

An Innodisk White Paper  
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# Using Innodisk's iCell Technology To Prevent Data Loss in SSDs

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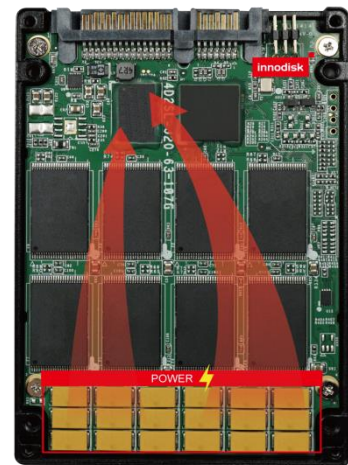
Triggering DRAM Buffer to Flash Data  
Transfer during Sudden Power Outage

## Revision History

Date	Version	Information
2012.07.09	1.0	First Release
2015.01	2.0	Change into new logo and new product series

## Introduction

This white paper presents Innodisk's iCell Technology's solution for data loss during sudden power failure. Through the use of capacitors, voltage detectors and buffer management, data stored in volatile DRAM is sent to flash storage before total power loss to a system. iCell Technology finds use in a variety of applications in the IPC industry where backup power is not always available.

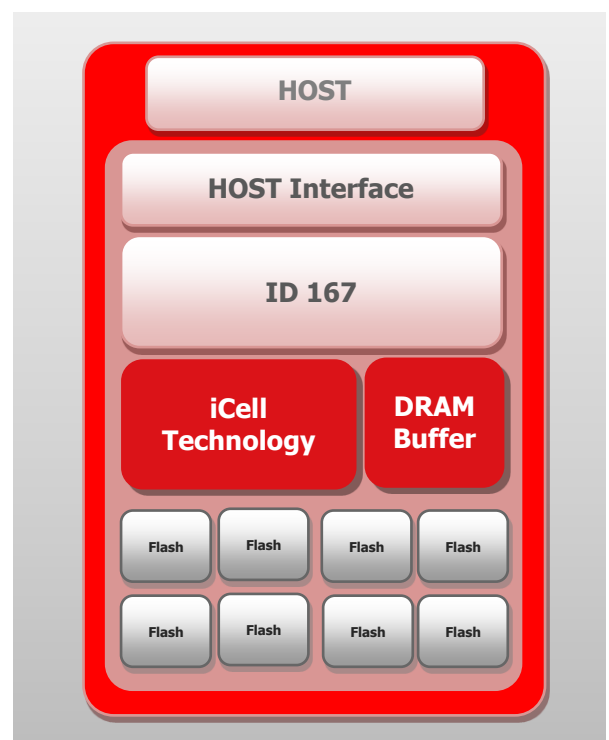


## How Innodisk's iCell Technology prevents SSD data loss

SSDs apply DRAM buffering during operations. This makes I/O operations faster and more efficient. iCell Technology takes this architecture a step further by engineering several capacitors on the IC board to provide power buffering after sudden power outage. The capacitors deliver an instantaneous charge after voltage detectors in the circuitry detect a sudden change from regular 5V to low voltage.

Under normal operating conditions – while power supply remains constant – user data (including data in the DRAM buffer) can be written to flash storage. In the case of sudden power failure, there is a potential for data in the buffer to be lost.

### Innodisk's iCell Technology Architecture



iCell Technology, when abnormal power-off occurs, can detect the lower voltage caused by the sudden power shut-off and sends feedback to the SSD controller. Once the SSD controller receives this feedback signal, the SSD firmware triggers a mechanism to write the data into the flash storage. As a result, iCell is able to provide power during power outage, preventing any data loss from happening.

## Application

### ● Data Buffer Management

The following section applies iCell Technology along with data buffer management to three product solutions: Innodisk's 3MG-P/3MR-P/3SR-P/3SE-P

3MG-P/3MR-P/3SR-P/3SE-P contain 10 DRAM buffers for write command. Each buffer has a 128KB capacity. When a host writes data to an SSD, the data is written to the DRAM buffer first. The data is handled on a first in, first out basis.

#### 10 DRAM Buffers



All buffer data is written to the flash chip when DRAM buffer has more than 2 or the SSD is in idle status.

#### Data Buffer Management Example

##### 1. Write command in



##### 2. Write command in



##### 3. Flush data to Flash chip



##### 4. More write command in



##### 5. Keep flushing data to Flash chip



##### 6. Flush all buffer data until it is empty.

When the voltage detector detects low power, it will stop all operations. The SSD will go into an abnormal power down status. The SSD then writes all data in the DRAM buffer to flash storage. iCell Technology can write up to 15MB of data to flash storage in 60ms. 3MG-P/3MR-P/3SR-P/3SE-P solutions have a maximum of 10MB in the DRAM buffer. This ensures ample room for iCell to write buffer data to flash storage.

## Testing Data

The image below shows data captured from an SSD without iCell Technology during a power outage. Residual power in the system is only around 2ms. Data cannot be written to flash storage before total power loss. See Figure 1.

The image below shows data being captured from an SSD with iCell Technology during a sudden power outage. Residual power available to the SSD is around 60ms. The SSD writes 15MB of data to flash within 60ms. See Figure 2.

### Comparison With and Without iCell

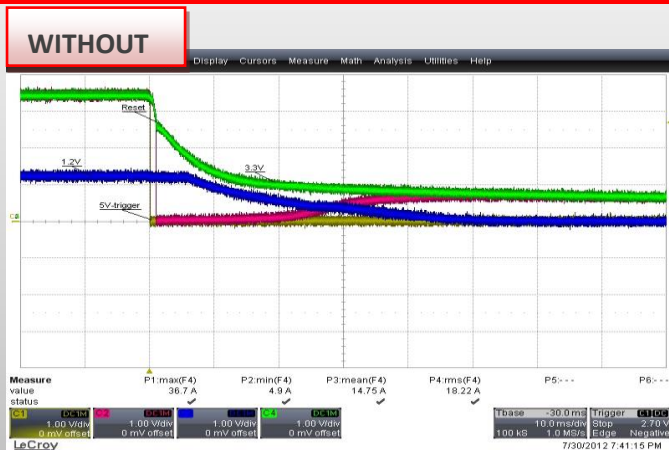


Figure 1: Sudden power outage **WITHOUT** iCell

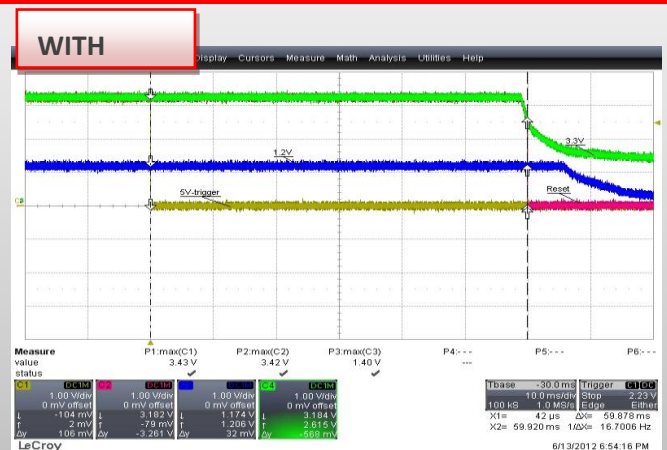


Figure 2: Sudden power outage **WITH** iCell Technology

## Conclusion

The captured data from the two images above clearly illustrates the benefit gained from using iCell Technology with SSDs. An increase of 60ms of system power allows the controller to flush data from DRAM to flash storage. iCell Technology offers a valuable data protection mechanism for the solid-state drive industry. Using capacitors with voltage detectors ensures instant, reliable and total transfer of buffer data to flash storage. On top of that, iCell's sophisticated data buffer management guarantees all buffer data is flushed to the flash chip before total power loss.

## About us

Innodisk is a service driven provider of flash memory and DRAM products for the industrial and enterprise applications. With satisfied customers across the embedded, aerospace and defense, cloud storage markets and more, we have set ourselves apart with a commitment to dependable products and unparalleled service. This has resulted in products including embedded peripherals designed to supplement existing industrial solutions and high IOPS flash arrays for industrial and enterprise applications. The expanded business lines are leading our next step in being a comprehensive solution and service provider in industrial storage industry.

For more information on Innodisk's product line, technologies and applications, please visit [www.innodisk.com](http://www.innodisk.com)