

swissbit®

Product Data Sheet

Industrial 2.5" SATA SSD

X-600 Series

SATA III - 6.0 Gbit/s

Standard and Industrial
Temperature Grade



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X-600 Series – Industrial 2.5" SATA Solid State Drive

8 GBytes up to 256 GBytes

1. Product Summary

- **Capacities:** 8 GBytes, 16 GBytes, 32 GBytes, 64 GBytes, 128 GBytes, 256 GBytes
- **Form Factor:**
 - 2.5" SATA Solid State Drive (70 mm x 100 mm x 7 mm)
 - 7-Pin SATA and 15-Pin Power Connector
- **Compliance:** SATA Rev 3.1 – 6 Gbit/s (3 Gbit/s and 1.5 Gbit/s backward compatible)
- **Command Sets:** Supports ATA/ATAPI-8 and ACS-2
- **Performance:**
 - Burst Transfer Rate: Up to 600 MBytes/s in SATA III – 6.0 Gbit/s
 - Read Performance: Sequential Read up to 520 MBytes/s, Random Read IOPs up to 79,000
 - Write Performance: Sequential Write up to 425 MBytes/s, Random Write IOPs up to 76,000
- **Operating Temperature Range¹:**
 - Commercial: 0 °C to 70 °C
 - Industrial: -40 °C to 85 °C
- **Storage Temperature Range:** -40 °C to 85 °C
- **Operating Voltage:** 5 V ± 10% (3.3 V available upon request)
- **Power (Max Capacity):**
 - Read (Active): 2.45 W
 - Write (Active): 3.8 W
 - Idle: 550 mW
 - Slumber: 75 mW
- **Data Retention:** 10 Years @ Life Begin / 1 Year @ Life End
- **Endurance:** TeraBytes Written (TBW) @ Max Capacity²
 - Client > 8340
 - Embedded > 4995
 - Enterprise > 2235
- **Shock/Vibration:** 1,500 g / 50 g
- **High-Performance 32-Bit Processor with Integrated, Parallel Flash Interface Engines:**
 - Single-Level Cell (SLC) NAND Flash
 - Hardware BCH Code ECC (up to 66 bit correction per 1 KByte page)
- **High Reliability:**
 - Mean Time Between Failure (MTBF): > 2,000,000 hours
 - Data Reliability: < 1 non-recoverable error per 10¹⁶ bits read

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.

² According to JEDEC (JESD471), the time to write the full TBW is 18 months. Higher average daily data volume reduces the specified TBW.

2. Product Features

- Dynamic and Static Wear Leveling
- Page Mode Flash Translation Layer (FTL)
- Data Care Management
 - Active: Adaptive Read Refresh
 - Passive: Background Media Scan
- Lifetime Enhancements
 - Dynamic Bad Block Remapping
 - Write Amplification Reduction
- On-Board Power Fail Protection
- AHCI, TRIM, and NCQ Support
- ATA Security Feature Set Support
- In-Field Firmware Update
- Enterprise-Grade Self-Monitoring, Analysis, and Reporting Technology (S.M.A.R.T.)
- 30 µinch Gold-Plated Connector (IPC-6012B Class 2 Compliant)
- Life Cycle Management
- Controlled "Locked" BOM
- RoHS-6 Compliant
- AES256 Encryption (on request)
- Swissbit Life Time Monitoring (SBLTM) Tool and SDK for SBLTM (on request)



3. Ordering Information

Table 1: Standard Product List

Capacity	Commercial Temperature	Industrial Temperature
	Part Number	Part Number
8 GBytes	SFSA008GQxAA1T0-C-DB-2y6-STD	SFSA008GQxAA1T0-I-DB-2y6-STD
16 GBytes	SFSA016GQxAA2T0-C-DB-2y6-STD	SFSA016GQxAA2T0-I-DB-2y6-STD
32 GBytes	SFSA032GQxAA4T0-C-DB-2y6-STD	SFSA032GQxAA4T0-I-DB-2y6-STD
64 GBytes	SFSA064GQxAA4T0-C-QC-2y6-STD	SFSA064GQxAA4T0-I-QC-2y6-STD
128 GBytes	SFSA128GQxAA4T0-C-NC-2y6-STD	SFSA128GQxAA4T0-I-NC-2y6-STD
256 GBytes	SFSA256GQxAA8T0-C-NC-2y6-STD	SFSA256GQxAA8T0-I-NC-2y6-STD

x = product generation and y = firmware revision

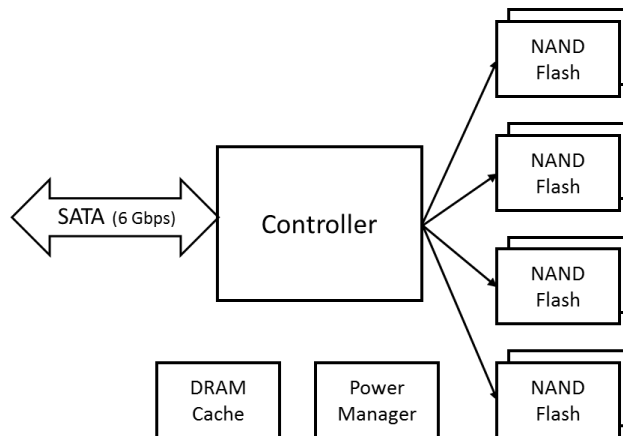
Table 2: Available Part Numbers

Capacity	Commercial Temperature	Industrial Temperature
	Part Number	Part Number
8 GBytes	SFSA008GQ1AA1T0-C-DB-216-STD	SFSA008GQ1AA1T0-I-DB-216-STD
16 GBytes	SFSA016GQ1AA2T0-C-DB-216-STD	SFSA016GQ1AA2T0-I-DB-216-STD
32 GBytes	SFSA032GQ1AA4T0-C-DB-216-STD	SFSA032GQ1AA4T0-I-DB-216-STD
64 GBytes	SFSA064GQ1AA4T0-C-QC-216-STD	SFSA064GQ1AA4T0-I-QC-216-STD
128 GBytes	SFSA128GQ1AA4T0-C-NC-216-STD	SFSA128GQ1AA4T0-I-NC-216-STD
256 GBytes	SFSA256GQ1AA8T0-C-NC-216-STD	SFSA256GQ1AA8T0-I-NC-216-STD

4. Product Description

The Swissbit X-600 Solid State Drive (SSD) leverages the 2.5" SATA industry-standard form factor and connectivity. Combined with a SATA Gen III controller and Single-Level Cell (SLC) NAND flash technology, the X-600 realizes a robust non-volatile storage solution for today's embedded storage applications. A functional block diagram of the X-600 SSD is provided below in Figure 1.

Figure 1: X-600 2.5" SATA Functional Block Diagram



The X-600 SSD is a non-volatile memory drive that provides high capacity data storage. It has a standard combined connector for SATA signals (7) and power (15) control. Both connector sections are on the same plane of the connector as specified in the JEDEC specification. The Swissbit 2.5" SATA SSDs provide a 30 µinch gold connector edge for rugged storage in embedded and industrial systems. The 2.5" SATA SSDs also provide rugged storage for embedded and industrial systems where performance, data and system reliability, power fail protection, and flexibility are important design considerations.

The on-board SATA III controller manages the interface between the host and the non-volatile NAND flash memory array. The controller is designed to support SATA Gen III (6 Gbit/s) interface speeds and is fully backward compatible with SATA Gen II (3 Gbit/s) and SATA Gen I (1.5 Gbit/s) to enable the broadest possible range of platform compatibility. The controller utilizes an ARC 700 processing core, providing an optimum balance between read/write performance, Data Care Management, and power fail protection.

The X-600 achieves sequential read/write performance of up to 520/405³ MBytes/s (MBPS) and random read/write input/output operations (IOPs) of up to 77K/73K. In addition, the X-600 series feature Swissbit's proven power fail safety and support for the ATA security feature set, enhanced secure erase tools, NCQ, TRIM, advanced wear leveling and bad block management, and in-field firmware updates.

An on-controller BCH Error Correction Code (ECC) engine provides the X-600 hardware ECC, which is capable of correcting up to 66 bits per 1 KByte page. This, combined with Swissbit's Data Care Management firmware, provides both passive and active data management strategies to ensure data integrity and extract the maximum possible endurance and reliability from the NAND flash array. These strategies include, but are not limited to, Global Wear Leveling, Adaptive Read Refresh, Background Media Scan, and Dynamic Block Remapping.

The risk of data loss as a result of an unexpected power fail event is mitigated using a robust sequence of voltage regulators and detectors designed to ensure a graceful shutdown of the controller and NAND flash array. A combination of both hardware and firmware power fail features prevent the possibility of resident data being corrupted during an unexpected power failure.

³ Performance numbers are based on a 128 GByte drive. Performance values for the 256 GByte drive are pending.

Related Documentation

- Serial ATA International Organization Serial ATA Revision 3.0 (<http://www.serialata.org>)
- Serial Transport Protocols and Physical Interconnect (ATA/ATAPI-8) (<http://www.t13.org>)
- Electronic Industries Alliance (<http://www.ecianow.org>)

4.1 Performance Specifications

The X-600 read/write sequential and random I/O performance benchmarks are detailed below in Table 3.

Table 3: Read/Write Performance⁴

Capacity	Sequential Read (MBPS)	Sequential Write (MBPS)	Random Read (IOPs)	Random Write (IOPs)
8 GBytes	245	65	32,000	17,000
16 GBytes	470	125	63,000	33,000
32 GBytes	520	250	77,000	63,000
64 GBytes	520	400	77,000	73,000
128 GBytes	520	405	77,000	73,000
256 GBytes	520	425	79,000	76,000

4.2 Current Consumption

The drive-level current consumption as a function of operating mode is shown below Table 4.

Table 4: Current Consumption⁵

Drive Capacity	Sequential Read	Sequential Write	Random Read	Random Write	Idle	Slumber	Unit
8 GBytes	270	250	255	250	90	15	mA
16 GBytes	360	320	320	320	90	15	
32 GBytes	400	430	390	425	90	15	
64 GBytes	420	600	420	570	90	15	
128 GBytes	460	630	460	610	95	15	
256 GBytes	490	760	490	760	110	15	

⁴ The values are measured using Crystal Disk Mark (CDM) across the full drive density. Performance depends on flash type and number, file/cluster size, and burst speed.

⁵ All values are the maximum recorded at 25 °C, with nominal supply voltage, and SATA III performance test using IOMeter (512 byte-1 MByte transfer sizes).

4.3 Environmental Specifications

4.3.1 Recommended Operating Conditions

The recommended operating conditions for the X-600 SSD are provided in Table 5 below.

Table 5: Recommended Operating Conditions⁶

Parameter	Value
Commercial Operating Temperature	0 °C to 70 °C
Industrial Operating Temperature	-40 °C to 85 °C
Power Supply V _{CC} Voltage	5.0 V ± 10%

4.3.2 Recommended Storage Conditions

The recommended storage conditions are listed below in Table 6.

Table 6: Recommended Storage Conditions

Parameter	Value
Commercial Storage Temperature	-40 °C to 85 °C
Industrial Storage Temperature	-40 °C to 85 °C

4.3.3 Shock, Vibration, and Humidity

The maximum shock, vibration, and humidity conditions are listed below in Table 7.

Table 7: Shock, Vibration, and Humidity

Parameter	Value
Non-Operating Shock	1,500 g, 0.5 ms pulse duration, half-sine wave (IEC 60068-2-27 and JESD22-B110 cond. B)
Non-Operating Vibration	50 g, 131-2,000 Hz, 3 axes, 12 cycles (IEC 60068-2-6, MIL-STD-883 H Method 2007.3)
Humidity (Non-Condensing)	85% RH 85 °C, 1000 hrs, max. supply voltage (JESD22-A101B)
High Temperature Biased Life	85 °C, 1000 hrs (JESD22-A108D)
Temperature Cycling	-40 °C to 125 °C, 500 Cycles (JESD22A-A104D)

⁶ 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.

4.4 Regulatory Compliance

The X-600 devices comply with the standards listed in the following table.

Table 8: Regulatory Compliance

Compliance	Country	Type	Standard(s)/Directive
CE	European Union	Certificate	2011/65/EU, 2012/19/EU, 2014/30/EU
CE/EMC	European Union	Compliance	2004/108/EC (AS/NZS CISPR22 :2009 +A1:2010, EN 61000-6-2:2005/AC:2005, EN 61000-6-4:2007/A1:2011 [EN55022:2010 Class B])
CE/RoHS	European Union	Compliance	2011/65/EU
CE/WEEE	European Union	Compliance	2012/19/EU
REACH	European Union	Certificate	1907/2006
FCC	United States	Certificate	47CFR Part 15, Class B
UL	United States	Compliance	UL/CSA 60950-1, Second Edition
VCCI	Japan	Compliance	ITE (Class A)
CCC	China	Compliance	Laws and Regulations of the People's Republic of China Governing Foreign-Related Matters (1991.7)
C-Tick	Australia	Compliance	AS/NZS CISPR22
TüV	Germany	Compliance	TüV IEC 60950-1; UL/CSA 60950-1, Second Edition
SATA-IO	International	Compliance	SATA Revision 1.4 Interoperability

4.5 Mechanical Specifications

The X-600 SSD consists of a flash controller and NAND flash memory devices. The controller interfaces with a host system, allowing data to be written to and read from the flash memory array. The SSD has a 7-pin SATA data connector and a 15-pin power connector. Physical dimensions are detailed in Table 9 below. Figure 2 on page 12 illustrates the X-600 dimensions.

Table 9: Physical Dimensions

Physical Dimensions		Unit
Length	100.10±0.25	mm
Width	69.85 ±0.25	
Thickness (Max)	7.00 +0.20/-0.50	
Weight (Max Capacity)	70	g

4.6 Reliability and Endurance

The Mean Time Between Failure (MTBF) is specified to exceed the value listed below. Data reliability with effective error tolerance and data retention at the beginning and end of life is also provided.

Table 10: Reliability

Parameter	Value
MTBF (at 25 °C)	> 2,000,000 hours
Data Reliability	< 1 Non-Recoverable Error per 10 ¹⁶ Bits Read
Data Retention	10 Years at Start (JESD47), 1 Year at EOL

Endurance represented as both TeraBytes Written (TBW) and full Drive Writes Per Day (DWPD) for three different application scenarios is provided in the following table.

Table 11: Endurance⁷

Drive Capacity	Client		Enterprise		Embedded	
	TBW	DWPD	TBW	DWPD	TBW	DWPD
8 GBytes	260.73	18.28	69.97	4.91	156.25	10.95
16 GBytes	521.47		139.94		312.50	
32 GBytes	1042.94		279.89		625.00	
64 GBytes	2085.88		559.78		1250.00	
128 GBytes	4171.76		1119.55		2500.00	
256 GBytes	8343.51		2239.10		5000.00	

4.7 Drive Geometry Specification

The X-600 drive geometry is set to report industry standard LBA settings per the IDEMA standard (LBA1-03). The values for each capacity are shown below in Table 12.

Table 12: Drive Geometry

Raw Capacity	User Capacity ⁸	Total LBA	User Addressable Bytes
		Decimal	(Unformatted)
8 GBytes	8 GBytes	15,649,200	8,012,390,400
16 GBytes	16 GBytes	31,277,232	16,013,942,784
32 GBytes	32 GBytes	62,533,296	32,017,047,552
64 GBytes	64 GBytes	125,045,424	64,023,257,088
128 GBytes	128 GBytes	250,069,680	128,035,676,160
256 GBytes	256 GBytes	500,118,192	256,060,514,304

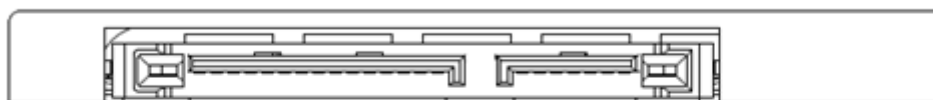
⁷ Client and Enterprise workloads follow the JEDEC JESD219 standard; the Embedded workload creates a 4 KByte file and appends it. Enterprise workload values are measured based on 168 hours of runtime.

⁸ 1 GByte = 10⁹ bytes

5. Electrical Interface

The SSD is connected with a standard 7-pin SATA connector and a standard 15-pin power connector. The signal/pin assignments and descriptions are listed in Table 13.

Front View



Bottom View

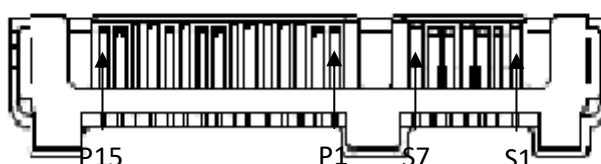


Table 13: Pin Assignment, Name, and Description

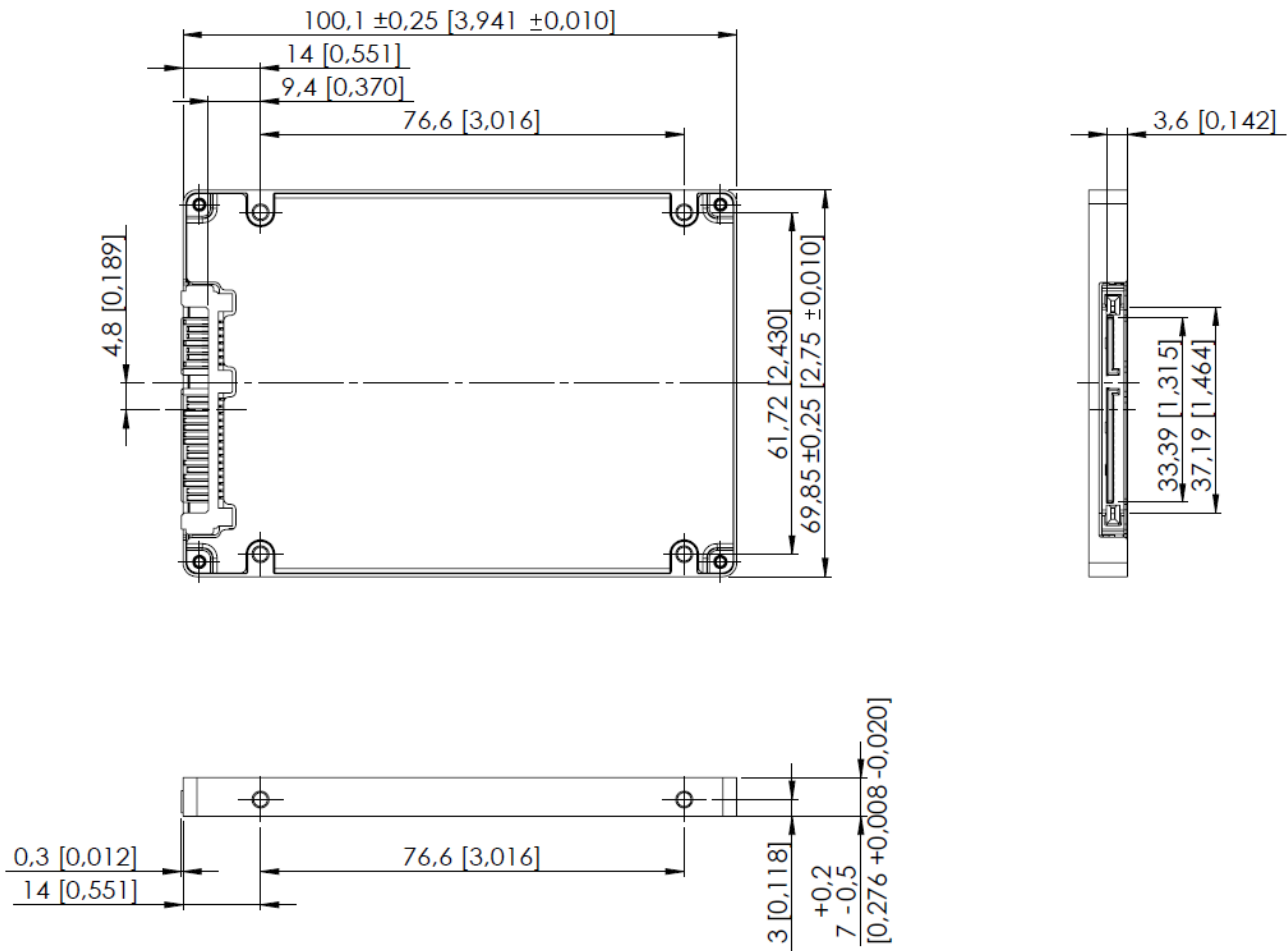
Pin	Signal Name	Description
S1	SGround	Signal Ground
S2	A+	+ Differential Device Transmit Signal
S3	A-	- Differential Device Transmit Signal
S4	SGround	Signal Ground
S5	B-	- Differential Device Receive signal
S6	B+	+ Differential Device Receive signal
S7	SGround	Signal Ground
P1-P2	3.3V	3.3 V Power (Not Used)
P3	NC	Reserved for DEVSLP
P4-P6	GND	Power Ground
P7	5.0V	Power Pre-Charge
P8-P9	5.0V	5.0 V Power Supply Voltage
P10	GND	Power Ground
P11	NC	No Connect ⁹
P12	GND	Power Ground
P13-P15	12V	12V Power (Not Used)

⁹ Optional device activity LED (on request).

6. Package Mechanical

NOTE: The dimensions in the following figure are the maximum values based on the JEDEC standard. For the product dimensions, see the *Mechanical Specifications* section on page 9.

Figure 2: 2.5" SATA SSD Dimensions in mm [in]



7. ATA Commands

This section provides information on the ATA commands supported by the SSD. The commands are issued to the ATA by loading the required registers in the command block with the supplied parameter, and then writing the command code to the register. For backward compatibility, some commands are implemented as a "no operation". See Table 14 for a list of ATA commands the device supports. For details about setting up the command registers, see the latest ATA Specification.

Table 14: ATA Command Set

Command	Code	Protocol
General Feature Set		
Execute Device Diagnostic	90h	Execute Device Diagnostic
Flush Cache	E7h	Non-data
Identify Device	ECh	PIO data-in
Initialize Drive Parameters	91h	Non-data
Read DMA	C8h	DMA
Read Log Ext	2Fh	PIO data-in
Read Multiple	C4h	PIO data-in
Read Sector(s)	20h	PIO data-in
Read Verify Sector(s)	40h or 41h	Non-data
Set Feature	EFh	Non-data
Set Multiple Mode	C6h	Non-data
Write DMA	CAh	DMA
Write Multiple	C5h	PIO data-out
Write Sector(s)	30h	PIO data-out
NOP	00h	Non-data
Read Buffer	E4h	PIO data-in
Write Buffer	E8h	PIO data-out
Power Management Feature Set		
Check Power Mode	E5h or 98h	Non-data
Idle	E3h or 97h	Non-data
Idle Immediate	E1h or 95h	Non-data
Sleep	E6h or 99h	Non-data
Standby	E2h or 96h	Non-data
Standby Immediate	E0h or 94h	Non-data
Security Mode Feature Set		
Security Set Password	F1h	PIO data-out
Security Unlock	F2h	PIO data-out
Security Erase Prepare	F3h	Non-data
Security Erase Unit	F4h	PIO data-out
Security Freeze Lock	F5h	Non-data
Security Disable Password	F6h	PIO data-out
S.M.A.R.T. Feature Set		
S.M.A.R.T. Disable Operations	Boh	Non-data
S.M.A.R.T. Enable/Disable Autosave	Boh	Non-data
S.M.A.R.T. Enable Operations	Boh	Non-data
S.M.A.R.T. Execute Off-Line Immediate	Boh	Non-data
S.M.A.R.T. Read Data	Boh	PIO data-in
S.M.A.R.T. Read Log	Boh	PIO data-in
S.M.A.R.T. Read Threshold	Boh	PIO data-in
S.M.A.R.T. Return Status	Boh	Non-data
S.M.A.R.T. Save Attribute Values	Boh	Non-data
S.M.A.R.T. Write Attribute Values	Boh	Non-data
S.M.A.R.T. Write Log	Boh	PIO data-out

Command	Code	Protocol
Host Protected Area Feature Set		
Read Native Max Address	F8h	Non-data
Set Max Address	F9h	Non-data
Set Max Set Password	F9h	PIO data-out
Set Max Lock	F9h	Non-data
Set Max Freeze Lock	F9h	Non-data
Set Max Unlock	F9h	PIO data-out
48-Bit Address Feature Set		
Flush Cache Ext	EAh	Non-data
Read Sector(s) Ext	24h	PIO data-in
Read DMA Ext	25h	DMA
Read Multiple Ext	29h	PIO data-in
Read Native Max Address Ext	27h	Non-data
Read Verify Sector(s) Ext	42h	Non-data
Set Max Address Ext	37h	Non-data
Write DMA Ext	35h	DMA
Write DMA FUA Ext	3Dh	DMA
Write Multiple Ext	39h	PIO data-out
Write Multiple FUA Ext	CEh	PIO data-out
Write Sector(s) Ext	34h	PIO data-out
NCQ Feature Set		
Read FPDMA Queued	60h	DMA Queued
Write FPDMA Queued	61h	DMA Queued
Others		
Data Set Management	06h	DMA
Seek	70h	Non-data

8. Identify Device Information

The following table describes the 512 bytes of data the drive returns for the Identify Device command (ECh).

Table 15: Identify Device Information

Word(s)	Default Value	Total Bytes	Data Field Type Information
0	0040h*	2	Standard Configuration Fixed (optional 848Ah for removable)
1	XXXXh	2	Default number of cylinders
2	0000h	2	Reserved
3	00XXh	2	Default number of heads
4-5	0000h	4	Obsolete
6	XXXXh	2	Default number of sectors per track
7-8	XXXXh	4	Number of sectors per drive (Word 7 = MSW, Word 8 = LSW)
9	0000h	2	Obsolete
10-19	aaaa	20	Serial number in ASCII (right-justified)
20-22	0000h	6	Obsolete
23-26	SBR13040	8	Firmware revision in ASCII (big-endian byte order in Word)
27-46	XXXX*	40	Model number in ASCII (right-justified)
47	8002h	2	Maximum number of sectors on Read/Write Multiple command
48	4000h	2	Trusted Computing feature set not supported
49	2F00h*	2	Standby Timer, DMA, LBA, IORDY supported
50	4000h	2	Capabilities
51	0000h	2	PIO data transfer cycle timing mode 0
52	0000h	2	Obsolete
53	0007h*	2	Words 88 and 64-70 valid
54	XXXXh	2	Current numbers of cylinders
55	XXXXh	2	Current numbers of heads
56	XXXXh	2	Current sectors per track
57-58	XXXXh	4	Current capacity in LBAs (Word 57 = LSW, Word 58 = MSW)
59	910Xh*	2	Multiple sector setting (host changeable)
60-61	XXXXh	4	Total number of sectors addressable in LBA mode
62	0000h	2	Obsolete
63	0007h*	2	Multiword DMA transfer support modes 2, 1, and 0
64	0003h	2	Advanced PIO modes supported
65	0078h*	2	Minimum Multiword DMA transfer cycle time per Word
66	0078h*	2	Recommended Multiword DMA transfer cycle time
67	0078h*	2	Minimum PIO transfer cycle time without flow control
68	0078h*	2	Minimum PIO transfer cycle time with IORDY flow control
69	4D20h	2	Trimmed range returning zeros, 28-bit commands supported, download
70-74	0000h	10	Reserved
75	001Fh	1	Queue Depth
76	830Eh	2	SATA Capabilities
77	0086h	2	Additional SATA Capabilities
78	014Ch	2	SATA feature support
79	0040h*	2	SATA features enabled (host changeable)
80	003F0h	2	Major revision
81	0000h	2	Minor revision
82-84	746Bh*	6	Features/command sets supported
85-87	7469h*	6	Features/command sets enabled (may change in operation)
88	407F*	2	UDMA mode supported
89	0002*	2	Time for security erase unit completion
90	0002h*	4	Time for enhanced security erase completion
91	0000h	2	Power Management
92	FFFEh*	2	Master password revision code
93-99	0000h*	14	Reserved

Word(s)	Default Value	Total Bytes	Data Field Type Information
100-103	XXXXh	8	Max user LBA48 address feature set
104-105	0000h	4	Reserved
106	4000h	2	Sector size
107-118	0000h	24	Reserved
119-120	4018h	4	Command set supported settings
121-127	0000h	14	Reserved
128	0021h*	2	Security status (may change in operation)
129-159	XXXXh	62	"Swissbit SSD"
160	0000h*	2	Power requirement
161	0000h	2	Reserved
162	0000h	2	Management schemes
163	0000h	2	IDE Timing
164	0000h	2	IO Timing
165-168	0000h	8	Reserved
169	0001h	2	Data Set Management supported
170-208	XXXXh	78	Reserved
209	4000h	2	Logical block alignment
210-216	0000h	14	Reserved
217	0001h*	2	Nominal media rotation rate: Solid State Device
218-221	0000h	8	Reserved
222	107Fh	2	Transport major revision
223-233	0000h	22	Reserved
234	0001h	2	Minimum number of 512-byte units per segmented download
235	0200h	2	Maximum number of 512-byte units per segmented download
236-254	0000h	38	Reserved
255	XXXXh	2	Integrity Word

* Standard values for full functionality are listed. Values depend on device configuration.

9. S.M.A.R.T. Functionality

The X-600 SSD fully supports the ATA Specification for Self-Monitoring, Analysis, and Reporting Technology (S.M.A.R.T.). For details about the S.M.A.R.T. subcommands and attributes, see the *S.M.A.R.T. Attribute Technical Reference Guide*.

9.1 S.M.A.R.T. Subcommands

The following table lists the supported S.M.A.R.T. subcommands and the Features register values.

Table 16: S.M.A.R.T. Features Supported

Features	Operation
D0h	S.M.A.R.T. Read Data
D1h	S.M.A.R.T. Read Attribute Thresholds
D2h	S.M.A.R.T. Enable/Disable Autosave
D3h	S.M.A.R.T. Save Attribute Values
D4h	S.M.A.R.T. Execute Off-Line Immediate
D5h	S.M.A.R.T. Read Log
D6h	S.M.A.R.T. Write Log
D7h	S.M.A.R.T. Write Attribute Thresholds
D8h	S.M.A.R.T. Enable Operations
D9h	S.M.A.R.T. Disable Operations
DAh	S.M.A.R.T. Return Status

The device aborts any S.M.A.R.T. subcommands with Features register values not listed in the above table.

9.2 S.M.A.R.T. Read Data

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 17: S.M.A.R.T. Data Structure

Byte(s)	Value	Description
0-1	0100h	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	0002h	S.M.A.R.T. capabilities
370	01h	Error logging capability
371	00h	Vendor specific
372	01h	Short self-test routine recommended polling time, in minutes
373	01h	Extended self-test routine recommended polling time, in minutes
374	01h	Conveyance self-test routine recommended polling time, in minutes
375-385	00h	Reserved
386-395	XXh	Firmware version in ASCII ("SBR13040")
396-399	00h	Reserved
400-405	XXh	Controller model in ASCII ("SM2246")
406-510	00h	Reserved
511	XXh	Data structure checksum

9.3 S.M.A.R.T. Attributes

The X-600 drives support the S.M.A.R.T. attributes listed in the following table.

Table 18: S.M.A.R.T. Attributes

ID	Worst	Threshold	Attribute	Description
01h	100	0	Raw Read Error Rate	Total number of Cyclic Redundancy Check (CRC) errors that occurred over the SATA interface
05h	100	0	Reallocated Sector Count	Total number of runtime identified (field marked) bad blocks
09h	100	0	Power-On Hours	Total hours that the device has been powered on and operational (not in Sleep mode)
0Ch	100	0	Power Cycle Count	Total number of power cycles that have occurred during the life of the drive
A0h	100	0	Uncorrectable Sector Count	Total number of sectors read (active or passive) with UECC errors
A1h	100	0*	Spare Blocks	Total number of spare blocks currently available
A3h	100	0	Number of Initial Invalid Blocks	Total number of initially identified (factory marked and pretest) bad blocks
A4h	100	0	Total Erase Count	Total number of erase operations that have ever been performed on all currently valid blocks (excluding the system, bad and reserved blocks)
A5h	100	0	Maximum Erase Count	The maximum number of erase operations that have ever been performed on a single block (excluding the system, bad and reserved blocks)
A6h	100	0	Minimum Erase Count	The minimum number of erase operations that have ever been performed on a single block (excluding the system, bad and reserved blocks)
A7h	100	0*	Average Erase Count	The average number of erase operations that have ever been performed on a single block (excluding the system, bad and reserved blocks)

ID	Worst	Threshold	Attribute	Description
A8h	100	0	Maximum Specified Erase Count	The specified maximum erase count; equivalent to number of program/erase (P/E) cycles rated for the device
A9h	100	0	Power on UECC Count	The number of uncorrectable errors encountered during a power up event
C0h	100	0	Initial Spare Block Count	Total number of original spare blocks
C1h	100	0	Dynamic Remaps	Total number of dynamic remap operations
C2h	100	0	Temperature	Temperature (minimum, maximum, and current) of the device
C3h	100	0	Flash ECC Recovered	Total number of times the read-retry process was required to recover data
C4h	0	0	Reallocation Event Count	Total count of remapping operations
C6h	100	0	Uncorrectable Sector Count Offline	Total number of sectors read (active only) with UECC errors
C7h	100	0	SATA PHY CRC Error Count	Total count of PHY errors (including CRC) that occurred over the interface cable
D7h	100	0	TRIM Count	Total number of TRIM commands issued by the host
EBh	100	0	Total Flash LBAs Written	The lower 7 bytes of the total number of LBAs (in 16 KByte increments) written to the flash; the higher 5 bytes are located in attribute EDh
EDh	100	0	Total Flash LBAs Written Expanded	The upper 5 bytes of the total number of LBAs (in 16 KByte increments) written to the flash; the lower 7 bytes are located in attribute EBh
F1h	100	0	Total Host LBAs Written	The lower 7 bytes of the total number of LBAs written to the device by the host; the higher 5 bytes are located in attribute F3h
F2h	100	0	Total Host LBAs Read	The lower 7 bytes of the total number of LBAs read from the device by the host; the higher 5 bytes are located in attribute F4h
F3h	100	0	Total Host LBAs Written Expanded	The upper 5 bytes of the total number of LBAs written to the device by the host; the lower 7 bytes are located in attribute F1h
F4h	100	0	Total Host LBAs Read Expanded	The upper 5 bytes of the total number of LBAs read from the device by the host; the lower 7 bytes are located in attribute F2h
F8h	100	0	SSD Remaining Life	Percent of SSD life remaining on the SSD (a value from 0 to 64h), normalized to 100; based upon Average Erase Count (A7h) scaled by the Maximum Specified Erase Count (A8h)
F9h	100	0	Spare Block Remaining Life	Percent of spare blocks remaining

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

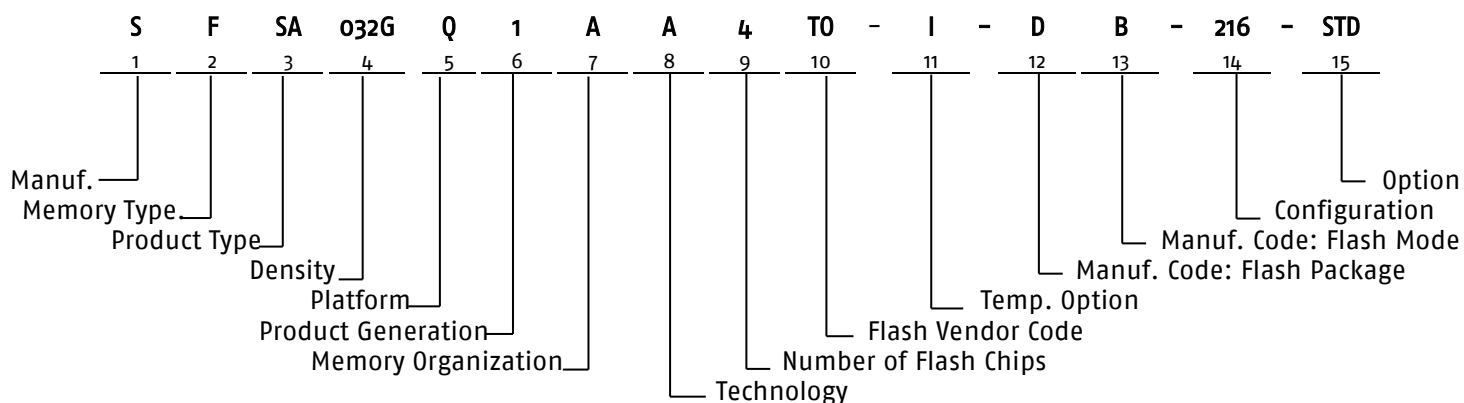
9.4 S.M.A.R.T. Attribute Entry Structure

Each attribute entry consists of 12 bytes. See the following table for the data structure of each entry.

Table 19: Attribute Entry

Byte(s)	Value	Description
0	XXh	Attribute ID (see Table 18)
1-2	XXXXh	Flags (little-endian)
3	XXh	Attribute value as a percentage
4	XXh	Worst value as a percentage
5-8	XXXXh	Raw value (little-endian)
9-11	00h	Reserved

10. Part Number Decoder



10.1 Manufacturer

Swissbit code	S
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10.2 Memory Type

Flash	F
-------	---

10.3 Product Type

SATA Interface	SA
----------------	----

10.4 Density

8 GBytes	008G
16 GBytes	016G
32 GBytes	032G
64 GBytes	064G
128 GBytes	128G
256 GBytes	256G

10.5 Platform

2.5" SATA SSD	Q
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10.6 Product Generation

10.7 Memory Organization

x8	A
----	---

10.8 Technology

X-600 Series	A
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10.9 Number of Flash Chips

1 Flash	1
2 Flash	2
4 Flash	4
8 Flash	8

10.10 Flash Code

Toshiba	T0
---------	----

10.11 Temperature Option

Industrial Temperature Range: -40 °C to 85 °C	I
Standard Temperature Range: 0 °C to 70 °C	C

10.12 Die Classification

SLC MONO (single die package)	M
SLC DDP (dual die package)	D
SLC QDP (quad die package)	Q
SLC ODP (octal die package)	N

10.13 Pin Mode

	TSOP	BGA
Single nCE and Single R/nB	S	A
Dual nCE and Dual R/nB	T	B
Quad nCE and Quad R/nB	U	C
Octal nCE and Dual R/nB	*	D

*Not Available

10.14 Drive configuration XYZ

X = Type

Drive Mode	PIO	DMA support	X
Fix	Yes	Yes	2

Y = Firmware Revision

FW Revision	Y
SBR13040	1

Z = Max Transfer Mode and PFAIL

Max PIO Mode/CIS	Z
UDMA6 (MDMA2, PIO4)	6

10.15 Option

Swissbit/Standard	STD
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11. Swissbit 2.5" SATA SSD Marking Specification

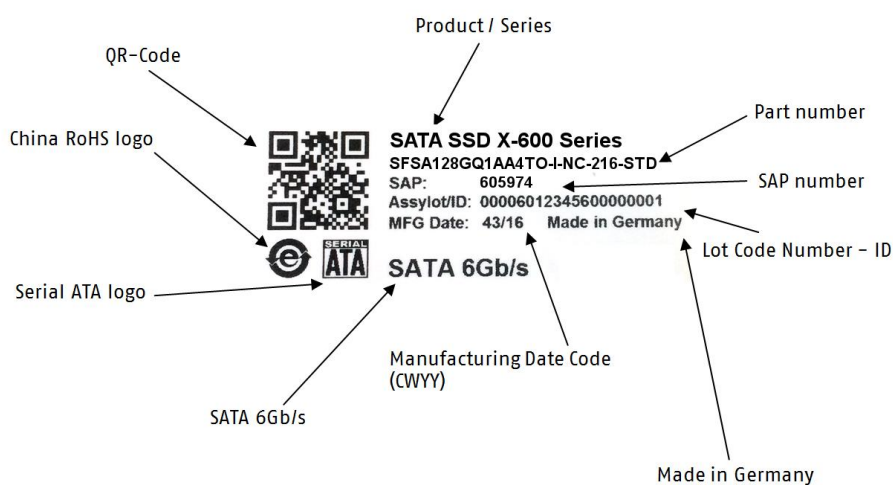
11.1 Top View



11.2 Label Content

- Part Number
- Lot Code/Identification
- Type Code
- Density
- Manufacturing Date
- Swissbit Logo
- Country of Origin
- CE Logo
- FCC Logo
- WEEE Logo

11.3 Print on the Label



12. Revision History

Table 20: Document Revision History

Date	Revision	Description	Revision Details
26-Jul-2016	0.01	Preliminary draft.	
6-Apr-2017	1.00	Initial release.	Doc. req. no. 1623
19-Jun-2017	1.01	Updated mechanical drawing.	Doc. req. no. 1725
28-Nov-2017	1.02	Updated mechanical drawing, firmware field, endurance values, added temperature test-conditions	Doc. req. no. 1964

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