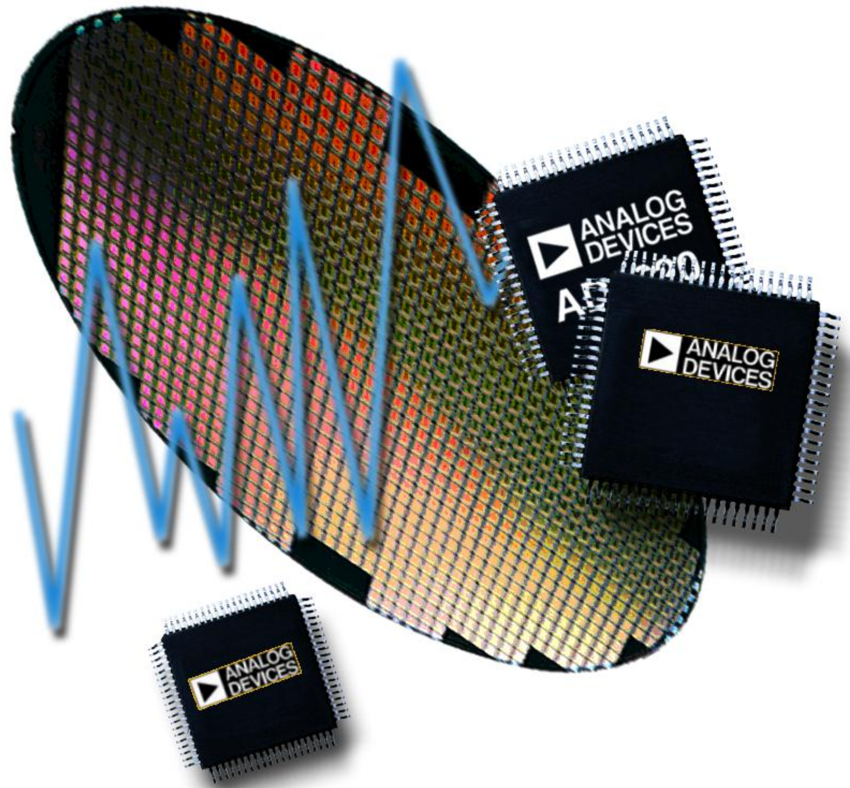
ANALOG DEVICES



FIT DATA

Process: ADIS16003 MCM

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Process FIT Data

The wafer fabrication processes represented in these MCM's have been fully characterized on the device/element level as well as on the product (I.C.) level. Samples of some of the many device types designed within these processes are continuously undergoing reliability evaluation as part of ADI Reliability Monitor Program. The FIT data and details on failure rate calculations are described below.

Failure Rate Calculation

Device failure rate during normal operating conditions may be estimated from the performance of the sample units during high temperature operating life test (HTOL). The MCM FIT rate therefore, can be estimated as the sum of the individual IC FIT rates. ***This method is based on the following assumption: The contribution to the overall MCM FIT from passive elements, simple transistors, PWB, mechanical hardware and solder connections is negligible and therefore not included in the calculation.***

The quantity of rejects obtained from the sample must be modified to reflect the likely quantity of rejects that would have been discovered had the whole population been life tested. This modification is achieved using the Chi-squared distribution function.

In order to relate the high stress temperature to a more normal equipment operating temperature, the Arrhenius relationship is used. The Arrhenius equation determines the amount of acceleration achieved by stress of the samples at evaluated temperature, activating the latent failure mechanisms. A key factor in the equation is the value of activation energy used to simulate the acceleration and results are quoted based on the industry standard value of 0.7 eV.

The temperature acceleration factor, T_{acc} is defined as:

$$T_{acc} = exp[(E_a/k)*(1/T_a - 1/T)]$$

Symbol	Definition	Value	Units
E_a	Activation energy	0.7	eV
k	Boltzmann's constant	8.62×10^{-5}	eV/K
T	Accelerated operating temperature		K
T_a	Ambient operating temperature		K

The failure rate is then given by:

$$\lambda_{CL} = \chi^2_{\%CL,2f+2}/(2NHT_{acc})$$

Symbol	Definition
N	Number of devices tested
T_{acc}	Temperature acceleration factor
χ^2	Chi-square function
H	Number of hours completed during the test
λ_{CL}	Failure rate
CL	Confidence level
f	Number of failures

Finally, to convert this failure rate to FITs, the result must be multiplied by 10^9 (1 FIT = 1 failure in 10^9 device-hours). The corresponding Mean Time To Failure (MTTF) in hours can be obtained by dividing 10^9 by the failure rate in FITs.

Chi-square (χ^2) values for 60% and 90% confidence intervals for up to 12 failures are shown below.

Chi-Square Table

# of Failures	χ^2 at 60% Confidence Level	χ^2 at 90% Confidence Level
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
10	23.031	30.813
11	25.106	33.196
12	27.179	35.563
13	29.249	37.916
14	31.316	40.256
15	33.381	42.585
16	35.444	44.903
17	37.505	47.212
18	39.564	49.512
19	41.622	51.805
20	43.678	54.090

Note: This calculation will yield artificially high FIT rates when the sample sizes are low.

ANALOG DEVICES

ADIS16003 MCM FIT

Micromachines	
U3 FIT	
Number of Devices in Test	43500
Total No. of Failures	0
Equiv. Device Hours @ +55°C	8499650885
60% Confidence Level	
Equivalent FIT Rate @ +55°C	0.11
MTTF (hrs)	9276158078
90% Confidence Level	
Equivalent FIT Rate @ +55°C	0.27
MTTF (hrs)	3691359642
Number per MCM	1

0.6um CMOS	
U1 FIT	
Number of Devices in Test	43384
Total No. of Failures	0
Equiv. Device Hours @ +55°C	5335420397
60% Confidence Level	
Equivalent FIT Rate @ +55°C	0.17
MTTF (hrs)	5822851277
90% Confidence Level	
Equivalent FIT Rate @ +55°C	0.43
MTTF (hrs)	2317148762
Number per MCM	1

0.5um CMOS	
U2 FIT	
Number of Devices in Test	43384
Total No. of Failures	0
Equiv. Device Hours @ +55°C	5335420397
60% Confidence Level	
Equivalent FIT Rate @ +55°C	0.17
MTTF (hrs)	5822851277
90% Confidence Level	
Equivalent FIT Rate @ +55°C	0.43
MTTF (hrs)	2317148762
Number per MCM	1

ADIS16003 FIT	
60% Confidence Level	
Equivalent FIT Rate @ +55°C	0.45
90% Confidence Level	
Equivalent FIT Rate @ +55°C	1.13