

How much data can I write?

All NAND Flash based SSDs have a finite amount of write endurance. Each time a cell is written to it degrades by a very small amount and eventually with enough write activity it will become unreliable.

Fortunately this is a normal, predictable, and easily monitored characteristic of the SSD. Legacy Electronics' SSDs feature all of the S.M.A.R.T. registers necessary to accurately calculate the life expectancy of the SSD based on real world work loads as measured with customer specific applications. This ensures that the SSD will exceed all expectations and provide end users with the highest levels of reliability and performance.

To begin a snapshot of the current S.M.A.R.T. registers on the drive must be taken. Next an amount of data will be written to the drive over a recorded period of time. Ideally this data would be as close to the expected every day usage of the drive as possible. The final S.M.A.R.T. values will be subtracted from the initial values to get an accurate account of the drive usage during the test.

Finally all of the collected data will be entered into some basic equations along with a few constants to create an accurate prediction of the life expectancy of the drive in Terabytes Written (TBW) and days or years. This will consider several factors including Write Amplification (WA) and wear leveling efficiency.

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Values used in the calculations:

- PE Cycles: This will vary based on the type of NAND flash used, effectiveness of ECC, wear leveling, and how conservative a particular manufacturer is. Common values include 100000 for SLC, 3000 for MLC, and 1000 for TLC.
- Write amplification: This is typically a value between 1 and 6, but can be much higher. It is best to calculate it by dividing the writes to the flash by the writes from the host with real world test data. This value is second only to flash type in significance to the final result and therefore should only be estimated as a last resort.
- Wear Leveling Efficiency: For Legacy Electronics' Drives this is typically 1.2.
- Capacity: This is the raw capacity of the drive. The space reserved for firmware and other system info is small enough to be insignificant in the calculation.

Example Calculations:

Lets start with a partial table of S.M.A.R.T. data downloaded from the drive. This is an example of a 480GB drive based on a common Legacy Electronics' S.M.A.R.T. register table, and will vary based on product line and manufacturer.

| Register Description | Address | Value (Before) |
|------------------------------------|---------|----------------|
| Lifetime Writes to Controller (TB) | EAh | 00000000000054 |
| Lifetime Writes to Flash (TB) | E9h | 000000000000FC |
| SSD Life Left | E7h | 00000000000064 |

The next table shows the S.M.A.R.T. register status after the drive has been running in a customer's system with their application for 72 hours.

| Register Description | Address | Value (After) |
|------------------------------------|---------|----------------|
| Lifetime Writes to Controller (TB) | EAh | 0000000000043C |
| Lifetime Writes to Flash (TB) | E9h | 00000000000CB4 |
| SSD Life Left | E7h | 00000000000064 |

First the values must be converted to decimal from hexadecimal:

- 54h = 84
- FCh = 252
- 43Ch = 1084
- CB4h = 3252

Subtracting initial values from final values gives us 1000 TB written to the controller and 3000 TB written to the flash.

Write Amplification (WA) = (Writes to Flash / Writes to the Controller) so:

$$WA = 3000 / 1000 = 3.$$

The Terabytes Written (TBW) rating for the drive = (Raw Capacity * PE Cycles) / (ECC Efficiency * WA) so:

$$TBW = (512GB * 3300) / (1.2 * 3) = 469 \text{ Terabytes Written over the lifetime of the drive.}$$

Since we know that 1 Terabyte was written over the 72 hour test we can calculate that this drive will last 1407 days or 3.85 years at the current rate of one terabyte every three days.

Example Specifications:

The following tables show examples of the expected TBW rating for several Legacy Electronics' part numbers. As you can see, write amplification is critical to the life expectancy of the drive. These values are only examples and it is always recommended to calculate write amplification using data from tests involving the software and hardware that will be used in by the end customer.

| Part Number | Description | TBW (WA = 0.5) | TBW (WA = 6) |
|------------------|-----------------|----------------|--------------|
| SSD20604S0016100 | 60GB 2.5" MLC | 351 | 29 |
| SSD20804S0016100 | 80GB 2.5" MLC | 527 | 44 |
| SSD21204S0016100 | 120GB 2.5" MLC | 703 | 58.5 |
| SSD22404S0016100 | 240GB 2.5" MLC | 1407 | 117 |
| SSD24804S0016100 | 480GB 2.5" MLC | 2814 | 234.5 |
| SSD21004S0046500 | 100GB 2.5" eMLC | 7030 | 585 |
| SSD22004S0046500 | 200GB 2.5" eMLC | 14070 | 1170 |
| SSD24004S0046500 | 400GB 2.5" eMLC | 28140 | 2345 |
| SSD20304S00261T0 | 30GB 2.5" SLC | 117000 | 9500 |
| SSD20604S00261T0 | 60GB 2.5" SLC | 234000 | 19000 |
| SSD21204S00261T0 | 120GB 2.5" SLC | 468000 | 39000 |
| SSD22404S00261T0 | 240GB 2.5" SLC | 938000 | 78000 |
| SSD24804S00261T0 | 480GB 2.5" SLC | 1876000 | 156300 |

After the quantity of data and the write amplification for a given system has been characterized, the above table can be used to narrow down the most appropriate solution. Sometimes if write activity or write amplification is moderately high, it is more cost effective to use a larger MLC drive, even if the capacity is not required. On the other hand, if write activity and write amplification are very high it is often more cost effective in the long run to use SLC technology, even though the initial expense is greater.

Legacy Electronics' sales and engineering staff are available to analyze our customer's requirements to help ensure that the products we sell always exceed expectations and deliver industry leading quality and performance. If you are unsure what product would provide the correct level of write endurance for your application, please use the contact information on the following page and we can help.

About Us

Located in Canton, South Dakota, Legacy Electronics specializes in designing and manufacturing a full line of high-density memory modules, printed circuit boards, SSDs, and other computer products.

Legacy Electronics is home of the patented Canopy® chip-stacking alternative, a three-dimensional printed circuit board subassembly and process technology. Legacy utilizes an ISO 9001:2008 certified Quality Management System.

Legacy's cutting edge products are available in a variety of densities, speeds, and voltage levels. Our standard and custom modules are available in a wide array of form factors, including JEDEC-standard DIMMs and SO-DIMMs. Our products exceed industry standards. All Legacy products are proudly made in the USA..

Advanced tested memory products

Legacy Electronics is the only company to have a 100% pass rate for over 300 tests in a calendar year at CMTL (Computer Memory Test Labs).

In addition, CMTL awarded Legacy Electronics with a lifetime achievement award after 15 plus years of service with CMTL.

The CMTL Memory Module Certification Program performs advanced compatibility testing on motherboards from the industry's leading manufacturers like Intel®. All the modules listed at CMTL have passed rigorous cross platform certification testing criteria and are proven to be compatible with the motherboards on which they were tested.



Contact Us

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