

by **Duncan Bennett**

Ramtron International

DYNAMIC DATA INTEGRITY IN AUTOMOTIVE INFOTAINMENT APPLICATIONS

Data requirements in all vehicle systems are increasing. However, in infotainment applications, the data changes as the user's environment changes and impacts system operation.

The quantity of dynamic data in today's infotainment applications is exploding. This data is often essential to the correct operation of a system and/or is user-centric, changing as the user's environment changes (e.g., local traffic information).

SUDDEN POWER LOSS

A common problem that many automotive infotainment systems designers face is sudden power loss. This typically occurs any time the engine is restarted after a stall. Power loss can cause data corruption and, therefore, disrupt proper system operation, unless provisions are designed in to maintain data integrity.

The following standard circuit techniques make the most of F-RAM nonvolatile memory to prevent the pitfalls of sudden power loss in automotive applications. The first is to replace an EEPROM + capacitor combination with F-RAM memory. F-RAM uses much less power than EEPROM and writes much more quickly, eliminating the need for a capacitor to keep the

power alive while writing is completed in a power-loss scenario. In addition, the F-RAM-based solution requires less physical board space than the EEPROM + capacitor combination, while the cost of eliminating the capacitor can prove a significant difference in applications that demand a large amount of capacitance.

The below two circuits are essentially equivalent.

F-RAM is commonly used when the system demands that data be stored upon power loss. The graph below shows a typical RC decay curve. The microcontroller (MCU) sees the power starting to fail at

3.1 V and has until Vdd reaches 2.8 V before the brown-out detector fires the reset of the MCU and prevents further writing. In the example below, the MCU only has 10 milliseconds between these two points—just enough time to write 1 byte or one page of data to an EEPROM. In the same time, it is possible to complete 50,000 writes to a serial peripheral interface (SPI) F-RAM device.

F-RAM has already been adopted in advanced navigation systems to maintain system integrity if the power suddenly fails. In systems that rely on a DVD for mapping information, F-RAM is used to record the position of the DVD reading

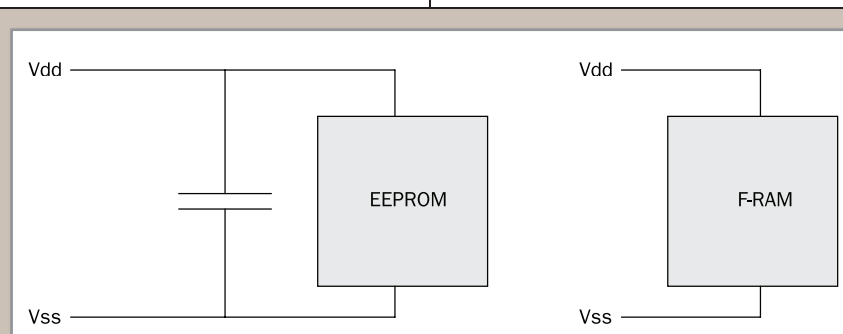


Figure 1. Standard circuit techniques.

head, so if power is unexpectedly lost (i.e., the vehicle engine stalls) the DVD player can quickly resume from its last position. The solution is to continuously write the position of the head to the F-RAM, making use of F-RAM's virtually unlimited endurance.

The same technique is commonly used in automotive DVD players to prevent data loss if the power fails. Movies recommence exactly where they stopped since the F-RAM knows the DVD reading head position. This is an essential feature to avoid the wrath of a child complaining that poor driving has caused the movie to restart.

F-RAM also solves the problem of navigation systems losing contact with enough satellites to make a firm position fix. This typically occurs when the vehicle enters a tunnel or an underground garage. If the position of the vehicle is being constantly stored in the F-RAM, the navigation system can use the F-RAM-stored position until a new satellite position fix is acquired. This also means that the position is available if power is suddenly lost. This type of continu-

ous writing is a common technique when using high-endurance F-RAM.

HIGH ENDURANCE/LOW POWER

Many of today's new automotive radio formats handle large quantities of data in addition to the regular audio channels. This data ranges from traffic or weather information to road conditions and should be available as soon as the driver starts the car. This means that the radio must download the data while the car engine is off. Since the system cannot know when the driver will return to the vehicle, it must download and store the data continuously.

While automobile manufacturers are demanding more sophisticated car radio systems, they are increasingly limiting the amount of power that can be drawn from the vehicle's electrical supply, particularly when the engine is off. This presents car infotainment designers with a very difficult challenge. F-RAM solves this because it can be written to as often as required, with no practical limitation on the memory's endurance. This means that data is written to the F-RAM whenever

data is available. And after writing, the radio enters a low power state to await the next wake up.

In addition, the power required to write to F-RAM is considerably lower than writing to EEPROM (approximately 1/60th for 64 kilobits), further reducing the overall power budget. EEPROM in this application would not suffice as it does not have enough endurance and consumes too much power when writing.

DYNAMIC DATA STORAGE

USB connectivity is being designed into new vehicles as a standard user interface. A USB connector allows the vehicle to access music collections stored on portable music players/flash drives via the vehicle's audio system. The USB interface must recognize a variety of available music storage devices and a variety of music (or video) file formats. It must be able to store playlists for different devices (e.g., MP3 players or USB flash drives). It must recall the last play points for each playlist on each device. This data is stored in the F-RAM so that the music resumes exactly where it stopped before the

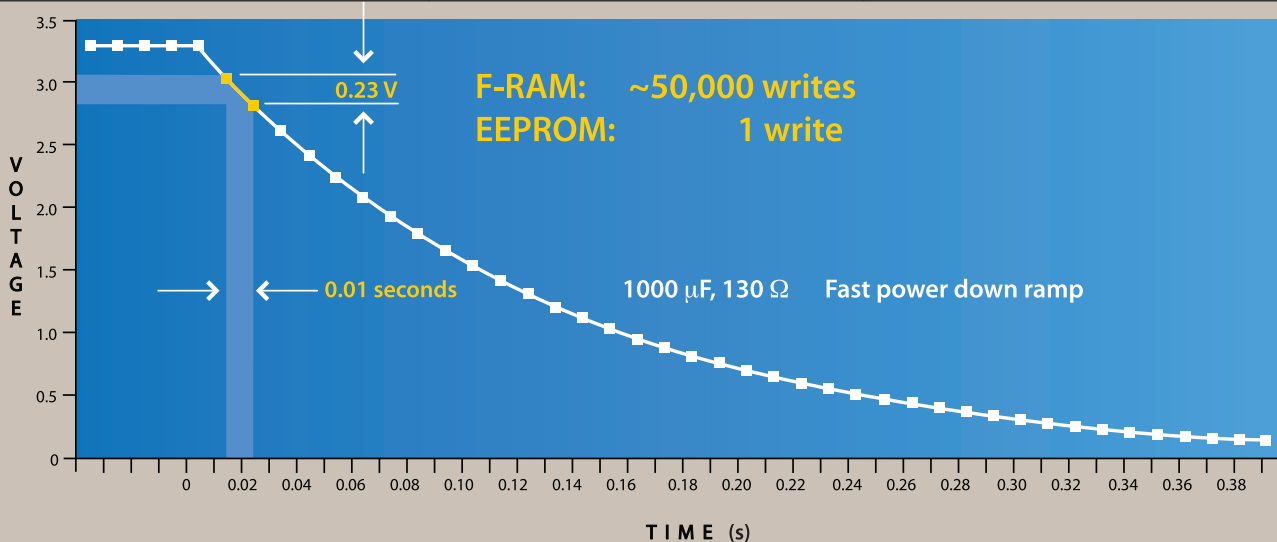


Figure 2. During fast power down ramp, F-RAM writes faster than EEPROM.

vehicle was turned off. F-RAM's non-volatility and high endurance enable these features.

Extensive data storage is also crucial in next-generation navigation systems. An exciting prospect for future navigation systems is its ability to access localized points-of-interest via a server connection. This dynamic data includes information on the car's immediate surroundings such as local restaurants, attractions, and activities. This constantly changing data is written to the F-RAM as quickly as the data becomes available, ensuring that the most recently acquired data is immediately available after a power interruption.

Another future development in navigation systems is the distribution of localized data. With the growth of electronic stability control, a vehicle can detect an icy patch in the road, send this information to the navigation system, which, in turn notifies the server. Other navigation systems interrogating the server are then warned of the road conditions.

Storage of dynamic data is also integral to many new car radio features. This data may be:

- Favorite artist/song: The radio remembers favorite songs/artists and changes stations if the artist/song is playing on another station.
- Favorite station: The radio records favorite radio stations as the car travels from area to area and tunes into those stations if the car makes a similar journey.
- Last station recall: The radio remembers the previous station and can switch back to it when prompted.

All of this dynamic data must be retained between journeys, requiring a storage memory that is nonvolatile, enables frequent writes, and often operates at low-power.

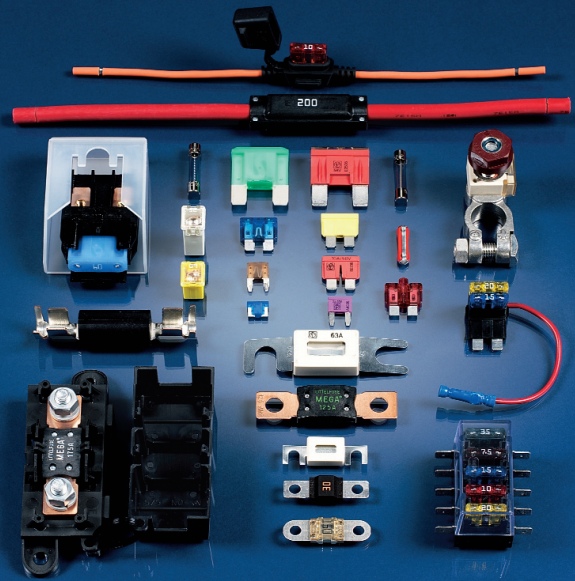
Dynamic data is a fundamental component of many automotive infotainment systems and protecting this data is essential. The unique advantages of F-RAM (fast writes, virtually unlimited endurance, and low-power) allow designers to guarantee that this dynamic data has higher availability and greater integrity. ■

ABOUT THE AUTHOR

Duncan Bennett is strategic marketing manager at Ramtron International where he is responsible for the definition of new products using Ramtron's F-RAM technology in automotive applications. Bennett spent 10 years as a senior design engineer at three different companies designing products ranging from control systems to high-end graphics processors. He can be contacted at duncan.bennett@ramtron.com.

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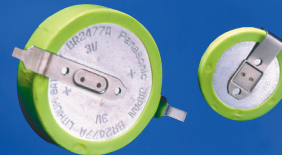
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