

# RELIABILITY DATAPACK

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**OPERATING LIFE TEST  
By Product Group  
July 2009**

DEVICE TYPE	PACKAGE TYPE	DATE		NO. UNITS	DEVICE HRS (K) 150°C	EQUIV. DEVICE HRS (K) @ 125°C	PARA FAIL	FUNC FAIL	FAILURE %/K HRS PARA (1&2)	RATE %/K HRS FUNC.
		CODES								
OP AMP	D,F,H,J,M8,M10,N,QF,S,T,W	0301	0843	12,955	2,670	13,416	2	1	0.024	0.012
HIGH SPEED OP AMP	N,TSOT	0301	0710	465	83	465	0	0	0.111	0.111
DAC / ADC	D,F,G,J,M8,M10,N,QF,S,LGA	0301	0852	10,235	2,747	9,168	0	0	0.007	0.015
REFERENCE	H,M8,TSOT	0301	0737	1,887	673	3,418	0	0	0.026	0.026
FILTER	J,S,D,Q,F	0301	0902	352	94	345	0	0	0.152	0.152
SWITCH	S	0301	0833	2,695	662	2,207	0	0	0.039	0.039
COMPARATOR	D,G,J,M8,N,S,TSOT,W	0301	0813	1,766	446	1,715	0	0	0.038	0.038
INTERFACE	D,G,J,M8,M10,N,QF,S,TSOT	0301	0839	30,545	4,075	13,802	0	0	0.004	0.004
OTHER	G,H,M,M8,M10,N,QF	0301	0844	1,620	455	1,517	0	0	0.036	0.036
REGULATOR	D,F,G,H,J,K,M,M8,M10,N,P,Q,QF,R,S,TSOT,W,Z,LGA	0301	0909	64,345	17,044	66,971	2	1	0.005	0.004
MIXER	F,G,QF	0301	0839	3,132	448	2,510	0	0	0.033	0.033
	<b>TOTAL</b>			<b>129,997</b>	<b>29,396</b>	<b>115,535</b>	<b>4</b>	<b>2</b>	<b>0.007</b>	<b>0.003</b>

**OPERATING LIFE TEST  
By Technology Group  
July 2009**

DEVICE TYPE	PACKAGE TYPE	DATE		NO. UNITS	DEVICE HRS (K) 150°C	EQUIV. DEVICE HRS (K) @ 125°C	PARA FAIL	FUNC FAIL	FAILURE %/K HRS PARA (1&2)	RATE %/K HRS FUNC.
		CODES								
CMOS 0.18μ	QF		0850	231	46	154	0	0	0.175	0.175
CMOS 0.25μ	M10,QF, TSOT	0301	0737	542	163	542	0	0	0.034	0.034
CMOS 0.35μ	F,TSOT	0301	0837	2,770	781	2,608	0	0	0.709	0.709
CMOS 0.50μ	F,S,N	0301	0421	77	23	77	0	0	0.004	0.004
CMOS 0.65μ	F,G,M8,M10,QF,S,TSOT, LGA	0301	0852	18,086	4,840	16,146	0	0	0.005	0.010
CMOS 1.2μ	D,F,G,M8,M10,QF,S,TSOT, ST	0301	0909	10,784	3,326	10,934	0	0	0.055	0.055
BICMOS 0.65μ	G,M8,M10,QF	0301	0907	3,649	999	3,332	0	0	0.014	0.014
BICMOS 1.2μ	D,F,G,M8,M10,QF,S,S5,S6	0301	0837	6,658	1,778	5,923	0	0	0.020	0.020
BIPOLAR 1.5μ	F,M8,M10,QF,S,S5,S6	0301	0844	8,319	2,107	11,793	0	0	0.008	0.018
BICMOS 2μ	F,G,M10,QF,S	0301	0851	9,019	2,135	7,122	0	1	0.039	0.039
CMOS 2μ	G,M8,S	0301	0720	1,196	263	879	0	0	0.029	0.029
COMP BP 2μ	D,M8,N,S	0301	0826	2,361	425	2,379	0	0	0.463	0.463
BICMOS 3μ	S	0301	0508	169	35	118	0	0	0.023	0.023
CMOS 3μ	F,G,S	0301	0827	2,350	641	2,137	0	0	0.007	0.003
CMOS 4μ	D,G,J,M8,M10,N,S,S5	0301	0848	34,452	5,129	17,108	1	0	0.009	0.019
HS BP 4μ	D,F,G,H,J,L,M,M8,W,Q,QF,S,S3,S5,S6,T	0301	0824	8,065	2,016	11,201	0	0	0.074	0.034
STEPPER BP 4μ	N,S,QF,F,G,M10,M12	0301	0846	2,422	484	2,611	0	0	0.065	0.065
BIFET 7μ	N,S,TSOT	0301	0722	1,070	186	1,039	0	0	0.019	0.019
CMOS 7μ	D,G,J,N,S	0301	0841	2,577	817	2,730	0	0	0.238	0.108
COMP BP 7μ	N,M10,S,T,W	0301	0816	611	117	655	0	0	0.030	0.015
STD BP 7μ	F,G,M,QF,S,TSOT,ST,H,J,K,N,W	0301	0834	7,353	1,733	9,651	3	1	0.238	0.238
SIGE 0.35μ	QF	0301	0843	993	179	993	0	0	0.055	0.031
RF	F,G,QF	0301	0820	3,366	490	2,744	0	0	0.238	0.135
MODULE	LGA	0301	0828	2,877	683	2,661	0	0	0.008	0.004
	<b>TOTAL</b>			<b>129,997</b>	<b>29,396</b>	<b>115,535</b>	<b>4</b>	<b>2</b>	<b>0.007</b>	<b>0.003</b>

TO-5 = H	TO-3P = P	PDIP = N	TSOT = S3, S5, S6, ST8	SO-8/14/16/20/24/28 = S
TO-3 = K	TO-92 = Z	CERDIP = J	SOT-223 = ST	SSOP = G
TO-46 = H	TO-220 = T	Sidebraze = D	MSOP = M8, M10	TSSOP = F
LCC = L	DD PACK = M, Q, R	Flat Pack = W	QFN/DFN = QF	LGA = Module

**NOTES:**

- (1) Equivalent failure rate calculated to a 60% confidence level assuming an activation energy of 1.0 eV for bipolar comparison purposes.  
(2) Parametric failures for precision operational amplifiers are defined as a Vos drift exceeding 100mV.

## HAST (HIGHLY ACCELERATED STRESS TEST)

### By Product Group

July 2009

Package: Plastic HAST (2) @ 131°C/85% RH, Continuous Operation at Rated Supply Voltage, Minimum Power

DEVICE TYPE	PACKAGE TYPE	DATE CODES	NO. UNITS	DEVICE HRS (K) 131°C	EQUIV. DEVICE HRS (K) @ 85°C <sup>(1)</sup>	PARA FAIL	FUNC FAIL
OP AMP	N, S, F	8951 0706	29,024	2,043,050	40,861,008	0	0
HIGH SPEED OP AMP	N, S	9443 0101	591	40,330	806,600	0	0
DAC / ADC	M8, N, QF, S,	9001 0429	1,521	217,101	4,342,020	0	0
REFERENCE	M8, N, ST, S, TSOT, Z	9006 0637	25,577	1,758,017	35,160,340	0	0
FILTER	N, S	9019 9341	1,144	111,006	2,220,120	0	0
SWITCH	S	9236 0106	533	68,803	1,376,060	0	0
COMPARATOR	N, Z	9033 9649	320	28,801	576,020	0	0
INTERFACE	G, N, QF, S	8847 0831	19,461	1,279,870	25,597,400	0	1
REGULATOR	QF, F, S, M8, M10, N, S, SOT, P, LGA	8917 0826	24,172	2,410,586	48,217,477	0	0
MIXER	QF	0447 0704	184	17,664	353,280	0	0
<b>TOTAL</b>			<b>102,527</b>	<b>7,975,228</b>	<b>159,510,325</b>	<b>0</b>	<b>1</b>

## HAST (HIGHLY ACCELERATED STRESS TEST)

### By Package Type

PACKAGE TYPE	DATE CODES	NO. UNITS	DEVICE HRS (K) 131°C	EQUIV. DEVICE HRS (K) @ 85°C <sup>(1)</sup>	PARA FAIL	FUNC FAIL
DD PACK	9147-0630	2,404	193,868	3,877,360	0	0
F-16	9724-0826	355	20,928	418,560	0	0
F-20	9232-0020	713	71,849	1,436,980	0	0
F-28	9326-0127	10	500	10,000	0	0
G-16	9724-0026	241	42,066	841,320	0	0
G-28	9232-0819	339	35,752	715,040	0	0
G-36	9602-9709	321	46,609	932,180	0	0
G-44	0831	30	6,000	120,000	0	0
N-08	9010-0105	9,040	807,174	16,143,480	0	0
N-14	9033-9926	1,044	80,417	1,608,340	0	0
N-16	9107-0715	1,429	126,645	2,532,900	0	1
N-18	9038-0611	714	84,199	1,683,980	0	0
N-20	9049-9739	500	61,394	1,227,880	0	0
N-24	9101-9301	765	71,817	1,436,340	0	0
N-28	8847-9726	356	40,358	807,160	0	0
M-08	9726-0215	622	97,309	1,946,180	0	0
M-10	0801	65	6,240	124,800	0	0
S-08	8951-0743	43,089	2,726,353	54,527,068	0	0
S-14	9448-9742	273	61,208	1,224,160	0	0
S-16	9001-0715	10,095	582,200	11,644,000	0	0
S-18	9049-0634	3,803	217,838	4,356,760	0	0
S-20	9001-0516	1,629	177,755	3,555,102	0	0
S-24	9019-9231	720	84,730	1,694,600	0	0
S-28	8948-0814	956	100,353	2,007,060	0	0
ST	9115-9727	1,680	204,040	4,080,800	0	0
S-03	9644	98	24,990	499,800	0	0
S-05	9715-0340	421	76,028	1,520,560	0	0
S-06	9943-0709	363	44,764	897,200	0	0
TO-220	8917-0748	5,193	549,454	10,989,080	0	0
TO-3P	0225-9913	952	97,011	1,940,215	0	0
T0-92(Z)	0225-0238	12,983	1,078,985	21,579,700	0	0
DFN-08	0225-0646	231	22,176	443,520	0	0
DFN-10	0225-0238	33	2,376	47,520	0	0
QFN-16	0225-0704	306	32,976	659,520	0	0
QFN-24	0711	125	27,708	554,160	0	0
QFN-32	0639-0748	233	22,368	451,200	0	0
QFN-64	0649	200	32,272	645,440	0	0
LGA-0606	0717	46	4,278	85,560	0	0
LGA-0915	0739	45	2,160	43,200	0	0
LGA-1515	0740	105	10,080	201,600	0	0
<b>TOTAL</b>		<b>102,527</b>	<b>7,975,228</b>	<b>159,510,325</b>	<b>0</b>	<b>1</b>

TO-3P = P  
TO-92 = Z  
TO-220 = T

DD PACK = M, Q, R  
PDIP = N  
QFN/DFN = QF

TSOT = S3, S5, S6, ST8  
SOT-223 = ST  
MSOP = M8, M10

SO-8/14/16/20/24/28 = S  
SSOP = G  
TSSOP = F

LGA = Module

**NOTES:**

- (1) Assume 20X acceleration from 131C/85% RH to 85C/85% RH.
- (2) This test has replaced 85/85 testing

### AUTOCLAVE TEST

#### By Product Group

July 2009

Package: Plastic Autoclave @ 15 PSIG, 121°C, No Bias Applied

DEVICE TYPE	PACKAGE TYPE	DATE CODES		NO. UNITS	TOTAL DEVICE HRS	CUM FAILURE
OP AMP	Q,F,R,F,G,M8,N,TSOT,S,T,QF	0301	0913	86,422	8,247,592	0
HIGH SPEED OP AMP	G,M8,N,TSOT,QF	0301	0912	2,971	87,960	0
DAC / ADC	F,G,M8,N,S,TSOT,QF,T	0301	0913	44,871	5,998,738	0
REFERENCE	M8,N,S,TSOT,Z	0301	0914	59,793	3,157,488	0
FILTER	G,N,S,QF	0301	0914	5,679	356,232	0
SWITCH	G,S	0301	0812	2,188	239,568	0
COMPARATOR	F,M8,M10N,S,ST,TSOT,Z,QF	0301	0906	7,093	880,872	0
INTERFACE	QF,F,G,M8,M10,N,S5,S6,S,ST8	0301	0913	92,792	6,230,954	0
OTHER	G,QF,M8,M10,N,S5,S6,S	0301	0908	9,417	612,376	0
REGULATOR	M,Q,R,QF,F,G,M8,M10,N,S,S3,S5,S6,ST,ST8,T,Z	0301	0916	730,031	50,597,236	0
MIXER	QF,F,G,M8,M10,TSOT	0301	0842	4,912	1,135,276	0
	<b>TOTAL</b>			<b>1,046,169</b>	<b>77,544,292</b>	<b>0</b>

### AUTOCLAVE TEST

#### By Package Type

July 2009

PACKAGE TYPE	DATE CODES	NO. UNITS	TOTAL DEVICE HRS	FUNC. FAILURE
DD PACK	0301-0915	15,604	954,912	0
F-14	0301-0817	431	10,344	0
F-16	0301-0913	34,604	2,424,178	0
F-20	0301-0913	9,575	1,083,461	0
F-24	0301-0819	231	77,616	0
F-28	0301-0903	2,532	408,711	0
F-38	0301-0822	119	33,264	0
F-48	0301-0850	2,428	733,142	0
G-16	0301-0915	24,924	1,734,957	0
G-20	0301-0909	15,379	924,072	0
G-24	0301-0913	41,211	2,247,398	0
G-28	0301-0916	99,888	4,907,292	0
G-36	0301-0908	19,560	1,568,607	0
G-44	0301-0907	1,630	257,184	0
N-08	0301-0903	4,045	283,736	0
N-14	0301-0836	2,405	370,128	0
N-16	0301-0717	798	19,152	0
N-18	0301-0826	1,328	31,872	0
N-20	0301-0908	2,838	341,977	0
N-24	0301-0906	5,324	272,376	0
N-28	0301-0844	1,399	174,824	0
M-08	0301-0913	40,973	2,721,382	0
M-10	0301-0915	44,351	3,101,195	0
M-12	0301-0810	462	142,296	0
M-16	0301-0852	763	218,400	0
S-08	0301-0914	71,651	6,092,216	0
S-14	0301-0851	2,743	460,699	0
S-16	0301-0848	11,106	1,148,442	0
S-18	0301-0851	999	223,728	0
S-20	0301-0848	1,298	78,360	0
S-24	0301-0852	3,593	680,325	0
S-28	0301-0913	7,379	719,233	0
ST	0301-0915	61,591	3,760,560	0
S-03	0301-0914	93,700	4,616,688	0
S-05	0301-0916	62,240	4,747,661	0
S-06	0301-0914	62,673	4,360,532	0
ST8	0301-0915	53,444	3,186,516	0
TO-220	0301-0913	8,432	342,216	0
TO-3P	0301-0913	6,285	248,784	0
T0-92(Z)	0301-0913	37,233	2,193,696	0

**AUTOCLAVE TEST**  
**By Package Type**  
**July 2009**

PACKAGE TYPE	DATE CODES	NO. UNITS	TOTAL DEVICE HRS	FUNC. FAILURE
DFN-03	0301-0909	680	103,680	0
DFN-04	0301-0722	100	2,400	0
DFN-06	0301-0915	11,966	1,025,984	0
DFN-08	0301-0914	22,817	3,115,327	0
DFN-10	0301-0914	19,489	1,656,424	0
DFN-12	0301-0910	12,913	1,172,295	0
DFN-14	0301-0912	4,546	419,889	0
DFN-16	0301-0913	10,494	1,007,536	0
DFN-22	0301-0843	2,273	144,462	0
DFN-32	0301-0843	392	56,520	0
QFN-12	0301-0352	100	2,400	0
QFN-16	0301-0911	20,585	2,122,225	0
QFN-20	0301-0912	3,953	357,720	0
QFN-24	0301-0912	29,176	2,577,740	0
QFN-28	0301-0913	3,033	96,792	0
QFN-32	0301-0914	29,804	2,859,198	0
QFN-36	0301-0912	153	25,704	0
QFN-38	0301-0910	7,014	544,896	0
QFN-40	0301-0830	304	102,144	0
QFN-48	0301-0909	3,349	808,639	0
QFN-52	0301-0719	152	51,072	0
QFN-56	0301-0713	154	51,744	0
QFN-64	0301-0911	4,172	963,237	0
QFP-48	0301-0849	1,150	296,520	0
QFP-32	0301-0852	231	77,616	0
<b>TOTAL</b>		<b>1,046,169</b>	<b>77,544,292</b>	<b>0</b>

TO-3P = P  
TO-92 = Z  
TO-220 = T

DD PACK = M, Q, R  
PDIP = N  
QFN/DFN = QF

TSOT = S3, S4, S5, ST8  
SOT-223 = ST  
MSOP - M8, M10

SO-8/14/16/20/24/28 = S  
SSOP = G  
TSSOP = F

**NOTE:** Approximate duration is 168 hours.

**TEMPERATURE CYCLE TEST**  
**By Package Type**  
**July 2009**

Temperature Cycle Data: Hermetic and Plastic -65°C to 150°C (Air to Air)

PACKAGE TYPE	DATE CODES	NO. UNITS	TOTAL DEVICE CYCLES	FUNC. FAILURE
HERMETIC	0301 0834	5,009	4,202,700	0
PLASTIC	0301 0920	700,072	196,672,580	0
<b>TOTAL</b>		<b>705,081</b>	<b>200,875,280</b>	<b>0</b>

**TEMPERATURE CYCLE TEST**  
**By Package Type**  
**July 2009**

PACKAGE TYPE	DATE CODES	NO. UNITS	TOTAL DEVICE CYCLES	FUNC. FAILURE
<b>METAL CAN</b>				
TO-3	0301 0829	595	262,900	0
TO-5, TO-39, TO-46, TO-52	0301 0834	2,300	2,490,150	0
<b>CERDIP</b>				
J-08 to J-28	0301 0833	1,528	1,391,050	0
<b>FLAT PACK</b>				
W-10, W-14	0301 0627	203	20,300	0
<b>LEADLESS CHIP CARRIER</b>				
L-14 to L-20	0301 0547	17	1,700	0
<b>SIDE BRAZE</b>				
D-08 TO D-28	0301 0814	366	36,600	0
<b>SSOP/TSSOP</b>				
F-20	0301 0913	47,266	15,589,816	0
G-16	0301 0911	19,175	4,406,843	0
G-20	0301 0910	6,106	1,546,500	0
G-24	0301 0906	5,360	1,532,341	0
G-28	0301 0915	57,319	10,114,930	0
G-36	0301 0908	19,750	5,349,190	0
G-44	0301 0907	2,404	540,400	0
<b>PLASTIC DIP</b>				
N-08	0301 0835	11,152	2,581,300	0
N-14	0301 0836	3,882	2,252,750	0
N-16	0301 0825	671	136,400	0
N-18	0301 0913	3,880	1,141,300	0
N-20	0301 0914	6,547	1,736,500	0
N-24	0301 0906	5,287	1,133,100	0
N-28	0301 0911	2,206	586,200	0
<b>SOIC / MSOP</b>				
M-08	0301 0913	32,149	5,770,995	0
M-10	0301 0913	34,230	7,332,592	0
M-16	0301 0852	459	343,500	0
S-08	0301 0920	62,942	15,240,230	0
S-14	0301 0851	3,510	1,221,791	0
S-16	0301 0912	17,834	5,718,647	0
S-18	0301 0851	3,101	2,160,500	0
S-20	0301 0907	3,237	423,800	0
S-24	0301 0852	6,255	2,252,338	0
S-28	0301 0909	6,125	2,040,700	0
<b>POWER PACKAGE</b>				
DD PACK	0301 0912	17,927	4,207,850	0
SOT-223	0301 0913	8,923	4,012,200	0
TO-220	0301 0835	13,624	4,488,990	0
TO-3P	0301 0827	5,416	1,303,000	0
<b>OTHER PLASTIC</b>				
SOT-23	0301 0915	93,522	25,358,199	0
T0-92(Z)	0301 0914	8,005	2,778,300	0
QFN	0301 0914	180,698	53,766,936	0
LGA	0301 0908	9,909	8,563,942	0
QFP	0301 0902	1,201	1,040,500	0
<b>TOTAL</b>		<b>705,081</b>	<b>200,875,280</b>	<b>0</b>

NOTE: Approximate duration is 500 cycles.

**THERMAL SHOCK TEST**  
**By Package Type**  
**July 2009**

Thermal Shock Data: Hermetic and Plastic: -65°C to 150°C (Liquid to Liquid)

PACKAGE TYPE	DATE CODES	NO. UNITS	TOTAL DEVICE CYCLES	FUNC. FAILURE
HERMETIC	0301 0641	813	42,285	0
PLASTIC	0301 0920	631,603	176,338,844	0
<b>TOTAL</b>		<b>632,416</b>	<b>176,381,129</b>	<b>0</b>

**THERMAL SHOCK TEST**  
**By Package Type**  
**July 2009**

PACKAGE TYPE	DATE CODES	NO. UNITS	TOTAL DEVICE CYCLES	FUNC. FAILURE
<b>METAL CAN</b>				
TO-3	0301 0638	170	11,220	0
TO-5, TO-39, TO-46, TO-52	0301 0631	340	13,770	0
<b>CERDIP</b>				
J-08 to J-28	0301 0641	133	10,410	0
<b>FLAT PACK</b>				
W-10, W-14	0301 0627	153	6,630	0
<b>LEADLESS CHIP CARRIER</b>				
L-14 to L-20	0301 0547	17	255	0
<b>SSOP/TSSOP</b>				
F-20	0301 0913	51,985	14,759,270	0
G-16	0301 0911	20,763	4,430,000	0
G-20	0301 0904	4,010	1,411,700	0
G-24	0301 0906	5,090	1,186,900	0
G-28	0301 0915	51,385	8,656,804	0
G-36	0301 0908	18,726	4,057,430	0
G-44	0301 0907	1,542	647,700	0
<b>PLASTIC DIP</b>				
N-08	0301 0738	899	645,200	0
N-14	0301 0738	835	700,000	0
N-18	0301 0844	384	384,000	0
N-20	0301 0844	1,044	999,000	0
N-24	0301 0827	1,040	681,800	0
N-28	0301 0827	305	152,500	0
<b>SOIC / MSOP</b>				
M-08	0301 0913	22,495	4,345,600	0
M-10	0301 0913	39,984	8,485,188	0
M-12	0301 0810	613	498,500	0
M-16	0301 0852	792	676,500	0
S-08	0301 0920	48,831	13,464,470	0
S-14	0301 0851	2,513	972,940	0
S-16	0301 0912	9,513	3,390,800	0
S-18	0301 0851	1,147	749,650	0
S-20	0301 0907	1,121	255,000	0
S-24	0301 0852	2,702	1,729,300	0
S-28	0301 0909	7,165	2,021,700	0
<b>POWER PACKAGE</b>				
DD PACK	0301 0912	12,254	2,558,691	0
SOT-223	0301 0913	6,903	2,331,864	0
TO-220	0301 0833	6,925	1,369,900	0
TO-3P	0301 0830	4,623	988,800	0
<b>OTHER PLASTIC</b>				
SOT-23	0301 0915	108,863	25,385,846	0
T0-92(Z)	0301 0914	7,091	2,380,800	0
QFN	0536 0914	179,722	53,580,421	0
LGA	0301 0912	9,035	11,568,070	0
QFP	0614 0902	1,303	872,500	0
<b>TOTAL</b>		<b>632,416</b>	<b>176,381,129</b>	<b>0</b>

NOTE: Approximate duration is 500 cycles.

## MOISTURE SENSITIVITY OF PACKAGES

Moisture Sensitivity Classification testing is performed in accordance with J-STD-020. The chart below reflects the flow of Surface Mount Preconditioning. This test is designed to identify package types and molding compounds that are susceptible to "Popcorn Cracking." This phenomenon usually affects higher pin count packages during PC board soldering processes like Infrared Reflow and Vapor Phase. As the molding compound expands, it can tar the bond wires off the die surface resulting in catastrophic failure. Molding compounds with lower moisture absorption and improved adhesion have been qualified for use at LTC. The results of this testing, including extended reliability stress tests on packages exposed to the surface mount preconditioning, are detailed in the next three pages of this Data Pack. The levels, test conditions and associated floor life expectations and summary of the actual levels are shown below.

LTC solved the popcorn cracking phenomena per the previous version of J-STD-020, we have re-evaluated all surface package types to the latest revision of J-STD-020. Newer, environmentally friendly, state-of-the-art molding compounds and die attach epoxies are always being evaluated. These promise to deliver Level One at +260°C performance for all packages. An updated cross-reference of package type, pin count, and Moisture Sensitivity Level (MSL) can be found on the LTC website at: [http://www.linear.com/designtools/PACKAGE\\_MSL\\_CROSS\\_REFERENCE.pdf](http://www.linear.com/designtools/PACKAGE_MSL_CROSS_REFERENCE.pdf)

### Through Hole Package Technology –

No moisture sensitivity classification testing required because these packages are not normally subjected to surface mount assembly conditions and are not prone to board level mounting induced popcorn problems. Through hole packages include:

- Plastic Dual-In-Line Packages (PDIP)
- TO-92
- TO-220
- TO-3P

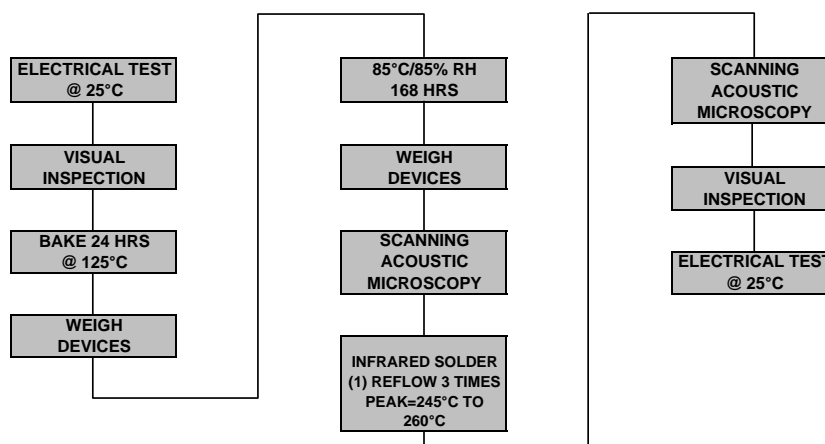
## MOISTURE SENSITIVITY CLASSIFICATION TESTING

LEVEL	TEST CONDITIONS	SOAK TIME	FLOOR LIFE	FLOOR CONDITIONS
1	85°C / 85%RH	168 HOURS	UNLIMITED	≤30°C / 85%RH
2	85°C / 60%RH	168 HOURS	1 YEAR	≤30°C / 60%RH
2A	30°C / 60%RH	696 HOURS	4 WEEKS	≤30°C / 60%RH
3	30°C / 60%RH	192 HOURS	168 HOURS	≤30°C / 60%RH
4	30°C / 60%RH	96 HOURS	72 HOURS	≤30°C / 60%RH
5	30°C / 60%RH	72 HOURS	24 HOURS	≤30°C / 60%RH
5A	30°C / 60%RH	48 HOURS	24 HOURS	≤30°C / 60%RH
6	30°C / 60%RH	TOL	TOL	≤30°C / 60%RH

**NOTE:**

TOL = Time on Label

## J-STD-020 FLOW CHART



NOTE: (1) Exceeds actual specification. Testing per Pb-free profile can be obtained on the LTC website at: [www.linear.com](http://www.linear.com). Click on site map, packaging information and then "MSL by package type."

**RELIABILITY DATA**  
**SURFACE MOUNT PRECONDITIONING per J-STD-020**  
**July 2009**

PACKAGE TYPE	DATE CODES	SAMPLE SIZE	# FAILURE
DD PACK	9147 0915	48,189	0
F-14	0301 0817	1,029	0
F-16	0301 0913	104,162	0
F-20	9326 0913	30,538	0
F-24	0301 0819	460	0
F-28	0301 0912	7,832	0
F-38	0301 0822	119	0
F-48	0301 0850	6,109	0
G-16	9724 0915	65,103	0
G-20	0301 0910	25,495	0
G-24	0301 0913	51,661	0
G-28	9232 0916	208,931	0
G-36	9602 0908	58,357	0
G-44	0301 0907	5,606	0
N-08	9010 0903	25,136	0
N-14	9033 0836	8,166	0
N-16	9107 0825	2,898	0
N-18	9038 0913	6,306	0
N-20	9049 0914	10,929	0
N-24	9101 0906	12,416	0
N-28	8847 0911	4,266	0
M-08	9726 0913	96,239	0
M-10	0301 0915	118,630	0
M-12	0301 0810	1,075	0
M-16	0301 0852	2,014	0
S-08	8951 0920	226,513	0
S-14	9448 0910	9,039	0
S-16	9001 0914	48,548	0
S-18	9049 0851	9,050	0
S-20	9001 0907	7,285	0
S-24	9019 0852	13,270	0
S-28	8948 0913	21,625	0
ST	9115 0915	79,097	0
S-03	9644 0914	102,322	0
S-05	9715 0916	145,679	0
S-06	9943 0914	161,543	0
ST8	0301 0915	65,780	0
TO-220	8917 0913	34,174	0
TO-3P	9133 0913	17,276	0
T0-92(Z)	9006 0914	65,312	0
DFN-03	0301 0909	1,666	0
DFN-04	0301 0722	298	0
DFN-06	0301 0915	33,038	0
DFN-08	0301 0914	65,708	0
DFN-10	0301 0914	59,917	0
DFN-12	0301 0910	38,161	0
DFN-14	0301 0912	11,450	0
DFN-16	0301 0913	32,785	0
DFN-22	0301 0843	5,895	0
DFN-32	0301 0843	983	0
QFN-12	0301 0640	348	0
QFN-16	0301 0911	58,918	0
QFN-20	0301 0912	10,063	0
QFN-24	0301 0912	81,638	0
QFN-28	0301 0913	10,726	0
QFN-32	0301 0914	94,700	0
QFN-36	0301 0912	307	0
QFN-38	0301 0910	19,495	0
QFN-40	0301 0830	681	0
QFN-48	0301 0909	9,550	0
QFN-52	0301 0814	833	0
QFN-56	0301 0713	462	0
QFN-64	0301 0911	11,545	0
LGA-0606	0301 0845	934	0
LGA-0611	0301 0846	431	0
LGA-0911	0301 0852	1,161	0
LGA-1111	0301 0912	727	0
LGA-1115	0301 0850	300	0
LGA-0915	0301 0908	4,848	0
LGA-1515	0301 0910	10,739	0
QFP-48	0301 0902	3,654	0
QFP-32	0301 0652	231	0
<b>TOTAL</b>		<b>2,480,371</b>	<b>0</b>

**RELIABILITY DATA**  
**TEST RESULT POST J-STD-020 PRECONDITIONING**  
**July 2009**

**HAST 131°C/85%RH AFTER JEDEC PRECONDITIONING**

PACKAGE TYPE	SAMPLE SIZE	DATE CODES	# OF DEVICE HRS @ 85°C (1)	# FAILURE
DD PACK	2,404	9147 0630	3,877,360	0
F-16	355	0301 0826	418,560	0
F-20	713	9326 0020	1,436,980	0
F-28	10	0301 0127	10,000	0
G-16	241	9724 0026	841,320	0
G-28	339	9232 0819	715,040	0
G-36	321	9602 9709	932,180	0
G-44	30	0301 0831	120,000	0
N-08	9,040	9010 0105	16,143,480	0
N-14	1,044	9033 9926	1,608,340	0
N-16	1,429	9107 0715	2,532,900	1
N-18	714	9038 0611	1,683,980	0
N-20	500	9049 9739	1,227,880	0
N-24	765	9101 9301	1,436,340	0
N-28	356	8847 9726	807,160	0
M-08	622	9726 0205	1,946,180	0
M-10	65	0301 0801	124,800	0
S-08	43,089	8951 0743	54,527,068	0
S-14	273	9448 9742	1,224,160	0
S-16	10,095	9001 0715	11,644,000	0
S-18	3,803	9049 0634	4,356,760	0
S-20	1,629	9001 0516	3,555,102	0
S-24	720	9019 9231	1,694,600	0
S-28	956	8948 0814	2,007,060	0
ST	1,680	9115 9727	4,080,800	0
S-03	98	9644 9644	499,800	0
S-05	421	9715 0340	1,520,560	0
S-06	363	9943 0709	895,280	0
TO-220	5,193	8917 0748	10,989,080	0
TO-3P	952	9133 9913	1,940,215	0
T0-92(Z)	12,983	9006 0238	21,579,700	0
DFN-08	231	0301 0646	443,520	0
DFN-10	33	0301 0238	47,520	0
QFN-16	306	0301 0704	659,520	0
QFN-24	125	0301 0711	554,160	0
QFN-32	233	0301 0748	447,360	0
QFN-64	200	0301 0649	645,440	0
LGA-0606	46	0301 0717	85,560	0
LGA-0915	45	0301 0739	43,200	0
LGA-1515	105	0301 0740	201,600	0
<b>TOTAL</b>	<b>102,527</b>		<b>159,504,565</b>	<b>1</b>

TO-5 = H  
 TO-3 = K  
 TO-46 = H  
 LCC = L

TO-3P = P  
 TO-92 = Z  
 TO-220 = T  
 DD PACK = M, Q, R

PDIP = N  
 Cerdip = J  
 Sidebrazed = D  
 Flat Pack = W

TSOT = S3, S5, S6, ST8  
 SOT-223 = ST  
 MSOP = M8, M10  
 QFN/DFN

SO-8/14/16/20/24/28 = S  
 SSOP = G  
 TSSOP = F  
 LGA = Module

**NOTE:** (1) Assumes 20X acceleration from 131 °C to 85°  
**NOTE:** Approximate duration is 96 hours.

**RELIABILITY DATA**  
**TEST RESULT POST J-STD-020 PRECONDITIONING**  
**July 2009**

**AUTOCLAVE 15 PSIG 121C AFTER JDEDC PRECONDITIONING**

PACKAGE TYPE	SAMPLE SIZE	DATE CODES	TOTAL # OF DEVICE HRS	# FAILURE
DD PACK	15,604	0301 0915	954,912	0
F-14	431	0301 0817	10,344	0
F-16	34,604	0301 0913	2,424,178	0
F-20	9,575	0301 0913	1,083,461	0
F-24	231	0301 0819	77,616	0
F-28	2,532	0301 0903	408,711	0
F-38	119	0301 0822	33,264	0
F-48	2,428	0301 0850	733,142	0
G-16	24,924	0301 0915	1,734,957	0
G-20	15,379	0301 0909	924,072	0
G-24	41,211	0301 0913	2,247,398	0
G-28	99,888	0301 0916	4,907,292	0
G-36	19,560	0301 0908	1,568,607	0
G-44	1,630	0301 0907	257,184	0
N-08	4,045	0301 0903	283,736	0
N-14	2,405	0301 0836	370,128	0
N-16	798	0301 0717	19,152	0
N-18	1,328	0301 0826	31,872	0
N-20	2,838	0301 0908	341,977	0
N-24	5,324	0301 0906	272,376	0
N-28	1,399	0301 0844	174,824	0
M-08	40,973	0301 0913	2,721,382	0
M-10	44,351	0301 0915	3,101,195	0
M-12	462	0301 0810	142,296	0
M-16	763	0301 0852	218,400	0
S-08	71,651	0301 0914	6,092,216	0
S-14	2,743	0301 0910	460,699	0
S-16	11,106	0301 0914	1,148,442	0
S-18	999	0301 0851	223,728	0
S-20	1,298	0301 0848	78,360	0
S-24	3,593	0301 0852	680,325	0
S-28	7,379	0301 0913	719,233	0
ST	61,591	0301 0915	3,760,560	0
S-03	93,700	0301 0914	4,616,688	0
S-05	62,240	0301 0916	4,747,661	0
S-06	62,673	0301 0914	4,360,532	0
ST8	53,444	0301 0915	3,186,516	0
TO-220	8,432	0301 0913	342,216	0
TO-3P	6,285	0301 0913	248,784	0
T0-92(Z)	37,233	0301 0913	2,193,696	0
DFN-03	680	0301 0909	103,680	0
DFN-04	100	0301 0722	2,400	0
DFN-06	11,966	0301 0915	1,025,984	0
DFN-08	22,817	0301 0914	3,115,327	0
DFN-10	19,489	0301 0914	1,656,424	0
DFN-12	12,913	0301 0910	1,172,295	0
DFN-14	4,546	0301 0912	419,889	0
DFN-16	10,494	0301 0913	1,007,536	0
DFN-22	2,273	0301 0843	144,462	0
DFN-32	392	0301 0843	56,520	0
QFN-12	100	0301 0352	2,400	0
QFN-16	20,585	0301 0911	2,122,225	0
QFN-20	3,953	0301 0912	357,720	0
QFN-24	29,176	0301 0912	2,577,740	0
QFN-28	3,033	0301 0913	96,792	0
QFN-32	29,804	0301 0914	2,859,198	0
QFN-36	153	0301 0912	25,704	0
QFN-38	7,014	0301 0910	544,896	0
QFN-40	304	0301 0830	102,144	0
QFN-48	3,349	0301 0909	808,639	0
QFN-52	152	0301 0719	51,072	0
QFN-56	154	0301 0713	51,744	0
QFN-64	4,172	0301 0911	963,237	0
QFP-48	1,150	0301 0849	296,520	0
QFP-32	231	0301 0652	77,616	0
<b>TOTAL</b>	<b>1,046,169</b>		<b>77,544,292</b>	<b>0</b>

TO-5 = H	TO-3P = P	PDIP = N	TSOT = S3, S5, S6, ST8	SO-8/14/16/20/24/28 = S
TO-3 = K	TO-92 = Z	CERDIP = J	SOT-223 = ST	SSOP = G
TO-46 = H	TO-220 = T	Sidebrazed = D	MSOP = M8, M10	TSSOP = F
LCC = L	DD PACK = M, Q, R	Flat Pack = W	QFN/DFN	QFP

**NOTE:** (1) Assumes 20X acceleration from 131°C to 85°  
**NOTE:** Approximate duration is 96 hours.

**RELIABILITY DATA**  
**TEMPERATURE CYCLE (AIR TO AIR) -65°C TO 150°C AFTER JEDEC PRECONDITION**  
**July 2009**

PACKAGE TYPE	SAMPLE SIZE	DATE CODES		TOTAL # OF DEVICE CYCLES	# FAILURE
DD PACK	17,927	0301	0912	4,207,850	0
F-14	249	0301	0740	24,900	0
F-16	32,316	0301	0913	8,593,628	0
F-20	10,073	0301	0908	3,977,800	0
F-28	2,621	0301	0912	1,235,772	0
F-48	2,007	0301	0850	1,757,716	0
G-16	19,175	0301	0911	4,406,843	0
G-20	6,106	0301	0910	1,546,500	0
G-24	5,360	0301	0906	1,532,341	0
G-28	57,319	0301	0915	10,114,930	0
G-36	19,750	0301	0908	5,349,190	0
G-44	2,404	0301	0907	540,400	0
N-08	11,152	0301	0835	2,581,300	0
N-14	3,882	0301	0836	2,252,750	0
N-16	671	0301	0825	136,400	0
N-18	3,880	0301	0913	1,141,300	0
N-20	6,547	0301	0914	1,736,500	0
N-24	5,287	0301	0906	1,133,100	0
N-28	2,206	0301	0911	586,200	0
M-08	32,149	0301	0913	5,770,995	0
M-10	34,230	0301	0913	7,332,592	0
M-16	459	0301	0852	343,500	0
S-08	62,942	0301	0920	15,240,230	0
S-14	3,510	0301	0851	1,221,791	0
S-16	17,834	0301	0912	5,718,647	0
S-18	3,101	0301	0851	2,160,500	0
S-20	3,237	0301	0907	423,800	0
S-24	6,255	0301	0852	2,252,338	0
S-28	6,125	0301	0909	2,040,700	0
ST	8,923	0301	0913	4,012,200	0
S-03	3,873	0301	0910	848,100	0
S-05	38,146	0301	0915	11,073,628	0
S-06	45,118	0301	0914	10,648,345	0
ST8	6,385	0301	0909	2,788,126	0
TO-220	13,624	0301	0835	4,488,990	0
TO-3P	5,416	0301	0827	1,303,000	0
T0-92(Z)	8,005	0301	0914	2,778,300	0
DFN-03	445	0301	0850	44,500	0
DFN-04	100	0301	0722	10,000	0
DFN-06	9,762	0301	0909	2,645,079	0
DFN-08	21,694	0301	0914	8,944,610	0
DFN-10	20,316	0301	0914	4,248,879	0
DFN-12	11,854	0301	0910	3,132,500	0
DFN-14	2,840	0301	0912	492,519	0
DFN-16	10,942	0301	0913	2,856,879	0
DFN-22	1,918	0301	0843	396,925	0
DFN-32	246	0301	0843	163,200	0
QFN-12	150	0301	0640	15,000	0
QFN-16	19,085	0301	0908	5,878,785	0
QFN-20	2,440	0301	0912	592,600	0
QFN-24	24,522	0301	0909	7,290,006	0
QFN-28	4,519	0301	0913	451,900	0
QFN-32	35,689	0301	0914	9,989,973	0
QFN-38	5,954	0301	0910	1,370,968	0
QFN-40	75	0301	0830	75,000	0
QFN-48	3,431	0301	0909	2,060,136	0
QFN-52	527	0301	0814	395,600	0
QFN-56	154	0301	0713	154,000	0
QFN-64	4,035	0301	0906	2,557,877	0
LGA-0606	557	0301	0845	603,000	0
LGA-0611	100	0301	0846	75,000	0
LGA-0911	628	0301	0852	740,000	0
LGA-1111	204	0301	0842	159,000	0
LGA-1115	150	0301	0850	150,000	0
LGA-0915	2,165	0301	0908	2,542,436	0
LGA-1515	6,105	0301	0908	4,294,506	0
QFP-48	1,201	0301	0902	1,040,500	0
<b>TOTAL</b>	<b>700,072</b>			<b>196,672,580</b>	<b>0</b>

DD PACK = M, Q, R  
 QFN/DFN = QF  
 LGA = uModule

TO-3P = P  
 TO-92 = Z  
 TO-220 = T

PDIP = N  
 CERPDI = J  
 Sidebraze = D

TSOT = S3, S5, S6, ST8  
 SOT-223 = ST  
 MSOP = M8, M10

SO-8/14/16/20/24/28 = S  
 SSOP = G  
 TSSOP = F

**RELIABILITY DATA**  
**THERMAL SHOCK (LIQUID TO LIQUID) -65°C TO 150°C AFTER JEDEC PRECONDITION**  
**July 2009**

PACKAGE TYPE	SAMPLE SIZE	DATE CODES		TOTAL # OF DEVICE CYCLES	# FAILURE
DD PACK	12,254	0301	0912	2,558,691	0
F-14	349	0301	0817	34,900	0
F-16	36,887	0301	0913	7,990,370	0
F-20	10,177	0301	0908	3,980,600	0
F-24	229	0301	0819	229,000	0
F-28	2,669	0301	0912	1,200,400	0
F-48	1,674	0301	0850	1,324,000	0
G-16	20,763	0301	0911	4,430,000	0
G-20	4,010	0301	0904	1,411,700	0
G-24	5,090	0301	0906	1,186,900	0
G-28	51,385	0301	0915	8,656,804	0
G-36	18,726	0301	0908	4,057,430	0
G-44	1,542	0301	0907	647,700	0
N-08	899	0301	0738	645,200	0
N-14	835	0301	0738	700,000	0
N-18	384	0301	0844	384,000	0
N-20	1,044	0301	0844	999,000	0
N-24	1,040	0301	0827	681,800	0
N-28	305	0301	0827	152,500	0
M-08	22,495	0301	0913	4,345,600	0
M-10	39,984	0301	0913	8,485,188	0
M-12	613	0301	0810	498,500	0
M-16	792	0301	0852	676,500	0
S-08	48,831	0301	0920	13,464,470	0
S-14	2,513	0301	0851	972,940	0
S-16	9,513	0301	0912	3,390,800	0
S-18	1,147	0301	0851	749,650	0
S-20	1,121	0301	0907	255,000	0
S-24	2,702	0301	0852	1,729,300	0
S-28	7,165	0301	0909	2,021,700	0
ST	6,903	0301	0913	2,331,864	0
S-03	4,651	0301	0910	1,131,100	0
S-05	44,872	0301	0915	11,109,117	0
S-06	53,389	0301	0914	11,045,529	0
ST8	5,951	0301	0901	2,100,100	0
TO-220	6,925	0301	0833	1,369,900	0
TO-3P	4,623	0301	0830	988,800	0
TO-92(Z)	7,091	0301	0914	2,380,800	0
DFN-03	541	0301	0850	54,100	0
DFN-04	98	0301	0722	9,800	0
DFN-06	11,310	0301	0909	2,763,750	0
DFN-08	20,966	0301	0914	8,609,213	0
DFN-10	20,079	0301	0914	4,421,200	0
DFN-12	13,394	0301	0910	3,749,000	0
DFN-14	4,064	0301	0912	1,086,472	0
DFN-16	11,349	0301	0913	2,828,196	0
DFN-22	1,704	0301	0843	313,800	0
DFN-32	345	0301	0843	173,100	0
QFN-12	98	0301	0352	9,800	0
QFN-16	18,942	0301	0908	6,044,500	0
QFN-20	3,670	0301	0912	1,068,000	0
QFN-24	27,815	0301	0909	6,803,050	0
QFN-28	3,174	0301	0913	317,400	0
QFN-32	28,974	0301	0914	9,027,640	0
QFN-36	154	0301	0912	77,000	0
QFN-38	6,527	0301	0910	1,545,000	0
QFN-40	302	0301	0830	266,500	0
QFN-48	2,770	0301	0909	2,043,930	0
QFN-52	154	0301	0719	154,000	0
QFN-56	154	0301	0713	154,000	0
QFN-64	3,138	0301	0910	2,060,970	0
LGA-0606	331	0301	0845	446,500	0
LGA-0611	331	0301	0846	562,000	0
LGA-0911	533	0301	0852	914,000	0
LGA-1111	523	0301	0912	595,500	0
LGA-1115	150	0301	0850	154,000	0
LGA-0915	2,638	0301	0908	3,943,400	0
LGA-1515	4,529	0301	0910	4,952,670	0
QFP-48	1,303	0301	0902	872,500	0
<b>TOTAL</b>	<b>631,603</b>			<b>176,338,844</b>	<b>0</b>

TO-5 = H  
 TO-3 = K  
 TO-46 = H  
 LCC = L

TO-3P = P  
 TO-92 = Z  
 TO-220 = T  
 DD PACK = M, Q, R

PDIP = N  
 CERDIP = J  
 Sidebraze = D  
 Flat Pack = W

TSOT = S3, S5, S6, ST8  
 SOT-223 = ST  
 MSOP = M8, M10  
 QFN/DFN

SO-8/14/16/20/24/28 = S  
 SSOP = G  
 TSSOP = F  
 LGA = Module

<b>ACCELERATED HIGH TEMPERATURE OPERATION LIFE (HTOL) TEST RESULT</b>	
<b>FIT Rate</b>	<b>0.127</b>
Numbers of Total Failures	6
Total HTOL Sample Size from Q202 to Q308	129,997
Equivalent Device Hours at 55°C	57,698,121,070

- (1) Assumes Activation Energy = 1.0 Electron Volts
  - (2) Failure Rate Equivalent to +55°C, 60% Confidence Level
  - (3) 1 FIT = 1 Failure in One Billion Hours.
- Note: FIT rate calculation base on JEDEC Standard JESD 85.