PRODUCT RELIABILITY REPORT

Product: MPQ5857-AEC1

Reliability Department
Monolithic Power Systems
79 Great Oaks Boulevard
San Jose, CA 95119
Tel: 408-826-0600
Fax: 408-826-0601

1. Device Information

Product:	MPQ5857-AEC1
Package:	16-PIN FC-QFN(3mm×4mm)
Process Technology:	BCD
Report Date:	09/05/2025

2. Summary of Test Results

TEST GROUP A – ACCELERATED ENVIRONMENT STRESS TESTS					
Test	**#**	**Test Condition**	**Lot# or Date Code**	**Test Results (S.S./Rej)**	**Comment**
Preconditioning, prior to THB/HAST, AC/UHAST, TC, HTSL and PTC	A1	J-STD-020 Reflow: Tp>=260°C, tp>=30sec, 3×reflows	2511 2515 2523	308/0 308/0 308/0	MSL=1
Highly Accelerated Temperature and Humidity Stress Test (HAST)	A2	JESD22-A110, @130°C/85%RH static bias at Vinmax for 96 hours or equivalent	2511 2515 2523	77/0 77/0 77/0	
Unbiased HAST(UHAST)	A3	JESD22-A118, @130°C/85%RH for 168 hours or equivalent	2511 2515 2523	77/0 77/0 77/0	
Temperature Cycling (TC)	A4	JESD22-A104, from -65°C to 150°C for 1000 cycles or equivalent.	2511 2515 2523	77/0 77/0 77/0	
Power Temperature Cycling (PTC)	A5	JESD22-A105, from -40°C to 125°C for 1000 cycles.	HPB403	45/0	
High Temperature Storage Life (HTSL)	A6	JESD22-A103, @175°C for 1000 hours.	2511 2515 2523	77/0 77/0 77/0	
TEST GROUP B – ACCELERATED LIFETIME SIMULATION TESTS					
Test	**#**	**Test Condition**	**Lot# or Date Code**	**Test Results (S.S./Rej)**	**Comment**
High Temperature Operating Life (HTOL)	B1	JESD22-A108, @Tj=150°C for 1000 hours or equivalent	HPB403 HPA652 HPB872	77/0 77/0 77/0	

Early Life Failure Rate (ELFR)	B2	AEC-Q100-008, @Tj=150°C for 48 hours, or equivalent	HPB403 HPA652 HPB872	800/0 800/0 800/0	
High Temperature Data Retention – HTDR	B3	AEC-Q100-005, @150°C for 1000 hours	HPB403 HPA652 HPB872	39/0 39/0 39/0	
Dynamic READ – HTOL-R	B3	AEC-Q100-005, Read @125°C for 100K times	HPB403 HPA652 HPB872	38/0 38/0 38/0	
Low Temperature Data Retention – RTDR	B3	AEC-Q100-005,@25°C for 500hours	HPB403 HPA652 HPB872	39/0 39/0 39/0	
Dynamic READ – RTOL-R	B3	AEC-Q100-005, Read @25°C for 100K times	HPB403 HPA652 HPB872	38/0 38/0 38/0	
TEST GROUP C – PACKAGE ASSEMBLY INTEGRITY TESTS					
Test	**#**	**Test Condition**	**Lot# or Date Code**	**Test Results (S.S./Rej)**	**Comment**
Solderability (SD)	C3	JESD22-B102 J-STD-002D >95% lead coverage	2511	15/0	
Physical Dimensions (PD)	C4	JESD22-B100/108 AEC-Q003 C_{PK} >1.67	2511 2515 2523	30/0 30/0 30/0	
Bump Shear Test (BST)	C7	JESD22-B117 AEC-Q003 C_{PK} >1.67 20 bumps/pillars from a minimum of 5 devices	2511	5/0	
TEST GROUP D – DIE FABRICATION RELIABILITY TESTS					
Test	**#**	**Test Condition**	**Lot# or Date Code**	**Test Results (S.S./Rej)**	**Comment**
Electromigration (EM)	D1	JESD61 JP001	—	—	Pass
Time Dependent Dielectric Breakdown (TDDB)	D2	JESD36 JP001	—	—	Pass
Hot Carrier Injection (HCI)	D3	JESD60 and 28 JP001	—	—	Pass
Negative Bias Temperature Instability (NBTI)	D4	JESD90 JP001	—	—	Pass
Stress Migration (SM)	D5	JESD61,87 and 202 JP001	—	—	Pass

TEST GROUP E – ELECTRICAL VERIFICATION TESTS					
Test	**#**	**Test Condition**	**Lot# or Date Code**	**Test Results (S.S./Rej)**	**Comment**
ESD: Human Body Model (HBM)	E2	AEC-Q100-002	HPB403	3/0	>2000V
ESD: Device Charged Model (CDM)	E3	AEC-Q100-011	HPB403	3/0	>750V
Latch-up	E4	AEC-Q100-004	HPB403	6/0	>+/-100mA & >1.5Vccmax

5. Failure Rate Calculation

Sample Size:	8950
Rejects:	0
Activation Energy (eV):	0.7
Equivalent Device Hours:	6.98×10^{8} Hours
Failure Rate (FIT@60%CL):	1.3 FIT
MTBF (years):	87,095 Years

Revision / Update History

Revision	Reason for Change	Date	Rel Engineer
1.0	Initial release	September 2025	Ramon Lei

Appendix: Description of Reliability Test and Failure Rate Calculation

High Temperature Operating Life Test

Purpose: This test is a worst-case life test that checks the integrity of the product. The high temperature testing is use for acceleration of any potential failures over time. The calculation for failure rate (FIT) using the operating ambient temperature is done using the Arrhenius equation.
Condition: Tj=150°C @ Vinmax
Pass Criteria: All units must pass the min/max limits of the datasheet.

ESD Test

Purpose: The purpose of the ESD test is to guarantee that the device can withstand electrostatic voltages during handling.
Condition: Human Body Model and Charged Device Model
Pass Criteria: ESD Testing on every pin. The device must be fully functional after testing and pass the min/max limits in the datasheet.

IC Latch-Up Test

Purpose: The purpose of this specification is to establish a method for determining IC latch-up characteristics and to define latch-up failure criteria. Latch-up characteristics are extremely important in determining product reliability and minimizing No Trouble Found (NTF) and Electrical Overstress (EOS) failures due to latch-up.
Condition: Voltage and current injection
Pass criteria: All pins with the exception of "no connect" pins and timing related pins, shall be latch-up tested. The device must be fully functional after testing and pass the min/max limits in the datasheet.

Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices

Purpose: The purpose of this standard is to identify the classification level of nonhermetic solid state surface mount devices (SMDs) that are sensitive to moisture-induced stress so that they can be properly packaged, stored, and handled to avoid damage during assembly solder reflow attachment and/or repair operations.
Condition: Bake + moisture soak + 3X reflow at 260°C
Pass criteria: All units must pass the min/max limits of the datasheet

Accelerated Moisture Resistance- Unbiased Autoclave/ Unbiased HAST

Purpose: To check the performance of the device in humid environments. This test checks the integrity of the passivation, poor metal to plastic seal and contamination level during assembly and material compatibility.
Condition: 121°C/100% RH (Unbiased Autoclave), 130°C/85% RH (Unbiased HAST).
Pass Criteria: All units must pass min/max limits of the datasheet.

Temperature Cycle Test

Purpose: This test is conducted to determine the ability of components and solder interconnects to withstand mechanical stresses induced by alternating high- and low-temperature extremes.
Condition: -65°C to 150°C or other conditions.
Pass Criteria: All units must pass min/max limits of the datasheet.

Temperature Humidity Bias(THB)/Biased Highly Accelerated Stress Test (BHAST)

Purpose: This is to evaluate the reliability in humid environments. Temperature, humidity, and bias conditions are applied to accelerate the penetration of moisture through the external protective material (encapsulant or seal) or along the interface between the external protective material and the metallic conductors which pass through it check the performance of the device in humid environments.
Condition: 85°C/85%RH(THB), 130°C/85% RH (BHAST), with Vin=Vinmax.
Pass Criteria: All units must pass min/max limits of the datasheet.

Failure Rate Calculation

The failure rate is gauged by a Failures-In-Time (FIT) based upon accelerated stress data. The unit for FIT is failure per billion device hour.

$$FIT\ Rate = \frac{(\chi^2/2) \times 10^9}{EDH}$$

Where

$\chi 2$ (Chi-Squared) is the goodness-of-fit test statistic at a specified level of confidence;
EDH= Equivalent Device Hours = AF × (Life test sample size) × (test duration);
AF= Acceleration Factor.

High Temperature Operating Life (HTOL) test is usually done under acceleration of temperature and voltage. The total number of failures from the stress test determines the chi-squared factor.

$$AF=AF_T \times AF_V$$

The Temperature Acceleration Factor AF_T:

$$AF_T = \exp\left(\frac{E_a}{K}\left(\frac{1}{T_{J(use)}} - \frac{1}{T_{J(stress)}}\right)\right)$$

T_{Juse} = Junction temp under typical operating conditions;
$T_{Jstress}$ =Junction temp under accelerated test conditions;
Ea is Activation energy=0.7eV;
K=Boltzmann's constant=8.62×10^{-5} eV/K.

The voltage Acceleration Factor AF_V:

$$AF_V = e^{\beta\times[V_{stress}-V_{use}]}$$

V_{use} = Gate voltage under typical operating conditions;
V_{stress} = Gate voltage under accelerated test conditions;
β = Voltage acceleration factor (in 1/Volts) and specified by technology.
Note: For calculation in the report, AF_V = 1 for simplicity.

MTBF (Mean Time Between Failure) equals to 10^9/FIT (in hours).