# Delta-Sigma Heart Rate Monitor

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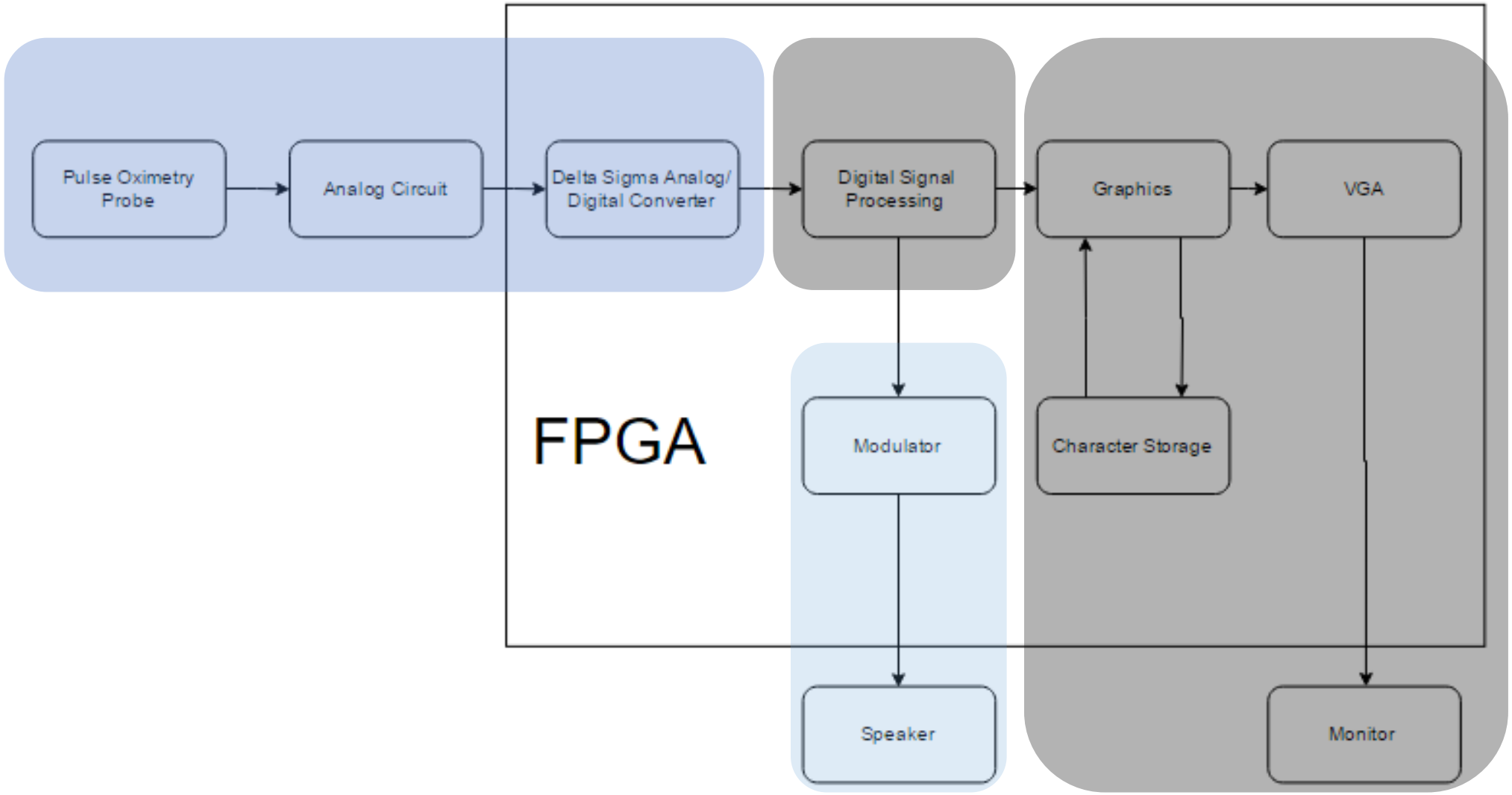
# Motivation

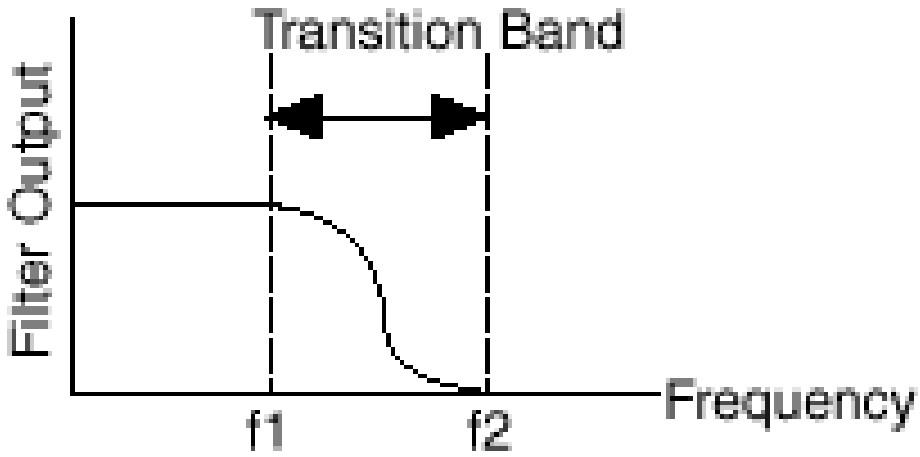
- Use pulse oximetry and a FPGA to display heart rate visually.
- Implement 6.341 methods to process signals.
- Use 6.111 material to do cool things.

# Block Diagram



# Analog Circuitry

- Anti-aliasing filter
- Comparator
- TTL level shifter




b. Practical Anti-alias Filter

# Delta Sigma Analog to Digital Converter (ADC)

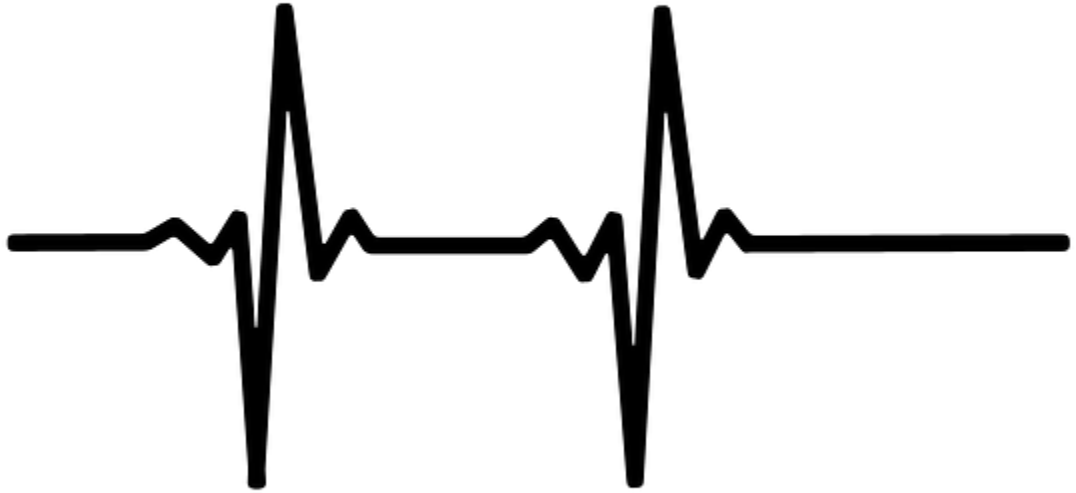
- Take Nyquist frequency
- Oversample by factor M
- Apply sharp cutoff digital filter
- Decimate by factor M

# Digital Signal Processing (DSP)

- Implement built in FFT
- Identify primary frequency component
- Pass waveform and heartrate data to graphics module

# Graphics

- Plot waveform data points
- Use interpolation to connect pixel data
- Manage memory calls to memory buffer for heartrate printing
- Generate control signals for VGA module



# Character Storage

- ROM storing transparency bits for pixels in character space
- Indexed by pixel location

- Use Matlab to generate characters FPGA can use

# Video Graphics Array (VGA)

- Similar to Lab 3
- Use ADV7125 control module
- Control signals for lab 3 module generated by graphics module

# Timeline

| | |
|---|---|
| **Week of November 2** | Design finalized, parts ordered, begin building and Testing Blocks. |
| **Week of November 9** | Continue Building and Testing Blocks |
| **Week of November 16** | Continue Building and Testing Blocks, Start integrating blocks |
| **Week of November 23** | Debugging Block interconnect |
| **Week of November 30** | Add finishing touches |
| **Week of December 7** | Demonstrate Completed Project |

# If time permits…

- Implement noise shaping for Delta Sigma ADC.
- Implement better interpolation method for data point plotting.

# Anti Aliasing Filter

- Restricts the bandwidth of a signal.
- Implemented with a bandpass filter, low pass filter.

- Our idea: $2^{nd}$ order low pass filter.

# Delta Sigma Analog to Digital Converter

- System assumes signal is bandlimited.
- Sample at low precision well above target frequency.
- Pass through high precision digital filter
- Down sample to low frequency. (Decimator)
- High precision coefficients allow trading
  - Sampling frequency for high precision
  - Generation of bits depend on oversampling rate.

# Noise Shaping

- Increase the signal to noise ratio of a signal.

- No noise shaping means quadrupling sampling frequency adds 1 bit of precision
- $1^{st}$ order noise shaping means quadrupling sampling frequency adds 3 bits of precision.
- There is a limit: Don’t go over $3^{rd}$ order noise shaping.

# Interpolation

- Method of constructing new data points within range of discrete data points.
- Activate pixels needed in graphics module

- Method here: Manhattan style
- Eventually: Linear