating of the 24V SPV power generating modules shall be 24V/250~~125~~Wp to 24V/550~~300~~Wp"(refer clause 2.1.1).

~~3.1.1.3~~ The array shall be made by connecting the number of panels in parallel or series or in series -parallel combination as per requirement. The number of panels in the array shall be as per the present load requirement with the provision of adding more panels for the projected ultimate limit, whenever required at later date.

~~**3.1.2**~~**3.1.2.1** ~~**Insolation :** The recommended mean Insolation on any panel kept at optimum tilt at places where the solar panel is to be used shall be 4.5 KW hour/m²/day but can be used in lower insolation sites depending upon local requirement regional requirement as well as commercial viability.~~

3.1.3 **Minimum stipulated life :** The de-rating factor of 0.5%per year of the SPV Generating source ~~System~~/module rated power is permissible. The module/SPV Generating source~~module/system~~ shall deliver at least 90%

of its rated power in the 10th year ~~also~~. The de-rating factor of 0.5%/year of the SPV Generating Source/module rated power is permissible (can be high for first year). The module/SPV power generating source shall deliver at least 90% of its rated power in 10th year.

3.1.4 **SPV Module Ratings** : Rated power (minimum) at maximum Power Output to be specified by the manufacturer.

3.1.5 **Peak (Maximum) Power Output** : The SPV Module shall deliver minimum specified rated power at maximum power point of "I-V Curve" at standard condition of 100 mw/cm2 solar intensity at 25 deg C AM(air mass coefficient) 1.5.

3.1.6 **Cells :** Cells can be either mono-crystalline/Polycrystalline/PERC/TOPcon or any other latest technology encapsulated Silicon Cells. All the cells used in a module shall be identical, of regular shape and shall have the same rating with tolerance +/-5%. The actual rating of the modules in a panel shall be within 5% of the average rating of the four modules. While in an array, the rating of the panels shall also be within 5% of the average rating of the panels in the SPV power generating source.

3.1.7 ~~Considering the application voltage and Geographical location of India, the number of cells in series in a module shall be 36/60/72.~~Configuration of the module to be specified by manufacturer: Number of cells in series or in series – parallel configuration.

3.1.8 **Open circuit Voltage :** Maximum, minimum and nominal Voltages to be specified by the manufacturer at 25 deg C. but in no case it shall be less than the reference value.

3.1.9 **Short circuit Current :** To be specified by the manufacturer.

3.1.10 **SPV modules Voltages at peak Power point :** 17.0 V (min.) for 12V Modules and 34V (min.) for 24V Module. In addition to it, SPV Vmp~~mp~~ should be 0.45V(min.) per cell minimum.

3.1.11 **Voltage de-rating :** shall Not more than -0.5% per deg C above 25 deg C cell temperature.

3.1.12 **Conversion efficiency & fill factor :** For Panels rating below 250 Wp: Conversion efficiency of the encapsulated cell at peak power shall not be less~~be better~~ than 13% and that of module at peak power shall not be less than 12%. The fill factor shall be better than 68%. For Panels rating above 250 Wp: Conversion efficiency of the encapsulated cell, peak power, shall not be less than 20 % and that of module shall not be less than 19%. Fill factor shall be better than 75%

3.2 **Charge Controller Unit :** The charge controller unit shall be a Hybrid power supply of single combined unit that shall be capable of working on both AC commercial mains as well as SPV power generating system.

~~3.2.1~~ **Voltage to Load & battery:** The SPV voltage at the output of the charge controller shall be limited to 13.8V for 12V power supply, 27.6V for 24V power supply With DSCA in communication, the output of the charge controller or MPPT module shall be dynamically adjusted to ensure optimal utilization of the available Solar energy source. In case of without communication with DSCA, the output of the charge controller shall be limited to 13.8V for 12V power supply, 27.6V for 24V power supply and

55.2V for 48V power supply. The SMPS output voltage shall also be controlled within these limits. When working with SMPS, for

3.2.1 proper load sharing of SPV power generating source and SMPS, provision shall be made in the charge controller so that it dynamically adjusts to extract the maximum possible power from the SPV array based on the available input voltage and current, ensuring optimal energy utilization and~~the voltage of SPV power generating source,~~ even in worst working conditions (high SPV cell temperature) the voltage of SPV source is higher than that of the SMPS.

3.2.2 Efficiency (SPV Section):

(i) For 12V & 24V Power Supply:

Efficiency of the charge controller at full load and rated output voltage of 13.5V for 12V power supply, 27V for 24V power supply and 54V for 48V power supply respectively shall be in excess of 90%~~ while all working condition on SPV power source~~. However, purchaser may specify efficiency to be 85% for 12V system depending upon the cost effectiveness of the power supply.

(ii) For 48V Power Supply:

Efficiency of the charge controller: Under nominal input and output conditions, the power conversion efficiency shall be ≥ 93%

(iii) Solar Module (MPPT) tracking efficiency shall be ≥98% for 12V/24V/48V power supply.

~~**3.2.3**~~ **Note:** For validation of this parameter, test reports of NABL accredited / TEC designated lab shall be allowed.

~~**3.2.4**~~**3.2.3** Psophometeric Noise (e. m. f. weighted at 800 Hz): While working on SPV

Power as well as SMPS, Psophometeric Noise with a battery of appropriate capacity floated and Radio Telephone equipment connected across the output shall be within 2mVrms and ripple voltage shall be 2mVrms +/- 0.5% for float applications as per latest standards.as per ITU-T Rec. O-41.

3.3 SMPS (Switch Mode Power Supply):

3.3.1.1 Hybrid SPV power supply, in addition to SPV power source as given in the previous clauses, shall include a SMPS as detailed below:

3.3.1.2 SMPS shall be composed of a number of FR-FC (float rectifier-cum float charger) modules to cater the load requirements. This unit shall be capable to meet the load and battery requirements when the AC mains are available. The SMPS shall be in compliance of all the requirements of this clause and its sub-clauses.

3.3.1.3 These float chargers may be either 12V or 48V as per the telecom equipment requirements.

3.3.1.4 Normally the load of the telecom equipments to be fed by this type of power supply is small, hence SMPS envisaged for this application are single phase of maximum current rating of 150A, based on single phase FR-FC modules of rating 6.25A, 12.5A~~-~~,~~and~~ 25A.

3.3.1.5 In non-integrated~~-~~ SMPS based hybrid SPV system, the FR/FC modules may be mounted preferably on the top of the rack/unit for efficient extraction of heat from the modules. DSCA of the SMPS may be mounted in the upper/lower part of the rack or on side of the FR/FC modules, while FR-FC modules shall be mounted in the remaining rack. While in case of integrated SMPS based hybrid SPV system, it will employ modular configuration. The matching of the SPV Power source output and SMPS output shall be ensured by the charge controller.

3.3.1.6 It shall provide for the surge protection devices for SMPS, in compliance of clause 5.6 of this GR~~6~~.

3.3.1.7 SMPS shall be based on Switch Mode Power Supply (SMPS) Techniques using switching frequencies of 20KHz and above. The SMPS shall be capable of, independently, meeting the load requirements of load (telecom equipment) and battery bank. SMPS is intended to be used in Float-cum-Charge mode as a regulated D.C. Power Source. The system~~unit~~ should be expandable at rack level itself or by additional racks using the basic FR/FC modules of the same rating in non-integrated SMPS based hybrid SPV system. The prescribed FR/FC ratings are 12.5A ,and 25A. In case of integrated SMPS based hybrid SPV system, it will employ modular configuration. They all use single phase supply except for 50A basic module, which may be with single phase supply.”

~~3.3.1.7~~The Power Plant as per this GR shall be compatible with VRLA battery as well as Li-ion battery. However, at any point of time VRLA & Li-ion battery cannot work simultaneously with the SMPS power plant.

~~3.3.1.8~~The system~~unit~~ shall only be based on menu driven Micro Processor Controlled Techniques (both DSCA as well as FR/FC module) for control, monitoring and alarms. DSCA shall display its Software version for both DSCA and FR/FC. Setting of all the parameters shall be through menu-driven microprocessor control only. DSCA shall have menu for selection of type of battery between VRLA and Li-ion battery and type of battery should be displayed on DSCA.. ~~Use of potentiometer for setting of parameters is not permitted.~~ The failure of Micro-processor or DSCA shall not affect the setting of individual

FR/FC. NoAll the parameter of FR/FC modules' ~~parameter~~ shall ~~not~~ be disturbed on the failure of DSCA. In this condition aAll the FR/FC modules shall take care of the load on default settings and share the load collectively. Only the setting of new parameters from DSCA shall be affected. In case of failure of microprocessor of FR/FC module, its last setting shall not be affected. The system ~~power supply~~ shall be RS 485/RS 232 and Ethernet (SNMP Protocol) compatible, if remote monitoring is required. It shall be feasible to set any monitoring control parameter from a remote site through RS 485/ RS232 and Ethernet (SNMP Protocol). All the information regarding Control and monitoring of Power Plant data shall be accessible on demand from the remote site. ~~All the information regarding Control and monitoring of Power Plant data shall be accessible on demand from the remote site.~~ The exchange of information and protocol format shall comply as per Annexure - 3 of this GR. RS 485/ RS 232 and Ethernet communication cable of suitable length (to be decided by purchaser) shall be protected with pluggable and DIN Rail Mountable surge protection devices (to be decided by purchaser) to be mounted on both side of the cable. SPD shall have surge discharge current capacity of 10KA (8/20 µsec) and lightening discharge current capacity of equal or more than 0.5 KA per line (10/350 µsec). The SPDs shall have an end of life indication either via signal disruption or a visual indication.

~~3.3.1.9~~3.3.1.8 The system~~unit~~ shall be sufficiently flexible to serve any load from 6.25A onwards depending on manufacturer's design, rating, number of FR/FC modules, used in a rack and system~~power supply~~ configuration. To cater for higher load requirements, same type of FR/FCs mounted in the same rack or different racks, shall be capable of working in parallel load sharing arrangement in non-integrated SMPS based hybrid SPV system.

~~3.3.1.10~~3.3.1.9 In the non-integrated SMPS based hybrid power supply, The DSCA shall be provided for the ultimate capacity of the Power Plant. The DSCA, in addition to control, monitoring and alarms, shall ~~DSCA of the SMPS shall also~~ provide for the following:

a) Termination for the batteries*.

b) Termination for the exchange load.

c) Interconnecting arrangement for power equipment.

d) Battery Switching arrangement (Connection to/isolation from power supply)**

e) Termination for AC input to the rack shall be finger touch proof, flame retardant, insulated. Use of bus-bars for the purpose is precluded.

f) Termination for AC and DC to FR/FC modules.

g) Circuit Breakers/fuses /MCB etc. for DC output (refer Note 3)

* The capacity and number of batteries shall be as per order. For the purpose of Type Approval, it shall be taken as one battery for 12V stand alone power supply and two batteries for other power supply.

** Only CACT/NABL/TEC Designated labs approved DC contractors or ~~Purchaser may decide to procure CACT approved~~ `MCBs' (which do not produce spark while cutting in or out), shall be used for ~~while~~ manuall~~y~~ isolationng /re~~or~~ connection ng of the battery by tripping the contactor through an external switch is not permitted. circuit from any source, including switching equipment such as contactor, MCB coil and their control and sensing circuitry.~~, as per their requirement.~~

Note-1: For AC input supply AC contactor with AC Coil shall preferably be used. AC Contactor with DC coil (if used) shall have its own power supply and shall not be fed form Exchange battery.

Note-2~~3~~: Solid state switching device may preferably be used. Relays, if used, shall be UL or CE compliant.

Note-3: DC MCBs complying with IEC 60947-2 and having CACT approval to be used for DC output. The Fuse that shall be used, shall be DC Rated (up to 80V DC)

~~3.3.1.11~~3.3.1.10 There shall be provision to start the SMPS without battery supply.

~~3.3.1.12~~3.3.1.11 The SMPS (including FR/FCs and DSCA), shall be suitable for operation from A.C mains or a DG set (of capacity 1.25 times AC load of power plant).

3.3.2 **Rack/Unit Configuration**: The unit/Rack (in non-integrated SMPS based hybrid power system) is composed of following units, accommodated in 19" (482.6 mm) or smaller sub-rack:

a) Float Rectifier-cum-Float Charger (FR/FC)

b) Distribution, Switching, Control, Alarm and Monitoring (DSCA) unit.

3.3.3 Unit Configuration :

3.3.3.1 The unit shall employ a modular configuration to provide flexibility, keeping in view the future load requirements of D.C. Power.

3.3.3.2 in non-integrated SMPS based hybrid SPV system, the FR/FC modules shall be accommodated in a rack. DSCA, for the ultimate capacity, shall be provided in first rack. AC and DC distribution may however, be provided in First/separate rack or in the individual racks. In case, distribution arrangement is provided in First/separate rack, it shall be for the ultimate unit capacity. In case the distribution is provided in the individual racks DC distribution/switching shall be for the ultimate unit capacity, while AC distribution shall be for fully equipped rack. All factory wiring for the rack shall be for the ultimate capacity so that only plugging-in of FR/FC module shall enhance the DC power output.

3.3.3.3 The SMPS shall be tested for the following ultimate capacities for awarding TAC:

Category No.	Basic Module	Ultimate capacity
1	12V/6.25A(Single phase)	6.25A/12.5A/18.75A
2	12V/ 12.5ASingle phase)	12.5A/25A
3	24V/ 6.25A(Single phase)	6.25A/12.5A/18.75A/31.25A
4	24V/12.5A (Single phase)	12.5A/25A/37.5A
5	24V/25A (Single phase)	25A/50A
6	48V/6.25A (single phase)	6.25A/12.5A/18.75A/31.25A
7	48V/12.5A(Single Phase)	12.5/25A/37.5A
8	48V/25A(Single phase)	25A/50A

3.3.4 Electrical Requirements:

3.3.4.1 **AC input Supply** : The power plant shall work from the single phase single phase FR/FC modules shall operate from single phase AC input supply. ~~AC power supply without any degradation with~~ The input voltage range shall be Single Phase nominal 230 volts AC with voltage variation of -15% to +10% at 50 Hz ± 2 Hz. However keeping in view of specific requirement for rural area, purchaser may specify the requirement as special case as: The Power Plant shall operate from single phase AC mains supply 230 V with variation from 170 to 260 V and frequency as 50 Hz +/-2Hz.

3.3.4.2 DC output Characteristics : The Module shall be capable of operating in "Auto Float-cum- Charge" mode. It shall be programmed to operate as a float rectifier or a charger, depending on the condition of the battery sets being sensed by the DSCA.

3.3.4.3 Auto Float Mode:

3.3.4.3.1 For 12 V FR/FC: ~~12V FR/FC Modules~~ The float voltage of each rectifier module shall be ~~capable of operating in the float mode~~ ~~(~~continuously adjustable and pre settable~~)~~ at any value in the range of -12 to-14V from FR/FC, modules or~~and~~ DSCA.. The prescribed float voltage setting is -13.5 V for VRLA battery respectively.

3.3.4.3.2 For 48V FR/FC: The float voltage of each rectifier module shall be ~~Modules shall be capable of operating in the float mode~~ ~~(~~continuously adjustable and pre-settable) at any value in the range of -48 to -56V from FR/FC, modules or~~and~~ DSCA.. The prescribed float voltage setting is -54V for VRLA battery respectively.

There shall also be a provision of setting the float/charge voltages globally from~~so that~~ DSCA . There shall also be a provision so that DSCA may over ride the values set by individual module. Float Voltage adjustment may be made globally, and not for individual rectifiers.

~~3.3.4.3 The prescribed float voltage setting is-13.5V for 12V and - 54V for 48V units respectively.~~

3.3.4.4 Auto Charge Mode:

3.3.4.4.1 For 12V FR/FC: In Auto charge mode FR/FC shall supply battery & equipment current till terminal voltage reaches set value, which is normally -14.2V, this value shall be settable between -12V and -14.6V) and shall change over to constant voltage mode. It shall remain in this mode till a change over to float mode signal is received. (This Clause is applicable for VRLA Battery only") .

For Li-ion battery setting of Float & Charge voltage should be specified by the purchaser based on the requirement.

3.3.4.4.2 For 48V FR/FC: In Auto charge mode FR/FC shall supply battery & equipment current till terminal voltage reaches set value, which is normally 2.3V/cell (-55.2V, this value shall be settable between -48V and -56V) and shall change over to constant voltage mode. It shall remain in this mode till a change over to float mode signal is received. (This Clause is applicable for VRLA Battery only").

~~3.3.4.4~~ 3.3.4.5 The DC output voltage shall be maintained within +/-1% of the half load preset voltage in the range 25% load to full load when measured at the output terminals over the full specified input range.

3.3.5 **Efficiency :** The efficiency of the unit shall be given below :

12V units :

Condition	**Single Phase AC**
Under all specified Input, output conditions and load between 50 to 100%.	better than 85%

~~a) under all specified Input, output conditions: better than 85% and load between 50 to 100%~~

~~a)~~ 24V units :~~under all specified Input, output conditions: better than 85% and load between 50 to 100%~~

Condition	**Single Phase AC**
Under all specified Input, output conditions and load between 50 to 100%.	better than 85%

48V units :

a) Rectifier rating < 50A

Condition	**Single Phase AC**
At nominal input, output and full rated load	better than 90%
Other specified Input, output conditions and load between 50% to 100%.	better than 85%

~~48V units :~~

~~a). At nominal input, output & full rated load: better than 89%, &~~

~~at other specifies input, output conditions: better than 85% & load between 50 to 100%.~~

~~b). For System below 1KW ,under all specified Input, output conditions: better than 85% and load between 50 to 100% .~~

~~3.3.6~~ **Input Power Factor** : The true input Power Factor at nominal input, output voltage and rated load shall be better than 0.98 and shall be better than 0.95 in any other working condition and load between 50% to 100%. Active Power factor correction only shall be employed for the purpose.

~~3.3.7 Electrical Noise: The Rectifier (FR/FC) Modules shall be provided with suitable filter on the output side.~~

~~3.3.8 A resistor shall be provided to discharge the capacitors after the Rectifier modules have stopped operation and output is isolated.~~

~~3.3.9 The Psophometeric Noise (e.m.f. weighted at 800Hz) : The Psophometeric Noise with a battery of appropriate capacity connected across the output should be within 2mV, while delivering the full rated load at nominal input of 230V. For test purposes, this shall be taken as equivalent to 4mV when the battery is not connected, other conditions remaining the same as per ITU-T Rec. O.41.~~

3.3.6

~~3.3.10 The Peak-to-Peak Ripple : Voltage at the output of the rectifier module without battery connected shall not exceed 300 mV at the Switching~~

~~Frequency measured by an Oscilloscope of 50/60 MHz band-width (Typical).~~

~~3.3.11~~3.3.7 Soft Start Feature and Transient Response:

~~3.3.11.1~~3.3.7.1 Slow start circuitry shall be employed such that FR/FC module input current and output voltage shall reach their nominal value within 10 seconds.

~~3.3.11.2~~3.3.7.2 The maximum instantaneous current during start up shall not exceed the peak value of the rectifier input current at full load at the lowest input voltage specified.

~~3.3.12~~3.3.8 Voltage overshoot/Undershoot: The requirements of this clause shall be achieved without a battery connected to the output of FR/FC module.

~~3.3.12.1~~3.3.8.1 The FR/FC modules shall be designed to minimise output voltage Overshoot/ Undershoot such that when they are switched on the DC output voltage shall be limited to +/-5% of the set voltage and return to their steady state within 20 ms for any load of 25% to 100%.

~~3.3.12.2~~3.3.8.2 The DC output voltage overshoot for a step change in AC mains from specified lowest to highest and vice-versa shall not cause shut-down of FR/FC module and the voltage overshoot shall be limited to +/- 5% of its set voltage and return to steady state within 20 ms.

~~3.3.12.3~~3.3.8.3 The modules shall be designed such that a step load change of 25 to 100% shall not result in DC output voltage Overshoot/ Undershoot of not more than 5% and return to steady state value within 10 ms without resulting the unit to trip.

~~3.3.13~~3.3.9 Total Harmonic Distortion :

~~3.3.13.1~~3.3.9.1 **Total Voltage Harmonic Distortion**: The Total line harmonic voltage distortion shall not be more than 10% in conformity with CIGRE's limits ~~5%.~~

Note: The above Harmonic Distortion limits are as per communication received from Central Electricity Authority vide their office letter No. GO2/Comm.I/1/1-95/962 dated 22.12.92.

~~3.3.13.2~~3.3.9.2 **Total Current Harmonic Distortion**: The total harmonic distortion shall be limited as per EN 61000-3-2 Ed.2:2000. The total current harmonic distortion contributed by the unit at the input shall not exceed 10% for input voltage range 170V-260V (for single phase units); ~~120V-300V~~, for load between 50 to 100% of the rated capacity.

~~3.3.14~~3.3.10 **Current limiting (Voltage Droop):** The Current limiting (Voltage Droop) shall be provided for Float/Charge operation. The float/charge current limiting shall be continuously adjustable between 50 to 100% of rated output current for output voltage range of -11.1V to -13.98V for 12V unit and -44.4 to -56 volts for 48V unit respectively. For test purposes upper limit of 100% + 5% and lower limit of 50% - 5% shall be acceptable.

~~3.3.15~~3.3.11 The float and charge current limit adjustment shall be provided, either on the front panel of the individual FR/FC module or through a provision at the centralised location on front panel of DSCA through a menu driven program capable of adjusting the float and charge current limits of the each FR/FC module individually, irrespective of the rating and number of modules located in the same rack or in other racks of the power plant for the ultimate capacity of the unit.

~~3.3.16~~3.3.12 The FR/FC modules shall be fully protected against short circuit. It shall be ensured that short circuit does not lead to any fire hazard. The unit shall start delivering output automatically when the short circuit is removed.

~~3.3.17 DC output Regulation : DC output shall regulate in the range 13.5+/-1%(13.5V nominal) and 54V +/-1% for 48V units for load between 25% to 100%, over the full specified input range. The nominal voltage shall be set at half load.~~

~~3.3.18~~3.3.13 Load Sharing (Parallel operation) :

~~3.3.18.1~~3.3.13.1 FR/FC modules shall be suitable for operating in parallel with one or more modules of similar type, make and rating, other output conditions remaining within specified limits.

~~3.3.18.2~~3.3.13.2 The current sharing shall be within +/- 10% of the average current per rectifier module in the unit (mounted in the same or different racks) when loaded between 50 to 100% of its rated capacity for all working conditions.

~~3.3.18.3~~3.3.13.3 In the event of failure of DSCA, FR/FC modules parameter shall not be disturbed. All the FR/FC modules shall take care of the load on default settings and share the load collectively.

~~3.4~~ Electrical Protections :

3.4

~~3.4.1~~ The charge controller ~~circuit using solid state switching only~~ shall for the control circuitry using solid state switching techniques to incorporate suitable protections ~~include suitable protection arrangement to safeguard circuits against the following conditions. Protection~~ (with a tolerance of +/- 1% in case of DC voltage & current) ~~and +/-5V in case of AC voltage shall be incorporated.~~ to safeguard circuit against the following conditions:

~~3.4.2 AC Input : There shall be an automatic arrangement to provide galvanic isolation at the AC input of the FR/FC module whenever the input voltage is beyond the specified operating range (single phase AC mains supply 230 V with variation in the range of +10% and -15%), with suitable alarm indication. The FR/FC module shall resume normal working automatically when the input is restored within the working~~

~~limits. Hysteresis within specified working limits shall not cause shutting down of the FR/FC. A tolerance of +/-5V may be acceptable for protection and alarm operation. Reconnection shall occur at a voltage, 10V lower than the set voltage high isolation limit and 10V higher than the lower set limit to avoid hunting. The circuitry used for sensing the voltage for operation of isolation/ reconnection device shall be able to withstand a voltage 15% higher than the specified extreme limit of isolation.~~

~~3.4.3~~3.4.1 A) DC over voltage :

(i)Charge controller: The output voltage of the charge controller shall be maintained in accordance with clause 3.3.1.1. In case the charge controller output voltage exceeds 56.5 V for 48V power supply, 28.2 V for 24V power supply and 14.1 V for 12V power supply due to failure of the voltage control device provided to control the SPV Power Source voltage, the SPV power source shall be isolated automatically, creating alarm. Restoration of the SPV Power Source (MPPT) shall be through manual reset.

(ii) SMPS: Shall be in accordance with relevant clause of TEC Standard No. 66110:2025 or latest

~~**3.4.4**~~

~~3~~

~~4~~

~~**a)** Due to FC failure :~~

~~4.2 Each rectifier module shall be fitted with an internal over- voltage protection circuit. In case output DC voltage exceeds –56V (for 48V unit) and -14V (for 12V unit), the over voltage protection circuit shall operate and shut-off the faulty module. A tolerance of +/- 0.01V/cell is permitted in this case. Restoration of the module shall be through a reset switch/push button.~~

~~5~~

~~5.2 Shutting-off of faulty FR/FC module shall not affect the operation of other FR/FCs operating in the rack.~~

~~6~~

~~6.2 Operation of over-voltage shut down shall be suitably indicated on the module and also extended to monitoring/control unit~~

~~7~~

~~7.2 The circuit design shall ensure protection against the discharge of the Battery through the FR/FC module in any case.~~

~~8~~

~~8.2 The over voltage protection circuit failure shall not cause any safety hazard.~~

~~9~~

b) ~~**Due to SPV Power Source** : The output voltage of the charge controller shall be limited to 13.8V for 12V power supply, 27.6V for 24V power supply and 55.2V for 48V power supply. In case the charge controller output voltage exceeds 56.5 V for 48V power supply,~~

~~28.2 V for 24V power supply and 14.1 V for 12V power supply due to failure of the~~

~~voltage control device provided to control the SPV Power Source voltage, the SPV power source shall be isolated automatically, creating alarm. SPV power source shall get reconnected when the load voltage falls below the specified level, which corresponds to output voltage of 55.2V for 48V power supplies, 27.6V for 24 V power supplies and 13.8V for 12V power supplies respectively.~~

~~10~~

~~Over voltage protection circuit failure shall not cause any safety hazard.~~

3.4.2 Battery Under Voltage Isolation:

~~3.4.5 There shall be a provision for Automatic Isolation/reconnection of each battery from the load. The Tendering Authority shall specify the load and battery capacity. The DC contactor used for the purpose shall be of single pole only.~~

~~The operate and release voltages for the above conditions shall be as follows :~~

For VRLA Battery~~:~~

~~:~~ In case output DC voltage falls below 44.4V for 48V power supply, 22.2V for 24V and 11.1V for 12V power supply, the battery shall be isolated from the load. The load shall automatically be reconnected, when the voltage is above 51.6V for 48V, 25V for 24V power supply and 12.5V for 12V power supply respectively~~Cut-off: 1.85V/cell (44.4V for 48V units and 11.1V for 12V units). It shall be settable between 1.85V and 1.9V/cell. A tolerance of 0.01V/cell is permissible in this case.~~

~~Reconnect: When the FR/FC voltage has built-up fully. It shall be settable between 2.15V to 2.3V/cell.~~

For Li-ion Battery:

In case output DC voltage falls below, between 11.2V to 11.6 V for 12V power supply, 22.4V to 23.2 V for 24V power supply, 42V to 44 V for 48V power supply, the battery shall be isolated from the load. The load shall automatically be reconnected, when the voltage is more than 12.8V for 12V power supply, 25.6V for 24V power supply, 48 V for 48V power supply respectively

~~Cut-off Voltage (V) : Between 11.2V to 11.6 V for 12V battery, 22.4V to 23.2 V for 24V battery, 42V to 44 V for 48V battery.~~

~~Reconnect: When the charger voltage has built-up fully. Battery voltage more than 12.8V for 12V battery, 25.6V for 24V battery, 48 V for 48V battery.~~

~~**3.4.6**~~**3.4.3** Reverse Polarity: There shall not be any damage to the components of the power supply in case the polarity is reversed. The unit shall start its normal function when the correct polarity is restored

~~**3.4.7**~~ Reverse flow of current from the battery to the module. ~~To avoid the discharge of the battery through the modules during non-sunlight period or SMPS when not delivering the output, the blocking diodes or any other suitable arrangement shall be provided in the charge controller between:~~

~~SPV power source and battery terminals and~~

~~10.2.1~~3.4.4 ~~SMPS (in case of hybrid power supply only) and battery.~~ The circuit design shall ensure protection against the discharge of the Battery through the FR/FC & SPV power source (MPPT) module in any case.

~~**3.4.8**~~**3.4.5** Over Load/Short Circuit : ~~The FR/FC modules shall be fully protected~~

~~against short circuit. It shall be ensured that short circuit does~~

~~not lead to any fire hazard. The unit shall start delivering output automatically when the short circuit is removed.~~The unit shall be protected for over load/ short circuit. It shall be ensured that short circuit does not lead to any fire hazard.

~~3.4.9~~3.4.6 Battery Path Current Limiting : ~~To ensure the availability of required exchange load and safety of the battery, the current in each battery path shall be settable as per the battery capacity so that the battery path current is kept to{(33 % or C/3.33 for VRLA battery) OR (0.5C for Li-ion battery)} of battery AH capacity. Tendering Authority will give the capacity of the battery to be used for this purpose. For the type approval the manufacturer shall demonstrate the facility and undertake to make provision as per order.~~In Auto Mode the current in each battery path (For VRLA type battery) shall be settable as per the battery capacity and DG capacity as applicable so that the battery path current is kept at 5% to 10% of battery AH capacity. When Li-ion battery selected setting the current in each battery path should be settable as per the battery capacity and DG capacity as applicable so that battery path current is kept at 5% to 50% of battery AH capacity and actual battery path current will be decided by the purchaser. Further, purchaser will give the capacity of the battery and DG set if applicable to be used for this purpose. For the type approval the manufacturer shall demonstrate the facility and undertake to make provision as per order.

~~3.4.10~~3.4.7 **Fuses / circuit Breakers/MCB with current limiting devices :** Suitably fault rated fuses or circuit breakers with current limiting devices shall be provided for the following :

1. Live AC input line. (Hybrid power supply only)
2. Negative DC output ~~with self restoring type fuse~~
3. Against failure of control sensing circuit.

Note : 1. Use of mechanical switching devices such as relays etc. is not permitted in the control circuit. MCBs are however, permitted for short circuit protection only.

2. Two fuses /Circuit breakers/MCBs (minimum)of each type shall be provided with each unit. provided fuses are non-solderable and cartridge type ~~*These fuses shall be kept inside the unit in an enclosure.*~~

~~10.2.2~~3.4.8 The circuit design shall be such that failure of components in the control circuit or the circuit itself shall result in the output voltage dropping to a value lower than the normal in order to prevent the possible damage to the equipment in such cases.

~~3.4.11~~3.4.9 **Temperature Compensation for Battery** : For VRLA: In auto float/charge mode t~~T~~here shall be provision for monitoring the temperature of battery and consequent arrangement for Automatic temperature compensation of the FR/FC ,FR/BC ~~(in Auto float/charge mode)~~ output voltage to match the battery temperature dependant charge characteristics. The output voltage of the rectifier in

Float/Charge operation shall decrease or increase at the rate of 72mV (24 cells battery@ 3mV per cell) and 18mV (6 cells battery @ 3mV per cell) per degree increase or decrease in temperature over the set voltage. The output voltage shall decrease till the open circuit voltage of the battery is reached. The open circuit voltage range shall be settable between 2.1V/cell to 2.2V/cell. At this voltage the power plant voltage get locked and further increase in temperature shall not decrease the voltage further. This voltage shall also remain locked till the temperature falls below the value corresponding to set value. When the output voltage reaches 55.8V (for 48V unit) and 13.98V (for 12V unit), due to increase in the output voltage owing to decrease in temperature, it shall get locked at this voltage and any further decrease in temperature shall not lead to further rise in the output voltage of the power plant. This voltage shall also remain locked till the temperature rises above the value corresponding to set value. A tolerance +/- 5 mV ~~1%~~ may be acceptable over the ~~rates as~~ specified rate of 72mV/degree C~~above~~. The nominal distance between the battery and power plant may be 20 metres. The manufacturer shall provide the necessary sensor and cord for the purpose with the power plant. Failure of temperature compensation circuit including sensors (including the open or short circuit) shall create an alarm and shall not lead to abnormal change in output voltage. Proper sign-writing shall be made in DSCA and both ends of temperature compensation cord for its easy termination.

For Li-ion battery: Temperature compensation for battery should be disable when Li-ion battery selected. Temperature sensor is not required.~~The reference temperature shall be taken as 27ºC to start the temperature~~

~~compensation.~~

~~3.5~~ **Monitoring Alarms and Indicating Lamps**: Visual indications/display shall be provided by means of "bright LCD/LEDs" on each FR/FC module~~.~~ and DSCA.~~Different colour display for different modes shall also be provided.~~

3.5

3.5.1 Functional Indications: The following indications shall be provided to indicate mode in which the unit is functioning. In case of hybrid power supply the functional indications of FR/FC modules and DSCA~~shall be on FR/FC and DSCA of the SMPS also~~:

a) Mains available
b) FR/FC, FR/BC On Auto Float
c) FR/FC, FR/BC On Auto Charge

~~FR/FC, FR/BC On Auto Float~~
~~c) FR/FC, FR/BC On Auto~~
~~Charge~~

Note: The functional indication a) shall be provided on both DSCA & FR/FC module, while b), c), may be provided either on DSCA or on both FR/FC and DSCA.

~~1.~~	~~AC Mains available (on charge controller, FR/FC module and DSCA)~~	~~Green~~
~~2.~~	~~Battery Charging by SMPS~~	~~Amber~~
~~3.~~	~~Battery Charging by SPV Power~~	~~Yellow~~
~~4.~~	~~Load on battery~~	~~Blue~~

3.5.2 Alarms Indications (both for Standalone and Hybrid Charge controller):

1. Battery Low
2. Battery reverse polarity
3. Over load

4. Rectifier(s) Fail

~~4. SMPS fail – SMPS fails to deliver power due to any reason (Hybrid power supply)~~

5. Equipment Circuit Breaker Trip (if used)

~~3.5.3~~ Alarm Indications:

A. On FR/FC :

~~a. FR/FC Over voltage,~~

~~b. FR/FC Under voltage or Output Fail~~

~~c. FR/FC Over Load (Voltage Droop)~~

~~Fan fail (due to any reason)~~ .

a. LED Green - Healthy

b. LED Amber - Warning

~~d.~~ c. LED Red – Major

~~All the above alarm Indications shall be extended to DSCA as FR/FC fail.~~

B. On DSCA :

a) Load~~SMPS output~~ voltage High

~~a)~~ ~~/low(if applicable)~~12 unit : above 13.9V/Low below 11.4V

48 unit :above 55.6V/Low below 45.6V

b) Alarms on FR/FC ~~fail~~ (As per clause 3.25.2 A ~~any failure condition as in "A" Above)~~

c) Mains Out of range

d) System~~Unit~~ Over Load

e) Mains "ON"/Battery Discharge

f) ~~Temp. Compensation~~Fan fail(in case fan provided at rack level)

~~f)~~g) Temp. Sensor fail (for VRLA battery only)

~~g)~~h) Battery Fail or No Battery (separate for each Battery)

~~h)~~i) Battery isolated from the load~~(due to any reason)~~

~~i)~~j) Lightning and surge protection Stage II Fail

~~3.5.4~~3.5.3 All the alarm circuits shall be provided with solid state technology. Use of electromechanical relays is precluded.

~~3.5.5~~3.5.4 All the alarms shall be DC only. All alarm circuits shall be provided with suitable delay to ensure that they do not operate to transients.

~~3.5.6~~3.5.5 Every Alarm condition shall be accompanied with an audio alarm with a Auto/manual ~~non-locking type~~ audio cut-off facility. In such cases, the visual indication shall remain active to signal the need for attention until the fault has been addressed and rectified.

~~3.5.7~~3.5.6 All the protections/alarms shall be within tolerance of 0.25V in case of DC voltage and 1% in case of current. For AC voltage it shall be +/-5V.

~~3.5.8~~3.5.7 Two Potential Free Contacts (one for alarm and one redundant) shall be provided for extension of alarm to centralised display.

~~3.5.9~~3.5.8 All Indications shall be suitably designated and there shall be provision for their easy identification from a distance of upto 3 meters.

~~3.5.10 A manual reset switch (non-locking/push button type) for disabling 'audio alarm' shall be provided. In such case the visual indication shall continue~~

~~for the receive attention, till the fault is attended and rectified.~~

~~3.5.11~~3.5.9 Provision shall be made on the front panel of the charge controller to enable/disable the alarms/monitoring indications pertaining to the SMPS depending on, whether the charge controller is being used with standalone or hybrid power source.

~~3.6~~ **Battery Health Check:** There shall be a provision of monitoring the voltage, current, trickle current, temperature and conductance at a set periodicity(programmable) of the batteries associated with the power plant. There shall also be ~~if required by the purchaser~~ a provision of monitoring of each cell of the battery bank for voltage and temperature. ~~The instrumentation provided, shall also calculate the conductance of each cell. All the above information shall be made available to the remote site through RS~~

~~485/Ethernet (SNMP Protocol). Any abnormality observed during these tests shall be highlighted.~~

3.6 The~~re shall also be a~~ provision for conducting a partial discharge test (about 20%~~ of rated capacity~~), of a pre-determined duration and frequency. During this test, ~~the battery~~ current and voltage ~~, conductance~~ and temperature of each cell be recorded. ~~All these information shall be made available to the remote site with the information about abnormal behaviour of any of the cell.~~ Frequency and duration of partial test discharge shall be programmable.

~~Th~~C~~c~~onductance measurements/observations shall be off-line to prevent noise interference. The first observation of conductance, recorded by the power plant system, for the battery~~unit~~ shall form the base value for future comparison. The provision of partial test discharge shall be implemented in such a way that at a time only one battery is put to discharge, so as to ensure that necessary battery reserve is available in case of power failure during or immediately after the test discharge. Provision shall be made for observing the state of charge of battery before commencing this test. In case the battery is not fully charged this test may be deferred till the battery is fully recouped.

Any abnormality observed during above observations shall be highlighted by initiating an alarm. All the above information shall be made available to the remote site through RS 485 / RS 232 and Ethernet (Refer Clause 1.3 of TEC 66090:2025 for specified protocol).

Note: The manufacturer will give the list of hardware equipment required, for the purpose, at the time of procurement. **Purchaser shall clearly indicate the requirement of battery health check feature while ordering the power plant.** The manufacturer shall also undertake that the above provision will become fully functional by adding the hard ware/software for the purpose, if ordered by purchaser.

~~Note-2: This clause is optional and applicable to VRLA battery.~~

3.7 **Remote control and monitoring**: The power plant~~Charge controller~~ shall be RS 485/Rs 232 and Ethernet(SNMP) compatible. It shall provide for the monitoring, alarm and control of the power plant and its associated batteries from a remote site through RS 485/ Rs 232 and Ethernet (SNMP~~ Protocol~~). ~~Purchaser may specify the requirement for~~The exchange of information and protocol format between the power plant and remote site shall be as given in the Clause No. 1.3 of TEC GR 66110:2025.

3.8 **Battery Bank:** The following batteries shall be suitable for SPV applications:

~~10.2.3~~**3.8.1** The battery shall be 48V (24 cell) or 12V (6 cells) VRLA type (deep-cyclic)i.e. slow rate of charge and discharge conforming to TEC GR TEC/GR/TX/BAT - 001/04.JUNE.2011 with amendments, if any.

OR

~~10.2.4~~3.8.2 The battery shall be 48V (24 cell) or 12V (6 cells) Tubular VRLA based on GEL technology (deep-cyclic), conforming to TEC GR No. TEC/GR/TX/BAT - 003/02.MAR.2011 with amendments, if any.

OR

~~3.8.1~~3.8.3 The battery shall be 48V or 12V Li-ion type (deep-cyclic) conforming to TEC GR: TEC/GR/TX/Li-ion - 001/01.MAR.2016 with amendments, if any.

~~10.2.5~~3.8.4 For 24 V (Standalone Application only), the batteries mentioned above in (i) or (ii) or (iii) of required capacity may be used.

~~10.2.6~~3.8.5 The capacity of the battery shall be so designed so as to supply the ultimate load during the non-sunlight hours i.e. during the night and also during the cloudy weather (Number of sunless days at a stretch as specified by the ordering authority) or when both SPV power and AC mains are not available with 80% reserved power in fully charged condition and shall be floated across the SPV panel or SMPS and load through charge controller.

~~3.8.2~~3.8.6 The nominal voltage of the Battery shall be 48V or 12V as per application. However, the actual capacity of the battery in terms of Ampere-hour shall be calculated as per sample calculation sheet, placed at annexure 4~~2~~, taking into consideration the actual load and the autonomy (refer chapter - 2 for ordering information of this document).

~~10.2.7~~3.8.7 **For VRLA Battery:** The battery shall deliver at 120% of its rated capacity at low rate of discharge between C/20 and C/120. At discharge rate of C/120 or slower, the battery shall deliver at least 150% of its rated capacity.

For Li-ion Battery: When a module is discharged at C/5 rate, it shall deliver 90% of rated capacity (corrected at 25°Celsius) before the module voltage reaches 12 for 12V battery, 24 for 48V battery & 45V for 48V battery. The capacity (corrected at 25°Celsius) shall also not be less than C (rated capacity) and not more than 120% of C (rated capacity) when discharged to the voltage of 11.2 for 12V battery, 22.4V for 24V battery & 42V for 48Vbattery.

4.0 Quality Requirements :

4.1 **Components** : The component parts of the equipment shall be of professional grade of the reputed manufacturers to ensure prompt and continuous service and delivery of spares. For use of CACT approved Components, Purchaser may clearly specify the requirement. The Peak Inverse Voltage (PIV) ratings of components used shall have a minimum rating of twice the maximum system voltage. Use of potentiometers is precluded. Switching components used at input side of the SMPS shall be rated at 600V (minimum).

4.2 **Power transformers & Chokes :** Power transformers & chokes shall use class B or higher grade of insulation. The transformers and chokes shall be wound with copper wire and provided with adequate insulation.

4.3 Fuses/MCBs with current limiting device or circuit breakers of proper rating shall be provided wherever appropriate for protection of control/sensing circuit. Fuses/MCBs shall conform to BIS specification.

4.4 Component Approval : All the components, used, shall be~~For use of~~ CACT/NABL accredited Labs approved~~ Components, Purchaser may clearly specify the requirement~~. Components shall neither be combustible nor shall support combustion.

4.5 Quality and Workmanship :

a) All the units of the system shall be manufactured in accordance with international quality management systems ISO-9001-2015 (latest issue)~~2000~~, for which the manufacturer shall be duly accredited. A quality plan describing the quality assurance system followed by the manufacturer would be required to be submitted. The manufacturer shall also be accredited for the compliance of ISO 14001:2015 (latest issue) pertaining to environmental requirements.

b) All the equipment shall be manufactured as per the latest QA Guidelines indicated in Quality Manuals QM-118 (Quality reliability in product design), Manuals QM-202 (Pictorial guidelines for Visual assessment of quality of printed board assemblies (PBA) and discrete terminal assemblies), QM-204 (Guidelines for workmanship standards for repair & modification of printed wiring board assemblies), QM-205 (Guidelines for standard of workmanship for printed boards), QM-206 (Guidelines for standard of workmanship for printed boards assemblies), QM-207 (Guidelines for soft solder and fluxes for Telecom Equipments) and QM-210 (Guidelines for standard of workmanship for surface Mounting Devices).

c) All wiring shall be neatly secured in position and adequately supported. Metal panel or cover holes through which the wires or cables pass shall be suitably bushed.

d) All materials and workmanship shall be of professional quality to ensure the MTBF requirements.

4.6 Quality Assurance Tests : Each of the units supplied against the specific order after type approval shall be inspected and tested to ensure that the requirements of this document have been met. These tests shall be carried out by QA wing of BSNL~~the respective Telecom operator~~.

4.7 Module Replacement Time & MTBF

~~4.7~~ 4.7.1 **Module Replacement Time**: The mean time to replace / restore (MTTRPL~~TR~~) a faulty rectifier module shall be less than 20 minutes.

4.8 ~~MTTR /~~ MTBF(Mean Time between Failures) ~~/ SPARES~~ : ~~T~~ MTBF of the system shall not be less than 100,000 hours. The MTBF for fans shall be better than 70,000 hours at 40°C. The concurrence of CACT of QA wing of BSNL in this regard is mandatory.~~he MTTR (Mean Time To Restore) and MTBF (Mean Time Between Failure) predicted and observed values shall be furnished along-with calculations by the manufacturer~~. The MTBF shall be verified as per QM-115. MTBF, predicted and observed values shall be furnished along with calculations by the manufacturer. Based on these figures three years maintenance spares shall be specified by the equipment supplier. The equipment availability shall be in excess of 99.9 %.

5.0 Environment Requirements :

~~5.1 The system shall be designed to work satisfactorily under all the environmental conditions as specified in this clause~~SPV module/panel/arrays, C~~c~~harge C~~c~~ontroller unit, SMPS (in case of hybrid power supply), M~~m~~ounting structure and B~~b~~atteries ~~shall be capable of working in a saline atmosphere in coastal areas and shall be free~~

5.1 ~~from any corrosion at any period of time~~ in compliance with the requirements of relevant clauses of 14016:2010 (old no. QM-333:2010) shall be capable of working in a saline atmosphere in coastal areas and shall be free from any corrosion at any period of time(IEC 61701 compliance may be provided).~~QM-333~~. The SPV module/panel/array, charge controller, SMPS and battery shall also work with the guaranteed performance at an altitude in excess of 3000 metres above Mean Sea Level (MSL) in compliance with the relevant clauses of QM 333. These units shall also be capable of withstanding the rigors of transportation and storage and shall comply with the vibration, drop and topple test requirements as given in the relevant clauses of TEC 14016:2010(old no. QM-333:2010).

~~5.2~~ Environmental requirements for SPV Module/Panels : These environmental requirements should be complied as per Clause 5.2.1 & 5.2.2 of TEC GR 66100:2025 (old No. TEC/GR/TX/HPS-001/01 MAR 2017).

~~5.2.1 The SPV modules shall be soaked for at least for a week in natural sunlight before offering for tests or supply in accordance with the Instructions issued by the ministry of Non-Conventional Energy Sources to Test Centres vide letter No. 29(2)/Testing-97/PVTF dated 13.12.98. A sample check of 1% of the total modules offered will be carried out by QA wing of the respective~~

~~Telecom operator.~~

~~**5.2.2** In addition to the requirement of clause 5.2.1, the SPV modules shall also satisfy the following environmental test conditions :~~

5.2

~~S. No~~	~~Tests~~	~~Test Condition~~	~~Reference/Specification~~
~~1.~~	~~Dry heat~~	~~+85· C 16 hours~~	~~IEC-68-2-2 Test Bb~~
~~2.~~	~~Cold~~	~~-40· C 16 hours~~	~~IEC-68-2-1 Test Ab~~
~~3.~~	~~Rapid Change of Temperature~~	~~-40· C to 80· C~~ ~~10 cycles~~	~~IEC-68-2-14~~
~~4.~~	~~Composite Temperature Humidity Cyclic Test~~	~~25· C to -10· C~~ ~~25· C to 65· C 95% RH~~ ~~10 cycles~~	~~IEC-68-2-38~~
~~5.~~	~~Rain~~	~~2 Hours~~	~~IS 9000 (PART 16)~~
~~6.~~	~~Heavy dust/sand storm~~	-	~~Clause 16.0 of QM-333~~

~~7.~~	~~Wind speed~~	~~200Kms/hour~~	-
~~8.~~	~~Hail Storm~~	~~Hails of 25mm dia size at 23m/Sec velocity shall not cause physical damage to any part of the solar array or associated structures.~~	-
~~9.~~	~~Bending & twisting~~	~~module shall withstand a displacement at one corner by 20 mm/metre measured along with the shortest edge without open or short circuit within the module or suffer low resistance between~~	

		~~terminals to frame.~~	
~~10~~	~~Insulation test for module~~	~~As per IEC : 61215~~	~~IEC : 61215~~
~~11~~	~~Hot-spot endurance test~~	~~As per IEC : 61215~~	~~IEC : 61215~~
~~12~~	~~Robustness of termination test~~	~~As per IEC : 61215~~	~~IEC : 61215~~
~~13~~	~~Wet leakage current test~~	~~As per IEC : 61215~~	~~IEC : 61215~~
~~14~~	~~Bypass diode thermal test~~	~~As per IEC : 61215~~	~~IEC : 61215~~

5.3 Environmental requirements for **Charge Controller and SMPS:** In addition to the requirement of Clause 5.2 of this document, the charge controller and SMPS, shall operate at the specified rating and conform to the requirements contained in TEC 14016:2010(old no. QM 333:2010) ~~QM- 333~~ Category B2.

~~**5.4**~~ Burn-in Test: The Hybrid CCU or Standalone CCU~~The Charge controller and SMPS~~ shall be capable of withstanding a burn-in test for 72 hours at an ambient temperature of

5.4

50°C, when the ~~hen the~~ equipment working at full rated load. This test may be performed in a temperature controlled room with free air flow. The ambient temperature shall be measured at a distance of 1 foot from the equipment under test. Necessary test set-up for the purpose shall be provided by the manufacturer.

5.4.1 The temperature rise of heat dissipating components above the ambient, measured directly or at the heat sink in the first 8 hours of the above test shall not be more than :

a) **Transformers & Chokes** : 70°C for B grade of Insulation. For higher grade of insulation, higher temperature rise is permissible subject to the ~~or B grade of Insulation. For higher grade of insulation, higher temperature rise is permissible subject to th the~~ following conditions :

i) It is at least 20°C below the permissible limit for the grade of ~~elow the permissible limit for the grade ofof i~~insulation.

ii) The temperature rise shall be at least 30°C below the curie ~~el~~temperature of the magnetic material.

iii) This temperature shall neither affect other components nor lead to fire hazard.

b) **Semiconductor devices** : 60°C ~~0~~ or as per component specification.

5.5 Insulation Resistance and Voltage Proof Tests :

5.5.1 **Insulation Resistance** : The insulation resistance of a fully wired FR/FC & MPPT Module~~Charger Controller and SMPS~~, when tested with a 500V DC megger shall ~~not~~ be ~~less than 5Meg ohms for the following conditions~~ given below :

A) FR/FC

a) AC Input & Earth - Greater than 2 meg Ohm

b) DC Output & Earth - Greater than 1 meg Ohm

c) AC Input & DC output - Greater than 5 meg Ohm

B) MPPT

a) DC Input & Earth - Greater than 2 meg Ohm

b) DC Output & Earth - Greater than 1 meg Ohm

c) DC Input & DC output - Greater than 5 meg Ohm

~~a) Shorted DC Output terminals and Earth (Charge Controller)/ (SMPS).~~

~~b) Shorted AC Input terminals and Earth (SMPS).~~

~~c) Shorted DC input Terminals and Earth(Charge controller unit).~~

~~d) Shorted AC input terminals and shorted DC output terminals (SMPS).~~

~~e) Shorted DC input terminals and Shorted DC output Terminals (Charge controller).~~

~~Note- For serial number (b) & (d) above, Tests may be performed on integrated SMPS Hybrid power supply, If applicable.~~

5.5.2 Voltage Proof Test: The Voltage Proof Test of a fully wired FR/FC & MPPT Module w~~W~~ith EMI/RFI capacitors and MOVs/Tranzorbs removed from the circuit a test voltage of 1500V/50Hz is applied for one minute.~~,~~ ~~between~~ ~~:~~ -Between earth and interconnected output terminals. -Between interconnected input and output terminals.

~~a) Shorted DC Output terminals and Earth (Charge Controller)/ (SMPS).~~

~~b) Shorted AC Input terminals and Earth (SMPS).~~

~~c) Shorted DC input Terminals and Earth(Charge controller unit).~~

~~d) Shorted AC input terminals and shorted DC output terminals (SMPS).~~

~~e) Shorted DC input terminals and Shorted DC output Terminals (Charge controller).~~

~~**Note- For serial number (b) & (d) above, Tests may be performed on integrated SMPS Hybrid power supply, If applicable.**~~

Alternatively without removing EMI/RFI capacitors, the lightning protection circuitry and Tranzorbs etc., but with EMI/RFI discharge resistors removed :

a) A 2150V DC can be applied for one minute between interconnected~~shorted AC~~ input &~~DC~~ output terminals

b) 650V DC can be applied for one minute between interconnected~~shorted AC~~ Input ~~terminals, shorted input DC terminals, shorted DC~~ output terminals & earth.

This DC voltage test is in accordance with UL ~~1~~950~~(UL 60950)~~ & IEC ~~60~~950 Standards.

No breakdown or abnormal temperature rise shall occur.

5.6 ~~Lightning and Surge Protection~~**Lightning Protection :** The power supply~~system~~ shall be adequately protected against lightning at both AC input mains & SPV input side by a protection device, in a separate casing, attached on out side the charge controller in the following configuration:

5.6.1 **Protection of SPV Modules/Panels/Array:** An external interceptor, with down conductor connected to proper earth, shall ensure the protection of the SPV modules/panels/array against direct lightning. It shall be installed at a distance of 0.5 metre (minimum). The cone of the protector shall be capable of providing protection to the whole SPV array and at the same time it shall not obstruct the sunlight to array. The external lightening protection shall be in compliance with Table 5, 6 and 7 of IEC 62305 – 1.

~~5.6.1~~ Protection of Charge controller ~~and Telecom equipment~~ from SPV array side: ~~On the SPV power source side of charge controller, the charge controller and telecom equipment shall be adequately protected against lightning and surges in a manner as given below:~~

5.6.2

~~Surge protection Device on input side of CCU shall consist of Spark Gap/MOV surge-arrestors(Type I for DC) and Metal Oxide Varistors (MOV-Type II for DC) connected between +ve and –ve, +ve and ground, –ve and ground in Y configuration.~~

~~Type I SPD shall be able to discharge total lightning impulse current (10/350 µsec) of 12.5KA SPD shall have Iscpv (short-circuit current rating) value as per the total SPV system current with a minimum value 1000A of Iscpv. SPD shall have thermal Disconnection for fail safe operation.~~

~~Type II SPD shall be able to discharge max current (8/20 µsec) of 40KA & nominal discharge current of 20KA total surge discharge current more than 15KA (8/20 µsec). SPD shall have Iscpv (short-circuit current rating) value as per the total SPV system current with a minimum value 1000A of Iscpv. SPD shall have thermal Disconnection for~~

~~fail safe operation.~~

~~SPD shall comply to the IEC 61643-31 standards and shall be certified from labs accredited by ILAC signatories or TEC designated labs or NABL Accredited Labs in India.~~

~~If required by the purchaser, provisioning of an integrated internal by-pass SPV-DC fuse or external series fuse or external disconnector (Refer EN 50539-11 &12/IEC 60634-7-712) connected in +ve & -ve strings may be specified so that SPD(Type I & II) can extinguish the DC arc safely.~~

~~SPD(Type I & II) shall have mechanical indication on +ve, -ve and ground path for local indication and potential free / auxiliary contacts for remote indication. SPD shall comply to the EN 50539-11 standards and certified from KEMA or VDE.~~

~~Proper de-coupling using suitably rated inductance shall be provided between the two stages for proper co-ordination.~~

Surge protection Device on input side of CCU shall consist of MOV surge-arrestors (Type1+2) connected between +ve and ground, –ve and ground. +ve and -ve in SPD(Type I & II) shall have mechanical indication on +ve, -ve and ground path for local indication and potential free / auxiliary contacts for remote indication.

Type I+2 SPD shall be able to discharge total lightning impulse current (10/350 μsec) of 12.5KA SPD shall have Iscpv (short- circuit current rating) value as per the total SPV system current with a minimum value 1000A of Iscpv. SPD shall be able to discharge max current (8/20 μsec) of 40KA & nominal discharge current of 20KA (8/20 μsec).SPD shall have thermal Disconnection for fail safe operation SPD shall comply to the IEC 61643-31 standards and shall be certified from labs accredited by ILAC signatories or TEC designated labs as applicable.

~~5.6.2~~5.6.3 Protection on AC Main Side (Hybrid Power supply only): Stage-1 Lightning and Surge Protection is not in the scope of system. Stage-2 Lightning and Surge Protection for AC input of Site against the lightning and high voltage surges shall be as per GR of lightning and Surge Protection of Site (GR No. TEC 66130:2025). Purchaser may decide to buy Stage -1 & 2 protection devices for equipment safety against lightning and surges.~~This protection shall be the be part of Telecom Site. The GR on Lightening and Surge Protection of Telecom Sites (No. TEC/GR/FLA/LSP -001/01/June.2010).~~

~~**6.0** Electromagnetic Compatibility (EMC):~~

~~The equipment shall conform to the EMC requirements as per the following standards and limits indicated therein. A test certificate and test report shall be furnished from an accredited test agency.~~

~~**a)** Conducted and radiated emission (applicable to telecom equipment): Name of~~

~~**EMC Standard:** "As per CISPR 22 (2008) - Limits and methods of measurement of radio disturbance characteristics of Information Technology Equipment" for the following~~

~~**Limits:-**~~

~~i. To comply with **Class A** of CISPR 22 (2008).~~

~~ii. The values of limits shall be as per TEC Standard No. TEC/SD/DD/EMC-221/05/OCT-16.~~

~~iii. For Radiated Emission tests, limits below 1 GHz shall be as per Table 4 (a) or 5 (a) for measuring distance of 10m **OR** Table 4 (a1) or 5 (a1) for measuring distance of 3m.~~

~~**OR**~~

~~Conducted and radiated emission (applicable to instruments such as power meter, frequency counter etc.):~~

~~**Name of EMC Standard:** "As per CISPR 11 {2015} - Industrial, scientific and medical (ISM) radio- frequency equipment -Electromagnetic disturbance characteristics- Limits and methods of measurement" for the following~~

~~Limits :-~~

i. ~~To comply with the category of Group 1 of Class A of CISPR 11 {2015}~~

ii. ~~The values of limits shall be as per clause No. 8.5.2 of TEC Standard No. TEC/SD/DD/EMC-221/05/OCT-16.~~

~~b)~~ ~~Immunity to Electrostatic discharge:~~

~~**Name of EMC Standard:** As per IEC 61000-4-2 {2008) "Testing and measurement techniques of Electrostatic discharge immunity test" for the following.~~

~~Limits: -~~

i. ~~Contact discharge level 2 {± 4 kV} or higher voltage;~~

ii. ~~Air discharge level 3 {± 8 kV} or higher voltage;~~

~~c)~~ ~~Immunity to radiated RF:~~

~~**Name of EMC Standard:** As per IEC 61000-4-3 (2010) "Testing and measurement techniques-Radiated RF Electromagnetic Field Immunity test" for the following~~

~~Limits:-~~

~~For Telecom Equipment and Telecom Terminal Equipment with Voice interface (s)~~

i. ~~Under Test level 2 {Test field strength of 3 V/m} for general purposes in frequency range 80 MHz to 1000 MHz and~~

ii. ~~Under test level 3 (10 V/m) for protection against digital radio telephones and other RF devices in frequency ranges 800 MHz to~~

~~960 MHz and 1.4 GHz to 6.0 GHz.~~

~~**For Telecom Terminal Equipment without Voice interface (s)**~~

~~Under Test level 2 {Test field strength of 3 V/m} for general purposes in frequency range 80 MHz to 1000 MHz and for protection against digital radio telephones and other RF devices in frequency ranges 800 MHz to 960 MHz and 1.4 GHz to 6.0 GHz.~~

~~**d) Immunity to fast transients (burst):**~~

~~**Name of EMC Standard:** As per IEC 61000- 4- 4 {2012) "Testing and measurement techniques of electrical fast transients / burst immunity test" for the following.~~

~~Limits:-~~

~~Test Level 2 i.e. a) 1 kV for AC/DC power lines; b) 0. 5 kV for signal / control / data / telecom lines;~~

~~**e)** Immunity to surges:~~

~~**Name of EMC Standard:** As per IEC 61000-4-5 (2014) "Testing & Measurement techniques for Surge immunity test" for the following.~~

~~Limits:-~~

~~i) For mains power input ports:~~

~~(a) 1.0 kV peak open circuit voltage for line to ground coupling~~

~~(b) 0.5 kV peak open circuit voltage for line to line coupling~~

~~(c) 4.0 kV peak open circuit voltage for line to ground coupling~~

~~(d) 2.0 kV peak open circuit voltage for line to line coupling~~

~~ii) For telecom ports:~~

~~(a) 1.0 kV peak open circuit voltage for line to ground~~

~~(b) 0.5 KV peak open circuit voltage for line to line coupling.~~

~~(c) 4.0 kV peak open circuit voltage for line to ground~~

~~(d) 2.0 KV peak open circuit voltage for line to line coupling.~~

~~f) Immunity to conducted disturbance induced by Radio frequency fields: Name of EMC Standard: As per IEC 61000-4-6 (2013) "Testing & measurement techniques-Immunity to conducted disturbances induced by radio- frequency fields" for the following.~~

~~Limits:-~~

~~Under the test level 2 {3 V r.m.s.}in the frequency range 150 kHz-80 MHz for AC / DC lines and Signal /Control/telecom lines.~~

~~**g)** Immunity to voltage dips & short interruptions (applicable to only ac mains power input ports, if any):~~

~~**Name of EMC Standard:** As per IEC 61000-4-11 (2004) "Testing & measurement techniques- voltage dips, short interruptions and voltage variations immunity tests" for the following.~~

~~Limits:-~~

~~i. a voltage dip corresponding to a reduction of the supply voltage of 30% for 500ms (i.e. 70 % supply voltage for 500ms)~~

~~ii. a voltage dip corresponding to a reduction of the supply voltage of 60% for 200ms; (i.e. 40% supply voltage for 200ms)~~

~~iii. a voltage interruption corresponding to a reduction of supply voltage of > 95% for 5s.~~

~~iv. a voltage interruption corresponding to a reduction of supply voltage of >95% for 10ms.~~

~~**Note 1**: Classification of the equipment:~~

~~Class B: Class B is a category of apparatus which satisfies the class B disturbance limits. Class B is intended primarily for use in the domestic environment and may include:~~

- ~~Equipment with no fixed place of use; for example, portable equipment powered by built in batteries;~~
- ~~Telecommunication terminal equipment powered by the~~

~~telecommunication networks~~

- ~~Personal computers and auxiliary connected equipment.~~

~~Please note that the domestic environment is an environment where the use of broadcast radio and television receivers may be expected within a distance of 10 m of the apparatus connected.~~

~~**Class A:** Class A is a category of all other equipment, which satisfies the class A limits but not the class B limits.~~

~~**Note 2:** The test agency for EMC tests shall be an accredited agency and details of accreditation shall be submitted.~~

~~Note 3: For checking compliance with the above EMC requirements, the method of measurements shall be in accordance with TEC Standard No. TEC/SD/DD/EMC-221/05/OCT-16 and the references mentioned therein unless otherwise specified specifically. Alternatively, corresponding relevant Euro Norms of the above IEC/CISPR standards are also acceptable subject to the condition that frequency range and test level are met as per above mentioned sub clauses (a) to (g). The details of IEC/CISPR and their corresponding Euro Norms are as follows:~~

~~IEC/CISPR~~	~~Euro Norm~~
~~CISPR 11~~	~~EN 55011~~
~~CISPR 22~~	~~EN 55022~~
~~IEC 61000-4-2~~	~~EN 61000-4-2~~
~~IEC 61000-4-3~~	~~EN 61000-4-3~~
~~IEC 61000-4-4~~	~~EN 61000-4-4~~
~~IEC 61000-4-5~~	~~EN 61000-4-5~~
~~IEC 61000-4-6~~	~~EN 61000-4-6~~
~~IEC 61000-4-11~~	~~EN 61000-4-11~~

~~N.B.: The manufacturer/supplier shall submit a test certificate and test report from test agency. The test agency for EMI/EMC compliance shall be an accredited one and details of accreditation shall be submitted.~~

6.0 GENERAL REQUIREMENTS

6.1 Radio Frequency Interference (RFI) Suppression:

The system (FR/FC, FR/BC & DSCA modules) shall be designed to minimise the level of electromagnetic interference (EMI), both conducted and radiated, detected in its vicinity and generated by the module and shall comply the following clauses :

6.1.1 Conducted and Radiated Emission from the single phase ~~and three phase~~ Power equipment.

Name of EMC Standard: CISPR 32 (2015) with A1(2019) "Electromagnetic compatibility of multimedia equipment – Emission requirements; Limits and methods of measurement of radio disturbance characteristics of Information Technology Equipment".

Limits: -

i) To comply with Class A of CISPR 32 (2015) with A1(2019).

ii) The values of limits shall be as per relevant tables under CISPR 32 (2015) with A1(2019).

Test Procedure: Test setup, Test procedure & Measurements shall be conducted as per IEC- CISPR 32 (2015) with A1(2019).

6.1.2 Electrostatic discharge (ESD) immunity limits:

The limits shall be as per IEC 61000- 4-2, 9(1) (both Contact discharge method and Air discharge method) as given below:

Test level:

Contact discharge		Air discharge	
Level	Test voltage (KV)	Level	Test voltage (KV)
4	8	4	15

Test Procedure: This test shall be conducted as per IEC 610004-2 for both requirements & unit shall comply of clause 9(1) of IEC 61000-4-2.

6.1.3 **Radiated radio-frequency Electromagnetic field immunity limits:** The limits as per IEC 61000-4-3.

Test level:

Frequency range: 80 MHz to 1000 MHz.	
Level	Test field strength V/m
3	10

Test Procedure: This test shall be conducted as per IEC 61000-4-3. Test results shall be in compliance of clause 9(a) of IEC 61000-4-3.

6.1.4 **Electrical fast transient/Burst immunity limits:** The limits shall be as specified in IEC 61000-4-4.

Test level:

Open–circuit output test voltage (+/-10%) &repetition rate of impulses (+/-20%)		
Level	On Power supply port, Protection Earth	
	Voltage peak KV	Repetition rate KHz
4	4	2.5
Rise time of one Pulse - 5 ns +/- 30%		
Impulse duration - 50 ns +/- 30%		

Test Procedure: This test shall be conducted as per IEC 61000-4-4. Test results shall be in compliance of clause 9(1) of IEC 61000-4-4.

6.1.5 **Surge immunity limits:** The limits as per IEC 61000-4-5.

Test level:

Level	Open circuit test voltage (+/- 10%) KV
1 2 3 4	0.5 1.0 2.0 4.0
Voltage surge - 1.2/50 µs Amplitude - 2 KV(DM) - 4 KV(CM) - After testing for 4KV, the amplitude shall also be increased to 6 KV (1.2/50 µs) Combined wave form as per IEEE C62.41- 1991 to cover Lightening/ Surge protection test also. - Test results shall be in compliance of clause 9(b) of IEC 61000-4-5.	

Test Procedure: This test shall be conducted as per IEC 61000-4-5. After testing for 4KV, the amplitude shall also be increased to 6 KV (1.2/50 µs) Combined wave form as per IEEE C62.41-1991(to cover Lightening/ Surge protection test also).

Note: The rated voltage of the MOVs used for the above shall not be less than 320V.

6.1.6 **Radio-Frequency Conducted Susceptibility immunity limits:** The limits as per IEC 61000-4-6.

Test level:

Frequency range: 150 KHz- 80 MHz	
Level	Voltage level (e.m.f.)
3	10

Test Procedure: This test shall be conducted as per IEC 61000-4-6. Test results shall be in compliance of clause 9(a) of IEC 61000-4-6.

6.1.7 **Conducted Susceptibility Limits**: Power equipment used in Telecom Network shall not malfunction when high voltage surge as specified below is superimposed at the input power mains to the power equipment, for more than two seconds as per IEC 61000- 4-18. The equipment shall also not fail or degrade in performance after the surge is withdrawn.

Test levels:

Voltage Rise time (First peak): 75 nano sec +/- 20%.

Oscillation Frequencies: 100KHz & 1 MHz +/- 10%

Repetition rate: at least 40/s for 100KHz and 400/s for 1 MHz

Decaying: 50% of the peak value between the 3rd & 6th periods

Burst duration: not less than 2s

Surge amplitude: 250V (-10%) to 2.5 KV (+10%)

Wave shape: Damped

Test Procedure: Test set up, test procedure & Measurements shall be as per IEC 61000-4-18. EMI surge of specified levels injected on power leads of test sample shall not cause degradation of performance or malfunction.

6.1.8 At the time of Type approval the testing officer shall ensure that the power plant is in compliance of the clauses 6.1.1 to 6.1.7 given above.

~~6.1~~ 6.2 **Noise and Vibration:** The fully equipped Charge controller unit and SMPS rack, at full load, shall not contribute more than 15 dB (weighted) to the ambient noise level taken as 45dBA. It shall be measured at a distance of 1 metre from the rack and 1.25m above the floor level in the Acoustic Range. The correction factor for Total Noise when the ambient noise level is more than 45dBA shall be as given below:

Ambient Noise	Correction Factor	Ambient Noise	Correction Factor	Ambient Noise	Correction Factor
45dBA	0dB	51dBA	1.41dB	57dBA	3.69dB
46dBA	0.18dB	52dBA	1.73dB	58dBA	4.17dB
47dBA	0.39dB	53dBA	2.07dB	59dBA	4.68dB
48dBA	0.61dB	54dBA	2.43dB	60dBA	5.21dB
49dBA	0.86dB	55dBA	2.82dB		
50dBA	1.12dB	56dBA	3.25dB		

Note: The correction Factor shall be added to the limit of 60dBA to arrive at the limit when the ambient is greater than 45dBA.

7.0 Safety Requirements:

~~7.0~~7.1 The equipment shall conform to relevant safety requirements as per IS/IEC 61204: Part 7: 2016 as prescribed under Table no. 1 of the TEC document 'SAFETY REQUIREMENTS OF TELECOMMUNICATION EQUIPMENT": TEC10009: 2024'.

~~7.1 The equipment shall conform to IS 13252 part 1:(2010) "information technology Equipment Safety Part 1: General Requirements {equivalent to IEC 60950-1 (2005)} "information technology Equipment-Safety" Part 1: General Requirements and IS 10437(1986) "Safety requirements for radio~~

~~transmitting equipments" equivalent to IEC 60215.~~

8.0 Other requirements:

Rack: The rack structure shall be made up of rigid framework of steel profiles and shall be free of sharp edges or sharp corners. The structural strength of the rack shall be able to withstand the ultimate mechanical load capacity of the rack without any deformity. The rack shall have suitable ventilating arrangements (forced cooling from the sides is not permitted). The front door (if provided) and rear door may be of hinged or removable type. The gauge of metal sheet for load bearing part shall not be less than 1.5 mm and for rest of the parts shall not be less than 1.2mm. The unit may be floor-mounted or wall-mounted as specified by the purchaser. The unit may be either expandable or of ultimate size, as per purchaser's requirement". Sheet used in cabinet manufacturing should be Galvanized Iron (GI – 120gsm) & duly powder coated as per the colour given in clause no. 8.11.

~~8.1 Constructional Requirements :~~

~~All the components as given in clause 2.1.2 shall be mounted in the charge controller made of a metallic box with the captive screws with washers. Non-integrated SMPS as per clause 3.3 shall be mounted in a 19" rack. The mechanical design and construction of SPV modules, charge controller & mounting structure shall be inherently robust and rigid under all conditions of operation, adjustment, replacement, storage & transport. Sharp edges shall be avoided. Packing and transportation shall be made such that the equipment is not damaged, while transporting,~~

~~loading and unloading.~~

8.1.1 **SPV Module/Panel** : The mechanical design and construction of SPV modules, panels and mounting structure shall be inherently robust and rigid under all conditions of operation, adjustment, replacement, storage and transport. Sharp edges shall be avoided.

8.1.1.1 The cells shall be fully encapsulated and mounted behind a toughened low iron high transmission glass surface of thickness not less than 3mm to protect the cells from moisture, dust and external environment. The contacts should be corrosion resistant. Crane/scrim glass shall be used inside the SPV module in order to help the evacuation process. Standard practice of using crane/scrim glass (not up to the edges) shall be adopted. The leads must be weather protected.

8.1.1.2 SPV modules shall be constructed of materials and component, which are known to be resistant to damage or deleterious change when exposed outdoors for a period of 15 years in any of the climatic conditions prevailing in India and provide mechanical and environmental protection to the encapsulated components. The possibility of attack by birds and animals shall be taken into account when selecting materials for the exterior of modules.

8.1.1.3 The modules shall have proven laminate construction. The laminates shall be sealed in a frame of light-weight anodised aluminium, with a suitable edge gasket/silicon rubber sealant to provide shock resistance and a further moisture barrier. The back surface shall be of impermeable aluminium foil/polyester and white refractive plastic material such as TEDLAR.

8.1.1.4 The sealing of edges of glass on the frames shall be hermetically tight so that rain water and dew do not enter into the cell compartment.

8.1.1.5 A terminal box shall be attached to the SPV module frame. The terminal box should be resistant to moisture ingress and shall include integral by- pass diode to protect cell overheating due to localised shading. The module shall preferably be self draining and self cleaning.

8.1.1.6 The design of the solar module shall be multi-cell and modular in construction to provide the required output.

8.1.1.7 The SPV module is for use in terrestrial application and is to comprise of mono-crystalline/poly-crystalline silicon solar cells to be connected in series parallel arrangement. Each module shall be completely encapsulated and sealed to provide reliable operation under adverse climatic conditions.

8.1.1.8 The SPV modules, being used for Telecom supply, need to be characterised at NPL (National Physical Laboratory) or any other recognised Test Lab. In association with QA, BSNL for each type of cells used. The manufacturer will give the spread- in of silicon cells used by him.

8.1.2 The structure of the unit/rack shall be made up of rigid frame work of MS steel profiles with a proper ventilating arrangements. The structural strength of the framework shall be able to withstand the ultimate mechanical load of the unit/rack without any deformity. Unit/rack shall be free of sharp edges or sharp corners. The unit/rack shall have suitable ventilating arrangements (forced cooling from the sides is not permitted).The front door (if provided) and rear door may be of hinged or removable type. The gauge of metal sheet for panels shall not be less than 2mm. However purchaser may specify thickness/gauge of metal sheet to be less than 2mm for lower weight system, but quality and strength of the rack shall be ensured.

8.1.3 Proper thermal engineering of– hardware design shall be done by the manufacturer so as to ensure the uninterrupted use of the equipment. Unit/rack, complete, with all panels fitted, shall be designed to allow cooling by natural convection. For the systems~~SMPS~~, using 25A &50A FR-FC modules, ~~may be~~ forced cooling~~ed for which use of DC fans only~~ is permitted.

~~**8.1.3**~~ For Outdoor racks, use of temperature-based speed-controlled DC Fans are only permitted for the purpose. There shall be an arrangement for automatic Switching-OFF of fans during AC input failure. If required, individual modules may be separated by air baffle to provide effective convection. The manufacturer shall also ensure that the —failure of fan does not cause any fire hazard. The failure of any of the fans shall

draw

immediate attention of the maintenance staff. The filter used in outdoor cabinet shall be minimum of G3 grade.~~The design of the charge controller unit and SMPS rack shall be such that it prevents ingress of pests, insect and other foreign material of the size larger than 5mm dia.~~

8.1.4 To prevent the misuse of battery there shall be a provision for mounting the battery inside the charge controller, away from the heat generating components, if any. In such cases a provision of locking the charge controller which can be opened by a key or proper tool shall be made. However terminations for SPV power and Load with proper protection against accidental touch shall be accessible without opening the charge controller unit. If the above arrangement is not feasible due to large battery size the battery terminals shall be so designed to avoid its misuse. On input AC side 2 metre fire retardant cable of proper current rating with a 5A moulded 3 pin plug shall be provided.

8.1.5 In case the battery is mounted inside the unit, the battery mounting fixture shall be such as to hold the battery firmly in position in any orientation. Proper sign showing the orientation of the unit shall be marked.

8.1.6 The unit shall be designed for easy maintenance & installation.

8.1.7 Provision for mounting the Standalone CCU ~~charge controller unit~~ on the wall as well as table shall be provided. Hybrid CCU ~~SMPS rack~~ shall have the provision for fixing it on the floor.

~~8.1.8 The use of mechanical switching such as relays etc. is not permitted in the control circuit. All the components mounted on the PCB shall be permanently soldered to PCB. Use of mounting sockets for components is not allowed~~

~~8.1.9~~8.1.8 The base of ~~unit or~~ rack shall ensure uniform floor loading of not more than 975 kg/Sq. metre in case of Hybrid CCU &~~below~~ 320 kg/Sq metre.

in case of Standalone CCU. Lifting facilities shall be provided by removable eyebolt located at the top of the rack. The necessary arrangement for fixing the rack on the floor shall be provided. The rack shall be provided with bottom clearance of 110 mm minimum or more.

~~**8.1.10** SMPS: In addition to the above requirements, the SMPS rack shall also have the following provisions :~~

~~**8.1.11** The necessary arrangement for fixing the rack on the floor shall be provided. The rack shall be provided with bottom clearance of 110 mm minimum or more.~~

8.1.11 **Standalone CCU:** The top of the rack shall be fully covered except for ventilation and bus bar or cable entries. Each air flow vent shall be covered by a grill to prevent foreign material larger than 5 mm dropping into the rack.

8.1.12 Hybrid CCU: Rack shall be protected from dust & water complying to IP55 in accordance with IEC 60529.

8.1.13 Standalone CCU:-The rack shall be designed for easy maintenance & installation. Rack mounting arrangement shall provide easy access from front, rear and top for Installation and Maintenance. Hybrid CCU: The rack shall be designed for any maintenance and installation. Rack mounting arrangement shall provide easy access from front and rear for Installation and Maintenance.

8.1.14 The individual FR/FC modules shall be easily mounted to/removed from the front side of the rack. The FR/FC module shall be designed to slide into the rack on a suitable mechanical arrangement.

8.1.15 The associated AC input, DC output connections, Control, alarms & interface cable connecting the modules shall be connected/disconnected easily without causing any interruption in the supply and damage to load or other working module.

8.1.16 Facility shall be made to connect external AC power at the bottom of rack and alarm cable & DC output distribution module at the top of the rack. Where cables pass through metal panels suitable bushing shall be provided to protect cables from damage. Bus-bars, if used, shall be suitably spaced, insulated and bushed(where it passes through holes) to prevent any possibility of short circuit between bus-bar and/or rack.

8.1.17 Standalone CCU: With doors in position, all Visual alarms and meters shall be clearly visible. In case of hinged door meters & alarm indications are permitted on door provided, the fixtures on the door do not restrict the movement of door in any way. Hybrid CCU: Meters and alarm indications (if any) shall remain inside the cabinet and shall not be positioned on the door.

8.1.18 ~~The FR/FC modules shall be cooled by natural convection for smaller capacities i.e. 12.5A FR/FC modules of more than or equal to 25A may have natural or forced cooling~~The FR/FC module shall either be cooled by natural convection or by forced cooling. Manufacturers should decide the cooling method of FR/FC modules based upon their design topology or cooling requirements if the purchaser as not mentioned any specific cooling requirement.

8.1.19 AC input to FR/FC modules shall be through composite type hot plug-in connectors~~locking type arrangement~~. DC output shall be through hot plug-in connector on the FR/FC side and through lugged termination on the bus-bar/termination end. Control, alarm and monitoring connections shall only be through polarised connectors.

~~**8.1.20**~~ The FR/FC module shall be removable from the front of the rack only. All AC input, DC output and alarm/control/monitoring cables interconnecting the modules and racks shall be easily connected/disconnected by plugs or connectors. ~~Connecting/~~

~~disconnecting of modules shall not cause any interruption in the supply or damage to the load and other working modules.~~

8.1.20

8.1.21 The Distribution/Switching sub-system of DSCA shall preferably be modular but Control, alarm and monitoring sub-system shall only be modular. The Distribution/ Switching sub- system may be accommodated in a rack with other FR/FCs. These sub-systems shall be rack mountable.

8.1.22 DSCA shall preferably be housed in the upper portion of the rack above the FR/FC and shall be equipped to meet the ultimate system capacity.

~~8.1.11~~8.1.23 DSCA shall be provided for the ultimate system capacity as per clause 3.3.3.2 & 3.3.3.3~~3.3~~. All AC, DC or control/alarm cabling/wiring shall be pre-wired for the ultimate SMPS capacity so that mere plugging-in of FR/FC module or connecting the additional panels shall add to the DC power output. It shall be ensured that the FR-FC modules are not site specific.

~~8.1.23~~8.1.24 Mounting Structure of SPV ARRAY:

~~8.1.23.1~~8.1.24.1 A suitable ~~Mounting structure shall be~~ hot dip galvanized iron structure shall be ~~,~~ provided for mounting the module on any of the following locations :-

~~a)~~ roof top on the ground at an angle of tilt with horizontal an accordance with the latitude of the place of installation.

~~b)~~ on the Self Supporting Mast/Tower.

~~8.1.23.2~~8.1.24.2 The steel for the mounting structure shall be a per IS 2062 : 1992 & the galvanisation of the mounting structure shall be in compliance of IS 4759 latest issue.

~~8.1.23.3~~8.1.24.3 The mounting arrangement~~structure~~ shall be suitabl~~ey~~ for column mounting or flat surface, as desied by the ordering authority.~~designed to withstand the weight of the panel.~~

~~8.1.23.4~~8.1.24.4 The Mounting structure shall be easily transportable and designed to withstand the wind speed of 200KM/hour. Design calculation shall be furnished to show that the proposed structure will withstand the wind speed of 200 Km/hr. The design for the mounting structure shall have the certification from a recognised or accredited

Lab/Institution for the purpose. If required purchaser may reduce the wind speed requirement depending upon geographical condition of the site.

~~8.1.23.5~~8.1.24.5 The mounting arrangement shall be suitable for pole (mast) mounting, column mounting or flat surface, as desired by the ordering authority.

~~8.1.23.6~~8.1.24.6 The exact mounting mechanism as well as the height of the mast (if required) shall have to be decided upon and specified by the ordering authority, as per the actual requirement at the site of installation and the same shall be mentioned in the purchase order (refer chapter-2 of this document).

8.1.24.7 Provision for directional and angular adjustment from North to South shall be made to ensure the ~~shall be provided to get~~ optimum utilisation of incident sunlight. Three or more holes shall be provided to adjust the module seasonally.

~~8.1.23.7~~

8.1.24.8 The design/drawings of the mounting structure shall be supplied along with the module to the purchaser.

~~8.1.23.8~~8.1.24.9 The mounting structure shall be suitably designed to withstand the weight of the panel/array.

8.2 Terminations :

8.2.1 A C Terminations :

8.2.1.1 The input terminals terminals shall be clearly marked as R, Y, B & N for three phase and~~of SMPS and FR/FC modules shall be clearly marked as~~ L and N for single phase as applicable..

8.2.1.2 All the terminals, except AC earth, shall be electrically isolated. The terminal blocks shall be of Polyamide 6.6. To avoid any voltage, drop at the connection points due to electrolytic thermal expansion, all metal parts should be non-ferous including screws

8.2.1.3 AC input termination shall be suitably protected against the accidental touch/contact with the working staff for their protection and shall also have clear and prominent "DANGER" marking. AC terminations shall be through standard finger safe lock-in type connectors conforming to BIS or any other international standard, with the concurrence of CACT. The use of nuts and bolts for AC termination is precluded.

8.2.1.4 Screening shall be provided between AC and DC components to prevent accident.

8.2.1.5 The AC input connection to the rectifier module shall be by a locking type hot plug-in connectors ~~plug~~ and socket arrangement.

8.2.1.6 All the connections between DSCA and FR/FC modules , shall be through proper rated cables only.

8.2.1.7 Fuses and Circuit-breakers for each FR/FC shall be easily accessible and properly rated.

8.2.1.8 Proper terminations for AC at the input of the circuit-breakers and its output to the FR/FC.

8.2.1.9 Nuts and bolts used for securing electrical connections shall not be used for clamping terminals to their mountings.

8.2.2 DC Terminations:

8.2.2.1 Proper termination shall be provided in the Standalone CCU & Hybrid CCU ~~charge controller~~ to terminate the leads from the battery, load and cable from the SPV power source .~~and SMPS. In SMPS also the proper termination shall be provided for terminating battery and cable from charge controller.~~

8.2.2.2 At the input and output, proper rated fuses and circuit breakers shall be provided on the -ve lead from the unit. All DC +ve and -ve leads shall be clearly marked.

8.2.2.3 All conductors shall be properly rated to prevent excessive heating.

8.2.2.4 The terminals shall be capable to withstand the ultimate peak load.

8.2.2.5 The fuse or circuit-breakers with current limiting devices used, shall be easily accessible and properly rated.

8.2.2.6 The male connectors shall be mounted in the FR/FC module and female connectors be terminated to the cable.

8.2.2.7 The DC output to Battery and Load shall be through cable/bus-bars as per users requirement. However, for inter-rack connections, cables of proper rating are permitted.

8.2.2.8 ~~There shall be~~ P~~p~~rovision shall be made for interconnection between telecom equipment, Hybrid or standalone CCUs ~~Charge controller~~ and batteries~~y~~ and including necessary ~~also between SMPS Telecom equipment and battery (along with~~ switching arrangement~~).~~ . Additionally, appropriate terminations for telecom equipment, batteries, and Hybrid or Standalone CCUs shall be provided.~~The terminations for Exchange and battery shall be made in SMPS as well as charge controller. Provision for termination of FR/FCs in SMPS shall be made.~~ The isolation of any of the battery from the load shall create an alarm.

8.2.2.9 All the AC, DC Control & alarm cabling shall be supplied with the rack.

8.3 **Mounting of Component and Layout** : Component mounting and fixing methods shall be secured.

Suitable mechanical structure/ arrangement for holding modules in position shall be provided so that the module is held firmly by sliding through it.

8.4 **Bus Bars:** Tinned Bus-bars or tinned High conductive electrolytic copper strips with purity of 99.90% (min) as per BIS 613 latest issue, be able to withstand maximum Load current. The Bus-bar shall be capable to carry current density of 2 Amps/mm~~ square but shall not be less than 25mmX5mm in any case~~. Nuts & bolts shall be of stainless steel with tinned copper washers only. The size of bus-bars chosen for battery and load path shall be capable to take care of the current of maximum power plant capacity for which it is designed. The Bus-bar/cable size shall also ensure that the voltage drop between the output of the farthest FR/FC module riser and also between battery and exchange riser, as per the layout drawing shall be less than 500mV. The tinning shall be in compliance of IS 1359 : 1992 and its thickness shall be 10 μm (minimum).~~10 · 0 minimum).~~

~~8.4.1 Bus-bar Riser height wherever applicable shall be 250 mm for both exchange and battery. Hhowever purchaser may decide on actual height.~~

8.5 **Cabling and Wiring :** All insulated conductors except those within the confines of a printed circuit board assembly shall be of the rating enough to withstand the maximum current and voltage during fault and overload. All the wires and cables used shall be fire retardant as per IS 1554 with amendment 1 (June 94). All the cables & wires used shall also be Rodent & reptiles repellent. Uninyvin cables are also allowed to use in system. All wiring ~~It~~ shall be neatly secured in position and adequately supported. Where wires pass through any part of metal panel or cover the hole through which they pass shall be suitably bushed.

~~8.6~~ Meters: ~~There shall be provision to monitor the voltage and current of the system as given below :~~

8.6

For Hybrid CCU & Standalone CCU,~~In Charge Controller,~~ there shall be a provision to monitor DC current as well as voltage of the System, any of the Battery, SPV array and that of the load with the help of Digital panel meter or LCD. In addition, provision shall also be made for Hybrid CCU to monitor AC voltage of the system and DC current as well as voltage with the help of Digital meters to read the voltage and current of the system, any of the battery or any of the individual FR/FC (at individual FR/FC module also permitted). Digital meter's display/resolution should be such that it is clearly and unambiguously readable from a distance of 1 metre. Normally the meters shall indicate the System voltage and current.

~~In case of SMPS, in addition to the above a provision shall also be made to monitor the AC voltage of the SMPS and individual FR-FC modules. It shall also be able to read the DC voltage and current of the SMPS and individual FR/FC modules (monitoring of current and voltage at individual FR/FC module level is also permitted). Normally the meters mounted at DSCA of the SMPS shall indicate the SMPS voltage~~

~~and current.~~

a. Current: +/- 1.5% of the range or better, shall be able to read up to full digit for meter range 50A & above and 1 place decimal for lower meter range.

b. Voltage: +/- 1.5% of the range or better with a resolution of one decimal point in case of DC voltmeter and full digit in case of AC voltmeters.

All the meters and shunts used for the above shall be CACT approved.

8.7 Dimensions:

Purchasing authority shall clearly specify the height of the rack as per his power room/equipment room requirements.

1. Standalone CCU
2. Hybrid CCU
3. Battery Space required or not

~~8.7.1 **SPV Module/panel/array** : To be specified by the manufacturer.~~

~~8.7.2 **Charge Controller**: The dimensions of the charge controller unit shall be minimum but sufficient to house all the components, including battery, lightning protection section and SMPS(in case of integrated SMPS based Hybrid power supply). It shall take care of the thermal engineering requirements of the unit. Dimensions shall not be changed after Type Approval. The unit/enclosure used shall be IP55 complaint.~~

~~8.7.3 **SMPS**: SMPS rack(in case non-integrated SMPS based Hybrid Power Supply) shall preferably be be 19" (482.6mm) or 19"/2(241.3mm). the maximum dimensions of the rack shall be as given below :~~

~~Height: 1500mm (Maximum)~~

~~Depth: 600mm (maximum.)~~

~~Width: 750mm (maximum)~~

8.8 Earthing: Standalone CCU & Hybrid CCU rack ~~: Proper earthing~~ shall be ~~provided for SPV modules/panels/array, mounting structure, lightning surge protection component and body of charge controller. Charge controller cabinet and SMPS rack shall be~~ provided with ~~two~~ earth terminals (two in each rack), in effective electrical contact with the body of the framework, shall be provided~~cabinet/rack~~. ~~For example; Non- bentonite, graphite based chemical. Copper bonded (min 250micro) steel earthing rod 3m long with UL certified copper bonded rod. However purchaser may decide exact requirement.~~ All metal parts of the components, which do not carry current, shall be bonded thereto. Nominal cross-sectional area of earth continuity conductor, not contained within the cable, shall be half (minimum) of each current carrying conductor to be protected but in no case it shall be less than 3 mm diameter. Continuity conductor used for the purpose shall only be of copper. Suitable terminals shall be provided for terminating earth conductor.

8.9 Marking and Labelling : ~~The~~ It shall be possible to locate each component on the PCB with the help of layout and circuit drawing. All terminals ~~of the module/panel, battery,~~

~~Charge Controller, components of the charge controller and terminals and components of SMPS,~~ shall be properly sign written and all components properly labelled so that it shall be easy to identify them ~~to enable identification of each of them~~ with reference to the supplier's instruction and installation manual. Designation of keys, switches and other components mounted on the front/inside panel and other operating positions shall clearly engraved~~screen printed~~ or sign-written. Wiring shall be clearly & permanently identified with designation or a colour code which corresponds to circuit diagram. Where non-standard colours are used, cable functions shall be clearly & permanently labelled at both ends.

8.9.1 Fuse holder identification shall include details of fuse rating & type.

8.10 Circuit & Cabling Diagram: A cabling diagram, ~~A~~ screen printed, or any other better arrangement ensuring better life expectancy~~circuit and cabling diagram, of Charge Controller and SMPS~~ shall be placed~~provided in the charge controller/SMPS. Interconnection diagram of the modules of the panels on SPV module/panels and FR-FC modules in SMPS shall also be provided for~~ ready reference of the maintenance staff.

8.11 **Danger Label:** There shall be a clear demarcation between the AC to DC converter unit and other components of the Charge controller. A Proper "Danger" warning shall be fixed on AC to DC conversion unit.

8.12 Finish & Painting:

~~a. Corrosion Resistance : All surfaces of the equipment including frameworks, modules, covers, chassis, brackets, etc shall be treated to prevent corrosion, and the type of finish used shall be stated.~~

~~b. Mould Growth : Materials used in the equipment shall not support mould growth to the extent detrimental to the normal operating performance of the equipment.~~

~~c. Whisker Growth : Precautions shall be taken to ensure that metallic surface plating shall not cause "whisker growth" which may hinder normal operating performance of the equipment.~~

~~d.~~a. **Finish** : The finish of the structure and panels ~~charge controller~~ shall conform to the latest issue of IS 101 and IS 168. The thickness of powder coating shall be between 60 to 100 Micron for indoor rack and 80 to 120 Micron for outdoor rack. The Colour used shall conform to IS 5 latest issue.~~BIS 5~~. The Colour using powder coating painting shall be as follows :

~~Outside except front panel~~Rack & Door - Satin Blue, No. 177

~~Inside and front panel.~~Modules and inside - Shall harmoniously match the outside Colour

Outdoor Rack: - Light Grey (RAL7035)

8.13 Name Plate ~~: A name plate, anodised shall be suitably fixed to the modules(inside the glass), mounting structure and charge controller~~ ~~with the following details.~~

Name Plate for SPV Panel and Mounting Structure :

i) GR number

ii) Name of the User :

iii) Manufacturer's name and identification mark

iv) Name of the Item

v) Model No.

vi) Serial No. of the unit

vii) Year of manufacture

viii) TAC No.

Note: Anodised GR number and Name of the user may be provided on the back of the module frame.

~~xii) Battery impedance of the fully charged, 80% discharged and fully discharged condition.~~

~~xiii) Date on which the freshening charge was given to the battery before dispatch.~~

~~xiv) Due date for the freshening charge.~~

~~xv) Voltage at 80% DOD.~~

~~xvi) Input voltage (Hybrid systems only)~~

~~Output Voltage and Current~~Name Plate for Charge Controller and SMPS unit/rack :

1. Specification Number:
2. Type of the Unit:
3. Manufacturer's name and identification:
4. Model No.:
5. Unit Serial No.:
6. TAC No.:
7. Input voltage and phase (SMPS):
8. Output Voltage and Current (SMPS):
9. Year of manufacture:
10. Rating and Output voltage of the charge controller (MPPT) :
11. Input Voltage of charge controller (MPPT):

~~xvii)~~ 12. Battery Capacity and voltage

8.13.1 On the front top of the Charge controller cabinet and SMPS rack~~unit~~ an anodised, screen printed or any other arrangement ensuring batter life expectancy designation plate in 'BOLD' letters showing " 1 12V/…W or 24 V /…KW or 48V/….KW SPV~~2V/24V/48V STANDALONE/HYBRID~~ POWER

SUPPLY TELECOM EQUIPMENT WITH 12V OR 48V/ …. A SMPS USING …A FR/FC MODULE~~FOR Wi Fi TERMINALS & OTHER SIMILAR TELECOM TERMINALS~~ ”

shall be provided~~.~~
as per the power supply specification

CHAPTER-2

9.0 Information for the procurer of product

(Purchaser should specify the exact requirements against the purchaser guidelines before initiating the procurement process.)

This chapter describes the requirements which may be included in the tender by the purchaser as per its needs. The following items need to be specified by ordering authority depending upon the actual requirements:

9.1 **Guarantee** : The manufacturer shall be responsible for replacing free of charge, any components of the units if they become faulty due to any reason (except due to wrong handling) within a period of 24 months from the date of dispatch or 12 months from the date of commissioning of the system into actual service whichever is earlier.

9.2 **Packing** : Packing and transportation of solar panels, Charge Controller, SMPS, Battery and Mounting Structure shall be made such that the equipment is not damaged, while transporting, loading and unloading. The packing of all the above items shall be done separately as per the latest version of QA manuals issued by QA.

9.3 **Documentation** : T~~wo copies of t~~echnical literature in English ~~and Hindi~~ with complete layout, detailed block schematic and circuit diagrams of its assemblies with test voltages at different test points of the units shall be provided~~.~~ in hard copy. Additionally, a ~~A~~ soft copy QR code on the system in respect of technical literature ~~as well as a hard copy of the above~~ shall also be provided both in Hindi and English. All aspects of installation, operation, maintenance, trouble shooting and repair shall be covered in this manual. The manual shall also include the following :

a) **Installation, Operation and Maintenance manual part shall include:**

i) Detailed structural drawing of mounting structure, charge controller, modules & panels.

ii) The detailed circuit, schematic, PC card layouts of each unit & detailed interconnecting diagram between the various units of the system.

iii) The details of testing and adjustment procedure.

iv) Initial checks on receipt at site.

v) Detailed installation, commissioning and maintenance procedure.

vi) Proposed routine maintenance tests, Actual tests results obtained.

vii) Required Test Jigs and fixtures.

viii) Typical "I -V" curves at 25 deg C with the formula of interpolation shall be provided in the Instruction & Maintenance manual. Circuit description & working of DSCA. Circuit description and working of FR/FC module at various stages staring from AC mains input to the DC output with Block Schematic.

ix) A Table giving details of size/dimension of maintenance of cables used in the design.

x) Earthing Guide lines for the Power unit as per BIS Specification.

b) Repair manual :

i) List of replaceable parts used with the source of procurement.

ii) Detailed ordering information for all replaceable parts for ordering of spares as and when required.

iii) Procedure with flowchart for trouble shooting and sub-assembly replacement.

iv) Test Instruments, Test fixtures, accessories and tools required for maintenance and repair.

v) Systematic trouble shooting charts (fault tree) for probable faults and their remedial action..

vi) Address and telephone numbers of Maintenance centre.

9.4 Hard copy of the documentation shall be prepared using good quality paper with clear and crisp printing. All the drawings in clear printing shall be attached to the hand-book binding. The binding of the manual shall be long lasting and presentable. One set of flow chart drawings necessary for trouble-shooting shall be provided with lamination, with each manual.

(i) If the product has various categories it may be explained here that the applicant can offer any of the category of the product.

(ii) If any or all categories of the product have multiple interfaces, out of which some interfaces are optional, it may be explained here that testing will be done with mandatory interfaces, however, the optional interfaces will also be tested if offered.

(iii) Accordingly, the tariff categories shall be mentioned in the Information sheet.

9.5 It is preferable that AR Coated tempered textured toughened Glasses should be used while manufacturing solar Modules to improve the efficiency of Module(Remark: It has the characteristics of high transmission ratio and high reflectance thus improves the efficiency of Module by 2%-2.5%.)

9.6 It is preferable that screw less frame for design for a long term durability & corrosion resistance.

9.7 It is preferable that Silicon Sealant for increases the life of Modules.

9.8 For manufacturing of Solar PV Module, the solar cells are used. While manufacturing of solar Modules, the incoming solar cells must be checked with EL Tester (Electro Luminance) to avoid micro crack on solar cells level to check as well on Solar Module Level to avoid failure of Solar Module in the field.

9.9 If desired by Purchaser/User, The unit shall include controller unit for SPV power, FC, Lightning Surge Protection Device and Battery shall be mounted in IP66 FRP enclosure suitable for outdoor mounting with an impact level of IK 10. Therefore, usage of IP66 enclosure is suitable for outdoor usage and IK 10 will ensure the mechanical strength of the enclosure.

9.10 Battery Capacity (refer clause 2.1.3 of this document)

9.11 Mounting structure (refer clause 8.1.12 of this document)

9.12 Necessary instructions shall have to be issued by the ordering authority to all concerned that the battery that is to be used with these SPV Power supplies shall be charged fully before sending the same to the site, since it will not be possible to charge the battery, first time, to its full capacity through the SPV Panel.

9.13 It is suggested that while deciding on the system type and the battery capacity , the calculations should be made considering the worst case i.e assuming there is practically no commercial AC available and the autonomy may be taken as at least 3 days and preferably 6 days.

9.14 If desired by Purchaser/User, the SMPS/CCU may have galvanic isolation in addition to MPPT features to protect the Telecom Load from any potential hazards owing to short circuits at the primary levels. The telecom equipment should never be allowed to get exposed to the un-isolated source of power.

9.15 The exact mounting mechanism shall have to be decided upon and specified by the ordering authority, as per the actual requirement at the site of installation ,and the same shall be mentioned in the purchase order (refer Ordering information of this document).

9.16 The minimum height of the mast/pole from the ground, if used, shall be site specific and shall be decided by user/purchaser.

9.17 If required by Purchaser/User, the solar charge controller shall be based on MPPT technology which can charge battery from Solar panels arrays of higher/lower voltage. It should convert higher voltage into current or vice- versa so that more energy can be harvested from same Solar panels. However, higher voltage thus generated shall not be hazardous and all possible protection arrangement as per IEC 60950-1{2005} shall be made from safety point of view

9.18 If desired by Purchaser/User, the advantages of PWM control techniques may be taken.

9.19 If desired by Purchaser/User, the SMPS/CCU may have galvanic isolation in addition to MPPT features to protect the Telecom Load from any potential hazards owing to short circuits at the primary levels. The telecom equipment should never be allowed to get exposed to the un-isolated source of power.

9.20 The exact mounting mechanism shall have to be decided upon and specified by the ordering authority, as per the actual requirement at the site of installation ,and the same shall be mentioned in the purchase order (refer Ordering information of this document).

9.21 The minimum height of the mast/pole from the ground, if used, shall be site specific and shall be decided by user/purchaser.

~~9.22~~ SPV Power supply Requirement: Hybrid (With SMPS) or Standalone (without

9.22 SMPS)

9.23 SPV Power supply Voltage rating: 12V/24V/48V

9.24 Charge controller ratings: -

a) 12V/100W Charge controller
b) 12V/200W Charge controller
c) 12V/400W Charge controller
d) 48V/100W Charge controller

e) 48V/ 200W charge controller

f) 48V/ 200W charge controller

g) 48V/ 500W charge controller

h) 48V/ 1KW charge controller

i) 48V/ 2KW charge controller

j) 48V/ 4KW charge controller

k) 24V/ 500W charge controller

l) 24V/ 1KW charge controller

m) 24V/ 2KW charge controller

9.25 SMPS Rating:

Capacity:

12V/12.5A or 12V/18.75A or 48V/12.5A or 48V/18.75A or 48V/50A;

FR/FC Module Rating: 12V/6.25A or 12V/12.5A or 48V/6.25A or 48V/12.5A or 48V/25A

9.26 SPV Module Rating: 12V/50Wp to 12V/300Wp and 24V/125Wp to 24V/300Wp 24V/250Wp to 24V/550 Wp and above. However, purchaser may specify '300Wp or higher' as per the requirement.

~~9.27~~ Battery Capacity as per ultimate load (refer clause 1.4 of this document).
9.27

9.28 Number of basic modules required for the present load.

9.29 Type of mounting structure for SPV panel array required.

9.30 Necessary instructions shall have to be issued by the ordering authority to all concerned that the battery that is to be used with these SPV Power supplies shall be charged fully before sending the same to the site, since it will not be possible to charge the battery, first time, to its full capacity through the SPV Panel.

9.31 It is suggested that while deciding on the type of the system and the battery capacity, the calculations (as per annexure 4) shall be made for ultimate load and the autonomy 3 days minimum.

~~9.32~~ Purchaser may specify ‘300Wp or higher’ as per the requirement. (Clause 2.1.1).

9.32

9.33 If required by purchaser, for a 48V equipment, less than four or four or more than four(in case of MPPT based CCU)12V SPV modules may be connected in series to form a 48V SPV panel and less than two or two or more than two(in case of MPPT based CCU) 24V modules (for standalone application only) may be connected in series to form a 48V SPV panel. However, higher voltage thus generated shall not be hazardous and all possible protection arrangement shall be made from safety point of view. (Clause 2.1.1).

9.34 Putting the charge controller and battery in same enclosure may reduce life and performance of charge controller. There should be adequate arrangement such that the rise in the temperature of one unit should not impact the temperature of the other. If purchaser requires the charge controller and battery may be kept in separate enclosures.

~~9.35~~ Purchaser may specify overall redundancy for the power supply including the Charge controller & SMPS(clause 2.2.2 B).

9.35

~~9.36 **Battery Bank:** If required by the purchaser, Battery cabinet may have physical security system in place. Security system may be battery operated/AC powered for:~~

~~(i) Need based access control ensuring authorized personnel to have access when required.~~

~~(ii) Thermal management that ensures controlled fans and can be connected to a fire suppression system.~~

~~(iii) Complete data and audit trail to understand all operations about the site and door status.~~

~~(iv) Online/offline communication.~~

~~(clause 2.1.4)~~

~~9.37~~ Purchaser may specify efficiency to be 85% for 12V system depending upon the cost effectiveness of the power supply. (clause 3.3.4).

9.36

~~9.38~~9.37 Purchaser shall clearly indicate the requirement of battery health check feature while ordering the power plant.(clause 3.6).

~~9.39~~9.38 The Power Plant shall operate from single phase AC mains supply 230 V with variation in the range of +10% and -15% and frequency as 50 Hz +/-2Hz. However keeping in view of specific requirement for rural area, purchaser may specify the requirement as special case as: The Power

Plant shall operate from single phase AC mains supply 230 V with variation from 170 to 260 V and frequency as 50 Hz +/-2Hz.(clause 3.7.1, 3.16.2 & 3.23.1).

~~9.40~~9.39 RS 485/Ethernet communication cable of suitable length (**to be decided by purchaser**) shall be protected with surge protection devices to be mounted on both side of the cable. SPD shall have surge discharge current capacity of 10KA (8/20 μsec) and lightening discharge current capacity of equal or more than 0.5 KA per line (10/350 μsec).(clause 3.3.1.8)

~~9.41~~9.40 If required by the purchaser, provisioning of an integrated internal by-pass SPV-DC fuse or external series fuse or external disconnector ~~(Refer EN 50539-11 &12/IEC 60634-7-712)~~ connected in +ve & -ve strings may be specified so that SPD~~(Type I & II)~~ can extinguish the DC arc safely. (clause 5.5.2).

~~9.42~~9.41 Purchaser may specify thickness/gauge of metal sheet to be less than 2mm for lower weight system, but quality and strength of the rack shall be ensured.(clause 8.1.1).

~~9.43~~9.42 For smaller standalone systems, to prevent, the misuse of battery there shall be a provision for mounting the battery inside the charge controller, away from the heat generating components, if any. In such cases a provision of locking the charge controller which can be opened by a key or proper tool shall be made. However terminations for SPV power and Load with proper protection against accidental touch shall be accessible without opening the charge controller unit. If the above arrangement is not feasible due to large battery size the battery terminals shall be so designed to avoid its misuse.

~~9.44~~9.43 Bus-bar Riser height wherever applicable shall be 250 mm for both exchange and battery. however purchaser may decide on actual height.(clause 8.4.1)

~~9.45~~9.44 Earthing: For example; Non-bentonite, graphite based chemical. Copper bonded (min 250micro) steel earthing rod 3m long with UL certified copper bonded rod. However purchaser may decide exact requirement.(clause 8.8)

~~9.46~~9.45 If required purchaser may reduce the wind speed requirement depending upon geographical condition of the site.(clause 8.13.4).

~~9.47~~9.46 If desired by Purchaser/User, the SMPS/CCU may have galvanic isolation in addition to MPPT features to protect the Telecom Load from any potential hazards owing to short circuits at the primary levels. The telecom equipment should never be allowed to get exposed to the un-isolated source of power.

~~9.48~~9.47 The minimum height of the mast/pole from the ground, if used, shall be site specific and shall be decided by user/purchaser.

9.48 All functional parameter for SMPS FR/FC has been taken from GR 'SMPS based Power Plants' No. TEC 66110:2025~~TEC/GR/FLA/SMP-001/06/June.2010~~. Purchaser shall ensure latest version of said GR and may specify updated parameter before initiating the procurement procedure.

9.49 The following batteries shall be suitable for SPV applications:

(i) The battery shall be 48V (24 cell) or 12V (6 cells) VRLA type (deep-cyclic) i.e. slow rate of charge and discharge conforming to TEC 67010:2011(Old TEC GR TEC/GR/TX/BAT - 001/04.JUNE.2011 with amendments), if any.

OR

(ii) The battery shall be 48V (24 cell) or 12V (6 cells) Tubular VRLA based on GEL technology (deep-cyclic), conforming to TEC 67020:2011 (TEC GR No. TEC/GR/TX/BAT - 003/02.MAR.2011) with amendments, if any.

OR

(iii) The battery shall be 48V or 12V Li-ion type (deep-cyclic) conforming to TEC GR: TEC 67030:2024 (Old No. TEC/GR/TX/Li-ion - 001/01.MAR.2016) with amendments, if any.

~~9.49~~ (iv) For 24 V (Standalone Application only), the batteries mentioned above in (i) or (ii) or (iii) of required capacity may be used.

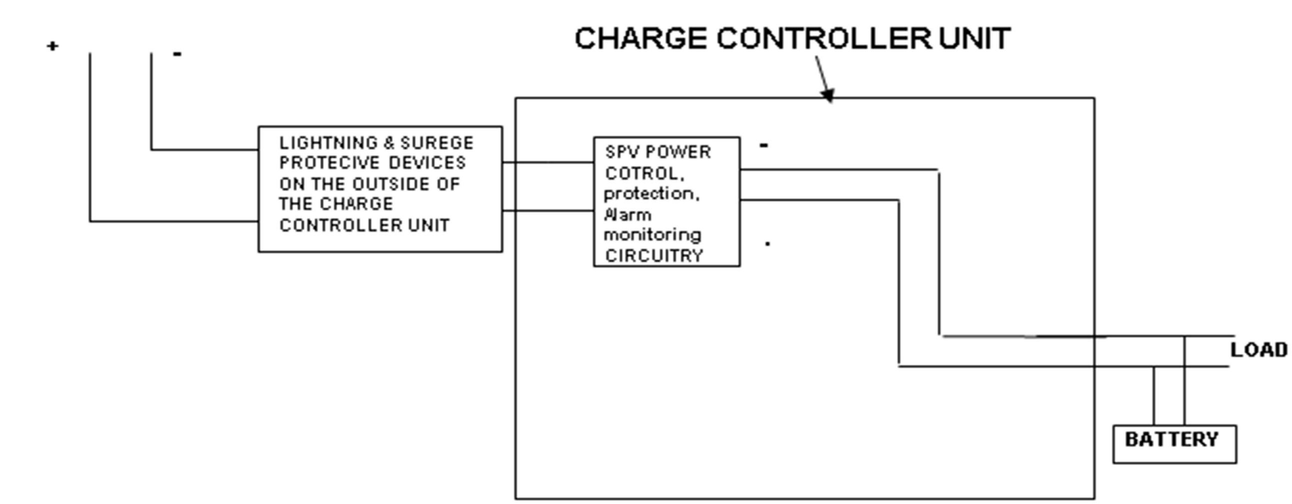
Note: The ordering authority shall issue instructions to all concerned so as to ensure that the battery is fully charged before its dispatch to the site.

~~9.51 Some of the requirements mentioned in this document are to be decidedthe Purchaser as mentioned in the respective clauses. Purchaser/Procurer shall specify their requirements in those clauses.~~

9.51 The FR/FC module shall either be cooled by natural convection or by forced cooling. Manufacturers should decide the cooling method of FR/FC modules based upon their design topology or cooling requirements if the purchaser as not mentioned any specific cooling requirement.

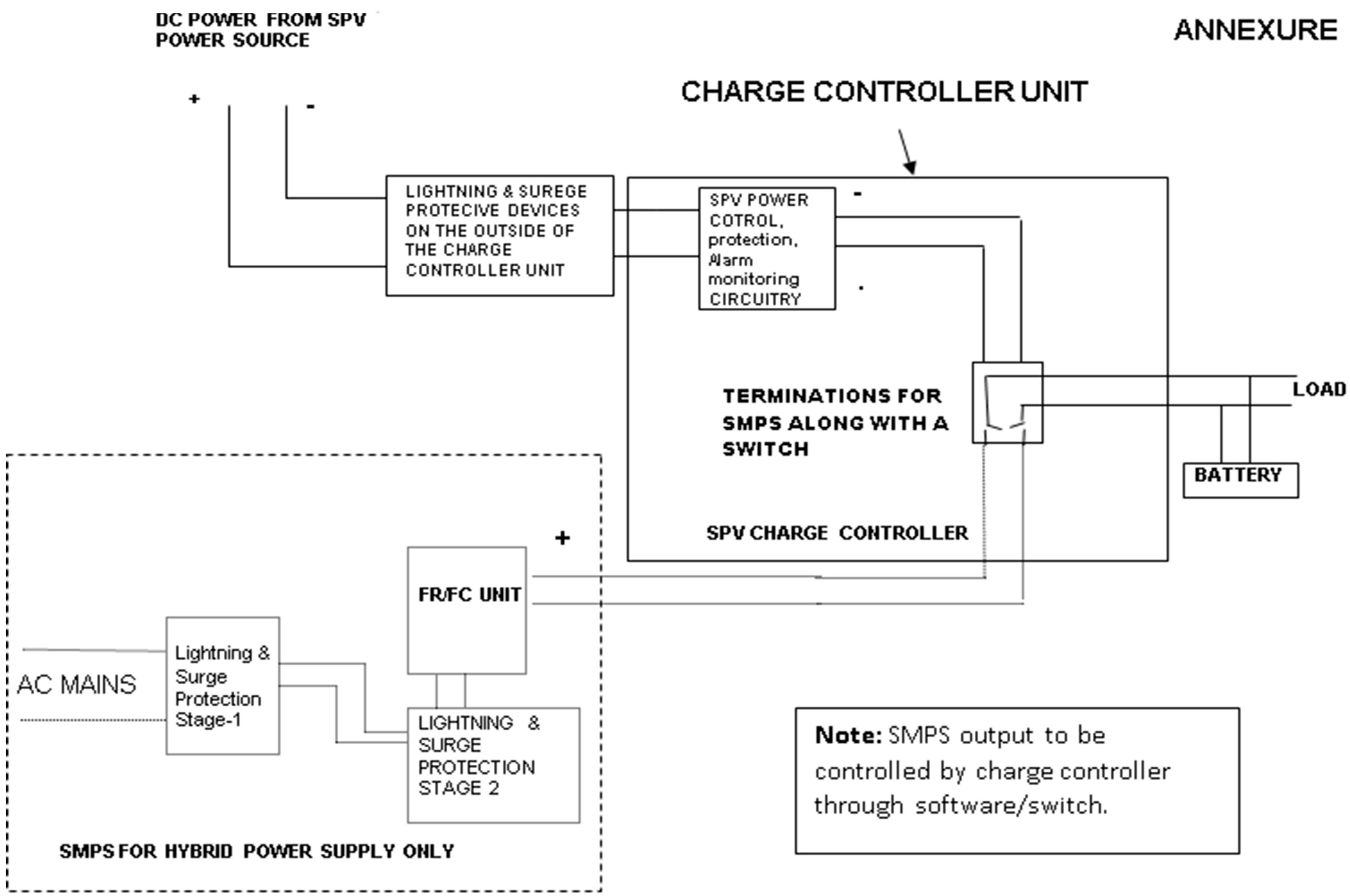
9.52~~1~~ Some of the requirements mentioned in this document are to be decided by the Purchaser as mentioned in the respective clauses. The Purchaser/Procurer shall specify their requirements in those clauses.

ANNEXURE 1



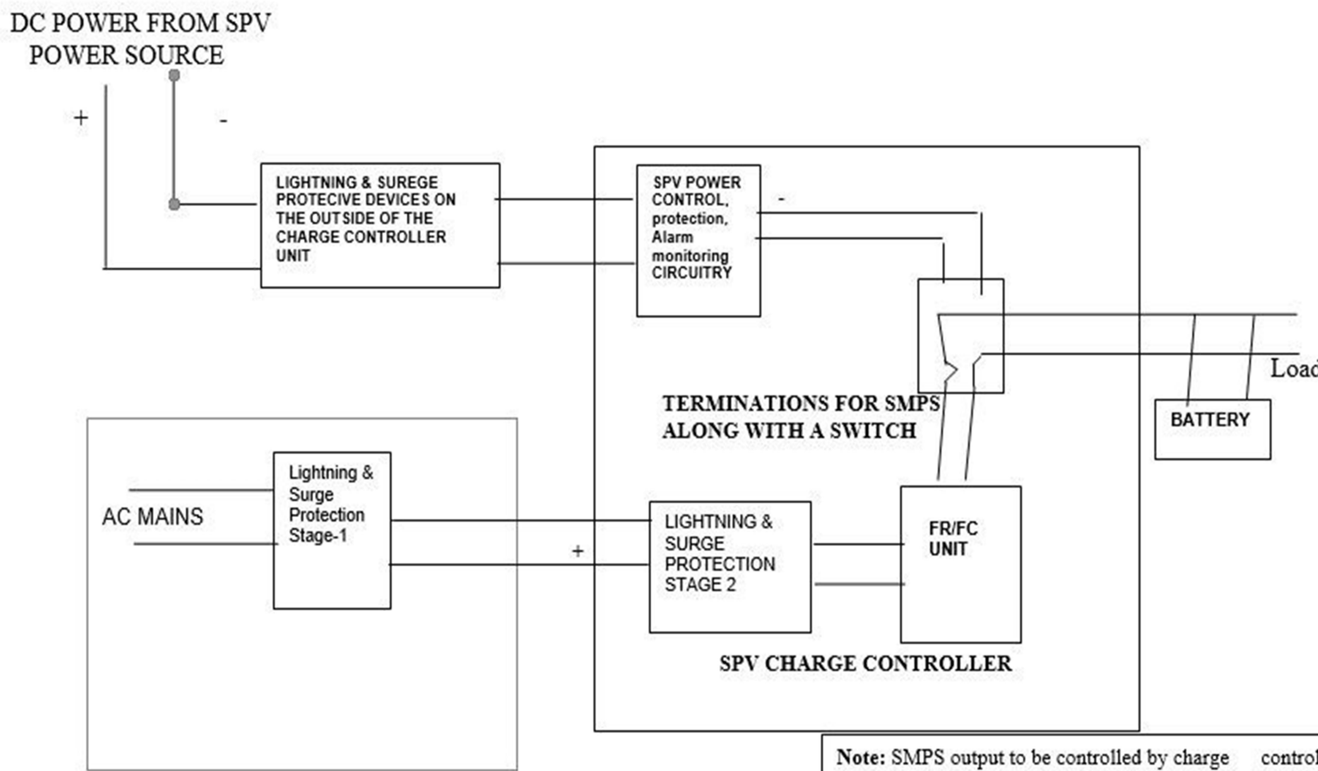
BLOCK SCHEMATIC FOR SPV BASED POWER SUPPLY(STANDALONE MODE) FOR Wi Fi TERMINAL AND OTHER SIMILAR TELECOM TERMINALS

ANNEXURE 2a



BLOCK SCHEMATIC FOR SPV BASED HYBRID POWER SUPPLY(NON-INTEGRATED SMPS)FOR Wi Fi TERMINALS AND OTHER SIMILAR TELECOM TERMINALS

ANNEXURE 2b



Note: SMPS output to be controlled by charge controller through software / switch.

BLOCK SCHEMATIC FOR SPV BASED HYBRID POWER SUPPLY(INTEGRATED SMPS)FOR Wi Fi TERMINALS AND OTHER SIMILAR TELECOM TERMINALS

ANNEXURE - 3

SNMP and RS232/RS485 Modbus Communication Specifications for sequence of Exchange of information between hybrid SPV Power system & Remote Site monitoring equipment shall be as given in TEC GR 66110:2025 or latest.~~**Protocol or Sequence of Exchange of Information between Power plant & Remote Site monitoring equipment**~~

~~RS 485 (4 wire) interface at speed 19.2Kbps (minimum) shall be used for both monitoring & control between power plants and Remote site (First level) of monitoring & control. The protocol shall be as given below ;~~

- ~~First four bytes as starting or hand shake bites (includes identifications etc.)~~
- ~~5th Byte for equipment Identification (Power plant battery, Inverter etc.)~~
- ~~6th Byte for Class of parameter (Alarms urgent, alarms non-urgent, Monitoring etc.)~~
- ~~7th ,8th and 9th Bytes for the parameter observation/medications :~~

~~Equipment side will send parameter code (same that on Master side) along with desired information.~~

- ~~10th and 11th for checksum for parity on both sides in communication.~~

~~The exchange of information between the Remote site controller and the power equipment shall on 4 wire RS 485 bus. All the eleven bytes shall be sent as a packet for exchange of information.~~

~~In this concept Remote site equipment shall work as a Master and power equipment as slave in the Master slave concept. In this concept:~~

- ~~The master will send all the above 11 bytes containing the information for each byte as given above..~~
- ~~Power Equipment after verify the correctness of the data will send back the desired information in the same pattern as given above with bytes 7 to 9 shall contain the desired information and 10th 11th the checksum number.~~
- ~~In case of mismatch, power equipment or remote controller will send a fixed anomaly signal.~~
- ~~On receipt of mismatch the previous data will again be offered by the concerned end.~~
- ~~In case of acknowledgement (desired information or next information) the concerned end will put-up the next information.~~

~~Each byte information in HEX shall be as detailed below:~~

~~5th Byte: Equipment Designation~~

~~Equipment Designation~~	~~Hex Code~~	
	~~From Master~~	~~From Slave Equipment~~
~~Power Plants(AC-DC Converters) (sixteen Max.)~~	~~00 to~~	~~00 to~~

	~~0F~~	~~0F~~
~~VRLA Battery Bank (Maximum sixteen)~~	~~10 to 1F~~	~~10 to 1F~~
~~Li-Ion Battery Module (Maximum sixteen)~~	~~20 to 2F~~	~~20 to 2F~~

~~6th Byte: Classification of Information~~

~~Class of Parameter~~	~~Hex Code~~	
	~~From Ma~~	~~From S~~

	~~ster~~	~~lave Equipment~~
~~Alarms Urgent~~	~~01~~	~~01~~
~~Alarms Non-urgent~~	~~02~~	~~02~~
~~Monitoring of Parameters~~	~~03~~	~~03~~
~~Parameter Control~~	~~04~~	~~04~~
~~System Details~~	~~05~~	~~05~~
~~Any other information~~	~~06 te~~	~~06 te~~

	~~FF~~	~~FF~~

~~7th to 9th Byte : Parameter name :~~

~~a) Power Plant (5th byte : 00 to 0F)~~

~~i) Alarms Urgent (6th byte : 01)~~

~~Parameter Name~~	~~Hex Code~~	
	~~From Master~~	~~From Slave Equipm~~

		~~ent~~
~~Mains "ON"/Battery Discharging – Any reason for failure of Power plant to deliver the output (including AC input contactor failure)~~	~~01, 00, 00~~	~~01, 00: OK 01, 02,~~

		~~00:FAULT~~
~~System Over Load~~	~~02,00,00~~	~~02,01,00:OK02,~~

		~~02, 00: FAULT~~
~~Load Voltage High~~	~~03, 00, 00~~	~~03, 01, 00: OK~~

		~~03, 02, 00: FAULT~~
~~Load Voltage Low~~	~~Same sequen~~	~~Same sequen~~

	~~ce~~	~~ce~~
~~Fan Fail – Rack~~	~~Same sequence~~	~~Same sequence~~
~~Battery 1 : Temp. Compensation fail~~	~~Same sequence~~	~~Same sequence~~
~~Battery 2 : Temp.~~	~~S~~	~~S~~

~~Compensation fail~~	~~ame sequence~~	~~ame sequence~~
	~~Same sequence~~	~~Same sequence~~
~~Battery 5 : Temp. Compensation fail~~	~~Same~~	~~Same~~

	~~sequence~~	~~sequence~~
~~Battery 1 Fail OR No Battery~~	~~Same sequence~~	~~Same sequence~~
~~Battery 2 Fail OR No Battery~~	~~Same se~~	~~Same se~~

	~~quence~~	~~quence~~
	~~Same sequence~~	~~Same sequence~~
~~Battery 5 Fail OR No Battery~~	~~Same seque~~	~~Same seque~~

	~~nce~~	~~nce~~

~~ii) Alarms Non-Urgent (Sixth Byte: 02)~~

~~Parameter Name~~	~~Hex Code~~	
	~~From Master~~	~~From Slave Equipment~~
~~Mains High~~	~~01~~	~~01~~

	,00,00	,01,00:OK01,02,00:FA

		~~U~~ ~~L~~ ~~T~~
~~Mains Low~~	~~0~~ ~~2~~ ~~,~~ ~~0~~ ~~0~~ ~~,~~ ~~0~~ ~~0~~	~~0~~ ~~2~~ ~~,~~ ~~0~~ ~~1~~ ~~,~~ ~~0~~ ~~0~~ ~~:~~ ~~O~~ ~~K~~ ~~0~~ ~~2~~ ~~,~~ ~~0~~ ~~2~~ ~~,~~ ~~0~~ ~~0~~

		~~: FAULT~~
~~FR/FC 1 – Over Voltage~~	~~03, 00, 00~~	~~03, 01, 00 : OK 03, 0~~

		~~2; 00: FAULT~~
~~FR/FC 2 Over Voltage~~	~~Same sequence~~	~~Same sequence~~
	~~Sam~~	~~Sam~~

	~~e sequence~~	~~e sequence~~
~~FR/FC 30 –Over Voltage~~	~~Same sequence~~	~~Same sequence~~
~~FR/FC 1 –Under Voltage/Output Fail~~	~~Same s~~	~~Same s~~

	~~equence~~	~~equence~~
~~FR/FC 2 Under Voltage/Output Fail~~	~~Same sequence~~	~~Same sequence~~
	~~Same sequ~~	~~Same sequ~~

	~~ence~~	~~ence~~
~~FR/FC 30 –Under Voltage/Output Fail~~	~~Same sequence~~	~~Same sequence~~
~~FR/FC 1 –Over Load~~	~~Same sequenc~~	~~Same sequenc~~

	~~e~~	~~e~~
~~FR/FC 2 –Over Load~~	~~Same sequence~~	~~Same sequence~~
	~~Same sequence~~	~~Same sequence~~
~~FR/FC 30 –Over Load~~	~~Sa~~	~~Sa~~

	~~me sequence~~	~~me sequence~~
~~Fan Fail – FR/FC 1~~	~~Same sequence~~	~~Same sequence~~
~~Fan Fail – FR/FC 2~~	~~Same s~~	~~Same s~~

	~~equence~~	~~equence~~
	~~Same sequence~~	~~Same sequence~~
~~Fan Fail - FR/FC 30~~	~~Same seque~~	~~Same seque~~

	~~nce~~	~~nce~~
~~FR/FC 1 – Fail~~	~~Same sequence~~	~~Same sequence~~
~~FR/FC 2 – Fail~~	~~Same sequence~~	~~Same sequence~~
	~~S~~	~~S~~

	~~ame sequence~~	~~ame sequence~~
~~FR/FC 30 Fail~~	~~Same sequence~~	~~Same sequence~~
~~Any other Alarm condition~~	~~Same~~	~~Same~~

	~~sequence~~	~~sequence~~

~~iii) Monitoring Parameters (6th byte : 03)~~

~~Parameter Name~~	~~Hex Code~~	
	~~From Master~~	~~From SlaveEquipme~~

		~~n~~ ~~t~~
~~Power plant on Mains/Standby~~	~~0~~ ~~1~~ ~~;~~ ~~0~~ ~~0~~ ~~;~~ ~~0~~ ~~0~~	~~0~~ ~~1~~ ~~;~~ ~~0~~ ~~1~~ ~~;~~ ~~0~~ ~~0~~ ~~:~~ ~~M~~ ~~A~~ ~~I~~ ~~N~~ ~~S~~ ~~0~~ ~~1~~ ~~;~~ ~~0~~ ~~2~~ ~~;~~ ~~0~~

		~~0:STANDBY~~
~~Load on power plant/Battery~~	~~02,00,00~~	~~02,01,00:PowerP~~

		~~lant 02, 02, 00 : Battery~~
~~AC Mains Voltage~~	~~03, 0~~	~~03, V~~

	~~0, 00~~	~~ALUE(H),VALUE(L)~~
~~System Output Voltage~~	~~04, 00, 00~~	~~04, VALUE(H),V~~

		~~ALUE(L)~~
~~System Load~~	~~05,00,00~~	~~05,VALUE(H),VALUE(L)~~
~~FR/FC 1 – Load~~	~~Sa~~	~~Sa~~

	~~me sequence~~	~~me sequence~~
~~FR/FC 2 – Load~~	~~Same sequence~~	~~Same sequence~~
	~~Same s~~	~~Same s~~

	~~equence~~	~~equence~~
~~FR/FC 30 – Load~~	~~Same sequence~~	~~Same sequence~~
~~Battery 1 Path Current~~	~~Same seque~~	~~Same seque~~

	~~nce~~	~~nce~~
~~Battery 2 path current~~	~~Same sequence~~	~~Same sequence~~
	~~Same sequence~~	~~Same sequence~~
~~Battery 5 path Current~~	~~S~~	~~S~~

	~~ame sequence~~	~~ame sequence~~
~~Load sharing performance (%)~~	~~Same sequence~~	~~Same sequence~~
~~Any other Monitoring requirements~~	~~Same~~	~~Same~~

	~~sequence~~	~~sequence~~

~~iv) Parameter Control (Sixth Byte : 04)~~

~~Parameter Name~~	~~Hex Code~~	
	~~From Master~~	~~From Slave Equipment~~
~~Mains High~~	~~01, VALUE(H), VALUE(L)~~	~~01, VALUE (H), VALUE (L)~~
~~Mains Low~~	~~02, VALUE(H), VALUE(L)~~	~~02, VALUE (H), VALUE (L)~~

~~System Over Load (Value)~~	~~03, VALUE(H), VALUE(L)~~	~~03, VALUE (H), VALUE (L)~~
~~System Float Voltage~~	~~04, VALUE(H), VALUE(L)~~	~~04, VALUE (H), VALUE (L)~~
~~System Charge Voltage~~	~~05, VALUE(H), VALUE(L)~~	~~05, VALUE (H), VALUE (L)~~
~~Load Voltage High~~	~~Same sequence~~	~~Same sequence~~
~~Load Voltage Low~~	~~Same sequence~~	~~Same sequence~~
~~Battery 1~~	~~Sam~~	~~Same~~

~~Path Current Limit~~	~~e- sequ ence~~	~~sequen ce~~
~~Battery 2 path current Limit~~	~~Sam e- sequ ence~~	~~Same sequen ce~~
~~------------- ------------- -----------~~	~~Sam e- sequ ence~~	~~Same sequen ce~~
~~Battery 5 path Current Limit~~	~~Sam e- sequ ence~~	~~Same sequen ce~~
~~FR/FC 1 – Float Voltage~~	~~Sam e- sequ ence~~	~~Same sequen ce~~
~~FR/FC 2 – Float Voltage~~	~~Sam e- sequ ence~~	~~Same sequen ce~~
~~------------- ------------- -----------~~	~~Sam e- sequ ence~~	~~Same sequen ce~~
~~FR/FC 30 Float Voltage~~	~~Sam e- sequ~~	~~Same sequen ce~~

	~~ence~~	
~~FR/FC 1 –~~ ~~Charge~~ ~~Voltage~~	~~Sam~~ ~~e~~ ~~sequ~~ ~~ence~~	~~Same~~ ~~sequen~~ ~~ce~~
~~FR/FC 2 –~~ ~~Charge~~ ~~Voltage~~	~~Sam~~ ~~e~~ ~~sequ~~ ~~ence~~	~~Same~~ ~~sequen~~ ~~ce~~
~~------------~~ ~~------------~~ ~~-----------~~	~~Sam~~ ~~e~~ ~~sequ~~ ~~ence~~	~~Same~~ ~~sequen~~ ~~ce~~
~~FR/FC 30~~ ~~Charge~~ ~~Voltage~~	~~Sam~~ ~~e~~ ~~sequ~~ ~~ence~~	~~Same~~ ~~sequen~~ ~~ce~~
~~FR/FC 1 –~~ ~~Over~~ ~~Voltage~~	~~Sam~~ ~~e~~ ~~sequ~~ ~~ence~~	~~Same~~ ~~sequen~~ ~~ce~~
~~FR/FC 2 –~~ ~~Over~~ ~~Voltage~~	~~Sam~~ ~~e~~ ~~sequ~~ ~~ence~~	~~Same~~ ~~sequen~~ ~~ce~~
~~------------~~ ~~------------~~ ~~------------~~ ~~–~~	~~Sam~~ ~~e~~ ~~sequ~~ ~~ence~~	~~Same~~ ~~sequen~~ ~~ce~~
~~FR/FC 30~~	~~Sam~~	~~Same~~

~~-Over Voltage~~	~~e-sequence~~	~~sequence~~
~~FR/FC 1 – Under Voltage~~	~~Same-sequence~~	~~Same sequence~~
~~FR/FC 2 – Under Voltage~~	~~Same-sequence~~	~~Same sequence~~
~~-------------------------------------~~	~~Same-sequence~~	~~Same sequence~~
~~FR/FC 30 -Under Voltage~~	~~Same-sequence~~	~~Same sequence~~
~~FR/FC 1 – Over Load~~	~~Same-sequence~~	~~Same sequence~~
~~FR/FC 2 – Over Load~~	~~Same-sequence~~	~~Same sequence~~
~~------------------------------------~~	~~Same-sequ~~	~~Same sequence~~

	~~ence~~	
~~FR/FC 30 Over Load~~	~~Same sequence~~	~~Same sequence~~
~~Any other parameter to control~~	~~Same sequence~~	~~Same sequence~~

~~Note : 1. If the remote controller wants to check the current setting, it shall send 8th and 9th bytes as 00 00 along with the data of 7th byte as given above, the associated equipment shall return the current value.~~

~~2. If the associated equipment returns the same value as sent by controller it shall be taken as accepted otherwise not accepted and shall be resent after doing the needful.~~

~~v) System details (sixth byte : 05) :~~

~~Parameter Name~~	~~Hex Code~~	
	~~From Master~~	~~From Slave~~

		~~Equipment~~
~~System Make~~	~~May be generated in the remote controller by manual inputting~~	
~~Date of commissioning~~	~~May be generated in the remote controller by manual inputting~~	
~~System Ultimate capacity~~	~~03,00,00~~	~~03, VALUE(H), VAL~~

		~~UE(L)~~
~~System Equipped capacity~~	~~04,00,00~~	~~04,VALUE(H),VALUE(L)~~
~~Number of FR/FCs~~	~~Same sequence~~	~~Same~~

		~~sequence~~
~~Rating of FR/FCs~~	~~Same sequence~~	~~Same sequence~~
~~Number of FR/FC Working~~	~~Same sequence~~	~~Same seq~~

		~~uence~~
~~Number of FR/FC Faulty~~	~~Same sequence~~	~~Same sequence~~
~~Number of batteries connected with the power plant~~	~~Same sequence~~	~~Same sequenc~~

		~~e~~
~~Battery 1 : Make~~	~~May be generated in the remote controller by manual inputting~~	
~~Date of Commissioning~~	~~May be generated in the remote controller by manual inputting~~	
~~AH Capacity~~	~~May be generated in the remote controller by manual inputting~~	
~~Battery 2 : Make~~	~~Same sequence~~	~~Same sequence~~
~~Date of Commissioning~~	~~Same sequence~~	~~Same seq~~

		~~uence~~
~~AH Capacity~~	~~Same sequence~~	~~Same sequence~~
~~-----------~~ ~~-----------~~ ~~-----------~~ -	~~Same sequence~~	~~Same sequen~~

		~~ce~~
~~Battery 5 : Make~~	~~Same sequence~~	~~Same sequence~~
~~Date of commissioning~~	~~Same sequence~~	~~Same sequence~~
~~AH~~	~~Same~~	~~S~~

~~Capacity~~	~~sequence~~	~~ame sequence~~

~~**Note :** In case the above information can not be provided by the associated equipment, same may be generated in the First stage system by manually in putting the data.~~

~~b) Battery Parameters (5th Byte: 10 to 1F):~~

~~i) Alarms Urgent (sixth byte as 01)~~

~~Parameter Name~~	~~Hex Code~~	
	~~From~~	~~From~~

	~~Master~~	~~Slave Equipment~~
~~Battery 1 : Voltage OK/High/LOW~~	~~01;00;00~~	~~01;01;00:~~

		~~OK 01, 02, 00: High 01, 03,~~

		~~00: Low~~
~~Temperature OK/High/Low~~	~~02;00;00~~	~~02;01;00: OK 02;0~~

		~~2, 00: High 02, 03, 00: Low~~

~~Trickle Current OK/High (As per set value)~~	~~03;00;00~~	~~03;01;00:OK03;02;00:H~~

		~~igh~~
~~Battery Current OK/High (As per limit set)~~	~~04;00;00~~	~~04;01;00: OK 04;02;00~~

		~~: High~~
~~Cell 1Failing (Voltage High/ low, conductance out of range low high/ Low, Temp High/low as~~	~~Same sequence~~	~~Same sequence~~
~~compared to other cells)~~		
~~Cell 2 Failing~~	~~Same sequ~~	~~Same sequ~~

	~~ence~~	~~ence~~
	~~Same sequence~~	~~Same sequence~~
~~Cell 24 Failing~~	~~Same sequence~~	~~Same sequence~~

~~Battery 2 : Voltage OK/High/LOW~~	~~Same sequence~~	~~Same sequence~~
~~Temperature OK/High/Low~~	~~Same sequence~~	~~Same sequence~~
~~Trickle Current OK/High (As per set value)~~	~~Same~~	~~Same~~

	~~sequence~~	~~sequence~~
~~Battery Current OK/High (As per limit set)~~	~~Same sequence~~	~~Same sequence~~
~~Cell 1 Failing~~	~~Same seq~~	~~Same seq~~

	~~uence~~	~~uence~~
~~Cell 2 Failing~~	~~Same sequence~~	~~Same sequence~~
	~~Same sequenc~~	~~Same sequenc~~

	~~e~~	~~e~~
~~Cell 24 Failing~~	~~Same sequence~~	~~Same sequence~~
	~~Same sequence~~	~~Same sequence~~
~~Battery 5 : Voltage OK/High/LOW~~	~~Sam~~	~~Sam~~

	~~e sequence~~	~~e sequence~~
~~Temperature OK/High/Low~~	~~Same sequence~~	~~Same sequence~~
~~Trickle Current OK/High (As per set value)~~	~~Same se~~	~~Same se~~

	~~quence~~	~~quence~~
~~Battery Current OK/High (As per limit set)~~	~~Same sequence~~	~~Same sequence~~
~~Cell 1 Failing~~	~~Same sequen~~	~~Same sequen~~

	~~ce~~	~~ce~~
~~Cell 2 Failing~~	~~Same sequence~~	~~Same sequence~~
	~~Same sequence~~	~~Same sequence~~
~~Cell 24 Failing~~	~~Sa~~	~~Sa~~

	~~me sequence~~	~~me sequence~~
~~Any other Alarm Conditions~~	~~Same sequence~~	~~Same sequence~~

~~Note: 1. All the cells which are showing failing tendency during routine observation or during discharge test shall be reported as an Urgent alarm.~~

~~2. There shall be provision to set the battery to discharge for a certain duration, during which the voltage, current and conductance out of range of each cell shall be recorded. Deviation from the bench mark value shall be high lighted as an alarm.~~

~~3. Trickle current during battery float operation shall be observed and high trickle current higher than~~

~~the set threshold shall create an Urgent alarm.~~

~~ii) Alarms Non-Urgent (Sixth Byte as 02)~~

~~Parameter Name~~	~~Hex Code~~	
	~~From Master~~	~~From Slave Equipment~~
~~Battery on discharge~~	~~01, 0~~	~~01, 0~~

	~~0, 00~~	~~1, 00: NO 01, 02, 00: YES~~
~~Any other Alarm condition~~	~~Sam~~	~~Sam~~

	~~e sequence~~	~~e sequence~~

~~iii) Monitoring Parameters (Sixth Byte as 03)~~

~~Parameter Name~~	~~Hex Code~~	
	~~From Master~~	~~From Slave Equipment~~

~~Battery 1 : State of Charge battery (%)~~	~~01; 00; 00~~	~~01, Value (H), Value (L)~~
~~Voltage battery~~	~~02; 00; 00~~	~~02, Value (H), Value (L)~~

~~Voltage - cell1~~	~~03;00;00~~	~~01; Value (H); Value (L)~~
~~Voltage - cell 2~~	~~04;00;00~~	~~01; Value (H); Value (L)~~

	~~Same sequence~~	~~Same sequence~~
~~Voltage cell 24~~	~~Same sequence~~	~~Same sequence~~
~~Temperature Battery~~	~~Same~~	~~Same~~

	~~sequence~~	~~sequence~~
~~Temperature cell1~~	~~Same sequence~~	~~Same sequence~~
~~Temperature cell 2~~	~~Same seq~~	~~Same sequ~~

	~~uence~~	~~ence~~
	~~Same sequence~~	~~Same sequence~~
~~Temperature cell 24~~	~~Same sequence~~	~~Same sequence~~

	e	
~~conductance out of range out of range Battery~~	~~Same sequence~~	~~Same sequence~~
~~Conductance out of range cell1~~	~~Same sequence~~	~~Same sequence~~
~~Conductance out of range cell 2~~	~~Sam~~	~~Sam~~

	~~e sequence~~	~~esequence~~
	~~Same sequence~~	~~Samesequence~~
~~Conductance out of range cell 24~~	~~Same se~~	~~Sameseq~~

	~~quence~~	~~uence~~
~~Battery 2 : State of Charge Battery (%)~~	~~Same sequence~~	~~Same sequence~~
~~Voltage Battery~~	~~Same sequen~~	~~Same sequenc~~

	~~e e~~	~~e~~
~~Voltage – cell1~~	~~Same sequence~~	~~Same sequence~~
~~Voltage – cell 2~~	~~Same sequence~~	~~Same sequence~~
	~~Sa~~	~~Sa~~

	~~me sequence~~	~~mesequence~~
~~Voltage cell 24~~	~~Same sequence~~	~~Samesequence~~
~~Temperature Battery~~	~~Same s~~	~~Samese~~

	~~equence~~	~~quence~~
~~Temperature cell1~~	~~Same sequence~~	~~Same sequence~~
~~Temperature cell 2~~	~~Same seque~~	~~Same sequen~~

	~~nce~~	~~ce~~
	~~Same sequence~~	~~Same sequence~~
~~Temperature cell 24~~	~~Same sequence~~	~~Same sequence~~
~~Conductance out of~~	~~S~~	~~S~~

~~range Battery~~	~~ame sequence~~	~~amesequence~~
~~Conductance out of range cell1~~	~~Same sequence~~	~~Samesequence~~
~~Conductance out of range cell 2~~	~~Same~~	~~Sames~~

	~~sequence~~	~~equence~~
	~~Same sequence~~	~~Same sequence~~
~~Conductance out of range cell 24~~	~~Same sequ~~	~~Same seque~~

	~~ence~~	~~nce~~
	~~Same sequence~~	~~Same sequence~~
~~Battery 5 : State of Charge battery (%)~~	~~Same sequence~~	~~Same sequence~~

~~Voltage battery~~	~~Same sequence~~	~~Same sequence~~
~~Voltage - cell1~~	~~Same sequence~~	~~Same sequence~~
~~Voltage - cell 2~~	~~Same~~	~~Same~~

	~~sequence~~	~~sequence~~
	~~Same sequence~~	~~Same sequence~~
~~Voltage cell 24~~	~~Same seq~~	~~Same sequ~~

	~~uence~~	~~ence~~
~~Temperature Battery~~	~~Same sequence~~	~~Same sequence~~
~~Temperature cell1~~	~~Same sequence~~	~~Same sequence~~

	~~e~~	
~~Temperature cell 2~~	~~Same sequence~~	~~Same sequence~~
	~~Same sequence~~	~~Same sequence~~
~~Temperature cell 24~~	~~Sam~~	~~Sam~~

	~~e sequence~~	~~esequence~~
~~Conductance out of range Battery~~	~~Same sequence~~	~~Same sequence~~
~~Conductance out of range cell1~~	~~Same se~~	~~Same seq~~

	~~quence~~	~~uence~~
~~Conductance out of range cell 2~~	~~Same sequence~~	~~Same sequence~~
	~~Same sequen~~	~~Same sequenc~~

	~~ce~~	~~e~~
~~Conductance out of range cell 24~~	~~Same sequence~~	~~Same sequence~~
~~Any other parameter to be monitored~~	~~Same sequence~~	~~Same sequence~~

~~iv) Parameter Control (Sixth Byte as 04)~~

~~Parameter Name~~	~~Hex Code~~	
	~~From-Master~~	~~From Slave Equipment~~
~~Battery 1 : Trickle current Limit~~	~~01,Value~~	~~01, Valu~~

	~~-(H);Value(L)~~	~~e (H); Value(L)~~
~~Voltage limit for alarm~~	~~02;Value-(H);Va~~	~~02; Value (H);~~

	~~lue(L)~~	~~Value(L)~~
~~Charge Current limit for alarm~~	~~03;Value-(H);Value(L)~~	~~03;Value(H);Value(~~

		~~L)~~
~~Temperature limit for alarm~~	~~Same-sequence~~	~~Same sequence~~
~~Conductance out of range Limit for Alarm~~	~~Same-sequence~~	~~Same sequence~~
~~Cell 1 : Voltage limit~~	~~S~~	~~S~~

~~for alarm~~	~~ame-sequence~~	~~ame sequence~~
~~Cell 2 : Voltage limit for alarm~~	~~Same-sequence~~	~~Same sequence~~
	~~Same~~	~~Same~~

	~~-sequence~~	~~sequence~~
~~Cell 24 : Voltage limit for alarm~~	~~Same-sequence~~	~~Same sequence~~
~~Cell 1 : Temperature limit for Alarm~~	~~Same-se~~	~~Same se~~

	~~quence~~	~~quence~~
~~Cell 2 : Temperature limit for alarm~~	~~Same-sequence~~	~~Same sequence~~
	~~Same-seque~~	~~Same seque~~

	~~nce~~	~~nce~~
~~Cell 24 : Temperature limit for alarm~~	~~Same-sequence~~	~~Same sequence~~
~~Cell 1 : conductance out of range limit for alarm~~	~~Same-sequence~~	~~Same sequence~~

~~Cell 2 : conductance out of range limit for alarm~~	~~Same-sequence~~	~~Same sequence~~
	~~Same-sequence~~	~~Same sequence~~
~~Cell 24 : conductance out of range limit for alarm~~	~~Sam~~	~~Sam~~

	~~e-sequence~~	~~e sequence~~
~~Battery 2 : Trickle current Limit~~	~~Same-sequence~~	~~Same sequence~~
~~Voltage limit for alarm~~	~~Same-s~~	~~Same s~~

	~~equence~~	~~equence~~
~~Charge Current limit for alarm~~	~~Same-sequence~~	~~Same sequence~~
~~Temperature limit for alarm~~	~~Same-sequ~~	~~Same sequ~~

	~~ence~~	~~ence~~
~~conductance out of range Limit for Alarm~~	~~Same-sequence~~	~~Same sequence~~
~~Cell 1 : Voltage limit for alarm~~	~~Same-sequenc~~	~~Same sequenc~~

	~~e~~	~~e~~
~~Cell 2 : Voltage limit for alarm~~	~~Same-sequence~~	~~Same sequence~~
	~~Same-sequence~~	~~Same sequence~~
~~Cell 24 : Voltage limit for alarm~~	~~Sa~~	~~Sa~~

	~~me-sequence~~	~~me sequence~~
~~Cell 1 : Temperature limit for Alarm~~	~~Same-sequence~~	~~Same sequence~~
~~Cell 2 : Temperature limit for alarm~~	~~Same-~~	~~Same~~

	~~sequence~~	~~sequence~~
	~~Same-sequence~~	~~Same sequence~~
~~Cell 24 : Temperature limit for alarm~~	~~Same-seq~~	~~Same seq~~

	~~uence~~	~~uence~~
~~Cell 1 : conductance out of range limit for alarm~~	~~Same-sequence~~	~~Same sequence~~
~~Cell 2 : conductance out of range limit for alarm~~	~~Same-sequen~~	~~Same sequen~~

	~~ce~~	~~ce~~
	~~Same-sequence~~	~~Same sequence~~
~~Cell 24: conductance out of range limit for alarm~~	~~Same-sequence~~	~~Same sequence~~
	~~Sa~~	~~Sa~~

	~~me-sequence~~	~~me sequence~~
~~Battery 5 : Trickle current Limit~~	~~Same-sequence~~	~~Same sequence~~
~~Voltage limit for alarm~~	~~Same-s~~	~~Same s~~

	~~equence~~	~~equence~~
~~Charge Current limit for alarm~~	~~Same-sequence~~	~~Same sequence~~
~~Temperature limit for alarm~~	~~Same-seque~~	~~Same seque~~

	~~nce~~	~~nce~~
~~conductance out of range Limit for Alarm~~	~~Same-sequence~~	~~Same sequence~~
~~Cell 1 : Voltage limit for alarm~~	~~Same-sequence~~	~~Same sequence~~
~~Cell 2 : Voltage~~	~~S~~	~~S~~

~~limit for alarm~~	~~ame-sequence~~	~~ame sequence~~
	~~Same-sequence~~	~~Same sequence~~
~~Cell 24 : Voltage limit for alarm~~	~~Same-~~	~~Same~~

	~~sequence~~	~~sequence~~
~~Cell 1 : Temperature limit for Alarm~~	~~Same-sequence~~	~~Same sequence~~
~~Cell 2 : Temperature limit for alarm~~	~~Same-sequ~~	~~Same sequ~~

	~~ence~~	~~ence~~
	~~Same-sequence~~	~~Same sequence~~
~~Cell 24: Temperature limit for alarm~~	~~Same-sequence~~	~~Same sequence~~

~~Cell 1 : conductance out of range limit for alarm~~	~~Same-sequence~~	~~Same sequence~~
~~Cell 2 : conductance out of range limit for alarm~~	~~Same-sequence~~	~~Same sequence~~
~~-------------------------- ----------------~~	~~Same~~	~~Same~~

	~~-sequence~~	~~sequence~~
~~Cell 24 : conductance out of range limit for alarm~~	~~Same-sequence~~	~~Same sequence~~
~~Any other parameter to set~~	~~Same-seq~~	~~Same seq~~

	~~uence~~	~~uence~~

~~Note: 1. If the remote controller wants to check the current setting, it shall send 8th and 9th bytes as 00 00 along with the data of 7th byte as given above, the associated equipment shall return the current value.~~

~~2. If the associated equipment returns the same value as sent by controller it shall be taken as accepted otherwise not accepted and shall be resent after doing the needful.~~

~~v) System details (Sixth Byte as 05) :~~

~~Parameter Name~~	~~Hex Code~~	
	~~From Master~~	~~From Slave Equi~~

		~~pment~~
~~Number of Batteries in the bank~~	~~01, 00, 00~~	~~01, Value (H), Value (L)~~
~~Battery 1 : Make~~	~~May be generated in the remote controller by manual inputting~~	

~~Date of Commission of battery~~	~~May be generated in the remote controller by manual inputting~~	
~~AH Capacity~~	~~04, 00, 00~~	~~04, Value (H), Value (L)~~
~~Battery 2 : Make~~	~~Same sequence as for Bat. 1~~	~~Same sequence as for Bat. 1~~
~~Date of Commission of battery~~	~~Same sequence as for Bat. 1~~	~~Same sequence as for Bat. 1~~
~~AH Capacity~~	~~Same sequence as for Bat. 1~~	~~Same sequence as for Bat. 1~~
~~------------------------------------~~	~~Same sequence as for Bat. 1~~	~~Same sequence as for Bat. 1~~
~~Battery 5 : Make~~	~~Same sequence as for Bat. 1~~	~~Same sequence as for Bat. 1~~
~~Date of Commission of battery~~	~~Same sequence as for Bat. 1~~	~~Same sequence as for Bat. 1~~
~~AH Capacity~~	~~Same sequence as for Bat. 1~~	~~Same sequence as for Bat. 1~~
~~Any other information~~	~~Same sequence as for Bat. 1~~	~~Same sequence as for Bat. 1~~

~~**Note:** In case the above information can not be provided by the power plant or battery controller the same will be generated in the First stage system.~~

~~c) Li-Ion Battery Module (5th byte : 20 to 2F)~~

~~i) Alarms Urgent (6th byte : 01)~~

~~Parameter Name~~	~~Hex Code~~	
	~~From Master~~	~~From Slave Equipment~~
~~Module 1 Cell Overvoltage Alarm~~	~~10, 00, 00~~	~~10,01,00-OK~~ ~~10,02,00-Alarm~~
~~Module 2 Cell Overvoltage Alarm~~	~~11, 00, 00~~	~~11,01,00-OK~~ ~~11,02,00-Alarm~~
~~———————————————~~	~~Same Sequence~~	~~Same Sequence~~
~~Module 16 Cell Overvoltage Alarm~~	~~1F, 00, 00~~	~~1F,01,00-OK~~ ~~1F,02,00-Alarm~~
~~Module 1 Cell Under Voltage Alarm~~	~~20, 00, 00~~	~~20,01,00-OK~~ ~~20,02,00-Alarm~~
~~———————————————~~	~~Same Sequence~~	~~Same Sequence~~
~~Module 16 Cell Under Voltage Alarm~~	~~2F, 00, 00~~	~~2F,01,00-OK~~ ~~2F,02,00-Alarm~~
~~Module 1 Charge Over Temperature Alarm~~	~~30, 00, 00~~	~~30,01,00-OK~~ ~~30,02,00-Alarm~~
~~———————————————~~	~~Same Sequence~~	~~Same Sequence~~
~~Module 16 Charge Over Temperature Alarm~~	~~3F, 00, 00~~	~~3F,01,00-OK~~ ~~3F,02,00-Alarm~~
~~Module 1 Discharge Over Temperature Alarm~~	~~40, 00, 00~~	~~40,01,00-OK~~ ~~40,02,00-Alarm~~

	~~Same Sequence~~	~~Same Sequence~~
~~Module 16 Discharge Over Temperature Alarm~~	~~4F, 00, 00~~	~~4F,01,00-OK~~ ~~4F,02,00-Alarm~~
~~Module 1 Charge Over Current Level-2 Alarm~~	~~50, 00, 00~~	~~50,01,00-OK~~ ~~50,02,00-Alarm~~
	~~Same Sequence~~	~~Same Sequence~~
~~Module 16 Charge Over Current Level-2 Alarm~~	~~5F, 00, 00~~	~~5F,01,00-OK~~ ~~5F,02,00-Alarm~~
~~Module 1 Discharge Over Current Level-2 Alarm~~	~~60, 00, 00~~	~~60,01,00-OK~~ ~~60,02,00-Alarm~~
	~~Same Sequence~~	~~Same Sequence~~
~~Module 16 Discharge Over Current Level-2 Alarm~~	~~6F, 00, 00~~	~~6F,01,00-OK~~ ~~6F,02,00-Alarm~~
~~Module 1 Total Cell Over Voltage Alarm~~	~~70, 00, 00~~	~~70,01,00-OK~~ ~~70,02,00-Alarm~~
	~~Same Sequence~~	~~Same Sequence~~
~~Module 16 Total Cell Over Voltage Alarm~~	~~7F, 00, 00~~	~~7F,01,00-OK~~ ~~7F,02,00-Alarm~~
~~Module 1 Total Cell Under Voltage Alarm~~	~~80, 00, 00~~	~~80,01,00-OK~~ ~~80,02,00-Alarm~~
	~~Same Sequence~~	~~Same Sequence~~
~~Module 16 Total Cell Under Voltage Alarm~~	~~8F, 00, 00~~	~~8F,01,00-OK~~ ~~8F,02,00-Alarm~~
~~Module 1 Hardware Alarm~~	~~90, 00, 00~~	~~90,01,00-OK~~ ~~90,02,00-Alarm~~
	~~Same Sequence~~	~~Same Sequence~~

~~Module 16 Hardware Alarm~~	~~9F, 00, 00~~	~~9F,01,00-OK~~ ~~9F,02,00-Alarm~~
~~Module 1 Isolated Alarm~~	~~A0, 00, 00~~	~~A0,01,00-OK~~ ~~A0,02,00-Alarm~~
~~————————————————~~	~~Same Sequence~~	~~Same Sequence~~
~~Module 16 Isolated Alarm~~	~~AF, 00, 00~~	~~AF,01,00-OK~~ ~~AF,02,00-Alarm~~
~~Module 1 SOC Low level-2 Alarm~~	~~B0, 00, 00~~	~~B0,01,00-OK~~ ~~B0,02,00-Alarm~~
~~————————————————~~	~~Same Sequence~~	~~Same Sequence~~
~~Module 16 SOC Low level-2 Alarm~~	~~BF, 00, 00~~	~~BF,01,00-OK~~
		~~BF,02,00-Alarm~~
~~Module 1 Ambient Temperature High Alarm~~	~~C0, 00, 00~~	~~C0,01,00-OK~~ ~~C0,02,00-Alarm~~
~~————————————————~~	~~Same Sequence~~	~~Same Sequence~~
~~Module 16 Ambient Temperature High Alarm~~	~~CF, 00, 00~~	~~CF,01,00-OK~~ ~~CF,02,00-Alarm~~
~~Module 1 Ambient Temperature Low Alarm~~	~~D0, 00, 00~~	~~D0,01,00-OK~~ ~~D0,02,00-Alarm~~
~~————————————————~~	~~Same Sequence~~	~~Same Sequence~~
~~Module 16 Ambient Temperature Low Alarm~~	~~DF, 00, 00~~	~~DF,01,00-OK~~ ~~DF,02,00-Alarm~~

~~II) Alarms Non Urgent (6th byte : 02)~~

~~Parameter Name~~	~~Hex Code~~	
	~~From Master~~	~~From Slave Equipment~~

~~Module 1 Charge Over Current Level-1 Alarm~~	~~10, 00, 00~~	~~10,01,00-OK~~ ~~10,02,00-Alarm~~
~~Module 2 Charge Over Current Level-1 Alarm~~	~~11, 00, 00~~	~~11,01,00-OK~~ ~~11,02,00-Alarm~~
~~———————————————~~	~~Same Sequence~~	~~Same Sequence~~
~~Module 16 Charge Over Current Level-1 Alarm~~	~~1F, 00, 00~~	~~1F,01,00-OK~~ ~~1F,02,00-Alarm~~
~~Module 1 Charge Under Temperature Alarm~~	~~20, 00, 00~~	~~20,01,00-OK~~ ~~20,02,00-Alarm~~
~~———————————————~~	~~Same Sequence~~	~~Same Sequence~~
~~Module 16 Charge Under Temperature Alarm~~	~~2F, 00, 00~~	~~2F,01,00-OK~~ ~~2F,02,00-Alarm~~
~~Module 1 Discharge Under Temperature Alarm~~	~~30, 00, 00~~	~~30,01,00-OK~~ ~~30,02,00-Alarm~~
~~———————————————~~	~~Same Sequence~~	~~Same Sequence~~
~~Module 16 Discharge Under Temperature Alarm~~	~~3F, 00, 00~~	~~3F,01,00-OK~~ ~~3F,02,00-Alarm~~
~~Module 1 Discharge Over Current Level-1 Alarm~~	~~40, 00, 00~~	~~40,01,00-OK~~ ~~40,02,00-Alarm~~
~~———————————————~~	~~Same Sequence~~	~~Same Sequence~~
~~Module 16 Discharge Over Current Level-1 Alarm~~	~~4F, 00, 00~~	~~4F,01,00-OK~~ ~~4F,02,00-Alarm~~
~~Module 1 Current Limit Mode Alarm~~	~~50, 00, 00~~	~~50,01,00-OK~~ ~~50,02,00-Alarm~~
~~———————————————~~	~~Same Sequence~~	~~Same Sequence~~
~~Module 16 Current Limit Mode Alarm~~	~~5F, 00, 00~~	~~5F,01,00-OK~~ ~~5F,02,00-Alarm~~

~~Module 1 Cell Unbalanced Alarm~~	~~60, 00, 00~~	~~60,01,00-OK~~ ~~60,02,00-Alarm~~
~~--~~	~~Same Sequence~~	~~Same Sequence~~
~~Module 16 Cell Unbalanced Alarm~~	~~6F, 00, 00~~	~~6F,01,00-OK~~ ~~6F,02,00-Alarm~~
~~Module 1 CBMS Communication Fail Alarm~~	~~70, 00, 00~~	~~70,01,00-OK~~ ~~70,02,00-Alarm~~
~~--~~	~~Same Sequence~~	~~Same Sequence~~
~~Module 16 CBMS Communication Fail Alarm~~	~~7F, 00, 00~~	~~7F,01,00-OK~~ ~~7F,02,00-Alarm~~
~~Module 1 SOC Low Level-1 Alarm~~	~~80, 00, 00~~	~~80,01,00-OK~~ ~~80,02,00-Alarm~~
~~--~~	~~Same Sequence~~	~~Same Sequence~~
~~Module 16 SOC Low Level-1 Alarm~~	~~8F, 00, 00~~	~~8F,01,00-OK~~ ~~8F,02,00-Alarm~~
~~Module 1 Cell Under Voltage Warning~~	~~90, 00, 00~~	~~90,01,00-OK~~ ~~90,02,00-Alarm~~
~~--~~	~~Same Sequence~~	~~Same Sequence~~
~~Module 16 Cell Under Voltage Warning~~	~~9F, 00, 00~~	~~9F,01,00-OK~~ ~~9F,02,00-Alarm~~

~~iii) Monitoring Parameters (6th byte : 03)~~

~~Parameter Name~~	~~Hex Code~~	
	~~From Master~~	~~From Slave Equipment~~
~~Battery Bank instantaneous Capacity~~	~~01,00,00~~	~~01, Value (H), Value (L)~~
~~Total Battery Bank State of Charge~~	~~02,00,00~~	~~02, Value (H), Value (L)~~
~~Battery Bank Estimated Backup time~~	~~03,00,00~~	~~03, Value (H), Value (L)~~
~~Total Battery Bank Current~~	~~04,00,00~~	~~04, Value (H), Value (L)~~
~~Total Battery Bank Current Limit~~	~~05,00,00~~	~~05, Value (H), Value (L)~~
~~Module Max Charge Current Limit~~	~~06,00,00~~	~~06, Value (H), Value (L)~~
~~Instantaneous Maximum Module Current~~	~~07,00,00~~	~~07, Value (H), Value (L)~~
~~Ambient Temperature~~	~~08,00,00~~	~~08, Value (H), Value (L)~~
~~Required Charge Voltage~~	~~09,00,00~~	~~09, Value (H), Value (L)~~

~~Module 1 Remaining Capacity (xx.xAH)~~	~~20,00,00~~	~~20, Value (H), Value (L)~~
~~Module 2 Remaining Capacity (xx.xAH)~~	~~21,00,00~~	~~21, Value (H), Value (L)~~
	~~Same Sequence~~	~~Same Sequence~~
~~Module 16 Remaining Capacity (xx.xAH)~~	~~2F,00,00~~	~~2F, Value (H), Value (L)~~
~~Instantaneous Module 1 Current (xx.xA)~~	~~30,00,00~~	~~30, Value (H), Value (L)~~
	~~Same Sequence~~	~~Same Sequence~~
~~Instantaneous Module 16 Current (xx.xA)~~	~~3F,00,00~~	~~3F, Value (H), Value (L)~~
~~Module 1 Voltage (xx.xxV)~~	~~40,00,00~~	~~40, Value (H), Value (L)~~
	~~Same Sequence~~	~~Same Sequence~~
~~Module 16 Voltage (xx.xxV)~~	~~4F,00,00~~	~~4F, Value (H), Value (L)~~
~~Module 1 State Of Charge (in percentage 0-100%)~~	~~50,00,00~~	~~50, Value (H), Value (L)~~
	~~Same Sequence~~	~~Same Sequence~~
~~Module 16 State Of Charge (in percentage 0-100%)~~	~~5F,00,00~~	~~5F, Value (H), Value (L)~~
~~Module 1 State Of Health (in percentage 0-100%)~~	~~60,00,00~~	~~60, Value (H), Value (L)~~
	~~Same Sequence~~	~~Same Sequence~~
~~Module 16 State Of Health (in percentage 0-100%)~~	~~6F,00,00~~	~~6F, Value (H), Value~~

		~~(L)~~
~~Module 1 Maximum Cell Voltage (x,xxxV)~~	~~70,00,00~~	~~70, Value (H), Value (L)~~
~~--~~	~~Same Sequence~~	~~Same Sequence~~
~~Module 16 Maximum Cell Voltage (x,xxxV)~~	~~7F,00,00~~	~~7F, Value (H), Value (L)~~
~~Module 1 Minimum Cell Voltage (x,xxxV)~~	~~80,00,00~~	~~80, Value (H), Value (L)~~
~~--~~	~~Same Sequence~~	~~Same Sequence~~
~~Module 16 Minimum Cell Voltage (x,xxxV)~~	~~8F,00,00~~	~~8F, Value (H), Value (L)~~
~~Module 1 Maximum Cell Temperature (xx,x'C)~~	~~90,00,00~~	~~90, Value (H), Value (L)~~
~~--~~	~~Same Sequence~~	~~Same Sequence~~
~~Module 16 Maximum Cell Temperature (xx,x'C)~~	~~9F,00,00~~	~~9F, Value (H), Value (L)~~
~~Module 1 Minimum Cell Temperature (xx,x'C)~~	~~A0,00,00~~	~~A0, Value (H), Value (L)~~
~~--~~	~~Same Sequence~~	~~Same Sequence~~
~~Module 16 Minimum Cell Temperature (xx,x'C)~~	~~AF,00,00~~	~~AF, Value (H), Value (L)~~
~~Module 1 Charge Current Limit~~	~~B0,00,00~~	~~B0, Value (H), Value (L)~~
~~--~~	~~Same Sequence~~	~~Same Sequence~~
~~Module 16 Charge Current Limit~~	~~BF,00,00~~	~~BF, Value (H), Value (L)~~

~~iv) Parameter Control (Sixth Byte as 04)~~

~~Parameter Name~~	~~Hex Code~~	
	~~From Master~~	~~From Slave Equipment~~

~~iv) System details (Sixth Byte as 05) :~~

~~Parameter Name~~	~~Hex Code~~	
	~~From Master~~	~~From Slave Equipment~~
~~Number of Modules Installed~~	~~01, 00, 00~~	~~01, Value (H), Value (L)~~
~~Number of Active Modules~~	~~02, 00, 00~~	~~02, Value (H), Value (L)~~
~~Total Battery Rated Capacity~~	~~03,00,00~~	~~03, Value (H), Value (L)~~
~~Module 1 Rated Capacity~~	~~04,00,00~~	~~04, Value (H), Value (L)~~
~~Module 2 Rated Capacity~~	~~05,00,00~~	~~05, Value (H), Value (L)~~
~~——————————————~~	~~Same Sequence~~	~~Same Sequence~~
~~Module 16 Rated Capacity~~	~~13,00,00~~	~~13, Value (H), Value (L)~~
~~Module 1 Make~~ ~~(string of less or equal to16 char including null)~~ ~~e.g. for make of abcdefgh Response will be 03, hexvalue of a, hexvalue of b~~	~~20, 00, 00~~ ~~21,00,00~~ ~~22,00,00~~ ~~23,00,00~~ ~~24,00,00~~ ~~25,00,00~~ ~~26,00,00~~ ~~27,00,00~~	~~20, Value (H), Value (L)~~ ~~21, Value (H), Value (L)~~ ~~22, Value (H), Value (L)~~ ~~23, Value (H), Value (L)~~ ~~24, Value (H), Value (L)~~ ~~25, Value (H), Value (L)~~ ~~26, Value (H), Value (L)~~ ~~27, Value (H), Value (L)~~
~~Module 1 Date of Commission of battery~~	~~28, 00, 00~~	~~28, Value (H), Value (L)~~
~~(string of less or equal to16 char including null)~~ ~~e.g. for date of~~ ~~d1d2/m1m2/y1y2 ,h1h2:m1m2:s1s2~~	~~29,00,00~~ ~~2A,00,00~~ ~~2B,00,00~~ ~~2C,00,00~~ ~~2D,00,00~~	~~29, Value (H), Value (L)~~ ~~2A, Value (H), Value (L)~~ ~~2B, Value (H), Value (L)~~ ~~2C, Value (H), Value (L)~~ ~~2D, Value (H), Value (L)~~

~~Response will be 02, hexvalue of d1, hexvalue of d2~~	~~2E,00,00~~ ~~2F,00,00~~	~~2E, Value (H), Value (L)~~ ~~2F, Value (H), Value (L)~~
~~Module 2 Make~~	~~Same sequence as Module 1(30-37)~~	~~Same sequence as Module 1~~
~~Module 2 Date of Commission of battery~~	~~Same sequence as Module 1(38-3F)~~	~~Same sequence as Module 1~~
- -	- - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - -
~~Module 16 Make~~	~~Same sequence as above~~	~~Same sequence as above~~
~~Module 16 Date of Commission of battery~~	~~Same sequence as above~~	~~Same sequence as above~~

~~Note: In case the above information cannot be provided by the power plant or battery controller the same will be Generated in the First stage system.~~

Calculations for Battery Bank & SPV Power Generating System

1. Basic considerations for the above calculations:

a) Battery :

1. Battery shall be selected to cater for ultimate load.
2. The battery should not be allowed to discharge beyond 80% of its rated capacity in case of 3 or more days of autonomy and 50% in case of lower autonomy.
3. VRLA batteries shall deliver 120% of its rated capacity when discharged at a rate of C/20 & slower & 150% of its rated capacity for discharge rates of C/120 & slower.
4. Average battery voltage during discharge is 1.9V/cell.
5. Battery in this case will be 24cell/48V or 12 Cell/24V battery.

Formula for calculating battery capacity:

When load is in Ampre hours :

[(Load per day)*(Autonomy in days)]/{(permissible DOD)*(battery capacity expected)#} …. (1)

When load is in Watts or watt hours :

[(load/45.6##)*(Autonomy in days)]/{(permissible DOD)*(battery capacity expected)#}…..... (2)

In case of autonomy between 1 and 4 days the expected capacity shall be 1.2 times the rated capacity while for 4 days or higher autonomy it shall be 1.5 times the rated capacity.

45.6V((1.9V/cell)*24) is the average battery voltage during discharge

b) SPV Power Generating System

1. India falls under 4 hour Full Sun insolation per day Zone whereas in case of Himalayan regions it shall be 3.5 hours.
2. Load requirements : a) Present

   ~~b)~~a) Ultimate

3. Battery conversion efficiency of VRLA batteries is 90%.
4. Efficiency of the Charge Controller is 85%.
5. The SPV Power Generating systems are designed to supply rated power at voltage of 17V & above.
6. 1.25 multiplying factor shall be used to cover the power loss factors such as de-rating due to temperature, dust on the top glass cover etc.
7. SPV Generating system shall be capable to charge the battery close to C/20 rate of charge,

Formula for calculating SPV Power Generator Capacity :

If load is in Ah : [{(Load per day to be met by SPV power)*1.25/(0.9*0.85)}/4]*17*4…….(3)

If load is in Wh : {(Load per day to be met by SPV power)*1.25/(0.9*0.85)}/4 ………(4)

Where :: 1. 0.9 is conversion efficiency of the battery

2. 0.85 is the efficiency of the charge controller

3. 4 is Expected full sun-insolation in hours/day in Indian plain areas

4. 68V (17*4V)is the Voltage at which peak power is available.

5. 1.25 is the safety factor taking care of temperature derating, dust, ageing etc.

"**Note:** Formula 2 & 4 is applicable for MPPT Charger Controller and Formula 1 & 3 is applicable for PWM Charger Controller."

Sample calculations for Battery & SPV Generating System:

Required Inputs

1. Load per day : a) Present

~~b)~~a) Ultimate

2. Autonomy : 3 continuous sunless days

Sample Calculation –1

(Load Amps or AH/day)

		Present	Ultimate
Load	Say Continuous load	2A	2A
	Off Hook Current	30mA (30 subs)	30mA(480 subs)
	Anticipated traffic	0.1 Erlang	0.1 Erlang
Load/day	Continuous	2X24 = 48AH	2X24 = 48AH
	Off-Hook Load	((0.03X30)/10)X24 = 2.16AH	((0.03X480)/10)X24 = 34.6AH
Place of use	Say Barmer		
Autonomy	3 days		

Battery Bank Calculations:

Using formula ……(1)

Battery reserve required = 82.6*3/0.8/1.2 = 258Ah/48V

(for ultimate load) Nearest higher capacity battery available may be chosen

Where : 82.6Ah is the load, 3 is the autonomy in days and 1.2 is the battery capacity at rate of discharge slower than C/20 and faster than C/120 and 45.6 is the average battery voltage during discharge.

SPV Generating Requirements:

Using formula ….. (3)

Present : {[{50.16/(0.9*.85)}*1.25]/4}*17*4 = 1393Watts

Ultimate : {[{82.6/(0.9*.85)}*1.25]/4}*17*4 = 2294 Watts

Where : 50.16Ah & 82.6Ah are the load per day, 0.9 is battery conversion efficiency, 0.85 is the efficiency of the charge controller, 1.25 is the safety factor for SPV power losses, 4 is full sun-insolation availability in India & 68(17*4) is the voltage at which peak power is available.

SPV System may be configured of 7, 48V panels(4 modules of 50W connected in series) or 5, 48V panels(4 modules of 75W connected in series) with the provision of 5 panels (50W basic module), panels (75W basic module) may be added at the later stages when ever required. The most suitable basic module may be chosen as per site and users requirements.

Sample Calculation – 2

(Load in Watts) Required

Inputs

		Present	**Ultimate**
Load	say Continuous load	192W	340W
	Off Hook Current	1.5W (120 Ports)	1.5W (240 ports)
	Anticipated traffic	0.1 Erlang	0.1 Erlang
Load/day	Continuous	192 X 24 = 4508WH	340 X 24 = 8160WH

	Off-Hook Load	((1.5X120)/10)X24 = 432WH	((1.5X240)/10)X24 = 864WH
Place of use	Say Barmer		
Autonomy	3 days		

Battery Bank Calculations:

Using formula …… (1)

Battery reserve required = 9024*3/45.6/0.8/1.2 = 890Ah/48V

(For ultimate load) Nearest higher capacity battery available may be chosen

Where: 9024Wh is the load, 3 is the autonomy in days and 1.2 is the battery capacity at rate of discharge slower than C/20 and faster than C/120 and 45.6 is the average battery voltage during discharge.

SPV Generating Requirements:

Using formula ….. (4)

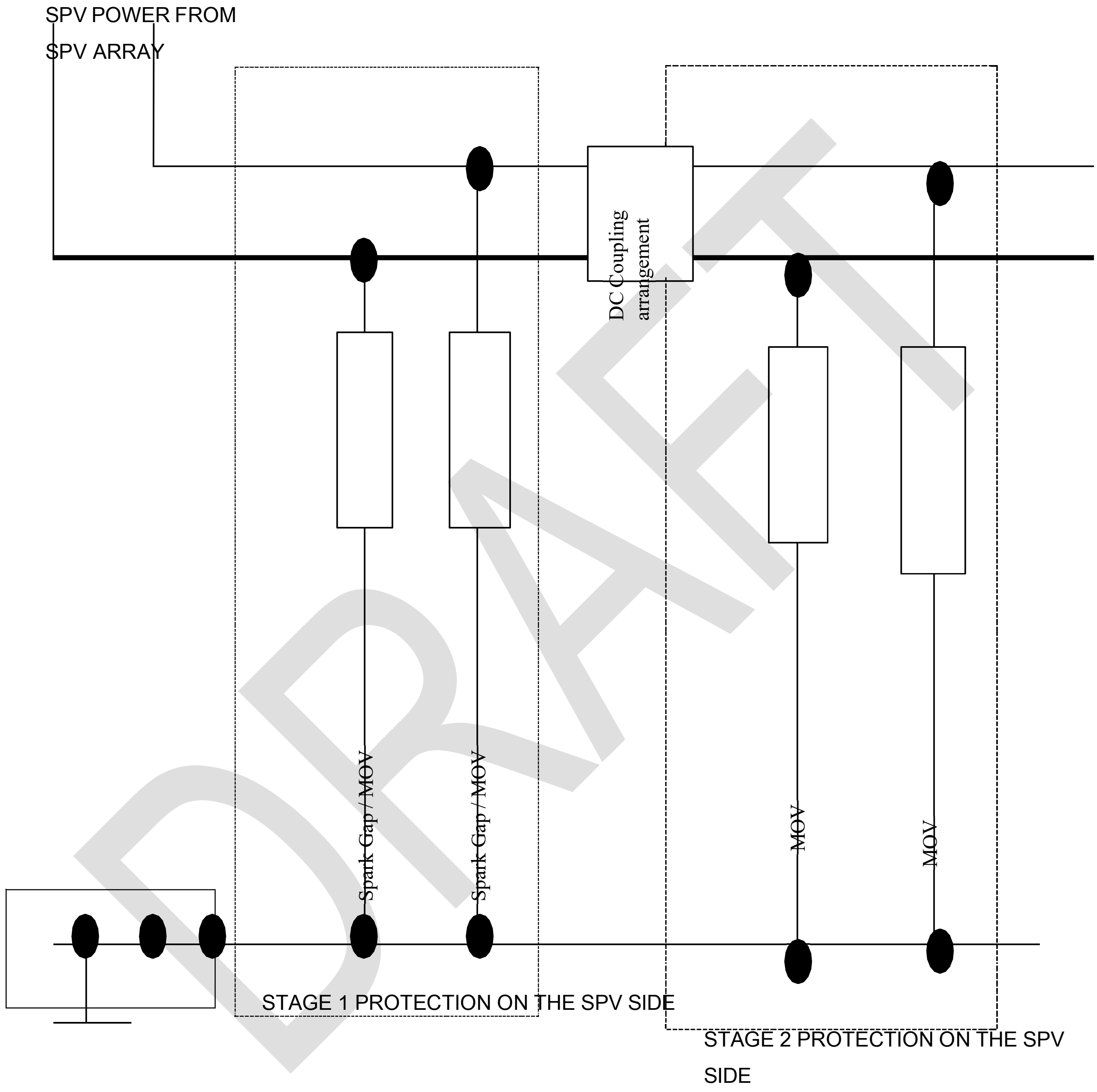
Present : {[{4940/(0.9*.85)}*1.25]/4} = 2018Watts
Ultimate : {[{9024/(0.9*.85)}*1.25]/4} = 3684 Watts

Where: 4940Wh & 9024Wh are the load per day, 0.9 is battery conversion efficiency, 0.85 is the efficiency of the charge controller, 1.25 is the safety factor for SPV power losses, 4 is full sun-insolation availability in India.

SPV System may be configured of 10, 48V panels(4 modules of 50W connected in series) or 7, 48V panels(4 modules of 75W connected in series) with the provision of adding 9 panels (50W basic module), 5 panels (75W basic module) may be added at the later stages when ever required. The most suitable basic module may be chosen as per site and users requirements.

ANNEXURE – 5

STAGE 1 & STAGE 2 FOR LIGHTNING & SURGE VOLTAGE PROTECTION EQUIPMENT FOR SPV CHARGE CONTROLLER



STAGE 1 PROTECTION ON THE SPV SIDE

STAGE 2 PROTECTION ON THE SPV SIDE

PE	PROTECTIVE EARTH
RATING OF GD TUBE	NOT LESS THAN 10KA FOLLOWING CURRENT >=
100A RATING OF MOV	15 KA AT 8/20 µS WAVE SHAPE
VOLTAGE OF RATING	10 v HIGHER THAN SPV ARRAY (MINIMUM)

DC Line Protection Scheme:

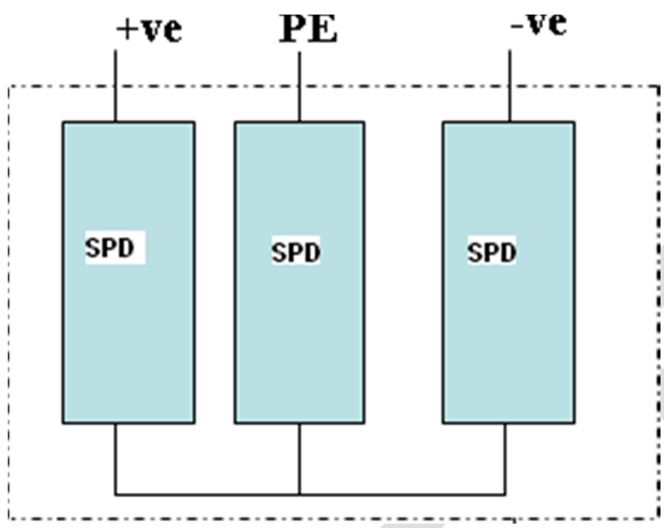


Fig: Connection diagram for DC Line Protection

For DC path, from the SPV array a protection shall be provided between the +ve, -ve & ground connection as per the Y connection scheme.

Abbreviations

A	Amperes
AC	Alternate Current
AH	Ampere Hour
AM	Air Mass
BIS	Bureau Of Indian Standards
BSNL	Bharat Sanchar Nigam Limited
CACT	Component Approval Centre of Telecommunication
CCU	Charge Controller Unit
CIGRE	International Conference on Large High Voltage Electric Systems
dB	Decibel
dBA	Decibel Absolute
DC	Direct Current
deg C	Degrees Celsius
DG	Diesel Generator
DOT	Department of Telecommunication
DSCA	Distribution, Switching, Control, Alarm and Monitoring Unit
emf	Electro motive force
EMC	Electro Magnetic Compatibility
EMI	Electro Magnetic Interference
FET	Field Effect Transistor
~~gL/gG~~	~~General line/General Gracia (slow action fuses)~~
~~FSD~~	~~Full Scale Deflection~~
FR/FC	Float Rectifier cum Charger
FR/BC	Float Rectifier cum Battery Charger
GI~~D~~	Galvanized Iron~~Gas Discharge~~
GR	Generic Requirements
GSM	Grams per Square Meter

HJT	Heterojunction Technology
IEC	International Electro-technical Commission
IS	Indian Standards
ISCPV	Short-Circuit Current of the Photovoltaic system or component.
ISO	International Organisation for Standardisation
ITU-T	International Telecommunication Union-Transmission.
~~I-V~~	~~Current vs Voltage~~
Kg	Kilo Grams
KHz	Kilo Hertz
KW	Kilo Watts
~~LA~~	~~Flooded Type Lead Acid~~
LED	Light Emitting Diodes
LCD	Liquid Crystal Device
~~LM~~	~~Low Maintenance~~
MCB	Miniaturised Circuit Breaker
MHz	Mega Hertz
~~MIB~~	~~Management Information Base~~
MOV	Metal Oxide Varistor
MPPT	Maximum Power Point Tracking
MSL	Mean Sea Level
MTBF	Mean Time between Failures
MTTR	Mean Time To Restore
Ms	milli seconds
NABL	National Accreditation Board for Testing and Calibration Laboratories
NPL	National Physical Laboraties
PCB	Printed Circuit Board
PERC	Passivated Emitter and Rear Cell
~~PF~~	~~Power factor~~
PIV	Peak Inverse Voltage

~~PTC~~	~~Positive Temperature Co-efficient~~
PWM	Pulse Width Modultion
QA	Quality Assurance
QM	Quality Manual
RFI	Radio Frequency Interference
RTEC	Regional Telecom Engineering Centre
SMPS	Switch Mode Power Supply
SNMP	Simple Network Management Protocol
SPD	Surge Protective Device
SPV	Solar Photo voltaic
TOPCon~~S~~ ~~S~~	Tunnel Oxide Passivated Contact~~Self Supporting~~
~~T & D~~	~~Technical & Development~~
V	Volts
VDE	Verband Der Elektrootechniker
VRLA	Valve Regulated Lead Acid
W	Watts
Wp	Watt Peak