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SOLID STATE STORAGE TECHNOLOGY CORPORATION

ENGINEERING SPECIFICATIONS

Product Name: ER3-CDXXX
(ER3-CD240/480/480A/960A/1920A)

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Version	History	Date
1.0	First Release for STD H2	2022/11/09
1.1	To modify MTBF for Industrial Application	2022/12/09
1.2	To add "DDR3 DRAM Cache embedded" in key features	2023/03/27

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1 INTRODUCTION

1.1 Overview

The **ER3-CDXXX** series provides enterprise users with all the benefits of a high-speed SSD on the SATA interface. The fast, efficient storage drive takes overall PC and server performance to the next level by unleashing the common storage-level bottleneck. It shall be a deserving upgrade for any enterprise application – feeding the right data at lightning speed while remaining accountable for the ones kept in storage.

The **ER3-CDXXX** series offers a rock-solid chip-based storage ready to conquer high-level workloads of applications such as OLTP and many others. Not only does it speed up data processing by minimizing the discrepancies between the rates of data fetching and processing, it also guarantees swift loads and saves of files during run-time, extracting the optimal performance out of each component within the system. The effect of the boost from the upgrade shall be imminent as data delivery to the graphics card, memory, and processor takes the overall performance to a level conventional hard-drives had no hopes of reaching.

Whether for a professional IT engineer, a special enterprise application, or any individual looking for an unmatched storage experience, the **ER3-CDXXX** series is the direct path to experiencing the latest solid state drive technology. With SSSTC's promise to deliver only the best within our capability, the **ER3-CDXXX** series SSDs shall shine with its performance from the very first OS boot and sustain with long-term consistency for the years to come.

SSSTC SSD **ER3-CDXXX** support below key features:

- High I/O and throughput performance
- Consistent I/O latency
- Enhanced power-loss data protection
- Thermal throttling
- Temperature Sensor
- Inrush current management
- High reliability
- Temperature monitor and logging
- End to end Data Path Protection
- Power loss protection capacitor self-test
- DDR3 DRAM Cache embedded

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1.2 Product Specification

1.2.1. Form Factor: 2.5" SSD form factor (SFF-8144)

1.2.2. Capacity:

Table 1 User Addressable Sectors

Model	Unformatted capacity	Total user addressable sectors in LBA mode
ER3-CD240	240GB	468,862,128
ER3-CD480	480GB	937,703,088
ER3-CD480A	480GB	937,703,088
ER3-CD960A	960GB	1,875,385,008
ER3-CD1920A	1920GB	3,750,748,848

Notes:

- 1). 1GB=1,000,000,000 bytes and not all of the memory can be used for storage.
- 2). 1 Sector = 512 bytes

1.2.3. Flash: Triple-Level Cell (TLC) component with Toggle-Mode

1.2.4. Band Performance

Table 2 Maximum Sustained Read and Write Bandwidth

Capacity	240GB	480GB	960GB	1920GB
Sequential Read	Up to 520MB/s	Up to 520MB/s	Up to 520MB/s	Up to 520MB/s
Sequential Write	Up to 280MB/s	Up to 520MB/s	Up to 520MB/s	Up to 520MB/s

Notes:

- 1). Performance (Average) measured by FIO 2.6 under Ubuntu 17.04 operation system and using native SATA 6Gb/s interface. (100% Sequential Read and Write with 128KB transfer size, Queue Depth 32, 4KB align)
- 2). 1 MB/sec = 1,000,000 bytes/sec is used in measuring sequential performance.
- 3). Test results may be different on different platform.

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1.2.5. Read and Write IOPS

Table 3 Random Read/Write Input/Output Operations per Second

Capacity	240GB	480GB	480GB(A)	960GB(A)	1920GB(A)
4K Read (IOPS)	90,000	90,000	90,000	90,000	90,000
4K Write (IOPS)	10,000	15,000	45,000	30,000	30,000

Table 4 Random Read/Write IOPS Consistency

Capacity	240GB	480GB	480GB(A)	960GB(A)	1920GB(A)
4K Read (%)	95.00%	95.00%	95.00%	98.00%	98.00%
4K Write (%)	90.00%	90.00%	90.00%	90.00%	90.00%

Notes:

- 1). IOPS value measured by FIO 2.6 under Ubuntu 17.04 operation system and using native SATA 6Gb/s interface. (100% Random Read and Write with 4KB transfer size, Queue Depth 32, 4KB align)
- 2). IOPS Consistency value measured by FIO 2.6 under Ubuntu 17.04 operation system and using native SATA 6Gb/s interface. (100% Random Read and Write with 4KB and transfer size, Queue Depth 32, 4KB align) % is measured as the (IOPS in the 99.9th percentile slowest 1-second interval)/(average IOPS during the test).
- 3). Measurements are performed on a full logical block address (LBA) span of the drive once the workload has reached steady state but including all background activities required for normal operation and data reliability.
- 4). Test results may be different on different platform.

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1.2.6. Read and Write Latency

Table 5 Latency

Capacity	240GB	480GB	480GB(A)	960GB(A)	1920GB(A)
Read	120 us	120 us	120 us	115 us	115 us
Write	90 us	70 us	40 us	40 us	40 us

Notes:

- 1). Latency (Average) measured by FIO 2.6 under Ubuntu 17.04 operation system and using native SATA 6Gb/s interface. (100% Random Read and Write with 4KB transfer size, Queue Depth 1, 4KB align)
- 2). Test results may be different on different platform.

1.2.7 Quality of Service

Table 6 Quality of Service

	240GB	480GB	480GB(A)	960GB(A)	1920GB(A)
Quality of Service (99.9%)					
Read Queue Depth 1 (ms)	0.2	0.2	0.2	0.2	0.2
Write Queue Depth 1 (ms)	1	0.8	0.5	0.5	0.5
Quality of Service (99.999%)					
Read Queue Depth 1 (ms)	0.8	0.8	0.5	0.7	0.7
Write Queue Depth 1 (ms)	6	6	0.7	1	1

Notes:

- 1). QoS measured by FIO 2.6 under Ubuntu 17.04 operation system and using native SATA 6Gb/s interface. (100% Random Read and Write with 4KB transfer size, Queue Depth 1, 4KB align) Which is measured as the time taken for 99.9 percentile of commands to finish the round-trip from host to drive and back to host.
- 2). Measurements are performed on a full logical block address (LBA) span of the drive once the workload has reached steady state but including all background activities required for normal operation and data reliability.
- 3). Test results may be different on different platform.

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1.2.8. Ready Time

Table 7 Ready Time Specifications

Type	Maximum Time to Ready (sec)				
	240GB	480GB	480GB(A)	960GB(A)	1920GB(A)
Power On to Ready for OOB negotiation ¹	0.5				
Power On to Ready for Media access command ² Typical	2	2	2	4	5

Notes:

- 1). Device measured from power-on to ready to reply FIS34 to Host
- 2). Device measured from power-on to ready to receive first Media command.
Including operation under worst case environment or after abnormal power-off; and need any retries to complete boot work. For 95% of the time, the maximum time for power on to ready will be less than 15 seconds(480GB/960GB) or 30 seconds(1920GB).

1.2.9. Compatibility

- SATA Revision 3.2 compliant
Compatible with SATA 1.5Gb/s, 3.0Gb/s & 6.0Gb/s interface rates
- ATA/ATAPI- 8 compliant
- SSD enhanced SMART ATA feature set
- Native Command Queuing (NCQ) command set
- TRIM supported

1.2.10. Certifications

CE, UL, BSMI, KC, RCM, TUV, UKCA, VCCI, FCC, RoHS compliant and WEEE

1.2.11. Power Management

- 5V SATA
- SATA interface power management
- OS-aware hot plug/removal

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1.2.12. Power Consumption

Table 9 Operating Voltage

Capacity	Description	Min	Max	Unit
240GB	Operating voltage for 5V (+/- 5%)	4.75	5.25	V
480GB	Operating voltage for 5V (+/- 5%)	4.75	5.25	V
480GB(A)	Operating voltage for 5V (+/- 5%)	4.75	5.25	V
960GB	Operating voltage for 5V (+/- 5%)	4.75	5.25	V
1920GB	Operating voltage for 5V (+/- 5%)	4.75	5.25	V

Notes:

- 1). Inrush current :1.5A max.

Table 10 Power Consumption

Capacity	Operation	Max	Unit
240GB	Read	3	W
	Write	3.5	W
	Idle	1.2	W
480GB	Read	3	W
	Write	3.5	W
	Idle	1.2	W
480GB(A)	Read	3	W
	Write	3.5	W
	Idle	1.2	W
960GB	Read	3.5	W
	Write	4	W
	Idle	1.2	W
1920GB	Read	4.5	W
	Write	5	W
	Idle	1.2	W

Notes:

- 1). The workload equates 128KB (131,072bytes) Queue depth equal to 32 sequential writes.
- 2). Root Mean Squared (RMS) average power is measured using scope trigger over a 500ms sample period.

1.2.13. Temperature

Table 11 Temperature Relative Specifications

Environment	Mode	Min	Max	Unit
Ambient Temperature	Operating	0	70	°C
	Non-operating	-40	85	°C
Humidity	Operation	5	95	%
	Non-operation	5	95	%

Note:

- 1). Measured without condensation

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1.2.14. Reliability

Table 12 Reliability specification

Parameter	Value
Uncorrectable Bit Error Rate (UBER) ¹	1 error in 10 ¹⁷ bits transferred
Mean Time between Failure (MTBF) ²	>3,000,000 hours
Power on/off cycles ³	50,000 cycles
Data Retention ⁴	3 months power-off retention under the condition below a. The drive is at the end of its design life b. The temperature is no greater than 40°C while the drive is unpowered.

Notes:

- 1).Uncorrectable bit error rate according to the JESD218 enterprise standard.
- 2).MTBF is calculated based on a Part Stress Analysis. It assumes nominal voltage. With all other parameters within specified range.
- 3).Power on/off cycles is defined as power being removed from the drive, and then restored.
Most host systems remove power from the drive when entering suspend and hibernate as well as on a system shutdown.
- 4).The period of time during which the drive can remain in an unpowered state, and still meet the error rate specification when power is applied.

Table 13 Endurance Rating

Capacity	DWPD(for 5years)	Total Bytes Written(Unit TB)
240GB	1	430
480GB	1	870
480GB(A)	1.8	1600
960GB(A)	1.2	2100
1920GB(A)	1.2	4200

Notes:

- 1). Total Bytes Written measured with the requirements according to the JESD218 standard and the JESD219 workload standard.
- 2). 1TB = 1,000,000,000,000Bytes.

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1.2.15. Shock and Vibration

Table 14 Shock and Vibration

Item	Mode	Timing/Frequency	Max
Shock ¹	Non-operating	At 0.5msec	1500G
Vibration ²	Non-operating	5~800 Hz	3.13Grms

Notes:

- 1). Shock specifications assume that the SSD is mounted securely with the input vibration applied to the drive mounting screws. Stimulus may be applied in the X, Y or Z axis
- 2). Vibration specifications assume that the SSD is mounted securely with the input vibration applied to the drive mounting screws. Stimulus may be applied in the X, Y or Z axis. The measured specification is in root mean squared form.

1.2.16. Electromagnetic Immunity

Electromagnetic Immunity tests assume the SSD is properly installed in the representative host system. The drive operates properly without errors degradation in performance when subjected to radio frequency (RF) environments defined in the following table.

Table 15 Radio Frequency Specifications

Test	Reference standard
Electrostatic discharge	IEC 61000-4-2
Radiated RF immunity	IEC 61000-4-3
Electrical fast transient	IEC 61000-4-4
Surge immunity	IEC 61000-4-5
Conducted RF immunity	IEC 61000-4-6
Power frequency magnetic field	IEC 61000-4-8

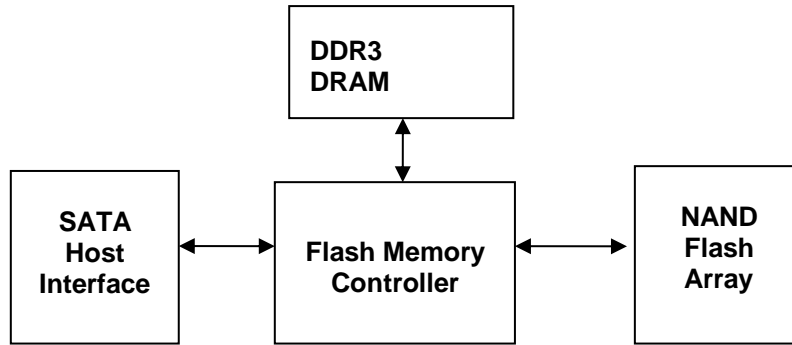
1.2.17. Weight: 56g Max (with case)

1.2.18. Dimension: 100.0 x 69.85mm x 6.8 mm (L x W x H)

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1.3 Functional Block Diagram

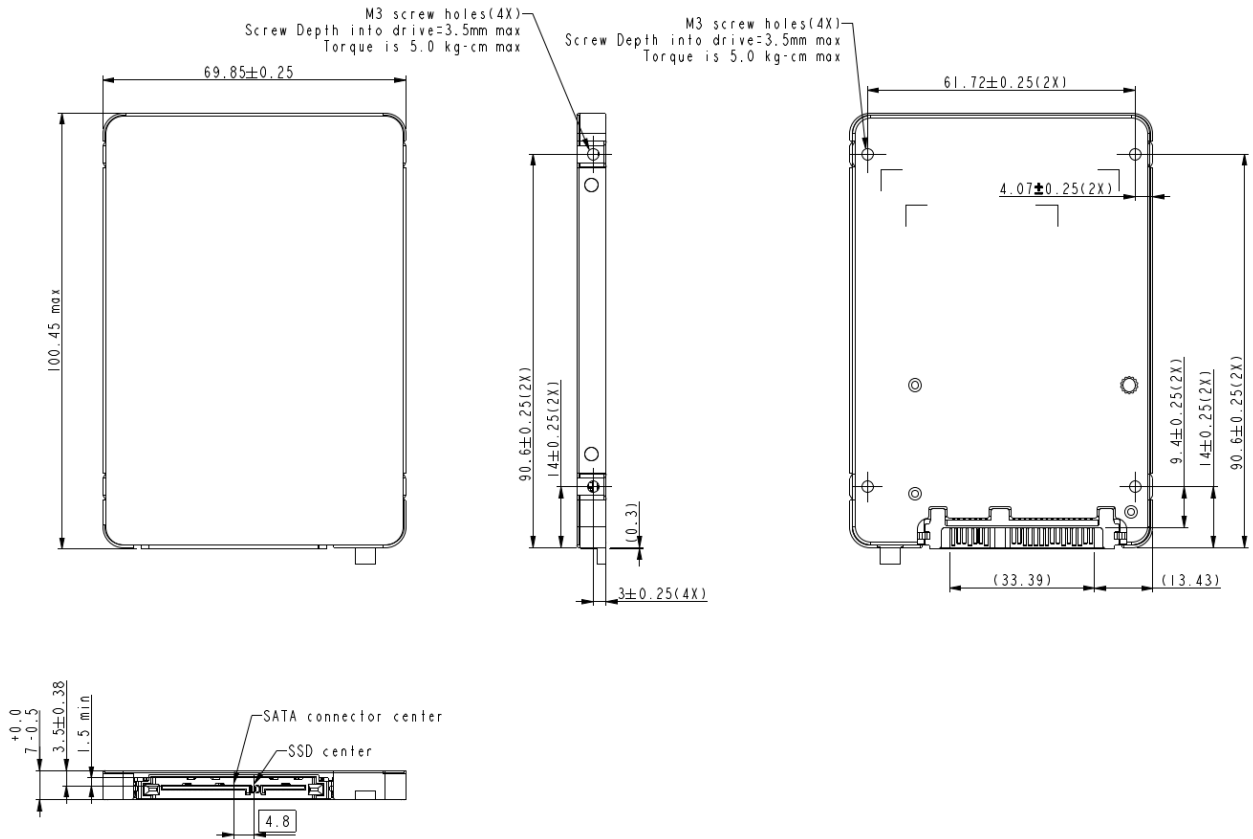


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1.4 Mechanical Drawing



Dimension: 100.0 x 69.85mm x 6.8 mm (L x W x H)

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1.5 Architecture

The **ER3-CDXXX** Series SSD utilizes a cost effective system-on-chip (SoC) design to provide a full 6 Gb/s bandwidth with the host while managing multiple flash memory devices on multiple channels internally.

1.6 Hot Plug Support

Hot Plug insertion and removal are supported when the correct connector and an appropriate operating system (OS) are used as described in the SATA 3.0 Specification. This product supports asynchronous signal recovery and will establish communications with a host system without hardware device detection by issuing an unsolicited COMINIT when first mated with a powered connector.

1.7 Power Loss Data Protection

The **ER3-CDXXX** series support backup power mechanisms in the system architecture, to ensuring data integrity and implementing reliable power fail protection at the storage level.

1.8 Power Loss Protection Capacitor Self-test

The **ER3-CDXXX** series support power loss capacitor self-test, which can be monitored for capacitor in normal or abnormal status using SMART attributes: volatile memory backup source failure (E5h).

1.9 Temperature Sensor and Monitor

The **ER3-CDXXX** series have an internal temperature sensor with an accuracy of +/-3C over a range of 0C to +70C, which can be read temperature value using SMART attributes: Drive Temperature (C2h).

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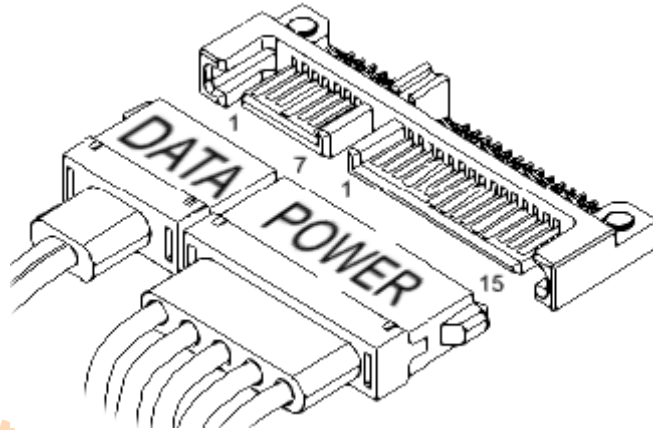
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2 PIN LOCATIONS AND SIGNAL DESCRIPTIONS

2.1 Pin Locations

The data and power connector pin locations of the ER3-CDXXX Series SSD are as shown below.



2.2 Signal Descriptions

Data Connector:

Table 16 Serial ATA Data Connector Pin Definitions

Name	Type	Description
S1	CND	1 st Mate
S2	A+	Differential Signal Pair A
S3	A-	
S4	GND	1 st mate
S5	B-	Differential Signal Pair B
S6	B+	
S6	GND	1 st mate

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Power Connector:

Table 17 Serial ATA Power Connector Pin Definitions

Name	Type	Description	Mating Order
P1	Retired	No Use	NC
P2	Retired	No Use	NC
P3	Retired	No Use	NC
P4	GND	Ground	1 st Mate
P5	GND	Ground	1 st Mate
P6	GND	Ground	1 st Mate
P7	V ₅	5V Power, Pre-change	1 st Mate
P8	V ₅	5V Power	2 nd Mate
P9	V ₅	5V Power	2 nd Mate
P10	GND	Ground	1 st Mate
P11	DAS	Device Activity Signal	2 nd Mate
P12	GND	Ground	1 st Mate
P13	V ₁₂	12V Power, Pre-change	1 st Mate
P14	V ₁₂	12V Power	2 nd Mate
P15	V ₁₂	12V Power	2 nd Mate

Note:

- 1). All pins are in a single row, with a 1.27mm (0.05") pitch
- 2). The mating sequence is
 - The ground pins P4-P6, P10, P12 and the 5V power pin P7
 - The signal pins and the rest of the 5V power pins P8-P9
- 3). Ground connectors P4 and P12 may contact before the other 1st mate pins in both the power and signal connectors to discharge ESD in a suitably configured backplane connector.
- 4). Power pins P7, P8 and P9 are internally connected to one another within the device.
- 5). The host may ground P11 if it is not used for Device Activity Signal (DAS)
- 6). Pins P13, P14, P15 are connected together, although they are not connected internally to the device.

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3 ATA COMMAND SETS

3.1 ATA Command

The **ER3-CDXXX** Series SSD supports all the mandatory ATA commands defined in the ATA/ATAPI-8 specification.

3.1.1 ATA General Feature Command Set

The **ER3-CDXXX** Series SSD supports the ATA General feature Command set (non-packet), which consists of the following events.

- EXECUTE DEVICE DIAGNOSTIC
- FLUSH CACHE
- IDENTIFY DEVICE
- READ DMA
- READ DMA WITHOUT RETRIES
- READ SECTOR(S)
- READ SECTORS(S) WITHOUT RETRIES
- READ VERIFY SECTORS(S)
- READ VERIFY SECTORS(S) WITHOUT RETRIES
- SEEK
- SET FEATURES
- WRITE DMA
- WRITE DMA WITHOUT RETRIES
- WRITE SECTOR(S)
- WRITE SECTOR(S) WITHOUT RETRY
- READ MULTIPLE
- SET MULTIPLE MODE
- WRITE MULTIPLE
- INITIALIZE DEVICE PARAMETERS
- DATA SET MANAGEMENT
- NOP
- WRITE UNCORRECTABLE EXT

The **ER3-CDXXX** Series SSD supports all the following optional commands.

- READ BUFFER
- WRITE BUFFER
- DOWNLOAD MICROCODE

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3.1.2 Identify Device Data

The following table details the sector data returned after issuing an IDENTIFY DEVICE command.

Table 18 Returned Sector Data

Word	Setting	Default Value	Description
0	X	0040h	General configuration bit-significant information
1	X	3FFFh	Obsolete-Number of logical cylinders (16,383)
2	V	C837h	Specific configuration
3	X	0010h	Obsolete-Number of logical heads (16)
4-5	X	0000h	Retired
6	X	003Fh	Obsolete-Number of logical sectors per logical track (63)
7-8	V	0000h	Reserved for assignment by the Compact Flash Association
9	X	0000h	Retired
10-19	F	Var.	Serial number (20 ASCII characters)
20-22	X	0000h	Retired / Obsolete
23-26	F	Var.	Firmware revision (8 ASCII characters)
27-46	F	Var.	Model number
47	F	8001h	7:0 – Maximum number of sectors transferred per interrupt on multiple commands
48	F	4000h	Trusted Computing feature set options, bit14 should be 1
49	F	2F00h	Capabilities
50	F	4000h	Capabilities
51-52	X	0000h	Obsolete
53	F	0007h	Words 88 and 70:64 valid
54	X	Var.	Obsolete - Number of logical cylinders (16,383)
55	X	Var.	Obsolete - Number of logical heads (16)
56	X	Var.	Obsolete - Number of logical sectors per logical track (63)
57-58	X	Var.	Obsolete - Capacity(Cylinders*heads*sectors)
59	F	BD01h	Number of sectors transferred per interrupt on multiple commands
60-61	V	0FFFFFFFh (480GB)	Total number of user addressable logical sectors for 28-bit commands (DWord)
		0FFFFFFFh (960GB)	
		0FFFFFFFh (1920GB)	
62	X	0000h	Obsolete
63	X	0007h	Multi-word DMA modes supported/selected
64	F	0003h	PIO modes supported
65	F	0078h	Minimum multiword DMA transfer cycle time per word

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Word	Setting	Default Value	Description
66	F	0078h	Manufacture's 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	4C30h	Additional Supported
70	F	0000h	Reserved(for future command overlap and queuing)
71-74	F	0000h	Reserved for the IDENTIFY packet DEVICE command
75	F	001Fh	4:0 Maximum Queue depth-1=31
76	F	850Eh	Serial ATA capabilities
77	V	Var.	Serial ATA additional capabilities
78	F	0044h	Serial ATA features supported
79	V	0040h	Serial ATA features enabled
80	F	07FEh	Major Version Number
81	F	0021h	Minor Version Number
82	F	346Bh	Commands and feature sets supported
83	F	7D01h	Commands and feature sets supported
84	F	6163h	Commands and feature sets supported
85	X	3469h	Commands and feature sets supported or enabled
86	X	BC01h	Commands and feature sets supported or enabled
87	X	6123h	Commands and feature sets supported or enabled
88	X	407Fh	Ultra DMA modes
89	F	0003h	Time required for security erase unit completion
90	F	0003h	Time required for enhanced security erase completion
91	V	0000h	Current advanced power management value
92	V	Var.	Master Password Identifier
93	X	0000h	Hardware reset result. The contents of bits (12:0) of this word shall change only during the execution of a hardware reset.
94	V	0000h	Obsolete - Current AAM 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(DWord)

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Word	Setting	Default Value	Description
100-103	V	937,703,088 (480GB)	Number of User Addressable Logical Sectors(QWord)
		1,875,385,008 (960GB)	
		3,750,748,848 (1920GB)	
104	V	0000h	Streaming Transfer Time - PIO
105	V	0008h	Maximum number of 512-byte blocks per DATA SET MANAGEMENT command
106	F	6003h	Physical sector size/logical sector size
107	F	0000h	Inter-seek delay for ISO-7779 acoustic testing in microseconds
108-111	F	Var.	World wide name
112-115	F	0000h	Reserved for word wide name extension to 128 bits
116	V	0000h	Obsolete
117-118	F	0000h	Logical sector size (DWord)
119	F	411Ch	Commands and feature sets supported
120	X	401Ch	Commands and feature sets supported or enabled
121-126	F	0000h	Reserved for expanded supported and enabled settings
127	X	0000h	Obsolete - Removable Media Status Notification feature set support
128	X	0021h	Security status
129-159	X	0000h	Vendor specific
160	X	0000h	Compact Flash Association (CFA) power mode 1
161-167	X	0000h	Reserved for the CompactFlash Association
168	X	0003h	Device Nominal Form Factor
169	X	0001h	DATA SET MANAGEMENT command supported
170-173	F	0000h/0000h /0000h/0000h	Additional Product Identifier (ATA String)
174-175	F	0000h	Reserved
176-205	V	0000h	Current media serial number (ATA string)
206	X	003Dh	SCT Command Transport
207-208	F	0000h	Reserved
209	X	4000h	Alignment of logical blocks within a physical block
210-211	V	0000h	Write-Read-Verify Sector Count Mode 3 (DWord)
212-213	F	0000h	Write-Read-Verify Sector Count Mode 2 (DWord)

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Word	Setting	Default Value	Description
214	X	0000h	Obsolete - NV Cache Capabilities
215-216	V	0000h	Obsolete - NV Cache Size in Logical Blocks (DWord)
217	F	0001h	Nominal media rotation rate
218	V	0000h	Reserved
219	F	0000h	Obsolete - NV Cache Options
220	V	0000h	Write-Read-Verify feature set current mode
221	X	0000h	Reserved
222	F	10FFh	Transport major version number
223	F	0000h	Transport minor version number
224-229	F	0000h	Reserved
230-233	X	0000h	Extended Number of User Addressable Sectors (QWord)
234	F	0001h	Minimum number of 512-byte data blocks per DOWNLOAD MICROCODE command
235	F	0190h	Maximum number of 512-byte data blocks per DOWNLOAD MICROCODE command
236-254	X	0000h	Reserved
255	V	Var.	Integrity word

Notes:

- 1).F=Fixed. The content of the word is fixed and does not change for removable media devices, these values may change when media is Removed or changed.
- 2).V=Variable. The state of at least one bit in a word is variable and may change depending on the state of the device or the commands executed by the device.
- 3).X=F or V. The content of the word may be fixed or variable

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3.2 Power Management Command Set

The **ER3-CDXXX** Series SSD supports the power management command set, which consists of the following events.

- CHECK POWER MODE
- IDLE
- IDLE IMMEDIATE
- SLEEP
- STANDBY
- STANDBY IMMEDIATE

3.3 Security Mode Feature Set

The **ER3-CDXXX** Series SSD supports the Security Mode command set, which consist of the following events.

- SECURITY SET PASSWORD
- SECURITY UNLOCK
- SECURITY ERASE PREPARE
- SECURITY ERASE UNIT
- SECURITY FREEZE LOCK
- SECURITY DISABLE PASSWORD

3.4 SMART Command Set

The **ER3-CDXXX** Series SSD supports the SMART command set, which consist of the following events.

- SMART ENABLE OPERATIONS
- SMART DISABLE OPERATIONS
- SMART ENABLE/DISABLE AUTOSAVE
- SMART RETURN STATUS

The **ER3-CDXXX** Series SSD supports the following optional commands.

- SMART EXECUTE OFF-LINE IMMEDIATE
- SMART READ DATA
- SMART READ LOG
- SMART WRITE LOG
- SMART READ ATTRIBUTE THRESHOLDS
- SMART SAVE ATTRIBUTE VALUES
- SMART ENABLE/DISABLE AUTOMATIC OFFLINE

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The table below lists the SMART commands.

Table 19 SMART commands

Subcommand	Code	LBA Low value
SMART ATTRIBUTE VALUES (READ DATA)	D0h	
READ ATTRIBUTE THRESHOLDS	D1h	
ENABLE/DISABLE ATTRIBUTE AUTOSAVE	D2h	
SAVE ATTRIBUTE VALUES	D3h	
EXECUTE OFF-LINE IMMEDIATE	D4h	
EXECUTE SMART OFF-LINE ROUTINE		00h
EXECUTE SMART SHORT SELF-TEST ROUTINE (OFFLINE)		01h
EXECUTE SMART EXTENDED SELF-TEST ROUTINE (OFFLINE)		02h
ABORT OFF-LINE ROUTINE		7Fh
EXECUTE SMART SHORT SELF-TEST ROUTINE (CAPTIVE)		81h
EXECUTE SMART EXTENDED SELF-TEST ROUTINE (CAPTIVE)		82h
READ LOG SECTOR	D5h	
WRITE LOG SECTOR	D6h	
ENABLE SMART OPERATIONS	D8h	
DISABLE SMART OPERATIONS	D9h	
RETURN SMART STATUS	DAh	
Enable/Disable Automatic OFFLINE	DBh	

The table below lists the SMART attributes that ER3-CDXXX supported

Table 20 SMART attributes

ID	Attribute Name	Description
05h	Reallocated Block Count	Report the total number of retired read and program failed blocks [Unit: block]
09h	Power On hours Count	The power on time of the device up to now [Unit: hour]
0Ch	Power Cycle Count	The number of Power cycles up to now [Unit: count]
AAh	Grown Bad Blocks	Total used reserved blocks in SSD [Unit: block]
ABh	Program Fail Count(Total)	Total program fail count [Unit: block]
ACH	Erase Fail Count(Total)	Total erase fail count [Unit: block]
ADh	Average Program/Erase Count	Average erase count of total block (SLC blocks are not included) [Unit: count]
Aeh	Unexpected Power Loss Count	Number of unexpected power loss [Unit: count]
Afh	Program Fail count (Worst case)	Maximum number of NAND program fails among all of dies [Unit: block]

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ID	Attribute Name	Description
B7h	SATA Interface Down Shift	Number of interface downshifts encountered between the host and the device [Unit: count]
B8h	End-to-End Data Errors Count	Report the number of data errors detected in end-to-end data protection path [Unit: count]
BBh	Uncorrectable Error Count	Number of Non-Recoverable Read Error [Unit: block]
BDh	Maximum Erase Count	Report the maximum erase count of total blocks
BEh	Drive Temperature	Drive Temperature in Celsius degree [Unit: ° C]
BFh	Minimum Erase Count	Report the minimum erase count of total blocks
C3h	ECC rate	Report percentage of uncorrected errors count (Read Err count). [Unit: count/ GB]
C6h	OffLine Uncorrect Error Count	Number of Non-Recoverable GC Read Error [Unit: block]
C7h	SATA CRC Error Count	Number of Interface CRC error [Unit: count]
CAh	Percentage Lifetime Remaining	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. [Unit: %]
E5h	Power Loss Protection Failure	Reports Capacitance health status. The normalized value is 0, if the capacitance circuit was broken.
E8h	Available Reserved Space	Normalized value of spare super blocks remaining [Unit: %]
E9h	Total NAND Written	Total number of data and meta data written to media [Unit : 32MB]
F1h	Total Host Data Written	Accumulated the amount of the host written data [Unit : 32MB]
F2h	Total Host Data Read	Accumulated the amount of the host read data [Unit : 32MB]

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3.5 SMART Command Transport (SCT)

The SCT Command Transport provides a method for a host to send commands and data to a device and for a device to send data and status to a host using logs. Log Address E0h (e.g., SCT Command/Status) is used to issue commands and return status. Log Address E1h (e.g., SCT Data Transfer) is used to transport data.

The following methods are used to access the logs defined for the SCT Command Transport:

- a) using SMART READ LOG and SMART WRITE LOG commands;
- b) using READ LOG (DMA) EXT and WRITE LOG (DMA) EXT commands.

The **ER3-CDXXX** Series SSD supports the following standard SCT actions:

SCT ERROR RECOVERY CONTROL command (0003h) (Set the limits of time for error recovery in **READ** and **WRITE** commands/Return Current Value).

The Recovery Time Limit default is 0050h (8 seconds).

SCT FEATURE CONTROL command (0004h) (Set state for a feature/Return the current state of a feature/Return feature option flags for a. write cache b. Write Cache Reordering enable or disable/temperature logging time interval)

SCT status command: Status for an SCT command may be read at any time by reading the SCT Command/Status log

3.6 Data Set Management Command Set

The **ER3-CDXXX** Series SSD supports the Data Set Management command set Trim attribute, which consists of:

- DATA SET MANAGEMENT

3.7 Host Protected Area Command Set

The **ER3-CDXXX** Series SSD supports the Host Protected Area command set which consists of the following events.

- READ NATIVE MAX ADDRESS
- SET MAX ADDRESS
- READ NATIVE MAX ADDRESS EXT
- SET MAX ADDRESS EXT

The **ER3-CDXXX** Series SSD supports the following optional commands.

- SET MAX SET PASSWORD
- SET MAX LOCK
- SET MAX FREEZE LOCK
- SET MAX UNLOCK

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3.8 48-Bit Address Command Set

The **ER3-CDXXX** Series SSD supports the 48-Bit Address Command Set, which consists of the following events.

- FLUSH CACHE EXT
- READ DMA EXT
- READ NATIVE MAX ADDRESS EXT
- READ SECTOR(S) EXT
- READ VERIFY SECTOR(S) EXT
- READ MULTIPLE EXT
- SET MAX ADDRESS EXT
- WRITE DMA EXT
- WRITE MULTIPLE EXT
- WRITE MULTIPLE FUA EXT
- WRITE SECTOR(S) EXT
- WRITE DMA FUA EXT

3.9 Device Configuration Overlay Command Set

The **ER3-CDXXX** Series SSD supports the Device configuration Overlay command set, which consists of the following events.

- DEVICE CONFIGURATION FREEZE LOCK
- DEVICE CONFIGURATION IDENTITY
- DEVICE CONFIGURATION RESTORE
- DEVICE CONFIGURATION SET

3.10 General Purpose log Command Set

The **ER3-CDXXX** Series SSD supports the general purpose log command set, which consists of the following events.

- READ LOG EXT
- READ LOG DMA EXT
- WRITE LOG EXT
- WRITE LOG DMA EXT

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4 SATA COMMAND SETS

4.1 SATA Command

The SATA 3.2 Specification is a super set of the ATA/ATAPI-8 specification with regard to supported commands. The **ER3-CDXXX** Series SSD supports the following features which are unique to the SATA 3.2 Specification.

4.1.1. Software Settings Preservation

The **ER3-CDXXX** Series SSD supports the SET FEATURES parameter to enable/disable the preservation of software settings.

4.1.2. Native Command Queuing

The **ER3-CDXXX** Series SSD supports the Native Command Queuing (NCQ) command set, which includes the following events.

- READ FPDMA QUEUED
- WRITE FPDMA QUEUED

Note: with a maximum queue depth equal to 32

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5 REFERENCES

This document references standards defined by a variety of organizations as listed below.
Table 21 Standards References

Date	Title	Location
Dec 2008	VCCI	http://www.vcci.or.jp/vcci_e/general/join/index.html
July 2007	ROHS	Search for material description datasheet at http://intel.pcnalert.com
February 2007	Serial ATA Revision 2.6	http://www.sata-io.org
May 2006	SFF-8223, 2.5" Drive w/Serial Attachment Connector	http://www.sffcommittee.org
May 2005	SFF-8201, 2.5" drive form factor	http://www.sffcommittee.org
April 2004	ATA-7 Spec. Volume 1	http://www.t13.org/
Aug. 2009	ATA-8 Spec. Rev 2	http://www.t13.org/
2008	International Electro Technical Commission EB61000	http://www.iec.ch
2008	4-2 Personnel Electrostatic Discharge Immunity	
2008	4-3 Electromagnetic compatibility (EMC)	
2004	4-4 Electromagnetic compatibility (EMC)	
2005	4-5 Electromagnetic compatibility (EMC)	
2008	4-6 Electromagnetic compatibility (EMC)	
2008	4-11 (Voltage variations)	
2004	ENV 50204 (Radiated electromagnetic field from digital radio telephones)	http://www.iec.ch

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6 TERMS AND ACRONYMS

This document incorporates many industry and device specific words use the following list to define a variety of terms and acronyms.

Table 22 Glossary of Terms and Acronyms

Term	Definition
ATA	Advanced Technology Attachment
ATAPI	Advanced Technology Attachment Packet Interface
DIPM	Device Initiated Power Management The ability of the device to request SATA link power state changes
DMA	Direct Memory Access
DRAM	Dynamic Random Access Memory
GB	Giga-byte defined as 1×10^9 bytes
Hot Plug	A term used to describe the removal or insertion of a SATA hard drive when the system is powered on
AES	Advanced Encryption Standard (AES) is a specification for the encryption of electronic data.
IOPS	Input output operations per second
LBA	Logical Block Address
MB	Mega-bytes defined as 1×10^6 bytes
MTBF	Mean time between failure
NCQ	Native Command Queuing The ability of the SATA hard drive to re-order commands in order to maximize the efficiency of gathering data from the platters
NOP	No operation
OS	Operation System
SATA	Serial ATA
SMART	Self-Monitoring, Analysis and reporting Technology An open standard for developing hard drive and software systems that automatically monitors a hard drive's health and reports potential problems
SSD	Solid State Drive
WHQL	Microsoft* Windows Hardware Quality Labs
Write Cache	A memory device within a hard drive, which is allocated for the temporary storage of data before that data is copied to its permanent storage location
VCCI	Voluntary Control Council for Interface