**Product Requirements Document**

**Project B298**

**Apple Inc.**

**Wearables division**

Project Manager: John Doe

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**Introduction**

Apple’s first-generation AirPods were among the first truly wireless in-ear headphones and generated phenomenal demand with sales units exceeding 16 million in just the first year after launch. Customer satisfaction surveys have reported a great need among users to personalize their product and improve the in-ear fit and audio quality. Users also express a desire for more compact earbuds with shorter microphone extensions. Observational studies show an opportunity to expand upon and improve touch interactions and the need for enhanced sound quality. These will be backed by technological developments such as the H1 wireless connectivity chip, Cypress CY8C4146FN PSoC, dual beam-forming microphones, Bluetooth 5.2, iOS 14, force-sensitive resistors, gyroscopes, and IR proximity sensors.

**Objectives**

This project aims to investigate and develop smart adaptive technologies, an improved user experience, better fit, improved product design, and product customization options for the next-generation AirPods. The target is to maintain global dominance in the wireless earphone market, drive up AirPod sales to 100 million+ units sold with a 60% global market share in 2021 and expand the user base more towards the luxury, professional, and fitness segments. We believe that adding smart interactions and adaptive audio filters alone will already expand our user base by 15%. With the new generation AirPods we aim to match at least the sound quality of our main competitor, the Sony WF-1000XM3, and include Active Noise Canceling that is also featured in Mifo, House of Marley, Bose, and Amazon Echo products. We will also obtain IPX4 sweat-resistant rating equal to Bose, House of Marley, and Amazon Echo earbuds, and aim to extend our range of colors, as seen in Urbanista and Jabra’s lifestyle products. For a full overview of competitors, see Appendix A.

**Stakeholders**

**Target group.** High-income upper-class professionals between the age of 20 and 45. Their personalities are determined and ambitious. The main benefits sought are recreation and self-expression.

**Target purchaser***.* Target group profile with special attention to Full Nest I and Full Nest II mothers.

**Customer service.** Prefers easy-to-repair, recyclable product, and easy-to-fix complaints to fit with Apple’s intuitive user experience.

**Marketing & Sales division**. Looks for unique selling points around the Apple Aspirer-Explorer lifestyle and user experience.

**Senior Management***.* Ensures compliance to Apple Brand Identity, determines operational constraints, and sets research and development budgets.

**Retailers**. Prefer products that can withstand a wide range of storage conditions including variations in temperature, vibration, humidity, and atmospheric pressure, and have a strong and compact, theft, and vandalism-proof packaging.

**Regulatory instances***.* The product needs to comply with CE guidelines in Europe, including 2014/53/EU, 2011/65/EU, and 2009/125/EC as well as RoHS: EN50581:2012, FCC Rules part 15 ID BCG-A2083 and BCG-A2084 for the United States, Canada IC numbers 579C-A2083 and 579C-A2084, TP TC 020/2011 for Russia, Mexico NOM conformity to A2083, A2084, and A2083, Turkey’s AEEE compliance, Japan VCCI codes 003-190159, D190123003, 003-190158, and D190122003, Singapore IMDA DB00063, and Malaysia MCMC-CIDF15000007.

**Use Cases**

**User Story #1: Jenna**

Jenna is a 33-year-old executive who regularly visits a bar for lunch to blow off some steam. The bar is often loud with people, but it is paramount that she can hold business conversations over the phone there. Then again, she does not want to miss out on the atmosphere and be able to hear the waiters as well. Her new Apple wireless earphones allow her to switch instantly between a mode where she can fully focus on the phone conversation and a mode where the phone call and environmental sound are seamlessly combined. They also allow her to rapidly adjust the volume on the earbuds themselves without having to take out her phone.

Jenna occasionally visits the bar in the evenings. She is a big fan of the L.A. Lakers, and whenever they play, she streams the live footage through her phone. Her new earbuds allow her to easily switch to hearing everything around her and streaming the match commentary without having to ever take the earbuds out. She sometimes gets compliments on how stylish the earbuds look on her, and she wouldn’t want to miss out on hearing those either.

**User Story #2: William**

William is a 6’7” 26-year-old professional sprinter who trains every day. His ears are sizable, and while he occasionally enjoys music to get him into the athletic spirit, he hasn’t been able to find earbuds that do not fall out while working out. What’s more, his profuse sweating makes most silicone ear tips slippery and impedes sound quality on most devices. He’s excited that the new Apple earbuds offer a custom fit, so he has decided to have his personal shopper Pía buy them. In the store, they could even engrave his initials and his signature flame symbol for an additional fee.

Because William understands that with the vigorous exercise that he does, any type of earbud may fall out at some point, he can also track his earbuds to the location where they were last connected to his phone via the Find My app. William loves his new earbuds and, as brand-loyal as he is, from now on, he will buy his personal electronics only from Apple.

**User Story #3: Keith**

Keith is a 45-year old self-made man. He has set up three companies, including a local restaurant chain specialized in vegan food, that are now thriving, but they also require him to be on the road often. Keith has an obsession for vintage cars and he likes to drive around in his red 1957 Chevrolet Corvette (C1) convertible. As the car is preserved in its original condition, it doesn’t have a modern entertainment system. Keith’s wife Jennifer bought him the earphones as his Christmas gift so he can now listen to music from his phone in the car.

Keith likes the noise cancelling feature, especially because he can now reduce the sound of the wind when the roof is down, but he appreciates the option that he can turn the feature off as well to be aware of the traffic. As a busy businessman, Keith also often takes advantage of Siri to send messages and schedule meetings in the car. With his new earbuds, he can access Siri directly which allows him to focus on driving.

**Aspects**

**1.** **Product Design**

The new product design will be based on that of the AirPods with improvements based on the following requirements:

1.1 The product shall be visually easy to distinguish from existing AirPods as well as main competitors Sony WF-1000XM3, Jabra Elite, Amazon Echo Buds, Samsung Galaxy Buds, and Bose SoundSport Free, and Urbanista Stockholm.(P10)

1.2 The product shall be easy to recognize as an Apple product without needing a logo on its exterior. (P10)

1.3 The product shall avoid styling elements from our Powerbeats over-ear wireless headphones since those address a different market segment. (P8)

1.4 The product shall incorporate one or more physical features to improve grip to facilitate inserting and removing the earbuds. (P2)

1.5 The product shall have an easy-to-clean outer surface consisting of at least 80% glossy white plastic. (P7)

1.6 The product shall be as small as possible. (P8)

1.7 The two earbuds shall be an exact mirror image of one another. (P8)

1.8 Cutouts, details, indents, and holes shall be oval or circular wherever possible.(P5)

1.9 The product’s rod extensions that house microphone and antenna shall be shorter by >4mm. (P6)

1.10 The product shall have at least one dimension <16mm to fit inside the packaging box. (P5)

1.11 The product shall incorporate the Apple aesthetic also on the interior wherever possible. (P3)

1.12 The product’s shape will facilitate better bass response. (P5)

**2** **Functionality**

2.1 The product shall incorporate one or more optical proximity sensors to detect the user wearing it. (P10)

2.2 The product shall offer a dual microphone in each earbud. (P10)

2.3 The product shall incorporate one or more accelerometers for head tracking. (P8)

2.4 The product shall have connectivity to a tracker app that lets the user find lost earphones. (P5)

2.5 The product shall offer a ‘Fast Fuel’ quick-charge mode for charging up to one hour in under five minutes.(P9)

2.6 The accompanying charger shall provide a total listening time of > 20 hours.(P10)

2.7 The product shall function based on the latest Bluetooth 5.2 standard. (P10)

2.8 The product shall incorporate a vent for pressure equalization. (P10)

2.9 The product shall incorporate some form of fitness or activity tracking. (P4)

2.10 Sound leakage shall be under 10 dB at all times. (P9)

2.11 Sound quality must be perceived by our users as equal or better to the main competitor Sony WF-1000XM3.(P8)

3 **Interactivity**

3.1 The product shall function and pair to an Apple device right out of the box with at most three actions needed on behalf of the user. (P8)

3.2 The product shall offer at least four different touch actions that can be custom-mapped to different functionalities. (P9)

3.3 The product shall offer at least one non-binary gradual input action such as a stroke, slide, twist, rotate, or squeeze interaction. (P3)

3.4 The product shall auto-pause the track played upon removal of earbuds, and resume where it left off until re-insertion. (P8)

3.5 The user interface shall be intuitive for all users after a single moment of learning how it works. (P9)

3.6 The product shall seamlessly connect to Apple Music. (P10)

3.7 The product shall offer a shortcut to Siri voice assistant using voice command or a single user action. (P9)

3.8 The product shall be designed so as to prevent accidental use.(P8)

4 **Adaptive Intelligence**

4.1 The product shall incorporate Active Noise Cancellation technology. (P10)

4.2 The product shall offer a mode where the environment can be heard along with the audio played by the earbuds. (P9)

4.3 The product shall adapt the audio experience when the user is wearing only one of the earbuds. (P6)

4.4 Upon detecting the user switching their attention to a different device, the product shall automatically switch to that device’s audio output. (P8)

4.5 The product shall tune the audio experience to the shape of the wearer’s ear. (P5)

4.6 The product shall be compatible with spatial audio systems where sound becomes tuned to head orientation for a directional experience while watching a movie. (P5)

5 **Customization**

5.1 The product shall offer multiple custom fit options that provide an ideal fit to at least 98% of the general population. (P10)

5.2 The product shall offer customization so that it does not fall out of the ear once during running a 10-kilometer route by runners of different heights, ethnicities, and sexes. (P9)

5.3 The product shall be offered with an additional engraving service for texts or icons onto the product. (P3)

5.4 The product shall be offered in at least five colorways, including black, white, gold, and a selection of our successful colorways that include Pine Green, Khaki, Cactus, Seafoam, Coastal Grey, Alaskan blue, and Stone for our wearables. (P5)

6 **Manufacturing**

6.1 The total FOB cost price of the product shall be <$75.(P9)

6.2 Parts must be mass-producible in batches of 100,000 parts. (P10)

6.3 The product shall be designed to assemble in under 60 seconds. (P7)

6.4 The position of any component cannot change during assembly. (P10)

6.5 Functioning of the device shall be easy to check by the manufacturer. (P8)

6.6 The product shall be designed to consist of the minimum possible amount of parts. (P8)

6.7 Metals, plastics, and small toxic waste shall be easy to separate out at the product’s end-of-life. (P3)

7 **Regulations**

7.1 The product shall meet Ingress Protection rating IP-X4 for water and sweat resistance under IEC standard 60529. (P9)

7.2 The product shall pass a guided drop test based on IEC 60068 guidelines. The product will be dropped from a height of 1.22m onto lauan plywood from 26 different directions. (P9)

7.3 The product shall pass vibration testing. It will be tested in 3 directions for one hour each, subjected to frequencies from 20 to 2,000 Hz. (P8)

7.4 The product shall pass hammer impact testing based on IEC 60068-2-75 guidelines. (P9)

7.5 The product shall have a 100% pass rate in an ALT, including swinging temperatures, stress, strain, and corrosion. (P8)

7.6 The product shall survive a soft pressure test with 1,000 cycles of 1,000N. (P8)

7.7 The product shall pass EMI testing according to IEC 61000-4-2, 61000-4-6, and 61000-4-11 standards. (P9)

7.8 The product shall incorporate measures to ensure hearing health protection, informing the user when he/she exceeds the World Health Organization’s advised weekly listening dose and the prescribed limit of 85 dB. (P9)

7.9 The product shall not discolor by more than 2% saturation after 2,000 hours of exposure to direct sunlight. For an estimate, it will be tested in continuous UV-light for 10 days totaling 1,120 W/m2. (P9)

7.10 The product shall pass humidity resistance tests and will be subjected to high humidity conditions for 10 days, of which 16 hours a day at 45% and 8 hours at 95% humidity. (P8)

7.11 The product shall pass temperature endurance tests and will be subjected to temperatures between -21°C and 50°C for three straight hours per degree.

7.12 The product shall pass low-pressure testing where an environment of 4,572 meters altitude is simulated (57.11 kPa) for two hours straight. (P6)

7.13 The product shall pass salt fog resistance testing where it is subjected to 5% salt fog for 24 hours straight, then dried for 24 hours. (P8)

**Open Questions**

· Can we move towards a recyclable and repairable product, for example, with ZIF connectors and glue-free assembly?

· Can we improve on failing or self-igniting batteries?

· Can we improve Android connectivity?

· Is there a soft-touch coating available that is durable and easy-to-clean or self-cleaning (nanocoatings)?

· What kind of pivots can we make in case early user evaluations prove the product undesirable?

**Milestones**

Concept presentation: 10/12/2017

Design presentation: 11/08/2018

Design freeze: 04/18/2019

Planned release: 10/28/2019

**Appendix A: Competitive Analysis**



**Explanation of Terms**

*ALT* Accelerated Life Test

*Dual beam-forming microphones* Technique to include multiple microphones so as to improve signal-to-noise ratio (SNR) and enable directional reception.

*EMI* Electro-Magnetic Interference

*EQ* Classic audio equalizer

*FOB* Free On Board. The total cost price of manufactured goods, including shipping to the target destination.

*IPXX* Ingress Protection Rating. IPX2 means splash-resistant against drops, IPX3 is resistant to sprayed water from a sixty-degree angle, IPX4 is resistant to sprayed water from different angles, IPX5 is waterproof to pressurized jets, IPX6 resistant to microscopic dust and powerful jets, IPX7 means waterproofness when submerged to low depths, IPX8 means waterproofness when submerged permanently and at high depths.

*P1-P10* Code to indicate the priority of the requirement, from low to high.

*PSoC* Programmable System-on-a -Chip. A type of microcontroller that enables the configuration of peripheral devices. An application processor that integrates a system’s different components.

*ZIF* Zero Insertion Force connector. Connector that requires little to no force to assemble/disassemble.