- Amplitude modulation (AM), in which the voltage applied to the carrier is varied over time
- Frequency modulation (FM), in which the frequency of the carrier waveform is varied in small but meaningful amounts
- Phase modulation (PM), in which the natural flow of the alternating current waveform is delayed temporarily.

4.1.5 Ac to Dc

Both **AC** and **DC** describe types of current flow in a circuit. In direct current (DC), the electric charge (current) only flows in one direction. Steady magnetism along the wire. Electric charge in alternating current (AC), on the other hand, changes direction periodically. Rotating magnet along the wire.

4.1.6 ADC and Processor

The variable O/P DC signal of signal conditioner is fed to Analog to Digital converter IC. ADC IC converts analog signal in to 12 bit binary signal. The processor accepts this digital signal on its data bus, along with this it takes care of keypad, display and serial communication routines. An analog-to-digital converter (ADC, A/D, or A to D) is a device that converts a continuous physical quantity (usually voltage) to a digital number that represents the quantity's amplitude. The conversion involves quantization of the input, so it necessarily introduces a small amount of error. Instead of doing a single conversion, an ADC often performs the conversions ("samples" the input) periodically. The result is a sequence of digital values that have been converted from a continuous-time and continuous-amplitude analog signal to a discrete-time and discrete-amplitude digital signal.

4.1.7 LVDT Sensor

The linear variable differential transformer (LVDT) (also called just a differential transformer, linear variable displacement transformer, or linear variable displacement transducer) is a type of electrical transformer used for measuring linear displacement (position). LVDTs are robust, absolute linear position/displacement transducers; inherently frictionless, they have a virtually infinite cycle life when properly used. As AC operated LVDTs do not contain any electronics. The LVDT converts a position or linear displacement from a mechanical reference (zero, or null position) into a proportional electrical signal containing phase (for direction) and amplitude (for distance) information. The LVDT operation does not require an electrical contact between the moving part (probe or core assembly) and the coil assembly, but instead relies on electromagnetic coupling.

The Single-Channel Indicators can be used in conjunction with LVDTs to make up a comprehensive, reliable, measurement system. The combination can be applied to a wide variety of demanding measurement applications, such as in process gaging in automated assembly machinery, differential measurements in thickness gaging, and other measurements. Utilize the units' programmable set points, relays and you have an economical solution when you need control functions for direct measurements in smaller automated systems. The 4-digit alphanumeric 7-segment displays provide easy to follow setup prompts for all LVDT parameters using the intuitive scrolling text configuration menus.

Most cartridge gage heads operate on a linear variable differential transducer (LVDT) principle. The LVDT is an electromechanical device consisting of a primary coil, flanked by two secondary coils connected in series. All coils surround a movable, magnetic core—the spindle—which provides a path for magnetic flux linking the coils.

4.1.8 Microcontroller

A microcontroller (sometimes abbreviated µC, uC or MCU) is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. Program memory in the form of NOR flash or OTP ROM is also often included on chip, as well as a typically small amount of RAM. Microcontrollers are designed for embedded applications.

4.1.9 Keypad

A keypad is a set of buttons arranged in a block or "pad" which usually bear digits, symbols and usually a complete set of alphabetical letters. Keypad is used to make changes manually in device.

4.1.10 Display

We have used 7-segment display to show the measurement reading. It changes color for output accordingly. We have used Tri-color display so, it would be easy for operators. In this we will use Green, Red and Orange color for simplicity purpose.

4.1.11 Relay

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal.

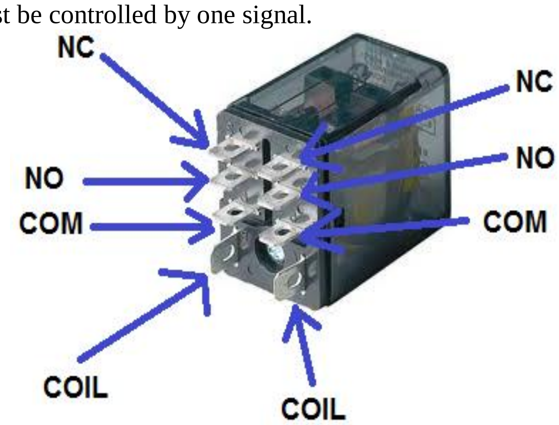

Figure 2: 12v Relay DODT

COIL-This is the COIL terminal. These are the terminals where you apply voltage to in order to give power to the coils (which then will close the switch). Polarity does not matter. One side gets positive voltage and the other side gets negative voltage.

NO- This is Normally Open switch. This is the terminal where you connect the device that you want the relay to power, when the relay is powered, meaning when the COIL receives sufficient voltage. The device connected to NO will be off when the relay has on power.

NC- This is the Normally Closed Switch. This is the terminal where you connect the device that you want powered when the relay receives no power. The device connected to NC will be on when the relay has no power and will turn off when the relay receives power.

COM- This is the common of the relay. If the relay is powered and the switch is closed, COM and NO have continuity. If the relay isn't powered and the switch is open, COM and NC have continuity. This is the terminal of the relay where you connect the first part of your circuit to.

5. Layout and Design of the Set-up

We developed the system made of three different parts. We designed the circuit for the hardware which will be used to collect data from the inductive linear displacement sensor and generate a output of digital data. Signal conditioning circuit was used to filter the sensor signal to the ADC of core microcontroller. We also developed the firmware using the COMP port which is a framework for the AVR microcontroller as the core processing unit of our system. A user interface software in the PC side also been developed written it Embedded C programming language.

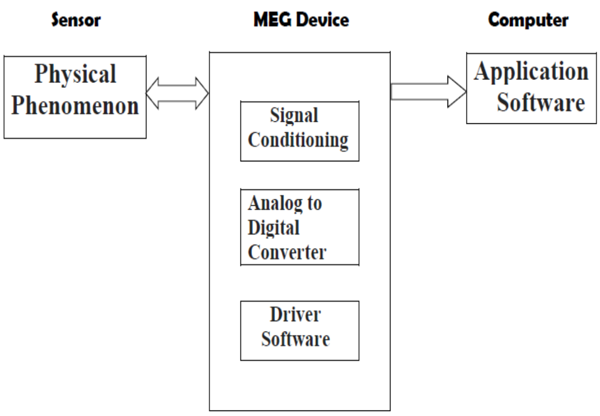

Figure 3: A Schematic of the Design architecture

5.1.1 Hardware Design

The Hardware consists of a signal conditioning unit and a microcontroller. The linear displacement of LVDT is represented as voltage from +2 to -2 volt as output from the sensor. Operational amplifier and voltage level converter IC was used to condition the signal from the sensor and convert it to 0 volt to 5 volt range accordingly. Then we need analog to digital converter to make our analog data to take digital form. After that we need to send the digital data to the bus of PC side interface. We chose AVR microcontroller as it serves the dual purpose of analog to digital conversion and interfacing with the PC with its built In COMP port. Therefore, the hardware construction was done by making the circuit of signal conditioning unit and microcontroller based unit.

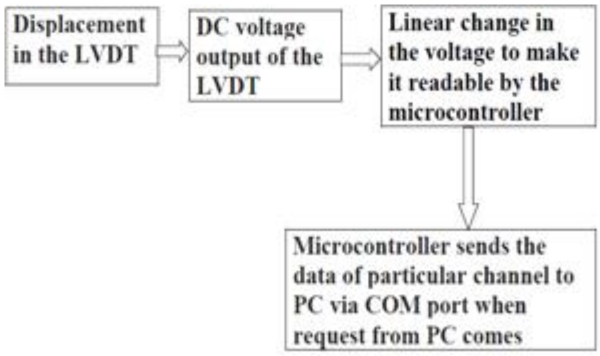

Figure 4: A Circuit Diagram of the Design architecture

5.1.2 Software Design

Section 1:
The software communicates with the hardware with COM port.

In GUI (Graphical User Interface of the software)) the COM port number of the hardware connected to the PC should be entered in the proper text-box.

Section 2:
The COM port number of the 2175 hardware can be found from "Control Panel\Hardware and Sound\Devices and Printers" or Device Manager of the PC.

6. Result and Discussion

Range

The system is designed for the range of -1999 to +1999 microns. But the range can be increased by choosing ADC with high number of bits. The range of the system depends on the transducer.

Resolution

The resolution of the ADC used is 10 mV when V Refis 2.5V as it is a12 bit ADC. So with a change of 10 mV in the input of the ADC, the digital output of the system changes by 1 micron. Therefore the resolution of the system is 1µ.

Accuracy

The output of the designed system is found almost. Linearly proportional to the input displacement. There are a number of factors affecting the accuracy of the system such as unsterilized input AC voltage; the transducer may be non-linear, presence of noise in the circuit components. Though accuracy of the system is somewhat reduced but according to its design it gives quite satisfactory results. Also by using 16-bit ADC, the resolution and accuracy of the system can be increased to a great extent.

7. Conclusion and Future Work

In the static Measuring Electronic Gauging System conventional filtering method employed have limitation in improving the accuracy and in throughput rate. In this case, an alternative technique has been explored to find a solution. It will enable high measurement accuracy and good throughput rate of article measuring. By doing this work we also experienced that it is tough task to get good result with 12-bit ADC under much more noisy circumstances. Thus with the help of this it is possible to design very high precision enhanced measuring scale at low cost. The displacement sensor is useful in various fields of engineering and testing. The described device is a substantially cheap structure for the displacement sensor. Therefore by proper finance and marketing, the device may be a potential replacement for present displacement sensors along with being much more cost-effective.

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