FAILURE MODE & EFFECTS ANALYSIS

Aurora TWS Earbuds

Engineering Validation Test (EVT) Stage · Sample Report

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About This Document

This FMEA report was generated by DFM Insights from the Aurora TWS Earbuds product requirements document (PRD) and bill of materials (BOM). It covers 14 failure modes across six engineering disciplines — Mechanical, Electrical, RF & Antenna, Software, Battery, and Manufacturing — and provides Risk Priority Number (RPN) scoring with recommended mitigation actions for each failure mode.

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RPN Scoring Methodology

Risk Priority Number = Severity (S) × Occurrence (O) × Detectability (D). Each factor is rated 1–10. RPN thresholds and required actions:

200–1000	**CRITICAL**	Immediate programme hold. Must resolve before next build stage.
100–199	**HIGH**	Mandatory carry-forward to next build. Gate criteria item.
50–99	**MEDIUM**	Action required before DVT. Monitor at gate review.
1–49	**LOW**	Document and monitor. Address in normal engineering flow.

Executive Summary — RPN Overview

The table below summarises all 14 failure modes identified, sorted by Risk Priority Number (highest first). Items shaded red require immediate action before proceeding to DVT.

EE-001	Electrical	BT antenna coupling to Qi coil causing 8–12 dB reduction in …	**8**	**7**	**3**	**168**	**HIGH**	Yusuf Al-Rashid
RF-001	RF & Antenna	Antenna detuning due to ear canal proximity during wear	**7**	**6**	**4**	**168**	**HIGH**	Yusuf Al-Rashid
ME-001	Mechanical	Hinge rattle at temperature extremes	**8**	**5**	**4**	**160**	**HIGH**	Rachel Lead)
RF-002	RF & Antenna	Qi switching frequency harmonics causing BT packet loss duri…	**8**	**5**	**4**	**160**	**HIGH**	Yusuf Al-Rashid
EE-002	Electrical	Excessive BMS polling interval causing 0.8 mA parasitic drai…	**6**	**6**	**4**	**144**	**HIGH**	James O'Brien
MFG-001	Manufacturing	O-ring not fully seated due to undefined assembly sequence	**9**	**5**	**3**	**135**	**HIGH**	Frank Nakamura
BAT-001	Battery	Cell swelling after 300 charge cycles reducing acoustic cham…	**8**	**4**	**4**	**128**	**HIGH**	Leila Ahmadi
ME-002	Mechanical	Vent resonance causing 6–8 dB SPL dip at 8 kHz	**7**	**6**	**3**	**126**	**HIGH**	Rachel Kim
BAT-002	Battery	Self-discharge exceeding spec during 30-day storage	**6**	**5**	**4**	**120**	**HIGH**	Leila Ahmadi
MFG-002	Manufacturing	Vent mesh misalignment causing partial blockage; yield loss	**6**	**5**	**4**	**120**	**HIGH**	Frank Nakamura
EE-003	Electrical	BT antenna component tombstoning due to reflow profile misma…	**7**	**4**	**4**	**112**	**HIGH**	Maria Santos
ME-003	Mechanical	Gasket compressed below minimum sealing force due to toleran…	**9**	**4**	**3**	**108**	**HIGH**	Rachel Kim
SW-001	Software	ANC instability causing 400 Hz self-oscillation tone audible…	**9**	**4**	**3**	**108**	**HIGH**	James O'Brien
SW-002	Software	OTA update failure leaving earbud in non-bootable state (bri…	**9**	**3**	**4**	**108**	**HIGH**	James O'Brien

0 CRITICAL (RPN ≥ 200)	**14 HIGH (RPN 100–199)**	**0 MEDIUM (RPN 50–99)**	**0 LOW (RPN < 50)**	**14 TOTAL FAILURE MODES**

Mechanical — Failure Mode Analysis

Covers housing, hinge, gaskets, vent placement, drop performance, and dimensional tolerance stack-ups.

ME-001	**Earbud hinge** Allows case lid to open/close smoothly; retains earbud during transpor…	Hinge rattle at temperature extremes	Perceived quality failure; customer returns; potential IP54 failure if gasket is disturbed	Hinge tolerance stack-up not worst-case analysed; spring preload not specified	**8**	**5**	**4**	**160**
ME-002	**Acoustic vent (earbud body)** Pressure equalisation; vent resonance tuning for bass response	Vent resonance causing 6–8 dB SPL dip at 8 kHz	ANC performance degraded; product fails acoustic specification; DVT respin required	Vent diameter and depth not co-designed with acoustic simulation; placed for mechanical convenience	**7**	**6**	**3**	**126**
ME-003	**IP54 gasket (earbud / case interface)** Prevents moisture and dust ingress; required for IP54 certification	Gasket compressed below minimum sealing force due to tolerance variation	IP54 certification failure; programme hold; 3-week re-test lead time	Gasket compression spec derived from nominal dimensions only; no worst-case analysis	**9**	**4**	**3**	**108**

Recommended Actions

ID	RPN	Current Control	Recommended Action	Owner	Target
ME-001	**160**	Dimensional drawing; prototype fit check	Conduct full worst-case tolerance stack-up analysis. Tighten spring preload spec. Validate at -10°C and +45°C.	Rachel Kim (ME Lead)	EVT-1 build
ME-002	**126**	Bench acoustic measurement on early samples	Run FEA acoustic simulation with proposed vent geometry before tooling. Correlate with 3 vent diameter variants in EVT.	Rachel Kim / Amanda Foster	Pre-tooling
ME-003	**108**	Visual inspection; manual feel-check at build	Define minimum compression force spec. Add go/no-go gauge to assembly SOP. Book IP54 lab slot at Week 7.	Rachel Kim / Frank Nakamura	EVT-1 SOP

Electrical — Failure Mode Analysis

Covers PCBA layout, charging coil placement, BMS architecture, reflow process, and signal integrity.

EE-001	**Qi charging coil (earbud case)** Wireless charging at up to 5W; case battery management	BT antenna coupling to Qi coil causing 8–12 dB reduction in BT range	BT range falls below 10m spec; regulatory pre-compliance failure; PCB respin required	Coil placed within BT antenna keep-out zone; keep-out not defined before layout	**8**	**7**	**3**	**168**
EE-002	**BMS firmware (charging management)** Manages cell charging; monitors self-discharge; drives BT coexistence …	Excessive BMS polling interval causing 0.8 mA parasitic drain during case storage	Standby battery life reduced from 30 days to ~8 days; fails product specification	BMS polling interval defaulted to 10 mA/10 ms from reference design; not optimised for low-power storage	**6**	**6**	**4**	**144**
EE-003	**PCBA reflow process (earbud PCB)** Solder joint formation for all SMD components	BT antenna component tombstoning due to reflow profile mismatch	BT antenna RF performance degraded; yield loss at PVT; potential field return	Reflow profile not tuned for mixed 0201/0402 population near antenna; CM using standard profile	**7**	**4**	**4**	**112**

Recommended Actions

ID	RPN	Current Control	Recommended Action	Owner	Target
EE-001	**168**	RF range measurement on assembled units	Define RF keep-out zones before PCBA layout. Run 3D EM simulation. Evaluate alternative coil positions with Felix (ID).	Yusuf Al-Rashid / David Osei	Pre-layout
EE-002	**144**	Battery drain measurement during EVT build	Define BMS polling architecture before PCBA layout. Target 60s wake interval in storage mode. Verify on EVT-1 with power analyser.	James O'Brien / David Osei	EVT-1
EE-003	**112**	AOI inspection; RF range check at EOL	Define product-specific reflow profile for antenna area. Request CM trial run with 20 boards before EVT-1 production.	Maria Santos / Frank Nakamura	Pre-EVT build

RF & Antenna — Failure Mode Analysis

Covers Bluetooth antenna performance, coexistence between Qi and BT, and regulatory pre-compliance.

RF-001	**BT 5.3 antenna (earbud PCB)** Bluetooth audio transmission; BLE pairing and connection management	Antenna detuning due to ear canal proximity during wear	BT range drops below 5m in-ear; intermittent audio dropout; customer complaints	Antenna performance measured in free space only; head/ear loading effect not simulated	**7**	**6**	**4**	**168**
RF-002	**Qi + BT coexistence (simultaneous charging + audio)** Allow BT audio playback while earbuds are charging in case	Qi switching frequency harmonics causing BT packet loss during charging	Audio stuttering during wireless charging; feature unusable; DVT respin	Qi switching frequency not selected with BT coexistence in mind; no coexistence simulation performed	**8**	**5**	**4**	**160**

Recommended Actions

ID	RPN	Current Control	Recommended Action	Owner	Target
RF-001	**168**	Bench range test; initial antenna simulation	Run antenna simulation with head phantom model. Add head-loading test to EVT test plan. Define minimum in-ear range spec.	Yusuf Al-Rashid	EVT test plan
RF-002	**160**	Manual listening test during charging	Simulate Qi harmonic spectrum against BT channels. Adjust Qi switching frequency or add shielding. Validate with automated coexistence test in EVT.	Yusuf Al-Rashid / David Osei	EVT-1

Software — Failure Mode Analysis

Covers ANC DSP stability, OTA update integrity, and BMS firmware power management.

SW-001	**ANC DSP algorithm (earbud firmware)** Active noise cancellation; adaptive filter update at 48 kHz	ANC instability causing 400 Hz self-oscillation tone audible to user	Severe user experience failure; 100% return rate if shipped; programme hold	ANC filter coefficients from reference design not validated against final acoustic enclosure; mic placement finalised late	**9**	**4**	**3**	**108**
SW-002	**OTA firmware update (BLE)** Enable field firmware updates without returning product	OTA update failure leaving earbud in non-bootable state (brick)	Permanent product failure; full replacement required; warranty cost; regulatory reporting if widespread	OTA state machine has no rollback path on partial transfer; not covered by current test plan	**9**	**3**	**4**	**108**

Recommended Actions

ID	RPN	Current Control	Recommended Action	Owner	Target
SW-001	**108**	Listening test; FFT analysis on bench units	Lock acoustic enclosure geometry before ANC DSP tuning begins. Allocate 3 tuning iterations in DVT schedule. Do not gate DVT on ANC — gate PVT.	James O'Brien / Amanda Foster	DVT-1
SW-002	**108**	Manual OTA test on 3 units	Implement dual-bank bootloader with automatic rollback on checksum failure. Add OTA stress test (50 consecutive updates) to DVT test plan.	James O'Brien / Luke Turner	DVT firmware

Battery — Failure Mode Analysis

Covers cell cycle life, volumetric expansion, self-discharge, and charging system safety.

BAT-001	**LiPo cell (earbud; 55 mAh)** Power supply for earbud; 6h playback at target; charge from case	Cell swelling after 300 charge cycles reducing acoustic chamber volume	ANC performance degrades; earbud lid fit loosens; potential safety issue if swelling is severe	Cell sourced from prototype supplier; no long-term cycle test data available; no volumetric expansion spec	**8**	**4**	**4**	**128**
BAT-002	**Case battery (500 mAh)** Provides 3 full earbud charges; shows charge level via LED indicator	Self-discharge exceeding spec during 30-day storage	Customer receives dead product in box; poor first-use experience; returns	BMS wake-up interval not optimised; no self-discharge test in current EVT plan	**6**	**5**	**4**	**120**

Recommended Actions

ID	RPN	Current Control	Recommended Action	Owner	Target
BAT-001	**128**	None — no cycle test scheduled for EVT	Start 500-cycle retention test on EVT-1 cells immediately. Define maximum volumetric expansion limit. Gate DVT on 200-cycle interim data.	Leila Ahmadi	EVT Day 1
BAT-002	**120**	Manual check after 7-day storage	Measure self-discharge rate on 10 EVT-1 units over 30 days. Optimise BMS sleep interval. Add storage self-discharge test to DVT acceptance criteria.	Leila Ahmadi / James O'Brien	EVT-1

Manufacturing — Failure Mode Analysis

Covers assembly SOPs, press-fit processes, yield risks, and EOL test coverage.

MFG-001	**IP54 gasket installation (assembly)** Correct seating of O-ring during case assembly	O-ring not fully seated due to undefined assembly sequence	IP54 certification failure; 100% affected if SOP not corrected; 3-week re-test penalty	No assembly SOP exists; IP54 O-ring installation left to CM discretion; not validated in EVT	**9**	**5**	**3**	**135**
MFG-002	**Acoustic vent press-fit (earbud body)** Precise placement of acoustic vent mesh during assembly	Vent mesh misalignment causing partial blockage; yield loss	SPL and frequency response out of spec; acoustic yield loss at PVT	Press-fit force and alignment not specified; tool design not reviewed with CM	**6**	**5**	**4**	**120**

Recommended Actions

ID	RPN	Current Control	Recommended Action	Owner	Target
MFG-001	**135**	Visual inspection post-assembly	Write O-ring installation SOP before EVT build. Include go/no-go gauge check. First-article inspection on 10 units before full EVT build.	Frank Nakamura / Diego Cruz	Pre-EVT build
MFG-002	**120**	SPL measurement at EOL	Define press-fit force window and alignment tolerance. Commission alignment fixture for EVT. Correlate acoustic yield with press-fit force data.	Frank Nakamura / Helen Park	EVT build prep

Generate This Report for Your Product

This sample report was generated to demonstrate what DFM Insights produces from a Product Requirements Document and Bill of Materials. The paid AI Package generates an equivalent FMEA report — plus a Project Charter and EVT/DVT/PVT Build Timeline — tailored to your actual product.

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DFM Insights is founded by Hans Stam — author of The Hardest Hardware Lessons and hardware consultant with 18+ years experience across EVT, DVT, PVT, and mass production. AI generates the documents. Hans reviews and signs off.

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