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CLOSED LOOP FOUR QUADRANT OPERATION OF SIX PULSE DUAL CONVERTER FED DC MOTOR DRIVE WITH CIRCULATING CURRENT

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ABSTRACT: The dual converter with circulating current mode has been proposed to meet the high-power requirement of the four-quadrant dc power supplies. A four quadrant closed-loop speed controlled dc motor drive fed from the proposed dual converter is designed, constructed, and tested. The experimental results obtained are shown to be in good agreement with theory. The proposed control scheme can solve the problems of zero crossing miss by experimental test.

Keywords— DC motor drives, Microcontroller, Speed control, Temperature control

1. INTRODUCTION

Thyristor based three-phase dual converter is widely used in the industry for controlling dc motor drives. Controlled rectifiers offering power conversion from ac to dc are reliable and have higher lifetime compared to other converters. DC motors have higher torque than ac motors and hence are suitable for variable speed and speed reversing applications. The dual converter is employed for bidirectional current flow. So we can control the speed in both directions. In the power supply configuration, inter converter inductors are used to limit the circulating current. Main use of dual converter is to easily change the direction of the motor and handle braking system of the motor. It gives a full range control of the firing angle between 0Â° and 180Â° for both positive and negative current control. Although the operation of controlled rectifier is simple, the realization of the converter control circuit is complex in nature. The control circuit needs the basic functionalities like (i) Six state pulse generation and gate drive isolation, (ii) Synchronization of the control pulse to the power frequency, (iii) Smooth transition in phase angle control, (iv) Startup control.

2. THE CONTROLLED RECTIFIER

The dual-converter is designed with silicon-controlled-rectifier (SCR) modules. Here two converters are connected in anti parallel. The P converter gives positive output voltage Vs, whereas, the N converter gives negative output voltage. The structure of the dual converter is shown in Fig.1. Three phase mains are connected to the ac inputs A,B and C for phase-A, phase-B and phase-C respectively.

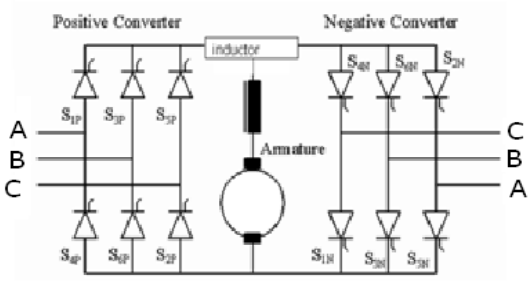


Fig.1 Thyristor based dual converter structure

The firing angle of individual converter is controlled such that each produce the same dc terminal voltage with same polarity. If firing angle of one converter is 60 degree then firing angle of other converter is maintained at 120 degree. Thus for this firing angle one converter operates as rectifier and produce mean voltage at dc terminal and other operates as inverter and produce mean counter voltage. When operating in qua 1 ,rectifier A will be in the rectifying ($0<\alpha1<90$) region and B in inverting($90< \alpha2 <180$)region.

2.1 Voltage waveform of dual converter.

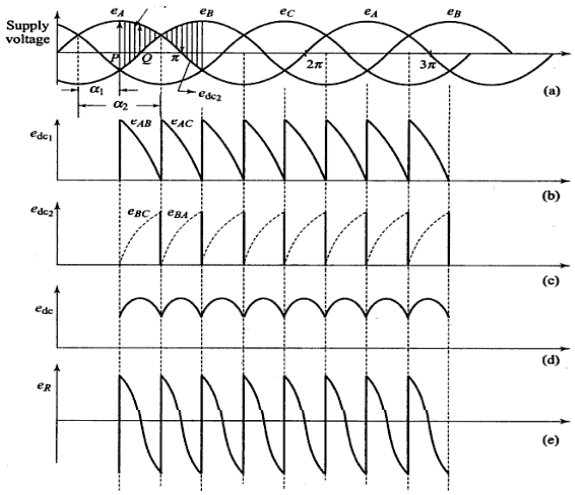


Fig 2 Voltage wave form of dual converter

2.2 Current waveform of dual converter.

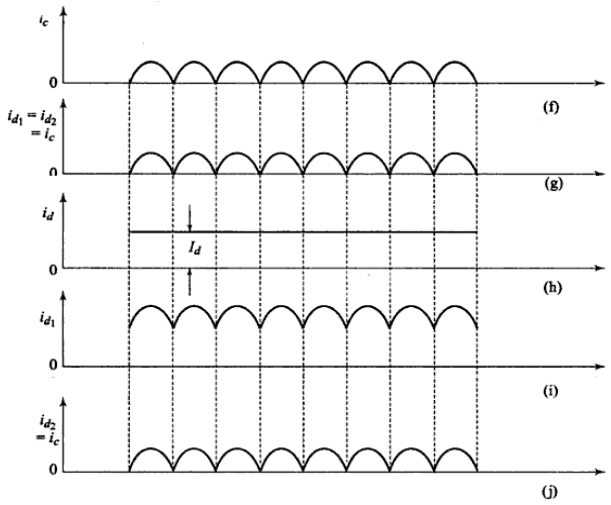


Fig 3 Current wave form of dual converter

2.3 Schematic diagram of dual converter

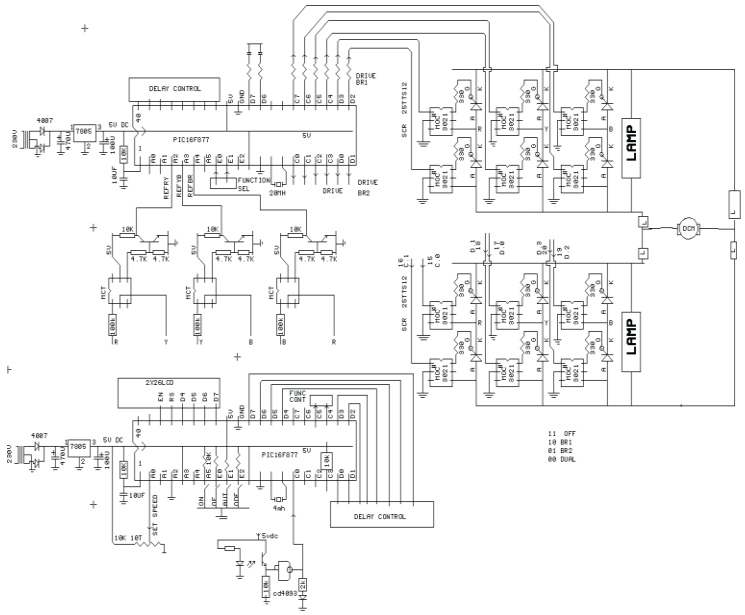
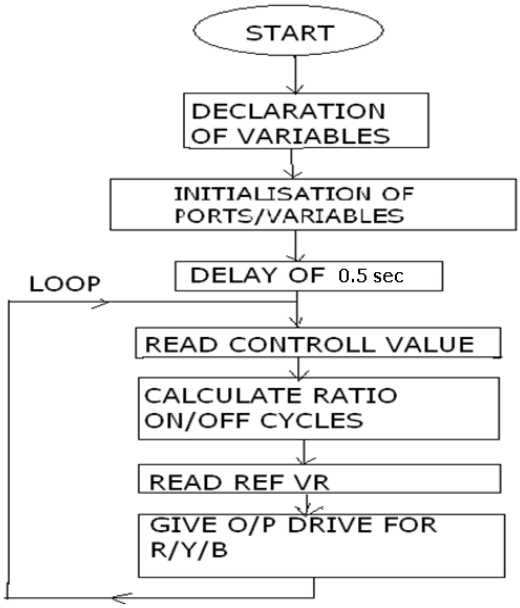


Fig 4 Schematic diagram of dual converter

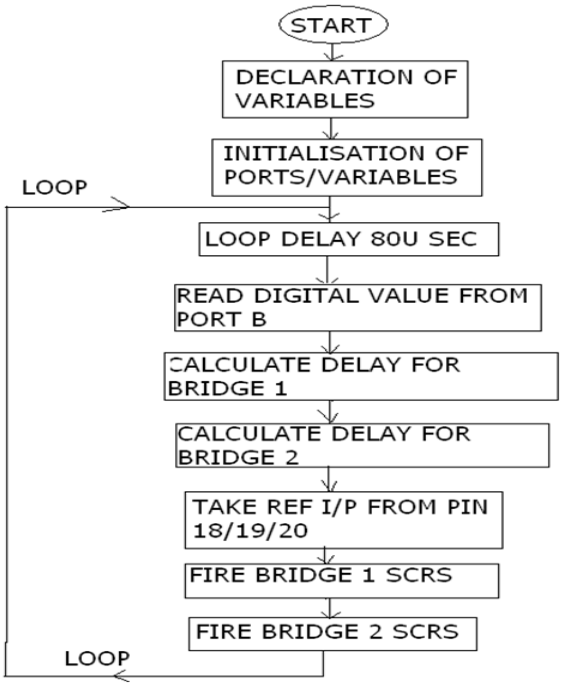
The hardware control system includes the DC motor, power circuit, PIC16F877A microcontroller, speed sensor. In this paper, a new approach is proposed where a MOC 3021 IC work as drivers for Converter and provide isolation. One micro controller is continuously firing 12 SCRs and the other microcontroller is used for LCD display and speed measurement. Three references are fed to the microcontroller. MCT is used to provide isolation from the line and it converts the sine wave to square wave, so zero crossing is done. It is observed that PIC16F877 (first) is driven from a 20MHz clock because it continuously fires 12 SCRs. Other microcontroller is driven from 4MHz clock because it is used for LCD display, speed measurement and speed feedback.

3. FLOW CHART

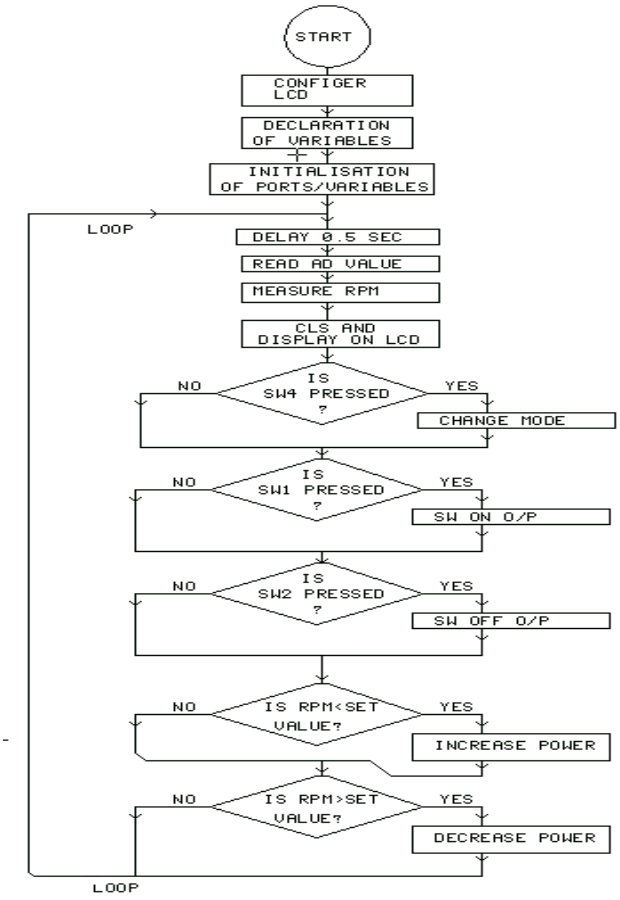
3.1 Flow chart of fully controlled bridge rectifier:-



3.2 Flowchart of dual converter:-



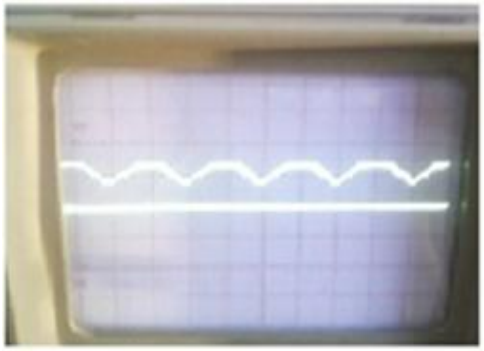
3.3 Flow chart of Speed control of dual converter:-



RESULT

Zero crossing detection.

Input & output of microcontroller



Output voltage of rectifier

The proposed converter and the controller are built and tested in the laboratory . The converter is also tested as part of the ½ HP dc shunt motor drive. The controller functions properly as per theoretical expectations and offer smooth operation. Reversal of speed, increase or decrease of speed and constant motor speed operations are also tested and verified at no load conditions. The rectifier output voltage is shown above.

4. CONCLUSION

The 16F877A microcontroller can control speed of a DC motor accurately with minimum hardware at low cost. The microcontroller based adjustable closed-loop DC motor speed controller system has been developed. The results showed that the microcontroller is a reliable instrument to control the motor. Thus it can be concluded that the present system is a reliable adjustable drive system for DC motors. We can control the speed in both directions.

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