Template for submitting comments/inputs on Draft Test Guide titled "Uninterrupted Power Supply (UPS) System (Draft Test Guide No. TEC 66141:2026)"

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 66141:2026 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 ६६१४१:२०२६
PROVISIONAL TEST GUIDE
TEC 66141:2026

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for

निर्बाध वद्धुत आपूर्ति प्रणाली

(मानक संख्या.: टीईसी ६६१४०:२०२६)

UNINTERRUPTED POWER SUPPLY (UPS) SYSTEM

(STANDARD No.: TEC 66140:2025)

ISO 9001:2015

दूरसंचार अभियांत्रिकी केंद्र
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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 Uninterrupted Power Supply (UPS) System as per GR No. TEC 66140:2026

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A. HISTORY SHEET

Sl. No.	*Standard/*Document No.	*Title*	Remarks
1.	(GR No. : TEC/GR/UPS-001/03/MAY.2006) TSTP No. TSTP/ TEC/GR/UPS-001/03/MAY2006	Test Schedule & Test Procedure as per GR UNINTERUPPTED POWER SUPPLY (UPS) SYSTEM	First issue
2.	(GR No. : TEC/GR/FA/UPS-001/05/MAR-19) TSTP No. TSTP/ TEC/GR/FA/UPS-001/05/MAR-19	Test Schedule & Test Procedure as per GR UNINTERUPPTED POWER SUPPLY (UPS) SYSTEM	Second issue
3.	TEC66141:2026	UNINTERUPPTED POWER SUPPLY (UPS) SYSTEM	Third issue

B. INTRODUCTION

This document enumerates detailed test schedule and procedure for evaluating conformance / functionality / requirements / performance Uninterrupted Power Supply (UPS) System as per GR No. TEC 66140:2026.

C. General information

Sl. No.	General Information	Details *(to be filled by testing team)*	
1.	Name and Address of Applicant		
2.	Date Of registration:		
3.	Name and No. of GR/IR/Applicant's Spec. against which type approval sought		
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)

S. No.	Name	Designation	Organization	Signature
1.				
2.				
3.				
4.				
5.				

E. List of the test instruments:

S. No.	Name of test Instrument	Quantity	Make / Model *(to be filled by testing team)*	Validity of calibration *(to be filled by testing team)* dd/mm/yyyy	Remark
1.					
2.					

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:

Sl. 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	TECHNICAL REQUIREMENTS	
1.0	**Scope** This document contains the Generic Requirements of UPS (Uninterrupted Power Supply) Systems based on Switch Mode Power Supply (SMPS) techniques for providing uninterrupted AC power to the equipment associated with various telecom systems. The UPS shall be suitable for operation from grid supply AC mains or standby AC and battery sets only.	Information
1.1	**UPS system requirements:** UPS system consists mainly of the following building blocks : 1. **Distribution, Switching, Control & Alarm (DSCA) unit:** Provides for Distribution, Switching, Monitoring, Control and alarm of the UPS unit/system. For UPS with >4KVA (equal or more) rating shall have DSCA unit while for UPS less than 4KVA rating, DSCA function may be performed by single chip. 2. **Rectifier:** Rectifier unit is used for conversion of AC into regulated DC. 3. **Battery Bank:** Battery of suitable capacity for providing power to the inverter when Rectifier unit is not working due to any reason. 4. **Inverter Unit:** Inverter unit shall be capable of providing uninterrupted AC power to the Telecom Equipment. 5. **Static Transfer Switch:** Static Transfer Switch is for transferring the load, automatically to AC mains (regulated or unregulated). Transfer of load back to UPS shall also be	Test No. 1

	automatic but it shall take place, only after the inverter output has stabilised and is within the specified limits. Transfer time in this case shall be within 10 milli seconds. 6. **Manual Transfer Switch:** In case of Parallel Operation of UPS, a manual transfer switch shall be provided. Manual transfer switch is for the transfer of load from inverter to Stand by power and back to Inverter unit, manually without the interruption of power to the load. The interlocking inverter operation should be prevented from unsynchronized switches. 7. **Voltage Regulator:** Voltage Regulator (VR) is for providing Standby regulated AC power (wherever applicable) to the telecom equipment. It shall be optional depending on the purchaser's requirement.	
1.1.1	**UPS System Concept:** UPS system used for telecom application, envisaged in this GR, works on "ON LINE" concept. In this concept, under normal operating conditions, the AC load is fed by the inverter unit of the UPS system, which in turn derives its DC power from Rectifier unit, while the battery remains floated across the output of the Rectifier unit Rectifier unit draws AC power from the commercial AC mains or stand by DG set. In the event of interruption in the AC input to the UPS, the DC power to the inverter unit gets instantly transferred to battery, so that AC output of the inverter unit remains uninterrupted. Under this condition the battery gets discharged. When the commercial AC mains is restored or the Engine Alternator is switched 'ON', the DC power to the inverter unit, again, gets instantly transferred back (without any interruption to the load) to the Rectifier unit. On restoration of AC mains, Rectifier unit, always operates in "Charge Mode". It enables the Rectifier to give higher current to the battery to recoup its lost capacity faster. When the battery gets fully recouped the Rectifier unit reverts	Test No. 1

	back to the float mode, automatically.	
1.1.2	**UPS System Configuration:** UPS systems envisaged in this GR may be a Unitary or Modular in configuration as described in subsequent clauses :	Test No. 1
1.1.2.1	**Unitary UPS systems:** This type of system shall have the components as inverter unit, rectifier unit and DSCA, Static Transfer Switch, and manual transfer switch, all housed in a single cabinet. The system shall have the battery of the desired rating as per backup requirements. It may be with or without regulated standby power supplied by a Voltage regulator depending on the purchaser's requirement. Fig-1 of Annexure-1 show the block-schematic layout, considering, the possible two combinations as per users requirement.	Test No. 1
1.1.2.2	**Modular UPS systems:** In these type of systems, UPS is composed of the basic modules and each module has the building block as: one rectifier unit, one inverter unit, DSCA unit. The battery shall be as per the desired rating of the UPS. The battery AH capacity will be according to the battery backup requirement. DSCA unit provides for all the control, monitoring, alarm functions and necessary terminations/switches as per the GR. In addition to this, the DSCA shall also have the capability of operating its inverter unit in synchronous mode with the inverter units of other UPS units of same make and rating. Static Transfer Switch and manual transfer switch in this concept will be common for the ultimate system capacity (as envisaged by the user) proposed to be constituted by paralleling of these UPS units). These type of UPS unit shall be capable of sharing load with other UPS units of same rating and make, in synchronous load sharing mode. Maximum number of UPS unit which can be paralleled is 5. Fig-2 and Fig-3 of annexure 1 show the block-schematic layout, considering,	Test No. 1

	all the possible combinations as per users requirement. As these UPS units are capable of synchronous load sharing with other UPS units (Maximum five such units). The user may configure a UPS system as per his/her requirements. He/She may choose the rating of UPS unit as per his/her ultimate requirement and the equipment shall be ordered accordingly.	
1.1.2.3	**Redundancy criteria** -The maximum number of UPS modules in a system shall be N+1, where N is the number of basic UPS units decided as per the load requirement of the user / purchaser, and 1 is redundant unit. - -The rating of the Static Transfer Switch and Manual transfer switch shall be 1.2 times the ultimate rating of the UPS system (redundant UPS unit not counted).	Test No. 1
1.1.3	**UPS system Rating:** UPS system ratings as per this Test Guide are: -.	Information
1.1.3.1	**Standalone UPS systems:** Specified ratings for standalone UPS systems, are 0.5 KVA, 1KVA, 2KVA, 3KVA & 5KVA. UPS. shall deliver single phase AC and shall work on single phase AC mains/stand by AC only. -Rating of inverter unit shall be the same as the rating of UPS. -The rating of the battery shall be as per back-up requirement. -Rating of FR-FC unit shall be such that it shall be capable of catering the inverter load in 110% overload condition and battery load at the charge rate specified by the user. Normally the recommended battery charge rate is C/10. -The rating of Voltage Regulator equal the rating of UPS (redundant unit not included). -The Static Transfer Switch and manual Transfer switch shall be rated at 1.2 of the UPS rating.	Test No. 1, 5, 14 a, b, c

	Note-1: For calculating the rating of Inverter unit, rectifier unit, etc., refer guidelines given in Annexure 2. **Note-2**: The purchaser may opt for Unitary UPS systems for more than 5KVA as per their specific requirements and in that case, the purchaser shall prescribe the specific technical requirements that are not covered in this GR.	
1.1.3.2	**Modular UPS Systems:** Specified ratings for modular UPS systems, are 1KVA, 2KVA, 3KVA, 4KVA, 5KVA, 6 KVA, 7.5KVA, 10KVA or any higher rating as per user requirement. The UPS of1KVA, 2KVA, 3 KVA and 4 KVA rating shall be single phase, While UPS of 5 KVA and higher ratings shall be three phase only. . -The rating of the battery shall be as per back-up requirement. . The input rating of Voltage Regulator, if used, shall be as per the voltage regulation required by purchaser.-The Static Transfer Switch and manual Transfer switch shall be rated at 1.2 of the UPS system rating. Note: For calculating the rating of Inverter unit and Rectifier unit, VR, Static Transfer Switch, manual transfer Switch, the guidelines given in fig 3 of Annexure 1 may be referred to.	Test No. 1, 5, 14 a, b, c
1.1.3.3	**Distribution, Switching, Control, & Alarm Monitoring (DSCA) unit:** The UPS system shall consist of a common controller called DSCA, based only on menu driven Micro Processor Controlled Techniques for control, monitoring & alarms. It shall control the operation of rectifier, battery charging etc. It shall monitor alarms, various parameters and report them to the remote monitoring system. DSCA shall display its Software version. **1.1.3.3.1** For remote monitoring purpose, system shall support SNMP (Simple Network Management Protocol) v2 or higher version. **1.1.3.3.2** However, system shall also support RS-485 Modbus communication additionally if it is required by the purchaser/procurer.	Information and Test No 1, 7,15(c), 23 c), 31

	1.1.3.3.3 DSCA shall have the remote software up-gradation feature through Over the Air (OTA) using Ethernet interface. However, DSCA shall also support remote software up-gradation feature using RS485 interface as applicable. **1.1.3.3.4** Setting of all the parameters shall be through menu-driven microprocessor control only. Use of potentiometer at any stage is precluded. The failure of Microprocessor or DSCA shall not affect the setting of individual rectifier / Solar charge controller / Inverter / DC-DC converter module and none of the parameter shall be disturbed. (Purchaser may decide about redundancy of DSCA based on its application.) Only the setting of new parameters from DSCA, shall be affected. In the event of failure of DSCA, all the modules shall take care of the load on latest settings. **1.1.3.3.5** There shall be a provision for Automatic isolation/reconnection of battery from the load as specified in the relevant clause of this GR. **1.1.3.3.6** DSCA shall communicate with Li-ion battery BMS to monitor the parameters and alarms and control the charging current of battery. Charging voltage shall be 54.0V or specified by the purchaser based on the requirement. **1.1.3.3.7** Battery path Current Limit: Battery Charging Current shall be settable from 10 to 50% of battery AH capacity. **1.1.3.3.8** Protections: Failure of control and sensing circuitry of DSCA shall not cause any hazard. The voltages of the system shall not abnormally increase to endanger the load. **1.1.3.3.9** Monitoring Alarms and Indications: Visual indications/display shall be provided by means of bright	

	LCDs/LEDs on DSCA to indicate the following minimum conditions (but not limited to) : a) Battery Voltage High (above 56V)/Low (below 45.6V) b) Rectifier fail c) Mains fail d) Mains "ON"/Battery Discharge e) Fan Fail (in case fan provided at rack level) f) Battery Fail or Battery missing (separate for each Battery) g) Battery isolated from the load h) Lightning and surge protection i) Inverter fault k) Inverter overload l) AC output voltage abnormal -The system shall be RS 232/ RS 485/ Ethernet (SNMP protocol) /USB compatible. It shall be feasible to set any monitoring control parameter from a remote site. All the information regarding Control and monitoring of UPS system data shall be accessible on demand from the remote site.	
1.1.3.4	In addition to the alarm, monitoring, control and the provision of the above clause, the DSCA unit shall also provide for the following : Interconnecting arrangement of the various building blocks/units i.e. Inverter & battery, Inverter & rectifier , Battery and rectifier , UPS and load through transfer switch, VR & Manual Transfer Switch VR (if used as per user's requirement) etc. • Arrangement for Isolation of Inverter unit at the input, Rectifier output and Battery, manually. • Suitably rated mechanisms like contactor, SCR, IGBT etc for auto battery low cut -off and /Reconnection. • Arrangement for Isolation of Inverter unit at the input. • Terminations for : • AC input to the Rectifier unit • DC output of Rectifier and Battery • Input & output of the Inverter unit	Test No.1

	• Input & output to VR unit • Static Transfer Switch • Manual Transfer Switch • Load • Circuit Breakers • Fuses etc • Isolation arrangement between Inverter output & AC Commercial Mains. • All supervisory Alarms Indications. • All necessary protection, control & Monitoring Circuitry at UPS system level. Note: 1. Only nationally accredited lab approved isolation devices which do not produce spark while isolating or connecting the battery to rectifier output and inverter input manually. The contactor shall not be used for this purpose. 2. The testing authority shall ensure that the lower rating MCBs/ contactors/ Circuit-Breakers/ fuses are not paralleled to handle the higher current and only single pole devices are used.	
1.1.3.5	The rating of VR unit, wherever required shall be as per the rating of UPS system. Static Transfer switch and Manual Transfer Switch shall be 120% of the rating of UPS system. .	Refer Test No. 6 a), b), c) & 28.
1.1.3.6	Battery capacity will depend on back-up requirements. -It shall be calculated in accordance with the guidelines given in Annexure-2. The VRLA battery shall be in compliance of the GR No. TEC 67040:2019.The Li-ion battery shall be in compliance of the GR No. TEC 67030:2024.	Information

1.1.4	**UPS System Configurations** The following UPS System configurations are proposed : **(i) Unitary UPS Systems**	Test No. 1,6, 14 a, b, c, 22a, b, c & 28.

Category No.	**Type of System**	**Ratings**					
1	Single Phase	**System (Ultimate)**	**Basic Inverter**	**Basic rectifier**	**Static Transfer Switch**	**Manual Transfer Switch**	**Battery Capacity**
1a	Single Phase	0.5 KVA	0.5 KVA	*Inv + battery requirement	0.6KVA	0.6KVA	As per back-up
1b	Single Phase	1KVA	1KVA	-do-	1.2KVA	1.2KVA	-do-
1c	Single Phase	2KVA	2KVA	-do-	2.4KVA	2.4KVA	-do-
1d	**Single Phase**	3KVA	3KVA	-do-	3.6KVA	3.6KVA	-do-
		5KVA	**5KVA**	**-do-**	**6KVA**	**6KVA**	**-do-**

ii) Modular UPS SYSTEMS

Category No.	**Type of System**	**Ratings**

		System Configuration **(N+1)	Basic UPS	Basic FR-FC	VR	Static Transfer Switch	Manual Transfer Switch	Battery Capacity
3	Single Phase without VR	4 KVA (4+1)	1KVA	*Inv + battery requirement	-	4.8KVA	4.8KV A	As per back-up
3a	Single phase with VR	4KVA (4+1)	1KVA	-do-	4KVA	4.8KVA	4.8KV A	As per back-up
3b	Single Phase Without VR	8 KVA (4+1)	2 KVA	-do-	-	9.6KVA	9.6KVA	As per backup
3c	Single Phase	8 KVA (4+1)	2 KVA	-do-	8KVA	9.6 KVA	9.6KVA	As per backup

	With VR							
3d	Single Phase without VR	12 KVA (4+1)	3K VA	-do-	-	14.4KVA	14.4K VA	As per back-up
3e	Single phase with VR	12KVA (4+1)	3K VA	-do-	12 K VA	14.4KVA	14.4K VA	As per back-up
3f	Single Phase Without VR	12 KVA (3+1)	4 KVA	-do-	-	14.4 KVA	14.4K VA	As per backup
3g	Single Phase With VR	12 KVA (3+1)	4 KVA	-do-	12 K VA	14.4 KVA	14.4K VA	As per backup

	4	Three Phase (without VR)	24KVA (4+1)	6KVA	-do-	-	28.8KVA	28.8KVA	As per backup	
	4a	Three Phase (with VR)	24KVA (4+1)	6KVA	-do-	24KVA	28.8KVA	28.8KVA	As per backup	
	4b	Three Phase (without VR)	40KVA (4+1)	10KVA	-do-	-	48KVA	48 KVA	As per backup	
	4c	Three Phase (with VR)	40KVA (4+1)	10KVA	-do-	40KVA	48KVA	48 KVA	As per backup	

4d	Three Phase (without VR)	4N KVA (4+1)	NKVA	-do-	-	(1.2*4*N) KVA	(1.2*4*N) KVA	As per backup
4e	Three Phase (with VR)	4N KVA (4+1)	NKVA	-do-	4NKVA	(1.2*4*N) KVA	(1.2*4*N) KVA	As per backup

* The rating of rectifier shall be sufficient to take care of 1.1 times the Inverter DC load and battery load as per back-up and rate of charging.

** In this configuration N is the desired rating of Basic UPS units for load as decided by purchaser, and 1 is redundant.

Note-1: Type approval shall be accorded for ultimate capacity only. The version of the microprocessor soft-ware shall be indicated in TAC along with the model number and category.

2. Tendering authority may choose any of the above categories (ultimate capacity) as per load requirements. Load shall include, the equipment load and any other load. While choosing the UPS it may also be ensured that the redundancy requirement has been taken care of.

3. In all the above configurations, there shall be a provision of automatic load transfer to stand-by power supply within 5 mili seconds, in the event of failure of the inverter unit

	of the UPS due to any reason. Standby power in this case may be a VR, AC commercial mains or standby Engine alternator. Transfer of load back to inverter unit/ system shall also be automatic but it shall take place, only after the inverter output has stabilised and is within the specified limits. Transfer time in this case shall also be within 5 mili seconds. Manual transfer switch is for the transfer of load from inverter to Stand by power and back to Inverter unit, manually. When VR is used the provision shall be made to transfer the load to standby mains/DG Set in the event of the failure of VR.	
1.1.5	**UPS system compatibility with Engine Alternator:** The UPS system (including Rectifiers, and DSCA, Inverters), shall be suitable for operation from A.C mains or a DG set (of capacity 1.25 times AC load of UPS System).	Refer Test No. 1, 5.
2.0	**Technical Requirements**	
2.1	**Environmental Requirements:** The whole UPS unit shall operate at specified rating & in conditions conforming to each system shall be capable of operating in conditions conforming to TEC 14016:2010. This requirement shall be verified by conducting the tests on Static Transfer switch, VR, Manual Transfer Switch. It shall also comply with vibration requirements of Test No. 6 of TEC 14016:2010. The UPS unit shall also be capable of working at an altitude in excess of 3000 meters in compliance of TEC 14016:2010. The system shall also be capable of working in the saline atmosphere of the coastal areas in compliance of TEC 14016:2010. The Manufacturer/supplier shall submit a test result from accredited/TEC designated Lab in respect of compliance to these requirements.	Information and Test Certificate, Test No. 14 (a &b), 22 (a, b & c) & 28
2.2	**Burn-in test**: The complete UPS unit with a Static Transfer Switch, Manual Transfer Switch & VR (if used) 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	Test No. 30

	controlled room with free air flow. The ambient temperature shall be measured at a distance of one foot from the equipment under test. The 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 for first 8 hours of the above test shall not be more than: **Transformers & 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 the other components nor shall lead to fire hazard. **Semiconductors devices:** 60°Celsius or as per component specification.	
2.3	**Insulation Resistance** **Test:** The insulation resistance of the complete UPS unit, VR, Static Transfer Switch, Manual Switch) when tested with a 500V DC megger shall not be less than 5meg ohms for the following conditions : - Interconnected Input terminals and Earth - Interconnected Output terminals and Earth - Interconnected Input terminals and Interconnected output terminals.	Test No. 3(a)

2.4	**Voltage Proof Test:** No breakdown or abnormal temperature rise shall occur, when-after EMI/RFI capacitors and MOVs/Tranzorbs etc. removed from the circuit. Test to be Conducted as per module/ unit-wise **Rectifier** 1. 1.5KVAC between Earth and AC input 2. 650V DC between DC output and Earth 3. 2KVAC between AC input and DC output **Inverter** 1. 650V DC between input and earth 2. 1.5KVAC between AC Output and Earth 3. 2kVAC between DC Input and AC output Alternatively, without removing EMI/RFI capacitors, the lightning protection circuitry and Tranzorbs etc., but with EMI/RFI discharge resistors removed: **Rectifier** 1. 2150V DC between Earth and AC input 2. 650V DC between DC output and earth 3. 2150DC between AC input and DC output **Inverter** 1. 650V DC between input and earth 2. 2150V DC between AC Output and earth 3. 2150V DC between DC input and AC output This DC voltage test is in accordance with UL950 & IEC 950 Standards.	Test No. 3 (b)
2.5	**Operating Noise:** The fully equipped UPS system 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 unit and 1.25m above the floor level in the Acoustic Range.	Test No. 4

For >10 KVA capacity purchaser may specify its requirements. The correction factor for Total Noise when the ambient noise level is more than 45dBA shall be as given below:

AMBIENT NOISE	CORRECTION FACTOR	AMBIENT NOISE	CORRECTION FACTOR	AMBIENT NOISE	CORRECTION FACTOR	AMBIENT NOISE	CORRECTION FACTOR
45 dBA	0 dB	49dBA	0.86dB	53dBA	2.07dB	57Dba	3.69dB
46 dBA	0.18 dB	50dBA	1.12dB	54dBA	2.47dB	58dBA	4.17dB
47 dBA	0.39 dB	51dBA	1.41dB	55dBA	2.82dB	59dBA	4.68dB
48 dBA	0.61 dB	52dBA	1.73dB	56dBA	3.25dB	60dBA	5.21dB

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

2.6	**Lightning & Surge Protection:** **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 66130:2024). Purchaser may decide to buy	**Refer test No. 7, Certificate**

	Stage -1 & 2 protection devices for equipment safety against lightning and surges.	
2.7	**Monitoring Alarms and indicating lamps:** Visual indications/display such as LEDs, LCDs or a combination of both shall be provided on DSCA of the UPS unit to indicate:	test No. 7
2.7.1	**Functional Indications:** The following functional indications shall be provided on Rectifier, Inverter & DSCA: a) Mains available b) Rectifier of the Unit on : Auto Float (Battery Charged) : Auto Charge (Battery Charging) c) Load on : UPS : VR (if used) : Standby	test No. 7
2.7.2	**Alarm Indications: Following parameter should be monitored individually or in combination of:** **(i) For UPS with ≥4KVA(equal or more) rating:** a) AC Input out of range. b) DC Over Voltage. c) DC Under Voltage. d) AC Mains "ON" and Battery Discharging. e) Temp. Compensation fail. f) Battery low/Battery fail or No battery. g) Rectifier over load. h) Rectifier unit Fail (Rectifier unit fail due to any reason). i) Inverter unit fail (inverter fail due to any reason) j) Lightning Protection stage II device fail. k) UPS Overload. l) UPS Fail. m) AC Input Frequency out of range. n) UPS fan fail (Due to any reason) **(ii) For UPS with <4KVA (less) rating:**	test No. 7

	a) AC Input out of range. b) AC Mains “ON” and Battery Discharging. c) Battery low/Battery fail or No battery. d) UPS Fail.	
2.7.3	All the alarms shall be available even in the absence of AC input and output. Also all alarm circuits shall be provided with suitable delay to ensure that they do not operate to transients.	Test No. 7
2.7.4	All the alarms and protection limits shall be settable through a menu driven program.	Test No. 7
2.7.5	All the protections/alarms shall be within a tolerance of 1% in case of DC voltage and current. For AC voltage it shall be +/- 5V.	Test No. 7
2.7.6	Every Alarm condition shall be accompanied with an Audio alarm, with a non locking type key or push button, audio cut-off facility. The visual alarm indication will, however, continue to glow to attract the attention of maintenance staff and shall extinguish by pressing the alarm reset key, only after the alarm condition is cleared by rectifying the fault or repair/replacement of the faulty unit.	Test No. 7
2.7.7	Potential Free Contacts two (one for alarm and one redundant) shall be provided for extension of alarms to Centralised Display.	Test No. 7
2.8	**Remote control and monitoring:** DSCA controller shall having the necessary features to exchange information between UPS system & Remote Site monitoring equipment through SNMP and RS485 Modbus Communication as specified at Section 1.3 of TEC GR 66110: 2024. OEM / Manufacturer of UPS shall ensure that UPS shall be interoperable with the equipment’s/ products that need to be connected with the UPS system. Further, in case of any problems / issues in interoperability, the concerned manufacturer /OEM shall extend support / help in solving the problems / issues. List of alarms and parameters to be extended over (a) SNMP for remote monitoring (b) RS485/CAN/MODBUS for internal communication shall be as per TEC GR 66110: 2025	Test No. 7, 31

	in addition to specifically mentioned in this document. Purchaser may specify the additional alarms to be extended for remote monitoring over and above the alarms listed in TEC GR 66110:2025.	
2.9	**Rectifier**	
2.9.1	Rectifier shall employ Switch Mode Power Supply (SMPS) Techniques using switching frequencies of 20KHz and above.	Test No. 5, 14 (a, b & c)
2.9.2	Rectifier is intended to be used in Auto Float-cum-Charge mode as a regulated DC Power Source.	Refer Test No. 5, 14 (a, b & c)
2.9.3	**Starting of UPS without battery supply:** There shall be provision to start the UPS unit without battery supply.	Test No. 1, 14 (a, b & c)
2.9.4	**UPS unit compatibility with Engine alternator:** The UPS unit shall be suitable for operation from A.C mains or a DG set (of capacity 1.25 times AC load of **UPS**). UPS should not create any distortion in the generator output voltage.	Test No. 5, 14 a, b & c
2.9.5	**AC input Supply:** Rectifier unit (0.5KVA, 1KVA, 2 KVA, 3 KVA, 4KVA) of the UPS system rating up to 12KVA shall operate on single phase AC input while Rectifier unit of UPS Systems of rating higher than 12KVA shall operate only on 3 phase/ 4wire AC input. The nominal input frequency is 50Hz which may vary from 48-52 Hz. The input voltage range shall be as given below: a) Single Phase (Nominal 230V): 100V to 300V b) Three Phase/4 wire (Nominal 400V): 320V to 480V	Test No. 1,14 a, b & c
2.9.5.1	For three phase/4 wire Rectifier unit only delta connection are permitted. Rectifier units shall work satisfactorily for unbalance of +/- 10% of nominal input. Phase current unbalance under all working conditions, mentioned in this document, shall not be more than 10%. Neutral phase current shall not exceed 100mA under all specified input, output and load conditions. **Note:** Single phase and Three phase UPS system shall be configured by single phase and three phase UPS unit only at both UPS unit as well as rack level.	Test No. 14 a, b & c

2.9.6	**DC output Characteristics (Auto Float/Charge Operation):** The Rectifier unit 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 charge condition of the battery sets being sensed by DSCA.	Test- 14 a, b & c & 15 (b)
2.9.6.1	The float voltage of each Rectifier unit shall be continuously adjustable & pre-settable at any value in the range of (number of cells * 2.1) & (number of cells * 2.33) Volts for VRLA batteries from DSCA. There shall also be a provision so that DSCA may override the values set by individual unit. The prescribed float voltage setting for VRLA battery are: (number of cells * 2.25 Volts). For Lithium ion batteries, the boost & float charge voltage range shall be in range from 3.45-4.15 V per cell based on Manufacturer /OEM design requirements.	Test No.14 (a) , (b),15 (b)
2.9.6.2	Auto Charge voltage: For VRLA batteries in auto charge mode Rectifier unit shall supply battery & equipment current at a voltage 2.3V/cell (This shall be settable between 2.1V/cell and 2.4V/cell) till the battery terminal voltage reaches this value. It shall change over to constant voltage mode when the battery terminal voltage has reached this set charge voltage and it shall remain in this mode till a changeover to float mode signal is received. For Lithium ion batteries, the boost & float charge voltage range shall be in range from 3.45-4.15 V per cell based on Manufacturer /OEM design requirements.	Test No.14 (b)
2.9.6.3	In both Auto Float & Auto Charge Mode, the DC output voltage shall be maintained within +/-1% of the half load pre-set voltage in the range 25% load to full load when measured at the output terminals over the full specified input range.	Test No.14 a, b
2.9.7	**Efficiency**: The efficiency of the UPS unit while working on Rectifier and Inverter shall be as given below : i) At nominal AC input, output better than 90% better than 95% and full rated load other specifier. **Units working on**	Test No.14 (a & b) & 22 (a, b, & c)

	Single phase AC **Three phase** better than 90% better than 95% ii) At all AC input conditions, and load between 50% to 100% better than 85% better than 92%	
2.9.8	**Input Power Factor:** The true input power factor at nominal input, output, and full rated load shall be better than 0.98. In any other working condition and load between 50% to100% shall be better than 0.95. Only active power factor correction shall be employed for the purpose.	Test No.14 (a & b)
2.9.9	A resistor shall be provided to discharge the capacitors after the Rectifier unit have stopped operation and output is isolated.	Test no. 8
2.9.10	**Electrical Noise:** The Rectifier units shall be provided with suitable filter on the output side.	Test no. 8
2.9.11	**The Peak-to-Peak Ripple:** Peak to peak ripple imposed on DC voltage, without battery connected, but full load Inverter being fed by it, shall not exceed 1% of the DC voltage at the Switching Frequency measured by an Oscilloscope of 50/60 MHz band-width (Typical).	Test No. 14 a, b & c
2.9.12	**Transient Response :**	
2.9.12.1	**Soft Start Feature:** Slow start circuitry shall be employed such that the input current and input voltage of Rectifier unit reach their nominal value within 10 seconds for UPS less than 4KVA rating or within 60 seconds for UPS >4KVA(equal or more) rating.. The maximum instantaneous current during start up shall not exceed the peak value of the Rectifier input current at full load and the lowest specified input voltage.	Test No. 9, 17
2.9.12.2	**Voltage overshoot/Undershoot:** The requirements of this clause shall be achieved without a battery connected to the output of Rectifier unit. The Rectifier unit shall be designed to minimize output voltage Overshoot/ Undershoot such that when they are switched on the DC output voltage shall be limited to +/-5% of the set voltage & return to their steady state within 20 ms for any load of 25% to 100%.	Test No. 9, 10 (a & b)

2.9.12.3	The DC output voltage overshoot for a step change in AC mains from specified lowest to highest and vice-versa shall not cause shut- down of Rectifier unit and the voltage overshoot shall be limited to +/- 5% of its set voltage and return to steady state within 20 ms.	Test 9, 10 (a & b)
2.9.12.4	The Rectifier unit shall be designed such that a step load change of 25 to 100% shall not result in DC output voltage Overshoot/ Undershoot of not more than 5% and return to steady state value within 10 ms without resulting the tripping of unit.	Test 9, 10 (a & b)
2.9.13	**Total Harmonic Distortion :**	
2.9.13.1	**Total Voltage Harmonic Distortion:** The Total line harmonic voltage distortion shall not be more than 5% under all working condition.	Test No. 11(a), 18
2.9.13.2	**Total Current Harmonic Distortion:** The total current harmonic distortion contributed by the UPS unit at the input shall not exceed 5% for input voltage range 100 to 300V for single phase units and 320V to 480V for three phase systems & load 25 to 100% of the rated capacity.	Test No. 11(b)
2.9.14	**Current limiting (Voltage Droop):** The Current limiting (Voltage Droop) shall be provided for Float/Charge operation (for the operation of the rectifier). The float/charge current limiting shall be continuously adjustable between 50 to 100% of rated output current for output voltage range of 42vdc to 56 vdc. For test purposes upper limit of 100% + 5% and lower limit of 50% - 5% shall be acceptable. The float and charge current limit adjustment shall be provided through a menu driven program on DSCA.	Test no. 8,12
2.9.15	**Battery Monitoring:**	

2.9.15.1	**Battery Under Voltage Isolation:** There shall be a provision for Automatic Isolation/ reconnection of battery from the load. The Tendering Authority shall specify the load and battery capacity. The DC contactors used for the purpose shall be of single pole only. The operate and release voltages for the above conditions shall be as follows : **VRLA Battery:-** **Cut-off** : 1.75V/cell. It shall be settable between 1.75V & 1.9V/cell) **Reconnect:** When the Rectifier voltage has built-up fully. It shall be settable between 2.15V to 2.35V/cell. **Li-ion Battery:** **Cut-off: 2.8V/cell. It shall be settable between 2.8V & 3.0V/cell as per** Manufacturer /OEM design requirements. **Reconnect:** When the Rectifier voltage has built-up fully. It Shall be settable between 3.2V to 3.7V/cell as per Manufacturer /OEM design requirements.	Test No 15(a)
2.9.15.2	**Battery Health Monitoring In Auto Mode:** To keep the battery in healthy state the battery condition shall be continuously monitored. On restoration of AC mains after an interruption, depending on the battery condition (depth of discharge) sensed, the system shall change over to Auto Charge mode to charge the battery at higher voltage of 2.3V/cell till the battery is fully recouped.	Test No. 15(b)
2.9.15.3	**Battery Health Check:** There shall be a provision of monitoring the voltage, current, trickle current and temperature (programmable) of the batteries associated with the UPS System at a set periodicity. There shall also be a provision of monitoring of each cells of the battery bank for voltage and temperature. This feature shall be provided for	Test No. 15(d)

	UPS ≥ 4KVA rating. However in case of UPS with less than 4KVA, Purchaser may ask for this feature, if required. If required by Purchaser, The provision for conducting a partial discharge (about 20%) test, of a pre-determined duration and frequency, shall be made available in the UPS system (Frequency and duration of partial discharge test shall be programmable). During this test, the current and voltage of the battery as well as each individual cell shall be recorded. It shall also record the temperature of each cell. 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. **Note:** The Battery Health Check feature shall be optional. However, type approval shall only be accorded with the above provision. The manufacturer will give the list of hardware equipment required for the purpose in the instruction and maintenance manual. User shall clearly indicate the requirement of battery health check feature while ordering the power plant. The manufacturer shall also undertake that the above provision will become fully function by adding the hard ware (indicated in the instruction manual) for the purpose.	

2.9.15.4	**Battery path Current Limiting Circuit :** In Auto Mode to ensure the availability of required UPS System load and safety of the battery, the current in each battery path shall be settable as per the battery capacity so that the battery path current is kept at 10% to 20% of battery AH capacity as per the tender requirements. Tendering Authority will give the capacity of the battery to be used for this purpose and the rate of charge proposed. For the type approval the manufacturer shall demonstrate the facility and undertake to make provision as per order.	Test No. 15(c)
2.9.15.5	**Temperature Compensation for Battery:** There shall be provision for monitoring the temperature of battery and consequent arrangement for Automatic temperature compensation of the Rectifier output voltage to match the battery temperature dependent charge characteristics. Details are mention in GR No. TEC 67040:2019 (for VRLA battery) and GR No. TEC 67030:2024(for lithium-ion battery). This feature shall be provided for UPS ≥ 4KVA rating. However in case of UPS with less than 4KVA, Purchaser may ask for this requirement depending upon criticality of operation.	Test No. 16 (a &b)
2.9.16	**Protections:**	
2.9.16.1	**AC Input**: There shall be an automatic cut-off of the mains AC input supply of the Rectifier unit whenever the input voltage is beyond the specified operating range (nominal 230 volts AC with voltage range 100V to 300V for single phase and 320V to 480V for three phase systems). Suitable alarm indication shall also be provided. The unit 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 Rectifier unit. A tolerance of +/-5V is acceptable for protection & alarm operation. Reconnection shall occur at a voltage, 10 V	Test No. 8

	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.	
2.9.16.2	In case of the unit working on three phase input supply, it shall be isolated (if required for the protection of the unit) in the event of unbalance beyond 10% and shall restore when the input is within limits.	Test No. 8
2.9.16.3	**D. C. Over voltage :**	
2.9.16.3.1	Rectifier unit shall be fitted with an internal over- voltage protection circuit.	Test No. 8
2.9.16.3.2	In case output DC voltage exceeds 2.33V/cell (for VRLA battery) and 56V (for Li-Ion battery), the over voltage protection circuit shall operate & shut-off the faulty unit. A tolerance of +/- 1% is permitted in this case. Restoration of the Rectifier shall be through a reset switch/push button.	Test No. 8
2.9.16.4	Shutting-off of faulty UPS unit shall not affect the operation of other UPS units (if used).	Test No. 8,23
2.9.16.5	Operation of over-voltage shut down shall be suitably indicated on the unit and also extended to DSCA unit.	Test No. 8
2.9.16.6	The circuit design shall ensure protection against the discharge of the Battery through the Rectifier unit under any condition.	Test No. 8
2.9.16.7	The over voltage protection circuit failure shall not cause any safety hazard.	Test No. 8
2.9.16.8	**Fuse/Circuit Breakers :** Fuses or circuit breakers shall be provided for each Rectifier unit as follows : 1. Live AC input line (MCB). 2. Negative D.C output (handled enclosed ultra-fast fuse assembly or DC circuit breaker).	Test No. 8

	3. Against failure of Control sensing circuit.	
2.9.16.9	All fuses/circuit breaker used shall be suitably fault rated.	Test No. 8
2.9.16.10	**Over Load/Short Circuit:** Each unit of UPS shall be Protected for Over load/Short circuit.	Information and Test no. 8,13
2.10	**Inverter**	
2.10.1	The inverter shall be based on Switch Mode Power Supply (SMPS) techniques using switching frequencies of 20KHz and above.	Refer Test no. 22 a, b & c
2.10.2	**Inverter Input Operating Range :** i) Input Voltage:48vdc in case of VRLA battery, 54vdc in LI-ion battery The Inverter of the UPS unit shall operate without any degradation between the voltage range between ii) Input Voltage(Range): (2.33 X Number of cells) in case of VRLA battery and and42vdc to 57vdc) in the case of in LI-ion battery.	Refer Test no. 22 a, b & c
2.10.3	**Input Switch over:** The switch-over to battery and vice versa shall not cause any interruption to the inverter output AC power.	Refer Test no. 22 a, b & c
2.10.4	**Inverter Output and Standby mains Isolation:** The isolations between the inverter output and the AC/Standby commercial mains shall be provided by means of any proven solid state arrangement. Isolation device shall be approved by any accredited laboratory.	Certificates from accredited test labs, Refer Test no. 22 a, b & c

2.10.5	**Load of Transfer:** Provision of automatic transfer of load to stand by power (AC mains, DG Set or VR) through a Static Transfer Switch (provided for isolation between inverter system output and Stand by power, within 10 milli seconds, in the event, the inverter/s fail/s to take load due to any reason. Transfer of load back to inverter unit/ system shall also be automatic but it shall take place, only after the inverter output has stabilised and is within the specified limits. Transfer time in this case shall also be within 10 milli seconds. The rating of Static Transfer Switch shall be 1.2 times the rating of UPS System.	Refer Test No.5, 6
2.10.5.1	The transfer switch used for the purpose shall be capable of transferring load at PF between 0.7 lead to 0.7 lag	Refer Test No. 6 (b & c)
2.10.5.2	The Static Transfer switch shall not add any distortion to the output.	Test no. 6
2.10.5.3	Output of Inverter in bypass mode should be 176Vdc to 265 vdc for single phase and 320V to 460V. If bypass voltage is beyond the defined range, it shall disconnect the load from the bypass supply.	Information and Undertaking
2.10.6	**Parallel operation:** In Modular configuration inverter unit of each UPS (similar make, type and rating) shall work together in parallel load sharing arrangement in synchronous mode of operation for all specified input and output conditions.	Test No. 23
2.10.6.1	The current sharing shall be within +/- 10% of the average current per inverters individual capacity of each inverter in the system (mounted in the same or different racks) when loaded between 50 to 100% of its rated capacity for all working conditions.	Test No. 23
2.10.7	**Protections :** Adequate protection shall be provided for :	Information

2.10.7.1	**DC Reverse Polarity:** There shall not be any damage to the components of the inverter battery and load in case the DC polarity is reversed & the unit shall start its normal functioning when the correct polarity is restored.	**Information** Test no. 24
2.10.7.2	**DC Under Voltage:** In case the DC voltage to the inverter due to any reason goes below the set value, it shall trip at the input. This voltage shall be settable between 1.75V/cell & 1.9V/cell, with the normal setting at 1.85V/cell in case of VRLA battery and between 42V to 52V in case of Li-Ion battery. The inverter shall start automatically when the input is restored to a value higher than 2V/cell in case of VRLA battery and 53vdc in case of Li-Ion battery (depending on the Purchaser/OEM design requirements).	Test No. 8, 17, 20, 21, 24
2.10.7.3	**DC Over Voltage:** The inverter shall trip when the input voltage due to any reason goes beyond the defined range. The inverter shall start automatically when the input is restored to a value lower than 2.3V/cell in case of VRLA battery and 55vdc in case of Li-Ion battery (depending on the Purchaser/OEM design requirements).	Test No. 8,17, 20, 21, 24
2.10.7.4	**Output Voltage High:** The Inverter should automatically get switched off or disconnected in the event of the output voltage exceeding 10% over the set output voltage for more than 1 second.	Test No. 8,17, 20, 21, 24
2.10.7.5	**Output Voltage Low:** Inverter shall trip in the event the output voltage due to any reason goes below 10% of the set output voltage for more than 1 second.	Test No. 8,17, 20, 21, 24
2.10.7.6	**Output Frequency Out of Range:** The inverter shall trip, if the output frequency goes beyond +/- 2Hz of the nominal 50 Hz.	Test No. 8,17, 20, 21, 24
2.10.7.7	**Overload**: The inverter shall be capable of taking 110% of its full rated load for one hour without any damage or overheating of the components. While taking 110% overload, the output voltage shall remain within the specified limits. Inverter shall also be capable of withstanding an overload of	Test No. 20, 24

	150% for one minute. The over load condition shall also create inverter over load alarm. If the over load of 150% persists for more than 1minute the inverter shall trip creating inverter fail alarm. In case of short circuit or overload of 150%, the inverter shall shutdown instantly, creating " inverter fail" alarm at DSCA. In all the above cases it shall restore only when the load is within specified limits. Over load at system level shall also create "system over load alarm". The UPS system shall be capable of handling Crest Factor of 3.5 times the steady state for period of 40ms (two cycles).	
2.10.7.8	There shall be necessary protection circuit against surges & transients.	Test no. 24
2.10.8	**DC Voltage:** The DC voltages shall be as per manufacturers design. All the protections for manual safety shall be provided as per the latest IEC UL standards for the purpose. The battery shall remain floated across the DC Rectifier unit output and Inverter input.	Test no. 24
2.10.9	**Output :**The inverter shall be capable of delivering a continuous uninterrupted single phase sine wave full output power as per its rating as follows: i) 230V/50 Hz AC in case of 0.5KVA, 1KVA, 2KVA, 3 KVA and 4 KVA , 5KVA, 7.5 KVA, 10KVA UPS unit and ii) 400V/50 Hz three phase sine-wave full output power as per its rating and also in case of higher ratings, The full rated output power shall be achievable for the rated power factor of 0.7 in both the cases of Single Phase or Three Phase. On energisation, the output shall build up gradually within 5 seconds.	Test No. 22 (a, b & c)
2.10.9.1	The output of the inverter shall be continuously settable at any value between 210 to 230V in case of single phase unit and 390V to 420V in case of three phase inverter units. It shall be maintained within +/-2% of the set value for :	Test No. 22 (a, b & c)

	a) Input voltage variations in the range as specified in clause above. b) Load current variations from Zero to 100% (full load). c) Load power factor variations from 0.7 lagging to 0.7 leading.	
2.10.9.2	The Output Voltage shall be free of modulation and hunting.	Test no. 22
2.10.9.3	To get the stabilised frequency the crystal oscillators shall only be used. The frequency of the output voltage shall remain within 50 +/- 0.5Hz for all specified conditions of the GR.	Test No. 22 (a, b & c)
2.10.10	**Power Factor**: The Power Factor with resistive load and at nominal input shall be near unity without the use of Power Factor improvement capacitors.	Test No. 19,22
2.10.11	**Transient Response:** The transient overshoot shall not exceed 10% with battery floated under the following conditions provided it gets restored within regulating range within 60ms: i) Load Switch ON ii) Step change of input voltage specified in the GR. iii) Load change from 100% to 10%. and vice versa **Note:** For test purposes, transient overshoot at the output can be up to 30% when the battery not floated at the input, provided it is restored within the limit of 10% under two cycles (40 ms) and regulating range within 60 ms.	Test No. 17 (a, b & c)
2.10.12	**Inrush Current**: It shall be possible to start the unit on no load or any load up to full load. Maximum instantaneous current during start-up shall not exceed the peak value of inverter input current at full load for the lowest input voltage specified.	Tests No. 17(a , b & c)
2.10.13	**Total Harmonic Distortion:**	

2.10.13.1	**Total Voltage Harmonic Distortion:** The Total line harmonic voltage distortion shall not be more than 3% for resistive load and shall not be more than 5% for non-linear load.	Test No. 11,18
2.10.14	The inverter shall not have any tendency to hunt under any input and output conditions.	Test no. 17, 22 (a & b)
2.11	**Voltage Regulator (VR)**	
2.11.1	The VR provided (if asked for bypassed) shall be capable of providing regulated AC to the load. VR for single phase UPS system shall be single phase and three phase UPS systems shall be three phase.	Test no. 28
2.11.2	The VR shall be natural air cooled & shall be in conformity of ensuing clauses of the GR.	Test no. 28
2.11.3	All non-current carrying metal parts shall be bonded together and adequately earthed in accordance with standard practice for Telecom Equipment.	Information and Undertaking
2.11.4	The transformers and inductors used shall be vacuum impregnated & shall be of natural air cooled type & conform to IS 2026 and IS 6297. The gauge of wire shall be such that the current density does not exceed 1.85A/Sq. mm.	Certificate from Accredited lab, Undertaking
2.11.5	Unit shall be designed for continuous operation at any load from no load to full load.	Test no. 28
2.11.6	The output voltage shall be maintained within 2% of the set nominal output voltage in case of single phase unit and three phase systems at all loads from 25 to 100%, and the rated power factor of 0.7. Output voltage shall be settable between 210V and 230V in case of single phase and 390V to 410 in case of the 3 phase systems.	Test no. 25, 28
2.11.7	The regulator shall work satisfactorily within supply frequency of 50 Hz +/- 2%. For every 1% variation in frequency, up to 1.5% change in output voltage is permissible.	Test no. 29

2.11.8	The VR shall work satisfactorily for input range 100Vac to 300Vac at 50 Hz in case of single phase units & 320Vac to 480Vac at 50 Hz in case of three phase units respectively without degradation in its performance.	Test no. 28
2.11.9	For sudden variation in AC input voltage over the specified range or load from 25% to 100% of the rated load the output voltage to settle within +/- 5% of the set value within 50 ms provided it is restored to specified limits within 250 ms.	Test no. 27
2.11.10	The full load efficiency of the VR shall not be less than 90% for input voltage 230V and an output voltage of 230V AC in case of single phase and 400V input and output in case of three phase and load power factor 0.7 lead to 0.7 lag. It shall also not be less than 85% for other input and Load between 25% to 100% and power factor between 0.7 lagging and 0.7 leading.	Test no. 28
2.11.11	The Total line harmonic voltage distortion at the output shall not be more than 5% for input, output and load conditions.	Test no. 28
2.11.12	The total current harmonic distortion introduced at the input i.e. mains shall not be more than **5%** for loads 25% to 100% under any working conditions as specified above.	Test no. 28
2.11.13	The Unit shall be capable of handling any load from 0.7 lag to 0.7 lead without degradation in THD as specified in clause. The Voltage shall remain within +/-5% of the set value for the change in PF from unity to 0.7 lag to 0.7 lead.	Test no. 28
2.11.14	Unit shall be protected against over load & short circuit & shall start its normal operation without any degradation in its performance, when overload or short circuit is removed.	Test no. 26
3.0	**General requirements**	

3.1	**Constructional Features:** The rack structure shall be made up of rigid and self-supporting structure of steel profiles. It shall be free of sharp edges or corners. The sides shall have suitable ventilating arrangements. The front door (if provided) & rear door shall be hinged type. Rear door & front door (if provided) shall have proper ventilation arrangement. Use of fans on the sides for forced ventilation is precluded as the racks are mounted side-by-side in the field. 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. Sheet used in manufacturing Shall be Galvanized (GI – >80gsm) or MS Iron.	Information
3.1.1	The structural strength of the rack shall be such as to withstand its ultimate mechanical load (with all the individual units mounted) without any deformity.	Information
3.1.2	The base of rack shall ensure uniform floor loading of not more than 320 kg/Sq. metre. Lifting facilities shall be provided by removable eyebolt located at the top of the rack/unit. The necessary arrangement for fixing the rack/unit on the floor shall also be provided.	Information
3.1.3	The top of the rack shall be fully covered except for ventilation & cable entries. Each air flow vent shall be covered by a grill to prevent the entry of foreign material larger than 5mm.	Information
3.1.4	With doors in position, all the common visual alarms and meters shall be clearly visible. In case of hinged door, meters and alarm indications are permitted on door also. However, the fixtures on the door shall not restrict the movement of door in any way.	Information

3.1.5	The rack shall be designed for easy maintenance & installation. Rack mounting arrangement shall be such as to provide easy access from front, rear and top for Installation and Maintenance.	Information
3.1.6	The rack shall be made standalone with a rigid framework with bottom clearance of 110 mm with a tolerance of +/- 10mm.	Physical Check
3.1.7	In case of Modular system if more than one UPS can be accommodated in a rack there shall be provision of easily mounting to/removing from the front side of the rack. In such case UPS unit shall be designed to slide into the rack on a suitable mechanical arrangement. The associated AC, DC connections, Control, alarms & interface cable connecting the unit shall be connected/disconnected easily without causing any interruption in the supply and damage to load or other working units. The units as per this GR shall not be site specific.	Information
3.1.8	All basic units shall be preferably cooled by natural convection, however forced cooling is permitted, subject to the compliance of the clause 3.1.10.	Information
3.1.9	Dimensions: The UPS Unit shall preferably 19 inch rack configuration. The depth of rack /unit shall not be more than 600 mm from front door (when provided) to rear with door fitted. The width shall not be more than 600 mm(max) and height shall not be more than 2200 mm (max). In case it is not feasible to accommodate the unit in 19 inch rack. Dimension shall be as per manufacturer design. Once Type approved the dimensions shall not be changed.	Test No. 1.

3.1.10	**Cooling Arrangements:** Proper thermal engineering of hardware design shall be done by the manufacturer so as to ensure the uninterrupted use of the equipment. Unit/rack (if rack accommodates more than one unit complete with all panels fitted shall preferably be designed to allow cooling by natural convection. The use of fans (complying with the MTBF requirements of this GR) for inducing an accelerated air-flow is permitted at unit level only. However the fans can only be used on the front and rear of the unit. Use of fans on the sides of the unit or rack is not permitted. The manufacturer shall also ensure that the failure of the fan does not cause any fire hazard. The failure of fan shall draw the immediate attention of the maintenance staff. The fan shall be switched off when output of the unit fails due to any reason and shall start automatically on the restoration of their output. The fan shall be switched off when output of the unit fails due to any reason and shall start automatically on the restoration of their output.	Information
3.1.11	In case of Modular systems, the units shall be removable from the front of the rack only. All AC and DC input, DC and AC output and control, alarm and monitoring cables interconnecting the units and rack shall be easily disconnected by plugs or connectors.	Information
3.1.12.1	The DSCA unit shall be equipped to meet the ultimate system capacity. All AC, DC or control/alarm cabling/wiring shall be pre-wired for the ultimate Rack capacity so that mere plugging-in of UPS unit shall add to the AC power output.	Information
3.1.13	**Accessibility :**	
3.1.13.1	All the termination points shall be easily accessible from front, rear or top with proper labelling and safety compliance.	Information
3.1.13.2	AC and DC terminals shall be separated by physical barriers to ensure safety.	Information
3.1.13.3	All the terminals except AC earth shall be electrically isolated.	Information

3.1.13.4	All the AC, DC control of alarm carline shall be supplier with the power shelf.	Information and Physical Check
3.1.14	**Terminations :** The Input & output AC terminals for single phase systems shall be clearly marked as L and N and for three phase systems as R, Y, B & N and Input DC terminals as +ve & -ve respectively.	Information
3.1.14.1	**AC Termination:**	
3.1.14.1.1	AC 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.	Information
3.1.14.1.2	Screening shall be provided between AC & DC components to prevent accident.	Information
3.1.14.1.3	All the connections between DSCA unit and individual units shall be through proper rated cables only.	Information
3.1.14.1.4	Fuses & Circuit-breakers provided shall be easily accessible and properly rated.	Information
3.1.14.2	DC Terminations:	Information
3.1.14.2.1	All the Connection between the individual units and DSCA unit shall be through a proper rated lugged and cables only.	Information
3.1.14.2.2	All the AC, DC and Control, alarm cabling shall be supplied with the system.	Information
3.1.14.2.3	All conductors shall be properly rated to prevent excessive heating.	Information
3.1.14.2.4	DC output of the Rectifier unit & input to the Inverter unit shall be through proper rated hot plug-in connectors on the unit and lugged termination on the termination end.	Information
3.1.14.5	The DC input through the cable is permitted for UPS systems with the input load up to 200A. For higher input loads, bus-bar or special Uninyvin type cables only shall be used. However, for inter-rack connections, cables of proper rating are permitted.	Information

3.1.15	**Mounting of Component & Layout :**	
3.1.15.1	Component mounting and fixing methods shall be secured.	Information
3.1.15.2	Suitable mechanical structure/arrangement for \ holding units in position shall be provided so that the unit is held firmly by sliding through it.	Information
3.2	**Bus-bars:** Tinned bus-bars or tinned High conductivity electrolytic copper strips with purity of 99.90% (min.) as per standard IS latest issue shall be able to withstand maximum load current. The bus-bars shall be capable of carrying current density of 2 Amp/mm^2 and size shall not be less than 25mmX5mm in any case. Nuts & Bolts shall be of stainless steel along with tinned copper washers. The tinning shall be in compliance of IS 1359: 1992 & its thickness shall be 10 μm (minimum).	Information & Test Certificate of Busbar Purity
3.3	**Cables & Wiring:** All insulated conductors except those within the confines of a printed circuit board assembly, shall be of the rating enough to withstand the maximum current and voltage during fault and overload. Uninyvin cables and also allowed to use in system. All the wires and cables including uninyvin cables used shall be fire retardant as per IS1554 with amendment 1 (June 94). All the cables & wires used shall also be Rodent & reptiles repellent.	Information & Test Certificate
3.3.1	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.	Information
3.4	**Earthing:** Proper Earth terminal (two in each rack), with 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 (copper only), 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	Information

	mm diameter. Suitable terminals shall be provided for terminating earth conductor. Continuity conductor used for purpose shall only be of copper. Suitable terminals shall be provided for terminating earth conductor. The manufacturer shall clearly specify the earthing requirements for trouble-free performance of the UPS system.	
3.5	**Documentation:** Technical literature in English and Hindi with complete layout, detailed block schematic and circuit diagrams of its assemblies with test voltages at different test points of the units shall be provided. A soft copy or QR code as well as a hard copy of the above shall also be provided. All aspects of installation, operation, maintenance, trouble shooting and repair shall be covered in this manual. The manual shall also include the following : **a) Installation, Operation and Maintenance manual part shall include :** i) Safety measures to be observed in handling of the equipment. ii) Precautions at the time of installation, operation and maintenance. iii) Required Test Jigs and fixtures. iv) Procedures for routine maintenance, preventive maintenance, trouble shooting and replacement. v) Illustration of internal and external mechanical parts. vi) Complete layout, detailed block schematic and circuit diagrams of its assemblies with test voltages at different test points. vii) Circuit description and working of UPS System (Inverter, Rectifier, DSCA units, Static Transfer Switch and VR unit) at various stages staring from AC input to Rectifier to the AC output with Block Schematic. viii) Circuit description & working of DSCA. ix) A Table giving details of size/dimension of maintenance of cables & Bus-bar used in the design.	Information

	x) Earthing Guide lines for the UPS system as per BIS Specification. xi) Test method for testing each and every parameter of the unit and whole system. **b) Repair manual :** i) List of replaceable parts used with the source of procurement. ii) Detailed ordering information for all replaceable parts for ordering of spares as and when required. iii) Procedure with flowchart for trouble shooting and sub-assembly replacement. iv) Test Instruments, Test fixtures, accessories and tools required for maintenance and repair. v) Systematic trouble shooting charts (fault tree) for probable faults and their remedial action. vi) Address and telephone numbers of Maintenance centre.	
3.5.1	Hard copy of the documentation shall be prepared using good quality paper with clear and crisp printing. All the drawings in clear printing shall be attached to the hand-book binding. The binding of the manual shall be long lasting and presentable. One set of flow chart drawings necessary for trouble-shooting shall be provided with lamination, with each manual.	Information
3.6	**Quality Requirements**	
3.6.1	**Components:** The component parts of the equipment shall be of professional grade of reputed manufacturer to ensure prompt and continuous service and delivery of spare parts. Use of potentiometer is precluded. Switching components used on the AC input side shall be rated at 600V (minimum).	Information, Certificate

3.6.1.2	Fuses or circuit breakers shall be provided wherever appropriate to protect against failure of control/sensing circuit. Fuses shall conform to BIS specification.	Information, Certificate
3.6.1.3	**Static Transfer Switch:** Static Transfer Switch **approved by any accredited Lab**, capable of handling 120% of the rated system capacity in compliance of Note 3 of clause 1.1.4 and clause 2.10.5.	Test No. 1,5, 6 & 22
3.6.1.3.1	**Manual Transfer Switch:** Manual Transfer Switch **approved by any accredited Lab**, capable of handling 120% of the rated system capacity in compliance of Note 3 of clause 1.1.4.	Test No. 1,5, 6 & 22
3.6.1.4	**Meters:** There shall be provision on UPS with ≥ 4KVA rating to monitor the followings: a) AC input voltage to the UPS, AC output voltage, current of the UPS unit. b) DC current & voltage (rectifier unit, battery & Inverter unit). c) Frequency input to rectifier unit, output of the inverter.". d) Output Power of UPS in K Watts or Watts. For UPS with less than 4KVA rating to monitor the followings: a) AC input voltage to the UPS, AC output voltage, output current of the UPS unit. b) DC current & voltage. c) Output Power of UPS in K Watts or Watts. Digital display panel's resolution should be such that it is clearly and unambiguously readable from a distance of 1 metre. Normally the meters mounted at DSCA display on external meter shall indicate the System voltage and current. The meters with accuracy as given below shall be used : **a. Current:** +/- 1.5% of the range or better, shall be able to read full digit for meter range 50A and above & 1 place	Test No. 2

	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. The range for ammeters used shall be capable to read 125% of the maximum current of the unit/system (nearest high available shall be selected). The range of AC voltmeters shall be 0 V to 300 V where voltages are measured between phase and neutral and 0 to 500V where voltages are measured between the phases & that of DC voltmeters shall be as per Inverter input requirements. **c. Shunts:** The shunts (75mV) for ammeters, if used, shall have an accuracy class 1.5 & conform to IS: 1248 (latest issue). Separate shunt shall be used for each path. Other proven techniques having higher accuracy and resolution are also permitted. **d. Frequency Meter:** Frequency Meter of accuracy of +/- 1% & resolution of one place decimal (sufficient to read +/-0.1 Hz) and range 45 Hz to 55 Hz shall be used. **Note:** Use of rotary switch for the purpose is precluded.	
3.6.1.5	**Component Approval:** The components used in UPS system, shall be certified by accredited National/International Lab and approved by CACT wing. Components shall neither be combustible nor support combustion. NABL approved test reports are also be acceptable as an alternative to approval of CACT wing.	Information, Certificate from accredited lab
3.7	**Quality & Workmanship:** **a)** The equipment shall be manufactured in accordance with international quality management systems ISO-9001-2015, for which the manufacturer shall be duly	Certificate from accredited lab

	accredited. A quality plan describing the quality assurance system followed by the manufacturer would be required to be submitted. **b)** The equipment shall be manufactured as per the latest BSNL QA Guidelines indicated in Quality Manuals QM-118(Quality reliability in product design), Manuals QM-202 (Pictorial guidelines for Visual assessment of quality of printed board assemblies (PBA) and discrete terminal assemblies), QM-204 (Guidelines for workmanship standards for repair & modification of printed wiring board assemblies), QM-205 (Guidelines for standard of workmanship for printed boards), QM-206 (Guidelines for standard of workmanship for printed boards assemblies), QM-207 (Guidelines for soft solder and fluxes for Telecom Equipments) and QM 210 (Guidelines for standard of workmanship for surface Mounting Devices). 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. c) All materials and workmanship shall be of professional quality to ensure the MTBF requirements. d) The equipment and components shall not use any material which support combustion.	
3.8	**Quality Assurance Tests**: Each of the UPS system supplied against the specific order after type approval shall be inspected and tested to ensure that the requirements of this document have been met. For these test, testing agency shall be designated by purchaser.	Certificate from accredited lab
3.9	**Finish and Painting:** The finish of the structure and panels shall conform to the latest issue of IS 101 & IS 168. The structure	Information

	and panels shall only be powdered coated. The thickness of powder coating shall be between 60 to 100 micrometers. The Colour used shall conform to IS 5 latest issue. Colour scheme shall be as follows: Outside except front panel - RAL 7035 (light Grey) /RAL 9005 (Black) or as per purchaser requirement. Inside and front panel. - Shall harmoniously match the Outside Colour. UPS (Inverter & Rectifier units) Units – Shall harmoniously match with rack colour.	
3.10	**Marking & Labelling :**	Information
3.10.1	It shall be possible to locate each component on the PCB by the layout & circuit drawing. All terminals shall be properly sign-written and all components properly labelled to enable their identification with reference to the supplier's Installation operation, maintenance manual and repair manuals. Designation of keys, switches and other components mounted on the front/inside panel and their operating positions shall be clearly engraved or sign- written. The wiring shall be clearly and permanently identified with the designation or 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.	Information
3.10.2	Fuse holder identification shall include details of fuse rating and type. In case of fuses on PCB the rating shall be either on fuse or PCB at the base of the fuse.	Information
3.10.3	A screen printed, circuit & cabling diagram shall be placed in side of the front door or any other convenient place for ready reference of the maintenance staff.	Information
3.10.4	**Danger Label :** Each unit shall have a screen printed "Danger" label duly fixed in prominent place with RED characters against WHITE background.	Information

3.10.5	**Name plate :** A name plate, anodised or screen printed, shall be suitably fixed on each rack/unit and contain following information : 1. TEC Standard Number : 2. TAC No. : 3. Type of the Unit : 4. Manufacturer's name and identification : 5. Model No. : 6. Unit Serial No. : 7. Input voltage : 8. Output Voltage & rating : 9. Battery voltage (DC): 10. Year & Month of manufacturing :	Information
3.10.5.1	On the front top of the Rack, an etched engraved or anodised designation plate in BOLD letters showing "System Configuration & the rating of the system" shall be provided.	Information
3.11	**MTTRPL & MTBF:**	
3.11.1	**MTTRPL:** The mean time to replace (MTTRPL) a faulty module/unit (Rectifier, Inverter, CCU, DC-DC Converter) shall be less than 2 minutes.	Declaration and Calculation
3.11.2	**MTBF (Mean Time Between Failure):** MTBF of the each module/unit shall not be less than 100,000 hours excluding fan. 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%.	Declaration and Calculation
3.12	**Field Observations:** For new products field observation will be carried out for the first 5 systems procured by the department, to assess the performance of the equipment for a period not exceeding 6 months from the date of commissioning. The manufacturer shall undertake to repair/replace the system without any financial obligation to the	Information

	user, in case the performance of the system is not found satisfactory during the period of observation. User shall also provide the feed-back to TEC, so that necessary improvement may be incorporated in the GR.	
3.13	**Packing:** Packing shall be done in accordance with latest guidelines for UPS system, issued by QA wing of BSNL.	Information
3.14	**SAFETY REQUIREMENTS** The equipment shall conform to relevant safety requirements as per IS 16242 (Part 1) : 2014/ IEC 62040-1 : 2017+ AMD1:2021+ AMD2:2022 or latest as prescribed under Table no. 1 of the TEC document 'SAFETY REQUIREMENTS OF TELECOMMUNICATION EQUIPMENT': TEC10009: 2024.	Undertaking/Certificate
3.15	**Electromagnetic Compatibility (EMC/EMI)** **3.15.1 Radio Frequency Interference (RFI) Suppression** The system (FR/FC, CCU, INVERTER & DSCA modules) shall be designed to minimize 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: **I. Conducted and Radiated Emission from the Power equipment.** Name of EMC Standard: CISPR 11 (2015) or latest "Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement ". **Limits: -** a) To comply with Class A of CISPR 11 (2015) or latest. b) The values of limits shall be as per relevant tables under CISPR11 (2015) or latest. **II. Conducted Susceptibility Limits**: Power equipment used in Telecom Network shall not malfunction when high	Certificates from accredited test labs are to be submitted

voltage surge as specified below is superimposed at the input power mains to the power equipment, for more than two seconds as per IEC 61000- 4-18. The equipment shall also not fail or degrade in performance after the surge is withdrawn.

Test levels:

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

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

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

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

Burst duration : not less than 2s

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

Wave shape : Damped

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

III. **Electrostatic discharge (ESD) immunity limits:** The limits and test methods as per IEC 61000- 4-2, (both Contact discharge method and Air discharge method) as given below:

Test level:

Contact discharge	Air discharge

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

IV. Electrical fast transient/Burst immunity limits: The limits and test methods as specified in IEC 61000-4-4.

Test level:

Open–circuit output test voltage (+/-10%) &repetition rate of impulses (+/-20%)		
Level	On Power supply port, Protection Earth	
	Voltage peak KV	Repetition rate KHz
2	1	2.5
Rise time of one Pulse - 5 ns +/- 30% Impulse duration - 50 ns +/- 30%		

V. **Radiated radio-frequency Electromagnetic field immunity limits:** The limits and test methods as specified in IEC 61000-4-3.

Test Level:

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

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

For mains power input ports:

(a) 1.0 kV +/- 10% peak open circuit voltage for line to ground coupling

(b) 0.5 kV +/- 10% peak open circuit voltage for line to line coupling

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

VII. Radio-Frequency Conducted Susceptibility immunity limits: The limits and test methods as per IEC 61000-4-6.

Test level:

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

	VIII. Immunity to voltage dips & short interruptions (applicable to only ac mains power input ports with Input current less than 16A, if any): **Name of EMC Standard:** As per IEC 61000-4-11 (2004) "Testing & measurement techniques- voltage dips, short interruptions and voltage variations immunity tests" for the following. **Limits:-** i. a voltage dip corresponding to a reduction of the supply voltage of 30% for 500ms (i.e. 70 % supply voltage for 500ms) ii. a voltage dip corresponding to a reduction of the supply voltage of 60% for 200ms; (i.e. 40% supply voltage for 200ms) iii. a voltage interruption corresponding to a reduction of supply voltage of > 95% for 5s. iv. a voltage interruption corresponding to a reduction of supply voltage of >95% for 10ms. Performance Criteria shall be as per Table 1 under Clause 6 of TEC Standard No. TEC/1016/2016(old No. TEC/SD/DD/EMC-221/05/OCT-16). Applicable Performance Criteria shall be as per Table 3 under Clause 7.2 of TEC Standard No. TEC/1016/2016(old No. TEC/SD/DD/EMC-221/05/OCT-16). **IX. Immunity to voltage dips & short interruptions (applicable to only ac mains power input ports, if any):** Name of EMC Standard: As per IEC 61000-4-11 (2004) (with Input current less than 16A) / IEC 61000-4-34 (2015) (with Input current more than 16A) as applicable "Testing &	

	measurement techniques- voltage dips, short interruptions and voltage variations immunity tests" for the following limits: - i. a voltage dip corresponding to a reduction of the supply voltage of 30% for 500ms (i.e. 70 % supply voltage for 500ms) 30 TEC Standard No. TEC 66160:2024 ii. a voltage dip corresponding to a reduction of the supply voltage of 60% for 200ms; (i.e. 40% supply voltage for 200ms) iii. a voltage interruption corresponding to a reduction of supply voltage of > 95% for 5s. iv. a voltage interruption corresponding to a reduction of supply voltage of >95% for 10ms. Performance Criteria shall be as per Table 1 under Clause 6 of TEC Standard No. TEC 11016:2016 (old no. TEC/SD/DD/EMC-221/05/OCT-16). Applicable Performance Criteria shall be as per Table 3 under Clause 7.2 of TEC Standard No. TEC 11016:2016 (old no. TEC/SD/DD/EMC-221/05/OCT-16). **X. Immunity to voltage dips & short interruptions (applicable to only DC power input ports, if any):** **Name of EMC Standard:** IEC 61000-4- 29:2000: Electromagnetic compatibility (EMC) - Part 4-29: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations on d.c. input power port immunity tests **Limits:** i. Voltage Interruption with 0% of supply for 10ms. Applicable Performance Criteria shall be B. ii. Voltage Interruption with 0% of supply for 30ms, 100ms, 300ms and 1000ms. Applicable	

	Performance Criteria shall be C. iii. Voltage dip corresponding to 40% & 70% of supply for 10ms, 30 ms. Applicable Performance Criteria shall be B iv. Voltage dip corresponding to 40% & 70% of supply for 100ms, 300 ms and 1000 ms. Applicable Performance Criteria shall be C v. Voltage variations corresponding to 80% and 120%of supply for 100 ms to 10s as per Table 1c of IEC 61000-4-29. Applicable Performance Criteria shall be B. **Note 1:** Classification of the equipment: Class B: Class B is a category of apparatus which satisfies the class B disturbance limits. Class B is intended primarily for use in the domestic environment and may include: • Equipment with no fixed place of use; for example, portable equipment powered by built in batteries; • Telecommunication terminal equipment powered by the telecommunication networks • Personal computers and auxiliary connected equipment. Please note that the domestic environment is an environment where the use of broadcast radio and television receivers may be expected within a distance of 10 m of the apparatus connected. **Class A:** Class A is a category of all other equipment, which satisfies the class A limits but not the class B limits. **Note 2:** The test agency for EMC tests shall be an accredited agency and details of accreditation shall be submitted. **Note 3:** For checking compliance with the above EMC requirements, the method of measurements shall be in accordance with TEC Standard No. TEC 11016:2016 (Old No. TEC/SD/DD/EMC-221/05/OCT-16) and the references	

	mentioned therein unless otherwise specified specifically. Alternatively, corresponding relevant Euro Norms of the above IEC/CISPR standards are also acceptable subject to the condition that frequency range and test level are met as per above mentioned sub clauses (a) to (g). The details of IEC/CISPR and their corresponding Euro Norms .	

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 UPS will be done on the basis on testing facility available for testing UPS. If no testing facility is available for testing UPS, then undertaking from OEM may be taken.

GENERAL TESTS:

Test No. 1

General System Requirements: Clause 1.1, 1.1.1, 1.1.2, 1.1.2.1, 1.1.2.2, 1.1.2.3, 1.1.3.1, 1.1.3.2, 1.1.3.3, 1.1.3.4, 1.1.4 ,1.1.5

S. No	GR requirements	Observation/Remarks
1.	Type of UPS : Standalone /Unitary	
A. Standalone UPS System		
a.	Category	
b.	Micro Microprocessor soft-were version	
C.	Model No.	
d.	UPS Rating	
e.	Type of system (with or without VR)	
f.	Type of system application : Single phase	
g.	UPS system capacity	
h.	SMPS (FR-FC) Ultimate rating	
i	Inverter rating	
j	DSCA unit rating (ultimate capacity)	
k	Battery capacity (as per backup requirement)	
l	Voltage Regulator rating (To provide standby regulated AC to the load	
m	Static Transfer Switch rating	
n	Manual Transfer Switch rating	
o	Inverter Output & Standby mains isolation arrangement	
B. Unitary UPS System		
a.	Category	
b.	Micro Microprocessor soft-were version	

C.	Model No.	
d.	UPS Rating	
e.	Type of system (with or without VR)	
f.	Type of system application : Single phase/ Three phase	
g.	UPS ultimate system capacity	
h.	SMPS (FR-FC) rating (Ultimate)	
i	Inverter rating (Ultimate)	
j	DSCA unit rating (ultimate capacity)	
k	Battery capacity (as per backup requirement)	
l	Voltage Regulator rating (To provide standby regulated AC to the load	
m	Static Transfer Switch rating as per requirement	
n	Manual Transfer Switch rating as per requirement	
o	Inverter Output & Standby mains isolation arrangement	

Note : 1. All the details above shall form a part of the product details in TAC.

2. Single phase UPS system shall be configured by single phase UPS unit and

Three phase UPS system shall be configured by Three UPS unit only (Clause 2.9.5)

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Termination , Interconnecting & Switching Arrangement(Clause 1.1.3.3) :

S. No.	GR requirement	Observation/ Remarks
1.	Interconnecting arrangement along with switching arrangements of the various building blocks/units i.e. Inverter & battery, Inverter & **rectifier**, Battery and **rectifier**, UPS and load through Static transfer switch, Manual Transfer Switch & VR (if used as per user's requirement) etc.All necessary protection, control & Monitoring Circuitry at UPS system level.	
2.	1.Arrangement for Isolation of Inverter unit at the input. and Rectifier output and battery, manually. 2. Suitably rated mechanisms like contactor, SCR, IGBT etc for auto battery low cut -off and /Reconnection.	
3.	**Terminations for :** • AC input to the Rectifier unit • DC output of Rectifier and Battery • Input & output of the Inverter unit • Input & output to VR unit • Static Transfer Switch • Manual Transfer Switch • Load • Circuit Breakers • Fuses etc • Isolation arrangement between	

	Inverter output & AC Commercial Mains.	
4.	All supervisory Alarms Indications	
5.	All necessary protection, control & Monitoring Circuitry at UPS system level as per GR.	
6.	Inverter Output & Standby mains isolation arrangement	
7.	RS 232/485/ Ethernet(SNMP protocol)/ USB compatibility	

Note : 1. CACT/NABL accredited Lab approved isolation devices which do not produce spark while isolating or connecting the battery to FR-FC output and inverter input manually. The contactor shall not be used for this purpose.

2. The testing authority shall ensure that the lower rating MCBs/ contactors/ Circuit-Breakers/ fuses are not paralleled to handle the higher current and only single pole devices are used.

System offered is :

GR Requirement

Observation/Remarks

1. **Standalone system** : In this type of system both inverter unit, FR-FC unit and DSCA, the battery of the desired rating as per backup requirements, Static Transfer Switch, manual transfer switch and Voltage regulator (in case of UPS system with regulated stand by DC) are mounted in a single cabinet/rack. It may with or without a regulated standby power supplied by a Voltage regulator.

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GR	Requirement	Observation/Remarks
2. Unitary UPS system	: In these type of systems, UPS unit is composed of one FR-FC unit, one inverter unit, DSCA unit and the battery. Rating of the Inverter unit is equal to rating of the UPS in KVA. The rating of FR-FC unit shall be as per the load requirement of the battery and inverter unit. The battery AH capacity will be according to the battery backup requirement. DSCA unit provides for all the control, monitoring, alarm functions and necessary terminations/switches as per the GR. In addition to this, the DSCA shall also have the capability of operating its inverter unit in synchronous mode with the inverter units of other UPS units of same make and rating. VR unit (if require), Static Transfer Switch and manual transfer switch in this concept will be common for the ultimate system capacity (as envisaged by the user) proposed to be constituted by paralleling of these UPS units). These type of UPS unit shall be capable of sharing load with other UPS units of same rating and make, in synchronous load sharing mode. Maximum number of UPS unit which can be paralleled is 5.	

Load transfer, System configuration, Micro Processor control, Software version, default setting and share of load, remote monitoring control etc (Clause 1.1.3.3 and 1.1.4)

Requirement	Observation/Remarks

Load transfer :

In all the above configurations, there shall be a provision of automatic load transfer to stand-by power supply within 5 mili seconds, in the event of failure of the inverter unit of the UPS due to any reason. Standby power in this case may be a VR, AC commercial mains or standby Engine alternator. Transfer of load back to inverter unit/ system shall also be automatic but it shall take place, only after the inverter output has stabilised and is within the specified limits. Transfer time in this case shall also be within 5 mili seconds.

System configuration :

UPS systems envisaged in this GR may be a Unitary or Modular in configuration as described in subsequent clauses .

Micro Processor control, Software version, default setting and share of load, remote monitoring control etc.

It shall be based only on menu driven Micro Processor Controlled Techniques for control, monitoring & alarms. DSCA shall display its Software version. Setting of all the parameters shall be through menu-driven microprocessor control only. Use of potentiometer at any stage is precluded. The failure of Micro processor or DSCA shall not affect the setting of individual inverter or FR/FC. No parameter of inverter or FR/FC units shall be disturbed on the failure of DSCA. In this condition all the inverter and FR/FC shall take care of the load on default settings and share the load collectively (wherever applicable). Only the setting of new parameters from DSCA, shall be affected.

The system may be RS 232/ RS 485/ Ethernet (SNMP protocol) /USB compatible. It shall be feasible to set any monitoring control parameter from a remote site. All the information regarding Control and monitoring of UPS system data shall be accessible on demand from the remote site. DSCA unit shall provide for the following :

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Dimension of the rack/unit (Clause 3.1.9) :

GR Requirement	Observation/Remarks
Depth : Shall not be more than 600mm From front door (when provided) To rear door fitted.	
Width : Shall not be more than 600mm(ma	
Height : Shall not be more than 2200mm (Ma	

Starting of UPS without battery supply (Clause 2.9.3) :

S. No.	GR requirement	Observation/ Remarks
1.	There shall be provision to start the UPS without battery supply	

UPS unit compatibility with Engine alternator (Clause 2.9.4) :

S. No.	GR requirement	Observation/ Remarks
1.	The UPS unit shall be suitable for operation from A.C mains or a DG set (of capacity 1.25 times AC load of UPS t UPS should not create any distortion in the generator output voltage.	

Note : 1. Only CACT /NABL accredited Lab approved ' Handled enclosed Knife fuse assembly ', 'Contactor' or 'MCBs' which do not produce spark while isolating or connecting the battery shall be used. If the contactor provided for battery under voltage isolation can be used for isolating & connecting the battery with power plant manually by a switch provided in the contactor, 'Handled enclosed Knife fuse assembly' or 'MCB' may not be required.

2. The testing authority shall ensure that the lower rating MCBs/ contactors/ Circuit-Breakers/ fuses are not paralleled to handle the higher current and only single pole devices are used.

Test No. 2

Meter/Shunt Verification (Clause 3.6.1.4)

a) Meters :																									
	FR-FC							INVERTER							UPS										
Ammeters :																									
Range Amps->																									
DC Ammeters	Digital : S No. : Make : Range : Scale/ Length :							Digital : S No. : Make : Range : Scale/ Length :							Digital : S No. : Make : Range : Scale/ Length :										
Readings On a)Under test b)Standard Accuracy																									
Voltmeters :																									
Range Volts->																									
AC Voltmeter	Digital : S No. : Make : Range : Scale/ Length :							Digital : S No. : Make : Range : Scale/ Length :							Digital : S No. : Make : Range : Scale/ Length :										
Readings On a)Under test b)Standard Accuracy																									
DC Voltmeter	Digital : S No. : Make : Range : Scale/ Length :							Digital : S No. : Make : Range : Scale/ Length :							Digital : S No. : Make : Range : Scale/ Length :										
Readings On a)Under test b)Standard Accuracy																									
Frequency Meter	Digital : S No. : Make : Range : Scale/ Length :							Digital : S No. : Make : Range : Scale/ Length :							Digital : S No. : Make : Range : Scale/ Length :										
Readings On a)Under test b)Standard Accuracy																									

b) Shunts : LOAD P .TH								BATTRY PATH							INVERTER						
Range Amps->																					
Readings On a)Under test b)Standard Accuracy																					
	FR-FC							STS							MTS						
Readings On a)Under test b)Standard Accuracy																					
	VR																				
Readings On a)Under test b)Standard Accuracy																					

Limits : All Meter & hunts shall be CACT approved. The meters & Shunts shall comply with :

Meters : CACT /NABL accredited Lab approved meters with accuracy shall be used. There shall be provision on UPS with > 4KVA rating to monitor the followings:

a) AC input voltage to the UPS, AC output voltage, current of the UPS unit.
b) DC current & voltage (rectifier unit, battery & Inverter unit).
c) Frequency input to rectifier unit, output of the inverter.".
d) Output Power of UPS in K Watts or Watts.
For UPS with less than 4KVA rating to monitor the followings:

a) AC input voltage to the UPS, AC output voltage, output current of the UPS unit.
b) DC current & voltage.
c) Output Power of UPS in K Watts or Watts.
Digital display panel's resolution should be such that it is clearly and unambiguously readable from a distance of 1 metre. Normally the meters mounted at DSCA display on external meter shall indicate the System voltage and current. The meters with accuracy as given below shall be used :

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 meter range.

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.

Frequency : The CACT **/NABL accredited Lab** approved Frequency meter of accuracy of +/- 1% & resolution of one place decimal (sufficient to read +/- 0.1 Hz) and range 45 Hz to 55 Hz shall be used.

Shunts :

The shunts (75mV) for ammeters shall have an accuracy class 1.5 & conform to IS : 1248 (latest issue). Separate shunt shall be used for each path. Other proven techniques having higher accuracy and resolution are also permitted.

Accuracy shall be calculated as given : Accuracy = (error/standard meter reading) X 100 Where 1. Error =(Actual meter reading - standard meter reading.

2. Standard meter reading is the reading on the standard meter for the same condition.

Note : Digital display meters shall be used. Use of rotary switch for the purpose is precluded .This shall be done with the help of Digital (with Digital display of intensity enough to read from a distance of 1 metre) metres to read the voltage and current of the system and individual inverter (at individual inverter unit/module also permitted) . Normally the meters mounted at DSCA shall indicate the system voltage and current.

Test No. 3

Voltage Proof & Insulation Tests :

a) Insulation Resistance Test (Clause 2.3) :

The insulation resistance of the complete UPS unit, VR, Static Transfer Switch, Manual Transfer Switch shall be tested with a 500V DC megger.

	UPS unit		VR		Static Transfer Switch		Manual transfer Switch	
Between Terminal	Required	Observation	Required	Observation	Required	Observation	Required	Observation
Interconnected Input Terminal & earth	>5 m Ω	m Ω	>5 m Ω	m Ω	>5 m Ω	m Ω	>5 m Ω	m Ω
Interconnected Output Terminal & Earth	>5 m Ω	m Ω	>5 m Ω	m Ω	>5 m Ω	m Ω	>5 m Ω	m Ω
Interconnected Input terminals & Interconnected Output Terminal	>5 m Ω	m Ω	>5 m Ω	m Ω	>5 m Ω	m Ω	>5 m Ω	m Ω

b) High Voltage Test (Clause2.4) : A. test voltage of 2000V/50 Hz shall be applied for one minute.

Observation : Between	UPS Unit	VR	Static Transfer Switch	Manual Transfer Switch
Earth & Interconnected output Terminal	OK/Not OK	OK/Not OK	OK/Not OK	OK/Not OK
Earth & Interconnected input Terminal	OK/Not OK	OK/Not OK	OK/Not OK	OK/Not OK
Input & Output Terminal	OK/Not OK	OK/Not OK	OK/Not OK	OK/Not OK

Note : 1. While taking above tests printed circuit boards, EMI/RFI capacitors and MOVs/Tranzorbs removed from the circuit 2. No breakdown or abnormal temperature rise shall occur.

Test to be Conducted as per module/ unit-wise

Rectifier

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

Inverter

1. 650V DC between input and earth
2. 1.5KVAC between AC Output and Earth
3. 2kVAC between DC Input and AC output

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

Rectifier

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

Inverter

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

This DC voltage test is in accordance with UL950 & IEC 950 Standards.

Note : This Test is to be conducted on each of the basic units of the system.

Test No. 4

Operating Noise (Clause 2.5)

a) **When system working on FR/FC & Inverter :**

Input Voltage (V)	Output Current (A)	Noise level reading (dBA) for meters position with respect to System							
		System `OFF'		System `ON'		Contribution factor		Noise Corrected	
		Front	Rear	Front	Rear	Front	Rear	Front	Rear
320/150V									
400/230V (Nom.)									
480/275V									
Unbalance +10%									
Unbalance –10%									

b) **When system working on VR :**

Input Voltage (V)	Output Current (A)	Noise level reading (dBA) for meters position with respect to System							
		System `OFF'		System `ON'		Contribution factor		Noise Corrected	
		Front	Rear	Front	Rear	Front	Rear	Front	Rear
320/150V									
400/230V (Nom.)									
480/275V									
Unbalance +10%									
Unbalance –10%									

Note-1 : In all cases the Audio Level Meter shall be placed at a distance of 1 metre from the unit & 1.25 metre above floor level in the Acoustic Range.
Note-2 : All noise inducing appliances may be shut down during the test to achieve the minimum ,ambient noise level. Note-3 : Tests is to be conducted on a fully loaded system.
Note-4: For >10 KVA capacity purchaser may specify its requirements.

Limits : The fully equipped UPS system at full load shall not contribute more than 15 dB (weighted) to the ambient noise level taken as 45dBA. The correction factor for Total Noise when the ambient noise level is more than 45dBA shall be as given below :

Ambient Noise	Correction Factor	Ambient Noise	Correction Factor	Ambient Noise	Correction Factor	Ambient Noise	Correction Factor
45dBA	0dB	49dBA	0.86dB	53dBA	2.07dB	57dBA	3.69dB
46dBA	0.18dB	50dBA	1.12dB	54dBA	2.47dB	58dBA	4.17dB
47dBA	0.39dB	51dBA	1.41dB	55dBA	2.82dB	59dBA	4.68dB
48dBA	0.61dB	52dBA	1.73dB	56dBA	3.25dB	60dBA	5.21dB

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

Test No. 5

Performance Tests On DG Set (Clause 1.1.5) :

a) FR-FC on DG SET :

Type of UPS System : **S. No. of the Unit :**

AC Input						DC Output				
Voltage (V)	Current (A)			Power (W)	P.F.	Current (A)		Voltage (V)	Ripple Peak-toPeak (Mv)	Efficiency (%)
	R	Y	B			Actual	%			
							25			
							50			
							100			

b) VR on DG set :

Type of UPS System : **S. No. of the Unit :**

AC Input						DC Output					
Voltage (V)	Current (A)			Power (W)	P.F.	Current (A)		Voltage (V)	Ripple Peak-toPeak (Mv)	Efficiency (%)	Distortion
	R	Y	B			Actual	%				
							25				
							50				
							100				

Note : 1. The system shall be capable of working with DG set of capacity 1.25 times the capacity of FR-FC unit, VR under DSCA load if any.

2. **Static Transfer Switch (Clause 3.6.1.3) :** Static Transfer Switch **approved by any accredited Lab**,, capable of handling 120% of the rated system capacity in compliance of Note 3 of clause 1.1.4 and clause 2.10.5.

3. **Manual Transfer Switch (Clause 3.6.1.3.1) :** Manual Transfer Switch approved by any accredited Lab, capable of handling 120% of the rated system capacity in compliance of Note 3 of clause 1.1.4 shall be used.

Test No. 6

a) Transfer of Load (Clause 1.1.4, 2.10.5)

Condition	Requirement	Observation/Remarks
1. Transfer of Load a) From Inverter to VR - Switch on all the Inverters	Ensure the load is fed by the Inverter unit	
- Fail all the Inverters and observe	Load is automatically transferred to VR through Static Transfer Switch (provided for isolation between inverter system output and stand by power), within 10 ms without any interruption to load, in the event, the inverter/s fail/s to take load due to any reason. The rating of Static Transfer Switch shall be 1.2 times the rating of UPS System.	
b) VR to Stand by Power (AC mains and DG Set)	Ensure the load is fed by VR.	
- Fail the VR	Load is automatically transferred to stand- by power (AC mains and DG set) through Static Transfer Switch (provided for isolation between inverter system output and stand by power), within 10 ms without any interruption to load, in the event, the inverter/s fail/s to take load due to any reason. The rating of Static Transfer Switch shall be 1.2 times the rating of UPS System. Ensure the load is fed by stand by power.	
c) Transfer of load back to inverter unit/system : - Fail the Stand by power	Transfer of load back to Inverter unit/System shall also be automatic but it shall take place, only after the Inverter output has stabilized and is within the specified limits. Transfer time in this case shall also be within 10 mili second.	
2. Inverter load from FR-FC to battery and vice versa - Switch on all the FR-FCs	Ensure the Inverter & battery are being fed FR-FC. Inverter load is transferred to battery without battery dipping.	
- Fail all the FR-FC of the unit & observe. - Switch over the FR-FC unit	Inverter & battery load is fed by FR-FC unit in Charge mode.	

b) Static Transfer Switch (Clause 1.1.3.5, 1.1.4, 2.10.5, 2.10.5.1, 2.10.5.2, 3.6.1.3, 3.6.1.3.1) :

Condition	Requirement	Observation/Remarks
1. Rating of the transfer switch 2. Load Transfer at 100% load at load P.F. 0.7 lag. 3. Load Transfer at 25% load at load P.F. 0.7 lag. 4. Load Transfer at 100% load at load P.F. 0.7 lead. 5. Load Transfer at 25% load at load P.F. 0.7 lead. 6. Distortion contributed by Static Transfer Switch.	Shall be 120% of the ultimate rating of the inverter unit. Shall be automatic for transfer time less than 5 ms. Shall be automatic for transfer time less than 5 ms. Shall be automatic for transfer time less than 5 ms. Shall be automatic for transfer time less than 5 ms. nil	

Note : Static Transfer Switch approved by any accredited Lab, capable of handling 120% of the rated UPS system capacity shall be used.

c) Manual Transfer Switch (Clause 1.1.3.5, 1.1.4 ,3.6.1.3, 3.6.1.3.1)

GR Requirement	Requirement	Observation/Remarks
1. Rating of the transfer switch 2. Load Transfer at 100% load at load P.F. 0.7 lag. 3. Load Transfer at 25% load at load P.F. 0.7 lag. 4. Load Transfer at 100% load at load P.F. 0.7 lead. 5. Load Transfer at 25% load at load P.F. 0.7 lead. 6. Distortion contributed by Static Transfer Switch.	Shall be 120% of the ultimate rating of the inverter unit. Takes place without any interruption & hunting. Takes place without any interruption & hunting. Takes place without any interruption & hunting. Takes place without any interruption & hunting. nil	

Note : Manual Transfer Switch approved by any accredited Lab,capable of handling 120% of the rated UPS system capacity shall be used.

Test No. 7

Monitoring Alarms and Indicating (clause1.1.3.3.9) :

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

a) Battery Voltage High (above 56V)/Low (below 45.6V)

b) Rectifier fail

c) Mains fail

d) Mains "ON"/Battery Discharge

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

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

g) Battery isolated from the load

h) Lightning and surge protection

i) Inverter fault

k) Inverter overload

l) AC output voltage abnormal

Functional Indications : (Clauses 2.7.1) : The following functional indications shall be provided on Rectifier, Inverter & DSCA :

Functional Indications :

GR requirement	Observation /Remarks
a) Mains available	Provided/Not Provided
b Rectifier of the Unit on : Auto Float (Battery Charged) : Auto Charge (Battery Charging)	Provided/Not Provided
c) Load on : UPS : VR (if used) : Standby	Provided/Not Provided

Alarm Indications : Clause 2.7.2

GR requirement	Observation /Remarks
a) AC Input out of range	Provided/Not Provided
b) DC over voltage (voltage droop)	Provided/Not Provided
c) DC under voltage	Provided/Not Provided
d) AC Mains "ON" and Battery Discharging	Provided/Not Provided
e) Temp. Compensation fail	Provided/Not Provided
f) Battery low/Battery fail or No battery	Provided/Not Provided
g) FR-FC over load	Provided/Not Provided
h) FR-FC unit Fail (FR-FC unit fail due to any reason)	Provided/Not Provided
i) Inverter unit fail (inverter fail due to any reason)	Provided/Not Provided
j) Lightning Protection stage II device fail	Provided/Not Provided
k) UPS Overload	Provided/Not Provided
l) UPS Fail	Provided/Not Provided
m) AC Input Frequency out of range.	Provided/Not Provided
n) UPS fain fail (due to any reason)	Provided/Not Provided

Note :

1. All the alarms shall be available even in the absence of AC input and output. Also all alarm circuits shall be provided with suitable delay to ensure that they do not operate to transients. (Clause 2.7.3)

All the alarms and protection limits shall be settable through a menu driven program(Clause **2.7.4)**. All the protections/alarms shall be within a tolerance of 1% in case of DC voltage and current. For AC voltage it shall be +/-5V (Clause **2.7.5)**.

Every Alarm condition shall be accompanied with an Audio alarm, with a non locking type key or push button, audio cut-off facility. The visual alarm indication will, however, continue to glow to attract the attention of maintenance staff and shall extinguish by pressing the alarm reset key, only after the alarm condition is cleared by rectifying the fault or repair/replacement of the faulty unit (Clause **2.7.6)**.

Potential Free Contacts two (one for alarm and one redundant) shall be provided for extension of alarms to Centralised Display (Clause 2.7.7)

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Lightning & Surge Protection (Clause 2.6)

GR requirement	Observation /Remarks
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 66130:2024).	Purchaser may decide to buy Stage -1 & 2 protection devices for equipment safety against lightning and surges

Remote control and monitoring (Clause2.8.) :

GR requirement	Observation /Remarks
1. The UPS system shall be RS 485 compatible	Provided/Not Provided
2. DSCA controller shall having the necessary features to exchange information between UPS system & Remote Site monitoring equipment through SNMP and RS485 Modbus Communication	Provided/Not Provided
3. List of alarms and parameters to be extended over (a) SNMP for remote monitoring (b) RS485/CAN/MODBUS for internal communication shall be as per TEC GR 66110: 2025 in addition to specifically mentioned in this document. Purchaser may specify the additional alarms to be extended for remote monitoring over and above the alarms listed in TEC GR 66110:2025.	Provided/Not Provided

Test No. 8

Protection & Alarm Clause : 2.9.9, 2.9.10, 2.9.14, 2.9.16, 2.9.16.1,2.9.16.2, 2.9.16.3.1, 2.9.16.3.2, 2.9.16.4, 2.9.16.5, 2.9.16.6, 2.9.16.7,2.9.16.8,2.9.16.9, 2.9.16.10, 2.10.7.2

On FR-FC unit/ UPS unit :

S.No.	Alarm Description	Alarm Condition	Extension of Indication to Switching, Control & Monitoring unit	Remarks
1.	AC Under/Over Voltage (Galvanic isolation)	As per Clause 2.9.16.1		
2.	DC Over voltage : a. In case output DC voltage exceeds 2.33V/cell, (for VRLA battery) and 56V (for Li-Ion battery), the over voltage protection circuit shall operate & shut-off the faulty unit. A tolerance of +/- 1% is permitted in this case. Restoration of the FR/FC shall be through a reset switch/push button. b. FR-FC unit shall be fitted with an internal over- voltage protection circuit. c. The over voltage protection circuit failure shall not cause any safety hazard.	DC voltage exceeds 2.33V /cell +/-1% (for VRLA battery) and 56V (for Li-Ion battery),		

3.	DC under-voltage or output fail Battery under-voltage (clause 2.10.7.2)	Not Below1.75V/cell +/-1% Cut-off between 1.75V/cell & 1.9V/cell (settable) with the normal setting at 1.85V/cell in case of VRLA battery and between 42V to 52V in case of Li-Ion battery. Reconnect : 2V/cell in case of VRLA battery and 53vdc in case of Li-Ion battery		
4.	Overload(voltage droop) /Short Circuit Mode : Float/Charge (Clause2.10.7.7)	50 to 100% load 1.85V/cell to 2.33V/cell		
5.	UPS system Fan fail (Due to any reason)	Fan not working		

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S.No.	Alarm Description	Alarm Condition	Extension of Indication to Switching, Control & Monitoring unit	Remarks
6.	protection against the discharge of the Battery through the FR/FC unit	The circuit design shall ensure protection against the discharge of the Battery through the FR/FC unit under any condition.		
7	Discharge of capacitors	A resistor shall be provided to discharge the capacitors after the FRFC unit have stopped operation and output is isolated		
8.	Electrical noise	The FR/FC units shall be provided with suitable filter on the output side.		
9.	Fuse or circuit breaker shall be provided for each FR/FC unit as follow : 1. AC input live (MCB) 2. -ve DC output (Handled enclosed ultra-fast fuse assembly or DC circuit breaker: 3. failure control sensing circuit. **Note : Fuse/ circuit breaker used shall be suitable fault rated.**			
10.	Over load/ Short circuit	Each unit of UPS shall be protected for Over voltage/Short circuit.		

Note :

1. Operation of over-voltage shut down shall be suitably indicated on the unit and also extended to DSCA unit.
2. The circuit design shall ensure protection against the discharge of the Battery through the FR/FC module in any case.
3. Each FR-FC unit shall be fitted with an internal over- voltage protection circuit. The over voltage protection circuit failure shall not cause any safety hazard.

4. All the alarms shall be available even in the absence of AC input and output. Also, all alarm circuits shall be provided with suitable delay to ensure that they do not operate with transients.
5. All the alarms and protection limits shall be settable through a menu driven program.
6. All the protections/alarms shall be within tolerance of 1% in case of DC voltage and current. For AC voltage it shall be +/-5V.
7. Every Alarm condition shall be accompanied with an Audio alarm, with a non locking type key or push button, audio cut-off facility. The visual alarm indication will, however, continue to glow to attract the attention of maintenance staff and shall extinguish by pressing the alarm reset key, only after the alarm condition is cleared by rectifying the fault or repair/replacement of the faulty unit..

   Potential Free Contacts two (one for alarm and one redundant) shall be provided for extension of alarms to Centralised Display.
8. Every Alarm condition shall be accompanied with an Audio alarm, with, audio cut-off facility.
9. Shutting-off of faulty UPS unit shall not affect the operation of other UPS units (if used) in the rack.
10. Remote control and monitoring : The power plant shall be RS 485 compatible. It shall provide for the monitoring, alarm and control of the power plant and its associated batteries from a remote site through RS 485.

Test No. 9

Soft Start Test (Clause 2.9.1.2.1, 2.9.1.2.2, 2.9.1.2.3, 2.9.1.2.4)

	On 25% Load	On Full Load
	FR-FC	FR-FC
i) Build up time	s	s
ii) Over/Under shoot	%	%
iii) Stabilising time	ms	ms
iv) Instant. Current	A	A

Limits :1.Slow start circuitry shall be employed such that the input current and input voltage of Rectifier unitreach their nominal value within 10 seconds for UPS less than 4KVA rating or within 60 seconds for UPS >4KVA(equal or more) rating.

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

3. The Rectifier unit 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 & return to their steady state with in 20ms for any load of 25 to 100%.

Note : a) The above conditions shall be met without battery floated.
b) Necessary graph shall also be provided for ready reference.

Test No. 10

a) Voltage Overshoot/Undershoot (Clause 2.9.12.2, 2.9.12.3, 2.9.12.4) :

a) Step change in Input Voltage from X to Y (As applicable)

a) 90V to 300V & Vice Versa
b) 320V to 480V & Vice Versa

	At 25% Load	At 100% Load
	FR-FC	FR-FC
X to Y		
i) Over/Under shoot	%	%
ii) Stabilising time	ms	Ms

Y to X		
i) Over/Under shoot	%	%
ii) Stabilising time	ms	Ms

Limits : AC mains as specified shall not cause shut-down of FR/FC module and shall be limited to +/- 5% of its set voltage and return to steady state within 20ms.

Note : a) The above conditions shall be met without battery floated.

b) Necessary graph shall also be provided for ready reference.

b) For Step Change in Load at Nominal Input 400V for Three Phase & 230V for Single Phase : (Clause2.9.1.2.2, 2.9.1.2.3, 2.9.1.2..4)

	From 25-100% (rated load)	From 100-25%(rated load)
	FR-FC	FR-FC
i) Over/Under shoot	%	%
Ii) Stabilising time	ms	ms

Limits : The step load change of 25 to 100% shall not result in DC output voltage Overshoot/Undershoot of not more than 5% and return to steady state value within 10 ms without resulting the unit to trip.

Note : a) The above conditions shall be met without battery floated.
b) Necessary graph shall also be provided for ready reference.

Test no. 11

a) Total Voltage harmonic Distortion (Clause 2.9.13.1,2.10.13.1)

I/P Voltage(V)			O/P Current(A)			% Voltage Distortion		
Unit OFF	Unit ON		Actual		%	R	Y	B
	FR- FC	FR-BC*	FR-FC	FR-BC*		FR-FC	FR-FC	FR-FC
320/90V					50 100			
400V/ 230V (nom)					50 100			
480/300V					50 100			
Unba- Lance +10%					50 100			
Unba- Lance -10%					50 100			

Limits : 1. In case of single phase use only one column from R, Y & B.

2. The Total line Harmonic voltage Distortion shall not be more than 5% under all working condition

b) Total Current harmonic Distortion (Clause 2.9.13.2)

I/P Voltage(V)			O/P Current(A)			% Current Distortion		
Unit OFF	Unit ON		Actual		%	R	Y	B
	FR-FC	FR-BC*	FR-FC	FR-BC*		FR-FC	FR-FC	FR-FC
320/90V					50 100			
400V/230V (nom)					50 100			
480/300V					50 100			

Limits : 1. In case of single phase use only one column from R, Y & B.
2.The Total Current Harmonic Distortion contributed by the unit at the input shall not exceed 5%, in any of the above case

Test No. 12

Current Limiting {Voltage Droop} (Clause 2.9.14) :

Output Voltage	Settability Range (...% to …….. %)		Voltage Droop Starts at % Load	
	Auto Float	Auto Charge	Auto Float	Auto Charge
1.85V /cell 2V/ cell 2.15V/cell 2.25V/cell 2.33V/cell				

Note : a) Shall be continuously adjustable between 50 to 100% of rated output current for output voltage range of 42vdc to 56 vdc. For test purposes upper limit of 100% + 5% and lower limit of 50% - 5% shall be acceptable.

b) Further increase in load shall not increase the current and should result only in further voltage droop.

c) Test shall be performed at 100% setting in case Auto Float/Charge Mode.

d) The float and charge current limit adjustment shall be provided through a menu driven program on DSCA.

Test No. 13 Short Circuit Test (Clause 2.9.16.10)

		UPS unit	Remarks
Switch-on the unit at rated full load & Note O/P Voltage after the unit has stabilized	:	V	
Apply a short at its output.	:	Goes into voltage droop	
Maximum Short Circuit Current : (in case of voltage droop)		A	
Remove Short Circuit. Unit Starts automatically to take the load	:	Yes/No	
It takes the load	:	Yes/No	
Note the output voltage	:	V (shall be same as before)	

Note : Ensure that short circuit shall not lead to any excessive temperature rise or fire Hazard.

Test No. 14 Regulation/AC Input Range/Peak-to-Peak Ripple/Efficiency/Load PF

Tests :

Specification Requirements :

a) **Switching Frequency (clause 2.9.1) . Limits :** > 20KHz

b) **AC Input Range (Clause 2.9.5)**Rectifier unit (0.5KVA,1KVA,2KVA,,3KVA & 4KVA) of the UPS system rating up to 12KVA shall operate on single phase AC input while FR/FC unit of UPS systems of rating higher than 12KVA shall operate only on 3 phase/4wire AC input.

The nominal input frequency is 50Hz which may vary from 48-52Hz. The input voltage range shall be as given below

:

i))Single Phase (Nominal230V) : 100V to 300V ii) Three Phase/4wire (nominal400V) : 320V to 480V

For three phase/4 wire Rectifier unit only delta connection are permitted. Rectifier units shall work satisfactorily for unbalance of +/- 10% of nominal input. Phase current unbalance under all working conditions, mentioned in this document, shall not be more than 10%. Neutral phase current shall not exceed 100mA under all specified input, output and load conditions (Clause 2.9.5.1).

Note : Single phase and Three phase UPS system shall be configured by single phase and three phase UPS unit only at both UPS unit as well as rack level.

c) **In both Auto Float & Auto Charge Mode, (Clause 2.9.6.3). :**The DC output voltage shall be maintained within +/-1% of the half load preset voltage in the range 25% load to full load when measured at the output terminals over the full specified input range.

d) **Peak-to-Peak Ripple Voltage (C1ause 2.9.11) .Limits:** Peak to peak ripple imposed on DC voltage, without battery connected, but full load Inverter being fed by it. shall not exceed 1% of the DC voltage at the Switching Frequency measured by an Oscilloscope of 50/60 MHz band-width (Typical).

e) **Efficiency (Clause2.9.7) . Limits :** The efficiency of the UPS unit while working on Rectifier and Inverter shall be as given below :

	Units working on Single phase AC	**Three phase AC**
i) At nominal AC input, output and full rated load other specifier.	better than 90%	better than 95%
ii) At all AC input conditions, and load between 50% to 100%	better than 85%	better than 92%

f) **Input Power Factor (Clause** 2.9.8) The true input power factor at nominal input, output, and full rated load shall be better than 0.98. In any other working condition and load between 50% to 100% shall be better than 0.95. Only active power factor correction shall be employed for the purpose. **Clause 2.9.5.1Note : Single phase and Three phase UPS system shall be configured by single phase and three phase UPS unit only at both UPS unit as well as rack level.**

g) **Clause** 2.9.3**: Starting of UPS without battery supply : There shall be provision to start the UPS unit without battery supply.**

Note : Clause 1.1.3.1 : Rating of FR-FC unit shall be such that it shall be capable of catering the inverter load in 110% overload condition and battery load at the charge rate specified by the user. Normally the recommended battery charge rate is C/10.

The rating of Voltage regulator equal the ultimate rating of UPS System.

The Static Transfer Switch and Manual Transfer switch shall be rated at 1.2 of the UPS system rating.
For calculating the rating of Inverter unit and FR-FC unit, VR, Static Transfer Switch, Manual Transfer Switch, the guidelines given in Annexure 2 may be referred . The purchaser may opt for Unitary UPS systems for more than 5KVA as per their specific requirements and in that case, the purchaser shall prescribe the specific technical requirements that are not covered in this GR

Continued on next page

Continued ……

a) FR-FC in Auto Float Mode (Clause 2.9.6.1) :

for VRLA batteries

a) Half Load output voltage set at (2.25V * Number of cells) : Volts
b) Output voltage settability 2.1 * Number of cells to 2.33 * Number of cells.) : Volts

AC Input									DC Output				
Voltage (V)	Current (A)			Power (W)	True P.F.	SW Freq.(Hz)			Current (A)		O/P Voltage (V)	Ripple Peak-toPeak mV)	Efficiency (%)
	R	Y	B			R	Y	B	Actual	%			
320/90V										25 50 100			
400V/ 230V (nom)										25 50 100			
480/300V										25 50 100			
Unba-Lance +10%										25 50 100			
Unba-Lance -10%										25 50 100			

Note :1. In case of single phase use only one column from R, Y & B.
2. Single phase and Three phase UPS system shall be configured by single phase and three phase UPS unit only at both UPS unit as well as rack level.
3. Starting of UPS without battery supply : There shall be provision to start the UPS unit without battery supply.
4. For Lithium ion batteries, the boost & float charge voltage range shall be in range from 3.45-4.15 V per cell based on Manufacturer /OEM design requirements

b) FR-FC in Auto Charge Mode (Clause 2.9.6.2) :

for VRLA batteries

a) Half load voltage set at (2.3V/cell) : Volts
b) Output voltage settability 2.01 * Number of cells to 2.40 * Number of cells.) : Volts

AC Input									DC Output					
Voltage (V)	Current (A)			Power (W)	load P.F.	SW Freq.(Hz)			Current (A) Actual				O/P Voltage (V)	Ripple peak to-Peak (mV)	Efficiency (%)
	R	Y	B			R	Y	B	R	Y	B	%			
320/90V												25 50 100			
400V/ 230V (nom)												25 50 100			
480/300V												25 50 100			
Unba-Lance +10%												25 50 100			
Unba-Lance -10%												25 50 100			

Note : 1. In case of single phase use only one column from R, Y & B.

2. Single phase and Three phase UPS system shall be configured by single phase and three phase UPS unit only at both UPS unit as well as rack level.

3. Starting of UPS without battery supply : There shall be provision to start the UPS unit without battery supply.

4. For Lithium ion batteries, the boost & float charge voltage range shall be in range from 3.45-4.15 V per cell based on Manufacturer /OEM design requirements.

c) Frequency Tolerance (Clause 2.9.15) :

AC Input						DC Output						
Frequency (Hz)	Current (A)			Power (W)	Load P.F.	Current (A) Actual				O/P Voltage (V)	Ripple Peak toPeak (mV)	Efficiency (%)
	R	Y	B			R	Y	B	%			
FR-FC in Auto Float Mode :												
48									25 50 100			
50									25 50 100			
52									25 50 100			
FR-FC auto Charge Mode :												
48									25 50 100			
50									25 50 100			
52									25 50 100			

Note : 1. At DG set all the parameters tested as per above sheet shall be within limit.

2. The nominal input frequency is 50Hz which may vary from 48-52Hz.

Test No. 15

Battery Monitoring :

a) **Battery Under Voltage Isolation (Clause 2.9.15.1) :**

	Battery Cut -Off		Battery Reconnect		MARKS
	ired (V)	erved (V)	QUIRED (V)	SERVED (V)	
Total TD)	able between 1.75V to		ectifier Voltage has built-up fully. Shall be Settable between V/cell		

Note : 1. In above case battery isolation alarm shall be created.
2. Only the single pole DC contactor shall be used.

Li-ion Battery: Cut-off : 2.8V/cell. It shall be settable between 2.8V & 3.0V/cell as per Manufacturer /OEM design requirements.

Reconnect: When the Rectifier voltage has built-up fully. It Shall be settable between 3.2V to 3.7V/cell as per Manufacturer /OEM design requirements.

b) **Battery Health Monitoring In Auto Mode (Clause 2.9.6, 2.9.6.1,**2.9.15.2**)**

Start Mode Test :

Switch-ON the Unit/System & Observe the O/P Voltage : V (Shall always be Float voltage)

Mode Change over :

i) As per manufacturer's design change the battery path current or voltage & observe O/P voltage : V (shall change over to charge voltage)

Remarks :

i) Set the battery path current or voltage as per manufacturer's manual and observe O/P voltage : V (shall change back to float voltage)

Remarks :

c) Battery Current Limiting (Clause 2.9.15.4) :

S. No.	Battery path current (Amps)	Requirements	Observation	Remarks
1.	Increase battery path current to set limit slowly	It shall increase Gradually		

2.	Increase Battery load further	It shall not Increase beyond Set limit.		

Battery path Current limit settability :
Battery path current is settable between % & %

The current in each battery path shall be settable as per the battery capacity so that the battery path current is kept to 10% to 20% of battery AH capacity. Tendering Authority will give the capacity of the battery to be used for this purpose. For the type approval the manufacturer shall demonstrate the facility & undertake to make provision as per order.

d) Battery Health Check (Clause 2.9.15.3) :

S. No.	Battery Health Check	Requirements	Observation /Remarks
1.	Battery health check feature hardware equipment etc required for the purpose shall be provided to have the provision of :	1. Monitor the voltage, current, trickle current and temperature (programmable) of the batteries associated with the UPS system at a set periodicity. 2. Monitoring of each cells of the battery bank for voltage and temperature. 3. Conduct a partial discharge (about 20%) test, of a pre-determined duration and frequency, shall be made available in the power plant (Frequency and duration of partial discharge test shall be programmable). During this test, the current and voltage of the battery as well as each individual cell shall be recorded. 4. It shall also record the temperature of each cell. 5.Any abnormality observed during above observations shall be highlighted by initiating an alarm. 6. All the above information shall be made available to the remote site through RS 485). **Note : All the above readings shall be recorded and verify & ensure the compliance of the clause.**	

Note : 1. There shall be a provision of monitoring the voltage, current, trickle current 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 cells of the battery bank for voltage and temperature.

2. **The provision for conducting a partial discharge (about 20%) test of a pre-determined duration and frequency, shall be made available in the power plant (Frequency and duration of partial test discharge shall be programmable). During this test, the current and voltage of the battery as well as each individual cell shall be recorded. It shall also record the temperature of each cell.**
3. **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.**
4. **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(Refer Annexure 1 for specified protocol).**

5. **The Battery Health Check feature shall be optional. However, type approval shall only be accorded with the above provision. The manufacturer will give the list of hardware equipment required for the purpose in the instruction and maintenance manual. User shall clearly indicate the requirement of battery health check feature while ordering the power plant. The manufacturer shall also undertake that the above provision will become fully function by adding the hard ware (indicated in the instruction manual) for the purpose.**

Test No. 16

Temperature Compensation for the Battery (Clause No. 2.9.15.5) :

a) In Auto Float Mode of Operation

Float Voltage set at : V (2.25V/cell)

Temp. sensed (deg C)	System O/P Voltage	Change in Voltage

b) In Auto Charge Mode of Operation :

Output Voltage set at : V (2.30V/cell)

Temp. sensed (deg C)	System O/P Voltage	Change in Voltage

Limit : The output voltage of the rectifier in Float/Charge operation shall decrease or increase at the rate of 3mV/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. When the output voltage reaches 2.33V/cell due to the increase in 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 FR-FC. A tolerance of +/-5mV may be acceptable over the specified rate of 3mV/cell/deg C. The nominal distance between the battery & power plant may be 20 metres. The manufacturer shall provide the necessary sensor and card for purpose with the UPS. Failure of temperature compensation circuit including sensors shall create an alarm and shall not lead to abnormal change in output voltage. Proper sign-writing shall be made in DSCA and both end of temperature compensation card for its easy termination

INVERTER UNIT :

Test No. 17

Transient Response :

a) Switch on /Soft Start Feature (Clause 2.9.12.1, 2.10.7.2, 2.10.7.3, 2.10.11, 2.10.12)

		On no Load	On 50% load	On Full Load
		Inverter unit	Inverter unit	Inverter unit
i) Build up time		S	S	S
ii) Over/Under shoot		%	%	%
iii) Stabilising time		ms	ms	ms
iv) Inrush Current		A	A	A
v) Crest Factor Inrush current/ Steady state current				

b) Voltage Overshoot/Undershoot (Clause2.10.11, 2.10.12.2) :

Step change in Input Voltage from X to Y (As applicable) : 1.75V/cell to 2.33V/cell & Vice Versa

	At 10% Load	At 100% Load
	Inverter unit/ module	Inverter unit/ module
X to Y		
i) Over/Under shoot	%	%
ii) Stabilising time	ms	ms
Y to X		
i) Over/Under shoot	%	%
ii) Stabilising time	ms	ms

c) For Step Change in Load at Nominal Input 2V/cell (Clause 2.10.11, 2.10.12) :

From 10% to100% (rated load)	From 100% to 10%(rated load)
Inverter unit/ module	Inverter unit / module

i) Over/Under shoot	%	%
Ii) Stabilising time	ms	ms

Limits: 1.The Inverter shall be capable of delivering a continuous uninterrupted single phase sine wave full output power as per its rating at 230V/50Hz AC in case of 0.5 KVA, 1KVA, 2KVA, 3KVA & 4 KVA UPS unit and 400/50Hz AC in case of three phase sine- wave full output power as per its rating in case of higher ratings at any power factor from 0.7 lead to 0.7 lag..

2.It shall be possible to start the unit on no load or any load up to full load. On energisation, the output built up gradually within 5 seconds.

3.The maximum instantaneous current during start up shall not exceed the peak value of inverter input current at full load for the lowest input voltage specified. The voltage shall not dip more than 20% of its set value without battery at the input.

4. The UPS system shall be capable of handling crest factor of 3.5 times the study state for period of 40ms.

5. The transient overshoot shall not exceed 10% with battery floated under Load switch on, step change and load change from 100% to 10% and vise versa (Clause 2.10.11).

6. For test purposes, the transient Overshoot/Undershoot at the output can be up to 30% when the battery not floated at the input, provided it is restored within the limit of 10% under the two cycles(40ms) and regulating range within 60ms.

7.The inverter shall not have any tendency to hunt under any input and output condition (Clause 2.10.14).

8. **Inrush Current** : It shall be possible to start the unit on no load or any load up to full load. Maximum instantaneous current during start-up shall not exceed the peak value of inverter input current at full load for the lowest input voltage specified.

Note : a) The above conditions shall be met without battery floated.
b) Necessary graph shall also be provided for ready reference.

Test No. 18

Total Harmonic Distortion : ;

a) Total Voltage harmonic Distortion (Clause 2.9.13.1 ,2.10.13.1)

I/P Voltage(V)		Output Voltage (V)	O/P Current(A)		% Voltage Distortion		
Unit OFF	Unit ON		Actual	%	At PF		
					Unity	08 Lagging	0.8 Leading
	Inverter unit/ module		Inverter unit/ module		Inverter unit/ module	Inverter unit/ module	Inverter unit/ module
1.75V/cell				25 50 100			
2.0V/cell				25 50 100			
2.25V/cell				25 50 100			
2.30V/cell				25 50 100			

Limits :1.The Total Current Harmonic Distortion contributed by the Inverter unit at the output shall not exceed 3 % for resistive load and shall not be more than 5% for non-linear load. 2. The Static Transfer switch shall not add any distortion to the output

Test No. 19

Power Factor Test (Clause 2.10.10) :

Condition	Procedure	Requirements	Observation/ Remarks
Power Factor Test without Pf Improvement Capacitors	Set the Input Voltage at : 2.25V/cell Set the Output Voltage at : 230V / 400V Connect the full rated resistive load Read & record the PF at AC Output	Out PF shall be near unity	

Test No. 20

Overload/Short Circuit Test (Clause 2.10.7.2, 2.10.7.3 ,2.10.7.7) :

DC input Voltage	Load				Output Voltage (V)			% of change in Output Voltage			Inverter/system trips in (mts Hr)	Observation/Remarks
	Actual			%								
	R	Y	B		R	Y	B	R	Y	B		
1.75V/cell				100% 105% 110% >110% 150% >150% Short cct Crest Factor								
2.15V/cell				100% 105% 110% >110% 150% >150% Short cct. Crest Factor.								
2.25V/cell				100% 105% 110% >110% 150% >150% Short cct. Crest Factor								
2.35V/cell				100% 105% 110% >110% 150% >150% short cct. Crest Factor								

Limits: 1. The Inverter/system shall be capable of taking 110% of its full rated load for one hour without any damaged or overheating of the components.
2. While taking 110% overload the output voltage shall remain within the specified limits.
3. Inverter/system shall also be capable of withstanding an overload of 150% for one minute.
3. In case of short circuit or overload of 150% for more than 1 minute at the output, the inverter/system shall shutdown and create over load alarm. Rrestore only when the load is within specified limits.
4. The UPS shall be capable of handling load crest factor of 3.5 times the steady state value for 40ms (two cycles).
Note : In case of single phase use only one column from R, Y & B.

Test No. 21

Reverse Polarity at the Input (Clause 2.10.7.1) :

Condition	Requirement	Observation/ Remarks
Reverse Polarity at the Input	i) There shall not be any damage to the components of the Inverter , battery and load in case the Input polarity is reversed. (Unit should trip and shall not be any damaged to the components of the Inverter, Battery and Load). ii) The unit shall start its normal functioning when the correct polarity is restored.	

Note : In above case alarm & indication shall be created.

Test No. 22

Regulation Tests :

Specification Requirements (Limits) :

a) Switching Frequency (Clause 2.10.1) : The inverter shall be based on Switch Mode Power Supply (SMPS) techniques. using switching frequencies of 20KHz and above.

b) Inverter Input Operating Range (Clause2.10.2) : i) Input Voltage: 48vdc in case of VRLA battery, 54vdc in LI-ion battery The Inverter of the UPS unit shall operate without any degradation between the voltage range between ii) Input Voltage(Range):(2.33 X Number of cells) in case of VRLA battery and 42vdc to 57vdc) in the case of in LI-ion battery **c) Output (Clause 2.10.9) :**The inverter shall be capable of delivering a continuous uninterrupted single phase sine wave full output power as per its rating, at 230V/50Hz AC in case of 0.5KVA, 1KVA, 2KVA, 3 KVA and 4 KVA,5KVA, 7.5 KVA, 10KVA UPS unit and 400V/50Hz three phase sine-wave full output power as per its rating also in case of Higher ratings, The full rated output power shall be achievable for the rated power factor of 0.7 in both the cases of Single Phase or Three Phase. On energisation, the output shall build up gradually within 5 seconds.

1. Clause 2.10.9.1: The output of the inverter shall be continuously settable at any value between 210 to 230V in case of single phase unit and 390V to 420V in case of three phase inverter units. It shall be maintained within +/-2% of the set value for :
   a) Input voltage variations in the range as specified in clause above.
   b) Load current variations from Zero to 100% (full load).
   c) Load power factor variations from 0.7 lagging to 0.7 leading.
2. **Clause 2.10.9.2:** The output voltage shall be free of modulation and hunting.

d) Frequency (Clause 2.10.9.3) : To get the stabilised frequency the crystal oscillators shall only be used. The frequency of the output voltage shall be remain within 50 +/- 0.5 Hz for all specified conditions of the GR.

d) **Peak-to-Peak Ripple Voltage (2.9.11) .Limits:** Peak to peak ripple imposed on DC voltage, without battery connected, but full load Inverter being fed by it. shall not exceed 1% of the DC voltage at the Switching Frequency measured by an Oscilloscope of 50/60 MHz band-width (Typical).

e) **Efficiency (Clause 2.9.7) . Limits :** The efficiency of the UPS unit while working on Rectifier and Inverter shall be as given below :

	Units working on Single phase AC	Three phase AC
i) At nominal AC input, output and full rated load other specifier.	better than 90%	better than 95%

ii) At all AC input conditions,

better than 85% better than 92%

and load between

f) 50% to 100%**Power Factor (Clause 2.10.10) :** The power Factor with resistive load and at nominal input shall be near unity without the use of Power Factor improvement capacitors.

g) Input Switch over (Clause 2.10.3) : The switch-over to battery and vice versa shall not cause any interruption to the inverter output AC power.

h) Static Transfer Switch (Clause 3.6.1.3) : Static Transfer Switch approved by any accredited Lab, capable of handling 120% of

the rated system capacity in compliance of Note 3 of clause 1.1.4 and clause 2.10.5.

i) Manual Transfer Switch (Clause 3.6.1.3.1) : Manual Transfer Switch approved by any accredited Lab, capable of handling 120% of the rated system capacity in compliance of Note 3 of clause 1,.1.4 shall be used.

Output voltage Settable at any value between : 210V to 230V for single phase and 400V +/- 10V for three phase : Yes/ No

Continued on next page

a) At PF unity (Clause 2.9.7, 2.10.10) :

1.Switch on the Inverter at No load **: Starts/ Does not start.**
2.Switch on the Inverter at 100% load **: Starts/ Does not start**
3. Set the output voltage at Half load & input 2.25V/cell

DC Input Voltage			AC output Voltage					
Input Voltage (V)	Input Current (A)	Input Power (W)	Current (A) Actual	Current (A) %	Output Voltage (V)	Output Power (W)	Frequency (F)	Efficiency (%)
1.75V/cell				25 50 100	210V			
				25 50 100	230V			
2.15V/cell				25 50 100	210V			
				25 50 100	230V			
2.25V/cell				25 50 100	210V			
				25 50 100	230V			
2.3V/cell				25 50 100	210V			
				25 50 100	230V			
2.35V/cell				25 50 100	210V			

				25 50 100	230V			
2.40V/cell				25 50 100	210V			
				25 50 100	230V			

b) AT 0.8 PF Lagging (Clause 2.9.7, 2.10.10) :

1.Switch on the Inverter at No load **: Starts/ Does not start** .
2.Switch on the Inverter at 100% load **: Starts/ Does not start**
3. Set the output voltage at Half load & input 2.25V/cell

Dc Input Voltage			AC output Voltage					
Input Voltage (V)	Input Current (A)	Input Power (W)	Current (A)		Output Voltage (V)	Output Power (W)	Frequency (F)	Efficiency (%)
			Actual	%				
1.75V/cell				* 0 25 50 100	210V			
				* 0 25 50 100	230V			
2.15V/cell				* 0 25 50 100	210V			
				* 0 25 50 100	230V			
2.25V/cell				* 0 25 50 100	210V			
				* 0 25 50 100	230V			
2.3V/cell				* 0 25 50 100	210V			
				* 0 25 50 100	230V			
2.35V/cell				* 0 25 50 100	210V			
				* 0 25 50 100	230V			
2.40V/cell				* 0 25 50 100	210V			

				* 0 25 50 100	230V			

c) AT 0.8 PF Leading (Clause 2.9.7, 2.10.10) :

1.Switch on the Inverter at No load **: Starts/ Does not start .**
2.Switch on the Inverter at 100% load **: Starts/ Does not start**
3. Set the output voltage at Half load & input 2.25V/cell

DC Input Voltage			AC output Voltage					
Input Voltage (V)	Input Current (A)	Input Power (W)	Current (A)		Output Voltage (V)	Output Power (W)	Frequency (F)	Efficiency (%)
			Actual	%				
1.75V/cell				* 0 25 50 100	210V			
				* 0 25 50 100	230V			
2.15V/cell				* 0 25 50 100	210V			
				* 0 25 50 100	230V			
2.25V/cell				* 0 25 50 100	210V			
				* 0 25 50 100	230V			
2.3V/cell				* 0 25 50 100	210V			
				* 0 25 50 100	230V			
2.35V/cell				* 0 25 50 100	210V			
				* 0 25 50 100	230V			
2.40V/cell				* 0 25 50 100	210V			
				* 0 25 50 100	230V			

Note : Setting of all the parameters shall be through menu-driven microprocessor control only. Use of potentiometer at any stage is precluded.

Test No 23

Load Sharing clause 2.10.6

a) Load Sharing Under Different Input Conditions :

Input Voltage	Total load (Amps)		UPS-1						UPS -2						UPS - n						% of Unbalance (max.)
			Voltage			Current			Voltage			Current			Voltage			Current			
	Actual	%	R	Y	B	R	Y	B	R	Y	B	R	Y	B	R	Y	B	R	Y	B	
320V 90V		50 100																			
400/230V (nom)		50 100																			
480/300V		50 100																			
Unbalance -10% nom.		50 100																			
Unbalance +10% nom		50 100																			

Remark : Maximum unbalance in load sharing is %.

% of Unbalance = (Unbalance in load/Average load per unit) X 100

Note : It shall be less than 10%.

Note : In case of single phase use only one column from R, Y & B.

b) Load Sharing on Failure of any Unit (Clause 2.9.16.4) : Shutting-off of faulty UPS unit shall not affect the operation of other UPS units.

S.No.	Condition	Total load (Amps)	UPS-1						UPS-2						UPS-n						% of Unbalance (max.)
			Voltage			Current			Voltage			Current			Voltage			Curre t n			
			R	Y	B	R	Y	B	R	Y	B	R	Y	B	R	Y	B	R	Y	B	
1.	Before failure of any unit: *Condition-1 *Condition-2																				
2.	ON failure of Inverter-1 Condition-1 Condition-2																				
3.	ON failure of Inverter-n Condition-1 Condition-1																				

Note : In case of single phase use only one column from R, Y & B.

* Condition-1 : When the shutting down of unit does not leads to overload condition for the remaining units.
* Condition-2 : When the shutting down of unit leads to overload condition for the remaining units.

Remarks : Condition-1 : On failure of any unit other units shall share the load with in the limits of +/10%.
Condition-2 : On failure of any unit, since load is more than rated capacity of individual unit, the units shall come on current limit without any problem.

C) Load Sharing on failure of Micro processor or DSCA unit (Clause 1.1.3.3)

S.No.	Condition	Total load (Amps)	UPS -1						UPS-2						UPS -n						% of Unbalance (max.)
			Voltage			Current			Voltage			Current			Voltage			Current			
			R	Y	B	R	Y	B	R	Y	B	R	Y	B	R	Y	B	R	Y	B	
1.	Before failure of Microprocessor or DSCA unit																				
2.	ON failure of Microprocessor or DSCA unit																				

Remark : Maximum unbalance in load sharing is %.

% of Unbalance = (Unbalance in load/Average load per unit) X 100

Note : 1. In the event of failure of DSCA, UPS -Inverter unit parameter shall not be disturbed. All the UPS- Inverter unit shall take care of the load on default settings and share the load collectively with in the limits of +/-10%.

Note : In case of single phase use only one column from R, Y & B.

d) Load Sharing On Mains Restoration :

S. No.	Condition	Total load (Amps)	UPS -1						UPS-2						UPS -n						% of Unbalance (max.)
			Voltage			Current			Voltage			Current			Voltage			Current			
			R	Y	B	R	Y	B	R	Y	B	R	Y	B	R	Y	B	R	Y	B	
1.	Before Input Supply failure																				
2.	ON Input Supply failure																				
3.	ON input Supply restoration																				

Note : There shall be no change in the value before and after Input Supply failure.
Note : In case of single phase use only one column from R, Y & B.

Test No 24

Protection and Alarm : (Clause 2.10.7.1, 2.10.7.2, 2.10.7.3, 2.10.7.4, 2.10.7.5, 2.10.7.6, 2.10.7.7 , 2.10.7.8, 2.10.8) :

On Inverter unit :

S. No.	Alarm Description	Alarm Condition	Indication		Extension of Indication to DSCA unit	Remarks
			Visual	Audio		
1.	Reverse Polarity at the input	There shall not be any damage to the components of the inverter battery and load in case the DC polarity is reversed & the unit shall start its normal functioning when the correct polarity is restored.				
2.	Input Under voltage	Trip : Below the set value Settable between 1.75V/cell to 1.9V/cell with normal setting at 1.85V/cell. Reconnect : Higher than 2V/cell Shall be automatically				
3.	Input DC Over voltage	Trip Beyond 2.5V/cell Reconnect : Lower than 2.3V/cell Shall be automatically				
4.	Output Voltage High	Voltage exceeding more 10% over the set output voltage for more than 1 second due to any reason. Inverter shall be automatically get switched off or disconnected.				
5.	Output Voltage Low	In the event of output voltage goes below 10% of the set output voltage for more than 1 second, due to any reason, Inverter should trip				
6.	Output Frequency out of range	Beyond 2Hz of the nominal 50Hz. Inverter should trip				
7.	Overload	The inverter shall be capable of taking 110% of its full rated load for one hour without any damage or overheating of the components. While taking 110% overload, the output voltage shall remain within the specified limits. Inverter shall also be capable of withstanding an overload of 150% for one minute. The over load condition shall also create inverter over load alarm. If the over load of 150% persists for more than 1minute the inverter shall trip creating inverter fail alarm. In case of short circuit or overload of 150%, the inverter shall shutdown instantly, creating "inverter fail" alarm at DSCA. In all the above cases it shall restore only when the load is within specified limits. Over load at system level shall also create " system over load alarm ". The UPS system shall be capable of handling Crest Factor of 3.5 times the steady state for period of 40ms (two cycles) .				
S. No.	**Alarm Description**	**Alarm Condition**	Indication		**Extension of Indication to DSCA unit**	**Remarks**
8.	UPS Fan fail (in case fan provided)	Fan not working				

9.	Surge & transients	Check the necessary protection circuit against Surge & Transients				
10.	Voltage protections for manual safety	The DC voltages shall be as per manufacturers design. All the protections for manual safety shall be provided as per the latest IEC UL standards for the purpose. The battery shall remain floated across the DC FR-FC unit output and Inverter input.				
11.	positive terminal	The positive terminal of the input shall be taken as earthed.				

VOLTAGE REGULATOR (VR) :

Test No. 25

Output Voltage Satiability (Clause 2.11.6) :

Condition	Product Requirement	Satiability	Observation/Remarks
Output Voltage satiability	The output voltage shall be maintained within 2% of the set nominal output voltage in case of single phase unit and & three phase systems at all loads from 25 to 100%, and PF between 0.7 lead and l0.7ag. Output voltage shall be settable between 210V and 230V in case of single units and 390V to 410 in case of the 3 phase systems.	V & V	

Test No. 26

Over Load and Short Circuit Test (Clause2.11.14)

Condition	Product	Requirement	Observation/Remarks
Over Load and Short Current	**a.** Switch 'ON ' the unit & Short the output **b.** Remove the short circuit	Current flowing shall be limited to certain limit to avoid damage to the components. Unit shall come to normal operation without any degradation in its performance (Healthy state).	

Note : The rating of VR unit, wherever required shall be as per the rating of UPS (Clause 1.1.3.5).

Test No. 27

Transient Response :

a) Voltage Overshoot/Undershoot (Clause 2.11.9) :

i) Step change in Input Voltage from X to Y (As applicable)

a) Single phase : 90V to 300V & Vice Versa

b) Three phase : 320V to 480V & Vice Versa

		At 25% Load	At 100% Load
		Voltage regulator unit	Voltage Regulator unit
X to Y			
i) Over/Under shoot		%	%
ii) Stabilising time		ms	ms
Y to X			
i) Over/Under shoot		%	%
ii) Stabilising time		ms	ms

ii) For Step Change in Load at Nominal Input 230V (single phase)/ 400V(Three phase):

	From 25% to100% (rated load)		From 100% to 25%(rated load)
	Voltage regulator unit		Voltage regulator unit
i) Over/Under shoot		%	%
Ii) Stabilising time		ms	ms

Limits : 1.The transient Overshoot/Undershoot at the output can be up to +/- 5% of the set value within 50 ms provided it is restored within the specified regulating range within 250ms in all the above cases.

2. The VR shall not have any tendency to hunt under any input and output condition.

Note : Necessary graph shall also be provided for ready reference.

Test No. 28

Regulation Tests : Specification Requirements (Limits) :

a) **Clause** 2.11.5**) :** Unit shall be designed for continuous operation at any load from no load to full load.

b) **Clause** 2.11.6**: 1.** The output voltage shall be maintained within 2% of the set nominal output voltage in case of single phase unit and three phase systems at all loads from 25 to 100%,

c) Clause 2.11.8: The VR shall work satisfactorily for input range 100Vac to 300Vac of 50 Hz in case of single phase units & 320Vac to 480Vac at 50 Hz in case of three phase units respectively without degradation in its performance.

AC Input							AC Output								
Voltage (V)	Current (A)			Power (W)	THD (A)	Load PF	Current (A)				Voltage	Power (W)	Ripple Peak-toPeak mV)	THD (V)	Efficiency %
	R	Y	B				%	Actual							
								R	Y	B					
90/ 320V						0.7 lag	0								
						unity	0								
						0.7 lead	0								
						0.7 lag	25								
						unity	25								
						0.7 lead	25								
						0.7 lag	50								
						unity	50								
						0.7 lead	50								
						0.7 lag	100								
						unity	100								
						0.7 lead	100								
230/400V (Nom)						0.7 lag	0								
						unity	0								
						0.7 lead	0								
						0.7 lag	25								
						unity	25								
						0.7 lead	25								
						0.7 lag	50								
						unity	50								
						0.7 lead	50								
						0.7 lag	100								
						unity	100								
						0.7 lead	100								
300/480V						0.7 lag	0								
						unity	0								
						0.7 lead	0								
						0.7 lag	25								
						unity	25								
						0.7 lead	25								

d) Clause 2.11.10: The full load efficiency of the VR shall not be less than 90% for input voltage 230V and an output voltage of 230V AC in case of single phase and 400V input and output in case of three phase and load power

factor 0.7 lead to 0.7 lag. It shall also not be less than 85% for other input and Load between 25% to 100% and power factor between 0.7 lagging and 0.7 leading.

e) Clause 2.11.11: The Total line harmonic voltage distortion at the output shall not be more than 5% for input, output and load conditions.

f) Clause 2.11.12: The total current harmonic distortion introduced at the input i.e. mains shall not be more than **5%** for loads 25% to 100% under any working conditions as specified above.

g) Clause 2.11.13: The unit shall be capable of handling any load from from PF to 0.7 lad to 0.7 lead without degradation in THD as specified in clause. The voltage shall remain within +/- 5% of the set value for the change in the PF from unity to 0.7 lag to 0.7 lead.

Note : 1. The rating of VR unit, wherever required shall be as per the rating of UPS (Clause 1.1.3.5).

2. The VR provided shall be capable of providing regulated AC to the load. VR for single phase UPS System shall be single phase and three phase UPS Systems shall be three phase (Clause 2.11.1).

3. Output voltage Settable at any value between : 210V to 230V for single phase and 400V +/- 10V : Yes/ No

4. The VR is natural air cooled & shall be in conforming of ensuring clauses of the GR(Clause 2.11.2).

Note : Testing officer shall test on all the above output voltages.

Continued on next page

Continued ……

AC Input							AC Output								
Voltage (V)	Current (A)			Power (W)	THD (A)	Load PF	Current (A)				Voltage	Power (W)	Ripple Peakto-Peak mV)	THD (V)	Efficiency (%)
	R	Y	B				%	Actual							
								R	Y	B					
						0.7 lag	50								
						unity	50								
						0.7 lead	50								
						0.7 lag	100								
						unity	100								
						0.7 lead	100								
Phase Unbalance + 10%						0.7 lag	0								
						unity	0								
						0.7 lead	0								
						0.7 lag	25								
						unity	25								
						0.7 lead	25								
						0.7 lag	50								
						unity	50								
						0.7 lead	50								
						0.7 lag	100								
						unity	100								
						0.7 lead	100								

Phase Unbalance - 10%						0.7 lag	0								
						unity	0								
						0.7 lead	0								
						0.7 lag	25								
						unity	25								
						0.7 lead	25								
						0.7 lag	50								
						unity	50								
						0.7 lead	50								
						0.7 lag	100								
						unity	100								
						0.7 lead	100								

Note : In case of single phase use only one column from R, Y & B.

Note : 1. The rating of VR unit, wherever required shall be as per the rating of UPS (Clause 1.1.3.5).

2. **The VR provided shall be capable of providing regulated AC to the load. VR for single phase UPS System shall be single phase and three phase UPS Systems shall be three phase (Clause 2.11.1).**
3. **The VR is natural air cooled & shall be in conforming of ensuring clauses of the GR (Clause 2.11.2).**

Test No 29

a) Voltage variation against change in frequency (Clause 2.11.7)

Output voltage Settable at any value between : 210V to 230V for single phase and 400V +/- 10V : Yes/ No

Note : Testing officer shall test on all the above output voltages.

Frequency Hzs	Input Voltage (V)	Input Current (A)	Output Current (A)		Output Voltage (V)	Output Frequency (F)
			Actual	%		
49	90/320V			25 100		
	230/400V			25 100		
	300/480V			25 100		
49.5	90/320V			25 100		
	230/400V			25 100		
	300/480V			25 100		
50	90/320V			25 100		
	230/400V			25 00		
	300/480V			25 00		

50.5	90/320V			25 100		
	230/400V			25 100		
	300/480V			25 100		
51	90/320V			25 100		
	230/400V			25 100		
	300/480V			25 100		

Note : 1. At DG set all the parameters tested as per above sheet shall be within limits.

2. The regulator shall work satisfactorily within supply frequency of 50 Hz +/- 2%. For every 1% variation in frequency, up to 1.5% change in output voltage is permissible.

Test No 30

Burn-in (Clause 2.2) :

The complete UPS unit/ System with a Static Transfer Switch, Manual Transfer Switch & VR, shall be capable of withstanding a burn-in test for 72 hours at an ambient temperature of 50□C when the equipment is working at full rated load. This test may be performed in a temperature controlled room with free air flow. The ambient temperature shall be measured at a distance of 1 foot from the equipment under test. The necessary set-up for the purpose shall be provided by the manufacturer.

UPS												**STATIC TRANSFER SWITCH**										
Reading->	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6	7	8	9	10	11
Recording Time ->																						
Temp. Ambient-> (Outside)																						
Inside ->																						
Component																						

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

a) **Transformers and Chokes** : 70 deg C for Grade B insulation.
For higher grade of insulation, higher temperature rise may be permissible subject to the following conditions :
i) It is at least 20 deg C below the permissible limit for the grade of Insulation used.
ii) The temperature rise shall be at least 30 deg C below Curie temperature of the magnetic material. iii) This temperature shall neither affect the other components nor shall lead to fire hazard.

b) Semiconductors devices. : 60 deg C or as per component specification.

a) Heat Run Test (First 8 hours) :

Complete UPS unit with a Static Transfer Switch, Manual Transfer Switch & VR .

i) UPS Unit/ System :
ii) Static Transfer Switch : iii) Manual Transfer Switch : iv) Voltage Regulator :

1) Unit Model & Sr. No.: 4) Unit Switched ON :
2) Output Rating : 5) Unit Switched OFF: 3) Input Voltage :

Continued on next page

Continued ……

1) Unit Model & Sr. No.: 3) Input Voltage : 5) Unit Switched OFF :
2) Output Rating : 4) Unit Switched ON :

VR												**MANUAL TRANSFER SWITCH**										
Reading->	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6	7	8	9	10	11
Recording Time ->																						
Temp. Ambient-> (Outside)																						
Inside ->																						
Component																						

Note 1 : The unit under test shall be subjected to Heat run for 8 hours at full load.
2 : All temperature readings shall be recorded in deg. C.
3 : Reading are to be recorded at an hourly interval for first 5 hours & after every half an hour afterwards till end.

b) Burn-in Test (Remaining 64 hours)

a) This test shall be conducted at 100% load at nominal input.
b) No failure of any component during the burn-in-test of 72 hrs
c) All the component's temperature shall remain well within limits.
d) Performance tests such as regulations, input power factor, efficiency, peak to peak ripple, voltage droop, Short Circuit, Load sharing, Indications & alarms & Alarm settings etc shall be repeated after bringing the unit/ system to ambient & shall meet all the requirements of the GR.

Observations :

Date/time of test start :
Date/time of test end :

S.No.	DATE	TIME	Output of Units					
			UPS		STS & MTS		VR	
			Voltage	Current	Voltage	Current	Voltage	Current

c) Temperature Rise On Critical Components During Burn-in-Test

Date->								
Time ->	M/E	M/E	M/E	M/E	M/E	M/E	M/E	M/E
	UPS	UPS	STS	STS	MTS	MTS	VR	VR
Temp. Ambient Outside->								
Inside ->								
Component								

Test No. 31 (Clause no. 1.1.3.3, 2.8)

Protocol or Sequence of Exchange of Information between power plant & its peripheries(UPS system) & Remote Site Monitoring equipment.

RS 485 (4 wire) interface at speed 19.2Kbps (minimum) shall be used for both monitoring & control between inverter systems and other associated equipment (UPS) and Remote site (First level) of monitoring & control. The protocol shall be as given below ;

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

  Equipment side will along with parameter code same that on Master side along with desired information.

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

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

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

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

- In case of acknowledgement (desired information or next information) the concerned end will put-up the next information.

Each byte information in HEX shall be as detailed below :

5th Byte : Equipment Designation

Equipment Designation	Hex Code		Observation/Remarks
	From Master	From Slave Equipment	
Power Plant s(AC-DC Converters) (sixteen Max.)	00 to 0F	00 to 0F	
Battery Bank (Maximum sixteen)	10 to 1F	10 to 1F	
Inverter Systems (Max Sixteen)	20 to 2F	20 to 2F	
UPS System (Max Sixteen)	30 to 3F	30 to 3F	
SPV System(Max Sixteen)	40 to 4F	40 to 4F	
DG Set (Max Sixteen)	50 to 5F	50 to 5F	
Air conditioning group (Max Sixteen)	60 to 6F	60 to 6F	
Fire Alarm Group ((Max. Sixteen)	70 to 7F	70 to 7F	
Security Group (Max Sixteen)	80 to 8F	80 to 8F	
Flood Group (Max Sixteen)	90 to 9F	90 to 9F	
Any other equipment	A0 to FF	A0 to FF	

6th Byte : Classification of Information

Class of Parameter	Hex Code		Observation/Remarks
	From Master	From Slave Equipment	
Alarms Urgent	01	01	
Alarms Non-urgent	02	02	
Monitoring of Parameters	03	03	
Parameter Control	04	04	
System Details	05	05	
Any other information	06 to FF	06 to FF	

7th to 9th Byte : Parameter name :

UPS Systems (5th Byte 30 to 3F)

i) Alarms Urgent (6th Byte : 01)

Parameter Name	Hex Code		Observation/Remarks
	From Master	From Slave Equipment	
Mains "ON"/Battery Discharging - Any reason for failure of Charger unit of UPS to deliver the output (including AC input contactor failure)	01, 00, 00	01, 01, 00 : OK 01, 02, 00 : FAULT	
Battery Fail OR No Battery –Battery	02, 00, 00	02, 01, 00 : OK 02, 02, 00 : FAULT	
System Over Load	Same sequence	Same sequence	
FR/FC unit Voltage High	Same sequence	Same sequence	
FR/FC unit Voltage Low	Same sequence	Same sequence	
Fan Fail – Rack	Same sequence	Same sequence	
Temp. Compensation fail –Battery	Same sequence	Same sequence	
Inverter System Over Load	Same sequence	Same sequence	
Load Voltage High	Same sequence	Same sequence	
Load Voltage Low	Same sequence	Same sequence	
Unit Input Voltage High	Same sequence	Same sequence	
Unit Input Voltage Low	Same sequence	Same sequence	

Inverter Frequency Out of Range	Same sequence	Same sequence	
Any other Alarm condition	Same sequence	Same sequence	

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

Parameter Name	Hex Code		Observation/Remarks
	From Master	From Slave Equipment	From Slave Equipment
Mains High	01, 00, 00	01, 01, 00 : OK 01, 02, 00 : FAULT	01, 01, 00 : OK 01, 02, 00 : FAULT
Mains Low	02, 00, 00	02, 01, 00 : OK 02, 02, 00 : FAULT	02, 01, 00 : OK 02, 02, 00 : FAULT
FR/FC : Fail	Same sequence	Same sequence	Same sequence
Fan Fail	Same sequence	Same sequence	Same sequence
Over Voltage	Same sequence	Same sequence	Same sequence
Under Voltage/Output Fail	Same sequence	Same sequence	Same sequence
Over Load	Same sequence	Same sequence	Same sequence
Inverter : Fail	Same sequence	Same sequence	Same sequence
Fan Fail	Same sequence	Same sequence	Same sequence
Output Voltage High	Same sequence	Same sequence	Same sequence
Output Voltage Low	Same sequence	Same sequence	Same sequence
Input Voltage High	Same sequence	Same sequence	Same sequence
Input Voltage Low	Same sequence	Same sequence	Same sequence
Over Load	Same sequence	Same sequence	Same sequence
Any other Alarm condition	Same sequence	Same sequence	Same sequence

iii) Monitoring Parameters (6th Byte : 03)

Parameter Name	Hex Code		Observation/Remarks
	From Master	From Slave Equipment	
UPS on Mains/Stand by	01, 00, 00	01, 01, 00 : MAINS 01, 02, 00 : STAND BY	
Inverter Load on power plant/Battery	02, 00, 00	02, 01, 00 : Power Plant 02, 02, 00 : Battery	
Load on Inverter/ Stand by	03, 00, 00	03, 01, 00 : Inverters 03, 02, 00 : Stand by Mains	
FR/FC unit Voltage	04, 00, 00	04, VALUE(H), VALUE(L)	
FR/FC unit Load	05, 00, 00	05, VALUE(H), VALUE(L)	
Battery Path Current	Same sequence	Same sequence	
Battery trickle Current	Same sequence	Same sequence	
System Load	Same sequence	Same sequence	
UPS unit Output Voltage	Same sequence	Same sequence	
Input Voltage	Same sequence	Same sequence	
Frequency	Same sequence	Same sequence	
Load Sharing performance of Inverters (%)	Same sequence	Same sequence	
Any other Alarm condition	Same sequence	Same sequence	

iv) Parameter Control (6th Byte : 04)

Parameter Name	Hex Code		Observation/Remarks
	From Master	From Slave Equipment	
Mains High	01, VALUE(H), VALUE(L)	01, VALUE(H), VALUE(L)	
Mains Low	02, VALUE(H), VALUE(L)	02, VALUE(H), VALUE(L)	
FR/FC unit Over Load	03, VALUE(H), VALUE(L)	03, VALUE(H), VALUE(L)	
FR/FC unit Float Voltage	04, VALUE(H), VALUE(L)	04, VALUE(H), VALUE(L)	

FR/FC Charge Voltage	05, VALUE(H), VALUE(L)	05, VALUE(H), VALUE(L)	
FR/FC Load Voltage High	Same sequence	Same sequence	
FR/FC Load Voltage Low	Same sequence	Same sequence	
Battery : Path Current Limit	Same sequence	Same sequence	
FR/FC : Over Voltage	Same sequence	Same sequence	
Under Voltage	Same sequence	Same sequence	
Over Load	Same sequence	Same sequence	
UPS unit Over Load	Same sequence	Same sequence	
Load Voltage High	Same sequence	Same sequence	
Load Voltage Low	Same sequence	Same sequence	
Input Voltage High	Same sequence	Same sequence	
Input Voltage Low	Same sequence	Same sequence	
Any other parameter to be control	Same sequence	Same sequence	

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

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

v) System details : (6th Byte : 05)

Parameter Name	Hex Code		Observation/Remarks
	From Master	From Slave Equipment	
System Make	May be generated in the remote controller by manual inputting		
System Ultimate capacity	May be generated in the remote controller by manual inputting		
System Equipped capacity	03,00,00	03, VALUE(H), VALUE(L)	
Number of FR/FCs	04,00,00	04, VALUE(H), VALUE(L)	
Rating of FR/FCs	Same sequence	Same sequence	
Number of FR/FC Working	Same sequence	Same sequence	
Number of FR/FC Faulty	Same sequence	Same sequence	
Number of Inverters	Same sequence	Same sequence	
Rating of Inverters	Same sequence	Same sequence	
Number of Inverters Working	Same sequence	Same sequence	
Number of Inverters Faulty	Same sequence	Same sequence	
Any other information	Same sequence	Same sequence	

Note : In case the above information can not be provided by the UPS system the same may be generated in the First stage manually by in-putting the information. Faulty FR/FC & inverter details can be generated from the FR/FC & inverter Fail alarms.

For remote monitoring purpose, system shall support SNMP (Simple Network Management Protocol) v2 or higher version.

However, system shall also support RS-485 Modbus communication additionally if it is required by the purchaser/procurer.

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

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

DSCA shall communicate with Li-ion battery BMS to monitor the parameters and alarms and control the charging current of battery. Charging voltage shall be 54.0V or specified by the purchaser based on the requirement.

J. SUMMARY OF TEST RESULTS

GR/IR No._____
TSTP 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'.***