# Operating Solenoid Valve with NI-myRIO using LabVIEW

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*Abstract—* In this article the operation of the solenoid valve is control and monitor through the LabVIEW platform which is interfaced using NI-myRIO component. Solenoid valves can be used in a vast range of Industrial applications, such as general On-off control, pneumatic, hydraulic and process control systems. For example, Domestic washing machines and dish washers also uses these valves to control water entry into the machine. These valves are simply called as "solenoids". We have used the solenoid valve operates with the supply of 230V ac which require for its switching on/off or open/close in its real time process. In order to monitor and control the actions in automatic manner we are going for the LabVIEW based programming implementation.

*Key words:* Solenoid Valve, LabVIEW, NI-myRIO

## I. INTRODUCTION

Extensively solenoids are used as control elements in Fluidics. Based on the electromechanical principle the solenoid valve operates, it converts the electrical energy into mechanical energy which in turn opens or closes the valve mechanically. Their functions are to shut off, release, distribute or mix fluids in many applications. They exemplify some of the features such as fast and safe switching, reliability, long life, compatible medium, low control power and compact designing.



Fig. 1.1: solenoid valve

It comprises of two main parts a solenoid and the valve. There are various accessibility in valve designing. Ordinary valves can have many ports and fluid paths. A 2-way valve has 2 ports; if the valve is open, then the two ports are connected and fluid may flow between the ports; if the valve is closed, then ports are isolated. If the valve is open when the solenoid is not energized, then the valve is termed normally open (N.O.).[1] Similarly, if the valve is closed when the solenoid is not energized, then the valve is termed normally closed. There are also 3-way and more complicated designs. A 3-way valve has 3 ports; it connects one port to either of the two other ports (typically a supply port and an exhaust port.

## II. BASIC OPERATION INVOLVED IN SOLENOID

A solenoid is a modest form of electromagnet consisting of a coil of Insulated copper wire. It activates in the following way:

– When the solenoid coil is electrically energised, it produces a magnetic field that attracts iron and many of its alloys.
– An iron armature or plunger is drawn up into the core of the solenoid.
– A stem and pin or poppet attached to this plunger opens the valve port.
– When the solenoid valve is de-energised, the plunger falls, and the poppet closes the valve port.

Note: This magnetic principle constitutes the basis of design for all the solenoids.
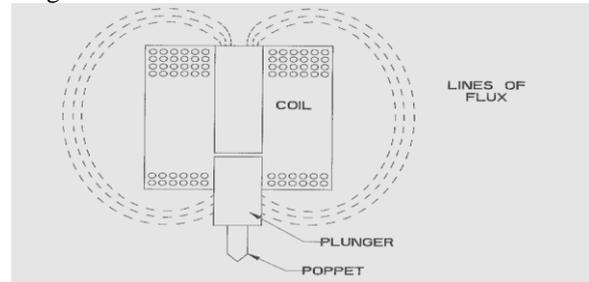


Fig. 1.2: Parts of solenoid

Because solenoid valves are electrically operated, their on-off function can be controlled automatically by suitable control systems. This function is extremely, in terms of system performance.

## III. TYPES OF SOLENOID VALVES

Solenoid valves can be generally classified into two types:
– Direct acting
– Pilot operated

### A. Direct Acting Solenoid Valve Operation:

A small solenoid can generate a limited force. If that force is sufficient to open and close the valve, then direct acting solenoid operation is possible. In a direct acting solenoid valve, the pull of the coil opens the valve port directly, by lifting the pin off valve seat. An approximate relationship between the required solenoid force $F_s$, the fluid pressure $P$, the orifice area $A$ and orifice diameter d for direct acting solenoid valve is,
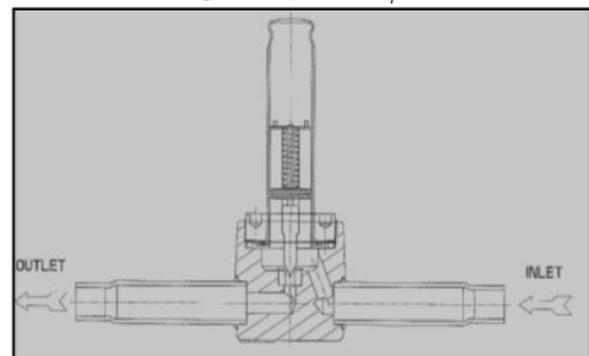
$$F_s = PA = P\pi d^2/4$$



Fig. 1.3: Direct acting type solenoid valve.

### B. Pilot Operate Solenoid Valve:

When high pressures and large orifices are encountered, then high forces are required. [2].To generate those forces, an internally piloted solenoid valve design may be possible. In such a design, the line pressure is used to generate the high valve forces, a small solenoid controls the line pressure or the plunger does not open the main port directly, instead the following operation occurs:

- The plunger opens a pilot port.
- Pressure on the top of a piston is released through the pilot port, thus creating a pressure imbalance across the piston.
- With the pressure underneath the piston now greater than the pressure on the top, the piston will move in an upward direction, opening the main port.
- When the plunger drops, it closes the port, thus the pressure above and below the piston equalizes, and the piston closes the main port.
- The pressure difference across the valve, acting on the area of the main port, holds the piston in a tightly closed position.
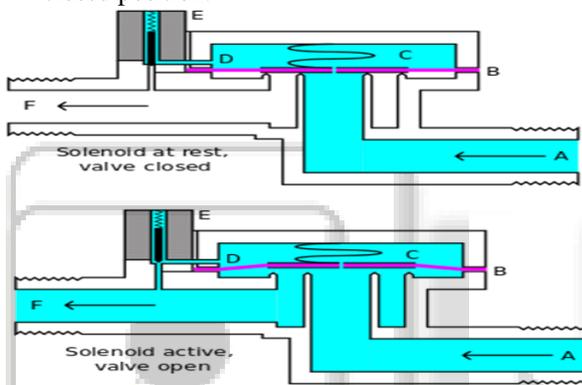


Fig. 1.4: Piloted Type Valve

A~Input side
B~Diaphragm
C~Pressure chamber
D~Pressure relief passage
E~solenoid
F~Output side.

- Application: Internally piloted valves are used in dishwashers and in irrigation systems.

## IV. LABVIEW

Laboratory Virtual Instrument Engineering Workbench (LabVIEW) designed by National Instruments of Austin, Texas, USA. LabVIEW has become the leading application of the graphical programming.

It is growing fast in India with widespread adoption by industries, research institutions, and academia for data acquisition, signal analysis, control and presentation. LabVIEW is also a powerful, Industry-standard graphical development environment. Academic campuses worldwide use the LabVIEW to deliver project based learning to the users unrivalled integration with thousands of hardware devices and provides hundreds of built in libraries for advanced analysis and data visualization LabVIEW can be used across Electrical, Electronics, communication, computer science, Mechanical, Civil, Telecom, Aerospace, Biomedical and many more disciplines. But the most interesting facts is that Graphical Programming paradigm in LabVIEW, which automatically took advantage of a parallel computing architecture, is looking extremely prescient with the advent of multicore microprocessors in computers and FPGA's, in embedded systems.

LabVIEW already runs on all such platforms and its certain to grow exponentially in the coming years.

### A. Components of LabVIEW:

Any instrumentation application will have two components, namely the user interface and the underlying code. In LabVIEW the user interaction takes place through the *front panel* (called the panel in short), while the code itself resides on the *block diagram* (diagram in short).The user sees two overlapping panes, the grey pane is the Panel and the white pane the Diagram. The panel can be populated with two kinds of objects-the controls and the indicators. As the names suggest the control is an input to the code, while the indicator displays the output from the code. Any control or indicator placed on the panel automatically produces an icon in the diagram which is used to connect the code from and to it. Controls can be immediately distinguished from the indicators by their thicker border. A Labview program is stated as to VI (Virtual Instrumentation), sometimes this VI is identical with LabVIEW.

The other key features available are owned free labels.

- Tools and other palettes
- Arranging objects
- Pop-up menus
- Colour coding
- Code debugging
- Context sensitive help
- Creating SUB-Vis

Some of the suggestions for programming in LabVIEW VI:

1) Keep the diagram well-ordered by good positioning of the symbols.
2) Arrange controls and indicators in groups on the panel by using highlighting options and decorative options.
3) Ensure the wiring are properly done and connected clearly to the appropriate terminals, by using the "clean up" diagram.
4) The VI should provide the good resolution for the users it goes up to (1024*768) resolution.
5) Clean coding saves the space and it makes the VI with good impression for the user.

## V. NI-MYRIO
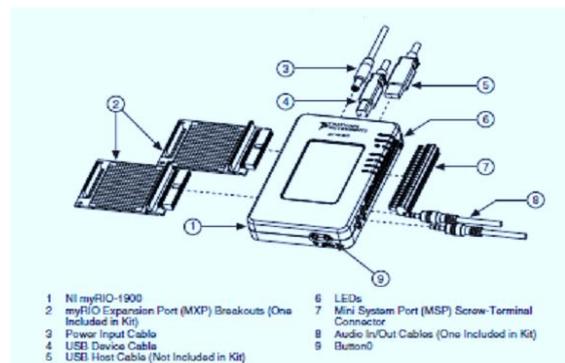
Fig. 1.5: NI-myRIO

The National Instruments myRIO is a portable reconfigurable Input/output (RIO) device that can be used to design control, robotics and mechatronics systems. It supports analog input (AI), digital input/output (DIO), audio and power output in a précised embedded device. The NI myRIO connects to a host computer over USB and wireless 802.11.b.g.n.The following figure shows the components involved in the hardware kit of NI-myRIO.
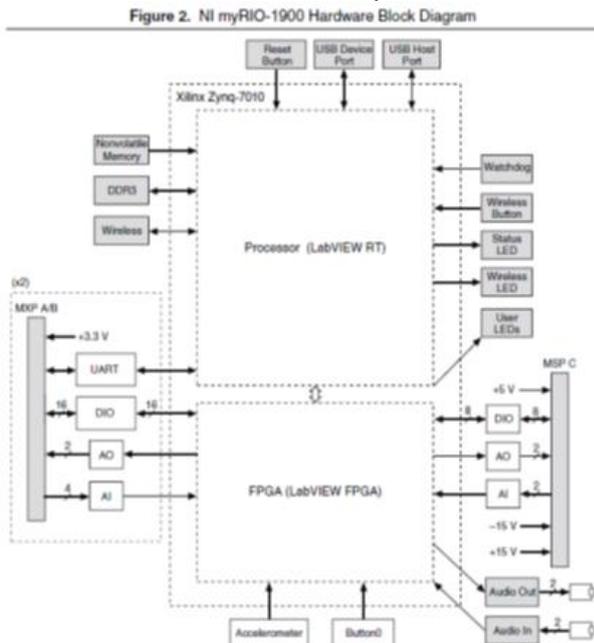


Fig. 2: Hardware block diagram

### A. Hardware Overview of NI-myRIO:

In the NI-myRIO product the processor type configures Xilinx Z-7010, the speed possess by it is 667MHZ and the memory used is non-volatile memory of 256MB, its operating temperature ranges from 0˙ to 40˙.
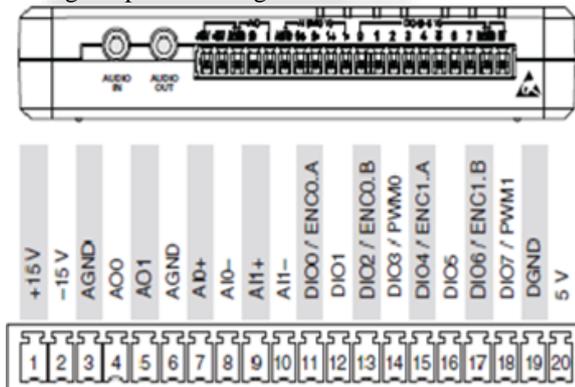


Fig. 2.1: Pinout Diagram

It consists of accelerometer, watch dog timer, UART lines, LED's and buttons. Also it comprises of expansion ports referred as MXP connectors A and B which is carrying identical sets of signals and MSP (Mini System Port) connector C which carries secondary functions as well as primary functions. Power output is of +5V,output voltage ranges from 4.75V to 5.25V,maximum current obtain at each connector is 100mA and power output of +3.3v, the output voltage is from 3.0V to 3.6V and maximum current on each connector is of 150mA,in the digital ports. And the power outputs in the analog port

obtain ranges from +15V and -15V and current of 32mA is provided.

For the operation of solenoid valve of direct acting type, we can use this MSP connector C which supports with the digital output of +3.3v is sufficient and it need furthermore amplification and relay circuits to energize the solenoid valve. The description of the MSP connector is discussed as follows with the pin out diagram and specifications afford in the NI-myRIO.

### B. Driver Circuit for the Excitation of Solenoid:



Fig. 2.2: Driver circuit

Components Involved and operations:
- Relay
- 12v Triac
- 5v Triac
- Transistor
- Supply port

From the NI-myRIO the digital output obtain 3.3 v and 150mA,is used to energize the solenoid valve.so, we need a additional circuit which contains the relay as the major component design to supply 230vac.To trigger this relay external voltage of (12v,1A) is required it is further reduce to (5v,1A) using a 12v Triac and 5v Triac. Then the 3.3v digital pulse gets amplify with transistor. This transistor output triggers the 5v, 1A into the relay to open and supply the 230v ac to the solenoid valve.

## VI. SIMULATION OF SOLENOID IN LABVIEW

The front panel of the solenoid valve is given below and it mainly used to monitor and control the actions of solenoid valve takes .By running the program for the given time period through the iteration method the valve gets open and closes within the range.
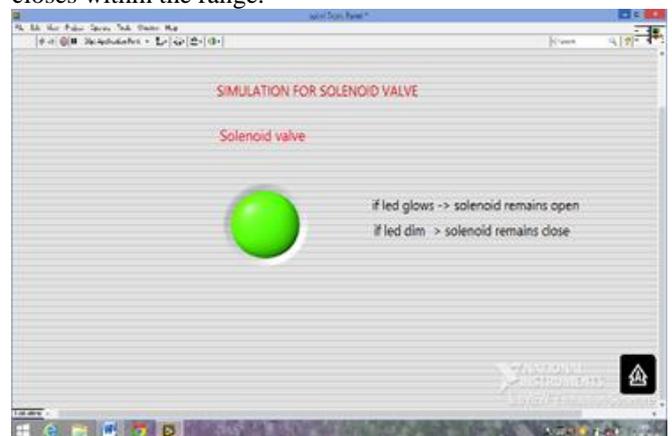


Fig. 2.3: Simulation
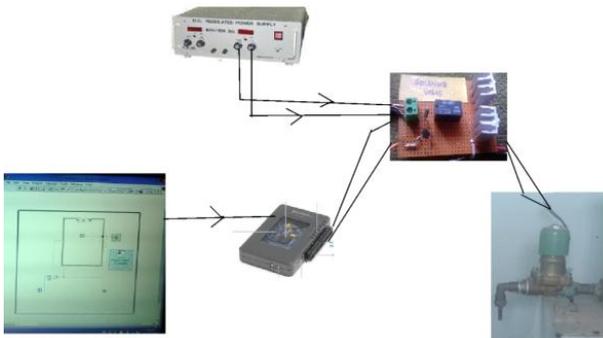
## VII. PROCESS FLOW DESCRIPTION:



Fig. 2.4: Real time connection diagram

Initially the NI-myRIO is interfaced with the labview source(laptop) using USB cable and is power using the power cable of myRIO.The driver circuit needs the regulated power supply of of 12v and the digital pulse from rio is generated at the 5th pin of c-port. Finally,the solenoid is energise using the relay which supply the operating voltage of 230v to the solenoid valve.

## VIII. CONCLUSION

Thus, the solenoid operates with graphical programming of LabVIEW interfaced using the NI-myRIO device along with the hardware components like driver circuit,power source.It helps for beverages industry,pharmaceutical production, and packaging industries.

### REFERENCES

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