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# Automatic mini CNC machine for PCB drawing and drilling

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**Abstract -** *Due to the rapid growth of technology the usage & utilization of CNC machine in industries are increased. The fabrication of low cost CNC machine is used to reduce cost and complexity of machine. This paper deals with the design of automatic mini CNC machine for PCB drawing and drilling. The Idea behind our project is to design and drill PCB based on low cost CNC system the lower cost is achieved by incorporating features of PC with ATMEGA 328 controller in an arduino. We have use an G code for whole system operation G code is nothing but a language in which people tell computerized machine tools 'How to make something'. The How is defined by instructions on where to move & how fast to move.*

***Key Words:*** **CNC, Arduino controller, G code, FTDI, A3967**

## 1. INTRODUCTION

CNC Machining is a process used in the manufacturing sector that involves the use of computers to control machine tools. Tools that can be controlled in this manner include lathes, mills, machines and grinders. The CNC stands for Computer Numerical Control. Inspiring from this CNC technology and revolutionary change in the world of digital electronics & Microcontroller, we are presenting here an idea of CNC pen plotter using custom built PLC. The idea behind this project is to make a small CNC machine which can draw images or pictures on surface which can be a paper or anything. It uses three stepper motors as linear actuators on each axis X, Y & Z. While printing / drawing, the proper synchronization of all this three axis i.e. stepper motors, is most challenging task. At present the data to draw is given programmatically i.e. hardcoded in program in binary format. A pen touches the surface & prints the pixel for logic 1 and lifts up in air for logic zero & actuator changes it position for next commands execution. As in future plan, it can access the G-Code directly from supporting software like inkscape. Presented plotter is one dimensional 1D plotter.

### 1.1 Objective

To develop a low cost automatic mini CNC machine for PCB drawing and drilling. This system reduces the cost of machine and increases the flexibility.

### 1.2 Methodology

The G code is interfaced with ATMEGA 328 CNC based controller by FTDI module which is used to convert the code in convenient controller code i.e serial to USB converter. Hence it acts like interfacing module between PC to Controller. This code is further passed to stepper motor by easy drivers which converts the code and as per instructions the stepper motor moves. We need three axises X,Y,Z which operates as follows X stepper motor move left and right Y stepper motor moves front and back and Z stepper motor up and down as per given dimensions these axis's will move on..

## 2. BLOCK DIAGRAM

In this idea of project, Arduino microcontroller platform with ATMEGA 328 core is used. It can be easily interfaced

with PC using FTDI module where as also with the easy drivers and stepper motors to.

The basic block diagram is as shown in FIG.1 The explanation is given as follows:

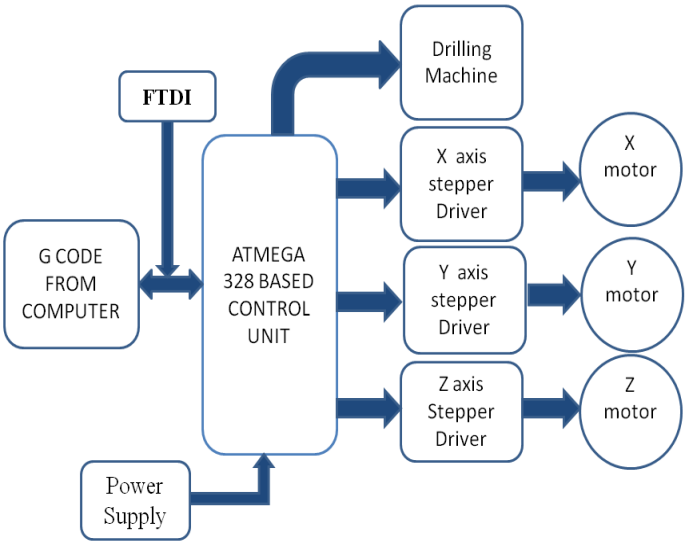


**Fig -1**: Block diagram

### 2.1 G code from PC

G code is nothing but a language in which people tell computerized machine tools 'How to make something'. The How is defined by instructions on where to move, how fast to move, & through what path to move.

### 2.2 Serial to USB converter

It is used for making the communication between USB based computers and serial devices. We use here, FTDI (Future Tech Devices International) serial to USB converter is used. FT232RL IC is used. It is bidirectional converter. This converter is used to load the data which is coming from the PC system into the controller. This converter converts human interpretation language into its ASCIIvalue which is understandable by the controller. FT232RL is 28 pin IC. It has internal clock generator so that no external crystal is required. It works on FIFO i.e. First In First Out technique.

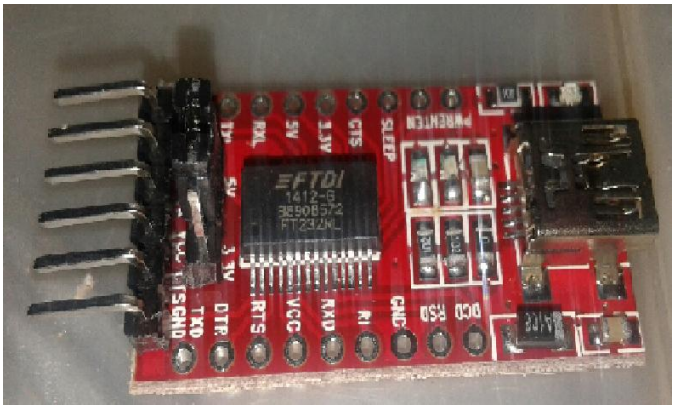

**Fig -2**: FTDI module

To interface the computer to the controller we use FT232RL IC which converts the USB data into serial data.

### 2.3 ATMEGA 328 Controller

This system uses Arduino controller platform with ATMEGA 328 core. The ATMEGA 328 is a single chip controller which is created by Atmel and it belongs to MEGA AVR series.

It is 28 pin IC and it is of 8 bit. It is based on RISC (Reduced Instruction Set Computer) architecture. It has 26 I/O pins, 32 working registers, 32Kb of flash memory, 2Kb RAM and 1Kb EEPROM.

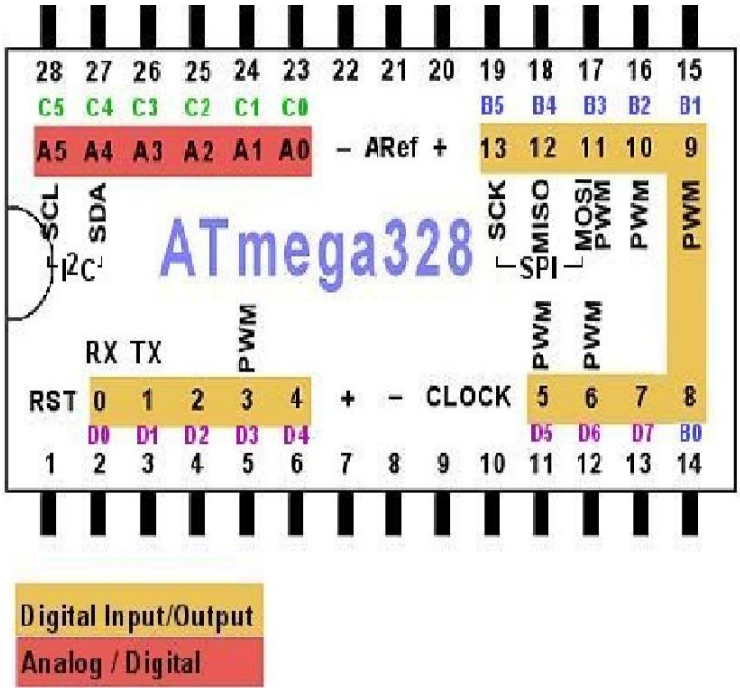


**Fig -3**: Pin out of ATmega328

The maximum operating frequency of ATMEGA 328 is 20 MHz It has external and internal interrupts. Each pin of microcontroller provides 5 Volts, 40mA current. It has 16 digital and 8 analog channels. If we want more than 16 digital channels then we can convert the analog channels to digital channels by using in build ADC (Analog to Digital Converter) by writing the proper code.

### 2.4 Stepper motor

**Fig -4**: Stepper motor

A stepper motor is a brushless, synchronous electric motor that converts digital pulses into mechanical shaft rotation in a number of equal steps. The motor's position can then be commanded to move and hold at one of these steps without any feedback sensor (an open-loop controller) .ANEMA 23 stepper motor is a stepper motor with a 2.3 x 2.3 inch size is chosen to drive the motion of the axes. NEMA 23 stepper motors are high torque about 19KG-Cm holding torque .NEMA 23 stepper motors have 1.8 degree step angle with 2.5A rated current. The speed of rotation is directly proportional to the pulse frequency .The higher the output voltage from the driver, the higher the level of torque drive.

### 2.5 Easy drivers

Easy Driver consist of 16 pins from which we are using in our project only 9 pins. Four pins are used for two stepper motor coil i.e. coil A and coil B. Two pins for input 5volt supply i.e. VCC and GND. Three pins are used for STEP, DIR, GND. STEP is used for microstepping. DIR is direction input pin which will move stepper motor according to the given dimensions. Third pin is directly grounded.

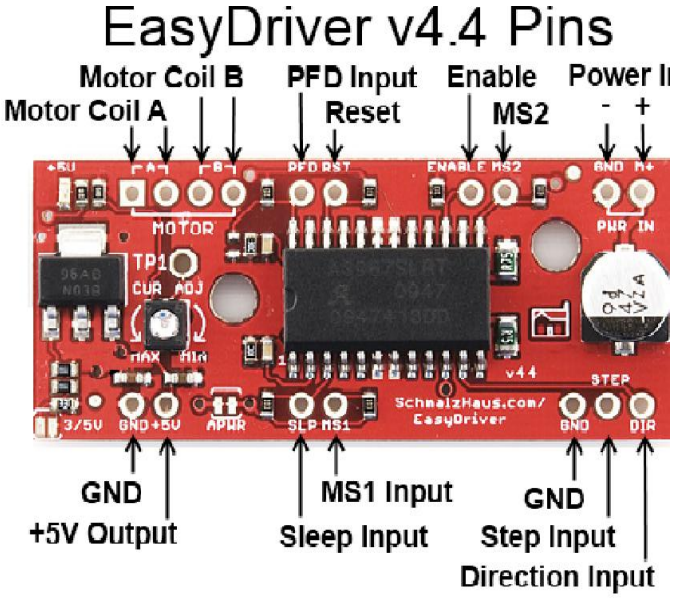


**Fig -5**: Easy driver

### 3. PROCESS DESCRIPTION

Main blocks of this system consists of power supply, FTDI module, ATMEGA328, 3 Easy drivers each connected to stepper motors X, Y, Z. From power supply we get two voltages i.e. +5volt and +12 volt. 5volt which is required to ATMEGA328, Easy drivers whereas +12volt supply is required to stepper motors. RESET is connected to5v supply through 10k ohms resistors to pull up the voltage thus it act as a pull up resistors. We have used here16MHz crystal oscillator connected to ATMEGA with two capacitors of 22pF.

The GRBL code from computer is interface with controller using FTDI 232 module i.e. serial to USB converter. The output of FTDI is given to pin no.2 and 3 i.e. RXD and TXD pins of ATMEGA328. The output of ATMEGA328 is given to three Easy Drivers.

Easy Driver consists of 16 pins from which we are using in our project only 9 pins. Four pins are used for two stepper motor coil i.e. coil A and coil B. Two pins for input 5volt supply i.e. VCC and GND. Three pins are used for STEP,

DIR; GND. STEP is used for micro stepping. DIR is direction input pin which will move stepper motor according to the given dimensions. Third pin is directly grounded.

Spindle motor is connected to pin no. 16 of ATMEGA328. It is used for drilling purpose. According to the given dimensions Easy drivers or drilling machine will move. When working of motors is completed the dimensions on pc will roll of to again its initial value i.e zero.

**Fig -6**: Circuit design

## 4. HARDWARE IMPLEMENTATION

**Fig -7**: Hardware implementation

## 5. CONCLUSION

This setup of hardware with a combination of G-code gives better accuracy and reduces the work load. G code make easy to find the information of locations of all stepper motor moving, as the status of our moving motor are directly seen on computer hence we can start or stop the machine whenever we are needed. Making a small machine brings an flexibility to do work.

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