swissbit®

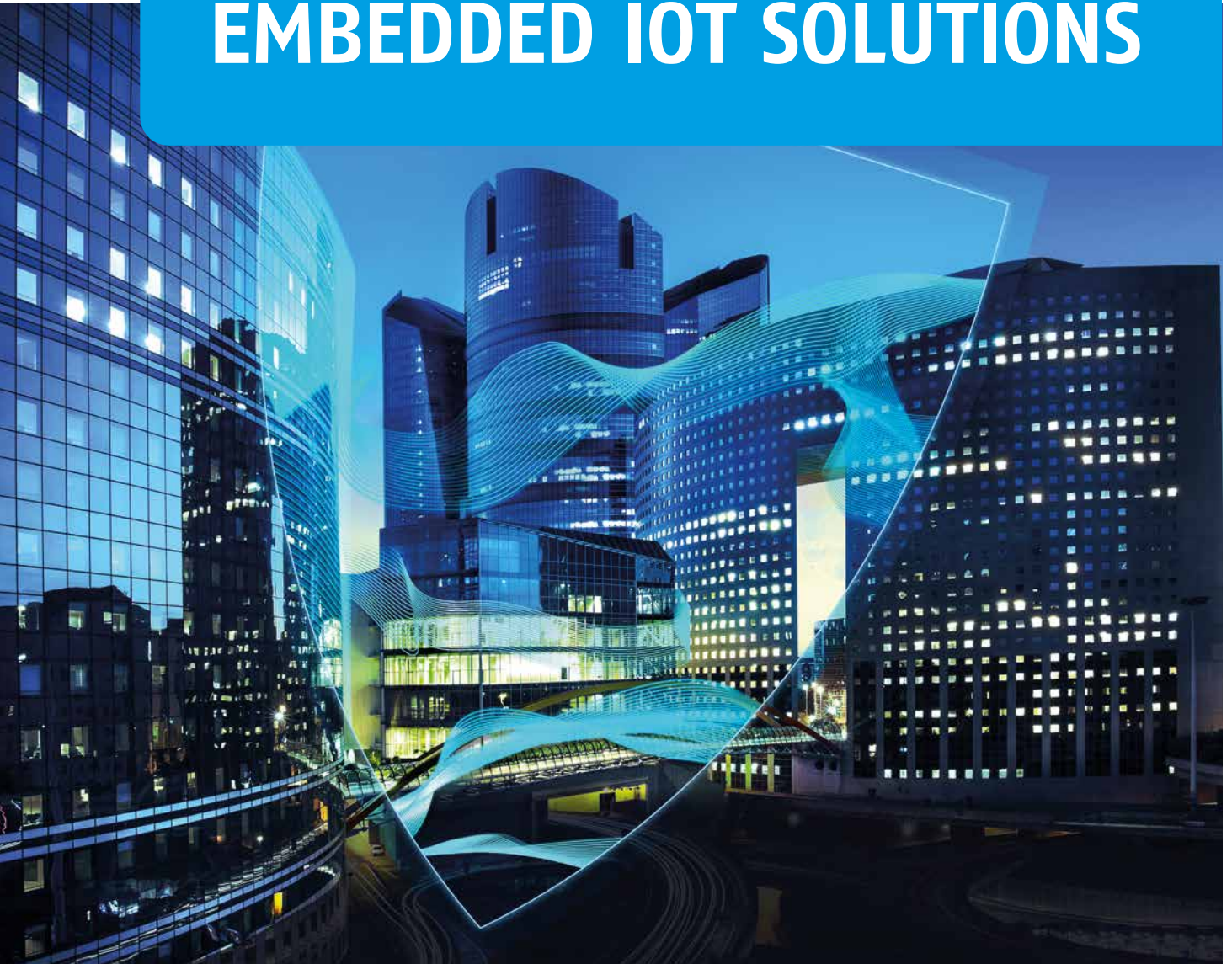# RELIABLE STORAGE & EMBEDDED IOT SOLUTIONS

INDUSTRY • AUTOMOTIVE • SECURITY
**NETWORKING & COMMUNICATION • IOT**

Data is the fuel of the future and is driving global growth and change. Swissbit takes care of data by storing and protecting data reliably. As a leader in industrial storage and embedded IoT (Internet of Things) solutions, Swissbit drives the development of demanding industrial and IoT applications to make our lives easier, safer, and more comfortable.

More than 5,000 customers around the world including Fortune 500 companies and the world's leading OEMs already rely on Swissbit for their critical data storage and security requirements. With over 25 years of experience in the development of removable and embedded storage and embedded IoT solutions for the most demanding markets, coupled with a trusted global distribution and support network, Swissbit is firmly established as a global innovation leader in storage and security products for high-reliability solutions.

MADE IN GERMANY

New technological trends are driving the demand for highly integrated solutions and advanced packaging technologies. Digitization will increase the demand for industrial memory products for industrial, tele-communications, automotive (e.g. autonomous driving), medical, and fiscal applications. In addition, the growing connectivity of devices in the Internet of Things means that the demands on the protection of data and devices, and thus the demand for smart security products, will increase massively. Swissbit has prepared for this with new state-of-the-art production capacities at the new plant in Berlin, Germany.

Conception — Development — Verification — Qualification — Production & Test — Supply Chain Service
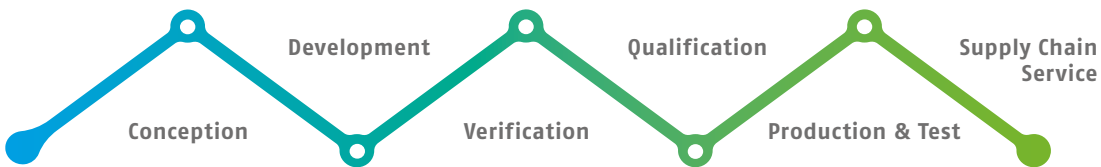
CORPORATE PROFILE

Established
1992 – 2000 as SIEMENS AG
Swissbit AG was formed in 2001 through a management buyout

Financial Strength
Privately held company, equity ratio > 60%

CAGR 2009–2018
Continuous positive annual growth

Headquarters
Swissbit AG: Bronschhofen (St. Gallen, Lake Constance area)

Subsidiaries
Germany, USA, Japan, Taiwan
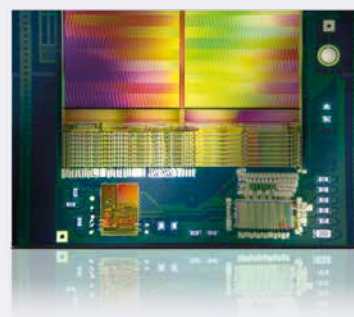
R & D sites
Switzerland, Germany and USA

Production Site
Berlin, Germany

Made in Germany

CONTENT

OUR PRODUCTS AND TECHNOLOGIES

NAND FLASH PRODUCTS

SECURITY PRODUCTS

SYSTEM IN PACKAGE

INDUSTRY

EMBEDDED PRODUCTS

Swissbit's embedded memory and storage solutions are the perfect fit for demanding embedded applications. They offer the highest reliability and quality. Swissbit's strategic cooperation with suppliers allows for long-term availability of products. To guarantee high-quality standards, each product undergoes thorough functional testing before being released for shipment. The broad portfolio with different NAND technologies and industry-dedicated features guarantee the right solution for each embedded use case.

Memory and non-volatile storage solutions for embedded applications must provide reliable operation even in the most extreme conditions: temperature, shock, and vibration. As such, both the qualification cycle and the support life cycle needed for these products by far exceed those of devices designed for typical consumer applications.

TYPICAL APPLICATIONS:

- Industrial automation
- Energy distribution
- Energy consumption
- Smart grid
- Infotainment
- Healthcare
- Transportation
- Aerospace and defense

IOT
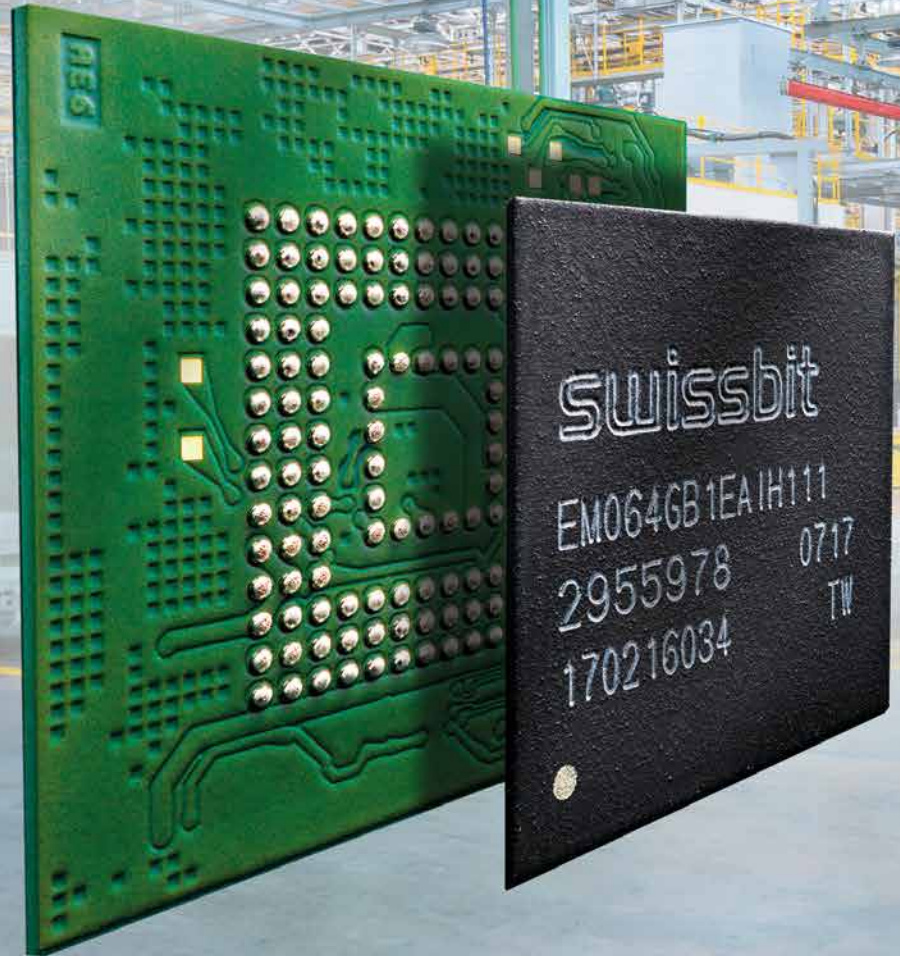
IOT PRODUCTS

Memory and non-volatile storage solutions for edge computing must work uninterrupted and with a long service interval. Edge computing systems experience wide temperature ranges, shock, and vibration.

Remotely installed sensors, actuators and communication channels need to have local storage for pre-processing of big data, temporary storage for optimized network usage, and format conversion. Stored data as well as Internet of Things (IoT) devices must be protected against manipulation or theft. The storage product must provide a high bandwidth for small block write operations.

The life time status of the storage device must be controllable by local maintenance routines.

Swissbit provides the perfect rugged and reliable small form factor storage products for edge computing systems.
The Swissbit SD, microSD, e.MMC, and USB products offer the right storage capacity, longevity, and operation temperature range for remotely in-stalled systems. Swissbit security products can be used as a TPM–like, hardware–based root of trust to give IoT devices a unique ID and protect access, boot code, communication, and stored data.

TYPICAL APPLICATIONS:

· Industrial connectivity
· Manufacturing / IIoT
· Remote sensors
· Remote actuators
· Surveillance
· Point of Sale (POS)
· Smart Infrastructure
· Mobility

NETWORKING & COMMUNICATION

NETCOM PRODUCTS

Swissbit supports the demanding field of NetCom applications with products that withstand a wide range of frequent temperature changes and operate between −40°C and +85°C. It is mandatory that products perform for an extended life time in the field without the need for replacement or service. Swissbit's durabit™ range of SSDs fulfill this requirement.

For system boot purposes, a common frequently utilized device is the embedded USB module. With the U−4x and U−5x family, Swissbit offers a broad range of capacities and interface modes. Data care management with retention optimization maintains the boot image data over the complete service life and guarantees a safe and fast restart of the NetCom system.

The latest technologies and life changing developments rely on the Internet. The Internet of Things (IoT) cannot be realized without a strong network of communication channels.
Transmitting data to remote areas of the world is challenging and involves a high cost. Transceivers, routers and bridges that require uninterrupted, autonomous 24/7 operation are often under extreme environmental conditions and may be installed in areas that are difficult to service.

TYPICAL APPLICATIONS:

- ATCA Blade
- Cable modem
- Content and video delivery
- Digital Subscriber Line access multiplexer
- Enterprise Media Gateway
- Switches and routers
- Optical network
- Radar / Sonar
- Radio network controller
- Security infrastructure
- Tetra Base Station
- Wireless Base Station

AUTOMOTIVE

AUTOMOTIVE PRODUCTS

All components used in automotive applications need to operate within a wide temperature range and withstand sudden power loss as well as shock and vibration. Additionally, very low failure rates are essential, because replacement of malfunctioning parts can incur high costs. Swissbit is the only independent embedded memory and storage manufacturer with an IATF 16949 certified fab. Our new 3D NAND based S-50 SD memory card lineup caters to the demands of automotive applications, offering the highest reliability and quality at competitive prices.

The increasing varieties of infotainment and dashboard applications in cars today require significantly higher storage capacities than before. For autonomous driving, the demand for fast and high capacity storage drives the development of embedded products. Swissbit participates in this trend with newly developed, dedicated storage solutions.

TYPICAL APPLICATIONS:

- Entertainment systems
- Navigation systems
- Head unit / dashboard
- Black box / crash recorder
- Instrument cluster
- Dash cam

SECURITY

SECURITY PRODUCTS

Governments, enterprises, banks, and industry demand high-end security to protect their assets. The growing number of IoT devices need to be secured against interception of data transfer and hacking of control systems.

But even trusted security solutions like Management Engines, Smartcard chips, or secured CPUs prove to be imperfect. An upgradeable security solution based on exchangeable hardware cryptography and standard interfaces is the solution to update systems to a constant state-of-the-art level of security. Swissbit's secure memory solutions offer smart card functionality coupled with NAND flash storage. Systems with SD card, microSD card, or USB interface can easily be updated to the protection level of a smart card chip. For efficient data protection of stored information, Swissbit offers SSDs as self-encrypted drives (SED) with TCG OPAL compliance or SD Cards with AES encryption.

SECURED BY
swissbit

Hardware–based security offers the highest level of protection and security. Swissbit's middleware creates a standardized layer to offer security functionality to the system without the need to understand the underlying hardware interfaces. The Swissbit Security Interface supports all relevant mobile, portable, embedded, and PC platforms.

TYPICAL APPLICATIONS:

· Surveillance
· Audit trails
· License protection
· Secure update
· Secure voice communication
· Authentication and authorization
· Data encryption and protection
· Point of Sale (POS)

PRODUCT FEATURES

ROBUSTNESS FEATURES

SHOCK AND VIBRATION
The design, assembly, and use of selected materials guarantee extreme mechanical robustness.

CONFORMAL COATING
A thin polyurethane film protects against aggressive environmental conditions such as dust, moisture, or corrosive gas.

LONGEVITY
These products offer the lowest TCO in demanding applications with high requalification cost.

PERFORMANCE FEATURES

HIGH PERFORMANCE
Optimized for high sequential data rates and IOPS by use of SLC technology.

WAF REDUCTION
The WAF (write amplification factor) for MLC-based products is reduced by combining a page-based firmware block management with a powerful card architecture and configuration settings.

DATA FEATURES

DATA CARE MANAGEMENT
Multiple routines inside the controller firmware improve data quality and eliminate degradation effects.

LIFE TIME MONITORING (LTM)
The Swissbit Life Time Monitoring feature enables users to access the memory device's detailed Life Time Status and allows remaining life time prediction, thereby avoiding unexpected data loss.

SECURE ERASE (SANITIZE / PURGE) / FAST ERASE
This feature uses an uninterruptible sequence of data erase commands.

READ-ONLY OPTIMIZED
For cases where content is written to the NAND flash once, the firmware can be optimized to guarantee the highest possible data retention and read disturb.

TRIM SUPPORT
Expired data can be released and deleted in the Flash which reduces garbage collection and increases the life time.

ZONE PROTECTION
The device allows the configuration of multiple zones with either no protection, write protection, or access protected settings.

TEMPERATURE FEATURES

WIDE TEMPERATURE SUPPORT
The products are designed and approved for reliable operation over a wide temperature range.

TEMPERATURE SENSOR
The sensor allows the host hardware or software to monitor the storage device temperature.

ELECTRONIC FEATURES

ESD AND EMI SAFE
The product designs are in line with the latest regulations for electrostatic discharge and electromagnetic interference.

LOW POWER CONSUMPTION
Electronic devices with lower power consumption decrease energy cost, prolong battery life, and reduce heat generation in the device, and hence require less cooling.

WEAR LEVELING
Sophisticated wear leveling and bad block management ensure that flash cells are sparingly and equally used to prolong the device's life.

IN FIELD FW UPDATE
The storage product can be upgraded with new firmware in the field. The upgrade process is protected against power loss.

POWER FAIL PROTECTION & RECOVERY
During an unintentional shutdown, firmware routines and intelligent hard-ware architecture ensure that no corruption of user or system data will occur.

SECURITY FEATURES

TRUE HARDWARE RNG
True random numbers are generated inside the secure element to prevent brute force attacks.

DIGITAL SIGNATURE
Digital signatures are very popular and indispensable to protect against data or code manipulation.

HARDWARE BASED DATA ENCRYPTION
Hardware based security is key when it comes to replaceability, simple workflows, and trusted runtime environments.

MOBILE BANKING & EPURSE
Strong authentication and offline security for mobile banking and payment.

DEVICE PROTECTION BY DUAL FACTOR AUTHENTICATION
The user needs to have the card and know the PIN.

SECURE VOICE
The product is optimal for fast, encrypted, and user-friendly secure voice solutions.

ELLIPTIC CURVE CRYPTOGRAPHY SUPPORT
Elliptic curves are faster and more efficient than RSA cryptography.

DATA PROTECTION & ENCRYPTION
The card offers a data safe function with strong AES encryption and PIN access protection.

SECURE LOGGING
Any data can be stored securely in write-once mode, queue mode, or random-access mode.

SECURE CD-ROM
Important data can be modified only after PIN authentication.

PRESALES
YOUR FUTURE WITH OUR SOLUTION

Our experienced Business Development and Field Application Engineering teams in Europe, North America, and Asia support you in the selection and qualification of the most suitable memory and storage solution for your applications.
This includes TCO analysis with the Swissbit Life Time Monitor, hardware or firmware customization, middleware development, the provision of evaluation units and ultimately a joint qualification.

SALES
YOUR TRUSTWORTHY PARTNER

We understand the importance of providing local support in your language and time zone. For that reason, Swissbit has established sales offices in all major regions plus a strong network of partners that reaches even farther. Our experienced sales teams manage forecasting and order fulfillment, or can engage third-party logistics or distribution networks if required.

AFTERSALES
LOCAL SUPPORT – GLOBALLY

Our engagement stretches far beyond the delivery of our products. Through sophisticated life cycle management, we can ensure maximum longevity and smooth transitions in the event of product changes. And while we are proud of our best-in-class quality, we are still prepared to provide fast and solution-oriented RMA support at any time, including 4D and 8D reports whenever required.

SWISSBIT'S UNIQUE 360° CUSTOMER SERVICE

PRE SALES

CUSTOMER

AFTER SALES

SALES

WHAT IS THE CUSTOMER BENEFIT?

HIGHEST ROBUSTNESS

WHAT MATTERS WHEN
STORAGE NEEDS TO BE TOUGH

We assure that Swissbit storage products deliver the best endurance at the maximum performance and for the lowest cost of ownership in our customers' applications. We combine reliable design and zero-defect manufacturing with world-class product qualification for the highest quality and long service life: key factors that ensure the highest productivity and efficiency in the tough applications that Swissbit serves.

01 **Availability of a full portfolio of storage and security products** with best fit to the customer use case

02 **Fast and easy qualification** of a mature product without risk of undetected issues

03 **Long service life** without need of frequent requalification

04 **Reduced cost** of maintenance and RMA handling

05 **Fast and effective** application engineering support

SAFE PROCESSES THROUGH RELIABLE DEVELOPMENT

- Product design and development with focus on industrial, NetCom, and automotive market requirements
- Optimized for demanding applications
- Stringent hardware and firmware qualification verify design effort

SAVINGS THROUGH LONG SERVICE LIFE

- Swissbit products use components with long-term availability
- The service life of Swissbit products exceed industry practice by far
- Swissbit commits to locked BOM and PCN process

MAXIMUM STABILITY

- Improved signal integrity
- In-house COB process for maximum mechanical robustness
- PCB design and soldering process withstand high thermal stress
- True industrial temperature support
- Firmware for highest endurance

NAND FLASH PRODUCTS

SWISSBIT'S EMBEDDED STORAGE SOLUTIONS

Our sophisticated flash handling algorithms optimize the performance and life of the 2D and 3D NAND flash used in our products.

OEMs of various industries require a variety of memory and storage solutions. In contrast to typical consumer devices, Swissbit's embedded memory and storage solutions are designed for the highest reliability under extreme environmental conditions. They come with a large feature set tailored to the demands of the industrial, automotive, and NetCom markets and with our commitment to long-term availability. Swissbit's embedded memory and storage solutions portfolio covers all relevant interfaces and form factors including SD and microSD memory cards, CompactFlash™ and CFast™ cards, 2.5" SATA SSDs, SLIM SATA and mSATA SSDs, M.2 in SATA and PCIe NVMe, USB Flash Drives (UFD), and modules. Our sophisticated flash handling algorithms optimize the performance and life of the SLC, MLC and 3D NAND flash used in our products.

	SLC	everbit™ pSLC	durabit™ MLC	3D pSLC	3D TLC	3D QLC
Chip Capacity	•	••	•••	••	••••	•••••
Cost per Bit	•••••	••••	•••	•••	••	•
Reliability & Endurance	••••	••••	•••	••••	•••	••
Industrial Temperature	••••	•••	•••	•••	••	•
Write Performance	••••	••••	•••	•••	••	•
ECC Requirement	•	••	••	••••	••••	••••
Data Retention	••••	•••	•••	•••	•••	•
Longevity	••••	••	••	••	••	

••••• maximum; •••• highest; ••• high; •• medium; • low
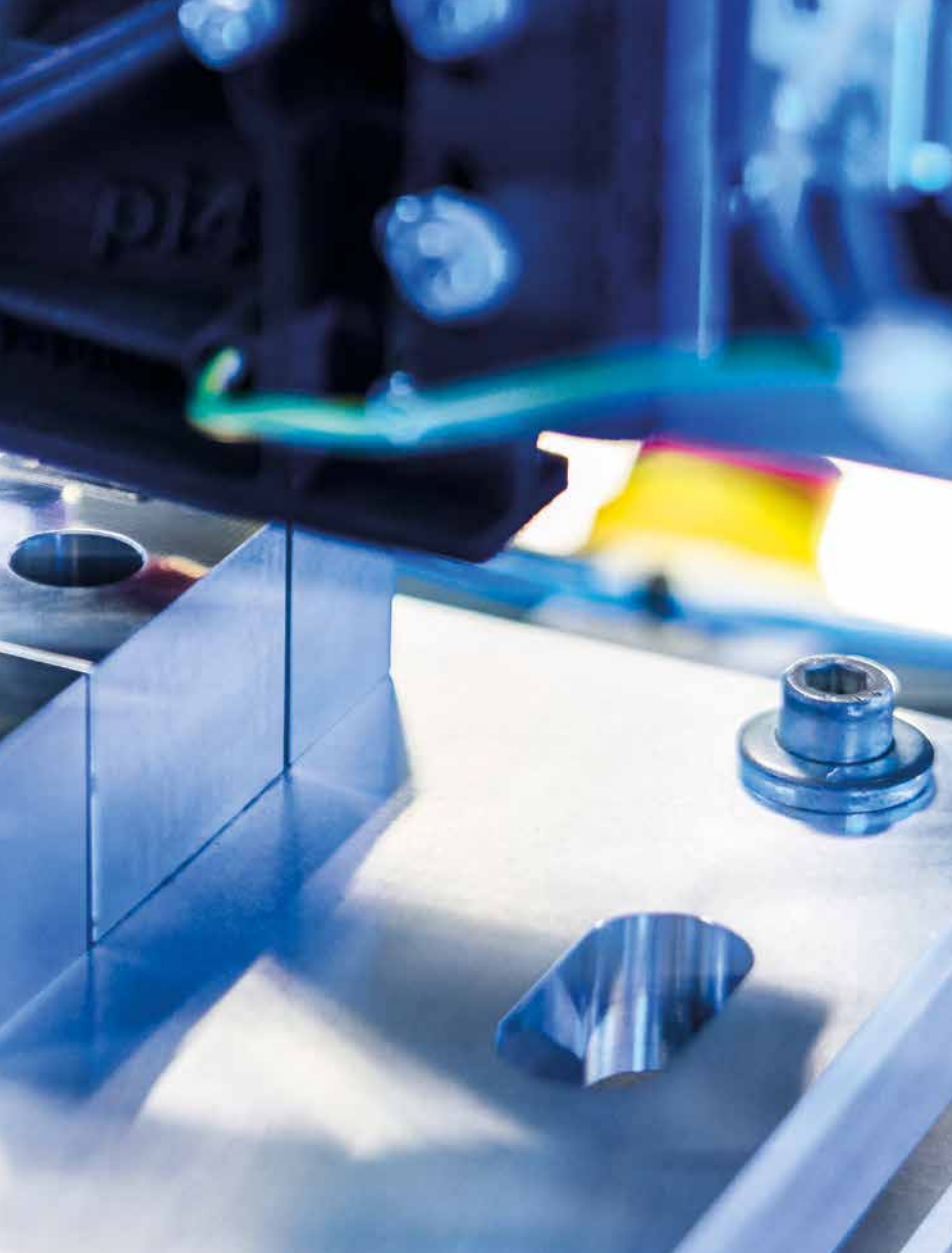
FLASH LIFE TIME PREDICTION

The endurance of flash-based products is primarily defined by the maximum number of program / erase cycles of the flash components. SLC components normally allow 100,000 PE cycles per block while MLC is typically specified as 3,000 PE cycles.

This transparency of NAND component endurance is no longer provided for integrated flash cards with controllers and firmware. For each write that the host initiates, the flash controller has to perform internal management steps and may need to erase and write multiple blocks even at the smallest external write transfer size. The ratio between internal write data volume and the external request size is called WAF (write amplification factor) and can vary between one (theoretical best case) and several hundred depending on card structure, flash components used, firmware architecture, and user-application write profile.

As explained in the box to the right, the endurance and performance of a FLASH product is massively defined by the internal write amplification (WAF).
The way in which customer applications write to the storage device has a high impact on the WAF, but is difficult to calculate analytically. Swissbit supports a realistic evaluation of the WAF and the endurance of their SSDs and storage cards with help of the Swissbit Life Time Monitoring Tool and statistical data stored in the flash by the firmware. This tool can read out the real usage data, such as the number of writes and erase cycles, the bad block statistic, and successful ECC correction, and provides all the data necessary to extrapolate the life time of the device.

Swissbit durabit™ products use architectural improvements such as page-based FTL, increased overprovisioning, and DRAM supported flash management to significantly decrease the WAF for small writes. This enables unprecedented endurance and write performance in these critical use cases.

SSD ENDURANCE

durabit™

DRAM supported PBM

Page Based Mapping (PBM)

Block Based Mapping (BBM)

Endurance

Random Small block Write · Sequential Write
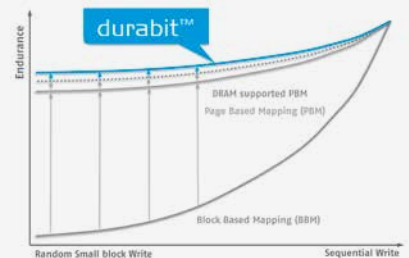
PCIe SSD Modules

Although SATA is still a dominant interface in embedded and NetCom systems, the future belongs to PCIe. PCIe breaks the bandwidth limitations of SATA and offers flexible solutions with multiple lanes that can be combined. The second innovation to increase the performance is the new protocol NVMe, which has been designed specifically for Non-Volatile Memory. The protocol significantly reduces the latency of read and write requests. The higher performance also requires higher power consumption,

especially with the common 4-lane configuration. The Swissbit N-10m2 and N-12m2 PCIe Gen3 / NVMe 1.2 modules only use 2 PCIe lanes and reduce the power consumption without sacrificing performance. Even if only operated with one PCIe lane, the performance still exceeds the SATA limits. Swissbit addresses applications with high endurance requirements with the pSLC versions N-16m2 and N-18m2. The N-20m2 is a very flexible solution that can be cut into different lengths, from 22110 to 2230.

	Wide Temp. Support	ESD & EMI Safe	Shock & Vibration	Life Time Monitor	Secure Erase	Temp. Sensor	Power Loss Protected	Wear Leveling	Read-Only Improved	TRIM Support	Data Care Managed	WAF Reduction
N-10m2 / N-16m2	●	●	●	●	●	●	●	●	●	●	●	●
N-12m2 / N-18m2	●	●	●	●	●	●	●	●	●	●	●	●
N-20m2	●	●	●	●	●	●	●	●	●	●	●	●

● default implemented;

INFORMATION

TYPE	M.2 PCIe / NVMe		
STANDARD & INTERFACE	PCI Express (PCIe) Specification Revision 3.1 / NVMe 1.2		PCIe 3.1 / NVMe 1.3
FORM FACTOR	PCI Express® M.2 (2280) B&M key, 2 lanes		max 22110 M key, 4 lanes
OUTLINE DIMENSIONS	80 x 22 x 2.23 mm		110,80,60,42,30 x 22 x 3.5 mm
FLASH TYPE	3D NAND TLC / pSLC		3D NAND TLC / pSLC
DENSITY RANGE	120 GB – 960 GB / 40 GB – 320 GB	30 GB – 240 GB / 10 GB – 80 GB	15 GB – 240 GB / 5 GB – 80 GB
DATA RETENTION	10 years @ life begin 1 year @ life end		
ENDURANCE [DWPD]*	max 2.17 / 25.0	max. 1.42 / 15.2	max. 0.6 / 6.0

TEMPERATURE

OPERATING TEMPERATURE	Commercial: 0°C to +70°C Industrial: –40°C to +85°C		
STORAGE TEMPERATURE	–40°C to +85°C		

PERFORMANCE

SEQUENTIAL READ (MB/S) SEQUENTIAL WRITE (MB/S) RANDOM 4KB READ (IOPS) RANDOM 4KB WRITE (IOPS)	up to 1,600 / 1,620 up to 1,000 / 1,070 up to 190,000 / 195,000 up to 190,000 / 195,000	up to 1,570 / 1,520 up to 860 / 860 up to 100,000 / 148,000 up to 166,000 / 166,000	up to 1,750 up to 750 up to 149,000 up to 106,000

ELECTRICAL DATA

VOLTAGE	3.3V +– 5%		
POWER CONSUMPTION	Max. Read Active: 4.1 W Max. Write Active: 3.6 W Power State 3: < 500 mW	Max. Read Active:3.0 W Max. Write Active: 2.4 W Power State 3: < 500 mW	Typ. Read: 2.0 W Typ. Write: 1.3 W Power State 3: < 330 mW

FEATURE LIST

FEATURES & TOOLS	DRAM support	HMB support (Host memory buffer)	
	Active and Passive Data Care Management AES 256 / E2E Data protection Power Fail Data Loss Protection Active State Power Management (ASPM) Support NVMe Security Command Support In-Field Firmware Update Self-Monitoring, Analysis, and Reporting Technology (S.M.A.R.T.) TCG OPAL 2.0 (on request for N–10m2 and N–20m2) Swissbit Life Time Monitoring (SBLTM) Tool and SDK for SBLTM (on request)		
MORE INFORMATION	For more details see www.swissbit.com/product-finder		

* DWPD values are according to JESD219 Client Endurance Workload based on a service life of 3 years

2.5" SATA SSDs

Swissbit's 2.5" SSDs are ideal solutions for embedded applications requiring reliable and long service life storage. The X–60 SATA 6Gb/s series is Swissbit's MLC–based solution for high performance, cost sensitive, high capacity markets.

X–600 has best–in–class endurance using SLC technology, while X–66 is the perfect compromise with MLC NAND in pSLC mode.

The new X–7x range is based on 3D NAND TLC with focus on best TCO. The X–76 is the flagship with 3D NAND pSLC, offering the best endurance per cost. ALL products feature Swissbit's proven Power Fail Safety, Data Care Management, a detailed S.M.A.R.T.–based Life Time Monitoring, NCQ, TRIM, advanced wear leveling, bad block management, and in–field firmware update functionality.

	Wide Temp. Support	ESD & EMI Safe	Shock & Vibration	Life Time Monitor	Secure Erase	Conformal Coating	Temp. Sensor	Power Loss Protected	Wear Leveling	Read-Only Improved	TRIM Support	Data Care Managed	Longevity	WAF Reduction
X-600	●	●	●	●	●	◖	●	●	●	●	●	★	●	●
X-60 / X-66	●	●	●	●	●	◖	●	●	●	●	●	★	○	●
X-70	●	●	●	●	●	◖	●	●	●	●	●	●	○	●
X-75 / X-73 / X-76	●	●	●	●	●	◖	●	●	●	●	●	★	○	●

★ Industry Leading; ● default implemented; ◖ on request; ○ not available

X-600 / X-66 / X-60   X-75   X-73 / X-76   X-70

INFORMATION

	X-600 / X-66 / X-60	X-75	X-73 / X-76	X-70
TYPE	2.5" SATA Gen3 SSD			
INTERFACE / DATA TRANSFER MODE	SATA Gen3 –6Gbit/s ATA8			
CONNECTOR	15 + 7 pin Serial ATA			
OUTLINE DIMENSIONS	100 x 70 x 7 mm			
FLASH TYPE	SLC / pSLC / MLC	3D NAND TLC	3D NAND TLC / pSLC	3D NAND TLC
DENSITY RANGE	SLC: X-600: 8 GB – 256 GB pSLC: X-66: 16 GB – 480 GB MLC: X-60: 30 GB – 960 GB	60 GB – 1920 GB	X-73: 30 GB – 960 GB X-76: 10 GB – 320 GB	60 GB – 480 GB
DATA RETENTION	10 years @ life begin | 1 year @ life end			
ENDURANCE [DWPD]*	30.5 / 13.2 / 2.0	max 0.93	max 0.93 / 9.5	max 1.85

TEMPERATURE

OPERATING TEMPERATURE	Commercial: 0°C to +70°C Industrial: –40°C to +85°C			Commercial: 0°C to +70°C
STORAGE TEMPERATURE	–40°C to +85°C			

PERFORMANCE

	X-600 / X-66 / X-60	X-75	X-73 / X-76	X-70
SEQUENTIAL READ (MB/S) **SEQUENTIAL WRITE (MB/S)** **RANDOM 4KB READ (IOPS)** **RANDOM 4KB WRITE (IOPS)**	up to 520 / 520 / 525 up to 425 / 450 / 460 up to 79,000 / 80,000 / 74,300 up to 76,000 / 75,000 / 77,900	up to 565 up to 495 up to 73,600 up to 79,400	up to 565 / 565 up to 495 / 480 up to 73,600 / 77,000 up to 79,400 / 85,000	up to 560 up to 465 up to 83,500 up to 66,900

ROBUSTNESS

MTBF	≥2,000,000 hours			
SHOCK	1,500 G, 0.5 ms			
VIBRATION	50 G, 80–2,000 Hz			20 G, 80–2,000 Hz
HUMIDITY	85 % RH 85 °C, 1,000 hrs			

ELECTRICAL DATA

	X-600 / X-66 / X-60	X-75	X-73 / X-76	X-70
VOLTAGE	5 V ± 10% / 3.3 V ± 5%	5 V ± 10 %		
POWER CONSUMPTION	Read (Active): 2.45 W Write (Active): 3.8 W Idle: 550 mW Slumber: 125 mW	Read (Active): 2.5 W Write (Active): 3.3 W Idle: 475 mW Partial: 175 mW	Read (Active): 2.7 W Write (Active): 3.4 W Idle: 475 mW Partial: 125 mW	Read (Active): 3.0 W Write (Active): 3.1 W Idle: 600 mW Slumber: 200 mW

FEATURE LIST

	X-600 / X-66 / X-60	X-75 / X-73 / X-76	X-70
FEATURES & TOOLS	Proven Power Fail Safety NCQ, TRIM Advanced Wear Leveling & Bad Blockmanagement In-field firmware update SBLTM Tool & SDK for S.M.A.R.T. based Life Time Monitoring AES 256 Encryption optional	E2E Data Protection AES 256 Encryption optional TCG OPAL optional Proven Power Fail Safety NCQ, TRIM, Data Refresh In-field firmware updateS SBLTM Tool & SDK for detailed S.M.A.R.T. based Life Time Monitoring	Proven Power Fail Safety NCQ, TRIM Advanced Wear Leveling & Bad Block management In-field firmware update SBLTM Tool & SDK for S.M.A.R.T. based Life Time Monitoring
MORE INFORMATION	For more details see www.swissbit.com/product-finder		

* DWPD values are according to JESD219 Client Endurance Workload based on a service life of 3 years

SATA Modules

Equally to the 2.5″ drives, the Swissbit mSATA (M0-300), SLIM SATA (M0-297), and the M.2 SSDs target embedded applications that require solid state storage in small, removable form factors. The SSD modules are designed for robustness against frequent temperature changes within the –40°C to 85°C range, withstand high shock and vibration, and offer superior performance and endurance.

The five families, X-75, X-76, X-60, X-66, and X-600, target different use cases including OS booting, data logging, surveillance recording, or vaulting. The amount and type of write access defines the required endurance in TBW. Swissbit provides their detailed S.M.A.R.T-based Life Time Monitor, which helps to analyze the use case and identify the best fit between the Swissbit SSD product families and the user application.

	Wide Temp. Support	ESD & EMI Safe	Shock & Vibration	Life Time Monitor	Secure Erase	Conformal Coating	Temp. Sensor	Power Loss Protected	Wear Leveling	Read-Only Improved	TRIM Support	Data Care Managed	Longevity	WAF Reduction
X-600m/s/m2	●	●	●	●	●	◐	●	●	●	●	●	★	●	●
X-60 / X-66m/s/m2	●	●	●	●	●	◐	●	●	●	●	●	★	○	●
X-200m/s	●	●	●	●	○	◐	○	●	●	○	○	○	●	○
X-75 / X-76m/s/m2	●	●	●	●	●	◐	●	●	●	●	●	★	○	●

★ Industry Leading;　● default implemented;　◐ on request;　○ not available

INFORMATION

	X-600m	X-600s	X-600m2		X-200m	X-200s
TYPE	MO-300 mSATA	MO-297 SLIM SATA	M.2 2242	M.2 2260 / 2280	MO-300 mSATA	MO-297 SLIM SATA
INTERFACE DATA TRANSFER MODE	SATA Gen3 –6Gbit/s ATA8				SATA Gen2 – 3 Gbit/s up to PIO4, MDMA2, UDMA6	
CONNECTOR	52 pos. Edge Connector PCI Express (PCIe) mini	15 + 7 pin Serial ATA Connector	75 pos. Edge Connector B & M key		52 pos. PCI Express (PCIe) mini	15 + 7 pin Serial ATA Connector
OUTLINE DIMENSIONS	50.8 x 29.85 mm	54 x 39 mm	22 x 42 mm	22 x 60 / 80 mm	50.8 x 29.85 mm	54 x 39 mm
THICKNESS (MAX)	3.8 mm	4.0 mm	3.58 mm		3.8 mm	4.0 mm
FLASH TYPE	SLC					
DENSITY RANGE	8 GB – 128 GB	16 GB – 128 GB	8 GB – 64 GB	16 GB – 128 GB	2 GB – 64 GB	
DATA RETENTION	10 years @ life begin | 1 year @ life end					
ENDURANCE [DWPD]*	30.5				3.5	

TEMPERATURE

OPERATING TEMPERATURE	Commercial: 0°C to +70°C Industrial: –40°C to +85°C					
STORAGE TEMPERATURE	–40°C to +85°C					

PERFORMANCE

	X-600m	X-600s	X-600m2		X-200m	X-200s
SEQUENTIAL READ (MB/S) SEQUENTIAL WRITE (MB/S) RANDOM 4KB READ (IOPS) RANDOM 4KB WRITE (IOPS)	up to 520 up to 405 up to 76,000 up to 73,000		up to 520 up to 245 up to 76,000 up to 54,000	up to 520 up to 405 up to 76,000 up to 73,000	up to 120 up to 95 up to 3,100 up to 25	

ROBUSTNESS

MTBF	≥2,000,000 hours					
SHOCK	1,500 G, 0.5 ms					
VIBRATION	50 G, 80-2,000 Hz				20 G, 10-2,000 Hz	
HUMIDITY	85 % RH 85°C, 1,000 hrs					

ELECTRICAL DATA

	X-600m	X-600s	X-600m2		X-200m	X-200s
VOLTAGE	3.3 V ± 5 %	5 V ± 10 %	3.3 V ± 5 %			5 V ± 10 %
POWER CONSUMPTION	Read (Active): 1.7 W Write (Active): 2.5 W Idle: 380 mW Slumber: 115 mW	Read (Active): 2.0 W Write (Active): 2.9 W Idle: 550 mW Slumber: 275 mW	Read (Active): 1.7 / 1.5 W Write (Active): 2.5 / 1.7 W Idle: 380 / 345 mW Slumber: 115 mW		Read (Active): 1.3 W Write (Active):1.6W Idle: 660 mW	Read (Active): 1.5 W Write (Active):1.6W Idle: 700 mW

FEATURE LIST

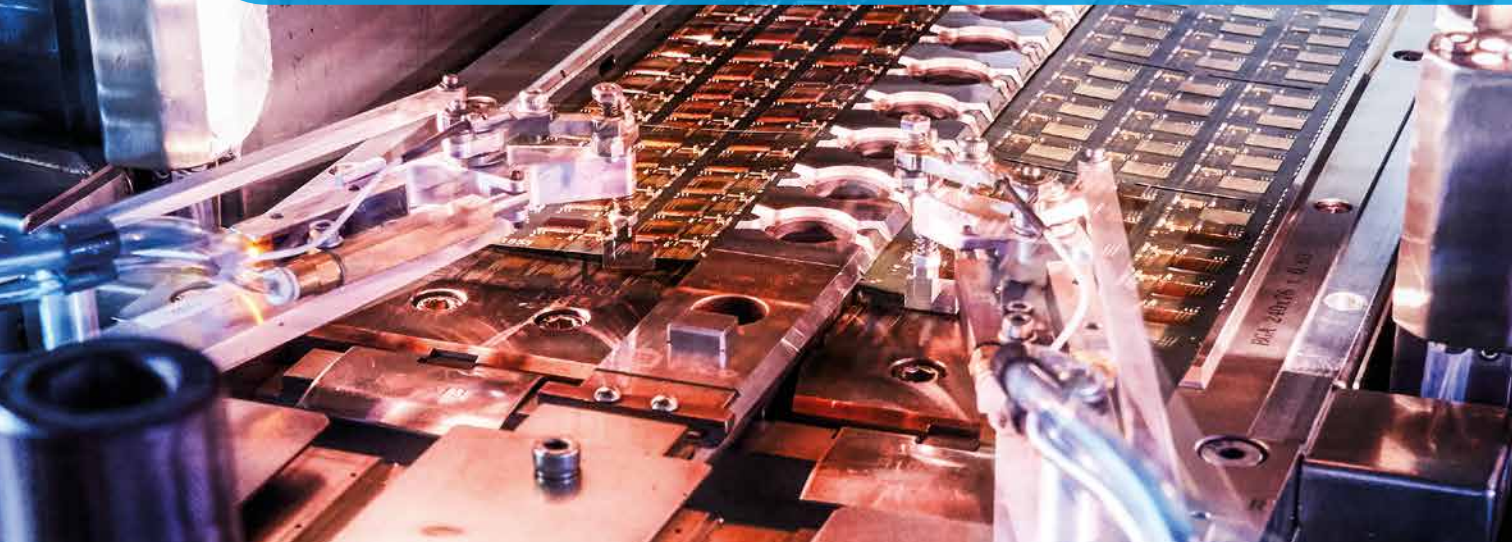|	X-600m / X-600s / X-600m2	X-200m / X-200s
FEATURES & TOOLS	Proven Power Fail Safety NCQ, TRIM Advanced Wear Leveling & Bad Block management In-field firmware update SBLTM Tool & SDK for S.M.A.R.T. based Life Time Monitoring AES 256 Encryption (optional)	Proven Power Fail Safety Advanced Wear Leveling & Bad Block management SBLTM Tool & SDK for S.M.A.R.T. based Life Time Monitoring
MORE INFORMATION	For more details see www.swissbit.com/product-finder	

* DWPD values are according to JESD219 Client Endurance Workload based on a service life of 3 years

X-60m2 / X-66m2   X-60s / X-66s   X-60m / X-66m

INFORMATION

TYPE	M.2 2242	M.2 2260 / 2280	MO-297 SLIM SATA	MO-300 mSATA
INTERFACE **DATA TRANSFER MODE**	SATA Gen3 –6Gbit/s ATA8			
CONNECTOR	75 pos. Edge Connector B & M key		15 + 7 pin Serial ATA Connector	52 pos. Edge Connector PCI Express (PCIe) mini
OUTLINE DIMENSIONS	22 x 42 mm	22 x 60 / 80 mm	54 x 39 mm	50.8 x 29.85 mm
THICKNESS (MAX)	3.58 mm	3.58 mm	4.0 mm	3.8 mm
FLASH TYPE	MLC durabit™	pSLC everbit™			
DENSITY RANGE durabit everbit	30 GB – 240 GB 16 GB – 120 GB	30 GB – 960 GB 16 GB – 480 GB	30 GB – 480 GB 16 GB – 240 GB	8 GB – 480 GB 16 GB – 240 GB
DATA RETENTION	10 years @ life begin | 1 year @ life end			
ENDURANCE [DWPD]*	durabit™: 2.0 | everbit™: 13.2			

TEMPERATURE

OPERATING TEMPERATURE	Commercial: 0°C to +70°C Industrial: –40°C to +85°C
STORAGE TEMPERATURE	–40°C to +85°C

PERFORMANCE

SEQUENTIAL READ (MB/S) **SEQUENTIAL WRITE (MB/S)** **RANDOM 4KB READ (IOPS)** **RANDOM 4KB WRITE (IOPS)**	up to 520 / 520 up to 340 / 415 up to 72,000 / 80,000 up to 78,000 / 73,000	up to 520 / 520 up to 450 / 450 up to 75,000 / 80,000 up to 75,000 / 75,000

ROBUSTNESS

MTBF	≥2,000,000 hours
SHOCK	1,500 G, 0.5 ms
VIBRATION	50 G, 80–2,000 Hz
HUMIDITY	85 % RH 85°C, 1,000 hrs

ELECTRICAL DATA

VOLTAGE	3.3 V ± 5 %		5 V ± 10 %	3.3 V ± 5 %
POWER CONSUMPTION	Read (Active): 1.3 W Write (Active): 1.6 W Idle: 360 mW Slumber: 115 mW	Read (Active): 1.6 W Write (Active): 3.4 W Idle: 415 mW Slumber: 115 mW	Read (Active): 1.7 W Write (Active): 3.7 W Idle: 550 mW Slumber: 275 mW	Read (Active): 1.5 W Write (Active): 3.2 W Idle: 380 mW Slumber: 115 mW

FEATURE LIST

FEATURES & TOOLS	Proven Power Fail Safety NCQ, TRIM Advanced Wear Leveling & Bad Block management In-field firmware update SBLTM Tool & SDK for S.M.A.R.T. based Life Time Monitoring AES 256 Encryption (optional)
MORE INFORMATION	For more details see www.swissbit.com/product-finder

* DWPD values are according to JESD219 Client Endurance Workload based on a service life of 3 years

INFORMATION

TYPE	M.2 2242	M.2 2280	MO–297 SLIM SATA	MO–300 mSATA
INTERFACE DATA TRANSFER MODE	SATA Gen3 –6Gbit/s ATA8			
CONNECTOR	75 pos. Edge Connector B & M key		15 + 7 pin Serial ATA	52 pos. PCI Express (PCIe) mini
OUTLINE DIMENSIONS	22 x 42 mm	22 x 80 mm	54 x 39 mm	50.8 x 29.85 mm
THICKNESS (MAX)	3.58 mm	3.58 mm	4.0 mm	3.8 mm
FLASH TYPE	X–75*: 3D NAND TLC | X–76*: 3D NAND pSLC			
DENSITY RANGE	X–75m2: 30 GB – 480 GB X–76m2: 10 GB – 160 GB	X–75m2: 30 GB – 960 GB X–76m2: 10 GB – 320 GB	X–75s: 30 GB – 960 GB X–76s: 10 GB – 320 GB	X–75m: 30 GB – 960 GB X–76m: 10 GB – 320 GB
DATA RETENTION	10 years @ life begin | 1 year @ life end			
ENDURANCE [DWPD]*	X–75*: max 0.98 | X–76*: max 21.7			

TEMPERATURE

OPERATING TEMPERATURE	Commercial: 0°C to +70°C Industrial: –40°C to +85°C
STORAGE TEMPERATURE	–40°C to +85°C

PERFORMANCE

SEQUENTIAL READ (MB/S) SEQUENTIAL WRITE (MB/S) RANDOM 4KB READ (IOPS) RANDOM 4KB WRITE (IOPS)	up to 565 / 565 up to 490 / 480 up to 73,200 / 77,400 up to 79,400 / 84,900	up to 565 / 565 up to 495 / 490 up to 73,600 / 77,400 up to 79,400 / 84,900	up to 565 / 565 up to 495 / 490 up to 73,600 / 77,400 up to 79,400 / 84,900	up to 565 / 565 up to 495 / 490 up to 73,600 / 77,400 up to 79,400 / 84,900

ROBUSTNESS

MTBF	≥2,000,000 hours
SHOCK	1,500 G, 0.5 ms
VIBRATION	50 G, 80–2,000 Hz
HUMIDITY	85 % RH 85°C, 1,000 hrs

ELECTRICAL DATA

VOLTAGE	3.3 V ± 5 %		5 V ± 10 %	3.3 V ± 5 %
POWER CONSUMPTION	Read (Active): 2.2 W Write (Active): 2.9 W Idle: 395 mW Partial: 115 mW	Read (Active): 2.3 W Write (Active): 3.0 W Idle: 395 mW Partial: 115 mW	Read (Active): 2.7 W Write (Active): 3.4 W Idle: 475 mW Partial: 125 mW	Read (Active): 2.4 W Write (Active): 3.0 W Idle: 395 mW Partial: 100 mW

FEATURE LIST

FEATURES & TOOLS	E2E Data Protection AES 256 Encryption (optional) / TCG OPAL 2.0 (optional) Advanced Wear Leveling, Bad Block Management Proven Power Fail Safety NCQ, TRIM Data Refresh In–field firmware update SBLTM Tool & SDK for detailed S.M.A.R.T. based Life Time Monitoring
MORE INFORMATION	For more details see www.swissbit.com/product–finder

* DWPD values are according to JESD219 Client Endurance Workload based on a service life of 3 years

CFast™ Cards

CFast™ cards combine the CompactFlash™ (CF) card form factor and the Serial ATA (SATA) interface into a single product. CFast™ cards can replace both HDDs and CompactFlash™ cards in applications requiring small form factors, high endurance, and the ability to withstand shock, vibration, extreme temperatures (−40°C to +85°C), and rough environmental conditions.

Swissbit's CFast™ cards provide rugged and easy replaceable storage for embedded and industrial systems. The Swissbit CFast™ card portfolio covers the range from high-end SLC-based F-600 to the cost/performance optimized F-50. With an equal feature set as the 2.5" X-60 SSD, the F-60 MLC product and F-66 pSLC card are perfect devices for high performance and endurance and the lowest total cost of ownership.

	Wide Temp. Support	ESD & EMI Safe	Shock & Vibration	Life Time Monitor	Secure Erase	Conformal Coating	Temp. Sensor	Power Loss Protected	Wear Leveling	Read-Only Improved	TRIM Support	Data Care Managed	Longevity	WAF Reduction
F-600	●	●	●	★	●	◐	●	★	●	●	●	★	○	●
F-60 / F-66	●	●	●	★	●	◐	●	★	●	●	●	★	○	●
F-50 / F-56	●	●	●	★	●	◐	●	★	●	○	●	●	○	○
F-240	●	●	●	★	○	◐	○	★	●	★	●	○	●	○

★ Industry Leading; ● default implemented; ◐ on request; ○ not available

	F-600	F-60 / F-66	F-50 / F-56	F-240

INFORMATION

	F-600	F-60 / F-66	F-50 / F-56	F-240
TYPE	CFast™ CARD			
INTERFACE DATA TRANSFER MODE	CFast™ 2.0 – SATA Gen3 6Gbit/s ATA8			CFast™ 1.0 – SATA Gen2 3Gbit/s ATA7
CONNECTOR	CFast™ Type I			
OUTLINE DIMENSIONS	36.4 x 42.8 x 3.6 mm			
FLASH TYPE	SLC	MLC durabit™ / pSLC everbit™	MLC / pSLC	SLC
DENSITY RANGE	8 GB – 64 GB	MLC: 8 GB – 240 GB pSLC: 4 GB – 120 GB	MLC: 8 GB – 256 GB pSLC: 4 GB – 128 GB	2 GB – 64 GB
DATA RETENTION	10 years @ life begin | 1 year @ life end			
ENDURANCE [DWPD]*	33.8	1.98 / 13.2	max 1.50 / 7.98	max 2.63

TEMPERATURE

OPERATING TEMPERATURE	Commercial: 0°C to +70°C Industrial: –40°C to +85°C			
STORAGE TEMPERATURE	–40°C to +85°C			

PERFORMANCE

	F-600	F-60 / F-66	F-50 / F-56	F-240
SEQUENTIAL READ (MB/S) **SEQUENTIAL WRITE (MB/S)** **RANDOM 4KB READ (IOPS)** **RANDOM 4KB WRITE (IOPS)**	up to 520 up to 245 up to 76,000 up to 54,000	up to 520 / 520 up to 180 / 415 up to 72,000 / 80,000 up to 43,000 / 75,000	up to 500 / 510 up to 330 / 415 up to 53,500 / 32,000 up to 74,000 / 66,000	up to 120 up to 120 up to 3,200 up to 75

ROBUSTNESS

MTBF	≥ 2,000,000 hours			≥ 2,500,000 hours
SHOCK	1,500 G, 0.5 ms		500 G, 1 ms	500 G, 1 ms
VIBRATION	50 G, 80–2,000 Hz		20 G, 80–2,000 Hz	20 G
HUMIDITY	85 % RH 85°C, 1,000 hrs			

ELECTRICAL DATA

	F-600	F-60 / F-66	F-50 / F-56	F-240
VOLTAGE	3.3 V ± 5 %			
POWER CONSUMPTION	Read (Active): 1.6 W Write (Active): 2.4 W Idle: 347 mW Slumber: 115 mW	Read (Active): 1.4 W Write (Active): 1.8 W Idle: 380 mW Slumber: 116 mW	Read (Active): 1.2 W Write (Active): 2.1 W Idle: 248 mW Slumber: 17 mW	Max. 3.2 W Idle: 380 mW PHYSLP < 80 mW

FEATURE LIST

FEATURES & TOOLS	Proven Power Fail Safety NCQ, TRIM Advanced Wear Leveling & Bad Block management In-field firmware update SBLTM Tool & SDK for S.M.A.R.T. based Life Time Monitoring F-6x: AES 256 Encryption (optional)	Proven Power Fail Safety Sophisticated Wear Leveling & Bad Block management Read Disturb Management TRIM Low Power Consumption Security & SBZoneProtection features available SBLTM Tool & SDK for S.M.A.R.T. based Life Time Monitoring
MORE INFORMATION	For more details see www.swissbit.com/product-finder	

* DWPD values are according to JESD219 Client Endurance Workload based on a service life of 3 years

CompactFlash™

To this day, CompactFlash™ (CF) cards are widely used as boot and data logging devices in many NetCom and industrial applications.
Swissbit's dedication to these markets is shown by the broad portfolio and recent launch of a new product family.
Swissbit products are developed with a strong focus on quality, reliability, robustness, and longevity.

All Swissbit's CF Series are offered in both commercial (0°C to +70°C) and industrial (−40°C to +85°C) temperature ranges. Swissbit's most recent CF Card product families C−500, C−50 and C−56 are using page based Flash management and thus provide the highest write IOPS rate as well as outstanding endurance.

	Wide Temp. Support	ESD & EMI Safe	Shock & Vibration	Life Time Monitor	Secure Erase	Conformal Coating	Power Loss Protected	Wear Leveling	Read-Only Improved	TRIM Support	Data Care Managed	Longevity	WAF Reduction
C-300	●	●	●	●	○	◑	★	●	○	○	○	●	○
C-300 LONGEVITY	●	●	●	★	○	◑	★	●	●	○	○	●	○
C-320	●	●	●	●	◑	◑	★	●	◑	○	○	●	○
C-440	●	●	●	★	◑	◑	★	●	★	★	○	●	○
C-500 / C-56 / C-50	●	●	●	★	◑	◑	★	●	★	★	●	●	★

★ Industry Leading; ● default implemented; ◑ on request; ○ not available

	C-300 / C-300L / C-320	**C-440**	**C-500**	**C-50 / C-56**

UDMA6 CF · UDMA6 CF · UDMA6 CF

INFORMATION

TYPE	COMPACTFLASH™ CARD			
INTERFACE DATA TRANSFER MODE	CFA4.1 True IDE / PC card – Up to UDMA4, MDMA4 & PIO6	CFA5.0 True IDE / PC card – Up to UDMA6, MDMA4 & PIO6		
CONNECTOR	CFC Type I			
OUTLINE DIMENSIONS	36.4 x 42.8 x 3.3 mm			
FLASH TYPE	SLC			MLC durabit™ / pSLC everbit™
DENSITY RANGE	C-300: 128 MB–4 GB C-300L: 128 MB – 1 GB C-320: 2 GB – 32 GB	2 GB – 64 GB	512 MB – 64 GB	C-50: 8 GB – 128 GB C-56: 4 GB – 64 GB
DATA RETENTION	10 years @ life begin | 1 year @ life end			
ENDURANCE [DWPD]*	C-300: max 1.70 C-320: max 0.92	max 2.15	max 3.50	C-50: max 0.14 C-56: max 1.11

TEMPERATURE

OPERATING TEMPERATURE	Commercial: 0°C to +70°C Industrial: –40°C to +85°C			
STORAGE TEMPERATURE	–40°C to +85°C			

PERFORMANCE

SEQUENTIAL READ (MB/S) **SEQUENTIAL WRITE (MB/S)** **RANDOM 4KB READ (IOPS)** **RANDOM 4KB WRITE (IOPS)**	up to 45 up to 35 up to 3,300 up to 50	up to 65 up to 35 up to 2,400 up to 300 (with TRIM)	up to 64 up to 44 up to 3,200 up to 1,900	up to 114 / 115 up to 39 / 66 up to 3,500 / 5,000 up to 2,400 / 3,300

ROBUSTNESS

MTBF	≥ 3,000,000 hours
SHOCK	1,500 G
VIBRATION	20 G
HUMIDITY	85 % RH 85°C, 1,000 hrs

ELECTRICAL DATA

VOLTAGE	3.3 V ± 5 % | 5 V ± 10 %			
POWER CONSUMPTION	PIO typ 60 mA @ 3.3 V DMA typ 90 mA @ 3.3 V DMA typ 130 mA @ 5 V	PIO typ 60 mA @ 3.3 V DMA typ 80 mA @ 3.3 V DMA typ 90 mA @ 5 V	max 120 mA Idle 4.5 mA	max 130 mA Idle 4.5 mA

FEATURE LIST

FEATURES & TOOLS	Proven Power Fail Safety Sophisticated Wear Leveling & Bad Block management Security & SBZoneProtection features available SBLTM Tool & SDK for S.M.A.R.T. based Life Time Monitoring	Proven Power Fail Safety Sophisticated Wear Leveling & Bad Block management Read Disturb Management TRIM Security & SBZoneProtection features available SBLTM Tool & SDK for S.M.A.R.T. based Life Time Monitoring	Page based FTL for maximum Endurance Proven Power Fail Safety Sophisticated Wear Leveling & Bad Block management Read Disturb Management TRIM Security & SBZoneProtection features available SBLTM Tool & SDK for S.M.A.R.T. based Life Time Monitoring	
MORE INFORMATION	For more details see www.swissbit.com/product-finder			

* DWPD values are according to JESD219 Enterprise Endurance Workload based on a service life of 3 or 5 years

SD Memory Cards

Secure Digital (SD) memory cards have a widespread use in industrial and automotive applications, ranging from read only applications as in navigation systems to utilization as boot media, for video recording, or data logging. Swissbit's Industrial Secure Digital (SD) card series is designed for high sustained performance and endurance and is manufactured and tested in Swissbit's own fab to withstand extreme environmental conditions. The SLC based S-450/455 offers the best sequential performance and highest endurance, while the durabit™ S-45 and the everbit™ S-46 series rely on MLC NAND. They combine an industry leading controller with sub-page-based firmware and achieve unprecedented random write performance. The new S-30 and S-50 models feature 3D NAND, with S-30 targeting read-mostly applications and S-50 as a full featured device.

	Wide Temp. Support	ESD & EMI Safe	Shock & Vibration	Life Time Monitor	Conformal Coating	Power Loss Protected	Wear Leveling	Read-Only Improved	Data Care Managed	Longevity	WAF Reduction
S-200	●	●	●	●	○	★	●	○	○	●	○
S-45	●	●	●	★	●	●	●	★	★	○	★
S-46	●	●	●	★	●	★	●	★	★	○	★
S-450	●	●	●	★	●	★	●	★	★	●	○
S-455	●	●	●	★	●	★	●	★	★	●	★
S-30	○	●	●	●	●	●	●	●	○	○	★
S-50	●	●	●	●	●	★	●	★	★	○	★

★ Industry Leading; ● default implemented; ◖ on request; ○ not available

	S-200	S-450 / 455	S-45 / S-46	S-30	S-50

INFORMATION

	S-200	S-450 / 455	S-45 / S-46	S-30	S-50
TYPE	SD MEMORY CARD (SD / SDHC)		SD MEMORY CARD (SD / SDHC / SDXC)	SD MEMORY CARD (SDHC / SDXC)	
INTERFACE DATA TRANSFER MODE	SD 2.0, Class 6	SD 3.0, Class 10, UHS-I		SD 6.1, Class 10, UHS-I, V30, A1	SD 6.1, Class 10, UHS-I, A1, Automotive Type
CONNECTOR	SD				
OUTLINE DIMENSIONS	32 x 24 x 2.1 mm				
FLASH TYPE	SLC		MLC durabit™ pSLC everbit™	3D NAND TLC	
DENSITY RANGE	512 MB – 2 GB (SD)	512 MB – 2 GB (SD) 4 GB – 32 GB (SDHC)	S-45: 4 GB – 128 GB S-46: 2 GB – 64 GB	32 GB (SDHC) 64 GB – 256 GB (SDXC)	32 GB (SDHC) 64 GB – 128 GB (SDXC)
DATA RETENTION	10 years @ life begin | 1 year @ life end				
ENDURANCE	100k P/E Cycles (Flash Cell Level)		S-45: 3k P/E Cycles S-46: 20k P/E Cycles	1k P/E Cycles	3k P/E Cycles

TEMPERATURE

	S-200	S-450 / 455	S-45 / S-46	S-30	S-50
OPERATING TEMPERATURE	Extended: –25°C to +85°C Industrial: –40°C to +85°C			Extended: –25°C to +85°C	Extended: –25°C to +85°C Industrial: –40°C to +85°C
STORAGE TEMPERATURE	–40°C to +100°C			–40°C to +85°C	–40°C to +100°C

PERFORMANCE

	S-200	S-450 / 455	S-45 / S-46	S-30	S-50
SEQUENTIAL READ (MB/S)	up to 24	up to 88 / 44	up to 43 / 46	up to 95	typ 90
SEQUENTIAL WRITE (MB/S)	up to 18	up to 73 / 38	up to 21 / 52	up to 85	typ 40
RANDOM 4KB READ (IOPS)	up to 1,640	up to 1,430 / 1,250	up to 1,200 / 1,440	up to 1,700	typ 2,050
RANDOM 4KB WRITE (IOPS)	up to 31	up to 28 / 1,100	up to 950 / 1,260	up to 1,050	typ 800

ROBUSTNESS

	S-200	S-450 / 455	S-45 / S-46	S-30	S-50
MTBF	≥ 3,000,000 hours				
SHOCK	1,000 G	1,500 G			
VIBRATION	15 G	50 G		20 G	50 G
HUMIDITY	85 % RH 85°C, 1,000 hrs				

ELECTRICAL DATA

	S-200	S-450 / 455	S-45 / S-46	S-30	S-50
VOLTAGE	2.7 –3.6 V Normal				
POWER CONSUMPTION	Read typ 40 mA Write typ 65 mA	Read typ 75 mA Write typ 75 mA	Read typ 80 mA Write typ 70 mA	Read typ 80 mA Write typ 100 mA	Read typ 110 mA Write typ 110 mA

FEATURE LIST

	S-200	S-450 / 455	S-45 / S-46	S-30	S-50
FEATURES & TOOLS	Proven Power Fail Safety Sophisticated Wear Leveling & Bad Block management Diagnostic features & Life Time Monitoring through SD / SPI command set	S-450 block based FTL / S-455, S-45, S-46 page based FTL Proven Power Fail Safety Sophisticated Wear Leveling & Bad Block management Autonomous Data Care Management SBLTM Tool & SDK for detailed Life Time Monitoring		Support SD SPI mode Static and Dynamic Wear Leveling Bad Block Management Auto-Read Refresh Embedded Mode	Support SD SPI mode Proven Power Fail Safety Sophisticated Wear Leveling & Bad Block management Autonomous Data Care Management SBLTM Tool & SDK for detailed Life Time Monitoring
MORE INFORMATION	For more details see www.swissbit.com/product-finder				

microSD Cards

Manufactured in Swissbit's own fab with chip on board technology and based on a dedicated industrial controller and reliable NAND flash, the microSD memory cards withstand extreme environmental conditions and provide the highest level of mechanical stability and enhanced ESD protection. Furthermore, the hard gold SD connectors endure a minimum of 20,000 insertion cycles.

The different series in SLC technology (S–300u, S–200u and S–450/455u), as well as the MLC products S–45u and the pSLC configuration S–46u, feature a long list of hardware and firmware improvements.

Sub–page based firmware, known under the durabit™ and everbit™ brands, enables unprecedented endurance and random write performance for S–455u, S–46u and S–45u. The Swissbit Life Time Monitor support allows you to choose the perfect product for your use case. The new S–30u and S–50u models feature 3D NAND, with S–30u targeting read–mostly applications and S–50u as a full featured device.

	Wide Temp. Support	ESD & EMI Safe	Shock & Vibration	Life Time Monitor	Conformal Coating	Power Loss Protected	Wear Leveling	Read-Only Improved	Data Care Managed	Longevity	WAF Reduction
S–300u	●	●	●	○	●	●	●	○	○	●	○
S–200u	●	●	●	●	●	★	●	○	○	○	○
S–45u	●	●	●	★	●	●	●	★	★	○	★
S–46u	●	●	●	★	●	★	●	★	★	○	★
S–450u	●	●	●	★	●	★	●	★	★	●	○
S–455u	●	●	●	★	●	★	●	★	★	●	★
S–30u	○	●	●	●	●	●	●	●	○	○	★
S–50u	●	●	●	●	●	●	●	★	★	○	★

★ Industry Leading; ● default implemented; ◐ on request; ○ not available

	S–200u/300u	S–450u/455u	S–45u/46u	S–30u	S–50u

INFORMATION

	S–200u/300u	S–450u/455u	S–45u/46u	S–30u	S–50u
TYPE	microSD MEMORY CARD SD / SDHC	microSD MEMORY CARD SD	microSD MEMORY CARD SDHC / SDXC	microSD MEMORY CARD SDHC / SDXC	microSD MEMORY CARD SDHC / SDXC
INTERFACE DATA TRANSFER MODE	SD 2.0, Class 10 / 6	SD 3.0, Class 10, UHS–I		SD 6.1, Class 10, UHS–I, V30, A1	SD 6.1, Class 10, UHS–I, A1, Automotive Type
CONNECTOR	microSD				
OUTLINE DIMENSIONS	15 x 11 x 0.7 / 1 mm				
FLASH TYPE	SLC		S–45u: MLC durabit™ S–46u: pSLC everbit™	3D NAND TLC	
DENSITY RANGE	512 MB – 2 GB (SD) 4 GB – 8 GB (SDHC)	512 MB – 2 GB (SD) 4 GB – 8 GB (SDHC)	2 GB – 32 GB (SDHC) 64 GB (SDXC)	32 GB (SDHC) 64 GB – 256 GB (SDXC)	32 GB (SDHC) 64 GB – 128 GB (SDXC)
DATA RETENTION	10 years @ life begin | 1 year @ life end				
ENDURANCE (FLASH)	100k P/E Cycles		3k / 20k P/E Cycles	1k P/E Cycles	3k P/E Cycles

TEMPERATURE

	S–200u/300u	S–450u/455u	S–45u/46u	S–30u	S–50u
OPERATING TEMPERATURE		Extended: –25°C to +85°C Industrial: –40°C to +85°C		Extended: –25°C to +85°C	Extended: –25°C to +85°C Industrial: –40°C to +85°C
STORAGE TEMPERATURE	–40°C to +85°C	–40°C to +100°C		–40°C to +85°C	–40°C to +100°C

PERFORMANCE

	S–200u/300u	S–450u/455u	S–45u/46u	S–30u	S–50u
SEQUENTIAL READ (MB/S) **SEQUENTIAL WRITE (MB/S)** **RANDOM 4KB READ (IOPS)** **RANDOM 4KB WRITE (IOPS)**	up to 19 / 24 up to 21 / 22	up to 30 / 40 up to 24 / 28 up to 1,200 / 1,150 up to 28 / 1,500	up to 44 / 42 up to 19 / 40 up to 1,350 / 1,400 up to 950 / 1,250	up to 95 up to 85 up to 1,700 up to 1,050	typ 90 typ 40 typ 2,050 typ 800

ROBUSTNESS

	S–200u/300u	S–450u/455u	S–45u/46u	S–30u	S–50u
MTBF	≥ 3,000,000 hours				
SHOCK	1,500/ 1,000 G	1,500 G			
VIBRATION	50 / 15 G	50 G			
HUMIDITY	93 % RH 40°C, 500 hrs	85 % RH 85°C, 1,000 hrs			

ELECTRICAL DATA

	S–200u/300u	S–450u/455u	S–45u/46u	S–30u	S–50u
VOLTAGE	2.7 – 3.6 V				
POWER CONSUMPTION	Read typ 30 / 50 mAWrite typ 40 / 50 mA	Read typ 50 mA Write typ 60 mA	Read typ 75 mA Write typ 80 mA	Read typ 80 mA Write typ 100 mA	Read typ 110 mA Write typ 110 mA

FEATURE LIST

	S–200u/300u	S–450u/455u	S–45u/46u	S–30u	S–50u
FEATURES & TOOLS	Proven Power Fail Safety Advanced Wear Leveling & Bad Block management	S–450u block based FTL / S–455u, S–45u, S–46u page based FTL Proven Power Fail Safety Sophisticated Wear Leveling & Bad Block management Autonomous Data Care Management SBLTM Tool & SDK for detailed Life Time Monitoring		Support SD SPI mode Static and Dynamic Wear Leveling Bad Block Management Auto–Read Refresh Embedded Mode	Support SD SPI mode Proven Power Fail Safety Sophisticated Wear Leveling & Bad Block management Autonomous Data Care Management SBLTM Tool & SDK for detailed Life Time Monitoring
MORE INFORMATION	For more details see www.swissbit.com/product-finder				

USB Products

The Universal Serial Bus (USB) is still a widely used interface for NetCom system booting or for update and licensing purposes. Swissbit offers USB 2 and USB 3 products in different form factors and in commercial and industrial operating temperature ranges. State-of-the-art NAND flash handling algorithms, stringent component selection, PCN control, and a 100% final system test at the full temperature range (−40°C to 85°C)

qualify Swissbit's USB Flash Drive (UFDs) for embedded and NetCom markets.

All Swissbit USB solutions combine security features and Life Time Monitoring tools for product life control.

USB products are available in SLC, MLC, and pSLC technology to meet the endurance and speed requirements of the different use cases.

	Wide Temp. Support	ESD & EMI Safe	Shock & Vibration	Life Time Monitor	Power Loss Protected	Wear Leveling	Longevity	Data Care Managed	TRIM Support	WAF Reduction
U–50 / U–56 / U–45 / U–46	●	○	●	●	●	●	◐	●	●	●
U–56n / U–50n	●	●	●	●	●	●	●	●	●	●
U–500 / U–400	●	○	●	●	●	●	●	●	●	◐/○
U–500k / U–56k / U–50k	●	●	●	●	●	●	●	●	●	●

● default implemented; ◐ on request; ○ not available

U–500
U–56 / 50 / 58

U–400
U–46 / U–45

U–500k
U–56k / U–50k

U–56 / U–50n
NANO

INFORMATION

TYPE	eUSB FLASH MODULE		USB FLASH DRIVE	
INTERFACE **DATA TRANSFER MODE**	USB 3.1 Super Speed / High / Full	USB 2.0 High / FullSpeed	USB 3.1 Super Speed / High / Full	
CONNECTOR	Standard: 2.54 mm –10 Pin (key option) Low Profile: 2.00 mm –10 Pin (key option)		USB 3.0 Type A–Plug	
OUTLINE DIMENSIONS	Standard: 36.8 mm x 26.65 mm x 9.7mm Low Profile: 36.8 mm x 26.65 mm x 6.0mm		68.0 mm x 18.0 mm x 8.2 mm	24.0 mm x 12.1 mm x 4.5 mm
FLASH TYPE	SLC / pSLC everbit™ / MLC durabit™			
DENSITY RANGE	SLC: 4 GB – 32 GB pSLC: 4 GB – 32 GB MLC: 8 GB – 64 GB 3D pSLC: 8 GB – 16GB	SLC: 1 GB – 32 GB pSLC: 2 GB – 16 GB MLC: 4 GB – 32 GB	SLC: 2 GB – 32 GB pSLC: 8 GB – 64 GB MLC: 16 GB – 128 GB	pSLC: 4 – 32 GB MLC: 8 – 64 GB
DATA RETENTION	10 years @ life begin | 1 year @ life end			
ENDURANCE [DWPD]*	U–500: 4.0 / U–58: 4.1 / U–56: 1.8 / U–50: 0.15 / U–400:0.8 / U–46: 1.51 / U–45: 0.15			

TEMPERATURE

OPERATING TEMPERATURE	Commercial: 0°C to +70°C Industrial: –40°C to +85°C
STORAGE TEMPERATURE	–40°C to +85°C

PERFORMANCE

SEQUENTIAL READ (MB/S) **SEQUENTIAL WRITE (MB/S)** **RANDOM 4KB READ (IOPS)** **RANDOM 4KB WRITE (IOPS)**	up to 175 / 170 / 140 up to 95 / 90 / 60 up to 3,050 / 3,200 / 2,500 up to 1,000 / 1,050 / 700	up to 36 / 39 / 23 up to 27 / 29 / 18 up to 1,600 / 1,800 / 1,400 up to 30 / 800 / 550	up to 175 / 170 / 140 up to 95 / 90 / 60 up to 3,050 / 3,200 / 2,500 up to 1,000 / 1,050 / 700	up to 190 / 140 up to 115 / 60 up to 3,600 / 2,600 up to 1,250 / 750

ROBUSTNESS

MTBF	≥3,000,000 hours	
SHOCK	1,500 G, 0.5 ms	
VIBRATION	50 G	20 G
HUMIDITY	85% RH 85°C, 1,000 hrs	

ELECTRICAL DATA

VOLTAGE	3.3 V ±5 % / 5 V ±10 %	5 V ± 10 %
POWER CONSUMPTION	Full Speed typ 70 mA High Speed typ 80 mA	

FEATURE LIST

FEATURES & TOOLS	Page based FTL for best write performance and endurance (not U–400) Proven Power Fail Safety Windows / Linux – Spare block read out Bootable USB Drive Supports latest OS as Fixed Drive Connector pitch & key variations available Shock & vibration resistant
MORE INFORMATION	For more details see www.swissbit.com/product–finder

* DWPD values are according to JESD219 Enterprise Endurance Workload based on a service life of 3 or 5 years

Managed NAND

Small form factor embedded systems have often used NAND components that were directly interfaced and managed by the host controller software. This task has become a challenge due to the increasing complexity of NAND devices and their management.

Managed NAND is the solution: a single small size BGA component incorporates multiple Flash drives, a NAND controller and the management firmware and eases the integration.

Swissbit's e.MMC EM-10 and EM-20 family covers multiple densities and interface speeds. Sophisticated NAND management makes the EM-20 ideal for applications like POS/POI, PLC, IoT, gaming, medical, or as a general boot medium for embedded applications. The EM-10 substitutes NOR / NAND combinations with a fast boot option. The EN-20 PCIe/NVMe BGA opens the door for high speed at small density.

	Wide Temp. Support	Life Time Monitor	Secure Erase	Power Loss Protected	Wear Leveling	TRIM Support	Data Care Managed	In-field FW Update	WAF Reduction	Instant On	Low Power
EM-20 / EM-26	●	●	●	●	●	●	●	●	●	○	●
EM-10 / EM-16	●	●	●	●	●	●	●	●	●	●	●
EN-20	●	●	●	●	●	●	●	●	●	○	●

● default implemented; ◐ on request; ○ not available

INFORMATION

	EM-20 / EM-26	EM-10 / EM-16	EN-20
TYPE	e.MMC		PCIe M.2 1620 BGA
STANDARD & INTERFACE	e.MMC 5.0, 1-bit, 4-bit, 8-bit up to HS400	e.MMC 4.41 1-bit, 4-bit, 8-bit up to SDR52	PCIe Gen 3.1 / NVMe 1.3 4 PCIe lanes
PACKAGE	153-ball BGA, 0.5mm pitch		BGA, 0.8mm pitch
OUTLINE DIMENSIONS	11.5 x 13 x 1 mm		16 x 20 x 1.8 mm
FLASH TYPE	MLC / pSLC reliable mode		3D NAND
DENSITY RANGE	4 GB – 64 GB MLC / 2 GB – 32 GB pSLC	4 GB – 16 GB MLC / 2 GB – 8 GB pSLC	15 GB – 240 GB
DATA RETENTION	10 years @ life begin | 1 year @ life end		
ENDURANCE	3k P/E cycles MLC mode / 20k P/E cycles reliable mode		3k P/E cycles 3D NAND

TEMPERATURE

OPERATING TEMPERATURE	Industrial: –40°C to +85°C	
STORAGE TEMPERATURE	–40°C to +85°C	

PERFORMANCE

	EM-20 / EM-26	EM-10 / EM-16	EN-20
SEQUENTIAL READ (MB/S)	up to 250 / 270	up to 49 / 49	up to 1,600
SEQUENTIAL WRITE (MB/S)	up to 90 / 160	up to 14 / 31	up to 650
RANDOM 4KB READ (IOPS)	up to 5,100 / 5,900	up to 3,100 / 3,760	up to 120,000
RANDOM 4KB WRITE (IOPS)	up to 1,800 / 2,100	up to 1,110 / 1,870	up to 150,000

ELECTRICAL DATA

VOLTAGE	VCCQ: 1.70–1.95V / 2.70–3.60V ; VCC: 2.70–3.60	3.3V ±5%, 1.8V ±5%, 0.9V ±5%
POWER CONSUMPTION	Typ. Read Current: 180 mA @ 1.8V VCCQ, 38mA @ 3.3V VCC Typ. Write Current: 105 mA @ 1.8V VCCQ, 80mA @ 3.3V VCC Standby: 20 mA	Max. Active 5.7 W

FEATURE LIST

	EM-20 / EM-26	EM-10 / EM-16	EN-20
FEATURES & TOOLS	High performance up to HS400 mode Sophisticated Wear Leveling & Read Disturb Management Page based FTL Management Production State Awareness Proven Power Fail Safety Security features – secure erase & RPMB	Instant-up for fast boot Data Care Manegement Page based FTL Management Production State Awareness Proven Power Fail Safety Safe Shutdown Security features – secure erase & RPMB Detailed S.M.A.R.T. data	HMB support Dynamic and Static Wear Leveling Page Mode Flash Translation Layer Data Care Management Write Amplification Reduction Power Fail Data Loss Protection In-Field Firmware Update Self-Monitoring, Analysis, and Reporting Technology (S.M.A.R.T.) AES256 Encryption TCG Opal (on request)
MORE INFORMATION	For more details see www.swissbit.com/product-finder		

SECURITY PRODUCTS

Unique hardware security for the protection of data and devices

Swissbit's modular security products are based on standard interfaces and offer system manufacturers a range of hardware-based cyber security solutions for the protection of data and devices.

Swissbit provides easy-to-integrate and retrofittable hardware-based security products together with software development kits (SDK) and customization services, enabling manufacturers to offer systems with secured devices, secure data storage, and secure data communication. Security products from Swissbit

cover many applications including secure boot and safeguarding M2M communication, as well as legally compliant and tamper-proof data storage in bodycams or cash register systems.

There are many scenarios where the need to store data and protect access and communication can be achieved in a single step. Swissbit's security products are extremely robust and durable, which makes them ideal for challenging applications with long life time and maintenance cycles.

CUSTOMER BENEFITS:
Easy to integrate, easy to retrofit, and modular custom products with:

· fast time to market
· reduced development costs
· minimized life time risk

HARDWARE SECURITY PRODUCTS

SECURED BY swissbit

The security product series in USB, microSD, and SD form factors address the growing demand for mobile, portable, and industrial security. The products offer tangible hardware security in the same manner as the plug and play approach. For various markets, Swissbit adresses a broad set of security use cases. The flash memory can be used by any host to store data on the cards at high speed. Additional security functions of the card can be activated to protect any data or device.

Valuable data such as sensitive files, emails, photos, OS images, firmware updates, log files, and audit trails can be protected by encryption, access protection, or made resistant to tampering by digital signature. Voice and video calls, as well as data streams for M2M communication, can be protected by the card in high speed. The best fitting product can be chosen depending on the use case.

	True Hardware RNG	Digitally Sign & Verify	Hardware based Encryption	2nd factor authentication	Mobile Banking	Secure Voice	Elliptic Curve Crypto	Secure CD-ROM	Secure Storage	Secure Logging	FIPS 140-2 MODE
SE	●	●	●	●	●	●	●	○	○	○	◐
PE	●	●	●	●	●	●	●	●	★	★	◐
DP	○	○	○	○	○	○	○	●	★	★	○

★ Industry Leading; ● default implemented; ◐ on request; ○ not available

SECURITY EDITIONS

STANDARD EDITION SE
The Standard Edition SE fits best into authentication and PKI (Public Key Infrastructure) use cases. The card is supported by leading middleware vendors in mobile, desktop, and tablet use cases to ensure a seamless design-in into existing security infrastructures.

DATA PROTECTION DP
The Data Protection DP cards and USB drive offer state-of-the-art data protection. All data stored in the Flash is AES encrypted in high speed and can be protected by various options like CD-ROM, PIN protected data, hidden storage, and WORM data area.

PREMIUM EDITION PE
The Premium Edition PE combines high-end smartcard security with state-of-the-art data protection like CD-ROM, WORM, and hidden storage. Data can be protected and digitally signed and fully AES encrypted in one device. Additionally, PE cards can provide a secure element according FIPS 140-2 certification.

AUDIT TRAILS / FISCAL
Swissbit offers an audit trail solution for the tamper-proof recording of fiscal data of Point-of-Sales (POS) systems and has developed a plug-in solution that is extremely easy to integrate.

INFORMATION

COMPLIANCE	SD 3.0 SD, ASSD V1.1			USB 3.1
DATA TRANSFER	UHS-1 Speed class 10			USB 3.1 SuperSpeed
TEMPERATURE	-25°C to 85°C			-25°C to 85°C
COMPATIBLE TO	S-45/45u	S-46/46u	S-450/450u	U-50n
FLASH TYPE	MLC	pSLC	SLC	MLC / pSLC

SECURITY PRODUCT MATRIX

		SE Standard Edition	PE Premium Edition	AuditTrail/ Fiscal	DP Data Protection
DEVICE	PS-45 SD	8 GB – 16 GB	8 GB – 16 GB	8 GB	8 GB – 64 GB
	PS-45u microSD	8 GB – 16 GB	8 GB – 16 GB	8 GB	8 GB – 32 GB
	PS-46 SD	4 GB – 8 GB	4 GB – 8 GB		4 GB – 32 GB
	PS-46u microSD	4 GB – 8 GB	4 GB – 8 GB		4 GB – 16 GB
	PS-450 SD	4 GB – 32 GB	4 GB – 32 GB		4 GB – 32 GB
	PS-450u microSD	0.5 GB – 2 GB	0.5 GB – 2 GB		0.5 GB – 2 GB
	PU-50n		8 GB –16 GB*	8 GB	8 GB - 64 GB
SECURITY		Infineon / NXP smart card chip CC EAL 5+/6+ HW and OS Java card 3.0.1/ 3.0.4 Global Platform 2.2.1 / 2.2.2 Infineon JTOP/ NXP JCOP 3 RSA up to 2048 bit optional ECC up to 512 / 521 bit AES up to 256 bit SHA2 up to 512 bit RNG AIS31, FIPS-140 Compatible Middleware: ·AET SafeSign ·Cryptovision SCinterface 80 / 145 k EEPROM secure storage		NXP smart card chip BSI TR-03153 certified TSE SMAERS:EAL2 CSP: EAL4 384 bit encryption Validity of signature certificate: 5 or 7 years + 6 months for shelf storage Guaranteed 20 Mio signatures Signature processing time < 250 ms 10 years retention	Partitioning: ·CD-ROM ·Private ·Hidden/WORM AES 256 bit flash encryption User and administrator PIN Configurable retry counter Unique ID Fast crypto wipe
DRIVERS / API		Windows Linux Android SDK available PKCS#11 Middleware		Windows Linux Android Embedded on request SDK available	Windows Linux RaspBerryPi Arduino SDK available
MORE INFORMATION		For more details see www.swissbit.com/product-finder			

*higher capacity on request

ADVANCED PACKAGING, ASSEMBLY & TEST SOLUTIONS

SYSTEM IN PACKAGE

System-in-Package (SiP) is the umbrella term for using advanced packaging and assembly technologies to integrate and test sensitive bare silicon dies or chips (active circuits) and supporting components (passives) into robust finished modules or components. Together with integrated software or firmware this will create a fully functional system solution.

With over 25 years of experience, Swissbit successfully uses advanced packaging technologies to achieve the smallest form factors and to build multi-chip-packages. Moreover, Swissbit develops unique test hard- and software solutions for dedicated applications and temperature ranges.

With this electronic integration and testing approach, our products provide more functionality inside one package, various functional blocks (RF, digital, sensors, security, and memory) and passive components are combined. Having all necessary capabilities in-house we have the best design for reliability, test and manufacturing.

For our highly-integrated SiPs (e.g. MicroSD Card) we developed processes for stacking multiple large dies, wire bonding the smallest bond pads, and molding the narrowest clearances.

Swissbit provides different assembly and packaging technologies (e.g SMT, CoB, FlipChip) in one single unit. The concentration of strong engineering and design knowhow and experience enables new, innovative electronic packages and devices for a wide range of applications.
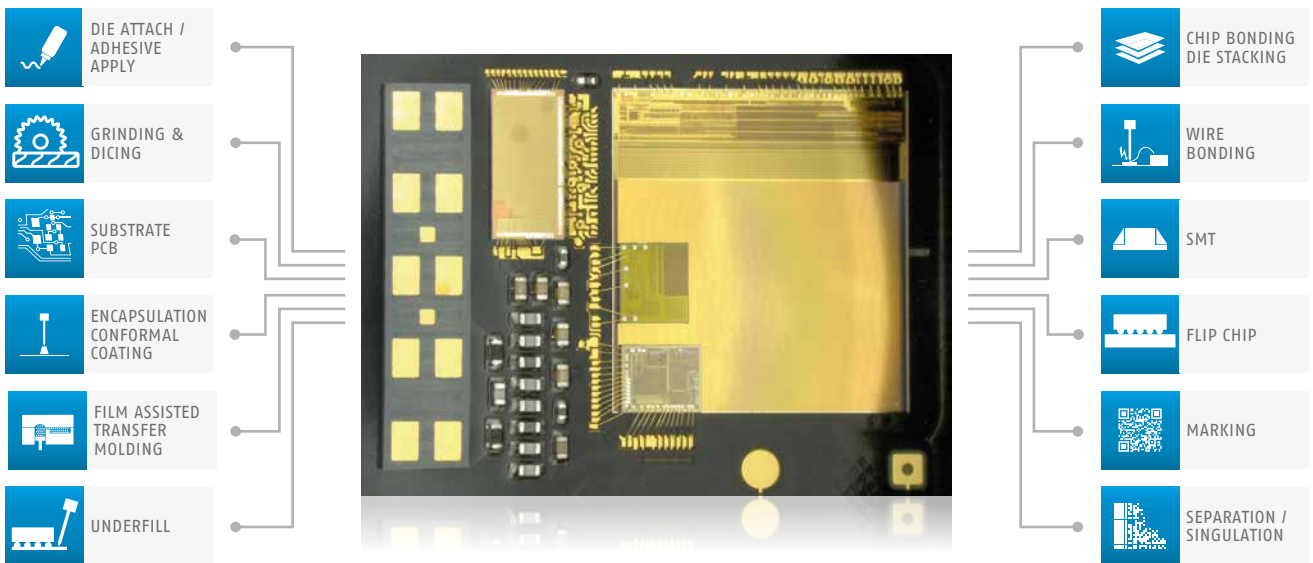
Our customers benefit from a reduced development cost and higher yields and reliability. We use smart production organizations, which allows the production of small volume series with short lead times and on-time delivery in high product variations.

Swissbit produces and develops in accordance with ISO 9001, IATF 16949, and ISO 14001 approved processes and is an experienced partner for global industrial and automotive accounts.

SYSTEM–IN–PACKAGE BENEFITS:

- Reduced process complexity
- Lower TCO (total cost of ownership)
- Reduced system board space
- Layer count reduction of system PCB
- Mixed analog / digital design
- Reduced system board test complexity

DIE ATTACH /
ADHESIVE
APPLY

GRINDING &
DICING

SUBSTRATE
PCB

ENCAPSULATION
CONFORMAL
COATING

FILM ASSISTED
TRANSFER
MOLDING

UNDERFILL

CHIP BONDING
DIE STACKING

WIRE
BONDING

SMT

FLIP CHIP

MARKING

SEPARATION /
SINGULATION

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