Test Report

Test Name : MTBF Prediction

Report No. : 2013-MP-1122-1

Company : Suprema

Product : Finger print module

Model : SFU-slim(S20) V01A

Confirm	Written by Sun-Woo, Lee Assistant Manager	Confirmed by Hyuck-Ki, Lee Technical Manager

The result of this test report is applied for specimen which is given from applicant.
The test report must not be used for a publicty or a legal basis of other lawsuit.

Nov 22, 2013

IIRA Corp., CEO

Classification : Report	Reliability Prediction Report

The details of the system are as follows :

1. Date : 2013-11-22
2. Model : SFU-slim(S20) V01A
3. Quantity 1
4. Analyst : Suprema

5. Results

Name	Failure Rate	MTBF	Remark
SYSTEM	315.4168 Fits	3,170,408.02 Hours	361.92 years

* Fits(Failure Unit) = Failure Per Billion Hour(10^9)

Standard : Telcordia SR-332 - Reliability Prediction Procedure for Electronic Equipment Failure Distribution : Exponential Operating Temperature 40 °C Operating Stress : 50% (Voltage, Current, Power)

Reliability Prediction Report

Contents

I. Purpose

A reliability prediction is simply the analysis of parts and components in an effort to predict the rate at which an item will fail. A reliability prediction is one of the most common forms of reliability analyses. These predictions can help development engineers make decisions about component selection, stress levels and different designs.

II. Terms

1. MTBF (Mean Time Between Failure)

The average between failure occurrences. The sum of the operating time of a machine divided by the total number of failures.

2. MTTF (Mean Time To Failure)

A basic measure of system reliability for non-repairable items: The total number of life units of an item divided by the total number of failures within that population, during a particular measurement interval under stated conditions.

3. Failure

An event when machinery/equipment is not available to produce parts at specified conditions when scheduled or is not capable of producing parts or perform scheduled operations to specification. For every failure, an action is required.

4. Failure Rate

Number of failures per unit of gross operating period in terms of time, events, cycles, or number of parts.

5. Reliability

The probability that machinery/equipment can perform continuously, without failure, for a specified interval of time when operating under stated conditions.

6. Availability

A measure of the degree to which machinery/equipment is in an operable and committable state at any point in time. Specifically, the percent of time that machinery/equipment will be operable when needed.

III. Analysis Methods

1) Model : MIL-HDBK-217

This handbook contains two methods of reliability prediction such as Part Stress Analysis and part Count. These methods vary in degree of information needed to apply them

1-1) Part Stress Methods

Part Stress Analysis Methods requires a greater amount of detailed information and is applicable during the later design phase when actual hardware and circuits being designed.

1-2) Parts Count Methods

Parts Count Methods required less information, generally part quantities, quality level and the application environment. The Parts Count Methods will usally result in a more conservative estimate of system reliability than the Parts Stress Method.

1-3) equation for calculation

MIL-HDBK-217F Gate/Logic Arrays and Microprocessor Equations

$\lambda_P = (C_1 \pi_T + C_2 \pi_E) \pi_Q \pi_L$

where:

C_1 = Die Complexity Failure Rate

π_T = Temperature Factor

C_2 = Package Failure Rate

π_E = Environment Factor

π_Q = Quality Factor

π_L = Learning Factor

MIL-HDBK-217F Memories Equations

$\lambda_P = (C_1 \pi_T + C_2 \pi_E + \lambda_{CYC}) \pi_Q \pi_L$

where:

C_1 = Die Complexity Failure Rate

π_T = Temperature Factor

C_2 = Package Failure Rate

π_E = Environment Factor

λ_{CYC} = EEPROM Read/Write Cycling Induced Failure Rate

π_Q = Quality Factor

π_L = Learning Factor

MIL-HDBK-217F VHSIC/VHSIC-Like and VLSI CMOS Equations

$\lambda_P = \lambda_{BD} \pi_{MFG} \pi_T \pi_{CD} + \lambda_{BP} \pi_E \pi_Q \pi_{PT} + \lambda_{EOS}$

where:

λ_{BD} = Die Base Failure Rate

π_{MFG} = Manufacturing Process Correction Factor

π_T = Temperature Factor

π_{CD} = Die Complexity Correction Factor

λ_{BP} = Package Base Failure Rate

π_E = Environment Factor

π_Q = Quality Factor

π_{PT} = Package Type Correction Factor

λ_{EOS} = Electrical Overstress Failure Rate

MIL-HDBK-217F GaAs MMIC and Digital Devices Equations

$\lambda_P = (C_1 \pi_T \pi_A + C_2 \pi_E) \pi_L \pi_Q$

where:

C_1 = Die Complexity Failure Rate

π_T = Temperature Factor

π_A = Device Application Factor

C_2 = Package Failure Rate

π_E = Environment Factor

π_L = Learning Factor

π_Q = Quality Factor

Failure Rate(λ) = 1X10^6 Hours

MTBF=1/λ

2) Model : Bellcore(Telcordia) TR-332

The Bellcore reliability prediction model was originally developed by AT&T Bell Labs. Bell Labs modified the equations from MIL-HDBK-217 to better represent what their equipment was experiencing in the field. The main concepts between MIL-HDBK-217 and Bellcore were very similar, but Bellcore added the ability to take into account burn-in, field, and laboratory testing. This added ability has made the Bellcore standard very popular with commercial organizations.

The current versionof Telcordia is Issue 1, and follows Bellcore Issue 6 in order of release. Telcordia Issue 1 was released in May 2001.

Telcordia also supports the ability to perform a parts count or part stress analysis, but in Telcordia, these different calculations are referred to as Calculation Methods. Telcordia offers ten different Calculation Methods. Each of these Methods is designed to take into account different information. This information can include stress data, burn-in data, field data, or laboratory test data.

Failure Rate(λ) = 1X10^9 Hours (FITs)

MTBF = 1 / λ

Bellcore Method I - Case 1 Equations

Device Steady-State Failure rate = λ_{SSi}

$\lambda_{SSi} = \lambda_{Gi}\ \pi_{Qi}\ \pi_{Si}\ \pi_{Ti}$

where:

λ_{Gi} = Generic steady-state failure rate for the ith device

π_{Qi} = Quality Factor for the ith device

π_{Si} = Stress Factor = based on 50% stress (value of 1.0)

π_{Ti} = Temperature Factor = based on 40°C temperature(value of 1.(

Bellcore Method I - Case 2 Equations

Same as Method 1 - Case 1 above.

Bellcore Method I - Case 3 Equations

Device Steady-State Failure rate = λ_{SSi}

$\lambda_{SSi} = \lambda_{Gi}\ \pi_{Qi}\ \pi_{Si}\ \pi_{Ti}$

where:

λ_{Gi} = Generic steady-state failure rate for the ith device

π_{Qi} = Quality Factor for the ith device

π_{Si} = Stress Factor for the ith device

π_{Ti} = Temperature Factor for the ith device due to normal operating temperature during the steady state

Bellcore Method II Equations

Method II Equations are based on the same basic principles as Method I. The calculation of the Device Steady-State Failure rate (λ_{SSi}) is the same as Method I with the only difference being the possible calculation of λ_{Gi}. The basic equation is as follows:

$\lambda_{SSi} = \lambda_{Gi}\ \pi_{Qi}\ \pi_{Si}\ \pi_{Ti}$

where:

λ_{Gi} = Base steady-state failure rate for the ith device

π_{Qi} = Quality Factor for the ith device

π_{Si} = Stress Factor for the ith device

π_{Ti} = Temperature Factor for the ith device due to normal operating temperature during the steady state

The basis for the calculation of λGi i_s outlined below for each different case:

Bellcore Method II - Case L1 Equations

If $T_1 \le 10,000$, then:

$$\lambda_{Gi} = [2+n]/[(2/\lambda_{Gi})+(4x10^{-6})N_0(T_1)^{0.25}\pi_Q]$$

If $T_1 > 10,000$, then:

$$\lambda_{Gi} = [2+n]/[(2/\lambda_{Gi})+((3x10^{-5})+(T_1X10^{-9}))N_0\pi_Q]$$

where:

- n = The number of failures in the laboratory test
- λ_{Gi} = Generic steady–state failure rate for the ith device
- N_0 = Number of devices on test
- T_1 = Effective time on test in hours
- π_Q = Device Quality Factor

Bellcore Method II - Case L2 Equations

If $T_1 \le 10,000$, then:

$$\lambda_{Gi} = [2+n]/[(2/\lambda_G)+(4x10^{-6})N_0(T_1)^{0.25}]$$

If $T_1 > 10,000$, then:

$$\lambda_{Gi} = [2+n]/[(2/\lambda_G)+((3x10^{-5})+(T_1X10^{-9}))N_0]$$

where:

- n = The number of failures in the laboratory test
- λ_G = Generic failure rate
- N_0 = Number of units on test
- T_1 = Effective time on test in hours

Bellcore Method II - Case L3 Equations

λ_{Gi} = $[2+n]/[(2/\lambda_{Gi})+(4x10^{-6})N_0 \; W \; \pi_Q]$

where:

- n = The number of failures in the laboratory test
- λ_{Gi} = Generic steady–state failure rate for the ith device
- N_0 = Number of devices on test
- π_Q = Device Quality Factor
- W = Special time factor

If $T_1 + T_e \leq 10{,}000$, then: $W = (T_1 + T_e)^{0.25} - T_e^{0.25}$

If $T_1 + T_e > 10{,}000 \geq T_e$, then:

$W = ((T_1 + T_e) / 4000) + 7.5 - T_e^{0.25}$

If $T_e > 10{,}000$, then: $W = T_1 / 4000$

where:

- T_1 = The effective time on test
- T_e = Total effective burn–in time for devices as defined:
  - $T_e = A_{b,d} \; t_{b,d}$
  - where:
    - $A_{b,d}$ = temperature acceleration factor due to device burn–in
    - $t_{b,d}$ = device burn–in time (hours)
- N_0 = Number of devices on test
- π_Q = Device Quality Factor
- W = Special time factor

Bellcore Method II - Case L4 Equations

λ_{Gi} = $[2+n]/[(2/\lambda_{Gi})+(4x10^{-6})N_0\ W]$

where:

- n = The number of failures in the laboratory test
- λ_{Gi} = Generic steady–state failure rate for the ith device
- N_0 = Number of devices on test
- W = Special time factor

If $T_1 + T_e \leq 10{,}000$, then: $W = (T_1 + T_e)^{0.25} - T_e^{0.25}$

If $T_1 + T_e > 10{,}000 \geq T_e$, then:

$W = ((T_1 + T_e) / 4000) + 7.5 - T_e^{0.25}$

If $T_e > 10{,}000$, then: $W = T_1 / 4000$

where:

- T_1 = The effective time on test
- T_e = Total effective burn–in time for devices as defined:

  $T_e = T_{b,d} + A_{b,u}\ t_{b,u}$

  where:

  $T_{b,d}$ = average device effective burn–in time

  $A_{b,u}$ = temperature acceleration factor due to device burn–in

  $t_{b,u}$ = device burn–in time (hours)

- N_0 = Number of devices on test
- π_Q = Device Quality Factor
- W = Special time factor

Bellcore Method III Equations

Due to the complexity and detail of the calculations for Method III, the equations have not been included for reference here. Refer to the Bellcore [Reliability Prediction Procedure for Electronic Equipment] for all details regarding Method III equations.

RDF 2000

RDF 2000 is the new version of the CNET UTEC80810 reliability prediction standard that covers most of the same components as MIL-HDBK-217. The models take into account power on/off cycling as well as temperature cycling and are very complex with predictions for integrated circuits requiring information on equipment outside ambient and print circuit ambient temperatures, type of technology, number of transistors, year of manufacture, junction temperature, working time ratio, storage time ratio, thermal expansion characteristics, number of thermal cycles, thermal amplitude of variation, application of the device, as well as per transistor, technology related and package related base failure rates. As this standard becomes more widely used it could become the international successor to the US MIL-HDBK-217

NPRD-95 data

NPRD-95 data provides failure rates for a wide variety of items, including mechanical and electromechanical parts and assemblies. The document provides detailed failure rate data on over 25,000 parts for numerous part categoriesgrouped by environment and quality level. Because the data does not include time-to-failure, the document is forced to report average failure rates to account for both defects and wearout. Cumulatively, the database represents approximately 2.5 trillion part hours and 387,000 failures accumulated from the early 1970's through 1994. The environments addressed include the same ones covered by MIL-HDBK-217; however, data is often very limited for some environment and specific part types. For these cases, it then becomes necessary to use the [rolled up[estimates provided, which make use of all data available for a bro class of parts and environments. Although the data book approach is generally thought to be less desirable, it remains an economical means of estimating [ballpark] reliability for mechanical components.

Summary Report

System Name	SYSTEM		Date	2013-11-22
Environment	Ground,Fixed Controlled		Standard	Telcordia SR-332
Temperature	40		Analyst	

구분	모델명	수량	고장률	MTBF	Reliability
SYSTEM	SFU-slim(S20) V01A	1	315.416815	3,170,408.02	0.997241
Unit1	MAIN	1	291.416815	3,431,510.98	0.99745
Unit2	LFD-L	1	12	83,333,333.33	0.999895
Unit3	LFD-R	1	12	83,333,333.33	0.999895