

APEX MICROTECHNOLOGY CORPORATION  
RELIABILITY PREDICTION  
SA03

by

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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 Gb	Ground, Benign
Case temperature is	55 C
Internal power dissipation=	85 W
Supply voltage is	90 V
An AC signal is applied.	
Product introduction date:	15-Aug-97

The results of this prediction are:

34.7 failures per million hours; or,  
MTBF= 29 thousand hours.

## Monolithic MOS Digital Devices:

$$L_p = C_1 * P_{IT}$$

IC8	Cpd(pF)= 22	Watts = 1.25	Tj = 150	#/Gates = 6	
	Usage: Vstress = 5	Watts = 8E-05	F(KHz)= 45	Max Tj = 55.008	
C1	PiT			Gates @ F = 2	
0.01	1.01327			Clod (pF)= 10	0.010133
IC9	Cpd(pF)= 22	Watts = 1.25	Tj = 150	#/Gates = 4	
	Usage: Vstress = 5	Watts = 0.0004	F(KHz)= 250	Max Tj = 55.041	
C1	PiT			Gates @ F = 2	
0.01	1.0156			Clod (pF)= 10	0.010156
IC10	Cpd(pF)= 22	Watts = 1.25	Tj = 150	#/Gates = 4	
	Usage: Vstress = 5	Watts = 0.0004	F(KHz)= 250	Max Tj = 55.041	
C1	PiT			Gates @ F = 2	
0.01	1.0156			Clod (pF)= 10	0.010156
IC6	Cpd(pF)= 22	Watts = 1.25	Tj = 150	#/Gates = 10	
	Usage: Vstress = 5	Watts = 0.0001	F(KHz)= 45	Max Tj = 55.012	
C1	PiT			Gates @ F = 3	
0.01	1.01352			Clod (pF)= 10	0.010135

## Monolithic Bipolar and MOS Linear Devices:

$$L_p = C_1 * P_{IT}$$

IC3,7		Watts = 4.8	Tj = 150	#/Qs = 83	
	Usage: Vstress = 15	Watts = 0.45	lpwr= 0.03	Max Tj = 66.719	
C1	PiT			Nc	
0.01	2.23875			2	0.044775
IC7	#/Pins = 8	Watts = 0.5	Tj = 150	#/Qs = 23	
	Usage: Vstress = 12	Watts = 0.072		Max Tj = 73	
C1	PiT			Nc	
0.01	3.35017			1	0.033502
IC7	#/Pins = 8	Watts = 0.8	Tj = 150	#/Qs = 96	
	Usage: Vstress = 10	Watts = 0.007		Max Tj = 56.094	
C1	PiT			Nc	
0.01	1.09312			1	0.010931
IC1	#/Pins = 7	Watts = 1	Tj = 150	#/Qs = 96	
	Usage: Vstress = 5	Watts = 0.0163		Max Tj = 57.031	
C1	PiT			Nc	
0.01	1.16666			1	0.011667

Transistors, Low Frequency, Bipolar:

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

Q8		Volts = 40	Watts = 1.2	Tj = 175	'K/W= 125	
Usage:	Vstress = 9.74	Vpwr = 9.74	Ic = 1E-06	Vs = 0.2435	Power = 1E-05	
Lb	PiT	PiR	PiS	Nc	Tj = 55.001	
0.00074	1.91336	1.0698	0.0957	1		0.000145
Q15		Volts = 40	Watts = 1.2	Tj = 175	'K/W= 125	
Usage:	Vstress = 12	Vpwr = 12	Ic = 1E-06	Vs = 0.3	Power = 1E-05	
Lb	PiT	PiR	PiS	Nc	Tj = 55.002	
0.00074	1.91337	1.0698	0.1141	1		0.000173
Q2-5		Volts = 60	Watts = 1.2	Tj = 175	'K/W= 125	
Usage:	Vstress = 10	Vpwr = 10	Ic = 1E-06	Vs = 0.1667	Power = 1E-05	
Lb	PiT	PiR	PiS	Nc	Tj = 55.001	
0.00074	1.91336	1.0698	0.0754	4		0.000457

Transistors, Low Frequency, Si MOSFET: Lb = 0.012

$L_p = L_b * P_{iT}$

Q10,14			Watts = 150	Tj = 150	'K/W= 0.8333	
Usage:		Fraction Output Pwr = 1/	2		Power = 42.5	
Lb	PiT			Nc	Tj = 90.417	
0.012	3.19882			2		0.076772
Q11,13			Watts = 150	Tj = 150	'K/W= 0.8333	
Usage:		Fraction Output Pwr = 1/	20		Power = 4.25	
Lb	PiT			Nc	Tj = 58.542	
0.012	1.9223			2		0.046135
Q1,7,16		Volts = 450	Watts = 2.25	Tj = 150	'K/W= 55.556	
Usage:		Vpwr = 78	Ic = 0.0005		Power = 0.039	
Lb	PiT			Nc	Tj = 57.167	
0.012	1.87638			3		0.06755
Q6		Volts = 450	Watts = 15	Tj = 150	'K/W= 8.3333	
Usage:		Vpwr = 90	Id = 1E-06		Power = 9E-05	
Lb	PiT			Nc	Tj = 55.001	
0.012	1.80551			1		0.021666
Q9		Volts = 450	Watts = 15	Tj = 150	'K/W= 8.3333	
Usage:		Vpwr = 10	Id = 1E-06		Power = 1E-05	
Lb	PiT			Nc	Tj = 55	
0.012	1.80549			1		0.021666
Q12		Volts = 450	Watts = 15	Tj = 150	'K/W= 8.3333	
Usage:		Vpwr = 10	Id = 0.0005		Power = 0.005	
Lb	PiT			Nc	Tj = 55.042	
0.012	1.80683			1		0.021682

Capacitors, ceramic general purpose type CK:

$L_p = L_b * P_iT * P_iC * P_iV$        $L_b = 0.00099$

C13,18		Volts = 100	pF = 180			
Usage:	Vstress = 12			S =	0.12	
Lb	PiT	PiC	Pi V		Nc	
0.00099	3.47866	0.25	1.008		2	0.001716
C7		Volts = 100	pF = 470			
Usage:	Vstress = 7			S =	0.07	
Lb	PiT	PiC	Pi V		Nc	
0.00099	3.47866	0.27	1.0016		1	0.000929
C21		Volts = 100	pF = 470			
Usage:	Vstress = 0.65			S =	0.0065	
Lb	PiT	PiC	Pi V		Nc	
0.00099	3.47866	0.27	1		1	0.000928
C3		Volts = 25	pF = 1000			
Usage:	Vstress = 0.2			S =	0.008	
Lb	PiT	PiC	Pi V		Nc	
0.00099	3.47866	0.29	1		1	0.000993
C2		Volts = 50	pF = 10000			
Usage:	Vstress = 10			S =	0.2	
Lb	PiT	PiC	Pi V		Nc	
0.00099	3.47866	0.35	1.037		1	0.001267
C6		Volts = 50	pF = 10000			
Usage:	Vstress = 7			S =	0.14	
Lb	PiT	PiC	Pi V		Nc	
0.00099	3.47866	0.35	1.0127		1	0.001237
C8		Volts = 50	pF = 10000			
Usage:	Vstress = 5			S =	0.1	
Lb	PiT	PiC	Pi V		Nc	
0.00099	3.47866	0.35	1.0046		1	0.001228
C15		Volts = 50	pF = 10000			
Usage:	Vstress = 12			S =	0.24	
Lb	PiT	PiC	Pi V		Nc	
0.00099	3.47866	0.35	1.064		1	0.0013
C17,20		Volts = 50	pF = 10000			
Usage:	Vstress = 23			S =	0.46	
Lb	PiT	PiC	Pi V		Nc	
0.00099	3.47866	0.35	1.4506		2	0.003545
C14		Volts = 200	pF = 2200			
Usage:	Vstress = 0.68			S =	0.0034	
Lb	PiT	PiC	Pi V		Nc	
0.00099	3.47866	0.31	1		1	0.001066

C9			Volts = 100	pF = 1500					
Usage:	Vstress = 3				S =			0.03	
Lb	PiT	PiC	Pi V					Nc	
0.00099	3.47866	0.3	1.0001					1	0.00103
C4,11			Volts = 25	pF = 100000					
Usage:	Vstress = 11.3				S =			0.452	
Lb	PiT	PiC	Pi V					Nc	
0.00099	3.47866	0.44	1.4275					2	0.004292
C10			Volts = 25	pF = 1E+06					
Usage:	Vstress = 15				S =			0.6	
Lb	PiT	PiC	Pi V					Nc	
0.00099	3.47866	0.54	2					1	0.003699
C5,12			Volts = 45	pF = 47					
Usage:	Vstress = 12				S =			0.2667	
Lb	PiT	PiC	Pi V					Nc	
0.00099	3.47866	0.22	1.0878					2	0.001641
C16,19			Volts = 45	pF = 47					
Usage:	Vstress = 7				S =			0.1556	
Lb	PiT	PiC	Pi V					Nc	
0.00099	3.47866	0.22	1.0174					2	0.001535
Diodes, Low Frequency:									
Lp = Lb * PiT * PiS * PiC									
Diodes, Switching, Lb = 0.001									
D8,9			Volts = 100	Watts = 0.38	Tj =			175	'K/W= 394.74
Usage:			Volts = 15	Ic = 2E-05	Vs =			0.15	Power = 1E-05
Lb	PiT	PiS	PiC					Nc	Tj = 55.004
0.001	2.58264	0.05	2					2	0.000558
D12,13,15,16			Volts = 100	Watts = 0.38	Tj =			175	'K/W= 394.74
Usage:			Volts = 12	Ic = 0.0003	Vs =			0.12	Power = 0.0002
Lb	PiT	PiS	PiC					Nc	Tj = 55.064
0.001	2.58712	0.05	2					4	0.001118
D19,20			Volts = 100	Watts = 0.38	Tj =			175	'K/W= 394.74
Usage:			Volts = 12	Ic = 0.0005	Vs =			0.12	Power = 0.0003
Lb	PiT	PiS	PiC					Nc	Tj = 55.128
0.001	2.59189	0.05	2					2	0.00056

Diodes, Power Rectifier, Fast Recovery, Lb = 0.025

D2,3,4,6			Volts = 600	Watts = 4.29	Tj = 175	'K/W= 34.965	
Usage:			Volts = 90	Ic = 0.001	Vs = 0.15	Power = 0.0007	
Lb	PiT	PiS	PiC		Nc	Tj = 55.023	
0.025	2.58404	0.05	1		4		0.013954

Diodes, Zener, Lb = 0.002

D1,11,14			Volts = 12	Watts = 1.39	Tj = 175	'K/W= 107.91	
Usage:				Ic = 0.0005		Power = 0.006	
Lb	PiT	PiS	PiC		Nc	Tj = 55.647	
0.002	1.82648	1	2		3		0.021918

D18			Volts = 12	Watts = 1.39	Tj = 175	'K/W= 107.91	
Usage:				Ic = 0.018		Power = 0.216	
Lb	PiT	PiS	PiC		Nc	Tj = 78.309	
0.002	2.66507	1	2		1		0.01066

D5			Volts = 5	Watts = 1.6	Tj = 175	'K/W= 93.75	
Usage:				Ic = 0.003		Power = 0.015	
Lb	PiT	PiS	PiC		Nc	Tj = 56.406	
0.002	1.85129	1	2		1		0.007405

Diodes, Schottky:

$L_p = L_b * PiT * PiR$        $L_b = 0.027$

D7,10				Watts = 6.9444	Tj = 150	'K/W= 18	
Usage:						Power = 0.03	
Lb	PiT		PiR		Nc	Tj = 55.54	
0.027	1.92527		1		2		0.103964

Sum of all components      0.543664

Hybrid microcircuit:

$L_p = \sum L_c * (1 + 2 * PiE) * PiF * PiQ * PiL$   
 0.54366    1.1      5.8    10      1

Total failures per million hours = 34.686

Mean time between failures = 28830