

Report No. MCR-21-0743

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RENESAS SEMICONDUCTOR RELIABILITY REPORT

SERIES : RL78/F14

DEVICE : R5F10PLHCLFB

APPLICATION : Automobile

Reliability & Failure Analysis Dept.
Quality Assurance Div.
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Q100 Qualification Test Results for R5F10PLHCLFB

[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 J-STD-020 | Preconditioning: (Test @ Rm) SMD only; Moisture Preconditioning for THB/HAST, AC/UHST, TC, &PTC ; Peak Reflow Temp=260°C | Min.MSL=3 | | | MSL=3 | - |
| THB or HAST | A2 | JESD22 A101 | Temperature Humidity Bias: (Test @ Rm/Hot) Ta=85°C, RH=85%, 1000hrs | 3 | 77 | 231 | 0 of 231 | - |
| AC or UHST or TH | A3 | JESD22 A118 | Unbiased Highly Accelerated Stree Test: (Test @ Rm) 110°C, 85% RH, 264h | 3 | 77 | 231 | 0 of 231 | - |
| TC | A4 | JESD22 A104 | Temperature Cycle: (Test @ Hot) Ta=-65°C to 150°C, 500cyc | 3 | 77 | 231 | 0 of 231 0 Fails after TC (WBP) | - |
| PTC | A5 | JESD22 A105 | Power Temperature Cycle: (Test @ Rm/Hot) | - | - | - | - | N/A |
| HTSL | A6 | JESD22 A103 | High Temperature Storage Life: (Test @ Rm/Hot) 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) Ta=125°C, 1000hrs | 3 | 77 | 231 | 0 of 231 | - | |
| ELFR | B2 | AEC-Q100-008 | Early Life Failure Rate: (Test @ Rm/Hot) 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 | - |

| 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 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 Method 2011 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 JSTD-002D | Solderability: (>95% coverage) 8 hr steam aging prior to testing | 1 | 15 | 15 | 0 of 15 | - |
| PD | C4 | JESD22 B100, JESD22 B108 AEC-Q003 | Physical Dimensions: (Cpk > 1.67) | 3 | 10 | 30 | 0 of 30 | Cpk>1.67 |
| SBS | C5 | AEC-Q100-010 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 (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 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 | 3 | 1 | 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. |

| 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) 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 |

Calculation method of standard failure rate

Target : 0.13um CMOS process product (RL78 series Automobile)

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

Calculation method of standard failure rate (λ)

$$\lambda = \lambda_b \times \pi T \quad (\text{FIT})$$

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 (2)Temperature parameter

 (1)Basic failure rate

(1)Basic failure rate(λ_b)

λ_b : 0.18 (FIT)

(2)Temperature parameter

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

E_a : Activation energy (eV)

T_a : ambient temperature

πT Simplified chart ($E_a=0.7\text{eV}$)

| $T_a(^{\circ}\text{C})$ | 40 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 100 | 110 |
|-------------------------|------|------|----|------|------|------|------|------|------|-------|-------|-------|
| πT | 0.31 | 0.68 | 1 | 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)

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