Power Supply with a Function Generator

Introduction

The Power supply and Function generator will allow students the ability to safely output a maximum of 30V and 3A. The buck converter power supply allows for steady voltage regulation that will maintain output voltage while the power increases to the max capability of 90W. For our function generator, the maximum amplitude is 10Vpp with a frequency range of up to 2.4MHz. The function generator can supply a triangular, rectangular, and sinusoidal waveform with or without DC offset. Our goal is to give students the ability to achieve electrical engineering projects from home with a cheaper and effective tool that can improve the capability of home labs. This power supply and function generator's primary use is for students during the pandemic. Our group wanted function generator capabilities in our power supply so students the ability to achieve electrical engineering projects from home with a cheaper and effective tool that can improve the capability of home labs. This power supply and function generator will allow students the ability to conduct their experiments safely and effectively.

Methodology

The power supply schematic is based on a buck converter topology. The buck converter was the choice for this power supply because of its ability to be stepped down in voltage making it more simple to work with and efficient for student use. The buck converter maintains regulated voltage regardless of the increase in current. Keeping the necessary input voltage for the buck converter allows for the circuit to be used as a stable and cheap power supply:

- The buck converter IC that was chosen was an LM2576 which has a maximum output of 30V and 3 A when using the plus and minus pins. The efficiency of the buck converter IC is around 80% which is a good amount for students.
- The topology can be easily implemented in the schematic seen in Figure 1 and Figure 2 which was designed for a PCB to make the circuit more compact to fit better in our housing unit in Figure 1. The output power is connected to the terminals which will supply plus and minus 15V when the transformers supply power after being plugged in.

- The function generator utilizes the Analog Devices AD9833 arbitrary waveform generator IC. The corresponding datasheet is utilized to determine the bits needed to be written to the internal registers to set the expected waveform type, frequency, and phase of the output. The data is all written serially through the SPI interface. To handle the DC offset and waveform amplification, an operational amplifier circuit is designed with feedback control for the user to interact with.
- The code will be written to interface with the UI elements to program the AD9833 arbitrary function generator IC. The next step is to simulate the gain and offset circuit and build a corresponding schematic, followed by PCB design.

Analysis and Results

Results for the Function Generator

Initially, the function generator used an interface using trimmer control sampled by the microcontroller analog to digital converter. However, given the frequency range of 0 to 2.4MHz, a keypad is deemed necessary. The keypad is implemented using the typical keyboard input technique of row-column input scanning.

The output stage was manufactured, put together with the components, and verified independently for functionality. The interface includes a gain trimmer, offset trimmer, and gain mode selection switch for high and low gain resistor configurations.

Results for the Power Supply

<table>
<thead>
<tr>
<th>Load (OHM)</th>
<th>Output Voltage (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>11.4</td>
</tr>
<tr>
<td>10</td>
<td>11.3</td>
</tr>
<tr>
<td>47</td>
<td>11.1</td>
</tr>
<tr>
<td>100</td>
<td>11.3</td>
</tr>
<tr>
<td>250</td>
<td>11.3</td>
</tr>
<tr>
<td>470</td>
<td>11.4</td>
</tr>
<tr>
<td>1100</td>
<td>11.4</td>
</tr>
</tbody>
</table>

The design buck converter outputs -15V to +15V by turning the potentiometer. The output voltage was displayed using the voltage meter analog to digital converter as shown in Figure 1. Since there was no high current drawing load on hand, the IC temperature was cool and under control. Since we tested the stability at lower voltage to see the voltage drop, there was no issue with the heat dissipation. At a higher range, our attached heatsink will keep the IC cool even under high wattage.

The design board was tested using different loads at the output to check the output voltage stability. The data was tabulated and graphed as shown in Figure 11. As shown in the table, we were able to get stable voltage until 470 ohm load then we encountered some voltage drop after 470 to 10-ohm loads. Since we did not have any smaller high wattage resistors, we could not test the voltage drop at a very small load. The tested load shows that the voltage drop is within the acceptable range of 200-300 mV voltage drop.

Summary/Conclusions

Our design project can supply 30V output at 3A and can generate three different waveforms at 10Vpp. The voltage ranges from -15V to 15V and the function generator can output sine, triangular, and square wave up to 2.4MHz. The system can be adjusted using the knobs for both systems and can also be configured with buttons for the function generator. The output for both systems is displayed on the screen for easy use for the users. With the help of this interface, students can use this power supply with function generator capabilities at a much cheaper price remotely for most of the school work and other small projects which are within the capabilities of our system.

Key References

[1] Waveform Generator, AD9833 Datasheet


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