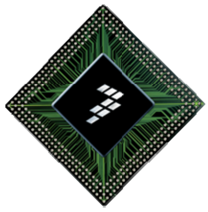
0.18µm S12XE/XS/P Family FIT and PPM Performance



Douglas Blackwood

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1. Summary

The FIT data represented below comprises of Qualification activity and ongoing Reliability Monitors used to make up generic data for the S12XE, S12XS, and S12P 0.18µm family. Materials represented in these calculations are from the same technology and process.

High Temperature Operational Life Data

Stress (Ta)	Read Point	Qty of Devices	Qty of Rejects	% Rejects
ELFR @ 125°C	48hrs	6409	0	0.00
HTOL @ 125°C	168hrs	1809	0	0.00
HTOL @ 125°C	504hrs	1327	0	0.00
HTOL @ 125°C	1008hrs	1327	0	0.00
HTOL @ 125°C	2016hrs	310	0	0.00
HTOL @ 125°C	3024hrs	310	0	0.00
HTOL @ 125°C	4032hrs	310	0	0.00
HTOL @ 125°C	5040hrs	226	0	0.00
HTOL @ 125°C	6048hrs	0	0	0.00

Current FIT data stands at **1.0 at 90%** confidence derated to 70°C Tj.

Common FIT Rates* based on 0.7eV

	Junction Temperature				
FIT	**25°C**	**55°C**	**70°C**	**125°C**	**150°C**
95%	0.04	0.4	1.3	33.8	112.7
90%	0.03	0.3	1.0	26.0	86.6
60%	0.01	0.1	0.4	10.3	34.5

(*See section 4 for detailed curves)

High Temperature Storage Data

Stress (Ta)	Read Point	Qty of Devices	Qty of Rejects	% Rejects
W/E @ 125°C or -40°C	Post Cycling	3004	0	0.00
Data Retention @ 150°C	1008hrs	4506	0	0.00
Data Retention @ 150°C	2016hrs	720	0	0.00

2. Description of Stress Tests

Early Life Fail Rate (ELFR) - JESD22-A108

125°C, 2.8V (core voltage, nominal 2.5V), 48hrs

The purpose of this stress is to characterise the early failure rate portion of the bathtub curve. Devices used in this test are sampled directly after the standard production final test flow with no pre-screening. A dynamic electrical bias is applied to stimulate the device during the test in much the same way as HTOL below.

High Temperature Operational Life test (HTOL) – JESD22-A108

125°C, 2.8V (core voltage, nominal 2.5V), 1008hrs minimum

To determine the constant failure rate of the product at the specified operating temperature (usually 70°C), by accelerating temperature and voltage-activated failure mechanisms to produce device failures.

A dynamic electrical bias is applied to stimulate the device during the life test. Microcontrollers are cycled through software routines, developed to stress the devices to simulate actual use, at elevated temperature and voltage. Reject quantities at the test temperature are modified by the Chi-squared distribution function at 90% confidence levels. The failure rates are then calculated and derated to the required temperature using the Arrhenius equation with a 0.7eV activation energy assumed as an average for the failure mechanisms. Further details are given in 'Calculation of Failure Rates'.

3. Calculation of Failure Rates

Life test is a technique for determining constant failure rate. To derate from the temperature at which the life test is carried out to the maximum operating temperature an acceleration factor is applied. This calculation uses the Arrhenius equation, with **0.7eV** assumed for the activation energy.

Temperature Acceleration Factor, **Aft = exp (θ/k (1/To - 1/Tt))**

Where: θ is activation energy (eV)
k is Boltzmann's constant (8.617 x 10 $^{-5}$ eV/K) (K = -273.16°C)
To = Ta (op) + (Pd x θja)
Tt = Ta (tst) + (Pd x θja)

And: Ta (op) is the ambient user operating temperature (K)
Ta (tst) is the ambient temperature on stress test (K)
Pd is power dissipated by the device (W)
θja is thermal resistance of the package (°C/W)

Rejects obtained in the sample must be modified at a stated confidence level to obtain the rejects which would occur were the entire population tested. This is done using the Chi-square distribution function.

Failure Rate, **Fa = Z / (2 x N x h x Aft)**

where: Z is Chi-square (χ2) reject quantity
N is number of devices on test
h is test duration (hours)

* Fa is multiplied by 10^9 to give the result in FITS (1 FIT = 1 failure in 10^9 device hours).
* Fa is multiplied by 10^5 for % per 1000 hours.

χ2 value Z, is derived from statistical tables using (2 x Qty. fails + 2) for the Degrees of Freedom:

Qty fails	60% confidence level χ2 qty	90% confidence level χ2 qty
0	1.833	4.605
1	4.045	7.779
2	6.211	10.645
3	8.351	13.362
4	10.473	15.987
5	12.584	18.549
6	14.685	21.064
7	16.780	23.542
8	18.868	25.989
9	20.951	28.412

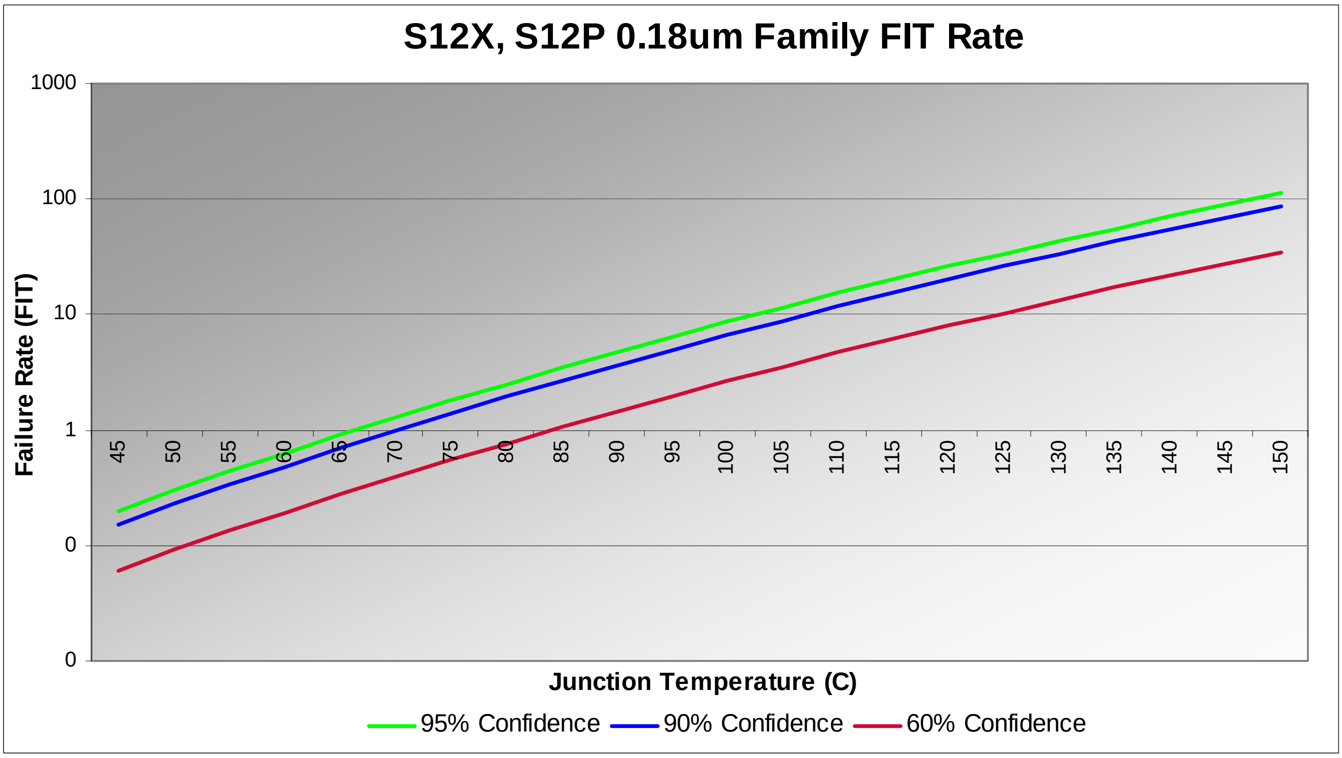
Voltage Acceleration is also taken into account when determining the life of devices. This is calculated by taking the oxide thickness into consideration and derating from the stress test voltage to the life operating voltage.

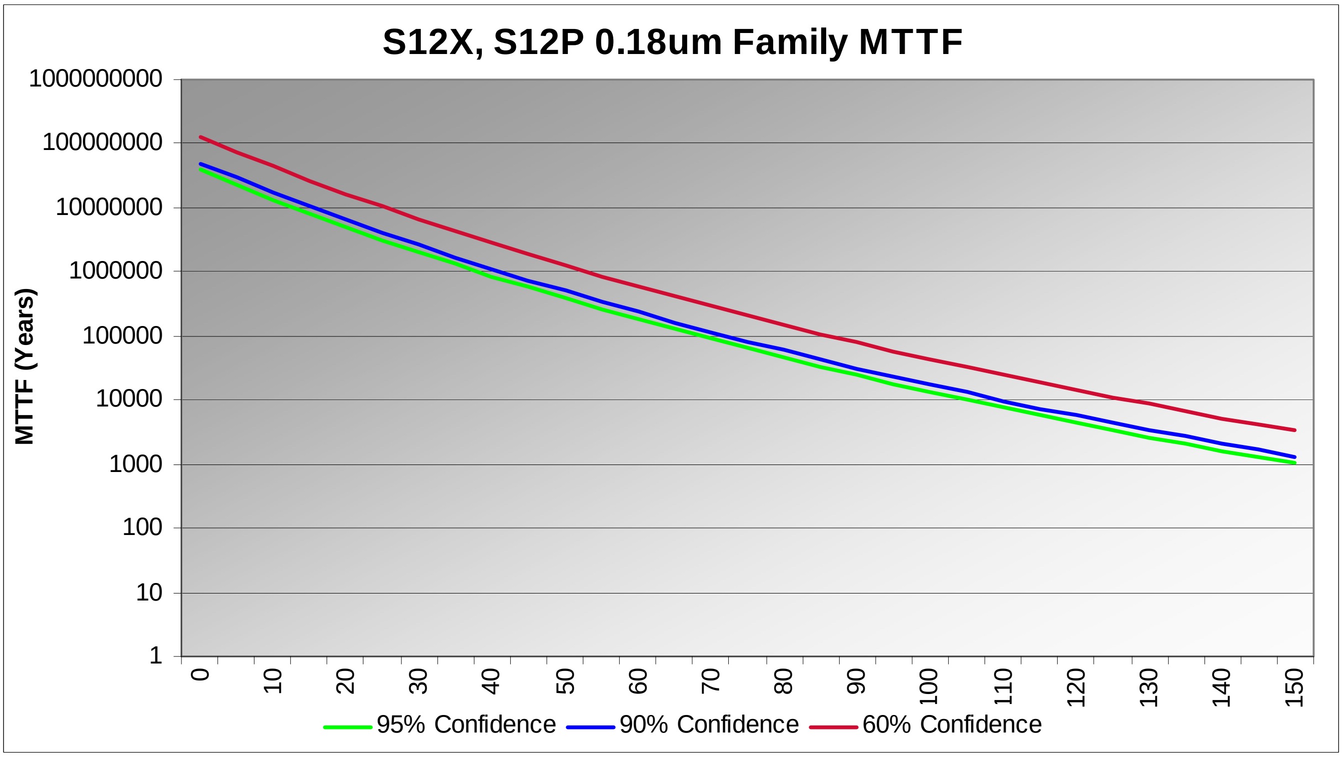
Voltage Acceleration Factor, **Afv = exp $^{\beta[Vt - V_O]}$**

Where:
Vo = Gate voltage under typical operating conditions (in Volts) *
Vt = Gate voltage under accelerated test conditions (in Volts) *
β = Voltage acceleration factor (in 1/Volts) **

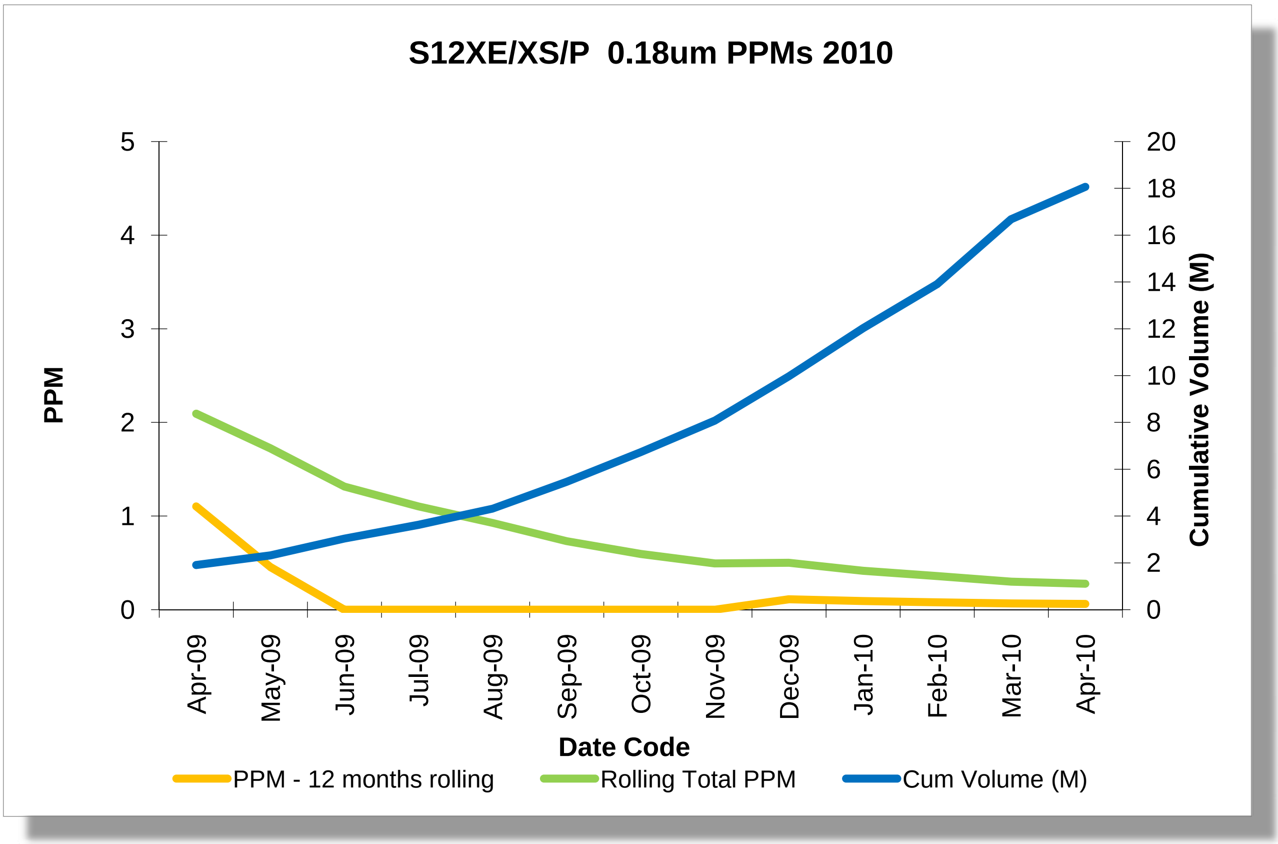
** For devices with dual gate oxide, the thin gate oxide voltages are applicable.*
*** Specified by technology in the Reliability Model document 68MWS00084B.*

4. 0.18µm Family FIT Curve Based on Generic Data





5. PPM History



Source: Freescale CQI Database

As of April 2010 the total lifetime ppm of this family stands at 0.3ppm, the 12 month rolling ppm stands at 0.1ppm.