MEASURING THE PRESSURE ALTITUDE USING MEMS SENSORS

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Barometric altimeter is an integral part of every dashboard in aviation. The main reason that led us to choose this topic has been interested in knowledge and approach of measuring barometric height, which is still an integral part of the aircraft. To obtain reliable results, the article uses the method of measuring barometric height sensor using MEMS in the pressure chamber. The measurement results are processed in a transparent table and the measurement results reflect the possible deviation from the standard atmosphere, the classification used in aviation for at least small unmanned aircraft.

K e y w o r d s. altimeter, the aircraft, the pressure chamber

1 INTRODUCTION

Barometric method is currently the greatest importance in aviation. Based on the known dependence of static and absolute pressure of geo prospective. This method can be measured by the initial setup of the absolute level of HABS, the relative size or height Hrel flight level HL. Do case is brought static pressure measuring air pressure through hoses that are connected to a static pressure sensor where it flows through the static pressure [1]. The static pressure acting on the so-called closed pressure gauging box. Pressure measuring boxes are usually still two to minimize the error device. These boxes are called pressure measuring disc membrane, expressed in circular bronze, high quality flexible sheets. Therefore, in aviation such instruments designated as membrane devices. In the middle of the membrane is attached to the box a small circular bronze plates, so called. bridges by which they are attached to the box components of mechanical transmission device. The pressure measuring boxes in the production of exhausted air, but in small boxes remains unsurpassed air, we call it the residual pressure.

Presure compressed inside a box in the axis perpendicular to the membrane [6]. With increasing height of the static air pressure decreases and Presure box to its own elastic action back to its original state, has moving outwards. This box consists of movement of the exposure to pressure and called a stroke. The lift arm is transmitted to the arm via the first shaft and gear lever on analogue [2].

2 RESONANCE PRESSURE SENSOR WITH MEMS

The silicon membranes are created by two H-shaped resonators whose natural frequency varies with mechanical tension. Resonators are wobbly magnetic field and positioned so that when exposed to pressure were loaded mechanical stress of different signs. Gap frequency is directly proportional to the measured pressure. The main advantage of sensors is low hysteresis and temperature coefficient of sensitivity. Pressure on the principle of achieving precision below 0.1% [3].
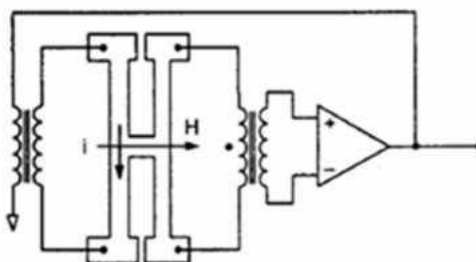

Fig.1 The principal electric scheme MEMS sensor

3 PROPOSE MEASURING CHAIN

To measure the barometric pressure are used:
- Barometric sensor-BMP from 085 companies Bosch
- Mega-Arduino (ATmega 1280)
- Pressure measuring chamber
- Air pump
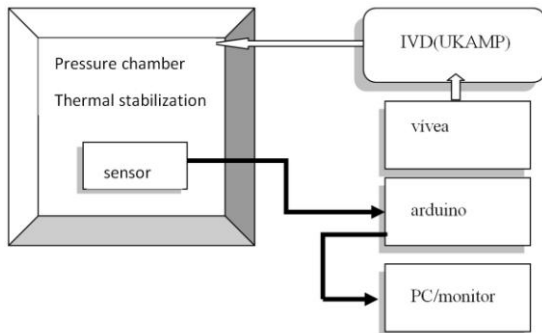- Pressure gauge IVD (equipment UKAMP)
- Computer.

Fig.2 Measuring string

It is a simple board for Nouvelle BMP085 is highly accurate and has low requirements for electrical connection of the barometric sensor. BMP085 offers a measuring range from 300 to 1100 mBa with absolute accuracy up to 0.03 mB. It is based on a piezo-resistive technology has high accuracy and linearity, as well as long-term stability. This supports the sensor voltage between 1.8 and 3.6VDC. It is designed to connect directly to microcontroller via I² C bus. [7]

In this example we will use Arduino and Pressure BMP085 so that we can measure data on pressure and temperature.

The sensor must first connect to the arduino and then through a connecting cable that is connected to the arduino and the other end is connected to a PC via USB port [5]. Then using the measured values show the program where these values are read. We must not forget that the market is a lot of models Arduino. We are used to measure barometric pressure sensor with BMP 085 of title arduino Arduino Mega (ATmega 1280).
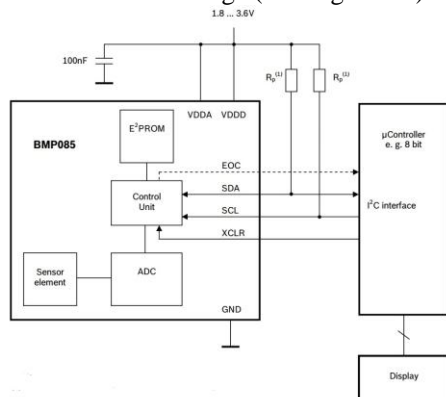

Fig.3 BMP 085 sensor and interconnection circuits

4 Thermally stabilized chamber

Chamber we needed to test and prepare it for our conditions and our measurement. After some adjustments and corrections chamber was ready for measurement, then we took the cable, which we linked the sensor inside the chambers with Arduino, which was out of chambers in order to destroy him in the chamber.
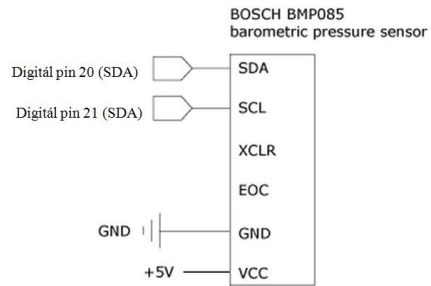

Fig.4 Schematically linking BMP 085 with Arduino

The chamber is thermally stabilized by heating element and is regulated by the regulator on the outside of the chambers. The thermostat is inside the chambers, and everything is connected to 24V DC. When measuring and adjusting the temperature, we did not want to destroy the sensor in direct sunlight the temperature sensor. Following this request, we have created a table called, which is formed from durable material. It is resistant to heat and radiation and direct flame, the ceramic plate is on legs, which do not heat and also resist him. After removal of dangerous radiation directly to the reader, we continued on creating a stand that served us afterwards that we probe just hanging on cables. The sensor has a place to stand and be identified as we mount the sensor on the end that there is no error in the rotation sensor. Is there a title VCC, which indicates that pin should be on the side and the complete removal of the rotation sensor is also written in yellow, which shows us that the cable comes to us from the chambers to know where to connect the beginning of by the yellow connector to connect to the Arduino, and that it yellow color indicates the VCC pin on the sensor.
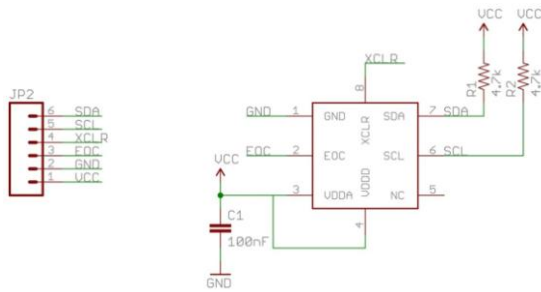
Fig.5 BMP 085 sensor schematic

The chamber of his heart is still light for illumination, terminal block for power or thermostat. The chamber is controlled from the front through the valves. Control pressures are there. On the other chambers are switches for power control chambers. On the back of the circuit breakers to protect our chamber.

5 Meter of air pressure

To create a vacuum, we use vive, followed by connecting the device to measure air pressure IVD (UKAMP), where they built three altimeters, which measure pressure in units of mm Hg. We set pressure by the middle valve. The chamber must be airtight, it must not be measured is no leakage and compressor must have sufficient strength so that we know to create a pressure height H = 33.528 ft. This method is used for calibrating altimeters. It created the same workplace. The interior is embedded device, which we calibrated using a pressure control and tolerance of what should be the altimeters know whether it is in order or not.
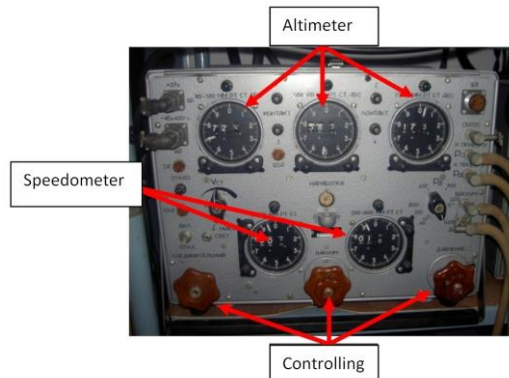

Fig.6 Meter of air pressure IVD (UKAMP)

6. The measurement procedure

After the measurement of static pressure, we had to really seal the chamber and check run arduino program, where we had prepared a program for measuring pressure, temperature, and once the conversion of the amount:

1. Chamber thermally stabilized and we began to measure where we are progressing slowly in increments. First, we have found today's pressure on our latitude where we reported 998 mB. This pressure is essential for the calculations is the change in pressure that occurs due to weather changes from MSA where you enter 1013.25 mB.

2. Started we ensured that our pressure pH, which enters the system pressure control IVD where we were setting up the pressure. Which we entered the chambers. Pressure, we adjusted the valves with pressure, this pressure we have checked the altimeter, which are implemented in the meter IVD.

After stabilization of pressure that we wanted to set up, we started measuring that recorded data from the air data system and connected devices. These values we write to the paper in the next section, we compare the values measured from the sensor BMP085.

3. This sensor is inside the pressure measuring chambers. The measured values of the sensor we saw were coming up through the interface cable. This cable is connected to one side over the pin sensor and the other is connected to the arduino.

4. Arduino we are linked through the USB port of your computer where we had prepared and installed by us the information recorded. Arduino was used as a transmitter and a computer as a display of measured values.

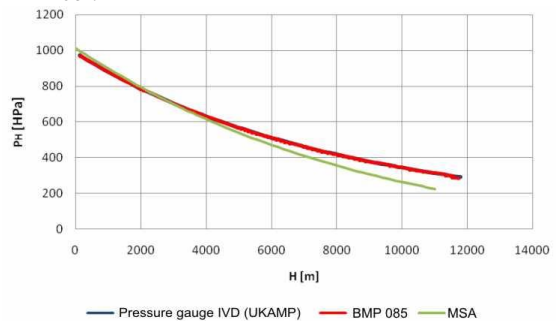5. This measured values are processed in the Arduino program and then check to see converted in Excel.

Fig.7 Graphs of the measured parameter

7 CONCLUSION

The article was to propose a chain measuring air data computer to measure the absolute height. I managed to design and implement a system with aerometry BMP085 pressure sensor from Bosch, which works reliably and we can we measure barometric altitude and ambient temperature. The right program will be designed and loaded into the Arduino. The compiled program allows us to change the values directly measured. In the future, an opportunity to establish in this article, which formed the basis for other theses, such as the implementation of this sensor for pilotless means of which will be either a memory chip for collecting information or cordless arduino.

BIBLIOGRAPHY

[1] Bréda, R. – Čižmár, J. – Soták, M. – Beňo V.: Letecké prístroje, Vysokoškolská učebnica, Technická Univerzita Košice, Letecká Fakulta, 2011, ISBN: 987-80-553-0626-1.

[2] Pačes, P.; Reinštein, M.; Draxler, K.: Fusion of Smart Sensor Standards and Sensors with Self-Validating Abilities In: Journal of Aircraft. 2010, vol. 47, no. 3, p. 1041-1046.

[3] Popelka, J.; Pačes, P.: Performance of smart sensors standards for aerospace applications. Przeglad Elektrotechniczny. 2012, vol. 88, no. 01a, p. 229-232. ISSN 0033-2097.

[5] Sotak, M.: Determining stochastic parameters using an unified method. In: Acta Electrotechnica et Informatica. - ISSN 1335-8243, Vol. 9, No. 2 (2009

[6] Mike Tooley and David Wyatt: Aircraft Electrikal and Elektronic Systems Principles, operation and maintenance, 2009, ISBN: 987-0-7506-8695-2

[7] http://dlnmh9ip6v2uc.cloudfront.net/datasheets/Sensors/Pressure/

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