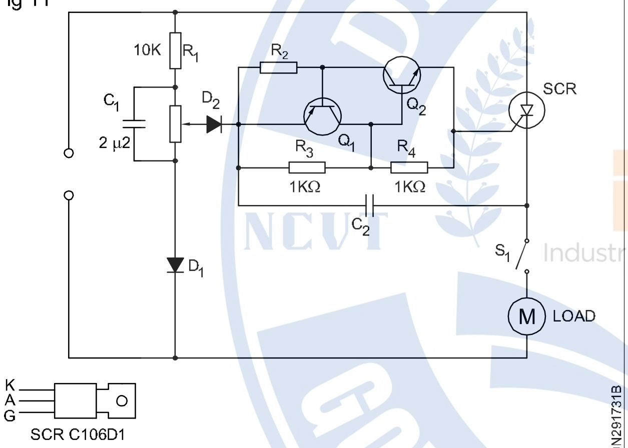
- The wave form at point A (V_A) for one positive half cycle is in Fig 10b and with V_{SCR}, V_D and motor generated emf V_M. The phase angle at which the SCR would trigger is shown by the vertical dotted line.
- For any reason if the motor speed increases, then V_M will increase, the trigger would move upwards and to the right along the curve so that the SCR would trigger later in the half - cycle thus providing less power to the motor, causing it to slow down. Similarly, if the motor speed decreases, the trigger point will move to the left and down the curve, causing the SCR to trigger earlier in the half cycle providing more power to the motor thereby speeding it up.
- Resistors R_1, R_2, R_3 along with diode D_1 and C_1 forms a ramp generator. Capacitor C_1 is charged by the voltage divider R_1, R_2 and R_3 during the positive half cycle. Diode D_2 prevents negative current flow during the negative half cycle, therefore C_1 discharges through R_2 and R_3 during negative half cycle. Varying the value of R_2 varies the trigger angle α.

A practical version of the circuit for controlling the speed of universal motors is in Fig 11.

Fig 11



CIRCUIT DIAGRAM OF UNIVERSAL MOTOR SPEED CONTROLLER

As can be seen, the circuit at Fig 11 is quite similar to that at Fig 10 but for the addition of two transistors and a few resistors.

In Fig 11, the action of Q_1 - Q_2 is to provide adequate gate current to trigger the SCR into conduction.

Q_1 - Q_2 and their associated resistors acts as a voltage sensitive switch. In each half cycle, C_2 is able to charge via R_1. As soon as voltage across C_2 rises to suitable value. Q_1 and Q_2 both switch- on and partially discharge C_2 into the gate of the SCR, thus delivering a pulse of high current to the SCR gate, independent of any current drive limitations of RV1. The Q_1 - Q_2 and C_2 network thus enables virtually any SCR to be used in the circuit almost irrespective of its sensitivity characteristics.

The universal motor speed control circuit is in Fig 11 enables the motor speed to be smoothly varied from zero to 75% of maximum via a single control. It also incorporates built - in feedback compensation to maintain the motor speed virtually constant at any given speed setting, regard-less of load changes.

Voltage stabilizer and UPS

Objectives: At the end of this lesson you shall be able to
- **state the basic concept of stabilizer**
- **draw the block diagram and explain the function of each blocks**
- **state the working various types of voltage stabilizers**
- **state the basics of UPS system**
- **explain the block diagram of OFF line UPS and its various controls and functions**
- **explain the block diagram ON line UPS and advantages and disadvantages.**

Voltage stabilizer

It is an electrical supply device controlled by electronic circuit which gives the constant output voltage irrespective of the variation in the high input supply voltage or disconnect the output circuit if the input voltage is very low or very high.

Every electrical device is designed to operate at a certain rated voltage for optimum efficiency and maximum length of service. Power supply voltages should not drop or rise by more than 5% of rated voltage as per IS.

The effect of voltage variations in commonly used electrical appliances are given below.

Sl.No.	Name of the equipment	Low voltage	High voltage
1	Incandescent lamp	Lamp efficiency decreases if the voltage is decreased.	Life of the lamp decreases or the lamp fuses in extreme cases.
2	Fluorescent lamp	If voltage is too low, lamp will not light up.	Life of the tube/choke decreases.
3	Electric stove, electric iron, water heaters, toasters etc.	Increases the heating time as heat produced is low.	Shortens the life of heating elements or heating elements burnt out.
4	Fans, vacuum cleaners	Efficiency decreases.	Life of the equipment is decreased
5	Washing machines, refrigerators and air-conditioners	Motor of the machine will draw more current from the line that results in overheating of the motor which may lead to burn out.	The motor insulation may fail and draw excess current which can lead to burn out.
6	Radios and television sets	Poor quality of reception, picture will not be clear in the television sets.	Life of the equipment is decreased

Some of the electronic equipment such as colour television sets are designed by the manufacturers with built in electronic stabilizers like Switch Mode Power Supplies (SMPS). Hence there is no need to provide an additional external stabilizers for these equipments.

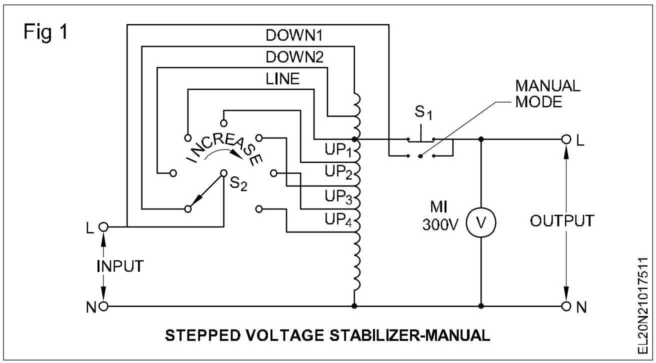
Types of AC voltage stabilizers

1 Stepped voltage stabilizer
   a) Manual
   b) Automatic relay type
2 Servo voltage stabilizer
3 Constant voltage transformer

Stepped voltage stabilizer - manual type : Fig 1 shows an auto-transformer in which the output voltage increases as the tap changing switch S_1 is turned clockwise. The output voltage can be seen by connecting a voltmeter in the output side as in Fig 1. Increasing or decreasing the output voltage near to the set value is possible by rotating the tap changing switch S_2 in the appropriate direction within ±10% of the desired output voltage. A push-button switch S_1 enables to measure the incoming voltage.

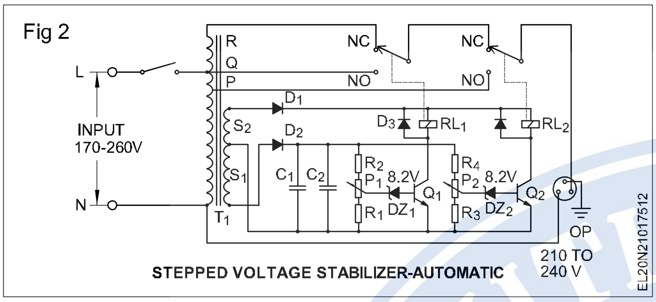
Stepped voltage stabilizer - automatic type : Fig 2 shows a stepped voltage stabilizer of the automatic type operated by relays. T_1 is an auto-transformer with multiple tappings. S_1 and S_2 are two secondaries for relay operation. The secondary voltage of S_1 is rectified and filtered for the use of the sensing circuit while voltage S_2 is rectified and filtered for the use of the relay operation. P_1 and P_2 are pre-set resistors (variable resistors) used for adjustment. R_1, P_1 and R_2 provide sensing voltage to the zener diode. DZ_1 and R_3P_2 and R_4 to the zener diode DZ_2. Q_1 and Q_2 are two transistors used as switches. RL_1 and RL_2 are two relays.

Fig 1



STEPPED VOLTAGE STABILIZER-MANUAL

Fig 2



STEPPED VOLTAGE STABILIZER-AUTOMATIC

When the input voltage is low, say less than 200V, both DZ_1 and DZ_2 do not conduct as the voltages at the preset tappings are less than their zener diode voltages. This causes both transistors to cut off and the relays are in the off position. At the off position of the relays, NO contacts of both the relays connect terminal R of the auto-transformer to output which results in booster output voltage.

When the input voltage increases above 210V, but below 240V voltage across S_1 increases proportionally. This increases the pre-set tap voltage, thereby the zener diode DZ_1 conducts and hence make the transistor Q_1 to ON. The relay RL_1 operates and connects the supply voltage directly to the output through NO. contact of RL_1 and NC contact of RL_2. By this operation the output voltage will be the same as the input voltage.

When the input supply voltage increases above 240V the zener diode DZ_2 gets voltage from P_2 and hence conducts which makes Q_2 to ON. This results relay RL_2 energise and output is taken from NO. point of RL_2. The output voltage reduces or bucks.

Usually 12V DC relays with the required current ratings of contacts are preferred for stabilizers. Diodes or capacitors are used across the relay coil to protect the transistors from reversed induced emf when the relays become OFF. LED indicators are sometimes used to indicate the mode of operation such as buck, normal, boost etc.

Stepped voltage stabilizers are available with different types of electronic circuits with one to three relays to provide an output voltage of 200-240V. They are specified for maximum input voltage variation and for their output, KVA ratings say 170 to 270 volts 1 KVA or 135 to 260 volts 0.5 KVA.

Some of the stabilizers are provided with over-voltage and under-voltage cut off to protect the connected equipment.

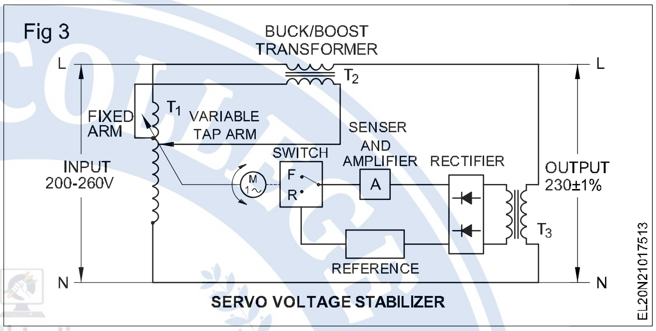
Applications : Stepped voltage stabilizers are used along with refrigerators, air conditioners, TVs, VCRs etc. Colour TVs with self-contained switch mode power supplies do not require voltage stabilizer as they are designed to operate from 130 to 260 volts.

Servo - voltage stabilizer

The servo voltage stabilizer employs a toroidal auto-transformer and a servo motor driven by a sensing circuit which senses the voltage. The difference between the output and nominal voltage is sensed by a sensing circuit which drives the servo motor. Any variations in mains cause the motor to move clockwise or anticlockwise thus correcting the voltage.

A servo voltage stabilizer is provided with three transformers function along with control circuits and a servo motor as in Fig 3. T_1 is a continuously variable toroidal auto-transformer (variac) driven by a servo motor M.

Fig 3



SERVO VOLTAGE STABILIZER

The output from the variac, drives a series buck/boost transformer T_2 so that boost takes place when the variable tap arm moves down and bucks the voltage when the arm moves up. The transformer T_3 provides the required reference voltage and sensing voltage for the electronic circuit which drives the motor.

When the output voltage is less than the reference voltage, the electronic circuit senses the difference, drives the motor in one direction which results in increase in the output voltage.

When the output voltage increases above the ratings, the motor is driven in the opposite direction so that the output voltage increases. When the voltage difference in output and the reference are equal, the servo motor is switched off by the circuit.

A servo stabilizer provides constant voltage to an accuracy around ±1% or ±0.5% and a correction range 10 to 30 volt/sec.

A servo stabilizer is more accurate and also costlier, and, therefore, used with costlier equipments such as computers, xerox machines, medical electrical equipments etc.

Constant voltage transformer

A constant voltage transformer works on ferro-resonant principle. The variation in the primary flux with an unsaturated iron core does not affect the secondary flux with saturated iron core. Thus, the secondary induced voltage remains relatively independent of the voltage impressed upon the primary winding.

Basics of UPS systems : Most people take the mains AC supply for granted and use it almost casually without giving the slightest thought to its inherent defects and the danger posed to sophisticated and sensitive electronic instruments. For ordinary household appliances such as incandescent lamps, tubes, fans, TV and fridge, the mains AC supply does not make much of a difference, but when used for computers, medical equipments and telecommunication systems, a clean, stable, interruption-free power supply is of utmost importance.

UPS (Uninterrupted Power Supply) is the only solution available to an individual customer faced with the problem of ensuring high quality of power for critical loads. All UPS designs contain a battery charger to keep the battery fully charged by the power from mains. Small UPS normally comes with a sealed maintenance free (SMF) batteries which can provide 10 to 15 minutes of power backup, the backup time increases with the capacity of the battery. Tubular batteries or automotive batteries are used in medium and large capacity UPSs.

UPS classification : There are two broad categories of UPS topologies - OFF line, and ON line . These topologies differ in the way they serve the load when the mains is present and is healthy. They vary in features & pricing.

OFF-Line and ON-Line : OFF-Line UPS filters the mains and feeds it directly to the load for most of the time. When the mains is unhealthy, perhaps due to a slight drop in voltage, the load is switched by a fast relay, in typically less than half a cycle, to an inverter deriving its power from a battery. The inverter generates a square or stepped waveform to emulate the mains-satisfactorily for most computers. This particular technique represents the lowest cost solution.

Online UPS converts AC mains into DC before inverting again to AC to power the load with a synthetic sine wave. A battery connected across the DC link acts as the backup power source.

This gives a supply for the computer that totally isolates the input mains from the load, removing all mains noise and with no break when the mains fails.

Standby/OFF Line block diagram (Fig 4) : In the off line UPS, the load is connected directly to the mains when the mains supply is available. When working over voltage/ under voltage conditions are detected on the mains, the off line UPS transfers the load to the inverter. When the line is present, the battery charger charges the battery and the inverter may either be shut down or will be idling. Thus in an off line UPS, there is a load transfer involved every time, the mains is interrupted and restored. This transfer is effected by change- over relays or static transfer switches. In any case there will be a brief period during which the load is not provided with voltage. If the load is a computer and the transfer time is more than 5ms, then there is a chance that the computer will reboot.

Some modified designs incorporate a limited range of voltage regulation by transformer tapping and a certain degree of transient protection by using RF filters and MOV's (Metal Oxide Varistor). Off line UPS is an economical and simple design and hence it is preferred for small rating, low cost units aimed at individual PC user's market. When the load is really a critical one an off line UPS is not acceptable. Usually square wave output off line UPS are available in market with lower loading capacities.

Advantages of OFF line UPS: High efficiency, small size, low cost.

Disadvantages: There can be change over complaint in offline UPS. Off line very much depends on battery. If battery fails entire system fails. Sometimes during change-over computer re-boots which causes loss of files. Another disadvantage is that output voltage will be a varying one. Usually in the range of 200V-240V and hence not suitable to all electronic gadgets.

Front panel indications and rear panel sockets/ switches used in UPS : All UPS systems have

- Fuse/Fuse holder
- Switches
- Sockets
- Panel indicator (LED and Neon lamp)
- Meters (Volt/Ampere)

Fig 4

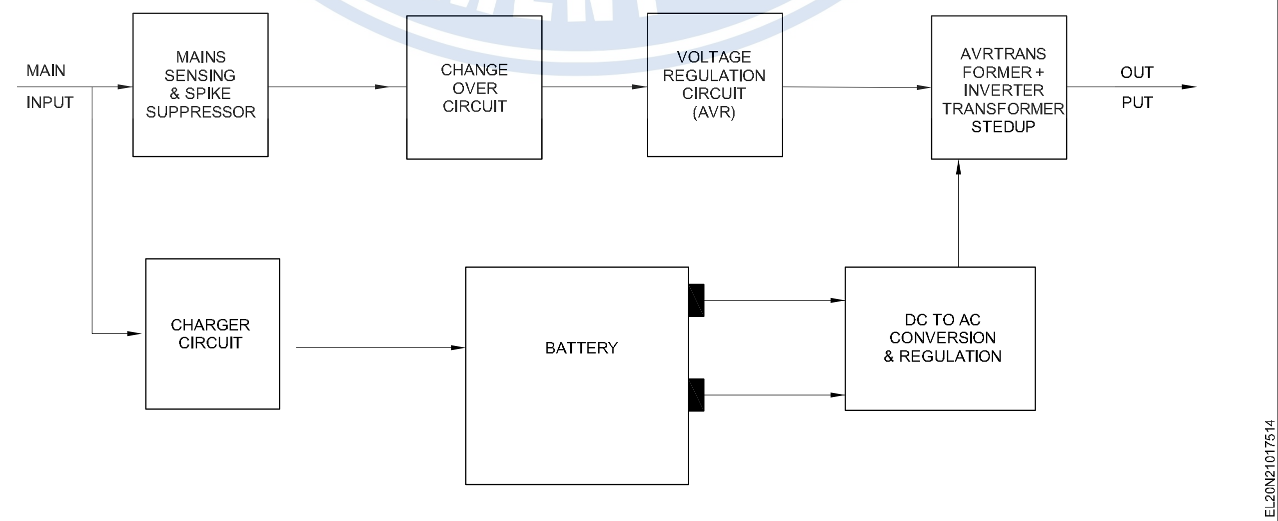
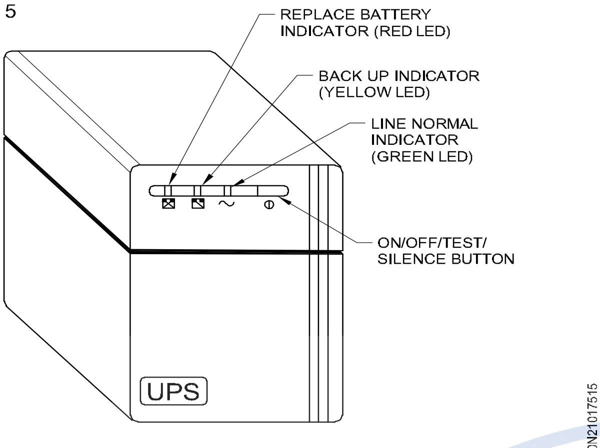


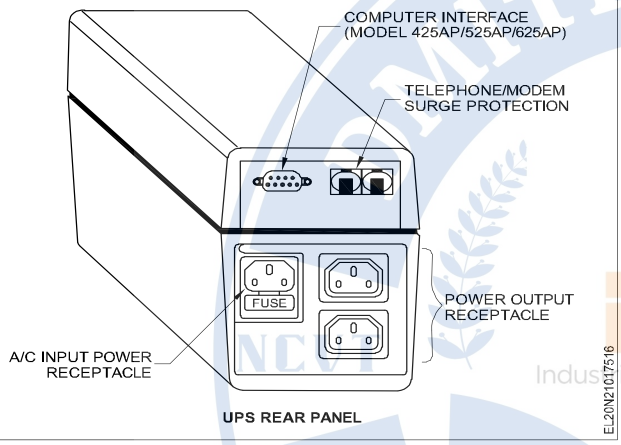
Fig 5 and 6 shows the front and rear panel controls/ sockets.

Fig 5



UPS FRONT PANEL

Fig 6



UPS REAR PANEL

ON line UPS

In an ON line UPS, the inverter always supplies the load irrespective of whether mains power is available or not. The load is always left connected to inverter and hence there is no transfer process involved. When the mains power is present, it is rectified and applied in parallel with the battery. Hence all the supply system transients are isolated at the battery and the inverter always delivers pure sine wave of constant amplitude to the load.

Fig 7 represents a basic block diagram of an ON Line UPS.

In the block diagram (Fig 7), the mains input is stepped down to a lower level and applied to a thyristor based phase controlled AC to DC converter, employing firing angle(α) control. The PWM inverter which usually employs pulse width modulation using triangular/square wave carrier runs in battery mode. The output is filtered and given to the load. The PWM inverter is switched in the frequency range (50Hz) depending on the power rating and hence the DC side current drawn by the inverter will contain switching frequency components.

Along with the charging current the second harmonic component of DC side current of the inverter also flows into the battery. This second harmonic is quite large in value and this represents unnecessary strain on the battery. This is one of the major disadvantages of this design since it affects the battery life adversely.

When the mains is present the load power flows though the converter, reaches the battery node and from there flows into the inverter i.e there is double conversion of power. The converter, Inverter and the two level shifting transformers incur power losses in this process. Hence the efficiency of this design is lower than the OFF line design.

In a properly designed control system the battery voltage is measured and compared with a set float voltage. The error is processed in a proportional controller and the processed error decides the charging current that should flow into the battery. Charging current will be a constant one for ON line UPS.

Often it is found that the battery is in discharge mode even when mains is present i.e the battery shares the load current with the mains. This happens when the mains voltage is low and/or the output is loaded to above 75%. The efficiency of ON line UPS can be increased by using boost type power factor correction circuit.

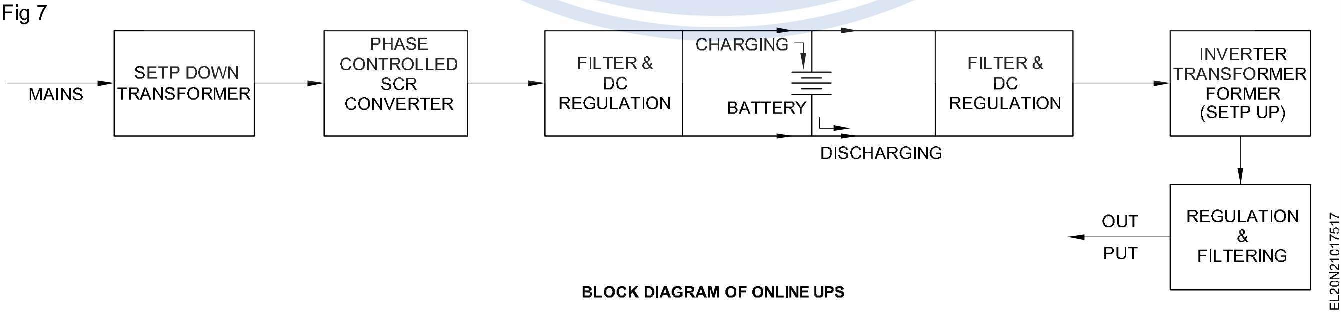
Advantages

- Constant output voltage (No AVR card) free from changeover problem.
- Constant charging current.

Disadvantages

- complex in design, lower efficiency, higher cost, bigger in size and strain on the battery.

Fig 7



BLOCK DIAGRAM OF ONLINE UPS

Emergency light

Objectives: At the end of this lesson you shall be able to
- **explain the block diagram of emergenccy light**
- **explain the emergency light circuit diagram and charging of battery.**

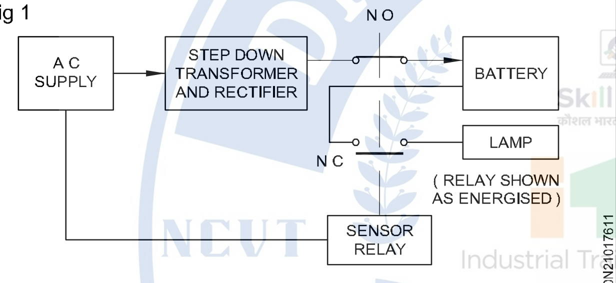
Emergency light

Emergency lighting system is commonly used in public building, work places, residences etc., The main function of the emergency lamp in the industry are

- to indicate ESCAPE routes
- to provide illumination to path ways and exit
- indicate the location of the fire fighting equipments.

The block diagram of an emergency light is in Fig 1. The circuit is discussed here are basic circuits without over charging protection for battery or trickle charging facility. Modern emergency lights have these facilities.

Fig 1



BLOCK DIAGRAM OF AN EMERGENCY LIGHT HAVING INCANDESCENT LAMP

As shown in the block diagram AC main supply is fed to the step down transformer, then it is rectified to charge the battery through a sensor relay. A lamp is connected in the battery circuit through the relay. When AC supply fails the relay enables the battery to the connected lamp circuit through the normally closed contact and the lamp will glow.

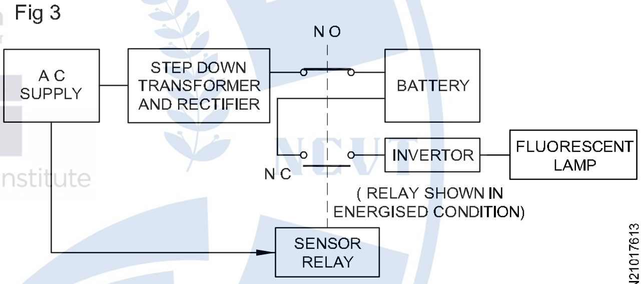
When the AC supply is restored, the battery will be getting charged through the normally open contact of the relay. The charging current is regulated by the series resistances of 2.2 ohm, 5 watt. as in Fig 2. The two LEDs, one is red and the other is green are provided in the circuit to indicate the presence of AC and the lighting of the lamp through the battery supply respectively.

One 1000 microfarad capacitor is used in the rectifier circuit to smoothen the output D.C. supply and one 10 microfarad capacitor is used across the relay to increase the efficiency of relay operation.

Emergency tube light circuit: The emergency light which is connected to an ordinary incandescent lamp will give less light. If the fluorescent tube is used in emergency light it will give about 3 times more light consuming same wattage. Hence most of the emergency lights are incorporated with fluorescent tube lights.

The inverter circuit is incorporated with the ordinary incandescent lamp could be replaced by a tube light as shown in the block diagram, (Fig 3). The tube light requires a high voltage for its operation. The inverter is used to convert DC supply to AC and then it is stepped up to light the fluorescent tube. The inverter circuit is made operative by the sensor (relay). When AC supply is not available, during power failure battery voltage operates the inverter, in which DC is converted to AC and then stepped up to high voltage to enable the fluorescent tube to light up.

Fig 3



BLOCK DIAGRAM OF AN EMERGENCY LIGHT HAVING FLUORESCENT LAMP

Inverters are basically transistorised oscillators as in Fig 4. They can be made to oscillate at the frequency of about 6.6 kHz. The frequency of the circuit can be changed by changing the value of resistor and capacitor in the circuit which is connected in the base of the transistor.

When the AC supply is resumed the sensor relay connects the battery terminals to the rectified DC circuit for charging and the inverter circuit is disconnected from the circuit by the relay.

For keeping the temperature of the power transistor within its temperature range suitable heat sink should be mounted over the power transistor.

Fig 2

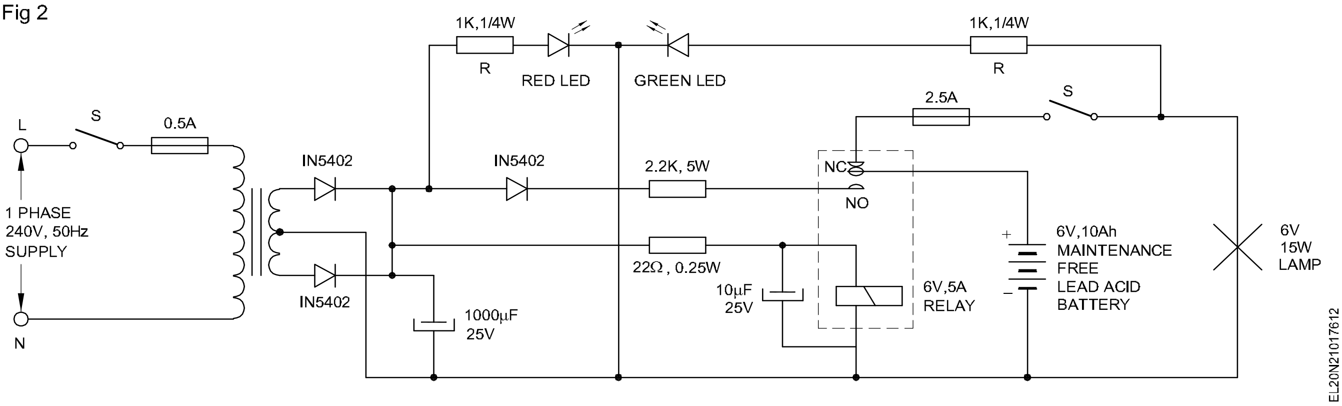
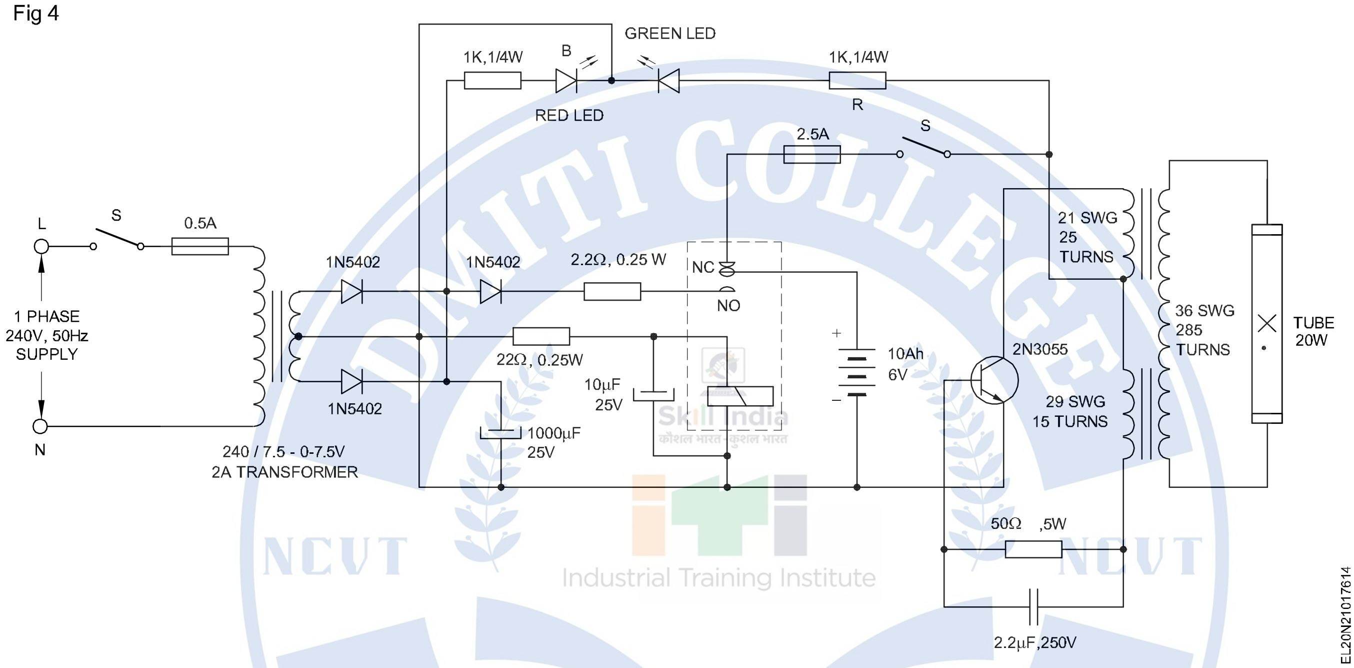

1K,1/4W
R
RED LED
GREEN LED
1K,1/4W
R
2.5A
S
L
S
0.5A
1 PHASE
240V, 50Hz
SUPPLY
N
IN5402
IN5402
IN5402
2.2K, 5W
NC
NO
22Ω , 0.25W
10µF
25V
1000µF
25V
6V,5A
RELAY
6V,10Ah
MAINTENANCE
FREE
LEAD ACID
BATTERY
6V
15W
LAMP
EL20N21017612

Fig 4


GREEN LED
1K,1/4W
B
RED LED
1K,1/4W
R
2.5A
S
L
S
0.5A
1 PHASE
240V, 50Hz
SUPPLY
N
1N5402
1N5402
1N5402
2.2Ω, 0.25 W
NC
NO
22Ω, 0.25W
10µF
25V
1000µF
25V
10Ah
6V
240 / 7.5 - 0-7.5V
2A TRANSFORMER
21 SWG
25
TURNS
36 SWG
285
TURNS
TUBE
20W
2N3055
29 SWG
15 TURNS
50Ω ,5W
2.2µF,250V
EL20N21017614

Battery charger and inverter

Objectives: At the end of this lesson you shall be able to
- **explain the working of battery charger with the help of block diagram**
- **state the principle of inverter with the help of block diagram.**

A Simple battery charger : The charger can charge 6V,12Vand 24V battery at Suitable current rate. This circuit has many protection built in it to protect the battery from overcharge and reverse polarity etc.

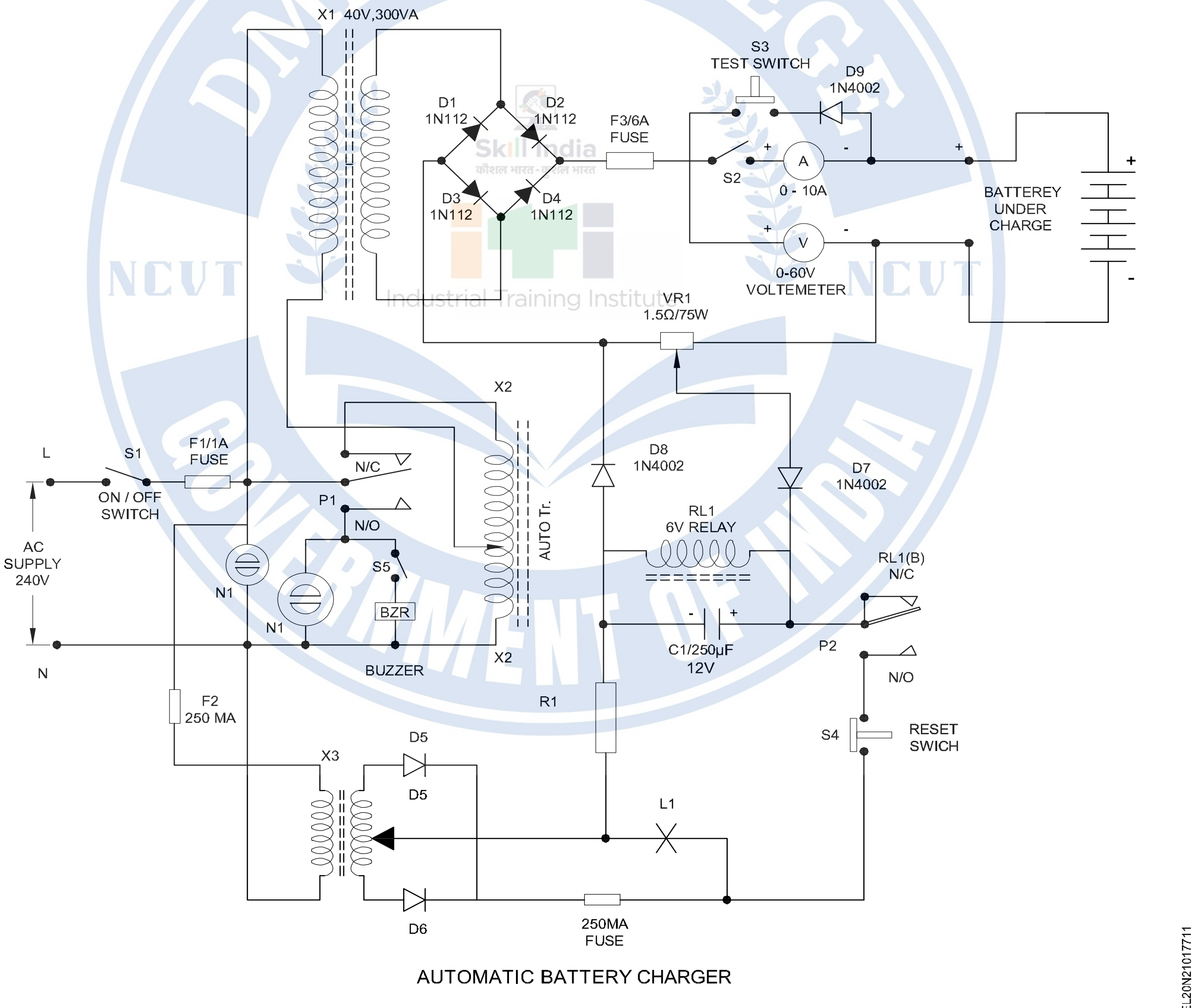
The charger consist of an auto transformer X_2 (Fig 1) for supplying constant current and voltage.

A charger transformer 'X_1' is connected to the auto transformer and the secondary of the X_1 (Fig 1) is rectified through full wave bridge rectifier and supplied to the battery under charger through. Ammeter voltmeter and a potentiometer (Fig 1)

A step down transformer X_3 is used to keep cut off relay is energised condition when the mains AC supply is cut off to the charger circuit. Relay RL_1 used to cut off the AC mains supply to the charger circuit. Pole P_1 of relay RL_1 is connected to AC mains supply and pole P_2 is connected to cut off circuit.

Relay is energised by the centre tapping of potentiometer, which is set such that, the current in the charger circuit exceeds then it is energised and poles P_1 & P_2 are connected to normally opened (NO)pin, switching 'Off' A/C mains supply to the circuit.

Fig 1



AUTOMATIC BATTERY CHARGER

The test switch S_3 is connected to check battery polarity, reset switch S_4 is used to reset the charger, when any fault occurs. Then the charger is cut off and the Switch 'S_1' is mains ON/OFF switch.

A fully charged lead acid battery must be 2.1 volt/cell during on charge. It will increase upto 2.7V/cell. The voltage of a battery is multiple of the number of cells.

In discharged condition the voltage is 1.8V/cell, it should not be further discharged in this condition as it may permanently damage the cell.

E.g A 100AH (ampere hour)battery requires (100 AH/ 10Hr=10 Amp) 10 Amp. Charging current for 10 hours for fully charged. To get complete discharge at the rate of 5Amps will require 20 Hrs.

The fully discharged battery requires about 11/2 times more to get charged .If the battery is in dead (or)not in use for long time even in normal changing current is passed. These dead batteries require higher charge voltage to start the charging current.

Checking of battery : Acid level and specific gravity of electrolyte, will indicate the condition of battery whether it requires charging or not.

The hydro meter is used for checking the acid level in a battery .The scale in marked in the hydrometer from 1100 to 1300.when it is inserted in the battery, the reading

i 1100-1150 -indicates battery is down

ii 1200-1250- indicates battery is o.k.

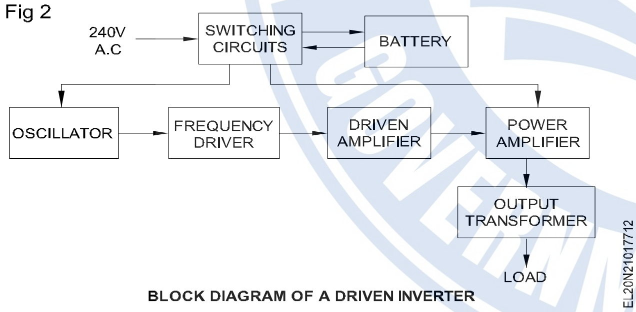
iii 1250-1300 indicates excess acid

Voltage testing : By using high rate discharge tester, the voltage the each cell must be 2.1V, If it indicates below than 1.8V, then it shows the battery is in fully discharged. It is still below 1.8V.Then the battery becomes dead condition.

Inverter : It is an electronic device, which converts a D.C potential (voltages) normally derived from a lead-acid battery into a stepped-up AC potential (voltage) which is similar to the domestic AC voltage.

Locating the fault and troubleshooting of an inverters which provide sine wave outputs or the use of PWM(Pulse Width Modulation) technology is very difficult. (Fig 2)

Fig 2



BLOCK DIAGRAM OF A DRIVEN INVERTER

Switching circuits : It is the input stage of a inverter. This circuits supplying the power to further stages and connected to battery. The DC supply of battery in this supplies to the switching circuits for various needs.

Oscillator

It is an electronic circuit which generates the oscillating pulses either through an IC circuit or a transistorized circuit. This oscillations are the production of alternate pulse of positive and negative (ground) voltage peaks of a battery and at a specified frequency (No.of positive peaks per second). These are generally in the form of square waves and the inverters are called square wave inverters.

The complete circuit diagram of a static 50Hz static inverter is in Fig 3.

The oscillator section of the inverter used a IC circuit to produce control signal frequency to the control and drianer section. The received oscillating frequency is amplified to a high current level using power transistor or MOSFET.IC 7473(JK Flip type) used to power amplification and control the frequency to the driver transistors T1 and T2 driving the power transistor to the required level as in the Fig 3.

The two parallel connected power transistor T5, T6 and T7, T8 are connected to the output transformer which is used to step up the low level AC from the amplifies stage into the specified level.

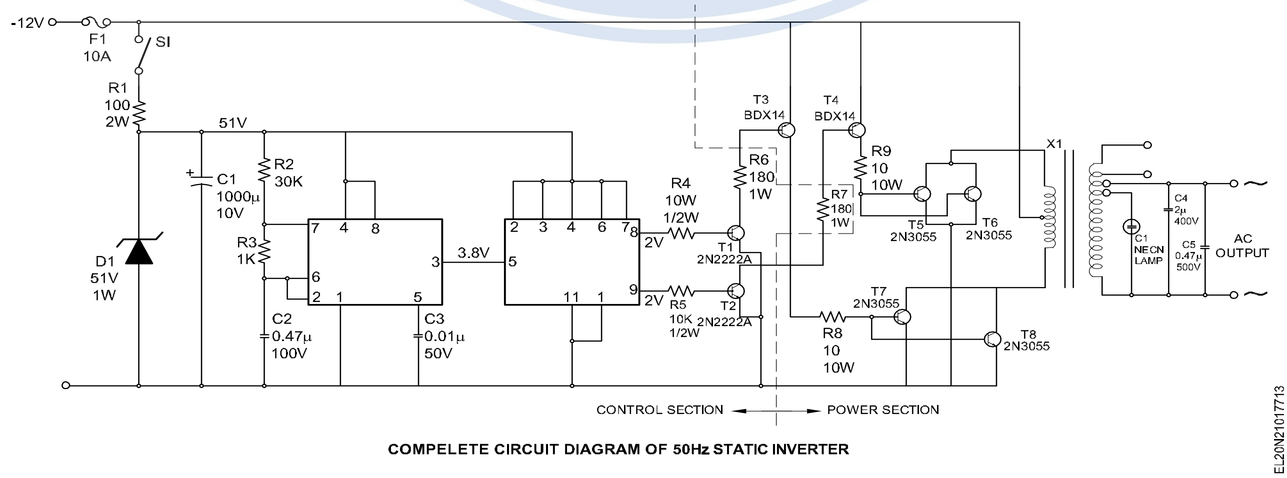
The transformer secondary is supplied the required level of AC 240V. The generation of the oscillations due to which the process of voltage induction is able to take place across the windings of the transformer.

The inverter does not produce any power and the power produced by DC source. The inverter requires a relatively stable power source capable of supplying of enough current for the intended power demands of the system.

An inverter can produce square wave, modified sine wave, pulsed sine wave, pulse width modulated wave (PWM) or sine wave depending on circuit design.

The inverters more than three stages are more complex and expensive. Most of the electric devices are working with pure sine wave and AC motors directly operated on non-sinusoidal power may produce extra heat, and have different speed-torque characteristics.

Fig 3



COMPELETE CIRCUIT DIAGRAM OF 50Hz STATIC INVERTER

Trouble shooting of voltage stabiliser, battery charger, emergency light, inverter and UPS

Objectives: At the end of this lesson you shall be able to
- **state the general precaution to carryout for preventive maintenance**
- **explain the steps to follow the break down maintenance**
- **service the voltage stabilizer, emergency light, battery charger, inverter and UPS**
- **analyse the trouble shooting chart and find the problem/ repair the equipment.**

Use of troubleshooting charts for fault location : The circuit diagram is in Fig 1 is given for your reference. The working of the mains cord, fuse, relay contacts, windings of the auto-transformer etc. can easily be ascertained by using a test lamp and/or a series lamp or by a voltmeter for checking the electronic circuit and relay coil winding. A multimeter in appropriate range is a must to localise the fault. A series lamp or test lamp should not be used to test these as they are liable to spoil while testing.

Troubleshooting chart given in Table 1 illustrates the problem, section to be suspected possible cause and action required for a stepped automatic voltage stabilizer.

General precautions for preventive maintenance

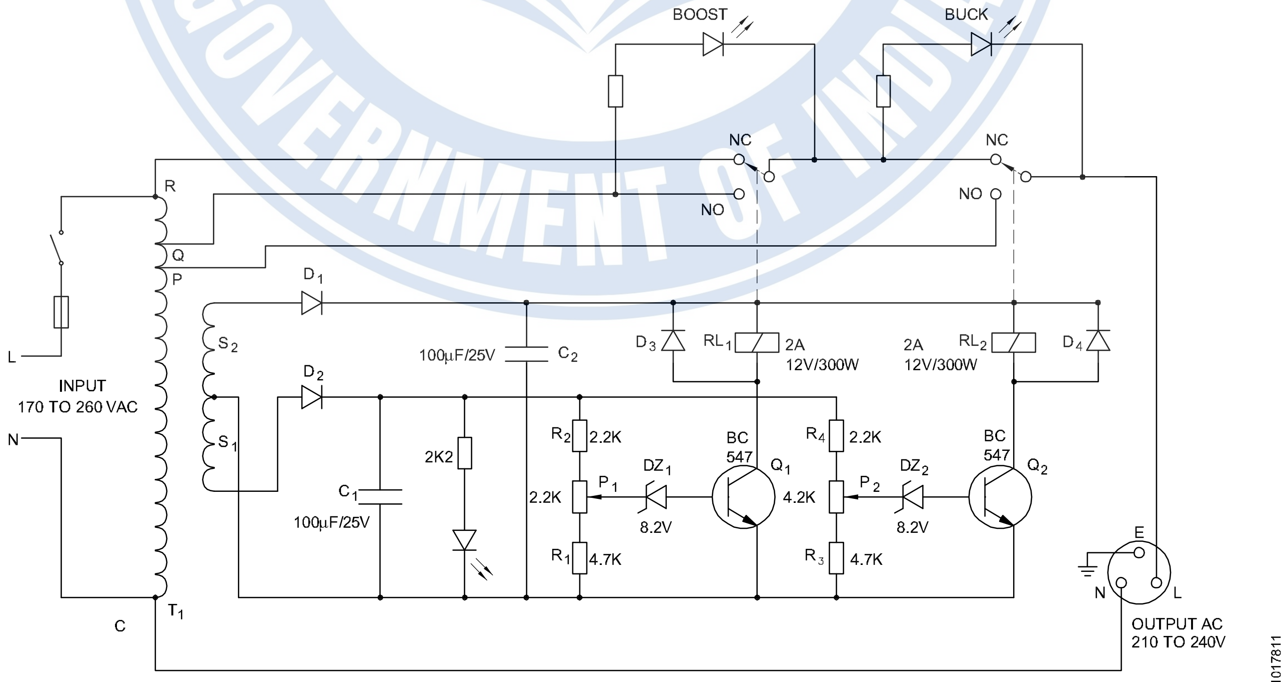
Maintenance for any equipment needs a working knowledge of that machine is very much essential to the person concerned. For example the volt ampere rating of voltage stabilizer is very important to carryout the preventive maintenance. Low quality, substandard components or materials never be used or recommended for use. Necessary steps to taken for safe temperature controlling and over loading conditions. Proper operating sequence or working steps to follow of all the equipments under maintenance.

Steps to follow break down maintenance

Break down can happen anytime, anywhere. Adequate protection might have provided to all equipments, for its smooth working. However continuous running or usage, lack of maintenance, human error and some unexpected reasons break down is happening.

Once break down maintenance or repair is required a detailed study of that equipment is essential. Always involve more persons pertain to the repair work or maintenance work for achieving a good result. A collective and competitive effort only will produce good results. Give value for everyone suggestion, expertise and workmanship. There must be a clean idea and vision to finalise the maintenance and repair. Ensure the services of experts, availability of spares, details of past records, diagrams and past history of the equipment such as its installation date, service records, number of break downs and its frequency etc; Servicing of voltage stabilizer by trouble shooting method.

Fig 1



TYPICAL CIRCUIT DIAGRAM OF A STABILZER

Table 1

Trouble shooting chart for stepped automatic stabilizer

Sl. No.	Problem	Section to be suspected	Possible cause for defective	Action
1	No output voltage at output socket.	Input buck/boost relays.	Mains cord, switch, fuse, transformer and relays	Locate and repair or replace
2	The output voltage is more, do not regulate.	Electronic circuit or relays.	Open/shorted rectifier / diodes, or open zener diodes	Locate the defective part and replace.
3	Output voltage is same as input. Do not regulate.	Transformer or Electronic circuit	Transistor or held up relay contacts or Partial open transformer / leads.	Test, repair or replace.
4	Output voltage is low. Do not regulate.	Electronic circuit	Shorted zener diode or transistor or open resistors	Test and replace.
5	Chattering in relays	Electronic circuit/relays	Leakage capacitors	Replace.

Trouble shooting of UPS

The trouble shooting and repair of UPS is difficult as this circuit is so complicated with so many functions. A step by step trouble shooting approach with a reasonable analysing is very important to carryout the troubleshooting in the UPS circuit.

A trouble shooting chart of UPS is given for your reference in table - 2.

Table 2

Troubleshooting chart of UPS

Sl.No.	Fault	Possible Reason	Troubleshooting
1	UPS works on 240V VAC mains but does not operate on battery	1 Battery fuse is blown out 2 Battery is discharged	1 Check the battery fuse. If fuse is blown, replace it, if it is loose, tighten 2 Recharge the battery, also check the polarity of battery
2	When UPS is switched on, charger does not turn on	1 Mains input fuse may be blown 2 Charger input fuse blown out	1 Change mains fuse, if fuse blown 2 Check the battery polarity and conditions, correct it if wrong, replace the fuse 3 Check the supply from mains, if OK, then check relay wiring, check relay coil.
3	240 VAC mains supply NOT available	1 Mains supply fails 2 Input AC mains is very low 3 Loose connection in input wiring	1 Check the supply of mains 2 Check the voltage 3 Tight the connection of wiring coming from distribution board
4	DC voltage is OK, but UPS shows DC under voltage and trips	1 Inverter fuse is blown 2 Rust/loose connection in battery	1 Replace fuse 2 Check the connection
5	When the UPS is switched ON with out load but DC under voltage indicator turns ON at load.	1 Load too high 2 Loose connection of battery terminal	1 Check the load, add loads gradually. 2 Tight the connections and check the polarity of battery

		3 Short or earth fault in load	3 Check the load circuit wiring
6	Where there is no AC mains supply and the UPS is operating on battery, DC under voltage indicator turns ON	1 Battery is discharged 2 Battery terminal dust or loose	1 Recharge the battery, use proper current capacity cable in the battery circuit. 2 Check the connection
7	DC fuse blows OFF	1 Overload or short circuit	1 Change DC fuse 2 Reduce the overload. If power transistors are short or leaky, replace them.
8	UPS does not switch ON	1 Supply fails due to blown out fuse or some break in cable 2 No DC supply in the control card due to dry soldering or desoldering	1 Replace fuse, check the cables 2 Check and correct dry soldering and de-soldering 3 Check control card wiring
9	UPS trips when full load is connected	1 Overload setting is wrong	1 Adjust the overload setting, check the power consumption of the load. Gradually increase the load.
10	UPS output is high	1 Some connection is broken in the feedback loop 2 Control card is not functioning properly 3 Over voltage sensing is faulty	1 Check feedback transformer wiring and adjust feedback voltage preset. 2 Check /Replace control card 3 Check overload sensing circuit
11	UPS does not switch on in battery mode	1 Mains earthing is not proper 2 Problem in inverter circuit	1 Check the earth connection 2 Check battery, MOSFET, oscillator section, driver section, output section
12	Battery wire getting burned	1 The relay points are joined together	1 Check / Replace relays
13	Change over time high, computer connected to the UPS reboots during change over.	1 Check oscillator circuit	1 Check /replace IC and other components of oscillator section
14	Low backup time	1 Main filter capacitor problem 2 Battery get short circuit/discharge	1 Check and replace capacitor 2 Check battery, replace if required

Trouble shooting of battery charger and emergency light

As you have seen that the battery charger is a simple circuit compare to UPS. The main function of the charger circuit is to feed the DC voltage to battery at a prescribed level we discuss only the trouble shooting of charger circuit and its repair. Battery maintenance is not discussed in the trouble shooting chart.

Analyse the fault in battery charging circuit (Fig 1) with the help of trouble shooting chart given in Table 3 and 4.

Table 3

Sl. No.	Problems	Section to be suspected	Possible cause for defects	Action
1	No DC voltage at charging terminal	1 Faulty Ammeter (open circuit)	Aged/over current	Replaced Ammeter
		2 Blown fuse	Over current	Replace fuse
		3 Faulty rectifies diode	Aging/over loading	Replace all diodes

		4 Defective transformer	Aging/over loading	Replace transformer
		5 Faulty Relay contacts	Repeated closed open	Replace contact
		6 Open Relay coil	Over voltage/current	Replace relay
		7 Main fuse blown	Over loading	Replace fuse
		8 No link between meter to battery	Loose connection	Tighten the connection
		9 Defective auto transformer	Over loading	Replace transformer
2	Low terminal voltage	Anyone pain diode open circuited	Ageing	Replace all four diodes
		Partial short in transformer	Over heat	Replace transformer
3	No automatic charging voltage cut off	Defective potentiometer	Long use	Replace new potentiometer
		Driver diode open	Ageing	Replaced 2 diodes(D7)
		Defective electrolytic capacitor	Ageing	Replace capacitor (C_1)
		Defective bleeder resistor	Over current	Replaced same value resistor(R_1)
		Control circuit rectifier diode open	Ageing Over current	Replace both diodes(D_5 & D_6)
		LT winding transformer open	Ageing / over current	Replace new transformer (x_3)
		LT fuse open	Over current	Replace fuses (F_2)
		Defective auxiliary relay terminal	Repeated operation	Replace contact RLI(B)
4	Irregular over voltage cut off	Defective potentiometer	Loose contact in the disc (track)	replace new potentiometer (VP1)
		Shorted driver diode	ageing/over current	replace new diode (d7)
		Loose in relay contacts leaky electrolytic capacitor	Repeated contacts ageing	replace contacts replace electrolytic capacitor

Table 4

Trouble shooting chart for emergency light

Sl No	Problems	Section to be suspected	Possible cause for defective	Action
1	Lamp dead in both condition lamp	Defective tube	Ageing	Replace tube lamp
		Defective inverter transformer	Over loading/ageing	Replace inverter transformer
		Defective driver	Over loading/ageing transistor	Replace transistor (213055)
2	Lamp out glowing if AC fails	Low/ dead battery	Ageing	Replace New battery

Servicing of equipment are discussed based on a sample circuits. When servicing of other equipments with different circuits may differ from the troubleshooting sequences. However the basic principle based on the block diagram may be taken for guidance to service/repair the equipment.

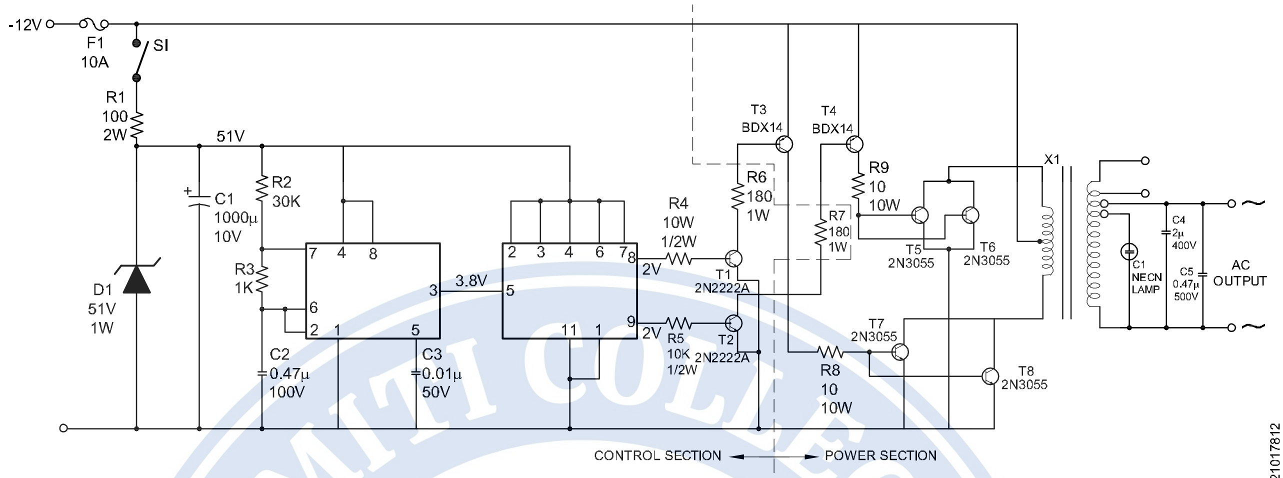
Trouble shooting of inverter

DC to AC inverter is quite complicated circuit, it consists of many functions. The switching circuit, oscillator circuit, control circuit power amplifier circuit, driver, finally the output circuit through the transformer. A feed back is also taken from the output transformer to regulate the output through the control circuits.

A constant DC source; either from a converter or battery is very much essential to keep the power output in a constant stage. DC to AC conversion with a specified frequency and a particular wave is difficult.

Analyse the fault in a inverter is explained (Fig 2) with the help of trouble shooting chart is given in Table 5. However the fault and problem are discussed while considering the 50Hz static inverter circuit is in Fig 2.

Fig 2



COMPELETE CIRCUIT DIAGRAM OF 50Hz STATIC INVERTER

Table 5

SI No	Problems	Section to be suspected	Possible cause for defects	Action
1	Output - Dead	- Output transformer - DC source	- Transformer open or short - CT & transformer open - No DC from battery - Battery dead	Rectify transformer Rectify the CT connection Replace battery
2	Low or high frequency	- Oscillator IC (555) - Control IC JK Flip-Flop	- Faulty IC - Faulty IC - No supply to IC (series resistor open) - Capacitor connected to IC 555 shorted	Replace IC Replace IC Replace resistor Charge faulty capacitor
3	Low voltage frequency ok	- Driver transistor - Power transistor (output transistor)	Fault in driver transistor Fault in power transistor Fault in output transformer Partial short in winding / cave	Charge the transistor Replace the power transistor Rectify the transformer fault or Replace the transformer
4	Frequent cut-off the output	- Battery - Fault in IC - Fault in power transistor	- Low A/H capacitor of battery - Over heat in IC - Over heat in power transistor	Replace Battery Provide heat Sink to IC Sink to transistor

Installation of inverter in domestic wiring

Objectives: At the end of this lesson you shall be able to
- **enumerate the important points to be kept in your mind to select the inverter to be installed**
- **state how to select the place to install the inverter and battery**
- **explain how to install the inverter with battery and load, and check for its performance**
- **state the rating of inverter and its sample calculation.**

Important points to be considered before installing an inverter : Many time when a new inverter is not giving proper service, the fault is due to improper installation only, not in inverter.

Another most important point is when connecting an inverter to the line is, the total load connected to the inverter should not exceed 80% of capacity of inverter.

Before providing points to connect the loads to the inverter, the total connected load must be considered.

If over load occur, then the overload protection will 'cut OFF' the output and reduce the load then the reset key must be pressed, and if the inverter is not provided with overload protection, it may get damaged at the time of over load than the capacity of the inverter.

Selection of place for installation of inverter : To connect inverter to the supply line, suitable place for the inverter is to be located. That place must be nearer to the service energy meter and ICDP switch and provide a 3 pin output socket from the mains supply line for the inverter and connect the inverter to the socket as in (Fig 1).

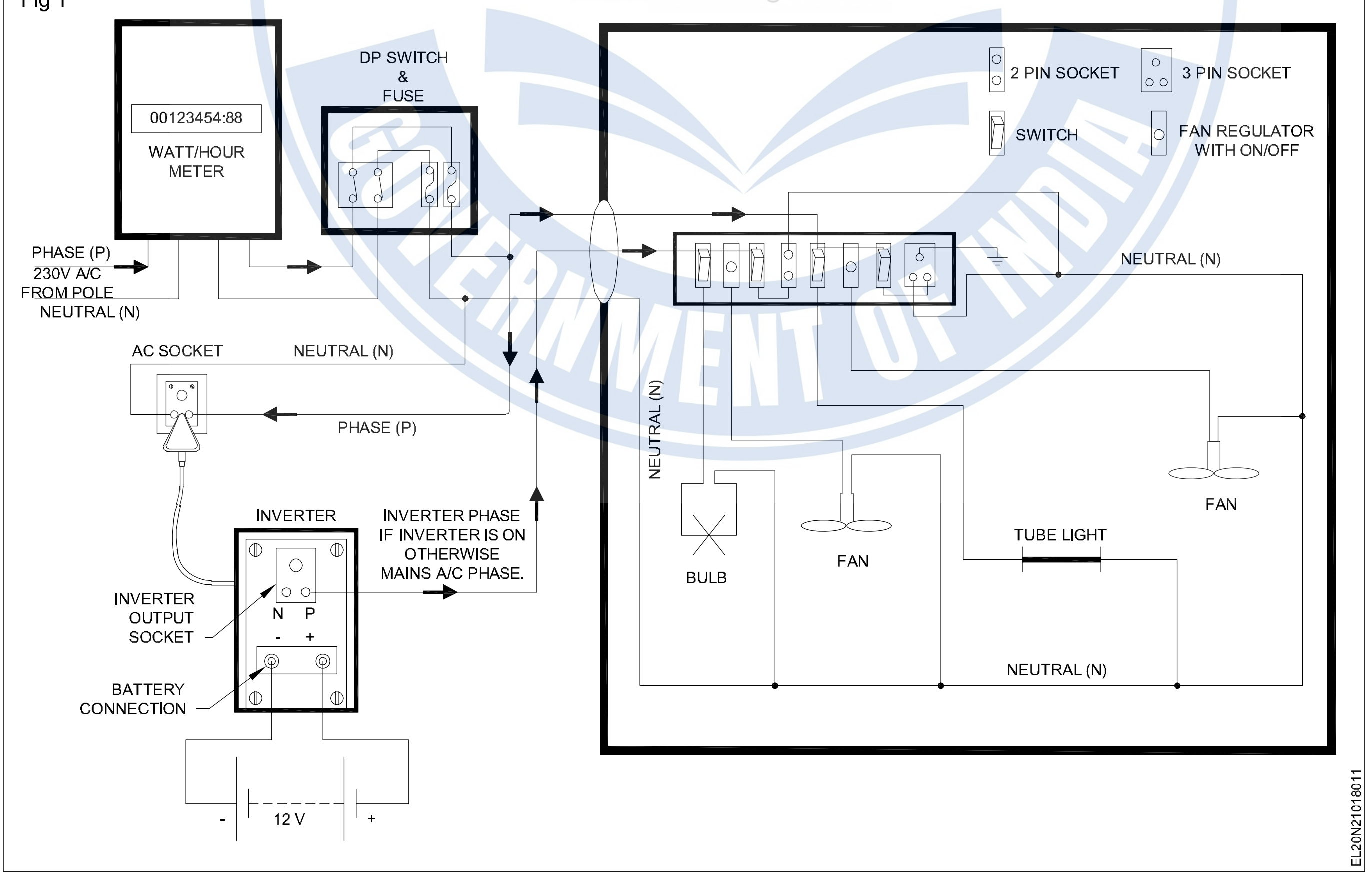
Installation of inverter : Collect the suitable inverter with sealed free maintenance battery to be installed, and check for their proper function

Place the inverter's battery to a suitable place near the inverter and connect the battery to the inverter.(Fig 1)

Keep the battery as close as possible to the inverter, so that the wire connecting the battery terminals to the inverter can be small and current loss is reduced. Make sure the battery is fully charged before installation.

The positive terminals of battery (red wire) is connected to the place provided for the positive terminal on the inverter and the negative terminal of the battery (blue or black wire), which is to be connected to the place provided for the negative terminal on the inverter.

Fig 1



When connecting battery terminals to the inverter, use special auto wires do not use common mains wiring with wires such as '3/20' and 7/20 etc.connecting battery using these wires will not provide proper connection between the battery and the inverter.

After connecting the battery, put some grease (or) vaseline on the battery terminals, which reducing the terminal corrosion.

All the connection is completed take the output from the inverters output socket and use it to power the load. Use 1/18 copper wire to the output of the load. Do not use 3/20, 3/22 or 7/20 wires, commonly used in house wiring.

The output is taken from the phase out 'pin of inverter' output socket, and is provided to the ON/OFF switches on the wall pause.(Fig 1)

The neutral line is common for both the inverter output and the mains A/C line. So, only one wire for the phase line can be drawn from the inverter output socket to the switches.

In Fig 1, one bulb, one fan and a 2 pin output socket are connected to the inverter output and the other devices in the room. (ie) the tube light, fan (2) and a 3 pin output socket are directly connected to the mains A/C line.

In the two pin socket, should not be connected with heavy load during power 'OFF' only small load like mosquito repeller can be connected.

As in (Fig 1) the load connected to the inverter will get the mains A.C supply. If the mains supply is 'On' at the same time, other devices will also work on the main supply, because they are connected directly to the mains A.C supply.

But at the time of power shut down, the devices directly are connected to the mains A.C will stop functioning and the devices, which are connected to the inverter output will keep on working on the inverter output.

Later, if the mains A.C supply returns, the inverter will once again connect the load, which are connected to its output to the main supply. This process is shown in Fig 2.

Fig 2