Determining Solid-State Drive (SSD) Lifetimes for SEL Computing Platforms Installation Guide

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INTRODUCTION

There are three types of solid-state drives (SSDs) offered for SEL's computing platforms family. The type of SSD you choose depends on your application. This application note briefly explains the types of SSDs offered by SEL and assists you in determining the best type of SSD to use for your application.

PROBLEM

It can be difficult to determine the correct SSD for your application. When evaluating which type of SSD best meets your application needs, consider the following key operational variables: environment, capacity, and endurance. Environmental factors include the temperature of the operating environment and the moisture or chemicals in the air that may cause the internal components of the SSDs to require conformal coating in order to be protected. Capacity is the amount of data storage space needed to store the operating system, application software, and data or log files (consider both current needs and future room for expansion). Endurance is a measure of how many times the drive can be overwritten before it wears out. For more information on SSD flash endurance, refer to the "NAND Flash Memory Reliability in Embedded Computer Systems" white paper available on the SEL website (**selinc.com**).

The three types of SSDs that SEL offers use either single-level cell (SLC), pseudo-single-level cell (pSLC, also called iMLC), or multilevel cell (MLC or 3D TLC) flash memory. Use Figure 1 as a starting point to determine which type of SSD fits your application. For example, applications requiring high capacity and high endurance should use pSLC SSD types.

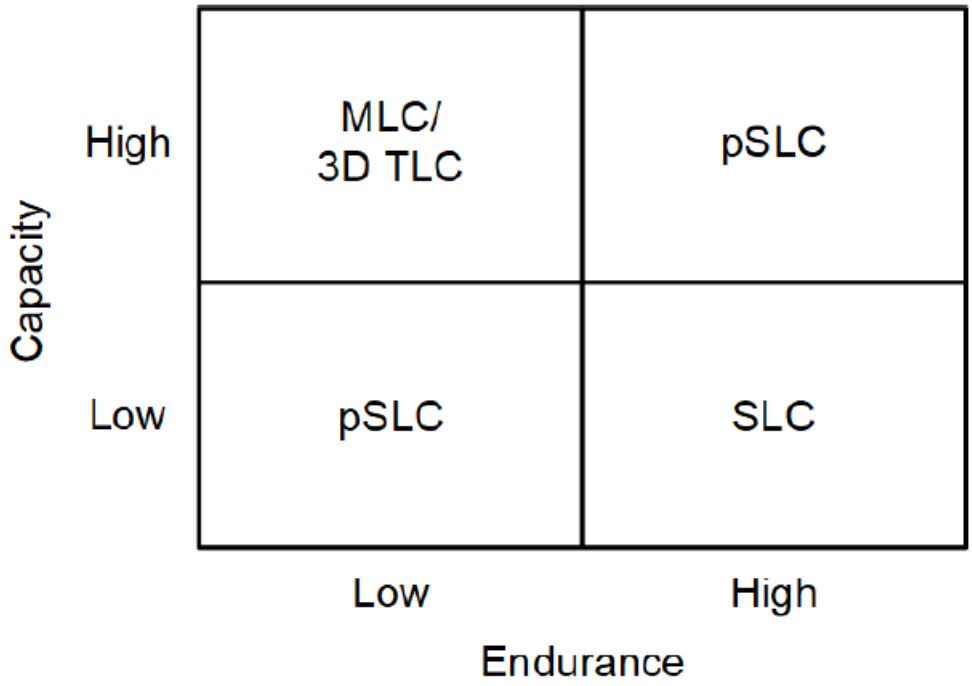


Figure 1 Decision Matrix for SSD Memory Types, Weighing Endurance vs. Capacity

SLC technology provides the highest level of endurance and reliability. SLC drives are suited for the most demanding applications and provide the best value for high-endurance applications.
pSLC drives provide high capacity at a lower cost but with less endurance than SLC drives. They are suited for applications that require a large drive with good endurance or a smaller drive with only moderate endurance.
MLC and 3D TLC drives provide the highest capacities and lowest cost but have the lowest endurance. MLC and 3D TLC drives are suitable for use in applications that require the highest capacity and/or the lowest initial cost but do not require high endurance.
Table 1 shows the important characteristics of SLC, pSLC, and MLC/3D TLC drives.

Table 1 Comparison of SLC, pSLC, and MLC/3D TLC Drives2

Considerations	**SLC**	**pSLC**	**MLC/3D TLC**
Write endurance1	100,000	20,000	1,000–3,000
Temperature range	–40 to +85°C	–40 to +85°C	–40 to +85°C
Conformal coating	Yes	Yes	Yes
Warranty	10 years	5 years	5 years
Capacity	32–256 GB	120–480 GB	240–1,920 GB

1. Write endurance is measured in program/erase cycles, or number of times the entire drive can be overwritten.
2. Consumer-grade SSDs from third parties are usually rated for 0 to +60°C, have no conformal coating, and may have significantly shorter warranty periods.

Example applications with typical requirements include the following:

- HMI device or protocol converter. With low logging requirements, these applications have low endurance and capacity requirements. MLC and 3D TLC or pSLC drives are appropriate.

- Historian or data logger. These applications have high endurance requirements. Capacity requirements vary greatly, depending on the amount of data that must be retained. SLC or pSLC drives are appropriate, depending on how much data must be stored.
- Video recorder or synchrophasor archiver. These applications have high-endurance and -capacity requirements. pSLC drives offer excellent reliability and endurance; however, MLC and 3D TLC drives may be required in order to meet the capacity requirements.

SEL SOLUTION

To assist you in selecting the appropriate SSD for your application, SEL created the SSD Lifetime Calculator tool. It uses performance parameters from your application to estimate the lifetime of the different types of SSDs based on their capacity and endurance.

SSD Lifetime Calculator Field Descriptions

The SSD Lifetime Calculator has the following fields:

- Drive size. This is the capacity (in gigabytes) of the SSD used for data storage.
- Write amplification. This value varies based on the size and order of data written to the drive. The value typically ranges from 1.1x to 8x. For example, a video recording server that writes data in large (over 1 MB), sequential chunks typically has a low write amplification value (between 1x and 2x). An event logging server that writes data in small (less than 1 KB), random chunks typically has a high write amplification value (between 4x and 8x). If you are unsure of the correct value for your application, use the default of 4x.
- Design life. This value is the required life of the drive in the system running your application.
- Design margin. This field allows you to account for unexpected drive wear by specifying a safety margin. Use 0 percent for no safety margin and 100 percent for a 2 times safety factor. Design margin is calculated as (Expected Life / Design Life) – 1.
- Application write activity. This is the anticipated drive write activity in gigabytes per day. This is entirely dependent on your application and requires some research and testing or simulating to determine how much data your application writes to the SSD each day.

The following are typical values that a historian or data logger application uses:

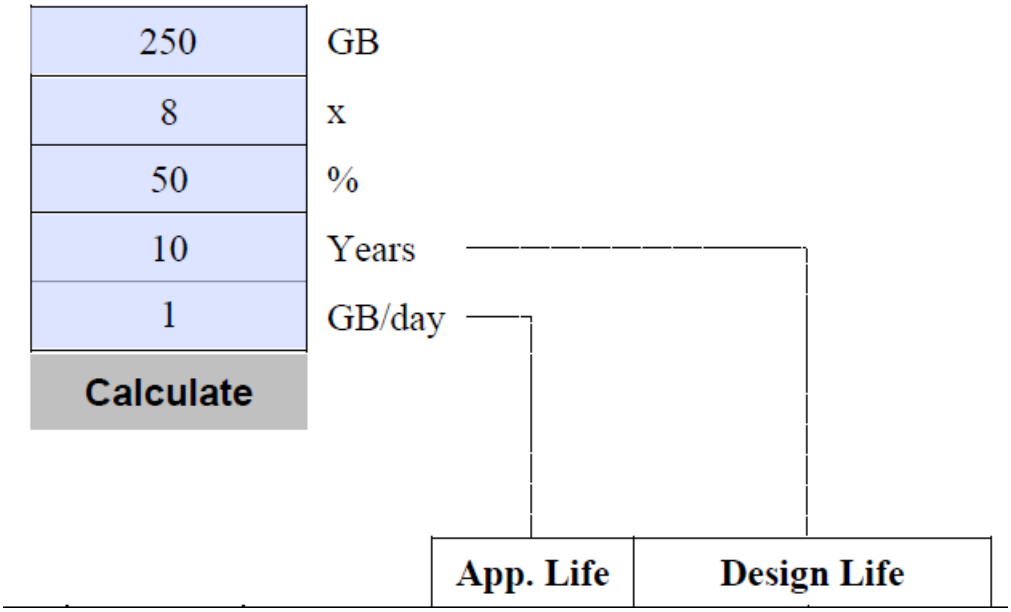
- Drive size. 250 GB (long-term data storage).
- Write amplification. 8x (mostly small-sized files and/or records are written).
- Design life. 10 years (long service life with minimal maintenance).
- Design margin. 50 percent (expected SSD life is 1.5 times the design life).
- Application write activity. 1 GB per day (this is a high, rough estimate of average activity).

SSD Lifetime Calculator
Enter data from your application into the calculator in this PDF, click the Calculate button, and use the design life and/or application life fields to determine the appropriate SSD for your application

Calculator Inputs

Drive Size:

Write Amplification:
Design Margin:
Design Life:
App. Write Activity:



Calculator Results

Flash Type	Cost/ GB ($)	Drive Cost ($)	Rated Cycles	Total TBW	Years	MB/s	GB/day	Cost/ TBW ($)
MLC/ 3D TLC	0.75	187.50	3,000	62.500	171.23	0.198	17.123	3.00
pSLC	3.00	750.00	20,000	416.667	1,141.55	1.321	114.155	1.80
SLC	10.00	2,500.00	100,000	2,083.333	5,707.76	6.606	570.776	1.20

Notes:

- Write Amplification is application-dependent and varies depending on the type of data being written.
- The Cost/GB (cost per gigabyte) is the approximate price for SEL customers.
- Total TBW (terabytes written) is the amount of data in terabytes that can be written to the drive before the drive wears out, based on the specified Drive Size and Write Amplification.
- MB/s (megabytes per second) and GB/day (gigabytes per day) are the maximum average App. Write Activity (application write activity) allowed in order to reach the specified Design Life.
- App. Life (application life) is how long the drive takes to wear out given the specified App. Write Activity (application write activity).

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Documents / Resources

	**SEL Determining Solid-State Drive (SSD) Lifetimes for SEL Computing Platforms** [pdf] Installation Guide Determining Solid-State Drive SSD, Lifetimes for SEL Computing Platforms

References

- selinc.com