WHITE PAPER

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nvSRAM in Portable Ultrasound Scanners

Abstract

Ultrasound is a procedure that uses high-frequency sound waves to view internal organs and produce images of the human body. Portable ultrasound scanners are small and compact in size and provide unique combination of user-friendliness, reliability and affordability for doctors and users all over the world. Portable ultrasound scanners use non volatile memory to keep the record of patient's data in real time and retain it when its power is switched off.

This white paper discusses the benefits of using Cypress' nvSRAM in comparison to the other nonvolatile RAMs (Random Access Memory) in portable ultrasound scanners.

What are Ultrasound Scanners?

Medical sonography (Ultrasonography) is an ultrasound-based diagnostic medical imaging technique used to visualize muscles, tendons, and other internal organs for their size, structure, and any pathological lesions with real time images.

Ultrasonography uses a probe containing one or more acoustic transducers to send pulses of sound into a material. When a sound wave encounters a material with a different density (acoustical impedance), part of the sound wave is reflected back to the probe and is detected as an echo. The time taken for the echo to travel back to the probe is measured and used to calculate the depth of the tissue interface causing the echo. The greater the difference between acoustic impedances, the larger the echo. If the pulse hits gases or solids, the density difference is so great that most of the acoustic energy is reflected and it becomes impossible to see deeper.

The frequencies used for medical imaging are generally in the range of 1 MHz to 18 MHz. Higher frequencies have correspondingly smaller wavelength and are used to make sonograms with more details. However, the attenuation of the sound wave is increased at higher frequencies. Therefore, to have better penetration of deeper tissues, a lower frequency (3 MHz to 5 MHz) is used.

Observing deep into the body is very difficult with sonography. Some acoustic energy is lost every time an echo is formed, but most of it is lost from acoustic absorption.

The speed of sound is different in different materials and is dependent on the acoustical impedance of the material. However, the sonographic instrument assumes that the acoustic velocity is constant at 1540 m/sec. An effect of this assumption is that in a real body with non-uniform tissues, the beam loses focus and the image resolution is reduced.

Portable Ultrasound Scanners

The new generation of ultrasound scanners is portable and all functions are controlled remotely. This facilitates better communication with the patient during examination. Patients feel more at ease when there is no machine between them and the operator. With remote control, there is 'Fingertip control'; that is, any system function can be operated remotely at the touch of a button. It also provides the flexibility to position the system anywhere in a room, creating the most effective setting.

The method to remotely configure and service a field replaceable unit associated with a medical diagnostic system includes:

- Establishing a communication connection between the medical diagnostic system and a remote facility.
- Communicating identification information from an electronic device, coupled to the field replaceable unit, to the remote facility.
- Communicating configuration information from the remote facility to the medical diagnostic system.
- Configuring the medical diagnostic system in accordance with the configuration information from the remote control facility.

A corresponding apparatus includes a memory unit configured to store identification indicia associated with the field replaceable unit. It also has a communication interface to communicate identification information from the identification indicia to a remote facility.

This memory unit must be nonvolatile because it contains the identification and configuration information and a system cannot be identified and configured every time it is powered on. It is also important to retain the previous configuration when the system is powered on. Because systems are portable, ensure that data is preserved when the device is not powered.

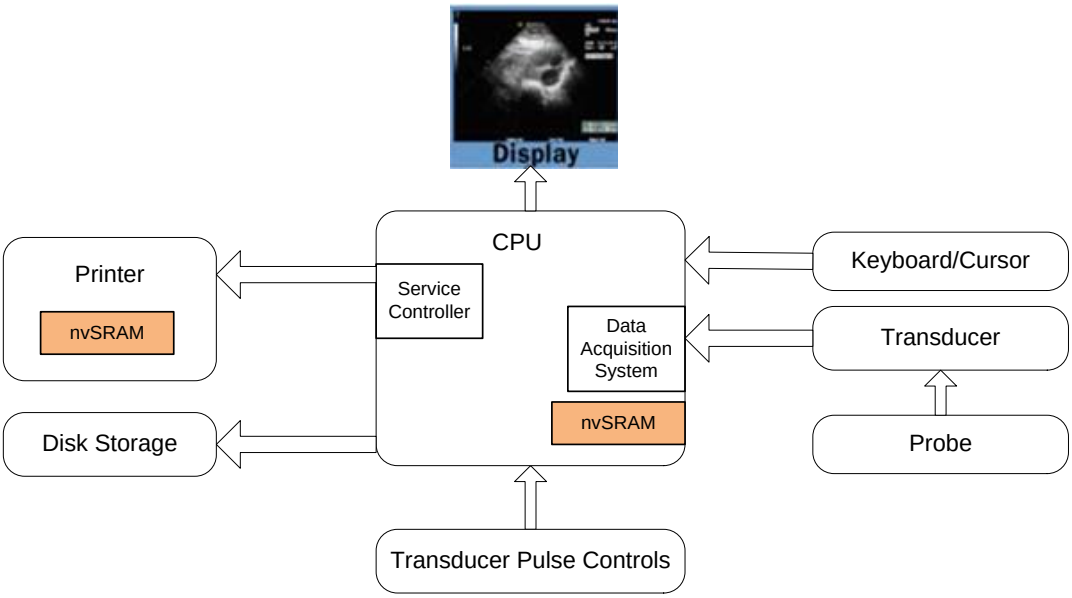
This memory must also be similar to RAM because the configuration information changes when the user modifies it and there is no limit to the number of times a user can do so.

The available solutions for such a nonvolatile RAM memory are nvSRAMs, BBSRAMs, MRAMs, and FRAM. Currently some scanners use the BBSRAM, but the nvSRAM scores over it. It does not incorporate a battery, and is therefore cleaner and smaller. There is no risk of losing data at the end of battery life.

Also most portable ultrasound scanners provide nonvolatile image and report memory (NVIRM). This also calls for the nvSRAM because the images occur at a fast rate and must be stored accordingly. For example, L&T Medical's Selectra Lx provides NVIRM for storage and retrieval of 100 images and 40 reports, with user editable report formats. The nvSRAM is a high speed SRAM and supports fast read/write cycles at 20 ns (the best in the industry).

Figure 1 shows a typical ultrasound scanner. The major components of such a system are the transducer, display, and the processing unit. The data from the transducer is continuous and the data acquisition system stores it in a temporary memory, before printing/storing it permanently in disk storage.

Figure 1. Typical Block Diagram of Ultrasound Scanner



The transducer receives the echo of the wave it transmits which is processed in the data acquisition system. It first digitizes the analog data through an ADC. The intensity of the wave and its total travel time are required. This occurs continuously at high speeds and needs to be stored accordingly for further processing. Since the portable data acquisition system is a standalone system and the acquired data is critical, it should be nonvolatile. Thus, the data acquisition system is interfaced with an nvSRAM. The nvSRAM is also used to store the configuration information of the scanner. Once the data is processed and the images and reports generated, they are displayed and can also be stored in the NVIRM, which again calls for the nvSRAM. The printer in ultrasound scanner shares the nonvolatile memory space and stores the configuration details in the nvSRAM.

Why use Cypress' nvSRAMs in ultrasound scanners?

The following key characteristics make nvSRAM the most suitable choice of nonvolatile RAM memory in this application.

Fast access, eliminates nonvolatile memory write speed barrier

nvSRAM offers industry standard parallel and serial access which allows data write at 20 ns speed in case of parallel (Asynchronous mode) transfer and up to 104 MHz in case of serial SPI. Data write and read to the nvSRAM cells happen at the speed of processor bus, thus allowing controllers to write into nvSRAM cells directly rather than storing first into an on-chip SRAM buffer and then transferring to external memory such as EEPROM/Flash due to its slow page based access.

No page writing mechanism, allows entire memory access using a single write command in bulk mode

A typical non volatile memory such as EEPROM or FLASH require a write cycle of ~6 ms for every page data transfer from buffer to the non volatile memory. This result in long write times when several kilo bytes of data need to be written. The nvSRAM does not suffer from this write slowdown; all writes occur at the bus speed and there is no memory-based latency. Cypress's nvSRAM products operate just like a standard SRAM under all combinations of temperature and supply voltage. This is much faster than EEPROM technology, and shortens the amount of time needed to transfer blocks of data to a non volatile memory.

No endurance limitations, free from wear leveling overheads

A write operation takes place directly to the SRAM cell of nvSRAM at the bus speed. Like any other standard SRAM, the nvSRAM offers unlimited write endurance cycles. This makes nvSRAM a superior nonvolatile memory product for all data logging applications. Many applications restrict data logging time intervals only due to the finite write endurance cycles offered by EERPOM and Flash and thus compromising on data logging interval (granularity). The nvSRAM removes this barrier by offering unlimited endurance cycles which provides system designer freedom to reduce the data sampling and logging interval to the shortest possible duration which is limited to system's capability.

Scalable CMOS technology, a clear future roadmap

Cypress's nvSRAM technology is built on standard CMOS processes in volume production and can be ported to almost any CMOS backplane. In contrast, more recent, novel technologies such as MRAM rely on the magnetic properties of a specialized material which is hard to integrate into the normal silicon manufacturing flow. Consequently, the nvSRAM devices have both the advantages as lower cost per bit and total cost of design-in over time.

High Reliability, an ideal requirement for critical data storage

Data reliability of entries is important to attain the goals of accuracy, consistency, and more importantly, durability. The nvSRAM technology has proven its reliability in challenging Avionics, Military, Industrial, and communications applications for nearly two decades.

Integrated Real Time Clock, reduced BOM and board space

Many metering systems prefer to time stamp the metrological data. This typically requires an additional RTC device increasing the total BOM cost and board area. While using nvSRAM, this is not a concern as nvSRAM comes with the option of integrated RTC. This not only reduces the BOM but also uses fewer pins for the metering controllers and frees up the resources required to interface with the external RTC device.

Standard package options, footprint compatibility with the other non volatile memory products

Cypress's nvSRAM devices are available in industry standard package options for serial and parallel nvSRAM products. Standard package options make system designer's life easier and allow them in migrating from the existing vendor to an alternate vendor without requiring any change in the PCB.

Summary

The Cypress nvSRAM fits into more than one place in ultrasound scanners. It is used to store system configuration and for Non Volatile Image and Report Memory (NVIRM). When acquiring data from the transducer, the nvSRAM can replace the functions of a ROM, nvRAM, clock, and EEPROM, and thus provide an integrated high speed solution.

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