Air Mouse

Wireless translation of hand gestures into two and three-dimensional mouse movements

Group 07

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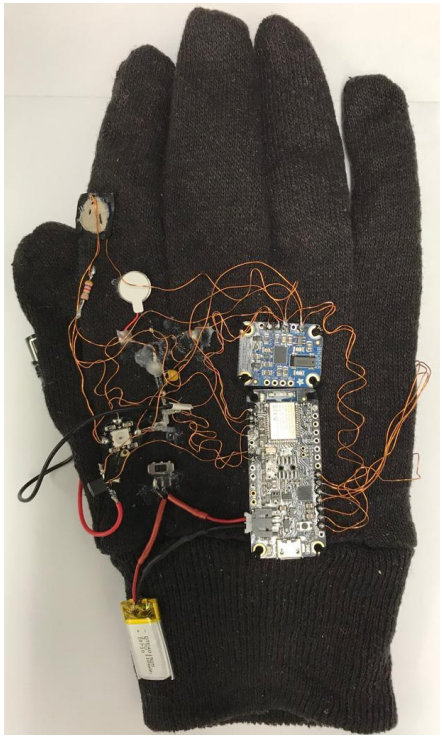
Topology

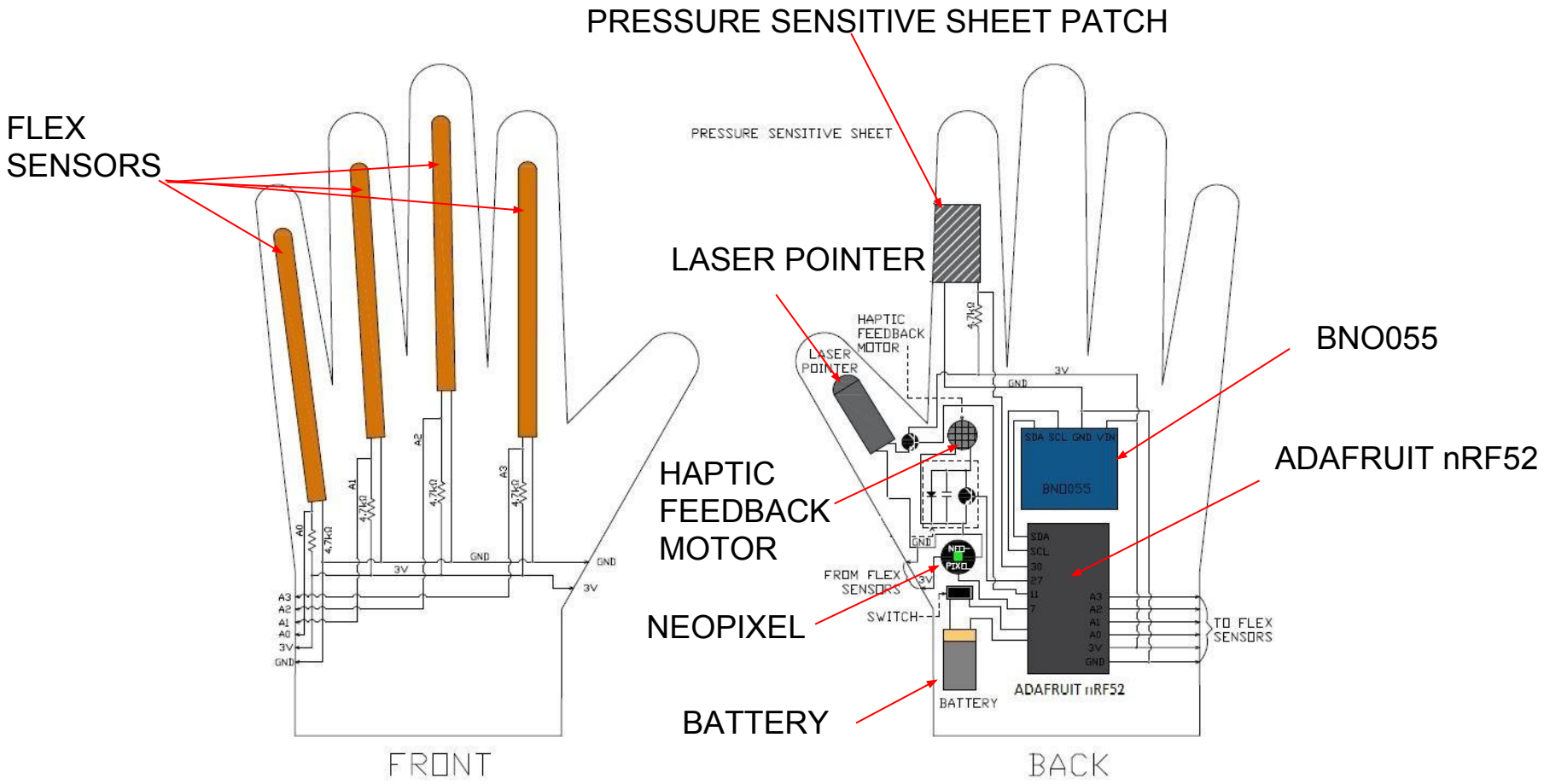
Front Side



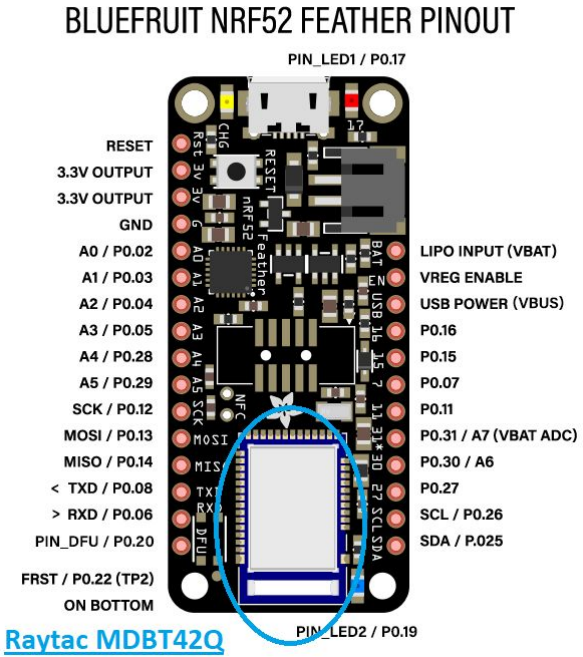
Back Side

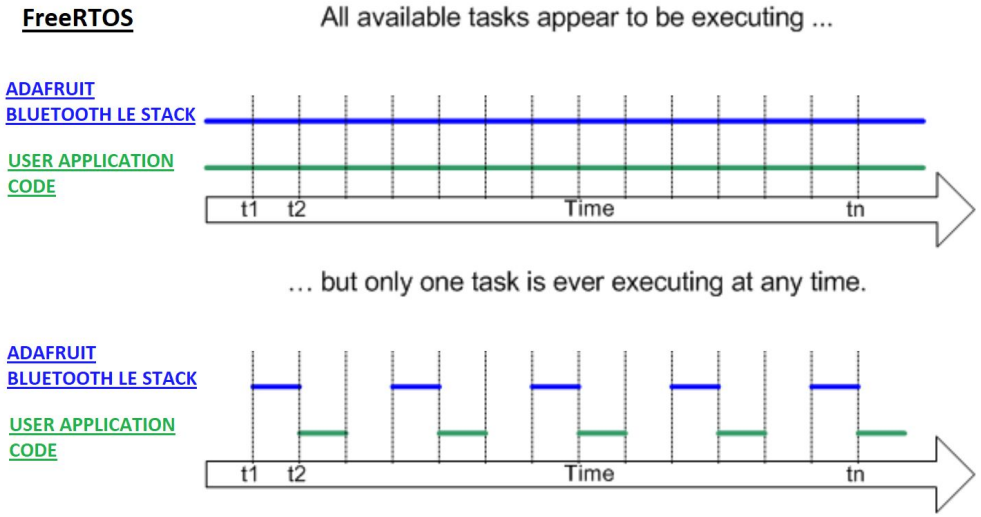
With Slip-on

Topology


PRESSURE SENSITIVE SHEET PATCH
FLEX SENSORS
PRESSURE SENSITIVE SHEET
LASER POINTER
HAPTIC FEEDBACK MOTOR
BNO055
ADAFRUIT nRF52
NEOPIXEL
BATTERY
FRONT
BACK
TO FLEX SENSORS
FROM FLEX SENSORS
SWITCH
ADAFRUIT nRF52
A0
A1
A2
A3
3V
GND
4.7kΩ

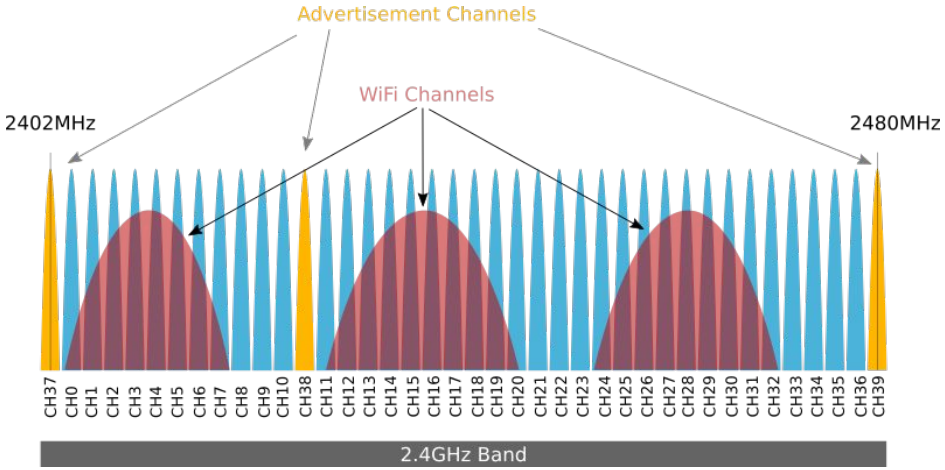
nRF52 and FreeRTOS



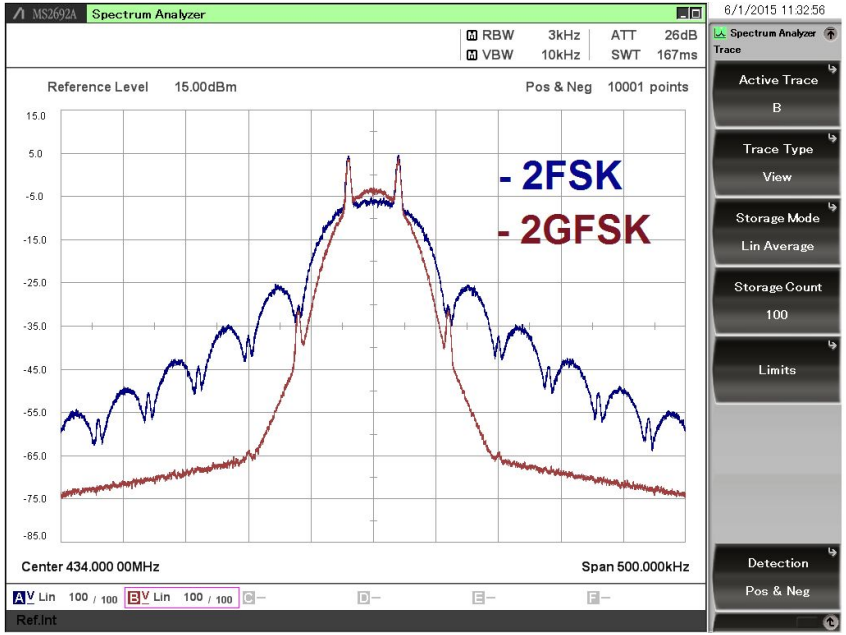


nRF52 uses FreeRTOS which allows Adafruit BLE Stack and User Code to run asynchronously at the same time

Bluetooth LE Frequency Channels and GFSK Modulation

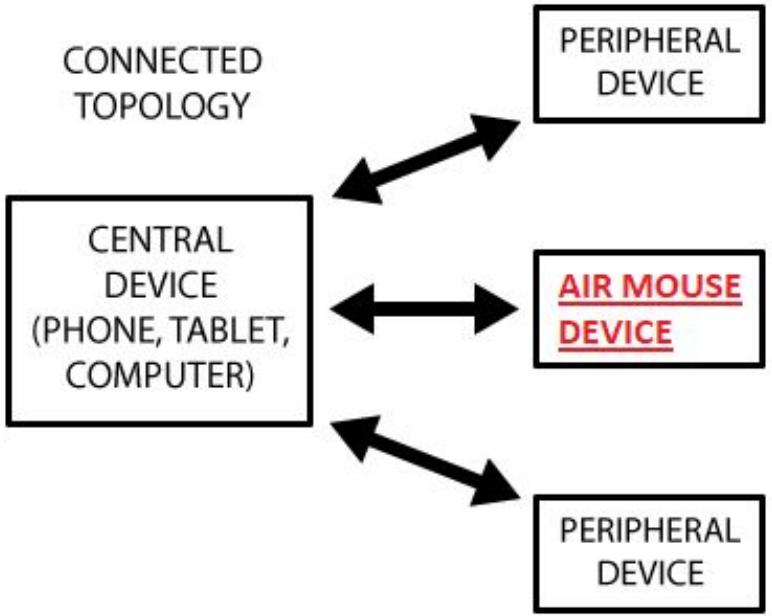


2.4 GHz Frequency Spectrum of Bluetooth LE Channels and IEEE 802.11 WiFi Channels



GFSK has lower sideband power compared to FSK

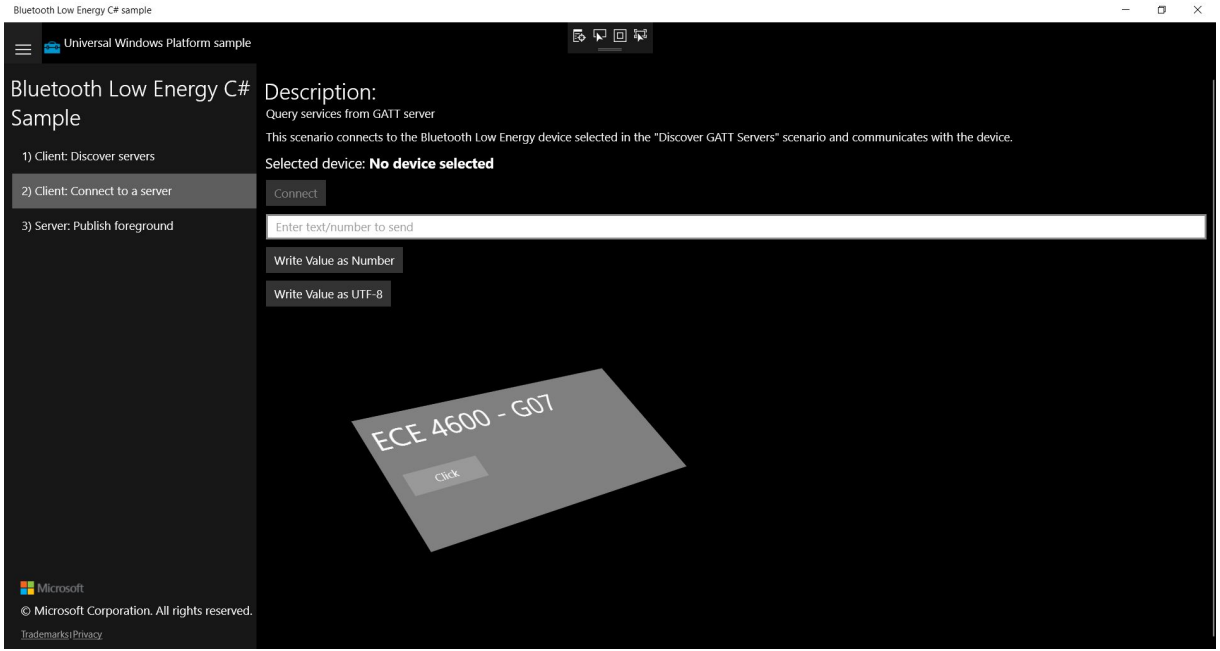
Bluetooth LE with GATT and Adafruit API - John



BLE uses GATT Services in a Client/Server relationship

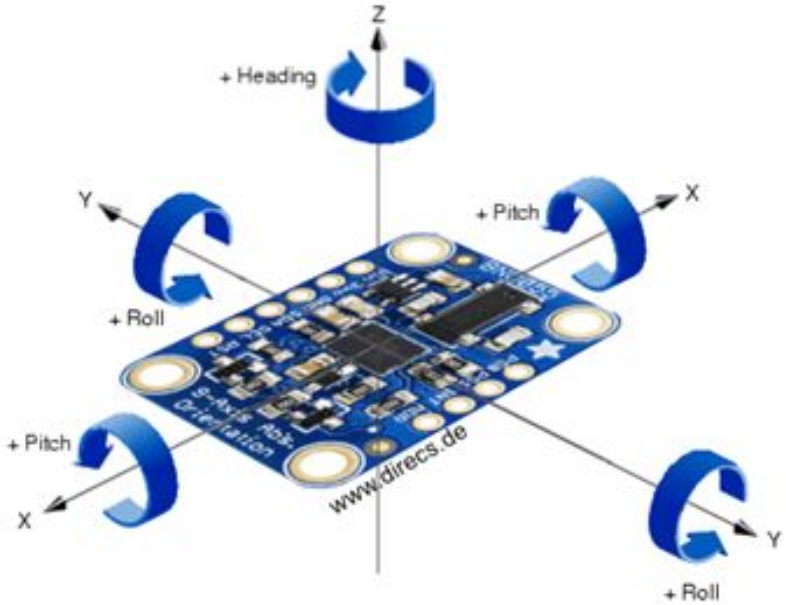
Adafruit Bluetooth LE API allows emulation of Human Interface Devices (mouse, keyboard), and UART as GATT Services

Windows (UWP) 3D Demo



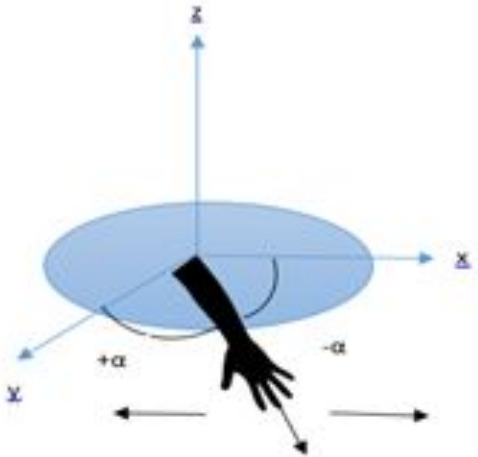
Windows Application receives data from the nRF52 using the BLEUart Service.
Rectangular Panel added to visualize 3D Movement and Rotation

BNO055- Absolute Orientation Sensor

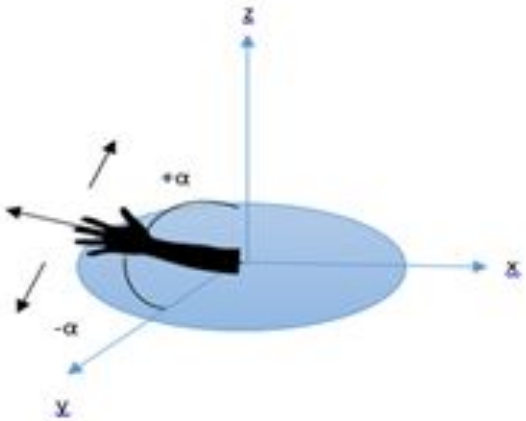


Euler Rotation Angles

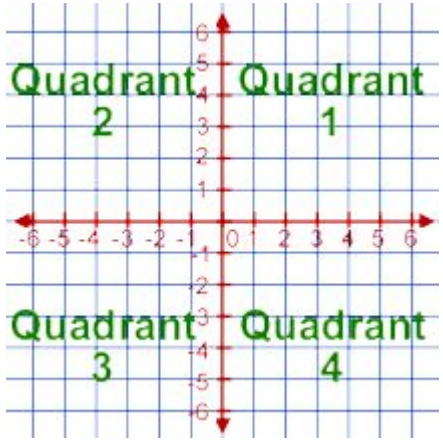
BNO055



Reference in Quadrant I of x-y plane

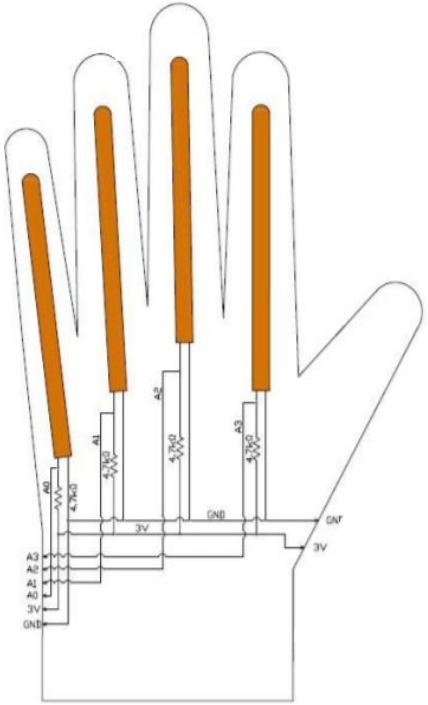


Reference in Quadrant II of the x-y plane



Four Quadrants of a two dimensional axis system

Flex Sensors



Bottom side of the Right Hand

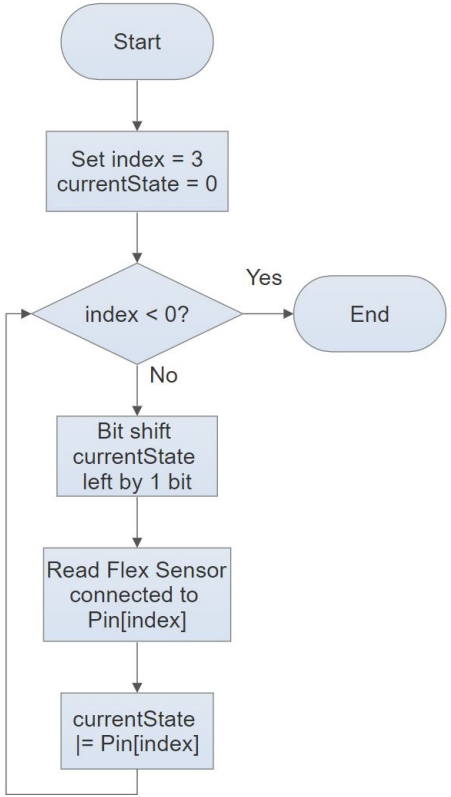
Pin	Label	Flexed Resistance (Ω)	Threshold voltage (V)
0	Pinky	10.83K	2.58
1	Ring	11.40K	2.62
2	Middle	11.11K	2.60
3	Index	15.76K	2.85

Voltage measurements for the flex sensors on each finger.

Finite State Machine

1 – Flexed
0 - Unflexed

- MODE_POINTING = B0000,
- MODE_LEFTCLICK = B1000,
- MODE_RIGHTCLICK = B0100,
- MODE_CALIBRATION = B0010,
- MODE_MOVING = B0111,
- MODE_SCROLLING = B1111



Reading Flex States

SCROLLING (B1111)

POINTING (B0000)

LEFT_CLICKING (B1000)

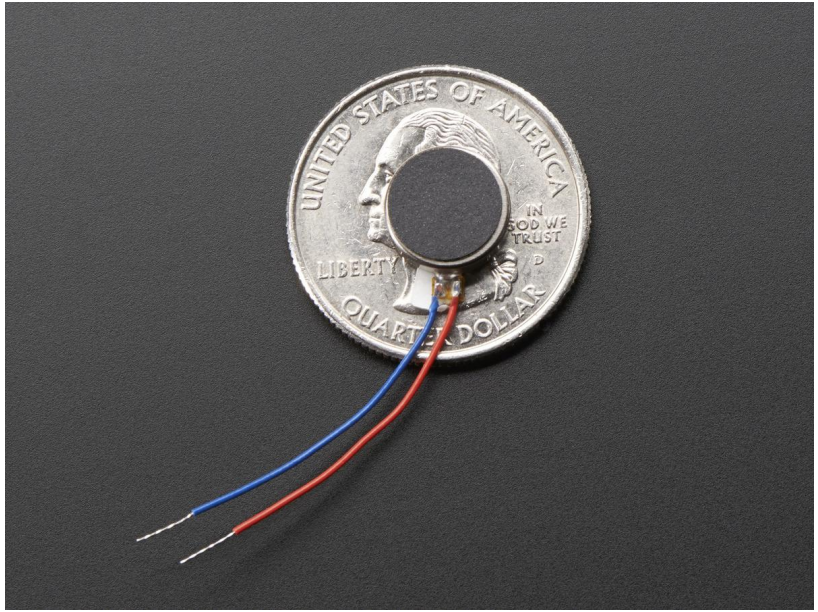
FINITE STATE MACHINE

MOVING (B0111)

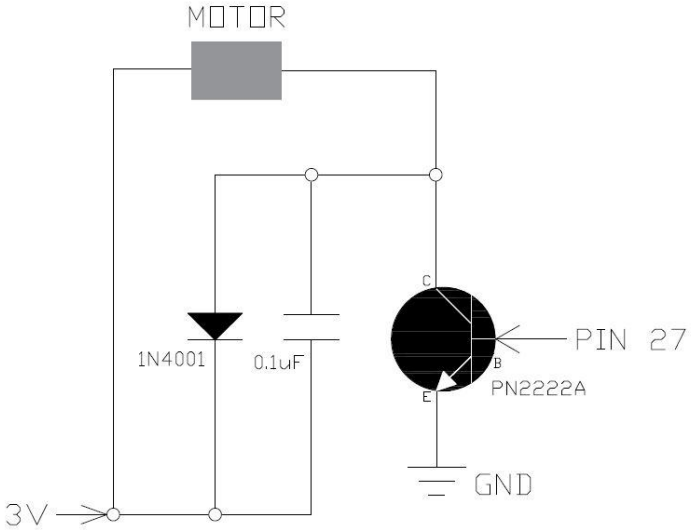
CALIBRATION (B0010)

RIGHT_CLICKING (B0100)

Vibration Motor

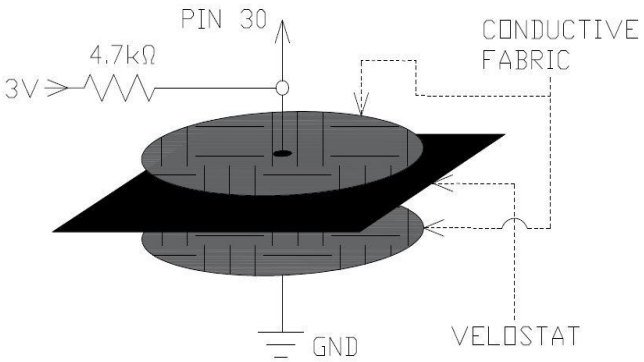


Vibration Motor referenced to quarter



Vibration Motor Configuration

Pressure Sensitive Sheets

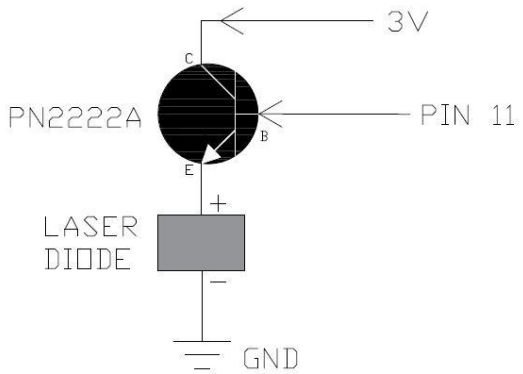


Pressure Sensitive Sheet Configuration

Conductive Fabric (Silver)

Velostat (Black)

Laser Diode

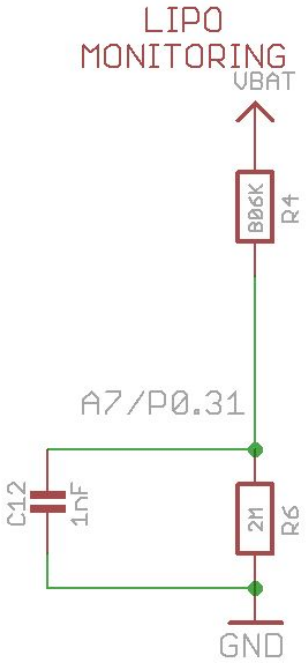


Laser Diode Configuration

Laser Diode Activation Gesture

Power Management and Monitoring System

3.70V/110mAh
Lithium Polymer Battery



LiPo battery monitoring circuit on the nRF52 board

Voltage Level (mV)	Remaining Battery Life (%)
>= 3000	100
> 2900	99 - 43
> 2740	42 - 19
> 2440	18 - 6
> 2100	6 - 1
= 0	0

Voltage level (mV) conversion to percentage(%)

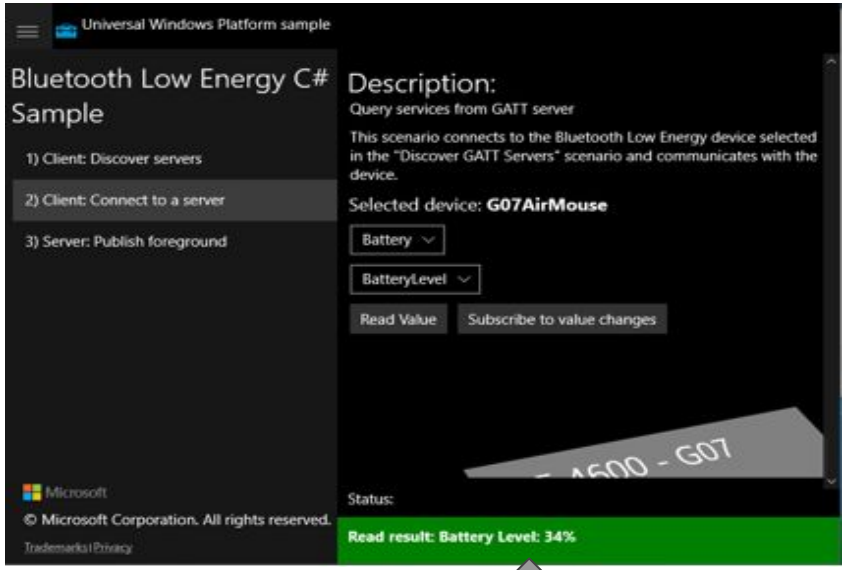
Battery State Indicators

Green
100% - 43%

Yellow
42% - 7%

Red
6% - 0%

NeoPixel with colors of Green, Yellow and Red with varying brightness indicate remaining charge levels



Battery Level Displayed on the Windows Application

Current Draw and Operational Time

DEVICE	CURRENT DRAW	
NeoPixels	18.5mA	
BNO055	12.3mA	
Flex Sensors	1.05mA	
Laser pointer*	25mA	
Vibration Motor*	16mA	
Pressure Sensitive Sheet	0.7mA	
Antenna Transmission Current	7.5mA	
nRF52 CPU Current	3.9mA	
Total Operational Time	**THEORETICAL**	**TESTED**
	2 hours 39 mins	2 hours 20 mins

* indicates component is not assumed to be running continuously

Summary of Results

FEATURE AND RESULTS	COMPLETED
(1) All **components** must fit on all standard glove **sizes** (XS-X)	Yes
(2) Design is able to **send/receive** information using the Bluetooth LE	Yes (nRF52 Bluetooth Module)
(3) Design can **move mouse cursor** on a computer using hand movements	Yes (controlled by BNO055)
(4) Design can **perform mouse clicks** on a computer using hand movements	Yes (Left and Right Click triggered by Flex)
(5) Design **can scroll/pan** on a computer using hand movements	Yes (controlled by BNO055)
(6) Design is able to be used in a **3D axis application**	Yes (Windows 10 Application)
(7) Design is powered by a **portable power source**	Yes (3.7V 110mAh LiPo battery)
(8) User is able to **turn on/off** device to reduce power consumption	Yes (Switch)
(9) Battery **Life** Specifications	Yes (2h 20m)
(10) Battery State of **Charge Indicator**	Yes (Green, Yellow, Red, with varying brightness)
(11) Haptic feedback on mouse clicks	Yes (3V motor)
(12) Hand gestures to enable **laser pointer** aid for presentations	Yes (triggered by pressure sheets)

Any Questions?