

Memo

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| Topic: | MTBF for TIM-4x, LEA-4x and NEO-4S GPS Receivers |
| | GPS.G4-MS4-08005 |
| Author: | Stéphane Vincent, Jean-Pierre Wyss |
| Date: | 5/05/2008 |
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1 Introduction

The calculation of an MTBF figure of the TIM-4x, LEA-4x and NEO-4S in a traditional way, using the MTBF values of all the components and production processes, is not possible. Several suppliers cannot provide MTBF figures for their parts. Therefore u-blox uses a different approach to determine the MTBF figure of the units. We are using the data found in the qualification of the modules and do a prediction of the MTBF based on an accelerative factor.

2 MTBF Calculation

Assuming a given test batch (QTY_{sample}) is tested for several hours (t_{test}) without failure, the MTBF for a given confidence level can be calculated. An accelerative factor can be achieved by performing the tests at higher temperature (T_2). Whereas the MTBF is calculated for environment temperature (T_1).

$$t_{test} = \frac{MTBF_{predict} \times R}{QTY_{sample} \times ACC}$$

Abbreviations:

| | |
|----------------|---------------------------------|
| t_{test} | Test Time of sample quantity |
| MTBF | Mean Time Between Failure Value |
| QTY_{sample} | Sample Quantity |
| ACC | Accelerative factor |
| R | Poisson factor (see Appendix A) |

Whereas the accelerative factor is calculated as follows:

$$ACC = \frac{e^{-\Delta H / K \times T_2}}{e^{-\Delta H / K \times T_1}} = \frac{e^{-0.445 / 8.623E-5 \times (273+85)}}{e^{-0.445 / 8.623E-5 \times (273+25)}} = 18.22$$

with

| | | | |
|----------------|-------------------------------------|----------|-------|
| t_{test} | Test Time | 1000 | h |
| T_2 | Test Temperature | 85 | °C |
| T_1 | Environment Temperature (MTBF) | 25 | °C |
| QTY_{sample} | Number of units under test (UUT) | 46 | units |
| R | 85% confidence level for 0 failures | 1.89 | |
| ΔH | | 0.445 | |
| K | | 8.623E-5 | |

Therefore:

$$MTBF = \frac{t_{test} \times QTY_{sample} \times ACC}{R} = \frac{1000 \times 46 \times 18.22}{1.89} = 4.42E + 05hrs = 50.5 years$$

This MTBF is calculated for an environmental temperature of 25°C and no vibration or mechanical shock, 24hrs operation per day.

A Poisson Table

| Confidence Level | Failure Number | | | | | | | |
|------------------|----------------|--------|--------|--------|--------|---------|---------|---------|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 95% | 2.9957 | 4.7439 | 6.2956 | 7.7537 | 9.1535 | 10.5130 | 11.8424 | 13.1481 |
| 90% | 2.3026 | 3.8897 | 5.3223 | 6.6808 | 7.9936 | 9.2742 | 10.5321 | 11.7709 |
| 85% | 1.8971 | 3.3724 | 4.7231 | 6.0135 | 7.2670 | 8.4947 | 9.7031 | 10.8965 |
| 80% | 1.6094 | 2.9943 | 4.2790 | 5.5151 | 6.2710 | 7.9060 | 9.0754 | 10.2325 |
| 75% | 1.3863 | 2.6926 | 3.9204 | 5.0194 | 6.2744 | 7.4227 | 8.5585 | 9.6844 |
| 70% | 1.2040 | 2.4392 | 3.6156 | 4.7622 | 5.8904 | 7.0056 | 8.1111 | 9.2090 |
| 65% | 1.0498 | 2.2189 | 3.3474 | 4.4547 | 5.5486 | 6.6331 | 7.7105 | 8.7823 |
| 60% | 0.9163 | 2.0223 | 3.1054 | 4.1753 | 5.2366 | 6.2919 | 7.3427 | 8.3898 |