adesto® TECHNOLOGIES

Technology Note

Mavriq CBRAM for Medical Products

Gordon MacNee, Applications Engineer

Within the medical industry, electronics are finding their way into more applications, from large, high value imaging devices down to smart tags for blood products and surgical packs. Adesto offers an extremely low power, sterilization tolerant memory device to support this industry.

With the growth of intelligent medical devices and the uptake of smart electronics within the pharmaceutical industry, there is a growing need for devices capable of surviving sterilization through heat treatment or gamma irradiation. The electronics most susceptible to radiation damage are the nonvolatile memories.

Each gamma sterilization cycle typically exposes the electronics to approximately 35k Gray using cobalt-60 or cesium-137 isotopes.

FLASH, EEPROM, DRAM and SRAM memories use a 'floating gate' or a capacitor to store charge or use a simple latch to store state information. These cells are easily upset when bombarded with alpha particles, cosmic rays, UV light, gamma or x-rays. The result of a ray striking the memory cell is that the state may change leading to data, or more critically, program errors. Because these errors are not the result of damaged cells but are corrupted data, they are often referred to as 'soft errors' and can be corrected by resetting and reloading the program and configuration information from an uncorrupted source.

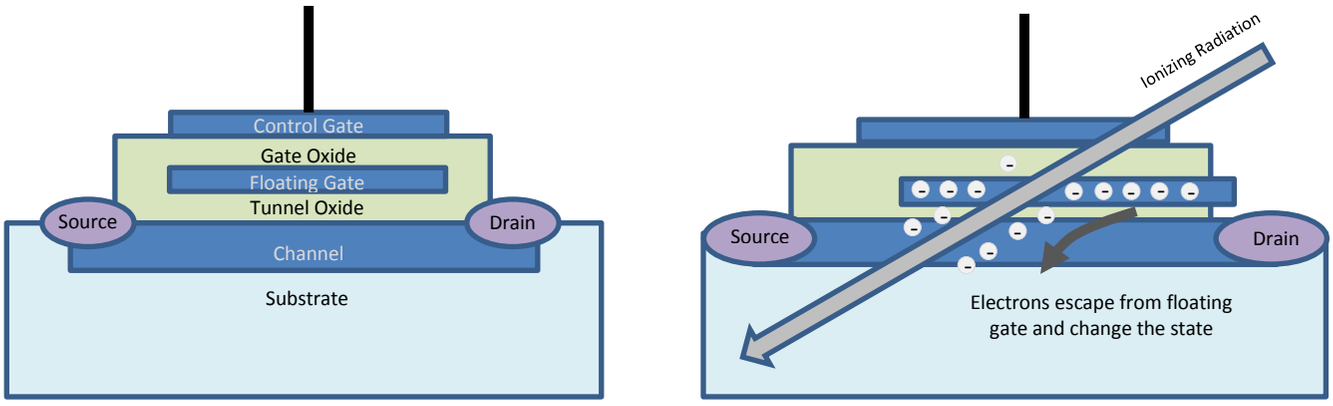


Figure 1. *Information Storage in a Floating Gate Memory.*

Another option is to use a 'radiation tolerant' memory technology that is not easily disrupted by exposure to radiation. Adesto's Conductive Bridging RAM (CBRAM®) technology meets this requirement.

Adesto's Mavriq™ CBRAM products are nonvolatile memory devices that operate similar to serial EEPROM with the advantages of a very fast write at a very low power. This makes Mavriq CBRAM an ideal memory for battery operated or energy harvesting devices such as RFID tagging, IoT, and 'wearables'. Mavriq CBRAM is also inherently radiation tolerant to levels well in excess of 200kGray due to its use of an electrically induced, reversible conductive bridge. With its fast, low power write and its ability to survive temperature and radiation sterilization, it is an excellent candidate for medical devices.

CBRAM is a simple technology constructed using an electrically insulating material sandwiched between two electrodes, one of which is electrochemically active. The memory effect is based on polarity-dependent resistance changes at very small voltage and currents due to the electrochemical rearrangement of metals in that insulating medium. Digital information is stored as logic “1” or “0” by the presence of absence of the conductive bridge. Unlike traditional Flash, CBRAM requires very low voltages and currents to cause this memory effect and hence is very attractive to be used in applications which are energy conscious or battery operated. Since data is stored as robust conductive links inside a dielectric, CBRAM is highly resistant to temperature and radiation.

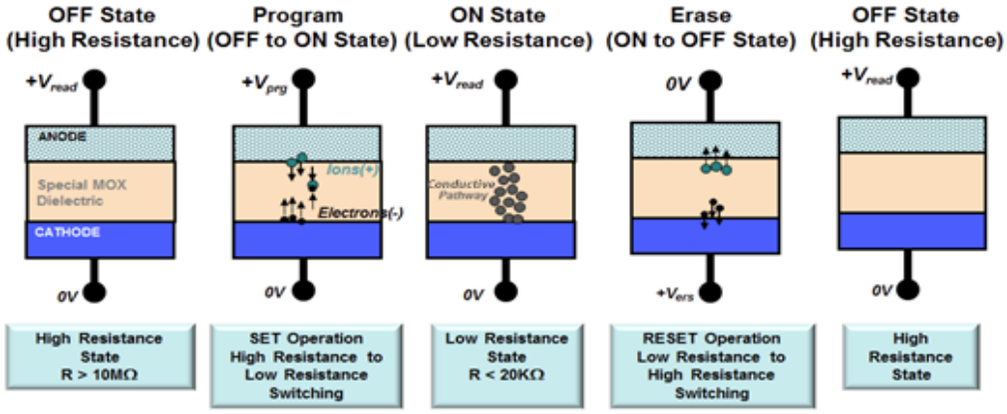
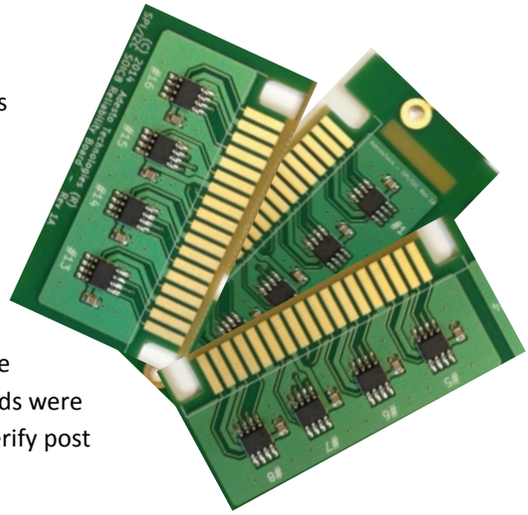


Figure 2. *Information Storage in CBRAM Technology.*

To determine the technology’s robustness against stresses imposed by different sterilization techniques (heat/radiation), a series of tests were conducted by Adesto Technologies in partnership with Nordion, Johnson and Johnson and Nutek Corporation.

Test Methodology



256 units of RM24EP64 64kBit Mavriq CBRAM were assembled on printed circuit boards (PCB) to verify sterilization tolerance. Units were preprogrammed with chip ID and data pattern (of alternating 1’s and 0’s) inside the memory array and then assembled on the PCB using standard infrared solder reflow which is very common in mass-manufacturing of electronics devices. Assembled boards were checked for data integrity before sending them for sterilization. This step is critical since the process involves stressing the product in heat up to 260C for 3 or 5 minutes. Gamma and e-beam sterilization were accomplished at different doses up to 200kGy (up to 8 times the typical dose) independently at Nordion, Nutek and Johnson and Johnson. Exposed boards were characterized for data retention and subjected to additional Program/Erase cycles to verify post radiation exposure product functionality.

Radiation Sterilization Tolerance

DOSE[1]	CBRAM	Flash/EEPROM
15 kGy	PASS	FAIL
25 kGy	PASS	FAIL
50 kGy	PASS	FAIL
100 kGy	PASS	FAIL
200 kGy	PASS	FAIL

Figure 3. *CBRAM products demonstrate immunity to Gamma and e-beam radiation, even at levels up to 200 kGy.*
[1]One gray is equal to 100 rads. Therefore the dosage range of 25 - 35 kGy is equivalent to 2.5 - 3.5 Mrad.

Results: **Data retention and product functionality were unaffected by radiation.** Zero errors were detected in all the units (including the ones exposed to 200kGy) and all units could successfully be operated or programmed and erased after exposure. CBRAM products also demonstrate immunity to heat during solder reflow and harsh radiation during sterilization.

Product designs utilizing Mavriq CBRAM benefit from reduction of manufacturing logistics and added device functionality. This increases sterilization options for the medical device designer.

With high reliability and excellent operating performance, Adesto's Mavriq code and data storage solutions are well matched to the sterilization requirements of the medical and healthcare industry.

adesto® TECHNOLOGIES

1250 Borregas Avenue
Sunnyvale, CA 94089
Phone: (+1) 408.400.0578
Email: contact@adestotech.com