

E.V.D.S

Emergency Vehicle Detection System

Group 28

Ryan Chappell – EE

Daniel Christiano - EE

John Fick - EE



E.V.D.S

- Motivation
 - To decrease frequency of accidents involving Emergency Vehicles
 - Modern soundproofing technology has muted the driver to the outside world
 - Provide a link between the driver and the outside world

An ambulance carrying a patient in critical condition is struck by an unaware driver in Portland, Oregon.



E.V.D.S

- Objective
 - To alert drivers to the presence of emergency vehicles
 - Identify an emergency vehicle within 50 yards (stationary)
 - Identify position of emergency vehicle relative to vehicle
- Requirements
 - Compatible with most consumer vehicles

E.V.D.S

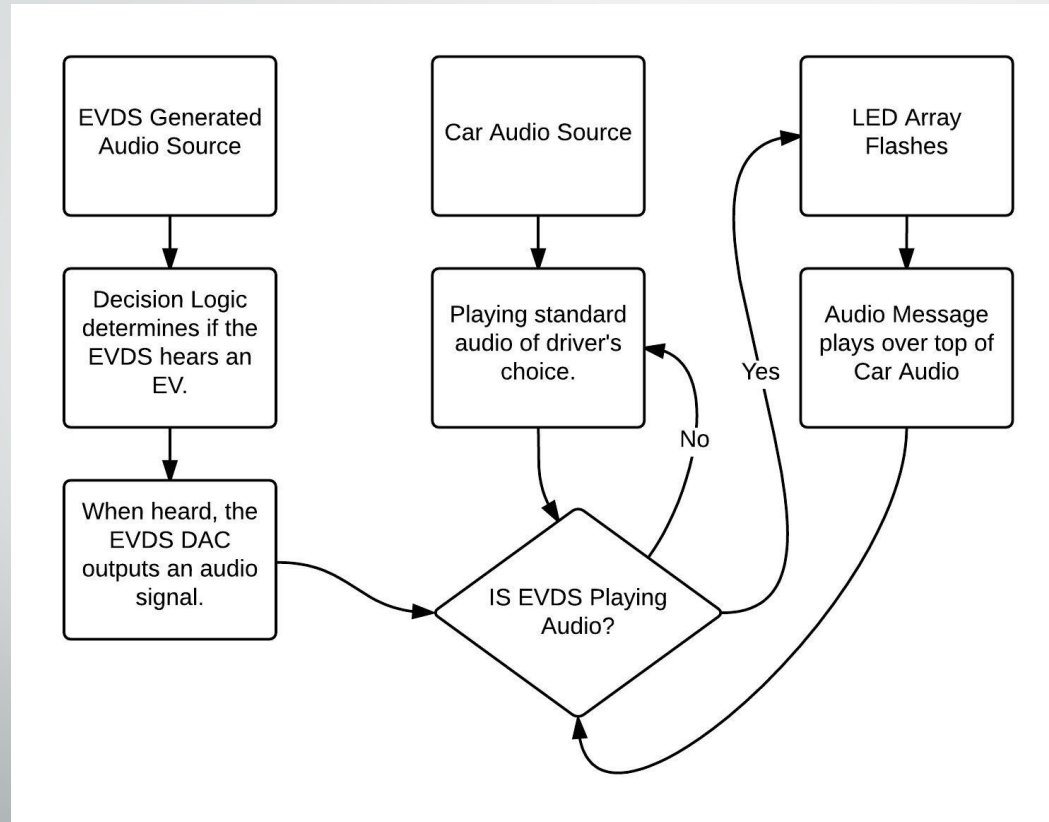
- Standards
 - USDoT Emergency Vehicle Siren Standards
 - States that Sirens must be below 120 dB
 - No Applicable Automotive Standards for this stage
 - 12 volt battery or alternator for power
 - DC power

E.V.D.S

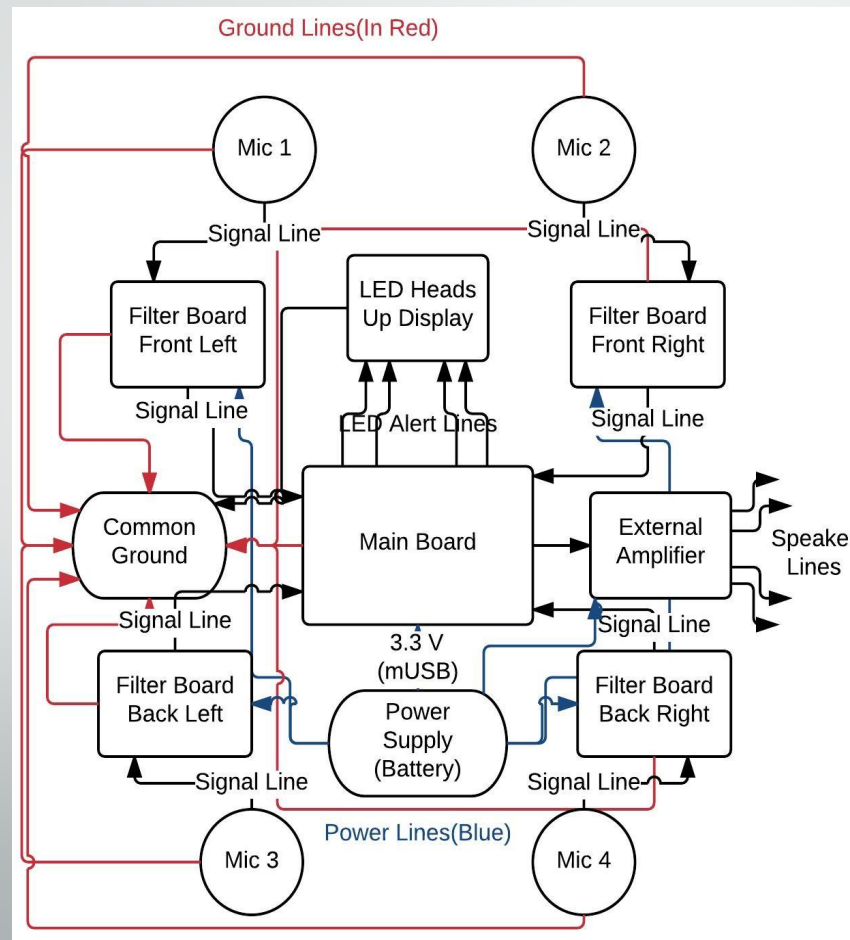
- Specifications

Part	Function	Specification
Microphone	Polar Pattern	120° Cardioid Pattern
Filter	Bandpass	338.6-3386 Hz
	Gain	6943
ADC	Bit Resolution	12 bit
	Sampling Rate	>44000 Hz
DSP/Decision Logic	Response Time	2.5 seconds
	Accuracy	<5% false negative
	Accuracy	<10% false positive

E.V.D.S



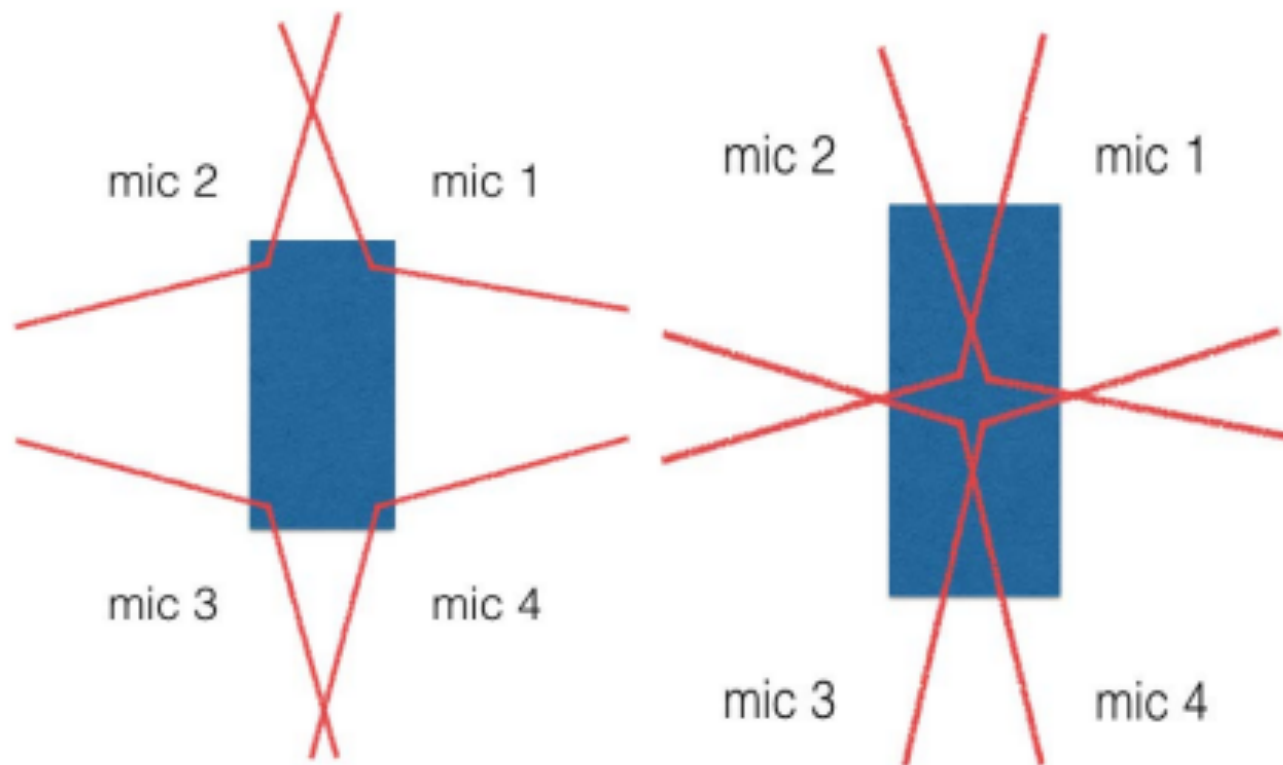
E.V.D.S



E.V.D.S

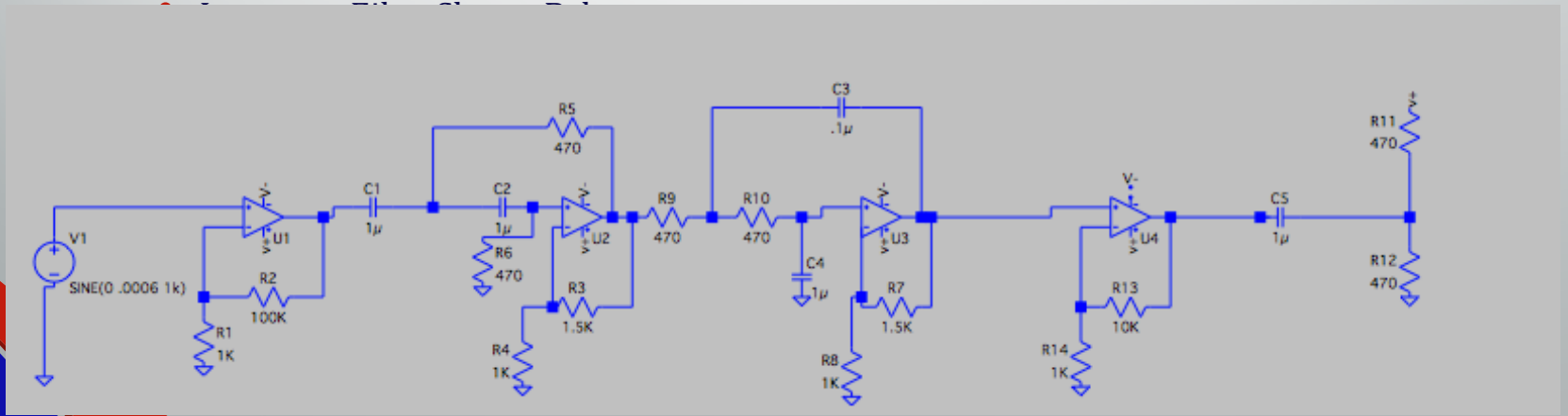
- Microphones
 - Shure SM 58
 - Frequency Response
 - Cardioid Polar Pattern
 - Affordable
 - Versatile
 - Dynamic
 - Number
 - Orientation
 - Positioning





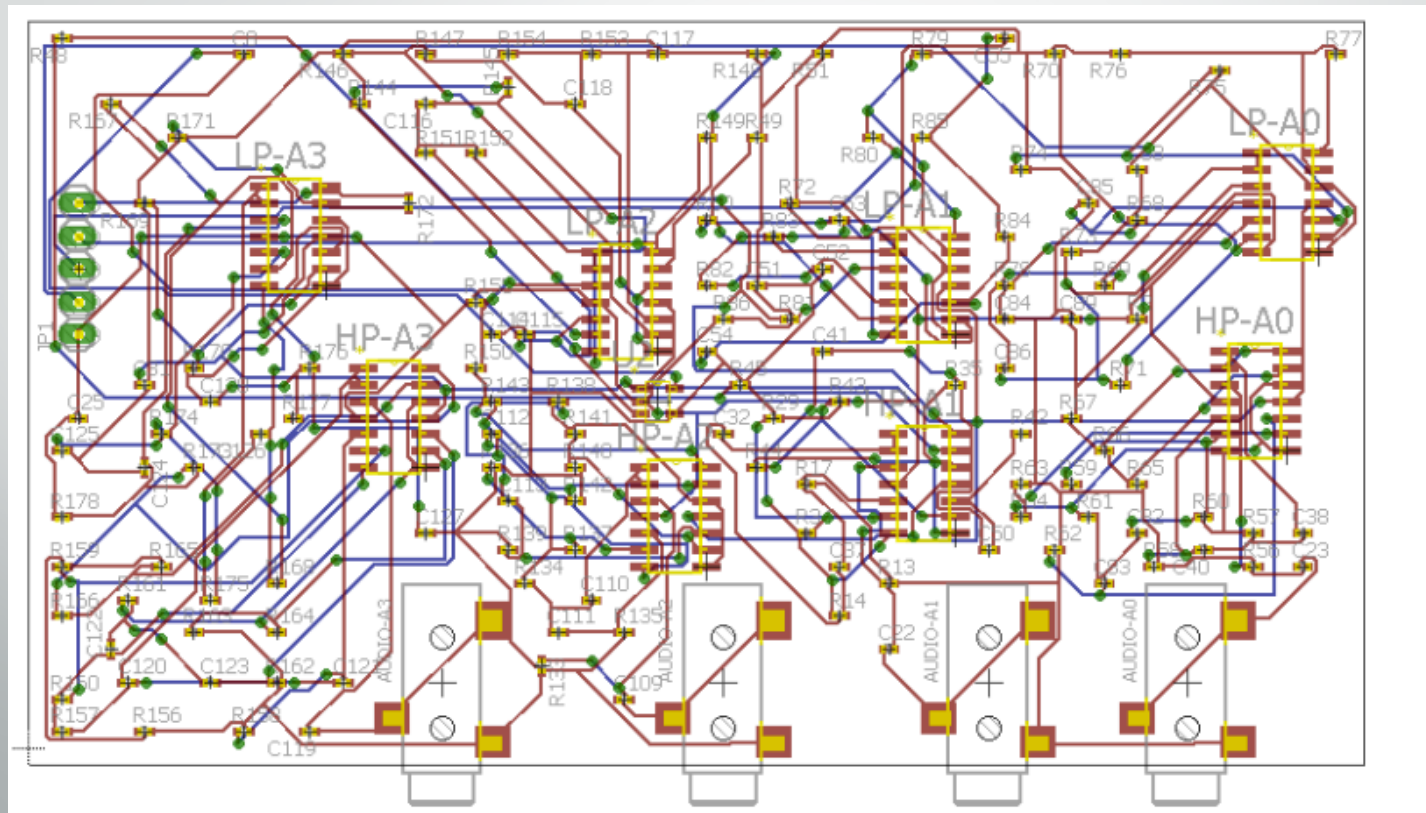
E.V.D.S

- Filter
 - Two second order Butterworth filters
 - Passband range: 338.6 Hz – 3386.3 Hz
 - Gain: 6943.75
 - Quality factor of low pass: 2
 - Quality factor of high pass: 2
 - Bandpass Filter below:



E.V.D.S

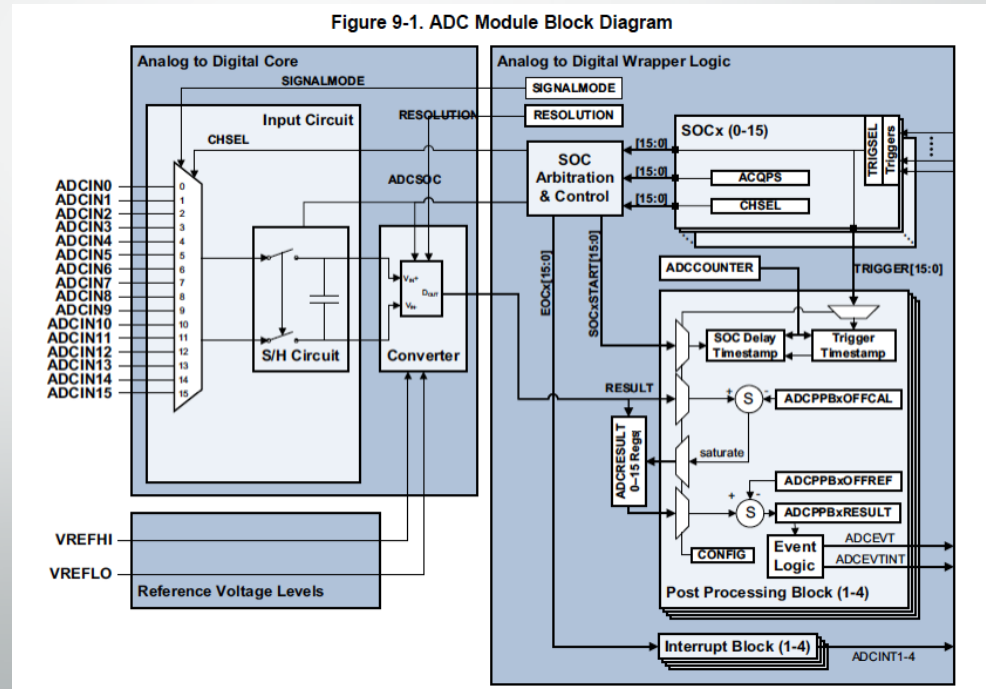
- Filter - PCB



E.V.D.S

- Processor - ADC
 - TMS320F28377S
 - Sample and Hold ADC
 - Bit Resolution- 12 Bit
 - 100 KHz clock rate

Figure 9-1. ADC Module Block Diagram



E.V.D.S

- Processor - DSP
 - TMS320F28377S
 - Fourier Transformations
 - Sample segments
 - 26 transforms a second
 - Finding frequency and amplitude

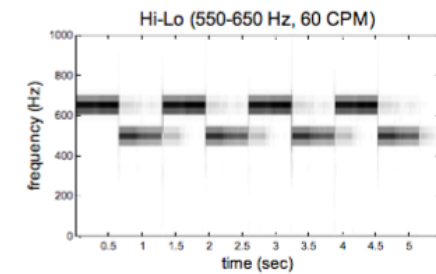
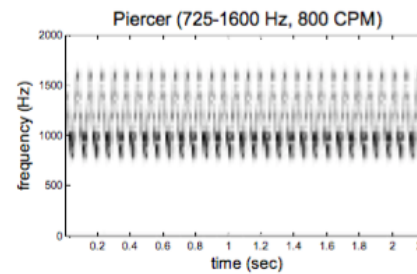
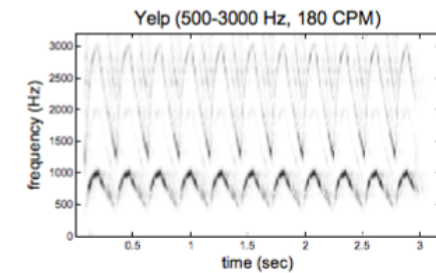
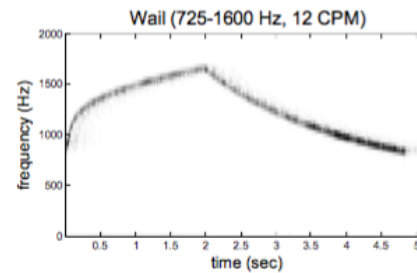


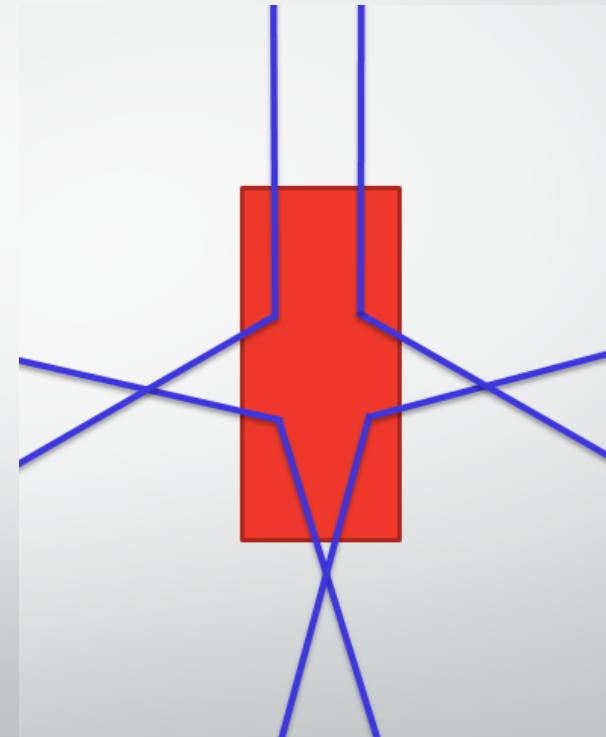
Figure 1. Frequency vs. time for the four types of sirens.

E.V.D.S

- Processor – Decision Logic
 - TMS320F28377S
 - Using calculated frequencies
 - Compares sampled frequencies to known siren frequencies
 - Compares sampled frequencies to previous sampled frequencies
 - Determines when input frequencies match siren pattern range

E.V.D.S

- Processor – Directional Identification
 - TMS320F28377S
 - Using Recorded Amplitudes
 - Compare the four amplitude values
 - The microphone(s) with the greatest amplitude indicate the direction of the Emergency Vehicle

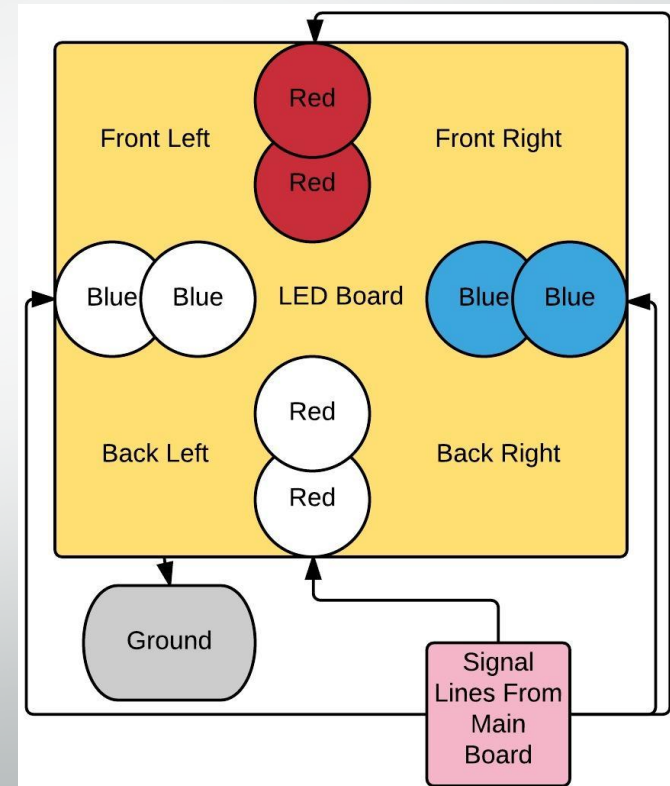


E.V.D.S

- Processor – PWM as DAC
 - TMS320F28377S
 - Generating output audio signal
 - Using a PWM as method of producing audio warning signals.
 - 1Khz beeps as warning signals

E.V.D.S

- Visual Output
 - LED Heads Up Display
 - 8 LEDs in a 4 Directional Configuration
 - Light up four at a time to indicate direction of siren



E.V.D.S

- Audio System – Receiver
 - Technics SA-DX940(Simulated Car Audio)
 - Inputs 8
 - Outputs 5
 - Power Source 120V AC



E.V.D.S

- Audio System – External Amplifier
 - Kinter MA-180
 - Inputs 2
 - Outputs 2
 - Power Source 12 VDC



E.V.D.S

- Audio System – Speakers
 - Cambridge Soundworks
 - Extremely Similar to Car Audio Speakers



E.V.D.S

- Power Supply
 - Car Battery (Simulated by 12V DC Wall Plug)
 - 12.6 V Supplied
 - 3.3 V for Processor
 - Voltage Regulator incorporated into PCB Design
 - 12.6 V for Amplifier and receiver



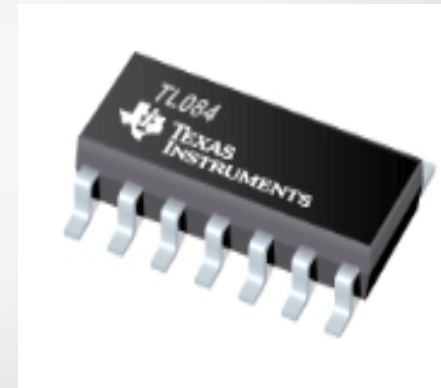
E.V.D.S

- Negative Voltage
 - Dr. Meter HY3005-M
 - Simulates Negative voltage Rail in Car



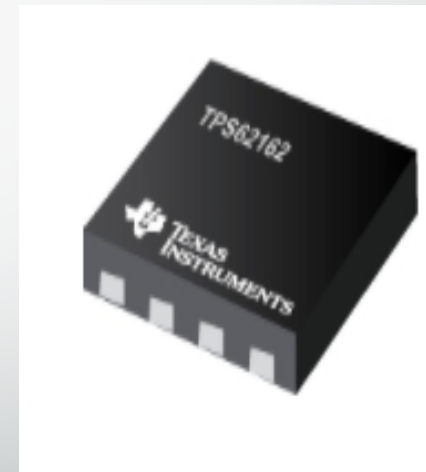
E.V.D.S

- PCB
 - TL084 – General Purpose Operational Amplifier
 - 1.4 mA/Ch power consumption
 - 13 V/us slew rate
 - Vcc up to 18 V
 - Input Voltage up to Vcc+-
 - Cost: \$10.23 for 10



E.V.D.S

- PCB
 - TPS62162 – Buck Voltage Converter
 - 3-17 V input range
 - Output Voltage .9 – 6 V
 - Output current up to 1 A
 - Common use is with 12 V rails
 - Cost: Sampled from TI



E.V.D.S

- PCB
 - FT2232H – USB to Multipurpose
 - USB to JTAG
 - Allows for one port for power and computer communication
 - 3.3 V input
 - Cost: \$6.71- Digikey



E.V.D.S

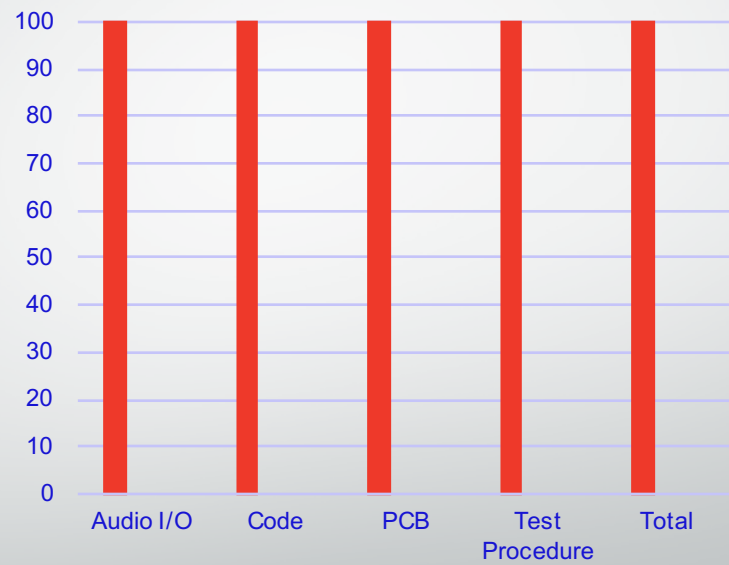
Initial Budget	
Description	Amount
Microphones (4)	\$548
Processor	\$50
PCB	\$100
Wiring	\$20
Battery	\$50
Siren	\$50
Car Receiver	\$100
Speakers	\$50
Amplifier	\$100
Hardware	\$10
"Car"	\$10
ADC (4)	\$20
Total	\$1108

E.V.D.S

Updated Budget	
Description	Amount
Microphones (4)	\$210
Processor	\$60
PCB	\$180
PCB Parts	\$160
Wiring	\$20
Power Supply	\$70
Siren	\$0
Car Receiver	\$0
Speakers	\$0
Amplifier	\$15
Hardware	\$10
"Car"	\$40
Testing Supplies	\$100
Total	\$865

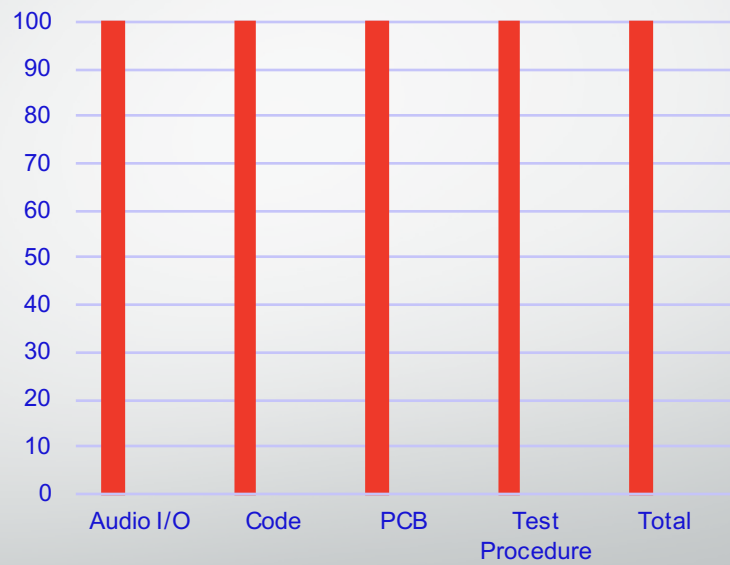
E.V.D.S

- Design Progress
 - Audio Input/Output
 - 100%
 - Code
 - 100%
 - PCB
 - 100%
 - Testing Procedure
 - 100%
 - Total
 - 100%



E.V.D.S

- Build Progress
 - Audio Input/output Build
 - 100%
 - Code Build
 - 100%
 - PCB Print
 - 100%
 - Testing Platform Build
 - 100%
 - Total
 - 100%



E.V.D.S

Component	Primary	Secondary
Microphones	Ryan	
ADC	Daniel	
Filter	Daniel	John/Ryan
DSP	Daniel	Ryan
Decision Logic	John	Ryan
DAC	John	Daniel
Testing Platform	John/Ryan	
Warning (visual, audio)	John/Daniel	Ryan
Testing	Everyone	
PCB	Daniel	
Administrative Content	Ryan	Daniel/John

E.V.D.S

- **Lessons Learned**

- Populating your own PCB is incredibly difficult
 - Paying to have it populated is even more difficult on your wallet
- Ground planes are necessary on PCBs
- Cheap components may catch fire
- Formatting in Microsoft Word is nearly impossible
- Having a CpE in a coding heavy project would be useful
- Can use PWM as DAC



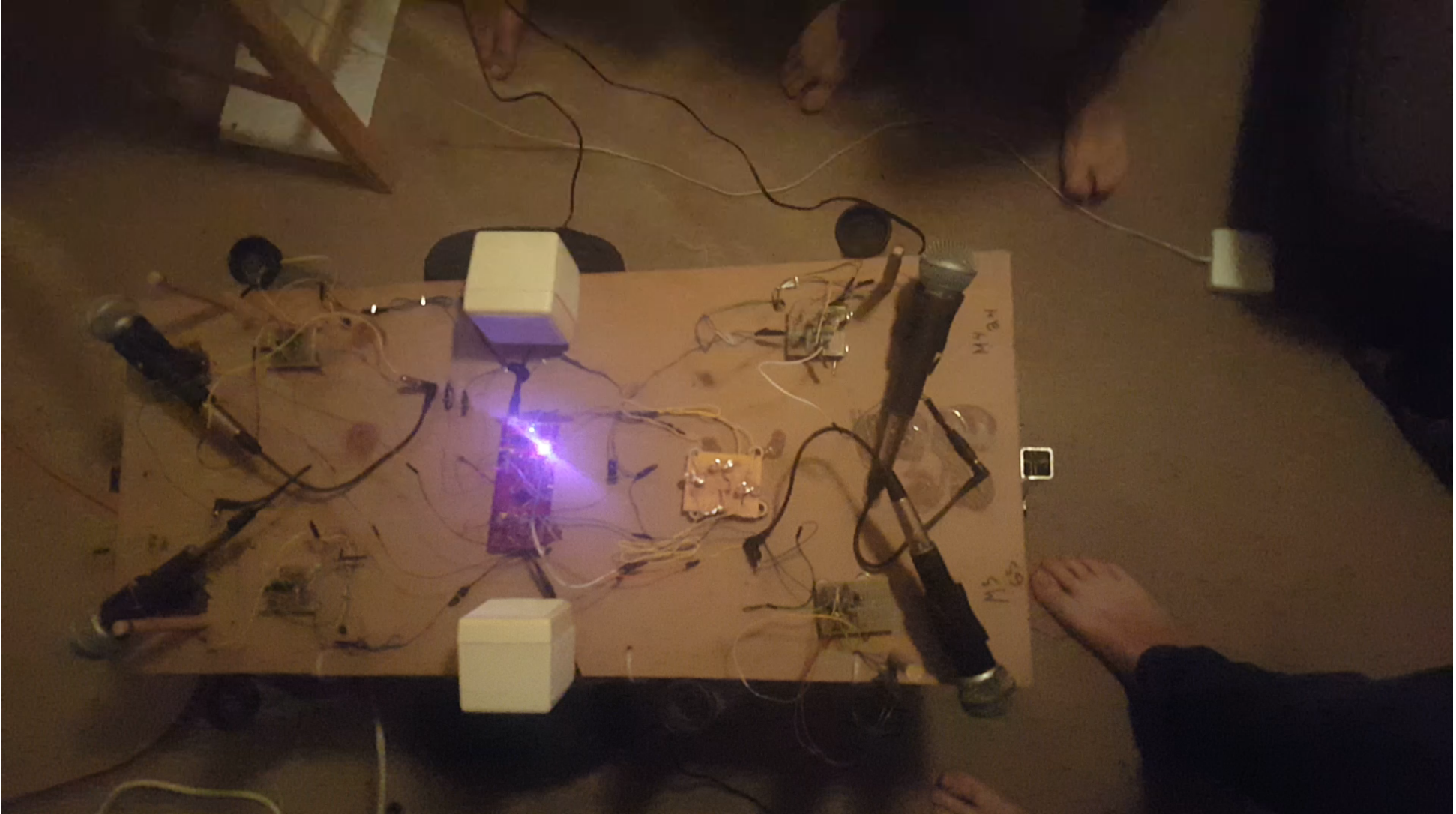
E.V.D.S

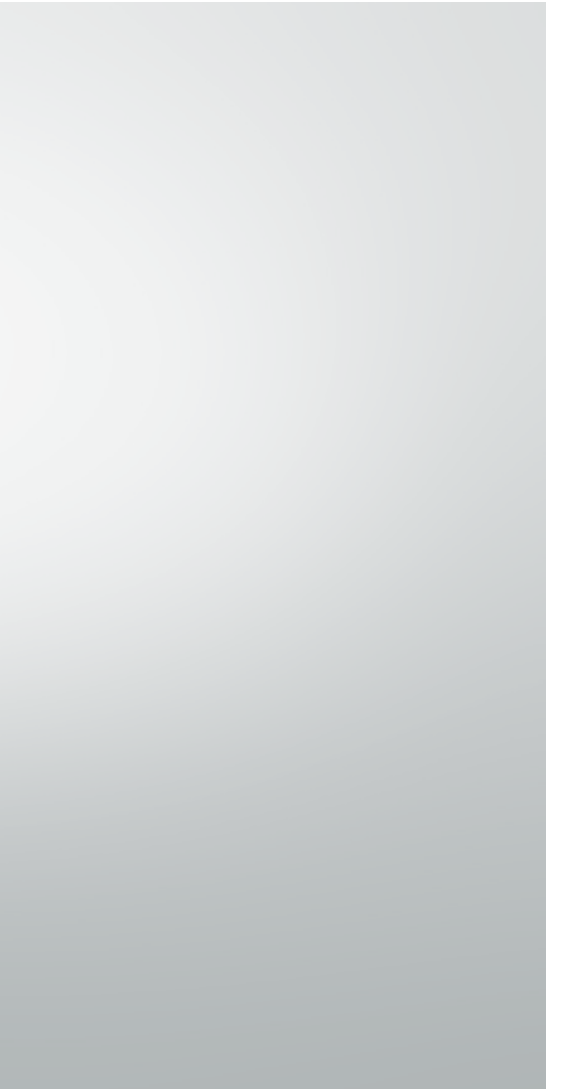
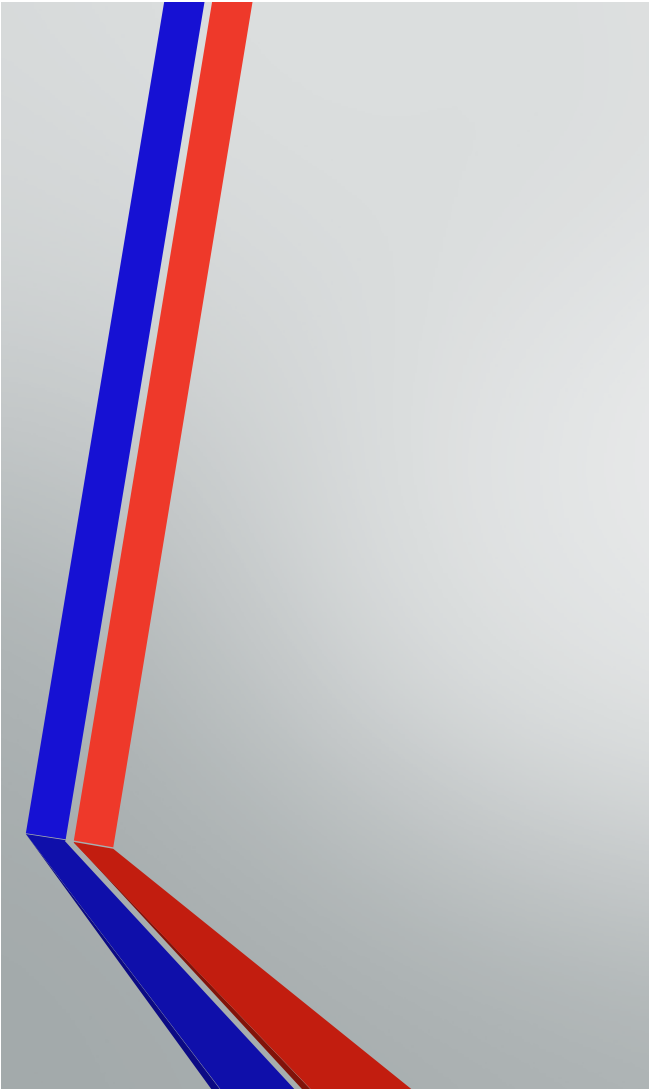
Questions?

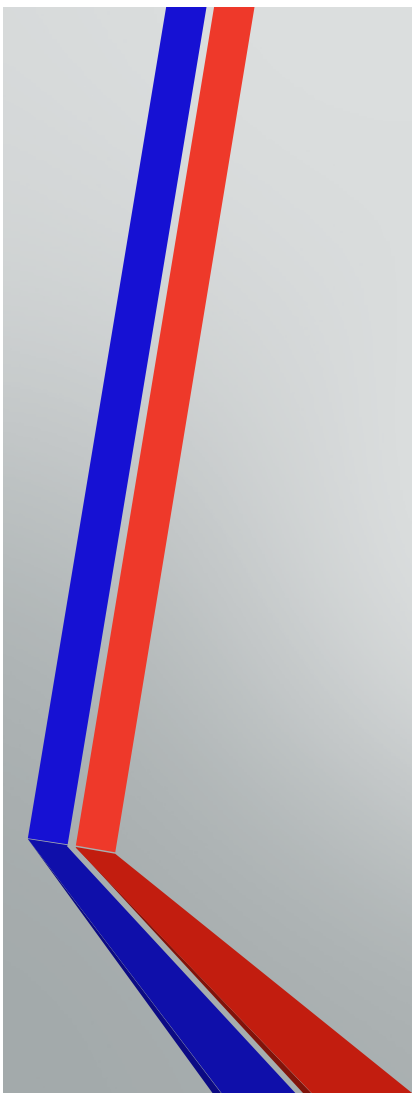


E.V.D.S

Demonstrations









E.V.D.S

Questions?