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Programmable Voltage/Current Output Source with Overflow of Voltage/Current Protection Circuit

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Abstract: ***In this paper, I am designing a programmable current/voltage source, using the analog devices 'industrial current/voltage output driver (ad5750)', '12-bit nano dac (ad5624)'. The output programmable range of current is 4 ma to 20 ma, 0 ma to 20 ma and the output programmable voltage range is 0 v to 10 v, ±5 v, or ±10 v. The circuit is designed for overvoltage and overcurrent protection. The pcb is under design compatible for arduino mega. The applications of this source are process control, actuator control, industrial purpose and plcs.***
Keywords- Digital-to-analog converter (dac), microcontroller (uc), arduino mega 2560, serial peripheral interface (spi).

I. INTRODUCTION

A source is "Programmable currant/voltage output source", which will design for industrial use**.** The aim and objective of this project is to design a PCB which can provide the programmable ranges of current and voltage on a single channel. These output programmable range of current is 4 mA to 20 mA, 0 mA to 20 mA and the output programmable voltage range is 0 V to 10 V, ±5 V, or ±10 V. The schematic circuit of this source will have been designed such that it can protect the used devices from the reverse flow of overvoltage and overcurrent. And the PCB board will design which is compatible for ARDUINO MEGA 2560. In this project, we will interface our PCB with Arduino mega 2560 by the serial communication which is known as serial peripheral interface (SPI). After completing the PCB designing we will burn the programming into the designed PCB board by using language C coding. This designed programmable source is for a laboratory application purpose to calibrate temperature transmitter or any other devices.In this project, we have used the Industrial current and voltage output driver (AD5650), 12 bit nanoDAC (AD5624) to design the programmable current/voltage output source, voltage regulator (UA7805) and for voltage reference (LT1634).

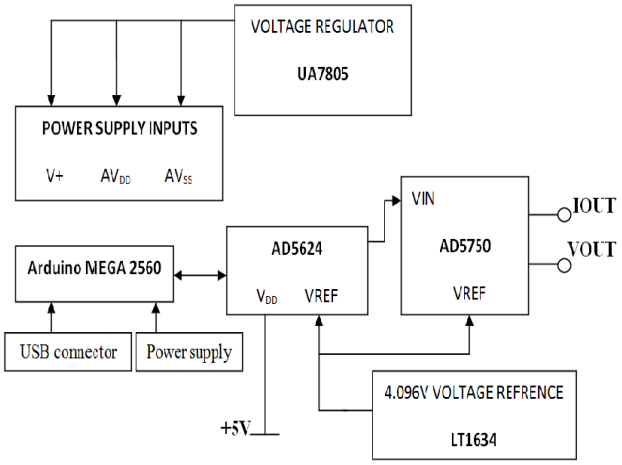

Figure 1.Functional block diagram of the schematic circuit

II. LITERATURE REVIEW

In this project, to get the programmable range of voltage and current we will use the some devices. These are AD5750, AD5624, LT1634 and UA7805. Here AD5750 is a one-channel, less cost, precision voltage/current output drivers with output programmable ranges of hardware or software [1]. The software ranges are configured by using the SPI in this project, which is a serial interface. The applications of AD5750 are in industrial process control and in PLC. The AD5750 is required 4.096V at VIN and also required

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the voltage reference is 4.096V. This analog voltage range at VIN has been provided to this AD5750 from a digital-toanalog converter, which should be single supply and a low voltage device. [2]. Here we have decided to use AD5750 because it provides the programmable ranges [1] and AD5624 provides 12-bit accuracy [2].AD5750 and AD5624 both devices requires the reference voltage to set output range. This reference voltage will have been given by LT1634. In this project, we have decided to give the operating voltage 5V to both devices and the voltage reference 4.096 V. To provide the 4.096 V reference voltages to the both AD5750 and AD5624, we have chosen the LT1634 because it is a micro power, precision, shunt voltage reference [3]. It will provide accurate 4.096 V voltage reference. UA7805 is a voltage regulator [4], which will provide the power supply to the AD5750 and where to need. Here we will give +15V to the UA7805 at input than it will provide +5V at the output [4]. To protect this functional circuit from the reverse over flow of current and voltage, we have decided to design a protection circuit at the output. For protection circuit of over flow of voltage and current, we have decided to use components. These components are bidirectional Schottky diodes, bidirectional TVS diodes, fuses and resisters. TVS diodes serve as parallel protection element, is presents a high impedance to the protected circuit although a small amount of leakage current is present [5]. The transient voltage suppressor operates by shunting excess current when the induced voltage exceeds the avalanche breakdown potential. TVS is a clamping device, and suppress all over voltages above its breakdown voltage. It resets when the overvoltage goes away automatically, but absorbs much more of the transient energy internally than a similarly rated crowbar device [6]. And we will use BAT54 device in protection circuit, it is a bidirectional Schottky diode, which uses as voltage clamping protection circuit [7].

III. WORKING

In this paper, we will describe the working of this source into two parts. These parts are divided such one is whole programmable source and another is its protection circuit.

A. Programmable Source

This is a current/voltage programmable source, which can provide different ranges of current and voltage at the output. These ranges of current and voltage are selected as per our industrial requirements. As we have decided to make such source which provide the required ranges of current and voltage hence these ranges are for current 0 mA to 20 mA, 4mA to 20 mA and for voltage ±5 V, or ±10 V, 0 V to 10 V. These programmable ranges can be generating by hardware mode and software mode by using SPI interfacing. Figure 2 showing the schematic diagram of the desired functionality. This programmable source has designed such that it can compatible with the Arduino Mega 2560. Here, to generate the programmable range we have used Arduino board. In the figure, four devices have been used for main circuit U1 is AD5750, U2 is AD5624, U3 is LT1634, U4 is UA7805, U5 is ADR MEGA 2560. Here U1 is a current/ voltage driver, U2 is a 12-bit digital to analog converter, will provide the V_{in} to the AD5750. U3 is a precision shunt voltage reference, will provide voltage reference of 4.096 V to both U1 and U2. U4 (UA7805) is a voltage regulator which provides the analog supplies to the U1. This regulator provides the fixed positive voltage at the output. In this paper UA7805 providing the 5V power supply to the AD5750 (U1).

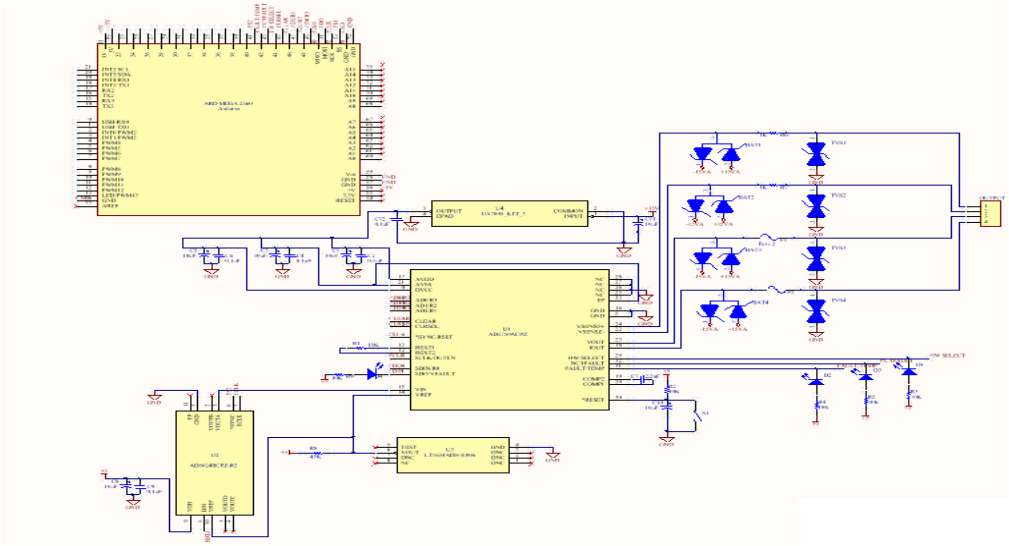

Figure2. Schematic diagram of programmable source

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B. Protection Circuit

A protection circuit, which we have used in this programmable current and voltage source at the output for the protection from reverse flow of over voltage and over current to the AD5750 driver. For this protection circuit we have used some components and devices these are SMBJ16CA, BAT54S, fuse and register. The Figure 3 showing the schematic diagram of protection circuit. The device SMBJ16CA is a 600 watt transient voltage suppressor bidirectional zener diodes. BAT54S is also a bidirectional schottky diodes. Both devices are connected in parallel. Register and fuse are connected in series.

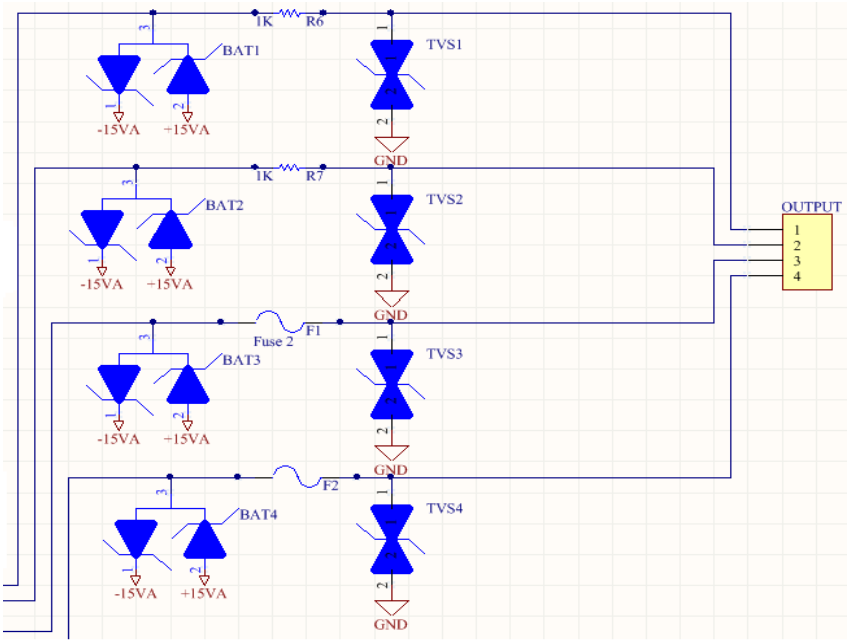

Figure3. Schematic diagram of Protection Circuit

IV. APPLICATIONS

"Programmable voltage and current output source" is a source which will provide the programmable range of current and voltage at the output on the single channel. The output programmable range of current is 4 mA to 20 mA, 0 mA to 20 mA and the output programmable voltage range is 0 V to 10 V, ±5 V, or ±10 V.

The applications of this programmable voltage and current source;

A. process control,
B. actuator control,
C. industrial purpose
D. PLCs.

V. CONCLUSION

This device will provide an accurate Vout of 4.096V at AD5624 which is the Vin of AD5750. And the device LT1634 will provide accurate Vref of 4.096V which is needed to both devices DAC AD5624 and IV driver AD5750. And at the output of the programmable source we have designed a protection circuit which will protect our programmable source from reverse flow of over current and over voltage.

VI. FUTURE WORK

This prepared PCB is designed for to provide programmable ranges of current and voltage at the output as per our required ranges of voltage and current as we have mentioned earlier in this paper. The future advantages can be for same programmable sources of different ranges as per need. And also here we have used microcontroller Arduino mega 2560 to program it at software mode, we can also design the same circuit by using other microcontrollers which can be compatible with it.

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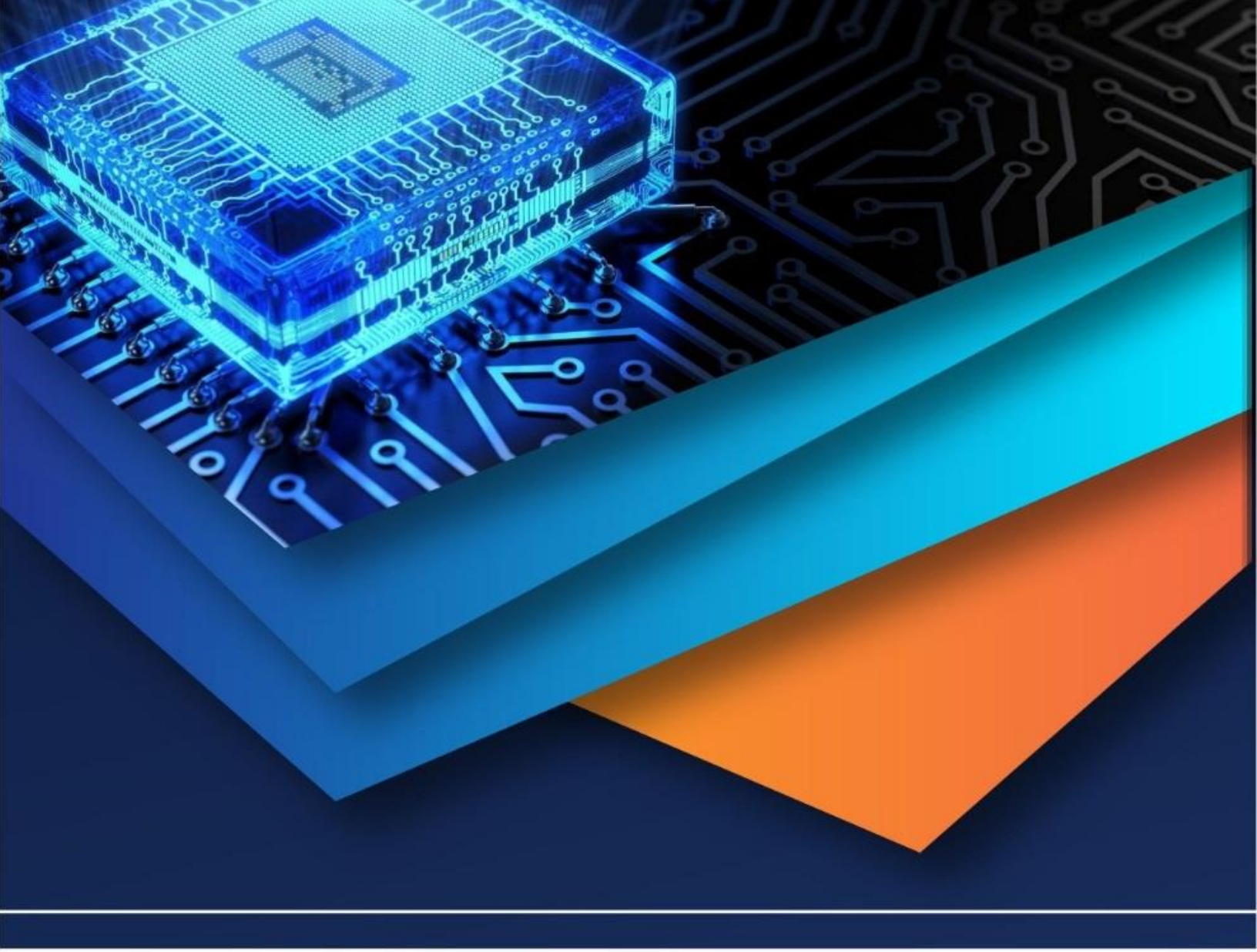

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