



E-music Performance System

Team #6:

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ECE 445 Senior Design
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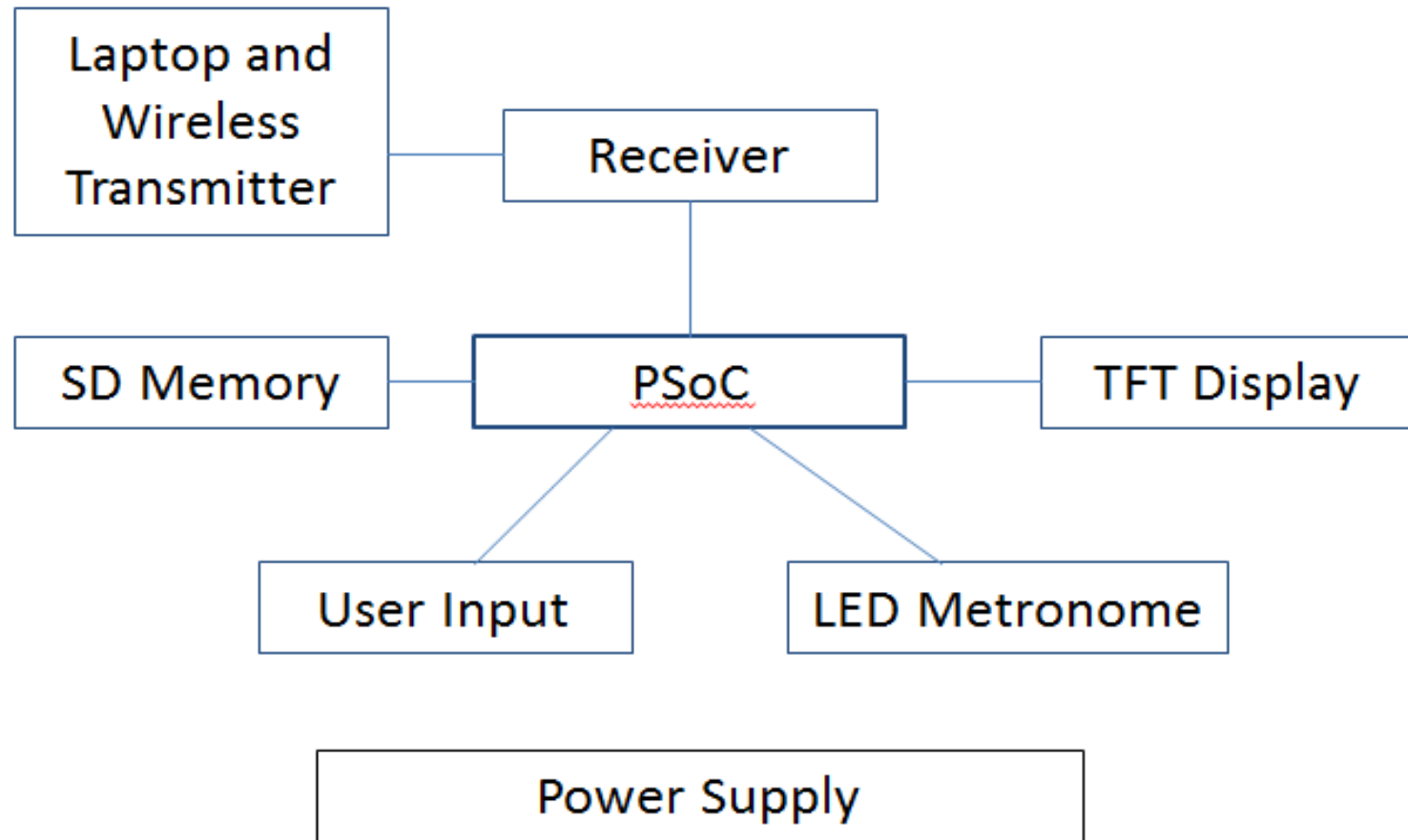
Purpose

- Eliminate printing costs for marching bands by making electronic flipfolder at a reasonable price
- Make managing large repertoires of music easier by making music easier to add, delete, and organize
- Facilitate conductor-performer communication by enhancing visual cues
- Cut down on time between switching songs

Features

- TFT screen displays electronic sheet music
- MicroSD card memory to store electronic music files
- Wireless remote to allow conductor to transmit visual cues and/or sheet music to performers
- Push-button interface for page turning in-performance
- LED Metronome for practicing
- AA Rechargeable Battery powered
- Central controller interface with PC

Top Level Block Diagram



Display Hardware

- Original Plan: Use E-Ink Display
 - Sunlight Readable
 - Low Power Usage
 - Holds state when powered off
- Problems
 - Expensive (\$100+)
 - Displays and Development Tools not made available to students

Display Hardware

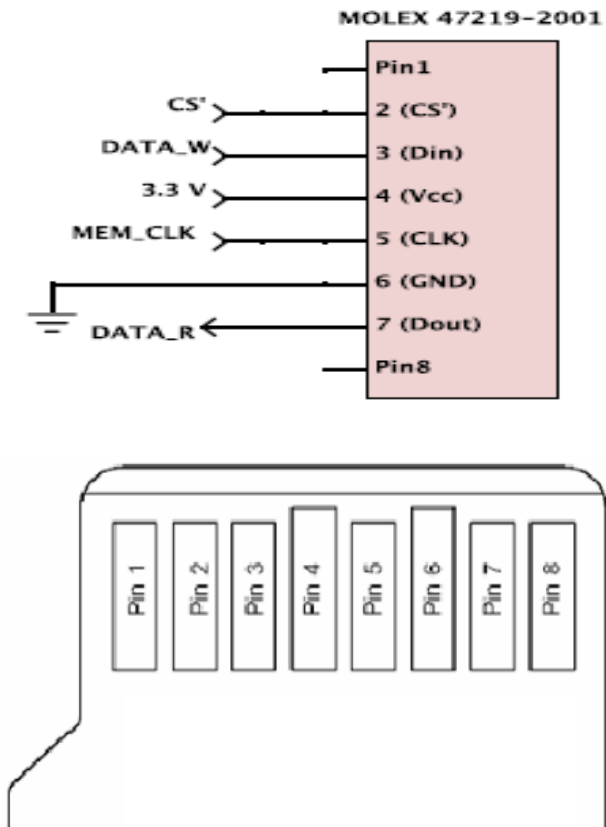
- Solution: TFT Display
 - Hantronix HDA700L-2S (\$55)
 - 7" diagonal, comparable to flipfolder
 - Sufficient Resolution (800 x 480)
 - Simple 40 pin TTL interface
- Display software still programmed as if slower E-ink display was used

Display Hardware

- Drawbacks of TFT display
 - Loss of Sunlight Readability
 - Consumes more power
 - Backlighting is essential, requires higher voltage than digital components
 - 18-bit RGB Color Display is unnecessary, only used grayscale

Memory Hardware

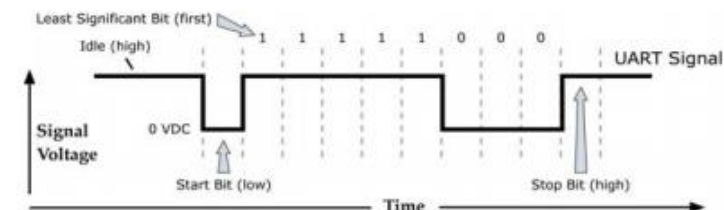
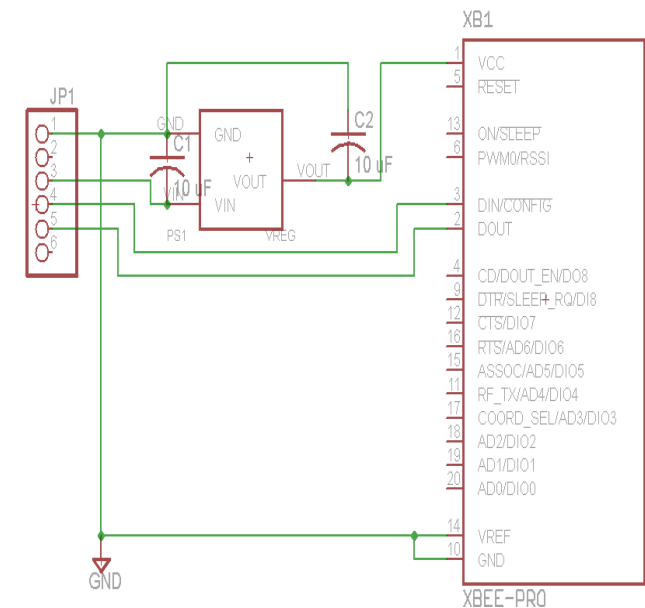
- 4GB MicroSD card and surface mount PCB connector (\$7)
 - 1 page of music = 1-bit
800 x 480 bitmap = 47 KB
 - Easily connected to computer to load music
 - Simple interfacing to microcontroller via SPI interface



Wireless TX/RX



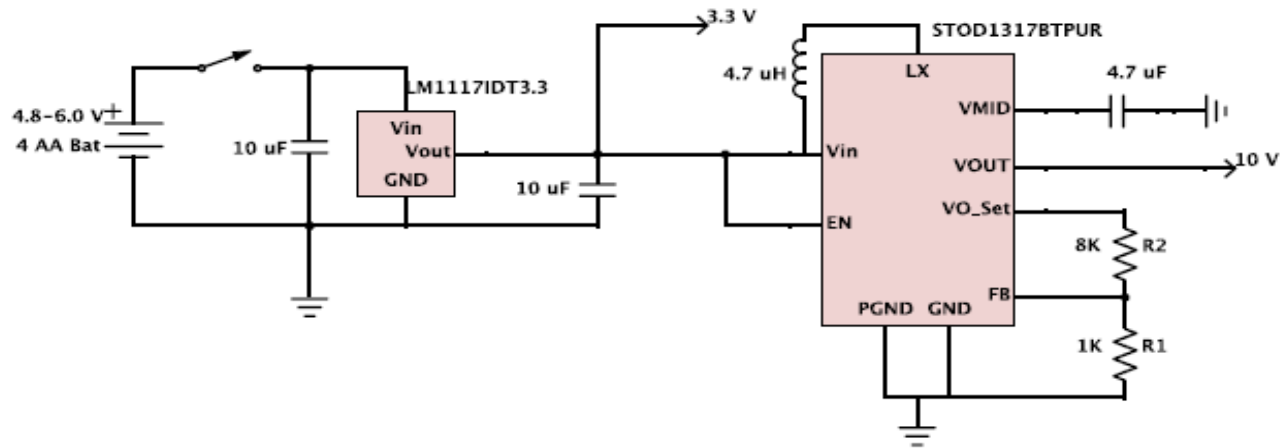
- Receiver: XB24 (\$19)
- Transmitter: XBP24 (\$32) connected to PC via FTDI
- Transmitter has listed range of 1 mile
- Transmitter can send packets of up to 100 bytes at a time to receiver via UART



User Input and LED Metronome

- User Input
 - 6 tactile switches located on left side of device, plus main power switch on back
 - Used to change pages, bring up music selection menu, and toggle metronome
- LED metronome
 - LED on right side of device flashes at adjustable number of beats per minute
 - Operated in current sink mode, tied to high current pin on microprocessor

Power Supply



- 4 AA batteries and 3.3 V linear regulator supply power to all digital components
- Boost Converter provides 10 V to display backlight

Power Budget

3.3 V Component	Typical Current
Display	200 mA
Receiver	50 mA
Memory	30 mA
Processor	10 mA
User Input and LED	20 mA
Total	310 mA

10 V Component	Typical Current
Backlight	160 mA

Energy Input = $1.2 \text{ V} * 2500 \text{ mAh}$
= 3000 mWh per battery
= 12000 mWh

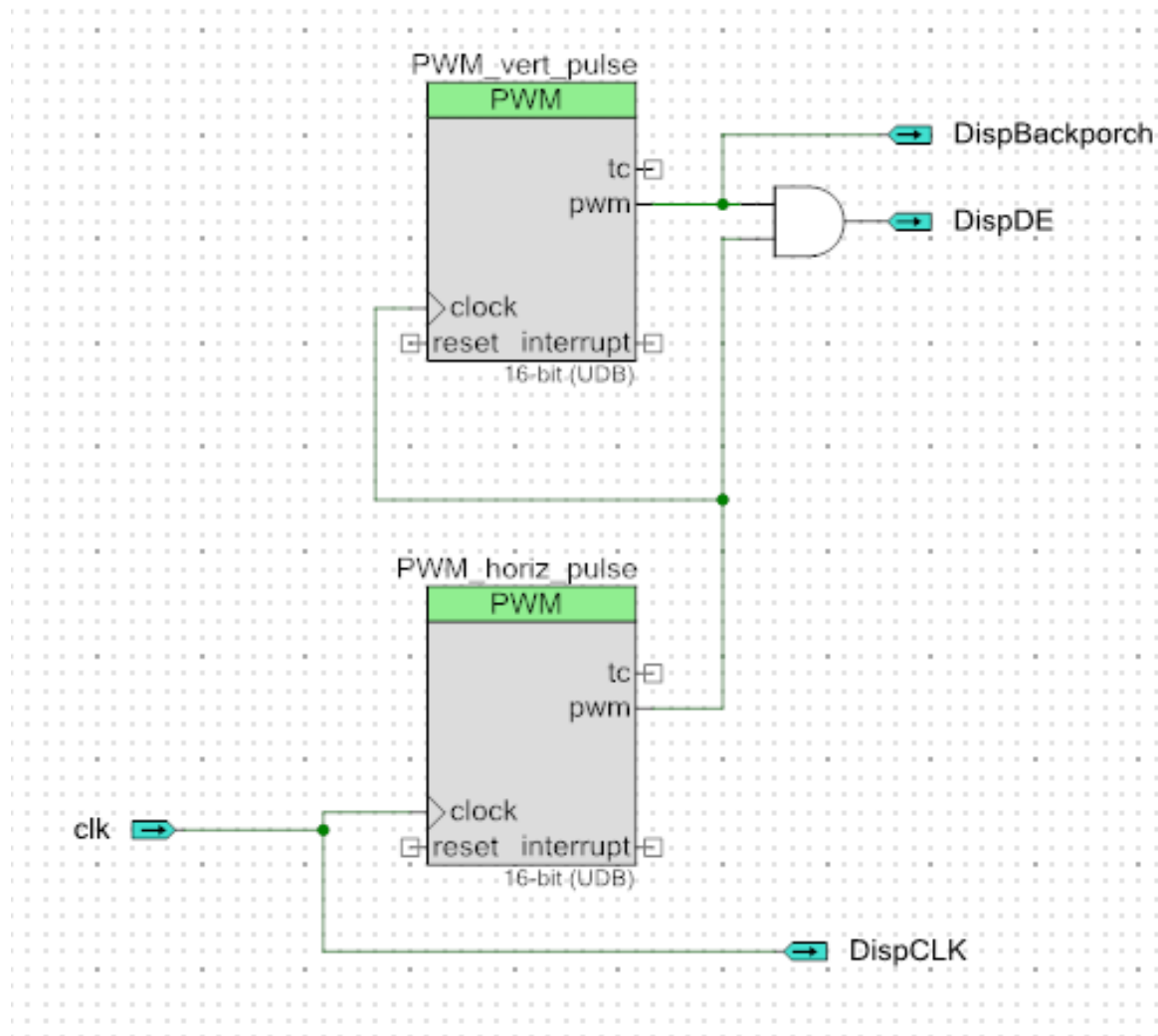
Power Usage = 2623 mW

Battery Life = 4.57 hours

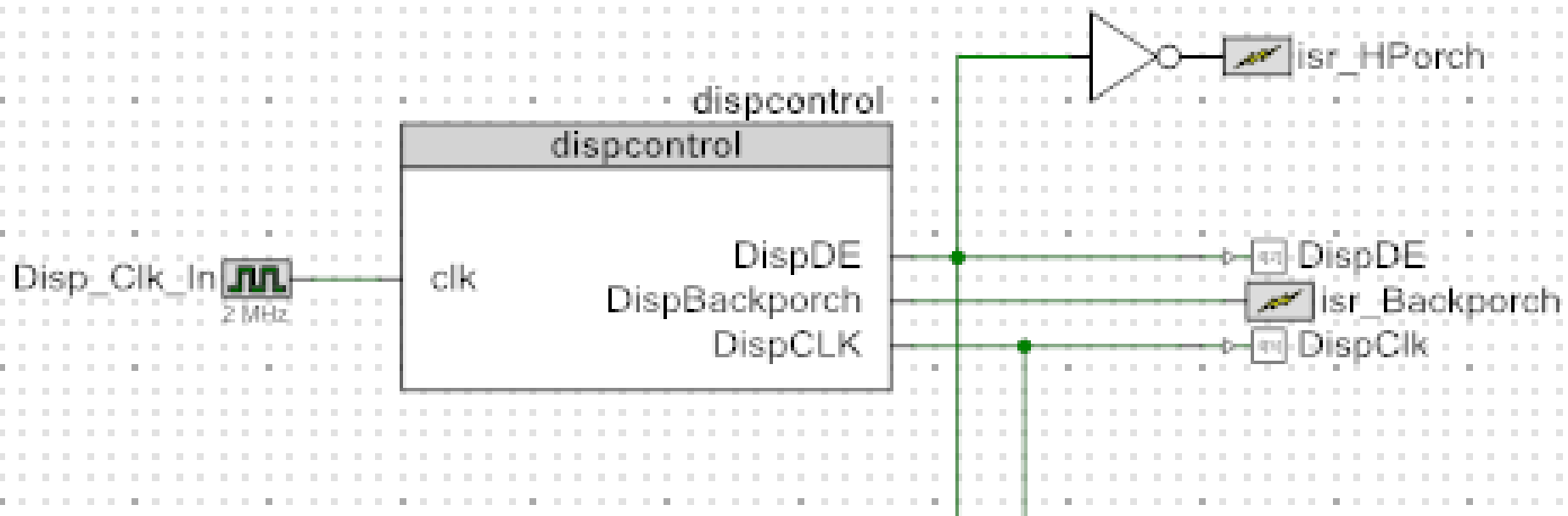
Cypress PSoC

- Expensive as a microprocessor, cheap as system (\$10)
- Capable microprocessor
- Digital blocks
 - Fast hardware prototyping
 - Adaptable to different display methodologies

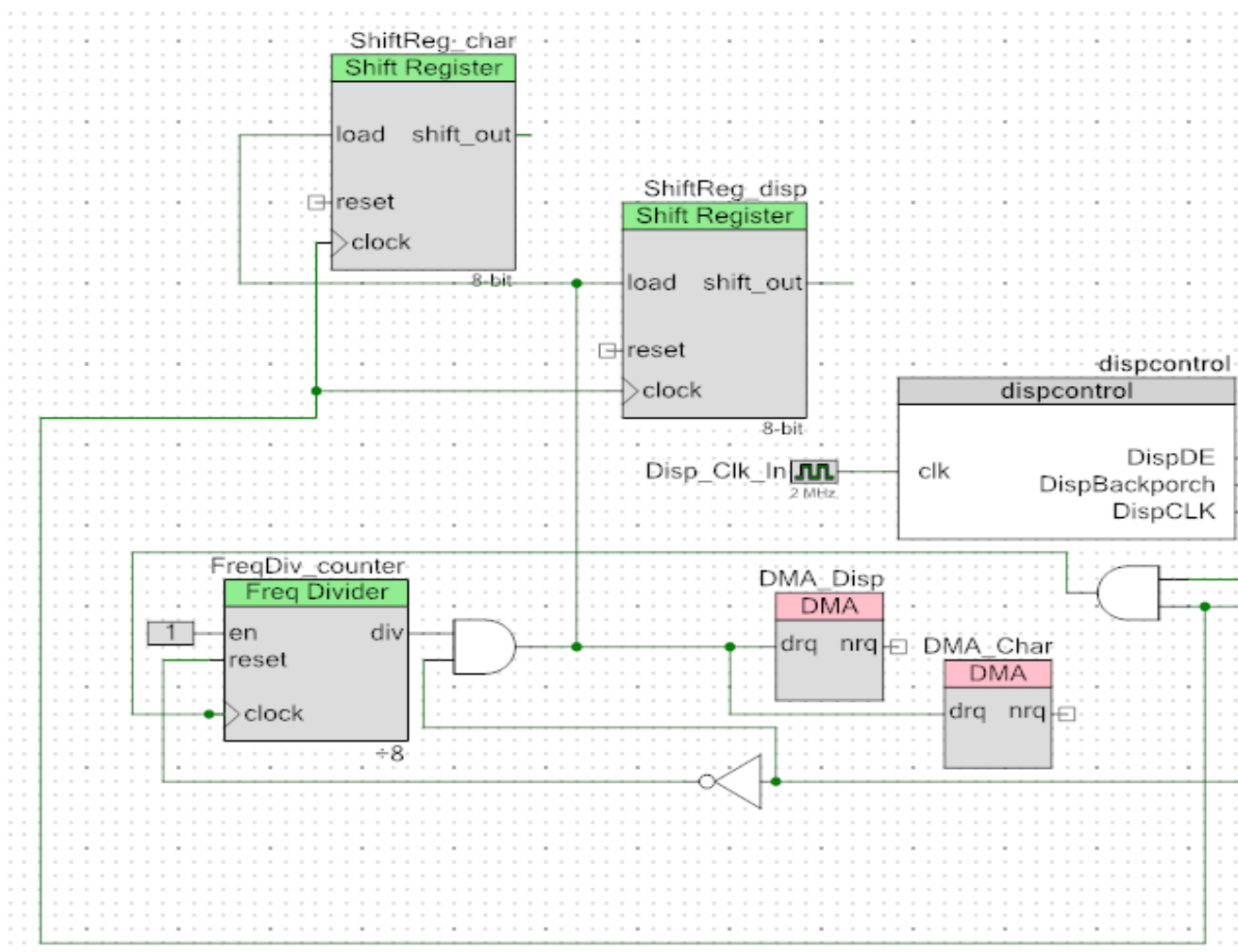
Display Blocks



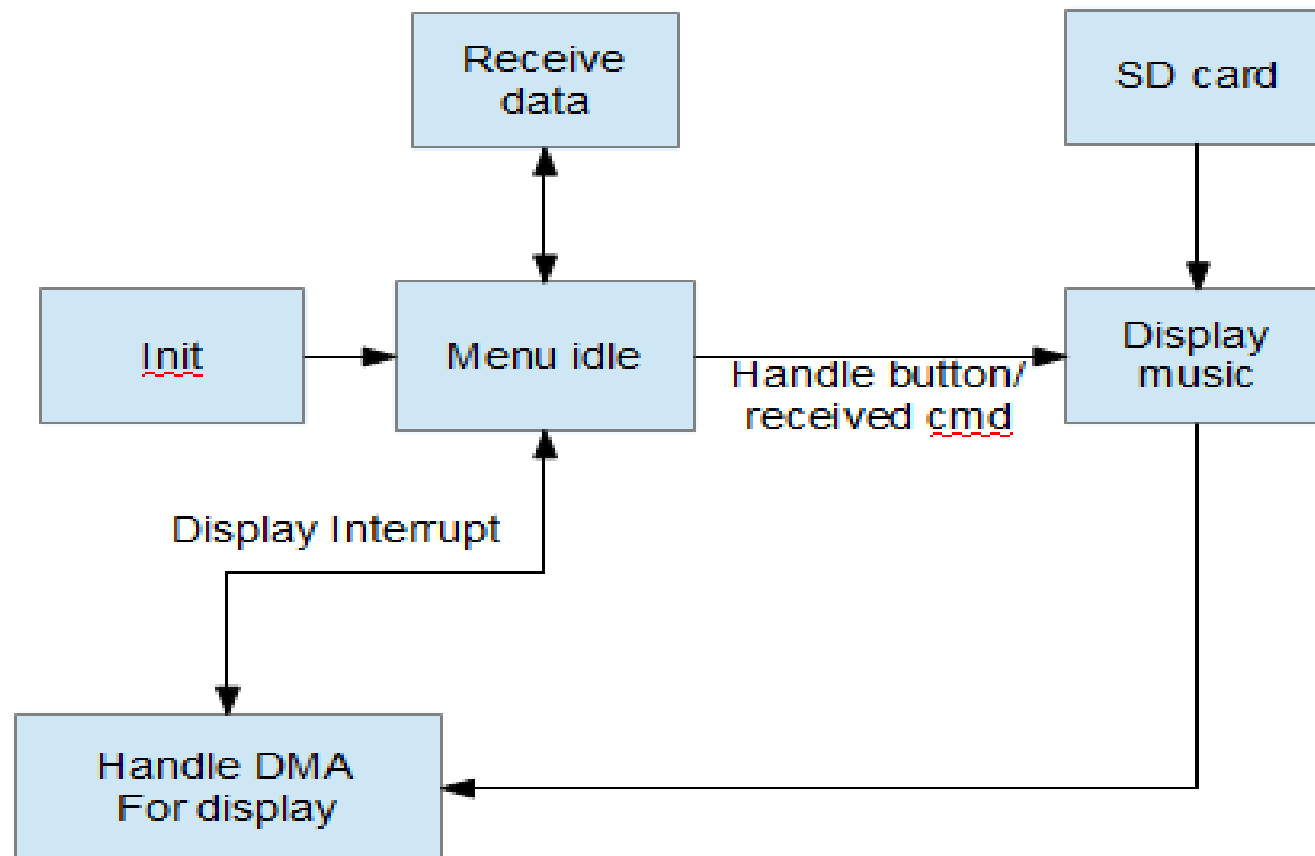
Display Blocks



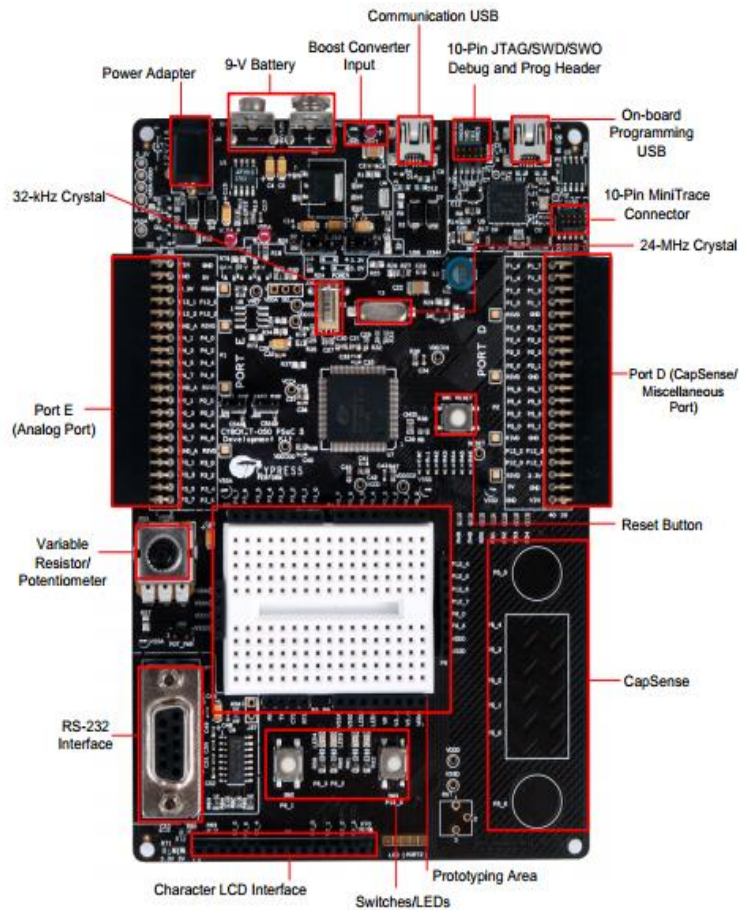
Display Blocks



Software



Cypress DevBoard Interface

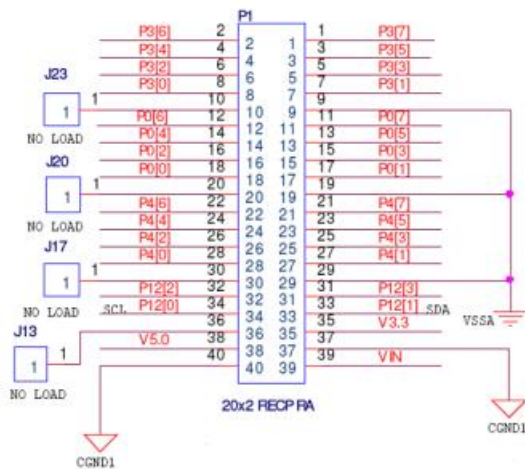


- Simple PCB to connect display, SD card, and Xbee to PSoC 5 Development kit
- Kit provides power to components, user I/O, and can be programmed via USB input
- Provided a way to test display and memory software before migration to final hardware

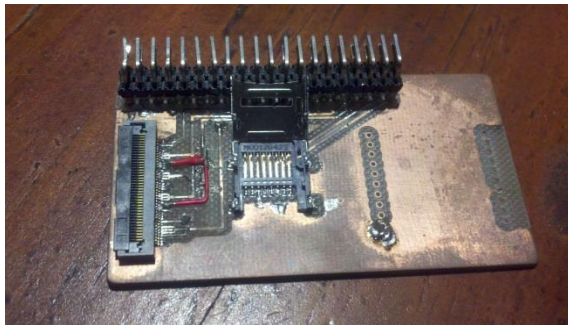
Source: cypress.com

Cypress DevBoard Interface

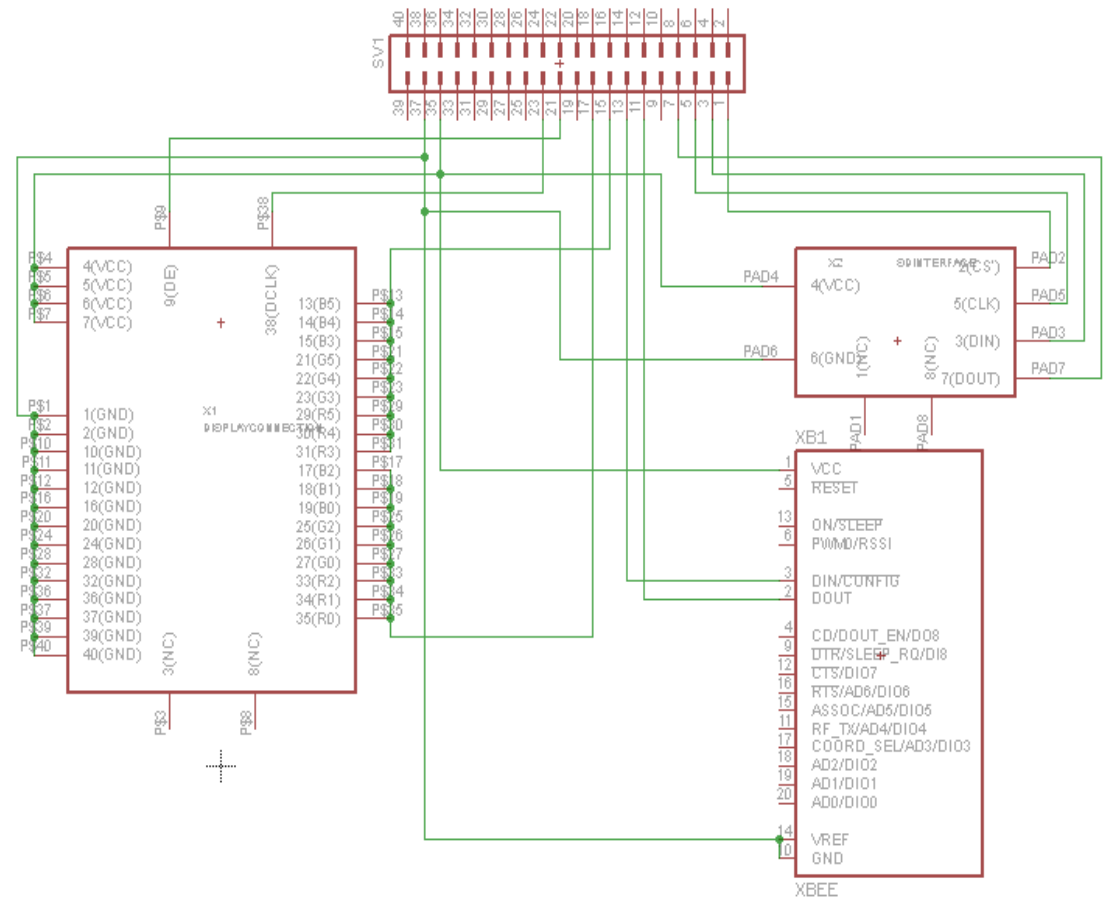
Port E Schematic



Picture



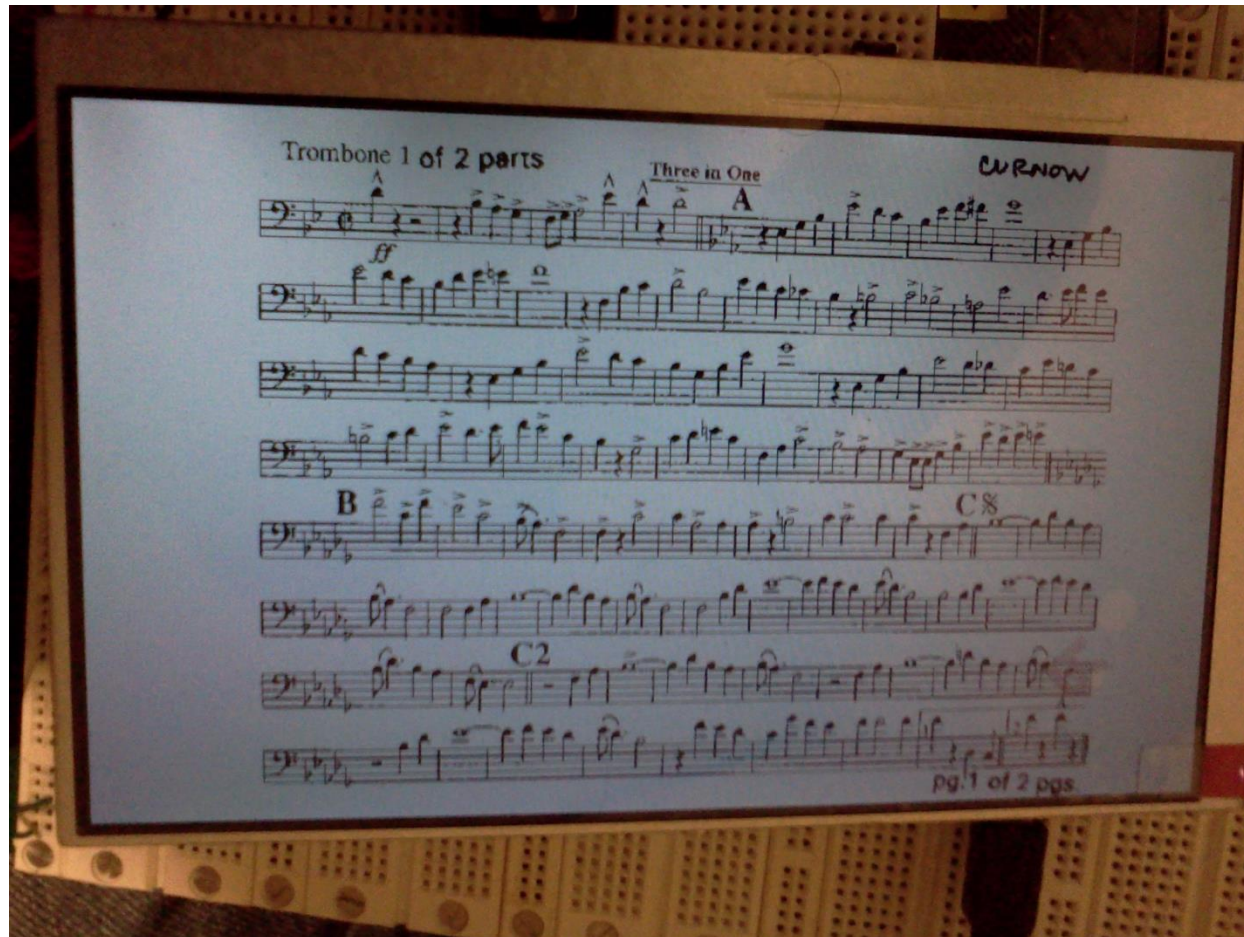
Hardware Interface Schematic



Dev Board Testing

- Easy debugging with LCD character display
- Character display made menu easier to make
- Platform usable for spring football game

Sample Sheet Music



Hardware Design Decisions

- Make 2-bit grayscale possible
 - Improves image quality, especially with scanned music
- Remove boost converter
 - Small, hard to solder, leads underneath IC
 - Inefficient conversion
 - Display backlight tolerates 8-12 Volts
 - Solution: Use 9 V battery

New Power Budget

3.3 V Component	Typical Current
Display	200 mA
Receiver	50 mA
Memory	30 mA
Processor	10 mA
User Input and LED	20 mA
Total	310 mA

9 V Component	Typical Current
Backlight	160 mA

Energy Input = $1.2 \text{ V} * 2500 \text{ mAh}$
= 3000 mWh per battery
= 12000 mWh

Power Usage = 1023 mW

Battery Life = 11.7 hours

Energy Input = $9 \text{ V} * 600 \text{ mAh}$
= 5400 mWh

Power Usage = 1440 mW

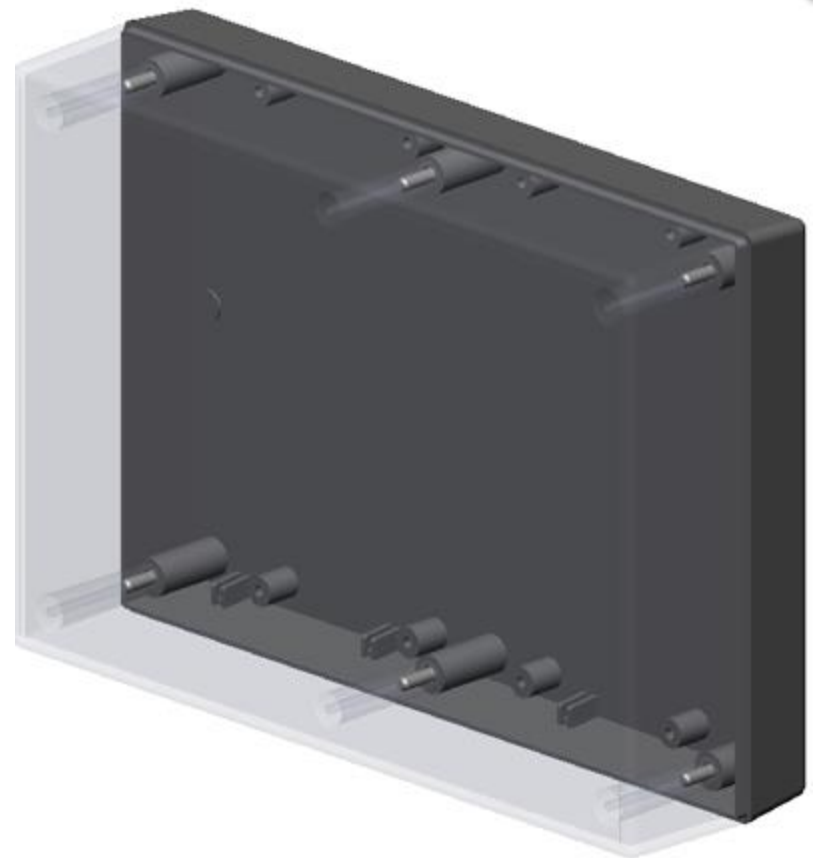
Battery Life = 3.75 hours

Hardware Design Decisions

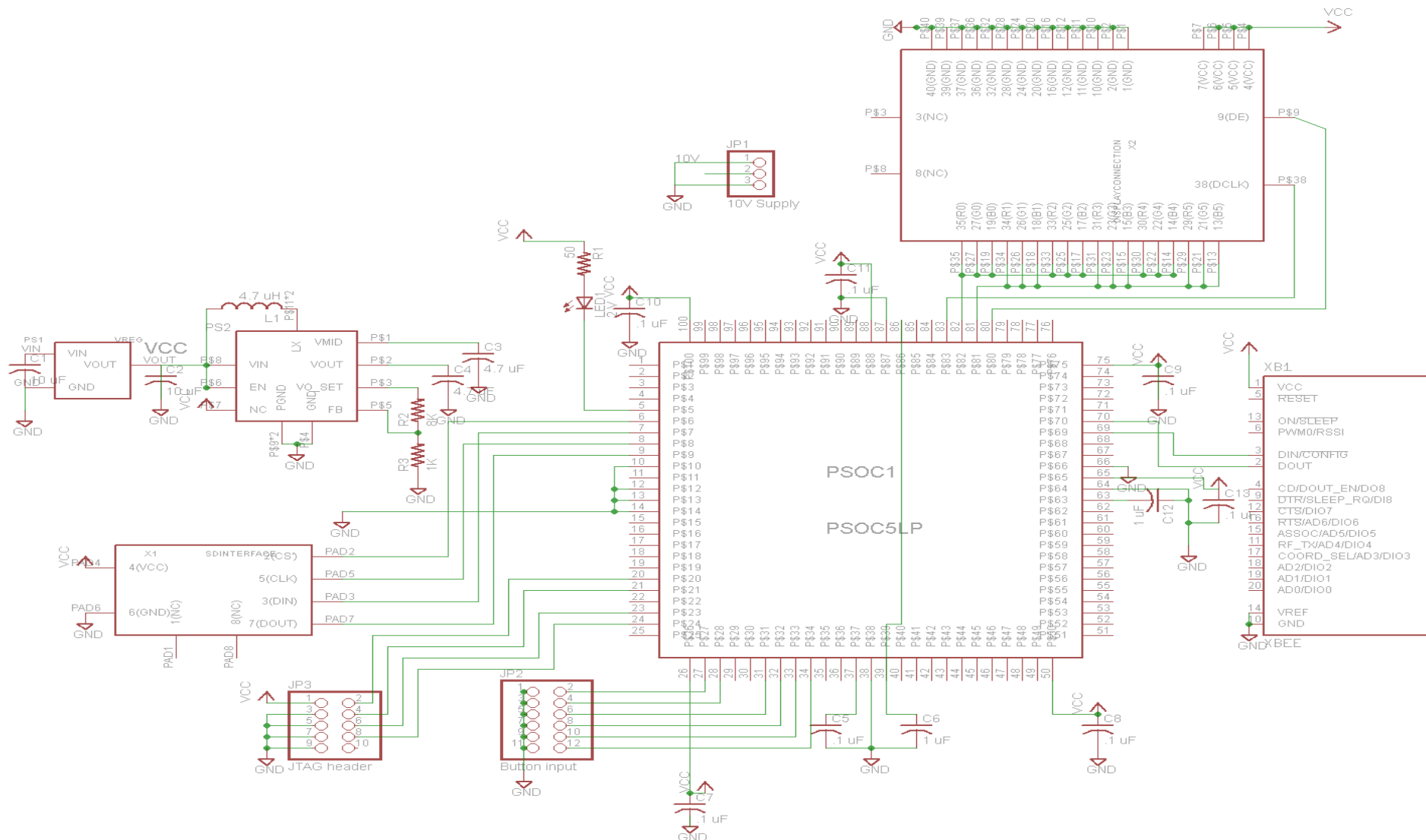
- Send Final PCB to Sunstone for fabrication
 - Lots of fine pitch components (PSoC, display connector, JTAG connector)
 - Plated vias and through holes
- Casing is necessary
 - Added protection and neatness worth the extra time

Casing

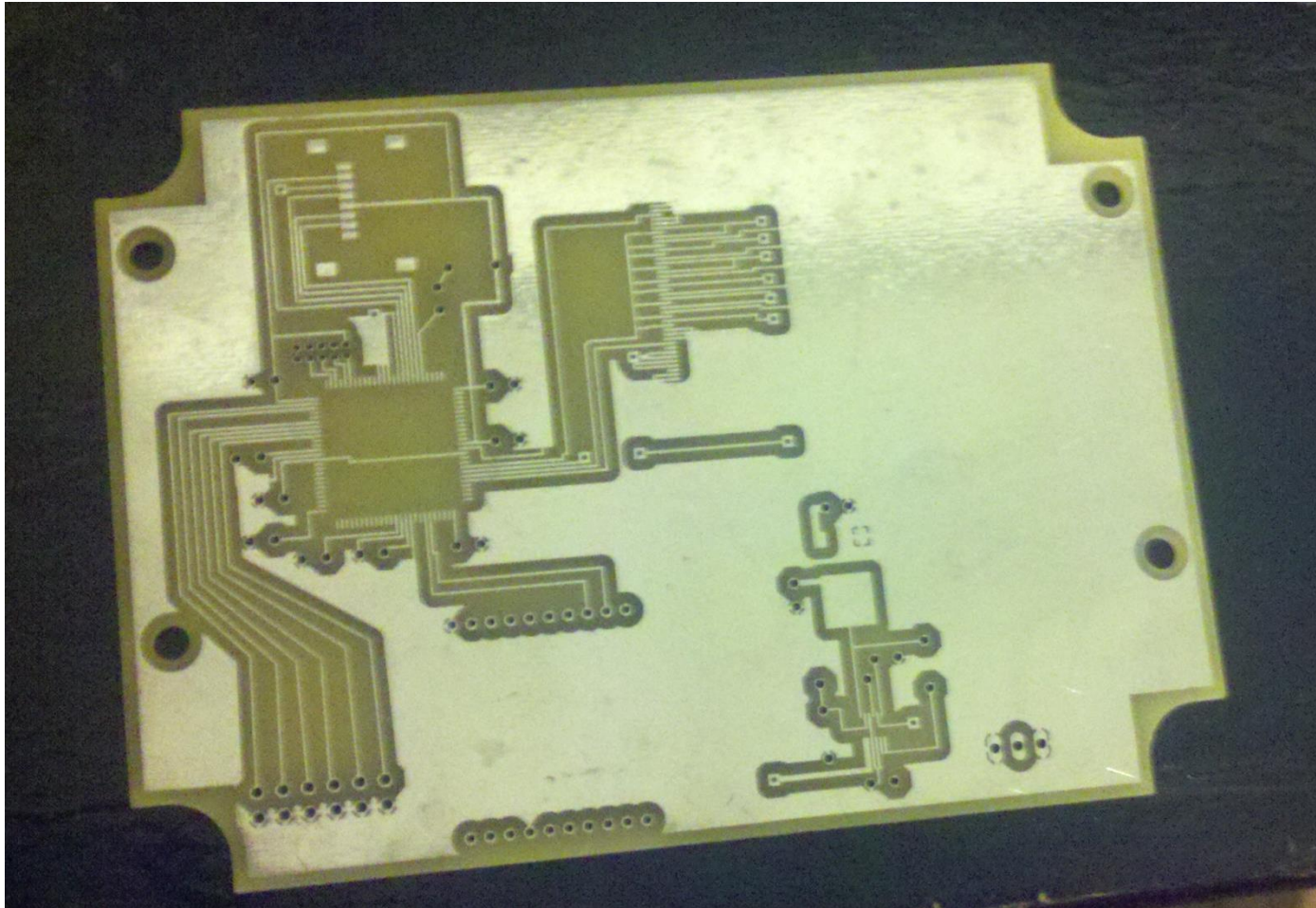
- Serpac Clear Case: 6.88" x 4.88" x 1.40"
- Display mounted on front panel, batteries and PCB on back
- 5 panel mount buttons and 1 toggle switch (backlight) on left
- 1 red LED on right



Final Schematic



Final Board



Finished Reader Device



Final Unit Cost

Reader Components	Cost
TFT Display, ribbon cable, and board connector	\$60.00
MicroSD card and socket	\$7.00
XB24	\$19.00
PSoC 5 and programming conn.	\$12.00
PCB	\$35.00
Case	\$10.00
Batteries, holders, and voltage reg.	\$8.00
Buttons, LED, resistors, capacitors	\$5.00
Total	\$160.00

Transmitter Components	Cost
XBP24	\$32.00
FTDI cable	\$20.00
Voltage regulator and capacitors	\$2.00
Total	\$54.00

Testing the Final Device

- Successes
 - Clear Stable Image on Display
 - Memory Read/Write functions as intended
 - Menu displays on screen, and is navigable by buttons
 - Metronome blinks correctly, and rate can be changed
- Failures
 - Wireless capability
- Possible Explanations
 - PC communicates with transmitter and transmits correct signal
 - Receiver and transmitter hardware/firmware functional
 - Probable Cause: Software interface with microprocessor

Summary

- E-Reader device successfully built, with some modification to original design
- Transmitter hardware successfully built
- Core software functions properly
 - Music display, menu navigation
- Wireless not functioning, due to software interface with PSoC

Future Work

- Improve Battery Life
 - Implement Boost Converter
 - Add variable resistor, so backlight can be dimmed
 - Get E-Ink display
- Improve Case
 - Lighter, thinner casing
 - Make battery easier to replace
 - Anti-reflective coating
- Include music education tools (e.g. tuner)

Acknowledgements

- ECE Parts Shop Staff
- ECE Machine Shop Staff
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- Kevin Bassett, and all the ECE 445 TA's



Questions?