IR HUB
CRITICAL DESIGN REVIEW

By:
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Nathaniel Bradley
Jesus Castro
DEVELOPMENT TEAM:

• Jeremiah Prousalis:  
  • Project Lead  
  • Firmware Lead  
  • Bluetooth Module Interfacing

• Nathaniel Bradley:  
  • Hardware Lead  
  • Analog IR Design  
  • Power System Design

• Jesus Castro:  
  • Software Lead  
  • Android Application  
  • PCB Layout Lead
PRODUCT DESCRIPTION:

- IR Hub will feature an MCU connected to a Bluetooth Low Energy Module.
- The BLE Module will enable users to interact with the Hub via an accompanying Android app.
- An IR receiver will be used to read and store button codes from users’ remote controls.
- An array of IR LEDs will be arranged around the perimeter of the PCB allowing known button codes to be rebroadcast on command.
APPLICATION:

• **IR Hub** will solve the problem of cluttering your living room with one or more infrared remotes by turning your **phone** into a **universal remote**.

• The **IR sensor** will allow the Hub to act as a truly **universal** remote by enabling the device to **learn** the outputs of any remote control no matter how obscure the brand.

• This will all be housed in a domed casing intended to be mounted in a central location of a user’s room, and any IR signals transmitted provide **360° room coverage**.
CRITICAL ELEMENTS:

• Precise signal capturing
• Precise signal broadcasting
• Responsive handling of user input
PARTS:

- **Microprocessor**
  - LPC4088
    - 512kB Flash
      - persistent storage used for remote codes
    - 12 bit ADC
      - 400kHz Conversion Rate
    - PWM Capture Pin
    - 120MHz Clock
    - 2.4V-3.6V Supply Voltage
    - UART Interface
    - On-Board PWM
**SUB-SYSTEMS:**

- **Power**
  - Optional wall or battery power

- **Bluetooth**
  - Bluetooth Low Energy module allowing users to command Hub to either learn or transmit a remote code

- **IR Receiver**
  - Infrared phototransistor for reading raw signal from remotes

- **IR Transmitter**
  - 8 infrared LEDs arranged around the perimeter of the PCB

- **User Interface**
  - Android Application allowing users to create, organize, and activate buttons for various devices
POWER DISTRIBUTION:

- 9V input, regulated down to 3.3V to supply entire PCB
- Jumper to select between wall or battery power
  - Barrel Jack with 9V input on wall power
  - 9V battery on battery power
- 1 Analog and 1 Digital Power Plane
  - IR Receiver/Transmitter supply analog plane
  - Rest digital plane
PARTS:

- Bluetooth Module
  - Adafruit Bluefruit LE
    - UART interface at 9600 baud
    - HW flow control (CTRS, RTS)
    - Simple AT command set for configuration
    - 3.3V Supply Voltage
    - 20 mA peak current consumption
    - On-board ADC for battery read
  - Through hole female socket connectors for mounting module
PARTS:

- **IR I/O**
  - BPV22 IR Phototransistor
  - 8 TSAL6200 IR Emitters
    - 940nm wavelength
    - 1.35V
    - 100mA
ANDROID APPLICATION MOCKUP:
TECHNOLOGY REUSE:

• BLE Module
  • Existing Adafruit BLE Libraries for nRF51 based modules
  • Proprietary Nordic UART BLE connection profile
    • Nordic UART Service (UUID: 6E400001-B5A3-F393-E0A9-E50E24DCCA9E)
    • TX Characteristic (UUID: 6E400002-B5A3-F393-E0A9-E50E24DCCA9E)
    • RX Characteristic (UUID: 6E400003-B5A3-F393-E0A9-E50E24DCCA9E)

• LPCOpen
  • Open source libraries and code
FIRMWARE STRUCTURE:

• **Battery Read**
  • BLE module contains ADC and battery read AC Command
  • Periodic interrupt reads battery level
  • Red LED indicator blinks when battery is low
FIRMWARE STRUCTURE:

- **Learning Mode**
  - BLE command over UART bridge wakes MCU from idle state
  - Frame "0xF0" indicates learning mode
  - ID sent for addressing button in the future
  - Yellow LED indicates state change
  - Timeout timer started
  - IR Receiver interrupts enabled
  - PWM1_CAP0 reads in remote signal
  - Green LED indicates whether signal has been received
FIRMWARE STRUCTURE:

• **Store**
  • Input data is processed and compressed
  • Data is broken down into 3 key pieces of information:
    • Carrier Frequency
    • Pulse Duration
    • Code
  • Data is stored in flash, indexed according to ID previously provided by phone
FIRMWARE STRUCTURE:

- **Send**
  - BLE command over UART bridge wakes MCU from idle state
  - Frame "0xFF" indicates learning mode
  - ID indicates index of code to transmit
  - PWM0_1 configured to carrier frequency
  - Code is iterated through, bit by bit delaying by pulse duration each iteration

<table>
<thead>
<tr>
<th>Start</th>
<th>0xFF</th>
<th>&lt;ID&gt;</th>
<th>Stop</th>
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</thead>
</table>

## BILL OF MATERIALS:

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturer</th>
<th>Manuf Part #</th>
<th>Units per Board</th>
<th>Total Units</th>
<th>Unit Price</th>
<th>Total Price</th>
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**Total:** $239.45
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Questions?