Report No. MCR-21-0807
Date: 7/Sep./2021

# RENESAS SEMICONDUCTOR
# RELIABILITY REPORT

SERIES : RH850/F1KM-S1

DEVICE : R7F7016853AFP-C

APPLICATION : Automobile

Reliability & Failure Analysis Dept.
Quality Assurance Div.
Renesas Electronics Corporation

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# Q100 Qualification Test Results for R7F7016853AFP-C

[Note : Basically qualification tests were performed using a representative product with the same wafer process and the same package structure .]

| Test | # | Reference | Test Conditions | | Lots | S.S. | Total | Results (Fail of Total) | Comments: (N/A =Not Applicable) |
|---|---|---|---|---|---|---|---|---|---|
| **TEST GROUP A – ACCELERATED ENVIRONMENT STRESS TESTS** | | | | | | | | | |
| PC | A1 | JESD22 A113<br>J-STD-020 | Preconditioning: (Test @ Rm)<br>SMD only; Moisture Preconditioning for THB/HAST, AC/UHST, TC, &PTC ; Peak Reflow Temp=260°C | | Min.MSL=3 | | | MSL=3 | - |
| THB<br>~~or~~<br>~~HAST~~ | A2 | JESD22 A101 | Temperature Humidity Bias: (Test @ Rm/Hot)<br>Ta=85°C, RH=85%, 1000hrs | | 3 | 77 | 231 | 0 of 231 | - |
| ~~AC or~~<br>UHST<br>~~or TH~~ | A3 | JESD22 A118 | Unbiased Highly Accelerated Stree Test: (Test @ Rm)<br>110°C, 85% RH, 264h | | 3 | 77 | 231 | 0 of 231 | - |
| TC | A4 | JESD22 A104 | Temperature Cycle: (Test @ Hot)<br>Ta=-65°C to 150°C, 500cyc | | 3 | 77 | 231 | 0 of 231<br><br>0 Fails after TC (WBP) | - |
| PTC | A5 | JESD22 A105 | Power Temperature Cycle: (Test @ Rm/Hot)<br>- | | - | - | - | - | N/A |
| HTSL | A6 | JESD22 A103 | High Temperature Storage Life: (Test @ Rm/Hot)<br>Ta=150°C, 1000hrs | | 1 | 45 | 45 | 0 of 45 | - |
| **TEST GROUP B – ACCELERATED LIFETIME SIMULATION TESTS** | | | | | | | | | |
| HTOL | B1 | JESD22 A108 | High Temp Operating Life: (Test @ Rm/Cold/Hot)<br>Ta=150°C, 1000hrs | | 3 | 77 | 231 | 0 of 231 | - |
| ELFR | B2 | AEC-Q100-008 | Early Life Failure Rate: (Test @ Rm/Hot)<br>Ta=125°C, 48hrs | | 3 | 800 | 2400 | 0 of 2400 | - |
| EDR | B3 | AEC-Q100-005 | NVM Endurance & Data Retention Test: (Test @ Rm/Hot) | For HTOL | 3 | 77 | 231 | 0 of 231 | - |
| | | | | For HTSL | 1 | 45 | 45 | 0 of 45 | - |

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| Test | # | Reference | Test Conditions | Lots | S.S. | Total | Results (Fail of Total) | Comments: (N/A =Not Applicable) |
|---|---|---|---|---|---|---|---|---|
| **TEST GROUP C – PACKAGE ASSEMBLY INTEGRITY TESTS** | | | | | | | | |
| WBS | C1 | AEC-Q100-001<br>AEC-Q003 | Wire Bond Shear Test: (Cpk > 1.67) | 30 bonds | 5 parts Min. | 30 bonds | 0 of 30bonds | Cpk>1.67 |
| WBP | C2 | Mil-STD-883<br>Method 2011<br>AEC-Q003 | Wire Bond Pull: (Cpk > 1.67); Each bonder used | 30 bonds | 5 parts Min. | 30 bonds | 0 of 30bonds | Cpk>1.67 |
| SD | C3 | JESD22 B102<br>JSTD-002D | Solderability: (>95% coverage)<br>8 hr steam aging prior to testing | 1 | 15 | 15 | 0 of 15 | - |
| PD | C4 | JESD22 B100,<br>JESD22 B108<br>AEC-Q003 | Physical Dimensions: (Cpk > 1.67) | 3 | 10 | 30 | 0 of 30 | Cpk>1.67 |
| SBS | C5 | AEC-Q100-010<br>AEC-Q003 | Solder Ball Shear: (Cpk > 1.67); 5 balls from min. of 10 devices | - | - | - | - | N/A |
| LI | C6 | JESD22 B105 | Lead Integrity: (No lead cracking or breaking); Through-hole only; 10 leads from each of 5 devices | - | - | - | - | N/A |
| **TEST GROUP D – DIE FABRICATION RELIABILITY TESTS** | | | | | | | | |
| EM | D1 | JESD61 | Electromigration: | - | - | - | Pass | Confirmed by process TEG |
| TDDB | D2 | JESD35 | Time Dependant Dielectric Breakdown: | - | - | - | Pass | Confirmed by process TEG |
| HCI | D3 | JESD60 & 28 | Hot Carrier Injection: | - | - | - | Pass | Confirmed by process TEG |
| NBTI | D4 | JESD90 | Negative Bias Temperature Instability: | - | - | - | Pass | Confirmed by process TEG |
| SM | D5 | JESD61,87 & 202 | Stress Migration: | - | - | - | Pass | Confirmed by process TEG |

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| Test | # | Reference | Test Conditions | Lots | S.S. | Total | Results (Fail of Total) | Comments: (N/A =Not Applicable) |
|---|---|---|---|---|---|---|---|---|
| **TEST GROUP E- ELECTRICAL VERIFICATION** | | | | | | | | |
| TEST | E1 | User/Supplier Specification | Pre and Post Stress Electrical Test: | All | All | All | 0 of All | - |
| HBM | E2 | AEC-Q100-002 | Electrostatic Discharge, Human Body Model: (Test @ Rm/Hot); (2KV HBM / Class 2 or better) | 1 | 3 | 3 | 0 of 3 ESD Level= HBM:2 | HBM>2KV |
| CDM | E3 | AEC-Q100-011 | Electrostatic Discharge, Charged Device Model: (Test @ Rm/Hot); (750V corner leads, 500V all other leads / Class C4B or better) | 1 | 3 | 3 | 0 of 3 ESD Level= CDM:C4B | Corner leads: 750V Pass<br>All other leads:500V Pass |
| LU | E4 | AEC-Q100-004 | Latch-Up: (Test @ Rm/Hot) | 1 | 6 | 6 | 0 of 6 | - |
| ED | E5 | AEC-Q100-009 AEC-Q003 | Electrical Distributions: (Test @ Rm/Hot/Cold) (where applicable, Cpk>1.67) | 3 | 30 | 90 | Cpk>1.67 | - |
| FG | E6 | AEC-Q100-007 | Fault Grading: | - | - | - | >98% | - |
| CHAR | E7 | AEC-Q003 | Characterization: (Test @ Rm/Hot/Cold) | - | - | - | Pass | According to Renesas standard procedure |
| EMC | E9 | SAE J1752/3 | Electromagnetic Compatibility (Radiated Emissions) | 1 | 1 | 1 | 0 of 1 | - |
| SC | E10 | AEC Q100-012 | Short Circuit Characterization | - | - | - | - | N/A |
| SER | E11 | JESD89-1 JESD89-2 JESD89-3 | Soft Error Rate | 1 | 3 | 3 | Pass | - |
| LF | E12 | AEC-Q005 | Lead (Pb) Free: (see AEC-Q005) | - | - | - | Pass | Solderability: See SD (C3) result. Solder heat resistance: N/A (Wave Solder is Not recommended.) Whisker: Performed on product TEG with test method based on JESD201. |

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| Test | # | Reference | Test Conditions | Lots | S.S. | Total | Results (Fail of Total) | Comments: (N/A =Not Applicable) |
|---|---|---|---|---|---|---|---|---|
| **TEST GROUP F – DEFECT SCREENING TESTS** | | | | | | | | |
| PAT | F1 | AEC-Q001 | Process Average Testing: (see AEC-Q001) | All | All | All | Reject units outside PAT limits | Apply to mass production according to Renesas standard procedure |
| SBA | F2 | AEC-Q002 | Statistical Bin/Yield Analysis: (see AEC-Q002) | All | All | All | Reject units outside criteria | Apply to mass production according to Renesas standard procedure |
| **TEST GROUP G – CAVITY PACKAGE INTEGRITY TESTS (for Ceramic Package testing only)** | | | | | | | | |
| MS | G1 | JESD22 B104 | Mechanical Shock: (Test @ Rm) | - | - | - | - | N/A |
| VFV | G2 | JESD22 B103 | Variable Frequency Vibration: (Test @ Rm) | - | - | - | - | N/A |
| CA | G3 | MIL-STD-883 Method 2001 | Constant Acceleration: (Test @ Rm) | - | - | - | - | N/A |
| GFL | G4 | MIL-STD-883 Method 1014 | Gross and Fine Leak: | - | - | - | - | N/A |
| DROP | G5 | ---------- | Drop Test: (Test @ Rm)<br>MEMS cavity parts only. Drop part on each of 6 axes once from a height of 1.2m onto a concrete surface. | - | - | - | - | N/A |
| LT | G6 | MIL-STD-883 Method 2004 | Lid Torque: | - | - | - | - | N/A |
| DS | G7 | MIL-STD-883 Method 2019 | Die Shear: | - | - | - | - | N/A |
| IWV | G8 | MIL-STD-883 Method 1018 | Internal Water Vapor: | - | - | - | - | N/A |

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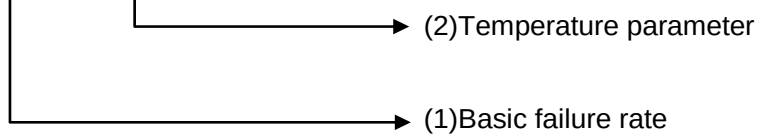
# Calculation method of standard failure rate

Operating reliability is decided by inherent reliability of device and environment condition of use (See below).

・Calculation method of standard failure rate (λ)

$$\lambda = \underline{\lambda b} \times \underline{\pi T} \quad (FIT)$$




(1) Basic failure rate (λ)

Ea：0.7(eV)　λb：0.0011　(FIT)

(2) Temperature parameter ( $\pi T$ )

$$\pi T = \exp\left\{11600 \times Ea \times \left(\frac{1}{273+55} - \frac{1}{273+Ta}\right)\right\}$$

Ea ： Activation energy(eV)

Ta ： ambient temperature

| πT simplified chart (Ea=0.7eV) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ta(˚C) | 40 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 100 | 110 |
| πT | 0.31 | 0.68 | 1.00 | 1.45 | 2.08 | 2.95 | 4.15 | 5.77 | 7.96 | 10.88 | 19.82 | 34.99 |

・Confidence level 60%　・Standard temperature　Ta = 55°C

(3) MTTF ( Mean Time To Failure )

$$MTTF = \frac{1}{\lambda}$$

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