The controller and monitoring system of 1-10 kV high voltage power supply

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Abstract. The controller and monitoring system of 1-10 kV high voltage power supply was developed. The system composed of an Arduino mega 2560 microcontroller boards, a digital to analog conversion (DAC) part, a high voltage module and the designed software on a personal computer. The software was developed by LabVIEW software for controlled the high voltage module and displayed the high voltage values. The microcontroller board used for the digital data transmission to the DAC part and converted the high voltage value to digital data for monitoring. The DAC part generated the analog signal from a board for adjusting a high voltage value of a module. The completed system can be controlled the high voltage and the real-time monitored the high voltage value of a module with the resolution of 2.5 V. The error of actual high voltage values with the setting one was maximum of 5%

1. Introduction

The high voltage (HV) applications have received a lot of attention over the years. It is well known that high voltage power can cause electric fields [1], [2]. Based on research in biology, the researchers introduced high voltage to study the effects of E. coli bacteria on living under the electric field of 4 kV/cm [3]. In engineering research, high voltage has been used to study the distribution of diamond particles for grinding and abrasive coatings that using a high voltage of 6 kV, which results in a more uniform distribution than the conventional ones [4]. In addition, the research on the agricultural thread has introduced high voltage to study the condition of eggs, which use the electric field from 30 kV/m, 60 kV/m and 90 kV/m [5]. And recently, the study of materials science has studied the properties of materials that change under the power of electric fields in the range of 700 V/mm to 2 kV/mm, which stimulate materials by synchrotron light sources in the energy range of x-ray. Some properties of the material change [6], [7]. However, the inaccuracies and the precision in these researches are the handlings of high voltage control systems. In this paper, we focus on studying and creating high voltage generators that provide precise voltage control that can be controlled and monitored on a computer. In our experiment, we used the Arduino Mega 2560 board for the interface and developed the control system with LabVIEW software. We can control the high voltage generator in the range of 1 kV to 10 kV so that it can be applied to other research. To be more precise. The experimental details are shown in Part 2, the analysis and discussions are shows in part 3, and the summary is shown in Part 4.

2. Experimental

2.2 The circuit designing

In generating the high voltage, we used the module for high voltage generators and connected to the Arduino mega 2560 control board. The circuit shown in Figure 1 is a circuit specially designed for high voltage generation. Figure 1(a) Show about the Arduino mega 2560 is used to connect to computers and electronic circuits. Figure 1(b) show about the digital to analog converter circuit (DAC) MCP4922 is used to convert the signal from the board. Figure 1(c) are amplifier circuit (non-inverting amplifier circuit) LM358. Figure 1(d) drives the current circuit (P55NF06) and Figure 1(e) is high voltage module.

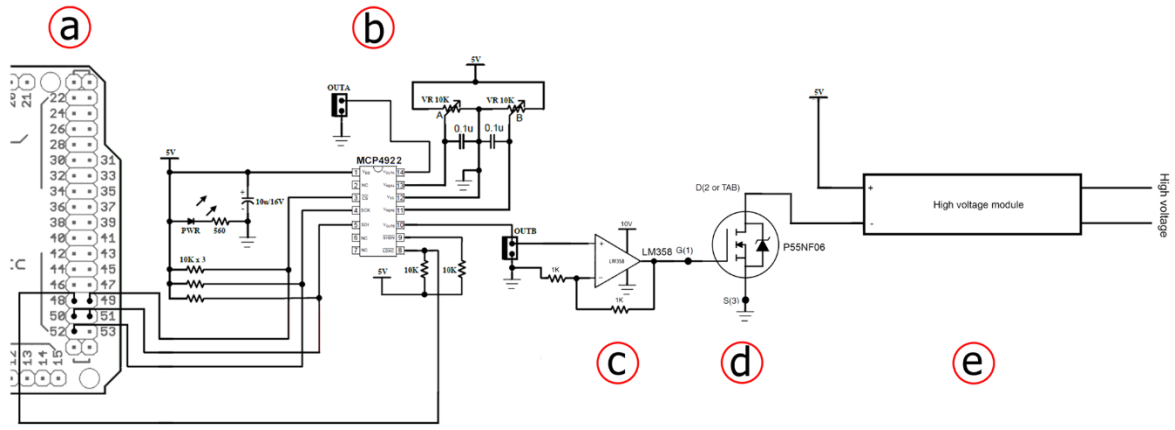


Figure 1. The high voltage circuit parts **a)** an Arduino mega 2560 board **b)** Digital to analog converter circuit (DAC) MCP4922 **c)** an amplifier circuit **d)** a current driver circuit (P55NF06) and **e)** the high voltage module.

The high voltage values were adjusted by varies the digital value in the application on a computer. The Arduino board received the data and transmit to DAC circuits then convert to analog form. The signals were amplified by an amplifier circuit for drives the high voltage module by a driver circuit. The appearance high voltage values were monitored by the high voltage probe and collected by the program on a computer via the Arduino board as shown in Figure 2.

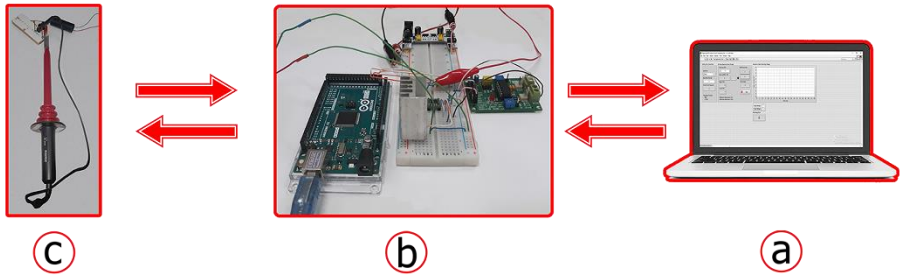


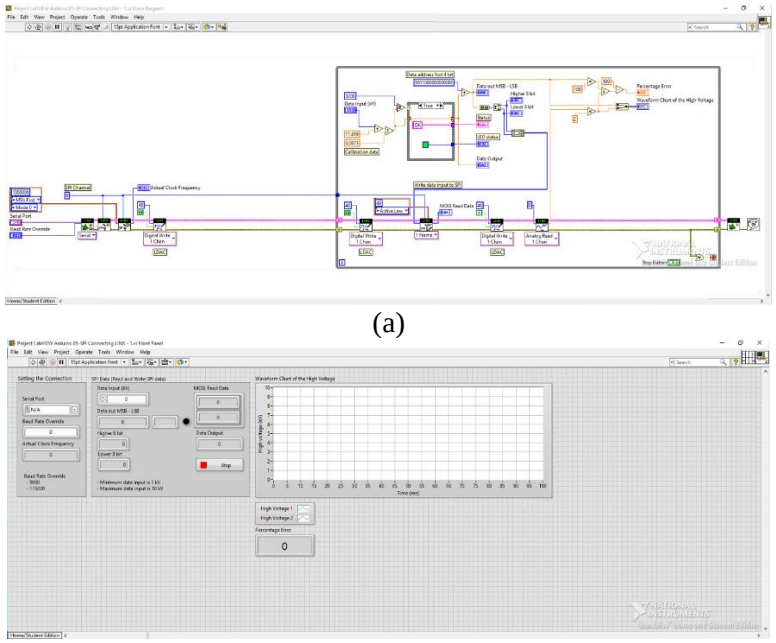
Figure 2. The controller and monitoring system **a)** the computer used for controls and collects the data. **b)** The electronic circuit part. **c)** The high voltage output and the high voltage probe.

2.2 The software designing

The development of control systems using the LabVIEW software (Home Edition) interface with Arduino board. The control is divided into two parts, as part of the development of the application program for processing LINX applications and part of a window for control, parameter setting, and display in high voltage generators.

3. Results and Discussion

The program development is divided into the two-part with the part of the controlling panel and the part of the program processing panel. Shown in Figure 3.

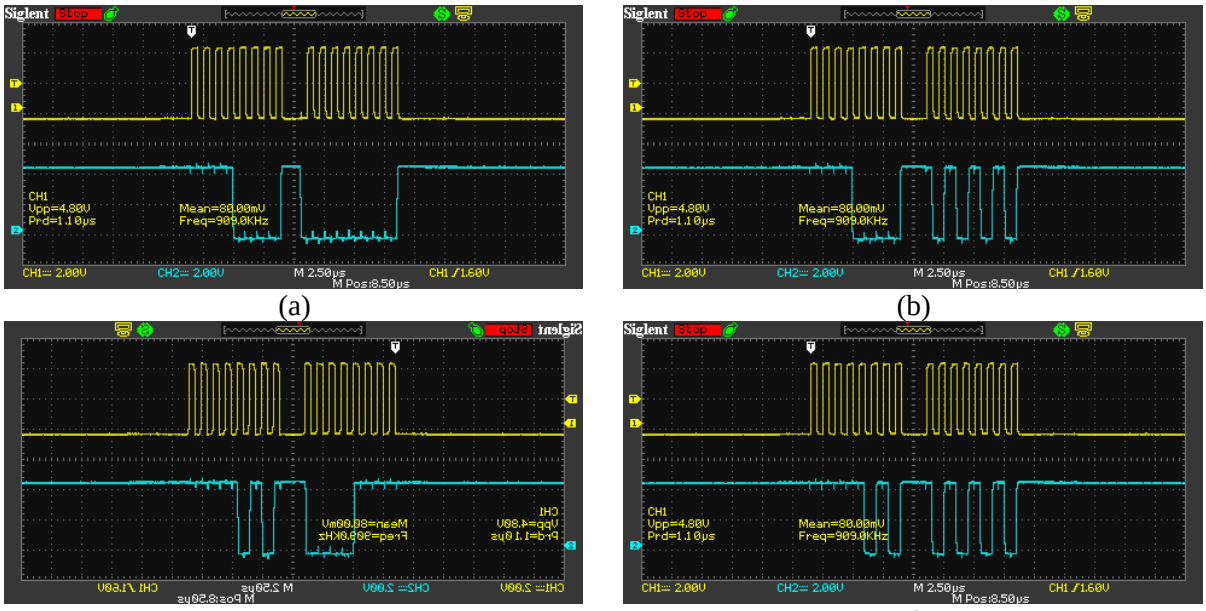


(a)

(b)

Figure 3. Shown about the development program of the panel on the computer control system. a) The panel of the processing program is used to send and receive the data with the electronic circuit part. b) The panel of the monitoring is used to set the parameter to generate the high voltage and to display the data from generating.

The digital data transmission from the Arduino board to DAC via the SPI bus with 16-bit data transfer. Figure 4 shown the comparison of SCLK and MOSI waveform with the various data.



(a) (b)

(c) (d)

Figure 4. characteristics of digital signals, the clock signal is measured by a 16 bit oscilloscope **a)** send digital information to 1111 0000 0000 0000 **b)** Send digital information to 1111 0000 1010 1010 **c)** send digital information to 1111 0000 1010 0000 And **d)** send digital information to 1111 1010 1010 1010.

Figure 5 shown the relation between the digital values and the DAC output voltage. The analog output was linearity with the R^2 = 1 and 1.22 mV/bit resolution. The results have shown that the analog output can be adjusted by the developed program on a computer.

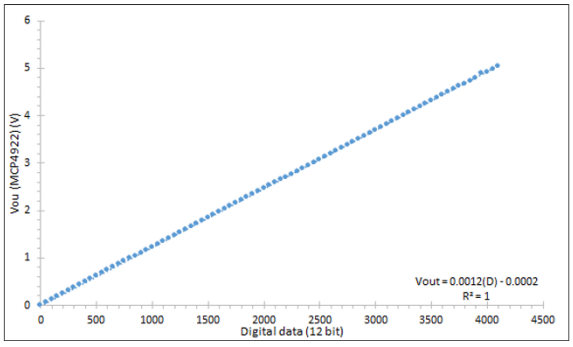


Figure 5. The relation between the digital values and the DAC output voltage.

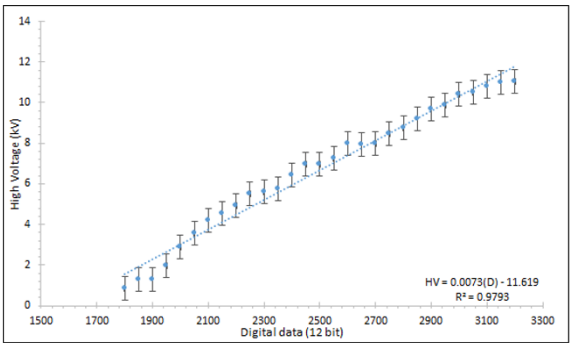


Figure 6. The relation between the digital value and the high voltage output of the high voltage module.

Figure 6 shown the relation between the digital value and the high voltage output of the high voltage module. The high voltage value can be varied in the range of 1 - 10 kV with the input digital values in the range of 0 - 1700. The high voltage output closely linear with the R^2 = 0.9793 and the 2.5 V/bit resolution. The appearance high voltage value can be monitored by the probe and displayed in the developed program on a computer. The error has occurred over this digital range was 5% maximum.

4. Conclusion

In this work, the high voltage is generated from a high voltage module in the range of 1 kV to 10 kV. The error was occurred over this digital range was 5% maximum. In the controller used the developed program on a computer for connection to an Arduino mega 2560 board and an electronic circuit. The high voltage values can be varied and real-time monitoring with the program.

5. References

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