

swissbit®

Product Data Sheet

Industrial mSATA SSD (M0-300 Full Size)

X-76m Series

SATA Gen3 – 6.0 Gbit/s, 3D pSLC

Commercial and Industrial
Temperature Grade

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X-76m Series – Industrial mSATA Solid State Drive

10 GBytes up to 320 GBytes (M0-300A)

1. Product Summary

- **Capacities:** 10 GBytes, 20 GBytes, 40 GBytes, 80 GBytes, 160 GBytes, 320 GBytes
- **Form Factor¹:**
 - JEDEC M0-300A Sized Solid State Drive (50.8 mm x 29.85 mm x 3.8 mm)
 - 52-Pin PCI Express (PCIe) Mini-Connector (SATA Gen3)
- **Compliance:** SATA Gen3 – 6 Gbit/s (Gen2 – 3 Gbit/s and Gen1 – 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 Gen3 – 6.0 Gbit/s
 - Read Performance: Sequential Read up to 560 MBytes/s, Random Read 4K up to 74,000 IOPS
 - Write Performance: Sequential Write up to 480 MBytes/s, Random Write 4K up to 84,900 IOPS
- **Operating Temperature Range²:**
 - Commercial: 0 °C to 70 °C
 - Industrial: -40°C to 85 °C
- **Storage Temperature Range:** -40 °C to 85 °C
- **Operating Voltage:** 3.3 V ± 5%
- **Power (Max):**
 - Read (Active): 2.4 W
 - Write (Active): 2.7 W
 - Idle: 415 mW
 - Partial: 115 mW
- **Data Retention:** 10 Years @ Life Begin / 1 Year @ Life End
- **Endurance in TeraBytes Written (TBW) @ Max Capacity³:**
 - Sequential Workload ≥ 10,520
 - Client Workload ≥ 7,950
 - Enterprise Workload ≥ 2,070
- **Shock/Vibration:** 1,500 *g* / 50 *g*
- **High-Performance 32-Bit Processor with Integrated, Parallel Flash Interface Engines:**
 - Triple-Level Cell (TLC) 3D NAND Flash in pSLC mode
 - LDPC ECC with up to 165 bit correction per 1 KByte page (BCH equivalent)
- **High Reliability:**
 - Mean Time Between Failure (MTBF): > 2,000,000 hours
 - Data Reliability: < 1 non-recoverable error per 10¹⁶ bits read

¹ The verification of the hosts system and storage device compatibility is the customer's responsibility. Swissbit can provide guidance and support upon request.

² Adequate airflow is required to ensure the temperature, as reported in the S.M.A.R.T. data, does not exceed 110°C (industrial temperature drive) and 95°C (commercial temperature drive) respectively.

³ According to JEDEC (JESD471), the time to write the full TBW is a minimum of 18 months. Higher average daily data volume reduces the specified TBW. The values listed are estimates and are subject to change without notice.

2. Product Features

- Pseudo SLC Flash with 30,000 Program/Erase Cycles and Reduced Write Amplification
- Dynamic and Static Wear Leveling
- Subpage Mode Flash Translation Layer (FTL)
- Data Care Management
 - Active: Adaptive Read Refresh
 - Passive: Background Media Scan
- Read Disturb Management
- Lifetime Enhancements
 - Dynamic Bad Block Remapping
 - Write Amplification Reduction
- On-Board Power Fail Protection
- TRIM and NCQ Support
- ATA Security Feature Set Support
- DEVSLP Compatible
- In-Field Firmware Update⁴
- Enterprise-Grade Self-Monitoring, Analysis, and Reporting Technology (S.M.A.R.T.)
- 30 µinch Gold-Plated Connector (IPC-6012B Class 2 Compliant)
- End-to-End (E2E) Data Protection
- AES256 Encryption (on request)
- TCG Opal 2.0 Compliant (on request)
- Life Cycle Management
- Controlled "Locked" BOM
- RoHS-6 Compliant
- Swissbit Life Time Monitoring (SBLTM) Tool and SDK for SBLTM (on request)



⁴ A host system that supports in-field firmware updates is recommended.

3. Ordering Information

Table 1: Standard Product List

| Capacity | Part Number |
|------------|------------------------------|
| 10 GBytes | SFSA010GUxAK1TO-t-5S-1yP-STD |
| 20 GBytes | SFSA020GUxAK1TO-t-6B-2yP-STD |
| 40 GBytes | SFSA040GUxAK2TO-t-6B-2yP-STD |
| 80 GBytes | SFSA080GUxAK4TO-t-6B-2yP-STD |
| 160 GBytes | SFSA160GUxAK2TO-t-8C-2yP-STD |
| 320 GBytes | SFSA320GUxAK4TO-t-8C-2yP-STD |

x = product generation; t = temperature grade; y = firmware revision

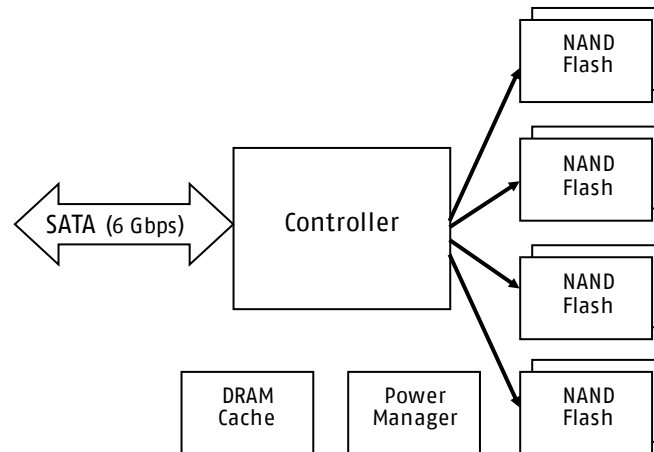
Table 2: Available Part Numbers

| Capacity | Commercial Temperature | Industrial Temperature |
|------------|------------------------------|------------------------------|
| 10 GBytes | SFSA010GU2AK1TO-C-5S-21P-STD | SFSA010GU2AK1TO-I-5S-21P-STD |
| 20 GBytes | SFSA020GU2AK1TO-C-6B-21P-STD | SFSA020GU2AK1TO-I-6B-21P-STD |
| 40 GBytes | SFSA040GU2AK2TO-C-6B-21P-STD | SFSA040GU2AK2TO-I-6B-21P-STD |
| 80 GBytes | SFSA080GU2AK4TO-C-6B-21P-STD | SFSA080GU2AK4TO-I-6B-21P-STD |
| 160 GBytes | SFSA160GU2AK2TO-C-8C-21P-STD | SFSA160GU2AK2TO-I-8C-21P-STD |
| 320 GBytes | SFSA320GU2AK4TO-C-8C-21P-STD | SFSA320GU2AK4TO-I-8C-21P-STD |

4. Product Description

The Swissbit X-76m Solid State Drive (SSD) leverages the JEDEC M0-300A industry-standard form factor and connectivity as well as support for AES encryption, E2E security and TCG OPAL standards. Combined with a SATA Gen3 controller and Triple-Level Cell (TLC) 3D NAND flash technology, the X-76m realizes a robust non-volatile storage solution for today's embedded storage applications. The flash is managed as pseudo Single-Level Cell (pSLC) flash, providing an optimal balance of endurance and performance. A functional block diagram of the X-76m SSD is provided below in Figure 1.

Figure 1: X-76m SATA Functional Block Diagram



The X-76m SSD incorporates a 52-pin edge type connector set to support host read/write, control, and power activity per the applicable JEDEC and SATA I/O specifications⁵. In addition, the X-76m SSD host interface pins include 30 µinch gold plating to meet or exceed industrial and NetCom industry subsystem compliance requirements. Mechanical robustness is assured with two 2.6 mm (diameter) JEDEC-compliant mounting holes located at the opposite end of the drive assembly to secure the X-76m SSD to the host platform, in even the most extreme operating environments.

The on-board SATA Gen3 controller manages the interface between the host and the non-volatile NAND flash memory array. The controller is designed to support SATA Gen3 (6 Gbit/s) interface speeds and is fully backward compatible with SATA Gen2 (3 Gbit/s) and SATA Gen1 (1.5 Gbit/s) to enable the broadest possible range of platform compatibility. The controller utilizes a high performance 32-bit RISC CPU, providing an optimum balance between read/write performance, Data Care Management and power fail protection.

Swissbit's X-76m SSDs deliver an impressive IOPS rate and endurance by combining TLC 3D NAND flash technology in pSLC mode with a high-end controller architecture, firmware and an optimized configuration. The SSDs are designed for applications requiring high data transfer rates (see Table 3: Read/Write Performance). This performance is achieved through an on-board DRAM cache and the 4-channel NAND flash controller interface that supports ONFI and Toggle 2 (400 MT/s) interface speeds. In addition, the X-76m series features Swissbit's proven power fail safety and support for the ATA security feature set, NCQ, TRIM, advanced wear leveling, bad block management and in-field firmware updates.

An on-controller LDPC Error Correction Code (ECC) engine provides the X-76m hardware ECC, which is capable of correcting up to 165 bits per 1 KByte page (BCH equivalent). This engine, combined with Swissbit's Data Care Management firmware, provides 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 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, capacitors and detectors designed to ensure a graceful shutdown of the controller and NAND flash array. The combination of hardware and firmware power fail features prevents the possibility of resident data being corrupted during an unexpected power failure.

⁵ SerialATA I/O rev 3.2 Section 6.6, Aug 7, 2013
<https://www.jedec.org/standards-documents/focus/flash/solid-state-drives>

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>)
- AT Attachment Interface Document, American National Standards Institute, X3.298-1997
- JEDEC MO-300 standard – JEDEC Publication 95: Registered and Standard Outlines for Solid State and Related Products

4.1 Performance Specifications

The X-76m read/write sequential and random CDM performance benchmarks are detailed in the following Table 3.

Table 3: Read/Write Performance⁶

| Capacity | Sequential Read (MBPS) | Sequential Write (MBPS) | Random Read 4K (IOPS) | Random Write 4K (IOPS) |
|------------|------------------------|-------------------------|-----------------------|------------------------|
| 10 GBytes | 230 | 90 | 17,500 | 22,500 |
| 20 GBytes | 440 | 180 | 33,900 | 44,500 |
| 40 GBytes | 560 | 360 | 66,100 | 78,600 |
| 80 GBytes | 560 | 480 | 73,400 | 82,900 |
| 160 GBytes | 560 | 480 | 72,900 | 84,900 |
| 320 GBytes | 560 | 450 | 74,000 | 76,500 |

4.2 Current Consumption

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

Table 4: Current Consumption⁷

| Capacity | Sequential Read | Sequential Write | Random Read 4K | Random Write 4K | Idle | Partial | Unit |
|------------|-----------------|------------------|----------------|-----------------|------|---------|------|
| 10 GBytes | 430 | 400 | 410 | 400 | 120 | 30 | mA |
| 20 GBytes | 590 | 520 | 535 | 515 | 120 | 30 | |
| 40 GBytes | 740 | 715 | 735 | 705 | 125 | 30 | |
| 80 GBytes | 725 | 730 | 720 | 720 | 110 | 30 | |
| 160 GBytes | 705 | 765 | 700 | 755 | 115 | 30 | |
| 320 GBytes | 675 | 815 | 670 | 810 | 120 | 35 | |

⁶ The values are measured using Crystal Disk Mark 6.0.2. Performance depends on flash type and number, file/cluster size, and burst speed.

⁷ All values are the maximum recorded running IOMeter script for Read/Write operations with 1MB transfer size in 1 minute intervals at 25 °C, with nominal supply voltage and SATA transfer rate 6Gb/s.

4.3 Environmental Specifications

4.3.1 Recommended Operating Conditions

The recommended operating conditions for the X-76m SSD are provided in the following Table 5.

Table 5: Recommended Operating Conditions⁸

| Parameter | Value |
|--------------------------------------|-----------------|
| Commercial Operating Temperature | 0 °C to 70 °C |
| Industrial Operating Temperature | -40 °C to 85 °C |
| Power Supply V _{CC} Voltage | 3.3 V ± 5% |

4.3.2 Recommended Storage Conditions

The recommended storage conditions are listed in the following 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 in the following 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, 80-2,000 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) |

⁸ Adequate airflow is required to ensure the temperature, as reported in the S.M.A.R.T. data, does not exceed 110°C (industrial temperature drive) and 95°C (commercial temperature drive) respectively.

4.4 Regulatory Compliance

The X-76m devices comply with the directives and standards listed in the following Table 8.

Table 8: Regulatory Compliance

| Abbreviation | Regulation/ Standard |
|--------------|---|
| EMC | (EU) 2014/30 (FCC) 47 CFR Part 15 |
| RoHS | (EU) 2011/65/EU with 2015/863 and 2017/2102 |
| REACH | (EU) 1907/2006 and 207/2011 |
| WEEE | (EU) 2012/19 |

4.5 Mechanical Specifications

The X-76m 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 PCIe mini connector with a SATA interface. Physical dimensions are detailed in the following Table 9. Figure 3 on page 11 illustrates the X-76m dimensions.

Table 9: Physical Dimensions

| Physical Dimensions | | Unit |
|-----------------------|------------|------|
| Length | 50.80±0.15 | mm |
| Width | 29.85±0.15 | |
| Thickness (Max) | 3.80 | |
| Weight (Max Capacity) | ≤ 7.00 | g |

4.6 Reliability and Endurance

The Mean Time Between Failure (MTBF) is specified to exceed the value listed in the following Table 10. 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 (up to 40 °C) | 10 Years at Start (JESD47), 1 Year at EOL |

Endurance represented as both TeraBytes Written (TBW) and full Drive Writes Per Day (DWPD) for different application scenarios is provided in the following Table 11.

Table 11: Endurance^{9,10}

| Capacity | Sequential | | Client ¹ | | Enterprise | |
|------------|------------|--------------------|---------------------|--------------------|------------|--------------------|
| | TBW | DWPD ¹² | TBW | DWPD ¹² | TBW | DWPD ¹² |
| 10 GBytes | 326 | 29.74 | 158 | 14.48 | 85 | 7.76 |
| 20 GBytes | 660 | 30.13 | 345 | 15.78 | 145 | 6.61 |
| 40 GBytes | 1,308 | 29.86 | 760 | 17.35 | 332 | 7.58 |
| 80 GBytes | 2,631 | 30.03 | 1,680 | 19.25 | 637 | 7.28 |
| 160 GBytes | 5,255 | 29.99 | 3,790 | 21.63 | 1,090 | 6.25 |
| 320 GBytes | 10,524 | 30.03 | 7,950 | 22.69 | 2,070 | 5.91 |

4.7 Drive Geometry Specification

The X-76m drive geometry is set to report industry standard LBA settings per the IDEMA standard (LBA1-03). The values for each capacity are shown in the following Table 12.

Table 12: Drive Geometry

| Raw Capacity | User Capacity ¹³ | Total LBA | User Addressable Bytes |
|--------------|-----------------------------|-------------|------------------------|
| | | Decimal | (Unformatted) |
| 32 GBytes | 10 GBytes | 19,556,208 | 10,012,778,496 |
| 64 GBytes | 20 GBytes | 39,091,248 | 20,014,718,976 |
| 128 GBytes | 40 GBytes | 78,161,328 | 40,018,599,936 |
| 256 GBytes | 80 GBytes | 156,301,488 | 80,026,361,856 |
| 512 GBytes | 160 GBytes | 312,581,808 | 160,041,885,696 |
| 1024 GBytes | 320 GBytes | 625,142,448 | 320,072,933,376 |

⁹ Client and Enterprise workloads follow the JEDEC JESD219 standard. Enterprise workload values are measured based on 168 hours of runtime. 1 TByte = 10¹² bytes

¹⁰ According to JEDEC (JESD471), the time to write the full TBW is a minimum of 18 months. Higher average daily data volume reduces the specified TBW. The values listed are estimates and are subject to change without notice

¹¹ Because the JEDEC master trace file for the Client workload is designed for capacities ≥ 60 GBytes, the TBW and DWPD values for the capacities below 60 GBytes are estimates

¹² DWPD values are based on a service life of 3 years

¹³ 1 GByte = 10⁹ bytes

5. Electrical Interface

The mini-SATA connector is the same as the miniPCIe and eeePC card connector, but the pinout is specific to the mSATA interface. Swissbit mSATA SSDs follow the SATA specification, offering a maximum performance of 6 Gbit/s, and look much like mini-PCI-Express devices, but the two connectors are not inter-compatible. The signal/pin assignments and descriptions are listed in the following Table 13.

Figure 2: X-76m mSATA Electrical Interface

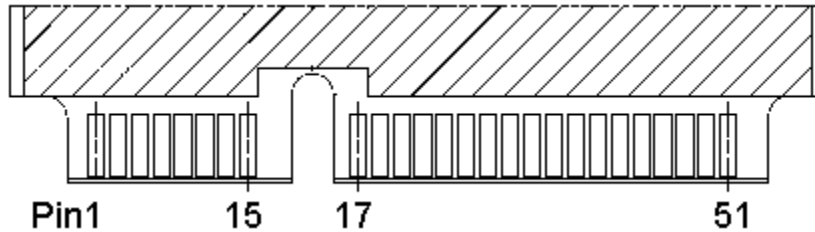


Table 13: Pin Assignment, Name and Description

| Description | Assignment | Pin | Pin | Assignment | Description |
|-------------------------------------|------------------------|-----|-----|------------|-----------------------------|
| No Connect | N/A | 1 | 2 | +3.3V | 3.3 V Source |
| No Connect | N/A | 3 | 4 | GND | Return Current Path |
| No Connect | N/A | 5 | 6 | +1.5V | No Connect |
| No Connect | N/A | 7 | 8 | N/A | No Connect |
| Return Current Path | GND | 9 | 10 | N/A | No Connect |
| No Connect | N/A | 11 | 12 | N/A | No Connect |
| No Connect | N/A | 13 | 14 | N/A | No Connect |
| Return Current Path | GND | 15 | 16 | N/A | No Connect |
| No Connect | N/A | 17 | 18 | GND | Return Current Path |
| No Connect | N/A | 19 | 20 | N/A | No Connect |
| Return Current Path | GND | 21 | 22 | N/A | No Connect |
| +SATA Differential Transmit Signal* | B+ | 23 | 24 | 3.3V | 3.3 V Source |
| -SATA Differential Transmit Signal* | B- | 25 | 26 | GND | Return Current Path |
| Return Current Path | GND | 27 | 28 | 1.5V | No Connect |
| Return Current Path | GND | 29 | 30 | N/A | No Connect |
| -SATA Differential Receive Signal* | A- | 31 | 32 | N/A | No Connect |
| +SATA Differential Receive Signal* | A+ | 33 | 34 | GND | Return Current Path |
| Return Current Path | GND | 35 | 36 | N/A | No Connect |
| Return Current Path | GND | 37 | 38 | N/A | No Connect |
| 3.3 V Source | 3.3V | 39 | 40 | GND | Return Current Path |
| 3.3 V Source | 3.3V | 41 | 42 | N/A | No Connect |
| Optional Return Current Path | NC | 43 | 44 | DEVSLP | Low Power Device Sleep Mode |
| No Connect | Reserved | 45 | 46 | N/A | No Connect |
| No Connect | Reserved ¹⁴ | 47 | 48 | +1.5V | No Connect |
| DEVACT Device Activity Signal | DAS/DSS ¹⁴ | 49 | 50 | GND | Return Current Path |
| Pulled to GND by Device | Presence Detection | 51 | 52 | 3.3V | 3.3 V Source |

*TX (transmit) and RX (receive) pins are labeled from the SSD view and must be connected with the reversed RX and TX signals of the host (i.e., TX to RX and RX to TX).

¹⁴ The write protect or quick erase option is available on this pin upon request

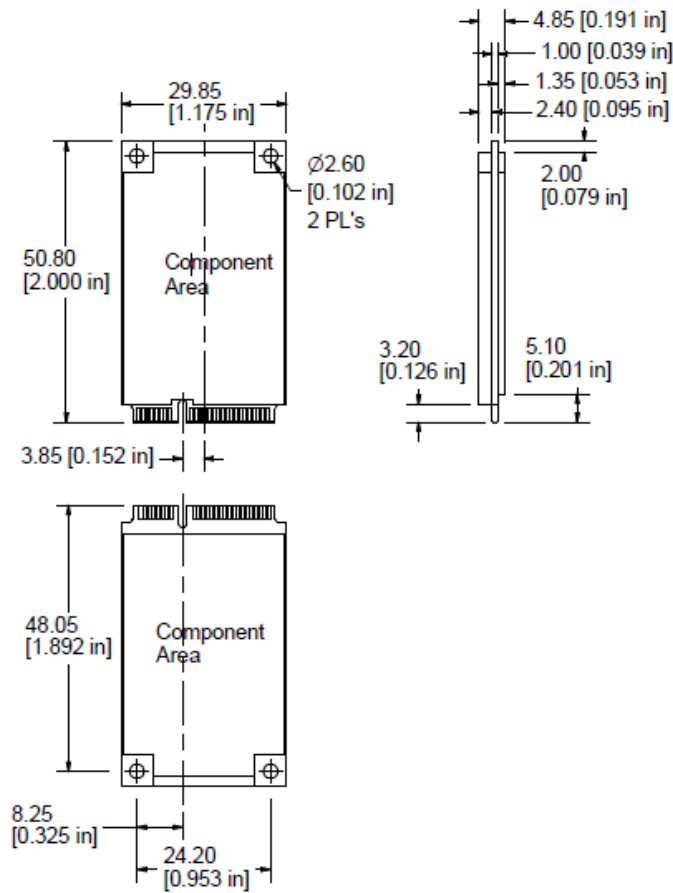
6. Package Mechanical

NOTE: The dimensions in the following figures are the maximum values based on the JEDEC standard. For the product dimensions, see the

| Abbreviation | Regulation/ Standard |
|--------------|---|
| EMC | (EU) 2014/30 (FCC) 47 CFR Part 15 |
| RoHS | (EU) 2011/65/EU with 2015/863 and 2017/2102 |
| REACH | (EU) 1907/2006 and 207/2011 |
| WEEE | (EU) 2012/19 |

Mechanical Specifications section on page 9.

Figure 3: X-76m 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 device 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 the following 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 |
| Read DMA | C8h | DMA |
| 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 |
| Write Buffer DMA | E9h | DMA |
| Download Microcode | 92h | PIO data-out |
| Download Microcode DMA | 93h | DMA |
| Power Management Feature Set | | |
| Check Power Mode | E5h | Non-data |
| Idle | E3h | Non-data |
| Idle Immediate | E1h | Non-data |
| Sleep | E6h | Non-data |
| Standby | E2h | Non-data |
| Standby Immediate | E0h | Non-data |
| Sanitize Feature Set | | |
| Sanitize | B4h | 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 Thresholds | Boh | PIO data-in |
| S.M.A.R.T. Return Status | Boh | Non-data |

| Command | Code | Protocol |
|--|---------|--------------|
| S.M.A.R.T. Save Attribute Values | Boh | Non-data |
| S.M.A.R.T. Write Log | Boh | PIO data-out |
| S.M.A.R.T. Write Thresholds | Boh | PIO data-out |
| 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 Log Ext | 2Fh | PIO data-in |
| Read Log DMA Ext | 47h | 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 |
| Trusted | | |
| Trusted Send | 5Eh | PIO data-out |
| Trusted Send DMA | 5Fh | DMA |
| Trusted Receive | 5Ch | PIO data-in |
| Trusted Receive DMA | 5Dh | DMA |
| Trusted (Non-Data) | 5Bh | Non-data |
| Others | | |
| Data Set Management | 06h | DMA |
| Seek | 70h-7Fh | Non-data |

8. Identify Device Information

The following Table 15 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) |
| 1 | 3FFFh | 2 | Default number of cylinders |
| 2 | C837h | 2 | Specific configuration |
| 3 | 0010h | 2 | Default number of heads |
| 4-5 | 0000h | 4 | Obsolete |
| 6 | 003Fh | 2 | Default number of sectors per track |
| 7-8 | 0000h | 4 | Number of sectors per drive (Word 7 = MSW, Word 8 = LSW) |
| 9 | 0000h | 2 | Obsolete |
| 10-19 | XXXX* | 20 | Serial number in ASCII (right-justified) |
| 20-22 | 0000h | 6 | Obsolete |
| 23-26 | XXXX* | 8 | Firmware revision in ASCII (big-endian byte order in Word) |
| 27-46 | XXXX* | 40 | Model number in ASCII (left-justified) |
| 47 | 8010h | 2 | Maximum number of sectors on Read/Write Multiple command |
| 48 | 0400h | 2 | Trusted Computing feature set |
| 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 | 3FFFh | 2 | Current numbers of cylinders |
| 55 | 0010h | 2 | Current numbers of heads |
| 56 | 003Fh | 2 | Current sectors per track |
| 57-58 | XXXXh | 4 | Current capacity in LBAs (Word 57 = LSW, Word 58 = MSW) |
| 59 | B110h* | 2 | Sanitize and 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 | 4D30h | 2 | CFast support |
| 70-74 | 0000h | 10 | Reserved |
| 75 | 001Fh | 1 | Queue depth |
| 76 | 850Eh | 2 | SATA capabilities |
| 77 | 0086h | 2 | Additional SATA capabilities |
| 78 | 017Ch | 2 | SATA feature support |
| 79 | 0040h* | 2 | SATA features enabled (host changeable) |
| 80 | 07FCh | 2 | Major revision |
| 81 | FFFFh | 2 | Minor revision |
| 82-84 | 746Bh* 7701h* 6163h* | 6 | Features/command sets supported |
| 85-87 | 7469h* B401h* 6163h* | 6 | Features/command sets enabled (host changeable) |
| 88 | 407F* | 2 | UDMA mode supported |

| Word(s) | Default Value | Total Bytes | Data Field Type Information |
|---------|----------------|-------------|--|
| 89 | 0002h* | 2 | Time for security erase unit completion |
| 90 | 0001h* | 4 | Time for enhanced security erase completion |
| 91 | 00FEh | 2 | Power Management |
| 92 | FFFEh* | 2 | Master password revision code |
| 93-99 | 0000h* | 14 | Reserved |
| 100-103 | XXXXh | 8 | Max user LBA48 address feature set |
| 104 | 0000h | 2 | Reserved |
| 105 | 0008h | 2 | Maximum number of 512-bytes blocks per Data Set Management command |
| 106 | 4000h | 2 | Sector size |
| 107-118 | 0000h | 24 | Reserved (WWN) |
| 119-120 | 401Ch 401Ch | 4 | Command set supported settings Command set features enabled (may change in operation) |
| 121-127 | 0000h | 14 | Reserved |
| 128 | 0021h* | 2 | Security status (may change in operation) |
| 129-159 | XXXXh | 62 | "Swissbit SSD" |
| 160 | 84Boh* | 2 | Power requirement |
| 161 | 8203h | 2 | CFast configuration |
| 162 | 0000h | 2 | Management schemes |
| 163 | 0000h | 2 | CF IDE Timing |
| 164 | 0000h | 2 | CF Timing |
| 165 | 8080h | 2 | CFast Operating Temperature Range |
| 166-167 | 0000h | 4 | Reserved |
| 168 | 0003h | 2 | Form Factor |
| 169 | 0001h | 2 | Data Set Management supported |
| 170-205 | XXXXh | 72 | Reserved |
| 206 | 003Dh | 2 | SCT Command Transport |
| 207-208 | 0000h | 4 | Reserved |
| 209 | 0400h | 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 | 10FFh | 2 | Transport major revision |
| 223-233 | 0000h | 22 | Reserved |
| 234 | 0002h | 2 | Minimum number of 512-byte units per segmented download |
| 235 | 0400h | 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-76m SSD fully supports the ATA Specification for Self-Monitoring, Analysis and Reporting Technology (S.M.A.R.T.).

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

The following Table 16 lists the supported S.M.A.R.T. subcommands and the Features register values. The device aborts any S.M.A.R.T. subcommands with Features register values not listed in Table 16.

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 |
| D8h | S.M.A.R.T. Enable Operations |
| D9h | S.M.A.R.T. Disable Operations |
| DAh | S.M.A.R.T. Return Status |

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 17 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 18) |
| 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 | 01h | Error logging capability |
| 371 | 00h | Vendor specific |
| 372 | 01h | Short self-test routine recommended polling time, in minutes |
| 373 | 02h | Extended self-test routine recommended polling time, in minutes |
| 374 | 01h | Conveyance self-test routine recommended polling time, in minutes |
| 375-510 | XXh | Reserved (vendor specific) |
| 511 | XXh | Data structure checksum |

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

Each attribute entry consists of 12 bytes. See the following Table 18 for the data structure of each entry.

Table 18: Attribute Entry

| Byte(s) | Value | Description |
|---------|-------|---------------------------------|
| 0 | XXh | Attribute ID (see Table 19) |
| 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 |

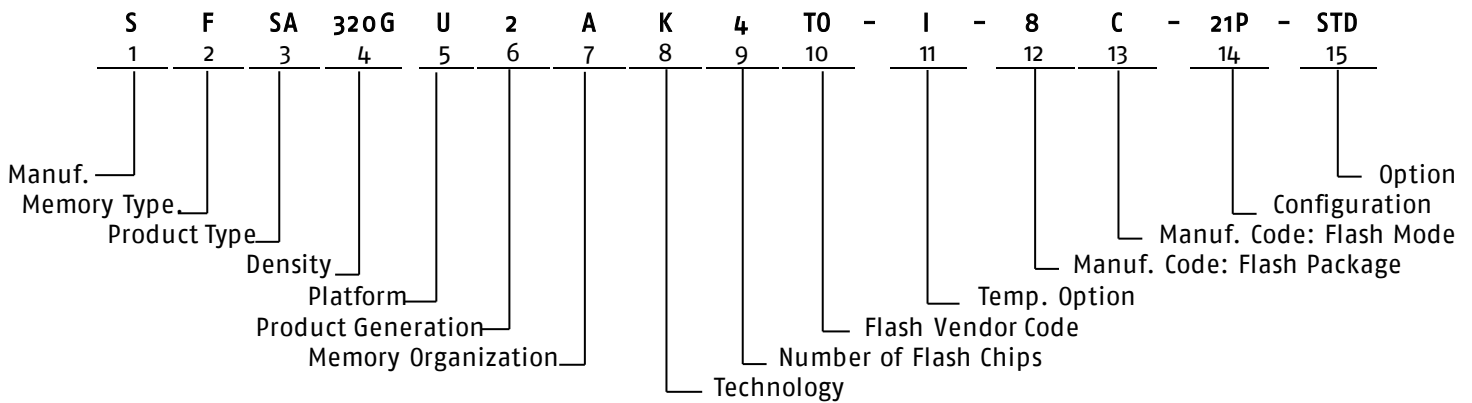
9.4 S.M.A.R.T. Attributes

The X-76m drives support the S.M.A.R.T. attributes listed in the following Table 19.

Table 19: S.M.A.R.T. Attributes

| ID | Threshold | Attribute | Description |
|------|-----------|------------------------------------|--|
| 0x01 | 0 | Read Error Rate | CRC Error count/total LBAs read |
| 0x05 | 0 | Reallocated Sectors Count | Total number of runtime bad blocks (physical blocks) |
| 0x09 | 0 | Power On Hours | Total number of hours the device has had power applied since the date of manufacturer |
| 0x0C | 0 | Power Cycle Count | Total number of power cycles the device encountered |
| 0x10 | 1 | Average Erase Count (pSLC) | Average Erase Count on pSLC blocks |
| 0x11 | 0 | Rated Erase Count (pSLC) | Rated Erase Count on pSLC blocks |
| 0xA0 | 0 | Uncorrectable Sector Count On Line | Read/Write Uncorrectable Sector Count |
| 0xA1 | 0 | Spare Block Count | Number of available spare blocks |
| 0xA3 | 0 | Number of Initial Invalid Blocks | Number of initial invalid blocks |
| 0xA4 | 0 | Total Erase Count | Total Erase Count on all blocks |
| 0xA5 | 0 | Maximum Erase Count | Maximum Erase Count on a single block |
| 0xA6 | 0 | Minimum Erase Count | Minimum Erase Count on a single block |
| 0xA7 | 0 | Average Erase Count | Average Erase Count on data storage blocks |
| 0xA8 | 0 | Rated Erase Count | Rated Erase Count on data storage blocks |
| 0xA9 | 0 | Power On Uncorrectable Error Count | Number of uncorrectable errors encountered during a power up event |
| 0xC1 | 0 | Dynamic Remaps | Total number of remap operations |
| 0xC2 | 0 | Temperature | On-chip temperature sensor value (degrees Celsius) |
| 0xC3 | 0 | Flash ECC recovered | Total number of times the device required the read-retry process to recover data |
| 0xC4 | 0 | Reallocation Event Count | Uncorrectable error count |
| 0xC6 | 0 | Reported Uncorrectable Errors | Total uncorrectable count when off-line |
| 0xC7 | 0 | SATA PHY CRC Error Count | Host Interface CRC Error |
| 0xD7 | 0 | TRIM Count | Total number of times the host has issued the TRIM command |
| 0xE7 | 25 | Life Remaining | Percentage of flash life remaining based on the number of spare blocks remaining |
| 0xEB | 0 | Total Flash LBAs Written | Total number of flash sectors written (in 512-byte increments) |
| 0xED | 0 | Total Flash LBAs Written, Expanded | Total number of flash sectors written, expanded (in 512-byte increments) |
| 0xF1 | 0 | Total Host LBAs Written | Total number of host sectors written (in 512-byte increments) |
| 0xF2 | 0 | Total Host LBAs Read | Total number of host sectors read (in 512-byte increments) |
| 0xF3 | 0 | Total Host LBAs Written, Expanded | The upper 5 bytes of the total number of host sectors written (in 512-byte increments) |
| 0xF4 | 0 | Total Host LBAs Read, Expanded | The upper 5 bytes of the total number of host sectors read (in 512-byte increments) |
| 0xF8 | 1 | SSD Remaining Life | Percent of flash life remaining based upon the number of P/E cycles consumed |

10. Part Number Decoder



10.1 Manufacturer

| | |
|---------------|---|
| Swissbit code | S |
|---------------|---|

10.2 Memory Type

| | |
|-------|---|
| Flash | F |
|-------|---|

10.3 Product Type

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

10.4 Density

| | |
|------------|------|
| 10 GBytes | 010G |
| 20 GBytes | 020G |
| 40 GBytes | 040G |
| 80 GBytes | 080G |
| 160 GBytes | 160G |
| 320 GBytes | 320G |

10.5 Platform

| | |
|-----------|---|
| mSATA SSD | U |
|-----------|---|

10.6 Product Generation

10.7 Memory Organization

| | |
|----|---|
| x8 | A |
|----|---|

10.8 Technology

| | |
|--------------|---|
| X-76m Series | K |
|--------------|---|

10.9 Number of Flash Chips

| | |
|---------|---|
| 1 Flash | 1 |
| 2 Flash | 2 |
| 4 Flash | 4 |

10.10 Flash Code

| | |
|------------------|----|
| Toshiba / Kioxia | T0 |
|------------------|----|

10.11 Temperature Option

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

10.12 Die Classification

| | |
|----------------------------------|---|
| 3D TLC MONO (single die package) | 5 |
| 3D TLC DDP (dual die package) | 6 |
| 3D TLC QDP (quad die package) | 7 |
| 3D TLC ODP (octal die package) | 8 |

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 Octal R/nB | * | V |
| Sexdec nCE & Sexdec R/nB | * | W |

*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 |
|------------------------------|---|
| SBR15002 (\leq 80 GBytes) | 1 |
| TBD (\geq 160 GBytes) | 1 |

Z = Feature

| Feature | Z |
|---------|---|
| pSLC | P |

10.15 Option

| | |
|----------|-----|
| Standard | STD |
|----------|-----|

11. Swissbit M.2 SATA SSD Marking Specification

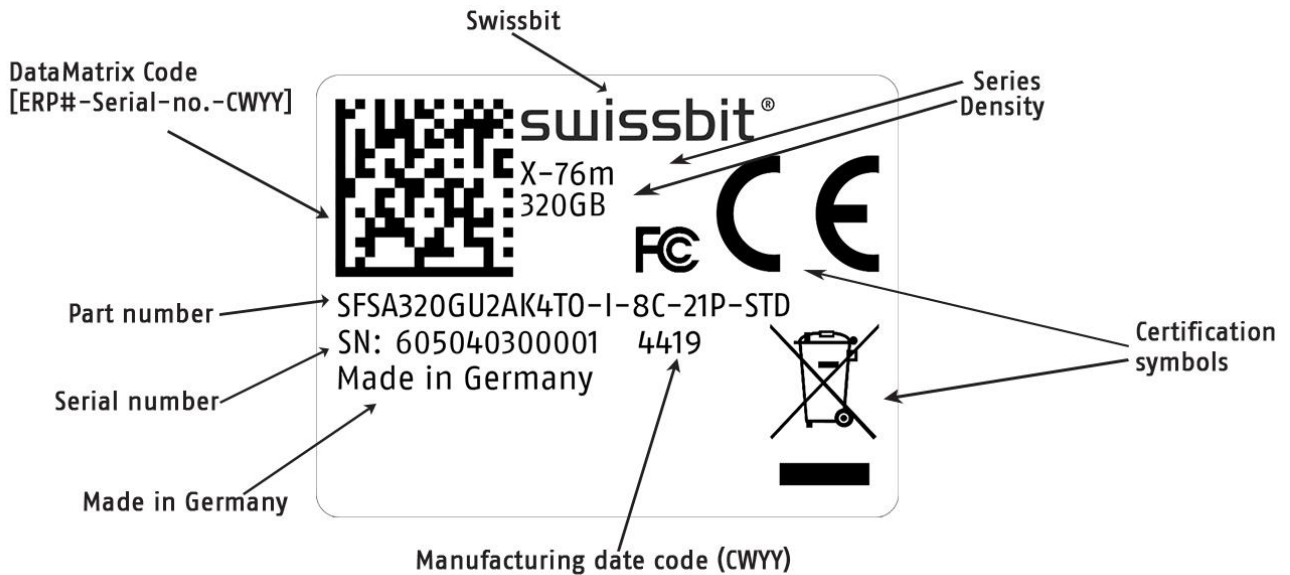
11.1 Top View

Figure 4: X-76m top view



11.2 Print on the label

Figure 5: X-76m label details



12. Revision History

Table 20: Document Revision History

| Date | Revision | Description | Revision Details |
|-------------|----------|--|--------------------|
| 31-Oct-2019 | 0.90 | Preliminary draft. | Doc. req. no. 3248 |
| 05-Mar-2020 | 1.00 | Initial release. | Doc. req. no. 3504 |
| 15-Apr-2020 | 1.01 | Added sequential endurance values. Added 160GB and 320GB part numbers. | Doc. req. no. 3599 |
| 22-Jan-2021 | 1.02 | Updated footnotes, regulatory table, and feature icons. | Doc. req. no. 4330 |

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