



ADOPT DESIGN PRACTICES FOR COMPONENT RELIABILITY

ELECTRONIC DEVICES HAVE CREPT INTO almost every aspect of our daily life. Electronic component unreliability can be critical, and in some cases life threatening. Reliability should be a key concern for companies designing electronic products. Every manufacturer wants the products to work—the bottom line is that product returns cost money, whether it is repair or replacement cost, or potentially compromised customer confidence, or even the expense of litigation.

So how can a manufacturer ensure a certain level of consistent reliability? By designing for reliability, of course!

Derating

Two of the main factors that contribute to component failure are thermal and electrical overstressing. Both of these conditions are avoidable by practising derating. Derating is a design practice intended to limit the electrical and environmental stresses applied to the parts to levels that are within specified capabilities. Derating is intended to enhance reliability and improve design integrity. For example, if you want to operate a particular component in an ambient operating temperature of 50°C, you would choose components rated to operate at higher temperatures, perhaps 60°C or 70°C.

Distribution and redundancy

Distribution and redundancy are two common practices of designing for reliability. You can liken the principle of distribution to the old saying, don't put all your eggs in one basket. For example, if you had a product with a fan to provide cooling, you may want to consider using multiple fans instead of one large unit. With this design

topology in place, losing one fan might not mean immediate thermal failure of your device. It could buy a technician some time to replace the failed fan or time for someone to shut the unit down before it sustained any permanent damage.

Redundancy is another common practice that enhances reliability. You may have heard the term n+1, which simply means use one more than you need. For example, to improve upon the principle of distribution, you might apply the n+1 principle. In the preceding example you may have needed three fans to provide adequate cooling to your unit. By adding a fourth, your product would be able to tolerate the loss of one fan and still have adequate cooling with no interruption to operation.

Reliability prediction

Once you have designed your product with the desired reliability and quality, you want to be able to quantify the reliability of the design. Most often this means calculating the mean time between failure (MTBF). The simplest method for calculating MTBF is the parts count method. Each component is assigned a failure rate which is expressed as the number of failures in 10⁹ hours. These failure rates, or FITs (failures in time) are added up and divided by the number of hours in a year (8,760), yielding the MTBF in years. Other factors considered, such as thermal and electrical stress become multipliers for the FITs. For the purpose of the next example assume an electrical stress of 50 percent and ambient

PRODUCT X

Part	FITS	Quantity	Total
Resistor	1	100	100
Diode	1	50	50
Transistor	3	20	60
Integrated Circuit	5	10	50
Total FITS for Product X			260
MTBF in Years[(10 ⁹ hours/Total Fits)/8760 hours]			439 Years

temperature of 40°C (these figures yield a multiplier of 1).

The product has a low MTBF but this is a simplified example. Typical electronic products would have more parts and hence a higher MTBF (lower number of years). The preceding example was calculated using the Bellcore method found in TR-332. There is also a handbook published by the U.S. military called *MIL Handbook 217-F* that contains data on component reliability and prediction methods.

There is also an excellent text by Norman B. Fuqua, *Engineering for Electronic Design*, ISBN#0-8247-7571-6. The IEEE also has a reliability society which is a great source for the latest information on new models and prediction methods. ■

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