INTEGRATED POWER SUPPLY
(As per Specs. No.: RDSO/SPN/165/2012 with Latest Amendment)

OPERATION & MAINTENANCE MANUAL

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<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>AFTC</td>
<td>AUDIO FREQUENCY TRACK CIRCUIT</td>
</tr>
<tr>
<td>RE</td>
<td>RAILWAY ELECTRIFICATION</td>
</tr>
<tr>
<td>PI</td>
<td>PANEL INTERLOCKING</td>
</tr>
<tr>
<td>SMPS</td>
<td>SWITCH MODE POWER SUPPLY</td>
</tr>
<tr>
<td>SPD</td>
<td>SURGE PROTECTION DEVICE</td>
</tr>
<tr>
<td>PCB</td>
<td>PRINTED CIRCUIT BOARD</td>
</tr>
<tr>
<td>RFI</td>
<td>RADIO FREQUENCY INTERFERENCE</td>
</tr>
<tr>
<td>MCB</td>
<td>MINIATURE CIRCUIT BREAKER</td>
</tr>
<tr>
<td>DSA</td>
<td>DISTRIBUTION SUPERVISORY CONTROL &amp; ALARM</td>
</tr>
<tr>
<td>PFC</td>
<td>POWER FACTOR CORRECTION</td>
</tr>
<tr>
<td>VRLA</td>
<td>VALVE REGULATED LEAD ACID</td>
</tr>
<tr>
<td>AC</td>
<td>ALTERNATING CURRENT</td>
</tr>
<tr>
<td>DC</td>
<td>DIRECT CURRENT</td>
</tr>
<tr>
<td>SM</td>
<td>STATION MASTER</td>
</tr>
<tr>
<td>GA</td>
<td>GENERAL ARRANGEMENT</td>
</tr>
<tr>
<td>PT</td>
<td>POTENTIAL TRANSFORMER</td>
</tr>
<tr>
<td>CT</td>
<td>CURRENT TRANSFORMER</td>
</tr>
<tr>
<td>OV</td>
<td>OVER VOLTAGE</td>
</tr>
<tr>
<td>UV</td>
<td>UNDER VOLTAGE</td>
</tr>
<tr>
<td>ACL</td>
<td>AC CURRENT LIMIT</td>
</tr>
<tr>
<td>VA</td>
<td>VOLT-AMPERE</td>
</tr>
<tr>
<td>Ah</td>
<td>AMPERE-HOUR</td>
</tr>
<tr>
<td>AVR</td>
<td>AUTOMATIC VOLTAGE REGULATOR</td>
</tr>
<tr>
<td>MOV</td>
<td>METAL OXIDE VARIASTOR</td>
</tr>
<tr>
<td>EMI</td>
<td>ELECTROMAGNETIC INTERFERENCE</td>
</tr>
<tr>
<td>DPM</td>
<td>DIGITAL PANEL METER</td>
</tr>
<tr>
<td>EBB</td>
<td>EQUIPOTENTIAL BUS-BAR</td>
</tr>
<tr>
<td>TCL</td>
<td>TOTAL CURRENT LIMIT</td>
</tr>
<tr>
<td>BCL</td>
<td>BATTERY CURRENT LIMIT</td>
</tr>
<tr>
<td>TCS</td>
<td>TEMPERATURE COMPENSATION SET</td>
</tr>
<tr>
<td>PWM</td>
<td>PULSE WIDTH MODULATION</td>
</tr>
<tr>
<td>LED</td>
<td>LIGHT EMITTING DIODE</td>
</tr>
<tr>
<td>SSI</td>
<td>SOLID STATE INTERLOCKING</td>
</tr>
</tbody>
</table>


INTRODUCTION TO SMPS BASED IPS SYSTEM

The Integrated Power supply Unit (IPS), designed as per customer supplied schematic block diagrams, is suitable for wayside signaling installations up to 6 lines without AFTC (or up to 7KVA total signaling load) in RE/Non-RE areas. It also covers PI / SSI stations.

The SMPS base IPS system is meant to give continuous supply to both AC & DC signaling circuits. The SMPS based IPS system consists of the following:

**SMPS based Float rectifier Boost Charger (FRBC) Panel**

This panel consists of FRBC (float rectifier cum boost charger) module, Distribution Supervisory control & Alarm (DSA) unit and metering section. The advantages of SMPS based FRBC over conventional types of controlled chargers are: a) they are modular and therefore easily replaceable. b) Works on wide range (150V AC–275VAC) input voltage. c) They have low current distortion and high power factor. d) High efficiency. e) Active current sharing in parallel operation. f) Low output ripple and low noise.

The special features of this panel includes class 'C' type protection against low voltage surges provided at the equipment input level. This is thermal disconnecting type and equipped with protection against SPD failure due to open & short circuit of SPD s connected between line & neutral. Additional protection against high input AC voltage or single phasing is provided by high speed static switch which trips the supply in this case and protects the IPS.

**AC Distribution Panel**

This panel consists of inverters; Ferro-resonant based Automatic voltage regulator (AVR), transformers and metering section.

**DC Distribution Panel**

This panel consists of all the DC-DC converters modules and common Digital voltmeter for measurement. The advantages of using these modules above the conventional transformer rectifiers are: a) They operate on wide range of input supply. b) They are custom built having wide output voltage range. c) High efficiency d) low output ripple and noise and e) Auto tracking output over voltage protection.

**Status Monitoring Panel for SM’s Room**

This panel consists of status indications and critical alarms of IPS to be provided in SM’s room. It is wall mounting type.

**Battery Bank**

IPS system is suitable for charging 110V battery bank of Low maintenance cells or VRLA Maintenance free cells. Battery bank is part of the specification and is supplied and commissioned along with the IPS. The battery is installed in a separate room. Low maintenance batteries are charged at site.
INITIAL CHECKS ON RECEIPT AT SITE

Initial checks and preliminary check out procedure are recommended for safe operation. Please follow step-by-step procedure described in the chapter.

INITIAL CHECKS:

Inspect the package for external evidence of damage and inform company handling in transit. Notify the damage if any and inform company immediately. Do not destroy or remove any of packing materials used in damaged shipment.

After unpacking the unit inspect through visual check to detect any transit damage to any component on the front panel or inside the cubicle. If any loose or broken connections are noticed set it right.

SAFETY PRECAUTIONS

Authorized, qualified and skilled electrical technician should only attempt installation, testing, fault location and repair of this IPS system. Firm in no way shall be held responsible for the electrocution, in any way, of the personnel doing this work.

This equipment carries dangerous voltages and stores electrical energy.

Before touching any live parts remove metal objects, e.g., metal bracelets, rings or a watch that may come into contact with electricity carrying items. Carry out the following instructions.

1. Switch-off the AC main supply external to the equipment.
2. Check with a suitable voltmeter fitted with insulated test probe that the equipment does not carry any voltage at either the input or the output before commissioning work.

The above instructions must always be followed before making any adjustment, and also before making any electrical connections to the part of the equipment for the purpose of servicing. Such connections should always be checked for safety before re-applying power.

The above instructions must also be carried out before any connection is modified or removed.

Note:

Adjustment should only be carried out with a non-conducting tool taking care not to touch any item carrying electricity while doing so.
INSTALLATION AND COMMISSIONING PROCEDURE

The initial installation of IPS Unit should be done by technically trained staff and under the supervision of the Firm’s representative. Also it is recommended that the operation of the unit be entrusted to a trained person only. Since the IPS unit has 230V AC input and 110V DC outputs Firm is not responsible for any accident or injury to any person due to negligence in carrying out maintenance work in it. Initial inspection and preliminary check out procedure are recommended for safe operation. Before switching on the IPS, all the connections shall be checked as per the interconnection wiring diagram.

MECHANICAL INSTALLATION:

The panels are free-standing steel structure mounted on a bottom channel along with 10mm anti vibration pads. The panels should be installed in dust free well-ventilated place of the building.

Clean the equipment properly to remove dust particles settled on the components and the equipments.

ELECTRICAL INSTALLATION:

1. Please check or verify the site condition as per Pre-Commissioning Check list attached.
2. Connect AC input supply on terminals provided in this equipment.
3. Connect earth connection to the panel.
4. Check all the fuses; they might have become loose in transit.
5. Check that all the PCB connections are properly connected in their correct position.

Important Note: - Please do not change the setting of potentiometer/preset before switching on the unit.
FRBC PANEL- GENERAL DESCRIPTION,
DESCRIPTION OF SUB SYSTEMS/MODULES,
TECHNICAL PARTICULARS, CONTROLS- INDICATIONS 
AND OPERATING INSTRUCTIONS.
(A.1) GENERAL DESCRIPTION OF FRBC PANEL

FRBC panel is the main source of power supply to the complete IPS system. The main input AC supply as well as the battery bank is connected in this panel as the main AC and DC source of input supply. These two sources of supply together with a suitably rated SMPS based battery charger constitute the source of AC and DC power supply for the other panels which then provide low voltage AC/DC supply to the railways’ signaling loads.

The FRBC panel consists of the following Main components:

1. SMPS based FRBC modules.
2. DSA module.
3. Static switch.
4. Class-C type protection device.

The SMPS FRBC is rated according to number of FRBC modules connected in N+1 configuration. Each module is rated at 110VDC / 20A.

In the healthy and switched-on condition the FRBC keeps the 110V DC battery bank in charged (floating) condition as well as supply to the DC loads such as DC-DC converters, inverters, etc which are provided in the adjacent panels. In the switched-off condition these loads are floated across the battery. On resumption of input AC supply to the FRBC it automatically start boost charging the battery to restore its charge.

This panel also conveys the failure of FRBC modules or the modules provided in AC distribution panel or DC-distribution panel to the user. This is done by providing normally open potential free contacts which are terminated on the control terminal strip in the FRBC panel.

Refer Electrical Circuit Diagram of this panel, the Incoming supply is 230VAC, 50Hz, single phase, which is connected on the L, N & E terminals which are provided inside the panel at the rear side. The cable entry is from the top of the panel. This supply is switched-on/off by input switch ‘SW1’ provided on the front panel. Choke ‘L1’ is input line choke. A short circuit on the AC side is protected by fuse ‘F1’.

A static switch module is provided which provides protection against AC out of-range, which disconnects the AC supply to the FRBC modules in case input AC supply goes out of range of the specified voltage. It will automatically re-connect the AC supply if it comes back within the range of operation. The voltage for disconnection is 145VAC while it reconnects at 160VAC.

The Current transformer connected on the AC input side is for monitoring of input AC current, the proportionate signal generated is fed to the DSA module for display and control. Now this input AC supply is fed to the FRBC modules through individual single pole MCBs. The modules run in active current sharing mode where the total DC load of (n-1) x 20 amps is shared by n modules. ‘n’ is total quantity of modules wired in the panels. The 110VDC output
from this is terminated on the output bus, through a system current shunt ‘SH1’. From this bus the 110VDC is distributed on the battery terminals-through a battery current shunt ‘SH2’.

Terminals are provided at the rear of this panel for 230VAC input supply, 110VDC battery, 110VDC for inverters (in AC distribution panel), 110VDC for DC-DC converter modules (in DC distribution panel), and 230VAC for AVR (in AC distribution panel), 110VDC for point machine, etc. The cable entry for all the terminals is from the top.

The DSA module is responsible for the control for current sharing of FRBC modules, total system current limiting, battery current limiting, changeover from float charging to boost and vice-versa, battery status monitoring, battery under voltage isolation of load, module failure alarm, system annunciation and various parameter display by Sensing the output voltage, battery voltage, total system current and battery current. The main circuits of DSA module are for temperature compensation, Float to boost change over, battery current limit and battery depth of discharge alarms. In addition it provides protection and alarms for AC under/over voltage, system overload and DC under voltage.

This SMPS FRBC panel also has facility to send status and fail signal of modules, provided in all the panels, to the Status monitoring panel which is mounted in the ASM room. Potential free contacts of different fail sensing relays are also wired up to the control terminal block.

A coordinated set of Class-B and class-C type SPDs are used in IPS system the have the complete protection against external influences of lightening current by class-B SPD and internal power supply load switching surge over-voltages by the class-C SPD.
(A.2) GENERAL DESCRIPTION OF SMPS BASED FRBC MODULE

FRBC MODULE -: The SMPS based FRBC module consists of Mother Board (DC-DC mother board and PFC mother board), PFC controller and DC-DC controller. A schematic drawing of the FRBC module is attached which shows connectors for input 230VAC supply, output 110VDC supply and control cable to connect it to DSA unit for protection, control and current sharing purpose are provided. A cooling fan, voltage setting potentiometer and one pair of socket is provided to monitor the output voltage of the module with the help of a Multimeter. The output voltage and current of the module can also be monitored on the DPM module provided on the FRBC module. A schematic block diagram of the mother board, PFC controller and DC-DC controller is given below with the description.

a. Description of Mother Board PCB

In this the Incoming supply is passed through RL1 & EMI filter consisting of L1, L2 & capacitor C10, C11. MOV1 is for surge protection. BR1 is bridge to rectify the incoming AC. L3 is PFC choke. Q6, Q8 are Mosfet for boosting the DC voltage. Boost Mosfet Q6, Q8 are driven by driver circuit. The rectangular Pulses for Mosfet driving are set at 18V. D18, D19 are blocking rectifiers. PFC boost voltage is used to charge capacitor C22- C25. Boost voltage is set at 395V. CT1 & CT2 are for monitoring the current into the DC-DC converter bridge consisting of Mosfet Q1 – Q8. This operates at frequency of 85 KHz. The gate drive to Q1-Q8 is square pulse of > 12V and can be monitored between gate & source of Q1 – Q8. These are isolated by TXR1. Output of Q1 – Q8 bridge circuit is fed to transformer TXR1. It has approximate amplitude of 395V. The output of TXR1 is approximately 200V. This high frequency voltage is rectified in ultra fast recovery diode consisting of diode D33-D35. L4, C11 is filtering circuit. L5 is common mode choke C12-C14 are filter capacitors. Module O/P is available at L -Ve & L +Ve.

Block Schematic of Mother Board
b. Description of PFC Controller

Function of PFC controller is to provide starting logic, generate PFC pulses. It senses the voltage and gives starting command to PFC controller, with a delay. A soft start resistance for capacitor charging is bypassed by relay RL1. It also has circuit to provide delay between PFC pulses & DC-DC converter pulses. LED1, LED2 are provided to show status of card, LD1 “ON” shows PFC over voltage. LD2 “ON” shows RL1 is operating.

Block schematic of PFC Control Board

```
  RL1
   /
  +-----------------+-----------------+
  |                 |                 |
  | STARTING LOGIC | PFC PULSE GEN. |
  |                 |                 |
  |                 |                 |
  |     LD1         |       LD2       |
  |                 |                 |
  | PFC OVER VOLTAGE LOGIC AND MIN. AC SUPPLY LOGIC |
  |                 |                 |
  |                 |                 |
  v                 v                 v
  TO MOTHER BOARD FOR MOSFET DRIVE
```

LED1, LED2


c. Description of DC-DC Controller.

Function of DC-DC control board is to provide voltage regulation, current limit, current sharing. It also provides Battery current limiting, float / boost selection and protection for output over voltage, under voltage, over load. This has indications for float, boost rectifier over voltage, mains on, output fail & fan fail on this card and generate gate pulse for Mosfet. Block description of the Circuit is as follows: Output voltage is fed to voltage divider & feed back processing network. This also receives temperature compensation from DSA. A current signal from shunt on mother board is processed in current amplifier & PI controller. The amplifier voltage is set at 5V at full load. This voltage is varying with reference voltage which is set at 6V DC and over load voltage reference is set at 5V for maximum current. DC under voltage & DC over voltage comparator compare the output voltage and produce high signal at output with delay and provides alarm. Unit trips in case of DC over voltage. In case of DC under voltage only alarm and indication comes. In case of Fan-fail unit trips with indication & alarm comes on.

Battery signal from DSA is fed to current clamping circuit for providing current limit feature for all modules as per battery requirement. Float & Boost command from DSA is for changing voltage reference to set voltage in float or boost. Output voltage in float mode, boost mode and current in float mode & boost mode is settable by preset on the front.
(A.3) **FRBC MODULE – TECHNICAL PARTICULAR**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Supply</td>
<td>230V AC (150V - 275V AC)</td>
</tr>
<tr>
<td>LM Batt</td>
<td>VRLA</td>
</tr>
<tr>
<td>Output voltage</td>
<td>Float mode: 118.25V 123.75</td>
</tr>
<tr>
<td></td>
<td>Boost mode: 133.0V 126.5</td>
</tr>
<tr>
<td>Output Current</td>
<td>20 Amps per module</td>
</tr>
<tr>
<td>Battery path Current limit</td>
<td>5% to 15% of the Battery Ah capacity</td>
</tr>
<tr>
<td>Ripple (without batt.)</td>
<td>Less than 300 mV Peak to peak</td>
</tr>
<tr>
<td>Psophometric noise (without batt)</td>
<td>Less than 10mV</td>
</tr>
<tr>
<td>Regulation</td>
<td>Less than +/- 1% for 25% to 100% Load.</td>
</tr>
<tr>
<td>Efficiency</td>
<td>Greater than 90% at nominal input and rated load.</td>
</tr>
<tr>
<td>Total Harmonic Distortion</td>
<td>Less than 10% at 50%-100% of rated load.</td>
</tr>
<tr>
<td>Type of charging</td>
<td>Automatic Float - Boost.</td>
</tr>
<tr>
<td>Type of indications/protections</td>
<td>LEDs on front PANEL.</td>
</tr>
<tr>
<td>Over Load Protection</td>
<td>Current limiting with voltage droop.</td>
</tr>
<tr>
<td>Short Circuit protection</td>
<td>Provided with auto reset facility.</td>
</tr>
<tr>
<td>DC Over volt Protection</td>
<td>Shutoff at 2.37/2.5V/cell (VRLA/low maintenance)</td>
</tr>
<tr>
<td>Battery under volt isolation</td>
<td>At 1.80/1.85 V/cell (for VRLA/low maintenance)</td>
</tr>
<tr>
<td>Battery reverse polarity</td>
<td>Reverse Polarity contactor does not operate and Indication appears.</td>
</tr>
</tbody>
</table>
(A.4)  

FRBC MODULE - CONTROLS & INDICATIONS

Volt/Amp push button : This push button when un-pressed shows the output voltage of module and when pressed shows the output current of the module.

Mains : This indicates mains supply to the module is on.

Float : This indication shows the module is in float mode of charging.

Boost : This indication shows the module is in boost mode of charging.

Overload/Short Circuit : This shows that the module is overloaded.

Under voltage : This shows that the output DC voltage of the module is low or it is sensing a discharged battery voltage when all the three modules are off.

Output Fail : This indication shows that the output DC of the modules is not available.

Over voltage : This shows that the output DC Voltage of the module have Exceeded normal output operating range.

Over Temperature : This indicates that the temperature of the module inside is more than 85°C.

Fan Fail : This shows that the cooling fan of the module has failed.

Display (DPM) : Following parameters are displayed on the display of the module.

  Output voltage
  Output current
(A.5) OPERATING PROCEDURE OF FRBC PANEL

FRBC PANEL

BATTERY: The 110V Battery Bank is connected in charged condition.

NOTE: Connect equipment earth to Rack/panel and panel earth to EBB. In absence of good earth the proper functioning of some circuits is not ensured. Ensure that earth resistance is <2Ω.

Keep main switch, provided on the front of the panel, in off position.

- Connect 230V AC supply at the rear of the panel across L, N & E input supply terminals. The cable entry is from the top cover side. Check this supply on the terminals
- Keep SMPS FRBC modules off.
- Switch ON the main switch.
- Switch ON FRBC modules one at a time. The modules are switched-on through single pole MCB, provided inside the panel at the rear. Observe its voltage on the display on its front.
- Check 230V AC across the terminals marked ‘230V AC to AC PANEL’.
- Check Float charging voltage of FRBC module at the following terminals provided at the rear top side of the PANEL.
  - Battery Terminals
  - 110V DC for inverters.
  - 110V DC DC-DC converters.
  - 110V DC for point machine.

- Switch OFF FRBC modules. Switch OFF Mains input switch.
- Connect battery bank in correct polarity across battery terminals.
- Switch ON mains input switch. Switch ON FRBC modules. Battery draws current. Connect cables on the terminals provided for 110VDC Turnouts.
- For readings and settings procedure refer the instructions on “Microcontroller based DSA module: Operating instructions”.

The SMPS FRBC PANEL is now installed.
(A.6) MICROCONTROLLER BASED DSA MODULE: OPERATING INSTRUCTIONS

1. The display in the system shows
   a. AC voltage (left corner of the display at 1st line): This is the phase to neutral voltage connected to the IPS.
   b. AC Current (right corner of the display at 1st line):
   c. DC Voltage (left corner of the display at 2nd line): This is the Battery voltage which is common for both batteries (provision of single or two battery banks is made as per requirement).
   d. Load current (Right corner of the display at 2nd line): In normal mode, it is showing "Load current" with symbol "T".
   e. Battery current (Right corner of the display at 2nd line): To see the "Battery current", press "Increase" for 3 seconds. The system will display "Battery current" with symbol "B" for 10 seconds.

2. The system will display “FC” in Float mode and “BC” in Boost charge mode.

3. For any fault, the system will give alarm and display “FLT” with blinking effect till the fault goes. Press “ENTER” to see the faults, the list of faults is displayed for 30 seconds & buzzer will stop ringing.

4. To come to normal mode press “ENTER”.

5. To see the parameters values, press “SET” for 3 seconds.

6. The system will display “Login: User Set”.

7. Press “SET” again to choose “Fact set”.

8. Choose the User Set Login mode and press “ENTER”.

9. To choose the Fact set Login mode. Enter 4-digit password (only for factory person).

10. After pressing “ENTER” key in User set, display will show “Float: voltage”, the first parameter of the User Set.

11. Press “SET” button. Subsequent pressing of set button, the display shows all the parameter with its value one by one, these parameters are “FLOAT”, “BOOST”, “AC OV SET”, “AC UV SET”, “AC SPAN”, “DC OV SET”, “DC UV SET”, “50% DOD”, “60% DOD”, “70% DOD”, “SYS CRNT” (for system current), “BCL”, “ACL”, “TCS”, “F to B Current”, “B to F Current”, “RESTORE USER SET”.

12. To change the parameter values, first select the parameter.

13. To increase the value of selected parameter, press “INCREASE”.

14. To decrease the value of selected parameter, press “DECREASE”

15. To register (store) the set value, press “ENTER”.

16. To restore the Default User setting first select the “RESTORE USER SET” of user set Login mode then press “INCREASE” key and “DECREASE” key simultaneously for 4 seconds.

   Note: Except “Float”, “Boost” and “BCL (Battery current limit)” all are factory settings. Do not disturb the settings.
AC DISTRIBUTION PANEL GENERAL DESCRIPTION,
DESCRIPTION OF SUBSYSTEMS/MODULES, TECHNICAL
PARTICULARS, CONTROLS- INDICATIONS AND
OPERATING INSTRUCTIONS.
(B.1) GENERAL DESCRIPTION OF AC DISTRIBUTION PANEL

AC DISTRIBUTION PANEL (ACDP) consists of Inverters, AVR and Transformer modules. The input supply to the inverters is 110V DC from the FRBC panel. The AVR is connected in standby mode from 230V AC commercial input supply. The signaling transformers are connected at the output of a changeover circuit between two inverter modules in hot standby mode and one AVR.

One or more groups of inverters and AVR are connected in master/slave configuration. In each group two inverters and one AVR is wired. One of the Inverters works as Master and other as its slave. The output load connected to this group is operated on the Master inverter. Upon failure of master inverter the slave inverter takes over the output load. After both inverters fail, the AVR start running the load. The output of each group is 230VAC. This 230VAC is fed to the input of signal transformer modules or any other load as shown on the block diagram. An auto-manual bypass switch is also provided at the output of each auto changeover. Normally this switch is kept at Auto position. In case the auto changeover is not working the switch may be kept at a marked bypass position. A detailed electrical circuit diagram is enclosed.

Digital panel meter for displaying AC voltage of AVR, inverter modules and transformer module and the signal load current is provided on the front panel cover.

The failure status of each module is detected through control circuits provided inside the modules and passed to the FRBC panel as described earlier. The failure may be switched-off condition also.

Each module provided in this panel is equipped with a termination card (T-card) which senses its output voltage and gives various indications as per specification. It also generates failure signal in case its output fails. The failure signal of inverters is sent separately, the failure signals of all the AVRs and transformer modules is combined and sent separately. All these failure signals are sent to the DSA module of the FRBC panel.

Terminals are provided in this panel for 230VAC input supply for AVR, 110VDC input supply for inverters, and AC output supply (normally 110V) from transformer modules. As per requirement terminals for 230VAC output supply for PC loads and goomties are also provided.
(B.2) GENERAL DESCRIPTION OF INVERTER MODULE

The inverter Module is IGBT based, in which the IGBTs are configured in bridge formation. Electrical circuit diagram of the same is enclosed in the manual.

The input DC to the inverter is fed through main MCB. This voltage is sensed by the inverter card, which then gives control voltage to the DC contactor to operate. When the DC contactor operates, its auxiliary contact helps in soft start, by releasing the gate drive only after the input DC contacts are made.

The gate drive to the IGBTs is given through a PWM controller. The PWM controller employs a pulse generator, whose duty cycle varies according to the variation in the output voltage, which is sensed through PT and the output load current, which is sensed by CT. The duty cycle varies in such a way that the output voltage remains stabilized to 230V +/- 2%.

The output of the bridge is fed to a step-up transformer. The step-up voltage decides the output voltage. The frequency of the output voltage is kept at 50Hz by synchronizing the pulses with a 50Hz crystal oscillator.

This transformer is a specially designed one, in that the leakage inductance itself is used to filter the PWM wave shape.

(B.3) GENERAL DESCRIPTION OF AVR MODULE

AVR MODULE - The automatic voltage regulator (AVR) is designed to cater for any load from no load to full load of its rated capacity. It is completely static type involving no moving parts. The output voltage is maintained at the nominal value of 230V ± 1% at all the loads varying from 25% to full load keeping the input voltage constant at 230V 50Hz.

It works satisfactorily within supply frequency of 50Hz ± 2.5 Hz. The output voltage of the regulator is maintained within ± 3% of the reference output voltage for ± 1 Hz frequency variation and within ± 6% for ± 2 Hz frequency variation.
The AVR works satisfactorily within a range of 160V to 270V input at 50Hz mains supply. The output voltage is maintained within 230V ± 1% when the unit is connected to rated load.

(B.4) GENERAL DESCRIPTION OF TRANSFORMER MODULE

TRANSFORMER MODULE – The offered transformer module is a 230VAC/110VAC step-down transformer. It is double wound type and designed for an input supply of 230V ± 2% 50Hz. It is having separate input and output windings. The secondary of the transformer is provided with taps at 0, 100, 110, 120, 130V at no load. It is designed to achieve less than ± 5% voltage regulation.

(B.5) INVERTER MODULE – TECHNICAL PARTICULARS

- Input Voltage: 110V (98V - 138V) DC
- Output Voltage: 230V AC
- Output Power: Rated as per requirement.
- Output Frequency: 50Hz ± 1%
- Voltage Regulation: <± 2% of 230V AC at 25-100% rated load
- Efficiency: Greater than 85% at rated load
- Waveform distortion: Less than 8%
- Over Load Protection: Provided
- Short circuit Protection: Provided with auto reset facility.

(B.6) AVR MODULE – TECHNICAL PARTICULARS

- Input Voltage: 230V (160V - 270VAC)
- Output Voltage: 230V ± 1% for 25-100% load (230V Input)
- Output Capacity: As per requirement
- Regulation: ± 1% for 25% to 100% load change at 230V AC Input
- O/P voltage vs frequency change: ± 3% for ± 1Hz change in frequency
- Frequency relation: ± 6% for ± 2Hz change in frequency
- Waveform Distortion: Less than 8%
- Efficiency: >85% for 1000VA AVR
(B.7) TRANSFORMER MODULE – TECHNICAL PARTICULARS

Input Voltage : 230V± 2% AC
Output condition : As per requirement
Efficiency : > 90% at rated load
Regulation : ±5% at 230V

(B.8) INVERTER MODULE – CONTROLS AND INDICATIONS

Input MCB : This MCB at the rear extends input 110V DC to the Inverter.
ON, OFF/Reset switch : This switch switches on the inverter.
Mains : This indicates that mains DC supply is available in inverter
Output : This indicates that the 230V AC is available at the output terminal of the inverter, not necessarily at the AC load bus.
Inverter Fail : This indicates that the Inverter is not working.
On Load : This indicates that the output load is running on this inverter.
Fan Fail : This indicates the failure of cooling fan.
O/P Overload * : This indicates that the 230V AC output of the inverter is overloaded.
DC under Voltage * : This indicates that the input DC voltage to the inverter is below 98V.
AC Over/ under Voltage * : This indicates that the output AC voltage of the inverter has crossed the upper set limit.
DC over Voltage * : This indicates that the DC input of the inverter have crossed the upper set limit.

- These indication LEDs are provided on the main control card of the inverter.

(B.9) AVR MODULE – CONTROLS & INDICATIONS

AVR ON/OFF Switch : This switch is used to extend input 230V AC supply to the AVR.
AVR ON : This indicates that the output 230V AC of the AVR is available at its output terminal.
Voltage Monitoring Socket : This is to monitor the voltage of AVR Module through Voltage monitoring jack. Voltage can be monitored on the digital display meter provided on the front of the AC- Distribution Panel.
(B.10) TRANSFORMER MODULE – CONTROLS & INDICATIONS

INPUT SUPPLY : This switch extends input supply to the module.

INPUT ON : This indication shows that the input to the transformer module is on.

FAIL : This indicates that the transformer module has failed or its fuse is blown.

OUTPUT : This indicates that the output AC of the transformer is ON.

Voltage Monitoring Socket: This is to monitor the voltage of Transformer Module through Voltage monitoring jack. Voltage can be monitored on the digital display meter provided on the front of the AC-Distribution Panel.
AC DISTRIBUTION PANEL -

**NOTE:** Connect equipment earth to Rack/panel and panel earth to EBB. In absence of good earth the proper functioning of some circuits is not ensured. Ensure that earth resistance is <2Ω.

Ensure all the terminals which are used for inter connection between all the Panels doesn’t carry any supply.

- Connect inter connection cables between terminals of-
  - **FRBC PANEL**
  - **AC DISTT.PANEL**
  - 110V DC TO AC PANEL - INVERTER INPUT TERMINALS
  - 230V AC TO AC PANEL - AVR INPUT TERMINALS

  Check the above supplies 110V DC and 230VAC at the input terminals of AC distribution panel.

- Connect inter connection Fail- signal wires between cards of FRBC PANEL and AC DISTT.PANEL. These cards are mounted at the rear side top of these Panels.

- Firmly place the input, output and control bus connectors of AVR, Inverters and Transformer Modules. These are provided at the rear of these modules.

- The other end of the control-bus flat cable is firmly placed on the interface cards provided at the rear of the PANEL. These carry fail signals.

- Keep the ‘Auto-Manual Bypass’ switch provided at the rear of the panel to ‘Auto’ position.

- Switch ON Inverter-1 through its ‘MCB’ at the rear and ‘on-reset’ switch on the front and check its voltage on the 230V AC bus at the rear.

- Switch OFF this Inverter.

- Switch ON Inverter-2 through its ‘MCB’ at the rear and ‘on-reset’ switch on the front, checks its voltage on the 230V AC bus at the rear.

- Switch OFF this Inverter.

- Switch ON the AVR and check 230V AC on the AC bus.

- Again switch-ON both the Inverters. Inverter-1 will remain on the AC bus. Inverter-2 will be standby and AVR will automatically be switched OFF.

- Switch-ON Signal and Track Transformers.

- Check 110V AC supply output of the transformer modules at marked terminals at rear.

The AC Distribution PANEL is now installed.
DC DISTRIBUTION PANEL GENERAL DESCRIPTION,
DESCRIPTION OF SUB SYSTEMS/MODULES,
TECHNICAL PARTICULARS, CONTROLS- INDICATIONS
AND OPERATING INSTRUCTIONS.
(C.1) GENERAL DESCRIPTION OF DCDP PANEL

DC DISTRIBUTION PANEL (DCDP) provided in this IPS consists of a number of groups of DC-DC Converters connected in parallel as per IPS system configuration. DC-DC converters are wired in minimum (N+1) redundancy. Each group of DC-DC converters used for a particular load circuit work in active current sharing mode such that all the modules share the total load current of that circuit within 10%. As a result even in case of failure of a module the load supply remains uninterrupted.

The input supply for these DC-DC converters is taken from the SMPS FRBC panel. The 3,1/2 digit display unit provided for this panel shows the output voltage of the DC-DC converters. For this a plug provided on the front is inserted in the monitoring socket of the DC-DC converter module.

The failure of the DC-DC converters is also detected by the control circuits provided inside the modules itself and transferred to the DSA unit. The control signals which includes the ±12 V DC power supply, the fail signal track of the module and the current sharing signal track (within the group) is carried by flat cables. First the modules of same group of DC-DC converters are interconnected through flat cables. Up to this stage the ±12 V DC power supply, the fail signal of the module and the current sharing signal is shared. Now a single flat cable from each two or three groups is terminated on a paralleling card. The current sharing track is not provided on this card. Only the ±12 V DC power supply and the fail signal track is provided on it. In this way the current sharing is done within the same group of DC –DC converters but the fail signal of all the modules is combined to make it as a group fault signal which is then sent to the DSA unit.

DC-DC converters are also protected by EMI/RFI interference.

Terminals are provided in this panel for 110VDC input supply for DC-DC converters (except for Tele modules), 110VDC for Tele DC-DC modules, outgoing terminals of each group of converter modules. A Schematic wiring diagram of this panel is enclosed.
(C.2) GENERAL DESCRIPTION OF DC-DC CONVERTER MODULE

DC-DC CONVERTER MODULE – Function of DC-DC converter is to provide DC of different voltage from 110VDC input supply. This unit has protection for input DC under voltage, Input DC over voltage and Output DC over voltage. It has voltage regulation, current regulation and current sharing circuit. The block schematic description is given below. The DC input voltage is passed through EMI, RFI and surge protection circuit. The input DC under voltage and over voltage circuit monitors the voltage & trips the DC-DC converter if it is below 98V or more than 138V. This DC is converted into 80KHZ AC by power conversion switch ‘T’. This AC is fed to TX. The input of this is rectangular pulse of magnitude of 110V at nominal input. This output is rectified and is filtered in filter consisting of L2 and capacitor C31. L3 and C33 form second stage filter. Voltage from output and current signal from CT2, CT3 are processed in dual Op-amp and they are used to control the pulse generator. The pulses are fed to transformer TX2 which provides the gate drive for Mosfet used for power conversion. Indication for DC on, converter on and converter fail are provided thro LED1, LED2, & LED3. As shown in schematic drawing of DC-DC converter, one on/off switch, potentiometer for voltage setting and one pair of socket to monitor the output DC voltage with the help of a multimeter is also provided.

Block Schematic of DC-DC Converter
(C.3) DC-DC CONVERTER MODULE - TECHNICAL PARTICULARS

- **Input Voltage**: 98V - 138V DC
- **Output condition**: As per sketch
- **Efficiency**:
  - > 50% : 10VA to 50VA
  - > 75% : 50VA to less than 150VA
  - > 80% : 150VA and above

Note: Efficiency measured at maximum voltage of the given range of module

- **Regulation**: ±1 of the set value for load variation of 10% to 100% rated, input supply 98V-138V DC
- **Ripple**: < 50 mV pp,
- **Psophometric noise**: < 4mV. - BLOCK LINE, BLOCK TELE
- **Facility for current sharing**: Within 10% for 50%-100% load, except Block-Tele.
- **Over Load protection**: Provided at 105% of the rated current
- **Over voltage protection**: Provided at 110% of the rated current

(C.4) DC-DC CONVERTER MODULE - CONTROLS & INDICATIONS

- **UNIT ON/OFF**: This switch on front PANEL of each DC-DC converter is used to switch ON or OFF the converter.
- **INPUT**: This indicates that the 110V DC input to the DC-DC converter is on.
- **FAIL**: This indicates the failure of DC-DC converter.
- **OUTPUT**: This indicates that the DC-DC converter is on and giving DC output.
- **VOLT ADJ.**: This adjusts the output voltage of DC-DC converter. This pot is accessible from the right cover after pulling the module out.

Voltage Monitoring Socket: This is to monitor the voltage of DC-DC converter through Voltage monitoring jack. Voltage can be monitored on the digital display meter provided on the front of the DC-Distribution panel.
(C.5) OPERATING PROCEDURE OF DC DISTRIBUTION PANEL

Input of DC distribution panel is 110V DC, which is extended from the SMPS FRBC panel. Since a battery is floated across this every care must be taken not to short circuit the battery.

- Replace the fuses removed in SMPS charger section. Check 110V DC across the terminals.
- Ensure firm placing of input, output and control-bus connectors of DC-DC converter modules. All the DC-DC converter modules of a group are interconnected by flat-cables. Then a single flat cable from one or two groups of DC-DC converters is terminated on a paralleling card.
- Switch-On the DC-DC converter modules of a group, say, ‘External Relay supply’, one at a time and set equal voltage of all the modules of this group. Voltage can be observed on DC display. Repeat this step with other set of DC-DC Converter modules.
- Check the voltage of a group on the terminals provided at the top.
- The DC Distribution panel in now installed.

Note: For adjustment of voltage of DC-DC converters of a group follow these steps:

1. Switch-on on module of the group at a time.
2. Gently pull out the module so that the voltage adjustment potentiometer is accessible from the right side, through the cover.
3. Adjust the desired voltage through the potentiometer. The voltage is observed on the digital panel meter after inserting the jack-plug into the socket of the converter.
4. Repeat the steps 2 and 3 on the remaining DC-DC converter modules of the same group.
**D.1) STATUS MONITORING PANEL**

Status monitoring panel is installed in the room of SM on duty. The panel has LED indications and alarms with resetting button.

The indications and alarms provided on the panel:

1. **Run Gen set** – at 50% DOD – gives audio / visual alarm. Alarm can be acknowledged.
2. **Emergency start gen** – at 60% DOD - gives audio / visual alarm. Alarm can be acknowledged.
3. **System shut down** – at 70% DOD – signal feed cut-off, all DC-DC to work. Audio alarm will continue till generator is started.
4. **Call S & T** - Equipment fault – failure of any module will give alarm which can be acknowledged.
5. **Stop gen set** – FRBC changeover to Float – Audio/visual alarm.

A circuit diagram of the panel is enclosed in the manual.

**D.2) Depth of discharge setting for ASM BOX**

As the AC power fails the battery connected to the IPS starts discharging.

Considering the nominal bank voltage of 110V DC (2.0V/cell), load connected, as fully charged and 101.75 V DC (1.85V/cell for Low Maintenance, 1.8V/cell for VRLA) as 100% discharged, its status during this span is constantly monitored in the DSA module of the FRBC panel and signals are sent to the SM monitoring PANEL at three stages, which are:

- 50% Depth of Discharge (DOD) -105.9V (approx.), calls for Start Generator
- 60% Depth of Discharge (DOD) -105.1V Calls for Emergency, Start Generator
- 70% Depth of Discharge (DOD) -104.3V Calls for System -Shut-Down except the DC Circuits.

When the battery is discharged to 1.85V/cell for LM or 1.80V/cell for VRLA battery, all the loads except telephones are disconnected from the battery.
DO's AND DON'T's
(E.1) **FRBC MODULE**

**Do's**
* Keep all the modules in on position.
* Set equal voltage for float & boost in all modules for proper current sharing.
* Set battery path current to battery Ah capacity / 10.
* Set battery voltages according to type of battery. For VRLA battery float is 2.25V/cell & boost is 2.3V/cell for LM Battery float is 2.15V/cell & boost is 2.4V/cell.

**Dont's**
* 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 under voltage –cut-off setting.

(E.2) **INVERTER MODULE**

**Do's**
- Ensure correct DC polarity to Inverter input.
- Keep the Auto-Manual bypass switch provided in the panel in Auto position.

**Dont's**
- Do not switch OFF the MCBs of both or in fact any one. Both the inverters are working in master-slave fashion.
- Do not Switch OFF the Incoming of AVR.
- Do not remove input / output connectors when unit is on.

(E.3) **DC-DC CONVERTER MODULE**

**Do's**
* Always connect connectors and then switch on DC-DC converters.
* Proper grouping of the DC-DC converter modules on the paralleling card.
* Ensure input DC voltage is within the range of 98-138V equal.
* Always set equal voltage for modules working in parallel.

**Dont's**
- Do not switch-off any of the modules of a group of DC-DC converters.
- Do not set unequal voltages of the DC-DC converters of the same group.
- Do not remove the flat cable connected to a DC-DC converter.
(E.4) **AVR MODULE**

**Do's**
* Ensure proper input supply.
* Ensure the frequency of supply is within 50 HZ ±2 HZ.

**Dont's**
- Do not Run AVR at no load.

(E.5) **TRANSFORMER MODULE**

**Do's**
* Always ensure 230V supply to transformer.
* Always load only up to rated current.

**Dont's**
* Do not Short output of transformer.
TROUBLE SHOOTING FLOW CHART
TROUBLE SHOOTING

Trouble shooting should be entrusted to qualified personnel and should be done without disturbing other settings. Given below are the troubles shooting flow charts.

A. FRBC PANEL

i. Problem No. 1

![Trouble shooting flow chart for FRBC PANEL Problem No. 1](image-url)
ii. Problem No. 2

Output is low

Output is drooping

YES → Wait for the current to reduce below the limit-set

NO

Volt adjustment is not proper

YES → Correct the Float voltage and Boost voltage setting

NO

Battery current is reduced

YES

Correct O/P voltage is available

NO

iii. Problem No. 3

Module is tripping

Output voltage setting is higher than 140DC

YES → Correct the output voltage setting

NO

Fan fail indication is glowing

YES → Replace faulty Fan or Sensor

NO

Fan or the temp. sensor is faulty

YES

Module is not tripping

iv. Problem No. 4

The current sharing between modules is not proper

Module voltage setting is not equal

YES → Set equal voltage of each module

Current sharing is within 10-15% of equal currents
B. AC DISTRIBUTION PANEL

a. Inverter Module

- Inverter is not coming-on
  - Input DC supply on the input terminals is not available
    - YES: Provide input DC supply
    - NO:
      - Input MCB in Inverter is not ON
        - YES: Switch-on the input MCB
        - NO:
          - Input fuse inside the inverter is blown
            - YES: Replace input fuse
            - NO:
              - Input DC is lower than 70% DOD level of battery
                - YES: Let the battery charged above 70% DOD level
                - NO
              - Input DC is lower than 70% DOD level of battery
                - YES: Let the battery charged above 70% DOD level
                - NO:
                  - DC voltage is higher then 138V DC
                    - YES: Correct the input DC voltage
                    - NO:
                      - AC output voltage is higher than 250V AC
                        - YES: Replace Driver Card
                        - NO:
                          - Inverter is faulty
                            - YES: Replace controller Cards
                            - Inverter’s output is available

b. AVR Module

i. Problem No. 1

- Output is not available
- One inverter is giving output
  - YES: AVR will give output after both inverters fails
  - NO

- Input switch is off
  - YES: Switch-on the input switch
  - NO

- Input or Output connector is loose
  - YES: Tightly place the loose connector
  - NO

- Input supply is not available
  - YES: Provide input supply within the range

- Output is available

ii. Problem No. 2

- Voltage regulation is poor

- Input supply is lower than 160V AC
  - YES: Provide input supply within the range
  - NO

- Load current exceeded the rated current
  - YES: Bring load current within the rated current

- Output is available
c. Transformer Module

Output is not available

Input or Output connectors is loose

YES
Firmly place the loose connector

NO

Input 230V ac is not available

YES
Provide Input 230V AC from Inverter or AVR output

NO

Input switch is OFF

YES
Keep the switch to ON position

NO

Output is available
D. DC DISTRIBUTION PANEL

PROBLEM-1

Output of a DC-DC Module not available

Input or Output connectors are loose

YES Firmly place the loose connector

NO

Input switch is OFF

YES Switch – ON the module

NO

Modules tripped on fault

YES Fault may be O/P OV or OL

NO

Input fuse may be blown

YES Replace I/P Fuse

NO

Output is available

---

PROBLEM-2

Converter O/P is low

Voltage is not set correctly

YES Set correct output voltage

NO

Module is on over-load

YES Check & reduce the load

NO

Converter O/P is correct

---

PROBLEM-3

Connector Voltage is not settable

Control loop is faulty

YES Replace the module

NO

Problem is solved