DC Power Supply using Digital Potentiometer on Switching Regulator Module Monitored and Controlled via NI LabView

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Abstract. Smart Controlled Adjustable Power Supply is an automated power supply device in which the Voltage output from the device can be controlled using Digital Potentiometer as a voltage feedback manipulator and can be monitored using PC. Voltage and output current can be controlled in accordance with the specifications of the desired voltage 0-30V DC with 0.01 V resolution. This Study will show how Digital POT can change the output voltage of the LM2576 Module and show the correlation between the BIT number of POT and the Voltage output. Afterward, the device will be controlled and monitored via NI LabView so it can easily be accessed by everyone and can compete in industry 4.0 due to its accessibility. There will be some test runs to prove the designed device is working properly and match the desired specifications.

1. Introduction

Nowadays Voltage DC power supply was used in many fields and power electronics are used to control the energy flow process by giving voltage and current in an optimal form and suitable for loads [1]. Traditional Power supply whose voltage regulating method was manually mechanical operation. In order to be able to adapt to industrial automation, the voltage regulating method must be upgraded by changing the mechanical operation onto automatic operation. This paper will show the design of a power supply DC that can be controlled. The keys of this method were the LM2576 module and digital potentiometer AD5292. LM2576 module is the power supply module that can produce output 1.25V – 30 V DC voltage with an input of 30DC constant voltage. AD5292 is connected to the module for controlling the output voltage of the module and communicate with the Arduino serial. So the main purpose of this paper was to design a new method for regulating dc voltage output of a power supply. The controlled adjustable power supply will be controlled and monitored via NI LabView. The voltage output of the device will be shown in graph voltage vs time, also the desired output will be controlled using a graphical interface that available in NI LabView.

2. Design of the Power Supply

2.1. Power Supply Specification

The power supply specifications were determined in the beginning so the author could choose what kind of voltage regulator module that can be used. Specs were determined near to PXI programmable power supply from National Instruments.
Table 1. Design Specifications

| Num. | Parameter                  | Units                      |
|------|----------------------------|----------------------------|
| 1    | Input Voltage              | 30 V DC                    |
| 2    | DC output range            | 0 – 30 V DC                |
| 3    | Max current output         | 3 A                        |
| 4    | Ratio level voltage        | XX.X / 0.1 V per Level     |

2.2 Designing System

Design is made to suit all of the determined specifications. The switching regulator module picked due to high efficiency and has an adjusted voltage feature [2][3]. Another component to design was the voltage sensor and the current sensor.

![Figure 1. Circuit Block Diagram of the System.](image)

In Figure 1 shows all of the system circuits. Voltage input of 30 V DC goes into module LM2576 which is the chosen switching regulator, also goes into LM7815 and LM7805 for powering Arduino Nano, and the last goes into potentiometer digital, AD5292 [4]. Current sensor ACS712 placed after the switching regulator. The output of this system is the voltage variance of 0-30V DC with 3 A max.

2.3 Control Algorithm

The program is planted in Arduino nano for doing all the activities for adjusting the desired voltage output and communicate in serial with NI LabView for exchanging data. Figure 2 shows how the program in Arduino works. That flow chart is the process of input voltage turning into an adjusted output voltage.
2.4 NI LabView Design

LabView is used for monitoring and controlling the device that has been made. Block diagram is designed to make Arduino and LabView can communicate interchangeably and all of that made from sets of VIs. VIs were chosen to make a program so Arduino and LabView can communicate. Arduino passes voltage output data and then the data put into graphs. In Figure 3 shows a list of used VIs to communicate and manipulate the data.
After made all of the block diagrams, there was also a front panel that works for the user interface. User interface made with the graphical metered cursor and a graph of voltage vs time. In Figure 4 are shown the display of a front panel in LabView. The red bar is the slider for voltage input, and there is the numeric input on the right side of the slider. Numeric input allows us to type input using the keyboard.

![Figure 4. Front panel of NI LabView](image)

2.5 Circuit Schematics and PCB Layout

The designing of the hardware circuit was done by Eagle PCB design software. In Figure 5 is shown the layout of the printed circuit board. Every module and all the electronic components are implemented in one board. In Figure 6 is shown the schematic of the designed circuit. In the schematic also shown that there are pins that designed for Arduino Shield and ACS712 Shield.

![Figure 5. PCB Layout](image)  ![Figure 6. Schematic Design](image)
3. Tests Runs and Analysis

This chapter will discuss the results of the tests that have been carried out along with the results of the analysis. There are 3 tests to be performed, including testing the output voltage that can be issued by the device by looking at the range of voltage that can be issued, then testing the resolution that can be issued by the device and finally testing the maximum current that can be given from the output by the device.

In Figure 7 shown the test of every bit position of the wiper of potentiometer digital. As the graph shows, the rise of the voltage is linear meaning its suitable to use the AD5292 for controlling voltage output. The resolution also covered with this device, it makes up to 0.08V, which means it covers the target spec at 0.1V resolution.

AD5292 is compatible with our power supply specification, then move on to the other test. The next test is to measure the accuracy of voltage input vs voltage output. The device is controlled using LabView Via PC. Voltage inputs are compared with voltage outputs to see how the device can control the voltage outputs precisely. In Figure 8 are shown 30 samples of voltage inputs and outputs. The difference between the those approximately only 0.02V.

The next test is to test the device by giving the load to it. Resistor given is at 1 Ω. This test measures how the current output flow if it’s attached to a load. Voltage input is adjusted at constant 1.5V. In Figure 9 shown that the current that flows through the device and the load are fluctuates. It happened because of the current sensor ACS712 is not suitable for this kind of test condition. ACS712 suits in AC voltage measurement.

The last test was measuring how fast the voltage output change from 0-30V. The voltage input gradually increases from 0-30V then the output voltage is measured in time. In Figure 10 shown voltage output change in time. It needed the 90s to make a 0-30V change. It also shows the steady state time and settling time needed for the device to change its voltage output form 0-30V. All the tests have been done proving that the design is quite stable and it reaches the desired specification.
4. Conclusion
This study aims to design and implement a power supply whose output voltage can be set from the range of 0-30 V DC with a resolution of 0.1 V per level with a maximum current of 3 A and the most important thing, to be controlled and monitored by NI LabView. After doing this research, the results met all the required parameters. There are 3 parameter specifications: range volt, volt resolution, and maximum voltage output at 30V. The result of the required range of volts meets the desired specifications. For volt resolution, it can be adjusted to a precise 0.1V per level. The maximum current at the output can meet the target of 3A, it’s just that the application is not enough because there will be the decrease in current due to automatic safety on ICLM2576. The current reading also not quite right because of the used unsuitable current sensor (ACS712), for further research, the current sensor should be replaced with more suitable current reading. On the other hand, controlling and monitoring can be done using NI LabView. The interface shows the exact data that was expected, and it is easy to be accessed so this device could be useful in the industry 4.0 environment.

References
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