

Key Factors for Industrial Flash Storage

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<http://www.embestor.com>

Agenda

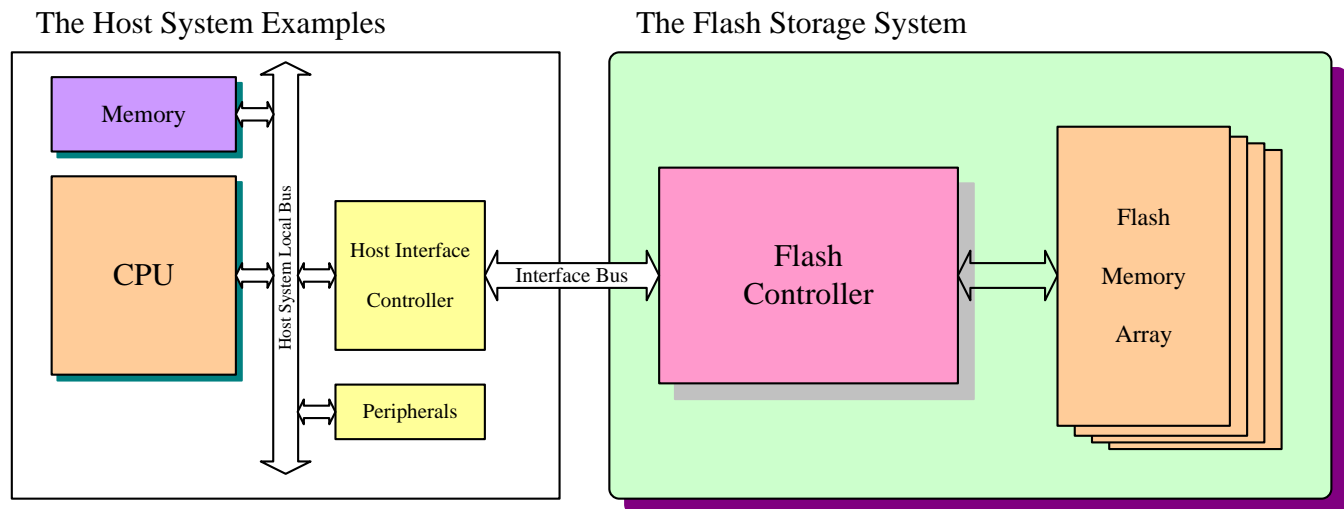
- Industrial Flash Storage Overview
- Performance Index
- Data Integrity and Security
- High Quality Design
- Reliability test reports
- SMART Information
- Failure analysis and reporting
- Backup: EmBestor Company Overview

Industrial Flash Storage Applications



System Factors for Data Storage

- **Host Interface** and Target Application.
- **Data Transfer Rate:** to maintain a fast-enough data rate.
- **Data Integrity:** to have a useful BER (Bit Error Rate).
- **Data Security:** Content Protection and Data Remanence.
- **Product lifetime:** must be long-enough, and reliable.



NAND Flash Memory Deficiencies

Deficiency	Type	Effect
Initial defective blocks	Hard error	Program / Erase Failure.
Defective blocks during use	Hard error	Program / Erase Failure.
Over-programming	Soft error	Bit errors happen as read.
Program disturbance	Soft error	Bit errors happen as read.
Read disturbance	Soft error	Bit errors happen as read.
Page program, block erase	Problematic	Need erase before program.
Program must be in order	Problematic	Need sequentially program in a block.
Partial page program Inhibit	Problematic	Need buffer RAM.
Long program time	Weakness	Poor performance.
Long erase time	Weakness	Poor performance.
Limited endurance	Weakness	Permanent failure as Wear-out.

Topics on Industrial Flash Storage

- Performance
- Product Quality
- Product Reliability
- Design Safety
- Data Integrity and Security
- Product Continuation and Maintenance
- Customization and platform design
- On-site service and response
- Failure analysis and reporting
- Test report and documentation

Performance Index

- Data Transfer Rate:
 - Sequential Write / Read vs. Random Write / Read
 - IOPS.
- Defect (Bad Blocks) Management:
 - Time-0 vs. Run-time
- Wear-leveling:
 - Static vs. Dynamic; Global vs. Segmented
- Write Amplification Factor:
- Parallelism:
 - Multi-channel vs. Interleave
- Robustness: Power Cycling Test

Data Integrity and Security

- ECC and CRC:
 - Reduce the data error rate
- Background auto-refreshing:
 - Maintain the stored data in a reliable state.
- Secure Erase:
 - Static vs. Dynamic; Global vs. Segmented
- Content Protection and Cryptography:
- Data Redundancy:
 - RAID concept.

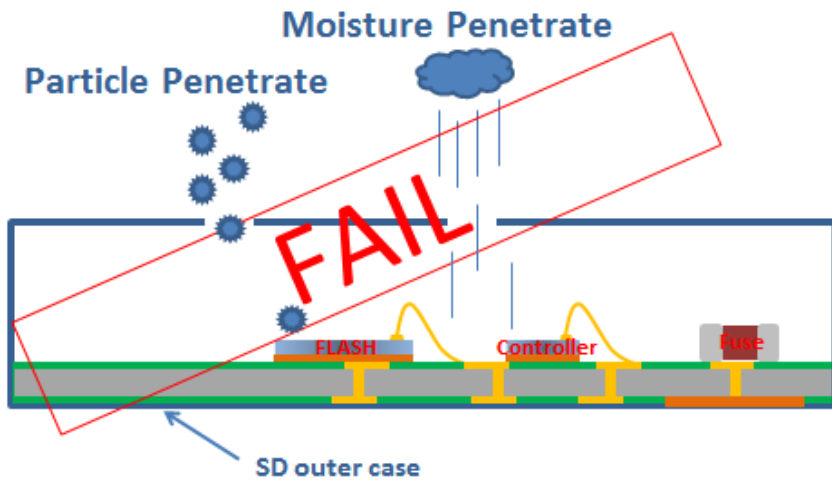
SLC-NAND for High Quality

- **Longer Lifetime for Stream Data Recording:**
 - >20 times of MLC NAND write data amount
 - >200 times of TLC NAND write data amount
- **Best Choice for Non-volatile Cache**
 - Longer endurance and faster write speed
- **Stronger Data Retention.**
- **More Robust, Reliable and higher write speed.**

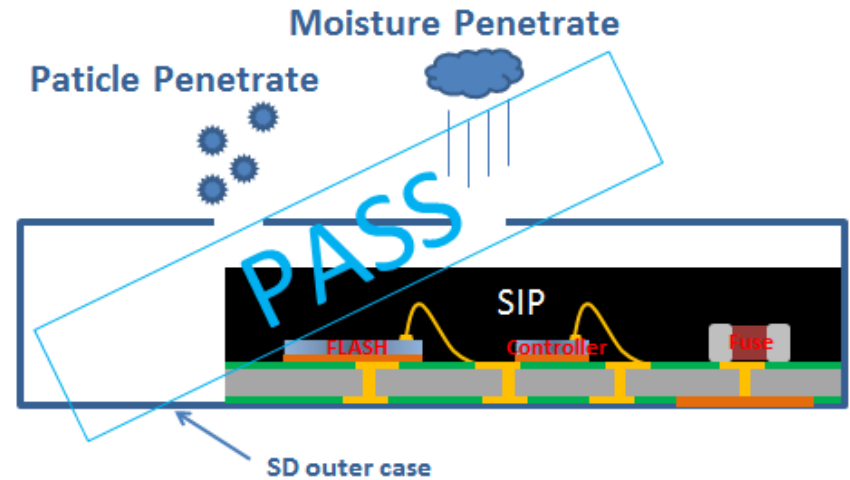
Flash Type	P/E Endurance	Page / t_{PROG}
SLC-NAND	>60K Cycles	8KB/400μs = 20MB/s
MLC-NAND	1K~ 3K Cycles	16KB/1.4ms = 11.4MB/s
TLC-NAND	300~500 Cycles	8KB/2.4ms = 3.3MB/s

Waterproof and Dustproof

- The EmBestor i-SD using SIP (System in package) module assembly technology which provides perfect protection



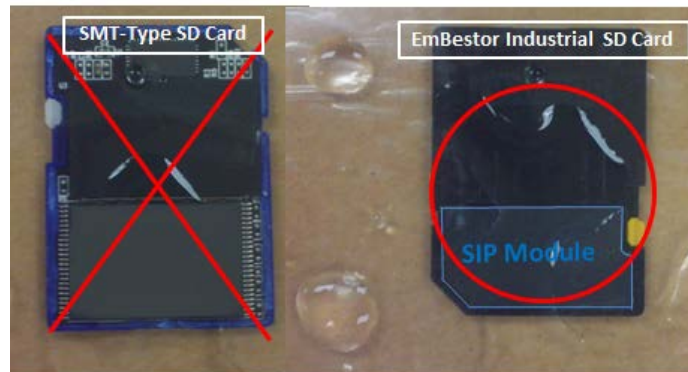
SMT-Type SD Card



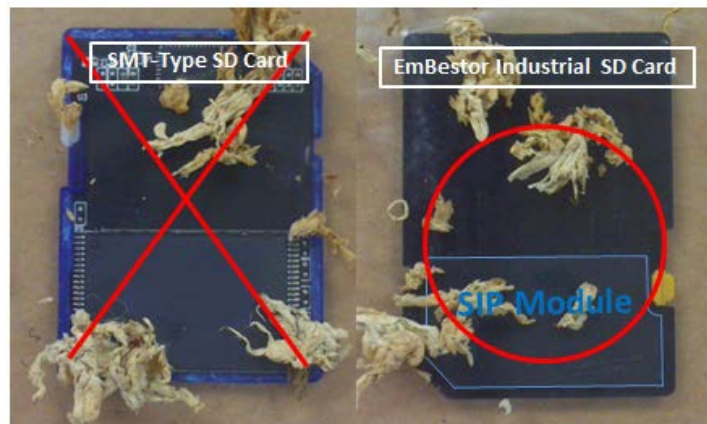
EmBestor Industrial SD Card

Examples: EmBestor i-SD

- Each of the i-SD card can pass severe IPX7 water proof and IP5X dust proof testing level by IEC/EN 60529 standard



IPX7
Water Proof

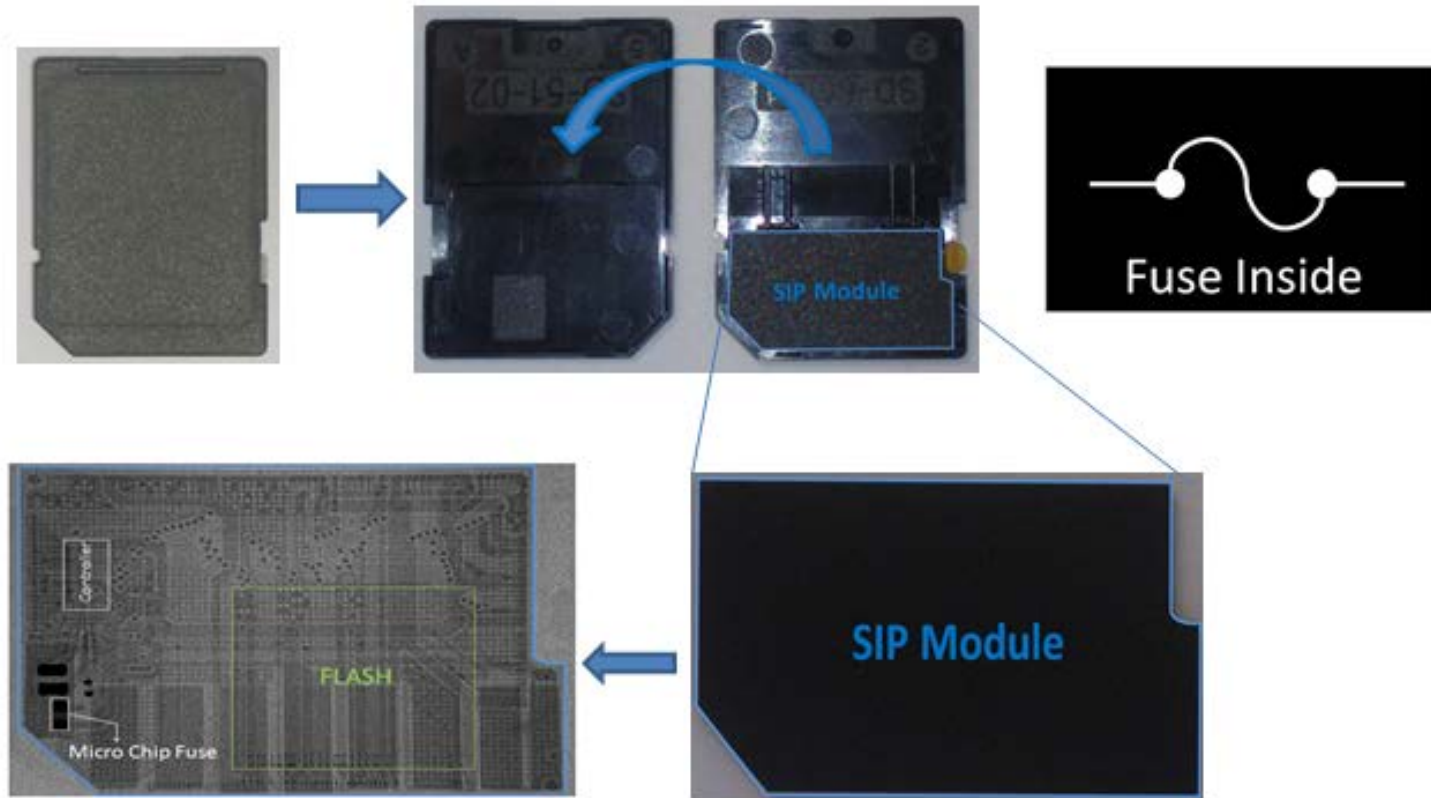


IP5X
Dust Proof

Example: Reliability Reports

No.	Test Item	Test Condition	Standard Reference	Result
1	Operating Test (Low Temperature)	-40 degreeC 168hour	SD Specifications Part 1 microSD Card Addendum Version 4.10 Section 3.1.2	Pass
2	Operating Test(High Temperature)	+85 degreeC 500hour	SD Specifications Part 1 microSD Card Addendum Version 4.10 Section 3.1.2	Pass
3	Operating Test(Moisture and Corrosion)	+40degreeC 93% 500h	SD Specifications Part 1 microSD Card Addendum Version 4.10 Section 3.1.2	Pass
4	Salt water spray	3% NaCl/35°C, 24 hours	SD Specifications Part 1 microSD Card Addendum Version 4.10 Section 3.1.2	Pass
5	Durability	10,000 mating cyc Operating result and photo	SD Specifications Part 1 microSD Card Addendum Version 4.10 Section 3.1.2	Pass
6	Bend Test	10N center of the card(Both side), 60sec (micro SD Spec Appendix E-1)	SD Specifications Part 1 microSD Card Addendum Version 4.10 Section 3.1.2	Pass
7	Toruque Test	0.1N-m or +/-2.5°, keep 30sec (microSD Spec Appendix E-2)	SD Specifications Part 1 microSD Card Addendum Version 4.10 Section 3.1.2	Pass
8	Drop Test	1.5m Free fall	SD Specifications Part 1 microSD Card Addendum Version 4.10 Section 3.1.2	Pass
9	UV light exposure	UV: 254 nm, 15 Ws/cm ² according to ISO 7816-1	SD Specifications Part 1 microSD Card Addendum Version 4.10 Section 3.1.2	Pass
10	X-ray exposure	0.1 Gy of medium-energy radiation (70 keV to 140 keV, cumulative dose per year) to both sides of the card	ISO7816-1	Pass
11	ESD	Contact Dsicharge (According to microSD Spec. AppendixD.1)	SD Specifications Part 1 microSD Card Addendum Version 4.10 Section 3.1.3	Pass
		Air Discharge (According to microSD Spec. AppendixD.2)	SD Specifications Part 1 microSD Card Addendum Version 4.10 Section 3.1.3	
12	EMI	CE ClassB	EN55022:2010 EN55024:2010 (IEC61000-4-2:2008, IEC61000-4-3:2010, IEC61000-4-8:2009)	Pass
		FCC ClassB	FCC 47 CFR Part 15 Subpart B, ICES-003 Issue 5, ANSI C63.4-2009	Pass
		VCCI ClassB	V-3/2013.04	Pass
13	Testmetrix	Test Report and log data		Pass
14	Altitude	80,000feetmax_ 4hrs	MIL-STD-810 G Method 500.5	Pass
15	Dust Proof	Depression of 2 Kpa (20 mbar) Talcum powder 2kg/m ³ , 8 hrs	IEC/EN 60529 IP5X	Pass
16	Wafer Proof	Depth of water 1m, 30 mim.	IEC/EN 60529 IPX7	Pass
17	Mechanical Shock	Duration: 0.5ms, 1500G,3 axes	MIL-STD-883E	Pass
18	Vibration	30G Peak, 10Hz to 2K Hz, 3 axes	MIL-STD-202	Pass

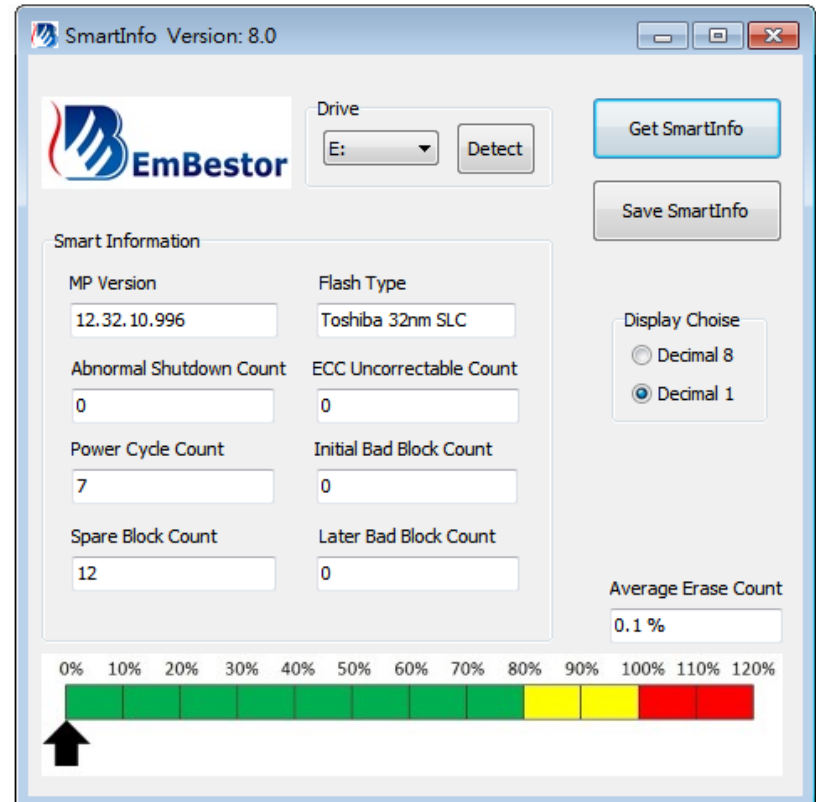
Safety guard by Fuse inside



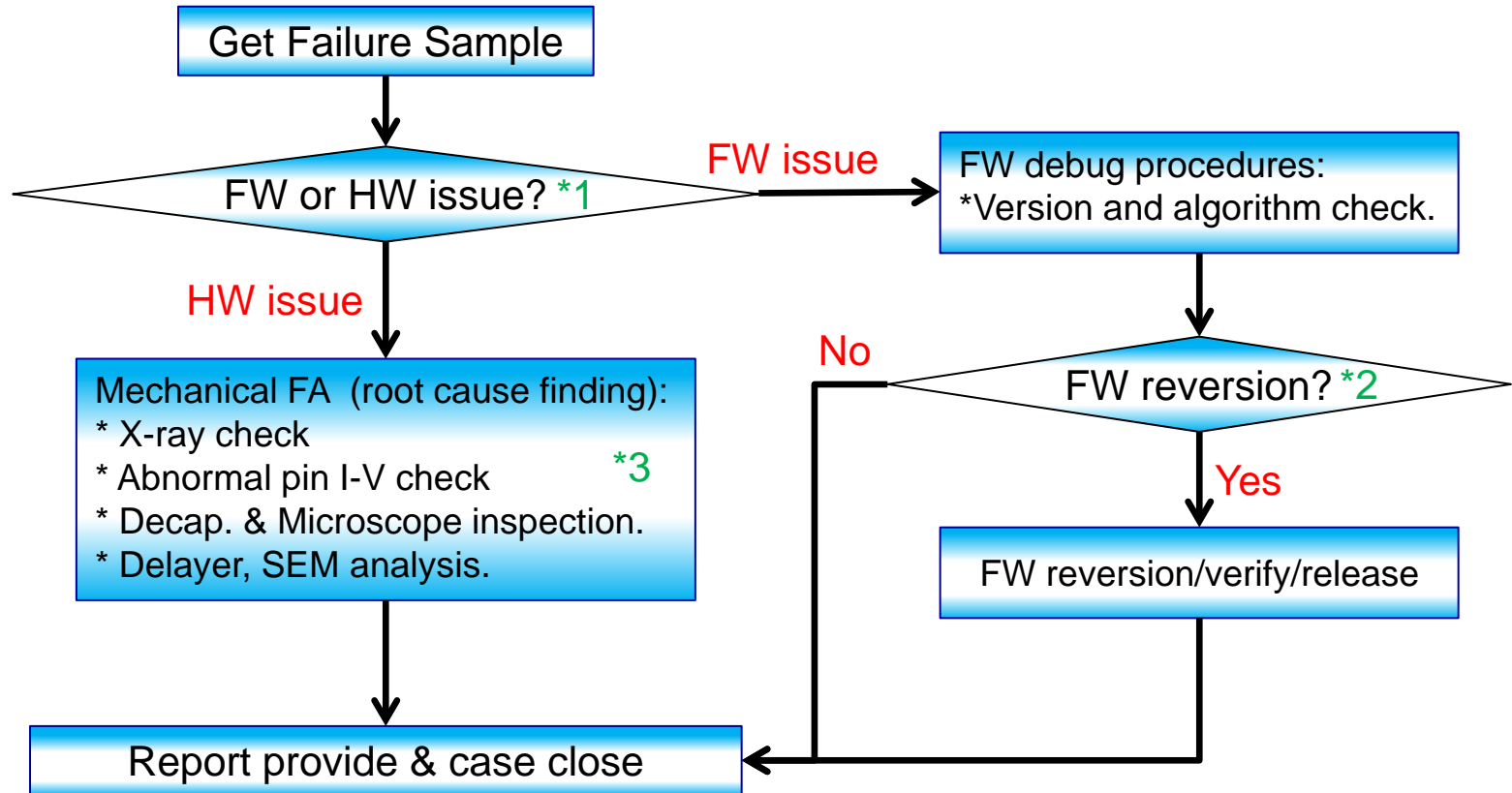
Embedded a micro chip Fuse inside to protect the Host machine and SD card itself from been destroyed by **suddenly abnormal or in-rush current.**

SMART Information Support

- Life Monitor
- Average Erase Count
- MP Version
- Flash Type
- Abnormal Shutdown Count
- Power Cycle Count
- Spare Block Count
- ECC Uncorrectable Count
- Initial Bad Block Count
- Later Bad Block Count



Failure Analysis Flow



*1 : Diagnosed by MP tool & emulation verification board (EVB).

*2 : FW may not be reversion if the issue can be recovered by HOST adjustment.

*3 : The analysis scheme depends on failure mechanism of the returned sample .

Thank You!



EmBestor Overview



Company	EmBestor => <u>E</u>mbedded <u>S</u>torage
Establish	July 4, 2013
President	Chanson Lin
Capital	USD \$4.8 million
Employee	45 staffs
Business	Embedded Flash Storage: SIP & Modules; Removable Commodity: SD, UFD Controllers.
Philosophy	Empower Teamwork ; Enable Passion ; Create Value .
Operation	Hsinchu – Headquarters, R&D, back-end & manufacturing support Shenzhen – Field application support

2014: Launched EFS Modules

2013: **EmBestor** Founded. (Spun-off from ITE Tech. Inc.)

2009: Integrated to **ITE Tech. Inc.**

2008: Launched SD Card Controllers

2007: Renamed as **Afatech**

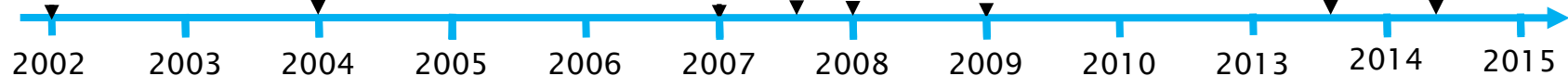
2007: Launched Card Reader Controllers

2004: Launched UFD Controllers

2002: **USBest** Founded



AFA TECHNOLOGIES, INC.



Removable Commodity (Controllers)

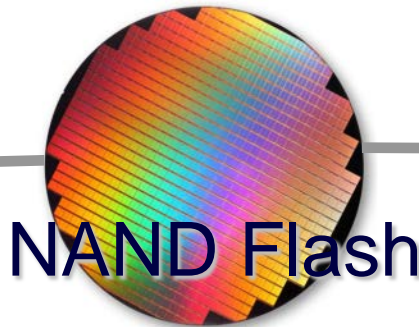
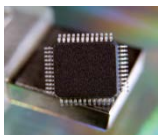
USB Flash Disk:
USB2.0 & USB3.0



Memory Cards:
SD2.0 & SD3.0



eMMC Application:
eMMC to UFD



Industrial Applications (Industrial Modules)

Industrial SD Cards:
i-TF & i-SD



CF/C-Fast Cards:
CF , CFast , i-CF



SATA/PATA Modules:
mSATA , SATA/PATA DOM



Industrial UFD Modules:
USB DOM & i-UFD



Technical

- More than 10 Years Flash controller design experience
- Support Customized and Platform Design
- In-house Testing Capability

Manufacturing

- EOL/Revision Management
- Fixed BOM
- Lead time advantage

Product

- Complete solution provider
- Focus on Industrial markets