Virtium
Solid State Storage and Memory

TuffDrive® SD Memory Card

Industrial SD 3.0, pSLC

VTDST0EDXI

Datasheet - Rev. 1.0

1. Description

Virtium TuffDrive® VTDST0EDPI SD card provide highly reliable storage media in a very small space. The simplicity of the SD and SPI protocols allows easy host design and integration. The TuffDrive SD card supports a high security level of copyright protection and an easy to implement interface.

Features

Capacity
- 8GB, 16GB, 32GB, 64GB,128GB

NAND: pSLC

Class: Class 10, UHS-I

Sequential Performance(1)
- 128kB Sequential Read: 96 MB/s (QD: 32)
- 128kB Sequential Write: 79 MB/s (QD: 32)

Random Performance(1)
- 4kB IOPS Read: up to 1,350 (QD: 32)
- 4kB IOPS Write: up to 1,060 (QD: 32)

Voltage Supply: 3.3V ±5%

Power(1)
- 128kB Sequential Read: 0.48 W
- 128kB Sequential Write: 0.37 W
- 4kB Random Read: 0.22 W
- 4kB Random Write: 0.22 W
- Idle: < 0.04 W

Temperature Ranges
- Industrial: -40ºC to 85ºC
- Non-Operating: -40ºC to 85ºC

Reliability
- 40-Bit/1K Hardware BCH ECC
- Number of card insertions/removals up to 10,000
- MTBF: >5M hours

Endurance(1)
- JESD219A: 850 TBW
- Sequential: 5,070 TBW

Advanced Flash Management
- ECC Correction
- Static and Dynamic Wear Leveling
- Bad Block Management

Write Protect with mechanical switch

Mechanical Dimensions
- 9-Pin SD Standard
- Length x Width x Height mm (inches)
  32.00 (1.259) x 24.00 (0.945) x 2.1 (0.083)
- Weight: 2g ± 0.1g

Compliance
- SD Memory Card Specifications
  - Physical Layer Specification Ver. 3.1 (Part 1)
  - File System Specification Ver. 3.0 (Part 2)
  - Security Specification Ver. 3.0 (Part 3)
- FCC, CE, UL, RoHS, WEEE
- 15kV ESD Compliant

Environmental (Non-operating)
- Humidity (non-condensing): 5% to 95%
- Shock: 1500G, half-sine wave, 0.5ms duration
- Vibration: 20G, 20 Hz to 2000 Hz

(1) Based on the 128GB device

Electrostatic Discharge (ESD) can damage this device. When handling the device, always wear a grounded wrist strap and use a static dissipative surface.

Any damage to the unit that occurs after its removal from the shipping package and ESD protective bag is the responsibility of the user.

Part Numbering System

V T D S T 0 E D X I xxx - 0011

Where:	
V	= Virtium
T	= Storage
DST0ED	= Form Factor / Interface: 9-Pin SD card
X	= Product Class: X = XE
I	= Operating Temperature: I = Industrial (-40ºC to 85ºC)
xxx	= Capacity (1GB = 1,000,000,000 bytes) 008 = 8 GB 016 = 16 GB 032 = 32 GB 064 = 64 GB 128 = 128 GB
0011	= Virtium Proprietary

Order Information

Capacity (GB)	Part Number
8	VTDST0EDXI008-0011
16	VTDST0EDXI016-0011
32	VTDST0EDXI032-0011
64	VTDST0EDXI064-0011
128	VTDST0EDXI128-0011

2. Revision History

Date	Revision	Page(s)	Description
03/22/2023	1.0	All	Initial Release

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3. Specifications

Capacity

Unformatted Capacity (GB)(1)	User-Addressable LBA(2)	User-Addressable Capacity Bytes
8	15,649,200	8,012,390,400
16	31,834,112	16,299,065,344
32	62,531,584	32,016,171,008
64	125,045,424	64,023,257,088
128	250,069,680	128,035,676,160

(1) 1GB = 1,000,000,000 bytes. LBA: Logical Block Address; Logical Block Size = 512 Bytes/1 Sector.
(2) LBA: Logical Block Address; Logical Block Size = 512 Bytes/1 Sector.

Performance

Capacity (GB)	Performance Throughput(1) 128kB File, Queue Depth (QD) = 32		IOPS(1) 4kB File, Queue Depth (QD) = 32	
	Sequential Read MB/s	Sequential Write MB/s	100% Random Read	100% Random Write
8	96	77	1,410	1,260
16	96	76	1,420	1,390
32	97	80	1,600	1,440
64	97	80	1,440	1,080
128	96	79	1,350	1,060

(1) Performance is based on fresh out-of-box condition formatted with NTFS filesystem and running CrystalDiskMark 8.0.0 with file size 1024MB. Actual results may vary depending on file system, workload, and SSD condition.

Power Consumption – 3.3V Supply

Capacity (GB)	Sequential Read(1) 128kB, QD = 32	Sequential Write(1) 128kB, QD = 32	Random Read(1) 4kB, QD = 32	Random Write(1) 4kB, QD = 32	Idle	Unit
8	0.45	0.35	0.23	0.20	< 0.04	W
16	0.45	0.35	0.22	0.20	< 0.04	W
32	0.46	0.36	0.22	0.21	< 0.04	W
64	0.46	0.36	0.21	0.21	< 0.04	W
128	0.48	0.37	0.22	0.22	< 0.04	W

(1) Measured at 3.3V

Temperature and Humidity

Part Number	Operating Temperature	Non-Operating (1) Temperature	Humidity (Non-Condensing)
VTDST0EDXIxxx-0011	-40ºC to 85ºC	-40ºC to 85ºC	5% to 95%

(1) Maximum non-operating temperature assumes data is stored on the SSD. Temperatures above 85ºC are beyond NAND specification for data retention. Please see *Temperature Considerations for Industrial Embedded SSDs* whitepaper under the industrial SSD section of Virtium website (Virtium.com)

Shock and Vibration

Reliability	Test Conditions	Reference Standards
Shock	1500G, half-sine wave, 0.5ms duration	JESD22-B110B.01
Vibration	20G, 20 Hz to 2000 Hz	JESD22-B103B.01

Electrostatic Discharge (ESD)

	Test Conditions
Non-operating	Contact discharge: ±8kV; 5 times/Pin Air discharge: ±8kV; 5 times/Position
Operating	Air discharge: ±8kV; 10 times/Position (EN55024-61000-4-2)

4. Reliability

Endurance

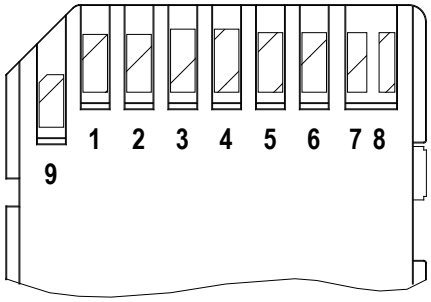
Capacity (GB)	JESD218A(1) & JESD219 Enterprise Workloads		100% Sequential Workloads	
	Total Bytes Written TBW (TB)	Drive Writes per day (5 years)	Total Bytes Written TBW (TB)	Drive Writes per day (5 years)
8	231	15.82	636	43.56
16	128	4.38	636	21.78
32	213	3.64	1268	21.72
64	426	3.64	2537	21.72
128	850	3.64	5070	21.72
(1) JESD218A assumes an active temperature at 55°C and a retention temperature at 40°C				

Mean Time Between Failures (MTBF)

The SSD achieves a MTBF of greater than 5,000,000 hours predicted and is derived from the component reliability data using Telcordia SR-332 methods at 40°C and tested under standard environmental operating conditions.

5. Physical Specifications

Pin Layout / Assignments



SD Memory Card Pin assignment (Back View of the card)

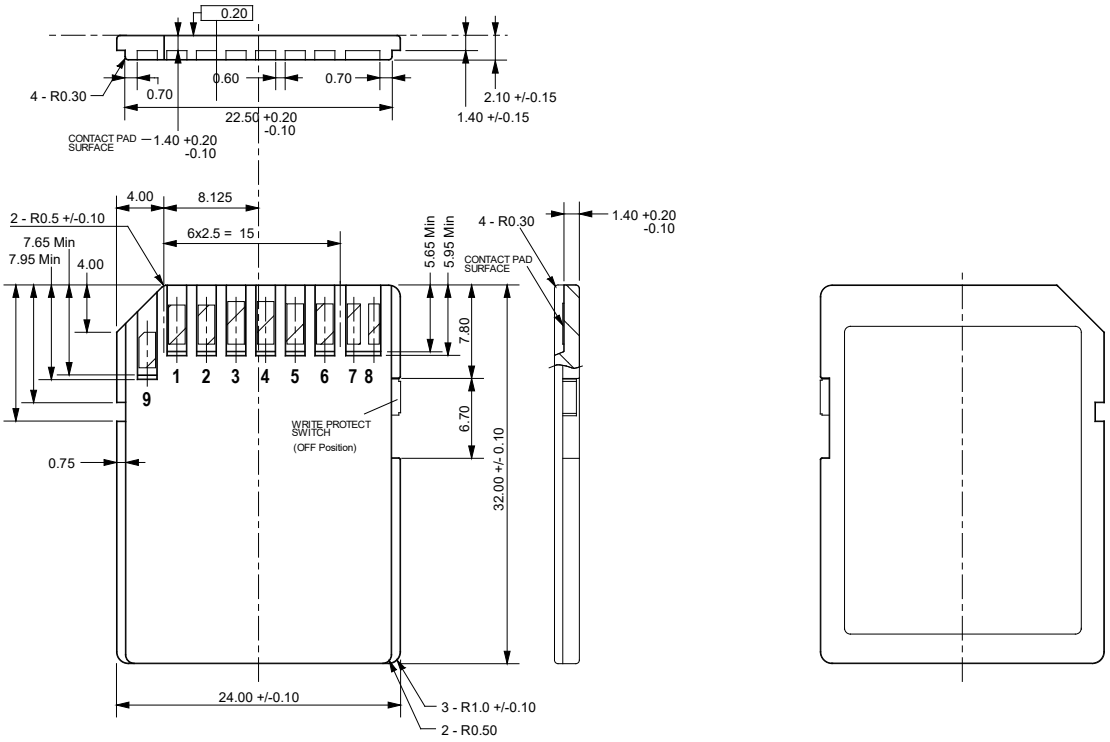
Pin	SD Mode			SPI Mode		
	Name	Type(1)	Description	Name	Type	Description
1	CD/DAT3(2)	I/O/PP(3)	Card Detect/ Data Line [bit3]	CS	I(3)	Chip Select (neg. true)
2	CMD	PP	Command/Response	DI	I	Data In
3	VSS	S	Supply voltage ground	VSS	S	Supply voltage ground
4	VDD	S	Supply voltage	VDD	S	Supply voltage
5	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		
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 with SET_CLR_CARD_DETECT (ACMD42) command.

Mechanical Dimensions



Note: 1. All dimensions are in millimeters
2. The dimensional diagram is for reference only

6. Electrical Specifications

DC Characteristic

Bus Operation Conditions for 3.3V Signaling

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
Peak voltage on all lines		-0.3	VDD+0.3	V	
Input Leakage Current – All Input		-10	10	uA	
Output Leakage Current – All Input		-10	10	uA	

Bus Operation Conditions for 1.8V Signaling

Parameter	Symbol	Min	Max	Unit	Condition
Supply Voltage	VDD	2.7	3.6	V	
Regulator Voltage	VDDIO	1.7	1.95	V	Generated by VDD
Output High Voltage	VOH	1.4	-	V	IOH=-2mA
Output Low Voltage	VOL	-	0.45	V	IOL=2mA
Input High Voltage	VIH	1.27	2.00	V	
Input Low Voltage	VIL	Vss-0.3	0.58	V	
Input Leakage Current – All Input		-2	2	uA	

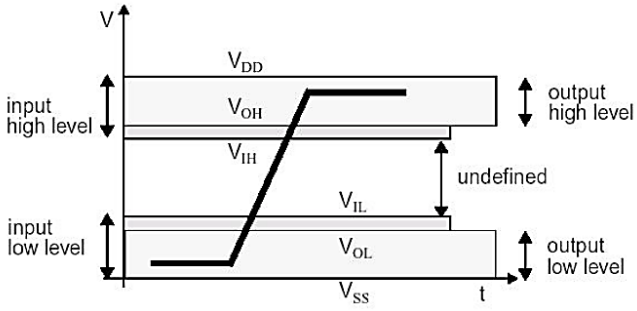
Bus Operation Conditions – Signal Line's Load

Total Bus Capacitance = CHOST + CBUS + N CCARD

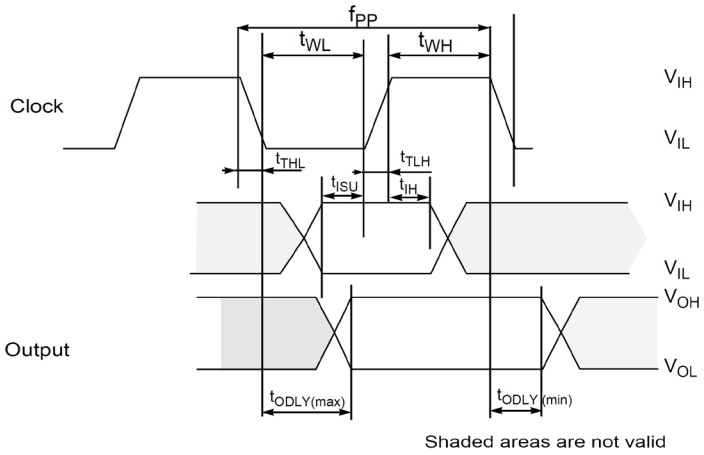
Parameter	Symbol	Min	Max	Unit	Condition
Pull-up resistance	RCMD	10	100	kΩ	to prevent bus floating
Total bus capacitance for each signal line	RDAT		40	pF	1 card CHOST+CBUS shall not exceed 30 pF
Card Capacitance for each signal pin	CL		10	pF	
Maximum signal line inductance	CCARD		16	nH	
Pull-up resistance inside card (pin1)	RDAT3	10	90	kΩ	May be used for card detection
Capacity Connected to Power Line	CC		5	uF	

AC Characteristic

Bus Signal Levels



Bus Timing (Default Mode)

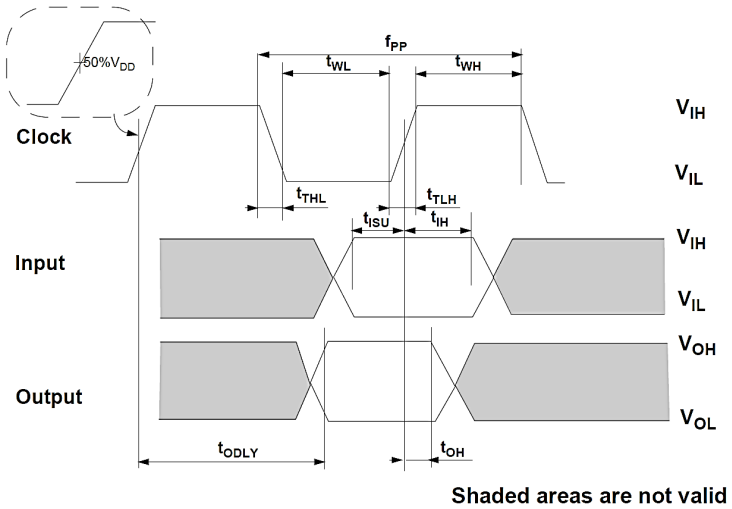


Timing diagram data input/output referenced to clock (Default)

Parameter	Symbol	Min	Max	Unit	Condition
Clock CLK (All values are referred to min. (VIH) and max. (VIL)					
Clock frequency Data Transfer Mode	fPP	0	25	MHz	CCARD <= 10 pF (1 card)
Clock frequency Identification Mode	fOD	0(1)/10	400	kHz	CCARD <= 10 pF (1 card)
Clock low time	tWL	10		ns	CCARD <= 10 pF (1 card's)
Clock high time	tWH	10		ns	CCARD <= 10 pF (1 card)
Clock rise time	tTLH		10	ns	CCARD <= 10 pF (1 card)
Clock fall time	tTHL		10	ns	CCARD <= 10 pF (1 card)
Inputs CMD, DAT (referenced to CLK)					
Input set-up time	tISU	5		ns	CCARD <= 10 pF (1 card)
Input hold time	tIH	5		ns	CCARD <= 10 pF (1 card)
Outputs CMD, DAT (referenced to CLK)					
Output delay time during Data Transfer Mode	tODLY	0	14	ns	CL <= 40 pF (1 card)
Output delay time during Identification Mode	tODLY	0	50	ns	CL<= 40 pF (1 card)

1) 0Hz means to stop the clock. The given minimum frequency range is for cases where a continuous clock is required

Bus Timing (High-speed Mode)



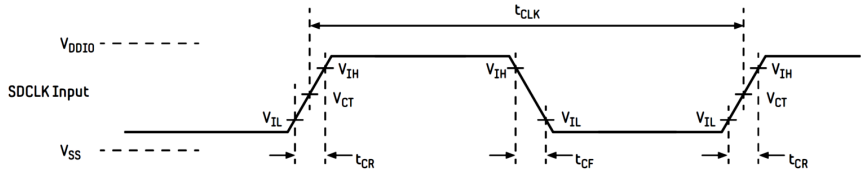
Timing diagram data input/output referenced to clock (High-speed)

Parameter	Symbol	Min	Max	Unit	Condition
Clock CLK (All values are referred to min. (VIH) and max. (VIL)					
Clock frequency Data Transfer Mode	fPP	0	50	MHz	CCARD <= 10 pF (1 card)
Clock low time	tWL	7		ns	CCARD <= 10 pF (1 card)
Clock high time	tWH	7		ns	CCARD <= 10 pF (1 card)
Clock rise time	tTLH		3	ns	CCARD <= 10 pF (1 card)
Clock fall time	tTHL		3	ns	CCARD <= 10 pF (1 card)
Inputs CMD, DAT (referenced to CLK)					
Input set-up time	tISU	6		ns	CCARD <= 10 pF (1 card)
Input hold time	tIH	2		ns	CCARD <= 10 pF (1 card)
Outputs CMD, DAT (referenced to CLK)					
Output delay time during Data Transfer Mode	tODLY		14	ns	CL <= 40 pF (1 card)
Output Hold time	tOH	2.5		ns	CL <= 15 pF (1 card)
Total Systme capacitance for each line(1)	CL		40	pF	CL <= 15 pF (1 card)

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

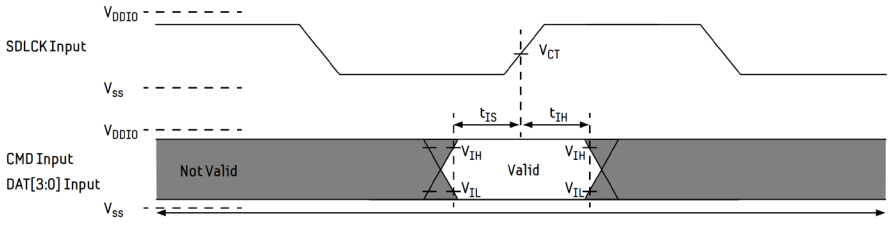
Bus Timing Specification in SDR12, SDR25, SDR50 and SDR104 Modes

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 < 0.96ns (max.) at 208MHz, CCARD=10pF tCR, tCF < 2.00ns (max.) at 100MHz, CCARD=10pF The maximum value of tCR, tCF is 10ns regardless of clock frequency
Clock Duty	30	70	%	



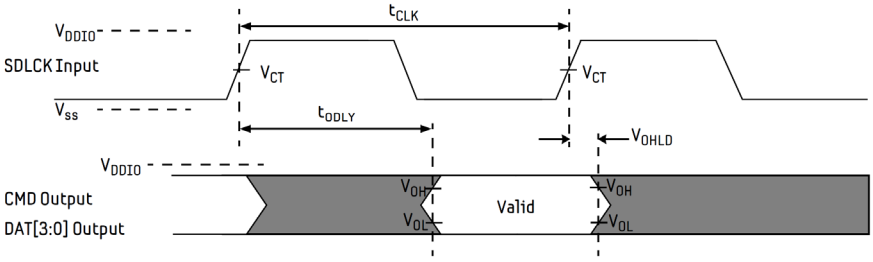
Clock Signal Timing

SDR50 and SDR104 Input Timing				
Symbol	**Min**	**Max**	**Unit**	**SDR104 Mode**
tIS	1.40	-	ns	CCARD=10pF, VCT= 0.975V
tIH	0.80	-	ns	CCARD=5pF, VCT= 0.975V
Symbol	**Min**	**Max**	**Unit**	**SDR50 Mode**
tIS	3.00	-	ns	CCARD=10pF, VCT= 0.975V
tIH	0.80	-	ns	CCARD=5pF, VCT= 0.975V



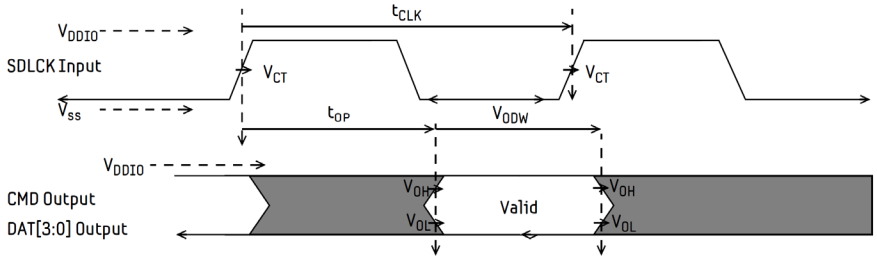
Card Input Timing

Output Timing of Fixed Data Window (SDR12, SDR25 and SDR50)				
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

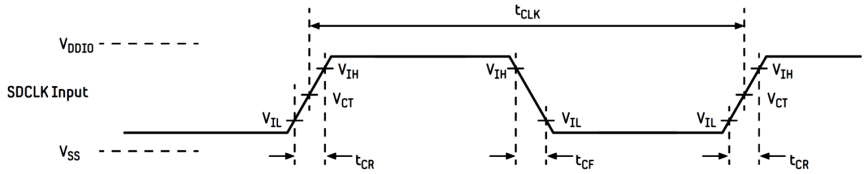
Output Timing of Variable Window (SDR104)				
Symbol	**Min**	**Max**	**Unit**	**Remark**
tOP	0	2	UI	Card Output Phase
ΔtOP	-350	+1550	ps	Delay variation due to temperature change after tuning
tODW	0.60	-	UI	tODW = 2.88ns at 208MHz



Output Timing of Variable Data Window

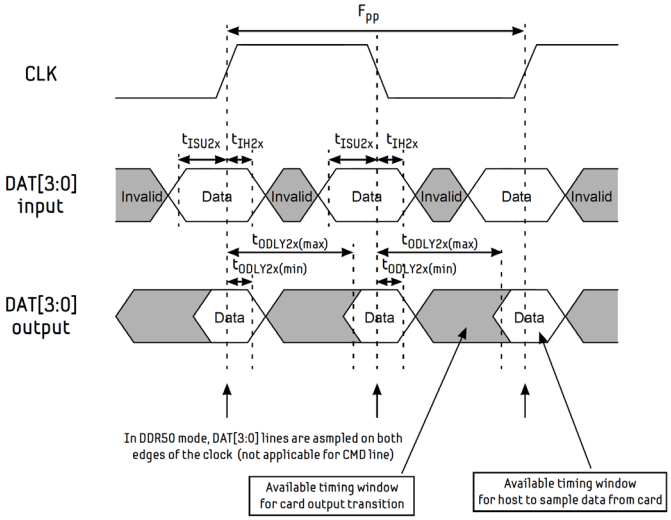
Bus Timing Specification in SDR50 Modes

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	70	%	



Clock Signal Timing

Bus Timings - Parameters Values (DDR50 mode)					
Parameter	**Symbol**	**Min**	**Max**	**Unit**	**Remark**
Input CMD (referenced to CLK rising edge)					
Input set-up time	tISU	6	-	ns	CCARD ≤10pF (1 card)
Input hold time	tIH	0.8	-	ns	CCARD ≤10pF (1 card)
Output CMD (referenced to CLK rising edge)					
Output Delay time during Data Transfer Mode	tODLY	-	13.7	ns	CCARD ≤30pF (1 card)
Output hold time	tOH	1.5	-	ns	CCARD ≤15pF (1 card)
Inputs DAT (referenced to CLK rising and falling edges)					
Input set-up time	tISU2X	3	-	ns	CCARD ≤10pF (1 card)
Input hold time	tIH2X	0.8	-	ns	CCARD ≤10pF (1 card)
Outputs DAT (referenced to CLK rising and falling edges)					
Output Delay time during Data Transfer Mode	tODLY2x	-	7.0	ns	CCARD ≤25pF (1 card)
Output hold time	tODLY2x	1.5	-	ns	CCARD ≤15pF (1 card)



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

7. Card Registers

SD Card Registers

Name	Width	Description
CID	128bit	Card Identification information
RCA(1)	16bit	Relative card address
DSR	16bit	Driver Stage Register
CSD	128bit	Card Specific Data
SCR	64bit	SD Configuration Register
OCR	32bit	Operation conditions register
SSR	512bit	SD Status
OCR	32bit	Operation Condition Register

(1) RCA register is not used (or available) in SPI mode.

8. SD Card Bus Topology

The SD Memory Card supports two alternative communication protocols: SD and SPI Bus mode. The host system can choose either one of the modes. The same data on the SD Card can be read and written by both modes.

SD mode allows 4-bit high-performance data transfer. SPI mode supports the easy and common interface for SPI channel. The disadvantage of this mode is the loss of performance relative to the SD mode.

Please see the SD Memory Card Specifications Part 1 - Physical Layer Specification, Version 6.10 for details.

9. Certifications and Compliance

Compliance / Certification	Description
CE and FCC Compliant	Class: FCC Part 15 Subpart B Class B:2011 Declaration of Conformity registration No. STE120607699
RoHS Compliant	Restriction of Hazardous Substance Directive
UL Certified	Underwriters Laboratories, Inc. 94V-0
WEEE Certified	Waste, Electrical and Electronic Equipment Directive

10. Contact Information

Corporate Headquarters and Manufacturing Location:
30052 Tomas, Rancho Santa Margarita, CA 92688 USA

Main Website:	www.virtium.com
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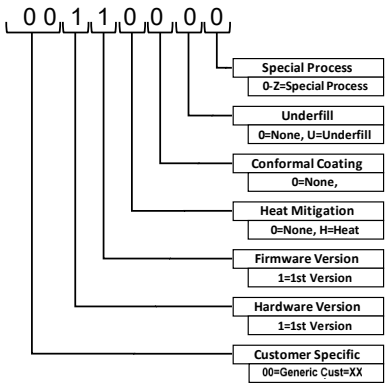
Toll Free:	(888) VIRTIUM / (888) 847.8486
Telephone:	+1 (949) 888.2444
Fax:	+1 (949) 888.2445
Customer Support	custserv@virtium.com
	https://www.linkedin.com/company/virtium/mycompany/
	https://twitter.com/Virtium
	https://www.facebook.com/virtium

11. ADDENDUM Deviations from Generic Product

Product Name: TuffDrive® SD Memory Card

Customer Name: Virtium Generic

Requested Changes to Generic Product: None



Part Number	VTDST0EDXIxxx-0011	Additional Notes: N/A

By Purchsing this product you agree to the terms and information provided in the Addendum

Virtium is a leading designer and manufacturer of industrial-grade SSD Storage and Memory Module solutions. Our 25+ years of successful innovation, high-quality production, and customer commitment, differentiate us from our competitors and have earned us many notable customers service awards. Virtium solutions offer many benefits to our customers, including high-volume production of the most reliable industrial-grade solid-state drives and memory modules with the greatest durability, highest consistency, and extended product life beyond the fast-moving industry changes - our product availability is up to 10 years. Virtium has consistently provided product solutions to the world's largest Networking, Telecom, Industrial OEM, and other key industries that require the highest levels of data-storage integrity. We design, manufacture and support our products in the USA