2018 Q1 Quarterly Reliability Report

Table of Contents

1. Introduction 3
2. Reliability Tests and Test Conditions 4
3. Reliability Data/Analysis 6
   - 3.1 The Exponential Distribution 6
   - 3.2 Failure Distributions 6
   - 3.3 Calculations of Failure Rates 8
4. Data Summaries by Process Technology 9
   - 4.1 S29CD-J, S29NS-J, S29PL-J, S71NS-J, S71PL-J Product Families 10
   - 4.2 S29AL-J, S29AS-J, S29JL-J Product Families 11
   - 4.3 S29GL-N, S29NS-N, S29PL-N, S29WS-N, S70PL-N, S71GL-N, S71NS-N, S71PL-N, S71WS-N Product Families 12
   - 4.4 S19FL-P, S25FL-P, S29GL-P, S29NS-P, S29WS-P, S70FL-P, S70GL-P, S71GL-P, S71NS-P, S71WS-P, S72NS-P Product Families 13
   - 4.5 S29GL-S, S25FL-S S25FS-S, S26KL-S, S26KS-S Product Families 14
   - 4.6 S29GL-T Product Families 15
   - 4.7 S25FL1-K, S25FL2-K Product Families 16
   - 4.8 S25FL-L Product Families 17
   - 4.9 S34ML-1 Product Families 18
   - 4.10 S34ML-1 Product Families 19
   - 4.11 S34ML-2 Product Families 20
   - 4.12 HSLS_USB (CY7C64713*, CY7C68013A*) Product Families 21
   - 4.13 ASYNC (CY7C1041D*) Product Families 22
   - 4.14 HRUSB (CYUSB3304*, CYUSB2302*) Product Families 23
   - 4.15 CLOCKS (CY29430F*) Product Families 24
   - 4.16 ASYNC (CY7C1061AV*, CY7C1041CV33*) Product Families 25
   - 4.17 ASYNC (CY62167DV30*) Product Families 26
   - 4.18 SPCM (CY7C144E*) Product Families 27
   - 4.19 SYNC (CY7C1380D*, CY7C1471BV33D*, CY7C1472BV33*, CY7C1480BV33*) Product Families 28
   - 4.20 ASYNC (CY62147EV30LL*, CY62146ESL*, CY62167EV18LL*, CY62167EV30LL*, CY62177EV30LL*) Product Families 29
   - 4.21 AUTOPSOC (CY8C21334*, CY8C21534*, CY8C29466*, CY8CTMA120); PSOC (CY8C4124*, CY8C4125*) Product Families 30
   - 4.22 NVSRAM (CY14B101*, CY14B104*, CY14B108L*, CY14B116L*, CY14V101LA*); AUTOPSOC (CY8C20236A*, CY8CTMA461*, CY8CTMA616*, CYAT81688*, CY8C4245*); PSOC (CY8C4124*, CY8C4125*, CY8C4127*,CY8C4128*, CY8C4147*,CY8C4245*, CY8C4146*, CY8C4248*); TYPE-C (CYPD21222*, CYPD21227*, CYPD21228*, CYPD3135*, CYPD3175,* CYPD4226*, CYPD5225*); TT (TT21100*, CYTT21403*, CYTT21402*, CYAT81688*, CYTMA445A*); WUSB (CYBL10161*,CYBL10162*,CYBL10563*, CYBL111712*,CYBL115732*); CLOCKS (CY27430FL*) Product Families 31
   - 4.23 F-RAM (CY15B064*, CY15B102N*, CY15B102Q7*, CY15B104Q7*, CY15B256*, CY15E064J*, FM24V107*, FM24CL64B7*, FM25V20A7*, FM25V01*, FM25V107*, FM28V202*) Product Families 32
   - 4.24 S6AXXXX, S6BXXXX Product Families 33
   - 4.25 S6J33X, S6J34X, S6J35X Product Families 34

4.26 S6J31X, S6J32X Product Families 35
4.27 S6E1XXX, S6E2XXX, MB9AFXXX, MB9BFXXX, MB9DFXXX, MB9EFXXX, MB91F52X Product Families 36
4.28 MB90FXXX, MB91FXXX, MB95F5XX, MB95F6XX Product Families 37
4.29 MB90F3XX, MB91F3XX, MB95F1XX Product Families 38
5. Data Summaries by Package Family 39
5.1 BGA (Ball Grid Array) 39
5.2 BGA (Ball Grid Array) – Flip Chip 39
5.3 DFN (Dual Flat no-leads) 39
5.4 DIP (Dual Flat no-leads) 39
5.5 LCC (Leaded Chip Carrier) 40
5.6 LGA (Land grid array) 40
5.7 QFN (Quad Flat no-leads) 40
5.8 QFP (Quad Flat Package) 40
5.9 SOJ (Small Outline J Lead) 40
5.10 SOP (Small Outline Gull Wing Lead Package) 41
5.11 SSOP (Shrink Small Outline Package) 41
5.12 TSOP (Thin Small Outline Package) 41
5.13 WLCSP (Wafer Level Chip Scale Package) 41

1. Introduction

Cypress's Reliability Monitor Program (RMP) is used to measure the reliability of all process technologies on a regular basis. This is an extensive effort that is aimed at providing generic fab process coverage for all fab process technologies.

The Reliability Monitor Program has two purposes:

1. Improved Reliability Performance

   Each reject is analyzed to its root cause in order to drive continuous improvement through the implementation of corrective actions.

2. Generation of Reliability Data

   RMP test results are used to assess the benefits of burn-in, provide estimates of typical lifetimes, model field applications, and determine suitability of plastic packaging in various temperature and humidity environments.

A number of process technology groupings are established for the purpose of reliability assessment. These groupings result in larger sample sizes so that the reliability analysis is statistically significant. Process similarity guidelines are used to define these process groupings.

Cypress Semiconductor has established aggressive reliability objectives. The quality standard at Cypress is zero defects, driven by a culture requiring continuous improvement in quality and reliability.

Product reliability is assured by a total quality management system. The quality management system is described in detail in Cypress Semiconductor Quality Manual. Key reliability related programs of the total quality management system are: (1) design rule review and approval; (2) control of raw materials and vendor quality; (3) manufacturing statistical process controls; (4) "Maverick Lot" yield limits; (5) formal training and certification of manufacturing personnel; (6) qualification of new products and manufacturing processes; (7) continuous reliability monitoring; (8) formal failure analysis and corrective action; and (9) competitive benchmarking.

Product Reliability data is accumulated as a result of new product qualification test plan activities as well as from the reliability monitor program. All reliability test samples are obtained from standard production material. Sample selection is based on generic product families. These generic products are designed with very similar design rules and manufactured from a core set of processes. Sampling of device is not limited to in-house Cypress facilities but also includes certified external subcontractor foundries.

Reliability strategy requires that every failure that occurs during reliability testing be subjected to failure analysis to determine the failure mechanism. Corrective action is then implemented to prevent future failures, resulting in continuous improvement in product reliability.

Sabbas Daniel

Executive Vice-President, Quality

2. Reliability Tests and Test Conditions

The results of the RMP testing for the past six quarters are summarized in this document. The stress tests employed and the typical test conditions used are shown in the Table 2.1.

Table 2.1 Reliability Monitor Stress Conditions

Stress	Ambient Condition	Typical Read Point
Early Life	150°C, 125°C	48, 96 hours
Inherent Life	150°C, 125°C	168, 408, 500, 1000 hours
Data Retention	150°C, 125°C	1000 hours
HAST	110°C, 85% RH	264 hours
	130°C, 85% RH	96 hours
Temperature Cycle	-40°C to 150°C (Condition M)	1000 cycles
	-55°C to 125°C (Condition B)	1000 cycles
	-65°C to 150°C (Condition C)	500 cycles
Unbiased HAST	110°C, 85% RH, no bias	264 hours
	130°C, 85% RH, no bias	96 hours
Pressure Cooker Test	121°C, 15 PSIG, no bias	96, 168 hours
High Temperature Storage	150°C, 125°C	1000 hours

Package level reliability testing refers to the assessment of the overall reliability of the device in packaged form. This consists of subjecting packaged samples to reliability tests that exposed the sample sets to different stress conditions, after which the samples are tested for any degradation.

At Cypress, plastic surface mount devices are pre-conditioned prior to undergoing Temperature Cycling, Pressure Cooker Test/Unbiased HAST, and HAST. Pre-conditioning per JEDEC Standard JESD22-A113 is required in order to simulate the stresses to which the packaged parts are subjected to during shipping, storage, board assembly and cleaning operations. Package reliability tests are performed as part of the qualification processes and as part of the standard reliability monitor program. The reliability test employed is chosen based on the failure mechanism, as different stress tests accelerate different failure mechanisms. These reliability tests utilize one or more of the following stress factors such as: temperature, moisture or humidity, voltage and pressure, to accelerate failure. Figure 2.1 shows Cypress package reliability stress flow. Packages are soaked and reflowed based on their shipping moisture sensitivity classification. The samples are tested (acoustic and electrical) after preconditioning, failures from which are considered as preconditioning failures and not reliability failures. Preconditioning failures should be taken seriously, since these imply that the samples are not robust enough to withstand the board mounting process.

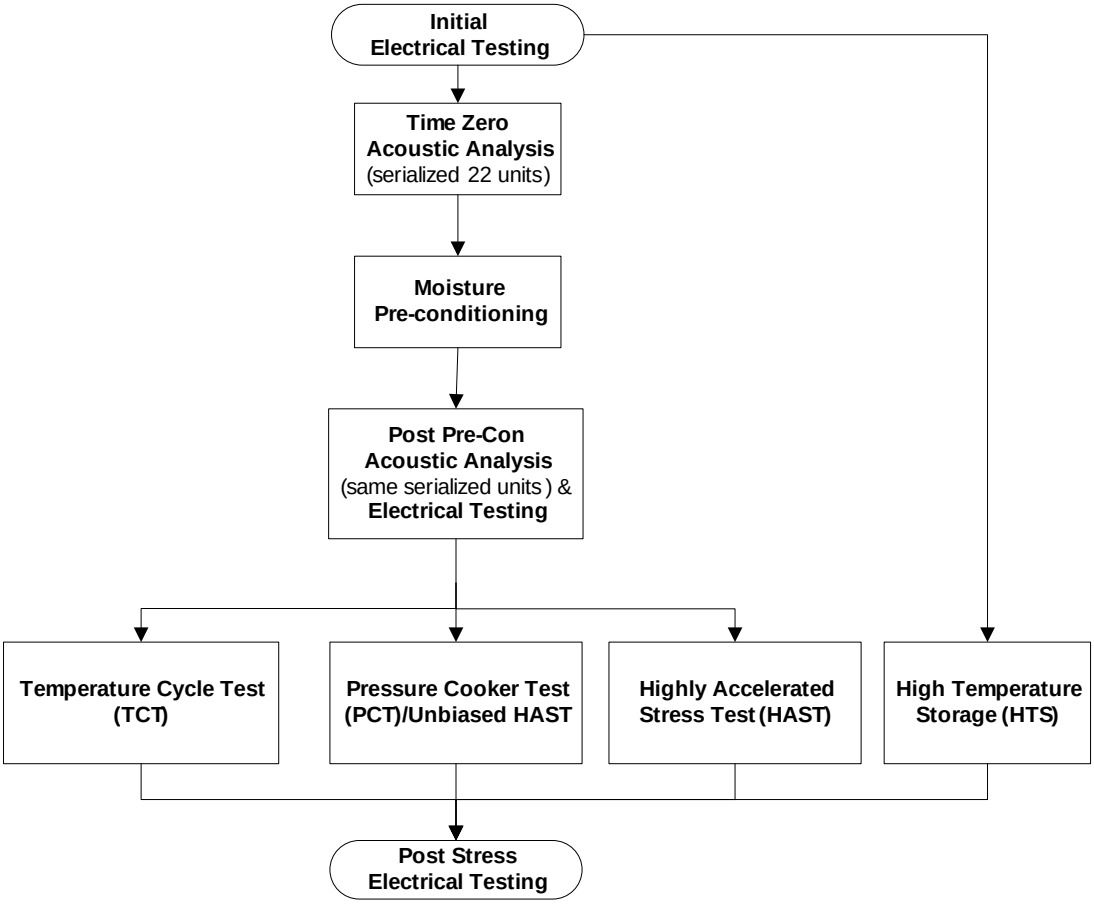


Figure 2.1 Cypress Package Reliability Stress Flow

3. Reliability Data/Analysis

The reliability data generated from the Reliability Monitor Program is presented in this section along with a detailed description of the modeling procedure used for estimating reliability under field conditions.
Also included is a summary of environmental stress results for each process technology grouping by package types.

3.1 The Exponential Distribution

The exponential distribution is simple to use, well understood and as valid as any for life tests with large sample sizes and few failures. No actual distribution can be implied as there is seldom enough data to determine one. The exponential distribution, characterized by a constant failure rate, is a special case of the Weibull. The average failure rate is the same as the instantaneous failure rate for the exponential distribution because the failure rate is constant.

The exponential distribution is the only one for which a MTTF (mean time to failure) value may easily be estimated and it is simply the reciprocal of the failure rate (λ). In addition, it is the only one for which a confidence level may be readily assigned to the failure rate calculation.

The conventional expression for the failure rate, λ, is

$$\lambda = \chi^2(2n + 2, 1 - \alpha) * 10^9 / (2 * SS * t * AF)$$

where λ is the failure rate in FITs (failures per billion unit-hours), $\chi^2(2n+2,1-\alpha)/2$ is the upper confidence value for "**n**" failures and upper confidence limit, (expressed as a decimal value), **SS** is the sample size, t is the test duration in hours, and **AF** is the acceleration factor relating the life test junction temperature to a assumed field junction temperature.

The χ^2(chi square) value for 2n+2 degrees of freedom and the probability, 1-α, can be obtained from a table or calculated using Microsoft® Excel chi squared inverse function [=CHIINV(1-α,2n+2)].

The best way to understand the concept of confidence levels is to consider this example. Assume that a life test on a 100-part sample from a certain product population had one failure and a 60% confidence level was desired. The chi square value corresponding to one failure at 60% confidence is 2.02. This means that one has a 60% confidence that the "true" value of the population's defect rate is between zero (or some very small value) and 2.02%.

3.2 Failure Distributions

The lognormal and Weibull CDF's are the distributions most often used to represent reliability failure mechanisms. The exponential distribution, characterized by a constant failure rate, is a special case of the Weibull. The lognormal distribution is specified by two parameters: T_{50}, the median time to failure, and sigma, the shape parameter. Similarly, the Weibull distribution, which can be written in closed form as

$$F(t) = 1 - \exp[-(t/c)^m],$$

is characterized by a characteristic life c and a shape parameter m. The value of the shape parameter determines whether the failure rate is increasing (m>1), decreasing (m<1), or constant (m=1). The exponential distribution, is specified completely by the one parameter c which is called the mean time to failure (MTTF). Figures 1 and 2 show failure rates for several values of the scale parameters of the lognormal and Weibull distributions, respectively.

$$F(t) = 1 - \exp[-(t/c)],$$

Figure 1. Lognormal Distribution

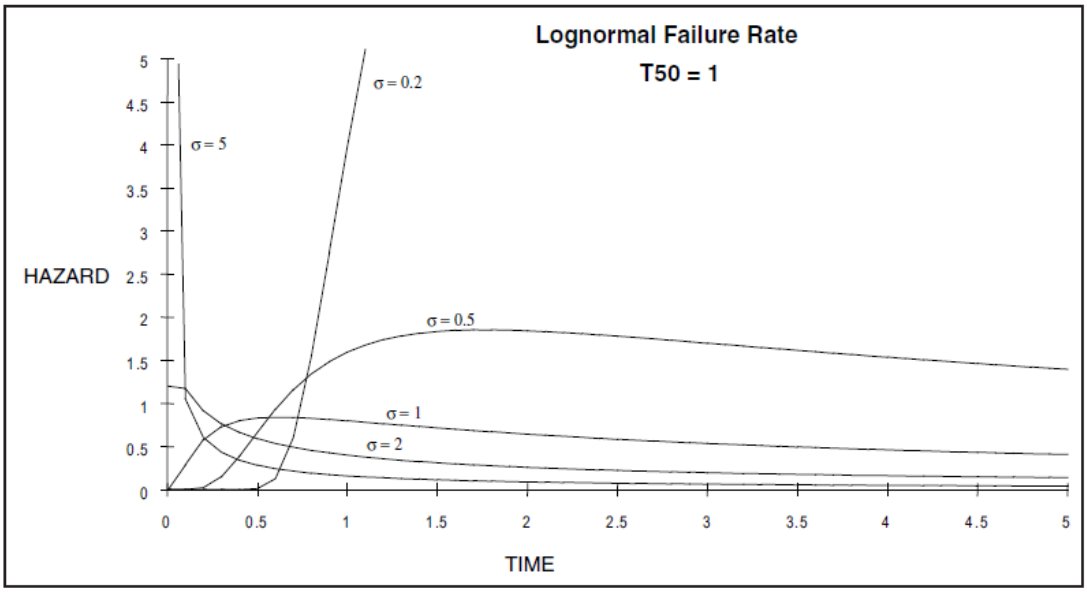
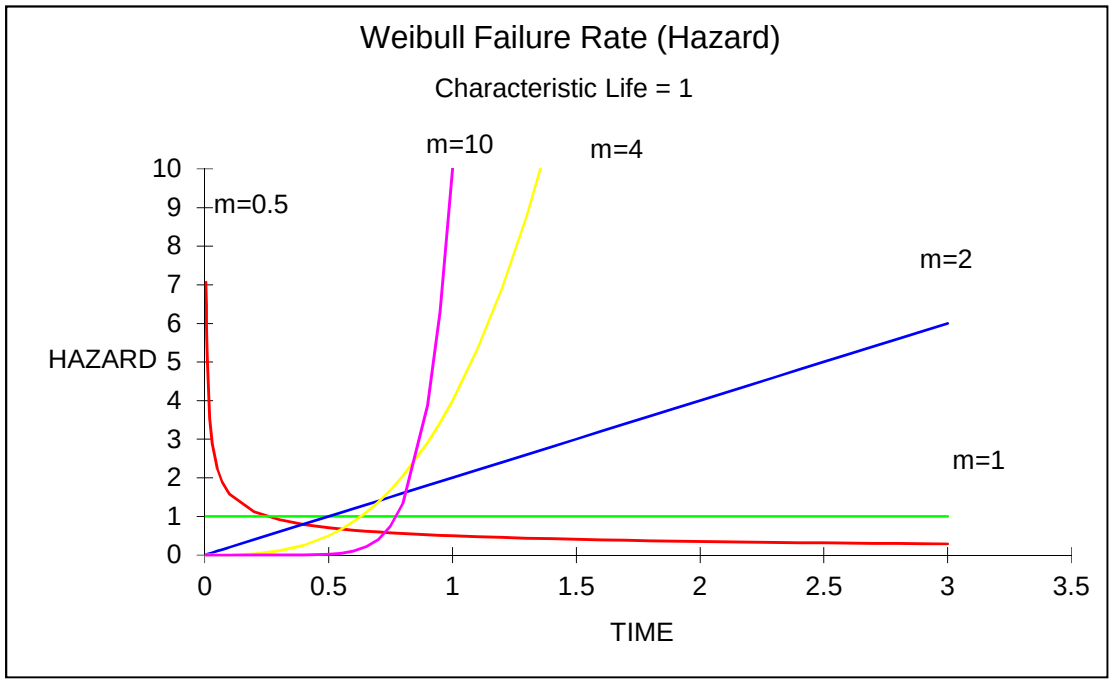


Figure 2. Weibull Distribution



3.3 Calculations of Failure Rates

To estimate field failure rates from reliability studies, many factors must be considered. One primary requirement is the identification of individual failure mechanisms in order to ascribe the failures to the proper categories used in the Cypress reliability model.

3.3.1 Considerations and Assumptions

1. Defective subpopulations and Early Life failures:

   In any production lot, a defective subpopulation may exist. These are devices that fail by a mechanism that is not common to the general population and is usually the result of some processing error or defect. These failures usually occur early and consequently called Early Life failures. Early life reliability is reported in terms of ppm defective expected during the first year of use under typical use conditions. No upper confidence bound will be used for this estimate. The ppm defective is the ration of the number of rejects to the number of samples and expressed in ppm.

   PPM = (Total Reject / Total samples) * 1,000,000

2. Inherent Life failures:

   Failures that occur in later life reliability are usually caused by mechanisms related to defects that could occur in any product of this type. These are known here as Inherent Life failures. Inherent life reliability is reported in using the exponential model, in terms of FITs (failures per billion unit-hours) with a 60% upper confidence bound for zero failure.

3. Estimation of thermal acceleration factors:

   The best-known activation energies for each mechanism are used in calculating the thermal acceleration using the standard Arrhenius equation for thermal acceleration. For each process group/ package combination, representative acceleration factors were estimated based on the weighted average of acceleration factors of individual devices in that group.

4. Voltage acceleration factor is not included in failure rate calculation even though voltage acceleration may be used during stress.

5. It is common in reliability literature to see failure rates stated at a specified level of confidence:

   For example, a 60% upper confidence limit on the failure rate indicates that unless a 4 in 10 chances (40%) has occurred, the true population failure rate is less than the stated limit. The summation of individual failure rate components, each at 60% confidence, will however, result in an overall failure rate at an unknown confidence level that may dramatically exceed 60%. The failure rates quoted in the Quarterly Reliability Report are at a 60% upper confidence level.

4. Data Summaries by Process Technology

Technology	Products Family	Inherent Life (FITS)
CS 69S, CS 69LS	S29CD-J, S29NS-J, S29PL-J, S71NS-J, S71PL-J Product Families	3
CS 69SS, CS 69LSS	S29AL-J, S29AS-J, S29JL-J Product Families	2
CS 119S, CS 119LS	S29GL-N, S29NS-N, S29PL-N, S29WS-N, S70PL-N, S71GL-N, S71NS-N, S71PL- N, S71WS-N Product Families	4
CS 129, CS 129L, CS 129AL	S19FL-P, S25FL-P, S29GL-P, S29NS-P, S29WS-P, S70FL-P, S70GL-P, S71GL-P, S71NS-P, S71WS-P, S72NS-P Product Families	3
CS 239LS	S29GL-S, S25FL-S S25FS-S, S26KL-S, S26KS-S Product Families	7
CS 340L	S29GL-T Product Families	19
90 nm SPI Floating Gate	S25FL1-K, S25FL2-K Product Families	3
65nm SPI Floating Gate	S25FL-L Product Families	20
48 nm SLC NAND	S34ML-1 Product Families	8
41 nm SLC NAND	S34ML-1 Product Families	7
32 nm SLC NAND	S34ML-2 Product Families	6
C8	HSLS_USB (CY7C64713*, CY7C68013A*) Product Families	**
C9	ASYNC (CY7C1041D*) Product Families	**
LL65	SYNC (CY7C1460K*); HRUSB (CYUSB3304*, CYUSB2302*) Product Families	21
LP55	CLOCKS (CY29430F*) Product Families	**
R7	ASYNC (CY7C1061AV*, CY7C1041CV33*) Product Families	**
R8	ASYNC (CY62167DV30*) Product Families	**
R42	SPCM (CY7C144E*)	**
R9	SYNC (CY7C1380D*, CY7C1471BV33D*) Product Families	26
R95	ASYNC (CY62147EV30LL*, CY62167EV18LL*, CY62167EV30LL*) Product Families	12
S4	AUTOPSOC (CY8C21334*, CY8C21534*, CY8C29466*, CY8CTMA120); PSOC (CY8C4124*, CY8C4125*) Product Families	20
S8	NVSRAM (CY14B101*, CY14B104*, CY14B108L*, CY14B116L*); AUTOPSOC (CY8C20236A*, CY8CTMA461* CY8CTMA616*, CYAT81688*, CY8C4245*); PSOC (CY8C3866A*, CY8C4124, CY8C4125*, CY8C4245* CY8C4146*, CY8C4246*, CY8C4248*); TYPE-C (CYPD21222*, CYPD21227*, CYPD21228*, CYPD21342*, CYPD3135*, CYPD4226*, CYPD5225); TT (TT21100*, CYTT21403*, CYTT21402*, CYAT81688*, CYTMA445A*); WUSB (CYBL10161*, CYBL10563*) Product Families	1
130nm TI F-RAM	F-RAM (CY15B064*, CY15B102N*, CY15B102Q7*, CY15B104Q7*, CY15B256*, CY15E064J*, FM24C16B7*, FM24V107*, FM24CL64B7*, FM25040B7*, FM25V20A7*, FM25V01*, FM25V107*, FM28V202*) Product Families	5
180nm PMICs	S6AXXXX, S6BXXXX Product Families	20
40 nm MCU (FLASH)	S6J33X, S6J34X Product Families	8
55nm MCU (FLASH)	S6J31X, S6J32X Product Families	**
90nm MCU (FLASH)	S6E1XXX, S6E2XXX, MB9AF11X, MB91F52X Product Families	8
180nm MCU (FLASH)	MB91F4XX, MB95F5XX, MB95F6XX Product Families	5
350 nm MCU (FLASH)	MB90F3XX, MB91F3XX, MB95F1XX Product Families	20

Note:

***Insufficient data – interpret as insufficient accumulated life-time hours to project a 60%confidence bound for a zero-fails sample.*

4.1 S29CD-J, S29NS-J, S29PL-J, S71NS-J, S71PL-J Product Families

CS 69S, CS 69LS

This 0.11 micron CMOS Flash technology was introduced in December 2003 and utilizes a tunnel oxide, polysilicon floating gate, silicided poly word line and interconnections are three metal layers with contact plugs and barrier metal.

Data Summary and Failure Rate Estimation using Exponential Model HTOL Stress Temperature - 150°C

Failure Mechanisms	Read Point / Test Result					Modeling Parameters @ 55°C					Average Failure Rate	
	Early Life (hrs)		Inherent Life (hrs)			Ea eV	TAF	VAF	OAF	MTTF (yrs)	Early Life (PPM)	Inherent Life (FITS)
	24	48	168	1000	2000							
Sample Size	1050	3800	4030	870	60							
150C, Zero fails, Process ave. Ea	0	0	0	0	0	0.7	217	1	217	34310	0	3

Data Retention Bake - 150°C

Reliability Stress	Sample Size	Reject	PPM	FITS
500	1001	0	0	<1
1000	1000	0	0	
2000	461	0	0	

4.2 S29AL-J, S29AS-J, S29JL-J Product Families

CS 69SS, CS 69LSS

This 0.11 micron CMOS Flash technology was introduced in February 2008 and utilizes a tunnel oxide, polysilicon floating gate, silicided poly word line and interconnections are three metal layers with contact plugs and barrier metal.

Data Summary and Failure Rate Estimation using Exponential Model HTOL Stress Temperature - 150°C

Failure Mechanisms	Read Point / Test Result				Modeling Parameters @ 55°C					Average Failure Rate	
	Early Life (hrs)	Inherent Life (hrs)			Ea eV	TAF	VAF	OAF	MTTF (yrs)	Early Life (PPM)	Inherent Life (FITS)
	48	168	1000	2000							
Sample Size	4550	3800	1352	80							
150C, Zero fails, Process ave. Ea	0	0	0	0	0.7	227	1	227	47032	0	2

Data Retention Bake - 150°C

Reliability Stress	Sample Size	Reject	PPM	FITS
500	1078	0	0	<1
1000	924	0	0	
2000	1077	0	0	

4.3 S29GL-N, S29NS-N, S29PL-N, S29WS-N, S70PL-N, S71GL-N, S71NS-N, S71PL-N, S71WS-N Product Families

CS 119S, CS 119LS

This 0.11 micron CMOS Flash technology was introduced in June 2004 and utilizes a tunnel oxide, Silicon Nitride (SiN) data storage layer, silicided poly word line and interconnections are three or four metal layers with contact plugs and barrier metal.

Data Summary and Failure Rate Estimation using Exponential Model HTOL Stress Temperature - 150°C

Failure Mechanisms	Read Point / Test Result				Modeling Parameters @ 55°C					Average Failure Rate	
	Early Life (hrs)	Inherent Life (hrs)			Ea eV	TAF	VAF	OAF	MTTF (yrs)	Early Life (PPM)	Inherent Life (FITS)
	48	168	1000	2000							
Sample Size	4800	4299	780	50							
150C, Zero fails, Process ave. Ea	0	0	0	0	0.7	196	1	196	29689	0	4

Data Retention Bake - 150°C

Reliability Stress	Sample Size	Reject	PPM	FITS
500	762	0	0	<1
1000	839	0	0	

4.4 S19FL-P, S25FL-P, S29GL-P, S29NS-P, S29WS-P, S70FL-P, S70GL-P, S71GL-P, S71NS-P, S71WS-P, S72NS-P Product Families

CS 129, CS 129L, CS 129AL

This 90 nanometer CMOS Flash technology was introduced in Aug 2006 and utilizes a tunnel oxide, Silicon Nitride (SiN) data storage layer, silicided poly word line and interconnections are three copper layers.

Data Summary and Failure Rate Estimation using Exponential Model HTOL Stress Temperature - 150°C

Failure Mechanisms	Read Point / Test Result			Modeling Parameters @ 55°C					Average Failure Rate	
	Early Life (hrs)	Inherent Life (hrs)		Ea eV	TAF	VAF	OAF	MTTF (yrs)	Early Life (PPM)	Inherent Life (FITS)
	48	168	1000							
Sample Size	4800	4997	1410							
150C, Zero fails, Process ave. Ea	0	0	0	0.7	188	1	188	41414	0	3

Data Retention Bake - 150°C

Reliability Stress	Sample Size	Reject	PPM	FITS
500	1078	0	0	<1
1000	1232	0	0	

4.5 S29GL-S, S25FL-S S25FS-S, S26KL-S, S26KS-S Product Families

CS 239LS

This 65 nm Mirror bit flash technology was introduced in September 2010 and utilizes a tunnel oxide, Silicon Nitride (SiN) data storage layer, silicided poly word line and interconnections are four metal layers with contact plugs and barrier metal.

Data Summary and Failure Rate Estimation using Exponential Model HTOL Stress Temperature - 125°C

Failure Mechanisms	Read Point / Test Result						Modeling Parameters @ 55°C					Average Failure Rate	
	Early Life (hrs)			Inherent Life (hrs)			Ea eV	TAF	VAF	OAF	MTTF (yrs)	Early Life (PPM)	Inherent Life (FITS)
	24	48	96	168	1000	2000							
Sample Size	280	3620	800	4486	1426	90							
125C, Zero fails, Process ave. Ea	0	0	0	0	0	0	0.7	69	1	69	15568	0	7

Data Retention Bake - 150°C

Reliability Stress	Sample Size	Reject	PPM	FITS
500	2836	0	0	<1
1000	2771	0	0	

4.6 S29GL-T Product Families

CS 340L

This 45nm Mirror bit flash technology was introduced in December 2015 and utilizes a tunnel oxide, Silicon Nitride(SiN) data storage layer, silicided poly word and interconnections are four metal layers with contact plu and five metal layers with contact plug and barrier metal.

Data Summary and Failure Rate Estimation using Exponential Model HTOL Stress Temperature - 125°C

Failure Mechanisms	Read Point / Test Result					Modeling Parameters @ 55°C					Average Failure Rate	
	Early Life (hrs)			Inherent Life (hrs)		Ea eV	TAF	VAF	OAF	MTTF (yrs)	Early Life (PPM)	Inherent Life (FITS)
	24	48	96	168	1000							
Sample Size	1050	2608	1000	3658	954							
125C, Zero fails, Process ave. Ea	0	0	0	0	0	0.7	40	1	40	6111	0	19

Data Retention Bake - 150°C

Reliability Stress	Sample Size	Reject	PPM	FITS
500	685	0	0	3
1000	607	0	0	

4.7 S25FL1-K, S25FL2-K Product Families

90 nm SPI Floating Gate

90 nm SPI (Serial Peripheral Interface) Floating Gate Flash Technology was introduced in May 2012 and utilizes tunnel oxide, polysilicon floating gate and interconnections are three metal layers with contact plugs and barrier metals.

Data Summary and Failure Rate Estimation using Exponential Model HTOL Stress Temperature - 150°C

Failure Mechanisms	Read Point / Test Result				Modeling Parameters @ 55°C					Average Failure Rate	
	Early Life (hrs)		Inherent Life (hrs)		Ea eV	TAF	VAF	OAF	MTTF (yrs)	Early Life (PPM)	Inherent Life (FITS)
	24	48	168	1000							
Sample Size	1100	3900	4393	1324							
150C, Zero fails, Process ave. Ea	0	0	0	0	0.7	208	1	208	42303	0	3

Data Retention Bake - 150°C

Reliability Stress	Sample Size	Reject	PPM	FITS
500	616	0	0	<1
1000	693	0	0	

4.8 S25FL-L Product Families

65 nm SPI Floating Gate

65nm SPI (Serial Peripheral Interface) Floating Gate Technology was introduced in August 2016 and utilizes tunnel oxide, polysilicon floating gate and interconnections are three metal layers with contact plugs and barrier metals.

Data Summary and Failure Rate Estimation using Exponential Model HTOL Stress Temperature - 150°C

Failure Mechanisms	Read Point / Test Result			Modeling Parameters @ 55°C					Average Failure Rate	
	Early Life (hrs)	Inherent Life (hrs)		Ea eV	TAF	VAF	OAF	MTTF (yrs)	Early Life (PPM)	Inherent Life (FITS)
	48	168	1000							
Sample Size	1120	119	220							
150C, Zero fails, Process ave. Ea	0	0	0	0.7	227	1	227		0	20
								5588		

Reliability Stress	Sample Size	Reject	PPM	FITS
500	154	0	0	1
1000	154	0	0	

4.9 S34ML-1 Product Families

48 nm SLC NAND

48 nm SLC NAND was introduced in July 2012 and utilize tunnel Oxide, Polysilicon floating gate and interconnections are three metal layers with contact plugs and barrier metals. The 1st Metal layer for 48 nm SLC NAND is using Tungsten.

Data Summary and Failure Rate Estimation using Exponential Model HTOL Stress Temperature - 125°C

Failure Mechanisms	Read Point / Test Result					Modeling Parameters @ 55°C					Average Failure Rate	
	Early Life (hrs)		Inherent Life (hrs)			Ea eV	TAF	VAF	OAF	MTTF (yrs)	Early Life (PPM)	Inherent Life (FITS)
	48	96	168	1000	2000							
Sample Size	2650	1000	4750	1170	50							
125C, Zero fails, Process ave. Ea	0	0	0	0	0	0.7	74	1	74	14725	0	8

Data Retention Bake - 150°C

Reliability Stress	Sample Size	Reject	PPM	FITS
500	608	0	0	1
1000	381	0	0	

4.10 S34ML-1 Product Families

41 nm SLC NAND

41 nm SLC NAND were introduced in Jun 2012 and utilize tunnel Oxide, Polysilicon floating gate and interconnections are three metal layers with contact plugs and barrier metals. The 1st Metal layer for 41 nm SLC NAND is using Copper.

Data Summary and Failure Rate Estimation using Exponential Model HTOL Stress Temperature - 125°C

Failure Mechanisms	Read Point / Test Result					Modeling Parameters @ 55°C					Average Failure Rate	
	Early Life (hrs)		Inherent Life (hrs)			Ea eV	TAF	VAF	OAF	MTTF (yrs)	Early Life (PPM)	Inherent Life (FITS)
	48	96	168	1000	2000							
Sample Size	3200	1000	4300	1384	150							
125C, Zero fails, Process ave. Ea	0	0	0	0	0	0.7	74	1	74	16795	0	7

Data Retention Bake - 150°C

Reliability Stress	Sample Size	Reject	PPM	FITS
500	1078	0	0	<1
1000	924	0	0	

4.11 S34ML-2 Product Families

32 nm SLC NAND

32 nm SLC NAND were introduced in October 2012 and utilize tunnel Oxide, Polysilicon floating gate and interconnections are three metal layers with contact plugs and barrier metals. The 1st Metal layer for 32 nm SLC NAND is using Copper

Data Summary and Failure Rate Estimation using Exponential Model HTOL Stress Temperature - 125°C

Failure Mechanisms	Read Point / Test Result						Modeling Parameters @ 55°C					Average Failure Rate	
	Early Life (hrs)			Inherent Life (hrs)			Ea eV	TAF	VAF	OAF	MTTF (yrs)	Early Life (PPM)	Inherent Life (FITS)
	24	48	96	168	1000	2000							
Sample Size	190	4137	810	4327	1560	150							
125C, Zero fails, Process ave. Ea	0	0	0	0	0	0	0.7	74	1	74	18178	0	6

Data Retention Bake - 150°C

Reliability Stress	Sample Size	Reject	PPM	FITS
500	1232	0	0	<1
1000	1386	0	0	

4.12 HSLS_USB (CY7C64713*, CY7C68013A*) Product Families

C8 Technology

Failure Mechanisms	Read Point / Test Result		Modeling Parameters @ 55°C					Average Failure Rate	
	Early Life (hrs)	Inherent Life (hrs)	Ea eV	TAF	VAF	OAF	MTTF (yrs)	Early Life (PPM)	Inherent Life (FITS)
	96	1000							
Sample Size	370	370							
125C, Zero fails, Process ave. Ea	0	0	0.7	55	1	55	2549	0	**

Note:

***Insufficient data – interpret as insufficient accumulated life-time hours to project a 60%confidence bound for a zero-fails sample.*

4.13 ASYNC (CY7C1041D*) Product Families

C9 Technology

Failure Mechanisms	Read Point / Test Result		Modeling Parameters @ 55°C					Average Failure Rate	
	Early Life (hrs)	Inherent Life (hrs)	Ea eV	TAF	VAF	OAF	MTTF (yrs)	Early Life (PPM)	Inherent Life (FITS)
	48	500							
Sample Size	152	152							
150C, Zero fails, Process ave. Ea	0	0	0.7	170	1	170	1608	0	**

Note:

***Insufficient data – interpret as insufficient accumulated life-time hours to project a 60%confidence bound for a zero-fails sample.*

4.14 HRUSB (CYUSB3304*, CYUSB2302*) Product Families

LL65 Technology

Failure Mechanisms	Read Point / Test Result		Modeling Parameters @ 55°C					Average Failure Rate	
	Early Life (hrs)	Inherent Life (hrs)	Ea eV	TAF	VAF	OAF	MTTF (yrs)	Early Life (PPM)	Inherent Life (FITS)
	71	770							
Sample Size	4200	503							
140C, Zero fails, Process ave. Ea	0	0	0.7	110	1	110		0	21
							5315		

4.15 CLOCKS (CY29430F*) Product Families

LP55 Technology

Failure Mechanisms	Read Point / Test Result		Modeling Parameters @ 55°C					Average Failure Rate	
	Early Life (hrs)	Inherent Life (hrs)	Ea eV	TAF	VAF	OAF	MTTF (yrs)	Early Life (PPM)	Inherent Life (FITS)
	96	1000							
Sample Size	5065	392							
125C, Zero fails, Process ave. Ea	0	0	0.7	55	1	55		0	**
							2701		

Note:

***Insufficient data – interpret as insufficient accumulated life-time hours to project a 60%confidence bound for a zero-fails sample.*

Data Retention Bake - 150°C

Reliability Stress	Sample Size	Reject	PPM	FITS
1000	239	0	0	23

4.16 ASYNC (CY7C1061AV*, CY7C1041CV33*) Product Families

R7 Technology

Failure Mechanisms	Read Point / Test Result			Modeling Parameters @ 55°C					Average Failure Rate	
	Early Life (hrs)	Inherent Life (hrs)		Ea eV	TAF	VAF	OAF	MTTF (yrs)	Early Life (PPM)	Inherent Life (FITS)
	48	408	500							
Sample Size	315	236	79							
150C, Zero fails, Process ave. Ea	0	0	0	0.7	170	1	170	2874	0	**

Note:

***Insufficient data – interpret as insufficient accumulated life-time hours to project a 60%confidence bound for a zero-fails sample.*

4.17 ASYNC (CY62167DV30*) Product Families

R8 Technology

Failure Mechanisms	Read Point / Test Result		Modeling Parameters @ 55°C					Average Failure Rate	
	Early Life (hrs)	Inherent Life (hrs)	Ea eV	TAF	VAF	OAF	MTTF (yrs)	Early Life (PPM)	Inherent Life (FITS)
	48	500							
Sample Size	231	231							
150C, Zero fails, Process ave. Ea	0	0	0.7	170	1	170	2444	0	**

Note:

***Insufficient data – interpret as insufficient accumulated life-time hours to project a 60%confidence bound for a zero-fails sample.*

4.18 SPCM (CY7C144E*) Product Families

R42 Technology

Failure Mechanisms	Read Point / Test Result		Modeling Parameters @ 55°C					Average Failure Rate	
	Early Life (hrs)	Inherent Life (hrs)	Ea eV	TAF	VAF	OAF	MTTF (yrs)	Early Life (PPM)	Inherent Life (FITS)
	96	1000							
Sample Size	233	233							
125C, Zero fails, Process ave. Ea	0	0	0.7	55	1	55	1605	0	**

Note:

***Insufficient data – interpret as insufficient accumulated life-time hours to project a 60%confidence bound for a zero-fails sample.*

4.19 SYNC (CY7C1380D*, CY7C1471BV33D*, CY7C1472BV33*, CY7C1480BV33*) Product Families

R9 Technology

Failure Mechanisms	Read Point / Test Result		Modeling Parameters @ 55°C					Average Failure Rate	
	Early Life (hrs)	Inherent Life (hrs)	Ea eV	TAF	VAF	OAF	MTTF (yrs)	Early Life (PPM)	Inherent Life (FITS)
	48	500							
Sample Size	412	412							
150C, Zero fails, Process ave. Ea	0	0	0.7	170	1	170	4360	0	26

4.20 ASYNC (CY62147EV30LL*, CY62146ESL*, CY62167EV18LL*, CY62167EV30LL*, CY62177EV30LL*) Product Families

R95 Technology

Failure Mechanisms	Read Point / Test Result					Modeling Parameters @ 55°C					Average Failure Rate	
	Early Life (hrs)		Inherent Life (hrs)			Ea eV	TAF	VAF	OAF	MTTF (yrs)	Early Life (PPM)	Inherent Life (FITS)
	48	96	408	500	1000							
Sample Size		76			76						0	12
125C, Zero fails, Process ave. Ea		0			0	0.7	55	1	55			
Sample Size	987		756	231								
150C, Zero fails, Process ave. Ea	0		0	0		0.7	170	1	170			
										9496		

4.21 AUTOPSOC (CY8C21334*, CY8C21534*, CY8C29466*, CY8CTMA120); PSOC (CY8C4124*, CY8C4125*) Product Families

S4 Technology

Failure Mechanisms	Read Point / Test Result			Modeling Parameters @ 55°C					Average Failure Rate	
	Early Life (hrs)	Inherent Life (hrs)		Ea eV	TAF	VAF	OAF	MTTF (yrs)	Early Life (PPM)	Inherent Life (FITS)
	96	408	1000							
Sample Size	759		240							
125C, Zero fails, Process ave. Ea	0		0	0.7	55	1	55			
Sample Size		463							0	20
150C, Zero fails, Process ave. Ea		0		0.7	170	1	170			
								5651		

Data Retention Bake - 150°C

Reliability Stress	Sample Size	Reject	PPM	FITS
1000	190	0	0	28

4.22 NVSRAM (CY14B101*, CY14B104*, CY14B108L*, CY14B116L*, CY14V101LA*); AUTOPSOC (CY8C20236A*, CY8CTMA461*, CY8CTMA616*, CYAT81688*, CY8C4245*); PSOC (CY8C4124*, CY8C4125*, CY8C4127*,CY8C4128*, CY8C4147*,CY8C4245*, CY8C4146*, CY8C4248*); TYPE-C (CYPD21222*, CYPD21227*, CYPD21228*, CYPD3135*, CYPD3175,* CYPD4226*, CYPD5225*); TT (TT21100*, CYTT21403*, CYTT21402*, CYAT81688*, CYTMA445A*); WUSB (CYBL10161*,CYBL10162*,CYBL10563*, CYBL111712*,CYBL115732*); CLOCKS (CY27430FL*) Product Families

S8 Technology

Failure Mechanisms	Read Point / Test Result					Modeling Parameters @ 55°C					Average Failure Rate	
	Early Life (hrs)		Inherent Life (hrs)			Ea eV	TAF	VAF	OAF	MTTF (yrs)	Early Life (PPM)	Inherent Life (FITS)
	48	96	408	500	1000							
Sample Size		5470			1161						9	1
125C, Zero fails, Process ave. Ea		0			0	0.7	55	1	55			
Sample Size	107829		1332	7904								
150C, Zero fails, Process ave. Ea	1*		0	0		0.7	170	1	170	103140		

Notes:

** 1u (Device: CYPD31357) - Gate Oxide Damage*

- CAR# 201704039 - CO2:Sparge in the develop rinse limits the incidence of surface charging and gate oxide damage

Data Retention Bake – 150°C

Reliability Stress	Sample Size	Reject	PPM	FITS
1000	1834	0	0	3

4.23 F-RAM (CY15B064*, CY15B102N*, CY15B102Q7*, CY15B104Q7*, CY15B256*, CY15E064J*, FM24V107*, FM24CL64B7*, FM25V20A7*, FM25V01*, FM25V107*, FM28V202*) Product Families

130nm TI F-RAM Technology

Failure Mechanisms	Read Point / Test Result		Modeling Parameters @ 55°C					Average Failure Rate	
	Early Life (hrs)	Inherent Life (hrs)	Ea eV	TAF	VAF	OAF	MTTF (yrs)	Early Life (PPM)	Inherent Life (FITS)
	96	1000							
Sample Size	86939	3016							
125C, Zero fails, Process ave. Ea	0	0	0.7	55	1	55	20779	0	5

Data Retention Bake – 125/150°C

Reliability Stress	Sample Size	Reject	PPM	FITS
1000 (125)	1309	0	0	<1
1000 (150)	700	0	0	

4.24 S6AXXXX, S6BXXXX Product Families

180 nm PMICs

Failure Mechanisms	Read Point / Test Result		Modeling Parameters @ 55°C					Average Failure Rate	
	Early Life (hrs)	Inherent Life (hrs)	Ea eV	TAF	VAF	OAF	MTTF (yrs)	Early Life (PPM)	Inherent Life (FITS)
	96	1000							
Sample Size	847	847							
125C, Zero fails, Process ave. Ea	0	0	0.7	55	1	55		0	20
							5835		

4.25 S6J33X, S6J34X, S6J35X Product Families

40 nm MCU (FLASH)

Failure Mechanisms	Read Point / Test Result				Modeling Parameters @ 55°C					Average Failure Rate	
	Early Life (hrs)	Inherent Life (hrs)			Ea eV	TAF	VAF	OAF	MTTF (yrs)	Early Life (PPM)	Inherent Life (FITS)
	96	168	500	1000							
Sample Size	2098	712	1458	2098							
125C, Zero fails, Process ave. Ea	0	0	0	0	0.7	55	1	55	14454	0	8

4.26 S6J31X, S6J32X Product Families

55 nm MCU (FLASH)

Failure Mechanisms	Read Point / Test Result			Modeling Parameters @ 55°C					Average Failure Rate	
	Early Life (hrs)	Inherent Life (hrs)		Ea eV	TAF	VAF	OAF	MTTF (yrs)	Early Life (PPM)	Inherent Life (FITS)
	96	500	1000							
Sample Size	384	77	384							
125C, Zero fails, Process ave. Ea	0	0	0	0.7	55	1	55	2546	0	**

Note:

***Insufficient data – interpret as insufficient accumulated life-time hours to project a 60%confidence bound for a zero-fails sample.*

4.27 S6E1XXX, S6E2XXX, MB9AFXXX, MB9BFXXX, MB9DFXXX, MB9EFXXX, MB91F52X Product Families

90 nm MCU (FLASH)

Failure Mechanisms	Read Point / Test Result			Modeling Parameters @ 55°C					Average Failure Rate	
	Early Life (hrs)	Inherent Life (hrs)		Ea eV	TAF	VAF	OAF	MTTF (yrs)	Early Life (PPM)	Inherent Life (FITS)
	96	500	1000							
Sample Size	2169	145	2024							
125C, Zero fails, Process ave. Ea	0	0	0	0.7	55	1	55	13944	0	8

4.28 MB90FXXX, MB91FXXX, MB95F5XX, MB95F6XX Product Families

180 nm MCU (FLASH)

Failure Mechanisms	Read Point / Test Result		Modeling Parameters @ 55°C					Average Failure Rate	
	Early Life (hrs)	Inherent Life (hrs)	Ea eV	TAF	VAF	OAF	MTTF (yrs)	Early Life (PPM)	Inherent Life (FITS)
	96	1000							
Sample Size	3199	3199							
125C, Zero fails, Process ave. Ea	0	0	0.7	55	1	55	22040	0	5

4.29 MB90F3XX, MB91F3XX, MB95F1XX Product Families

350 nm MCU (FLASH)

Failure Mechanisms	Read Point / Test Result			Modeling Parameters @ 55°C					Average Failure Rate	
	Early Life (hrs)	Inherent Life (hrs)		Ea eV	TAF	VAF	OAF	MTTF (yrs)	Early Life (PPM)	Inherent Life (FITS)
	96	500	1000							
Sample Size	837	762	836							
125C, Zero fails, Process ave. Ea	0	0	0	0.7	55	1	55	5760	0	20

5. Data Summaries by Package Family

5.1 BGA (Ball Grid Array)

Reliability Stress		Sample Size	Reject	Failure Rate PPM
HAST	96hrs	975	0	0
	264hrs	3352	0	0
High Temperature Storage	1000hrs	5825	0	0
Pressure Cooker Test	96hrs	339	0	0
	168hrs	408	0	0
Temperature Cycle	500cycle	1614	0	0
	1000cycle	7161	0	0
Unbiased HAST	96hrs	4351	0	0
	264hrs	3435	0	0

5.2 BGA (Ball Grid Array) – Flip Chip

Reliability Stress		Sample Size	Reject	Failure Rate PPM
High Temperature Storage	1000hrs	75	0	0
Temperature Cycle	1000cycle	80	0	0
Unbiased HAST	96hrs	100	0	0

5.3 DFN (Dual Flat no-leads)

Reliability Stress		Sample Size	Reject	Failure Rate PPM
HAST	96hrs	586	0	0
High Temperature Storage	1000hrs	873	0	0
Pressure Cooker Test	168hrs	250	0	0
Temperature Cycle	500cycle	808	0	0
	1000cycle	306	0	0
Unbiased HAST	96hrs	411	0	0

5.4 DIP (Dual Flat no-leads)

Reliability Stress		Sample Size	Reject	Failure Rate PPM
HAST	96hrs	110	0	0
High Temperature Storage	1000hrs	524	0	0
Pressure Cooker Test	168hrs	472	0	0
Temperature Cycle	500cycle	843	0	0
Unbiased HAST	96hrs	200	0	0

5.5 LCC (Leaded Chip Carrier)

Reliability Stress		Sample Size	Reject	Failure Rate PPM
High Temperature Storage	1000hrs	60	0	0
Pressure Cooker Test	168hrs	60	0	0
Temperature Cycle	500cycle	60	0	0

5.6 LGA (Land grid array)

Reliability Stress		Sample Size	Reject	Failure Rate PPM
High Temperature Storage	1000hrs	90	0	0
Temperature Cycle	1000cycle	462	0	0
Unbiased HAST	264hrs	462	0	0

5.7 QFN (Quad Flat no-leads)

Reliability Stress		Sample Size	Reject	Failure Rate PPM
HAST	96hrs	3971	0	0
High Temperature Storage	1000hrs	2392	0	0
Pressure Cooker Test	96hrs	1017	0	0
Temperature Cycle	500cycle	7785	0	0
	1000cycle	100	0	0
Unbiased HAST	96hrs	3178	0	0

5.8 QFP (Quad Flat Package)

Reliability Stress		Sample Size	Reject	Failure Rate PPM
HAST	96hrs	6954	0	0
	264hrs	75	0	0
High Temperature Storage	1000hrs	7038	0	0
Pressure Cooker Test	96hrs	978	0	0
	168hrs	1359	0	0
Temperature Cycle	500cycle	13316	0	0
	1000cycle	539	0	0
Unbiased HAST	96hrs	9556	0	0

5.9 SOJ (Small Outline J Lead)

Reliability Stress		Sample Size	Reject	Failure Rate PPM
HAST	96hrs	180	0	0
High Temperature Storage	1000hrs	180	0	0
Pressure Cooker Test	168hrs	180	0	0
Temperature Cycle	500cycle	208	0	0

5.10 SOP (Small Outline Gull Wing Lead Package)

Reliability Stress		Sample Size	Reject	Failure Rate PPM
HAST	96hrs	4450	0	0
	264hrs	231	0	0
High Temperature Storage	1000hrs	4082	0	0
Pressure Cooker Test	96hrs	1078	0	0
	168hrs	1437	0	0
Temperature Cycle	500cycle	3781	0	0
	1000cycle	1722	0	0
Unbiased HAST	96hrs	2357	0	0

5.11 SSOP (Shrink Small Outline Package)

Reliability Stress		Sample Size	Reject	Failure Rate PPM
HAST	96hrs	1588	0	0
High Temperature Storage	1000hrs	1020	0	0
Pressure Cooker Test	96hrs	1409	0	0
	168hrs	581	0	0
Temperature Cycle	500cycle	2219	0	0

5.12 TSOP (Thin Small Outline Package)

Reliability Stress		Sample Size	Reject	Failure Rate PPM
HAST	96hrs	5726	0	0
	264hrs	462	0	0
High Temperature Storage	1000hrs	6272	0	0
Pressure Cooker Test	96hrs	714	0	0
	168hrs	2816	0	0
Temperature Cycle	500cycle	5942	0	0
	1000cycle	3352	0	0
Unbiased HAST	96hrs	3176	0	0

5.13 WLCSP (Wafer Level Chip Scale Package)

Reliability Stress		Sample Size	Reject	Failure Rate PPM
HAST	264hrs	30	0	0
High Temperature Storage	1000hrs	644	0	0
Temperature Cycle	1000cycle	1402	0	0
Unbiased HAST	96hrs	2031	0	0
	264hrs	77	0	0

Document History Page

Document Title: 2018 Q1 QUARTERLY RELIABILITY REPORT
Document Number: 002-23547

Rev.	ECN No.	Orig. of Change	Description of Change
**	6122384	BHGO/ MLIE	Initial Spec Release