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S650DC Series 1.8-Inch SAS NAND Flash SSD

MTFDJAA400MBS, MTFDJAA800MBS

Features

- One endurance level: S650DC = 10 DWPD
- Micron® 16nm MLC NAND Flash
- RoHS-compliant package
- SAS
 - Interface = 12 Gb/s
 - Speed = 3 Gb/s, 6 Gb/s, 12 Gb/s, and auto-speed negotiation
 - SAS-3 support
- SAM-5 compliant
- Enterprise sector size support = 512, 520, 524, 528, 4096, 4160, 4192, and 4224-byte
- Hot-plug capable
- 128-entry command queue depth
- Digitally signed firmware for SED and non-SED
- Secure erase via format unit
- Reliability
 - MTTF: 2.5 million device hours¹
 - Static and dynamic wear leveling
 - Uncorrectable bit error rate (UBER): 1×10^{17} bits transferred
- Capacity² (unformatted): 400GB, 800GB
- Endurance: Total bytes written (TBW) over warranty period⁴
 - S650DC (10 DWPD):
400GB – 7PB, 800GB – 14PB

- Electrical
 - Supply voltage: 3.3 V_{DC} (±5%) and 5 V_{DC} (±5%)
- Mechanical
 - 1.8-inch drive: 78.5mm × 54.0mm × 5.0mm
- Field-upgradeable firmware
- Power consumption: 9W (TYP) and 12W (MAX)
 - Configurable through information exceptions mode page
- Operating temperature
 - 0°C to +50°C (MAX)³

- Notes:
1. Product achieves a mean time to failure (MTTF) based on population statistics that are not relevant to individual units.
 2. 1GB = 1 billion bytes; formatted capacity is less.
 3. Based on ambient air temperature.
 4. As defined in the product manual, warranty is five years or device expiration as indicated by the device life indicator, whichever comes first.

Warranty: Contact your Micron sales representative for further information regarding the product, including product warranties.



S600DC Series 1.8-Inch SAS NAND Flash SSD Features

Table 1: Performance

Notes apply to entire table

Device and Capacity	Sequential 128KB Transfer		Random 4KB Transfer		Random 4KB Transfer (70/30)	Average Latency (μ s)
	Read (MB/s)	Write (MB/s)	Read (KIOPS)	Write (KIOPS)	Mixed Read/Write (KIOPS)	
S650DC						
400GB	1550	625	180	67	80	115
800GB	1850	850	200	80	105	115

- Notes:
1. Typical I/O performance numbers: measured using an iometer in a steady state region with a queue depth of 32 for sequential and random transfers and write cache enabled; a queue depth of 1 for READ/WRITE latency values.
 2. Consistent host system interface, configurations, and variables: maintained with variation only in the drive being tested.
 3. Response time measurement conditions: recorded with nominal power at 25 °C ambient temperature.
 4. Page-to-page response times: derived from all possible page-to-page accesses on a sequentially preconditioned drive.
 5. Average response time: derived from at least 5000 access measurements between programmable pages on a randomly preconditioned drive to ensure a true statistical random average.

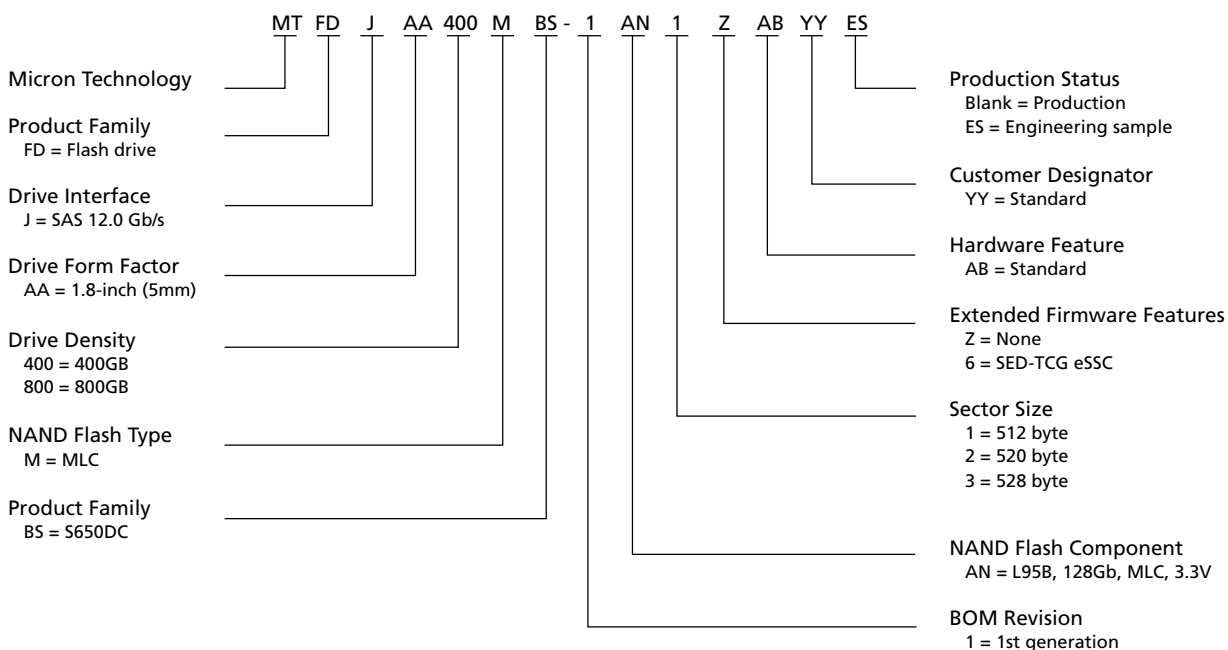


S600DC Series 1.8-Inch SAS NAND Flash SSD Features

Part Numbering Information

Micron's 600 series SAS SSD is available in different configurations and densities. Visit www.micron.com for a list of valid part numbers.

Figure 1: Part Number Chart





S600DC Series 1.8-Inch SAS NAND Flash SSD General Description

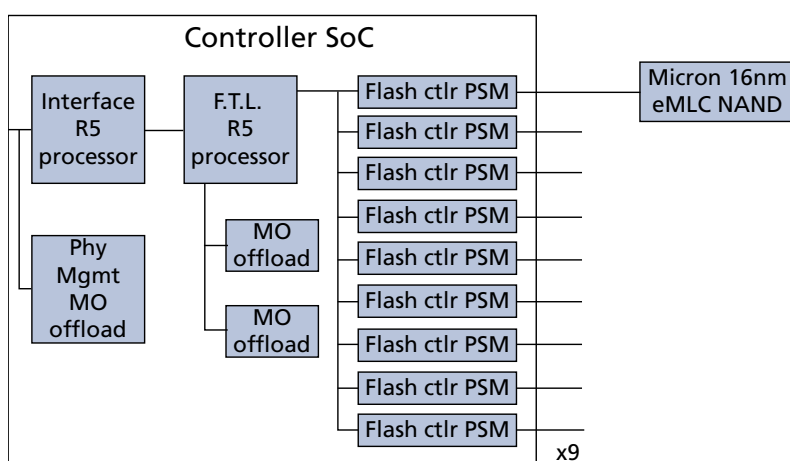
General Description

Micron's solid state drive (SSD) uses a single-chip controller with a dual-port SAS interface on the system side and 10 channels of Micron NAND Flash internally. Packaged in an HDD replacement enclosure, the SSD integrates easily into existing storage infrastructures.

The SSD is designed to support and manage the needs of highly available, high-performance platforms that use significant read/write mixed workloads. Optimized to support enterprise needs previously supported only by single-level cell (SLC) solutions, this SSD provides endurance and data integrity required by growing environments.

Functional Block Diagram

Figure 2: Functional Block Diagram – 5mm Variant (Controller Attached to NAND Directly)





S600DC Series 1.8-Inch SAS NAND Flash SSD Logical Block Address Configuration

Logical Block Address Configuration

Each device is set to report its logical block address (LBA) settings, which ensure sufficient storage per device capacity. The tables below show LBA settings according to device size.

Standard OEM models are formatted to 512 bytes per block. The block size is selectable at format time, and users with the necessary equipment can modify the data block size to capacities different than those listed below before issuing a format command. To provide a stable target capacity environment while also providing users with flexibility, Micron recommends product planning.

Micron ensures that current and future product generations will meet capacity points at certain block sizes. Planning with this in mind ensures a stable operating point with backward and forward compatibility across product generations. The current operating points for each device are shown below. The capacity stated is identical when the drive is formatted with or without PI enabled.

Programmable Drive Capacity

Using the MODE SELECT command, users can change the drive capacity to less than its maximum value. A value of zero in the Number of Blocks field means that the MODE SELECT command will leave the drive capacity unchanged. A value greater than zero and less than the maximum number of LBAs in the Number of Blocks field means that the MODE SELECT command will change the drive capacity to the value in the Number of Blocks field. A value greater than the maximum number of LBAs means that the MODE SELECT command will round down to the maximum capacity.

Table 2: Standard LBA Settings – 512-Byte Sector Size

Capacity	Total LBA		Max LBA		User Available Bytes (Unformatted)
	Decimal	Hexadecimal	Decimal	Hexadecimal	
400GB	781,422,768	2E9390B0	781,422,767	2E9390AF	400,088,457,216
800GB	1,562,824,368	5D26CEB0	1,562,824,367	5D26CEAF	800,166,076,416

Table 3: Standard LBA Settings – 520-Byte Sector Size

Capacity	Total LBA		Max LBA		User Available Bytes (Unformatted)
	Decimal	Hexadecimal	Decimal	Hexadecimal	
400GB	764,871,800	2D970478	764,871,799	2D970477	397,733,336,000
800GB	1,529,743,600	5B2E08F0	1,529,743,599	5B2E08EF	795,466,672,000



S600DC Series 1.8-Inch SAS NAND Flash SSD Logical Block Address Configuration

Table 4: Standard LBA Settings – 524-Byte Sector Size

Capacity	Total LBA		Max LBA		User Available Bytes (Unformatted)
	Decimal	Hexadecimal	Decimal	Hexadecimal	
400GB	754,677,072	2CFB7550	754,677,071	2CFB754F	395,450,785,728
800GB	1,509,354,136	59F6EA98	1,509,354,135	59F6EA97	790,901,567,264

Table 5: Standard LBA Settings – 528-Byte Sector Size

Capacity	Total LBA		Max LBA		User Available Bytes (Unformatted)
	Decimal	Hexadecimal	Decimal	Hexadecimal	
400GB	743,833,040	2C55FDD0	743,833,039	2C55FDCF	392,743,845,120
800GB	1,487,666,080	58ABFBA0	1,487,666,079	58ABFB9F	785,487,690,240

Table 6: Standard LBA Settings – 4096-Byte Sector Size

Capacity	Total LBA		Max LBA		User Available Bytes (Unformatted)
	Decimal	Hexadecimal	Decimal	Hexadecimal	
400GB	97,677,846	5D27216	97,677,845	5D27215	400,088,457,216
800GB	195,353,046	BA4D9D6	195,353,045	BA4D9D5	800,166,076,416

Table 7: Standard LBA Settings – 4160-Byte Sector Size

Capacity	Total LBA		Max LBA		User Available Bytes (Unformatted)
	Decimal	Hexadecimal	Decimal	Hexadecimal	
400GB	95,769,232	5B55290	95,769,231	5B5528F	398,400,005,120
800GB	191,538,464	B6AA520	191,538,463	B6AA51F	796,800,010,240

Table 8: Standard LBA Settings – 4192-Byte Sector Size

Capacity	Total LBA		Max LBA		User Available Bytes (Unformatted)
	Decimal	Hexadecimal	Decimal	Hexadecimal	
400GB	94,561,072	5A2E330	94,561,071	5A2E32F	396,400,013,824
800GB	189,122,144	B45C660	189,122,143	B45C65F	792,800,027,648



S600DC Series 1.8-Inch SAS NAND Flash SSD Physical Configuration

Table 9: Standard LBA Settings – 4224-Byte Sector Size

Capacity	Total LBA		Max LBA		User Available Bytes (Unformatted)
	Decimal	Hexadecimal	Decimal	Hexadecimal	
400GB	93,844,704	597F4E0	93,844,703	597F4DF	396,400,029,696
800GB	187,689,400	B2FE9B8	187,689,399	B2FE9B7	792,800,025,600

Physical Configuration

Dimensions and Weight

Form factor	Capacity (GB)	Height (mm)	Width (mm)	Length (mm)	Weight (grams)
1.8-inch	400/800	5.00 ±0.35	54.00 ±0.20	78.50 ±0.30	TBD

Dual Port Support

Micron's 600 Series SAS SSD drives have two independent ports, which can be connected in the same or different SCSI domains. Each drive port has a unique SAS address.

The two ports are capable of independent port clocking. For example, both ports can run at 12 Gb/s, or the first port can run at 12 Gb/s while the second runs at 6 Gb/s. Supported link rates are 3.0, 6.0, or 12.0 Gb/s.

Subject to buffer availability, SSD drives support the following:

- Concurrent port transfers: Supports receiving COMMAND and TASK management transfers on both ports simultaneously
- Full duplex transfers: Supports sending XFER_RDY, DATA, and RESPONSE transfers while receiving frames on both ports



S600DC Series 1.8-Inch SAS NAND Flash SSD Physical Configuration

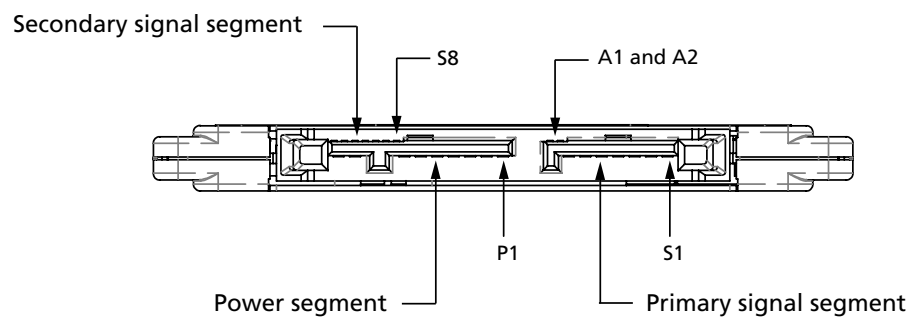
Interface Connectors

The SAS signal segment interface cable has four transmission conductors and three ground conductors for each channel. As shown in the figure below, the cable includes two 7-pin signal segments (primary and secondary) and a 9-pin power segment arranged in a single row with a 1.27mm (0.050 inch) pitch.

SAS drives use the device connector for the following:

- DC power
- SAS interface (dual port)
- Activity LED (DAS)

Figure 3: SSD Interface Connections





S600DC Series 1.8-Inch SAS NAND Flash SSD Physical Configuration

Pin Assignments

Table 10: Primary SAS Signal Segment Pin Assignments

Signal Name	Type	Description
S1	GND	Second mate to ground
S2	RX0+	Positive (RX0 from target); short pin to support hot plugging
S3	RX0-	Negative (RX0 from target); short pin to support hot plugging
S4	GND	Second mate to ground
S5	TX0-	Negative (TX0 to target); short pin to support hot plugging
S6	TX0+	Positive (TX0 to target); short pin to support hot plugging
S7	GND	Second mate to ground

Table 11: Secondary SAS Signal Segment Pin Assignments – Back Side

Signal Name	Type	Description
S8	GND	Second mate to ground
S9	RX1+	Positive (RX1 from target); short pin to support hot plugging
S10	RX1-	Negative (RX1 from target); short pin to support hot plugging
S11	GND	Second mate to ground
S12	TX1-	Negative (TX1 to target); short pin to support hot plugging
S13	TX1+	Positive (TX1 to target); short pin to support hot plugging
S14	GND	Second mate to ground

Table 12: SAS Power Segment Pin Assignments

Signal Name	Type	Description
P1	V3.3	3.3V power; short pin to support hot plugging
P2	V3.3	3.3V power (charge)
P3	GND	Ground
P4	GND	Ground
P5	V5	5V power (charge)
P6	V5	5V power; short pin to support hot plugging
P7	Reserved	Reserved; short pin to support hot plugging
P8	NC	NC (reserved for manufacturing diagnostics); short pin to support hot plugging; no internal connection to drive.
P9	NC	NC (reserved for manufacturing diagnostics); short pin to support hot plugging; no internal connection to drive.
Vendor Specific		
A1*	–	Vendor specific; short pin to support hot plugging
A2*	–	Vendor specific; short pin to support hot plugging



SAS Features

Task Management

Table 13: Task Management Functions

Task Name	Supported
Abort task	Y
Abort task set	Y
Clear ACA	Y
Clear task set	Y
I_T nexus reset	Y
Logical unit nexus reset	Y
Query task	Y
Query task set	Y
Query asynchronous event	Y

Task Management Responses

Table 14: SAS Response to Task Management Functions

Function Name	Response Code
Function complete	0
Invalid frame	2
Function not supported	4
Function failed	5
Function succeeded	8
Invalid logical unit	9

Thin Provisioning

The device supports thin provisioning and the READ CAPACITY 16 (9Eh) command, but the level of thin provisioning support varies by product model. Thin provisioning returns a default data pattern from a READ command to a logical block even when that block is not mapped to a physical block by a previous WRITE command.

To determine whether thin provisioning is supported and which of its features are implemented, a READ CAPACITY 16 (9Eh) command must be issued to the drive. The LBPME (logical block provisioning management enabled) bit settings indicate whether the logical unit implements LBPM (logical block provisioning management). The LBPME and LBPRZ (logical block provisioning read zeros) bit settings are shown in the table immediately below.


Table 15: Product Configuration and Bit Settings

Bit	Product Configuration		Bit Settings	Description
	SED Support	Non-SED Support		
LBPME	Y	Y	LBPME = 1 (Logical unit is thin provisioned)	LBPM is implemented.
			LBPME = 0 (Logical unit is fully provisioned)	LBPM is not implemented.
LBPRZ	N	Y	LBPRZ = 1	For an unmapped LBA specified by a READ operation, the device server sends to the data-in buffer user data with all bits set to 0.
			LBPRZ = 0	For an unmapped LBA specified by a READ operation, the device server sends to the data-in buffer user data with all bits set to any value.

UNMAP Command

The UNMAP command requests that the device server break the association of a specific LBA from a physical block, thereby freeing up the physical block from use and no longer requiring it to contain user data. An unmapped block will respond to a READ command with data that is determined by the setting of the LBPRZ bit in the read capacity parameter data.

Protection Information (PI) and Security (SED)

Requirements in this section apply to any device that supports LBA unmapping. In a SCSI device, an unmapped LBA is defined as part of the thin provisioning model, whose support is indicated by an LBPME bit value of 1 in the read capacity parameter data.

When a cryptographic ERASE command erases a region of LBAs, the drive unmaps those LBAs. And when the host attempts to access an unmapped or trimmed LBA, the drive returns scrambled data.

For a given LBA, data is identical from access to access until it is either updated from the host or is cryptographically erased. Then the drive reports an LBPRZ bit value of 0 in the read capacity parameter data.

When the host attempts access to an unmapped LBA on a drive that has been formatted with protection information (PI), the drive returns scrambled PI data for that LBA.

Depending on the value of the RDPROTECT field in the data-access command CDB, the drive might return a standard PI error to the host. When a host reduces a drive's addressable capacity via a MODE SELECT command, the drive unmaps or trims any LBA within the inaccessible region of the device. Additionally, an UNMAP command is not permitted on a locked band. PI and SED drive configuration information is shown below.



S600DC Series 1.8-Inch SAS NAND Flash SSD Format Unit

Table 16: PI and SED

PI and SED Bit Definition	Drive Configuration					
	Standard (Non-SED)			SED		
PI setting	Disabled	Enabled		Disabled	Enabled	
PROT_EN bit	0	1		0	1	
LBPME bit	1	1		1	1	
LBPRZ bit	1	1		0	0	
PI check requested	NA	Yes	No	NA	Yes	No
DATA returned for thin provisioned LBA	0x00	0x00	0x00	Random	None	Random
PI returned for thin provisioned LBA	None	0xFF	0xFF	None	None	Scrambled PI data
PI check performed	NA	No	No	NA	Yes	No
Error reported to host	No	No	No	None	Yes	No

Format Unit

The device may be formatted either as a thin provisioned device or a fully provisioned device. Thin provisioned is the default format and is recommended for most applications. Thin provisioning provides the most flexibility for the device to manage the flash medium to maximize endurance.

Table 17: Format Unit Command Execution Times for 512-Byte LBAs

Format Mode	DCRT Bit	IP Bit	400GB	800GB	Unit	
Non-SED Configuration						
Thin provisioned (Default)	0	0	5	5	minutes	
	1	0	5	5		
Fully provisioned	0	1	10	10		
	1	1	10	10		
SED Configuration						
Thin provisioned (Default)	0	0	5	5		
	1	0	5	5		
Fully provisioned	0	1	430	430		
	1	1	280	280		



Commands

Table 18: SAS Command Set and Additional Supported Bits – SED and Non-SED

Command	Op-Code (Hex)	Sub-Command/ Functional Bit	Description	Supported
CHANGE DEFINITION	40	–	–	No
FORMAT UNIT	04	–	–	Yes
		DPRY bit	–	No
		DCRT bit	–	Yes
		STFP bit	–	Yes
		IP bit	–	Yes
		DSP bit	–	Yes
		IMMED bit	–	Yes
		VS	Vendor specific	No
INQUIRY (12)	12	–	–	Yes
		B0h	Block limits page	Yes
		B1h	Block device characteristics	Yes
		C1h	Date code page	Yes
		C3h	Device behavior page	Yes
		83h	Device identification page	Yes
		86h	Extended inquiry data page	Yes
		C0h	Firmware numbers page	Yes
		C2h	Jumper setting page	No
		8Ah	Power condition page	Yes
		8Dh	Power consumption page	Yes
		00h	Supported vital product data page	Yes
		B2h	Thin provisioning page	Yes
		80h	Unit serial number page	Yes
		D1h	Vendor unique page	Yes
		D2h	Vendor unique page	Yes
LOG SELECT (10)	4C	–	–	Yes
		PCR bit	–	Yes
		DU bit	–	No
		DS bit	–	Yes
		TSD bit	–	Yes
		ETC bit	–	No
		TMC bit	–	No
		LP bit	–	No



S600DC Series 1.8-Inch SAS NAND Flash SSD Commands

Table 18: SAS Command Set and Additional Supported Bits – SED and Non-SED (Continued)

Command	Op-Code (Hex)	Sub-Command/ Functional Bit	Description	Supported
LOG SENSE (10)	4D	–	–	Yes
		0Fh	Application client log page	Yes
		15h	Background scan results log page	Yes
		01h	Buffer over-run/under-run page	No
		37h	Cache statistics page	Yes
		3Eh	Factory log page	Yes
		2Fh	Information exceptions log page	Yes
		0Bh	Last n deferred errors or async events page	No
		07h	Last n error events page	No
		06h	Non-medium error page	Yes
		00h	Page support list	Yes
		1Ah	Power conditions transitions page	Yes
		18h	Protocol-specific port log page	Yes
		03h	Read error counter page	Yes
		04h	Read reverse error counter page	No
		10h	Self-test results page	Yes
		11h	Solid state media log page	Yes
		0Eh	Start-stop cycle counter page	Yes
		0Dh	Temperature page	Yes
		38h	Vendor unique page	Yes
3Ch	Vendor unique page	Yes		
05h	Verify error counter page	Yes		
02h	Write error counter page	Yes		



S600DC Series 1.8-Inch SAS NAND Flash SSD Commands

Table 18: SAS Command Set and Additional Supported Bits – SED and Non-SED (Continued)

Command	Op-Code (Hex)	Sub-Command/ Functional Bit	Description	Supported
MODE SELECT (6)	15	–	–	Yes
MODE SELECT (10)	55	08h	Caching parameters page	Yes
MODE SENSE (6)	1A	0Ah	Control mode page	Yes
MODE SENSE (10)	5A	02h	Disconnect/reconnect page	Yes
		01h	Error recovery page	Yes
		03h	Format page	No
		1Ch	Information exceptions control page	Yes
		1Ch/01h	Background scan mode subpage	Yes
		18h	Protocol-specific LUN mode page	Yes
		19h	Protocol-specific port page	Yes
		19h/01h	Physical control and discover subpage	Yes
		19h/03h	Enhanced physical control subpage	Yes
		1Ah	Power condition page	Yes
		00h	Unit attention page	Yes
		07h	Verify error recovery page	Yes
		10h	XOR control page	No
PERSISTENT RESERVE IN	5E	–	–	Yes
		–	–	Yes
		00h	Read keys	Yes
		01h	Read reservations	Yes
		02h	Read capabilities	Yes
PERSISTENT RESERVE OUT	5F	–	–	Yes
		03h	Clear	Yes
		04h	Preempt	Yes
		05h	Preempt and abort	Yes
		00h	Register	Yes
		06h	Register and ignore existing keys	Yes
		07h	Register and move	Yes
		02h	Release	Yes
		08h	Replace lost reservation	Yes
		01h	Reserve	Yes
READ (6)	08	–	–	Yes
READ (10)	28	–	–	Yes
		DPO bit supported	–	Yes
		FUA bit supported	–	Yes



S600DC Series 1.8-Inch SAS NAND Flash SSD Commands

Table 18: SAS Command Set and Additional Supported Bits – SED and Non-SED (Continued)

Command	Op-Code (Hex)	Sub-Command/Functional Bit	Description	Supported
Read (12)	A8	–	–	No
READ (16)	88	–	–	Yes
READ (32)	7F/0009	–	–	Yes
READ BUFFER (Mode 0, 2, 3, A, and B)	3C	1Ch	Error history	Yes
READ CAPACITY (10)	25	–	–	Yes
READ CAPACITY (16)	9E/10	–	–	Yes
READ DEFECT DATA (10)	37	–	–	Yes
READ DEFECT DATA (12)	B7	–	–	Yes
REASSIGN BLOCKS	07	–	–	Yes
RECEIVE DIAGNOSTIC RESULTS	1C	–	–	Yes
		00h	Supported diagnostic pages	Yes
		40h	Translate page	No
RELEASE (6)	17	–	–	Yes
RELEASE (10)	57	–	–	Yes
REPORT IDENTIFYING INFORMATION	A3	05h	–	Yes
REPORT LUNS	A0	–	–	Yes
REPORT SUPPORTED OPERATIONS CODES	A3	0Ch	–	Yes
REPORT SUPPORTED TASK MANAGEMENT FUNCTIONS		0Dh	–	Yes
REQUEST SENSE	03	–	–	Yes
		–	Actual retry count bytes	Yes
		–	Extended sense	Yes
		–	Field pointer bytes	Yes
RESERVE (6)	16	–	–	Yes
		–	3rd party reserve	Yes
		–	Extent reservation	No
RESERVE (10)	56	–	–	Yes
		–	3rd party reserve	Yes
		–	Extent reservation	No
REZERO UNIT	01	–	–	Yes
SANITIZE	48	–	–	Yes
		01h	Overwrite	Yes
		02h	Block erase	Yes
		1Fh	Exit failure mode	Yes
SEEK (6)	0B	–	–	Yes



S600DC Series 1.8-Inch SAS NAND Flash SSD Commands

Table 18: SAS Command Set and Additional Supported Bits – SED and Non-SED (Continued)

Command	Op-Code (Hex)	Sub-Command/ Functional Bit	Description	Supported
SEEK (10)	2B	–	–	Yes
SEND DIAGNOSTIC	1D	–	–	Yes
		00h	Supported diagnostic pages	Yes
		40h	Translate page	No
SET IDENTIFYING INFORMATION	A4	06h	–	Yes
SET TIMESTAMP		0Fh	–	Yes
START / STOP UNIT	1B	–	–	Yes
SYNCHRONIZE CACHE (10)	35	–	–	Yes
SYNCHRONIZE CACHE (16)	91	–	–	Yes
TEST UNIT READY	00	–	–	Yes
UNMAP	42	–	–	Yes
VERIFY (10)	2F	–	–	Yes
		BTYCHK bit	–	Yes
VERIFY (12)	AF	–	–	No
VERIFY (16)	8F	–	–	Yes
VERIFY (32)	7F/000A	–	–	Yes
WRITE (6)	0A	–	–	Yes
WRITE (10)	2A	–	–	Yes
		DPO bit supported	–	Yes
		FUA bit supported	–	Yes
WRITE (12)	AA	–	–	No
WRITE (16)	8A	–	–	Yes
WRITE (32)	7F/0008	–	–	Yes
WRITE AND VERIFY (10)	2E	–	–	Yes
		DPO bit supported	–	Yes
WRITE AND VERIFY (12)	AE	–	–	No
WRITE AND VERIFY (16)	8E	–	–	Yes
WRITE AND VERIFY (32)	7F/000C	–	–	Yes
WRITE BUFFER (Modes 0 and 2 Supported)	3B	1Ch	Download application log	Yes
WRITE LONG (10)	3F	–	–	Yes
WRITE LONG (16)	9F/11	–	–	Yes
WRITE SAME (10)	41	–	–	Yes
		Pbdata	–	No
		Lbdata	–	No
WRITE SAME (16)	93	–	–	Yes
WRITE SAME (32)	7F/000D	–	–	Yes
XDREAD	52	–	–	No



S600DC Series 1.8-Inch SAS NAND Flash SSD Commands

Table 18: SAS Command Set and Additional Supported Bits – SED and Non-SED (Continued)

Command	Op-Code (Hex)	Sub-Command/ Functional Bit	Description	Supported
XDWRITE	50	–	–	No
XPWRITE	51	–	–	No

Table 19: SAS Command Set and Additional Supported Bits – SED Only

Command	Op-Code (Hex)	Sub-Command/ Functional Bit	Description	Supported
SANITIZE	48	–	Cryptographic erase	Yes
		03h		
SECURITY PROTOCOL IN	A2	–	–	Yes
SECURITY PROTOCOL OUT	B5	–	–	Yes
WRITE BUFFER (Modes 0 and 2 Supported)	3B	Modes 4, 5, and 7	Firmware download option	Yes

Table 20: SAS Command Set and Additional Supported Bits – Non-SED Only

Command	Op-Code (Hex)	Sub-Command/ Functional Bit	Description	Supported
READ BUFFER (Mode 0, 2, 3, A, and B)	3C	–	–	Yes
READ LONG (10)	3E	–	–	Yes
READ LONG (16)	9E/11	–	–	Yes
WRITE BUFFER (Modes 0 and 2 Supported)	3B	–	Firmware download option	Yes
		Modes 5, 7, Ah, and Bh		



S600DC Series 1.8-Inch SAS NAND Flash SSD Mode, Log, and VPD Pages

Mode, Log, and VPD Pages

Table 21: Supported Mode Pages

Mode Page Code	Sub-Page Code	Mode Page Name
01h	–	Read-Write error recovery
02h	–	Disconnect-reconnect
07h	–	Verify error recovery
08h	–	Caching
0Ah	–	Control
19h	–	Protocol specific port
1Ah	01h	Power consumption
1Ch	–	Informational exceptions control

Table 22: Supported Log and VPD Pages (Log Sense – 4Dh Command)

Log Page Code (Hex)	Log Page Name
0F	Application client log page
15	Background scan results log page
01	Buffer over-run/under-run page
37	Cache statistics page
3E	Factory log page
2F	Information exceptions log page
0B	Last n differed errors or async event page
07	Last n error events page (07h)
06	Non-medium error page
00	Page support list
1A	Power conditions transitions page
18	Protocol-specific port log page
03	Read error counter page
04	Read reverse error counter page
10	Selt-test results page
11	Solid state media log page
0E	Start-stop cycle counter page
0D	Temperature page
38	Vendor unique page
3C	Vendor unique page
05	Verify error counter page
02	Write error counter page



S600DC Series 1.8-Inch SAS NAND Flash SSD Mode, Log, and VPD Pages

Table 23: Internal Drive Characteristics

Characteristic	Description
Memory type	NAND Flash MLC
Emulated LBA size (bytes)	512
	520
	524
	528
	4096
	4160
	4192
Native programmable	4224
	Page size = 8192 user bytes Map unit size = 4096
Default transfer	Alignment offset = 0



Reliability

A Micron SSD incorporates advanced technology for defect and error management, using various combinations of hardware-based error correction algorithms and firmware-based static and dynamic wear-leveling algorithms.

Over the life of the SSD, uncorrectable errors may occur. An uncorrectable error is defined as data that the device reports as successfully programmed, but when read, the data differs from what was programmed.

The following reliability specifications assume correct host and drive operational interface, including all interface timings, power supply voltages, environmental requirements, and drive mounting constraints.

Table 24: Uncorrectable Bit Error Rate

Read Error Rates	READ Operation
Less than 1 LBA in 10^{17} bits transferred	Unrecovered READ
Less than 1 LBA in 10^{21} bits transferred	Mis-corrected READ

Note: 1. Error rate specified with automatic retries and data correction with ECC enabled and all flaws reallocated.

Mean Time Between Failures

SSD mean time to failure (MTTF) and mean time between failures (MTBF) are predictable based on component reliability data using methods referenced in the Telcordia SR-332 reliability prediction procedures for electronic equipment.

Table 25: MTBF

Density	MTBF (Million Hours)	Failure Rate (% per-Year)
400GB	2.5	0.35
800GB	2.5	0.35



Data Retention

As a NAND Flash device ages with use, its capability to retain a programmed value is affected by the number of PROGRAM and ERASE operations to its cells, causing deterioration. When new, the device has a powered-off data retention capability of several years, but with use, data retention is reduced.

Temperature also affects how long the device retains its programmed value when power is removed. High temperature reduces retention capability when power is off, but is not an issue when power is applied. The SSD drive contains firmware and hardware features that can monitor and refresh memory cells when power is applied.

Table 26: Data Retention and Drive Writes per-Day

Density	Typical Data Retention with Power Removed (Months) ¹	Drive Writes per-Day (DWPD)
400GB	3	10
800GB	3	10

Note: 1. Typical data retention with power removed, at 40 °C and up to 90% of write endurance.

Endurance

Endurance rating is the expected amount of host data that can be written by product when subjected to a specified workload at a specified operating and storage temperature over the specified product life. For the specific workload to achieve this level of endurance, refer to JEDEC specification JESD218. TBW is defined as 1×10^{12} bytes.

Table 27: Endurance

Density	Endurance Rating	Unit	Notes
400GB	7000	TBW	1, 2
800GB	14,000		

- Notes:
- Limited warranty with media usage provides coverage either for the warranty period or until the SSD percentage used endurance indicator reaches 100, whichever comes first.
 - TBW per the JEDEC JESD218 specification assuming typical workloads are 50% sequential and 50% random and consist of the following: 5% are 4KB; 5% are 8KB; 10% are 16KB; 10% are 32KB; 35% are 64KB; and 35% are 128KB.



Electrical Characteristics

Device DC power (+3.3V and +5V) is through the standard SAS interface. Typical power measurements listed below are based on an average of drives tested, under nominal conditions, using the listed input voltage at 60°C internal temperature. Measurements are made at 12Gb interface speeds.

- Startup power: Measured from power-on to when the drive reaches operating condition and can process media access commands.
- Peak operating mode power: Measured by testing the drive in various read and write access patterns that simulate worst case power consumption.
- Idle mode power: Measured when the drive is powered up and ready for media access commands, but before the host has sent the commands.

Note: Stresses greater than those listed in the following tables may cause permanent damage to the device. These are stress ratings only and device operation above ratings or conditions listed in the operation sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.



S600DC Series 1.8-Inch SAS NAND Flash SSD Electrical Characteristics

Power Consumption

Specifications

Table 28: Power Consumption Specifications

Device and Capacity	V _{DC} Start Current ¹		Power (W)	Average Idle Power (W)	Average Power Under Workload (W) ²		Configurable Power Limit Settings
	+5A	+3.3A			Sequential Read	Sequential Write	
S650DC							
400GB	0.65	1.07	6.99	2.58	4.60	6.52	6, 7, 8, 9, 10, 11
800GB	0.62	1.10	9.35	3.11	5.39	8.98	6, 7, 8, 9, 10, 11

- Notes: 1. Measured with average reading DC ammeter. Instantaneous +12V current peaks will exceed these values. Power supply at nominal voltage. Number of drives tested = 6 at 60 °C internal.
2. Sequential READ and WRITE operations are based on 128K block transfer at queue depth = 32.

Identifier and Supported Settings

Supported power consumption identifier settings are shown in the table below. An INQUIRY SCSI command or MODE SENSE command can be used to query VPD page 0x8D for supported power levels and associated identifiers.

The MODE SENSE and SELECT commands can be used to read, write, and modify the mode page 0x1A, subpage 1. When the SELECT command is used to write a new identifier value, the value is saved in nonvolatile memory, unchanged until modified.

Table 29: Power Consumption Identifier and Supported Settings

Note applies to entire table.

Device and Capacity	Mode Page							Unit
	0x0 (Default)	0x1	0x2	0x3	0x4	0x5	0x6	
S655DC								
200GB	11	10	9	8	7	6	N/A	W
400GB	11	10	9	8	7	6	N/A	

- Note: 1. Device settings can be configured by modifying VPD mode page 0x1A, subpage 0x1.

Power

Table 30: Power Specifications

Parameter/Condition	V _{DC} (Margin)	Min	Max	Unit
Voltage input – Start up	5 (±10%)	4.5	5.5	V _{DC}
Voltage input – Steady state	5 (±5%)	4.75	5.25	
Voltage input	3.3 (±5%)	3.13	3.46	



S600DC Series 1.8-Inch SAS NAND Flash SSD Electrical Characteristics

Environmental Specifications

Table 31: Environmental Specifications – 1

Parameter/Condition	Min	Max	Unit
Operating temperature ¹	32/0	122/50	°F/°C
Non-operating temperature	-40/-40	167/75	
Rate of temperature change	-	36/20	
Relative humidity (non-condensing)	5	95	%rh
Relative humidity (rate of change /hr)	-	20	
Effective altitude (operating)	-1000/304.8	10,000/3048	ft/M
Effective altitude (non-operating)	-1000/304.8	40,000/12,192	

Note: 1. Based on ambient air temperature

Table 32: Environmental Specifications – 2

Parameter	Condition	Max	Unit
Operating shock (half sine wave)	Gs	1000	g
	Duration	0.5	ms
	Interval	2	sec
Non-operating shock (half sine wave)	Gs	1000	g
	Duration	0.5	ms
	Interval	2	sec