भारत सरकार –GOVERNMENT OF INDIA
रेल मंत्रालय– MINISTRY OF RAILWAYS
(कार्यालयीन प्रयोग हेतु)–(For official use only)

पॉवर उपकरण
पर हस्तपुस्तिका

HANDBOOK ON
POWER EQUIPMENT

CAMTECH/ S /2006/PE/2.0

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Centre
for
Advanced
Maintenance
TECHnology

Excellence in Maintenance

Maharajpur, Gwalior - 474020

CONTENTS

FOREWORD

This handbook is prepared with the object of imparting knowledge to the maintenance staff about correct way of maintaining various parts on the power equipment.

This book gives details and circuit diagrams of Battery Charger , Voltage Regulator and Inverter portions. It also has a separate section for trouble shooting of these equipments which will help the maintenance staff in quickly diagnosing the problems and removing the defects.

CAMTECH ***KULBHUSHAN***
GWALIOR ***EXECUTIVE DIRECTOR***
DATE : 31.03.2006

PREFACE

On Indian Railways ,failures of Power Equipment affects the punctuality of trains. CAMTECH is therefore continuously putting efforts in the field of documentation and upgradation of information on maintenance practices.

It is clarified that this handbook does not supersede any existing provisions laid down in the "Signal Engineering Manual".

Since technological upgradation and learning is a continuous process, So If you may feel the need of some addition/modification in this hand book, Please feel free to write us. We will be highly thankful for your kind contribution.

CAMTECH ***JAGMOHAN RAM***
GWALIOR ***DIRECTOR (S&T)***
DATE : 31.03.2006

POWER EQUIPMENT

1. Introduction

Power equipments are defined as circuits which transform electrical input power AC/DC into output power AC/DC. This definition excludes power supplies based on rotating machine principles.

Power equipments can be divided into four broad classifications as shown in table below.

Sr. No.	Power		Equipments
	Input	Output	
1.	AC	DC	Rectifiers,Battery Chargers
2.	AC	AC	VoltageRegulators,Transformers
3.	DC	AC	Invertors
4	DC	DC	Convertors,DC regulators

Part A,B&C of this handbook covers Installation & Maintenance Instructions for Battery Charger, Voltage Regulator & Inverter.

PART A : BATTERY CHARGER

1. INTRODUCTION

This part of handbook covers Installation & Maintenance Instructions for Battery Charger of IRS Specification IRS:S:86/2000(With latest Amd). The battery chargers covered in this specification are self regulating type with automatic working and are suitable for lead acid batteries. Battey chargers as per specifications No. IRS:S 93/96(B) (With latest Amnd) are suitable for Maintenance free cells.

In Signal & Telecommunication department the battery charger is used very extensively for charging secondary lead acid batteries at Telephone Exchanges, Microwave Stations, Repeaters, Testrooms, Computer Centres, Cabins, Axle Counter Rooms, RRI, Panels etc.

1.1 Basic Circuit

Basically battery charger is a rectifier circuit attached with a filter circuit in output. Rectifier is a device which converts Alternating current (AC) into pulsating Direct Current (DC). Refer figure A1, a simple block diagram is shown. AC is first rectified by rectifier and then pulsating DC is filtered by filter circuit. The output of this filter can be used as a direct supply to load or charging of batteries or both.

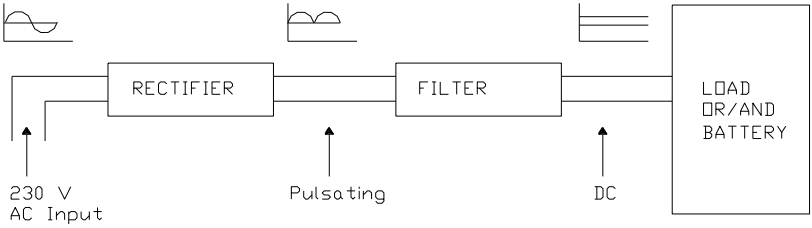

Figure A1

1.2 BRIEF WORKING

RECTIFIER

A simple circuit of rectifier circuit is shown in figure A2 by which working of circuit can be under stood easily.

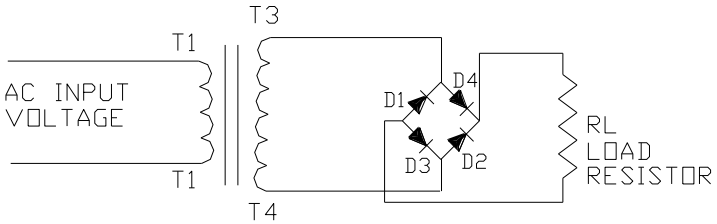

Figure A2

Assume that the top of the transformer secondary winding T3 is initially positive during first half cycle of the AC input voltage. The voltage during this half cycle is applied across a series circuit, consisting of diode D1, load resistor RL and diode D2. The cathode of D1 is at maximum negative potential and plate of D2 at max. positive potential so an current flows through D1, RL, D2 and transformer's secondary windings. During this half cycle plates of diodes D3 & D4 are more negative than their cathode and so do not conduct.

In the next half cycle the top T3 of the transformer secondary winding becomes negative and bottom becomes positive, so diodes D1 & D2 can not conduct. The plates of D3 & D4 are positive with respect to their cathodes so that current flows through D3, RL, D4 and transformer's secondary winding. For both half cycles current flows through load in unidirectional and we get pulsating DC at output.

FILTER CIRCUIT

A simple capacitor input filter circuit is shown in figure A3. Rectifier output is connected directly to filter.

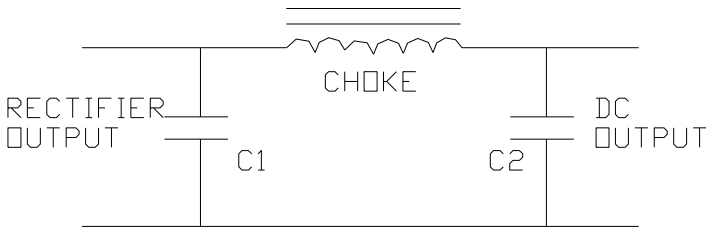

Figure A3

When such an arrangement is switched ON, the charge on C1 is zero, and during successive half cycles, two halves of the rectifier pass a current which charges C1 initially to the peak value of the pulsation. The capacitor tends to hold this charge between successive pulses, though discharging slowly through the choke and load. Consequently the filter output voltage drops off slightly between successive pulses as indicated in figure A4. It however, remains substantially near the peak value. Series choke opposes the fluctuations of the rectifier output current and C2 bypasses them to ground. A small AC ripple still remain which may be further reduced by adding additional identical filter section in series.

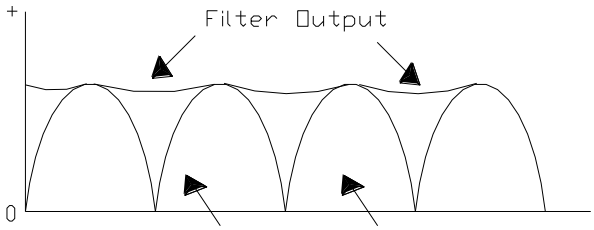

Figure A4

2.0 CONTROLS, INDICATORS & METERS

1. ON/OFF ROTARY SWITCH

This double pole MCB is used to connect or disconnect incoming supply to the charger.

2. MODE SELECTOR SWITCH

A two position selector switch designated as **" Mode Selector switch**" confirming to IS:4064(Pt-1) is provided for selecting Auto/Manual mode of working.

3. AMMETER

An Ammeter is provided with a selector switch for measuring Battery current and total current.

4. VOLTMETER

It is a moving coil type meter to indicate the output voltage of the charger.

5. MANUAL VOLTAGE SELECTOR SWITCH

It is provided to select the various predesignated voltages, when the charger is working in manual mode consequent upon failure of automatic mode of working or otherwise.

6. CURRENT CONTROL POT

It is a potentiometer provided inside the cubicle to set the charging rate.

7. VOLTAGE CONTROL POT

It is a potentiometer provided inside the cubicle to adjust the output voltage.

8. MAINS ON INDICATORS

It indicates the ON/OFF position of mains supply.

9 AUTO FLOAT INDICATOR

This indicate that unit is working on Auto float mode.

10. AUTO BOOST INDICATOR

This indicates that unit is working on Auto boost mode.

11. OVER LOAD INDICATOR

This indicates overload.

12. SHORT CIRCUIT INDICATOR

This indication comes when current exceeds due to short circuit in the circuit.

13. REVERSE CONNECTION INDICATOR

This indicates that the battery is connected in reverse polarity.

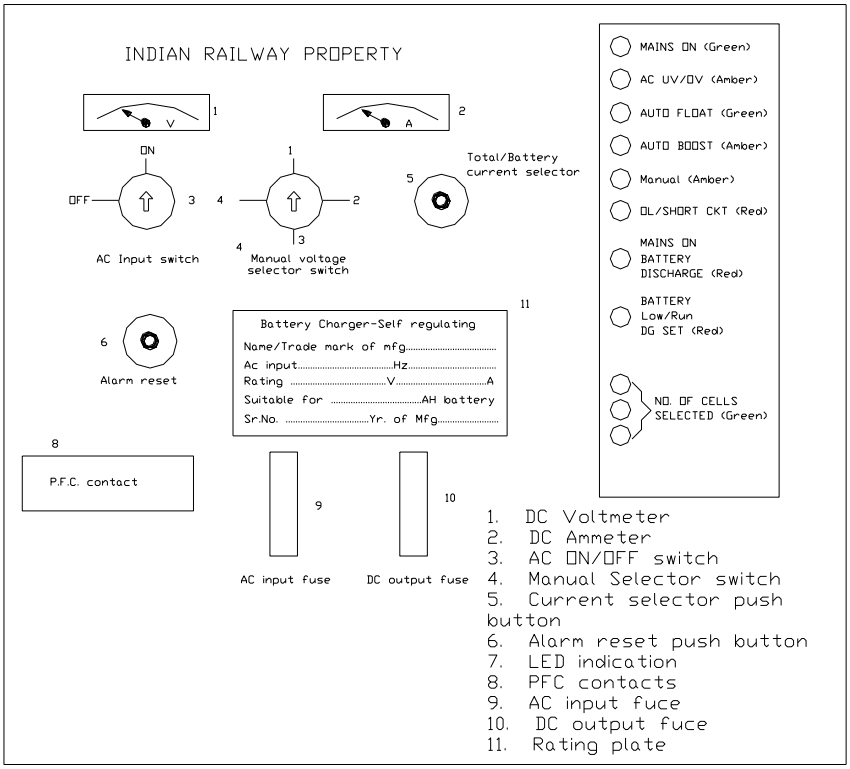

Figure A5

Front panel layout of Battery Charger –Self Regulating as per IRS:S:86/2000 with Amnd. 4.

Figure A5 on page no.8 shows a typical diagram of front panel of Self Regulating Battery Charger as per IRS:S86/2000 with Amd.4,and consisting of following meters etc.

1. DC Voltmeter
2. DC Ammeter
3. AC ON/OFF switch
4. Manual Selector Switch
5. Current Selector Push button
6. Alarm reset push button
7. LED indication
8. PFC contacts
9. AC Input fuse
10. DC output fuse
11. Rating plate

3. INSTALLATION

3.1 UNPACKING

The Charger unit received from supplier is in a fully packed condition.It should be removed from all external wrapping and packing materials which include the wooden packing, plastic film, cardboard and thermocole material used. After complete unpacking the unit should be inspected for any physical damages and any loose components/connentions. The unit should be switched on only after ensuring that all the controls and the circuits are in place

3.2 LOCATION

Locate the charger at a desired place which is free from extremes of dust and moisture. Minimum ventilation clearance on all sides should be maintained (about 300 mm).

3.3 INPUT &OUTPUT TERMINATION

The input and output (load and battery) terminals are provided inside the cubicle. Terminate AC mains supply at input and load and battery at output terminals with proper size of cables/wires. Ensure that line and neutral are connected properly at input terminals.

Ensure proper polarity of connection at Battery terminals, first connect the negative of the battery to the charger and then positive of the battery.

Use the cable of adequate size for the maximum DC current. If the charger is located far away from the battery, select the cable size for a minimum voltage drop from charger to battery.

Connect the load to the terminals marked for LOAD with proper polarities, again connect negative first and then positive, choosing the adequate size of the cable to carry the rated load current with minimum voltage drop from charger output to input load terminals.

4. INITIAL COMMISSIONING

4.1 AUTO MODE WORKING

a) Connect Earth terminal to the earth. After connecting 230V AC mains to input terminal, switch ON the unit by Mains ON/OFF switch(*3) to ON position. Indication ON (green LED) will glow.

b) Set the Mode selector switch in Auto position.

c) Since battery is no battery connected across the battery terminals, the charger will come in Auto-Float mode immediately. Indication of auto float will glow. Adjust the Float voltage to 2.15/cell(25.8V for a 24V charger/12.9V for a

12V charger) by adjusting voltage control pot by removing the small cover.

d) Current control potentiometer is provided to adjust the output battery current of the charger as per actual battery requirement. The current across battery terminals should not exceed 10% of AH capacity of battery(i.e.C/10 rate of charging). The use of current control pot is explained by the following example.

Example:

Sometimes a higher current rating battery charger is required to be used at site for charging of lower AH capacity batteries. For example, only 10 A rating charger is required for charging 40 AH battery set. However, if 20A charger connected to a 40AH battery set,The current control shall be adjusted to 4A i.e C/10 rate of battery capacity, as per table given in clause 4.3.We can therefore avoid overcharging of batteries by making use of the control potentiometer.

If the AH capacity of the batteries is matching the charger output current rating, the current potentiometer is kept at 100% position.

e) Connect batteries across the battery terminals with mode selector switch in Auto mode, the charger is in " Auto float mode". But if the current drawn by the batteries changes by more than 8 to 12% of the set current , the charger automatically changes to Auto Boost Mode and its output voltages to 2.4v/cell(28.8v in case of

24 v charger and 14.4v in case of 12v charger). It comes back to " Auto float mode" when the current drawn across battery terminals drops down to less than 10% of C10 rate and the battery voltage builds up to 2.4 V/ cell. This happens after the batteries have almost got fully charged.

f) In this mode of working Manual voltage selector switch is ineffective and therefore need not to be touched.

4.2 MANUAL MODE

a) Connect Earth terminal to earth. After connecting 230V AC mains to input terminal, switch ON the unit by changing the ON/OFF switch(*3) to ON position, Indication MAINS ON (green LED) will glow.

b) Change Mode selector switch to Manual position. The charger comes into manual mode and indication MANUAL(Amber) glows.

c) Connect rated load across the load terminals. Keep Manual voltage selector switch(*4) in position1 and check the output voltage. It should be 2.15V/cell. In position 2,3 and 4 of switch(*4) the output voltages should be 2.4V,2.7V and 2.9V per cell with rated load connected across the load terminals. This mode is unregulated and therefore output voltages vary widely with change of input AC voltage and load respectively.

d) Initial setting in manual mode is to be done by the SSE/SE(signal) depending on the load connected. ESM of the station should closely monitor the

battery charger as per instruction of the SSE/SE(Signal).

e) Manual mode is to be used when Auto mode fails. Manual mode is an unregulated mode where the output voltage changes with changes in AC input voltage,and output load. Therefore the maintainer should keep a watch so that batteries are not over charged.

4.3 RECOMMENDED CURRENT LIMIT

Recommended capacity of chargers for some of the standard capacity secondary cells, used on Railways are given in table on next page.

Sr No	**Cell cap AH)**	**C/10 Rate(A)**	**Maximum permissible Load (A)**	**Mini.Current rating of Charger(A)**	**Recommended current Rating of the charger(A)**
1	40	4	4	8	10
2	80	8	8	16	20
3	120	12	12	24	30
4	200	20	20	40	40
5	300	30	30	60	60
6	400	40	40	80	80
7	500	50	50	100	100

4.4 PROTECTION AND INDICATIONS

[To be checked at the time of initial installation]

a) Indication ON appears as soon as ON/OFF switch is switched ON.

b) When in auto mode, indications Auto float or Auto boost will appear depending on whether the charger is in Auto float or Auto boost mode.

c) Switch on the charger in Auto mode and short the load terminals. Indication OL/ Short ckt(Red) will glow and charger output becomes Zero. If short circuit is removed, the indication OL/ short circuit (Red) extinguishes and the charger gives the required output without any other adjustment. The charger should not trip.

d) Indication over load (Red) will glow when charger is overloaded by more than 10% of rated current in Auto mode

5. MAINTENANCE

5.1 ROUTINE OPERATION (by ESM)

a) Normally the charger will be working in Auto mode.

Once it is initially commissioned in Auto mode, by the Senior section engineer/ Section Engineer(Signal),no adjustment is required to be done by the ESM.

b) Change over to Manual mode

i) When Auto mode fails the mode Selector Switch shall be turned to Manual position.

ii) Manual Voltage Selector Switch (*4) may be kept in position 1,2,3 and 4,depending on load/battery charging requirement.

ii) Failure of Auto mode will be immedeately informed to SE(Signal), who in turn will check up the charger as soon as possible.

5.2 ROTINE MAINTENANCE

a) During the visit of on duty ESM to the station, he must check the front panel of the battery charger for correctness of the indications. The indications displayed must be in conformity with the mode in which charger is working. If not so, he must be refer to Routine operation as above, changeover the battery charger to Manual mode and report the failure to Section Engineer(Signal).

b) The ESM will check the tightness of the connections to battery and load terminals on the front panel and tighten the same if found loose.

c) If every thing is normal and indications on the charger front panel are in conformity with the mode of working, the ESM will not disturb the control switches of the charger.

6. TROUBLE SHOOTING

sr	Nature of Fault	Probable Reasons	Remedial Measures
1	Charger not receiving Input supply	Check Mains card And main fuse	Replace defective Items
2	No charger output	a.Input fuse may be blown b. output fuse may be blown c. control PCB may be defective d. Rectifier may be defective	Check fuse and replace if defective. If still no output Replace the control PCB with spare.
3.	There is no output Voltage adjustment.	a. POT may be open b. Control card may be be defective.	Replace the defective
4.	There is no automatic Changeover.	Control PCB may be defective.	Replace the defective.
5.	There is no current adjustment.	Potentiometer may be Open.	Replace potentiometer if necessary.
6.	Input fuse blowing while switching ON.	Input MOVR may be defective.	Replace MOVR.

PART B: VOLTAGE REGULATOR

1. INTRODUCTION

The colour light signals used by the Railways requir 12 v for illumination which is derived from 25 kv traction voltage or commercial supply. These lamps are very sensitive to voltage variations. Due to varying load condition there is very much fluctuation in Traction voltage results blown off of signalling bulbs and damaging of other equipments. Appreciable savings in labour and cost are achieved by providing voltage regulators, which prevent frequent replacement of signalling bulbs and contribute over all safety of fast moving trains

This Handbook covers Installation Maintenance Instruction for Ferro-Resonant type Automatic Voltage Regulator confirming to IRS Specifications S-74/89(latest).

2. BRIFE DESCRIPTION

2.1 GENERAL DESCRIPTION

The stringent operation conditions has required the use of ferro-resonant technology. Voltage regulators manufactured with this technology are able to handle a wide variation in voltage and deliver precisely regulated output voltage. Operating on the principle of saturation and the resultant storage capacity, these regulators demonstrate a high degree of immunity to line surges.

Ferro-resonant voltage regulators do not use any electronic or electromechanical components, resulting in good reliability and are virtually maintenance free. These regulators demonstrate a high degree of self protecting features.

2.2 WORKING PRINCIPLE

As soon as the input voltage is given to the charger, the primary coil of the transformer is energized. Corresponding voltage is also magnetically induced into the secondary coil of the main transformer. Secondary winding connected in series with capacitors form a resonating tank at line frequency and drive the transformer into saturation. Once the transformer is saturated, the flux density of the transformer becomes constant. It is the constant flux density

available at the transformer, which results in a constant output. In other words, the transformer develops immunity to the input voltage variation. Resultant harmonics, generated by the saturation, are filtered by the combination of filter windings on the main transformer, additional filter choke and capacitors.

2.3 BRIEF SPECIFICATION

Input	:	160 to 270 Volts, 50 Hz AC
Output	:	230 Volt +/- 1%AC (R.M.S)
Efficiency	:	Above 80% minimum

3. MAIN PARTS AND FUNCTIONS

Such type voltage regulators having very few control switches on panel showing below:

1. Main ON/OFF Rotary switch

Two pole ON/OFF Rotary switch confirming to IS:4064 (Pt-.I) is provided to connect and disconnect the AC main to input.

2. Input ON Indicator

A lamp to indicate that the unit is ON is provided on the front panel.

3. Voltmeter

An AC voltmeter of accuracy class not worse than 1.5 of IS:1248-1968 is provided on the front panel to indicate r.m.s voltage at both input and output terminals.

4. Selector switch

A suitable selector switch is also provided on the front panel to select r.m.s voltage at input and output terminals.

5. AMMETER

An AC ammeter is provided on the front panel to indicate R.M.S value of the output current.

6. EARTH Terminal

An earth terminal suitable for connecting 4mm dia wire is provided.

4 PRE INSTALLATION PRECAUTIONS

4.1 STORAGE AND SITE SELECTION

Do not store the equipment in an open yard. Always ensure that equipment is stored under covered area or indoors. To prevent shock and fire hazard, do not expose this equipment to rain or moisture. Ensure that storage place is not prone to water logging.

Ensure installation of the unit in a well ventilated area to avoid excessive heat build-up during operation. Avoid installing the unit near the damp area or where the unit could be exposed to direct sunlight and rain. This would prevent rust formation and enhance insulation resistance of the unit.

Floor mounted units may be grouted.

4.2 VISUAL INSPECTION

After unpacking the unit, carry out visual inspection with top cover of the unit removed. Check for any component damaged caused during transit. Check for loose terminal connections and tighten if required. Also check for external damage to voltmeter, ammeter and switches etc.

5 INSTALLATION & MAINTENANCE

5.1 Connect single phase supply to input terminal through a suitable fuse of adequate rating and should be earthed for safety.

5.2 Ensure input and output terminal cables are of proper capacity to handle the required power.

5.3 Ensure that unit is earthed properly to prevent shock hazard .

5.4 Ensure that phase and neutral are connected properly at the input and output terminals.

5.5 Switched ON the unit, after ensuring input and output connections are connected properly.

5.6 Ensure that the regulator is not overloaded.

6 TROUBLE SHOOTING

Sr.	Fault/Indication	Probable Cause	Remedy
1.	No AC output	One or more capa -citors shorted	Identify the faulty Capacitor and replace
		Entire Regulator Overloaded	Remove overloading
		Entire Regulator Short circuited	Remove short circuit
2.	Low AC output	i) Calibration of voltmeter may be out	Calibrate voltmeter
		ii) Voltmeter faulty	Replace voltmeter
		iii) Input voltage is below 160 volt	Report to SE(Sig)

		iv) Capacitor open	Identify and replace.
		v)Unit overloaded	Remove overloading.
3.	No voltmeter Indication.	i)Voltmeter defective ii) Selector switch defective	i)Replace ii) Replace
4.	No Ammeter Indication.	i) Ammeter defective	i) Replace
		ii) Very low load connected	ii) Increase load
5.	Indication Lamp not burning	No input power	Check Input Connections.
6.	Fuse at input line blowing repeatedly On turning ON No Indication	i)Improper Input Connections	i)Check Input connections
		ii) Primary coil shorted	ii) Replace

PART C : INVERTER

1. Introduction

A power conversion device, which converts DC power into AC power is called Inverter. The basic function of Inverter is to supply the continuous, conditioned AC power to the load. A conditioned supply means a stabilized, Free from spikes/surges, noise isolated sinewave supply.

1.1 Use in S&T

In Signal and Telecommunication, inverter are used for supplying power to signal and control circuits of signalling.

Mostly all other signalling equipments works on DC supply with battery back up.

1.2 Normal operation

Normally the inverter is fed from the DC sources (e.g. Battery along with a battery charger).When commercial AC supply is available the inverter draws power from the battery charger output and converts the DC supply into a conditioned AC supply. In case of failure of commercial AC supply the inverter draws power from the battery bank and maintain the AC supply to the load

without any interruption. On resumtion of the commercial AC supply, the inverter starts drawing power again from the battery charger. In both the transitions the load gets uninterrupted AC supply.

1.3 Basic Circuit

Theoretically Inverter is a power oscillator. Generally all types of inverter consists a transformer with one primary and one or more secondary windings to get various output voltages as per requirement.

Figure C1 shows the basic circuit of a inverter. DC supply is connected through switch S1 and S2 to the primary windings of the transformer. Switches S1and S2 shall work alternately i.e. when S1 switch will be in close(ON) position, switch S2 will remain open(OFF) and vice versa.When S1 switch is ON & S2 switch is (OFF), current flows in primary winding A, causes induced e.m.f and flow of current in secondary winding in one direction.

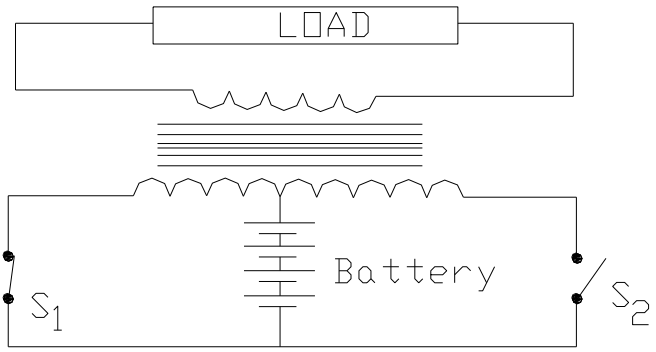

Figure C1

Similarly when S1 switch is in OFF and S2 is in ON condition, current flows in B of primary winding causes induced e.m.f. and flow of current in secondary winding in opposite direction. Therefore in a complete cycle, flowing of current changes in primary winding and AC voltages produces in secondary winding.

Practically the switching function is carried out by Transistors, SCRs, MOSFETS or other fast switching components according to requirement.

This handbooks covers Inverters to specification No.IRS:S: 82-92(latest) and capacity upto 5KVA used for signal.

2. Function of Front Panel Controls, Meters and Indicators

A) METER

AC Voltmeter

An AC voltmeter is provided on the front panel along with suitable protection device against over voltage. This indicate r.m.s voltage at the output. A distinct green marking is provided at the rated output voltage.

AC Ammeter

An AC Ammeter is provided to measure r.m.s current at the output. A red line is provided from rated output current to full scale of the ammeter.

B) SWITCHES

AC output ON/OFF Switch

A double pole miniature circuit breaker as per IS: 8828 is provided on the front panel. This connects /disconnects output to the load.

DC Input ON/OFF

A rotary switch is provided which connects/disconnects the DC supply to the inverter.

Mains Input ON/OFF
This connects/disconnects the AC mains to the unit.

Manual Bypass Switch
An auto change over arrangement for change-over of load from inverter`s AC output to commercial supply within 50 mili second is provided in case of inverter failure. In addition to the auto change-over system a manual bybass switch is provided. This transfers the load manually to the AC supply in case of inverter failure.

C) INDICATORS

Mains ON

This will glow when the mains switch is turned ON.

Inverter ON

This will glow when the inverter starts working after starting the unit.

AC output ON

This will glow when the output is switched ON.

DC Input ON

This will glow when the DC input switch is switched ON after connecting the DC input with correct polarity.

DC Under Voltage

This will glow if the DC input goes below specified voltage of 1.8 V per cell.

DC over voltage

This will glow if the DC input of unit goes above the specified voltage.

Inverter Trip

This will glow if the inverter trips due to any abnormal condition such as under voltage and over voltage or over load.

Pole Reversal
This will glow when the DC input polarity are wrongly connected at the input terminal of the unit.

DC Input Over Load

This will glow when the unit trips on Over Load of DC input in case of any fault on DC Bus of the inverter.

Over Load/Short circuit of AC output

This will glow in case of any fault on the load side. The current transformer in the inverter senses the over current condition.

Inverter Bypass

This will glow in case of auto/manual change-over with commercial supply is provided.

3. INSTALLATION

3.1 Visual Inspection

The equipment received from supplier is in ready to use condition. After unpacking the inverter following visual inspection should be made.

a) Inspect all the items as per the packing list.
b) Inspect all meters, controls, switches for evidence of damage.
c) Inspect cabinet assembly for evidence of clipped paint, paint scratches etc.
d) Check if any components like printed circuit boards, capacitors, chokes, transformers are dislocated during transportation.
e) Check for Two copies of Instruction Manual**.**

3.2.1 Pre Installation Procedure

While installing the unit certain procedures should be taken, which are given below.

a) The unit should be kept in a place where free air for circulation is available and sufficient space is provided on the front and back side of the unit for maintenance work.

b) The unit must not be placed in the proximity of acidic or corrosive fumes, as this would reduce its life.

c) The batteries used for DC input must be of correct nominal voltage, and should have adequate capacity to supply the full load current to the inverter.

d) The conductors used to connect these batteries to the inverter input should be thick enough to carry the full load current otherwise the voltage will drop in these wires, and the actual DC voltage will be considerably less at the input terminals. Therefore the inverter should be kept as close to the batteries as possible.

e) **Size of Conductors**

Rating of Inverter	INPUT		BATTERY		OUTPUT
	Voltage AC	Cable Sq.mm	Voltage DC	Cable Sq.mm.	Cable Sq.mm
500VA	230 V	1.5	24V	10.0	1.5
750VA	230 V	1.5	48V	6.0	1.5
1KVA	230V	2.5	110V	4.0	2.5
1.5KVA	230V	2.5	110V	6.0	2.5
2KVA	230V	4.0	110V	10.0	4.0
2.5KVA	230V	4.0	110V	10.0	4.0
3KVA	230V	6.0	110V	16.0	6.0
3.5KVA	230V	6.0	110V	16.0	6.0
4KVA	230V	8.0	110V	21.0	8.0
4.5KVA	230V	8.0	110V	21.0	8.0
5KVA	230V	10	110V	26.0	10.0

3.3 Installation

1. Connect the commercial AC supply to the terminals marked as AC INPUT.

2.Connect the battery charger`s load terminals to the terminals marked as DC INPUT with proper polarity.

3. connect the inverter output to the LOAD with terminals as AC OUTPUT.

4.Before making the connections, ensure that the switches DC INPUT and AC OUTPUT are in OFF position.

5. Switches ON the commercial AC supply & the DC input of the inverter. Measure the input supply AC & DC at the terminals.

4. Operational Instruction

4.1 Operating Instruction

The sequence of the procedure to operate the Inverter is listed here under.

1. Ensure the Battery or DC output of the Rectifier/ charger is connected to the DC input terminals of the Inverter with proper polarity.

2. Switch on the "DC ON" M.C.B. The "DC ON" LED will glow.

3. Press the START micro switch. The " output ON" LED will light and the output voltage of the Inverter will be seen on the voltmeter.

4. Press the "RESET" micro switch to clear off the spurious annuciations if any.

5. Then switch ON the loads which are connected at the inverter output terminals.

6. The Inverter may trip under fault conditions.

7. However, if so happens, the respective LED will indicate the cause of tripping. After attending the indicated fault, RESET the system and start the Inverter.

4.2 WARNING

HIGH VOLTAGE IS USED IN THE OPRERATION OF THE SYSTEM. HENCE EXTREME CARE SHOULD BE TAKEN WHEN PERFORMING MAINTENANCE TASK OR TROUBLE SHOOTING OF THIS SYSTEM TO PREVENT ACCIDENTAL ELECTRICAL SHOCK.

5. INSPECTION AND MAINTENANCE

Items	**Period**	**Procedure**
Ventilation & Openings	Weekly	Check that intake and exhaust air openings are not obstructed. This high power equipment dissipates lot of power therefore, it should be located in a well ventilated space. Otherwise the ambient temperature surrounding the equ--ipment will increase. The equipment should be protected From dust on the components and wires may lead to insulation break down and may result in failures of components.
Chassis Assemblies	2Months	Remove dust and foreign particles within the chassis using compression air or blower. Check mounting bolts and terminals looseness. Tighten them. Clean electrical contacts with a cloth dampened in with carbon tetra chloride. Do not use cleaning solvents on electrical contacts. Replace if found defective.
Controls & Indicators	Weekly	Check all indicator lamps.
	6Months	Check all controls for operability. Check the operation of meters. Replace if there is any damage or

		manufacturing observed.
	12Months	Check the cable for input and output power and internal wiring to components. Check for cracks or broken insulation.
	12 Months	Inspect PCB, sockets for loose electrical connections. Tighten the mounting screws and replace defective sockets, if any
	12Months	Inspect terminals boards for breakage of joints. Replace defective TB if necessary. Tighten mounting screws if necessary.
	12Months	Inspect the electric wiring for broken solder connections, evidence of peeled insulation and general deterioration. Repair or replace damaged wiring.

Warning	**Use carbon tetra-chloride in well ventilation areas. Do not breathe fumes**

6. REPAIRS & REPLACEMENTS

When replacing the components, observe the following :

1. When soldering avoid excessive heat which may damage associated components.

2. Be careful while making all soldering joints, as poorly soldered joint can cause further trouble and one of the most difficult faults to locate.

3. Do not drop drips of solder or hardware into the chassis.

4. Do not damage leads of other components by pushing or pulling them aside.

5. Maintain a log of all repair and adjustment. Comprehensive notes and accurate log, make it possible to reverse the procedure or to facilitate the communications regarding repair procedure.

6. When detaching wires from components, mark the wire with tape to ensure correct re-wiring.

7. Always place the component in the exact position occupied by the original.

8. Whenever one more components have been replaced, testing and readjustment of appropriate circuit is necessary.

7. TROUBLE SHOOTING

In case there is any fault in the system, It is preferable that the unit is tested step by step. It is further desirable that the basic principle of operation of each section is clear in mind before doing any trouble shooting. However, brief guidelines are provided through the following chart for expediting the fault tracing.

S. No.	**Fault**	**Probable Cause**	**Remedy**
1.	DC fuse fail	Skin effects due to prolong Use. Short circuit excessive overload on inverter.	Replace fuse. Check inverter output for excessive overloading and reduce the load to the limit. or check inverter power transistors for short circuit and replace the defective transistors.
2.	DC under voltage Indication comes on even when DC voltage is nominal and the inverter trips.	Inverter DC fuse blown.	Replace fuse.
3.	DC under voltage comes Immediately after the inverter Switching ON (no load).	DCinput cable is less than rated capacity.	Replace the cable. Use proper cable.

S. No.	Fault	Probable Cause	Remedy
		Loose contact input lines.	Tighten all the Connections.
4.	DC under voltage indication comes	Battery is discharged.	Keep the charged battery.
	DC under voltage indications comes while the unit is working on battery & inverter trips.	Battery is discharged.	Keep the charged battery.
		Due to excessive voltage drop in Cable used for battery since less than rated capacity	Replace the battery cable with proper rating cable.
5.	Inverter is not getting ON	Break in DC supply either due to blown fuse or wire disconnected.	Replace fuse and check Wiring.
		Control card not receiving DC supply or Some wires got desoldered.	Check fuses and replace If found faulty or check Control wiring as required

S. No.	Fault	Probable Cause	Remedy
6.	Inverter output high	Power supply transistors faulty.	Replace faulty transistor
		Control card defective.	Replace control card.
		Feed back Loop broken	Check feed back Transformer or break in transformer`s or Voltage adjust Potentiometer`s wiring.
		Control card not Functioning Properly.	Replace control card.
		False indication due to defective over voltage sensing card.	Check and set over voltage card circuit.
7.	Inverter trips before Loading.	Setting of over tripping is not proper.	Set overload Tripping by adjusting resistor and check power requirement of the load.
8.	Unit not working neither	Output MCB	Switch ON the MCB.

S. No.	**Fault**	**Probable Cause**	**Remedy**
	On inverter nor on mains	Tripped.	

8. DO`S AND DON`TS

8.1 DO`s

1. On every roster take a careful look at the connections made to the system.

2. Before starting the inverter check that all the load circuits are off.

3. After starting the inverter wait till the output voltage meter shows normal then start the load

4. Understand the operational instructions thoroughly.

5. Please ensure the earthing is done properly and is maintained periodically.

8.2 DON`TS

1. Do not disconnect DC BUS from Inverter.

2. Do not over load the inverter or connect loads like tube light, fan ,drilling machine to output.

3. DO not keep anything on the inverter.

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