C86TFS FIT Summary

SUMMARY

The FIT data represented below is comprised of recent qualification HTOL device-level stress data for the Kinetis Family C86TFS masksets manufactured in the **Global Foundries Fab7** facility . Materials represented in these calculations are from the same technology and processes. These values are measures of observed accelerated life stress data and do not constitute guarantees of future performance levels. See below for actual results and FIT/MTTF assessments.

High Temperature Operational Life – Global Foundries Fab7

STRESS	READ POINT	Qty of DEVICES	Qty of REJECTS	% REJECTS
Q221943-0N15J, 1.58 core/125C	168	240	0	0
Q223407-1N15J, 1.58 core/125C	168	80	0	0
Q230319-0N32P, 1.52V core/125C	168	79	0	0
Q227723-0N87M, 1.58V core/125C	192	80	0	0
Q226584-0N71K, 1.58V core/125C	192	160	0	0
Q226584-0N71K, 1.58V core/125C	24	80	0	0
Q225787-0N86K, 1.54V core/125C	192	80	0	0
Q226708-1N86K, 1.54V core/125C	192	80	0	0
Q225737-0N41J-2, 1.6V core/125C	264	80	0	0
Q225446- 0N41J-5, 1.6V core/125C	264	239	0	0
Q227084- 0N51M, 1.6V core/125C	264	79	0	0
Q233909-0N50M, 1.63V core/125C	1008	240	0	0
Q226519-0N50M, 1.63V core/125C	264	80	0	0
Q226520-0N74K, 1.63V core/125C	264	80	0	0
Q221591-0N03G, 1.558 core/125C	1008	240	0	0
Q222166-2N03G, 1.558 core/125C	14	80	0	0
Q225516-1N41K, 1.558 V core/125C	168	79	0	0
Q224185-0N83J, 1.558 V core/125C	1008	80	0	0
Q224185-0N83J, 1.558 V core/125C	1008	78	0	0
Q224185-0N83J, 1.558 V core/125C	1008	77	0	0
Q228983-2N73J, 1.65V core/125C	168	157	0	0
Q226024-0N73J, 1.65V core/125C	168	80	0	0
Q226024-0N73J, 1.65V core/125C	1008	80	0	0
Q226571-1N73J, 1.65V core/125C	1008	80	0	0
Q229693-0N65N, 1.65V core/125C	1008	80	0	0
Q224701-0N81H, 1.52V core/125C	240	80	0	0
Q232619-1N86P, 1.65V core/125C	300	240	0	0
Q234562-N16S, 1.65V core/125C	168	80	0	0
Q240492-N96T 1.65V core/125C	1008	80	0	0
Q239845-N96T 1.65V core/125C	1008	160	0	0
Q227839-N72K 1.65V core/125C	264	80	0	0
Q243779-0N41U 1.65V core/125C	1000	240	0	0

Q255085-1N41U 1.65V core/125C	1000	240	0	0
Q243380-0N69S 1.65V core/125C	1008	240	0	0
Q252318-3N69S 1.65V core/125C	336	80	0	0
Q254979-0N64Y 1.53V core/125C	1008	240	0	0
Q258360-0N64Y 1.53V core/125C	1008	240	0	0
Q255608-0N57Y 1.58V core/130C	1000	80	0	0
Q257795-0P06B 1.58V core/130C	1000	80	0	0

Note*: Stress data collected in the above table is from initial qualification studies and onwards*

FIT Rates are calculated for each die size using the above data:

N15J: Current FIT data stands at 0.14/0.3 FIT at 60%/90% Upper Confidence Limit at 55°C Tj constant duty cycle. Respective MTTF calculations are 837623/ 333323.

N32P: Current FIT data stands at 0.24/0.6 FIT at 60%/90% Upper Confidence Limit at 55°C Tj constant duty cycle. Respective MTTF calculations are 476130/ 189471.

N87M: Current FIT data stands at 0.13/0.3 FIT at 60%/90% Upper Confidence Limit at 55°C Tj constant duty cycle. Respective MTTF calculations are 911231/ 362615.

N71K: Current FIT data stands at 0.18/0.4 FIT at 60%/90% Upper Confidence Limit at 55°C Tj constant duty cycle. Respective MTTF calculations are 651948/ 259436.

N86K: Current FIT data stands at 0.08/0.2 FIT at 60%/90% Upper Confidence Limit at 55°C Tj constant duty cycle. Respective MTTF calculations are 1504695/ 598778.

N41J-2/N51M: Current FIT data stands at 0.26/0.6 FIT at 60%/90% Upper Confidence Limit at 55°C Tj constant duty cycle. Respective MTTF calculations are 441473/ 175679.

N41J-5/N50M: Current FIT data stands at 0.33/0.8 FIT at 60%/90% Upper Confidence Limit at 55°C Tj constant duty cycle. Respective MTTF calculations are 349453/ 139061.

N74K: Current FIT data stands at 0.21/0.5 FIT at 60%/90% Upper Confidence Limit at 55°C Tj constant duty cycle. Respective MTTF calculations are 535555/ 213118.

N03G/N41K: Current FIT data stands at 0.52/1.3 FIT at 60%/90% Upper Confidence Limit at 55°C Tj constant duty cycle. Respective MTTF calculations are 219126/ 87199.

N83J: Current FIT data stands at 0.61/1.5 FIT at 60%/90% Upper Confidence Limit at 55°C Tj constant duty cycle. Respective MTTF calculations are 187805/ 74735.

N65N/N73J: Current FIT data stands at 1.14/2.9 FIT at 60%/90% Upper Confidence Limit at 55°C Tj constant duty cycle. Respective MTTF calculations are 100261/ 39898.

N81H: Current FIT data stands at 0.12/0.3 FIT at 60%/90% Upper Confidence Limit at 55°C Tj constant duty cycle. Respective MTTF calculations are 982487/ 390971.

N86P: Current FIT data stands at 1.0/2.5 FIT at 60%/90% Upper Confidence Limit at 55°C Tj constant duty cycle. Respective MTTF calculations are 114409/ 45527.

N16S: Current FIT data stands at 0.57/1.4 FIT at 60%/90% Upper Confidence Limit at 55°C Tj constant duty cycle. Respective MTTF calculations are 200496/ 79785.

N96T: Current FIT data stands at 1.82/4.6 FIT at 60%/90% Upper Confidence Limit at 55°C Tj constant duty cycle. Respective MTTF calculations are 62585/ 24905.

N72K: Current FIT data stands at 0.27/0.7 FIT at 60%/90% Upper Confidence Limit at 55°C Tj constant duty cycle. Respective MTTF calculations are 427071/169948.

N41U: Current FIT data stands at 0.56/1.4 FIT at 60%/90% Upper Confidence Limit at 55°C Tj constant duty cycle. Respective MTTF calculations are 203690/ 81056.

N69S: Current FIT data stands at 1.31/3.3 FIT at 60%/90% Upper Confidence Limit at 55°C Tj constant duty cycle. Respective MTTF calculations are 87095/ 34658.

N64Y: Current FIT data stands at 0.27/0.7 FIT at 60%/90% Upper Confidence Limit at 55°C Tj constant duty cycle. Respective MTTF calculations are 430324/ 171243.

N57Y/P06B: Current FIT data stands at 0.66/1.7 FIT at 60%/90% Upper Confidence Limit at 55°C Tj constant duty cycle. Respective MTTF calculations are 172049/ 68465.

N03P: Current FIT data stands at 0.81/2.0 FIT at 60%/90% Upper Confidence Limit at 55°C Tj constant duty cycle, Respective MTTF calculations are 141571/ 56336.

N51R: Current FIT data stands at 0.45/1.1 FIT at 60%/90% Upper Confidence Limit at 55°C Tj constant duty cycle, Respective MTTF calculations are 251846/ 100219.

N63P: Current FIT data stands at 0.16/0.4 FIT at 60%/90% Upper Confidence Limit at 55°C Tj constant duty cycle, Respective MTTF calculations are 712711/ 283616.

N36M: Current FIT data stands at 0.21/0.5 FIT at 60%/90% Upper Confidence Limit at 55°C Tj constant duty cycle, Respective MTTF calculations are 535555/ 213118.

Please note; Larger die size results in higher FIT rates and lower MTTF values; therefore each mask calculation is provided above. Lower junction temperatures and duty cycles will result in lower FIT rates and higher MTTF value.

DESCRIPTION OF STRESS TEST

High Temperature Operational Life test (HTOL)

125°C, Stress Voltage Bias between 1.52 ~ 1.65 Volts

To determine the constant failure rate of the product at the specified operating temperature (usually 55-70°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 0.54 eV activation energy assumed as an average for the failure mechanisms. Further details are given in 'Calculation of Failure Rates'.

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 **0.54eV** 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 ($\chi 2$) 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.

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

Qty fails	60% confidence level $\chi 2$ qty	90% confidence level $\chi 2$ 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 docu*