



# Panther Military ST Series 2.5" SATA3 SSD Data Sheet





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# 1. Introduction

## 1.1 General Description

The Panther ST Series 2.5" SATA SSD houses a powerful SATA SSD controller that is fully compliant to SATA 6Gbps (Revision 3.0) standards on the front-end. Matching the speed on the back-end side, the SSD controller is designed with 4 high-speed NAND Flash channels. This allows the product to achieve superior performance for fulfilling the market's ever increasing demand of convenient user-experience, improved multi-tasking capabilities and extreme responsiveness.

The Panther ST Series 2.5" SATA SSD is a perfect storage device for various Military/Industrial/Embedded applications. It beats HDD in every possible metric – size, weight, shock and vibration tolerance, power consumption, sequential and random read performances as well as sequential and random write performances. Furthermore, the Panther ST Series 2.5" SATA SSD employs a low-power architecture that significantly reduces the power consumed by the device in low power modes - allowing the users' to extend the charge cycles of the battery – highly-desired by mobility applications.

Built on the fundamentals of solid state technology, ST Series 2.5" SATA SSD has no moving parts, unlike an HDD, significantly improving the mechanical reliability of the device. The advanced flash management technology designed into the device firmware allows it to achieve superior sequential and random IO performance, and improves long-term data endurance significantly. The device firmware also implements functions of Dynamic bad block management, global wear-leveling, and robust error correction code (ECC) to ensure data integrity. Once the SSD has been configured by the host, it appears to the host as a standard SATA disk drive.



## 1.2 Key Features

- High-capacity, ultra-small form factor supporting unformatted capacities of 32GB, 64GB, 128GB, 256GB, 512GB and 1TB:
- Interface to host: SATA 6Gbps (Revision 3.0) compliant
- Backwards compliant to SATA 3Gbps & SATA 1.5Gbps
- ATA Command Set ACS-2
- NCQ support up to queue depth = 32
- Flash: 2xnm Micron Sync MLC NAND flash
- External Cache: 256MB SDRAM DDRIII: 32GB, 64GB, 128GB, 256GB
- 512MB SDRAM DDRIII: 512GB
- 1GB SDRAM DDRIII: 1TB

### High performance:

- Sustained Sequential Read: 560 MB/s
- Sustained Sequential Write: 450 MB/s
- 4K Random Read: 77,000 IOPS
- 4K Random Write: 70,000 IOPS
  
- Low power consumption:
- Max read/write: 3.23W
- Slumber power mode: 0.30W
  
- Advanced Flash Management:
- Support for TRIM, Global Wear-leveling
- Bad Block Management
- Background Garbage Collection
- BCH ECC up to 66 bits/KB

### Advanced power management:

- Built-in voltage detectors for power failure protection
- Built-in temperature sensor for SSD temperature detection
- Automatic sleep and wake-up mechanism to save power

### Highly-reliable: Compliant with MIL-STD-810G

- MTBF:2,000,000 hours
- Operating shock: 3,000G, 0.5ms; 100G11ms,1/2 sine
- Operating vibration: 30Grms,15-2000Hz, 3 axis, 3 hours
- Operating temperature (optional): -40°C to 85°C
- Storage temperature (optional): -55°C to 95°C



## 2. General Product Specifications

### 2.1 Interface

The Panther ST Series 2.5" SATA SSD interface complies with the Serial ATA standard published by ANSI. The device complies with the SATA 6Gbps, Revision 3.0 specifications and supports ATA Command Set ACS-2.

### 2.2 Capacity

Unformatted Capacity	Logical Cylinders	Logical Heads	Logical Sectors per Track	Total Sectors
<b>32GB</b>	16383	16	63	61,865,984
<b>64GB</b>	16383	16	63	123,731,968
<b>128GB</b>	16383	16	63	247,463,936
<b>256GB</b>	16383	16	63	494,927,872
<b>512GB</b>	16383	16	63	989,855,744
<b>1TB</b>	16383	16	63	1,979,711,488

Table 2- 1: Capacity Specification

### 2.3 Performance

Capacity	ATTO R/W(MB/s)		AS SSD ((MB/s)				IOmeter 2008	
			Seq. R/W		4KB R/W		4KB-R	4KB-W
<b>32GB</b>	265	39	245.44	37.23	28.00	37.09	21529	9614
<b>64GB</b>	528	79	487.05	74.97	28.21	73.45	42308	19109
<b>128GB</b>	563	153	515.25	143.53	28.14	74.48	72211	37202
<b>256GB</b>	561	296	494.46	282.01	26.51	77.23	72246	70609
<b>512GB</b>	564	452	510.92	427.55	25.68	61.59	76201	70513
<b>1TB</b>	561	460	500.47	431.23	28.42	78.65	77000	70000

Table 2- 2: Performance Specification



## 2.4 Power Consumption

Input Voltage: 5V±5%

Capacity	Idle	Read	Write	Unit
32GB	0.29	0.91	0.97	W
64GB	0.28	1.10	1.36	W
128GB	0.27	1.11	1.97	W
256GB	0.25	1.19	2.94	W
512GB	0.25	1.20	2.98	W
1TB	0.30	1.50	3.23	W

Table 2- 3: Power Consumption Specification

## 2.5 Endurance

Capacity	32GB	64GB	128GB	256GB	512GB	1TB
Data Retention	>10 years					
Read	Unlimited					
Write	96.87TB	193.74TB	387.48TB	774.95TB	1549.9TB	3099.81TB

Table 2- 4: Endurance Specification

## 3. Physical Specification

Length (mm)	Width (mm)	Height (mm)	Weight (g)
100.20 ± 0.25	69.80 ± 0.25	7.00/9.00 ± 0.1	80

Table 3- 1: Physical Specification

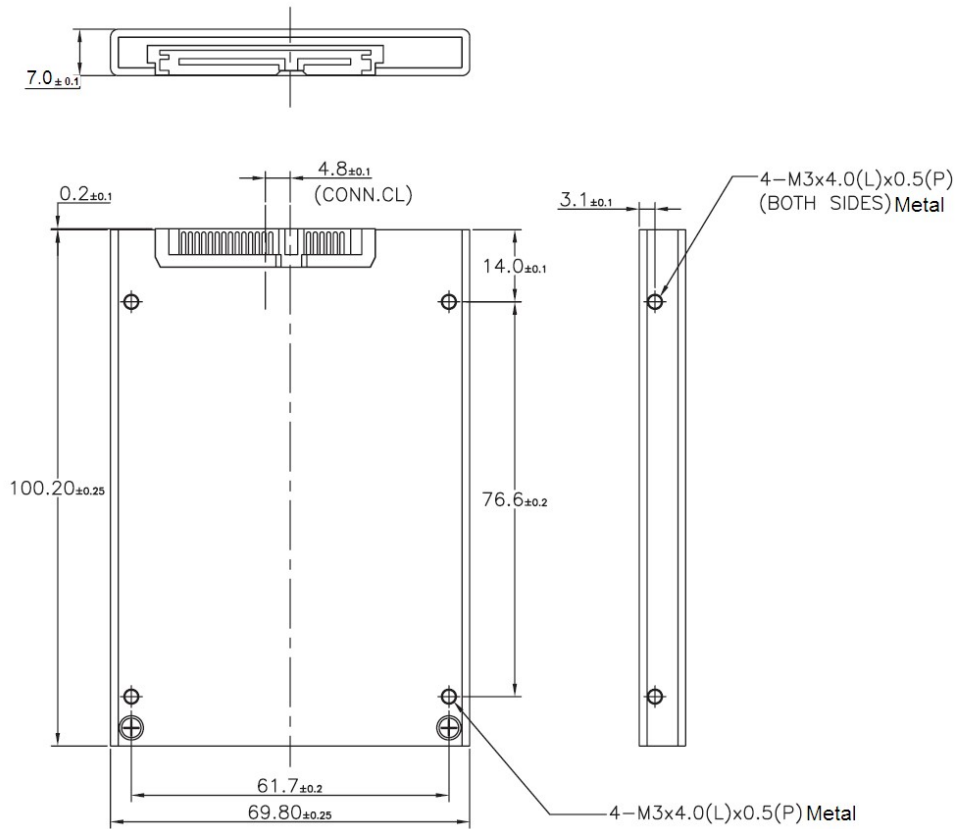


Figure 3- 1: Physical Specification

## 4. Interface

### 4.1 Supported Standards

The ST Series 2.5" SATA SSD complies with the following standards:

- > SATA 6Gbps, Revision 3.0
- > ATA Command Set ACS-2

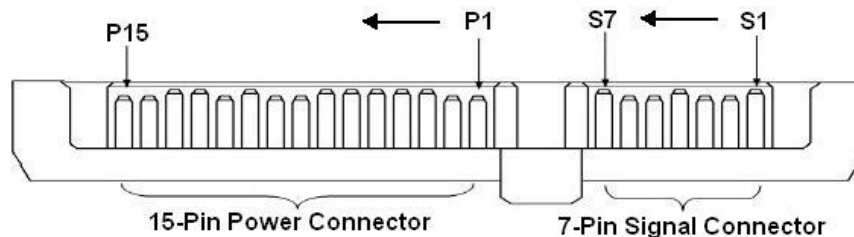


Figure 4- 1: Interface Specification



## 4.2 Pin Assignments

Pin number	Signal name	Description
<b>Signal Connector</b>		
S1	GND	2nd mate
S2	A+	Differential signal pair A From physical layer electronics
S3	A-	
S4	GND	2nd mate
S5	B-	Differential signal pair B From physical layer electronics
S6	B+	
S7	GND	2nd mate
<b>Power Connector</b>		
P1	V33	3.3V power (unused)
P2	V33	3.3V power (unused)
P3	V33	3.3V power,pre-charge,2nd mate(unused)
P4	GND	1st mate
P5	GND	2nd mate
P6	GND	2nd mate
P7	V5	5V power,pre-charge,2nd mate
P8	V5	5V power
P9	V5	5V power
P10	GND	2nd mate
P11	DAS/DSS	Device activity signal/Disable staggered spinal(unused)
P12	GND	1st mate
P13	V12	12V power,pre-charge,2nd mate(unused)
P14	V12	12V power(unused)
P15	V12	12V power(unused)

Table 4- 1: Pin Assignments Specifications

## 5. Environmental Specifications

### 5.1 Temperature

Parameter	Specifications
Operational	-40 °C to +85 °C
Storage	-55 °C to +95 °C

Table 5- 1: Temperature Specifications





### 5.2 Humidity

Parameter	Specifications
Operational/ Non-Operational	5%~95%(no condensation)

Table 5- 2: Humidity Specifications

### 5.3 Vibration

Parameter	Specifications
Operational/ Non-Operational	30Grms,15-2000Hz, 3 axis, 3 hours

Table 5- 3: Vibration Specifications

### 5.4 Shock

Parameter	Specifications
Operational	3,000G, 0.5ms; 100G11 ms,1/2 sine

Table 5- 4: Shock Specifications

### 5.5 Altitude

Parameter	Specifications
Operational	50,000feet

Table 5- 5: Altitude Specifications

### 5.6 Electrostatic Discharge (ESD)

Parameter	Test Voltage
Contact	2kv,4kv



Air	4kv,8kv
-----	---------

Table 5- 6: ESD Specifications

## 6. Reliability Characteristics

### 6.1 Error and Bad Block Management

The SSD soft error rate specification is much better than the hard disk drive specification. In the extremely rare case that a read error does occur, SSD will recover the data by using error detection code and error correction code (ECC). The hardware Error Correction Coding engine executes parity generation and error detection/correction features, and enhances decoding throughput and data reliability.

Bad blocks are occasionally created during the life cycle of a flash component, which called dynamic bad-block accumulation. These bad blocks must be marked and replaced dynamically in order to prevent read/write failures.

### 6.2 Global Wear-leveling

Global wear leveling is employed to maximize the life span of the device. It is a block management technique to even distribution of erase counts in all the flash blocks. It can move cold data (rarely accessed data) to a block with high erase counts to average the life of every block and enhance the data reliability.

### 6.3 Garbage Collection

Garbage collection that can keep spare and cache block in a best ratio for host command execution. This feature can prevent performance downgrade due to the device running out of spare blocks and maintain the performance in an optimized level. The garbage collection operations will be dynamically adjusted by threshold values based on different host commands and situations in order to keep the device always in high performance.



## 7. Supported ATA Commands

### 7.1 Command Set

Command	Code	Protocol
<b>General Feature Set</b>		
Execute Device Diagnostic	90h	Execute device diagnostic
Flush Cache	E7h	Non-data
Identify Device	ECh	PIO data-in
Initialize Drive parameters	91h	Non-data
Read DMA	C8h	DMA
Read Log Ext	2Fh	PIO data-in
Read Multiple	C4h	PIO data-in
Read Sectors	20h	PIO data-in
Read Verify Sectors	40h or 41h	Non-data
Set Feature	EFh	Non-data
Set Multiple Mode	C6h	Non-data
Write DMA	CAh	DMA
Write Multiple	C5h	PIO data-out
Write Sectors	30h	PIO data-out
NOP	00h	Non-data
Read Buffer	E4h	PIO data-in
Write Buffer	E8h	PIO data-out
<b>Power Management Feature Set</b>		
Check Power Mode	E5h or 98h	Non-data
Idle	E3h or 97h	Non-data
Idle Immediate	E1h or 95h	Non-data
Sleep	E6h or 99h	Non-data
Standby	E2h or 96h	Non-data



Standby Immediate	E0h or 94h	Non-data
<b>Security Mode Feature Set</b>		
Security Set Password	F1h	PIO data-out
Security Unlock	F2h	PIO data-out
Security Erase Prepare	F3h	Non-data
Security Erase Unit	F4h	PIO data-out
Security Freeze Lock	F5h	Non-data
Security Disable Password	F6h	PIO data-out
<b>SMART Feature Set</b>		
SMART Disable Operations	B0h	Non-data
SMART Enable/Disable Autosave	B0h	Non-data
SMART Enable Operations	B0h	Non-data
SMART Execute OFF-LINE Immediate	B0h	Non-data
SMART Read Log	B0h	PIO data-in
SMART Read Data	B0h	PIO data-in
SMART Read Threshold	B0h	PIO data-in
SMART Return Status	B0h	Non-data
SMART Save Attribute Values	B0h	Non-data
SMART Write Log	B0h	PIO data-out

Command	Code	Protocol
<b>Host Protected Area Feature Set</b>		
Read Native Max Address	F8h	Non-data
Set Max Address	F9h	Non-data
Set Max Set Password	F9h	PIO data-out
Set max Lock	F9h	Non-data
Set Max Freeze Lock	F9h	Non-data
Set Max Unlock	F9h	PIO data-out



<b>48-bit Address Feature Set</b>		
Flush Cache Ext	EAh	Non-data
Read Sectors Ext	24h	PIO data-in
Read DMA Ext	25h	DMA
Read Multiple Ext	29h	PIO data-in
Read Native Max Address Ext	27h	Non-data
Read Verify Sectors Ext	42h	Non-data
Set Max Address Ext	37h	Non-data
Write DMA Ext	35h	DMA
Write Multiple Ext	39h	PIO data-out
Write Sectors Ext	34h	PIO data-out
<b>NCQ Feature Set</b>		
Read FPDMA Queued	60h	DMA Queued
Write FPDMA Queued	61h	DMA Queued
<b>Others</b>		
Data Set Management	06h	DMA
Seek	70h	Non-data

Table 7- 1: Command Set Specifications

## 7.2 Identify Data

The Identify Device command enables the host to receive parameter information from SSD. This command has the same protocol as the Read Sector(s) command. The parameter words in the buffer have the arrangement and meanings defined in the following table.

Word	F/V	Default Value	Description
0	F	0040h	General configuration



1	X	XXXXh	Default number of cylinders
2	V	0000h	Reserved
3	X	00XXh	Default number of heads
4	X	0000h	Obsolete
5	X	0240h	Obsolete
6	F	XXXXh	Default number of sectors per track
7-8	V	XXXXh	Number of sectors per card(Word7=MSW,Word8=LSW)
9	X	0000h	Obsolete
10-19	F	XXXXh	Serial number in ASCII(Right justified)
20	X	0002h	Obsolete
21	X	0002h	Obsolete
22	X	0000h	Obsolete
23-26	F	XXXXh	Firmware revision in ASCII Big Endian Byte Order in Word
27-46	F	XXXXh	Model number in ASCII(left justified) Big Endian Byte Order in Word
47	F	8001h	Maximum number of sectors on Read/Write Multiple command
48	F	0000h	Reserved
49	F	0F00h	Capabilities
50	F	4000h	Capabilities
51	F	0200h	PIO data transfer cycle timing mode
52	X	0000h	Obsolete
53	F	0007h	Field validity
54	X	XXXXh	Current numbers of cylinders
55	X	XXXXh	Current numbers of heads
56	X	XXXXh	Current sectors per track
57-58	X	XXXXh	Current capacity in sectors(LBAs) Word57=LSW,WORD58=MSW)
59	F	0101h	Multiple sector setting



60-61	F	XXXXh	Total number of user addressable logical sectors for 28-bit command (DWord)
62	X	0000h	Reserved
63	F	0207h	Multiword DMA transfer Supports MDMA mode 0,1,2
64	F	0003h	Advanced PIO modes supported
65	F	0078h	Minimum Multiword DMA transfer cycle time per word
66	F	0078h	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	4000h	Additional supported
70-74	F	0000h	Reserved
75	F	001Fh	Queue depth
76	F	070Eh	Serial ATA capabilities >Supports Serial ATA Gen3 >Supports Serial ATA Gen2 >Supports Serial ATA Gen1 >Supports Phy event counters log >Supports receipt of host initiated power management requests >Supports Native Command Queuing
77	F	0080h	Serial ATA additional capability >DevSleep_to_ReducedPwerState
78	F	0148h	Serial ATA features supported >supports Device Sleep >Supports software settings preservation >Device supports initiating power management
79	V	0040h	Reserved
80	F	03F0h	Major version number(ACS-2)
81	F	0000h	Major version number



82	F	742Bh	Command sets supported 0
83	F	7500h	Command sets supported 1
84	F	4023h	Command sets supported 2
85-87	V	XXXXh	Command set/feature enabled
88	V	007Fh	Ultra DMA mode supported and selected
89	F	0003h	Time required for a Normal Erase mode Security Erase Unit command
90	F	0001h	Time required for an Enhanced Erase mode Security Erase Unit command
91	V	0000h	Current advanced power management value
92	V	FFFEh	Master password identifier
93-99	V	0000h	Reserved
100-103	V	XXXXh	Maximum user LBA for 48-bit address feature set
104	V	0000h	Reserved
105	F	0100h	Maximum number of 512-byte blocks per Data Set Management Command
106-127	V	0000h	Reserved
128	V	0001h	Security status
129-159	X	XXXXh	Vendor specific
160	F	0000h	Power requirement description
161	X	0000h	Reserved
162	F	0000h	Key management schemes supported
163	F	0000h	CF Advanced True IDE timing mode capability and setting
164-168	F	0000h	Reserved
169	F	0001h	Data Set Management supported
170-216	V	XXXXh	Reserved
217	F	0001h	Non-rotating media(SSD)
218-221	X	0000h	Reserved
222	F	107Fh	Transport major revision(SATA Rev 3.1)





223-254	X	0000h	Reserved
255	X	XXXXh	Integrity word

Table 7- 2: Identify Data Value

**Notes:**

F: content (byte) is fixed and does not change.

V: content (byte) is variable and may change depending on the state of device or the commands executed by the device.

X: Content (byte) is vendor specific and may be fixed or variable.

### 7.3 SMART Feature Set

If the reserved size is below the threshold, the status can be read from the Cylinder Register using the Return Status command (DAh).

Value	Command	Value	Command
D0h	Read Data	D5h	Read Log
D1h	Read Attribute Threshold	D6h	Write Log
D2h	Enable/Disable Autosave	D8h	Enable SMART Operations
D3h	Save Attribute Values	D9h	Disable SMART Operations
D4h	Execute OFF-LINE Immediate	DAh	Return Status

Table 7- 3: Smart Feature Set

### 7.4 SMART Data Structure

The following 512 bytes make up the device SMART data structure. Users can obtain the data using the command "Read Data" command (D0h).

Byte	F/V	Description
0-1	X	Revision code



2-361	X	Vendor specific
362	V	Off-line data collection status
363	X	Self-test execution status byte
364-365	V	Total time in seconds to complete off-line data collection activity
366	X	Vendor specific
367	F	Off-line data collection capability
368-389	F	SMART capability
370	F	Error logging capability >7-1 Reserved > 1=Device error logging supported
371	X	Vendor specific
372	F	Short self-test routine recommended polling time(in minutes)
373	F	Extended self-test routine recommended polling time (in minutes)
374	F	Conveyance self-test routine recommended polling time(in minutes)
375-385	R	Reserved
3686-395	F	Firmware version/data code
396-399	F	Reserved
400-405	F	"SM2246"
406-510	X	Vendor specific
511	V	Data structure checksum

Table 7- 4: Smart Data Structure

Notes:

F: content (byte) is fixed and does not change.



V: content (byte) is variable and may change depending on the state of device or the commands executed by the device.

X: Content (byte) is vendor specific and may be fixed or variable.

R: content (byte) is reserved and shall be zero.

## 7.5 SMART Attributes

The following table defines the vendor specific data in byte 2 to 361 of the 512-byte SMART data.

Attribute ID		Raw Attribute Value							Description
Decimal	hex								
1	01	MSB	00	00	00	00	00	00	Read Error Rate
5	05	LSB	MSB	00	00	00	00	00	Reallocated sectore count
9	09	LSB			MSB	00	00	00	Power on hours count
12	0C	LSB			MSB	00	00	00	Power cycle count
160	A0	LSB			MSB	00	00	00	Uncorrectable sector count when read/write
161	A1	LSB	MSB	00	00	00	00	00	Number of valid spare block
163	A3	LSB	MSB	00	00	00	00	00	Number of initial invalid block
164	A4	LSB			MSB	00	00	00	Total erase count
165	A5	LSB			MSB	00	00	00	Maximum erase count
166	A6	LSB			MSB	00	00	00	Minimum erase count
167	A7	LSB			MSB	00	00	00	Average erase count
168	A8	LSB			MSB	00	00	00	Max erase count of spec
169	A9	LSB			MSB	00	00	00	Remain Life(percentage)
175	AF	LSB			MSB	00	00	00	Program fail count in worst die
176	B0	LSB	MSB	00	00	00	00	00	Erase fail count in worst die
177	B1	LSB			MSB	00	00	00	Total wearlevel count
178	B2	LSB	MSB	00	00	00	00	00	Runtime invalid block count
181	B5	LSB			MSB	00	00	00	Total program fail count
182	B6	LSB	MSB	00	00	00	00	00	Total erase fail count



187	BB	LSB			MSB	00	00	00	Uncorrectable error count
192	C0	LSB	MSB	00	00	00	00	00	Power-off retract count
194	C2	MSB	00	00	00	00	00	00	Controlled temperature
195	C3	LSB			MSB	00	00	00	Hardware ECC recovered
196	C4	LSB			MSB	00	00	00	Reallocation event count
198	C6	LSB			MSB	00	00	00	uncorrectable error count off-line
199	C7	LSB	MSB	00	00	00	00	00	UltraDMA CRC error count
225	E1	LSB						MSB	Total LBAs written(each write unit=32MB)
232	E8	LSB	MSB	00	00	00	00	00	Available reserved space
241	F1	LSB						MSB	Total LBAs written(each write unit=32MB)
242	F2	LSB						MSB	Total LBAs read(each write unit=32MB)

Table 7- 5: Smart Attributes

## 8. Ordering Information

Model Name	Part Number	Capacity	Working Temp. Range
ST 2.5" SATA 6Gbps SSD	SD-25W3ST32	32GB	-40 °C ~ +85 °C
	SD-25W3ST64	64GB	
	SD-25W3ST128	128GB	
	SD-25W3ST256	256GB	
	SD-25W3ST512	512GB	
	SD-25W3ST1TB	1TB	

Table 8- 1: Ordering Information

