White Paper

Stable SSD Performance in Unstable Power Supply Situations

Executive Summary

Unstable power sources are a common challenge for devices in remote and extreme environments. This can severely affect solid state drive (SSD) operation. Instability during start-up and shutdown can cause system crashes and restarting issues.

Hardware-based preventive features will protect the SSD from unstable voltage levels. Extending the ramp-up time during startup will ensure that the voltage has stabilized before allowing the SSD to switch on. After system shutdown or during a quick restart, there is often residual voltage that can cause issues. This is mitigated by tweaking the hardware to only allow startup after the voltage has been lowered.

By incorporating these two hardware functions the SSD is protected both during start-up and shutdown.

Introduction

Power source instability and sudden power loss have always been a challenge for storage devices. The sudden drop in power supply can cause data corruption, and in worst case, lead to total device failure. For this reason, most SSDs for critical applications come with emergency functions that save data and assure that no issues occur when restarting after a sudden power loss.

These technologies are mainly in place to ensure data integrity after an incident has happened. There are, however, other power supply factors that can impact SSD data integrity. Certain applications operate in conditions where power supply is unstable. During start-up and use the voltage might fluctuate, which in turn can interfere with SSD operation and also damage the device. Another significant risk is residual voltage after shutting down. This can further cause issues when restarting the system.

There are, however, preventive measures that can help mitigate these issues. Safeguards can be implemented by optimizing the hardware structure – allowing the SSD to prevent data corruption, damage, and sudden restart issues. This paper will further explain the risks of power loss and power instability, and more importantly, what can be done to avoid these risks.

Background

Power instability is mainly seen in systems with poor and unstable power supply. This is true for applications such as in-vehicle computers, remote installations, and devices used in under-developed areas where the power grid is less reliable.

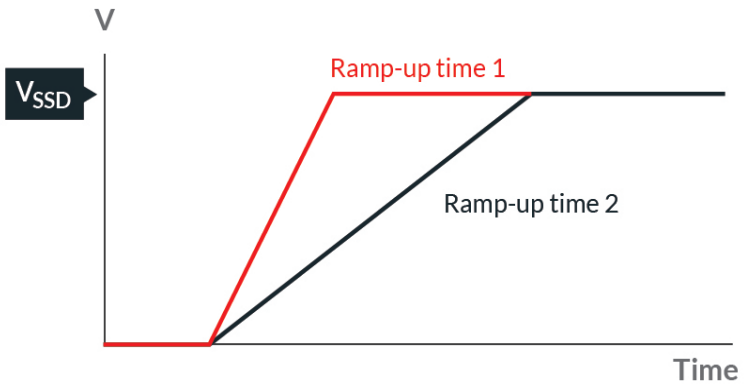
However, even in areas where the power supply is stable, power loss can still happen due to unforeseen circumstances. Construction work or a lightning strike is all it takes for the grid to momentarily go down. So even though the risk is lower, mission-critical data still requires data integrity measures.

Challenges

Start-up instability

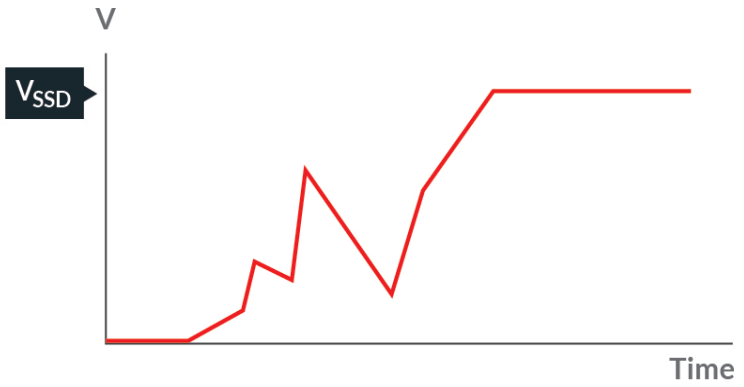
There are two risks associated with system start-up: unpredictable ramp-up time and power supply instability.

The SSD will only start after crossing a pre-set threshold voltage. This can cause problems when the ramp-up time takes too long, as the threshold voltage is not sufficient for the SSD. The ramp-up time is dependent on the local power supply situation, and will therefore vary from place to place (see graph 1), making it hard for the manufacturer to come up with a design that takes this variation into account.



Graph 1: Two different examples of differing device ramp-up time

During ramp-up, the voltage might fluctuate (see graph 2). This can trigger SSD start-up, but the voltage might continue fluctuating before eventually stabilizing. As with the slow ramp-up time described above, this scenario can cause issues with device start-up and potentially lead to data corruption and damage to the SSD.



Graph 2: Fluctuating voltage during SSD ramp-up

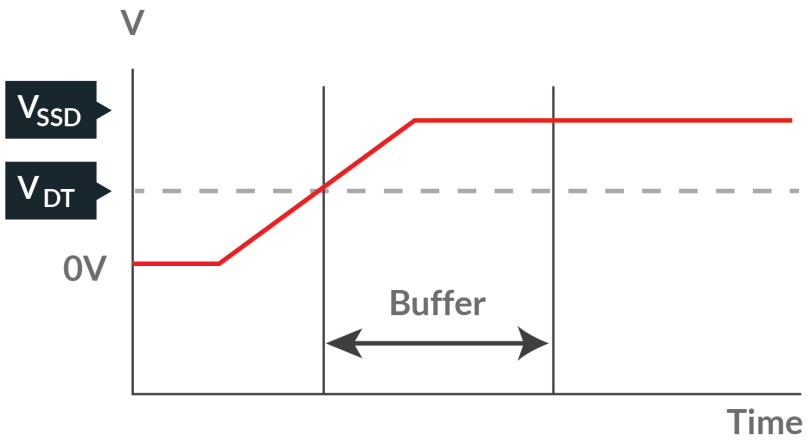
Residual Voltage

After a successful shut-down, the voltage level should be close to or at 0V. However, a poor power supply can leave a residual voltage after shut-down. This can lead to problems when restarting.

Solutions

Ramp-up Buffer

To avoid any issues at start-up, the SSD creates a buffer zone after reaching the pre-set voltage threshold. When the threshold is met, the SSD will adjust device start-up to ensure that a stable voltage level has been reached. Any power instability or slow ramp-up time is thus safely caught within the buffer. This function will run at any system start-up, so differing conditions are also accounted for.



Graph 3: After reaching the threshold voltage (V_{DT}), the SSD adds a buffer zone to ensure that stable voltage (V_{SSD}) has been reached before initiating start-up

Start-up without Residual Voltage Interference

Residual voltage can cause issues during SSD start-up. If there are any residual voltage after shut-down, the SSD will force it down close to 0V before allowing a system restart. This safeguard is always in place ensuring safe startup every time, further increasing the SSD's preventive power protection.

Conclusion

An unstable power supply is a huge risk factor for any device using flash memory. Algorithms for safe shut-down has been available for a long time, but not many are aware of the preventive measures available to ensure a safer power on and power off, as well as a more stable performance.

Efficient power protection measures can safeguard any SSD from unstable and fluctuating voltage – allowing for greater data integrity and a more efficiently run system.

The Innodisk Solution

iPower Guard™

iPower Guard technology is a set of preventive measures that protect the SSD in an unstable power supply environment. This comprehensive package comprises safeguards for startup and shutdown to maintain device performance and ensure data integrity.

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