White Paper

Low-Cost Integration of Serial EEPROMs and Flash Memory Devices

Introduction

In many applications, non-volatile memory needs are addressed by general-purpose serial-interface electrically erasable programmable read-only memories (EEPROMs) or flash memory devices, especially since they offer low pin-count, small packages, low voltage operation, and low power consumption. Nevertheless, designers still face the challenge of reducing board space and total system cost. Many of the uses for these memory devices are related to system configuration, manufacturing, and security. The functionality provided by serial EEPROMs and some flash devices in these applications can be integrated into a MAX® II CPLD, which offers an 8-Kbit flash storage block called the user flash memory (UFM). The UFM allows users to integrate existing serial EEPROMs on a board, reducing total system cost, minimizing board space, and offering higher reliability and better manufacturability.

Serial EEPROM and Flash Memory Device Challenges

As electronic systems continue to shrink, the demand for smaller board sizes increases. The packaging of a product is defined by board size and is driven by the number of components. Board components are a direct function of the end-product cost: the more components on a board, the more expensive the end product. Assembly costs, shipping costs, programming costs, and additional support circuitry for serial EEPROMs and flash devices add to total board cost, increasing the cost of the end product.

Power consumption and reliability are other challenges design engineers face; the fewer devices resident on the board, the lower the power consumption. The potential for improved reliability of the end product also increases. Power dissipation can be reduced by using a single part instead of having to power-up several devices on the board that may not be fully utilized. Using a single part instead of several parts also reduces the chance of encountering bad solder joints on the board, which may lead to intermittent failures.

Yet another challenge faced by engineers is device obsolescence. Discrete devices such as serial EEPROMs and flash memory devices often become obsolete over time due to process technology advances and are discontinued. As a result, system designers using these devices can be forced into costly and time-consuming hardware and software re-designs.

User Flash Memory Reduces Board Space and Total System Cost

The functionality provided by serial EEPROMs and some flash memory devices can be integrated into the Altera® MAX II CPLD, which offers an 8-Kbit flash storage block or UFM. The UFM reduces the number of board components, which in turn reduces total system cost. Table 1 below shows a comparison of the costs and features of some serial EEPROM devices and CPLD solutions. MAX II CPLDs can deliver a lower overall cost as they offer programmable logic resources that can integrate other functions on the board, reducing board space and system complexity. MAX II CPLDs also provide a better alternative to serial EEPROM devices in that they provide a flexible user interface to the memory, and are not prone to obsolescence.

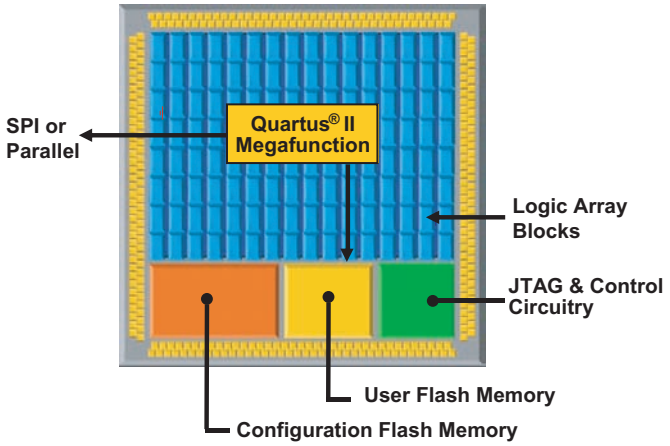
Table 1. Pricing of Serial EEPROM Devices and CPLD Solutions

Solution	Memory Size (Kbits)	User Flash Memory	Memory User Interface	Obsolescence Proof	Approximate Solution Price *(1)*
Altera MAX II EPM240T100C5	8	✔	SPI, I^2C, Core Logic	✔	$5.40
Altera MAX II EPM570T100C5	8	✔	SPI, I^2C, Core Logic	✔	$12.00
ST Microelectronics M95080-W and non-Altera CPLD *(2)*	8		SPI		$16.00-$21.00
Microchip Technology 24AA04 and non-Altera CPLD	4		I^2C		$17.00-$22.00
Philips Semiconductor PCF8598C2N and non-Altera CPLD	8		I^2C		$22.00-$27.00

Notes:
(1) Pricing based on 100-unit list price
(2) An example non-Altera CPLD is the Lattice Semiconductor LC4256V-75TN100C (priced at $17.60 for 100 units).

The UFM block is partitioned into two sectors that can be erased, read, and written independently. The interface to the UFM uses a serial input for address and data, and a serial output for data output. The addressable data size is 16 bits, and data is read out serially in 16-bit words. An auto-increment option allows the user to send one address to the UFM and have it automatically increment the address and shift out consecutive locations of data. The UFM also interfaces with JTAG circuitry and core logic, giving designers the flexibility to write to the device in a variety of ways (see Figure 1). Using a simple GUI-based megafunction in development software, a user can interface to a standard bus such as serial peripheral interface (SPI), I^2C, or parallel, or to a proprietary interface.

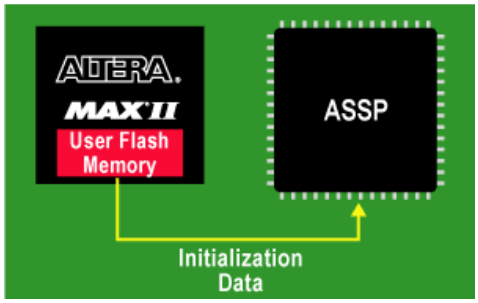
Figure 1. User Flash Memory Interface to Core Logic and JTAG



Non-Volatile Memory for System Configuration

Microprocessors, ASSPs, ASICs, and microcontrollers often require configuration data to power up. Microprocessors and ASSPs use boot configuration data to define initial states and basic system information, such as bus widths. Typically, processors require between 256 and 1,000 bits of configuration data and ASSPs and ASICs require between 1,000 and 4,000 bits. Many system boards use serial EEPROM or flash devices to store this configuration data. Alternatively, the UFM provides a single-chip, low-cost solution that can replace any serial EEPROM or general-purpose flash on the board used for boot-up and configuration of the devices (shown in Figure 2).

Figure 2. Integrating Serial EEPROM Functions in the User Flash Memory



The UFM also can be used in board design where system designers are increasingly using serial EEPROMs instead of dual in-line package (DIP) switches and jumpers to configure their boards. This configuration data can control system parameters such as memory configuration, IP or port address, or peripheral address specification (e.g., USB).

Non-Volatile Memory for Board Manufacturing

Serial EEPROMs and small flash devices are sometimes used in the board manufacturing process, where an electronic identification code is used to identify boards. These electronic IDs hold generic information and board-specific information such as date of manufacture, board serial number and product identification, and PC board and test program revision.

The UFM can be used to implement the same functionality at a lower cost in a single-chip solution. Using the UFM instead of serial EEPROM devices to write, read, and store the electronic ID enables board manufacturers to use the JTAG port, potentially saving costs in cases where edge connector pins or an additional header had previously been used. The UFM can also replace serial EEPROMs that are used in security-related applications, such as identifying the board installed and determining its compatibility with the system, before powering up and enabling it.

Ease RoHS Transition With Altera Products

Altera maintains one of the most extensive RoHS-compliant product offerings in the industry, with over 1200 products in lead-free packages. As a preeminent supplier of environmentally friendly programmable logic solutions, Altera has shipped over 25 million RoHS-compliant products since 2002. Altera's devices comply with the maximum concentration restrictions, as required in the EU Directive on the Restriction of Hazardous Substances ("RoHS Directive") No.2002/95 with respect to lead (Pb), mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB), and polybrominated diphenyl ethers (PBDE). Help ease your RoHS transition by integrating non-compliant ASSPs with Altera's PLDs.

Conclusion

The UFM supported in MAX II CPLDs offers several key benefits over existing serial EEPROMs and flash memory devices. The UFM allows users to integrate existing serial EEPROMs on a board, reducing total system cost and minimizing board space. In addition, the UFM offers higher reliability, better manufacturability, and better memory interface flexibility. For most applications where serial EEPROMs and flash memory devices are used, the UFM feature provides a compelling solution for replacing these devices.

Additional Resources

- Integrate Serial EEPROM and Flash Devices to Reduce Costs:
  www.altera.com/technology/integration/eeprom/int-eeprom.html
- MAX II CPLD Family: The Lowest-Power, Lowest-Cost CPLDs Ever:
  www.altera.com/products/devices/cpld/max2/mx2-index.jsp
- *Replacing Serial EEPROMs With MAX II User Flash Memory*:
  www.altera.com/literature/hb/max2/max2_mii51012.pdf

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