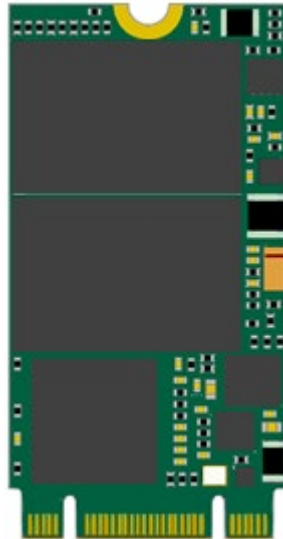


Virtium StorFly® M.2 2242 SSD
6Gbps Solid-State Drive
Data Sheet



VSFCM4C(C/I)120G



Important!

Printed copies of this document are considered current only on the date of print.
It is the responsibility of the user for the replacement and disposal of previous versions.

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1. Introduction

1.1 Overview

Virtium's StorFly® M.2 CE class 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 systems, gaming equipment, point-of-sale terminals and data recorders. StorFly 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.

1.2 Features

- **Capacities**
 - 120 GB
- **Sequential Performance**
 - 128 kB Sequential Read: 550MB/s
 - 128 kB Sequential Write: 350MB/s
- **Random Performance**
 - 4kB IOPS Read: 52,000
 - 4kB IOPS Write: 57,000
- **Power: 3.3V±5%**
 - Maximum: 2.4W
 - Typical: 2.0W
 - Idle: 1.3W
- **Temperature Ranges**
 - Industrial: -45°C to 85°C
 - Commercial: 0°C to 70°C
 - Non-Operating: -55°C to 95°C
- **Reliability**
 - BCH ECC correction of up to 142-bit/2KB
 - MTBF: >2M hours
- **Endurance**
 - JESD219: 102 TBW
 - Sequential: 127 TBW
- **vtGuard® Power Fail Protection**
 - Integrated power fail protection
 - Preserves data in the event of power failure
 - Restores cache/buffer contents
- **SMART Support**
 - SMART Command Set
 - SMART Attribute Reporting
- **Mechanical Dimensions**
 - M.2 Type 2242 Form Factor
 - Length x Width x Height mm (inches)
42mm (1.659) x 22mm (0.872) x 3.65mm (0.144)
- **Compliance**
 - SATA Revision 3.x (SATA 6Gbps)
 - ATA/ATAPI-8 (ACS-2)
 - FCC, CE, UL, RoHS, WEEE
- **Environmental (Operating/Non-operating)**
 - MIL-STD-810F
 - Shock: 1500G, 0.5ms duration
 - Vibration: 16.4G_{RMS}
 - Altitude: 80,000 feet

1.3 Audience

This data sheet is intended for a technically advanced audience; the *user*, as referenced throughout this document, is concerned with industrial computing applications. The device is designed to store and process data while preserving data integrity over a wide range of environmental conditions.



Electrostatic Discharge (ESD) can damage this device. When handling the device, always wear a grounded wrist strap and use a static dissipative surface.



Any damage to the unit that occurs after its removal from the shipping package and ESD protective bag is the responsibility of the user.

1.4 Part Number Decoder and Ordering Information

1.4.1 Part Number Decoder

V SF CM4 C (C/I) 120G

Table 1: Part Number Decoder

Where:		
V	=	Virtium
SF	=	StorFly
CM4	=	Form Factor / Interface: CM4 = M.2, Type 2242, SATA 6Gbps
C	=	Product Class: C = CE Class
(C/I)	=	Operating Temperature: C = Commercial (0° to 70°C); I = Industrial (-40° to 85°C)
120G	=	120G = 120 GB Capacity (1GB = 1,000,000,000 bytes)

1.4.2 Model Numbers

Table 2: Model Numbers

Model Number	Capacity
VSFCM4C(C/I)120G	120GB

2. Specifications

2.1 Capacity

Table 3: Capacity

Unformatted Capacity (GB) ⁽¹⁾	User-Addressable LBA ⁽²⁾	User-Addressable Capacity Bytes
120	234,441,648	120,034,123,776
(1) 1GB = 1,000,000,000 bytes (2) LBA: Logical Block Address; Logical Block Size = 512 Bytes/1 Sector		

2.2 Performance

Table 4: Performance

Capacity (GB)	Throughput ⁽¹⁾		IOPS ⁽¹⁾	
	128KB File, Queue Depth (QD) = 32		4KB File, Queue Depth (QD) = 32	
	Sequential Read MB/s	Sequential Write MB/s	100% Random Read	100% Random Write
120	550	350	52,000	57,000
(1) OakGate Tester, fresh out of box condition, CrystalDiskMark workload				

2.3 Power Requirements

Table 5: Power Requirements

Maximum ⁽¹⁾	Typical ⁽¹⁾	Idle
2.4	2.0	1.3
(1) For a 70/30 Read/Write workload		

3. Environmental Specifications

3.1 Temperature and Humidity

Table 6: Temperature and Humidity

Part Number	Operating Temperature	Non-Operating Temperature	Moisture Sensitivity (Non-Condensing)
VSFCM4CC120G	0°C to 70°C	-55°C to 95°C	5% to 95%
VSFCM4CI120G	-40°C to 85°C	-55°C to 95°C	5% to 95%

3.2 Shock, Vibration and Altitude

Table 7: Shock, Vibration and Altitude

Reliability	Test Conditions
Shock ⁽¹⁾	1,500G half-sine, 0.5ms duration
Vibration ⁽²⁾	16.4Grms
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. Reliability Specifications

4.1 Endurance

Table 8: Endurance

Capacity (GB)	JESD218A ⁽¹⁾ & JESD219 Enterprise Workloads		100% Sequential Workloads	
	Total Bytes Written TBW (TB)	Drive Writes Per Day (DWPD: 3 Years)	Total Bytes Written TBW (TB)	Drive Writes Per Day (DWPD: 3 Years)
120	102	0.78	127	0.96
1) JESD218A assumes an active temperature at 55°C and a retention temperature at 40°C.				

4.2 Mean Time Between Failures (MTBF)

The SSD achieves a MTBF of greater than 2,000,000 hours as derived from the component reliability data using Telcordia SR-332 methods at 40°C and tested under standard environmental operating conditions as specified in *Section 3, Environmental Specifications*.

4.3 vtGuard® Power Fail Protection System

vtGuard® is an integrated power failure protection technology that will preserve data on the SSD if a sudden power failure should occur. It will also transfer the write cache (metadata, mapping tables) contents to the non-volatile flash and restore the contents upon power restoration. This data will be preserved regardless of the duration of the power failure event. This technology also ensures that the SSD will be recoverable after sudden power failure events although a rebuild of the mapping tables may delay readiness of the SSD on the ensuing power cycle on larger capacities.

5. Physical Specifications

5.1 Mechanical Dimensions

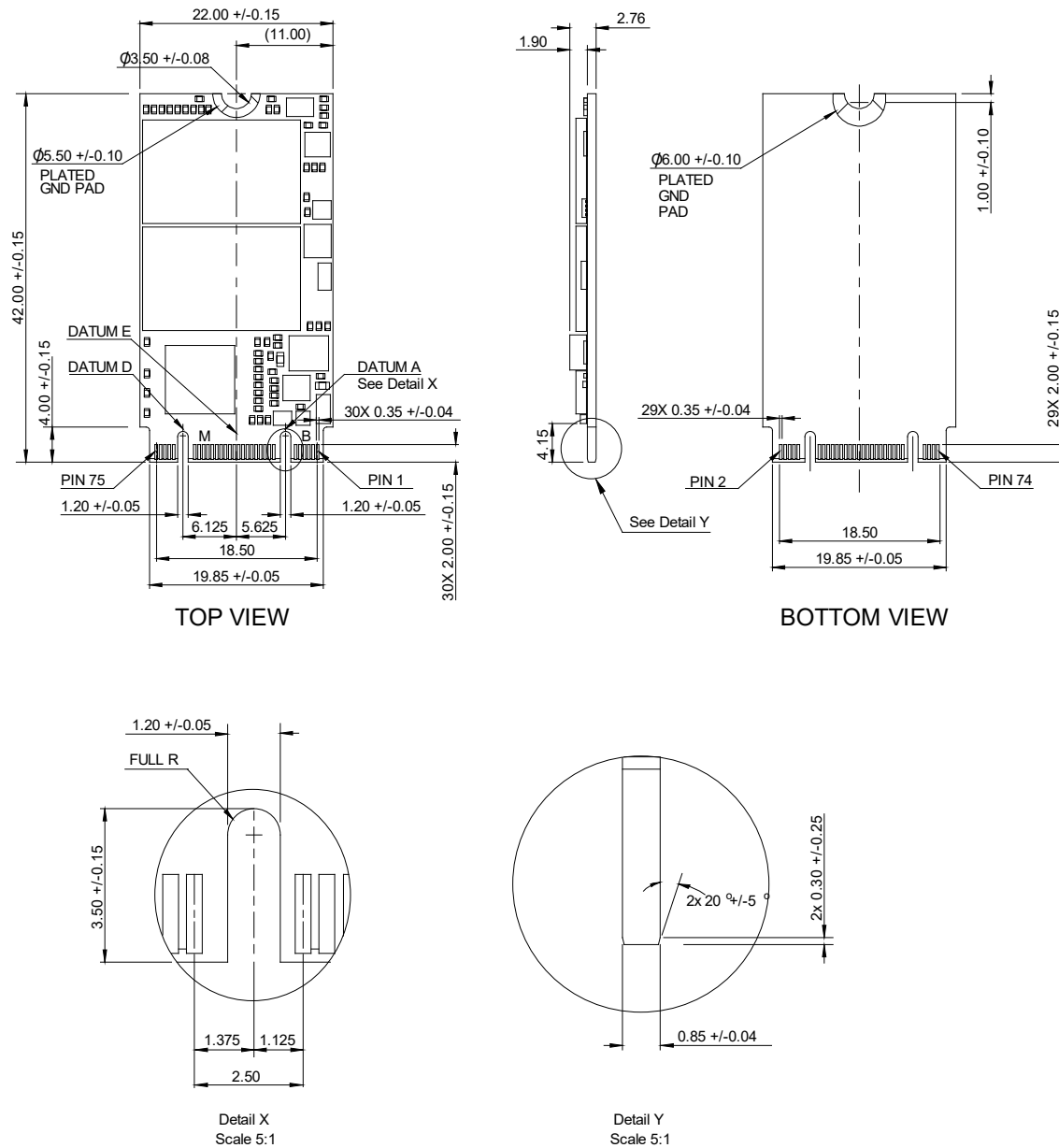


Figure 1: Mechanical Dimensions

5.2 Pin Assignments

Table 9: Connector Pinout

Top Side			Bottom Side		
Pin	Signal Name	Description	Pin	Signal Name	Description
1	CONFIG_3	Ground			
3	GND	Ground	2	V33	3.3V Power ($\pm 5\%$)
5	Reserved	No Connect	4	V33	3.3V Power ($\pm 5\%$)
7	USB_D+	No Connect	6	Full_Card_P_Off	No Connect
9	USB_D-	No Connect	8	W_Disable	No Connect
11	Reserved	No Connect	10	DAS/DSS	Device Activity Signal/ Disable Staggered Spinup
Key			Key		
21	CONFIG_0	Ground	20	GPIO	No Connect
23	GPIO	No Connect	22	GPIO	No Connect
25	GPIO	No Connect	24	GPIO	No Connect
27	GND	Ground	26	GPIO	No Connect
29	PERn1	No Connect	28	GPIO	No Connect
31	PERp1	No Connect	30	GPIO	No Connect
33	GND	Ground	32	GPIO	No Connect
35	PETn1	No Connect	34	GPIO	No Connect
37	PETp1	No Connect	36	GPIO	No Connect
39	GND	Ground	38	DEVSLP	No Connect
41	TX+	Device Transmit Differential Signal	40	GPIO	No Connect
43	TX-	Device Transmit Differential Signal	42	GPIO	No Connect
45	GND	Ground	44	GPIO	No Connect
47	RX-	Device Receive Differential Signal	46	GPIO	No Connect
49	RX+	Device Receive Differential Signal	48	GPIO	No Connect
51	GND	Ground	50	GPIO	No Connect
53	REFCLKN	No Connect	52	CLKREQ#	No Connect
55	REFCLKP	No Connect	54	PEWAKE#	No Connect
57	GND	Ground	56	MFG1	No Connect
Key			58	MFG2	No Connect
67	No Connect	No Connect	Key		
69	CONFIG_1	No Connect	68	SUSCLK	No Connect
71	GND	Ground	70	V33	3.3V Power ($\pm 5\%$)
73	GND	Ground	72	V33	3.3V Power ($\pm 5\%$)
75	CONFIG_2	Ground	74	V33	3.3V Power ($\pm 5\%$)

5.3 Card Edge Details

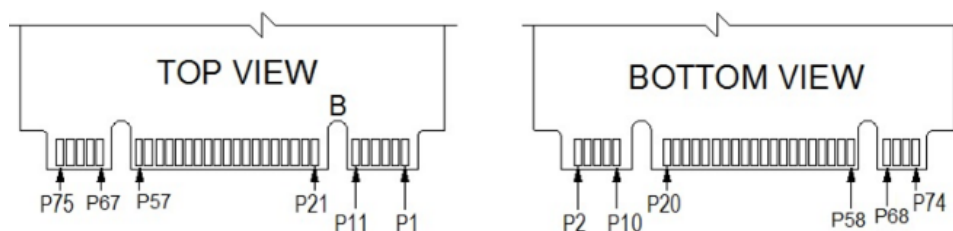


Figure 2: Connector Details

6. ATA Command Set Specifications

6.1 Introduction

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

6.2 General Commands

Table 10: Supported ATA Commands

Command	Code	Protocol
Execute Drive Diagnostic	90h	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

6.3 Power Management Commands**Table 11: 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

6.4 Security Mode Commands**Table 12: Security Mode 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

6.5 SMART Commands**Table 13: SMART 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

Command	Code	Protocol
SMART Return Status	B0h	Non-data
SMART Save Attribute Values	B0h	Non-data
SMART Write Log	B0h	PIO data-out

6.6 Host Protected Area

Table 14: 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

6.7 48-Bit Address Feature Set

Table 15: 48-Bit Address Feature Set

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

6.8 Native Command Queuing (NCQ)

Table 16: Native Command Queuing (NCQ)

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

6.9 Data Set Management and Seek

Table 17: Data Set Management and Seek

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

6.10 Identify Device (ECh) Data

The Identify Device (ECh) 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 18: Identify Device (ECh) 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

Word	F/V/X	Value	Description
49	F	XXXXh	Capabilities
50	F	XXXXh	Capabilities
51	F	0200h	Obsolete
52	X	0000h	Obsolete
53	F	0007h	Field Validity
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 Supports MDMA Mode 0, 1 and 2 Advanced PIO Modes supported
64	F	0003h	
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 • 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

Word	F/V/X	Value	Description
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
93-99	V	0000h	Reserved
100	V	XXXXh	Maximum User LBA for 48-bit Address Feature Set
101		XXXXh	
102		XXXXh	
103		XXXXh	
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 Revision 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.

6.11 SMART Attributes

Self-Monitoring, Analysis, and Reporting Technology (SMART) is a system that monitors the device condition according to indicators reported by the device itself. This system is designed to anticipate and predict any failures that might occur, thereby allowing the user to prevent data loss or corruption.

This section is for informational purposes only; its purpose is to inform users about the SMART commands and attributes implemented by Virtium Technology, Inc., including the data structures returned by those commands.

Note: Please refer to ACS-2 Specification for information on how to invoke the SMART command.

6.11.1 SMART Command Set

The following table defines the SMART Command Set that is supported by SSDs.

Table 19: 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

6.11.2 SMART Attribute Definitions

The following table defines the SMART data attributes that are currently supported. These SMART attributes are located at Offset 2 of the SMART Data Structure.

Table 20: SMART Attribute Definitions

ID (Hex)	ID (Decimal)	Description	Type
01	1	Raw Read Error Rate: Rate of CRC errors occurred over the total number of LBA read. Legacy attribute from HDDs. Kept in SMART for host compatibility issues.	Reset at power on.
05	5	Reallocated Sector Count: Count of sectors moved to the spare area.	
09	9	Power-On Time Count: Cumulative number of power-on hours while drive is in active mode over the life of the device.	Life Cumulative
0C	12	Drive Power Cycle Count: Cumulative count of power cycle event (on/off) over the life of the device. This attribute includes both proper power down and unsafe power down	Life Cumulative
A0	160	Uncorrectable Sector Count Read/Write: Total Count of uncorrectable errors when device performing reading/writing operation	Reset at power on.
A1	161	Total number of overall valid spare block	
A3	163	Number of Initial Invalid Block: Total number of bad blocks found during the card initialization	
A4	164	Total Erase Count: Total number of erase operations those have been performed	Life Cumulative
A5	165	Maximum Erase Count: The maximum number of erase operations on any active block	Life Cumulative
A6	166	Minimum Erase Count: The minimum number of erase operations on any active block	Life Cumulative
A7	167	Average Erase Count: Total number of erase operations over the total available blocks	Life Cumulative

ID (Hex)	ID (Decimal)	Description	Type
A8	168	NAND Endurance: Max erase count of the NAND	
B1	177	Total wear level count: Total number of wear leveling events	Life Cumulative
B5	181	Total Program Fail: Total number of failed program requests (failed writes)	Life Cumulative
B6	182	Total Erase Fail: Total number of failed erase requests	Life Cumulative
BB	187	Uncorrectable Error Count: The count of errors that could not be recovered using hardware ECC	Life Cumulative
C0	192	Unsafe Power Off: Count of Unsafe power off. Power off without STANDBY-IMMEDIATE command being the last command	Life cumulative
C2	194	SSD Temperature: Indicates the current internal temperature of the SSD controller (in degrees centigrade).	
C3	195	Hardware ECC Recovered: Count of correctable ECC	Life cumulative
C4	196	Reallocation Event Count: Count of Sector remap operations. Number of all (successful and failed) remap operations	Life Cumulative
C5	197	Current Pending Sector: Total sectors pending to be moved to a new block because of ECC failure	Life Cumulative
C6	198	Off-Line Uncorrectable Sector Count: Count of uncorrectable errors when reading/writing	
C7	199	UltraDMA CRC Error Count: Total CRC error count of the SATA interface	Life Cumulative
E8	232	Available Reserved Space: Reports the reserved space of the SSD as a percentage (100% to 0%). When this number reaches zero, the SSD will go into read-only mode	Life cumulative
F1	241	Total LBAs Written: Total LBAs written (each write unit = 32MB)	Life cumulative

ID (Hex)	ID (Decimal)	Description	Type
F2	242	Total LBAs Read: Total LBAs read (each read unit = 32MB)	Life cumulative
F8	248	Remaining Life Left: Reports remaining life of the SSD as a percentage (100% to 0%). When this number reaches zero, the SSD will not go into read-only mode and will continue to operate as normal. The percentage is based on the number of factors and accounts for the number of program/erases cycles the device's NAND flash can endure. This provides guidance on the anticipated lifespan for the device and allows for proactive transfer of data before eventual device failure.	Life cumulative
F9	249	Remaining Spare Block: Reports remaining spare blocks as a percentage (100% to 0%). When this number reaches zero, the SSD will go into read-only mode.	Life Cumulative
FA	250	Total written to NAND (SLC): Total Written to NAND SLC region (each write unit = 32MB)	Life Cumulative
FB	251	Total written to NAND (TLC): Total Written to NAND TLC region (each write unit = 32MB)	Life Cumulative

7. References

The *Industry Standards*, *Manufacturing Location* and *Certifications and Compliance* sections list the formal standards, relevant specifications, and interface protocols that apply, in whole or in part, to the product.

7.1 Industry Standards

Reference Title	Date / Revision	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

7.2 Manufacturing Location

Location	Certifications
Rancho Santa Margarita, CA	ISO-9001 AS9001 Revision C Certificate
United States of America (USA)	ISO-14001 Certificate

7.3 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

8. Contact Information

8.1 General Information

Main Web Site: www.virtium.com

Contacts / Sales: <http://www.virtium.com/contacts-sales/>

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30052 Tomas
Rancho Santa Margarita, CA 92688 USA

Toll Free: (888) VIRTUUM / (888) 847.8486

Telephone: 1+ (949) 888.2444

Fax: +1 (949) 888.2445

8.2 Customer Support

Email: custserv@virtium.com

9. Revision History

Revision	Date	Page(s)	Data	Description
1.0	2/6/2020	All	17380	Initial release



Virtium manufactures storage and memory and solutions for the world's foremost industrial embedded OEMs. For over two decades, we have designed, manufactured and supported our products in the USA – fortified by a network of global locations. Our world-class technology and unsurpassed support provide a superior customer experience that continuously results in better industrial embedded products for an increasingly interconnected world.

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