# P1 M.2 2280 NVMe/PCIe NAND Flash SSD

## CT500P1SSD8, CT1000P1SSD8, CT2000P1SSD8

## Features

- Micron® 3D QLC NAND Flash
- RoHS-compliant package
- NVMe/PCIe Gen3 x4 Interface
- Industry-standard, 512-byte sector size support
- NVMe low power states supported
- Native command queuing support with 256-command support
- NVMe-standard self-monitoring, analysis, and reporting technology (SMART) command set
- Power loss protection for data-at-rest
- Performance[1]
  - Sequential 128KB READ: Up to 2000 MB/s
  - Sequential 128KB WRITE: Up to 1750 MB/s
- Reliability
  - MTTF: 1.8 million device hours[2]
- Static and dynamic wear leveling
- Low power consumption
  - 100mW TYP[3]
- Endurance – total bytes written (TBW)
  - Up to 400TB
- Capacity (unformatted): 500GB, 1000GB and 2000GB
- M.2, 22mm x 80mm form factor
- Operating Temperature
  - Commercial (0°C to 70°C)[4]
- Digitally Signed Firmware

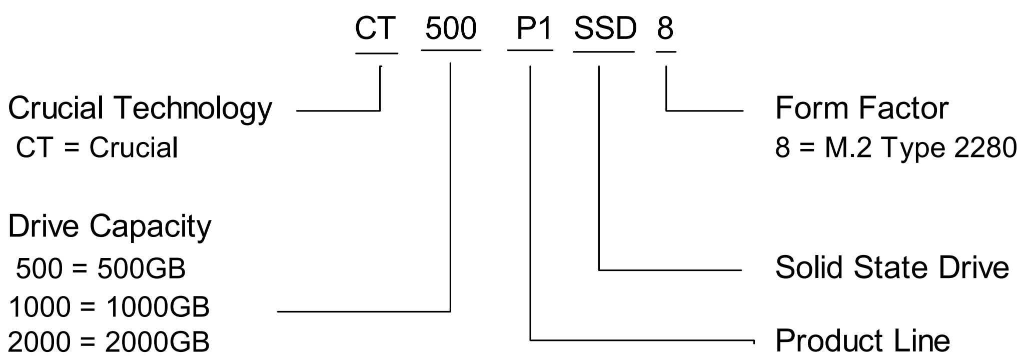
Notes: 1. Typical I/O performance numbers as measured fresh-out-of-the-box (FOB) using CrystalDiskMark with write cache enabled.
2. The product achieves a mean time to failure (MTTF) based on population statistics not relevant to individual units.
3. Active average power measured during execution of MobileMark® 2014
4. Temperature is recorded and displayed at SMART offset 1, and is best read by the Crucial Storage Executive Software.

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

## Part Numbering Information

The SSD is available under Micron's Crucial brand in different configurations and densities. The chart below is a comprehensive list of options for the P1 series devices; not all options listed can be combined to define an offered product.

### Figure 1: Part Number Chart

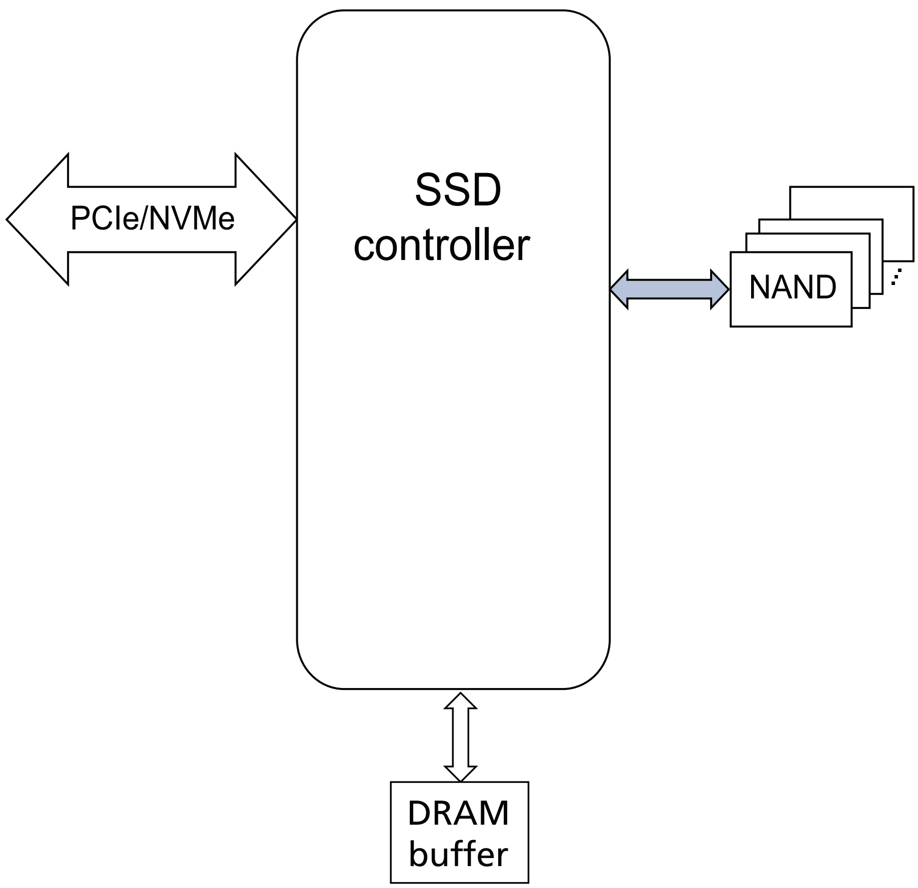


## General Description

Micron's solid state drive (SSD) uses a single-chip controller with a NVMe/PCIe interface on the system side and 4-channels of Micron NAND Flash internally. The SSD integrates easily in existing storage infrastructures.

The SSD is designed to use the NVMe/PCIe 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.

**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 (LBA1-03), are shown below.

### Table 1: Standard LBA Settings

| Capacity | Total LBA | | Max LBA | | User Available Bytes |
|---|---|---|---|---|---|
| | Decimal | Hexadecimal | Decimal | Hexadecimal | (Unformatted) |
| 500 | 976,773,168 | 3A386030 | 976,773,167 | 3A38602F | 500,107,862,016 |
| 1000 | 1,953,525,168 | 74706DB0 | 1,953,525,167 | 74706DAF | 1,000,204,886,016 |
| 2000 | 3,907,029,168 | E8E088B0 | 3,907,029,167 | E8E088AF | 2,000,398,934,016 |

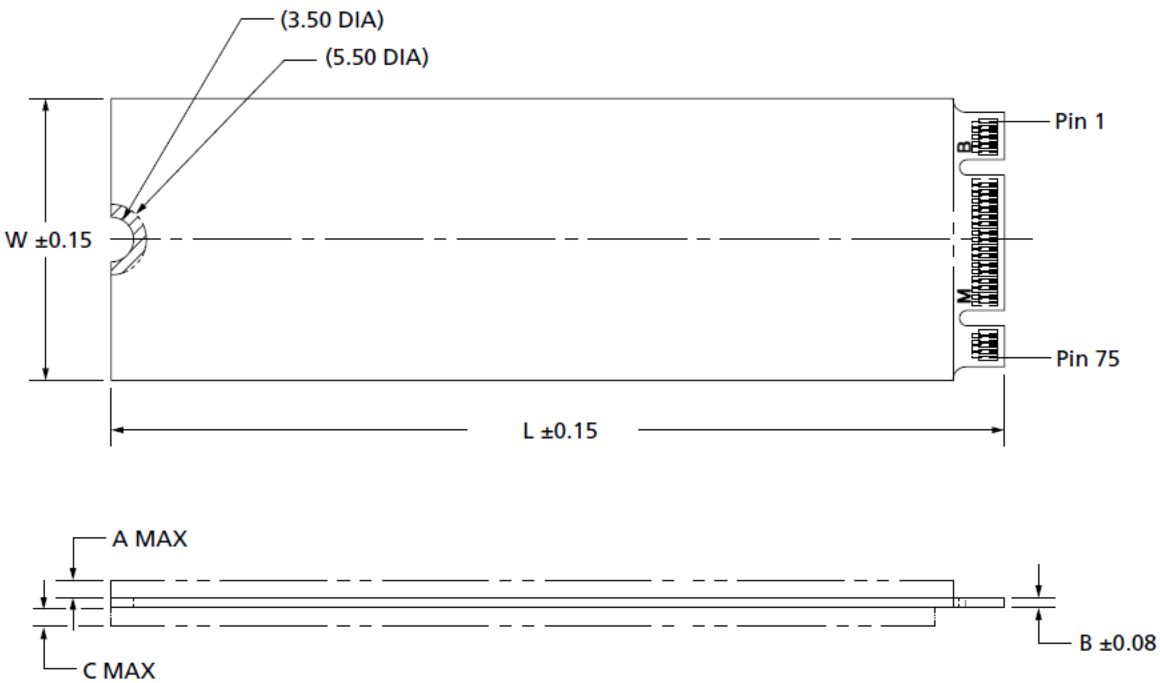
# Physical Configuration

## M.2 2280 (22mm x 80mm)

Product mass: less than 10 grams

Physical dimensions conform to the applicable form factor specifications as listed in the figure below.

**Figure 3: M.2 Type 2280 Package**




Notes: 1. All dimensions are in millimeters.

**Table 2: M.2 Type 2280 Package Dimensions**

| Capacity (GB) | Specification | W | L | A | B | C | Unit |
|---|---|---|---|---|---|---|---|
| 500 | S2 | 22.00 | 80.00 | 1.35 | 0.80 | 1.50 | mm |
| 1000 | | | | | | | |
| 2000 | D3 | | | | | | |

Notes: 1. Dimension values in millimeter per SFF 8201 Rev. 3.3.

# Interface Connectors

**Figure 4: SSD Interface Connections M.2 Type 2280**

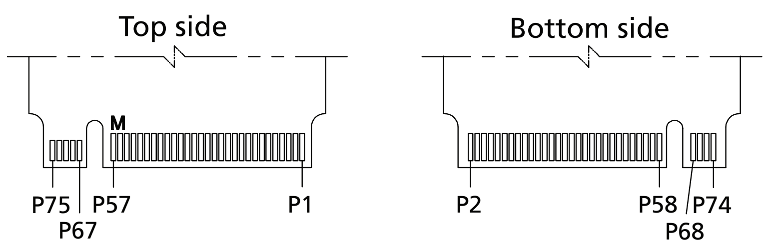



**Table 3: Signal Assignments**

| Top Side | | | Bottom Side | | |
|---|---|---|---|---|---|
| **Pin#** | **Signal Name** | **Description** | **Pin#** | **Signal Name** | **Description** |
| 1 | GND | Ground | 2 | 3.3V | +3.3V |
| 3 | GND | Ground | 4 | 3.3V | +3.3V |
| 5 | PETn3 | PCIe TX– Lane 3 | 6 | NC6 | No connect |
| 7 | PETp3 | PCIe TX+ Lane 3 | 8 | NC8 | No connect |
| 9 | GND | Ground | 10 | DAS | Drive activity signal |
| 11 | PERn3 | PCIe RX– Lane 3 | 12 | 3.3V | +3.3V |
| 13 | PERp3 | PCIe RX+ Lane 3 | 14 | 3.3V | +3.3V |
| 15 | GND | Ground | 16 | 3.3V | +3.3V |
| 17 | PETn2 | PCIe TX– Lane 2 | 18 | 3.3V | +3.3V |
| 19 | PETp2 | PCIe TX+ Lane 2 | 20 | NC20 | No connect |
| 21 | GND | Ground | 22 | NC22 | No connect |
| 23 | PERn2 | PCIe RX– Lane 2 | 24 | NC24 | No connect |
| 25 | PERp2 | PCIe RX+ Lane 2 | 26 | NC26 | No connect |
| 27 | GND | Ground | 28 | NC28 | No connect |
| 29 | PETn1 | PCIe TX– Lane 1 | 30 | NC30 | No connect |
| 31 | PETp1 | PCIe TX+ Lane 1 | 32 | NC32 | No connect |
| 33 | GND | Ground | 34 | NC34 | No connect |
| 35 | PERn1 | PCIe RX– Lane 1 | 36 | NC36 | No connect |
| 37 | PERp1 | PCIe RX+ Lane 1 | 38 | NC38 | No connect |
| 39 | GND | Ground | 40 | NC40 | No connect |
| 41 | PETn0 | PCIe TX– Lane 0 | 42 | NC42 | No connect |
| 43 | PETp0 | PCIe TX+ Lane 0 | 44 | NC44 | No connect |
| 45 | GND | Ground | 46 | NC46 | No connect |
| 47 | PERn0 | PCIe RX– Lane 0 | 48 | NC48 | No connect |
| 49 | PERp0 | PCIe RX+ Lane 0 | 50 | PERST# | PERST# |
| 51 | GND | Ground | 52 | CLKREQ# | CLKREQ# |

**Table 3: Signal Assignments (Continued)**

| Top Side | | | Bottom Side | | |
|---|---|---|---|---|---|
| **Pin#** | **Signal Name** | **Description** | **Pin#** | **Signal Name** | **Description** |
| 53 | REFCLKn | PCIe REFCLK– | 54 | PEWAKE# | No connect |
| 55 | REFCLKp | PCIe REFCLK+ | 56 | MFG_DATA | Reserved |
| 57 | GND | Ground | 58 | MFG_CLOCK | Reserved |
| Mechanical M Key | | | Mechanical M Key | | |
| 67 | NC67 | No Connect | 68 | SUSCLK | No connect |
| 69 | PEDET | No Connect | 70 | 3.3V | +3.3V |
| 71 | GND | Ground | 72 | 3.3V | +3.3V |
| 73 | GND | Ground | 74 | 3.3V | +3.3V |
| 75 | GND | Ground | 0 | 0 | 0 |

## Performance

Measured performance can vary for a number of reasons. The major factors affecting drive performance are the capacity of the drive, the host computer's storage controller and drivers. Additionally, overall system performance can affect the measured drive performance. When comparing drives, it is recommended that all system variables are held constant, with only the drive under test changing.

Performance numbers will also vary depending on the host system configuration, as CPU speed and memory configuration may affect storage performance.

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.com/ssd.

**Table 4: Drive Performance**

| Capacity | 500GB | 1000GB | 2000GB | Unit |
|---|---|---|---|---|
| Interface | PCIe Gen3 x4 | | | |
| Sequential read (128KB transfer) | 1,900 | 2,000 | 2,000 | MB/s |
| Sequential write (128KB transfer) | 950 | 1,700 | 1,750 | MB/s |
| Random read (4kB transfer) | 90,000 | 170,000 | 250,000 | IOPS |
| Random write (4kB transfer) | 220,000 | 240,000 | 250,000 | IOPS |

**Notes:**
1. Performance numbers are maximum values.
2. Typical I/O performance numbers as measured using CrystalDiskMark® 6.0.1 with write cache enabled, a queue depth of 64 (QD = 8, Threads = 8). 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. System variations will affect measured results.
3. Due to security concerns, computer manufacturers have introduced updates to BIOS firmware which can affect SSD performance as measured in common benchmark tests. Some of these tests have shown as much as a 20% to 25% decrease in performance, after the security changes are installed, especially for random transactions.

## 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.

## Mean Time To Failure

Mean time to failure (MTTF) for the SSD is predicted based on the component reliability data using the methods referenced in the Telcordia SR-332 reliability prediction procedures for electronic equipment, in addition to Micron's Reliability Demonstration Testing.

**Table 5: MTTF**

| Capacity | MTTF (Operating Hours)[1] |
|---|---|
| 500GB | 1.8 million |
| 1000GB | |
| 2000GB | |

Notes: 1. Mean time to failure (MTTF) is a statistic based on the total service hours of a large population of SSDs, and does not predict the lifetime of any individual unit.

## Endurance

Endurance for the SSD can be predicted based on 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 6: Drive Lifetime – Client Computing**

| Capacity | Drive Lifetime (Total Bytes Written) |
|---|---|
| 500GB | 100TB |
| 1000GB | 200TB |
| 2000GB | 400TB |

Notes:
1. Total bytes written calculated with the drive 90% full.
2. SSD volatile write cache is enabled. Access patterns used during reliability testing are 25% sequential and 75% random and consist of the following: 50% are 4KB; 40% are 64KB; and 10% are 128KB.
3. GB/day can be estimated by dividing the total bytes written value by (365 × number of years). For example: 100TB/5 years/365 days = 54GB/day for 5 years.
4. Host workload parameters, including write cache settings, I/O alignment, transfer sizes, randomness, and percent full, that are substantially different than the described notes may result in varied endurance results.

# 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 7: NVMe/PCIe Power Consumption**

| Capacity | NVMe Power State 4 Sleep (Typ) | NVMe Power State 3 Slumber (Max) | NVMe Power State 0 | | Unit |
|---|---|---|---|---|---|
| | | | Idle Power (Max) | Sequential Writes (Max) | |
| 500GB | 2 | 80 | 800 | 8,000 | mW |
| 1000GB | 2 | 80 | 800 | 8,000 | mW |
| 2000GB | 2 | 80 | 800 | 8,000 | mW |

**Notes:**
1. Data taken at 25°C using a NVMe/PCIe interface.
2. Active average power measured while running MobileMark Productivity Suite.
3. NVMe Low Power States supported.
4. Active maximum power is measured using Iometer with 128KB sequential write transfers @QD64.

**Table 8: Maximum Ratings**

| Parameter/Condition | Symbol | Min | Max | Unit | Notes |
|---|---|---|---|---|---|
| Voltage input, M.2 | 3V3 | 3.14 | 3.46 | V | – |
| Operating temperature | $T_C$ | 0 | 70 | °C | 1 |
| Non-operating temperature | – | –40 | 85 | °C | – |
| Rate of temperature change | – | – | 20 | °C/hour | – |
| Relative humidity (non-condensing) | – | 5 | 95 | % | – |

**Notes:**
1. Operating temperature is best measured by reading the SSD's on-board temperature sensor, which is recorded in SMART data at Offset 1. SMART data is best read using the Crucial Storage Executive software.

**Table 9: Shock and Vibration**

| Parameter/Condition | Specification |
|---|---|
| Non-operating shock | 1500G/0.5ms |
| Non-operating vibration | 5–800Hz @ 3.1G |

## Compliance

Micron SSDs comply with the following:

- Micron Green Standard
- Built with sulfur resistant resistors
- CE (Europe): EN55032, EN55024 Class B, RoHS
- FCC: CFR Title 47, Part 15, Class B
- UL/cUL: approval to UL-60950-1, 2nd Edition, IEC 60950-1:2005 (2nd Edition); EN 60950-1 (2006) + A11:2009+ A1:2010 + A12:2011 + A2:2013
- BSMI (Taiwan): approval to CNS 13438 Class B, CNS 15663
  - http://www.crucial.com/usa/en/company-environmental
- CM (Morocco): Approval to No. 2574.14 and No. 2573.14 of 16 July 2015
- RCM (Australia, New Zealand): AS/NZS CISPR32 Class B
- KC RRL (Korea): approval to KN32 Class B, KN 35 Class B

| | |
|---|---|
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- W.E.E.E.: Compliance with EU WEEE directive 2012/19/EC. Additional obligations may apply to customers who place these products in the markets where WEEE is enforced.
- TUV (Germany): approval to IEC60950/EN60950
- VCCI (Japan): 2015-04 Class B

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  - 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.

# References

- NVM Express, Revision 1.3
- PCI Express Base Specification, Revision 3.0
- PCI Express M.2 Electromechanical Specification, Revision 1.0
- IDEMA Standard LBA 1-03

# Revision History

## Rev. A – 9/18

- Initial release

## Rev. B – 9/18

- Added random performance benchmark scores

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