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Design and development of TMS320F28335 Based Platform for Motor Drive Applications

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Abstract—**This paper presents the need of speed control in induction motor, high processing speed and the control accuracy of the DSP which allows sophisticated control technique to be used to build the circuit. Out of different controlling methods voltage/frequency control has proven to be the most versatile. The control circuit designed is realized on a digital signal processor TMS320F28335 development board based on v/f which is specially designed to have an accurate control on the three phase induction motor. The controller in the circuit consists of faster generation of the voltage and frequency inputs of sine wave in PWM. The inner sine generation using the voltage and frequency components, the speed control of a three phase induction motor can be handled accurately and a smoother control can be obtained. Three phase inverter is used to convert the PWM signal from the digital signal processor to analog signal. For this the 3 phase MOSFET inverter is designed with the gate driver. The experimental results for the speed (v/f) control of the three phase induction motor drive controlled by a digital signal processor TMS320F28335 chip has been observed.**

Index Terms—**PWM, Driver, MOSFET inverter.**

I. Introduction

Induction motors are often termed the "Workhorse of the Industry". This is because it is one of the most widely used motors in the world. It is used in transportation and industries and also in household appliances and laboratories. Another major advantage of the induction motor over other motors is the ease with which its speed can be controlled. Different applications require different optimum speeds for the motor to run at. V/f Control is the most popular and has found widespread use in industrial and domestic applications because of its ease-of-implementation. Traditionally motor control was designed with analog components, they are easy to design and can be implemented with relatively inexpensive components. However, there are several drawbacks with analog systems. Aging and temperature can bring variation causing the system to need regular adjustment, as the parts count increase the reliability of the system decreases. Analog components raise tolerance issues and upgrades are difficult as the design is hardwired. Digital systems offer improvements over analog designs. Drift is eliminated since most functions are performed digitally, upgrades can easily be made in software and part count is also reduced since digital systems can handle several functions on-chip. Digital Signal Processors go on further to provide high speed, high resolution and sensor less algorithms in order to reduce system costs. Providing a more precise control to achieve better consumption or radiation performances often means performing more calculations, the use of some 1- cycle multiplication & addition instructions included in a DSP speeds-up calculations. The main objective of the paper is to design and develop TMS320F28335 Evaluation board to implement V/f control of an induction motor.

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II. Constant Volts/Hz Operation

If an attempt is made to reduce the supply frequency at the rated supply voltage, the air gap flux ψ_m will tend to saturate, causing excessive stator current. Therefore, the region below the rated frequency should be accompanied by the proportional reduction of stator voltage so as to maintain the air gap flux constant. *Fig. 1* shows the plot of torque-speed curves at *Volt / Hz* = constant. It is clear from *Fig. 1* that the starting torque at the minimum frequency is much less than the breakdown torque at higher frequencies, and this could be a problem for loads which require a high starting torque.

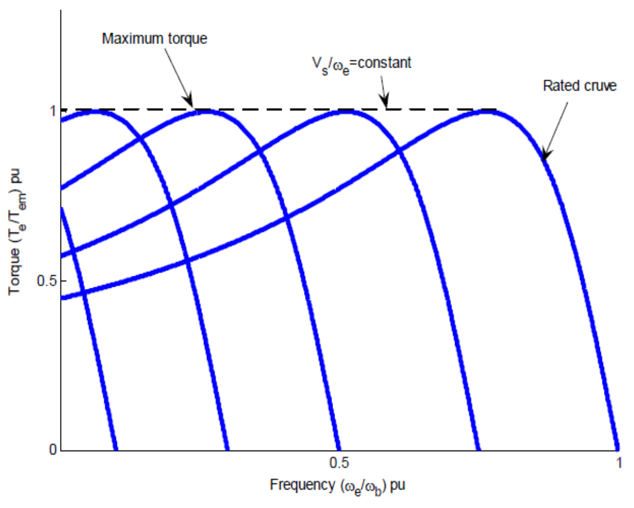


Fig. 1: Torque-speed curves with constant voltage/frequency ratio

III. HARDWARE DESIGN

A. 32-Bit C2000 Controllers for Digital Motor Control (DMC)

The C2000 family of devices possess the desired computation power to execute complex control algorithms along with the right mix of peripherals to interface with the various components of the DMC hardware like the analog-to-digital converter (ADC), enhanced pulse width modulator (ePWM), quadrature encoder pulse (QEP), enhanced capture (eCAP), and so forth.

These peripherals have all the necessary hooks for implementing systems, which meet safety requirements, like the trip zones for PWMs and comparators. Along with this, the C2000 ecosystem of software (libraries and application software) help in reducing the time and effort needed to develop a Digital motor control solution.

The designed board for motor control purpose is shown in the Fig.3. It is a 4 layer PCB board. The top and bottom layer is used for routing, the 2 inner layers are power planes i.e., V_{cc} and ground.

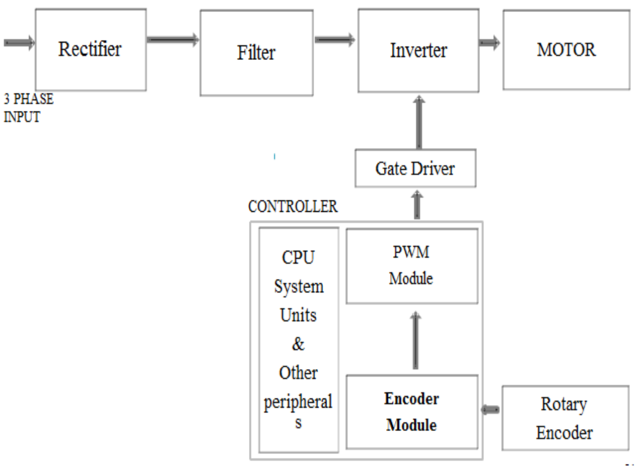
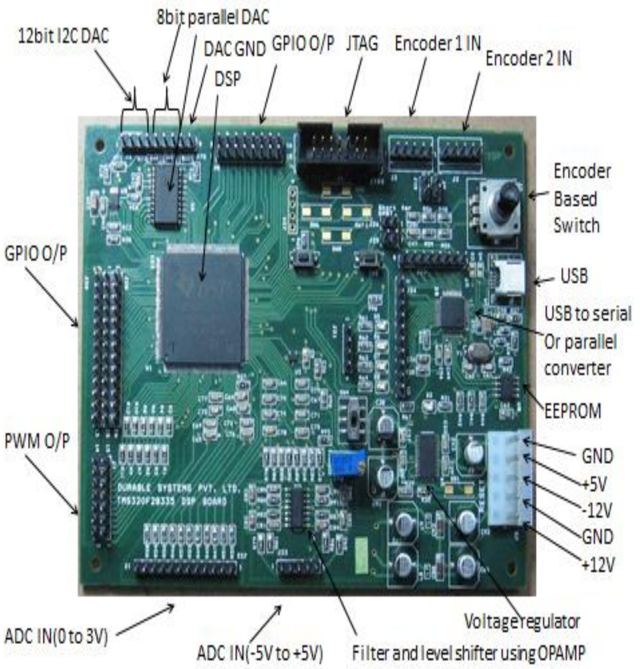


Fig. 2 Block Diagram



. Fig. 3 Printed Circuit Board

B. Evaluation Board Components

TMS320F28335:

GPIO Pins:

The GPIO pins are multiplexed for two or more signals; each GPIO pin could be used to implement digital I/O or peripheral I/O. To help the routing of signals or to use the pin for a different multiplexed option, some of the peripheral signals are multiplexed at two different sets of pins.

Control Peripherals - PWM, CAP, QEP and Event Manager:

The event manager of the F281x devices and the ePWM, eCAP and eQEP blocks of the F280xx/F28xxxdevices account for generating and/or interfacing the PWM and pulse signals for various control applications.

Serial Communication Ports (McBSP, I2C, SPI, SCI and CAN):

I2C and serial peripheral interface (SPI) are board-level interfaces that are connected to other devices on the board or system serial communications interface (SCI) and controller area network (CAN) interfaces are used to connect to different systems running under another processor.

AD7305

The AD7305 is quad, 8-bit DACs that operate from a single +3 V to +5 V supply, or ±5 V supplies. The AD7305 has a parallel interface.

MCP4728

The MCP4728 device is a quad, 12-bit voltage output Digital-to-Analog Convertor (DAC) with non-volatile memory (EEPROM).

TPS767d301

The TPS767D3xx family of dual voltage regulators offers fast transient response, low dropout voltages and dual outputs in a compact package.

CB3LV-3C-30M000 Clock Oscillator

Applications for Model CB3 and CB3LV include digital video, networking equipment, wireless communications, broadband access, Ethernet/Gigabit Ethernet, microprocessors/DSP/FPGA, storage area networks, fiber channel, computers and peripherals, test and measurement, SONET/SDH/DWDM, base stations and Pico cells.

REF3020

The REF30xx is a precision, low power, low voltage dropout voltage reference family available in a tiny SOT23-3.

Rotary Encoder

A rotary encoder, also called a shaft encoder, is an electro-mechanical device that converts the angular position or motion of a shaft or axle to an analog or digital code. There are two main types: absolute and incremental (relative). The output of absolute encoders

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indicates the current position of the shaft, making them angle transducers. The output of incremental encoders provides information about the *motion* of the shaft, which is typically further processed elsewhere into information such as speed, distance and position.

Interfacing the XINTF
F2812 and F2833x devices are supported with this non-multiplexed asynchronous bus to add an external parallel device. This interface is primarily used to expand system memory; generally RAM. These memories can be fast, running at or near the processor speed, or slow, many times slower than the processor speed, and can be asynchronous like SRAM, ROM, or Flash. The XINTF is designed with a high-performance buffer to support a 35pf load. For more information regarding the drive strength for all pins, see the device-specific data sheet. Make sure the address, data, and control signals are balanced with a minimum pf load. Consider faster memories or longer wait states to account for slew on the control signals.

IV. Hardware Blocks

- Diode Bridge - Rectification of the AC input voltage - constant amplitude and frequency - coming from the power grid.
- DC link or filter –Regulation or smoothing of the rectified signal with energy storage through a capacitor bank.
- Inverter- Inversion of the voltage coming from the link DC into an alternate signal of variable amplitude and frequency

A. Three Phase Inverter

Electronic motor control for various types of motors represents one of the main applications for MOSFET drivers today. The bridging element between the motor and MOSFET driver is normally in the form of a power transistor.

B. PWM based MOSFET driver

Pulse-width modulation (PWM) of a signal or power source involves the modulation of its duty cycle to either convey information over a communications channel or control the amount of power sent to a load.

V. Software Implementation

Texas Instruments provides an integrated solution called *Control SUITE™* for industrial control purpose which *consists* of necessary header files, source files, library, linker command files for developing an executable program. Besides it gives extensive example codes, which allows the new user to be able to quickly start. *Code Composer Studio™* (CCS) is the Integrated Development Environment (IDE) for TI's microcontrollers, which is an integrated user interface guiding users through each code developing step. There are various versions of CCStudio in current circulation, each differing in the processors available to debug, how codes are run and how projects are complied. For TMS320F28335 the code composer studio version is CCSV.5.3.0.

A. Flow chart

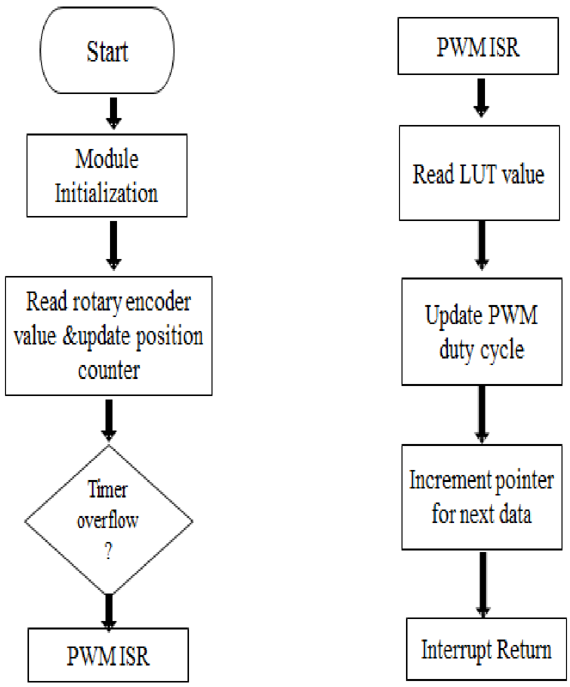

Fig 4 Flowchart

VI. Conclusion

Speed control of induction motor is necessary in engineering applications. To control the speed of induction motor different methods are there. Out of the various methods of controlling induction motors, V/f Control has proven to be the most versatile. To implement the speed control an efficient evaluation board is developed. PWM based speed controlling is carried out. The discrete ON/OFF states of the modulation are used to control the state of the switch(s) which correspondingly control the voltage across or current through the load. The major advantage of this system is the switches are either off and not conducting any current or on and have (ideally) no voltage drop across them. PWM based MOSFET inverter is also designed to deliver the PWM control to the induction motor.

REFERENCES

[1] Dr. P. S. Bimbhra, "Electrical Machinery", 7th Edition Khanna Publishers, New Delhi, 2010.

[2] Gopal K. Dubey, "Fundamentals of Electrical Drives", 2nd Edition, Narosa Publishing House, New Delhi, 2011.

[3] M. C. Trigg and C. V. Nayar, "Matlab Simulink modelling of a single phase voltage controlled voltage source inverter", Dept. of Electrical Engineering, Curtin University of Technology.

[4] M. Harsha Vardhan Reddy and V. Jegathesan, "Open loop V/f Control of Induction Motor based on hybrid PWM with Reduced Torque Ripple", ICETECT 2011, Karunya University.

[5] Sharad S. Patil, R. M. Holmukhe, P. S. Chaudhari, "Steady State Analysis of PWM inverter fed Cage Induction Motor Drive", Department of Electrical Engineering, College of Engineering Pune, India

[6] Neelashetty Kashappa and Ramesh Reddy K., "Performance of Voltage Source Multilevel Inverter-fed Induction Motor Drive using Simulink", ARPN journal of engineering and applied science, vol 6,no 6, June 2011.

[7] A. E. Fitzgerald, Charles Kingsley, Jr. And Stephan D. Umans, "Electrical Machinery", McGraw-Hills Publications, 2002.

[8] Scott Wade, Matthew W. Dunnigan, and Barry W. Williams, "Modelling and Simulation of Induction Machine Vector Control with Rotor Resistance Identification", IEEE Transactions on power electronics, vol. 12, no. 3, May 1997.

[9] IEEE Standard Test Procedure for Polyphase Induction Motors and Generators", volume 112, issue 1996 of IEEE, by IEEE Power Engineering Society.

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