



Reliability Report

Q2 CY2005

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Accelerated Reliability Testing

The failure rate of semiconductor devices is inherently small. For this reason Actel uses accelerated testing to assess reliability of its devices. Overstresses are used to produce the same failure mechanisms that would be seen under normal conditions but in a much shorter period of time. Acceleration factors are used by Actel to estimate failure rates based on the results of accelerated testing. The objective of this testing is to identify the failure mechanisms and eliminate them as a cause of failure during the useful life of Actel products.

Die selection is determined by both the largest die size and/or the currently available die. Actel will, whenever possible, test the largest die in a given family. Package selection for the testing is determined by test board availability and will not always include the largest package available. The primary use of this report is to include the reliability data of the silicon devices.

Actel Standard FIT Rate and MTTF Assumptions

All of the FIT (Failure in Time) rate and MTTF (Mean Time to Failure) numbers reported here use a base set of assumptions. The given information in the summary tables and in the data tables allows other calculations for different variable values. Below are the basic variables used to calculate the results indicated in this report.

Activation energy (E_A) = 0.7 eV, Junction temperature (T_J) = 55°C, and Confidence = 60%

Reliability testing (High Temperature Operating Life, or HTOL) of the devices are run either at 125°C or 150°C ambient and the maximum operating voltages reported in the datasheets. The results obtained by testing at ambient temperature 150°C are converted to reflect at 125°C by using the Arrhenius equation for calculating the temperature acceleration factors and using their ratios.

$$\text{The Acceleration Coefficient} = \alpha = \text{Exp} \left\{ \left(\frac{E_a}{k} \right) \times \left(\frac{1}{T_2} - \frac{1}{T_1} \right) \right\}$$

Where E_a = Activation Energy (eV)

K = Boltzmann's constant (8.617×10^{-5} eV/°K)

T_1 = Temperature at accelerated conditions in degrees Kelvin

T_2 = Temperature at normal use conditions in degrees Kelvin

This provides both temperature and voltage acceleration factors. Assuming that the actual usage voltage is within the rated specification, acceleration coefficients are calculated for temperature stress. Sample sizes, total devices tested, device hours, and failures can be found in the data tables for each product family. The Arrhenius Life-Temperature relationship is widely used to model product life as a function of temperature. This relationship is used to express both a single failure mechanism's sensitivity to temperature and the product thermal acceleration factor.

General Note:

- Notes at the end of each table correspond to the numbers or asterisk indicated by the superscript in the product column of that table. If there is only one note, an asterisk is used.
- Failures indicated in parenthesis represent false failures due to ESD or EOS, etc.

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Reliability Summary

Table 1: Reliability Summary: FIT Rate by Device Technology

Product Family and Device Technology	Number of Failures	Device Hours	TJ °C	EA, eV	Confidence	FIT	MTTF
1.0 µm CMOS FPGA	1	3.11E+08	55	0.7	60%	6.49	1.54E+08
1.0 µm CMOS FPGA (RH1020)	0	3.97E+07	55	0.7	60%	23.5	4.34E+07
0.8 µm CMOS FPGA (RH1280)	1	9.16E+07	55	0.7	60%	22.10	4.53E+07
0.8 µm CMOS FPGA	1	1.80E+08	55	0.7	60%	11.24	8.90E+07
0.6 µm CMOS FPGA	0	1.82E+08	55	0.7	60%	5.04	1.99E+08
0.6 µm RT54SX CMOS FPGA	0	2.29E+07	55	0.7	60%	39.88	2.51E+07
0.45 µm CMOS FPGA	0	6.96E+07	55	0.7	60%	13.16	7.60E+07
0.35 µm CMOS FPGA	0	6.31E+07	55	0.7	60%	14.51	6.89E+07
0.25 µm MEC CMOS FPGA	2	7.51E+07	55	0.7	60%	41.40	2.42E+07
0.25 µm Infineon Flash FPGA	0	3.62E+07	55	0.7	60%	25.30	3.95E+07
0.25 µm UMC CMOS FPGA	0	5.83E+07	55	0.7	60%	15.69	6.37E+07
0.22 µm UMC CMOS FPGA	0	1.10E+08	55	0.7	60%	8.28	1.21E+08
0.22 µm UMC Flash CMOS FPGA	0	3.78E+07	55	0.7	60%	24.24	4.13E+07
0.15 µm UMC CMOS FPGA	0	1.90E+07	55	0.7	60%	48.11	2.08E+07

Table 2: Reliability Summary: FIT Rate by Product Family

Device Technology and Product Family	Number of Failures	Device Hours	TJ °C	EA, eV	Confidence	FIT	MTTF
1.0 µm CMOS FPGA	1	3.11E+08	55	0.7	60%	6.49	1.54E+08
Act 1	1	1.60E+08	55	0.7	60%	13.72	7.29E+07
Act 2	0	1.51E+08	55	0.7	60%	6.07	1.65E+08
1.0 µm CMOS FPGA (RH1020)	0	3.97E+07	55	0.7	60%	23.5	4.34E+07
0.8 µm CMOS FPGA (RH1280)	1	9.16E+07	55	0.7	60%	22.10	4.53E+07
0.8 µm CMOS FPGA	1	1.80E+08	55	0.7	60%	11.24	8.90E+07
Act 3	0	1.67E+08	55	0.7	60%	5.46	1.83E+08
XL	1	6.08E+06	55	0.7	60%	332.27	3.01E+06
DX	0	6.24E+06	55	0.7	60%	146.75	6.81E+06
0.6 µm CMOS FPGA	0	1.82E+08	55	0.7	60%	5.04	1.99E+08
Act 3	0	6.13E+07	55	0.7	60%	14.93	6.70E+07
XL	0	7.73E+07	55	0.7	60%	11.83	8.45E+07
DX	0	4.31E+07	55	0.7	60%	21.25	4.70E+07
0.6 µm CMOS FPGA (RT54SX)	0	2.29E+07	55	0.7	60%	39.88	2.51E+07
0.45 µm CMOS FPGA (MX)	0	6.96E+07	55	0.7	60%	13.16	7.60E+07
0.35 µm CMOS FPGA (SX)	0	6.31E+07	55	0.7	60%	14.51	6.89E+07
0.25 µm MEC CMOS FPGA	2	7.51E+07	55	0.7	60%	41.40	2.42E+07
SX-A	0	3.15E+07	55	0.7	60%	29.08	3.44E+07
RTSX-S	2	4.37E+07	55	0.7	60%	71.23	1.40E+07
0.25 µm Infineon Flash FPGA (ProASIC)	0	3.62E+07	55	0.7	60%	25.30	3.95E+07
0.25 µm UMC CMOS FPGA (RTSX-SU)	0	5.83E+07	55	0.7	60%	15.69	6.37E+07
0.22 µm UMC CMOS FPGA (SX-A / eX*)	0	1.10E+08	55	0.7	60%	8.28	1.21E+8
0.22 µm UMC Flash CMOS FPGA (ProASIC^{PLUS} (APA))	0	3.78E+07	55	0.7	60%	24.24	4.13E+07
0.15 µm UMC CMOS FPGA (AX)	0	1.90E+07	55	0.7	60%	48.11	2.08E+07

Note: *The eX family of devices is covered under the 0.22 µm FPGA family by similarity (Extension). Testing is conducted on the SX-A devices for the eX family. The smallest SX device (A54SX08A) is the largest die equivalent to the eX256.

ESD Performance

Table 3: A Summary of ESD Performance for All Actel Product Families

Product Family	ESD (volts) HBM	Family Members	Fab Technology
ACT 1	2000	A1010B, A1020B	1.0 μm
ACT 2	1000	A1225A, A1240A, A1280A, RT1280A	1.0 μm
RH1020	4100	RH1020, RT1020	1.0 μm
RH1280	1500	RH1280	0.8 μm
ACT 3	2000	A1415A, A1425A, A1460A, A14100A, & RT Variants	0.8 μm
XL	1500	A1225XL, A1240XL, A1280XL	0.6 μm
DX	2000	A3265DX, A32100DX, A32140DX, A32200DX, A32300DX	0.6 μm
RT54SX	2000	RT54SX16, RT54SX32	0.6 μm
MX	2000	A40MX02, A40MX04, A42MX09, A42MX16, A42MX24, A42MX36	0.45 μm
SX	2000	A54SX08, A54SX16, A54SX16P, A54SX32	0.35 μm
SX-A	75	A54SX16A, A54SX32A, A54SX72A	0.25 μm
RTSX-S	75	RT54SX32S, RT54SX72S	0.25 μm
PA5 (ProASIC)	2000	A500K050, A500K130, A500K180, A500K270	0.25 μm
RTSX-SU	75	RTSX32SU, RTSX72SU	0.25 μm
SX-A	75	A54SX08A, A54SX16A, A54SX32A, A54SX72A	0.22 μm
eX	50	eX64, eX128, eX256	0.22 μm
APA	2000	APA075, APA150, APA300, APA450, APA600, APA750, APA1000	0.22 μm
AX	2000	AX125, AX250, AX500, AX1000, AX2000	0.15 μm

Note: ESD performance tests were performed on all pins.

Group E Inspection – Generic Data (Radiation Hardness)

Verification of radiation performance for each wafer lot is performed through in-line parameter monitoring in the QML RHA wafer production line. [Table 4](#) lists the summarized radiation performance of RH FPGAs.

Table 4: Radiation Performance for RH Devices (Data Published on SMDs)

Total Dose		RH1280	RH1020	Units
TID	Total Ionizing Radiation Dose	300	300	krads (Si)
SEP (Single Event Phenomena)				
SEL	Single Event Latch-up	177	> 84	LETth (MeV-cm2/mg)
SEU	Single Event Upset – Combinatorial	17	> 8	LETth (MeV-cm2/mg)
	Single Event Upset – Sequential	4	–	LETth (MeV-cm2/mg)
SEDR	Single Event Dielectric Rupture	> 60	> 40	LETth (MeV-cm2/mg)
Wafer Lot Acceptance (SEM): RHCMOS4EF (ONO PBEOL) wafer process utilizes plugged vias, which eliminates the step coverage issue, so the SEM metallization inspection is not required.				

1.0 μm FPGA Reliability Summary

Table 5: High Temperature Operating Life (HTOL)

Product	Run Number	Package	Number Units	Test Hours/Failures					
				Test Time	168	500	1000	2000	Unit Hours
A1010B	U1G-01	PLCC68	79	1000	0	0	0	–	79000
A1010B	U1G-02	PLCC68	57	500	0	0	–	–	28500
A1010B	U9G01P	PQFP100	76	1000	0	0	0	–	76000
A1020B	UP121	CQFP84	24	1000	0	0	0	–	24000
A1020B	U1P057/0014	PGA84	97	2000	0	0	0	0	194000
A1020B	JJ-13	PGA84	30	1000	0	0	0	–	30000
A1020B	JJ-13	PGA84	80	500	0	0	–	–	40000
A1020B	JJ-14	PLCC84	45	1000	0	0	0	–	45000
A1020B	JJ-15	PLCC84	45	1000	0	0	0	–	45000
A1020B	JJ-17	PLCC84	45	1000	0	0	0	–	45000
A1020B	JJ-16	PLCC84	80	1000	0	0	0	–	80000
A1020B	U1P-01	PLCC84	40	1000	0	0	0	–	40000
A1020B	U1P-02	PLCC84	40	1000	0	0	0	–	40000
A1020B	JJ-24	PLCC84	87	1000	0	0	0	–	87000
A1020B	EBFJ001	PLCC84	40	1000	0	0	0	–	40000
A1020B	EBFI004	PLCC84	40	1000	0	0	0	–	40000
A1020B	U1P209	PLCC84	40	1000	0	0	0	–	40000
A1020B	U9P-004	PLCC84	47	1000	0	0	0	–	47000
A1020B	U9P046	PLCC84	100	1000	0	0	0	–	100000
A1020B	6085878	PLCC84	100	1000	0	0	0	–	100000
A1020B ¹	UB1P001	PGA84	77	615	0	0	0	–	47355
A1020B	U9P128	PLCC84	100	1000	0	0	0	–	100000
A1020B	UB9P034	PLCC84	98	2000	0	0	0	0	196000
A1020B	U1P41HM	PQFP100	80	1000	0	0	0	–	80000
A1020B	U1P05	PQFP100	129	1000	0	0	0	–	129000
A1020B ²	U9P01, U9P021A	PQFP100	133	1000	0	1	0	–	133000
A1020B	U1P25	VQFP80	45	500	0	0	–	–	22500
A1020B	U1P83	VQFP80	43	1000	0	0	0	–	43000
A1020B	U1P25	VQFP80	39	1000	0	0	0	–	39000

Notes:

1. Tested at 150°C. Equivalent hours corresponding to 125°C were used to calculate the fit rates.
2. Functional failure was observed for the product A1020B, run U9P01, at 500 hours. No defects were observed after decapsulation.

Table 5: High Temperature Operating Life (HTOL) (Continued)

Product	Run Number	Package	Number Units	Test Hours/Failures					
				Test Time	168	500	1000	2000	Unit Hours
A1020B ¹	UB1P008	PGA84	77	615	0	0	0	–	47355
A1225A	UJ-01	PGA100	80	1000	0	0	0	–	80000
A1225A	MIX	PQFP100	32	1000	0	0	0	–	32000
A1225A	UJ-01	PQFP100	127	1000	0	0	0	–	127000
A1225A	U1J-02	PQFP100	80	1000	0	0	0	–	80000
A1240A	TI3257	PGA132	7	500	0	0	–	–	3500
A1240A	UI-01	PGA132	50	1000	0	0	0	–	50000
A1240A	UI-03	PLCC84	80	1000	0	0	0	–	80000
A1240A	E-04	PLCC84	30	2000	0	0	0	0	60000
A1240A	MIX	PQFP144	36	1000	0	0	0	–	36000
A1240A	E-02,03	PQFP144	100	1000	0	0	0	–	100000
A1240A	U1I-26	PQFP144	80	1000	0	0	0	–	80000
A1280A	U1H486	CQFP172	81	1000	0	0	0	–	81000
A1280A ¹	UB1H001	CQFP172	77	615	0	0	–	–	47355
A1280A	U1H486	CQFP172	81	1000	0	0	0	–	81000
A1280A ¹	U1H422	CQFP172	81	615	0	0	–	–	49815
A1280A	U1H439	CQFP172	18	1000	0	0	0	–	18000
A1280A ¹	U1H363	CQFP172	58	615	0	0	–	–	35670
A1280A ¹	U1H83	CQFP172	45	1670	0	0	0	–	75150
A1280A ¹	U1H511	PGA176	77	615	0	0	–	–	47355
A1280A	JH05	PGA176	15	2000	0	0	0	0	30000
A1280A	JH06	PGA176	15	2000	0	0	0	0	30000
A1280A	JH03(K)	PGA176	25	2000	0	0	0	0	50000
A1280A	JH03(SB)	PGA176	25	2000	0	0	0	0	50000
A1280A	UH-01	PGA176	26	1000	0	0	0	–	26000
A1280A	UH-02	PGA176	26	1000	0	0	0	–	26000
A1280A	UH-05	PGA176	40	1000	0	0	0	–	40000
A1280A	UH-10,14	PGA176	75	1000	0	0	0	–	75000
A1280A	U1H-35	PGA176	132	168	0	–	–	–	22176
A1280A	UH-04	PQFP160	79	1000	0	0	0	–	79000

Notes:

1. Tested at 150°C. Equivalent hours corresponding to 125°C were used to calculate the fit rates.
2. Functional failure was observed for the product A1020B, run U9P01, at 500 hours. No defects were observed after decapsulation.

Table 5: High Temperature Operating Life (HTOL) (Continued)

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	168	500	1000	2000	Unit Hours
A1280A	ADC18X	PQFP160	130	1000	0	0	0	–	130000
A1280A	EBFJ002	PQFP160	30	168	0	–	–	–	5040
A1280A	EBFJ003	PQFP160	30	168	0	–	–	–	5040
A1280A	EBFJ004	PQFP160	20	168	0	–	–	–	3360
A1280A	U1H-01	PQFP160	27	2000	0	0	0	0	54000
A1280A	U1H-02	PQFP160	27	2000	0	0	0	0	54000
A1280A	U1H-18	PQFP160	80	1000	0	0	0	–	80000
RT1280A ¹	U1H611	CQFP172	15	615	0	0	–	–	9225
Total Units for 1.0 µm FPGA =			4050	Total Test Time Hours					3990396
Total Failures for 1.0 µm FPGA = 1									
Act 1									
Total Units for 1.0 µm FPGA =			2013	Total Test Time Hours					2057710
Total Failures for 1.0 µm Act 1 FPGA = 1									
Act 2									
Total Units for 1.0 µm FPGA =			2037	Total Test Time Hours					1932686
Total Failures for 1.0 µm Act 2 FPGA = 0									

Notes:

1. Tested at 150°C. Equivalent hours corresponding to 125°C were used to calculate the fit rates.
2. Functional failure was observed for the product A1020B, run U9P01, at 500 hours. No defects were observed after decapsulation.

Table 6: 85C/85% Temperature Humidity BIAS

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	168	500	1000	2000	Unit Hours
A1020B	JJ-14	PLCC84	27	1000	0	0	0		27000
A1020B	JJ-15	PLCC84	27	1000	0	0	0		27000
A1020B	JJ-17	PLCC84	27	1000	0	0	0		27000
Total Units for 1.0 μm FPGA =			81	Total Test Time Hours					81000
Total Failures for 1.0 μm FPGA = 0									

Table 7: Biased Humidity (HAST)

				Test Hours/Failures				
Product	Run Number	Package	Number Units	Test Time	50	100	250	Unit Hours
A1020B	EBFJ001	PLCC84	44	100		0		4400
A1020B	EBFI004	PLCC84	36	100		0		3600
A1020B	U9P01	PLCC84	29	100		0		2900
A1020B	U9P021A	PLCC84	50	100		0		5000
A1020B	U9P039	PLCC84	50	100		0		5000
A1020B	U9P046	PLCC84	50	100		0		5000
A1020B	6085878	PLCC84	50	100		0		5000
A1020B	103501	PLCC84	61	100		0		6100
Total Units for 1.0 μm FPGA =			370	Total Test Time Hours				37000
Total Failures for 1.0 μm FPGA = 0								

Table 8: Temperature Cycle

				Number of Cycles/Failures					
Product	Run Number	Package	Number Units	Test Cycles	100	500	1000	2000	Cycles
(0°C – +125°C)									
Total Units for 1.0 µm FPGA =			0	Total Test Cycles					0
Total Failures for 1.0 µm FPGA = 0 (0° – 125°)									
(-40°C – +125°C)									
Total Units for 1.0 µm FPGA =			0	Total Test Cycles					0
Total Failures for 1.0 µm FPGA = 0 (-40°C – +125°C)									
(-55°C – +125°C)									
A1020B	U9P186	PLCC68	30	1000	0	0	0		30000
A1020B	U9G042	PQFP100	25	1000	0	0	0		25000
Total Units for 1.0 µm FPGA =			55	Total Test Cycles					55000
Total Failures for 1.0 µm FPGA = 0 (-55°C – +125°C)									
(-65°C – +150°C)									
A1010B	U1G-01,02	PLCC68	40	1000	0	0	0		40000
A1020B	JJ14-17	PLCC84	81	1000	0	0	0		81000
A1020B	U1P-01,02	PLCC84	40	1000	0	0	0		40000
A1020B	EBFJ001	PLCC84	80	1000	0	0	0		80000
A1020B	U1P41HM	PQFP100	80	1000	0	0	0		80000
A1020B	EWAI003	PLCC84	80	1000	0	0	0		80000
A1020B	U1P-209B	PLCC84	15	1000	0	0	0		15000
A1020B	U1P05	PQFP100	80	1000	0	0	0		80000
A1020B	U9P021A	PLCC84	55	1000	0	0	0		55000

Table 8: Temperature Cycle (Continued)

				Number of Cycles/Failures					
Product	Run Number	Package	Number Units	Test Cycles	100	500	1000	2000	Cycles
A1020B	U9P01	PLCC84	23	1000	0	0	0		23000
A1020B	U9P039	PLCC84	50	1000	0	0	0		50000
A1020B	U9P046	PLCC84	50	1000	0	0	0		50000
A1020B	6085878	PLCC84	50	1000	0	0	0		50000
A1020B	103501	PLCC84	62	1000	0	0	0		62000
Total Units for 1.0 µm FPGA =			786	Total Test Cycles					786000
Total Failures for 1.0 µm FPGA = 0 (-65°C – +150°C)									

Table 9: Thermal Shock

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	100	200	500	1000	Unit Hours
Total Units for 1.0 μm FPGA =			0	Total Test Time Hours					0
Total Failures for 1.0 μm FPGA = 0									

Table 10: Pressure Pot (Unbiased Autoclave)

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	96	168	240	336	Unit Hours
A1010B	U1G-01	PLCC68	40	264	0	0	0		10560
A1020B	JJ14-17	PLCC84	81	264	0	0	0		21384
A1020B	U1P-01	PLCC84	40	264	0	0	0		10560
A1020B	U09039	PLCC84	50	264	0	0	0		13200
Total Units for 1.0 µm FPGA =			211	Total Test Time Hours					55704
Total Failures for 1.0 µm FPGA = 0									

1.0 μ m FPGA (RH) Reliability Summary

Table 11: High Temperature Operating Life (HTOL)¹

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	168	500	1000	2000	Unit Hours
RH1020	T8036	CQFP172	78	1000	0	0	0		78000
RH1020	T9064	CQFP172	40	1000	0	0	0		40000
RH1020 ²	T9085	CQFP172	15	615	0	0			9225
RH1020	T9089	CQFP172	8	1000	0	0	0		8000
RH1020	T2208	CQFP172	18	1000	0	0	0		18000
RH1020 ³	T2404	CQFP172	48	1000	0	0	0		48000
Total Units for 1.0 μm RH1020 FPGA =			207		Total Test Time Hours				201225
Total Failures for 1.0 μm RH1020 FPGA = 0									

Notes:

1. Data from BAe
2. Tested at 150°C. Equivalent hours corresponding to 125°C were used to calculate the fit rates.
3. One unit failed at -55°C after completing 1000 hours, which was verified to be false failure due to tester noise.

0.8 μ m FPGA (RH) Reliability Summary

Table 12: High Temperature Operating Life (HTOL)¹

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	168	500	1000	2000	Unit Hours
RH1280	FPGAQQC11-95507A.1	CQFP172	6	1000	0	0	0		6000
RH1280	FPGAQQC11-95507C.1	CQFP172	17	1000	0	0	0		17000
RH1280	FPGAQQC11-95506C.1,2,3	CQFP172	34	1000	0	0	0		34000
RH1280	FPGAQQC11-95506D.1	CQFP172	20	1000	0	0	0		20000
RH1280	T7013C-96550L.2	CQFP172	12	1000	0	0	0		12000
RH1280	T7013C-96580C.1	CQFP172	33	1000	0	0	0		33000
RH1280 ²	T7013C-96580E.1	CQFP172	32	1000	1	0	0		32000
RH1280	T9065	CQFP172	61	1000	0	0	0		61000
RH1280	T9066	CQFP172	10	1000	0	0	0		10000
RH1280	T9072	CQFP172	12	1000	0	0	0		12000
RH1280	T9088-1990510 & 1990511	CQFP172	38	1000	0	0	0		38000
RH1280	T2208	CQFP172	59	1000	0	0	0		59000
Total Units for 1.0 μm RH1280 FPGA =			334		Total Test Time Hours				334000
Total Failures for 1.0 μm RH1280 FPGA = 1									

Notes:

1. Data from BAe
2. No defect found. Part destroyed in analysis.

0.8 μ m FPGA Reliability Summary

Table 13: High Temperature Operating Life (HTOL)

Product	Run Number	Package	Number Units	Test Hours/Failures					
				Test Time	168	500	1000	2000	Unit Hours
A1280XL ¹	24464430, 24381610, 24442620	PQFP160	78	1000	1	0	0		78000
A14100A ²	UBCLP01A	CQFP256	77	615	0	0	0		47355
A14100A ²	UCL058	CQFP256	82	615	0	0	0		50430
A14100A ^{2, 3}	UCL072	CQFP256	78	615	(1)	0	0		47970
A14100A ⁴	UCL049	CQFP256	15	1,000	0	0	(1)		15000
A14100A	UCL055	CQFP256	18	1,000	0	0	0		18000
A14100A ²	UCL058	CQFP256	82	561	0				46002
A14100A	UCL073	CQFP256	10	1,000	0	0	0		10000
A14100A ²	UCL082	CQFP256	10	1,670	0	0	0		16700
A14100A	25290820	PBGA313	45	1000	0	0	0		45000
A14100A	24239130	RQFP208	51	1000	0	0	0		51000
A14100A	UCLO1	RQFP208	25	1000	0	0	0		25000
A1425A ²	UCJ01/02E/03	PGA133	130	615	0	0	0		79950
A1425A	JK08, 09, 10	PGA133	140	1000	0	0	0		140000
A1425A	ACN32804, ACN30805, ACN33807	PGA133	130	1000	0	0	0		130000
A1425A ²	UCJ01, 2, 3	PGA133	130	615	0	0	0		79950
A1425A	JK08, 09, 10	PLCC84	135	1000	0	0	0		135000
A1425A	UCJ013	PQFP100	100	1000	0	0	0		100000
A1440A	51940	VQFP100	79	1000	0	0	0		79000
A1440A	JN05	VQFP100	79	1000	0	0	0		79000
A1460A ²	UCK056	PGA207	80	561	0				44880
A1460A ²	UCT01	CPGA207	81	561	0				45441
A1460A ²	UCK005	PGA207	77	615	0	0	0		47355
A1460A ²	UCK056	PGA207	80	615	0	0			49200
A1460A ²	UCT01	PGA207	81	615	0	0			49815

Notes:

1. Product A1280XL, run 24442620, one polyimide failure due to die saw defect in assembly.
2. Tested at 150°C. Equivalent hours corresponding to 125°C were used to calculate the fit rates.
3. Product A14100A, run UCL072, at 168 hours, one unit failed gross-functional. FA shown contact spike caused by ESD/ EOS, qualification passed by TRB approval.
4. Product A14100A, run UCL049, at 1000 hours, unit failed was proven by FA as EOS, no functional failures observed.

Table 13: High Temperature Operating Life (HTOL) (Continued)

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	168	500	1000	2000	Unit Hours
A1460A	JL-01	PGA207	80	1000	0	0	0		80000
A1460A	JL-06B	PGA207	65	1000	0	0	0		65000
A1460A	PC435091, PC435092, PC435093	PGA207	80	1000	0	0	0		80000
A1460A	20072420	PQFP208	30	1000	0	0	0		30000
A1460A	20094560	PQFP208	29	1000	0	0	0		29000
A1460A	20145270	PQFP208	30	1000	0	0	0		30000
A1460A	29350050	PQFP208	65	2000	0	0	0	0	130000
A1460A	UCK070	PQFP208	22	2000	0	0	0	0	44000
A1460A	JL-01	PQFP208	80	1000	0	0	0		80000
A1460A	JL-03	PQFP208	62	1000	0	0	0		62000
RT14100A	UCL055	CQFP256	18	1000	0	0	0		18000
RT14100A	UCL073	CQFP256	15	1000	0	0	0		15000
RT14100A	UCL073	CQFP256	10	1000	0	0	0		10000
RT14100A ¹	UCL72/9925	CQFP256	77	561	0				43197
A32100DX		CQFP84	80	1000	0	0	0		80000
Total Units for 0.8 μm FPGA =			2636	Total Test Time Hours					2306245
Total Failures for 0.8 μm FPGA = 1									
ACT 3									
Total Units for 0.8 μm Act 3 FPGA =			2478	Total Test Time Hours					2148245
Total Failures for 0.8 μm Act 3 FPGA = 0									
XL									
Total Units for 0.8 μm XL FPGA =			78	Total Test Time Hours					78000
Total Failures for 0.8 μm XL FPGA = 1									
DX									
Total Units for 0.8 μm DX FPGA =			80	Total Test Time Hours					80000
Total Failures for 0.8 μm DX FPGA = 0									

Notes:

1. Product A1280XL, run 24442620, one polyimide failure due to die saw defect in assembly.
2. Tested at 150°C. Equivalent hours corresponding to 125°C were used to calculate the fit rates.
3. Product A14100A, run UCL072, at 168 hours, one unit failed gross-functional. FA shown contact spike caused by ESD/ EOS, qualification passed by TRB approval.
4. Product A14100A, run UCL049, at 1000 hours, unit failed was proven by FA as EOS, no functional failures observed.

Table 14: 85C/85%Temperature Humidity Bias

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	168	500	1000	2000	Unit Hours
A14100A	25290820	PBGA313	45	1000	0	0	0		45000
Total Units for 0.8 μm FPGA =			45	Total Test Time Hours					45000
Total Failures for 0.8 μm FPGA = 0									

Table 15: Biased Humidity (HAST)

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	50	100	200	250	Unit Hours
A1280XL	24464430, 24381610, 24442620	PQFP160	46	100	0	0			4600
A1425A	JK8,9,10	PLCC84	81	100	0	0			8100
A1425A	ACN32804, ACN30805, ACN33807	PQFP100	80	100	0	0			8000
A1425A	UCJ01,2,3	PQFP100	80	100	0	0			8000
A1440A	JN05	VQFP100	45	100	0	0			4500
A1440A	51940	VQFP100	45	100	0	0			4500
A1460A	JL04A	PQFP208	80	100	0	0			8000
A1460A	WB24279010	PQFP208	47	100	0	0			4700
A14100A	24239130	RQFP208	14	100	0	0			1400
Total Units for 0.8 μm FPGA =			518		Total Test Time Hours				51800
Total Failures for 0.8 μm FPGA = 0									

Table 16: Temperature Cycle

				Number of Cycles/Failures					
Product	Run Number	Package	Number Units	Test Cycles	100	200	500	1000	Cycles
(-65 C – +150 C)									
A1280XL	25312500, 25312480	PQFP160	76	500	0	0	0		38000
A1280XL	25312500, 25312480	PQFP160	76	200	0	0			15200
A1280XL	25312500, 25312480	PQFP160	75	500	0	0	0		37500
A1280XL	25312500, 25312480	PQFP160	75	500	0	0	0		37500
A1280XL	25312500, 25312480	PQFP160	74	500	0	0	0		37000
A1280XL	25312500, 25312480	PQFP160	76	500	0	0	0		38000
A1280XL	25504560	PQFP160	36	500	0	0	0		18000
A1280XL	25026540	TQFP176	17	500	0	0	0		8500
A14100A	25290820	PBGA313	78	500	0	0	0		39000
A14100A	MIX	RQFP208	24	100	0				2400
A14100A	MIX	RQFP208	24	100	0				2400

Table 16: Temperature Cycle (Continued)

				Number of Cycles/Failures					
Product	Run Number	Package	Number Units	Test Cycles	100	200	500	1000	Cycles
A14100A	24239130	RQFP208	14	500	0	0	0		7000
A14100A	UCLO1	RQFP208	31	500	0	0	0		15500
A14100A	2537198	RQFP208	19	100	0				1900
A1425A	JK8,9,10	PGA133	81	500	0	0	0		40500
A1425A	JK8,9,10	PLCC84	83	500	0	0	0		41500
A1425A	UCJ01,2,3	PQFP100	80	500	0	0	0		40000
A1425A	ACN32804, ACN30805, ACN33807	PQFP100	80	500	0	0	0		40000
A1440A	JN-02	PQFP160	80	500	0	0	0		40000
A1440A	JN-05	VQFP100	80	500	0	0	1		40000
A1440A	51940	VQFP100	45	500	0	0	0		22500
A1460A	JL-01	PGA207	80	500	0	0	0		40000
A1460A	PC435091, PC435092, PC435093	PGA207	80	500	0	0	0		40000
A1460A	JL-01	PQFP208	80	500	0	0	0		40000
A1460A	25364430	PQFP208	45	500	0	0	0		22500
A1460A	2610001	PQFP208	80	500	0	0	0		40000
Total Units for 0.8 mm FPGA =			1589		Total Test Cycles				744900
Total Failures for 0.8 μm FPGA = 1									

Table 17: Pressure Pot (Unbiased Autoclave)

					Test Hours/Failures				
Product	Run Number	Package	Number Units	Test Time	48	96	168	336	Unit Hours
A1280XL	25312480	TQFP176	45	168	0	0	0		7560
A14100A	25290820	PBGA313	45	96	0	0			4320
Total Units for 0.8 mm FPGA =			90	Total Test Time Hours					11880
Total Failures for 0.8 μm FPGA = 0									

0.6 μ m FPGA Reliability Summary

Table 18: High Temperature Operating Life (HTOL)

Product	Run Number	Package	Number Units	Test Hours/Failures					
				Test Time	168	500	1000	2000	Unit Hours
A1225XL	ACP02187.1	PQFP100	26	1000	0	0	0	–	26000
A1225XL	ACQ10102	PQFP100	56	1000	0	0	0	–	56000
A1240XL	ACP57584.1	PLCC84	100	1000	0	0	0	–	100000
A1240XL	MIX	PQFP144	56	1000	0	0	0	–	56000
A1240XL	ACR50594.1	PQFP144	228	168	0				38304
A1240XL	ACR50594.1	PQFP144	143	168	0				24024
A1240XL	ACR50594.1	PQFP144	227	168	0				38136
A1240XL	ACP01117.1, ACN51939.1	PQFP144	52	1000	0	0	0	–	52000
A1280XL ¹	ACT 10293.1	CQFP172	80	561	0	0			44880
A1280XL ¹	ACT10293.1	CQFP172	80	615	0	0			49200
A1280XL ¹	ACY953401	CQFP172	77	615	0	0			47355
A1280XL ^{1, 2}	ACU413553	PGA176	77	615	(1)	0			47355
A1280XL ¹	ACV715861	PGA176	77	561	0	0			43197
A1280XL	MIX	PLCC84	100	1000	0	0	0		100000
A1280XL	ACR53214	PQFP160	129	168	0				21672
A1280XL	ACU458071/ 0008	PQFP160	86	2000	0	0	0	0	172000
A1280XL	ACP212072, ACP19329.1	PQFP160	76	1000	0	0	0		76000
A14100BP	26026670	RQFP208	27	1000	0	0	0		27000
A1415A	ACP17300	PQFP100	100	1000	0	0	0		100000
A1425A	UCJ01,02,03)	PGA133	130	1670	0	0	0		217100
A1425A	ACP17300	PQFP100	101	2000	0	0	0	0	202000
A1425A	ACP122761	PQFP100	100	1000	0	0	0		100000
A1425A	ACP12285	PQFP100	88	1000	0	0	0		88000
A1460BP	25430540	PQFP208	52	1000	0	0	0		52000
A32100DX ¹	ACR50293.1	CQFP84	80	615	0	0			49200
A32140DX	ACP562551	PQFP208	28	2000	0	0	0	0	56000

Notes:

1. Tested at 150°C. Equivalent hours corresponding to 125°C were used to calculate the fit rates.
2. Product A1280XL, run 2ACU413553, at 160 hours, unit failed was verified to be ESD/EOS.
3. Product A32200DX, run ACT16685.1, at 160 hours, rejects are due to electrical over stress (EOS) or ESD, which are induced by HP1 tester during the same time frame as these devices are tested. Failure modes are not life-test induced; therefore, the qualification is still passed.

Table 18: High Temperature Operating Life (HTOL) (Continued)

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	168	500	1000	2000	Unit Hours
A32140DX	G10854	PQFP208	26	1000	0	0	0		26000
A32140DX	ACP540231	PQFP160	26	1000	0	0	0		26000
A32140DX	25464510	PQFP160	26	1000	0	0	0		26000
A32140DX	ACP33277.1	PQFP208	75	1000	0	0	0		75000
A32140DX	ACP56255.1	PQFP208	52	1000	0	0	0		52000
A32200DX ^{1, 3}	ACT16685.1	CQFP256	77	1000	(1)	0	0		77000
A32200DX	ACV648421	CQFP256	5	615	0				3075
A32200DX1	ACV648421	CQFP256	5	615	0	0			3075
A32200DX1	26207340	PQFP208	29	1000	0	0	0		29000
A32300DX	ACQ09069.1	RQFP240	26	2000	0	0	0	0	52000
A3265DX	ACP163684	PQFP160	78	1000	0	0	0		78000
Total Units for 0.6 μm FPGA =			2801	Total Test Time Hours					2330573
Total Failures for 0.6 μm FPGA = 0									
Act 3									
Total Units for Act 3 FPGA =			598	Total Test Time Hours					786100
Total Failures for Act 3 FPGA = 0									
XL									
Total Units for XL FPGA =			1670	Total Test Time Hours					992123
Total Failures for XL FPGA = 0									
DX									
Total Units for DX FPGA =			1207	Total Test Time Hours					552350

Notes:

1. Tested at 150°C. Equivalent hours corresponding to 125°C were used to calculate the fit rates.
2. Product A1280XL, run 2ACU413553, at 160 hours, unit failed was verified to be ESD/EOS.
3. Product A32200DX, run ACT16685.1, at 160 hours, rejects are due to electrical over stress (EOS) or ESD, which are induced by HP1 tester during the same time frame as these devices are tested. Failure modes are not life-test induced; therefore, the qualification is still passed.

Table 19: Biased Humidity (HAST)

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	50	100	200	250	Unit Hours
A1225XL	ACP02187.1	PQFP100	17	100	0	0			1700
A1240XL	ACP01117.1, ACN51939.1	PQFP144	31	100	0	0			3100
A1280XL	ACP19329.1, ACP212072	PQFP160	76	100	0	0			7600
A1280XL	ACP33235.1	PQFP160	76	100	0	0			7600
A1280XL	ACQ01769	PQFP160	40	100	0	0			4000
A1280XL	ACQ05561	PQFP160	39	100	0	0			3900
A3265DX	ACP163684	PQFP160	40	100	0	0			4000
A1415A	ACP17300	PQFP100	50	100	0	0			5000
A1425A	ACP122761	PQFP100	50	100	0	0			5000
A32140DX	ACP54023.1	PQFP160	26	100	0	0			2600
A32140DX	ACP33277.1, ACP55730.1, ACP54023.1	PQFP208	76	100	0	0			7600
A32200DX	26207340	PQFP208	26	100	0	0			2600
A14100BP	26330340	RQFP208	26	100	0	0			2600
A32200DX	ACQ03818.1	PQFP208	30	100	0	0			3000
A1280XL	26084380	PQFP160	58	100	0	0			5800
A32140DX	55558	PQFP208	25	100	0	0			2500
Total Units for 0.6 μm FPGA =			686	Total Test Time Hours					68600
Total Failures for 0.6 μm FPGA = 0									

Table 20: Temperature Cycle

				Number of Cycles/Failures					
Product	Run Number	Package	Number Units	Test Cycles	100	200	500	1000	Cycles
(-65 C - +150 C)									
A1280XL	25026540	TQFP176	17	500	0	0	0		8500
A1280XL	25312500, 25312480	PQFP160	76	500	0	0	0		38000
A1280XL	25312500, 25312480	PQFP160	76	200	0	0			15200
A1280XL	25312500, 25312480	PQFP160	75	500	0	0	0		37500
A1280XL	25312500, 25312480	PQFP160	75	500	0	0	0		37500
A1280XL	25312500, 25312480	PQFP160	74	500	0	0	0		37000

Table 20: Temperature Cycle (Continued)

				Number of Cycles/Failures					
Product	Run Number	Package	Number Units	Test Cycles	100	200	500	1000	Cycles
A1280XL	25312500, 25312480	PQFP160	76	500	0	0	0		38000
A1280XL	25504560	PQFP160	36	500	0	0	0		18000
A1425A	JK8,9,10	PGA133	81	500	0	0	0		40500
A1425A	JK8,9,10	PLCC84	83	500	0	0	0		41500
A1425A	UCJ01,2,3	PQFP100	80	500	0	0	0		40000
A1425A	ACN32804, ACN30805, ACN33807	PQFP100	80	500	0	0	0		40000
A1440A	JN-02	PQFP160	80	500	0	0	0		40000
A1440A	JN-05	VQFP100	80	500	0	0	1		40000
A1440A	51940	VQFP100	45	500	0	0	0		22500
A1460A	JL-01	PQFP208	80	500	0	0	0		40000
A1460A	JL-01	PGA207	80	500	0	0	0		40000
A1460A	PC435091, PC435092, PC435093	PGA207	80	500	0	0	0		40000
A1460A	25364430	PQFP208	45	500	0	0	0		22500
A1460A	2610001	PQFP208	80	500	0	0	0		40000
A14100A	24239130	RQFP208	14	500	0	0	0		7000
	UCLO1	RQFP208	31	500	0	0	0		15500
A14100A	2537198	RQFP208	19	100	0				1900
A14100A	25290820	PBGA313	78	500	0	0	0		39000
A14100A	MIX	RQFP208	24	100	0				2400
A14100A	MIX	RQFP208	24	100	0				2400
Total Units for 0.6 μm FPGA =			1589	Total Test Cycles					744900
Total Failures for 0.6 μm FPGA = 1									

Table 21: Pressure Pot (Unbiased Autoclave)

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	48	96	168	336	Unit Hours
A1280XL	25312480	TQFP176	45	168	0	0	0		7560
A14100A	25290820	PBGA313	45	96	0	0			4320
Total Units for 0.6 μm FPGA =			90	Total Test Time Hours					11880
Total Failures for 0.6 μm FPGA = 0									

0.6 μ m RTSX FPGA Reliability Summary

Table 22: High Temperature Operating Life (HTOL)

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	168	500	1000	2000	Unit Hours
RT54SX16*	P05	CQFP256	77	615	0	0			47355
RT54SX16	P04	CQFP256	46	2000	0	0	0	0	92000
RT54SX16	P02, P03, P04	PQFP208	81	1000	0	0	0		81000
RT54SX16	T6HP12	CQFP256	101	240	0				24240
RT54SX32*	T6JP01A	CQFP208	76	615	0	0			46740
RT54SX32*	T6JP05A	CQFP256	5	615	0	0			3075
Total Units for 0.6 μm RTSX FPGA =			386	Total Test Time Hours					294410
Total Failures for RTSX 0.6 μm FPGA = 0									
Note: *Tested at 150°C. Equivalent hours corresponding to 125°C were used to calculate the fit rates.									

0.45 mm FPGA Reliability Summary

Table 23: High Temperature Operating Life (HTOL)

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	168	500	1000	2000	Unit Hours
A40MX04	2ACR23038.3	PLCC84	30	2000	0	0	0	0	60000
A40MX04	2ACR23038.3	PLCC84	45	2000	0	0	0	0	90000
A40MX04	2Act 160021	PLCC84	77	2000	0	0	0	0	154000
A40MX04	2ACU040091 (DC9919)	PLCC84	77	2000	0	0	0	0	154000
A40MX04	2XZR24206.5	PLCC84	29	2000	0	0	0	0	58000
A42MX16	2ACU492561 (DC0012)	PLCC84	148	1000	0	0	0		148000
A42MX16	2XZR25104.1	PQFP160	26	2000	0	0	0	0	52000
A42MX36 ¹	2ACZ310131	CQ208	77	1670	0	0	0		47355
A42MX36 ^{1, 2}	2ACT363611	CQFP256	77	615	(1)	0			47355
A42MX36	2Act10221	PQFP208	27	2000	0	0	0	0	54000
A42MX36 ¹	2ACU523241 (DC0019)	CQFP208	45	615	0	0	0		27675
Total Units for 0.45 µm FPGA =			658	Total Test Time Hours					892385
Total Failures for 0.45 µm FPGA = 0									

Notes:

1. Tested at 150°C Equivalent hours corresponding to 125°C were used to calculate the fit rates.
2. Product A42MX36, run 2ACT363611, at 168 hours, unit failed was verified to be ESD/EOS.

Table 24: Biased Humidity (HAST)

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	50	100	200	250	Unit Hours
A40MX04	2ACR23038.3	PLCC84	81	100	0	0			8100
A40MX04	2ACR23039.1	PLCC84	25	100	0	0			2500
A42MX09	2ACT110181	PQFP160	30	100	0	0			3000
A42MX16	2XZR25104.1	PQFP160	25	100	0	0			2500
A42MX36	2ACT180141	PBGA272	76	100	0	0			7600
A42MX36	2ACT110221	PQFP208	27	50	0				1350
Total Units for 0.45 µm FPGA =			264	Total Test Time Hours					25050
Total Failures for 0.45 µm FPGA = 0									

Table 25: Unbiased Humidity

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	50	100	200	250	Unit Hours
A42MX09	2ACT052662 (DC 9817)	PQFP160	30	100	0	0			3000
Total Units for 0.45 μm FPGA =			30	Total Test Time Hours					3000
Total Failures for 0.45 μm FPGA = 0									

Table 26: Temperature Cycle

				Number of Cycles/Failures					
Product	Run Number	Package	Number Units	Test Cycles	200	500	1000	2000	Cycles
(-65 C – +150 C)									
A40MX04	2XZR24206.5	PLCC84	26	1000	0	0	0		26000
A40MX04	2ACR23038.3	PLCC84	26	1000	0	0	0		26000
A42MX09	2ACT210121	PQFP160	30	1000	0	0	0		30000
A42MX16	2XZR25104.1	PQFP160	26	1000	0	0	0		26000
A42MX36	2ACT110221	PQFP208	27	1000	0	0	0		27000
Total Units for 0.45 μm FPGA =			135	Total Test Cycles					135000
Total Failures for 0.45 μm FPGA = 0									

0.35 mm FPGA Reliability Summary

Table 27: High Temperature Operating Life (HTOL)

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	168	500	1000	2000	Unit Hours
A54SX16 ^{1, 2}	2ACW210771	CQFP208	105	615	(2)	0	0		
A54SX16	2ACT110031	PQFP208	74	2000	0	0	0	0	148000
A54SX16	2XZR402521	PQFP208	38	1000	0	0	0		38000
A54SX16	2ACU420072	PQFP208	99	1000	0	0	0		99000
A54SX16	2ACT100081	PQFP208	81	2000	0	0	0	0	162000
A54SX16P	2ACT141821	PQFP208	45	1000	0	0	0		45000
A54SX32 ¹	2ACU390881	CQFP208	45	615	0	0			27675
A54SX32 ¹	2ACT500021	CQFP208	45	615	0	0			27675
A54SX32	2ACV103721	PQFP208	88	1000	0	0	0		88000
A54SX32	2XZT091468	PQFP208	43	2000	0	0	0	0	86000
A54SX32	2ACT330111, 2ACT330101, 2HCU462006	PQFP208	88	1000	0	0	0		88000
Total Units for 0.35 µm FPGA =			751	Total Test Time Hours					809350
Total Failures for 0.35 µm FPGA = 0									

Notes:

1. Tested at 150°C. Equivalent hours corresponding to 125°C were used to calculate the fit rates.
2. Product A54SX16, run 2ACW210771; the group C lot was started with 77 units and two devices failed during functional test. The failure analysis with the two failure devices was started to narrow down the failure location and find the root cause of failure. Bench setup testing was done to reproduce the failure seen on the tester. Unfortunately, the two devices in FA, plus one more reference unit from the same lot, were misplaced in the lab and got lost during the Actel facility move from Sunnyvale to Mt. View. The devices may have been scrapped by mistake as reject parts. Therefore, the failure analysis could not be continued. An additional 29 units from the same inspection lot were submitted for full group C process and all passed. As a result, this group C qualification was passed with 105(2) result based on the LTPD(5) criteria. Actel TRB approved this group C result, and agreed this was a one-time accident due to the facility move, which should not recur with the currently established handling procedure for FA devices.

Table 28: Low Temperature Operating Life (LTOL)

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	168	500	1000	2000	Unit Hours
A54SX32	2ACT330111, 2ACT330101, 2HCU462006	PQFP208	88	1000	0	0	0		88000
Total Units for 0.35 µm FPGA =			88	Total Test Time Hours					88000
Total Failures for 0.35 µm FPGA = 0									

Table 29: Biased Humidity (HAST)

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	50	100	200	250	Unit Hours
A54SX32	2ACU211641, DC 9941, DC9942, DC9943	PBGA329	81	100	0	0			8100
A54SX16	2ACU241341 DC 9947, 2ACU420072 DC 0002, 2ACU222448 DC 0004	PQFP208	84	100	0	0			8400
A54SX32	2ACU410201 DC 0013, 2ACU410201 DC 0014, 2ACU410201 DC 0015	PBGA329	76	100	0	0			7600
Total Units for 0.35 μm FPGA =			241	Total Test Time Hours					24100
Total Failures for 0.35 μm FPGA = 0									

Table 30: Unbiased Humidity (HAST)

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	50	100	200	250	Unit Hours
A54SX16	2ACU241341 DC 9947, 2ACU420072 DC 0002, 2ACU222448 DC 0004	PQFP208	84	100	0	0			8400
Total Units for 0.35 μm FPGA =			84	Total Test Time Hours					8400
Total Failures for 0.35 μm FPGA = 0									

Table 31: Temperature Cycle

				Number of Cycles/Failures					
Product	Run Number	Package	Number Units	Test Cycles	200	500	1000	2000	Cycles
(-65 C – +150 C)									
A54SX16	2ACU241341 DC 9947	PQFP208	93	1000	0	0	0		93000
	2ACU420072 DC 0002								
	2ACU222448 DC 0004								
A54SX32	2ACU410201 DC 0013	PBGA329	76	1000	0	0	0		76000
	2ACU410201 DC 0014								
	2ACU410201 DC 0015								
A54SX32	2HCU462006 DC 0010	PQFP208	76	1000	0	0	0		76000
	2HCU410216 DC 0017								
	2HCV022691 DC 0017								
Total Units for 0.35 µm FPGA =			245	Total Test Cycles					245000
Total Failures for 0.35 µm FPGA = 0									

0.25 μ m MEC FPGA Reliability Summary

Table 32: High Temperature Operating Life (HTOL)

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	168	500	1000	2000	Unit Hours
A54SX32A	T25J002 9943	PQFP208	80	1000	0	0	0		80000
A54SX32A	T25JP03 0012	PQFP208	88	1000	0	0	0		88000
A54SX32A	T25J002, P05, P04	PQFP208	50	500	0	0			25000
A54SX72A ^{1, 2}	T25K065	CQFP208	77	615	(1)	0			47355
A54SX72A	T25K001	PQFP208	88	1000	0	0	0		88000
A54SX72A	T25K065	PQFP208	77	615	0	0			47355
A54SX72A	T25KP04	PQFP208	28	1000	0	0	0		28000
RT45SX32S	T25JSP03	CQFP208	8	2000	0	0	0	0	16000
RT54SX32S	T25JS001	CQFP208	8	4000	0	0	0	0	32000
RT54SX32S	T25JS001	CQFP208	25	1000	0	0	0		25000
RT54SX32S	T25JSP03	CQFP208	24	1000	0	0	0		24000
RT54SX32S ¹	T25JSP03	CQFP208	52	615	0	0			31980
RT54SX32S	T25JS004	CQFP208	22	2000	0	0	0	0	44000
RT54SX32S	BP1037101	CQFP208	100	1000	0	0	0		100000
RT54SX32S	T25JS004	CQFP208	20	1000	0	0	0		20000
RT54SX32S ¹	T25JSP03	CQFP256	76	615	0	0			46740
RT54SX32S ³	BP0083301, T25JS004, T25JS001(KM1)	CQFP208	150	1000	0	1	1 (2)		149250
RT54SX72S	T25KS005	CQFP208	22	1000	0	0	0		22000
RT54SX72S ^{1, 2}	T25KS005	CQFP256	80	615	0	(1)			49200
Total Units for 0.25 μm MEC FPGA =			1075	Total Test Time Hours					963880
Total Failures for 0.25 μm MEC FPGA = 2									

Notes:

1. Tested at 150°C. Equivalent hours corresponding to 125°C were used to calculate the fit rates.
2. Product A54SX72A, run T25K065, and product RT54SX72S, run T25KS005; the failures determined were EOS.
3. K-Antifuse failed at 250 hours, F- Antifuse failure at 1000 hours and 2 ESD failures at 1000 hours

Table 33: Low Temperature Operating Life (LTOL)

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	168	500	1000	2000	Unit Hours
A54SX32A	T25J002, P05, P04	PQFP208	80	1000	0	0	0		80000
A54SX32A	T25JP03	PQFP208	88	1000	0	0	0		88000
A54SX32A	T25J002, P05, P04	PQFP208	50	500	0	0			25000
A54SX72A	T25K001	PQFP208	88	1000	0	0	0		88000
A54SX72A	T25KP04	PQFP208	28	1000	0	0	0		28000
RT54SX32S*	BP0083301, T25JS004, T25JS001(KM1)	CQFP208	149	250	0	1	0		28000
Total Units for 0.25 µm MEC FPGA =			483	Total Test Time Hours					346250
Total Failures for 0.25 µm MEC FPGA = 1									

Note: *One K-Antifuse failed at 250 hours during LTOL.

Table 34: Biased Humidity (HAST)

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	50	100	200	250	Unit Hours
A54SX32A	T25J002, P05, P04	PQFP208	80	100	0	0			8000
A54SX72A	T25KP04	PQFP208	28	100	0	0			2800
Total Units for 0.25 µm MEC FPGA =			108	Total Test Time Hours					10800
Total Failures for 0.25 µm MEC FPGA = 0									

Table 35: Temperature Cycle

				Number of Cycles/Failures					
Product	Run Number	Package	Number Units	Test Cycles	200	500	1000	2000	Cycles
(-65 C – +150 C)									
A54SX32A	T25J002, P05, P04	PQFP208	80	1000	0	0	0		80000
A54SX72A	T25KP04	PQFP208	28	1000	0	0	0		28000
Total Units for 0.25 µm MEC FPGA =			108	Total Test Cycles					108000
Total Failures for 0.25 µm MEC FPGA = 0									

0.25 μ m Flash FPGA Reliability Summary

Table 36: High Temperature Operating Life (HTOL)

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	168	500	1000	2000	Unit Hours
A500K130	ZA026941 ZA035953, ZA034979, DC 0039, DC 0040	PBGA272	76	1000	0	0	0		76000
A500K130	ZA051811	PBGA272	80	1000	0	0	0		80000
A500K270	ZA027920	PBGA456	28	1000	0	0	0		28000
A500K130	ZA051811	PBGA272	120	1000	0	0	0		120000
A500K130	ZA051811	PBGA272	80	1000	0	0	0		80000
A500K130	ZA049887	PBGA272	80	1000	0	0	0		80000
Total Units for 0.25 µm Flash FPGA =			464	Total Test Time Hours					464000
Total Failures for 0.25 µm Flash FPGA = 0									

Table 37: Low Temperature Operating Life (LTOL)

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	168	500	1000	2000	Unit Hours
A500K130	ZA026941 ZA035953, ZA034979, DC 0039, DC 0040	PBGA272	76	1000	0	0	0		76000
Total Units for 0.25 μm Flash FPGA =			76		Total Test Time Hours				76000
Total Failures for 0.25 μm Flash FPGA = 0									

Table 38: Endurance

				Number of Cycles/Failures					
Product	Run Number	Package	Number Units	Cycles	50	100	500	1000	Cycles
Room Temperature									
A500K130	ZA026941	CGA272	15	50	0				750
Total Units for 0.25 μm Flash FPGA =			15		Total Number of Cycles				750
Total Failures for 0.25 μm Flash FPGA = 0									

Table 39: Retention 225°C Unbiased 100% Programmed

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	168	500	1000	2000	Unit Hours
A500K130	ZA026941	CGA272	9	1000	0	0	0		9000
Total Units for 0.25 µm Flash FPGA =			9		Total Test Time Hours				9000
Total Failures for 0.25 µm Flash FPGA = 0									

Table 40: Retention 225°C Unbiased 100% Erased

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	168	500	1000	2000	Unit Hours
A500K130	ZA026941	CGA272	8	1000	0	0	0		8000
Total Units for 0.25 µm Flash FPGA =			8		Total Test Time Hours 8000				
Total Failures for 0.25 µm Flash FPGA = 0									

0.25 μ m UMC FPGA Reliability Summary

Table 41: High Temperature Operating Life (HTOL)

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	168	500	1000	2000	Unit Hours
RTSX32SU*	D122H1-KU1	CQFP208	150	1000	0	0	(1)		150000
RTSX32SU*	D122H1-KU2	CQFP208	150	1000	0	0	(2)		150000
RTSX32SU	D19S61	CQFP208	100	168	0				16800
RTSX32SU	D1AYJ1	CQFP208	100	168	0				16800
RTSX32SU	D1AYJ1	CQFP208	100	168	0				16800
RTSX32SU	D1JW21	CQFP208	100	168	0				16800
RTSX32SU	D1JW21	CQFP256	100	168	0				16800
RTSX32SU	D110A1	CQFP208	435	168	0				73080
RTSX32SU*	D19S61	CQFP256	80	184	(1)				14720
RTSX72SU*	D0Y311	CQFP256	133	1000	(1)	0	0		133000
RTSX72SU	D1JW01	CQFP256	100	168	0				16800
RTSX72SU	D1HLH4	CQFP256	100	168	0				16800
RTSX72SU	D1HLJ1	CQFP256	100	168	0				16800
RTSX72SU	D1HLJ1	CQFP256	79	1000	0	0	0		79000
RTSX72SU	DIJW01	CQFP256	35	168	0				5880
RTSX72SU	D0Y311	CQFP256	8	1000	0	0	0		8000
Total Units for 0.25 µm FPGA =			1870	Total Test Time Hours					748080
Total Failures for 0.25 µm FPGA = 0									

Note: *Failures with D122H1-KU1 and D122H1-KU2 devices showed high V_{th} due to ESD damage. Failures observed with D1AYH1 and D0Y311 were also due to ESD.

Table 42: Low Temperature Operating Life (LTOL)

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	168	500	1000	2000	Unit Hours
RTSX32SU*	D122H1-KU1	CQFP208	150	250	1,(1)				37500
RTSX32SU	D122H1-KU2	CQFP208	150	250	0				37500
RTSX32SU	D122H1	CQFP208	100	168	0				16800
RTSX72SU	D0Y311	CQFP208	100	168	0				16800
RTSX72SU	D0YMJ1	CQFP208	100	500	0	0			50000
RTSX72SU	D1AYH1	CQFP208	100	168	0				16800
RTSX72SU	D0Y311	CQFP256	134	500	0	0			67000
RTSX72SU	D0Y311	CQFP256	8	168	0				1344
Total Units for 0.25 μm FPGA =			842	Total Test Time Hours					243744
Total Failures for 0.25 μm FPGA = 1									

Note: *One of the failures was due to single S-Antifuse and the other failure was due to ESD.

Table 43: Temperature Cycle

0.25 μm FPGA Reliability Summary									
Temperature Cycle									
				Number of Cycles/Failures					
Product	Run Number	Package	Number Units	Test Cycles	200	500	1000	2000	Cycles
(-65°C - +150°C)									
RTSX32SU	D110A1	CQFP208	68	100					6800
RTSX72SU	D0YMJ1	CQFP208	68	100					6800
RTSX32SU	D110A1	CQFP208	135	100					13500
Total Units for 0.25 μm FPGA =			271		Total Test Cycles				27100
Total Failures for 0.25 μm FPGA = 0									

0.22 μ m UMC FPGA Reliability Summary

Table 44: High Temperature Operating Life (HTOL)

High Temperature Operating Life (HTOL) @ 125°C Ambient									
				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	168	500	1000	2000	Unit Hours
A54SX08A	DC183 0012	PQFP208	50	1000	0	0	0		50000
A54SX08A	D1X181	PQFP208	90	1000	0	0	0		90000
A54SX08A	D1X191	PQFP208	84	1000	0	0	0		84000
A54SX08A	D7K052 W 2	PQFP208	90	1000	0	0	0		90000
A54SX32A	D7682 14.15 0028	PQFP208	100	1000	0	0	0		100000
A54SX32A+08A ¹	D7682.14 (HS), D7766.12(HS), D7682.15 (FS), D7766.19(FS), DC183(HS)	PQFP208	150	3340	0	0	0	0	501000
A54SX72A	D03TC1	PQFP208	101	2000	0	0	0	0	202000
A54SX72A	D03TC1	PQFP208	1	500	0	0			500
A54SX72A	D4F117	PQFP208	38	168	0				6384
A54SX72A	DCT03.1	PQFP208	22	168	0				3696
A54SX72A ³	D55011	FC484	26	168	0				4368
A54SX72A	D09A21	PQFP208	77	516	0				39732
A54SX72A	D09A21	PQFP208	19	168	0				3192
A54SX72A	D03TC1(74), D0KA91 (26)	PQFP208	100	168	0				16800
A54SX72A	DOKA91	PQFP208	100	168	0				16800
A54SX72A	DOKA91	PQFP208	100	168	0				16800
A54SX72A	DCT03.1	PQFP208	90	168	0				15120
A54SX72A	DCT03.1	PQFP208	69	120					8280
A54SX72A + 08A	D2E131,D2E151,D1X171	PQFP208	76	1000	0	0	0		76000
A54SX72A ¹	DC 0143	PQFP208	38	516	0	0			19608
A54SX72A ¹	D0F1J1.1	CQFP256	23	615	0				14145
A54SX72A ^{1,2}	D0F1J1.1	CQFP208	96	615	0	0			59040
Total Units for 0.22 μm FPGA =			1540	Total Test Time Hours					1417465
Total Failures for 0.22 μm FPGA = 0									

Notes:

1. Tested at 150°C. Equivalent hours corresponding to 125°C were used to calculate the fit rates.
2. Product A54SX72A, Run D0F1J1, 76 units passed 150°C at all 3-temperatures for C qual. Then 24 units pass a total of 1K hours for long-duration reliability demonstration.
3. Engineering package. Not a production package.

Table 45: Low Temperature Operating Life (LTOL)

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	168	500	1000	2000	Unit Hours
A54SX08A	DC183 0012	PQFP208	50	1000	0	0	0		50000
A54SX32A	D7682 14.15 0028	PQFP208	100	1000	0	0	0		100000
A54SX72A	DC 0143	PQFP208	38	168	0				6384
A54SX72A + 08A	D2E131,D2E151, D1X171	PQFP208	76	1000	0	0	0		76000
A54SX72A	D4F117	PQFP208	38	168	0				6384
A54SX72A	DCT03.1	PQFP208	22	168	0				3696
A54SX72A	D03TC1	PQFP208	101	2000	0	0	0	0	202000
A54SX72A	D0KA91	PQFP208	85	168	0				14280
A54SX72A	D55011	FC484	26	168	0				4368
Total Units for 0.22 μm FPGA =			536	Total Test Time Hours					463112
Total failures for 0.22 μm FPGA = 0									

Table 46: Biased Humidity (HAST)

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	50	100	200	250	Unit Hours
A54SX08A	DC183 0012	PQFP208	50	100	0	0			5000
A54SX32A	D7682 14.15 0028	PQFP208	100	100	0	0			10000
Total Units for 0.22 μm FPGA =			150	Total Test Time Hours					15000
Total Failures for 0.22 μm FPGA = 0									

Table 47: Temperature Cycle

				Number of Cycles/Failures					
Product	Run Number	Package	Number Units	Test Cycles	200	500	1000	2000	Cycles
(-65°C – +150°C)									
A54SX08A	DC183 0012	PQFP208	50	1000	0	0	0		50000
A54SX32A	D7682 14.15 0028	PQFP208	100	1000	0	0	0		100000
A54SX72A	DC 0143	PQFP208	38	500	0	0			19000
A54SX72A + 08A	D2E131,D2E151,D1X171	PQFP208	76	1000	0	0	0		76000
A54SX72A	D4F117	PQFP208	38	500	0	0			19000
A54SX72A	D55011	FC484	26	1000	0	0	0		26000
A54SX32A + 08A	D7682.14 (HS), D7766.12(HS) D7682.15 (FS), D7766.19(FS) DC183(HS)	PQFP208	150	1000	0	0	0		150000
Total Units for 0.22 µm FPGA =			478		Total Test Cycles				440000
Total Failures for 0.22 µm FPGA = 0									

0.22 μ m Flash FPGA Reliability Summary

Table 48: High Temperature Operating Life (HTOL)

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	168	500	1000	2000	Unit Hours
APA1000	M279F, M279C	PBGA456	43	1000	0	0	0		43000
APA750	M1T74, M3AA6	PBGA456	86	1000	0	0	0		86000
APA750	MFJ2W, MFJ2S, MFJ2T	PBGA456	77	1000	0	0	0		77000
APA750	MFRGH, MFPQ8	PBGA456	18	1000	0	0	0		18000
APA750	MFR6H, MFPQ8	PBGA456	18	1000	0	0	0		18000
APA750	MFJ2W, MFJ2T, MFJ2s	PBGA456	77	1000	0	0	0		77000
APA750*	M3AA4	PBGA456	84	2000	(1)	0	(1)	0	167668
Total Units for 0.22 μm Flash FPGA =			403		Total Test Time Hours				484368
Total Failures for 0.22 μm Flash FPGA = 0									

Note: *One device failed at 168 hours and it was confirmed due to ESD. The second one failed at 1500 hours and this failure resulted from testing a feature that has been removed from silicon. The test programs have subsequently been updated.

Table 49: Low Temperature Operating Life (LTOL)

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	168	500	1000	2000	Unit Hours
APA1000	M297F, M279C	PBGA456	26	1000	0	0	0		26000
APA750	M1T74, M3AA6	PBGA456	51	1000	0	0	0		51000
Total Units for 0.22 μm Flash FPGA =			77		Total Test Time Hours				77000
Total Failures for 0.22 μm Flash FPGA = 0									

Table 50: Endurance

				Number of Cycles/Failures					
Product	Run Number	Package	Number Units	Test Cycles	50	100	500	1000	Cycles
Room Temperature									
APA1000	M297F, M279C	PGA391	30	500	0	0	0		15000
APA750	MFJ2W, MFJ2S, MFJ2T	PGA391	30	500	0	0	0		15000
Total Units for 0.22 μm Flash FPGA =			60		Total Test Cycles				30000
Total Failures for 0.22 μm Flash FPGA = 0									

Table 51: Retention 225°C Unbiased 100% Programmed

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	72	500	1000	3000	Unit Hours
APA1000	ZA026941	CGA391	73	3000	0	0	0	0	219000
APA750	MFJ2W, MFJ2S, MFJ2T	CGA391	12	1000	0	0	0		12000
Total Units for 0.22 µm Flash FPGA =			85		Total Test Time Hours				231000
Total Failures for 0.22 µm Flash FPGA = 0									

Table 52: Retention 225°C Unbiased 100% Erased

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	72	500	1000	3000	Unit Hours
APA1000	ZA026941	CGA391	73	3000	0	0	0	0	219000
APA750	MFJ2W, MFJ2S, MFJ2T	CGA391	73	1000	0	0	0		73000
Total Units for 0.22 µm Flash FPGA =			146		Total Test Time Hours				292000
Total Failures for 0.22 µm Flash FPGA = 0									

Table 53: Temperature Cycle

				Number of Cycles/Failures					
Product	Run Number	Package	Number Units	Test Cycles	50	100	500	1000	Cycles
(-55 C –+125 C)									
APA750	M3AA4	PBGA456	16	1000	0	0	0		16000
Total Units for 0.22 µm Flash FPGA =			16	Total Test Cycles					16000
Total Failures for 0.22 µm Flash FPGA = 0									

0.15 μ m FPGA Reliability Summary

Table 54: High Temperature Operating Life (HTOL)

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	168	500	1000	2000	Unit Hours
AX1000	DO3121, DO3131, DO4CA1	PQFP208	129	1000	0	0	0		129000
AX1000	D097H1, D097J1	PQFP208	77	1000	0	0	0		77000
AX2000	D0HGC1, DOH3M7	FPGA896	38	1000	0	0	0		38000
Total Units for 0.15 μm FPGA =			244	Total Test Time Hours					244000
Total Failures for 0.15 μm FPGA = 0									

Table 55: Low Temperature Operating Life (LTOL)

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	168	500	1000	2000	Unit Hours
AX1000	DO3121, DO3131, DO4CA1	PQFP208	129	1000	0	0	0		129000
AX1000	D097H1, D097J1	PQFP208	77	1000	0	0	0		77000
AX2000	D0HGC1, D0H3M6	FPGA896	38	1000	0	0	0		38000
Total Units for 0.15 μm FPGA =			244		Total Test Time Hours				244000
Total Failures for 0.15 μm FPGA = 0									

Table 56: Biased Humidity (HAST)

				Test Hours/Failures					
Product	Run Number	Package	Number Units	Test Time	50	100	200	250	Unit Hours
AX1000	DO3121, DO3131, DO4CA1	PQFP208	129	100	0	0			12900
AX2000	D0HGC1, D0H3M6	FPGA896	38	100	0	0			3800
Total Units for 0.15 μm FPGA =			167		Total Test Time Hours				16700
Total Failures for 0.15 μm FPGA = 0									

Table 57: Temperature Cycle

				Number of Test Cycles/Failures					
Product	Run Number	Package	Number Units	Test Cycles	200	500	1000	2000	Cycles
(-65°C – +150°C)									
AX1000	DO3121, DO3131, DO4CA1	PQFP208	129	500	0	0			64500
AX1000	D097H1, D097J1	PQFP208	77	500	0	0			38500
AX2000	D0HGC1, D0H3M6	FPGA896	22	500	0	0			11000
Total Units for 0.15 µm FPGA =			228		Total Test Cycles				114000
Total Failures for 0.15 µm FPGA = 0									

List of Changes

The following table lists critical changes that were made in the current version of the document.

Previous Version	Changes in Current Version	Page
Revision History Started with this Report (Q3_2004)	Products 1010A and 1020A were removed from 1.0 µm FPGA, Act 1 Family.	8
	All the earlier devices manufactured by TI were removed from the 1.0 µm FPGA, Act 1, and Act 2 Families.	8
	Industry Standard nomenclature was used for the package names.	N/A
	All the FIT rates were checked and corrected as necessary.	N/A
	"Group E Inspection – Generic Data (Radiation Hardness)" has been added.	7
	ESD performance data has been removed.	6
(Q2_2005)	"ESD Performance" data has been added.	6
	New ORT data has been added, 0.22 µm Flash FPGA (Table 45).	36
	0.22/0.25 µm CMOS FPGA results have been updated with new test results.	29–38

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