MTBF vs. Reliability

Introduction

The purpose of this document is to clarify the meaning of MTBF (Mean Time Between Failures). Many buyers of electronic products, such as the products Xycom Automation manufactures and sells, use this term as a gauge for product reliability. So an understanding of MTBF will help its users to more accurately interpret the relationship between MTBF claims and customer expectations for component reliability in their own applications. In general, higher MTBF correlates with fewer component failures, but an MTBF claim does not guarantee product reliability and does not represent a condition for warranty.

It is important to point out that MTBF is the least understood rating used in the computer industry. So is MTBF the same as reliability? To come to an acceptable and satisfactory answer this important question, let’s first look at the definitions of reliability and MTBF, and then their relationship.

What is Reliability?

As defined, reliability is the probability that a product will perform a required function under a stated condition for a defined period of time. This definition clearly defines reliability in probabilistic terms. And the three most important components of this definition are required function, stated condition, and defined period. It is important to understand these components in order to design a product that can be validated as reliable.

What is MTBF?

MTBF is the mean (average) of a distribution of product life time or life between successive failures. This definition assumes that the product in question can be repaired and placed back in operation after each failure. MTBF is expressed in hours. For electronic products, it is commonly assumed that during the useful operation life period, the parts have constant failure rates, and part failure rates follow an exponential law of distribution. In this case, the MTBF of the product can be calculated by the following equation:

\[
MTBF = \frac{1}{\text{sum of all the part failure rates}}
\]

And the probability or reliability that the product will work for a defined period of time without failure is given by the following equation:

\[
R(T) = \exp\left(-\frac{T}{MTBF}\right)
\]
Thus, for a hard disk or hard drive (HD) that is rated with an MTBF of 500,000 hours and expected to survive for 5 years ($5 \times 365 \times 24 \text{hrs} = 43,800 \text{ hours}$), the reliability is calculated by the following:

$$R(5) = \exp\left(-\frac{43,800}{500,000.00}\right) = 91.6$$

This result clearly indicates that there is a 91.6% probability that the hard disk will operate without a failure, or in other terms, that 91.6% of the hard disks in the field will still be working at the 5-year point.

MTBF figures can be derived in various ways such as lab test results through simulation, actual field failures, or prediction models (such as MIL-HDBK217 or Telcordia/Bellcore). There is also a plethora of software packages in the market today that would spell out this figure based on built-in prediction models.

**MTBF vs. Reliability**

From the example given above, a 91.6% probability of a hard disk operating for 5 years without failure is impressive. Now, let’s mark the word “probability”, which indicates that this may hold or may not hold.

The hard disk is rated for an MTBF of 500,000 hours, which is an equivalent of 57 years. Now let’s ask a simple question. If one installs a hard disk with an MTBF of 500,000 hours, can one expect the component to operate without a failure for 500,000 hours? The answer to this question is simply no. Why? The reason is that the component will reach an end-of-life long before reaching 500,000 hours. For example, a continuously operated component with 5 years of useful life will operate for 43,800 hours. In theory, if the HD component is to be replaced with a new component when it reaches the end of 5 years, and that component is replaced with another new component at the end of 5 years, and so on and so forth, then the probability that 500,000 hours would be attained is approximately 36% most of the time.

While 91.6% is a great probability figure, we’ve just found out that when MTBF hours equal component useful life, the product is only 36% reliable. People often take the 500,000 hours and run with it without understanding its true meaning. The simple fact is that no electronic component is designed for a useful life of 57 years. It was once calculated by an automotive engineer for a CompactFlash™ device to have an MTBF of 90 years. While this figure is impressive and exciting, it is just not attainable.

Another point that is worth exploring is the assumption that the higher the MTBF, the higher the reliability. While that may be true in theory, there is no
The direct proportionality between the two numbers or indices. For example, if the useful life of a product is one year (8,760 hours), the calculated reliability for the various MTBF levels or numbers are below:

<table>
<thead>
<tr>
<th>MTBF (Hours)</th>
<th>R (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50,000</td>
<td>83.9</td>
</tr>
<tr>
<td>100,000</td>
<td>91.6</td>
</tr>
<tr>
<td>200,000</td>
<td>95.7</td>
</tr>
<tr>
<td>1,000,000</td>
<td>99.1</td>
</tr>
</tbody>
</table>

From the above table, it can easily be deduced that a five-fold increase in MTBF hours from 200,000 to 1,000,000 hours yielded an increase of less than 4 percentage points as compared to doubling of MTBF hours from 50,000 to 100,000 hours to get an increase of approximately 8 percentage points.

What do we do at Xycom?

At Xycom, our efforts are focused on robust designs that are qualified and validated vigorously based on the environmental conditions within which the product will be used, which is the industrial environment for most of our products. If a product is not robust, it is worthless and we can’t afford to put our customers through such painstaking experiences on the manufacturing floor.

*Ask for our product qualification process and we will gladly share it with you.*

Does Xycom Calculate MTBF?

At Xycom, we prefer to use field failure data to calculate MTBF numbers instead of the MIL-STD-217 standard. MTBF numbers calculated using the MIL-STD-217 standard are over-conservative and do not typically reflect actual experiences in the field. Field failure data gives real world information on our products in daily operation, giving more realistic information for MTBF calculations.

Our calculations assume an operating time of 8 hours per day, 5 days per week, and 52 weeks per year. This is a conservative estimate of the product in use. In the field, our products may be running for more hours a day, which means that this number could be estimated higher. Therefore, our MTBF calculations are based on the volume of the product shipped and the actual failures returned to Xycom for repair throughout the product’s life cycle. These calculations also use the best known quantity of relevant failure information.
The data used for MTBF calculations is confidential to Xycom. The resulting MTBF figures can be shared with customers with the approval of the Xycom Quality department. Our customers must not distribute outside their organization without written approval from Xycom.

*Please note that these numbers may not hold in all cases, especially if the products are used above or beyond their specification limits.*

**What is considered a failure?**

Any event that prevents a component from meeting its defined operation and has not reached end of life (typically for an electronic component: 5 to 7 years). This includes components that have failed within the infant mortality period, and/or failures resulting from shipment. This does not include failed components resulting from damage or improper handling, nor does it include components that have reached end of life.