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BC95-G MTBF Test Report

NB-IoT Module Series

Rev. BC95-G MTBF Test Report

Date: 2019-04-24

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About the Document

History

Revision	Date	Author	Description
1.0	2019-04-24	Fioson WANG	Initial

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1 Purpose

The purpose of an MTBF test is to ensure the life time of the module can meet application designs.

2 Scope

This document is applicable to all BC95-G modules and designs developed by Quectel.

3 MTBF Representation

3.1. MTBF Formula

MTBF is calculated in traditional way via the formula below (according to Telcordia SR-332 Issue 3):

$$\mathrm{MTBF} = \frac{1}{\lambda_{SS}} = \frac{1}{\Pi_T \lambda_{PC}}$$

- Π_T: Thermal Factor, refer to **Chapter 3.2** for detailed description;
- λ_{PC}: The failure rate of the key devices.

3.2. Π_T Calculating Formula

$$\Pi_T = \exp\left(\frac{Ea}{K}\left(\frac{1}{T_0} - \frac{1}{T_1}\right)\right)$$

- *Ea = activation energy in eV, the value in this test is 0.7;*
- *K = Boltzmann constant = 8.617*E-5 eV/K;*
- *T_0 = reference temperature in °k = 40 + 273 = 313;*
- *T_1 = operating temperature in °k = operating temperature in °C + 273.*

4 MTBF Calculation

4.1. Part Count Prediction

The following table shows the failure rate prediction of the key devices (normal temperature). MTBF is determined by the key devices whose failure rate is much higher than other devices.

Table 1: Failure Rate Prediction of the Key Devices

Part Description	Category	Quantity	λss/FITS
RES MF +/-5% 1/20W RO	Resistor	24	0.08
CAP X5R +/-20% 6.3V RO	Capacitor	69	0.10
IND HIGH +/-5% RO	Inductor	13	0.11
TVS Bi Vrwm=4.5V 350pF 1.6x1.0mm H0.55mm RO	TVS	1	0.04
PMIC LDO Active Discharge 2.2-5.5V Fix 2.8V 150mA XDFN4 1x1mm H0.43mm RO	PMIC	1	3.29
PMIC DC-DC 2.7-5.5V 0.6-3.4V 750mA DSBGA-6 H0.6mm RO	PIMC	1	3.90
PMIC Load Switch 1.2-5.5V 3A 21mR@1A 6-WLCSP 1.0x1.5mm H0.63mm RO	PIMC	1	3.29
IC RF SAW BALUN 1805-2170MHz 0.6x0.5mm H0.4mm RO	SAW	1	29.85
IC RF SAW BALUN 729-960MHz 0.6x0.5mm H0.4mm RO	SAW	1	29.92
IC RF TX LPF 1695-2180MHz 1.0x0.5mm H0.5mm RO	Filter	1	0.011
IC RF TX LPF 699-960MHz 1.6x0.8mm H0.7mm RO	Filter	1	0.001
IC RF PA LTE B1/2/3/4/5/8/12/13/17/18/19/20/28/ 3.0x4.2mm H0.825mm RO	PA	1	0.59
IC RF SWITCH SP4T 39dBm 2.0x2.0mm H0.6mm RO	Switch	1	0.2
IC BB HI2115 121-TFBGA 0.5pitch 5.800x5.800mm H1.075mm RO	CPU	1	36.40
PCB BC95-G V3.1 6L HDI 19.9x23.6mm H0.6mm XL RO	PCB	1	10.00

Assume that the environmental factor πE=1 (Ground, Fixed, and Controlled) in this prediction, then the failure rate of the key devices can be calculated as:

$$\lambda_{PC} = \Pi_E \sum_{i=1}^{n} N_i \lambda_{ss_i}$$
$$= 127.74(FITS)$$

4.2. Thermal Factor

- *The Thermal Factor calculation formula is:*

$$\Pi_T = e^{\frac{E_a}{k}[\frac{1}{T_0} - \frac{1}{T1}]}$$

When T_1= (85+273) °K
E_a= 0.7
k= 8.62×10E-5
T_0= (40+273) °K
The value of Thermal Factor=26.08

4.3. MTBF Result

- When T=(85+273) °K

$$\text{MTBF} = \frac{1}{\lambda_{SS}} = \frac{1}{\Pi_T \lambda_{PC}}$$
$$\approx 300168.77\textbf{Hours}$$
$$\approx 34.26\ \boldsymbol{Years}$$

4.4. Conclusion

Through the comprehensive testing on MTBF, it is founded that MTBF value is 40.91years at the module temperature of 85℃.This means that the "mean life" for our product based on the data we have collected with no failure can reach or exceed 34.26 years when module temperature is 85℃, which are compliant with the standard values. Therefore, the testing on MTBF is successfully completed.

5 Appendix A Reference

Table 2: Terms and Abbreviations

Abbreviation	Description
FITS	Failures per billion device hours
MTBF	Mean Time Between Failures