

**POWER SUPPLY ARANGMENT FOR LEVEL CROSSING GATE & INTERMEDIATE  
BLOCK WORKING.**

**VERSION 1.0**

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Abstract  This document defines specification of Power Supply arrangement for level crossing Gate.			

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**ABBREVIATIONS USED**

Abbreviation	Detail
AVR	Automatic Voltage Regulator
ASM	Assistant Station Master
DSA	Distribution Switching & Alarm Unit
DG Set	Diesel Generator Set
DCDP	DC Distribution Panel
DOD	Depth of Discharge
EI	Electronic Interlocking
EMI	Electromagnetic Interference
IS/IEC	Indian Standard/ International Electrotechnical Commission
LCD	Liquid Crystal Diode
LED	Light Emitting Diode
MTBF	Mean Time Between Failure
MOV	Metal Oxide Varistors
OEM	Original Equipment Manufacturer
PI	Panel Interlocking
PF	Power Factor
PWM	Pulse Width Modulation
RE	Railway Electrification
RFI	Radio Frequency Interference
SMPS	Switch Mode Power Supply
SPD	Surge Protection Devices
VRLA	Valve Regulated Lead Acid

**GOVERNMENT OF INDIA  
MINISTRY OF RAILWAYS  
(RDSO)  
INDIAN RAILWAY SPECIFICATION  
FOR  
POWER SUPPLY ARANGMENT FOR LEVEL CROSSING GATE & INTERMEDIATE  
BLOCK WORKING  
FOR  
SIGNALLING INSTALLATIONS ON INDIAN RAILWAYS  
(RDSO/SPN/ /2012, Version 1.0)**

**0. FOREWORD**

- 0.1 This specification is issued with the fixed serial number followed by the year of adoption as standard or in case of revision, the year of latest revision.
- 0.2 This specification is intended chiefly to cover the technical provisions and does not include the necessary provisions of a contract.
- 0.3 This specification requires reference to following specifications:

IRS: S 88/2004	Low Maintenance Lead Acid Battery
IRS:S 93/96(A)	Valve Regulated Lead Acid Sealed Maintenance Free Stationary Battery
RDSO/SPN/144/2006	Safety & reliability requirements of electronic signalling equipment.
RDSO/SPN/165/2012	SMPS based integrated power supply system
IS:9000	Basic environmental testing procedure for electronic and electrical item
IRS:S 23	Electrical Signalling & Interlocking Equipment.
IEC-61643	Surge Protective Devices connected to low-voltage power distribution systems
IEC 61312	Protection against Lightning Electromagnetic Impulse
IEC 61024	Protection of structures against Lightning
EN 55022	European Standard for Information Technology Equipment
IRS:S 74/89	Voltage Regulator-Ferro Resonant
IRS:S 84/92	Solor Photo Voltaic Module.
EN 50129	Railway Application Safety Related Electronic System For Signalling

- 0.4 Wherever, in this specification, any of the above mentioned specifications is referred by number only without mentioning the year of issue, the latest issue of that specification is implied.

**1.0 OBJECTIVE & SCOPE**

- 1.1 This specification covers the technical requirements of Power Supply Arrangement for Level Crossing Gate and Intermediate Block Working with solor backup (PSA/LC/IB) suitable for wayside signalling installations in RE & Non-RE areas.
- 1.2 The PSA/LC/IB system is suitable to work with either Low Maintenance cells as per IRS: S 88/2004 or with VRLA Maintenance Free cells as per IRS: S 93/96(A).

**2.0 GENERAL REQUIREMENTS**

2.1 The Power Supply Arrangement for Level Crossing Gate and Intermediate Block Working (PSA/LC/IB) is meant to give continuous supply to both AC & DC signalling circuits for wayside signalling installations in RE & Non-RE areas. The Power Supply Arrangement for Level Crossing Gate and Intermediate Block Working (PSA/LC/IB) consists of the following:

2.1.1 **Bi-directional Inverter**

The design of Bi-directional Inverter is such that it charges the battery in charger mode and it converts the battery energy to AC in Inverter mode in the systems with renewable energy source, where energy is stored in batteries.

2.1.2 **DISTRIBUTION/ SUPERVISORY CONTROL /ALARM (DSA)**

The System shall have a distribution/ supervisory control / alarm section, preferably in the upper portion of the rack for termination of battery, load and AC/DC input & outputs.

2.1.3 **GPRS:** A GPRS based information system to transmit data corresponding to the Mains voltage, AC / DC output voltages and battery voltage in addition to the faults occurring

2.1.4 **Automatic voltage regulator (AVR)**

The Automatic Voltage Regulator shall be designed in line with specification IRS: S:74/89 to cater for any load from no load to full load (from unit power factor to 0.8 lagging) of its rated capacity. The voltage regulator shall be capable of handling any load, without degrading total harmonic distortion and regulation.

2.1.5 **Solar Photo Voltaic Module (SPV)**

The Solar Photo Voltaic Module (SPV) shall be designed in line with specification IRS: S:84:92 which covers the general and technical requirements and tests for solar photovoltaic module (for use in Railway S&T installation).

2.1.6 **Solar Charge controller**

The Solar Charge controller shall be Maximum Power Point Tracking (MPPT) type. Its rating shall be 25A min (11.0A for inverter & 10A for battery) and the input voltage range shall be 70V to 150 V minimum.

2.1.7 **Transformer rectifier**

Transformer-Rectifier set shall be designed in line with RDSO specification IRS: S:91:93 to covers the general and technical requirements for use in Railways signalling installations.



**2.1.8 Transformer**

The Transformer shall be designed in line with specification IRS: S:72:88 to cover the general and technical requirements for use in Railway S&T installation.

**2.1.9 Battery Bank**

Low Maintenance cells as per IRS: S 88/2004 or with VRLA Maintenance Free cells as per IRS: S 93/96(A) shall be in line with RDSO specification for use in railway signalling and telecommunication. The low maintenance battery shall be of design such that it requires very less topping up in the actual service.

2.1.10 Battery racks (MS) for VRLA batteries / wooden rack for low maintenance batteries, along with its accessories duly approved by purchaser, shall also be supplied with battery bank. Alternatively, battery may be housed in the Lower compartment of the IPS rack itself.

2.1.11 The battery is to be installed in a separate room. Low Maintenance batteries are to be charged at the site by OEM for which power supply shall be arranged by Railways. A test certificate of initial charging/capacity testing shall be submitted by OEM to Railways.

2.1.12 OEM shall supply copper cable of suitable dia as per IS: 694 and grade 1100V for connecting LC-IB power supply to Battery bank (distance to be given by Railways at the time of indenting) as given below –  
a) For 120AH battery – 10Sq.mm  
b) For 200AH battery – 16 Sq.mm  
c) For 300AH battery – 25 sq.mm

2.1.13 An exhaust fan of 12” size (minimum) shall be supplied for the LC-IB power supply room by the OEM. The exhaust fan shall run with commercial AC supply. Railways shall ensure installation & commissioning of the exhaust fan.

**2.2 Typical Configurations**

2.2.1 Typical configuration of) Power Supply Arrangement for Level Crossing Gate and Intermediate Block Working (PSA/LC/IB is meant to give continuous supply to both AC & DC signalling circuits for wayside signalling installations in RE & Non-RE areas is as per drawing no. **SDO/ PSA/LC-IB /001 (Ann-I)**.

2.2.2 Depending upon the power requirement at the Level Crossing Gate and Intermediate Block Working, purchaser can give any alternate configuration using standard modules and ensuring that it meets the overall design of input and output.

**2.3 Indoor Environmental condition**

The power supply arrangement for Level Crossing Gate and Intermediate Block Working is intended for use in most tropical climate in India where the maximum ambient temperature may reach upto 50°C with relative humidity reaching upto 95%.

**3.0 TECHNICAL REQUIREMENTS**

**3.1 Electrical Requirements**

3.1.1 Power Supply Arrangement for Level Crossing Gate and Intermediate Block Working (PSA/LC/IB) shall be suitable for operation for a nominal input voltage of 230V AC, 50Hz single phase power supply derived from Electricity Board or Railway Traction supply or 7.5/10/15 KVA diesel generator set with AMF control of appropriate quality. The system shall work satisfactorily with input voltage variation from 150 to 275V AC and frequency variation from 48Hz to 52 Hz.

3.1.2 It shall be ensured by Railway that the capacity of AC input feeder installed at the LC Gate/IB Installation is adequate as per the signalling load catered by system. All the switchgear and cables shall be adequately rated and shall be of approved makes.

3.1.3 The DG Set used for feeding LC-IB power supply shall be capable of taking 10% overload for period of one hour during any 12-hour period. It should be ensured that waveform of DG set is nearly sine wave.

3.1.4 The accidental short circuit at input feeder shall not cause any interruption to the system. The accidental over voltage shall not cause any damage to the system.

3.1.5 There shall be an automatic arrangement for disconnecting the mains within 500 ms to the rack whenever the input voltage is beyond the specified operating limits with suitable alarm indication. The LC- IB power supply system shall resume normal working automatically when the input is restored within the working limits.

**3.2 Module replacement time and MTBF**

3.2.1 The mean time to replace a faulty module of LC- IB power supply shall be less than 20 minutes.

3.2.2 The designed MTBF of Bi-directional Inverter, transformer rectifier and Supervisory control unit shall not be less than 35,000 hours.

3.2.3 The DC fan provided at rack /module level should have MTBF better than 70,000 hours at 40° C. The fan shall be covered with grill.

**3.3 Construction**

3.3.1 The cabinet shall be within the overall dimensions of 2000-mm max. Height 750 mm. max. Depth and 750 mm max. Width. The height and depth of cabinet shall be of equal size. The cabinet shall have min 10-mm thick anti-vibrating pad and 75 mm x 5-mm bottom channel as per sketch no. **SDO/ PSA/LC-IB /002 (Ann-II)**.

3.3.2 The spares (other than modules used for redundancy) may be placed at bottom of any rack as per the availability of space.

- 3.3.3 The rack structure and the module frame shall be made up of rigid framework of steel profiles. The front door, if used, shall be of hinged type. The rear panel shall be provided with proper ventilation arrangement. DC fan shall be provided at rack level for forced cooling. The operation of such fan shall be continuous.
- 3.3.4 The rack and module cabinets shall be of robust construction. They shall be housed in self-supporting cubicles made of cold rolled closed annealed mild steel sheet of thickness not less than 1.6mm. The rack shall be adequately ventilated. The ventilating opening shall be less than 3mm size for protection against entry of lizard's etc. The rack shall conform to IP31 type of protection as specified in table 1 of specification no. IS 2147-1962.
- 3.3.5 The rack and the modules shall be treated with zinc chromate primer followed by electrostatic epoxy powder coating paint finished, passivation shall be done through seven stage process/sand blasting. Small metal parts such as nuts, bolts and washers shall be chrome plated. All other metal parts of the rack shall be plated for protection against corrosion.
- 3.3.6 The rack and the module cabinets shall be free from sharp edges & sharp corners.
- 3.3.7 Provision of doors are optional, the cabinet sides shall have 3mm louvers covered with wire mesh. However, if the doors are not provided, the sub system shall have proper enclosures so that any reptile/ insect shall not enter the LC-IB power supply cabinet. The magnetic latches/handle shall be provided on the doors.
- 3.3.8 The racks and the modules shall be designed for easy maintenance and installation.
- 3.3.9 Facility shall be provided at the top of the rack to connect external AC power and lightning arrestors (if provided inside the rack). Where cables pass through metal panels, suitable rubber grommets shall be provided to protect cable from damage.
- 3.3.10 The modules shall be of modular type. The module shall be easily mounted or removed from the front side of the rack. The module shall be designed to slide into the rack on a suitable mechanical arrangement. Suitable arrangement shall be made for pulling out each module separately. The associated AC input, DC output connection, control/alarm & interface cable connecting the module shall be disconnected/installed easily without causing any interruption/damage to supply & working module.
- 3.3.11 All materials and workmanship shall be of professional quality to ensure the MTBF requirements.
- 3.3.12 The input and output terminals shall be accessible only when the cover of the cubicle is removed. All the terminals shall be clearly, neatly and indelibly marked to correspond with the wiring diagram for easy identification.

3.3.13 Input and output connections of Bi-directional inverter, AVR, Transformer Rectifier and step down transformer shall be made using plug & socket of adequate rating having power pins with locking arrangement. The male connector shall be mounted on the device and the female connector shall be terminated on the cable. Use of terminal blocks for input and output connections is not accepted.

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

- a) Rack & doors                      Pebble Grey RAL 7032
- b) All modules                      shall harmoniously match with rack colour

3.3.15 Baffles to be provided at the rack level for forced ventilation of individual modules.

**3.4 Components**

3.4.1 Semiconductor and other components used in the equipment shall be of industrial grade with min. operating temperature range -25°C to + 85°C. Components shall conform to relevant IS/IEC specification. Resistors and capacitors shall meet relevant provisions of latest RDSO/SPN/144/2006.

3.4.2 Semi-conductor power devices and other Solid state components used in LC-IB power supply shall not be operated at more than 50% of the rated maximum peak voltage and at not more than 50% of the rated maximum average current under any prevailing conditions. Manufacturer shall submit design details, components datasheet at the time of type approval.

3.4.3 The manufacturer shall declare the peak reverse voltage, current rating and working temperature of the rectifier element under ambient conditions, the number of elements used and the manner of their connection. The peak reverse voltage rating should not be less than two times the expected reverse voltage across the devices.

3.4.4 The recommended list of major components and their makes is available separately.

**3.5 Printed Circuit Board**

Printed Circuit Board shall generally conform to relevant provisions of latest RDSO/SPN/144/2006 for safety & reliability requirement of Electronic signalling equipment.

**3.6 Cables & Wiring**

3.6.1 All the cables and wires used for wiring and inter connections of modules shall conform to specification No. IRS: S 76-89/IS 694 of grading 1100V. Aluminium wires shall not be used. The gauge of wiring shall be such that the current density does not exceed 3 amperes/mm square.

The colour scheme employed for the rack wiring shall be as below:

- AC line : Yellow
- AC neutral : Black
- Earthing : Green
- DC positive : Red
- DC negative : Black
- Control wiring : Grey

3.6.2 All connections shall be made through crimped eyelets and shall be numbered with PVC cable marker rings/ inkjet printing on cables corresponding to the numbers/letters shown in the schematic wiring diagram. Soldering shall be used only where use of crimped eyelets is not possible.

3.6.3 All non-current carrying metal parts shall be bonded together and adequately earthed.

3.6.4 All wiring shall be neatly secured in position by bunching /strapping & adequately supported. Where wires pass through any part of metal panel or cover, the hole through which they pass shall be provided with rubber grommets.

3.6.5 There shall not be any exposed wiring outside the cabinet.

3.7 **Transformers and chokes**

3.7.1 Transformers and inductors/ chokes used shall be vacuum impregnated and shall be of natural air-cooled type conforming IS: 6297 (Category 3 & Grade 2). Class F or higher grade insulating material as per IS:1271 and polyester enamelled copper winding wire conforming to IS 13730(Pt. 3) shall be used for winding transformers and inductors/chokes. The gauge of winding wires shall be such that the current density shall not exceed 2A/sq.mm.

3.7.2 All exposed metal parts of the transformer including laminations shall be protected against corrosion.

3.8 **Potential free contacts**

3.8.1 Following potential free contacts shall be provided for extension of alarms at remote place:

- a) Inverter 1 fail
- b) Inverter 2 fail
- c) Transformer Rectifier fail
- d) Mains fail
- e) Call S & T staff
- f) Battery low (50% Deep discharge)

3.9 **Meters**

3.91. Accuracy of 3 ½ D Digital meters used in the LC-IB Power supply cabinet shall be ± 1%, ± 3 D or better.

3.9.2 Meter shall be provided on top of the rack as per Sketch No. **SDO/PSA/LC-IB /layout/003 (Ann-III)**.

**3.10 Fuses & Connectors**

- 3.10.1 All plug- in connectors shall be non-interchangeable. Connectors as per IEC 947 shall be provided.
- 3.10.2 Fuse holder identification shall include details of fuse rating and type.
- 3.10.3 All power fuses shall conform to specification IS 13703 / IS 9224.

**3.11 Noise and Vibration**

3.11.1 Fully equipped rack at full load shall not contribute more than 15dB (weighted) to the ambient noise level taken as 45dBA. It shall be measured at a distance of 1 meter from the unit and 1.25 meter above the floor level in the full audio range upto 3.4 KHz. The correction factor for total noise when the ambient noise level is more than 45dBA shall be as given below:

Ambient Noise (dBA)	Correction Factor (dB)	Ambient noise (dBA)	Correction Factor (dB)
45	0	53	2.07
46	0.18	54	2.43
47	0.39	55	2.82
48	0.61	56	3.25
49	0.86	57	3.69
50	1.12	58	4.17
51	1.41	59	4.68
52	1.73	60	5.21

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

3.11.2 The LC- IB power supply sub-systems shall be suitably screened and immune to any kind of EMI interference. The sub-system shall not produce any hum in the peripheral devices.

**3.12 Lightning & Surge Protection**

3.12.1 **Stage 1 Protection (at the entry point of input 230V AC supply in the power/ equipment room)**

(a) The Stage 1 protection shall consist of coordinated Class I / B & II / C type SPDs at the entry point of input 230V AC supply in Power /Equipment room in TT configuration in a separate wall mountable box. The Class I / B SPD shall be provided between Line to Neutral & Neutral to Earth. They shall be spark gap type voltage switching device and tested as per IEC 61643 with the following characteristics and features-

S N	Parameters	Limits	
		Between Line & Neutral	Between Neutral & Earth
1	Nominal Voltage (U <sub>0</sub> )	230V	230V
2	Maximum continuous operating voltage (U <sub>c</sub> )	≥ 255V	≥ 255V

3	Lightning Impulse current 10/350µs (I <sub>imp</sub> )	≥ 25KA	≥ 50KA
4	Response time (T <sub>r</sub> )	≤ 100 ns	≤ 100 ns
5	Voltage protection level (U <sub>p</sub> )	≤ 2.5KV	≤ 2.5KV
6	Short circuit withstand and follow up current extinguishing capacity without back up fuse (I <sub>sc</sub> & I <sub>f</sub> )	≥3KA	≥100A
7	Temporary Over Voltage (U <sub>T</sub> )	334V min. for 05 secs.	1200V min. for 200ms
8	Operating temperature / RH	- 25°C to +80°C/ 95%	- 25°C to +80°C/ 95%
9	Mounted on	din rail	din rail
10	Indication	Mandatory	Optional
11	Pluggability	Optional	Optional
12	Potential free contact for remote monitoring	Optional	Optional
13	Encapsulation	Encapsulated	Encapsulated
14	Degree of protection	IP20	IP20
15	Housing	Fire retardant as per UL 94	Fire retardant as per UL 94

- (b) The Class I / B SPD will be followed by Class II / C SPD adjacent to it and connected between Line & Neutral. The device shall be a single compact varistor of proper rating and in no case a number of varistors shall be provided in parallel. It shall be voltage clamping device, thermal disconnecting type and shall be tested as per IEC 61643 with the following characteristics and features-

SN	Parameters	Limits (between Line & neutral)
1	Nominal Voltage (U <sub>0</sub> )	230V
2	Maximum continuous operating voltage (U <sub>c</sub> )	≥ 300V
3	Nominal discharge current 8/20µs (I <sub>n</sub> )	≥ 10KA
4	Maximum discharge current 8/20µs (I <sub>max</sub> )	≥ 40KA
5	Response time (T <sub>r</sub> )	≤ 25 ns
6	Voltage protection level (U <sub>p</sub> )	≤ 1.5 KV
7	Operating temperature / RH	- 25°C to +80°C/ 95%
8	Mounted on	Din rail
10	Indication	Mandatory
11	Pluggability	Mandatory
12	Potential free contact for remote monitoring	Mandatory
13	Degree of protection	IP20
14	Housing	Fire retardant as per UL 94

- (c) Class I /B and class II /C SPDs of Stage I shall be so coordinated that the voltage protection level of the coordinated devices is ≤ 1.5 KV. As such, these devices shall be from the same manufacturer and necessary test certificate in this regard shall be submitted by the manufacturer/ supplier.

3.12.3 **Stage 2 protection (at the output side inside the distribution panel)**

The Stage 2 protection shall consist of Class II / C type SPDs for ≥24V-110V AC/DC supplies at the output side inside the rack of IPS. The Class II / C type SPD shall be a single compact varistor of proper rating and in no case a number of varistors shall be provided in parallel. It shall be voltage clamping device and thermal disconnecting type. These shall be provided at Solar MPPT charger,

Inverter, Transformer Rectifier and Signal transformer output. They shall be tested as per IEC 61643 with the following characteristics and features-

SN	Parameters	Limits (between L1 & L2, L1 & E , L2 & E)	
1	Nominal Voltage (U <sub>0</sub> )	60V-110V AC/DC	24V-60V AC/DC
2	Maximum continuous operating voltage (U <sub>c</sub> )	≥ 150 (AC) ≥ 200 (DC)	≥ 75 (AC) ≥ 100 (DC)
3	Nominal discharge current 8/20μs (I <sub>n</sub> )	≥ 10KA	≥ 10KA
4	Maximum discharge current 8/20μs (I <sub>max</sub> )	≥ 40KA	≥ 40KA
5	Response time (T <sub>r</sub> )	≤ 25 ñs	≤ 25 ñs
6	Voltage protection level (U <sub>p</sub> )	≤ 1.0 KV	≤ 0.5 KV
7	Operating temperature / RH	- 25°C to +80°C/ 95%	- 25°C to +80°C/ 95%
8	Mounted on	Din rail	Din rail
10	Indication	Mandatory	Mandatory
11	Pluggability	Mandatory	Mandatory
12	Potential free contact for remote monitoring	Mandatory	Mandatory
13	Degree of protection	IP20	IP20
14	Housing	Fire retardant as per UL 94	Fire retardant as per UL 94

- 3.12.4Length of all cable connection from SPDs to earth equi-potential busbar shall be kept less than 0.5mtrs. For this, a sub earth equi-potential busbar shall be installed at approx. 20cm from the SPD box. The details of connection of SPDs for Stage 1, & 2 of a typical installation with LC-IB power supply is enclosed as **Annexure-IV**.
- 3.12.5Batch test report of OEM should be submitted by the manufacturer /supplier of Lightning & Surge protection devices to the LC-IB Power supply manufacturer at the time of supply of these devices. Copy of the same shall be submitted by the LC-IB Power supply manufacturer to RDSO at the time of acceptance test of system.
- 3.13**Earthing**
- 3.13.1The LC-IB Power supply systems and its individual modules shall have earth terminals and shall be properly earthed to the cabinet.
- 3.13.2Zonal Railways shall provide earthing arrangement in conformity to Code of practice for earthing and Bonding RDSO/SPN/197/2008 as per details at **Annexure-V**.
- 3.14**Installation & Commissioning**
- Installation shall be done by OEM if specified by the purchaser. However, commissioning of LC-IB Power supply system shall be done by the OEM only. OEM shall issue a certificate of fitness of installation before commissioning. For this, Zonal Railways and OEM shall ensure the compliance to Pre-commissioning checklist issued by RDSO.



4.0 **PERFORMANCE REQUIREMENTS**

4.1 **SOLAR MPPT CHARG CONTROLLER**

4.1.1 Solar Charge controller shall be Maximum Power Point Tracking (MPPT) type.

4.1.2 Its rating shall be 25A min( 11.0A for inverter & 10A for battery).

4.1.3 The input voltage range shall be 70V to 150 V minimum

4.1.4 Resettable Fuses shall be provided, wherever appropriate, to protect the module against failure of control / sensing circuit.

4.1.5 The design shall have suitable time delay / hysteresis to avoid hunting during switching ON and OFF of the system.

4.1.6 Screen-printed procedure for adjustment of battery current limit and other adjustment required to be done in the field shall be prominently visible for ready reference of maintenance staff.

4.1.7 The DC volt/Ampere digital meter of 3 ½ digit with LCD/LED alphanumeric display having 12mm height shall be provided on the front side of the charger to read array voltage, load /charging/ discharge current.

4.1.8 The efficiency of Solar Charge controller from 70V to 150 V at full load shall be >90% with resistive load.

4.1.9 DC Over Voltage Protection: In case output DC voltage exceeds 2.37V/2.5V per cell respectively for VRLA/ low maintenance battery, the over voltage protection shall operate & shut off the charger. This shut off can be restored automatically as soon as fault removed.

4.1.10 The circuit design shall ensure protection against the discharge of the battery through charger. In any case, the discharge current i.e. reverse leakage current, shall not be more than 100 mA .

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

4.1.12 Solar Photovoltaic (SPV) Module shall be purchased from RDSO approved vendors in line with IRS:S:84/92 duly inspected by RDSO inspection wing.

4.1.12.1 Requirement of Solar Panel Solar (Typical calculation)

- a. Load on 48V DC bus = 489 (Load on DC bus )/0.85 = 575W
- b. Taking 15% extra for future load demand = 600W
- c. The power rating of PV panel to supply the 600W =  
(600\*1.15)/.94=731W  
(Considering 15% extra to cater for solar loss due to fixed installation/sun tracking & cable loss & 94% MPPT efficiency)
- d. PV panel power considering watt hour efficiency of battery 85%=  
731/.85= 860W
- e. Total no of 70W PV panel module 860/70= 12 Nos.
- f. For 70W module Voc=21V, V<sub>mp</sub> =17.2V, I<sub>mp</sub> = 4.3A

g. Panel Configuration for 860W solar power

- 6 nos. in series (string) so  $V_{oc} = 21V \times 6 = 126V$  &  $V_{mp} = 17.2 \times 6 = 102V$   
2 string in parallel.
- h. Total usable WH generated per day per hour=  $860 \times 0.94 \times .85 / 1.15 = 597.51WH$   
i. Total usable WH generated per day =  $597.51 \times 5 = 2987.5WH$   
(Considering average Solar Insolation period as 5 hrs)  
j. Usable AH generated per day =  $2987.5 / 48 = 62AH$   
So 62 AH is pumped to battery every day which is sufficient to give 4-5 hour back up. Since the battery used is 100AH .its 62AH can't be withdrawn per day.

4.1.13 Alarms & Indication of Solar Charge controller

4.1.13.1 The following indications, controls & measuring points shall be provided on the front panel of Solar Charge controller

A) Status Indication:

Description	Nomenclature	Indication
INPUT available	MAINS	Amber

B) Alarm Indication:

Description	Nomenclature	Indication
c) DC output fuse fail	OUTPUT FAIL	Red
d) CH Overload/ short circuit	OVERLOAD / SHORT CIRCUIT	Red
e) Reverse Polarity Indication	BATTERY REVERSE	Red

Note: "Provision shall be made for stopping the audio alarm with a non-locking push button.

C) Digital Voltmeter/ammeter of 3 ½ digit, ± 1% Accuracy with LCD/LED alphanumeric display having 12mm numerical display height shall be provided on the front panel of the Solar Charge controller for measuring input & output voltage and output current.

4.1.14 Terminations

- a) The DC input and output connection should be taken through irreversible plug and socket having power pins with locking arrangement.
- b) The output of Solar Charge controller in the positive lead shall be taken through the HRC fuse of 1.5 times of rated capacity.
- c) In all cases, the male connector shall be mounted in the Solar Charge controller and the female connector shall terminate the cable.
- d) To prevent hazards or damaging conditions, all plug-in components shall be non-interchangeable.
- e) All the connections between DSA unit and Solar Charge controller shall be through proper rated cables only.
- f) Circuit breakers at the input of each FRBC shall be easily accessible and rated to 25A .

4.2 DISTRIBUTION/ SUPERVISORY CONTROL /ALARM (DSA) UNIT

The LC-IB Power supply shall have a distribution/ supervisory control / alarm section, preferably in the upper portion of the rack which shall consist of the following-

- a) Termination for the batteries.
- b) Termination for the load (Inverters & Trans former rectifiers).
- c) Termination for AC input to the rack.
- d) Termination for DC to solar charger.
- e) GPRS: A GPRS based information system to transmit data corresponding to the Mains voltage, AC / DC output voltages and battery voltage in addition to the faults occurring.

Alarms & Indication of DSA Unit

All the indications shall be derived on a microprocessor based control and supervisory unit and displayed on an LED / LCD type alphanumeric display.

(a) Status Indication:

Description	Nomenclature	Indication
a) Mains available	MAINS	Amber
b) Mains fail	MAINS FAIL	Red

(b) Alarm Indication:

Description	Nomenclature	Indication
a) Load voltage high	OUTPUT VOLT HIGH	Red
b) Mains out of range	MAINS VOLT LOW /HIGH	Red
c) System overload	OVERLOAD	Red
d) Mains 'on'/battery discharging	MAINS ON & BATTERY ON LOAD	Red
f) Battery / load fuse fail	FUSE FAIL	Red
h) Battery disconnected from circuit	BATTERY DISCONNECTED	Red

4.2.1 Accessibility

- 4.2.1.1 The termination points shall be easily accessible from front or rear.
- 4.2.1.2 AC and DC terminals shall be separated by physical barriers to ensure safety.
- 4.2.1.3 All the terminals except AC earth shall be electrically isolated.

4.2.2 AC termination arrangement

- 4.2.2.1 The input terminals shall be clearly marked as L & N for mains supply voltages.
- 4.2.2.2 AC input termination shall be suitably protected against accidental touch/contact with the working staff for their protection and shall also have clear and prominent 'DANGER' Marking.

#### 4.2.3 DC terminations

4.2.3.1 Connection between the solar charger and DC distributions shall be through a proper rated lugged cable.

4.2.3.2 The DC output to battery and load shall be through bus bar or cable.

- a) Battery fuse shall be of 1.5 times of maximum current that passes to / from battery.
- b) Fuse at the O/P of FRBC rack shall be of 1.5 times the designed O/P current required for the system.

4.2.3.4 All the AC, DC and Control/Alarm cabling shall be supplied with the rack.

4.2.3.5 All DC positive & negative terminals shall be clearly marked and shall be suitable for minimum 10 sq. mm cable size. All conductors shall be properly rated to prevent excessive heating.

4.2.4 All the above indications may also be derived on a microprocessor based control and supervisory unit and may be displayed on an LED / LCD type alphanumeric display.

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

4.2.4.2 All the protection/alarms shall be within tolerance of  $\pm 0.012V$  per cell for voltage and  $\pm 1\%$  in case of current.

4.2.4.3 Every alarm condition shall be accompanied with audio alarm with auto cut off after 120 seconds. Provision shall be made for stopping the audio alarm with a push button switch.

4.2.4.4 In case of any kind of failure in DSA unit, the unit shall switch over to safe mode.

#### 4.2.5 Battery Health Monitoring

4.2.5.1 **Battery Current Limiting Circuit:** To ensure the availability of required load connected and safety of the battery, the battery charging current limit shall be provided @ 10% of battery AH capacity as per requirement..

4.2.5.2 **Battery Reverse Polarity Protection:** Protection for battery reverse polarity shall be provided in the system. The reverse polarity indication shall be provided near the battery terminal.

4.2.5.3 **Battery under voltage isolation:** The system shall have provision for battery isolation using DC contactor. The battery isolation shall be effective at

- i) For VRLA Battery: 1.80V/cell ( $\pm 0.012V$ /cell)
- ii) For low maintenance lead acid battery: 1.85V/cell ( $\pm 0.012V$ /cell)
- iii) Battery under voltage adjustment shall be provided inside the switching control unit/ DSA . This setting shall be adjustable from 1.80 to 2.0V/cell. Battery shall get reconnected after restoration of supply.

- 4.2.6 The system configuration shall be made either with cable or bus bar. Bus bar of high conductivity electrolytic copper strips with purity of 99.9% as per BIS 613 latest issue and shall be able to withstand maximum load and battery current. The bus bar/cable sizes shall be sufficient to cater current density upto 2 Amps per sq.mm. The size of bus bar shall not be less than 25mm x 5mm in any case.

### 4.3 **INVERTER**

- 4.3.1 The LC –IB power supply with solar back up shall consist of Bidirectional Inverter based on the sinusoidal PWM principal.
- 4.3.2 DC/AC power converters (Bidirectional Inverter) shall be compatible with renewable energy source systems, where energy is stored in batteries.
- 4.3.3 The inverter is controlled by two minimum time feedback loops, providing relatively low output voltage distortion and good load regulation with the inverter efficiency greater than 85% over a wide output power range.
- 4.3.4 The design of Bi-directional Inverter is such that it charges the battery in charger mode and it converts the battery energy to AC in Inverter mode.
- 4.3.5 The Inverter circuit should continuously monitor the 230 V AC bus and in case the same goes above or below the set values, the Inverter mode should come on within 40 ms.
- 4.3.6 Once this 230 V BUS voltage resumes to within the set range, the Inverter mode would be off and converter mode would be ON thus charging the battery and keeping it in Float mode once batteries are charged.
- 4.3.7 In AC-DC mode when batteries are charged, it should be done in CC/CV mode whereby on energization the unit starts as Float charger and battery path current is monitored. If it is found more than 10% of the Max Boost current of battery, the charger output changes over to Boost mode and constant current charging of battery starts (@ C/10 rate). Once the Battery voltage reaches the set boost voltage level, it turns to Constant Voltage (CV) mode whereby the battery path current starts falling. Once it falls to within 2 Amps for some time (5-45 sec) the charger output reverts back to Float mode.
- 4.3.8 Two identical Inverters are used In redundant Master-Slave mode such that normally the Master Inverter remains energized and only when it fails (due to its control card failure or any other failure including its own transformer), a command be given to the Slave Inverter to start and connect AC BUS with transfer time to less than 40 ms automatically.
- 4.3.9 The inverter shall be protected against overload and short circuit with auto reset facility. Whenever the failure condition persists, it shall trip and restart automatically after about 10-20 seconds. But if the problem still persists, the protection shall permanently get latched and inverter shall not be switched ON again unless the fault is cleared followed by pressing of reset push button switch. Inverter overload indication shall appear at 110% of rated load.

- 4.3.10 Inverter shall be designed for continuous operation for an input voltage of 44V to 56 V at a nominal of 48V DC, and shall be rated for an output of 230V AC.
- 4.3.11 The input & output of inverter shall be isolated from each other.
- 4.3.12 Each inverter shall be provided with suitable DC MCCB/MCB at the input for connecting the DC input.
- 4.3.13 The DC fan, if provided, should have MTBF better than 70,000 hours at 40°C. The switching ON & OFF the fan shall be with temperature control.
- 4.3.14 The following LED indications shall be provided on front panel:

Description	Nomenclature	Indication
a) Input ON	Input DC ON	Amber
b) Output OK	OUTPUT	Green
c) Inverter fail	INVERTER FAIL	Red
d) Inverter 'ON load'	ON LOAD	Green
e) Fan fail indication(In case of forced cooling)	FAN FAIL	Red

- 4.3.15 Voltage overshoot and under-shoot in the first cycle for complete load shut off shall be restricted to 20%.
- 4.3.16 The output voltage waveform shall be sine wave. Total harmonic distortion of the output shall not exceed 4% under any condition specified in clauses 4.3.10.
- 4.3.17 The inverter shall be capable of delivering 125% of rated full load for a period of 24 hours. It should be capable of delivering 200% of the rated full load for a period of 300 ms in order to cater for the high in-rush current at the time of switching 'ON' of the inverter.
- 4.3.18 The output of inverters shall be regulated to 230V ± 1% for an input variation of 44V to 56 V DC and for a simultaneous load variation of 25% to 100% of its rated capacity.
- 4.3.19 The overall watt efficiency of the inverter shall not be less than 85% at full load for the entire input range of 44V to 56V DC.
- 4.3.20 The unit shall be capable to withstand 20 cycles / hrs of 1.5 minute each ON and OFF at rated load.

4.4 **Ferro-Resonant Type Automatic Voltage Regulator (AVR)**

- 4.4.1 The design of the Automatic Voltage Regulator shall cater for any load from no load to full load of its rated capacity.
- 4.4.2 The voltage regulator shall be completely static without any moving parts.
- 4.4.3 The AVR shall be suitably screened so that other electronic equipment placed side by side of the regulator is not affected by the electromagnetic radiation of the regulator.

- 4.4.4 The voltage regulator shall be of natural air-cooled type and shall be suitable for indoor use in the cabins where maximum ambient temperature can reach upto 50°C.
- 4.4.5 The regulator shall function satisfactorily under shock and vibration conditions encountered by the side of railway track. Main transformer shall be mounted on anti vibrating padding.
- 4.4.6 AC Metal Can Capacitors of 600V rating of approved type with in-built wire shall only be used. The capacitors shall be mounted at a minimum distance of 2" away from the main transformer's top plate with metal partition in between the transformer and capacitor. This partition shall be of heat insulating material as the purpose is to protect capacitors from heat.
- 4.4.7 The output tapplings at 0, 220, 230& 240V shall be provided.
- 4.4.8 Transformers and inductors/ chokes used shall be vacuum impregnated and shall be of natural air-cooled type conforming IS: 6297 (Category 3 & Grade 2). Class F or higher grade insulating material as per IS:1271 and polyester enameled copper winding wire conforming to IS 13730(Pt. 3) shall be used for winding transformers and inductors/chokes. The gauge of winding wires shall be such that the current density shall not exceed 1.6A/sq.mm.
- 4.4.9 Two pole ON/OFF rotary switch conforming to IS: 4064 (Pt.I) shall be provided for input to the regulator.
- 4.4.10 A LED to indicate that the unit is 'ON' shall be provided on the front panel.
- 4.4.11 The output voltage shall remain at the nominal value of 230V $\pm$  1% at all the loads varying from 25% load to full load keeping the input voltage constant at 230V 50Hz.
- 4.4.12 The regulator shall work satisfactorily within supply frequency of 50Hz  $\pm$  2.5 Hz. The value of output voltage at rated load with an input of 230V at 50 Hz shall be taken as the reference output voltage for individual unit. When input frequency is varied from 47.5 Hz to 52.5 Hz, keeping the input voltage constant, the output voltage of the regulator unit shall be maintained within  $\pm$  3% of the reference output voltage for  $\pm$  1 Hz variation and within  $\pm$ 6% for  $\pm$  2 Hz frequency variation.
- 4.4.13 The regulator shall work satisfactorily within a range of 160V to 270V input at 50Hz mains supply. The output voltage shall be maintained within 230V  $\pm$  1% when the unit is connected to rated load.
- 4.4.14 The response time of regulator for sudden changes of 50 V AC input voltage or load variation from 25% to 75% of the rated load shall be such that the output voltage should settle at 230V  $\pm$  1% within 3 cycles/60m seconds.

- 4.4.15 The no load current shall not be more than 25% of the rated input current and the no load power shall not be more than 10% of the rated output power at nominal input voltage of 230V at 50Hz.
- 4.4.16 The overall watt efficiency shall not be less than 85%.
- 4.4.17 The total harmonic distortion measured at the output of the regulator shall not exceed 8% under any working conditions specified in Clauses 4.4.11, 4.4.12 & 4.4.13.
- 4.4.18 The voltage regulator shall be capable of handling any load from unit power factor to 0.8 lagging, without degrading total harmonic distortion and regulation.
- 4.4.19 When continuously operating at full load at any ambient condition specified in clause 2.3, the regulator shall withstand short-circuit on output side for one hour without any damage or deterioration to the regulator or any of its components.
- 4.4.20 The resonant voltage across the capacitor bank shall not exceed 480V at all input voltage and frequency conditions i.e 160-270V & 47.5Hz to 52.5Hz at no load.
- 4.4.21 Suitable surge voltage protection shall be incorporated in the circuit, preferably with high isolation between primary and secondary sides.
- 4.4.22 Ferro resonant voltage regulator for Signal load shall always be in 'switched on' condition and shall supply the load within 60 ms in case of any failure in Inverter/s and or inverter changeover arrangement. As soon as any one of Inverter becomes healthy, the load shall be automatically transferred back to inverter within 60ms.
- 4.4.23 In case of failure of contactor, provision shall be made for manual bypass of Static switch through a manual change over switch.

## **4.5 TRANSFORMER RECTIFIER**

- 4.5.1 The Transformer Rectifier covered under this specification shall work satisfactorily in line with IRS: S: 91/2014.
- 4.5.2 Transformer Rectifier shall be connected in the following order:
- i) Relay internal
  - ii) Relay external
  - iii) Track Circuit
  - iv) LED signal
  - v) Electric Lifting Barrier
  - vi) Panel indication
- 4.5.3 All components dissipating 3W or more power shall be mounted so that the component body is not in contact with the unit unless a clamp, heat sink or other means are used for proper heat dissipation.



- 4.5.4 Transformer Rectifier shall be provided with a proper plug in arrangement for AC input & output.. A toggle switch / push button switch shall be provided for switching ON/OFF the unit.
- 4.5.5 The Transformer Rectifier shall be provided with means for protection and visual indication on front panel for the following:

Description	Nomenclature	Indication
i) Input Power ON indication	INPUT	Amber
ii) Transformer Rectifier output OK	OUTPUT	Green
iii) Transformer Rectifier fail	FAIL	Red

- 4.5.6 The transformer rectifier shall be rated for 230 AC single phase input voltage at a frequency of 50Hz  $\pm$ 2Hz.
- 4.5.7 The nominal output voltage is 24 DC and current ratings are 5 and 10 Amps.
- 4.5.7 The DC output of the unit shall be smoothened by use of a suitable filter such that the RMS ripple content of the output voltage when delivering the rated output current through a resistive load, measured by an oscilloscope/ true r.m.s. multimeter shall not be more than 5%.
- 4.5.7.1 The overall watt efficiency shall not be less than 75% for rectifiers above 500VA capacity.
- 4.5.8 The no load input current of the transformer-rectifier unit shall be less than 10% of the rated input current.
- 4.5.9 No load to full load voltage regulation of the transformer when measured with the highest voltage tapping on secondary side loaded to the rated current shall be < 10% for < 100VA, < 5 % for 100VA & above.
- 4.5.10 The 'ON LOAD' output tap voltages shall be within +/- 2.5% of the nominal output voltages.
- 4.5.11 The output voltage regulation of transformer rectifier unit at no load to full load shall be less than 20% .
- 4.5.12 The output must be isolated from input.

4.6 **Step-down Transformer**

- 4.6.1 Terminals & associated screws shall be of nickel-plated brass, and shall be of the top screw pillar type, securely fixed.
- 4.6.2 The transformer shall be of double wound type and shall be designed for an input voltage of 230V  $\pm$  2%, 50Hz and ratings shall be 500 VA & 1000 VA.
- 4.6.3 The transformer shall have separate input and output windings.
- 4.6.4 The primary of the transformer is 230V. The secondary winding shall have tappings at 0, 100, 110, 120 & 130 volts at no load.

- 4.6.5 The gauge of winding wires shall be such that current density does not exceed 2A/mm sq.
- 4.6.6 A rotary switch of 10A or above shall be provided for switching ON/OFF the transformer.
- 4.6.7 The size of the core shall be as small as possible commensurate with the electrical characteristics required by this specification.
- 4.6.8 The core of the transformer shall be such that its Electro-magnetic property will not be affected due to ageing.
- 4.6.9 The body of the core is required to be earthed and one earth terminal shall be provided for this purpose. Suitable marking shall be made near the earth terminal.
- 4.6.10 The efficiency of the transformer at rated load with nominal input shall not be less than 90%.
- 4.6.11 The appropriate voltage shall be legibly & indelibly engraved near the input and output terminals.
- 4.6.12 An HRC fuse of appropriate rating shall be provided at the input of transformer.
- 4.6.13 The following LED indications shall be provided on the front panel:

Description	Nomenclature	Indication
a) Input ON	INPUT	Amber
b) Output ON	OUTPUT	Green
c) Tx. Fail	FAIL	Red

- 4.6.14 230V AC at 50 Hz shall be applied on primary side between terminals '0' and '230V' and the voltages across different tappings on the secondary side shall be measured, which shall be within  $\pm 1.5\%$  of the nominal value.
- 4.6.15 The open circuit secondary voltage and the primary no load current of the transformer shall be measured with the primary winding connected to 230V, 50Hz supply and the secondary winding open circuited. The open circuit secondary voltage at different tappings of the secondary windings shall be within  $\pm 1.5\%$  of the nominal values. The primary no load current shall not exceed 10% of the rated full load primary current for all transformers.
- 4.6.16 The percentage voltage regulation shall not be more than 5%.
- 4.6.17 **Induced High Voltage Test:** - The transformer shall withstand without break down, when 440 volt 100 Hz AC is applied to the primary winding, with secondary winding open-circuited. The voltage shall be raised from one third of the maximum value to maximum value as rapidly as is consistent with accurate reading of the indicating instrument. The full test voltage shall be maintained for one minute and shall then be reduced to the one third of the value before being switched off. At the end of the test the transformer shall be tested for the following:

- a) Insulation resistance (Clause 9.2)
- b) Open circuit test (Clause 4.6.15)

- 4.6.18 The transformer shall withstand without any damage short circuit of secondary windings momentarily when primary is fed with 230V AC at terminals 0V and 230V. The test shall be carried out after bypassing the fuse.
- 4.6.19 Applied high voltage test as per clause 9.3 shall be repeated after short circuit test.

4.7 **Requirements of LC-IB solar charge controller Panel**

- 4.7.1 The following 3 ½ D digital meters with LED/ LCD display having 12mm numerical display shall be provided on top of the charger panel. The selector switch for meter shall not be at a height of more than 1800 mm from the ground.

- a) AC Volt meter      0-300V      for AC input voltage
- b) AC Ammeter        0-50A        for AC input current
- c) DC Voltmeter       0-200V      for charger output voltage
- d) DC Ammeter        0-50A        for charger output current/charge/ Discharge current.

A selector switch shall be provided for reading Total/ Charge / Discharge current.

- 4.7.2 The DC meters shall work even when the AC supply is not available.
- 4.7.3 AC digital volt meter shall be provided with extendable cords for measurements of output voltages of the following:
- a) Inverter 1
  - b) Inverter 2
  - c) AVR
  - d) Tx. (ELB)

- 4.7.4 Output of Inverter, step down transformer & AVR shall be brought to one place at the rear of the cabinet. 30 Amp capacity TB type terminal capable of termination of 10-sq. mm cable shall be provided. Proper identification marking shall be provided on/near the terminals.
- 4.7.5 All the above indications/measurements may be derived on a microprocessor based control and supervisory unit and may be displayed on an LED / LCD type alphanumeric display.

4.8 **Status Monitoring Panel**

- 4.8.1 Status monitoring panel shall be installed in the room of Gateman on duty at LC gate. The panel shall have following LED indications and alarms with resetting switch:

	Instruction	Condition	LED Ind.	Remark
A	Run Gen set	50% DOD	RED	Audio / visual alarm. Alarm can be acknowledged for audio cut off.
B	Emergency start generator	60% DOD	RED	-do-
C	System shut down	70% DOD	RED	Signal feed cut off and all DC-DC converters to work. Audio alarm will continue till Generator is started.
D	Call S & T staff	Equipment fault	RED	Failure of any module or in case battery gets disconnected from circuit will give the alarm in panel. Alarm can be acknowledged for audio cut-off.
E	Stop Gen Set	FRBC change over to float mode	GREEN	Audio /Visual alarm

Audio alarm in case of A, B & C shall be of one type of tone and there shall be different tone for the case of D & E cases.

4.8.2 In A, B & C conditions, the visual LED indication will remain lit until fault is cleared or the DG set is started and battery is charged upto 110V i.e. 2V/cell as the case may be until reset push button is pressed. In case of D condition, if fault is not cleared, the LED will continue to glow, even if reset push button is pressed.

4.9 **INDENTING DESCRIPTION / INFORMATION TO BE SUPPLIED BY THE PURCHASER:**

Indenting description / information to be supplied by the Purchaser for the LC-IB power supply system configuration covered under clause 2.2.1 is as under:

	Details	Remarks
1	Configuration/ Applicable drawing No.	The configuration is as per details given in clause 2.2.1 or configuration specified by the purchaser using standard modules
2	Type of Battery	Low Maintenance or VRLA
3	Type of Internal & External relays	24V
4	Type of the track circuit	
5	Type of the ELB provided at LC	
6	Distance between LC gate Room & ASM Panel (in meters)	
7	Whether installation is to be done by OEM	

5.0 **LABELLING AND MARKING**

5.1 Each electrical/solid state component should be possible to be located by the layout/circuit drawing. The wiring shall be clearly and permanently identified with a designation or a colour code, which corresponds to the equipment circuit diagram. Where non-standard colours are used, cable functions shall be clearly and permanently labelled at both ends.

5.2 A screen printed cabling / wiring diagram shall be placed on the inside of the front door or any other convenient place for ready reference of maintenance staff.

- 5.3 Screen-printed Do's & Don'ts, adjustment procedures and operating instructions shall be provided at convenient place on front panel of the LC-IB panel. One laminated block diagram shall also be provided at convenient place inside the cabinet.
- 5.4 The layout of the components and wiring shall be such that all parts are easily accessible for inspection, repairs and replacement.
- 5.5 All markings shall be legible and durable. Where the marking is by use of labels, they shall be metallic or screen-printed. These shall be firmly struck and shall not be capable of being removed by hand easily. They shall be placed in the vicinity of the components to which they refer.
- 5.6 The cubicle shall be identified with the following appropriate name plates/labels:  
"LC-IB POWER SUPPLY PANEL"
- 5.7 The placement for particular module in respective rack shall be clearly marked with its application for the purpose of appropriate replacement.
- 5.9 Every LC-IB POWER SUPPLY PANEL shall be provided with a rating plate fixed outside at a conspicuous place in the cubicle. It shall be clearly and indelibly etched, engraved or screen printed and shall show the following minimum information:
  - a) Name and trade mark of the manufacturer
  - b) Specification No.
  - c) Nominal AC input voltage and frequency
  - d) Serial number and year of manufacturing.
  - e) Version number as per RDSO/SPN/144/2006.
- 5.10 All input and output terminals shall be clearly identified by using proper name tags/labels.

**6.0 DOCUMENTATION**

- 6.1 Two copies of the user's instruction manual shall be supplied along with each unit. The version number shall be clearly indicated on front cover. The manual shall include detailed design of the LC-IB POWER SUPPLY /modules, dimensional layout drawings, schematic diagrams, and detailed interconnecting drawing of all sub systems. Traceability of interconnection between sub systems shall be ensured. Details on initial checks on receipt at site, testing and adjustment procedures, installation and commissioning procedures, maintenance procedures and detailed trouble shooting chart shall be covered in the manual. All the details in the manual shall be in simple language with trouble shooting explained through suitable pictures/ photographs in step by step manner so that it is well understood by the maintenance staff.
- 6.2 The instruction manual is to be prepared using good quality paper with clear crisp printing. All the drawings in clear printing shall be attached to the handbook binding. One set of flow chart drawings necessary for trouble shooting shall be provided with lamination with each manual.

The handbook shall have a thick polythene sheet cover with plastic winding or comb winding.

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

6.4 The joint pre-commissioning checklist and post commissioning load measurements shall be a part of instruction manual. The system shall be commissioned, as per specification and representatives of manufacturer and purchaser/railways shall sign this jointly.

## 7.0 PACKING

7.1 Complete unit be packed in suitable wooden boxes/crate, strong enough, without additional packing to prevent damage or loss to the unit during transit. Loose space inside the box/crate shall be filled up with suitable packing material.

7.2 Solar MPPT charge controller, Transformer rectifier, inverters, AVRs & Step down Transformers shall be separately packed. These shall be wrapped in bubble sheet and then packed in thermocole boxes and empty space shall be filled with suitable filling material. All modules shall be finally packed in wooden case of sufficient strength so that it can withstand bumps and jerks encountered in a road / rail journey.

7.3 Each box shall be legibly marked at one end with code numbers, contents, quantity and name of manufacturer/ supplier. The upside shall be indicated with an arrow. Boxes should have standard signages to indicate the correct position and precaution "Handle with Care" with necessary instructions.

## 8.0 TEST AND REQUIREMENTS

8.1 Inspection & tests shall be carried out to ensure that requirements of this specification are complied. All tests, unless otherwise specified, shall be carried out at ambient atmospheric conditions on all the modules of system. For inspection of material, relevant clauses of IRS: S 23 and RDSO/SPN/144/2006 shall apply unless otherwise specified.

### 8.2 Initial type approval:

Manufacturer shall furnish following information at the time of initial type approval of IPS system.

- a) Details of protection provided and their effectiveness / proposed set values and range and working principle.
- b) Bill of material for racks and modules. Details of semi conductors devices used and its specification and data sheets.
- c) Safety margins in voltage, current, thermal (for junction temperature) along with the limit value for power devices, inductors and transformer etc.

- d) Installation & commissioning manual, Quality Assurance Plan and Service manual (consisting of indications and fault diagnostics, Do's & Dont's etc.)
- e) Design approach for the LC-IB POWER SUPPLY system and salient features through which required MTBF has been achieved..

8.2.1 While granting initial type approval, it shall be ensured that the system conforms to all the clauses and passes all type tests as mentioned in clause 8.3.1 and other relevant guidelines of RDSO.

### 8.3 Maintenance type approval

Before expiry of validity period, manufacturer shall submit prototype samples as per guidelines of RDSO. The LC-IB POWER SUPPLY system must pass all type tests as per Clause 8.3.1.

In case of design changes, RDSO may call for fresh sample in the intermediate stage. In such cases, manufacturers shall submit all the information as per clause 8.2.

Solar Photovoltaic (SPV) Module shall be purchased from RDSO approved vendors in line with IRS:S:84/92 duly inspected by RDSO inspection wing.

8.3.1 The following shall comprise the **Type Tests**:

- a) Visual Inspection (Cl. 9.1)
- b) Insulation Resistance (Cl. 9.2)
- c) Applied high voltage test (Cl. 9.3)
- d) Temperature rise test (Cl. 9.4)
- e) Performance test (Cl. 9.5)
- f) Test for protective devices (Cl. 9.6)
- g) Environmental & Climatic Test (Cl. 9.7)
- h) Functional test (Cl. 9.8)
- i) Vibration test on modules as per RDSO/SPN/144/2006.
- j) Static discharge test as per RDSO/SPN/144/2006. Electrostatic discharge test shall be carried out as per international standard IEC 61000-4-2 or its equivalent with 150 Pico Farad charged capacitor of 7KV and should be discharged through 330 ohm resistor.

#### Note:

- (i) Test for protective devices and performance test shall be carried out before and after climatic test. There shall not be any significant deviations in the observations recorded.
- (ii) Vibration & Static discharge test shall be conducted on one module of solar charge controller, DSA unit, SM panel and Inverter.

8.3.2 The following shall comprise the **Acceptance test**:

The acceptance test shall be carried out as per the sampling plan given in Clause in 10.0.

- a) Visual Inspection (Cl. 9.1)
- b) Insulation Resistance (Cl. 9.2)

c) Applied high voltage test (Cl. 9.3)

- d) Temperature rise test (Cl. 9.4)
- e) Performance test (Cl. 9.5)
- f) Test for protective devices (Cl. 9.6)
- g) Functional test (Cl. 9.8)

8.3.3 The following shall comprise the **Routine test**:

The routine test shall be carried out on every module of the LC-IB POWER SUPPLY system and the results will be submitted by the manufacturer to the inspecting authority at the time of inspection.

- a) Visual Inspection (Cl. 9.1)
- b) Insulation Resistance (Cl. 9.2)
- c) Applied high voltage test (Cl. 9.3)
- d) Performance test (Cl. 9.5)
- e) Test for protective devices (Cl. 9.6)
- f) Functional test (Cl. 9.8)

**9.0 TEST PROCEDURE**

**9.1 Visual Inspection**

Test for visual inspection shall be carried out as per relevant clauses of this specification and RDSO/SPN/144/2006.

**9.2 Insulation Resistance**

Insulation resistance (I.R) test shall be carried out:

- a) before the high voltage test
- b) after the high voltage test
- c) after climatic test

The measurement shall be made at a potential of not less than 500 V DC. The insulation resistance shall be measured at module level / rack as follows:

- i) Input line terminals and the body of the equipment
- ii) Output line terminals and the body of the equipment
- iii) Input line terminals and output line terminals
- iv) Between rack and earth

Value of the insulation resistance shall not be less than 10 M.ohm for the rack / equipment and 1000 M.ohm for the transformer/CVT when measured at a temperature of 40°C and relative humidity of 60%. There shall not be appreciable change in the values measured before and after high voltage test and after the temperature rise test.

After completion of climatic test, the values shall not be less than 5 M.ohm for the equipment and 500 M.ohm for the transformer/CVT when measured at a temperature of 40°C and relative humidity of 60%.

**Note:** - In case, temperature and humidity prevalent at the time of the above measurements of insulation resistance are different from those



specified above, the values of I.R. shall be obtained from the table given below -

9.3	<b>R.H</b>	<b>25°C</b>	<b>30°C</b>	<b>35°C</b>	<b>40°C</b>
	60%	>100 M.ohms	>100 M.ohms	>100 M.ohms	>100 M.ohms
	65%	100 M.ohms	90 M.ohms	85 M.ohms	80 M.ohms
	70%	80 M.ohms	70 M.ohms	65 M.ohms	60 M.ohms
	75%	60 M.ohms	53 M.ohms	47 M.ohms	43 M.ohms
	80%	42 M.ohms	36 M.ohms	33 M.ohms	30 M.ohms
	85%	29 M.ohms	25 M.ohms	22 M.ohms	18 M.ohms
	90%	20 M.ohms	16 M.ohms	13 M.ohms	10 M.ohms
	95%	15 M.ohms	10 M.ohms	7 M.ohms	5 M.ohms
	100%	<b>10</b> M.ohms	6 M.ohms	3 M.ohms	1 M.ohms

**Applied High Voltage test**

The module shall withstand the application of 2000 V AC rms for one minute without puncture and arching. The test voltage shall be approximately sine wave and of any frequency between 50 and 100 Hz. The high voltage shall be applied between the following:

- a) Input and earth
- b) Output and earth
- c) Input and output

**Note:**

- i) The test shall be carried out after removing surge arrestors /MOVs or any other surge absorbing components.
- ii) In routine test, only one module of each type shall be tested.

9.4 **Temperature rise test**

Temperature rise test should be logged during functional test of LC-IB POWER SUPPLY after 8 hours, either with the help of thermo-couple or with resistance method on one module of each type.

9.4.1 While conducting the test with the help of thermo-couple, the temperature of MOSFET/IGBT, diode, Transformer/ Ferrite Transformer, choke, Internal ambient, Inside cabinet and outside cabinet shall be recorded at every one hour for first four hours and every half hour for next four hours. During this test, the temperature compensation probe shall be disconnected.

9.4.2 The temperature rise of heat dissipating components above the ambient measured directly and at heat sink shall not be more than

- a) Transformer and chokes : 90° C
- b) Thyristor & diodes : 40°C
- c) IGBT/MOSFET : 30°C

9.5                    **Performance test**

9.5.1                    Performance test on Solar charge controller, DSA unit, Inverter, Ferro Resonant Voltage Regulator, Transformer rectifier and Step down Transformer shall be carried out as per clause no. 4.1, 4.2, 4.3, 4.4, 4.5 & 4.6 respectively.

9.6                    **Test for protective devices:**

9.6.1                    Test for protective devices for Solar charge controller shall include following and other relevant clauses of this specification.

- i)                    Short circuit: During this test, system shall be connected to DC input voltage of 170V. Output terminals shall be short-circuited through a suitable arrangement. Steady short circuit current shall be measured. It should not exceed rated current + 5%. There shall not be any damage to charger. Working of over load/ short circuit indications/ alarms will also be checked on the unit. This shall be achieved by controlling output current and voltage under short circuit condition and not by switching off the input/ output voltage under short circuit condition.
- ii)                    Reverse battery connection: A fully charged battery shall be connected in reverse polarity to output terminals of charger. There shall be no emission of smoke or undue temperature rise of any component of charger. Working of corresponding indication/ alarm shall also be checked.
- iii)                    Other protection such as over voltage, battery under voltage, battery current limit test shall be carried out as detailed as per clause 4.1.

9.6.2                    Test for protective devices for DSA unit, Inverter, Ferro Resonant Voltage Regulator, Transformer rectifier and Step Down Transformer shall be carried out as per relevant clause of the specification.

9.7                    **Environmental & Climatic test**

9.7.1                    i)The Environmental & climatic tests shall be conducted on complete LC-IB power supply system in integrated manner.

SN	Test	Reference	Severity
1	Change in temperature test	IS: 9000 Part XIV Section II	-10°C to +70°C (as per indoor application of RDSO/SPN/ 144/2006)
2	Dry heat test	IS: 9000 Part III Section III	+70°C (as per indoor application of RDSO/SPN/ 144/2006)
3	Cold test	IS: 9000 Part II Section III	-10°C (as per indoor application of RDSO/SPN/ 144/2006)
4	Damp Heat test (Cyclic)	IS: 9000 Part V Section 1 & 2	Temperature 55° C and other conditions as per RDSO/SPN/144/2006 for indoor application.
5	Damp Heat (Storage)	IS:9000 Part IV	As per Indoor applications of RDSO/SPN/144/2006

- ii) The climatic tests shall be carried out by setting the system in exposed condition. During the period of exposure in each test, the system shall be connected to supply mains of nominal input voltage and shall deliver the rated output voltage of to a resistive load.
- iii) During the exposure, the system shall be loaded as per load configuration given in clause 2.2.1 and output of the relay external /internal, ELB & track circuits etc shall be monitored at the end of every cycle.

9.7.2 Following tests shall be conducted on one module of solar charger, DSA unit, Inverter, Ferro Resonant AVR, transformer rectifier, Transformer & SM unit.

SN	Test	Reference	Severity
1	Salt Mist test	IS:9000 Part XI Procedure 3	As per Indoor applications of RDSO/SPN/144/2006
2	Dust test	IS: 9000 Part XII	As per Indoor applications of RDSO/SPN/144/2006

The performance of modules subjected to above tests shall be observed in IPS system.

9.7.3 Vibration test shall be conducted on solar charger, DSA unit, Inverter as per RDSO/SPN/144/2006. The working of modules subjected for vibration test shall be observed with the LC-IB power supply system.

9.8 **Overall functioning of PSA/LC/IB**

After above tests, overall functioning of LC-IB power supply shall be checked as follows:

- 9.8.1 All sub systems shall be put on full load and with battery bank connected and solar backup to the LC-IB power supply. The overall functioning of LC-IB power supply shall be observed for 72 hours during type test, 8 hours during acceptance test & 4 hours during routine test with frequent ON and OFF condition of AC Mains alternately, after every 60 minutes.
- 9.8.2 All the sub systems of LC-IB power supply shall be connected. The output of all sub systems shall be checked. The switching over from mains to standby and vice versa of solar charge controller and inverters shall be checked. Indication of working and faulty condition of solar charge controller, inverters & Transformer rectifier shall be checked.
- 9.8.3 All alarms and indications of SM status monitoring panel shall be checked for its proper functioning.

10.0 **SAMPLING PROCEDURE FOR ACCEPTANCE TEST**

Visual inspection shall be carried out on one of the LC-IB power supply unit . The modules shall be tested for insulation resistance, high voltage test, temperature rise test, performance and protection tests as per the sampling plan given below:

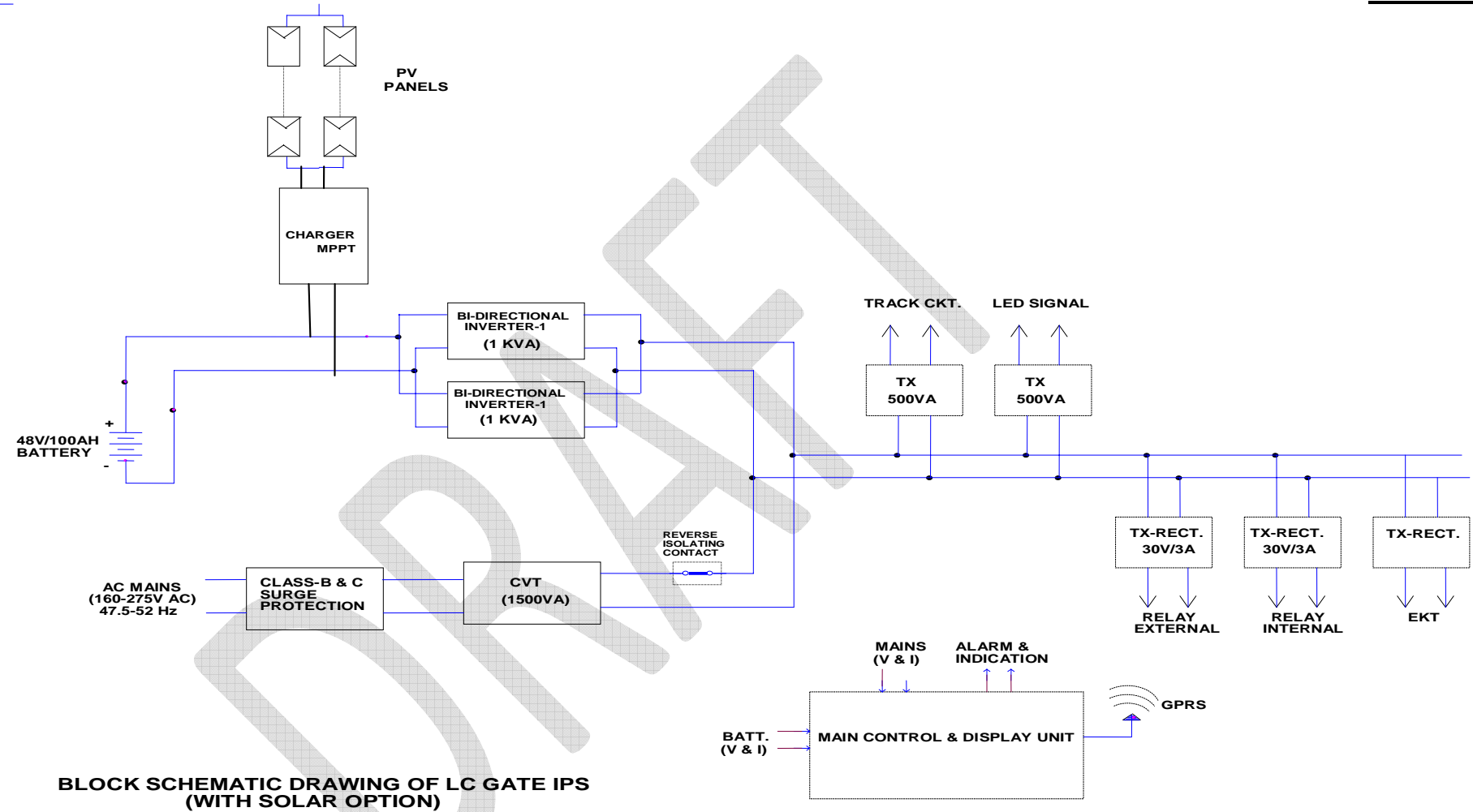
Test Description	Ins. Res.	HV test	Temp rise	Performance test	Protection test
Solar charge controller	N/2	N/2	N/2	N	N
Inverter	N/2	N/2	N/2	N	N
AVR	N/2	N/2	N/2	N	N
Trans former Rectifier	N/2	N/2	-	N	N
Transformer	N/2	N/2	N/2	N	N

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notes the no. of modules offered for inspection. N/2 shall be rounded off to the next number. In case of any failure during acceptance test, the lot shall be rejected.

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**Annexure-I**



Overall dimensions of cabinet sketch no. **SDO/ PSA/LC-IB /002 (Ann-II)**.

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Rack with front panel layout Sketch No. **SDO/ PSA/LC-IB /layout/003 (Ann-III).**

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