**Product Requirements Document**

**OVERVIEW**

| **Product Description** | |
| --- | --- |
| **Market Need** | Why does the world need your product? |
| **Key Features/ Functionality** | What does your product do? |
| **Other Product Compatibility,**  **Ecosystem, etc.** | With which other systems does your product need to work? |
| **Stakeholders** | |
| **Target User** | Who will use your product? |
| **Target Purchaser**  **(if different from user)** | Who will buy your product? |
| **Other Stakeholders** | Who else should be considered? |

**COMMERCIALS AND REGULATORY**

| **Countries of Sale** | In which countries will you sell this version of the product? |
| --- | --- |
| **Target Launch Date** | When would you like it to be available? |
| **Regulatory Requirements** | |
| **Safety (UL, CE)** | Which safety certifications are required? |
| **Emissions (FCC, CE)** | Which electrical radiation certifications are required? |
| **Interoperability (Cellular, WiFi)** | With which networks should your product operate? |
| **Labeling** | |
| **Regulatory Marks** | Which are required? |
| **Country of Origin** | Where was it assembled? |
| **Serial Number** | Does your product need a serial number? |
| **Financials** | |
| **BOM Cost** | How much do the components cost to make? |
| **COGs** | BOM Cost + assembly labor, freight forwarding, logistics, customs, duties, etc. |
| **MSRP** | Target retail price? |
| **Acceptable Margin** | How much do you need to earn when selling a unit? |
| **Volume** | |
| **MOQ of First Production Run** | How many do you need to make the first time you run your production line? |
| **Annual Volume** | How many do you expect to sell per year? |
| **Timeline for Product Refresh (EOL)** | How long before you launch your product’s replacement? |

**ENVIRONMENT**

| **Storage Environment** | |
| --- | --- |
| **Temperature Range** | Through which temperature range might the product be stored? |
| **Humidity Range** | Through which humidity range might the product be stored? |
| **Operating Environment** | |
| **Indoor, Outdoor, Wearable** | Where and how will the product be used? |
| **Temperature Range** | Through which temperature range might the product be used? |
| **Humidity Range** | Through which humidity range might the product be stored? |

**INDUSTRIAL DESIGN**

| **Brand** | What should your product communicate about your company values? |
| --- | --- |
| **Renderings** | Place images of your product here. |
| **Color, Material, and Finish (CMF)** | Which colors and textures will be used? |
| **Logo size and placement** | Where will the logo be placed? |
| **Connectors**  (Power, USB, Lighting, Audio) | Which connectors, if any, does your product need? |
| **Visual Interface**  (Screen size and type, LEDs) | What will the product display, visually? |
| **Touch Interface**  (Mechanical actuators/switches, touch sensitivity, haptics) | How will people interact with their sense of touch? |
| **Audio Interface**  (Microphones, speakers) | Which audio inputs and outputs? |

**SOFTWARE ARCHITECTURE AND DATA PROCESSING**

| **Block Diagram of Data Flow** | |
| --- | --- |
| Paste an image here showing how will data be collected, transferred, processed, and shared. | |

**ELECTRICAL HARDWARE AND SENSORS**

| **Block Diagram of Electrical Hardware** | |
| --- | --- |
| Paste an image here showing which hardware (e.g., sensors, screens, buttons) will be required and how they will connect. | |
| **Input/Sensor Requirements** | What should be sensed and to what accuracy? |
| **Output/Actuator Requirements** | How does the product affect its physical world? |
| **Critical BOM Components** | What are major electrical components? |
| **Communication Requirements** | With what and how fast does the product need to communicate? |
| **Power Requirements** | Should it be plugged into an outlet or powered with disposable or rechargeable batteries? If batteries, how long should it last between replacement or recharging? |

**DURABILITY**

| **Lifetime requirements** | How long should the product last before it is unusable? |
| --- | --- |
| **Cycles of various sub-systems** | How long should specific parts of the product last? |
| **Chemical resistance (sweat, sebum, sunscreen, salt water)** | Which chemicals should the product resist? |
| **UV resistance (sunlight)** | Should be product be UV resistant? |
| **Environmental (Dust, Water, etc.)** | Dust or water? Use IPX codes here. |
| **Mechanical (Drop, Vibration, Abrasion, etc.)** | What mechanical abuse should the product withstand? |

**PACKAGING**

| **In the Box** | What comes in the box? |
| --- | --- |
| **Unboxing Experience** | What should the user experience when unboxing the product? |
| **Printing, colors, inserts, cardboard type, drop requirements** | Which elements of packaging should be included? |
| **Retail Requirements** | Will your product be sold in stores? If so, are there size constraints for the shelves or other considerations? |
| **SKU Combinations** | Are there different options? Try to design for just one when you are starting out. |

**SERVICEABILITY**

| **Repair Services** | Will you repair or replace defective, broken, or unwanted products? |
| --- | --- |
| **Returns Process** | How would the customer return a product? |
| **Repair/Return Qualifications/Tolerances** | What defines a defective or broken product? |
| **Customer Support System** | How will customers contact your company? |

**Criteria:**

**Active Power**

**Quiescent Power**

**Part lifetime**

**Dimensions**

**Package Type**

**Weight**

**Accuracy**

**Temperature range**

**Humidity considerations**

**UV resistance**

**ESD**

**Costs**

**Tolerances, be aware of tolerance stack up**

**PCB components**

**Inductive Proximity Sensor**

Supply Voltage: 1.8 V – 3.3 V

Average Supply Current: < 20 µA @ 10 sps

Threshold tolerance: <1 % of coil diameter

Insensitive to DC Magnetic Fields

**Buzzer**

75db

Roughly 35 mA

<3 volts

**Buzzer transistor**

Only needed if MCU cannot drive enough current with a GPIO. Atmega328pb 40mA can drive enough but stm32 (25mA) cannot

Bipolar

**Buzzer transistor resistor**

Math to

**Reverse Polarity Mosfet**

* P-channel.. N-channel would be slightly more efficient but would require building separate power ground and load ground p -channel allows for them to be one.
* Threshold Vgs should be very low, say -1V
* High Vgs, above battery voltage. 4V+
* Drain-Source Resistance as low as possible. Excess resistance is waste. 100 MilliOhms
* Drain current - larger than max needed. >1A to be safe
* Drain to source breakdown voltage - above battery voltage >4V

**Buzzer switching transistor**

Bipolar NPN transistor

**Crystal**

Math: 10pF load capacitance, 16MHZ, assumed 5pF stray capacitance

2\* (C\_Load - C\_stray) = Capacitor value per cap

10-5=5, 5x2=10, 10pF per cap

**Voltage Divider**

Use precision resistors for this very sensitive portion of the circuit

Calculating resistor ratio

V\_out = V\_battery \* R2 / (R1 + R2)

2.2 = 3 \* R2 / (R1 + R2)

R2 = (R1 + R2) \* 0.7333

0.2667 \* R2 = 0.7333 \* R1

R1/R2 = 0.2667/0.7333 = 0.3636

R1 + R2 = R2 / 0.2667

Using higher resistor values with this ratio:

R1/R2 = 0.3636

R1 = 10 kOhm

R2 = R1 / 0.3636 = 27.6 kOhm

Adjusting for standard resistor values:

V\_out = V\_battery \* R2 / (R1 + R2) = 3 \* 27 / (10 + 27) = 2.19 volts

V\_drop = V\_battery \* R2 / (R1 + R2)

= 3 \* 2200 / (1000 + 2200)

= 1.29 volts

**Accelerometer**

Ability to withstand hard stops and large changes in acceleration without damage

Ability to self calibrate every once in a while

Factory calibrated

“AUTO-NORMALIZATION, Self-Calibrating, Auto-Normalization to direction of motion”

**MCU**

**Active power consumption**

**Sleep Power consumption**

**WDT capabilities**

**External interrupt pins**

2 pins

**Internal voltage regulator, comparator, analog capabilities**

Must have all three.

**Operating speed/ flashing speed**

**Operating Voltage Range**

**Pin current/voltage**

**LDO Regulator**

Input voltage

Output voltage

Dropout voltage

Enable pin

**Hall Effect Sensor (I am not sure a hall effect sensor will work since they do not detect small magnetic fields well and perform best with static magnetic fields which phones are not. A sensor that detects the electromagnetic radiation**

**Active power consumption**

Sleep power consumption

Voltage Drop

Sensing range

Hysteresis threshold values

**RF Detector /POWER DETECTOR**

Would only work when the phone is on

**NFC**

Operating distance

Memory

Ferrite blocking/shielding (preventing metal interference)

Frequency

Dimensions

Antenna (match the geometric size and shape with reader antenna, common practice called coil matching where matching impedance is key. Coil is tested with vector network analyzer)

Very precise and tested footprints to copy over to PCB are provided online. Alternatively an air coil like the PA6512-AE z-axis coil can be used)

Wire-Wound Ferrite Core Tag Antenna

Form factor built in, chip, sticker

Avoid having it near metal if possible

**Diode**

Schottky or rectifier

Peak current rating

Forward voltage rating

Low reverse leakage

**Clock**

**LDO Regulator**

Not using other types since the dropout will be minimal

**Inductor**

mH rating

Max peak current rating

**Programming Port**

**Test Pads**

**Hall effect sensor**

Sensing range 0-20mT

typical sensitivity of 5mV/V/G (50 mV/V/mT)

**Capacitors**

Heat resistance and mechanical stress resistance.

* Aluminum capacitors have poor heat tolerance and ceramic capacitors have a

propensity to crack. Currently the best solution seems to be to avoid aluminum capacitors like the plague and to use capacitors with flexible terminations aka with terminations composed of conductive polymer as it is much less fragile that ceramic.I think I plan to only use ceramic capacitors

**PCB Board**

**FR-4 layer**

More research needed later, this is for heat and humidity protection. Unsure if needed.

**Thermal Vias**

Placed typical in arrays (mostly beneath heat generating components)

**Packaging**

**Ink (if used on retail packaging)**

Avoid inks with heavy metals, that smear, that deteriorate in humidity

**Poly Bag (for retail packaging)**

Necessary so packaging won’t be scuffed in transit

**Retail packaging**

The lead times are shockingly high so make sure to plan accordingly

Needs to grab attention

Way too many people overpay. Keep packaging as cheap as possible. I am not Apple computer.

Keep it simple and minimize the amount of separate pieces needed.

**Plastics**

shock mounts or grommets to help with vibrations

Eventually a crush test stack test moisture test, friction test, drop test (side, corner, face)

