Preliminary Product Specification | Rev. 0.85|

G2 Silver

Industrial SATA CFast Card datasheet

120GB – 480GB

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1. Product Summary

Capacity Range	**120GB – 480GB**
Form Factor	**CFast Card**
Host Interface	**SATA Rev. 3.2** **SATA 3.0 6Gb/s** Backward compatible to SATA 3Gb/s, 1.5Gb/s
Performance	**Sequential read: up to 550 MB/s** **Sequential write: up to 500 MB/s** **Random read: up to 91K IOPS** **Random write: up to 85K IOPS**
Reliability	**MTBF: 3.0 million hours** **UBER: <1 sector / 10^{16} bits read**
Operating Temperature	
	Standard: 0°C ~ 70°C
Or	**Industrial: -40°C ~ 85°C**
Storage Temperature	**-40°C ~ 85°C**
Special Features	**Thermal throttling** **Security: AES256** **Thermal Monitor** **TCG OPAL2.0(optional)**
Compliances	**RoHS*, CE*, FCC*, WEEE*** *Note: Please contact with Intelligent Memory represent for the detail of compliance conformity.

2. Order Information

Table 1 – Part Numbers

Part Number	Capacity	Operating Temperature range
IMS3CAB1M2A2A1C3A9A0000	120GB	0°c ~ 70°c
IMS3CAB3M2A2A1C3B2A0000	240GB	
IMS3CAB5M2A2A1C3B4A0000	480GB	
IMS3CAB1M2A2A1I3A9A0000	120GB	-40°c ~ 85°c
IMS3CAB3M2A2A1I3B2A0000	240GB	
IMS3CAB5M2A2A1I3B4A0000	480GB	

3. Product Information

I'M's CFast Card product family features a SATA III interface and offers reliable high speed data throughput in various access modes. It is available in capacities up to 480GB, with customizable settings for Overprovisioning or Thermal Throttling.

3.1 Block Diagram

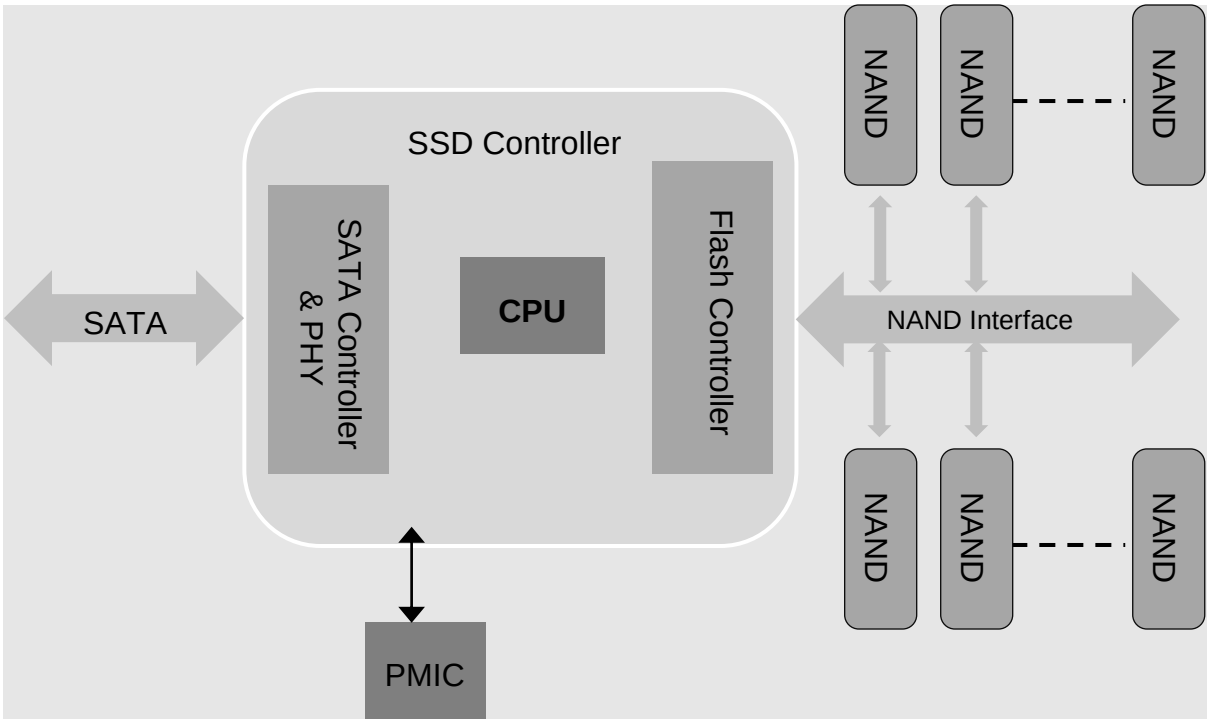


Figure 1 – Block Diagram

3.2 Product Features

Electrical/Physical Interface: *SATA*

- Compliant with SATA Revision 3.2.
- Compatible with SATA 1.5Gbps, 3Gbps and 6Gbps interface.
- Supports expanded register for SATA protocol 48 bits addressing mode.
- Supports power management.

Advanced Flash Management Features

LDPC ECC (Low Density Parity Check Error Correction Code)

The deterioration of the flash memory cell over time and the disruptions from neighboring flash memory pages can lead to random bit errors in the stored data. While the chances of any given data bit being corrupted is quite small, the vast number of data bits in a storage system makes the likelihood of data corruption a very real possibility. Error detection and correction codes are used in flash memory storage systems to protect the data from corruption.

Static and Dynamic Wear Leveling

Wear leveling is a process that helps reduce premature wearing out of NAND Flash devices. The Flash controller manages access to the NAND Flash memory devices and determines how the NAND Flash blocks are used. In most cases, the NAND Flash controller maintains a lookup table to translate the memory array's physical block address (PBA) to the logical block address (LBA) used by the host system known as Physical to Logical Address Translation Table.

Bad Block Management

Bad blocks are blocks that include one or more invalid bits, and their reliability is not guaranteed. Blocks that are identified and marked as bad by the manufacturer are referred to as "Initial Bad Blocks". Bad blocks that are developed during the lifespan of the flash are named "Later Bad Blocks"

S.M.A.R.T. functionality

SMART, an acronym for Self-Monitoring, Analysis and Reporting Technology, is an open standard that allows a hard disk drive to automatically detect its health and report potential failures. When a failure is recorded by SMART, users can choose to replace the drive to prevent unexpected outage or data loss. Moreover, SMART can inform users of impending failures while there is still time to perform proactive actions, such as copy data to another device.

Overprovision

Over provisioning is a technique used in the design of flash SSDs and flash media cards. By providing extra memory capacity (which the user can't access) the SSD controller can more easily create pre-erased blocks ready to be used in the virtual pool.

Overprovisioning improves:

· Write performance & IOPS

· Reliability & endurance

Thermal Throttling

Thermal throttling is designed to prevent any components in a SSD from over-heating during read and write operations. Intelligent Memory SSD implemented an on-die thermal sensor and with its accuracy; firmware can apply different levels of throttling to achieve the purpose of protection efficiently and proactively via temperature monitoring.

Security Features

Secure Erase

PSID (Optional for TCG OPAL 2.0)

Quick Erase (Optional)

Write Protection (Optional)

Lifetime & Endurance Management

Terabytes Written (TBW)

Media Wear Indicator

4. Product Specification

4.1 Performance

We specify the performance of our NAND products as below:

"**Peak**" describes the measured performance when the product is new and unused. It is commonly used by vendors in their datasheets. However, SSDs by design reduce performance after a relatively short usage period, so peak values cannot be used to predict an application's longer-term performance.

We are specifying peak performance for easier comparison of I'M's products with other solutions but recommend considering sustained performance values when selecting the most suitable solution for an application.

Table 2 – Peak Performance

Capacity	Sequential performance		Random Performance	
	Read (MB/s)	Write (MB/s)	4K Read (IOPS)	4K Write (IOPS)
120GB	550	450	44K	78K.
240GB	550	480	75K	82K
480GB	550	500	91K	85K

Notes:
1. Peak performance measured in **Fresh Out of the Box (FOB**) condition
2. Sequential performance is measured with 128KB transfer size; QD32 and 4KB align using CrystalDiskMark V5.0x64 with SATA 6Gbps host.
3. Random performance tested with 4KB length random write with QD32.
4. Performance may differ depending on application and platform.

4.2 Endurance and Reliability

4.2.1 Endurance

The lifetime of our NAND products is specified in TBW (Tera Byte Written) and DWPD(Drive Written per Day), i.e. the total amount of data that the host can write to the NAND media in a defined pattern. In our case this pattern is based on the workload definitions set by JEDEC in JESD219A.

Same as for performance, endurance specification varies greatly depending on the underlying assumptions (especially also if the formula set by JEDEC, including the guard band is used) and I'M recommend assuring these assumptions are the same when comparing TBW values of different products.

Table 3 – Tera Bytes Written

Capacity	TBW	TBW with guard band
120GB	90	45
240GB	230	115
480GB	550	275
Notes: 1. TBW values are specified based on JEDEC 218 client workload 2. Actual lifetime may vary depending on platform and application		
Note: JEDEC specifies to consider guard band of 2 for calculating the TBW as a wear levelling factor as industrial applications need more rigid working conditions.		

4.2.2 Reliability

Table 4 – Reliability

Parameter	Value
UBER	Uncorrectable Bit Error Rate (UBER) < 1 sector per 10^{16} bits read
MTBF	3,000,000 Hours

4.3 Power Supply

Table 5 – Supply Voltage

Supply Voltage	
Parameter	Rating
Operative Voltage	3.3V, +/-5%
Rise Time (Max/Min)	100ms/0.1ms
Fall Time (Max/Min)	5s/1ms
Min. Off Time*1	1s
Notes *1: Minimum time between power removed from SSD (Vcc < 100 mW) and power re-applied to the drive	

4.4 Power Consumption

Table 6 – Power Consumption

Capacity	Read	Write	Partial	Slumber	Idle
	Avg.	Avg.	Avg.	Avg.	Max.
120GB	1,200	1,200	65	25	210
240GB	1,200	1,350	65	25	210
480GB	1,250	1,550	65	30	210

Unit: mW

5. Environmental Specifications

5.1 Temperature and Humidity

Table 7 – High Temperature Test Condition

High Temperature Test			
Test Item		Temperature Standard/Wide Temp	Humidity
High Temperature Test	Operation	70°C/85°C	0% RH
	Storage	85°C	0% RH
Low Temperature Test	Operation	0°C /-40°C	0% RH
	Storage	-40°C	0% RH
High Humidity Test	Operation	40°C	90% RH
	Storage	40°C	93% RH
Temperature Cycle Test	Operation	0°C-70°C/-40°C-85°C	–
	Storage	-40°C ~ 85°C	–
Notes: 1. Operation temperature is measured by device temperature sensor. Airflow is suggested and it will allow device to be operated at appropriate temperature for each component during heavy workloads environment.			

5.2 Shock and Vibration

Table 8 – Mechanical Test Condition

Items			Condition
Shock	Operating	Acceleration Force	50G, (11ms duration, half sine wave)
	Non-operating		1500G, (0.5ms duration, half sine wave)
Vibration	Non-operating	Frequency/Acceleration	10Hz~2000Hz(peak)/10G

5.3 EMC

Table 9 – EMC Compliance

Items	Condition
ESD Compliance	EN 55024, CISPR 24 EN 61000-4-2 IEC 61000-4-2
EMI Compliance	EN 55032, CISPR 32(CE) CNS 13438 (BSMI) ANSI C63.4 (FCC) VCCI-CISPR 32 (VCCI)

6. Interface

6.1 Pin Assignment and Descriptions

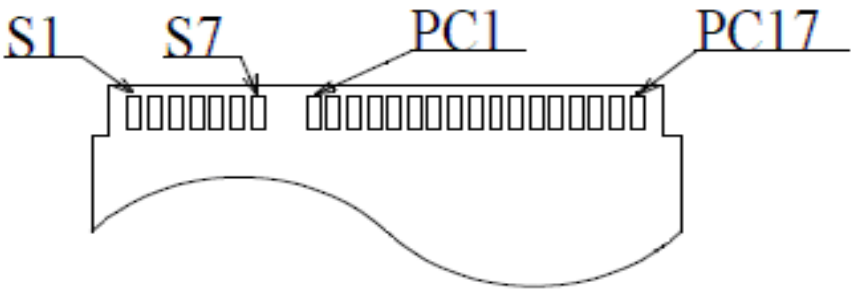


Figure 2 – Pin Locations

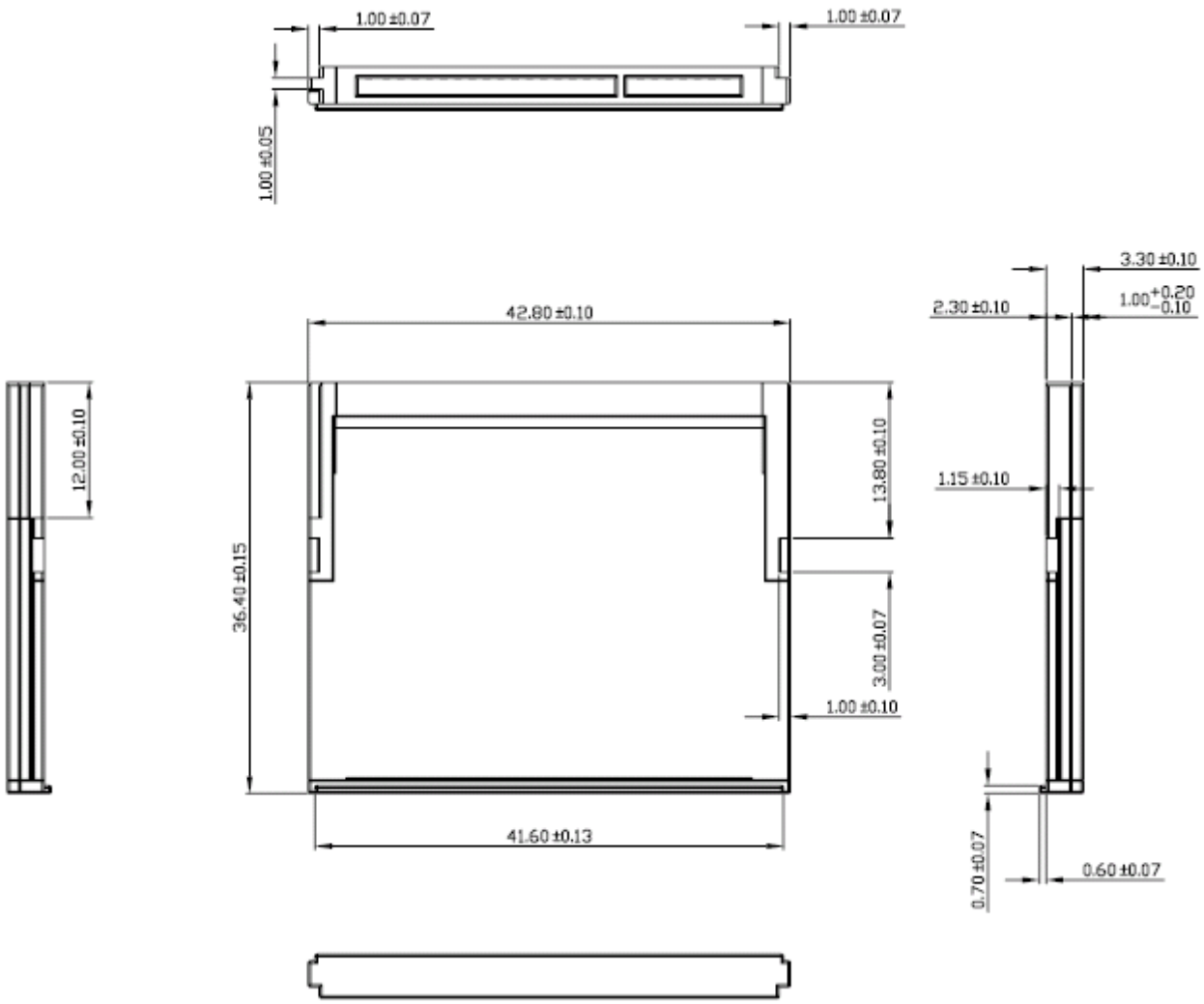
Table 10 – Pin Assignment and Descriptions

Pin #	Segment	Pin Definition	Type	Description	Meting Sequence
S1	SATA	SGND	Signal GND	Ground for signal integrity	1st
S2	SATA	A+	SATA Differential	Signal Pair A	2nd
S3	SATA	A-	SATA Differential	Signal Pair A	2nd
S4	SATA	SGND	Signal GND	Ground for signal integrity	1st
S5	SATA	B-	SATA Differential	Signal Pair B	2nd
S6	SATA	B+	SATA Differential	Signal Pair B	2nd
S7	SATA	SGND	Signal GND	Ground for signal integrity	1st
	Key				
	Key				
PC1	PWR/CTL	CDI	Input	Card Detect In	3rd
PC2	PWR/CTL	PGND	Device GND		1st
PC3	PWR/CTL	DEVSLP	DEVSLP Card Input	DevSleep Power State Enable	2nd
PC4	PWR/CTL			Reserved	2nd
PC5	PWR/CTL			Reserved	2nd
PC6	PWR/CTL			Reserved	2nd
PC7	PWR/CTL	PGND	Device GND		1st
PC8	PWR/CTL	LED1	LED Output	LED Output	2nd
PC9	PWR/CTL	LED2	LED Output	LED Output	2nd
PC10	PWR/CTL			Reserved	2nd
PC11	PWR/CTL			Reserved	2nd
PC12	PWR/CTL	IFDet	GND	Card output, connect to PGND on card	2nd
PC13	PWR/CTL	PWR	3.3V	Device Power (3.3V)	2nd
PC14	PWR/CTL	PWR	3.3V	Device Power (3.3V)	2nd
PC15	PWR/CTL	PGND	Device GND	Device Ground	1st

PC16	PWR/CTL	PGND	Device GND	Device Ground	1st
PC17	PWR/CTL	CDO	Output	Card Detect Out	3rd

7. Physical Dimensions

CFast Card Type I: 36.4mm (L) x 42.8mm (W) x 3.3mm (H)



8. Command Set

8.1 Supported Command List

Table 11 – ATA Command List

Description	Op Code			Description	Op Code	
CFA Write Sectors Without Erase	38h			Recalibrate	10h-1Fh	
Check Power Mode	E5h			Sanitize	B4h	
Data Set Management	06h			Security Disable Password	F6h	
Device Configuration	B1h			Security Erase Prepare	F3h	
Disable Device Automatic Partial to Slumber transitions	EFh	90h	07h	Security Erase Unit	F4h	
Disable Device Sleep	EFh	90h	09h	Security Freeze Lock	F5h	
Disable Device-initiated interface power state (DIPM) transitions	EFh	90h	03h	Security Set Password	F1h	
Disable DMA Setup FIS Auto-Activate optimization	EFh	90h	02h	Security Unlock	F2h	
Disable read look-ahead	EFh	55h		Seek	70h-7Fh	
Disable reverting to power-on defaults	EFh	66h		Set Features	EFh	
Disable Software Settings Preservation (SSP)	EFh	90h	06h	Set Max Address	F9h	
Disable the APM feature set	EFh	85h		SET MAX FREEZE LOCIK	F9h	04h
Disable use of SATA feature set	EFh	90h		SET MAX SET PASSWORD	F9h	01h
Disable volatile write cache	EFh	82h		SET MAX UNLOCK	F9h	03h
Download Microcode	92h			SET MAXLOCK	F9h	02h
Download Microcode DMA	93h			Set Multiple Mode	C6h	
Enable Device Automatic Partial to Slumber transitions	EFh	10h	07h	Set Native Max Address EXT	37h	
Enable Device Sleep	EFh	10h	09h	Set transfer mode	EFh	03h
Enable Device-initiated interface power state (DIPM) transitions	EFh	10h	03h	Sleep	E6h	
Enable DMA Setup FIS Auto-Activate optimization	EFh	10h	02h	SMART	B0h	
Enable read look-ahead	EFh	Aah		SMART DISABLE OPERATIONS	B0h	D9h
Enable reverting to power-on defaults	EFh	CCh		SMART ENABLE OPERATIONS	B0h	D8h
Enable Software Settings Preservation (SSP)	EFh	10h	06h	SMART ENABLE/DISABILE ATTRIBUTE AUTOSAVE	B0h	D2h
Enable the APM feature set	EFh	05h		SMART ENABLE/DISABILE AUTOMATIC OFF-LINE	B0h	DBh
Enable use of SATA features et	EFh	10h		SMART EXECUTE OFF-LINE IMMEDIATE	B0h	D4h
Enable volatile write cache	EFh	02h		SMART READ ATTRIBUTE THRESHOLDS	B0h	D1h
Execute Device Diagnostic	90h			SMART READ DATA	B0h	D0h
Flush Cache	E7h			SMART READ LOG	B0h	D5h

Flush Cache EXT	EAh	SMART RETURN STATUS	B0h	DAh
Identify Device	ECh	SMART SAVE ATTRIBUTE VALUES	B0h	D3h
Idle	E3h	SMART WRITE LOG	B0h	D6h
Idle Immediate	E1h	Standby	E2h	
Initialize Device Parameters	91h	Standby Immediate	E0h	
NOP	00h	Write Buffer	E8h	
Read Buffer	E4h	Write Buffer DMA	EBh	
READ BUFFER DMA	E9h	Write DMA	CAh	
Read DMA	C8h	Write DMA EXT	35h	
Read DMA EXT	25h	Write DMA FUA EXT	3Dh	
Read DMA without Retry	C9h	Write DMA without Retry	CBh	
Read FPDMA Queued	60h	Write FPDMA Queued	61h	
Read Log DMA EXT	47h	Write Log DMA EXT	57h	
Read Log EXT	2Fh	Write Long EXT	3Fh	
Read Multiple	C4h	Write Multiple	C5h	
Read Multiple EXT	29h	Write Multiple EXT	39h	
Read Native Max Address	F8h	Write Multiple FUA EXT	CEh	
Read Native Max Address EXT	27h	Write Sectors	30h	
Read Sectors	20h	Write Sectors EXT	34h	
Read Sectors EXT	24h	Write Sectors without Retry	31h	
Read Sectors without Retry	21h	Write Uncorrectable EXT	45h	
Read Verify Sectors	40h	Zero EXT	44h	
Read Verify Sectors EXT	42h			
Read Verify Sectors without Retry	41h			

8.2 Identify Device Data

Table 12 – Return Data of Identify Device Command

Word	F : Fixed V : Variable X : Both	Default Value	Description
0	F	0040h	General configuration bit-significant information
1	X	*1	Obsolete – Number of logical cylinders
2	V	C837h	Specific configuration
3	X	0010h	Obsolete – Number of logical heads (16)
4-5	X	00000000h	Retired
6	X	003Fh	Obsolete – Number of logical sectors per logical track(63)
7-8	V	00000000h	Reserved for assignment by the Compact Flash Association
9	X	0000h	Retired
10-19	F	Varies	Serial number (20 ASCII characters)

20-21	X	0000h	Retired
22	X	0000h	Obsolete
23-26	F	Varies	Firmware revision (8 ASCII characters)
27-46	F	Varies	Model number (xxxxxxxx)
47	F	8010h	7:0- Maximum number of sectors transferred per interrupt on MULTIPLE commands
48	F	4000h	Trusted Computing feature set options(not support)
49	F	2F00h	Capabilities
50	F	4000h	Capabilities
51-52	X	000000000h	Obsolete
53	F	0007h	Words 88 and 70:64 valid
54	X	*1	Obsolete – Number of logical cylinders
55	X	0010h	Obsolete – Number of logical heads (16)
56	X	003Fh	Obsolete – Number of logical sectors per track (63)
57-58	X	*2	Obsolete – Current capacity in sectors
59	F	0110h	Number of sectors transferred per interrupt on MULTIPLE commands
60-61	F	*3	Maximum number of sector (28bit LBA mode)
62	X	0000h	Obsolete
63	F	0407h	Multi-word DMA modes supported/selected
64	F	0003h	PIO modes supported
65	F	0078h	Minimum Multiword DMA transfer cycle time per word
66	F	0078h	Manufacturer's recommended Multiword DMA transfer cycle time
67	F	0078h	Minimum PIO transfer cycle time without flow control
68	F	0078h	Minimum PIO transfer cycle time with IORDY flow control
69	F	1F00h	Additional Supported (support download microcode DMA)
70	F	0000h	Reserved
71-74	F	0000000000000000h	Reserved for IDENTIFY PACKET DEVICE command
75	F	001Fh	Queue depth
76	F	C50Eh	Serial SATA capabilities
77	F	0006h	Serial ATA Additional Capabilities
78	F	044Ch	Serial ATA features supported
79	V	0040h	Serial ATA features enabled
80	F	0FF8h	Major Version Number
81	F	0000h	Minor Version Number
82	F	746Bh	Command set supported
83	F	7D09h	Command set supported
84	F	4163h	Command set/feature supported extension
85	V	7469h	Command set/feature enabled
86	V	BC01h	Command set/feature enabled
87	V	4163h	Command set/feature default
88	V	007Fh	Ultra DMA Modes
89	F	000Ah	Time required for security erase unit completion

90	F	001Eh	Time required for Enhanced security erase completion
91	V	0000h	Current advanced power management value
92	V	FFFEh	Master Password Revision Code
93	F	0000h	Hardware reset result. The contents of the bits (12:0) of this word can be changed only during the execution of hardware reset.
94	V	0000h	Vendor's recommended and actual acoustic management value
95	F	0000h	Stream Minimum Request Size
96	V	0000h	Streaming Transfer Time – DMA
97	V	0000h	Streaming Access Latency – DMA and PIO
98-99	F	0000h	Streaming Performance Granularity
100-103	V	*4	Maximum user LBA for 48 bit Address feature set
104	V	0000h	Streaming Transfer Time – PIO
105	F	0004h	Maximum number of 512-byte blocks per DATA SET MANAGEMENT command
106	F	4000h	Physical sector size/Logical sector size
107	F	0000h	Inter-seek delay for ISO-7779 acoustic testing in microseconds
108-111	F	0000000000000000h	Unique ID
112-115	F	0000000000000000h	Reserved
116	V	0000h	Reserved
117-118	F	00000000h	Words per logical Sector
119	F	4018h	Supported settings
120	F	4018h	Command set/Feature Enabled/Supported
121-126	F	0000h	Reserved
127	F	0000h	Removable Media Status Notification feature set support
128	V	0021h	Security status
129-140	X	0000h	Vendor specific
141	X	0000h	Vendor specific
142-159	X	00000h	Vendor specific
160	F	00000h	Compact Flash Association (CFA) power mode 1
161-167	X	00000h	Reserved for assignment by the CFA
168	F	3h 2.5 inch 4h 1.8 inch 5h Less than 1.8 inch	Device Nominal Form Factor
169	F	0001h	DATA SET MANAGEMENT command is supported
170-173	F	0000h	Additional Product Identifier
174-175	X	0000h	Reserve
176-205	V	0000h	Current media serial number
206	F	0000h	SCT Command Transport
207-208	F	0000h	Reserved
209	F	4000h	Alignment of logical blocks within a physical block
210-211	V	0000h	Write-Read-Verify Sector Count Mode 3 (not support)
212-213	F	0000h	Write-Read-Verify Sector Count Mode 2 (not support)
214-216	X	0000h	NV Cache relate (not support)

217	F	0001h	Non-rotating media device
218	F	0000h	Reserved
219	F	0000h	NV Cache relate (not support)
220	V	0000h	Write read verify feature set current mode
221	X	0000h	Reserved
222	F	107Fh	Transport major version number
223	F	0000h	Transport minor version number
224-229	X	0000h	reserved
230-233	F	0000h	Extend number of user addressable sectors
234	F	0001h	Minimum number of 512-byte data blocks per DOWNLOAD MICROCODE command for mode 03h
235	F	FFFEh	Maximum number of 512-byte data blocks per DOWNLOAD MICROCODE command for mode 03h
236-242	X	0000h	Reserved
243	F	0000h	Security Feature 4000 :Self Encrypting Drive
244-254	F	0000h	Reserved
255	X	XXA5h XX is variable	Integrity word (Checksum and Signature)

Table 13 –List of Device Identification for Each Capacity

Capacity (GB)	*1 (Word 1 / Word 54)	*2 (Word 57 – 58)	*3 (Word 60 – 61)	*4 (Word 100 – 103)
120	3FFFh	FBFC10h	DF94BB0h	DF94BB0h
240	3FFFh	FBFC10h	FFFFFFFh	1BF244B0h
480	3FFFh	FBFC10h	FFFFFFFh	37E436B0h

9. Revision History

Revision	Descriptions	Release Date
0.1	Preliminary release	May, 2022
0.85	Performance, Power measurement and Endurance updates	May, 2022

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IMS3CAB1M2A2A1I3A9A0000 IMS3CAB3M2A2A1I3B2A0000