### 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 48Hrs (125°C, 1.2*Vint) → Electrical Test (105°C, 25°C, -40°C)

**(2) OLT Test Flow**

B/I 168Hrs (125°C, 1.1*Vint) → Electrical Test (105°C, 25°C, -40°C)
→ B/I 500Hrs (125°C, 1.1*Vint) → Electrical Test (105°C, 25°C, -40°C)
→ B/I 1000Hrs (125°C, 1.1*Vint) → Electrical Test (105°C, 25°C, -40°C)

#### 3.2.2. Test Criteria

| Test Item | Reference Standard | Test Condition | Prediction Duration | Pass Criteria |
|---|---|---|---|---|
| EFR 48Hrs | AEC Q100-008 | Vcc= 1.2*Vint<br>Ta= 125°C | 0 – 1 (Year) | ≦1000 (DPM) |
| OLT 1000Hrs | JESD22-A108 | Vcc= 1.1*Vint<br>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

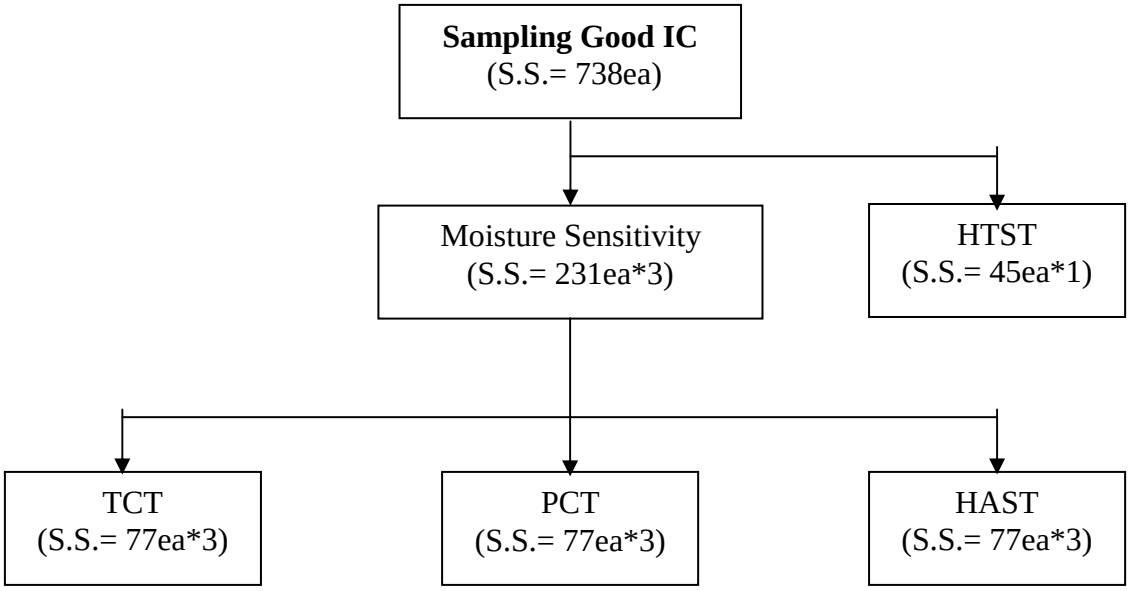
By combining the equation (1) & (2), the failure rate ( $\lambda$ ) can be calculated by using the following equation:

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

where

λ= Failure Rate in FIT

### 3.3.1. Test Flow



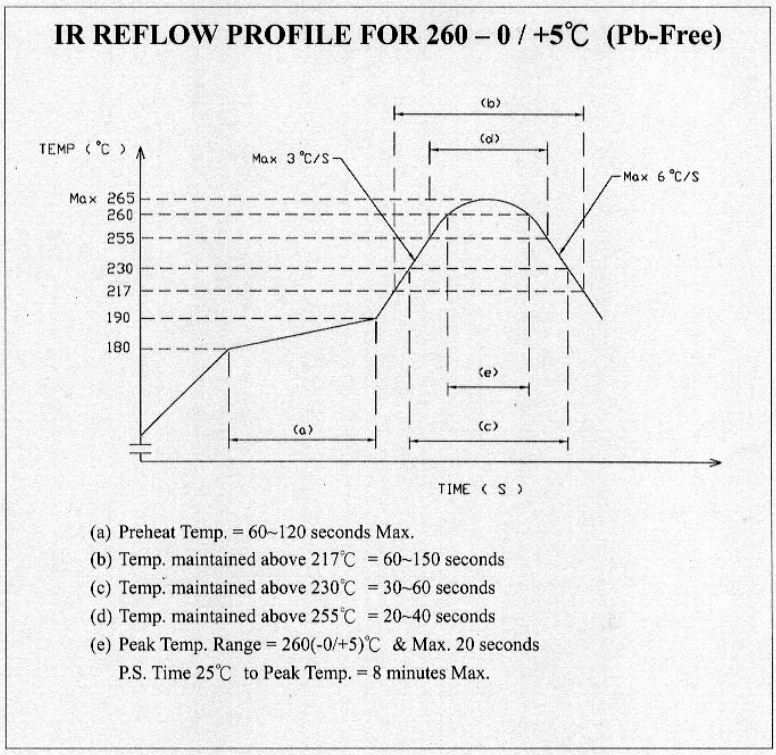

### 3.3.2. Test Condition and Time

#### 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 |  | 3Cycles |



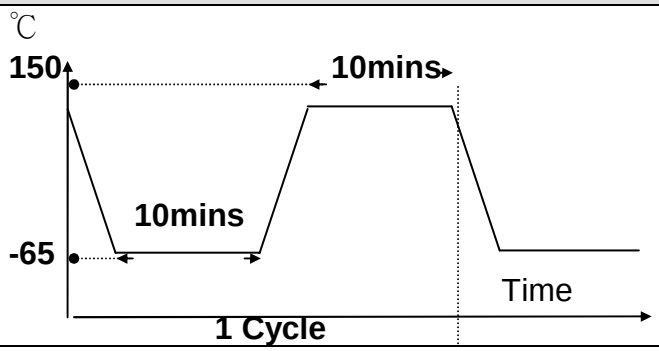
### 3.3.2.2. High-Temperature Storage Life Test

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.