

RELIABILITY DATAPACK

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**OPERATING LIFE TEST
By Product Group
June 2017**

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	0604 1713	60,224	4,587	20,482	0	1	0.001	0.002
DAC / ADC	D,F,G,J,M8,M10,M12,M16,N,QF,S,T SOT,LGA	0615 1710	15,183	3,068	10,249	0	0	0.002	0.002
REFERENCE FILTER	H,M8,TSOT	0620 1707	3,531	839	4,008	0	0	0.005	0.005
SWITCH	J,S,QF	0724 1519	724	102	343	0	0	0.053	0.053
COMPARATOR	G, N, S	0501 1434	2,846	608	2,032	0	0	0.009	0.009
INTERFACE	M8,S,TSOT,W	0723 1633	1,450	201	817	0	0	0.022	0.022
OTHER	F,G,M8,M10,M12,N,QF,S,TSOT, LGA	0601 1711	78,780	6,553	22,671	3	2	0.004	0.003
REGULATOR	G,M8,M16,QF,TSOT	0630 1629	4,141	1,178	4,317	0	0	0.004	0.004
MIXER	F,G,H,J,K,M8,M10,M12,M16,N,P,QF, S,T,TSOT,LGA, BGA	0602 1712	265,746	45,643	181,995	2	2	0.000	0.000
	F,G,QF	0630 1701	5,040	943	3,645	0	0	0.005	0.005
	TOTAL		437,665	63,722	250,559	5	5	0.0010	0.0010

**OPERATING LIFE TEST
By Technology Group
June 2017**

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	G, QF	0846 1617	9,927	429	1,430	0	0	0.083	0.083
CMOS 0.25μ	TS8, M16,QF	0626 1644	2,786	1,072	3,580	0	0	0.033	0.033
CMOS 0.35μ	TS8, M10,QF, TSOT	0615 1647	2,318	628	2,099	0	0	0.056	0.056
CMOS 0.60μ	F,G,M8,M10,M12,M16,N,QF,S,TSO T	0602 1710	63,584	7,521	25,121	0	1	0.005	0.010
CMOS 1.2μ	F,G,M8,M10,M16,QF,S,TSOT,T	0606 1709	29,657	2,817	9,408	0	0	0.028	0.028
BICMOS 0.65μ	G,F,M8,M10,QF,TSOT,LGA	0656 1709	65,091	11,747	39,465	3	1	0.014	0.007
BICMOS 1.2μ	F,G,M8,M10,M16,QF,S,TSOT,LGA	0639 1709	52,924	4,620	15,432	0	0	0.008	0.008
BIPOLAR 1.5μ	F,K,M8,M10,M16,QF,S,TSOT,LGA	0612 1709	38,316	10,699	59,693	0	0	0.002	0.002
BICMOS 2μ	F,G,M10,QF,S	0605 1708	19,972	2,414	8,064	0	1	0.015	0.032
CMOS 2μ	G,M8,QF,S5	0640 1709	10,657	852	2,844	0	0	0.042	0.042
COMP BP 2μ	G,M8,N,QF,S,W	0630 1348	1,571	190	1,061	0	0	0.112	0.112
BICMOS 3μ	S	1132 1559	1,120	175	584	0	0	0.188	0.188
CMOS 3μ	F,G,S	0632 1707	5,539	1,343	4,487	0	0	0.019	0.019
CMOS 4μ	D,G,J,M8,M10,N,S	0601 1711	40,599	4,429	14,792	2	1	0.019	0.006
HS BP 4μ	F,G,M8,M10,N,W,QF,S,TSOT	0630 1712	11,163	1,345	7,533	0	1	0.010	0.021
STEPPER BP 4μ	S,QF,F,G,M10,M12	0607 1713	13,874	1,264	7,076	0	0	0.013	0.013
BIFET 7μ	N,S	0604 1216	414	45	252	0	0	0.184	0.184
CMOS 7μ	D,G,J,N,S	0712 1645	2,038	378	1,261	0	0	0.056	0.056
COMP BP 7μ	N,M10,S	0724 1605	1,996	176	985	0	0	0.100	0.100
STD BP 7μ	S,H,J,K,N,W	0612 1707	12,331	1,300	7,108	0	0	0.055	0.085
SIGE 0.18μ	QF	1511 1701	3,696	908	3,038	0	0	0.040	0.040
SIGE 0.35μ	M10,QF	0713 1617	2,739	874	2,920	0	0	0.033	0.033
BCD 0.35μ	QF, M16, TSOT	0601 1713	33,147	5,890	19,672	0	0	0.009	0.009
RF	F,G,QF	0630 1532	2,040	244	1,369	0	0	0.044	0.044
MODULE	LGA, BGA	0630 1641	10,166	2,362	11,285	0	0	0.010	0.010
	TOTAL		437,665	63,722	250,559	5	5	0.0010	0.0010

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

June 2017

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	9201 - 1707	44,109	3,265,246	65,304,928	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	9209 - 1547	1,958	280,283	5,605,660	0	1
REFERENCE	M8,N,S,TSOT,Z	9201 - 1647	25,485	1,774,294	35,485,880	0	1
FILTER	N,S	9202 - 9341	727	64,246	1,284,920	0	0
SWITCH	S	9236 - 0106	533	68,803	1,376,060	0	0
COMPARATOR	N,Z	9240 - 9649	183	12,384	247,680	0	0
INTERFACE	G,N,S,QF, LGA	9202 - 1708	28,994	2,490,483	49,809,660	0	2
REGULATOR	F,G,M,M8,M10,M16,N,P,Q,R,S,S T,T,TSOT,Z,QF,LGA	9202 - 1710	73,600	8,073,369	161,473,137	0	5
MIXER	QF	0447 - 1450	310	37,056	741,120	0	0
OTHER	S, S6	1017 - 1635	1,337	171,240	3,424,800	0	0
	TOTAL		178,171	16,301,350	326,032,765	0	9

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	9204 - 1620	2,399	193,030	3,860,600	0	0
F-16	0702 - 1644	1,277	118,464	2,369,280	0	0
F-20	9326 - 1707	2,923	299,225	5,984,500	0	0
F-24	1552 - 1706	819	78,624	1,572,480	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 - 0917	36	3,456	69,120	0	0
G-16	9724 - 1704	872	124,050	2,481,000	0	0
G-20	1634 - 1642	60	5,760	115,200	0	0
G-28	9232 - 1710	13,169	1,395,100	27,902,000	0	2
G-36	9602 - 1706	2,674	340,339	6,806,780	0	1
G-44	0831 - 1708	2,821	329,472	6,589,440	0	0
G-48	1304 - 1649	1,320	189,504	3,790,080	0	0
N-08	9205 - 1638	8,255	713,782	14,275,640	0	0
N-14	9226 - 9926	952	67,240	1,344,800	0	0
N-16	9207 - 9606	1,085	92,573	1,851,460	0	0
N-18	9213 - 0611	442	50,563	1,011,260	0	0
N-20	9217 - 9739	371	51,182	1,023,640	0	0
N-24	9213 - 9301	451	42,179	843,580	0	0
N-28	9234 - 9726	252	21,558	431,160	0	1
M-08	9726 - 1647	4,582	568,869	11,377,380	0	1
M-10	0801 - 1709	8,432	930,864	18,617,280	0	0
M-12	1220 - 1649	814	113,088	2,261,760	0	0
M-16	0743 - 1644	1,757	211,776	4,235,520	0	0
S-08	9201 - 1708	57,960	3,896,786	77,935,728	0	0
S-14	9448 - 9742	273	61,208	1,224,160	0	0
S-16	9210 - 1635	10,634	641,420	12,828,400	0	0
S-18	9215 - 1310	3,929	248,643	4,972,860	0	0
S-20	9202 - 0516	950	104,201	2,084,022	0	0
S-24	9202 - 1617	1,676	142,872	2,857,440	0	0
S-28	9208 - 0814	904	86,521	1,730,420	0	0
ST	9215 - 1503	2,294	265,672	5,313,440	0	0
S-03	9644 - 9644	98	24,990	499,800	0	0
S-05	9715 - 1708	2,063	348,308	6,966,160	0	0
S-06, SC6, & TS8	9943 - 1703	3,123	436,868	8,739,280	0	0
TO-220	9202 - 0809	3,697	355,052	7,101,040	0	0
TO-3P	9239 - 9913	862	89,811	1,796,215	0	0
TO-92(Z)	9201 - 0238	10,146	749,701	14,994,020	0	1
DFN ≤ 3X3	0238 - 1639	1,634	207,336	4,146,720	0	0
DFN ≥ 4X4	0710 - 1625	398	37,672	753,440	0	0
QFN ≤ 3X3	1421 - 1706	1,620	163,008	3,260,160	0	0
QFN 4x4 ~ 7X7	0111 - 1709	16,286	1,965,004	39,303,920	0	2
QFN > 7X7	0420 - 1613	1,370	172,867	3,457,340	0	1
LQFP	1315 - 1612	685	131,638	2,632,760	0	0
BGA / LGA	0647 - 1633	1,380	178,062	3,561,240	0	0
	TOTAL	178,171	16,301,350	326,032,765	0	9

TO-3P = P DD PACK = M, Q, R TSOT = S3,S5,S6,TS8 SO-8/14/16/18/20/24/28 = S LGA = Module
TO-92 = Z PDIP = N SOT-223 = ST SSOP = G
TO-220 = T QFN/DFN = QF MSOP = M8,M10,M12,M16 TSSOP = F

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
June 2017**

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,	0601	1715	192,025	9,512,850	0
HIGH SPEED OP AMP	QF,G,M8,TSOT,S	0601	1704	3,894	202,416	0
DAC / ADC	M,Q,R,QF,F,G,M8,M10,M12,M16,N,TSOT,S	0601	1714	101,262	5,411,786	0
REFERENCE	QF,M8,N,TSOT,S,ST,Z	0601	1717	115,264	5,170,040	0
FILTER	QF,G,N,S	0601	1713	6,960	360,552	0
SWITCH	G,N,S	0601	1523	1,917	178,432	0
COMPARATOR	QF,G,M8,M10,TSOT,S,ST,Z	0601	1716	17,580	1,058,440	0
INTERFACE	QF,F,G,M8,M10,M12,N,TSOT,S,ST	0601	1715	271,967	11,898,158	0
OTHER	QF,G,M8,M10,TSOT,S	0601	1713	37,407	1,746,680	0
REGULATOR	M,Q,R,QF,F,G,M8,M10,M12,M16,N,TSOT,S,ST,Z,T,P	0601	1717	1,759,937	86,865,332	0
MIXER	QF,F,G,M8,TSOT	0601	1703	9,730	744,336	0
MODULE *	LGA, BGA	1209	1601	14,925	2,139,136	0
	TOTAL			2,532,868	125,288,158	0

**AUTOCLAVE TEST
By Package Type
June 2017**

PACKAGE TYPE	DATE CODES		NO. UNITS	TOTAL DEVICE HRS	FUNC. FAILURE
DD PACK	0601	1715	40,995	2,750,112	0
F-14	0601	0924	177	4,248	0
F-16	0601	1713	93,522	3,689,194	0
F-20	0601	1716	43,755	2,024,144	0
F-24	0601	1712	15,303	445,628	0
F-28	0601	1714	21,557	748,536	0
F-38	0601	1715	7,916	452,520	0
F-48	0601	1547	2,432	254,088	0
G-16	0601	1714	58,352	2,369,772	0
G-20	0601	1605	15,279	851,496	0
G-24	0601	1711	46,452	2,560,604	0
G-28	0601	1716	204,042	8,138,199	0
G-36	0601	1714	21,502	1,409,785	0
G-44	0601	1714	82,924	2,864,772	0
G-48	0601	1715	34,906	1,317,334	0
N-08	0601	1621	2,583	224,304	0
N-14	0601	1619	2,108	496,440	0
N-16	0601	1707	1,432	310,896	0
N-18	0601	0846	803	29,112	0
N-20	0601	1708	2,028	388,536	0
N-24	0601	1644	3,714	256,824	0
N-28	0601	1052	1,028	274,752	0
M-08	0601	1715	140,254	6,337,488	0
M-10	0601	1716	174,519	6,719,096	0
M-12	0601	1715	11,800	1,249,104	0
M-16	0601	1716	150,711	6,157,922	0
S-08	0601	1716	137,824	5,840,012	0
S-14	0601	1706	7,657	724,848	0
S-16	0601	1710	21,572	1,466,640	0
S-18	0601	1709	1,868	205,920	0
S-20	0601	1647	2,780	88,004	0
S-24	0601	1602	1,836	133,920	0
S-28	0601	1713	14,217	1,055,664	0
SOT-223	0601	1716	75,667	5,237,232	0
TSOT	0601	1716	420,387	18,987,103	0
SC70	0601	1715	29,131	1,162,872	0
TO-220	0601	1717	19,046	2,136,984	0
TO-3P	0601	1604	12,981	1,516,584	0
TO-92	0601	1717	52,075	2,852,128	0

AUTOCLAVE TEST
By Package Type
June 2017

PACKAGE TYPE	DATE CODES		NO. UNITS	TOTAL DEVICE HRS	FUNC. FAILURE
DFN ≤ 3X3	0601	1715	161,930	7,471,526	0
DFN > 3X3	0601	1714	86,557	4,098,696	0
QFN ≤ 3X3	0601	1710	31,192	1,547,352	0
QFN 4x4 ~ 7X7	0601	1716	231,113	13,783,833	0
QFN > 7X7	0601	1715	22,639	1,459,396	0
QFP	0601	1713	7,377	1,055,402	0
LGA / BGA *	1209	1601	14,925	2,139,136	0
TOTAL			2,532,868	125,288,158	0

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.

* LGA and BGA are stressed at unbiased +130°C / 85% RH

TEMPERATURE CYCLE TEST
By Package Type
June 2017

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	0601 1622	3,724	2,963,550	0
PLASTIC	0601 1717	2,432,270	539,501,948	0
TOTAL		2,435,994	542,465,498	0

TEMPERATURE CYCLE TEST
By Package Type
June 2017

PACKAGE TYPE	DATE CODES	NO. UNITS	TOTAL DEVICE CYCLES	FUNC. FAILURE
TO-5, TO-39, TO-46, TO-52	0601 1323	633	617,700	0
J-08 to J-28	0601 1622	2,708	2,307,550	0
W-10, W-14	0601 0627	34	3,400	0
D-08 TO D-28	0601 0814	349	34,900	0
F-14	0601 0924	149	14,900	0
F-16	0601 1713	91,673	14,654,982	0
F-20	0601 1716	46,888	9,022,909	0
F-24	0601 1712	15,594	2,240,500	0
F-28	0601 1714	23,394	3,246,200	0
F-38	0601 1714	8,314	1,994,500	0
F-48	0601 1547	2,575	737,200	0
G-16	0601 1714	53,007	7,923,500	0
G-20	0601 1605	5,968	1,329,500	0
G-24	0601 1637	12,025	2,949,900	0
G-28	0601 1716	160,380	24,104,052	0
G-36	0601 1714	24,912	7,532,400	0
G-44	0601 1714	79,544	10,685,700	0
G-48	0601 1714	34,868	5,034,600	0
N-08	0601 1510	10,447	2,850,100	0
N-14	0601 1619	4,028	2,656,200	0
N-16	0601 1650	1,240	89,430	0
N-18	0601 0913	2,680	1,021,300	0
N-20	0601 0919	5,129	1,764,100	0
N-24	0601 1334	3,311	1,074,000	0
N-28	0601 1103	1,969	985,500	0
M-08	0601 1715	130,111	21,588,850	0
M-10	0601 1716	166,966	26,896,900	0
M-12	0601 1715	12,495	6,003,100	0
M-16	0601 1716	150,092	25,918,052	0
S-08	0601 1716	135,585	22,114,800	0
S-14	0601 1706	8,041	2,341,300	0
S-16	0601 1710	27,987	6,330,300	0
S-18	0601 1603	3,208	2,192,800	0
S-20	0601 1553	4,262	426,200	0
S-24	0601 1602	4,795	823,300	0
S-28	0601 1713	13,281	3,011,300	0
DD PACK	0601 1715	41,925	8,200,850	0
SOT-223	0601 1716	17,326	8,392,100	0
TO-220	0601 1717	24,535	9,386,390	0
TO-3P	0601 1604	12,098	3,430,800	0
SOT-23	0601 1713	8,084	1,795,700	0
TSOT	0601 1716	213,814	36,338,200	0
SC70	0601 1715	27,414	3,287,700	0
TO-92(Z)	0601 1717	26,341	6,629,450	0
DFN ≤ 3X3	0601 1715	153,959	25,432,897	0
DFN > 3X3	0601 1714	86,994	15,362,122	0
QFN ≤ 3X3	0601 1710	32,137	6,949,500	0
QFN 4x4 ~ 7X7	0601 1716	257,709	63,084,392	0
QFN > 7X7	0601 1715	25,691	7,475,550	0
LGA*	0601 1715	165,490	78,859,948	0
BGA*	0601 1713	86,880	41,171,082	0
QFP	0601 1707	6,955	4,146,892	0
TOTAL		2,435,994	542,465,498	0

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
June 2017**

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	0601 1622	1,834	1,612,995	0
PLASTIC	0601 1717	2,179,941	433,667,706	0
TOTAL		2,181,775	435,280,701	0

**THERMAL SHOCK TEST
By Package Type
June 2017**

PACKAGE TYPE	DATE CODES	NO. UNITS	TOTAL DEVICE CYCLES	FUNC. FAILURE
TO-5, TO-39, TO-46, TO-52	0601 1323	633	616,255	0
J-08 to J-28	0601 1622	1,167	996,230	0
W-10, W-14	0601 0627	34	510	0
F-14	0601 0924	198	19,800	0
F-16	0601 1713	94,209	13,689,700	0
F-20	0601 1716	42,909	7,584,700	0
F-24	0601 1712	15,414	1,747,500	0
F-28	0601 1714	23,008	3,386,600	0
F-38	0601 1714	7,699	1,565,700	0
F-48	0601 1547	2,631	743,700	0
G-16	0601 1714	55,017	8,172,700	0
G-20	0601 1605	3,951	1,267,200	0
G-24	0601 1709	11,286	2,295,800	0
G-28	0601 1716	152,209	22,484,536	0
G-36	0601 1714	24,039	6,072,400	0
G-44	0601 1714	81,839	10,390,100	0
G-48	0601 1715	32,778	3,868,944	0
N-08	0601 1510	603	423,000	0
N-14	0601 1619	1,652	1,319,800	0
N-16	0601 1238	585	386,900	0
N-18	0601 0844	384	384,000	0
N-20	0601 0844	1,071	1,032,500	0
N-24	0601 1334	891	666,900	0
N-28	0601 1103	991	780,000	0
M-08	0601 1715	118,475	18,399,400	0
M-10	0601 1716	168,406	23,486,908	0
M-12	0601 1715	11,395	3,593,700	0
M-16	0601 1716	146,122	21,761,200	0
S-08	0601 1716	114,881	17,731,080	0
S-14	0601 1706	6,380	1,862,350	0
S-16	0601 1710	18,152	3,955,050	0
S-18	0601 1603	1,302	785,850	0
S-20	0601 1553	2,163	216,300	0
S-24	0601 1602	1,446	420,000	0
S-28	0601 1713	14,087	2,887,500	0
DD PACK	0601 1715	35,033	6,296,586	0
SOT-223	0601 1648	13,316	5,006,464	0
TO-220	0601 1717	13,974	4,417,650	0
TO-3P	0601 1604	10,162	2,026,200	0
SOT-23	0601 1713	8,110	1,756,900	0
TSOT	0601 1716	226,372	33,183,740	0
SC70	0601 1715	29,097	4,218,372	0
TO-92(Z)	0601 1717	26,580	6,967,600	0
DFN ≤ 3X3	0601 1715	155,358	23,162,336	0
DFN > 3X3	0601 1714	87,854	14,176,288	0
QFN ≤ 3X3	0601 1710	30,141	5,404,200	0
QFN 4x4 ~ 7X7	0601 1716	236,208	50,188,732	0
QFN > 7X7	0601 1715	23,814	6,339,200	0
LGA*	0601 1643	87,959	62,715,470	0
BGA*	0601 1709	34,320	22,372,250	0
QFP	0601 1707	5,470	2,053,900	0
TOTAL		2,181,775	435,280,701	0

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 OF PACKAGES

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

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

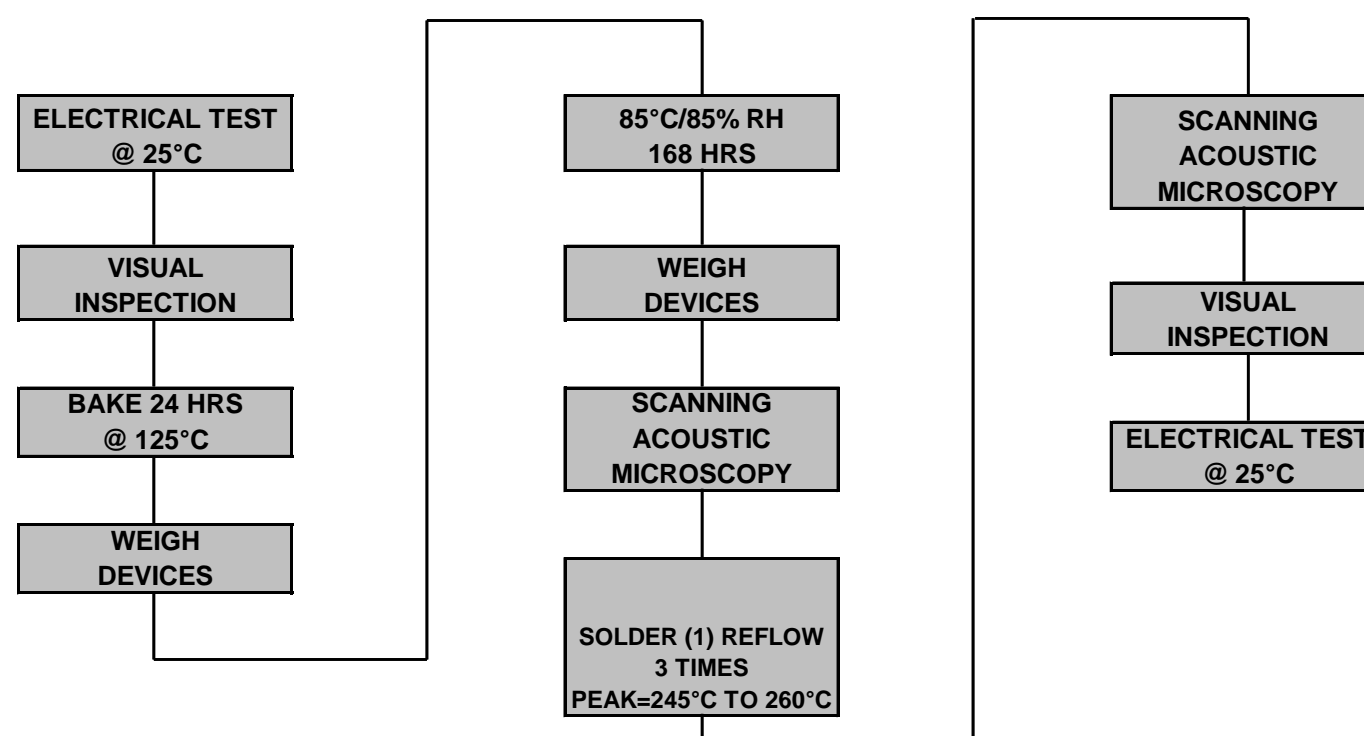
MOISTURE SENSITIVITY CLASSIFICATION TESTING

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. Click on site map, packaging information and then "MSL by package type."

RELIABILITY DATA
SURFACE MOUNT PRECONDITIONING per J-STD-020
June 2017

PACKAGE TYPE	DATE CODES		SAMPLE SIZE	# FAILURE
DD PACK	0601	1715	117,953	0
F-14	0601	924	524	0
F-16	0601	1713	279,404	0
F-20	0601	1716	133,552	0
F-24	0601	1712	46,311	0
F-28	0601	1714	67,959	0
F-38	0601	1715	23,929	0
F-48	0601	1547	7,638	0
G-16	0601	1714	166,376	0
G-20	0601	1605	25,198	0
G-24	0601	1711	69,763	0
G-28	0601	1716	516,631	0
G-36	0601	1714	70,453	0
G-44	0601	1714	244,307	0
G-48	0601	1715	102,552	0
N-08	0601	1621	13,633	0
N-14	0601	1619	7,788	0
N-16	0601	1707	3,257	0
N-18	0601	913	3,867	0
N-20	0601	1708	8,228	0
N-24	0601	1644	7,916	0
N-28	0601	1103	3,988	0
M-08	0601	1715	388,840	0
M-10	0601	1716	509,891	0
M-12	0601	1715	35,690	0
M-16	0601	1716	446,925	0
S-08	0601	1716	388,290	0
S-14	0601	1706	22,078	0
S-16	0601	1710	67,711	0
S-18	0601	1709	6,378	0
S-20	0601	1647	9,205	0
S-24	0601	1602	8,077	0
S-28	0601	1713	41,585	0
SOT-223	0601	1716	106,309	0
TO-220	0601	1717	57,555	0
TO-3P	0601	1604	35,241	0
SOT-23	0601	1713	16,194	0
TSOT	0601	1716	860,573	0
SC70	0601	1715	85,642	0
TO-92(Z)	0601	1717	104,996	0
DFN ≤ 3X3	0601	1715	471,247	0
DFN > 3X3	0601	1714	261,405	0
QFN ≤ 3X3	0601	1710	93,470	0
QFN 4x4 ~ 7X7	0601	1716	725,030	0
QFN > 7X7	0601	1715	72,144	0
BGA/LGA	0601	1715	374,649	0
QFP	0601	1713	19,802	0
TOTAL			7,130,154	

RELIABILITY DATA
TEST RESULT POST J-STD-020 PRECONDITIONING
June 2017

HAST 131°C/85%RH AFTER JEDEC PRECONDITIONING

PACKAGE TYPE	SAMPLE SIZE	DATE CODES	# OF DEVICE HRS @ 85°C (1)	# FAILURE
DD PAK	2,399	9204 - 1620	3,860,600	0
F-16	1,277	0702 - 1644	2,369,280	0
F-20	2,923	9326 - 1707	5,984,500	0
F-24	819	1552 - 1706	1,572,480	0
F-28	289	0127 - 1419	620,560	0
F-38	137	1010 - 1313	439,680	0
F-48	36	0917 - 0917	69,120	0
G-16	872	9724 - 1704	2,481,000	0
G-20	60	1634 - 1642	115,200	0
G-28	13,169	9232 - 1710	27,902,000	0
G-36	2,674	9602 - 1706	6,806,780	0
G-44	2,821	0831 - 1708	6,589,440	0
G-48	1,320	1304 - 1649	3,790,080	0
N-08	8,255	9205 - 1638	14,275,640	0
N-14	952	9226 - 9926	1,344,800	0
N-16	1,085	9207 - 9606	1,851,460	0
N-18	442	9213 - 0611	1,011,260	0
N-20	371	9217 - 9739	1,023,640	0
N-24	451	9213 - 9301	843,580	0
N-28	252	9234 - 9726	431,160	0
M-08	4,582	9726 - 1647	11,377,380	0
M-10	8,432	0801 - 1709	18,617,280	0
M-12	814	1220 - 1649	2,261,760	0
M-16	1,757	0743 - 1644	4,235,520	0
S-08	57,960	9201 - 1708	77,935,728	0
S-14	273	9448 - 9742	1,224,160	0
S-16	10,634	9210 - 1635	12,828,400	0
S-18	3,929	9215 - 1310	4,972,860	0
S-20	950	9202 - 0516	2,084,022	0
S-24	1,676	9202 - 1617	2,857,440	0
S-28	904	9208 - 0814	1,730,420	0
ST	2,294	9215 - 1503	5,313,440	0
S-03	98	9644 - 9644	499,800	0
S-05	2,063	9715 - 1708	6,966,160	0
S-06, SC6, & TS8	3,123	9943 - 1703	8,739,280	0
TO-220	3,697	9202 - 0809	7,101,040	0
TO-3P	862	9239 - 9913	1,796,215	0
TO-92(Z)	10,146	9201 - 0238	14,994,020	0
DFN ≤ 3X3	1,634	0238 - 1639	4,146,720	0
DFN ≥ 4X4	398	0710 - 1625	753,440	0
QFN ≤ 3X3	1,620	1421 - 1706	3,260,160	0
QFN 4x4 ~ 7X7	16,286	0111 - 1709	39,303,920	0
QFN > 7X7	1,370	0420 - 1613	3,457,340	0
LQFP	685	1315 - 1612	2,632,760	0
BGA / LGA	1,380	0647 - 1633	3,561,240	0
TOTAL	178,171		326,032,765	0

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

NOTE:

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

(2) Approximate duration is 96 hours.

**RELIABILITY DATA
 TEST RESULT POST J-STD-020 PRECONDITIONING
 June 2017**

AUTOCLAVE 15 PSIG 121C AFTER JEDEC PRECONDITIONING

PACKAGE TYPE	SAMPLE SIZE	DATE CODES		TOTAL # OF DEVICE HRS	# FAILURE
DD PACK	40,995	0601	1715	2,750,112	0
F-14	177	0601	0924	4,248	0
F-16	93,522	0601	1713	3,689,194	0
F-20	43,755	0601	1716	2,024,144	0
F-24	15,303	0601	1712	445,628	0
F-28	21,557	0601	1714	748,536	0
F-38	7,916	0601	1715	452,520	0
F-48	2,432	0601	1547	254,088	0
G-16	58,352	0601	1714	2,369,772	0
G-20	15,279	0601	1605	851,496	0
G-24	46,452	0601	1711	2,560,604	0
G-28	204,042	0601	1716	8,138,199	0
G-36	21,502	0601	1714	1,409,785	0
G-44	82,924	0601	1714	2,864,772	0
G-48	34,906	0601	1715	1,317,334	0
N-08	2,583	0601	1621	224,304	0
N-14	2,108	0601	1619	496,440	0
N-16	1,432	0601	1707	310,896	0
N-18	803	0601	0846	29,112	0
N-20	2,028	0601	1708	388,536	0
N-24	3,714	0601	1644	256,824	0
N-28	1,028	0601	1052	274,752	0
M-08	140,254	0601	1715	6,337,488	0
M-10	174,519	0601	1716	6,719,096	0
M-12	11,800	0601	1715	1,249,104	0
M-16	150,711	0601	1716	6,157,922	0
S-08	137,824	0601	1716	5,840,012	0
S-14	7,657	0601	1706	724,848	0
S-16	21,572	0601	1710	1,466,640	0
S-18	1,868	0601	1709	205,920	0
S-20	2,780	0601	1647	88,004	0
S-24	1,836	0601	1602	133,920	0
S-28	14,217	0601	1713	1,055,664	0
SOT-223	75,667	0601	1716	5,237,232	0
TSOT	420,387	0601	1716	18,987,103	0
SC70	29,131	0601	1715	1,162,872	0
TO-220	19,046	0601	1717	2,136,984	0
TO-3P	12,981	0601	1604	1,516,584	0
TO-92	52,075	0601	1717	2,852,128	0
DFN ≤ 3X3	161,930	0601	1715	7,471,526	0
DFN > 3X3	86,557	0601	1714	4,098,696	0
QFN ≤ 3X3	31,192	0601	1710	1,547,352	0
QFN 4x4 ~ 7X7	231,113	0601	1716	13,783,833	0
QFN > 7X7	22,639	0601	1715	1,459,396	0
QFP	7,377	0601	1713	1,055,402	0
LGA / BGA *	14,925	1209	1601	2,139,136	0
TOTAL	2,532,868			125,288,158	0

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	QFP

RELIABILITY DATA
TEMPERATURE CYCLE (AIR TO AIR) -65°C TO 150°C AFTER JEDEC PRECONDITION
June 2017

PACKAGE TYPE	SAMPLE SIZE	DATE CODES	TOTAL # OF DEVICE CYCLES	# FAILURE
F-14	149	0601 0924	14,900	0
F-16	91,673	0601 1713	14,654,982	0
F-20	46,888	0601 1716	9,022,909	0
F-24	15,594	0601 1712	2,240,500	0
F-28	23,394	0601 1714	3,246,200	0
F-38	8,314	0601 1714	1,994,500	0
F-48	2,575	0601 1547	737,200	0
G-16	53,007	0601 1714	7,923,500	0
G-20	5,968	0601 1605	1,329,500	0
G-24	12,025	0601 1637	2,949,900	0
G-28	160,380	0601 1716	24,104,052	0
G-36	24,912	0601 1714	7,532,400	0
G-44	79,544	0601 1714	10,685,700	0
G-48	34,868	0601 1714	5,034,600	0
N-08	10,447	0601 1510	2,850,100	0
N-14	4,028	0601 1619	2,656,200	0
N-16	1,240	0601 1650	89,430	0
N-18	2,680	0601 0913	1,021,300	0
N-20	5,129	0601 0919	1,764,100	0
N-24	3,311	0601 1334	1,074,000	0
N-28	1,969	0601 1103	985,500	0
M-08	130,111	0601 1715	21,588,850	0
M-10	166,966	0601 1716	26,896,900	0
M-12	12,495	0601 1715	6,003,100	0
M-16	150,092	0601 1716	25,918,052	0
S-08	135,585	0601 1716	22,114,800	0
S-14	8,041	0601 1706	2,341,300	0
S-16	27,987	0601 1710	6,330,300	0
S-18	3,208	0601 1603	2,192,800	0
S-20	4,262	0601 1553	426,200	0
S-24	4,795	0601 1602	823,300	0
S-28	13,281	0601 1713	3,011,300	0
DD PACK	41,925	0601 1715	8,200,850	0
SOT-223	17,326	0601 1716	8,392,100	0
TO-220	24,535	0601 1717	9,386,390	0
TO-3P	12,098	0601 1604	3,430,800	0
SOT-23	8,084	0601 1713	1,795,700	0
TSOT	213,814	0601 1716	36,338,200	0
SC70	27,414	0601 1715	3,287,700	0
TO-92(Z)	26,341	0601 1717	6,629,450	0
DFN ≤ 3X3	153,959	0601 1715	25,432,897	0
DFN > 3X3	86,994	0601 1714	15,362,122	0
QFN ≤ 3X3	32,137	0601 1710	6,949,500	0
QFN 4x4 ~ 7X7	257,709	0601 1716	63,084,392	0
QFN > 7X7	25,691	0601 1715	7,475,550	0
LGA*	165,490	0601 1715	78,859,948	0
BGA*	86,880	0601 1713	41,171,082	0
QFP	6,955	0601 1707	4,146,892	0
TOTAL	2,432,270		539,501,948	0

DD PACK = M, Q, R TO-3P = P PDIP = N TSOT = S3, S5, S6, TS8 SO-8/14/16/18/20/24/28 = S
 QFN/DFN = QF TO-92 = Z CERDIP = J SOT-223 = ST SSOP = G
 LGA = uModule TO-220 = T Sidebrazed = D MSOP = M8, M10, M12, M16 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
June 2017

PACKAGE TYPE	SAMPLE SIZE	DATE CODES	TOTAL # OF DEVICE CYCLES	# FAILURE
F-14	198	0601 0924	19,800	0
F-16	94,209	0601 1713	13,689,700	0
F-20	42,909	0601 1716	7,584,700	0
F-24	15,414	0601 1712	1,747,500	0
F-28	23,008	0601 1714	3,386,600	0
F-38	7,699	0601 1714	1,565,700	0
F-48	2,631	0601 1547	743,700	0
G-16	55,017	0601 1714	8,172,700	0
G-20	3,951	0601 1605	1,267,200	0
G-24	11,286	0601 1709	2,295,800	0
G-28	152,209	0601 1716	22,484,536	0
G-36	24,039	0601 1714	6,072,400	0
G-44	81,839	0601 1714	10,390,100	0
G-48	32,778	0601 1715	3,868,944	0
N-08	603	0601 1510	423,000	0
N-14	1,652	0601 1619	1,319,800	0
N-16	585	0601 1238	386,900	0
N-18	384	0601 0844	384,000	0
N-20	1,071	0601 0844	1,032,500	0
N-24	891	0601 1334	666,900	0
N-28	991	0601 1103	780,000	0
M-08	118,475	0601 1715	18,399,400	0
M-10	168,406	0601 1716	23,486,908	0
M-12	11,395	0601 1715	3,593,700	0
M-16	146,122	0601 1716	21,761,200	0
S-08	114,881	0601 1716	17,731,080	0
S-14	6,380	0601 1706	1,862,350	0
S-16	18,152	0601 1710	3,955,050	0
S-18	1,302	0601 1603	785,850	0
S-20	2,163	0601 1553	216,300	0
S-24	1,446	0601 1602	420,000	0
S-28	14,087	0601 1713	2,887,500	0
DD PACK	35,033	0601 1715	6,296,586	0
SOT-223	13,316	0601 1648	5,006,464	0
TO-220	13,974	0601 1717	4,417,650	0
TO-3P	10,162	0601 1604	2,026,200	0
SOT-23	8,110	0601 1713	1,756,900	0
TSOT	226,372	0601 1716	33,183,740	0
SC70	29,097	0601 1715	4,218,372	0
TO-92(Z)	26,580	0601 1717	6,967,600	0
DFN ≤ 3X3	155,358	0601 1715	23,162,336	0
DFN > 3X3	87,854	0601 1714	14,176,288	0
QFN ≤ 3X3	30,141	0601 1710	5,404,200	0
QFN 4x4 ~ 7X7	236,208	0601 1716	50,188,732	0
QFN > 7X7	23,814	0601 1715	6,339,200	0
LGA*	87,959	0601 1643	62,715,470	0
BGA*	34,320	0601 1709	22,372,250	0
QFP	5,470	0601 1707	2,053,900	0
TOTAL	2,179,941		433,667,706	0

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

ACCELERATED HIGH TEMPERATURE OPERATION LIFE (HTOL) TEST RESULT	
FIT Rate	0.09
Numbers of Total Failures	10
Total HTOL Sample Size from Q106 to Q117	437,665
Equivalent Device Hours at 55°C	125,130,059,250

- (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.