

# DC/AC INVERTERS FOR HOUSEHOLD APPLICATIONS

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# Introduction

## What is a DC/AC inverter?

The purpose of a DC/AC **inverter** is to change Direct Current (DC) electricity into Alternating Current (AC) electricity. It also will increase the voltage of the AC electricity to 240 Volts AC (depending on which part of the world you are).

DC/AC **inverters** are needed in PV systems because the electricity generated by your solar panels is DC electricity. In order to use the generated solar power with your electrical devices and household appliances, it needs to be converted to the standard voltage AC electricity for your region.

# Types of PV DC/AC Inverters

*PV inverters* can be categorized by the type of solar power system they are used with:

- **Grid Tie Inverter:** It converts the DC to AC electricity directly and channels it to your home's breaker panel where it is either used by your household loads and the excess is sent to the utility grid.
- **Off Grid Inverter:** An off-grid PV system typically uses batteries to store the DC electricity generated by your solar panels. The inverter then converts the DC electricity from the batteries into AC electricity for use in your home.

# Solar Panel and Battery Sizing

- **Solar Panel Sizing:** In order to know the number of solar panels required for the household, a design current has to be evaluated based on the number of ampere – hours when solar radiation is at its peak.

$$Ah = I_t \times \text{duty cycle}$$

where  $Ah$  is ampere - hours,  $I_t$  the transformer primary current and duty cycle is the number of hours of system operation per day. If we have a household with a TV of 60 watts, refrigerator of 200 watts, 4 light bulbs of 20 watts each working for 10 hours per day, would require  $I_t$  about 30A, which yields 300 ampere – hours.

$$\text{Design Current} = \frac{\text{Ampere hours per day}}{\text{Peak sun hours per day}}$$

For example, in Bauchi (Nigeria) located at Lat. 10.33°N, the peak sun hours where found to be from 9am to 4pm (7 hours per day) in April 1998.

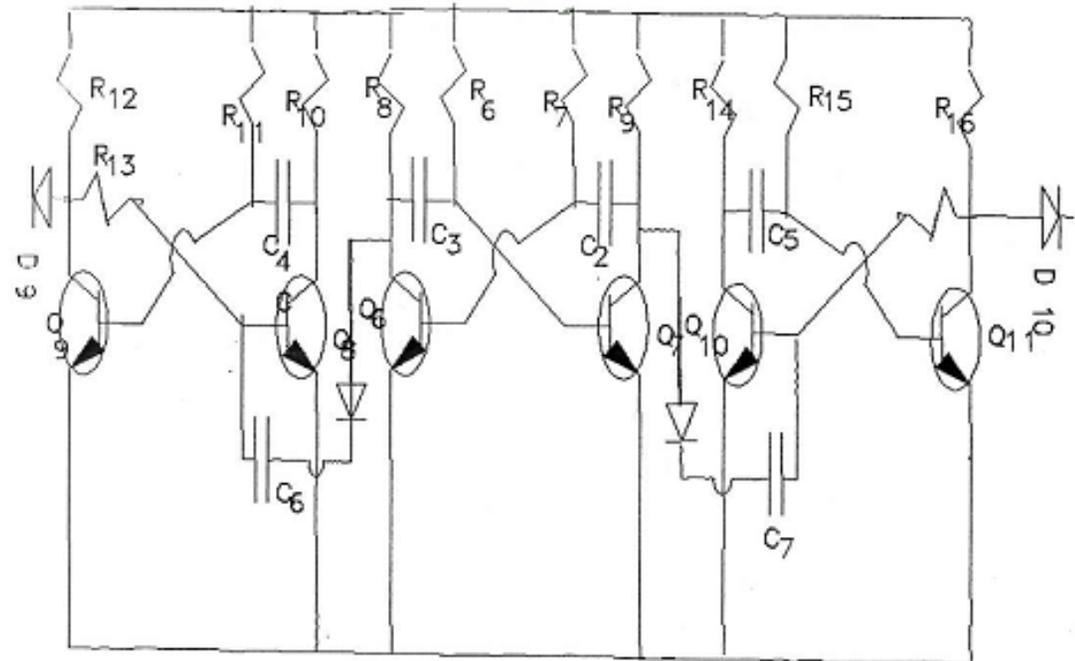
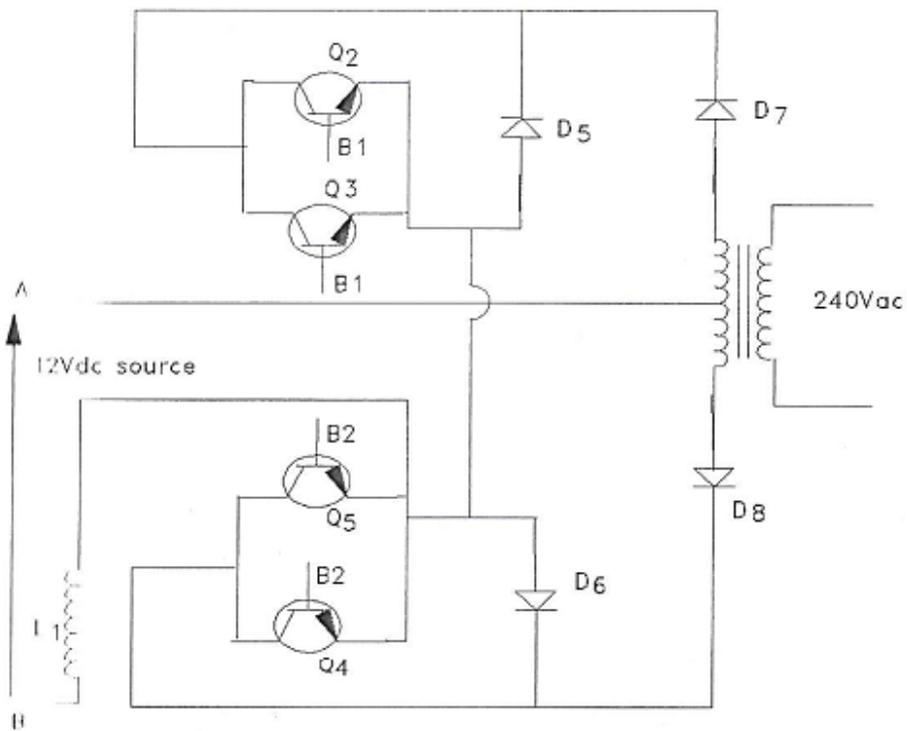
After applying typical derating factor, the number of factors required to take care of factors such as mismatch, temperature and dust cover is obtained by [1]:

$$\text{Modules in parallel} = \frac{\text{Derated design current}}{\text{Module derating factor} \times \text{Rated module current}}$$

**Battery System Sizing:** In our case of 300 Ah, we would require at least five 12 V, 600 Ah batteries in parallel.



# The Inverter Circuit



# Transformer Design

The transformer is used to step up the voltage from 24V ac to 240V ac. The design is based on the power capability equation [2]. A 800 VA transformer could have the following design sheet.

Winding Coil	Primary W1	Secondary W2
volts	24	240
Amperes	35	3.1
Turns	32.5	325.0
Gauge	AWG No. 16	AWG No.20
Turns/cm	5.4	10.8
Margin(cm)	1.0	1.0
winding length (cm)	6.0	6.0
Turns/layer	32.5	70.0
number of layers	1	5

# Maintenance

**PV Panels:** Based on a study carried out [3], it was recommended that solar panels in Northern Nigeria be **cleaned on three to four days intervals** during the harmattan period.

Practical outdoor operation of PV cells results in increased solar cell temperature with increasing insolation. Therefore, it is necessary to keep the solar cell temperature as low as possible. A possible measure to reduce heat dissipation from the back cover through convection and emission is to **use interference filters to reject the part of the spectral solar irradiation unusable for solar energy conversion.**

**Battery Maintenance:** When the lead-acid battery is being used, it is subject to discharge (this reaction is 100% efficient):



Both the lead dioxide of the positive plate and the sponge lead of the negative plate react with the acid to form lead sulphate and water.

The recharge process is the reverse of this:



The recharge process may be 100% efficient depending on the charge of the battery. When this reaction becomes less efficient, then gassing takes place (electrolysis of water).



In order to give the battery system long life, the following points must always be observed:

- The specific gravity of the electrolyte should always be checked to ensure it is of the correct value (1.215). If the acid is too concentrated, it produces sulphation during charging and if it is too weak, the capacity will be reduced.
- Acid should never be added to a battery until the cause of a low specific gravity has been found.
- The electrolyte should be topped with distilled water and should cover the plates completely. A certain amount of water is always lost due to evaporation and gassing leading to over concentration of the acid.
- The battery should not be overcharged as the gassing which results is liable to losing the active materials of the cells.
- The battery should not be over discharged (below 1.85V per cell) as sulphation will take place.
- After the battery has been in use for a considerable length of time, any active materials which must have fallen to the bottom of the cells should be removed as this is likely to cause short circuits and also reduce the specific gravity of the electrolyte.
- The battery should not be over ventilated or be in a very warm environment. Both these cause an increase in the rate of evaporation of the electrolyte.

# Bibliography

- [1] Yahya H. N. *et al.* (1996); Design and development of a photovoltaic powered portable lighting post, Nigerian Journal of Renewable Energy, 4(1) pp 69 – 74.
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- [3] Yahya H. N. and Sambo A. S. (1991); The effects of dust on the performance of photovoltaic modules in Sokoto, Nigerian Journal of Renewable Energy, 2(2) pp 36 – 42.