A Comparison Between NVSRAMs and BBSRAMs

AN6022

Introduction

Memories that offer a combination of SRAM features along with nonvolatility have several advantages in a system. Several memory technologies have tried to create an ideal SRAM-nonvolatile memory, but have not met performance expectations.

Cypress is introducing a family of high-speed, high-performance NonVolatile Static Random Access Memory (NVSRAM) products that include the performance characteristics of a high-speed SRAM with that of a nonvolatile cell. These NVSRAMs back up data into an internal shadow EEPROM from the SRAM. The other nonvolatile memory solution that mimics this is the Battery-Backed SRAM (BBSRAM). BBSRAMs back up SRAM data using an external battery.

This application note discusses the key differences between NVSRAMs and BBSRAMs.

NVSRAM

Cypress NVSRAMs have a high-performance SRAM with integrated shadow EEPROM for each bit. All standard Read and Write operations go through the SRAM array providing a high speed access path. Information is made nonvolatile by transferring the contents of the SRAM to EEPROM integrated with the SRAM cell, which takes less than 10 ms. This transfer, known as a STORE operation, is initiated automatically on power down (AutoStore™), by asserting an input pin LOW (Hardware STORE), or by executing a software sequence (Software STORE). The contents are loaded back into the SRAM either automatically on power up or by executing a software sequence (RECALL). A functional block diagram of the NVSRAM is shown in Figure 1.

BBSRAM

BBSRAMs are multichip memory products with an internal lithium power source, a low power SRAM, and a self contained control circuitry that constantly monitors the supply voltage for an out-of-tolerance condition. When such a condition occurs, the lithium battery switches ON and the information is made nonvolatile. A functional block diagram of the BBSRAM is shown in Figure 2.

Product Comparison

The key parameters determining the performance of both NVSRAM and BBSRAM are:

- Data Retention
- Access Time
- Package Size

I_{CC} and I_{SB} differences are not compared as these are not significant in systems using these products

The following section discusses these and a few other parameters in detail.

Figure 1. Block Diagram of NVSRAM

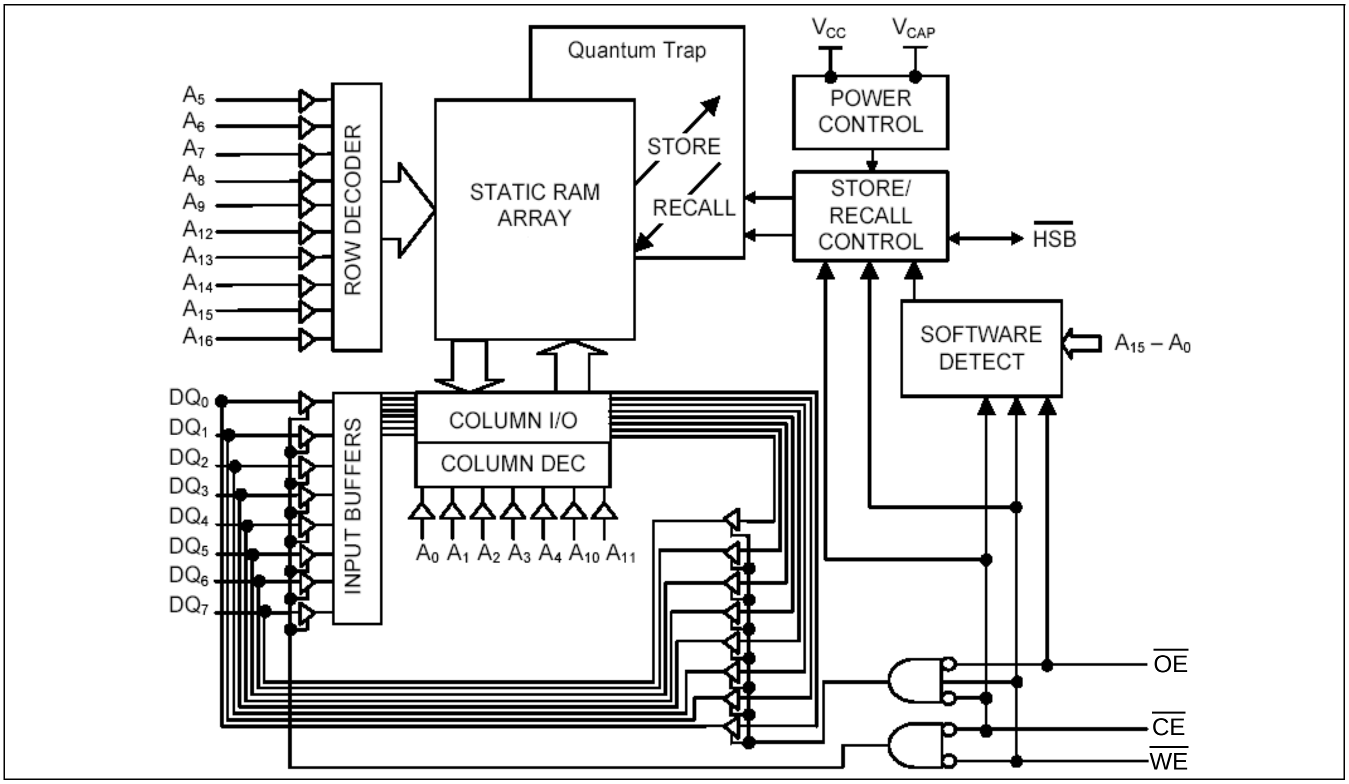
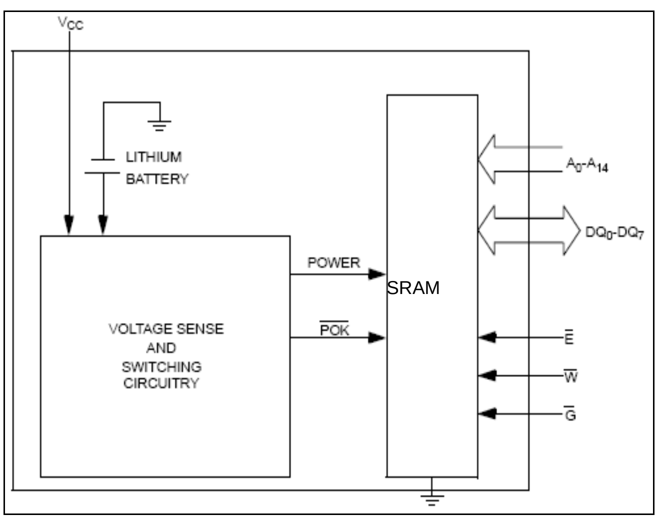


Figure 2. Block Diagram of BBSRAM



Data Retention

Data Retention is defined as the time during which the data stored remains in the nonvolatile elements of the memory. The NVSRAM has a fixed data retention, whereas the BBSRAM has a fixed product lifetime due to the battery.

The NVSRAM guarantees data retention of 20 years. The BBSRAM ceases to function as a nonvolatile memory once the battery loses its charge, typically 5–10 years in commercial systems.

The nonvolatile memory element in the NVSRAM is an EEPROM cell. This cell consists of a nitride insulator and a thin oxide insulator sandwiched between a conductor and the silicon surface. The programming charge is stored in the nitride insulator. Injection of charge into the nitride layer is controlled by the electric field between the conductors.

Data retention is determined by the insulator's ability to hold the charge. As the EEPROM cell is written to and erased or the temperature increased, the insulator will tend to permit more charge leakage. Thus, data retention of the NVSRAM is determined by the operating temperature and the number of STORE operations performed.

In BBSRAMs, the battery lifetime is reduced by two major factors:

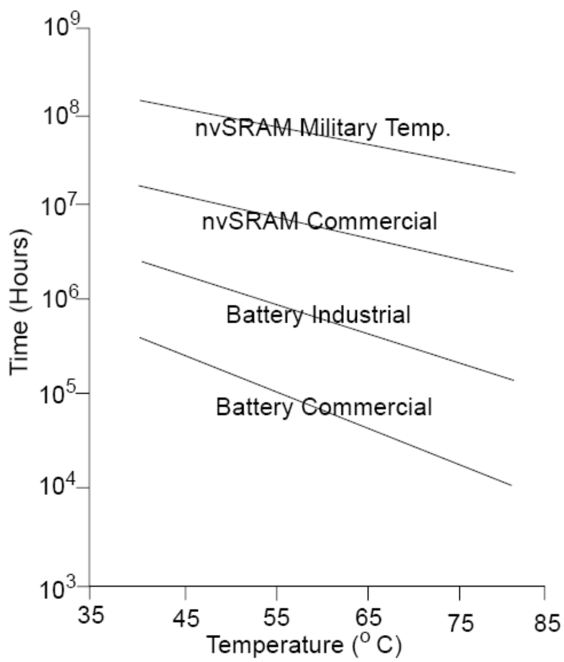
- Current drain from memory circuits
- Evaporation of electrolyte

The first of these depends on the current requirements of the memory, and is the predominant factor determining lifetime at room temperature. At 70°C, however, the rate of evaporation is such that disconnecting the battery from the memory does not extend its life. At 85°C, the battery will typically last no more than two years.

Figure 3 shows the data retention capabilities of NVSRAM and BBSRAM with increased temperature. As can be seen from the figure, the mean time to failure for a Battery-Backed SRAM device reduces drastically with increase in temperature. NVSRAM, on the other hand, has a much slower degradation in performance with increased temperature.

Uncontrolled power down sequences can have additional detrimental effects on the battery's life. In particular, V_{CC} undershoots due to ringing on power down can cause current to be drawn from the battery.

Figure 3. Data Retention vs. Temperature



Access Times

During normal SRAM operations, functionality of Cypress NVSRAM and BBSRAM devices are identical.

Cypress nonvolatile SRAMs are available in access times of 15 ns through 45 ns. To reduce the current drain on the battery and maximize data retention, BBSRAM devices use SRAMs with low standby power consumption and sacrifice access times in the process. The fastest BBSRAM devices have 70-ns to 100-ns access times.

Board Space

Systems implementing BBSRAMs must compromise on board space in height or width (or both) to accommodate the battery. Typical packaging ranges from 360 mil x 600 mil to 450 mil x 720 mil.

Cypress NVSRAM devices are available in space-saving true surface mount packages such as 300-mil SOIC and SSOP packages.

Figure 4 shows a comparison of the package dimensions of NVSRAM and BBSRAM

Board Assembly

Reflow solder operations cannot include batteries due to risk of explosion. BBSRAM products are therefore typically socketed.

Cypress NVSRAM devices have no restrictions on flow soldering.

System Reliability

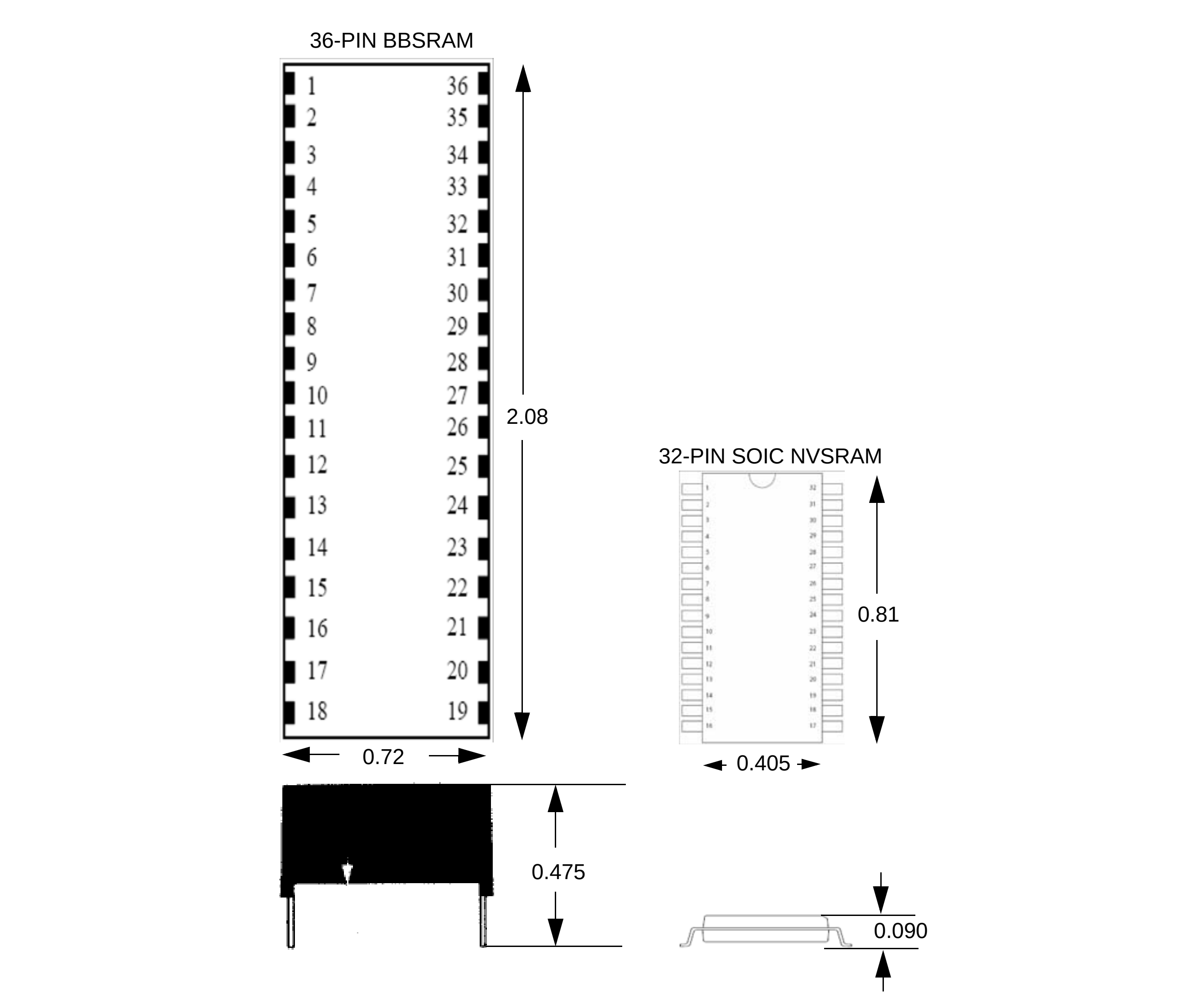
Data integrity becomes questionable when using BBSRAMs. They are vulnerable to shocks and vibrations. Data can be lost if there is a lack of proper contact of the device with the battery. Also, battery lifetimes are unpredictable and this introduces an additional level of failure point in most systems. BBSRAMs are vulnerable to moisture and dust due to multi-component assembly.

Output Current

Most BBSRAMs have an output current specification in the range of 1 mA to 2 mA. Low output drive current will restrict the ability to drive higher output loads and also result in slower access times with high output loads.

The output current capability of an NVSRAM is higher than BBSRAMs and is in the range of 4 mA to 8 mA.

Figure 4. Comparison of Package Dimensions between NVSRAM and BBSRAM



Comparison of Specifications

The following table summarizes the comparison of some important specifications of NVSRAMs as against BBSRAMs.

Table 1. Specification Comparison

Parameters	Cypress NVSRAM	BBSRAM
Speed (ns)	15/25/35	70/100
Data Retention (Years)	20	10
Output Current	4 mA	2 mA
Package Size	300 mil SOIC	720-mil DIP (height: 450 mil) 600-mil DIP (height: 360 mil)

Summary

NVSRAMs have a clear edge over the BBSRAM devices with respect to data retention, access times and package size. For systems requiring almost infinite endurance, high data retention and high-speed access to data stored in the memory, NVSRAMs are a great fit.

In March of 2007, Cypress recataloged all of its Application Notes using a new documentation number and revision code. This new documentation number and revision code (001-14733, beginning with rev. **), located in the footer of the document, will be used in all subsequent revisions.

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