Inverter

Introduction

- An inverter is a device that changes or inverts direct current (DC) input to alternating current (AC) output.
- It doesn't "create" or "make" electricity, just changes it from one form to another. DC in is changed to AC out.
- Output is usually 120 or 240 volts at 60-cycle alternating current to match line power.
- Inverters are often a good choice for applications that require the main engine to operate at a job site. i.e. powering hydraulic systems or air compressors.
- Since, inverters are electronic devices, we don't have the noise from a separate engine.
- An inverter requires no fuel and virtually no maintenance
- Since, inverter output is fully voltage and frequency regulated and functions independently from the speed of the engine.

History of inverter

From the late nineteenth century through the middle of the twentieth century, DC-to-AC power conversion was accomplished using rotary converters or motor-generator sets (M-G sets). In the early twentieth century, vacuum tubes and gas filled tubes began to be used as switches in inverter circuits.

APPLICATION

- Inverters are used for many practical purposes
- Small inverters can plug into your car cigarette lighter
- Large inverters can be used in a solar or wind powered home

What kind of inverter do I want?

- Inverters come in all different shapes and sizes, for all different purposes
- Inverters vary in output from 50 – 5,000 W
- Several different methods of changing DC power to AC power
- Some inverters put out electricity of higher ‘quality’ than others. What does that mean?

Characteristics of a good INVERTER

- Its output voltage waveform should be sinusoidal.
- Its gain should be high.
- Its output voltage and frequency should be controllable in the desired voltage.
- The power required by its controlling circuit should be minimum.
- Its overall cost must be minimum
- Its working life must be long.
- The semi conductor device used in the inverter should be minimum switching and conduction losses.

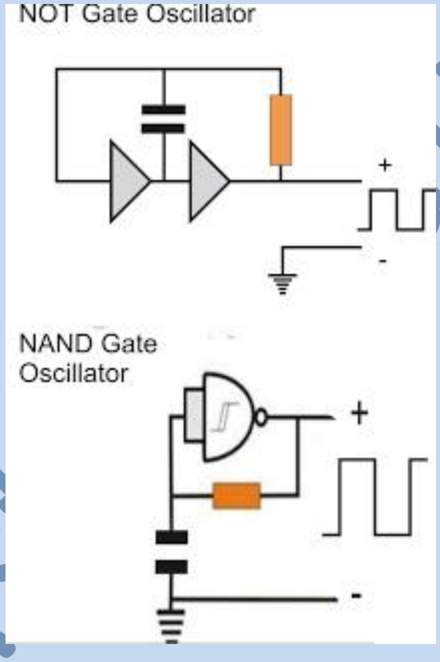
How to Design an Oscillator Circuit for an Inverter

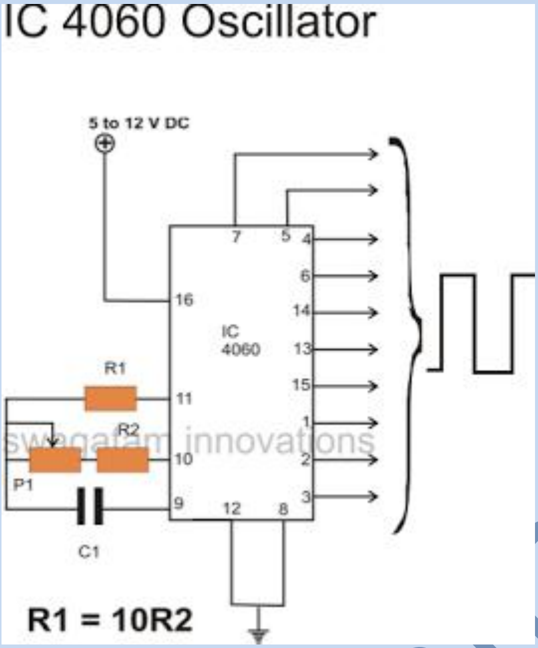
An oscillator stage is perhaps the simplest part in an inverter circuit. It's basically an astable multivibrator configuration which can be made through many different ways.

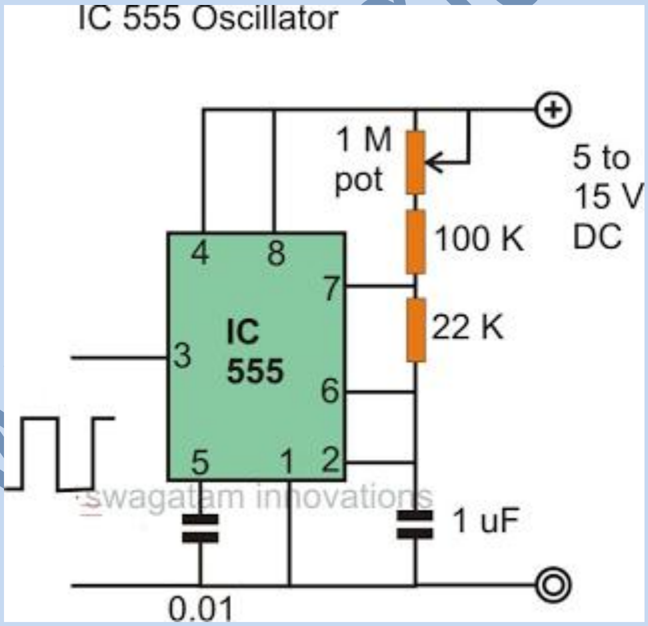
You can use NAND gates, NOR gates, devices with built-in oscillators such as IC 4060, IC LM567 or just utterly a 555 IC. Another option is the use of transistors and capacitors in standard astable mode.

The following images show the different oscillator configurations which can be effectively employed for achieving the basic oscillations for any proposed inverter design.

In the following diagrams we see a few popular oscillator circuit designs, the outputs are square wave which are actually positive pulses, the high square blocks indicate positive potentials, the height of the square blocks indicate the voltage level, which is normally equal to the applied supply voltage to the IC, and the width of the square blocks indicate the time span for which this voltage stays alive.




IC 4060 Oscillator
5 to 12 V DC
IC
4060
R1
R2
P1
C1
R1 = 10R2
swagatam innovations


IC 555 Oscillator
1 M
pot
100 K
22 K
5 to
15 V
DC
IC
555
1 uF
0.01
swagatam innovations

The Role of an Oscillator in an Inverter Circuit

As discussed in the previous section, an oscillator stage is required for generating basic voltage pulses for feeding the subsequent power stages.

However the pulses from these stages can be too low with their current outputs, and therefore it cannot be fed directly to the transformer or to the power transistors in the output stage.

In order to push the oscillation current to the required levels, an intermediate driver stage is normally employed, which might consist of a couple of high gain medium power transistors or even something more complex.

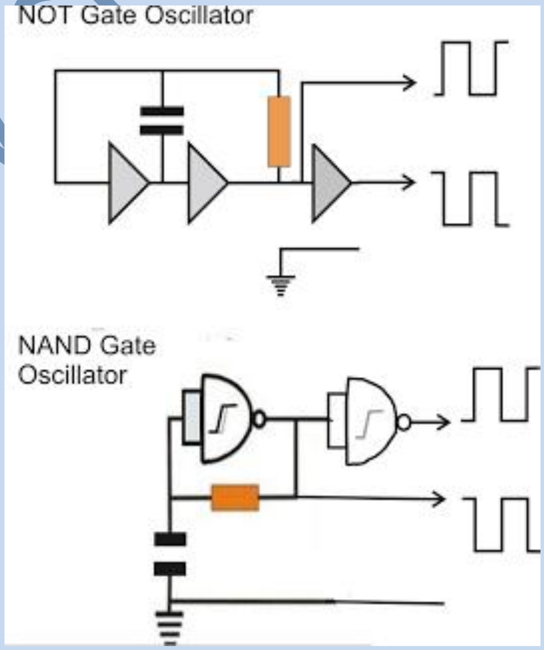
However today with the advent of sophisticated mosfets, a driver stage may be completely eliminated.

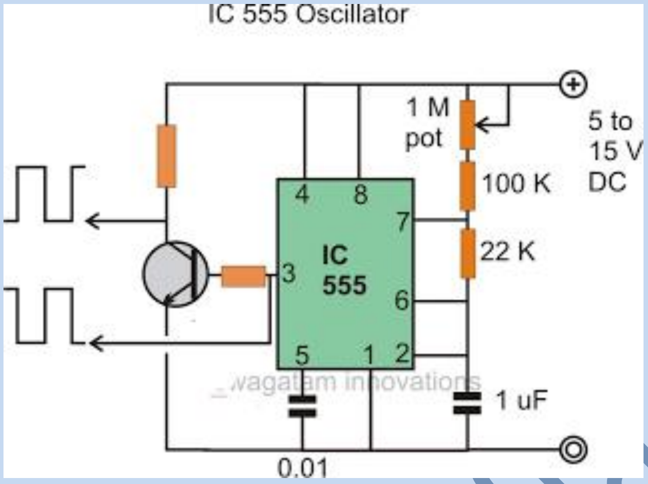
This is because mosfets are voltage dependent devices and does not rely on current magnitudes for operating.

With the presence of a potential above 5V across their gate and source, most mosfets would saturate and conduct fully across their drain and source, even if the current is as low as 1mA

This makes conditions hugely suitable, and easy for applying them for inverter applications.

We can see that in the above oscillator circuits, the output is a single source, however in all inverter topologies we require an alternately pulsing outputs from two sources. This can be simply achieved by adding an inverter gate stage (for inverting the voltage) to the existing output from the oscillators, see the figures below.





Understanding Inverter Topologies (How to Configure the Output Stage)

In the above sections we learned about the oscillator stages, and also the fact that the pulsed voltage from the oscillator goes straight to the preceding power output stage.

There are primarily three ways through which an output stage of an inverter may be designed.

By Using a:

Push Pull Stage (with Center Tap Transformer)

Push Pull Half-Bridge Stage

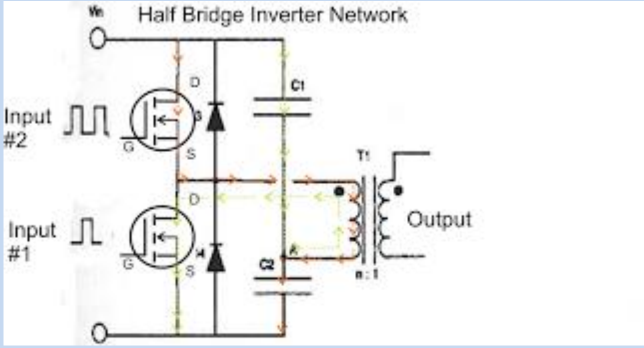
Push Pull Full-Bridge or H-Bridge Stage

The push pull stage using a center tap transformer is the most popular design because it involves simpler implementations and produces guaranteed results. However it requires bulkier transformers and output is lower in efficiency.

In this configuration, basically a center tap transformer is used with its outer taps connected to the hot ends of the output devices (transistors or mosfets) while the center tap either goes to the negative of the battery or to the positive of the battery depending upon the type of devices used (N type or P type).

A half bridge stage does not make use of s center tap transformer.

A half bridge configuration is better than a center tap push pull type of circuit in terms of compactness and efficiency, however it requires large value capacitors for implementing the above functions.



A full bridge or an H-bridge inverter is similar to a half bridge network since it also incorporates an ordinary two tap transformer and does not require a center tap transformer.

The only difference being the elimination of the capacitors and the inclusion of two more power devices.

A full bridge inverter circuit consists of four transistors or mosfets arranged in a configuration resembling the letter "H".

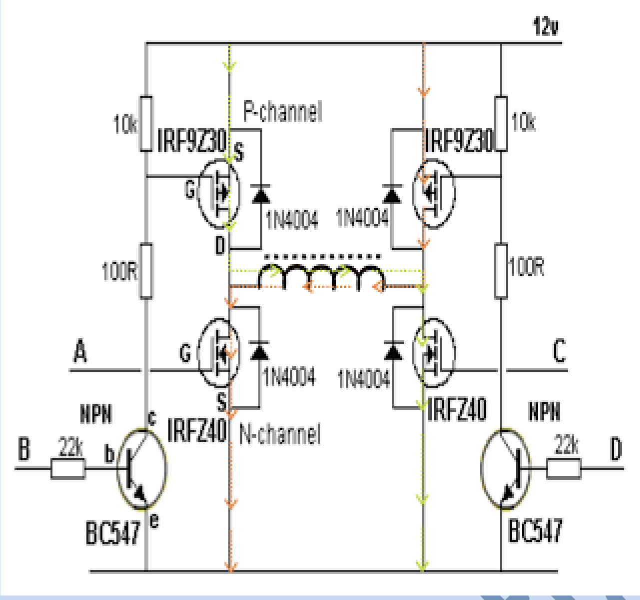
All The four devices may be N channel type or with two N channel and two P channel depending upon the external driver oscillator stage that's being used.

Just like a half bridge, a full bridge also requires separate, isolated alternately oscillating outputs for triggering the devices.

The result is the same, the connected transformer primary is subjected to a reverse forward kind of switching of the battery current through it. This generates the required induced stepped up voltage across the output secondary winding of the transformer. Efficiency is highest with this design.

The following diagram shows a typical H-bridge configuration, the switching are made as under:

A HIGH, D HIGH - forward push
B HIGH, C HIGH - reverse pull
A HIGH, B HIGH - dangerous (prohibited)
C HIGH, D HIGH - dangerous (prohibited)



The above explanation provides the basic information regarding how to design an inverter, and may be incorporated only for designing a ordinary inverter circuits, typically the square wave types.

However there are many further concepts that may be associated with inverter designs like making a sine wave inverter, PWM based inverter, output controlled inverter, these are just additional stages which may be added in the above explained basic designs for implementing the said functions.

Conclusion

- ✓ Inverter is a simple but versatile circuit.
- ✓ It is extensively used as buffer in the output stage to reduce the loading effect of the previous stage.
- ✓ Used as a basic block in many analog circuits like oscillators, Amplifiers.

REFERENCES

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