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**Design and Implementation of 1kva Uninterrupted Power Supply**

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**Abstract**

The power conditioner designed to deliver an output of 1.0KVA basically it's composed of a battery control circuit, the inverter and automatic voltage regulator.

The inverter stage is the part that will take power from the battery and by means of switching circuits inverts the d.c to a.c and steps up from 12V to 220V at the output.

The automatic voltage regulator is the part whose function is to regulate the output from the inverter and mains to the load (i.e. 220V).

The third stage is the control circuit, this uses a relay to sense when there is power or not, for economic reasons the same transformer used for inversion and battery charging. When there is power the relay switches such that the transformer is in step down mode and by means of full wave diode rectification supplies d.c to charge the battery. And when there is loss of power, the relay sense loss of power and switches to inversion mode and in this mode the transformer serves as a step up i.e. stepping 12V from battery to 220V. The output of transformer was equipped with several taps, which by means of a control circuit connected to several relays that selects which of the tap is best approximated to 220V at the output.

**Keywords:**

**Introduction**

It is clearly evident that for every electrical and electronic equipment power is required for operation and for these equipment to operate properly and at maximal output they must operate within the voltage range for which they are designed otherwise damage to equipment and appliances will occur. This situation of voltage fluctuation is very common within the Nigeria power supply system owing to a number of reason ranging from over loading of supply lines and transformers to fluctuation caused by external transient and induction of power lines etc. Hence, there is the evident need of protection device such as the automatic voltage regulator to limit the fluctuation of these electrical and electronic appliances to a safe working range and also the uninterruptible power supply , a device to prevent undesired features of the power source, outages, sags, surges, bad harmonics etc from the supply from adversely affecting the performance of the device.

As mentioned earlier, the problems associated with power supply in Nigeria have created a need to develop an electrical device that will help

ameliorate these effects. Automatic voltage regulator popularly known as a stabilizer function is to help regulate the output voltage to the load so that the load would receive a normal voltage of 220V±0.2% tolerance.

Electronic gadgets nowadays are increasingly being equipment with digital circuitries for increased functions and better performance. These digital circuits are very sensitive to fluctuation and power outages. Also included in this digital device is the computer environment. All applications of digital electronics and computer-based system are worse hit by problems of power supply. Hence the need for a device that incorporates the stabilization of power output and can also temporarily supply power for the duration of power outage.

The uninterrupted power supply consists of three major parts viz:-

- The inverter
- The automatic voltage regulator
- The control and battery charging circuit.

The inverter stage is the part that will take power from the battery (usually a rechargeable cell) and by means of switching circuit's inverter the d.c to a.c and steps up from 12V to 220V at the output. The automatic voltage regulator is the second stage whose function is to regulate the output from the inverter and mains to the load (i.e. 220V). The third stage is the control circuit, this uses a relay to sense when there is power or not. For economic reasons the same transformer would be used for inversion and battery charging. When there is power, the relay switches

such that the transformer is in step-down mode and by means of full wave diode rectification supplies d.c to charge the battery. And when there is loss of power, the relay senses loss of power and switches to inversion mode and in this mode the transformer serves as a step-up transformer i.e. supplying 220V a.c the output of the transformer will be equipped with several taps which by means of a control circuit connected to several relays that selects which of the tap is the best approximated to 220V at the output.

## Design

Design refers to a combination of science, art and intuitive judgement based on experience and personal drive to succeed

In the course of a transformer design, specification is the first requirement. In our design work of auto-transformer, the type and the variable tapping or condition of service affects it. Most transformers are designed and constructed based on certain standard specification as given below

- (1). KVA rating
- (2). Rated frequency (50Hz)
- (3). Number of phase
- (4). Rated Voltage
- (5). Connection (delta star e.t.c)
- (6). Tapping (if any)
- (7). Type of cooling (natural /force air, oil, water)
- (8). Ambient temperature (average 40°C)
- (9). No load losses
- (10). Load losses at rated current, principal tapping
- (11). Insulating choice (selection depends on temperature)
- (12). Regulation at full load, at 75°C, at unity and 0.8 power factor lagging
- (13). Efficiency at 75°C at unity power factor, at full load  $\frac{3}{4}$  the load and half load.
- (14). No load current
- (15). Percentage resistance at rated current and frequency

## DESIGN CALCULATIONS

1. Transformer rating = 1KVA
2. Frequency = 50Hz
3. Phase = single
4. Type = Shell
5. Primary voltage = 160V, 180V, 220V, 240V, 260V
6. Output voltage = 220V
7. Medium of cooling = Natural air.

$$P = IV\cos\theta$$

Where P = active power

$$IV = S = \text{Apparent power (vA)}$$

$$I = \text{Current (A)}$$

$$V = \text{Voltage (V)}$$

Cos  $\phi$  = lagging power factor

$$P = S \cos\theta$$

For a power factor of 0.9 the active power is;

$$P = 100 \times 0.9 = 900W.$$

### (A). Design of core

$$\text{Voltage per turn. } V_t = K\sqrt{S}$$

Where S = output KVA.

$K = 1.0$  for shell type transformer  $V_t = 1\sqrt{1} = / V/\text{Turn}$ .

**(B). Net Core Area:**

Knowing that e.m.f equation of a transformer for an induced voltage. Any one turn of the transformer winding

$$E_t = 4.44f B_m A_i$$

$$A_i = \frac{E_t}{4.44f B_m}$$

For  $B_m = 1.5T$ .

$$A_i = \frac{1}{4.44 \times 50 \times 1.4 \times 10^{-6}} = 3217.5 \text{mm}^2$$

**(C). Magnetic flux ( $\Phi_m$ )**

$$\Phi_m = B_m A_i$$

$$\Phi_m = 1.5 \times 3217.5 = 4826.2 \times 10^{-6} \text{wb}$$

$$= 4.826 \times 10^{-3} \text{wb}$$

**(D). Window Space Factor ( $K_w$ ).**

$$K_w = 0.1 + 0.08 \log_{10} \frac{[KVA]}{A} - 0.2 \log_{10} K V$$

$$0.1 = 0.1 + 0.08 \log_{10} [1/0.1] - 0.2 \log_{10} (220 \times 10^{-3}) = 0.311$$

**(E). Window Area ( $A_w$ ).**

$$S = 2.22 f B_m A_i A_w K_w J \times 10^{-3} \text{ (KVA)}$$

$$A_w = \frac{S}{2.22 f B_m A_i K_w J \times 10^{-3}}$$

$J$  = current density for natural air cooling the value is between 2-4 A/mm<sup>2</sup> for 5 to 6 A/mm<sup>2</sup> for forced cooling

Choosing  $J = 3A/\text{mm}^2$

$$A_w = \frac{1}{2.22 \times 50 \times 1.5 \times 0.311 \times 3 \times 3217.5 \times 10^{-6} \times 10^{-3}}$$

$$A_w = 2000 \text{mm}^2$$

$$A_w = L \times w \text{ (of window)}$$

Where  $L = 3w$

$$A_w = 3w \times w$$

$$= 3w^2$$

$$W = \sqrt{A}/3$$

$$W = 25.8 \text{mm}$$

$$L = 3 \times 25.8 = 77.4 \text{mm}$$

Gross cross sectional area  $A_g$  = stack height X width of central limb.

For a lamination that fits this window dimension, and width of central limb, the necessary stack height can be determined, thus

$$A_g = \frac{A_i}{K_s} \quad \text{where } K_s = \text{stacking factor} = 0.9$$

$$= \frac{3217.5}{0.9}$$

$$A_g = 3575 \text{mm}^2$$

$$\text{For a central limb of } 50 \text{mm, stack height} = \frac{3575}{50} = 71.5 \text{mm}$$

**Dimension of Available Chosen Core**

Window length = 66mm

Window width = 22mm

Width of central limb = 45mm

Diameter of bolt = 5mm

$$\text{Window Area (} A_w \text{)} = L \times w = 66 \times 22 = 1452 \text{mm}^2$$

Recall that  $K_w = 0.28$ ;  $J = 3A/\text{mm}^2$ ,  $B_m = 1.4 \text{tesla}$ ,  $F = 50\text{Hz}$ ,  $KVA = 1.0$

$$S = 2.22f B_m A_w A_i K_w J \times 10^{-3}$$

$$A_t = \frac{1.0}{2.22 \times 50 \times 1.5 \times 0.322 \times 3 \times 1452 \times 10^{-6} \times 10^{-3}} = 4433 \text{mm}^2$$

Recall that for a stacking factor of  $K_s = 0.9$   $A_i/A_g = 0.9$

$$\text{Gross cross sectional area } A_g = A_i/0.9 = 4926 \text{mm}^2$$

Gross core Area is 4926mm<sup>2</sup> and net core area is 4433mm<sup>2</sup>

$$\text{Recall that stack height} = \frac{\text{Gross Core Area}}{\text{Width of central limb}} = \frac{A_g}{W_d}$$

$$= \frac{4926}{109 \text{mm}}$$

• Number of laminations  $n = \frac{\text{stack height}}{\text{Lamination thickness}}$

For a thickness of 0.5m,  $n = \frac{\log}{0.7} = 156$  laminations

Voltage per turn

$V_t = 4.44 \times 50 \times 1.5 \times 4433 \times 10^{-6} = 1.47\text{V/Turn.}$

$\frac{\text{Number of turns}}{\text{Number of turns}} = \frac{\text{Voltage}}{\text{Volt per turn}}$

$\frac{160}{1.47} = 109$  turns,  $\frac{180}{1.47} = 122$  turns,  $\frac{200}{1.47} = 136$  turns,

$\frac{240}{1.47} = 163$  turns,  $\frac{260}{1.47} = 177$  turns,

$\frac{12}{1.47} = 8$  turns.

### Winding Calculations

Primary current =  $\frac{\text{KVA rating}}{\text{Input voltage}} = \frac{1.0 \times 10^{-3}}{220} = 4.54\text{A}$

Secondary current =  $\frac{1000}{12} = 83.33\text{A}$

#### (a). Conductor size

Current density  $J = \frac{\text{Current}}{\text{Area}}$   $J = 3\text{A/mm}^2$

Cross sectional Area,  $A = 1/J$

For the primary current of 4.54A  $A = \frac{4.54}{3} = 1.513\text{mm}^2$

$\frac{\lambda d^2}{4}$   
 $A = d = \sqrt{\frac{4 \times 1.5113}{3.142}}$   
 $d = 1.38\text{mm}$

For secondary current of 83.33A

$83.33\text{A} = 27.77\text{mm}^2$

$d = \sqrt{\frac{4 \times 27.77}{3.142}} = 5.94\text{mm}$

The primary corresponds to gauge 23 of SWG table and secondary correspond to gauge 10 of the British standard wire gauge table (SWG Table)

#### (b). Turns per layer

Turns per layer =  $\frac{\text{winding height}}{\text{Diameter of conductor}} = \frac{65\text{mm}}{1.38} = 47$  turns per layer

For the secondary =  $\frac{65}{5.94} = 11$  turns per layer

$\frac{\text{Number of layers}}{\text{No of layers}} = \frac{\text{Total No of turns}}{\text{Turns per layer}}$

For primary turns

No of layers =  $177/44 = 4$  layers

For secondary side =  $\frac{12 \times 2}{11} = \frac{24}{11} = 2$  layers

Total No. Of layers =  $4 + 2 = 6$  layers

#### (c). Total Number of turns ( $N_T$ )

Primary + secondary turns  $N_T = 177 + 11 = 188$  turns

#### (d). Mean length per turn (MLT).

Mean length =  $2(\text{width of central limb} + \text{stack height} + \text{window width}) = 2(45 + 66 + 22) = 264\text{mm.}$

#### (e). Total lengths of winding

Total length of winding =  $\text{MLT} \times \text{Total No of turns for primary } L_1 = 264 \times 188 = 49632\text{mm}$

Secondary  $L_2 = 11 \times 264 = 2904\text{mm}$

Total length =  $L_1 + L_2 = 2904 + 49632 = 52536\text{mm.}$

#### (f). Total mass of copper

Mass density x volume

Density of copper =  $900\text{kg/Cm}^3$

Volume of copper =  $\text{Total length} \times \text{Area}$

For primary  $V_1 = 49632 \times 1.513 \times 10^{-2} = 750.9316\text{cm}^3$

For secondary  $V_2 = 2904 \times 27.77 \times 10^{-2} = 806.44\text{cm}^3$   
 $V = V_1 + V_2 = 750.9316 + 806.44 = 1557.37$   
 Mass of copper = density x volume =  $9 \times 10^{-3} \times 1557.37 = 14\text{Kg}$

**DESIGN OF THE ELECTRONIC CONTROL CIRCUIT**

The control circuit stage serves to generate a squared wave signal of frequency of 50Hz, amplify and drive current through a step up transformer, these converting the d.c voltage to a step up a.c voltage. The features are

1. Overload protection (MCB)
2. Auto switch over
3. Automatic voltage regulator (AVR)

**Pulse Width Modulator (PWM)**

The PWM method offers excellent performance such as light line and load regulation and stability during temperature variations. A number of integrated circuit have been developed which include all the necessary functions to build a PWM circuit with a few external components. Among the PWM I.C that comes into the market in the 1970s has the PWM I.C SG3524, by silicon general (SG) company.

SG 3524 is an improved version of SG 1524 PWM. The I.C contains an oscillator stage, inverter amplifier, flip-flops latch and an output emitter follower drive. Below is a description of the SG 3524 chip. An internal linear saw tooth oscillator is frequency programmable by a resistor  $R_T$  and a capacitor  $C_T$ . The oscillator frequency is determined by

$$F_{OSC} = \frac{1.15}{R_T C_T} \text{-----(1)}$$

From data sheet, it is usable of frequencies beyond 500KHz.

The ramp voltage swings approximately 2.5V to change the comparator output from low (0) to high (1), by comparing it to either one to two control signals i.e. the error amplifier output or the current limit amplifier output. The error amplifier input range extends beyond 5V, eliminating the need for a pair of dividers, for 5V outputs. The chip also has on board 5V reference which is trimmed to a  $\pm 1$  percent accuracy. Output pulse width modulation is accomplished by steering the resulting modulated pulse out of the high gain comparator to the PWM latch along with the pulse steering flip-flop, which is synchronously toggled by the oscillator output.

The PWM, latch insures freedom from multiple pulsing within a period even in noisy environments. In addition, the shunt down circuits feeds directly to this latch, which will disable the output within 250ns of activation. The current limit amplifier is a wide band, high gain amplifier, which is useful for either linear or pulse-by-pulse current limiting in the ground or power supply output lines. Its threshold is set at 200mV. An under voltage lockout circuit has been added, which disable all the internal circuitry, except the reference, until the input voltage is 8v, this action holds standby current low until turn-on, greatly simplifying the design of low power off line switchers.

The power capability of the output transistors is 200mA and their voltage rating is 60V. The transistors may be parallel to increase current drive.

The I.C is a versatile I.C controller that can be used in a variety of isolated and non-isolated switching power supplies for a number of application life inverter. +For a frequency of 100Hz

$$\begin{aligned} & \frac{1.15}{R_T C_T} \\ \text{Choosing } g - C_T &= 0.1\mu F \\ R_T &= \frac{1.15}{F_{OSC} C_T} \\ &= \frac{1.15}{100 \times 0.1 \times 10^{-6}} \end{aligned}$$

The output of the oscillator I.C is half the oscillator frequency. Thus

$$\begin{aligned} F_{out} &= \frac{1}{2} F_{OSC} \\ F_{osc} &= 2F_{out}, \text{ if } F_{out} = 50\text{Hz}, F_{osc} = 100\text{Hz} \\ R_T &= \frac{1.15}{100 \times 0.1 \times 10^{-6}} = 115\text{k}\Omega \end{aligned}$$

**Power Switching Mosfet**

The MOSFET used in this stage is the SWM70N06N- channel MOSFET. This switches the current through the transformer. Below is the Data for the MOSFET used;

- SWM 70N06 Data N-Channel  
 $T_S$  (conductance) = 17 min  $\mu$  inbos  
 $BV_{DSS}$  drain to source = 150V  
 $BV_{GS}$  gate to source =  $\pm 30\text{V}$

$I_D$  drain current = 70A  
 $V_{GS}$  (TH) gate to source threshold =  $4V_{MAX}$   
 $R_{DS}$  (ON) Drain to source resistance =  $0.055\Omega$   
 $C_{ISS}$  = 200PF max  
 $P_0$  = power dissipation = 180W.  
 $t_d$  (off) = 170ns  
 $t_d$  (on) = 200ns  
 $t_f$  = 120ns  
 $t_r$  = 140ns  
 Two of the MOSFET was paralleled for each stage of the push pull arrangement

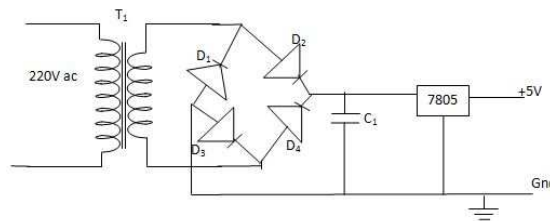
**Switch Over Control**

The switch over control from NEPA mains to inverter and vice versa is affected by a relay switching arrangement. The circuit is shown below the transformer step-down main voltage to 24V and this is rectified to d.c by the bridge rectifier stage. The output is connected to the relay coil.  
 The relay coil resistance =  $180\Omega$   
 Operation voltage = 24V

When there is mains voltage the relay coil receive current and it is activated and switches to battery charging mode<sup>3</sup>.

**Power Supply**

The power supply for the circuit for inversion process is the battery, while the power supply from the battery charging is from the mains. See figure 3.4.



**Fig1 .A complete power supply unit**

These two modes are made possible by the switching arrangement of the operating relay circuit.

**SNUBBER**

The snubber circuit helps to limit the  $dv/dt$  (i.e. rate of rise of voltage across the Mosfet). This is achieved by a PC network placed in parallel with the power Mosfet, the resistor  $R_S$  is necessary to limit the surge current from  $C_S$  when the mosfet conducts and to damp the ringing of the capacitance with the load inductance  $R_L$  this snubber network not only limits the voltage rise during communication but also suppress transient voltage that may occur as a result of a.c line disturbance using the formula (Resonance method)

$$V(t) = V_p \sin \omega t$$

$$dv/dt = V_p \omega \cos \omega t$$

But  $dv/dt$  will be maximum is  $\cos \omega t = 1$

$$Dv/dt (\max) = V_p \omega$$

$$Dv/dt (\max) = V_p 2\pi f$$

Where  $dv/dt (\max) =$  Maximum value of off state  $\cong 50V/\mu s$

$$f = \frac{dv}{dt (\max) 2\lambda}$$

$$f = \frac{50v/\mu s}{320x\sqrt{2x2x\lambda}} = \frac{50 x 10^6 v/s}{325 x 2\lambda} = 24KHz$$

let  $L = 220\mu H$

$$f = \frac{1}{2\lambda\sqrt{LC}}$$

$$C = \frac{1}{(2\lambda x 24KHz)^2 x 220 x 10^{-6}} = \frac{1}{(2x\lambda x 24 x 10^3)^2 x 220 x 10^{-6}}$$

$$C = 0.19\mu F.$$

$$C = 0.2\mu F.$$

**Power Supply Unit**

24V was fed to the stabilizer control by a 240.24V step-down transformer. Secondary voltage,  

$$V_m = \sqrt{2xV_{rms}} \text{ -----(2)}$$

$$= \sqrt{2x24V} = 33.9V$$

**Rectifier**

The full wave centre tapped transformer is not as efficient as the bridge rectifier circuit. The bridge circuit rectifies the 24V from the secondary of the step down transformer.

$$V_1 \text{ (peak)} = V_m - 2V_D \text{ (ON)} \text{-----(3)}$$
 (2V<sub>D</sub> being the diode drop in any cycle).

$$V_1 \text{ (peak)} = 33.9 - 2(0.7) \text{ volts} = 32.5V$$

For the PIV rating of diode to be used  $PIV = V_m - V_D \text{ (ON)} \text{-----(4)}$   

$$= 33.9 - 0.7 = 33.2V$$

The value is suitable for the design since the PIV rating of the diode is far greater than this value.

**Capacitor**

The voltage regulator does not accept the pulsing voltage output. A capacitor filter was connected between the rectifier output and the regulator to hold the voltage above the prescribed minimum while removing the ripples or pulsation. The capacitor is expected to charge to  $V_1 \text{ (peak)} = V_m - V_{rect}$   

$$= 33.9 - 2(0.7) = 32.5V$$

Thus, the choice of capacitor is to withstand at least 32.5V

Ripple voltage,  $V_r = I_0 / 2FC \text{-----(5)}$

Where I<sub>0</sub> = regulator output current.

For V<sub>r</sub> = 1.0V and I<sub>0</sub> = 200mA

$$C = I_0 / 2F V_r = \frac{200 \times 10^{-3}}{2 \times 50 \times 1.0} = 2000 \times 10^{-6} C = 2000 \mu F$$

Thus, a capacitor with at least 2000μF should be chosen for availability and proper filtering, a 2200μF, 35V capacitor was used.

**Voltage Regulator**

A regulator voltage power supply of 12V was provided by the Ic voltage regulator KiA7812P1 from the unregulated output voltage from the capacitor filter unit

Regulator Data:

Maximum output voltage = 35V

Minimum output voltage = 12.5V

Drop out voltage: 2.0V

Operating temperature: 0°C-150°C

**Comparators**

Lm 324N was used which is a quad comparator in single chip (i.e. four comparators in one chip). Because of its high slow rate, that is why it was chosen.

Slow rate = output voltage change/turn (μs). the regulated and unregulated output voltage arrangements and the output of the OP amp serves as a controller for the transistor-diode-relay arrangement. The resistors and the potentiometer connected to it forms a voltage divider to limit the voltage fed into non inverting inputs of the OP amps, hence, sets the voltage level at which the computer output should change state (i.e. go high from previously low state).

**RELAY-Transistor Stage**

The BC 337 n-p-n transistor was used to switch the relays. The choice was based on the calculation below from fig 3.8. When the comparator output goes high, the transistor goes into saturation turning on the relay as Ic flows into its coil developing required coil power to move contact into new position.

Maximum current through the relay will be Ic (max)  

$$V_{cc} - (V_{cc(sat)}) / R \text{-----6}$$

Where R = Relay coil resistance

Relay used has a resistance of 95 ohms (12V relay)

$$I_c \text{ (max)} = 12 - 0.3 / 95 = 0.1232A$$

This value is suitable for this design since it can be furnished by BC337 n-p-n transistor.

BC337 Data (N-P-N)

Ic = 100mA, Ic (max) = 0.8A

V<sub>CEO</sub> (max) = 45V

V<sub>CBO</sub> (max) = 50V

P<sub>D</sub> (max) = 625mW

Life (min-max) = 100-60

T<sub>a</sub> = 25<sup>0</sup>C

V<sub>ce</sub> = 1.0V

The diode D in fig 3.8 is necessary to dissipate the energy stored by the inductor of the relay and the capacitor serves as a damper to ensure a firm grip during the make action.

Working with a gain of life = 100 (assume)

$$I_{B2} = \frac{I_c}{\beta} = \frac{0.1232}{100} = 1.232\text{mA}$$

This is the value of the current needed to turn the transistor ON

$$\text{Value of the base resistor } R_b = \frac{V_0 - V_{bc}(\text{sat})}{I_b} \text{-----(7)}$$

$$R_b = \frac{12 - 0.6}{1.232 \times 10^{-3}} = 8.77\text{K}\Omega$$

Preferred value of 10K $\Omega$  was chosen based on availability.

**Indicator**

An indicator was used to show that there is supply in the stabilizer when the circuit breaker switch is put ON

**Fuse Rating**

For a 1KVA rating and output voltage of 220V, full load output current

$$I_{fL} = \frac{\text{KVA rating/output voltage}}{1000} = \frac{1 \times 10^3}{220} = 4.54 \text{Ams (fuse)}$$

Thus, a 3A fuse is used to also act as overload protection.

**Construction and Testing**

**Construction**

The circuit was first of all set up on a bread board of the design stage. The oscillator circuit was set up and tested with a digital frequency meter to ensure the frequency is at 50Hz. The AVR circuit was also set up on the bread board and tested too. The comparators and the switching transistors were connected as shown in the circuit diagram and tested accordingly. The transformer was also wound as stipulated by the design (chapter three). It was connected to the mains to test if the output would be 12V a.c was connected to the primary of the transformer, it stepped it up to 220V.

The inverter stage made up of the oscillator mosfet and the step up transformer was tested and the circuit worked. The AVR circuit worked after due adjustment of component values on the bread board.

After bread board testing was completed, the components were then transferred to a vero board where they were soldered. The inverter circuit stage was soldered before the AVR circuit. The oscillator and buffer stages were soldered and tested to see that they are okay. The mosfet were connected to the transformer and also to the control circuit. A battery of 12V was connected to the circuit and tested too. The circuit worked satisfactorily.

The AVR stage was soldered and tested. After these tests, the switch over relay was connected to the circuit and tested too. The circuit worked satisfactorily. The tests carried out are further explained and the results were recorded.

**Testing and Results**

The transformer was tested after winding and stacking of the core. The mains voltage of 220V was connected to the secondary of the transformer. And the output when checked by a voltmeter read 12.3V a.c. The table below shows the output of the transformer

**Table 1: Output of transformer result**

Input (V)	Output (V)
240	12.4
220	12.3
200	12.6

These results show that the transformer is okay.

The inverter circuit stage was tested with the MOSFET and the step up transformer. When connected to the 12V battery (lead acid), the inversion action took place and the output gave the 225V at one of the taps. The results are as shown in the table below.



**Table 2: Output of the inverter result**

Input (V)	Output (V)
12	225
11	200
10	179

The result shows the right output voltage based on the transformer ratio of the step up transformer. With the AVR control circuit connected, the full was tested, the AVR were adjusted such that the output would be around 220V when it is loaded. The table shows the output voltage for each D.C voltage from the battery.

**Table 3: Results from AVR circuit test**

Input (D.C/V)	Output (A.C/V)
12.3	225
11.0	220
10.0	212
9.0	210

**Final Tests Results**

When the entire individual test was completed, the device was loaded with a table fan and a cassette player. It was connected and tested with the ups and battery. The battery powered then for 1 hour. The battery was the medium 60AH type or model

Output Voltage (V)	Output Current (A)	Power consumption (W)
222	1.30	289
218	1.35	294
210	1.40	294

**Discussion**

This design is mainly an inverter circuit, it converts the d.c from the battery to a.c of 220V via a step up transformer. When the mains comes on it supplies mains power to the load. The change over process is affected by a relay (RLASW) operated by a 220V a.c. When the relay detects main voltage; it activates and directs mains supply to the transformer and also to the output. The transformer steps down the 220V to 12V in order to charge the battery again. The AVR circuit simply selects the taps at the output of the transformer to ensure that the output is 220V and that it remains constant.

The circuit worked with an observation about battery power that the more battery pack or ampere-hour, the longer would be the run-timeto power load.

**Conclusion**

It was not easy to get the full circuit working as it is now. Despite the problem encountered, the circuit worked i.e. the purpose of supplying a load

with constant 220V supply despite power output was achieved.

The unit was able to power an electric bulb, cassette player and a table fan. It also powered a 14'' color television.

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