Reliability Qualification Report

for

DDRII SDRAM with Pb/Halogen Free (Industrial)

(64M×16, 38nm SDRAM AS4C64M16D2A-25BIN)

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3.2. Life Test

The purpose of the Early Failure Rate (EFR) is to estimate the infant mortality failure rate that occurs within the first year of normal device operation by accelerating infant mortality failure mechanisms. The oven temperature for the EFR test is 125°C. Testing is performed with dynamic signals applied to the device, and the voltage is 1.2*Vint.

The purpose of the Operating Life Test (OLT) is to determine the reliability of products by accelerating thermally activated failure mechanisms by subjecting samples to extreme temperatures under biased operating condition of 1.1*Vint. The test is used to predict long-term failure rates in terms of FITs (failures in time), with one FIT representing one failure in 10^9 device-hours. The test samples are screened directly after final electrical testing. The oven temperature for the OLT is 125°C. Testing is performed with dynamic signals applied to the device, and the voltage is 1.1*Vint.

3.2.1. Test Flow

(1) EFR Test Flow

B/I 12Hrs (125°C, 1.2*Vint) → Electrical Test (95°C, 25°C, -40°C)

(2) OLT Test Flow

B/I 168Hrs (125°C, 1.1*Vint) → Electrical Test (95°C, 25°C, -40°C)
→ B/I 500Hrs (125°C, 1.1*Vint) → Electrical Test (95°C, 25°C, -40°C)
→ B/I 1000Hrs (125°C, 1.1*Vint) → Electrical Test (95°C, 25°C, -40°C)

3.2.2. Test Criteria

Test Item	Reference Standard	Test Condition	Prediction Duration	Pass Criteria
EFR 12Hrs	JESD22-A108	Vcc= 1.2*Vint Ta= 125°C	0 – 1 (Year)	≦1000 (DPM)
OLT 1000Hrs		Vcc= 1.1*Vint Ta= 125°C	1 – 10 (Year)	≦50 (FIT)

3.2.3. Failure Rate Calculation and Test Result

The life test is performed for the purpose of accelerating the probable electrical and physical weakness of devices subjected to the specified conditions over an extended time period.

By choosing the appropriate thermal activation energy (Ea), data taken at an elevated temperature can be translated to a lower standard operating temperature through the Arrhenius equation:

T(AF)= Exp [(Ea/k)*(1/Tn-1/Ts)]…(1)

where

T(AF)= Temperature Acceleration Factor

Tn= Normal Temperature in Absolute Temperature (K)

Ts= Stress Temperature in Absolute Temperature (K)

k= Boltzmann's Constant (8.62*10^-5 eV/K)

Ea= Thermal Activation Energy

By choosing the appropriate electrical field acceleration rate constant (Vf), data taken at an elevated voltage can be translated to a lower standard operating voltage through the Eyring model:

E(AF)= Exp [Vf*(Vs-Vn)]…(2)

where

E(AF)= Electrical Field Acceleration Factor

Vn= Normal Operating Voltage

Vs= Stress Operating Voltage

Vf= Electrical Field Acceleration Rate Constant

By combining the equation (1) & (2), the failure rate (λ) can be calculated by using the following equation:

λ(FIT)= [(Lamda of 60% CL) / (2*TDH*AF)]*10^9…(3)

where

λ= Failure Rate in FIT

AF= Acceleration Factor

= T(AF) * E(AF)

TDH= Total Device-Hours of the Test

= Device No. * Hour

Lamda of CL= 60% Confidence Level (Refer to the Following Table)

DF	Lamda
1	0.70
2	1.83
3	2.95
4	4.04
5	5.13
6	6.21
7	7.28
8	8.35
9	9.41
10	10.50

DF= 2 * (Failure No. + 1)

Therefore, from equation (3), we can get the FIT number for our OLT experiment. The MTBF can be also calculated from the reciprocal of the FIT rate multiplied by $10^{9.}$

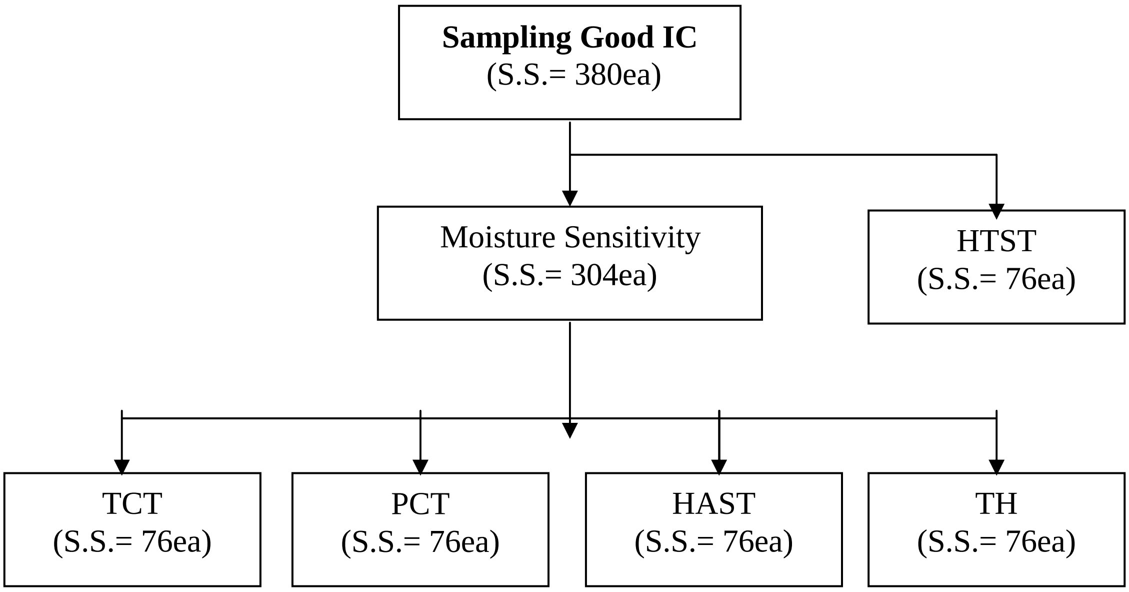
3.2.3.1. EFR Test Result

A summary of Early Failure Rate (EFR) data for the AS4C64M16D2A-25BIN is listed in Table 1, where the total of 1,000 devices at 125°C has been collected with 0 failure.

Test Item	Sample	Test Result (Failure / Sample Size)	Failure Mode
		12 Hrs	
EFR	1000ea	0/1000 [= 0 DPM]	N/A

Table 1. EFR Test Result for 0-1 Year Prediction

3.3.1. Test Flow



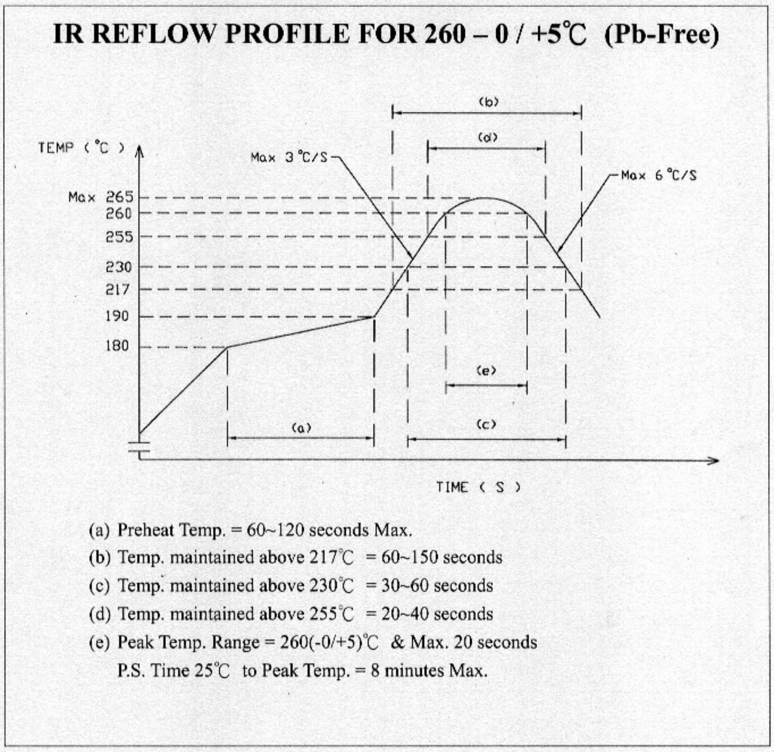
3.3.2. Test Condition and Time

3.3.2.1. Moisture Sensitivity Test

The purpose of moisture sensitivity test is to identify the classification level of nonhermetic solid state Surface Mount Devices (SMDs) that are sensitive to moisture-induced stress so that they can be properly packaged, stored, and handled to avoid subsequent thermal and mechanical damage during the assembly solder reflow attachment and/or repair operation.

***Moisture Sensitivity Test Flow**

Electrical Test → SAT → TC (-65℃~+150℃, 5Cycles) → Bake (125℃, 24Hrs) → Soak Level III (30℃, 60%R.H., 192Hrs) → Convection Reflow (260 +5/-0℃, 0~20Secs, 3Cycles) → Electrical Test → SAT

Test Item	Test Condition (Level III)	Test Time
Temp. Cycle	-65℃ ~ +150℃	5Cycles
Bake	125℃	24Hrs
Unbiased Temp-Humidity Soak	30℃, 60%R.H.	192Hrs
Convection Reflow	 IR REFLOW PROFILE FOR 260 – 0 / +5℃ (Pb-Free) (a) Preheat Temp. = 60~120 seconds Max. (b) Temp. maintained above 217℃ = 60~150 seconds (c) Temp. maintained above 230℃ = 30~60 seconds (d) Temp. maintained above 255℃ = 20~40 seconds (e) Peak Temp. Range = 260(-0/+5)℃ & Max. 20 seconds P.S. Time 25℃ to Peak Temp. = 8 minutes Max.	3Cycles

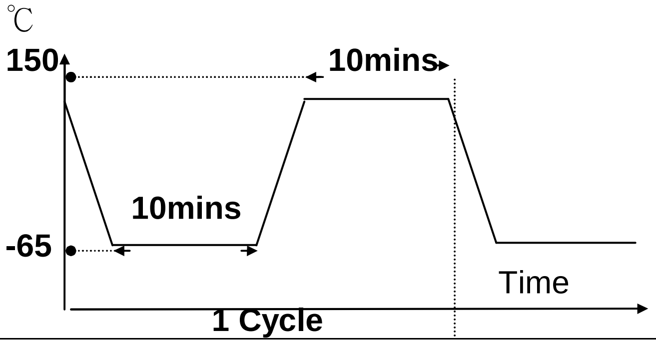
3.3.2.2. High-Temperature Storage Life Test

The high-temperature storage life test measures device resistance to a high-temperature environment that simulates a storage environment. The stress temperature is set to 150℃ in order to accelerate the effect of temperature on the test samples. In the test, no voltage bias is applied to the devices.

Test Item	Test Condition	Test Time
HTST	150℃	1000Hrs

3.3.2.3. Temperature Cycling Test

The purpose of temperature cycling test is to study the effect of thermal expansion mismatch among the different components within a specific die and package system. The cycling test system has a cold dwell at -65℃ and a hot dwell 150℃, and it employs a circulating air environment to ensure rapid stabilization at a specified temperature. During temperature cycling test, devices are inserted into the cycling test system and held at cold dwell for 10 minutes, then the devices are heated to hot dwell for 10 minutes. One cycle includes the duration at both extreme temperatures and the two transition times. The transition period is less than one minute at 25℃. Samples of surface mount devices must first undergo preconditioning and pass a final electrical test prior to the temperature cycling test.

Test Item	Test Condition	Test Time
TCT		500Cycles

3.3.2.4. Pressure Cooker Test

The pressure cooker test is an environmental test that measures device resistance to moisture penetration and the effect of galvanic corrosion. The stress conditions for the pressure cooker are 121℃, 100% relativity humidity, and 2.0atm pressure. Samples of surface mount devices are subjected to preconditioning and a final electrical test prior to the pressure cooker test.

Test Item	Test Condition	Test Time
PCT	121℃, 100%R.H., 2.0atm	96Hrs

3.3.2.5. Highly-Accelerated Temperature and Humidity Stress Test

The highly-accelerated temperature and humidity stress test is performed for the purpose of evaluating the reliability of nonhermetic packaged solid-state device in an environment with high humidity. It employs severe condition of temperature, humidity, and bias that accelerate the penetration of moisture through the external protective material (encapsulant or seal) or along the interface between the external protective material and the metallic conductor that pass through it. The stress conditions of the HAST are 130℃, 85% relativity humidity, 2.3atm pressure, and 1.9V maximum operating voltage. Samples of surface mount devices are subjected to preconditioning and a final electrical test prior to the highly-accelerated temperature and humidity stress test.

Test Item	Test Condition	Test Time
HAST	130℃, 85%R.H., 2.3atm, 1.9V	96Hrs

3.3.2.6. Steady State Temperature and Humidity Life Test

The temperature and humidity test is an environmental test designed to measure the corrosion and moisture resistance of plastic-encapsulated circuits. The stress conditions of the TH are 85℃ and 85% relativity humidity. Samples of surface mount devices are subjected to preconditioning and a final electrical test prior to the steady state temperature and humidity life test.

Test Item	Test Condition	Test Time
TH	85℃, 85%R.H.	1000Hrs