Product Specification | Rev. 1.1 |

G1 Silver

Industrial microSD Card 6.10 datasheet

32GB - 256GB

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1. Product Summary

CAPACITY RANGE:	32GB – 256GB
FORM FACTOR:	microSD Card
HOST INTERFACE:	SD 6.1
SPEED CLASS:	CLASS10, UHS-I Grade 3, V30, A2
PERFORMANCE:	Sequential read: up to 91 MB/s Sequential write: up to 80 MB/s Random read: up to 2.1K IOPS Random write: up to 1.4K IOPS
RELIABILITY:	MTBF: 3 million hours UBER: <1 sector / 10^{16} bits read
OPERATING TEMPERATURE:	
	Mobile: -25°C ~ 85°C
Or	Industrial: -40°C ~ 85°C
STORAGE TEMPERATURE:	-40°C ~ 85°C
SPECIAL FEATURES:	CPRM (Content Protection for Recordable Media) * Password Protection of cards (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	Speed Class	Operating Temperature range
IMSDUDA8D2A2A1E3A6A0000	32GB	CLASS10, UHS-I Grade 3, V30, A2	-25°c ~ 85°c
IMSDUDA8D2A2A1E3A8A0000	64GB	CLASS10, UHS-I Grade 3, V30, A2	
IMSDUDB1D2A2A1E3B1A0000	128GB	CLASS10, UHS-I Grade 3, V30, A2	
IMSDUDB3D2A2A1E3B3A0000	256GB	CLASS10, UHS-I Grade 3, V30, A2	
IMSDUDA8D2A2A1I3A6A0000	32GB	CLASS10, UHS-I Grade 3, V30, A2	-40°c ~ 85°c
IMSDUDA8D2A2A1I3A8A0000	64GB	CLASS10, UHS-I Grade 3, V30, A2	
IMSDUDB1D2A2A1I3B1A0000	128GB	CLASS10, UHS-I Grade 3, V30, A2	
IMSDUDB3D2A2A1I3B3A0000	256GB	CLASS10, UHS-I Grade 3, V30, A2	

* GB: 1GB = 1,000,000,000 bytes. The actual usable capacity may be less than the labeled capacity.

3. Product Information

3.1 Compliant Specifications – SD Memory Card Specifications:

Compliant with Part 1 Physical Layer Specification Ver. 6.10

Compliant with Part 2 File System Specification Ver. 3.00

Compliant with Part 3 Security Specification Ver. 7.00

Standard Size SD Card Mechanical Addendum Ver . 7.0

3.2 Bus Speed Mode (use 4 parallel data lines)

Non-UHS mode

- Default Speed Mode: 3.3V signaling, frequency up to 25MHz, data transfer up to 12.5MB/sec
- High Speed Mode: 3.3V signaling, frequency up to 50MHz, data transfer up to 25MB/sec

UHS-I mode

- SDR12: SDR up to 25MHz, 1.8V signaling
- SDR25: SDR up to 50MHz, 1.8V signaling
- SDR50: 1.8V signaling, frequency up to 100MHz, up to 50 MB/sec
- SDR104: 1.8V signaling, frequency up to 208MHz, up to 104MB/sec.
- DDR50: 1.8V signaling, frequency up to 50MHz, sampled on both clock edges, up to 50MB/sec

Note: Timing in 1.8V signaling is different from that of 3.3V signaling.

3.3 Product Features

Electrical/Physical Interface: *SD*

- Support SD SPI mode
- Designed for read-only and read/write cards
- The command list supports [Part 1 Physical Layer Specification Ver 6.01] definitions
- Support CPRM (Content Protection for Recordable Media) of SD Card (optional)
- Support Hot Plug

  Card removal during read operation will never harm the content
- Password Protection of cards (optional)
- +4KV/-4KV ESD protection in contact pads
- Operation voltage range: 2.7 ~ 3.6V

Copyrights Protection Mechanism

- Compliant with Part 1 Physical Layer Specification ver. 6.10, CPRM is Optional in SDHC/SDXC.

Advanced Flash Management

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".

3.4 SD Card Comparison

Table 2 – SDSC, SDHC, and SDXC Comparison table

Comparison Table			
	microSDSC	microSDHC	microSDXC
File System	FAT 12/16	FAT32	exFAT
Addressing Mode	Byte (1 byte unit)	Block (512 byte unit)	Block (512 byte unit)
HCS/CCS bits of ACMD41	Support	Support	Support
CMD8 (SEND_IF_COND)	Support	Support	Support
CMD16 (SET_BLOCKLEN)	Support	Support (Only CMD42)	Support (Only CMD42)
Partial Read	Support	Not Support	Not Support
Lock/Unlock Function	Mandatory	Mandatory	Mandatory
Write Protect Groups	Optional	Not Support	Not Support
Supply Voltage 2.0V – 2.7V (for operation)	Support	Support	Support
Total Bus Capacitance for each signal line	40pF	40pF	40pF
CSD Version (CSD_STRUCTURE Value)	1.0 (0x0)	2.0 (0x1)	2.0 (0x1)
Speed Class	Optional	Mandatory (Class 2 / 4 / 6 / 10)	Mandatory (Class 2 / 4 / 6 / 10)

4. Product Specification

4.1 Performance

We specify the performance of our NAND products in 2 ways:

- "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.
- "Sustained" describes the guaranteed average performance of the SSD and is in most cases more relevant for system designers to understand if a specific SSD will work reliably within the required parameters of an application. Sustained performance is usually not specified in datasheets which makes it harder to compare different products

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 3 – Burst Performance

Capacity	Speed Class	Sequential performance		Random Performance	
		Read (MB/s)	Write (MB/s)	4K Read (IOPS)	4K Write (IOPS)
32GB	A2, V30, CL10, UHS-I Grade 3	91	48	2130	1300
64GB		91	48	2130	1300
128GB		91	79	2160	1400
256GB		91	80	2060	1450

Notes:
1. Peak performance measured in **Fresh Out of the Box (FOB)** condition
2. Sequential performance is measured 1GB size with 128KB transfer size; 4KB align with IO Meter.
3. Random performance tested with IO Meter: 4KB random.
4. Performance may differ depending on application and platform.

Table 4 – Sustained Performance

Capacity	Speed Class	Sequential performance		Random Performance	
		Read (MB/s)	Write (MB/s)	4K Read (IOPS)	4K Write (IOPS)
32GB	A2, V30, CL10, UHS-I Grade 3	91	48	2230	750
64GB		91	48	2230	750
128GB		91	79	2150	880
256GB		91	80	2060	880

Notes:
1. Sustained performance specified average speed measured with following conditions.
   - Data among written over twice of the user capacity.
   - Measured with long duration test over whole user data area.
2. Sequential performance is measured with 128KB transfer size, 4KB align with IO Meter over 100% user data area and at Steady State condition.
3. Random performance tested with IO Meter: 4KB size random write over 100% user data area and at Steady State conditions.

3. Performance may differ according to application and platforms.

4.2 Endurance and Reliability

4.2.1 Endurance

Intelligent Memory defines Endurance with a comprehensive measure of TBW (Tera Bytes Written). By considering TBW, we recognize that P/E cycles alone do not provide a complete picture of the drive's endurance capabilities. TBW considers the total amount of data that can be written to the drive throughout its operational lifespan, offering a more accurate estimation of longevity.

The workload patterns can vary greatly among different users and applications. These are specified by JEDEC in the document JESD219A. We test the drives based on these workloads. Factors like write-intensive workloads, frequent data modifications, and large file transfers can impact the endurance of a storage device. By considering TBW, we can better align their products with the specific needs and expectations of their diverse customer base.

In the JEDEC document JESD219A, the importance and requirements of considering a guard bank of 2 as wear levelling factor when calculating TBW is being specified. This takes into account the additional write operations that occur during normal usage, ensuring accurate estimations of the expected lifetime of the storage device. This approach provides a more realistic assessment of the TBW, which is crucial for users and organizations relying on accurate specifications for their storage solutions.

Table 5 – Tera Bytes Written

Capacity	TBW	
	JEDEC Client Workload	JEDEC Enterprise Workload
32GB	150	33
64GB	150	33
128GB	300	63
256GB	600	130

Notes:
1. TBW values are measured based on Enterprise and Client workloads specified according JEDEC standards in JESD219A.
2. Actual lifetime may vary depending on platform and application.

4.2.2 Reliability

Table 6 – Reliability

Parameter	Value
MTBF	3,000,000 Hours

5. Electrical Specifications

5.1 Power Consumption

Table 7 – Power Consumption

Power Consumption			
Capacity	Max. Current Consumption		
	Read (mA)@@3.3V	Write (mA)@3.3V	Idle (mA)
32GB	75	75	0.15
64GB	75	75	0.15
128GB	75	100	0.15
256GB	80	105	0.15

Notes:
1.Power consumption are measured at room temperature.
2.Max.consumption measured with highest speed mode and highest performance condition.

5.2 DC Characteristic

Table 8 – Bus Operating Conditions – Threshold Level

Bus Operating Conditions – Threshold Level					
Parameter	Symbol	Min	Max	Unit	Condition
Supply Voltage	VDD	2.7	3.6	V	
Output High Voltage	VOH	0.75*VDD		V	IOH=-2mA VDD Min
Output Low Voltage	VOL		0.125*VDD	V	IOL=2mA VDD Min
Input High Voltage	VIH	0.625*VDD	VDD+0.3	V	
Input Low Voltage	VIL	VSS-0.3	0.25*VDD	V	
Power Up Time			250	ms	From 0V to VDD min

Table 9 – Peak Voltage and Leakage Current

Peak Voltage and Leakage Current			
Parameter	Min	Max	Unit
Peak voltage on all lines	-0.3	VDD+0.3	V
All inputs			
Input Leakage Current	-10	10	uA

All outputs			
Output Leakage Current	-10	10	uA

5.3 Bus Signal Line Levels

Table 10 – Bus Operation Conditions – Signal Line's Load

Bus Operation Conditions – Signal Line's Load					
Parameter	Symbol	Min	Max	Unit	Remark
Pull-up resistance	R_{CMD} R_{DAT}	10	100	kΩ	To prevent bus floating
Total bus capacitance for each signal line	C_L		40	pF	1 card C_{HOST}+C_{BUS} shall not exceed 30 pF
Card Capacitance for each signal pin	C_{CARD}		10	pF	
Maximum signal line inductance			16	nH	
Pull-up resistance inside card (pin1)	R_{DAT3}	10	90	kΩ	May be used for card detection
Capacity Connected to Power Line	C_C		5	uF	To prevent inrush current

Notes:
1.The total capacitance CL the CLK line of the SD Memory Card bus is the sum of the bus master capacitance CHOST, the bus capacitance CBUS itself and the capacitance CCARD of each card connected to this line: CL = CHOST + CBUS + N*CCARD , Where N is the number of connected cards.

5.4 Power up Time of Host

Host needs to keep power line level less than 0.5V and more than 1ms before power ramp up.

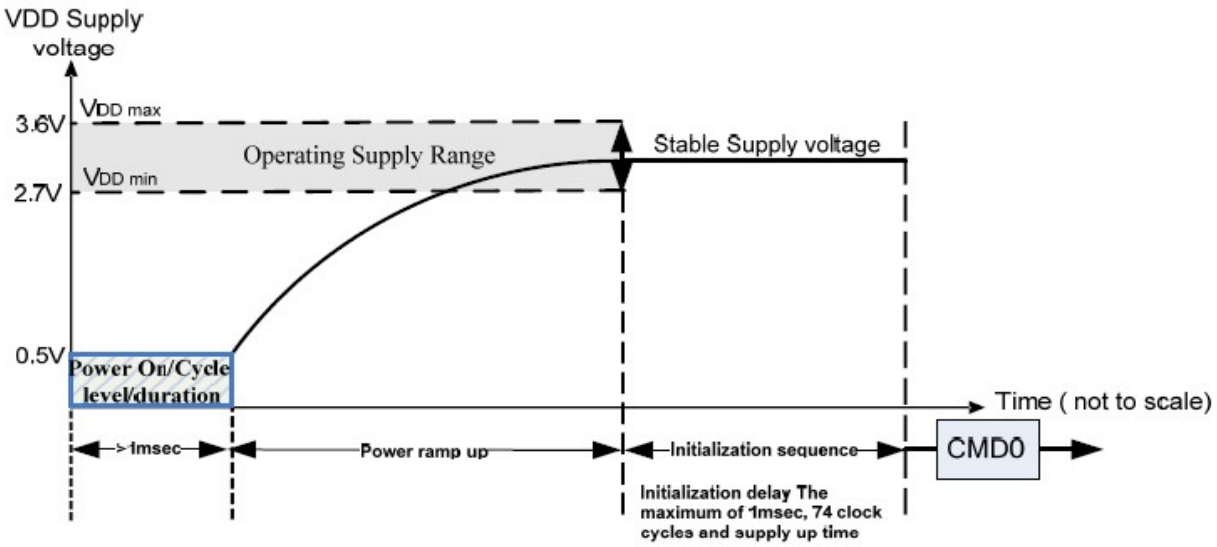


Figure 1 – Power up Time of Host

Power On or Power Cycle

Followings are requirements for Power on and Power cycle to assure a reliable SD Card hard reset.

(1) Voltage level shall be below 0.5V

(2) Duration shall be at least 1ms.

Power Supply Ramp Up

The power ramp up time is defined from 0.5V threshold level up to the operating supply voltage which is stable between VDD (min.) and VDD (max.) and host can supply SDCLK.

Followings are recommendation of Power ramp up:

(1) Voltage of power ramp up should be monotonic as much as possible.

(2) The minimum ramp up time should be 0.1ms.

(3) The maximum ramp up time should be 35ms for 2.7-3.6V power supply.

(4) Host shall wait until VDD is stable.

(5) After 1ms VDD stable time, host provides at least 74 clocks before issuing the first command.

Power Down and Power Cycle

When the host shuts down the power, the card VDD shall be lowered to less than 0.5Volt for a minimum period of 1ms. During power down, DAT, CMD, and CLK should be disconnected or driven to logical 0 by the host to avoid a situation that the operating current is drawn through the signal lines.

If the host needs to change the operating voltage, a power cycle is required. Power cycle means the power is turned off and supplied again. Power cycle is also needed for accessing cards that are already in Inactive State. To create a power cycle the host shall follow the power down description before power up the card (i.e. the card VDD shall be once lowered to less than 0.5Volt for a minimum period of 1ms).

5.5 Power Up Time of Card

A device shall be ready to accept the first command within 1ms from detecting VDD min. Device may use up to 74 clocks for preparation before receiving the first command.

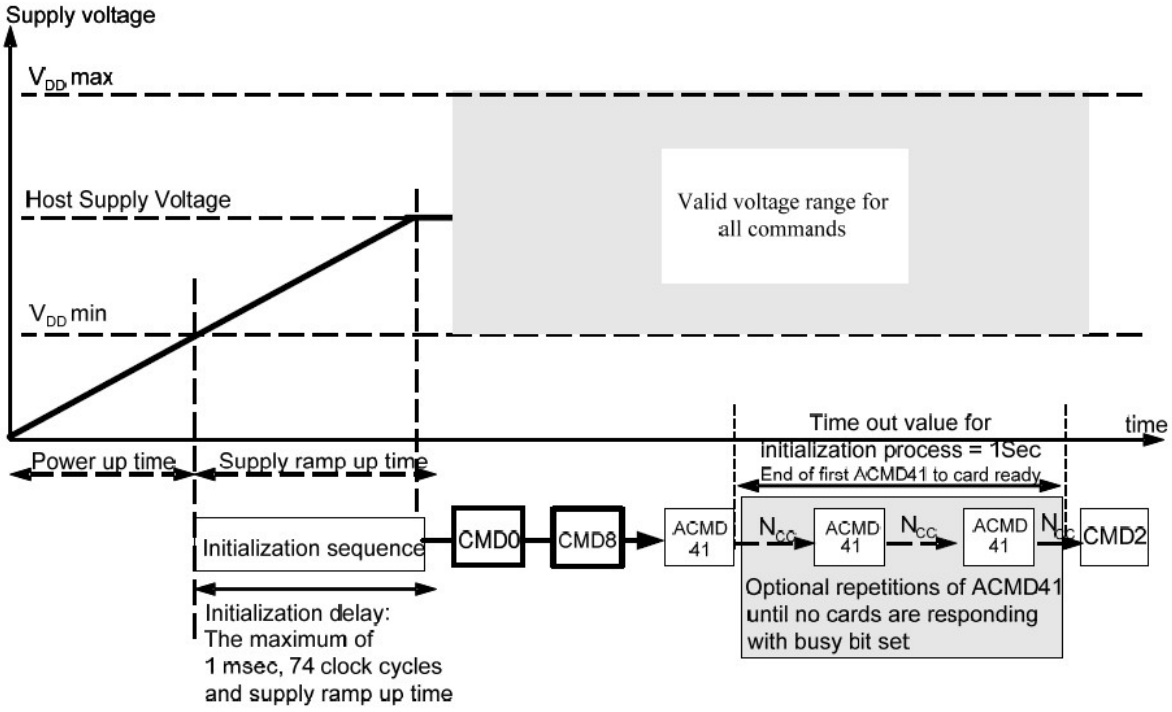


Figure 2 – Power up Time of Card

5.6 SD Interface Timing (Default)

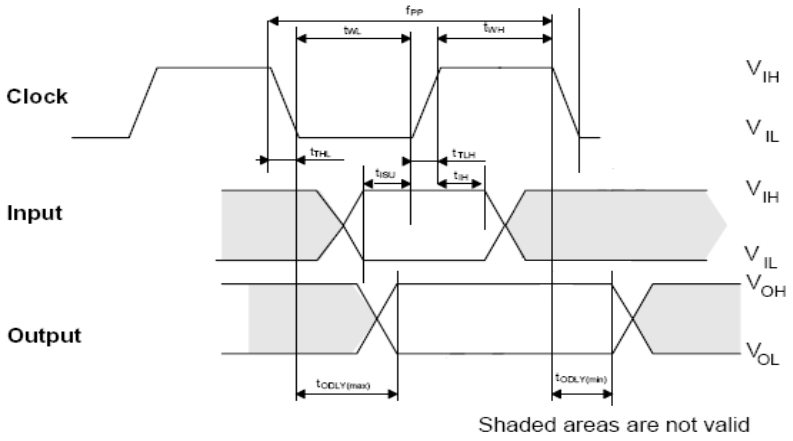


Figure 3 – Input/Output Timing (Default Speed Mode)

Table 11 – Bus Operation Conditions – Signal Line's Load

Interface timing (Default)					
Parameter	Symbol	Min	Max	Unit	Remark
Clock CLK (All values are referred to min(V_{IH}) and max(V_{IL})					
Clock frequency Data Transfer Mode	f_{PP}	0	25	MHz	Ccard≤ 10pF (1 card)
Clock frequency Identification Mode	f_{OD}	0_{*1}/100	400	kHz	Ccard≤ 10pF (1 card)
Clock low time	t_{WL}	10		n	Ccard≤ 10pF (1 card)
Clock high time	t_{WH}	10		ns	Ccard≤ 10pF (1 card)
Clock rise time	t_{TLH}		10	ns	Ccard≤ 10pF (1 card)
Clock fall time	t_{THL}		10	ns	Ccard≤ 10pF (1 card)
Inputs CMD, DAT (referenced to CLK)					
Input set-up time	t_{ISU}	5		ns	Ccard≤ 10pF (1 card)
Input hold time	t_{IH}	5		ns	Ccard≤ 10pF (1 card)
Outputs CMD, DAT (referenced to CLK)					
Output Delay time during Data Transfer Mode	t_{ODLY}	0	14	ns	C_L≤40pF (1 card)
Output Delay time during Identification Mode	t_{ODLY}	0	50	ns	C_L≤40pF (1 card)

Notes:
*1: 0Hz means to stop the clock. The given minimum frequency range is for cases were continues clock is required.

5.7 SD Interface Timing (High-Speed Mode)

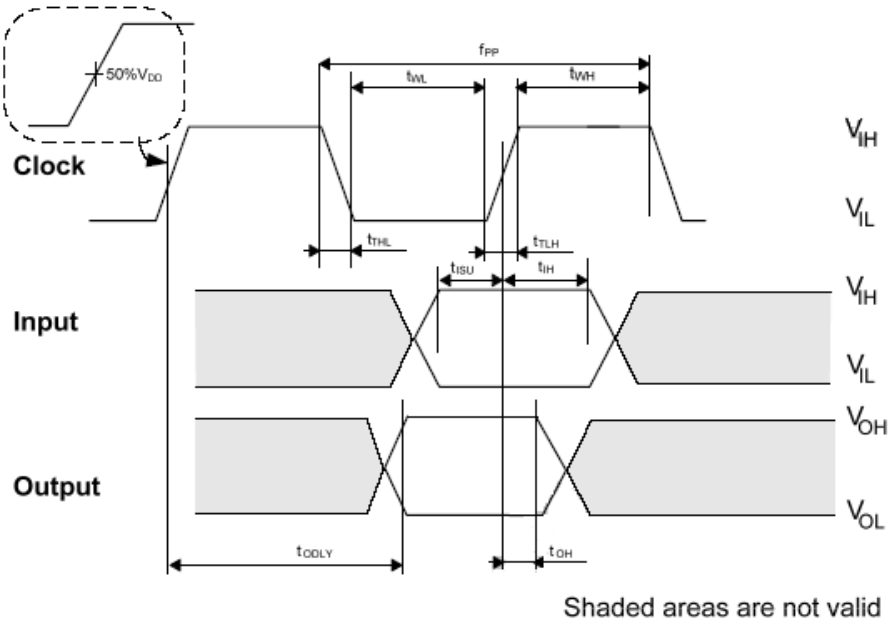


Figure 4 – Input/Output Timing (High-Speed Mode)

Table 12 – Interface timing (High-Speed Mode)

Interface timing (High-Speed Mode)					
Parameter	Symbol	Min	Max	Unit	Remark
Clock CLK (All values are referred to min(V_{IH}) and max(V_{IL})					
Clock frequency Data Transfer Mode	f_{PP}	0	50	MHz	C_{card}≤10pF (1 card)
Clock low time	t_{WL}	7		ns	C_{card}≤10pF (1 card)
Clock high time	t_{WH}	7		ns	C_{card}≤10pF (1 card)
Clock rise time	t_{TLH}		3	ns	C_{card}≤10pF (1 card)
Clock fall time	t_{THL}		3	ns	C_{card}≤10pF (1 card)
Inputs CMD, DAT (referenced to CLK)					
Input set-up time	t_{ISU}	6		ns	C_{card}≤10pF (1 card)
Input hold time	t_{IH}	2		ns	C_{card}≤10pF (1 card)
Outputs CMD, DAT (referenced to CLK)					
Output Delay time during Data Transfer Mode	t_{ODLY}		14	ns	C_L≤40pF (1 card)
Output Hold time	T_{OH}	2.5		ns	C_L≤15pF (1 card)
Total System capacitance of each line*1	C_L		40	nF	C_L≤15pF (1 card)
Notes: *1: In order to satisfy severe timing, the host shall drive only one card. AC Characteristic (SDR12, SDR25, SDR50 and SDR10					

SD Interface Timing (SDR12, SDR25, SDR50 and SDR104 Modes)

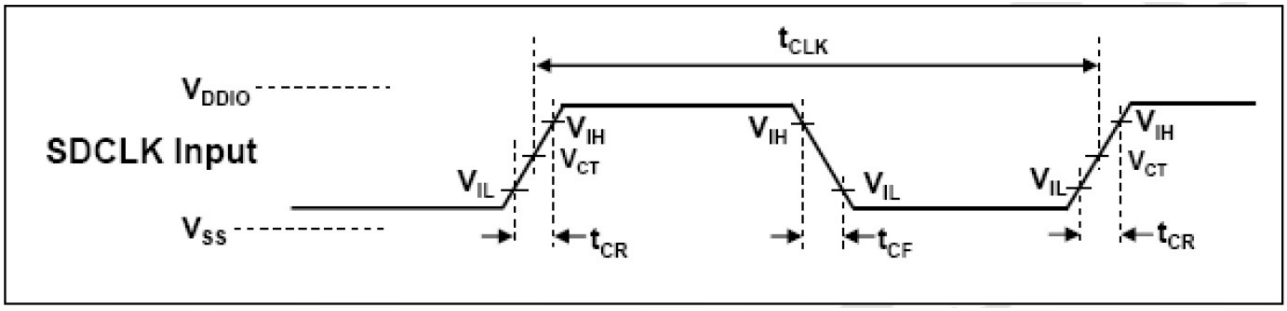


Figure 5 – Clock Signal Timing

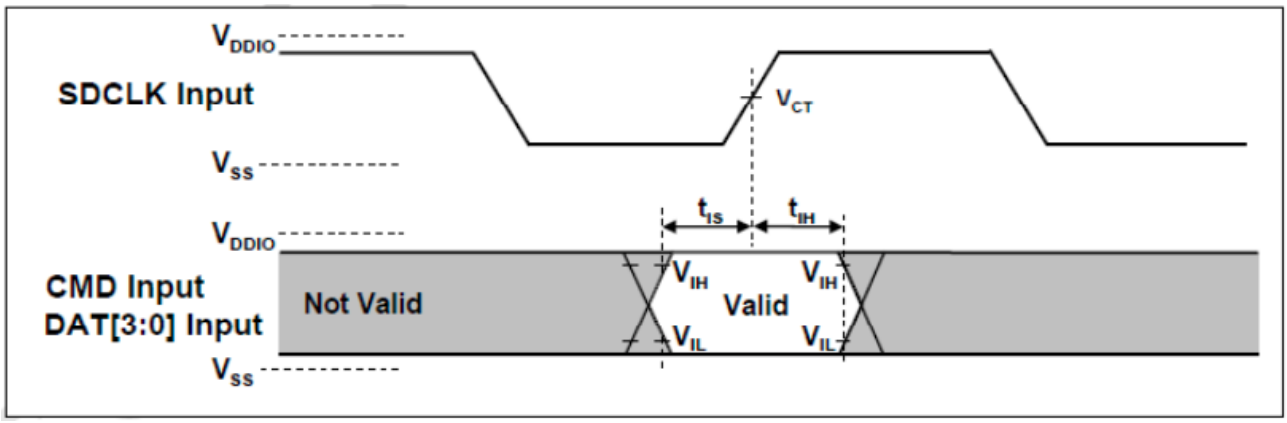


Figure 6 – Card Input Timing

Table 13 – Interface timing (High-Speed Mode)

Interface timing (SDR12, SDR25, SDR50 and SDR104 Modes Input)				
Symbol	Min	Max	Unit	Remark
tCLK	4.8	-	ns	208MHz (Max.), Between rising edge, V CT= 0.975V
tCR, tCF	-	0.2* tCLK	ns	tCR, tCF < 0.96ns (max.) at 208MHz, CCARD =10pF tCR, tCF < 2.00ns (max.) at 100MHz, CCARD =10pF The absolute maximum value 18ft he, tCF is 10ns regardless of clock frequency
Clock Duty	30	70	%	
Symbol	Min	Max	Unit	SDR 104 Mode
tIS	1.40	-	ns	CCARD =10pF, VCT= 0.975V
tIH	0.81	-	ns	CCARD = 5pF, VCT= 0.975V
Symbol	Min	Max	Unit	SDR50 Mode
tIS	3.00	-	ns	CCARD =10pF, VCT= 0.975V
tIH	0.81	-	ns	CCARD = 5pF, VCT= 0.975V

6. Environmental Specifications

Table 14 – Environmental Specifications

Environmental Specifications			
Test		**Test Condition**	
Temperature		Operation	Mobile temperature: -25°c ~ 85°c, 0% RH, 96 hours Industrial temperature: -40°c ~ 85°c, 0% RH, 300 hours
		Storage	Mobile temperature: -40°c, 0% RH, 168 hours; 85°c, 0% RH, 500 hours Industrial temperature: -40°c, 0% RH, 500 hours; 85°c, 0% RH, 500 hours
Humidity		Operation	Mobile temperature: 25°c, 95% RH 1 hours Industrial temperature: 55°c, 95% RH 4 hours
		Storage	Mobile temperature: 40°c, 93% RH 500 hours Industrial temperature: 55°c, 95% RH 500 hours
Shock		Mobile temperature: 500G, 0.5ms Industrial temperature: 1500G, 0.5ms	
Vibration		20Hz~80Hz/1.52mm (frequency/displacement) 80Hz~2000Hz/20G (frequency/displacement) X, Y, Z axis/30mins each	
Drop		150cm free fall, 6 face of each	
Bending		≧10N, hold 1Min / 5 Times	
Torque		0.15N-m or +/-2.5deg, hold 30 seconds / 5 Times	
Durability		10,000 times mating cycle	
ESD	Non-opeation	Contact: +/- 4KV each item; 5 times/Pin Air: +/- 15KV ; 5 times/Position	
	Operation	Air: +/- 8KV ; 10 times/Position (B-Grade)	

7. Interface

7.1 Pin Assignment and Descriptions

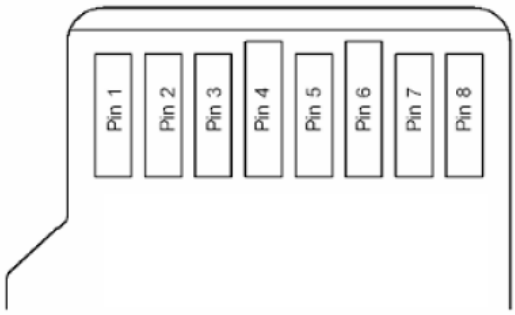


Figure 7 – Pin Locations

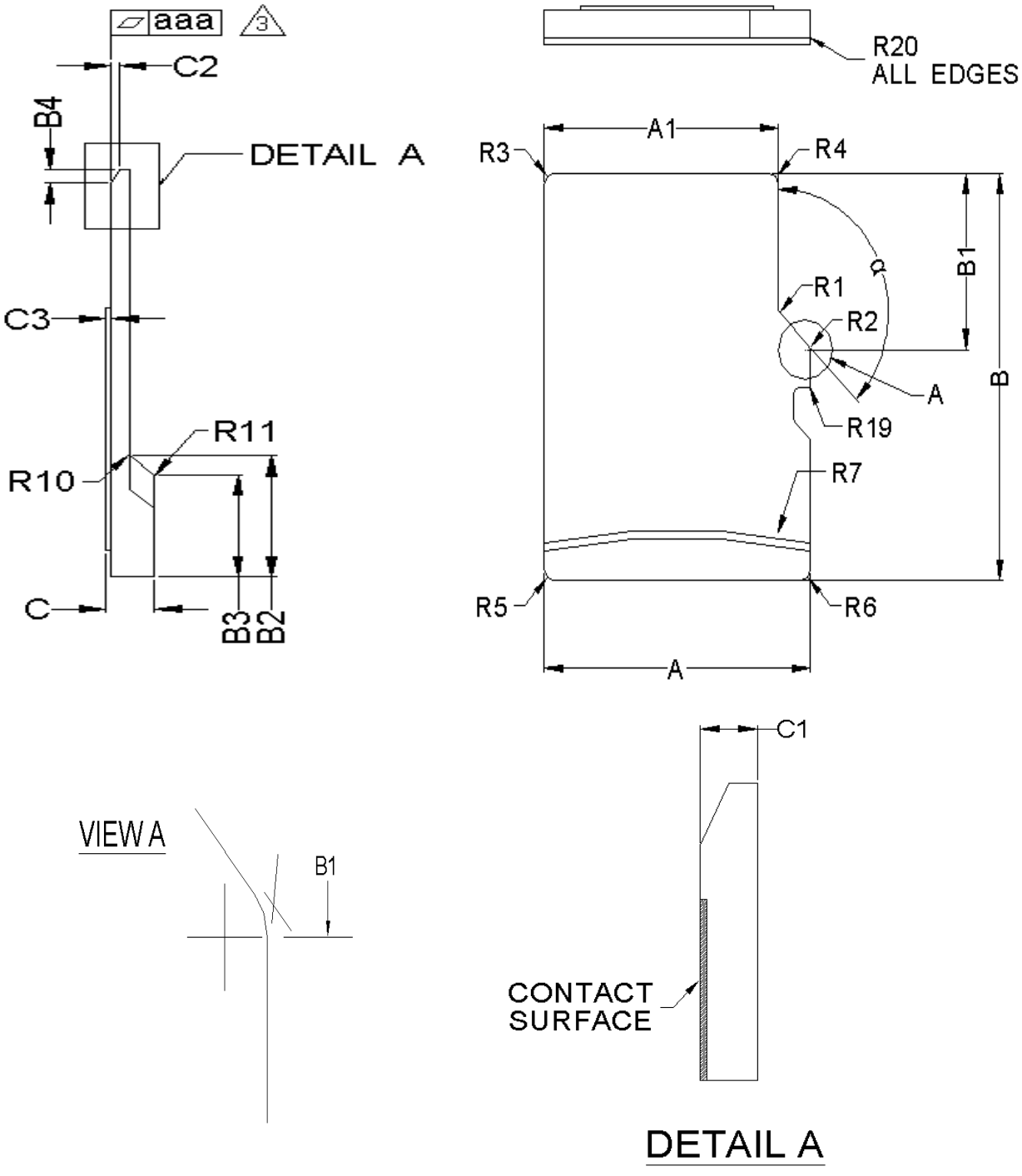
Table 15 – Signal Segment Pin Assignment and Descriptions

Pin Assignment and Descriptions						
Pin #	SD Mode			SPI Mode		
	Name	Type1	Description	Name	Type	Description
1	DAT2	I/O/PP	Data Line[bit2]	RSV		
2	CD/DAT3[2]	I/O/PP[3]	Card Detect/ Data Line[bit3]	CS	I[3]	Chip Select (negtrue)
3	CMD	PP	Command/Response	DI	I	Data In
4	VDD	S	Supply voltage	VDD	S	Supply voltage
5	CLK	I	Clock	SCLK	I	Clock
6	VSS	S	Supply voltage ground	VSS	S	Supply voltage ground
7	DAT0	I/O/PP	Data Line[bit0]	DO	O/PP	Data Out
8	DAT1	I/O/PP	Data Line[bit1]	RSV		

Note:
S: power supply
I: input
O: output using push-pull drivers
PP:I/O using push-pull drivers
The extended DAT lines (DAT1-DAT3)are input on power up. They start to operate as DAT lines after SET_BUS_WIDTH command. The Host shall keep its own DAT1-DAT3 lines in input mode, as well, while they are not used. It is defined so, in order to keep compatibility to MultiMedia Cards.
At power up this line has a 50Kohm pull up enabled in the card. This resistor serves two functions Card detection and Mode Selection. For Mode Selection, the host can drive the line high or let it be pulled high to select SD mode. If the host wants to select SPI mode it should drive the line low. For Card detection, the host detects that the line is pulled high. The user should disconnect this pull-up during regular data transfer period, with SET_CLR_CARD_DETECT (ACMD42) command.

8. Physical Dimension

Dimension: 15.0 mm(L) x 11.0 mm(W) x 1.00 mm(T)



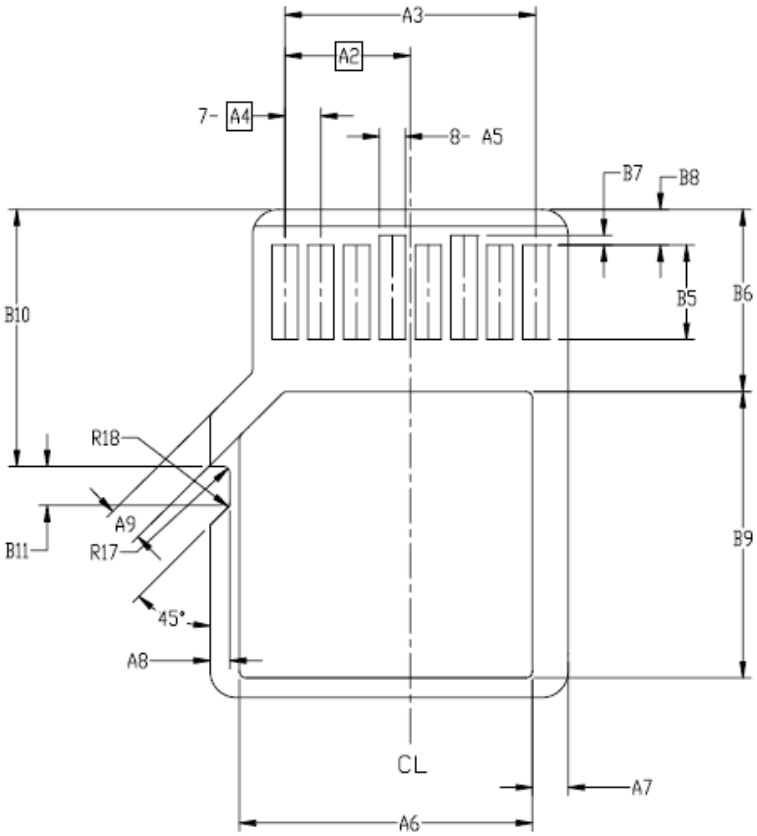


Figure 8 – Device Physical Dimension

Table 16 – Common Dimensions

SYMBOL	MIN	NOM	MAX	NOTE
A	10.9	11	11.1	
A1	9.6	9.7	9.8	
A2	-	3.85	-	BASIC
A3	7.6	7.7	7.8	
A4	-	1.1	-	BASIC
A5	0.75	0.8	0.85	
A6	-	-	8.5	
A7	0.9	-	-	
A8	0.6	0.7	0.8	
A9	0.8	-	-	
A10	1.35	1.4	1.45	
A11	6.5	6.6	6.7	
A12	0.5	0.55	0.6	
A13	0.4	0.45	0.5	
B	14.9	15	15.1	
B1	6.3	6.4	6.5	
B2	1.64	1.84	2.04	
B3	1.3	1.5	1.7	
B4	0.42	0.52	0.62	
B5	2.8	2.9	3	
B6	5.5	-	-	
B7	0.2	0.3	0.4	
B8	1	1.1	1.2	
B9	-	-	9	
B10	7.8	7.9	8	
B11	1.1	1.2	1.3	
B12	3.6	3.7	3.8	
B13	2.8	2.9	3	
B14	8.2	-	-	
B15	-	-	6.2	
C	0.9	1	1.1	
C1	0.6	0.7	0.8	
C2	0.2	0.3	0.4	
C3	0	-	0.15	
D1	1	-	-	
D2	1	-	-	
D3	1	-	-	
R1	0.2	0.4	0.6	
R2	0.2	0.4	0.6	
R3	0.7	0.8	0.9	
R4	0.7	0.8	0.9	
R5	0.6	0.8	0.9	
R6	0.6	0.8	0.9	
R7	29.5	30	30.5	
R10	-	0.2	-	
R11	-	0.2	-	
R17	0.1	0.2	0.3	
R18	0.2	0.4	0.6	
R19	0.05	-	0.2	

Note:

1. DIMENSIONING and TOLERANCING per ASME Y14.5M - 1994.
2. DIMENSIONS are in MILLIMETERS.
3. COPLANARITY is additive to C1 Max. thicknedd.

9. Revision History

Revision	Descriptions	Release Date
1.0	First Release	Oct, 2023
1.1	Add 32Gb in Table 1 – Part Numbers	Jun, 2024