MTBF PREDICTION REPORT

PRODUCT NAME: BLED112-V1

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1.0 Introduction and summary

Reliability is defined as the probability that a device will perform its required function under stated conditions for a specific period of time. Predicting with some degree of confidence is very dependent on correctly defining a number of parameters.

The following report follows the MIL-217F Technical Reference Reliability Prediction Procedure for Electronics Equipment, paragraph 2.4 of Task 100 of MIL-STD-756B; and the Parts Count Analysis method of MIL-HDBK-217F(N1/2), Appendix A.

Simulated environment:
Ground, Benign(GB), 30 Celsius degrees.
Prediction results:
Model: BLED112-V1
Failure Rate: **298. Fits**
MTBF: **3350757.27 Hours**

2.0 Method of analysis

Failure rates for individual parts in the product have been established based upon historical data. Generally, failure rates are expressed in terms of the numbers of failure in 1,000,000,000(1 x 10^9) hours of operation. The primary sources of this failure rate data is Military Hand Book, Reliability Prediction of Electronic Equipment; MIL-HDBK-217F and Bellcore Technical Reference, "Reliability Prediction Procedure for Electronic Equipment"; TR-332(Issue 6, December 1997) along with reliability data given by the component manufacturers.

Various factors such as temperature, humidity, vibration shock, power levels, voltage stress, cycle rates, construction characteristics, etc., all affect the predicted failure rate for a part or device. Within this reference, all the factors are taken into account according with the models that MIL-217F provides.

The method that was used to determine the failure rate is based solely on the "Parts Count" procedure. The baseline failure rates for Method I calculations are derived from telecommunications and other industry field data.

The results of the MTBF analysis were then sorted in descending order, to determine which components account for the majority of the failures. The detailed results are shown in Table 1.

The reliability model described only considers unit failures caused by device hardware failures; failures due to programming errors on software are not considered.

3.0 MTBF and Failure Rate Defined

The Mean Time between Failure (MTBF) is a measure of the average time interval between successive random failures of a product (or device). This assumes that the product(or device) is operating in the "Mature Reliability" period of its operating life. High failure rates normally associated with the "Infant Mortality" period are assumed to have been eliminated by testing. During the "Mature Reliability" period, failures are generally of a random nature and on the

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average, relatively constant in rate. Such failures are the result of inherent limitations in the design as well as accidents caused by usage.

A correct understanding of MTBF is important. For example: A device with an MTBF of 40,000 hours does not mean that the device should last for an average of 40,000 hours. According to the theory behind the statistics of confidence intervals, the statistical average becomes the true average as the number of samples increase. Sometimes failure rates are measured in percent failed per billion hours of operation instead of MTBF. The FIT is equivalent to one failure per billion device hours, which is equivalent to a MTBF of 1,000,000,000 hours. The formula for calculating the MTBF is

$$\theta = T / F$$

Where θ = MTBF, T = time and F = number of failures during that time.

Once MTBF has been calculated, what is the probability that any one particular BLED112-V1 will be operational at time equal to the MTBF? The distribution of time between failures statistically defines the probability of failure free operation over a specified period of time. Therefore the following equation can calculate the probability:

$$R(t) = e^{-t/MTBF}$$

Where $R(t)$ is the probability of failure free operation for a time period equal to or greater than time t.

The mathematical Model used for determining the BLED112-V1 reliability is known as the series model. This model is based on the equation:

$$r(t) = e^{-\lambda t}$$

Where $r(t)$ is the reliability of BLED112-V1, t = Elapsed operation time in hours and λ = BLED112-V1 failure rate in parts per billion hours.

The assumption is that if any part fails during operation, BLED112-V1 is considered to have failed as a whole, and maintenance is required. The reliability of the BLED112-V1, $r(t)$ is also the combined probability of the individual parts reliability, where the unit contains quantity n parts:

$$r(t) = \sum_{i=1}^{n} r(t)_i$$

Where $r(t)_i$ = reliability of part i, over time t, $e^{-\lambda t}$.

The parts count reliability prediction method reflects the generic part types, quantities and qualities used, and consider the operational environment impact. These factors are combined in the following mathematical model:

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$$\lambda_A = \sum_{i=1}^{n} N_i (\lambda_G \pi_Q)_i$$

Where λ_A = Total failure rate of (parts per billion hours) of BLED112-V1, λ_G = generic failure rate for a given environment for i:th generic part of assembly, π_Q = quality factor for the i:th generic part of assembly, N_i = quantity of the ith generic part of assembly and n = number of different generic part categories.

The failure rate model modifiers, quantity, quality factor and generic failure rate are listed under their respective columns in the appendix tables.

4.0 Environmental factors and assumptions

Every parts generic failure rate includes the effects of environment factors. The appropriate environment factor for the BLED112-V1 is Ground Benign (GB). For GB the semiconductor junction temperature, TJ, is 50 degrees Celsius, and the other parts ambient temperature, TA, is 30 degrees Celsius. No temperature rise above ambient is assumed for any part.

For most of the critical ICs reliability data was obtained from the device manufacturer. However, different manufacturers specify reliability data differently. Most test their parts for a short period of time and then apply mathematical formulas to discern FITs or MTBF number. The mathematical assumptions (Confidence level, temperature, EA energy, etc.) differ across manufacturers.

Operation duty is assumed to be 100%.

5.0 Results

Assembly/Parts List	Quantity	Failure Rate in Parts Per Million Hours Total	Quantity x Total
BLED112-V1/Bluegiga Technologies Inc	1	0.2944	0.2944

6.0 Sources

-Military Hand Book, Reliability Prediction of Electronic Equipment; MIL-HDBK-217F

-Practical Reliability of Electronic Equipment, Products - E. Hnatek (Marcel Dekker, 2003) WW

-Component manufacturer reliability data

- Bellcore Technical Reference, “Reliability Prediction Procedure for Electronic Equipment”; TR-332(Issue 6, December 1997)

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