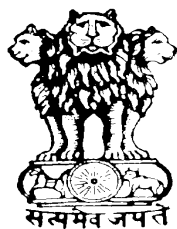


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**GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS**



**DRAFT SPECIFICATION
OF
SMPS BASED POWER PLANT FOR INDIAN RAILWAY TELECOM
EQUIPMENT**

SPECIFICATION NO. RDSO/SPN/TL/23/99

VERSION 4.0

ISSUED BY

**TELECOM DIRECTORATE
RESEARCH DESIGNS & STANDARDS ORGANISATION
MANAK NAGAR, LUCKNOW-226011**

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ABBREVIATIONS

1.	A	Amperes
2.	AC	Alternative Current
3.	AH	Ampere Hour
4.	dB	Decibel
5.	dBa	Decibel Absolute
6.	DC	Direct Current
7.	Deg.C	Degrees Celsius
8.	DG	Diesel Generator
9.	DoT	Department of Telecommunication
10.	Emf	Electro motive force
11.	EMI	Electro Magnetic Interference
12.	FET	Field Effect Transistor
13.	FSD	Full Scale Deflection
14.	FR-FC	Float Rectifier cum Charger
15.	FR-BC	Float Rectifier cum Boost Charger
16.	GR	Generic Requirements
17.	IS	Indian Standards
18.	Kg	Kilo Grams
19.	KHz	Kilo Hertz
20.	LCSO	Electronic Components Standardisation Organisation
21.	LED	Light Emitting Diodes
22.	LCD	Liquid Crystal Device
23.	MHz	Mega Hertz
24.	MOV	Metal Oxide Varistor
25.	MTBF	Mean Time between Failures
26.	ms	Milli Seconds
27.	PCB	Printed Circuit Board
28.	PF	Power Factor
29.	QA	Quality Assurance
30.	QM	Quality Manual
31.	RFI	Radio Frequency Interference
32.	SMPS	Switch Mode Power Supply
33.	V	Volts
34.	VRLA	Valve Regulated Lead Acid

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SECTION-1

GENERAL

- 1.0 Introduction:** This document covers the technical requirements of 48 V DC Power Plant (hereinafter will be called Power Plant) based on High Frequency Switch Mode Techniques for the use by Indian Railways for Telecom Equipments i.e. Exchanges, Multiplexing Equipments, Microwave Radio Equipments, GSM-R Equipments, TETRA Equipments, OFC Equipments etc..
- 1.1 The Power plant envisaged in this document will have to work either with VRLA or Conventional Lead Acid Battery. The Tendering Authority will indicate the type of battery in the Tender.
- 1.1.1 Power Plant shall consist of a Distribution-Switching-Control-Alarm Arrangement(DSCA) and Float Rectifier-cum-Chargers (FR-FCs) or Float Rectifier cum Boost Chargers (FR-BCs).
- 1.1.2 The Power Plant shall be capable of meeting the load requirement (equipment and battery bank) for various telecom equipments. The system shall be expandable at rack level itself, using the basic modules of the same rating.
- 1.1.3 The Distribution-Switching-Control-Alarm Arrangement(DSCA)shall comply with the requirements of Section-5 of this document.
- 1.1.4 To cater for higher load requirements, same type of FR-FCs or FR-BCs mounted in the same rack shall be capable of working in parallel load sharing arrangement.
- 1.2** The Power Plant including FR-FC or FR-BC modules shall be suitable for operation from AC Mains or from a DG Set.
- 1.3** Single Phase 48 V DC Power Plant are categorized as below depending upon Stability of Incoming Power Source.
- (i) Suitable for incoming power supply range from 165 V AC to 260 V AC.
 - (ii) Suitable for incoming power supply range from 90 V AC to 300 V AC.
- 1.4** The Power Plant not having the provision for the exclusive requirements of conventional batteries shall be certified as “The Power Plant compatible with VRLA Batteries only”.

SECTION 2

GENERAL TECHNICAL REQUIREMENTS

2.0 General:

This section covers the general requirement of **48 V DC SMPS Based Power Plants**, based on High Frequency Switch Mode Techniques using switching frequencies of 20KHz and above for use in Indian Railway Network.

2.1 SMPS Based Power Plants is intended to be used in Auto Float Rectifier-cum Float-Charger (FR-FC) and/or Float Rectifier cum Boost Charger (FR-BC) mode as a regulated DC Power Source.

2.2 Power System Configuration: The configuration of 48 V DC Power Plants with FR-FC & FR-BC Modules shall be as under:

SN	Basic SMR Module	Configuration	Permissible Ultimate Capacity*
1	12.5 A FR-FC	(n+1)	50 Amp
2	25 A FR-FC	(n+1)	150 Amp
3	50 A FR-FC	(n+1)	800 Amp
4	12.5 A FR-BC	(n+2)	50 Amp
5	25 A FR-BC	(n+2)	150 Amp
6	50 A FR-BC	(n+2)	800 Amp

The FR-FC or FR-BC modules shall be housed in (n+1) or (n+2) parallel configuration in a single rack where 'n' is the actual required number of FR-FC, FR-BC modules for meeting the particular load requirement.

Railway shall indicate the Type, Number and Configuration of SMR Modules, depending upon the load requirement. Railway shall also indicate Ultimate Expandable Capacity considering future expansion requirement.

* **Permissible Ultimate Capacity** stipulate that with particular Basic SMR Module, the ultimate Capacity can not be more than as defined in this column. However **Ultimate Expandable Capacity** for a particular product of manufacturer can be less than the **Permissible Ultimate Capacity** defined in this column.

2.3 Rack Configuration : Rack is composed of following units accommodated in sub racks

- Float Rectifier cum Float Charger (FR-FC) Modules or Float Rectifier cum Boost Charger (FR-BC) Modules
- Distribution-Switching-Control-Alarm Arrangement (DSCA)
- The number and rating of FR-FC, FR-BC Modules shall be provided as per purchaser's requirement. The Distribution-Switching-Control-Alarm Arrangement (DSCA) shall be provided for the Ultimate Expandable Capacity. All factory wirings for the rack shall be for the Ultimate Expandable Capacity so that only plugging-in of FR-FC or FR-BC module shall enhance the DC Power output.

Further details of System Rack Configuration are given in SECTION 3.

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2.4 The Electrical and Mechanical requirement of FR-FC & FR-BC Modules are given in SECTION 4 & SECTION 6 respectively.

2.5 The Electrical and Mechanical requirement of Distribution-Switching-Control-Alarm Arrangement (DSCA) are given in SECTION 5.

2.6 Parts & Components

2.6.1 The Parts & Components including Fuses and Circuit Breakers for manufacturing of the SMPS Based Power Plants shall be of Industrial Grade. These Parts & Components shall be procured from reputed manufacturers to ensure prompt and continuous service and delivery of spare parts.

2.6.2 The Components approved by recognized National/International Institutions like LCSO/CACT/UL/CSA/VDE/TUV shall only be used in manufacturing of SMPS Power Plant.

2.6.3 Power Transformers and Chokes shall use Class B or Higher Grade of insulation. The Transformers and Chokes shall be wound with copper wire provided with adequate insulation.

2.6.4 Component mounting and fixing methods shall be secured.

2.7 Wiring:

2.7.1 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 voltage during fault and overload.

2.7.2 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 with rubber grommet.

2.8 Bus Bars:

2.8.1 Bus bars shall be of high conductivity electrolytic copper strips capable to with-stand 1.5 times the maximum load current. The Bus bar shall be capable to carry current density of 2 Amps/mm² but shall not be less than 25mmx5mm in any case. The size of bus bars chosen for battery and load path shall be capable to take care of the current of maximum power plant capacity for which it is designed.

2.8.2 Bus-bar Riser height wherever applicable shall be 250mm for both load and battery.

2.9 Earthing: All non-current carrying metal parts shall be bonded together and earthed. An earth terminal suitable for taking minimum 4 mm dia wire and with suitable marking shall be provided.

2.10 Qualities and Workmanship

2.10.1 The guidelines contained in Quality Manuals QM-202, QM-204, QM-205, QM-206 and QM-207 of QA wing of BSNL for proper quality & workmanship shall be followed.

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

2.10.3 The equipment and components shall not use any material which support combustion.

2.11 Climatic Requirements:

2.11.1 The Power Plant shall operate at specified ratings and conforms to requirements contained in as per IS-9000 (Pt-III), IS-9000 (Pt.V/Section-2). Power Plant includes FR-FC Modules, FR-BC Modules and DSCA Modules.

2.11.2 The SMPS Based Power Plants shall be designed & manufactured for continuous operation at rated load in the ambient temperature range of 0°C to 55°C with RH up to 95%. For extreme temperature conditions of 0°C & 55°C, the efficiency shall remain as given below:

A. Efficiency:

1. Units working on Single Phase

- a) Nominal Input, Output & Full rated load - better than 85%
- b) For other specified Input, Output conditions - better than 80%

2. Units working on three phase

- a) At Nominal Input, Output & Full rated load - better than 90%
- b) For other specified Input, Output conditions - better than 85%

B. Power Factor:

- a) At nominal Input/Output & load 75% to 100%, the Power Factor should be between 0.95 lag & 0.98 lead
- b) For other than specified Input/Output conditions & load between 25% to 100%, the Power Factor should be between 0.90 lag & 0.90 lead

2.11.3 The fully equipped SMPS Based Power Plants shall be capable of withstanding Burn-In Test as per Clause 7.8.

2.12 Insulation Resistance and Voltage Proof

2.12.1 The insulation resistance of a fully wired FR-FC and FR-BC Modules when tested with a 500V DC Megger shall be as given below:

- a) AC input and Earth - Greater than 2 Mega Ohm
- b) DC Output and Earth - Greater than 1 Mega Ohm
- c) AC input and DC output - Greater than 5 Mega Ohm.

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2.12.2 With EMI/RFI Capacitors and MOVs/Transzorbs removed from the circuit, and a test voltage of 1500V/50Hz is applied for one minute.

- between earth and interconnected output terminals
- between input and output terminals

No breakdown or abnormal temperature rise shall occur.

2.13 Lightning Protection :

The SMPS Based Power Plants shall have modular type *Type I/Class B* and *Type II/Class C* type surge protection in TT configuration of wiring. Both the *Type I/Class B* and *Type II/Class C* arrestors should be from the same manufacture and shall be mounted as per the specific installation recommendations of the manufacturer to achieve perfect coordination. The schematic diagram of surge and lightning protection is as per Annexure I.

2.13.1 Type I/Class B Protection :

The product shall be tested as per the latest VDE 0675 and IEC 61643 standard. The protection shall be in compliance with IEC 61312. IEC 61024 and with the following characteristics.

Parameter of Type I/Class B Protection	Rating
Maximum Continuous Operating Voltage Between R,Y,B and N	
• SMPS Power Plant with 3 Phase Power Supply • SMPS Power Plant with Single Phase Incoming Power Supply within range of 165V-260V • SMPS Power Plant with Single Phase Incoming Power Supply within range of 90V-300V	≥ 285 Volt ≥ 285 Volt ≥ 320 Volt
Voltage Protection Level/Response Time	≤ 1.5 KV/ <100 nsec
Minimum Lightning impulses current R Y, B and N	50 KA, 10/350 μ s
Minimum Lightning Impulses Current between N and PE	100 KA, 10/350 μ s
Line follow current extinguisher capacity of arrester connected between R, Y, B and N at arrester rated voltage without back up fuse	≥ 10 KA r.m.s.

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2.13.2 Type II/ Class C Protection

The Class C arrester in the modular and pluggable form shall be provided. The products shall be tested as per the latest VDE 0675 and IEC 61643 standard. The protection shall be in compliance with IEC 61312, IEC 61024 and have the following characteristics.

Parameter of Type II/Class C Protection	Rating
Nominal voltage between R, Y, B and N	230 V working
Maximum Continuous Operating Voltage Between R,Y,B and N	
- SMPS Power Plant with 3 Phase Power Supply - SMPS Power Plant with Single Phase Incoming Power Supply within range of 165V-260V - SMPS Power Plant with Single Phase Incoming Power Supply within range of 90V-300V	≥ 285 Volt ≥ 285 Volt ≥ 320 Volt
Nominal discharge current of the arrester between R,Y,B and N	≥ 10 KA (8 / 20 μ s)
Maximum voltage protection level	1.6 KV
Response Time	≤ 25 nano second

2.13.3 Coordination Between Class B/Type I and Class C/Type II Protection

There shall be a perfect coordination between Class B/Type I and Class C/Type II stages. The coordinating inductor /cable distance is not required for coordination between class B/type I and class C/type II

The proper coordination of the SPD system as well as safety of operation shall be specifically ensured.

2.13.4 Parallel/Series arrangement of Spark Gap (SG) with MOVs is not permitted in Type I/Class B as well as Type II / Class C.

2.13.5 In built Thermal Disconnect arrangement and remote indication for type II/class C connected between R.Y B and N should be available.

2.13.6 The manufacturer shall clearly give the earthing guidelines required for the purpose.

2.13.7 Type III/Class D Protection

All external 48 V DC Power Lines connected to the SMPS Power Plant shall be protected by using pluggable Type-III/Class D Surge Protection Device which consists of a combination of Varistors and GD Tube with voltage and current limiting facilities. The device shall be in compliance to IEC 61643-1 and VDE 0675 Part-6. These devices are to be connected in parallel to the SMPS Power Plant output connected to the load as given in the figure 1.3 Annexure-II. These Class-D/Type-III devices shall be having a visual indication as well as remote indication function to indicate the prospective life and failure mode to facilitate

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replacement of the overstressed SPDs. These protection device shall be equipped with thermal disconnection, as a protection against SPD failure due to open and short circuit.

General Specification of the Devices.

Nominal Voltage	48 Volt
Maximum Continuous Operating Voltage(Uc)	≥ 75 Volt
Nominal Discharge Current(In) 8/20 μ s	≥ 2.5 KA
Rated Load Current	25 Amp
Maximum Discharge Current(Imax) 8/20 μ s	≥ 5 KA
Voltage Protection Level between L-L(U _p)	≤ 500 V
Voltage Protection Level between L-G	≤ 700 V
Response Time	≤ 25 ns

2.14 Radio Frequency Interference Suppression: The module shall be designed to minimize the level of electromagnetic interference (EMI), both conducted and radiated, detected in its vicinity and generated by Switch Mode Power Conversion Equipment operating within the rack. The radiated and conducted noise shall be within the limits as specified in ANNEXURE-V.

2.15 Finish and painting:

The finish of steel and panels shall conform to relevant IS specification. The colour scheme shall be as follows:

- (a) Rack & doors : Pebble gray – RAL 7032
- (b) FR-FC Module or FR-BC module: Shall harmoniously match with rack colour.

2.16 Marking & Labelling

2.16.1 Component marking

2.16.2 Each electrical component should be possible to be located on the PCB by the layout/circuit drawings. Switch Mode diodes may be marked as a block in the layout/circuit diagram. The wiring shall be clearly and permanently identified with a designation of a colour code which corresponds to the equipment circuit diagram. Where non standard colours are used, cable function shall be clearly and permanently labeled at both ends.

2.16.2.1 Fuse holder identification shall include details of the fuse rating and type. In case of fuses on PCBs, the rating shall be either on the fuse or PCB.

2.16.2.2 A cabling diagram, screen printed or any other better arrangement ensuring better life expectancy shall be placed on the inside of the front door or any other convenient place for ready reference of the maintenance staff.

2.16.2.3 Procedure for adjustment of float voltage, boost voltage, battery current limit and other adjustments required to be done in the field shall be printed or any other better arrangement ensuring better life

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expectancy shall be placed in the inside of the front door or any other convenient place for ready reference of maintenance staff.

2.17 Name plate : A name plat etched/engraved/anodized or any other better arrangement ensuring better life expectancy shall be suitably fixed on each rack/module and contain following information.

1. Specification Number
2. Type of Unit
3. Manufacturer's name and identification
4. Model No.
5. Unit Serial No.
6. Input Voltage and phase
7. Output Voltage and current
8. Year of manufacture
9. Suitable for battery capacity

2.18 Instruction and Maintenance Manual:

2.18.1 Two copies of the Instruction Manual shall be supplied along with each unit. The manual has to include dimensioned layout drawings, detailed circuit and schematic diagrams, PC card layouts and detailed interconnecting drawings of modules and switching arrangement. Details of testing and adjustment procedure, initial checks on receipt at site, detail installation & commissioning procedures, maintenance procedure, proposed routine maintenance tests, actual test results obtained for the particular and at the factory and a detailed trouble shooting chart shall be outlined in the manual. Feedback format is also to be included in the Instruction Manual. A copy of the Installation and Maintenance Manual shall also be provided on a CD(Compact Disk).

2.18.2 Instruction Manual is to be prepared using good quality paper with clear and crisp printing. All the drawings in clear printing shall be attached to the handbook binding. One set of flow chart drawings necessary for troubleshooting shall be provided with lamination with each manual. The handbook shall have a thick polythene sheet cover with plastic spiral binding or comb-binding.

2.18.3 The manufacturer shall submit certificate of the equipment for its satisfactory performance for 24 months. During the warranty period, any defect should be repaired free of cost.

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

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

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

2.20 Module Replacement Time & MTBF:

- 2.20.1 Module Replacement Time. The mean time to replace a faulty rectifier module shall be less than 20 minutes.
- 2.20.2 The MTBF of the system shall not be less than 70,000 hours. Calculation details of MTBF shall be furnished by the manufacturer at the time of Type Approval. Based on the MTBF figures, 3 Years Maintenance Spare shall be specified by manufacturers during Type Approval.
- 2.20.3 The fans provided shall have MTBF better than 70,000 hours at 40° C
- 2.20.4 In case of fan failure, the module shall have automatic protection to switch off with extension of suitable alarm. It shall not cause any fire hazard.

2.21 Packing:

- 2.21.1 Power plants complete shall be packed in suitable boxes/crates, strong enough, to prevent damage or loss to the unit during transit. Loose space inside the box/crate shall be filled up with suitable packing material.
- 2.21.2 It is desirable that the fragile components such as meters and PC cards are individually packed to prevent damage.
- 2.21.3 Each box shall be legally marked at one end with code numbers, contents quantity and name of manufacturer/supplier.

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SECTION 3

SYSTEM AND RACK CONFIGURATION

3.0 Scope: This section deals with the mechanical and electrical requirements of the rack.

3.1 Rack Configuration: Rack shall be capable of accommodating the following equipment/units as given below:

- a) Float Rectifier – cum – Float Charger (FR-FC) Modules or Float Rectifier – cum – Boost Charger FR-BC Modules.
- b) Distribution-Switching-Control-Alarm Arrangement..

3.2 Constructional features of Rack:

- 3.2.1 The FR-FC or FR-BC Modules shall be accommodated in a rack. The system shall employ a modular configuration to provide flexibility, keeping in view the future load requirements of DC power. Suitable mechanical structure/arrangement for holding modules in position shall be provided so that the module is held firmly by sliding through it.
- 3.2.2 The rack structure shall be made up of rigid frame work of anti-corrosive steel profiles conforming to IS: 226. The sides of rack may have suitable ventilating arrangements. The front door (if provided) and rear door may be of hinged or removable type. The rear door shall be provided with proper ventilation arrangement. The ventilator opening shall be less than 3 mm size for protection against entry of lizards etc. The rack shall conform to IP 31 type of protection as specified in table 1 of specification No. IS 2147 – 1962. The FR-FC or FR-BC Module shall have ventilation opening as per IP 20 Protection Enclosures.
- 3.2.3 The rack shall be treated with Zinc Chromate Primer followed by Electrostatic Epoxy Powder Coating Paint finished. Passivation shall be done through seven stage process. Small metal parts such as nuts, bolts and washers shall be either galvanized or chrome plated. All other metal parts of the rack shall be plated for protection against corrosion.
- 3.2.4 The structural strength of the rack shall be able to withstand the mechanical load for Ultimate Expandable Capacity of the Power Plant without any deformity.
- 3.2.5 The depth of rack shall not be more than 600mm from front door (when provided) to rear with door fitted and height shall be not more than 2200mm.
- 3.2.6 The case of rack shall ensure uniform floor loading of not more than 975 kg/Sq.mt. Lifting facilities shall be provided by removable eyebolt located at the top of the rack. The necessary arrangement for fixing the rack on the floor shall also be provided.
- 3.2.7 The top of the rack shall be fully covered except for proper ventilation and bus bar or cable entries. Each air flow vent shall be covered by a grill to prevent foreign material larger than 5mm dropping into the rack.
- 3.2.8 The rack shall be free of sharp edges & sharp corners.

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3.2.9 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.

3.3 Dimensions: Dimensions of the rack for all the capacities shall be as follows:

Height:	2200mm (max)
Depth:	600mm (max)
Width:	600mm (max)

3.4 The rack shall be designed for easy maintenance and installation.

3.5 Rack mounting arrangement shall be such as to provide easy access from front, rear and top for installation and maintenance.

3.6 The FR-FC & FR-BC Modules shall be provided as per requirement. The prescribed FR-FC or FR-BC Modules ratings are 12.5A, 25A & 50A.

3.7 The Distribution-Switching-Control-Alarm Arrangement shall be provided for the Ultimate Expandable Capacity as explained in Clause 2.2. All AC, DC or control/alarm cabling/wiring shall be pre-wired for the ultimate capacity so that mere plugging-in of FR-FC & FR-BC Module shall add to the DC power output.

3.8 The individual FR-FC or FR-BC Module shall be easily mounted to/removed from the rack. The FR-FC and FR-BC Module shall be designed to slide into the rack on a suitable mechanical arrangement. The associated AC input, DC output connections, Control/alarms and interface cable connecting the modules shall be disconnected/installed easily without causing any interruption/damage to the supply and working module.

3.9 Proper thermal engineering of hardware design shall be done by the manufacturer so as to ensure the uninterrupted use of the equipment. The rack complete with all panels fitted shall be designed to allow cooling by natural convection. For the racks using 50A modules, DC fans are permitted in the rack or FR-FC & FR-BC module. If cooling is provided at rack level, it shall be provided with additional fan with facility for manual switch over. Proper fitting shall be provided to control dust ingress. There shall be an arrangement for automatic switching off of fans during AC input failure. If required, individual modules may be separated by air baffle to provide effective convection. The manufacturer shall also ensure that the failure of fan does not cause any fire hazards. The failure of any of the fans shall draw immediate attention of the maintenance staff.

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

3.11 Electrical requirements:

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3.11.1 **AC input supply:** The Power Plant using FR-FC or FR-BC modules of 12.5 & 25 Amps shall operate from single phase AC input and FR-FC or FR-BC modules of 50A capacity may operate from single phase or 3 phase 4 wire AC input. The nominal input frequency is 50Hz which may vary from 48-52Hz. The input voltage range shall be as given below:

a) Single Phase (nominal 230V) :

- (i) For Power Plant to be used at stations having poor power supply regulation, incoming power supply range shall be from 90 V AC to 300 V AC.
- (ii) For Power Plant to be used at stations having reasonable power supply regulation, incoming power supply range shall be from 165 V AC to 260 V AC.

b) Three Phase/4 Wire 400V+10%/ - 15% (Nominal 400V)

3.11.2 There shall be an automatic arrangement for shutting off the FR-FC or FR-BC Modules wherever the input voltage is beyond the specified operating limits with suitable alarm indication. It shall resume normal working automatically when the input is restored within the working limits. Hysteresis within specified working limits shall not cause shutting down of the FR-FC or FR-BC Modules. A tolerance of $\pm 5V$ may be acceptable for protection & alarm operation. All the FR-FC or FR-BC Modules shall switch OFF simultaneously.

3.11.3 FR-FC or FR-BC Modules working from 3 phase/4 wire input shall work satisfactorily for unbalance of $\pm 10\%$ of nominal input. The module 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.

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SECTION 4

FLOAT RECTIFIERS CUM CHARGER (FR-FC) MODULES

4.0 Scope: This section deals with electrical and mechanical requirement of FR-FC Modules.

4.1 General: The FR-FC Modules used shall be such as to be accommodated in a rack in the standardized capacities of 12.5A, 25A & 50Amps.

4.2 Mechanical Requirements

4.2.1 The FR-FC Modules shall be cooled by natural convection for smaller capacities i.e. 12.5 Amp and by natural/forced cooling for higher capacity i.e. 25 Amp and 50 Amps.

4.2.3 The FR-FC module shall be removable from the front of the rack only. All AC input, DC output and alarm/control/monitoring cables interconnecting the modules and racks shall be easily disconnected by disconnecting the male-female of directly PCB mounted pluggable plugs or connectors.

4.3 DC Output Characteristics

4.3.1 The module shall be capable of operating in 'Auto Float-cum-Charge' mode and it shall be programmed to operate as a Float Rectifier or a Float Charger depending on the condition of the battery sets being sensed by the Distribution-Switching-Control-Alarm Unit.

4.3.2 Auto Float Mode

a) The float voltage of each rectifier module shall be continuously adjustable & pre-settable at any value in the range of -48V to -56V. The prescribed float voltage setting is -54V for VRLA battery.

b) The DC output voltage shall be maintained within $\pm 1\%$ 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.

4.3.3 Auto Charge Mode: In Auto Charge Mode FR-FC shall supply battery & equipment current till terminal voltage reaches set value, which is normally 2.3V/Cell (55.2V) & shall change over to constant voltage mode it shall remain in this mode till a change over to float mode signal is received.

4.4 Efficiency: The efficiency of the single phase and three phase unit shall be as given below: -

4.4.1 Units working on Single Phase AC

- | | | |
|----|--|-----------------|
| a) | At nominal input, output and full rated load | better than 85% |
| b) | For other specified input, output conditions and load between 25% to 100%. | better than 80% |

4.4.2 Units working on Three Phase AC

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- a) At nominal input, output and full rate load better than 90%
- b) For other specified input, output condition better than 85%
and load between 25% to 100%

4.5 Input Power Factor: The input power factor at nominal input, output voltage and load 75% to 100% shall be between 0.95 lagging and 0.98 leading but it shall remain between 0.90 lag and 0.90 lead in any other working condition and load between 25% to 100%.

4.6 Total Harmonic Distortion:

- 4.6.1 Total Voltage Harmonic Distortion: The total line harmonic voltage distortion shall not be more than 10%.
- 4.6.2 Total Current Harmonic Distortion: The total current harmonic distortion contributed by the unit at the input shall not exceed 10% for input voltage range 90V-300V/165V-260V(as the case may be) for single phase units and 340V to 440V for 3 phase respectively for load 50 to 100% of the rated capacity.

4.7 Current limiting (Voltage Droop)

- 4.7.1 The current limiting (Voltage Droop) shall be provided for Float Charge operation. The Float/Charge current limiting shall be continuously adjustable between 50 to 100% of rated output current for output voltage range of -44.4V to -56 volts. For test purposes upper limit of 100% +5% and lower limit of 50% - 5% shall be acceptable.
- 4.7.2 The float and charge current limit adjustment shall be provided on the front panel of the rectifier module.
- 4.7.3 The FR-FC modules shall be fully protected against short circuit. It shall be ensured that short circuit does not lead to any fire hazard.

4.8 Soft Start Feature:

- 4.8.1 Slow start circuitry shall be employed such that FR-FC module input current and output voltage shall reach their nominal value within 10 seconds.
- 4.8.2 The maximum instantaneous current during start up shall not exceed the peak value of the rectifier input current at full load at the lowest input voltage.

4.9 Voltage overshoot/undershoot

- 4.9.1 The requirements of clauses 4.9.2 to 4.9.4 shall be achieved without a battery connected to the output of FR-FC module.
- 4.9.2 The FR-FC modules shall be designed to minimize output voltage overshoot/undershoot such that when they are switched on the DC output voltage shall be limited to $\pm 5\%$ of the set voltage & return to their steady state within 20ms for any load of 25% to 100%.

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4.9.3 The DC output voltage overshoot for a step change in AC mains shall not cause shut down of FR-FC module and the voltage overshoot shall be limited to $\pm 5\%$ of its set voltage and return to steady state within 20 ms.

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

4.10 Electrical Noise

4.10.1 The rectifier (FR-FC) modules shall be provided with suitable filter on the output side.

4.10.2 A resistor shall be provided to discharge the capacitors after the rectifier modules have stopped operation and the output is isolated.

4.10.3 The Psophometric Noise (e.m.f weighted at 800 Hz) with a battery of appropriate capacity connected across the output should be within 2mV while delivering the full rated load at nominal input (400V AC for 3 phase supplies and 230V for single phase supply). For test purposes, this shall be taken as equivalent to 4mV when the battery is not connected and other conditions remaining the same as per ITU-T Rec P53.

4.10.4 The Peak to Peak Ripple: Voltage at the output of the rectifier module on full load without battery connected shall not exceed 300mV at the Switching Frequency measured by an Oscilloscope of 50/60 MHz band-width (typical).

4.11 Parallel Operation:

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

4.11.2 The current sharing shall be within $\pm 10\%$ of the average current per rectifier module and within individual capacity of each rectifier module in the system (mounted in the same or different racks) when loaded between 50 to 100% of its rated capacity for all other working conditions.

4.12 Protection:

4.12.1 DC over voltage protection.

4.12.1.1 Each rectifier module shall be fitted with an internal over-voltage protection circuit.

4.12.1.2 In case output DC voltage exceeds $-57V$ the over voltage protection circuit shall operate & shut off the faulty module. A tolerance of $\pm 0.25V$ is permitted in this case. Restoration of the module shall be through a reset switch/push button.

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

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

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4.12.1.5 The circuit design shall ensure protection against the discharge of the battery through the FR-FC module in any case.

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

4.12.2 **Fuse/Circuit Breakers:** Fuses or circuit breakers shall be provided for each FR-FC module as follows:

1. Live AC input line
2. Negative DC output
3. Against failure of Control sensing circuit

4.12.2.1 All fuses/circuit breaker used shall be suitably fault rated.

4.12.3 **AC Under/Over Voltage Protection:** AC input Under/Over voltage protection shall be provided as per clause 3.11.

4.12.4 **Over Load/Short Circuit Protection:** The FR-FC shall be protected for Over load/Short circuit as per clause 4.7.

4.13 Alarms and Indicating Lamps

Visual indications/display such as LEDs, LCDs or a combination of both shall be provided on each FR-FC module to indicate.

Functional Indications:

- A Mains available
- B FR-FC on Auto Float
- C FR-FC on Auto Charge

Alarm Indications

- A AC/DC Rectifier module Over Voltage, Under voltage or Output Fail
- B FR-FC Over Load (Voltage Droop)
- C Fan fail (due to any reason)

Functional indications shall be extended as status and alarm indications as “FR-FC” Fail to Distribution-Switching-Control and Alarm Arrangement.

4.14 Termination:

- A The AC Input Connection to the rectifier module shall be by means of Pluggable Connectors. These Connectors shall be made of complete non-ferrous metal parts. Housing material if any shall be of Polyamide 6.6 of V0/V2 inflammability class as per UL94.

The male connectors shall preferably be mounted in the FR-FC Module and female connectors be terminated to the cable.

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- B The DC Output Connection from the rectifier module for smaller rating (up to 25 Amps) shall be by means of Pluggable Connectors. These Connectors shall be made of complete non-ferrous metal parts. Housing material if any shall be of Polyamide 6.6 of V0/V2 inflammability class as per UL94.

For higher rating suitable termination lugs shall be provided.

The male connectors shall preferably be mounted in the FR-FC Module and female connectors shall be preferably terminated to the cable.

- C The output of each rectifier in the negative lead shall be taken through the full rated Fuse/MCB in the Distribution-Switching-Control-Alarm Arrangement (DSCA) or in the FR-FC Module.

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SECTION-5

DISTRIBUTION/SWITCHING/CONTROL AND ALARM AARANGEMENT(DSCA)

5.0 General:

Depending on the system requirements and manufacturer's design, Power Plant racks shall be provided with a Distribution-Switching-Control-Alarm Arrangement (DSCA) for the Ultimate Expandable Capacity as defined in Clause 2.2.

The unit shall comprise of the following:

- a) Termination for the batteries
- b) Termination for the load
- c) Interconnecting arrangement for power equipment
- d) Battery Switching Arrangement (Connection to/isolation from system)
- e) Termination for AC input to the rack
- f) Termination for AC and DC to FR-FC modules
- g) Circuit Breakers/fuses etc.

5.1 Dimensions:

- 5.1.1 The Distribution/Switching Sub-System of the equipment shall preferably be in the modular form whereas Control/Alarm & Monitoring Sub-System shall be modular only. The Distribution/Switching Sub-System may be accommodated in a rack with other FR-FC or in a separate rack. These sub-systems shall be rack mountable.
- 5.1.2 The unit shall preferably be housed in the upper portion of the rack above the FR-FC modules.
- 5.1.3 The DSCA shall be provided for ultimate capacity of SMPS Based Power Plant. All AC, DC Control, Alarm cabling/wiring shall be pre-wired for the ultimate capacity so that mere plugging-in of FR-FC module shall add to the DC Power Output.

5.2 Accessibility:

- 5.2.1 All the termination points shall be easily accessible from front, rear or top.
- 5.2.2 The AC modular earth terminal should be touch proof with universal yellow green housing symbolizing the potential earth with all non ferrous metal parts including the screws.

5.3 AC Termination Arrangement:

- 5.3.1 The Input Terminals shall be clearly marked as R, Y, B and N for three phase and L and N for single phase as applicable.

AC Termination should be modular in design These Termination shall be made of complete non-ferrous metal parts. Housing material if any shall be of Polyamide 6.6 of V0/V2 inflammability class as per UL94. The Termination Block should be as per IEC-947-7-1.

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- 5.3.2 AC input termination shall be suitably protected against the accidental touch/contact with the working staff for their protection and shall also have clear and prominent “DANGER” Marking.
- 5.3.3 Screening shall be provided between AC & DC components to prevent accident.
- 5.3.4 All the connections between DSCA and FR-FC shall be through properly rated cables only.
- 5.3.5 Fuses and Circuit Breakers for each FR-FC shall be easily accessible and properly rated.
- 5.3.6 Proper terminations for AC at the input of the circuit breakers and its output to the FR-FC.

5.4 DC Terminations:

- 5.4.1 Connection between FR-FC and DC Distribution shall be through a properly rated lugged Cable/Buster. Wherever cables are used, the same shall be terminated through the appropriately screw locking type Terminal Blocks. These Terminal Blocks shall be made of complete non-ferrous metal parts. Housing material if any shall be of insulating material with dielectric strength not less than 4 KV and of V0/V2 inflammability class as per UL94.
- 5.4.2 The DC output to battery and load shall be through cable.
- 5.4.3 The provision for interconnection between load & FR-FC or battery (along with switching arrangement) and terminations for load, battery & FR-FC shall be made. The isolation of any of the battery from the load shall create an alarm.
- 5.4.4 The proper rated fuses/circuit breakers shall be provided on the –ve DC lead from the FR-FC (if not provided at FR-FC module).
- 5.4.5 All the AC, DC and control/alarm cabling shall be supplied with the rack.
- 5.4.6 All DC + ve and –ve loads shall be clearly marked.
- 5.4.7 All conductors shall be properly rated to prevent excessive heating.

5.5 Alarms.

- 5.5.1 Following visual indications/display such as LEDs, LCDs or a combination of both shall be provided to indicate.

Functional Indications:

- a) Mains Available (not mandatory if provided at module level)
- b) FR-FC in Float Mode
- c) FR-FC in Charge Mode

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Alarm Indications:

- a) Load Voltage High (above 57V)/Low (below 44.4V)
- b) FR-FC Fail (Any failure condition as per clause 4.13.
- c) Mains Out of Range
- d) System Over Load
- e) Mains 'ON'/Battery Discharge
- f) Fan Fail (incase fan provided at rack level)
- g) Temperature Compensation Fail
- h) Battery Fail/Isolated

5.5.2 All alarm circuits shall be provided with suitable delay to ensure that they do not operate to transients.

5.5.3 All the protections/alarms shall be within tolerance of 0.25V in case of DC voltage and 1% in case of current. For AC voltage it shall be $\pm 5V$.

5.5.4 Every alarm condition shall be accompanied with an audio alarm with audio cut-off facility.

5.5.5 Two nos. of Potential Free Contacts (one for alarm and one redundant) shall be provided for extension of alarms to Centralized Display.

5.5.6 Two numbers of potential free contacts for connecting to network monitoring system for monitoring DC output fail, DC output over voltage, DC output under voltage and mains fail shall be provided. Alternatively, the Power Plant shall have provision for RS-232 or RS-485 or SNMP over TC/IP connectivity compatible for remote control monitoring of the above system parameters depending upon the user's requirements.

5.6 Battery Monitoring

5.6.1 Battery Under Voltage Isolation: To cater for the requirements of unattended stations like microwave repeater stations and other similar systems, the provision for automatic isolation of battery bank from the load shall be made available. The tendering authority shall specify for such type of power plants, the load and battery capacity. The operate and release voltages for the above conditions shall be as follows:

Cut-off: 1.85V/cell (44.4 V+0.25V) Reconnect: 1.90V/cell (45.6V+0.25V)

5.6.2 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 55.2 V till the battery is fully recouped.

5.6.3 Battery Current Limiting Circuit: In auto mode, to ensure the availability of required load and safety of the battery, battery path current limit shall be settable as per the battery bank requirements so that the battery path current is kept to 10% of battery AH capacity.

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Tending authority will give the capacity of the battery to be used for this purpose. For the type approval, the manufacturer shall demonstrate the facility and undertake to make provision as per order.

- 5.6.4 Temperature Compensation for Battery: There shall be provision for monitoring the temperature of battery and consequent arrangement for automatic temperature compensation of the FR-FC, FR-BC output voltage to match the battery temperature dependant charge characteristics. The output voltage of the rectifier in float/charge operation shall decrease or increase at the rate of 72m V (3mV/cell, 24 cell battery) 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. The increase in output voltage due to decrease in temperature has been taken care of by the tripping of the unit due to output voltage high (57V) protection. A tolerance of $\pm 5\text{mV}$ may be acceptable over the specified rate of 72mV/deg. C. Failure of temperature compensation circuit including sensors shall create an alarm and shall not lead to abnormal change in output voltage.
- 5.6.5 Battery Reverse Polarity Protection: Protection for battery reverse polarity shall be provided in the system.
- 5.6.6 D.C. Contactor: High quality DC contactors, UL approved should be used for battery path disconnection circuit. The contact tips should be brazed accordingly for long life and trouble free operation and the coil should be of H class insulation level. In case of battery disconnection due to low battery condition the battery shall be reconnected to the DC bus only after resumption of mains, the SMRs getting ON and ready to deliver the rated output. There shall also be a provision to switch on the contractor manually. DC contactor from Albright, Prestolite or Powernix should only be used.

5.7 Meters:

There shall be provision to monitor AC voltage (either at module or at the control unit), DC current and voltage with the help of analogue or digital (with digital display of height 12mm) meters to read the voltage and current of the system, batteries or any of the individual FR-FC (at individual FR-FC module also permitted) Normally the meters mounted at Distribution-Switching-Control-Alarm Arrangement shall indicate the system voltage and current.

Accuracy of the meters shall be as given below:

- A Current:
- Analogue: $\pm 1.5\%$ of F.S.D. or better
 - Digital: $\pm 1.5\%$ of the range or better, shall be able to read up to 1 place decimal for meter range up to 99A and full digit in case of higher range.
- B Voltage:
- Analogue: $\pm 1.5\%$ of F.S.D. or better
 - Digital $\pm 1.5\%$ 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.

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SECTION-6

POWER PLANTS COMPATIBLE WITH CONVENTIONAL BATTERIES

6.0 Introduction: The conventional lead acid batteries have special requirement of periodic boost charging @ 2.7 V per cell. To meet this requirement, the Power Plant shall be so configured that in addition to the specification requirements, detailed in Section-1 to Section-5, shall also have a provision of a group of FR-BC (as per battery capacity) for charging the batteries @ 2.7V/cell.

6.1 Float rectifier-float-charger-boost charger (FR-BC): In addition to requirement of FR-FC Modules, the FR-BC Modules shall meet the following additional requirement.

6.1.1 The FR-BC module shall be programmable to work as FR-FC or FR-BC. When programmed as FR-FC, it shall be capable of working as FR-FC with other FR-FCs and shall comply with all the requirements of FR-FC.

The rated capacity of the FR-BC when programmed as FR-FC shall be same as that of the other FR-FCs. The prescribed float voltage setting for conventional batteries is 52.8 V.

6.1.2 It shall also be programmable as a Boost Charger (BC) under manual control after isolating it from the float bus.

6.1.2.1 As a boost charger its output voltage shall be continuously adjustable and presettable at constant current up to 100% for voltage range 44.4 to 56 V and up to 50% to 70% rated capacity at any value in the range of 56V to 64.8V as per design of the FR-BC. The firm has to specify the percentage of rated capacity of FR-BC module when it is working in the boost charging mode (56 to 64.8V).

6.1.2.2 The boost voltage shall be maintained within $\pm 1\%$ of the set value over the full boost current range as specified.

6.1.2.3 When programmed in Boost Charging Mode, FR-BC modules shall work in parallel load sharing arrangement with other FR-BC modules in the same mode, keeping other output conditions within specified limits.

The current sharing shall be within $\pm 10\%$ of the average current per FR-BC module (in Boost Charging Mode) in the system (mounted in the same or different racks) when loaded between 50 to 100% of its rated capacity (as BC) for all other working conditions.

6.1.3 In addition to the Visual indications/display specified for FR-FC the following shall also be provided in FR-BC Module.

Functional Indications: FR-BC on Boost Mode

Alarm Indications: Following Alarms shall actuate in BC mode:
A. FR-BC Over Voltage.
B. FR-BC Over Load (Voltage Droop)

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6.1.4 Protection: The module shall also be protected against DC over voltage in BC Mode.

6.1.4.1 Shutting-off of faulty FR-BC module in FR-BC mode shall not affect the operations of other FR-BC & FR-BC in FR-FC mode.

6.2 Distribution-Switching-Control-Alarm Arrangement: The Distribution-Switching-Control-Alarm Arrangement, in addition to the facilities specified in Section-5 shall also provide for switching arrangement under SCHEME 1 and SCHEME 2 as elaborated in Clause 6.3 and 6.4 respectively.

6.3 SCHEME 1 Switching Arrangement: A Block Diagram is shown in Annexure-III. This Scheme is necessary if two nos. of battery bank of identical capacity are used and the total load requirement is more than 50 Amp. This uses two nos battery selection switches(as shown as SW4 and SW5 in Annexure III) and for boost extended charging of anyone battery bank at a time, operator has to carry out manual operation.

The switching arrangement may have knife-switches, Rotary switches or any other suitable arrangement in the same or separate rack for the following facilities.

- a) FR-BCs in Auto Float
- b) Selection and switching a Group FR-BC for Boost or Float charge operation

To achieve the above, the switching arrangement shall be capable of selecting

6.3.1 Battery Auto Float Charge/Boost Charge selection arrangement for selecting.

- i) All the batteries in Auto Float Charge Mode
- ii) Battery 1 on boost, others on auto float charge
- iii) Battery 'N' Boost, others on auto float charge

6.3.1.1 The above arrangement shall be provided with a suitable inter-locking arrangement so that one of the batteries is always on float. In case interlocking arrangement is not feasible due to the rack size, a provision of Alarm shall be made in the event of all the batteries are isolated accidentally.

6.3.1.2 The capacity and number of batteries shall be as order.

6.3.1.3 In case of failure of FR Module(s) supplying load the group of FR-BC modules can be used to supply load with battery floated across it by operation of the normal/emergency switch(shown as SW3 in Annexure III). By doing so while one pole of this switch will connect Boost bus to load its another pole will ensure that FR-BC modules do not go to boost. Once FR modules have been set right this switch position can be put to normal (as shown).

6.3.2 FR-BC Switching Arrangement shall be provided for connection of FR-BC group to the float bus for auto float charge operation or boost charge bus for boost charging of the battery after its isolation from the float bus.

6.4 SCHEME 2 Switching Arrangement : The schematic diagram of the scheme as per Annexure-IV may be implemented or otherwise the manufacturer may adopt another suitable design to meet the said functional requirements.

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The scheme is useful with only one Battery Bank used at a station. However it can also be used with two battery banks in parallel. The scheme is to be used for total requirement upto 50 Amp (using 12.5 Amp FR-BC Modules only). However it can also be used beyond 50 Amp load and upto 100 Amp load using 25 Amp FR-BC Modules as per user's choice. Its details are given as under.

- 6.4.1 The dropper diodes shall be using 14 nos. of diodes of at least 2 times rated current mounted on suitable heat dissipation platform.
- 6.4.2 The bypass contact C shall be DC rated to carry at least 1.5 times rated current and coil be rated at 48V DC nominal.
- 6.4.3 The control card shall sense the Battery Voltage and will cut in dropper diodes in the Battery to load path so that the voltage across load remains within 45V to 56.5V at rated load while voltage across Battery may vary between 48V to 64.5V.
- 6.4.4 The contact C must close automatically in case the AC main has failed or voltage across Battery Bank is 48V or less.
- 6.5** The Distribution-Switching-Control-Alarm Arrangement in addition to the facilities specified in Section-5 shall also provide for :

Functional indications:	FR-BCs in Boost Charge Mode.
Alarm Indications:	Boost Load Voltage High (above 66V)/Low (below 44.4V)

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SECTION-7

TESTS AND REQUIREMENTS

7.1 Conditions of tests: Unless otherwise specified, all tests shall be carried out at ambient and atmospheric conditions.

7.2 Type Tests

The following shall comprise type tests.

- a) Visual Inspection (Clause 7.5)
- b) Insulation Resistance Test (Clause 7.6)
- c) Applied High Voltage Test (Clause 7.7)
- d) Radio Frequency Interference Suppression Test (Clause 7.13)
- e) Burn-in Test (Clause 7.8)
- f) Performance Test (Clause 7.9)
- g) Test for Protection Device (Clause 7.10)
- h) Climatic Test (Clause 7.11)
- i) Vibration Test (Clause 7.12)
- j) MTBF Calculation (Clause 2.20.2)

7.2.1 Only one Power Plant shall be tested for this purpose. The Power Plant shall successfully pass all the type tests for proving conformity with this specification. If the module fails in any of the type test the purchaser or the nominee at his discretion, may call for further module of the same type and output rating and subject it to all the tests or to the test (s) in which failure occurred. No failure shall be permitted in the repeat test (s).

7.3 Acceptance Tests:

The following shall comprise acceptance test:

- a) Visual Inspection (Clause 7.5)
- b) Insulation Resistance Test (Clause 7.6)
- c) Applied High Voltage Test (Clause 7.7)
- d) Performance Test (Clause 7.9)
- e) Test for Protective Device (Clause 7.10)

7.3.1 Visual Inspection, insulation resistance test and performance test shall be carried out on all SMPS Based Power Plant.

The following sampling plan shall be adopted for the remaining tests:

Lot Size	Sample Size
2-8	2
9-15	3
16-25	5
26-50	8
51-100	13
101-150	20
151-200	32

7.3.1.1 For acceptance of the lot there shall be no failure in any of the test as mentioned under clause 7.3 above.

7.4 Routine Tests

Following shall constitute routine test and shall be conducted by manufacturer on every equipment and test results will be submitted during the inspection.

- a) Visual Inspection (Clause 7.5)
- b) Insulation Resistance Test (Clause 7.6)
- c) Applied High Voltage Test (Clause 7.7)
- d) Performance Test (Clause 7.9)

7.4.1 The performance test may be carried out only at nominal input voltage during the routine test.

7.5 Visual Inspection:

The system shall be visually inspected to ensure compliance with the relevant requirements of sections 2, 3, 4, 5 & 6.

7.6 Insulation Resistance Test:

This test shall be carried out after Applied High Voltage Test.

The measurement shall be made at a potential of not less than 500V DC. The insulation shall be measured between:

- a) AC line terminals and earth
- b) DC line terminals and earth
- c) AC terminals and DC terminals

The Insulation Resistance values shall comply with clause 2.12.1

7.7 Applied High Voltage Test:

This test should be done as per clause no. 2.12.2.

Note: 1. Module and Rack should be tested separately

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2. In Routine Test only one FR-FC, FR-BC module shall be tested.

7.8 Burn-In Test:

The fully equipped rack shall be capable of withstanding Burn-In Test for 72 hours during Type Test (8 Hours during Acceptance Test) at an ambient temperature of $50(\pm 2) ^\circ\text{C}$ when the equipment is working at full rated load. This test may be performed in a temperature-controlled room with free airflow. 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. 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°C for Grade B insulation. However for higher grade of insulation, higher temperature rise may be permissible subjected to the following conditions.
 - i) It is at least 20°C below the permissible limit for the grade of insulation used.
 - ii) The temperature rise shall be at least 30°C below Curie temperature of the magnetic material.
 - iii) This temperature shall neither affect the other components nor shall lead to fire hazard.
- b) Transistors/Thyristor/Diodes/FETs/Semiconductor Devices : 60°C or as per components specification.

7.9 Performance Test:

The Power Plant shall be tested for its output performance (Efficiency, Power Factor, Harmonic Distortion, Psophometric Noise and Ripple Voltage) at the AC Input Voltages 90V/165V, 230V and 260V/300V at different terminals for the Auto Float Mode and Auto Charge Mode respectively.

- 7.9.1 In Auto Float Mode, reading shall be taken for float voltage setting of 2.2V/cell at load current in the range 25% load to full load.
- 7.9.2 In Auto Charger Mode readings shall be taken for boost voltage setting of 2.3V/cell at load current in the ranges 25% load to full load.
- 7.9.3 During the performance test the Power Plant shall fulfill the requirement of Efficiency, Power Factor, Harmonic Distortion, Psophometric Noise, Ripple Voltage etc as given under clauses 4.4, 4.5, 4.6 & 4.10 of this specification.
- 7.9.5 The current sharing of the module working in parallel shall be tested as per Clause 4.11.

7.9.6 All other performance tests shall be carried out as mentioned in sections 2, 3, 4, 5 & 6.

7.10 Tests for Protective Devices:

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- 7.10.1 Short Circuit: During this test, system shall be connected to AC input voltage of **265V/305V**. Output terminals shall be short circuited through a suitable arrangement. Steady short circuit current shall be measured. It should not exceed rated current +5%. There shall not be any damage to charger. Working of over load/ short circuit indications/alarms will also be checked on the FR-FC. This shall be achieved by controlling output current and voltage under short circuit conditions and not by switching off the input/output voltage under short circuit condition.
- 7.10.2 Reverse Battery Connection: A fully charged battery shall be connected in reverse polarity to output terminals of charger. There shall be no emission of smoke or undue temperature rise of any component of charger. Working of corresponding indication/alarm will also be checked.
- 7.10.3 Other protection such as current limiting, voltage overshoot/undershoot, battery monitoring tests shall be as per clause nos. 4.7, 4.9 & 5.6 respectively.
- 7.10.4 For lightning protection manufacturer must submit a certificate of Class B and Class C type protection as per Clause 2.4.4 from International or National Agency.

7.11 Climatic Tests:

7.11.1 The Climatic Tests shall consist of:

- i) Dry heat at 55 ± 2 deg C as per IS: 9000 (Pt. III) for 16 hours duration.
- ii) Damp Heat (Cyclic) Test as per Variant 1 for 6 Cycles with severity of Upper Temperature 55°C as per IS: 9000 (Pt V/Sec.2) : 1981.
- iii) Cold test at 0°C for two hours duration as per IS: 9000 (Pt.III). The equipment will be kept inside the chamber in the energized condition in auto charge mode of operation.

7.11.2 These tests shall be performed by configuring the SMPS Based Power Plants as follows.

- i) Control & Monitoring Arrangements of ratings for Ultimate Expandable Capacity.
- ii) One FR-FC or FR-BC module with one standby FR-FC or two standby FR-BC module i.e. with minimum configuration as per Cl. 2.2.

7.11.3 The climatic test shall be carried out by setting the system in auto charge mode of operation. During the period of exposure in each test the system shall be connected to supply mains of nominal input voltage and shall deliver the rated output voltage of 2.3V/Cell to a resistive load.

7.11.4 During climatic test, after every climatic cycle, 2-4 hour restoration time in ambient, after completion of climatic tests as specified in para 7.11.1 above, 4 hours restoration time shall be given and insulation and protection tests shall be repeated. There shall not be any malfunction during test.

7.12 Vibration Test (Sinusoidal)

7.12.1 The vibration test shall be conducted to withstand the following test conditions.

- (i) Frequency 5 to 350 Hz
- (ii) Amplitude $\pm 6\text{mm}$ constant displacement or 1.5 g constant acceleration whichever is less.

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- | | |
|------------------------------|---------|
| (iii) Direction of vibration | X,Y,Z |
| (iv) Duration/axes | 2 Hours |

7.12.2 Endurance test by Frequency sweep: Frequency shall be varied at the rate of 1 octave per minute from min (5 Hz) to max (350 Hz) and maximum to minimum constituting one full sweep. The total duration of the endurance shall be 6 hours and this shall be conducted in all the three axis preferably with equal distribution.

7.12.3 The equipment is to be vibrated in three mutually perpendicular directions.

7.12.4 The frequency is to be varied continuously from the lowest to the highest value over the specified range, at such rate that resonances can be easily detected. The rate of change of frequency will not normally exceed one octave in one minute. Resonances may be observed by stroboscope or other means. All frequencies at which assemblies are detected to resonate shall be noted.

In case the Vibration Tests are not feasible on the SMPS Based Power Plants, the same may be conducted on basic modules mounted in Card-Cage in a packed condition or in a box.

7.12.5 At the end of the test the equipment is to be examined for mechanical damages and electrical performance.

Note: Vibration test is to be conducted on one FR-FC, FRBC module. In case the vibration tests are not feasible on the unit the same may be conducted on control cards mounted in card-edge, in a packed condition or a Box.

7.13 Radio Frequency Interference Suppression Test

This test shall be done to examine compliance with Clause 2.14 and shall be conducted during Type Test only. Separate Test will be required for power plants working on three phase and single phase input AC. EM/RFI test shall be conducted on one FR-FC-BC module of each type viz 12.5A, 25A, 50A SMPS Module separately.

7.14 Final examination and measurements:

After completion of vibration test the equipment is finally to be checked for any mechanical damages and performance tests as specified in clause number 7.9 are to be conducted.

7.15 Training Documents

Comprehensive Training Documents shall be submitted during Initial Type Approval. Training Documents should include Design Details, Detailed Circuit Diagram, Component Layout Plan, Preventive Maintenance Procedures, Corrective Maintenance Procedures etc. The Training Documents shall be structured in the form of Instructors Notes, Power Point Presentations, Trainee Notes, Course Materials etc. This Training Documents shall be reviewed by IRISSET/SC and subsequently manufacturers shall supply copies of these Training Documents to Training/Maintenance Units along with delivery of Power Plant(s).

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SECTION 8

INFORMATION TO BE SUPPLIED BY THE PURCHASER

- 8.1 The type of battery to be used, VRLA or Conventional Lead Acid (Clause. 1.1, Section I)
- 8.2 For Single Phase, Incoming Power Supply range either 90V-300V or 165V-260V. (Clause 1.3 of Section 1).
- 8.3 Battery capacity (Clause. 5.6.3 of Section 5) and numbers. of battery bank.
- 8.4 Ultimate Expandable Capacity of the Power Plant in terms of load(Clause 2.2 of Section 2).
- 8.5 Type, Number& Configuration of SMR Modules (Clause. 2.2, Section 2)
- 8.6 Power Plant will work on Single phase or 3 phase (Cl. 2.4.1, Section 2)
- 8.7 Power Plant to work as Float Rectifier–cum–charger (FR-FC) Mode or Float Rectifier– cum–charger–Boost Charger (FR-FC-BC) Mode.

ANNEXURE-I

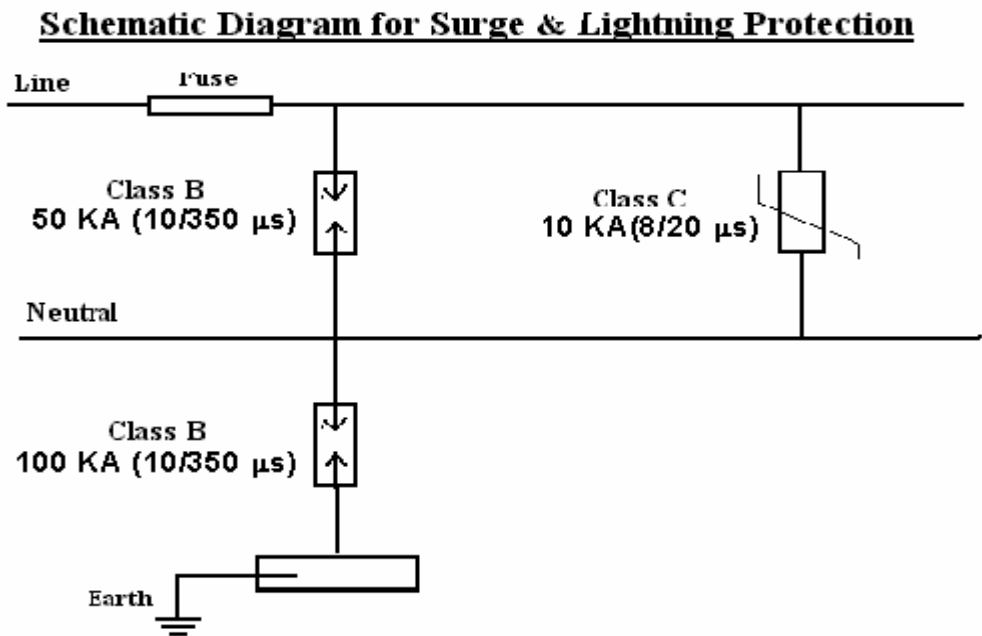


Figure 1.1: Single Phase:Schematic Diagram of Surge & Lightning Protection

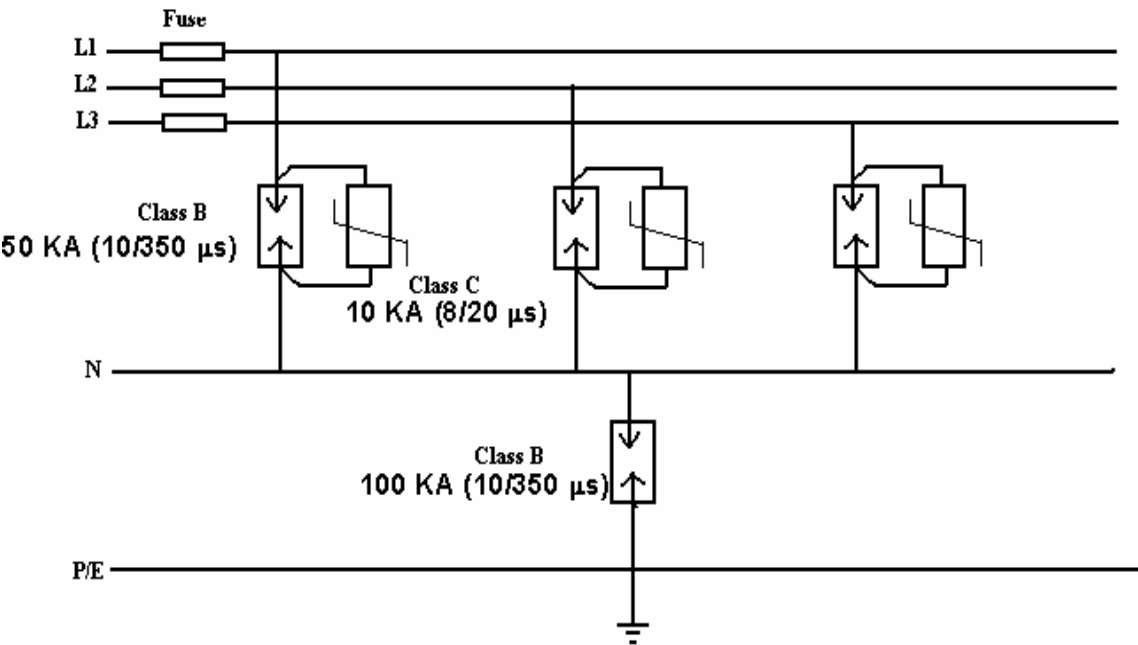
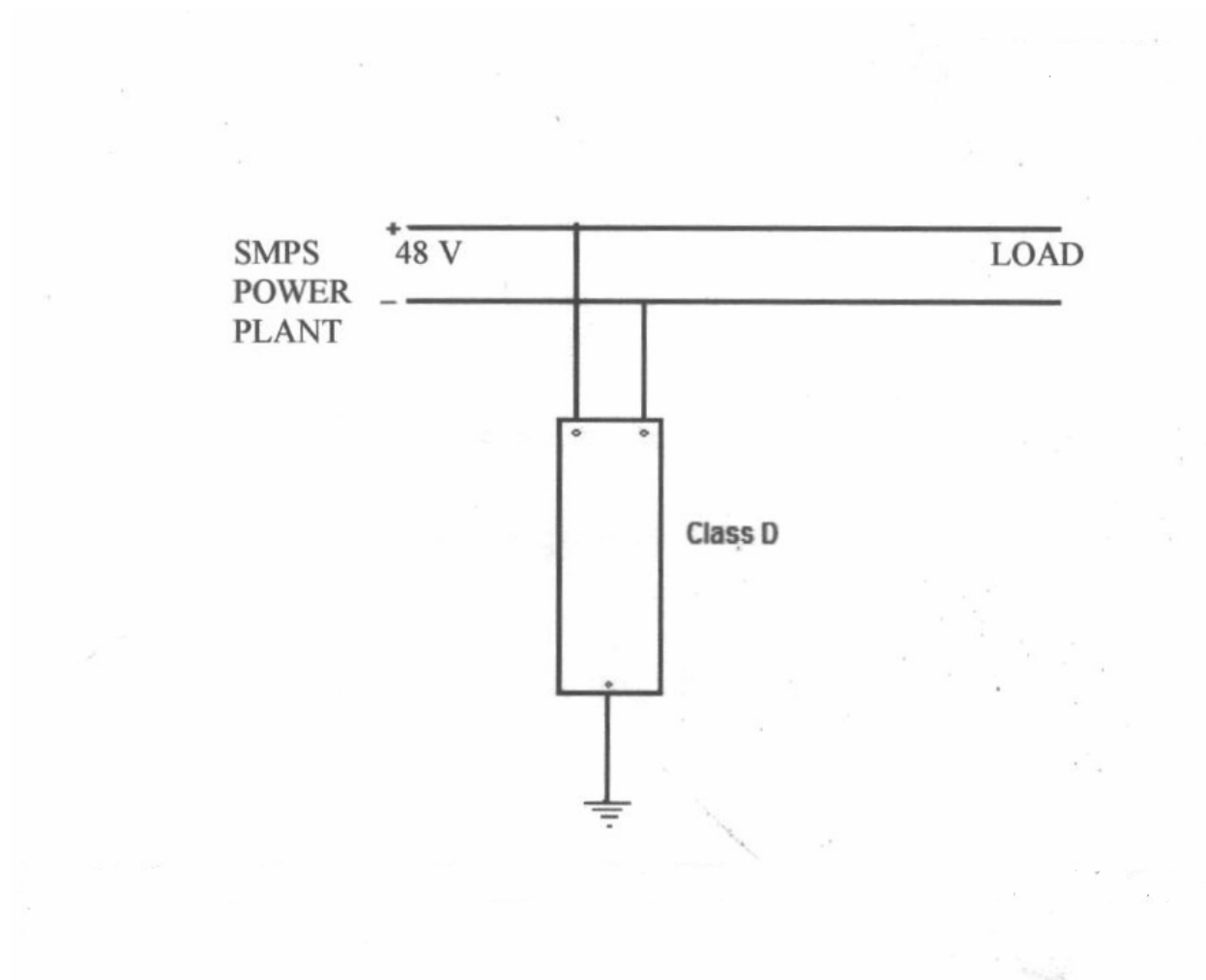


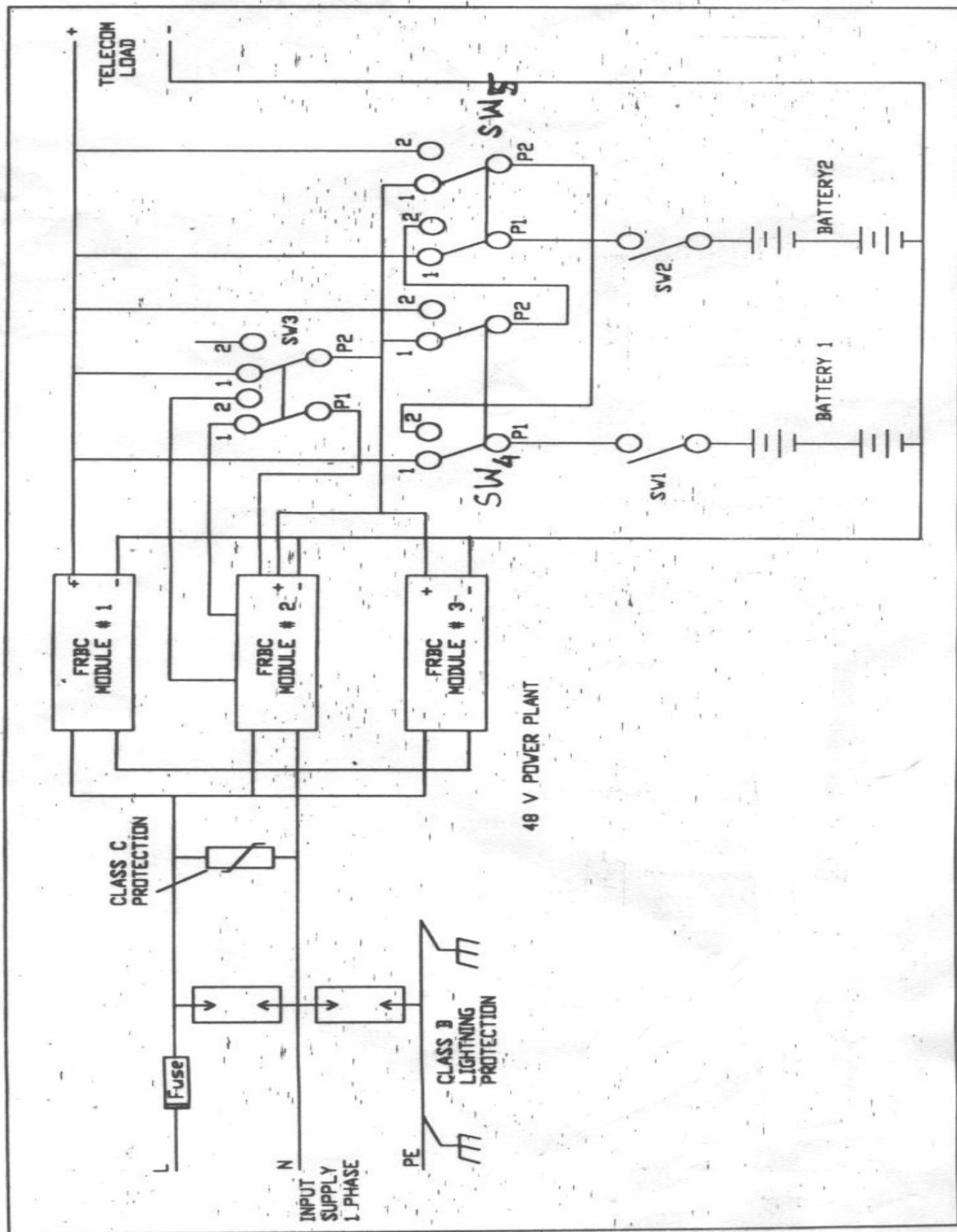
Figure1.2: Three Phase: Schematic Diagram of Surge & Lightning Protection

ANNEXURE-II



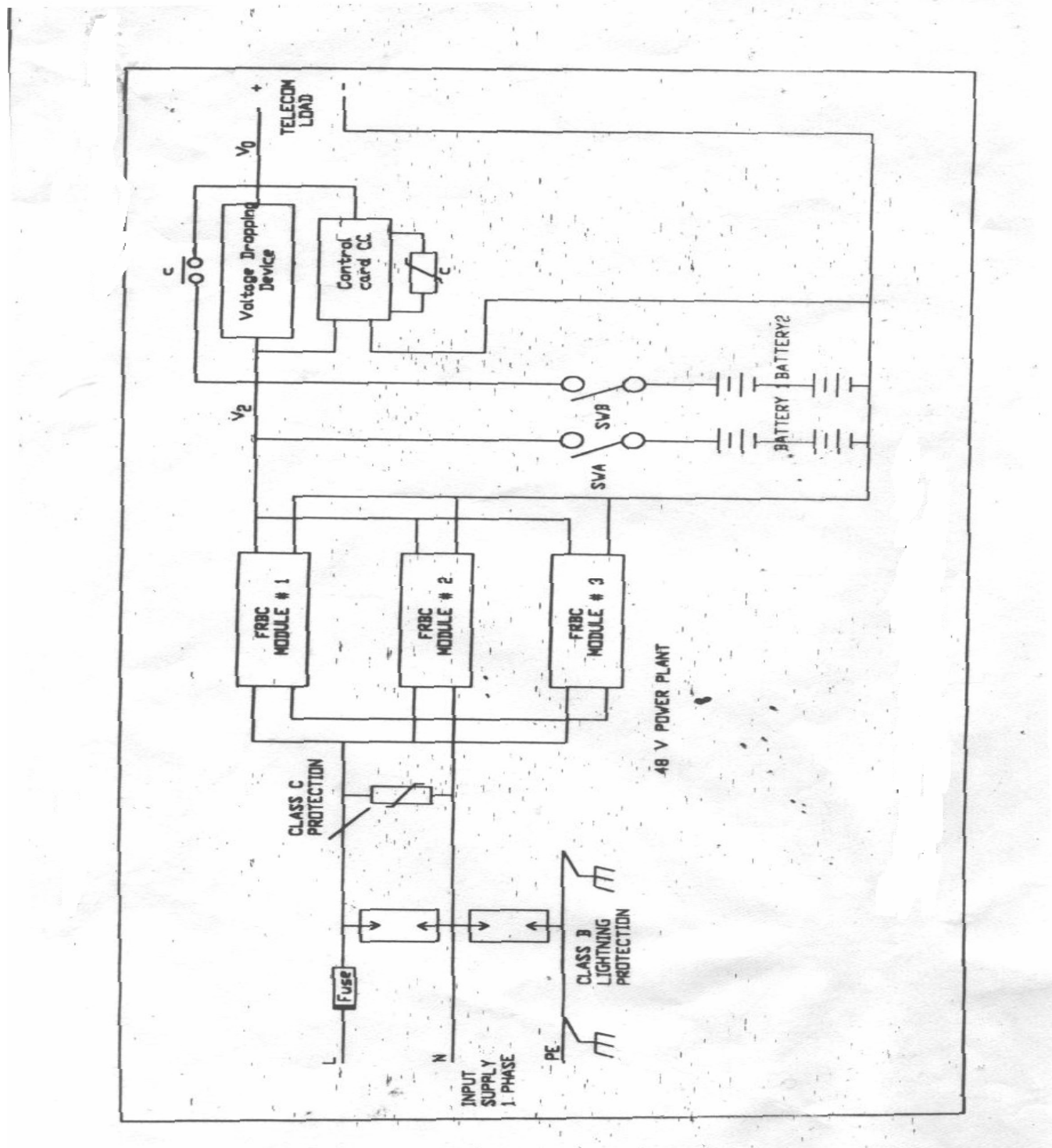
Schematic Diagram for connection of Class D Surge Arrestor for SMPS Power Plant

ANNEXURE-III



Power Plant having Manual Boost Charging Changeover Arrangement using a least two Battery Banks.

ANNEXURE-IV



Power Plant having Automatic Boost Charging Changeover Arrangement using only one or more Battery Banks.

ANNEXURE-V

General Requirements : Radio Frequency Interference Suppression: The system (FR-FC, FR-BC & 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 clause.

1. Radiated Emission from the single phase and three Phase power equipment.

Requirement: Any network of conductors and apparatus connected thereto shall not exceed the level of field strength specified in IEC-CISPR 22 'A' as given below:

Frequency (F) (MHz)	Distance (Meters)	Quasi peak limits dB(μ V/m)
30-230	10M	40 dB ((μ V/m)
230-1000	10 M	47 dB ((μ V/m)
1. The lower limit shall apply at the transition frequency.		
2. Additional provisions may be required for cases where interference occur.		

Test Procedure: Test setup, Test procedure & Measurements shall be conducted as per IEC – CISOPR 22.

2. Conducted Emission Limits: All conducted emissions from power equipment or accessories connected thereto, intended to be connected to the power lines of a public utility shall not exceed. the limits specified in IEC-CISPR 22'A' as given below :

Frequency (MHz)	Quasi peak limits dB(μ V)	Average limit dB(μ V)
0.15 – 0.5	79 dB ((μ V)	66 dB ((μ V)
0.5 – 30.0	73 dB((μ V)	60 dB ((μ V/m)
The lower limit shall apply at the transition frequency..		

Test Procedure: Test set up, Test procedure & Measurements shall be conducted as per IEC- CISPR 22.

3. Conducted Susceptibility Limits : Power equipment used in Telecom Network shall not malfunction when high voltage surge as specified below is superimposed at the input power mains to the power equipment, for more than two seconds as per IEC 61000 – 4-12 9(b). 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 $\pm$ 20%
Oscillation Frequencies : 100 KHz & 1 MHz $\pm$ 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 2 S
Surge amplitude : 250V (-10%) to 2.5 KV (+ 10%)

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Wave shape : Damped.

Test Procedure: Test set up, Test procedure & Measurements shall be as per IEC 61000-4-12. EMI surge of specified levels injected on power leads of test sample shall not cause degradation of performance or malfunction

4. **Electrostatic discharge (ESD) immunity limits:** the limits shall be as per IEC 61000 -4-2, 9(1) (Both contact discharge method and Air discharge method) as given below :

Test level:

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

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

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

Test level:

Open-circuit output test voltage ($\pm 20\%$)		
Level	On power supply port, Protection Earth	
	Voltage peak KV4	Repetition rate KHz
4	4	2.5
Rise time of one Pulse -5 ns $\pm 30\%$		
Impulse duration - 50 ns $\pm 30\%$		

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

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

Test level:

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

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

7. **Surge Immunity limits:** The limits as per IEC 61000-4-5.

Test level:

Level	Open circuit test voltage ($\pm 10\%$) KV
1	0.5
2	1.0
3	2.0
4	4.0

Voltage surge – 1.2/50 μ s
Amplitude - 2KV (DM)
- 4KV (CM)
- After testing for 4KV, the amplitude shall also be increased to 6KV (1.2/50 μ s Combined wave form as per EEE C62 41 – 1991 to cover lightening/Surge protection test also.
Test results shall be in compliance of clause 9(b) of IEC 61000-4-5.

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

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

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

Test level:

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

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

टेलीफोन/Tele : 2492 XXX
2493 XXX

फैक्स/Fax : 91-0522-2458500



भारत सरकार - रेल मंत्रालय
अनुसंधान अभिकल्प और मानक संगठन
लखनऊ - 226 011
Government of India-Ministry of Railways
Research Designs & Standards Organisation
Lucknow - 226 011

AN ISO 9001
CERTIFIED
ORGANISATION

No.: STT/Tele/SMPS/142/Vol-II

Dated: 28-11-2016

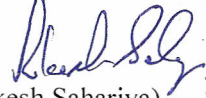
1.	The CSTE, CSTE/Const.:	सी.एस.टी.ई., सी.एस.टी.ई./निर्माण,, : 29
(i)	Central Rly., Mumbai, CST – 400001	मध्य रेलवे, मुम्बई सी.एस.टी.- 400 001
(ii)	Western Rly, Churchgate, Mumbai – 400020	पश्चिम रेलवे, चर्च गेट, मुम्बई – 400 020
(iii)	Eastern Rly., Fairlie Place, Kolkata 700001	पूर्व रेलवे, फेयरली प्लेस, कोलकाता – 700 001
(iv)	South Eastern Rly., Garden Reach, Kolkata	दक्षिण पूर्व रेलवे, गार्डन रीच, कोलकाता-700 043
(v)	Northern Rly. Baroda House, New Delhi-110001	उत्तर रेलवे, बड़ौदा हाउस, नई दिल्ली-110001
(vi)	North Eastern Rly., Gorakhpur- 273012	पूर्वोत्तर रेलवे, गोरखपुर – 273012
(vii)	North East Frontier Rly., Maligaon, Guwahati	पूर्वोत्तर सीमान्त रेलवे, मालीगांव, गुवाहाटी – 781011
(viii)	Southern Rly. Park Town, Chennai – 600003	दक्षिण रेलवे, पार्क टाउन, चेन्नई – 600 003
(ix)	South Central Rly., Secunderabad – 500371	दक्षिण मध्य रेलवे, सिकन्दराबाद –500371
(x)	East Central Railway, Hajipur	पूर्व मध्य रेलवे, हाजीपुर
(xi)	East Coast Railway, Rail Vihar BDA Rental Colony, Chandrasekharapur, Bhubneshwar	पूर्व तटीय रेलवे, रेल विहार बी.डी.ए. रेंटल कालोनी, चन्द्रशेखरपुर, भुवनेश्वर-751023
(xii)	North Central Railway, Hastings Road, Allahabad.	उत्तर मध्य रेलवे, हेस्टिंग रोड, इलाहाबाद
(xiii)	North Western Railway, Jaipur – 300206	उत्तर पश्चिम रेलवे, जयपुर-300206
(xiv)	South Western Railway, Club Road, Keshavpur, Hubli - 23.	दक्षिण पश्चिम रेलवे, क्लब रोड, केशवपुर, हुबली-23
(xv)	West Central Railway, Annex Building, Opp Indira Market, Jabalpur-482068	पश्चिम मध्य रेलवे, एनेक्स भवन, जबलपुर
(xvi)	South East Central Railway, R.E. Office Complex, Bilaspur – 495004	दक्षिण पूर्व मध्य रेलवे, आर0ई0 ऑफिस काम्पलेक्स, बिलासपुर- 495004
2.	The CSTE, Metro Railway, 23-A, Jawaharlal Nehru Road, Kolkata – 700071	सी.एस.टी.ई./ मेट्रो रेलवे, 23-ए, जवाहर लाल नेहरू रोड, कोलकाता – 71
3.	The CSTE, CORE, Nawab Yusuf Ali Road, Civil Lines, Allahabad	सी.एस.टी.ई./ कोर, नवाब यूसुफ अली रोड, सिविल लाइन्स, इलाहाबाद-211001
4.	The Director, IRISSET, Tarnaka Road, Lallaguda (P.O.), Secunderabad-500 017	निदेशक/इरीसेट/सिकंदराबाद-500017
5.	CAO/IRPMU IRCOT Building, Behind Shanker Market, New Delhi.	सी.ए.ओ./आई.आर.पी.एम.यू./इरकोट बिल्डिंग/शंकर मार्केट के पीछे/नई दिल्ली
6.	MD, RailTel Corporation of India Ltd., 10 th Floor, Bank of Baroda Building, Parliament Street, New Delhi	प्रबन्ध निदेशक, रेलटेल कार्पोरेशन आफ इन्डिया लिमिटेड, 10वीं मंजिल, बैंक आफ बड़ौदा भवन, पार्लियामेंट स्ट्रीट, नई दिल्ली

Sub.: Amendment No. 1 to RDSO Specification No RDSO/SPN/TL/23/99, Ver. – 4 for SMPS Based Power Plant for Indian Railway Telecom Equipment”

In Compliance to Vigilance Cell/RDSO Letter No. 13/Vig/Policy dated 26.07.2016 & 08.09.2016, Amendment No. 1 to the Specification No. RDSO/SPN/TL/23/99, Ver. - 4 for "SMPS Based Power Plant for Indian Railway Telecom Equipment". is hereby issued with the approval of competent authority for information & implementation please.

The Amendment No. 1 is effective from 28.11.2016.

संलग्न : Copy of Amendment No.1 of Specification No. RDSO/SPN/TL/23/99, Ver. - 4


(Rakesh Sahariya) 28/11
For Director General

Copy to:

कार्यकारी निदेशक/गुणवत्ता आश्वासन अ०अ०मा०सं०, लखनऊ।	Executive Director/QA/S&T/RDSO/LKO
निदेशक / गुणवत्ता आश्वासन/सिगनल एवं दूरसंचार, अ०अ०मा०सं०, निकट इस्कॉट, शंकर मार्केट के पीछे, नई दिल्ली. 110 001	Director/QA./S&T/RDSO, 1st Floor, IRCOT Bldg., Shivaji Bridge, New Delhi-110 001
निदेशक/गुणवत्ता आश्वासन/संकेत एवं दूरसंचार, अ०अ०मा०सं०, प्रथम तल, न्यू एनेक्सी बिल्डिंग, चर्चगेट, पश्चिम रेलवे, मुम्बई. 400 020	Director/QA./S&T/RDSO, 1st floor, New Annexe Bldg., W. Railway, Churchgate, Mumbai-400 020
निदेशक/गुणवत्ता आश्वासन/सिगनल एवं दूरसंचार, अ०अ०मा०सं०, भूतल, डी०आर०एम० ऑफिस,, बंगलोर - 560 023	Director/QA./S&T/RDSO, Ground Floor, DRM Office, Bangalore-560 023
निदेशक /गुणवत्ता आश्वासन/सिगनल एवं दूरसंचार, अ०अ०मा०सं०, चौथी मंजिल, 17 एन.एस. रोड, वैस्ट विंग, फेयरली प्लेस, कोलकाता - 700 001	Director/QA./S&T/RDSO, 4th Floor, 17 N.S. Road, West Wing, Fairlie Place, Kolkata-700 001
निदेशक /गुणवत्ता आश्वासन/सिगनल एवं दूरसंचार, अ०अ०मा०सं०, हंसपुरा जयपुर—302006	Director/QA/S&T/RDSO, Hasanpura Road, In Front of Railway Hospital JAIPUR-302006
अमरा राजा पावर सिस्टम लिमिटेड कर्कमबाडी-517520, तिरुपती, आन्ध्र प्रदेश	Amara Raja Power Systems Limited Karkambadi- 517520, Tirupati Andhra Pradesh
मेसर्स इलेक्ट्रीक इंडस्ट्रीज बी-121, ओखला इंडस्ट्रीयल एरिया फेज-1, नई दिल्ली-110020	M/s Electric Industries B-121, Okhla Industrial Area Phase-I, New Delhi-110020
मेसर्स पंजाब कम्युनिकेशन लिमिटेड बी-91, फेज-8, इंडस्ट्रीयल एरिया, एस.ए.एस. नगर, चण्डीगढ़-160071	M/s Punjab Communication Ltd. B-91, Phase VIII, Indl. Area, S.A.S. Nagar, Chandigarh-160071
मेसर्स स्टेटकॉन पावर कंट्रोल्स लिमिटेड ए-34, सेक्टर-59, गौतम बुद्ध नगर, नोएडा-201301	M/s Statcon Power Controls Limited A-34, Sector-59 Gautam Budh Nagar NOIDA- 201 301

संलग्न : Copy of Amendment No.1 of Specification No. RDSO/SPN/TL/23/99, Ver. - 4


(Rakesh Sahariya) 28/11
For Director General

Amendment No. 1
To
Specification No. RDSO/SPN/TL/23/99, Ver. - 4
Of
SMPS Based Power Plant for Indian Railway Telecom Equipment

Following Clause is added to the Specification No. RDSO/SPN/TL/23/99, Ver. - 4,

Clause No. 09.

"All the provisions contained in RDSO's ISO procedures laid down in Document No. QO-D-7.1-11 dated 19.07.2016 (titled "Vendor-Changes in approved status") and subsequent versions/amendments thereof, shall be binding and applicable on the successful vendor/vendors in the contracts floated by Railways to maintain quality of products supplied to Railways".

End of Amendment No. 1

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