

Report No. MCR-21-1101

Date: 15/Dec./2021

# RENESAS SEMICONDUCTOR RELIABILITY REPORT

SERIES : RH850/F1K

DEVICE : R7F7016234AFP-C

APPLICATION : Automobile

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

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## Q100 Qualification Test Results for R7F7016234AFP-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<br>(Fail of Total) | Comments:<br>(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,<br>&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>0 Fails after TC<br>(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:<br>(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<br>(Fail of Total) | Comments:<br>(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<br>bonds | 5 parts<br>Min. | 30<br>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<br>bonds | 5 parts<br>Min. | 30<br>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 |

| Test | # | Reference | Test Conditions | Lots | S.S. | Total | Results<br>(Fail of Total) | Comments:<br>(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:<br>(Test @ Rm/Hot); (2KV HBM / Class 2 or better)                                       | 1   | 3   | 3   | 0 of 3<br>ESD Level=<br>HBM:2   | HBM>2KV  |
| CDM  | E3  | AEC-Q100-011                     | Electrostatic Discharge, Charged Device Model:<br>(Test @ Rm/Hot); (750V corner leads, 500V all other leads / Class C4B or better) | 1   | 3   | 3   | 0 of 3<br>ESD Level=<br>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<br>AEC-Q003         | Electrical Distributions: (Test @ Rm/Hot/Cold)<br>(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<br>JESD89-2<br>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<br>(Wave Solder is Not recommended.) Whisker: Performed on product TEG with test method based on JESD201. |

| Test | # | Reference | Test Conditions | Lots | S.S. | Total | Results<br>(Fail of Total) | Comments:<br>(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<br>Method 2001 | Constant Acceleration: (Test @ Rm)  | - | - | - | - | N/A |
| GFL  | G4 | MIL-STD-883<br>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<br>Method 2004 | Lid Torque:   | - | - | - | - | N/A |
| DS   | G7 | MIL-STD-883<br>Method 2019 | Die Shear:  | - | - | - | - | N/A |
| IWV  | G8 | MIL-STD-883<br>Method 1018 | Internal Water Vapor:   | - | - | - | - | N/A |

### 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 ( $\lambda$ )

$\lambda = \lambda_b \times \pi T$  (FIT)

Diagram illustrating the components of the FIT equation:

- $\lambda_b$ : (1) Basic failure rate
- $\pi T$ : (2) Temperature parameter

(1) Basic failure rate ( $\lambda$ )

$E_a : 0.7(\text{eV}) \quad \lambda_b : 0.0011 \quad (\text{FIT})$

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

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

Ea : Activation energy(eV)

Ta : ambient temperature

| $\pi T$ simplified chart (Ea=0.7eV) |      |      |      |      |      |      |      |      |      |       |       |       |
|-------------------------------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| Ta(°C)                              | 40   | 50   | 55   | 60   | 65   | 70   | 75   | 80   | 85   | 90    | 100   | 110   |
| $\pi T$                             | 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  $T_a = 55^\circ\text{C}$

(3) MTTF ( Mean Time To Failure )

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