S.M.A.R.T. Attributes

Technical Reference for

XceedLite and XceedLite2 SATA Drives

February 2009

P/N: 810800016

Rev. A

ESD Warning

Before handling an Adtron drive or any media associated with the drive, ensure you are working in an ESD-safe environment.

Notice

This manual describes the self-monitoring and reporting technology (S.M.A.R.T.) attributes the specified Adtron drives support. Adtron reserves the right to modify, amend or in any way change the contents and/or products described herein, at any time, without notification.

The information contained in this document is provided for reference only. Adtron and SMART Modular Technologies do not assume any liability arising out of the application or use of the products or features described herein. This document may contain or reference information or products protected by copyrights or patents and does not convey any license under the patent rights of Adtron Corporation, nor the rights of others. Errors in this document may be reported in writing to the following address:

Adtron Corporation
4415 E. Cotton Center Blvd.
Phoenix, AZ 85040
Tel: 602-735-0300
Fax: 602-735-0349
www.adtron.com
techsupport@adtron.com

Adtron Corporation is an ISO 9001:2000 certified company.
Adtron is a wholly-owned subsidiary of SMART Modular Technologies.

EraSure® is a registered trademark of Adtron Corporation.
All other trademarks are the property of their respective owners.

© 2009 SMART Modular Technologies. All rights reserved.

TABLE OF CONTENTS

1.0 INTRODUCTION

Adtron drives support several self-monitoring analysis and reporting technology (S.M.A.R.T.) subcommands designed to alert you of possible drive problems. With these subcommands, you can retrieve information regarding S.M.A.R.T. attributes, such as the total number of hours the drive has been operational. While Adtron adheres to the ATA Specification for S.M.A.R.T. commands, the attributes are vendor-specific and include the following:

- Endurance Remaining
- Power-On Time (in Seconds)
- Uncorrectable ECC Count
- Good Block Rate
- Power-On Hours

This document describes how to use S.M.A.R.T. attributes to determine the "health" of the following drives:

- XceedLite 1.8" SATA
- XceedLite2 2.5" SATA

NOTE:	Future firmware versions may support different or additional attributes.

To obtain a technical reference for other drives, contact your Adtron sales representative.

2.0 S.M.A.R.T. SUBCOMMANDS

As indicated in the ATA Specification, the S.M.A.R.T. Operations command supports several subcommands, including Return Status and Read Data. For the purposes of monitoring drive health, the subcommands described in the following table are used.

Table 1: S.M.A.R.T. Commands

Command Name	Function	Page
Enable Operations	Enables S.M.A.R.T. functions on the drive. All other S.M.A.R.T. commands return an ABORT if this command is not issued first.	5
Disable Operations	Disables S.M.A.R.T. functions on the drive.	5
Return Status	Indicates whether or not an attribute value has exceeded the defined threshold. This command simply returns a pass or fail; it does not indicate the attribute that caused the failure.	6
Read Data	Returns the current value for each supported attribute.	7
Read Attribute Thresholds	Returns the defined threshold value for each supported attribute.	8

The following sections define the command and output registers.

2.1 S.M.A.R.T. Subcommand Registers

All S.M.A.R.T. subcommands are issued with the S.M.A.R.T. Operations command (code B0h). The Features register of the S.M.A.R.T. Operations command defines the subcommand, with all other registers set to the values indicated in the following table.

Table 2: S.M.A.R.T. Command Input Registers

	Bit							
Register	7	6	5	4	3	2	1	0
Features	Subcommand Code							
Sector Count	00h or 01h (depends on the command)							
Sector Number	00h							
Cylinder Low	4Fh							
Cylinder High	C2h							
Device/Head	A0h							
Command	B0h							

The drive returns an error if the any of the registers are not set properly (for example, Cylinder Low is set to 00h).

2.2 Output Registers

When the command succeeds, the drive returns the values indicated in the following table.

Table 3: Output Register

	Bit							
Register	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Features	00h							
Sector Count	00h or 01h (depends on the command)							
Sector Number	00h							
Cylinder Low	4Fh							
Cylinder High	C2h							
Device/Head	A0h							
Status	50h							

If an error occurs, the Status register is set to 51h, and the Error register (the first register) identifies the error that occurred. See the ATA specification for a description of the possible Error bytes.

NOTE: The drive returns an error with the ABRT bit set if the drive receives a S.M.A.R.T. subcommand and S.M.A.R.T. operations are not enabled. See the following section for more information.

If successful, the Read Data and Read Attribute Thresholds subcommands return 512 bytes of data containing the S.M.A.R.T. attribute information. See page 7 and 8 for more information.

3.0 S.M.A.R.T. ATTRIBUTE COMMANDS

This section describes the S.M.A.R.T. subcommands used to retrieve S.M.A.R.T. attribute data.

3.1 Enable/Disable S.M.A.R.T. Operations

Features: D8h (Enable); D9h (Disable)

Use: Enables S.M.A.R.T. on the drive. Before you can retrieve S.M.A.R.T. data, you must first enable S.M.A.R.T. operations. S.M.A.R.T. operations remain enabled across power cycles. To disable S.M.A.R.T. operations, issue the Disable S.M.A.R.T. Operations subcommand (D9h in the Features register).

Transfer: None

Input: See the following table for the input registers.

Table 4: S.M.A.R.T. Enable Operations Registers

	Bit							
Register	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Features	D8h (Enable) or D9h (Disable)							
Sector Count	00h							
Sector Number	00h							
Cylinder Low	4Fh							
Cylinder High	C2h							
Device/Head	A0h							
Command	B0h							

3.2 Return Status

Features: DAh

Use: Indicates the current status of the supported S.M.A.R.T. attributes. If the drive returns 4Fh in the Cylinder Low and C2h in the Cylinder High registers, the attribute values are below the specified threshold. If the Cylinder Low and Cylinder High registers contain F4h and 2Ch (that is, the nibbles are reversed), one or more of the attributes exceeded the defined threshold level.

Transfer: None

Input: See the following table for the input registers.

Table 5: S.M.A.R.T. Return Status Registers

	Bit							
Register	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Features	DAh							
Sector Count	00h							
Sector Number	00h							
Cylinder Low	4Fh							
Cylinder High	C2h							
Device/Head	A0h							
Command	B0h							

NOTE: Because none of the attributes set the Pre-Fail Advisory bit, the Return Status command should always return 4Fh in the Cylinder Low registry and C2h in the Cylinder High registry. That is, the command should never return a failure.

3.3 Read Data

Features: D0h

Use: Returns 512 bytes of information specific to each supported S.M.A.R.T. attribute.

Transfer: PIO Data-In

Input: See the following table for the input registers.

Table 6: S.M.A.R.T. Read Data Registers

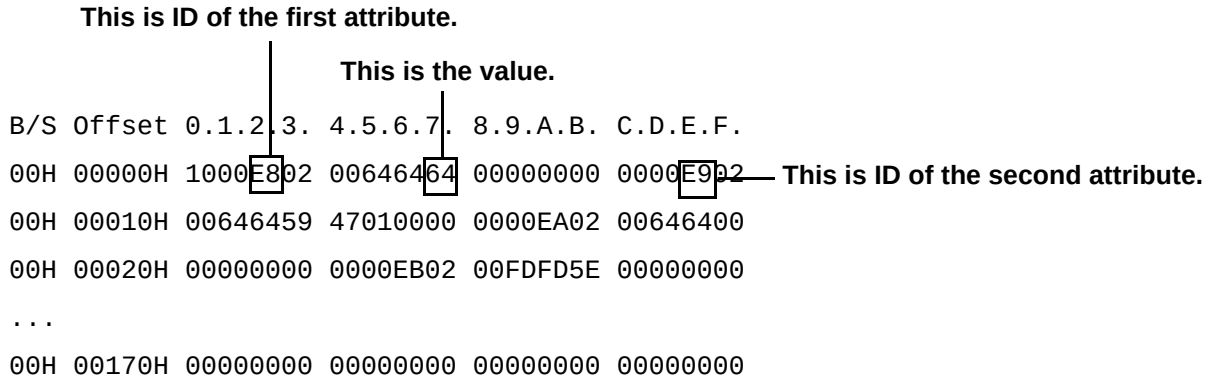
	Bit							
Register	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Features	D0h							
Sector Count	01h							
Sector Number	00h							
Cylinder Low	4Fh							
Cylinder High	C2h							
Device/Head	0h			Dev	0h			
Command	B0h							

Output: Each offset defines the specific attribute and the associated raw data. See the following table for the byte values (in hexadecimal format) and Figure 1 for an example of the data.

Table 7: Read Data Bytes

Byte(s)	Data		Comments
	Field Size	Content	
000...001	1 Word	Revision	Vendor-specific (1000h)
002...013	12 Bytes Each	1st Attribute	Attribute Layout (Each) Byte 0 = ID Number Bytes 1-2 = 0200h Byte 3 = 64h Bytes 4-11 = Raw Data
014...025	12 Bytes Each	2nd Attribute	
026...037	12 Bytes Each	3rd Attribute	
...	...	...	
350...361	12 Bytes Each	30th Attribute	
362...511	Byte	Reserved	

FIGURE 1: Read Data Bytes



The drive returns 12 bytes of data for each attribute, as indicated in Table 6: S.M.A.R.T. Read Data Registers. For attribute details, see page 10.

3.4 Read Attribute Thresholds

Features: D1h

Use: Returns 512 bytes of information specific to each supported S.M.A.R.T. attribute.

Transfer: PIO Data-In

Input: See the following table for the input registers.

Table 8: S.M.A.R.T. Read Attribute Thresholds Registers

	Bit							
Register	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Features	D1h							
Sector Count	01h							
Sector Number	00h							
Cylinder Low	4Fh							
Cylinder High	C2h							
Device/Head	A0h							
Command	B0h							

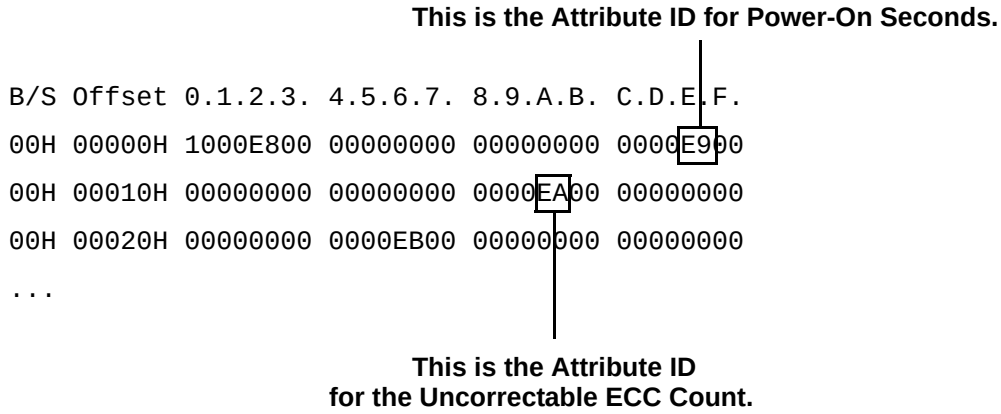
Output: Like the Read Data subcommand, the Read Attribute Thresholds subcommand returns 512 bytes of data. However, the data specifies only the attribute ID and threshold value for each attribute. All other attribute-specific bytes are set to 00h (see the following table).

Table 9: Read Attribute Thresholds Bytes

Byte(s)	Data		Comments
	Field Size	Content	
000...001	1 Word	Revision	Vendor-specific (1000h)
002...013	12 Bytes Each	1st Attribute	Attribute Layout (Each) Byte 0 = Attribute ID Byte 1 = Threshold Bytes 2-11 = Reserved
014...025	12 Bytes Each	2nd Attribute	
026...037	12 Bytes Each	3rd Attribute	
...	...	...	
350...361	12 Bytes Each	30th Attribute	
362...511	Byte	Reserved	

If the threshold value for an attribute is 00h, the drive does not examine the attribute value when returning a pass or fail for the Return Status subcommand. Currently, no attributes are examined because all threshold values are set to 00h. See the following figure for an example of the data.

FIGURE 2: Read Attribute Thresholds Bytes



4.0 SUPPORTED ATTRIBUTES

4.1 Endurance Remaining

Attribute ID: E8h (232 decimal)

Threshold: None

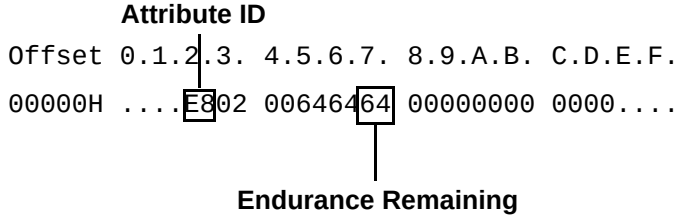
Description: The Endurance Remaining attribute reports the number of physical erase cycles completed on the drive as a percentage of the maximum physical erase cycles the drive supports. Because the maximum physical erase cycles is a theoretical number (100,000), a low value in this attribute does not necessarily mean the drive will fail. In other words, the drive may exceed the maximum number of erase cycles, causing the drive to report 0%, without impacting drive performance. See the following table for the byte definitions.

Table 10: Endurance Remaining

Byte(s)	Value	Indication
0	E8h	This is the attribute ID (232 decimal).
1-2	0200h	These two bytes are always 0200h.
3	64h	Each of these bytes is set to 64h.
4	64h	
5	Variable	Number of physical erase cycles the drive performed as a percentage of the theoretical maximum. The valid range is 00h to 64h (0 to 100).
6-11	00h	These bytes are reserved and set to 00h.

Example: Based on the data returned from the Read Data command, attribute 232 is the first attribute (offsets 2h through Dh). Byte 5 indicates the drive has not performed any erase cycles, resulting in 100% of the endurance remaining. See the following figure for example data.

FIGURE 3: Endurance Remaining Example



4.2 Power-On Time

Attribute ID: E9h (233 decimal)

Threshold: None

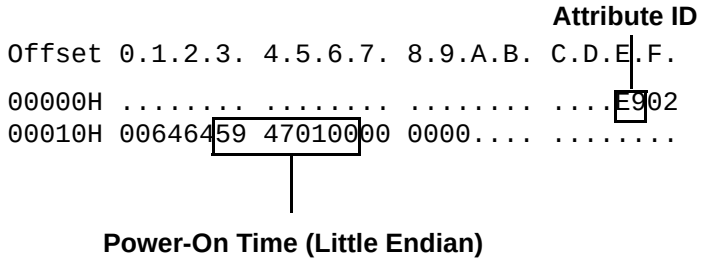
Description: The Power-On Time attribute indicates the total number of seconds the drive has been operational. This timer starts when the drive is manufactured in production and continues whenever the drive is powered on. See the following table for the byte definitions.

Table 11: Powered-On Time

Byte(s)	Value	Indication
0	E9h	This is the attribute ID (233 decimal).
1-2	0200h	These two bytes are always 0200h.
3	64h	Each of these bytes is set to 64h.
4	64h	
5-8	Variable	These bytes are little endian indicate the total number of seconds the drive has been operational.
9-11	00h	These bytes are reserved and set to 00h.

Example: Based on the data returned from the Read Data command, attribute 233 is the second attribute (offsets Eh through 19h). The bytes indicating the power-on time are 0x59470100, as shown in the following figure. Because the bytes are little endian, the value is 0x00014759, which equates to 83,801 seconds, or 1396.68 hours.

FIGURE 4: Power-On Time Example



NOTE:	"Little endian" means the least-significant byte is the first byte, and the most-significant byte is the last byte. For example, in Figure 4, the most-significant byte value is 00h, and the least-significant byte value is 59h.

4.3 Uncorrectable ECC Count

Attribute ID: EAh (234 decimal)

Threshold: None

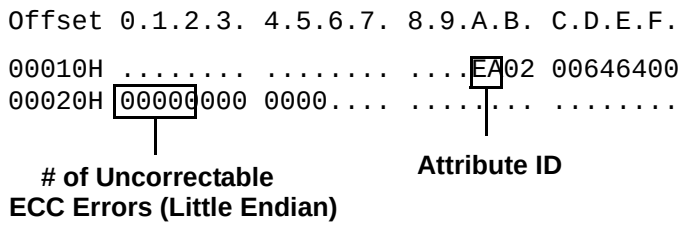
Description: The Uncorrectable ECC Count attribute stores the total number of ECC errors the drive encountered but could not resolve. If an uncorrectable ECC error occurs, the drive returns the error in the Status and Error registers and increments this counter. See the following table for the byte definitions.

Table 12: Uncorrectable ECC Count Bytes

Byte(s)	Value	Indication
0	EAh	This is the attribute ID (234 decimal).
1-2	0200h	These two bytes are always 0200h.
3	64h	Each of these bytes is set to 64h.
4	64h	
5-8	Variable	These bytes are little endian and indicate the total number of uncorrectable ECC errors the drive encountered.
9-11	00h	These bytes are reserved and set to 00h.

Example: Based on the data returned from the Read Data command, attribute EAh is the third attribute (offsets 1Ah through 25h). The bytes indicate the drive has not encountered an uncorrectable ECC error, as shown in the following figure.

FIGURE 5: Uncorrectable ECC Count Example



4.4 Good Block Rate

Attribute ID: EBh (235 decimal)

Threshold: None

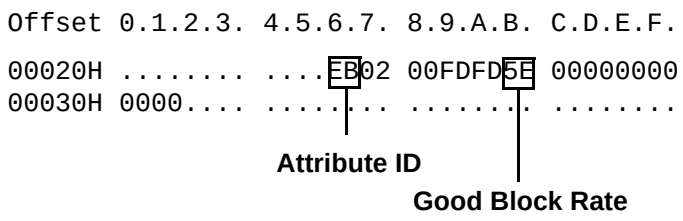
Description: The Good Block Rate attribute reports the number of available reserved blocks (for spares) as a percentage of the total number of reserved blocks. Whenever the drive swaps a reserved block for a bad block, this percentage decreases.

Table 13: Good Block Rate Bytes

Byte(s)	Value	Indication
0	EBh	This is the attribute ID (235 decimal).
1-2	0200h	These bytes are always set to 0200h for this attribute.
3	FDh	Each of these bytes is set to FDh.
4		
5	Variable	These bytes indicate the percentage of good blocks remaining. The range is 00h to 64h (0-100 decimal).
6-11	00h	These bytes are reserved and set to 00h.

Example: Based on the data returned from the Read Data command, attribute 235 is the fourth attribute (offsets 26h through 31h). Based on the returned data, the drive has 94% of its reserved blocks remaining (5Eh = 94), as shown in the following figure.

FIGURE 6: Good Block Rate Example



4.5 Power-On Hours

Attribute ID: 09h (9 decimal)

Threshold: None

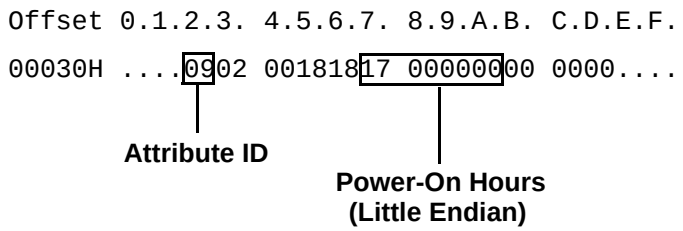
Description: The Power-On Hours attribute indicates the total number of hours the drive has been operational. See the following table for the byte definitions.

Table 14: Power-On Hours

Byte(s)	Value	Indication
0	09h	This is the attribute ID (9 decimal).
1-2	0200h	These bytes are always set to 0200h for this attribute.
3	18h	Each of these bytes is set to 18h.
4		
5-8	Variable	These bytes are little endian and specify the total number of hours the drive has been operational.
9-11	00h	These bytes are reserved and set to 00h.

Example: Based on the data returned from the Read Data command, attribute 9 is the fifth attribute (offsets 32h through 3Dh). The bytes indicate the power-on hours is 0x17000000, as shown in the following figure. Because the bytes are little endian, the value is 0x00000017, or 23 hours.

FIGURE 7: Power-On Hours Example



5.0 EXAMPLE USING ATADEMO

This section provides an example of issuing the S.M.A.R.T. subcommands and attributes using ATADEMO. ATADEMO sends vendor-specific ATA commands to the drive to enable S.M.A.R.T. operations. For a copy of the ATADEMO test program, visit *http://www.ata-atapi.com/atademo.html*. Before using the ATADEMO program, Adtron recommends you download and review the User Guide.

To issue S.M.A.R.T. subcommands in ATADEMO:

1. Start ATADEMO, entering the correct bus, device, drive, and host adapter information to communicate with the drive.
2. Type `ndx 0xD8 0x00 0x00 0x4F 0xC2 0xA0 0xB0` and press **ENTER** to enable S.M.A.R.T. operations.
3. Type ndx `0xDA 0x00 0x00 0x4F 0xC2 0xA0 0xB0` and press **ENTER** to view the current status of the S.M.A.R.T. attributes.
4. Type `showcb` and press **ENTER** to view the command block and verify the Cylinder Low and Cylinder High registers contain 0x4F and 0xC2, respectively. If the nibbles are reversed, one or more of the S.M.A.R.T. attributes exceeded the threshold.
5. Type `fillz` and press **ENTER** to fill the buffer with zeroes.

NOTE:	Although filling the buffer with zeroes is not required, it is recommended that you first fill the buffer to ensure you are receiving updated data.

6. Type `pdix 0xD1 0x01 0x00 0x4F 0xC2 0xA0 0xB0 1` and press **ENTER** to retrieve the S.M.A.R.T. attribute threshold values.
7. Type `dump` and press **ENTER** to view all 512 bytes.
8. Type `fillz` and press **ENTER** to fill the buffer with zeroes.
9. Type `pdix 0xD0 0x01 0x00 0x4F 0xC2 0xA0 0xB0 1` and press **ENTER** to retrieve the S.M.A.R.T. data.
10. Type `dump` and press **ENTER** to view all 512 bytes.

6.0 SALES AND TECHNICAL SUPPORT

Contact Adtron Corporation for technical support, application questions, data sheets, and documentation. Normal business hours are Monday through Friday, 8am to 5pm, MST. Please note that Arizona does not observe Daylight Savings Time.

6.1 SMART Modular Technologies Headquarters

SMART Modular Technologies
P. O. Box 1757
Fremont, CA 94538
Tel: (510) 623-1231
Fax: (510) 623-1434
E-mail: info@smartm.com
Web: http://www.smartm.com

6.2 SSD Design Center – Sales

Adtron Corporation
4415 E. Cotton Center Blvd.
Phoenix, AZ 85040
Tel: 602-735-0300
Fax: 602-735-0349
Web: http://www.adtron.com
E-mail: sales@adtron.com

6.3 International

Phoenix, AZ
Tel: 602-735-0300
Fax: 602-735-0349
E-mail: international@adtron.com

6.4 United States – Technical Support

Tel: 602-735-0300
Fax: 602-735-0349
E-mail: techsupport@adtron.com
Web: http://www.adtron.com/support