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DESIGN of THE SPYGHMOMANOMETER CALIBRATOR EQUIPPED WITH THERMOHYGROMETER Andjar Pudji, M.Ridha Ma,ruf Electro Medical Engineering Department Health Polytechnic Surabaya Pucang Jajar Timur No.10 Surabaya, Indonesia Email : asnanibr@gmail.com ABSTRACT Background Calibration is a technical method that consists of establishing and determining one or more characteristics of a product, according to the procedures that has been agreed. The purpose of calibration is to ensure the result of measurement result according to national and international standarts. One of medical devices that need to be calibrated is sphygmomanometer, while the tool to calibrate sphygmomanometeris called Digital Pressure Meter. Method Thermohygrometer is a device that combines the functions of a thermometer and hygrometer. In general, we are more familiar with thermometer than hygrometer, we use its function to measure the temperature in daily life we use, while hygrometer is rarely use because its function to measure humidity both indoor and outdoor. Thermohygrometer is used to measure the air temperature and humidity. In this research, the researchers designed a calibrator of sphygmomanometer equipped with Thermohygrometer. The purpose of this research is to design a calibrator of sphygmomanometer equipped with thermohygrometer. The design of this research is a purely experimental research, which is the independent variable

is the pressure, and the dependent variable is Thermohygrometer. Results The stages that use in this research is circuit design, testing and calibration The result of this research is show the difference measurement of sensor output of 0.1 volts between measurements and calculations, this is because the sensor has a percentage of error about 2.5% .At the PSA there is a voltage difference of about 0.01 volts to the circuit summing amplifier and an inverting amplifier, it is due to the influence of the pressure tolerance. LM358 sensor can receive pressure of 0-250 mmHg, with an average error 0.091%. temperature sensor can tolerate temperatures of 10-60 ° C, with an average error of 0.2% . sensor humidity can receive humidity 20-85% RH, with an average error of 0.44% Keywords: Calibration sphygmomanometer, Thermohygrometer INTRODUCTON Calibration is a technical activity which consists of the determination and the determination of a characteristic or more of a product, in according to the special procedure has been set. The purpose of calibration is to ensure the measurement results inaccording to national and international standards. One of the medical devices that need to be calibrated is sphygmomanometer, while the tool to calibrate sphygmomanometer is a Digital Pressure Meter. Digital Pressure Meter is a device designed to measure the pressure of a medical device in the form of a liquid or gas to help calibrate medical devices, in this case the calibration sphygmomanometer. Sphygmomanometer is an instrument that used to measure blood pressure that works manually or automatically, in the pumping or reduce pressure on the cuff with a non-invasive system. In the measurement of the blood, there are two kinds of blood pressure, the systolic (upper limit) and diastolic (the lower limit). Systolic pressure of 95 up to 140 mmHg, while diastolic pressure sebasar 60 up to 90 mmHg. According with technological development in the medical devices, sphygmomanometer has been developed ranging from mercury sphygmomanometer, aneroid sphygmomanometer, and most recently the digital sphygmomanometer. According to the writer's observation, the results of blood pressure measurement is performed with a mercury sphygmomanometer results are different from the results of measurement conducted by digital sphygmomanometer. With the difference of the measuring results it is necessary to identify the blood pressure measuring devices. The results of blood pressure measurements should be done properly, this is due to concern health and safety of patients. Errors in the measurement of blood pressure can be caused by human error or the function of the tool itself that its accuracy has exceeded the allowable threshold (Standart error up to 3 mmHg). In connection with the global demands in the quality of health services, the ISO 9000 and Law no 8 / 99 on consumer protection, the necessary measurement and calibration of medical must be scheduled.The procedures of calibration must be performed on a scheduled basis in order to maintain the safety of the user or operator and patients as consumers. In this regard needs to be calibrated to determine the truth value of a sphygmomanometer by comparing it with a standard measuring traceable. It is listed in Health Minister Regulation No. 363 / Menkes / PER / IV / 1998 on Testing and Calibration Medical Devices in Health Care facilities. In this case sphygmomanometer calibration can be done with DPM (Digital Pressure Meter), to obtain a degree of accuracy and a high degree of precision (Republic of Indonesia. 1998. Permenkes NO 363 / Menkes / PER / IV / 1998). Thermohygrometer is a tool that combine the fuction between thermometer and hygrometer.Thermohygrometer can be use to measure the air temperature and humidity in indoor and outdoor. Thermometer is a tool that use to measure the temperature or the changing of temperature. Thermometer come from Latin words that means heat and meter mean ro measure. The unit of this measure is ussualy using Celcius (0C). Hygrometer is an instrument used to calculate the percentage of water vapor (moisture)

in the air, or simply a tool to measure the level of air humidity. Unit of measurement is the percentage (%). The larger the percentage, the higher the humidity. At the hospital, the tool is used to measure the level of humidity of a room or a device that has a certain standard operating room, for example, 45-60% moisture is needed, laboratory space, baby care, sterilization is required 35-60% (source: Ministry of Health Decree No. 1204 / Menkes / SK / X2004) Based on the problems above, The Researchers Designed A Chronological Related Devices Such Problems With The Title Design Of The Spyghmomanometer Calibrator Equipped With Thermohygrometer Blood Pressure Blood pressure is the pressure used by the blood at an angle of 900 were punched in the wall of blood vessels, blood pressure refers to systemic arterial blood pressure, the pressure in the veins or arteries that send blood to body parts other than the lungs, as the main pulse with respect to the arm (in the arm). Values that are universally stated in millimeters of mercury (mmHg). Illustrates the peak systolic pressure artery pressure and circulatory kejantung, while diastolic pressure is the lowest blood pressure (Ahmad, Muhlisin.2013). The magnitude of the blood pressure to heart resting between 120 mmHg as systolic and 80 mmHg as diastolic (written as 120/80 mmHg), measure blood pressure is not static, but undergo natural variations from one person to another person, depending on nutrition factors, drugs / toxins, or disease (Ahmad, Muhlisin.2013). Sphygmomanometer Sphygmomanometer or Blood Pressure Meter is an instrument used to measure arterial blood pressure indirectly (Non Invasive) with the help of a stethoscope (Booth, J.1977). Sphygmus word of the Greek word meaning pulse, the scientific term manometer or pressure meter. At first discovered by Dr Samuel Siegfried Karl Ritter von Basch.Scipione Riva-Rocci, from Italy, in 1896. And popularized by Harvey Cushing in 1901 (Booth, J.1977). Thermohygrometer Thermohygrometer is a device that combines the functions of a thermometer and hygrometer. Thermohygrometer tool can be used to measure the air temperature and humidity both indoors and outdoors. (Source: Adi R W, 2011). The Working Principle of Thermohygrometer a. Temperature The air temperature is a measure of kinetic energy average of the movement of molecules. Temperature of an object is a state that determines the ability of objects stretcher, to move (transfer) of heat to other objects or receive the heat from the other objects. In a system of two objects, objects that heat loss is has a higher temperature. b. Humidity Humidity can be interpreted in several ways. Relative Humidity is generally capable of representing the sense of humidity .To know the Relative Humidity, Absolute Humidity should be known first. Absolut Humidity is the amount of water vapor in a certain volume of air that is affected by temperature and pressure. Relative Humidity is a percentage ratio of the amount of water vapor containedzin the volume compared with the maximum amount of water vapor that can be contained in the volume (occurs when experiencing saturation). Relative Humidity is also the percentage ratio of the current vapor pressure measurements were taken and the water vapor pressure when saturation. Thermometer Thermometer is an instrument used to measure the temperature or a change in temperature. The term comes from the Latin thermometer, thermo means heat and meter means to measure. The working principle of the thermometer is diverse, the most commonly used is mercury. When thermometer measuring the temperature is using thermometer, there are several scales which are used, such as the Celsius scale, Reamur, Fahrenheit and Kelvin scale. The four scales have differences in temperature measurement. Theromometer in Celcius Scale Has a boiling point of 100 ° C and a freezing point of 0 ° C. The range of temperature is at 0 ° C - 100 ° C and is divided into 100 scale. Termometer in Reamur Scale Has a boiling point of 80 ° R and a freezing point of 0 ° R. The range of temperature is at 0 ° R - 80 ° R and is divided

into 80 scale. Thermometer in Fahrenheit scale Has a boiling point of 212 ° F and a freezing point of 32 ° F. The range of temperature is at a temperature of 32 ° F - 212 ° F and is divided into 180 scale. Thermometer in Kelvin scale Has a boiling point of 373,15K and freezing point 273.15 ° K. The range of temperature is at a temperature of 273.15 ° K - 373.15 ° K and is divided into 100 scale. So, based on the data above, a scale in degrees Celsius is equal to one scale in degrees Kelvin, while the Celsius scale is less than one Reamur scale and the Celsius scale over a Fahrenheit scale. Mathematically comparison fourth such scale, as follows: Figure 1 Boiling Point Temperature Hygrometer Hygrometer is an instrument used to measure the relative humidity of the air, or the number of invisible water vapor in a given environment. Lower moisture will prevent the growth of fungus whuch is an enemy on the equipment. The Relations Between Temperature and Humidity When the temperature increases, the humidity will decrease and the capacity to accommodate the water vapor in the air will be increase. If the water vapor decreases, the temperature decreases and will lead to increased humidity. Pressure Sensor (MPX) Fugure 2 MPX Sensor MPX 5100 sensor is a pressure sensor with temperature compensation, signal conditioning and has been calibrated. The pressure sensor is a monolithic silicon pressure sensor designed for a variety applications, especially using a microcontroller or microprocessor with input A / D (Sensor Datasheet MPX series). Humidity Sensor 808 H5V5 Humidity sensor 808 H5V5 is a sensor based capacitive humidity sensor that changes the amount of moisture into a voltage. This sensor can measure humidity. This sensor contains a substrate thin film of polymer or metal ocide mounted between two conductive electrodes. Figure 3 Humidity Sensor 808 H5V5 LM35 LM35 Temperature Sensor is one type of sensor that changes the temperature scale electric unit into voltage. LM35 have three pieces of pin legs, pin1 to INPUT positive voltage (+), PIN2 OUTPUT, INPUT pin3 negative voltage / GND (-). It can operate at voltages of 4 volts to 30volt. IC Mikrocontroller ATMega 328 ATMega 328 is a microcontroller in a group of AVR 8 bit. Figure 5 IC Microcontroller ATmega328 has three main PORT, PORTB, PORTC and PORTD with a total pin input / output 23 pins. That PORT eventually serves as the input / output function as a digital or other peripherals. LCD Character 2x16 LCD Character is a dot matrix display is enabled to display the text in the form of numbers or letters as desired (according to the program used to control). LCD Module can be easily connected to the microcontroller. LCD to be used has a wide display 2 rows 16 columns or commonly referred to as character LCD 2 x16 Figure 6 LCD Character circuit Figure 4 Temperature Sensor LM35 Results The process of this research work in the form of a block diagram below through the microcontroller, then displayed via the LCD Figure 7 Block Diagram How it works Ways of working When power button is pressed, all the circuit gets voltage including all sensors, so that the sensor in a state ready and ready operate. Then to choose the measuring of temperature and humidity by pressing up / down. After that press enter. Temperature and humidity received by sensor converted into an analog voltage. Then the voltage is processed by a analog signal conditioning before entering the internal ADC Microcontroller. After the input in ADC voltage, analog voltage to be converted into digital voltage to be processed by a microcontroller. Data from the processing will be processed via the microcontroller then displayed via LCD. To start the calibrationof sphygmomanometer, select pressure measurement mode. Then do the selection pressure boundary as a reference point by pressing up / down. After that press enter. Before there was pressure, the display shows the value 0 mmHg. Pumping is work manually. The pressure entry will be accepted by the pressure sensor, then converted into an analog voltage. The voltage will be processed by the analog signal conditioning (PSA) circuit before entering into internal ADC which has been

available in the Microcontroller IC. After input come into the ADC voltage, analog voltage will be converted into digital voltage to be processed by a microcontroller. Data from the processing will be processed Figure 8 Flow Diagram In start condition, the tool in ready condition, the LCD display will show a selection of modes, namely mode temperature measurement and humidity or pressure measurement. When the temperature and humidity measurement mode is selected then the LCD display will display the temperature and humidity conditions in the room, if the pressure measurement mode is selected, then the LCD display will show the value of pressure on the LCD display. DISCUSSION Microcontroller Atmega 8 Circuit Figure 9 Microcontroller Atmega 8 Circuit MPX 5100 GP Sensor Circuit The Specifications of MPX 5100 GP Sensor Circuit required as follows: 1. The input is 5V and ground 2. MPX 5100 GP given the pressure Room Temperature Sensor circuit which then entered the PORTC.0 for display to the LCD. Table 1. The Comparison of Output Sensor Calculation and Measurement Accuracy Output (V) Figure 13. Schematic of Room Temperature Point (mmhg) Measureme nt Calculation Sensor circuit 0 50 100 150 200 250 0,36 0,65 0,92 1,27 1,55 1,86 0,312 0,612 0,912 1,212 1,512 1,812 Humidity Sensor circuit Figure 14. Schematic of Humidity Sensor H5V6 Working Methods Before the process of pumping, we choose the mode that available, such as the leakage mode or calibration mode. In the leakage mode is used to detect leaks in the Figure 10. The comparison of Output Sensor value of sphygmomanometer. While the (Calculation and Measurement) calibration mode to calculate the accuracy of From the comparison between measurements pressure at certain points (0, and calculations, there is a difference of 50,100,150,200,250) and measuring of voltage is about 0.1 volts. This is because the temperature and humidity in the room when sensor has presentese error about 2.5% the calibration. Based on the measurement results, the Calculation of Output Differensiator measurement of the pressure rises to the point Amplifier accuracy 0 mmHg, the instrument reads the Differensiator amplifier circuit is used measurement standard of 0.0 mmHg. At the to set the output voltage sensor MPX5100GP point accuracy of 50 mmHg, the instrument to 0 volts when there is no pressure, because reads the measurement standard of 50.0 the sensor output voltage MPX5100GP = 0.36 mmHg. At the point accuracy of 100 mmHg, volt when no pressure, so the voltage needs to the instrument reads the standard be at zero right in differensiator circuit measurement of 100.2 mmHg. At the point voltage amplifier with a deduction of 0.36 volt accuracy of 150 mmHg, the instrument reads on the inverting foot. the standard measurement of 144.9 mmHg. At the point accuracy to 200 mmHg, the instrument reads the standard measurement of 199.7 mmHg. At the point accuracy to 250 mmHg, the instrument reads the standard measurement of 249.9 mmHg. While the measurement of the pressure drops to 0 mmHg point accuracy, readings obtained standard measurement of 0.0 mmHg. At the Figure 11. Schematic of MPX 5100 GP point accuracy of 50 mmHg, standard Sensor readings obtained measurements of 50.5 mmHg. At the point accuracy of 100 mmHg, standard readings obtained measurements of 100.1 mmHg. At the point accuracy of 150 mmHg, standard readings obtained measurements of 150.0 mmHg. At the point accuracy to 200 mmHg, standard readings obtained measurements of 199.9 mmHg. At the point accuracy to 250 mmHg, standard readings obtained measurements of 250.2 mmHg. Measurement results are point specific accuracy which has a value of error is quite large, this is because the sensor MPX5100GP has a maximum error of ± 2.5 kPa or equal to 18.75 mmHg. CONCLUSION AND RECOMMENDATION: Conclusion 1. After measurements obtained sensor output is 0.1 volts between measurements and calculations, this is because the sensor has a percentage of error of about 2.5%. 2. After measurements on a circuit of PSA there is a

voltage difference is about 0.01 volts to the circuit summing amplifier and an inverting amplifier, this is because the effect of LM358 tolerance and resistance values used in the circuit is not exactly the same. 3. After making the minimum system, the using of digital pin and analog pin si already matching with the necessary to LCD Display, button and ADC input. 4. After testing, the pressure sensor can receive pressure of 0-250 mmHg, with an average of 0.091% on the measurement error up and down 0.083% on the measurement. 5. After testing, the temperature sensor can tolerate temperatures of 10-60 ° C, with an average error of 0.2%. 6. After testing, the humidity sensor can receive humidity 20-85% RH, with an average error of 0.44% Recommendation Suggestions can be considered for further refinement of research: 1. Minimizing percentage error values so the result can be more accurate by using components that have little tolerance. 2. Equipped by the indicator for battery . 3. Can be developed with a connection to a PC (Personal Computer) for data collection. BIBLIOGRAPHY [1] Awan Suck T.Hygrometer sebagai sensor Thermal Pendeteksi Kelembabab https://awambelajar.wordpress.com/2014/ 03/23/hygrometer-sebagai-sensor- thermal-pendeteksi-kelembaban /2014 [2] Hygrometer.LaboratoriumCore.Medan http://laboratoriumcore.blogspot.co.id/20 12/04/hygrometer.html [3] Keputusan Menteri Kesehatan RI Nomor1204/MENKES/SK/X2004. http://www.jasamedivest.com/files/perme nkes120-4-2004-persyaratan kes-rs.pdf [4] Lakitan,Benyamin,Dasar-dasar Klimatologi.Cetakan ke II.Raja Grafindo Persada http://budisma.web.id/apa itu hygrometer/2014 [5] Middletton W.E.K.A history of the thermometer and its use in meteorology.Baltimore: Johns Hopkins Press.Reprinted ed 2002,ISBN 0-8018- 7153-0 http://id.wikipedia.org/wiki/termometer [6] Onny.Prinsip Kerja Termometer. --. -- .http://artikel-teknologi.com/prinsip- kerja-termometer/. . 2011 [7] http://perpustakaancyber.blogspot.com/2 013/01/temperatur-perpindahan-kalor- pemuaian-zat-pengukuran-pengertian- perubahan.html [8] Thermohygro Medan, Sekilas Mengenai Suhu dan Kelembaban.http://www.pengukursuhuto p.blogspot.com/p/beranda.html 2013 [9] Fluke biomedical. Digital pressure meter ,http://www.flukebiomedical.com/Biome dical/usen/pressure-meters/DPM4-Pressure-Vacuum-Temperature tester.htm?PID=55945 Soeprijatno, Djoko. 2013. [10] Sphygmomanometer atau tensimeter ,http://djokosoeprijanto.blogspot.com/20 13/04/sphygmomanometer-atau-tensimeter.html , Republik Indonesia. 1998. [11] Permenkes No.363/MENKES/PER/IVl19 98 [12] .Muhlisin, Ahmad. 2013. TekananDarah. http://mediskus.com/penyakit/tekanan- darah.html [13] Anderson, Paul D. 1996. AnatomidanFisiologiTubuhManusi a. Jakarta : EGC [14] .Kalibrasi alat kesehatan .http://elektromedik.blogspot.com/2008/0 4/kalibrasi-alat-kesehatan. [15] .Booth, J (1977). "A short history of blood pressure measurement"Proceedings of the Royal Society of Medicine [16] Zainuddin, M 2002, Metodologi penelitian, Program Pascasarjana Universitas Airlangga, Surabaya, pp. 23- 29, 38-52 575 576 577 578 579 580 581 582