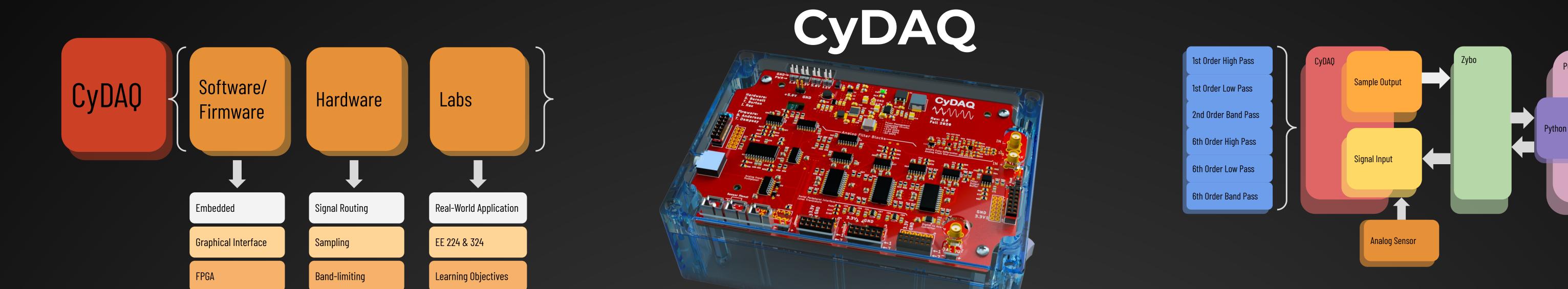
# Introduction of Real-World Signals and Systems into ECpE DSP Laboratory Curriculum

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### **Our Goals:**

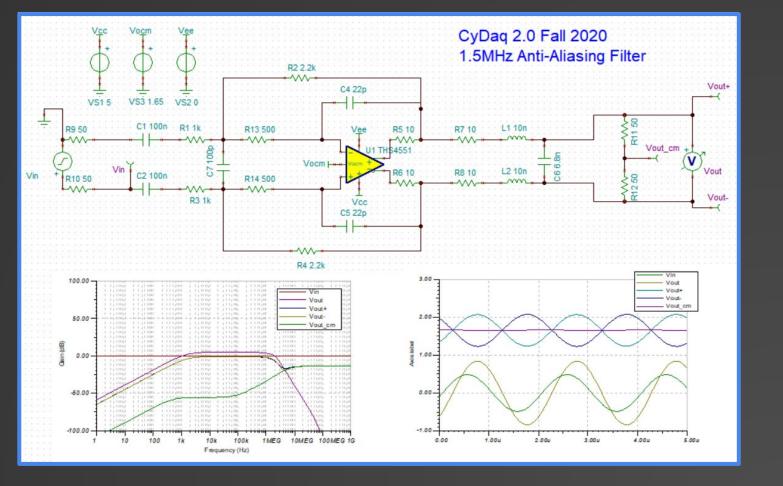
- Use the CyDAQ to redesign signal processing laboratory curriculum
- Incorporate real-world applications and hardware into the Signals & Systems curriculum
- Design firmware, software, and hardware to support the CyDAQ system

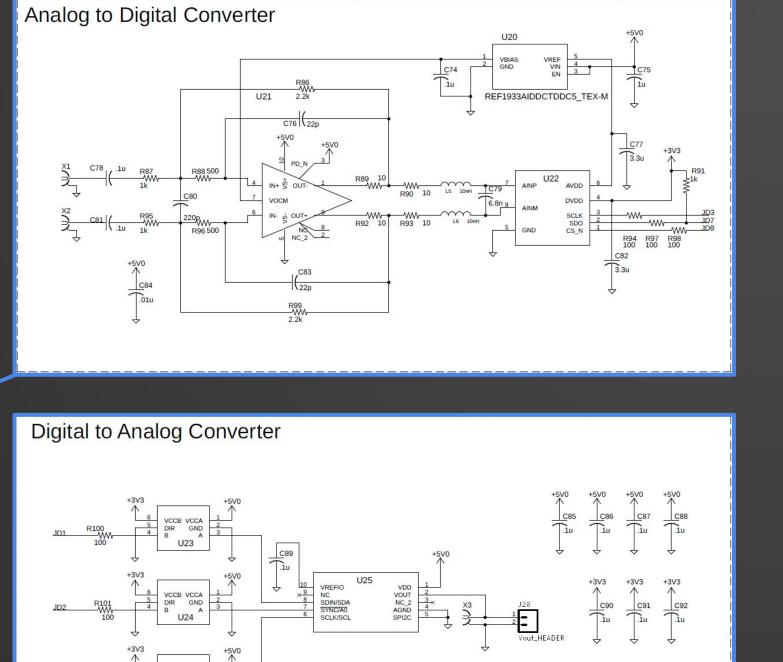
#### **General Overview:**

- Teaching platform for EE Signals & Systems curriculum
- Uses hardware to reinforce textbook theory
- Labs designed to introduce industry design engineering concepts

## Hardware

- Analog input: 3MSPS ADC with fully differential, active multiple feedback 1.5MHz anti-aliasing filter
- Analog output: SPI DAC with buffered 5Vpp single-ended output
- Peripheral Module to bring new hardware functionality to legacy CyDAQ Rev. 1 models

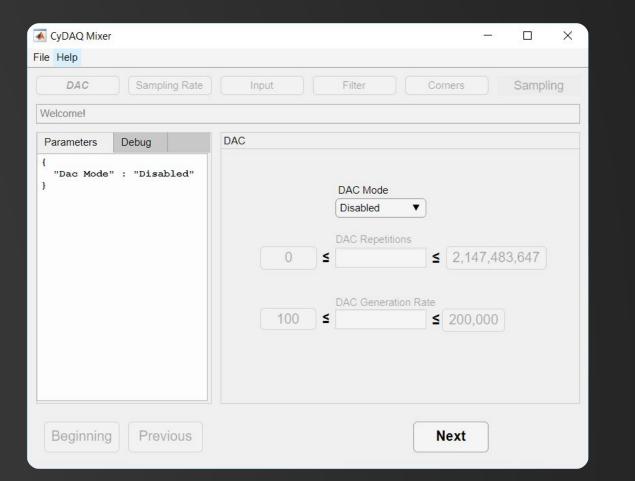




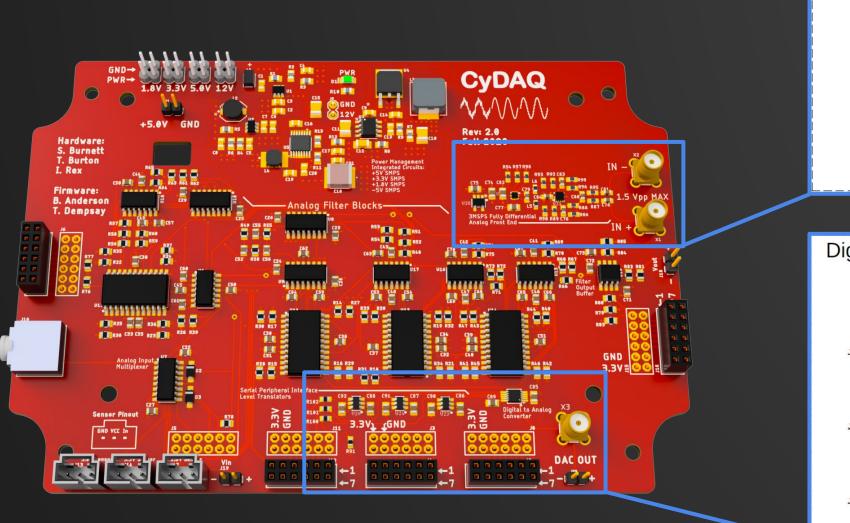
### Front End

### CyDAQ Mixer:

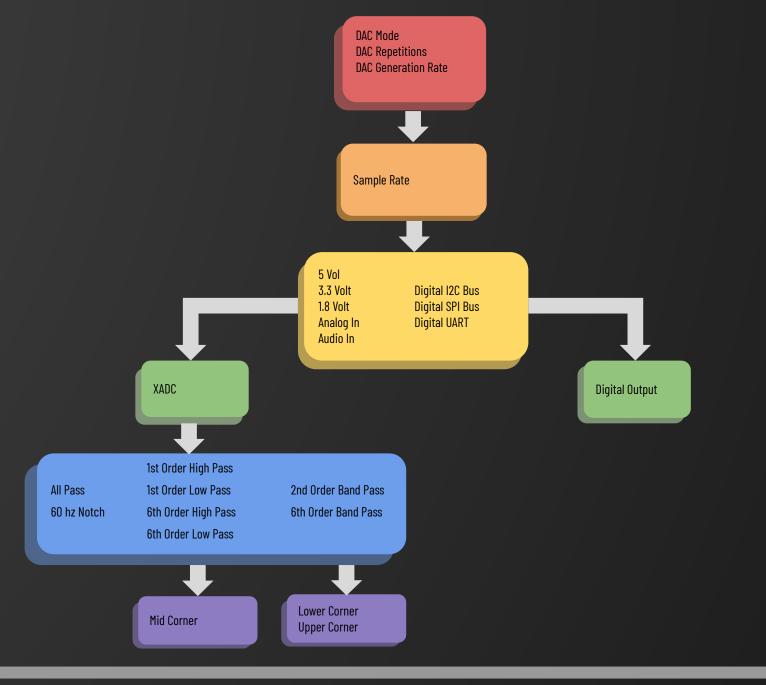
- Front-end in MATLAB, back-end in PYTHON
- Provides step-by-step direction on picking the right parameters for the CyDAQ to run on
- User proof: Mixer will not allow you to configure the CyDAQ with an invalid set of parameters



#### • Full layout revision for new circuits



• Simple design for students using it for the first time



# Firmware

- 50MHz SPI Controller in fabric
- Custom PWM core in fabric
- External SPI ADC and DAC drivers
- Arbitrary waveform generation

		20.485000	<mark>) us 4</mark> 0	.965000 us
) us	10 us	20 us	30 us	40 us
		0000000		
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- Created, tested, and wrote answer keys for 8 Signals and Systems labs
- Lab Examples:

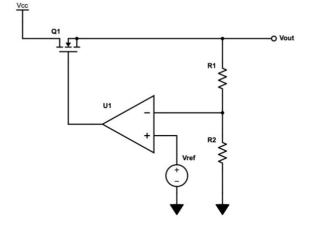
### EE224:

- Noise filtering in hardware(EE 224)
- DSP image restoration (EE 224)

### Labs

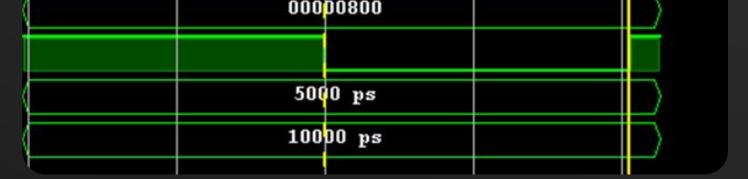
EE 324	Lab X
Part 1	The Circuit

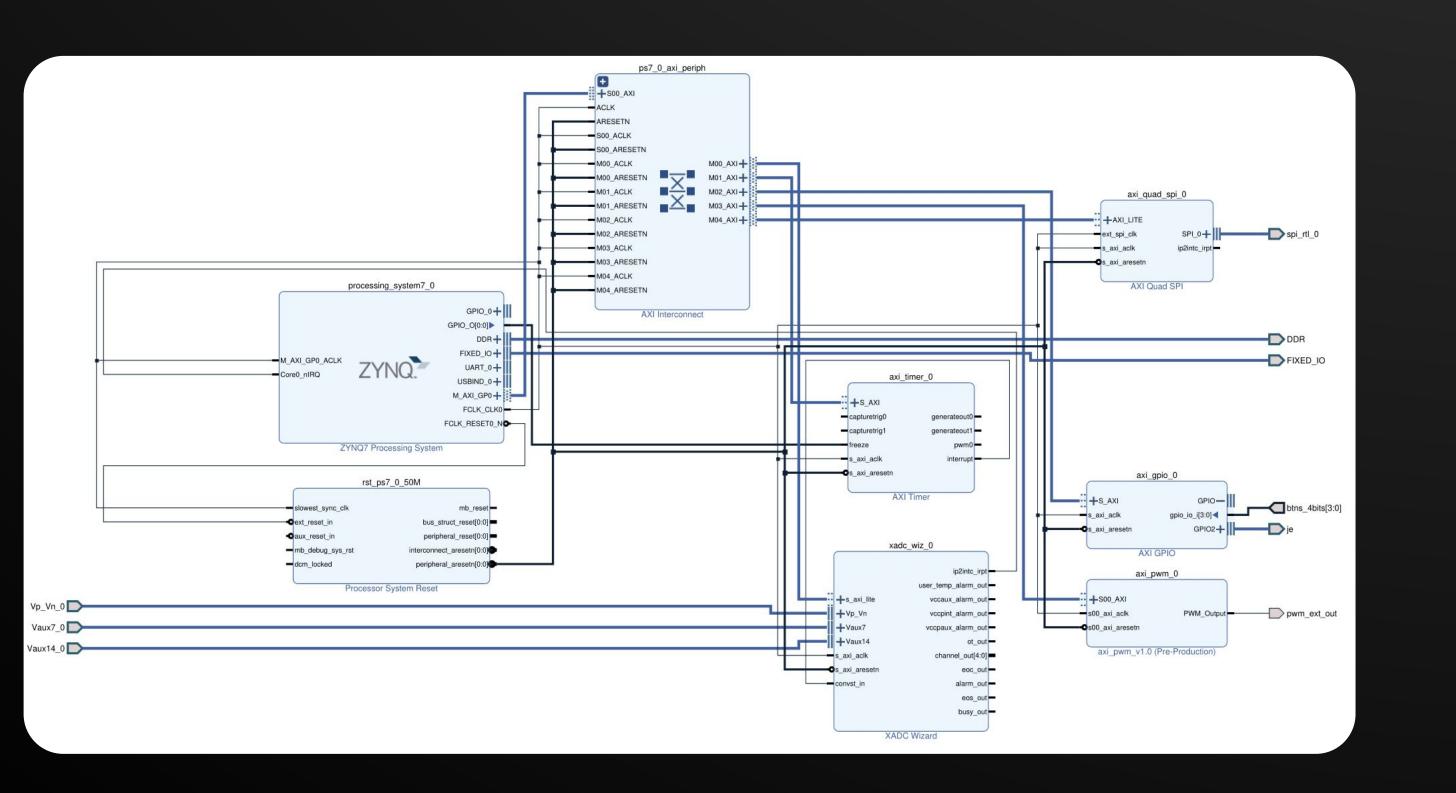
The basic power supply topology is shown in Figure 2. You should read at least page 3 of Texas Instruments' AN-1148, but the entire app-note (and most from TI, Analog Devices, Linear Technologies, and others) is an incredibly valuable resource.



### via dataset upload

 High-speed interrupt-based firmware





Heart rate monitor design (EE 224)

### EE324:

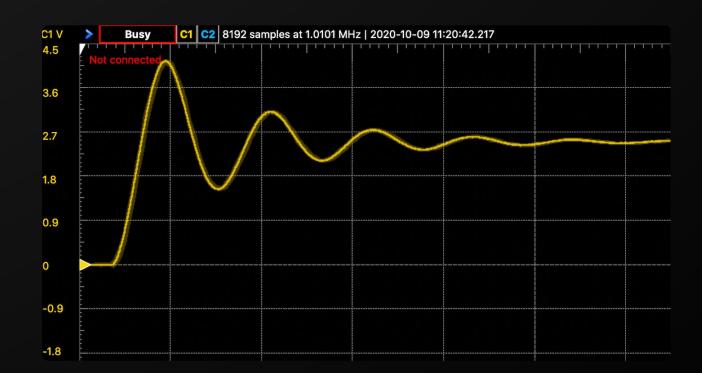
- System dynamic modeling (EE 324)
  Loop response measurement (EE 324)
  Ball & beam controller design (EE 324)

Figure 2: The basic voltage regulator circuit

In your report, provide a brief explanation for how this circuit regulates  $V_{out}$ . You do not need to provide any equations, but explain in words the basic operating principle.

#### Part 1.1 Stability, Transient Response, and Frequency Response

The circuit posed in Figure 2 would work under some output load conditions, but it is not particularly stable, but what does it mean to have "good" stability? One ubiquitous measure is the *transient response* of the output. The transient response describes how the circuit reacts when there is a step change in load current (either low current to high current, or high to low). Figure 3 shows a typical transient response from the rather remarkable LT3080 linear voltage regulator (the whole datasheet is a goldmine of linear power supply knowledge). Another common way to evaluate loop stability is with the Bode plot. The relationship between transient response and frequency response could be its own class, but you should get a



#### Use lab equipment to measure in-system signals