

# **Transferring a Single DC/Stepper Motor Into Servo Motor**

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**ABSTRACT:** The objective of this paper is to design the transfer the function of stepper/dc motor into servo motor in discrete time system. In motion control system the stepper motor is widely used as it is an electromechanical device which converts electrical pulses into discrete mechanical movements with the use of cortex M0 Processor the controlling of the shaft or spindle of a stepper motor rotates in discrete step increments when electrical pulses are applied to it in the proper sequence. The stepper drivers are used to compatible anything as the motor description but take input voltage according to TTL voltage of microcontroller and control the rotation of the motor and provide more flexibility. The PID control system to enhance the performance of the stepper motor system, to control the speed of the stepper motor and work according to the servo motor for a given reference input.

**KEYWORDS:** PSoC Chip, Stepper driver, Stepper Motor.

## **I. INTRODUCTION**

A stepper motor is a digital electromechanical system wherein each electrical pulse input moves the rotor by a discrete angle called as step angle and hence the name stepping motor. Stepper motors are used in varied range of measurement application and precise motion. The amount of the input impulses is directly proportional to its output angular displacement, and the frequency of the input impulses is directly proportional to the speed of rotation. These motors are incremental driving devices whose output corresponds to the input impulses. [3]

There are two type of DC/Stepper (i) Brushless DC motor (BLDC) (ii) Permanent DC motor (PMDC). In BLDC the rotation of motor is done with the help of field magnet generated while in PMDC the rotation of motor is done with the help of permanent magnet inside the motor.

The Stepper motor is part of DC motor as it has permanent magnet, synchronous electric motor that converts digital pulses into mechanical shaft rotation. There are two type of stepper (i) unipolar (ii) bipolar. The unipolar motor operates with one winding with a center tap per phase. Each section of the winding is switched on for each direction of the magnetic field. While the bipolar motor operates as there is only a single winding per phase. The driving circuit needs to be more complicated to reverse the magnetic pole; this is done to reverse the current in the winding.

The servo motor has some control circuits and a potentiometer that is connected to the output shaft. The potentiometer allows the control circuitry to monitor the current angle of the servo motor. If the shaft is at the correct angle, then the motor shuts off. If the circuit finds that the angle is not correct, it will turn the motor the correct direction until the angle is correct. The output shaft of the servo is capable of travelling somewhere around 180 degrees.

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## II. LITERATURE SREVEY

### Paper-1:

**Title:**Speed Control of Stepper Motor for Collimator Jaws Positioning based on FPGA Implementation<sup>[4]</sup>

**Author:** Mr. Khan ZarrarahmedZaferullaht, Mr. Rajesh Bansode, Mr. S.N. Pethe, Mr. MandarVidwans, Mr.KelvinDsouza

**Publication:**Circuits, Systems, Communication and Information Technology Applications (CSCITA), 2014 International Conference on, April 2014

**Conclusion:**This paper describes the frequency variation technique to generate various speed profiles for control of dynamic mode. This algorithm implemented on FPGA allows a substantial decrease of the equivalent processing time develop by classical velocity controller.<sup>[4]</sup>

### Paper-2:

**Title:**Design of Improved PID Algorithm for Position Control of Servo Unit<sup>[7]</sup>

**Author:** Shuwang Du, ZhilinFeng and Zhiming Fang

**Publication:**Computer and Communication Technologies in Agriculture Engineering (CCTAE), 2010 International Conference On (Volume: 3), June 2010

**Conclusion:** This paper describe the design process of improved PID controller in detail, and give an analysis of the efficiency of the control model in dynamic characteristics of tracking and eliminating the load disturbance. It shows that controller can satisfy the target, and have a good performance and strong anti-interference ability. In fact combined with the actual operation of servo control devices, there are other factors will affect the control accuracy, such as load volume of back-clearance, which equivalent to the introduction of a nonlinear part, will result in a decline of precision. Also the load torque changes dramatically, it is demanded that the actuator should provide with sufficient power to overcome the disturbance torque. Otherwise no enough power will lead to the decreased control precision of servo system. These above factors must be taken into account, and then the ultimate ideal control effect can be achieved.<sup>[7]</sup>

### Paper- 3:

**Title:** Speed Control of Brushless DC Motor Using Intelligent Controller<sup>[8]</sup>

**Author:** Md Mustafa Kamal, Lini Mathew and S.Chatterji

**Publication:**Intelligence Systems in Electrical Engineering Journal, 4<sup>th</sup> year, No. 4,January 2014

**Conclusion:** This paper describes the design of PID controller using genetic algorithm has been presented. The dynamic behavior of BLDCM has been studied with the conventional controllers as well as fuzzy PID controller. It is observed that from the conventional controller the results can be better to an extent. By using fuzzy logic controller, results can be further better thanconventional controllers. The proposed GA-PID controller not only eliminates the overshoot of the response but also shows better improvement in term of rise time, settling time and peak overshoot. Thus it is concluded that for the speed control of BLDCM, GA-PID provided far better response.<sup>[8]</sup>

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**Paper- 4:**

**Title:** A PSoC Controller for a NASA Robotic Arm<sup>[9]</sup>

**Author:** Erik Goodman, Daniel Baker, Patrick Kane, Michael Shanblatt

**Publication:** Microelectronic Systems Education, 2007. IEEE International Conference on, June 2007

**Conclusion:** This paper describes the implement of a success, allowing joystick control of the arm and providing both position data and a video feed to the computer program's GUI. <sup>[9]</sup>

### III. HARDWARE AND SOFTWARE

**PSoC:** It is most closely resembles a microcontroller combined with a PLD and programmable analog. Code is executed to interact with the user-specified peripheral functions (called "Components"), using automatically generated APIs and interrupt routines. PSoC Designer or PSoC Creator generates the startup configuration code. Both integrate APIs that initialize the user selected components upon the user's needs in a Visual-Studio-like GUI. Using configurable analog and digital blocks, designers can create and change mixed-signal embedded applications. The digital blocks are state machines that are configured using the blocks registers. There are two types of digital blocks, Digital Building Blocks (DBBxx) and Digital Communication Blocks (DCBxx). Only the communication blocks can contain serial I/O user modules, such as SPI, UART, etc. [2]

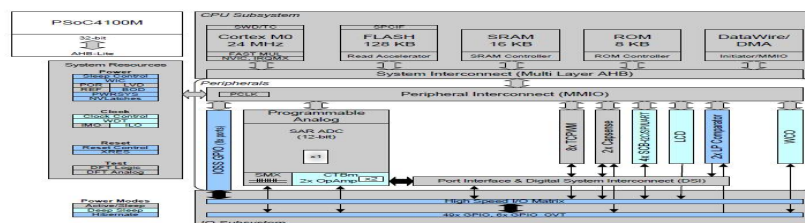


Figure: 1 PSoC block diagram

Figure 1 describe the Programmable system on chip (PSoC) is a family of microcontroller integrated circuits by Cypress Semiconductor. These chips include a CPU core and mixed-signal arrays of configurable integrated analog and digital peripherals. PSoC architecture that provides the industry's lowest-power 32-bit ARM Cortex-M0 based System on-Chip, with unmatched ability to integrate analog and digital ICs. It offers larger devices with up to 128KB of Flash and 55 GPIOs and new peripherals including RTC, CAN and DMA, while supporting the AEC-Q100 standard - enabling designers to reduce system BOM cost while quickly developing product variants.

**Stepper Motor:** The shaft or spindle of a stepper motor rotates in discrete step increments when electrical command pulses are applied to it in the proper sequence. Figure 2 describe the motors rotation has several direct relationships to these applied input pulses. The sequence of the applied pulses is directly related to the direction of motor shafts rotation. The speed of the motor shafts rotation is directly related to the frequency of the input pulses and the length of rotation is directly related to the number of input pulses applied. [3]

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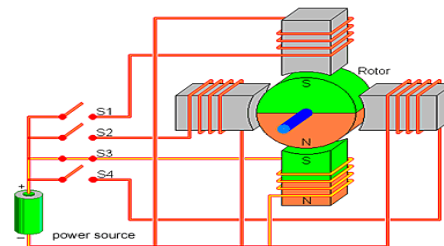
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Figure: 2 Stepper Motor

**Operation:** We know that like poles of a magnet repel and unlike poles attract shows a typical cross-sectional view of the rotor and stator of a stepper motor. Figure 3 describe the stator has eight poles, and the rotor has six poles. The rotor will require 24 pulses of electricity to move the 24 steps to make one complete revolution. Another way to say this is that the rotor will move precisely  $15^\circ$  for each pulse of electricity that the motor receives. The number of degrees the rotor will turn when a pulse of electricity is delivered to the motor can be calculated by dividing the number of degrees in one revolution of the shaft by the number of poles he rotor. In this stepper motor  $360^\circ$  is divided by 24 to get  $15^\circ$ .



Figures: 3 Schematic of Motor

**Stepper Driver:** The stepper driver is used to control the rotation of shaft of the motor. The encoder send the error signal to the driver and according it will acceleration and deceleration the speed of the motor. Figure 4 show the RMCS-1106 is Rhino Motion Controls new and improved DSP based micro-stepping drive for 1.8deg Bipolar Stepper Motors. It is designed for smooth and quiet operation without compromising on torque and control at higher speeds. It has short-circuited protection for the motor outputs, over-voltage and under-voltage protection. The RMCS-1106 achieves micro-stepping using a synchronous PWM output drive and high precision current feedback and this is absolutely silent when the motor is stopped or turning slowly. It virtually eliminates stopped-motor heating regardless of power supply voltage using a DSP based PID current control loop.[5]



Figure: 4 stepper driver

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**PSoC Creator:** The PSoC creator is the product of Cypress. Cypress is one-stop shop for high-performance embedded system design. They back up our uniquely flexible programmable system-on-chip architectures with high quality software tools that help you get the most out of your PSoC device. With PSoC Creator, PSoC Designer and PSoC Programmer have access to a suite of world-class integrated design environments to support embedded development with PSoC. There is simply no faster way to configure the perfect device, develop application code, then build, debug and deploy an embedded design.

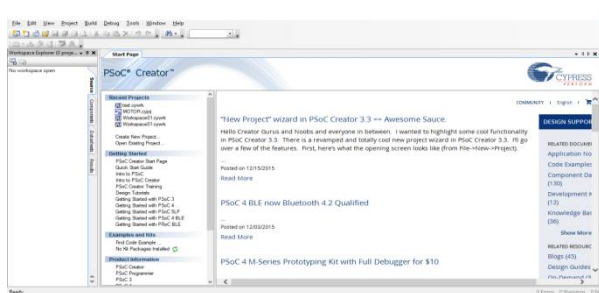


Figure: 5 PSoC Creator

Figure 5 describe the PSoC creator initial setup after software were we can start the new program according to the programmer required and boot loader is used to load the program into the chip and working of the program is seen on the hardware.

## IV. RESULT ANALYSIS

After setting up the PSoC Creator and creating a new project and programming the main .c file according to the requirement then with the help of the boot loader the program is to be loaded on the chip hardware to the stimulation. For loading the PSoC chip is connect to device with the help of the USB as in PSoC chip have serial communication facility and serial is internally connected to the parallel communication. Hence the program can be done parallel communication. Figure 6 show the LED program and installed on the chip.

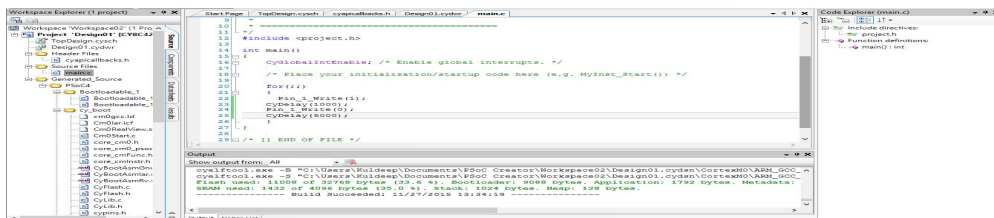


Figure: 6 Led Program

Now after blinking of led the motor is connected. Another new project is created and program of motor is done with the help of predefined block along with the software like PWM and clock block. The predefined block are blank just need to enter the value of pulse and starting and stop of the block in program file.

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Figure 7 show the blinking of LED on the chip after installing the program on the chip attached serial communication to the computer and LED is connected to the parallel communication which is the basic program for every chip to understand.

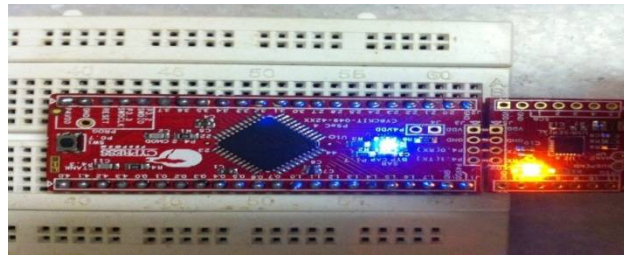


Figure: 7 ON Led

Figure 8 show the circuit diagram of the rotation of the motor is depend upon the frequency applied hence to increase the rotation the value of pulse throw the driver is reduced by 16 times or 32 times the original pulse applied hence the run off problem is get overcome and can handle the load easily.

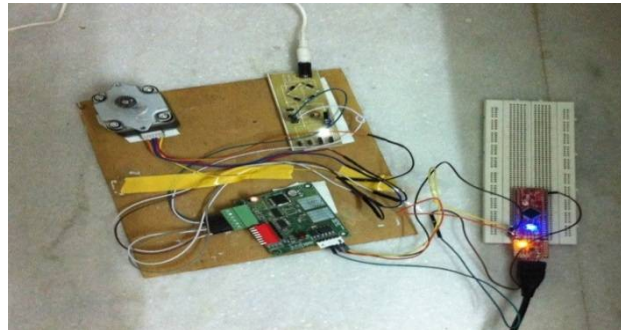


Figure: 8 Circuit Diagram

### V. CONCLUSION & FUTURE WORK

**Conclusion:** Hence, conclude that with the help of PSoC FPGA, which is programmable can make program according to the requirement which offer by the cypress and cypress company provide the free software PSoC creator to stimulate the program on software based and try to implement the rotation of the stepper motor on the chip with the help of the stepper driver and try to implementation of real time encoder position of the motor for calculating the rotation of the shaft as per the pulse given by the driver and load balancing tuning for industrial precise machine application.

**Future work:** The implement of the PID or Fuzzy algorithm for the encoder purpose which measure the position and angle of motor shaft. The encoder will used as feedback signal after measured with the help of algorithm and send to stepper driver for acceleration and deceleration of the motor as per different load applied on the motor and to get the precise movement of the motor as servo motor used for machine.

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