APEX MICROTECHNOLOGY CORPORATION
RELIABILITY PREDICTION
PA89

by

Granger Scofield

Date of prediction: 15-Mar-01

This reliability prediction is based on MIL-HDBK-217F, December 2, 1991 including Notice 2, February 28, 1995.

Conditions of this prediction are as follows:

Hybrid quality level is Commercial
Environment is Gf Ground, Fixed
Case temperature is 35 C
Internal Power Dissipation = 10 W
Supply voltage is +/- 400 V
An AC signal is applied.
Product introduction date: 01-Apr-90

The results of this prediction are:

62.2 failures per million hours; or,
MTBF=16.1 thousand hours.
Transistors, Low Frequency, Bipolar:
\[ L_p = L_b \cdot \Pi T \cdot \Pi R \cdot \Pi S \]

| Transistor | Volts | Watts | Tj | 'KW | Usage: | \( \text{Vstress} \) | \( \text{Vpwr} \) | \( \text{Ic} \) | \( \text{Vs} \) | Power | \( \text{Lb} \) | \( \Pi T \) | \( \Pi R \) | \( \Pi S \) | \( \text{Nc} \) | \( \text{Tj} \) | \( \text{Lb} \) PiT PiR PiS | \( \text{Vstress} \) | \( \text{Vpwr} \) | \( \text{Ic} \) | \( \text{Vs} \) | Power | \( \text{Lb} \) PiT PiR PiS | \( \text{Vstress} \) | \( \text{Vpwr} \) | \( \text{Ic} \) | \( \text{Vs} \) | Power | \( \text{Lb} \) PiT PiR PiS |
|-----------|-------|-------|----|-----|--------|-------------|-----------|-------|-------|--------|--------|---------|-------|-------|-------|----|-------|---------|-------------|-----------|-------|-------|--------|--------|---------|-------|-------|-------|--------|--------|---------|-------|-------|-------|--------|--------|
| Q26,36    | 40    | 1.2   | 175 | 125 | 0.0163 | 0.65       | 0.65      | 1E-05  | 0.0163 | 7E-06  | 0.0074 | 1.25903 | 1.0698 | 0.0473 | 2     | 9.43E-05 |
| Q1        | 20    | 0.38  | 150 | 328.95 | 0.0325 | 0.65       | 0.65      | 0.0007 | 0.0163 | 0.0049 | 0.0074 | 1.262911 | 0.6991 | 0.0498 | 1     | 3.25E-05 |
| Q2        | 20    | 0.38  | 150 | 328.95 | 0.0325 | 0.65       | 0.65      | 0.0007 | 0.0163 | 0.0049 | 0.0074 | 1.277095 | 0.6991 | 0.0716 | 1     | 4.73E-05 |

Transistors, Low Frequency, Si JFET: \[ L_b = 0.0045 \]
\[ L_p = L_b \cdot \Pi T \]

| Transistor | Volts | Watts | Tj | 'KW | Usage: | \( \text{Vpwr} \) | \( \text{Ic} \) | \( \text{Vs} \) | Power | \( \text{Lb} \) PiT PiR PiS | \( \text{Vstress} \) | \( \text{Vpwr} \) | \( \text{Ic} \) | \( \text{Vs} \) | Power | \( \text{Lb} \) PiT PiR PiS |
|-----------|-------|-------|----|-----|--------|-------------|-----------|-------|--------|---------|-------------|-----------|-------|--------|---------|-----|--------|---------|-------------|-----------|-------|--------|--------|--------|
| Q30,31,34,35 | 30 | 0.8 | 150 | 156.25 | 2E-06 | 1.5 | 1E-06 | 4 | 0.0222 |
| Q57,59,60,61 | 30 | 0.8 | 150 | 156.25 | 3E-06 | 2.5 | 1E-06 | 4 | 0.0222 |
| Q58        | 30    | 0.8   | 150 | 156.25 | 4E-06 | 4    | 1E-06 | 1 | 0.00555 |
| Q25A,B     | 25    | 0.55  | 150 | 227.27 | 0.0021 | 3.285 | 0.0007 | 2 | 0.01121 |

Transistors, Low Frequency, Si MOSFET: \[ L_b = 0.012 \]
\[ L_p = L_b \cdot \Pi T \]
<table>
<thead>
<tr>
<th>Q8,14,20,42,50,56</th>
<th>Volts = 450</th>
<th>Watts = 25</th>
<th>Tj = 150</th>
<th>'K/W= 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage: Fraction Output Pwr = 1/3</td>
<td>Power = 3.3333</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lb PiT</td>
<td>Nc Tj = 51.667</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.012 1.699907</td>
<td>6</td>
<td>0.122393</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q3,11,17</th>
<th>Volts = 450</th>
<th>Watts = 4</th>
<th>Tj = 150</th>
<th>'K/W= 31.25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage: Vpwr = 133.33 Id = 8E-05</td>
<td>Power = 0.0107</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lb PiT</td>
<td>Nc Tj = 35.333</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.012 1.241709</td>
<td>3</td>
<td>0.044702</td>
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<td></td>
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</tbody>
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<table>
<thead>
<tr>
<th>Q5,28,33,41,43,52</th>
<th>Volts = 450</th>
<th>Watts = 4</th>
<th>Tj = 150</th>
<th>'K/W= 31.25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage: Vpwr = 263.9 Id = 0.0025</td>
<td>Power = 0.6545</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lb PiT</td>
<td>Nc Tj = 55.452</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.012 1.820134</td>
<td>6</td>
<td>0.13105</td>
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<td></td>
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<thead>
<tr>
<th>Q6,51</th>
<th>Volts = 450</th>
<th>Watts = 4</th>
<th>Tj = 150</th>
<th>'K/W= 31.25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage: Vpwr = 3 Id = 8E-05</td>
<td>Power = 0.0002</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lb PiT</td>
<td>Nc Tj = 35.007</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.012 1.233523</td>
<td>2</td>
<td>0.029605</td>
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<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Q7,13,19,44,45,48,53,55</th>
<th>Volts = 450</th>
<th>Watts = 4</th>
<th>Tj = 150</th>
<th>'K/W= 31.25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage: Vpwr = 133.33 Id = 0.0013</td>
<td>Power = 0.1733</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lb PiT</td>
<td>Nc Tj = 40.417</td>
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<td></td>
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<tr>
<td>0.012 1.37403</td>
<td>9</td>
<td>0.148395</td>
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<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Q9,10,15,16,22,23</th>
<th>Volts = 450</th>
<th>Watts = 4</th>
<th>Tj = 150</th>
<th>'K/W= 31.25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage: Vpwr = 133.33 Id = 0.0007</td>
<td>Power = 0.0867</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Lb PiT</td>
<td>Nc Tj = 37.708</td>
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<td></td>
</tr>
<tr>
<td>0.012 1.302402</td>
<td>6</td>
<td>0.093773</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q21,32,40,46,49,54</th>
<th>Volts = 450</th>
<th>Watts = 4</th>
<th>Tj = 150</th>
<th>'K/W= 31.25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage: Vpwr = 133.33 Id = 0.0003</td>
<td>Power = 0.04</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Lb PiT</td>
<td>Nc Tj = 36.25</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>0.012 1.264902</td>
<td>6</td>
<td>0.091073</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q29</th>
<th>Volts = 450</th>
<th>Watts = 4</th>
<th>Tj = 150</th>
<th>'K/W= 31.25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage: Vpwr = 6 Id = 0.0013</td>
<td>Power = 0.0075</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lb PiT</td>
<td>Nc Tj = 35.234</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.012 1.239222</td>
<td>2</td>
<td>0.029741</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Capacitors, ceramic general purpose type CK:

\[ L_p = L_b \times \Pi_T \times \Pi_C \times \Pi_V \]

\( L_b = 0.00099 \)

\( C_1 \) Volts = 100

\( pF = 470 \)

Usage:

\( V_{stress} = 0.65 \quad S = 0.0065 \)

\( L_b \quad \Pi_T \quad \Pi_C \quad \Pi_V \quad N_c \)

\( 0.00099 \quad 1.556444 \quad 0.269 \quad 1 \quad 1 \quad 0.000415 \)

\( C_2 \) Volts = 100

\( pF = 470 \)

Usage:

\( V_{stress} = 5.3 \quad S = 0.053 \)

\( L_b \quad \Pi_T \quad \Pi_C \quad \Pi_V \quad N_c \)

\( 0.00099 \quad 1.556444 \quad 0.269 \quad 1.0007 \quad 1 \quad 0.000416 \)

\( C_3 \) Volts = 100

\( pF = 15000 \)

Usage:

\( V_{stress} = 6 \quad S = 0.06 \)

\( L_b \quad \Pi_T \quad \Pi_C \quad \Pi_V \quad N_c \)

\( 0.00099 \quad 1.556444 \quad 0.368 \quad 1.001 \quad 1 \quad 0.000568 \)

\( C_{4,5,6,7,8,9} \) Volts = 500

\( pF = 68 \)

Usage:

\( V_{stress} = 133.3 \quad S = 0.2667 \)

\( L_b \quad \Pi_T \quad \Pi_C \quad \Pi_V \quad N_c \)

\( 0.00099 \quad 1.556444 \quad 0.226 \quad 1.0878 \quad 6 \quad 0.002277 \)

Diodes, Low Frequency:

\[ L_p = L_b \times \Pi_T \times \Pi_S \times \Pi_C \]

Diodes, Zener, \( L_b = 0.002 \)

\( D_{1,4} \) Volts = 3.1

\( Watts = 2.5 \quad T_j = 175 \quad 'K/W= 60 \)

Usage:

\( I_c = 8E-05 \quad Power = 0.0002 \)

\( L_b \quad \Pi_T \quad \Pi_S \quad \Pi_C \quad N_c \quad T_j = 35.014 \)

\( 0.002 \quad 1.233696 \quad 1 \quad 2 \quad 2 \quad 0.00987 \)

Sum of all components

\( 0.765612 \)

Hybrid microcircuit:

\[ L_p = \text{sum}L_c(1+2^{\Pi_E}) \times \Pi_F \times \Pi_Q \times \Pi_L \]

\( 0.765612 \quad 1.4 \quad 5.8 \quad 10 \quad 1 \)

Total failures per million hours = 62.168

Mean time between failures = 16086