



भारत सरकार & GOVERNMENT OF INDIA
रेल मंत्रालय & MINISTRY OF RAILWAYS
(For official use only)

दूरसंचार संस्थापनों के लिये स्विच मोड पावर सप्लाई आधारित शक्ति संयंत्र
पर अनुरक्षण हस्तपुस्तिका

[अमराराजा निर्मित]

MAINTENANCE HANDBOOK ON
SMPS POWER PLANT FOR TELECOM INSTALLATIONS
[AMARARAJA MAKE]



कैमटेक/एस/प्रोज/16-17/एचबी - एसएमपीएस/1.0

अक्टूबर 2016

CAMTECH/S/PROJ/16-17/HB-SMPS/1.0

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खंडन DISCLAIMER

It is clarified that the information given in this handbook does not supersede any existing provisions laid down in the Telecomm Engineering Manual, Railway Board and RDSO publications. This document is not statutory and instructions given are for the purpose of guidance only. If at any point contradiction is observed, then Telecom Engineering Manual, Railway Board/RDSO guidelines may be referred or prevalent Zonal Railways instructions may be followed.

हमारा उद्देश्य OUR OBJECTIVE

To upgrade Maintenance Technologies and Methodologies and achieve improvement in Productivity and Performance of all Railway assets and manpower which inter-alia would cover Reliability, Availability and Utilisation.

If you have any suggestion & any specific comments, please write to us:

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SMPS POWER PLANT FOR TELECOM INSTALLATIONS

1. परिचय Introduction

Power supply system is the heart of telecom systems & electronic equipments. For a reliable installation of telecom assets, reliable power supply system is most important.

In AC electrified area, the main power is derived from the traction supply. This supply is very reliable but its occasional interruption/ low voltage can not be ruled out. In non-electrified area, the main supply is obtained from commercial power supply. The source of power supply is through a rural feeder, which is quite unreliable in respect of its availability and voltage. The battery backup is provided in all the DC circuit, which requires more maintenance.

The function of SMPS Power Supply system is to provide a stable and reliable AC and DC power supply to the telecom installations against mains supply variations or interruptions. The SMPS Power Plant for Indian Railway telecom circuits shall be manufactured as per RDSO's Specification NO. RDSO/SPN/TC/23/99. This Power plant can work either with VRLA or Conventional Lead Acid Battery. The system including FR/FC or FR/BC modules shall be suitable for operation from AC mains or from a DG set.

RDSO approved Firms अ अ मा स द्वारा अनुमोदित फर्म

At present following are the RDSO approved firms for supply and installation of SMPS Power Plant for IR Telecom Equipments.

1. M/s Amara Raja Power Systems Pvt. Ltd.,
Renigunta, Cuddaph Roa, Karakambadi, Tirupati.517-520 (A.P.)
2. M/s Statcon Power Controls Ltd.,
A-34, Sector-59, Noida, G.B.Nagar 201-301 (U.P.)
3. M/s Punjab Communication Limited,
B-91, Phase-VIII, Industrial area, SAS Nagar, Chandigarh 160059.
4. M/s Electric Industries
B-121, Okhala Industrial area, Phase-I, New Delhi-110020.

This handbook covers the technical requirement of a 48 V DC Power Plant based on high frequency Switch Mode Techniques for the use by Indian Railways for Telecom Equipments, typical Amara Raja's SMPS power supply system AR-4 based on RDSO/SPN/TC/23/99 version 4.0.

ABBREVIATIONS

1.	A	Amperes
2.	AH	Ampere Hour
3.	CSU	Control Supervisory Unit
4.	dB	Decibel
5.	dba	Decibel Absolute
6.	DC	Direct Current
7.	EMI	Electro Magnetic Interference
8.	FR/FC	Float Rectifier cum Float Charger
9.	FR/BC	Float Rectifier cum Boost Charger
10.	KHz	Kilo Hertz
11.	LED	Light Emitting Diodes
12.	LCD	Liquid Crystal Device
13.	LVDS	Low Voltage Disconnect Switch
14.	MOV	Metal Oxide Varistor
15.	MTBF	Mean Time between Failures
16.	MMIB	Mains Monitoring Interface Board
17.	MUIB	Master User Interface Board
18.	ms	Milli Seconds
19.	PCB	Printed Circuit Board
20.	SMPS	Switch Mode Power Supply
21.	V	Volts
22.	VRLA	Valve Regulated Lead Acid

2. सामान्य तथा तकनीकी आवश्यकताएँ General & Technical Requirements**General: सामान्य**

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

2.1 Power System Configuration: पावर सिस्टम विन्यास

The configuration of 48 V DC power plant with FR/FCs & FR/BCs modules is as under: -

SN	Basic SMR Module	Configuration	Permissible ultimate capacity
1.	12.5A 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.	12.5A 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 number of FR/FC or FR/BC modules as required for meeting a particular load 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.

2.2 Rack Configuration रैक विन्यास

Rack is composed of following units accommodated in sub racks

- Float Rectifier cum Float Charger (FR/FC) or Float Rectifier cum Boost Charger (FR/BC) modules.
- Distribution, Switching, Control Alarm unit (arrangement) (DSCA)

Dimensions: विमाएं

Dimensions of the rack for all the capacities are as follows:

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

The insulation resistance of a fully wired FR/FC 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.

2.3 Radio Frequency Interference Suppression रेडियो फ्रीक्वेंसी हस्तक्षेप दमन

The module is 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.

2.4 Earthing अर्थिंग

All non-current carrying metal parts are bonded together and earthed. An earth terminal suitable for taking minimum 4 mm dia wire and with suitable marking is provided.

2.5 Module Replacement Time & MTBF मोड्यूल प्रतिस्थापन समय और एम टी बी एफ

The mean time to replace a faulty rectifier module is less than 20 minutes. The MTBF of the system shall not be less than 70,000 hours.

2.6 Float Rectifiers cum Charger Modules फ्लोट रेक्टिफ़ायर युक्त चार्जर मोड्यूल

- The FR/FC modules used are accommodated in a rack in the standardized capacities of 12.5A, 25A & 50Amps.
- The module is capable of operating in 'Auto Float-cum-Charge' mode. It is programmed to operate as a float rectifier or a charger depending on the condition of the battery sets being sensed by the DSCA.
- The float voltage of each rectifier module is continuously adjustable & pre-settable at any value in the range of 48V to 56V. The prescribed float voltage setting is 54 V (VRLA battery).
- The DC output voltage is 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.
- In Auto charge mode FR/FC is supply battery & equipment current till terminal voltage reaches set value, which is normally 2.3 Volt per cell (55.2V) & changeover to constant voltage mode. It shall remain in this mode till a changeover to float mode signal is received.
- The float and charge current limit adjustment is provided on the front panel of the rectifier module.
- The FR/FC module is fully protected against short circuit. Ensured that short circuit does not lead to any fire hazard.

2.7 Soft Start Feature सॉफ्ट स्टार्ट सुविधा

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

2.8 Voltage overshoot/undershoot वोल्टेज ओवरशूट/ अंडरशूट

- 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%.
- 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.
- 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.

2.9 Electrical Noise विद्युतीय शोर

- The rectifier (FR/FC) modules is provided with suitable filter on the output side.
- A resistor is provided to discharge the capacitors after the rectifier modules have stopped operation and the output is isolated.

2.10 Parallel Operation समानान्तर प्रचालन

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

2.11 Protection सुरक्षा

DC overvoltage protection डी सी ओवर वोल्टेज सुरक्षा

- Each rectifier module is fitted with an internal over-voltage protection circuit.
- In case output DC voltage exceeds $-57V \pm 0.25V$ the over voltage protection circuit shall operate & shut off the faulty module. Restoration of the module is through a reset switch/push button.
- Shutting-off of faulty FR/FC module shall not affect the operation of other FR/FCs operating in the rack.
- Operation of over-voltage shut down is suitably indicated on the module and also extended to monitoring/control unit.
- The over voltage protection circuit failure shall not cause any safety hazard.

2.12 Alarms and Indicating Lamps अलार्म और संकेत लैंप

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

Functional Indications कार्यात्मक संकेत

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

Alarm Indications अलार्म संकेत

- | | |
|---|--|
| A | Rectifier module overvoltage, under voltage or Output Fail |
| B | FR/FC or FR/BC Over Load |
| C | Fan fails (due to any reason) |

2.13 Termination टर्मिनेशन

- The AC input connection to the rectifier module is by means of screw-locking type pluggable/Rail mounted screw connectors.
- The DC output connection for smaller rating (up to 25 Amps) is taken through screw type pluggable connectors with complete non-ferrous metal parts. For higher rating suitable termination lugs shall be provided.
- The output of each rectifier in the negative lead is taken through the full rated fuse/MCB in the distribution, switching, control alarm arrangement or in the FR/FC (FR/BC) module.
- The male connectors is preferably be mounted in the FR/FC or FR/BC module and female connectors be terminated to the cable.

2.14 Distribution, Switching Control and Alarm Unit (DSCA)

वितरण, स्विचिंग नियंत्रण और अलार्म यूनिट (डी एस सी ए)

Depending on the system requirements and manufacturer's design, one or all power plant racks are provided with a distribution/switching/control and Alarm unit (arrangement) for the ultimate system capacity.

The unit shall comprise of the following:

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

Dimensions विमाएं

The distribution/switching sub-system of the equipment shall preferably be in the modular form whereas control, alarm & monitoring sub-system shall only be modular. The distribution/switching sub-system may be accommodated in a rack with other FR/FCs or in a separate rack. These sub-systems shall be rack mountable.

The unit preferably be housed in the upper portion of the rack above the FR/FC or FR/BC modules and equipped to meet the ultimate system capacity.

Accessibility अभिगम्यता

- All the termination points shall be easily accessible from front, rear or top.
- AC and DC termination are modular in design with all non-ferrous metal parts.

- The AC modular earth terminal is touch proof with universal yellow green housing symbolizing the potential earth with all non ferrous metal parts including the screws.

AC Termination ए सी टर्मिनेशन

- The input terminals are marked as R, Y,B and N for three phase and L and N for single phase as applicable.
- AC input termination is suitably protected against the accidental touch/contact with the working staff for their protection and shall also have clear and prominent “DANGER” Marking.
- Screening is provided between AC & DC components to prevent accident.
- All the connections between distribution and FR/FC or FR/BC are through proper rated cables only.
- Fuses and circuit breakers for each FR/FC or FR/BC are easily accessible and properly rated.
- Proper terminations for AC at the input of the circuit breakers and its output to the FR/FC, FR/BC

DC Terminations डी सी टर्मिनेशन

- Connection between FR/FC, FR/BC and DC distribution is through a proper rated lugged cable/buster. Wherever cables are used, the same is terminated through the appropriately rail mounted screw locking type terminal blocks with all non-ferrous metal parts.
- The DC output to battery and load is through cable.
- The provision for interconnection between load & FR/FC, FR/BC or battery (along with switching arrangement) & terminations for load, battery & FR / FCs. FR / BC is provided. The isolation of any of the battery from the load shall create an alarm.
- The proper rated fuses/circuit breakers are provided on the –ve DC lead from the FR / FCs, FR / BC (if not provided at FR/FC, FR/BC module).
- All the AC, DC and control/alarm cabling are supplied with the rack.
- All DC + ve and –ve loads are clearly marked.
- All conductors are properly rated to prevent excessive heating.

Alarms अलार्म्स

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

i Functional Indications कार्यात्मक संकेत

- Mains Available (not mandatory if provided at module level)
- FR/FCs, FR/BC in Float
- FR/FCs, FR/BC in charge mode

ii Alarm Indications अलार्म्स संकेत

- Load voltage high (above 57V)/Low (below 44.4V)
 - FR/FC, FR/BC fail
 - Mains out of range
 - System over load
 - Mains 'ON'/Battery discharge
 - Fan fail (in case fan provided at rack level)
 - Temp. Compensation fail
 - Battery fail/isolated
- All alarm circuits are provided with suitable delay to ensure that they do not operate to transients.
 - All the protections/alarms are within tolerance of 0.25V in case of DC voltage, 1% in case of current and $\pm 5V$ for AC voltage.
 - Every alarm condition is accompanied with an audio alarm with audio cut-off facility.
 - Two nos. of Potential Free Contacts (one for alarm and one redundant) is provided for extension of alarms to Centralized Display.
 - As an optional requirement, 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 is provided.

Battery Monitoring बैटरी की निगरानी

i. Battery Under Voltage Isolation बैटरी अंडरवोल्टेज आइसोलेशन

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 is provided. The operate and release voltages for the above conditions shall be as follows:

Cut-off: 1.85V/cell ($44.4 V \pm 0.25V$) Reconnect: 1.90V/cell ($45.6V \pm 0.25V$)

ii. Battery Health Monitoring in Auto Mode आटो मोड में बैटरी का शक्ति परीक्षण

To keep the battery in healthy state, the battery condition is 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.

iii Battery Current Limiting Circuit बैटरी करंट लिमिटिंग परिपथ

In auto mode, to ensure the availability of required load and safety of the battery, battery path current limit is settable as per the battery bank requirements so that the battery path current is kept to 10% of battery AH capacity.

iv Temperature Compensation for Battery बैटरी के लिए तापमान कमपेनशेशन

There is a 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 is 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 is decrease till the open circuit voltage of the battery is reached. The open circuit voltage range is 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.

v Battery Reverse Polarity Protection बैटरी रिवर्स पोलरिटी संरक्षण

Protection for battery reverse polarity is provided in the system.

2.15 Power Plants Compatible with Conventional Batteries

पावर संयंत्रों का पारंपरिक बैटरी के साथ संगत

- The conventional lead acid batteries have special requirement of periodic boost charging @ 2.7V per cell. To meet this requirement, the power plant have a provision of a group of FR/BC (as per battery capacity) for charging the batteries (one set at a time) @ 2.7V/cell (Extended boost mode equivalent to initial charging) after isolating both the battery and FR/BC group from the load bus.
- The FR/BC module shall be programmable to work as FR/FC or BC.
- When programmed FR/FC, it is capable of working as FR/FC with other FR/FC and comply with all the requirements of FR/FC. The rated capacity of the FR/BC and FR/FC is same as that of the other FR/FCs. The prescribed float voltage setting for conventional batteries is 52.8V.
- It is also be programmable as a Boost Charger (BC) under manual control after isolating it from the float bus.
- As boost charger its voltage be continuously adjustable and pre-settable 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 boost voltage shall be maintained within $\pm 1\%$ of the set value over the full boost current range as specified.

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 Drop)

FR/BCs in Auto Float

By the switching arrangement selection and switching a Group FR/BC for Boost or Float charge operation can be achieved.

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

The above arrangement is 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 is made in the event of all the batteries are isolated accidentally.

FR/BC Switching Arrangement:

This switching arrangement is 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.

The following additional alarms shall be provided for boost charge operation FR/BCs.

Functional indications: FR/BCs in boost charge mode.

Alarm Indications:

Boost Load Voltage High (above 66V)/Low (below 44.4V)

3. System Description सिस्टम विवरण

The modular system has been designed specially to power 48V telecommunications equipment requiring accurate temperature compensate float and equalisation voltages, low output noise and EMI levels and currents up to 300 Ampere.

A typical system comprises number of rectifiers, a monitoring and control subsystem comprising Control Supervisory Unit (CSU) and a Master User Interface Board (MUIB), Mains Monitoring Interface Board (MMIB), Battery input circuit breaker and AC input distribution.

The rectifier is designed to slide and plug into a magazine that can accommodate up to 6 rectifiers and this can be monitored and controlled by a CSU. Two such magazines can be accommodated in a single rack, thus giving an ultimate capacity of 300 amperes.

The system with basic blocks of monitoring and control functions is shown in figure given below:

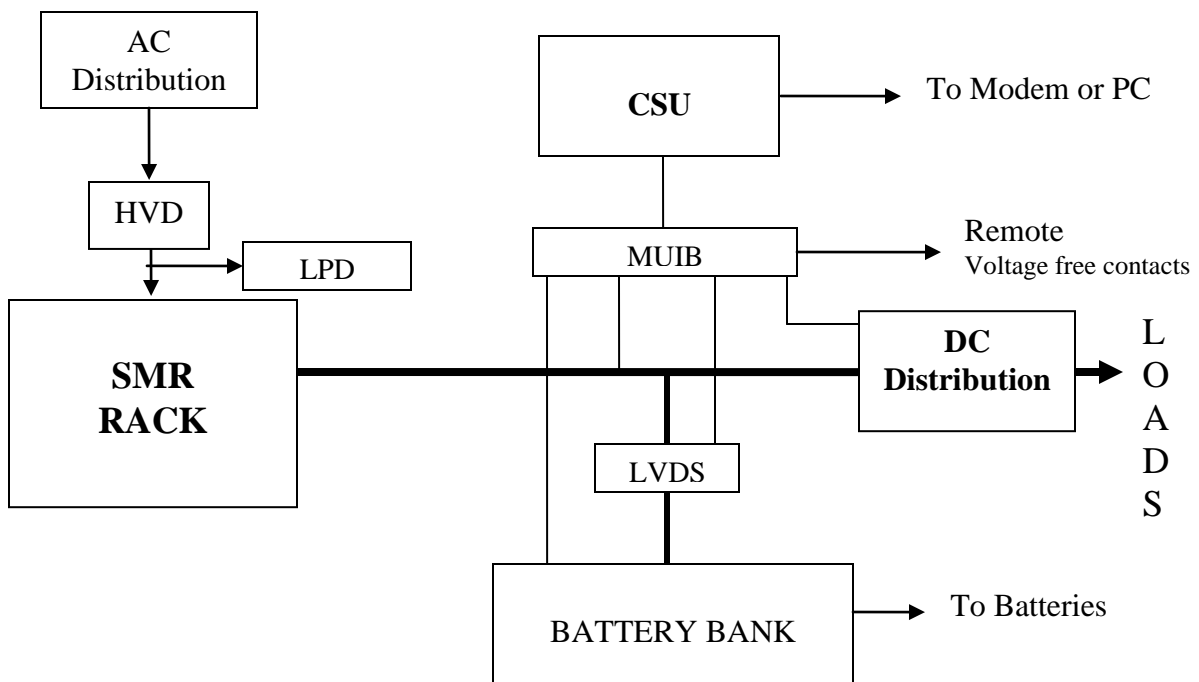


Figure1: System with basic blocks of monitoring and control functions

The rectifier is housed in the magazine and the DC output is connected to the load and to the battery bank. Low voltage disconnect switch (LVDS) is included in series with the batteries in order to prevent deep discharge of the battery bank in the event of an unusually long AC power outage. At the input side input High/Low voltage disconnect switch is installed to provide a galvanic isolation for the modules from abnormal AC inputs. The magazine and rack can be configured to build different ultimate capacities of 100 Ampere and 200 ampere.

The monitoring and control signals, such as AC input voltage, load current, battery current, temperature, battery switch status, LVDS control and status, system voltage are connected to the monitoring and control module (CSU) via master user interface board (MUIB) and mains monitoring interface board (MMIB).

A 4-wire cable, which carries the digital communication signals that allow control and monitoring of the rectifier, connects the CSU.

A relay is provided to extend potential free contacts for alarm condition in the MUIB. This relay operates when fault arises. An analog AC voltmeter is provided at front panel to monitor system AC input voltage.

3.1 Main features of CSU सी एस यू की की मुख्य विशेषताएं

Used in conjunction with the CSU and optional WINCSU windows based control and supervisory software, the principle features of the unit is as follows:

- Local and remote (via modem) monitoring of any alarm condition of each of the rectifiers.
- Local and remote (via modem) monitoring of output current of each rectifier.
- Enables setting of parameters of all the rectifiers using the CSU front panel or an optional remote PC running WINCSU software.
- Enables monitoring of DC load current and voltage.

The following functions are standard:

- Temperature compensation of the battery float and equalisation voltage (require temperature sensor).
- Programmable battery charging current limits (3 limits).
- Automatic equalisation of the battery with selectable start (choose voltage/current level or discharge Ampere-hours) and end (choose time duration or equalisation current) parameters.
- Active current sharing.

The following functions are optional:

- Automatic dialing: the monitoring and control software has automatic dialing features. A remote PC is dialed via an optional modem in the event of an alarm condition occurring in the system.
- RS-232 port connection to computer or modem.

4. Installation संस्थापन

4.1 Initial Check up प्रारंभिक जाँच

- No damage should be observed during transportation
- Check the received material list as per the packing list
- All screws should be tightened once again at the site of the rack.
- No damage should be observed in the CSU.
- Follow installation and commissioning procedure for SMR.
- Modules are individually packed and all packed modules are supplied in one separate wooden box. Unpack the modules and check for any transit damage Installation

4.2 Installation & Commissioning स्थापना और कमीशनिंग

- The system should be installed with sufficient space at rear and front for easy maintenance and servicing. The location selected for placing the system should be away from dropping or falling substances as well as heat producing equipment.
- Avoid placing the system, where ceiling fan is fixed
- Lightning Protection Devices (LPD) and Surge Protection Devices (SPD) are installed in the rack side by side as these have been tested in coordination without the need of wire or inductor between them.
- Before applying power to the system, please ensure that the body of the cabinet is properly earthed.

Warning चेतावनी

Initial battery connection & load connection shall be done without energizing the system. When the system is under operation, adequate precaution shall be taken while installing and removing SMPS modules since higher voltages are available on rear side of the panel.

- Do not install the power plant near heat generating equipment. Avoid locations subjected to corrosive fumes or extremes of dirt and moisture.

- A minimum clearance of approximately 1.0 meter is recommended to be provided for the power plant.
- Check the nominal output voltage of power plant shown on the name plate. It should correspond to battery voltage.
- To maintain proper voltage regulation at the battery, cable installed between power plant and battery must be sized to provide minimum voltage drop.

4.3 Installing the lightning protection devices बिजली संरक्षण उपकरणों का संस्थापन

Lightening protection devices (LPD) are provided in a separate enclosure, which is intended to be installed at the AC mains distribution level. Line, neutral and earth shall be connected to the terminal block provided inside the enclosure. This terminal block is accessible by opening the front cover of the enclosure. Connect the respective cables to the terminals marked as line, neutral and earth.

It is advised to maintain a distance of minimum 5 meters between the main AC distribution point and power plant. If this distance is not physically possible, use at least 5 meter lengths of cables to connect AC to power plant. This is required to establish a perfect co-ordination between lightening protection device installed near the distribution and the surge protection device (SPD) installed in the rack. Cable length adds some inductance in the path, which is essential in transferring the surge energy between SPD and LPD.

4.4 Inserting a Module in to Magazine मेगज़ीन में मोड्यूल लगाना

- Hold the unit by the handle provided with one hand and holding it in the correct orientation by placing the other hand on the unit, place the unit carefully on the guide rails provided and slide gently in to the magazine.
- Press the unit into the magazine unit until it is flush with the magazine front and then moves the handle downwards until it “clicks” into place in its captive position parallel with the front panel. This action has the effect of locking the rectifier in position, so that it will not fall out in the event of severe shaking as might occur in the event of an earthquake.
- AC input, DC output and communication cables are provided at the rear side of the cabinet. Self locking type wago connector is provided for AC and DC connections. Six wire communication cable is used for communication. These connectors have to be connected after inserting module into the magazine.

5. Rectifier Modules रेक्टिफायर मोड्युल्स

The CSU is used for the purpose of setting rectifier operating parameters and showing system voltage and current, while a bar graph on each module display output current supplied by each module.

5.1 LED Indicators on the rectifier front panel रेक्टिफायर पर एल ई डी संकेतक

There are three LEDs on the front panel of each rectifier module to indicate the operating status of the individual module. They are as follows:

	LED Name	LED Colour	What in indicates
1	ON	Green	Rectifier functioning normally. Mains available
2	Alarm	Amber (flashing)	Alarm condition
2	Alarm	Amber (not flashing)	Unit is in Equalisation mode
3	Shutdown	Red (With amber LED flashing)	Unit is switched off or failed
3	Shutdown	Red (amber LED not on or flashing)	Micro in SMR has failed

5.2 Output Current Bar- Graph आउटपुट करंट बार ग्राफ

A 10 LED bar-graph display is included in the front panel of the rectifier module to indicate the output DC current, each element of the bar graph represents one tenth of the rated capacity of the rectifier.

5.3 Adding and removing rectifiers from the magazine

मेगज़ीन से रेक्टिफायर निकालना व जोड़ना

The rectifiers are designed to be “hot pluggable” in that they can be plugged into and out of a “live” magazine without disturbing others modules working in the rack.

A relay in the output circuit ensures that the rectifier output is connected to the output DC bus only when the difference in voltage between the output bus and the rectifier output is less than a predetermined value. An inrush limiting circuit in the AC input circuit which utilizes a relay and an inrush current limiting resistor limits the disturbance to the AC source to an acceptable level when a unit is plugged in with AC voltage present on the AC bus.

5.3.1 To remove a rectifier from the magazine मेगज़ीन से रेक्टिफायर निकालना

To remove a module from the magazine, use following steps. Although the connectors are designed to be "hot pluggable" it is advisable to first switch off power to the unit by means of the circuit breaker in the AC distribution panel before unplugging the unit.

- Open the rear side door to access the AC/DC connector and communication cable.
- Un-plug AC/DC connector and communication connector from their positions on the module.
- Each rectifier has a handle, which normally sits flat within the rectifiers front panel. The handle can be pulled directly forward to remove the rectifier from the magazine. A latch which prevents the rectifier from being removed from the magazine under normal conditions is attached to the handle and releases when the handle is in the forward position.

Warning!! Take care when removing the rectifier as it may be uncomfortably hot to hold especially if the ambient temperature is high and the unit has been operating at maximum load

5.3.2 Inserting a rectifier into the magazine मेगज़ीन मे रेक्टिफायर जोड़ना

Although the connectors in the unit are designed for "hot plug-ability" it is advisable to turn off the AC power to the input connector by means of the related circuit breaker in the AC distribution panel before plugging in the unit.

Hold the unit by the handle provided with one hand and holding it in the correct orientation by placing the other hand under the unit, place the unit carefully on the guide rails provided and gently side in to the magazine.

Press the unit into the magazine until it is flush with the magazine front and then move the handle downwards until it " clicks" into place in its captive position parallel with the front panel. This action has the effect of locking the rectifier in position, so that it will not fall out in the event of severe shaking as might occur in the event of an earthquake.

Turn to rear side of the cabinet and plug AC/DC and communication connectors in to their mating ends on the module.

Switch on the AC circuit breaker. The rectifier will start automatically and connected itself to the DC bus at the appropriate time.

5.4 Changing Operating Parameters प्रचालन पैरामीटरों को बदलना

There are two ways in which the operating parameters of the rectifiers can be changed:

1. By means of the CSU front panel SMR menu; Press SMR menu button and scroll through the menu using the INC or DEC buttons . Once the appropriate parameter is displayed, press Enter key which will make the parameter value flash on and off; The value can now be incremented or decremented using the INC or DEC buttons until the desired value is obtained; Press enter again and the new value is executed.
2. By means of a laptop PC connected to the CSU. This is the most convenient method of making changes to any parameter. (it is an optional feature)

It should be noted that it is not possible to change parameters on individual rectifiers. Any parameter change will be implemented in all the rectifiers connected to the CSU.

5.5 Security feature सुरक्षा सुविधा

A security function can be activated such that it is impossible to change any operating parameters unless the security function is first disabled. If an attempt is made to change an operating parameter a message " Panel Locked" will appear on the screen.

This function is intended to prevent any personnel not familiar with the equipment from unintentionally changing operating parameters.

To temporarily disable the security function, press all three INC, DEC and Enter buttons simultaneously and hold pressed for three seconds. The security function is automatically enabled again if no button is pressed during a period of approximately two minutes.

6. CSU Module सीएसयू मोड्यूल

The CSU is a supervisory and control unit for a power plant comprising rectifiers connected in parallel with two/three parallel battery banks.

6.1 Alpha Numeric LCD Display अक्षरांकीय एलसीडी डिस्प्ले

A single line 16 character alphanumeric back-lit display with large 9mm high characters normally displays output voltage and current as well as the system status Float (FL) or Equalize (EQ). This is the default or "HOME" screen.

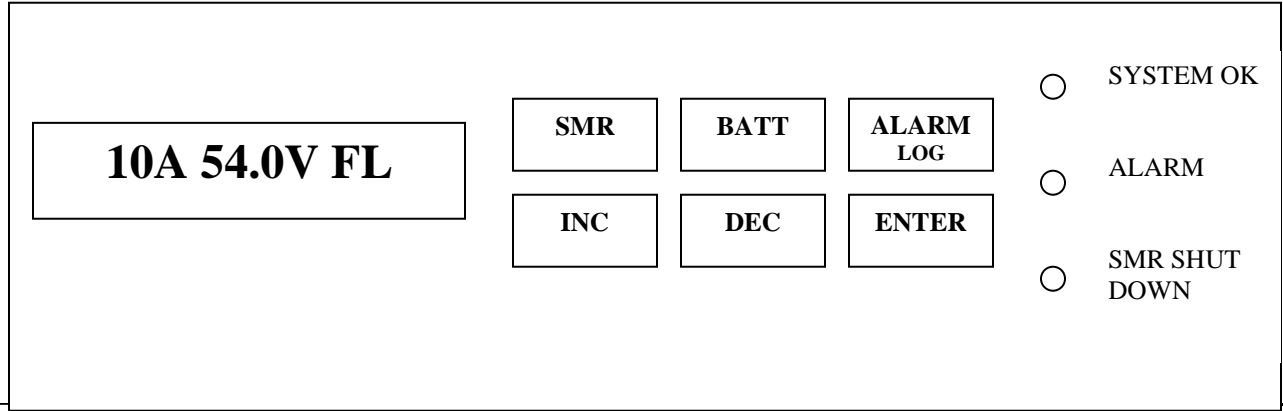
10A 54.0V FL

"HOME SCREEN"

Whenever there is no push button activity for more than 40 seconds, the display always reverts to this home screen.

6.1.1 Front panel push buttons फ्रंट पैनल पुश बटन

There are push buttons associated with the LCD screen for the purpose of entering different menus and for scrolling through the menus. The layout of push buttons is shown below



Apart from the CSU or "Home" menu which includes mostly system oriented parameters, there are three other menus which can be accessed by momentarily pressing the relevant push buttons.

- SMR menu which includes the individual rectifier related programmed parameters as well as the output current and heat sink temperature for each rectifier.
- Battery menu in which all the parameters pertaining to the batteries are found.
- Alarm log which stores all the individual alarm information together with date and time starting with the most recent alarm. A total of 100 alarms are stored in memory.

6.1.2 Entering and moving through different menus विभिन्न मेनू से प्रवेश व चालन

To scroll through the CSU menu from top to bottom just press the INC button. If the DEC button is pressed, the screen at the bottom of the menu will appear first and will be followed by the other screens in reverse order. This can be useful when it is desired to access a screen near the bottom of the menu.

To enter the other menus, momentarily press the relevant button - SMR, BATT or ALARM LOG . If at any time it is necessary to return to the CSU or home menu, just press the current menu button once. E.g. if the present menu being scrolled is BATT, just press BATT button again and the screen will return to the default "home" screen.

The INC and DEC keys are also used to increase or decrease parameter values when the parameters are programmable.

In this case press ENTER first. The parameter value will begin flashing on and off. Press INC to increase the value or DEC to decrease the value until the desired value is obtained. Then press ENTER again to actually enter the value into memory.

6.1.3 Status indicating LEDs (CSU) एल ई डी की स्थिति का संकेत (सी एस यू)

In addition to the alphanumeric display there are also three LEDs to indicate system status as follows:

SYSTEM OK	Green
ALARM	Amber
SMR SHUTDOWN	Red

When all three LEDs are off, the unit is off and there are a number of possible reasons for this.

- DC is not present
- Internal failure of CSU

The amber LED indicates any alarm condition, either system or rectifier related. The red LED indicates that one or more of the rectifiers in the system is shut down.

6.2 User interface board – MUIB उपयोगकर्ता इंटरफ़ेस बोर्ड - एम यू आइ बी

The connections between the CSU and the external transducers and other inputs are made on connectors provided on an interface card MUIB (Main User Interface Board) which in turn is connected to the CSU via a 34-way ribbon cable.

6.2.1 Relay contact outputs रिले कॉन्टैक्ट आउटपुट

Relay contact for remote annunciation for group alarm is provided in the MUIB.

7. Operation of the CSU सीएसयू का प्रचालन

A detailed description of the contents of the various menus is given below.

Summary of CSU front panel controls.

There are four Menus which can be viewed using the INC or DEC buttons.

- a) The default or "Home" menu which contains general system information.
- b) SMR menu contains all the parameters pertinent to the rectifiers
- c) Battery menu contains all the parameters regarding the batteries.
- d) Alarms log which is chronological record of the last 100 alarms

M Moving from one menu to another

If no button has been pressed for two minutes, the display will revert back to the Home screen. This shows the output voltage and current.

To move from any menu to any other menu press the corresponding button. e.g to move to the battery Menu from any other menu momentarily press the BATT button.

To move to the Home menu from any other menu press the button of the current menu. e.g. if in the SMR menu, press SMR button to return to the Home menu.

Scrolling through the Menus:

- To scroll through any menu from the first screen to the last, press the INC button.
- To scroll to the last (bottom) screen first, then upwards through the menu to the first screen, press the DEC button.

Incrementing and decrementing programmable parameters

- To change a programmable parameter press ENTER, the value will flash on and off. To increase the number, press INC; to decrease that number, press DEC. When the desired number is on the screen, press ENTER again.

To Change parameters when the security functions is activated.

- If an attempt is made to alter any parameter when the security function is activated the display will show the message "Panel Locked"
- To change a parameter, simultaneously press all three INC, DEC and ENTER buttons for three seconds. Then proceed to change the parameter in the normal way.

When scrolling through the Alarms log

- To observe the date and time of a given alarm do not press any button for at least two seconds and the date and time will flash on for two seconds and then the alarm name will be displayed for two seconds. The display will alternate between the two screens in this manner until a button is pressed.

7.1 CSU display messages सी एस यू डिस्प्ले मैसेज

The screen which is displayed if the INC button is pressed when the default or "home" screen is displayed is shown below.

10A 54.0V FL

As can be seen some screens merely display a monitored operating parameter, such as load current, while other screens display programmable operating parameters, such as rectifier current limit, which can be altered if so desired.

The screen have been arranged so that, when scrolling using the INC button, all the monitoring screen are displayed first followed by the programmable parameter screens, since it is unusual to access these except during commissioning.

By scrolling with the DEC button the reverse is true the programmable parameter screens are accessed first, starting with the one at the bottom of the menu.

In either case, if the buttons are not touched for forty seconds, the display reverts to the "Home" screen.

7.1.1 When an alarm condition exists जब एक अलार्म की स्थिति उत्पन्न हो

If one or more alarm conditions exit at any time the following message will alternate with the "home" screen for 2 seconds in every six seconds in addition to warning LED indicators.

3 Press ENT

In this case, the message indicates that there are three alarms present and they can be observed by pressing the ENTER button.

When the ENTER button is pressed the most recent alarm name, such as the one shown below will appear on the display.

Ambient Temp. Hi

If the Enter button is not pressed again for ten seconds, the display will revert to the "home" screen and the sequence begins again. To view the remaining alarms, use INC and DEC

buttons. ENTER returns to the home screen. Pressing the ENTER button a fourth time will return the display to the "home" screen. The time and date of any given alarm can be obtained by entering the alarm log menu.

7.1.2 CSU SCREEN सी एस यू स्क्रीन

The INC button can be pressed to scroll through the CSU menu. The following screens will appear in sequence.

CSU "Home" screen: indicates that the system is in float mode	15A 54.3V FL
"C" indicates that battery temperature compensation function is active	15A 54.3V FLC

The screens below display programmable parameters within the CSU menu. To change a parameter, press INC button until the desired parameter is found, then press ENTER. The parameter value will flash on and off. Press INC to increase the value or DEC to decrease the value until the desired value is on the screen. Press ENTER to enter the value into memory.

Ambient temperature alarm level	: Amb Tmp Alm 45C
Float voltage High level	: Volts High 56.1 V
Float voltage Low level	: Volts Low 50.5 V
System output load current there should "Sys O-Load" Alarm will appear when output load current is higher than this level	: Sys O - Load 310 A
Security on or off. When security function is activated attempts to alter any programmable value will result in the display showing "Panel Locked". To temporarily unlock the system press all three INC, DEC and Enter buttons simultaneously for three seconds. The system reverts back to the locked state if no button is pressed for longer than 2 minutes	: Security On Panel Locked Security Off
Test function, when this function is activated all LEDs on the rectifiers and CSU begin flashing on and off. The display alternates between showing the software version and a screen with all pixels on.	: Test On Test Off
Number of SMRs in the system. This number must be entered otherwise the display will show that some SMRs are not responding.	: NO. of SMRs 12
No. of external boards such as mains	: Interface MUIB 2

monitoring board can be interfaced to the SMR for various applications where in this case MUIB2 is the one which is interfaced to the SMR.		
No. of batteries to be connected to the battery terminals is an option between independent and common battery banks.	:	No. of Batt 3/Ind
DC transducer full scale rating E.g if a hall transducer has 100A/4V rating, enter 100 in the screen.	:	FS Batt I -100A
CSU Access code address, this can be number up to 7 digits long.	:	CSU# 1252636
Clock set, used to set the date and time of the CSU clock. Note DD/MM/YY 24 hour clock	:	26/01/2009 12:58
Modem enable this can be toggled between On and OFF	:	Modem ON
The screens below will only be displayed if the modem is enabled (ON)	:	Modem OFF
Audio Alarm is a choice among OFF, t-out and On. No. audible Alarm will be observed if this option is set to OFF. And the same can be enabled by setting it to ON. In between, by setting to t-out option, the audible alarm will cut off automatically after 3 minutes.	:	Audio Alarm OFF Audio Alarm t - Out Audio Alarm ON
Expansion shall be kept in On position, which enables AC voltage monitoring in the CSU.	:	Expan 1 (ENTER) Expan 1 ON
Do not operate this parameter.	:	Expan 2 (ENTER)

7.2 CSU Alarm सी एस यू अलार्म

A list of all the possible alarms which can be annunciated is shown in the following table

R = Red Led on A = Amber Led flashing A*= Amber LED continuous

Alarm Name	Comments	LED
SMR Alarm	Combination of one or more SMR alarms	A
SMR Alarm- Urgent	One or more SMRs have shut down	A+R
SMR HVSD	SMR shut down due to output over voltage	A+R
Unit Off	SMR is off	A+R
No Response	A particular SMR is not responding to the CSU	A
Power Limit	SMR is in Power Limit	A
No Load	SMR output current less than 1A	A

SMR 1 Limit	SMR in current limit	A
Volts High	Voltage measured by SMR too high	A
Volts Low	Voltage measured by SMR too low	A
EEPROM Fail	EEPROM failed (CSU or SMR)	A
No. Demand	Control loop in SMR not in normal state	A
H/S Temp High	SMR heat sink temperature too high	A
DDC Controller	SMR DC/DC converter fault	A+R
Temp Sensor Fail	Temp sensor in SMR faulty S/C or O/C	A+R
Reference Fail	Voltage reference in SMR microprocessor cct faulty	A+R
HVDC not OK	DC/DC converter (boost) voltage in SMR not OK	A+R
High Volts SD	Shut down of SMR due to output volts too high	A+R
AC Fail	Non of SMRS are responding (AC fail assumed)	A+R
Temp Sensor Fail	Temp sensor in MUIB not plugged in	A
Battery Switch	Battery switch open	A
LVDS Open	Low Voltage Disconnect switch open	A
System Volts High	System output volts too high	A
System Volts Low	System output volts too low	A
Battery Disch	Batteries are discharging	A
SMR Comms Fail	One or more of SMRs are to responding	A
AC Volt Fault	AC voltage lower or higher than preset value	A+R
Batt Temp High	Battery temperature higher than preset limit	A
Batt Current Limit	Battery charging current is being limited to preset value	A
Equalise	System is in equalize mode	A*

7.3 SMR Menu and display messages एस एम आर तथा डिस्प्ले मैसेज

All information relating to the individual rectifiers is found in the menu activated by pressing the SMR button on the CSU front panel.

When an SMR is not connected or not switched ON or is faulty, the screen indicates that the rectifier is not responding	SMR 1 No Response
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Warning : It is important to declare the correct number of rectifiers in the rack using the CSU (home) menu.

SMR 1 Current: When a rectifier is on line and operating normally its output current is displayed.	SMR 1 20A
When the Enter button is pressed momentarily, the Version and heat-sink temperature are displayed together with the SMR number. Press Enter again to return to the	SMRI G1050#j 68C

SMR “home” screen	
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To return to the CSU menu at any time, press SMR button. To return to the SMR menu, press the SMR button again. The rest of the SMR menu consists of screens which show the operating parameter of the SMRs.

Float Voltage value. This parameter is globally (and indirectly) set in the BATT menu so cannot be changed in this screen. It is set automatically to a value equal to the sum of the Sys Float and Sys Drop values set in the BATT menu	SMR Float 54.0V
As with the Float Voltage value, the Equalisation Voltage parameter is globally (and indirectly) set in the BATT menu so cannot be changed in this screen. It is set automatically to a value equal to the sum of the Sys Equal and Sys Drop values set in the BATT menu.	SMR Equal 55.2V

The remaining screens show the SMR related operating parameters which can be changed by pressing Enter. When this is done, the number flashes on and off and can then be incremented or decremented by pressing the INC or DEC buttons respectively. When the correct value is obtained press Enter to enter the number into memory.

NOTE: Any parameter change will apply to all the SMRs.

SMR high voltage alarm level	SMR V High 56V
SMR low voltage alarm level	SMR V Low 48.1V
SMR DC High Volts Shutdown (HVSD)	SMR HVSD 57V
SMR Current Limit	SMR I Limit 26 A
Fault Reset; By pressing Enter when this screen is displayed and latched alarm such as HVSD is reset and the unit will restart unless it is damaged or faulty	SMR Fault Reset
Short circuit will be displayed if there is any short circuit arrived at the O/P	Bus short ckt.

7.4 Battery Parameters Menu बैटरी पैरामीटर मेनू

All information pertaining to the batteries is accessed by momentarily pressing the BATT button on the front panel. To return to the CSU “home” menu at any time, momentarily press the BATT button on the front panel.

As for the other menus, in general a programmable parameter can be incremented or decremented by use of the INC and DEC buttons respectively. If this is attempted when a monitored parameter is being displayed (i.e. not a programmable operating parameter), then the message “Not Adjustable” will be displayed.

The following screens will appear in turn when the INC button is pressed.

Total Battery Current	:	Batt 1 13A
Battery Temperature: If a sensor is fitted, the battery temperature is shown in degrees Celsius. Since there is provision for only one sensor, the sensor should be located in the hottest spot of the two batteries) if the temperature sensor is not connected, the message reads as shown (sensor not attached); when Batt temp sensor condition alarm is selected this screen will show.	:	Batt Temp 35C Temp Sensor N/A Temp Sensor Fail
Battery over Temperature alarm level. This is a programmable level and can be adjusted in the normal way by the INC, DEC and ENTER buttons.	:	Batt T Alarm 60C
Estimated Battery I state of charge this screen shows the estimated charge in the battery at any given time	:	QEst Batt 1 500AH
Ampere-hour rating of batteries; the rated A/H number for he batteries must be entered in this screen (Set total AH capacity)	:	Batt Rated 500AH
Battery Temperature Compensation Coefficient sin mV per Deg C per Cell is entered in this screen. the allowable range is 0.1 5mV/C/Cell. If the value is decremented below 0.1 the display will shown Off.	:	BTC mV/C/C 3.0 BTC 3.0 m V/C/C
BTC Nominal setting is a base temperature for all temp. Compensation calculations. Output voltage will be corrected to the temperature with this setting as reference. This normally set at 27 ⁰ C	:	BTC Nominal 27⁰C

Note: टिप्पणी

If there are no temperature sensors connected or if BTC is set to 0 the compensation function is disabled. In this instance, the status message in the CSU home screen is FL or EQ instead of FLC or EQC.

Number of cells for the Battery connected must be entered in the screen enter 24 for 48V battery 12 for 24 V Battery	Number Cells 24
Maximum Voltage per cell must be entered in this screen. This screen can be observed when the battery temperature compensation coefficient function is enabled.	Max 2.30V/Cell =55.2V
Minimum Voltage per cell must be entered in this screen. This screen can be observed when the battery temperature compensation coefficient function is enabled.	Min 2.10V/cell = 50.4V
Battery Charging Current Limit applicable for voltage below Vdd. This parameter sets the maximum current	BILim Vb<Vdd 12A

which flows into the batteries when the voltage across the two batteries is less than Vdd, the deep discharge voltage. Vdd is programmed in the next screen.	
Battery deep discharge voltage- Vdd	Vdd Level 44.0V
Battery Charging Current Limit applicable when the battery voltage is between Vdd and the float voltage Vfl. This limit is normally higher than the one for a deeply discharged battery.	BILim Vb<Vfl 12A
System Float Voltage; This sets the system output voltage at the output bush bar terminals.	Sys Float 54.0V
Battery Charging Current Limit for battery voltages greater than the float voltage. This applies when the batteries are being equalized.	BILim Vb>Vfl 12A
Equalisation Voltage. This sets the maximum voltage reached during Equalisation of the batteries	Sys Equal 55.2 V
System Voltage Drop. This parameter is used to set the maximum voltage that the individual rectifiers can output over and above the programmed system float voltage.	Sys Drop 0.6 V

The System Voltage Drop parameter is calculated by summing the resistive voltage drop in each rectifier (due to output connector, output relay and passive current sharing output "slop") and the increased voltage required for temperature compensation if this function is activated.

For example, if the temperature compensation coefficient is set to (negative) $3.0\text{mV}/^{\circ}\text{C}/\text{cell}$, then the maximum increase in float voltage will occur if the temperature is 17°C or below. In this instance, the compensation will be $+0.72\text{V}$ since the compensation range is 10 to 50°C with the reference (no compensation) temperature being 27°C ($27-17=10^{\circ}\text{C}$ multiplied by 24 cells and $3\text{mV}=720\text{mV}$).

Add 0.6 V for resistive voltage drop at full load and a system drop value rounded up to 1.4 V would be programmed in to the system.

Battery discharging alarm level. This level is set to a value to which the battery voltage falls to during a discharge. It is used to issue an alarm indicating that the batteries are discharging.	B Disch A I 45.0V
Equalisation initialized by voltage level V reached during battery discharge.	V Start Eq On
Equalisation is initialed when the battery voltage falls to this level	V Eq Trig 46.0 Off
Equalisation is not initialized by voltage level	V Start Eq Off
Equalisation is initialized based on charge supplied to the load by the batteries (measured in Ampere Hours).	Q Start Eq On
Equalisation is initialized when the charge out of the batteries is greater than the level set in this screen.	Q Start Eq off
Equalisation can be terminated after the time set in this screen. If termination is to be only based on the A/H	Qdis Trig 20 AH

discharge method, set this number to its highest value (48Hours)	
Equalisation initialized by current level I reached during Battery discharge.	I Start Eq On
Equalisation in not initialized by Current level	I Start Eq Off
Equalisation is initialized when the Battery current falls to the level	I EQ Trig 6A
Equalisation is not initialed by the discharge A/H method	EQ End (Off)0A
Equalisation is ended based on the level of battery charging current set in this screen	Equal Dur 20Hr
If Equalisation is to end independently of charging current, reduce the value of current in this screen to less than 5% of the A/H rating of the batteries (programmed in earlier screen) and the number will then be replaced by OFF as shown.	EQ End 4A
If no equalisation occurs due to battery discharges for period longer than the time set in this screen, an equalisation cycle will be initiated automatically.	Equal Per 12Wk
Equalization cab be ended manually by presetting ENTER when this screen appear. This screen is only obtained if the tem is in Equalisation mode. When ENTER is pressed the system revert to Float mode and the window change to that shown ready for a manual equalization start. This screen is only obtained if the system is in float mode.	Manual Stop EQ Manual Start EQ
A Low Voltage Disconnect contactor (LVDS) is often integrated into the system to disconnect the batteries from the load in the event that the AC Power outage is too long causing the batteries to discharge beyond a safe level. The voltage level at which the LVDS open is set in this screen	LVDS TRIP 44.0V LVDS AUTO
When this screen is as shown, the LVDS contactor opens automatically when the voltage drops to the trip level set in the previous screen. When the AC power is restored and the system output voltage rises after the rectifiers start up the LVDS contactor will close automatically.	LVDS Closed
To operate the contactor manually, press ENTER and the Auto will flash on and off. Press INC to scroll to closed followed by Open followed by auto again. Press Enter at the desired stage e.g. Open to open the contactor.	LVDS Open
Battery Discharge Test (BDT) parameters are not applicable and set to off.	BDT OFF

7.5 Alarms log अलार्म्स लॉग

A record of the most recent alarms is kept in the CSU memory and can be viewed by momentarily pressing the Alarms Log pushbutton. The screen shows the number corresponding to where the particular alarm is in relation to the most recent alarm which is number one. It then shows the alarm name as shown below.

1 AC fault

In the example shown the frequency of the AC source is either too high or too low. If the INC button is pressed within two seconds the second alarm will be shown. If pressed again the third alarm appears etc. If on the other hand the button is not pressed for two seconds a second screen will appear which shows the alarm sequence number followed by the date and time at which the alarm occurred.

1 02/01/2009 12:05

It is thus possible to quickly scroll through the alarm log to identify the most recent alarms that have occurred and then if the time and date of a particular alarm is required, it is only a matter of scrolling to that alarm waiting two seconds and the date and time information will appear.

If at any time it is desired to clear the alarms log, press ENTER whilst in the alarms log menu and the following screen will appear.

DEC to Clear Log

Press the DEC button as requested and the log will be cleared and the following screen will confirm it.

No Alarms

8. Maintenance अनुरक्षण

Some general routine maintenance procedures are described below which should be carried out to ensure reliable performance of the equipment.

8.1 Warnings and precautions चेतावनी तथा सावधानियाँ

Since the unit utilises high voltages and large storage capacitors, it is imperative to take great care when working on the unit. In particular, only qualified personnel should be allowed to service the units. In addition, the following precaution should be observed:

1. **Make sure the relevant isolating AC input MCB is OFF (open) before attempting to remove any unit from the rack.**
2. **Do not remove the cover with power on**
3. **Allow five minutes to elapse after switch off before removing the cover to make sure high voltage capacitors are fully discharged.**

8.2 SMR Maintenance एस एम आर अनुरक्षण

Since the SMRs are fully alarmed and operate in an active loop current sharing arrangement, there is no need for regular checks or adjustments of operating parameters. However, some regular checks can be an early warning of problems waiting to happen.

8.2.1 Current Sharing करंट शेयरिंग

It is applicable where numbers of modules are more than 1. Under normal conditions, the current by every rectifier should be within $\pm 2A$ or $\pm 3\%$ of each other. It is possible however, for internal loop parameters to change to such an extent that a unit does not share to the extent that it should.

If the lack of sharing is extreme then either a CURRENT LIMIT or NO LOAD alarm will be active. If, however, the current sharing is not so extreme as to generate an alarm, a regular check of the current sharing among the rectifiers can lead to early detection of any units which may be developing a fault.

In general, if only one or two units are “drifting”, the most probable explanation is a “drifting” component in the secondary control card of the SMRs involved. If, on the other hand, many of the SMRs are not sharing satisfactorily, then the most likely problem area is in the System Controller (CSU).

8.2.2 Integrity of Electrical Connections बिजली के कनेक्शन की प्रामाणिकता

It is good practice to check all accessible electrical connections at regular intervals to ensure that no "hot spots" develop over time due to loose connections. An infra-red "hot spot" detector is very useful for this function. Alternatively, mechanical connections can be checked manually for tightness.

8.3 Routine Checks नियमित जांच

The power plant does not need any elaborate routine checks as it has been designed for a rugged application. For the purpose of longevity of the useful life of the Power Plant, some hints have been enumerated below.

1. A general cleanliness should be maintained in the equipment room.
2. A logbook of battery current, load current, AC input voltage and AC input current and load voltage should be maintained.
3. The ventilation paths should not be obstructed for free flow of air in the room (overcrowding of the equipment room should be avoided).
4. Check the availability of clear and legible instructions in the vicinity of the power plant.

8.4 Preventive Checks निवारक जांच

1. The batteries connected to the equipment should be monitored daily for the proper voltages with the use of LCD display on the front panel and a log can be maintained.
2. It is recommended to apply rust free jelly once in a month to the connections given from bus bars to avoid generation to contact resistance. The same can be applied to the points where the high current carrying cables are connected to various points like loads, inputs and batteries etc..
3. The earth resistance to the Power Plant cabinet should be measured every six month and should be maintained below 0.2 Ohm.

8.5 DO'S and DON'T's क्या करें और क्या नहीं

DO's करें

- Keep all the module in on position.
- Set equal voltage in all modules for proper current sharing.
- Set battery path current to AH/10.
- Set battery voltage according to type of battery. For SMF battery Float is 2.25V/cell & Boost is 2.3V/cell. For LM battery Float is 2.2V/cell & Boost is 2.4V/cell.

DONT's नहीं करें

- Do not take out plugs of modules when working.
- Do not connect battery when modules are on.
- Do not connect battery in reverse polarity.
- Do not disturb battery undercut setting.

9. Fault Finding and Replacement Procedures दोष निवारण एवं प्रतिस्थापन प्रक्रिया

This section describes some detail of possible causes for alarms that may occur from time to time and the procedures that should be followed to clear the alarms and more importantly, address the problem or cause of the alarm.

It is assumed here that mostly field maintenance persons will change the complete module. It is normally impractical to attempt to repair a particular unit without test equipment, which is normally not available with the maintenance staff. The recommendation is for spare complete units to be kept on site.

The fault finding procedures are presented below.

9.1 System Fault Finding Procedures सिस्टम दोष निवारण विधियाँ

The following table outlines suggested procedures to be followed if it is assumed that no internal repairs of units will be attempted. It is assumed instead that only front panel adjustments and unit replacement will be performed.

Alarm Condition	Possible Cause	Action Suggested
Unit Off	No AC power to SMR	Check AC supply to SMR; if necessary reset CB supplying SMR
	SMR faulty	Replace SMR
Equalise Mode	Automatic cycle in progress due to recent AC power failure	No action required
	Automatic periodic equalise cycle in progress.	Check on CSU if system is in AUTO or MAIN mode. If in AUTO mode, display will show remaining equalise time. Check log for previous cycle date. If cycles are too early, replace CSU.
	Manual initialization of equalise cycle	Check operator log; in BATT menu, scroll to "Manual Stop EQ" screen and press ENTER to terminate cycle if necessary.
SMR Alarm-Urgent	All SMRs off due to AC power failure	If possible restore AC power
	One or more SMRs off due to faults;	Check Individual SMRs for obvious problem; replace SMRs if necessary
	All SMRs off due to incorrect Inhibit signal from CSU	Replace CSU
	One or more SMRs in Current Limit	Check Current Limit settings and adjust if necessary; or batteries being recharged

Alarm Condition	Possible Cause	Action Suggested
SMR Warning	Any of the above or non critical problem with one or more SMRs	Select SMR menu. Check status of SMRs which are flashing alarm LED.
	Any of the above or no load alarm	If unit is not sharing correctly, replace SMR
	Any of the above or unit is in equalise mode	Check Equalise/Float Mode and change if in incorrect state; change SMR if CSU is not requesting equalising mode.
AC Fail (SMR alarm)	Total AC power failure or AC voltage not within operating limits	Check AC supply and confirm condition; If AC is OK replace SMR units if only to show alarm condition
	Communication link failure	Check 4 way communication cable between CSU and all SMRs
Battery Switch	Battery switch is open	Close if appropriate
	Bad connection to MUIB	Repair connection
Battery Temp High	Battery temperature higher than pre-set level	Check battery temperatures and if necessary increase ventilation and cooling
	Set point is too low	Check Batt Temp High threshold level and re-adjust if necessary
	Temperature sensor is faulty	Replace sensor
	Connection to MUIB faulty	Repair connections
Volts High	SMR fault	SMR Fault Chart
	One SMR in equalise mode	Switch SMR back to float mode
	Float level set too high on CSU	Check and adjust if necessary
	CSU fault	Replace CSU
Volts Low	AC power has failed; system on battery power	Restore AC power if possible
	Alarm threshold level set too high	Check set point and adjust if necessary
	All SMRs are off due to CSU Inhibit signal, system on battery power	Check reason for signal; if necessary replace CSU
	Battery charging current limiting LED due to faulty battery current signal - this will depress float voltage	Check battery currents. If one of them shows figure higher than battery charging current limit set point, check corresponding current transducer; check connections to transducer; check MUIB connections
	Battery Temperature Compensation too high due to faulty battery temperature monitoring	Check battery temperature readings in Batt menu; Check and if necessary replace faulty sensor; check connections to transducer and MUIB

Alarm Condition	Possible Cause	Action Suggested
	Battery Temperature Compensation too high due to faulty MUIB	Replace MUIB
SMR HVSD	Output voltage too high due to SMR fault	Replace faulty SMR
	HVSD threshold on SMRs set too low	Check and re-adjust threshold level
	CSU fault	Replace CSU
SMRs not sharing load current	Faulty CSU voltage and current control loop IODEM signal	Replace CSU
	Float or Equalise level on SMRs set too high/too low.	Check and re-adjust Float or Equalise level on CSU
No Response	SMR not responding to CSU	Check and if necessary replace communication cable at back of magazine faulty
	Faulty microprocessor card in SMR	Replace SMR
Power Limit	Unit not current sharing (if only one showing power limit)	Replace SMR
	Load current too high (if more than one unit showing alarm)	Reduce load
No Load	Load circuit breakers have tripped and there is no load	Reset circuit breakers
	If only one unit showing alarm, communication line to SMR may be faulty	Check & replace communication line
	Faulty SMR	Replace SMR
Current Limit	Batteries being recharged if more than one unit showing alarm	No action required
	If only one unit shows alarm, internal control loop faulty	Replace SMR
No Demand	Internal control loop faulty	Replace SMR
EEPROM Fail	Faulty EEPROM or microprocessor card	Replace SMR
DDC Controller	Fault in DC/DC converter	Replace SMR
H/S Temp High	SMR Heat sink temperature too high	Check that air intake to SMR is not blocked

Alarm Condition	Possible Cause	Action Suggested
	Ambient temperature is too high	Try to reduce ambient temperature
	Microprocessor card is faulty	Replace SMR
Temp Sensor Fail	Temperature sensor is faulty	Replace SMR or Temperature sensor in SMR
Reference Fail	Reference voltage source in, or entire microprocessor card is faulty	Replace SMR
HVDC not OK	Faulty boost controller	Replace SMR
	Inrush limiting fuse or resistor O/C	Replace SMR
High Volts SD	Feedback voltage circuit faulty	Replace SMR
	Faulty microprocessor card	Replace SMR
Temp Sensor N/A	Temperature Sensor in CSU not attached or faulty	Plug in temperature sensor if required; Replace temperature sensor
	Faulty MUIB connection(s)	Replace MUIB
	Faulty CSU card	Replace CSU
LVDS Open	Battery discharged to the limit voltage level due to no AC power	Check AC voltage and reset if possible
	Battery voltage OK, and CSU faulty	Replace CSU
	LVDS threshold level set too high	Reset level in BATT menu
System Volts High	Volts High level in CSU set too low	Reset level to correct value
	Temperature compensation coefficient set too high	Set correct temperature compensation coefficient
	Faulty MUIB or CSU	Replace CSU
System Volts Low	Volts Low threshold in CSU too high	Reset level to correct value
	Temperature compensation coefficient set too high	Set correct temperature compensation coefficient
	Faulty MUIB or CSU	Replace CSU or MUIB
Battery Discharge	Output voltage low due to SMRs off	Check AC voltage & restore if possible;
	Float level set too low	Set float level to correct value
	Battery Discharge level set too high	Set correct Battery Discharge level
	Faulty control loop in CSU	Replace CSU
SMR Comms Fail	Communication cable faulty	Replace cable
	SMR communication circuits faulty	Replace SMR
	Faulty CSU	Replace CSU

Alarm Condition	Possible Cause	Action Suggested
AC Volt Fault	AC voltage out of tolerance	Check AC voltages and fix if possible
Batt I-Limit	Battery charging current is being limited to preset value	No action necessary
	Battery current limit set too low	Set correct limit
	Battery current sensor faulty	Replace sensor
	Faulty MUIB or CSU	Replace MUIB or CSU
Battery Dis 1 Fail	Battery 1 is faulty	Repair/replace battery if necessary
For all batteries	Battery current sensor is faulty	Check and replace sensor if necessary
	Faulty MUIB or CSU	Replace CSU or MUIB

9.2 CSU Fault Finding and Repair Procedures सी एस यू दोष निवारण एवं रिपेयर प्रक्रिया

In addition to performing a supervisory function by monitoring output voltage and current and the various system alarms, the CSU also performs a voltage control function in order to achieve battery charging current control, battery temperature compensation, battery equalisation and active current sharing.

To control current to the lowest battery voltage, the CSU has the ability to suppress the SMR output voltage to a value lower than the minimum battery voltage.

It therefore follows that it is possible for a CSU fault to occur which can suppress the SMR voltage to that low level and thus cause a battery discharge despite the precautions that have been taken to ensure that this does not happen.

In such a situation disconnecting the 4-way cable, which connects the SMRs to the CSU will remove the voltage suppressing communications control signal and thus avoid the batteries discharging. Alternatively, the CSU can be pulled out of the magazine to achieve the same result. Without the CSU connected, the SMRs will revert to their pre-set Float voltage and passive current sharing.

There are virtually no electronic components on the MUIB except for the Remote alarm relays, and some fuse links, but there are many connectors. It is worth checking for poor connections when a CSU system problem is being investigated.

Replacing CSU

To replace a CSU the following procedure should be followed:

1. Unplug the 34-way cable first and then the other cables. The SMR will now be working in passive current sharing mode and current sharing may not be as good as previously. The output voltage will also rise to the value pre-set in the SMRs.

2. Remove the knurled screws holding the front panel in the DSA rack and hold away from the DSA.
3. Gently pull the CSU unit forward, and hold it in a horizontal position until the back is just clear of the rack.
4. Bring the replacement CSU to its position in the rack.
5. Plug in all the cables ensuring that the 34-way cable is connected last. Gently push unit in the rack.
6. Check operating parameters.

NOTE: In CSU one can able to set different parameter are required based on the configuration. All settable parameters are set by manufacturer. Few parameters may be adjusted based on:

- “Number of module connected” &
- “Number of batteries connected”.

10. Set Points of the System सिस्टम के सेट पॉइंट

Sr.No.	Description	Settable Range	Set Points
CSU (OR) HOME MENU			
1.	Ambient Temp. Alarm	30 ⁰ C – 90 ⁰ C	Not Applicable
2.	Volts High Alarm	52V – 66V	56V
3.	Volts Low alarm	40V – 54V	45.6V
4.	System Over Load	Depending upon the No. of module connected	104%
5.	No. of SMRs	--	1
6.	Interface	MUIB/MUIB-2	MUIB 2
7.	Number of Batteries	1, 2 or 3	Depend upon the number of batteries connected
8.	FS Battery I		100A
9.	Modem	OFF/ON	OFF
10.	Audio Alarm	ON/T-out/OFF	ON
11.	Expan 1	None / AC1 - ph	AC1-ph
12.	Expan 2	None / AC 3 - ph	None
SMR MENU			
1.	SMR Voltage High	52V – 65V	56V
2.	SMR Voltage low	44V – 54V	45.6V
3.	SMR HVSD	54V – 66V	57.5V
4.	SMR 1 Limit	4A – 27A	26A
BATTERY MENU			
1.	Battery Temp. Alarm	30 ⁰ C – 90 ⁰ C	50 ⁰ C
2.	Battery Rated	Depending upon the number of batteries connected. Each battery rated 120AH	
3.	BTC	ON, 0.1mV/C/C-6mV/C/C	3.0mV/C/C

4.	Number cells	22-42 Cells	24 Cells
5.	Max 2.3V/Cell = 55.2V Min 2.1V/Cell = 50.4V	Do not adjust Do not adjust	
6.	Battery I lim Vb < Vdd Battery I lim Vb < VFL Battery I lim Vb > VFL	Depends on battery AH capacity and is settable between 3% & 10% of AH	10% AH capacity is recommended
7.	Vdd level	40V – 47V	44.4V
8.	Sys float	47.5V – 56.5V	54V
9.	Sys Equalize	50V – 61V	55.2V
10.	Sys Drop	0 - 1V (In steps 0.1V)	This voltage is adjusted in such a way that the load sharing for all modules should be equal
11.	Battery discharge Alarm	44V – 52V	47V
12.	V start Eq.	ON/OFF	OFF
13.	V Eq- trig.	44V – 50V	48V
14.	Q start - Eq	ON/OFF	OFF
15.	Q Dis. Trig.	5AH	5AH
16.	I start Eq.	ON/OFF	ON
17.	I Eq. Trig.	Depend upon battery rated capacity. 5% of Battery AH – Boost - Float	5% of rated Connected battery AH capacity
18.	Eq. End	Depend upon battery rated capacity. 3% of Battery AH – Boost - Float	Boost to Float current set in the screen. 3% of AH capacity
19.	Equal Duration	3 hour – 48 hour	Not Applicable
20.	Equal Per	1 week – 52 week	Not Applicable
21.	Manual start Eq. (when in Float Mode)	--	May select EQ Mode
22.	Manual stop Eq. (when in EQ Mode)	--	May select EQ Mode
23.	LVDS Trip	40V – 48V	44.4V
24.	LVDS	Closed/Open/Auto	Auto
25.	Sensor Alarm	ON/OFF	ON
26.	BDT per	OFF/1 day-365 days	---
27.	BDT Time	00.00 to 23.00	---
28.	BDT Duration	3hr.to2hr.in steps & 5min	---
29.	BDT Current	OFF/1A	---
30.	BDT End Voltage	36V – 48V	---
31.	BDT End Q	25 AH	---

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