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**Power Electronics**

**Sessional Assignment**

**Total Marks=20**

There are different types of Power Electronics Converters used in industries. In this assignment you are required to search the industrial applications and catalogues of these converters and write on any of the following converters, your assignment should cover the following topics;

- i) Block Diagram
- ii) Circuit Diagram
- iii) Waveforms
- iv) Equations
- v) Specifications
- vi) Application in Industries
- vii) Converter Design

Types of Power Electronic Converters:

- a) Controlled Rectifier
- b) DC Converter (Buck, Boost and Buck-Boost)
- c) AC converters (Cycloconverters, Phase Converter, Triacs, Diacs)
- d) Inverters
- e) VFDs and VSD

**Helpful Links:**

- 1) <http://dir.indiamart.com/impact/industrial-rectifier.html>
- 2) <http://www.industry.siemens.com/verticals/global/en/mining-industry/heavy-duty-rectifier-applications/pages/default.aspx>
- 3) <http://www.ni.com/manuals/>
- 4) <https://www.industry.siemens.com/drives/global/en/pages/drive-technology.aspx>

# Inverters:

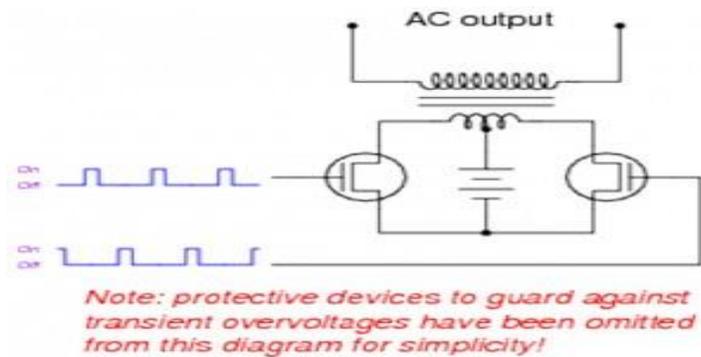
## Introduction:

An inverter is an electrical device which converts DC voltage, almost always from batteries, into standard household AC voltage so that it is able to be used by common appliances. In short, an inverter converts direct current into alternating current.

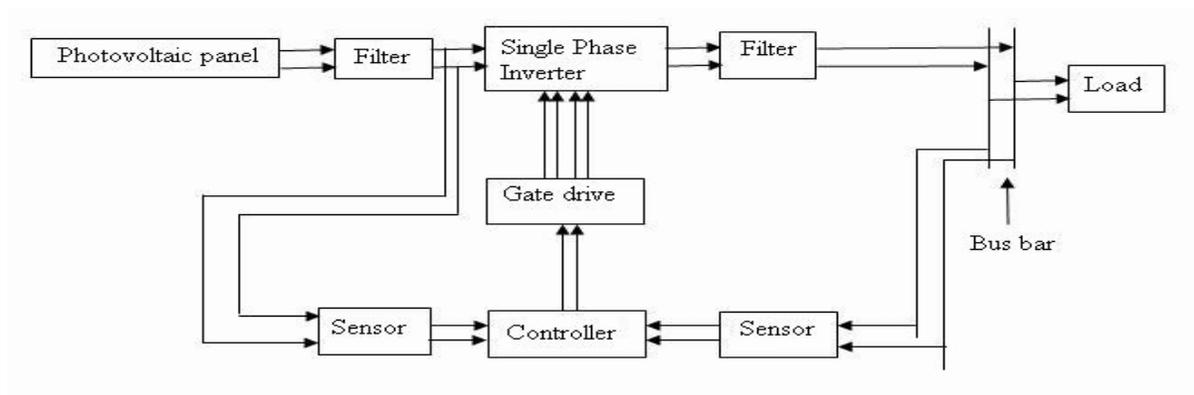
Direct current is used in many of the small electrical equipment such as solar power systems, since solar cells is only able to produce DC.

They are also used in places where a small amount of voltage is to be used or produced such as power batteries which produce only DC. Other than these fuel cells and other power sources also produce DC.

## CIRCUIT DIAGRAM:



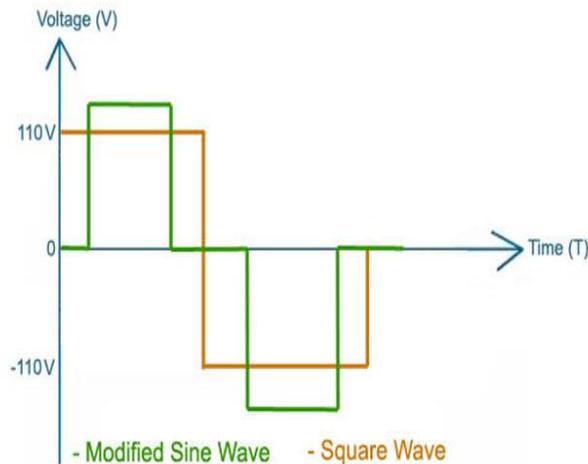
## BLOCK DIGRAM:



## Inverter output waveforms:

The inverters are classified according to their output waveforms with the three common types being the square wave, the pure sine wave and the modified sine wave.

The square wave is simple and cheaper, however, it has a low power quality compared to the other two. The modified square wave provides a better power quality (THD~ 45%) and is suitable for most electronic equipment. These have rectangular pulses that have dead spots between the positive half cycle and the negative half cycle (THD about 24%).



### MODIFIED WAVEFORM

#### Applications:

Inverters are used for a variety of applications that range from small car adapters to household or office applications, and large grid systems.

- Uninterruptible power supplies
- As standalone inverters
- In solar power systems
- As a building block of a switched mode power supply

### EQUATION

Voltage equation for inverter is

$$V_{dc}/2 = V_{out \text{ peak (phase voltage)}} \cdot (1/m)$$

Where m is modulation index

So 3 phase inverter the dc input can be calculated as

$$V_{dc} = 2 \cdot \sqrt{2} \cdot V \text{ (line to line)} / (\sqrt{3} \cdot m)$$

## **SPECIFICATION OF INVERTER:**

- (a) Three phase PCU/ inverter shall be used with each power plant system (10 kW and/or above) but in case of less than 10 kW single phase inverter can be used
- (b) . (b) PCU/inverter shall be capable of complete automatic operation including wake-up, synchronization & shutdown.
- (c) (c) Inverter should have internal protection arrangement against any sustainable fault in feeder line and against the lightning on feeder.
- (d) (d) Built-in meter and data logger to monitor plant performance through external computer shall be provided.
- (e)(e) Anti-islanding (Protection against Islanding of grid): The PCU shall have anti islanding protection in conformity to IEEE 1547/UL 1741/ IEC 62116 or equivalent BIS standard.
- (f) (f) In PCU/Inverter, there shall be a direct current isolation provided at the output by means of a suitable isolating transformer. If Isolation Transformer is not incorporated with PCU/Inverter, there shall be a separate Isolation Transformer of suitable rating provided at the output side of PCU/PCU units for capacity more than 100 kW
- (g) The PCU/ inverter generated harmonics, flicker, DC injection limits, Voltage Range, Frequency Range and Anti-Islanding measures at the point of connection to the utility services should follow the latest CEA (Technical Standards for Connectivity Distribution Generation Resources) Guidelines
- (h) The PCU / Inverters should comply with applicable IEC/ equivalent BIS standard for efficiency measurements and environmental tests as per standard codes IEC 61683/IS 61683 and IEC 60068-2 (1,2,14,30)/ Equivalent BIS Std