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S600DC Series 2.5-Inch SAS NAND Flash SSD

MTFDJAK400MBS, MTFDJAK400MBT, MTFDJAK800MBS, MTFDJAK800MBT, MTFDJAL1T6MBS, MTFDJAL1T6MBT, MTFDJAL3T2MBS, MTFDJAL3T2MBT, MTFDJAK480MBT, MTFDJAK960MBT, MTFDJAL1T9MBT, MTFDJAL3T8MBT, MTFDJAL1T9MBU, MTFDJAL3T8MBU, MTFDJAK200MBW, MTFDJAK400MBW

Features

- Four endurance levels
  - S655DC = 25 DWPD; S650DC = 10 DWPD
  - S630DC = 2–3 DWPD; S610DC = <1 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
- FIPS140-2 level 2 certification option available on each S650DC 2.5-inch device: 400GB, 800GB, 1600GB, and 3200GB
- Secure erase via format unit
- Reliability
  - MTTF: 2.5 million device hours[1]
  - Static and dynamic wear leveling
  - Uncorrectable bit error rate (UBER): 1×10^{17} bits transferred
- Capacity [2] (unformatted): 200GB, 400GB, 480GB, 800GB, 960GB, 1600GB, 1920GB, 3200GB, 3840GB
- Endurance: TBW over warranty period[4]
  - S655DC (25 DWPD): 200GB-8PB, 400GB-17PB
  - S650DC (10 DWPD): 400GB-7PB, 800GB-14PB 1600GB-29PB, 3200GB-58PB

- Endurance: TBW over warranty period[4]
  - S630DC (2–3 DWPD): 400GB-2.1PB, 480GB-2.6PB, 800GB-2.9PB, 960GB-5.2PB, 1600GB-5.8PB, 1920GB-10PB, 3200GB-12PB, 3840-21PB
  - S610DC (1 DWPD): 1920GB-2.8PB, 3840GB-5.6PB
- Electrical
  - Supply voltage: $5\,V_{DC}$ (±5%) and $12\,V_{DC}$ (±5%)
- Mechanical
  - 2.5-inch drive: 100.5mm × 69.85mm × 7mm, and 100.5mm × 69.85mm × 15mm
- 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. Total bytes written (TBW): Warranty defined in the product manual 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.
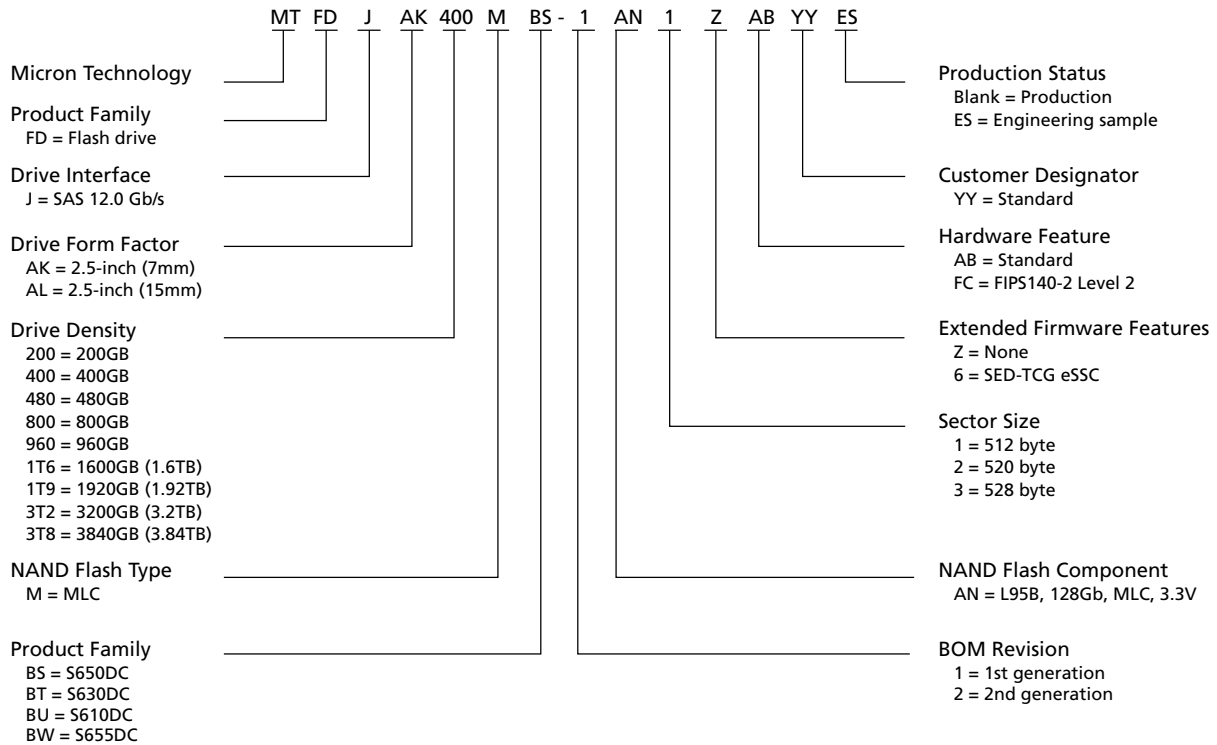
Table 1: Performance

Notes apply to entire table

Device and Capacity	Sequential 128KB Transfer		Random 4KB Transfer		Random 4KB Transfer (70/30)	Average Latency (μs)
	Read (MB/s)	Write (MB/s)	Read (KIOPS)	Write (KIOPS)	Mixed Read/Write (KIOPS)	
S655DC						
200GB	1550	600	200	120	85	115
400GB	1700	850	200	120	115	115
S650DC						
400GB	1550	625	180	67	80	115
800GB	1850	850	200	80	105	115
1600GB	1900	850	200	80	120	115
3200GB	1900	800	200	80	120	115
S630DC						
400GB	1400	490	180	20	45	115
480GB	1550	615	180	30	45	115
800GB	1400	710	180	20	45	115
960GB	1700	850	180	30	65	115
1600GB	1600	850	180	20	45	115
1920GB	1850	850	180	30	65	115
3200GB	1600	850	180	20	45	115
3840GB	1850	770	180	30	65	115
S610DC						
1920GB	1700	850	190	12	45	115
3840GB	1600	770	190	15	45	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.

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

```
            MT  FD  J  AK 400 M  BS - 1  AN  1  Z  AB  YY  ES
```

Micron Technology

Product Family
  FD = Flash drive

Drive Interface
  J = SAS 12.0 Gb/s

Drive Form Factor
  AK = 2.5-inch (7mm)
  AL = 2.5-inch (15mm)

Drive Density
  200 = 200GB
  400 = 400GB
  480 = 480GB
  800 = 800GB
  960 = 960GB
  1T6 = 1600GB (1.6TB)
  1T9 = 1920GB (1.92TB)
  3T2 = 3200GB (3.2TB)
  3T8 = 3840GB (3.84TB)

NAND Flash Type
  M = MLC

Product Family
  BS = S650DC
  BT = S630DC
  BU = S610DC
  BW = S655DC

Production Status
  Blank = Production
  ES = Engineering sample

Customer Designator
  YY = Standard

Hardware Feature
  AB = Standard
  FC = FIPS140-2 Level 2

Extended Firmware Features
  Z = None
  6 = SED-TCG eSSC

Sector Size
  1 = 512 byte
  2 = 520 byte
  3 = 528 byte

NAND Flash Component
  AN = L95B, 128Gb, MLC, 3.3V

BOM Revision
  1 = 1st generation
  2 = 2nd generation

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 Diagrams

Figure 2: Functional Block Diagram – 7mm Variant (Controller Attached to NAND Directly)
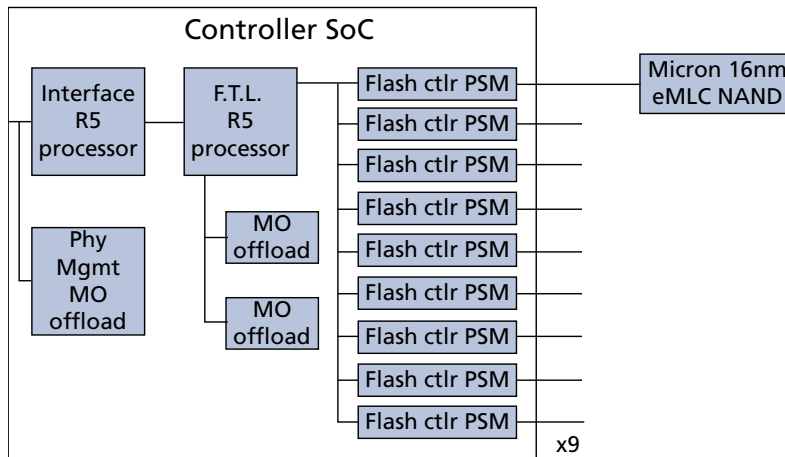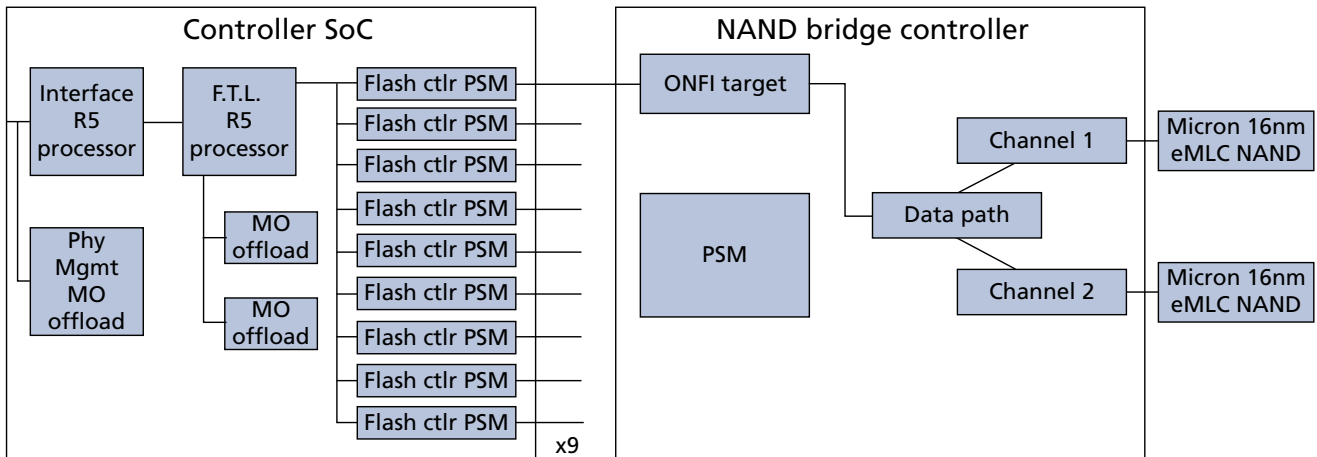

Figure 3: Functional Block Diagram – 15mm Variant (Controller Attached to NAND by Bridge)

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

Device and Capacity	Total LBA		Max LBA		User Available Bytes (Unformatted)
	Decimal	Hexidecimal	Decimal	Hexidecimal	
S655DC					
200GB	390,721,968	1749F1B0	390,721,967	1749F1AF	200,049,647,616
400GB	781,422,768	2E9390B0	781,422,767	2E9390AF	400,088,457,216
S650DC					
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
1600GB	3,125,627,568	BA4D4AB0	3,125,627,567	BA4D4AAF	1,600,321,314,816
3200GB	6,251,233,968	1749A42B0	6,251,233,967	1749A42AF	3,200,631,791,616
S630DC					
400GB	781,422,768	2E9390B0	781,422,767	2E9390AF	400,088,457,216
480GB	937,703,088	37E436B0	937,703,087	37E436AF	480,103,981,056
800GB	1,562,824,368	5D26CEB0	1,562,824,367	5D26CEAF	800,166,076,416
960GB	1,875,385,008	6FC81AB0	1,875,385,007	6FC81AAF	960,197,124,096
1600GB	3,125,627,568	BA4D4AB0	3,125,627,567	BA4D4AAF	1,600,321,314,816
1920GB	3,750,748,848	DF8FE2B0	3,750,748,847	DF8FE2AF	1,920,383,410,176
3200GB	6,251,233,968	1749A42B0	6,251,233,967	1749A42AF	3,200,631,791,616

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

Device and Capacity	Total LBA		Max LBA		User Available Bytes (Unformatted)
	Decimal	**Hexidecimal**	**Decimal**	**Hexidecimal**	
3840GB	7,501,476,528	1BF1F72B0	7,501,476,527	1BF1F72AF	3,840,755,982,336
S610DC					
1920GB	3,750,748,848	DF8FE2B0	3,750,748,847	DF8FE2AF	1,920,383,410,176
3840GB	7,501,476,528	1BF1F72B0	7,501,476,527	1BF1F72AF	3,840,755,982,336

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

Device and Capacity	Total LBA		Max LBA		User Available Bytes (Unformatted)
	Decimal	**Hexidecimal**	**Decimal**	**Hexidecimal**	
S655DC					
200GB	382,435,904	16CB8240	382,435,903	16CB823F	198,866,670,080
400GB	764,871,800	2D970478	764,871,799	2D970477	397,733,336,000
S650DC					
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
1600GB	3,059,487,192	B65C11D8	3,059,487,191	B65C11D7	1,590,933,339,840
3200GB	6,118,974,384	16CB823B0	6,118,974,383	16CB823AF	3,181,866,679,680
S630DC					
400GB	764,871,800	2D970478	764,871,799	2D970477	397,733,336,000
480GB	917,846,160	36B53890	917,846,159	36B5388F	477,280,003,200
800GB	1,529,743,600	5B2E08F0	1,529,743,599	5B2E08EF	795,466,672,000
960GB	1,835,692,320	6D6A7120	1,835,692,319	6D6A711F	954,560,006,400
1600GB	3,059,487,192	B65C11D8	3,059,487,191	B65C11D7	1,590,933,339,840
1920GB	3,671,384,640	DAD4E240	3,671,384,639	DAD4E23F	1,909,120,012,800
3200GB	6,118,974,384	16CB823B0	6,118,974,383	16CB823AF	3,181,866,679,680
3840GB	7,342,769,280	1B5A9C480	7,342,769,279	1B5A9C47F	3,818,240,025,600
S610DC					
1920GB	3,671,384,640	DAD4E240	3,671,384,639	DAD4E23F	1,909,120,012,800
3840GB	7,342,769,280	1B5A9C480	7,342,769,279	1B5A9C47F	3,818,240,025,600

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

Device and Capacity	Total LBA		Max LBA		User Available Bytes (Unformatted)
	Decimal	**Hexidecimal**	**Decimal**	**Hexidecimal**	
S655DC					
200GB	377,338,536	167DBAA8	377,338,535	167DBAA7	197,725,392,864
400GB	754,677,072	2CFB7550	754,677,071	2CFB754F	395,450,785,728
S650DC					
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
1600GB	3,018,708,272	B3EDD530	3,018,708,271	B3EDD52F	1,581,803,134,528
3200GB	6,037,416,536	167DBAA58	6,037,416,535	167DBAA57	3,163,606,264,864
S630DC					
400GB	754,677,072	2CFB7550	754,677,071	2CFB754F	395,450,785,728
480GB	905,612,480	35FA8CC0	905,612,479	35FA8CBF	474,540,939,520
800GB	1,509,354,136	59F6EA98	1,509,354,135	59F6EA97	790,901,567,264
960GB	1,811,224,960	6BF51980	1,811,224,959	6BF5197F	949,081,879,040
1600GB	3,018,708,272	B3EDD530	3,018,708,271	B3EDD52F	1,581,803,134,528
1920GB	3,622,449,920	D7EA3300	3,622,449,919	D7EA32FF	1,898,163,758,080
3200GB	6,037,416,536	167DBAA58	6,037,416,535	167DBAA57	3,163,606,264,864
3840GB	7,244,899,840	1AFD46600	7,244,899,839	1AFD465FF	3,796,327,516,160
S610DC					
1920GB	3,622,449,920	D7EA3300	3,622,449,919	D7EA32FF	1,898,163,758,080
3840GB	7,244,899,840	1AFD46600	7,244,899,839	1AFD465FF	3,796,327,516,160

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

Device and Capacity	Total LBA		Max LBA		User Available Bytes (Unformatted)
	Decimal	**Hexidecimal**	**Decimal**	**Hexidecimal**	
S655DC					
200GB	371,916,520	162AFEE8	371,916,519	162AFEE7	196,371,922,560
400GB	743,833,040	2C55FDD0	743,833,039	2C55FDCF	392,743,845,120
S650DC					
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
1600GB	3,719,165,192	DDADF508	3,719,165,191	DDADF507	1,963,719,221,376
3200GB	5,950,664,304	162AFEE70	5,950,664,303	162AFEE6F	3,141,950,752,512
S630DC					
400GB	743,833,040	2C55FDD0	743,833,039	2C55FDCF	392,743,845,120

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

Device and Capacity	Total LBA		Max LBA		User Available Bytes (Unformatted)
	Decimal	Hexidecimal	Decimal	Hexidecimal	
480GB	892,599,648	3533FD60	892,599,647	3533FD5F	471,292,614,144
800GB	1,487,666,080	58ABFBA0	1,487,666,079	58ABFB9F	785,487,690,240
960GB	1,785,199,296	6A67FAC0	1,785,199,295	6A67FABF	942,585,228,288
1600GB	3,719,165,192	DDADF508	3,719,165,191	DDADF507	1,963,719,221,376
1920GB	3,570,398,592	D4CFF580	3,570,398,591	D4CFF57F	1,885,170,456,576
3200GB	5,950,664,304	162AFEE70	5,950,664,303	162AFEE6F	3,141,950,752,512
3840GB	7,140,797,184	1A99FEB00	7,140,797,183	1A99FEAFF	3,770,340,913,152
S610DC					
1920GB	3,570,398,592	D4CFF580	3,570,398,591	D4CFF57F	1,885,170,456,576
3840GB	7,140,797,184	1A99FEB00	7,140,797,183	1A99FEAFF	3,770,340,913,152

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

Device and Capacity	Total LBA		Max LBA		User Available Bytes (Unformatted)
	Decimal	Hexidecimal	Decimal	Hexidecimal	
S655DC					
200GB	48,840,246	2E93E36	48,840,245	2E93E35	200,049,647,616
400GB	97,677,846	5D27216	97,677,845	5D27215	400,088,457,216
S650DC					
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
1600GB	390,703,446	1749A956	390,703,445	1749A955	1,600,321,314,816
3200GB	781,404,246	2E934856	781,404,245	2E934855	3,200,631,791,616
S630DC					
400GB	97,677,846	5D27216	97,677,845	5D27215	400,088,457,216
480GB	117,212,886	6FC86D6	117,212,885	6FC86D5	480,103,981,056
800GB	195,353,046	BA4D9D6	195,353,045	BA4D9D5	800,166,076,416
960GB	234,423,126	DF90356	234,423,125	DF90355	960,197,124,096
1600GB	390,703,446	1749A956	390,703,445	1749A955	1,600,321,314,816
1920GB	468,843,606	1BF1FC56	468,843,605	1BF1FC55	1,920,383,410,176
3200GB	781,404,246	2E934856	781,404,245	2E934855	3,200,631,791,616
3840GB	937,684,566	37E3EE56	937,684,565	37E3EE55	3,840,755,982,336
S610DC					
1920GB	468,843,606	1BF1FC56	468,843,605	1BF1FC55	1,920,383,410,176
3840GB	937,684,566	37E3EE56	937,684,565	37E3EE55	3,840,755,982,336

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

Device and Capacity	Total LBA		Max LBA		User Available Bytes (Unformatted)
	Decimal	Hexidecimal	Decimal	Hexidecimal	
S655DC					
200GB	47,884,616	2DAA948	47,884,615	2DAA947	199,200,002,560
400GB	95,769,232	5B55290	95,769,231	5B5528F	398,400,005,120
S650DC					
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
1600GB	383,076,928	16D54A40	383,076,927	16D54A3F	1,593,600,020,480
3200GB	766,153,848	2DAA9478	766,153,847	2DAA9477	3,187,200,007,680
S630DC					
400GB	95,769,232	5B55290	95,769,231	5B5528F	398,400,005,120
480GB	114,923,080	6D99648	114,923,079	6D99647	478,080,012,800
800GB	191,538,464	B6AA520	191,538,463	B6AA51F	796,800,010,240
960GB	229,846,160	DB32C90	229,846,159	DB32C8F	956,160,025,600
1600GB	383,076,928	16D54A40	383,076,927	16D54A3F	1,593,600,020,480
1920GB	459,692,312	1B665918	459,692,311	1B665917	1,912,320,017,920
3200GB	766,153,848	2DAA9478	766,153,847	2DAA9477	3,187,200,007,680
3840GB	919,384,616	36CCB228	919,384,615	36CCB227	3,824,640,002,560
S610DC					
1920GB	459,692,312	1B665918	459,692,311	1B665917	1,912,320,017,920
3840GB	919,384,616	36CCB228	919,384,615	36CCB227	3,824,640,002,560

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

Device and Capacity	Total LBA		Max LBA		User Available Bytes (Unformatted)
	Decimal	Hexidecimal	Decimal	Hexidecimal	
S655DC					
200GB	47,280,536	2D17198	47,280,535	2D17197	198,200,006,912
400GB	94,561,072	5A2E330	94,561,071	5A2E32F	396,400,013,824
S650DC					
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
1600GB	378,244,280	168B8CB8	378,244,279	168B8CB7	1,585,600,021,760
3200GB	756,488,552	2D171968	756,488,551	2D171967	3,171,200,009,984
S630DC					
400GB	94,561,072	5A2E330	94,561,071	5A2E32F	396,400,013,824
480GB	113,473,288	6C37708	113,473,287	6C37707	475,680,023,296

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

Device and Capacity	Total LBA		Max LBA		User Available Bytes (Unformatted)
	Decimal	Hexidecimal	Decimal	Hexidecimal	
800GB	189,122,144	B45C660	189,122,143	B45C65F	792,800,027,648
960GB	226,946,568	D86EE08	226,946,567	D86EE07	951,360,013,056
1600GB	378,244,280	168B8CB8	378,244,279	168B8CB7	1,585,600,021,760
1920GB	453,893,136	1B0DDC10	453,893,135	1B0DDC0F	1,902,720,026,112
3200GB	756,488,552	2D171968	756,488,551	2D171967	3,171,200,009,984
3840GB	907,786,264	361BB818	907,786,263	361BB817	3,805,440,018,688
S610DC					
1920GB	453,893,136	1B0DDC10	453,893,135	1B0DDC0F	1,902,720,026,112
3840GB	907,786,264	361BB818	907,786,263	361BB817	3,805,440,018,688

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

Device and Capacity	Total LBA		Max LBA		User Available Bytes (Unformatted)
	Decimal	Hexidecimal	Decimal	Hexidecimal	
S655DC					
200GB	46,922,352	2CBFA70	46,922,351	2CBFA6F	198,200,014,848
400GB	93,844,704	597F4E0	93,844,703	597F4DF	396,400,029,696
S650DC					
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
1600GB	375,378,792	165FD368	375,378,791	165FD367	1,585,600,017,408
3200GB	750,757,576	2CBFA6C8	750,757,575	2CBFA6C7	3,171,200,001,024
S630DC					
400GB	93,844,704	597F4E0	93,844,703	597F4DF	396,400,029,696
480GB	112,613,640	6B65908	112,613,639	6B65907	475,680,015,360
800GB	187,689,400	B2FE9B8	187,689,399	B2FE9B7	792,800,025,600
960GB	225,227,280	D6CB210	225,227,279	D6CB20F	951,360,030,720
1600GB	750,757,576	2CBFA6C8	750,757,575	2CBFA6C7	3,171,200,001,024
1920GB	450,454,552	1AD96418	450,454,551	1AD96417	1,902,720,027,648
3200GB	757,725,329	2D29F891	757,725,328	2D29F890	3,200,631,791,616
3840GB	900,909,096	35B2C828	900,909,095	35B2C827	3,805,440,021,504
S610DC					
1920GB	450,454,552	1AD96418	450,454,551	1AD96417	1,902,720,027,648
3840GB	900,909,096	35B2C828	900,909,095	35B2C827	3,805,440,021,504

Physical Configuration

Dimensions and Weight

Form factor	Capacity (GB)	Height (mm)	Width (mm)	Length (mm)	Weight (grams)
2.5-inch	200/400/480/800/960	7.00 +0.20/–0.50	69.85 ±0.25	100.24 ±0.21	TBD
	1600/1920/3200/3840	15.00 +0.00/–0.50			

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

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 15-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 4: SSD Interface Connections
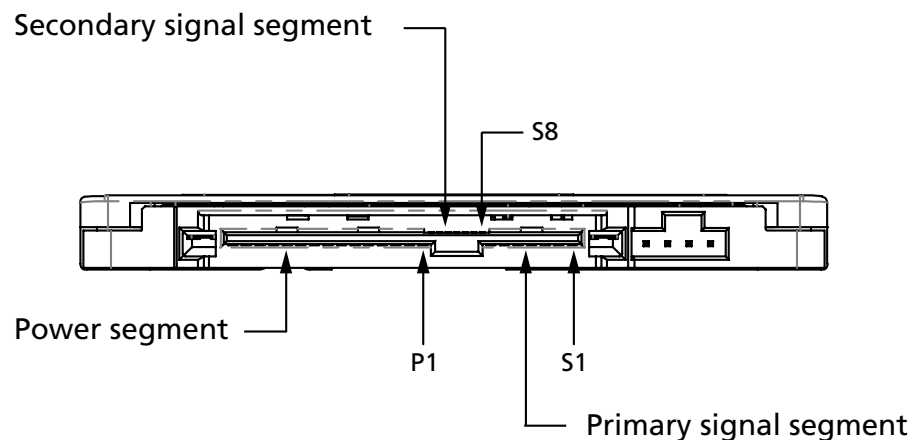
Pin Assignments

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	Reserved; Short pin to support hot plugging; Behind a SAS drive plug connector, P1 and P2 are connected only to each other.
P2	V3.3	Reserved; Short pin to support hot plugging; Behind a SAS drive plug connector, P1 and P2 are connected only to each other.
P3	V3.3	No connect (vendor specific): No internal connection to drive.
P4	GND	Ground
P5	GND	Ground
P6	GND	Ground
P7	V5	5V power (charge)
P8	V5	5V power; Short pin to support hot plugging.
P9	V5	5V power; Short pin to support hot plugging.
P10	GND	Ground
P11	DAS	Ready/Drive activity LED; Short pin to support hot plugging.
P12	GND	Ground
P13	V12	12V power (charge)
P14	V12	12V power; Short pin to support hot plugging.
P15	V12	12V power; 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 umapped 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.

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	All S600DC Series Devices (Capacity in GB)									Unit
			200	400	480	800	960	1600	1920	3200	3840	
Non-SED Configuration												
Thin provisioned (Default)	0	0	5	5	5	5	5	5	5	5	5	minutes
Thin provisioned (Default)	1	0	5	5	5	5	5	5	5	5	5	
Fully provisioned	0	1	10	10	10	10	10	10	10	10	10	
Fully provisioned	1	1	10	10	10	10	10	10	10	10	10	
SED Configuration												
Thin provisioned (Default)	0	0	5	5	5	5	5	5	5	5	5	minutes
Thin provisioned (Default)	1	0	5	5	5	5	5	5	5	5	5	
Fully provisioned	0	1	430	430	430	430	430	430	430	430	430	
Fully provisioned	1	1	280	280	280	280	280	280	280	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

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

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) MODE SELECT (10) MODE SENSE (6) MODE SENSE (10)	15 55 1A 5A	–	–	Yes
		08h	Caching parameters page	Yes
		0Ah	Control mode page	Yes
		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 sub-page	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

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 OPERA- TIONS 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

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

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		

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

Table 23: Internal Drive Characteristics

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