DESIGN OF SINGLE PHASE DUAL CONVERTER

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ABSTRACT
A single phase dual converter mainly consists of two single phase converters which uses thyristors for four quadrant operation of dc shunt motor. In this project, instead of thyristors we are using IGBT power electronic devices for achieving four quadrant operation in non-circulating mode of operation. Converter 1 and converter 2 will be rectifying from 0° to 90° and will be inverting from 90° to 180º.These types of drives are mainly used when load changes are slight, however in certain applications e.g., rolling mill drives or machine tools, cutting tools etc.

KEYWORDS: DC motor drive, IGBT,Bridge rectifier, Dual Converter

INTRODUCTION

Now a day's, mainly using the single phase dual converter in DC drives operation for obtaining four quadrant operation. For effective control on speed direction of DC drives and AC-DC conversion, a dual converter is used which is simple in construction and controllable. DC motors have high starting torque which is required for traction application. In a DC motor control over the large speed range can be achieved easily. There are many methods of speed control of separately excited DCmotors such as armature voltage control, armature resistance control and field control.To obtain control on the speed of DC drives, armature voltage control method is widely used. By using advanced power electronic devices such as thyristor, MOSFET, IGBT, BJT, diode etc. we have control over the speed.

Modes of Operations:

Basically, there are two modes of operation of single phase dual converter that are as

1. Circulating mode
2. Non-circulating mode

1. Circulating mode:

In this mode of operation, at the same time both the converters are in ON condition. Hence, currentwhich is circulating in nature is present. The condition for the firing angles is given as $\alpha1+ \alpha2 = 180º$. Where α1 is the firing angle of converter 1 and α2 is the fring angle of converter 2. In this mode of operation, rectification operation of converter 1 will be occurswhen firing angle is $0º<\alpha1<90º$ and inversion operation of converter 2 will be occurs when firing angle is $90º<\alpha2<180º$. In this condition, Vdc and Idc both are

positive. Converter 1 operation is as a inverter when firing angle be $90^o<\alpha1<180^o$ and converter 2 operation is as a controlled rectifier when firing angle be $0^o<\alpha2<90^o$.

2.Non-circulating mode:

In non-circulating mode of operation of dual converter, there is complete inhibition of circulating current. In this mode, only one converter operates at a time and other converter will be in blocking state. The other converter is not permanently blocked. To operate converter 1 in rectifier mode and quadrant I, firing pulses are given as $0^o<\alpha1<90^o$ to the particular IGBT's and the pulses of the converter 2 are blocked. In this case both Vdc and Idc are positive.And hence forward motoring operation will be performed. When converter 2 is in ON, other converter is in blocked condition. In this situation, both Vdc and Idc are negative and converter 2 operates in III quadrant and reverse motoring operation will be performed. When firing angle is greater than 90^o upto 180^o, regenerative braking operation will be performed in quadrant II and IV and power is fed back to the supply which is negative because of reversal of current from armature to supply.

COMPONENTS

DC Motor Drive

A DC shunt motor is used for the application of speed control and four quadrant operation of DC motor drive. The advantage of DC shunt motor over the DC series motor is that it is able to maintain a constant speed regardless of load on the motor.A DC shunt motor consists of armature winding and field winding connected in parallel.

IGBT

IGBT (Insulated Gate Bipolar Transistor) is power electronic device with high input impedance and having large current carrying capability. IGBT exhibit characteristics of MOSFET and BJT.IGBT having three terminals such as gate,collector and emitter. Pulses are given to the gate terminal with the help of gate driver IC IR2110 and the delay of2 msec is provided by using microcontroller.The features of the IGBT are, it have positive temperature coefficient and extremely enhanced avalanche capability.

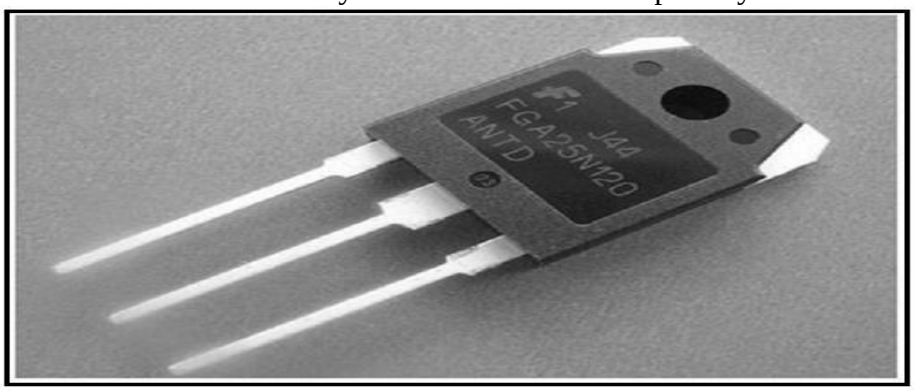


Photo no.1. IGBT

BRIDGE RECTIFIER

AC to DC conversion is possible by using silicon bridge rectifier. It may be full bridge rectifier or half bridge rectifier. Bridge rectifier includes four diodes which are connected in bridge and its arrangement is shown in the photo.2.

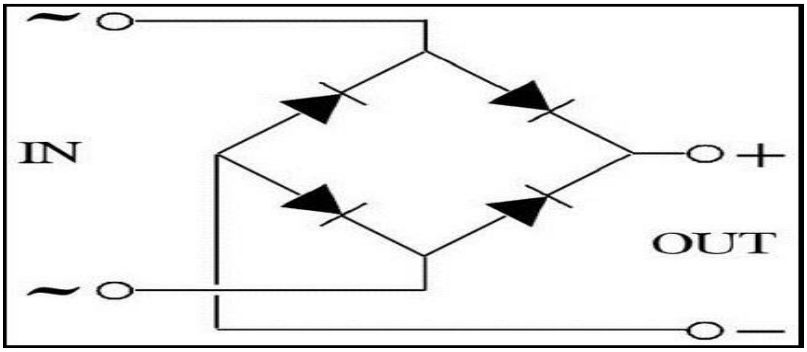


Figure no.2. Bridge Rectifier

DUAL CONVERTER

Dual converter consists of two converters i.e. converter 1 and converter 2. The ideal dual converter is shown in fig3. Converter 1 and converter 2 includes four IGBT's which are triggered with the help of gate driver IC IR2110. The microcontroller Atmega398 have control over the IGBT's triggering and delay time ensures reliable communication of IGBT's in both the converters. The output voltage of the converter 1 is given by the formulae,

$$V1 = \left(\frac{2Vm}{\Pi}\right) * Cos\alpha 1$$

As the converter 2 is connected anti-parallel the converter 1 i.e. V1= - V2. The output voltage of converter 2 is given by formulae,

$$V2 = -\left(\frac{2Vm}{\Pi}\right) * Cos\alpha 2$$

WORKING

An AC supply of 1-phase, 230volt, 50Hz is given to both converter 1 and converter 2 as shown in the block diagram. A supply is given to the step down transformer through the fuse. The supply voltage 230 volt is stepped down to 12 volt with the help of step down transformer. The obtained 12 V is an AC voltage, which is converted to DC by using bridge rectifier which may be full bridge rectifier or half bridge rectifier. The output voltage obtained from bridge rectifier is pure DC. From the bridge rectifier, 12V supply is given to opto coupler and 12V voltage of bridge rectifier is adjusted to 5V by using voltage regulator.

The 5V voltage is required to operate the microcontroller IC Atmega 398.To generate the operating frequency of microcontroller, a crystal oscillator is used. Microcontroller IC has four input-output ports such as P1, P2, P3 and P4. By using these ports we can do programming for delay time of IGBT's and various instructions. The LCD display is interfaced with the microcontroller. The zero crossing of the voltage waveform is detected by zero crossing detector (ZCD) and by the adjustment of POT, firing angle is regulated with the help of gate driver IC IR2110.Theopto-coupler IC is used for isolation of the electrical circuits. The output of the both the converters is regulated by using capacitive filters and the harmonics which are generated at the output voltage is reduced using mica capacitor.The output DC voltage is given to the motor terminals.

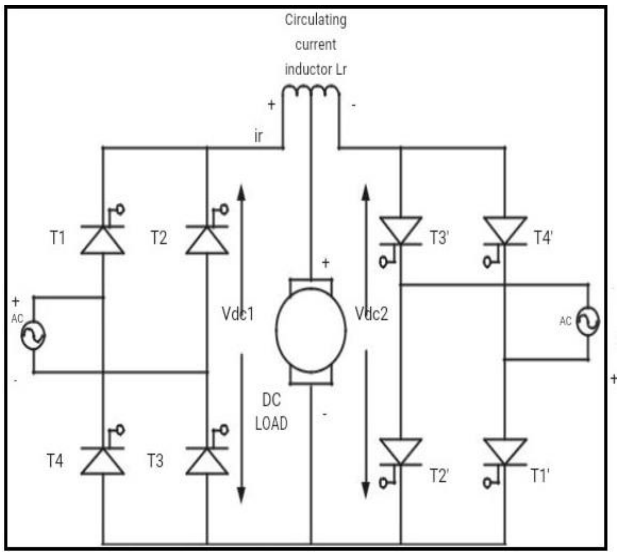


Figure no,4.Block diagram of dual converter

RESULT

Modes of operation

1. Forward Motoring(I Quadrant)

Sr.no.	Voltage(volt)	Firing angle	Speed(rpm)
1	115	56	510

2. Regenerative Braking(IV Quadrant)

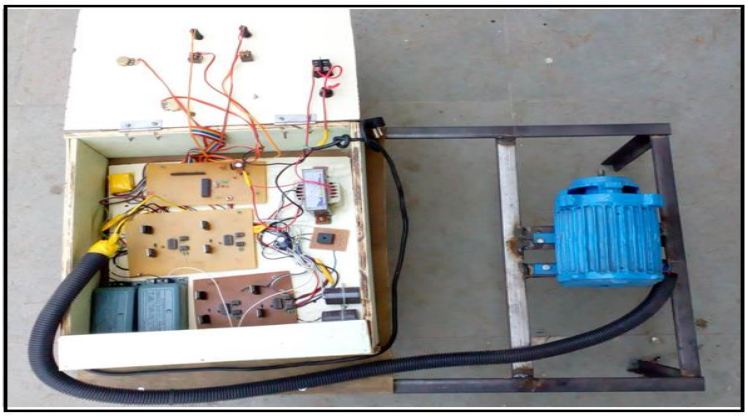
Sr.no	Voltage(volt)	Firing angle	Speed(rpm)
1.	-112	122	0

3. Reverse Motoring (III Quadrant)

Sr.no.	Voltage(volt)	Firing angle	Speed(rpm)
1	172	33	760

4. Regenerative Braking (II Quadrant)

Sr.no.	Voltage(volt)	Firing angle	Speed(rpm)
1	-169	144	0



Photono.2. Design of dual converter

CONCLUSION

This project explains the four quadrant operation of dc shunt motor i.e.

Forward motoring - I quadrant ($0^o<\alpha1<90^o$)
Reverse motoring - II quadrant ($0^o<\alpha1<90^o$)
Regenerative braking - III and IV quadrant ($90^o<\alpha1<180^o$)

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