

Pre-lab questions

- Q1.** Write a short C program that prints the word “hi” every time the I2S2 transmit interrupt occurs. Don’t worry about what that interrupt is, but do be sure to enable it and otherwise set up all the parts needed to get it to work. Model your answer off of the code we used in lab 5.
- Q2.** In your own words, explain why interrupts are useful and common on both modern desktop processors and embedded processors. This should take a couple of paragraphs.
- Q3.** The order these inputs are found is often called “bit reversed” why is that named used? What bits are reversed?
- Q4.** Consider doing an 8-point FFT on complex numbers using the `cfft()` function in DSPlib. List all 16 outputs (real and imaginary parts) in the order they would come out. Your answer should be of the form R0, C0, R5, C5, R2, C1, etc.
- Q5.** Explain what `cbrev32()` does. Explain why that’s helpful. (This is pretty straightforward).
- Q6.** The `rfft32()` function takes n_x real inputs and generates $n_x/2$ complex outputs (and thus takes the same amount of memory for the input and output even though the input is restricted to only real numbers). Why is this possible? Why doesn’t it apply to the `cfft()` function?
- Q7.** What is “scaling” and why do some of the TI dsplib FFT functions support it? How much do they scale by at each stage and why does that make sense? How do you get `rfft32()` to use scaling?
- Q8.** This question asks you to think about doing FFTs on real-time audio data. For this problem, assume we are sampling 16-bit inputs at 48KHz and that our processor runs at 100MHz.
- About how many CPU cycles do we have between our samples?
 - How long (in cycles) would we expect it would take `cfft()` to handle an input with 1024 entries? Can we do this between two data samples? What is the largest radix 2 FFT (if any) we could do between samples?
 - If we want to do a 1024 FFT after every 1024 samples, how can we manage that without missing some of the audio samples?
- Q9.** Why do we use windowing when working with FFTs? Provide a fairly detailed answer (a couple of paragraphs).
- Q10.** Write a MATLAB script to generate 3 files containing values of the Chebyshev window with 100 dB relative side-lobe attenuation. You will need these values in the lab so the files could be C header files or just text files but then you will need to read in these values in your code. Use the `chebwin()` function in MATLAB. Values of N and the files names to be used are:
- | N | name |
|------|-------------------|
| 512 | cheby100N512.txt |
| 1024 | cheby100N1024.txt |
| 2048 | cheby100N2048.txt |

Multiply the **chebwin** values by 32767 then round in order to generate 16-bit Q15 values. These can be written out as integer values.

In-lab & Post-lab Questions

- Q1.** What is an I2S bus?
- Q2.** In the “C5515 DSP System Guide” the I2S0 interrupt settings are discussed. If the external bus selection register is set correctly:
- Is the flag register for this interrupt IFR0 or IFR1? Which bit of that register?
 - What is the table offset for that interrupt?
- Q3.** What are we doing in the I2S handler (I2S_ISR)? What is going out on the left channel? The right one?
- Q4.** What is the variable “Counter” doing? How many samples must occur before we start the FFT?
- Q5.** At what input frequency would you expect to see a maximum V_{pp} for the output signal? Show your work.
- Q6.** This code is making extensive use of interrupts. Use a reasonable technique to figure out how many data samples arrive before the FFT is done being computed. How many samples was it? Explain the technique you used.
- Q7.** What are the dimensions of the screen? Where is the location (0, 0) on the screen?
- Q8.** What did you see with the ramp and square wave? In terms of the Fourier series, what would you expect to see? Does the output meet expectations?
- Q9.** When observing the FFT output you should have noticed that certain output bins vary with time. That is, they jump around a bit even with a constant input. Explain why that is. You might find it useful to discuss the possible range of values for $X(0)$ if the input is half the frequency spacing. What impact did your window have on this if any?
- Q10.** Do some reading about the SPI protocol (the Wikipedia article is pretty good). What are the signals involved? What is their role? What is a “slave” vs. a “master” device? In our set up is the C5515 acting as slave or master? Is the FPGA acting as a slave or master?