

APEX MICROTECHNOLOGY CORPORATION
RELIABILITY PREDICTION
PA19

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	55 C
Internal Power Dissipation =	25 W
Supply voltage is +/-	28 V
An AC signal is applied.	
Product introduction date:	01-Jun-83

The results of this prediction are:

11.2 failures per million hours; or,
MTBF=89.6 thousand hours.

Transistors, Low Frequency, Bipolar:

$$L_p = L_b * P_{iT} * P_{iR} * P_{iS}$$

Q8		Volts = 40	Watts = 0.6	Tj = 150	'K/W= 208.33	
Usage:	Vstress = 5	Vpwr = 4	Ic = 0.053	Vs = 0.125	Power = 0.212	
Lb	PiT	PiR	PiS	Nc	Tj = 99.167	
0.00074	4.111175	0.8278	0.0663	1		0.000167
Q11		Volts = 40	Watts = 0.6	Tj = 150	'K/W= 208.33	
Usage:	Vstress = 7.33	Vpwr = 6.33	Ic = 0.053	Vs = 0.1833	Power = 0.3355	
Lb	PiT	PiR	PiS	Nc	Tj = 124.89	
0.00074	5.935692	0.8278	0.0794	1		0.000289
Q3		Volts = 120	Watts = 1.2	Tj = 200	'K/W= 145.83	
Usage:	Vstress = 1.3	Vpwr = 1.3	Ic = 0.009	Vs = 0.0108	Power = 0.0117	
Lb	PiT	PiR	PiS	Nc	Tj = 56.706	
0.00074	1.978209	1.0698	0.0465	1		7.29E-05
Q4		Volts = 120	Watts = 1.2	Tj = 200	'K/W= 145.83	
Usage:	Vstress = 4.4	Vpwr = 3.4	Ic = 0.009	Vs = 0.0367	Power = 0.0306	
Lb	PiT	PiR	PiS	Nc	Tj = 59.463	
0.00074	2.086208	1.0698	0.0504	1		8.33E-05
Q15		Volts = 120	Watts = 1.2	Tj = 200	'K/W= 145.83	
Usage:	Vstress = 44.8	Vpwr = 44.8	Ic = 0.004	Vs = 0.3733	Power = 0.1792	
Lb	PiT	PiR	PiS	Nc	Tj = 81.133	
0.00074	3.078544	1.0698	0.1432	1		0.000349
Q12,13		Volts = 140	Watts = 1.2	Tj = 200	'K/W= 145.83	
Usage:	Vstress = 37.7	Vpwr = 25.7	Ic = 0.009	Vs = 0.2693	Power = 0.2313	
Lb	PiT	PiR	PiS	Nc	Tj = 88.731	
0.00074	3.489792	1.0698	0.1037	2		0.000573
Q14		Volts = 140	Watts = 1.2	Tj = 200	'K/W= 145.83	
Usage:	Vstress = 12.4	Vpwr = 11.4	Ic = 1E-06	Vs = 0.0886	Power = 1E-05	
Lb	PiT	PiR	PiS	Nc	Tj = 55.002	
0.00074	1.913378	1.0698	0.0592	1		8.97E-05
Q23		Volts = 140	Watts = 1.2	Tj = 200	'K/W= 145.83	
Usage:	Vstress = 36	Vpwr = 23	Ic = 0.02	Vs = 0.2571	Power = 0.46	
Lb	PiT	PiR	PiS	Nc	Tj = 122.08	
0.00074	5.715546	1.0698	0.0999	1		0.000452

Q16		Volts = 80	Watts = 16	Tj =	200	'K/W= 10.938	
Usage:	Vstress = 45.3	Vpwr = 45.3	Ic = 0.053	Vs =	0.5663	Power = 2.4009	
Lb	PiT	PIR	PIs		Nc	Tj = 81.26	
0.00074	3.085114	2.7895	0.2604		1		0.001658
Q6		Volts = 80	Watts = 0.5	Tj =	150	'K/W= 250	
Usage:	Vstress = 3.5	Vpwr = 3.5	Ic = 0.004	Vs =	0.0438	Power = 0.014	
Lb	PiT	PIR	PIs		Nc	Tj = 58.5	
0.00074	2.048045	0.7738	0.0515		1		6.04E-05
Q9		Volts = 80	Watts = 0.5	Tj =	150	'K/W= 250	
Usage:	Vstress = 4.65	Vpwr = 4.65	Ic = 0.004	Vs =	0.0581	Power = 0.0186	
Lb	PiT	PIR	PIs		Nc	Tj = 59.65	
0.00074	2.093698	0.7738	0.0539		1		6.46E-05
Q10		Volts = 80	Watts = 0.5	Tj =	150	'K/W= 250	
Usage:	Vstress = 1.32	Vpwr = 1.32	Ic = 0.0055	Vs =	0.0165	Power = 0.0073	
Lb	PiT	PIR	PIs		Nc	Tj = 56.815	
0.00074	1.982395	0.7738	0.0474		1		5.38E-05
Q21		Volts = 80	Watts = 0.5	Tj =	150	'K/W= 250	
Usage:	Vstress = 52	Vpwr = 52	Ic = 1E-06	Vs =	0.65	Power = 5E-05	
Lb	PiT	PIR	PIs		Nc	Tj = 55.013	
0.00074	1.913805	0.7738	0.3375		1		0.00037
Q24		Volts = 80	Watts = 0.5	Tj =	150	'K/W= 250	
Usage:	Vstress = 40.6	Vpwr = 40.6	Ic = 0.0045	Vs =	0.5075	Power = 0.1827	
Lb	PiT	PIR	PIs		Nc	Tj = 100.68	
0.00074	4.206526	0.7738	0.217		1		0.000523
Q1		Volts = 80	Watts = 0.5	Tj =	150	'K/W= 250	
Usage:	Vstress = 3	Vpwr = 3	Ic = 0.001	Vs =	0.0375	Power = 0.003	
Lb	PiT	PIR	PIs		Nc	Tj = 55.75	
0.00074	1.941657	0.7738	0.0505		1		5.62E-05
Q2		Volts = 80	Watts = 0.5	Tj =	150	'K/W= 250	
Usage:	Vstress = 3	Vpwr = 3	Ic = 1E-06	Vs =	0.0375	Power = 3E-06	
Lb	PiT	PIR	PIs		Nc	Tj = 55.001	
0.00074	1.913344	0.7738	0.0505		1		5.54E-05
Q5		Volts = 80	Watts = 0.5	Tj =	150	'K/W= 250	
Usage:	Vstress = 38.6	Vpwr = 25.6	Ic = 0.002	Vs =	0.4825	Power = 0.0512	
Lb	PiT	PIR	PIs		Nc	Tj = 67.8	
0.00074	2.437342	0.7738	0.2008		1		0.00028

C2			Volts = 200	pF = 100			
Usage:	Vstress = 3.34				S =	0.0167	
Lb	PiT	PiC	Pi V			Nc	
0.00099	3.478655	0.234	1			1	0.000807
C1			Volts = 100	pF = 6800			
Usage:	Vstress = 11.4				S =	0.114	
Lb	PiT	PiC	Pi V			Nc	
0.00099	3.478655	0.343	1.0069			1	0.001188
C3			Volts = 100	pF = 6800			
Usage:	Vstress = 1				S =	0.01	
Lb	PiT	PiC	Pi V			Nc	
0.00099	3.478655	0.343	1			1	0.00118
C5			Volts = 100	pF = 6800			
Usage:	Vstress = 48.7				S =	0.487	
Lb	PiT	PiC	Pi V			Nc	
0.00099	3.478655	0.343	1.5347			1	0.001811

Diodes, Low Frequency:
 $Lp = Lb * PiT * PiS * PiC$

Diodes, Zener, Lb = 0.002

D1,2			Volts = 3.7	Watts = 2.5	Tj = 175	'K/W= 60	
Usage:				Ic = 0.0045		Power = 0.0167	
Lb	PiT	PiS	PiC			Nc	Tj = 55.999
0.002	1.837948	1	2			2	0.014704

Sum of all components 0.137485

Hybrid microcircuit:

$Lp = \text{sum}Lc * (1 + .2 * PiE) * PiF * PiQ * PiL$
 0.137485 1.4 5.8 10 1

Total failures per million hours = 11.164

Mean time between failures = 89575