FRAM Products for Automotive Applications White Paper

Electronic content in passenger automobiles and trucks is steadily increasing. Over five hundred million sensors were consumed by the car market in 2004. The increase of electronics and sensors means that the car market is experiencing an explosion in data handling and storage. The average low end auto has five to ten electronic control units while a luxury car may have fifty to sixty. Some newer models have over seventy five microcontrollers.
Recent introductions include improved ABS systems with traction control, continuously variable transmissions, electronic shift, dynamic stability control, and digital radio platforms. In the coming years, new electronic applications will include adaptive cruise control with collision avoidance, DVD players with car navigation, and control by wire (x-by-wire), and crash recording (black-box) technology. Additional sophisticated network technologies will continue to improve behind the scenes automation and performance.

The challenge of handling and storing data is a pervasive theme in the proliferation of automotive electronics. One implication is that increased data handling results in an increase in the frequency of data updates. Existing memory choices are often inadequate in managing the frequent updates. FRAM, with fast write and effectively unlimited endurance offers unique benefits for data handling and storage intensive applications. Consequently it is expected to be widely adopted in automotive applications in the coming years.

What are the real opportunities for FRAM? Below are some of the applications for which automotive development engineers are evaluating or designing with FRAM products today.

<u>Airbag</u>
Airbag systems have two data collection aspects that benefit from FRAM. So called smart airbags that adapt to the passenger collect and store information about once per second. An additional will be crash recorders, commonly know as black-boxes. The automotive black box will be integrated into the airbag or restraint system, it is unlikely to be a separate assembly such as the aircraft black box. This architecture is attractive because the sensor data that is critical for a crash recorder is largely available to the controller or can be accessed via busses already in place such as CAN.

Both applications are data loggers. They may be called on to collect data frequently over a long period of time in a circular buffer, or to respond very quickly based on sensor readings. Ideally they can perform both. In this rugged environment the data must be stored in a true nonvolatile memory as any form of battery backup will present crash survivability challenges. Technologies such as Flash face performance problems as they provide write endurance which is limited when it comes to long term data collection and they are far too slow to store data in the moment of impact. Crash statistics show high percentages of serious crashes result in a power outage during the crash, therefore data must be stored instantly and in a non-volatile state, before power leaves the vehicle and data is lost.

<u>Telematics/navigation</u>
Telematic functions are increasingly part of a high end vehicle electronics package. These systems provide dynamic maps that allow routing to be adjusted based on traffic patterns or other criteria. FRAM memories are used today in such system to store navigation waypoints, bookmarks etc. 16Kb memories are commonly used in this application. Matsushita selected Ramtron's FRAM for its in-car navigation system. The 16K FM25C160's fast read/write and high-endurance features provide Matsushita mobile automotive devices with a distinctive resume play function. The FM25C160 stores scene changes and unique user data upon power down, enabling the user to continue where they left off when the unit is powered back up.

<u>Entertainment</u>
Digital car radios are gaining in popularity. Such radios can download station information and store it in nonvolatile memory. The uncertainty of changes in this data makes it risky to use a limited endurance memory such as EEPROM. A common work-around is to maintain such download data in RAM and write it when power is turned off. This requires the use of a large capacitor which can maintain power on the EEPROM while it is written. While inexpensive, these capacitors are physically bulky and undesirable in ever shrinking electronic radios. Ramtron's upcoming process companion the FM33x family is aimed at digital in-car entertainment.

Instrument Cluster

Instrument clusters provide varying capabilities. The presence of a low density nonvolatile memory is common, and tracking elapsed miles often leads to frequent writes. The problem of intermittent data errors is frequently experienced by users in this application, possibly associated with electrical noise interfering with slower writing nonvolatile memories. A 4Kb FRAM such as the FM24C04 has been used in such instrumentation with great success and provides robust operating and data integrity in a noisy environment.

Tire pressure

Recent legislation mandated direct tire pressure sensing technology in order to mitigate the risks associated with driving with under-inflated tires. A natural extension of this data generation is logging. A historical record of tire pressures could present compelling documentation in determining liability should tire pressure contribute to an accident. Tire pressure logs might be implemented in the car and also in the tire, and FRAM is an ideal solution for this application given its unlimited ability to write in low power environments, such as that of a tire-based historical logger.

ABS -- Stability Control

ABS has evolved from its basic form to include traction control and more recently to include stability control. Traction control uses the wheel slip information already produced by ABS sensors to regulate power to prevent spinning tires due to slippery conditions. Stability control is a more sophisticated variety where power is regulated to each wheel depending on driving conditions. Based on speed, turn radius and road conditions the rotation of individual wheels is managed. Such systems are very sophisticated and involve learning algorithms. FRAM devices specified to +125C are in qualification.

Power train

Like stability control, power train management systems are ever more adaptive and can benefit from a nonvolatile memory that can be updated quickly and often. Also like ABS, these systems operate at 125C and will depend on a future generation of FRAM products, most likely 256Kb parts rated at 125C or higher.

FRAM Road Map

Ramtron plans a full range of densities and operating temperatures to support automotive data handling and storage applications. In addition, the FRAM technology can easily be combined with logic and mixed signal technologies to offer more cost effective integrated solutions in the future.

Resources:

Ramtron International Corporation Web Site
http://www.ramtron.com