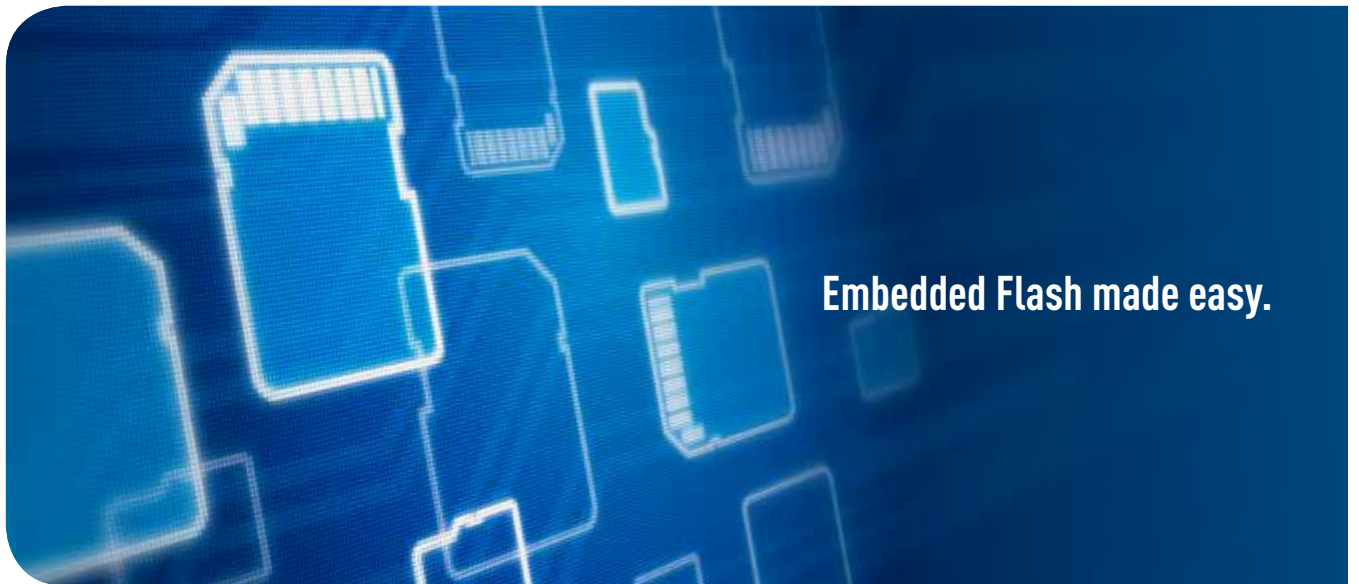


Fail-safe Flash Translation Layer



There are many NAND and NOR Flash memory devices, interfaces and technologies that developers can choose. Integrating them reliably and achieving the maximum potential life and high performance presents a significant design challenge. HCC has developed robust fail-safe flash management software and file systems and has support for hundreds of different kinds of memory types, interfaces and controllers. HCC's truly fail-safe SafeFTL Flash Translation Layer provides a high-performance solution that allows developers to interface to any Flash-based media. SafeFTL presents a simple logical sector interface to an application, such as a file system, and manages the underlying complexity efficiently and safely. When used in conjunction with HCC's advanced file systems there is a complete solution for almost any type of media and performance requirement.

■ Key Features

- Up to 4 Terabytes in single wear-leveled array
- High performance, small footprint
- Multi-chip arrays
- Zero copy block read/write
- Cache options
- Support up to 16kB page size
- Fail-safe from unexpected reset
- Effective wear-leveling algorithms
- Bad block management
- Automatic garbage collection
- Support for all common NAND/NOR devices
- Flash drivers and ECC algorithms
- Typically >98% of blocks available
- Fast initialization
- SLC, MLC, multi-plane support
- Optimized random read/write
- Parallel programming
- ONFI driver
- CFI driver
- Secure Data Erase

■ Flash Management Technologies

Enhanced Wear-leveling: Flash cells have a limited life and can only be erased/programmed a certain number of times before becoming unreliable – in effect they ‘wear out’. Wear-leveling algorithms are used to maximize the life of the chip by moving the data between physical blocks to ensure some cells are not overused by comparison to others. HCC has developed sophisticated Static and Dynamic wear-leveling algorithms that maximize the life of the Flash device. These algorithms can be fine-tuned to match the performance requirements.

Error Correction Codes (ECC): The worst-case rate at which wear occurs is defined by the flash manufacturer. Error Correction Codes are used to ensure the data is always consistent if used within the chip specification. The strength of the required ECC is defined by the worst-case bit failure rate. HCC provides algorithms for ECC or can work with controller based ECC solutions when they are essential for Flash with higher bit error rates. HCC also provides experience and expertise to ensure the performance meets system requirements.

Bad Block Management: Flash memory contains blocks that may be error-prone or unusable when the device is new. During operation, data in „good blocks” can later be corrupted by charge leakage or disturbance from writes in adjacent parts of the chip. SafeFTL provides management of bad blocks and maps unusable areas to ensure that data is not corrupted.

Secure Data Erase: data written to flash is always written to a new page and that page is re-mapped. When data is overwritten it will not be accessible using a normal read operation but it may still persist for some time. An optional secure data erase command can be used to ensure overwritten data is immediately and permanently erased.

■ Fail Safety

Conventional file systems are not fail-safe and often experience difficulties when common problems such as power loss or unexpected resets occur. When SafeFTL is used in a correctly designed system, it will guarantee that data will always be consistent. In order to ensure the maximum integrity, the underlying media drivers are also designed to provide fail-safe behavior. HCC takes great care to ensure that file systems are truly fail-safe and are capable of providing a system level review ensuring that the system exhibits correct behavior. Contact your local HCC sales representative if you would like to discuss system level safety.

Flash Support

HCC provide support for a significant range of technologies from a single, sub-megabyte NOR Flash to a multi-Terra-byte array of NAND Flash. Most devices can be supported easily using our off-the-shelf solutions that include a large array of drives for specific types of flash.

SafeFTL

SafeFTL has been tested with an extensive range of embedded and standalone flash controllers, NAND and NOR flash devices. Devices supported come from manufacturers including Atmel, Intel, Micron, Toshiba, Hynix, Samsung, Spansion, Numonyx, Macronix, Winbond and many others.

	Wear-leveling	BBM	ECC Support	Fail-safe
NAND Flash	Y	Y	Y	Y
NOR Flash	Y	Y	Y	Y
Small Sector NOR	Y	Y	Y	Y

Atmel Dataflash Management Layer (DFML)

Atmel DataFlash is the world's leading serial flash memory family. It contains a number of features that make it an excellent choice both for embedded applications and HCC's file system solutions. HCC's DFML is designed to be a clean interface layer between a file system and DataFlash devices. It provides a substantial set of features:

- A reliable and fail-safe page write operation, ensuring that critical data will always be reliably written to the device even in the event of power loss
- A normal page write for non-critical data
- Managed sectors set aside for non-file system usage
- Unmanaged sector reservation for private functions, such as boot memory operations
- 10K random write per sector refresh operations are managed transparently
- Optional error correction algorithms for added reliability
- Enhanced wear leveling operations
- Support for multiple devices in a single array



DFML provides a robust DataFlash management and file system for a PC-compatible or fail-safe application. It supports all serial DataFlash and DataFlash cards from 1Mbit – 64Mbit.

SSD Flash Translation Layer (SSD-FTL)

SSD-FTL has a different set of design parameters from the standard fail-safe FTL. SSD-FTL is designed to maximize performance and longevity for large arrays of NAND flash while retaining fail-safety. It supports parallel read/write across multiple planes and/or physical devices. In addition to advanced wear-leveling, SSD-FTL includes early detection and repair of failing blocks and algorithms to handle read-disturb problems. SSD-FTL focuses on ultra-fast performance and therefore requires more RAM than Safe-FTL with the benefit of exceptional speed for parallel read/write operations, particularly random read/write operations.

■ Compatible File Systems



HCC's Flash Translation Layers hide the complexity of managing physical arrays of flash from the user. Any file system that can address a set of logical sectors can use the FTL as a drive. This means that any of HCC's relevant file systems such as FAT, SafeFAT or THIN can be easily used in conjunction with FTL to provide a complete solution for NAND/NOR Flash.

■ Broad Range of Target Processors & Tools

HCC's SafeFTL can operate efficiently on a broad range of target processors. Designed so that it can be ported easily and quickly to new architectures, it is available for a large number of leading processors and Flash controllers.

RTOS Abstractions

RTOS abstractions are available for the following systems: CMX RTX, eCOS, emBOS, EUROS, FreeRTOS, Keil RTX, Nucleus, Quadros RTXC, ThreadX, μ -velOSity, μ C/OS-II, and many others. Importantly, for custom schedulers and super loops, HCC offers an abstraction for 'No RTOS'. We also offer our own eTaskSync, a small cooperative scheduler, which is designed to handle all processing and interface requirements of HCC middleware. This means that developers can choose our robust quality and outstanding performance irrespective of their legacy software.

Extensive Compiler Support

Eclipse/GCC, IAR Embedded Workbench, Keil ARM Compiler, Freescale CodeWarrior, Atmel AVR Studio, Green Hills Multi, Microchip MPLAB, Renesas HEW, TI Code Composer Studio, Mentor CodeSourcery, Atollic True Studio and many more.

Microcontrollers

ARM Cortex-M0/M1/M3/M4/R4/A8, ARM7/9/11; **Atmel** AVR32, SAM3/4/7/9; **Freescale** ColdFire, Kinetis, PowerPC, i.MX, Vybrid, QorIQ; **Infineon** C164, XMC1000, XMC4000; **Microchip** PIC24, PIC32; **NXP** LPC1300/1700/1800/2000/3000/4000; **Renesas** SuperH, RX, RL, 78k; **SiliconLabs** EFM32, SIM3; **Spansion** FMO/FM3/FM4; **STMicroelectronics** STM32; **Texas Instruments** MSP430, Stellaris, C2000, Hercules, DaVinci, Sitara, Tiva; **Toshiba** TMP M0/M3;

■ Licensing & Purchasing

All HCC reusable software components are royalty-free and distributed in source form with support and maintenance included for one year with all purchases. We deliver sample projects tailored to an environment agreed with customers to ensure the quickest possible start. Visit HCC's website to find a sample license and to obtain the contact details of your local sales representative. Or, simply send an email to info@hcc-embedded.com and we will send all the details you require.

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