Instrumentation Design for Load Cell Using LabVIEW

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Abstract- *The aim of the paper is to form a signal conditioning circuit with the elements such as load cell and instrumentation amplifier. The Load cell is a transducer which is used to measure force or pressure or weight applied on it. The load cell is used for Original Equipment Manufacturer (OEM) applications which include electronic scales and weighing machines. The strain gauge load cell may have a difficulty in providing stable weight measurements. The value will move up and down continuously for the same weight. The change in weight is mainly due to the presence of moisture in the load cell or load cell cable. To prevent the difficulty in changing values, the condition of the load cell junction box and trimming circuit must be checked whether it is damaged or contaminated with moisture. The load cell produces its actual output in milliVolt (mV). The variation of voltage when load is applied is also very low. In order to do further processing, an instrumentation amplifier is added. The output of the load cell is given to the instrumentation amplifier. The instrumentation amplifier is a high gain differential amplifier which amplifies the output of the load cell. The output of the amplifier is then used for further processing. Here the further processing includes acquisition of the output voltage from INA125P to LabVIEW through myRIO. The gain of the instrumentation amplifier can be varied depending upon the gain resistance* R_g.

Keywords- Load cell, Instrumentation amplifier, LabVIEW, myRIO.

I. INTRODUCTION

1.1 LOAD CELL

Load cell is a transducer which is normally used to measure the force or weight. It produces an electrical signal corresponding to the force applied on it. As the load is applied to the correct spot on the load cell, a proportional electric signal is provided by the strain gauge [2].

Here the load cell used is CZL601.It is a strain gauge type single point load cell. In a strain gauge type load cell the strain gauges in a fashion similar to the resistor arrangement in a whetstone's bridge. The excitation source voltage of load cell is 9V-12V.

When load is applied on the load cell two of these strain gauges undergo compression and the other two undergo tension, therefore change in resistance undergoes. These change in resistance is based on the fact that when length of a conductor changes its resistance changes.

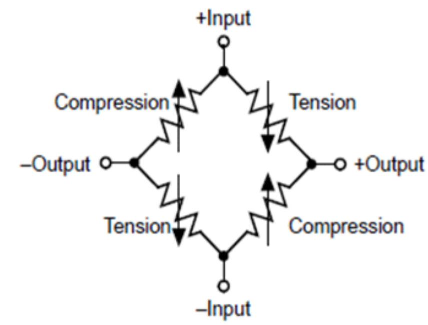

Fig 1-Load cell working diagram

To provide the highest possible output, strain is distributed uniform with gauges in the gauge area at the maximum strain location. For different measured, the load cell response can change. In a system as the mass contributes to inertial parameters, when a load is applied the characteristics of the load cell changes [3].

Fig-2 CZL601 load cell

It is noticed that when the load is applied on one side of the load cell, the output increases and on the other side it decreases. In order to take to have a linear value of output voltage the load is applied on the increasing voltage side making the other side fixed. This arrangement is similar to a cantilever beam arrangement.

The output of the load cell is in the range of very few mV. So to acquire it using myRIO an instrumentation amplifier is used.

1.2 INSTRUMENTATION AMPLIFIER

In analog signal processing applications, the instrumentation amplifier is used for the purpose of voltage mode measurement. The output of the load cell is in the range of very few millivolts. In order to do further process such as acquisition the output voltage of the load cell has to be amplified. For amplifying such small voltages we normally use an instrumentation amplifier. An instrumentation amplifier is a high gain dc coupled differential amplifier which is used in circuits where high accuracy and stability are required. The instrumentation amplifier used here is INA125 P by Texas instruments.

The small differential signals provided by the transducers in which there may be a large common mode signals or levels are amplified using instrumentation amplifier. The bridge arrangement of resistors i.e. strain gauge is an example where the strain is converted into resistance which provides the differential output voltage in mV. The instrumentation amplifier has high Common Mode Rejection Ratio (CMRR) and it amplifies the differential output voltage signals to volts [4].

The instrumentation amplifier is powered up with the single supply (+15V).The gain of the amplifier depends on the formula,

$G=4+ (60K\Omega/R_g)$

The output voltage of the amplifier is given by the formula

$Vo= (V_{IN}^{+}- V_{IN}^{-}) G$

It can be seen that the gain of the amplifier depends upon the resistance Rg. Therefore by changing the resistance Rg the desired gain for the amplifier can be obtained.

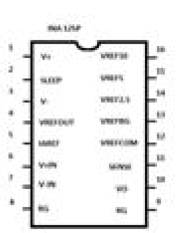

Fig 2-Instrumentation amplifier

2. NI MULTISIM

Multisim is a simulation and circuit design software. It is a design approach which helps to save prototype iteration, reduce design errors and optimise printed circuit board design earlier in the process. It is an unified environment used to teach concepts in analog, digital and power electronics.

3. LOAD CELL WITH INSTRUMENTATION AMPLIFIER

3.1 SIMULATION USING MULTISIM

The load cell is given as a bridge circuit with four resistances on all the sides. The instrumentation amplifier is provided with a supply voltage of 15V. The gain resistance Rg is connected between the terminals 8 and 9 and all other necessary terminals are given corresponding to the circuit diagram.

The output of the amplifier is taken from the pin 10. The SENSE (pin 11) and OUT (pin 10) are shorted and the output is measured with the help of a multimeter.

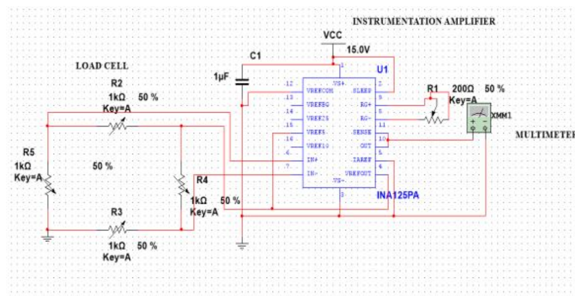

Fig 3-Simulation using Multisim

The above diagram shows the simulation of load cell using INA125P.

4. NI LABVIEW

LabVIEW is a software used for wide variety of applications. It is a graphical programming language. LabVIEW can be connected to wide variety of instruments by interfacing ranginging from traditional boxes to software-defined PXI modular instruments to acquire nearly any measurement. For this instrumentation design LabVIEW is interfaced with myRIO to acquire the output voltage from the loadcell to LabVIEW.

5. NI MYRIO

NI myRIO is an embedded device used to "do real-world engineering". It is a reconfigurable and reusable tool. It featued as as all programmable system on-chip (SoC) to unleash the power of NI LabVIEW system design in both the real-time application and FPGA level. For the current application, the output signals from the instrumentation amplifier are acquired with the help of myRIO.

II. HARDWARE IMPLEMENTATION

After completion of the simulation part, the hardware implementation is done.

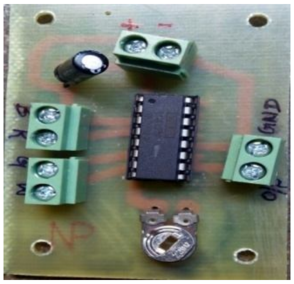

Fig-4 Hardware implementation of load cell with instrumentation amplifier.

The above diagram shows the PCB layout of instrumentation amplifier INA125P with its pins.

It could be seen that a potentiometer is attached to the circuit. The potentiometer is used in the place of R_g. The gain of the circuit can be varied by simply changing the resistance value in the POT.

III. ACQUISTION THROUGH MYRIO:

After the hardware implementation part is over, the output voltage from the instrumentation amplifier is acquired to LabVIEW using myRIO. Since the input voltage is an analog form of voltage the analog input pin of the myRIO is configured and the analog ground pin is configured as the ground pin. Then configuring myRIO, a waveform chart is connected to note the change in the voltage when the force is applied to the load cell.

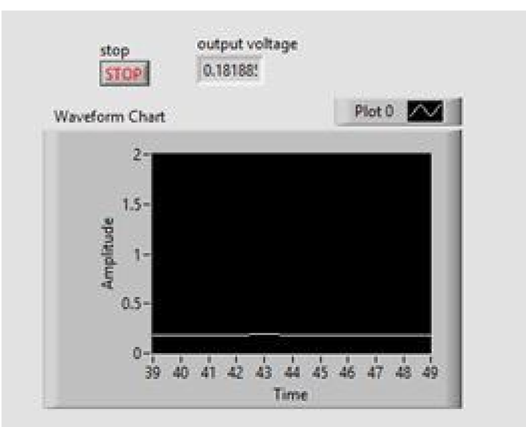

Fig5- Front panel of LabVIEW when no load is applied.

It can be seen from the chart that the output voltage remains at a constant level when no force is applied. The output voltage value remains at a nominal level for no load condition.

When force or weight is applied on the load cell a sudden increase in the voltage of the load cell is measured which can be seen in the above diagram.

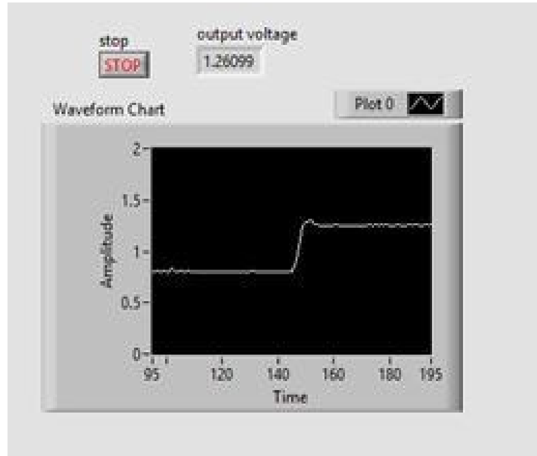

Fig6- Front panel of LabVIEW when load is applied.

The analog output voltage value indicated is also increased because of placing a load of say 3Kg to the load cell.

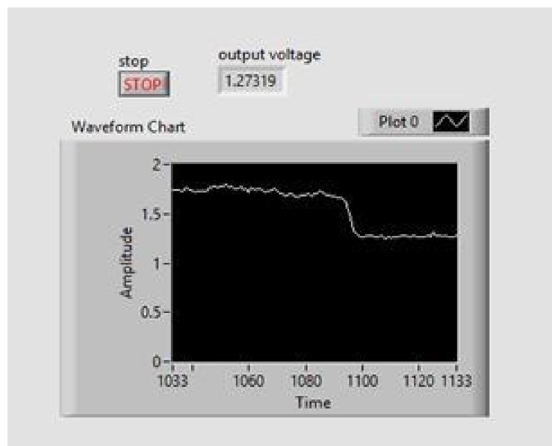

Fig7- Front panel of LabVIEW when load is removed.

The similar way when the load is reduced from 5kg to 4kg the sudden drop in voltage is observed and the voltage value is also indicated.

IV. RESULTS

When the load cell is loaded with weights directly over the load cell or indirectly through plastic or a steel plate the following results are obtained.

LOADING EFFECT DIRECTLY TO THE LOADCELL

TABLE I

LOAD (Kg)	LOADING OUTPUT VOLTAGE (VOLT)	UNLOADING OUTPUT VOLTAGE (VOLT)
0.0	0.15	0.15
1.0	0.42	0.18
2.0	0.76	0.35
3.0	1.12	0.71
4.0	1.43	1.05
4.5	1.67	1.67

LOADING EFFECT WITH STEEL OVER THE LOADCELL

TABLE II

LOAD (Kg)	LOADING OUTPUT VOLTAGE (VOLT)	UNLOADING OUTPUT VOLTAGE (VOLT)
0.0	0.22	0.23
1.0	0.55	0.28
2.0	0.76	0.46
3.0	1.35	0.64
4.0	1.67	1.25
5.0	1.95	1.95

LOADING EFFECT WITH PLASTIC OVER THE LOADCELL

TABLE III

LOAD (Kg)	LOADING OUTPUT VOLTAGE (VOLT)	UNLOADING OUTPUT VOLTAGE (VOLT)
0.0	0.20	0.19
1.0	0.50	0.34
2.0	0.84	0.54
3.0	1.26	0.83
4.0	1.52	1.27
5.0	1.87	1.87

V. CONCLUSION

Thus the instrumentation design for load cell is designed through the process of signal conditioning and calibration. And also the measurement of the load cell using Labview serves to be a method which finds great industrial applications such as force and torque measurement, load measurement in food processing industries and in measuring instruments such as weight or force measuring scales. Thus this method provides accurate measurement and control for industrial applications. For the time variant processes measurement, the proposed method of instrumentation design will serves good experience.

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