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Product Data Sheet

Swissbit USB TSE
PU-50n TSE Series

TR-03153 certified

Extended Temperature Grade

swissbit®

TSE-TR03153
8GB
SFU300xGCxPEx
T0-x-xx-xxx-xxx
CWYY-Z

Made in Germany

Contents

Swissbit AG
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PU-50n USB TSE – Industrial USB Flash Drive
8 GBytes

1. Product Summary

- **Capacities:** 8 GBytes
- **Form Factor:** USB3.1 solid state flash drive with USB Type-A connector (24.0 mm x 12.1 mm x 4.5 mm)
- **Compatibility:** USB 2.0 high-speed specification compatible (backward compatible with USB 1.1)
- **Operating Temperature Range** [1]**:**
  - o Extended: -25 °C to 70 °C
- **Storage Temperature Range:** -40 °C to 85 °C
- **Operating Voltage:** 5.0 V ± 10%
- **Data Retention:** 10 Years (please refer to section 4.6)
- Multi-Level Cell (MLC) NAND Flash
- Hardware BCH Code ECC (up to 40bit correction per 1 KByte page)

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[1] Adequate airflow is required to ensure the drive temperature, as reported in the S.M.A.R.T. data, does not exceed the specified maximum operating temperature.

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2. Product Features

2.1 Flash Features

- Page based Flash management with durabit™ technology for increased endurance & random performance
- Optimized FW algorithms especially for high read access and long data retention applications
    - Proven power fail management for highest reliability
    - Near Miss ECC technology
    Minimize the risk of uncorrectable bit failure over the product life time. Each read command analyzes the ECC margin level and refreshes data if necessary.
    - Read Disturb Management
    The read commands are monitored and the content is refreshed when critical levels have occurred.
    - Wear Leveling technology
    Equal wear leveling of static and dynamic data. The wear leveling assures that dynamic data as well as static data is balanced evenly across the memory. This guarantees the maximum write endurance of the device.
    - Data Care Management
    The interruptible background process controls the user data for read disturb effects or high temperature related retention degradation and refreshes data if necessary.
- Detailed S.M.A.R.T. support and extended vendor information
- LED for operation indication
- 30 µinch gold-plated USB 3.0 Type-A connector contacts
- Swissbit Life Time Monitoring (SBLTM) tool and SDK for SBLTM (on request)

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2.2 Fiscal Solution Features

- BSI-TR-03153 compliance coming with EDS-SW ("Einheitliche Digitale Schnittstelle" or compatible)
- Inalterability of data inside TSE Tar Storage
- Intuitive file based backup and data export
- Data retention 10 years (please refer to section 4.6)
- In-field firmware update in compliance with TR-03153 requirements

2.3 Supported TSE Profiles

The Swissbit TSE supports the following profiles according BSI TR-03153:

Supported Profile ID	Comment
STORAGE_BASIC	Has local storage (6.5 GB)
SM_BASIC	Has a local Secure Element (384 bit ECDSA, signature time <250ms)
SM_NOAGG	Supports signed transaction updates (saves 1 signature per receipt)
SM_MULTI	Supports managing multiple transactions in parallel (up to 512)
CUSTOM_INTEGRATION_INTERFACE	Manufacturer specific interface (Android, Linux, Windows, Java, embedded)
SDI_DELETE	Supports method deleteStoredData
NO_TIME_SYNC	Time is set by host
MULTI_CLIENT	Supports multiple clients (up to 100)

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3. Ordering Information

Table 1: Available Part Numbers

Capacity	Part Number
8 GBytes	SFU3008GC1PE2TO-E-GE-C31-TE1
8 GBytes	SFU3008GC2PE2TO-E-GE-C32-TE1

See section 9 for detailed description of part number.

Configuration

The production configuration is specified as follows:

Table 2: TSE configuration

Item	Value	Remark
CSP (Smart Card)	Yes	BSI-DSZ-CC-1118, TCOS CSP 2.0 Release1/P60D145
Overall size of all TSE_TAR files	6.5 GB	Value in GB
Key length / algorithm for digital signature	brainpoolP384r1, ecdsa-plain-384	
Customization Identifier	SB01	4 byte ASCII, can be customized
TSE Description	BSI-K-TR-0362	NULL terminated ASCII string containing a short description of the TSE
Storage Type	USB	Which form factor (USB / microSD / SD)
Memory Size	8GB	Memory size
Fiscal Data protection	Yes	All Fiscal Data are access protected according TR-03153
Subdirectory Support	Yes	Defines if the TSE Files shall be made available in sub directories (e.g. on Android hosts)
Certificate Validity (certificate for signing transactions)	Up to 7 years Default: 5 years	5 and 7 years are available as product options. At the time of production at Swissbit, the expiration date is set to 5 years and 6 months or 7 years and 6 months from then. The additional 6 months are intended as a time buffer for logistics & stocking.

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4. Product Description

The Swissbit USB TSE provides a robust, high performance, and reliable storage product with industry compatible interface and small form factor. The USB TSE MLC technology both enables high NAND flash operation and excellent endurance. The use of page based Flash management and a global wear leveling extends the endurance to unprecedented values for USB products.

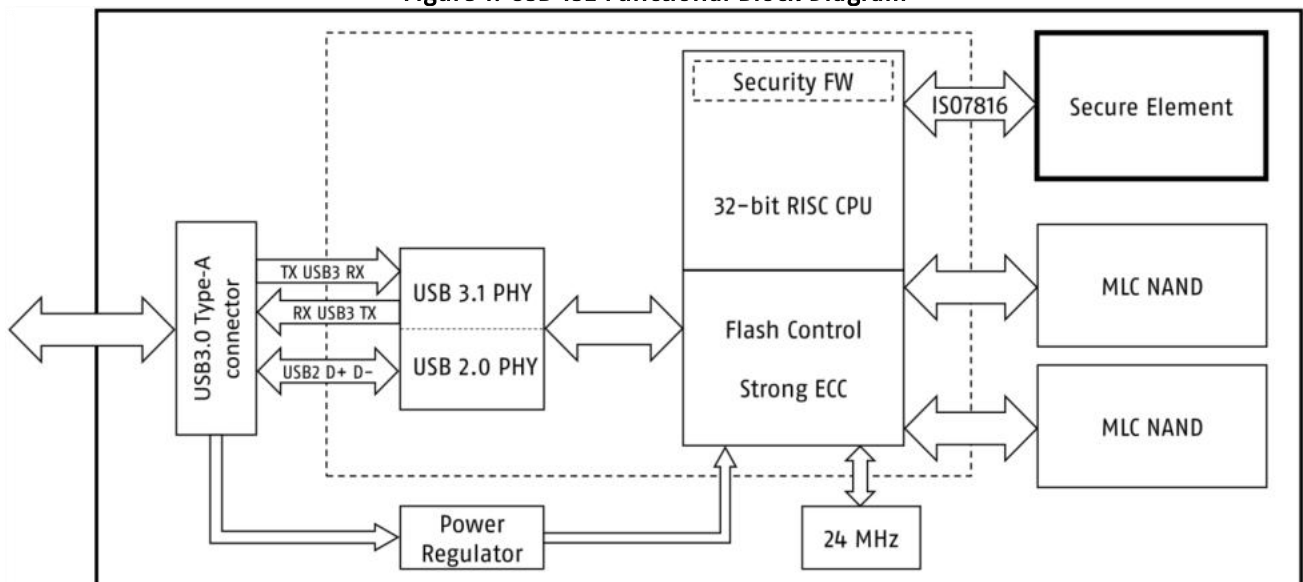The USB TSE product allows easy operation with USB3 or USB2 Type-A sockets.

For outdoor use or in poorly ventilated systems the USB TSE is available in extended temperature grade from -25°C to +70°C. Each individual extended temperature grade drive is tested at these corners to verify the temperature resistance.

The USB TSE firmware includes data care management features which refresh storage areas that are not or only infrequently read. At high temperature storage these areas are prone to retention loss. The firmware monitors the state of the NAND blocks and refreshes those that show a high level of degradation, thus preventing uncorrectable errors. This is an important feature for USB flash drives that are used as read only boot media.

The USB TSE operates at 5V nominal with ±10% tolerance.

It supports USB 2.0 high-speed and is fully backwards compatible to USB 2.0/1.1 High/Full Speed.

Figure 1: USB TSE Functional Block Diagram

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4.1 Performance Specifications

The Read/Write performance cannot be fully tested due to policy restrictions that protect some areas of the freely addressable memory space.

4.2 Current Consumption

The drive-level current consumption as a function of operating mode is shown below in Table 3.
During start up the idle current consumption may increase up to 55mA.

Table 3: Typical Current Consumption for max transfer speed at 5V[2]

Drive Capacity	Sequential Read	Sequential Write	Random Read 4k	Random Write 4k	Idle	Unit
8 GBytes	60	60	50	54	33	mA

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[2] All values are the typical recorded at 25 °C, with 5V supply voltage at fastest CrystalDiskMark 6.0.2 x64 (CDM) in high-speed mode.

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4.3 Environmental Specifications

4.3.1 Recommended Operating Conditions

The recommended operating conditions for the USB TSE flash drives are provided in Table 4 below.

Table 4: Recommended Operating Conditions

Parameter	Value
Extended Operating Temperature	–25 °C to 70 °C
Power Supply V_{CC} Voltage	5V ± 10%

4.3.2 Recommended Storage Conditions

The recommended storage conditions are listed below in Table 5.

Table 5: Recommended Storage Conditions

Parameter	Value
Storage Temperature	–40 °C to 85 °C [3]

4.3.3 Humidity

The maximum humidity conditions are listed below in Table 6.

Table 6: Humidity

Parameter	Value
Humidity (Non-Condensing)	85% RH 85 °C, 1000 hrs (JESD22–A101)

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[3] The retention at high temperature is reduced. The acceleration factor at 85°C compared with 40°C is 170, i.e. the initial endurance 10 years@40°C is reduced to 22 days@85°C.

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4.4 Regulatory Compliance

The PU-50n devices comply with the standards listed in the following table.

Table 7: Regulatory Compliance

Compliance	Country	Type	Standard(s)/Directive
CE	European Union	Compliance	2014/30/EU IEC 61000-4-3 EN 61000-6-2 :2005 EN 61000-4-2 :2008 EN 55032 :2015 CISPR 32 :2015
FCC	United States	Compliance	47 CFR Part 15, class B
RoHS	European Union	Compliance	2011/65/EU, 2015/863
WEEE	European Union	Compliance	2012/19/EU
REACH	European Union	Compliance	1907/2006
UL	United States	Compliance	Conformity by subparts

4.5 Mechanical Specifications

The PU-50n uses a USB Type-A connector fully integrated into the metal housing. Physical dimensions and tolerances are detailed in Table 8 below. Figure 3 at page 14 illustrates the PU-50n dimensions.

Table 8: Measured Physical Dimensions

Physical Dimensions		Unit
Length	24.00±0.2	mm
Width	12.10±0.10	mm
Thickness (Max)	4.50±0.10	
Weight (Max Capacity)	5	g

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4.6 Reliability and Data Retention

Table 9: Reliability

Parameter	Value[4]
MTBF (at 25°C)	> 6,000,000 hours
Supported number of cryptographic signatures (reliable key usages)	20 million
Supported number of "Update Time" Commands	150,000
Data Retention at beginning (<300 PE cycles) @ 40°C	10 years
Data Retention at life end (2k-3k PE cycles) @ 40°C	1 year

Data Retention correlates negatively with the amount of data written to the device over its lifetime. The specified endurance of this device is max. 3'000 program/erase (PE) cycles on flash cell level (MLC). After consuming the max. available PE cycles, the data retention @40°C is 1 year (i.e. data is readable after 1 year of unpowered storage at max. 40°C).
In order to attain a data retention of 10 years @40°C (i.e. data is readable after 10 years of unpowered storage at max. 40°C), the amount of data written to the card must be max. 300 PE cycles (on flash cell level).

A product feature named global wear leveling makes sure that write/erase operations to both (1) the memory area reserved for fiscal transactions and (2) the freely available memory area will be distributed evenly over the full memory capacity.

Field Usage Advice: Swissbit highly recommends to monitor the already consumed PE cycles via the provided Lifetime-Monitoring functions and limit product usage to the described PE cycle levels in order to ensure the required data retention.

4.7 Drive Geometry Specification

Table 10: Drive Geometry

Raw Capacity	Total LBA	User Addressable Bytes
	Decimal	(Unformatted)
8 GBytes[5]	15,663,104	8,019,509,248

---

[4] After every power on the card reads the whole flash and performs a data refresh if necessary. So, the data retention can be much longer in most use cases.

[5] 6.5 GB of the memory capacity is reserved for fiscal data, leaving 1 GB free.

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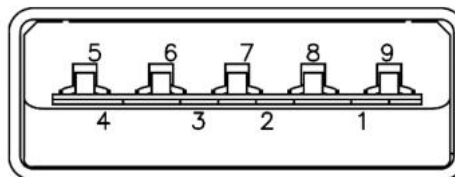Data_sheet_USB_TSE_Rev110
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5. Electrical Interface

- USB3 Type-A connector, 9pin
- USB2.0 high-speed interface and 1.1 full-speed compatible

Table 11: Electrical pinout from device and host view.

Pin	Signal device view	Signal host view	Description host view
1	V_Bus	V_Bus	Operating voltage
2	D-	D-	Data signal pair
3	D+	D+	Data signal pair
4	GND	GND	Power Ground
5	SSTX-	SSRX-	Host receive -
6	SSTX+	SSRX+	Host receive +
7	GND	GND	Signal Ground
8	SSRX-	SSTX-	Host transmit -
9	SSRX+	SSTX+	Host transmit +
Shield			Connector shield

Figure 2: USB3 Type-A connector pinout

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6. Electrical Specification

Table 12: Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Unit
Power Supply Voltage	V_Bus	-0.5	6.0	
Voltage at D+ and D-	V_Data	-0.5	5.0	V
Voltage at USB3 pins	V_Data	-0.5	1.8	

Table 13: DC characteristics for High-Speed operation (T=25°C, V_Bus=5V)

Parameter	Symbol	Density	Min	Typ	Max	Unit
Supply Voltage	V_Bus	all	4.5	5.0	5.50	V
Write current	I_WR	8GB		60	81	
Read current	I_RD	8GB		60	66	
Idle current	I_IDL	all		33[6]	45	mA
Suspend current	I_CCS	all		1.7	2.5	
High Speed Idle Level	V_HSOI	all	-10		10	
High Speed Data Signaling LOW	V_HSOL	all	-10		10	
High Speed Data Signaling HIGH	V_HSOH	all	360		440	mV
Chirp J Level (differential)	V_CHIRPJ	all	360		440	
Chirp K Level (differential)	V_CHIRPK	all	-440		-360	

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[6] Typically 5 minutes after power on the device performs a background data care management, that needs up to 120mA

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7. Package Mechanical

Figure 3: Mechanical Dimensions in mm for PU-50n
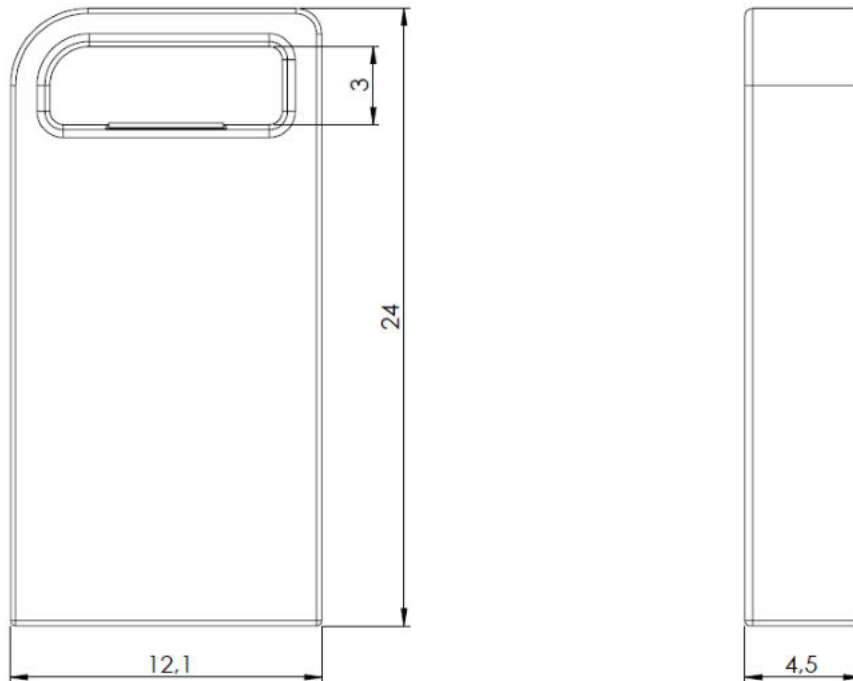
All dimensions are in millimeters, tolerances as listed in Table 8 on page 10.

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8. ATA Pass-Through commands (Identify Device and S.M.A.R.T.)

8.1 ATA Pass-Through commands

Additional to the standard SCSI commands the device also supports the ATA Pass-Through commands.

Table 14: ATA PASS-TRHOUGH(x) commands

SCSI command	OpCode	Description
ATA PASS-THROUGH(12)	A1h	Write and read ATA registers to send commands and read information
ATA PASS-THROUGH(16)	85h	

http://www.t10.org/ftp/t10/document.04/04-262r8.pdf

Table 15: ATA register addressing

Offset address	Input	Output	Type	Identify device	e.g. SMART commands
0	Data		Word		
1	Feature	Error	Byte	xx	yyh*
2	Sector count		Byte	xx	01h
3	LBA_Low		Byte	xx	xx
4	LBA_Mid		Byte	xx	4Fh
5	LBA_High		Byte	xx	C2h
6	Drive/head		Byte	E0h	E0h
7	Command	Status	Byte	ECh	B0h

* see below

8.2 Identify Device

The Identify Device returns a identify sector compatible to ATA and SATA devices.
Here an example of the interpretation of this sector.

Table 16: Identify Device Information

Word(s)	Default Value		Total Bytes	Data Field Type Information
0	0040h		2	Standard Configuration Fixed (optional 848Ah for removable)
...	...	...	...	...
10-19	aaaa*		20	Serial number in ASCII (right-justified)
...	...	...	...	...
23-26	XXXX*		8	Firmware revision in ASCII (big-endian byte order in Word)
27-46	XXXX*		40	Model number in ASCII (right-justified)
...	...	...	...	...
60-61	XXXXh		4	Total number of sectors addressable in LBA mode
...	...	...	...	...
82	0101h 7701h* 4063h*		2	Command set: SMART feature set, service interrupt
...	...	...	...	...
85	000Xh 0701h* 4063h*		2	Command set enabled: SMART feature set enabled/disabled
...	...	...	...	...
255	XXA5h		2	Integrity Word

* Values depend on device configuration.

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8.3 S.M.A.R.T. commands

The intent of the SMART command feature set is to protect user data and minimize the likelihood of unscheduled system downtime that may be caused by predictable degradation and/or fault of the device. By monitoring and storing critical performance and calibration parameters, SMART feature set devices attempt to predict the likelihood of a near-term degradation or fault condition. Providing the host system the knowledge of a negative reliability condition allows the host system to warn the user of the impending risk of a data loss and advise the user of the appropriate action.

All S.M.A.R.T. commands have the command code Boh. The different commands are selected by the Feature register.

Table 17: S.M.A.R.T. Features Supported

Operation	Feature	Sect Count	LBA low	LBA mid	LBA high	DRV head	Com-mand
S.M.A.R.T. Read Data	D0h	01h	xx	4Fh	C2h	E0h	B0h
S.M.A.R.T. Read Attribute Thresholds	D1h	01h	xx	4Fh	C2h	E0h	B0h
S.M.A.R.T. Enable Operations	D8h	xx	xx	4Fh	C2h	E0h	B0h
S.M.A.R.T. Disable Operations	D9h	xx	xx	4Fh	C2h	E0h	B0h
S.M.A.R.T. Return Status	DAh	xx	xx	4Fh	C2h	E0h	B0h

All commands are aborted, if the LBA signature is invalid.

8.3.1 S.M.A.R.T. Read Data (D0h)

When the drive receives the S.M.A.R.T. Read Data subcommand, it returns one sector (512 bytes) of data. See the following table for the data structure of this sector.

Table 18: S.M.A.R.T. Data Structure

Byte(s)	Value	Description
0-1	0010h	S.M.A.R.T. structure version
2-361	XXh	Attribute entries 1 to 30 (see Table 19)
362	00h	Off-line data collection status (no off-line data collection started)
363	00h	Self-test execution status byte (self-test completed)
364-365	0000h	Total time, in seconds, to complete off-line data collection
366	00h	Vendor specific
367	00h	Off-line data collection capability (no off-line data collection)
368-369	0003h	S.M.A.R.T. capabilities
370	00h	No Error logging capability
371	00h	Vendor specific
372	00h	Short self-test routine recommended polling time, in minutes
373	00h	Extended self-test routine recommended polling time, in minutes
374-385	00h	Reserved
386-387	0004h	SMART Version
388-510	XXh	Vendor specific
511	XXh	Data structure checksum

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8.3.2 S.M.A.R.T. Attribute Entry Structure

Each attribute entry (Bytes 2-361) consists of 12 bytes. See the following table for the data structure of each entry.

Table 19: Attribute Entry

Offset Byte(s)	Value	Description
0	XXh	Attribute ID (see Table 20)
1-2	XXXXh	Flags (little-endian) Bit0: Advisory (0) or Prefailure (1) Bit1: Not used (0) or updated during normal operation (1)
3	XXh	Current value as a percentage 64h = 100%
4	XXh	Worst value as a percentage 64h = 100%
5-10	XXXXh	Raw value (little-endian)
11	00h	Reserved

8.3.3 S.M.A.R.T. Attributes

The drives support the S.M.A.R.T. attributes listed in the following table.
The Threshold values can be read out with the S.M.A.R.T. Read Attribute Thresholds command (D1h)
The first attributes (196, 213, 229) are "Pre-Fail" type, while all other are Advisory (Old Age).

Table 20: S.M.A.R.T. Attributes

ID dec	ID hex	Value	Worst	Thres-hold	Attribute	Description	RAW values Offset 5-10
196	C4h	X%	X%	25	Spare Block Count	Number of total available NAND spare blocks	Initial (offset 5-7) and current (offset 8-10) number of spare blocks
213	D5h	X%	X%	25	Spare Block Count worst channel	Spare block count for the NAND with the lowest number of remaining spare blocks	Initial (offset 5-7) and current (offset 8-10) number of spare blocks of the channel with the lowest current number of spare blocks
229	E5h	X%	X%	2	Total Erase Count	Estimated number of total NAND block erases	Estimated number of total NAND block erases
203	CBh	100	100	0	Total ECC Errors	All recorded ECC errors	Total number of ECC errors (correctable and uncorrectable) (offset 5-8)
204	CCh	100	100	0	Correctable ECC Errors	Total recorded ECC errors that were corrected during the life of the drive	Total number of correctable ECC errors (offset 5-8)
199	C7h	100	100	0	UDMA CRC Errors	Dummy attribute, included for legacy reasons	This value is fixed at 0.
232	E8h	100	100	0	Total Number of Reads	Total number of NAND READ commands	Total number of NAND READ commands
12	0Ch	100	100	0	Power-On Count	Count of power-on events	Number of power cycles (offset 5-8)
241	F1h	100	100	0	Total LBAs Written	Total amount of data written to the drive	Total number of LBAs written to the disk, divided by 65536
242	F2h	100	100	0	Total LBAs Read	Total amount of data read from the drive	Total number of LBAs read from the disk, divided by 65536
214	D6h	100	100	0	Management Block status	Total number of times the management block has been updated	Management block write count (offset 5-8)
194	C2h	X°C	Max °C	0	Temperature Status	Device temperature in Celsius (°C)	Current (offset 5) /Min (offset 6) / Max temperature (offset 7)

* These threshold values are changeable using the Write Attribute Thresholds command.

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8.3.4 S.M.A.R.T. Read Attribute Thresholds (D1h)

When the drive receives the S.M.A.R.T. Read Attribute Thresholds subcommand, it returns one sector (512 bytes) of data similar as S.M.A.R.T. Read data sector, but with the threshold value in offset 1 of each attribute (see Table 20)

8.3.5 S.M.A.R.T. Enable Operations (D8h)

This command enables access to the S.M.A.R.T. capabilities of the drive. The state of SMART (enabled or disabled) is preserved across power cycles.

8.3.6 S.M.A.R.T. Disable Operations (D9h)

This command disables access to the S.M.A.R.T. capabilities of the drive. The state of SMART (enabled or disabled) is preserved across power cycles.
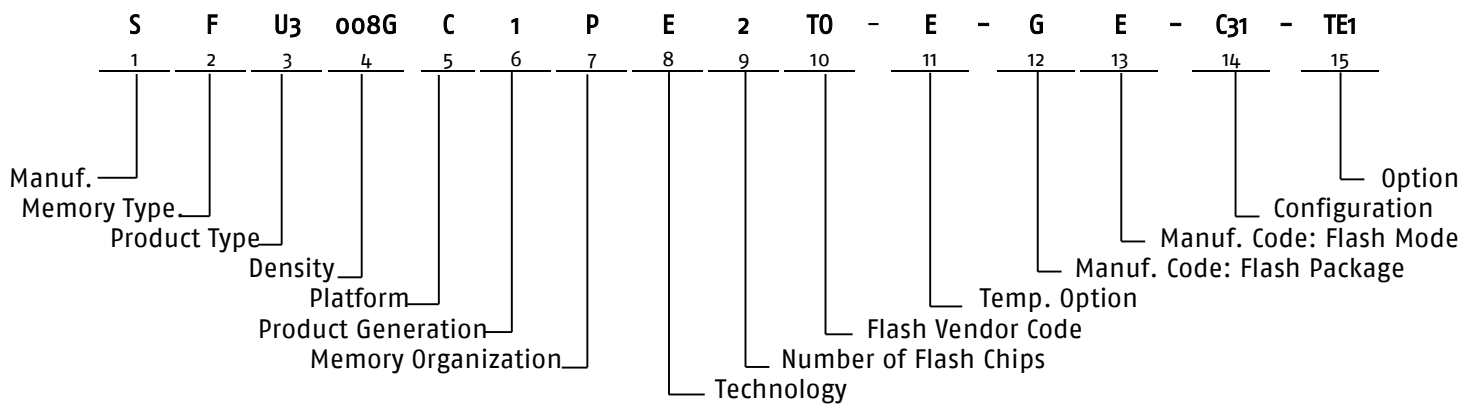
8.3.7 S.M.A.R.T. Return Status (DAh)

Table 21: S.M.A.R.T. Return Status

Operation	Feature	Sect Count	LBA low	LBA mid	LBA high	DRV head	Com- mand
Command S.M.A.R.T. Return Status	DAh	xx	xx	4Fh	C2h	E0h	B0h
Response							
S.M.A.R.T. Return Status OK	xx	xx	xx	4Fh	C2h	xx	xx
S.M.A.R.T. Return Status Pre-FAIL*	xx	xx	xx	F4h	2Ch	xx	xx

* If a threshold exceeded condition exists for either the Spare Block Count Worst Channel attribute or the Erase Count attribute, the device will set the Cylinder Low register to F4h and the Cylinder High register to 2Ch. In this case the drive should be replaced soon.

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9. Part Number Decoder

9.1 Manufacturer

Swissbit code	S

9.2 Memory Type

Flash	F

9.3 Product Type

USB Flash Drive	U3

9.4 Density

8 GBytes	008G

9.5 Platform

USB COB Inlay	C

9.6 Product Generation

First generation	1

9.7 Memory Organization

Security product	P

9.8 Technology

U-5xx platform UFD	E

9.9 Number of Flash Chips

1 Flash	1
2 Flash	2
4 Flash	4

9.10 Flash Code

Toshiba	T0

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9.11 Temperature Option

Extended Temperature Range: –25 °C to 70 °C	E

9.12 Die Classification

MLC MONO (single die package)	G
MLC DDP (dual die package)	L
MLC QDP (quad die package)	H

9.13 Pin Mode

Single nCE and Single R/nB	E
Dual nCE and Dual R/nB	F
Quad nCE and Quad R/nB	G

9.14 Configuration XYZ

X = Smart Card Controller

Smart Card Configuration	X
No Smart Card controller	0
Fiscal Germany Smart Card	C

Y = Firmware Extension

Firmware Extension	Y
TSE mode (Germany)	3

Z = Optional

Optional	Z
Revision 1	1
Revision 2	2

9.15 Option

Swissbit TSE Edition	TE1
Customer specific configuration (customer token)	XXX

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10. Marking Specification

Swissbit logo

Datamatrix-Code (Unique-ID, Production Date CWYY, Certificate Validity)

TSE TR-03153
Density
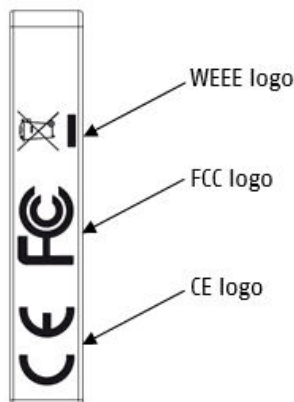Partnumber
Partnumber (continued)
Production Date (CWYY) – Certificate Validity (years)

Front view

Secured by Swissbit logo

WEEE logo

FCC logo

CE logo

Rear view   Side view

11. Export Control

The Swissbit TSE contains a smart card that provides exclusively digital signature functionality to recorded user data. Therefore, the Export Control Customs EU Tariff Number is 85235110.

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12. Software Licensing and Disclaimers

Swissbit is using the following Open Source Software internally in the TSE either unchanged or in modified form.

libecc – Library for elliptic curves cryptography; provided under BSD License.

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13. Revision History

Table 22: Document Revision History

Date	Revision	Description	Revision Details
December 06, 2019	1.00	Initial release	Doc.Req.no.3751
June 12, 2020	1.10	Updated reliability chapter (Update Time), corrected current consumption & DC characteristics, added new Part number in Ordering Information	Doc.Req.no.3764

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