

Flash storage testing

- EF eMMC Tester for Consumer
- EF eMMC Tester for Automotive
- Testing Technology



SMART & STRONG FLASH STORAGE TESTING PLATFORM

We provide hardware and software integrated platforms for powerful and fast testing by gray-box testing algorithm based on the knowledge of inner algorithms of eMMCs and SSDs.

EF eMMC Tester I for Consumer Device

EF eMMC Tester is AP (application processor) based test equipment under room temperature. This solution consists of a maximum 64 sets of embedded boards with a single built-in eMMC socket and control PC.

It's major testing items are as follows:

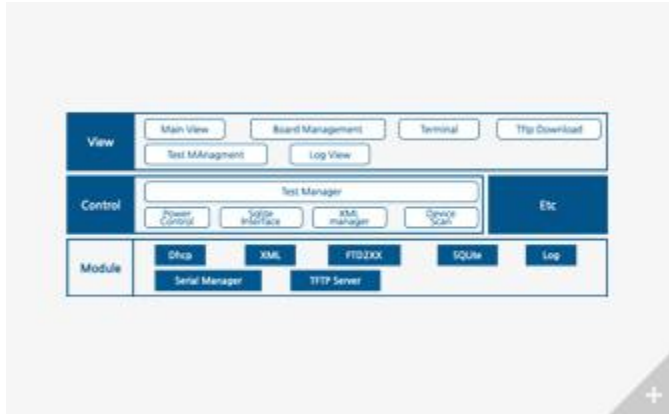
- Smart power-cycle test
- Device endurance test
- Performance benchmark
- System level compliance test



The control program, the EF-monitor, consists of a Windows GUI program that allows one-click program execution, which allows users to conduct testing and monitoring a maximum of 64 eMMC devices. It offers functions such as failure analysis on damaged data blocks when an error occurs, e-mail transmission of error-related information and saving it to database. Moreover, it is designed so as to provide easy environment to develop a new test case.



The core technology of the tester is the test cases set which consists of more than 50 test cases to implement various ideas for gray-box testing. They are implemented not only on the driver level, but also on system level running on the file system to provide a testing environment similar to an actual system. Besides the test cases, the control protocol that controls multiple boards is one of the core technologies to realize a mass testing platform.



E-bench for performance evaluation is the world's first Android app-based storage benchmarking program. This program not only measures the app's performing speed and UI conversion speed, but also measures command running time for the eMMC device, and analyze the correlation of UI speed and device speed by automatically performing camera shooting, web approach, etc. in repetition. For more correct performance evaluation, it is capable of providing a similar testing environment as the actual user environment by measuring the dirty status as well as clean status of device





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EF eMMC Tester II

for Automotive

EF eMMC Tester II is chamber-based stability/endurance testing equipment used for automotive eMMC testing.

The testing scenario conducts fast I/O testing under temperatures of -25°C ~ 85°C and storage testing under extreme temperature conditions (-40°C - 100°C).

For this purpose, this tester consists of an FPGA-type eMMC host controller, test board with built-in 8 eMMC sockets and PC program that controls multiple boards.



The eMMC Tester II is capable of conducting power-cycle tests under high or low temperature conditions, which simulates a similar testing environment of eMMC device used for in-vehicle devices that operate under extreme temperature. The burn-in test equipment in the test chamber minimizes testing time and maximizes coverage as it allows users to actually reproduce bad blocks in an eMMC in mass that occur during repetitive uses and easily test the management of the eMMC controller against them.

Flash Host Software



THE NEXT GENERATION OF STORAGE SOFTWARE



This software maximizes the performance of a large capacity storage system based on flash storage and secures the stability of the embedded system based on flash storage using host software technology.

Flash Storage Caching System, EF-Keepfast

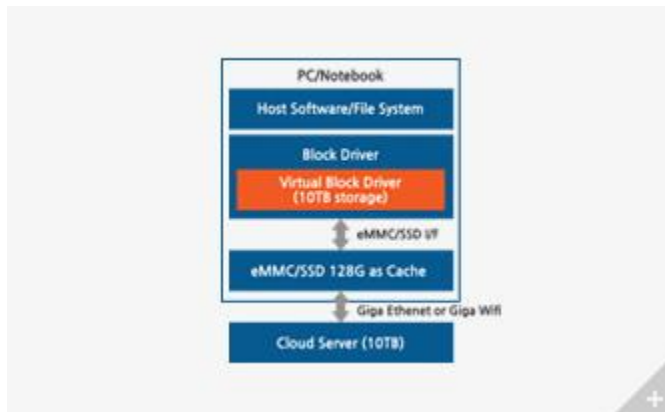
This solution is software layer for mobile devices and desktops that maximizes the speed of large capacity storage by using a local flash storage (eMMC or SDD) as cache. This allows user to use a local cloud storage

at a fast speed as if it is a local disk.

Even though personal users have a large volume of data such as multimedia data, they only access limited amount of data at a certain point in time. Therefore, this system provides a 10TB high speed storage system for users since a small flash cache can handle 99.9% of data traffic.



The EF-Keepfast realized as a virtual block drive is recognized as a large capacity disk by host system. But, the host has only a 64GB or 128GB eMMC(or SSD) cache and uses remote cloud server as the large capacity disk. The smart cache algorithm that utilizes hot data separation technology, data approach estimation technology, etc. can maximize the hit ratio of the small capacity local storage.



Highly Stable File System, EF-FAT

This file system is a power fail tolerant file system that is optimized to SD card-based embedded devices such as car black boxes. This highly stable FAT file system that passed our company's stringent testing environments allows user to save data safely such as recent recorded video to flash storage, against all possible accidents.



The special features of this file system are as follows:

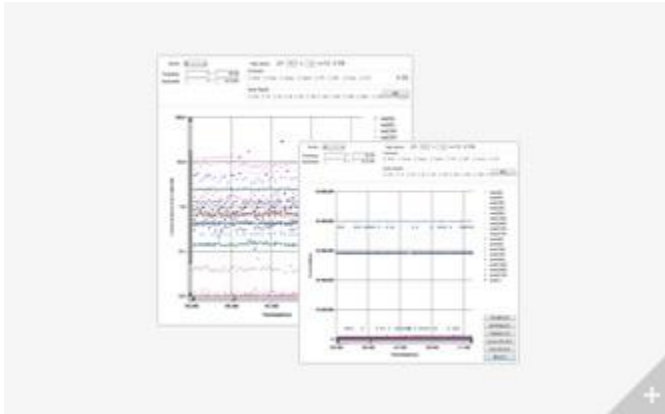
1) From a safety point of view, users can safely save the last saved data even when the SD is separated by user mistake or impact from an accident during operations, and 2) from a performance point of view, it offers the feature to maximize the SD card's performance by generating the host traffic in sequential pattern.



Storage Traffic

Analyzer: EF-STAN

This is a windows program which shows the delay time and access address, etc. for each storage command in GUI forms and allows users to make statistics and conduct analysis. This program is a useful tool for memory development engineers and evaluation engineers of mobile phone manufacturers as it allows them to evaluate the storage's performance of and understand its characteristics. This program shows the distribution and statistics of latencies by flash command and distribution of the access addresses on logical address space.



File System Analyzer:

EF-Parser

This world's first Windows GUI-based ext4-parser is a tool for conducting an analysis in the case a file system crash occurs due to an eMMC failure or file system failure. When a crash of meta-data or journal-data of a file system occurs, this program allows users to access the target sector and conduct an analysis on it by clicking the inode on the list, or perform the sector analysis function to perform an analysis on previous and successive data of the crash data. It offers a top-down access function to access specific files by using the inode data of the file and directory, and bottom-up access function to find a file or directory by using a sector address.



Host Aware FTL



THE NEXT GENERATION OF FTL

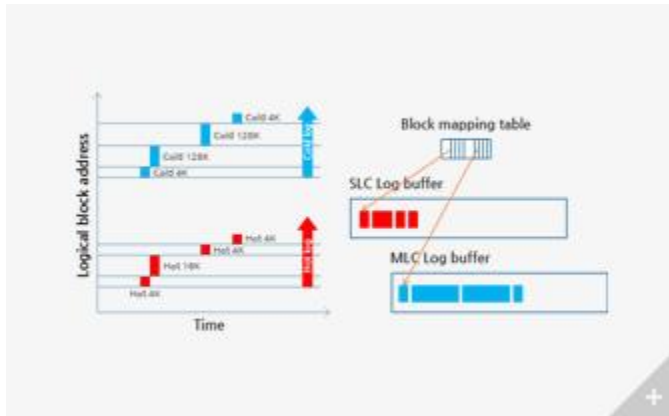


This FTL, which is specialized for TLC eMMC, maximizes the endurance and performance of the eMMC since FTL receives property information of data from the host and use it for efficient management of the data.

Host Aware FTL :

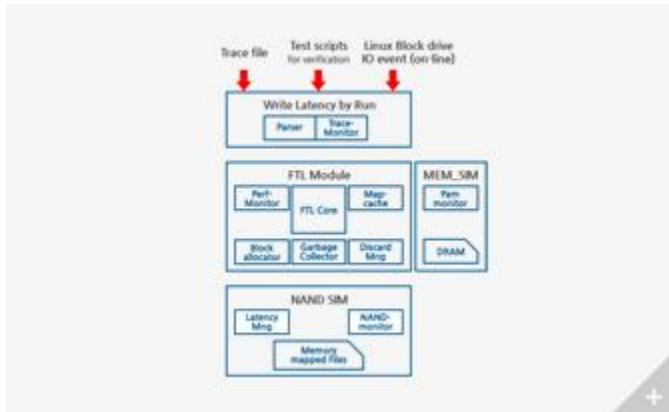
EF-FTL

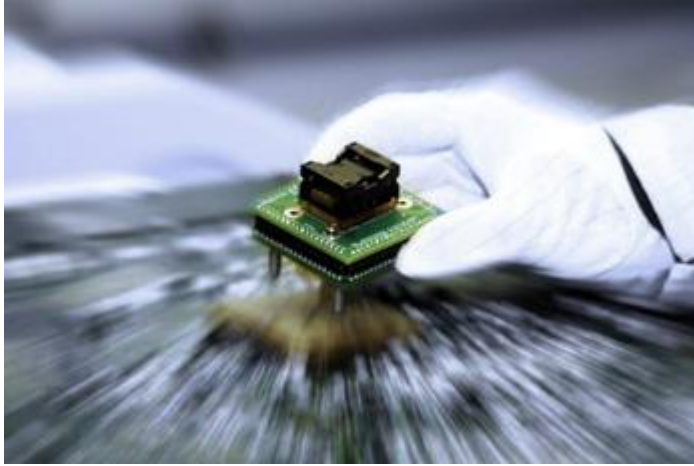
The EF-FTL maximizes the performance and endurance of the memory using host data. The first version of the EF-FTL is optimized to f2fs (flash friendly file system), a new Linux file system, and enhances the performance and endurance by employing an inner FTL log buffer management technique interlocked to the log buffer management technique of f2fs. The idea is to reduce garbage collection cost by aligning data of a similar access cycle to physically near space. The method to realize this idea is to place hot or cold marks on storage data not only in the FTL dedicated to f2fs but also in the ext4 file system and deliver it to the storage so that the storage can use it for its internal operation.



Flash storage simulator

This is a simulator for developing eMMC, SSD, etc. This simulator offers performance evaluation function based on the numbers of read/program/erase and latencies in consideration of the parallelism of various levels inside the storage. This simulator calculates the latency of individual command language considering all the following - system parallelism achieved in the storage's cache mode, multi-channel parallelism achieved in multiple NAND operation on multiple channels, single-channel parallelism in a channel achieved by multiple NAND operation, device's parallelism achieved by multi-plane command language, NAND cache read/write, etc.





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Patented Smart

Testing Technology

As semiconductor processing technology advances, the capacity/price ratio of flash memory doubles each year, but the quality become worse than 200% per year.

The quality of the NAND cell itself is shown by the fact that the PE cycles limitation (program/erase cycles) of TLC is only 500 times, which shows how weak NAND-based flash storage is. However, its areas of application are expanding from smartphone storage to vehicle infotainment systems with built-in OS platforms such as Android. Therefore, the necessity of strong quality test is increasing.



Our company's patented smart testing technology is enabled by gray-box testing technology based on our knowledge of the firmware of flash storage.

For example, for the power-off test, the hardware and software of our testing platform is developed to induce the tested storage to frequently show intervals of weakness of the firmware, recognize the interval as a vulnerable one and execute the power-off instruction.

With this technology, our platform enables semiconductor manufacturers and set manufacturers to achieve more than 10 times faster testing speed compared to existing equipment and make a big cost-reduction effect.