

# RELIABILITY DATAPACK

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# **OPERATING LIFE TEST** **By Product Group** **May 2016**

DEVICE TYPE	PACKAGE TYPE	DATE CODES	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.
OP AMP	D,G,H,J,M8,M10,N,QF,S,TSOT,W	0501 1528	42,080	4,298	19,457	0	1	0.005	0.010
DAC / ADC	D,F,G,J,M8,M10,M12,M16,N,QF,S,TSOT,LGA	0501 1535	13,512	2,950	9,852	0	0	0.009	0.009
REFERENCE	H,M8,TSOT	0501 1517	2,964	746	3,706	0	0	0.025	0.025
FILTER	J,S,QF	0501 1519	533	112	377	0	0	0.243	0.243
SWITCH	G, N, S	0501 1434	2,843	647	2,163	0	0	0.042	0.042
COMPARATOR	M8,S,TSOT,W	0501 1541	1,367	245	1,000	0	0	0.092	0.092
INTERFACE	F,G,M8,M10,M12,N,QF,S,TSOT,LGA	0501 1533	58,863	6,393	22,014	2	1	0.014	0.009
OTHER	G,M8,M16,QF,TSOT	0501 1518	3,671	1,003	3,734	0	0	0.025	0.025
REGULATOR	F,G,H,J,K,M8,M10,M12,M16,N,P,Q	0501 1539	191,496	39,668	160,971	2	2	0.002	0.002
MIXER	F,S,T,TSOT,LGA, BGA								
	F,G,QF	0501 1514	4,977	885	3,712	0	0	0.025	0.025
<b>TOTAL</b>			<b>322,306</b>	<b>56,947</b>	<b>226,986</b>	<b>4</b>	<b>4</b>	<b>0.0023</b>	<b>0.0023</b>

# **OPERATING LIFE TEST** **By Technology Group** **May 2016**

DEVICE TYPE	PACKAGE TYPE	DATE CODES	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.
CMOS 0.18μ	QF	0501 1501	4,016	296	988	0	0	0.092	0.092
CMOS 0.25μ	M16,QF	0501 1512	2,252	805	2,690	0	0	0.034	0.034
CMOS 0.35μ	M10,QF, TSOT	0501 1428	2,546	717	2,394	0	0	0.038	0.038
CMOS 0.60μ	F,G,M8,M10,M12,M16,N,QF,S,TSOT	0501 1421	51,020	7,748	25,878	0	1	0.004	0.008
CMOS 1.2μ	F,G,M8,M10,M16,QF,S,TSOT,T	0501 1539	19,969	3,248	10,848	0	0	0.008	0.008
BICMOS 0.65μ	G,F,M8,M10,QF,TSOT,LGA	0501 1532	37,542	8,315	28,011	2	1	0.011	0.007
BICMOS 1.2μ	F,G,M8,M10,M16,QF,S,TSOT,LGA	0501 1529	35,835	4,235	14,144	0	0	0.006	0.006
BIPOLAR 1.5μ	F,K,M8,M10,M16,QF,S,TSOT,LGA	0501 1518	29,255	9,921	55,558	0	0	0.002	0.002
BICMOS 2μ	F,G,M10,QF,S	0501 1519	16,203	2,448	8,179	0	1	0.011	0.025
CMOS 2μ	G,M8,QF,S5	0501 1520	6,914	700	2,338	0	0	0.039	0.039
COMP BP 2μ	G,M8,N,QF,S,W	0501 1348	1,802	231	1,293	0	0	0.074	0.074
BICMOS 3μ	S	0501 1519	1,090	146	488	0	0	0.188	0.188
CMOS 3μ	F,G,S	0501 1434	5,536	1,424	4,755	0	0	0.019	0.019
CMOS 4μ	D,G,J,M8,M10,N,S	0501 1519	38,112	4,800	16,033	2	0	0.019	0.006
HS BP 4μ	F,G,M8,M10,N,W,QF,S,TSOT	0501 1541	10,750	1,708	9,565	0	1	0.010	0.021
STEPPER BP 4μ	S,QF,F,G,M10,M12	0501 1520	10,880	1,242	6,957	0	0	0.013	0.013
BIFET 7μ	N,S	0501 1216	722	89	497	0	0	0.184	0.184
CMOS 7μ	D,G,J,N,S	0501 1512	2,162	487	1,625	0	0	0.056	0.056
COMP BP 7μ	N,M10,S	0501 1518	1,991	163	914	0	0	0.100	0.100
STD BP 7μ	S,H,J,K,N,W	0501 1519	10,632	1,274	7,135	0	0	0.055	0.085
SIGE 0.18μ	QF	0501 1511	2,694	687	2,293	0	0	0.040	0.040
SIGE 0.35μ	M10,QF	0501 1528	2,585	828	2,766	0	0	0.033	0.033
BCD 0.35μ	QF, M16, TSOT	0501 1538	16,269	3,035	10,140	0	0	0.009	0.009
RF	F,G,QF	0501 1514	2,902	376	2,104	0	0	0.044	0.044
MODULE	LGA, BGA	0501 1533	8,627	2,024	9,393	0	0	0.010	0.010
<b>TOTAL</b>			<b>322,306</b>	<b>56,947</b>	<b>226,986</b>	<b>4</b>	<b>4</b>	<b>0.0023</b>	<b>0.0023</b>

TO-5 = H	TO-3P = P	PDIP = N	TSOT = S3, S5, S6, TS8	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, M12, M16	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 at 125C, 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

May 2016

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 (1)	PARA FAIL	FUNC FAIL
OP AMP	F,N,S	8951 1517	40,555	2,936,306	58,726,128	0	0
HIGH SPEED OP AMP	N,S	9443 1323	935	63,946	1,278,920	0	0
DAC / ADC	F,M8,N,S,TSOT,QF,LGA	9001 1511	2,253	313,115	6,262,300	0	1
REFERENCE	M8,N,S,TSOT,Z	9006 1544	27,774	2,050,745	41,014,900	0	1
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,S,QF, LGA	8847 1549	28,760	2,458,334	49,166,680	0	2
REGULATOR	F,G,M,M8,M10,M16,N,P,Q,R,S,S T,T,TSOT,Z,QF,LGA, BGA	8917 1551	65,111	7,660,843	153,222,617	0	5
MIXER	QF	0447 1450	360	41,856	837,120	0	0
OTHER	S, S6	1017 1521	782	102,792	2,055,840	0	0
	<b>TOTAL</b>		<b>168,527</b>	<b>15,836,547</b>	<b>316,736,705</b>	<b>0</b>	<b>9</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 (1)	PARA FAIL	FUNC FAIL
DD PAK	9147-1513	2,434	196,748	3,934,960	0	0
F-16	0702-1445	651	58,368	1,167,360	0	0
F-20	9326-1526	1,743	185,945	3,718,900	0	0
F-28	0127-1419	289	31,028	620,560	0	0
F-38	1010-1313	137	21,984	439,680	0	0
F-48	0917	36	3,456	69,120	0	0
G-16	9724-1440	607	98,610	1,972,200	0	0
G-28	9232-1514	11,213	1,198,012	23,960,240	0	2
G-36	9602-1505	1,502	208,243	4,164,860	0	1
G-44	0831-1519	2,389	288,000	5,760,000	0	0
G-48	1206-1549	922	143,616	2,872,320	0	0
N-08	9010-0105	9,112	823,014	16,460,280	0	0
N-14	9033-9926	1,044	80,417	1,608,340	0	0
N-16	9107-9606	1,390	122,901	2,458,020	0	0
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	336	39,078	781,560	0	1
M-08	9726-1544	4,072	514,005	10,280,100	0	1
M-10	0801-1548	3,809	467,952	9,359,040	0	0
M-12	1316-1510	414	51,648	1,032,960	0	0
M-16	0743-1514	1,462	183,456	3,669,120	0	0
S-08	8951-1517	53,410	3,423,169	68,463,388	0	0
S-14	9448-9742	273	61,208	1,224,160	0	0
S-16	9001-1516	10,488	626,840	12,536,800	0	0
S-18	9049-1310	4,047	264,686	5,293,720	0	0
S-20	9001-0516	1,629	177,755	3,555,102	0	0
S-24	9019-1504	1,719	154,234	3,084,680	0	0
S-28	8948-0814	956	100,353	2,007,060	0	0
ST	9115-1503	2,342	267,976	5,359,520	0	0
S-03	9644	98	24,990	499,800	0	0
S-05	9715-1336	878	196,148	3,922,960	0	0
S-06, SC6, & TS8	9943-1539	2,434	347,876	6,959,440	0	0
TO-220	8917-0809	5,222	552,238	11,044,760	0	0
TO-3P	9133-9913	952	97,011	1,940,215	0	0
TO-92(Z)	9006-0238	12,983	1,078,985	21,579,700	0	1
DFN < 3X3	0238-1531	1,384	168,552	3,371,040	0	0
DFN > 4X4	0710-1434	339	46,984	939,680	0	0
QFN < 4X4	1421-1450	306	29,472	589,440	0	0
QFN 4x4 ~ 7X7	0111-1528	6,723	906,412	18,132,080	0	2
QFN > 7X7	0420-1517	886	121,531	2,430,620	0	1
LQFP	1315-1432	213	41,014	820,280	0	0
BGA / LGA *	0645-1447	1,137	144,822	2,896,440	0	0
BGA / LGA **	1209-1551	14,567	2,070,400	41,408,000	0	0
	<b>TOTAL</b>	<b>168,527</b>	<b>15,836,547</b>	<b>316,736,705</b>	<b>0</b>	<b>9</b>

TO-3P = P

TO-92 = Z

TO-220 = T

DD PACK = M, Q, R

PDIP = N

QFN/DFN = QF

TSOT = S3,S5,S6,TS8

SOT-223 = ST

MSOP = M8,M10,M12,M16

SO-8/14/16/18/20/24/28 = 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

\* - BIASED HAST

\*\* - UNBIASED HAST

**AUTOCLAVE TEST**  
**By Product Group**  
**May 2016**

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	M,Q,R,QF,F,G,M8,M10,N,S,TSOT,ST,T,	0501	1522	159,200	8,761,794	0
HIGH SPEED OP AM	QF,G,M8,TSOT,S	0501	1520	3,672	197,088	0
DAC / ADC	M,Q,R,QF,F,G,M8,M10,M12,M16,N,TSOT,S	0501	1544	90,635	6,263,859	0
REFERENCE	QF,M8,N,TSOT,S,ST,Z	0501	1544	109,273	5,022,344	0
FILTER	QF,G,N,S	0501	1519	6,795	356,592	0
SWITCH	G,N,S	0501	1405	2,067	182,032	0
COMPARATOR	QF,G,M8,M10,TSOT,S,ST,Z	0501	1522	15,745	1,022,368	0
INTERFACE	QF,F,G,M8,M10,M12,N,TSOT,S,S	0501	1539	198,559	9,670,052	0
OTHER	QF,G,M8,M10,TSOT,S	0501	1535	28,389	1,364,256	0
REGULATOR	M,Q,R,QF,F,G,M8,M10,M12,M16,N,TSOT,S,ST,Z,T,P	0501	1549	1,499,354	80,139,173	0
MIXER	QF,F,G,M8,TSOT	0501	1514	8,597	919,992	0
<b>TOTAL</b>				<b>2,122,286</b>	<b>113,899,550</b>	<b>0</b>

**AUTOCLAVE TEST**  
**By Package Type**  
**May 2016**

PACKAGE TYPE	DATE CODES		NO. UNITS	TOTAL DEVICE HRS	FUNC. FAILURE
DD PACK	0501	1521	36,582	2,554,512	0
F-14	0501	0924	177	4,248	0
F-16	0501	1522	86,832	3,923,057	0
F-20	0501	1524	35,868	1,782,984	0
F-24	0501	1521	9,011	291,236	0
F-28	0501	1524	15,648	742,800	0
F-38	0501	1532	3,886	341,448	0
F-48	0501	1517	2,722	401,778	0
G-16	0501	1519	54,821	2,384,268	0
G-20	0501	1443	15,829	869,496	0
G-24	0501	1515	46,632	2,592,022	0
G-28	0501	1522	187,729	8,015,709	0
G-36	0501	1537	21,023	1,423,489	0
G-44	0501	1525	52,328	1,996,892	0
G-48	0501	1519	2,913	234,314	0
N-08	0501	1519	2,863	246,824	0
N-14	0501	1431	1,977	448,944	0
N-16	0501	1238	1,359	294,744	0
N-18	0501	0846	957	32,808	0
N-20	0501	0908	2,397	408,217	0
N-24	0501	1334	4,095	365,968	0
N-28	0501	1052	1,355	289,800	0
M-08	0501	1544	110,343	5,469,096	0
M-10	0501	1547	142,244	5,948,544	0
M-12	0501	1535	7,449	958,920	0
M-16	0501	1526	70,293	4,097,826	0
S-08	0501	1521	117,954	5,144,068	0
S-14	0501	1513	7,441	791,736	0
S-16	0501	1517	19,923	1,427,064	0
S-18	0501	1512	1,413	195,000	0
S-20	0501	1519	2,530	81,504	0
S-24	0501	1241	3,087	489,480	0
S-28	0501	1517	13,847	1,061,040	0
SOT-223	0501	1517	73,152	4,753,776	0
TSOT	0501	1539	387,711	17,957,741	0
SC70	0501	1523	27,406	1,427,062	0
TO-220	0501	1521	18,286	2,051,712	0
TO-3P	0501	1505	13,731	1,476,984	0
TO-92	0501	1522	51,528	2,886,736	0

**AUTOCLAVE TEST**  
**By Package Type**  
**May 2016**

PACKAGE TYPE	DATE CODES		NO. UNITS	TOTAL DEVICE HRS	FUNC. FAILURE
DFN ≤ 3X3	0501	1523	135,713	6,974,724	0
DFN > 3X3	0501	1521	83,567	4,233,318	0
QFN ≤ 3X3	0501	1523	32,854	1,982,208	0
QFN 4x4 ~ 7X7	0501	1549	194,385	12,565,847	0
QFN > 7X7	0501	1531	15,687	1,543,708	0
QFP	0501	1517	4,738	735,898	0
<b>TOTAL</b>			<b>2,122,286</b>	<b>113,899,550</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, TS8

SOT-223 = ST

MSOP - M8, M10, M12, M16

SO-8/14/16/18/20/24/28 = S

SSOP = G

TSSOP = F

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

# TEMPERATURE CYCLE TEST

By Package Type

May 2016

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	0501 1323	5,950	5,452,625	0
PLASTIC	0501 1549	1,977,579	474,228,554	0
<b>TOTAL</b>		<b>1,983,529</b>	<b>479,681,179</b>	<b>0</b>

# TEMPERATURE CYCLE TEST

By Package Type

May 2016

PACKAGE TYPE	DATE CODES	NO. UNITS	TOTAL DEVICE CYCLES	FUNC. FAILURE
<b>METAL CAN</b>				
TO-3	0501 0829	578	261,200	0
TO-5, TO-39, TO-46, TO-52	0501 1323	2,695	3,084,050	0
<b>CERDIP</b>				
J-08 to J-28	0501 1322	1,756	1,635,250	0
<b>FLAT PACK</b>				
W-10, W-14	0501 0627	68	6,800	0
<b>LEADLESS CHIP CARRIER</b>				
L-8 to L-20	0501 1209	504	430,425	0
<b>SIDE BRAZE</b>				
D-08 TO D-28	0501 0814	349	34,900	0
<b>SSOP/TSSOP</b>				
F-14	0501 0924	149	14,900	0
F-16	0501 1541	85,630	15,564,682	0
F-20	0501 1548	37,114	7,906,309	0
F-24	0501 1521	9,152	1,596,300	0
F-28	0501 1524	16,338	2,796,700	0
F-38	0501 1522	4,143	1,560,200	0
F-48	0501 1450	2,764	1,149,700	0
G-16	0501 1517	49,824	7,771,604	0
G-20	0501 1443	6,593	1,392,000	0
G-24	0501 1515	11,875	2,837,700	0
G-28	0501 1536	144,983	23,627,232	0
G-36	0501 1537	24,306	7,543,900	0
G-44	0501 1525	49,275	7,304,800	0
G-48	0501 1537	3,158	968,400	0
<b>PLASTIC DIP</b>				
N-08	0501 1510	10,497	2,855,100	0
N-14	0501 1431	3,820	2,512,200	0
N-16	0501 1238	1,290	859,300	0
N-18	0501 0913	3,380	1,091,300	0
N-20	0501 0919	6,028	1,854,000	0
N-24	0501 1334	4,391	1,182,000	0
N-28	0501 1103	2,069	995,500	0
<b>SOIC / MSOP</b>				
M-08	0501 1544	100,772	17,576,540	0
M-10	0501 1547	133,650	20,961,000	0
M-12	0501 1535	7,505	3,525,500	0
M-16	0501 1526	69,858	16,567,052	0
S-08	0501 1521	121,713	18,295,630	0
S-14	0501 1513	8,222	2,395,570	0
S-16	0501 1515	28,737	6,405,300	0
S-18	0501 1505	3,208	2,192,800	0
S-20	0501 1515	4,362	436,200	0
S-24	0501 1241	6,046	1,952,800	0
S-28	0501 1517	12,880	2,974,700	0
<b>POWER PACKAGE</b>				
DD PACK	0501 1521	37,632	7,891,650	0
SOT-223	0501 1517	13,804	5,903,400	0
TO-220	0501 1521	23,855	9,240,490	0
TO-3P	0501 1505	12,348	3,455,800	0
<b>OTHER PLASTIC</b>				
SOT-23	0501 1517	8,040	1,791,300	0
TSOT	0501 1541	183,252	32,154,590	0
SC70	0501 1518	25,184	3,610,500	0
TO-92(Z)	0501 1522	26,044	6,734,750	0
DFN ≤ 3X3	0501 1539	132,924	22,553,254	0
DFN > 3X3	0501 1541	84,129	15,251,227	0
QFN ≤ 3X3	0501 1521	33,261	7,575,000	0
QFN 4x4 ~ 7X7	0501 1548	219,101	52,228,162	0
QFN > 7X7	0501 1538	17,532	6,464,600	0
LGA*	0501 1549	128,294	73,011,538	0
BGA*	0501 1547	54,349	37,248,982	0
QFP	0501 1533	4,098	2,446,392	0
<b>TOTAL</b>		<b>1,983,529</b>	<b>479,681,179</b>	<b>0</b>

NOTE: Approximate duration is 500 cycles.

\* LGA and BGA are cycled to one of three conditions 1) -40°C to +125°C, 2) -55°C to +125°C, or 3) -65°C to +150°C

## THERMAL SHOCK TEST

### By Package Type

May 2016

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	0501 1451	1,893	1,211,615	0
PLASTIC	0501 1551	1,820,460	410,030,982	0
<b>TOTAL</b>		<b>1,822,353</b>	<b>411,242,597</b>	<b>0</b>

## THERMAL SHOCK TEST

### By Package Type

May 2016

PACKAGE TYPE	DATE CODES	NO. UNITS	TOTAL DEVICE CYCLES	FUNC. FAILURE
<b>METAL CAN</b>				
TO-3	0501 0638	153	2,295	0
TO-5, TO-39, TO-46, TO-52	0501 1323	820	619,060	0
<b>CERDIP</b>				
J-08 to J-28	0501 1451	430	242,485	0
<b>FLAT PACK</b>				
W-10, W-14	0501 0627	68	1,020	0
<b>LEADLESS CHIP CARRIER</b>				
L-8 to L-20	0501 1209	422	346,755	0
<b>SSOP/TSSOP</b>				
F-14	0501 0924	198	19,800	0
F-16	0501 1521	87,565	14,453,700	0
F-20	0501 1545	35,896	7,070,800	0
F-24	0501 1521	9,025	1,108,600	0
F-28	0501 1524	16,854	3,072,800	0
F-38	0501 1522	3,832	1,297,600	0
F-48	0501 1450	2,571	883,700	0
G-16	0501 1517	51,749	8,220,200	0
G-20	0501 1443	4,550	1,327,100	0
G-24	0501 1515	11,132	2,403,800	0
G-28	0501 1536	136,506	21,654,216	0
G-36	0501 1516	23,072	5,792,400	0
G-44	0501 1525	52,057	7,439,500	0
G-48	0501 1519	2,896	873,900	0
<b>PLASTIC DIP</b>				
N-08	0501 1510	653	428,000	0
N-14	0501 1431	1,394	1,170,800	0
N-16	0501 1238	585	386,900	0
N-18	0501 0844	384	384,000	0
N-20	0501 0844	1,121	1,037,500	0
N-24	0501 1334	891	666,900	0
N-28	0501 1103	991	780,000	0
<b>SOIC / MSOP</b>				
M-08	0501 1541	89,437	15,275,800	0
M-10	0501 1547	138,118	21,559,508	0
M-12	0501 1522	7,287	2,978,600	0
M-16	0501 1526	66,912	13,728,400	0
S-08	0501 1521	99,988	15,071,880	0
S-14	0501 1513	6,560	1,916,120	0
S-16	0501 1515	16,954	3,835,250	0
S-18	0501 1505	1,303	785,950	0
S-20	0501 1515	2,263	226,300	0
S-24	0501 1241	2,548	1,567,000	0
S-28	0501 1517	13,734	2,871,400	0
<b>POWER PACKAGE</b>				
DD PACK	0501 1521	30,339	5,849,086	0
SOT-223	0501 1517	11,886	4,640,064	0
TO-220	0501 1521	13,295	4,444,850	0
TO-3P	0501 1505	10,263	2,036,300	0
<b>OTHER PLASTIC</b>				
SOT-23	0501 1517	8,053	1,751,200	0
TSOT	0501 1541	196,593	30,605,440	0
SC70	0501 1518	26,977	4,770,462	0
TO-92(Z)	0501 1522	26,079	7,051,600	0
DFN ≤ 3X3	0501 1539	134,222	22,313,686	0
DFN > 3X3	0501 1541	84,474	14,937,568	0
QFN ≤ 3X3	0501 1521	32,220	6,568,500	0
QFN 4x4 ~ 7X7	0501 1549	207,223	45,890,532	0
QFN > 7X7	0501 1531	17,325	6,257,500	0
LGA*	0501 1548	87,235	61,564,020	0
BGA*	0501 1551	41,640	29,108,750	0
QFP	0501 1533	3,610	1,953,000	0
<b>TOTAL</b>		<b>1,822,353</b>	<b>411,242,597</b>	<b>0</b>

NOTE: Approximate duration is 500 cycles.

\* LGA and BGA are cycled to one of three conditions 1) -40°C to +125°C, 2) -55°C to +125°C, or 3) -65°C to +150°C

Moisture Sensitivity Classification testing is performed in accordance with J-STD-020. The chart below reflects the flow of Surface Mount Preconditioning process. 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 Reflow and Vapor Phase. As the molding compound expands, it can tear 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 mount 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 solutions deliver Moisture Sensitivity Level One at +260°C peak body temperature performance for most lead-frame based packages. An updated cross-reference of package type, pin count, and Moisture Sensitivity Level (MSL) can be found on the LTC website at:

[http://cds.linear.com/docs/Quality/MSL\\_By\\_Package\\_Type.pdf](http://cds.linear.com/docs/Quality/MSL_By_Package_Type.pdf)

## µModule Package Technology -

The Moisture Sensitivity Level (MSL) of µModule packages is unique to each µModule device. Factors such as construction and component layout influence the MSL performance. µModule packages are rated MSL 3 or lower, with floor life and maximum allowed peak body temperatures specified by J-STD-020. For more information, please see Module Design and Manufacturing Resources:

<http://www.linear.com/designtools/packaging/umodule.php>

## 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

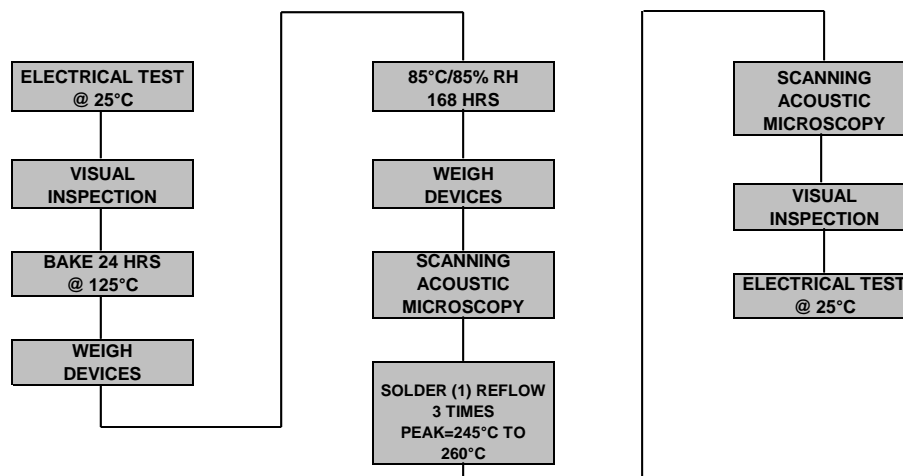
## MOISTURE SENSITIVITY CLASSIFICATION TESTING

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	48 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**  
**May 2016**

PACKAGE TYPE	DATE CODES		SAMPLE SIZE	# FAILURE
DD PACK	0501	1521	104,553	0
F-14	0501	924	524	0
F-16	0501	1541	260,027	0
F-20	0501	1548	108,878	0
F-24	0501	1521	27,188	0
F-28	0501	1524	48,840	0
F-38	0501	1532	11,861	0
F-48	0501	1517	8,057	0
G-16	0501	1519	156,394	0
G-20	0501	1443	26,972	0
G-24	0501	1515	69,639	0
G-28	0501	1536	469,218	0
G-36	0501	1537	68,401	0
G-44	0501	1525	153,660	0
G-48	0501	1537	8,967	0
N-08	0501	1519	14,013	0
N-14	0501	1431	7,191	0
N-16	0501	1238	3,234	0
N-18	0501	913	4,721	0
N-20	0501	919	9,546	0
N-24	0501	1334	9,377	0
N-28	0501	1103	4,415	0
M-08	0501	1544	300,552	0
M-10	0501	1547	414,012	0
M-12	0501	1535	22,241	0
M-16	0501	1526	207,063	0
S-08	0501	1521	339,655	0
S-14	0501	1513	22,223	0
S-16	0501	1517	65,614	0
S-18	0501	1512	5,924	0
S-20	0501	1519	9,155	0
S-24	0501	1241	11,681	0
S-28	0501	1517	40,461	0
SOT-223	0501	1517	98,842	0
TO-220	0501	1521	55,436	0
TO-3P	0501	1505	36,342	0
SOT-23	0501	1517	16,093	0
TSOT	0501	1541	767,556	0
SC70	0501	1523	79,567	0
TO-92(Z)	0501	1522	103,651	0
DFN $\leq$ 3X3	0501	1539	402,859	0
DFN > 3X3	0501	1541	252,170	0
QFN $\leq$ 3X3	0501	1523	98,335	0
QFN 4x4 ~ 7X7	0501	1549	620,709	0
QFN > 7X7	0501	1538	50,544	0
BGA/LGA	0501	1551	311,518	0
QFP	0501	1533	12,446	0
<b>TOTAL</b>			<b>5,920,325</b>	

**RELIABILITY DATA**  
**TEST RESULT POST J-STD-020 PRECONDITIONING**  
**May 2016**

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

PACKAGE TYPE	SAMPLE SIZE	DATE CODES	# OF DEVICE HRS @ 85°C (1)	# FAILURE
DD PAK	2,434	9147 1513	3,934,960	0
F-16	651	0702 1445	1,167,360	0
F-20	1,743	9326 1526	3,718,900	0
F-28	289	0127 1419	620,560	0
F-38	137	1010 1313	439,680	0
F-48	36	0917	69,120	0
G-16	607	9724 1440	1,972,200	0
G-28	11,213	9232 1514	23,960,240	0
G-36	1,502	9602 1505	4,164,860	0
G-44	2,389	0831 1519	5,760,000	0
G-48	922	1206 1549	2,872,320	0
N-08	9,112	9010 0105	16,460,280	0
N-14	1,044	9033 9926	1,608,340	0
N-16	1,390	9107 9606	2,458,020	0
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	336	8847 9726	781,560	0
M-08	4,072	9726 1544	10,280,100	0
M-10	3,809	0801 1548	9,359,040	0
M-12	414	1316 1510	1,032,960	0
M-16	1,462	0743 1514	3,669,120	0
S-08	53,410	8951 1517	68,463,388	0
S-14	273	9448 9742	1,224,160	0
S-16	10,488	9001 1516	12,536,800	0
S-18	4,047	9049 1310	5,293,720	0
S-20	1,629	9001 0516	3,555,102	0
S-24	1,719	9019 1504	3,084,680	0
S-28	956	8948 0814	2,007,060	0
ST	2,342	9115 1503	5,359,520	0
S-03	98	9644	499,800	0
S-05	878	9715 1336	3,922,960	0
S-06, SC6, & TS8	2,434	9943 1539	6,959,440	0
TO-220	5,222	8917 0809	11,044,760	0
TO-3P	952	9133 9913	1,940,215	0
TO-92(Z)	12,983	9006 0238	21,579,700	0
DFN < 3X3	1,384	0238 1531	3,371,040	0
DFN > 4X4	339	0710 1434	939,680	0
QFN < 4X4	306	1421 1450	589,440	0
QFN 4x4 ~ 7X7	6,723	0111 1528	18,132,080	0
QFN > 7X7	886	0420 1517	2,430,620	0
LQFP	213	1315 1432	820,280	0
BGA / LGA *	1,137	0645 1447	2,896,440	0
BGA / LGA **	14,567	1209 1551	41,408,000	0
<b>TOTAL</b>	<b>168,527</b>		<b>316,736,705</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  
Sidebrazed = D  
Flat Pack = W

TSOT = S3, S5, S6, TS8  
SOT-223 = ST  
MSOP = M8, M10, M12, M16  
QFN/DFN

SO-8/14/16/18/20/24/28 = S  
SSOP = G  
TSSOP = F  
LGA = Module

**NOTE:**

(1) Assumes 20X acceleration from 131°C to 85°

(2) Approximate duration is 96 hours.

\* - BIASED HAST

\*\* - UNBIASED HAST

**RELIABILITY DATA**  
**TEST RESULT POST J-STD-020 PRECONDITIONING**  
**May 2016**

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

PACKAGE TYPE	SAMPLE SIZE	DATE CODES		TOTAL # OF DEVICE HRS	# FAILURE
DD PACK	36,582	0501	1521	2,554,512	0
F-14	177	0501	0924	4,248	0
F-16	86,832	0501	1522	3,923,057	0
F-20	35,868	0501	1524	1,782,984	0
F-24	9,011	0501	1521	291,236	0
F-28	15,648	0501	1524	742,800	0
F-38	3,886	0501	1532	341,448	0
F-48	2,722	0501	1517	401,778	0
G-16	54,821	0501	1519	2,384,268	0
G-20	15,829	0501	1443	869,496	0
G-24	46,632	0501	1515	2,592,022	0
G-28	187,729	0501	1522	8,015,709	0
G-36	21,023	0501	1537	1,423,489	0
G-44	52,328	0501	1525	1,996,892	0
G-48	2,913	0501	1519	234,314	0
N-08	2,863	0501	1519	246,824	0
N-14	1,977	0501	1431	448,944	0
N-16	1,359	0501	1238	294,744	0
N-18	957	0501	0846	32,808	0
N-20	2,397	0501	0908	408,217	0
N-24	4,095	0501	1334	365,968	0
N-28	1,355	0501	1052	289,800	0
M-08	110,343	0501	1544	5,469,096	0
M-10	142,244	0501	1547	5,948,544	0
M-12	7,449	0501	1535	958,920	0
M-16	70,293	0501	1526	4,097,826	0
S-08	117,954	0501	1521	5,144,068	0
S-14	7,441	0501	1513	791,736	0
S-16	19,923	0501	1517	1,427,064	0
S-18	1,413	0501	1512	195,000	0
S-20	2,530	0501	1519	81,504	0
S-24	3,087	0501	1241	489,480	0
S-28	13,847	0501	1517	1,061,040	0
SOT-223	73,152	0501	1517	4,753,776	0
TSOT	387,711	0501	1539	17,957,741	0
SC70	27,406	0501	1523	1,427,062	0
TO-220	18,286	0501	1521	2,051,712	0
TO-3P	13,731	0501	1505	1,476,984	0
TO-92	51,528	0501	1522	2,886,736	0
DFN ≤ 3X3	135,713	0501	1523	6,974,724	0
DFN > 3X3	83,567	0501	1521	4,233,318	0
QFN ≤ 3X3	32,854	0501	1523	1,982,208	0
QFN 4x4 ~ 7X7	194,385	0501	1549	12,565,847	0
QFN > 7X7	15,687	0501	1531	1,543,708	0
QFP	4,738	0501	1517	735,898	0
<b>TOTAL</b>	<b>2,122,286</b>			<b>113,899,550</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  
Sidebrazed = D  
Flat Pack = W

TSOT = S3, S5, S6, TS8  
SOT-223 = ST  
MSOP = M8, M10, M12, M16  
QFN/DFN

SO-8/14/16/18/20/24/28 = S  
SSOP = G  
TSSOP = F  
QFP

**RELIABILITY DATA**  
**TEMPERATURE CYCLE (AIR TO AIR) -65°C TO 150°C AFTER JEDEC PRECONDITION**  
**May 2016**

PACKAGE TYPE	SAMPLE SIZE	DATE CODES	TOTAL # OF DEVICE CYCLES	# FAILURE
F-14	149	0501 0924	14,900	0
F-16	85,630	0501 1541	15,564,682	0
F-20	37,114	0501 1548	7,906,309	0
F-24	9,152	0501 1521	1,596,300	0
F-28	16,338	0501 1524	2,796,700	0
F-38	4,143	0501 1522	1,560,200	0
F-48	2,764	0501 1450	1,149,700	0
G-16	49,824	0501 1517	7,771,604	0
G-20	6,593	0501 1443	1,392,000	0
G-24	11,875	0501 1515	2,837,700	0
G-28	144,983	0501 1536	23,627,232	0
G-36	24,306	0501 1537	7,543,900	0
G-44	49,275	0501 1525	7,304,800	0
G-48	3,158	0501 1537	968,400	0
N-08	10,497	0501 1510	2,855,100	0
N-14	3,820	0501 1431	2,512,200	0
N-16	1,290	0501 1238	859,300	0
N-18	3,380	0501 0913	1,091,300	0
N-20	6,028	0501 0919	1,854,000	0
N-24	4,391	0501 1334	1,182,000	0
N-28	2,069	0501 1103	995,500	0
M-08	100,772	0501 1544	17,576,540	0
M-10	133,650	0501 1547	20,961,000	0
M-12	7,505	0501 1535	3,525,500	0
M-16	69,858	0501 1526	16,567,052	0
S-08	121,713	0501 1521	18,295,630	0
S-14	8,222	0501 1513	2,395,570	0
S-16	28,737	0501 1515	6,405,300	0
S-18	3,208	0501 1505	2,192,800	0
S-20	4,362	0501 1515	436,200	0
S-24	6,046	0501 1241	1,952,800	0
S-28	12,880	0501 1517	2,974,700	0
DD PACK	37,632	0501 1521	7,891,650	0
SOT-223	13,804	0501 1517	5,903,400	0
TO-220	23,855	0501 1521	9,240,490	0
TO-3P	12,348	0501 1505	3,455,800	0
SOT-23	8,040	0501 1517	1,791,300	0
TSOT	183,252	0501 1541	32,154,590	0
SC70	25,184	0501 1518	3,610,500	0
TO-92(Z)	26,044	0501 1522	6,734,750	0
DFN ≤ 3X3	132,924	0501 1539	22,553,254	0
DFN > 3X3	84,129	0501 1541	15,251,227	0
QFN ≤ 3X3	33,261	0501 1521	7,575,000	0
QFN 4x4 ~ 7X7	219,101	0501 1548	52,228,162	0
QFN > 7X7	17,532	0501 1538	6,464,600	0
LGA*	128,294	0501 1549	73,011,538	0
BGA*	54,349	0501 1547	37,248,982	0
QFP	4,098	0501 1533	2,446,392	0
<b>TOTAL</b>	<b>1,977,579</b>		<b>474,228,554</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

CERDIP = J

Sidebrazed = D

TSOT = S3, S5, S6, TS8

SOT-223 = ST

MSOP = M8, M10, M12, M16

SO-8/14/16/18/20/24/28 = S

SSOP = G

TSSOP = F

\* LGA are cycled to one of three conditions 1) -40°C to +125°C, 2) -55°C to +125°C, or 3) -65°C to +150°C

**RELIABILITY DATA**  
**THERMAL SHOCK (LIQUID TO LIQUID) -65°C TO 150°C AFTER JEDEC PRECONDITION**  
**May 2016**

PACKAGE TYPE	SAMPLE SIZE	DATE CODES	TOTAL # OF DEVICE CYCLES	# FAILURE
F-14	198	0501 0924	19,800	0
F-16	87,565	0501 1521	14,453,700	0
F-20	35,896	0501 1545	7,070,800	0
F-24	9,025	0501 1521	1,108,600	0
F-28	16,854	0501 1524	3,072,800	0
F-38	3,832	0501 1522	1,297,600	0
F-48	2,571	0501 1450	883,700	0
G-16	51,749	0501 1517	8,220,200	0
G-20	4,550	0501 1443	1,327,100	0
G-24	11,132	0501 1515	2,403,800	0
G-28	136,506	0501 1536	21,654,216	0
G-36	23,072	0501 1516	5,792,400	0
G-44	52,057	0501 1525	7,439,500	0
G-48	2,896	0501 1519	873,900	0
N-08	653	0501 1510	428,000	0
N-14	1,394	0501 1431	1,170,800	0
N-16	585	0501 1238	386,900	0
N-18	384	0501 0844	384,000	0
N-20	1,121	0501 0844	1,037,500	0
N-24	891	0501 1334	666,900	0
N-28	991	0501 1103	780,000	0
M-08	89,437	0501 1541	15,275,800	0
M-10	138,118	0501 1547	21,559,508	0
M-12	7,287	0501 1522	2,978,600	0
M-16	66,912	0501 1526	13,728,400	0
S-08	99,988	0501 1521	15,071,880	0
S-14	6,560	0501 1513	1,916,120	0
S-16	16,954	0501 1515	3,835,250	0
S-18	1,303	0501 1505	785,950	0
S-20	2,263	0501 1515	226,300	0
S-24	2,548	0501 1241	1,567,000	0
S-28	13,734	0501 1517	2,871,400	0
DD PACK	30,339	0501 1521	5,849,086	0
SOT-223	11,886	0501 1517	4,640,064	0
TO-220	13,295	0501 1521	4,444,850	0
TO-3P	10,263	0501 1505	2,036,300	0
SOT-23	8,053	0501 1517	1,751,200	0
TSOT	196,593	0501 1541	30,605,440	0
SC70	26,977	0501 1518	4,770,462	0
TO-92(Z)	26,079	0501 1522	7,051,600	0
DFN ≤ 3X3	134,222	0501 1539	22,313,686	0
DFN > 3X3	84,474	0501 1541	14,937,568	0
QFN ≤ 3X3	32,220	0501 1521	6,568,500	0
QFN 4x4 ~ 7X7	207,223	0501 1549	45,890,532	0
QFN > 7X7	17,325	0501 1531	6,257,500	0
LGA*	87,235	0501 1548	61,564,020	0
BGA*	41,640	0501 1551	29,108,750	0
QFP	3,610	0501 1533	1,953,000	0
<b>TOTAL</b>	<b>1,820,460</b>		<b>410,030,982</b>	<b>0</b>

TO-5 = H      TO-3P = P      PDIP = N      TSOT = S3, S5, S6, TS8      SO-8/14/16/18/20/24/28 = 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, M12, M16      TSSOP = F  
 LCC = L      DD PACK = M, Q, R      Flat Pack = W      QFN/DFN      LGA = Module  
 \* LGA & BGA are cycled to one of three conditions 1) -40°C to +125°C, 2) -55°C to +125°C, or 3) -65°C to +150°C

<b>ACCELERATED HIGH TEMPERATURE OPERATION LIFE (HTOL) TEST RESULT</b>	
<b>FIT Rate</b>	<b>0.08</b>
Numbers of Total Failures	8
Total HTOL Sample Size from Q105 to Q415	322,306
Equivalent Device Hours at 55°C	113,358,618,880

(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.