Industrial
2.5 inch SATA III SSD
SSD500R Series
Datasheet

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. Revision History

Revision	Date	Major Changes
0.1	2016/12/30	1. Preliminary release.
1.0	2017/10/20	1. Formal release.
1.1	2017/12/08	1. Update ordering information.
1.2	2018/11/16	1. Update performance table.

1. Product Description

1.1 Overview

Silicon Power's 2.5" SATA Solid State Disk (SSD) 500R series is the storage device based on NAND flash memory technology. This product complies with Serial ATA standard interface and is suitable for data storage media, code storage device, or boot disk for embedded systems. In case of heavy write operating applications. For the applications with less write but high performance read operating, this series also provide Toggle MLC solutions to support the requirements. By using solid state NAND Flashes, it operates good performance/power consumption and can have better environmental sustention for the systems.

With standard form factor, the applicable appliance can add or install this SATA storage device into complete set of industrial PCs or rugged systems.

Application Fields:
  - Industrial PC and Thin Client
  - Game and Telecommunication machine
  - Ticketing, examining, testing machine
  - Equipments or machines for health, production, or rugged applications
  - Other machines and equipments with Serial ATA 6.0Gb/s interface.

1.2 Features

  - 2.5" standard form factor with Serial ATA standard interface connector.
  - exclusive pSLC technology
  - Compliant with Serial ATA revision 3.1 standard with 6.0 Gb/s transfer rate.
  - Compliant with ATA/ATAPI-8 standard and ACS-2 command protocol.
  - Support SMART feature command set.
  - Support 28/48 bit LBA addressing.
  - Support SATA DEVSLP for advance power saving.
  - High performance and reliability. noiseless and stable installation to system
  - Operating as boot disk, or code storage device for embeded operating system
  - Support Power Failure Protection technology.

1.3 System Requirements

  - SATA 6.0Gb/s interface, backward compatible with 3.0Gb/s & 1.5Gb/s interface, with 2.5" standard form factor.
  - Voltage: DC +5V ± 5%
  - Operating System:
    - Windows XP/7/8/10, or Windows Embedded Systems, or DOS
    - Linux

2. Specification

2.1 Physical Dimension

2.1.1 Dimension

The dimensions of 2.5" SATA SSD are illustrated in Figure 1 and described in Table 1.
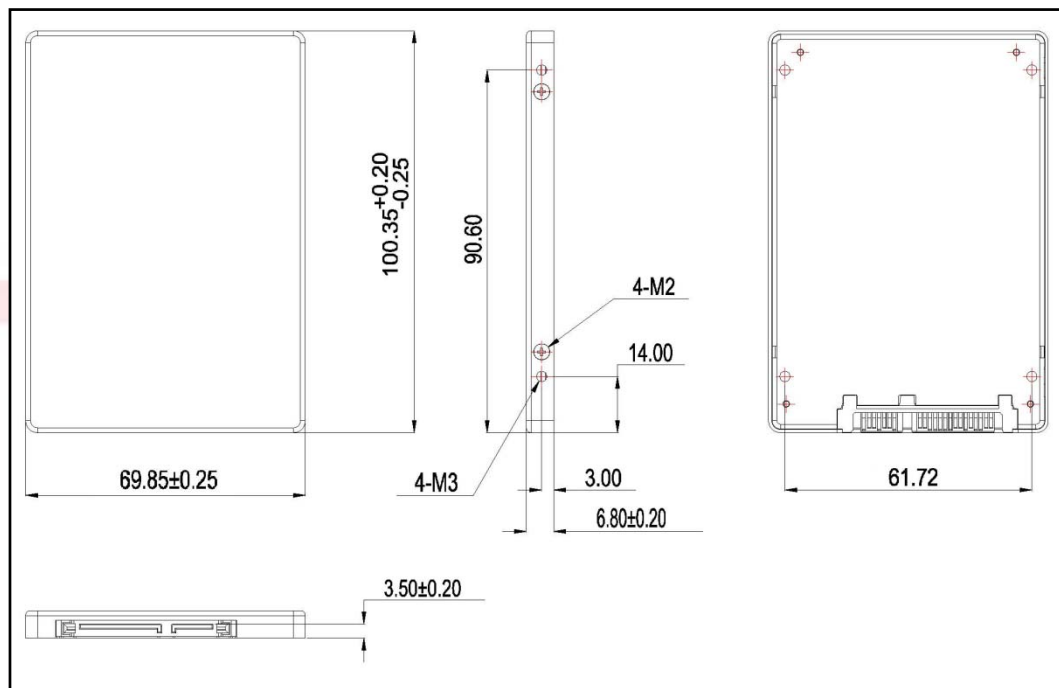
Figure 1:2.5" SATA SSD dimensions with 7mm thickness

Table 1 :2.5" SATA SSD Physical Dimension

	7mm
Length	$100.35\ {}^{+0.20}_{-0.25}$ mm
Width	69.85 ± 0.25 mm
Thickness (connector)	6.80 ± 0.20mm

2.1.2 Weight

   - Weight: < 75g

2.2 Electrical Specifications

2.2.1 Operating Condition

- Supply voltage: DC +5V ± 5%

- Power consumption (maximum):

Mode (Current)	pSLC						Unit
	16GB	32GB	64GB	128GB	256GB	512GB	
Read	140	260	260	270	290	315	mA
Write	190	365	380	415	430	450	mA
Stand-by	75						mA
Slumber	20						mA

※ *Testing Platform:*
Mother-Board: ASUS H87-PLUS, CPU: Intel(R) Core i5-4670 CPU 3.4GHz, Chipset: Intel H87, Main Memory: DDR3-1333 4GB X
3pcs, Operating System: Win 7, 64bit
Test Temperature: 25°C
Notice: *The data could be different, depended on the test platforms and the test setups.*

2.2.2 Capacity and Block Size information

- Capacity:

- pSLC: 16GB,32GB, 64GB, 128GB, 256GB, 512GB

- Sector size: 512Bytes

2.3 Performance

2.3.1 Transfer Modes

  - Serial ATA 6.0Gb/s, backward compatible with Serial ATA 3.0GB/s & 1.5Gb/s.

2.3.2 Data Access Performance

  - Maximum sustained sequential access (estimated)

Mode	Performance						Unit
	pSLC						
	16GB	32GB	64GB	128GB	256GB	512GB	
Read	520	520	520	520	520	520	MB/s
Write	230	210	410	400	400	400	MB/s

  ※ *Test Platform: Average Value are based on Serial ATA 6.0Gb/s interface*

  Mother-Board: ASUS H87-PLUS, CPU: Intel(R) Core i5-4670 CPU 3.4GHz, Chipset: Intel H87, Main Memory: DDR3-1333 4GB X 3pcs, Operating System: Win 7, 64bit

  Testing Software: CrystalDiskMark 3.0, Testing OS: Windows 7 Ultimate, 64bit

  `Notice:` *The value is various bases on the capacity and the testing platform.*

2.3.3 TeraByte Write

  - Maximum TBW data

	pSLC						Unit
	16GB	32GB	64GB	128GB	256GB	512GB	
TBW	115	231	462	925	1851	3703	TB

  `Notice:` *The data represents a theoretical data based on the client mode without degrading estimation. It could be different depended on the workload or usage containing data size and access rate.*

2.3.4 Wear-leveling

  - Enhanced endurance by Global wear-leveling.

2.4 Environmental Conditions

2.4.1 Temperature

Grade	Operating	Non-operating
Normal grade	0°C to +70°C	-55°C to +95°C
Wide temperature grade	-40°C to +85°C	

2.5 Reliability

2.5.1 ECC/EDC Capability (Error Correction Code/Error Detection Code)

 - support BCH ECC up to 66bits per 1,024 Bytes at each channel.

2.6 Compliance Specifications

 - CE

 - FCC

3. Functional Description

3.1 Architecture

SILICON POWER'S 2.5" SATA SSD 500R series is designed to operate and work as data or code storage device by NAND Flash memory and its controller through Standard Serial ATA 6.0Gb/s interface to host systems.
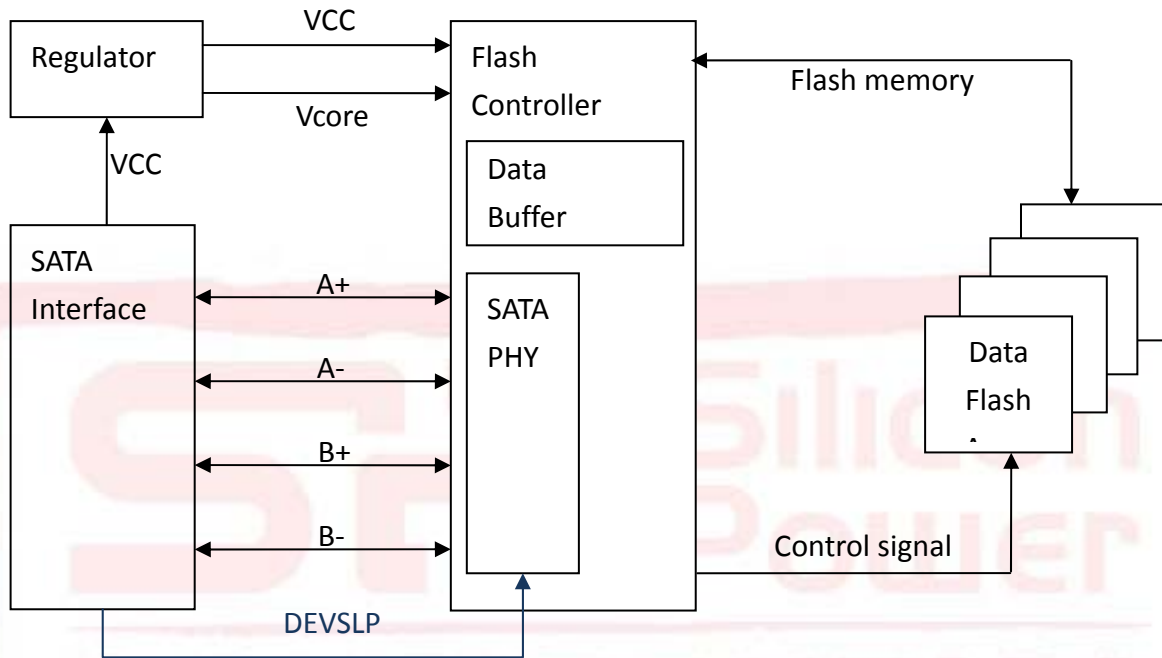
Figure 2 :2.5" SATA III SSD Block Diagram

3.2 PFP (Power Failure Protection)

During SSD operation, data is temporarily stored in the DRAM cache to reduce the performance gap between the host interface and the NAND Flash memory. However, in cases of unexpected sudden power loss, such as unplugging the power to the system, sudden battery loss or unplugging devices from the system, the flushing process cannot be completed and may cause serious device failure.
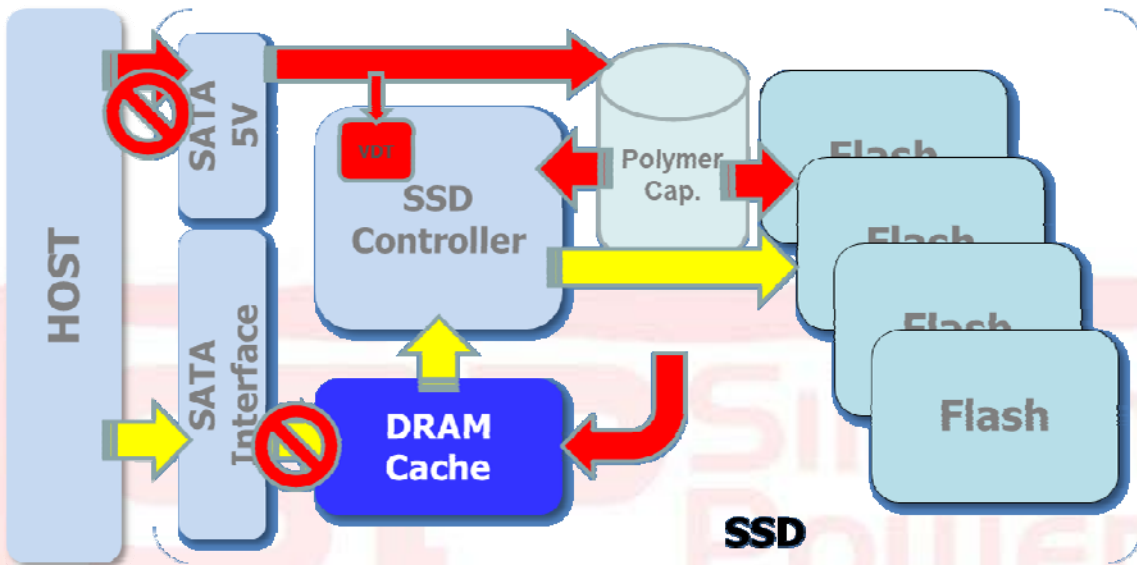
Figure 3 :PFP architecture

PFP integrates built-in VDT and firmware mechanism. The trigger alert is able to monitor abnormal power drop and take instant actions, such as prohibit receiving data from host and backup mapping/ link table into Flash, once a possible power failure is detected.

Advanced PFP is a way to gain more time for the data flushing process from DRAM cache to Flash, under sudden power off situations by using dedicated polymer capacitor components. These capacitors are charged during power on and offer charged power to the SSD circuit when external power is off.

SP guarantee PFP technology SSD provide at least 20ms to ensure data flushing task should be completed within the discharge time. And always pass 3000 times abnormal power cycling during operating test.
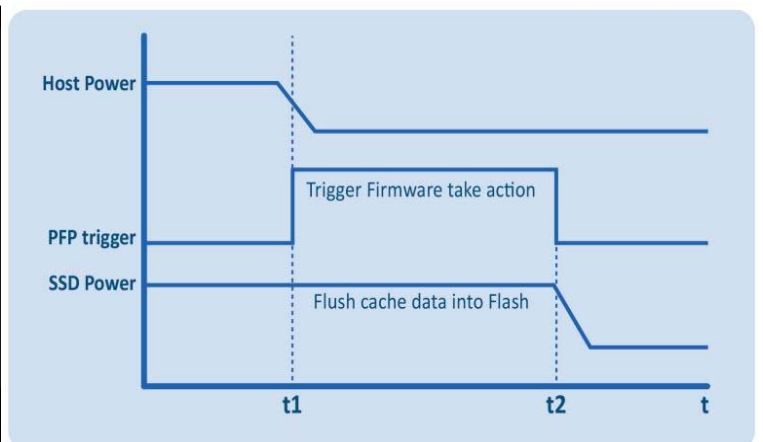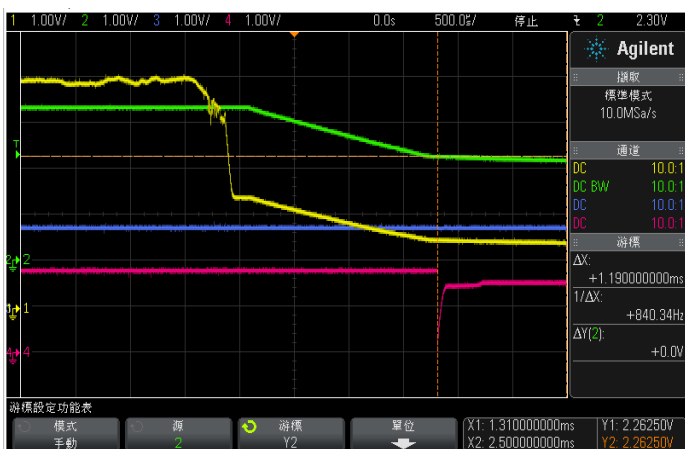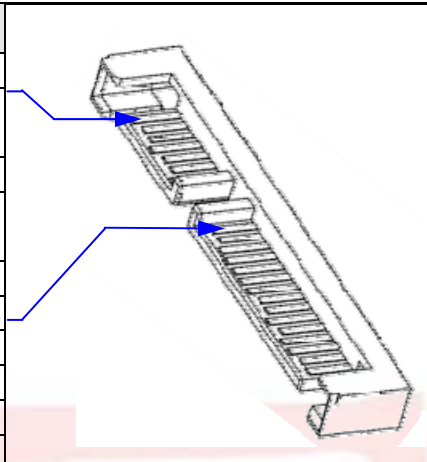
Figure 4 :Power lose wave

3.3 Signal Assignment

The signals assigned for Serial ATA applications are described in the following table.

Table 2 :Serial ATA connector pin definitions

Segment	Pin No	Function	Definition	
Signal	S1	Gnd	Pin 1	
	S2	A+	Differential signal pair A from Phy	
	S3	A-		
	S4	Gnd		
	S5	B-	Differential signal pair B from Phy	
	S6	B+		
	S7	Gnd		
Power	P8~P10	NC	NC Pin 8	
	P11~P13	GND		
	P14~P16	5V	Voltage	
	P17~P19	GND		
	P20~P22	NC		

Notice: *All pins are with 1.27 mm (0.050") pitch.*

Figure 5 :SATA Signal Connector
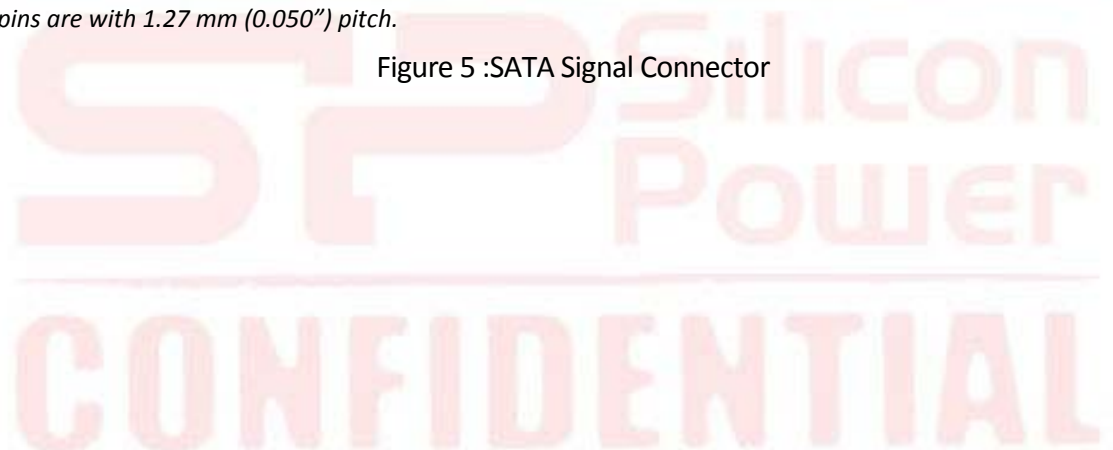
3.4 Support ATA Commands

The table showed below summarizes the supported ATA command set. For detail description of the commands, please check the ATA standard or contact Silicon Power local representatives for the helps.

Table 3: ATA Command Set

No	Command Set	Code	FR	SC	SN	CY	DH	LBA
General Feature Set
1	Execute Drive Diagnostic Mode	90h	-	-	-	-	D	-
2	Flush Cache	E7h	-	-	-	-	D	-
3	Identify Device	ECh	-	-	-	-	D	-
4	Initialize Device Parameters	91h	-	Y	-	-	Y	-
5	NOP	00h	-	-	-	-	D	-
6	Read Buffer	E4h	-	-	-	-	D	-
7	Read DMA	C8h	-	Y	Y	Y	Y	Y
8	Read Multiple	C4h	-	Y	Y	Y	Y	Y
9	Read Sector(s)	20h	-	Y	Y	Y	Y	Y
10	Read Verify Sector(s)	40h or 41h	-	Y	Y	Y	Y	Y
11	Seek	7xh	-	Y	-	Y	Y	Y
12	Set Feature	EFh	Y	-	-	-	D	-
13	Set Multiple Mode	C6h	-	Y	-	-	D	-
14	Write Buffer	E8h	-	-	-	-	D	-
15	Write DMA	CAh	-	Y	Y	Y	Y	Y
16	Write Multiple	C5h	-	Y	Y	Y	Y	Y
17	Write Sector(s)	30h	-	Y	Y	Y	Y	Y
48-bit Address Feature Set
18	Flush Cache Ext	EAh	-	-	-	-	D	-
19	Read DMA Ext	25h	-	Y	Y	Y	Y	Y
20	Read Multiple Ext	29h	-	Y	Y	Y	Y	Y
21	Read Sector(s) Ext	24h	-	Y	Y	Y	Y	Y
22	Read Verify Sector(s) Ext	42h	-	Y	Y	Y	Y	Y
23	Write DMA Ext	35h	-	Y	Y	Y	Y	Y
24	Write DMA FUA Ext	3Dh	-	Y	Y	Y	Y	Y
25	Write Multiple Ext	39h	-	Y	Y	Y	Y	Y
26	Write Multiple FUA Ext	CEh	-	Y	Y	Y	Y	Y
27	Write Sector(s) Ext	34h	-	Y	Y	Y	Y	Y
Host Protected Area (HPA) Feature Set (Option)
28	Read Native Max Address	F8h	-	-	-	-	D	-
29	Read Native Max Address Ext	27h	-	-	-	-	D	-
30	Set Max Address	F9h	-	Y	Y	Y	Y	Y
31	Set Max Address Ext	37h	-	Y	Y	Y	Y	Y
32	Set Max Freeze Lock	F9h	04h	-	-	-	D	-
33	Set Max Lock	F9h	02h	-	-	-	D	-
34	Set Max Set Password	F9h	01h	-	-	-	D	-
35	Set Max Unlock	F9h	03h	-	-	-	D	-
Power Management Feature Set
36	Check Power Mode	E5h or 98h	-	-	-	-	D	-
37	Idle	E3h or 97h	-	Y	-	-	D	-
38	Idle Immediate	E1h or 95h	-	-	-	-	D	-
39	Sleep	E6h or 99h	-	-	-	-	D	-
40	Standby	E2h or 96h	-	-	-	-	D	-

No	Command Set	Code	FR	SC	SN	CY	DH	LBA
41	Standby Immediate	E0h or 94h	-	-	-	-	D	-
Security Mode Feature Set								
42	Security Disable Password	F6h	-	-	-	C	-	-
43	Security Erase Prepare	F3h	-	-	-	C	-	-
44	Security Erase Unit	F4h	-	-	-	C	-	-
45	Security Freeze Lock	F5h	-	-	-	C	-	-
46	Security Set Password	F1h	-	-	-	C	-	-
47	Security Unlock	F2h	-	-	-	C	-	-
SMART Feature Set								
48	SMART Disable Operations	B0h	D9h	Y	-	Y	Y	-
49	SMART Enable/Disable Autosave	B0h	D2h	Y	-	Y	Y	-
50	SMART Enable Operations	B0h	D8h	Y	-	Y	Y	-
51	SMART Execute Off-Line Immediate	B0h	D4h	Y	-	Y	Y	-
52	SMART Read Data	B0h	D0h	Y	-	Y	Y	-
53	SMART Read Threshold	B0h	D1h	Y	-	Y	Y	-
54	SMART Return Status	B0h	DAh	Y	-	Y	Y	-
55	SMART Save Attribute Values	B0h	D3h	Y	-	Y	Y	-

Definitions：

  FR = Features register   **SN** = Sector number register **DH** = Device/drive/head register

  CY = Cylinder register   **SC** = Sector count register   **D** = Only the device parameter is valid and not the head parameter

  LBA = Logical block address mode supported (see command descriptions for use).

  Y - The register contains a valid parameter for this command. For the drive/head register Y means both the device and
      head parameters are used.

  C - The register contains command specific data (see command descriptions for use).

3.5 Device Identification

The following is the device identify table.

Table 4 : Identify Device Information

Word Address	Default Value	Total Bytes	F/V	Data Field Type Information
0	0044h	2		General configuration – Bit Significant with ATA definitions.
			F	15 0:ATAdevice
			X	14-8 Retired
			F	7 1:removablemediadevice
			X	6 Obsolete
			X	5-3 Retired
			F	2 Response incomplete
			X	1 Retired
			F	0 Reserved
1	XXXXh	2	X	Default number of cylinders
2	0000h	2	V	Reserved
3	00XXh	2	X	Default number of heads
4-5	XXXXh	4	X	Reserved
6	XXXXh	2	X	Default number of sectors per track
7-8	XXXXh	4	V	Reserved for assignment by the CFA
9	0000h	2	X	Reserved
10-19	Aaaa	20	F	Serial number in ASCII (Right Justified)
20-21	XXXXh	4	X	Reserved
22	XXXXh	2	X	Reserved
23-26	aaaa	8	F	Firmware revision in ASCII. Big Endian Byte Order in Word
27-46	aaaa	40	F	Model number in ASCII (Left Justified) Big Endian Byte Order in Word
47	8001h	2		Maximum number of sectors on Read/Write Multiple command
			F	15-8 80h: Fixed
			F	7-0 00h: Reserved
				01h: Maximum number of 1 sectors on READ/WRITE MULTIPLE commands
48	XXXXh	2	X	Reserved
49	0F00h	2		Capabilities: DMA, LBA, IORDY supported
			F	15-14 Reserved for the IDENTIFY PACKET DEVICE command.
			F	13 1: Standby timer values as specified in this standard are supported
				0: Standby timer values shall be managed by the device
			F	12 Reserved for the IDENTIFY PACKET DEVICE command
			F	11 1: IORDY supported
				0: IORDY may be supported
			F	10 1: IORDY may be disabled
			F	9 1: LBA supported
			F	8 1: DMA supported
			X	7-0 Retired

Word Address	Default Value	Total Bytes	F/V	Data Field Type Information
50	4000h	2		Capabilities: Others, Fixed
			F	15 Shall be cleared to zero.
			F	14 Shall be set to one.
			F	13-2 Reserved.
			X	1 Obsolete
			F	0 Shall be set to one to indicate a device specific Standby timer value minimum
51	0200h	2		PIO data transfer cycle timing mode 2
			X	15-8 PIO data transfer cycle timing mode
			X	7-0 Reserved
52	XXXXh	2	X	Reserved
53	0007h	2		Data Fields 54 to 58, 64 to 70 and 88 are valid
			F	15-3 Reserved
			F	2 1: the fields reported in word 88 are valid
				0: the fields reported in word 88 are not valid
			F	1 1: the fields reported in words 70:64 are valid
				0: the fields reported in words 70:64 are not valid
			X	0 1: the fields reported in words 58:54 are valid
				0: the fields reported in words 58:54 are not valid
54	XXXXh	2	X	Current numbers of cylinders
55	00XXh	2	X	Current numbers of heads
56	XXXXh	2	X	Current sectors per track
57-58	XXXXh	4	X	Current capacity in sectors (LBAs)(Word 57 = LSW, Word 58 = MSW)
59	0100h	2		Multiple sector setting
			F	15-9 Reserved
			V	8 1: Multiple sector setting is valid
			V	7-0 xxh: Setting for number of sectors that shall be transferred per interrupt on R/W Multiple command
60-61	XXXXh	4	F	Total number of sectors addressable in LBA Mode
62	0000h	2	X	Reserved
63	0007h	2		Multiword DMA transfer.
			F	15-11 Reserved
			V	10 1: Multiword DMA mode 2 is selected
				0: Multiword DMA mode 2 is not selected
			V	9 1: Multiword DMA mode 1 is selected
				0: Multiword DMA mode 1 is not selected
			V	8 1: Multiword DMA mode 0 is selected
				0: Multiword DMA mode 0 is not selected
			F	7-3 Reserved
			F	2 1: Multiword DMA mode 2 and below are supported
			F	1 1: Multiword DMA mode 1 and below are supported
			F	0 1: Multiword DMA mode 0 is supported

Word Address	Default Value	Total Bytes	F/V	Data Field Type Information
64	0003h	2		Advanced PIO modes 3 and 4 supported
			F	15-8　　Reserved
			F	7-0　　Advanced PIO modes supported
65	0078h	2	F	Minimum Multiword DMA transfer cycle time per word.
				15-0　　Cycle time in ns.
66	0078h	2	F	Recommended Multiword DMA transfer cycle time.
				15-0　　Cycle time in ns.
67	0078h	2	F	Minimum PIO transfer cycle time without flow control.
				15-0　　Cycle time in ns.
68	0078h	2	F	Minimum PIO transfer cycle time with IORDY flow control
				15-0　　Cycle time in ns.
69-70	0000h	4	F	Reserved
71-74	0000h	8	F	Reserved for Identify Packet Device Command
75	0000h	2		Queue depth
			F	15-5　　Reserved
			F	4-0　　Maximum queue depth - 1
76	0206h	2		Serial ATA Capabilities
			F	15-11　　Reserved for Serial ATA
			F	10　　1: supports PHY Event Counts
			F	9　　1: supports receipt of Host initiated power management requests
			F	8　　1: supports NCQ Feature Set
			F	7-3　　Reserved for Serial ATA
			F	2　　1: supports SATA Gen2 Signaling Speed (3.0Gb/s)
			F	1　　1: supports SATA Gen1 Signaling Speed (1.5Gb/s)
			F	0　　Shall be cleared to zero
77	0000h	2	X	Reserved for Serial ATA
78	0008h	2		Serial ATA Feature Supported
			F	15-7　　Reserved for Serial ATA
			F	6　　1: supports Software Settings Preservation
			F	5　　Reserved for Serial ATA
			F	4　　1: supports in-order data delivery
			F	3　　1: supports initiating power management
			F	2　　1: Supports DMA setup auto-activation
			F	1　　1: Supports none-zero buffer offset
			F	0　　Shall be cleared to zero
79	0000h	2		Serial ATA Feature Enabled
			F	15-7　　Reserved for Serial ATA
			F	6　　1: Software Settings Preservation enabled
			F	5　　Reserved for Serial ATA
			F	4　　1: In-order data delivery enabled
			F	3　　1: Initiating power management enabled
			F	2　　1: DMA setup auto-activation enabled
			F	1　　1: None-zero buffer offset enabled
			F	0　　Shall be cleared to zero
80	01FCh	2		Major version number, ATA-8 support

Word Address	Default Value	Total Bytes	F/V		Data Field Type Information
			F	15	Reserved
			F	14	Reserved for ATA/ATAPI-14
			F	13	Reserved for ATA/ATAPI-13
			F	12	Reserved for ATA/ATAPI-12
			F	11	Reserved for ATA/ATAPI-11
			F	10	Reserved for ATA/ATAPI10
			F	9	Reserved for ATA/ATAPI-9
			F	8	1: supports 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
			F	2	Obsolete
			F	1	Obsolete
			F	0	Reserved
81	0000h	2	F		Minor version number
82	742Bh	2	F		Features/command sets supported (NOP, SMART,…)
			X	15	Obsolete
			F	14	1: NOP command supported
			F	13	1: READ BUFFER command supported
			F	12	1: WRITE BUFFER command supported
			X	11	Obsolete
			F	10	1: Host Protected Area feature set supported
			F	9	1: DEVICE RESET command supported
			F	8	1: SERVICE interrupt supported
			F	7	1: release interrupt supported
			F	6	1: look-ahead supported
			F	5	1: write cache supported
			F	4	Shall be cleared to zero to indicate that the PACKET Command feature set is not supported.
			F	3	1: mandatory Power Management feature set supported
			F	2	1: Removable Media feature set supported
			F	1	1: Security Mode feature set supported
			F	0	1: SMART feature set supported
83	7500h	2			Features/command sets supported (Flush Cache, …)
			F	15	Shall be cleared to zero
			F	14	Shall be set to one
			F	13	Reserved
			F	12	Shall be set to one to indicate that the mandatory FLUSH CACHE command is supported
			F	11	1: DCO feature set is supported
			F	10	1: 48-bit Address feature set is supported
			F	9	1: AAM feature set is supported
			F	8	1: SET MAX security extension supported
			F	7	Reserved

Word Address	Default Value	Total Bytes	F/V		Data Field Type Information
			F	6	1: SET FEATURES subcommand required to spin up after power-up
			F	5	1: Power-Up In Standby feature set supported
			F	4	1: Removable Media Status Notification feature set supported
			F	3	1: Advanced Power Management feature set supported
			F	2	1: CFA feature set supported
			F	1	1: READ/WRITE DMA QUEUED supported
			F	0	1: DOWNLOAD MICROCODE command supported
84	4002h	2			Features/command sets supported (extension)
			F	15	Shall be cleared to zero
			F	14	Shall be set to one
			F	13	1: IDLE IMMEDIATE command with UNLOAD feature is supported
			F	12-11	Reserved for TLC
			F	10-9	Obsolete
			F	8	1: 64-bit World wide name is supported
			F	7	1: WRITE DMA QUEUED FUA EXT command is supported
			F	6	1: WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands are supported
			F	5	1: GPL feature set is supported
			F	4	1: Streaming feature set is supported
			F	3	1: Media Card Pass Through Command feature set is supported
			F	2	1: Media serial number is supported
			F	1	1: SMART self-test supported
			F	0	1: SMART error logging supported
85	XXXXh	2			Features/command sets enabled (NOP, SMART,…)
			X	15	Obsolete
			F	14	1: NOP command enabled
			F	13	1: READ BUFFER command enabled
			F	12	1: WRITE BUFFER command enabled
			X	11	Obsolete
			V	10	1: Host Protected Area feature set enabled
			F	9	Shall be cleared to zero to indicate that the DEVICE RESET command is not supported
			V	8	1: SERVICE interrupt enabled
			V	7	1: release interrupt enabled
			V	6	1: look-ahead enabled
			V	5	1: write cache enabled
			F	4	Shall be cleared to zero to indicate that the PACKET Command feature set is not supported.
			F	3	Shall be set to one to indicate that the mandatory Power Management feature is supported
			X	2	Obsolete
			V	1	1: Security feature set enabled
			V	0	1: SMART feature set enabled

Word Address	Default Value	Total Bytes	F/V		Data Field Type Information
86	XXXXh	2			Features/command sets enabled (Flush Cache, …)
			F	15	1: Word 119-120 are valid
			F	14	Reserved
			F	13	1: FLUSH CACHE EXT command supported
			F	12	1: FLUSH CACHE command supported
			F	11	1: DCO feature set is supported
			F	10	1: 48-bit Address feature set is supported
			V	9	1: AAM feature set is supported
			V	8	1: SET MAX security extension enabled by SET MAX SET PASSWORD
			X	7	Reserved for Address Offset Reserved Area Boot Method
			F	6	1: SET FEATURES subcommand required to spin-up after power-up
			V	5	1: Power-Up In Standby feature set enabled
			X	4	Obsolete
			V	3	1: Advanced Power Management feature set enabled
			F	2	1: CFA feature set is supported
			F	1	1: TCQ feature set is supported
			F	0	1: DOWNLOAD MICROCODE command supported
87	XXXXh	2			Features/command sets enabled (extension)
			F	15	Shall be cleared to zero
			F	14	Shall be set to one
			F	13	1: The IDLE IMMEDIATE command with UNLOAD feature is supported
			X	12-11	Reserved for TLC
			X	10-9	Obsolete
			F	8	1: 64-bit World wide name is supported
			F	7	1: WRITE DMA QUEUED FUA EXT command is supported
			F	6	1: WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands are supported
			F	5	1: GPL feature set is supported
			X	4	Obsolete
			V	3	1: Media Card Pass Through Command feature set is supported
			V	2	1: Media serial number is supported
			F	1	1: SMART self-test supported
			F	0	1: SMART error logging supported
88	007Fh	2			Ultra DMA Mode Supported and Selected
			F	15	Reserved
			V	14	1: Ultra DMA mode 6 is selected
					0: Ultra DMA mode 6 is not selected
			V	13	1: Ultra DMA mode 5 is selected
					0: Ultra DMA mode 5 is not selected
			V	12	1: Ultra DMA mode 4 is selected
					0: Ultra DMA mode 4 is not selected
			V	11	1: Ultra DMA mode 3 is selected

Word Address	Default Value	Total Bytes	F/V		Data Field Type Information
			V	10	0: Ultra DMA mode 3 is not selected 1: Ultra DMA mode 2 is selected
			V	9	0: Ultra DMA mode 2 is not selected 1: Ultra DMA mode 1 is selected
			V	8	0: Ultra DMA mode 1 is not selected 1: Ultra DMA mode 0 is selected
					0: Ultra DMA mode 0 is not selected
			F	7	Reserved
			F	6	1: Ultra DMA mode 6 and below are supported
			F	5	1: Ultra DMA mode 5 and below are supported
			F	4	1: Ultra DMA mode 4 and below are supported
			F	3	1: Ultra DMA mode 3 and below are supported
			F	2	1: Ultra DMA mode 2 and below are supported
			F	1	1: Ultra DMA mode 1 and below are supported
			F	0	1: Ultra DMA mode 0 is supported
89	0003h	2	X	15-8	Reserved
			F	7-0	Time required for security erase unit completion
90	0000h	2	X	15-8	Reserved
			F	7-0	Time required for Enhanced security erase completion
91	0000h	2	V		Current advanced power management value
92	FFFEh	2	V		Master Password Identifier
93-99	0000h	14	X		Reserved
100-103	VVVVh	8	V		Total Number of User Addressable Logical Sectors for 48-bit commands (QWord)
104-127	0000h	48	V		Reserved
128	0001h	2			Security status
			F	15-9	Reserved
			V	8	Security level 0: High, 1: Maximum
			X	7-6	Reserved
			F	5	1: Enhanced security erase supported
			V	4	1: Security count expired
			V	3	1: Security frozen
			V	2	1: Security locked
			V	1	1: Security enabled
			F	0	1: Security supported
129-159	0000h	62	X		Reserved for vendor
160	0000h	2			CFA power mode
			F	15	Word 160 supported
			X	14	Reserved
			F	13	CFA power mode 1 is required for one or more commands implemented by the device
			V	12	CFA power mode 1 disabled
			F	11-0	Maximum current in mA
161-175	0000h	30	X		Reserved for Compact Flash Association
176-216	0000h	82	V		Reserved
217	0001h	2	F		Nominal media rotation rate

Word Address	Default Value	Total Bytes	F/V	Data Field Type Information
218-254	0000h	74	X	Reserved
255	VVVVh	2		Integrity Word
			V	15-8 Checksum
			V	7-0 Signature

Note:

1. F/V: Fixed/Variable content.
2. F: 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.

   V: The contents of the word are variable and may change depending on the state of the device or the commands executed by the device.

   X: The content of the word may be fixed or variable.

3.6 Set Feature Command

The table listed below is the supported feature field set in feature register

Table 5 : SET FEATURES Feature Field Definitions

Value	Function
02h	Enable volatile write cache
03h	Set transfer mode
05h	Enable the APM feature set
10h	Enable use of SATA feature
55h	Disable read look-ahead feature
66h	Disable reverting t power on defaults by soft reset
82h	Disable volatile write cache
85h	Disable the APM feature set
90h	Disable use of SATA feature
AAh	Enable read look-ahead feature
CCh	Enable reverting to power-on defaults

The effective SATA features are defined as below:

Table 6 : SATA Features

Sector Count Value	Description
02h	DMA Setup FIS Auto-Active optimization
03h	Device-Initiated interface power state transitions
06h	Software Settings Preservation

3.7 SMART Feature Command

SILICON POWER'S 2.5" SATA SSD supports SMART function. It response the up-to-date SMART command set with the SMART data structure as following:

Table 7 : SMART Feature Registers Values

Value	Command
D0h	SMART Read Data
D1h	Read Attribute Threshold
D2h	SMART Enable/Disable Attribute Autosave
D3h	Save Attribute Values
D4h	Execute Off-Line Immediate
D8h	SMART Enable Operations
D9h	SMART Disable Operations
DAh	SMART Return Status
Others	Reserved

Table 8 : Device SMART Data Structure

Offset	Description
0-1	SMAT Structure Revision code
2-361	Attribute entries 1 to 30 (12 bytes each)
362	Off-line data collection status (No off-line data collection) (Fixed)
363	Self-test execution status byte (Self-test completed) (Fixed)
364-365	Total time in seconds to complete off-line data collection activity (Fixed)
366	Reserved
367	Off-line data collection capability (No Off-line data collection) (Fixed)
368-369	SMART capability
370	Error logging capability (No error logging) (Fixed)
371	Reserved
372	Short self-test routine recommended polling time (in minutes) (Fixed)
373	Extended self-test routine recommended polling time (in minutes) (Fixed)
374-510	Reserved
511	Data structure checksum

- (0-1) Revision code

This revision code area defines the firmware revision for the device.

- (2-361) Attribute entries 1 to 30 (12 bytes each)

There are five attributes that are defined for this device. These return their data in the attribute section of the SMART data, using a 12 byte data field. Rest of the area is reserved. The Individual attribute data structure is defined as following:

Offset	+0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+10	+11
Attribute	ID	Flag		Init	Worst	Raw Attribute Value						Rsv
Read Error Rate	01h	00h	00h	64h	64h	(1)	00h	00h	00h	00h	00h	00h
Reallocated Sectors Count	05h	00h	00h	64h	64h	(2)		00h	00h	00h	00h	00h
Power Cycle Count	0Ch	00h	00h	64h	64h	(3)		00h	00h	00h	00h	00h
Uncorrectable SC when R/W	A0h	00h	00h	64h	64h	(4)				00h	00h	00h
No. of Valid Spare Block	A1h	00h	00h	64h	64h	(5)		00h	00h	00h	00h	00h
No. of Valid Child Pair	A2h	00h	00h	64h	64h	(6)		00h	00h	00h	00h	00h
No. of Initial Invalid Block	A3h	00h	00h	64h	64h	(7)		00h	00h	00h	00h	00h
Total Erase Count	A4h	00h	00h	64h	64h	(8)			00h	00h	00h	00h
Max. Erase Count	A5h	00h	00h	64h	64h	(9)			00h	00h	00h	00h
Min. Erase Count	A6h	00h	00h	64h	64h	(10)			00h	00h	00h	00h
Average Erase Count	A7h	00h	00h	64h	64h	(11)			00h	00h	00h	00h
Power-off retract Count	C0h	00h	00h	64h	64h	(12)			00h	00h	00h	00h
H/W ECC Recovered	C3h	00h	00h	64h	64h	(13)			00h	00h	00h	00h
Reallocation Event Count	C4h	00h	00h	64h	64h	(14)			00h	00h	00h	00h
UDMA CRC Error Count	C7h	00h	00h	64h	64h	(15)		00h	00h	00h	00h	00h
Total LBAs Written (unit: 32MB)	F1h	00h	00h	64h	64h	(16)			00h	00h	00h	00h
Total LBAs Read (unit: 32MB)	F2h	00h	00h	64h	64h	(17)			00h	00h	00h	00h

Notice:
1. Use "Little Indian" rule. If the data is in two bytes length, LSB is in lower bytes and MSB is in higher byte. All of the data are in HEX format.
2. The entries with other indices are reserved for controller vendor specific usage.

- (368-369) SMART capabilities

The following describes the definition for the SMART capabilities bits.

- Bit 0 - If this bit is set to one, the device saves SMART data prior to going into a power saving mode (Idle, Standby, or Sleep) or immediately upon return to Active or Idle mode from a Standby mode. If this bit is cleared to zero, the device does not save SMART data prior to going into a power saving mode (Idle, Standby, or Sleep) or immediately upon return to Active or Idle mode from a Standby mode.

- Bit 1 - This bit shall be set to one to indicate that the device supports the SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE command.

- Bits (15:2) (Reserved).

- (372-373) Self-test routine recommended polling time

The self-test routine recommended polling time shall be equal to the number of minutes that is the minimum recommended time before which the host should first poll for test completion status. Actual test time could be several times this value. Polling before this time could extend the self-test execution time or abort the test depending on the state of bit 2 of the off-line data capability bits.

- (511) Data structure checksum

The data structure checksum is the two's complement of the sum of the first 511 bytes in the data structure. Each byte shall be added with unsigned arithmetic, and overflow shall be ignored. The sum of all 512 bytes will be zero when the checksum is correct. The checksum is placed in byte 511.

4. Installation

4.1 Installation

For Installation of SATA SSD to your system, please follow up below steps;

1. Make sure your computer is turned off before you open the case.

2. Plug the SATA SSD carefully into the Serial ATA slot on your computer or host adapter.

3. Plug the SATA SSD into Serial ATA power cable with 5V

4. Check cable connections and SATA SSD is firm enough.

4.2 Partition

For Windows Operating System：

- To partition your new SATA SSD, for example use Microsoft Windows7 or WES 7:

1. In your windows system. You can Click the 『Start』→ 『Control Panel』→ 『System and Security』
→『Administrative Tools』→『Computer Management』 then select 『Storage』→『Disk Management』
to setup the partition.
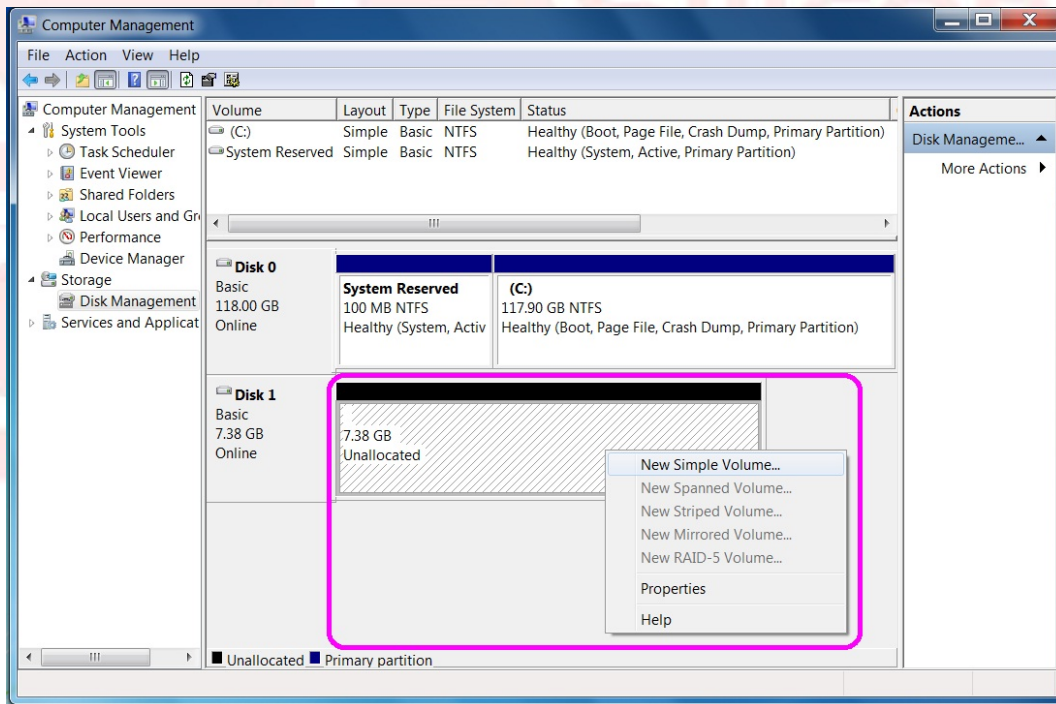
4.3 Format

For Windows Operating System:

- To format your new SATA SSD, for example use Microsoft Windows7 or WES7:

1. Click the 『Start』→『Control Panel』→『System and Security』→『Administrative Tools』→『Computer Management』 then select 『Storage』→『Disk Management』 to setup the file format. With such setup procedure, the format type of File system may have more choice depended on the capacity of the device.

2. Select suitable format type for usage.
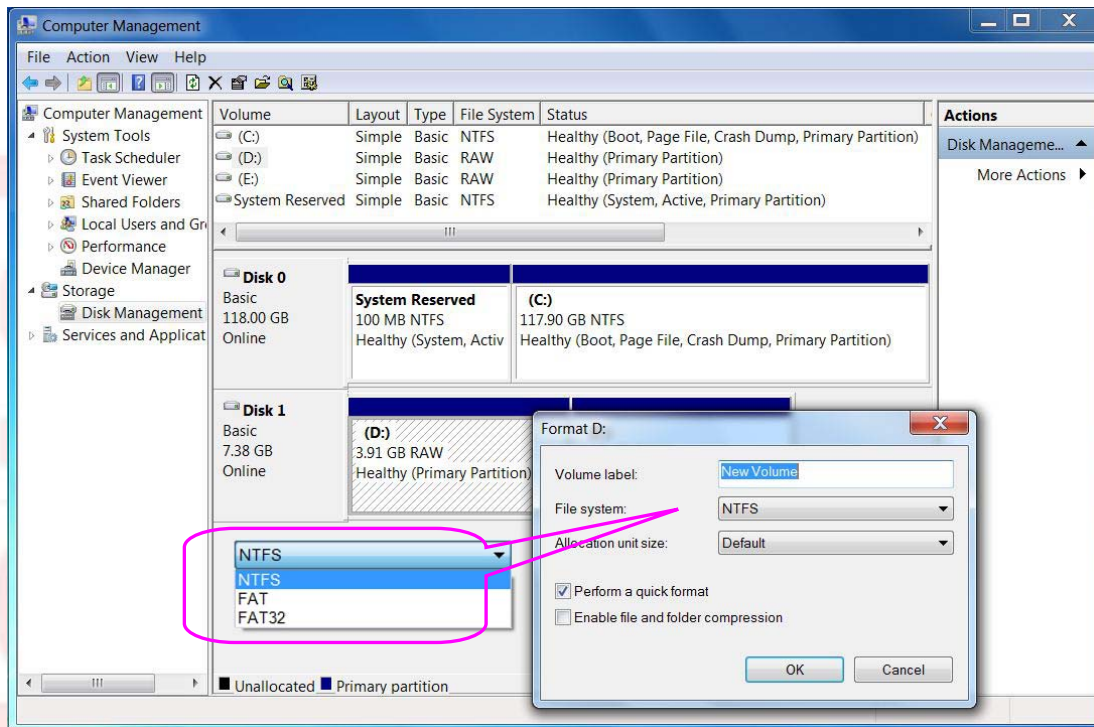
5. Troubleshooting

5.1 BIOS can not identify SATA SSD

5.1.1 Check Power Cable Status

5.1.2 Check Connector status

5.1.3 Check the Power Voltage (only 5V)

5.2 SATA SSD can not boot the system

5.2.1 Check BIOS setting

5.2.2 Reinstall your system

Notice: *Please contact your closest Silicon Power office or local representatives for verifying your other troubles.*

6. Ordering Information

6.1 Part Number Definition

SP	XXXX	I	SSD	5	0	1	R	V	0
|	|	|	|	|	|	|	|	|	|
Prefix	Capacity	Industrial Product	Form Factor	Flash Type	Controller	Flash Brand	SSD Series	Temp	Reserve

Code	Definition	Description
XXXX	Capacity	016G: 16GB, 032G: 32GB, 064G: 64GB, 128G: 128GB, 256G: 256GB, 512G: 512GB
SSD	Form Factor	SSD: 2.5" SSD, MSA: mSATA, MSM:mSATA mini, MDA: M.2 2242 MDB: M.2 2260, MDC: M.2 2280, MDD:M.2 22110, HSD: Half Slim SFM: SATA DOM
5	Flash Type	7: SLC, 5: pSLC, 3: MLC
0	Controller	0: SM2246EN
1	Flash	1: Toshiba
R	SSD Series	R: Robust & Extreme, S: Performance, E:Embedded
V	Operation Temp	W:Wide Temp -40 - +85℃, E:Extended Temp -25 - +85℃ V:Normal temp: 0 - +70℃

2.5" SATA III SSD Ordering Information

Capacity	Part Number	BOM Code	Description	R/W Performance (MB/s)
Industrial 2.5" SATA SSD500R series, 7mm, MLC, Normal Temperature				
16GB	SP016GISSD501RV0	016GISSD501RV0-010	SM2246EN AA + 15nm 64Gb*4	520 / 230
32GB	SP032GISSD501RV0	032GISSD501RV0-010	SM2246EN AA + 15nm 128Gb*4	520 / 210
64GB	SP064GISSD501RV0	064GISSD501RV0-010	SM2246EN AA + 15nm 128Gb*8	520 / 410
128GB	SP128GISSD501RV0	128GISSD501RV0-010	SM2246EN AA + 15nm 256Gb*8	520 / 400
256GB	SP256GISSD501RV0	256GISSD501RV0-010	SM2246EN AA + 15nm 512Gb*8	520 / 400
512GB	SP512GISSD501RV0	512GISSD501RV0-010	SM2246EN AA + 15nm 1Tb*8	520 / 400

Capacity	Part Number	BOM Code	Description	R/W Performance (MB/s)
Industrial 2.5" SATA SSD500R series, 7mm, MLC, Wide Temperature				
128GB	SP128GISSD501RW0	128GISSD501RW0-010	SM2246EN AA + 15nm 256Gb*8	520 / 400

Capacity	Part Number	BOM Code	Description	R/W Performance (MB/s)
Industrial 2.5" SATA SSD500R series, 7mm, MLC, Wide Temperature				
256GB	SP256GISSD501RW0	256GISSD501RW0-010	SM2246EN AA + 15nm 512Gb*8	520 / 330
		256GISSD501RW0-020	SM2246EN AA + 15nm 512Gb*8	520 / 400
512GB	SP512GISSD501RW0	512GISSD501RW0-010	SM2246EN AA + 15nm 1Tb*8	520 / 400

6.2 Contact Information

Silicon Power Computer & Communications Incorporation, a solid state memory or storage business company, provides total solutions in the design and marketing of SSD, Flash Module, and Industry Card products. For further supporting or detail information related to the products, please inform us through the following contact email address: isupport@silicon-power.com. We will response the requests soon.