QNFL9901
QUALITY NOTE

Predicting the Memory Data Retention Time

This document describes how the prediction of the Data Retention Time is calculated, based on exhaustive tests of statistical samples.

Arrhenius's law states that, within certain limits, it is valid to test a semiconductor device for a short time at a high temperature, and to use this to deduce its behavior over a longer time at a lower temperature.

Thus, if we take a silicon device, such as one of ST's memory devices, with an activation energy E_a=0.6 eV, we can test it at a temperature of T_1=250 °C (523 K), and make conclusions about its eventual behavior at its typical operating temperature of T_2=55 °C (328 K). Arrhenius's law gives an acceleration factor, A_T, as follows (where Boltzmann's constant=k=8.63x10^{-5} eV/K):

$$A_T = e^{-\frac{E_a}{k} \cdot \left(\frac{1}{T_1} - \frac{1}{T_2}\right)}$$

Using the temperatures given above, we find that A_T=2700. If the sample is tested for t=96 hours, this corresponds to a minimum data retention time of 2700x96 hours (about 30 years). So, our typical specification of 20 years can be guaranteed. In fact, though, we usually test our samples for no failures over 1000 hours at T_1=250 °C (corresponding to a guaranteed data retention time of about 50 years at 85 °C, and about 300 years at 55 °C).

The next step is to evaluate the failure rate of the devices. In the following equation, we introduce a term $(X^2/2)$ to represent the confidence level. This term has the value 0.916 at the 60% confidence level, and 2.305 at the 90% confidence level.

$$FIT = \frac{(\chi^2/2)\times 10^9}{N \times t \times A_t}$$

FIT is the predicted failure rate, with the given confidence level. Because of the 10^9 term, it has been scaled to give ppm/khr (parts per million failing per kilo hour). To convert this to ppm/yr (parts per million failing per year) the result needs to be multiplied by a scaling factor of 8.766 (the number of khrs in a year).

For further details, and updates on the parameters used in this document, please see the QRR document on the ST web site (*www.st.com*). This is updated quarterly.

If you have any questions or suggestions concerning the matters raised in this document, please send them to the following electronic mail address:

ask.memory@st.com (for general enquiries)

Please remember to include your name, company, location, telephone number and fax number.

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