TERM PAPER ON PULSE WIDTH MODULATION AND ITS EFFECTS ON INVERTERS

NAME: Soyebo Ibukunoluwa
MATRICULATION NUMBER: 16CI020669
PROGRAM: Electrical and Electronics Engineering
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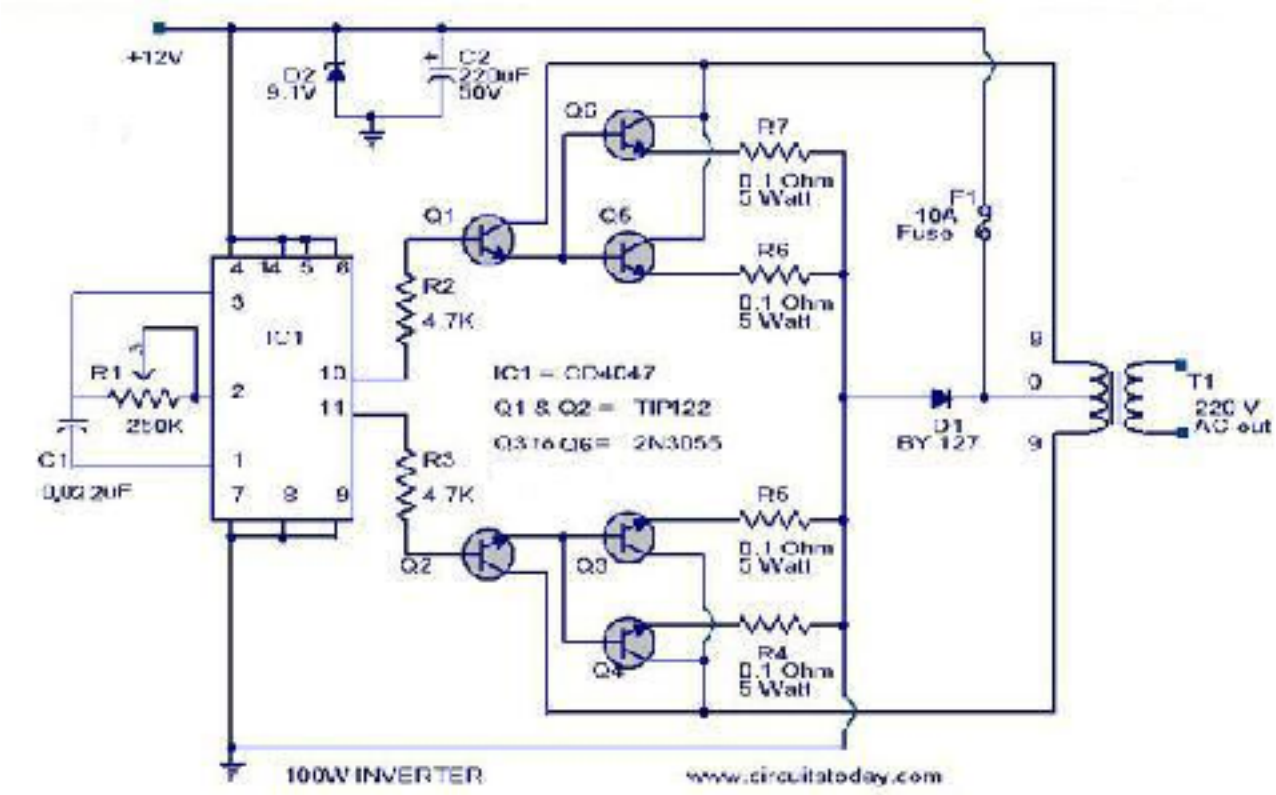
INRODUCTION

Inverters

A power inverter, or inverter, is a power electronic device or circuitry that changes direct current (DC) to alternating current (AC).
The input voltage, output voltage and frequency, and overall power handling depend on the design of the specific device or circuitry. The inverter does not produce any power; the power is provided by the DC source.
A power inverter can be entirely electronic or may be a combination of mechanical effects (such as a rotary apparatus) and electronic circuitry. Static inverters do not use moving parts in the conversion process. Power inverters are primarily used in electrical power applications where high currents and voltages are present; circuits that perform the same function for electronic signals, which usually have very low currents and voltages, are called oscillators. Circuits that perform the opposite function, converting AC to DC, are called rectifiers.

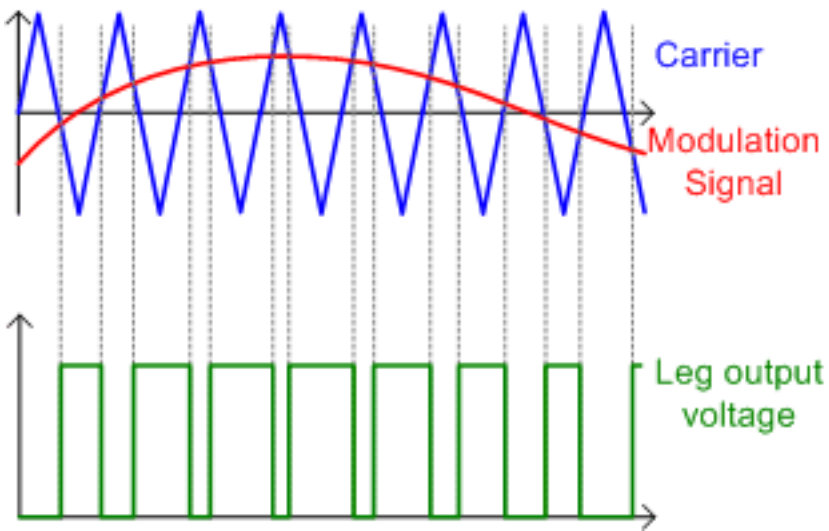
Based on the output waveforms, there are three types of Inverters. These are Sine wave, Modified Sine wave or Quasi sine wave and Square wave inverters.



PULSE WIDTH MODULATION

Pulse width modulation (PWM), or pulse-duration modulation (PDM), is a method of reducing the average power delivered by an electrical signal, by effectively chopping it up into discrete parts. The average value of voltage (and current) fed to the load is controlled by turning the switch between supply and load on and off at a fast rate. The longer the switch is on compared to the off periods, the higher the total power supplied to the load. Along with MPPT maximum power point tracking, it is one of the primary methods of reducing the output of solar panels to that which can be utilized by a battery. PWM is particularly suited for running inertial loads such as motors, which are not as easily affected by this discrete switching, because they have inertia to react slow. The PWM switching frequency has to be high enough not to affect the load, which is to say that the resultant waveform perceived by the load must be as smooth as possible.

The rate (or frequency) at which the power supply must switch can vary greatly depending on load and application. For example, switching has to be done several times a minute in an electric stove; 120 Hz in a lamp dimmer; between a few kilohertz (kHz) and tens of kHz for a motor drive; and well into the tens or hundreds of kHz in audio amplifiers and computer power supplies. The main advantage of PWM is that power loss in the switching devices is very low. When a switch is off there is practically no current, and when it is on and power is being transferred to the load, there is almost no voltage drop across the switch. Power loss, being the product of voltage and current, is thus in both cases close to zero. PWM also works well with digital controls, which, because of their on/off nature, can easily set the needed duty cycle. PWM has also been used in certain communication systems where its duty cycle has been used to convey information over a communications channel.



INVERTERS WITH PULSE WIDTH MODULATION

Pulse Width Modulation or PWM technology is used in Inverters to give a steady output voltage of 230 or 110 V AC irrespective of the load. The Inverters based on the PWM technology are more superior to the conventional inverters. The use of MOSFETs in the output stage and the PWM technology makes these inverters ideal for all types of loads. In addition to the pulse width modulation, the PWM Inverters have additional circuits for protection and voltage control.

The quality of the output wave form (230 / 110 volt AC) from the inverter determines its efficiency. The quality of the inverter output wave form is expressed using Fourier analysis data to calculate the Total Harmonic Distortion (THD). THD is the square root of the sum of the squares of the harmonic voltage divided by the fundamental voltage.

THD = √ V2 2 + V3 2 + V4 2……. Vn 2 / V1

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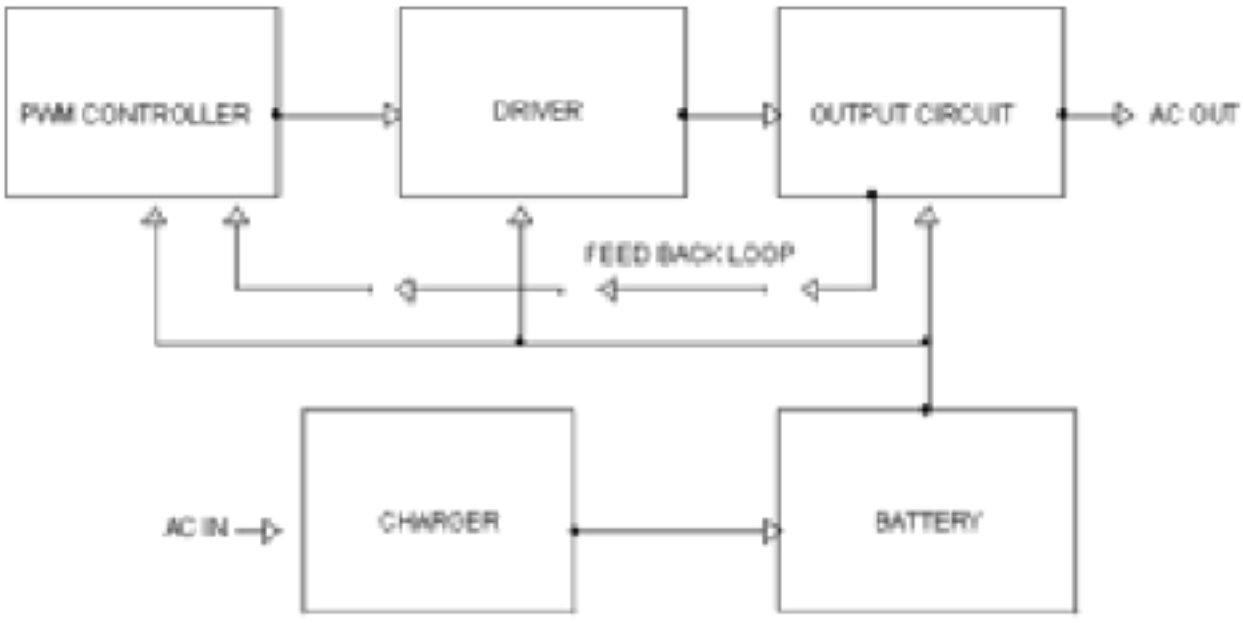
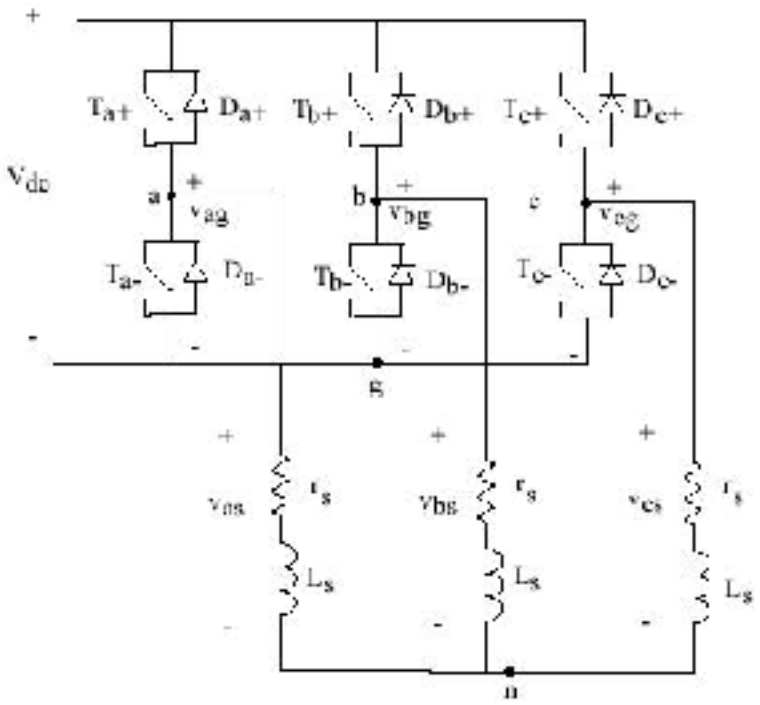


PWM INVERTER BLOCK DIAGRAM

How It Works



To design an Inverter, many power circuit topologies and voltage control methods are used. The most important aspect of the Inverter technology is the output waveform. To filter the waveform (Square wave, quasi sine wave or Sine wave) capacitors and inductors are used. Low pass filters, are used to reduce the harmonic components. Resonant filter can be used if the Inverter has a fixed output frequency. If the inverter has adjustable output frequency, the filter must be tuned to a level above the maximum fundamental frequency. Feedback rectifiers are used to bleed the peak inductive load current when the switch turns off.

As per the Fourier analysis, a square wave contains odd harmonics like third, fifth, seventh etc only if it is anti-symmetrical> about 180 degree point. If the waveform has steps of certain width and heights, the additional harmonics will be cancelled. If a Zero voltage step is introduced between the positive and negative parts of the square wave, the harmonics that are divisible by three can be eliminated. The width of the pulse should be 1/3 of the period for each positive and negative steps and 1/6 of the period for each of the Zero voltage steps. This leaves on the fifth, seventh, eleventh, thirteenth harmonics etc

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The Pulse Width Modulation technology is meant for changing the characteristics of the square wave. The switching pulses are Modulating, and regulating before supplied to the load. When the Inverter requires no voltage control, fixed pulse width can be used.

Advantages and Disadvantages of Pulse Width modulation on Inverters

Advantage of Pulse Width Modulation on Inverters

In a standard Inverter without the PWM technology, the output voltage changes according to the power consumption of the load. The PWM technology corrects the output voltage> according to the value of the load by changing the Width of the switching frequency in the oscillator section. As a result of this, the AC voltage from the Inverter changes depending on the width of the switching pulse. To achieve this effect, the PWM Inverter has a PWM controller IC which takes a part of output through a feedback loop. The PWM controller in the Inverter will makes corrections in the pulse width of the switching pulse based on the feedback voltage. This will cancel the changes in the output voltage and the Inverter will give a steady output voltage irrespective of the load characteristics.

A modified sinusoidal PWM waveform from an inverter is used for power control and optimization of the power factor. The main concept is to shift current delayed on the grid to the voltage grid by modifying the PWM converter. Consequently, there is an improvement in the efficiency of power as well as optimization in power factor.

Disadvantages of Pulse Width Modulation on Inverters

It possesses harmonic oscillations which can cause unwanted counter forces on engines, interference on radio equipments and surge current on condensers.

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