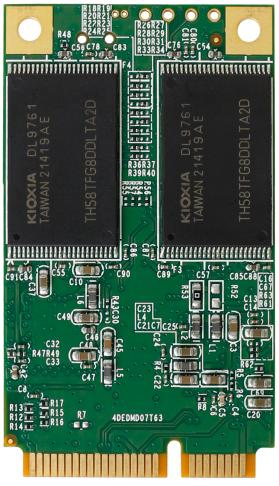
User Manual

Mini PCIeDOM

IMPeDOM Series



Version 1.0

October. 2015

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REVISION HISTORY

Revision	Description	Date
Rev. 1.0	Official release	October, 2015

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1.Product Overview

1.1 Introduction of ICOP Mini PCIeDOM

ICOP Mini PCIeDOM is a Flash based disk module with Mini PCI Express interface, which brings you new generation of storage solution, especially focused on embedded systems. It not only provide standard MiniPCIe interface but also delivers excellent performance.
Comparing with most Mini PCIe storage devices in the market, IMPeDOM comes with standard MiniPCI Express interface, just plug and play without any circuit modification, and no driver needed, which is the easiest way for board maker or system integrator to design in the product as a boot drive or storage device.

1.2 Product View and Models

ICOP Mini PCIeDOM is available in follow capacities:

IMPeDOM-8GB-M

IMPeDOM-16GB-M

IMPeDOM-32GB-M

IMPeDOM-64GB -M

IMPeDOM-128GB-M

IMPeDOM-256GB-M

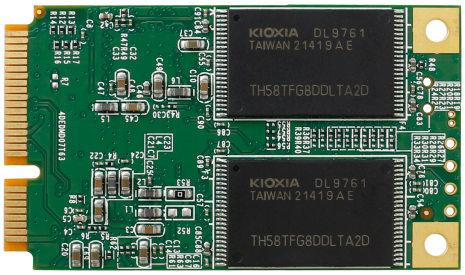


Figure 1: ICOP Mini PCIeDOM

1.3 PCI Express Interface

ICOP Mini PCIeDOM supports PCIe Gen.1 interface, with 1 lane.

2. Product Specifications

2.1 Capacity and Device Parameters

IMPeDOM device parameters are shown in Table 1.

Table 1: Device parameters

Capacity	LBA	Cylinders	Heads	Sectors	User Capacity(MB)
8GB	15649200	13587	16	63	7641
16GB	31277232	16383	16	63	15272
32GB	62533296	16383	16	63	30533
64GB	125045424	16383	16	63	61057
128GB	250069680	16383	16	63	122104
256GB	500118192	16383	16	63	244198

2.2 Performance

Burst Transfer Rate: 2.5Gbps

Table 2: Performance

Capacity	8GB	16GB	32GB	64GB	128GB	256GB
Sequential* Read (max.)	100 MB/sec	120 MB/sec	130MB/sec	130 MB/sec	130 MB/sec	130 MB/sec
Sequential* Write (max.)	20 MB/sec	40 MB/sec	70 MB/sec	100 MB/sec	100 MB/sec	100 MB/sec
4KB Random** Read (QD32)	3300	3300	3300	3300	3300	3700
4KB Random** Write (QD32)	5000	6900	8900	8900	9000	9000

Note: Base on CrystalDiskMark 3.01 with file size 1000MB

2.3 Electrical Specifications

2.3.1 Power Requirement

Table 3: ICOP Mini PCIeDOM Power Requirement

Item	Symbol	Rating	Unit
Input voltage	V_{IN}	+3.3 DC +- 5%	V

2.3.2 Power Consumption

Table 4: Power Consumption

Mode	Power Consumption (mA)
Read	565 (max.)
Write	622 (max.)
Idle	542 (max.)

* Target: IMPeDOM 64GB

2.4 Environmental Specifications

2.4.1 Temperature Ranges

Table 5: Temperature range for IMPeDOM

Temperature	Range
Operating	Standard Grade: 0°C to +70°C
	Industrial Grade: -40°C to +85°C
Storage	-40°C to +85°C

2.4.2 Humidity

Relative Humidity: 10-95%, non-condensing

2.4.3 Shock and Vibration

Table 6: Shock/Vibration Testing for IMPeDOM

Reliability	Test Conditions	Reference Standards
Vibration	7 Hz to 2K Hz, 20G, 3 axes	IEC 68-2-6
Mechanical Shock	Duration: 0.5ms, 1500 G, 3 axes	IEC 68-2-27

2.4.4 Mean Time between Failures (MTBF)

Table 7 summarizes the MTBF prediction results for various IMPeDOM configurations. The analysis was performed using a RAM Commander™ failure rate prediction.

- **Failure Rate**: The total number of failures within an item population, divided by the total number of lifeunits expended by that population, during a particular measurement interval under stated condition.
- **Mean Time between Failures (MTBF)**: A basic measure of reliability for repairable items: The meannumber of life units during which all parts of the item perform within their specified limits, during a particular

  measurement interval under stated conditions.

Table 7: IMPeDOM MTBF

Product	Condition	MTBF (Hours)
ICOP Mini PCIeDOM	Telcordia SR-332 GB, 25°C	>3,000,000

2.5 CE and FCC Compatibility

IMPeDOM conforms to CE and FCC requirements.

2.6 RoHS Compliance

IMPeDOM is fully compliant with RoHS directive.

2.7 Reliability

Parameter	Value
Read Cycles	Unlimited Read Cycles
Wear-Leveling Algorithm	Support
Bad Blocks Management	Support
Error Correct Code	Support
TBW* (Total Bytes Written)	Unit: TB
8GB	2.4
16GB	4.8
32GB	9.6
64GB	19.2
128GB	38.4
256GB	76.8
* Total bytes written is based on JEDEC 218 (Solid-State Drive Requirements and Endurance Test Method)	
** Lifespan is calculated by device written per day	

2.8 Transfer Mode

IMPeDOM support following transfer mode:

PCIe Gen.1, x1 2.5Gbps

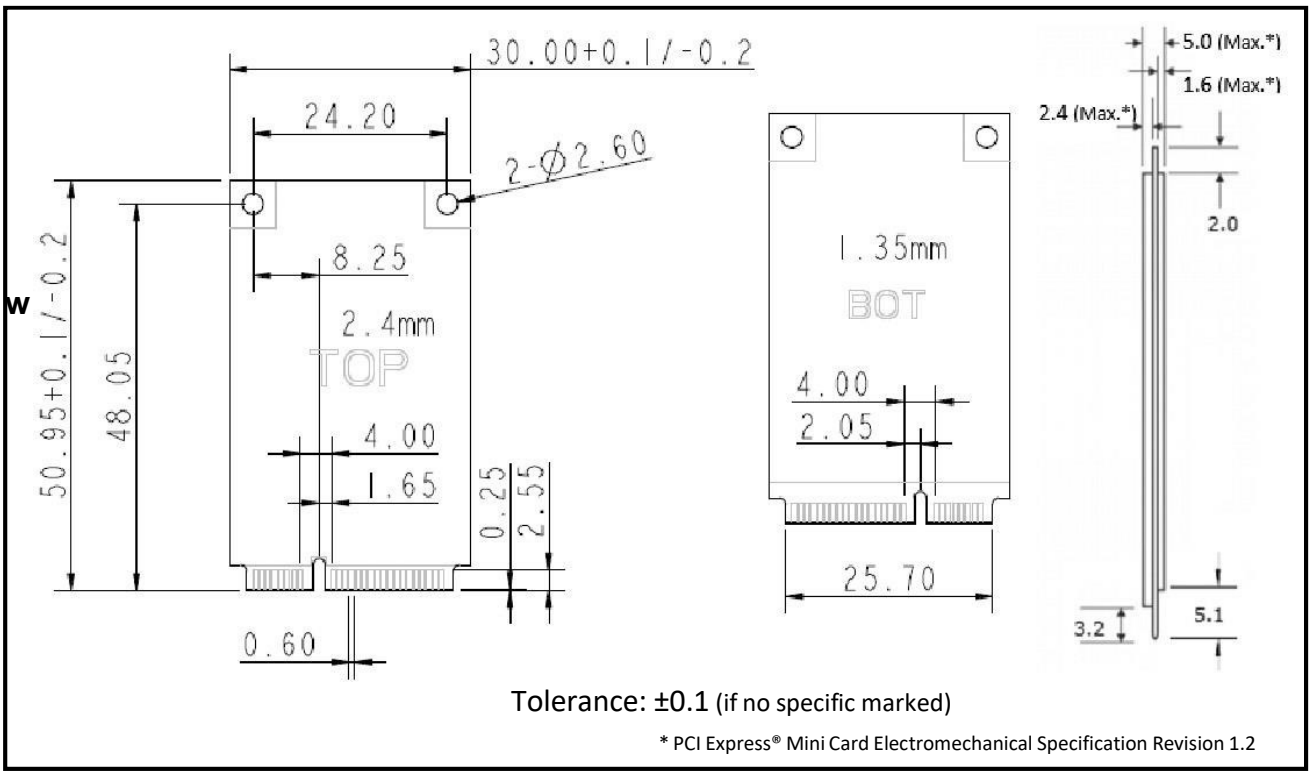
2.9 Pin Assignment

ICOP Mini PCIeDOM is designed with standard Mini PCIe pin-out. See Table 8 for IMPeDOM pin assignment.

Pin #	Signal Name	Pin #	Signal Name
51	NC	52	3.3V
49	NC	50	GND
47	NC	48	NC
45	NC	46	NC
43	GND	44	NC
41	3.3V	42	NC
39	3.3V	40	GND
37	GND	38	NC
35	GND	36	NC
33	PERp0	34	GND
31	PERn0	32	NC
29	GND	30	NC
27	GND	28	NC
25	PETp0	26	GND
23	PETn0	24	3.3V
21	GND	22	PERST#
19	NC	20	NC
17	NC	18	GND
Mechanical Key			
15	GND	16	NC
13	REFCLK+	14	NC
11	REFCLK-	12	NC
9	GND	10	NC
7	GND	8	NC
5	NC	6	NC
3	NC	4	GND
1	NC	2	3.3V

Table 8: ICOP Mini PCIeDOM Pin Assignment

2.10 Mechanical Dimensions



2.11 Assembly Weight

6.5g±0.5g

2.12 Seek Time

ICOP Mini PCIeDOM is not a magnetic rotating design. There is no seek or rotational latency required.

2.13 NAND Flash Memory

ICOP Mini PCIeDOM uses Multi Level Cell (MLC) NAND flash memory, which is non-volatility, high reliability and high speed memory storage.

3.Theory of Operation

3.1 Overview

Figure 2 shows the operation of ICOP Mini PCIeDOM from the system level, including the major hardware blocks.

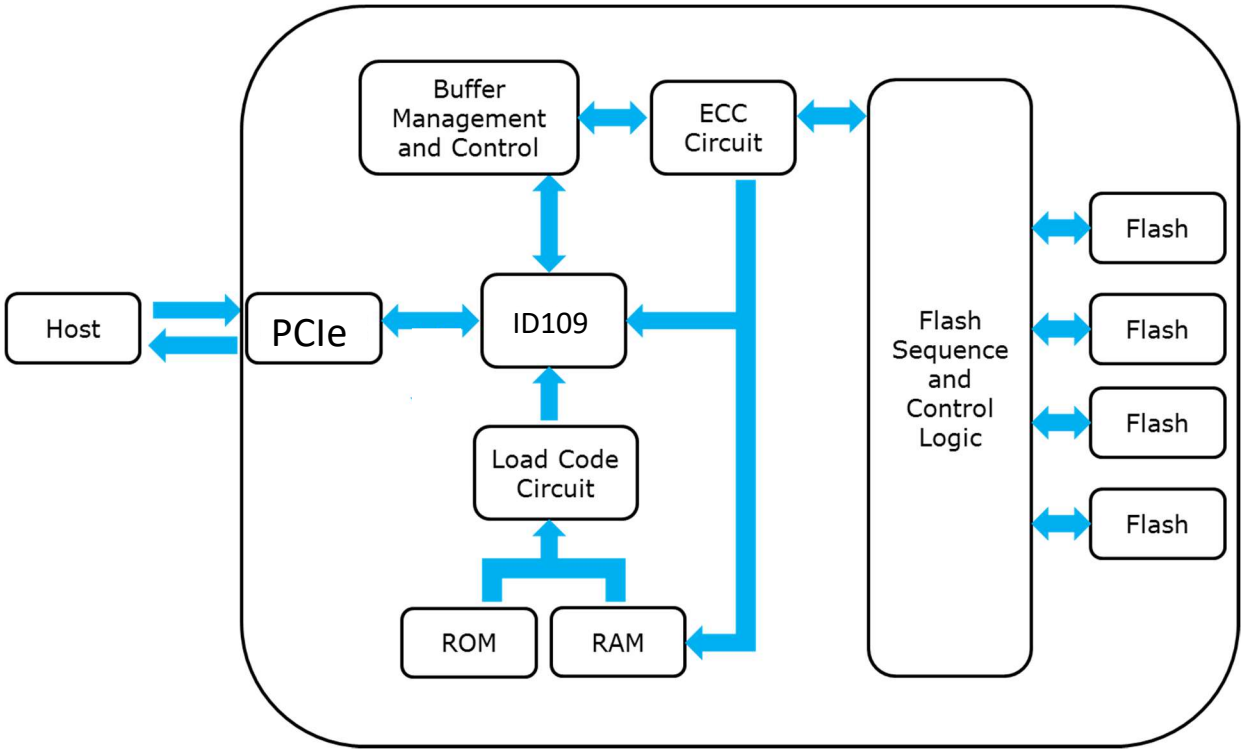


Figure 2: ICOP Mini PCIeDOM Block Diagram

ICOP Mini PCIeDOM integrates SATA controller, PCIe bridge controller and NAND flash memories. Communication with the host occurs through the host interface, using the standard PCIe protocol. Communication with the flash device(s) occurs through the flash interface.

3.2 Error Detection and Correction

Highly sophisticated Error Correction Code algorithms are implemented. The ECC unit consists of the Parity Unit (parity-byte generation) and the Syndrome Unit (syndrome-byte computation). This unit implements an algorithm that can correct 40 bits per 1024 bytes in an ECC block. Code-byte generation during write operations, as well as error detection during read operation, is implemented on the fly without any speed penalties.

3.3 Wear-Leveling

Flash memory can be erased within a limited number of times. This number is called the ***erase cycle limit*** or ***write endurance limit*** and is defined by the flash array vendor. The erase cycle limit applies to each individualerase block in the flash device.

ICOP Mini PCIeDOM uses a static wear-leveling algorithm to ensure that consecutive writes of a specific sector are not written physically to the same page/block in the flash. This spreads flash media usage evenly across all pages, thereby extending flash lifetime.

3.4 Bad Blocks Management

Bad Blocks are blocks that contain one or more invalid bits whose reliability are not guaranteed. The Bad Blocks may be presented while the SSD is shipped, or may develop during the life time of the SSD. When theBad Blocks is detected, it will be flagged, and not be used anymore. The SSD implement Bad Blocks management, Bad Blocks replacement, Error Correct Code to avoid data error occurred. The functions will beenabled automatically to transfer data from Bad Blocks to spare blocks, and correct error bit.

3.5 Power Cycling

Power cycling management is a comprehensive data protection mechanism that functions before and after a sudden power outage to SSD. Low-power detection terminates data writing before an abnormal power-off, while table-remapping after power-on deletes corrupt data and maintains data integrity. Power cycling provides effective power cycling management, preventing data stored in flash from degrading with use.

3.6 Garbage Collection

Garbage collection technology is used to maintain data consistency and perform continual data cleansing on SSDs. It runs as a background process, freeing up valuable controller resources while sorting good data into available blocks, and deleting bad blocks. It also significantly reduces write operations to the drive, thereby increasing the SSD’s speed and lifespan.

4.Installation Requirements

4.1 IMPeDOM Pin Directions

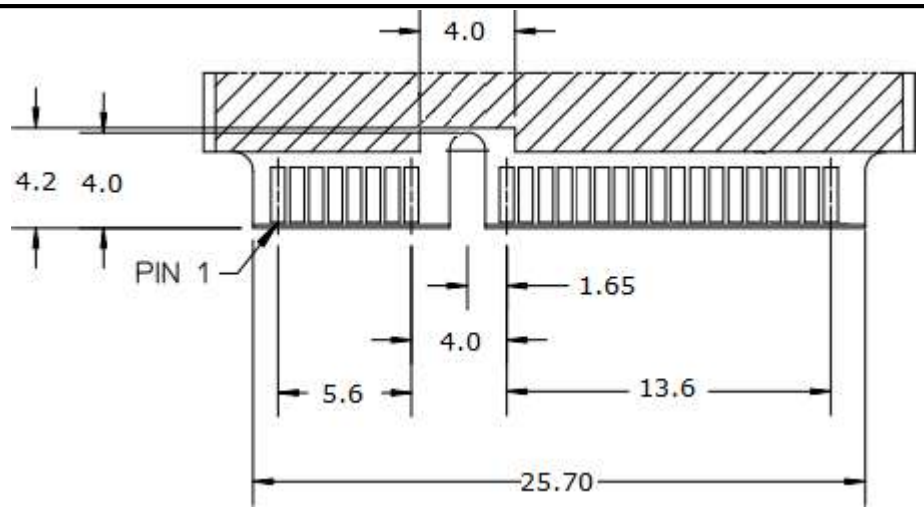


Figure 3: Signal Segment and Power Segment

4.4 Device Driver

No additional device driver are required. ICOP Mini PCIeDOM can be configured as a boot device