

White Paper
Dec 2016

Innodisk Physical Destroy for SSDs

Data Destruction for
Aerospace and Defense
Applications

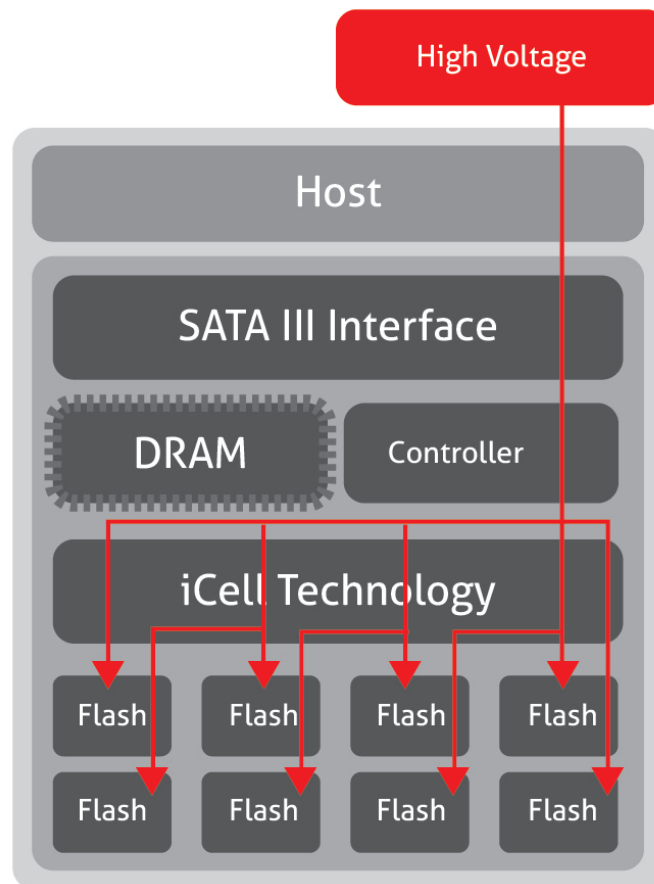
Introduction

Innodisk's Physical Data Destroy Technology is a self-destructing mechanism activated via high voltage input which destroys the SSD controller and NAND flash cells. This destruction provides security against data from being used for unauthorized purposes. It also ensures that the data in each flash cell is physically and permanently destroyed and therefore unrecoverable. SSDs enabled with the physical data destroy function are suitable for classified information storage, especially for aerospace and defense applications.

The Importance of Data Destroy Mechanisms

Data protection is a critical issue in industrial applications. Storage devices must secure confidential data by integrating a full set of data protection mechanisms. Data destroy carries out a comprehensive and complete data erase of the SSD. There are two methods to permanently destroy data: logical data destroy and physical destroy. Logical data destroy ensures that the confidential user data, SSD information and even the firmware will be erased and unrecoverable. Alternatively, physical destroy uses high voltage input to completely destroy flash cells and firmware making the SSD completely inaccessible. Innodisk's physical destroy mechanism will physically burn out the controller, flash cells and power circuit within a short period of time, resulting in irreversible destruction (see Figure 1).

Figure 1 : Physical Destroy Mechanism



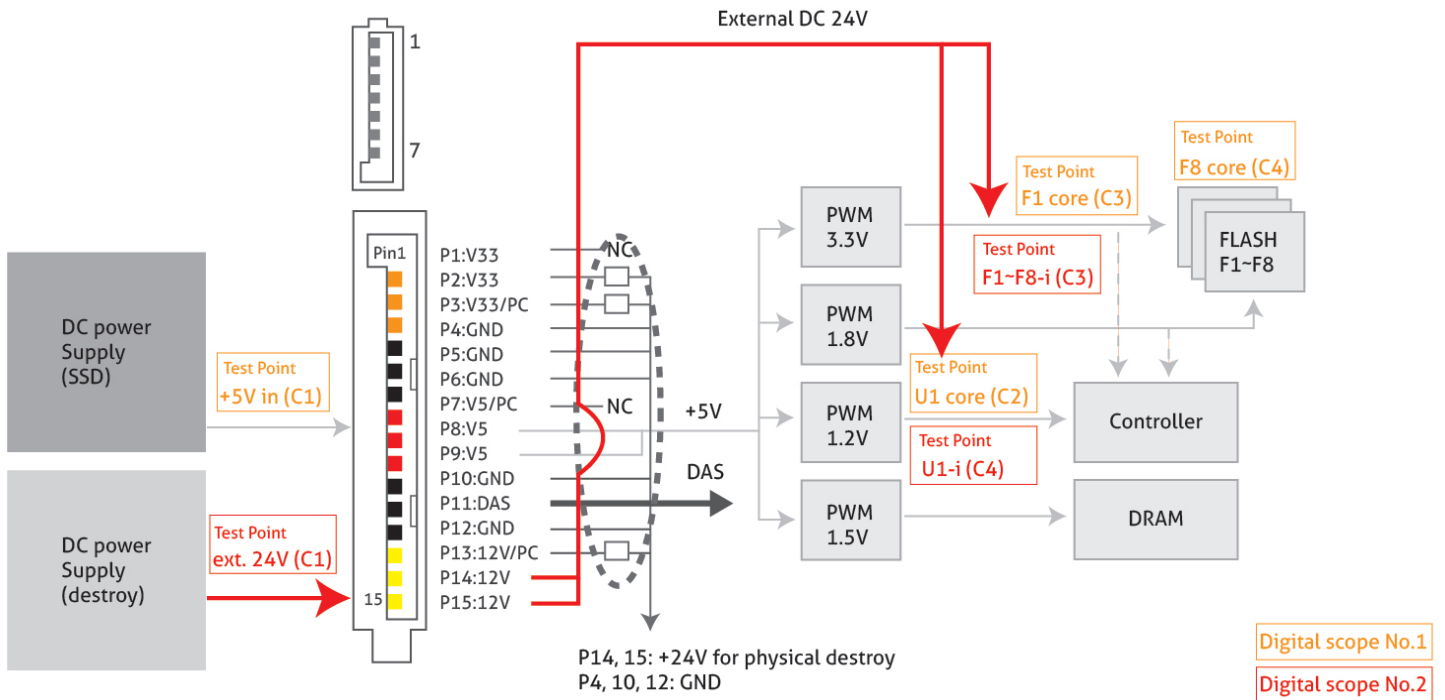
How Does It Work : Innodisk's Physical Destroy Operation

Innodisk's physical destroy utilizes 24V power input via Pin 14 and Pin 15 of a standard SATA connector to activate physical destroy. Once triggered, the high voltage burns out the controller, flash cells and power circuit making it unrecoverable.

• Physical Destroy Process Demonstration

Figure 2 displays a block diagram of the physical destroy mechanism. It begins with an external power supply of 24V through Pin 14 and Pin 15 to the SSD. Next, the high voltage will be transmitted to each flash module in succession. Finally, the flash module will no longer be able to withstand the excessive voltage and it will be obliterated.

Figure 2 : Block Diagram of Physical Destroy Mechanism



*NOTE : Flash F1 is the closest flash IC to the controller while F8 is the farthest one.

• Fuse Implementation

There are typically several flash cells designed into a single disk. To ensure that each flash module is destroyed, an embedded fuse circuit is designed for directing the current to each flash cell and SSD controller, destroying each one within the storage device sequentially (see Figure 3). After the first flash IC burns out and the fuse is destroyed, the current will be re-directed to destroy the next flash module and fuse, and the next flash module will be destroyed thereafter. Each flash and controller will be completely destroyed and data will be eradicated (see Figure 4). Without a fuse design, the current would stop at the first flash cell and not continue to burn out the other flash cells.

Figure 3 : Flash/Controller Fuse Design

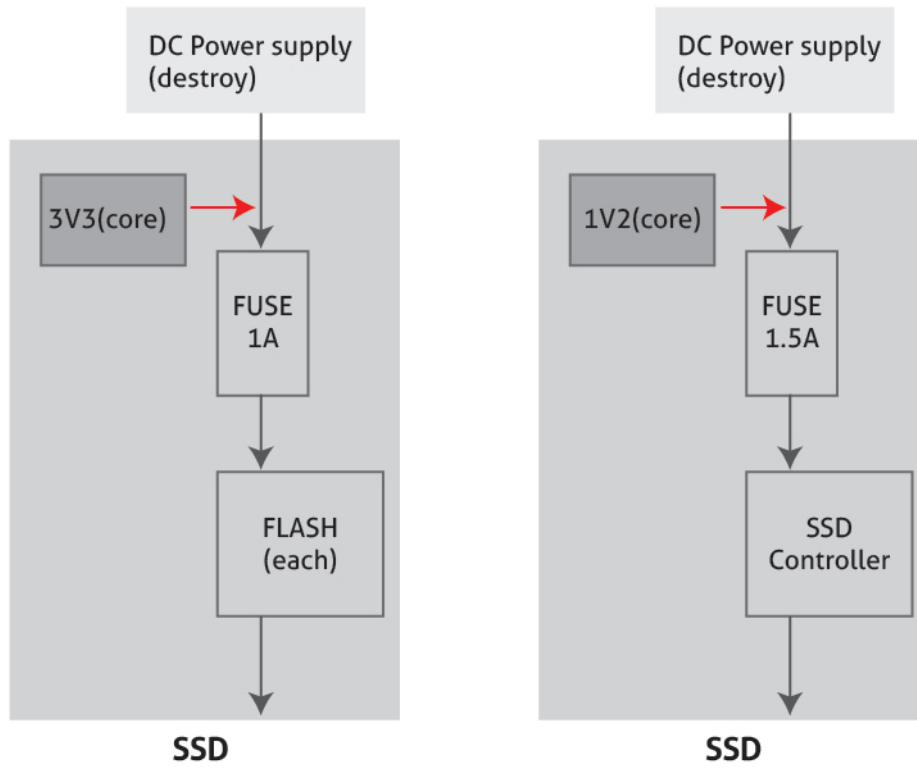
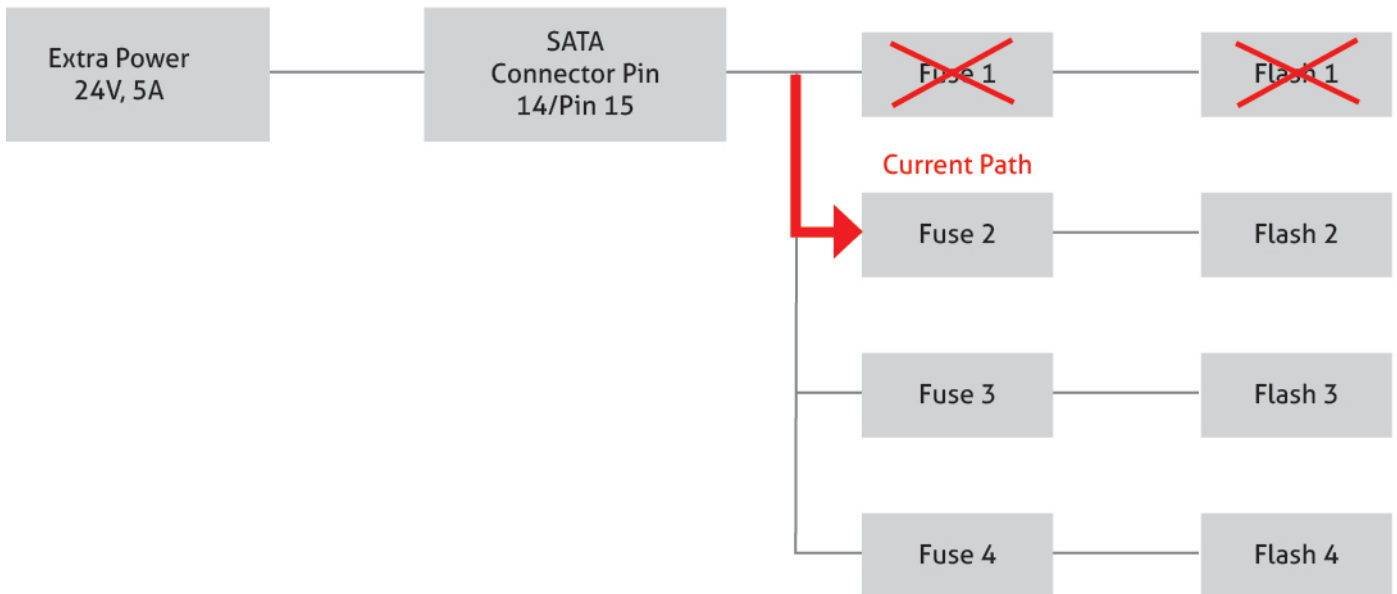


Figure 4 : Fuse Current Redirection Diagram



Real Experiment and Test Results

• Experiment Description

Innodisk used two digital scopes to measure the SSD’s waveform (see Figure 2). The No. 1 digital scope was used to monitor the voltage of +5V in, SSD controller core voltage and flash memory core voltage from F1-F8. Additionally, the external destroy voltage, SSD controller core power current and total flash memory core power current (F1-F8) are monitored by the No. 2 digital scope (see Table 1).

Table 1 : Digital Scope and Test Point Description

Test Scope	Test Point	Description
Digital Scope 1	+5Vin	Voltage supply for SSD
	U1 core	SSD controller core voltage
	F1 core	Core voltage of flash F1
	F8 core	Core voltage of flash F8
Digital Scope 2	External 24V	External destroy voltage
	F1~F8-i	Total current of flash module core power
	U1-i	Current of SSD controller core power

• Test Results

1. No. 1 digital scope:

The first waveform indicates that the HOST looks harmless and is still working with 5Vin during the physical destroy execution for flash destruction. The typical duration for physical destroy function is under 5ms for the flash controller and flash cells (see Figure 5).

Probe_C1 (5Vin) : Voltage supply for SSD

Probe_C2 (1V2) : Flash controller core voltage

Probe_C3 (3V3F1) : Core voltage of flash F1 (the nearest to the controller)

Probe_C4 (3V3F8) : Core voltage of flash F8 (the farthest to the controller)

Figure 5 : Waveform 1



2. No. 2 digital scope :

The second waveform shows the current change of the SSD controller as well as all flash cells during physical destroy execution (see Figure 6).

Probe_C1 (24Vin) : External destroy voltage

Probe_C3 (3V3F-current) : Total current of the flash cells' core power

Probe_C4 (1.2-current) : Current of SSD controller core power

Figure 6 : Waveform 2



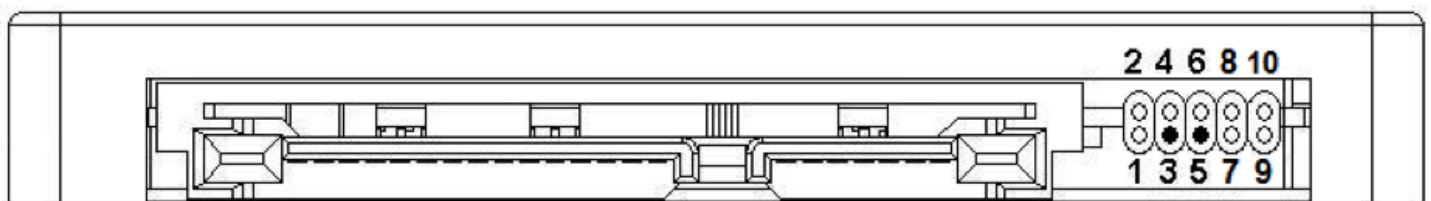
How to Activate Physical Destroy with Pin Header

Innodisk physical destroy requires high voltage to initiate the security mechanism. With 24V input to a standard SATA connector Pin 14 and Pin 15, Innodisk has designed pin headers beside the SATA connector so that the user can use the pin headers (Pin 9/Pin 10) to enable or disable the physical destroy function.

• Physical Destroy Disabled Mode (Default)

When the jumper is inserted with default setting (Pin 3 and Pin 5), it means that physical destroy function is disabled. The user can use standard SATA power cable to supply 5V for the SSD under this mode (see Figure 7).

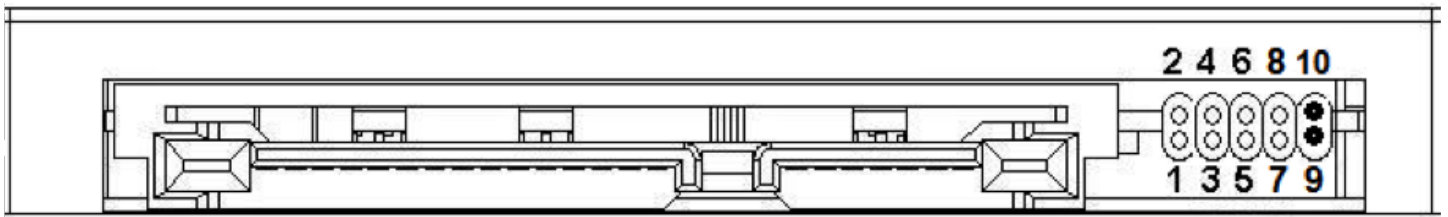
Figure 7 : Physical Destroy Disabled Mode



• Physical Destroy Enabled Mode

The physical destroy function will be triggered by inserting the jumper on Pin 9 and Pin 10. Once Pin 9 and Pin 10 are shorted, the external power is supplied to the device through Pin 14 and 15 of a standard SATA connector. Afterwards, the power voltage will be transmitted to each flash modules and cause them to burn out (see Figure 8).

Figure 8 : Physical Destroy Enabled Mode



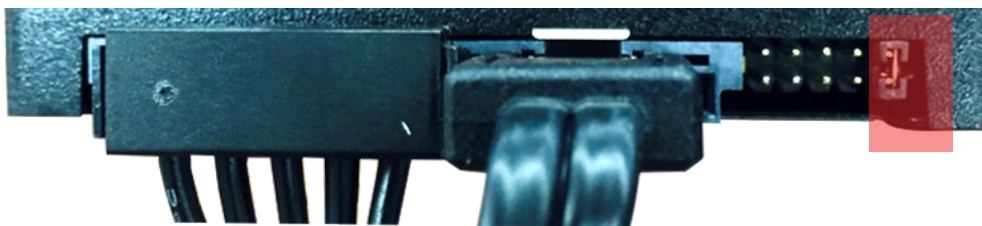
• Initiation Steps

Step 1 : Connect the SSD with a standard SATA connector to the system and turn on the system power. The jumper is inserted with default setting (Pin 3 and Pin 5).



Step 2 : Confirm that the SSD is functioning properly.

Step 3 : Remove the jumper from Pin 3/Pin 5 to Pin 9/Pin 10 to enable the physical destroy function and then trigger high voltage input. The SSD will be burned.



Step 4 : Turn off the power and re-boot the system.

Step 5 : Check the burned SSD. The SSD will no longer be accessible due to the burn.

Conclusion

Innodisk’s physical destroy mechanism is the ultimate security protection feature specially designed for mission critical applications. Confidential data will be destroyed logically and all internal storage and access components will be physically destroyed, making data retrieval impossible. The storage device becomes permanently unrecoverable.

Appendix

1. Physical Destroy Time Reference

Capacity	Flash Configuration	Estimated Destroy time (flash & controller)
8GB	Flash x 2 pcs	<2ms
16GB	Flash x 2 pcs	<2ms
32GB	Flash x 4 pcs	<2ms
64GB	Flash x 8 pcs	<5ms
128GB	Flash x 8 pcs	<5ms
256GB	Flash x 8 pcs	<5ms

2. SATA Pin Assignment for Physical Destroy

Name	Type	Description
S1	GND	NA
S2	A+	Differential Signal Pair A
S3	A	
S4	GND	NA
S5	B-	Differential Signal Pair B
S6	B+	
S7	GND	NA

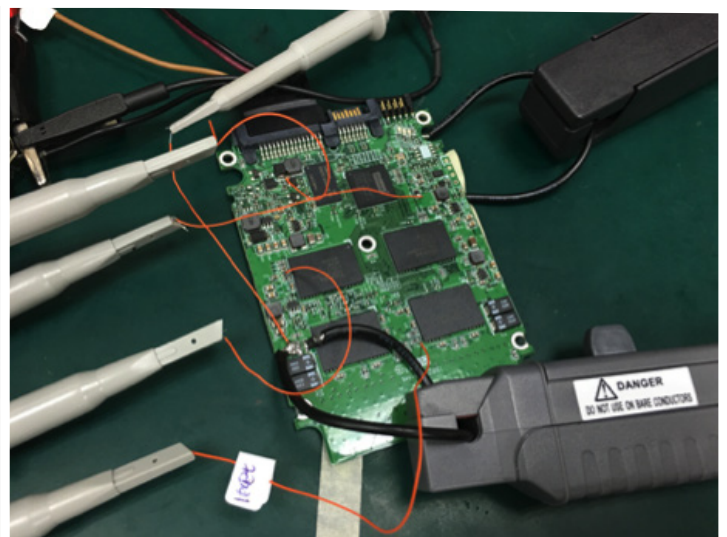
Key and Spacing Separate Signal and Power Segments

P1	NC	NA
P2	NC	NA
P3	NC	NA
P4	GND	GND
P5	GND	GND
P6	GND	GND
P7	V5	5V Power, Pre-Charge
P8	V5	5V Power
P9	V5	5V Power
P10	GND	NA
P11	DAS/DSS	Device Activity Signal / Disable Staggered Spinup
P12	GND	GND
P13	NC	NA
P14	24V	24V Vendor specific for physical destroy function
P15	24V	24V Vendor specific for physical destroy function

3. Test Equipment

- Programmable DC power analyzer (supply): Agilent N6705B
- Digital scope: LeCroy 104Xi-A
- Digital scope: Agilent MSO9404A
- Current probe: CHAUVIN ARNOVX E3N
- Current probe: CYBERTEK CP8030H
- DC power supply: LSR-350-24

4. Test Environment



About US

Innodisk is a worldwide leading provider of data storage and memory module solutions for industrial and mission-critical applications. Leveraging in-house engineering and R&D expertise with a keen insight on industry trends, Innodisk's solid-state drive (SSD) technologies provide enhanced, vertically-integrated data storage solutions. Our advanced Flash-based data storage and DRAM memory solutions meet stringent aerospace and defense application requirements, and are also widely used in industrial applications and embedded systems. Innodisk offers customized solutions, from unique form factors to special firmware designs, and our support team of hardware, software and firmware engineers is always ready to tailor the right solution to each customer's needs. Innodisk continually strives for innovation, while providing system integrators and end customers with the best service in the industry.

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