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EE E3082. Digital Electronics Laboratory

Laboratory 2: A/D and D/A Converters

Analog to Digital Converter

The ADC0804 was used to find analog to digital conversions and as well as the characteristics of such a conversion. The clock was found to operate at a frequency of 224.74kHz with a period of 4.4496µS. The clock waveform can be seen in *Figure 1*.

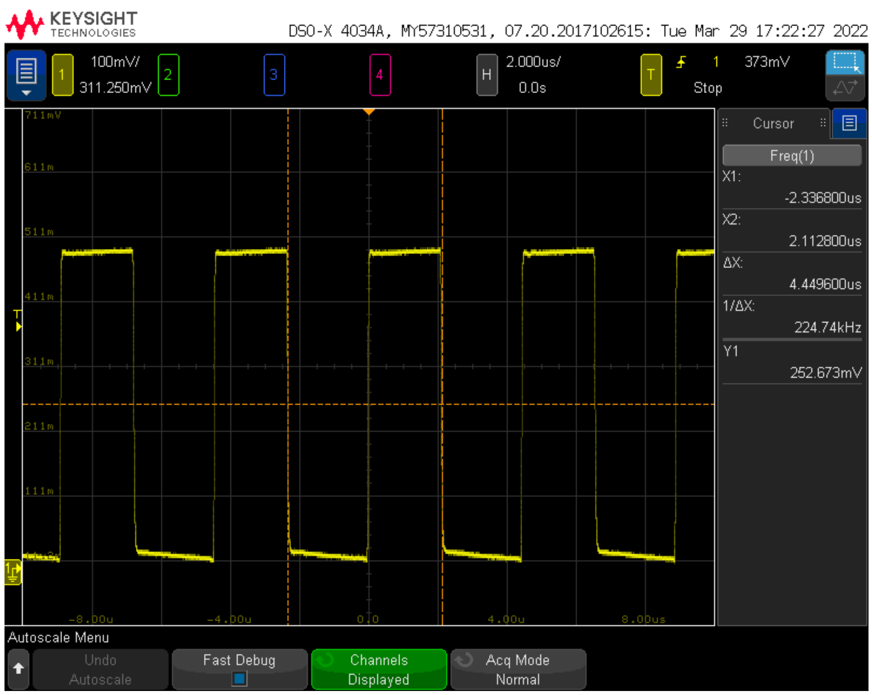

Figure 1: Clock at pin 19, measured as a function of µS and mV.

We can then measure the output at pin 5, the interrupt signal. This output, seein in *Figure 2* operates at 3.1411kHz and has a conversion time of 318.364800 µs. This means that one conversion takes 71.5 clock cycles since $318.364800\mu s/4.44960\mu s = 71.5$. Finally, the conversion time did not seem to depend on the input voltage. Changes in the input resulted in ±2µs changes which were negligible.

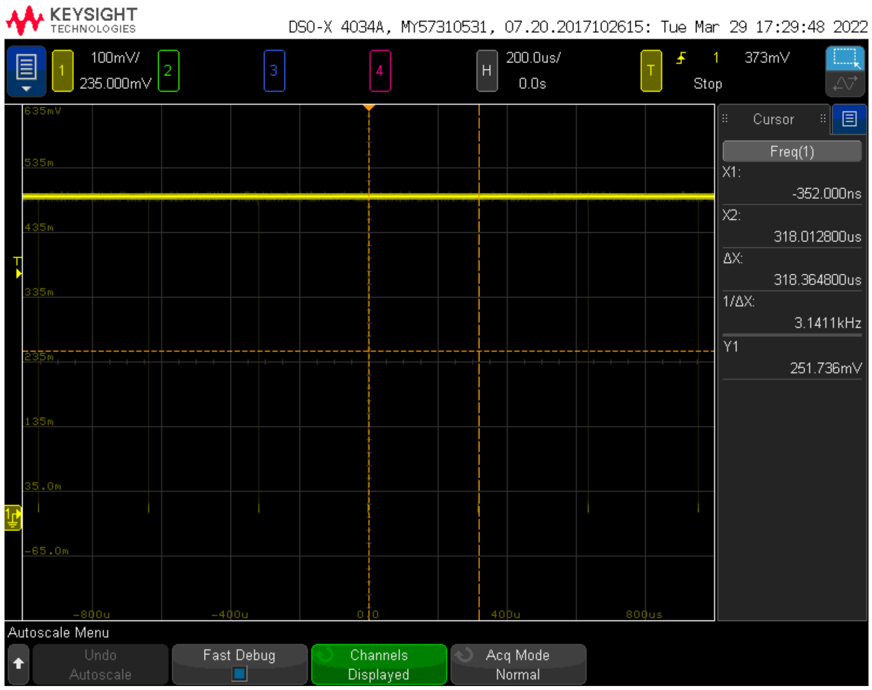

Figure 2: Interrupt signal at pin 5, measured as a function of µS and mV.

Digital Multimeter

A digital multimeter can be constructed by simply reading the output pins 11-18, which will produce binary numbers that, when converted to octal, represent a given voltage. The schematic for this circuit can be seen in *Figure 3*.

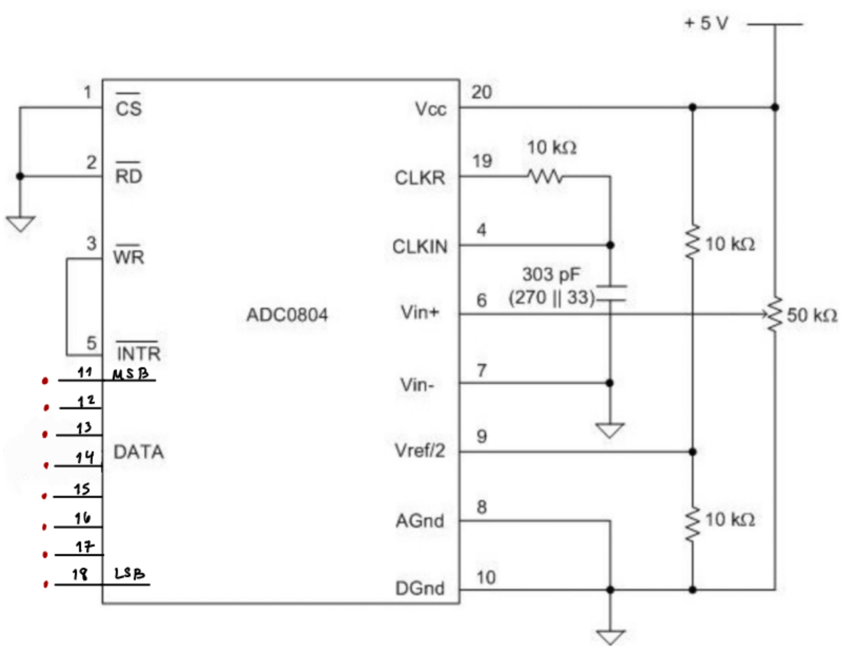

Figure 3: Digital Multimeter with outputs in pins 11-18.

The multimeter can be tested to find different input voltages, as seen in *Figure 4*. The tests demonstrated the relative reliability and accuracy of the multimeter.

Tests	Input voltage (V)	$Output_8$	$Output_{10}$	Expected $output_{10}$	Error
1	0	0	0	0	0
2	.50	$000110\cancel{00}_2 = 6_8$	6	6	0
3	1.25	$010000\cancel{00}_2 = 20_8$	16	16	0
4	2.4	$011110\cancel{10}_2 = 36_8$	30	30	0
5	3.0	$100110\cancel{11}_2 = 46_8$	48	38	10
6	4.1	$110100\cancel{11}_2 = 64_8$	52	52	0
7	5	$11111111_2 = 77_8$	63	63	0

Figure 4: Output of digital multimeter.

Reconstructing Analog Signals

An analog to digital and digital to analog converter can be used to demonstrate reconstruction and potential problems with signal reconstruction. The sampling frequency of the system was found to be equal to that of the clock of the ADC—in this case, the sampling frequency of 224kHz is inline for the expected sampling frequencies, which vary between 100kHz—1460kHz.

Figures 5, 6, 7, 8, and *9* demonstrate the signal reconstruction with varying voltages and frequencies. Each plot shows the input signal graphed in yellow, V_{out}- in blue, and V_{out}+ in green. The pink signal is the sum of both the V_{out}- and V_{out}+ signals.

Figures 8 and *9* include an input which exceeds the Nyquist Sampling Frequency—unsurprisingly, this results in aliasing for both reconstructed signals. Both of the reconstructed signals clearly do not follow the input signal, directly showing aliasing.

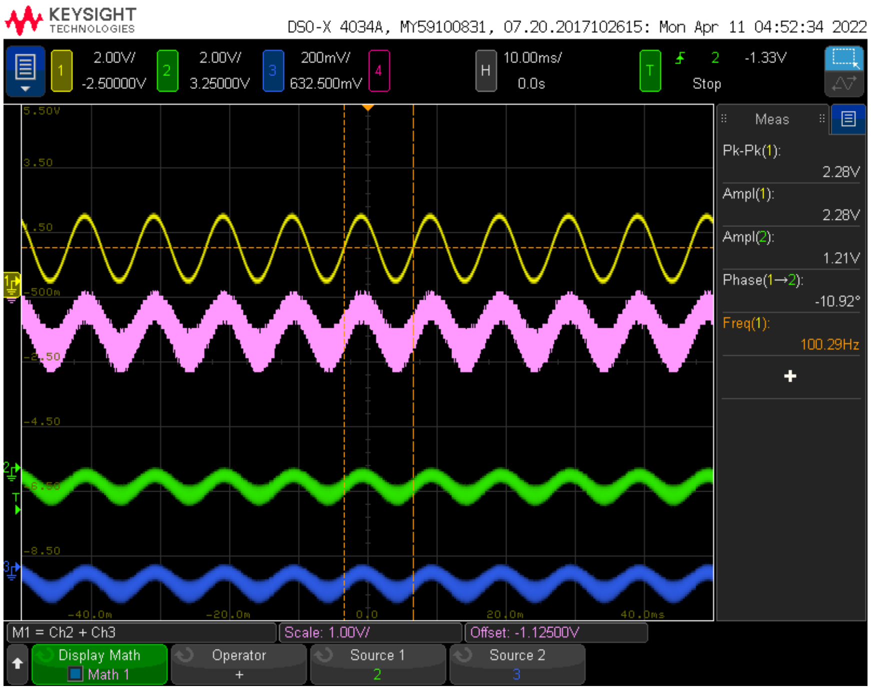

Figure 5: Signal reconstruction with a 100Hz frequency, 1V amplitude, and 0.5V offset. Graphed as a function of ms and V.

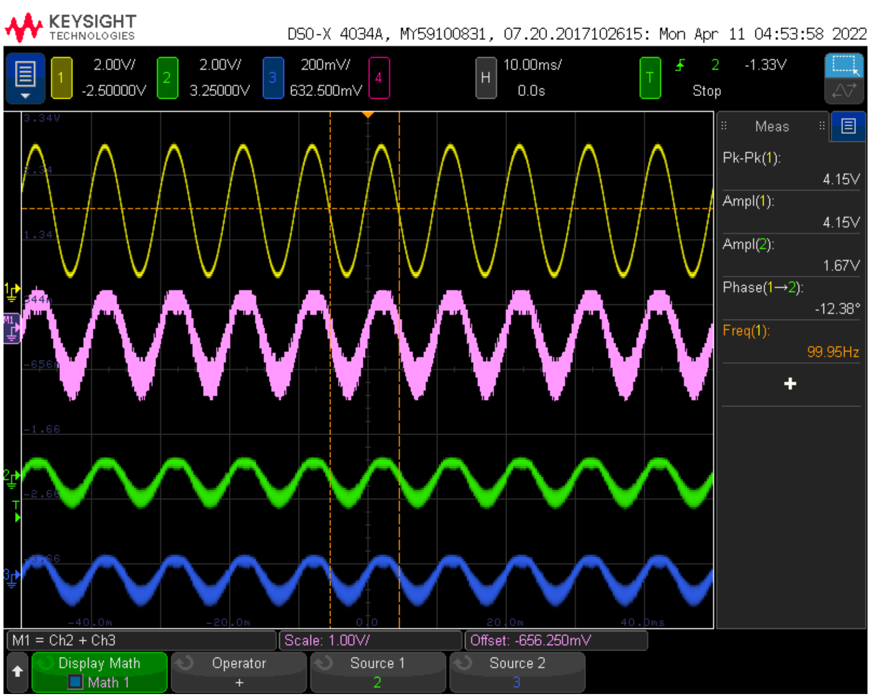

Figure 6: Signal reconstruction with a 100Hz frequency, 2V amplitude, and 1.2V offset. Graphed as a function of ms and V.

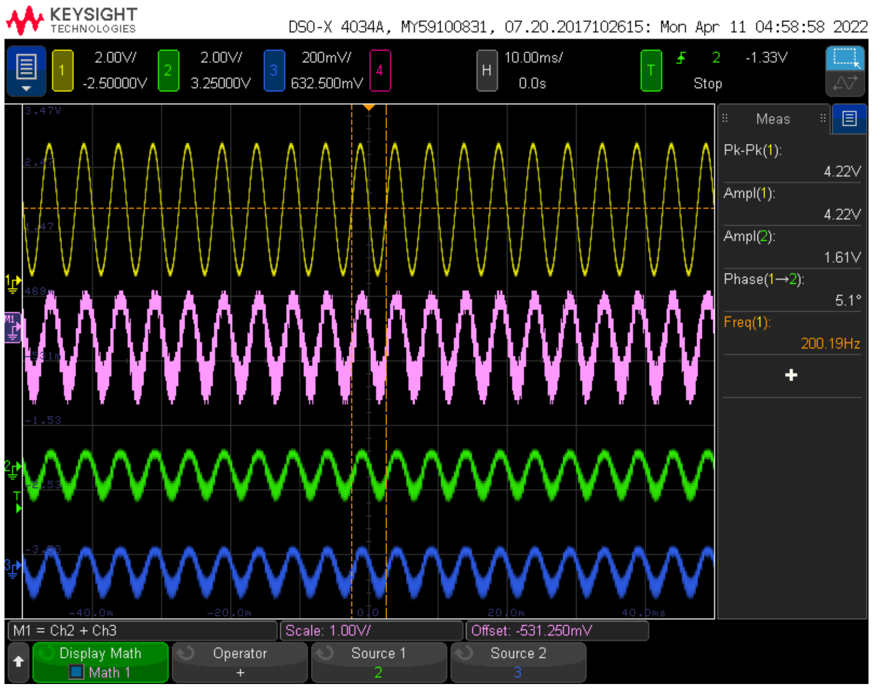

Figure 7: Signal reconstruction with a 200Hz frequency, 2V amplitude, and 1.1V offset. Graphed as a function of ms and V.

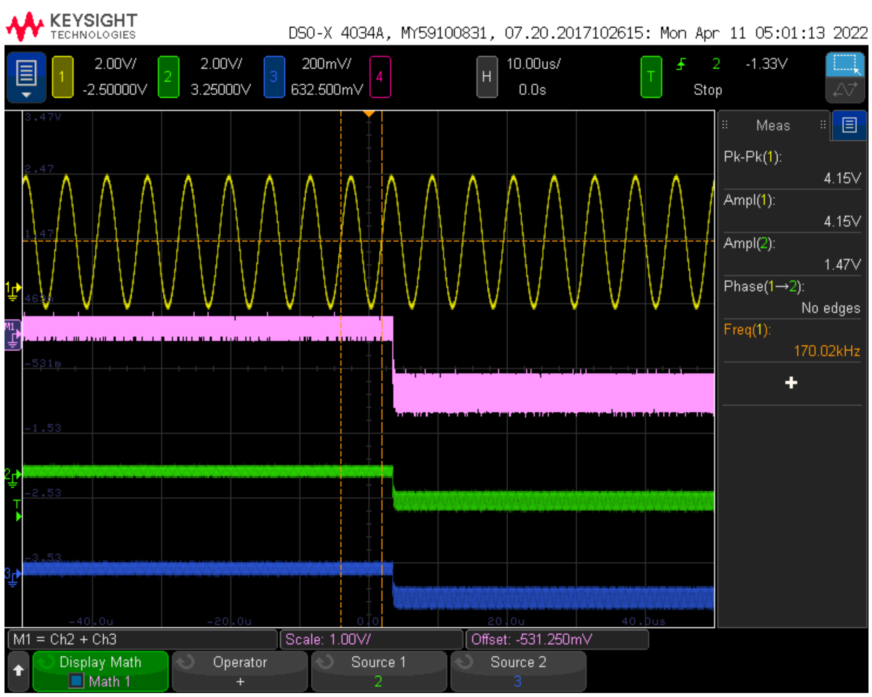

Figure 8: Signal reconstruction with a 170kHz frequency, 2V amplitude, and 0.7V offset. Graphed as a function of ms and V.

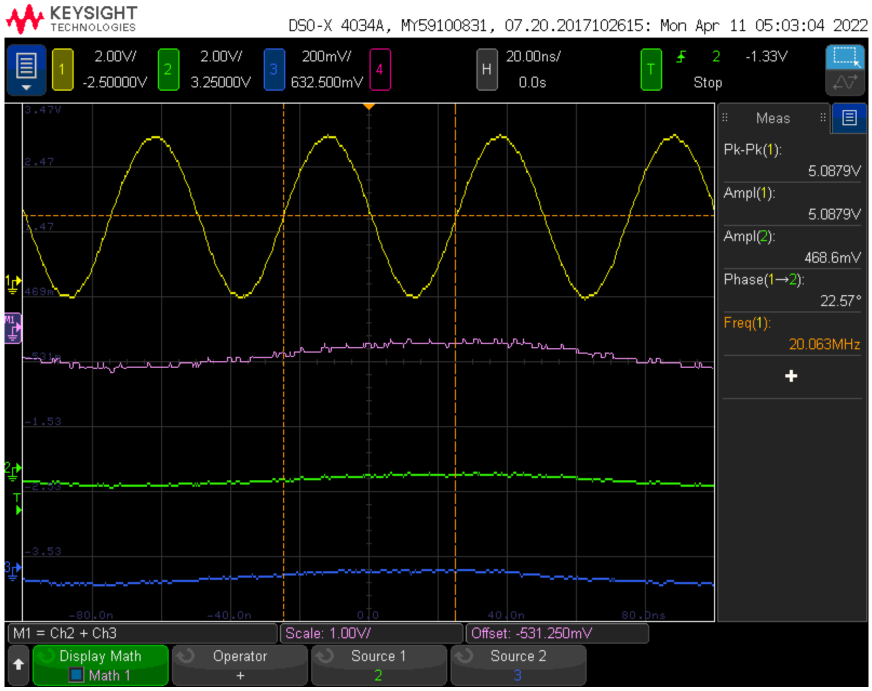

Figure 9: Signal reconstruction with a 20MHz frequency, 4V amplitude, and 1.0V offset. Graphed as a function of ms and V.

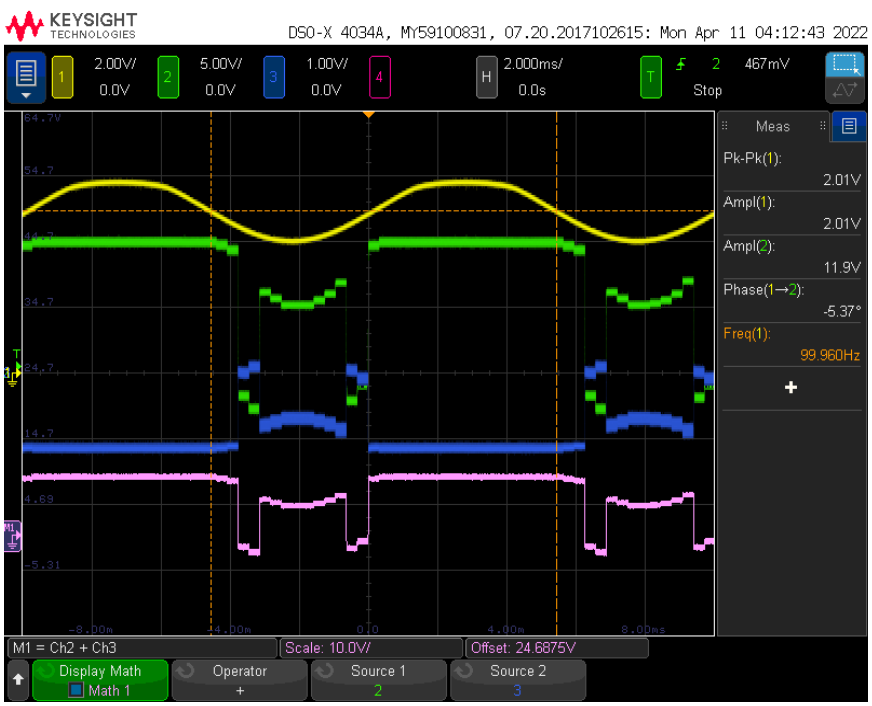

Figure 10: Bonus of an incorrect signal, but one that looks like a frog.