

MOTIVATIONAL MP3 PLAYER

Group #7

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INTRODUCTION

Create an MP3 Player which:

- Helps monitor workout progress
 - Customizes the workout experience
 - Provides user with information of their heart rate
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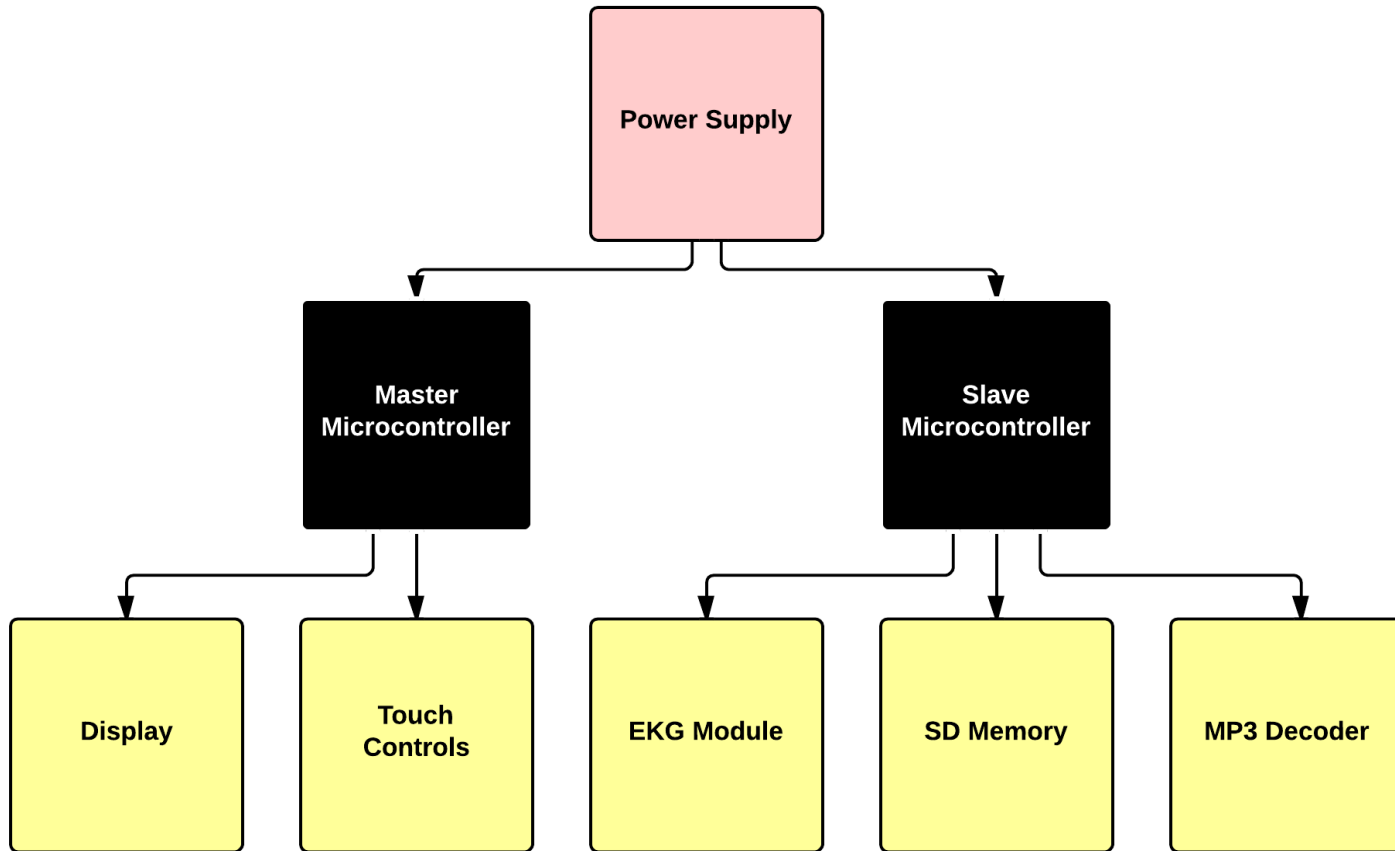
SPECIFICATIONS

Battery Life	6 Hours
Dimensions	5.5 in x 2.75 in x 0.7 in
Weight	5 oz.
Flash Memory Size	16 GB
Supported Digital Audio Standards	MP3, WMA, WAV
ID3 Tag Support	Yes
Headphones	Wired
Sound Output Mode	Stereo
Connectivity	Wired
System Display	LCD
Display Diagonal Size	2.5 in

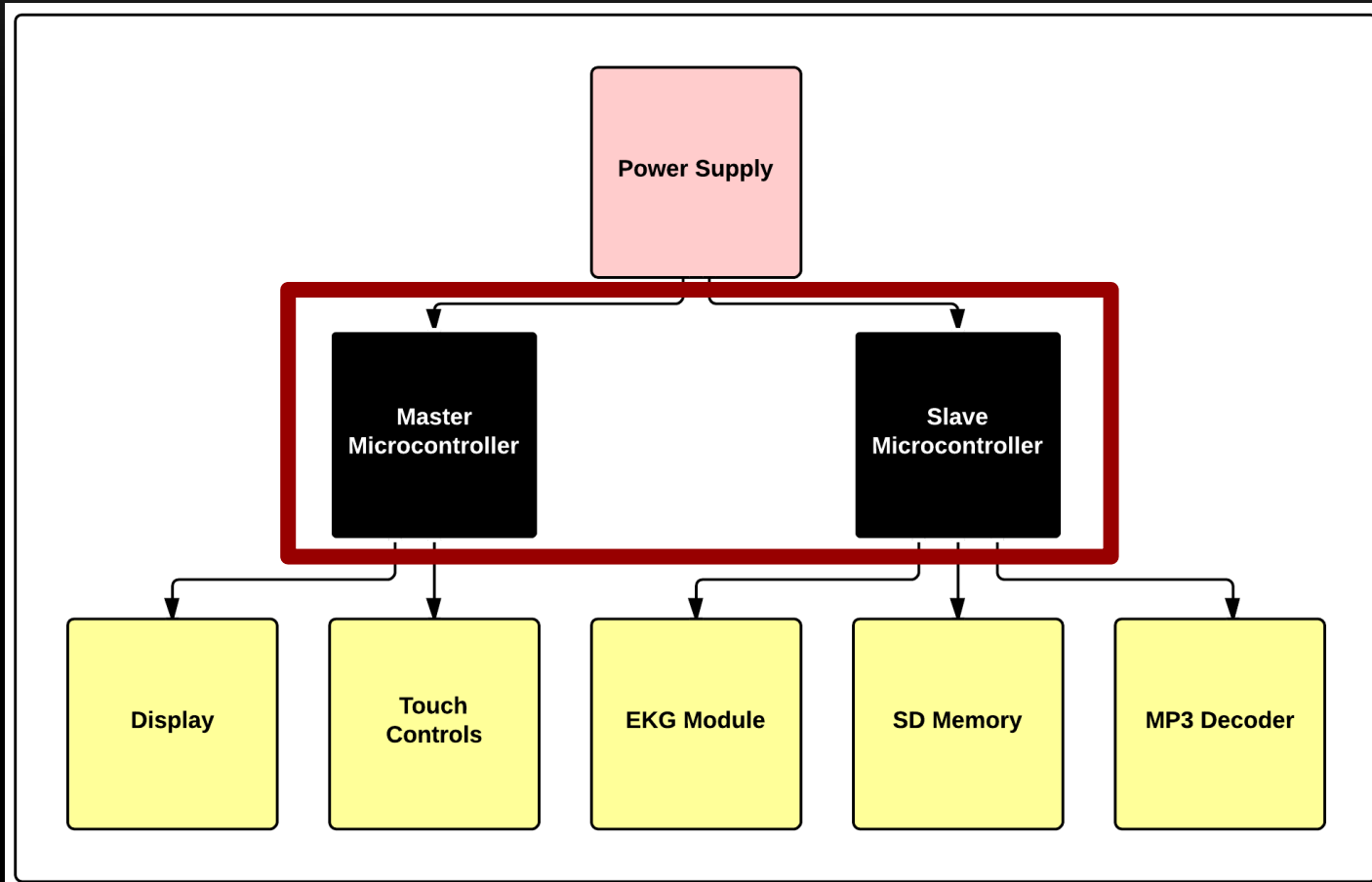
REQUIREMENTS

- Audio Playback
 - Electrocardiography (EKG)
 - Mode Select
 - Anaerobic Exercising
 - Basic Playback
 - User Interface
-

OVERVIEW



MICROCONTROLLER



MICROCONTROLLER

	MSP430G2553	ATMEGA328P	PIC18LF2550
Flash Memory	16KB	32KB	32KB
SRAM	0.5KB	2KB	2KB
GPIO	24	28	24
Frequency	16MHz	20MHz	48MHz
Supply Voltage	1.8 - 3.6V	3.0 - 5.0V	2 - 5.5V
Comm Interface	UART, SPI, I2C	UART, SPI, I2C	SPI, I2C
ADC	10 bit / 8 channels	10 bit / 6 channels	10 bit / 10 channels
Pricing	\$2.43	\$2.24	\$5.38
IDE	Energia	Arduino	N/A

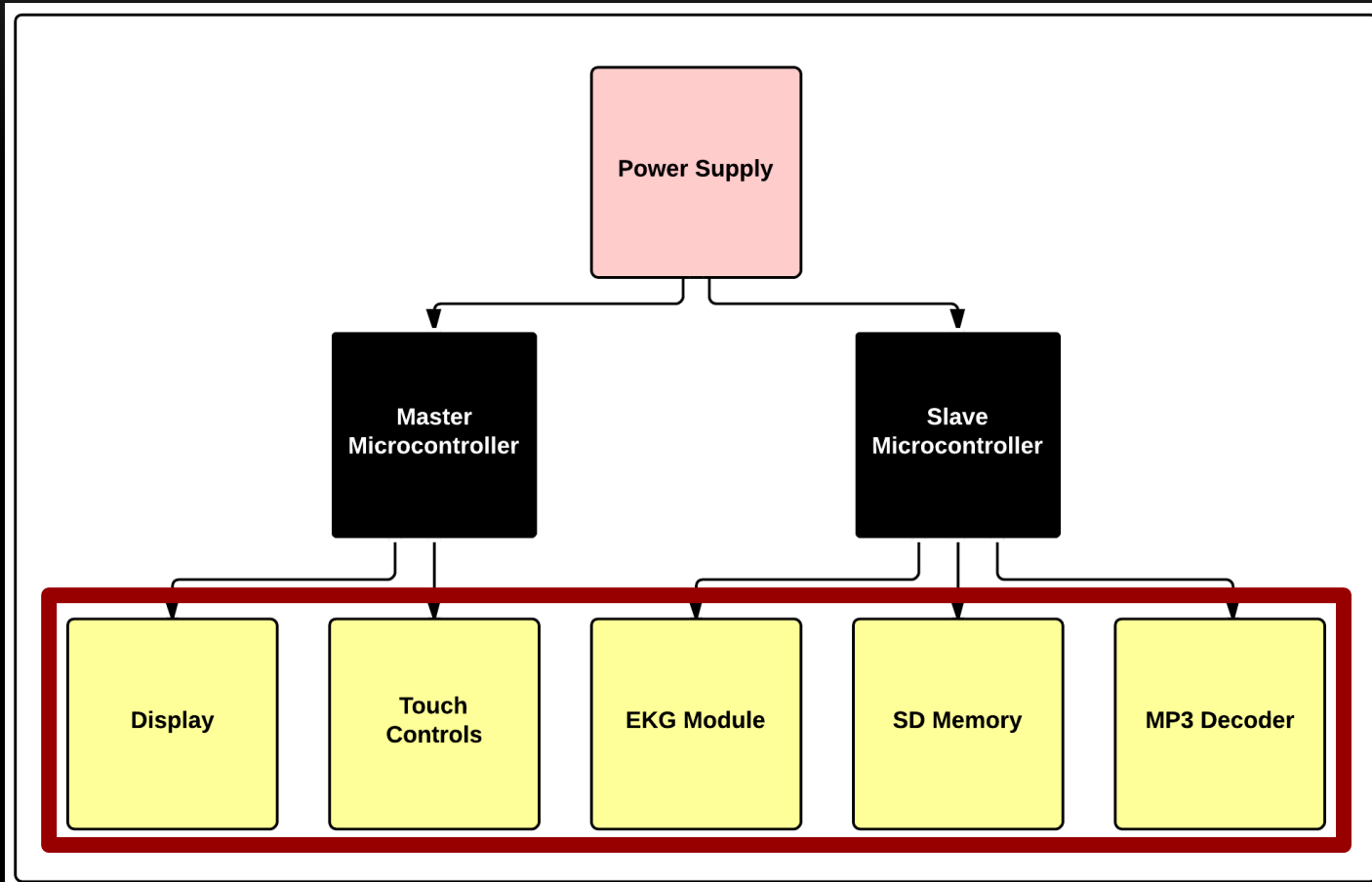
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MICROCONTROLLER

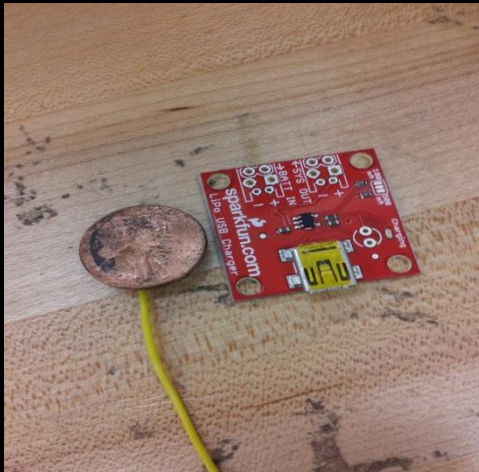
	Master	Slave
Model	MSP430g2553	ATmega328p
Pin Type	Surface Mount	DIP
Communications	UART	UART, SPI, I2C
Peripherals	Capacitive Touch Controls	Display, SD Card, MP3 Decoder, EKG

PERIPHERALS



POWER SUPPLY

- Lithium Polymer USB Charger and Battery
- 3.7V Cell
- 850mAh LiPo Battery
- Highest Energy Density In Production



SWITCHING REGULATOR

- 4.1V down to 3.3V
- Switching regulator reduces power consumption
- Schottky diode necessary for switching
- 1.5mA max switch current
- Adjustable output voltage

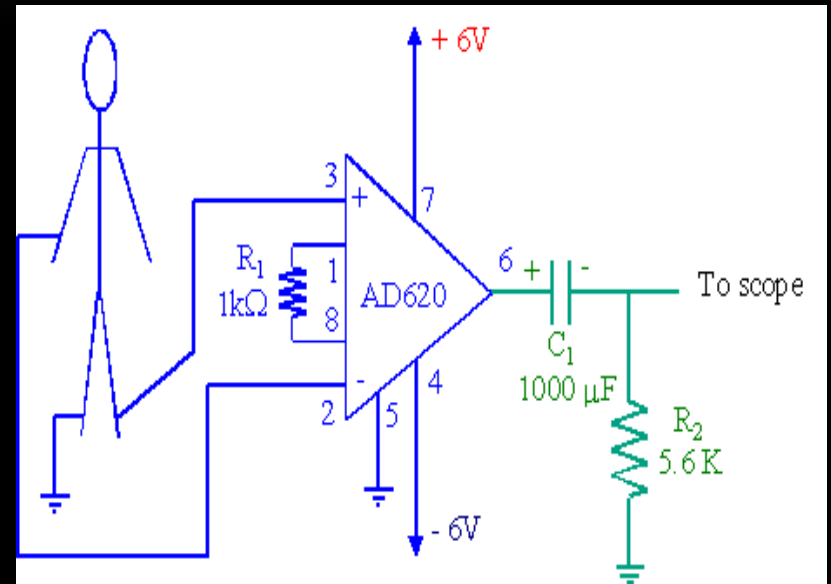
ELECTROCARDIOGRAPH

- EKG/ECG
- Medical Device
- Measures Potential Difference
- Amplifies/Filters
- Average person is around 10mV

“A test of a patient's heartbeat that involves placing leads, or detectors, on the patient's chest to record electrical impulses in the heart. This test will produce a strip, or picture record of the heart's electrical functioning.”

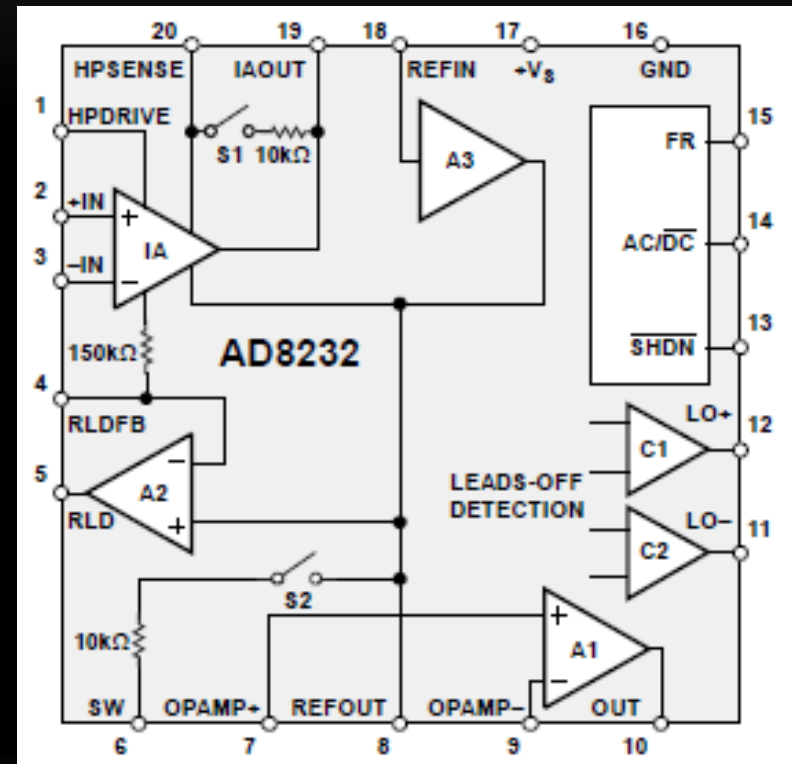
EKG

- Small Compact Circuit
- Reliable
- Low-Power
- Robust



EKG

- Solutions Too Inaccurate
- Too Much Noise
- Really Meant for Patients that are Not in Motion
- New Solution
- AD8232 by Analog Devices

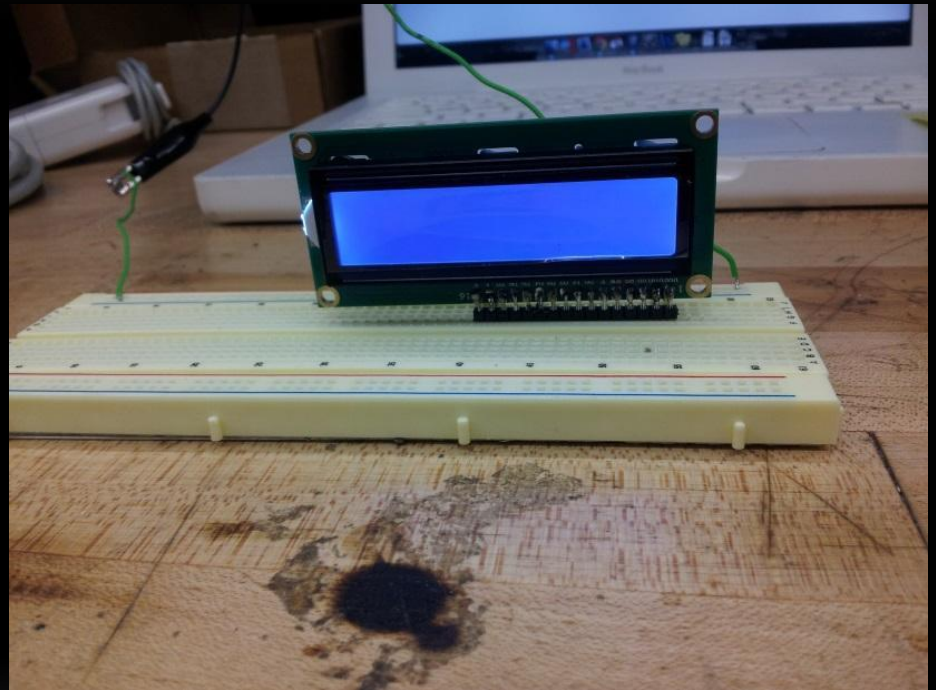


EKG



DISPLAY

- Liquid Crystal
- 16 x 2 Characters
- 3.3v
- Parallel Interface
- Menu Navigation



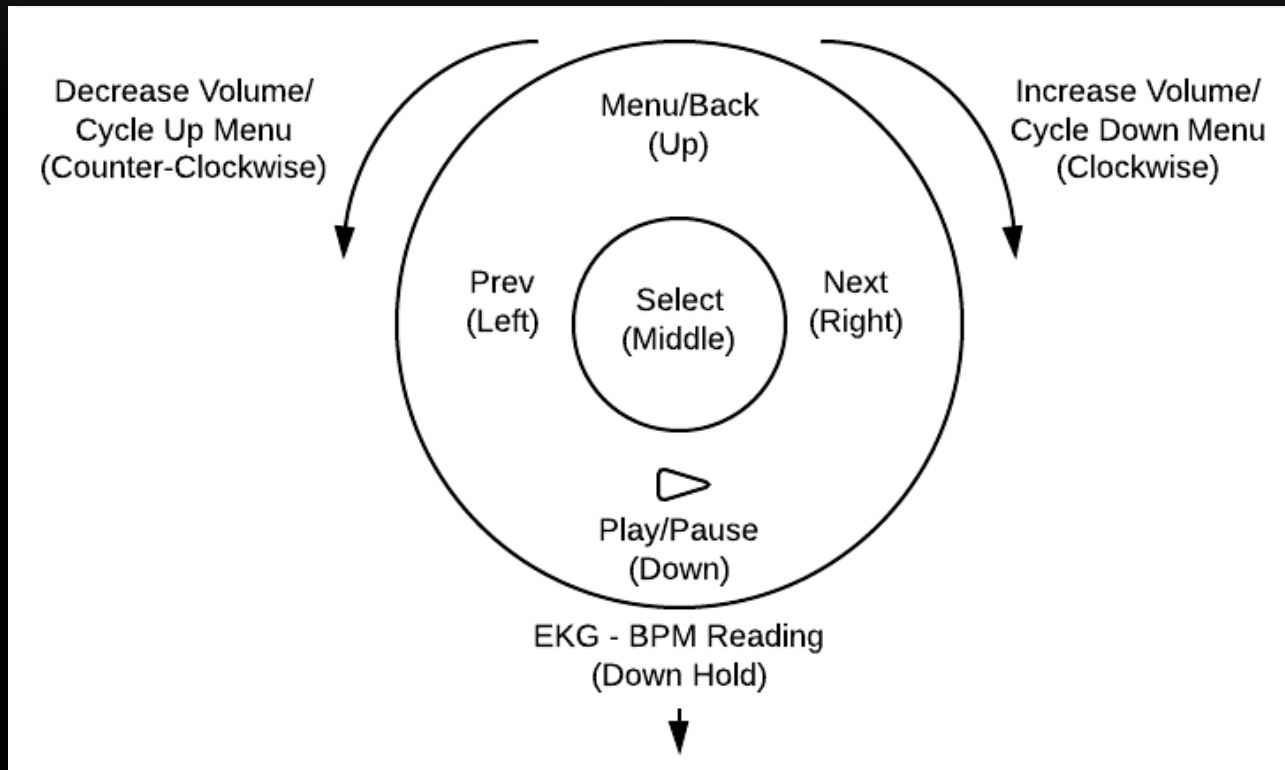
CONTROLS

MSP430 Capacitive Touch Boosterpack

- Low powered control system
- Natural feel
- Tons of included libraries



CONTROLS



MENU OVERVIEW

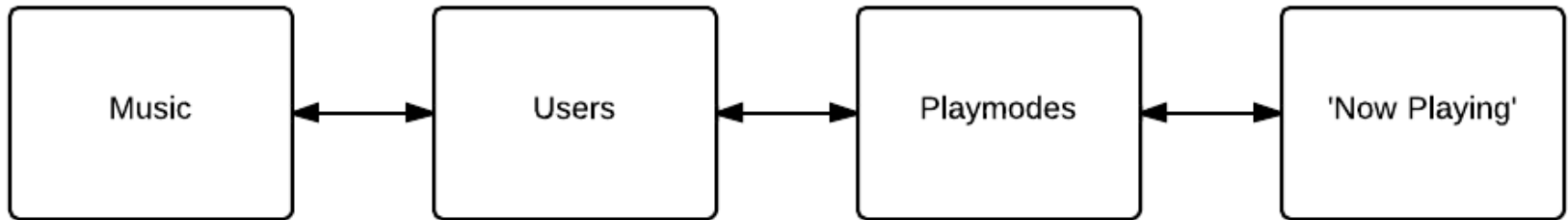


Figure 01. First-Level
Flow Diagram

MENU

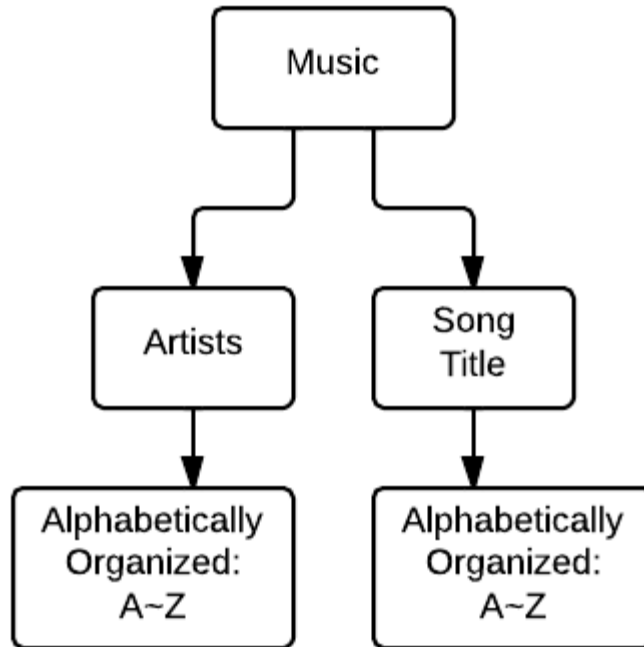


Figure 02.
Music Submenu

MENU

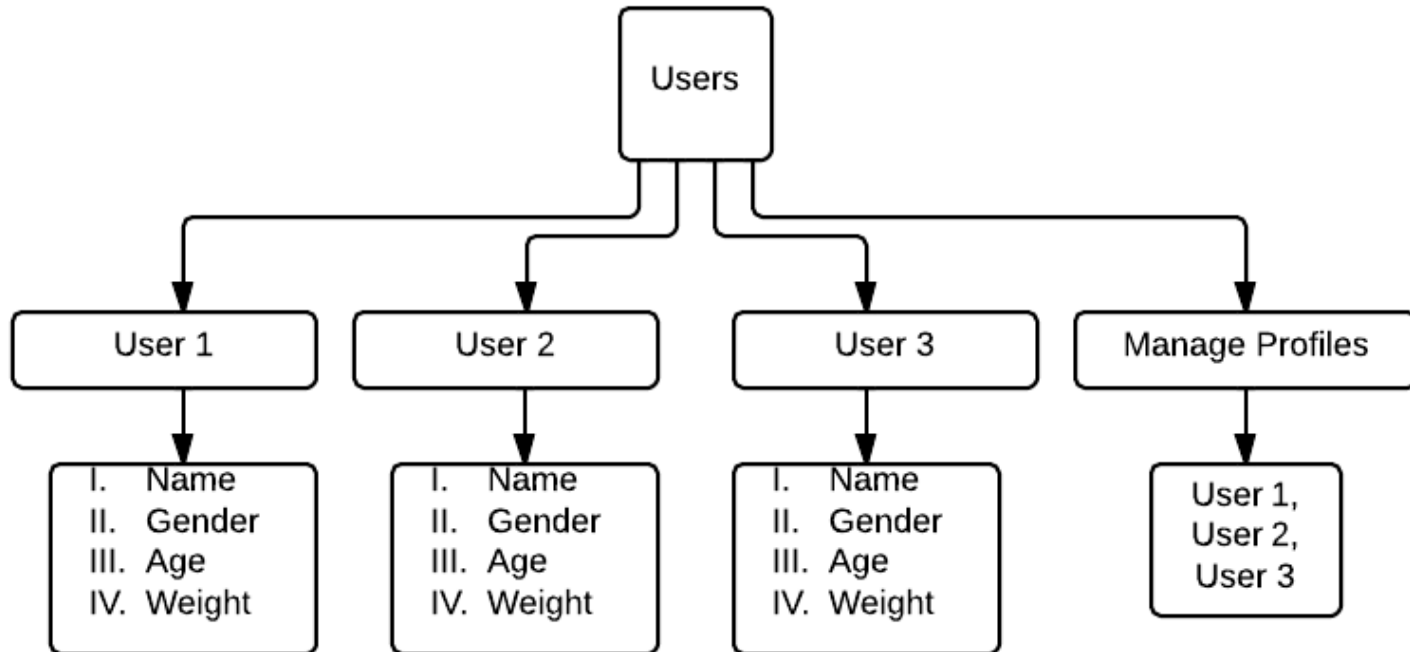
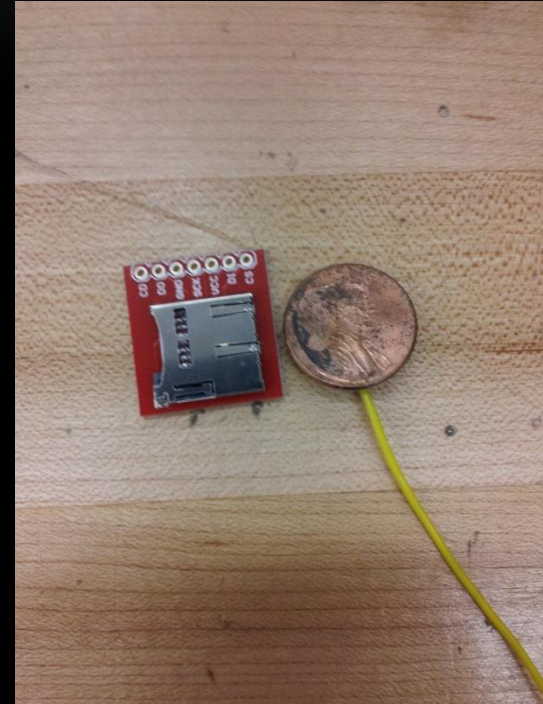


Figure 03.
User Submenu

SD MEMORY

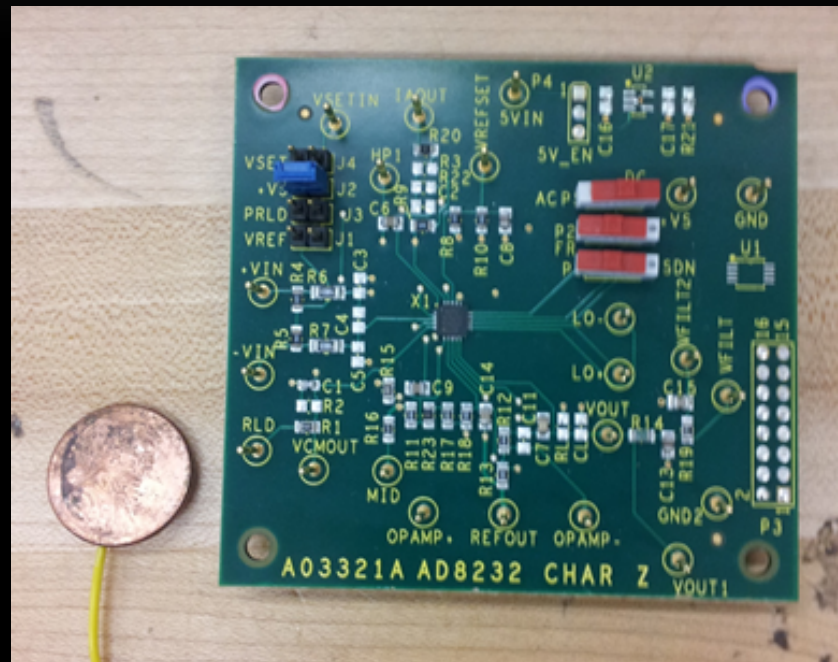
- Various Sizes of Data Storage Available
 - E.g. 2GB to 32GB
- Housing for Audio and User Files
- SD Protocol Compatible
- Supports SPI Mode
- 2.7V to 3.6V Supply Voltage
- 10uA Output Leakage Current



MP3 DECODER

	STA013	VS1053
Type	IC	dsp
Communication	I2C/SPI	I2C/SPI
Relevance	Over 10 years old	Less than 1 year
	Limited support network	Massive support Network

HEART RATE MONITOR



HEART RATE MONITOR

- High-Pass Filter:

- $f_c = \frac{100}{2\pi R_9 C_6} = \frac{100}{2\pi(10M\Omega)(0.22\mu F)} = 7.23\text{Hz}$

- $f_c = \frac{1}{2\pi R_{11} C_9} = \frac{1}{2\pi(100k\Omega)(0.22\mu F)} = 7.23\text{Hz}$

- Total Roll-off of 40dB/dec

- 6dB Attenuation at Corner Frequency

HEART RATE MONITOR

- Low-Pass Filter

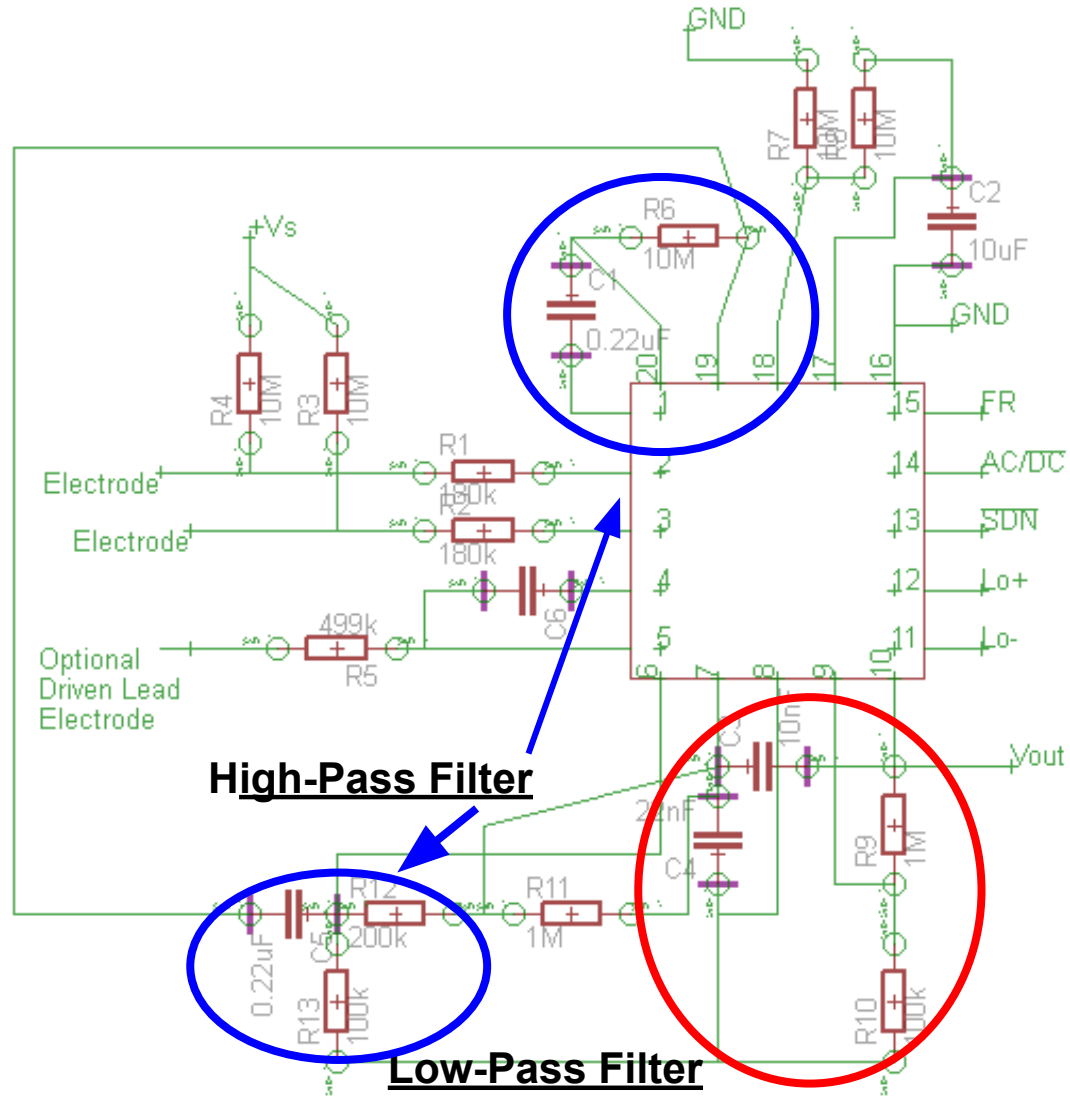
- $f_c = \frac{1}{2\pi\sqrt{R_{18}C_{14}R_{17}C_7}} = \frac{1}{2\pi\sqrt{(1M\Omega)(22nF)(200k\Omega)(10nF)}} = 24\text{Hz}$

- $G = 1 + \frac{R_{12}}{R_{13}} = 1 + \frac{1M\Omega}{100k\Omega} = 11$

- $R_{12} + R_{13} = 1.1M\Omega > 50k\Omega$

- Saves Power

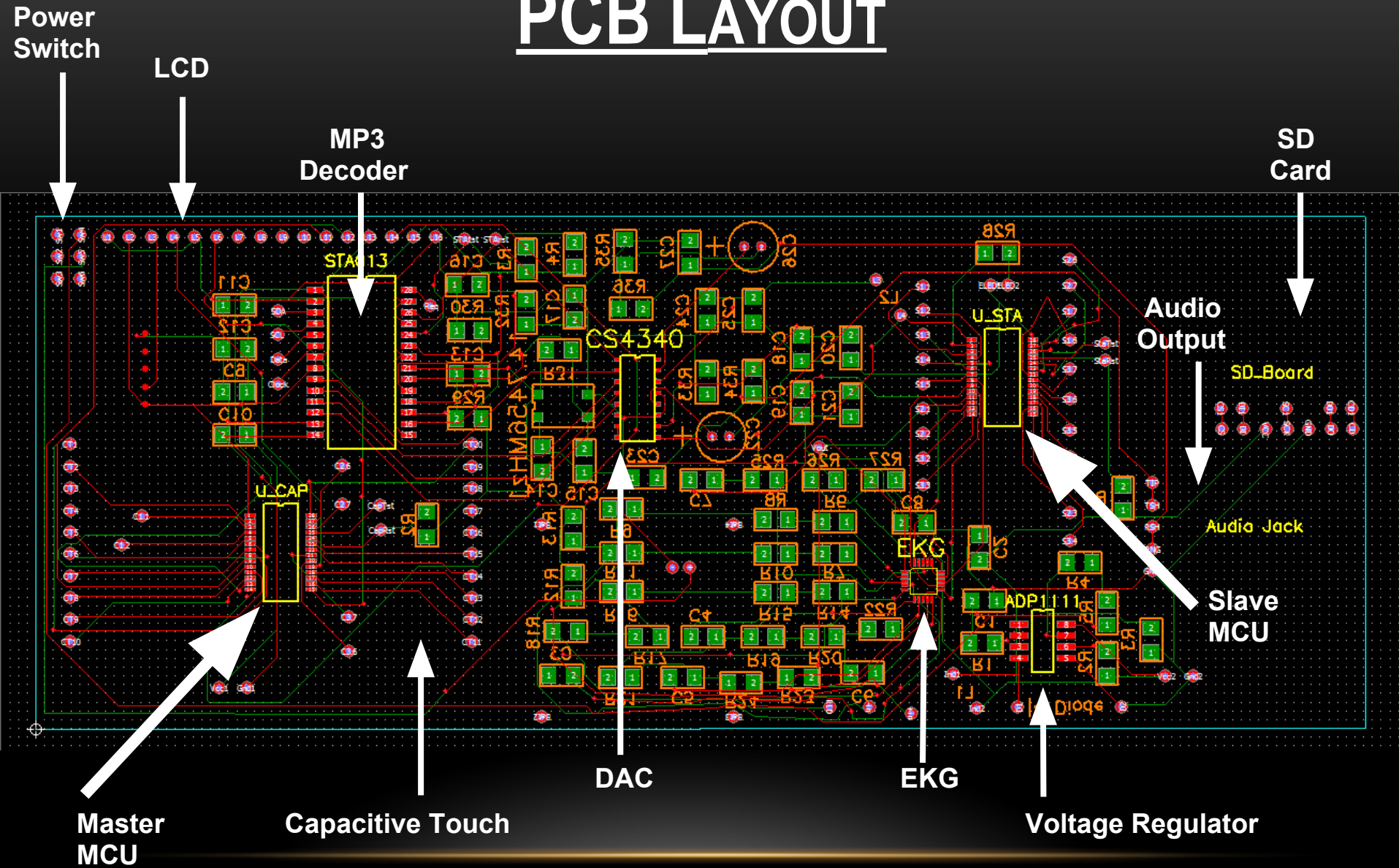
HEART RATE MONITOR



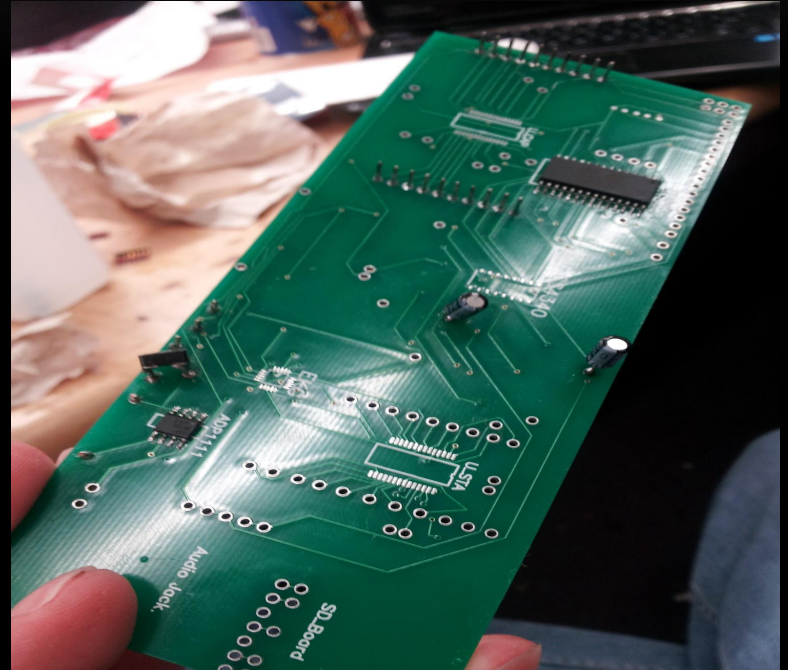
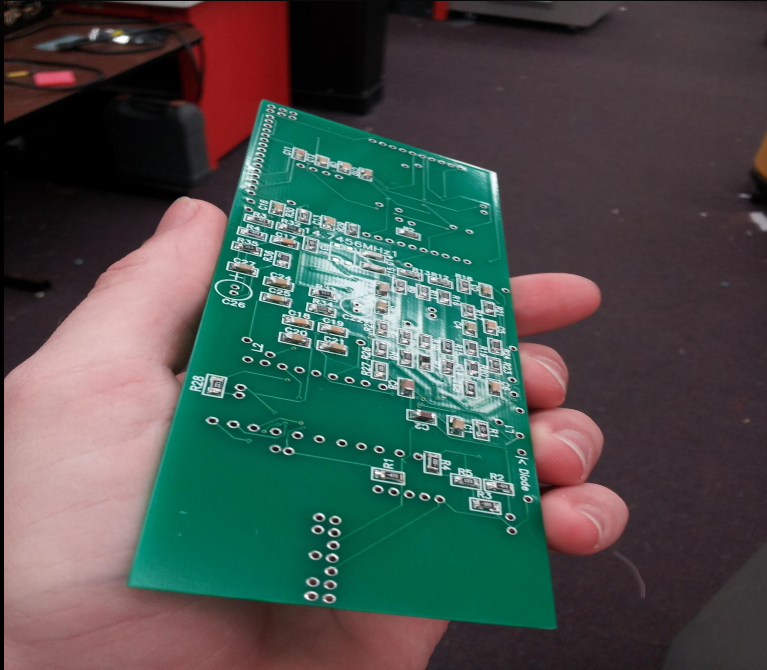
BRINGING IT TOGETHER

- Place All Components on Single Printed Circuit Board
 - Circuit Board Should Be Small In Size
 - Utilizing Front and Back of PCB Will Allow More Components
-

PCB LAYOUT



PCB



DISTRIBUTION OF WORK

	Adam	Brian	Neil
EKG	X		
Power Supply	X		
PCB Design	X		
Display		X	
Controls		X	X
Audio Decoding		X	X
SD Memory			X

PROGRESS

- Menu Navigation
 - via Capacitive Touch Controls
 - EKG Reading
 - SD Card Access
 - Read From
 - Write To
 - Open Directory
 - LCD Display
-

PROBLEMS

- Incompatibility of the STA013 with the MSP430
 - Solution change slave to ATmega328 and decoder to VS1053
- Not Enough Power to the EKG
 - Solution: Separate Battery for the EKG sensor.
- Miscalculation of PCB size.

BUDGET

Product					
Part		Price			
MSP430G2452	Samples	\$0		Eval boards	
MSP430G2553	Samples	\$0		TI LaunchPad	Free \$0
Audio Jack		\$2		Capaticve Touch	Free \$0
Leads		\$6		Audio Booster Pack	\$35
LCD Display		\$8		Arduino Uno	\$30
Heart Rate Sensor		\$8		AD8232	\$50
opamps		\$9		Dev Cost	\$115
SD card		\$10			
SD card reader		\$10		Grand total	\$523
Battery		\$25		Initial Budget	\$350
PCB		\$240		Over/Under	\$173
Product cost		\$318		Person Overage	\$57.67
Misc					
capactiors		\$5			
resistor		\$10			
Breadboard		\$15			
wire		\$30			
Solder		\$30			
Misc Cost		\$90			

CLOSING

- Overall Design
- Approach & Implementation
- Demo Date Reschedule - 7/31

QUESTIONS

