iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 7 **Issue:** I **Month of publication:** January 2019

DOI: http://doi.org/10.22214/ijraset.2019.1112

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 7 Issue I, Jan 2019- Available at www.ijraset.com

Control System for BLDC Motor using Back EMF Method

Mahesh Dattatraya Bhambure[1], Shrenik Suresh Sarade[2]
[1, 2]*Dr. Babasaheb Ambedkar Technical Univercity,Lonere, Maharashtra, India*

Abstract*: Existence of position sensor to identify rotor position in speed control of BLDC motor makes configuration more complex. In this paper, rotor position is detected via back e.m.f. zero crossing detector and by detecting phase terminal voltages, which reduces cost and volume of motor. Speed controlling of BLDC motor become flexible, simple and in reduced cost. BLDC motor has various applications in Medical, Automobile, Automation, home appliances used for teeth drilling, polishing and in medical instruments lathes, electric bikes, electric ships, wipers, small conveyors, fans, drones, spinning, BLDC motor fans convenient for electronic equipment, computers, mobile equipments, in vehicles and in spindle drives. BLDC motors are use in various types of actuators in advanced aircraft and satellite systems
Keywords: Brushless DC motor, Back EMF, Sensor less control, MOSFET Power module

I. INTRODUCTION

The most important feature of Brushless DC motor is the mechanical commutation configuration constituted by commutator and brushes are replaced by electronic commutation circuitry. It solves drawbacks caused by mechanical commutation. BLDC motor has less maintenance due to absence of brushes, enables operation at all speeds with rated load. Provide high efficiency, reduced size, and reduced maintenance and gives higher speed range; hence BLDC motors are use for large number of applications such as in medical field, fans, drones, transportation field, Electric vehicles, Electric ship, Automobile, Automation. In specialized fields such as when in high temperature position sensors does not work, this system plays important role. Brushless DC motors such as fans are smaller in size and weight than AC fans using shaded pole or universal motors. BLDC motors can work with the low voltage sources such as 24V or 12V DC supply, due to which BLDC motors can use for small fans, in electronic equipment, spindle drives, mobile equipments, it have high efficiency and ability to reverse rapidly. Brushless DC motors in the fractional horsepower range have been used in various types of actuators in advanced aircraft and satellite systems. BLDC motors mainly consist three phases which are controlled and driven by full bridge transistor circuits. Forces produced due to interaction of magnetic fields and shafts starts to rotate. One magnetic field is of permanent magnet and one magnetic field is due to excitation. This system uses a MSP430 microcontroller and a rectified power supply, optocoupler is connected to trigger the MOSFET for driving BLDC. A BLDC motor of 12V DC is used to which control signals receives from controller through MOSFET circuit. A Back EMF circuit provides feedback and by using zero crossing detector rotor position can be detected. A speed command circuit can help to get variable frequency, variable speed system based on microcontroller MSP430, which provide a compact, flexible speed control for brushless DC motor using Back EMF and zero crossing detector without using position sensor at low cost. It consist A. Main circuit B. Control circuit C. Command circuit D. Display circuit.

II. SYSTEM HARDWARE STRUCTURE

A. Main circuit

Main circuit consist Power unit and MOSFET module, Power unit of this system consist Two 12V fixed DC power supply which consist a transformer which convert 230V AC supply in to 12V AC, Bridge rectifier with four diodes to convert that 12V AC into 12V DC supply and RC filters. This 12V DC power supply is given to MOSFET module, display circuit, command circuit and control circuit. MOSFET module consist six MOSFET of IRF Z44N having fast switching and low on-resistance per silicon area. It provides the highest power capability and the lowest possible on-resistance in any existing surface mount package. For the MOSFET to carry drain current, a channel between the drain and the source must be created. This occurs when the gate to source voltage exceeds the device threshold voltage V Th. For v GS > V Th , the device can be either in the triode region, which is also called‗constant resistance'' region, or in the saturation region, depending on the value of v DS .For given v GS , with small v DS(v DS< v GSÿ V Th), the device operates in the triode region (saturation region in the BJT), and for larger v DS. vDS> v GSÿ V Th), the device enters the saturation region (active region in the BJT). For v GS < V Th, the device turns off, with drain current almost equal to zero. Under both regions of operation, the gate current is almost zero. This is why the MOSFET is known as a voltage.

B. Control Circuit

The control circuit of this system is composed by MSP430G2253 microcontroller, Back EMF zero crossing detection circuit, speed command and display circuit. MSP430G2253 consist of several devices featuring different sets of peripherals targeted for various applications. It contains 16 RISC CPU, 16 bit registers and constant generator, digitally controlled oscillator(DCO), which change microcontroller from low power modes to active mode, 16 bit timers. These microcontrollers have 24 I/O capacitive touch enabled pins, a versatile analog comparator and built in communication capacity using the universal serial communication interface, 10 bit analog to digital convertor. This microcontroller works on 1.8V to 3.6V, having ultra low power consumption. Controller operates with its software energia which is based on c language. Controlled Signals to 12V BLDC motor getting from microcontroller. Controlled Signals are in pulse width modulated form. MOSFET module works as three phase inverter it's three phase output terminal voltages corresponds to ground act as terminal voltage, this terminal voltage is feed to controller trough Back- EMF zero crossing detector circuit. Pulse width modulation is employed to achieve varying voltage conveniently, reduce torque ripples also helps in enlarging speed controlling range.PWM mode we can set independently only if the value in the period registerer is constant, via changing the value in the compare registerers can modulate the width of the PWM output signals. By varying delay time we can change speed of motor for this time delay and speed calculation obtained from microcontroller.

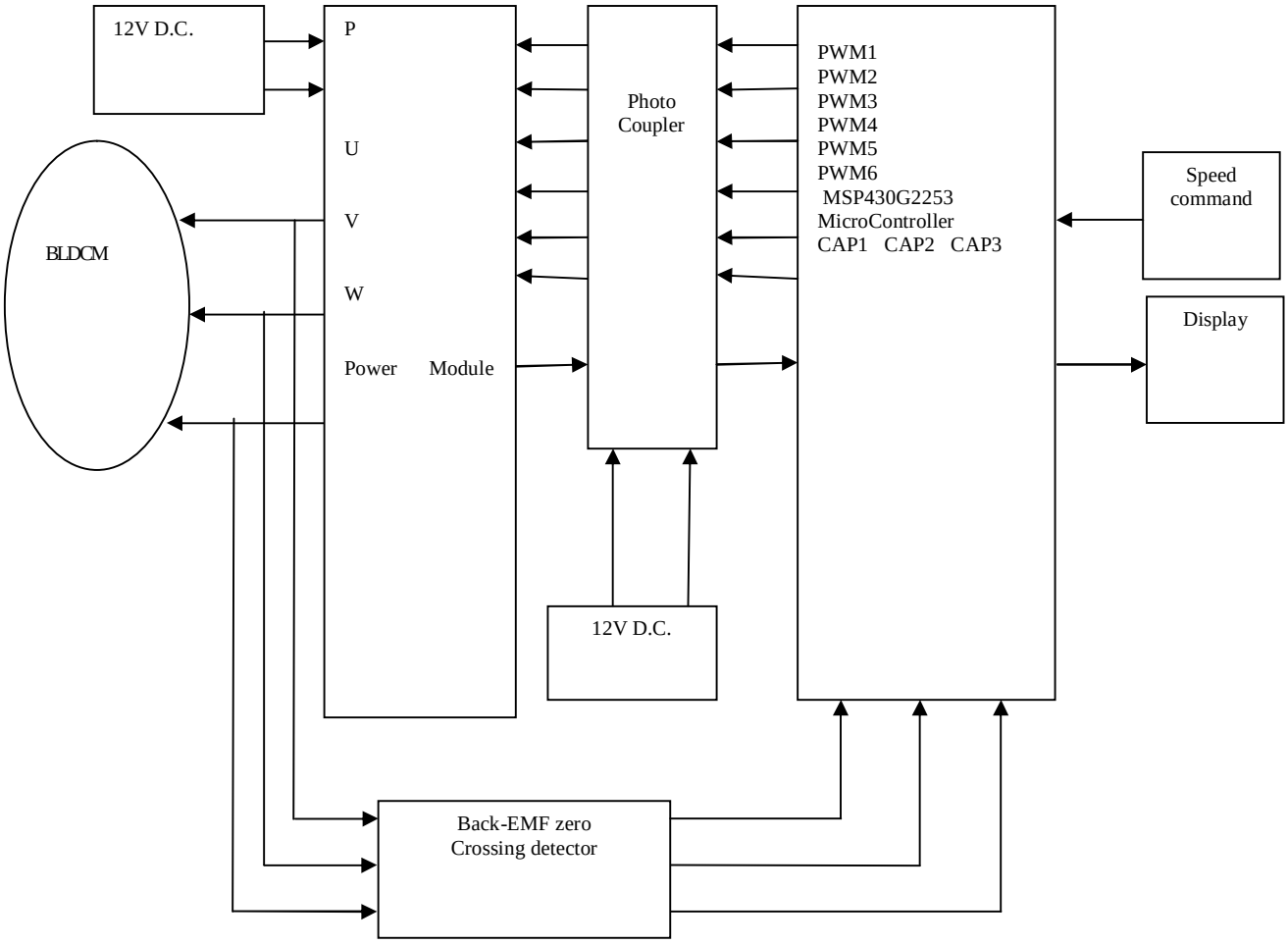


Fig.1 Block diagram of system

C. Command Circuit

Command circuit consist provides controlled signal to controller It consist touch pad with keys, by pressing keys we can increment or decrement values of parameters. Here we are fiddling angle and speed by pressing keys

D. Display Circuit

It consist seven segment LCD display which indicates the angle of rotation of motor speed .

III. SOFTWARE DESIGN OF THE CONTROL SYSTEM

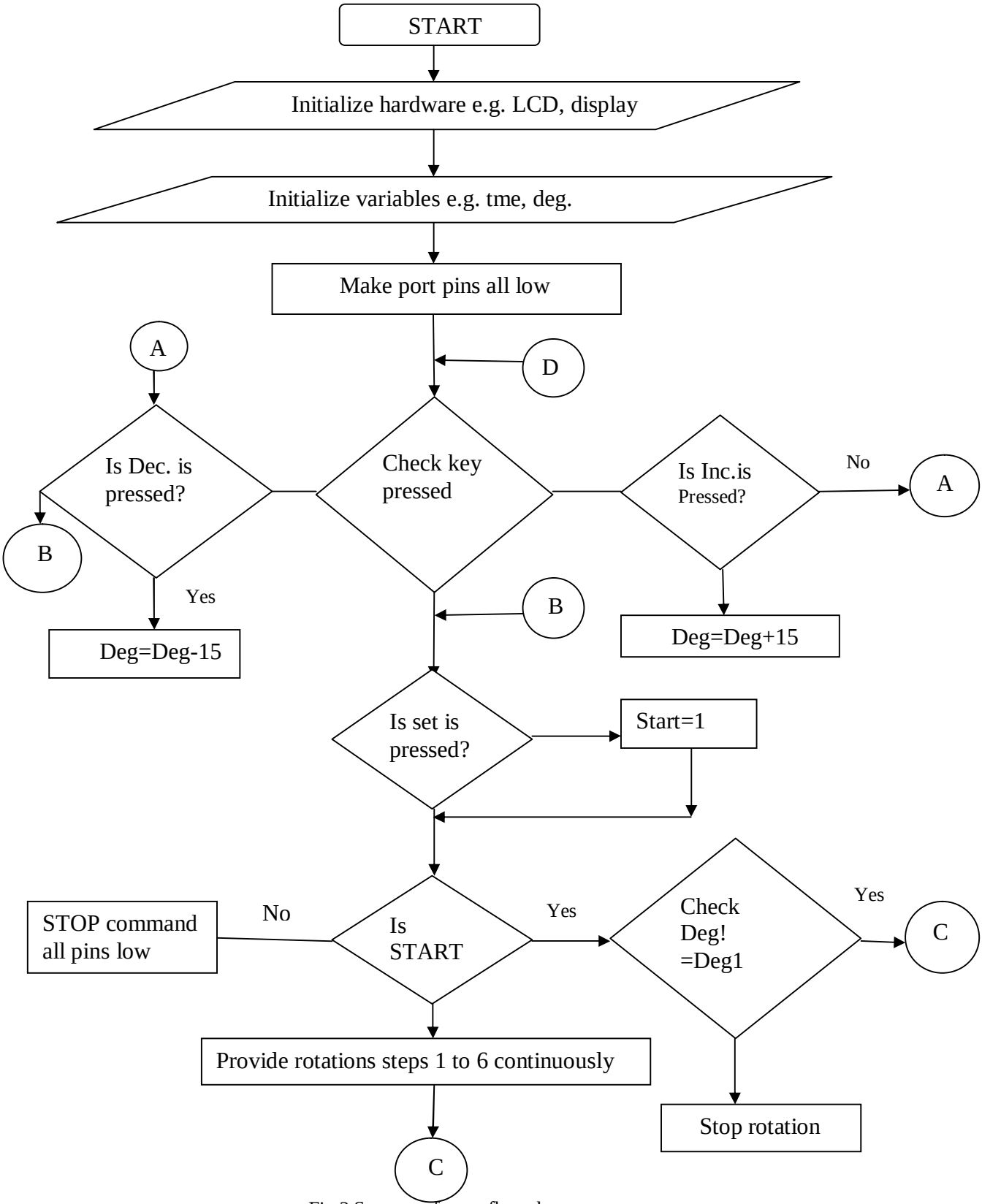


Fig.2 System software flow chart

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 7 Issue I, Jan 2019- Available at www.ijraset.com

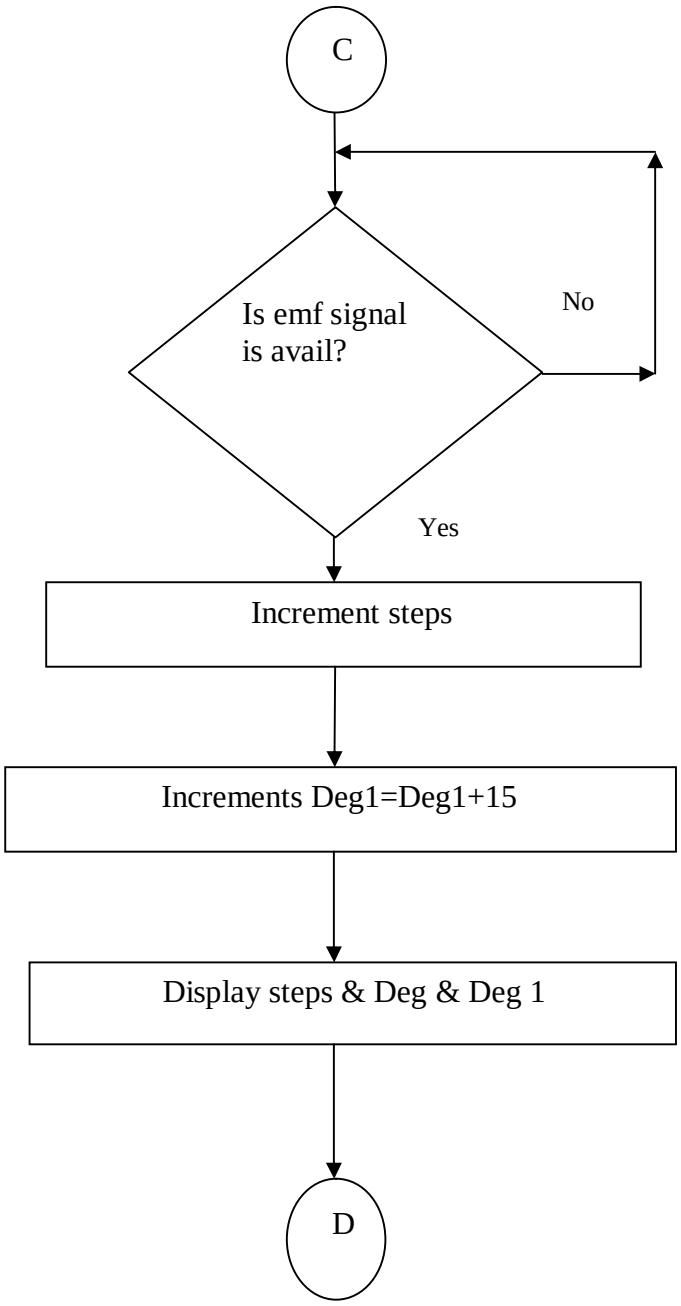


Fig.4 System software flow chart

Fig.3 and Fig.4 is the software flow chart of system. In which Fig.3 shows main flowchart of system the while Fig.4 shows flowchart of system between C and D. Whole control system software is composed by the main program and the interrupt service subsystem. Main program consist system initialize program, motor start program, check commands, interrupt program, and interrupt service subprogram. Interrupt program consist checking for back e.m.f. zero crossing instants and time interval between capture. Delay and degree of rotation is read, by considering increment or decrement in delay, degree and speed start or stop command given to controller. Degree which indicates angle of rotation and speed given by keys according that motor start and stop commands generates. Time consumed by rotor for rotating 360 degree angle divided into 12, the relating average time to 15 degree angle can be obtained. The average time is used as the time delays between the lower half period zero-crossing point and the related communication point. Initial position of motor is detected by back-emf and zero crossing circuit.

IV. EXPERIMENTAL RESULT

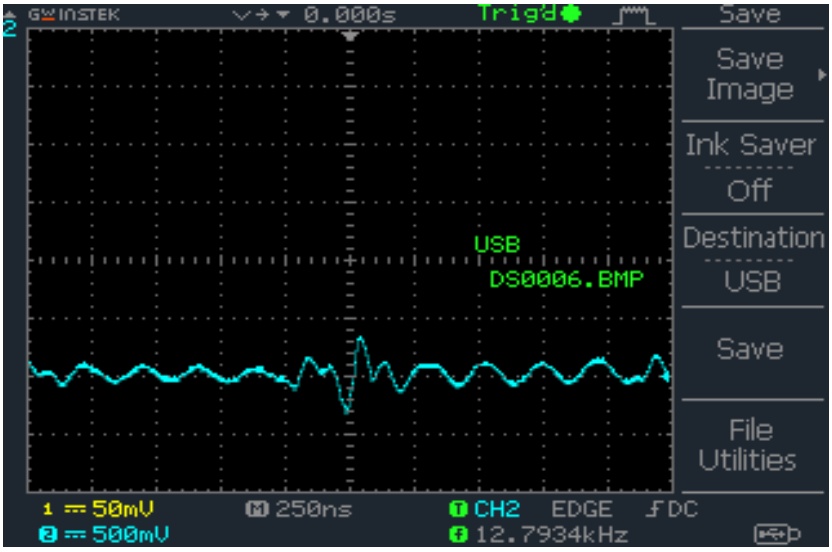


Fig.5 Terminal voltage waveform

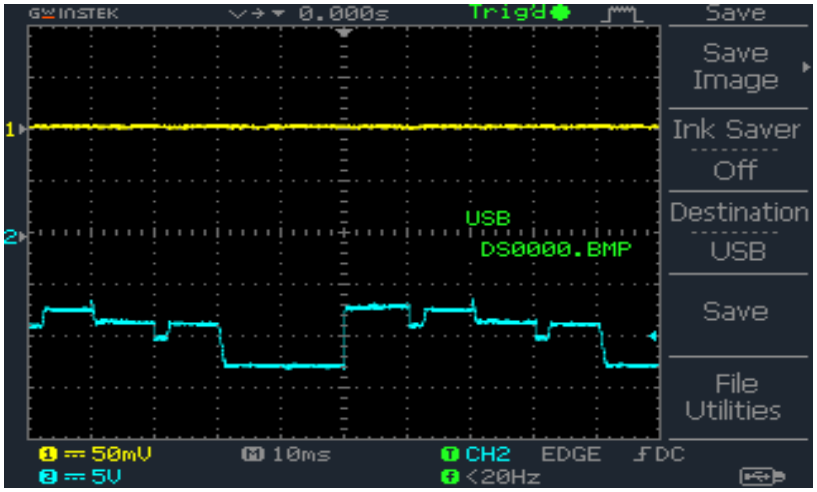


Fig.6 Terminal voltage waveform

Fig.5 Shows pre-phase terminal voltage waveform for continuous rotation program and when motor operates at stable state. Fig.6 is the expanded waveform. As we increase speed of motor by pressing keys on speed command circuit, terminal voltage and terminal current increases due to which speed of motor increases. In Motor speed control for rotation in particular degree also, as terminal voltage and terminal current increases motor rotation speed increases but rotation done for particular angle.

V. CONCLUSIONS

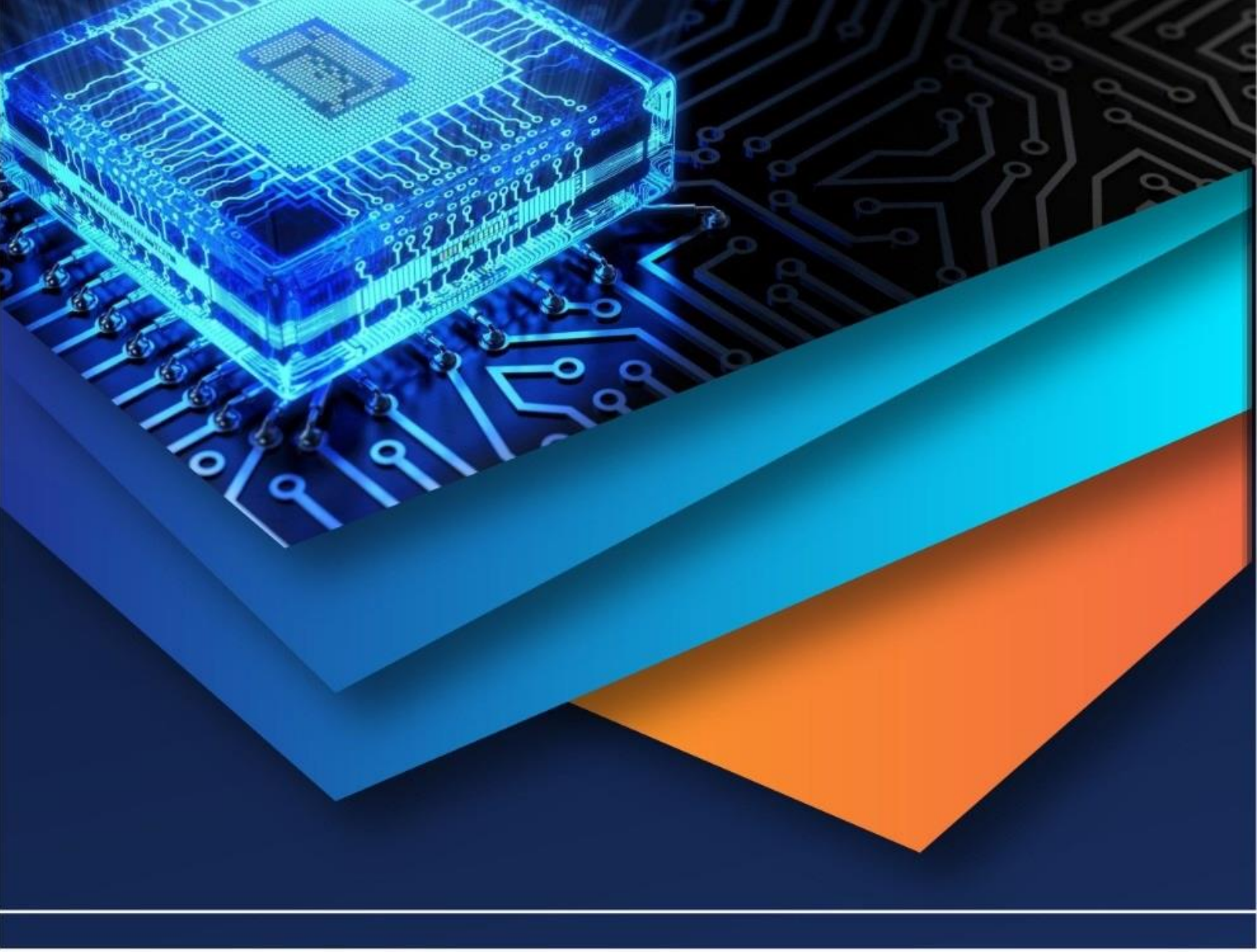
This is microcontroller based variable speed control system of sensor less brushless DC Motor. Microcontroller MSP430G2253 provide flexible control with quick and accurate response. MOSFET Power module gives good switching actions. Sensor less configuration makes whole system configuration compact and gives flexible control. System failure chances less due to sensor less configuration. Variable speed control can achieve, such as motor speed control over total speed range, motor speed control over certain speed range, motor rotation in degree.

VI. ACKNOWLEDGMENT

We would like to thanks to my guide Mr.S.R.Jagtap, Parents, and Friends for their valuable suggestions and consistent encouragement.

REFERENCES

[1] 3-phase BLDC Motor control with sensor less Back-EMF ADC Zero crossing detection using DSP56F80X". Motorola order Number, AN1913/D, 2001.
[2] JHuang Qingxin, Liang Hui Department of Electrical Engineering, Beijing, jotong University, Beijing 100044, China, "DSP Control System of Brushless DC Motor without Position Sensor" IEEE Paper..
[3] G.SantoshKumar, S.Arockia Edwin Xavier, Thiagarajar College of Engineering, Electrical and Electronic Engineering, Madurai, Tamil Nadu
[4] Hanamoto T,Hara H,Tanaka Y, "Sensorless control of BLDCM applying the modified induced voltage observer", ELECTR END JPN,1999, 129(2), Pp.87-89.
[5] Advanced PM Brushless DC Motor Control & System for Electric Vehicles Fang Lin &, IEEE Senior Member and Hock Guan Yea Nanyang Technological University, Nanyang Avenue, Singapore 639798
[6] Low Cost and Efficient Control for Brushless DC motors T. Hascher, W. Zeng, K. Kanelis, A. Kampka, C. Bournot European Patent Office, Munich, Germany
[7] Simulation of sensor less operation of BLDC motor based on Motors the zero cross detection from the line voltage S. Tara Kalyani, Syfullah khan
[8] Low Cost and Efficient Control for Brushless DC Motors T. Hascher, W. Zeng, K. Kanelis, A. Kampka, C. Bournot European Patent Office, Munich, Germany
[9] On Industry Applications, Vol.33, No. 5, September October A novel single-switch-per-phase converter topology for four quadrant PM Brushless DC Motor Drive," in IEEE Trans.
[10] "PM Brushless DC Motor Drive with a New Power-Converter Topology," in IEEE Trans. On Industry Applications, Vol.33, No.4, JulyIAugust 1997,
[11] Jessen Chen, Pei-Chong Tang: "A Sliding Mode Current Control Scheme for PWM Brushless DC Motor Drives", IEEE Trans. on Power Electronics, Vol. 14, No. 3, May 1999



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY