ECG

[Electrocardiogram]

Senior Design 2 CDR

Group 12

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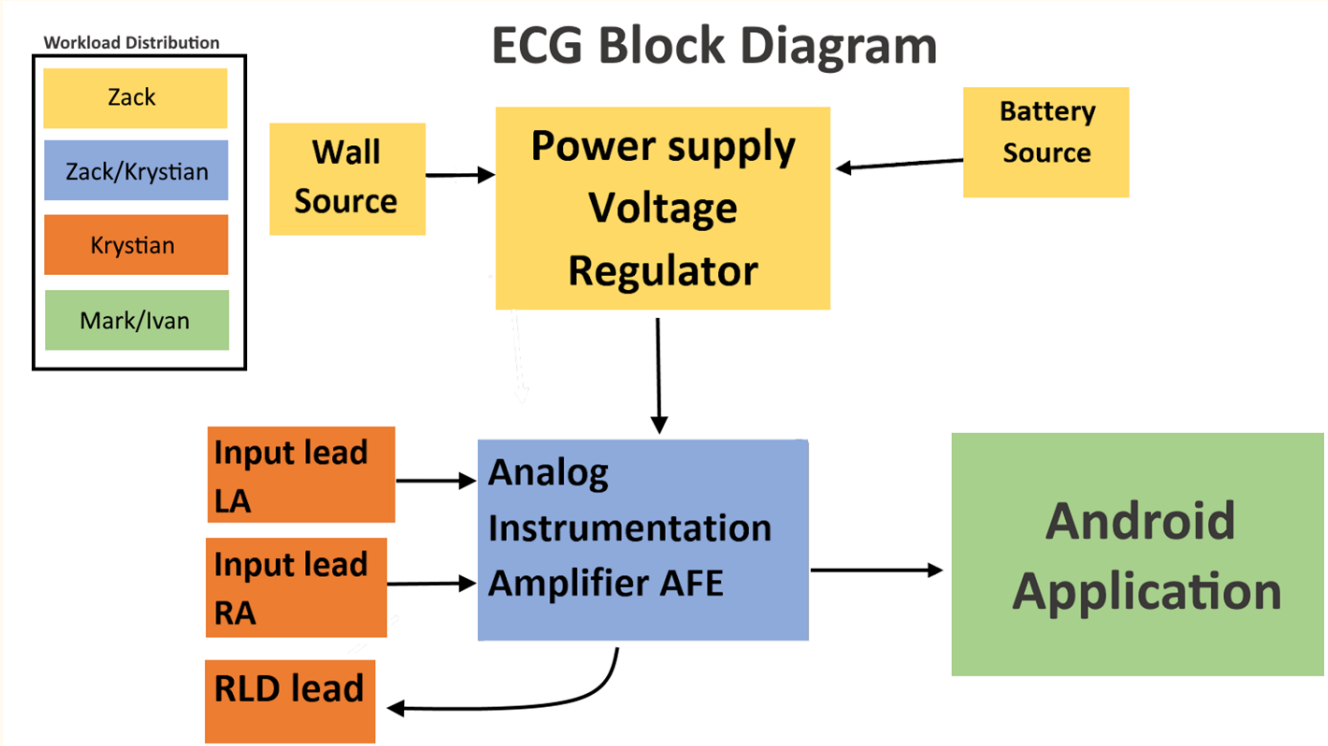
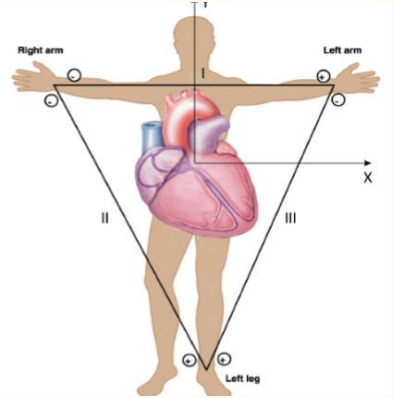

ECG Block Diagram
Workload Distribution
Zack
Zack/Krystian
Krystian
Mark/Ivan
Wall Source
Power supply Voltage Regulator
Battery Source
Input lead LA
Input lead RA
RLD lead
Analog Instrumentation Amplifier AFE
Android Application

Motivation

- Producing the prototype of a useful product.
- Applying our knowledge from courses that we have taken.
- Practice teamwork in a project that requires members with different knowledge backgrounds.

ECG Introduction

- An ECG/EKG is the medical instrument that can measure the heart activity and convert it into an analog signal which can be recorded on paper or digitized on an LCD screen.
- ECGs work by detecting and amplifying the tiny voltage changes on the skin that are caused when the electrical signal in the heart muscle is charged and spread during each heartbeat.



ECG Introduction

- Once the signal is amplified and filtered, it gets passed into an ADC so it can be sampled and displayed on an LCD screen using a microprocessor.
- Making an ECG is an appropriate idea for senior design because it utilizes a lot of the knowledge learned from previous classes.

Project Goals and Specifications

- Our goal is to design a portable ECG to be used for educational purposes.
- We will construct a single lead ECG system primarily used for basic heart monitoring.
- A few features we might implement are arrhythmia checking, pulse measuring, lead off detection and pacemaker detection.

Realistic Design Constraints

- The success of our project relies on finding the best balance between time and cost, always while maintaining a high level of safety and risk.

- Given the tight time constraints, experience of our group, and how mature the market is for ECGs, our device is purely for educational purposes and should not be mistaken for a credible medical device for diagnosing actual heart problems.

Difficulties

- In researching the ECG AFE we came across several unique designs that each had its own pros and cons.

- The coronavirus pandemic was a massive difficulty that we are still overcoming. It has prevented us from accessing the senior design lab at UCF, receiving our packages on time, and collaborating with each other in person.

Difficulties

Wireless Transceivers:

- There are many different versions and types, all with different protocol standards that aren't very versatile. Most modules work uniquely to specific projects. Some modules have plenty of documentation while others, which so happen to be relevant to our project, have very little documentation.

Software:

- There are plenty of coding languages out there and one of the challenges is that we had to teach ourselves particular coding languages from the ground up. Being electrical engineers, we aren't exposed to Java or Kotlin in within our major.

Successes

- We managed to get a heart pulse to display on the oscilloscope using our homemade analog front end.

- We decided on the programming language and the components so it can all work together on a single board. Several extensions and peripherals are also being considered like the aux port in order to utilize more software solutions than hardware solutions.

Initial approach

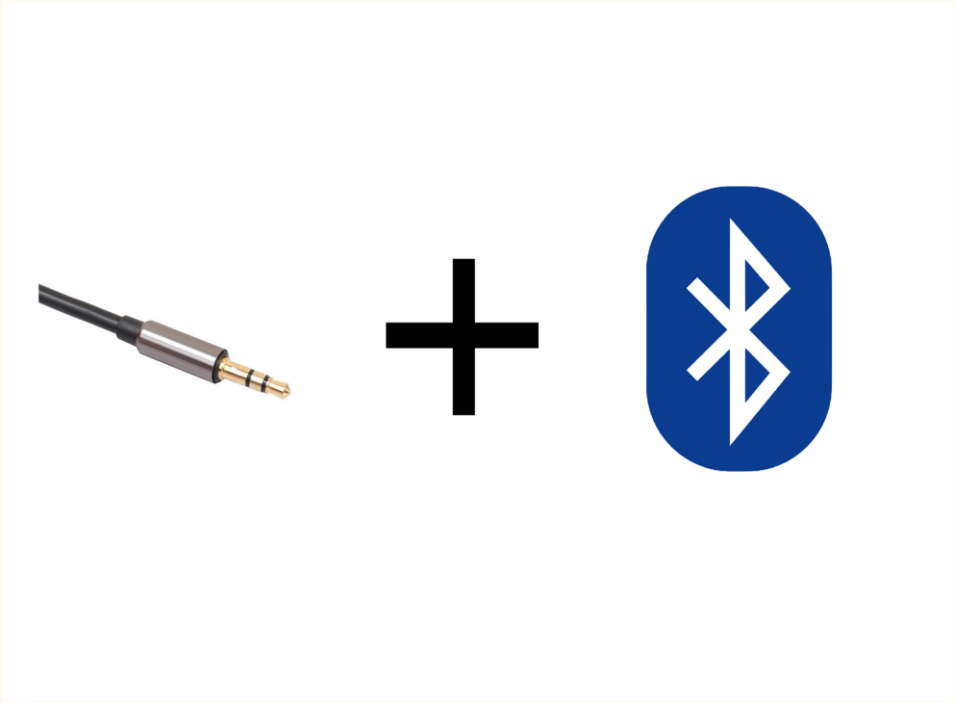
- LCD display with built-in Operating System.

Improved design

- Changing the output method: Using android mobile devices as our ECG displays.

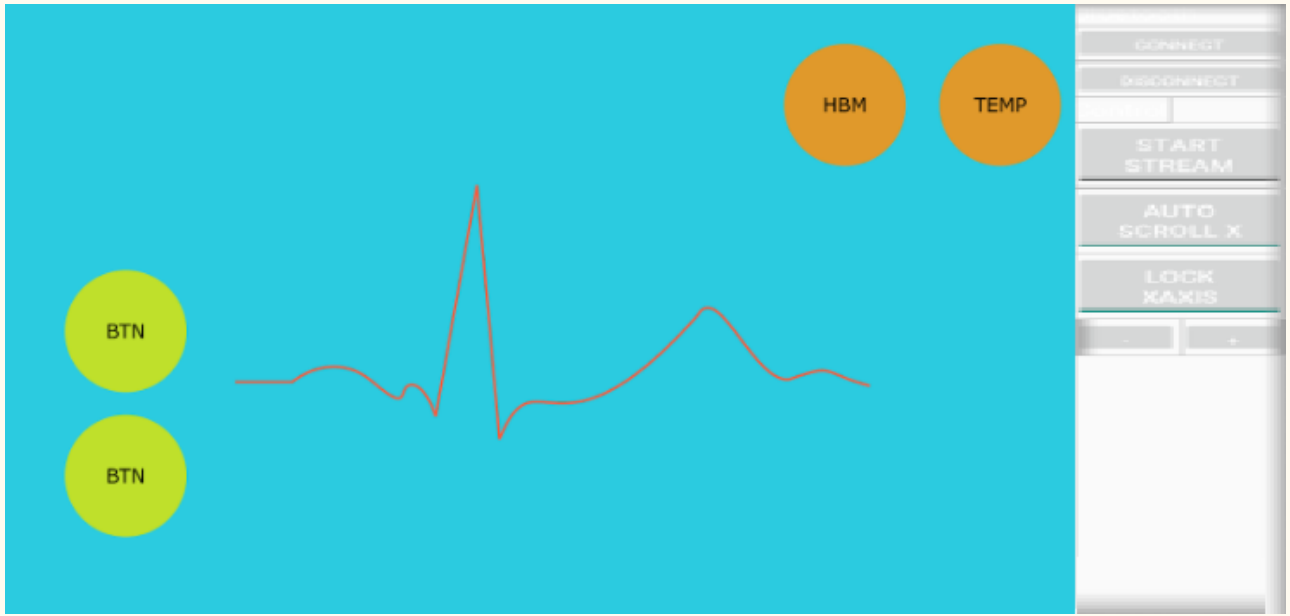
Improved design

- Adding more interfaces: add Bluetooth connection as another method for our prototype to interact with the display instead of directly wired only.



Improved design

- Using Mobile App for our ECG display:



Regulations for medical equipment

These regulations recognize standards fully or partially, if they specify and publicize their intent.

The purpose of these regulations is to ensure the harmonized standards of medical devices.

Medical product compliances are established by government recognized standards.

Standards that are applied in our design

- Professional standards.
- Standards for power supplies.

  IEEE Std 3001.2-2017

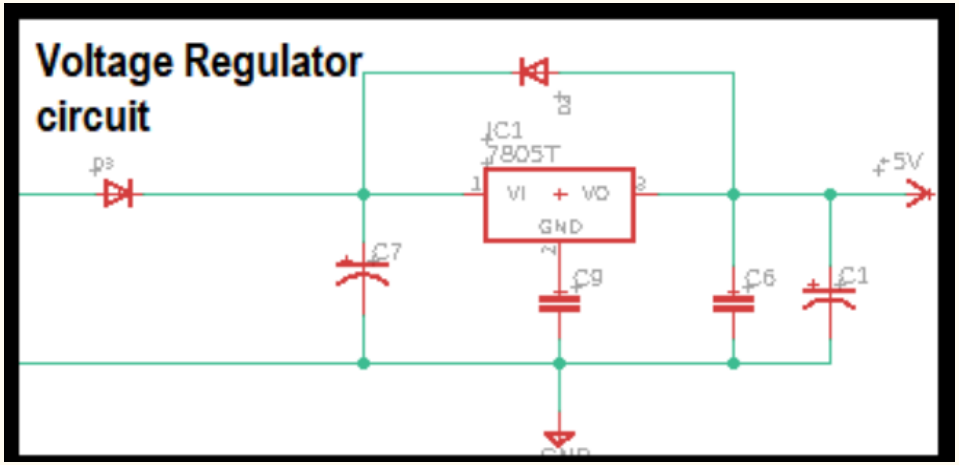
  ANSI Standard C18.2M for battery

- Standards for safety procedures in testing.
- Personal health device standards.

Hardware components

Power System

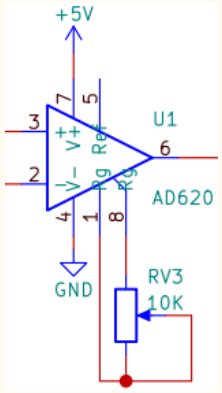
- ECG will be powered by a 9V lithium ion rechargeable battery
- The 9 volts from the battery is then regulated to 5 volts to properly power the components of the hardware



Analog Front End

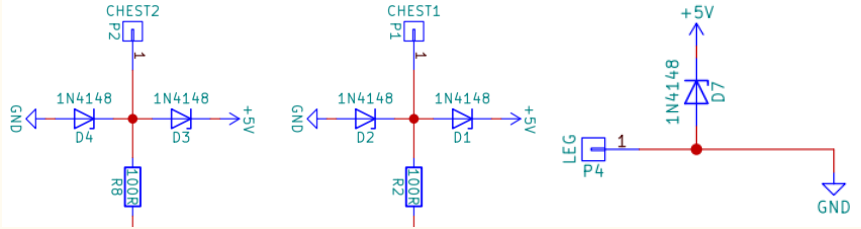
Instrumentation Amplifier:

We used an AD620 to take the difference between two voltages on the patient while removing common mode noise.



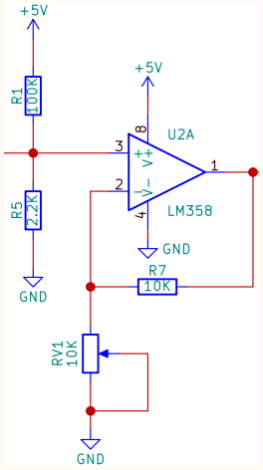
ECG Leads and Protection:

We used zener diodes in reverse bias orientation to protect the user from dangerous amperage.



Amplification:

We used an LM358 amplifier to amplify the small signal from the instrumentation amplifier. This was fine tuned using a 10k potentiometer.



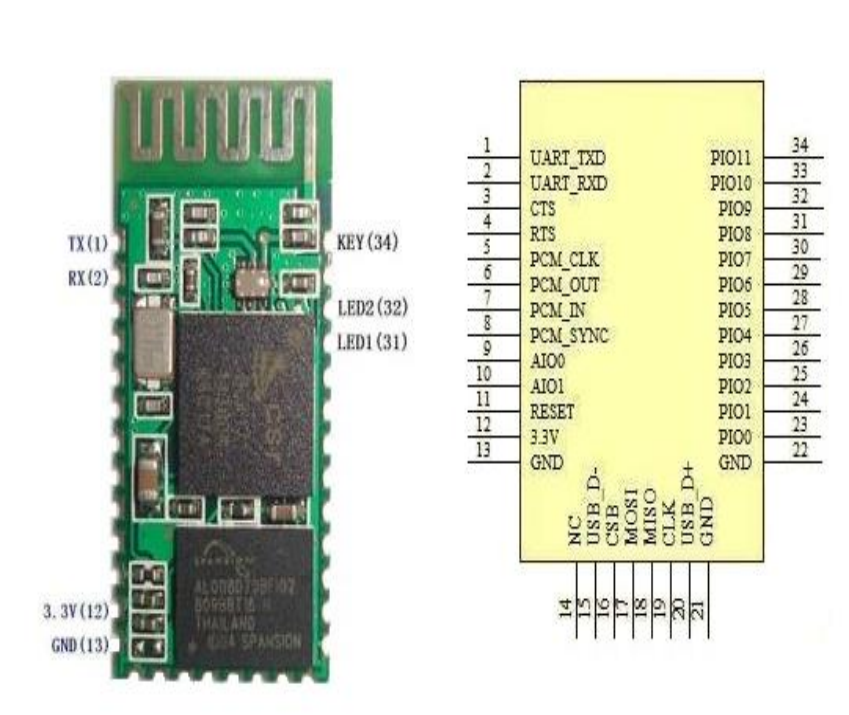
Wireless Transceivers

			
Model	**HC - 06**	**ESP - 8266**	**ESP - 32**
Price	$6.00	$7.00	$12.00
Temperature	-40°C to 125°C	-40°C to 125°C	-40°C to 125°C
Bluetooth	BT 2.0 Comm. Classic	X	BT 4.2 and BLE
SPI/I2C/I2S/UART	UART	2 / 1 / 2 / 2	4 / 2 / 2 / 2
Voltage	(3.1V~4.2V)	(3.0V~3.6V)	(2.2V~3.6V)
Band	2.40GHz—2.48GHz, ISM	2.40GHz	2.40GHz
Receiver Sensitivity	-85dBm	-91 dBm	-94 dBm

UART Through Bluetooth

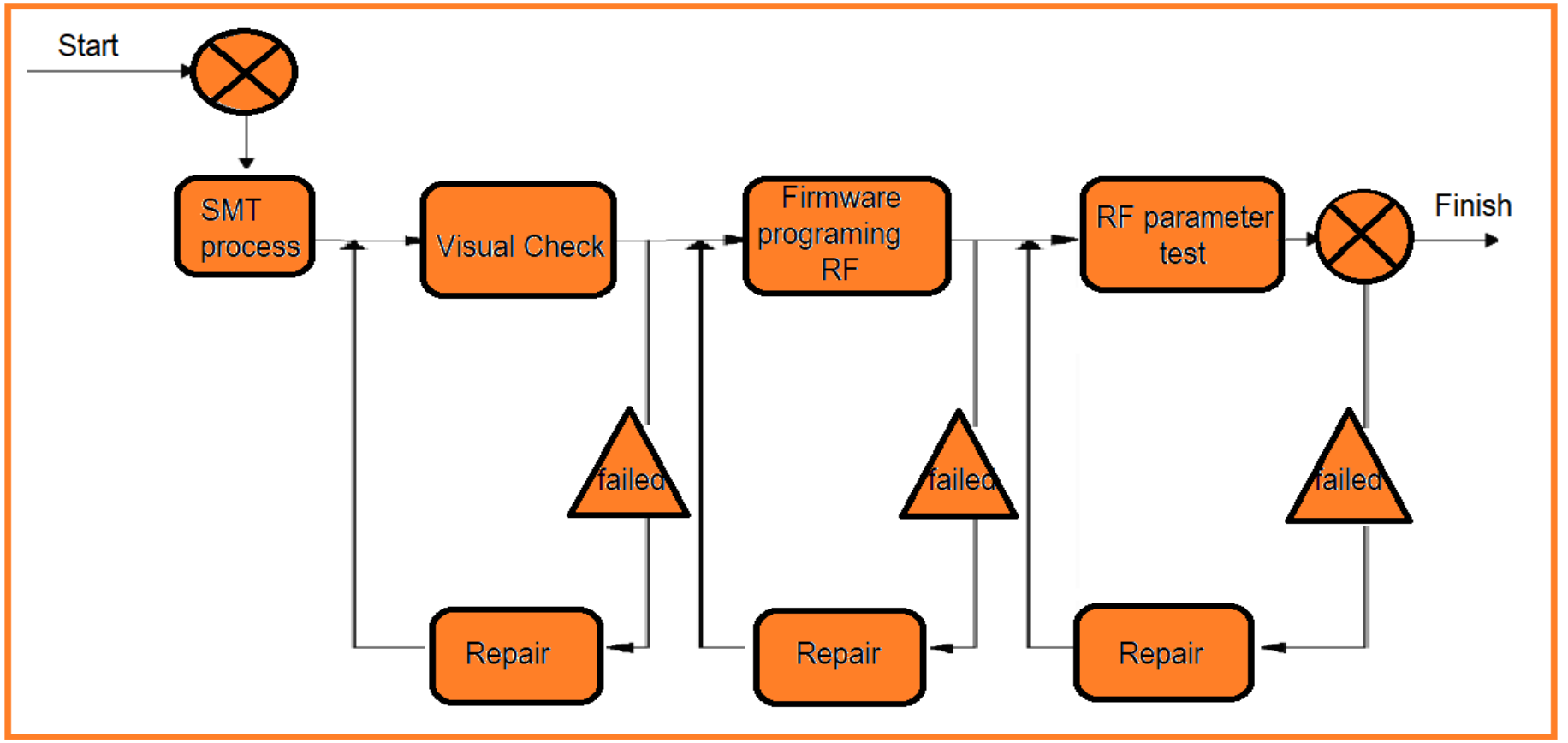
- Asynchronous.
- high speed
- RX, TX.
- Programmable setting alternatives
- Parity : Odd, Even None, Mark, Space
- Data : 7 & 8
- Baud Rate : 300, 1200, 2400 ,4800 ,9600, 19.2k...

Transceiver Adopted HC-06

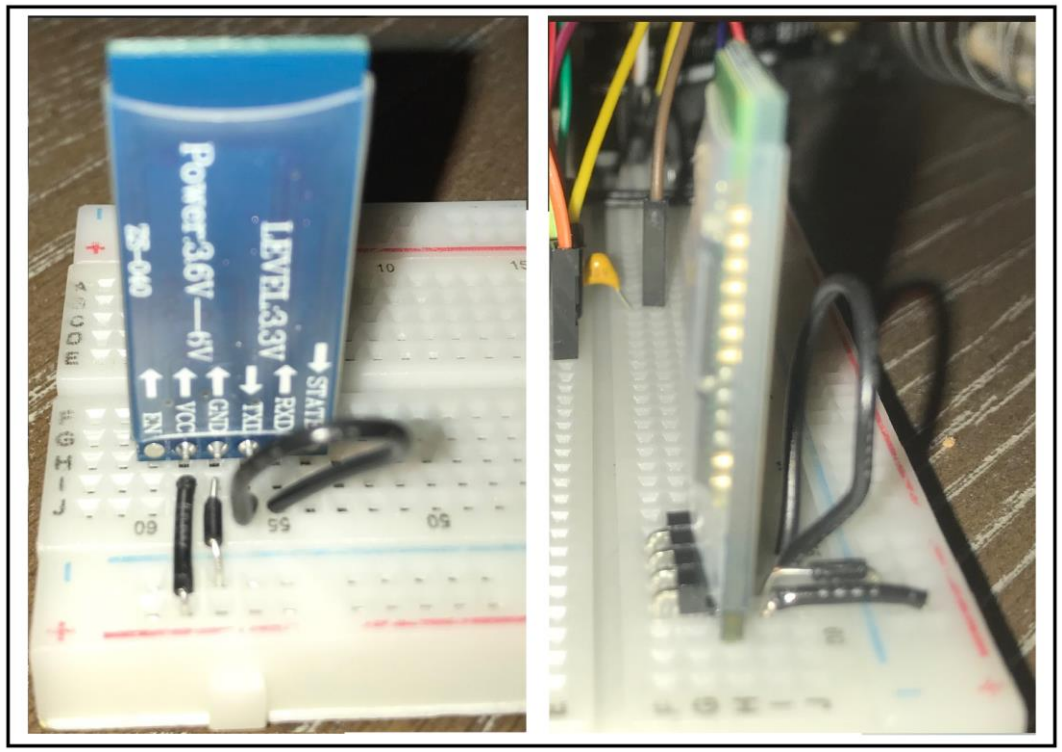


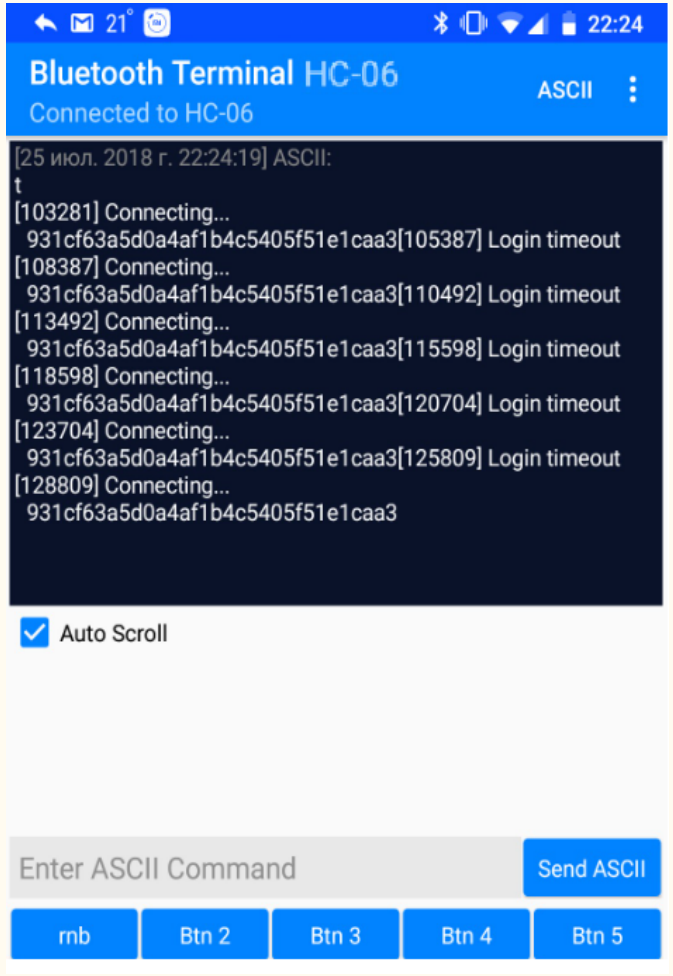
- The Bluetooth module HC-06 engineered for establishing short range wireless data communication between two systems.
- Contains full duplex transmission with hardware UART and analog UART.
- This setup is most inexpensive and more versatile methods for wireless data transmission with speeds up to 2.1Mb/s using Bluetooth 2.0 communication protocol acting as a Slave device.

HC-06 Flowchart Testing



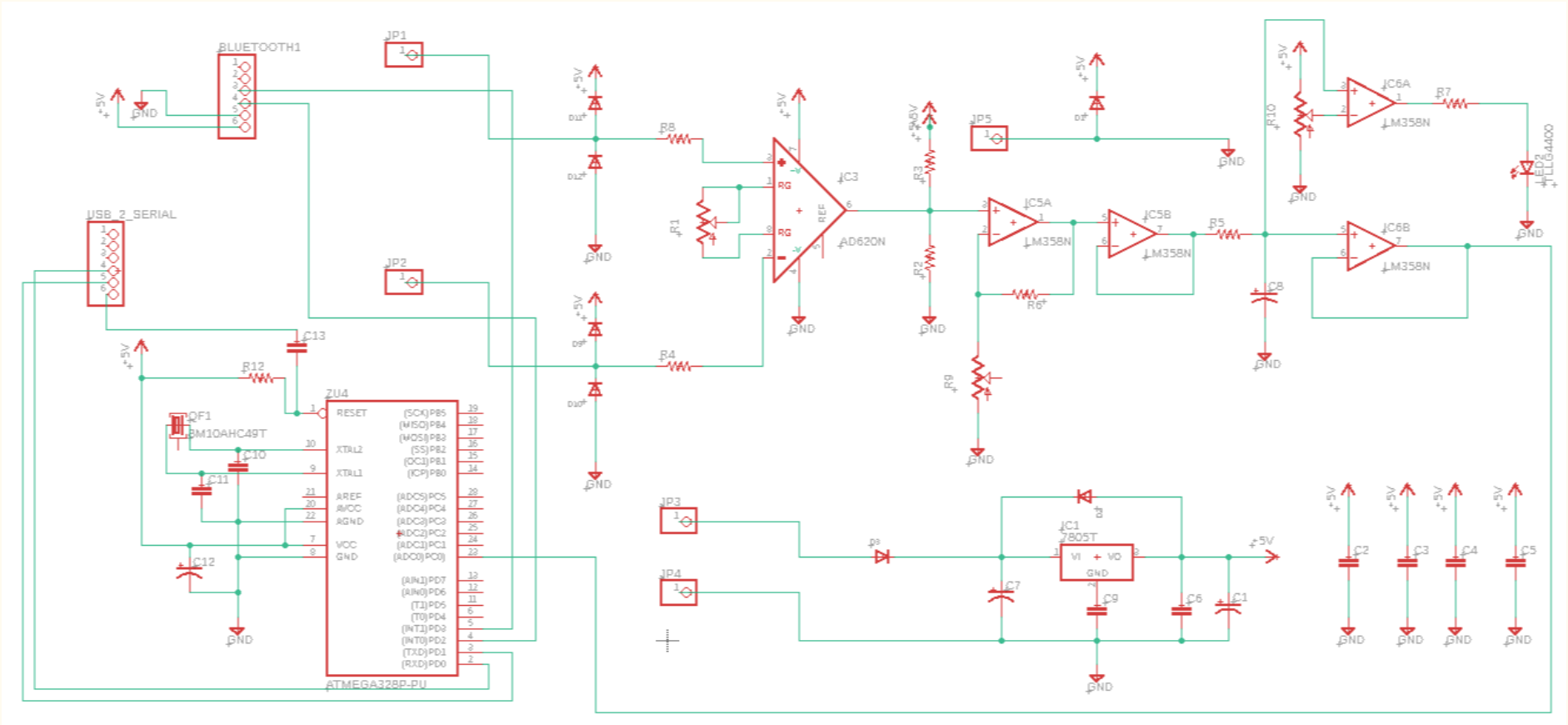
HC-06 Testing

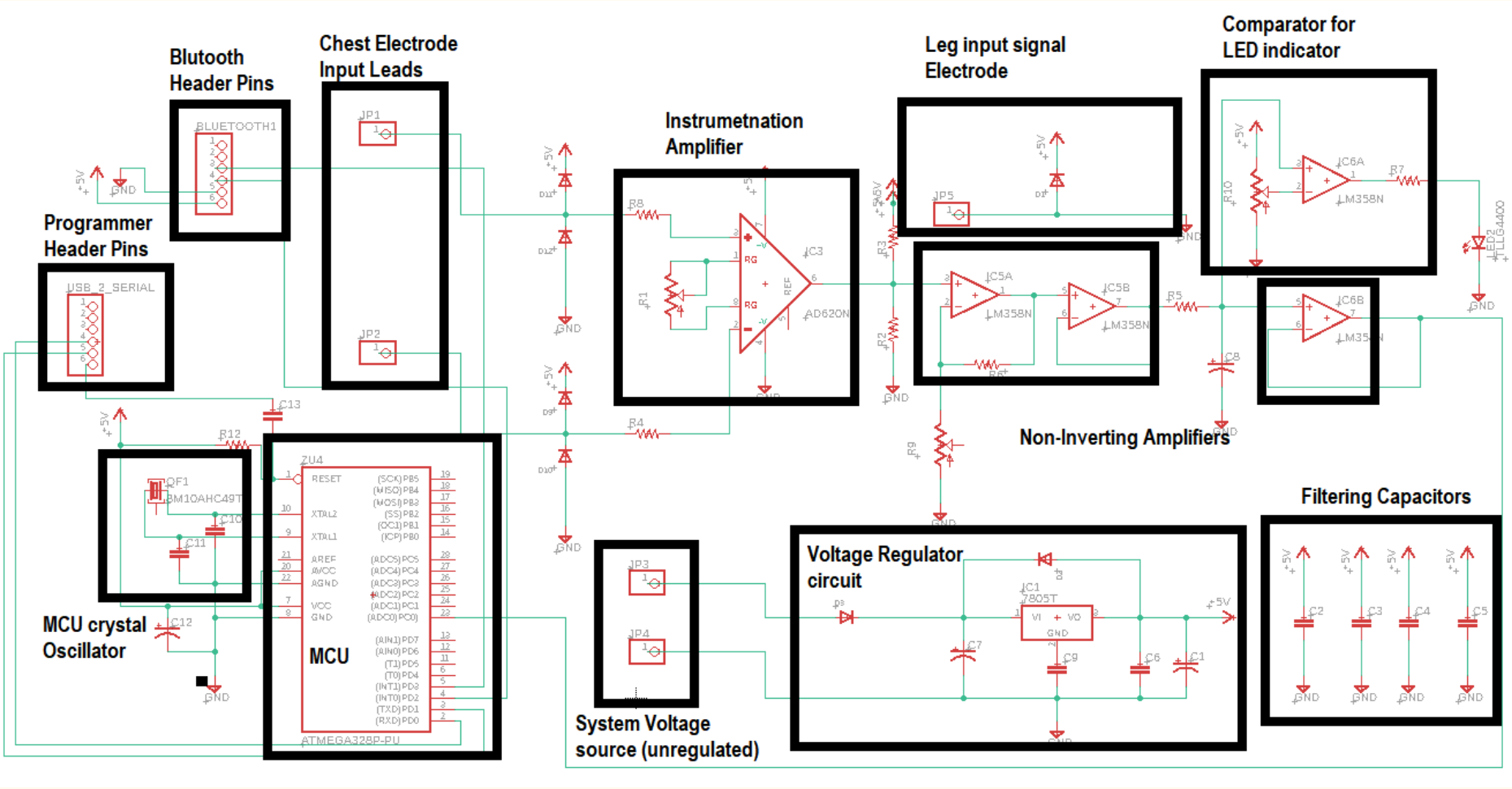




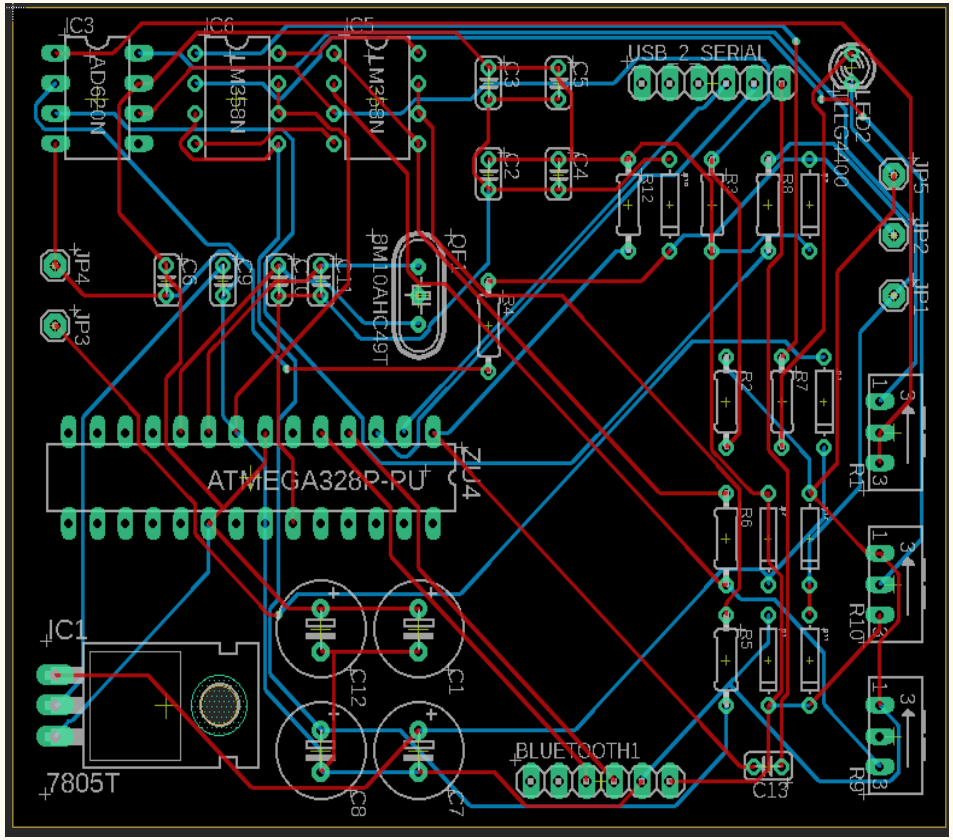
Eagle Schematic
&
Board Design

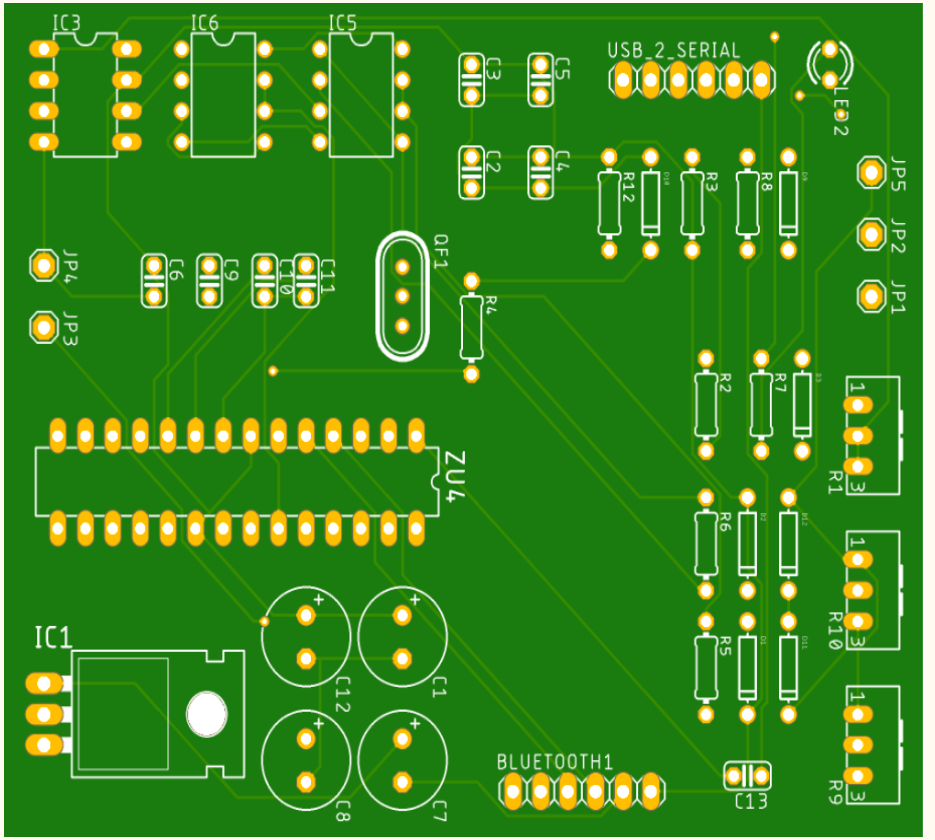
ECG Schematic Design




Blutooth
Header Pins
Chest Electrode
Input Leads
Instrumetnation
Amplifier
Leg input signal
Electrode
Comparator for
LED indicator
Programmer
Header Pins
Non-Inverting Amplifiers
Filtering Capacitors
MCU crystal
Oscillator
MCU
System Voltage
source (unregulated)
Voltage Regulator
circuit
BLUETOOTH1
USB_2_SERIAL
JP1
JP2
JP3
JP4
JP5
AD620N
LM358N
7805T
ATMEGA328P-PU
GND
+5V

PCB Routing Completion

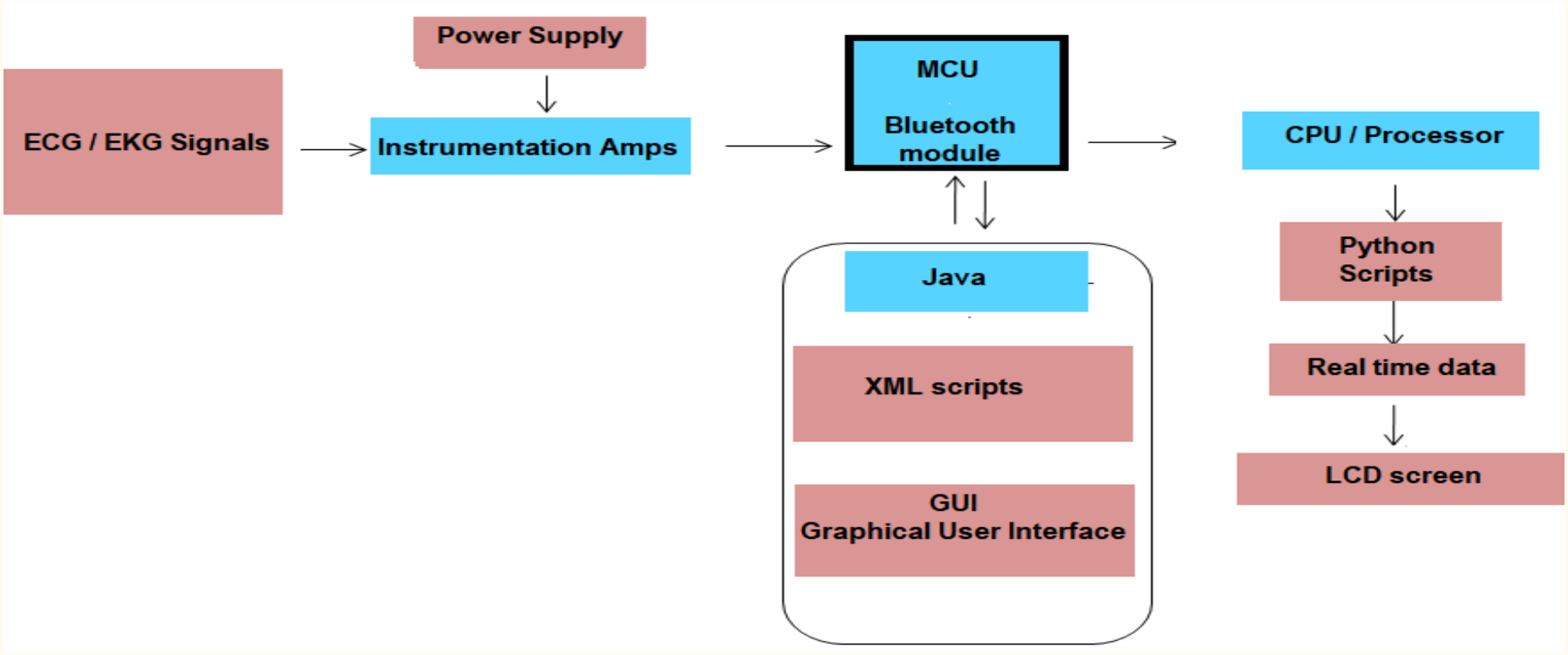




Software
&
GUI

(Graphical User Interface)

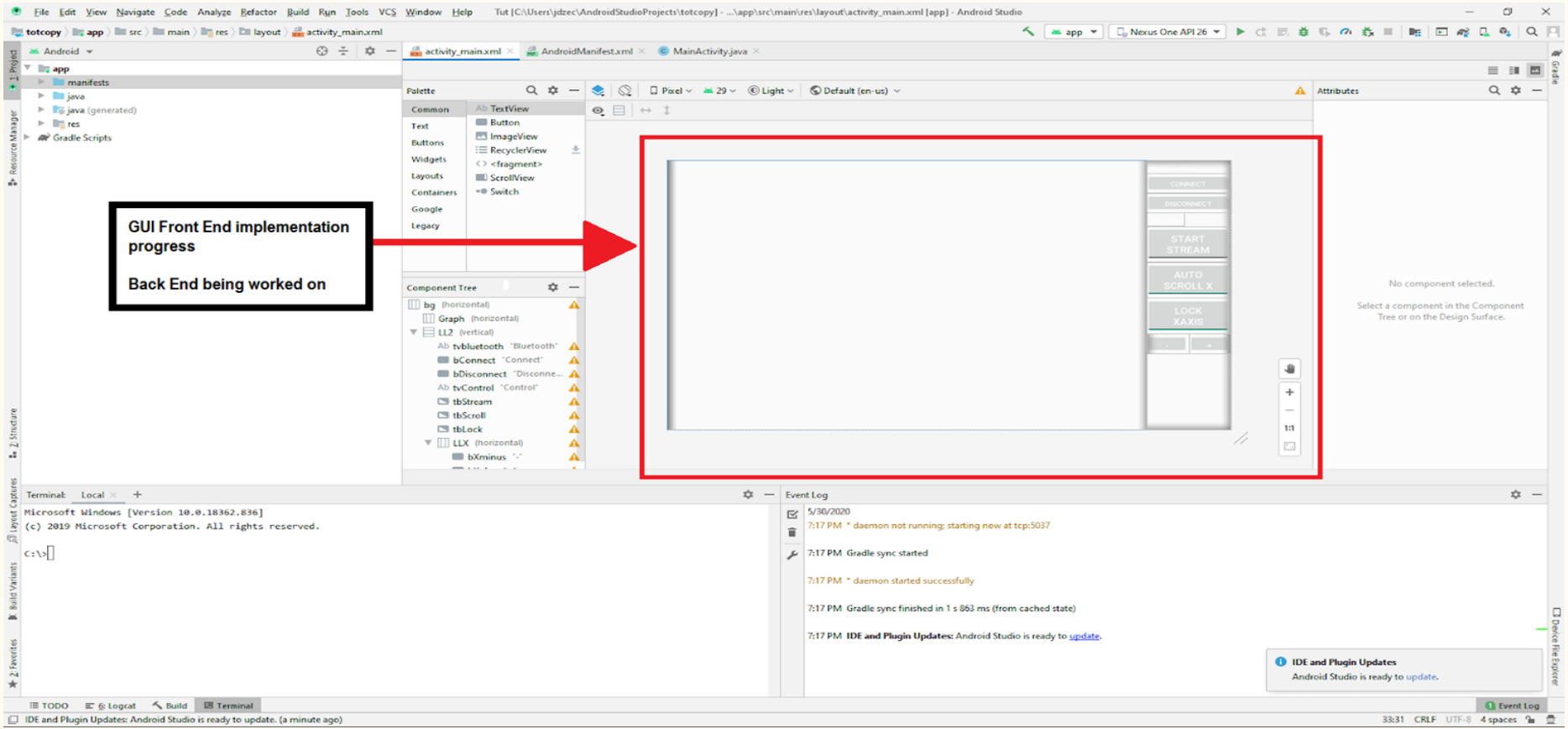
Software Block Diagram



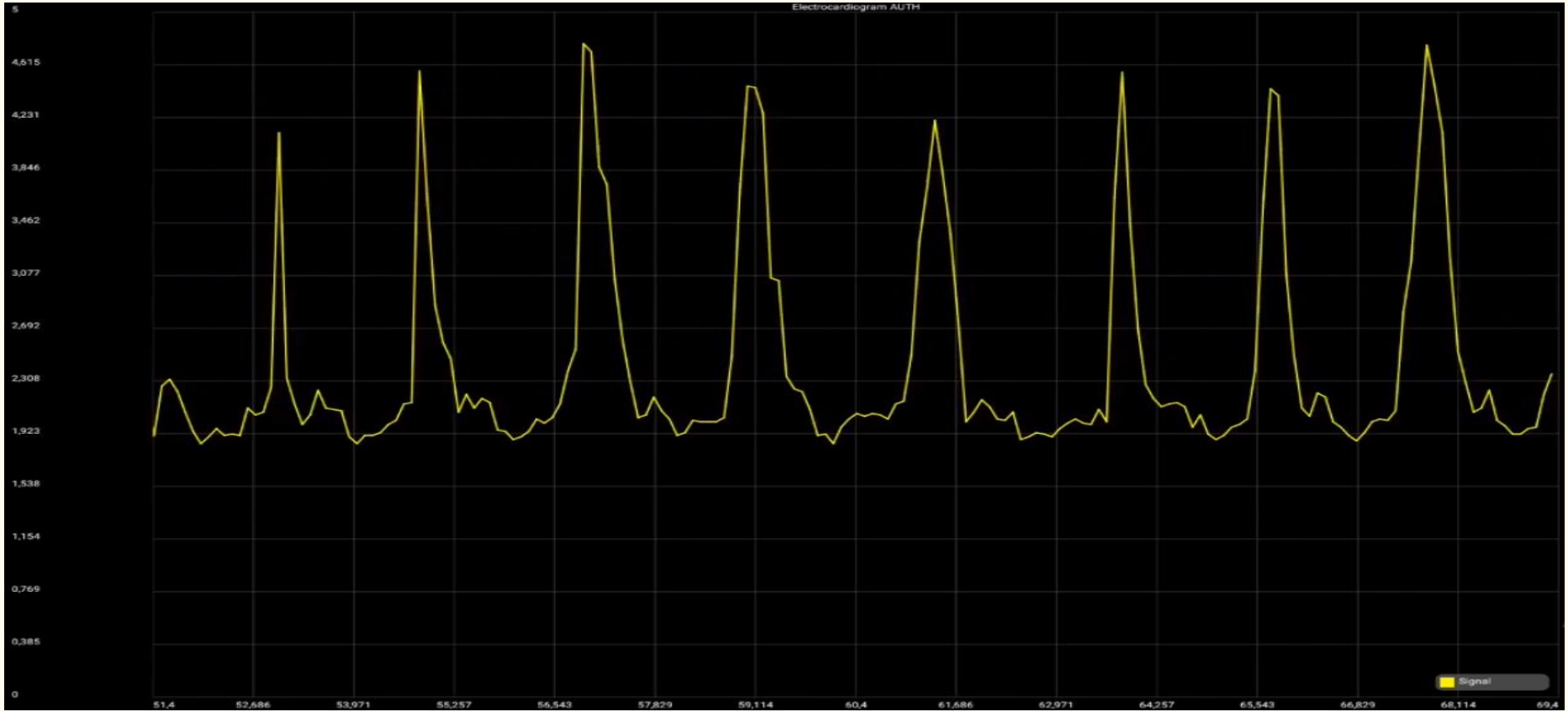
Smart Phone Application

- Android Studio is an excellent IDE choice for our Android App development.
- Android Studio is free and also very easy to use.
- It has a built in graphical preview of every component while the App is being developed.
- The IDE is supported in many major computer OS such as Windows, Mac, and Linux
- Open source

“Android Studio” GUI Design Progress



“Android Studio” Waveform Expectation



Computer Applications

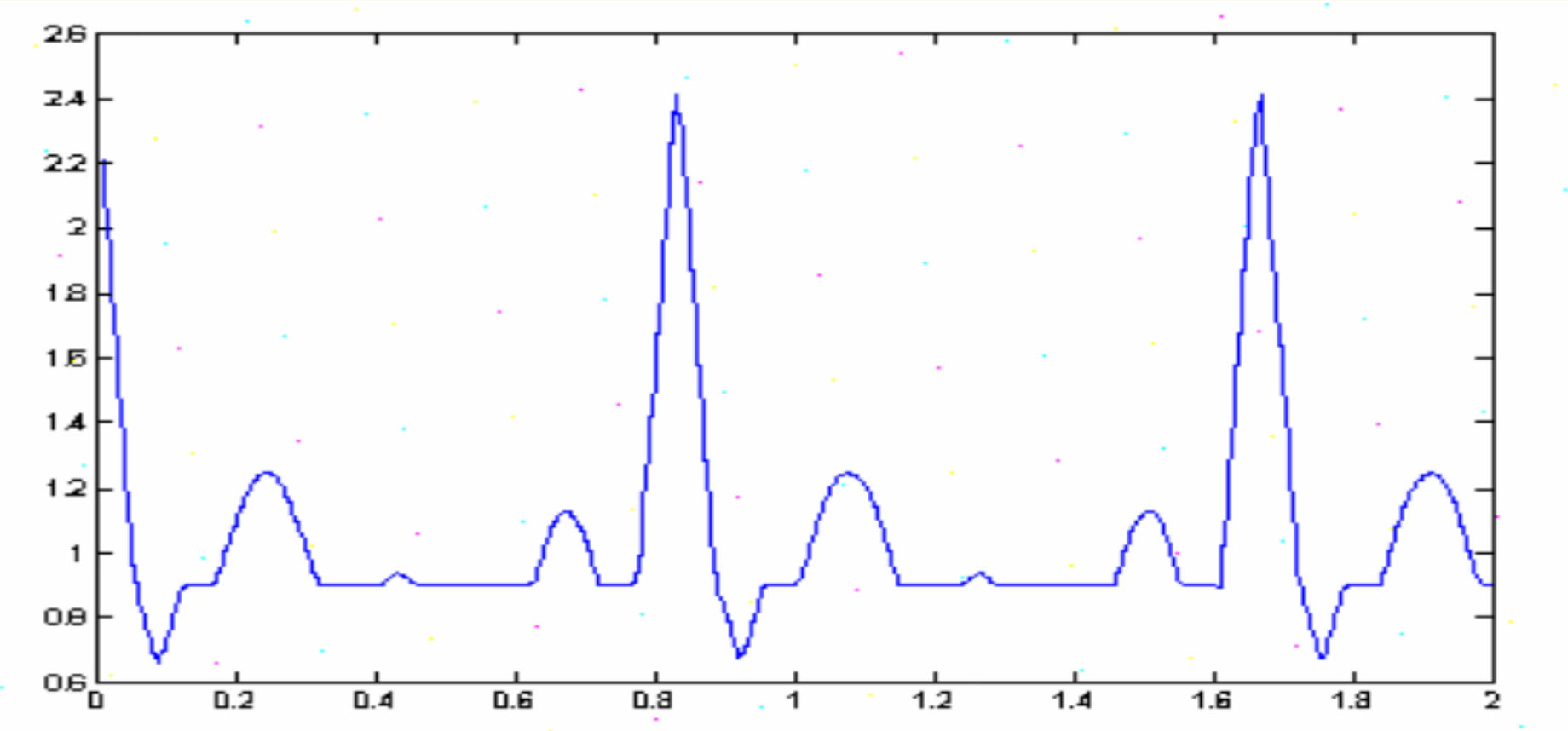
MATLAB

- MATLAB can allow for the data to be easily processed in real time where it becomes a huge advantage for stock chart trends and heart pulses.
- MATLAB can also develop trends using Fourier Series using simulink by which that differentiates from other software platforms for gathering data.

Command Prompt using WinPython

- Agile and Real Time
- This implementation is one that saves time and another one is removing the difficulties of taking real ECG signals with invasive and noninvasive methods.

Computer Waveform Expectation



Administrative content

Work distribution

	Zack	Krystian	Mark	Ivan
AFE	XX	X		
Power system	X	XX		
Software			X	XX
Analog cord (Aux) / Wireless Transceiver			XX	X

X = Primary task
XX = Secondary task

Budget

AD620ANZ-ND - $11.26000+$18.99 shipping+$0.74 tax = $30.99

Sensor Cable - Electrodes $4.95+$12.50 shipping=$17.45

Texas Instruments LM358N $9.97+$10.00 shipping+$1.40 tax=$21.37

AD620 IA Voltage Amplifier Module $29.27

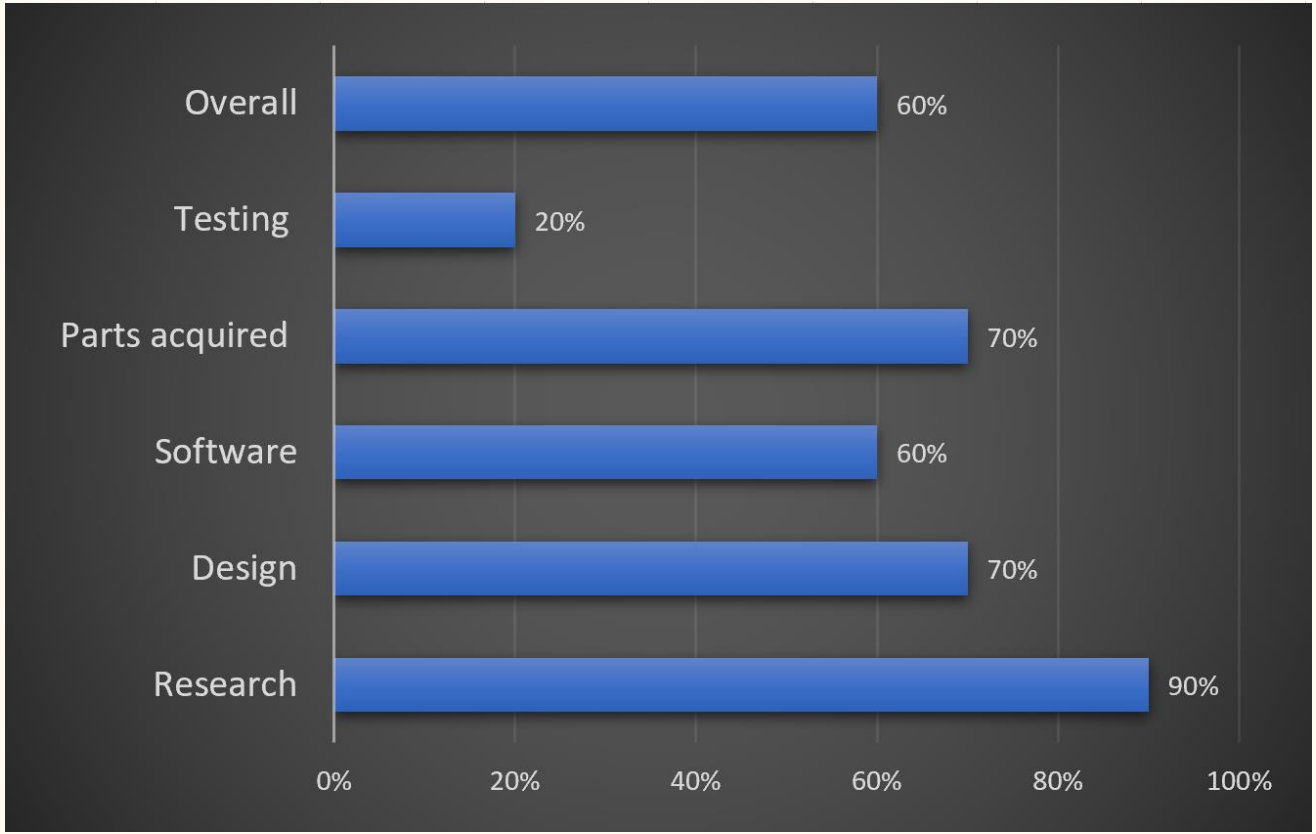
3.5mm Stereo Female port $7.59

Total: $106.67

Financing to date

- Without any sponsorship, we needed to fund our project on our own
- We decided to scale back some aspects of the hardware and include more software to save cost while still providing a senior design level project

Progress


Overall
60%
Testing
20%
Parts acquired
70%
Software
60%
Design
70%
Research
90%
0%
20%
40%
60%
80%
100%

Plans for completion

- Update PCB with battery charging circuit and then order PCB
- Continue testing analog front end while working on app development
- Research options on housing our ECG

Questions?