# Test Report: RSD-60G-3.3

60W Reliable Railway DC-DC Converter

## ■ DESIGN VERIFY TEST

Output Function Test
Input Function Test
Protection Function Test
Component Stress Test

## ■ SAFETY & E.M.C. TEST

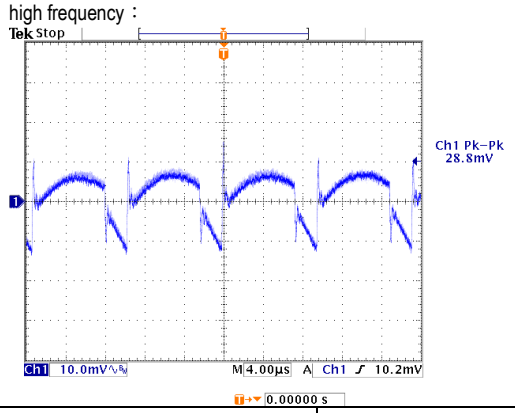
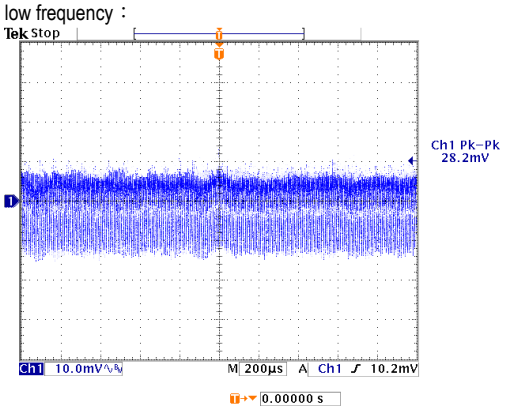
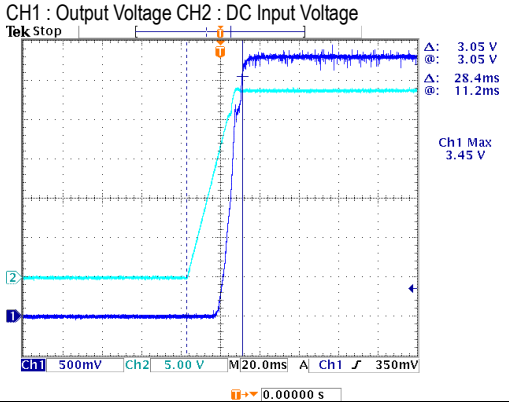
Safety Test
E.M.C. Test

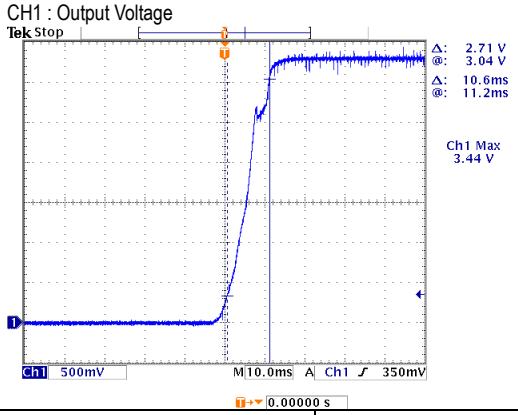
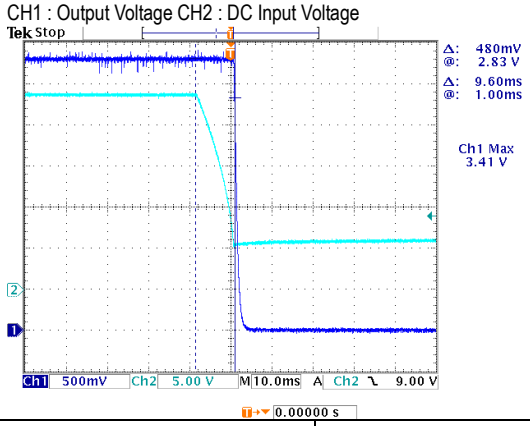
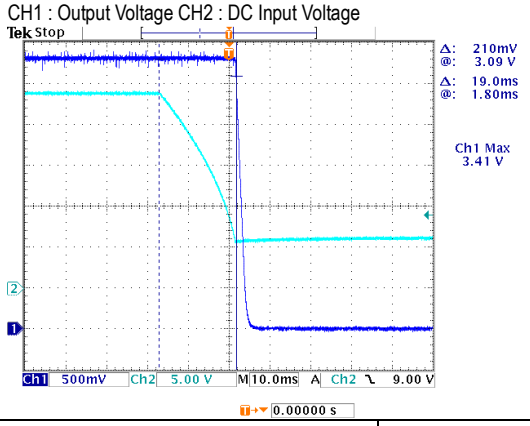
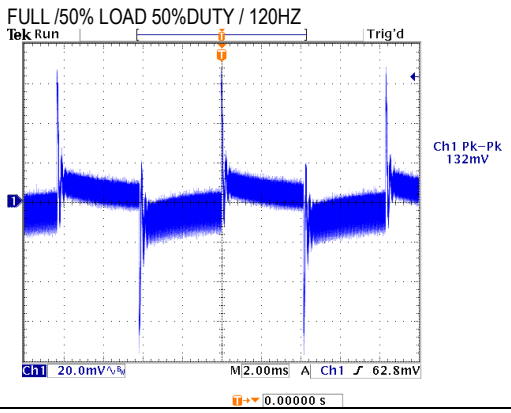
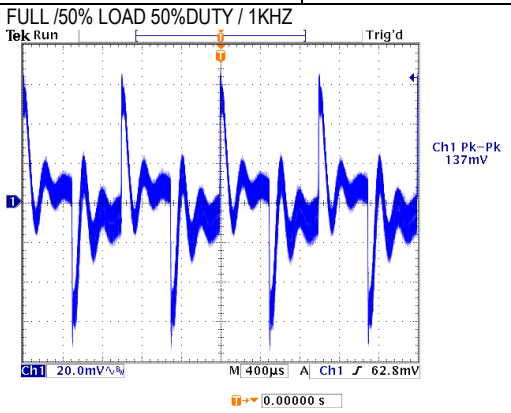
## ■ RELIABILITY TEST

ENVIRONMENT TEST

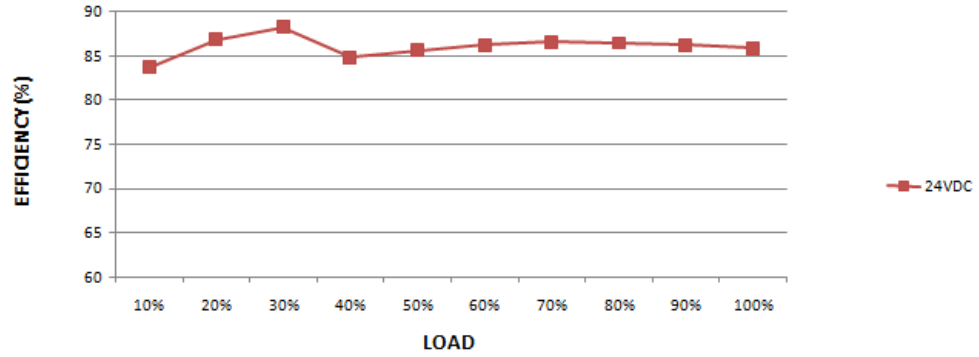
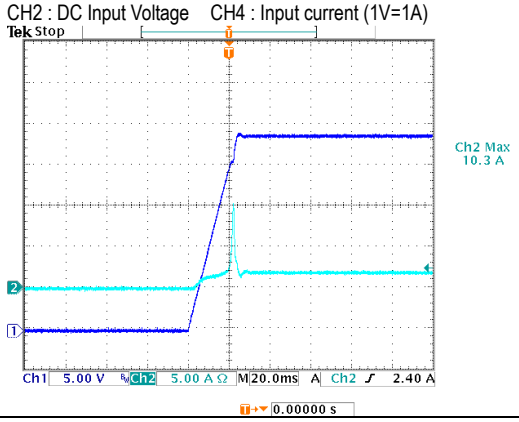
# ■ DESIGN VERIFY TEST

### OUTPUT FUNCTION TEST

| NO | TEST ITEM | SPECIFICATION | TEST CONDITION | RESULT |
|---|---|---|---|---|
| 1 | OUTPUT VOLTAGE TOLERANCE (Max) | V1: 2 %~ -2 % | I/P: 9 VDC / 36 VDC<br>O/P:FULL/ MIN. LOAD<br>Ta:25℃ | V1: 0.5545%~ 0.9788% |
| 2 | LINE REGULATION (Max) | V1: 0.5 %~ -0.5 % | I/P: 9 VDC / 36 VDC<br>O/P:FULL LOAD<br>Ta:25℃ | V1: 0 %~ 0 % |
| 3 | LOAD REGULATION (Max) | V1: 0.5 %~ -0.5 % | I/P: 24VDC<br>O/P:FULL ~MIN LOAD<br>Ta:25℃ | V1:-0.207%~0.207% |
| 4 | OVER/UNDERSHOOT TEST | < ±15% | I/P: 24 VDC<br>O/P:FULL LOAD<br>Ta:25℃ | TEST: 9.091% |
| 5 | RIPPLE & NOISE (Max) | V1: 60 mVp-p | I/P: 24 VDC<br>O/P:FULL LOAD<br>Ta:25℃ | V1: 28.8mVp-p |
| | high frequency：<br>  | | low frequency：<br>  | |
| 6 | SET UP TIME (Max) | 24VDC/ 100 ms | I/P: 24VDC<br>O/P:FULL LOAD<br>Ta:25℃ | 24VDC/ 28.4ms |
| | INPUT=24VDC @ FULL LOAD<br>CH1 : Output Voltage CH2 : DC Input Voltage<br>  | | | |
| 7 | RISE TIME (Max) | 24VDC/ 60 ms | I/P: 24 VDC<br>O/P:FULL LOAD<br>Ta:25℃ | 24VDC/ 10.6 ms |

| | | | | |
|---|---|---|---|---|
| | INPUT=24VDC @ FULL LOAD<br>CH1 : Output Voltage<br>  | | | |
| 8 | HOLD UP TIME (TYP) | 24VDC/ 3 ms<br>24VDC/ 10 ms | I/P: 24 VDC<br>O/P:F ULL LOAD / 50% LOAD<br>Ta:25℃ | 9.6 ms / full load<br>19 ms / 50% load |
| | INPUT=24VDC @ FULL LOAD<br>CH1 : Output Voltage CH2 : DC Input Voltage<br>  | | INPUT=24VDC @ 50% LOAD<br>CH1 : Output Voltage CH2 : DC Input Voltage<br>  | |
| 9 | DYNAMIC LOAD | V1: 990 mVp-p | I/P: 24VDC<br>O/P:<br>(1)FULL /MIN LOAD 50%DUTY / 120HZ<br>(2)FULL /MIN LOAD 50%DUTY / 1KHZ<br>Ta:25℃ | <br><br>132mVp-p<br>137mVp-p |
| | FULL /50% LOAD 50%DUTY / 120HZ<br>  | | FULL /50% LOAD 50%DUTY / 1KHZ<br>  | |

## INPUT FUNCTION TEST

| NO | TEST ITEM | SPECIFICATION | TEST CONDITION | RESULT |
|---|---|---|---|---|
| 1 | INPUT VOLTAGE RANGE | 9VDC~ 36 VDC | I/P:TESTING<br>O/P:FULL LOAD<br>Ta:25℃ | 8.148V~ 36 V |
| | | | I/P:<br>LOW-LINE-0.2= 8.8 V<br>HIGH-LINE+3V= 39 V<br>O/P:FULL/MIN LOAD<br>(PLEASE CHECK DERATING CURVE)<br>ON: 30 Sec . OFF: 30 Sec 10MIN<br>( POWER ON/OFF NO DAMAGE ) | TEST ： OK |
| 2 | DC CURRENT(TYP) | 24VDC/ 2.1A | I/P: 24VDC<br>O/P:FULL LOAD<br>Ta:25℃ | I =1.884A/24VDC |
| 3 | EFFICIENCY(TYP) | 86.5% | I/P: 24VDC<br>O/P:FULL LOAD<br>Ta:25℃ | 87.1% |
| | EFFICIENCY vs LOAD  | | | |
| 4 | INRUSH CURRENT(TYP) | 24VDC/ 20A<br>COLD START | I/P:24VDC<br>O/P:FULL LOAD<br>Ta:25℃ | I =10.3A/24 VDC |
| | INPUT=24VDC @ FULL LOAD<br>CH2 : DC Input Voltage CH4 : Input current (1V=1A)  | | | |

### PROTECTION FUNCTION TEST

| NO | TEST ITEM | SPECIFICATION | TEST CONDITION | RESULT |
|---|---|---|---|---|
| 1 | OVER LOAD PROTECTION | 105%~135 %RATED OUTPUT POWER<br>PROTECTION TYPE：<br>Constant current limiting, recovers automatically after fault condition is removed | I/P: 36VDC<br>I/P: 24VDC<br>I/P: 9VDC<br>O/P:TESTING<br>Ta:25℃ | 117.42%<br>117.42%<br>117.25%<br>PROTECTION TYPE：<br>Constant current limiting, recovers automatically after fault condition is removed |
| 2 | OVER VOLTAGE PROTECTION | CH: 4.3V~ 4.95 V<br>PROTECTION TYPE：<br>Shut down o/p voltage, re-power on to recover | I/P: 36 VDC<br>I/P: 24VDC<br>I/P: 9VDC<br>O/P：NO LOAD<br>Ta:25℃ | 4.69V<br>4.64V<br>4.70V<br>PROTECTION TYPE：<br>Shut down o/p voltage, re-power on to recover |
| 3 | SHORT PROTECTION | SHORT EVERY OUTPUT<br>1 HOUR NO DAMAGE | I/P: 36VDC<br>O/P: FULL LOAD<br>Ta:25℃ | NO DAMAGE<br>PROTECTION TYPE： |
| 4. | INPUT REVERSE | POWER OK | I/P: 36 VDC<br>O/P: NO LOAD<br>Ta:25℃ | NO DAMAGE |

## COMPONENT STRESS TEST

| NO | TEST ITEM | SPECIFICATION | TEST CONDITION | RESULT |
|---|---|---|---|---|
| 1 | PWM Transistor<br>( D to S) or (C to E) **Peak Voltage** | Q3 Rated<br>:70 A/ 100V | I/P:High-Line +3V =39V<br>AC ON/OFF<br>VDS:<br>O/P: (1)Full Load<br>(2)Output Short<br>(3) Full Load Continue<br>Ta:25℃ | <br><br>VDS:<br>(1) 98.5V<br>(2) 92.4V<br>(3) 88.8V |
| 2 | Diode Peak **Voltage** | Q100 Rated<br>:90 A/ 40V | I/P:High-Line +3V =39V<br>AC ON/OFF<br>O/P: (1)Full Load<br>(2)Output Short<br>(3) Full Load Continue<br>Ta:25℃ | Q100:<br>VDS:<br>(1) 35.4V<br>(2) 29.2V<br>(3) 35.0V |
| 3 | **Input Capacitor Voltage** | C5 Rated:<br>:220 μ / 50 V<br>100℃ | I/P:High-Line +3V =39V<br>O/P: (1)Full Load input on/off<br>(2) Min load input on /Off<br>(3)Full Load /Min load Change<br>(4)Full load continue<br>Ta:25℃ | (1) 40.6V<br>(2) 40.6V<br>(3) 40.6V<br>(4) 40.6V |
| 4 | **Control IC Voltage Test** | PWM IC U1 Rated<br>: 40 V<br>V(MIN.) -0.3 V | I/P:High-Line +3V =39V<br>AC ON/OFF<br>O/P(1)FULL LOAD<br>(2) Output Short<br>(3)O.L.P<br>(4)O.V.P.<br>Ta:25℃ | (1) 17.8V<br>(2) 12.0V<br>(3) 12.0V<br>(4) 16.6V |

| | | | | |
|---|---|---|---|---|
| 5 | Clamp Diode Peak Voltage | D4 Rated：<br>600 V / 3 A | I/P：High-Line +3V = 39V<br>AC ON/OFF<br>O/P： (1) Dynamic Load<br>90%Duty/1KHz<br>(2)Full load continue<br>Ta：25℃ | (1) 39.0V<br>(2) 30.4V |

**SAFETY TEST**

| NO | TEST ITEM | SPECIFICATION | TEST CONDITION | RESULT |
|---|---|---|---|---|
| 1 | WITHSTAND VOLTAGE | EN 60950-1<br>I/P-O/P:4KVDC/min<br>I/P-FG:2 .5KVDC/min<br>O/P-FG:2.5KVDC/min | I/P-O/P: 4.4KVDC/min<br>I/P-FG: 3 KVDC/min<br>O/P-FG:3KVDC/min<br>Ta:25℃ | I/P-O/P: 1.49mA<br>I/P- FG: 1.23mA<br>O/P-FG: 1.54mA<br>NO DAMAGE |
| 2 | ISOLATION RESISTANCE | I/P-O/P:500VDC>100MΩ<br>I/P-FG: 500VDC>100MΩ<br>O/P-FG:500VDC>100MΩ | I/P-O/P: 500 VDC<br>I/P-FG: 500 VDC<br>O/P-FG: 500 VDC<br>Ta:25℃ | I/P-O/P: 9999 MΩ<br>I/P- FG: 9999 MΩ<br>O/P - FG: 9999 MΩ<br>NO DAMAGE |
| 3 | GROUNDING CONTINUITY | EN 60950-1<br>FG(PE) TO CHASSIS<br>OR TRACE < 100 mΩ | 40A / 2min<br>Ta:25℃ | **25mΩ** |

**E.M.C TEST**

| NO | TEST ITEM | SPECIFICATION | TEST CONDITION | RESULT |
|---|---|---|---|---|
| 1 | RADIATION | EN55032<br>CLASS B | I/P: 24 VDC<br>O/P:FULL LOAD<br>Ta:25℃ | PASS<br>Test by certified Lab |
| 2 | CONDUCTION | EN55032<br>CLASS B | I/P: 24 VDC<br>O/P:FULL LOAD<br>Ta:25℃ | PASS<br>Test by certified Lab |
| 3 | E.S.D | EN61000-4-2<br>LIGHT INDUSTRY<br>AIR:8KV / Contact:6KV | I/P: 24 VDC<br>O/P:FULL LOAD<br>Ta:25℃ | CRITERIA A |
| 4 | E.F.T | EN61000-4-4<br>LIGHT INDUSTRY<br>INPUT: 2KV | I/P: 24 VDC<br>O/P:FULL LOAD<br>Ta:25℃ | CRITERIA A |
| 5 | SURGE | IEC61000-4-5<br>LIGHT INDUSTRY<br>L-N :1KV<br>L,N-PE:2KV | I/P: 24 VDC<br>O/P:FULL LOAD<br>Ta:25℃ | CRITERIA A |
| 6 | Test by certified Lab & Test Report Prepare | | | |

# ■ RELIABILITY TEST

## ENVIRONMENT TEST

<table>
<tr><th>NO</th><th>TEST ITEM</th><th>SPECIFICATION</th><th>TEST CONDITION</th><th>RESULT</th></tr>
<tr><td>2</td><td>TEMPERATURE RISE TEST</td><td colspan="3">MODEL： RSD-60G-5<br>1. ROOM AMBIENT BURN-IN： 1HRS<br>I/P： 36VDC O/P： FULL LOAD Ta= 23.4℃<br>2. HIGH AMBIENT BURN-IN： 1HRS<br>I/P： 36VDC O/P： FULL LOAD Ta= 53.2℃
<table>
<tr><th>NO</th><th>Position</th><th>ROOM AMBIENT Ta= 23.4 ℃</th><th>HIGH AMBIENT Ta= 53.2 ℃</th></tr>
<tr><td>1</td><td>C12</td><td>47.8℃</td><td>76.7℃</td></tr>
<tr><td>2</td><td>LF1</td><td>50.6℃</td><td>80.1℃</td></tr>
<tr><td>3</td><td>C5</td><td>48.8℃</td><td>77.9℃</td></tr>
<tr><td>4</td><td>C6</td><td>50.5℃</td><td>79.7℃</td></tr>
<tr><td>5</td><td>C40</td><td>52.7℃</td><td>81.9℃</td></tr>
<tr><td>6</td><td>T2</td><td>59.5℃</td><td>89.0℃</td></tr>
<tr><td>7</td><td>T1</td><td>65.7℃</td><td>95.3℃</td></tr>
<tr><td>8</td><td>C110</td><td>56.5℃</td><td>86.0℃</td></tr>
<tr><td>9</td><td>C105</td><td>59.8℃</td><td>89.6℃</td></tr>
<tr><td>10</td><td>L100</td><td>55.5℃</td><td>85.0℃</td></tr>
<tr><td>11</td><td>C108</td><td>47.8℃</td><td>76.5℃</td></tr>
<tr><td>12</td><td>Q1</td><td>49.1℃</td><td>78.3℃</td></tr>
<tr><td>13</td><td>Q2</td><td>50.1℃</td><td>79.4℃</td></tr>
<tr><td>14</td><td>Q3</td><td>67.5℃</td><td>98.3℃</td></tr>
<tr><td>15</td><td>U1</td><td>55.7℃</td><td>84.8℃</td></tr>
<tr><td>16</td><td>D4</td><td>66.3℃</td><td>95.4℃</td></tr>
<tr><td>17</td><td>Q100</td><td>60.5℃</td><td>90.4℃</td></tr>
<tr><td>18</td><td>U100</td><td>50.0℃</td><td>79.0℃</td></tr>
<tr><td>19</td><td>D1</td><td>47.9℃</td><td>77.1℃</td></tr>
</table></td></tr>
<tr><td>3</td><td>OVER LOAD BURN-IN TEST</td><td>NO DAMAGE<br>1 HOUR ( MIN )</td><td>I/P： 24VDC<br>O/P：114 % LOAD<br>Ta：25℃</td><td>TEST：OK</td></tr>
<tr><td>4</td><td>LOW TEMPERATURE<br>TURN ON TEST</td><td>TURN ON AFTER 2 HOUR</td><td>I/P： 36VDC/ 9VDC<br>O/P： 100 % LOAD<br>Ta= -40 ℃</td><td>TEST：OK</td></tr>
<tr><td>5</td><td>HIGH HUMIDITY<br>HIGH TEMPERATURE<br>HIGH VOLTAGE<br>TURN ON TEST</td><td>AFTER 12 HOURS<br>IN CHAMBER ON<br>CONTROL 55 ℃<br>NO DAMAGE</td><td>I/P： 39VDC<br>O/P：FULL LOAD<br>Ta= 55 ℃<br>HUMIDITY= 95 %R.H</td><td>TEST：OK</td></tr>
<tr><td>6</td><td>TEMPERATURE<br>COEFFICIENT</td><td>± 0.03 %(0~50℃)</td><td>I/P： 24VDC<br>O/P：FULL LOAD</td><td>± 0.0066 %(0~50℃)</td></tr>
<tr><td>7</td><td>STORAGE TEMPERATURE TEST</td><td colspan="2">1. Thermal shock Temperature： -40℃~ +85℃<br>2. Temperature change rate ：25℃ / MIN<br>3. Dwell time low and high temperature ： 30 MIN/EACH<br>4. Total test cycle：5 CYCLE<br>5. Input/Output condition： STATIC</td><td>TEST：OK</td></tr>
</table>

| | | | |
|---|---|---|---|
| **8.** | THERMAL SHOCK TEST | 1. Thermal shock Temperature： -45℃~ +60℃<br>2. Temperature change rate ：25℃ / MIN<br>3. Dwell time low and high temperature ： 30 MIN/EACH<br>4. Total test cycle：10 CYCLE<br>5. Input/Output condition： 36VDC/Full Load DC ON/OFF TEST<br>turn on 58sec；turn off 2sec | TEST：OK |
| **9** | VIBRATION TEST | 1 Carton & 1 Set<br>(1) Waveform： Sine Wave<br>(2) Frequency：10~500Hz<br>(3) Sweep Time：12min/sweep cycle<br>(4) Acceleration：5G<br>(5) Test Time：60min in each axis (X.Y.Z)<br>(6) Ta：25℃ | TEST：OK |
| **10** | CAPACITOR<br>LIFE CYCLE | SUPPOSE C105 IS THE MOST CRITICAL COMPONENT<br>(1) I/P： 230VAC O/P：FULL LOAD Ta= 55℃ LIFE TIME<br>(2) I/P： 230VAC O/P：FULL LOAD Ta= 55℃ LIFE TIME<br>(3) I/P： 230VAC O/P：75% LOAD Ta= 55℃ LIFE TIME<br>(4) I/P： 230VAC O/P：50% LOAD Ta= 55℃ LIFE TIME | (1) 158118HRS<br>(2) 25053HRS<br>(3) 88914HRS<br>(4) 158118HRS |
| **11** | MTBF | Conducted by Parts Stress Analysis Prediction<br>593.8K hrs min. MIL-HDBK-217F (25℃) | |
| **12** | DMTBF/Accelerated Life Test | Demonstration Mean Time Between Failure (Expected Life): Above 30,000 hours @ TA 55℃ | |

| TEST RESULT | TESTER | REVIEW | APPROVAL |
|---|---|---|---|
| PASS | Frank | Gesg | Wangdz |

**2007/3/20 A50-S014**