

R A Q ' s

Rarely Asked Questions

Strange but true stories from the call logs of Analog Devices

The Long Term Stability of Precision Analog ICs, or How to Age Gracefully and Avoid Sudden Death

Q. *The life expectancy of my product is 20 years. How well will its calibration survive?*

A. Quite well, actually. Provided you protect it from abuse.

I am, alas, too fond of good one-liners. When asked how precision analog ICs age I usually answer "gracefully" or "365 days per year". But although these answers are true they are not always very helpful.

Precision analog ICs are very stable devices. Unlike wine they do not actually improve with age, but typically they have long-term age-related changes of around 1 ppm/thousand hours (the value may be given on the data sheet). It is important to realize that this aging is not cumulative, it obeys a "drunkard's walk" law. If you want the mathematics of a drunkard's walk you should consult this reference¹, but essentially each consecutive step is in a random direction. For a one-dimensional drunkard's walk this means that the distance from the origin is approximately proportionate to the square root of the number of steps.

So if a device ages at 1 ppm/1000 hours it ages at $\sqrt{2}$ ppm/2000 hours, etc. Since there are 8766 hours in a year (on average, 8760 in a normal year and 8784 in a leap year) 1 ppm/1000 hours = 2.96 ppm/year = 9.36 ppm/decade and 13.24 ppm/2 decades.

This does not vary much between devices that are continually powered, in storage, or have a reasonable range of ambient temperatures. Since this is a statistical process the variation between devices will be as large as the effect itself. High temperatures do accelerate the process, but not by very much, and the characteristics vary with different processes. Unless your circuit is spending the majority of its time above 100°C it is not unreasonable to expect aging to be close to the data sheet rate.



However there is another mechanism that causes ungraceful and abrupt changes of accuracy, and may also increase the rate of subsequent aging. That is electrostatic damage (ESD). It is a popular superstition that ESD is sudden death to an IC and that is often true. A discharge can do a small amount of damage which does not destroy the device, but does affect its performance (and may lead to sudden death later on). Such damage is often one-off but it can be cumulative—we once had a Finnish customer who complained that one of our op-amps got noisier with the passing years. Closer investigation revealed that actually nothing much had happened during the passing Summers, but it had indeed got noisier around the turn of each year, when the cold dry air of a Finnish Winter encouraged much more static electricity.

Adequate ESD protection is essential if an IC is to age gracefully.

¹ http://en.wikipedia.org/wiki/Random_walk

**To learn more about
precision analog ICs,
Go to: <http://rbi.ims.ca/5696-114>**



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