Programmable Benchtop Power Supply Unit

OAMK
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Introduction

Programmable Benchtop Power Supply Unit (PBPSU) was a project for Applied Electronics Project course. It was made to provide reliable and adjustable power in range of 0 - 20 V, 0 - 2 A.

Objectives

Our team's objective was to design and create a highly accurate and dependable Power Source Unit as a tool for our electronic work projects outside OAMK university. It quickly became apparent that programming an Arduino to give our unit some intelligence was the best way to develop features that would make this PSU more exceptional for our use.

Methods

PBPSU's circuit was designed and drawn with EAGLE software and we separated the circuitry into digital and analog sections. Processing, controlling and signaling is done by the digital board. Power input and its distribution, amplification and output stage is built on the analog board. Circuits were manufactured with university's CNC milling machine. Enclosuring, parts and components were sold by a local electronic store, SP-elektroniikka.

An LCD was installed to display device's set output voltage, current and measured V/A, power output, temperature and power loss at the output stage. Voltage and current output is adjustable with two rotary encoders with an accuracy of 10 mV and 10 mA. This user input is processed by an Arduino nano which sends both adjusted V and A values as one 24 bit signal into a series of three 8-bit shift registers to distribute two 12 bit V- and A-value signals to their corresponding DACs which in turn then create two separate 0-5 V reference signals to analog board's operational amplifiers and the output stage.

DIGITAL INPUT (MSB … LSB)	ANALOG OUTPUT
1 1 1 1 1 1 1 1 1 1 1 1	$-V_{REF}\left(\frac{4095}{4096}\right)$
1 0 0 0 0 0 0 0 0 0 0 0	$-V_{REF}\left(\frac{2048}{4096}\right) = -1/2V_{REF}$
0 0 0 0 0 0 0 0 0 0 0 1	$-V_{REF}\left(\frac{1}{4096}\right)$
0 0 0 0 0 0 0 0 0 0 0 0	0V

FIGURE 1: DAC Code table

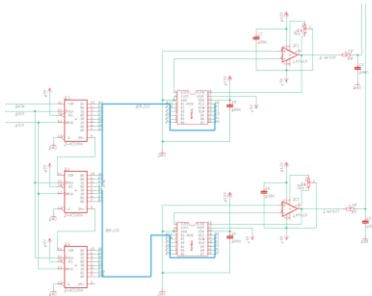


FIGURE 2: DA-converters, partial schematic of digital board

The voltage at the output stage is measured and monitored by a simple voltage divider, while the current is measured from a high side shunt resistor by an instrumentation amplifier, which then converts the voltage differential from the shunt resistor to a logic level analog signal. This signal is then used for reading and limiting the output current.

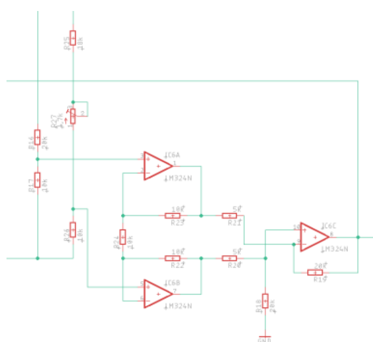


FIGURE 3: Instrumentation amplifier

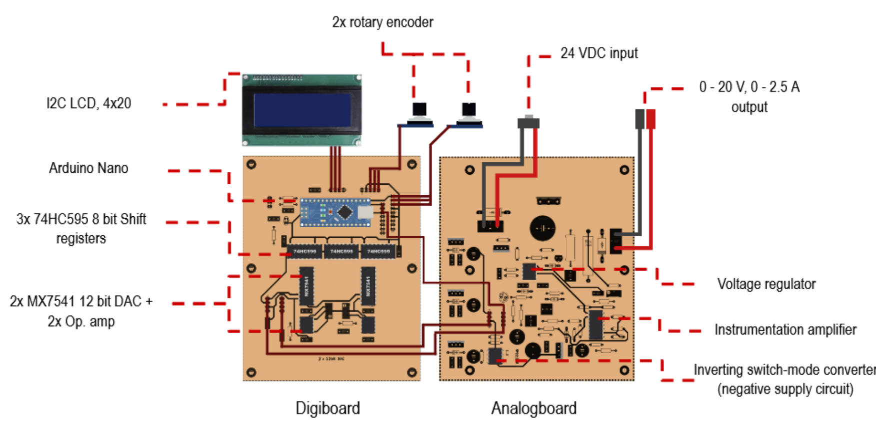
Results

Main features were implemented successfully. Due to time constraints we were not able to add function generator and other features that would've been interesting to implement into a PSU. Output V/A values and measurements matched with other V/A measuring instruments. Heat dissipation at the PNP output stage transistor is controlled and limited with program, to keep the series regulation power loss in a safe thermal operating area. Output stage also has a programmed short-circuit protection. Heatsink temperature is monitored with calibrated NTC-sensor. Finished product is a handful tool in later study and hobby projects.

Conclusion

Project was an in-depth introduction into designing circuits and learning about combining analog and digital electronics. It was our first large project with EAGLE-software and CNC milled circuits with such precise proportions. The project was a good application of the contents of the first study year.

FIGURE 4: Finished Product



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