Power Supply MTBF ratings – what do they really mean?

Most power supply manufacturers can provide MTBF (Mean Time Before Failure) ratings for their products. This data is presented as a number of hours ranging from hundreds of thousands to over a million hours. Ratings are generally quite impressive but can also be meaningless.

First, let's look at what MTBF really means. An MTBF of 100,000 hours means that 1 failure can be expected in 100,000 hours of testing. Another way of stating it is that out of 100,000 products, 1 can be expected to fail in 1 hour. The calculation is:

MTBF=cumulative hours of operation of all products / # of failures

In reality, products are not tested for 100,000 hours nor are 100,000 products tested. Knowing the time period is critical to understanding an MTBF number. If 1000 products operate continuously for 10 years the total number of operating hours is 10 years x 8760 hours per year x 1000 products giving 87.6M hours. If 2 products fail per year the result is 87.6M ÷(2 products x 10 years) giving 4.38M hours MTBF. If all the remaining products fail within the next 10 years the MTBF for all 1000 products over 20 years would be 20 x 8760 x 1000 / 1000 giving 175,200 hours. Thus the MTBF for 10 years is 87.6M hours but for 20 years is 175,200 hours for the exact same product.

It is very important to realize that MTBF is not life expectancy. <u>It is possible to make a product with very high MTBF but low life expectancy and vice versa</u>.

Another factor to be kept in mind is that MTBF calculations can be just that – a mathematical calculation. There are two widely used models used for these calculations. One is the military standard MIL-HDBK-217 and the other is the Bellcore model. The MIL standard is recognized internationally. The two models differ in the following ways:

- Bellcore is designed for commercial equipment while MIL-HDBK-217 is intended for military and commercial equipment.
- The MIL standard focuses on part count and part stress while Bellcore includes provision for actual test data. "Part stress" is directly related to the component's operating temperature.
- Each model makes provision for components that the other doesn't. If using a method that doesn't provide a model for a specific component some assumptions concerning that part's stress characteristics must be made. Each assumption can reduce the accuracy of the final analysis.
- Bellcore is perceived to be more optimistic than MIL-HDBK-217.

Looking specifically at power supplies, even high efficiency switchmode designs dissipate heat. The power dissipation is combined with the ambient temperature around the power supply to determine the maximum operating temperature. The ambient plus the temperature rise caused by the power dissipation must not result in any temperature exceeding the operating temperature rating of the components. In the case of power

semiconductors such as transistors and MOSFETs it is the junction temperature within the device, which is several degrees higher than the case temperature, that cannot be exceeded. Good engineering practice is to have a margin of 10^0C.

The operating temperature of an individual component determines the part stress according to the MTBF models. A device rated 1A but operated at 0.8A will obviously not dissipate as much heat as it would at 1A and the life expectancy is increased. This also applies to the rating of the complete power supply – a 5A supply operated at 4A will have a longer MTBF than the same unit operated at full power operating at the same ambient temperature.

In order for MTBF ratings to be meaningful they must be presented with respect to ambient temperature, loading, the time period the calculation is based on and the model used must be known.