ENVOY DATA Memory

Industrial Solution
SD Card 3.0
Specification

Ver. 1.2

Contents

General Description

The Secure Digital (SD) card version 3.0 is fully compliant to the specification released by SD Card Association. The Command List supports [Part 1 Physical Layer Specification Ver3.01 Final] definitions. Card Capacity of Non-secure Area, Secure Area Supports [Part 3 Security Specification Ver3.0 Final] Specifications.

The SD 3.0 card comes with 9-pin interface, designed to operate at a maximum operating frequency of 50MHz or 100MHz. It can alternate communication protocol between the SD mode and SPI mode. It performs data error detection and correction with very low power consumption and supports densities from 4GB and up to 128GB.

Envoy Data's Industrial Secure Digital 3.0 card is one of the most popular cards today based on its high performance, good reliability and wide compatibility. Not to mention that it's well adapted for hand-held applications in industrial/medical markets already.

A. Features

- Support SD system specification version 2.0 and 3.0.
- Card Capacity of Non-secure Area, Secure Area Supports [Part 3 Security Specification Ver3.1 Final] Specifications
- Support SD SPI mode
- Designed for read-only and read/write cards.

- Operation Temp. Range
  Commercial Temp: 0°C ~70°C
  Industrial Temp: -40°C ~ +85°C
- Storage Temp. Range
  -40~+85°C
- Capacity Range
  4GB-128GB

- Read/Write Performance:
  MLC SD Card
  Read: 22MB/s (Max.)
  Write: 18MB/s (Max.)

- The Command List supports [Part 1 Physical Layer Specification Ver3.01 Final] definitions
- Copyrights Protection Mechanism - Complies with highest security of SDMI standard
- Password Protection of cards (optional)
- Built-in write protection features (permanent and temporary)
- +4KV/-4KV ESD protection in contact pads.
- Dimension : 32mm (L) x 24mm (W) x 2.1mm (H)

B. Comparison of SD Card

	SD3.0 Standard (Backward compatible to 2.0 host)	SD3.0 SDHC (Backward compatible to 2.0 host)
Addressing Mode	Byte (1 byte unit)	Block (512 byte unit)
HCS/CCS bits of ACMD41	Support	Support
CMD8 (SEND_IF_COND)	Support	Support
CMD16 (SET_BLOCKLEN)	Support	Support (Only CMD42)
Partial Read	Support	Not Support
Lock/Unlock Function	Mandatory	Mandatory
Write Protect Groups	Optional	Not Support
Supply Voltage 2.0v – 2.7v (for initialization)	Not Support	Not Support
Total Bus Capacitance for each signal line	40pF	40pF
CSD Version (CSD_STRUCTURE Value)	1.0 (0x0)	2.0 (0x1)
Speed Class	Optional	Mandatory (Class 2/4/6/10)

C. Pin Assignment

pin	SD Mode			SPI Mode		
	Name	Type[1]	Description	Name	Type	Description
1	CD/DAT3 [2]	I/O/PP [3]	Card Detect/ Data Line[bit3]	CS	I [3]	Chip Select (net true)
2	CMD	PP	Command/Response	DI	I	Data In
3	V_{SS1}	S	Supply voltage ground	VSS	S	Supply voltage ground
4	V_{DD}	S	Supply voltage	VDD	S	Supply voltage
5	CLK	I	Clock	SCLK	I	Clock
6	V_{SS2}	S	Supply voltage ground	VSS2	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		
9	DAT2	I/O/PP	Data Line[bit2]	RSV		

(1) S: power supply, I: input; O: output using push-pull drivers; PP:I/O using push-pull drivers

(2) 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.

(3) 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. This pull-up should be disconnected by the user during regular data transfer period, with SET_CLR_CARD_DETECT (ACMD42) command.

Name	Width	Description
CID	128bit	Card identification number; card individual number for identification. **Mandatory**
RCA[1]	16bit	Relative card address; local system address of a card, dynamically suggested by the card and approved by the host during initialization. **Mandatory**
DSR	16bit	Driver Stage Register; to configure the card's output drivers. **Optional**
CSD	128bit	Card Specific Data; information about the card operation conditions. **Mandatory**
SCR	64bit	SD Configuration Register; information about the SD Memory Card's Special Features capabilities **Mandatory**
OCR	32bit	Operation conditions register. **Mandatory.**
SSR	512bit	SD Status; information about the card proprietary features **Mandatory**
OCR	32bit	Card Status; information about the card status **Mandatory**

D. Power Consumption

Table list as below is the power consumption of SD card with different type of flash memory. (Controller + Flash Memory)

Flash mode	Max Power up Current (uA)	Max Stand by Current (uA)	Max Read Current (mA)	Max Write Current (mA)
Single(1) flash(1x8bit)	150	150	100@ 3.6V	100@ 3.6V
SDR/DDR	150	150	400	400

(1) Data transfer mode is single channel.

E. Electrical Specifications

Absolute Maximum Rating

Item	Symbol	Parameter	MIN	MAX	Unit
1	V_{DD}-V_{SS}	DC Power Supply	-0.3	+3.3	V
2	V_{IN}	Input Voltage	V_{SS}-0.3	V_{DD}+0.3	V
3	Ta	Operating Temperature	0	+70	V
4	Tst	Storage Temperature	-25	+85	V

Parameter	Symbol	Min	MAX	Unit
Operating Temperature	T_a	0	+70	V
V_{DD} Voltage	V_{DD}	2.7	3.6	V

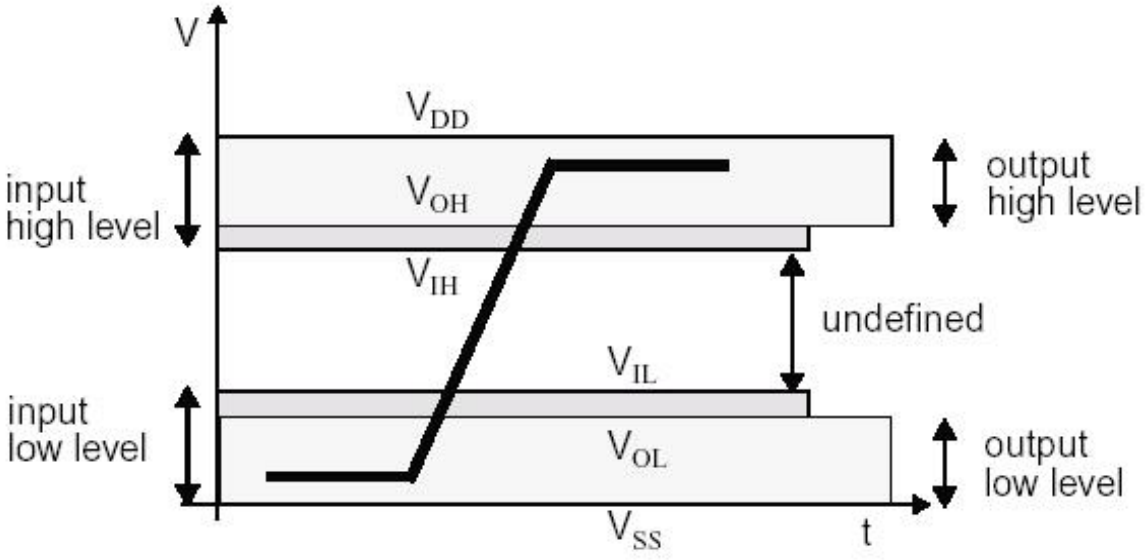
F. DC Characteristic

F1. Bus Operating Conditions for 3.3V Signaling

- **Threshold level for High Voltage Range**

Parameter	Symbol	Min	Max	Unit	Remarks
Supply voltage	V_{DD}	2.7	3.6	V	
Output High Voltage	V_{OH}	0.75*V_{DD}		V	IOH=-100uA V_{DD}Min.
Output Low Voltage	V_{OL}		0.125*V_{DD}	V	I_{OL} = 100uA $V_{DD\ min}$
Input High Voltage	V_{IH}	0.625*V_{DD}	V_{DD}+0.3	V	
Input Low Voltage	V_{IL}	V_{SS}-0.3	0.25 *V_{DD}	V	
Power up time			250	ms	from 0v to VDD min.

Bus Signal Levels



Bus signal levels

- **Peak Voltage and Leakage Current**

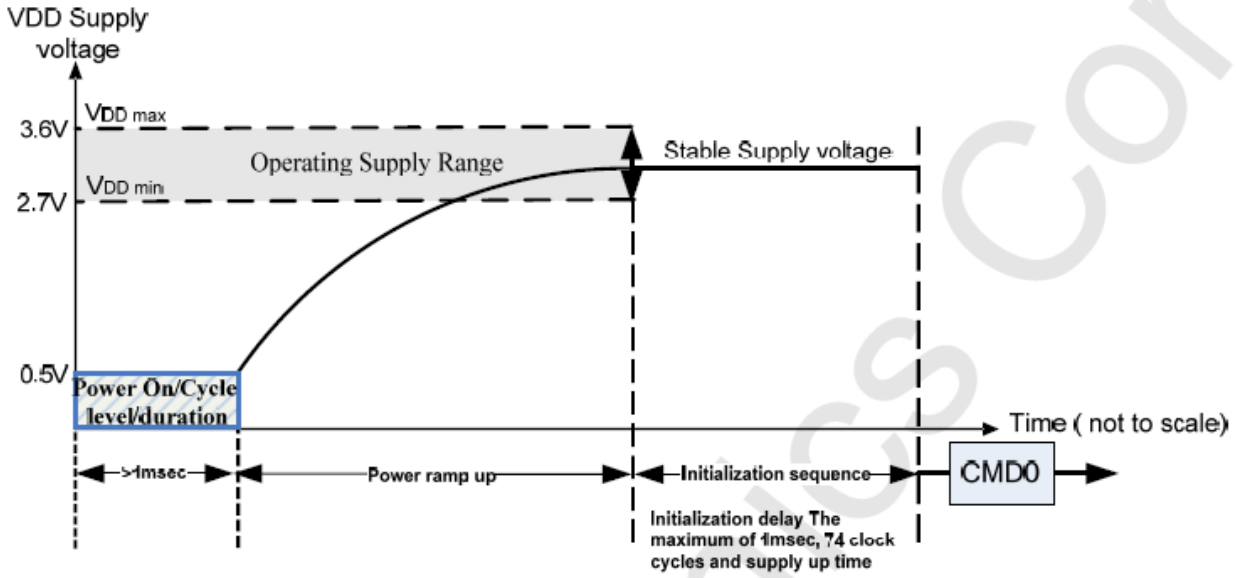
Parameter	Symbol	Min	Max.	Unit	Remarks
Peak voltage on all lines		-0.3	V_{DD}+0.3	V	
All Inputs					
Input Leakage Current		-10	10	uA	
All Outputs					
Output Leakage Current		-10	10	uA	

F2. Bus Signal Line Levels

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 CHOST+CBUS shall not exceed 30 pF
Capacitance of the card for each signal pin	CCARD		10	pF	
Maximum signal line inductance			16	nH	f_{pp}<20 MHz
Pull-up resistance inside card (pin1)	RDAT3	10	90	kΩ	May be used for card detection

Power Up Time

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



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.

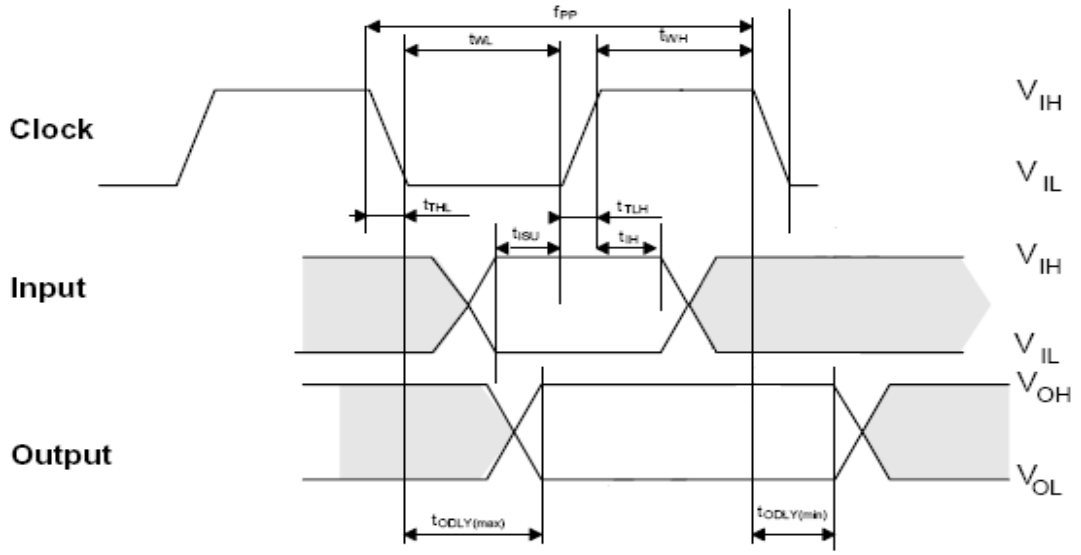
Power Down and Power Cycle

• 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).

G. AC Characteristic

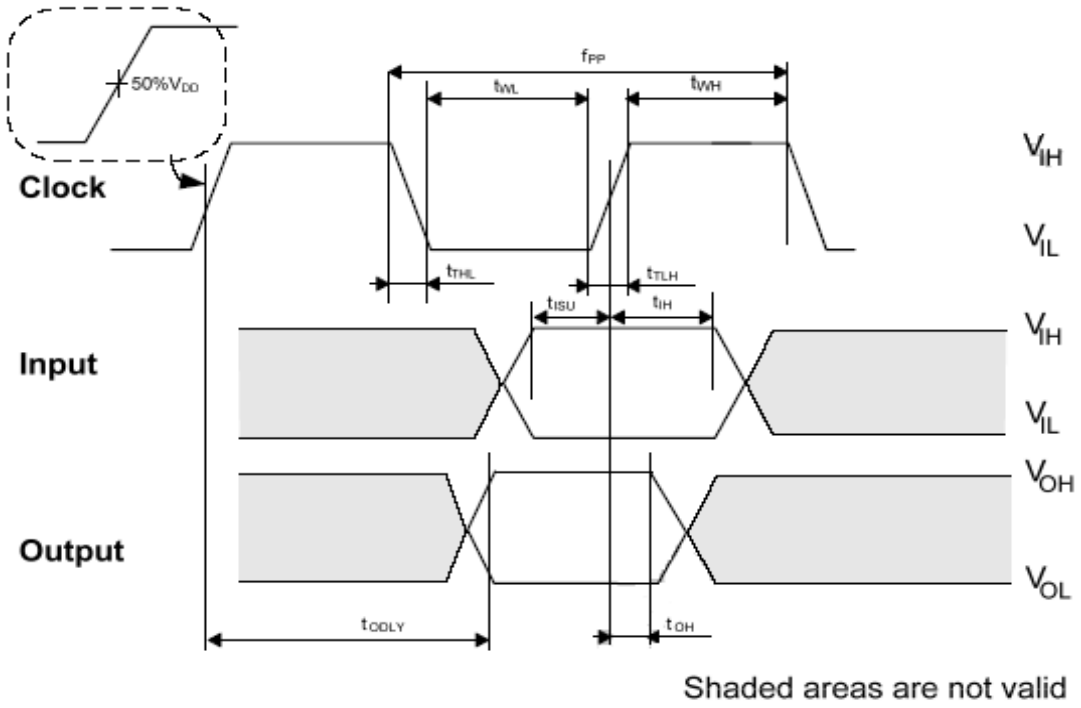
G1. SD Card Interface timing (Default)



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	C_{card}≤10 pF (1 card)
Clock frequency Identification Mode	f_{OD}	$0_{(1)}$/100	400	kHz	C_{card}≤10 pF (1 card)
Clock low time	t_{WL}	10		ns	C_{card}≤10 pF (1 card)
Clock high time	t_{WH}	10		ns	C_{card}≤10 pF (1 card)
Clock rise time	t_{TLH}		10	ns	C_{card}≤10 pF (1 card)
Clock fall time	t_{THL}		10	ns	C_{card}≤10 pF (1 card)
Inputs CMD, DAT (referenced to CLK)					
Input set-up time	t_{ISU}	5		ns	C_{card}≤10 pF (1 card)
Input hold time	t_{IH}	5		ns	C_{card}≤10 pF (1 card)
Outputs CMD, DAT (referenced to CLK)					
Output Delay time during Data Transfer Mode	t_{ODLY}	0	14	ns	C_L≤40 pF (1 card)
Output Delay time during Identification Mode	tODLY	0	50	ns	C_L≤40 pF (1 card)

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

G2. SD Card Interface timing (High-speed Mode)

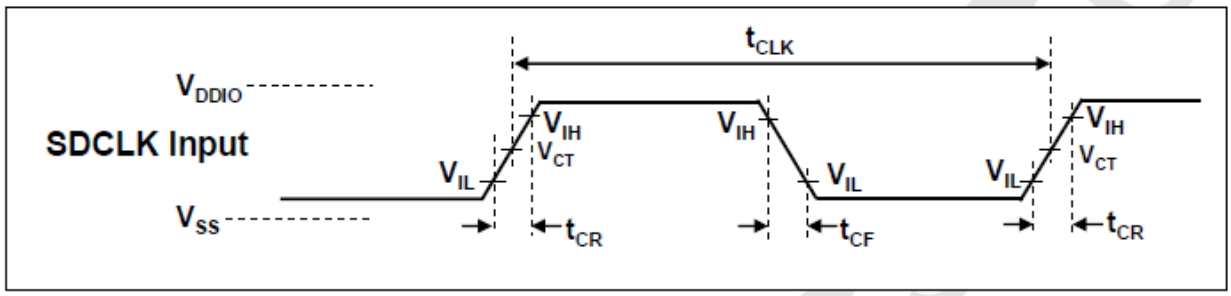


Parameter	Symbol	Min	Max	Unit	Remark
Clock CLK (All values are referred to min(V_{IH}) and max(V_{IL})					
Clock frequency Data Transfer Mode	f_{PP}	0	50	MHz	C_{card}≤10 pF (1 card)
Clock low time	t_{WL}	7		ns	C_{card}≤10 pF (1 card)
Clock high time	t_{WH}	7		ns	C_{card}≤10 pF (1 card)
Clock rise time	t_{TLH}		3	ns	C_{card}≤10 pF (1 card)
Clock fall time	t_{THL}		3	ns	C_{card}≤10 pF (1 card)
Inputs CMD, DAT (referenced to CLK)					
Input set-up time	t_{ISU}	6		ns	C_{card}≤10 pF (1 card)
Input hold time	t_{IH}	2		ns	C_{card}≤10 pF (1 card)
Outputs CMD, DAT (referenced to CLK)					
Output Delay time during Data Transfer Mode	t_{ODLY}		14	ns	C_L≤40 pF (1 card)
Output Hold time	T_{OH}	2.5	50	ns	C_L≤15 pF (1 card)
Total System capacitance of each line[1]	C_L		40	pF	CL≤15 pF (1 card)

(1) In order to satisfy severe timing, host shall drive only one card.

G3. SD Interface timing (SDR12, SDR25 and SDR50 Modes)

Input:

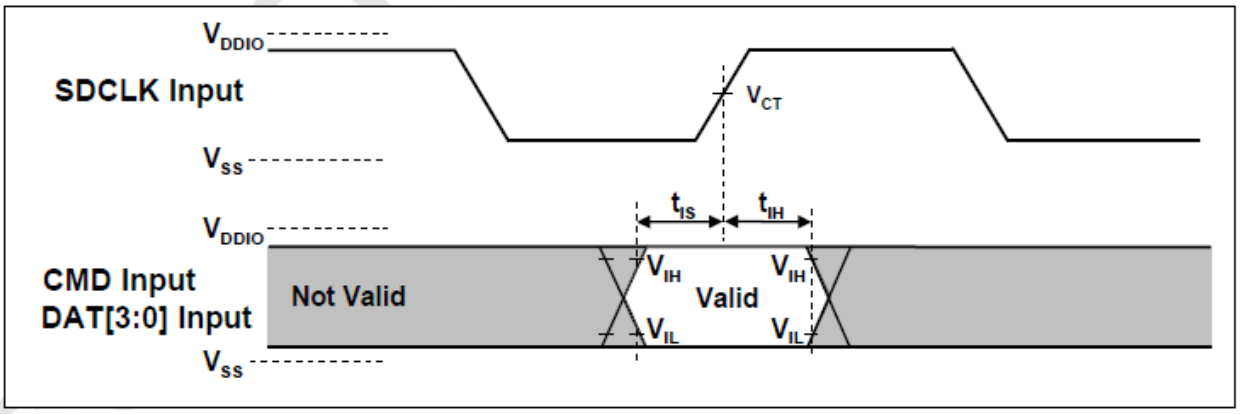


Clock Signal Timing

Symbol	Min	Max	Unit	Remark
tCLK	4.80	-	ns	208MHz (Max.), Between rising edge, VCT= 0.975V
tCR, tCF	-	0.2* tCLK	ns	tCR, tCF < 2.00ns (max.) at 100MHz, CCARD=10pF
Clock Duty	30	70	%	

Clock Signal Timing

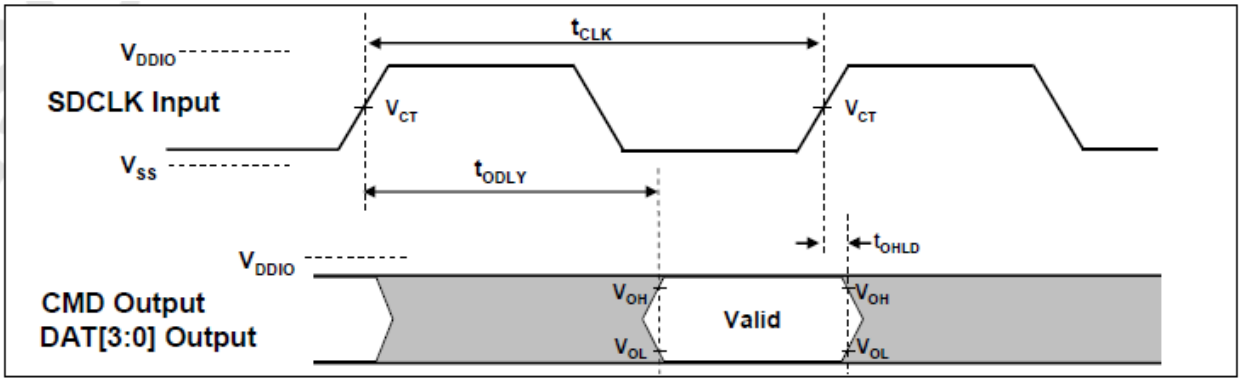
SDR50 Input Timing:



Card Input Timing

Symbol	Min	Max	Unit	SDR50 Mode
tIs	3.00	-	ns	CCARD =10pF, VCT= 0.975V
tIH	0.80	-	ns	CCARD =5pF, VCT= 0.975V

Output:

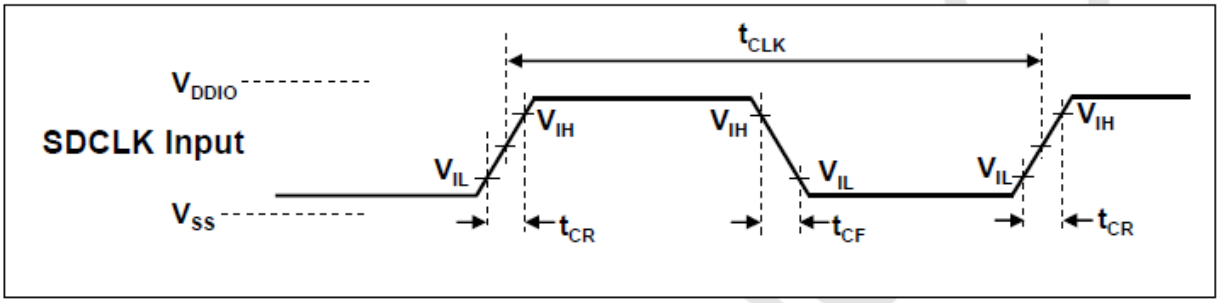


Output Timing of Fixed Data Window

Symbol	Min	Max	Unit	Remark
tODLY	-	7.5	ns	tCLK>=10.0ns, CL=30pF, using driver Type B, for SDR50
tODLY	-	14	ns	tCLK>=20.0ns, CL=40pF, using driver Type B, for SDR25 and SDR12,
TOH	1.5	-	ns	Hold time at the tODLY (min.), CL=15pF

Output Timing of Fixed Data Window

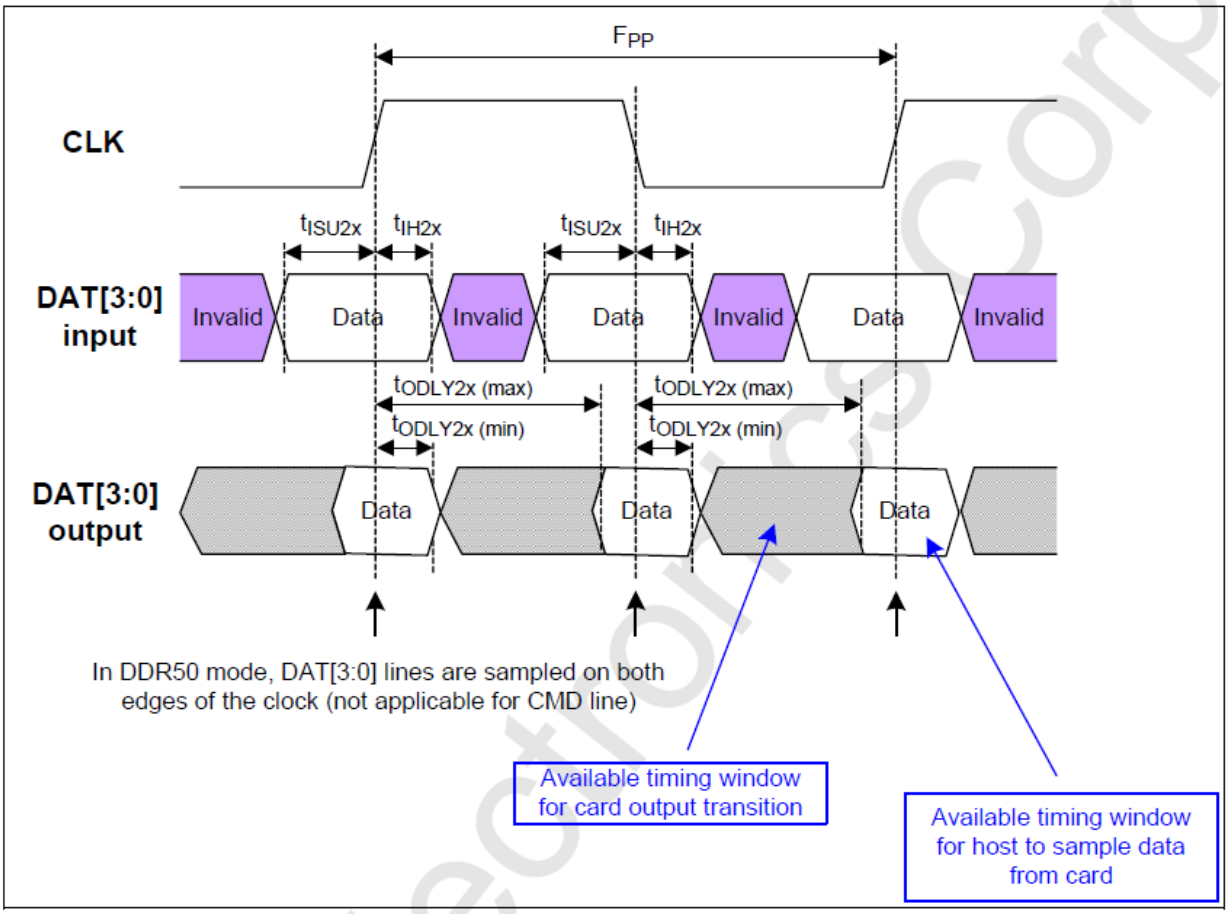
G4. SD Interface timing (DDR50 Modes)



Clock Signal Timing

Symbol	Min	Max	Unit	Remark
tCLK	20	-	ns	50MHz (Max.), Between rising edge
tCR, tCF	-	0.2* tCLK	ns	tCR, tCF < 4.00ns (max.) at 50MHz, CCARD=10pF
Clock Duty	45	55	%	

Clock Signal Timing



Timing Diagram DAT Inputs/Outputs Referenced to CLK in DDR50 Mode

Parameter	Symbol	Min	Max	Unit	Remark
Input CMD (referenced to CLK rising edge)					
Input set-up time	t_{ISU}	6	-	ns	C_{card}≤10 pF (1 card)
Input hold time	t_{IH}	0.8	-	ns	C_{card}≤10 pF (1 card)
Output CMD (referenced to CLK rising edge)					
Output Delay time during Data Transfer Mode	t_{ODLY}		13.7	ns	C_L≤30 pF (1 card)
Output Hold time	T_{OH}	1.5	-	ns	C_L≥15 pF (1 card)
Inputs DAT (referenced to CLK rising and falling edges)					
Input set-up time	t_{ISU2x}	3	-	ns	C_{card}≤10 pF (1 card)
Input hold time	t_{IH2x}	0.8	-	ns	C_{card}≤10 pF (1 card)
Outputs DAT (referenced to CLK rising and falling edges)					
Output Delay time during Data Transfer Mode	t_{ODLY2x}	-	7.0	ns	C_L≤25 pF (1 card)
Output Hold time	T_{OH2x}	1.5	-	ns	C_L≥15 pF (1 card)

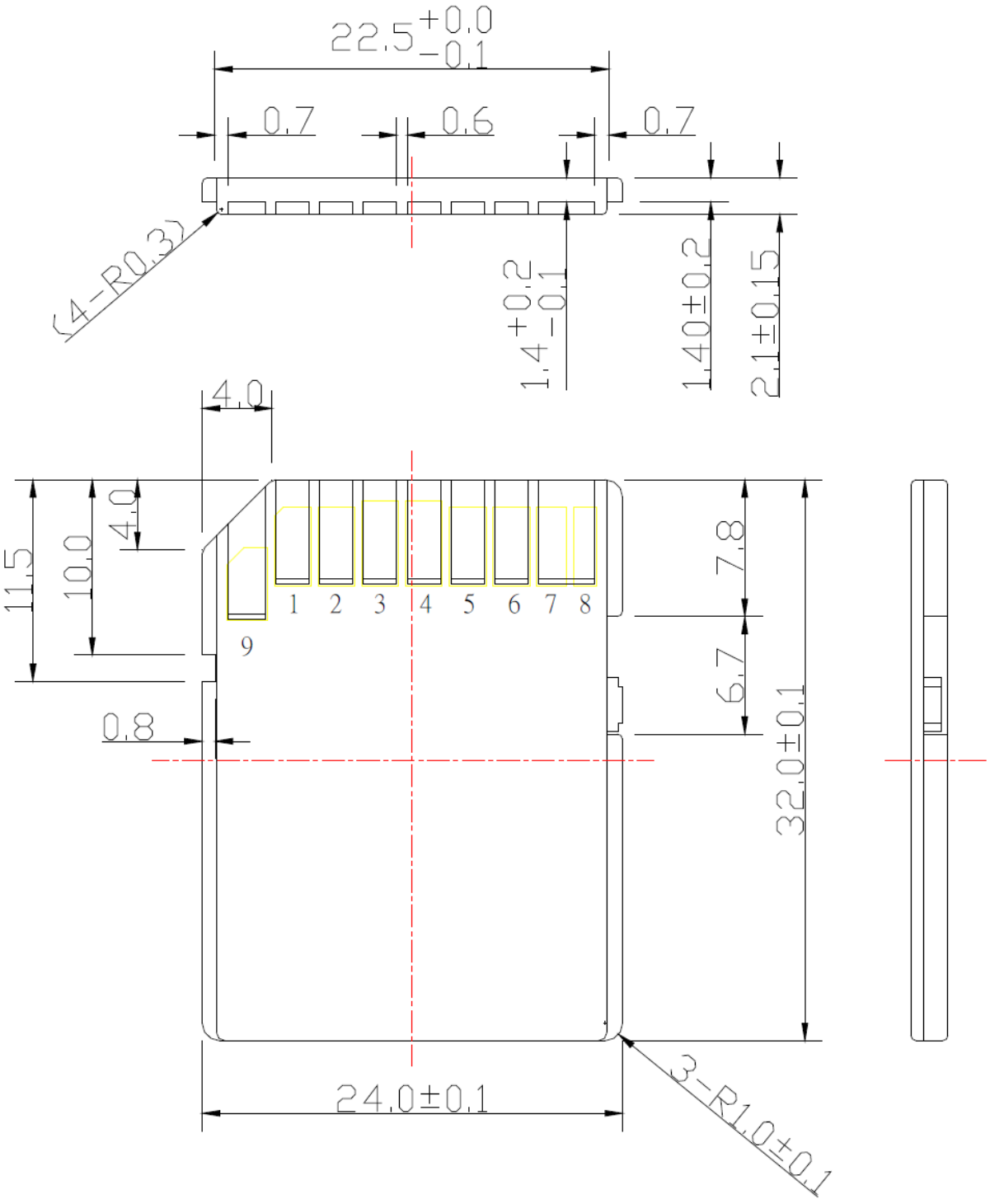
Bus Timings – Parameters Values (DDR50 mode)

H. Part Numbers

Part Number	Description	Operating Temperature
EN-K0J004GDSC	4GB SLC SD CARD	0°C ~ 70°C
EN-K0J008GDSC	8GB SLC SD CARD	0°C ~ 70°C
EN-K0J016GDSC	16GB SLC SD CARD	0°C ~ 70°C
EN-K0J032GDSC	32GB SLC SD CARD	0°C ~ 70°C
EN-K0J004GDSI	4GB SLC SD CARD	-40°C ~ 85°C
EN-K0J008GDSI	8GB SLC SD CARD	-40°C ~ 85°C
EN-K0J016GDSI	16GB SLC SD CARD	-40°C ~ 85°C
EN-K0J032GDSI	32GB SLC SD CARD	-40°C ~ 85°C

Part Number	Description	Operating Temperature
EN-K0J004GDMC	4GB MLC SD CARD	0°C ~ 70°C
EN-K0J008GDMC	8GB MLC SD CARD	0°C ~ 70°C
EN-K0J016GDMC	16GB MLC SD CARD	0°C ~ 70°C
EN-K0J032GDMC	32GB MLC SD CARD	0°C ~ 70°C
EN-K0J064GDMC	64GB MLC SD CARD	0°C ~ 70°C
EN-K0J128GDMC	128GB MLC SD CARD	0°C ~ 70°C
EN-K0J004GDMI	4GB MLC SD CARD	-40°C ~ 85°C
EN-K0J008GDMI	8GB MLC SD CARD	-40°C ~ 85°C
EN-K0J016GDMI	16GB MLC SD CARD	-40°C ~ 85°C
EN-K0J032GDMI	32GB MLC SD CARD	-40°C ~ 85°C
EN-K0J064GDMI	64GB MLC SD CARD	-40°C ~ 85°C

I. Dimension



Dimensions of A SD Card (Bottom View, DIN)