Design and Implementation of Three Phase Power Converter using PIC18F452

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ABSTRACT
This paper presents the design and implementation of a three-phase inverter that produces a symmetric ac output voltage of desired magnitude and frequency. Although the inverter has traditionally been designed as analog circuitry, now the digital inverters are preferred. These devices use low-cost microcontrollers and digital signal processors and offer sophisticated control algorithms with highly flexible software, the ability to add user interface, reduce components, and introduce testing procedures with increase reliability. The PIC18FXX2 of Microchip is used for the implementation of inverter.

Keywords
Three-phase inverter, SPWM, PIC microchip

1. INTRODUCTION
The lots of advances in semiconductor technology, power electronics devices with high power handling capabilities are commercially available and inexpensive. Power electronics are playing an important role in today's technology; they have an increasing number of applications in the industrial and domestic areas. The major function of power electronics is to control the flow of power by shaping the supplied power from the source. Power electronics also introduces distortion of the output waveform and injects harmonics into the supplier system; using appropriate filter circuits can reduce these harmonics. PWM control is the most powerful technique that offers a simple method for controlling of analog systems with the processor's digital output. Control methods, which generate the necessary pulse width modulation (PWM) patterns, have been discussed extensively in literature. These could be classified as voltage con- trolled and current controlled PWM. All these methods aim at generating a sinusoidal inverter output voltage without low-order harmonics. With the availability of low cost high performance microchips characterized by the execution of most instructions in one instruction cycle, complicated control algorithms can be executed with fast speed, making very high sampling rate possible for digitally-controlled inverters.

It is possible to supply a three-phase load by using three separate single-phase inverters, if each inverter produces an output displaced by 120° of fundamental frequency with respect to each other. The function of inverter is to change a dc voltage to ac voltage by operating the active device in switch mode. Switch mode of operation of devices, only three values of voltage can be delivered to the output positive, negative and zero. But the desired output is a continuous wave commonly a sinusoidal. Pulse width modulation (PWM)solves the problem of generating a real value range of (+U, -U) for the output from three discrete values of +U, -U, and zero.

2. HARDWARE FEATURES
The complete hardware divided into three main parts
Microchip, which is used for generation of triggering pulse for the IGBTs
Gate driver circuit
Three-phase inverter

2.1 MICROCHIP
Although the inverter has traditionally been designed as analog circuitry, now the digital inverters are preferred. These devices use low-cost microcontrollers and digital signal processors and offer sophisticated control algorithms with highly flexible software, the ability to add user interface, reduce components, and introduce testing procedures with increase reliability.

The microchip PIC18FXX2 family is used for digital generation of control signal for driver circuit. The PIC18FXX2 controller includes program memory of 32K words (16-bit) of Program Flash and PIC18FX52 devices can store up to 16K of single word instructions. On chip RAM of 1.5K bytes and data EEPROM of 256 bytes. 18 interrupt sources are present, five input-output port are present namely A, B, C, D and E. the two PWM modules are present. Parallel Slave Port (PSP) is available for parallel communication. Analogy feature are Compatible10-bitAnalog-to-DigitalConverter module (A/D) with Fast sampling rate and Conversion available during SLEEP. The PIC18FXX2 has a 16-bits wide instructions and this allows operations up to 10MIPS (Mega Instructions per Second) @ 40MHz. all the analog circuitry has been replaced by a digital modulation scheme.

2.2 INVERTER
The function of inverter is to change the input DC voltage to a symmetrical voltage with controllable magnitude and frequency. The dc input of the inverter is obtained from the battery. The three-phase inverter has six switches in the circuit with three arms. Each arm of bridge has two switches. Each switch of the inverter is control by the small signal. Switches in the same leg are not turn ON at the same time to prevent short circuit in that leg. Blanking time must be added to make sure that there are no two switches in the same leg turning on at the same time. The three-phase inverter has an input of 72 volt dc and consists of six Insulated gate bipolar transistors (IGBTs). Higher switching frequency capability than

competitive IGBTs. Highest efficiency available and minimized recovery characteristics require less/no snubbing.

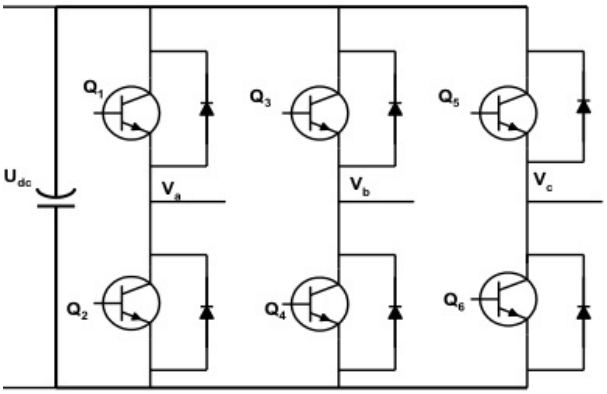


Figure 1. Schematic diagram of three-phase inverter

2.3 DRIVER CIRCUITRY

The function of gate driver circuit is to turn ON and OFF the switch in the inverter and vice-versa. The power rating of the drivers vary depending on the type of switches being used. There is another function that driver circuit also creates the blanking time for switches in same leg. The voltage and current level of the microchip output signal fails to operate the IGBTs. IGBT driver circuit amplifies the microchip output signal to the required level for triggering the IGBTs and isolates the microchip from the power circuit. TLP250 ICs are commonly used for drivers' circuit for IGBTs. This gate driver circuit also has built in overcurrent protection. It senses the current from IGBTs drain and determines the whether the inverter handling too much current or not. An opto-isolator, also called an optocoupler, photocoupler, or optical isolator, is an electronic device designed to transfer electrical signals by utilizing light waves to provide coupling with electrical isolation between its input and output. The main purpose of an opto-isolator is "to prevent high voltages or rapidly changing voltages on one side of the circuit from damaging components or distorting transmissions on the other side.

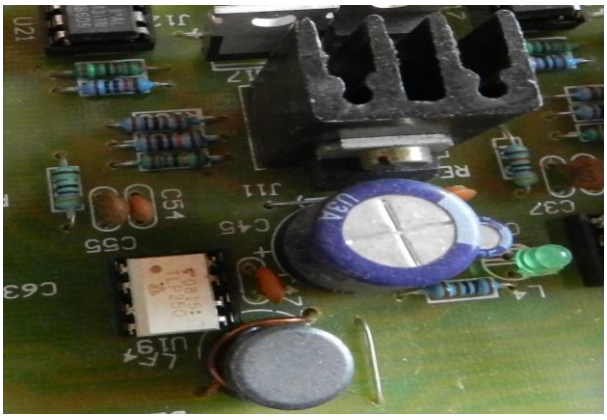
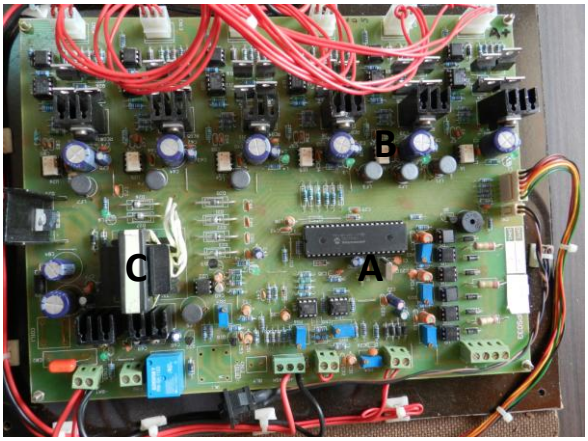
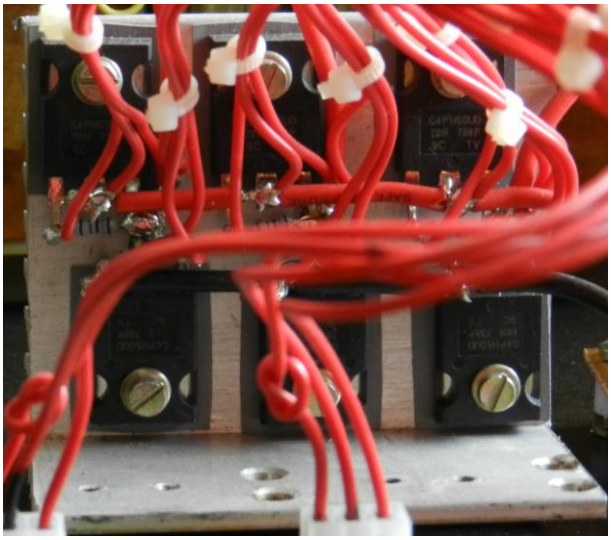


Figure 2. Practically implementation of Gate driver circuit

3. EXPRIMENTAL



(i)



(ii)

Figure 3. Experimental setup for Three-phase inverter (i) control circuit (ii) Power circuit.

The figure 3 (i) shows the control circuit where (A) shows the microchip, which gives the digital signal for the gate driver circuit. The output waveform of microchip shown in the figure (4). The power supply for microchip fed for the output for the transformer connected at the output side of bridge. The gate driver circuit indicates by B. The SMPS indicated by C, the 5 V and 12V power supply from the SMPS. The figure 3 (ii) represents the power circuit where six IGBTs switches are connected. The output from the driver's circuit with current amplification gives to IGBTs. The bridge output is of 35 volts the voltage fed to step up-transformer. The transformer secondary side voltage is 230 Volts. There are three such single phase transformer connected that gives the line to line three phase 440 Volt power. The transformer taps 0-230 Volts and 0-10 Volts. The 0-10 Volts power fed back to microchip circuit through the switch we can vary the output voltage.

Figure 4. Output signal from Microchip.

4. CONCLUSION

The paper presents the implementation of a digitally controlled three-phase inverter using microchip PIC18F452. PWM inverter develops more theoretical and practical knowledge on digital controlled inverter and their applications. The inverter unit consists of six discrete IGBTs connected as a bridge and power driver with a low cost driver.

5. REFERENCES

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