DESIGN 12V-TO-230V POWER INVERTER

MOHD YAZID BIN ISMAIL

MAY 2008

"I hereby declared that I have read through this report and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power)"

Signature : ....

Supervisor's Name : EN. AZZIDDIN BIN MOHAMAD RAZALI

Date : 7 MEI 2008

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This Report Is Submitted In Partial Fulfillment of Requirement for the Degree of Bachelor in Electrical Engineering (Industrial Power)

Faculty of Electrical Engineering
Universiti Teknikal Malaysia Melaka

May 2008

"I hereby declared that this report is a result of my own work except for the excerpts that have been cited clearly in the reference."

Signature : ....

Name : MOHD YAZID BIN ISMAIL

Date : 7 MEI 2008

Untuk Bonda Yang Tersayang

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It is therefore difficult to name all the people who have directly or indirectly helped me in this effort; an idea here and there may have appeared insignificant at the time but may have appeared insignificant at the time but may have had a significant causal effect.

Last but not least, I take this opportunity to dedicate this thesis for all electrical engineering students. All suggestions for further improvement of this thesis are welcomed and will be gratefully acknowledged.

ASBTRACT

This project is to design and develop *"12V-to-230V Power Inverter consists of IC SG3526"*. This project is to develop a portable device that can allow the use of 230V electrical appliances from a car battery or a solar battery. It must therefore supply a voltage that corresponds to an rms of 230 Volts sine-wave like household main supply or similar. This device can be used at public locations or camping sites, party events or in some emergency cases. There are several advantages while using this device. Consumers no longer to use a generator, it is not suitable and waste cost in petrol with it large size and heavy and didn't have to use a long cable from mains power to remote site but just connect it to 12Vdc car battery and this power inverter available capable to change it into 230Vav and will functioning as a power outlet.

ABSTRAK

Projek ini bertujuan untuk mereka dan membangunkan "*12V-to-230V Power Inverter yang mengandungi IC SG3526*". Secara ringkasnya, alat ini merupakan salah satu alat yang boleh membekalkan 230Vac seperti bekalan yang terdapat di rumah dengan hanya mendapat bekalan 12Vdc dari bateri kereta. Alat ini boleh digunakan ketika berada di kawasan awam, berkhemah ataupun ketika kecemasan. Terdapat beberapa kelebihan menggunakan alat ini. Pengguna tidak perlu menggunakan penjana kerana ia tidak sesuai dari segi kos bahan bakar dan juga saisnya yang besar dan berat. Selain itu, pengguna juga tidak perlu menggunakan kabel bekalan yang panjang untuk disambungkan ke punca bekalan kuasa tetapi hanya perlu sambungkan ke 12Vdc bateri kereta dan alat ini berupaya membekalkan 230Vac dimana ia akan berfungi sebagai punca bekalan kuasa

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CHAPTER I

INTRODUCTION

1.1 Project Background

The aim of this project is to develop an inverter that can take 12Vdc and steps it up to 230Vac. This device can be used in a wide range of applications, from small switching power supplies to large electric utility applications such as UPS, variable – speed ac motor drives etc. The advantage while using this portable device is consumer didn't have to use a long cable from mains power to remote site but just connect it to 12Vdc car battery and this power inverter available capable to change it into 230Vav and will functioning as a power outlet.

1.2 Problem Statement

The absence of mains power outlet is often keenly felt on camping sites, party events or in some emergency cases. By using a generator, it is not suitable and waste cost in petrol with it large size and heavy. Solution of this problem is by developing and designs one device that can produce a 230Vac to operate equipment that is normally supplied from a main power source. Power inverters, regardless of size, are typically constructed of a DC-DC converter and a DC-AC inverter. These are the two major circuit components that work together to convert the input voltage from a vehicle battery into a desirable AC output waveform. In the Malaysia, the standard AC output waveform consists of a voltage of 240 VAC and a frequency of 60 HZ. Electronic mobility has always been an issue when it comes to our mobile environment. Therefore, a mobile means of providing AC voltage is needed. The majority of portable electronic devices are more easily powered using 240 VAC. When these devices need to be used in a remote or mobile setting there is a problem. Most people have access to 12 VDC generated by the standard power supply system of a mobile vehicle, such as an automobile or electrical equipment. A power inverter of DC to AC type will be needed to convert 12 VDC to 240 VAC with acceptable power output.

1.3 Project Objectives

1. To design and develop an inverter base of following specification, 12Vdc to 230Vac output, and 100W active power.

2. To design a circuit that can takes 12Vdc and steps it up to 230Vac where it can be connected to load applications.

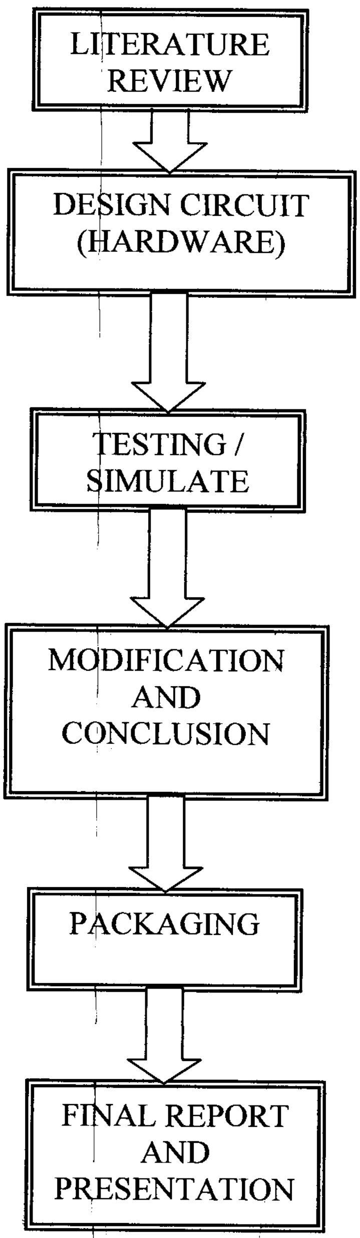
1.4 Scope of project

The project is focuses on development of the 12Vdc-to-230Vac Power Inverter which is the converter is consists of an IC SG3526. For hardware part, the circuit for power inverter are designed which is can takes 12Vdc and steps it up to 230Vac.

1.5 Design Requirement

There are several factors involving power that can be easily overlooked by the average person. These issues deal primarily with efficiency but are not limited to it. First, basically the amount of power consumed by the load must be looked at because different devices need different power wattages. Because of this fact, this inverter would not be able to supply a large power for devices that require a lot of power. This does not affect the efficiency of this device; it is just one of its limitations. Next, the sensitivity of the load being driven should be considered. This means the output signal of the inverter must provide a cleaner signal without distortion for more sensitive devices.

1.6 Methodology



In term of collecting data for material used in this project, there are several methods that have been done to complete this project. The several methods are:-

1. **Literature Review**

   In literature review, books, Internet and journals are used to get more information about this project. Also have a discussion with a project supervisor to identify the problem and solution.

2. **Design Circuit and Testing / Simulate**

   Circuit for this power inverter is designed by using Orcad software and then it was tested and simulated.

3. **Modification and Conclusion**

   Do a modification for the non-suitable system and make a conclusion for the overall project results.

4. **Packaging**

   The device is packed with a suitable casing and size.

5. **Report and Presentation**

   Prepared the complete report for this project and presentation.

1.7 Technical Design Constraints

At the end of this project, one power inverter 12Vdc-to-230Vac is produced that can operate electrical appliances where is normally supplied from a main power source. This power inverter has several advantages such as easy to use as a portable power outlet, compactness and reasonable cost. The four technical design constraints are shown in Table 1. These design constraints will rely heavily on the square wave output. A square wave output will be obtained through the use of an IC SG3526.

Table 1.7: Technical design constraints for the DC/AC power inverter.

Name	Description
Voltage	Convert 12 (V DC) to 240 (V AC).
Power	Will provide 100 (W).
Efficiency	The inverter will operate at no less than 90 %.
Output	This inverter will produce a square wave output.

CHAPTER II

LITERATURE REVIEW

2.1 Approach

This section explains the theory that must be considered along with the approach that has allowed for the successful implementation of the power inverter. It is worth mentioning that power inverter design requires knowledge of various areas in electrical and computer engineering including circuit analysis, power electronics, microprocessors, electromagnetic, signals and systems, and feedback controls. A general knowledge of these areas is critical in order to fully understand the physical behavior of each circuit component, as well as the interaction with other components. This section begins with a general overview of the technology considered in this project and then elaborates on the key design issues pertaining to both the hardware and software.

2.2 Introduction of DC to AC Converter (Inverter)

Inverters are power electronic devices, which convert DC (typically low voltage) into AC (at 230 V, 50 Hz) as required for conventional appliances. Inverter circuits are used to converts DC to AC power by switching the DC input voltage (or current) in a pre-determined sequence so as to generate AC voltage (or current) output. The power semiconductor devices perform the switching action and the desired output is obtained by varying their turn-on and turn-off times. Inverters are used in a wide range of applications, from small switching power supplies in computers, to large electric utility applications that transport bulk power. The typical applications of inverter are Un-interruptible power supply (UPS), Industrial (induction motor) drives, Traction and HVDC. One type of uninterruptible power supply uses batteries to store power and an inverter to supply AC power from the batteries when main power is not available. When main power is restored, a rectifier is used to supply DC power to recharge the batteries. The inverter is so named because it performs the opposite function of a rectifier.

An inverter allows the use of 230V electrical appliances from a car battery or a solar battery. It must therefore supply a voltage that corresponds to an rms of 230 Volts sine-wave like household main supply or similar. The general block diagram of inverter is shown as below.

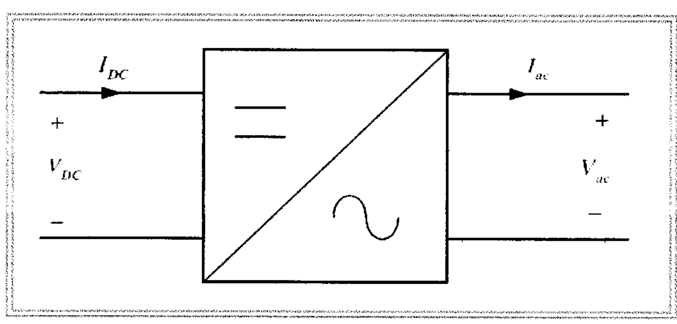


Figure 2.2(a): Inverter Block Diagram

Though the methods involved in constructing a power inverter are practically unlimited, they all encompass the common goal of altering an incoming DC voltage to form a sinusoidal output signal. Regardless of the specific design implementation, a quality power inverter should provide the end-user with desirable voltage, current, and frequency output characteristics that meet or exceed the standards for specific appliances. Often, consumers are satisfied with the least expensive inverter that will provide an adequate power level to allow constant operation of particular devices. Regardless of price, a close examination of the output waveform can distinguish the quality between particular power inverters. For example, many inexpensive power inverters create what is called a "modified sine wave". Figure 1 shows an actual inexpensive power inverter output waveform.

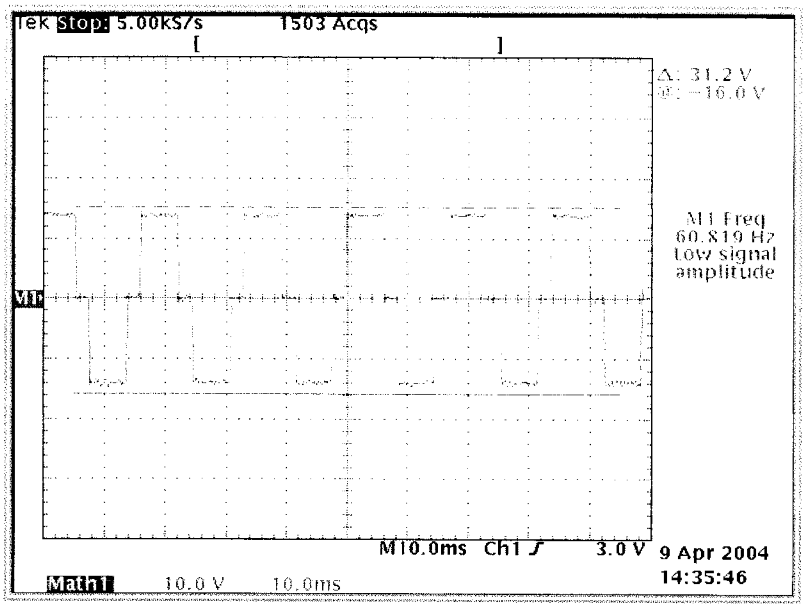


Figure 2.2(b): Modified sine wave output

The problem with this type of inverter is the harshness with which it switches. Harsh switching causes a high harmonic distortion in the output signal. Harmonic distortion is simply the amount of power that is contained in other frequencies other than the fundamental frequency. The harsh switching actually causes voltage and current spikes in the output signal. This often reduces the useful life of electronic devices. In many case, the connected device may fail to operate. This is why a sinusoidal waveform is the preferred and more expensive output waveform.

2.3 Types of Inverters

There are two types of inverters:

2.3.1 Voltage Source Inverter (VSI)

The output voltage, Vo, is function of the inverter operation and the load current, Io, is a function of the nature of the load where the current is free to respond to the load needs and the DC input, Vdc, is a constant input voltage.

A large capacitor in the DC link section is used to keep the DC voltage constant.

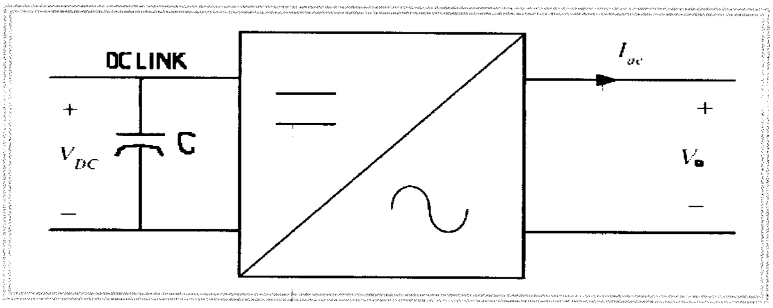


Figure 2.3.1: Voltage Source Inverter

2.3.2 Current Source Inverter (CSI)

The output voltage, Vo, is a function of the inverter operation and the load current, Io, is a function of the nature of the load where the current is free to respond to the load needs and the source, Idc, is a constant input current. A large inductor is used to keep the DC current constant.

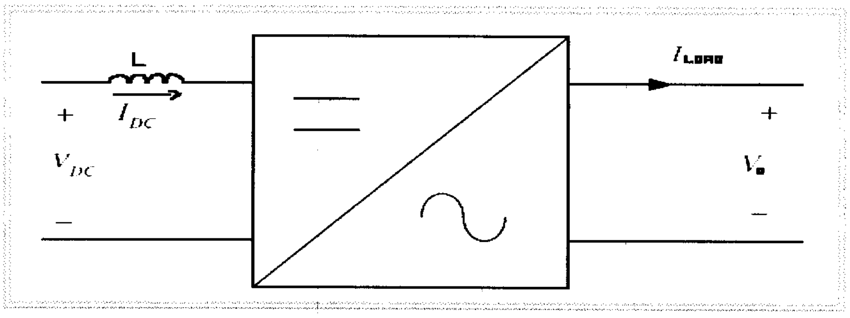


Figure 2.3.2: Current Source Inverter

2.4 Stand-Alone Inverters

Stand-alone, or battery supplied, inverters are demand driven which is they provide any power or current up to the rating of the inverter and assuming that there is enough energy in the battery. These inverters are being used increasingly to operate household appliances and other "normal" 230 V equipment. The question as to the maximum size for which a single central inverter for all electrical devices is still the best solution, is a matter of philosophy. The central inverter must be in operation all the time. In this case, it is important that the inverter itself has a very low internal consumption. Different types of inverter produce different AC waveforms and are suitable for different situations. In this PSM project, the output waveform that should be got is square wave output. There are three types of inverter that produce different AC waveforms.

2.4.1 Square Wave Inverters

The square wave inverter derives its name from the shape of the output waveform. Square wave inverters were the original "electronic" inverter. The first versions use a mechanical vibrator type switch to break up the low voltage DC into pulses. These pulses are then applied to a transformer where they are stepped up. With the advent of semiconductor switches the mechanical vibrator was replaced with "solid state" transistor switches. Nowadays, the most common circuit topology,