

Design a Low-Cost Digital Pressure Meter Equipped with Temperature and Humidity Parameters

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Article Information

Article History:

Received: April 5, 2021
Revision: April 15, 2021
Accepted: May 10, 2021

Keyword:

Calibration
Pressure meter
Sphygmomanometer
Humidity

Abstrak

Calibration is a technical activity which consists of determining one or more properties and characteristics of a product, process or service according to a predetermined special procedure. The purpose of calibration is to ensure measurement results comply with national and international standards. The purpose of this study is to design two mode digital pressure meter (DPM) device equipped with a thermo-hygrometer and pressure in which the design is completed with a selection mode to determine the positive and negative pressure (vacuum) using MPX 5050GP sensor as a positive pressure sensor. In this design DHT 22 sensors is used to measure the humidity and temperature. To test the leak test this device is also equipped with timer. This design uses a 2.4 inch Nextion TFT LCD screen to display data. Data analysis was performed by comparing modul with standard tools. In the measurement process, Mercury tensimeter was carried out 6 times the data and the smallest results were 0 mmHg on the module and 0 mmHg on the standard tool and the largest was 298.0 mmHg on the module and 300 mmHg on the standard tool. Data were collected in a room with a temperature of 31C and humidity of 87%. Finally, this design is applicable for daily used for electromedical engineer to calibrate the sphygmomanometer in the hospitals.

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I. INTRODUCTION

Digital Pressure Meter (DPM) is a tool used to measure positive and negative pressure on medical devices in liquid or gas form to assist in quality improvement and control. The way this tool works is by converting the value of the pressure sensor to be changed and displayed on the display. There are many forms, types, and functions of Digital Pressure Meter, such as those that serve only as inflatable pressure and suction pressure. In this study, the use of DPM related to calibration on mercury tensimeters and suction pumps. Tensimeter is a tool to measure blood pressure that is often used in the medical world, its function is vital because it becomes the basis for doctors to diagnose patient health.[1]

Accurate blood pressure measurement requires the use of an accurate sphygmomanometer. The accuracy of the sphygmomanometer relies heavily on performing the correct maintenance and calibration process of this equipment. One of the most common errors in blood pressure measurement is caused by the use of an uncalibrated sphygmomanometer and

improper use of cuffs. Inaccurate maintenance and calibration of sphygmomanometers is the cause of systematic errors in blood pressure measurement.

Tensimeter is a tool that has a low and high risk, judging by its use tensimeter is a tool that is often used continuously so that the risk of a decrease in tool performance is very high let alone never done good maintenance. frequent damage that is at the level of leakage. Several measuring instruments tensimeters and suction pumps have been made electromedical engineering students titled DPM Two Modes Equipped With Temperature And Humidity Portable Based Arduino Nano. [2] On the tool is made 2 modes of waiting for temperature and humidity by displayed on the character LCD. Furthermore, in 2017 N H Zunnur analyzed the suitability of mercury and digital tensimeter types to blood pressure measurements in adulthood in the analysis stated that the difference between the two tensimeters was indicated by good conformity tests, namely systolic pressure (Kappa Value=0.782) and Distolic pressure (Kappa value=0.565) [3]. In 2017 by Junia Dyah Permata Wibisono made the final task with the title Digital Pressure

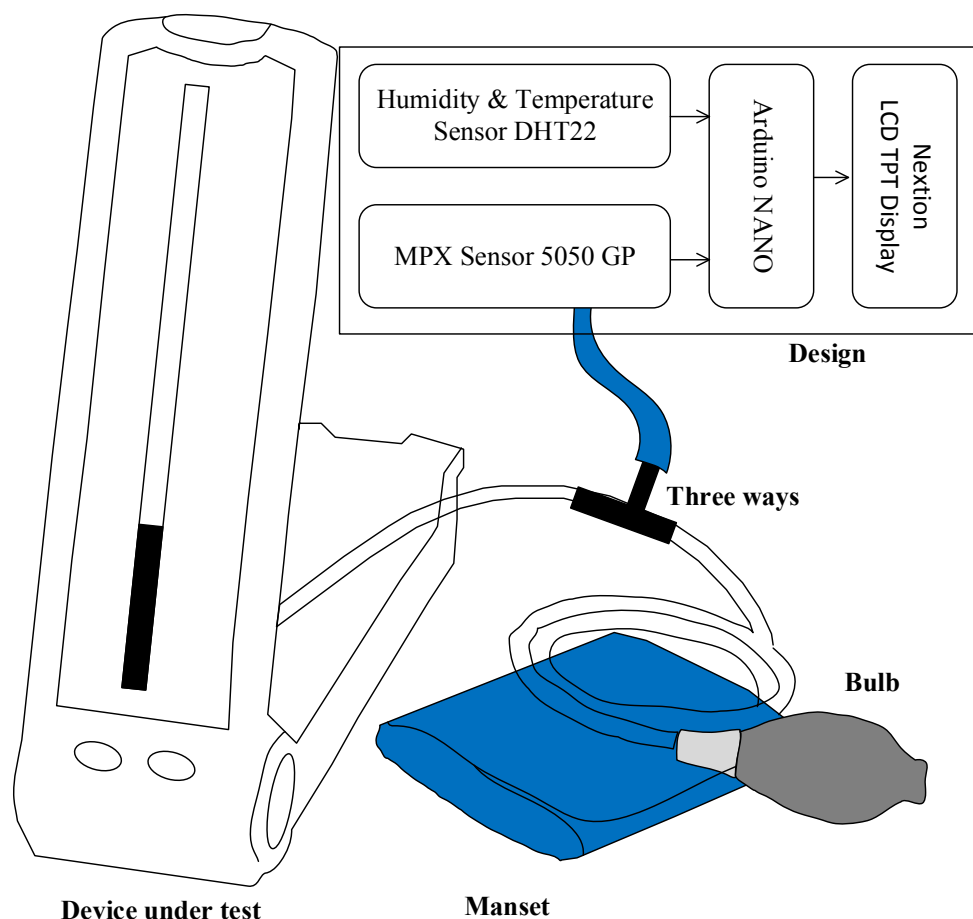


Fig. 1 The diagram block of the system

Meter (DPM) Vacuum Pressure with lcd display characters. In this tool only use 1 (one) mode that is used only for suction pump [3] and In 2018 Yosep Kurniawan made the final task of Digital Pressure Meter (DPM) two modes namely positive pressure and suction pressure but this tool is still relatively standard accuracy level that has a correction value of 0 - 3mmHg [4]. Furthermore, in 2019 Mukhamad Ryan Nur Rohman in a study on the design entitled Digital Pressure Meter (DPM) Tensimeter and Suction Pump, but this tool still has a deficiency in the measurement of the rate of leakage tensimeter is not equipped with the temperature and humidity of the room, this is very important because the temperature, and humidity of the room can affect the results at the time of measurement. [4]

Calibration environmental conditions should be adjusted according to the requirements of calibration methods such as temperature and humidity. [5] Not always calibration should be done in a tightly conditioned room. Calibration environmental conditioning is usually done for calibration of volatile equipment due to the influence of temperature, humidity, vibration, light, and so on. [6].

II. MATERIALS AND METHODS

A. Research Design

This study used measurements against mercury tensimeters with positive pressure settings; 0mmHg, 50mmHg, 100mmHg, 150mmHg, 200mmHg, 250mmHg, 300mmHg, which can then be converted to kPa. Data retrieval repeated 6 times. [7]

1) Materials

This study used the MPX 5050GP Sensor by Freescale Semiconductor to serve as an inflatable pressure. And the DHT22 Aosong Electronics Co.,Ltd sensor serves as a temperature, humidity sensor. Output sensor MPX 5050 GP then go to the input buffer circuit. The output of the buffer circuit then VCC, output and GND from the DHT 22 sensor legs then enter and be processed into the Arduino Nano. Arduino Nano as controller and controller. Arduino Nano output in the form of a display on the 2.4 inch TFT Nextion LCD[8][6].

2) Experiments

In this study, after the finished design, digital pressure meter (Positive Pressure) output testing was conducted with pressures of 0 mmHg, 50 mmHg, 100 mmHg, 150 mmHg, 200 mmHg,

250 mmHg, 300 mmHg, and measurements with the Tensimeter. Each setting, calculated to validate the results of this study.

B. Block Diagram

In this study, Positive data was obtained from cuff hoses and pump hoses from Tensimeters with several pressures namely 0 mmHg, 50 mmHg, 100 mmHg, 150 mmHg, 200 mmHg, 250 mmHg, 300 mmHg, shown in Figure. 1. MPX 5050 GP sensor as inflatable pressure. The sensor output then enters the buffer circuit input as a current amplifier without voltage amplifier occurring. The output buffer is then entered and processed into Arduino Nano. There is a conversion from mmHg to kPa to be processed to Arduino Nano as well. After processing using Arduino Nano, the output is a display on the 2.4 inch TFT Nextion LCD. [9] In Fig.1 Blog Diagrams it is explained that in the calibration process, the cuff hose and pump hose of the tensimeters used for calibration testing materials. MPX 5050 GP sensor as an inflatable pressure sensor. Output sensor further into the DHT 22 sensor as a humidity temperature sensor, VCC, output and ground are connected to the Arduino nano pin.[10] [11] then conduct a test for 60 seconds that serves as a time to perform a leak test when performing measurements on the tensimeter. Furthermore, the data displayed on the 2.4-inch TFT Nextion LCD serves as a display to display the measurement, calibration process. On the Digital Pressure Meter tool system, the LCD displays the result of pressure and conversion.

C. Flowchart

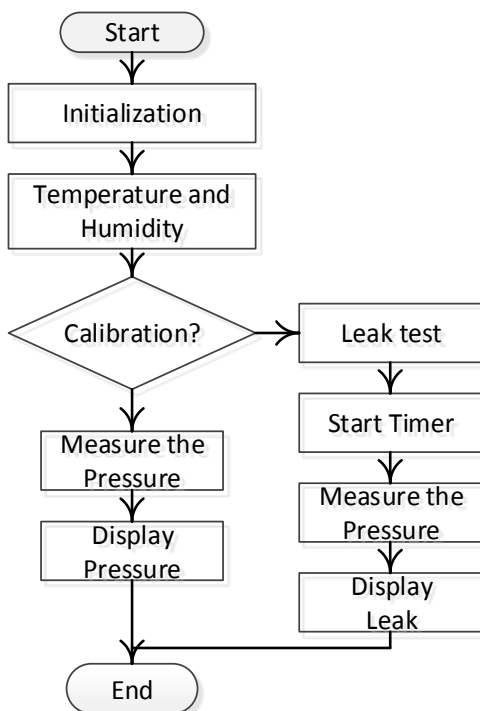


Fig. 2 The system flowchart

In figure 2 flow diagram starts when the module starts then there is initialization, there is the appearance of temperature, humidity, there are two modes of selection, namely positive mode and vacuum, when choosing a positive mode when doing manual pumping then the MPX 5050 GP sensor will read and the results will be displayed in positive mode measurement there is a 60-second timer for leak test. From the reading can be converted again pressure unit from mmHg to kPa and then the data is displayed on the LCD TFT Nextion 2.4 inch.

III. RESULTS

In this study, Digital Pressure Meter Module has been measured with Mercury Tensimeter tool



Fig.3 Pengukuran pada tensimeter

In fig.3 The Digital Pressure Meter module contains each connector of the maximum pressure sensor output of the vacuum pressure of -400 mmHg

1) Digital Pressure Meter Module Design

Display used using LCD TFT Nextion fig. 4



Fig. 4. Digital Pressure Display

Algorithm 1: Reading the Pressure

```
void loop(void)
BEGIN
    delay(50);
    sensorValue = analogRead(sensorPin);
    Vout = (sensorValue * 5.0/1023.0)*1000;
    Value_Kpa= ( Vout-165.29)/90;
    Value_mmHg = (Value_Kpa*7.5);

    static char tekananPositif[6];
    dtostrf(Value_mmHg, 3, 1, tekananPositif);
    t9.setText(tekananPositif);
    delay(50);
END
```

Algoritme2: Humidity Temperature

```
void bupdatePopCallback(void *ptr)
BEGIN
    float h = dht.readHumidity();
    float t = dht.readTemperature();
    IF (isnan(h) || isnan(t) ||)
    THEN
        return;

    static char temperatureCTemp[6];
    BEGIN
        dtostrf(t, 6, 2, temperatureCTemp);
        tTempC.setText(temperatureCTemp);
        char hTemp[10] = {0};
        utoa(int(h), hTemp, 10);
        tHumidity.setText(hTemp);
    END
```

3) Measurement on Mercury Tensimeter

Pressure measurements in the module range from 0 mmHg to 300 mmHg with the pressure measurement range rising per 50 mmHg performed for 3 x measurements. The results of the analysis can be seen in the table below.

TABLE I. ANOVA SINGLE FACTOR IN MEASUREMENT OF INCREASING MODE

Groups	Count	Sum	Average	Variance
Increase 1	7	1038	148,29	11504,9
Increase 2	7	1042	148,86	11386,5
Increase 3	7	1046	149,43	11534,6

TABLE II. ANOVA PARAMETER FOR SIGNIFICANT DIFFERENCE BETWEEN MEASUREMENT

Source of Variation	SS	MS	F	P-value	F crit
Between Groups	4,5714	2,28571	0,00019	0,9998	3,555
Within Groups	206556	11475,3			
Total	206561				

In table 1 the results of the analysis showed no influence ($p=0.999$) on measurements made for 3 x. Meanwhile, the measurements in the module are carried out from 0 mmHg to 300 mmHg can be seen in table II.

TABLE III THE VARIANCE CALCULATION AMONG MEASUREMENT

Groups	Count	Sum	Average	Variance
Down 1	7	1036	148	11452,7
Down 2	7	1033	147,571	11518
Down 3	7	1033	147,571	11585,3

TABLE IV. ANOVA PARAMETER FOR SIGNIFICANT DIFFERENCE BETWEEN MEASUREMENT

Source of Variation	SS	F	P-value	F crit
Between Groups	0,8571	3,72E-05	0,99996	3,55
Within Groups	207335			
Total	207336			

In table II the analysis showed no influence ($p=0.999$) as long as the measurements performed on the measurements dropped on the module from 0 mmHg to 300 mmHg.

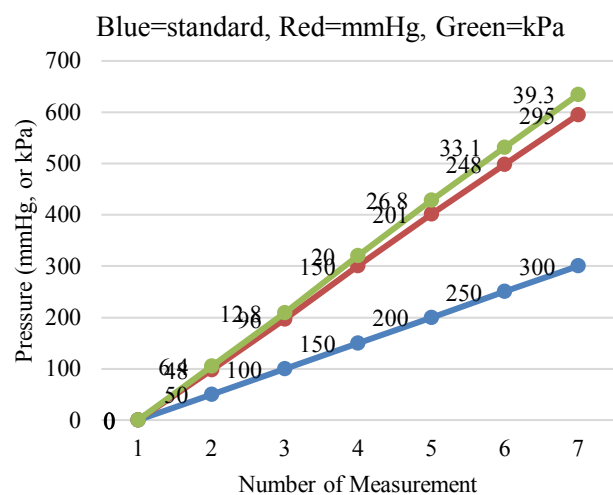


Fig. 8. Convert mmHg Value to Kpa at Up Position

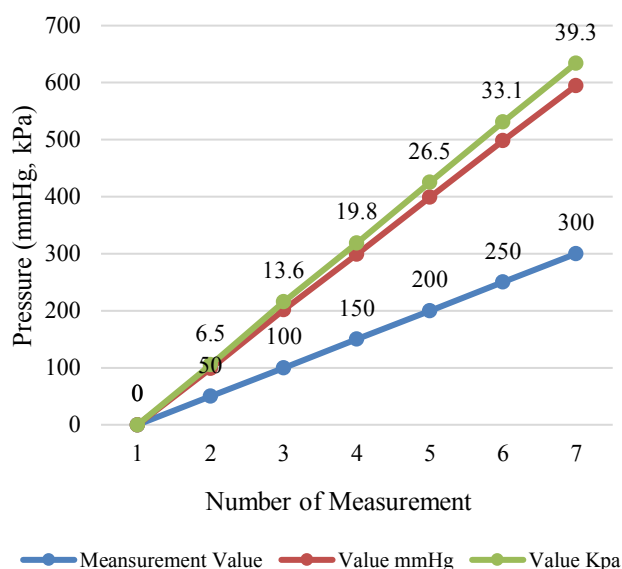


Fig. 9. Conversion of mmHg Value to Kpa at down position

Data retrieval in this module is done with a standard mercury tensimeter and this measurement is done for 6 measurements.

IV. DISCUSSION

Positive pressure measurement of 0-300mmHg with a 50mmHg point increase obtained a reduction difference of $-3.3 > 0 < 3.3$ with an average error factor of $2=0.39$. In negative pressure measurements of 0-300 mmHg with a decrease of 50mmHg the difference of $-3.7 > 0 < 3.7$ with an error factor of $rata2=0.26$, this meets calibration standards for uncertainty factors in measurement errors of 0.8. Measurement of this module is done by retrieving data on the mercury tensimeter

tool 6 times. Thus, the results of the design is not much different from standard equipment. The result of moisture temperature measurement is done in the room with the module's humidity temperature parameter obtained room temperature of 25oC and humidity of 80%. With a difference of < 0.2 from the standard equipment measurement.

IV. CONCLUSION

The purpose of this study is to design a complete standard of the digital pressure meter equipped with temperature and humidity parameter. In the design of the DPM Two Modes module equipped thermo-hygrometer and overall pressure selection it was concluded that the Circuit made was in accordance with the needs of the DPM module, namely for ADC, touch screen display button. The result of positive pressure measurement at pressure 0 to 300 mmHg commonly used on mercury tensimeter has an error rate below normal 5%, ie $rata2=0.39$ while at negative pressure $rata2$ of 0.26 with module design has met calibration standards. Furthermore, the results of the measurement of temperature and humidity in the module have met the standard of measurement room, namely: temperature 25oC and inertia by 80%. For the future this design research can be developed in the design towards IoT.

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