

swissbit®

Product Data Sheet

**Industrial
CFast™ Card**

F-60 Series

SATA Gen3 - 6.0 Gbit/s, MLC

Commercial and Industrial
Temperature Grade

durabit™

“the better MLC”



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F-60 Series – Industrial CFast™ Solid State Drive

8 GBytes up to 240 GBytes

1. Product Summary

- **Capacities:** 8 GBytes, 16 GBytes, 30 GBytes, 60 GBytes, 120 GBytes, 240 GBytes
- **Form Factor:** CFast-Sized Solid State Drive (36.4 mm x 42.8 mm x 3.6 mm)
- **Compliance:** SATA Gen3 – 6 Gbit/s (Gen2 – 3 Gbit/s and Gen1 – 1.5 Gbit/s backward compatible)
- **CFast 2.0 Compatible**
- **Command Sets:** Supports ATA/ATAPI-8 and ACS-2
- **High Performance:**
 - Burst Transfer Rate: Up to 600 MBytes/s in SATA Gen3 – 6.0 Gbit/s
 - Read Performance: Sequential Read up to 520 MBytes/s, Random Read 4K up to 72,000 IOPS
 - Write Performance: Sequential Write up to 180 MBytes/s, Random Write 4K up to 43,000 IOPS
- **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:** 3.3V ± 5%
- **Power (Max Capacity):**
 - Read (Active): 1.3 W
 - Write (Active): 1.6 W
 - Idle: 363 mW
 - Slumber: 115 mW
- **Data Retention:** 10 Years @ Life Begin; 1 Year @ Life End
- **Endurance:** TeraBytes Written (TBW) @ Max Capacity²
 - Client > 540
 - Embedded > 145
 - Enterprise > 135
- **Shock/Vibration:** 1,500 *g* / 50 *g*
- **High-Performance 32-Bit Processor with Integrated, Parallel Flash Interface Engines:**
 - Multi-Level Cell (MLC) 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 temperature, as reported in the S.M.A.R.T. data, does not exceed 115°C (industrial temperature drive) and 100°C (commercial temperature drive) respectively.

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

- Best-in-Class Performance and Endurance with **durabit™** Technology
- Dynamic and Static Wear Leveling
- Subpage 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
- DEVSLP Compatible
- In-Field Firmware Update
- Enterprise-Grade Self-Monitoring, Analysis, and Reporting Technology (S.M.A.R.T.)
- Life Cycle Management
- Controlled "Locked" BOM
- RoHS-6 Compliant
- AES256 Encryption (on request)
- 30 µinch Gold-Plated Connector (on request)
- Swissbit Life Time Monitoring (SBLTM) Tool and SDK for SBLTM (on request)



3. Ordering Information

Table 1: Standard Product List

| Capacity | Part Number |
|------------|------------------------------|
| 8 GBytes | SFCA008GHxAA1T0-t-GS-2y6-STD |
| 16 GBytes | SFCA016GHxAA2T0-t-GS-2y6-STD |
| 30 GBytes | SFCA030GHxAA2T0-t-GS-2y6-STD |
| 60 GBytes | SFCA060GHxAA2T0-t-LB-2y6-STD |
| 120 GBytes | SFCA120GHxAA2T0-t-HC-2y6-STD |
| 240 GBytes | SFCA240GHxAA2T0-t-OC-2y6-STD |

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

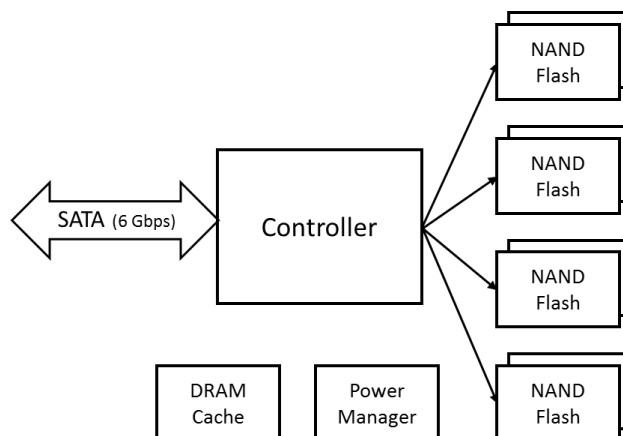
Table 2: Part Numbers Available for Ordering

| FW SBR11015 | | |
|-------------|------------------------------|------------------------------|
| Capacity | Commercial Temperature | Industrial Temperature |
| | Part Number | Part Number |
| 8 GBytes | SFCA008GH1AA1T0-C-GS-216-STD | SFCA008GH1AA1T0-I-GS-216-STD |
| 16 GBytes | SFCA016GH1AA2T0-C-GS-216-STD | SFCA016GH1AA2T0-I-GS-216-STD |
| 30 GBytes | SFCA030GH1AA2T0-C-GS-216-STD | SFCA030GH1AA2T0-I-GS-216-STD |
| 60 GBytes | SFCA060GH1AA2T0-C-LB-216-STD | SFCA060GH1AA2T0-I-LB-216-STD |
| 120 GBytes | SFCA120GH1AA2T0-C-HC-216-STD | SFCA120GH1AA2T0-I-HC-216-STD |
| 240 GBytes | SFCA240GH1AA2T0-C-OC-216-STD | SFCA240GH1AA2T0-I-OC-216-STD |
| FW SBR12055 | | |
| Capacity | Commercial Temperature | Industrial Temperature |
| | Part Number | Part Number |
| 8 GBytes | SFCA008GH3AA1T0-C-GS-226-STD | SFCA008GH3AA1T0-I-GS-226-STD |
| 16 GBytes | SFCA016GH3AA2T0-C-GS-226-STD | SFCA016GH3AA2T0-I-GS-226-STD |
| 30 GBytes | SFCA030GH3AA2T0-C-GS-226-STD | SFCA030GH3AA2T0-I-GS-226-STD |
| 60 GBytes | SFCA060GH3AA2T0-C-LB-226-STD | SFCA060GH3AA2T0-I-LB-226-STD |
| 120 GBytes | SFCA120GH3AA2T0-C-HC-226-STD | SFCA120GH3AA2T0-I-HC-226-STD |
| 240 GBytes | SFCA240GH3AA2T0-C-OC-226-STD | SFCA240GH3AA2T0-I-OC-226-STD |

4. Product Description

The Swissbit® F-60 Solid State Drive (SSD) leverages the CFast 2.0 compatible, industry-standard form factor and connectivity. Combined with a SATA Gen3 controller and Multi-Level Cell (MLC) NAND flash technology, the F-60 realizes a robust non-volatile storage solution for today's embedded storage applications. A functional block diagram of the F-60 SSD is provided below in Figure 1.

Figure 1: F-60 CFast Functional Block Diagram



The F-60 SSD incorporates two existing industry standards into a single product: the CompactFlash™ (CF) card form factor and the Serial ATA (SATA) interface commonly used with hard disk drives (HDDs) and SSDs. The interface consists of a female 7-pin SATA data connector and a female 17-pin power connector. Because standard SATA hard drives use male connectors, an adaptor is required to replace drives with CFast cards. CFast cards can be used to replace HDDs, SSDs, and Compact Flash™ cards in applications requiring smaller form factors, high endurance, and the ability to withstand shock, vibration, extreme temperatures (-40 °C to 85 °C), high altitude, and rough environmental conditions. The Swissbit CFast™ cards 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 supports 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 an ARC 700 processing core, providing an optimum balance between read/write performance, Data Care Management, and power fail protection.

Swissbit's **durabit™** F-60 CFast cards deliver an impressive IOPS rate and highest endurance by combining MLC flash technology with a high-end controller architecture, firmware, and an optimized configuration. The **durabit™** SSDs are designed for applications requiring high data transfer rates high data transfer rates (see Table 3: Read/Write Performance (SBR11015 and SBR12055)). This performance is achieved through an on-board DRAM cache and the controller 4-channel NAND flash interface that supports ONFI and Toggle 2 (400 MT/s) interface speeds. In addition, the F-60 series feature Swissbit's proven power fail safety and support for the ATA security feature set, 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 F-60 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 insure 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 insure 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.

Related Documentation

- CFast Specification 2.0 (<http://www.compactflash.org>)
- 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 F-60 sequential/random, read/write I/O performance benchmarks are detailed below in Table 3.

Table 3: Read/Write Performance³ (SBR11015 and SBR12055)

| Capacity | Sequential Read (MBPS) | Sequential Write (MBPS) | Random Read 4K (IOPS) | Random Write 4K (IOPS) |
|------------|------------------------|-------------------------|-----------------------|------------------------|
| 8 GBytes | 145 | 25 | 14,000 | 6,500 |
| 16 GBytes | 280 | 55 | 26,500 | 13,000 |
| 30 GBytes | 280 | 50 | 26,500 | 11,500 |
| 60 GBytes | 520 | 90 | 51,000 | 23,000 |
| 120 GBytes | 520 | 180 | 72,000 | 43,000 |
| 240 GBytes | 520 | 180 | 72,000 | 43,000 |

4.2 Current Consumption

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

Table 4: Current Consumption (SBR11015 and SBR12055)⁴

| Drive Capacity | Sequential Read | Sequential Write | Random Read 4K | Random Write 4K | Idle | Slumber | Unit |
|----------------|-----------------|------------------|----------------|-----------------|------|---------|------|
| 8 GBytes | 205 | 210 | 200 | 210 | 95 | 35 | mA |
| 16 GBytes | 250 | 255 | 240 | 255 | 100 | 35 | |
| 30 GBytes | 265 | 265 | 255 | 265 | 105 | 35 | |
| 60 GBytes | 365 | 370 | 330 | 365 | 110 | 35 | |
| 120 GBytes | 380 | 485 | 355 | 485 | 110 | 35 | |
| 240 GBytes | 390 | 495 | 360 | 495 | 110 | 35 | |

³ 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.

⁴ 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 F-60 SSD are provided in Table 5 below.

Table 5: Recommended Operating Conditions⁵

| 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 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, 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) |

⁵ Adequate airflow is required to ensure the temperature, as reported in the S.M.A.R.T. data, does not exceed 115°C (industrial temperature drive) and 100°C (commercial temperature drive) respectively.

4.4 Regulatory Compliance

The F-60 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, 2004/30/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 F-60 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 female 7-pin SATA data connector and a female 17-pin power connector. Because standard SATA hard drives use male connectors, an adaptor is required to replace drives with CFast cards. Physical dimensions are detailed in Table 9 below. Figure 3 on page 12 illustrates the F-60 dimensions and connector location.

Table 9: Physical Dimensions

| Physical Dimensions | | Unit |
|-----------------------|------------|------|
| Length | 36.40±0.15 | mm |
| Width | 42.80±0.10 | |
| Thickness (Max) | 3.60 | |
| Weight (Max Capacity) | 10 | 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: Endurance⁶

| Drive Capacity | Client ⁷ | | Enterprise | | Embedded | |
|----------------|---------------------|-------------------|------------|-------------------|----------|-------------------|
| | TBW | DWPD ⁸ | TBW | DWPD ⁸ | TBW | DWPD ⁸ |
| 8 GBytes | 16.93 | 1.98 | 4.36 | 0.51 | 4.69 | 0.55 |
| 16 GBytes | 33.87 | | 8.72 | | 9.38 | |
| 30 GBytes | 67.74 | | 17.44 | | 18.75 | |
| 60 GBytes | 135.48 | | 34.88 | | 37.50 | |
| 120 GBytes | 270.95 | | 69.76 | | 75.00 | |
| 240 GBytes | 541.91 | | 139.52 | | 150.00 | |

4.7 Drive Geometry Specification

The F-60 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

| Drive Capacity | User Capacity ⁹ | Total LBA | User Addressable Bytes |
|----------------|----------------------------|-------------|------------------------|
| | | Decimal | (Unformatted) |
| 8 GBytes | 7.5 GBytes | 14,672,448 | 7,512,293,376 |
| 16 GBytes | 15 GBytes | 29,323,728 | 15,013,748,736 |
| 32 GBytes | 30 GBytes | 58,626,288 | 30,016,659,456 |
| 64 GBytes | 60 GBytes | 117,231,408 | 60,022,480,896 |
| 128 GBytes | 120 GBytes | 234,441,648 | 120,034,123,776 |
| 256 GBytes | 240 GBytes | 468,862,128 | 240,057,409,536 |

⁶ 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.

⁷ 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

⁸ DWPD values are based on a service life of 3 years

⁹ 1 GByte = 10⁹ bytes

5. Electrical Interface

The CFast card is connected with a standard 7-pin SATA connector and a standard 17-pin power connector. The signal/pin assignments and descriptions are listed in Table 13.

Figure 2: F-60 CFast Connector

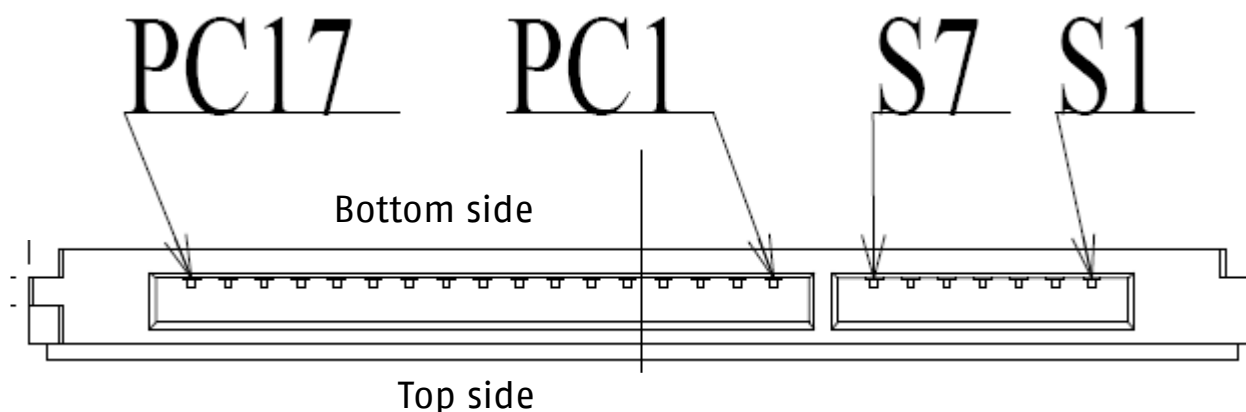


Table 13: Pin Assignment, Name, and Description

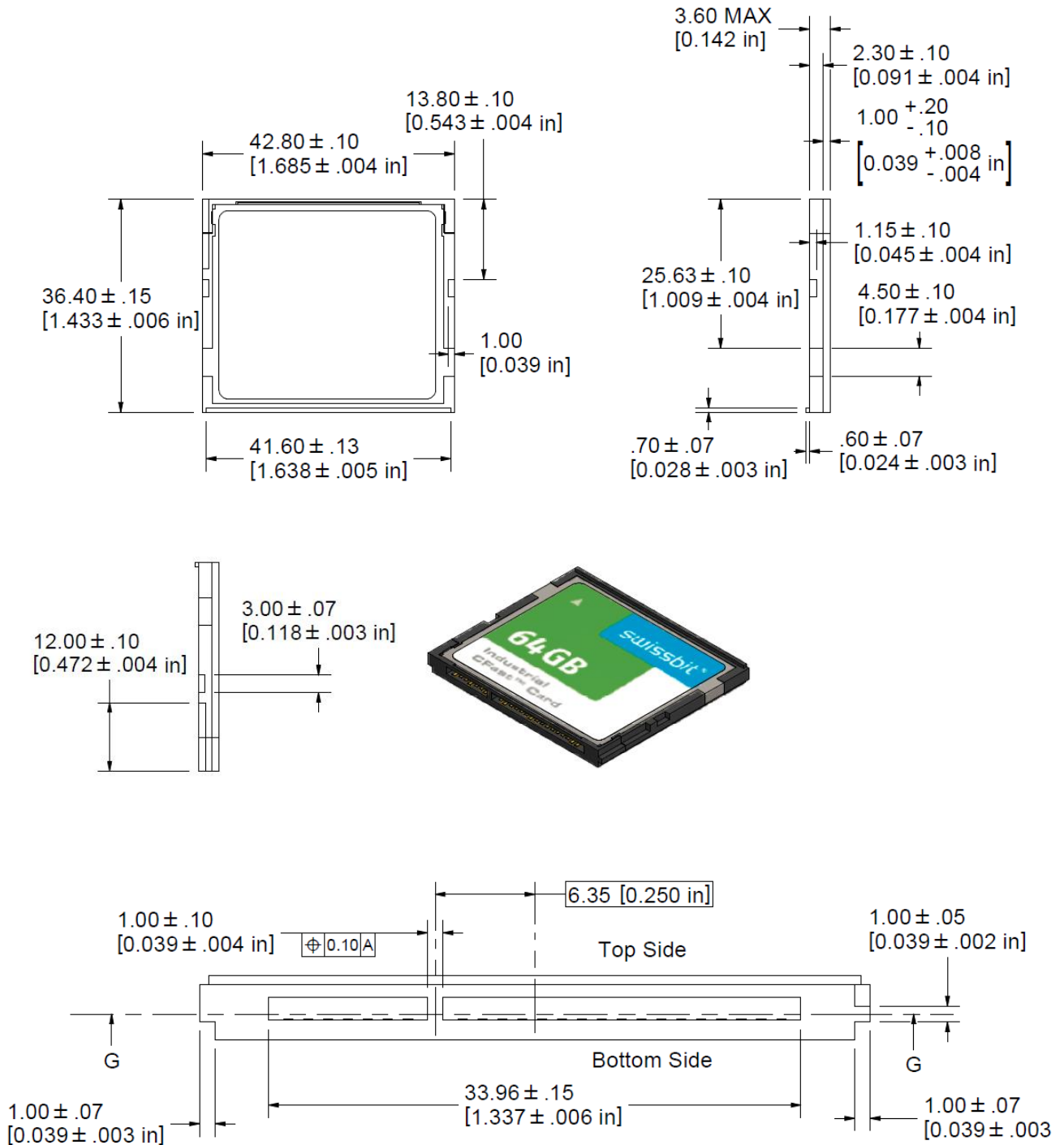
| Pin | Signal Name | Description |
|-----------|-------------------|---------------------------------------|
| S1 | SGround | Signal Ground |
| S2 | A+ | + Differential Device Transmit Signal |
| S3 | A- | - Differential Device Transmit Signal |
| S4 | SGround | Signal Ground |
| S5 | B- | - Differential Device Receive Signal |
| S6 | B+ | + Differential Device Receive Signal |
| S7 | SGround | Signal Ground |
| | | |
| PC1 | CDI ¹⁰ | Card Detect In |
| PC2 | PGround | Power Ground |
| PC3 | DEVSLP | DEVSLP Input |
| PC4-PC6 | NC | No Connect |
| PC7 | PGround | Power Ground |
| PC8 | LED1 | Reserved |
| PC9 | LED2 | Reserved |
| PC10-PC11 | | Reserved |
| PC12 | IFDet | Card Output, Connected to GND |
| PC13-PC14 | 3.3 V | Device Power 3.3 V |
| PC15-PC16 | PGround | Power Ground |
| PC17 | CDO ¹⁰ | Card Detect Out |

¹⁰ CDI and CDO are physically shorted together in the device. The CDO logic state shall follow the CDI logic state whether the device is powered up or not.

6. Package Mechanical

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

Figure 3: CFast 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 | B0h | Non-data |
| S.M.A.R.T. Enable/Disable Autosave | B0h | Non-data |
| S.M.A.R.T. Enable Operations | B0h | Non-data |
| S.M.A.R.T. Execute OFF-LINE Immediate | B0h | Non-data |
| S.M.A.R.T. Read Data | B0h | PIO data-in |
| S.M.A.R.T. Read Log | B0h | PIO data-in |
| S.M.A.R.T. Read Threshold | B0h | PIO data-in |
| S.M.A.R.T. Return Status | B0h | Non-data |
| S.M.A.R.T. Save Attribute Values | B0h | Non-data |
| S.M.A.R.T. Write Attribute Values | B0h | Non-data |
| S.M.A.R.T. Write Log | B0h | 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 Data

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 | XXXX* | 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* 0000h* | 2 | Multiword DMA transfer support modes 2, 1, and 0 Multiword DMA not supported |
| 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 microcode DMA, write/read Buffer DMA, deterministic read after TRIM |
| 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 | 03F0h | 2 | Major revision |
| 81 | 0000h | 2 | Minor revision |
| 82 -84 | 746Bh* 7701h* 4063h* | 6 | Features/command sets supported |
| 85-87 | 7469h* 7469h* 4063h* | 6 | Features/command sets enabled (may change in operation) |
| 88 | 407Fh* | 2 | UDMA mode supported |
| 89 | 0002h* | 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 |

| Word(s) | Default Value | Total Bytes | Data Field Type Information |
|---------|----------------|-------------|--|
| 93-99 | 0000h* | 14 | Reserved |
| 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 4018h | 4 | Command set supported settings Command set features enabled |
| 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 F-60 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 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 |
| 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 F-60 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 32 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 32 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.

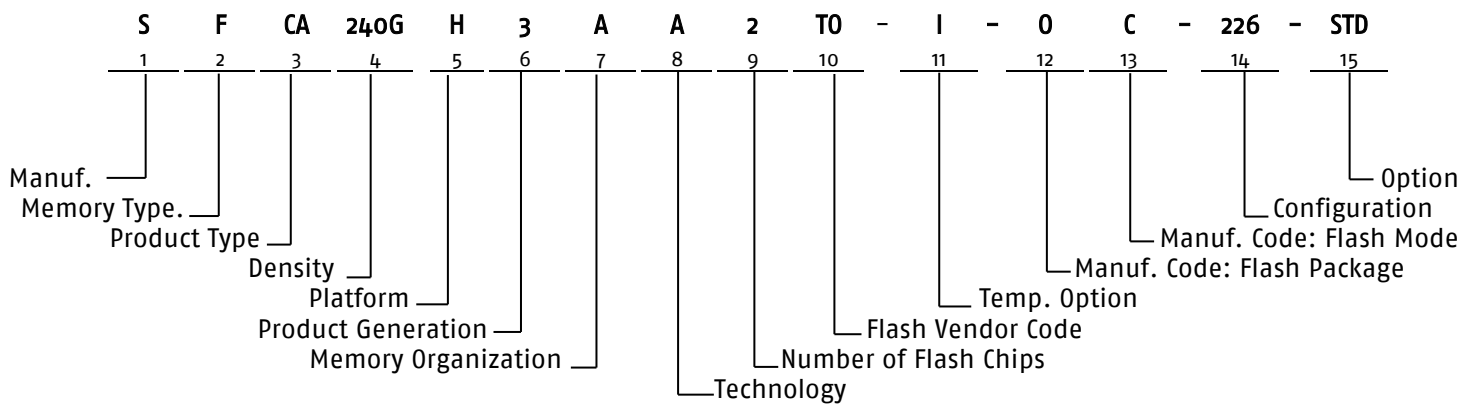
9.4 S.M.A.R.T. Attribute Entry Structure

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 |
|---------------|---|

10.2 Memory Type

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

10.3 Product Type

| | |
|-----------------|----|
| CFast Interface | CA |
|-----------------|----|

10.4 Density

| | |
|------------|------|
| 8 GBytes | 008G |
| 16 GBytes | 016G |
| 30 GBytes | 030G |
| 60 GBytes | 060G |
| 120 GBytes | 120G |
| 240 GBytes | 240G |

10.5 Platform

| | |
|-----------|---|
| CFast SSD | H |
|-----------|---|

10.6 Product Generation

10.7 Memory Organization

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

10.8 Technology

| | |
|-------------|---|
| F-60 Series | A |
|-------------|---|

10.9 Number of Flash Chips

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

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

| | |
|-------------------------------|---|
| MLC MONO (single die package) | G |
| MLC DDP (dual die package) | L |
| MLC QDP (quad die package) | H |
| MLC ODP (octal die package) | O |

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 | * | 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 |
|-------------|---|
| SBR11015 | 1 |
| SBR12055 | 2 |

Z = Feature

| Feature | Z |
|----------|---|
| Standard | 6 |

10.15 Option

| | |
|-------------------|-----|
| Swissbit/Standard | STD |
|-------------------|-----|

11. Swissbit CFast SSD Marking Specification

11.1 Top View



11.2 Bottom View



11.3 Label Content

- Swissbit Logo
- CFast Logo
- Part Number
- Lot Code information with Bar Code
- CE Logo
- RoHS Logo
- WEEE Logo
- Manufacturing Date
- Country of Origin

12. Revision History

Table 20: Document Revision History

| Date | Revision | Description | Revision Details |
|-------------|----------|---|--------------------|
| 25-Aug-2015 | 090 | First preliminary update. | |
| 26-Aug-2015 | 091 | Updated some performance and current numbers, cosmetics, pin assignments, CDII/CDO details, Power Management, and LED/IO chapter removed. | |
| 27-Aug-2015 | 092 | PHYSLP references removed and all ECC references set to 42bits/1KB. | |
| 27-Aug-2015 | 093 | Added Embedded Endurance workload numbers. Some table numbering. Adding 8GB everywhere. | |
| 28-Aug-2015 | 094 | Added 8GB in Available Standard part types and made 30GB TSOP based. | |
| 2-Sept-2015 | 1.00 | Initial release | |
| 28-Oct-2015 | 1.01 | Updated product features icon, RoHS, ACPEIP and WEEE declaration and changed formatting. | Doc. req. no. 0813 |
| 4-Jan-2016 | 1.02 | Updated Identify Device and S.M.A.R.T. information. Removed ATA command byte structures. Updated performance and current values. Added slumber current. Added Write Thresholds command. Added DEVSLP compatible to list of features. Updated the storage temperature. Updated copyright date. | Doc. req. no. 0911 |
| 22-Mar-2016 | 1.03 | Added JEDEC information for endurance workloads. Added FUA command support. Added durabit information. Added regulatory information. | Doc. req. no 1022 |
| 27-Jun-2016 | 1.04 | Added available part number table and footnote regarding TBW. | Doc. req. no 1147 |
| 31-Aug-2016 | 1.05 | Fixed typo. | Doc. req. no. 1250 |
| 4-Nov-2016 | 1.06 | Corrected endurance values and updated mechanical drawing. | Doc. req. no. 1353 |
| 23-Jan-2019 | 1.07 | Added new PN's for FW2 12055, updated endurance values, part-number decoder (pin mode) and sections to meet standard datasheet review criteria. | Doc. req. no. 2741 |
| 22-Oct-2019 | 1.08 | Minor information and formatting changes | Doc. req. no. 3230 |

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