Sergio Guerrero
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Project Report

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Introduction:

This project consisted of building and writing hardware and code that could output custom waveforms with various parameters such as frequency, amplitude, offset and phase shift. This was done using 4 different chips, MCP 4822, MAX 660, TLC 072, and the TLV 2374. Using the TM4C123GH6PM microcontroller as the driver board for this circuit.

Hardware:

The MAX 660 chip was used as a power supply for the rest of the chips on the board. This specific chip was powered with a 5V source from the controller. This then through a circuit had an output of +5V and -5V. These two voltages were used to power the TLC 072 and TLV 2374 which required a +5V and -5V to power the Op Amps.

The MCP 4822 was a Digital to Analog converter to convert an R value from 0-4096 to a output from the chips that ranged from 0V – 3.3V depending on the R value inputted into each DAC. This chip was equipped with 2 DACS which I referred to as DACA and DACB.

The TLC 072 was a Op Amp chip with two Op Amp internal circuits which used the outputs from DACA and DACB as its inputs. Once this chip received a voltage as an input it would then go through a circuit which would output a voltage from the range -5V to +5V depending on the input which was coming from the DACS.

The TLV 2374 was an Op Amp chip which acted as a rectifier for the voltages that were inputted onto the board. Although the chip had 4 Op Amps, two were used for each input thus this chip consisted of 2 inputs and 2 outputs. The outputs which were connected to Analog to Digital converter pins which were configured in software on the micro controller. (PE1, PE2)

Commands:

- Both channels (DACA/DACB) can output simultaneously using the stop/run command.
- The frequency for the output's waves is used by calculating a step size and summing the step size with a phase accumulator every time an interrupt occurs and a LUT value is written to the DAC. The phase accumulator value will loop back to zero once it has reached the max value of the LUT which is 2048 in my case.
- In the TimerISR, the DAC will be written to with the value of the LUT at the phase accumulator index in that iteration.

RESET

The reset command will reset all hardware

DC OUTPUT VOLTAGE
The DC command is to out a given direct voltage to the requested output. This voltage is to output from the ranges of -5 V to +5V.

RUN/STOP
The run/stop commands are used to begin the outputting of the waves as well as to stop the outputting of the waves.

SINE OUTPUT FREQ, VOLTAGE, OFFSET, SHIFT
The sine command was used to output a sine wave, this was done by filling up a Lookup Table (LUT) with values of the sine wave. This LUT held 0 – 2048 values for the sine wave, which was done using the equation below. The output parameter specified the output/dac to use.

```
fTemp = off + (voltF) * sin(((float)i/(float)LUT_SIZE) * 2.0 * M_PI + Fshift);
```

SQUARE OUTPUT FREQ, VOLTAGE, OFFSET
The square command was used to output a square wave, this was done by filling up a Lookup Table (LUT) with values of the sine wave. This LUT held 0 – 2048 values for the square wave, which was done using the equation below. The output parameter specified the output/dac to use.

1st half of wave:

```
fTemp = off + voltF;
```

2nd half of wave:

```
fTemp = off - voltF;
```

TRIANGLE OUTPUT FREQ, VOLTAGE, OFFSET

The triangle command was used to output a triangle wave, this was done by filling up a Lookup Table (LUT) with values of the triangle wave. This LUT held 0 – 2048 values for the square wave, which was done using the equation below. The output parameter specified the output/dac to use.

1st half of wave:

```
fTemp = off + (voltF * ((float)i/(float)(LUT_SIZE/2)));
```

2nd half of wave:

```
fTemp = off + (voltF * ((float)i/(float)(LUT_SIZE/2))
```

SAWTOOTH OUTPUT FREQ, VOLTAGE, OFFSET

The sawtooth command was used to output a sawtooth wave, this was done by filling up a Lookup Table (LUT) with values of the sawtooth wave. This LUT held 0 – 2048 values for the sawtooth wave, which was done using the equation below. The output parameter specified the output/dac to use.

```
fTemp = off + (voltF * ((float)i/(float)LUT_SIZE));
```

VOLTAGE INPUT

The voltage command is used to measure and output the voltage of the input requested to the terminal.

CYCLES #

The cycles command is used to output only a certain number of periods of each wave. Waves on both channels will stop outputting once the requested number of cycles has been reached.

Conclusion:

The LUTS for waveform are

This project was a great way for us to be able to work with Digital and Analog Signals. Being able to understand the conversion from R values to Voltage values give a better understanding of the multiple possibilities that could be used with such Op Amps.