

# Industrial Flash Storage Module

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## Current Market Trends for Flash Storage:

**Application Types:** Recently, data storage applications for Flash products have been extended for both daily use and at the workplace. From early digital cameras to cell phones, and now even in industrial applications, flash storage products have been included in a diverse range of applications. Due to the particular environmental requirements of the industrial market, flash memory, with its solid state and shock resistant features, has proved incredibly versatile as for example, a startup HDD, to setup OS, for software updates and as regular storage modules among others.

**Application Demands:** When using memory cards, users care most about stability, long life, speed, quality and data loss. Applications in industrial computing require even higher stability and reliability (for example, when used as system and data memory in public transportation applications) and will result in serious systemic problems if the memory card becomes damaged or critical data is lost without warning.

## Advantech's Techniques in SQFlash

### Advantech SQFlash Increases Stability

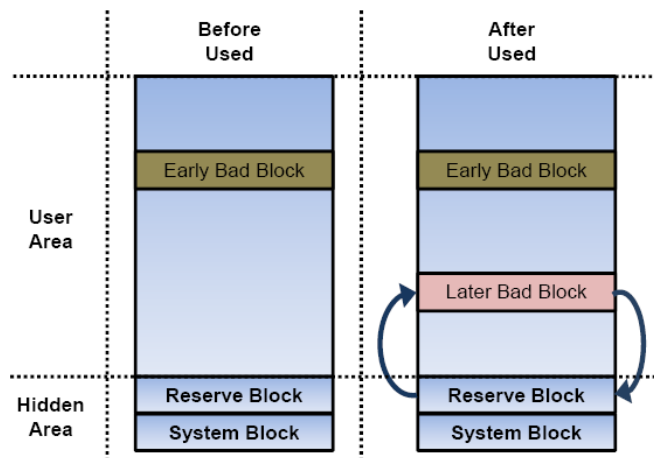
At present memory cards are mainly NAND Flash. To improve the capability, the semi-conductor factories have to use more advanced process technology to achieve this, lower the cost as well as keep the same size. The process technology has improved from the early 70/60 nm (2006), 50 nm (2007-2008), 40 nm (2008-2009) to 30 nm nowadays, and so has the capacity. However, this kind of process technology also increases the numbers of bad blocks within the flash, which are useless for data storage. The semi-conductor manufactures have to record and mark these bad blocks during the previous test process so that the bad blocks can be passed by. In addition, the proofreading system must be improved to prevent more errors. So BBM and ECC systems are used to improve the stability of the memory devices. The comparison of various SLC Flash types is as follows:

-	SLC Flash		
<b>NAND Process</b>	70 / 60nm	50nm	40 / 30nm
<b>ECC required</b>	1-bit	1-bit	4-bit
<b>Erase Cycle</b>	100K	100K	TBD
<b>Data Retention</b>	10 years	10 years	10 years

### 1) Advantech SQFlash's Technique in BBM and ECC

BBM (Bad Block Management) is a system to manage and mark bad blocks. It will mark all the damaged blocks so as to prevent users from writing data into them and committing data loss. ECC (Error Correction Code) is a system to proofread written data. When there are bit data mistakes during the writing process, the system will correct them. Advantech SQFlash makes use of the BCD and ECC methods supporting 12-bits. This method has stronger proofreading capability than the common RS code method, and can effectively avoid of data mistakes.

### 2) Advantech SQFlash's Application in Reserve Block



#### Early Bad Block:

The flash controller has detected this bad block. The bad block could be under 1% total.

#### User Area:

This area can be used normally.

#### Reserve Block:

The vendor of the controller will reserve about 4% space block for changing later bad blocks.

#### System Block:

This block has stored some information from controller IC.

#### Later Bad Block:

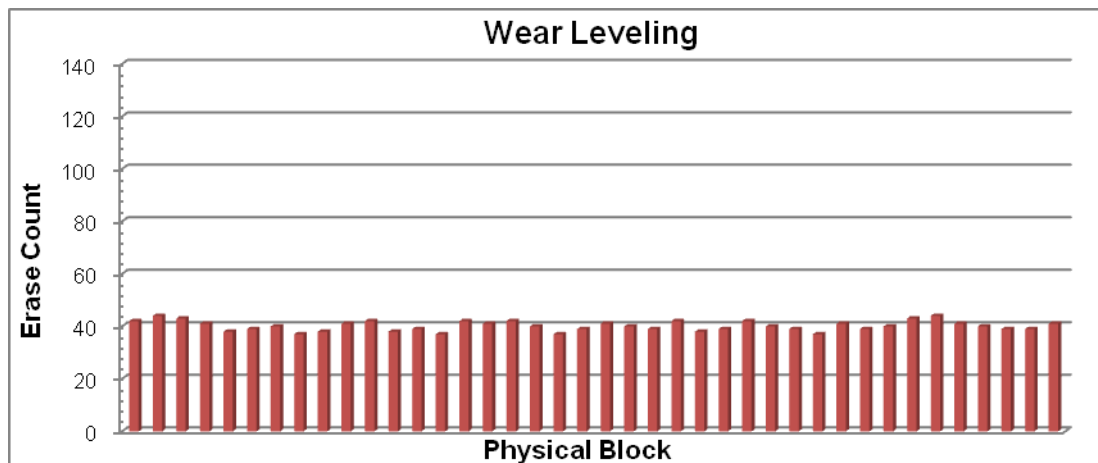
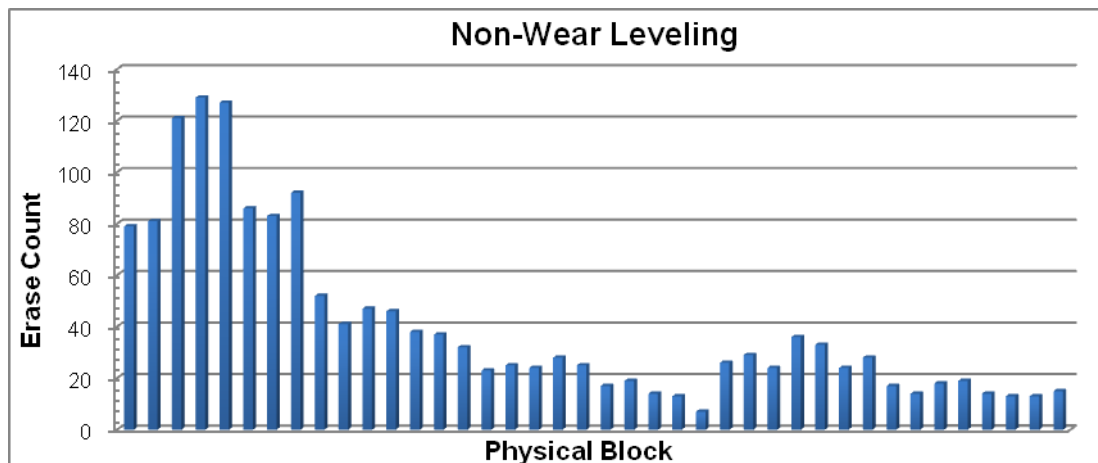
It can detect damaged blocks during use.

### **Advantech SQFlash Increases Endurance**

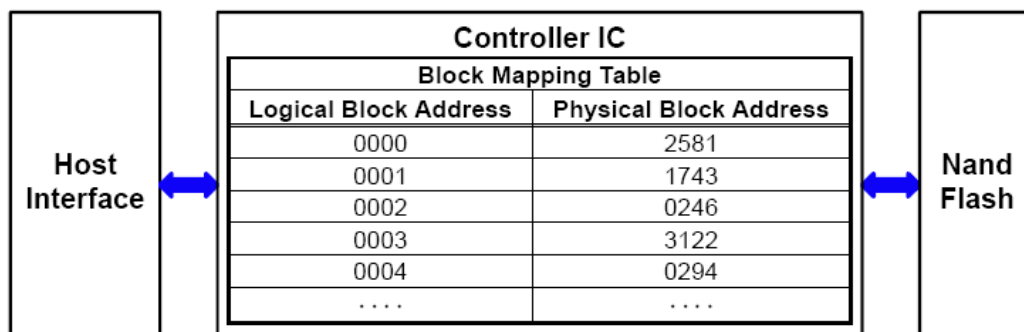
The memory of NAND Flash is composed of many cells. The service life of its writing and erase cycles are limited by its brand and type. At present the brands in the market include Samsung, Toshiba, Micron, Intel and others. The types includes SLC (Single-Level Cell) and MLC (Multi-Level Cell), the endurance of the former being 100,000 program / erase cycles times, while the latter being 10,000 program / erase cycles times. When the service life is over, these storage cells will be less reliable and even unusable. This is when the Reserve Block comes to rescue.

### 1) Advantech SQFlash's Technique in Wear Leveling

When the memory cell of the NAND Flash is limited, a special flash management and control method will be applied. This will overcome and manage the memory period and times, and increase its service life. This method is called Wear Leveling. The following is the difference between Non-Wear Leveling and Wear Leveling.



Seen from the Advantech SQFlash, within every memory block of NAND Flash, the Program / Erase Cycles are limited (SLC: 100,000 times; MLC: 10,000 times). If the data continues to be written into the same block when it reaches the maximum, then that block will be unable to be written to. But through Wear Leveling technology, the physical blocks will be transferred into it before the memory block is out of bound. The following figure gives a brief expression of it.



## 2) Advantech SQFlash Integrates dynamic and static Wear Leveling Technology

Dynamic wear leveling works within the memory block where the data continues to be written. As mentioned above, all new data writes into the blank memory blocks. However, it is the controller IC not the memory block that decides where and how data is written to the new blank memory blocks. When the new data is written, the controller IC will mark the place of the new Physical Block via the internal Block Mapping Table. Dynamic wear leveling will pick up the repeated data written into the same block, and transfer them to the new Physical Block. But it should be noted that Dynamic wear leveling algorithm systems will not be applied if the data are not in the correct write condition.

Static wear leveling applies to all memory blocks, that is, both those without written data and those already with written data. This system processes the background, and sends data to the main system terminal. The Program / Erase Cycle times trigger differently between memory blocks without written data and those with data already written. The comparison between Dynamic and Static is as follows:

-	Dynamic	Static
<b>Endurance</b>	Long life	Very long life
<b>Performance</b>	Fast Speed	Slow Speed
<b>Development Complexity</b>	Low Complexity	High Complexity

Advantech SQFlash integrates both the wear leveling algorithms of Dynamic and Static. It not only calculates data beginning to be written into the memory block, but also confirms data already existing. So it is possible for users to comprehensively increase the service life of this product when using it.

### 3) Advantech SQFlash Field Test: Life Cycle Testing

Sample Capacity : 4GB

Target life endurance : > 3 years

Test Date : Aug 25 ~ Sep 5

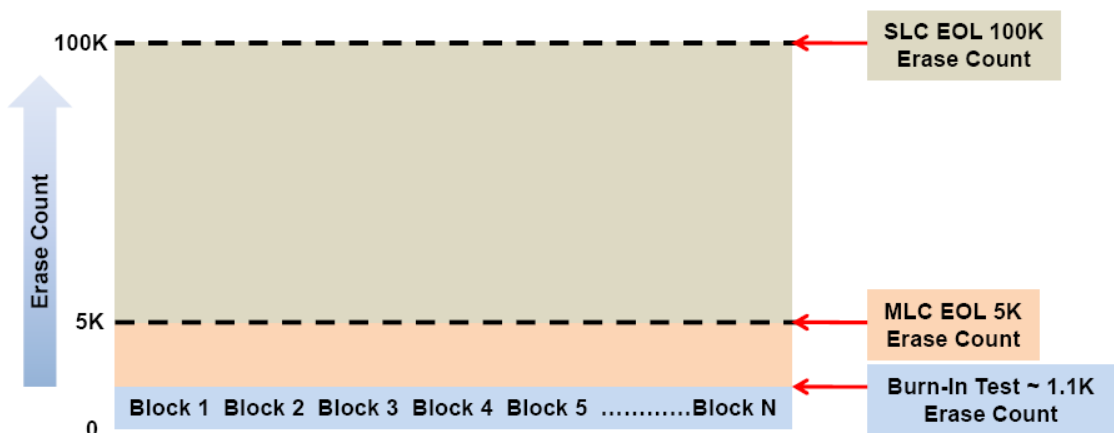
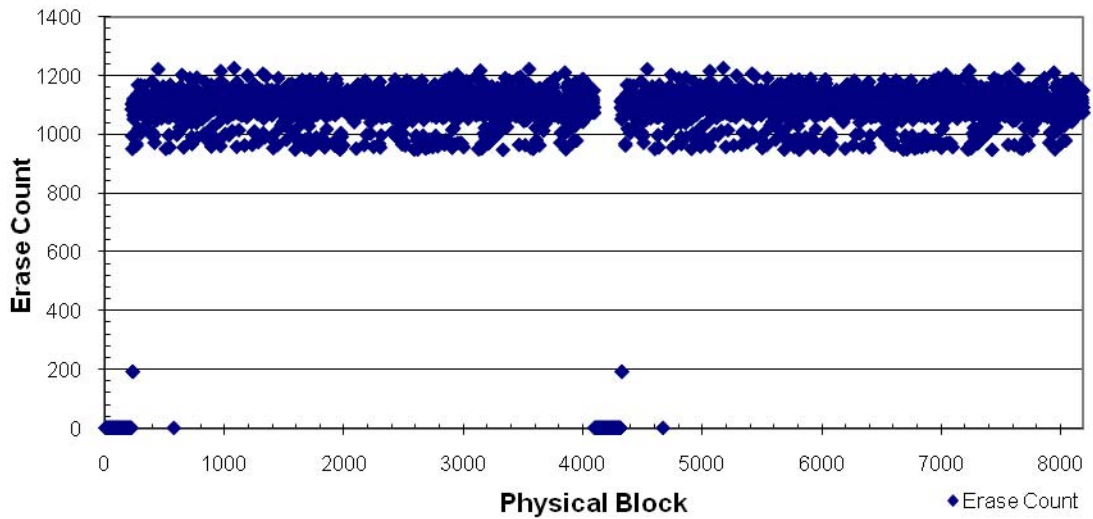
Volume of data transferred by user (based on top laptop maker's estimation):

= 125 MB/hr \* 10 hr/day \* 365 days/year \* 3 years

= 1368.75 GB

Total 382 cycles were run = 1529 GB

After 15 days, average erase count = 1.1 K << 100 K



## **Advantech SQFlash Increases Reliability**

When using flash products, unavoidable conditions may occur, such as high/low temperatures, unstable voltage and vulnerable power supply, which may affect the reliability of the data. If the power suddenly goes down or surges when the machine is operating or the voltage is lower than the specification, then processing data and file information could get lost, even the memory device itself may get damaged. Therefore, in industrial applications, a stable OS and flash device is required so that the OS runs normally. And within Advantech SQFlash memory devices, just such a protection system exists.

### *Advantech SQFlash Filed Test: Power Shutdown Cycle Time Testing*

Sample Capacity : 4GB

Test Method : Dynamic Read/Write Test, Pattern Test, Random 5 Static Area Test.

Result : 3,500 passes for each test before the CF card can be used.

## **Advantech's Pre-warning Software in SQFlash**

Many memory devices in embedded applications are used to save data but also function as disks for the OS. Most users are blind to their operation and do not know when the memory device is wearing out, and often only remedy the problem after they have already been damaged. To cater to this demand, Advantech has developed the SUSI-SQFlash-CF software, which can check the condition of the memory device at an early time and inform users well in advance. When the life of the memory device is lower than the specified level, the software will warn users to backup and change to another device.

SUSI-SQFlash software package is a flash management package that contains utilities and API to access and configure Advantech flash storage. It supports Software Protection (Security ID Read/Write) and Life Monitoring (S.M.A.R.T.) features. A product key protected package provides users with a safe environment which not only protects the application itself but also prevents Security ID being read without the same product key while writing. The S.M.A.R.T. attribute contains Max/Average Program and Erase Cycles, Power On Time, ECC count and Life Endurance utilities. Users can monitor directly via the SUSI-SQFlash utility or implement functions into the application via the SUSI-SQFlash API. A life-span detection mechanism can be designed from the Life Endurance information.

## Software Features:

### 1) Access Code

Once you type a valid access code with this utility, the system will keep a record and you won't need to type the access code next time.

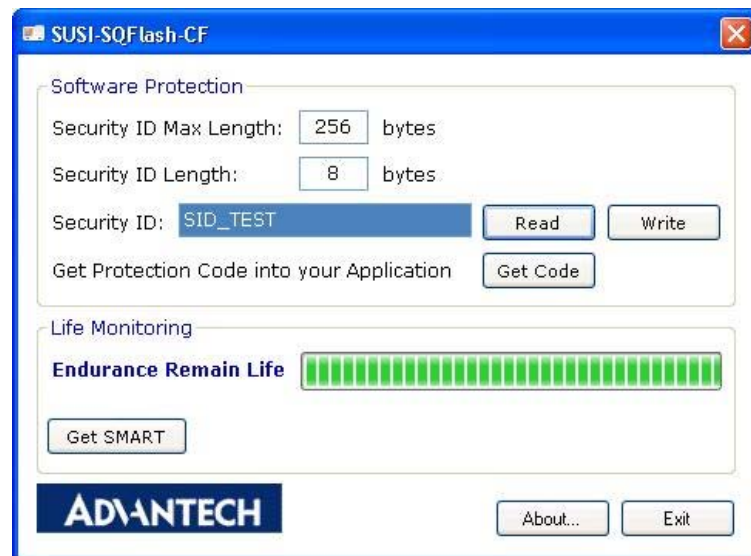


### 2) SUSI-SQFlash-CF

Detect max and user-defined length of Security ID

Read or Write Security ID into hidden area

Set protection code in application (C# sample)



### 3) Get SMART attribute

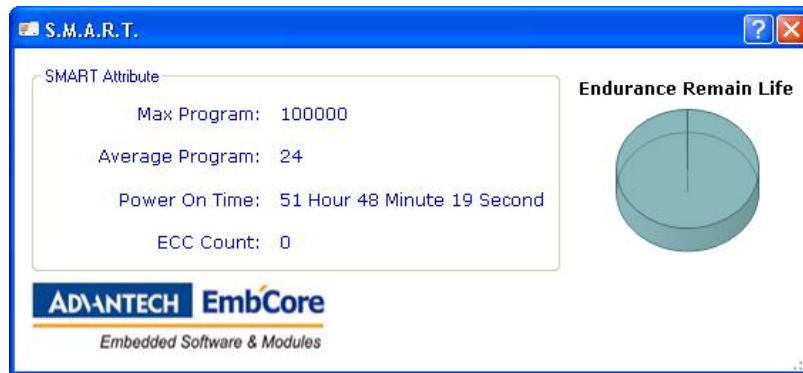
Max Program - In CF card max program and erase cycles.

Average Program - In CF card average program and erase cycles.

Power On Time - Power on accumulates time.

ECC Count - Error correct code number of times counting.

Life Endurance - Endurance (%) of remaining life is the result of (Average P/E cycles) / (Max P/E cycles).



## Conclusion

CompactFlash cards are one of the most popular cards today based on their high performance, good reliability and wide compatibility. CompactFlash cards do not require any additional mechanical parts, but have the properties of being highly vibration resistant and extremely low power consumption. The SQFlash CompactFlash is one of the best choices in the memory card market, and it not only has excellent performance but also comes in larger capacities.

### *For Further Information*

Click [here](#) for a more information about Advantech SQFlash.

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