Arduino-UNO based Magnetic Field Strength Measurement

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Abstract

The Arduino based gaussmeter is used to measure magnetic field using Hall Effect sensor. In this project the 12-bit MCP3201 (Microchip Technology Analog to Digital Converter) is used. The sensitivity of 12-bit ADC is 819 and operating voltage is 1.22mv.Now the circuit is generally works at 3v & 5v. The WSH 315 Hall Effect sensor has three terminals vcc, ground and vdd. So, one Gauss means 1.5mv.The LCD (Liquid Crystal Display) is used to shows the magnetic field in CGS (Centimeter Gram Second) system. The device is used in physic lab for conducting magnetic field experiment.

Keywords: ADC, Arduino-UNO, Connecting wires, LCD, Small PCB, WSH 315 Sensor

I. INTRODUCTION

First of all, the system input is serial and the processors may be Arduino, ARM, Rasberrypie.If mostly suitable is Arduino Uno board and the output is show in 2 ×16 display. It is operated with a 16MHz crystal oscillator and contains everything needed to support the microcontroller. It is very easy to use as the user simply needs to connect it to a computer with a USB cable or power it with an AC-to-DC adaptor or battery to get started. The microcontroller on the board is programmed in Arduino programming language using Arduino development environment. The magnetic field can be visualized as magnetic field lines. The field strength corresponds to the density of the field lines. The total number of magnetic field lines penetrating an area is called the magnetic flux. The unit of the magnetic flux is the tesla meter squared (T · m2, also called the weber and symbolized Wb). The older units for the magnetic flux, the Maxwell (equivalent to 10-8 Wb), and for magnetic flux density, the gauss (equivalent to 10-4T), are obsolete and seldom seen today. Magnetic flux density diminishes with increasing distance from a straight current-carrying wire or a straight line connecting a pair of magnetic poles around which the magnetic field is stable. At a given location in the vicinity of a current-carrying wire, the magnetic flux density is directly proportional to the current in amperes. If a ferromagnetic object such as a piece of iron is brought into a magnetic field, the "magnetic force" exerted on that object is directly proportional to the gradient of the magnetic field strength where the object is located. In our proposed project we can be able to measure magnetic field strength by using microcontroller specially arduino microcontroller. Arduino has six ADC channels. Any one channel or all of them can be used as inputs for analog voltage. The UNO ADC is of 10 bit resolution. This means that it will map input voltages between 0 and 5 volts into integer values between 0 and 1023. So for every (5/1024= 4.9mV) per unit. In all of this we are going to connect a potentiometer or pot to the 'A0' channel, and we are going to show the ADC result in a simple display. The simple displays are 16x1 and 16x2 display units. The 16x1 display unit will have 16 characters and are in one line. The 16x2 will have 32 characters in total 16in 1st line and another 16 in 2nd line. Here one must understand that in each character there are 5x10=50 pixels so to display one character all 50 pixels must work together, but we need not have to worry about that because there a another controller (HD44780) in the display unit which does the job of controlling the pixels (you can see it in LCD unit, it is the black eye at the back).

II. LITERATURE REVIEW

Gaussmeter is used to measure magnetic field parameters and material magnetic properties .The magnetic field can be called a manifestation of the electromagnetic field caused by move of the charged particles and changes in the electric field. It exerts force on moving charged particles or a conductor with current. The measurement of magnetic induction and strength of magnetic field in AC and DC magnetic fields, performed with using gaussmeter with Hall probe (sensor). When user places the Hall probe in a magnetic field on lateral edges of sensor an electromotive force is generated. A magnetometer is an instrument that

measures magnetism either the magnetization of a magnetic material like a ferromagnetic, or the direction, strength, or relative change of a magnetic field at a particular location. A compass is a simple type of magnetometer, one that measures the direction of an ambient magnetic field. The first magnetometer capable of measuring the absolute magnetic intensity was invented by Carl Friedrich Gauss in 1833 and notable developments in the 19th century included the Hall Effect, which is still widely used. Magnetometers are widely used for measuring the Earth's magnetic field and in geophysical surveys to detect magnetic anomalies of various types. They are also used in the military to detect submarines. Consequently, some countries, such as the United States, Canada and Australia, classify the more sensitive magnetometers as military technology, and control their distribution. Magnetometers can be used as metal detectors: they can detect only magnetic (ferrous) metals, but can detect such metals at a much larger depth than conventional metal detectors; they are capable of detecting large objects, such as cars, at tens of meters, while a metal detector's range is rarely more than 2 metres. In recent years, magnetometers have been miniaturized to the extent that they can be incorporated in integrated circuits at very low cost and are finding increasing use as miniaturized compasses.

III. HOW TO MEASURE MAGNETIC FIELD BY GAUSSMETER.

Turn on your gaussmeter pick up the end of the wire attachment. These is sometimes called as the probe, which has a sensor inside it that helps to measure. Put the magnets on the end of the probe and slide it across the sensors. Hold for a few second and note the highest rating the meter picks up. This is the general way to find gaussmeter, the average person may not really need to measure gauss because most magnet have the rating. If the north pole of the magnet side is positive while the south pole of the magnet side is negative.

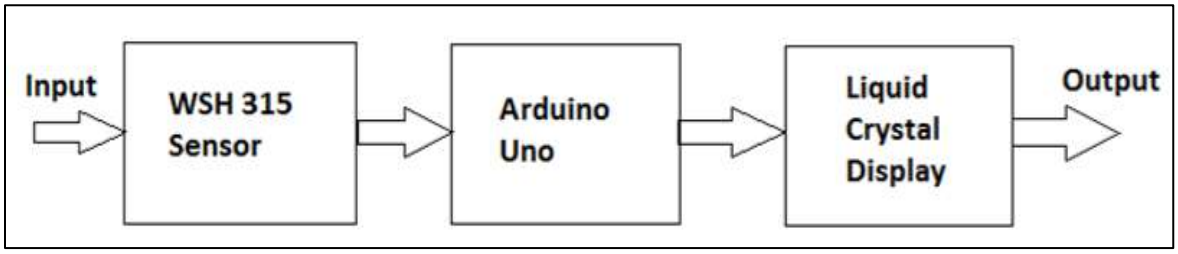

Fig. 1: Block Diagram of Arduino based Gaussmeter

In this block diagram the input is WSH 315 Sensor the serial input is applies to the system .The WSH 315 it has three terminals they are vcc, ground, vdd. W315 can be applied as current sensor, tooth sensor, proximity detectors and motion detectors. As sensitive monitor of magnetic flux, it can effectively measure a system's performance with negligible system loading while providing isolation from contaminated and electrically noisy environments. Magnetic sensors convert magnetic or magnetically encoded information into electrical signals for processing by electronic circuits, and in the Sensors and Transducers tutorials we looked at inductive proximity sensors and the LDVT as well as solenoid and relay output actuators. Magnetic sensors are solid state devices that are becoming more and more popular because they can be used in many different types of application such as sensing position, velocity or directional movement.

They are also a popular choice of sensor for the electronics designer due to their non-contact wear free operation, their low maintenance, robust design and as sealed Hall Effect devices are immune to vibration, dust and water. One of the main uses of magnetic sensors is in automotive systems for the sensing of position, distance and speed. For example, the angular position of the crank shaft for the firing angle of the spark plugs, the position of the car seats and seat belts for air-bag control or wheel speed detection for the anti-lock braking system. Magnetic sensors are designed to respond to a wide range of positive and negative magnetic fields in a variety of different applications and one type of magnet sensor whose output signal is a function of magnetic field density around it is called the Hall Effect Sensor.

The processor is Arduino uno board is used. Arduino Uno is a microcontroller board based on the ATmega. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. "Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards. The LCD is used to display the output. The output of gauss is shown in LCD screen .The rating is gauss in digits that is the CGS system. The Final output is shown in the LCD screen.

IV. HALL EFFECT PRINCIPLE

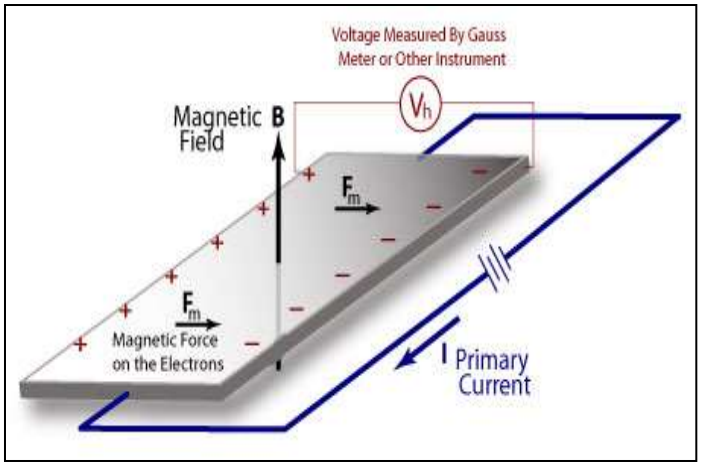

Fig. 2: Hall Effect

The name of the scientist who invent the hall effect is "EDWIN HALL" in 1879.The voltage builds up until the electric field produce an electric force on charges that is equal and opposite to the magnetic force. The effect is knows as Hall Effect. The Hall effect is the production of a voltage difference (the Hall voltage) across a current carrying conductor (in presence of magnetic field), perpendicular to both current and the magnetic field. The Hall Effect is due to the nature of the current in a conductor. Current consists of the movement of many small charge carriers, typically electrons .When a magnetic field is present, these charges experience a force, called the Lorentz force. When such a magnetic field is absent, the charges follow approximately straight, 'line of sight' paths between collisions with impurities, phonons, etc. However, when a magnetic field with a perpendicular component is applied, their paths between collisions are curved, thus moving charges accumulate on one face of the material. This leaves equal and opposite charges exposed on the other face, where there is a scarcity of mobile charges. The result is an asymmetric distribution of charge density across the Hall element, arising from a force that is perpendicular to both the 'line of sight' path and the applied magnetic field.

V. WSH 315 SENSOR & MCP3201 12-BIT ADC

A. WSH 315 Sensor:

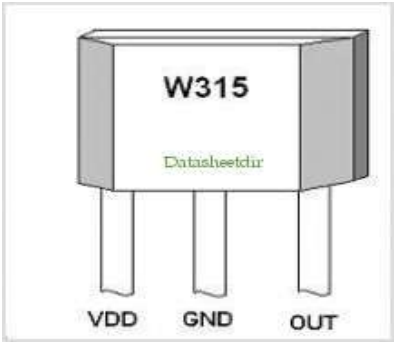

Fig. 3: Hall Effect Sensor

A Hall effect sensor is a transducer that varies its output voltage in response to a magnetic field. Hall effect sensors are used for proximity switching, positioning, speed detection, and current sensing applications .In a Hall effect sensor a thin strip of metal has a current applied along it, in the presence of a magnetic field the electrons are deflected towards one edge of the metal strip, producing a voltage gradient across the short-side of the strip (perpendicular to the feed current). Inductive sensors are just a coil of wire, in the presence of a changing magnetic field a current will be induced in the coil, producing a voltage at its output. Hall effect sensors have the advantage that they can detect static (non-changing) magnetic fields. In its simplest form, the sensor operates as an analog transducer, directly returning a voltage. With a known magnetic field, its distance from the Hall plate can be determined. Using groups of sensors, the relative position of the magnet can be deduced. The WSH315 is a new version of WSH135 with better measuring range and thermal shift. It integrates Hall sensing element, linear amplifier, sensitivity controller and emitter follower output stage. It accurately tracks extremely small change in magnetic flux density –generally too small to operate Hall effect switch. The W315 can be applied as current sensor, tooth sensor, proximity detectors and motion detectors. As sensitive

monitor of magnetic flux, it can effectively measure a system's performance with negligible system loading while providing isolation from contaminated and electrically noisy environments.

B. MCP 3201 12-BIT ADC:

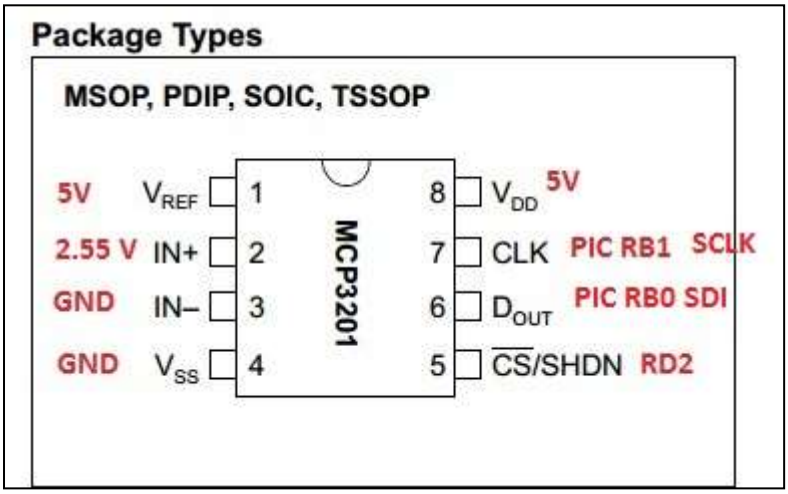

Fig. 4: Pin diagram of 12-Bit ADC

Vref & Vdd = supply voltage 5v.
IN+ = Positive analog input. This input can vary from IN- to VREF + IN-
IN- & Vss = Negative analog input. This input can vary ±100 mV from VSS.

Chip Select/Shutdown = (CS/SHDN) The CS/SHDN pin is used to initiate communication with the device when pulled low and will end a conversion and put the device in low power standby when pulled high. The CS/SHDN pin must be pulled high between conversions.

Serial Clock (CLK) = The SPI clock pin is used to initiate a conversion and to clock out each bit of the conversion as it takes place.

Serial Data Output (DOUT) = The SPI serial data output pin is used to shift out the results of the A/D conversion. Data will always change on the falling edge of each clock as the conversion takes place.

VI. CONCLUSION

All the study which had been reviewed show that, to co-ordinate appliances and other devices through programming language, to effectively receive and sense the magnetic field. To eliminate the need of being physically present in any location for tasks involving the operation of appliances within a household.

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