

Virtium StorFly™ 25PE – 2.5” SATA 3Gbps SSD

VSFA25 Product Manual

1.0 Introduction

Virtium's StorFly™ 25 is solid state drive (SSD) technology designed for the unique capacity, workload and product lifecycle 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™ 25 SSDs deliver stable configuration for long product life and eliminate the need for frequent product re-qualifications. StorFly™ 25PE SSDs are designed for optimum performance at low to moderate capacity points and are excellent solutions for write intensive applications.

1.1 Features

- Capacities: 8, 16, 32, 64, 128GB
- Sequential performance (128GB)
 - Read/write: 270.220 MB/s
- Random Performance (128GB)
 - Read/write IOPS: 15K/4K
- Latency:
 - Read/write (µs): TBD/TBD
- Temperature
 - Commercial operating: 0°C to 70°C
 - Industrial operating: -40°C to +85°C
 - Non-operating: -55°C to +95°C
- Power⁽¹⁾ (128GB; 5V)
 - Typical: 1.2W
 - Idle: 1.07W
- Reliability
 - UBER: 1 error per 10¹⁴ bits read
 - MTBF: 2,000,000 hours
 - Endurance: Upto 600 TBW (128GB)
- S.M.A.R.T. attribute reporting
- Compliance
 - SAT revision 2.6 (SATA 3Gbps and 1.5Gbps)
 - ATA/ATAPI-7
 - FCC, CE, UL, RoHS
- Mechanical Dimensions - L x W x H mm (in.)
 - 100.5 (3.96) x 69.85 (2.75) x 9.5 (0.37)
- Weight
 - 87 +/- 2 g (128GB)
- Environmental (Operating/non-operating):
 - Shock: 50G (11ms/Axis) x 3 Axes
 - Vibration: 10 to 2000 Hz, 16.4G, 3 Axes
 - Altitude: 40000 feet
 - Humidity: 95%

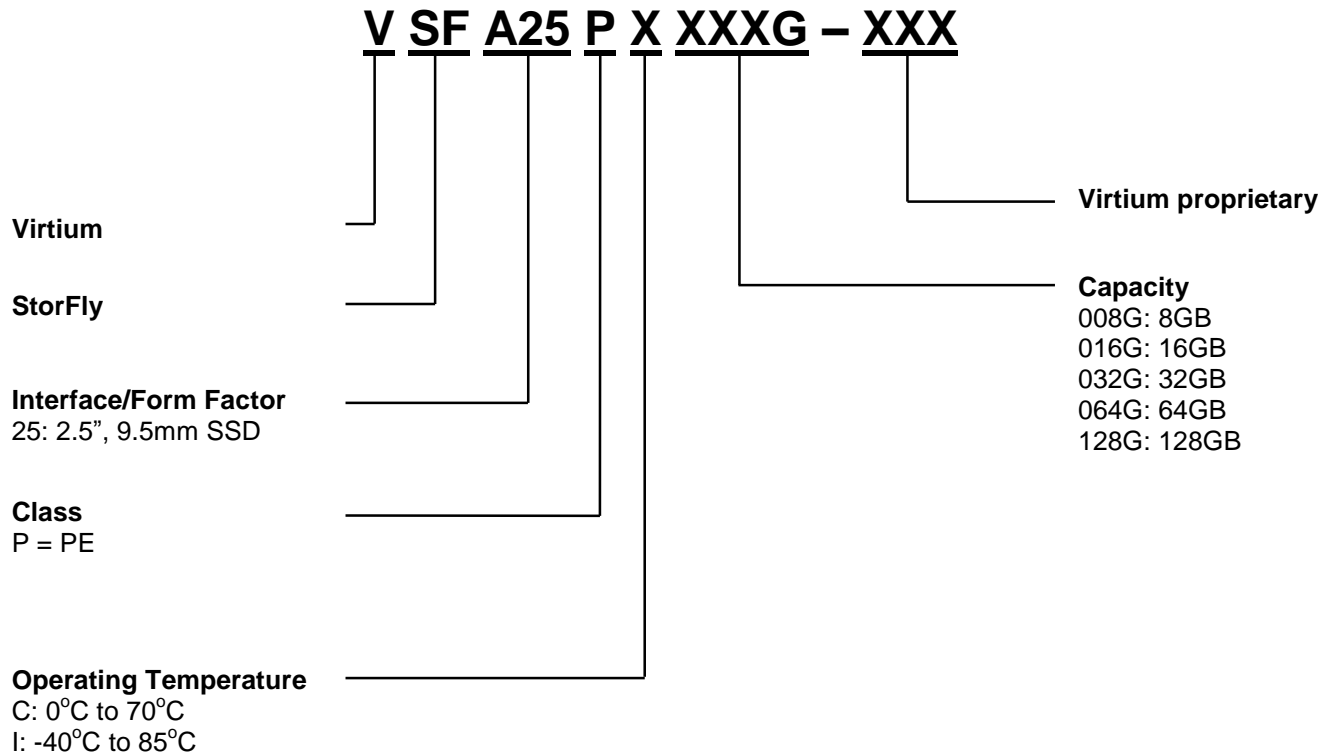


(1) Measured based on 70/30 random read/write. Power is vary depending upon capacities, see section 4.5 for completed typical and maximum power measurement per capacities



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2.0 Ordering Information and Part Numbering System





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4.0 Specifications

4.1 Capacity

Table 1: Product capacity

Advertised Capacities (GB)	User-Addressable LBA(1)	User-Addressable Capacities	
		Bytes	GBytes
8	15,458,304	7,914,651,648	7.37
16	31,358,976	16,055,795,712	14.95
32	62,717,952	32,111,591,424	29.90
64	125,435,904	64,223,182,848	59.81
128	250,871,808	128,446,365,696	119.63

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

4.2 Performance

Table 2: Performance

Capacities (GB)	THROUGH-PUT 64KB file, QD=32		IOPS 4KB file, Queue Depth=32, 100% Random		IOPS 4KB file, Queue Depth=32, 70% Read, 30% Write	
	Read Seq	Write Seq	Read Random	Write Random	Read Random	Write Random
8						
16						
32						
64						
128						

4.3 Environmental Specifications

4.3.1 Temperature Range

Table 3: Temperature range

P/N	Operating Temperature (0C)	Storage Temperature (0C)
VSFA25PCxxxG-xxx	0°C to 70oC	-55°C to +95°C



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VSFA25PIxxxG-xxx	-40°C to 85oC	-55°C to +95°C
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4.3.2 Humidity

Relative Humidity: 5-95%, non-condensing

4.3.3 Shock and Vibration

Table 4: Shock and Vibration

Reliability	Test Conditions
Vibration	???G, ??? MIL-STD-810F, Method ???, Procedure ?
Mechanical Shock	???G, ??? MIL-STD-810F, Method ???, Procedure ?
Altitude	???G, ??? MIL-STD-810F, Method ???, Procedure ?

4.4 System Reliability

Table 5: System Reliability

Capacities (GB)	TBW(1)	GB/day for 5 yrs. Services Life
8		
16		
32		
64		
128		

(1) TBW specifications are in accordance with JEDEC SSD standard JESD218, JESD219. The values measured at 250C ambient temperature. Actual resulte will vary depending application usage model



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4.4.1 Power Consumption

Table 6: Mean Time Between Failures (MTBF)

Capacities (GB)	MTBF(1)
8	
16	
32	
64	
128	

(1) MTBF specification is in accordance with Telcordia SR-332. The values estimated at 250C ambient temperature.

4.5 Power Requirements

5V (±10%) single power supply operation

Table 7: Power Consumption

Capacities (GB)	Sustained Write (Watts)	Sustained Read (Watts)	Typical(1) (Watts)	Idle (Watts)
8				
16				
32				
64				
128				

(1) Power measured based on 70/30 random R/W workload (IOMeter 2006)

4.6 FCC and CE Requirements

StorFly 25 products conform to CE and FCC requirements. Class: FCC Part 15 Subpart B Class B:2011

4.7 RoHS Compliance

StorFly 25 products are compliant with the ROHS directive.

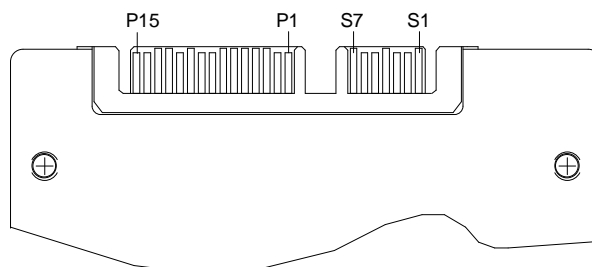
5.0 Physical Specification

5.1 Pin Assignments

Table 8: Pin Assignments

Name	Type	Description
S1	GND	Ground
S2	Rx+	Differential Receive Signal
S3	Rx-	
S4	GND	Ground
S5	Tx-	Differential Transmit Signal
S6	Tx+	
S7	GND	Ground
Key	Key	Key
Power Pin Assignments		
Key	Key	Key
P1	V33	No Connect
P2	V33	No Connect
P3	V33	No Connect
P4	GND	Ground
P5	GND	Ground
P6	GND	Ground
P7	V5	5V Power, Pre-Charge
P8	V5	5V Power
P9	V5	5V Power
P10	GND	Ground
P11	DAS/DSS	Device Active Signal/Disable Staggered Spinup
P12	GND	Ground
P13	V12	No Connect
P14	V12	No Connect
P15	V12	No Connect

Figure 1: Signal Segment and Power Segment





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5.2 Mechanical Dimensions

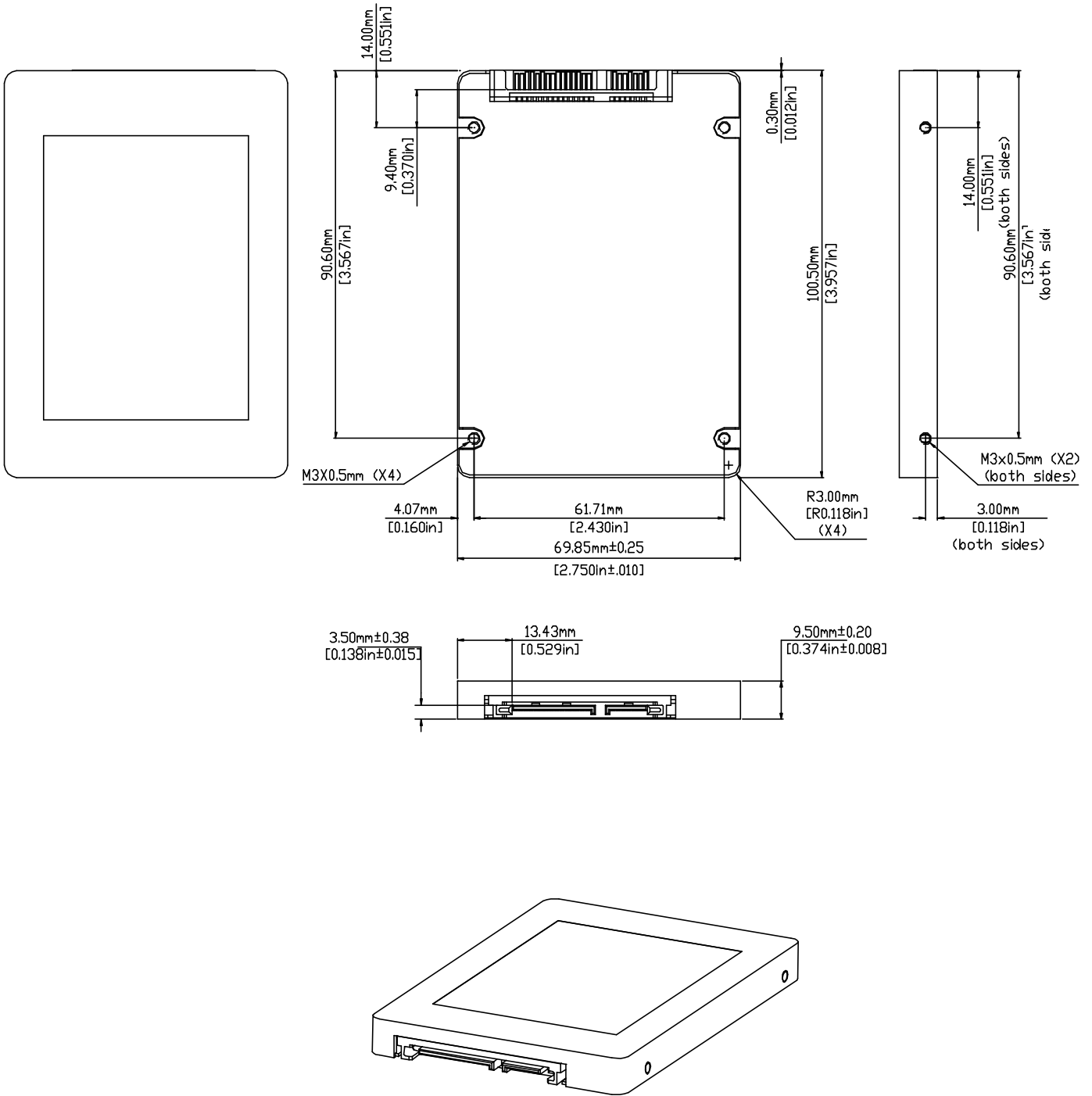


Figure 2: Mechanical Dimensions

6.0 ATA Commands

Virtium StorFly 25PE SSDs support all mandatory ATA commands defined in the ATA/ATAPI-7 specification.

6.1 Supported Commands

General

Table 9: Supported ATA Commands

Command	Code	Protocol
Execute Drive Diagnostic	90h	Device diagnostic
Flush Cache	E7h	Non-data
Identify Device	ECh	PIO data-in
Read DMA	C8h	DMA
Read Multiple	C4h	PIO data-in
Read Sector(s)	20h	PIO data-in
Read Verify Sector(s)	40h or 41h	Non-data
Set Feature	EFh	Non-data
Set Multiple Mode	C6h	Non-data
Write DMA	CAh	DMA
Write Multiple	C5h	PIO data-out
Write Sector(s)	30h	PIO data-out
NOP	00h	Non-data
Read Buffer	E4h	PIO data-in
Write Buffer	E8h	PIO data-out

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	E1 h or 95h	Non-data
Sleep	E6h or 99h	Non-data
Standby	E2h or 96h	Non-data
Standby Immediate	EOh or 94h	Non-data

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

S.M.A.R.T.

Table 12: 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 Return Status	B0h	Non-data
SMART Read Data	B0h	PIO data-in

Host Protected Area

Table 13: _____ 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

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	24 h	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

NCQ

Table 15: Native Command Queuing

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

Other

Table 16: Other Command

Command	Code	Protocol
Data Set Management	06h	DMA

6.2 Identify Device Data

Table 17: Execute Device Diagnostic Command Inputs

Word	O/M	F/V	Value	Description
0	M	F X F X X V X F	0040h	General configuration bit-significant information: 15 0=ATA device 14-8 Retired 7 1=removable media device 6 Obsolete 5-3 Retired 2 Response incomplete 1 Retired 0 Reserved
1		X	3FFFh	Obsolete
2	O	V	C837h	Specific configuration
3		X	0010h	Obsolete
4-5		X	2400000h	Retired
6		X	003Fh	Obsolete
7-8	O	V	0000h	Reserved for assignment by the CompactFlash [®] Association
9		X	0000h	Retired
10-19	M	F	P1T0xx	Serial number (20 ASCII characters)
20-21		X	0000h	Retired
22		X	0004h	Obsolete
23-26	M	F	L0213A	Firmware revision (8 ASCII characters)
27-46	M	F	StorFly -	Model number (40 ASCII characters)
47	M	F F F	8001h	15-8 80h 7-0 00h=Reserved 01h-FFh=Maximum number of sectors that shall be transferred per interrupt on READ/WRITE MULTIPLE commands
48			0000h	Reserved
49	M	F F F F F F F X	0F00h	Capabilities 15-14 Reserved for the IDENTIFY PACKET DEVICE command. 13 1 = Standby timer values as specified in this standard are supported 0 = Standby timer values shall be managed by the device 12 Reserved for the IDENTIFY PACKET DEVICE command. 11 1 = IORDY supported 0 = IORDY may be supported 10 1 = IORDY may be disabled 9 1 = LBA supported 8 1 = DMA supported. 7-0 Retired
50	M	F F F X	4000h	Capabilities 15 Shall be cleared to zero. 14 Shall be set to one. 13-2 Reserved. 1 Obsolete



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Word	O/M	F/V	Value	Description
		F		0 Shall be set to one to indicate a device specific Standby timer value minimum.
51-52		X	XXXXh	Obsolete
53	M	F F F X	0007h	15-3 Reserved 2 1 = the fields reported in word 88 are valid 0 = the fields reported in word 88 are not valid 1 1 = the fields reported in words 70:64 are valid 0 = the fields reported in words 70:64 are not valid 0 Obsolete
54-58			XXXXh	Obsolete
59	M	F V V	0101h	15-9 Reserved 8 1 = Multiple sector setting is valid 7-0 xxh = Current setting for number of sectors that shall be transferred per interrupt on R/W Multiple command
60-61	M	F	XXXXh	Total number of user addressable sectors
62			0000h	Obsolete
63	M	F V V V F F F F	0007h	15-11 Reserved 10 1=MultiwordDMAmode2isselected 0=MultiwordDMAmode2isnotselected 9 1=MultiwordDMAmode1isselected 0=MultiwordDMAmode1isnotselected 8 1=MultiwordDMAmode0isselected 0=MultiwordDMAmode0isnotselected 7-3 Reserved 2 1=MultiwordDMAmode2andbelowaresupported 1 1=MultiwordDMAmode1andbelowaresupported 0 1=MultiwordDMAmode0issupported
64	M	F F	0003h	15-8 Reserved 7-0 Advanced PIO modes supported
65	M	F	0078h	Minimum Multiword DMA transfer cycle time per word 15-0 Cycle time in nanoseconds
66	M	F	0078h	Manufacturer's recommended Multiword DMA transfer cycle time 15-0 Cycle time in nanoseconds
67	M	F	0078h	Minimum PIO transfer cycle time without flow control 15-0 Cycle time in nanoseconds
68	M	F	0078h	Minimum PIO transfer cycle time with IORDY flow control 15-0 Cycle time in nanoseconds
69-70		F	0000h	Reserved (for future command overlap and queuing)
71-74		F	4000h	Reserved for the IDENTIFY PACKET DEVICE command
75	O	F F	001Fh	Queue depth 15-5 Reserved 4-0 Maximum queue depth – 1
76-79		F	0306h	Reserved for Serial ATA
80	M	F F F	03F0h	Major version number 0000horFFFFh=device does not report version 15 Reserved 14 Reserved for ATA/ATAPI-14 13 Reserved for ATA/ATAPI-13



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Word	O/M	F/V	Value	Description
		F		12 Reserved for ATA/ATAPI-12
		F		11 Reserved for ATA/ATAPI-11
		F		10 Reserved for ATA/ATAPI-10
		F		9 Reserved for ATA/ATAPI-9
		F		8 Reserved for ATA/ATAPI-8
		F		7 1 = supports ATA/ATAPI-7
		F		6 1 = supports ATA/ATAPI-6
		F		5 1 = supports ATA/ATAPI-5
		F		4 1 = supports ATA/ATAPI-4
		F		3 Obsolete
		X		2 Obsolete
		X		1 Obsolete
		F		0 Reserved
81	M	F	0000h	Minor version number 0000h or FFFFh = device does not report version 0001h-FFFEh
82	M	X F F F X F F F F F F F F F F F F F	742Bh	Command set supported. 15 Obsolete 14 1 = NOP command supported 13 1 = READ BUFFER command supported 12 1 = WRITE BUFFER command supported 11 Obsolete 10 1 = Host Protected Area feature set supported 9 1 = DEVICE RESET command supported 8 1 = SERVICE interrupt supported 7 1 = release interrupt supported 6 1 = look-ahead supported 5 1 = write cache supported 4 Shall be cleared to zero to indicate that the PACKET Command feature set is not supported. 3 1 = mandatory Power Management feature set supported 2 1 = Removable Media feature set supported 1 1 = Security Mode feature set supported 0 1 = SMART feature set supported
83	M	F F F F F F F F F F F F	7500h	Command set supported. 15 Shall be cleared to zero 14 Shall be set to one 13-9 Reserved 8 1 = SET MAX security extension supported 7 Reserved 6 1 = SET FEATURES subcommand required to spinup after power-up 5 1 = Power-Up In Standby feature set supported 4 1 = Removable Media Status Notification feature set supported 3 1 = Advanced Power Management feature set supported 2 1 = CFA feature set supported 1 1 = READ/WRITE DMA QUEUED supported 0 1 = DOWNLOAD MICROCODE command supported



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Word	O/M	F/V	Value	Description
84	M	F F F F F F F F	4020h	Command set/feature supported extension. 15 Shall be cleared to zero 14 Shall be set to one 13-6 Reserved 5 0 = General Purpose Logging feature set not supported 4 Reserved 3 0 = Media Card Pass Through Command feature set not supported 2 0 = Media Serial Number not supported 1 0 = SMART self-test not supported 0 1 = SMART Error Logging not supported
85	M	X F F F X V F V V V V F F V V	7429h	Command set/feature enabled. 15 Obsolete 14 1 = NOP command enabled 13 1 = READ BUFFER command enabled F 12 1 = WRITE BUFFER command enabled 11 Obsolete 10 1 = Host Protected Area feature set enabled 9 1 = DEVICE RESET command enabled 8 1 = SERVICE interrupt enabled 7 1 = release interrupt enabled 6 1 = look-ahead enabled 5 1 = write cache enabled 4 Shall be cleared to zero to indicate that the PACKET Command feature set is not supported. 3 1 = Power Management feature set enabled 2 1 = Removable Media feature set enabled 1 1 = Security Mode feature set enabled 0 1 = SMART feature set enabled
86	M	F F F F F V F F F V V V F F F	3400h	Command set/feature enabled. 15-14 Reserved 13 1 = FLUSH CACHE EXT command supported 12 1 = FLUSH CACHE command supported 11 1 = Device Configuration Overlay supported 10 1 = 48-bit Address features set supported 9 1 = Automatic Acoustic Management feature set enabled 8 1 = SET MAX security extension enabled by SET MAX SET PASSWORD 7 See Address Offset Reserved Area Boot, INCITS TR27:2001 6 1 = SET FEATURES subcommand required to spin-up after power-up 5 1 = Power-Up In Standby feature set enabled 4 1 = Removable Media Status Notification feature set enabled 3 1 = Advanced Power Management feature set enabled 2 1 = CFA feature set enabled 1 1 = READ/WRITE DMA QUEUED command supported 0 1 = DOWNLOAD MICROCODE command supported
87	M	F F F	4022h	Command set/feature default. 15 Shall be cleared to zero 14 Shall be set to one 13 1 = IDLE IMMEDIATE with UNLOAD FEATURE supported 12 Reserved for technical report-



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Word	O/M	F/V	Value	Description
		V V F F F F F F V V V F F		11 Reserved for technical report- 10 1 = URG bit supported for WRITE STREAM DMA EXT and WRITE STREAM EXT 9 1 = URG bit supported for READ STREAM DMA EXT and READ STREAM EXT 8 1 = 64 bit World wide name supported 7 1 = WRITE DMA QUEUED FUA EXT command supported 6 1 = WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands supported 5 1 = General Purpose Logging feature set supported 4 1 = Valid CONFIGURE STREAM command has been executed 3 1 = Media Card Pass Through Command feature set enabled 2 1 = Media serial number is valid 1 1 = SMART self-test supported 0 1 = SMART error logging supported
88	O	F V V V V V V V F F F F F F F	047Fh	15-13 Reserved 14 1 = Ultra DMA mode 6 is selected 0 = Ultra DMA mode 6 is not selected 13 1 = Ultra DMA mode 5 is selected 0 = Ultra DMA mode 5 is not selected 12 1 = Ultra DMA mode 4 is selected 0 = Ultra DMA mode 4 is not selected 11 1 = Ultra DMA mode 3 is selected 0 = Ultra DMA mode 3 is not selected 10 1 = Ultra DMA mode 2 is selected 0 = Ultra DMA mode 2 is not selected 9 1 = Ultra DMA mode 1 is selected 0 = Ultra DMA mode 1 is not selected 8 1 = Ultra DMA mode 0 is selected 0 = Ultra DMA mode 0 is not selected 7 Reserved 6 1 = Ultra DMA mode 6 and below are supported 5 1 = Ultra DMA mode 5 and below are supported 4 1 = Ultra DMA mode 4 and below are supported 3 1 = Ultra DMA mode 3 and below are supported 2 1 = Ultra DMA mode 2 and below are supported 1 1 = Ultra DMA mode 1 and below are supported 0 1 = Ultra DMA mode 0 is supported
89	O	F	0003h	Time required for security erase unit completion
90	O	F	0000h	Time required for Enhanced security erase completion
91	O	V	0000h	Current advanced power management value
92	O	V	FFFEh	Master Password Revision Code
93		F F V F V	0000h	Hardware reset result. The contents of bits (12:0) of this word shall change only during the execution of a hardware reset. 15 Shall be cleared to zero. 14 Shall be set to one. 13 1 = device detected CBLID-above ViH 0 = device detected CBLID-below ViL 12-8 Device 1 hardware reset result. Device 0 shall clear these bits to zero. Device 1 shall set these bits as follows: 12 Reserved.



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Word	O/M	F/V	Value	Description
		V		11 0 = Device 1 did not assert PDIAG-. 1 = Device 1 asserted PDIAG-.
		F		10-9 These bits indicate how Device 1 determined the device number: 00 = Reserved. 01 = a jumper was used. 10 = the CSEL signal was used. 11 = some other method was used or the method is unknown.
		F		8 Shall be set to one.
		F		7-0 Device 0 hardware reset result. Device 1 shall clear these bits to zero. Device 0 shall set these bits as follows:
		V		7 Reserved.
		V		6 0 = Device 0 does not respond when Device 1 is selected. 1 = Device 0 responds when Device 1 is selected.
		V		5 0 = Device 0 did not detect the assertion of DASP-. 1 = Device 0 detected the assertion of DASP-.
		V		4 0 = Device 0 did not detect the assertion of PDIAG-. 1 = Device 0 detected the assertion of PDIAG-.
		V		3 0 = Device 0 failed diagnostics. 1 = Device 0 passed diagnostics.
		V		2-1 These bits indicate how Device 0 determined the device number: 00 = Reserved. 01 = a jumper was used. 10 = the CSEL signal was used. 11 = some other method was used or the method is unknown.
		F		0 Shall be set to one
94	O	V	0000h	Current automatic acoustic management value 15:8 Vendor's recommended acoustic management value. 7:0 Current automatic acoustic management value.
95		F	0000h	Stream Minimum Request Size
96		V	0000h	Streaming Transfer Time - DMA
97		V	0000h	Streaming Access Latency - DMA and PIO
98-99		F	0000h	Streaming Performance Granularity
100-103	O	V		Maximum user LBA for 48-bit Address feature set.
104	O	V	0000h	Streaming Transfer Time - PIO
105	O	F	0000h	Reserved
106	O	F	0000h	Physical sector size / Logical Sector Size 15 Shall be cleared to zero 14 Shall be set to one 13 1 = Device has multiple logical sectors per physical sector. 12 1 = Device Logical Sector Longer than 256 Words 11-4 Reserved 3-0 2X logical sectors per physical sector
107	O	F	0000h	Inter-seek delay for ISO-7779 acoustic testing in microseconds
108	O	F	0000h	15-12 NAA (3:0) 11-0 IEEE OUI (23:12)
109	O	F	0000h	15-4 IEEE OUI (11:0)



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Word	O/M	F/V	Value	Description
				3-0 Unique ID (35:32)
110	O	F	0000h	15-0 Unique ID (31:16)
111	O	F	0000h	15-0 Unique ID (15:0)
112-115	O	F	0000h	Reserved for worldwide name extension to 128 bits
116	O	V	0000h	Reserved for technical report-
117-118	O	F	0000h	Words per Logical Sector
119-126	O	F	0000h	Reserved
127	O	F F	0000h	Removable Media Status Notification feature set support 15-2 Reserved 1-0 00 = Removable Media Status Notification feature set not supported 01 = Removable Media Status Notification feature supported 10 = Reserved 11 = Reserved
128	O	F V F F V V V V F	0001h	Security status 15-9 Reserved 8 Security level 0 = High, 1 = Maximum 7-6 Reserved 5 1 = Enhanced security erase supported 4 1 = Security count expired 3 1 = Security frozen 2 1 = Security locked 1 1 = Security enabled 0 1 = Security supported
129-159		X	Virtium	Vendor specific
160	O	F F F V F	0000h	CFA power mode 1 15 Word 160 supported 14 Reserved 13 CFA power mode 1 is required for one or more commands implemented by the device 12 CFA power mode 1 disabled 11-0 Maximum current in ma
161-175		X	0000h	Reserved for assignment by the CompactFlash Association
176-205	O	V	@	Current media serial number
206-254		F	0000h	Reserved
255	M	X	XXXXh	Integrity word 15-8 Checksum 7-0 Signature

6.3 Device Overlay Data Structure

Table 18: Execute Device Diagnostic Command Inputs

Word	Value	Description
0	0002h	Data structure revision number
1	0007h	Multiword DMA modes supported Bit15:3 Reserved Bit2 1 = Reporting support for Multiword DMA mode 2 and below is changeable Bit1 1 =Reporting support for Multiword DMA mode 1 and below is changeable Bit0 1 =Reporting support for Multiword DMA mode 0 is changeable
2	007Fh	Ultra DMA modes supported Bit15:7 Reserved Bit6 1 = Reporting support for Ultra DMA mode 6 and below is changeable Bit5 1 = Reporting support for Ultra DMA mode 5 and below is changeable Bit4 1 = Reporting support for Ultra DMA mode 4 and below is changeable Bit3 1 = Reporting support for Ultra DMA mode 3 and below is changeable Bit2 1 = Reporting support for Ultra DMA mode 2 and below is changeable Bit1 1 = Reporting support for Ultra DMA mode 1 and below is changeable Bit0 1 = Reporting support for Ultra DMA mode 0 is changeable
3-6	Native MAX LBA	Maximum LBA (QWord) Bit63:48 Reserved Bit47:0 Maximum LBA
7	0089h	Command set/feature set supported part 1 Bit15 Reserved Bit14 1 = Reporting support for the Write-Read-Verify feature set is changeable Bit13 1 = Reporting support for the SMART Conveyance self-test is changeable Bit12 1 = Reporting support for the SMART Selective self-test is changeable Bit11 1 = Reporting support for the Forced Unit Access is changeable Bit10 Reserved for TLC Bit9 1 = Reporting support for the Streaming feature set is changeable Bit8 1 = Reporting support for the 48-bit Addressing feature set is changeable Bit7 1 = Reporting support for the HPA feature set is changeable Bit6 1 = Reporting support for the AAM feature set is changeable Bit5 1 = Reporting support for the TCQ feature set is changeable Bit4 1 = Reporting support for the PUIS feature set is changeable Bit3 1 = Reporting support for the Security feature set is changeable Bit2 1 = Reporting support for the SMART error log is changeable Bit1 1 = Reporting support for the SMART self-test is changeable Bit0 1 = Reporting support for the SMART feature set is changeable
8	0000h	Serial ATA Command set/feature set supported Bit15:5 Reserved for Serial ATA Bit4 1 = Reporting support for the SSP feature set is changeable Bit3 1 = Reporting support for asynchronous notification is changeable Bit2 1 = Reporting support for interface power management is changeable Bit1 1 = Reporting support for non-zero buffer offsets is changeable Bit0 1 = Reporting support for the NCQ feature set is changeable

Word	Value	Description
9	0000h	Reserved for Serial ATA
10-20	0000h	Reserved
21	0000h	Command set/feature set supported part 2 Bit15 1 = Reporting support for the NV Cache feature set is changeable Bit14 1 = Reporting support for the NV Cache Power Management feature set is changeable Bit13 1 = Reporting support for WRITE UNCORRECTABLE EXT is changeable Bit12 1 = Reporting support for the Trusted Computing feature set is changeable Bit11 1 = Reporting support for the Free-fall Control feature set is changeable Bit10:0 Reserved
22	0000h	Command set/feature set supported part 3 Bit15:0 Reserved
23-207	0000h	Reserved
208-254	0000h	Vender Specific
255	Checksum + A5h	Integrity word Bit15:8 Checksum Bit7:0 Signature

6.4 S.M.A.R.T. Attributes

6.4.1 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 Silicon Motion, Inc, including the data structure returned by those command. For more detail information on how to invoke the SMART command, please refer to the ATA specification since the topic is outside the scope of this document. For the information, the current implementation is based on the ATA-7 specification document.

6.4.2 SMART Command

The following table defines the SMART command set that is supported by SM2244/SM2250. Please note that D1h and D3h are obsolete commands. Although obsolete, the interfaces are still provided to maintain backward compatibility with the previous ATA specification.

Table 19: SMART Feature register values

Value	Command
D0h	SMART Read Data
D1h	SMART Read Attribute Threshold (Obsolete).
D2h	SMART Enable/Disable Attribute Auto-save.

D3h	SMART Save Attribute Values (Obsolete).
D4h	SMART Execute Off-Line immediate
D8h	SMART Enable Operations
D9h	SMART Disable Operations
DAh	SMART Return Status

6.4.3 SMART Read Data (D0h)

This command retrieves the SMART information from the device. The information is packed into the defined data structure in the following sub section.

Data Structure

The following table describes the data structure returned by “SMART Read Data” command.

Table 20: SMART Data Structure

Byte	F/V/X/R	Description
0 -1	X	Revision code
2-361	X	Vendor specific (see SMART Attributes)
362	V	Off-line data collection status
363	X	Self-test execution status byte
364 - 365	V	Total time in seconds to complete off-line data collection activity
366	X	Vendor specific
367	F	Off-line data collection capability
368 - 369	F	SMART capability
370	F	Error logging capability 7-1 Reserved 01= Device error logging supported
371	X	Vendor specific
372	F	Short self-test routine recommended polling time (in minutes)
373	F	Extended self-test routine recommended polling time (in minutes)
374	F	Conveyance self-test routine recommended polling time (in minutes)
375 - 385		Reserved
386 - 395	F	Firmware Version/Date Code
396 - 397	F	Reserved
398 - 399	F	Reserved
400 - 406	F	'SMI2250'
407-415		Vendor specific
416	F	Reserved
417	F	Program/write the strong page only
418-419	V	Number of spare block
420 - 423	V	Average Erase Count

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424-510	X	Vendor specific
511	V	Data structure 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 vendor specific and may be fixed or variable.
4. R = content (byte) is reserved and shall be zero.
5. All the offset and data those are highlighted with orange color are SMI proprietary definitions, while the non-highlighted offset and data are defined in the ATA specification.

6.4.4 SMART Attributes

Definitions

The following table defines the current SMI's SMART data attributes those are currently supported and their descriptions. These SMART attributes are located at offset 2 of the SMART Data Structure Please note that this attributes list might be modified as necessary without prior notice.

Table 21: SMART Attribute Definitions

Attribute ID	Attribute Name	Reset in Power On	Attribute Description
0x01	Read Error Rate	Yes	The rate of the total CRC errors occurred over the total of LB As read. The total LBAs read will be reset to 0 after each power-cycle while the CRC errors are accumulated for the life of the device.
0x05	Reallocated Sectors Count	No	Total number of bad blocks those are generated after the card is initialized by the pretest code.
0x09	Power-On Hours	Yes	Total hours the device is powered-on.
0xC0	Power-off Retract Count	No	Total number of sudden power-off count.
0xC2	Temperature	Yes	The temperature of the device. This attribute is not currently supported.
0xC3	Hardware ECC Recovered	N/A	Total number of errors those can be corrected by ECC engine. This attribute is not currently implemented. The value should be 0.
0xC4	Reallocation Event Count	N/A	Total count of remapping operations. This attribute is not currently implemented. The value should be 0.
0xC6	Uncorrectable Sector Count Off-line	No	Total count of errors those cannot be corrected by ECC engine.
0xC7	UltraDMA CRC Error Count	No	Total count of CRC errors during communication via the interface cable.
0x0C	Power Cycle Count	No	Total number of power cycles those have occurred during the life of the drive.

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0xF1	Total LBAs Written	No	Total number of 65536-LBAs counts (32 Megabytes data) written to the device. So, a value of 1 means that there are about 65536 total LBAs written to the device.
0xF2	Total LBAs Read	No	Total number of 65536-LBAs counts (32 Megabytes data) read from the device. So, a value of 1 means that there are about 65536 total LBAs read from the device.
0xA0	Uncorrectable Sector Count when read/write	Yes	Total count of uncorrectable errors when device performing reading/writing operation.
0xA1	Number of Valid Spare Block	No	Total number of overall valid spare block
0xA3	Number of Initial Invalid Block	No	Total number of bad blocks found during the card initialization (pretest mode).
0xA4	Total Erase Count	No	Total number of erase operations those have been performed.
0xA5	Maximum Erase Count	No	The maximum number of erase operations those have ever been performed on a block.
0xA6	Minimum Erase Count	No	The minimum number of erase operations those have ever been performed on a block.
0xA7	Average Erase Count	No	Total number of erase operations over the total blocks those are actually affected.

Data Structure

The attribute information occupies 12 bytes of data which describes in the following table.

Table 22: Bytes 2-361 Individual Attribute Data

Byte	Comment
0	Attribute ID.
1 -2	Reserved.
3	Contains normalized fixed value ("0x64").
4	Duplicate of byte-3, which is a fixed value ("0x64").
5-11	Raw Data value in little-endian format.

6.4.5 SMART Read Attribute Threshold (D1h)

This command is obsolete starting from ATA-4 Specification. The command interface is still supported to maintain backward compatibility with older host implementing ATA-4. When invoked, SM2244/SM2250 will respond to the command by returning normal output (provided the right command and parameters are entered) together with the fixed threshold data values. However, these threshold values should be ignored since they don't have any significant meaning.

Data Structure

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The following table describes the data structure returned by this SMART Read Attribute Threshold Command.

Table 23: SMART Read Attribute Threshold Command

Byte	Comment
0	Attribute ID
1	Threshold value
2-11	Reserved. Set these bytes to 0x00

Threshold Values

The following table describes the fixed values returned by SM2244/SM2250 firmware. These values are provided here for information only and as mentioned before that they should be ignored.

Table 24: Threshold Values

Attribute ID	Attribute Name	Threshold Value
0x01	Read Error Rate	0x00
0x05	Reallocated Sectors Count	0x00
0x09	Power-On Hours	0x00
0xC0	Power-off Retract Count	0x00
0xC2	Temperature	0x00
0xC3	Hardware ECC Recovered	0x00
0xC4	Reallocation Event Count	0X10
0xC6	Uncorrectable Sector Count Offline	0x32
0xC7	UltraDMA CRC Error Count	0x32
0x0C	Power Cycle Count	0x00
0xF1	Total LBAs Written	0x00
0xF2	Total LBAs Read	0x00
0xA0	Uncorrectable Sector Count when read/write	0x00
0xA1	Number of Valid Spare Block	0x00
0xA3	Number of Initial Invalid Block	0x00
0xA4	Total Erase Count	0x00
0xA5	Maximum Erase Count	0x32
0xA6	Minimum Erase Count	0x32
0xA7	Average Erase Count	0x64

SMART Enable/Disable Attribute Auto-Save (D2h)

The purpose of this command is to enable and disable the optional attribute auto-save feature. In

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SM2244/SM2250, the auto-save feature is always enabled; regardless the disable function is invoked. This will prevent SM2244/SM2250 to lose any information those might be critical for the device's life indicators. SM2244/SM2250 still responds by returning normal outputs when the command and right parameters are executed.

SMART Save Attribute Values (D3h)

This command is obsolete starting from ATA-6 specification. The command interface is still supported for backward compatibility with the older host implementing ATA-6. SM2244/SM2250 responds to the command by returning normal outputs, provided the command and right parameters are entered. It is currently not necessary to call this command since SM2244/SM2250 is saving the attributes values automatically. Please refer to SMART Enable/Disable Attribute Auto-Save (D2h) for the reason of this auto-save.

SMART Execute Off-Line Immediate (D4h)

The purpose of this command is to immediately initiate any activities that collect SMART data or execute self-diagnostic test routine in off-line mode or captive-mode depending on the given sub commands. The offline data collection status, self-test execution status, and estimated time of completion for the off-line data collection activity will be reported in the SMART data structure offset 362, 363, and 364 respectively. Please refer to SMART Data Structure.

Although the interfaces are supported, however, SM2244/SM2250 does not currently have any off-line data collection nor self-test defined in the firmware. Calling the off-line data collection sub-command will always result in status value of 02h, which is "Off-line data collection activity was completed without error". While calling self-test sub-commands will always result in status value of 0, which means that "the previous selftest routine completed without error or no self-test has ever been run"

The following sub command interfaces are currently accepted by SM2244/SM2250. Other sub commands will result in command aborted error.

Table 25: SMART Execute Off-Line Immediate LBA Low Register Values

Value	Description of subcommand to be executed
0	Execute SMART off-line routine immediately in off-line mode
1	Execute SMART Short self-test routine immediately in off-line mode
2	Execute SMART Extended self-test routine immediately in off-line mode
3	Execute SMART Conveyance self-test routine immediately in off-line mode
4	Execute SMART Selective self-test routine immediately in off-line mode
127	Abort off-line mode self-test routine
129	Execute SMART Short self-test routine immediately in captive mode
130	Execute SMART Extended self-test routine immediately in captive mode
131	Execute SMART Conveyance self-test routine immediately in captive mode
132	Execute SMART Selective self-test routine immediately in captive mode

SMART Enable Operations (D8h)

This command enables access to all SMART command operation. Without enabling the SMART operations, all the SMART command above will return command aborted error.

SMART Disable Operations (D9h)



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This command disables access to all SMART command operation. When the SMART operation is disabled, accessing all the other SMART Commands (other than D8h and D9h) will return command aborted error.

SMART Return Status (DAh)

This command returns the reliability status of the device to the host. It will check the device's attributes against pre-determined threshold values and return the status result. If the attributes have reached the threshold values, then the device will set the LBA Mid register to F4h and the LBA High register to 2Ch. Otherwise, it will keep the original LBA Mid Register value of 4Fh and the LBA High register value of C2h. Currently, SM2244/SM2250 only checks the total spare block available on the device against the minimum spare block threshold. This spare block threshold value is set in the CID offset 0x2C.

7.0 References

FCC, CE MIL 810G, ACS-2 references
JESD219, Solid State Drive (SSD) Endurance Workloads



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8.0 Revision History

Date	Rev.	Page	Changes
06/06/2012	1.0	All	Initial Released

FCC ID: OET-STORFY

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for

help.