ANNEXURE-II

NAME……(OF MEMBER/MANUFACTURER)

Inputs/Comments/Suggestions on Draft standard for **Revision of Standard on"Solar Photovoltaic (SPV) Power Supply For Telecom Equipments" (Standard No. TEC 66090:2017, old No. TEC/GR/TX/SPV-003/04/JAN-17)"**

Clause No.	Clause Description	Modified/ New Clause	Justification

Note: The comments on the revision of Standard **on"Solar Photovoltaic (SPV) Power Supply For Telecom Equipments"** may be provided in the above format vide Email to adgfa-tec-dot@gov.in with copy to dirfa.tec@gov.in and ddgfla.tec@gov.in .

वर्गीय आवश्यकताएँ

सं:टीईसी/जीआर/टीएक्स/एसपीवी-
००३/०४/जनवरी-१७

(सं:टीईसी/जीआर/टीएक्स/एसपीवी-००३/०३.मार्च.२०११ को अधिक्रमित करता है)

GENERIC REQUIREMENTS

TEC 66090:20~~17~~25

(Old No.: TEC/GR/TX/SPV-003/04/JAN-17)

(Supersedes No. TEC/GR/TX/ SPV - 003/03.MAR.2011)

सोलर फोटोवोल्टाइक पावर सप्लाइ फॉर टेलीकॉम इक्विपमेंटस

SOLAR PHOTO VOLTAIC (SPV) POWER SUPPLY FOR TELECOM EQUIPMENTS

दूरसंचार अभियांत्रिकी केंद्र
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Release 54: ~~--------January~~ 202517

~~Price: ₹ 800/-~~

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 Solar Photo Voltaic (SPV) power supply for various Telecom equipment, working on 12V DC or 48V DC or 24V DC (for Standalone Application only). These power supplies are capable of catering to load requirements of (i) up to 5A continuous or 120 AH per day for 12V telecom equipments and (ii) up to 20A continuous or 480 AH per day for 48V telecom equipments and (iii) up to 20A continuous or 480 AH per day for 24V telecom equipments.

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HISTORY SHEET

S. No.	Name of the Generic Requirements	No. of the Generic Requirements	Remarks
1)	Solar Photo Voltaic Power Source for Rural Radio System	G/SPV-01/01 OCT 1990	First Issue : 12V/70W (2 X 35 W) SPV Power supply
2)	Solar Photo Voltaic Power Source for Single Channel VHF and Similar Systems	G/SPV-01/02 SEP 1993	Second Issue : 12V/70W (2 X 35 W) SPV Power supply
3)	Solar Power Generating System for Single Channel VHF and Similar Systems.	G/SPV-01/03 DEC 1994	Third Issue : 12V/70W (2 X 35 W) SPV Power supply
4)	12V Solar Photovoltaic Power supply for Remote Terminals.	GR/SPV-03/01FEB 2001	First Issue : 12V SPV Power supply using 12V/50W and 12V/75 W SPV Modules.
5)	48V Solar Photovoltaic Power supply for Rural Telecom Equipments.	GR/SPV-04/01FEB 2001	First Issue : 48V SPV Power supply using 12V/50W and 12V/75 W SPV Modules.
6)	Solar Photovoltaic (SPV) Power supply for Telecom Equipments.	GR/SPV-03/02 JUN 2005	Second Issue:: To make full use of the AC mains availability, the system may work on both AC mains as well as SPV Power. Remote Monitoring Concept incorporated.

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7)	Solar Photovoltaic (SPV) Power supply for Telecom Equipments.	TEC/GR/TX/SPV - 003/03.MAR.2011	Third Issue:: - All the above GRs have been amalgamated in to one document to meet all the telecom requirements.
8)	Solar Photovoltaic (SPV) Power supply for Telecom Equipments.	TEC/GR/TX/SPV - 003/04/JAN-17	Fourth Issue
9)	Solar Photovoltaic (SPV) Power supply for Telecom Equipments.	TEC 66090:2017	New document number as per Revised numbering scheme issued by RC division of TEC.
10)	Solar Photovoltaic (SPV) Power supply for Telecom Equipments.	TEC 66090:2025	Fifth Issue: To incorporate the latest technological advancements in Solar cells, SPV modules and SMPS rectifiers.

REFERENCES

S. No.	Standard No.	Designation
1.	QM-115	Quality standard for calculation/verification of MTBF
2.	QM-118	Quality reliability in product design.
3.	QM-202	Pictorial guidelines for Visual assessment of quality of printed board assemblies (PBA) & discrete terminal assemblies.
4.	QM-204	Guidelines for workmanship standards for repair & modification of printed wiring board assemblies.
5.	QM-205	Guidelines for standard of workmanship for printed boards.
6.	QM-206	Guidelines for standard of workmanship for printed boards assemblies.
7.	QM-207	Guidelines for soft solder and fluxes for Telecom Equipments.
8.	QM 210	Guidelines for standard of workmanship for surface Mounting Devices.
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.~~
10.	QM-334	Packing Guidelines.
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 Purpose-Specification.
14.	IS- 613	Standard on Bus-bars.
15.	IS : 1248	Standard on Shunts.
16.	IS 1359	Specification for Tinning requirements
17.	IS 1554 Amend -1 (June 1994)	Standard for Cables & Wires.

18.	IS 2062	Steel for General Structural purposes-Specification.
19.	IS 4759	Specification for Hot-Dip Zink coatings on Structural Steel & Other Allied Products.
20.	ISO 9001:201508	Quality Management Systems Requirements.
21.	ISO 14001 (latest issue)	Pertaining to environmental requirements.
22.	IEC62368-1~~IEC 950 (UL1950)~~	Safety of information technology equipment including electrical business equipment
23.	IEC-61000-4-x	Electromagnetic compatibility: Testing and measurement techniques
24.	IEC-62305-1	Protection of Structures against Lightening: General Principles
25.	IEC600-68-2-38 Test Bb	Environmental Requirements for SPV Generating Modules/panels
26.	IEC600-68-2-1 Test Ab	-do-
27.	IEC600-68-2-2/14/38	-do-
28.	IS 9000(PART16)	-do-
29.	IEC 6230561024	Protection of structures against lightning
30.	IEC 62305-461312	Protection against lightning electromagnetic
31.	VDE V0100- 534	Devices for protection against excess voltages
32.	VDE 0675-6-11	Surge arresters for use in AC supply systems with rated voltages from 10V to 1000V.
33.	ITUT Rec. O.41	Psophomeric noise requirements.
34.	TEC67010:2011(Old No. TEC/GR/TX/BAT-001/04.JUNE.2011)~~GR/BAT-01/03 MAR 2004~~	GR for VRLA Batteries with amendments if any
35	IEC 61701	Salt Mist Corrosion Testing Of Photovoltaic (PV) Module
36	IEC 60215	Safety Requirements For Radio Transmitting Equipment
37	IEC 62040-1	Uninterruptible Power System (UPS)-Part 1:Safety Requirements

Note:

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

CHAPTER -1

1.0 Introduction

1.1 This document contains the generic requirements of Solar Photo Voltaic (SPV) power supply for various Telecommunications (also referred as Telecom hereafter) equipment, working on 12V DC or 48V DC or 24V DC (for Standalone Application only). These power supplies are capable of catering to load requirements of (i) up to 5A continuous or 120 AH per day for 12V telecom equipments and (ii) up to 20A continuous or 480 AH per day for 48V telecom equipments and (iii) up to 20A continuous or 480 AH per day for 24V telecom equipments.

1.2 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 Standalone SPV 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% load requirement is met by SPV power supply and remaining by the SMPS. 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. This type of power supply has also a battery bank to provide the higher autonomy.

~~This 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.~~ This type of power supply is so designed so that, when both the output of SMPS Rectifier and SPV power source are available, load requirement is met by SPV (Solar Photo Voltaic) Source. SPV power source shall deliver the load as per its available power, remaining load shall be taken care of by SMPS/Battery as per the preference given by the purchaser. For proper load sharing of the two power sources, it shall be ensured that output voltage of the SPV power source, even in worst working conditions (high SPV cell temperature) is higher than that of the SMPS.

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.

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.

A Block-schematic showing different component of the Hybrid SPV Power Supply power supply is given in ~~a~~Annexure -2~~1~~.

1.3 The power to the Telecom equipment is regulated and controlled by the Charge controller. The charge controller shall provide for all the functions, as detailed under the heading Charge Controller.

~~1.3~~1.4 All the requirements described in chapter 2 of this document are suggestive requirements and shall be decided by the purchaser at the time of procurement/ tender as per his requirements. However, the requirements described in Chapter-2 will not be tested/ verified by TEC.

2.0 Description

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

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

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/125Wp to 24V/300Wp~~24V/250Wp to 24V/550 Wp and above. However, purchaser may specify '550~~300~~Wp or higher' as per the requirement.

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 (for standalone application only) are to be connected in series to form a 48V SPV panel.

The solar charge controller shall be based on MPPT technology. ~~If required by purchaser,~~ fFor 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 as per IEC 60950-1{2005} shall be made from safety point of view.

SPV Array: A number of panels are connected in parallel or series or in series-parallel combination as per requirement to get the desired power. This whole combination is called an array. The SPV array is so designed that, it provides 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 shall be common for both standalone SPV power supply and Hybrid SPV power supply. It 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 (some on charge controller along with SMPS and all other on the SMPS). 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, while SMPS side lightning and surge protective devices on the SMPS. ~~The system should have Stage – I & II SPD as per TEC GR No. TEC/GR/FLA/LSP-001/01/June 2010.~~ In case of small 12V SPV power supplies using mono-blocks, the battery may be accommodated inside the charge controller.

~~If required by **Purchaser,** t~~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.

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

The CCU shall compose the following features:

(i) 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 1.2b whenever Solar Power is available.
(ii) Charge controller shall be capable of working in extreme temperatures of -15°C to +55°C ambient with out 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. However, de-rating is allowed when the temperature is above 55°C and until 75°C. Beyond 75°C, thermal shutdown is permissible.

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

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.

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

48V SPV Power Supply: For 48V SPV power supply, a twenty four 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.

2.1.4 **Mounting Structure:** SPV Modules/panels/arrays are mounted on a specially designed galvanised ~~angle~~ iron support structure. It shall also provide for angle of tilt with horizontal in accordance with latitude of place of installation.

2.1.5 **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)
- 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 power supply issued by TEC vide ~~No.~~ TEC 66079:2015" or as per latest technological advancements with mutual consultation among the Manufacturer/ OEM and the purchaser / user. ~~/GL/TX/SPV-05/02/MAR.2015" issued by TEC~~. The cables used shall be

fire retardant and weather proof. Rating of the cables may be clearly stated in the Ordering information.

2.2 **Power Supply Classification:** 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:

a) 12V/500W Standalone SPV Power supply: Composed of 12V/500W SPV power Generating source, with 12V/500W Charge controller

b) 12V/1000W Standalone SPV Power Supply: Composed of 12V/1000W SPV Power Generating source, with 12V/1000W Charge controller.

B 24V SPV Power Supply (for standalone application only)**:** Depending on the Charge Controller unit capacity and load requirements the 24V SPV power supplies are classified as follows:

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

b) 24V/5KW Standalone SPV Power Supply: Composed of 24V/5KW SPV Power Generating Source, with 24V/5KW 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:

a) 48V/2KW Standalone SPV Power Supply: Composed of 48V/2KW SPV Power generating source, with 48V/2KW Charge controller.

b) 48V/5KW Standalone SPV Power Supply: Composed of 48V/5KW

SPV Power generating source, with 48V/5KW Charge controller.

c) 48V/10KW Standalone SPV Power Supply: Composed of 48V/10KW SPV Power Generating Source, with 48V/10KW 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 supplies are further classified as follows :

a) 12V/500W Hybrid SPV Power Supply: It shall be composed of:

(i) 12V/500W SPV Power Generating source with 12V/500W Charge controller.

(ii) SMPS (based on 12V/12.5A FR/FC modules) with ultimate capacity of 37.5A (three FR/FC modules 12V/12.5A (2 for load and one for redundancy)).

b) 12V/1000W Hybrid SPV Power Supply: It shall be composed of:

(i) 12V/1000W SPV Power Generating Source with 12V/1000W Charge controller

(ii) SMPS (based on 12V/12.5A FR/FC modules) with ultimate capacity of 62.5A (Five FR/FC modules 12V/12.5A (4 for load and one redundancy)).

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/2KW Hybrid SPV Power Supply: it shall be composed of :

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

(ii) SMPS (based on 48V/12.5A or 25A FR/FC modules) with ultimate capacity of 37.5 A {i.e. either Three FR/FC modules 48V/12.5A (2 for load and one redundancy) or Two FR/FC modules 48V/25A (one for load and one for redundancy)}.

b) 48V/5KW Hybrid SPV Power Supply: it shall be composed of:

(i) 48V/5KW SPV Power Generating Source with 48V/ 5KW Charge controller.

(ii) SMPS (based on 48V/12.5A or 25A FR/FC modules) with ultimate capacity of 75A {either Six FR/FC modules 48V/12.5A (5 for load and one redundancy) or Three FR/FC modules 48V/25A (2 for load and one redundancy)}.

c) 48V/10KW Hybrid SPV Power Supply: It shall be composed of:

i) 48V/10KW SPV Power Generating Source with 48V/10KW Charge controller.

ii) SMPS (based on 48V/25A or 50A FR/FC modules) with ultimate capacity of 150A { either {Six FR/FC modules 48V/25A (5 for load and one redundancy) or Three FR/FC modules 48V/50A (2 for load and one redundancy) }.

2.2.3 Charge controller 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 by adding or removing the SMPS.

2.3 **Power Supply 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 configuration as given in clause 2.2 above may be selected. It shall be clearly highlighted at the time of ordering by the purchaser / user. (Refer Ordering information at Chapter ~~Annexure~~ 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~~/GL/TX/SPV-05/02/MAR.2015"~~ or as per latest technological advancements with mutual consultation among the Manufacturer/ OEM and the purchaser / user. Rating of each components, viz., SPV Power source, SMPS, charge controller etc. may be clearly stated in the Ordering information.

2.3.1 The power supply shall be designed to work within specified limits under any of the environmental conditions as specified in clause 5.0 of this document 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. In the~~is~~ case of Hybrid Power Supply, it shall have an in-built FC (float charger as per

clause no 3.6 of GR) that shall provide a regulated DC Power Supply in sharing with SPV power generating source to the load and the battery bank when the AC commercial mains are available.

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.

3.1.1 **Design Features:** 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.

3.1.2 **SPV Modules :** 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.

3.1.3 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~~.

3.1.4 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 of the module can be designed in such a way that it incorporates latest manufacturing processes like Glass , Transparent backsheet and white refractive backsheet.

3.1.5 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.

3.1.6 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.~~

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

3.1.8 ~~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.~~The Solar Photovoltaic (SPV) module is intended for use in terrestrial applications and shall be constructed using high-efficiency solar cells, which may include Poly-crystalline, mono-crystalline, PERC, TOPCon, HJT, or other advanced silicon-based technologies, connected in an appropriate series or series-parallel configuration to achieve the desired output. Each module shall be fully encapsulated using advanced materials (such as multi-layer polymer backsheet or glass-glass construction).

~~3.1.9~~ The SPV modules, being used for Telecom supply, need to be compliant to BIS relevant standards and Government of India regulatory requirements. ~~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. Clause not clear " External lab report or BIS may be~~

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3.2 Panel/Array configuration:

~~3. 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 12V50Wp to 12V/300Wp. 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/125Wp to 24V/300Wp"(refer clause 2.1.1).~~

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~~3.2.2~~3.2.1 ~~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.

~~3.2.3~~3.2.2 **Electrical requirements:** The module must deliver full current to the load corresponding to the terminal voltage of 13.5V for 12V SPV power generating source, 27V for 24V SPV power generating source and 54V for 48V SPV power generating source, plus the diode drop and cable drop at a maximum expected cell temperature (55°C).

~~3.2.4~~3.2.3 **Insolation:** The 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/m^2/day subject to feasibility at site.

~~3.2.5~~3.2.4 **Minimum stipulated life:** The de-rating factor of 0.5%/year of the SPV Generating Source/module rated power is permissible. The module/SPV

power generating source shall deliver at least 90% of its rated power in 10th year.

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

3.2.73.2.6 **Peak (Maximum) Power Output :** The SPV Module shall deliver minimum specified rated power at maximum power point of "IV Curve" at standard condition of 100 mw/cm^2 solar intensity at 25 deg C AM 1.5.

3.2.83.2.7 **Cells:** Cells can be either mono-crystalline/ ~~or~~ 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.

3.2.93.2.8 ~~Considering the application and Geographical location of India, the number of cells in series in a module shall be 36.~~

3.2.103.2.9 **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 specified value ~~specified in clause 3.2.3~~.

3.2.113.2.1 **Short circuit Current :** To be specified by the manufacturer

3.2.123.2.1 **SPV modules voltage at peak Power point: 1**7.0 V (min.) for 12V Modules and 34V (min.) for 24V Module. In addition to it, SPV Vmpp should be 0.45V per cell minimum.

3.2.133.2.1 **Voltage de-rating:** shall not be more than -0.5% per degree C above 25 degree C cell temperature.

3.2.143.2.1 **Conversion efficiency and Fill factor:** ~~Conversion efficiency of the encapsulated cell, at peak power, shall not be less than 13% and that of module shall not be less than 12%. Fill factor shall be better than 68%.~~For Panels rating below 250 Wp : Conversion efficiency of the encapsulated cell, at peak power, shall not be less than 13% and that of module shall not be less than 12%. Fill factor shall be better than 68%.

For Panels rating above 250 Wp : Conversion efficiency of the encapsulated cell, at 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%.

3.3 Charge Controller Unit:

3.3.1 Solar charge controller module shall convert Solar PV Panel / Array input voltage into 13.8V / 27.6 V / 55.2 V DC output voltage (maximum) for 12V / 24 V / 48 V SPV Power supply respectively using MPPT technology. The Solar Charge Controller shall have galvanic isolation in case of 55.2 V DC output voltage or higher and telecom equipment should never be allowed to get exposed to the un-isolated source of power.

3.3.2 **Electrical Requirements:**

3.3.2.1 Input Voltage (Nominal): The nominal input voltage (DC) shall be specified by the manufacturer based on maximum power point tracking voltage (Vmp) as per SPV Panel datasheet and based on solar panel capacity / rating conveyed by the purchaser / procurer. For example, 1KW Solar CCU, nominal input voltage will be 42*2=84Vdc where 42Vdc is Vmp Voltage of 1 SPV Panel of 500 W (Based on OEM / manufacturer SPV Panel Datasheet).

3.3.2.2 Input Voltage (Range): The allowable input voltage (DC) range is to be specified by the manufacturer based on SPV Panel datasheet and considering solar panel capacity / rating conveyed by the purchaser / procurer. Solar CCU should provide full output power up to input voltage "Vmp*N–10%" (Vmp should be derived from SPV Panel datasheet, N is no's

of SPV Panel connected in series.). Linear de-rating of solar CCU is allowed below "Vmp*N–10%".

3.3.2.3 **Voltage to Load and 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 and 55.2V for 48V power supply. The SMPS output voltage shall also be controlled within these limits.

3.3.2.3 When working with SMPS, for proper load sharing of SPV power generating source and SMPS. Provision shall be made in the charge controller so that the voltage of SPV power generating source, even in worst working conditions (high SPV cell temperature) is higher than that of the SMPS.

3.3.2.4 **Efficiency:** Power conversion eEfficiency 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 930% and Solar CCU (MPPT) tracking efficiency ≥98%. while all working condition on SPV power source". However, purchaser may specify Power conversion efficiency to be 9085% for 12V system depending upon the cost effectiveness of the power supply.

3.3.2.5 **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 $2mV_{rms}$ and ripple voltage shall be $2mV_{rms}$ +/- 0.5% for float applications as per latest standards of ITU-T Rec. O-41.

3.4 **Protections:** The charge controller shall provide for the control circuitry using solid state switching techniques to incorporate suitable protections (with a tolerance of +/- 1% for DC voltage and current) to safeguard circuit against the following conditions:

a) DC over voltage:

(i) Charge controller: The output voltage of the charge controller shall be maintained in accordance with clause 3.3.~~2~~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. 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.

(ii) SMPS: Shall be in accordance with clause 3.23.2.

b) Battery under voltage:

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 50V for 48V, 25V for 24V power supply and 12.5V for 12V power supply respectively

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

c) 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.

d) 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
SMPS (in case of hybrid power supply only) and battery.

e) Over Load/Short Circuit: The unit shall be protected for over load/ short circuit. It shall be ensured that short circuit does not lead to any fire hazard.

f) Fuse/ circuit Breakers 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
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.

Note-2: Two fuses (minimum) of each type shall be provided with each unit. These fuses shall be kept inside the unit in an enclosure.

3.4.1 The circuit design shall be such that the 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 otherwise possible damage to the telecom equipment in such cases.

3.5 Monitoring Alarms and Indicating Lamps:

Visual indications/display shall be provided by means of "bright LCD/LEDs" and / or common LCD panel. Different colour display for different modes shall also be provided.

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. AC Mains available - Green
(on charge controller, FR/FC module and DSCA)
b. Battery Charging by SMPS - Amber
c. Battery Charging by SPV Power - Yellow
d. Load on battery - Blue

In case of not providing above LED indicators, status of the above functional indications shall be displayed in common LCD panel.

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

1. Battery Low
2. Battery reverse polarity
3. Over load
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 All the alarm circuits shall be provided with solid state technology. Use of electromechanical relays is precluded.

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.

3.5.5 Every Alarm condition shall be accompanied with an audio alarm with a non-locking type audio cut-off facility.

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.

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

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.

3.5.9 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.

3.5.10 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 SMPS (Switch Mode Power Supply):

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

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.

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

Normally the load of the telecom equipments to be fed by these 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 12.5A, ~~and~~ 25A and 50A.

DSCA of the SMPS may be mounted in the upper part of the rack above the FR-FC modules, while FR-FC modules shall be mounted in the remaining

rack. The matching of the SPV Power source output and SMPS output shall be ensured by the charge controller.

It shall provide for the surge protection devices for SMPS, in compliance of clause 5.5.

3.6.1 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 unit should be expandable at rack level itself or by additional racks using the basic FR/FC modules of the same rating. The prescribed FR/FC ratings are 12.5A, ~~and~~ 25A and 50A. It shall employ modular configuration for flexible provision of DC power.

~~3. The unit shall only be based on menu driven Micro Processor Controlled Techniques (both DSCA as well as module) for control, monitoring and alarms. DSCA shall display its Software version. Setting of all the parameters shall be through menu-driven microprocessor control only. 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. All the FR/FC modules' parameter shall not be disturbed on the failure of DSCA. All 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 power supply shall be RS 232/RS485/Ethernet (SNMP Protocol) compatible. RS232 / RS 485 / Ethernet communication lines shall be protected with **surge protection device, which is mounted on both side of the cable.** It shall be feasible to set any monitoring control parameter from a remote site through RS 232/RS485/Ethernet (SNMP Protocol). 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. **SPD shall have**~~

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~~surge discharge current capacity of 10KA (8/20 µsec) and lightening discharge current capacity of equal or more than 1.0 KA per line (10/350 µsec).~~

~~3.6.3~~3.6.2 The unit shall be sufficiently flexible to serve any load from 12.5A onwards depending on manufacturer's design, rating, number of FR/FC modules, used in a rack and 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.

~~3.6.4~~3.6.3 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 etc.

* 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 approved `MCBs' which do not produce spark, while manually, isolating or connecting the battery.

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: Battery shall be protected against the short circuit from any source

including switching equipment such as contactor, MCB coil and their control and sensing circuitry.

~~3.6.5~~3.6.4 There shall be provision to start the SMPS without battery supply.

~~3.6.6~~3.6.5 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).

3.7 Electrical Requirements:

3.7.1 **AC input Supply :** 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.

3.7.2 **DC output Characteristics :**

12V FR/FC Modules shall be capable of operating in the float mode (continuously adjustable and pre-settable) at any value in the range of -12V to -14V from both FR/FC, modules and DSCA.

48V FR/FC Modules shall be capable of operating in the float mode (continuously adjustable pre-settable) at any value in the range of -48 to -56V from FR/FC, modules and DSCA.

There shall also be a provision so that DSCA may over ride the values set by individual module. The prescribed float voltage setting is -13.5V for 12V units and - 54V for 48V units respectively.

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.

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

12V units :

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

48V units :

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

b) At other specified Input, output conditions: better than 85% and load between 50 to 100% ~~Due to High efficiency technology of rectifier, 48V units : a) At nominal input, output and full rated load: better than 92%. b) At other specified Input, output conditions: better than 88% and load between 50 to 100%~~

3.9 **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.

3.10 **Electrical Noise:** The Rectifier (FR/FC) Modules shall be provided with suitable filter on the output side.~~In every switching rectifier , output filter is used. So it is not required in GR.~~

3.11 A resistor shall be provided to discharge the capacitors after the Rectifier modules have stopped operation and output is isolated.~~In every rectifier discharging resistor is used. So it is not required in GR.~~

3.12 **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.

3.13 **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).

3.14 **Soft Start Feature and Transient Response** :

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

3.14.2 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.

3.15 **Voltage Overshoot/Undershoot**: The requirements of this clause shall be achieved without a battery connected to the output of FR/FC module.

3.15.1 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%.

3.15.2 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.

3.15.3 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.

3.16 Total Harmonic Distortion :

3.16.1 **Total Voltage Harmonic Distortion** : The Total line harmonic voltage distortion shall not be more than 5%.

3.16.2 **Total Current Harmonic Distortion** :The total current harmonic distortion contributed by the unit at the input shall not exceed 10% for input voltage range (single phase AC mains supply 230 V with variation in the range of +10% and -15%), for load between 50 to 100% of the rated capacity.

3.17 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 -44.4 to -56 volts for 48V unit and -11.1V to -13.98V for 12V units respectively. For test purposes upper limit of 100% + 5% and lower limit of 50% - 5% shall be acceptable.

3.17.1 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.

3.17.2 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.

3.18 **DC output Regulation** : DC output shall regulate in the range 13.5V+/-1% (13.5V nominal) for 12V units 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. For lithium-Ion -battery, nominal DC output voltage can be reduced to 14.2 V for 12 V units, 28.4 V for 24 V units and 53.25 V for 48 V units. ~~should be 3.55V per Cell . Because Lithium battery life degrade sharply if we charge from higher voltage. Also there is 1-2% capacity loss but Battery life increase double with respect to every 100mv of decrement in cell charging voltage.~~

3.19 **Load Sharing (Parallel operation) :**

3.19.1 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.

3.19.2 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.

3.19.3 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.

3.20 **Battery Under Voltage Isolation**: 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:

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:

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.

3.21 **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), (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.

3.22 **Temperature Compensation for Battery** : There shall be provision for monitoring the temperature of battery and consequent arrangement for automatic temperature compensation of the FR/FC (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 +/- 1% may be acceptable over the rates as specified 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.

The reference temperature shall be taken as 27 degree C to start the temperature compensation". In case of Li Ion battery , Temp Compensation will be different from VRLA. It should be based on Li Ion Cell datasheet

3.23 **Protections:** In addition to the requirements given in clause 3.4, hybrid charge controller shall also provide for the following protections :

3.23.1 **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.

3.23.2 **D. C. Over voltage :**

a) 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.

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

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

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

e) The over voltage protection circuit failure shall not cause any safety hazard.

3.24 **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.

3.25 **Monitoring Alarms and Indicating Lamps** : In addition to the monitoring and alarm indications specified in clause 3.5, the SMPS shall also provide for the following visual indications/display by means of bright LCDs :

3.25.1 **Alarm Indications (On SMPS of the Hybrid Charge controller) :**

A. On FR/FC :

a. FR/FC Over voltage,

b. FR/FC Under voltage or Output Fail

c. FR/FC Over Load (Voltage Droop)

d. Fan fail (due to any reason)

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

B. On DSCA :

a) SMPS output voltage High

12V unit : above 13.9V/Low below 11.4V

48 unit : above 55.6V/Low below 45.6V

b) FR/FC fail (any failure condition as in "A" Above)

c) Mains Out of range

d) Unit Over Load

e) Mains "ON"/Battery Discharge

f) Temp. Compensation fail

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

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

i) Lightning and surge protection Stage II Fail

3.25.2 In case the SMPS fails to take load due to any fault condition, it shall extend an alarm to the charge controller unit as SMPS fail.

3.26 **Battery Health Check** (applicable in case of VRLA Battery only): There shall be a provision of monitoring the voltage, current, trickle current, conductance and temperature at a set periodicity (programmable) of the batteries associated with the power plant. There shall also be 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) (Refer TEC GR 66110:2024~~Annexure 3 for specified protocol~~). Any abnormality observed during these tests shall be highlighted.

There 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.

The conductance measurements/observations shall be off-line to prevent noise interference. The first observation of conductance, recorded by the unit shall form the base value for future comparison.

Note: The feature shall be optional. However, type approval shall only be accorded with the above provision. The manufacturer will give the list of hardware equipment required for the purpose in the instruction and maintenance manual. User 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 (indicated in the instruction manual) for the purpose.
~~In Case of Li Ion Battery Chemistry , This will not be required in CCU. These parameter can get from L Ion Battery through RS485 /CAN communication like SOC%, SOH , each Cell Voltage etc.~~

3.27 **Remote control and monitoring:** ~~The Charge controller shall be RS 232/RS 485 compatible. It shall provide for the monitoring, alarm and control of the power plant and its associated batteries from a remote site through RS232 /RS 485/Ethernet (SNMP Protocol). The exchange of information and protocol format between the power plant and remote site shall be as given in the Annexure -3.~~
DSCA controller shall having the necessary features to exchange information between SPV Power supply system & Remote Site monitoring equipment through SNMP and/or RS485 Modbus / RS 232 Communication as applicable and as specified at Section 1.3 of TEC GR 66110: 2024. OEM / Manufacturer of SPV Power supply system shall ensure that this system shall be interoperable with the equipments / products that need to be connected with the SPV system. Further, in case of any problems / issues in interoperability, the concerned manufacturer /OEM shall extend support / help in solving the problems / issues. List of alarms and parameters to be extended over (a)

SNMP / RS485 for remote monitoring (b) RS485/CAN/MODBUS for internal communication shall be as per TEC GR 66110 : 2024 in addition to specifically mentioned in this document, if any. Purchaser may specify the additional alarms to be extended for remote monitoring over and above the alarms listed in TEC GR 66110:2024.

3.28 Battery Bank:

3.28.1 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 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 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.

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

3.28.2 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.

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, taking into consideration the actual load and the autonomy (refer clause 2.3 and Chapter -2 for ordering information of this document).

3.28.3 **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.

3.29 DSCA (Distribution, Switching, Control, Alarm and Monitoring unit)

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The SPV power system shall consist of a common controller called DSCA, based only on menu driven Micro Processor Controlled Techniques for control, monitoring & alarms. It shall control the operation of rectifier/Solar charge controller, battery charging etc. It shall monitor alarms, various parameters and report them to the remote monitoring system. DSCA shall display its Software version.

3.29.1 For remote monitoring purpose, system shall support SNMP (Simple Network Management Protocol) v2 or higher version. However, system shall also support RS-485 modbus / RS 232 communication additionally if it is required by the purchaser/procurer.

3.29.2 DSCA shall have the remote software up-gradation feature through Over the Air (OTA) using Ethernet interface. However, DSCA shall also support remote software up-gradation feature using RS485 interface as applicable.

3.29.3 Setting of all the parameters shall be through menu-driven microprocessor control only. Use of potentiometer at any stage is precluded. The failure of Microprocessor or DSCA shall not affect the setting of individual rectifier / Solar charge controller / battery set and none of the parameter shall be disturbed. (Purchaser may decide about redundancy of DSCA based on its application.) Only the setting of new parameters from DSCA, shall be affected. In the event of failure of DSCA, all the power source units shall take care of the load on latest settings.

3.29.4 There shall be a provision for Automatic isolation/reconnection of battery from the load. The operate and release voltages for these conditions shall be as mentioned in the respective clauses related to Battery.

3.29.5 DSCA shall communicate with Li-ion battery BMS to monitor the parameters and alarms and control the charging current of battery. Similarly, DSCA shall communicate with VRLA battery to monitor the parameters and alarms.

3.29.6 Battery path Current Limit: Battery Charging Current shall be settable as mentioned at the respective clause above.

3.29.7 Protections: Failure of control and sensing circuitry of DSCA shall not cause any hazard. The voltages of the system shall not abnormally increase to endanger the load.

3.29.8 Monitoring Alarms and Indications: Visual indications/display shall be provided by means of bright LCDs/LEDs on DSCA to indicate the following minimum conditions (but not limited to) :

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a) Battery Voltage High (above 56V)/Low (below 45.6V)
b) Rectifier fail
c) Mains fail
d) Mains "ON"/Battery Discharge

e) Fan Fail (in case fan provided at rack level)

f) Battery Fail or Battery missing (separate for each Battery)

g) Battery isolated from the load

h) Lightning and surge protection

i) Solar charge controller fail

j) AC output voltage abnormal

3.29.9 DSCA shall have inbuilt logic to maximize solar utilization.

Other Features (optional): The purchaser may decide the requirements for optional Management features like

a) Energy saving Management,

b) Battery Efficiency & Management,

c) Data Logging of all the parameters and alarms which may be downloadable in excel or any readable format.

d) Ability to calculate and display run hrs with input power source from EB, Solar, Battery as applicable,

e) USB port or any other secured mode to download log file in pen drive, other authorised storage devices, etc.

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. Use of CACT approved/ NABNL / TEC accredited lab validated components only is permitted for the purpose. 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 on the AC at input side ~~of the SMPS~~ shall be rated at 600V (minimum).

4.2 Power transformers & Chokes: Power transformers & chokes shall use Class F ~~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 with current limiting device or circuit breakers of proper rating shall be provided wherever appropriate for protection of control/sensing circuit. Fuses shall conform to BIS / CACT specifications.

4.4 **Component Approval:** All the components, used, shall be CACT/NABL/ TEC accredited lab ~~UL~~ approved. 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 system ISO 9001:201508 ~~(latest issue)~~, 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 (latest issue) pertaining to environmental requirements.~~

b) All the equipments shall be manufactured as per the latest ~~BSNL 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 as per purchaser's requirement.~~by QA wing of BSNL.~~

4.7 **MTTR / MTBF / SPARES:**

4.7.1 The MTTR (Mean Time To Restore) and MTBF (Mean Time Between Failure) predicted and observed values shall be furnished along-with calculations by the manufacturer.

4.7.2 The MTBF of the system and individual module (CCU, SMPS, Battery, DSCA) shall not be less than 100,000 hours excluding fan.

4.7.3 The mean time to replace / restore (MTTR) a faulty module/unit (Rectifier, CCU) shall be less than 2 minutes.

4.7.4 ~~shall be verified as per QM-115.~~ 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**:

SPV module/panel/array, Charge Controller, SMPS (in case of hybrid power supply), Mounting Structure and Batteries in compliance with the requirements of relevant clause of TEC 14016:2010 (Old no.QM-333, category B2 or D whichever is applicable) shall be capable of working in a saline atmosphere in coastal areas and shall be free from any corrosion at any period of time. It shall also comply with vibration requirements of clause 12.0 of TEC 14016:2010 . 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 TEC 14016~~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 QM-333. The environmental tests shall be performed by configuring the power System as follows:

i. DSCA for ultimate capacity

ii. One FR/FC, CCU.

5.1 **Environmental requirements for SPV module/Panels :** The SPV modules shall be soaked in natural sunlight, at least for a week, before offering for tests or supply in accordance with the relevant iInstructions issued by the Mministry of New and Renewable Energy (MNRE), if any.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 shall be carried out by the purchaser.QA, BSNL. SPV Modules, in addition to the tests as given in clauses 5.0 and 5.1, shall satisfy the following additional environmental test conditions as desired by the purchaser.: These are very old standard and can be removed now

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	Test schedule/procedure for this GR.

		associated structures.	
9.	Bending and 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.	Test schedule/procedure for this CR.

5.2 **Environmental requirements for Charge Controller and SMPS:** The Charge Controller and SMPS, in addition to the environmental requirements given in clause 5.0 above, shall also operate at the specified rating and conform to the requirements contained in QM 333 Category B2.

5.35.2 **Burn-in Test:** The Charge controller and SMPS shall be capable of withstanding a burn-in test for 72 hours at an ambient temperature of 50°C, when the equipment is 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. 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 and Chokes: 70°C for B grade of Insulation. For higher grade of insulation, higher temperature rise is permissible subject to the following conditions :

i) It is at least 20°C below the permissible limit for the grade of insulation.
ii) The temperature rise shall be at least 30°C below the curie temperature

of the magnetic material.

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

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

~~5.4~~5.3 **Insulation Resistance and Voltage Proof Tests:**

~~5.4.1~~ **Insulation Resistance Test:** ~~The insulation resistance of a fully wired Charge Controller and SMPS, when tested with a 500V DC megger, shall not be less than 5 Meg ohms for the following conditions:~~

~~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).~~

~~In case of Maximum Input voltage 63V , Charge controller DC input to DC output isolation is not required~~

The insulation resistance of a fully wired Charge Controller and SMPS, when tested with a 500V DC megger shall not be less than 5meg ohms for the following conditions:

- Interconnected Input terminals and Earth
- Interconnected Output terminals and Earth
- Interconnected Input terminals and Interconnected output terminals (in case of galvanic isolation is provided as per purchaser's requirement) .

~~5.4.2~~5.3.1 **Voltage Proof Test:** ~~With EMI/RFI capacitors and MOVs/Tranzorbs removed from the circuit a test voltage of 1500V/50Hz is applied for one minute, between:~~

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~~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 and shorted DC output terminals (SMPS).~~

~~e) Shorted input DC terminals and shorted DC output terminals((Charge Controller)~~

~~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 shorted AC input and DC output terminals.~~

~~b) 50V DC can be applied for one minute between shorted AC Input terminals, shorted input DC terminals, shorted DC output terminals and earth.~~

~~This DC voltage test is in accordance with UL1950 and IEC 950 Standards~~ .

~~No breakdown or abnormal temperature rise shall occur.~~ No breakdown or abnormal temperature rise shall occur, when-after EMI/RFI capacitors and MOVs/Tranzorbs etc. removed from the circuit.

Test to be Conducted as under:

SMPS Rectifier

1. 1.5KVAC between Earth and AC input
2. 650V DC between DC output and Earth
3. 2KVAC between AC input and DC output

Solar CCU

1. 650V DC Input and Earth
2. 650V DC Output and Earth
3. 1200V DC between DC Input and DC Output.

Alternatively, without removing EMI/RFI capacitors, the lightning protection

circuitry and Tranzorbs etc., but with EMI/RFI discharge resistors removed:

SMPS Rectifier

1. 2150V DC between Earth and AC input
2. 650V DC between DC output and earth
3. 2150DC between AC input and DC output

Solar CCU

1. 650V DC input and earth
2. 650V DC output and earth
3. 1200V DC between DC Input and DC Output.

This DC voltage test is in accordance with IEC 62368-1 Standards.

~~5.5~~5.4 **Lightning and Surge Protection:** The power supply shall be adequately protected against lightning at both AC input mains and SPV input side by a protection device, in a separate casing, attached on out side the charge controller in the following configuration:

~~5.5.1~~5.4.1 **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.

~~5.5.2~~5.4.2 **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.

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 total surge discharge maximum current more than 40~~15~~KA (8/20 µsec) & nominal discharge current of 20KA (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.

The **purchaser** may specify the requirement for provisioning of an integrated internal by—pass SPV-DC fuse or external series fuse or external disconnector / circuit breaker connected in +ve & -ve strings 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 IEC 61643-31~~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.

~~5.5.3~~5.4.3 **Protection on AC Main Side (Hybrid Power supply only):** This protection shall be the be part of Telecom Site. The TEC GR on Lightening and Surge Protection of Telecom Sites (No. TEC 66130: 2024 as amended time to time~~/GR/FLA/LSP - 001/01/June.2010~~) shall be referred.

6.0 **Electromagnetic Compatibility (EMC):**

General Electromagnetic Compatibility (EMC) Requirements: - The equipment shall be designed to minimize the level of electromagnetic interference (EMI), both conducted and radiated, detected in its vicinity and generated by the system and it 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: CISPR 11 (2015) or latest

"Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement ". ~~"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)~~ 11 (2015) or latest..

ii. The values of limits shall be as per ~~TEC Standard No. TEC/SD/DD/EMC-221/05/OCT-16~~ relevant tables under CISPR 11 (2015) or latest..

~~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) Conducted Susceptibility Limits: The 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

Level	Open Circuit output test voltage (kV)	
	Slow damped oscillatory wave (100KHz,1MHz)	
	Line to Line	Line to Ground
2	0.5	1

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

The limits and test methods as per IEC 61000- 4-2, (both Contact discharge method and Air discharge method) as given below:

Test level:

Contact discharge	Air discharge

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Level	Test voltage (KV)	Level	Test voltage (KV)
2	4	3	8

~~**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;~~

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~~c)~~d) ~~**Immunity to radiated RF**~~ **Radiated radio-frequency Electromagnetic field immunity limits: The limits and test methods as specified in IEC 61000-4-3.**~~:~~

Test level:

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

~~**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)~~e) **Electrical fast transient/Burst immunity limits** ~~**Immunity to fast transients (burst):**~~ The limits and test methods as specified in IEC 61000-4-4.

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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
2	1	2.5
Rise time of one Pulse - 5 ns +/- 30% Impulse duration - 50 ns +/- 30%		

~~**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)~~f) **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.~~

The limits and test methods shall be as specified in IEC 61000-4-5 "Testing & Measurement techniques for Surge immunity test" for the following limits:-

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For mains power input ports:

(a) 1.0 kV +/- 10% peak open circuit voltage for line to ground coupling
(b) 0.5 kV +/- 10% peak open circuit voltage for line to line coupling
(c) 4.0 kV +/- 10% peak open circuit voltage for line to ground coupling
(d) 2.0 kV +/- 10% peak open circuit voltage for line to line coupling

~~f)~~g) ~~**Immunity to conducted disturbance induced by Radio frequency fields**~~ **Radio-Frequency Conducted Susceptibility immunity limits**:

~~**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.~~

The limits and test methods as per IEC 61000-4-6.

Test level:

Frequency range : 150KHz to 80MHz	
Level	Voltage level (e.m.f.)
2	3

g)h) **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~~

Performance Criteria shall be as per Table 1 under Clause 6 of TEC Standard No. TEC 11016:2016 (old no. TEC/SD/DD/EMC-221/05/OCT-16).

Applicable Performance Criteria shall be as per Table 3 under Clause 7.2 of TEC Standard No. TEC 11016:2016 (old no. TEC/SD/DD/EMC-221/05/OCT-16).

6.1 **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:

7.1 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.~~ relevant safety requirements as per IS 16242 (Part 1) : 2014/ IEC 62040-1 : 2017+ AMD1:2021+ AMD2:2022 or latest as prescribed under Table no. 1 of the TEC document 'SAFETY REQUIREMENTS OF TELECOMMUNICATION EQUIPMENT': TEC10009: 2024.

8.0 Other requirements:

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. SMPS as per clause 3.6 shall be mounted in a 19" rack.

8.1.1 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. Sheet used in manufacturing Shall be Galvanized (GI – >80gsm) or MS Iron.

8.1.2 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.

SMPS, using 25A / 50A FR-FC modules, may be forced cooled for which use of DC fans only is permitted. 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 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.

8.1.3 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.

8.1.4 Provision for mounting the charge controller unit on the wall or table shall be provided. In case of Hybrid SPV power supply system, the rack shall have the provision to accommodate solar charge controller unit. SMPS rack shall have the provision for fixing it on the floor.

8.1.5 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.

8.1.6 The unit or rack shall ensure uniform floor loading below 320 kg/Sq metre.

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

8.1.8 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.

8.1.9 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.

8.1.10 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.

8.1.11 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.

8.1.12 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.

8.1.13 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.

8.1.14 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.

8.1.15 The FR/FC modules shall be cooled by natural convection for smaller capacities i.e. 12.5A. FR/FC modules of 25A and 50A may have natural or forced cooling.

8.1.16 AC input to FR/FC modules shall be through 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.

8.1.17 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.

8.1.18 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.

8.1.19 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.

8.1.20 DSCA shall be provided for the ultimate system capacity as per clause 8.15.3. 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.

8.2 Terminations :

8.2.1 **A C Terminations :**

8.2.1.1 The input terminals of SMPS and FR/FC modules shall be clearly marked as L and N.

8.2.1.2 All the terminals, except AC earth, shall be electrically isolated.

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 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 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 The provision for interconnection between telecom equipment, Charge controller and battery and also between SMPS Telecom equipment and battery (along with switching arrangement). 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.

8.2.3 All the termination points for AC input, solar, battery, load and earthing shall be easily accessible from front, top & rear with proper labelling and safety compliance.

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

8.4 **Bus Bars:** Tinned Bus-bars or tinned High conductivity electrolytic copper strips with purity of 99.90% (min) as per BIS standard IS 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).

8.4.1 Bus-bar Riser height wherever applicable shall be 250 mm for both exchange and battery. however 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 including Uninyvin cables used shall be fire retardant as per IS 1554 with amendment 1 (June 94). All the cables & wires including Uninyvin cables used shall also be Rodent & reptiles repellent. 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 :

In case of standalone SPV power supply system, the 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 meters or LCD. Display's resolution should be such that it is clearly and unambiguously readable from a distance of 1 metre. The meters 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.~~

In case of hybrid SPV power supply system, there shall be provision to monitor parameter of the system with the help of DSCA Display or external meter to read voltage and current of the System, Battery, Charge Controller, SMPS. Display resolution Shall be such that it is clearly and unambiguously readable from a distance of 1 meter.

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.

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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. NABL approved test reports are also be acceptable as an alternative to approval of CACT wing.

8.7 Dimensions:

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 and lightning protection section. It shall take care of the thermal engineering requirements of the unit. Dimensions shall not be changed after Type Approval.

8.7.3 **SMPS:** SMPS rack shall only be 19" (482.6mm). Dimensions of the rack shall be as given below :

Height: 1500mm (Max.)
Depth: 600mm (max.)
Width: 750mm (max.)

8.8 Earthing: 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 in effective electrical contact with the body of the 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 terminals of the module/panel, battery, Charge Controller, components of the charge controller and terminals and components of SMPS, shall be properly sign written to enable identification of each of them with reference to the supplier's installation manual. Designation of keys, switches and other components mounted on the front/inside panel and other operating positions shall clearly 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 screen printed, circuit and cabling diagram, of Charge Controller and SMPS shall be 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 Finish & Painting:

a) **Corrosion Resistance:** All surfaces of the equipment including frameworks, modules, covers, chassis, brackets, etc shall be treated to prevent corrosion.

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) The finish of the structure and panels shall conform to the latest issue of IS 101 and IS 168. The structure and panels shall only be powdered coated. The thickness of powder coating shall be between 6050 to 10070 micrometers. The Colour used shall conform to IS 5 latest issue. Colour scheme shall be as follows :

Outside except front panel - RAL 7035, (Light Grey)~~Satin Blue, No. 177~~

Inside and front panel - Shall harmoniously match the outside Colour

8.12 **Name Plate**: A name plate, anodised shall be suitably fixed to the modules(inside the glass), iron structure and charge controller and SMPS with the following details.

8.12.1 **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.

8.12.2 **Name Plate for Charge Controller and SMPS unit/rack :**

i) GR number
ii) Name of the User :

iii) Manufacturer's name and identification mark
iv) Name of the Item
v) Model No.
vi) Type of unit
vii) Serial No. of the unit
viii) Year of manufacture
ix) TAC No.
x) Rating and voltage of the charge controller/SMPS .
xi) Battery Capacity and voltage
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)
xvii) Output Voltage and Current

8.12.3 On the front top of the Charge controller cabinet and SMPS rack, an anodized, screen printed or any other arrangement ensuring better life expectancy designation plate in '**BOLD**' letters showing **"12V/…W or 24 V /…KW or 48V/….KW SPV POWER SUPPLY FOR TELECOM EQUIPMENT WITH 12V OR 48V/ …. A SMPS USING …A FR/FC MODULE"** shall be provided as per the power supply specification.

8.13 Mounting Structure for SPV Array:

8.13.1 A suitable hot dip galvanized iron structure shall be provided for mounting the SPV module on any of the following locations:-

a) Roof top
b) On the ground at an angle of tilt with horizontal, in accordance with the latitude of the place of installation.
c) On the self supporting mast.

8.13.2 The steel for the mounting structure shall be as per IS 2062: 1992 and mounting structure galvanisation shall be in compliance of IS 4759 (latest issue).

8.13.3 The mounting arrangement shall be suitable for column mounting or flat surface, as desired by the ordering authority.

8.13.4 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.

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

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

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

8.14 Rack Configuration : Rack is composed of following units, accommodated in 19" (482.6 mm) Sub-rack :

a) Float Rectifier-cum-Float Charger (FR/FC)
b) Distribution, Switching, Control, Alarm and Monitoring (DSCA) unit.

8.15 Unit Configuration :

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

8.15.2 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.

8.15.3 The SMPS shall be tested for the following ultimate capacities for awarding

Category No.	Basic Module	Ultimate capacity
1	12V/12.5A (Single phase)	37.5A
2	12V/12.5A(Single phase)	62.5A
3	48V/12.5A(Single Phase)	75A
4	48V/25.0A(Single phase)	150A
5	48V/50.0A(Single phase)	150A

CHAPTER-2

[Chapter to start from fresh odd numbered page only]

9.0 Information for the procurer of product

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

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 :** Two copies of technical 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. A soft copy or QR code and / or ~~as well as a~~ hard copy of the above shall also be provided as specified by the purchaser. 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 advantages of PWM control techniques may be taken.

9.15 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.

9.16 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).

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

9.18 In respect of ~~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.

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

9.20 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.

9.21 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).

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

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

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

9.25 Charge controller ratings: -

a) 12V/500W Charge controller
b) 12V/1000W Charge controller
c) 48V/2KW Charge controller
d) 48V/5KW Charge controller
e) 48V/ 10KW charge controller
f) 24V/ 1KW charge controller
g) 24V/ 5 KW Charge Controller

9.26 SMPS Rating:
Capacity: 12V/37.5A or 12V/62.5A or 48V/37.5A or 48V/75A or 48V/150A

FR/FC Module Rating: 12V/12.5A or 48V/12.5A or 48V/25A or 48V/50A

9.27 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 '~~30~~550Wp or higher' as per the requirement.

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

9.29 Number of basic modules required for the present load.

9.30 Type of mounting structure for SPV panel array required.

9.31 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.

9.32 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.

9.33 Purchaser may specify '~~30~~550Wp or higher' as per the requirement. (Clause 2.1.1).

9.34 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 as per IEC 60950-1{2005} shall be made from safety point of view. (Clause 2.1.1).

9.35 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.

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

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).

9.38 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).

9.39 The purchaser may specify the requirement for provisioning of an integrated internal by pass SPV-DC fuse or external series fuse or external disconnector connected in +ve & -ve strings so that SPD can extinguish the DC arc safely.(clause 5.5.2).

9.40 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).

9.41 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.

9.42 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)

9.43 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)

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

9.45 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.

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

9.47 All functional parameter for SMPS FR/FC has been taken from GR 'SMPS based Power Plants' No.TEC 66110: 2024~~/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.

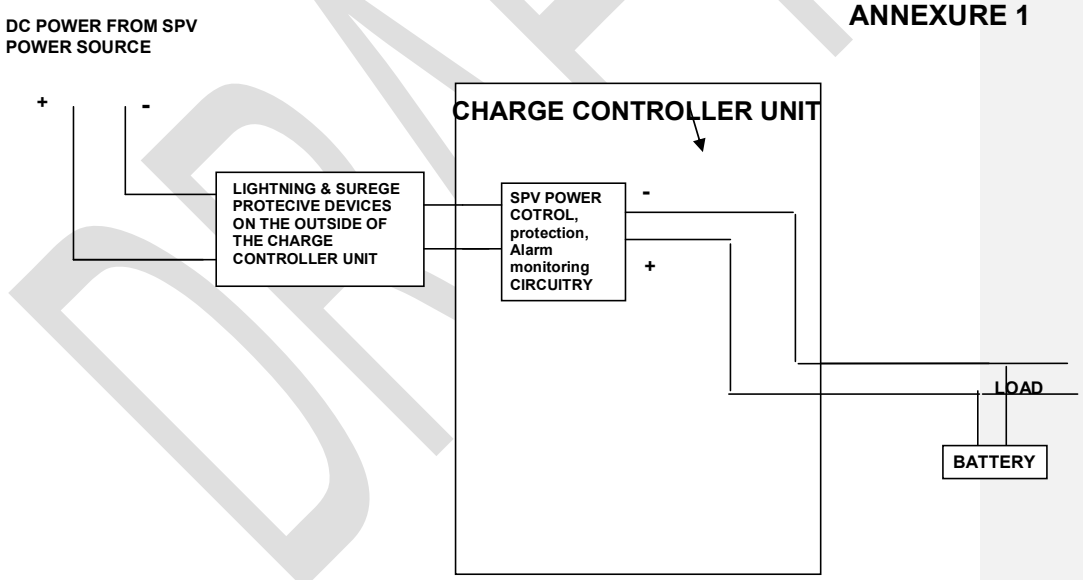
9.48 In the document, some features (which have been marked as per purchaser / procurer requirements) needs to be examined by the

purchaser / procurer and suitably specified in the tender conditions / ordering information as per their requirement.

~~9.47~~9.49

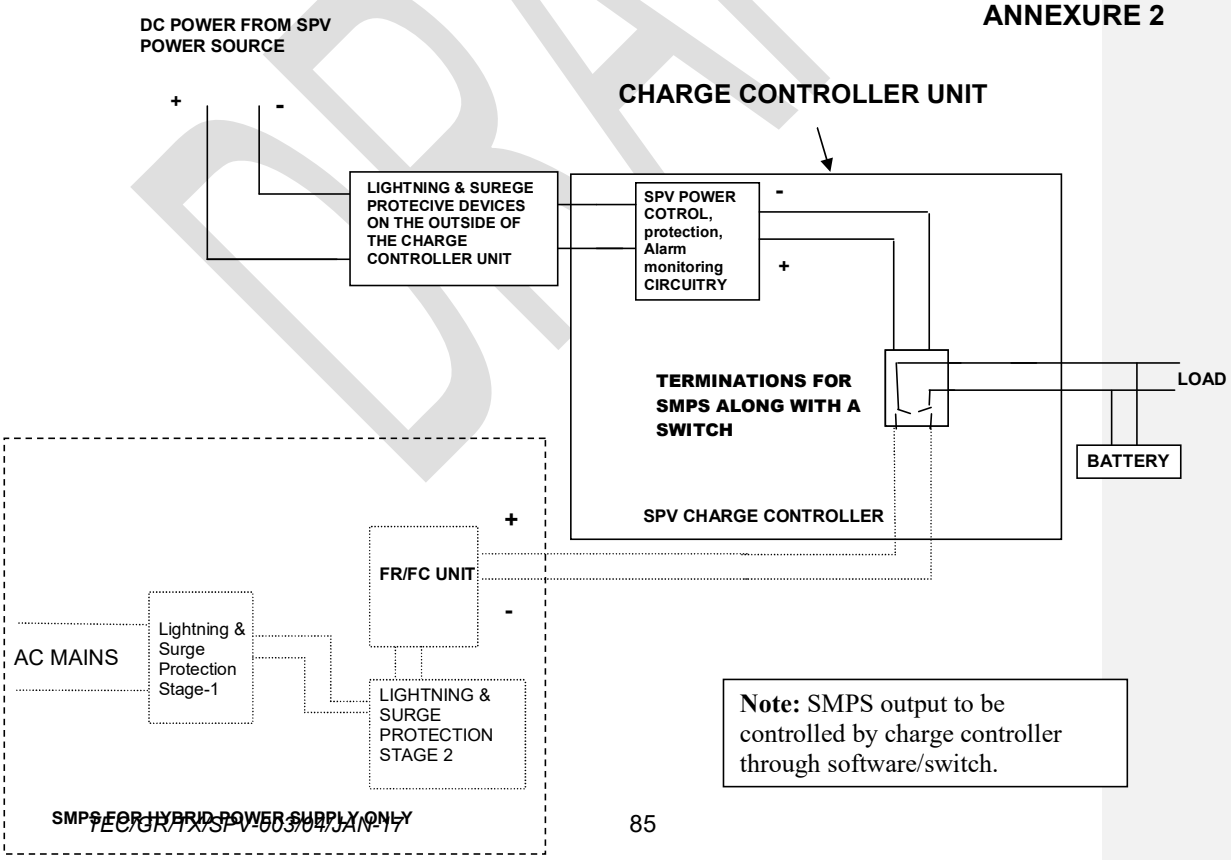
Note: The ordering authority shall issue instructions to all concerned so as to ensure that the battery is fully charged before its dispatch to the site.

ANNEXURE 1



BLOCK SCHEMATIC FOR STANDALONE SPV POWER SUPPLY Mode

ANNEXURE 2



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

BLOCK SCHEMATIC FOR HYBRID SPV POWER SUPPLY

ANNEXURE-3

Protocol or Sequence of Exchange of Information between Power plant & its peripherics & Remote Site monitoring equipment

RS-485 (4 wire interface at speed 19.2kbps)/Ethernet (SNMP Protocol) (10/100 Base T) shall be used for both monitoring & control between power plants and other associated equipments 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 along with 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 Plant s(AC-DC Converters) (sixteen Max.)	00 to 0F	00 to 0F

Battery Bank (Maximum sixteen)	10 to 1F	10 to 1F
Inverter Systems (Max Sixteen)	20 to 2F	20 to 2F
UPS System (Max Sixteen)	30 to 3F	30 to 3F
SPV System(Max Sixteen)	40 to 4F	40 to 4F
DG Set (Max Sixteen)	50 to 5F	50 to 5F
Air conditioning group (Max Sixteen)	60 to 6F	60 to 6F
Fire Alarm Group ((Max. Sixteen)	70 to 7F	70 to 7F
Security Group (Max Sixteen)	80 to 8F	80 to 8F
Flood Group (Max Sixteen)	90 to 9F	90 to 9F
Any other equipment	A0 to FF	A0 to FF

6th Byte: Classification of Information

Class of Parameter	**Hex Code**	
	From Master	**From Slave 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 to FF	06 to FF

7th to 9th Byte: Parameter name:

SPV Systems (Hybrid & Pure SPV Systems) : 5th Byte : 40 to 4F
Note: In case of pure SPV Power Supply the FR/FC parameters are to be skipped.

i) Alarms Urgent (6th Byte : 01)

Parameter Name	**Hex Code**	
	From Master	**From Slave Equipment**
Mains "ON"/Battery Discharging - Any reason for failure of FR/FC unit to deliver the output (including AC input contactor failure)	01, 00, 00	01, 01, 00 : OK 01, 02, 00 : FAULT
Battery Fail OR No Battery Battery 1	02, 00, 00	02, 01, 00 : OK 02, 02, 00 : FAULT
Battery Fail OR No Battery Battery 2	03, 00, 00	03, 01, 00 : OK 03, 02, 00 : FAULT
----------	Same sequence	Same sequence
Battery Fail OR No Battery Battery 5	Same sequence	Same sequence
System Over Load	Same sequence	Same sequence
Load Voltage High	Same sequence	Same sequence
Load Voltage Low	Same sequence	Same sequence
Battery Low	Same sequence	Same sequence
Fan Fail Rack	Same sequence	Same sequence
Temp. Compensation fail Battery 1	Same sequence	Same sequence
Temp. Compensation fail Battery 2	Same sequence	Same sequence
……		
Temp. Compensation fail Battery 5	Same sequence	Same sequence
SPV Source delivering output but not available to the load	Same sequence	Same sequence
Any other Alarm condition	Same sequence	Same sequence

ii) Alarms Non-Urgent (6th Byte : 02)

Parameter Name	**Hex Code**	
	From Master	**FromSlave Equipment**
Mains High	01, 00, 00	01, 01, 00 : OK 01, 02, 00 : FAULT
Mains Low	02, 00, 00	02, 01, 00 : OK 02, 02, 00 : FAULT
FR/FC 1 : Fail	Same sequence	Same sequence
Fan Fail	Same sequence	Same sequence
Over Voltage	Same sequence	Same sequence
Under Voltage/Output Fail	Same sequence	Same sequence
Over Load	Same sequence	Same sequence
FR/FC 2 : Fail	Same sequence	Same sequence

~~Fan Fail~~	~~Same sequence~~	~~Same sequence~~
~~Over Voltage~~	~~Same sequence~~	~~Same sequence~~
~~Under Voltage/Output Fail~~	~~Same sequence~~	~~Same sequence~~
~~Over Load~~	~~Same sequence~~	~~Same sequence~~
~~……~~	~~Same sequence~~	~~Same sequence~~
~~FR/FC 30 : Fail~~	~~Same sequence~~	~~Same sequence~~
~~Fan Fail~~	~~Same sequence~~	~~Same sequence~~
~~Over Voltage~~	~~Same sequence~~	~~Same sequence~~
~~Under Voltage/Output Fail~~	~~Same sequence~~	~~Same sequence~~
~~Over Load~~	~~Same sequence~~	~~Same sequence~~
~~SPV Source Voltage High~~	~~Same sequence~~	~~Same sequence~~
~~SPV Source Voltage low~~	~~Same sequence~~	~~Same sequence~~
~~Any other Alarm condition~~	~~Same sequence~~	~~Same sequence~~

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

~~Parameter Name~~	**~~Hex Code~~**	
	~~From Master~~	**~~FromSlave Equipment~~**
~~Power plant on Mains/Stand by~~	~~01, 00, 00~~	~~01, 01, 00 : MAINS~~ ~~01, 02, 00 : STAND BY~~
~~Load on power plant/SPV System/Battery~~	~~02, 00, 00~~	~~02,01, 00 : Power Plant~~ ~~02, 02, 00 SPV System~~ ~~02, 03, 00 : Battery~~
~~System Voltage~~	~~03, 00, 00~~	~~03, VALUE(H), VALUE(L)~~
~~System Load~~	~~04, 00, 00~~	~~04, VALUE(H), VALUE(L)~~
~~FR/FC 1 : Voltage~~	~~Same sequence~~	~~Same sequence~~
~~Load~~	~~Same sequence~~	~~Same sequence~~
~~FR/FC 2 : Voltage~~	~~Same sequence~~	~~Same sequence~~
~~Load~~	~~Same sequence~~	~~Same sequence~~
~~……~~	~~Same sequence~~	~~Same sequence~~
~~FR/FC 30 : Voltage~~	~~Same sequence~~	~~Same sequence~~
~~Load~~	~~Same sequence~~	~~Same sequence~~
~~Battery Path Current~~	~~Same sequence~~	~~Same sequence~~
~~Battery trickle Current~~	~~Same sequence~~	~~Same sequence~~
~~Load sharing performance (%)~~	~~Same sequence~~	~~Same sequence~~
~~Any other Alarm condition~~	~~Same sequence~~	~~Same sequence~~

~~iv) Parameter Control (6th Byte : 04)~~

~~Parameter Name~~	**~~Hex Code~~**	
	~~From Master~~	**~~From Slave Equipment~~**
~~Battery Low~~	~~01, 00, 00~~	~~01, VALUE(H), VALUE(L)~~
~~FR/FC Unit Over Load~~	~~01, 00, 00~~	~~01, VALUE(H), VALUE(L)~~
~~System Float Voltage~~	~~Same sequence~~	~~Same sequence~~
~~System Charge Voltage~~	~~Same sequence~~	~~Same sequence~~
~~Load Voltage High~~	~~Same sequence~~	~~Same sequence~~
~~Load Voltage Low~~	~~Same sequence~~	~~Same sequence~~
~~Battery 1 Path Current Limit~~	~~Same sequence~~	~~Same sequence~~
~~Battery 2 path current limit~~	~~Same sequence~~	~~Same sequence~~
~~……~~	~~Same sequence~~	~~Same sequence~~
~~Battery 5 Path current limit~~	~~Same sequence~~	~~Same sequence~~
~~Mains High~~	~~Same sequence~~	~~Same sequence~~
~~Mains Low~~	~~Same sequence~~	~~Same sequence~~
~~FR/FC 1 : Float Voltage~~	~~Same sequence~~	~~Same sequence~~
~~Charge Voltage~~	~~Same sequence~~	~~Same sequence~~
~~Over Voltage~~	~~Same sequence~~	~~Same sequence~~
~~Under Voltage~~	~~Same sequence~~	~~Same sequence~~
~~Over Load~~	~~Same sequence~~	~~Same sequence~~
~~FR/FC 2 : Float Voltage~~	~~Same sequence~~	~~Same sequence~~
~~Charge Voltage~~	~~Same sequence~~	~~Same sequence~~
~~Over Voltage~~	~~Same sequence~~	~~Same sequence~~
~~Under Voltage~~	~~Same sequence~~	~~Same sequence~~
~~Over Load~~	~~Same sequence~~	~~Same sequence~~
~~……~~	~~Same sequence~~	~~Same sequence~~
~~FR/FC 30 : Float Voltage~~	~~Same sequence~~	~~Same sequence~~

Charge Voltage	Same sequence	Same sequence
Over Voltage	Same sequence	Same sequence
Under Voltage	Same sequence	Same sequence
Over Load	Same sequence	Same sequence
SVP Source Voltage High	Same sequence	Same sequence
SPV Source Under voltage	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: (6th Byte: 05)

Parameter Name	Hex Code	
	From Master	**From Slave Equipment**
FR/FC Unit Make	May be generated in the remote controller by manual inputting	
FR/FC unit Ultimate capacity	May be generated in the remote controller by manual inputting	
FR/FC Unit Equipped capacity	03,00,00	03, 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 sequence
Number of FR/FC Faulty	Same sequence	Same sequence
SPV Power source Unit Make	May be generated in the remote controller by manual inputting	
SPV Power source unit Ultimate capacity	May be generated in the remote controller by manual inputting	
SPV Power source Equipped capacity	0A,00,00	0A, VALUE(H), VALUE(L)
Number of SPV panels	Same sequence	Same sequence
Rating of SPV panels	Same sequence	Same sequence
Number of panels connected	Same sequence	Same sequence
Number of panels faulty	Same sequence	Same sequence
Any other information	Same sequence	Same sequence

Note: In case the above information can not be provided by the SPV Power Supply Controller, the same may be generated in the First stage system by manually in putting the data. FR/FC fault may be recorded by analysing FR/FC fail alarms.

Battery Bank (5th Byte : 10 to 1F) :

i) Alarms Urgent (sixth byte as 01)

Parameter Name	Hex Code	
	From Master	**From 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, 02, 00 : High 02, 03, 00 : Low
Trickle Current OK/High (As per set value)	03, 00, 00	03, 01, 00 : OK 03, 02, 00 : High
Battery Current OK/High (As per limit set)	04, 00, 00	04, 01,00 : OK 04, 02, 00 : High
Cell 1 Failing (Voltage High/ low, Impedance high/Low Temp High/low as compared to other cells)	Same sequence	Same sequence
Cell 2 Failing	Same sequence	Same sequence
……	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 sequence	Same sequence
Battery Current OK/High (As per limit set)	Same sequence	Same sequence
Cell 1 Failing	Same sequence	Same sequence
Cell 2 Failing	Same sequence	Same sequence
……	Same sequence	Same sequence

Cell 24 Failing	Same sequence	Same sequence
----------	Same sequence	Same sequence
Battery 5 : 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 sequence	Same sequence
Battery Current OK/High (As per limit set)	Same sequence	Same sequence
Cell 1 Failing	Same sequence	Same sequence
Cell 2 Failing	Same sequence	Same sequence
……	Same sequence	Same sequence
Cell 24 Failing	Same sequence	Same 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 impedance/ conductance 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, 00, 00	01, 01, 00 : NO 01, 02, 00 : YES
Any other Alarm condition	Same sequence	Same 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 sequence	Same sequence
Temperature cell1	Same sequence	Same sequence
Temperature cell 2	Same sequence	Same sequence
----------	Same sequence	Same sequence
Temperature cell 24	Same sequence	Same sequence
Impedance Battery	Same sequence	Same sequence
Impedance cell1	Same sequence	Same sequence
Impedance cell 2	Same sequence	Same sequence
----------	Same sequence	Same sequence
Impedance cell 24	Same sequence	Same sequence
Battery 2 : State of Charge Battery (%)	Same sequence	Same sequence
Voltage Battery	Same sequence	Same sequence
Voltage - cell1	Same sequence	Same sequence
Voltage - cell 2	Same sequence	Same sequence
----------	Same sequence	Same sequence
Voltage cell 24	Same sequence	Same sequence
Temperature Battery	Same sequence	Same sequence
Temperature cell1	Same sequence	Same sequence
Temperature cell 2	Same sequence	Same sequence
----------	Same sequence	Same sequence
Temperature cell 24	Same sequence	Same sequence
Impedance Battery	Same sequence	Same sequence
Impedance cell1	Same sequence	Same sequence
Impedance cell 2	Same sequence	Same sequence
----------	Same sequence	Same sequence
Impedance cell 24	Same sequence	Same sequence
----------	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 sequence~~	~~Same sequence~~
~~----------~~	~~Same sequence~~	~~Same sequence~~
~~Voltage cell 24~~	~~Same sequence~~	~~Same sequence~~
~~Temperature Battery~~	~~Same sequence~~	~~Same sequence~~
~~Temperature cell1~~	~~Same sequence~~	~~Same sequence~~
~~Temperature cell 2~~	~~Same sequence~~	~~Same sequence~~
~~----------~~	~~Same sequence~~	~~Same sequence~~
~~Temperature cell 24~~	~~Same sequence~~	~~Same sequence~~
~~Impedance Battery~~	~~Same sequence~~	~~Same sequence~~
~~Impedance cell1~~	~~Same sequence~~	~~Same sequence~~
~~Impedance cell 2~~	~~Same sequence~~	~~Same sequence~~
~~----------~~	~~Same sequence~~	~~Same sequence~~
~~Impedance 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 (H), Value (L)~~	~~01, Value (H), Value (L)~~
~~Voltage limit for alarm~~	~~02, Value (H), Value (L)~~	~~02, Value (H), 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~~
~~Impedance Limit for Alarm~~	~~Same sequence~~	~~Same sequence~~
~~Cell 1 : Voltage limit for alarm~~	~~Same sequence~~	~~Same sequence~~
~~Cell 2 : Voltage limit for alarm~~	~~Same sequence~~	~~Same sequence~~
~~----------~~	~~Same sequence~~	~~Same sequence~~
~~Cell 24 : Voltage limit for alarm~~	~~Same sequence~~	~~Same sequence~~
~~Cell 1 : Temperature limit for Alarm~~	~~Same sequence~~	~~Same sequence~~
~~Cell 2 : Temperature limit for alarm~~	~~Same sequence~~	~~Same sequence~~
~~----------~~	~~Same sequence~~	~~Same sequence~~
~~Cell 24 : Temperature limit for alarm~~	~~Same sequence~~	~~Same sequence~~
~~Cell 1 : Impedance limit for alarm~~	~~Same sequence~~	~~Same sequence~~
~~Cell 2 : Impedance limit for alarm~~	~~Same sequence~~	~~Same sequence~~
~~----------~~	~~Same sequence~~	~~Same sequence~~
~~Cell 24 : Impedance limit for alarm~~	~~Same sequence~~	~~Same sequence~~
~~Battery 2 : Trickle current Limit~~	~~Same sequence~~	~~Same sequence~~
~~Voltage limit for alarm~~	~~Same sequence~~	~~Same sequence~~
~~Charge Current limit for alarm~~	~~Same sequence~~	~~Same sequence~~
~~Temperature limit for alarm~~	~~Same sequence~~	~~Same sequence~~
~~Impedance Limit for Alarm~~	~~Same sequence~~	~~Same sequence~~
~~Cell 1 : Voltage limit for alarm~~	~~Same sequence~~	~~Same sequence~~
~~Cell 2 : Voltage limit for alarm~~	~~Same sequence~~	~~Same sequence~~
~~----------~~	~~Same sequence~~	~~Same sequence~~
~~Cell 24 : Voltage limit for alarm~~	~~Same sequence~~	~~Same sequence~~
~~Cell 1 : Temperature limit for Alarm~~	~~Same sequence~~	~~Same sequence~~
~~Cell 2 : Temperature limit for alarm~~	~~Same sequence~~	~~Same sequence~~
~~----------~~	~~Same sequence~~	~~Same sequence~~
~~Cell 24 : Temperature limit for alarm~~	~~Same sequence~~	~~Same sequence~~
~~Cell 1 : Impedance limit for alarm~~	~~Same sequence~~	~~Same sequence~~
~~Cell 2 : Impedance limit for alarm~~	~~Same sequence~~	~~Same sequence~~
~~----------~~	~~Same sequence~~	~~Same sequence~~
~~Cell 24 : Impedance limit for alarm~~	~~Same sequence~~	~~Same sequence~~
~~----------~~	~~Same sequence~~	~~Same sequence~~
~~Battery 5 : Trickle current Limit~~	~~Same sequence~~	~~Same sequence~~
~~Voltage limit for alarm~~	~~Same sequence~~	~~Same sequence~~
~~Charge Current limit for alarm~~	~~Same sequence~~	~~Same sequence~~
~~Temperature limit for alarm~~	~~Same sequence~~	~~Same sequence~~
~~Impedance Limit for Alarm~~	~~Same sequence~~	~~Same sequence~~
~~Cell 1 : Voltage limit for alarm~~	~~Same sequence~~	~~Same sequence~~

Cell 2 : Voltage limit for alarm	Same sequence	Same sequence
----------	Same sequence	Same sequence
Cell 24 : Voltage limit for alarm	Same sequence	Same sequence
Cell 1 : Temperature limit for Alarm	Same sequence	Same sequence
Cell 2 : Temperature limit for alarm	Same sequence	Same sequence
----------	Same sequence	Same sequence
Cell 24 : Temperature limit for alarm	Same sequence	Same sequence
Cell 1 : Impedance limit for alarm	Same sequence	Same sequence
Cell 2 : Impedance limit for alarm	Same sequence	Same sequence
----------	Same sequence	Same sequence
Cell 24 : Impedance limit for alarm	Same sequence	Same sequence
Any other parameter to set	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 as 05) :

Parameter Name	**Hex Code**	
	From Master	**From Slave Equipment**
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.

ANNEXURE - 4

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) 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) 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

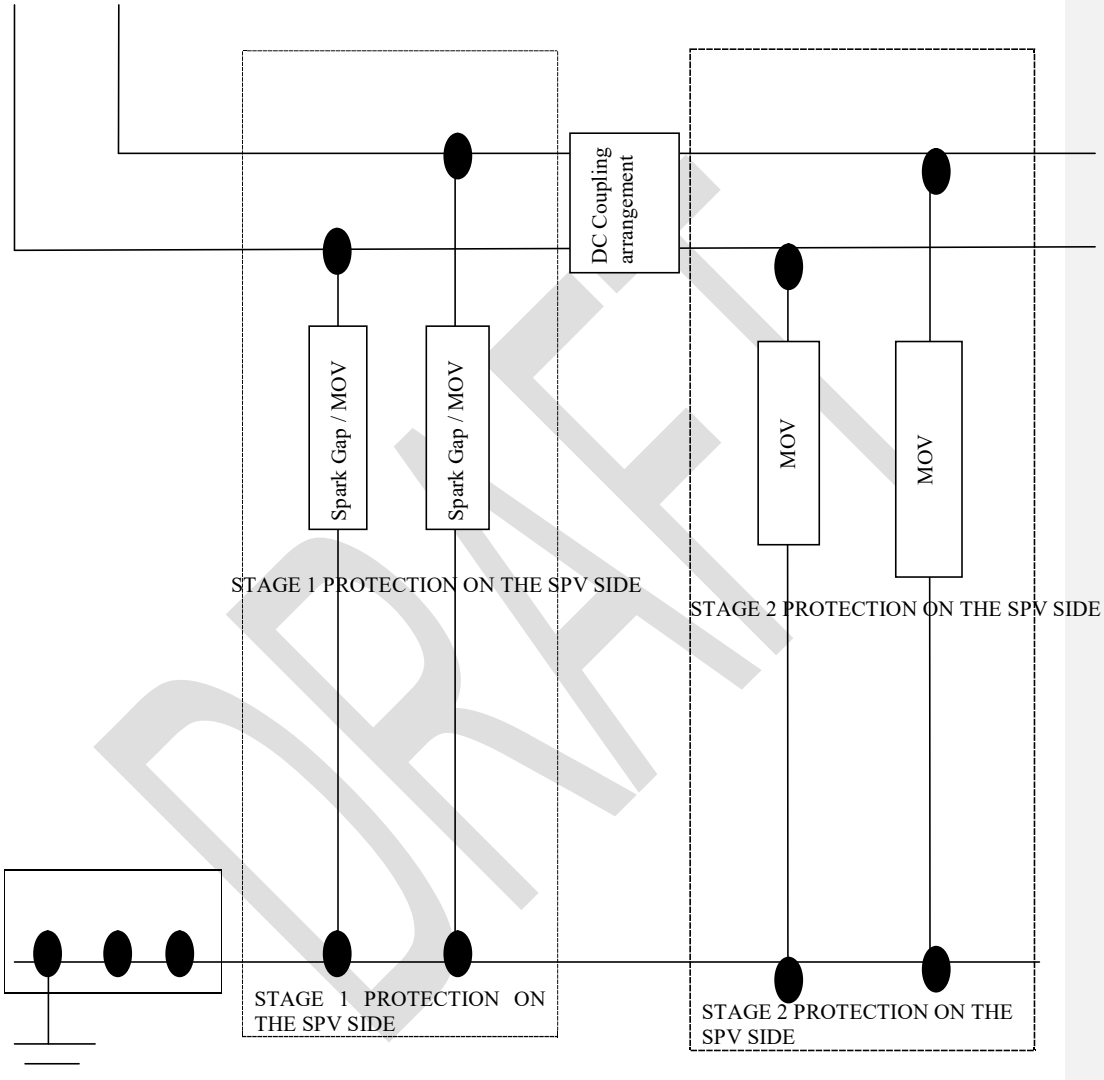
Where: 4940Wh & 9024Wh are the load per day, 0.9 is battery conversion efficiency, 0.85 is the efficiency of the charge controller, 1.25 is the safety factor for SPV power losses, 4 is full sun-insolation availability in India.

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

SPV POWER FROM
SPV ARRAY



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:

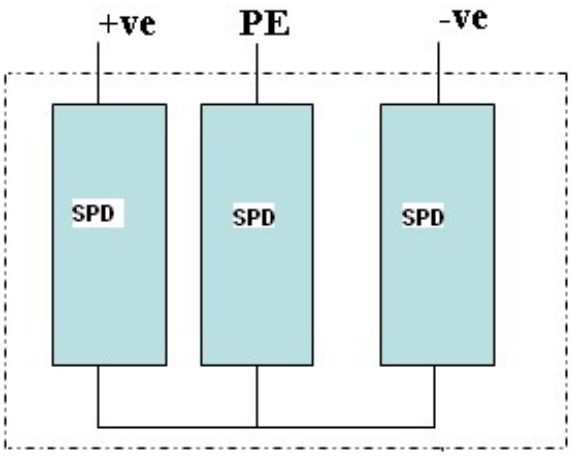


Fig: Connection diagram for DC Line Protection

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 or Amps	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
GD	Gas Discharge
GR	Generic Requirements
IEC	International Electro-technical Commission
IS	Indian Standards
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
NPL	National Physical Laboraties
PCB	Printed Circuit Board
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
SPV	Solar Photo voltaic
SS	Self Supporting
T & D	Technical & Development
V	Volts
~~VDE~~	~~Verband Der Elektrootechniker~~
VRLA	Valve Regulated Lead Acid

W	Watts

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