

A THYRISTOR BASED SPEED CONTROL OF DC MOTOR USING DUAL CONVERTER

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Abstract

Speed controller of DC motor using thyristor dual converter project is to implement a micro controller-based application for controlling speed DC motor using dual converter. Dual converter is a power electronics control system is to get either polarity DC from AC rectification by forward converter and reverse converter. Main use of dual converter is to change the direction of motor. Dual converter works on single firing unit and firing pulses, this unit is diverted by converter using a thyristor which is also called Master controller

Keywords: Dual converter, sensor

1. INTRODUCTION

The modern era of power electronics and drives began in 1958 when the general electrical component introduced a commercial thyristor just after 2 years, it was invented by Bell Telephone Laboratory. Soon all the industrial applications that were based on mercury – arc rectifier and power magnetic amplifiers were replaced by silicon – controlled rectifier (SCRs). Later, after introducing commercial SCRs, significant improvements came in semiconductors by physical and fabrication technology. Nowadays state of art speed control techniques of DC motor is available. Thyristor based DC drives with analog and digital feedback control schemes are used. Phase locked loop control technique is also used for precise speed control and zero speed regulation. In past, many researchers presented various new converter topologies of DC motor control for different applications of industry [1-4].

We use many electrical and electronic components while designing electronics projects and general circuits. DC motor have their inherent disadvantages that it needs regular maintenance and it is bulky in size, so it is very difficult to replace them[5]. These basic components include resistors, transistors, capacitors, diodes, inductors, LEDs, thyristors or silicon-controlled rectifier. Thyristor is a multi-layered semiconductor device and is similar to the transistor.

2. EXPERIMENTS

SOFTWARE REQUIREMENTS: • Keil compiler

- Keil ARM company makes C compilers, macro assemblers, real time kernels, debuggers, simulators, integrated environments, evaluation boards and emulators for ARM7/ARM9/Cortex-M3, XC16X/C16X/ST10,25/ and 8051 MCU families.
- Languages: Embedded C or assembly.

2.1. DUAL CONVERTER

In a dual converter two converters are connected together back-to-back. One of the bridges works as a rectifier (converts AC to DC) another half bridge works as an inverter (converts DC to AC) and it is connected commonly to a DC load is shown in fig. 1. The dual converter can provide four quadrant operations.

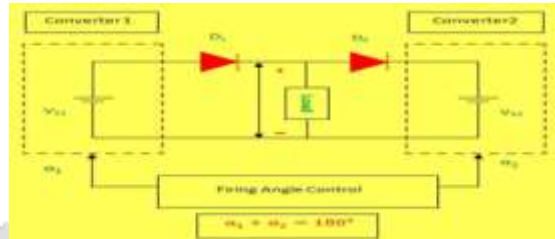


Fig.1 Dual converter

2.2. SINGLE PHASE DUAL CONVERTER:

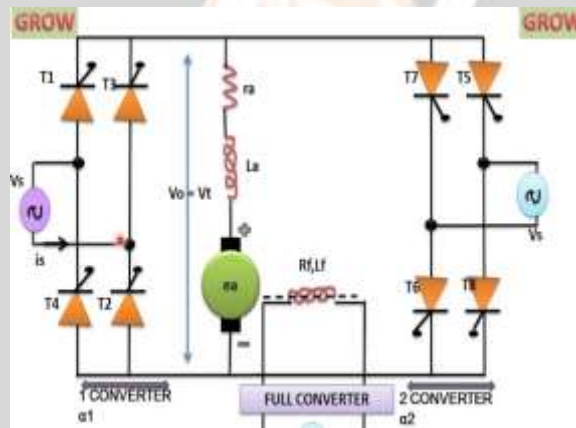


Fig. 2 single phase dual converter

The source of this type of conductor be single phase supply is shown in Fig.2. consider the converter is in non-circulating mode of operation. The input is given to the converter which converts the a.c to d.c by the method of rectification. The rectifier dc fed to the filter that removes pulses from rectified dc and converts it to a pure d.c by applying by filtering. Now it is given to inverter circuit that converts d.c to a.c and finally this a.c is taken as output. Optimum response is achieved when the output follows the input after one period with no overshoot at any operating point in continuous or discontinuous current conduction [6].

2.3. THREE PHASE DUAL CONVERTER:

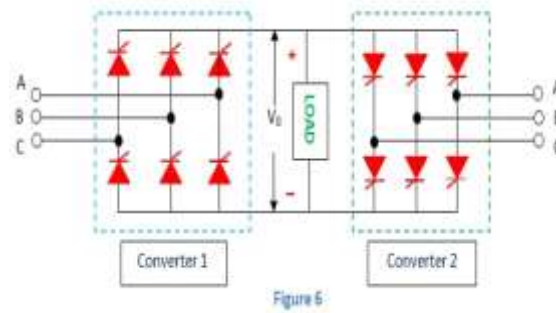


Fig.3.Three phase dual converter

In three phase dual converter make use of three phase rectifier which converts three phase ac supply to dc supply is shown in Fig.3. The structure of the converter is same as single phase dual converters same as in the single-phase converter. The output of three phase rectifier fed to filter and after filtering the power from the load. At last, the supply from the load is given to last bridge that is inverter. It does the invert process of rectifier converts dc into 3 phase ac which appears as output.

2.4. SEMI CONDUCTOR CONTROLLED RECTIFIER

SCR is made up of either silicon or germanium. SCR is the basic component in power electronics circuit is shown in Fig.4. By knowing the operation of SCR, it is easy to learn power electronics. Initially circuits are developed by using SCR.

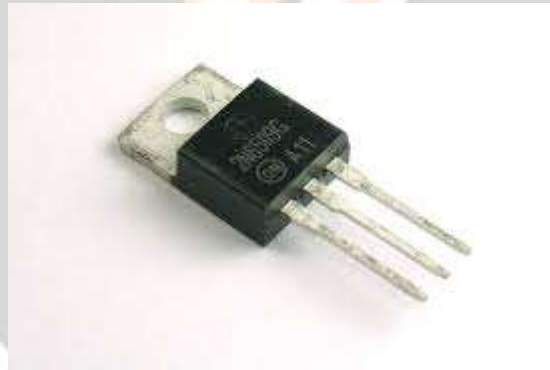


Fig.4 Silicon controlled Rectifier

A semiconductor-controlled rectifier is a four-layer solid-state current controlling device. SCRs are unidirectional devices. (i.e., can conduct current only in one direction) as opposed to TRIACs which are bidirectional (i.e., charge carriers can flow through them in either direction). SCR allows the control of current using a small current. To turn off the flow of current from the cathode to drain, simply removing the current from the gate won't do it.

2.5. THYRISTOR:

A thyristor is a solid-state semiconductor device with four layers of alternating P and N type materials is shown in Fig.5. The system employs the use of thyristor, which is controlled using the software implemented on the microcomputer. [10]

Krishnan Thyristor acts as bistable switch...It conducts when the gate receives a current trigger and continues to conduct until the voltage across the device is reversed biased. Thyristors are used to control alternating currents. A Thyristor turns ON by the application of positive gate current and turns OFF when the anode voltage drops to zero.



Fig.5 Thyristor

2.6. ARDUINONANO



Fig.6 Arduino Nano

Arduino Nano is used to produce a clock of precise frequency using constant voltage is shown in Fig.6. It doesn't come with DC power jack. So cannot supply external power source through a battery. Digital I/O pins is 22(6 of which are PWM). Microcontroller power consumption in AT mega 328 is 19 mA. They are acted as input pins when they are interfaced with sensors, but if you are driving some load then use them as output.

2.7. POTENTIOMETER

Potentiometer is used to find accurate resistance, potential difference and current. Potentiometer control electrical devices such as volume controls on audio equipment. It is calculated as V/L , where V is the potential difference between two points. Many applications of a potentiometer, from audio controller circuit to measuring distance angle or voltages. It is versatile in nature.

2.8. CRYSTALOSCILLATOR

A crystal oscillator is an electronic oscillator circuit that uses mechanical resonance of vibrating crystal of piezoelectric material to create an electrical signal with a constant frequency. The working principal of crystal oscillator is piezoelectricity and resonance crystal oscillator are compact and inexpensive. It works on the principle of inverse piezoelectric effect.

3. RESULT AND DISCUSSION

Three Phase dual converter for four quadrant operation of DC motor

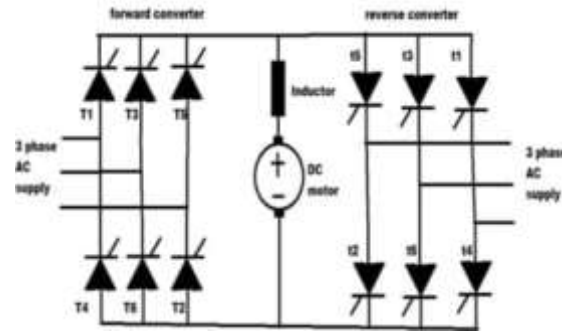


Fig.7 Dual converter for four quadrant operation of dc motor

Dual converter is the combination of two antiparallel full converters with same load. Each converter has six thyristors (SCR) is shown in Fig.7. From (fig 8) the speed Vs characteristics graph, The Dual converter can control separately excited dc shunt motor in either direction or mode i.e., generating and motoring. So, the motor can operate in all the four quadrants in forward motoring forward generating and reverse motoring and reverse generating. The power to the DC motors supplied through dual converter. The dual converter has one is circulating current mode and the other is without circulating current mode both converts and conducting at same time there is a circulating current mode and circulating current level is limited by inductor. We can use one converter at any instant but there is a small delay when switching from one converter to another.



Fig. 8 Speed Torque Characteristics

Motor can deliver maximum torque below its base speed and maximum power above its base speed. To control dc motor speed armature voltage is varied with field voltage. If the armature voltage is more than the field voltage speed will be more and if the armature voltage is less than the field voltage speed voltage will be less. The inductor is used in the series with motor to reduce impact of notches on line voltage. For obtaining the operation of dc drive in four quadrant operation mainly two types of converter are used [7][8]. Dual converter consists of two converters one is positive converter and other is negative converter. When the positive converter conduct motor operates in forward direction i.e., forward motoring (1st QUADRANT) when the negative converter conducting motor operate in reverse direction. I. e, reverse motoring (3rd quadrant) is shown in Fig.8. There are three control loops: one for armature current control, one for adjusting the firing angle of the oncoming converter, and for speed control. [9].

4. CONCLUSION

After collecting the required data for the project, is carried was observed that previous scheme consumes less power but provides less torque thus not applicable in industries. It can run a DC motors in either direction with speed

control too. The use of SPMC in the design of dual converter that has full controllability in both forward and reverses direction has been analyzed.

Following points are also under taken:

Under operating condition drive run successfully. Microcontroller based design is done successfully. Interfacing drive with computer.

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