

Virtium StorFly[®] CFast CE SATA 6Gbps SSD

VSFCS2C Product Specification

1.0 Introduction

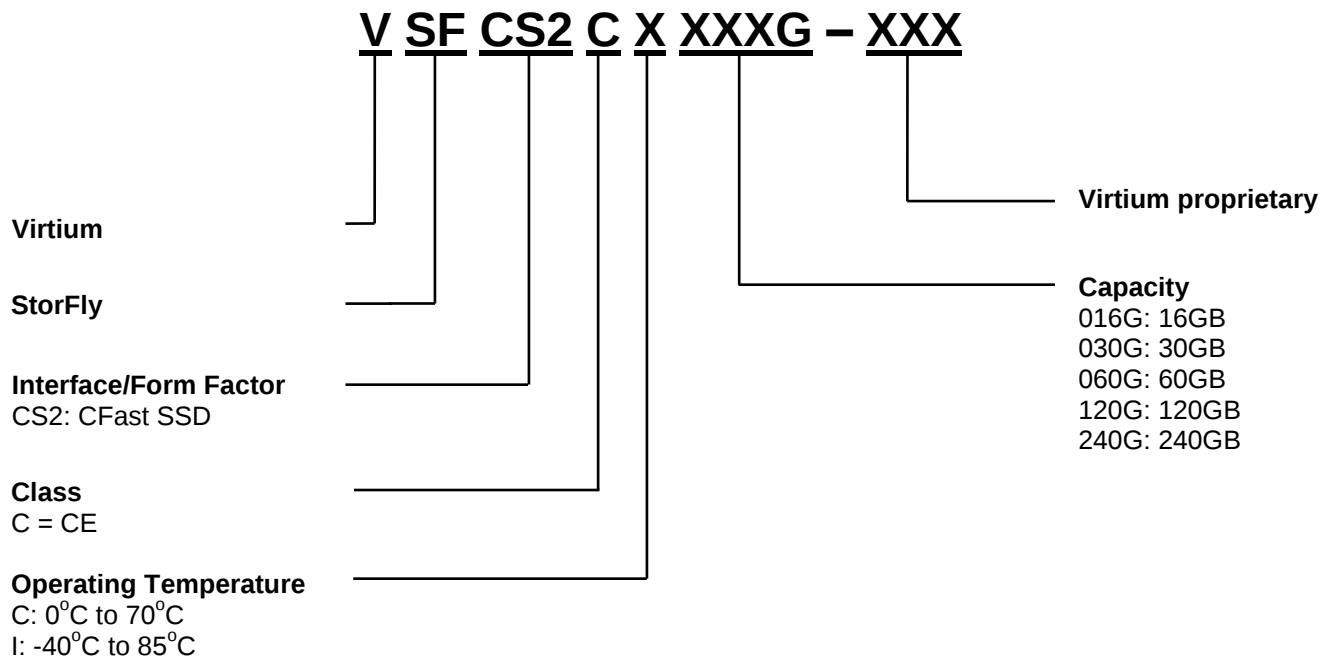
Virtium's StorFly[®] CFast is solid state drive (SSD) technology designed for the unique capacity and workload requirements of a broad range of embedded systems including networking, industrial automation, medical and gaming equipment as well as point-of-sale terminals, military data recorders and wearable computers. StorFly CFast CE SSDs are Virtium's entry level solid state drives that are designed to meet the critical storage demands of read-intensive and boot applications.

1.1 Features

- Capacities: 16GB, 30GB, 60GB, 120GB, 240GB
- Commercial MLC
- Sequential performance
 - Read: up to 525 MB/s
 - Write: up to 475 MB/s
- Random Performance
 - Read IOPS: up to 65,000 (4K QD 32)
 - Write IOPS: up to 10,000 (4K QD 32)
- Temperature
 - Commercial operating: 0°C to 70°C
 - Industrial operating: -40°C to 85°C
 - Non-operating: -55°C to +95°C
- Power 3.3V
 - Maximum: 3.62W
 - Typical: 2.38W
 - Idle: 0.3W
- Reliability
 - BCH ECC capable of correcting errors up to 66-bit/1KB
 - MTBF: > 2M hours
 - Endurance: up to 105 TBW
- S.M.A.R.T. attribute reporting
- vtGuard Power-Fail Protection
- Compliance
 - SATA revision 3.1 (SATA 6Gbps)
 - ATA/ATAPI-8 (ACS-2)
 - FCC, CE, UL, RoHS
- Mechanical Dimensions - L x W x H mm (inches)
 - 42.80 (1.685) x 36.4 (1.433) x 3.3 (0.130)
- Weight
 - 8.7 +/- 2 g
- Environmental (Operating/non-operating):
 - MIL-STD-810F
 - Shock: 1500G, 0.5ms duration
 - Vibration: 16.4G_{RMS}
 - Altitude: 80,000 feet



2.0 Ordering Information and Part Numbering System



Part Number	Capacity
VSFCS2CX016G-XXX	16GB
VSFCS2CX030G-XXX	30GB
VSFCS2CX060G-XXX	60GB
VSFCS2CX120G-XXX	120GB
VSFCS2CX240G-XXX	240GB

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StorFly CS2 VSFCS2CXxxxG-xxx	Rev: 1.0

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4.0 Specifications

4.1 Capacity

Table 1: StorFly CS2CE capacity

Unformatted Capacity (GB) ⁽¹⁾	User-Addressable LBA ⁽²⁾	User-Addressable Capacity Bytes
16	30,867,456	15,804,137,472
30	58,626,288	30,016,659,456
60	117,231,408	60,022,480,896
120	234,441,648	120,034,123,776
240	468,862,128	240,057,409,536

(1) 1GB = 1,000,000,000 bytes

(2) LBA: Logical Block Address. Logical block size of 512 bytes (1 sector)

4.2 Performance

Table 2: Performance

Capacity (GB)	Throughput ⁽¹⁾ 64KB file, Queue Depth (QD) =32		IOPS ⁽²⁾ 4KB file, QD =32, 100% Random	
	Read Seq MB/s	Write Seq MB/s	Read Random	Write Random
16	290	45	30,500	1,300
30	480	85	57,000	3,600
60	480	170	65,000	6,000
120	480	335	65,000	8,500
240	525	475	65,000	10,000

(1) OakGate tester, fully preconditioned drive, mixed compressed/uncompressed data pattern, 4K aligned, write cache enabled

4.3 Environmental Specifications

4.3.1 Temperature and Humidity

Table 3: Temperature and humidity

P/N	Operating Temperature	Non-Operating Temperature ⁽¹⁾ Moisture Sensitivity
VSFCS2CCxxxG-xxx	0°C to 70°C	-55°C to +95°C 5% to 95% (non-condensing)
VSFCS2CIxxxG-xxx	-40°C to 85°C ²	-55°C to +95°C 5% to 95% (non-condensing)

- (1) Please contact your Virtium representative for details on the non-operating temperature range
 (2) Target spec. Validated for read only and limited write workloads. Contact Virtium for applications that require heavy write workloads at maximum temperature.

4.3.2 Shock, Vibration and Altitude

Table 4: Shock, Vibration and Altitude

Reliability	Test Conditions
Shock ⁽¹⁾	1500G, ½ sine, 0.5ms duration
Vibration ⁽²⁾	16.4G _{RMS}
Altitude ⁽³⁾	80,000 feet

- (1) MIL-STD-810F, Method 516.5
 (2) MIL-STD-810F, Method 514.5
 (3) MIL-STD-810F, Method 500.4

4.4 System Reliability

4.4.1 Endurance

Table 5: Endurance⁽¹⁾

Capacity (GB)	JESD218A & JESD219 Enterprise workloads		100% Sequential Workloads	
	Total Byte Written TBW (TB)	Drive Writes per day (3 years)	Total Byte Written TBW (TB)	Drive Writes per day (3 years)
16	3	0.20	46	2.60
30	17	0.52	91	2.78
60	29	0.44	181	2.75
120	64	0.48	373	2.84
240	105	0.40	601	2.29

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- (1) JESD218 assumes active temp at 55C and retention temp at 40C. Please contact your Virtium representative for endurance values at other temperatures.

4.4.2 Mean Time Between Failures (MTBF)

Virtium's StorFly CFast CE SSD class achieves MTBF of greater than 2,000,000 hours predicted based on the component reliability data using Telcordia SR-332 methods at 40°C.

4.5 Power Requirements

Table 6: Power Consumption⁽¹⁾

Maximum	Typical ⁽²⁾	Idle
3.62W	2.38W	0.3W

(1) For 240GB, based on 3.3V input

(2) 70/30 read/write workload

4.6 Certifications and Compliance

Table 7: Certifications and Compliance

Compliance/Certification	Description
CE and FCC Compliant	Class: FCC Part 15 Subpart B Class B:2011 Declaration of Conformity registration No. STE120607699
RoHS Compliant	Restriction of Hazardous Substance Directive
UL Certified	Underwriters Laboratories, Inc. 94V-0
WEEE Certified	Waste, Electrical and Electronic Equipment Directive

5.0 Physical Specification

5.1 Pin Assignments

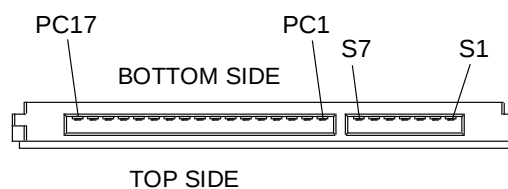
Table 8: Pin Assignments

Name	Type	Description
S1	GND	Ground
S2	Rx+	Device Transmit Signal
S3	Rx-	
S4	GND	Ground
S5	Tx-	Device Receive Signal
S6	Tx+	
S7	GND	Ground
Power Pin Assignments		
P1	CDI ⁽¹⁾	Card Detect In
P2	GND	Ground
P3	Reserved	No Connect
P4	Reserved	No Connect
P5	Reserved	No Connect
P6	Reserved	No Connect
P7	GND	Ground
P8	DAD/DSS	Device activity signal/disable staggered spinup
P9	Reserved	No Connect
P10	Reserved	No Connect
P11	Reserved	No Connect
P12	Reserved	No Connect
P13	V33	3.3V Power
P14	V33	3.3V Power
P15	GND	Ground
P16	GND	Ground
P17	CDO ⁽¹⁾	Card Detect Out

(1) CDI signal is connected to CDO signal on a CFast SSD. CDI & CDO provides a mechanism for a CFast host to detect that a CFast SSD has been fully inserted.

Figure 1: Signal Segment

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5.2 Mechanical Dimensions

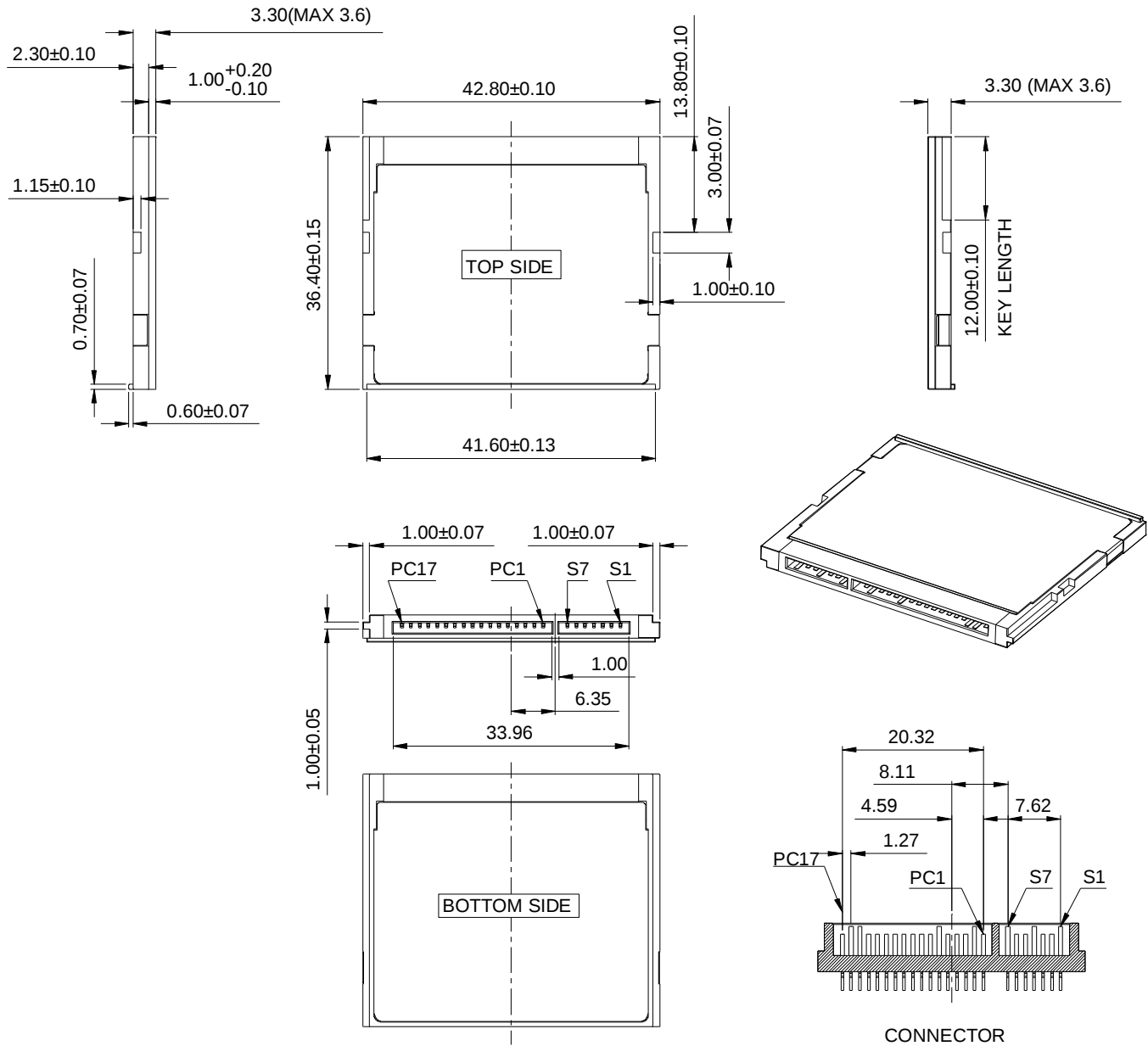


Figure 2: Mechanical Dimensions

6.0 ATA Commands

VSFCS2C SSDs support all mandatory ATA commands defined in the ATA/ATAPI-8 (ACS-2) specification.

6.1 Supported Commands

6.1.1 General

Table 9: Supported ATA Commands

Command	Code	Protocol
Execute Drive Diagnostic	90h	Device diagnostic
Flush Cache	E7h	Non-data
Identify Device	EC	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

6.1.2 Power Management

Table 10: Power Management Commands

Command	Code	Protocol
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

6.1.3 Security Mode

Table 11: Security Commands

Command	Code	Protocol
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

6.1.4 S.M.A.R.T.

Table 12: S.M.A.R.T Commands

Command	Code	Protocol
SMART Disable Operations	B0h	Non-data
SMART Enable/Disable Autosave	B0h	Non-data
SMART Enable Operations	B0h	Non-data
SMART Execute OFF-LINE Immediate	B0h	Non-data
SMART Read Log	B0h	PIO data-in
SMART Read Data	B0h	PIO data-in
SMART Read Threshold	B0h	PIO data-in
SMART Return Status	B0h	Non-data
SMART Save Attribute Values	B0h	Non-data
SMART Write Log	B0h	PIO data-out

6.1.5 Host Protected Area

Table 13: Host Protected Area Commands

Command	Code	Protocol
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

6.1.6 48-bit Address Feature Set

Table 14: 48-bit Address Feature Set Commands

Command	Code	Protocol
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 Multiple Ext	39h	PIO data-out
Write Sector(s) Ext	34h	PIO data-out

6.1.7 Native Command Queuing (NCQ)

Table 15: Native Command Queuing (NCQ)

Command	Code	Protocol
Read FPDMA Queued	60h	DMA Queued
Write FPDMA Queued	61h	DMA Queued

6.1.8 Other

Table 16: Other Command

Command	Code	Protocol
Data Set Management	06h	DMA
Seek	70h	Non-data

6.2 Identify Device Data

The Identify Device command enables the host to receive parameter information from the controller. This command has the same protocol as the Read Sector(s) command. The parameter words in the buffer have the arrangement and meanings defined in the following table.

Table 17: Identify Device Data

Word	F/V/X	Value	Description
0	F	0040h	General configuration
1	X	3FFFh	Default number of cylinders
2	V	C837h	Reserved
3	X	0010h	Default number of heads
4	X	0000h	Obsolete
5	X	0240h	Obsolete
6	F	003Fh	Default number of sectors per track
7-8	V	0000h	Reserved
9	X	0000h	Obsolete
10-19	X	XXXXh	Serial number in ASCII (Right justified)
20	X	0000h	Obsolete
21	X	FFFFh	Obsolete
22	X	0004h	Obsolete
23-26	F	XXXXh	Firmware revision in ASCII Big Endian Byte Order in Word
27-46	F	XXXXh	Model number in ASCII (Left justified) Big Endian Byte Order in Word
47	F	8002h	Maximum number of sectors on Read/Write Multiple command
48	F	0000h	Reserved
49	F	XXXXh	Capabilities
50	F	XXXXh	Capabilities
51	F	0200h	Obsolete
52	X	0000h	Obsolete
53	F	0007h	Field validity

Word	F/V/X	Value	Description
54-58	X	XXXXh	Obsolete
59	F	0101h	Multiple sector setting
60	V	XXXXh	Total number of user addressable logical sectors for 28-bit commands (DWord)
61		XXXXh	
62	X	0000h	Obsolete
63	F	0207h	Multiword DMA transfer
64	F	0003h	Supports MDMA mode 0, 1 and 2 Advanced PIO modes supported
65	F	0078h	Minimum Multiword DMA transfer cycle time per word
66	F	0078h	Recommended Multiword DMA transfer cycle time
67	F	0078h	Minimum PIO transfer cycle time without flow control
68	F	0078h	Minimum PIO transfer cycle time with IORDY flow control
69	F	4D20h	Additional supported
70-74	F	0000h	Reserved
75	F	001Fh	Queue depth
76	F	830Eh	Serial ATA capabilities • Supports Serial ATA Gen3 • Supports Serial ATA Gen2 • Supports Serial ATA Gen1 • Supports receipt of host initiated power management requests Supports Native Command Queuing
77	F	0040h	Serial ATA additional capability DevSleep_to_ReducedPwerState
78	F	0148h	Serial ATA features supported • Supports software settings preservation Device supports initiating power management
79	V	0040h	• Reserved
80	F	03F0h	• Major version number (ACS-2)
81	F	0000h	• Minor version number
82	F	746Bh	Command sets supported 0
83	F	7701h	Command sets supported 1
84	F	4063h	Command sets supported 2
85	V	7468h	Command set/feature enabled
86	V	B401h	Command set/feature enabled
87	V	4063h	Command set/feature enabled
88	V	007Fh	Ultra DMA mode supported and selected
89	F	0001h	Time required for a Normal Erase mode Security Erase Unit command
90	F	0001h	Time required for an Enhanced Erase mode Security Erase Unit command
91	V	0000h	Current advanced power management value
92	V	FFFEh	Master Password identifier

Word	F/V/X	Value	Description
93-99	V	0000h	Reserved
100 101 102 103	V	XXXXh XXXXh XXXXh XXXXh	Maximum user LBA for 48-bit Address feature set
104	V	0000h	Reserved
105	F	0008h	Maximum number of 512-byte blocks per Data Set Management command
106-127	V	0000h	Reserved
128	V	0021h	Security status
129-159	X	XXXXh	Virtium specific
160	F	0000h	Power requirement description
161-167	X	0000h	Reserved
168	V	0000h	Reserved
169	F	0001h	Data Set Management supported
170-208	V	0000h	Reserved
209	V	4000h	Reserved
210-216	V	0000h	Reserved
217	F	0001h	Non-rotating media (SSD)
218-221	X	0000h	Reserved
222	F	107Fh	Transport major revision (SATA Rev 3.1)
223-254	X	0000h	Reserved
255	X	XXXXh	Integrity word - Checksum

Notes:

1. F = content (byte) is fixed and does not change.
2. V = content (byte) is variable and may change depending on the state of the device or the commands executed by the device.
3. X = content (byte) is specific to manufacturer and may be fixed or variable.

6.3 S.M.A.R.T. Attributes

6.3.1 Introduction

Self-Monitoring, analysis, and reporting technology (SMART) is monitoring system that monitors device condition based on the indicators reported by the device itself. This system is created to anticipate/predict any failures that might happen before it actually happens in the hope that there is still time to take action. This document is only created for the purpose to inform users about the SMART commands and SMART attributes implemented by Virtium Technology, Inc., including the data structures returned by those commands.

For more detailed information on how to invoke the SMART command, please refer to ACS-2 specification.

6.3.2 SMART Command

The following table defines the SMART command set that is supported by VSFCS2C SSDs.

Table 18: SMART Feature Register Values

Value	Command
D0h	SMART Read Data
D1h	SMART Read Attribute Threshold
D2h	SMART Enable/Disable Auto-save
D3h	SMART Save Attribute Values
D4h	SMART Execute Off-Line immediate
D5h	SMART Read Log
D6h	SMART Write Log
D8h	SMART Enable Operations
D9h	SMART Disable Operations
DAh	SMART Return Status

6.3.3 SMART Attributes

Definitions

The following table defines the current Virtium 's SMART data attributes that are currently supported. These SMART attributes are located at offset 2 of the SMART Data Structure.

Table 19: SMART Attribute Definitions

ID (Hex)	ID (Decimal)	Description	Type
01	1	Raw read error rate - rate of CRC errors over the total number of LBA read	Reset at power on
09	9	Power-on time in hours	Reset at power on
0C	12	Power cycle count, including both proper power down (for example Windows or Linux Shutdown command) and unsafe power down.	Life cumulative
C0	192	Unsafe power down - power off without STANDBY-IMMEDIATE. Also called ungraceful power down. StorFly vtGUARD allows recovery from unsafe power down.	Life cumulative
C2	194	Temperature – controller °C	Reset at power on
C7	199	SATA interface CRC error count	Life cumulative
A0	160	Uncorrectable sector count read or write	Reset at power on
A1**	161	Remaining spare block count - reported as a percentage, starting at 100% and decreasing to 0%. When this value reaches 0%, the SSD enters read-only mode.	Life cumulative
F1	241	Total LBA write - increases by 1 for every 32MB (65,536 sectors at 512 bytes per sector) written	Life cumulative
F2	242	Total LBA read increases by 1 for every 32MB (65,536 sectors at 512 bytes per sector) read	Life cumulative
A9**	169	Remaining life left - reported as a percentage, starting at 100% and decreasing to 0%. When this value reaches 0%, the SSD enters read-only mode.	Life cumulative
F8*	248	Remaining life left - identical to attribute A9	Life cumulative
F9*	249	Remaining spare block count - identical to attribute A1.	Life cumulative

(*) – This attribute is only present in later than 0409 FW. In 0729 this attribute displays remaining in block life. In 0828 the life remaining is normalized to 100% then decreases.

(**) – This attribute is present in all FW. In 0729 this attribute displays remaining in block life. In 0828 the life remaining is normalized to 100% then decreases.

7.0 References

Reference Title	Date or Rev. Number	Location
ATA/ATAPI-8	September 2008	http://www.t13.org
ACS-2 - ATA/ATAPI Command Set-2	June 2011	http://www.t13.org
MIL-STD-810F	January 2000	Department of Defense Test Method Standard for Environmental Engineering Considerations and Laboratory Tests
SATA 3.1	July 2011	http://www.sata-io.org
JESD219, Solid State Drive (SSD) Endurance Workloads	September 2010	http://www.jedec.org
JESD218A: Solid-State Drive (SSD) Requirements and Endurance Test Method	February 2011	http://www.jedec.org

8.0 Revision History

Date	Rev.	Page	Changes
12/19/14	1.0	All	All current data added, ready for release. SVN rev. 2776