Reliability Considerations for products

BRODERSEN

simplifying systems

Reliability Considerations for products produced by Brodersen A/S

Introduction

In general reliability for electronic products is a very difficult issue, primary based on the fact that estimating lifetime is depending of a lot of variables. Some of the most important variables in the design are component specifications, load of components, ambient temperature, etc.

MTBF or the failure rate can be calculated using different kinds of input data. There are mainly three different categories:

A. Predicted value: Theoretically calculated value using ground failure rates and accelerations factors. MIL-HNDBK 217 is an example of a well-known procedure using predicted values.
B. Estimated value: Evaluated from field data based on different applications. These field data systems are often related to major companies.
C. Verified value: Sometimes referred to as "proven reliability". The ratio between accumulated components-hours and observed number of failures.

We are after considerations using a mix of B and C. Our experience is that the Theoretical value is difficult to calculate right and often give a not realistic picture of the actual reliability. After some research we have adopted a method used by several other companies among them Ericsson. This method is based on a "rule of thumb". The rule is that each time the ambient temperature rises by 7-15° Celsius, the MTBF value will be halved. The exact figure of course depends of the actual equipment and how the components are rated etc. Also is considered the fact that the relation between temperature and failure rate is similar to an exponential function when you exceed the maximum ratings of components. This "rule of thumb" must be very carefully handled and all equipment has to be evaluated in design and typical applications to set the exact figures.

After setting these figures we are stressing the products at 100% load and at absolute maximum temperature (typical 85-105°C) and let the product run until it "die". During this process we frequently test the unit under test to verify it still meets the specifications. With reference to the lifetime of the equipment we via calculations estimate the reliability at the expected operating temperature.

Product MTBF figures

Our products are constantly running in this process as changes are frequently done due to obsolete components, new production procedures etc.

The MTBF tests have shown the following figures for some of the most common modules/components;

Module	MTBF (hours at 30°C).	Constant failure rate λ	MTTR	Availability	Level
AI08A	417.000h	2,4 x 10E-6	0.5h	99,9999%	6 nines
AO02A	400.000h	2,5 x 10E-6	0.5h	99,9999%	6 nines
AO02B	400.000h	2,5 x 10E-6	0.5h	99,9999%	6 nines
CM02A	456.000h	2,4 x 10E-6	0.5h	99,9999%	6 nines
DI12H	476.000h	2,1 x 10E-6	0.5h	99,9999%	6 nines
DI20A	526.000h	1,9 x 10E-6	0.5h	99,9999%	6 nines
DI20B	526.000h	1,9 x 10E-6	0.5h	99,9999%	6 nines
DI20C	526.000h	1,9 x 10E-6	0.5h	99,9999%	6 nines
DM20A	500.000h	2,0 x 10E-6	0.5h	99,9999%	6 nines
DM20C	500.000h	2,0 x 10E-6	0.5h	99,9999%	6 nines
DO08R	400.000h	2,5 x 10E-6	0.5h	99,9999%	6 nines
DO12R	400.000h	2,5 x 10E-6	0.5h	99,9999%	6 nines
DO20A	435.000h	2,3 x 10E-6	0.5h	99,9999%	6 nines
FP02A	456.000h	2,4 x 10E-6	0.5h	99,9999%	6 nines
FP02B	456.000h	2,4 x 10E-6	0.5h	99,9999%	6 nines
FP02C	456.000h	2,4 x 10E-6	0.5h	99,9999%	6 nines
IM51A	425.000h	2,4 x 10E-6	0.5h	99,9999%	6 nines
IM51B	425.000h	2,4 x 10E-6	0.5h	99,9999%	6 nines
IO14A	400.000h	2,5 x 10E-6	0.5h	99,9999%	6 nines
IO14B	400.000h	2,5 x 10E-6	0.5h	99,9999%	6 nines
MP32A	417.000h	2,4 x 10E-6	0.5h	99,9999%	6 nines
MP32E	417.000h	2,4 x 10E-6	0.5h	99,9999%	6 nines
PM03A	357.000h	2,8 x 10E-6	0.5h	99,9999%	6 nines
PM03B	357.000h	2,8 x 10E-6	0.5h	99,9999%	6 nines
PM03C	357.000h	2,8 x 10E-6	0.5h	99,9999%	6 nines
PM04A	417.000h	2,4 x 10E-6	0.5h	99,9999%	6 nines
PM04B	417.000h	2,4 x 10E-6	0.5h	99,9999%	6 nines
PM04C	417.000h	2,4 x 10E-6	0.5h	99,9999%	6 nines
PS24A	357.000h	2,8 x 10E-6	0.5h	99,9999%	6 nines
PS48A	357.000h	2,8 x 10E-6	0.5h	99,9999%	6 nines
PS96A	357.000h	2,8 x 10E-6	0.5h	99,9999%	6 nines
RTU32N	425.000h	2,4 x 10E-6	0.5h	99,9999%	6 nines
SP04A	417.000h	2,4 x 10E-6	0.5h	99,9999%	6 nines
SP04B	417.000h	2,4 x 10E-6	0.5h	99,9999%	6 nines

The calculations are carried out similar to that described DN002 from ERICSSON for an ambient temperature of +30°C, which is considered to be a realistic operation temperature for these products.

That is an assumption based on a room temperature of 20°C and an excess temperature of not more than +10°C in the enclosure or the rack.

Failure rates and relevant acceleration factors have been found in the internal **Brodersen** statistical failure data system and where necessary MIL-HNDBK 217.

Brodersen statistical failure data system is based on both estimated values from field data and verified values from tests and maintenance. These figures can therefore be said to be realistic and based on a certain "proven reliability".

Comments to the MTBF figures

MTBF = 37-55 and 80 years is a relative high reliability figure. For this reason, it is appropriate to describe some of the methods used to achieve this high figure.

Mainly using ceramic capacitors: Where ever it has been possible, the products are designed using ceramic capacitor, which have a relatively low failure rate.

High temperature electrolytic capacitors: Where it has been necessary the designer has specified high temperature electrolytic capacitors. Therefore it has been possible to eliminate the big source of failures represented by electrolytic capacitors.

Low in-house temperature: As stated in the ERICSSON DN002, the reliability of a component is strongly dependent on the chip temperature. By means of our design technology and effective thermal management, the temperature of chips/components inside the products can be kept low and without hot spots. This gives very low failure rates for both semi-conductors and other components.

In line burn-in: Every system unit is operated at temperature 50-55°C and maximum load during 12-24 hours followed by a 100% functional test to reveal any component defects before delivery.

Mean Time To Repair (MTTR)

Mean Time To Repair (MTTR) measures the average time it takes to repair a RTU and restore it to full operating functionality following a failure. Also known as Mean Time To Restore or Mean Time To Recover, it is calculated by dividing the total maintenance time by the total number of maintenance actions over a set period of time.

The MTTR figures are based on the actual repair time and assume spare modules are in hand.

MTTR is set to maximum 30 min. All modules are hot-plug.

Availability

Availability measures both RTU running time and downtime. It combines the MTBF and MTTR metrics to produce a result rated in 'nines of availability' using the formula: Availability = (1 − (MTTR/MTBF)) x 100%.