

FMEA Analysis Report circuit

Failure Mode and Effects Analysis for Electronic Circuit Board

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Standard:	AIAG-VDA FMEA / IPC-A-610
Classification:	Quality Assurance Document

Executive Summary

This FMEA analysis evaluates the circuit circuit design to identify potential failure modes and assess associated risks. The analysis examined 16 components across 0 subsystems.

Key Findings

Metric	Value	Status
Total Failure Modes Analyzed	57	✓ Good
Critical Risk Modes (RPN ≥ 300)	3	■ Attention
High Risk Modes (125 ≤ RPN < 300)	34	■ Attention
Average RPN Score	177.4	■ Attention

System Overview

Circuit analysis of circuit.json

Subsystems

FMEA Analysis Table

ID	Component	Failure Mode	Effect	S	O	D	RPN	Risk
1	J1 - USB_C_Receptacl	Solder joint failure	Complete loss of connection, s	9	7	7	441	Critical
2	J2 - Conn_02x03_Odd_	Solder joint failure	Complete loss of connection, s	9	7	7	441	Critical
3	U1 - AMS1117-3.3	Thermal shutdown	System power loss, unexpected	8	7	6	336	Critical
4	U2 - ESP32-C6-MINI-1	ESD damage	Complete MCU failure, system i	9	4	8	288	High
5	U1 - AMS1117-3.3	Input overvoltage failure	Cascading component damage	9	4	7	252	High
6	C1 - C	ESR increase	Power supply instability, heat	6	6	7	252	High
7	C2 - C	ESR increase	Power supply instability, heat	6	6	7	252	High
8	C3 - C	ESR increase	Power supply instability, heat	6	6	7	252	High
9	C4 - C	ESR increase	Power supply instability, heat	6	6	7	252	High
10	U1 - AMS1117-3.3	Output voltage drift	Component malfunction, reduced	7	5	7	245	High
11	C1 - C	Capacitance degradation	Increased ripple, filtering in	5	7	7	245	High
12	C2 - C	Capacitance degradation	Increased ripple, filtering in	5	7	7	245	High
13	C3 - C	Capacitance degradation	Increased ripple, filtering in	5	7	7	245	High
14	C4 - C	Capacitance degradation	Increased ripple, filtering in	5	7	7	245	High
15	U1 - AMS1117-3.3	Dropout voltage increase	Component malfunction	6	5	8	240	High
16	U2 - ESP32-C6-MINI-1	Flash corruption	Firmware corruption, boot fail	7	4	7	196	High
17	U2 - ESP32-C6-MINI-1	Thermal damage	Component malfunction	8	4	6	192	High
18	R1 - R	Resistance drift	Component malfunction	4	6	8	192	High
19	R2 - R	Resistance drift	Component malfunction	4	6	8	192	High
20	R3 - R	Resistance drift	Component malfunction	4	6	8	192	High
21	R4 - R	Resistance drift	Component malfunction	4	6	8	192	High
22	R5 - R	Resistance drift	Component malfunction	4	6	8	192	High
23	D1 - ESD5Zxx	Junction failure	Component malfunction	8	4	6	192	High
24	D2 - ESD5Zxx	Junction failure	Component malfunction	8	4	6	192	High
25	J1 - USB_C_Receptacl	Contact oxidation	Intermittent connection, data	5	6	6	180	High
26	J2 - Conn_02x03_Odd_	Contact oxidation	Intermittent connection, data	5	6	6	180	High
27	D1 - ESD5Zxx	Reverse leakage	Component malfunction	5	5	7	175	High
28	D2 - ESD5Zxx	Reverse leakage	Component malfunction	5	5	7	175	High
29	R1 - R	Thermal damage	Component malfunction	7	4	6	168	High
30	R2 - R	Thermal damage	Component malfunction	7	4	6	168	High
31	R3 - R	Thermal damage	Component malfunction	7	4	6	168	High
32	R4 - R	Thermal damage	Component malfunction	7	4	6	168	High
33	R5 - R	Thermal damage	Component malfunction	7	4	6	168	High
34	U2 - ESP32-C6-MINI-1	I/O pin failure	Peripheral communication loss	6	5	5	150	High
35	U2 - ESP32-C6-MINI-1	Clock failure	System hang, timing errors	8	3	6	144	High

36	J1 - USB_C_Receptacl	Mechanical damage	Connection loss, physical dama	7	5	4	140	High
37	J2 - Conn_02x03_Odd_	Mechanical damage	Connection loss, physical dama	7	5	4	140	High
38	J1 - USB_C_Receptacl	Pin misalignment	Component malfunction	6	4	5	120	Medium
39	C1 - C	Short circuit	Power rail short, system damag	8	3	5	120	Medium
40	C2 - C	Short circuit	Power rail short, system damag	8	3	5	120	Medium
41	C3 - C	Short circuit	Power rail short, system damag	8	3	5	120	Medium
42	C4 - C	Short circuit	Power rail short, system damag	8	3	5	120	Medium
43	D1 - ESD5Zxx	Short circuit	Component malfunction	8	3	5	120	Medium
44	D2 - ESD5Zxx	Short circuit	Component malfunction	8	3	5	120	Medium
45	J2 - Conn_02x03_Odd_	Pin misalignment	Component malfunction	6	4	5	120	Medium
46	C1 - C	Open circuit	Component malfunction	7	3	5	105	Medium
47	C2 - C	Open circuit	Component malfunction	7	3	5	105	Medium
48	C3 - C	Open circuit	Component malfunction	7	3	5	105	Medium
49	C4 - C	Open circuit	Component malfunction	7	3	5	105	Medium
50	R1 - R	Open circuit	Component malfunction	6	3	5	90	Medium
51	R2 - R	Open circuit	Component malfunction	6	3	5	90	Medium
52	R3 - R	Open circuit	Component malfunction	6	3	5	90	Medium
53	R4 - R	Open circuit	Component malfunction	6	3	5	90	Medium
54	R5 - R	Open circuit	Component malfunction	6	3	5	90	Medium
55	D3 - LED	Luminosity degradation	Component malfunction	3	7	4	84	Medium
56	D3 - LED	Color shift	Component malfunction	2	6	5	60	Medium
57	D3 - LED	Burn out	Component malfunction	4	4	3	48	Low

Risk Assessment Matrix

Risk Level	RPN Range	Count	Action Required
Critical	≥ 300	3	Immediate action required
High	125-299	34	Action required before production
Medium	50-124	19	Monitor and improve if feasible
Low	< 50	1	Acceptable risk level

Recommendations

Priority Actions

- **J1 - USB_C_Receptacle_USB2.0_16P** - Solder joint failure: CRITICAL: Add mechanical support, use thicker copper pours, implement strain relief
- **J2 - Conn_02x03_Odd_Even** - Solder joint failure: CRITICAL: Add mechanical support, use thicker copper pours, implement strain relief
- **U1 - AMS1117-3.3** - Thermal shutdown: CRITICAL: Improve heatsinking, add thermal vias, consider higher-rated component
- **U2 - ESP32-C6-MINI-1** - ESD damage: CRITICAL: Add TVS diodes, implement ESD protection circuits, use guard rings
- **U1 - AMS1117-3.3** - Input overvoltage failure: CRITICAL: Review design and implement appropriate mitigation

General Recommendations

- Implement design review process with focus on high-RPN items
- Establish component derating guidelines (50-80% of maximum ratings)
- Add test points for critical signals to improve detection capability
- Implement thermal analysis and management for power components
- Establish incoming inspection procedures for critical components
- Document lessons learned and update FMEA regularly