DESIGN AND IMPLEMENTATION OF SINGLE PHASE CONTROLLED RECTIFIER USING PIC MICROCONTROLLER

M.SARAVANAN
UG scholars, Department of Electrical and Electronics Engineering
Rajalakshmi Engineering College, Chennai, Tamil Nadu, India
[1]saravananrec2505@gmail.com

A.M.ABDUL AYAS MOHAMMAD
UG scholars, Department of Electrical and Electronics Engineering
Rajalakshmi Engineering College, ,Chennai,Tamil Nadu,India
[2]babuayas95@gmail.com

T.RAJI
UG scholars, Department of Electrical and Electronics Engineering
Rajalakshmi Engineering College, Chennai, Tamil Nadu ,India
[3]rajirec93@gmail.com

B.LEKSHMI SREE
Assitant professor, Department of Electrical and Electronics Engineering
Rajalakshmi Engineering College, Chennai,Tamil Nadu,India

***Abstract*--This paper describes the working model of controlled Rectifier. The proposed design helps enhancing the control of DC Load that is installed in industries. It is based on the fully-controlled MOSFET based rectifier circuit. It is implemented using a Xilinx Spartan 3E PIC unit; this methodology reduces harmonics in voltage and current but also reduces losses that occur due to high switching frequencies in conventional pulse-width modulation (PWM) based drives. This proposed design may be extended to single phase or three-phase AC-DC converter.**

Key words –controlled rectifier , MOSFET, Pulse width modulation.

I. INTRODUCTION

Controlled rectifiers are line commutated ac to dc power converters which are used to convert a fixed voltage, fixed frequency ac power supply into variable dc output voltage.

The input supply fed to a controlled rectifier is ac supply at a fixed rms voltage and at a fixed frequency. We can obtain variable dc output voltage by using controlled rectifiers. By employing phase controlled thyristors in the controlled rectifier circuits we can obtain variable dc output voltage and variable dc (average) output current by varying the trigger angle (phase angle) at which the thyristors are triggered. We obtain a uni-directional and pulsating load current waveform, which has a specific average value.

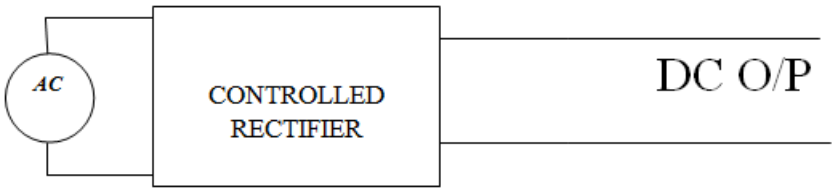


Fig 1:Type of input: Fixed voltage, fixed frequency ac power supply. Type of output: Variable dc output voltage

The thyristors are forward biased during the positive half cycle of input supply and can be turned ON by applying suitable gate trigger pulses at the thyristor gate leads. The thyristor current and the load current begin to flow once the thyristors are triggered (turned ON) say at $\omega t = \alpha$. The load current flows when the thyristors conduct from $\omega t = \alpha$ to β .

The output voltage across the load follows the input supply voltage through the conducting thyristor. At $\omega t = \beta$, when the load current falls to zero, the thyristors turn off due to AC line (natural) commutation.

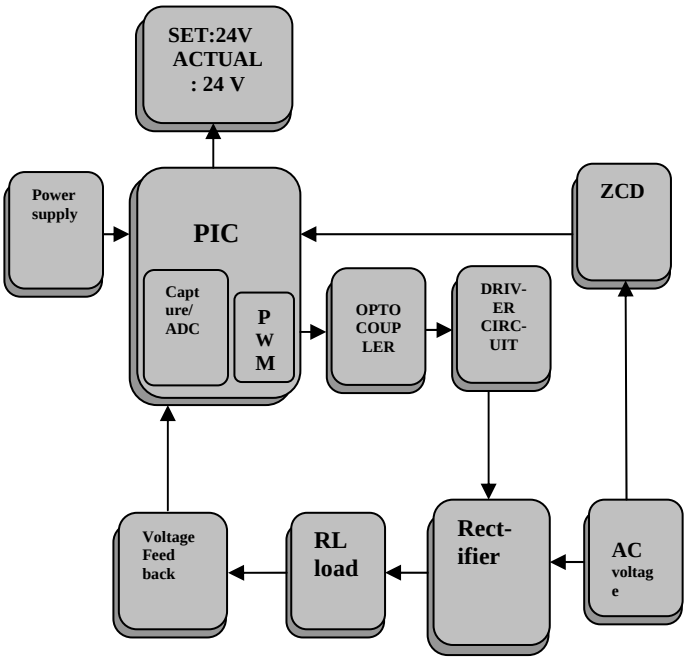
In some bridge controlled rectifier circuits the conducting thyristor turns off, when the other thyristor is (other group of thyristors are) turned ON.

The thyristor remains reverse biased during the negative half cycle of input supply. The type of commutation used in controlled rectifier circuits is referred to AC line commutation or Natural commutation or AC phase commutation.When the input ac supply voltage reverses and becomes negative during the negative half cycle, the thyristor becomes reverse biased and hence turns off. There are several types of power converters which use ac line commutation. These arereferred to as line commutated converters.

Different types of line commutated converters are:

- Phase controlled rectifiers which are AC to DC converters.
- AC to AC converters
- AC voltage controllers, which convert input ac voltage into variable ac output voltage at the same frequency.
- Cyclo converters, which give low output frequencies

II. BLOCK DIAGRAM:



The system consists of AC- DC converter, power driver, Power supply, Zero Crossing Detector and Microcontroller. The power stage performs the basic power conversion from the input voltage to the output voltage and includes switches and the output filter. The converter developed to Maintained voltage. Microcontroller is programmed to generate PWM. Switching pulse give to converter, it is generated from PWM Controller. AC supply is applied to converter circuit from Step down Transformer. The PWM pulses are given to input of optocoupler. Optocoupler is used to isolate between control circuit and driver circuit. Optocoupler output signal is inverted from original PWM input signal. Optocoupler output is given to driver circuit through NOT gate (NOT gate output signals same as the original input signal) The converter maintained as set voltage and display on LCD.

A. OPTOCOUPLER

The 6N137 optocoupler is designed for use in high-speed digital interfacing applications that require high-voltage isolation between the input and output. Applications include line receivers, microporcessors or computer interface, digital programming of floating power supplies, motors and other control systems.

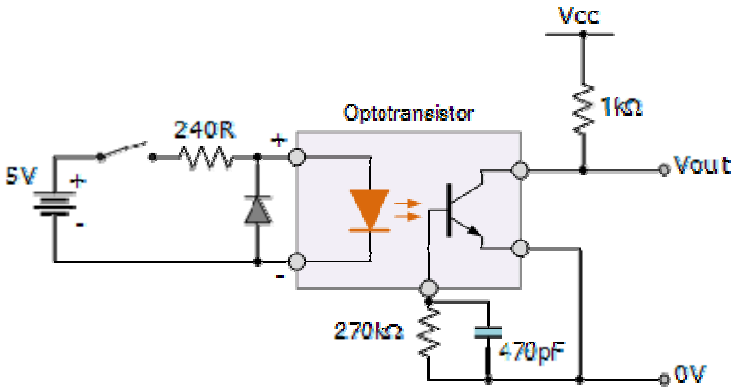


fig: optocoupler circuit

In electronics, an opto-isolator, also called an ***optocoupler***, photocopier or optical isolator, is a component that transfers electrical signals between two isolated circuits by using light. Opto-isolators prevent high voltages from affecting the system receiving the signal.

B. DRIVER CIRCUIT

In electronics, a **driver** is an electrical **circuit** or other electronic component used to control another **circuit** or component, such as a high-power transistor, liquid crystal display (LCD), and numerous others.In many applications, floating circuit is required to drive high side MOSFET. In H bridge used in pure sine wave inverter design 2 MOSFET are used ashigh side MOSFET and 2 MOSFET are usesd as low side MOSFET. International rectifiers IR2110 MOSFET driver can be used as high side and low side MOSFET driver. It have a floating circuit to handle to boostrap operation. IR2210 can with stand voltage upto 500v (offset voltage). Its output pins can provide peak current upto 2 ampere. It can also be used to as IGBT driver. IR2210 floating circuit can drive high side MOSFET upto 500 volt.

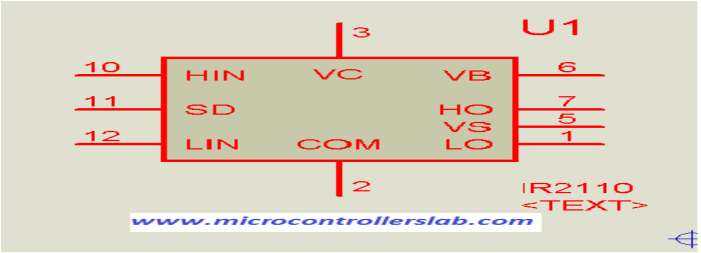
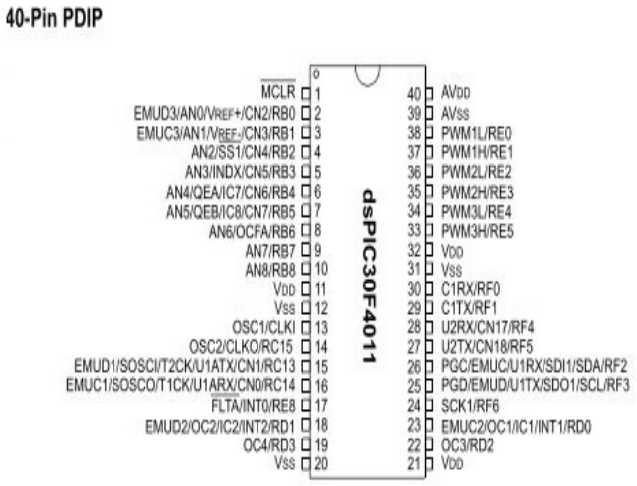


Fig :pin diagram (IR2110)

C. DSPIC 30f4011/4012

This document contains device specific information forthe dsPIC30F4011/4012 device. The dsPIC30Fdevices contain extensive Digital Signal Processor (DSP) functionality within a high performance 16-bitmicrocontroller (MCU) architecture.



III. SIMULATION

This paper simulated the single phase controlled rectifier using PIC microcontroller using MATLAB software.The various input and voltage waveforms are measured by using voltage an d current measurement blocks respectively.The output is viewed viewed from this measurement blocks by giving it to the scope terminal block.The MOSFET is triggered by pulse generator.

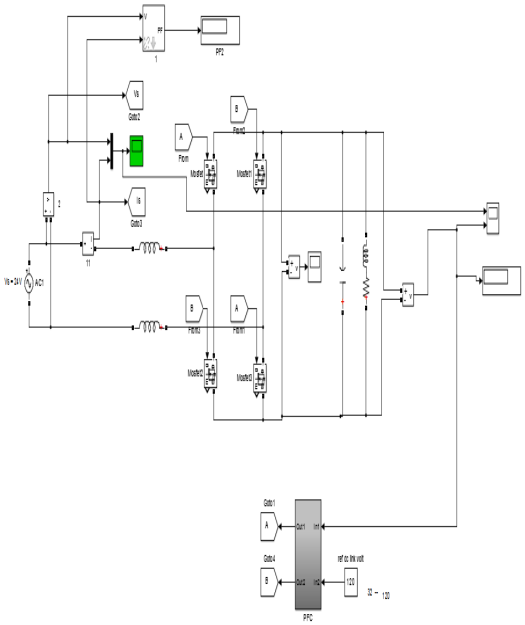


Fig: simulink model

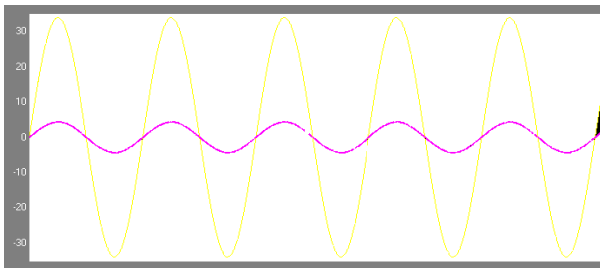


Fig: output waveform across load

IV. CONCLUSION

The proposed design helps enhancing the control of DC Load that is installed in industries. It is based on the fully-controlled MOSFET based rectifier circuit.This methodology reduces harmonics in voltage and current but also reduces losses that occur due to high switching frequencies in conventional pulse-width modulation (PWM) based drives. This proposed design may be extended to single phase or three-phase AC-DC converter.This design is mostly used in industries to control DC load.

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