



Intel® Solid State Drive Data Center for SATA SMART Attributes

Application Note

January 2017

Revision 1.00



Revision History

Revision	Description	Date
1.0	Initial Release	January 2017

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Overview

SMART (Self-Monitoring, Analysis and Reporting Technology) is an open standard used by drives and hosts to monitor drive health and report potential problems. This document lists and describes the SMART attributes supported by Intel® Data Center Solid State Drives (SSDs) for SATA.

Intel's Data Center Tool (DCT) can be used to read out the SMART attributes. The read out would include normalized, raw, status and threshold values. The below commands can be passed using the tool to read out the SMART attributes:

- Windows*:
isdct.exe show –destination <filepath> -intelssd <device index> -smart
- Linux*:
./issdct show –destination <filepath> -intelssd <device index> -smart

SMART Command Set

The Intel Data Center SSDs for SATA supports the SMART command set, which consists of:

- SMART READ DATA
- SMART READ ATTRIBUTE THRESHOLDS
- SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE
- SMART SAVE ATTRIBUTE VALUES
- SMART EXECUTE OFF-LINE IMMEDIATE
- SMART READ LOG SECTOR
- SMART WRITE LOG SECTOR
- SMART ENABLE OPERATIONS
- SMART DISABLE OPERATIONS
- SMART RETURN STATUS
- SMART ENABLE/DISABLE AUTOMATIC OFFLINE

SMART Attributes

The following table lists the SMART attributes supported by the Intel Data Center SSDs for SATA.

ID	Attribute	Description
05h	Re-allocated Sector Count	The raw value of this attribute shows the number of retired blocks since leaving the factory (grown defect count).
09h	Power-On Hours Count	The raw value reports power-on time, cumulative over the life of the SSD, integer number in hour time units.
0Ch	Power Cycle Count	The raw value of this attribute reports the cumulative number of power cycle events over the life of the device.
AAh	Available Reserved Space	See Attribute E8
ABh	Program Fail Count	The raw value of this attribute shows total count of program fails and the normalized value, beginning at 100, shows the percent remaining of allowable program fails.



ID	Attribute	Description
ACh	Erase Fail Count	The raw value of this attribute shows total count of erase fails and the normalized value, beginning at 100, shows the percent remaining of allowable erase fails.
AEh	Unexpected Power Loss	Also known as "Power-off Retract Count" per magnetic-drive terminology. Reports number of unclean shutdowns, cumulative over the life of the SSD. An "unclean shutdown" is the removal of power without STANDBY IMMEDIATE as the last command (regardless of PLI activity using capacitor power).
AFh	Power Loss Protection Failure	Last test result as microseconds to discharge cap, saturates at max value. Also logs minutes since last test and lifetime number of tests. <ul style="list-style-type: none"> Bytes 0-1: Last test result as microseconds to discharge cap, saturates at max value. Test result expected in range 25 <= result <= 5000000, lower indicates specific error code Bytes 2-3: Minutes since last test, saturates at max value. Bytes 4-5: Lifetime number of tests, not incremented on power cycle, saturates at max value.
B7h	SATA Downshift Count	Reports the number of times the SATA interface selected lower signaling rate due to error
B8h	End-to-End Error Detection Count	Raw value: Reports the number of LBA tag mismatches in end-to-end data protection path. Normalized value: always 100.
BBh	Uncorrectable Error Count	Raw value: Reports the count of errors that could not be recovered using Error Correction Code (ECC). Normalized value: always 100.
BEh	Case Temperature	Reports the SSD case temperature. Same values as reported in the attribute C2h. Raw value suggests 100 - case temperature in C degrees.
C0h	Power-Off Retract Count (Unsafe Shutdown Count)	The raw value of this attribute reports the cumulative number of unsafe (unclean) shutdown events over the life of the device. An unsafe shutdown occurs whenever the device is powered off without STANDBYIMMEDIATE being the last command.
C2h	Temperature - Device Internal Temperature	Reports the internal temperature of the SSD. Temperature reading is the value direct from the printed circuit board (PCB) sensor without offset.
C5h	Pending Sector Count	Shows the number of current unrecoverable read errors that will be re-allocated on next write.
C7h	CRC Error Count	Shows the total number of encountered SATA interface cyclic redundancy check (CRC) errors.
E1h	Host Writes	The raw value of this attribute reports the total number of sectors written by the host system. The raw value is increased by 1 for every 65,536 sectors (32MB) written by the host.



ID	Attribute	Description
E2h	Timed Workload Media Wear	Measures the wear seen by the SSD (since reset of the workload timer, attribute E4h), as a percentage of the maximum rated cycles.
E3h	Timed Workload Host Read/Write Ratio	Shows the percentage of I/O operations that are read operations (since reset of the workload timer, attribute E4h).
E4h	Timed Workload Timer	Measures the elapsed time (number of minutes since starting this workload timer).
E8h	Available Reserved Space	Reports the number of reserve blocks remaining. The normalized value begins at 100 (64h), which corresponds to 100 percent availability of the reserved space. The threshold value for this attribute is 10 percent availability.
E9h	Media Wearout Indicator	Reports the number of cycles the NAND media has undergone. The normalized value declines linearly from 100 to 1 as the average erase cycle count increases from 0 to the maximum rated cycles. Once the normalized value reaches 1, the number will not decrease, although it is likely that significant additional wear can be put on the device.
EAh	Thermal Throttle Status	Reports Percent Throttle Status and Count of events <ul style="list-style-type: none"> • Byte 0 = Throttling status. Decimal value 0 = No Throttle Applied, 100 = 100% throttling applied. Intermediate percentages are supported. A value larger than 100d is invalid. • Bytes 1-4 = Throttling event count. 32 bit counter indicates the number of times thermal throttle has activated. Value is preserved over power cycles. • Byte 5 = Reserved
F1h	Total LBAs Written	The raw value of this attribute reports the total number of sectors written by the host system. The raw value is increased by 1 for every 65,536 sectors (32MB) written by the host.
F2h	Total LBAs Read	The raw value of this attribute reports the total number of sectors read by the host system. The raw value is increased by 1 for every 65,536 sectors (32MB) read by the host.
F3h	Total Bytes Written	The raw value of this attribute reports the total number of sectors written to the NAND media. This includes NAND writes triggered by host writes, defrag, background data refresh and wear level relocation writes etc. The raw value is increased by 1 for every 65,536 sectors (32MB) writes to the NAND media. Upon NAND write, new value returned once per minute.