IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

ISO 3297:2007 Certified ⁜ Impact Factor 8.021 ⁜ Peer-reviewed / Refereed journal ⁜ Vol. 11, Issue 4, April 2023

DOI: 10.17148/IJIREEICE.2023.11413

Pressure Monitoring using dSPACE

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Abstract: There are seven main types of pressure sensors: Aneroid barometer pressure sensors, manometer pressure sensors, bourdon tube pressure sensors, vacuum (Pirani) pressure sensors, sealed pressure sensors, piezoelectric pressure sensors, and strain gauge pressure sensors. Here, the strain gauge has taken. Output of a strain gauge is being monitored. This strain gauge setup is comprised of sensors.

Numerous factors, including human action and weights, can result in pressure. In this instance, the weights create the pressure. The piezoelectric sensors are used to detect the pressure. The circuit simultaneously transmits a measured signal through dSPACE which the pressure can be monitored. Using Wheatstone bridge circuit, the output of strain gauge has monitored. The performance of strain gauge is evaluated experimentally using dSPACE controller board.

Keywords: Pressure monitoring, dSPACE, Strain gauge, Piezoelectric, Wheatstone bridge(simulink)..

I. INTRODUCTION

Pressure is characterized as the force per area that can be applied by a fluid, gas or fume and so forth on a given surface. The applied strain can be estimated as outright, measure or differential tension.

Strain can be estimated straight by estimation of the applied force or by implication, e.g., by the estimation of the gas properties. Instances of backhanded estimation strategies that are utilizing gas properties are warm conductivity or ionization of gas atoms. Before mechanical manometers and electronic diaphragm pressure sensors were created, pressure was estimated by fluid manometers with mercury or water.

There were many decades of research in the area of pressure monitoring has shown the viability and potential of this technology. Numerous applications have been suggested, and many of them have been experimentally imagined. Pressure transducers are the most useful for data collecting and control applications in industry and laboratories. While the number of applications is almost as numerous as the types of pressure transducers, here are some of the most common applications in which our customers use pressure transducers: measuring inlet, outlet, or system pressure in engine test setup, measuring pressure drops in a line for preventive maintenance, measuring fluid height or level in tanks, measuring slurry/slush pressure using a flush diaphragm pressure transducer, and sanitary pressure transducers in the bio or pharmaceutical industry etc. There are strain gauge transducers available for pressure levels ranging from 3 inches of water to 200,000 psig (1400 MPa). Inaccuracy ranges from 0.1% of the span to 0.25% of full scale.

Piezoelectric materials, which are used in many areas, are one type of adaptive material that can be incorporated with smart structures. Piezo ceramics are an efficient and high-quality actuation and sensing mechanism, and their use as actuators and sensors has significantly grown over the past 20 years. Piezo ceramics has several benefits, including affordability, the lack of moving parts, quick reaction, compactness, and simplicity of use. Compared to other smart materials, problems with signal conditioning, placement, and bonding are simple to solve with piezoceramics.

Pressure monitoring using strain gauge by placing weight on the gauge has been widely studied in the past decade and more dimensions are introduced to improve efficiency. The main design approach for this method is the use of wheatstone bridge simulink circuit. One has to design a bridge for the strain gauge, because strain gauge output is in resistance the bridge will convert it into voltage.

Although previous works have clearly shown the tremendous potential of wheatstone bridge, its applications in pressure monitoring. Therefore, the objective of the present experimental work is to monitoring the output of a strain gauge. The authors believe that the pressure monitoring of strain gauge using dSPACE is the first of its kind.

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II. DESIGN OF STRAIN GAUGE

Strain gauge was designed using matlab simspace components to run in simulation mode is the experiment. The strain gauge with resistance of 350 Ω connected with wheatstone bridge which has three 350 Ω resistors. The resistors are arranged in a way that follows the equation R1/R2=R3/R4, any one of the resistors. If all three resistors resistance and strain gauge resistance remains, the bridge is balanced and the voltmeter shows zero (i.e.no current is flowing through the bridge). If the gauge resistance has changed the bridge will be unbalanced. Hence, the current will be flowing through the bridge. Pressure monitoring using strain gauge experiment is described in table 2.2 in terms of bridge components.

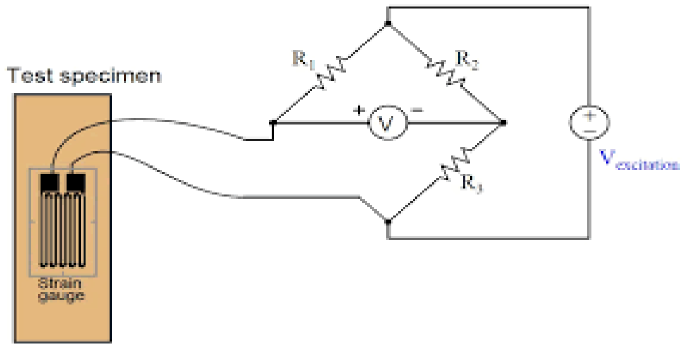

FIG.2.1. STRAIN GAUGE AND ITS CONNECTION WITH BRIDGE

TABLE 2.2 BRIDGE COMPONENTS IN SIMULINK

S. No	SYMBOL/ COMPONENTS	PARAMETERS (with unit)		VALUES	QUANTITY
1.	R	Resistance (Ω)		350	3
2.	Voltage sensor	Voltage(V)		-	1
3.	Strain gauge(E)	Strain(Ɛ)		-	1
4.	Power supply	Voltage(V)		5	1
5.	-PS converter, PS- converter	-		-	1 each
6.	Scope	-		-	2
7.	Display	-		-	2
8.	Constant or uniform random number	-		-	1

III. STRAIN GAUGE

A **strain gauge** is a resistor used to measure strain on an object. When an external force is applied on an object, due to which there is a deformation occurs in the shape of the object. This deformation in the shape is both compressive or tensile is called strain, and it is measured by the strain gauge. When an object deforms within the limit of elasticity, either it becomes narrower and longer or it become shorter and broadens. As a result of it, there is a change in resistance end-to-end. This digital signal is passed to the strain gauge randomly or constant by simulink block and it is monitored by using MATLAB programming. Then it can be also monitored using the ControlDesk7.2.

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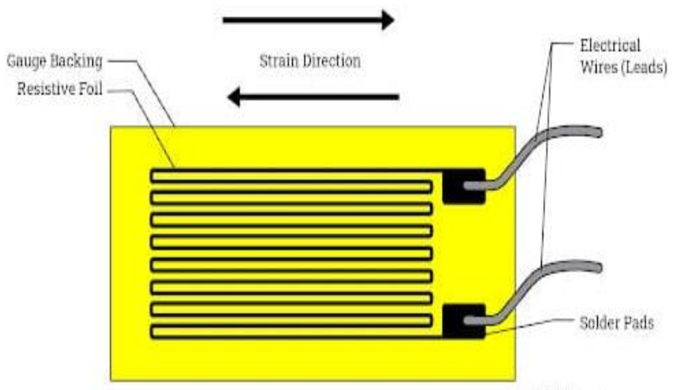

Fig.3.1. Strain gauge

IV. SIMULINK FOR STRAIN MONITORING

4.1 SIMULINK:

Simulink is a graphical extension to MATLAB for system design and simulation. Simulink's ability to model a real time system. Simulink displays systems as block layouts on the screen. Many block diagram components are available, including transfer functions, summing junctions, and virtual input and output devices such as function generators and oscilloscopes.

Data can be readily transferred between the programs because Simulink is integrated with MATLAB. In these tutorials, we will model the systems, create controllers, and simulate the systems using Simulink and examples from the MATLAB tutorials. Simulink is available on Unix, Macintosh, and Windows platforms, and it is included in the MATLAB student edition for desktop computers. These lessons are designed to be viewed in one window while Simulink is running in another. System model files can be obtained and opened in Simulink using the tutorials. These systems can be modified and extended while learning to use Simulink for system design, control, and simulation. Do not mistake the tutorial windows, icons, and menus for your real Simulink windows. The majority of the images in these tutorials are not interactive; they merely show what you should see in your own Simulink windows. All Simulink actions should be performed within the Simulink windows.

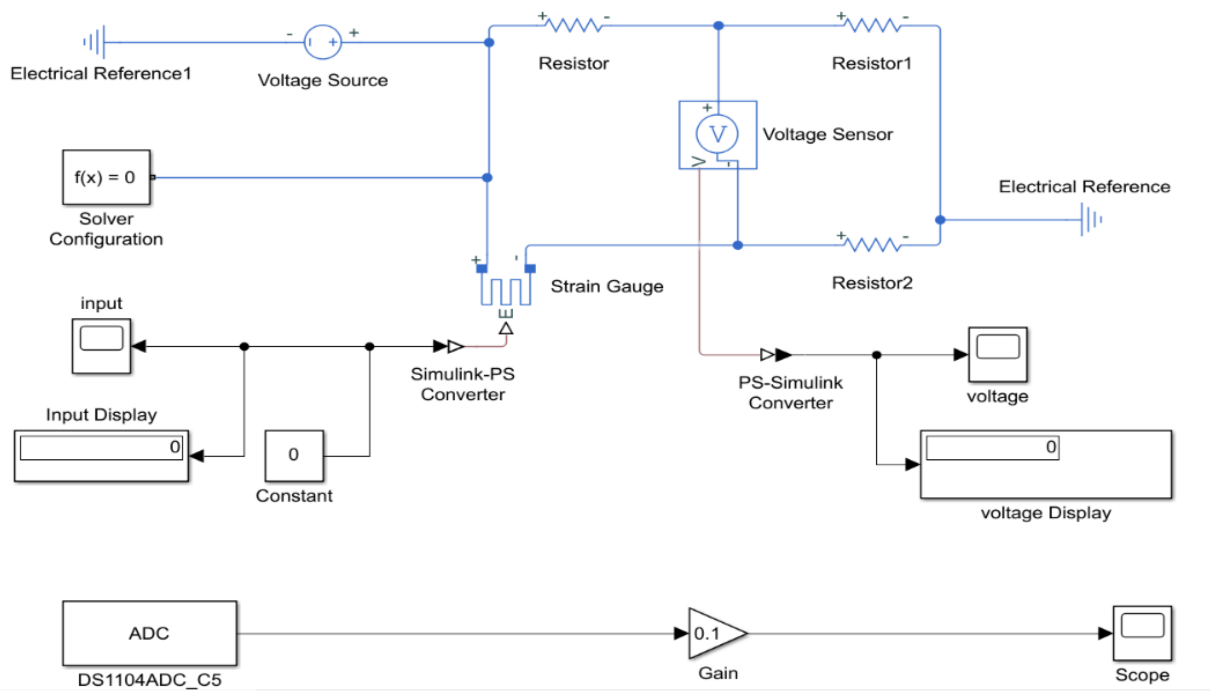

Fig 4.1.1 Simulink of Pressure monitoring

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4.2 CONTROL DESK:

The dSPACE experiment software for seamless ECU creation is Control Desk. It handles all of the required tasks and provides you with a unified working environment.

- Integrated ECU calibration, measurement and diagnostics access (CCP, XCP, ODX)
- Synchronized data capture across ECUs, RCP and HIL platforms, and bus systems
- Powerful lay outing, instrumentation, measurement and post-processing (ASAM MDF)

Control Desk unites functionalities that often require several specialized tools.

It can conduct measurement, calibration, and diagnostics on ECUs, for example, via standardized ASAM interfaces, and has access to simulation platforms as well as connected bus systems. Its adaptable modular structure allows for high scalability to suit the needs of specific application cases. This provides obvious advantages in terms of handling, training requirements, computing capacity, and costs.

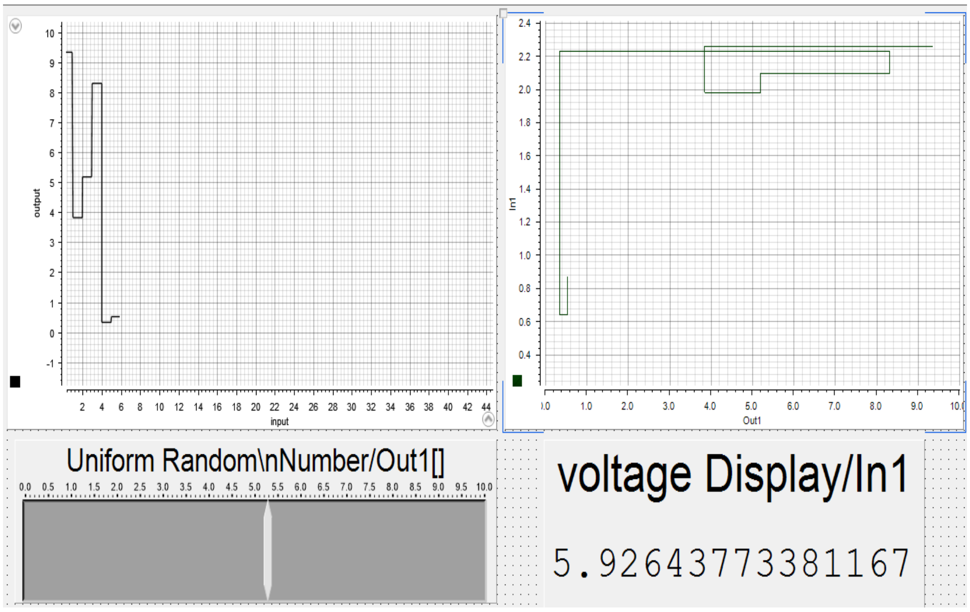

Fig 4.2.1 Control Desk 7.2 Pressure Monitoring

V. WHEATSTONE BRIDGE DESIGN

The wheatstone bridge design to convert the resistance into voltage.

A. Bridge resistance

The resistors are arranged in a way that follows the equation $\frac{R1}{R2} = \frac{R3}{R4}$, any one of the resistors. If all three resistors resistance and strain gauge resistance remains, the bridge is balanced and the voltmeter shows zero (i.e.no current is flowing through the bridge). One of the resistors is replaced by strain gauge (350 Ω). So, other three resistors value also chosen as 350Ω. The Fig5.1. Shows bridge connection.

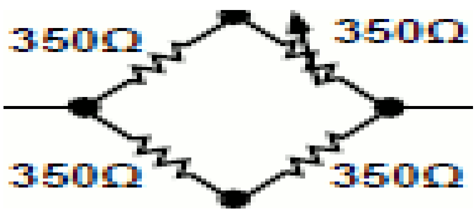

Fig.5.1. Bridge connection

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B. Gauge Factor

Gauge Factor is defined as the ratio of relative change in electrical resistance to the mechanical strain. Here relative change in resistance is defined as the ratio of change in resistance produced due to strain to its original resistance (without strained). It is also referred as Strain factor of a strain gauge. GF = (ΔR / R) / (ΔL / L) = (ΔR / R) / ε

VI. OPERATION

Strain gauge was designed using matlab simspace components to run in simulation mode is the experiment. The strain gauge with resistance of 350 Ω connected with wheatstone bridge which has three 350 Ω resistors. The resistors are arranged in a way that follows the equation $\frac{R1}{R2} = \frac{R3}{R4}$, any one of the resistors. If all three resistors resistance and strain gauge resistance remains, the bridge is balanced and the voltmeter shows zero (i.e.no current is flowing through the bridge). If the gauge resistance has changed the bridge will be unbalanced. Hence, the current will be flowing through the bridge.

The control algorithm is developed using simulink software and implemented in real time on dSPACE 1104 system using RTW and dSPACE real control block diagrams and real time workshop is used to generate C code from the simulink model. The C code is then converted to target specific code by real time interface and target language compiler supported by dSPACE1104. This code is then deployed on to the rapid prototype hardware system to run hardware in-the-loop simulation. Output can be only monitored in the ControlDesk7.2 as it is not available in real-time.

VII. RESULT

The resistors are arranged in a way that follows the e quation $\frac{R1}{R2} = \frac{R3}{R4}$, any one of the resistors. If all three resistors resistance and strain gauge resistance remains, the bridge is balanced and the voltmeter shows zero (i.e.no current is flowing through the bridge). If the gauge resistance has changed the bridge will be unbalanced. Hence, the current will be flowing through the bridge. Voltage across the bridge is measured using the voltage sensor in the simspace components. Output can be viewed in the display. The plot can be viewed through scopes.

7.1 Responses with constant inputs:

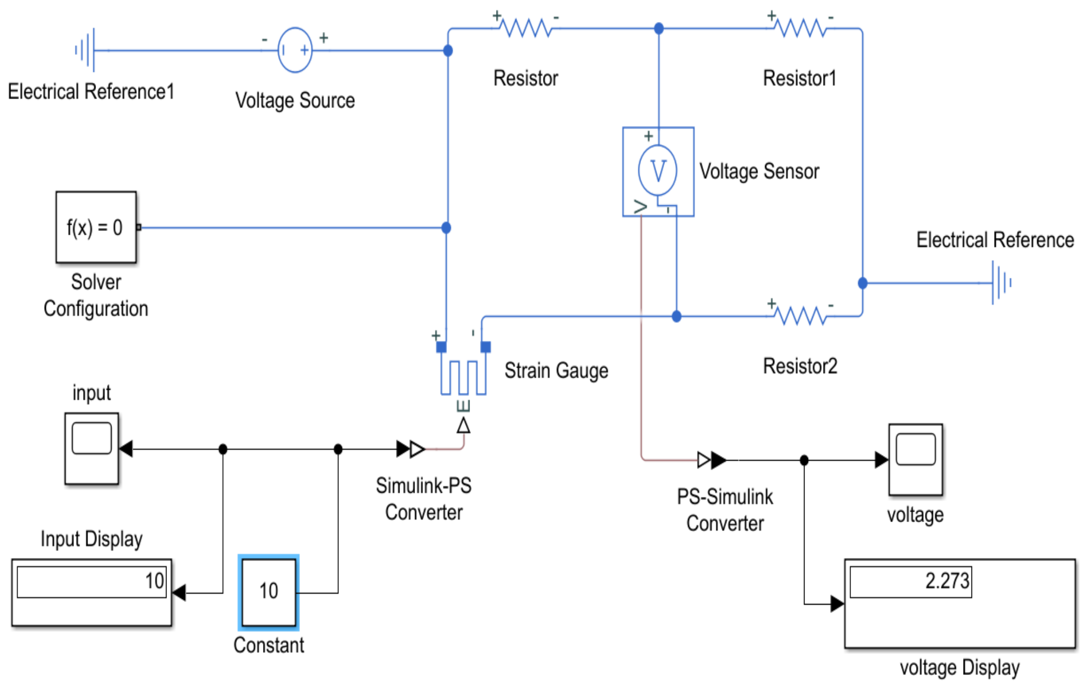

Fig:7.1.1. Block diagram with constant input

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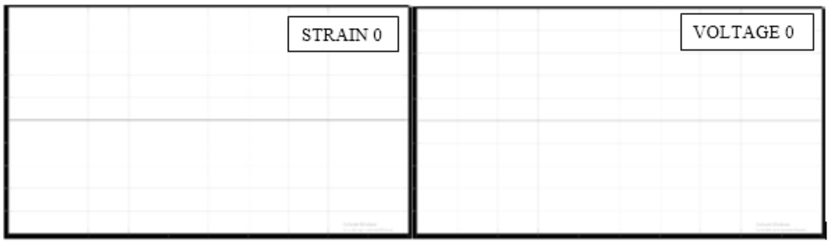

Fig:7.1.2. Matlab response withzero strain

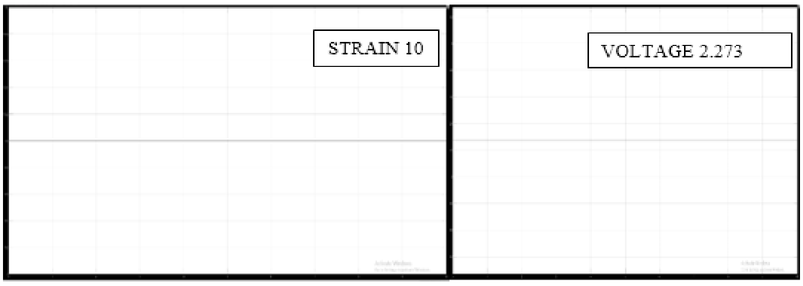

Fig:7.1.3. Matlab response with strain

7.2 Responses with random inputs:

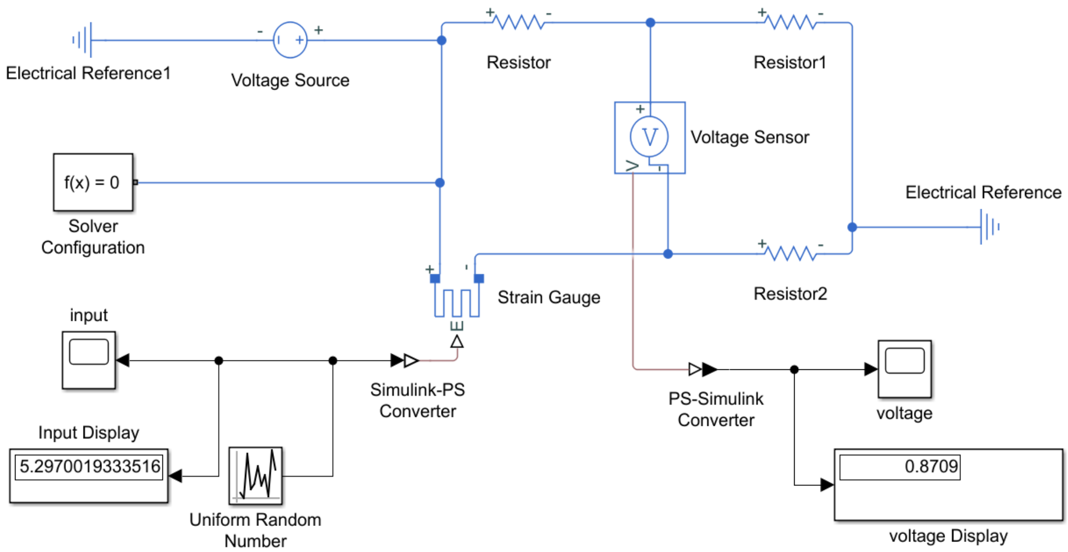

Fig:7.2.1. Block diagram with random input

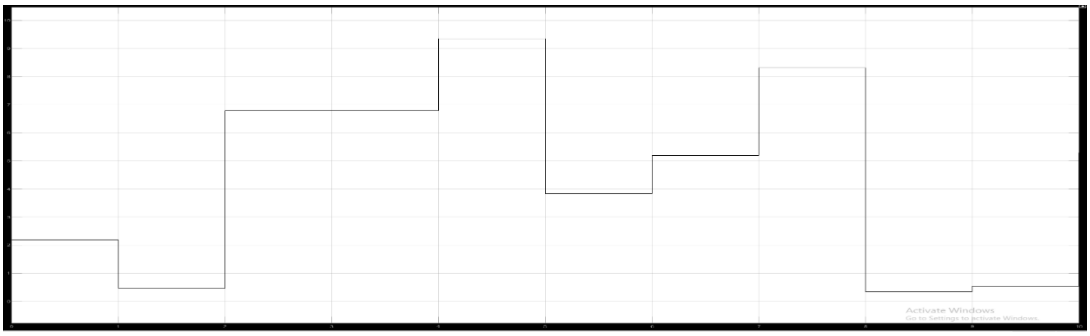

Fig:7.2.2. Matlab input response with random strain

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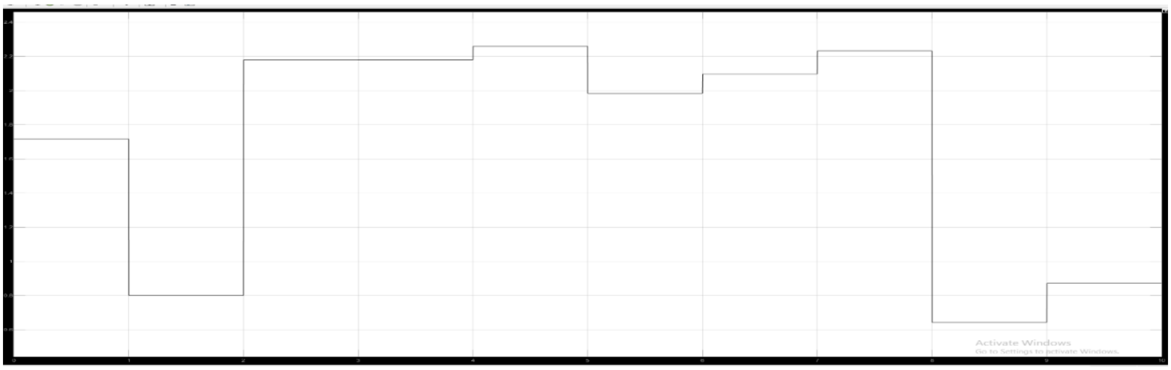

Fig:7.2.3. Matlab output response with random strain

7.3 Responses with random inputs:

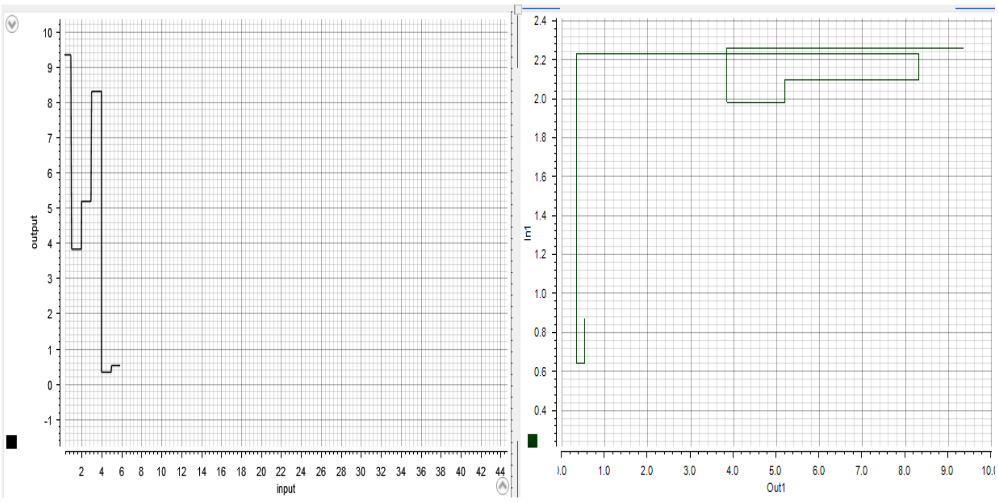

Fig:7.3.1. ControlDesk7.2 I/P & O/P response with random strain

VIII. CONCLUSION

This paper presents a monitoring of pressure by strain gauge. Change in resistance will be converted into voltage by wheatstone bridge circuit. From the experimental results it is observed that for zero input the output voltage will be zero. The experimental results demonstrate very good performance and simplicity of the bridge.

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