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Mil-HDBK-217F Notice 2 MTBF Prediction Report

Issue 1.0 / July 2016

This report has been prepared for:

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Your zip code & country

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1. List of Changes

Issue	Date	Editor	Change description
1.0	July 26th 2016	Thomas Reiter	First issue

Table 1: List of Changes

2. Introduction

This document contains the failure rate and MTBF assessment for the following unit

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The assessment has been performed using

Mil-HDBK-217F Notice 2

including the recommendations given in

ANSI/VITA 51.1-2008

ANSI/VITA 51.1-2008 contains recommendations for quality factor assessment for today's (2008 and later) commercial electronic components.

MTBF values are given in hours [h] and failure rate values in "failures per million hours" [fpmh].
1 fpmh = 1 failure per 1.000.000 hours.

Conversion MTBF – fpmh:

<fpmh> = 1.000.000 / MTBF [h]
<MTBF> = 1.000.000 / Failure Rate [fpmh]

3. Summary

3.1 Failure Rates [fpmh] for Ground Benign, Controlled Environment (GB)

If your system is complex (e.g. hierarchical or modular), results will be displayed on all assembly levels accordingly. More environments, if needed, will be included.

Temp [°C]	xxxxxxxx	yyyyyyyy	zzzzzzzz
-45	2,234	10,053	9,042
-40	2,457	11,058	9,847
-35	3,234	14,553	12,642
-30	3,557	16,008	13,807
-25	4,234	19,053	16,242
-20	4,657	20,958	17,767
-15	5,234	23,553	19,842
-10	5,757	25,908	21,727
-5	6,234	28,053	23,442
0	6,857	30,858	25,687
5	7,234	32,553	27,042
10	7,957	35,808	29,647
15	8,234	37,053	30,642
20	9,234	41,553	34,242
25	10,234	46,053	37,842
30	11,234	50,553	41,442
35	12,234	55,053	45,042
40	13,234	59,553	48,642
45	14,234	64,053	52,242
50	15,234	68,553	55,842
55	16,234	73,053	59,442
60	17,234	77,553	63,042
65	18,234	82,053	66,642
70	19,234	86,553	70,242
75	20,234	91,053	73,842
80	21,234	95,553	77,442
85	2,234	10,053	9,042

Table 2: Failure rates for ground benign, controlled (GB) environment

3.2 MTBF [h] for Ground Benign, Controlled Environment (GB)

Temp [°C]	xxxxxxxx	yyyyyyyy	zzzzzzzz
-40	447.628	99.473	110.590
-35	406.934	90.430	101.557
-30	309.215	68.714	79.099
-25	281.104	62.468	72.429
-20	236.183	52.485	61.567
-15	214.712	47.714	56.285
-10	191.058	42.457	50.397
-5	173.690	38.598	46.026
0	160.411	35.647	42.658
5	145.828	32.406	38.931
10	138.236	30.719	36.979
15	125.669	27.926	33.731
20	**121.448**	**26.988**	**32.635**
25	108.295	24.066	29.204
30	97.714	21.714	26.425
35	89.015	19.781	24.130
40	81.739	18.164	22.201
45	75.563	16.792	20.558
50	70.254	15.612	19.142
55	65.643	14.587	17.908
60	61.599	13.689	16.823
65	58.025	12.894	15.862
70	54.843	12.187	15.005
75	51.991	11.554	14.236
80	49.422	10.983	13.542
85	47.094	10.465	12.913

Table 3: MTBF for ground benign, controlled (GB) environment

4. Reliability Assessment

4.1 Mathematical Models

The analyzed board contains active and passive electronic components which are mounted on a printed circuit board. There is no further system breakdown due to the simple functional structure. This reliability assessment assumes that all components are equally necessary to perform the system function, which means that any component failure is assumed to result in functional failure of the board. As this is not the practical case and some failures may only result in a maintenance action the calculated MTBF is also called „Maintenance–related MTBF".

MTBF calculations are based on mathematical models for failure rates which are published in certain international standards (Mil-HDBK-217, Telcordia, Siemens SN 29500, IEC-TR-62380, FIDES, 217Plus).

4.1.1 Serial Reliability Model

Figure 1 shows a simple serial model.

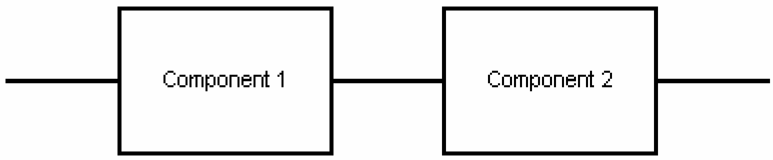

Figure 1: SERIAL RELIABILITY MODEL

If an element failure rate is constant over time, the reliability for a single series element can be expressed as the following exponential distribution.

$$R(t)_i = e^{-\lambda_i t}$$

where:

$R(t)_i$ = the probability of survival for a single series element for a given operating time *t*
e = the base of the natural logarithm
λ_i = a constant representing the ith element failure rate
t = the element operating time

If each exponentially distributed series element is independent, the series system reliability function can be expressed as the following product.

$$R(t)_{series} = \prod_{i=1}^{n} e^{-\lambda_i t}$$

where:

$R(t)_{series}$ = the probability of survival for a series system for a given operating time *t*.

e = the base of the natural logarithm
λ_i = a constant representing the i[th] element failure rate
t = the element operating time

If each element is independent, it can be shown that the failure rate for an exponential distribution series system is the sum of the failure rates of the individual elements.

$$\lambda_{series} = \sum_{i=1}^{n} \lambda_i$$

where:
λ_{series} = a constant representing a series system failure rate
λ_i = a constant representing the i[th] element failure rate
λ_n = a constant representing the last element failure rate

and

$$R(t)_{series} = e^{-\lambda_{series} t}$$

where:

$R(t)_{series}$ = the probability of survival for a series system for a given operating time t
e = the base of the natural logarithm
λ_{series} = a constant representing the series system failure rate
t = the series system operating time

The mean time between failures (MTBF) for an exponentially distributed single element or series system can be determined from the reliability function or, as shown below, directly from the failure rate.

$$MTBF = \int_0^\infty R(t)_i \, dt$$

$$MTBF = \int_0^\infty e^{-\lambda_i t} dt = \frac{1}{\lambda_i}$$

$$MTBF = \int_0^\infty e^{-\lambda_{seriessystem} t} dt = \frac{1}{\lambda_{seriessystem}}$$

where:

$MTBF_{seriessystem}$ = the mean time between failure of the series system
λ_i = the constant failure rate of the i[th] element
$\lambda_{seriessystem}$ = the constant failure rate of a series system
e = the base of the natural logarithm

t = the series system operating time

For a series system with exponentially distributed elements the, $MTBF_{series}$ can be expressed as shown below.

$$MTBF_{series} = \frac{1}{\lambda_1 + ... + \lambda_n}$$

where:

$MTBF_{series}$ = the mean time between failures for a series system
λ_n = a constant representing the n^{th} series element failure rate

4.1.2 Data Sources and Assumptions

In order to perform a failure rate assessment, several assumptions have to be made to minimize the complexity of the analysis.

1. Mil-HDBK-217F Notice 2 has been used for all components except those mentioned below in topic 6, special components.
2. Failure rate of mechanical components (screws, chassis, etc.) is negligible.
3. Quality factors: The recommendations of ANSI/VITA 51.1-2008 have been used. The quality factors of those component types not covered by ANSI/VITA 51.1-2008 have been assessed one level above the Mil-HDBK-217 quality level “commercial”.

   Connectors, for which ANSI/VITA 51.1-2008 recommends quality level “commercial”, have been assessed one level above “commercial”, too, because the Mil-HDBK-217 model for connectors addresses operating conditions which are substantially worse compared to civil applications.
4. Environmental factor GB (ground benign, controlled), has been used for calculation.
5. Stress levels: 50% power ratio, current ratio and stress ratio has been used for all applicable components.
6. Special components: None; all components have been assessed with Mil-HDBK-217F Notice 2.

5. Reliability Assessment Details

Detailed failure rate values on component level are provided for +20°C, GB environment.

All failure rates are given in *failures per million hours (fpmh)*

Conversion MTBF – fpmh:

<fpmh> = 1.000.000 / MTBF [h]
<MTBF> = 1.000.000 / Failure Rate [fpmh]

Name	PN1	PN2	Reference Designator	Description	Mil-217 Category	Mil-217 Subcategory	FR/Unit [fpmh]	Qty	FR [fpmh]
5.1 xxxxxxxx							**2,5623**	**1**	**2,5623**
5.1.1 yyyyyyyyyyy							0,4454	1	0,4451
	qwerty	qwerty	C1	SMD 1000pF 50V; 1n0/50V; 0603_C; GRM1885C1H102JA01D	Capacitor	General Ceramic (CK. CKR)	0,000251		0,000251
All components will be displayed here									

Table 4: Failure rates on component level for ground benign, controlled (GB) environment