Envoy Data Memory

SSD Controller
Technical Brief
Power Loss Protection

Introduction

In the data storage world, more and more users are adapting to SSDs over traditional HDDs. The benefits include higher performance, no moving mechanical parts and lower failure rates. But due to the characteristic of SSDs, there are also weaknesses. In the event of unexpected power loss occurring, data in the SSDs may be lost or gets corrupted. In this white paper we will be discussing how EDM SSDs handles unexpected power loss and overcome the risk of losing user's valuable data.

Characteristic of SSDs

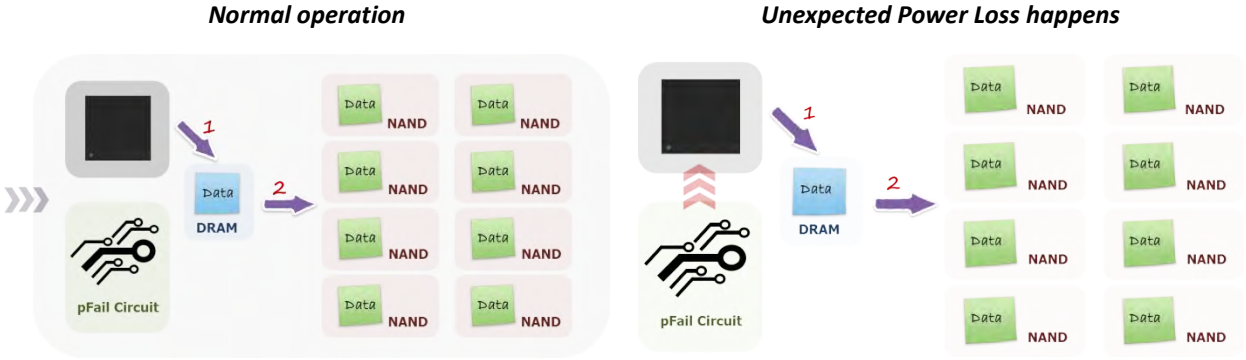
Inside a SSD, there are three major components: NAND Flash memory, DRAM, and SSD controller. When SSD receives data coming from the host, the data will be first process by the controller, then sends to the volatile memory – DRAM, acting as a data buffering cache to optimize the incoming data and improve performance. Finally, the data will be written and hardens to the NAND. But not only cached user data is stored inside the DRAM, there is also other information kept, including FW management table (L2P, P2L, and system table).

The Limitation

Because DRAM is a volatile memory, meaning the data temporary stored inside the DRAM buffer will not be kept when there is no power. In a normal expected power down scenario, the controller will manage and properly save all the data in DRAM to NAND before powering down to secure the data. But when unexpected power loss occurs, without any power loss protection mechanism, the data in the DRAM will be lost or corrupted.

The Solution

To prevent data loss or corruption from unexpected power loss event, EDM SSDs added pFail protection circuitry with capacitor components on the board design. These capacitors act like a UPS (Uninterruptible Power Supply) for the SSDs, the capacitors will be charged upon powering up and be prepared for emergency cases. When unexpected power loss happens, the capacitors can provide additional power up time for the controller to manage and flush all the critical information (Cached user data and P2L table) in the DRAM to NAND to ensure data integrity and prevent data loss.



The SSD is powered by the power supplied from host side, and the capacitors in pFail circuit is charging up.

SSD detects the supplied power is dropping, pFail protection circuit kicks in and provide power to the SSD to flush cached data from DRAM to NAND

Figure 1. *pFail protection mechanism*

How does EDM Power Loss Protection Work?

In an event of unexpected power drop occurs, SSD firmware will detect the power drop incidence through GPIO (General Purpose Input/Out) Pin, and all the internal activities of SSD will be suspended immediately, including garbage collection, wear-leveling, etc. In Stage 3, the cached user data and P2L table will be quickly flushed to a temporary assigned block for emergency data backup.

On the next power up of the SSD, during the power initial stage, the drive will read out the flushed data from the block and rearrange the data to dynamic block where it should be properly stored.

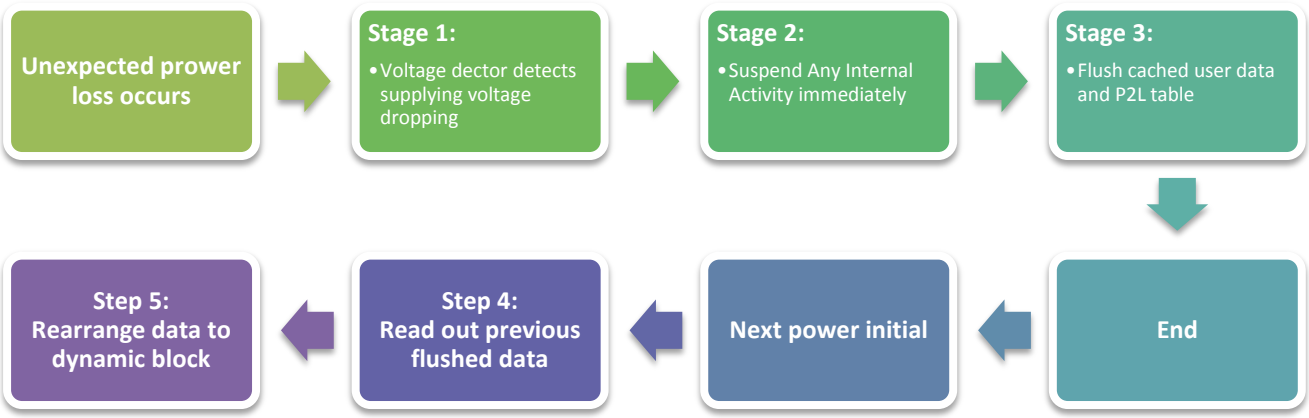


***Figure 2**. How SSD firmware mechanism handle unexpected power loss*

Example of EDM pFail SSD v.s. non-pFail SSD

In **Figure 3** below shows an example is based on a 512GB 2.5" SSD using EDM SATA III controller with Toshiba 15nm MLC NAND. The graph shows how much more hold up time the pFail circuit can provide versus one without pFail protection.

In this example, EDM's pFail protection mechanism can provide a maximum of 25ms holdup time to flush the cached data stored in DRAM buffer in order to preserve data integrity and prevent data loss.

*Note the voltage hold up time will be different depending on the drive configuration.

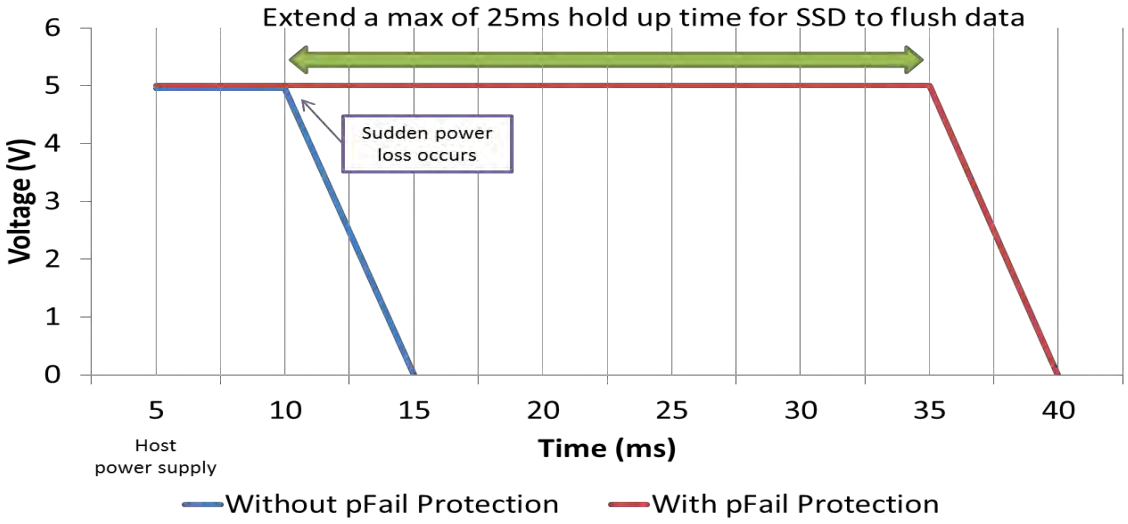
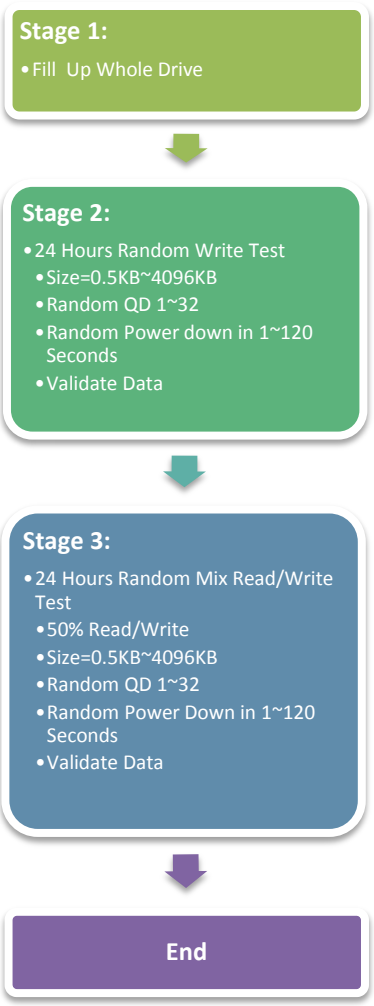


Figure 3. Hold up time for when unexpected power loss occurs

EDM Power Loss Verification Flow

In order to verify the power loss protection function, EDM uses OakGate testing system to create the test script and perform the verification process for the power loss protection to make sure the function can work normally.



Conclusion

As flash based storage drive are getting more and more popular, SSDs provides much higher performance and lower failure rates than traditional hard drives. There are also limitations to the SSDs that need to be overcome. Such as sudden power failures can potentially cause data loss or corruption. But with EDM's Power Loss Protection feature, the pFail circuits provides additional hold up time for the SSD to flush critical data stored in DRAM buffer to secure user's data. Making it a good solution for all kinds of application, including client based consumer, data center, and embedded applications.