DELKIN DEVICES®

S225 SATA SSD

2.5” Solid State SATA Drives

Engineering Specification

Document Number L500285

Revision: F

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1.0 General Specifications

The S225 Series of 2.5” SATA II drives represents Delkin Device’s next generation in solid state technology, delivering the performance, reliability and endurance demanded by embedded industrial users. Delkin’s drives are offered in two product grades: SLC Industrial and MLC Industrial, in capacities from 8GB to 512GB. This broad product range allows customers to select the optimum product for their application, whether as a boot drive or for heavy data capture, based on read/write performance, endurance, temperature range or cost per GB. Superior resistance to shock and vibration, along with optional conformal coating, make them ideal for embedded systems and harsh environments.

Table 1. General Specifications

Specification	Value	
Model Numbers	See Table 2	
Capacity	SLC: 8GB – 256GB MLC: 16GB – 512GB	
Form Factor	SFF-8201 Specification for 2.5” Form Factor (Small Form Factor Committee)	
Interface	SATA revision 2.6, compatible with SATA 1.5Gb/s and 3.0Gb/s interface rates.	
Interface connector	22 Pin (7 +15) SATA connector (see Section 4 for pin-out)	
Hot swappable	Yes	
Environmental certifications	RoHS and CE/FCC	
Performance		
Interface burst speed	1.5 or 3.0 Gb/s	
Sustained read (512 byte)	Up to 240 MB/s (varies by configuration)	
Sustained write (512 byte)	Up to 190 MB/s (varies by configuration)	
Reliability/Endurance		
MTBF	>2,500,000 power on hours @ 0°C >300,000 power on hours @ 60°C	
Endurance (TBW)	See table in section 3.6	
Features		
TRIM	Supports TRIM based on ATA-8	
Native Command Queuing	Supports up to 32 Commands	
Power		
Supply voltage (operating)	3.3V ±10%	5.0V ±10%
Max Current: (may vary with drive configuration)		
Idle	190mA	140mA
Read	330mA	235mA
Write	550mA	415mA

Environmental	
Storage temperature (°C)	-50 ~ 100°C
Operating temperature (°C)	-40 ~ 85°C
Vibration (operating/non-operating)	20G (80 – 2000 Hz)
Shock (operating/non-operating)	1,500G/0.5 ms
Acoustic noise	0 dB
Physical Dimensions	
Height	9.20 ±0.15mm (0.36”)
Width	69.75 +0.25mm/-0.15mm (2.75”)
Length	99.70 ± 0.25mm (3.93”)

1.1 Functional Block Diagram

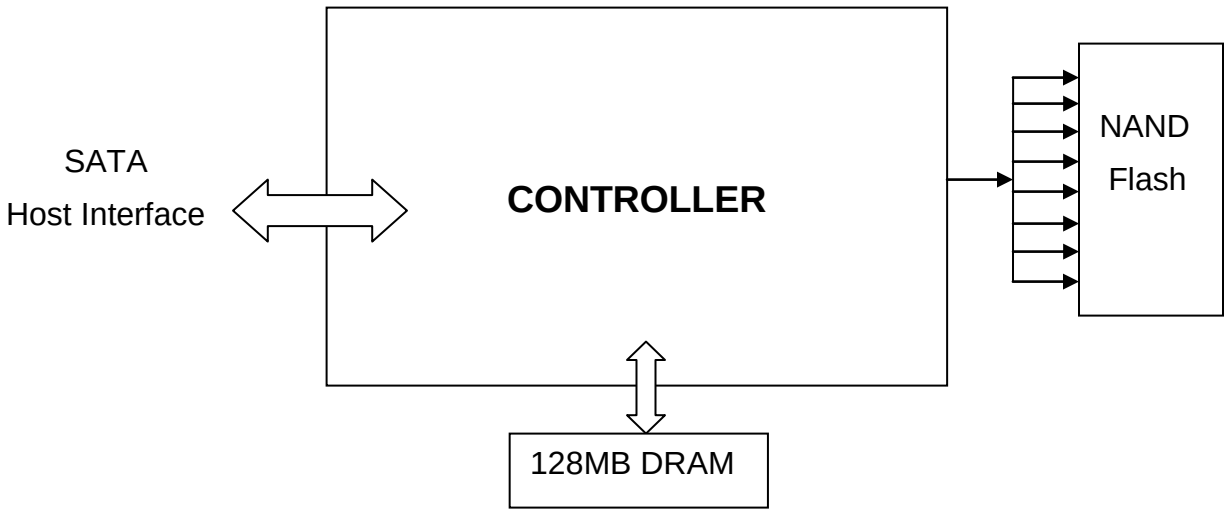

Figure 1. Functional Block Diagram

1.2 Part Numbers

Table 2. Part Numbers

Capacity	Product Grades MLC Industrial Grade (-40° to 85°C) SLC Industrial Grade (-40° to 85°C)	Part Numbers
8GB	SLC Industrial Grade	DE08TFHXP-25000-D
16GB	MLC Industrial Grade	DE16NHUXP-25000-D
	SLC Industrial Grade	DE16TFNXP-25000-D
32GB	MLC Industrial Grade	DE32NGTXP-25000-D
	SLC Industrial Grade	DE32TFNXP-25000-D DE32TGPXP-25000-D
64GB	MLC Industrial Grade	DE64NKBXP-25000-D
	SLC Industrial Grade	DE64MGGXP-25000-D DE64TGPXP-25000-D
128GB	MLC Industrial Grade	DE1HNKBXP-25000-D
	SLC Industrial Grade	DE1HMGMXP-25000-D
256GB	MLC Industrial Grade	DE2HNKCXP-25000-D
	SLC Industrial Grade	DE2HMGMXP-25000-D
512GB	MLC Industrial Grade	DE5HNKCXP-25000-D

*Note: Usable capacities are within 10% of the gross capacity figures shown above, which is typical with all NAND flash devices, as a small portion of the total is needed for controller firmware and spare block reserves.

2.0 Mechanical Specifications

2.1 Dimensions

Dimension	Measurement
Height	9.20 mm ±0.15 (0.36”)
Width	69.75 mm +0.25/-0.15 (2.75”)
Length	99.70 mm ±0.25 (3.93”)

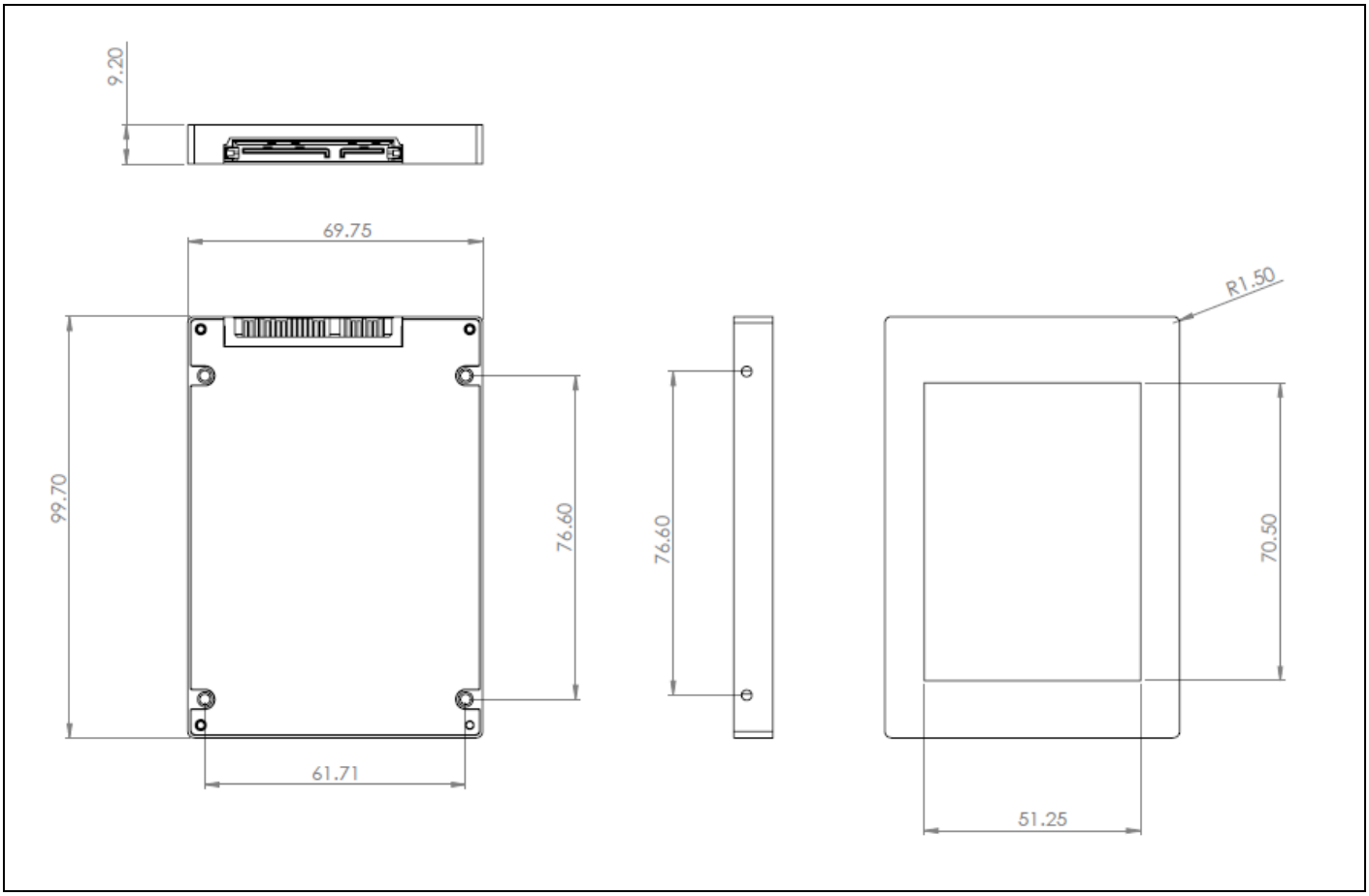

Figure 2. Physical Dimensions

Note: All dimensions are in millimeters

3.0 Product Specifications

3.1 System Interface and Configuration

- Interface burst speed: 3.0 Gb/s
- PIO 0-4
- Up to UDMA mode 6 (Ultra DMA133)
- Fully compatible with ATA-7 Standard
- SATA Rev. 2.6

3.2 System Performance

Read / Write	SLC Performance	MLC Performance
Sequential Read	Up to 240 MB/s*	Up to 240 MB/s*
Sequential Write	Up to 190 MB/s*	Up to 185 MB/s*

*Dependent upon drive capacity and flash configuration.

3.3 I/O Performance

	Sequential Read	Sequential Write	Random Read	Random Write	Units
512B	18300	13500	7500	1700	I/Os per second
4KB	14600	10100	4400	650	

3.4 Supply Voltage

Item	Requirements
Operating Voltages	3.3 V ± 10%
	5 V ± 10%

3.5 System Power Consumption

Power State	Max Current @ 3.3 V	Max Current @ 5 V
Idle	190 mA	140 mA
Read	330 mA	235 mA
Write	550 mA	415 mA

3.6 System Reliability

MTBF

Attribute	Value
MTBF	>2.5 Million power-on hours @ 0°C >300,000 power-on hours @ 60°C

Endurance

The table below provides estimates of drive endurance (expressed as Terabytes Written or TBW) based on specific workload scenarios, using a theoretical model that takes into account the specific flash specifications in each drive configuration. Contact Delkin for endurance estimates for other specific workload scenarios.

Table 3. Endurance Estimates by Part Number

		Sequential Write Size, 24/7 Operation	
Part Number(s)	Description	1000 Bytes/Sec	5000 Bytes/Sec
DE08TFHXP-25000-D	8GB SLC, Industrial Grade	8 TBW	18 TBW
DE16TFNXP-25000-D	16GB SLC, Industrial Grade	16 TBW	36 TBW
DE32TGPXP-25000-D DE32TFNXP-25000-D	32GB SLC, Industrial Grade	30 TBW	69 TBW
DE64MGGXP-25000-D	64GB SLC, Industrial Grade	33 TBW	133 TBW
DE64TGPXP-25000-D	64GB SLC, Industrial Grade	60 TBW	125 TBW
DE1HMGMXP-25000-D	128GB SLC, Industrial Grade	61 TBW	259 TBW
DE2HMGMXP-25000-D	256GB SLC, Industrial Grade	120 TBW	500 TBW
DE16NHUXP-25000-D	16GB MLC, Industrial Grade	<1 TBW	1 TBW
DE32NGTXP-25000-D	32GB MLC, Industrial Grade	1 TBW	3 TBW
DE64NKBXP-25000-D	64GB MLC, Industrial Grade	1 TBW	6 TBW
DE1HNKBXP-25000-D	128GB MLC, Industrial Grade	3 TBW	12 TBW
DE2HNKCXP-25000-D	256GB MLC, Industrial Grade	5 TBW	25 TBW
DE5HNKCXP-25000-D	512GB MLC, Industrial Grade	11 TBW	46 TBW

The figures provided are estimates and not guarantees of endurance. Actual results may vary depending on usage model, operating temperature and other conditions.

3.7 Environmental Specifications

Features	Operating
Operating Temperature	MLC Industrial Grade: 40 ~ 85°C SLC Industrial Grade: -40 ~ 85°C
Storage Temperature	-50 ~ 100°C
Vibration	20 G peak to peak max. (operating/non-operating)
Shock	1500 G max. (operating/non-operating)
Acoustic Noise	0 dB

3.8 Capacity Information*

Drive Size	Cylinders	Heads	Sectors	Total Sectors
8GB	15,538	16	63	15,466,496
16GB	16,383	15	63	30,932,992
32GB	16,383	15	63	61,865,984
64GB	16,383	15	63	123,731,968
128GB	16,383	15	63	247,463,936
256GB	16,383	15	63	494,927,872
512GB	16,383	15	63	989,855,744

*Note that for any drive with a capacity over 8GB, these are not true CHS settings, as the drive is in LBA mode and is only emulating CHS settings.

4.0 Electrical Interface Specification

4.1 Serial ATA Interface connector

The Host is connected to the SSD with a standard 22 pin (7 + 15) SATA connector.

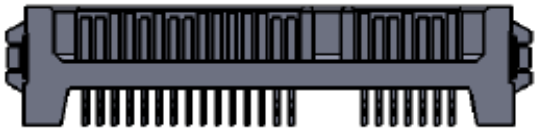

Figure 3. 22 pin (7+15) SATA connector

4.2 Pin Assignments

Signal Segment Pinout

Pin	Signal	
S1	GND	Power Ground
S2	RX+	Differential signal pair A
S3	RX-	
S4	GND	Power Ground
S5	TX-	Differential signal pair B
S6	TX+	
S7	GND	Power Ground

Power Segment Pinout

Pin	Signal	
P1	V3	3.3V Power Input
P2	V3	3.3V Power Input
P3	V3	3.3V Power Input
P4	GND	Ground
P5	GND	Ground
P6	GND	Ground
P7	V5	5V Power Input
P8	V5	5V Power Input
P9	V5	5V Power Input
P10	GND	Ground
P11	Reserved	Activity LED
P12	GND	Ground
P13	N.C.	No Connection
P14	N.C.	No Connection
P15	N.C.	No Connection

4.3 Absolute Maximum Ratings 3.3 Volt

Parameters	Symbol	Min	Max	Unit
Input Voltage	Vcc	-0.3	3.6	V

4.4 Absolute Maximum Ratings 5 Volt

Parameters	Symbol	Min	Max	Unit
Input Voltage	Vcc	-0.3	5.5	V

4.5 Electrical Characteristics

4.5.1 In 3.3 Volt Circuit

Parameters	Symbol	Typical	Unit
Supply Voltage	Vcc	3.3 ± 10%	V
Idle Current	ISLP	190	mA
Read Current	IACTR	300	mA
Write Current	IACTW	530	mA
TX Differential Output Voltage	VdiffTx	500	mVppd
RX Differential Input Voltage	VdiffRx	400	mVppd

4.5.2 In 5 Volt Circuit

Parameters	Symbol	Typical	Unit
Supply Voltage	Vcc	5 ± 10%	V
Idle Current	ISLP	140	mA
Read Current	IACTR	210	mA
Write Current	IACTW	350	mA
TX Differential Output Voltage	VdiffTx	500	mVppd
RX Differential Input Voltage	VdiffRx	400	mVppd

5.0 Command Descriptions

5.1 Supported ATA Commands

Table 4: Supported ATA Commands

Command Name	Command Code (Hex)	Protocol
General Feature Set		
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 Feature Set		
Check Power Mode	E5h or 98h	Non-data
Idle	E3h or 97h	Non-data
Idle Immediate	E1h or 95h	Non-data
Sleep	E6h or 99h	Non-data
Standby	E2h or 96h	Non-data
Standby Immediate	E0h or 94h	Non-data
Security Mode Feature Set		
Security Set Password	F1h	PIO data-out
Security Unlock	F2h	PIO data-out
Security Erase Prepare	F3h	Non-data
Security Erase Unit	F4h	PIO data-out
Security Freeze Lock	F5h	Non-data
Security Disable Password	F6h	PIO data-out

Command Name	Command Code (Hex)	Protocol
SMART Feature Set		
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 Execute Off-line Immediate	B0h	Non-data
SMART Read Data	B0h	Non-data
Host Protected Area Feature Set		
Read Native Max Address	F8h	Non-data
Set Max Address	F9h	Non-data
Set Max Set Password	F9h	PIO data-out
Set Max Lock	F9h	Non-data
Set Max Freeze Lock	F9h	Non-data
Set Max Unlock	F9h	PIO data-out
48-bit Address Feature Set		
Flush Cache Ext	EAh	Non-data
Read Sector(s) Ext	24h	PIO data-in
Read DMA Ext	25h	DMA
Read Multiple Ext	29h	PIO data-in
Read Native Max Address Ext	27h	Non-data
Read Verify Sector(s) Ext	42h	Non-data
Set Max Address Ext	37h	Non-data
Write DMA Ext	35h	DMA
Write DMA FUA Ext	3Dh	DMA
Write Multiple Ext	39h	PIO data-out
Write Multiple FUA Ext	CEh	PIO data-out
Write Sector(s) Ext	34h	PIO data-out
NCQ Feature Set		
Read FPDMA Queued	60h	DMA Queued
Write FPDMA Queued	61h	DMA Queued

5.2 Identify Device Parameters

The IDENTIFY DEVICE Command enables the host to receive parameter information from the device. The following table provides the definition and value of each field in the Identify Device Information.

Table 5: Identify Device Parameters

Word Address	Default Value	Fixed/Variable	Data Field Type Information
0	044Ah	F	General configuration bit
1	XXXXh	X	Default number of cylinders
2	0000h	V	Reserved
3	00XXh	X	Default number of heads
4	0000h	X	Obsolete
5	0240h	X	Obsolete
6	XXXXh	F	Default number of sectors per track
7-8	XXXXh	V	Number of sectors per card
9	0000h	X	Obsolete
10-19	XXXXh	F	Serial number in ASCII
20	0002h	X	Obsolete
21	0002h	X	Obsolete
22	0000h	X	Obsolete
23-26	XXXXh	F	Firmware revision in ASCII
27-46	XXXXh	F	Model number in ASCII
47	8001h	F	Max number of sectors on Read/Write Multiple command
48	0000h	F	Reserved
49	0F00h	F	Capabilities
50	4000h	F	Capabilities
51	0200h	F	PIO data transfer cycle timing mode
52	0000h	X	Obsolete
53	0007h	F	Field Validity
54	XXXXh	X	Current numbers of cylinders
55	XXXXh	X	Current numbers of heads
56	XXXXh	X	Current sectors per track
57 - 58	XXXXh	X	Current capacity in sectors (LBAs) (Word 57 = LSW, Word 58 = MSW)
59	0100h	F	Multiple sector setting
60-61	XXXXh	F	Total number of sectors addressable in LBA Mode
62	0000h	X	Reserved
63	0007h	F	Multiword DMA transfer mode Supports MDMA Modes 0,1 & 2
64	0003h	F	Advanced PIO modes supported

Word Address	Default Value	Fixed/Variable	Data Field Type Information
65	0078h	F	Minimum Multiword DMA transfer cycle time per word
66	0078h	F	Recommended Multiword DMA transfer cycle time
67	0078h	F	Minimum PIO transfer cycle time without flow control
68	0078h	F	Minimum PIO transfer time with IORDY flow control
69-74	0000h	F	Reserved
75	001Fh	F	Queue Depth
76	0006h	F	Serial ATA capabilities • Supports SATA Gen 1 • Supports SATA Gen 2
	0206h	F	• Supports receipt of host-initiated interface power management requests
77	0000h	V	Reserved
78	0008h	F	Device supports initiating interface power management
79	0000h	V	Reserved
80	0080h	F	Major version number (ATAPI-7)
81	0000h	F	Minor version number
82	742Bh	F	Command sets supported 0
83	5500h	F	Command sets supported 1
84	4002h	F	Command sets supported 2
85 - 87	XXXXh	V	Command sets/feature enabled
88	007Fh	V	UDMA mode supported and selected
89	0003h	F	Time required for Security erase unit completion
90	0000h	F	Time required for Enhanced security erase unit completion
91	0000h	V	Current Advanced power management value
92	FFFeh	V	Master Password Revision Code
93-99	0000h	V	Reserved
100-103	XXXXh	V	Maximum user LBA for 48bit address feature set
104-127	0000h	V	Reserved
128	0001h	V	Security status
129-159	0000h	X	Vendor unique bytes
160	0000h	F	Power requirement description
161	0000h	X	Reserved
162	0000h	F	Key management schemes supported
163	0000h	F	CF Advanced True IDE Timing Mode Capability and Setting
164 – 216	0000h	V	Reserved
217	0100h	F	Non-rotating media (SSD)
218 – 255	0000h	X	Reserved

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.

6.0 SMART Feature Set

The Delkin S225 drives feature Self-Monitoring, Analysis and Reporting Technology (SMART). Enabled by readily-available software utilities, SMART can monitor online storage devices for failure prediction, status reporting, and bad sector detection and repair. SMART can protect against system downtime and prevent data loss.

6.1 Sub Command Sets

In order to select a subcommand, the host must write the subcommand code to the device’s Features Register before issuing the SMART Function Set command. The subcommands are listed below:

Value	Subcommand	Description
D0h	READ DATA	Retrieves SMART information from the device, which is packed into the data structure as defined in Section 6.2
D1h	READ ATTRIBUTETHRESHOLD	This command is obsolete as of ATA-4 and later versions, but is maintained for backward compatibility.
D2h	ENABLE/DISABLE AUTOSAVE	Enables / disables optional attribute auto-save feature, however, the auto-save feature is always enabled.
D3h	SAVE ATTRIBUTE VALUES	This command is obsolete as of ATA-6 and later versions, but is maintained for backward compatibility. Attribute values are saved automatically.
D4h	EXECUTE OFF-LINE IMMEDIATE	This command initiates activities that collect SMART data or execute self-diagnostic test routines in an off-line mode or captive mode, however there are currently no self-test or off-line data collection capabilities.
D5h	RESERVED	
D6h	RESERVED	
D8h	ENABLE SMART OPERATIONS	This command enables access to all SMART command operations.
D9h	DISABLE SMART OPERATIONS	This command disables access to all SMART command operations.
DAh	RETURN STATUS	This command returns the reliability status of the device to the host. This reliability status is determined by comparing the number of available spare blocks to the minimum spare block threshold.

If the reserved size is below the threshold, the status can be read from the Cylinder Register using the Return Status command (DAh.) Please note that D1h and D3h are obsolete commands according to ATA-7, but are still provided to maintain backward compatibility with previous ATA specifications

6.2 SMART Data Structure

The following table describes the data structure returned by the "SMART Read Data (D0h)" Command.

Byte	Fixed/Variable	Data Field Type Information
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 • 0 1=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	R	Reserved
386 – 395	F	Firmware revision / Date code
396 – 397	F	Number of initial invalid blocks (396= MSB, 397= LSB)
398 – 399	F	Reserved
400 – 406	F	Vendor specific
407 – 415	X	Vendor specific
416	F	Reserved
417	F	Program/write to the strong page only
418 – 419	V	Number of spare blocks
420 – 423	V	Average Erase Count
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.

6.3 SMART Attributes

The following table defines the SMART data attributes currently supported and their descriptions, which are located at offset 2 of the SMART Data Structure (see section 6.2.)

Attribute ID	Attribute Name	Reset at Power On?	Max Size (Bytes)	Attribute Description
0x01	Read Error Rate	Yes	4	The rate of the total CRC errors occurred over the total LBA's read. The total LBA's read will be reset to 0 after each power cycle, while the CRC errors will be accumulated over the life of the drive.
0x05	Reallocated Sectors Count	No	2	Total number of bad blocks that are generated after the card is initialized by the pretest code.
0x09	Power-On Hours	No	4	Total accumulated hours the device is powered on.
0x0C	Power Cycle Count	No	2	Total number of power cycles that have occurred during the life of the drive.
0xA0	Uncorrectable Sector Count during Read/Write	Yes	4	Total count of uncorrectable errors when device performing read/write operations.
0xA1	Number of Valid Spare Blocks	No	2	Total number of overall valid spare blocks.
0xA3	Number of Initial Invalid Blocks	No	2	Total number of bad blocks found during the card initialization (pretest mode.)
0xA4	Total Erase Count	No	7	Total number of erase operations that have been performed on all the blocks (excluding the system blocks, bad blocks and reserved blocks.)
0xA5	Maximum Erase Count	No	4	The maximum number of erase operations that have ever been performed on a single block (excluding the system blocks, bad blocks and reserved blocks.)
0xA6	Minimum Erase Count	No	4	The minimum number of erase operations that have ever been performed on a single block (excluding the system blocks, bad blocks and reserved blocks.)
0xA7	Average Erase Count	No	4	The average number of erase operations over the all available valid blocks (excluding the system blocks, bad blocks and reserved blocks.)
0xC0	Power-Off Retract Count	No	2	Total number of sudden power-off count that affects the data reliability.
0xC6	Uncorrectable Sector Count Off-line	No	4	Total accumulated count of errors that cannot be corrected by ECC engine for the life of the device
0xC7	UltraDMA CRC Error Count	No	2	Total count of CRC errors during communication via the interface cable.

0xF1	Total LBA’s Written	No	7	The lower 7 bytes of the 12-byte total number of LBA’s written to the device. (The upper 5 byte value is located at Attribute 0xF3).
0xF2	Total LBA’s Read	No	7	The lower 7 bytes of the 12-byte total number of LBA’s read from the device. (The upper 5 byte value is located at Attribute 0xF4).
0xF3	Total LBA’s Written Expanded	No	5	The upper 5 bytes of the 12-byte total number of LBA’s written to the device. (The lower 7 byte value is located at Attribute 0xF1).
0xF4	Total LBA’s Read Expanded	No	5	The upper 5 bytes of the 12-byte total number of LBA’s read from the device. (The lower 7 byte value is located at Attribute 0xF2).

Data Structure

The attribute information occupies 12 bytes of data which is described in the following table:

Byte	**Description**
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