# "Smart instrumentation for the process used in rubber injection Moulding machine."

**An Internship Project Report**

*Submitted in Partial Fulfillment of the Requirements for the Degree of*

## BACHELOR OF TECHNOLOGY

## IN

## Instrumentation and Control Engineering


By

Name of Student: Neep Patel(17BIC034)

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**May 2021**

# CERTIFICATE

This is to certify that the Major Project Report entitled "**Smart instrumentation for the process used in rubber injection moulding machine**" submitted by **Mr. Neep Patel (17BIC034) & Mr. Abhishek Khatri (17BIC003)** towards the partial fulfillment of the requirements for the award of degree in **Bachelor of Technology** in the field of **IC Engineering** of **Nirma University** is the record of work carried out by him under our supervision and guidance. The work submitted has in our opinion reached a level required for being accepted for examination. The results embodied in this major project work to the best of our knowledge have not been submitted to any other University or Institution for award of any degree or diploma.

**Date: 17th May, 2021**

**Industry - Guide**

Mr. Pritesh Nar
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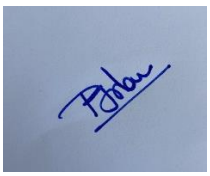
## TO WHOMSOEVER IT MAY CONCERN

This is to certify that **Mr. Neep Patel (17BIC034) & Mr. Abhishek Khatri (17BIC003),** a student of B.Tech. in **Instrumentation and Control** from Institute of Technology, Nirma University worked in **Kloeckner Desma Machinery Private Limited** as a project trainee during 3-1-2021 to 3-5-2021(4 months). During this period, he was found regular and had done his/her project on "**Smart instrumentation for the process used in rubber injection moulding machine**", under my supervision.

He has worked with utmost dedication and high level of engineering and analytical competence.

We wish him all the best for his future endeavors.

Date: 17-05-2021



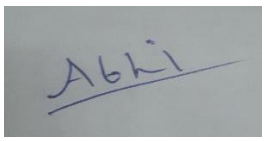
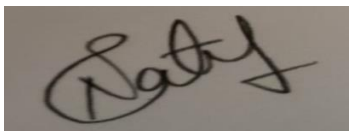
Mr. Pritesh Nar

Kloeckner Desma Machinery Pvt ltd.

Prof. Alpesh Patel

## Undertaking for Originality of the Work

I, Neep Patel, Roll No. (17BIC034) and Abhishek Khatri Roll No. (17BIC003), give undertaking that the Major Project entitled "Smart instrumentation for the process used in rubber injection moulding machine" submitted by me, towards the partial fulfillment of the requirements for the degree of Bachelor of Technology in Instrumentation and Control of Nirma University, Ahmedabad, is the original work carried out by me and I give assurance that no attempt of plagiarism has been made. I understand that in the event of any similarity found subsequently with any other published work or any project report elsewhere; it will result in severe disciplinary action.

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Signature of Student

Date: 17-05-2021

Place: Nirma niversity

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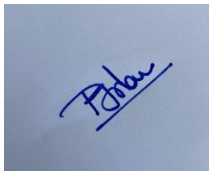
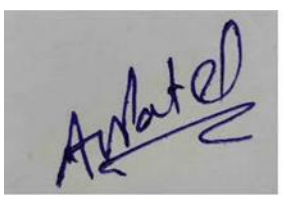

# ACKNOWELEDGEMENT

We would like to thanks Pritesh Nar sir (Guide) for giving us opportunity to work on the internship project in company named Kloeckner Desma Machinery Private Limited which are foremost Manufacturer, Trader & Service Provider of rubber injection moulding machines.
Special thanks to our guide Prof. Alpesh Patel to give us a grateful guidance and a support.
I would like to express my very great appreciation for his valuable and constructive suggestions during the Internship work. His willingness to give his time so generously has been very much appreciated. When we were working in this internship project, we faced many difficulties and problems but our guide helped us.

I am also grateful to the whole IC department for their consistent support and assistance, it was great sharing premises with all of you during last four years. Thanks for all your encouragement!

# ABSTRACT

Smart instrumentation involves one or more digital network communication. In this each and every sensor has microprocessor and memory. It has wireless internet connection. Nowadays, industries are trying to convert their manual sensors into smart sensors to make the work easy and more productive. It also includes transmitters and actuators which can monitor their own performance. Smart instrumentation will help industries in improving product quality with the time management, it will increase employee's satisfaction and safety of the workers. As its sensors and other parts can analyze the data on their own, they can inform about the health and maintenance of the system. The aim of project is to apply smart instrumentation on rubber injection moulding machine to enhance its accuracy, safety and minimize maintenance. And for that we used Data Acquisition Modules, ADAM 4017+ and Modscan64 is used to monitor data coming from other device with Modbus protocol. LabVIEW is used to process the data and then using mobile application Data Dashboard the data is taken of any sensors that can be used in ADAM 4017. By doing so, it can be modified in industry to send and analyze the data of machinery's sensor to its observer.

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## Nomenclature:

## FIFO:

At the point when the First-in-First-Out (FIFO) standard is applied, the material that has been plasticized first is infused into the Mold. This outcomes in an even abide season of the compound in the infusion unit at a steady stock pressing factor.

## Modbus:

Modbus is an information interchanges convention initially distributed by Modicon (presently Schneider Electric) in 1979 for use with its programmable logic controllers (PLCs). Modbus has become an accepted standard correspondence convention and is presently an ordinarily accessible methods for interfacing modern electronic gadgets.

## RS 485:

RS-485 (presently known as EIA/TIA-485) is a standard interface of the actual layer of correspondence, a sign transmission strategy, the first level of the Open System Interconnection model. RS-485 has been made to grow the actual capacities of RS-232 interface.

# 1. Introduction

This project was carried out at Kloeckner Desma Machinery Private Limited that manufactures the rubber injection moulding machines and also provide system solutions. They provide the machines as the client's requirement on the basis of how much modification they want. They have the ability to manufacture the machines with vertical clamping 500 kN to 40,000 kN of clamping force and 80 cm3 to 25,000 cm3 of Injection volumes. Main parts of this machine are control panel, oil tank, rubber injecting unit (FIFO), coolant, valve block, motor pump, heating plate.


*Figure 1Benchmark s3 series rubber moulding machines*

The instruments used in these industries play a vital role in providing safety and satisfaction to the workers. As this industry has many risks such as the safety of operating persons, health of machines as the high melted rubber is used smart instruments plays a vital role in terms of safety, flexibility, maintenance free and highly efficient. To make it so they use Safety Light curtain sensor at every space where the chances of accident happening is more, proximity sensors at every door, using many more such sensors, they take care of every part of machine. To keep eyes on working and performance of machine they have thermocouples at heating plate, oil tank and injection unit; flow meter in oil pipe; level sensors in oil tank and pressure sensors are around the moulding.

In these machines all sensors are not transferring data to the server. In this project by using IOT we implemented wireless communication and sent data to server. We connected the server to android phone so we can see data anytime anywhere from the phone.

Our goal is to apply smart instrumentation on rubber injection moulding machine to enhance its accuracy, safety and minimize maintenance.

# 2. Smart Instrumentation

## 2.1 What is smart instrumentation?

In smart Instrumentation each and every sensor is connected to wireless internet connection. It is done by using ADC, microprocessor and memory. Since sensors are connected to internet, we can access the machine remotely from anywhere.

## 2.2 Why smart instrumentation?

If we implement smart instrumentation, it has lot of advantages like remote access, data analysis, predictive maintenance etc.

For example, Smart Instrumentation can be used in motors to predict health and to achieve predictive maintenance. There are different parameters and data through which we can analyze and do predictive maintenance. Parameters like vibration, noise, rpm, power consumption and temperature. As given below chart we can see the different parameters different time frames before which we can predict the failure in motor. In many industries there are giant and costly motors if motor failure occurs then there are chances of big loss. This could be prevented .

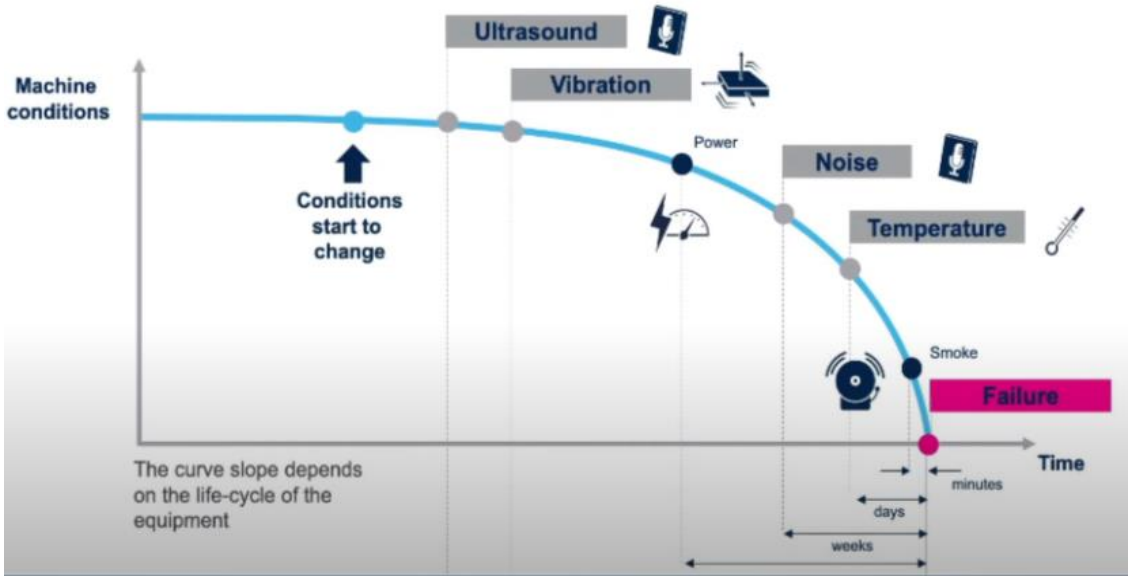


*Figure 2: Time duration of failure prediction and frequency relation*

Here is an example of predictive maintenance of motor by applying smart instrumentation and sensing frequency of motor.

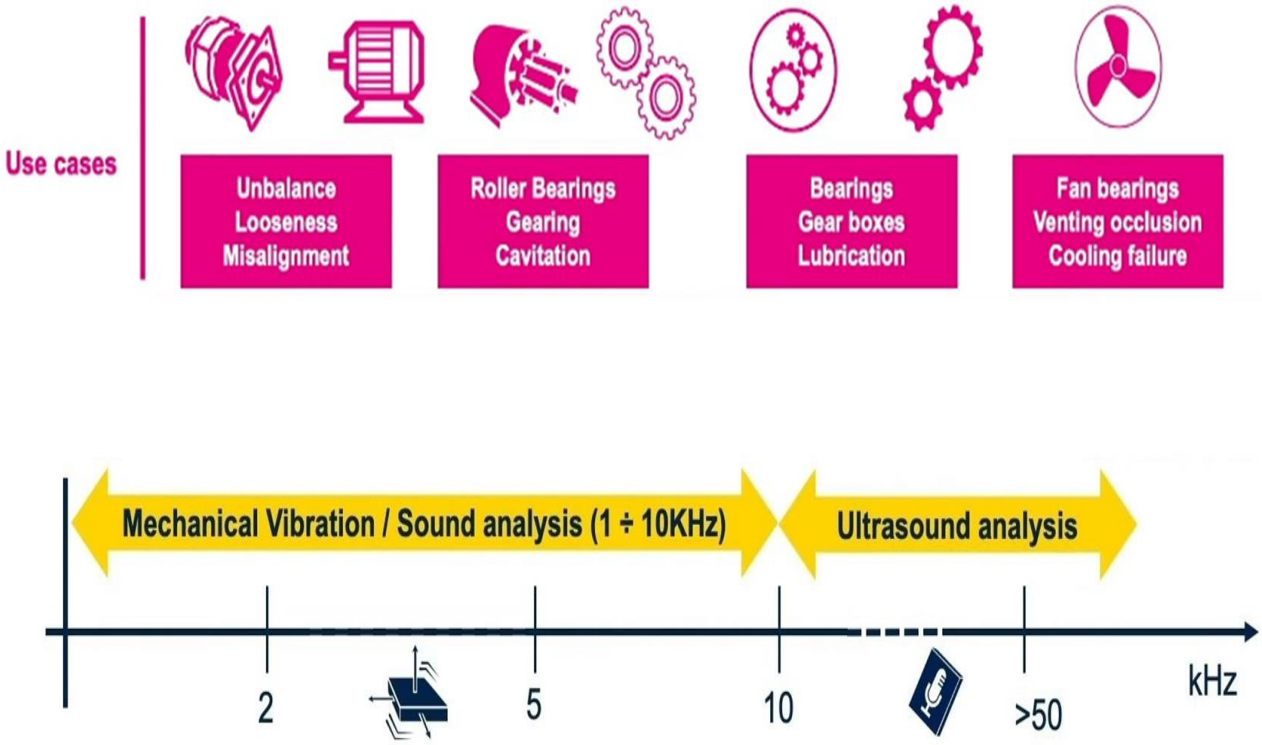


*Figure 3: Types of failure prediction and frequency relation*

# 3. Components

## 3.1 ADAM 4017+

**Specification of ADAM-4017+:**

Resolution: 16-bit

Channels: 8-channel analog input module (current or voltage)

Voltage range: ±150 mV ±500 mV ±1 V ±5 V ±10 V

Current range: ±20mA, 4~ 20 mA

3000VDC isolation protection

Watchdog timer to recover the system

Protocols: Modbus RTU, ASCII

Interfacing is done using RS485


*Figure 4: ADAM -4017+ Module*

### 3.2 USB to RS 485

*Figure 5: USB to RS 485 Converter*

USB to RS485 Converter is a smart module which interfaces with a PC USB port giving a fast offbeat RS-485 sequential port. The USB-485 Converter gives simple availability between the PC and standard correspondence ports, not needing any PC reconfiguration, task of IRQs or jumper settings.

### 3.3 Thermocouple

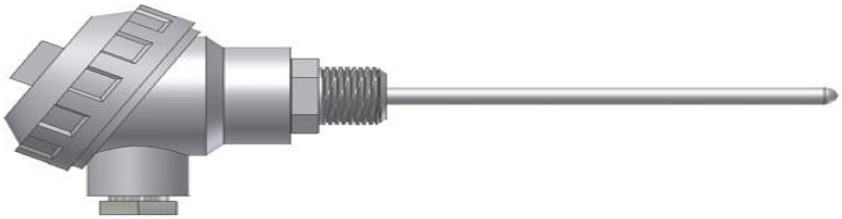

*Figure 6: Thermocouple*

Thermocouple is used at many places in rubber injection molding machine. So, we decided to acquire data of temperature from machine. There is main two parts from which we should acquire data.

1 injection unit

2 Oil tank

### 3.4 SMPS (Switched Mode Power Supply)

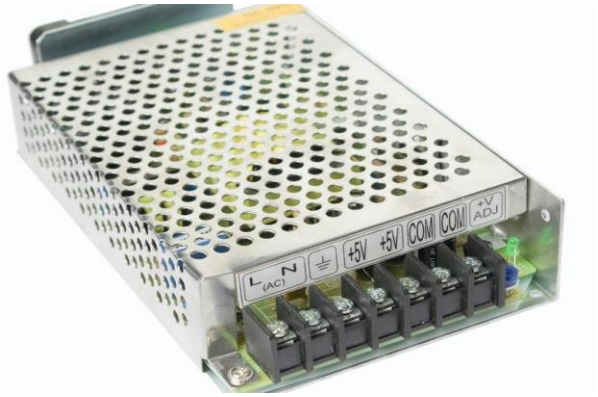


*Figure 7: SMPS (Switched Mode Power Supply):*

SMPS (switched-mode power supply) is used to get controlled DC power supply. A switched-mode power supply is an electronic power supply that incorporates a switching regulator to convert electrical power efficiently. Like other power supplies, an SMPS transfers power from AC to DC or DC to DC.

## 4. Understanding Modbus RS 485 Protocol

Modbus RTU is an open serial protocol derived from the Master/Slave architecture. It is a widely accepted serial level protocol due to its ease of use and reliability. It is supported by almost every commercial SCADA, HMI, OPC Server and data acquisition software program in the marketplace. This makes it very easy to integrate Modbus compatible equipment into new or existing monitoring and control applications.

A Modbus RTU Master is a single Master bus. It sends a message to an RTU slave device and gets an answer. Modbus RTU is limited to a single master. Only one set of signals can be on the RS485 link at any one time. Either the single RTU Master is transmitting or one of the RTU Client devices is transmitting.

**RTU Encoding**

An encoding mechanism describes how bit patterns are formed from the control and data values that are encoded into the packet. Both the sender and the receiver must use the same encoding to correctly understand the contents of the data. There are two mechanisms for encoding Modbus messages: ASCII and RTU.

RTU encoding is the much more common encoding mechanism used on Modbus. RTU simply means that values are encoded as standard big-endian binary. That means that in the case of 16-bit values, the Most Significant Byte (MSB) is encoded prior to the Least Significant byte (LSB). An 8-bit value like decimal 41 (29 hex) is encoded simply as 0010 1001. Whereas a 16-bit value like decimal 300 (12C hex) is encoded as 0000 0001 0010 1100. The MSB of 01 is encoded and transmitted prior to the LSB of 2C.

**MODBUS RTU Memory Map**

| **ModbusRTU Data Type** | **Common name** | **Starting address** |
|---|---|---|
| **Modbus Coils** | **Bits, binary values, flags** | **00001** |
| **Digital Inputs** | **Binary inputs** | **10001** |
| **Analog Inputs** | **Binary inputs** | **30001** |
| **Modbus Registers** | **Analog values, variables** | **40001** |


A transmitted Byte is coded as 8 Bit binary value, hexadecimal 0 – 9 and A – F. The least significant Bit is sent and received first.

**Baud Rate**

There are no methods for automated recognition of baud rates. The same baud rate must be utilized by the Slave(s) and Master connected to the bus. No specific baud rate is specified by the Modbus: typical baud rates are 9600 or 19200.

**Data Types**

There are only two data types in Modbus: coils and registers. Coils are simply single bits. The bits can be ON (1) or they can be OFF (0). Some coils represent inputs, meaning they contain the status of some physical discrete input. Or they represent outputs, meaning that they hold the state of some physical discrete output signal. Registers are simply 16-bit unsigned register data. Registers can have a value from 0 to 65535 (0 to FFFF hexadecimal). There is no representation for negative values, no representation for values greater than 65535.

**The address field** of a message frame contains two characters (ASCII) or eight bits (RTU). The individual slave devices are assigned addresses in the range of 1 ... 247.

**Function Field**

The Function Code field tells the addressed slave what function to perform. The following functions are supported by Modbus poll

| | | | |
|---|---|---|---|
| 01 | READ | COIL | STATUS |
| 02 | READ | INPUT | STATUS |
| 03 | READ | HOLDING | REGISTERS |
| 04 | READ | INPUT | REGISTERS |
| 05 | WRITE | SINGLE | COIL |
| 06 | WRITE | SINGLE | REGISTER |
| 15 | WRITE | MULTIPLE | COILS |

16 WRITE MULTIPLE REGISTERS

**As we have READ HOLDING REGISTERS in the project**

**Request**

The request message specifies the starting register and quantity of registers to be read. Example of a request to read 0...1 (register 40001 to 40002) from slave device 1:

| Field Name | RTU (hex) | ASCII Characters |
|---|---|---|
| Header | None | : (Colon) |
| Slave Address | 01 | 0 1 |
| Function | 03 | 0 3 |
| Starting Address Hi | 00 | 0 0 |
| Starting Address Lo | 00 | 0 0 |
| Quantity of Registers Hi | 00 | 0 0 |
| Quantity of Registers Lo | 02 | 0 2 |
| Error Check Lo | C4 | LRC (F A) |
| Error Check Hi | 0B | |
| Trailer | None | CR LF |
| Total Bytes | 8 | 17 |

**Response**

The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte. For each register the first byte contains the high-order bits, and the second contains the low-order bits.

Example of a response to the request:

| Field Name | RTU (hex) | ASCII Characters |
|---|---|---|
| Header | None | : (Colon) |
| Slave Address | 01 | 0 1 |
| Function | 03 | 0 3 |
| Byte Count | 04 | 0 4 |
| Data Hi | 00 | 0 0 |
| Data Lo | 06 | 0 6 |
| Data Hi | 00 | 0 0 |
| Data Lo | 05 | 0 5 |
| Error Check Lo | DA | LRC (E D) |
| Error Check Hi | 31 | None |
| Trailer | None | CR LF |
| Total Bytes | 8 | 19 |

# 5 Software configurations

## 5.1 ADAM UTILITY

Adam Utility is software for Advantech device from which Adam devices input/output can be programed or configured. For programming arrangement of the ADAM modules, the "Adam.Net.Utility" utility is utilized, provided on the CD along with the ADAM module. The IDAM modules are like ADAM modules along with comparative correspondence choices (ADAM ASCII convention). ADAM modules of 4000 arrangement All modules of this arrangement utilize its own correspondence convention ADAM ASCII.

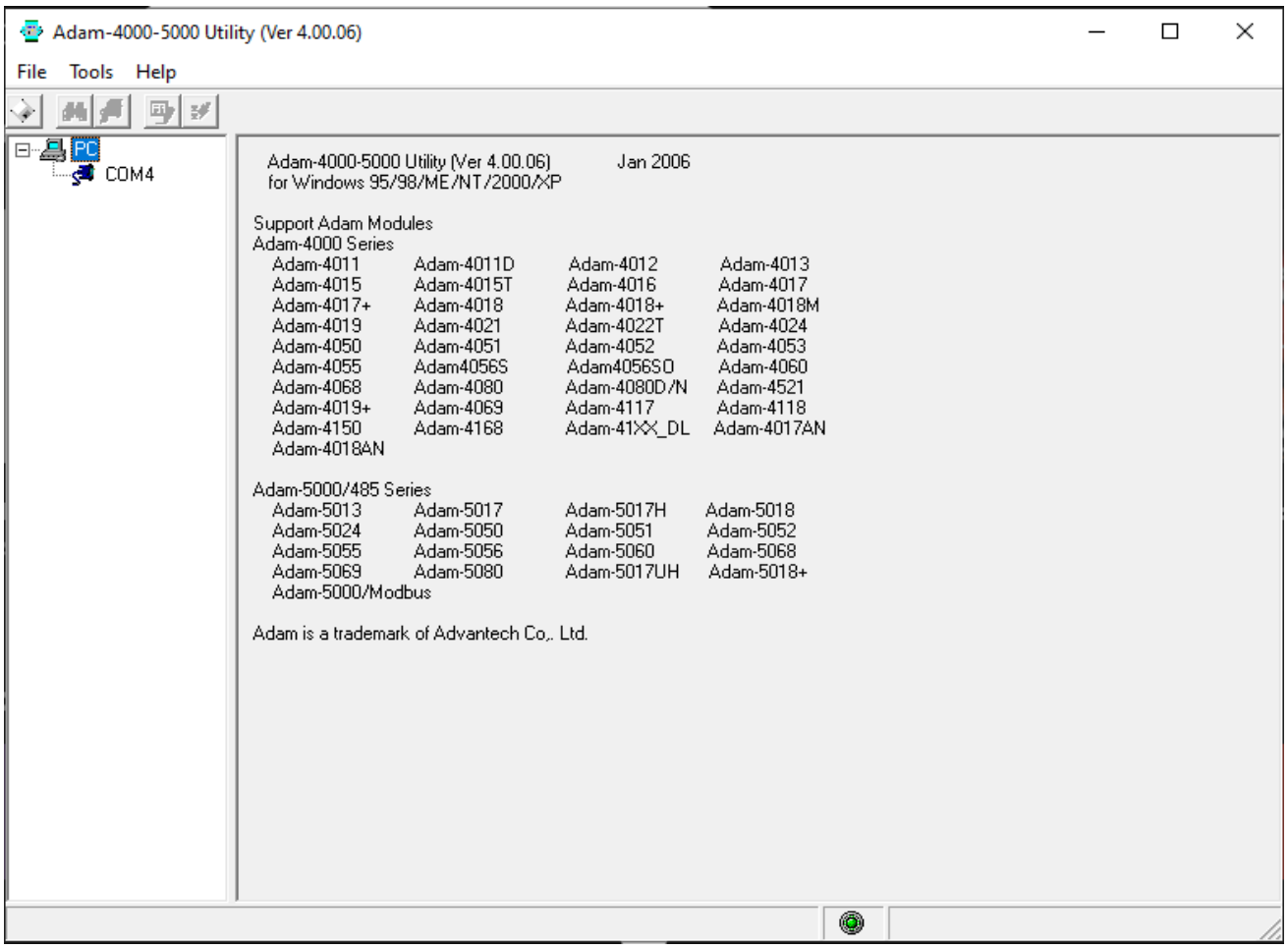


*Figure 8 : Adam utility*

## 5.2 Modscan64

Modscan64 is utilized as a MODBUS Master gadget for getting to information focuses in an associated PLC viable slave gadget. Like it's 64-digit predecessor, ModScan64 is planned principally as a testing gadget for confirmation of right convention activity in new or existing frameworks. Expansions have been worked in to permit outsider information procurement through Control Automation schedules. ModScan64 permits various records to be opened, each effectively examining a progression of information focuses from at least one associated MODBUS slaves. Curls and registers, might be perused or potentially composed from any open ModScan64 record utilizing MODBUS Commands 01-06.

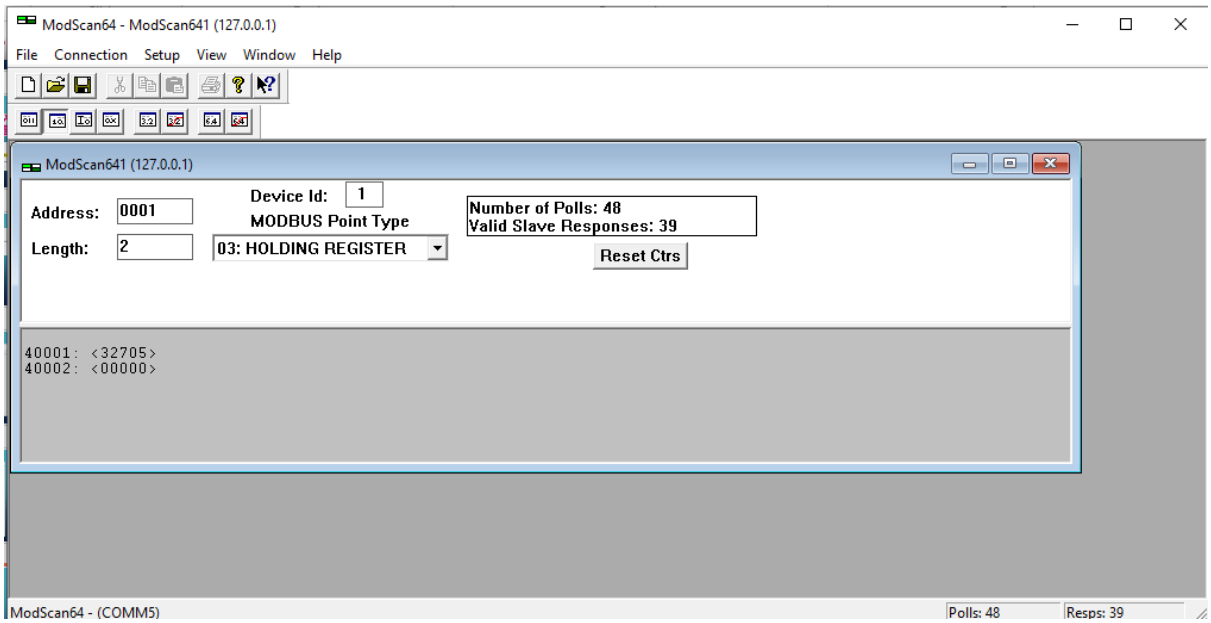


*Figure 9 Modbscan 64*

As ADAM 4017 is using RS-485 transmission mode we have used RS-485 to USB convertor and then we used Modscan64 to monitor the data coming in from ADAM module. Now as ADAM has 16-bitADC it converts the analog data using that ADC and sends to the computer reading it. We can read the data in Modscan64 and in Web Access too. To connect the Modscan64 we will select connection->connect, then we will set the comport and the baud rate, data bits and other important information. And we are using RTU Protocol for communicating with ADAM 4017+. And after pressing OK we can see data in real time on Modscan64. It is very important to keep the baud rate, parity, word length and stop bit same in Modscan64 and ADAM 4017+.

### 5.3 LabVIEW

LabVIEW offers a graphical programming approach that assists you with envisioning each part of your application, including equipment design, estimation information, and investigating. This perception simplifies it to incorporate estimation equipment from any merchant, address complex rationale on the graph, foster information examination calculations, and plan custom designing User Interfaces.

### 5.4 Data Dashboard Mobile for LabVIEW

Data Dashboard Mobile for LabVIEW lets you create a custom and portable view of your National Instruments LabVIEW applications by displaying the values of network published shared variables and/or web services on charts, gauges, text indicators and LEDs. As given below the mobile application allows us to present the data which is connected to LabVIEW via IP address.

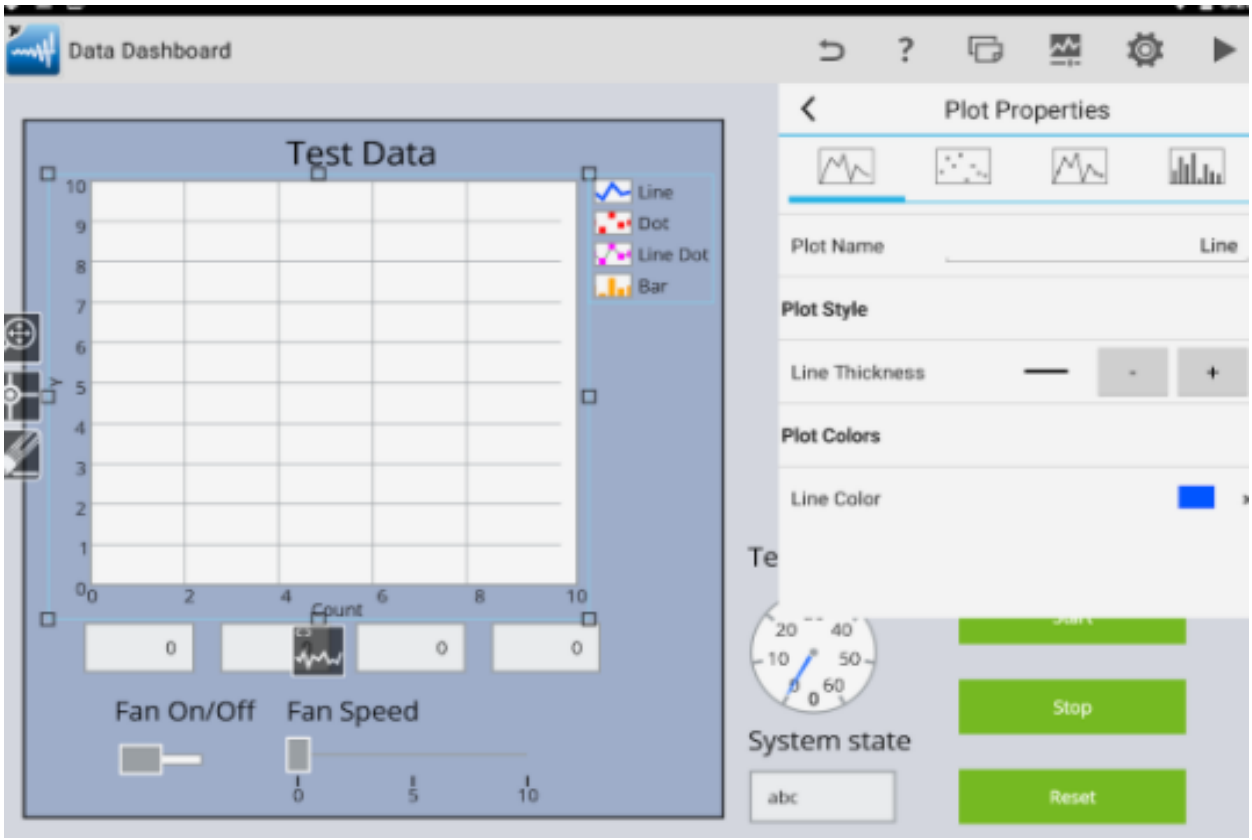


*Figure 10: Data Dashboard*

# 6. Executing the project

## 6.1: Wire Connections

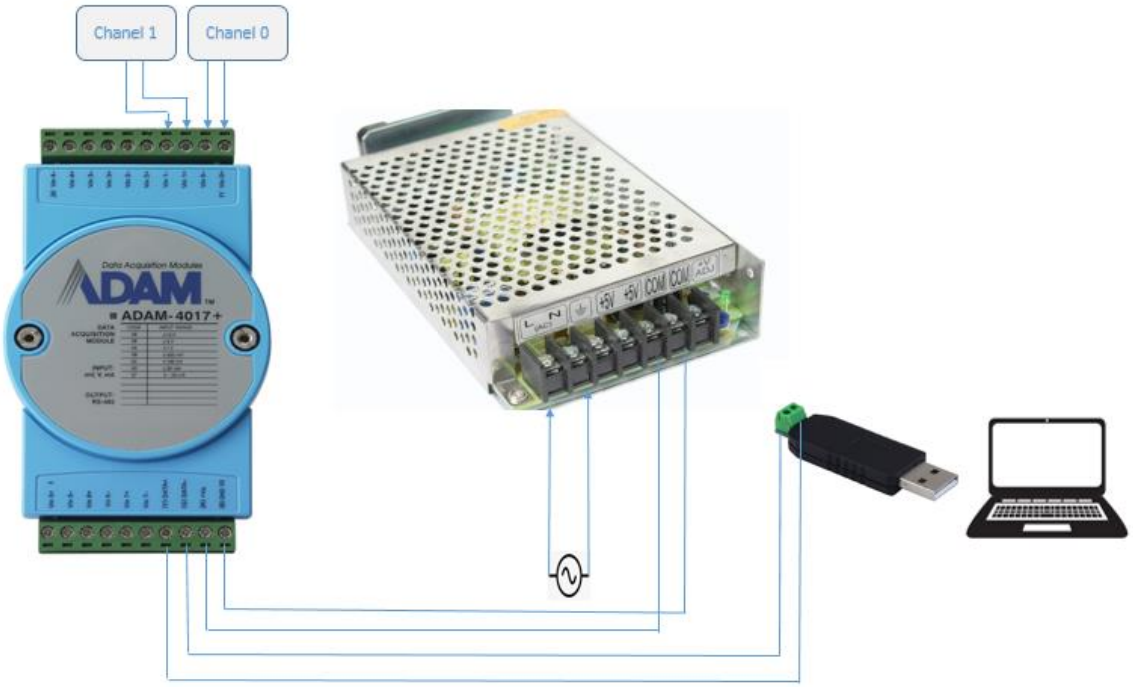


*Figure 11 : Wire connections*

As Shown in the figure we done the connections and using usb to RS 485 coverter configured it with laptop/pc.

## 6.1: Scanning the device on Adam utility

After all wire connections we scanned the device on Adam utility software. We want to measure 2 sensors data only so we enable 2 channels. In sensor we are getting voltage so we selected voltage for both channels. For channel 0 we set the range plus or minus 5V and for channel 1 we set the range plus or minus 10V. In this we can see the specifications which will be required to get the register values in LABVIEW. We can see the baud rate and register location.

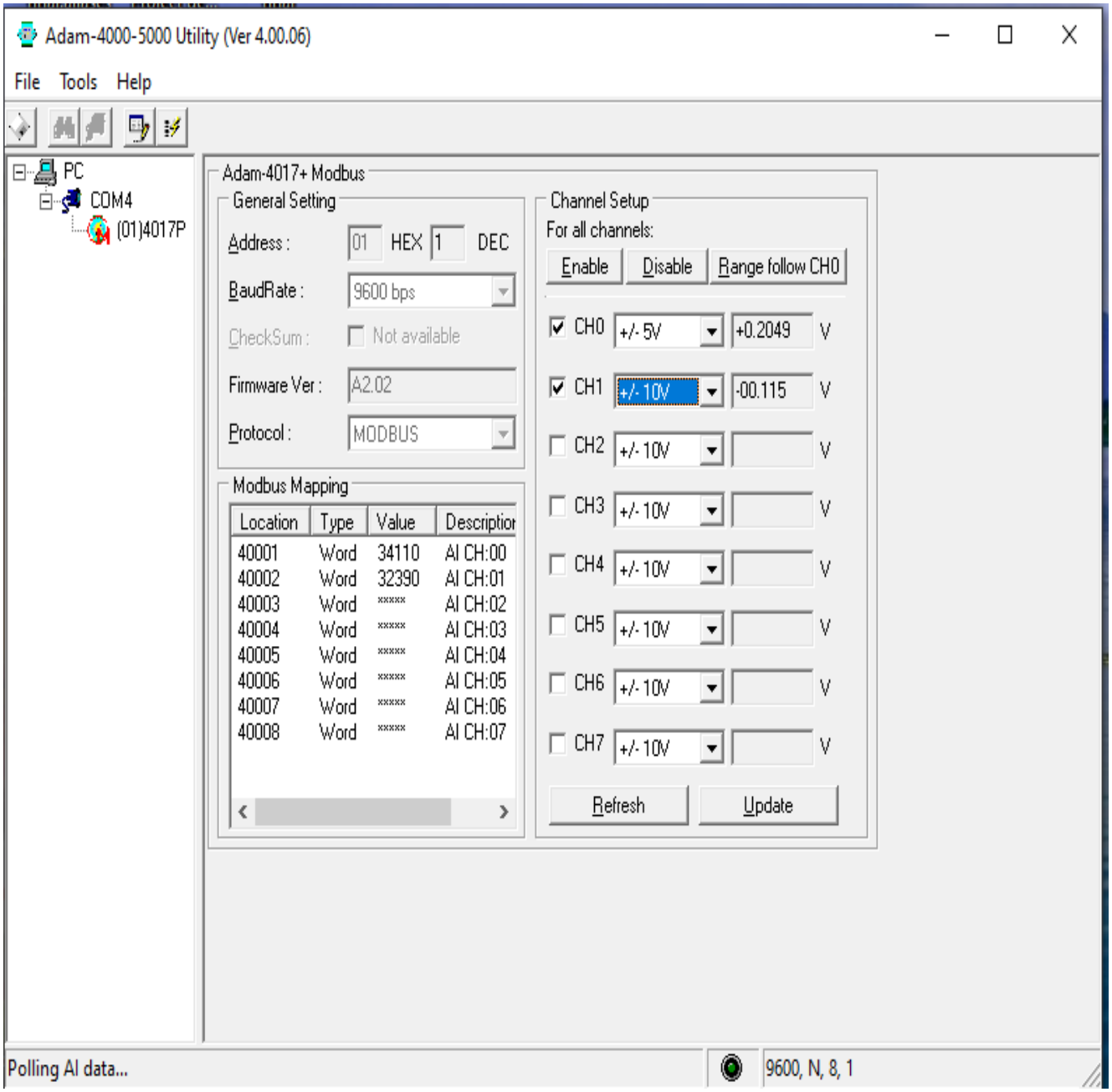


*Figure 12: Adam 4017+ configuration using Adam Utilty*

### 6.2: LABVIEW program

The communication between this devices is in the Modbus protocol. To read the holding register values we installed Modbus library. First of all we need to define the protocol specification to do that we have to use Modbus instance which initializes communication. Then we need to find unit number for that.

To read holding register value we used the read holding register module from Modbus library. To read First 2 register values we entered starting address 0 and no of registers we want to read as 2. Then we need to end the Modbus protocol to do that there is Modbus shutdown module. We need to connect the error nodes of all Modbus modules.

The holding registers values which we are getting is the sampled value as unsigned 16-bit word. We need to convert that in to specified voltage. We need to convert 0 - 65535 in to -5 - +5. So, for 0 we will get -5V and for 65535 we will get +5V. So, we divide this in two parts if we get value less than 32768 then divide it by 6553 and subtract with 5. If we get greater than 32768, we subtract it we 32768 and then divided with 6553. From this we got the 16-bit word to the specified voltage range conversion.

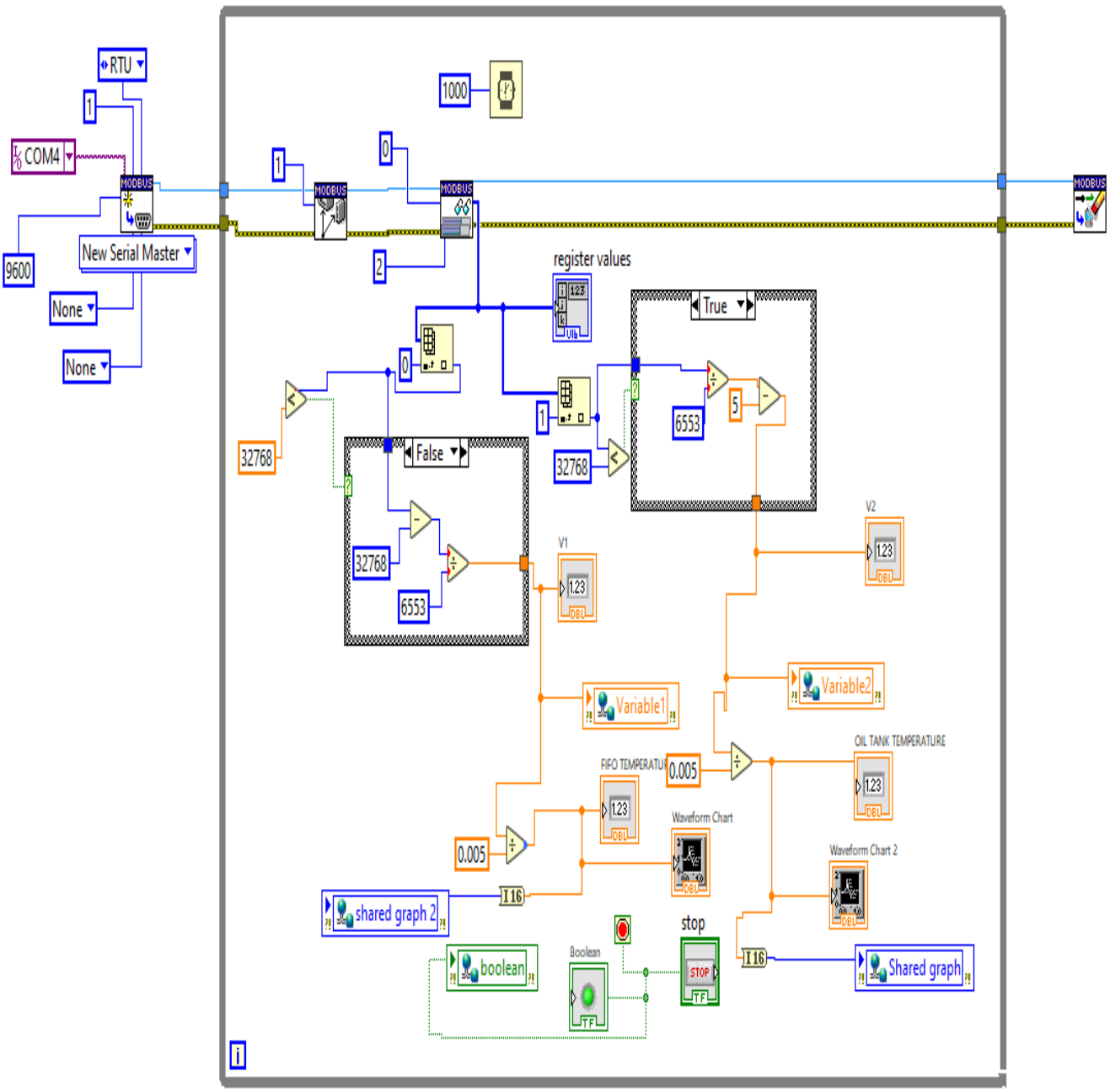


*Figure 13: Block Diagram of Labview*

We need to get temperature from the voltage which we are getting. There is 1-degree Celsius change in temperature with respect to 0.005 V change in voltage. So, we divided the voltage by 0.005. From this we can get the temperature value.

As shown in the figure we get the values of register, voltage and temperature (Thermocouple is not connected, calibration is done on assumption basis)

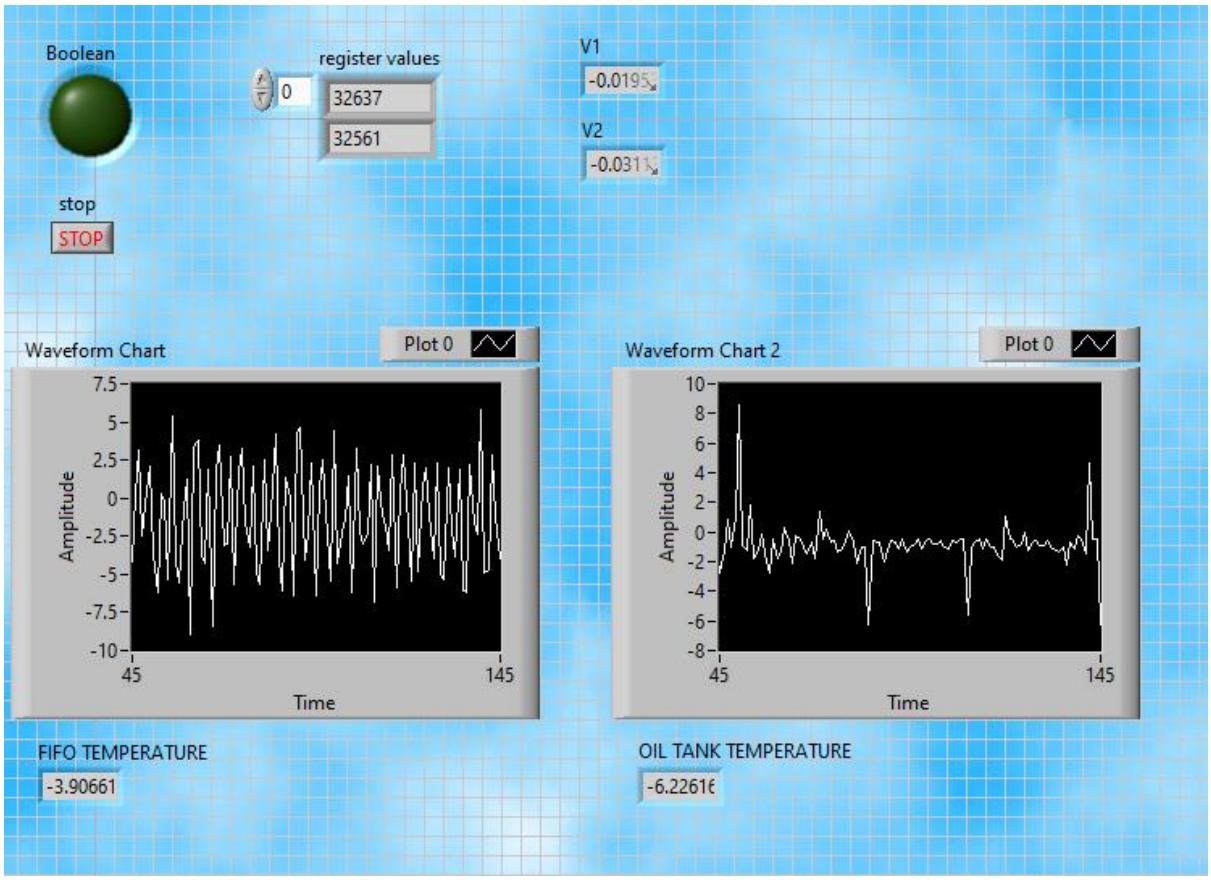


*Figure 14: Front panel of Labview*

### 6.3: connection to server (DATA DASHBOARD)

To see the data in smartphone we used Data Dashboard application developed by National Instruments, for that we need to define shared variable and configure the pc so it can act as a server.

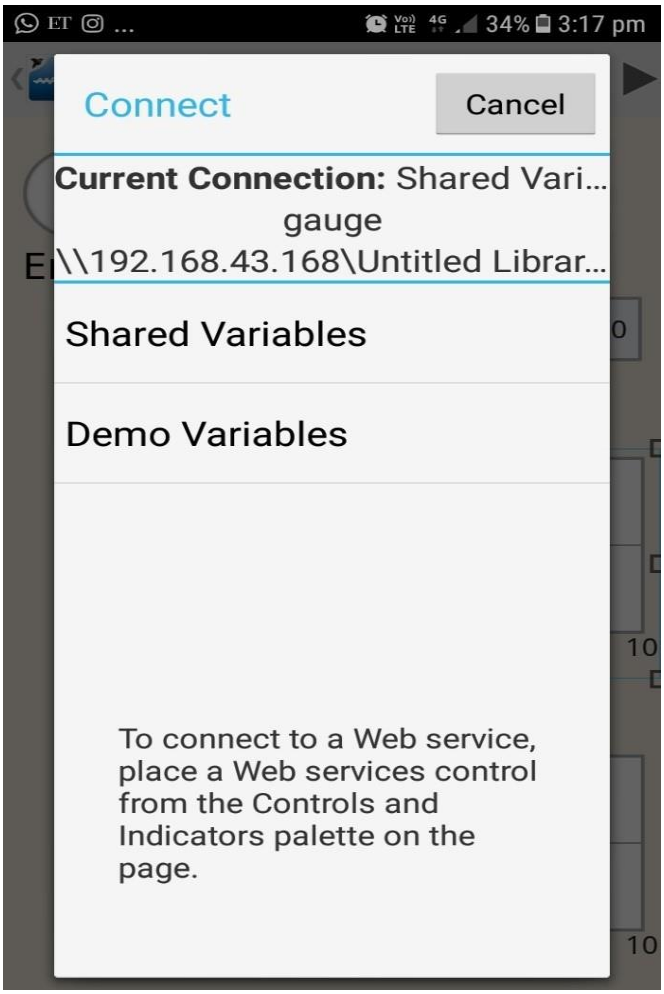


*Figure 15: Server configuration with Data dashboard*

We defined 5 shared variables, 2 for voltage 2 for temperature and 1 for error indicator. After that we connected our android phone to our pc server and put all the indicators of shared variables on Dashboard.

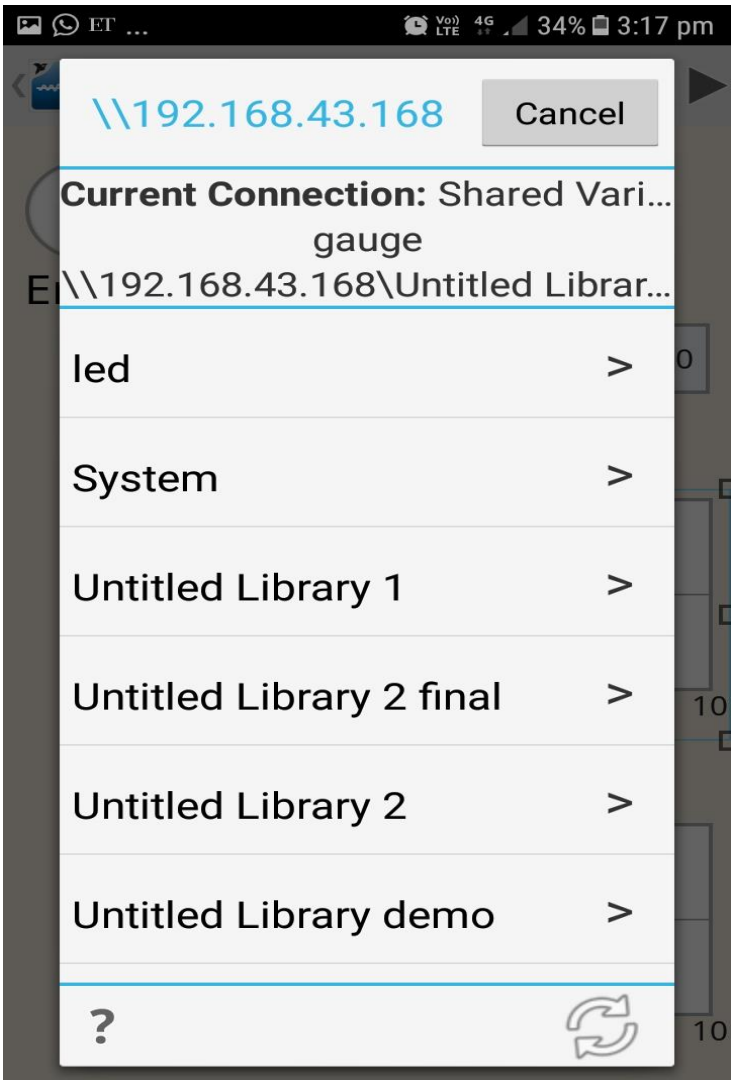


*Figure 16: shared variable configuration in data dashboard*

## 6.4. GUI on Data dashboard :

So in the Data Dashboard we can see the output voltages and temperatures of thermocouples mounted on oil tank and FIFO. We can also see the error indicator.

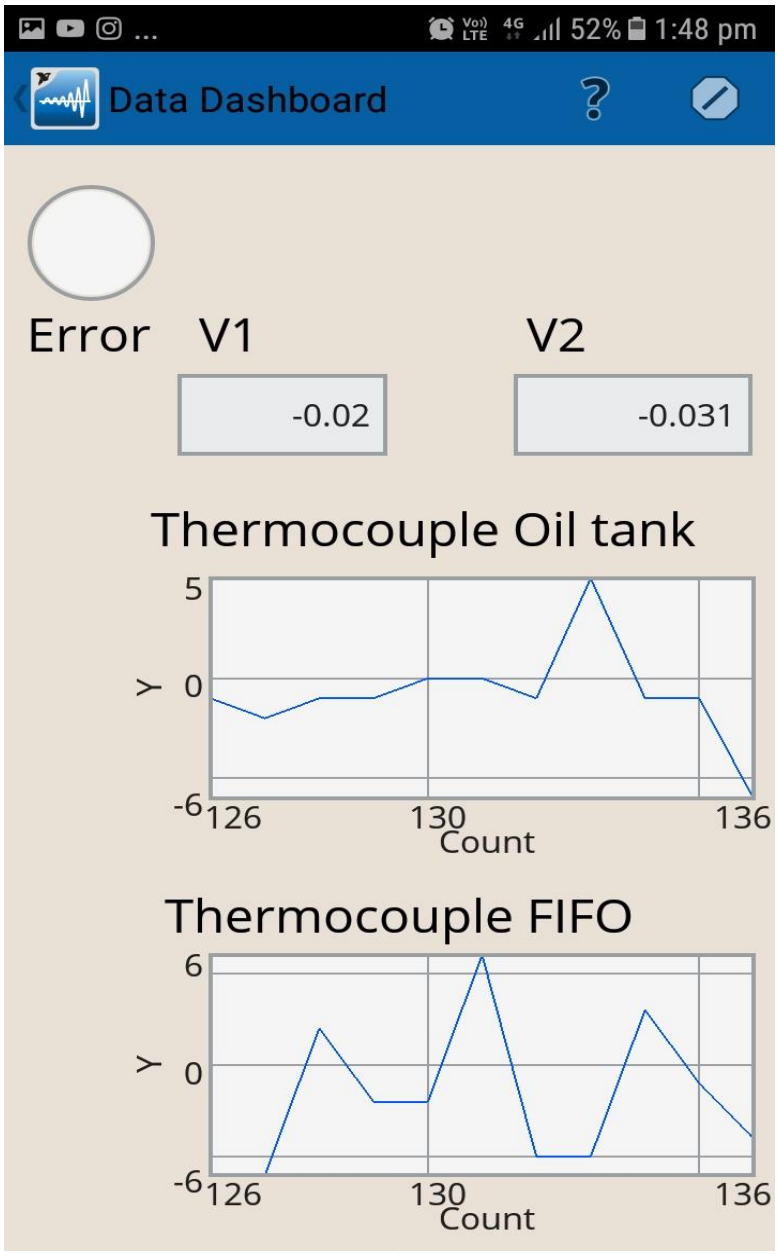


*Figure 17: GUI of Data Dashboard*

## 7. Conclusion

In this internship project with help of our faculty guide and industry guide we implemented smart instrumentation by using Labview and Adam -4017+ module. We used Modbus RTU communication protocol which is widely accepted as per industry standards .We made our pc act as server and made GUI on Data dashboard (developed for Android). In results we can access the sensor's data from anywhere using Android phone.

**Refrences**


1) **https://www.advantech.com/**
2) **https://realpars.com/**
3) **https://www.sciencedirect.com/**
4) **https://www.ni.com/**