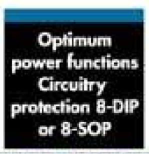
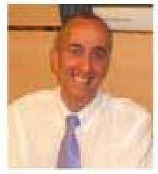


FRAM Memory Technology Moves Under the Hood

By Duncan Bennett, Ramtron International



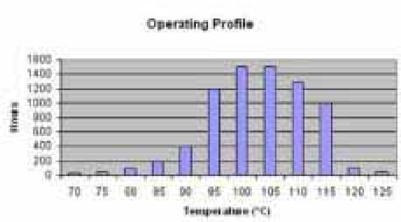
The automotive market is well known for adopting new technologies, slowly and methodically. As a technology matures, it often finds use first in entertainment and navigation systems. Eventually, it may move into in-cab applications. These are core automotive applications that are not subject to temperature extremes beyond other industrial electronics. The final step in a maturing technology is to be used in high temperature automotive applications.

FRAM memory technology has been moving along this track. As the most mature in a class of next generation nonvolatile memories, FRAM is beginning to aid the automotive design community through its fast write-speed and high endurance characteristics. The most recent development is a technological milestone. Successful AEC-Q100-qualification of a -40C to +125C degree (grade 1) FRAM product is a first. FRAM technology has never been available in this temperature range before. This allows it to be widely adopted across core automotive platforms.

Qualifying components to grade 1 demonstrates operation at +125C degrees, even after a variety of qualification stresses. Component qualification uses stress to simulate the operating lifetime of a system. These stresses include high temperature, high voltage, low temperature, pressure, humidity, and rapid changes between extremes. Achieving this level of performance requires demonstration of consistent reliability across the full temperature range. Grade 1 qualification is demanding for any component, but introduces additional challenges for a nonvolatile memory. Beyond operation a nonvolatile memory must exhibit data retention over the system lifetime. This is challenging because high temperature is a key accelerant of data loss and the +125C operating environment raises the bar.

For high temperature automotive applications, the operating temperature profile has two parts. When the vehicle is operating, the temperature is dictated by the heat generators including the engine, transmission and brakes. This temperature is much higher than typical industrial or commercial applications. However, the total amount of time at elevated temperature is a small percentage of the total lifetime of a car. The second part is non-operating time. Most of the hours on a vehicle are non-operating, but they still must be accounted for in the data retention lifetime. In this situation, the range of temperatures is dictated by outdoor ambient temperature so the average temperature is much lower than during operation.

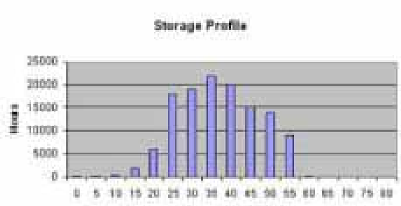
In order for FRAM memory technology to reach under-the-hood applications, a data retention specification that considers the two-part profile needed to be developed. The first part is operating life. The second is what remains of an overall vehicle life. The high temperature portion of the lifetime is based on a target of 250,000 km (155,000 miles) driving without major maintenance. Assuming an average speed of 56 km/hr (35 mph), this leads to an operating time of just over 4400 hours. During this time there is an elevated operating temperature profile. It ranges from the ambient temperature when the car starts to +125C degrees. In some applications there are excursions above this, but the time at temperature is critical and the excursions are insignificant. A model of a typical profile is as follows.



Typical Grade 1 Operating Profile

This model assumes 7400 operating hours rather than the expected 4400. In this profile there are roughly 3500 hours below 105C and 3900 hours at or above 105C. The average temperature of this profile is about 103C. To accommodate this profile, the FRAM data retention specification was set to 9000 hours at 125C. Considering the reliability expectations of the automotive industry, this is a reasonable guard band.

The second portion for the lifetime is the non-operating time. This is assumed to be roughly 14 years or 125,000 hours. The non-operating time occurs at a much lower temperature. The following profile is a typical temperature lifetime with an average of 38C:



Typical Grade 1 Storage Profile

From a data retention point of view, the impact of 125,000 hours at an average of 38C is a minimal burden compared to the high temperature requirement. Note that the non-operating profile is skewed toward a very warm climate. For purposes of data retention, this is the most severe assumption. Once again, the FRAM specification is set with a generous guard band at 17 years at 55C.

The introduction of a qualified +125C FRAM memory offers automotive system designers new choices for data collection and storage. FRAM offers the fastest write speed of any automotive qualified nonvolatile memory, nearly unlimited write endurance and low operating power consumption. Significant interest already exists in high temperature applications such as engine monitoring, steering, transmissions, tire pressure monitoring to name a
few.

Duncan Bennett is a Strategic Marketing Manager at Ramtron International of Colorado Springs, CO. ramtron.com. He has over 20 years experience in the semiconductor industry. He started as a design engineer in the industrial control/graphical instrumentation systems field, moving from applications to sales and, finally, marketing. Duncan is responsible at Ramtron for enabling new FRAM applicationsin the automotive industry and for the definition of new memory products.

-