Z⁺ 600 H.V Series

RELIABILITY

DATA

<table>
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<tr>
<th>APPD</th>
<th>CHK</th>
<th>DWG</th>
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<td>3/12/14</td>
<td>8/12/14</td>
<td>Kami S. Nov-29-14</td>
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TDK-Lambda
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1. MTBF; Calculated value of MTBF  
2. Components derating  
3. Main components temperature rise  
4. Electrolytic capacitors computed life  
5. Abnormal test  
6. Vibration test  
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8. Thermal shock test  
9. Fan life expectancy

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Terminology used

FG........ Frame Ground

*The above data is typical value. As all units have nearly the same characteristics, the data to be considered as ability value.*
1. Calculated value of MTBF

\[ Z^+ 600 \text{ H.V} \]

\[ Z^+ 600 \text{ H.V Series} \]

(1) Calculating Method

Method of calculation according to MIL-HDBK-217F. Individual failure rates is given to each part, and MTBF is calculated by the count of each part.

Formula:

\[ MTBF = \frac{1}{\lambda_{\text{equip}}} \times 10^6 = \frac{1}{\sum_{i=1}^{n} N_i (\lambda_G \pi_Q)_i} \times 10^6 (\text{hours}) \]

Where:

\[ \lambda_{\text{equip}} = \text{Total Equipment Failure Rate (Failures / 10^6 Hours)} \]

\[ \lambda_G = \text{Generic Failure Rate For The } i \text{ th Generic Part (Failure / 10^6 Hours)} \]

\[ N_i = \text{Quantity of } i \text{ th Generic Part} \]

\[ n = \text{Number of Different Generic Part Categories} \]

\[ \pi_Q = \text{Generic Quality factor for the } i \text{ th Generic Part (} \pi_Q = 1 \) \]

(2) MTBF Values

\[ G_F : (\text{GROUND, FIXED}) \]

\[ MTBF = 76,274 \text{ (HOURS)} \]

(MTBF calculation for fan isn't included.)
2. Components derating

*Z⁺ 600 H.V Series*

(1) Calculation method

1. Measuring Conditions
   
   Input: 100, 200Vac  
   Output: Full load  
   Ambient temperature: 50°C  
   Mounting Method: Standard Mounting

2. Semiconductors
   
   Compared with maximum junction temperature and actual one which is calculated based on on case temperature, power dissipation and thermal impedance.

3. IC, Resistors, Capacitors, etc.
   
   Ambient temperature, operating conditions, power dissipation and so on are within derating criteria.

4. Calculation Method of Thermal Impedance:

\[
\Theta_{j-c} = \frac{T_{j(max)} - T_c}{P_{c(max)}} \\
\Theta_{j-a} = \frac{T_{j(max)} - T_a}{P_{c(max)}}
\]

- \(T_c\) : Case temperature at start point of derating; 25°C in general
- \(T_a\) : Ambient temperature at start point of derating; 25°C in general
- \(P_{c(max)}\) : Maximum power dissipation
- \(T_{j(max)}\) : Maximum junction temperature
- \(\Theta_{j-c}\) : Thermal impedance between junction and case
- \(\Theta_{j-a}\) : Thermal impedance between junction and air
(2) Component derating list

<table>
<thead>
<tr>
<th>Location No.</th>
<th>Vin = 100Vac</th>
<th>Pd =</th>
<th>Tjmax =</th>
<th>D.F. =</th>
<th>Tj =</th>
<th>Tc =</th>
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<td>150 °C</td>
<td>0.2 W</td>
<td>Tj = Tc + (θ x Pd)</td>
<td>Ta = 71.0 °C</td>
<td>98.6 °C</td>
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<td>14.2 W</td>
<td>21.0 °C</td>
<td>D.F. = 65.7 %</td>
<td>104.5 °C</td>
<td>53.2 %</td>
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<td>11.1 °C</td>
<td>51.0 %</td>
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<td>Load=100%</td>
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<td>Tjmax= 175 °C  θj-c = 1.2 °C/W  Pd = 2.6 W  ΔTc = 26.5 °C  Tc = 76.5 °C  Tj = Tc + (θ j-c x Pd) =&gt; Tj = 79.6 °C  D.F. = 45.5 %</td>
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<tr>
<td>Q101 IPW60R075CP INFINEON</td>
<td>Tjmax= 150 °C  θj-c = 0.3 °C/W  Pd = 16.7 W  ΔTc = 21.0 °C  Tc = 71.0 °C  Tj = Tc + (θ j-c x Pd) =&gt; Tj = 75.9 °C  D.F. = 50.6 %</td>
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<td>Q104 FMP30N60S1 INFINEON</td>
<td>Tjmax= 150 °C  θj-c = 0.5 °C/W  Pd = 11.4 W  ΔTc = 55.2 °C  Tc = 105.2 °C  Tj = Tc + (θ j-c x Pd) =&gt; Tj = 110.9 °C  D.F. = 73.9 %</td>
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<td>SC101 CR12CM-12A B00 RENESAS</td>
<td>Tjmax= 125 °C  θj-c = 1.2 °C/W  Pd = 2.4 W  ΔTc = 24.3 °C  Tc = 74.3 °C  Tj = Tc + (θ j-c x Pd) =&gt; Tj = 77.2 °C  D.F. = 61.7 %</td>
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<td>PC101 PS2801-1-F3-A(P) NEC</td>
<td>Tjmax= 125 °C  θj-c = 1.67 °C/W  Pd = 0.06 W  ΔTc = 13.8 °C  Tc = 63.8 °C  Tj = Tc + (θ j-c x Pd) =&gt; Tj = 63.9 °C  D.F. = 51.1 %</td>
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<td>Q117 FMH09N90E FUJI</td>
<td>Tjmax= 150 °C  θj-c = 0.61 °C/W  Pd = 0.0 W  ΔTc = 21.2 °C  Tc = 71.2 °C  Tj = Tc + (θ j-c x Pd) =&gt; Tj = 71.2 °C  D.F. = 47.5 %</td>
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<td>AD7798BRUZ T1</td>
<td>Tjmax=150 °C θj-c = 14.0 °C/W</td>
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<td>Tj = Tc + (θ j-c x Pd) =&gt; Tj = 68.8 °C D.F. = 45.9 %</td>
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<td>Tj = Ta + (θ j-a x Pd) =&gt; Tj = 62.5 °C D.F. = 41.7 %</td>
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<td>Tj = Ta + (θ j-a x Pd) =&gt; Tj = 85.2 °C D.F. = 68.1 %</td>
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<td>L4941BV</td>
<td>Tjmax=150 °C θj-c = 3.0 °C/W</td>
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<td>Pd = 0.6 W ΔTc = 11.1 °C Tc = 61.1 °C</td>
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<td>Tj = Tc + (θ j-c x Pd) =&gt; Tj = 62.9 °C D.F. = 41.9 %</td>
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<td>Tj = Tc + (θ j-c x Pd) =&gt; Tj = 66.3 °C D.F. = 53.0 %</td>
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<td>Tj = Ta + (θ j-a x Pd) =&gt; Tj = 93.0 °C D.F. = 74.4 %</td>
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<td>MIP2E5DMY MATSUSHITA</td>
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<td>Pd = 1.4 W ΔTc = 24.3 °C Tc = 74.3 °C</td>
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<td>Tj = Tc + (θ j-c x Pd) =&gt; Tj = 78.5 °C D.F. = 52.3 %</td>
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<td>Pd = 0.08 W ΔTa = 18.6 °C Ta = 68.6 °C</td>
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<td>Tj = Ta + (θ j-a x Pd) =&gt; Tj = 87.1 °C D.F. = 69.7 %</td>
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<td>CRH01(TE85L,Q)</td>
<td>Tjmax=150 °C θj-c = 130.0 °C/W</td>
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<tr>
<td>TOSHIBA</td>
<td>Pd = 0.06 W ΔTc = 26.4 °C Tc = 76.4 °C</td>
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<td>Tj = Tc + (θ j-c x Pd) =&gt; Tj = 84.2 °C D.F. = 56.1 %</td>
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<td>CRH01(TE85L,Q)</td>
<td>Tjmax=150 °C θj-c = 130.0 °C/W</td>
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<tr>
<td>TOSHIBA</td>
<td>Pd = 0.035 W ΔTc = 16.1 °C Tc = 66.1 °C</td>
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<td>Tj = Tc + (θ j-c x Pd) =&gt; Tj = 70.7 °C D.F. = 47.1 %</td>
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<td>CRH01(TE85L,Q)</td>
<td>Tjmax=150 °C θj-c = 130.0 °C/W</td>
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<td>TOSHIBA</td>
<td>Pd = 0.03 W ΔTc = 13.8 °C Tc = 63.8 °C</td>
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<td></td>
<td>Tj = Tc + (θ j-c x Pd) =&gt; Tj = 67.7 °C D.F. = 45.1 %</td>
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<td>Q116</td>
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<td>IP037N06L3 G</td>
<td>Tjmax=175 °C θj-c = 6.3 °C/W</td>
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<td>INFINEON</td>
<td>Pd = 0.46 W ΔTc = 37.7 °C Tc = 87.7 °C</td>
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<td>Tj = Tc + (θ j-c x Pd) =&gt; Tj = 90.6 °C D.F. = 51.8 %</td>
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<td>PC106</td>
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<td>PS2581L2-E3-A(D)</td>
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<td>NEC</td>
<td>Pd = 0.004 W ΔTa = 10.4 °C Ta = 60.4 °C</td>
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<td>Tj = Ta + (θ j-a x Pd) =&gt; Tj = 63.1 °C D.F. = 50.5 %</td>
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### 3. Main components temperature rise

**MODEL : 160V-4A**

**Condition:**

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<td><strong>Output Current</strong></td>
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<td><strong>Ta</strong></td>
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<th>Location No.</th>
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<th>$\Delta T$ Temperature Rise ($^\circ$C)</th>
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<tr>
<td>D116</td>
<td>DIODE</td>
<td>38.1  37.2</td>
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<tr>
<td>D117</td>
<td>DIODE</td>
<td>38.6  36.4</td>
</tr>
<tr>
<td>D118</td>
<td>DIODE</td>
<td>39.2  38.2</td>
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<tr>
<td>D119</td>
<td>DIODE</td>
<td>34.8  31.6</td>
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<tr>
<td>D101</td>
<td>BRIDGE</td>
<td>46.0  26.6</td>
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<tr>
<td>L101</td>
<td>COMMON CHOKE</td>
<td>31.0  17.1</td>
</tr>
<tr>
<td>L102</td>
<td>COMMON CHOKE</td>
<td>29.5  16.6</td>
</tr>
<tr>
<td>L103</td>
<td>CHOKE PFC</td>
<td>46.4  42.2</td>
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<tr>
<td>L104</td>
<td>CHOKE DC-DC IN</td>
<td>36.8  34.8</td>
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<tr>
<td>Q101</td>
<td>MOSFET</td>
<td>38.2  20.3</td>
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<td>Q104</td>
<td>MOSFET</td>
<td>30.2  29.5</td>
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<td>MOSFET</td>
<td>22.1  18.0</td>
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<td>29.5  28.5</td>
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<td>T102</td>
<td>TRANSFORMER</td>
<td>17.6  16.8</td>
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<td>TRANSFORMER</td>
<td>19.9  19.2</td>
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<td>FILM CAP.</td>
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<td>C508</td>
<td>CAP. CER.</td>
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3. Main components temperature rise

MODEL: 320V-2A

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# Main components temperature rise

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4. Electrolytic capacitor lifetime

*Z*⁺ 600 H.V Series

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5. Abnormal test

MODEL : 650V-1.25A (Test results represent also Z650-1)

(1) Test condition and circuit:

Input Voltage: 230Vac    Output: 650V 1.25A    Ta : 50°C

(2) Test results

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<td>3-5</td>
<td>Open</td>
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<td>Pin decreased to 625W</td>
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<tr>
<td>28</td>
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<td></td>
<td>No Fan, D136</td>
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</tr>
<tr>
<td>29</td>
<td>D126</td>
<td>A-K</td>
<td>Open</td>
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<td>No Display, No Fan</td>
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</tr>
<tr>
<td>30</td>
<td>D126</td>
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<td>No Display, No Fan</td>
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</tr>
<tr>
<td>31</td>
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<td>32</td>
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<td>No Display, No Fan</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>D135</td>
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<td>Pin decreased to 275W</td>
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<tr>
<td>34</td>
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<td></td>
<td></td>
<td>No Display, No Fan</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>C500</td>
<td>1-2</td>
<td>Open</td>
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<td></td>
<td>F101, L104, D116, D118, D103</td>
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</tr>
<tr>
<td>36</td>
<td>C502</td>
<td>2-8</td>
<td>Open</td>
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<td></td>
<td>R123, R124, Q104, Q106, D116, L104</td>
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</tr>
<tr>
<td>37</td>
<td>C503</td>
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<td></td>
<td>Pin decreased to 22W</td>
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</tr>
<tr>
<td>38</td>
<td>D500</td>
<td>A-K</td>
<td>Open</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Pin decreased to 8.2V, All temperatures are normal</td>
<td></td>
</tr>
</tbody>
</table>

Note
5. Abnormal test

MODEL: 160V-5A (Test results represent also Z160-4)

(1) Test condition and circuit:

Input Voltage: 230Vac  Output:160V 5A  Ta: 50°C

(2) Test results

<table>
<thead>
<tr>
<th>No.</th>
<th>Test Position</th>
<th>Test Point</th>
<th>Test Mode</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>D116</td>
<td>A-K</td>
<td>Open</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pin decreased to 40W</td>
</tr>
<tr>
<td>2</td>
<td>T101</td>
<td>8-10</td>
<td>Open</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pin decreased to 40W</td>
</tr>
<tr>
<td>3</td>
<td>C500</td>
<td></td>
<td>Open</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pin decreased to 74W</td>
</tr>
<tr>
<td>4</td>
<td>C502</td>
<td></td>
<td>Open</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Pin decreased to 34W</td>
</tr>
<tr>
<td>5</td>
<td>D500</td>
<td>A-K</td>
<td>Open</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>V Fan decreased to 10.1V, All temperatures are normal</td>
</tr>
</tbody>
</table>
6. Vibration test

**Z⁺ 600 H.V Series**

(1) Vibration test class

Frequency variable endurance test

(2) Equipment used

<table>
<thead>
<tr>
<th>Name</th>
<th>Manufacturer</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vibration Test System</td>
<td>Ling Dynamic Systems</td>
<td>V875</td>
</tr>
<tr>
<td>Laser Shaker Control System</td>
<td>DACTRON</td>
<td>LASER</td>
</tr>
<tr>
<td>Isotron Accelerometer 98.2 mV/g</td>
<td>Dytran instruments Inc.</td>
<td>3256A2</td>
</tr>
<tr>
<td>Isotron Accelerometer 101.7 mV/g</td>
<td>Dytran instruments Inc.</td>
<td>3049E3</td>
</tr>
</tbody>
</table>

(3) Testing method

Test condition:

- Sweep frequency: 5~500Hz
- Acceleration: 1.07G
- Direction: X, Y, Z
- Test time: 1 hour per each axis

*E.U.T. is fixed to vibrator surface by mounting straps

(4) Test result

<table>
<thead>
<tr>
<th>Check item</th>
<th>Output Voltage (V)</th>
<th>Ripple (mVp-p)</th>
<th>E.U.T. state</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before test Direction</td>
<td>319.998</td>
<td>75.00</td>
<td>O.K.</td>
</tr>
<tr>
<td>X</td>
<td>319.998</td>
<td>75.00</td>
<td>O.K.</td>
</tr>
<tr>
<td>Y</td>
<td>319.982</td>
<td>70.00</td>
<td>O.K.</td>
</tr>
<tr>
<td>Z</td>
<td>322.998</td>
<td>75.00</td>
<td>O.K.</td>
</tr>
</tbody>
</table>
7. Noise Simulation Test

Z⁺ 600 H.V Series

(1) Test equipment:

NoiseKen INS - 4040 impulse noise simulator
NoiseKen IJ - 4050 coupling decoupling network

(2) Acceptance criteria:

1. No damage to PS
2. No output shutdown
3. No other abnormalities

(3) Test condition:

Ta=25°C

Noise level - ± (0.6kV, 1.2kV, 1.8kV, 2kV) (50Ω term.)

Pulse width - 50ns ~ 1us

Injection phase (AC input only) - 0°~360° (with step 45°)

Input voltage - 230Vac 50Hz

Output Current - 100%

Output Voltage - Rated

(4) Test result: OK

1. No damage to PS
2. No output shutdown
3. No other abnormalities

<table>
<thead>
<tr>
<th>Pulse</th>
<th>Polarity</th>
<th>Line-Neutral</th>
<th>Line-FG</th>
<th>Neutral-FG</th>
</tr>
</thead>
<tbody>
<tr>
<td>2kV</td>
<td>+</td>
<td>OK</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2kV</td>
<td>-</td>
<td></td>
<td>OK</td>
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<tr>
<td>2kV</td>
<td>+</td>
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<td>OK</td>
</tr>
<tr>
<td>2kV</td>
<td>-</td>
<td></td>
<td>OK</td>
<td>OK</td>
</tr>
</tbody>
</table>

TDK-Lambda R-14
8. Thermal Shock Test

**Z⁺ 600 H.V Series**

(1) Test Equipment

Thermal Shock Chamber: TSA-101S-W, ESPEC

(2) The number of D.U.T. (Device Under Test)

1 (unit)

(3) Test condition

Ambient temperature: -20°C <=+85°C

Test time: Refer to Dwg.

Test cycle: 100cycles

Not operating

(4) Test method

Before testing, check if there is no abnormal output, then put the D.U.T. in testing chamber, and test it according to the above cycle. Later leave it for 1hour at room temperature, then check if there is no abnormal output.

(5) Test Result

OK

Vin: 100Vac

<table>
<thead>
<tr>
<th>Before testing</th>
<th>After testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vout-100%, iout-100%</td>
<td>Vout-100%, iout-0%</td>
</tr>
<tr>
<td>319.975V</td>
<td>319.975V</td>
</tr>
</tbody>
</table>
9. Fan Life Expectancy

\( Z^+ \) 600 H.V Series

(1) Part name
H60T12BLA7-52 ("NIDEC")

(2) Life expectancy

The data shows fan life expectancy for fan only by manufacture (90% survival rate).

Fig1. shows measuring point of ambient temperature.

![Graph showing life expectancy vs ambient temperature](image)

Fig1. Measuring point of fan ambient temperature.

1 year = 365 day x 24 hours/day = 8760 hours