Template for submitting comments/inputs on Draft Test Guide titled "Solar Photovoltaic Power supply for Telecom Equipments (Draft Test Guide No. TEC 66091:2026)"

Name of Manufacturer/Stakeholder:

Organization:

Contact details:

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

Note: The comments/inputs on the draft Test Guide (Draft Test Guide No. TEC 66091:2026 may be furnished in the above format through email to adgfa-tec-dot@gov.in with copy to dirfa.tec@gov.in and ddgfla.tec@gov.in at the earliest and within prescribed time period.

अनंतिम टेस्ट गाइड
टीईसी ६६०९१:२०२६

PROVISIONAL TEST GUIDE
TEC 66091:2026

for

सोलर फोटोवोल्टाइक पावर सप्लाइ फॉर टेलीकॉम इक्विपमेंटस

(मानक संख्या.: टीईसी ६६०९०:२०२५)

SOLAR PHOTO VOLTAIC (SPV) POWER SUPPLY FOR TELECOM EQUIPMENTS

(STANDARD No.: TEC 66090:2025)

ISO 9001:2015

दूरसंचार अभियांत्रिकी केंद्र

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Release 1: XXX, 2026

FOREWORD

Telecommunication Engineering Centre (TEC) is the technical arm of Department of Telecommunications (DOT), Government of India. Its activities include:

- Framing of TEC Standards for Generic Requirements for a Product/Equipment, Standards for Interface Requirements for a Product/Equipment, Standards for Service Requirements & Standard document of TEC for Telecom Products and Services
- Formulation of Essential Requirements (ERs) under Mandatory Testing and Certification of Telecom Equipment (MTCTE)
- Field evaluation of Telecom Products and Systems
- Designation of Conformity Assessment Bodies (CABs)/Testing facilities
- Testing & Certification of Telecom products
- Adoption of Standards
- Support to DoT on technical/technology issues

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 enumerates detailed test schedule and procedure for evaluating conformance / functionality / requirements / performance of Solar Photo Voltaic (SPV) Power Supply for Telecom Equipments as per GR No. TEC 66090:2025.

CONTENTS

A. HISTORY SHEET

Sl. No.	*Standard/Document No.*	*Title*	*Remarks*
1	TEC 66091:2026	Solar Photo Voltaic (SPV) Power Supply for Telecom Equipments	Release 1

B. INTRODUCTION

This document enumerates detailed test schedule and procedure for evaluating conformance / functionality / requirements / performance of Solar Photo Voltaic (SPV) Power Supply for Telecom Equipments as per GR No. TEC 66090:2026.

C. General information:

Sl. No.	General Information	Details (to be filled by testing team)	
1	Name and Address of the Applicant		
2	Date of Registration		
3	Name and No. of GR/IR/Applicant's Spec. against which the approval sought	Solar Photo Voltaic (SPV) Power Supply for Telecom Equipments	TEC 66090 :2025
4	Details of Equipment		
	Type of Equipment	Model No.	Serial No.
(i)			
(ii)			
5	Any other relevant Information:-		

D. Testing team: *(to be filled by testing team)*

Sl. No.	Name	Designation	Organization	Signature
1.				
2.				
3.				

E. List of the Test Instruments:

S. No.	Name of the test instrument	Quantity	Make /Model (to be filled by testing team)	Validity of calibration (to be filled by testing team)	Remark
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					

F. Equipment Configuration Offered: *(to be filled by testing team)*

(a) <Equipment/product name> Configuration:

Sl. No.	Item	Details	Remarks

Relevant information like No. of cards, ports, slots, interfaces, size etc. may be filled as applicable for the product

(b) <Other equipment name> Configuration:

S.No.	Item	Details	Remarks

Relevant information like No. of cards, ports, slots, interfaces, size etc. may be filled as applicable for the product

G. Equipment System Manuals: *(to be filled by testing team)*

Availability of Maintenance manuals, Installation manual, Repair manual & User Manual etc. (Y/N)

H. Clause-wise Test Type and Test No.:

Clause No.	Clause	Type of Test / Test No. etc.
1.0	Introduction	
1.1	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 equipment's and (iii) up to 20A continuous or 480 AH per day for 24V telecom equipments.	Information
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 power supply is given in annexure -1 of the GR. **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	Information

	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 shall have provision, so that, when both the output of SMPS and SPV power source are available, they shall take the load collectively. SPV power source shall deliver the load as per its available power and rest of the load shall be taken care of by SMPS. For proper load sharing of the two power sources, it shall be ensured that voltage of the SPV power source, even in worst working conditions (high SPV cell temperature) is higher than that of the SMPS. 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 power supply is given in annexure -2 of the GR.	
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.	Information
2.0	**Description**	
2.1	**Power Supply Configuration:** The major components of the SPV Power Supply are as follows:	Information
2.1.1	**Solar Photo-voltaic Generating Source:** SPV generating source is	Physical

	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/250Wp to 24V/550Wp and above. However, purchaser may specify power '300Wp 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. 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. **SPV Array:** A number of panels are connected in parallel or series to get the desired power. This whole combination is called an	Check

	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 should have common MPPT Charge Controller module 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 through common DSCA (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 66130:2025. In case of small 12V SPV power supplies using mono-blocks, the battery may be accommodated inside the charge controller. (i) The CCU shall compose the following features: 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 without any de-rating in	Undertaking from OEM, Test Case-1 & Test case-21

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

	—Charge controller and battery —Charge controller and load. The length of the interconnecting cables shall be as per the requirement of the site. The gauge of the cable shall be so chosen that the total voltage drop across the whole length of cable shall be less than 340mV (2% of voltage at peak power) for 12V SPV power generating source , 680 mV for 24 V SPV power generating source and 1.36V for 48V SPV power generating source. It shall also be capable of taking load without overheating. The termination of the cables shall be through lugs of suitable gauge. Further, the rating of the cables to be used may be decided in accordance with the guidelines given in the "Planning and Maintenance Guidelines for SPV supply No. TEC 66079:2015 (Old TEC/GL/TX/SPV05/02/MAR.2015) issued by TEC. The cables used shall be fire retardant and weather proof.	
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	Physical Check

	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)).	Physical Check

	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/50A (1-phase) FR/FC modules) with ultimate capacity of 150A/350A/450A (Six FR/FC modules 48V/25A (5 for load and one redundancy) or Seven FR/FC modules 48V/50A single phase (6 for load and one redundancy) or Nine FR/FC modules 48V/50A single phase (8 for load and one redundancy) SMPS Ultimate capacity of 150A /350A/450A shall be	

	as per TEC GR 66110:2025 or latest.	
2.2.3	Charge controller module (MPPT module) for both Standalone and Hybrid SPV power supplies is common, hence a standalone power supply can be converted into hybrid power supply and vice-versa functionally by adding or removing the SMPS. Connections scheme/block diagram to convert Standalone SPV system into hybrid system is given at Annexure 2 of the GR.	Physical Check
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. (Refer Ordering information at 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	Declaration

	voltage, the optimum load and `autonomy'. The size of SPV array, Charge controller, SMPS, battery, interconnecting cables may be calculated in accordance with "Planning and maintenance guidelines for SPV power supply No. TEC 66079:2015(Old No. TEC/GL/TX/SPV-05/02/MAR.2015"). Rating of each components, viz., SPV Power source, SMPS, charge controller etc. may be clearly stated in the Ordering information.	
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.	Certificate from accredited test laboratories shall be submitted
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 this 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.	Test case-1
3.1	**SPV Power Source (Modules, Panels/Arrays):** The SPV power source shall be able to charge a 12V battery for 12V SPV power supply, 24V Battery for 24V power supply (for standalone application only) and 48 volt battery for 48V power supply through the necessary protection arrangement against the discharge of the battery through SPV panels/array during sunless period, while simultaneously feeding load.	Test Case-1

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.	Undertaking to be taken from OEM
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.	Physical Check
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.	Undertaking to be taken from OEM, Test report
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 can be Glass, Transparent and white refractive backsheet.	Certificates from accredited test labs are to be submitted
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.	Certificates from accredited test labs are to be submitted.

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.	Physical Check
3.1.7	The design of the solar module shall be multi-cell and modular in construction to provide the required output.	Physical Check
3.1.8	The Solar Photovoltaic (SPV) module is intended for use in terrestrial applications and shall be constructed using high efficiency solar cells, which may include mono-crystalline, Polycrystalline, 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)	Undertaking , Certificates from accredited test laboratories shall be submitted
3.1.9	The SPV modules, being used for Telecom supply, need to be characterised at NPL (National Physical Laboratory) or any BIS/ NABL /TEC recognised Test Lab.	Certificates from accredited test laboratories shall be submitted
3.2	**Panel/Array configuration:**	
3.2.1	The panel shall be modular in configuration, consisting of one module for 12V SPV power source and 4 modules connected in series for 48V SPV power source. The rating of the 12V SPV power generating modules shall be 12V/50Wp to 12V/300Wpor any other rating. The module may be selected as per the load requirements and availability of space. In case of 24V (for	Information

	Standalone Application only), the rating of the 24V SPV power generating modules shall be 24V/250Wp to 24V/550Wp or any other rating (refer clause 2.1.1).	
3.2.2	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.	Information
3.2.3	**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).	Undertaking to be taken from OEM
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. The de-rating factor of 0.5%/year of the SPV Generating Source/module rated power is permissible (can be high for first year). The module/SPV power generating source shall deliver at least 90% of its rated power in 10th year.	Undertaking to be taken from OEM
3.2.5	**SPV Module Ratings:** Rated power (minimum) at maximum Power Output to be specified by the manufacturer.	Undertaking to be taken from OEM
3.2.6	**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/cm2 solar intensity at 25 deg C Air mass 1.5	Test Result/ Certificates from accredited test labs are

		to be submitted
3.2.7	**Cells:** Cells can be either mono crystalline/ Polycrystalline/ PERC/ TOPcon or any other latest technology encapsulated Silicon Cells. All the cells used in a module shall be identical, of regular shape and shall have the same rating with tolerance +/-5%. The actual rating of the modules in a panel shall be within 5% of the average rating of the four modules. While in an array, the rating of the panels shall also be within 5% of the average rating of the panels in the SPV power generating source.	Physical Check & Manufacturer Report
3.2.8	Configuration of the module to be specified by manufacturer: Number of cells in series or in series – parallel configuration.	Information
3.2.9	**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 value specified in clause 3.2.3.	Information, Manufacturer report
3.2.10	**Short circuit Current :** To be specified by the manufacturer	Declaration
3.2.11	**SPV modules voltage at peak Power point:** 17.0 V (min.) for 12V Modules and 34V (min.) for 24V Module. In addition to it, SPV Vmpp should be 0.45V per cell minimum.	Undertaking to be taken from OEM
3.2.12	**Voltage de-rating:** shall not be more than -0.5% per degree C above 25 degree C cell temperature.	Undertaking to be taken from OEM
3.2.13	**Conversion efficiency and Fill factor:** For Panels rating below 250 Wp: Conversion efficiency of the encapsulated cell, 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, peak power, shall not be less than 20 % and that of module shall	Test Result/ Certificates from accredited test labs are to be

	not be less than 19%. Fill factor shall be better than 75%	submitted
3.3	**Charge Controller Unit:**	
3.3.1	**Electrical Requirements:**	
3.3.1.1	**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 With DSCA in communication, the output of the charge controller or MPPT module shall be dynamically adjusted to ensure optimal utilization of the available Solar energy source. In case of without communication with DSCA, the output voltage of the charge controller shall be limited to 13.8V for 12V power supply, 27.6V for 24V power supply and 55.2V for 48V power supply.	Test Case-2
3.3.1.2	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 it dynamically adjusts to extract the maximum possible power from the SPV array based on the available input voltage and current, ensuring optimal energy utilization and even in worst working conditions (high SPV cell temperature) the voltage of SPV source is higher than that of the SMPS.	Test Case-2
3.3.1.3	**Efficiency:** **(i) For 12V & 24V Power Supply:** Efficiency of the charge controller: Under nominal input and output conditions of 13.5V for 12V power supply and 27V for 24V power supply respectively shall be in excess of 90%. However, purchaser may specify efficiency to be 85% for 12V system depending upon the cost effectiveness of the power supply. **(ii) For 48V Power Supply:** Efficiency of the charge controller: Under nominal input and output conditions, the power conversion efficiency shall be ≥ 93%	Test Case-3 Or Test Result/Certificates from accredited test labs are to be submitted.

	(iii) Solar Module (MPPT) tracking efficiency shall be ≥98% for 12V/24V/48V power supply. **Note**: For validation of this parameter, test reports of NABL accredited / TEC designated lab shall be allowed.	
3.3.1.4	**Psophometeric Noise (e. m. f. weighted at 800 Hz):** While working on SPV Power as well as SMPS, Psophometeric Noise with a battery of appropriate capacity floated and Radio Telephone equipment connected across the output shall be within 2mVrms and ripple voltage shall be 2mVrms +/- 0.5% for float applications as per latest standards of ITU-T Rec. O-41.	Test Case-3
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 3.3.1.1. In case the charge controller output voltage exceeds 56.5 V for 48V power supply, 28.2 V for 24V power supply and 14.1 V for 12V power supply due to failure of the voltage control device provided to control the SPV Power Source voltage, the SPV power source shall be isolated automatically, creating alarm. Restoration of the SPV Power Source (MPPT) shall be through manual reset. **(ii) SMPS:** Shall be in accordance with relevant clause of TEC Standard No. 66110:2025 or latest **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	Test Case-4 & Test Case-5 & Test Case-6

	automatically be reconnected, when the voltage is above 51.6V for 48V, 25V for 24V power supply and 12.5V for 12V power supply respectively. **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:** The circuit design shall ensure protection against the discharge of the Battery through the FR/FC & SPV power source (MPPT) module in any case. **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/MCB with current limiting devices:** Suitably fault rated fuses or circuit breakers with current limiting devices shall be provided for the following: 1. Live AC input line(Hybrid power supply only). 2. Negative DC output 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 /Circuit breakers/MCBs (minimum) of each type shall be provided with each unit, provided fuses are non-solderable and cartridge type.	

3.4.1	Failure of control and sensing circuitry shall not cause any hazard. The 1 voltages of the system shall not abnormally decrease/ increase to endanger the load.	Information
3.5	**Monitoring Alarms and Indicating Lamps:** Visual indications/display shall be provided by means of “bright LCD/LEDs on each FR/FC module and DSCA:	Information
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 following functional indications shall be provided on FR/FC and DSCA : a) Mains available b) FR/FC On Auto Float c) FR/FC On Auto Charge d) Battery Charging e) Load on battery **Note:** The functional indication a) shall be provided on both DSCA & FR/FC module, while b), c), d), & e) may be provided either on DSCA or on both FR/FC and DSCA.	Test case-7
3.5.2	**Alarms Indications (both for Standalone and Hybrid Charge controller) :** 1. Battery Low 2. Battery reverse polarity 3. Over load 4. Rectifier(s) Fail 5. Equipment Circuit Breaker Trip (if used)	Test case-8
3.5.3	All the alarm circuits shall be provided with solid state technology. Use of electromechanical relays is precluded.	Information & Physical Check
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.	Information & Physical

		Check
3.5.5	Every Alarm condition shall be accompanied with an audio alarm, with Auto/manual audio cut-off facility. In such cases, the visual indication shall remain active to signal the need for attention until the fault has been addressed and rectified.	Physical Check
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.	Information
3.5.7	Two Potential Free Contacts (one for alarm and one redundant) shall be provided for extension of alarm to centralised display.	Test case-9
3.5.8	All Indications shall be suitably designated and there shall be provision for their easy identification from a distance of upto 3 meters.	Physical Check
3.5.9	Provision shall be made on the front panel of the charge controller to 1 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.	Physical Check
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 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 equipment's to be fed by this type	Information & Physical Check

	of power supply is small, hence SMPS envisaged for this application are single phase/three phase of maximum current rating of 150A/350A/450A, based on single phase FR-FC modules of rating 12.5A , 25A & 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. Provision shall be made for surge protection devices for the SMPS, in compliance of clause 5.5.	
3.6.1	SMPS shall be based on Switch Mode Techniques using switching frequencies of 20KHz and above. The SMPS shall be capable of, independently, meeting the load requirements of load (telecom equipment) and battery bank. SMPS is intended to be used in Float-cum-Charge mode as a regulated D.C. Power Source. The system 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 , 25A ,50A. They all use single phase supply except for 50A basic module, which may be with single phase or three phase supply." The Power Plant as per this GR shall be compatible with VRLA battery as well as Li-ion battery. However, at any point of time VRLA & Li-ion battery cannot work simultaneously with the SMPS power plant.	Information
3.6.2	The system shall only be based on menu driven Microprocessor Controlled Techniques (both DSCA as well as FR/FC module) for control, monitoring and alarms. DSCA shall display the Software version for both DSCA and FR/FC. Setting of all the parameters shall be through menu-driven microprocessor control only. DSCA shall have menu for selection of type of battery between VRLA and Li-ion battery and type of battery should be displayed on DSCA. The failure of Microprocessor or DSCA shall not affect the setting	Test Case-1 FR/FC module rating, Controller information Test Case-10

	of individual FR/FC. No parameter of FR/FC modules shall be disturbed on the failure of DSCA. In this condition 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 system shall be RS 485/RS232 and Ethernet (SNMP Protocol) compatible, if remote monitoring is required. It shall be feasible to set any monitoring control parameter from a remote site through RS 485/RS232 and Ethernet (SNMP Protocol). All the information regarding Control and monitoring of Power Plant data shall be accessible on demand from the remote site. The exchange of information and protocol format shall be given in the Clause 3. RS 485 / RS 232 and Ethernet communication cable of suitable length shall be protected with pluggable and DIN Rail Mountable surge protection devices (to be decided by purchaser), to be mounted on both side of the cable. SPD shall have surge discharge current capacity of 10KA (8/20 µsec) and lightening discharge current capacity of equal or more than 0.5 KA per line (10/350 µsec). The SPDs shall have an end of life indication either via signal disruption or a visual indication.	For failure of Microprocessor or DSCA Test Case-11 for RS 485 / RS 232 and Ethernet communication
3.6.3	The system shall be sufficiently flexible to serve any load from 6.25A onwards, depending on manufacturer's design, rating, number of FR/FC modules, used in a rack and system configuration. To cater to 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.	Information & Physical Check
3.6.4	The DSCA shall be provided for the ultimate capacity of the Power Plant. The DSCA, in addition to control, monitoring and alarms, shall provide for the following: a) Termination for the batteries*.	Physical Check& Certificates from

	b) Termination for the exchange load. c) Interconnecting arrangement for power equipment. d) Battery Switching arrangement (Connection to/isolation from system)** e) Termination for AC input to the rack shall be finger touch proof, flame retardant, insulated. Use of bus-bars for the purpose is precluded. f) Termination for AC and DC to FR/FC modules. g) Circuit Breakers/fuses /MCB etc. for DC output The capacity and number of batteries shall be as per order. For the purpose of Type Approval, it shall be taken as one battery for 12V stand alone power supply and two batteries for other power supply. Only CACT/NABL/TEC Designated labs approved DC contractors or `MCBs' (which do not produce spark while cutting in or out) shall be used for manual isolation and reconnection of the battery. The manual isolation/reconnection of the battery by tripping the contactor through an external switch is not permitted. circuit from any source, including switching equipment such as contactor, MCB coil and their control and sensing circuitry.	Accredited test Laboratories are to be submitted
3.6.5	There shall be provision to start the SMPS without battery supply.	Physical Check
3.6.6	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).	Information
3.7	**Electrical Requirements:**	
3.7.1	**AC input Supply:** The Power Plant using single phase FR/FC modules shall operate from single phase/three phase AC input supply. The input voltage range shall be Single Phase nominal 230	Test Case-12

	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 :** The Module shall be capable of operating in “Auto Float-cum-Charge” mode. It shall be programmed to operate as a float rectifier or a charger, depending on the condition of the battery sets being sensed by the DSCA.	Information
3.7.2.1	**Auto Float Mode** **For 12V FR/FC:** The float voltage of each rectifier module shall be continuously adjustable and pre-settable at any value in the range of -12 to -14V from FR/FC modules or DSCA. The prescribed float voltage setting is -13.5 V for VRLA battery respectively. **For 48V FR/FC:** The float voltage of each rectifier module shall be continuously adjustable and pre-settable at any value in the range of -48 to -56V from FR/FC modules or DSCA. The prescribed float voltage setting is -54V for VRLA battery respectively. There shall also be a provision of setting the float/charge voltages globally from DSCA. There shall also be a provision so that DSCA may override the values set by individual module. Float Voltage adjustment may be made globally, and not for individual rectifiers	Test Case-13
3.7.2.2	**Auto Charge Mode:** **For 12V FR/FC:** In Auto charge mode FR/FC shall supply battery & equipment current till terminal voltage reaches set value, which is normally - 14.2V, this value shall be settable between -12V and -14.6V) and shall change over to constant voltage mode. It shall remain in this mode till a change over to float mode signal is received. (This Clause is applicable for VRLA Battery only”).	Test Case-13

<table>
<tr><td></td><td>For Li-ion battery setting of Float & Charge voltage should be 54.0V or specified by the purchaser based on the requirement.
For 48V FR/FC: In Auto charge mode FR/FC shall supply battery & equipment current till terminal voltage reaches set value, which is normally 2.3V/cell (-55.2V, this value shall be settable between -48V and -56V) and shall change over to constant voltage mode. It shall remain in this mode till a change over to float mode signal is received. (This Clause is applicable for VRLA Battery only”).</td><td></td></tr>
<tr><td>3.7.2.3</td><td>The DC output voltage at the terminals shall be maintained within +/-1% of the half load preset voltage from 25% load to full load condition when measured over the full-specified input range.</td><td>Test Case-14</td></tr>
<tr><td>3.8</td><td>Efficiency : The efficiency of the unit shall be given below :
12V units :
<table><tr><th>Condition</th><th>Single Phase AC</th></tr><tr><td>Under all specified Input, output conditions and load between 50 to 100%.</td><td>better than 85%</td></tr></table>
48V units :
a) Rectifier rating < 50A
<table><tr><th>Condition</th><th>Single Phase AC</th></tr><tr><td>At nominal input, output and full rated load</td><td>better than 90%</td></tr><tr><td>Other specified Input, output conditions and load between 50% to 100%.</td><td>better than 85%</td></tr></table>
b) Rectifier rating 50A and above</td><td>Test Case-15</td></tr>
</table>

	<table><tr><th>Condition</th><th>Single Phase AC</th></tr><tr><td>At nominal input, output and full rated load</td><td>better than 93%</td></tr><tr><td>Other specified Input, output conditions and load between 50% to 100%.</td><td>better than 88%</td></tr></table>	
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.	Test Case-15
3.10	In every switching rectifier, output filter is used. So it is not required in GR.	Information
3.11	In every rectifier discharging resistor is used. So it is not required in GR.	Information
3.12	**Soft Start Feature and Transient Response :**	
3.12.1	Slow start circuitry shall be employed such that FR/FC module input current and output voltage shall reach their nominal value within 10 seconds.	Test Case-16
3.12.2	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.	Test Case-16
3.13	**Voltage Overshoot/Undershoot:** The requirements of this clause shall be achieved without a battery connected to the output of FR/FC module.	Information
3.13.1	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	Test Case-16

	return to their steady state within 20 ms for any load of 25% to 100%.	
3.13.2	The DC output voltage overshoot for a step change in AC mains from 1 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.	Test Case-16
3.13.3	The modules shall be designed such that a step load change of 25 to 100% 1 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.	Test Case-16
3.14	**Total Harmonic Distortion :**	
3.14.1	**Total Voltage Harmonic Distortion :** The Total line harmonic voltage distortion shall not be more than 10% in conformity with CIGRE's limits. **Note:** The above Harmonic Distortion limits are as per communication received from Central Electricity Authority vide their office letter No. GO2/Comm.I/1/1-95/962 dated 22.12.92.	Test Case-15
3.14.2	**Total Current Harmonic Distortion :** The total harmonic distortion shall be limited as per EN 61000-3-2 Ed.2:2000. The total current harmonic distortion contributed by the unit at the input shall not exceed 10% for input voltage range 170V-260V (for single phase units); for load between 50 to 100% of the rated capacity.	Test Case-15
3.15	**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.	Test Case-17

3.15.1	The float and charge current limit adjustment s hall 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.	Information
3.15.2	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.	Test Case-6
3.16	**Load Sharing (Parallel operation) :**	
3.16.1	FR/FC modules shall be suitable for operating in parallel with one or 1 more modules of similar type, make and rating, other output conditions remaining within specified limits.	Information
3.16.2	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.	Test Case-18
3.16.3	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.	Test Case-10
3.17	**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 :	Test Case-5

	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.	
3.18	**Battery Path Current Limiting** : In Auto Mode the current in each battery path (For VRLA type battery) shall be settable as per the battery capacity and DG capacity as applicable so that the battery path current is kept at 5% to 10% of battery AH capacity. When Li-ion battery selected setting the current in each battery path should be settable as per the battery capacity and DG capacity as applicable so that battery path current is kept at 5% to 50% of battery AH capacity and actual battery path current will be decided by the purchaser. Further, purchaser will give the capacity of the battery and DG set if applicable to be used for this purpose. For the type approval the manufacturer shall demonstrate the facility and undertake to make provision as per order.	Test Case-19
3.19	**Temperature Compensation for Battery :** **For VRLA:** In auto float/charge mode there shall be provision for monitoring the temperature of battery and consequent arrangement for automatic temperature compensation of the FR/FC , FR/BC output voltage to match the battery temperature dependant charge characteristics. The output voltage of the	Test Case-20

	rectifier in Float/Charge operation shall decrease or increase at the rate of 72mV (3mV/ cell, 24 cells battery) 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 any further. This voltage shall also remain locked till the temperature falls below the value corresponding to set value. When the output voltage reaches 55.8V (for 48V unit) and 13.98V (for 12V unit), due to increase in the output voltage owing to decrease in temperature, it shall get locked at this voltage and any further decrease in temperature shall not lead to further rise in the output voltage of the power plant. This voltage shall also remain locked till the temperature rises above the value corresponding to set value. A tolerance +/- 5 mV may be acceptable over the specified rate of 72mV/degree C . The nominal distance between the battery and power plant may be 20 meters. The manufacturer shall provide the necessary sensor and cord for the purpose with the power plant. Failure of temperature compensation circuit including sensors (including the open or short circuit) shall create an alarm and shall not lead to abnormal change in output voltage. Proper sign-writing shall be made in DSCA and both ends of temperature compensation cord for its easy termination. **For Li-ion battery:** Temperature compensation for battery should be disable when Li-ion battery selected. Temperature sensor is not required.	
3.20	**Protections:** In addition to the requirements given in clause 3.4, hybrid charge controller shall also provide for the following protections :	Information

3.20.1	**AC Input :** FR/FC module should be automatically cut off as the AC input of the FR/FC module is beyond the specified operating range (230 V 10 % to 230V-15% for single phase Supply systems). However, keeping in view of specific requirement for rural area, purchaser may specify the requirement as a special case as: - "The Power Plant shall operate from single phase AC mains supply 230V with variation from 170V to 260V with applied de-rating and frequency as 50 Hz +/-2Hz". Suitable alarm indication shall also be provided. The FR/FC module shall resume normal working automatically when the input is restored within the working limits. Hysteresis within specified working limits shall prevent shutting down of the FR/FC. A tolerance of +/-5V is acceptable for protection and alarm operation. Reconnection shall occur at a voltage, 10V lower than the set voltage for 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.	Test Case-12
3.20.2	**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 manual or through DSCA". 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	Test Case-4

	safety hazard.	
3.21	**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.	Test Case-6
3.22	**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 /LEDs on each FR/FC module and DSCA to indicate:	Information
3.22.1	**Functional Indications:** The following functional indications shall be provided on FR/FC & DSCA: a) Mains available b) FR/FC, FR/BC On Auto Float c) FR/FC, FR/BC On Auto Charge **Note:** The functional indication a) shall be provided on both DSCA & FR/FC/BC module, while b) & c) may be provided either on DSCA or on both FR/FC and DSCA.	Test Case-7
3.22.2	**Alarm Indications:** **A. On FR/FC:** a. LED Green - Healthy b. LED Amber - Warning c. LED Red – Major **B. On DSCA:** a) Load Voltage High 12V Unit: above 13.9V/Low below 11.4V 48V Unit: above 56.V/Low below 45.6V b) Alarms on FR/FC, (As per clause 3.25.2 A c) Mains Out of range d) System Over Load e) Mains "ON"/Battery Discharge	Test case-8

	f) Fan Fail (in case fan provided at rack level) g) Temp. Sensor fail (for VRLA battery only) h) Battery Fail or No Battery (separate for each Battery) i) Battery isolated from the load j) Lightning and surge protection Stage II Fail	
3.23	**Battery Health Check:** There shall be a provision of monitoring the voltage, current, trickle current, conductance and temperature (programmable) of the batteries associated with the power plant at a set periodicity. There shall also be a provision of monitoring of each cell of the battery bank for voltage and temperature. The provision for conducting a partial discharge (about 20%) test, of a predetermined duration and frequency, shall be made available in the power plant (Frequency and duration of partial discharge test shall be programmable). During this test, current and voltage of the battery as well as each individual, cell shall be recorded. It shall also record the conductance and temperature of each cell. Conductance measurements/observations shall be off-line to prevent noise interference. The first observation of conductance, recorded by the power plant system, for the battery shall form the base value for future comparison. The provision of partial test discharge shall be implemented in such a way that at a time only one battery is put to discharge, so as to ensure that necessary battery reserve is available in case of power failure during or immediately after the test discharge. Provision shall be made for observing the state of charge of battery before commencing this test. In case the battery is not fully charged this test may be deferred till the battery is fully recouped. Any abnormality observed during above observations shall be highlighted by initiating an alarm. All the above information shall be made available to the remote site through RS 485 / RS 232 and Ethernet (Refer Clause 1.3 for specified protocol). **Note-1:** The manufacturer will give the list of hardware equipment,	Test Case-11

	required for the purpose, at the time of procurement. Purchaser shall clearly indicate the requirement of battery health check feature while ordering the power plant. The manufacturer shall also undertake that the above provision will become fully function by adding the hardware/software, for the purpose, if ordered by purchaser. **Note-2:** This clause is optional and applicable to VRLA battery.	
3.24	**Remote control and monitoring:** The power plant shall be RS 485/RS 232 and Ethernet (SNMP) compatible. It shall provide for the monitoring, alarm and control of the power plant and its associated batteries from a remote site through RS 485 /RS 232 and Ethernet (SNMP). The exchange of information and protocol format between the power plant and remote site shall be as given in the Clause No. 1.3 of TEC GR 66110:2025.	Test Case-11
3.25	**Battery Bank:**	Information
3.25.1	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).	Information
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/ NABL 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 at input side of the SMPS shall be	Undertaking to be taken from OEM

	rated at 600V (minimum).	
4.2	**Power transformers & Chokes:** Power transformers & chokes shall use Class B or higher grade of insulation. The transformers and chokes shall be wound with copper wire and provided with adequate insulation.	Undertaking to be taken from OEM
4.3	Fuses /MCBs with current limiting device or circuit breakers of proper rating shall be provided wherever appropriate for protection of control/sensing circuit. Fuses/MCBs shall conform to BIS specification.	Physical check , Undertaking to be taken from OEM
4.4	**Component Approval:** All the components, used, shall be CACT/NABL approved. Components shall neither be combustible nor shall support combustion.	Undertaking to be taken from OEM
4.5	**Quality and Workmanship :** **a)** All the units of the system shall be manufactured in accordance with international quality management system ISO 9001:2015 (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 14001:2015 (latest issue) pertaining to environmental requirements. **b)** All the equipment's 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	Documents/ Undertaking to be taken from OEM

	of workmanship for printed boards assemblies), QM-207 (Guidelines for soft solder and fluxes for Telecom Equipments) and QM 210 (Guidelines for standard of workmanship for surface Mounting Devices). **c)** All wiring shall be neatly secured in position and adequately supported. Metal panel or cover holes through which the wires or cables pass shall be suitably bushed. **d)** All materials and workmanship shall be of professional quality to ensure the MTBF requirements.	
4.6	**Quality Assurance Tests:** Each of the units supplied against the specific order after type approval shall be inspected and tested to ensure that the requirements of this document have been met. These tests shall be carried out by QA wing of BSNL.	Physical Check
4.7	**Module Replacement Time & MTBF**	
4.7.1	Module Replacement Time: The mean time to replace / restore (MTTR) a faulty rectifier module shall be less than 20 minutes.	Documents/ Undertaking to be taken from OEM
4.7.2	**MTBF (Mean Time between Failures):** MTBF of the system shall not be less than 100,000 hours. The MTBF for fans shall be better than 70,000 hours at 40°C. The concurrence of CACT of QA wing of BSNL in this regard is mandatory. The MTBF shall be verified as per QM-115. MTBF, predicted and observed values shall be furnished along with calculations by the manufacturer. Based on these figures three years maintenance spares shall be specified by the equipment supplier. The equipment availability shall exceed 99.9%.	Documents/ Undertaking to be taken from OEM
5.0	**Environment Requirements:** SPV module/panel/array, Charge Controller unit, SMPS (in case of hybrid power supply), Mounting Structure and Batteries in compliance with the requirements of	Test Result from Accredited

	relevant clause of 14016:2010 (old no. QM-333:2010) shall be capable of working in a saline atmosphere in coastal areas and shall be free from any corrosion at any period of time(IEC 61701 compliance may be provided). The SPV module/panel/array, charge controller, SMPS and battery shall also work with the guaranteed performance at an altitude in excess of 3000 metres above Mean Sea Level (MSL) in compliance with the relevant clauses of QM 333. These units shall also be capable of withstanding the rigors of transportation and storage and shall comply with the vibration, drop and topple test requirements as given in the relevant clauses of TEC 14016:2010 (old no. QM-333:2010).	Test Laboratories need to be submitted.
5.1	**Environmental requirements for SPV module/Panels:** These environmental requirements should be complied as per Clause 5.2.1 & 5.2.2 of TEC GR 66100:2025 (old No. TEC/GR/TX/HPS-001/01 MAR 2017).	Test Result from Accredited Test Laboratories need to be submitted.
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 TEC 14016:2010(old no. QM 333:2010) Category B2.	Test Result from Accredited Test Laboratories need to be submitted.
5.3	**Burn-in Test:** The Hybrid CCU or Standalone CCU 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	Test case-21

	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	**Insulation Resistance and Voltage Proof Tests:**	
5.4.1	**Insulation Resistance Test:** The insulation resistance of a fully wired FR/FC & MPPT Module, when tested with a 500V DC megger, shall be as given below **:** **A) FR/FC** a) AC Input & Earth - Greater than 2 meg Ohm b) DC Output & Earth - Greater than 1 meg Ohm c) AC Input & DC output - Greater than 5 meg Ohm **B) MPPT** a) DC Input & Earth - Greater than 2 meg Ohm b) DC Output & Earth - Greater than 1 meg Ohm c) DC Input & DC output – Greater than 5 meg Ohm	Test Case-22
5.4.2	**Voltage Proof Test:** The Voltage Proof Test of a fully wired FR/FC & MPPT Module with EMI/RFI capacitors and MOVs/Tranzorbs removed the circuit a test voltage of 1500V/50Hz is applied for one	Test Case-23

	minute. - Between earth and interconnected output terminals. - Between interconnected input and output terminals. Alternatively without removing EMI/RFI capacitors, the lightning protection circuitry and Tranzorbs etc., but with EMI/RFI discharge resistors removed : a) A 2150V DC can be applied for one minute between interconnected input and output terminals. b) 650V DC can be applied for one minute between interconnected input and output terminals and earth. This DC voltage test is in accordance with UL 950 and IEC 950 Standards No. breakdown or abnormal temperature rise shall occur.	
5.5	**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 outside the charge controller in the following configuration:	Information
5.5.1	**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.	Declaration
5.5.2	**Protection of Charge controller from SPV array side:** Surge protection Device on input side of charge controller shall consist of MOV surge-arrestors(Type II) connected between +ve and ground,	Physical Check &Certificates

	–ve and ground . SPD shall be able to discharge max current (8/20 µsec) of 40KA & 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. SPD shall comply to the IEC 61643-31 standards and shall be certified from labs accredited by ILAC signatories or TEC designated labs or NABL Accredited Labs in India.	issued by accredited test laboratories shall be submitted
5.5.3	**Protection on AC Main Side (Hybrid Power supply only):** Stage-1 Lightning and Surge Protection is not in the scope of system. Stage-2 Lightning and Surge Protection for AC input of Site against the lightning and high voltage surges shall be as per GR of lightning and Surge Protection of Site (GR No. TEC 66130:2025). Purchaser may decide to buy Stage -1 & 2 protection devices for equipment safety against lightning and surges.	Physical Check
6.0	**GENERAL REQUIREMENTS**	
6.1	**Radio Frequency Interference (RFI) Suppression:** The system (FR/FC, FR/BC & DSCA modules) shall be designed to minimise the level of electromagnetic interference (EMI), both conducted and radiated, detected in its vicinity and generated by the module and shall comply the following clauses :	Certificates issued by accredited test laboratories shall be submitted
6.1.1	**Conducted and Radiated Emission from the single phase and three phase Power equipment.** Name of EMC Standard: CISPR 32 (2015) with A1(2019) “Electromagnetic compatibility of multimedia equipment – Emission requirements; Limits and methods of measurement of radio disturbance characteristics of Information Technology Equipment".	Certificates issued by accredited test laboratories shall be submitted

<table>
<tr><td></td><td>Limits: -
i) To comply with Class A of CISPR 32 (2015) with A1(2019).
ii) The values of limits shall be as per relevant tables under CISPR 32 (2015) with A1(2019).

Test Procedure: Test setup, Test procedure & Measurements shall be conducted as per IEC- CISPR 32 (2015) with A1(2019).</td><td></td></tr>
<tr><td>6.1.2</td><td>Electrostatic discharge (ESD) immunity limits: The limits shall be as per IEC 61000- 4-2, 9(1) (both Contact discharge method and Air discharge method) as given below:
Test level:
<table>
<tr><td colspan="2">Contact discharge</td><td colspan="2">Air discharge</td></tr>
<tr><td>Level</td><td>Test voltage (KV)</td><td>Level</td><td>Test voltage (KV)</td></tr>
<tr><td>4</td><td>8</td><td>4</td><td>15</td></tr>
</table>
Test Procedure: This test shall be conducted as per IEC 610004-2 for both requirements & unit shall comply of clause 9(1) of IEC 61000-4-2.</td><td>Certificates issued by accredited test laboratories shall be submitted</td></tr>
<tr><td>6.1.3</td><td>Radiated radio-frequency Electromagnetic field immunity limits: The limits as per IEC 61000-4-3.
Test level:
<table>
<tr><td colspan="2">Frequency range: 80 MHz to 1000 MHz.</td></tr>
<tr><td>Level</td><td>Test field strength V/m</td></tr>
<tr><td>3</td><td>10</td></tr>
</table>
Test Procedure: This test shall be conducted as per IEC 61000-4-</td><td>Certificates issued by accredited test laboratories shall be submitted</td></tr>
</table>

<table>
<tr><td></td><td>3. Test results shall be in compliance of clause 9(a) of IEC 61000-4-3.</td><td></td></tr>
<tr><td>6.1.4</td><td>Electrical fast transient/Burst immunity limits: The limits shall be as specified in IEC 61000-4-4.
<table>
<tr><td colspan="3">Open–circuit output test voltage (+/-10%) &repetition rate of impulses (+/-20%)</td></tr>
<tr><td rowspan="2">Level</td><td colspan="2">On Power supply port, Protection Earth</td></tr>
<tr><td>Voltage peak KV</td><td>Repetition rate KHz</td></tr>
<tr><td>4</td><td>4</td><td>2.5</td></tr>
<tr><td colspan="3">Rise time of one Pulse - 5 ns +/- 30%
Impulse duration - 50 ns +/- 30%</td></tr>
</table>
Test Procedure: This test shall be conducted as per IEC 61000-4-4. Test results shall be in compliance of clause 9(1) of IEC 61000-4-4.</td><td>Certificates issued by accredited test laboratories shall be submitted</td></tr>
<tr><td>6.1.5</td><td>Surge immunity limits: The limits as per IEC 61000-4-5.
Test level:
<table>
<tr><td>Level</td><td>Open circuit test voltage (+/- 10%) KV</td></tr>
<tr><td>1</td><td>0.5</td></tr>
<tr><td>2</td><td>1.0</td></tr>
<tr><td>3</td><td>2.0</td></tr>
<tr><td>4</td><td>4.0</td></tr>
</table></td><td>Certificates issued by accredited test laboratories shall be submitted</td></tr>
</table>

	Voltage surge - 1.2/50 µs Amplitude - 2 KV(DM) - 4 KV(CM) - After testing for 4KV, the amplitude shall also be increased to 6 KV (1.2/50 µs) Combined wave form as per IEEE C62.41- 1991 to cover Lightening/ Surge protection test also. - Test results shall be in compliance of clause 9(b) of IEC 61000-4-5. **Test Procedure:** This test shall be conducted as per IEC 61000-4-5. After testing for 4KV, the amplitude shall also be increased to 6 KV (1.2/50 µs) Combined wave form as per IEEE C62.41-1991(to cover Lightening/ Surge protection test also). **Note:** The rated voltage of the MOVs used for the above shall not be less than 320V.	
6.1.6	**Radio-Frequency Conducted Susceptibility immunity limits:** The limits as per IEC 61000-4-6. **Test level:** Frequency range: 150 KHz- 80 MHz Level: 3 — Voltage level (e.m.f.): 10 **Test Procedure:** This test shall be conducted as per IEC 61000-4-6. Test results shall be in compliance of clause 9(a) of IEC 61000-4-6.	Certificates issued by accredited test laboratories shall be submitted
6.1.7	**Conducted Susceptibility Limits:** Power equipment used in Telecom Network shall not malfunction when high voltage surge as specified	Certificates issued by

<table>
<tr><td></td><td>below is superimposed at the input power mains to the power equipment, for more than two seconds as per IEC 61000- 4-18. The equipment shall also not fail or degrade in performance after the surge is withdrawn.
Test levels:
Voltage Rise time (First peak): 75 nano sec +/- 20%.
Oscillation Frequencies: 100KHz & 1 MHz +/- 10%
Repetition rate: at least 40/s for 100KHz and 400/s for 1 MHz
Decaying: 50% of the peak value between the 3rd & 6th periods
Burst duration: not less than 2s
Surge amplitude: 250V (-10%) to 2.5 KV (+10%)
Wave shape: Damped
Test Procedure: Test set up, test procedure & Measurements shall be as per IEC 61000-4-18. EMI surge of specified levels injected on power leads of test sample shall not cause degradation of performance or malfunction.</td><td>accredited test laboratories shall be submitted</td></tr>
<tr><td>6.1.8</td><td>At the time of Type approval the testing officer shall ensure that the power plant is in compliance of the clauses 6.1.1 to 6.1.7 given above.</td><td>Information</td></tr>
<tr><td>6.2</td><td>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:
<table>
<tr><th>Ambient Noise</th><th>Correction Factor</th><th>Ambient Noise</th><th>Correction Factor</th><th>Ambient Noise</th><th>Correction Factor</th></tr>
<tr><td>45dBA</td><td>0dB</td><td>51dBA</td><td>1.41dB</td><td>57dBA</td><td>3.69dB</td></tr>
<tr><td>46dBA</td><td>0.18dB</td><td>52dBA</td><td>1.73dB</td><td>58dBA</td><td>4.17dB</td></tr>
</table></td><td>Test Case-24</td></tr>
</table>

	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 relevant safety requirements as per IS/IEC 61204: Part 7: 2016 as prescribed under Table no. 1 of the TEC document 'SAFETY REQUIREMENTS OF TELECOMMUNICATION EQUIPMENT": TEC10009: 2024'.						Certificates issued by accredited test laboratories shall be submitted
8.0	**Other requirements:**						
8.1	**Rack:** The rack structure shall be made up of rigid framework of steel profiles and shall be free of sharp edges or sharp corners. The structural strength of the rack shall be able to withstand the ultimate mechanical load capacity of the rack without any deformity. The rack shall have suitable ventilating arrangements (forced cooling from the sides is not permitted). The front door (if provided) and rear door may be of hinged or removable type. The gauge of metal sheet for load bearing part shall not be less than 1.5 mm and for rest of the parts shall not be less than 1.2mm. The unit may be floor-mounted or wall-mounted as specified by the purchaser. The unit may be either expandable or of ultimate size, as per purchaser's requirement". Sheet used in cabinet manufacturing should be Galvanized Iron (GI – 120gsm) & duly powder coated as per the colour given in clause no. 8.11.						Physical Check and Declaration from Manufacturer

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 arrangement. 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.	Physical Check and Declaration from Manufacturer
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. The /rack completes with all panels fitted shall be designed to allow cooling by natural convection For the systems, using 25A &50 A FR/FC modules force cooling is permitted. For Outdoor racks, use of temperature-based speed-controlled DC Fans are only permitted for the purpose. There shall be an arrangement for automatic Switching-OFF of fans during AC input failure. If required, individual modules may be separated by air baffle to provide effective convection. The manufacturer shall also ensure that the failure of fan does not cause any fire hazards. The failure of any of the fans shall draw immediate attention of the maintenance staff. The filter used in outdoor cabinet shall be minimum of G3 grade.	Information
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.	Information

8.1.4	Provision for mounting the Standalone CCU on the wall or table shall be provided. Hybrid CCU shall have the provision for fixing it on the floor.	Physical Check
8.1.5	The base of rack shall ensure uniform floor loading of not more than 975 kg/Sq. metre in case of Hybrid CCU & 320 kg/Sq. meter in case of Standalone CCU. Lifting facilities shall be provided by removable eyebolt located at the top of the rack. The necessary arrangement for fixing the rack on the floor shall also be provided. The rack shall also be provided with bottom clearance of 110 mm with a tolerance of +/- 10mm.	Physical Check and Declaration from Manufacturer
8.1.6	**Standalone CCU:** The top of the rack shall be fully covered except for proper 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. Hybrid CCU: Rack shall be protected from dust & water complying to IP55 in accordance with IEC 60529.	Physical Check Certificates from accredited test labs need to be submitted for IP in accordance with IEC60529.
8.1.7	**Standalone CCU**:-The rack shall be designed for easy maintenance & installation. Rack mounting arrangement shall provide easy access from front, rear and top for Installation and Maintenance. Hybrid CCU: The rack shall be designed for any maintenance and installation. Rack mounting arrangement shall provide easy access from front and rear for Installation and Maintenance. The individual FR/FC module 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. The associated AC	Physical Check

	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.	
8.1.8	Facility shall be made to connect external AC power at the top/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.	Physical Check
8.1.9	**Standalone CCU:** With doors in position, all Visual alarms and meters shall be clearly visible. In case of hinged door meters & alarm indications are permitted on door provided, the fixtures on the door do not restrict the movement of door in any way. Hybrid CCU: Meters and alarm indications (if any) shall remain inside the cabinet and shall not be positioned on the door.	Physical Check
8.1.10	The FR/FC modules shall be cooled by natural convection for smaller capacities i.e. 12.5A. FR/FC modules of more than or equal to 25A may have natural or forced cooling.	Information
8.1.11	AC input to FR/FC modules shall be through composite type hot plugin connectors. . 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.	Physical Check
8.1.12	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 disconnected by plugs or connectors.	Physical Check
8.1.13	The Distribution/Switching sub-system of DSCA shall preferably be	Physical

	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.	Check
8.1.14	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.	Physical Check
8.1.15	DSCA shall be provided for the ultimate system capacity as per clause 8.15.2 &8.15.3. All AC, DC or control/alarm cabling/wiring shall be prewired 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	Physical Check
8.2	**Terminations :**	
8.2.1	**A C Terminations :**	
8.2.1.1	The input terminals shall be clearly marked as R, Y, B & N for three phase and L and N for single phase as applicable.	Physical Check
8.2.1.2	All the terminals, except AC earth, shall be electrically isolated.	Physical Check
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.	Physical Check
8.2.1.4	Screening shall be provided between AC and DC components to prevent accident.	Physical Check

8.2.1.5	The AC input connection to the rectifier module shall be by a composite type hot plug-in connectors and socket arrangement.	Physical Check
8.2.1.6	All the connections between Distribution and FR/FC modules, shall be through proper rated cables only.	Physical Check
8.2.1.7	Fuses and Circuit-breakers for each FR/FC shall be easily accessible and properly rated.	Physical Check
8.2.1.8	Proper terminations for AC at the input of the circuit -breakers and its output to the FR/FC.	Physical Check
8.2.1.9	Nuts and bolts used for securing electrical connection s shall not be used for clamping terminals to their mountings.	Physical Check
8.2.2	**DC Terminations:**	
8.2.2.1	Proper termination shall be provided in the Standalone CCU & Hybrid CCU to terminate the leads from the battery, load and cable from the SPV power source.	Physical Check
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.	Physical Check
8.2.2.3	All conductors shall be properly rated to prevent excessive heating.	Physical Check
8.2.2.4	The terminals shall be capable to withstand the ultimate peak load.	Physical Check
8.2.2.5	The fuse or circuit -breakers with current limiting devices used, shall be easily accessible and properly rated.	Physical Check
8.2.2.6	The male connectors shall be mounted in the FR/FC module and female connectors be terminated to the cable.	Physical Check
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,	Physical Check

	cables of proper rating are permitted.	
8.2.2.8	Provision shall be made for the interconnection between telecom equipment, Hybrid or standalone CCUs, and batteries including necessary switching arrangements. Additionally, appropriate terminations for telecom equipment, batteries, and Hybrid or Standalone CCUs shall be provided. The isolation of any of the battery from the load shall create an alarm.	Physical Check
8.2.2.9	All the AC, DC Control & alarm cabling shall be supplied with the rack.	Information
8.3	**Mounting of Component and Layout :**	
8.3.1	Component mounting and fixing methods shall be secured.	Information
8.3.2	Suitable mechanical structure/ arrangement for holding modules in position shall be provided so that the module is held firmly by sliding through it.	Information
8.4	**Bus Bars:** Tinned Bus-bars or tinned High conductivity electrolytic copper strips with purity of 99.90% (min) as per BIS 613 latest issue, be able to withstand maximum Load current. The Bus-bar shall be capable to carry current density of 2 Amps/mm. 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).	Undertaking to be taken from OEM & Test Case-25
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	Physical Check

	and overload. All the wires and cables used shall be fire retardant as per IS 1554 with amendment 1 (June 94). All the cables & wires used shall also be Rodent & reptiles repellent. Uninyvin cables are also allowed to use in system." All wiring 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:** For Hybrid CCU & Standalone CCU, 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. In addition, provision shall also be made for Hybrid CCU to monitor AC voltage of the system and DC current as well as voltage with the help of Digital meters to read the voltage and current of the system, any of the battery or any of the individual FR/FC (at individual FR/FC module also permitted). Digital meter's display/resolution should be such that it is clearly and unambiguously readable from a distance of 1 metre. Normally the meters mounted at DSCA shall indicate the system voltage and current. **a. Current:** +/- 1.5% of the range or better, shall be able to read up to full digit for meter range 50A & above and 1 place decimal for lower meter range. **b. Voltage:** +/- 1.5% of the range or better with a resolution of one decimal point in case of DC voltmeter and full digit in case of AC voltmeters.	Physical Check & Test Case-26
8.7	**Dimensions:**	
8.7.1	Purchasing authority shall clearly specify the height of the rack as per his power room/equipment room requirements. 1. Standalone CCU 2. Hybrid CCU 3. Battery Space required or not	Information

8.8	**Earthing:** Standalone CCU & Hybrid CCU rack shall be provided with proper Earth terminal (two in each rack), in effective electrical contact with framework, shall be provided. 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.	Physical Check
8.9	**Marking and Labelling**: It shall be possible to locate each component on the PCB with the help of layout and circuit drawing. All terminals shall be properly sign-written and all components properly labelled so that it shall be easy to identify them with reference to the supplier's instruction and maintenance manuals. Designation of keys, switches and other components mounted on the front/inside panel and other operating positions shall clearly engraved or sign-written. The wiring shall be clearly & permanently identified with designation or a colour code which corresponds to the equipment circuit diagram. Where non-standard colours are used cable functions shall be clearly & permanently labelled at both ends.	Physical Check
8.9.1	Fuse holder identification shall include details of fuse rating & type.	Information
8.10	**Circuit & Cabling Diagram:** A cabling diagram, screen printed or any other better arrangement ensuring better life expectancy shall be placed in the inside of the front door or any other convenient place for ready reference of the maintenance staff.	Physical Check
8.11	**Finish & Painting:** 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 60 to 100 Micron for indoor rack and 80 to	Physical Check

	120 Micron for outdoor rack. The Colour used shall conform to IS 5 latest issue. Colour scheme shall be as follows : a. Rack & Door: Satin Blue, No. 177 b. Modules and inside: Shall harmoniously match with rack colour c. Outdoor Rack: - Light Grey (RAL7035)	
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.	Information
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.	Physical Check
8.12.2	**Name Plate for Charge Controller and SMPS unit/rack :** 1. Specification Number: 2. Type of the Unit: 3. Manufacturer's name and identification: 4. Model No.: 5. Unit Serial No.: 6. TAC No.: 7. Input voltage and phase (SMPS): 8. Output Voltage and Current (SMPS): 9. Year of manufacture: 10. Rating and Output voltage of the charge controller (MPPT) : 11. Input Voltage of charge controller (MPPT):	Physical Check

	12. Battery Capacity and voltage:	
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.	Physical Check
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.	Undertaking to be taken from OEM
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).	Undertaking to be taken from OEM
8.13.3	The mounting arrangement shall be suitable for column mounting or flat surface, as desired by the ordering authority.	Information
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.	Undertaking to be taken from OEM & Certificates from accredited test labs need to be

		submitted
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.	Information
8.13.6	The design/drawings of the mounting structure shall be supplied along with the module to the purchaser.	Information
8.13.7	The mounting structure shall be suitably designed to withstand the weight of the panel/array.	Information
8.14	**Rack Configuration :** Rack is composed of following units, a) Float Rectifier-cum-Float Charger (FR/FC) b) Distribution, Switching, Control, Alarm and Monitoring (DSCA) unit.	Information
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.	Information
8.15.2	The FR/FC modules shall be accommodated in a rack. DSCA, for the ultimate capacity, shall be provided in first rack or in a separate rack as per manufacturer's design. 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 system capacity. In case the Distribution is provided in the individual racks DC distribution/switching shall be for the ultimate system 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.	Physical Check
8.15.3	The SMPS shall be tested for the following ultimate capacities for awarding TAC:	Information

Category No.	Basic Module	Ultimate capacity
1	12V/12.5A (Single phase)	37.5A
2	24V/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)	450 A

	ANNEXURE -3	
	SNMP and RS232/RS485 Modbus Communication Specifications for sequence of Exchange of information between hybrid SPV Power system & Remote Site monitoring equipment shall be as given in TEC GR 66110:2025 or latest.	Test Case-11

I. TEST SETUP & PROCEDURES:

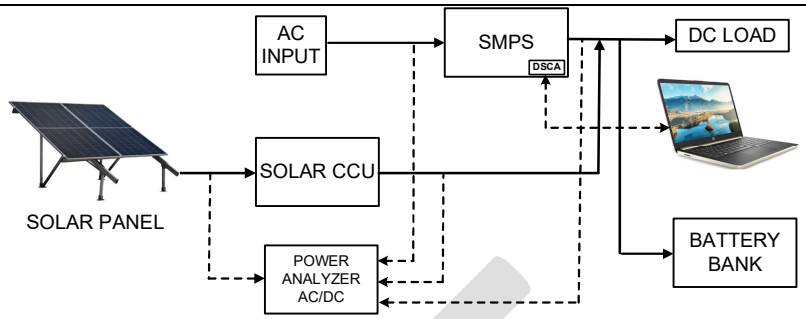
Note:

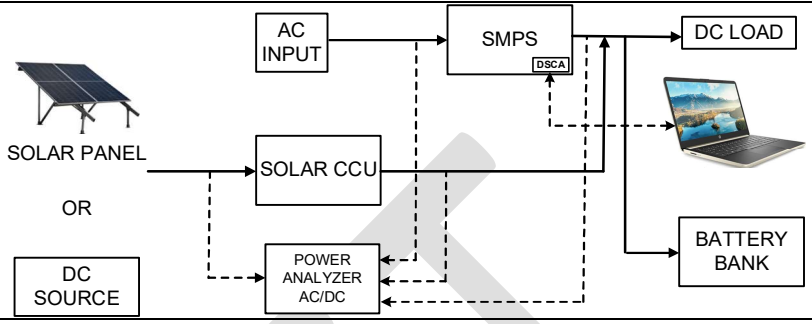
(a) The test set-up given in this document are tentative and may be changed by testing officer, taking in to account, network/testers/ analyzer/simulator availability. In case of any discrepancy between this TSTP and GR, GR clause shall prevail.

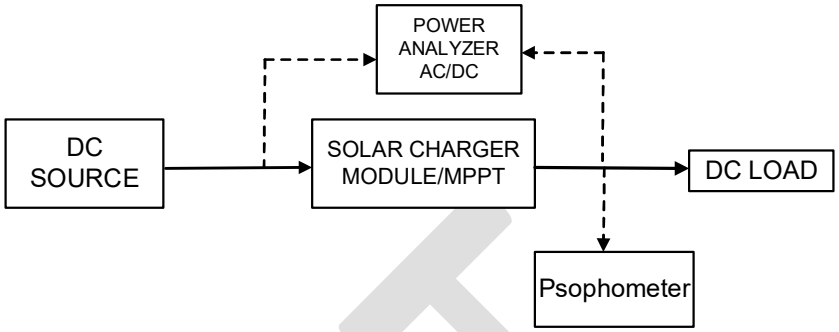
(b) Since this is provisional TSTP, on the basis of inputs received, setup was prepared. Therefore, whenever the first testing will be offered, this provisional TSTP would be revised.

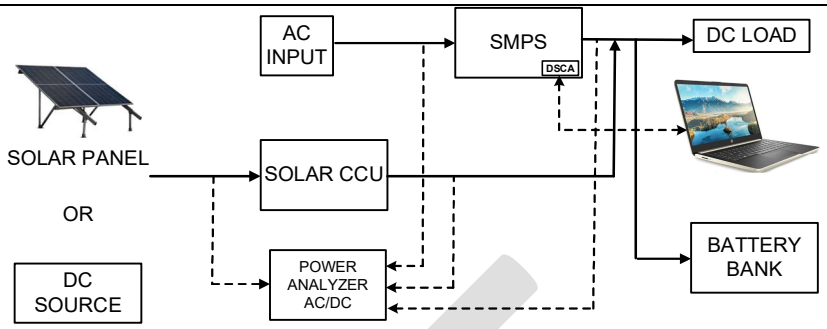
(c) Actual setup and tester/simulator may vary at the time of testing.

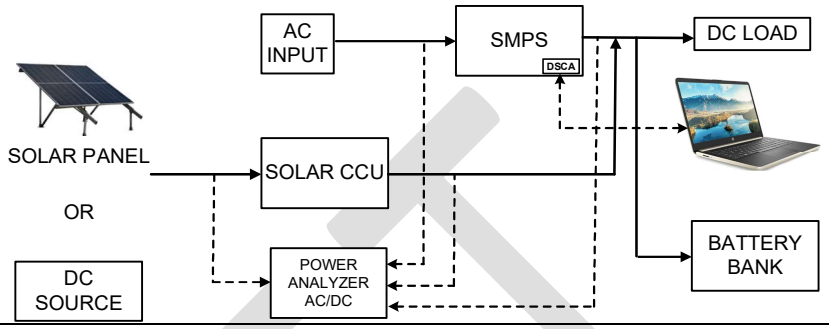
(d) Testing of L&SP will be done on the basis on testing facility available for testing L&SP. If no testing facility is available for testing L&SP, then undertaking from OEM may be taken.

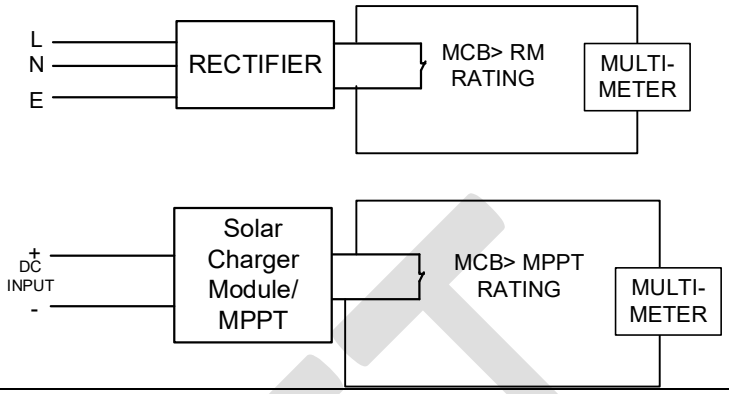
Test No.	**Test Case-1**
Test Details	Clause no. 2.1.2, 3.0, 3.1, 3.6.2
Test Setup	
Test Procedure	1. Connect AC input supply for SMPS section & DC supply for Solar CCU section. Also connect Battery and DC load. 2. Connect Laptop to DSCA to monitor system parameter. 3. Monitoring of system alarm, parameter over DSCA display. 4. System information on DSCA SW version, FR/FC SW version, module rating, Battery detail.
Test limits	1. FR/FC module rating, Controller information should be as specified in GR. 2. Monitoring & setting of all parameter shall be through DSCA. 3. Provision to switch off SMPS output. This can be done using a control signal from Charge controller which controls SMPS or a switch. 4. DSCA shall have menu for selection of type of battery between VRLA and Li-ion battery and type of battery should be displayed on DSCA
Expected Results	Check FR/FC module rating and parameter as specified in GR. SMPS output will be switched off through control signal from DSCA.

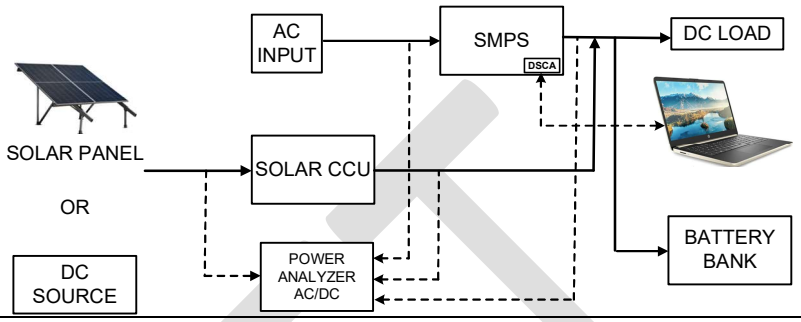
Test No.	**Test Case-2 (Voltage to Load and battery)**
Test Details	Clause no. 3.3.1.1, 3.3.1.2
Test Setup	
Test Procedure	1. Connect AC input supply for SMPS section & DC supply for Solar CCU section. Also connect Battery and DC load. 2. Connect Laptop to DSCA to monitor system parameter. 3. Measure the system output voltage when Charge Controller Module or MPPT is in communication with DSCA. 4. Disconnect the Charge Controller Module or MPPT communication with DSCA & measure the system output voltage. 5. Decrease the voltage from input DC Source of Solar CCU section & observe the output current limit of MPPT.
Test limits	1. The SPV voltage at the output of the charge controller shall be limited to 13.8V for 12V power supply, 27.6V for 24V power supply with DSCA in communication 2. Without communication with DSCA, the output voltage of the charge controller shall be limited to 13.8V for 12V power supply, 27.6V for 24V power supply and 55.2V for 48V power supply. 3. In worst working condition load should be delivered by SPV charger/MPPT as per available input voltage.
Expected Results	Output of the charge controller will be 13.8V for 12V, 27.6V for 24V & 54V for 48V power supply with DSCA in communication. And 13.8V for 12V, 27.6V for 24V and 55.2V for 48V power supply when not in communication with DSCA. MPPT module will share load as per available input voltage.

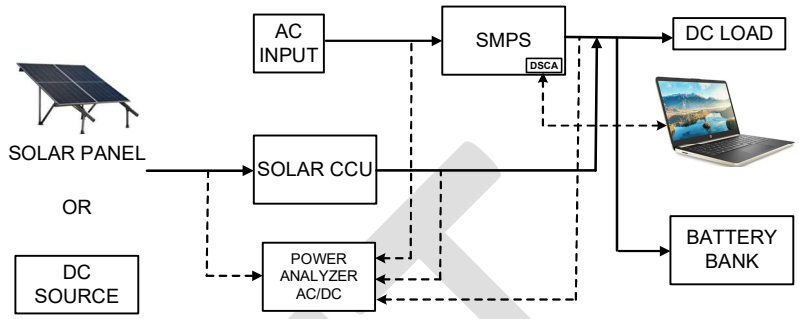
Test No.	**Test Case-3(Efficiency)**
Test Details	Clause no. 3.3.1.3, 3.3.1.4
Test Setup	
Test Procedure	1. Connect DC supply at the input & DC Load at the output of Solar CCU section. 2. Connect Power analyzer between DC input and DC Output of Solar Charger Module/MPPT. 3. Connect Psophometer at output of Solar Charger Module/MPPT to measure Psophometric noise. 4. Measure efficiency of Solar Charger /MPPT module separately as per GR.
Test limits	1. Efficiency: $\geq$93% 2. Psophometric Noise: $\leq$ 2mV with Battery connected.
Expected Results	Check system performance and limit as specified in GR.

Test No.	**Test Case-4 (Protection)**
Test Details	Clause no. 3.4 (DC Overvoltage), 3.20.2 (D.C. Over Voltage)
Test Setup	
Test Procedure	Solar Charger MPPT : 1. Connect DC supply at the input of Solar Charger (MPPT) 2. Connect multimeter or analyzer at the output of Solar charger. 3. Connect Laptop to DSCA to monitor system parameter. 4. Increase the output voltage of Charge Controller Module with the help of DSCA ≥56.5 V for 48V, 28.2 V for 24V and 14.1 V for 12V power supply & wait for Charge Controller Module/MPPT to isolated automatically. FR/FC Module: 1. Connect AC supply at the input of SMPS section. 2. Connect multimeter or analyzer at the output of SMPS. 3. Connect Laptop to DSCA to monitor system parameter. 4. Increase the output voltage of FR/FC module with the help of DSCA ≥ 56V (for 48V unit) and 14V (for 12V unit) & wait for FR/FC Module to isolated automatically.
Test limits	1. In case the Charge Controller Module output voltage exceeds 56.5 V for 48V power supply, 28.2 V for 24V power supply and 14.1 V for 12V, the module will isolate automatically. 2. In case the FR/FC Module output voltage exceeds 56V (for 48V unit) and 14V (for 12V unit), the module will isolate automatically 3. Restoration of the module shall be through manual or through DSCA.
Expected Results	Both Charge Controller Module & FR/FC Module will isolate automatically once output voltage reach the define limit in GR

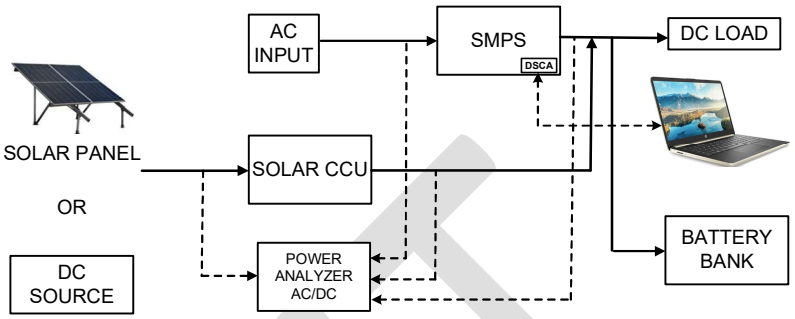
Test No.	**Test Case-5**
Test Details	Clause no. 3.4 (Battery Under Voltage), 3.17 (Battery Under Voltage Isolation
Test Setup	
Test Procedure	1. Switch off the AC & DC input supply. DSCA should be power up only on battery voltage. 2. Apply load on output & wait for battery to discharge & Voltage to falls below value define in respective GR clause for VRLA & Li-ion battery.
Test limits	In case output DC voltage falls below define limit in respective GR clauses, the battery shall be isolated from the load.
Expected Results	The battery will be isolated from load.

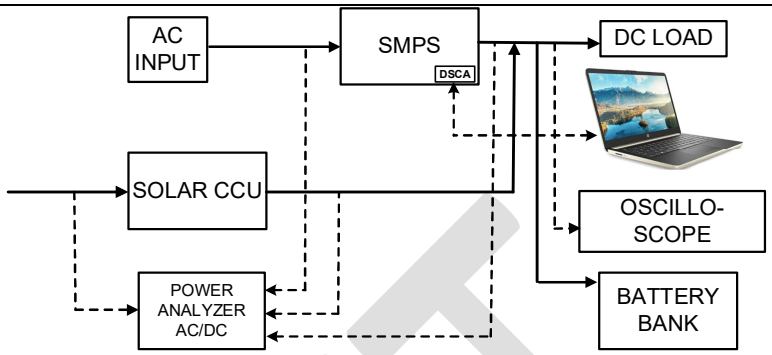
Test No.	**Test Case-6 (Overload/Short Circuit)**
Test Details	For Clause no. 3.4, 3.15.2, 3.21
Test Setup	
Test Procedure	1. Connect nominal AC supply/DC supply at FR/FC or MPPT module separately. 2. Terminate DC output (+ & -) both at single MCB (MCB rating should higher than module rating to avoid trip during short circuit condition. 3. Now switch on AC /DC input supply and check DC Output voltage. Input Voltage should be nominal. Now switch on MCB connected at DC output of module. 4. Check DC output Voltage with multimeter, it should be zero. 5. When test complete, switch off MCB and DC output should be nominal.
Test limits	Ensure that short circuit shall not lead to any excessive temperature rise or fire Hazard.
Expected Results	Check system performance and limit as specified in GR

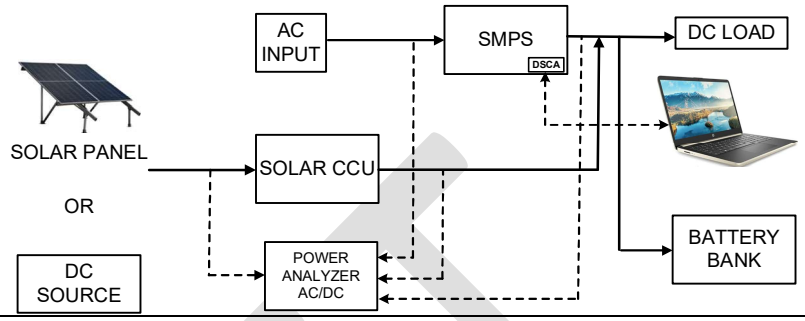
Test No.	**Test Case-7 for Functional Indication**
Test Details	For Clause no. 3.5.1, 3.22.1
Test Setup	
Test Procedure	1. Connect AC input to SMPS section & DC input to Solar CCU section. Connect DC load at the output of system. 2. Connect Laptop to DSCA to change or monitor parameter or through controller display. 3. Switch on AC input mains supply and check indication over DSCA and FR/FC. 4. Check FR/FC in auto float/Charge mode. 5. Check battery is charging & Load is on battery.
Test limits	1. Mains available shall be provided on both DSCA & FR/FC Module 2. FR/FC On Auto Float, FR/FC On Auto Charge, Battery charging & Load on battery may be provided either on DSCA or on both FR/FC & DSCA.
Expected Results	All above alarm indication shall be available on DSCA or FR/FC module as specified in GR.

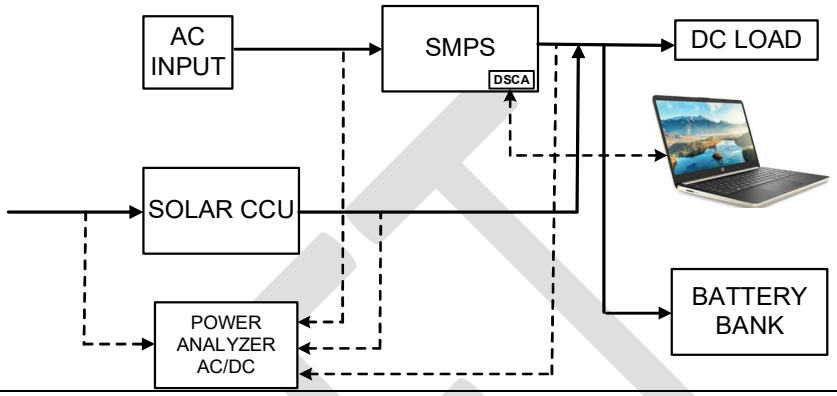
Test No.	**Test Case-8 Indication**
Test Details	For Clause no. 3.5.2, 3.22.2
Test Setup	
	1. Connect AC input to SMPS section & DC input to Solar CCU section. Connect DC load at the output of system 2. Connect Laptop to DSCA to change or monitor parameter or through controller display. 3. Check LED indication over FR/FC module for a. LED Green - Healthy b. LED Amber - Warning c. LED Red – Major 4. Switch off MCB of any one rectifier & check alarm on DSCA. 5. If MCB is provided for Load equipment's then switched Off any one MCB & check alarm on DSCA. 6. On DSCA increase voltage to 56V/13.9V for load voltage high and 45.6V/11.4 for load voltage low corresponding to 48V/12V system. Then check system performance. 7. Increase/decrease AC input voltage and check alarm for Mains out of range on DSCA 8. Increase DC load to check system overload alarm on DSCA. 9. For Mains On/and battery discharge test, increase DC load over the system capacity and check alarm on

	DSCA. 10. For OD system (if applicable), while FAN running, stop one FAN manually for FAN fail alarm at rack level. 11. Remove temp sensor and check Temp sensor fail alarm on DSCA. 12. With DSCA setting, disconnect BLVD and check battery isolation or no battery over DSCA. 13. Remove one MOV from SPD & then check alarm on DSCA.
Test limits	1. LED indication shall be available on FR/FC module 2. DC Over Voltage alarms shall operate within + or – 0.25Volts of the nominal set value. 3. Overload, Mains On & Battery discharge alarm will be available on DSCA. 4. Fan fail, Temp sensor fail alarm will be available on DSCA. The above limits may be taken as reference only. For the actual limits the relevant Clauses of the latest TEC GR with amendments if any, shall be referred.
Expected Results	All indication and alarm shall be available on FR/FC module or DSCA as specified in GR.

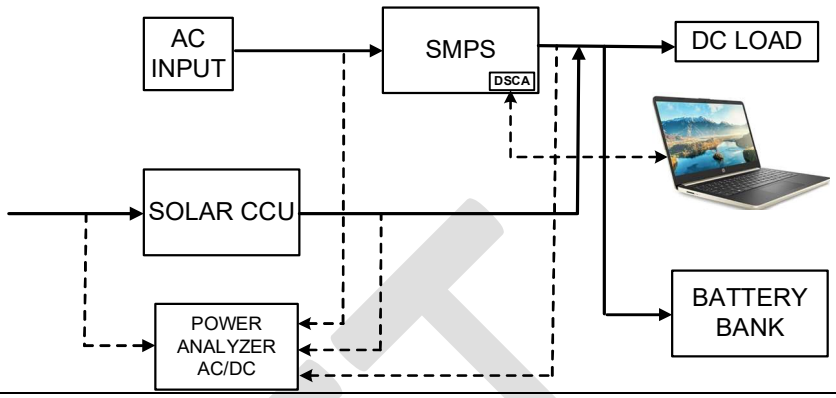
Test No.	**Test Case-9 (Potential Free Contacts)**
Test Details	Clause no. 3.5.7
Test Setup	
Test Procedure	1. Connect AC input to SMPS section & DC input to Solar CCU section. Connect DC load at the output of system 2. Connect Laptop to DSCA to change or monitor parameter or through controller display. 3. Generate PFC alarm as specified in GR.
Test limits	PFC alarm shall be as per GR.
Expected Results	Check PFC as specified in GR.

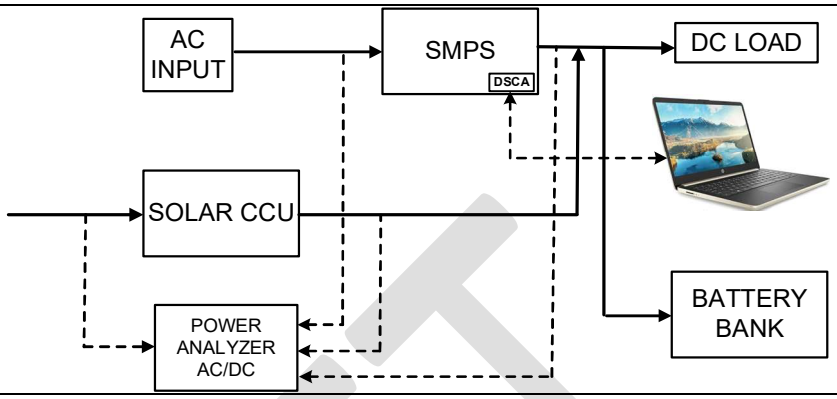
Test No.	**Test Case-10**
Test Details	Clause no. 3.6.2 (For microprocessor failure),3.16.3
Test Setup	
Test Procedure	1. Connect AC input to SMPS section & DC load at the output of system. 2. Connect laptop to DSCA or through controller display to monitor rectifier parameter and alarms. 3. Turn on AC input supply, check default voltage of rectifier. Now turn on DC load and check load sharing. 4. Now remove controller to check rectifier default voltage and same load must be supplied by the rectifier. DC load should remain power on.
Test limits	1. In the event of failure of Microprocessor or DSCA, FR/FC modules parameters shall not be disturbed. 2. All the FR/FC modules shall take care of the load on default settings and share the load collectively.
Expected Results	Check system parameter and limit as specified in GR

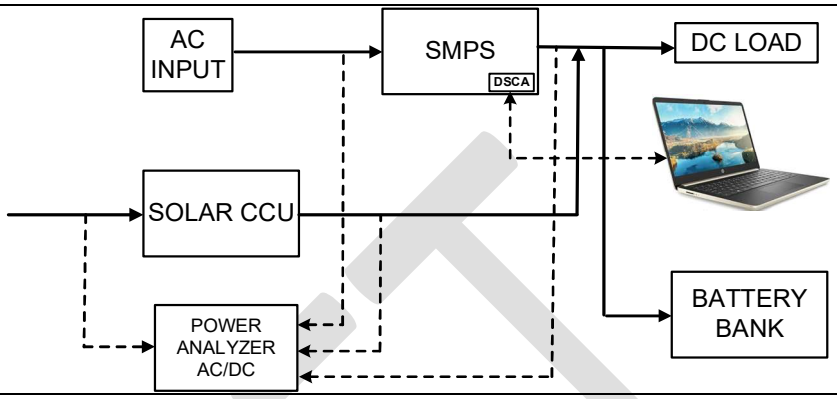
Test No.	**Test Case-11**
Test Details	Clause no. 3.6.2, 3.23, 3.24 & Annexure-3
Test Setup	
Test Procedure	1. Connect AC input to SMPS section & DC input to Solar CCU section. Connect DC load at the output of system. 2. Connect Laptop to DSCA to check system parameter load or through DSCA display. 3. Check DSCA and FR/FC SW version. 4. Monitor the SMPS & battery parameter on SNMP or RS-485/RS-232 as applicable as per GR.
Test limits	The system shall be RS 485/RS232 and Ethernet (SNMP Protocol) compatible, if remote monitoring is required. It shall be feasible to set any monitoring control parameter from a remote site
Expected Results	Check system parameter and limit as specified in GR.

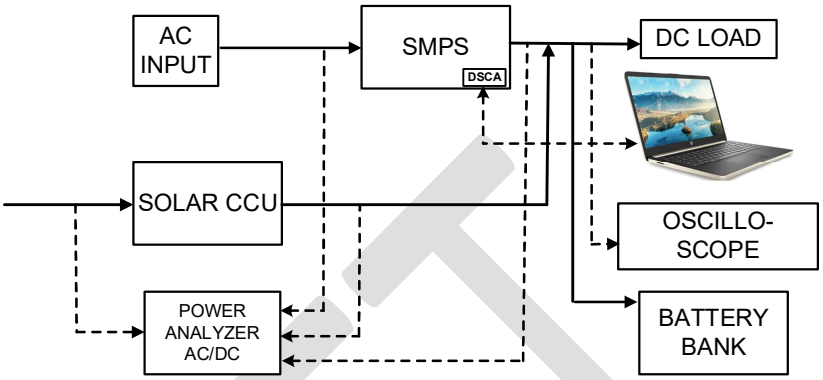
Test No.	**Test Case-12 (AC input Supply)**
Test Details	Clause no. 3.7.1, 3.20.1
Test Setup	
Test Procedure	1. Connect AC input to SMPS input and DC load to output of SMPS. 2. Connect Laptop to change or monitor system parameter and performance. 3. Connect power analyzer at AC input, DC output and battery. Apply Single Phase AC input nominal supply 230 V with variation in the range of +10% and -15% and frequency as 50 Hz +/-2Hz. Also supply AC input from 170 to 260 V and frequency as 50 Hz +/-2Hz. 4. While increasing/decreasing AC input on above specified range with tolerance, FR/FC module will shut down with RED LED indication on the same. 5. Mains Fail alarm will generate on DSCA in above case during shutdown. 6. When AC input becomes nominal, FR/FC module operate and will charge battery and will power up DC load.
Test limits	1. Power Plant should deliver DC output voltage as per define range in GR. 2. Hysteresis within specified working limits shall prevent shutting down of the FR/FC. A tolerance of +/-5V is acceptable for

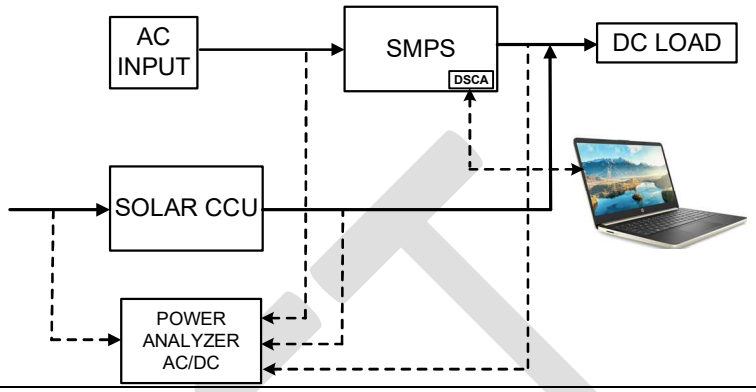
	protection and alarm operation. Reconnection shall occur at a voltage, 10V lower than the set voltage for high isolation limit and 10V higher than the lower set limit to avoid hunting. The circuitry used for sensing the voltage for operation of isolation/ reconnection device shall be able to withstand a voltage 15% higher than the specified extreme limit of isolation.
Expected Results	Power plant will work as normal during cut in after high/low cutoff range as specified in GR

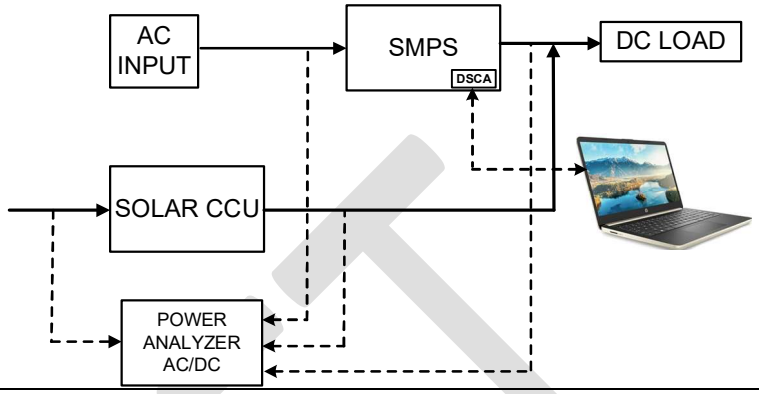
Test No.	**Test Case-13 (Auto Float Mode & Charge Mode)**
Test Details	Clause no. 3.7.2.1, 3.7.2.2
Test Setup	
Test Procedure	1. Connect AC input to SMPS input and DC load to output of SMPS. 2. Connect laptop to DSCA to change current limit or through DSCA display. 3. Check battery is fully charged and in Float. 4. Now change Float voltage to 13.5/54V, 12/48V & 14/56 for respective 12V or 54V system & check Voltage on DSCA. 5. Now discharge battery so it can charge with more the 5% current of its capacity & goes into auto Charge mode. Now similarly to point-4 change Charge voltage to 14.2/55.2V, 12/48V & 14.6/56 for respective 12V or 54V system & check Voltage on DSCA. 6. Battery charging current limit shall be adjustable through Laptop or DSCA display.
Test limits	FR/FC modules Voltage should increase or decrease as per setting done through DSCA. For 12V/48V FR/FC (Auto Float Mode): settable between -12V and -14V settable between -48V and -56V For 12V/48V FR/FC (Auto Charge Mode): settable between -12V and -14.6V settable between -48V and -56V
Expected Results	Check system parameter and limit as specified in GR.

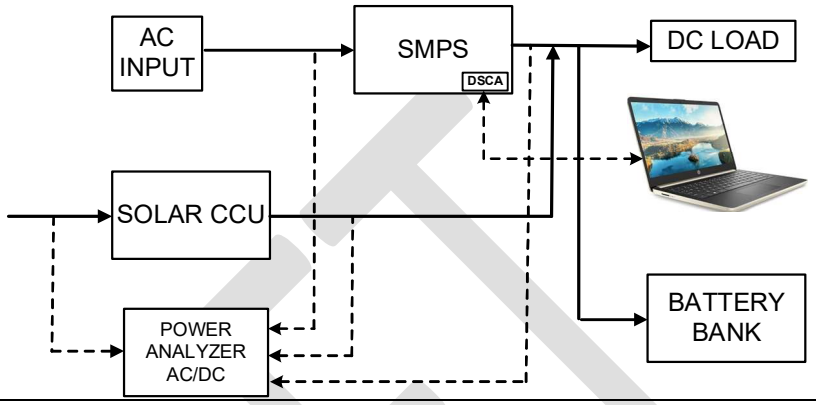
Test No.	**Test Case-14**
Test Details	For Clause 3.7.2.3
Test Setup	
Test Procedure	1. Connect AC input supply to SMPS section and connect DC load. 2. Connect Power analyzer between AC input and DC Load. 3. For load regulation test, provide nominal AC input voltage 230Vac to SMPS. Once DC voltage build up, connect DC load of 25% of full capacity. 4. Now measure DC output voltage. 5. In above test at same AC supply, now increase DC load to 100% and measure DC output voltage. .
Test limits	The DC output voltage at the terminals shall be maintained within +/-1% of the half load preset voltage from 25% load to full load condition when measured over the full-specified input range.
Expected Results	Check system parameter and limit as specified in GR.

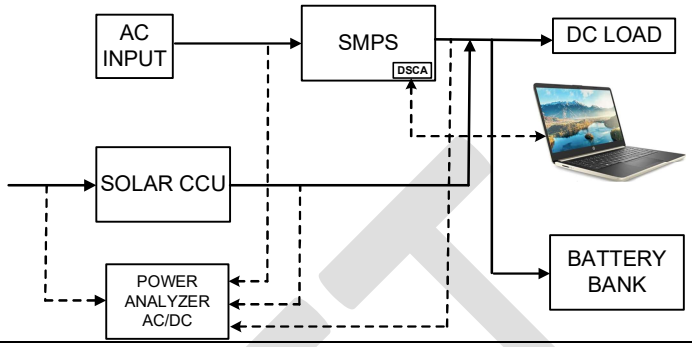
Test No.	**Test Case-15 (Efficiency, P.F. Harmonics)**
Test Details	For Clause no. 3.8, 3.9, 3.14.1, 3.14.2
Test Setup	
Test Procedure	1. Connect Power analyzer between AC input and DC Output of FR/FC. 2. Connect Oscilloscope at output of FR/FC to measure ripple. 3. Measure efficiency of FR/FC module separately as per GR. 4. measure input power factor on power analyzer. 5. Measure Psophometric Noise with Psophometer. 6. Measure Vthd & Ithd through power analyzer.
Test limits	1. CHD ≤ 10% 2. VHD ≤ 10% 3. Peak to Peak ≤ 300mV 4. Psophometric Noise ≤ 4mV without Battery connected & ≤ 2mV with Battery connected. 5. Float Voltage: 54.0V. 6. Charge Voltage: 55.2V. 7. Efficiency: As prescribed in the clause no. 3.8 8. Power factor: As prescribed in the clause no. 3.9
Expected Results	Check system performance and limit as specified in GR

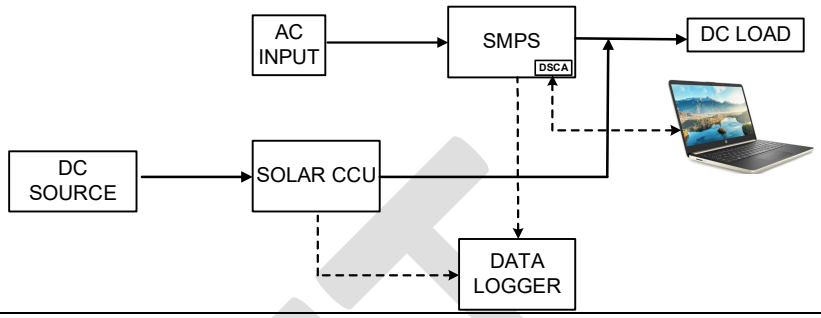
Test No.	**Test Case-16(Soft Start, Voltage Over/Undershoot)**
Test Details	For Clause no. 3.12.1,3.12.2, 3.13.1,3.13.2,3.13.3
Test Setup	
Test Procedure	1. Connect AC input supply to SMPS. 2. Connect power analyzer between AC input and DC output to Battery & DC load of SMPS. 3. Connect Laptop on DSCA or through DSCA display to change RM output voltage 4. Measure transient response as per respective clause when load switch ON 5. Now change in AC input through AC source as per GR and respective clause and output voltage of SMPS. 6. Now change AC input voltage of SMPS through AC source and check output voltage of SMPS for overshoot and undershoot at specified load mention in GR.
Test limits	1. The Step Load change of 25 to 100% shall not result in DC output voltage Over Shoot / Under Shoot of not more than + / - 5% and return to steady state value within 10mS without resulting the unit to trip. 2. If value not capture in CRO then write you observation (not traceable).
Expected Results	Check system performance and limit as specified in GR.

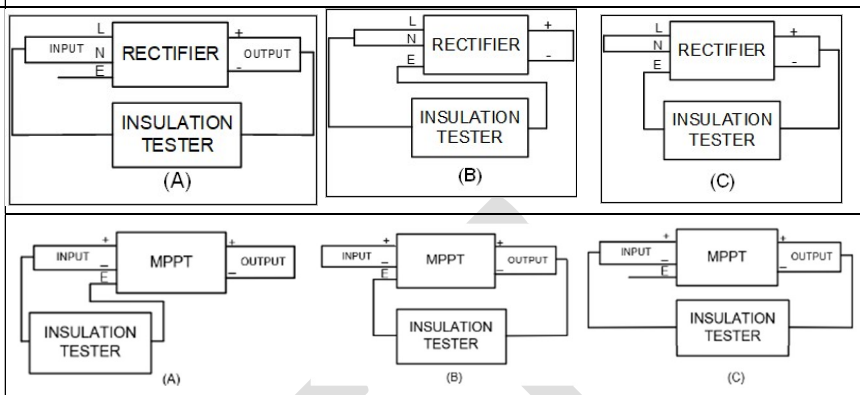
Test No.	**Test Case-17 (Current limiting (Voltage Droop))**
Test Details	Clause no. 3.15
Test Setup	
Test Procedure	1. Connect AC input supply to SMPS section and DC Load to output of SMPS section. 2. Connect Laptop on DSCA or through DSCA display to change FR/FC output voltage. 3. Set current limit from 50% from 100% & DC output of rectifier from 44.4V to 56V through DSCA. For test purposes upper limit of 100% + 5% and lower limit of 50% - 5% shall be acceptable. 4. FR/FC Modules goes in Current limit & voltage will droop while increasing the load. 5. Overload protection test will also be applicable with this test.
Test limits	1. Shall be settable between 50% to 100% of rated Output Current (45% to 105% for test purpose) for Output Voltage range of -44.4V to -56.0V. 2. Further increase in Load shall not increase the Current and should result only in further Voltage Droop.
Expected Results	Check system parameter and limit as specified in GR.

Test No.	**Test Case-18 (Load Sharing)**
Test Details	Clause no. 3.16.2
Test Setup	
Test Procedure	1. Connect AC input supply to SMPS section and connect DC load. 2. Connect Laptop to DSCA to check module sharing load or through DSCA display. 3. Turn on AC supply and DC load. 4. Check FR/FC module sharing load from 50% to 100% with float & charge voltage mode.
Test limits	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.
Expected Results	Check system parameter and limit as specified in GR.

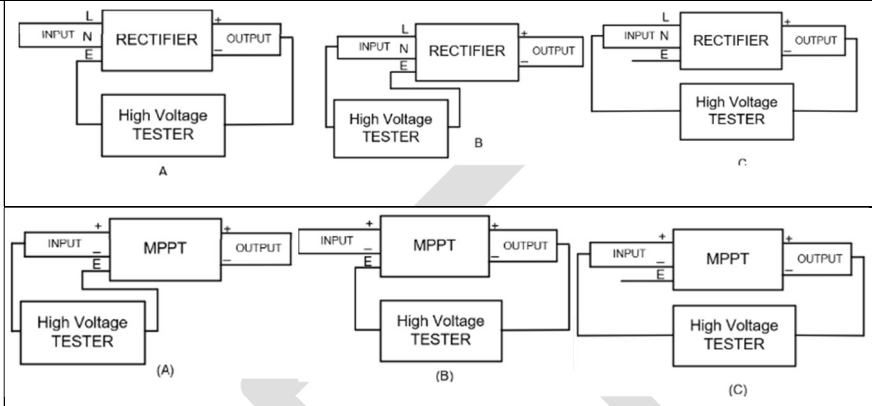
Test No.	**Test Case-19 (Battery Path Current Limit)**
Test Details	Clause no. 3.18
Test Setup	
Test Procedure	1. Connect AC input supply to SMPS section and connect DC load. 2. Connect laptop to DSCA to change current limit or through DSCA display. 3. Set battery charging limit (5% - 10%) in step as per AH capacity for VRLA Batteries & take reading. And Set charging limit at (5% - 50%) in step as per AH capacity for Li-ion Batteries & take reading.
Test limits	Auto Mode the current in each battery path (For VRLA type battery) shall be settable as per the battery capacity and DG capacity as applicable so that the battery path current is kept at 5% to 10% of battery AH capacity. When Li-ion battery selected setting the current in each battery path should be settable as per the battery capacity and DG capacity as applicable so that battery path current is kept at 5% to 50% of battery AH capacity
Expected Results	Check system parameter and limit as specified in GR

Test No.	**Test Case-20 (Temp Compensation)**
Test Details	Clause no. 3.19
Test Setup	
Test Procedure	1. Connect AC input supply to SMPS. 2. Check system voltage at different temperature during float & charging operation. The voltage will increase when temp decrease and vice versa 3. as per value provided in GR. 4. Check mV also at different temperature range as per test cases.
Test limit	1. The output voltage of the rectifier in Float/Charge operation shall decrease or increase at the rate of 72mV (3mV/cell, 24 cell battery) per degree increase or decrease in temperature over the set voltage. 2. The open circuit voltage range shall be settable between 2.1V/cell to 2.2V/cell 3. When the output voltage reaches 55.8V, due to increase in the output voltage owing to decrease in temperature, it shall get locked at this voltage & any further decrease in temperature shall not lead to further rise in the output voltage of the power plant. 4. A tolerance of +/ - 5mV may be acceptable over the specified rate of 72mV/deg C. 5. The above limits may be taken as reference only. For the actual limits the relevant Clauses of the latest TEC GR with amendments if any, shall be referred
Expected Results	Check system performance and limit as specified in GR

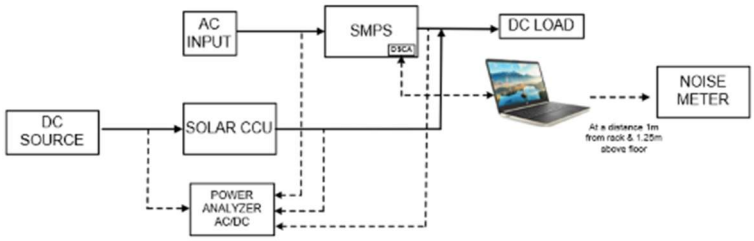
Test No.	**Test Case-21 (Burn-in Test)**
Test Details	Clause no. 5.3, clause 2.1.2
Test Setup	
Test Procedure	1. Connect AC input supply to SMPS section & DC supply to CCU section. Connect DC load to output of system. 2. Connect thermocouple as per detail mention in GR. 3. Data should be logged as per detail mention in GR.
	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.
Expected Results	The Unit under test shall be subjected to Heat run for 72 Hours of Elevated Burn-in at 50°C & full load. Heat run must be completed without failure of FR/FC, MPPT, DCSA & any fire hazard.

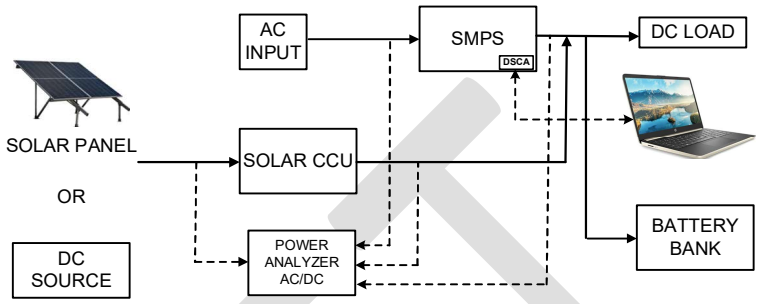
Test No.	**Test Case-22 (Insulation Resistance Test)**
Test Details	Clause no. 5.4.1
Test Setup	
Test Procedure	1. Short AC input terminal and DC output terminal separately as shown in figure A, B & C. 2. Connect insulation tester between shorting terminal of AC input and DC output (figure-A). Now check insulation as per clause. 3. Connect insulation tester between shorting terminal of AC input & earth (figure-B). Now check insulation as per clause. 4. Connect insulation tester between shorting terminal of DC output & earth (figure-C). Now check insulation as per clause. 5. Similarly now short DC input terminal and DC output terminal separately as shown in figure A, B & C for MPPT 6. Connect insulation tester between shorting terminal of DC input and earth (figure-A). Now check insulation as per clause. 7. Connect insulation tester between shorting terminal of DC output & earth (figure-B). Now check insulation as per clause. 8. Connect insulation tester between shorting terminal of DC input & DC output (figure-C). Now check insulation as per clause.
Test limits	**A) FR/FC** a) AC Input & Earth - Greater than 2 meg Ohm b) DC Output & Earth - Greater than 1 meg Ohm c) AC Input & DC output - Greater than 5 meg Ohm **B) MPPT** a) DC Input & Earth - Greater than 2 meg Ohm b) DC Output & Earth - Greater than 1 meg Ohm

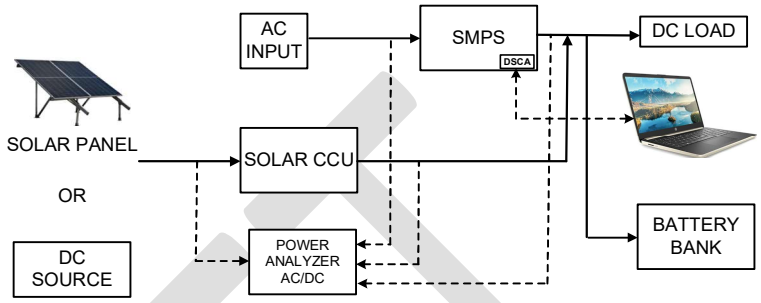
	c) DC Input & DC output - Greater than 5 meg Ohm
Expected Results	Module should pass as per define limit in GR

Test No.	**Test Case-23 (Voltage Proof Test)**
Test Details	Clause no. 5.4.2
Test Setup	
Test Procedure	1. Short AC input terminal and DC output terminal separately as shown in figure A, B & C. 2. Connect High Voltage tester between shorting terminal of AC input and DC output (figure-A). Now check insulation as per clause. 3. Connect High Voltage tester between shorting terminal of AC input & earth (figure-B). Now check insulation as per clause. 4. Connect High Voltage tester between shorting terminal of DC output & earth (figure-C). Now check insulation as per clause. 5. Similarly now short DC input terminal and DC output terminal separately as shown in figure A, B & C for MPPT 6. Connect High Voltage tester between shorting terminal of DC input and earth (figure-A). Now check insulation as per clause. 7. Connect High Voltage tester between shorting terminal of DC output & earth (figure-B). Now check insulation as per clause. 8. Connect High Voltage tester between shorting terminal of DC input & DC output (figure-C). Now check insulation as per clause.
Test limits	The Voltage Proof Test of a fully wired FR/FC & MPPT Module with EMI/RFI capacitors and MOVs/Tranzorbs removed the circuit a test voltage of 1500V/50Hz is applied for one minute. - Between earth and interconnected output terminals. - Between interconnected input and output terminals.

	Alternatively without removing EMI/RFI capacitors, the lightning protection circuitry and Tranzorbs etc., but with EMI/RFI discharge resistors removed : a) A 2150V DC can be applied for one minute between interconnected input and output terminals. b) 650V DC can be applied for one minute between interconnected input and output terminals and earth. 1. This DC voltage test is in accordance with UL 950 and IEC 950 Standards No. breakdown or abnormal temperature rise shall occur.
Expected Results	No breakdown or abnormal temperature rise occur during test.

Test No.	**Test Case-24 (Noise)**
Test Details	**Clause no. 6.2**
Test Setup	
Test Procedure	1. Connect AC input to SMPS section & DC input to Solar CCU section. Connect DC load at the output of system. 2. Set noise meter at distance as specified in GR. 3. Turn on AC & DC input supply. Turn on DC load also. 4. Connect Laptop to monitor system performance. 5. Measure noise reading from front, back, left & right of the system at different voltage & current.
Test limits	Noise shall be measured at a distance of 1 meter from the unit & 1.25m above the floor level in the Acoustic Range. The fully equipped rack at full load shall not contribute more than 15 dB (weighted) to the ambient noise level taken as 45dBA.
Expected Results	For result and limit, please refer GR.

Test No.	**Test Case-25 (Bus-Bar)**
Test Details	Clause no. 8.4
Test Setup	
Test Procedure	1. Connect AC input to SMPS section & DC input to Solar CCU section. Connect DC load at the output of system. 2. Connect Laptop to DSCA to change or monitor parameter or through controller display. 3. Measure mV drop between battery and exchange riser. 4. Measure mV drop between the output of the farthest FR/FC Module and Exchange riser (if applicable)
Test limits	The Bus-bar shall be capable to carry current density of 2 Amps/mm. 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
Expected Results	Check system performance and limit as specified in GR.

Test No.	**Test Case-26 (Meters)**
Test Details	Clause no. 8.6
Test Setup	
Test Procedure	1. Connect multimeter or Analyzer at AC input & DC input side to measure AC voltage. 2. Connect multimeter or analyzer/clamp meter at load path to measure DC output voltage and current. 3. Connect multimeter or analyzer at battery path shunt to measure mV for battery current measurement. 4. Check voltage, current over DSCA and compare with value showing in meter for accuracy.
Test limits	The Meters & Shunts shall comply with 1. Current: +/-1.5% of the range or better, shall be able to read up to full digit for meter range 50A & above & 1 place decimal for lower range. 2. 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 voltmeter.
Expected Results	Check measurement accuracy as specified in GR

J. SUMMARY OF TEST RESULTS

TEC Standard No._____

TEC Guide No._____

Equipment name & Model No._____

Clause No.	*Compliance* *(Complied /Not Complied / Submitted/Not Submitted / Not Applicable)*	*Remarks / Test Report Annexure No.*

[Add as per requirement]

Date:

Place:

Signature & Name of TEC testing Officer /

* Signature of Applicant / Authorized Signatory

* *Section J as given above is also to be submitted by the Applicant/ Authorised signatory as part of in-house test results along with Form-A. The Authorised signatory shall be the same as the one for Form 'A'.*