Hard Switching and Soft Switching Performance of Single Phase Push-Pull Inverter

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Abstract— The current project has as major aim the design of a single-phase inverter for educational purposes with clearly too known about hard switching and soft switching of an inverter. Switching operation of semi-conductor devices is mostly important control of an inverter. Because, switching process decides the performs of a device. So, in this project clearly analysis the switching operation of an inverter. Basically inverter designed with either hard switching components or soft switching components. So here we clearly discussed operating performs of both hard and soft switching. Since the first Arduino board was developed on 2005, there has been a turning point on the programming world, especially between non specialised users. With an intuitive software and a wide amount of applications, it is a highly recommended option for the first approach to digital programming for students. For those reasons, this paper has the aim to apply this tool to ease the switching operation on a single-phase inverter with the help of simulation program substituting analogical circuitry. To achieve those aims, a first complete theoretical analysis will be made, including its applications and basic elements. Afterwards, the specific characteristics of the desired inverter will be defined, allowing the computation and selection of the components required. After the theoretical approach, the complete circuit will be simulated with the Mat lab software and will implement in a protoboard. Some measurements will be also done in order to check the performance of the device and its efficiency.

Key words: Battery Cell, Charging and Discharging, Single Phase Inverter, Frequency, Voltage, Switching

I. INTRODUCTION

An inverter has the capability to improve the DC power into AC power that are useful for generating equipment like household items, computers, power tools and much more by simply plugging typically equipment into the inverter. All these are really not efficient way to run products alongside high power requirements really as electric utility heaters, air conditioners due to their high current draw and additionally battery utilization. It is among the easiest ways of getting transferable power for which you want it the vast majority of. This additionally creates its power from the batteries that are wired in parallel. It needs to be recharged soon after every utilize as well as can feel recharged by using gas generator, solar power panels and more techniques.

This might be obtainable in different output ranges to suit any sort of device which needs power. Low driven inverters are made specially for low driven electronic items. Huge effective inverters can be applied for several small machines or perhaps huge device that needs a tall power necessity. All these are a great device to have alongside you when you are in some sort of outing.

The stand-alone inverter is easily the most acquainted category related with power inverter. The quintessential popular power inverters that you can expect to find on the web tend to be stand-alone as well as that carry out solely one operation. This will fluctuate in size from 75 watts to 5000 watts. Pricing will alter based in the attributes granted and additionally typically size to feel selected appropriately to your requirements. Typically setting up process is very very easy to comprehend.

They typical kinds of power inverters: true-sine revolution or modified-sine wave. True-sine revolution inverters create power which is furthermore identical to the public utility power grid system. The power wave whenever noticed through a particular oscilloscope is an actually sine revolution. Modified-sine wave is regarded as the typical type in market. This creates power revolution and is sufficient for most of the equipment as well as provides good functional performance at a great value. Waveform is considered when choosing a power inverter.

Some inverters could have the ability to feel AC hardwired. This sort related with setting up definitely will need a licensed electrician or certified installer. This works most excellent if in case you tend to be wanting to power a complete circuit to use existing channels in a cabin, vessel.

An inverter charger integrates power inverter and additionally battery charger and additionally transfer it to single device. This creates a convenient device to prevent several components installations. It is design mainly for the applications in that AC power is going to be available from a particular outside provider, such as a power generator. The installation process is difficult needs a technician to install. Soon after installation it can work on their own. Typically most standard inverter purchased for emergency home back-up power is a 2000 watt. 2000 is perfect for many cars and trucks as well as for most of apparatus.

An inverter is used to produce an un-interrupted 220V AC or 110V AC (depending on the line voltage of the particular country) supply to the device connected as the load at the output socket. The inverter gives constant AC voltage at its output socket when the AC mains power supply is not available.

II. TOPALOGY OF INVERTER

Let's look how the inverter makes this possible. To grasp the functioning of an inverter, we should consider in the following situations.

- When the AC mains power supply is available.
- When the AC mains power supply is not available.

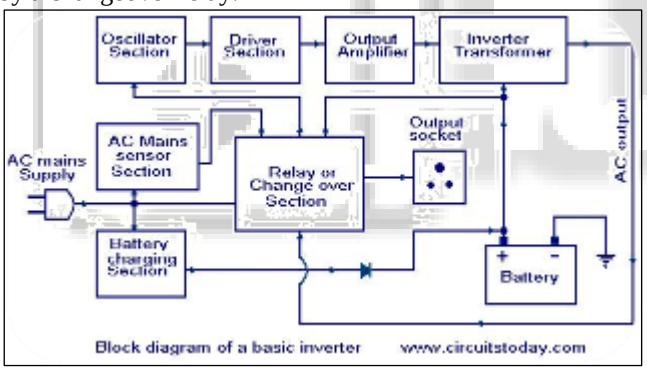
A. When the AC mains power supply is available.

When the AC mains supply is available, the AC mains sensor senses it and the supply goes to the Relay and battery

charging section of the inverter.AC main sensor activates a relay and this relay will directly pass the AC mains supply to the output socket. The load will by driven by the line voltage in this situation. Also the line voltage is given to the battery charging section where the line voltage is converted to a DC voltage (12V DC or 24V DC usually), then regulated and battery is charged using it. There are special circuits for sensing the battery voltage and when the battery is fully charged the charging is stopped. In some inverters there will be a trickle charging circuit which keeps the battery constantly at full charge.

B. When the AC mains power supply is not available.

When the AC mains power supply is not available, an oscillator circuit inside the inverter produces a 50Hz MOS drive signal. This MOS drive signal will be amplified by the driver section and sent to the output section. MOSFETs or Transistors are used for the switching operation. These MOSFETs or Transistors are connected to the primary winding of the inverter transformer. When these switching devices receive the MOS drive signal from the driver circuit, they start switching between ON & OFF states at a rate of 50 Hz. This switching action of the MOSFETs or Transistors cause a 50Hz current to the primary of the inverter transformer. This results in a 220V AC or 110V AC (depending on the winding ratio of the inverter transformer) at the secondary or the inverter transformer. This secondary voltage is made available at the output socket of the inverter by a changeover relay.



An inverter refers to a power electronic device that converts power in DC form to AC form at the required frequency and voltage output.

Inverters are classified into two main categories −

– Voltage Source Inverter (VSI) − the voltage source inverter has stiff DC source voltage that is the DC voltage has limited or zero impedance at the inverter input terminals.

C. Automation in an Inverter

Inverter contains various circuits to automatically sense and tackle various situations that may occur when the inverter is running or in standby. This automaton section looks after conditions such as overload, over heat, low battery, over charge etc. Respective of the situation, the automation section may switch the battery to charging mode or switch OFF. The various conditions will be indicated to the operator by means of glowing LEDs or sounding alarms. In advanced inverters LCD screens are used to visually indicate the conditions.

– Current Source Inverter (CSI) − A current source inverter is supplied with a variable current from a DC
– Source that has high impedance. The resulting current waves are not influenced by the load.

D. Single phase inverter

There are two types of single phase inverters − full bridge inverter and half bridge inverter.

E. Half Bridge Inverter

This type of inverter is the basic building block of a full bridge inverter. It contains two switches and each of its capacitors has a voltage output equal to Vdc2Vdc2. In addition, the switches complement each other, that is, if one is switched ON the other one goes OFF.

F. Full Bridge Inverter

This inverter circuit converts DC to AC. It achieves this by closing and opening the switches in the right sequence. It has four different operating states which are based on which switches are closed.

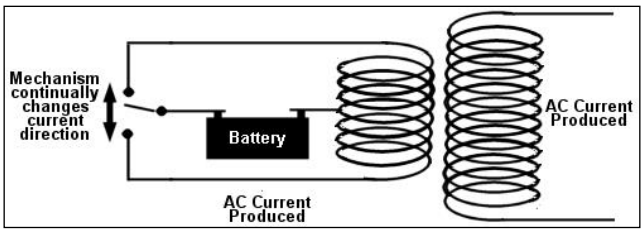
n the same way, we primarily classify inverters on the basis of their output characteristics. So there are three different types of outputs we get from inverters, and hence we classify inverters into three primary classes, which are:

1) The Square Wave inverter
2) The Modified Sine wave inverter or quasi sine wave inverter
3) A Pure sine wave inverter

G. The Square Wave inverter

A square wave inverter is one of the simplest inverter types, which convert a straight DC signal to a phase shifting AC signal. But the output is not pure AC, i.e. in the form of a pure sine wave, but it is a square wave.

At the same time they are cheaper as well. The simplest construction of a square wave inverter can be achieved by using an on-off switch, before a typical voltage amplifying circuitry like that of a transformer. This is shown below:



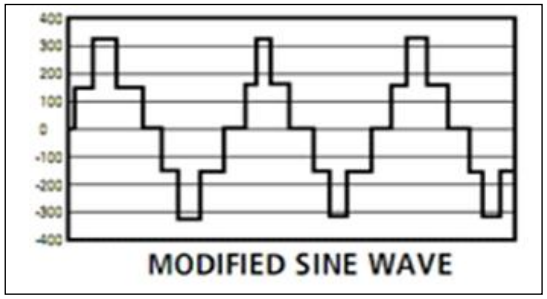
The output of this type of a circuit is a square wave.

H. The modified Sine wave inverter or quasi sine wave inverter

The construction of this type of inverter is a bit more complex than a simple square wave inverter, but still it is a lot simpler than a pure sine wave inverter.

A Modified sine wave shows some pauses before the phase shifting of the wave, i.e. unlike a square it does not shift its phase abruptly from positive to negative, or unlike a sine wave, does not make a smooth transition from positive to negative, but takes brief pauses and then shifts its phase.

The output waveform of a modified sine wave inverter is shown below:



I. Pure Sine Wave Inverter

The electrical circuit of a pure sine wave inverter is far more complex than a square wave or modified sine wave inverter. Another way to obtain a sine output is to obtain a square wave output from a square wave inverter and then modify this output to achieve a pure sine wave. A pure sine wave inverter has several advantages over its previous two forms:

– More efficiency, hence consumes less power.
– They can be adjusted according to your personal power requirements, since several types are available with different power outputs. The output of a pure sine wave inverter is very reliable, but at the same time, there is a tradeoff between the price and reliability. Due to this reason they are the best option for sensitive equipment.

III. HARD SWITCHING AND SOFT SWITCHING OF INVERTER

A. Hard Switching of Inverter

When we need to use an inverter circuit diagram. Sometimes we cannot find it. But we can build it easily. In two simple inverter schematic diagram below, just use 2 transistors, 2 resistors, and one transformer only. They can convert 12VDC from battery to 220VAC or 120VAC to apply small light bulbs or lamps max 10 watts.
Include two Circuit idea.

1) Very Simple Inverter circuit using MJ2955 (old circuit for me use PNP transistors)
2) Micro Inverter circuit diagram using TIP41 or 2N6121 (Chayapol made its small size)

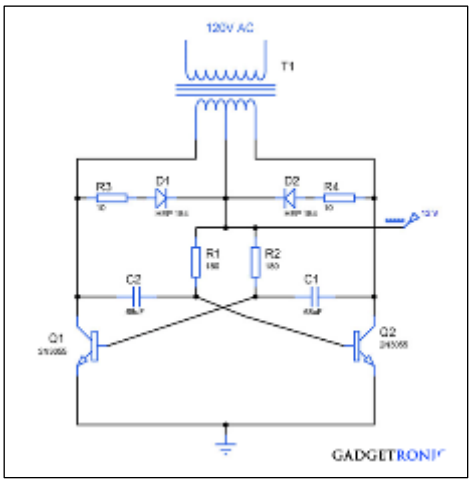
Very Simple Inverter circuit diagram using MJ2955
This is Simple inverter schematic diagram.

Today I need to use AC lamp and Soldering iron at outdoor which no 220V AC electrical current.

In this case, I do not need high power and longtime uses. Because I use the power of 40 watts for just a brief moment (30 minutes approximately).

Then, I look for all parts in my store, have many MJ2955 power transistors.

Thus I choose an inverter circuit diagram as Figure 1 it is very easy. It two MJ2955,68 ohms resistors; quantity: 2, and A transformer only. You see really it is possible.



B. The MJ2955 inverter circuit diagram

It is set in an astable multivibrator form. Same this inverter but it uses PNP transistor and high power than one. The transformer secondary works as a load that can transform electrical to high voltage, in this case, is 220V but not sure is 50Hz.
However, the frequency output does not need to use with the load.

C. Let's build this circuit.

This circuit is very simple but tiny size. I assemble them on the heatsink and connects all wires as Figure in the video below.

I use 12V battery 2.5Ah size as a source, secondly, I measure output AC voltage is 225-volts. Next, I apply lamps to the circuit. The voltage lower to 190-volts and can keep up power.

D. Testing/application

For example, I use this inverter circuit diagram projects to LED lamp 220V 3watt because of Low power consumption. I test working as follows step:

1) Use the 12 VDC battery 2.5Ahor 12VDC regulated current more than 2A to testing.
2) Use AC volts meter measure by setting 500 VAC range or AC volts digital meter such as I use.
3) Apply the 12 VDC source to this project.
4) Measure the output voltage. Should read voltage during 220 V up to 330 VAC.

After that, try uses load as LED lamp-220 VAC 3 watts to load.

This circuit has power output about 5watts to 10 watts only.

Today I want to show you a IC 555 inverter circuit. Which it is easy and small size. Because use IC 555 and transistor as main.

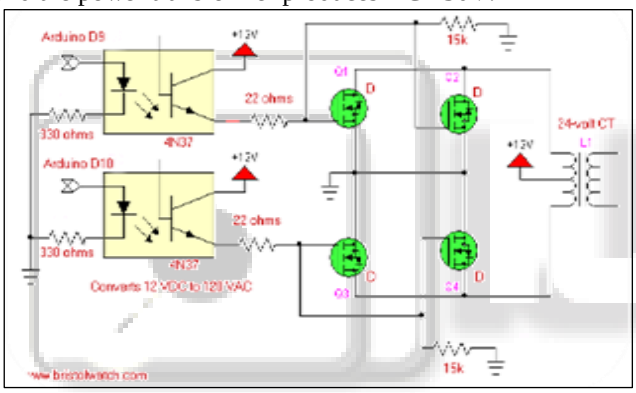
This circuit I experiment it work well, when use source is 12V battery will have output of 50 watts. The principle of circuit. I think many people does not like read many word or long reading. So please read at: Simple working principle of the inverters

E. Softwitching of Inverter

When we need to use an inverter circuit diagram. Sometimes we cannot find it. But we can build it easily. In two simple inverter schematic diagram below, just use 2 MOSFET,2 resistors, and one transformer only. They can convert 12VDC from battery to 220VAC or 120VAC to apply small light bulbs or lamps max 10 watts.

This is Simple inverter schematic diagram.

In this circuit consists of MCT 2E based mosfet driver circuit and IRF 840 BASED switching circuit, and, 12-0-12/230v/2A power transformer setup. The microcontroller gives the 50 Hz pulse to switch the mosfet driver. The mosfet driver manage the gate current of the mosfet. The mosfet IRF 840 switch the power transformer and the power transformer produces AC 230V.



F. The MJ2955 inverter circuit diagram

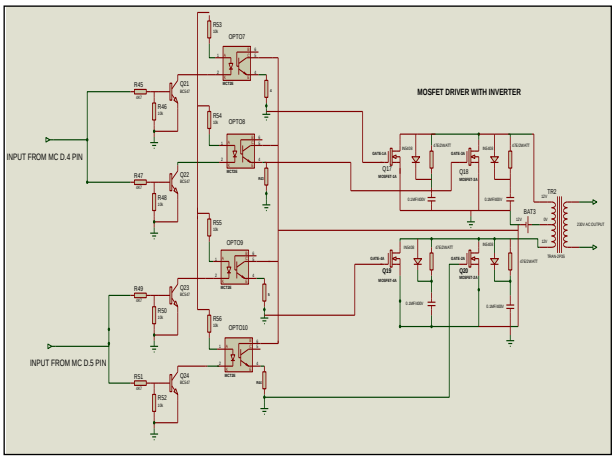
In this set am produced 50HZ frequency by using ATMEGA 16 icro controller. The transformer secondary works as a load that can transform electrical to high voltage, in this case, is 220V but not sure is 50Hz.

However, the frequency output does not need to use with the load.

G. Let's build this circuit.

This circuit is very simple but tiny size. I assemble them on the heatsink and connects all wires as Figure in the video below.

I use 12V battery 2.5Ah size as a source, secondly, I measure output AC voltage is 236-volts. Next, I apply lamps to the circuit. The voltage lower to 226-volts and can keep up power.



H. Testing/application

For example, I use this inverter circuit diagram projects to LED lamp 220V 3watt because of Low power consumption. I test working as follows step:

1) Use the 12 VDC battery 2.5Ahor 12VDC regulated current more than 2A to testing.
2) Use AC volts meter measure by setting 500 VAC range or AC volts digital meter such as I use.
3) Apply the 12 VDC source to this project.
4) Measure the output voltage. Should read voltage during 220 V up to 330 VAC.

After that, try uses load as LED lamp-220 VAC 3 watts to load. This circuit has power output about 5watts to 10 watts only. Today I want to show you a ATMEGA 16 inverter circuit. Which it is easy and small size. Because use ATMEGA 16 and MOSFET as main. This circuit I experiment it work well, when use source is 12V battery will have output of 100 watts.

The principle of circuit. I think many people does not like read many word or long reading. So please read at: Simple working principle of the inverters

IV. Conclusion

Soft switching using MOSFET gives low switching losses, higher efficiency, it's no load, full load voltage is more effective than hard switching. The waveforms of mosfet inverter has less harmonics then transistor switches. Frequency of hard switching inverter is stable than hard switching inverter. Soft switching converter gives "smoothed waveform with no transient spikes. It reduces switching losses and stress. Soft -switched converter can be operated at the very high frequency.

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