



# SMART Storage Products

## SMART Modular Xcel-100 2.5" SATA Solid State Drive



March 2011, Rev B  
PN: 810100030-1N





### **ESD Caution – Handling**

Static electricity may be discharged through this disk subsystem. In extreme cases, this may temporarily interrupt the operation or damage components. To prevent this, make sure you are working in an ESD-safe environment. For example, before handling the disk subsystem, touch a grounded device, such as a computer case, prior to handling.

### **Preliminary Notice**

This document is in the preliminary stage and is subject to change.

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One gigabyte, or GByte, equals one billion bytes when referring to drive capacity. Accessible capacity may vary based on the operating environment and drive formatting.



America

## REVISION HISTORY

Date	Revision	Section(s)	Description
Mar 2011	A	All	Initial Document.
Mar 2011	B	Table 6 Table 13 - 17  Table 19	Updated the Weight parameter and value information. Corrected and updated supported ATA Commands and SMART information in the tables.  Provided a description for the Grown Defect List and removed reference to Device Information log as it is not supported.

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**PRODUCT SPECIFICATION**


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## 2.0 GENERAL DESCRIPTION

### 2.1 Overview

SMART is a leading independent manufacturer of memory module and solid state storage products, inclusive of board-level through systems-level design, manufacturing, test, and fulfillment services. SMART offers more than 500 standard and custom products to leading OEMs in the computer, defense, industrial, networking, and telecommunications industries, worldwide.

The SMART Modular Xcel-100 SATA 2.5" solid state drive (SSD) is designed to meet the high performance, superior reliability, and low power consumption demands of mission critical computing applications. Maximizing the bandwidth limits of the SATA 3 Gbps interface, Xcel-100 SATA 2.5" SSDs deliver up to 250 MBytes/s sequential read/write performance and up to 30,000 random input/output operations per second (IOPS). To accommodate a variety of applications, the Xcel-100 SATA drives are available with Single Level Cell (SLC) flash in capacities from 50 to 200 GBytes. All versions operate within the industrial temperature range (-40 to +85 °C).

The Xcel-100 SATA 2.5" SSD provides industry-leading error-correction and detection capabilities, multi-level data path and code protection, Data Fail Recovery, and Data Integrity Monitoring, resulting in high reliability and data integrity, and are designed to fit the restricted power envelope of mission critical storage environments. Comprehensive diagnostic tools are also provided through drive-specific Self-Monitoring and Analysis Reporting Technology (S.M.A.R.T.) attributes.

Utilizing the latest Industrial Grade SLC NAND flash memory, the Xcel-100 SATA 2.5" SSD offers superior endurance when compared to MLC-based SSDs in industrial temperature environments. The Xcel-100 2.5" SATA SSD is the solution of choice for ruggedness, shock resistance, environmental resilience, and performance in no-compromise applications.

SMART has built its foundation by providing proven technology and quality products for the most demanding defense applications worldwide. SMART engineers its products to perform at the highest degree of reliability and compatibility while backing these products with outstanding services and technology expertise.



## 2.2 Features

- **Type:** 2.5" flash-based SATA SSD
- **Interface:** Compatible with the SATA 2.6 standard, fixed frequency.
- **Supported SATA Modes**
  - ◆ **PIO Modes:** 0-4
  - ◆ **Multiword DMA Modes:** 0-2
  - ◆ **Ultra DMA Modes:** 0-6
- **SATA Interface Transfer Rate:** 3 Gbps with support for 1.5 Gbps
- **Capacities:** 50 GBytes to 200 GBytes
- **Data Rates**
  - ◆ **Read/Write, Sustained:** Up to 250 MBytes/sec<sup>1</sup>
  - ◆ **Read/Write, Random:** Up to 30,000 IOPS<sup>2</sup>
- **Access Time:** <100 usec
- **Seek Time:** 0 msec
- **Superior Flash Management**
  - ◆ 12 Symbols per 512-byte block of ECC/EDC (Reed Solomon)
  - ◆ Data Fail Recovery
  - ◆ Static Wear Leveling
  - ◆ Bad Block Management
- **Operating Temperature:** -40 °C to +85 °C
- **Compliance**
  - ◆ RoHS
  - ◆ Halogen-Free
- **Warranty:** 3 years

<sup>1</sup> Based on 128 KByte transfer size.

<sup>2</sup> Based on 4 KByte transfer size using Iometer 2008.

### 2.3 Unique Features

- Native Command Queuing (NCQ) with a Queue Depth of 32
- Drive-Specific S.M.A.R.T. Attributes
- Advanced Encryption Standard (AES) 128-Bit Encryption
- Full Data Path Protection
- Data Integrity Monitoring
- Power Fail Recovery
- ATA-7 Security Erase Support
- 48-Bit LBA Address Support with Larger Maximum Transfer Size
- External LED Activity Support



## 2.4 Operational Characteristics

All listed values are typical unless otherwise stated.

### 2.4.1 Performance

**Table 1:** Performance Characteristics

Item	Estimated Performance
Sustained Sequential Read (Maximum)	Up to 250 MBytes/sec <sup>3</sup>
Sustained Sequential Write (Maximum)	Up to 250 MBytes/sec <sup>4</sup>
Sustained Random Read IOPS (Maximum)	Up to 30,000 <sup>5</sup>
Sustained Random Write IOPS (Maximum)	Up to 30,000
Access Time	< 100 usec
Start Up Time (POR to Busy)	592 msec
Start Up Time (POR to Ready)	1.42 sec

### 2.4.2 Reliability

**Table 2:** Reliability Characteristics

Item	Value
Data Reliability	< 1 in 10 <sup>17</sup> bits read
Data Retention	10 years at 25 °C
Endurance	10,000 TBW (Terabyte Written) <sup>6</sup>
Error Correction (Reed Solomon)	12 9-bit symbols for every 512-byte sector

### 2.4.3 Power Requirements

**Table 3:** Power Requirements

Parameter	Value (Typ)	Value (Max)	Unit
V <sub>IN</sub>	5.0 ± 5%	5.25	V

<sup>3</sup> One megabyte, or MByte, equals 1,048,576 bytes.

<sup>4</sup> Based on 128 KByte transfer size.

<sup>5</sup> Random performance values are based on 4 KByte transfers using Iometer 2008.

<sup>6</sup> 200GB, SLC.

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**Table 4:** Power Consumption<sup>7</sup>

Parameter	50 GB		100 GB		200 GB	
	mA	W	mA	W	mA	W
Read	157.8	0.789	161.5	0.807	237.0	1.185
Write	232.7	1.163	268.4	1.342	309.1	1.546
Idle	140.9	0.704	138.1	0.690	145.6	0.728

**2.4.4 Environmental Conditions**
**Table 5:** Environmental Conditions and Testing

Parameter	Value
Shock – Non-Operating	1500 g half-sine, 0.5ms, 6 shock (+/- each) along the X, Y, and Z axes <sup>8</sup>
Shock – Operating	50 g half-sine, 11 ms, 18 shocks (+/- each) along the X, Y, and Z axes <sup>9</sup>
Vibration – Operating	3 shocks along the X, Y, Z axes in accordance with the following: <ul style="list-style-type: none"> <li>• Category 12 for jets modified to 16.4 g rms, 10-2000 Hz random</li> <li>• Category 12 for jets, 10 g rms</li> <li>• Category 13 for propeller aircraft</li> <li>• Category 14 for helicopters</li> <li>• Category 20 for ground vehicle</li> </ul>
Operating Temperature – Industrial	-40 °C to 85 °C (Ambient) <sup>10</sup>
Storage Temperature	-55 °C to 95 °C <sup>10</sup>
Humidity	5% to 95%, non-condensing, relative humidity <sup>11</sup>
Altitude	24,384 m [80,000 ft] <sup>12</sup>

**2.4.5 Physical Characteristics**
**Table 6:** Physical Characteristics

Parameter	Value
Length	100.20 mm [3.945 in]
Width	69.85 mm [2.75 in]
Height (Mounted)	9.50 mm [0.37 in]
Weight (Typical)	133.20 g [4.70 oz]

<sup>7</sup> Typical rms values.

<sup>8</sup> Based on MIL-STD-810F, Method 516.5-10 Procedure I (Modified to 1500g)

<sup>9</sup> Based on MIL-STD-810F, Method 516.5-10 Procedure I (Modified to 50g)

<sup>10</sup> Based on MIL-STD-810F, Method 501.4 Procedure I & Method 502.4 Procedure I

<sup>11</sup> Based on MIL-STD 810-F, Method 507.4.

<sup>12</sup> Based on MIL-STD 810-F, Method 500.4, Procedure II

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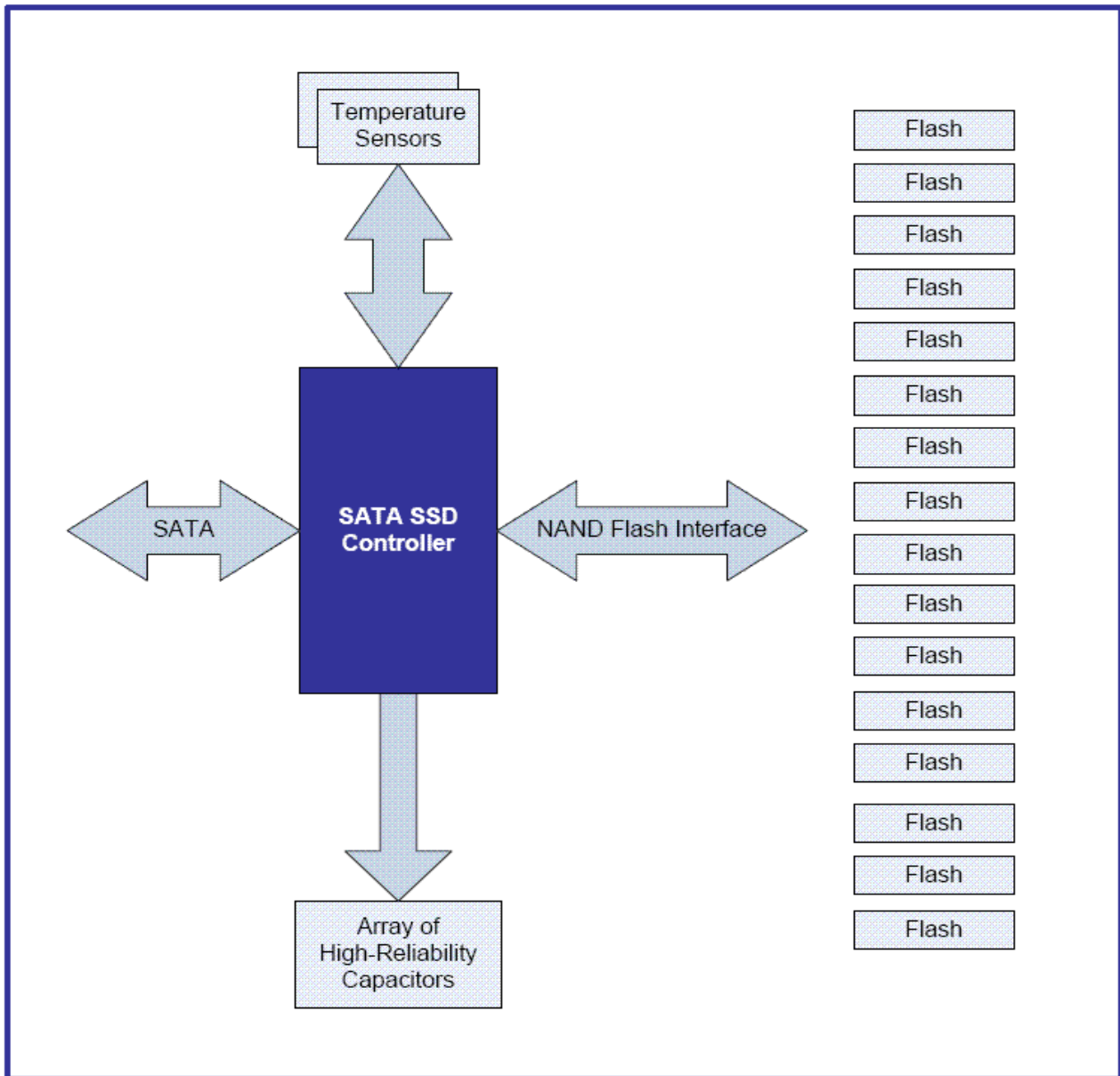
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### 3.0 PRODUCT DESCRIPTION

The SMART Xcel-100 SATA 2.5" SSD contains a NAND flash controller that provides a 3 Gbps SATA interface to the host. Parallel access to 16 flash sites allows overlapped, multi-block access to complete data transfer requests rapidly. Temperature sensors provide input to the controller regarding over-temperature conditions. An array of High-Reliability Capacitors ensures data integrity during power fail scenarios.

#### 3.1 Functional Block Diagram

Figure 1: Xcel-100 2.5" SATA Block Diagram



### 3.2 Endurance

The Xcel-100 2.5" SATA SSD incorporates the following attributes to optimize the endurance of the product:

- **Static Wear Leveling:** This feature eliminates overstressing flash media by spreading the data writes across all flash physical address space, including logical areas that are not written by the user.
- **ECC:** The Xcel-100 2.5" SATA SSD utilizes Reed Solomon ECC/EDC, 12 symbols per 512-byte block of user data. The SSD also includes a data fail correction feature that is invoked in the event the ECC engine is unable to correct the data.
- **Bad Block Management:** This feature tracks all manufacturing and run-time bad blocks of flash media and replaces them with new ones from the spare pool.
- **Performance Throttling:** This feature guarantees the life of the SSD over the entire warranty period (three years). To ensure unusual and temporary bursts of write-access traffic do not result in earlier-than-expected endurance concerns, the controller uses a throttling mechanism to force the data access speeds to align with the expected warranty period of the device.
- **Data Retention Management:** With increased P/E cycles, flash blocks start to lose their ability to retain the data, which is best characterized as an inability to recover data reliably during read operations. The Xcel-100 SATA 2.5" SSD incorporates multiple data-retention management techniques to ensure the highest data reliability and integrity, even towards the end of the drive life.

### 3.3 Mean Time Between Failures (MTBF)

The MTBF statistic for the Xcel-100 2.5" SATA SSD, shown below, was calculated based on the Telcordia, Ground Benign, controlled at 25°C (case temperature).

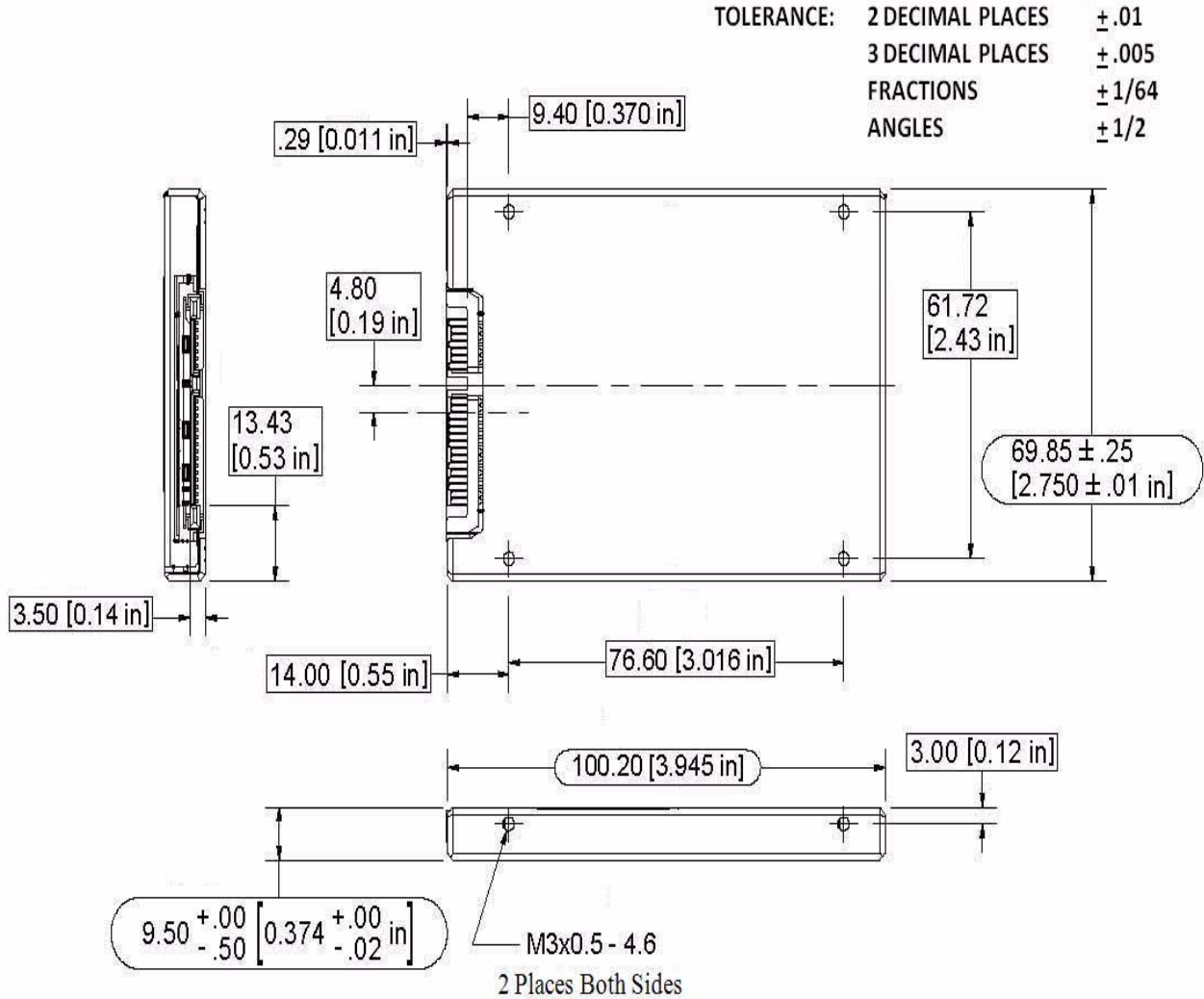
**Table 7:** MTBF Values

Drive Capacity	NAND Flash	MTBF (Hours)
50 GBytes	SLC	> 2,100,000
100 GBytes	SLC	> 2,100,000
200 GBytes	SLC	> 2,100,000

## 4.0 MECHANICAL SPECIFICATION

Tolerances per table unless specified otherwise.

Figure 2: Xcel-100 2.5" SATA Drive Dimensions in (mm [inches])



## 5.0 ELECTRICAL SPECIFICATION

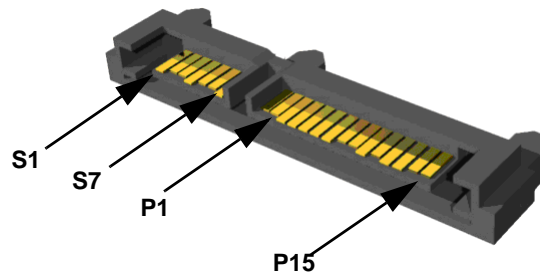
### 5.1 Electrical Interface

The Xcel-100 2.5" SATA drive is compliant with the SATA 2.6, 3.0 Gbps standard.

#### 5.1.1 SATA Interface Connector

The SATA connector on the Xcel-100 SATA 2.5" includes a signal bay (S1 to S7) and a power bay (P1 to P15). The SATA connector can support both cabled and backplane plug-in connections. The connector complies with the Telcordia GR-78 standard (NEBS), meeting the minimum requirement of 30 μinches of gold over a nickel base of 50 μinches.

**Figure 3:** SATA Interface Connector



#### 5.1.2 Signal Pinout Descriptions

**Table 8:** Signal Pinout Descriptions

Pin	Signal Name	In/Out	Signal Description
S1	GND	N/A	2 <sup>nd</sup> mate
S2	Dev Rx+	In	Receive differential pair signal in +
S3	Dev Rx-	In	Receive differential pair signal in -
S4	GND	N/A	2 <sup>nd</sup> mate
S5	Dev Tx-	Out	Transmit differential signal out -
S6	Dev Tx+	Out	Transmit differential signal out +
S7	GND	N/A	2 <sup>nd</sup> mate



### 5.1.3 Power Pinout Descriptions

**Table 9:** Power Pinout Descriptions

Pin	Signal Name	In/Out	Signal Description
P1	V3.3	N/A	3.3 V power (not used)
P2	V3.3	N/A	3.3 V power (not used)
P3	V3.3	N/A	3.3 V power (not used)
P4	GND	In	1 <sup>st</sup> mate
P5	GND	In	2 <sup>nd</sup> mate
P6	GND	In	2 <sup>nd</sup> mate
P7	V5	In	5 V power, pre-charged, 2 <sup>nd</sup> mate
P8	V5	In	5 V power
P9	V5	In	5 V power
P10	GND	In	2 <sup>nd</sup> mate
P11	Reserved	In/Out	Activity indicator; staggered in-rush
P12	GND	In	1 <sup>st</sup> mate
P13	V12	N/A	12 V power (not used)
P14	V12	N/A	12 V power (not used)
P15	V12	N/A	12 V power (not used)

## 5.2 Remote LED

In compliance with the SATA specification, pin P11 on the SATA 15-pin power connector supports a remote LED. Because the signal is not suitable for directly driving an LED, a circuit external to the device must first buffer the signal. When connected, the remote LED indicates activity. Refer to the ATA-8 Standard specification for more details.

## 5.3 Temperature Sensors

The Xcel-100 2.5" SATA drive contains two temperature sensors: one on each side of the printed circuit board. These sensors poll the drive for temperature information every 60 seconds, and the drive stores the highest reading in the drive logs. This temperature represents the temperature of the printed circuit board, not the drive case.

## 5.4 Absolute Maximum Ratings

**Table 10:** Voltage and Storage Temperature

Symbol	Parameter	Ratings (Max)	Unit
V <sub>IN</sub>	5 V Supply Voltage	5.25	V
T <sub>STG</sub>	Storage Temperature	-55 to +95	°C

## 5.5 Recommended Operating Conditions

**Table 11:** Recommended Operating Conditions

Symbol	Parameter	Ratings	Unit
V <sub>IN</sub>	5 V Supply Voltage	5 ± 5%	V
T <sub>A</sub>	Operating Temperature (Ambient)	-40 to +85 <sup>13</sup>	°C

## 5.6 DC Characteristics

**Table 12:** DC Characteristics<sup>14</sup>

Parameter (Symbol)	50 GB		100 GB		200 GB	
	mA	W	mA	W	mA	W
Active Read Current (I <sub>RD</sub> )	223.2	1.116	226.6	1.133	319.0	1.595
Active Write Current (I <sub>WR</sub> )	255.2	1.276	278.0	1.390	345.1	1.726
Idle Current (I <sub>IDLE</sub> )	213.6	1.068	229.0	1.145	254.6	1.273
Hot Swap Current (I <sub>HOTSWAP</sub> )	648.2	3.241	662.3	3.312	651.5	3.258
Power Up Current (I <sub>POWERUP</sub> )	642.0	3.210	661.0	3.305	666.5	3.333

<sup>13</sup>The drive operates at any ambient temperature and airflow provided the internal drive temperature, measured by the on-board thermal sensors, does not exceed 85 °C. The warranty is voided on drives that record temperatures in excess of 85 °C.

<sup>14</sup>Values subject to change. Maximum rms values measured during Design Verification testing.



## 6.0 ATA COMMANDS

### 6.1 Supported ATA Commands

The Xcel-100 2.5" SATA solid state drive supports the standard commands listed in Table 13. For more detailed descriptions of the commands, please refer to the ATA-8 Standard.

**Table 13:** Supported ATA Commands

Command Name	Op Code (Hex)	Command Set (Category)
Check Power Mode	E5	PwrMgmt
Data Set Management Ext	06	Data Set Mgmt
Download Microcode	92	General
Execute Device Diagnostic	90	General
Flush Cache	E7	General
Flush Cache Ext	EA	48-Bit Address
Identify Device	EC	General
Idle	E3	PwrMgmt
Idle Immediate	E1	PwrMgmt (no support for Unload)
Initialize Device Parameters	91	General
NOP	00	General
Read Buffer	E4	General
Read DMA	C8	Data Transfer
Read DMA Ext	25	48-Bit Address
Read DMA w/o Retries	C9	Obsolete
Read FPDMA Queued	60	Data Transfer NCQ
Read Log Ext	2F	General Purpose Logging
Read Log DMA Ext	47	General Purpose Logging 48-Bit Address
Read Long	22	Data Transfer
Read Long w/o Retries	23	Data Transfer
Read Multiple	C4	Data Transfer
Read Multiple Ext	29	48-Bit Address
Read Native Max Address	F8	HPA
Read Native Max Address Ext	27	HPA
Read Sector(s)	20	Data Transfer
Read Sector(s) w/o Retries	21	Data Transfer
Read Sector(s) Ext	24	48-Bit Address
Read Verify Sector(s)	40	General
Read Verify Sector(s) Ext	42	48-Bit Address
Read Verify Sector(s) w/o Retries	41	Obsolete
Recalibrate	10	Obsolete

**PRODUCT SPECIFICATION**
**Table 13:** Supported ATA Commands (Continued)

Command Name	Op Code (Hex)	Command Set (Category)
Security Disable Password	F6	Security
Security Erase Prepare	F3	Security
Security Erase Unit	F4	Security
Security Freeze Lock	F5	Security
Security Set Password	F1	Security
Security Unlock	F2	Security
Seek	70	General
Set Features	EF	Set Features
Set Max Address	F9	HPA
Set Max Address Ext	37	HPA
Set Multiple Mode	C6	General
Sleep	E6	Power Mgmt
S.M.A.R.T. Operations	B0	S.M.A.R.T.
Standby	E2	Power Mgmt
Standby Immediate	E0	Power Mgmt
Write Buffer	E8	General
Write DMA	CA	Data Transfer
Write DMA Ext	35	48-Bit Address
Write FUA Ext	3D	48-Bit Address
Write DMA w/o Retries	CB	Obsolete
Write FPDMA Queued	61	NCQ
Write Log Ext	3F	General Purpose Logging
Write Log DMA Ext	57	General Purpose Logging
Write Long	32	Data Transfer
Write Long w/o Retries	33	Data Transfer
Write Multiple	C5	Data Transfer
Write Multiple Ext	39	48-Bit Address
Write Multiple FUA Ext	CE	48-Bit Address
Write Sector(s)	30	Data Transfer
Write Sector(s) Ext	34	48-Bit Address
Write Sector(s) w/o Retries	31	Obsolete
Write Uncorrectable Ext	45	General

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## 6.2 Supported S.M.A.R.T. Operations

Self-monitoring analysis and reporting technology (S.M.A.R.T.) commands provide diagnostic information regarding drive operation and, in certain cases, can assist in predicting drive degradation.

Each S.M.A.R.T. attribute monitors a specific drive condition, with threshold levels configured for select attributes. A host-initiated S.M.A.R.T. Return Status command returns the current state of the drive, specifying whether or not an attribute exceeded the assigned threshold. If an attribute has exceeded a threshold level, SMART Modular Technologies recommends issuing the S.M.A.R.T. Read Data command to identify the specific attribute (see Table 15). In many cases, exceeding the threshold simply indicates you should monitor the drive more closely.

Although Xcel-100 2.5" SATA drives support several S.M.A.R.T. operations, which are subcommands of the S.M.A.R.T. Operations command (see Table 14), the S.M.A.R.T. Return Status and S.M.A.R.T. Read Data subcommands are used for monitoring the drive.

S.M.A.R.T. commands are issued with B0h in the Command register and the code for the desired operation in the Features register. A S.M.A.R.T. Enable Operations must be issued before any other S.M.A.R.T. command can be performed.

### 6.2.1 Supported S.M.A.R.T. Subcommands

**Table 14:** Supported S.M.A.R.T. Subcommands<sup>15</sup>

Subcommand Name	Code (Hex)
Reserved	00-CF
S.M.A.R.T. Read Data	D0
S.M.A.R.T. Read Attribute Thresholds	D1
S.M.A.R.T. Enable/Disable Attribute Autosave	D2
S.M.A.R.T. Save Attribute Values	D3
S.M.A.R.T. Execute Off-Line Immediate	D4
S.M.A.R.T. Read Log Sector	D5
S.M.A.R.T. Write Log Sector	D6
S.M.A.R.T. Write Attribute Threshold	D7
S.M.A.R.T. Enable Operations	D8
S.M.A.R.T. Disable Operations	D9
S.M.A.R.T. Return Status	DA
S.M.A.R.T. Enable/Disable Automatic Off-Line <sup>16</sup>	DB
Reserved	DC-FF

<sup>15</sup>Note that D1, D3 and D7 have been made obsolete in the ATA-8 specification.

<sup>16</sup>Not supported.

### 6.2.2 Supported S.M.A.R.T. Attributes

Table 15 describes the supported S.M.A.R.T. attributes. The possible values for attributes listed with an asterisk (\*) are normalized based on specific equations. For these attributes, the value range starts at 38 instead of 0. For details about the normalized equations and the S.M.A.R.T. attributes, see the *S.M.A.R.T. Attributes and Log Pages Technical Reference*.

It is important to note that most S.M.A.R.T. attribute values are maintained across power cycles (that is, they are non-volatile). The following attribute values, however, are cleared after a power cycle, erase, format operation, or firmware update:

- Raw Read Error Rate (ID 1)
- Soft Read Error Rate (ID 13)
- On-the-Fly ECC Uncorrectable Error Count (ID 195)
- SATA R-Errors (CRC) Error Count (ID 199)
- Uncorrectable Soft Read Error Rate (ID 201)
- Soft ECC Correction Rate (ID 204)

**Table 15:** Supported S.M.A.R.T. Attributes

Attribute ID (Dec)	Name	Values	Indicates
1	Raw Read Error Rate	38-120 (Normalized)	Raw read rate relative to the number of sectors read this power cycle. This attribute includes both uncorrectable ECC and uncorrectable RAISE errors. <b>Raw Usage:</b> [3-0]: Number of sectors read [6-4]: Read errors
5	Retired Block Count	1-100 (Normalized)	This attribute represents the total number of retired blocks since initial drive deployment. <b>Raw Usage:</b> [3-0]: Retired block count [6-4]: None (0x00)
9	Power-On-Hours (POH)	1-100 (Normalized)	The total number of hours the drive has had power applied to it. <b>Raw Usage:</b> [3-0]: Total number of power-on hours [6-4]: Total number of msec since last power-on hour update.
12	Device Power Cycle Count	1-100 (Normalized)	The number of full power cycles. The normalized equation $100 - (PCC/1024)$ decrements by 1 for each 1024 power cycles. <b>Raw Usage:</b> [3-0]: Cumulative lifetime power cycle count (PCC) [6-4]: None (0x00)
13	Soft Read Error Rate	38-120 (Normalized)	The number of corrected read errors reported. This attribute reads 120 until a sample size of 10E10 is available. <b>Raw Usage:</b> [3-0]: Number of sectors read [6-4]: Soft read error count (CECC)



**Table 15:** Supported S.M.A.R.T. Attributes (Continued)

Attribute ID (Dec)	Name	Values	Indicates
100	Gigabytes Erased	Raw Usage	Returns a byte count in increments of 64 GBytes. The count represents the number of flash bytes erased. This value remains at 0 until the byte count reaches 64 GBytes, at which time the value changes to 64 (decimal). <b>Raw Usage:</b> [3-0]: Gigabytes Erased [6-4]: None (0x00)
170	Reserved Block Count	Raw Usage	The number of reserved (over-provisioned) blocks. The attribute value is initially the total reserve block count. This attribute is related to attribute 5: Retired Block Count. <b>Raw Usage:</b> [3-0]: Reverse Block Count [6-4]: None (0x00)
171	Program Fail Count	Raw Usage	The number of flash program failures since the drive was deployed. This attribute is identical to attribute 181. <b>Raw Usage:</b> [3-0]: Program Fail Count [6-4]: None (0x00)
172	Erase Fail Count	Raw Usage	The number of flash erase failures since the drive was deployed. This attribute is identical to attribute 182. <b>Raw Usage:</b> [3-0]: Erase Fail Count [6-4]: None (0x00)
174	Unexpected Power Loss Count	Raw Usage	The number of unexpected power loss events since the drive was deployed. <b>Raw Usage:</b> [3-0]: Unexpected Power Loss Event Count [6-4]: None (0x00)
177	Wear Range Delta	Raw Usage	The delta between the most-worn and least-worn Flash blocks as a percentage of the max rated wear of the Flash memory on the SSD. <b>Raw Usage:</b> [3-0]: Wear Range Delta [6-4]: None (0x00)
181	Program Fail Count	Raw Usage	(Identical to Attribute 171) <b>Raw Usage:</b> [3-0]: Program Fail Count [6-4]: None (0x00)
182	Erase Fail Count	Raw Usage	(Identical to Attribute 172) <b>Raw Usage:</b> [3-0]: Erase Fail Count [6-4]: None (0x00)

**PRODUCT SPECIFICATION**
**Table 15:** Supported S.M.A.R.T. Attributes (Continued)

Attribute ID (Dec)	Name	Values	Indicates
184	Reported I/O Error Detection Code Rate	1-100 (Normalized)	The number of end-to-end CRC errors encountered during host-initiated reads and writes. <b>Raw Usage:</b> [3-0]: Cumulative Lifetime I/O EDC Error Count [6-4]: None (0x00)
187	Reported Uncorrectable Errors	1-100 (Normalized)	The number of uncorrectable RAISE error events reported to the host for all data access commands. <b>Raw Usage:</b> [3-0]: Cumulative Lifetime URAISE Error Count [6-4]: None (0x00)
194	Temperature	-127-127 (Normalized)	Internal SSD temperature. All temperature values for this attribute default to 25 degree C. <b>Raw Usage:</b> [1-0]: Current Temperature (°C) [3-2]: Highest Temperature Recorded (°C; lifetime max) [5-4]: Lowest Temperature Recorded (°C; lifetime min) [6 ]: None (0x00)
195	ECC On-the-Fly Count	38-120 (Normalized)	The total number of uncorrectable errors. This value is identical to the Uncorrectable Soft Read Error Rate (ID 201) and the Soft ECC Correction Rate (ID 204) values. This attribute reads 120 until a sample size between 10E10 and 10E12 is available. <b>Raw Usage:</b> [3-0]: Number of Sectors Read [6-4]: Number of Uncorrectable Errors
196	Reallocation Count	1-100 (Normalized)	This attribute represents the count of retired blocks since the initial drive deployment. <b>Raw Usage:</b> [3-0]: Retired Block Count [6-4]: None (0x00)
198	Uncorrectable Sector Count	38-120 (Normalized)	The difference between this count and reported uncorrectable will be those errors correctable by RAISE. This attribute reads 120 until a sample size between 10E10 and 10E12 is available. <b>Raw Usage:</b> [3-0]: Uncorrectable Sector Count (URAISE) this Power Cycle [6-4]: Number of Sectors Read this Power Cycle
199	SATA R-Errors (CRC) Error Count	1-200 (Normalized)	The total number of SATA R-errors (CRC) the drive encountered. <b>Raw Usage:</b> [3-0]: Current SATA R-Error Count this Power Cycle [6-4]: None (0x00)



**Table 15:** Supported S.M.A.R.T. Attributes (Continued)

Attribute ID (Dec)	Name	Values	Indicates
201	Uncorrectable Soft Read Error Rate	38-120 (Normalized)	The number of soft read errors that cannot be fixed on-the-fly and require recovery via RAISE. This value is identical to the ECC On-the-Fly Count (ID 195) and the Soft ECC Correction Rate (ID 204) values. This attribute reads 120 until a sample size between 10E10 and 10E12 is available. <b>Raw Usage:</b> [3-0]: Number of sectors read [6-4]: Uncorrectable soft error count (UECC)
204	Soft ECC Correction Rate	38-120 (Normalized)	The number of errors corrected by RAISE that could not be fixed on-the-fly and requires RAISE to correct. This value is identical to the Uncorrectable Soft Read Error Rate (ID 201) and the ECC On-the-Fly Count (ID 195) values. This attribute reads 120 until a sample size between 10E10 and 10E12 is available. <b>Raw Usage:</b> [3-0]: Number of sectors read [6-4]: Soft ECC correction count
230	Life Curve Status	90 or 100	Whether or not performance throttling is activated to ensure the life of the SSD reaches the warranty period. If throttling is activated the attribute returns a value of 90, otherwise a value of 100 is returned. <b>Raw Usage:</b> None
231	SSD Life Left	0-100 (Normalized)	The approximate percentage of the SSD life left in terms of PE cycles or Flash Blocks currently available for use. <b>Raw Usage:</b> [0 ]: 0 = Life Driven by PE Cycles 1 = Life Driven by Spare Blocks [6-1]: None (0x00)
232	Available Reserved Space	Raw Usage	Indicates the amount of Flash memory space in reserve. This is the Reserve Block Count (Attribute 170) represented in GBytes. The value is returned in units of Gigabytes at an update resolution of 1 GByte. <b>Raw Usage:</b> [3-0]: (Reserve Block Count * Pages Per Block * Bytes Per Page)/1024 <sup>3</sup> [6-4]: None (0x00)
235	Power Fail Backup	1-100 (Normalized)	The status of the SuperCap based on the self-tests. Since this drive does not have a SuperCap, the value of this attribute will remain 100. <b>Raw Usage:</b> [1-0]: Latest capacitor array test discharge time (in msec) [6-2]: None (0x00)
241	Lifetime Writes from Host	Raw Usage	Indicates the number of bytes (in 64GB resolution) written to the drive by the host over the life of the drive. <b>Raw Usage:</b> [3-0]: Count of 64GByte units written to the drive [6-4]: None (0x00)

**Table 15:** Supported S.M.A.R.T. Attributes (Continued)

Attribute ID (Dec)	Name	Values	Indicates
242	Lifetime Reads from Host	Raw Usage	Indicates the number of bytes (in 64GB resolution) read from the drive by the host over the life of the drive.  <b>Raw Usage:</b> [3-0]: Count of 64GByte units read from the drive [6-4]: None (0x00)

### 6.2.3 S.M.A.R.T. Attribute Threshold Sector

The Xcel-100 2.5" SATA SSD compares the S.M.A.R.T. Attributes to the threshold values when the S.M.A.R.T. Return Status command (DAh) is issued. To determine the current threshold value for a specific attribute, use the S.M.A.R.T. Read Attribute Threshold command (D1h). All threshold values are stored in the Saved Configuration Page (see the following table for the byte definitions).

**Table 16:** S.M.A.R.T. Attribute Threshold Data Structure

Byte(s)	Description
0:1	S.M.A.R.T. Structure Version Number
2	First Stored Attribute Number
3	Threshold Value for First Attribute
4:13	Reserved
14	Second Stored Attribute Number
15	Threshold Value for Second Attribute
16:25	Reserved
26:361	Format for the next 28 Attributes (12 Bytes Each): Byte 0: Stored Attribute Number Byte 1: Threshold Value Bytes 2-11: 10 reserved bytes for supported attributes
362:379	Reserved
380:510	Vendor-Specific
511	Checksum



#### 6.2.4 S.M.A.R.T. Attribute Threshold Values

By default, several attributes are assigned a threshold value (see following table). The drive reports the current attribute value exceeds the default threshold. Because there are no negative values in the attribute values, a default threshold of "0" indicates the drive will not report any problems for that specific attribute.

**Table 17:** Default S.M.A.R.T. Attribute Thresholds

Attribute ID (Dec)	Attribute Name	Default Threshold Value (Hex)
1	Raw Read Error Rate	32
5	Retired Block Count	3
9	Power-On Hours	0
12	Device Power Cycle Count	0
13	Soft Read Error Rate	0
100	Gigabytes Erased	N/A
170	Reserve Block Count	N/A
171	Program Fail Count	N/A
172	Erase Fail Count	N/A
174	Unexpected Power Loss	N/A
177	Wear Range Delta	N/A
184	Report I/O Error Detection Code Errors	5A
187	Reported Uncorrectable Errors	0
194	Temperature	0
195	ECC On-the-Fly Error Count	0
196	Reallocation Event Count	3
198	Uncorrectable Sector Count	0
199	SATA R-Errors Error Count	0
201	Uncorrectable Soft Read Error Rate	0
204	Soft ECC Correction Rate	0
230	Life Curve Status	0
231	SSD Life Left	0A
232	Available Reserved Space	N/A
235	SuperCap Health	2
241	Lifetime Writes from Host	N/A
242	Lifetime Reads to Host	N/A

### 6.3 Off-Line Mode

The S.M.A.R.T. Execute Off-Line Immediate command initiates the collection of S.M.A.R.T. data in off-line mode and preserves this data across power and reset events. The subcommand to execute is specified in the LBA Low register. See the following table for the supported subcommands and their respective codes. For more details about the subcommands, see the ATA-8 specification.

**Table 18:** Supported S.M.A.R.T. Execute Off-Line Immediate Subcommands

Subcommand Name	Code (Hex)
Execute S.M.A.R.T. Off-Line Routine in Off-Line Mode	00
Execute S.M.A.R.T. Short Self-Test Routine in Off-Line Mode	01
Execute S.M.A.R.T. Extended Self-Test Routine in Off-Line Mode	02
Execute S.M.A.R.T. Selective Self-Test Routine in Off-Line Mode	04
Abort Off-Line Mode Self-Test Routine	7F
Execute S.M.A.R.T. Short Self-Test Routine in Captive Mode	81
Execute S.M.A.R.T. Extended Self-Test Routine in Captive Mode	82
Execute S.M.A.R.T. Selective Self-Test Routine in Captive Mode	84

#### 6.3.1 Captive Mode

When in captive mode, the Xcel-100 SATA 2.5" SSD executes the self-test routine after receiving the command. The results are placed in the Self-Test Execution Status byte, and the drive reports command completion. If an error occurs while the drive is performing the routine, the drive discontinues testing, places the results in the Self-Test Execution Status byte and in the device state (DST) log page, and exits the routine.



## 6.4 S.M.A.R.T. Logs

The Xcel-100 2.5" SATA SSD supports the S.M.A.R.T. logs listed in the following table. To access the logs, set the LBA Low register to the log address. For more details about the logs, see the ATA-8 specification.

**Table 19:** Supported S.M.A.R.T. Logs

Log Name	Address (Hex)	Type	Description
Log Directory	00	Read-Only	This is standardized in the ATA specification.
Extended Comprehensive S.M.A.R.T. Error Log	03	Read-Only	Includes uncorrectable errors, IDNF errors for which the address requested was valid, write fault errors, etc. This is standardized in the ATA specification.
Device Statistics	04	Read-Only	Includes various statistics about the device. This is standardized in the ATA specification.
Extended S.M.A.R.T. Self-Test Log	07	Read-Only	Returns information regarding self-tests the drive has performed. This is standardized in the ATA specification.
Selective Self-Test Log	09	Read-Write	Allows the host to select the parameters for the self-test and to monitor the self-test progress. This is standardized in the ATA specification.
NCQ Command Error Log	10	Read-Write	Describes the most recent NCQ command failure. This log is standardized in the ATA specification.
SATA Log	11	Read-Only	Returns the current Phy counter values for the command and then resets all Phy event counter values. This is standardized in the SATA 2.6 specification.
Grown Defect List	A8	Read-Only	Returns a list of grown defects. For each defect, the physical address and timestamp is provided.
SSD Event Log	B7	Read-Only	Contains diagnostic information, such as counters, error information, etc. The first 512 bytes contain header and counter information, with the remaining sectors containing event information (that is, the first event starts at byte 512). When the log is full, new entries overwrite old entries. The drive, however, fills the entry sector with zeroes prior to writing the new event.
SCT Host Command Status Log	E0	Read-Write	Allow host systems to send commands and data to a device and an ATA device to send data and status to a host system. These logs are standardized in the ATA specification.
SCT Host Data Log	E1	Read-Write	
System Event Log	FB	Read-Only	Lists potentially noteworthy events designed to assist Technical Support in troubleshooting the drive.

## 6.5 Supported HPA Subcommands

Host Protected Area (HPA) subcommands are issued with F9h in the Command register and the code for the desired command in the Feature register. See the following table for the supported subcommands and the corresponding Feature code.

**Table 20:** Supported HPA Subcommands

Subcommand Name	Code (Hex)
Set Max Address	00
Set Max Freeze Lock	04
Set Max Lock	02
Set Max Set Password	01
Set Max Unlock	03



## 6.6 Identify Device

The Identify Device command passes one sector (512 bytes) of data to the host. This data describes the flash drive parameters. See the following table for a detailed description of the Identify Device information.

**Table 21:** Identify Device Information

Identify Device Information		
Word(s)	Data	Description
0	0400h	General configuration, bit-significant information
1	3FFFh	Obsolete - Number of cylinders
2	C837h	Does not require set features subcmd
3	0010h	Obsolete - Number of heads
4-5	0000h	Retired
6	003Fh	Obsolete- Number of sectors per track
7-8	0000h, 0000h	Reserved by CompactFlash Association
9	0000h	Retired
10-19	XXXXh	20-character serial number in ASCII
20-21	0000h	Retired
22	0004h	Obsolete - Number of ECC bytes passed on Read/Write Long commands
23-26	XXXXh	Firmware revision in ASCII; big-endian
27-46	[Manufacturer's Info]	SMART Xcel-100 Model Number
47	8001h	Maximum number of sectors on Read/Write Multiple commands
48	0000h	Trusted Computing
49	2F00h	Capabilities: Standby Timer Values, IORDY, IORDY(DIS), LBA, DMA supported
50	4000h	Reserved
51	0200h	Obsolete - Power On PIO
52	0000h	Obsolete
53	0007h	ID Words 54-56 are valid
54	03FFh	Obsolete - Number of current cylinders
55	0010h	Obsolete - Number of current heads
56	003Fh	Obsolete - Number of current sectors per track
57-58	FC10h 00FBh	Obsolete - Current capacity in sectors (Word 57 = LSW; Word 58 = MSW)
59	9101h	Current setting for block count; 1 is for Read/Write Multiple commands
60-61	2230h 0BA5h	Total number of user-addressable LBAs (Word 60 = LSW; Word 61 = MSW) - See Note
62	0000h	Obsolete
63	0007h	Multiword DMA mode 2 selected; modes 0, 1, and 2 supported
64	0003h	Advanced PIO modes 3 and 4 supported
65	0078h	Minimum Multiword DMA transfer cycle time per word

**PRODUCT SPECIFICATION**
**Table 21:** Identify Device Information (Continued)

Identify Device Information		
Word(s)	Data	Description
66	0078h	Recommended Multiword DMA transfer cycle time
67	0078h	Minimum PIO transfer cycle time without flow control
68	0078h	Minimum PIO transfer cycle time with IORDY flow control
69-74	0000h	Reserved
75	001Fh	Queue Depth
76	0706h	Serial ATA Capabilities
77	0000h	Reserved
78	004Ch	SATA Features Supported
79	0040h	SATA Features Enabled
80	01FCh	Major Version
81	0028h	Minor Version
82	746Bh	Features supported 0
83	7501h	Features supported 1
84	6163h	Features supported 2
85	7068h	Features enabled 0
86	B401h	Features enabled 1
87	6163h	Features enabled 2
88	207Fh	UDMA mode selected/embedded
89	00C8h	Time required for security erase unit completion
90	00C8h	Time required for enhanced security erase unit completion
91	00FEh	Current advanced power management value
92-99	0000h	Reserved
100-101 102-103	2230h 0BA5h 0000h 0000h	Total LBA48 (Word 100 = LSW; Word 103 = MSW) - See Note
104	0000h	Streaming Xfer Time PIO
105	0001h	Max number of 512-byte blocks per DATA SET MANAGEMENT command
106	4000h	Phy/Log SectSize
107	0000h	ISO-7779
108-111	[World Wide #]	(5) 00-05-16: 1000000xx
112-116	0000h	Reserved
117-118	0000h	Logical Sector Size - Not Support (Valid if Word 106 bit 12=1)
119	4014h	Support Settings
120	4014h	Command set / feature enabled / supported
121-126	0000h	Reserved
127	0000h	Obsolete



**Table 21:** Identify Device Information (Continued)

Identify Device Information		
Word(s)	Data	Description
128	0001h	Security status
129-159	XXXXh	Vendor-specific
160	0000h	Power requirement description
161-175	0000h	Reserved
176-205	0000h	Current Media Serial Number
206-216	0000h	Reserved
217	0001h	Nominal media rotation rate
218-221	0000h	Reserved
222	1010h	Transport Major revision number
223	FFFFh	Transport Minor revision number
224-254	0000h	Reserved
255	22A5	Integrity word

**NOTE:** The value is dependent on the total capacity of the flash drive. Values in the table are typical of a 50G drive.

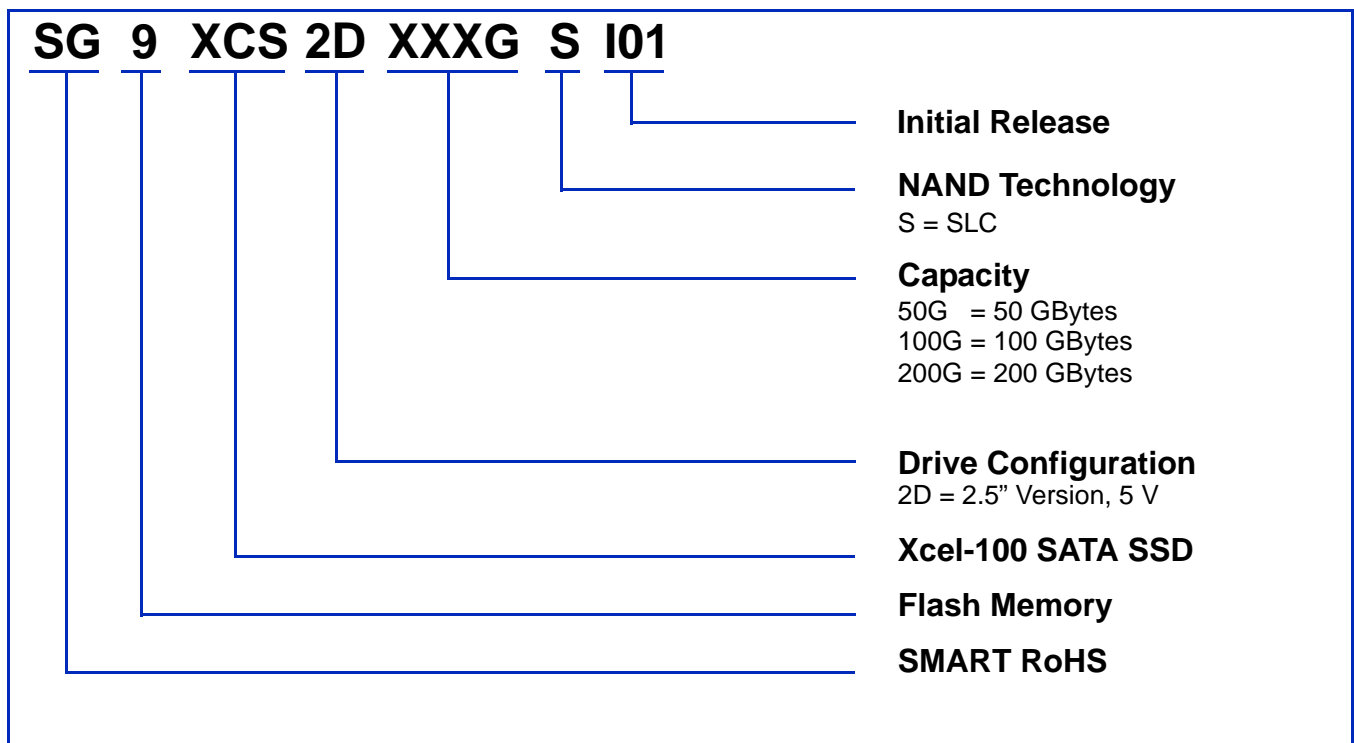
## 7.0 PART NUMBERS

### 7.1 Part Numbering Information

**Table 22:** Part Numbering Information<sup>17</sup>

SMART Part Number	NAND Technology	Usable Drive Capacity	Unformatted Capacity	Max LBA
SG9XCS2D50GSI01	SLC	50 GBytes	50,020 MBytes	97,696,368
SG9XCS2D100GSI01	SLC	100 GBytes	100,030 MBytes	195,371,568
SG9XCS2D200GSI01	SLC	200 GBytes	200,050 MBytes	390,721,968

### 7.2 Part Number Decoder



<sup>17</sup>One gigabyte, or GByte, equals one billion bytes when referring to drive capacity. Accessible capacity may vary based on the operating environment and drive formatting.



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