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Design and Simulation of Extended PC/104 For Housekeeping Data Sensors Based On Arduino Mega2560

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***Abstract*—PC/104 Standard is widely used in satellite spacecraft because of its rugged and robust. On Board Data Handling (OBDH) in our design uses PC/104 standard. To fulfill the OBDH requirement in gathering the housekeeping data, extended PC/104 is needed to be designed. To design the extended PC/104, *Proteus* software was used initially to simulate the electronic circuit application. In the *Proteus* Design, electronic circuit and components was created. The temperature sensor and voltage sensor was included to produce a precision data. To know the data value, Liquid Crystal Display (LCD) component was used to display the data value. It showed that the temperature, current and voltage sensors can be displayed for read the data sensors. The final result in this research is extended PC/104 has been designed and ready to be implemented in to the real device.**

Keywords-***OBDH, PC/104, microcontroller, satellite, sensor.***

I. INTRODUCTION

The development of science and technology has brought changes in the satellite system with fast data processing capabilities and reliable. Processing satellite data on the main brain that drives the sub-satellite systems, and one such technology is PC/104 technology. PC/104 is a standard computer embeeded system artificial from *RTD Embedded Technologies, Inc*. which is composed of several parts of the bus structure, which consists of modules that are connected via the connector. Module is connected to the connector include ISA, PCI and PCIe bus as communication interface. PC/104 module has been widely used by various groups in the world of technology, especially satellite. This can be evidenced by its use on Turksat-3usat [1], PW-Sat2 and QuakeSat [3] with the use of a microcontroller system on the *On Board Computer* (OBC), Strand-1 satellite [2] belonging to SSTL Surrey is used for satellite attitude determination system or known as *Attitude Determination Control System (*ADCS). EyasSat-1 was used PC/014 board standard on Modules subsystem [12] (ADCS, Communication, DHS, and EPS). OBC is part of *On Board Data Handling* (OBDH) satellites and is the brain of the entire satellite system that serves as a data processing unit of the various sub-satellite systems. The rapid growth of electronics technology, has led microcontroller technology in various applications including the applications design of OBDH Extended PC/104 satellite-based on Arduino Mega2560. Extended PC/104 is a circuit design of sensors used in OBDH satellite. In this design are the focus of research is the use of 24 channels temperature sensors, voltage sensors and current sensors. Because the output's of the three sensors is inserted into the ADC microcontroller, with output measurements displayed on GLCD LM3229. LM3229 is used to display customized characters and images. It has a 240x128 pixels character simultaneously. GLCD is an electronic device to display the output of a system that forms the image or series of images on a screen. By using a series of applications is expected implementation of sensors on satellite sub-systems of internal and external in the extreme environment of space can know the magnitude of temperatures that occur in a linear, continuous and automatic.

Diagram Block

To simplify the sequence analysis, the system created a block diagram as shown in Fig.1, a block diagram of the image can be seen that the 24 temperature sensor's incoming channels simultaneously with the voltage sensor and current sensor, where the results can be viewed through the LCD display format of 240x128 dots, can be displayed featuring 24 channels in 1 pieces then use the LCD to display data in 3 different types of sensors. This was done to facilitate the analysis results are displayed to the LCD.

Arduino Mega2560

There are many types of microcontrollers. It was used in electronics applications, one of which is the Arduino Mega2560. The arduino mega2560 development board is selected because of it flexibility, simplicity and most importanly it's for easy simulation on proteus and a real design implementation. The Arduino Mega2560 is a microcontroller board based on the Atmega2560. It has a 5V operating voltage, 54 digital I/O pins, 16 analogs inputs, 4 UARTs for hardware serial ports, a 16 MHz crystal oscillator, 8 KB SRAM and 4 KB EEPROM Memories, a USB connection, a power jack, an ICSP header, and a reset button [8]. Arduino Mega2560 board is presented on Fig.2 and Fig.3 shows the design of the Extended PC/104 schematics.

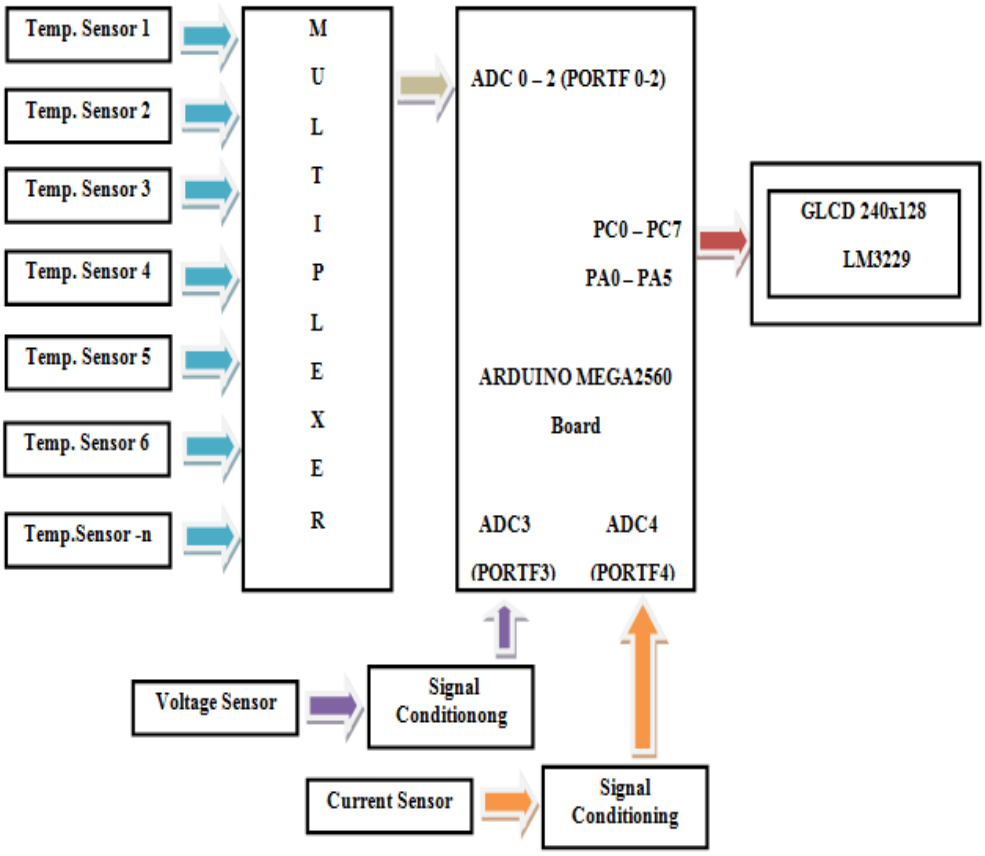

Figure.1 Extended PC/104 Diagram Block

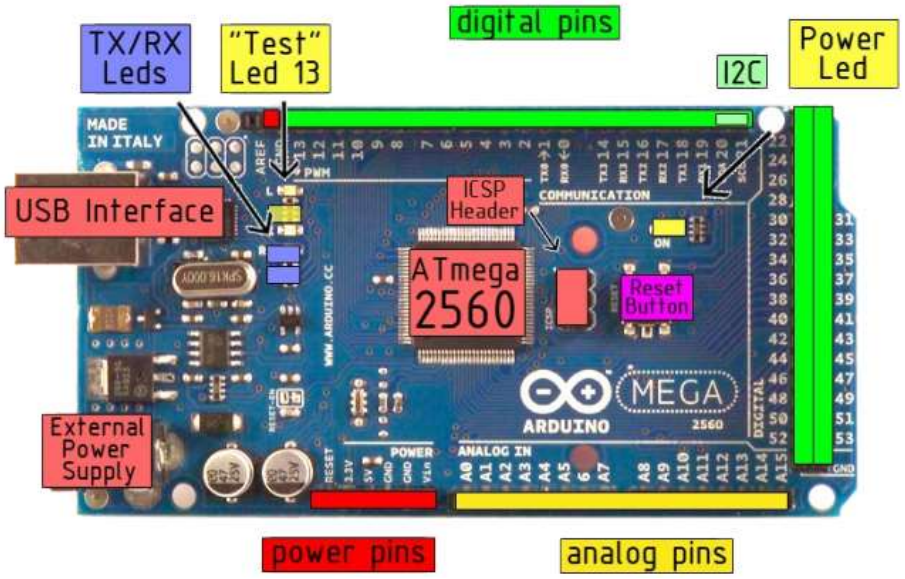

Figure.2 Arduino Mega2560 Board[8]

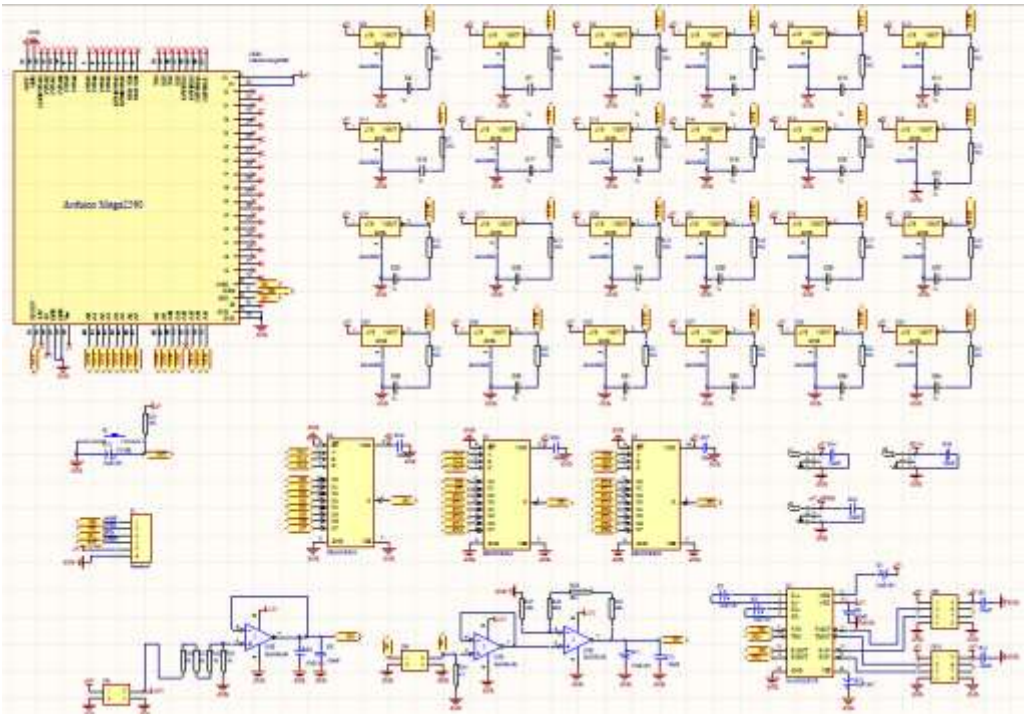

Figure.3 Extended PC/104 Schematics

Temperature Sensor

In this research, the LM 35 is used. The LM35 series are precision integrated-circuit temperature sensors with its output voltage is linearly proportional to the Celcius temperature [4]. The sensor circuitry is sealed and therefore it is not subjected to oxidation and other processes. With LM35, temperature can be measured more accurately than with a thermistor. It also posses low self heating and does

not cause more than 0.1°C temperature rise in still air. The operating temperature range is from -55°C to 150°C. The output voltage varies by 10mV in response to every °C rise/fall in ambient temperature, i.e., its scale factor is 0.01V/°C, and the maximum limit of the sensor output is +1.5 Volt at a temperature of 150°C to obtain the formula as, in [9]:

$$V_{LM35} = \text{Temperature}^{*} 10\ \text{mV/°C} \quad (1)$$

The output of this sensor directly inserted into the ADC and the results are displayed to the LCD monitor.

Voltage and Current Sensors

Voltage sensor used in this circuit system is supplied with the voltage of the power supply voltage limits range between 0 to +30 Volts with output sensor circuit after circuit amplifier or signal conditioning circuit is 0 to +5 Volts. The magnitude of the output voltage is inserted into the ADC Microcontroller. As well as a series of voltage sensor, the current sensor circuit is also the case with Ampere supply provided by the power supply with an input range between 0 to 5 Ampere's, the desired output voltage is the voltage with a range between 0 to +5 Volt. This voltage is the output voltage after a voltage divider circuit and fed to the ADC Microcontroller.

Multiplexer

Multiplexers are electronic component's that serves to select the input to be routed to the output. Multiplexer CD4051 [11] is an 8 channel analog multiplexer with three binary input control. Arduino Mega2560 board was used to provide a temperature sensor input with an 8 channels of input multiplexer CD4051 and will be forwarded to the ADC port microcontroller.

II. METHOD

The method used is prefixed with the process of reading data from the ADC temperature sensor to be processed by a microcontroller and displayed to the LCD, while the sensor voltage and current sensors, analog data is converted to digital data and processed forms so that the data can be read by the microcontroller. Then the sensor data that have been processed are displayed to the LCD. This process is carried out continuously over a predetermined time to the process flow diagram is stopped. Fig.4 shows the flowchart of design process.

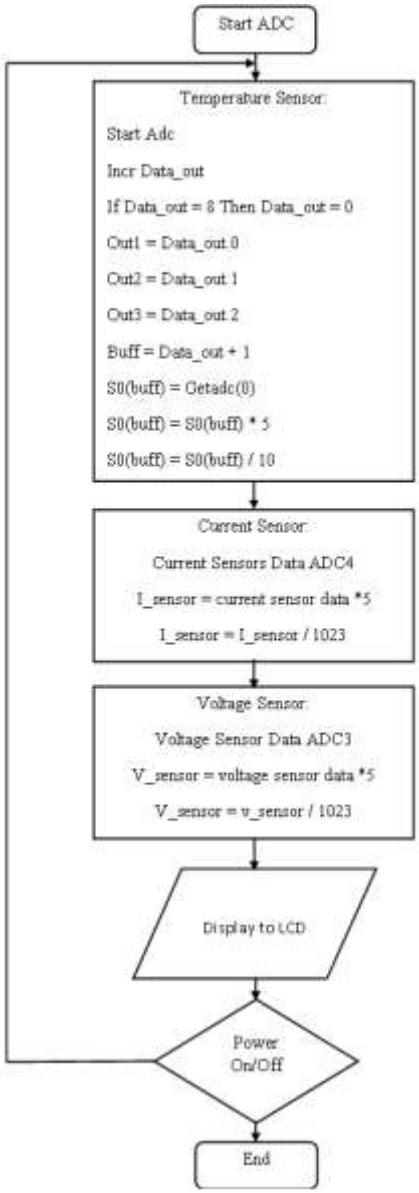

Figure.4 Flowchart of the design process sensor data acquasition

III. RESULT AND DISCUSSION

Temperature Sensor Circuit Testing

Testing on the sensor circuit is done to ensure the sensors work well. This sensor has an accuracy of 10 mV/°C which means that any increase in temperature of 1°C there will be a rise in voltage of 10 mV. Tests conducted simulations based on existing theory with results, V_{LM35} = 3°C x 10 mV/°C = 0.03 Volt as shown in Fig.5, as well as for the other channel sensor.

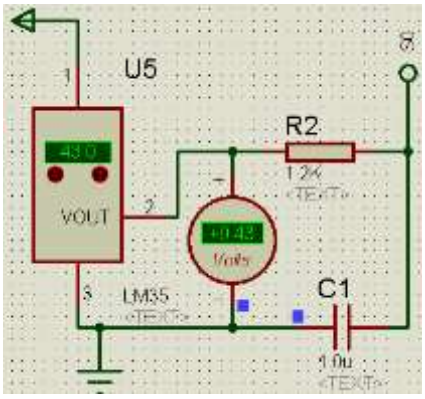

Figure.5 Temperature Sensor Simulation Test

Testing the 24 channels temperature sensor was done by showing the amount of degrees the temperature monitor to an LCD viewer in this case [7], simulation testing was done by proteus to ensure the temperature sensor data received and processed by the microcontroller is true precision. It is not independent of the programming language. The microcontroller on the board are written and programmed using the basic and it was created using compiler (BASCOM AVR) software and ready to be implemented to run simulations [5] [6]. The results of the temperature sensor display 24 channels are shown in Fig.6.

Temperature and Voltage Sensor Testing

In the current sensor circuit, using a 2-level reinforcement, where the first level is a signal conditioning circuit such as a buffer amplifier using LM358. The output voltage in the first amplifier is as the input voltage of the second op-amp amplifier. Where the second level is a non-inverting amplifier with gains of 9.93 times which is equipped with a filter capacitor. Tests conducted with a comparison between measurements in proteus simulation with measurement results of calculations using the formula did not reverse amplifier circuit (non-inverting amp).

$$\text{Vout} = \left(1 + \frac{Rf}{Rin}\right) x\ Vin \quad (2)$$

The measurement results in the calculation and measurement simulation is like the Table.1 and graph linear current sensor circuit is shown in Fig.7

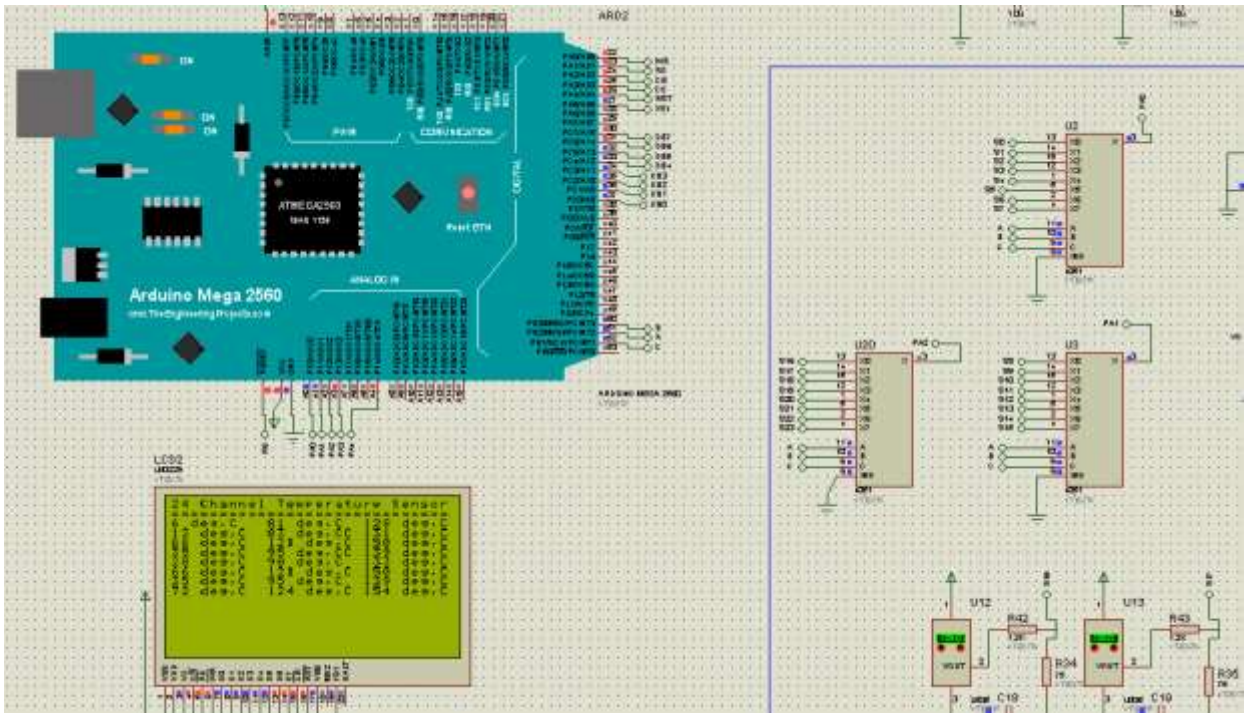

Figure.6 Result of temperature sensor simulation

TABLE I. RESULT THE CALCULATION AND MEASUREMENT OF CURRENT SENSOR

Input Current (Ampere)	Input Voltage, Vin (Volt)	Simulation Measurement	Calculation
		Output Voltage, Vout (Volt)	Output Voltage, Vout (Volt)
0	0	0.02	0
1	0.1	1.02	0.993
2	0.2	2.01	1.986
3	0.3	3.00	2.979
4	0.4	3.99	3.972
5	0.5	4.99	4.965

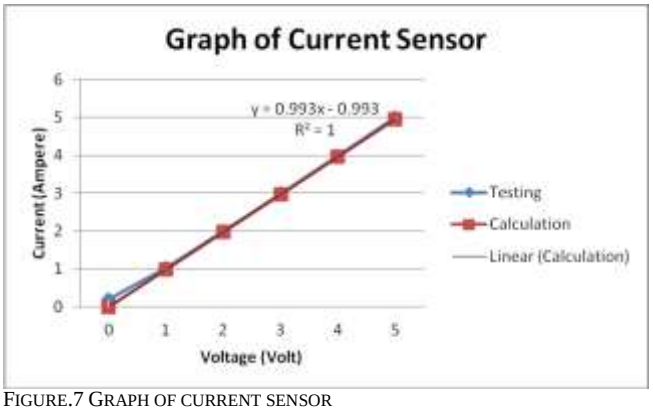

FIGURE.7 GRAPH OF CURRENT SENSOR

From the above table, it can be seen that the circuit current sensors [10] can work with the current range as planned, and from the graph can be informed that the rated current is linear with respect to voltage indicated by the R2 correlation (correlation coefficient) is 1, which means that the resulting graph is linear sensor with a sensitivity of 0.993 V/A and the offset voltage of 0.993 Volts. Test design simulating flow sensor circuits are shown in Fig.8

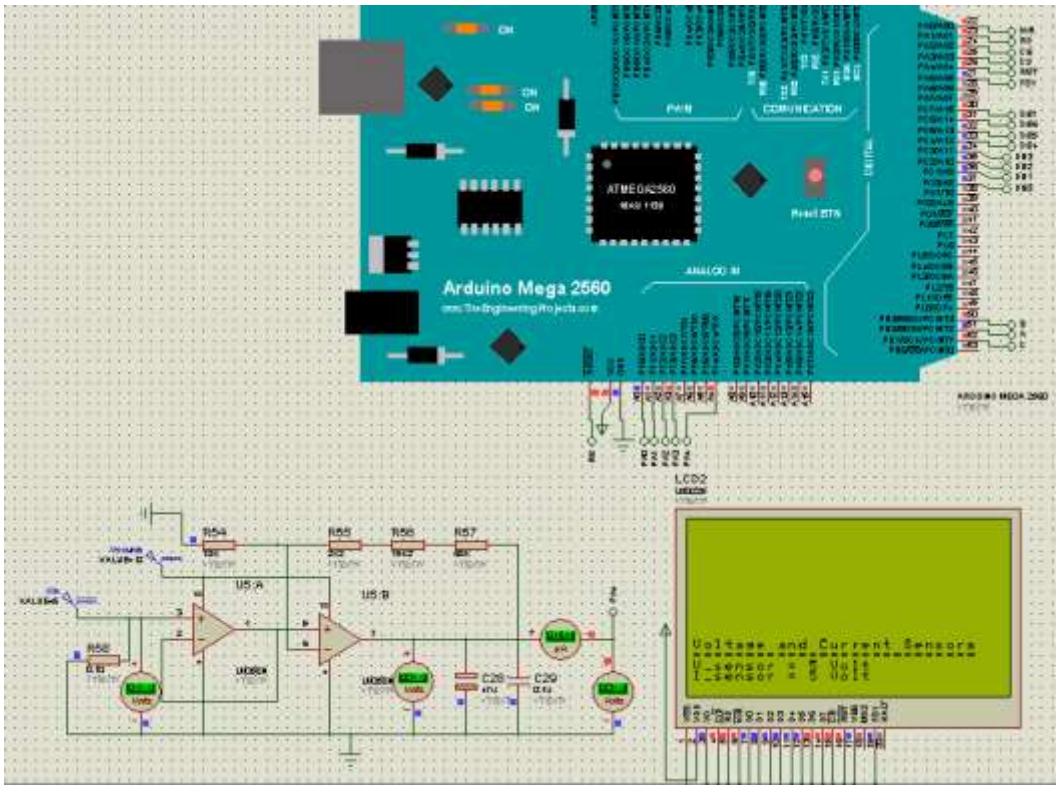

Figure.8 Design simulation test circuit current sensor

At this voltage sensor circuit using the input voltage divider circuit where the input voltage supplied by the power supply circuit with a range of 0 to 30 Volts, so that the resulting output voltage as in Table 2, while the simulated test circuit as shown in Fig.8.

TABLE II. RESULT OF MEASUREMENT AND CALCULATION OF THE VOLTAGE SENSOR CIRCUIT

Input Voltage, Vin (Volt)	Simulation Measurement	Calculation
	Output Voltage, Vout (Volt)	Output Voltage, Vout (Volt)
0	0	0
5	0.83	0.83
10	1.67	1.67
15	2.5	2.5
20	3.33	3.33
25	4.17	4.17
30	5.00	5.00

From the above table it can be seen that the measurement and calculation of the output voltage of the sensor circuit is precision.

IV. CONCLUSION AND FUTURE WORK

In this paper, we have designed and simulated the Arduino Mega2560 microcontroller based on system for monitoring data sensors. OBDH satellite as primary brain that drives the sub satellite system with the main components of a data processor that microcontroller can perform the data processing of both analog and digital data. In this experiment, LM35 sensor is able to demonstrate the accuracy of 10 mV/°C for each 1°C rise in temperature and voltage sensors can indicate the precision and accuracy while the linear current sensor can generate a data stream with an average accuracy of 1.1% linear. The next research will integrated this Extended PC/104 together with main PC/104 module and other subsystem s to see the operations.

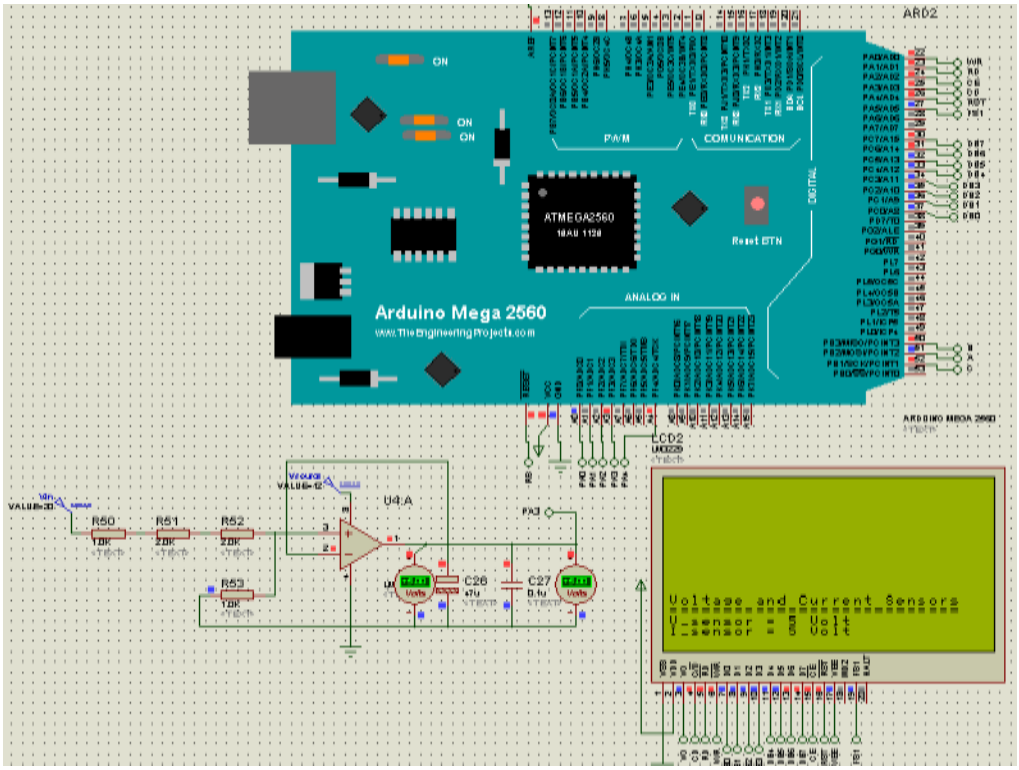

Figure.9 The design of the voltage sensor circuit simulation test

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