

M550 M.2 Type 2280 NAND Flash SSD

**MTFDDAV064MAY, MTFDDAV128MAY,
MTFDDAV256MAY, MTFDDAV512MAY**

Features

- Micron® 20nm MLC NAND Flash
- RoHS-compliant package
- SATA 6 Gb/s interface
- TCG/Opal 2.0-compliant self-encrypting drive (SED)
- Compatible with Microsoft eDrive®
- Hardware-based AES-256 encryption engine
- ATA modes supported
 - PIO mode 3, 4
 - Multiword DMA mode 0, 1, 2
 - Ultra DMA mode 0, 1, 2, 3, 4, 5
- Industry-standard, 512-byte sector size support
- Device Sleep (DEVSLEEP), extreme low power mode
- Native command queuing support with 32-command slot support
- ATA-8 ACS2 command set compliant
- ATA security feature command set and password login support
- Secure erase (data page) command set: fast and secure erase
- Sanitize device feature set support
- Self-monitoring, analysis, and reporting technology (SMART) command set
- Adaptive thermal monitoring
- Power loss protection for data-at-rest
- Performance^{1, 2}
 - PCMark® Vantage (HDD test suite score): up to 90,000
 - Sequential 128KB READ: up to 550 MB/s
 - Sequential 128KB WRITE: up to 500 MB/s
 - Random 4KB READ: up to 95,000 IOPS
 - Random 4KB WRITE: up to 85,000 IOPS
 - READ/WRITE latency: 5ms/25ms (MAX)

- Reliability
 - MTTF: 1.5 million device hours³
 - Static and dynamic wear leveling
 - Uncorrectable bit error rate (UBER): <1 sector per 10¹⁵ bits read
- Low power consumption
 - 150mW TYP⁴
- Endurance: Total bytes written (TBW) – Up to 72TB
- Capacity (unformatted): 64GB, 128GB, 256GB, 512GB
- Mechanical
 - M.2 "Socket 2" connector: 3.3V ±5%
 - Type 2280: 80mm x 22mm x 3.58mm
 - Weight: 10g (MAX)
- Secure firmware update with digitally signed firmware image
- Operating temperature
 - Commercial (0°C to +70°C)⁵

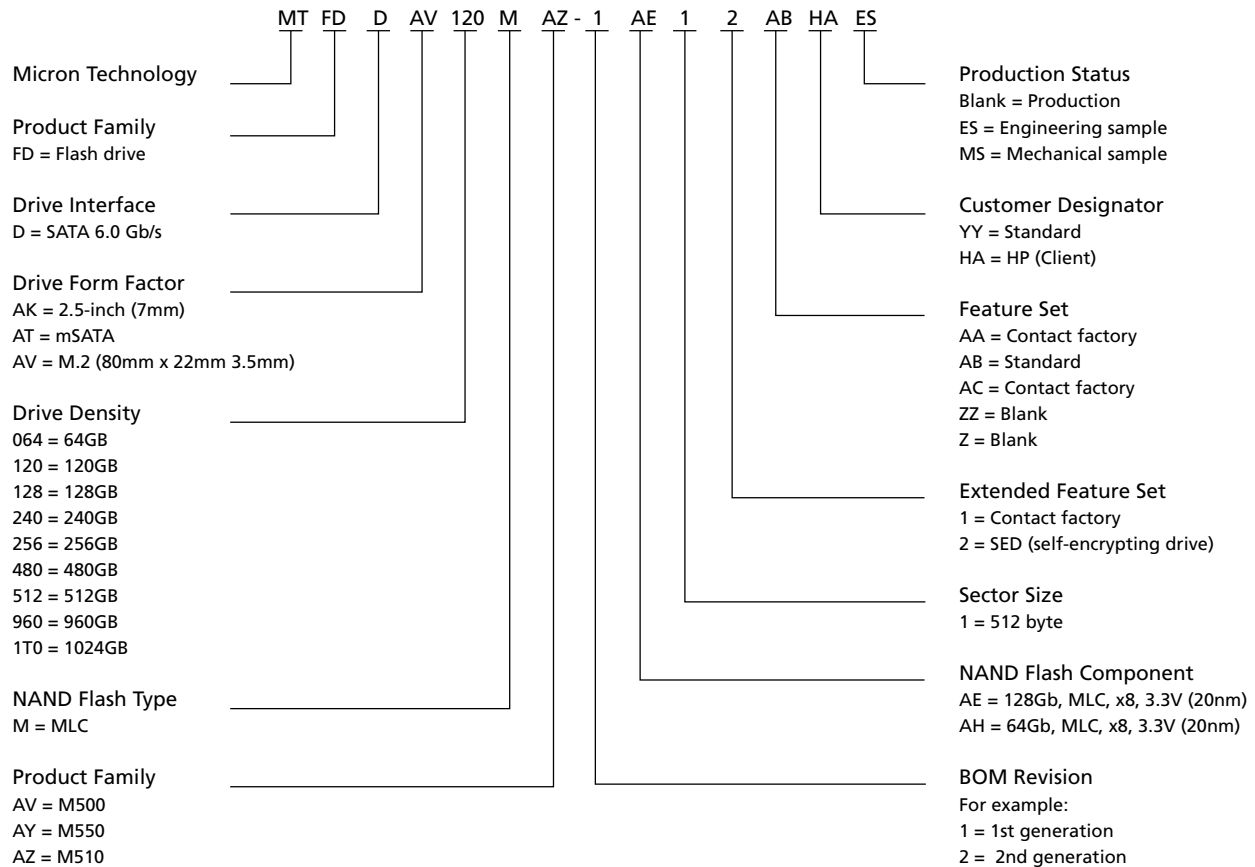
- Notes:
1. Typical I/O performance numbers as measured fresh-out-of-box (FOB) using Iometer with a queue depth of 32 and write cache enabled.
 2. 4KB transfers used for READ/WRITE latency values.
 3. The product achieves a mean time to failure (MTTF) based on population statistics not relevant to individual units.
 4. Active average power measured during execution of MobileMark® with DIPM (device-initiated power management) enabled.
 5. Case temperature.

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

Part Numbering Information

Micron's M500 SSD is available in different configurations and densities. The chart below is a comprehensive list of options for the M500 series devices; not all options listed can be combined to define an offered product. Visit www.micron.com for a list of valid part numbers.

Figure 1: Part Number Chart



General Description

Micron’s solid state drive (SSD) uses a single-chip controller with a SATA interface on the system side and 8-channels of Micron NAND Flash internally. Packaged in an HDD replacement enclosure, the SSD integrates easily in existing storage infrastructures.

The SSD is designed to use the SATA interface efficiently during both READs and WRITEs while delivering bandwidth-focused performance. SSD technology enables enhanced boot times, faster application load times, reduced power consumption, and extended reliability.

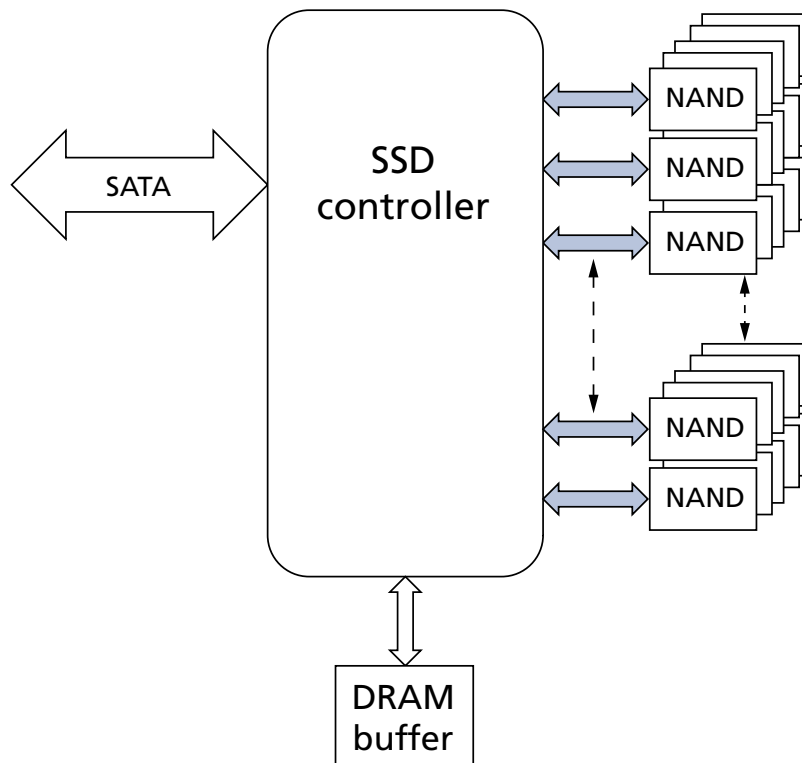
The M.2 Type 2280 is a caseless form factor ideally suited for ultrathin, mobile computing applications, which require mass storage in a very small footprint.

The self-encrypting drive (SED) features a FIPS-compliant, AES-256 encryption engine, providing hardware-based, secure data encryption, with no loss of SSD performance. This SED follows the TCG/Opal specification for trusted peripherals.

When TCG/Opal features are not enabled, the device can perform alternate data encryption by invoking the ATA security command-set encryption features, to provide full-disk encryption (FDE) managed in the host system BIOS. TCG/Opal and FDE feature sets cannot be enabled simultaneously.

The data encryption is always running; however, encryption keys are not managed and the data is not secure until either TCG/Opal or FDE feature sets are enabled.

Figure 2: Functional Block Diagram



Logical Block Address Configuration

The drive is set to report the number of logical block addresses (LBA) that will ensure sufficient storage space for the specified capacity. Standard LBA settings, based on the IDEMA standard (LBA1-02), are shown below.

Table 1: Standard LBA Settings

| Capacity | Total LBA | | Max LBA | | User Available Bytes (Unformatted) |
|----------|---------------|-------------|---------------|-------------|------------------------------------|
| | Decimal | Hexadecimal | Decimal | Hexadecimal | |
| 64GB | 125,045,424 | 7740AB0 | 125,045,423 | 7740AAF | 64,023,257,088 |
| 128GB | 250,069,680 | EE7C2B0 | 250,069,679 | EE7C2AF | 128,035,676,160 |
| 256GB | 500,118,192 | 1DCF32B0 | 500,118,191 | 1DCF32AF | 256,060,514,304 |
| 512GB | 1,000,215,216 | 3B9E12B0 | 1,000,215,215 | 3B9E12AF | 512,110,190,592 |

Physical Configuration

Table 2: M.2 Dimensions and Weight

| Specification | Value | | Unit |
|------------------|-------|------|----------------------|
| | Nom | Max | |
| Height | – | 3.58 | mm |
| Width | 22.00 | – | mm |
| Length | 80.00 | – | mm |
| Unit weight | – | 10 | g |
| Insertion rating | 10 | – | insert/remove cycles |

Interface Connectors

Figure 3: SSD Interface Connections

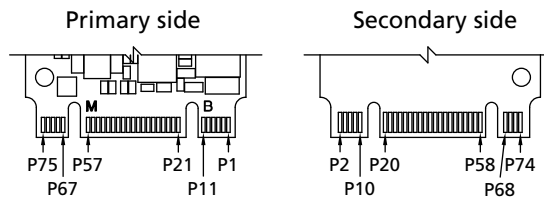




Table 3: Signal Assignments

| Primary Side | | | Secondary Side | | |
|--------------|---------------------|--------------------------|----------------|-------------|---------------------------|
| Pin # | Signal Name | Description | Pin # | Signal Name | Description |
| 1 | GND (PRESENCE) | Ground | 2 | 3V3 | +3.3V |
| 3 | GND | Ground | 4 | 3V3 | +3.3V |
| 5 | GND | No connect | 6 | Reserved | No connect |
| 7 | DNU | No connect | 8 | Reserved | No connect |
| 9 | DNU | Ground | 10 | DAS/DSS | Drive activity (host LED) |
| 11 | GND | Ground | Key | | |
| Key | | | 20 | Reserved | No connect |
| 21 | GND (Direct to P69) | No connect | 22 | Reserved | No connect |
| 23 | DNU | No connect | 24 | Reserved | No connect |
| 25 | DNU | No connect | 26 | Reserved | No connect |
| 27 | GND | Ground | 28 | Reserved | No connect |
| 29 | Reserved | No connect | 30 | Reserved | No connect |
| 31 | Reserved | No connect | 32 | Reserved | No connect |
| 33 | GND | Ground | 34 | Reserved | No connect |
| 35 | Reserved | No connect | 36 | Reserved | No connect |
| 37 | Reserved | No connect | 38 | DEVSLP | Device sleep |
| 39 | GND | Ground | 40 | Reserved | No connect |
| 41 | SATA +B | SATA B differential pair | 42 | Reserved | No connect |
| 43 | SATA -B | | 44 | Reserved | No connect |
| 45 | GND | Ground | 46 | Reserved | No connect |
| 47 | SATA -A | SATA A differential pair | 48 | Reserved | No connect |
| 49 | SATA +A | | 50 | Reserved | No connect |
| 51 | GND | Ground | 52 | Reserved | No connect |
| 53 | Reserved | No connect | 54 | Reserved | No connect |
| 55 | Reserved | No connect | 56 | Reserved | Vendor use |
| 57 | GND | Ground | 58 | Reserved | Vendor use |
| Key | | | Key | | |
| 67 | DNU | No connect | 68 | SUSCLK | No connect |
| 69 | PEDET | Ground | 70 | 3V3 | +3.3V |
| 71 | GND | Ground | 72 | 3V3 | +3.3V |
| 73 | GND | Ground | 74 | 3V3 | +3.3V |
| 75 | GND | Ground | | | |

Performance

Measured performance can vary for a number of reasons. The major factors affecting drive performance are the capacity of the drive and the interface of the host. Additionally, overall system performance can affect the measured drive performance. When comparing drives, it is recommended that all system variables are the same, and only the drive being tested varies.

Performance numbers will vary depending on the host system configuration.

For SSDs designed for the client computing market, Micron specifies performance in FOB ("fresh-out-of-box") state. Data throughput measured in "steady state" may be lower than FOB state, depending on the nature of the data workload.

For a description of these performance states and of Micron's best practices for performance measurement, refer to Micron's technical marketing brief "Best Practices for SSD Performance Measurement" (www.micron.com/products/solid-state-storage/).

Table 4: Drive Performance

| Capacity | 64GB | 128GB | 256GB | 512GB | Unit |
|-----------------------------------|--------|--------|--------|--------|-----------|
| Interface Speed | 6 Gb/s | 6 Gb/s | 6 Gb/s | 6 Gb/s | |
| PCMark Vantage | 70,000 | 80,000 | 85,000 | 90,000 | HDD score |
| Sequential read (128KB transfer) | 550 | 550 | 550 | 550 | MB/s |
| Sequential write (128KB transfer) | 190 | 350 | 500 | 500 | MB/s |
| Random read (4KB transfer) | 85,000 | 90,000 | 90,000 | 95,000 | IOPS |
| Random write (4KB transfer) | 45,000 | 75,000 | 80,000 | 85,000 | IOPS |
| READ latency (MAX) | 5 | 5 | 5 | 5 | ms |
| WRITE latency (MAX) | 25 | 25 | 25 | 25 | ms |
| READ latency (TYP) | 160 | 160 | 160 | 160 | μs |
| WRITE latency (TYP) | 40 | 40 | 40 | 40 | μs |

- Notes:
1. Performance numbers are maximum values, except as noted.
 2. Typical I/O performance numbers as measured using Iometer with a queue depth of 32 and write cache enabled. Fresh-out-of-box (FOB) state is assumed. For performance measurement purposes, the SSD may be restored to FOB state using the secure erase command.
 3. Iometer measurements are performed on an 20GB span of logical block addresses (LBAs).
 4. 4KB transfers are used to measure READ/WRITE latency values with write cache enabled.
 5. System variations will affect measured results. For comparison, PCMark scores are measured with the SSD as a secondary drive in a two-drive system. When measured as an OS drive, system overhead can cause lower scores.

For a description of these performance states and of Micron's best practices for performance measurement, refer to Micron's technical marketing brief "Best Practices for SSD Performance Measurement"

Reliability

Micron’s SSDs incorporate advanced technology for defect and error management. They use 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 is reported as successfully programmed to the SSD but when it is read out of the SSD, the data differs from what was programmed.

Table 5: Uncorrectable Bit Error Rate

| Uncorrectable Bit Error Rate | Operation |
|--|-----------|
| <1 sector per 10 ¹⁵ bits read | READ |

Mean Time To Failure

Mean time to failure (MTTF) for the SSD can be predicted based on the component reliability data using the methods referenced in the Telcordia SR-332 reliability prediction procedures for electronic equipment.

Table 6: MTTF

| Capacity | MTTF (Operating Hours) ¹ |
|----------|-------------------------------------|
| 64GB | 1.5 million |
| 128GB | 1.5 million |
| 256GB | 1.5 million |
| 512GB | 1.5 million |

Note: 1. The product achieves a mean time to failure (MTTF) of 1.5 million hours, based on population statistics not relevant to individual units.

Endurance

Endurance for the SSD can be predicted based on the usage conditions applied to the device, the internal NAND component cycles, the write amplification factor, and the wear-leveling efficiency of the drive. The tables below show the drive lifetime for each SSD capacity by client computing and sequential input and based on predefined usage conditions.

Table 7: Drive Lifetime – Client Computing

| Capacity | Drive Lifetime (Total Bytes Written) |
|----------|--------------------------------------|
| 64GB | 36TB |
| 128GB | 72TB |
| 256GB | 72TB |
| 512GB | 72TB |

- Notes:
1. Total bytes written calculated with the drive 90% full.
 2. SSD volatile write cache is enabled.
 3. Access patterns used during reliability testing are 25% sequential and 75% random and consist of the following: 50% are 4KiB; 40% are 64KiB; and 10% are 128KiB.
 4. Host workload parameters, including write cache settings, IO alignment, transfer sizes, randomness, and percent full, that are substantially different than the described notes, may result in varied endurance results.
 5. GB/day can be calculated by dividing the total bytes written value by (365 x number of years). For example: 72TB/5 years/365 days = 40 GB/day for 5 years.

Electrical Characteristics

Environmental conditions beyond those listed may cause permanent damage to the device. This is a stress rating only, and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

Table 8: SATA Power Consumption

| Capacity | Device Sleep Typical | Idle Average | Active Average | Active Maximum (128KB transfer) | Unit |
|----------|----------------------|--------------|----------------|---------------------------------|------|
| 64GB | 3 | 80 | 150 | 2400 | mW |
| 128GB | 3 | 95 | 150 | 3600 | mW |
| 256GB | 3 | 100 | 150 | 4400 | mW |
| 512GB | 3 | 100 | 150 | 4700 | mW |

- Notes:
1. Data taken at 25°C using a 6 Gb/s SATA interface.
 2. Active average power measured while running MobileMark Productivity Suite.
 3. DIPM (device-initiated power management) enabled. DIPM Slumber supported.
 4. Active maximum power is measured using Iometer with 128KB sequential write transfers.

Table 9: Maximum Ratings

| Parameter/Condition | Symbol | Min | Max | Unit |
|------------------------------------|----------------|------|------|---------|
| Voltage input | 3V3 | 3.14 | 3.46 | V |
| Operating temperature | T _C | 0 | 70 | °C |
| Non-operating temperature | | -40 | 85 | °C |
| Rate of temperature change | | - | 20 | °C/hour |
| Relative humidity (non-condensing) | | 5 | 95 | % |

- Notes:
1. Temperature is best measured with a thermocouple attached to the exterior center point of the SSD controller package (the larger package closest to the interface connector on the primary side). Contact with the drive serial number label is acceptable. Printed circuit board temperature is recorded in SMART attribute 194 (or 0xC2), and may differ from the SSD controller's surface temperature. Adequate airflow or heat sink is advised.
 2. Power-off sequence: When the SSD is shut down, the ATA STANDBY IMMEDIATE (STBI) command should be the last command sent by the host and acknowledged by the SSD. Failure to follow this process might result in a longer than normal time-to-ready (TTR) during the subsequent power-on sequence. TTR is the time from power-on to drive ready to accept SATA commands.

Table 10: Shock and Vibration

| Parameter/Condition | Specification |
|-------------------------|-----------------|
| Non-operating shock | 1500G/0.5ms |
| Non-operating vibration | 5–800Hz @ 3.13G |

Adaptive Thermal Monitoring

The device features adaptive thermal monitoring. While most host computers exhibit operating environments that keep an SSD running in the range of 40°C to 45°C, adaptive thermal monitoring enables the SSD device to operate in a wide variety of environments by helping to prevent the host computer from running at excessive temperatures.

Adaptive thermal monitoring reduces write data throughput to about 150MB/s when the temperature sensor reaches 78°C (this point is higher than Micron's maximum rated operating temperature to provide some operating margin). Performance will be reduced by approximately an additional 50% as the temperature hits higher points at 82°C, 85°C, and 88°C. Read rates are also reduced. While this is occurring, DRAM refresh rates are increased by a multiple of 4, in order to provide increased data integrity when the drive is operating above the temperature specification. The SSD remains in this lowered performance state until the temperature returns to 65°C; the SSD then returns to normal operating mode. These transition points might occur at points somewhat different from case or ambient temperature because of thermal effects that cause a difference between temperature sensed at the PCB level and temperature at the specified operating environment.

Adaptive thermal monitoring does not change the current negotiated speed of the SATA bus, nor require or cause any new commands to be issued on the SATA bus. Rated-throughput performance is not guaranteed at any point above the maximum specified operating temperature.

The thermal monitoring feature can be disabled using ATA SET FEATURE commands as described below. The default setting is ENABLED.

Note: The SSD will return to the default setting after each power cycle or COMRESET command. Arrangements should be made to re-issue the DISABLE command after each power cycle or COMRESET.

DISABLE THERMAL MONITORING Command

- Command set feature
- Sub-command enable SATA feature
- Specific feature hardware feature control
- LBA FFFFh
- IDFY word 78, bit 5 will be set to indicate SATA hardware feature control is active

Table 11: Disable Thermal Monitoring Command Set Register

| Feature Set | Register | | | | | | | |
|---------------|----------|---|---|---|---|---|---|---|
| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Feature | 10h | | | | | | | |
| Sector count | 08h | | | | | | | |
| Sector number | FFh | | | | | | | |
| Cylinder low | FFh | | | | | | | |
| Cylinder high | xx | | | | | | | |
| Drive head | xx | | | | | | | |
| Command | EFh | | | | | | | |

ENABLE THERMAL MONITORING Command

- Command set feature
- Sub-command disable SATA feature
- Specific feature hardware feature Control
- LBA FFFFh
- IDFY word 78, bit 5 will be set to indicate SATA hardware feature control is inactive

Table 12: Enable Thermal Monitoring Command Set Register

| Feature Set | Register | | | | | | | |
|---------------|----------|---|---|---|---|---|---|---|
| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Feature | 90h | | | | | | | |
| Sector count | 8h | | | | | | | |
| Sector number | FFh | | | | | | | |
| Cylinder low | FFh | | | | | | | |
| Cylinder high | xx | | | | | | | |
| Drive head | xx | | | | | | | |
| Command | EFh | | | | | | | |

TCG/Opal Support

Table 13: TCG/Opal Support Parameters

| Property | Supported? | Comments |
|--|-----------------------------|--|
| TCG Storage Specifications | | |
| OPAL: TCG Storage Security SubSystem Class | Specification 2.00 | Revision 1.00, Feb 24, 2012 |
| TCG Core Specification | Specification 2.00 | Revision 2.00, Nov 4, 2011 |
| TCG Storage Interface Interactions Specification | TCG Reference Specification | Specification Version 1.02 Revision 1.00 30 December, 2011 |
| OPAL SSC 1.00 (backward compatibility) | Not supported | – |
| OPAL SSC Additional Feature Set Specification | | |
| Additional DataStore Table | Supported | Specification 1.00 Revision 1.00, Feb 24, 2012 |
| Single User Mode | Supported | Specification 1.00 Revision 1.00, Feb 24, 2012 |
| TCG Storage Protection Mechanisms for Secrets | Supported | Specification Version 1.00 Revision 1.07 17 August, 2011 |
| PSID – Physical Presence SID | Supported | Specification Version 1.00 Committee Draft Revision 1.05 February 9, 2011 |
| GUDID (Globally Unique Serial Number) | Supported | Mandatory GUDID Proposal 11/03/2011 (Microsoft) |
| SID Authority Disable | Supported | SID Authority Disable Proposal 9/26/2011 (Microsoft) |
| Modifiable CommonName Columns | Supported | Modifiable CommonName Columns Proposal 7/22/2010 (Microsoft) |
| OPAL SSC Feature Set – Specific List | | |
| ALL OPAL Mandatory Features | Supported | – |
| Close Session (optional) | Supported | Allows Tper to notify the host it has aborted a session |
| Restricted Command & Table (optional) | Not Supported | The interface control template enables TPer control over selected interface commands; the benefit is the reduction of undesired side effects |
| Type Table (not required) | Not Supported | – |
| Activate Method | Supported | – |
| Revert Method | Supported | – |
| Revert SP Method | Supported | – |
| Activate Method Within Transactions | Not Supported | As per OPAL, this behavior is out of the scope |
| Revert Method within Transactions | Not Supported | As per OPAL, this behavior is out of the scope |
| Revert SP Method within Transactions | Not Supported | As per OPAL, this behavior is out of the scope |
| Creation/Deletion of Tables/Rows after Manufacturing | Not Supported | As per OPAL, this behavior is out of the scope |
| Tper Feature | | |
| COM ID Management Support | Not Supported | Dynamic COM ID allocation & management not supported |
| Buffer Management Support | Not Supported | Flow control |

Table 13: TCG/Opal Support Parameters (Continued)

| Property | Supported? | Comments |
|--|---------------|---|
| ACK/NACK Support | Not Supported | Session reliability |
| Async Support | Not Supported | Asynchronous protocol support with multiple commands per session |
| Geometry Reporting Feature | | |
| ALIGN | Supported | OPAL 2.0 (only) |
| Logical Block Size | 512 bytes | Logical block size = 512 Bytes |
| Alignment Granularity | 4096 Bytes | Page or Descriptor size <<Minimum AES LU size>> |
| Lowest Aligned LBA | 0 | – |
| OPAL SSC V2.00 Feature Descriptor | | |
| Base COM ID | 0x1000 | 0x1000-0xFFFF defined for COM ID management |
| Number of COM IDs | 1 | – |
| Range Crossing Behavior | 0 | If drive receives a READ or WRITE command that spans multiple LBA ranges and the LBA ranges are not locked, then: 1. Process the data transfer, if Range Crossing = 0 2. Terminate the command with “Other Invalid Command Parameter” if Range Crossing = 1 |
| Number of Locking SP Admin Authorities Supported | 4 | As per OPAL 2.0, drive should support at least 4 admin |
| Number of Locking SP User Authorities Supported | 9 | As per OPAL 2.0, drive should support at least 8 users |
| Initial C_PIN_SID PIN Indicator | 0x00 | 0x00 = The initial C_PIN_SID PIN value is equal to the C_PIN_MSID PIN value 0xFF = The initial C_PIN_SID PIN value is VU, and MAY not be equal to the C_PIN_MSID PIN value OPAL 2.0 (only) Customer-specific SID – Configurable |
| Behavior of C_PIN_SID PIN upon Ter Revert | 0x00 | 0x00 = The C_PIN_SID PIN value becomes the value of the C_PIN_MSID PIN column after successful invocation of revert on the admin SP’s object in the SP table 0xFF = The C_PIN_SID PIN value changes to a VU value after successful invocation of revert on the admin SP’s object in the SP table and MAY not be equal to the C_PIN_MSID PIN value OPAL 2.0 (only) |
| DataStore Table Feature | | |
| Maximum number of DataStore Tables | 9 | The maximum number of the DataStore tables that the TPer supports, including the DataStore table defined in OPAL SSC 2.0 |
| Maximum total size of DataStore Tables | 90MB | Specifies the maximum total size in bytes of all of the DataStore tables that TPer supports, including the DataStore table defined in OPAL SSC 2.0 |
| DataStore Table Size Alignment | 10MB | – |

Table 13: TCG/Opal Support Parameters (Continued)

| Property | Supported? | Comments |
|--|--|--|
| MBR Table | 128MB | – |
| Byte Table Access Granularity | | |
| Mandatory Write Granularity | 1 | TPer enforces when the host invokes the set method on byte tables; it should be less than or equal to 8192; it should be less than or equal to Recommended Access Granularity, OPAL 2.0 (only) |
| Recommended Access Granularity | 8192 | Tper recommends when the host invokes the set or get method on byte tables; it should be less than or equal to 8192 |
| Cryptographic Features | | |
| AES Key Size | 256 Bits | AES key is generated by using CTR DRBG algorithm (FIPS Compliant) |
| AES Mode | CBC | IV swapped |
| Number of Ranges/Band Supported | 9 (8 user definable, 1 global range) | Now supporting 8 LBA ranges; range cross read and write allowed if LBA ranges are unlocked |
| Re-Encryption | Not Supported | – |
| Key Management | | Authentication data required. Conforms to TCG Storage Protection Mechanisms for Secrets; Specification version 1.00, Revision 1.00, 05 March 2012 |
| Crypto Erase Completion Time <1s | Yes | – |
| Cryptographic Algorithms are Certified by FIPS-197 | Pending | – |
| AES 256-Bit CBC/ECB Mode | Supported | ECB mode used only for generating the random key by CTR DRBG |
| CTR DRBG | Supported | – |
| SHA 256 | Supported | – |
| RSA 2048 Signature Verification | Supported | – |
| TPer Communication Properties | | |
| Max ComPacket Size | 131072 | 256 sectors (128K) |
| Max Response ComPacket Size | 131072 | 256 sectors (128K) |
| Max Packet Size | 128512 | – |
| Max Individual Token Size | 123904 | – |
| Max Packets | 1 | – |
| Max SubPackets | 1 | – |
| Max Sessions | 1 | Each session requires a set of buffers and variables |
| Max Transaction Limit | 1 | Transaction are inside sessions |
| Max Methods | 1 | Methods are contained in a transaction |
| Max Authentications | 2 | – |

Table 13: TCG/Opal Support Parameters (Continued)

| Property | Supported? | Comments |
|--|---------------|---|
| Def Session Timeout | Yes | The session timeout length (in milliseconds) used by the TPer by default |
| IEEE1667 | | |
| Probe Silo | Supported | – |
| TCG Storage Silo | Supported | – |
| Other than Probe and TCG Storage Silo | Not Supported | – |
| IEEE1667 Major Version | TBD | As per current draft specification, major and minor versions are not yet decided |
| IEEE1667 Minor Version | TBD | – |
| Maximum P_OUT Transfer Size | 131072 | 256 sectors (128K) |
| Others | | |
| FDE (ATA Security with Key Management) | Yes | – |
| Secure Firmware Download | Supported | Firmware image is validated by using SHA256 and RSA2048 algorithm (FIPS-compliant; certification pending) |

Device ID

Table 14: Identify Device

See Note 1 for setting definitions

| Word | Bit(s) | Setting | Default Value | Description |
|------|--------|---------|----------------------|--|
| 0 | | | | General configuration bit-significant information |
| | 15 | F | 0b | 0 = ATA device |
| | 14–8 | X | 0000100b | Retired |
| | 7 | F | 0b | 1 = Removable media device |
| | 6 | F | 1b | 1 = Fixed disk HDD |
| | 5–3 | X | 000b | Retired |
| | 2 | V | 0b | Response incomplete |
| | 1 | X | 0b | Retired |
| | 0 | F | 0b | Reserved |
| 1 | | | 3FFFh | Obsolete |
| 2 | | F | C837h | Specific configuration |
| 3 | | F | 0010h | Obsolete |
| 4 | | F | 0000h 0000h | Retired |
| 6 | | F | 003Fh | Obsolete |
| 7 | | (O)V | 0000h 0000h | Reserved for assignment by the CompactFlash™ Association |
| 9 | | ()X | 0000h | Retired |
| 10 | | (M)F | varies | Serial number (20 ASCII characters) |
| 20 | | ()X | 0000h 0000h 0000h | Retired/Obsolete |
| 23 | | (M)F | varies | Firmware revision (8 ASCII characters) |
| 27 | | (M)F | varies | Model number (40 ASCII characters) |
| 47 | 15–8 | F | 80h | 80h |
| | 7–0 | F | 10h | 00h = Reserved 01h-FFh = Maximum number of logical sectors that shall be transferred per DRQ data block on READ/WRITE MULTIPLE commands |
| 48 | | | | Trusted Computing feature set options |
| | 15 | F | 0b | Shall be cleared to zero |
| | 14 | F | 1b | Shall be set to one |
| | 13–1 | F | 000000000000b | Reserved for the Trusted Computing Group |
| | 0 | F | 1b | 1=Trusted Computing feature set is support |

Table 14: Identify Device (Continued)

See Note 1 for setting definitions

| Word | Bit(s) | Setting | Default Value | Description |
|-------|--------|---------|-------------------------------------|--|
| 49 | | | | Capabilities |
| | 15–14 | F | 00b | Reserved for the IDENTIFY PACKET DEVICE command. |
| | 13 | F | 1b | 1 = Standby timer values as specified in this standard are supported |
| | | | | 0 = Standby timer values shall be managed by the device |
| | 12 | F | 0b | Reserved for the IDENTIFY PACKET DEVICE command. |
| | 11 | F | 1b | 1= IORDY supported |
| | | | | 0 = IORDY may be supported |
| | 10 | F | 1b | 1 = IORDY may be disabled |
| | 9 | | 1b | 1 = LBA supported |
| | 8 | F | 1b | 1 = DMA supported. |
| | 7–0 | F | 00000000b | Retired |
| 50 | | | | Capabilities |
| | 15 | F | 0b | Shall be cleared to zero |
| | 14 | F | 1b | Shall be set to one |
| | 13–2 | F | 000000000000b | Reserved |
| | 1 | X | 0b | Obsolete |
| | 0 | F | 1b | Shall be set to one to indicate a vendor specific standby timer value minimum. |
| 51 | | ()X | 0000h 0000h | Obsolete |
| 53 | 15–3 | F | 000000000000b | Reserved |
| | 2 | F | 1b | 1 = The fields reported in word 88 are valid 0 = the fields reported in word 88 are not valid |
| | 1 | F | 1b | 1 = The fields reported in words (70:64) are valid 0 = the fields reported in words (70:64) are not valid |
| | 0 | X | 1b | Obsolete |
| 54 | | ()X | 3FFFh 0010h 003Fh FC10h 00FBh | Obsolete |
| 59 | 15 | F | 1b | 1 = The BLOCK ERASE EXT command is supported |
| | 14 | F | 0b | 1 = The OVERWRITE EXT command is supported |
| | 13 | F | 0b | 1 = The CRYPTO SCRAMBLE EXT command is supported |
| | 12 | F | 1b | 1 = The Sanitize feature set is supported |
| | 11–9 | F | 000b | Reserved |
| | 8 | V | 1b | 1 = Multiple sector setting is valid |
| | | 7–0 | V | 00010000b |
| 60–61 | | M(F) | Varies by capacity | Total number of user addressable logical sectors |

Table 14: Identify Device (Continued)

See Note 1 for setting definitions

| Word | Bit(s) | Setting | Default Value | Description |
|------|--------|---------|---------------|---|
| 62 | | ()X | 0000h | Obsolete |
| 63 | 15–11 | F | 00000b | Reserved |
| | 10 | V | 0b | 1 = Multiword DMA mode 2 is selected 0 = Multiword DMA mode 2 is not selected |
| | 9 | V | 0b | 1 = Multiword DMA mode 1 is selected 0 = Multiword DMA mode 1 is not selected |
| | 8 | V | 0b | 1 = Multiword DMA mode 0 is selected 0 = Multiword DMA mode 0 is not selected |
| | 7–3 | F | 0000b | Reserved |
| | 2 | F | 1b | 1 = Multiword DMA mode 2 and below are supported |
| | 1 | F | 1b | 1 = Multiword DMA mode 1 and below are supported |
| | 0 | F | 1b | 1 = Multiword DMA mode 0 is supported |
| 64 | 15–8 | F | 0 | Reserved |
| | 7–0 | F | 00000011b | PIO modes supported |
| 65 | | F | 0078h | Minimum Multiword DMA transfer cycle time per word Cycle time in nanoseconds |
| 66 | | F | 0078h | Manufacturer's recommended Multiword DMA transfer cycle time Cycle time in nanoseconds |
| 67 | | F | 0078h | Minimum PIO transfer cycle time without flow control Cycle time in nanoseconds |
| 68 | | F | 0078h | Minimum PIO transfer cycle time with IORDY flow control Cycle time in nanoseconds |
| 69 | | F | | Additional Supported |
| | 15 | F | 0b | 1 = CFast Specification Support |
| | 14 | F | 1b | 1 = Deterministic read after Trim is supported |
| | 13 | F | 0b | 1 = Long Physical Sector Alignment Error Reporting Control is supported |
| | 12 | F | 0b | 1 = DEVICE CONFIGURATION IDENTIFY DMA and DEVICE CONFIGURATION SET DMA are supported |
| | 11 | F | 0b | 1 = READ BUFFER DMA is supported |
| | 10 | F | 0b | 1 = WRITE BUFFER DMA is supported |
| | 9 | F | 0b | 1 = SET MAX PASSWORD DMA and SET MAX UNLOCK DMA are supported |
| | 8 | F | 0b | 1 = DOWNLOAD MICROCODE DMA is supported |
| | 7 | F | 1b | Reserved for IEEE-1667 |
| | 6 | F | 0b | 1 = Optional ATA device 28-bit commands supported |
| | 5 | F | 1b | 1 = Read zero after Trim is supported |
| | 4 | F | 1b | 1 = Device encrypts all user data |
| 3–0 | F | 0000b | Reserved | |

Table 14: Identify Device (Continued)

See Note 1 for setting definitions

| Word | Bit(s) | Setting | Default Value | Description |
|------|--------|---------|----------------------------|--|
| 70 | | F | 0000h | Reserved |
| 71 | | F | 0000h 0000h 0000h 0000h | Reserved for the IDENTIFY PACKET DEVICE command |
| 75 | | | | Queue depth |
| | 15–5 | F | 00000000000b | Reserved |
| | 4–0 | F | 11111b | Maximum queue depth - 1 |
| 76 | | | | Serial ATA capabilities |
| | 15 | F | 0b | 1 = Supports READ LOG DMA EXT as equivalent to READ LOG EXT |
| | 14 | F | 0b | 1 = Supports device automatic partial to slumber transitions |
| | 13 | F | 0b | 1 = Supports host automatic partial to slumber transitions |
| | 12 | F | 1b | Supports Native Command Queuing priority information |
| | 11 | F | 0b | Supports Unload while NCQ commands outstanding |
| | 10 | F | 1b | Supports Phy event counters |
| | 9 | F | 0b | Supports receipt of host initiated interface power management requests |
| | 8 | F | 1b | Supports native Command Queueing |
| | 7–4 | F | 0000b | Reserved for future Serial ATA signaling speed grades |
| | 3 | F | 1b | 1 = Supports Serial ATA Gen-3 speed (6.0 Gb/s) |
| | 2 | F | 1b | 1 = Supports Serial ATA Gen-2 speed (3.0 Gb/s) |
| | 1 | F | 1b | 1 = Supports Serial ATA Gen-1 speed (1.5 Gb/s) |
| 0 | F | 0b | Reserved (set to 0) | |
| 77 | | | | Serial ATA additional capabilities |
| | 15–8 | F | 00000000b | Reserved for future Serial ATA definition |
| | 7 | F | 1b | 1 = Supports DEVSLP_to_ReducedPwrState |
| | 6 | F | 1b | Supports RECEIVE FPDMA QUEUED and SEND FPDMA QUEUED commands |
| | 5 | F | 0b | Supports NCQ Queue Management Command |
| | 4 | F | 0b | Supports NCQ Streaming |
| | 3–1 | V | 010b | Coded value indicating current negotiated Serial ATA signal speed |
| | 0 | F | 0b | Shall be cleared to zero |

Table 14: Identify Device (Continued)

See Note 1 for setting definitions

| Word | Bit(s) | Setting | Default Value | Description |
|------|--------|---------|---------------------|--|
| 78 | | | | Serial ATA features supported |
| | 15–8 | F | 000000000b | Reserved |
| | 7 | F | 0b | 1 = Supports NCQ Autosense |
| | 6 | F | 1b | 1 = Supports software settings preservation |
| | 5 | F | 1b | 1 = HARDWARE FEATURE CONTROL SUPPORTED bit |
| | 4 | F | 0b | 1 = Supports in-order data delivery |
| | 3 | F | 1b | 1 = Supports dev initiate interface power management |
| | 2 | F | 1b | 1 = Supports DMA Setup Auto-Activate optimization |
| | 1 | F | 0b | 1 = Supports non-zero buffer offsets in DMA Setup FIS |
| 0 | F | 0b | Reserved (set to 0) | |
| 79 | | | | Serial ATA features enabled |
| | 15–7 | V | 000000000b | Reserved |
| | 6 | V | 1b | 1 = Software settings preservation enabled |
| | 5 | V | 0b | 1 = Asynchronous notification enabled |
| | 4 | V | 0b | 1 = In-order data delivery enabled |
| | 3 | V | 0b | 1 = Device initiating interface power management enabled |
| | 2 | V | 0b | 1 = DMA Setup Auto-Activate optimization enabled |
| | 1 | V | 0b | 1 = Non-zero buffer offsets in DMA Setup FIS enabled |
| | 0 | V | 0b | Reserved (set to 0) |
| 80 | | | | Major revision number |
| | 15–10 | F | 000000b | Reserved |
| | 9 | F | 1b | 1 = Supports ATA8-ACS2 |
| | 8 | F | 1b | 1 = Supports ATA8-ACS |
| | 7 | F | 1b | 1 = Supports ATA/ATAPI-7 |
| | 6 | F | 1b | 1 = Supports ATA/ATAPI-6 |
| | 5 | F | 1b | 1 = Supports ATA/ATAPI-5 |
| | 4 | F | 1b | 1 = Supports ATA/ATAPI-4 |
| | 3 | F | 1b | Obsolete |
| | 2 | S | 0b | Obsolete |
| | 1 | S | 0b | Obsolete |
| | 0 | F | 0b | Reserved |
| 81 | | F | 0028h | Minor revision number |
| | | | | 0028h = ATA8-ACS version 6 |

Table 14: Identify Device (Continued)

See Note 1 for setting definitions

| Word | Bit(s) | Setting | Default Value | Description |
|------|--------|---------|--|--|
| 82 | | | | Command set supported |
| | 15 | X | 0b | Obsolete |
| | 14 | F | 1b | 1 = NOP command supported |
| | 13 | F | 1b | 1 = READ BUFFER command supported |
| | 12 | F | 1b | 1 = WRITE BUFFER command supported |
| | 11 | X | 0b | Obsolete |
| | 10 | F | 1b | 1 = Host Protected Area feature set supported |
| | 9 | F | 0b | 1 = DEVICE RESET command supported |
| | 8 | F | 0b | 1 = SERVICE interrupt supported |
| | 7 | F | 0b | 1 = Release interrupt supported |
| | 6 | F | 1b | 1 = Read look-ahead supported |
| | 5 | F | 1b | 1 = Write cache supported |
| | 4 | F | 0b | Shall be cleared to zero to indicate that the PACKET feature set is not supported. |
| | 3 | F | 1b | 1 = Mandatory Power Management feature set supported |
| | 2 | F | 0b | Obsolete |
| | 1 | F | 1b | 1 = Security feature set supported |
| 0 | F | 1b | 1 = SMART feature set supported | |
| 83 | | | | Command set supported |
| | 15 | F | 0b | Shall be cleared to zero |
| | 14 | F | 1b | Shall be set to one |
| | 13 | F | 1b | 1 = FLUSH CACHE EXT command supported |
| | 12 | F | 1b | 1 = Mandatory FLUSH CACHE command supported |
| | 11 | F | 1b | 1 = Device Configuration Overlay feature set supported |
| | 10 | F | 1b | 1 = 48-bit address feature set supported |
| | 9 | F | 0b | 1 = Automatic Acoustic Management feature set supported |
| | 8 | F | 1b | 1 = SET MAX security extension supported |
| | 7 | F | 0b | See Address Offset Reserved Area Boot INCITS TR27:2001 |
| | 6 | F | 0b | 1 = SET FEATURES subcommand required to spin-up after power-up |
| | 5 | F | 0b | 1 = Power-Up In Standby feature set supported |
| | 4 | F | 0b | Obsolete |
| | 3 | F | 1b | 1 = Advanced Power Management feature set supported |
| | 2 | F | 0b | 1 = CFA feature set supported |
| | 1 | F | 0b | 1 = READ/WRITE DMA QUEUED supported |
| 0 | F | 1b | 1 = DOWNLOAD MICROCODE command supported | |

Table 14: Identify Device (Continued)

See Note 1 for setting definitions

| Word | Bit(s) | Setting | Default Value | Description |
|------|--------|---------|---------------------------------------|--|
| 84 | | | | Command set/feature supported extension |
| | 15 | F | 0b | Shall be cleared to zero |
| | 14 | F | 1b | Shall be set to one |
| | 13 | F | 1b | 1 = IDLE IMMEDIATE with UNLOAD FEATURE supported |
| | 12 | F | 0b | Reserved for technical report INCITS TR-37-2004 (TLC) |
| | 11 | F | 0b | Reserved for technical report INCITS TR-37-2004 (TLC) |
| | 10–9 | F | 00b | Obsolete |
| | 8 | F | 1b | 1 = 64-bit word wide name supported |
| | 7 | F | 0b | 1 = WRITE DMA QUEUED FUA EXT command supported |
| | 6 | F | 1b | 1 = WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands supported |
| | 5 | F | 1b | 1 = General Purpose Logging feature set supported |
| | 4 | F | 0b | 1 = Streaming feature set supported |
| | 3 | F | 0b | 1 = Media Card Pass Through Command feature set supported |
| | 2 | F | 0b | 1 = Media serial number supported |
| | 1 | F | 1b | 1 = SMART self-test supported |
| 0 | F | 1b | 1 = SMART error logging supported | |
| 85 | | | | Command set/feature enabled. |
| | 15 | X | 0b | Obsolete |
| | 14 | F | 1b | 1 = NOP command supported |
| | 13 | F | 1b | 1 = READ BUFFER command supported |
| | 12 | F | 1b | 1 = WRITE BUFFER command supported |
| | 11 | X | 0b | Obsolete |
| | 10 | V | 1b | 1 = Host Protected Area feature set enabled |
| | 9 | F | 0b | 1 = DEVICE RESET command supported |
| | 8 | V | 0b | 1 = SERVICE interrupt enabled |
| | 7 | V | 0b | 1 = Release interrupt enabled |
| | 6 | V | 1b | 1 = Look-ahead enabled |
| | 5 | V | 1b | 1 = Write cache enabled |
| | 4 | F | 0b | Shall be cleared to zero to indicate that the PACKET feature set is not supported. |
| | 3 | F | 1b | Power Management feature set is enabled |
| | 2 | F | 0b | Obsolete |
| 1 | V | 0b | 1 = Security Mode feature set enabled | |
| 0 | V | 1b | 1 = SMART feature set enabled | |

Table 14: Identify Device (Continued)

See Note 1 for setting definitions

| Word | Bit(s) | Setting | Default Value | Description |
|------|--------|---------|---|---|
| 86 | | | | Command set/feature enabled. |
| | 15 | | 1b | 1 = Words 120-119 are valid |
| | 14 | F | 0b | 1 = Reserved |
| | 13 | F | 1b | 1 = FLUSH CACHE EXT command supported |
| | 12 | F | 1b | 1 = FLUSH CACHE command supported |
| | 11 | F | 1b | 1 = Device Configuration Overlay supported |
| | 10 | F | 1b | 1 = 48-bit Address features set supported |
| | 9 | V | 0b | 1 = Automatic Acoustic Management feature set enabled |
| | 8 | F | 0b | 1 = SET MAX security enabled by SET MAX SET PASSWORD |
| | 7 | F | 0b | Reserved for address Offset Reserved Area Boot, INCITS TR27:2001 |
| | 6 | F | 0b | 1 = SET FEATURES subcommand required to spin-up after power-up |
| | 5 | V | 0b | 1 = Power-Up In Standby feature set enabled |
| | 4 | V | 0b | Obsolete |
| | 3 | V | 1b | 1 = Advanced Power Management feature set enabled |
| | 2 | F | 0b | 1 = CFA feature set supported |
| 1 | F | 0b | 1 = READ/WRITE DMA QUEUED command supported | |
| 0 | F | 1b | 1 = DOWNLOAD MICROCODE command supported | |
| 87 | | | | Command set/feature enabled/supported |
| | 15 | F | 0b | Shall be cleared to zero |
| | 14 | F | 1b | Shall be set to one |
| | 13 | F | 1b | 1 = IDLE IMMEDIATE with UNLOAD FEATURE supported |
| | 12 | V | 0b | Reserved for technical report- INCITS tr-37-2004 (TLC) |
| | 11 | V | 0b | Reserved for technical report- INCITS TR-37-2004 (TLC) |
| | 10-9 | F | 00b | Obsolete |
| | 8 | F | 1b | 1 = 64-bit word wide name supported |
| | 7 | F | 0b | 1 = WRITE DMA QUEUED FUA EXT command supported |
| | 6 | F | 1b | 1 = WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands supported |
| | 5 | F | 1b | 1 = General Purpose Logging feature set supported |
| | 4 | V | 0b | Obsolete |
| | 3 | V | 0b | 1 = Media Card Pass Through Command feature set supported |
| | 2 | V | 0b | 1 = Media serial number is valid |
| | 1 | F | 1b | 1 = SMART self-test supported |
| 0 | F | 1b | 1 = SMART error logging supported | |

Table 14: Identify Device (Continued)

See Note 1 for setting definitions

| Word | Bit(s) | Setting | Default Value | Description |
|------|--------|---------|-----------------------------------|--|
| 88 | | | 0b | Ultra DMA modes |
| | 15 | | 0b | Reserved |
| | 14 | | 0b | 1 = Ultra DMA mode 6 is selected 0 = Ultra DMA mode 6 is not selected |
| | 13 | | 0b | 1 = Ultra DMA mode 5 is selected 0 = Ultra DMA mode 5 is not selected |
| | 12 | | 0b | 1 = Ultra DMA mode 4 is selected 0 = Ultra DMA mode 4 is not selected |
| | 11 | | 0b | 1 = Ultra DMA mode 3 is selected 0 = Ultra DMA mode 3 is not selected |
| | 10 | | 0b | 1 = Ultra DMA mode 2 is selected 0 = Ultra DMA mode 2 is not selected |
| | 9 | | 0b | 1 = Ultra DMA mode 1 is selected 0 = Ultra DMA mode 1 is not selected |
| | 8 | | 0b | 1 = Ultra DMA mode 0 is selected 0 = Ultra DMA mode 0 is not selected |
| | 7 | | 0b | Reserved |
| | 6 | | 1b | 1 = Ultra DMA mode 6 and below are supported |
| | 5 | | 1b | 1 = Ultra DMA mode 5 and below are supported |
| | 4 | | 1b | 1 = Ultra DMA mode 4 and below are supported |
| | 3 | | 1b | 1 = Ultra DMA mode 3 and below are supported |
| | 2 | | 1b | 1 = Ultra DMA mode 2 and below are supported |
| | 1 | | 1b | 1 = Ultra DMA mode 1 and below are supported |
| 0 | | 1b | 1 = Ultra DMA mode 0 IS supported | |
| 89 | | (O)F | 0001h | Time required for security erase unit completion |
| 90 | | (O)F | 0001h | Time required for enhanced security erase completion |
| 91 | | (O)V | 00FEh | Current advanced power management value |
| 92 | | (O)V | FFFEh | Master Password Revision Code |

Table 14: Identify Device (Continued)

See Note 1 for setting definitions

| Word | Bit(s) | Setting | Default Value | Description |
|------|--------|---------|--|--|
| 93 | | | | Shall be 0000h for SATA devices |
| | 15 | | 0b | Shall be cleared to zero |
| | 14 | | 0b | Shall be set to one |
| | 13 | | 0b | 1 = Device detected CBLID-above V_{IH} 0 = device detected CBLID-below V_{IL} |
| | | | | Device 1 hardware reset result Device 0 shall clear these bits to zero Device 1 shall set these bits as follows: |
| | 12 | | 0b | Reserved |
| | 11 | | 0b | 0 = Device 1 did not assert PDIAG- 1 = Device 1 asserted PDIAG- |
| | 10–9 | | | These bits indicate how Device 1 determined the device number: 00 = Reserved 01 = a jumper was used 10 = the CSEL signal was used 11 = some other method was used or the method is unknown |
| | 8 | | 0b | Shall be set to one |
| | | | | Device 0 hardware reset result. Device 1 shall clear these bits to zero. Device 0 shall set these bits as follows: |
| | 7 | | 0b | Reserved |
| | 6 | | 0b | 0 = Device 0 does not respond when Device 1 is selected. 1 = Device 0 responds when Device 1 is selected. |
| | 5 | | 0b | 0 = Device 0 did not detect the assertion of DASP- 1 = Device 0 detected the assertion of DASP- |
| | 4 | | 0b | 0 = Device 0 did not detect the assertion of PDIAG- 1 = Device 0 detected the assertion of PDIAG- |
| | 3 | | 0b | 0 = Device 0 failed diagnostics. 1 = Device 0 passed diagnostics. |
| 2–1 | | | These bits indicate how Device 0 determined the device number: 00 = Reserved 01 = a jumper was used 10 = the CSEL signal was used 11 = some other method was used or the method is unknown | |
| 0 | | | 00b | Shall be set to one |
| 94 | 15–8 | F | 00h | Vendor's recommended acoustic management value |
| | 7–0 | V | 00h | Current automatic acoustic management value |
| 95 | | (O)V | 0000h | Stream Minimum Request Size |

Table 14: Identify Device (Continued)

See Note 1 for setting definitions

| Word | Bit(s) | Setting | Default Value | Description |
|------|--------|---------|----------------------------|--|
| 96 | | (O)V | 0000h | Streaming Transfer Time – DMA |
| 97 | | (O)V | 0000h | Streaming Access Latency – DMA and PIO |
| 98 | | (O)F | 0000h 0000h | Streaming Performance Granularity (98-99) |
| 100 | | V | Varies by capacity | Maximum user LBA for 48-bit Address feature set |
| 104 | | (O)V | 0000h | Streaming Transfer Time – PIO |
| 105 | | ()F | 0008h | Maximum number of 512-byte blocks of LBA Range Entries per DATA SET MANAGEMENT command |
| 106 | | | | Physical sector size/logical sector size |
| | 15 | F | 0b | Shall be cleared to zero |
| | 14 | F | 1b | Shall be set to one |
| | 13 | F | 1b | 1 = Device has multiple logical sectors per physical sector |
| | 12 | F | 0b | 1 = Device logical sector longer than 256 words |
| | 11-4 | F | 00000000b | Reserved |
| | 3-0 | F | 0011b | 2 ^x logical sectors per physical sector |
| 107 | | (O)F | 0000h | Inter-seek delay for ISO-7779 acoustic testing in microseconds |
| 108 | 15-12 | F | 0101b | NAA (3-0) |
| | 11-0 | | 000000001010b | IEEE OUI (23-12) |
| 109 | 15-4 | F | 000001110101b | IEEE OUI (11-0) |
| | 3-0 | | Varies | Unique ID (35-32) |
| 110 | | (M)F | Varies | 5-0 Unique ID (31-16) |
| 111 | | (M)F | Varies | Unique ID (15-0) |
| 112 | | (O)F | 0000h 0000h 0000h 0000h | Reserved for 12- bit word-wide name extension to 128 bits |
| 116 | | (O)V | 0000h | Reserved for INCITS TR-37-2004 |
| 117 | | (O)F | 0000h 0000h | Words per Logical Sector |

Table 14: Identify Device (Continued)

See Note 1 for setting definitions

| Word | Bit(s) | Setting | Default Value | Description |
|------|--------|---------|---|---|
| 119 | | | | Commands and feature sets supported (continued from words 84–82) |
| | 15 | F | 0b | Shall be cleared to zero |
| | 14 | F | 1b | Shall be set to one |
| | 13–8 | F | 00000000b | Reserved |
| | 7 | F | 0b | 1 = Extended Power Conditions feature set is supported |
| | 6 | F | 0b | 1 = Extended Status Reporting feature set is supported |
| | 5 | F | 0b | 1 = Free-fall control feature set is supported |
| | 4 | F | 1b | 1 = The DOWNLOAD MICROCODE command with mode 3 is supported |
| | 3 | F | 1b | 1 = READ LOG DMA EXT and WRITE LOG DMA EXT commands are supported |
| | 2 | F | 1b | 1 = The WRITE UNCORRECTABLE EXT command is supported |
| | 1 | F | 1b | 1 = The Write-Read-Verify feature set is supported |
| | 0 | F | 0b | Reserved for DDT |
| 120 | | | | Commands and feature sets supported or enabled (continued from words 87–85) |
| | 15 | | 0b | Shall be cleared to zero |
| | 14 | | 1b | Shall be set to one |
| | 13–6 | | 00000000b | Reserved |
| | 5 | | 0b | 1 = Free-fall control feature set is enabled |
| | 4 | | 1b | 1 = The DOWNLOAD MICROCODE command with mode 3 is supported |
| | 3 | | 1b | 1 = The READ LOG DMA EXT and WRITE LOG DMA EXT commands are supported |
| | 2 | | 1b | 1 = The WRITE UNCORRECTABLE EXT command is supported |
| | 1 | | 0b | 1 = The Write-Read-Verify feature set is enabled |
| 0 | | 0b | 1 = Feature set "Disable Data Transfer After Error Detection" is enabled 0 = Feature set "Disable Data Transfer After Error Detection" is disabled | |
| 121 | | F | 0000h 0000h 0000h 0000h 0000h 0000h | Reserved for expanded supported and enabled settings |
| 127 | | (O) | 0000h | Obsolete |

Table 14: Identify Device (Continued)

See Note 1 for setting definitions

| Word | Bit(s) | Setting | Default Value | Description |
|---------|--------|---------|--|---|
| 128 | | | | Security status |
| | 15–9 | F | 0000000b | Reserved |
| | 8 | V | 0b | Security level 0 = High, 1 = Maximum |
| | 7–6 | F | 00b | Reserved |
| | 5 | F | 1b | 1 = Enhanced security erase supported |
| | 4 | V | 0b | 1 = Security count expired |
| | 3 | V | 0b | 1 = Security frozen |
| | 2 | V | 0b | 1 = Security locked |
| | 1 | V | 0b | 1 = Security enabled |
| 0 | F | 1b | 1 = Security supported | |
| 129–159 | | ()X | Vendor specific data | Vendor specific |
| 160 | | | | CFA power mode 1 |
| | 15 | F | 0b | Word 160 supported |
| | 14 | F | 0b | Reserved |
| | 13 | F | 0b | CFA power mode 1 is required for one or more commands implemented by the device |
| | 12 | V | 0b | CFA power mode 1 disabled |
| | 11–0 | F | 000000000000b | Maximum current in ma |
| 161 | | X | 0000h 0000h 0000h 0000h 0000h 0000h 0000h | Reserved for assignment by the CompactFlash Association |
| 168 | 15–4 | F | 000h | Reserved |
| | 3–0 | F | 5h | Device Nominal Form Factor |
| 169 | | | | DATA SET MANAGEMENT command support |
| | 15–1 | F | 0000000000000000b | Reserved |
| | 0 | F | 1b | 1 = The Trim bit in the DATA SET MANAGEMENT command is supported |
| 170 | | F | 0000h 0000h 0000h 0000h | Additional product identifier |
| 174 | | F | 0000h 0000h | Reserved |
| 176 | | (O)V | Varies | Current media serial number (60 ASCII characters) |

Table 14: Identify Device (Continued)

See Note 1 for setting definitions

| Word | Bit(s) | Setting | Default Value | Description |
|------|--------|---------|---------------------------------|---|
| 206 | | | | SCT Command Transport |
| | 15-12 | X | 0000b | Vendor-specific |
| | 11-6 | F | 000000b | Reserved |
| | 5 | F | 1b | SCT Command Transport Data Tables supported |
| | 4 | F | 1b | SCT Command Transport Features Control supported |
| | 3 | F | 0b | SCT Command Transport Error Recovery Control supported |
| | 2 | F | 1b | SCT Command Transport Write Same supported |
| | 1 | F | 0b | Obsolete |
| 0 | F | 1b | SCT Command Transport supported | |
| 207 | | ()F | 0000h 0000h | Reserved for CE-ATA |
| 209 | | (O) | | Alignment of logical blocks within a larger physical block |
| | 15 | F | 0b | Shall be cleared to zero |
| | 14 | F | 1b | Shall be set to one |
| | 13-0 | F | 00000000000000b | Logical sector offset within the first physical sector where the first logical sector is placed |
| 210 | | (O)V | 0000h 0000h | Write-Read-Verify Sector Count Mode 3 Only |
| 212 | | (O)F | 0000h 0000h | Verify Sector Count Mode 2 Only |
| 214 | | (O) | | NV Cache Capabilities |
| | 15-12 | F | 0000b | NV Cache feature set version |
| | 11-8 | F | 0000b | NV Cache Power Mode feature set version |
| | 7-5 | F | 000b | Reserved |
| | 4 | V | 0b | 1 = NV Cache feature set enabled |
| | 3-2 | F | 00b | Reserved |
| | 1 | V | 0b | 1 = NV Cache Power Mode feature set enabled |
| | 0 | F | 0b | 1 = NV Cache Power Mode feature set supported |
| 215 | | (O)V | 0000h | NV Cache Size in Logical Blocks (LSW) |
| 216 | | (O)V | 0000h | NV Cache Size in Logical Blocks (MSW) |
| 217 | | (M)F | 0001h | Nominal media rotation rate (ATA8-ACS 1699-D Revision 6) |
| 218 | | (O)V | 0000h | Reserved |
| 219 | | | | NV Cache Options |
| | 15-8 | F | 00h | Reserved |
| | 7-0 | F | 00h | Device Estimated Time to Spin Up in Seconds |
| 220 | 15-8 | F | 00h | Reserved |
| | 7-0 | V | 00h | Write-Read-Verify feature set current mode |
| 221 | | | 0000h | Reserved |

Table 14: Identify Device (Continued)

See Note 1 for setting definitions

| Word | Bit(s) | Setting | Default Value | Description |
|------|--------|---------|--|---|
| 222 | | | | Transport Major revision number. 0000h or FFFFh = device does not report version |
| | 15–12 | | 0001b | Transport Type - 0 = Parallel, 1 = Serial, 2-15 = Reserved Parallel (Type = 0) Serial (Type = 1) |
| | 11–7 | | 000000b | Reserved Reserved |
| | 6 | | 1b | Supports SATA Rev 3.1 |
| | 5 | | 1b | Supports SATA Rev 3.0 |
| | 4 | | 1b | Supports SATA Rev 2.6 |
| | 3 | | 1b | Supports SATA Rev 2.5 |
| | 2 | | 1b | Supports SATA II: Extensions |
| | 1 | | 1b | Supports SATA 1.0a |
| | 0 | | 1b | Supports ATA8-APT ATA8-AST |
| 223 | | (M)F | 0000h | Transport Minor revision number |
| 224 | | ()F | 0000h 0000h 0000h 0000h 0000h 0000h 0000h 0000h 0000h 0000h | Reserved for CE-ATA |
| 234 | | (O)F | 0001h | Minimum number of 512 byte units per DOWNLOAD MICROCODE command for mode 3 |
| 235 | | | 00FFh | Maximum number of 512 byte units per DOWNLOAD MICROCODE command for mode 3 |
| 236 | | | 0000h 0000h 0000h 0000h 0000h 0000h 0000h | Reserved |
| 243 | | | 4000h | Bit 14 = 1; Supports FDE security features |
| 244 | | | 0000h 0000h 0000h 0000h 0000h 0000h 0000h 0000h 0000h 0000h 0000h | Reserved |
| 255 | | (M)F | | Integrity word |
| | 15–8 | | varies | Checksum |
| | 7–0 | | A5h | Signature |

- Note: 1. F = The content of the word is fixed and does not change.
 V = The content of the word is 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.
 R = The content of the word is reserved and will be zero.

Commands

Table 15: Supported ATA Command Set

See ATA-8 standard for command details

| Command Name | Command Code (hex) |
|------------------------------------|--|
| CHECK POWER MODE | 98h or E5h |
| DEVICE CONFIGURATION RESTORE | B1h/C1h |
| DEVICE CONFIGURATION FREEZE LOCK | B1h/C3h |
| DEVICE CONFIGURATION IDENTIFY | B1h/C1h |
| DEVICE CONFIGURATION SET | B1h/C3h |
| DOWNLOAD MICROCODE | 92h |
| EXECUTE DEVICE DIAGNOSTIC | 90h |
| FLUSH CACHE | E7h |
| FLUSH CACHE EXT | EAh |
| IDENTIFY DEVICE | ECh |
| IDLE | E3h or 97h |
| IDLE IMMEDIATE | E1h or 95h |
| INITIALIZE DEVICE PARAMETERS | 91h |
| NOP | 00h |
| READ BUFFER | E4h |
| READ DMA (with retry) | C8h |
| READ DMA (without retry) | C9h |
| READ DMA EXT | 25h |
| READ FPDMA QUEUED | 60h |
| READ LOG EXT | 2Fh |
| READ MULTIPLE | C4h |
| READ MULTIPLE EXT | 29h |
| READ NATIVE MAX ADDRESS | F8h |
| READ NATIVE MAX ADDRESS EXT | 27h |
| READ SECTOR(S) EXT | 24h |
| READ SECTOR(S) (with retry) | 20h |
| READ SECTOR(S) (without retry) | 21h |
| READ VERIFY SECTOR EXT | 42h |
| READ VERIFY SECTOR(S) (with retry) | 40h |
| RECEIVE FPDMA QUEUED | 65h |
| SANITIZE DEVICE | B4h |
| SCT WRITE SAME | 02h/0001h 02h/0002h 02h/0101h 02h/0102h |
| SCT RETURN ERROR RECOVERY CONTROL | 030h/01h |
| SCT SET ERROR RECOVERY CONTROL | 03h/01h |

Table 15: Supported ATA Command Set (Continued)

See ATA-8 standard for command details

| Command Name | Command Code (hex) |
|----------------------------------|--------------------|
| SCT SET FEATURE CONTROL | 04h/01h |
| SCT RETURN FEATURE CONTROL | 04h/02h |
| SCT RETURN FEATURE OPTION FLAG | 04h/03h |
| SCT RETURN SCT DATA TABLE | 05h/01h |
| SECURITY DISABLE PASSWORD | F6h |
| SECURITY ERASE PREPARE | F3h |
| SECURITY ERASE UNIT | F4h |
| SECURITY FREEZE LOCK | F5h |
| SECURITY SET PASSWORD | F1h |
| SECURITY UNLOCK | F2h |
| SEEK | 7xh |
| SEND FPDMA QUEUED | 64h |
| SET FEATURES | EFh |
| SET MAX ADDRESS | F9h |
| SET MAX – FREEZE LOCK | F9h/04h |
| SET MAX – LOCK | F9h/02h |
| SET MAX ADDRESS EXT | 37h |
| SET MULTIPLE MODE | C6h |
| SET MAX – SET PASSWORD | F9h/01h |
| SET MAX – UNLOCK | F9h/03h |
| SLEEP | E6h or 99h |
| SMART DISABLE OPERATIONS | B0h/D9h |
| SMART ENABLE OPERATIONS | B0h/D8h |
| SMART ENABLE/DISABLE AUTOSAVE | B0h/D2h |
| SMART EXECUTE OFF-LINE IMMEDIATE | B0h/D4h |
| SMART READ DATA | B0h/D0h |
| SMART READ LOG SECTOR | B0h/D5h |
| SMART RETURN STATUS | B0h/DAh |
| SMART WRITE LOG | B0h/D6h |
| STANDBY | E2h or 96h |
| STANDBY IMMEDIATE | E0h or 94h |
| TRUSTED NON-DATA | 5Bh |
| TRUSTED RECEIVE | 5Ch |
| TRUSTED RECEIVE DMA | 5Dh |
| TRUSTED SEND | 5Eh |
| TRUSTED SEND DMA | 5Fh |
| WRITE BUFFER | E8h |

Table 15: Supported ATA Command Set (Continued)

See ATA-8 standard for command details

| Command Name | Command Code (hex) |
|------------------------------|---------------------------|
| WRITE DMA (with retry) | CAh |
| WRITE DMA (without retry) | CBh |
| WRITE DMA EXT | 35h |
| WRITE DMA FUA EXT | 3Dh |
| WRITE FPDMA QUEUED | 61h |
| WRITE LOG EXT | 3Fh |
| WRITE MULTIPLE | C5h |
| WRITE MULTIPLE EXT | 39h |
| WRITE MULTIPLE FUA EXT | CEh |
| WRITE SECTOR(S) (with retry) | 30h |
| WRITE SECTOR(S) EXT | 34h |
| WRITE UNCORRECTABLE EXT | 45h |

Compliance

Micron SSDs comply with the following:

- RoHS “green”
- CE (Europe): EN55022, 2006 Class B and EN55024, 1998 + A1: 2001 + A2:2003
- FCC: CFR Title 47, Part 15, ICES-003, all Class B
- UL (US): approval to UL-60950-1, 2nd Edition, 2007-03-27, IEC 60950-1:2005, 2nd Edition
- BSMI (Taiwan): approval to CNS 13438
- C-TICK (Australia, New Zealand): approval to AS/NZS CISPR22
- KCC RRL (Korea): approval to KCC MU2-C30025, KCC MU2-C30018 Class B
- W.E.E.E.: Compliance with EU WEEE directive 2002/96/EC. Additional obligations may apply to customers who place these products in the markets where WEEE is enforced.
- TUV (Germany): approval to IEC60950/EN60950
- V_{CCI}
- IC (Canada):
 - This Class B digital apparatus complies with Canadian ICES-003.
 - Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.

FCC Rules

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Package Dimensions

Figure 4: M.2 Type 2280 Package – 64GB, 128GB, and 256GB

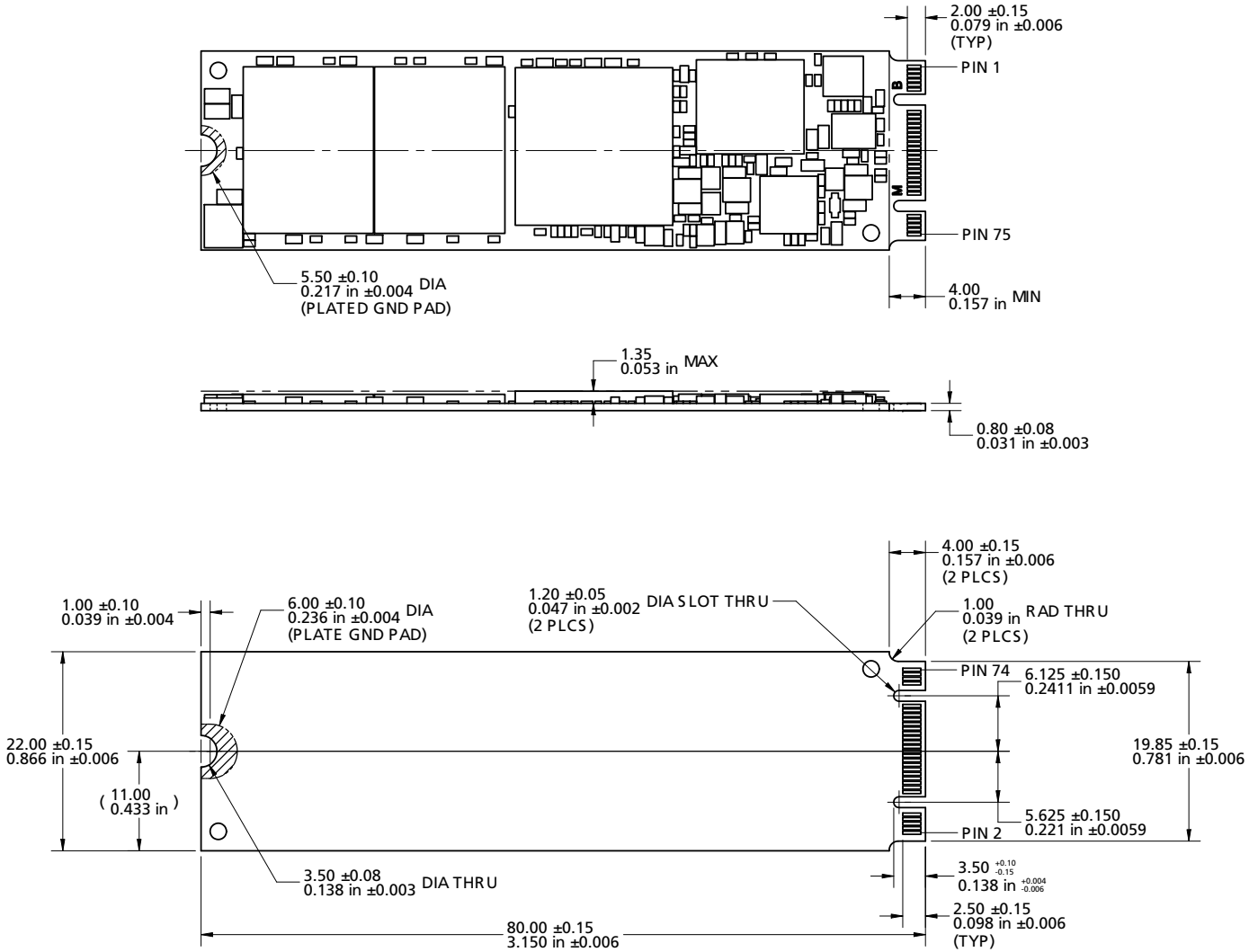
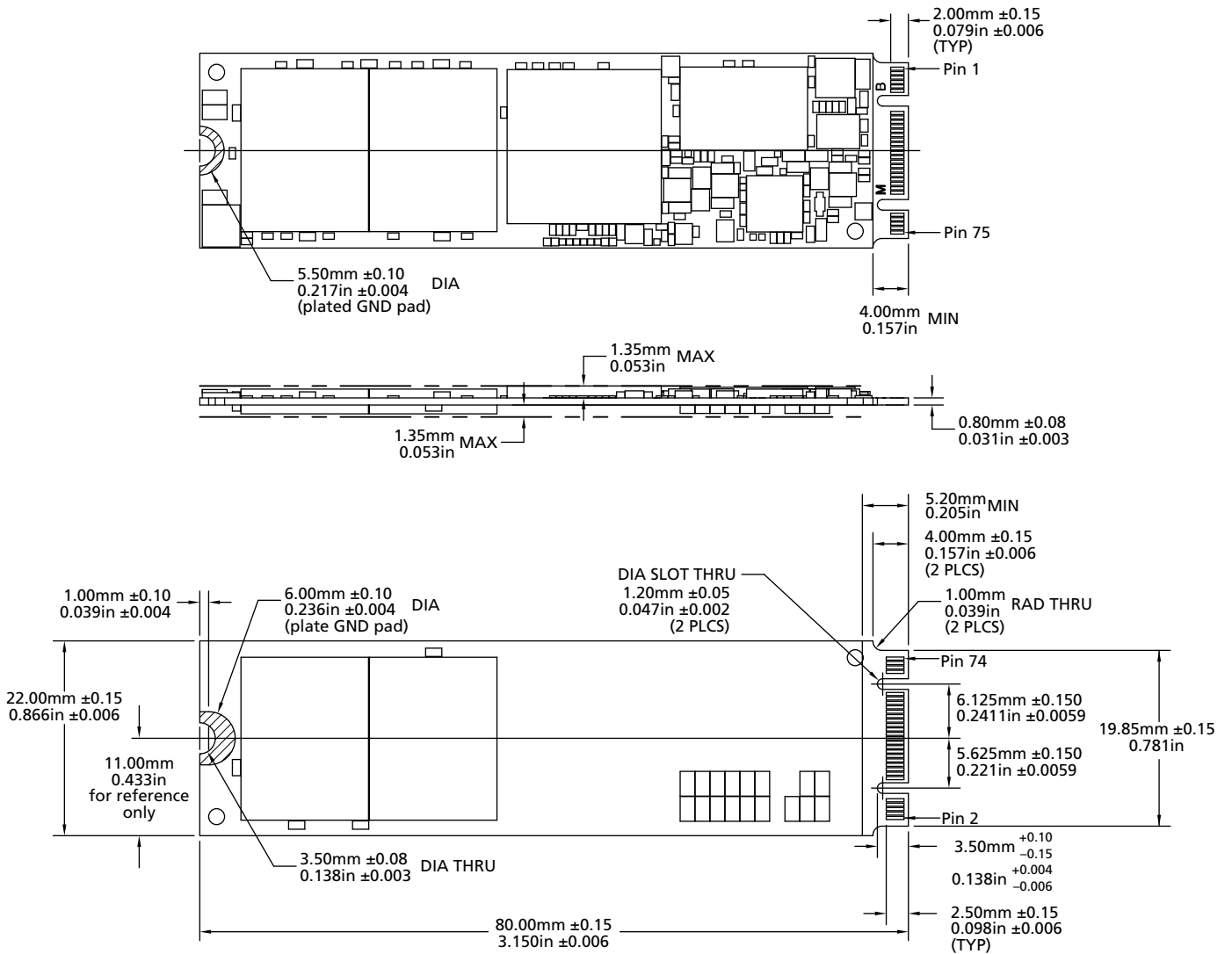


Figure 5: M.2 Type 2280 Package – 512GB



References

- Serial ATA: High-speed serialized AT attachment, Serial ATA working group, available at www.sata-io.org
- SATA 3.1 GOLD, and the following:
 - DEVSLP, SATA31_TPR_C108 rev. 1.0a 10/24/2011
 - SATA TP #37, Standard SATA Connector 3.3V Power Pin Assignments, Rev. 1.1 10/12/2011
 - SATA TP #39, DEVSLP Assignment on Standard SATA Connector, Rev. 01 01/02/12
- ATA-8 ACS2 (T13/2015-D, Revision 4), and the following:
 - Device Internal Logs (supports SSD Telemetry)
 - IDFY Device Data Logs (supports DEVSLP)
- PCI Express M.2 Specification, Revision 0.7a, Version 1.0, 01/02/13
- TCG Storage Security Subsystem Class Opal; Specification 2.00 Revision 1.00, Feb 24, 2012
- TCG Core Specification; Specification 2.00 Revision 2.00, Nov 4, 2011
- TCG Storage Interface Interactions: Specification Version 1.02 Revision 1.00 30 December, 2011
- IEEE-1667: "Standard Protocol for Authentication in Host Attachments of Transient Storage Devices"

Revision History

Rev. F – 8/14

- Added note 2 and note 4 to Table 7: Drive Lifetime – Client Computing

Rev. E – 2/14

- Changed operating temperature specification from "ambient temperature" to "case temperature"
- Added footnote to Maximum Ratings table explaining best practices for measuring device temperature
- Changed Random 4KB READ: from 90,000 IOPS to 95,000 IOPS and Random 4KB WRITE: from 90,000 to 85,000 IOPS
- Changed Random read (4KB transfer) to 85,000 for 64GB, 90,000 for 128GB, 90,000 for 256GB, and 95,000 for 512GB in the Drive Performance table
- Corrected typo in Dimensions and Weight table title, 4/29/14

Rev. D – 11/13

- To Production status
- Updated Identify Device
- Updated Adaptive Thermal Monitoring

Rev. C – 9/13

- Added a power cycle note to thermal monitoring

Rev. B – 8/13

- Updated Active MAX values in SATA Power Consumption in Electrical Specifications

Rev. A – 6/13

- Initial release.

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[SM8V4-240G-SCC](#) [96FD25-ST512G-M13](#) [VSFCM8CI960G](#) [MTFDDAK060MBD-1AH12ITYY](#)