



NETLIST

Datasheet
CFvault™ A1 - Compact Flash
4GB to 64GB
NLCFabcUAd-7vSHAAwxyz0

1. OVERVIEW

Netlist, the pioneer in the development of high-density memory subsystems, is proud to offer the Netlist CFvault™ A1 CompactFlash Storage Card, which provides 4GB to 64GB of nonvolatile storage. The Netlist solution uses a controller that provides a fully compatible PCMCIA interface to the Flash memory. Netlist's CFvault™ A1 Storage card is the product of choice in applications requiring high reliability and high tolerance to shock, vibration, humidity, altitude, and temperature. Because there are no moving parts to service or maintain, CF Storage card is a reliable alternative to a mechanical hard disk drive for high availability and mission critical applications. While the inherent ruggedness and reliability of solid-state storage relative to rotating hard drives is intuitive, new OEM applications are emerging due to the low cost per usable megabyte. Most applications that use embedded operating systems such as VxWorks™, Windows XP/embedded™, and Linux™ do not have large data storage requirements, and therefore a cost savings can be realized when using this robust media.

The Netlist CFvault™ A1 CompactFlash (CF) Storage Card provides a Write-Protect function that prevents the card from being written, modified and deleted. The Netlist CFvault™ A1 CompactFlash (CF) Storage Card also provides high capacity data storage that electrically complies with the Personal Computer Memory Card International Association (PCMCIA) standard. The Netlist CFvault™ A1 Storage Card also can sense your system's requirements and operate in True IDE Mode that is electrically compatible with an IDE disk drive. The on-card intelligent controller manages interface protocols, data storage and retrieval as well as Error Correcting Code (ECC), detects handling and diagnostics, power management and clock control.

2. SYSTEM FEATURES

- 4GB to 64GB of mass storage data utilizing SLC and MLC flash technology
- Non-volatile storage and completely solid state (No Moving Parts)
- Fully compliant to CFA 3.0, and PCMCIA 2.1 specifications
- Supports PIO mode 6, MDMA mode 4 and UDMA mode 4 (in True-IDE)
- Fixed and removable configurations available
- PC Card ATA and True IDE mode compatible
- Form factor: CF Type I
- Dual channel with two direct flash memory access (DFA) units
- Advanced wear leveling algorithm
- Card Information Structure (CIS) Programmed into 256 Bytes of Internal Memory
- Bad block management
- Sudden power-fail management
- 5V or 3.3V power supply
- RS-ECC engine with 4 symbol correction
- RoHS-6 compliant (Pb-free)
- Write-Protect switch
- Industrial and Commercial temperature

3. ORDERING INFORMATION

Ultra DMA Mode 4 in True IDE Mode & Auto Detect

Part Number: 128MB to 16GB Compact Flash NLCFabcUAd-7vSHAAwxyz0						
abc = Density	d = Temperature Range	v = Flash Manufacturer	w = Flash Die Geometry	x = #CE per Flash Location	y = #Flash Locations	z = #Die per Flash Location
012 = 128MB 025 = 256MB 051 = 512MB 01G = 1GB 02G = 2GB 04G = 4GB 08G = 8GB 16G = 16GB	I = Industrial - 40°C to +85°C C = Commercial 0°C to +70°C	S = Samsung M = Micron T = Toshiba 5 = Spansion	4 = 4xnm 3 = 3xnm 2 = 2xnm 1 = 1xnm	1 = 1 CE per Flash Location 2 = 2 CE per Flash Location 4 = 4 CE per Flash Location 8 = 8 CE per Flash Location	1 = 1 Flash Location 2 = 2 Flash Locations 4 = 4 Flash Locations	1 = 1 Die per Flash Location 2 = 2 Die per Flash Location 4 = 4 Die per Flash Location 8 = 8 Die per Flash Location

Density	Industrial Temperature Part Number	Commercial Temperature Part Number	Life Cycle Support
4GB	NLCF04GUAI-7TSHAA32220	NLCF04GUAC-7TSHAA32220	4Q 2015 NAND Transition
8GB	NLCF08GUAI-7TSHAA32240	NLCF08GUAC-7TSHAA32240	
16GB	NLCF16GUAI-7TSHAA32240	NLCF16GUAC-7TSHAA32240	
32GB	NLCF32GUAI-7TSHAA32440	NLCF32GUAC-7TSHAA32440	
64GB	NLCF64GUAI-7MSHAA22440	NLCF64GUAC-7MHSAA22440	

TABLE OF CONTENTS

1.	Overview.....	1
2.	System Features	1
3.	Ordering Information	2
4.	Block Diagram.....	5
5.	Physical Specifications.....	6
5.1.	CF Storage card Type 1 form-factor	6
5.2.	Physical Diagram	6
6.	Special Feature	7
6.1.	Write Protect.....	7
7.	Reliability and Durability	7
7.1.	Flash Controller	7
7.2.	Wear Leveling for Flash Memory	7
8.	System Performance	8
9.	CHS Parameters.....	8
10.	Pin Assignment	9
11.	Signal Description	11
12.	DC Characteristics.....	17
13.	AC Characteristics.....	19
14.	True IDE PIO Mode Read/Write Timing.....	23
15.	Card Configuration	25
15.1.	PCMCIA Memory Mode	25
15.2.	Attribute Memory Function	25
15.3.	Common Memory Function	25
15.4.	PCMCIA IO Mode.....	25
15.5.	True IDE Mode I/O Transfer Function	26
16.	Configuration Registers in the Attribute Memory.....	27
17.	CF-ATA Drive Register Set Definition and Protocol	27
17.1.	Addressing Modes.....	27
17.2.	CF-ATA Task-File Registers	28
18.	CF-ATA Command Set.....	29
19.	Appendix I (Standards and Specifications)	32
20.	Appendix II (CIS)	33
21.	Revision History	40

List of Figures

Figure 1: Netlist CFvault™ A1 Compact Flash Configuration using Single die Flash devices	5
Figure 2: Netlist CFvault™ A1 Compact Flash Configuration using Dual die Flash devices.....	5
Figure 3: Netlist CFvault™ A1 Compact Flash Configuration using Quad die Flash devices	5
Figure 4: Physical Diagram.....	6
Figure 5: Attribute Memory Read Timing Specification (PCMCIA mode).....	19
Figure 6: Attribute Memory Write Timing (PCMCIA mode)	20
Figure 7: Common Memory Read Timing Specification (PCMCIA mode).....	21
Figure 8: Common Memory Write Timing (PCMCIA mode)	22

List of Tables

Table 1: CF-Card Form Factor	6
Table 2: Flash Controller.....	7
Table 3: Reliability	7
Table 4: Latency Parameters	8
Table 5: Data Transfer Rates.....	8
Table 6: CHS Parameters	8
Table 7: Pin Assignment.....	9
Table 8: Signal Description	11
Table 9: Absolute Maximum Conditions.....	17
Table 10: Input Power	17
Table 11: Input Leakage Current	17
Table 12: Input Characteristics	17
Table 13: Output Drive Type.....	17
Table 14: Output Drive Characteristics.....	18
Table 15: Attribute Memory Read Timing Specification (PCMCIA mode).....	19
Table 16: Attribute Memory Write Timing (PCMCIA mode).....	20
Table 17: Common Memory Read Timing Specification (PCMCIA mode).....	21
Table 18: Common Memory Write Timing (PCMCIA mode).....	22
Table 19: True IDE PIO Mode Read/Write Timing	23
Table 20: True IDE Multiword DMA Mode Read/Write Timing.....	24
Table 21: Configuration Registers in the Attribute Memory	27
Table 22: Addressing Modes	27
Table 23: CF-ATA Task-File Registers	28
Table 24: Command Set.....	30
Table 25: Identify Device Information	31
Table 26: Appendix II (CIS).....	33

4. BLOCK DIAGRAM

FIGURE 1: NETLIST CFVAULT™ A1 COMPACT FLASH CONFIGURATION USING SINGLE DIE FLASH DEVICES

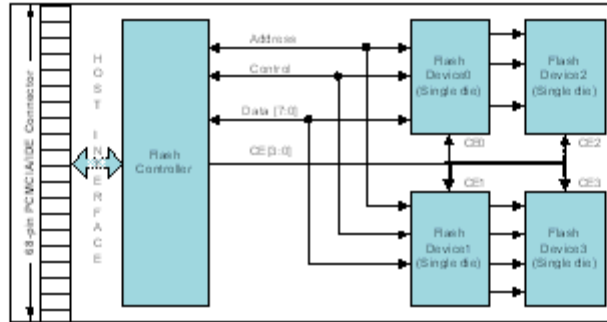


FIGURE 2: NETLIST CFVAULT™ A1 COMPACT FLASH CONFIGURATION USING DUAL DIE FLASH DEVICES

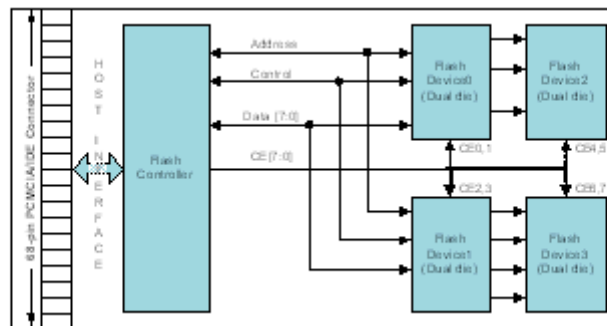
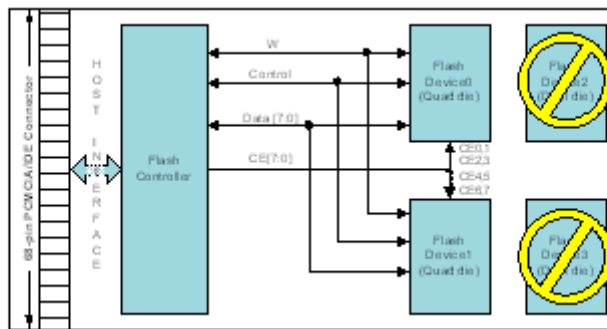


FIGURE 3: NETLIST CFVAULT™ A1 COMPACT FLASH CONFIGURATION USING QUAD DIE FLASH DEVICES



5. PHYSICAL SPECIFICATIONS

5.1. CF STORAGE CARD TYPE 1 FORM-FACTOR

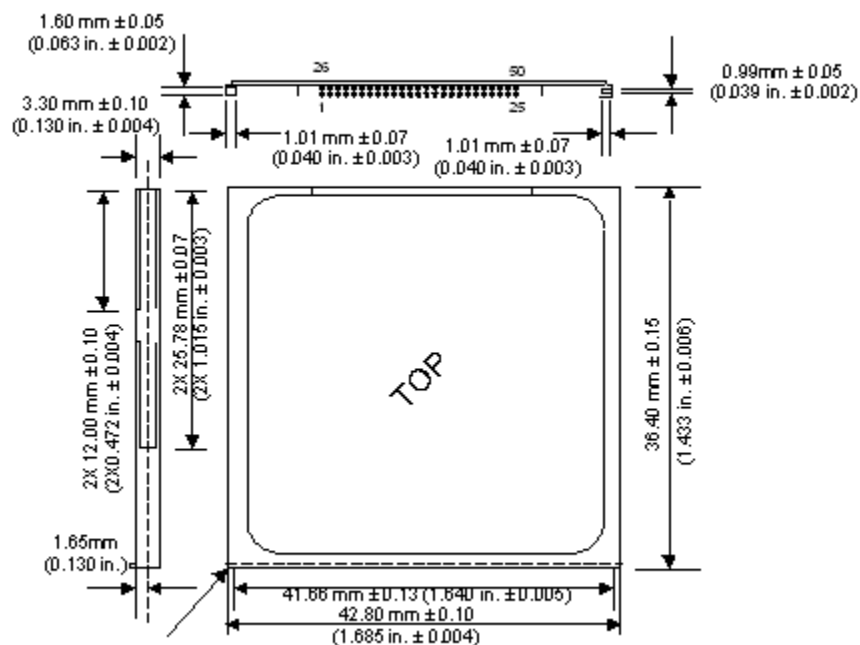
The host is connected to the CF Storage Card using a standard 50-pin connector. The connector in the host consists of two rows of 25 male contacts each on 50 mil (1.27 mm) centers.

TABLE 1: CF-CARD FORM FACTOR

Length	36.4 ± 0.15 mm (1.433 ± 0.006 in.)
Width	42.80 ± 0.10 mm (1.685 ± 0.004 in.)
Thickness Including Label Area	3.3 mm ± 0.10 mm (0.130 ± 0.004 in.)

5.2. PHYSICAL DIAGRAM

FIGURE 4: PHYSICAL DIAGRAM



6. SPECIAL FEATURE

6.1. WRITE PROTECT

Netlist CFvault™ A1 card within the Write-Protect function could prevent the CF card from modification and deletion. Write-Protected data in CF card could only be read, that is, users could not write to it, edit it, append data to it, or delete it.

When users would like to make sure that neither themselves nor others could modify or destroy the file, users could switch on Write-Protection. Thus Netlist CFvault™ A1 card would process write-protect mechanism and disable flash memory to be written-in any data. Only while the system power-off, users could switch on Write-Protection. Write-protection could not be switched-on, after OS booting.

7. RELIABILITY AND DURABILITY

7.1. FLASH CONTROLLER

TABLE 2: FLASH CONTROLLER

Temperature	Industrial Operation: -25°C to +85°C Commercial Operation: 0°C to +70°C	
Thermal Shock	-60°C to 150°C	
Atmospheric Pressure	Pressure Cooker Test (121°C, 100%RH, 29.7 psi for 168 hours) Highly Accelerated test (130°C, 33.3 psi for 100 hours)	
Vibration	15 G peak to peak maximum	
Humidity	8% to 95% non-condensing	
ESD Level	Contact discharge: Up to 8 kV Air discharge: Up to 15kV	
Acoustic Noise	0 dB	
Altitude	80,000 ft. maximum	
Shock	1,500 G	
Power Requirements	3.3V +/- 10% Sleep: 300 uA Read: 75 mA Write: 75 mA Read/Write/Peak: 500 mA	5V +/- 10% Sleep: 500 uA Read: 100 mA Write: 100 mA Read/Write/Peak: 500 mA

7.2. WEAR LEVELING FOR FLASH MEMORY

The Netlist CFvault™ A1 CompactFlash (CF) Storage Card makes use of the most advanced flash wear leveling and bad block management techniques. Wear leveling is performed with the use of reserved buffer blocks. "Wear leveled" blocks are swapped with replacement blocks that have the fewest erase cycles. Bad block management ensures that defective blocks created during device operation are mapped out and never accessed. In this manner, the life of the entire device is extended.

TABLE 3: RELIABILITY

Data Reliability	<1 non-recoverable error in 10 ¹⁴ bits read <1 erroneous correction in 10 ²⁰ bits read
------------------	---

8. SYSTEM PERFORMANCE

TABLE 4: LATENCY PARAMETERS

Parameter	Sub-parameter	Value
Start Up Times	Sleep to write	< 0.1 ms
	Sleep to read	< 0.1 ms
	Reset to ready	< 400 ms
Active to Sleep Delay		20 ms
Controller Overhead	CMD to DRQ Read CMD to DRQ Write	0.1 ms

TABLE 5: DATA TRANSFER RATES

CMD (Capacity)	Sustained Data-rate ¹
Read	Up-to 50 MB/s
Write	Up-to 40 MB/s with interleaving
Host data transfer rate in PIO mode 6 or MDMA mode 4	Up to 25 MB/s
Host data transfer rate in UDMA mode 4	Up to 66 MB/s

9. CHS PARAMETERS

TABLE 6: CHS PARAMETERS

Card Size	Cylinders	Heads	Sectors	Total Sector
4,096MB	7,964	16	63	8,027,712
8,192MB	15,880	16	63	16,007,040
16,384MB	31,769	16	63	32,014,080
32,768MB	63,538	16	63	64,028,160
65,536MB	120,076	16	63	128,056,320

¹ Based on internal testing on Intel Pentium 4 3.2 GHz, 800 MHz FSB, 512 MB DDR400, Intel 82801EB UATA controller; actual performance may vary on system and environmental factors. Controller frequency @ 55 MHz.

10. PIN ASSIGNMENT

TABLE 7: PIN ASSIGNMENT

Pin #	PC Card Memory Mode			PC Card I/O Mode			True IDE Mode ²		
	Signal Name	Pin Type	In, Out Type	Signal Name	Pin Type	In, Out Type	Signal Name	Pin Type	In, Out Type
1	GND		Ground	GND		Ground	GND		Ground
2	D03	I/O	I1Z, OZ ³	D03	I/O	I1Z, OZ ³	D03	I/O	I1Z, OZ ³
3	D04	I/O	I1Z, OZ ³	D04	I/O	I1Z, OZ ³	D04	I/O	I1Z, OZ ³
4	D05	I/O	I1Z, OZ ³	D05	I/O	I1Z, OZ ³	D05	I/O	I1Z, OZ ³
5	D06	I/O	I1Z, OZ ³	D06	I/O	I1Z, OZ ³	D06	I/O	I1Z, OZ ³
6	D07	I/O	I1Z, OZ ³	D07	I/O	I1Z, OZ ³	D07	I/O	I1Z, OZ ³
7	-CE1	I	I3U	-CE1	I	I3U	-CS0	I	I3Z
8	A10	I	I1Z	A10	I	I1Z	A10 ⁴	I	I1Z
9	-OE	I	I3U	-OE	I	I3U	-ATA SEL	I	I3U
10	A09	I	I1Z	A09	I	I1Z	A09 ⁴	I	I1Z
11	A08	I	I1Z	A08	I	I1Z	A08 ⁴	I	I1Z
12	A07	I	I1Z	A07	I	I1Z	A07 ⁴	I	I1Z
13	V _{CC}		Power	V _{CC}		Power	V _{CC}		Power
14	A06	I	I1Z	A06	I	I1Z	A06 ⁴	I	I1Z
15	A05	I	I1Z	A05	I	I1Z	A05 ⁴	I	I1Z
16	A04	I	I1Z	A04	I	I1Z	A04 ⁴	I	I1Z
17	A03	I	I1Z	A03	I	I1Z	A03 ⁴	I	I1Z
18	A02	I	I1Z	A02	I	I1Z	A02	I	I1Z
19	A01	I	I1Z	A01	I	I1Z	A01	I	I1Z
20	A00	I	I1Z	A00	I	I1Z	A00	I	I1Z
21	D00	I/O	I1Z, OZ ³	D00	I/O	I1Z, OZ ³	D00	I/O	I1Z, OZ ³
22	D01	I/O	I1Z, OZ ³	D01	I/O	I1Z, OZ ³	D01	I/O	I1Z, OZ ³
23	D02	I/O	I1Z, OZ ³	D02	I/O	I1Z, OZ ³	D02	I/O	I1Z, OZ ³
24	WP	O	OT3	-IOIS16	O	OT3	-IOCS16	O	ON3
25	-CD2	O	Ground	-CD2	O	Ground	-CD2	O	Ground
26	-CD1	O	Ground	-CD1	O	Ground	-CD1	O	Ground
27	D11 ⁵	I/O	I1Z, OZ ³	D11 ⁵	I/O	I1Z, OZ ³	D11 ⁵	I/O	I1Z, OZ ³
28	D12 ⁵	I/O	I1Z, OZ ³	D12 ⁵	I/O	I1Z, OZ ³	D12 ⁵	I/O	I1Z, OZ ³
29	D13 ⁵	I/O	I1Z, OZ ³	D13 ⁵	I/O	I1Z, OZ ³	D13 ⁵	I/O	I1Z, OZ ³
30	D14 ⁵	I/O	I1Z, OZ ³	D14 ⁵	I/O	I1Z, OZ ³	D14 ⁵	I/O	I1Z, OZ ³
31	D15 ⁵	I/O	I1Z, OZ ³	D15 ⁵	I/O	I1Z, OZ ³	D15 ⁵	I/O	I1Z, OZ ³
32	-CE2 ⁵	I	I3U	-CE2 ⁵	I	I3U	-CS1 ⁵	I	I3Z
33	-VS1	O	Ground	-VS1	O	Ground	-VS1	O	Ground
34	-IORD	I	I3U	-IORD	I	I3U	-IORD7	I	I3Z
	HSTROBE			HSTROBE			HSTROBE ¹⁰		
	-HDMARDY			-HDMARDY			-HDMARDY		
35	-IOWR	I	I3U	-IOWR	I	I3U	-IOWR ⁹	I	I3Z
	STOP ^{6,7}			STOP					

² The mode is required for CompactFlash Storage Cards.

³ The signal should be tied to V_{CC} by the host.

⁴ The signal should be grounded by the host.

⁵ These signals are required only for 16-bit accesses and not required when installed in 8-bit systems. Devices should allow for 3-state signals not to consume current.

Pin #	PC Card Memory Mode			PC Card I/O Mode			True IDE Mode ²		
	Signal Name	Pin Type	In, Out Type	Signal Name	Pin Type	In, Out Type	Signal Name	Pin Type	In, Out Type
36	-WE	I	I3U	-WE	I	I3U	-WE	I	I3U
37	READY	O	OT1	-IREQ	O	OT1	INTRQ	O	OZ1
38	V _{CC}		Power	V _{CC}		Power	V _{CC}		Power
39	-CSEL ⁸	I	I2Z	-CSEL ⁸	I	I2Z	-CSEL	I	I2U
40	-VS2	O	OPEN	-VS2	O	OPEN	-VS2	O	OPEN
41	RESET	I	I2Z	RESET	I	I2Z	-RESET	I	I2Z
42	-WAIT	O	OT1	-WAIT	O	OT1	IORDY ⁹	O	ON1
	-DDMARDY			-DDMARDY			- DDMARDY ₁₀		OT1 ¹¹
	DSTROBE ⁷			DSTROBE ⁷			DSTROBE ¹²		
43	-INPACK	O	OT1	-INPACK	O	OT1	DMARQ	O	OZ1
	-DMARQ ¹³			-DMARQ ¹³					
44	-REG	I	I3U	-REG	I	I3U	-DMACK	I	I3U
	-DMACK ¹³			DMACK ¹³					
45	BVD2	O	OT1	-SPKR	O	OT1	-DASP	I/O	I1U, ON ²
46	BVD1	O	OT1	-STSCHG	O	OT1	-PDIAG	I/O	I1U, ON ²
47	D08 ²	I/O	I1Z, OZ ³	D08 ²	I/O	I1Z, OZ ³	D08 ²	I/O	I1Z, OZ ³
48	D09 ²	I/O	I1Z, OZ ³	D09 ²	I/O	I1Z, OZ ³	D09 ²	I/O	I1Z, OZ ³
49	D10 ²	I/O	I1Z, OZ ³	D10 ²	I/O	I1Z, OZ ³	D10 ²	I/O	I1Z, OZ ³
50	GND		Ground	GND		Ground	GND		Ground

⁶ Signal usage in PC Card I/O and Memory Mode when Ultra DMA mode protocol DMA Write is active.

⁷ Signal usage in PC Card I/O and Memory Mode when Ultra DMA mode protocol DMA Read is active.

⁸ The -CSEL signal is ignored by the card in PC Card modes. However, because it is not pulled up on the card in these modes, it should not be left floating by the host in PC Card modes. In these modes, the pin should be connected by the host to PC Card A25 or grounded by the host.

⁹ Signal usage in True IDE Mode except when Ultra DMA mode protocol is active.

¹⁰ Signal usage in True IDE Mode when Ultra DMA mode protocol DMA Write is active.

¹¹ Signal is a totem-pole output during Ultra DMA data bursts in True IDE mode.

¹² Signal usage in True IDE Mode when Ultra DMA mode protocol DMA Read is active.

¹³ Signal usage in PC Card I/O and Memory Mode when Ultra DMA protocol is active.

11. SIGNAL DESCRIPTION

TABLE 8: SIGNAL DESCRIPTION

Pin	Dir.	Signal Name			Description
		PC Card Memory Mode	PC Card IO Mode	True IDE Mode	
8,10,11,12,14,15,16,17,18,19,20	I	A10 - A00			These address lines along with the -REG signal are used to select the following: The I/O port address registers within the CompactFlash Storage Card, the memory mapped port address registers within the CompactFlash Storage Card, a byte in the card's information structure and its configuration control and status registers.
			A10 - A00		This signal is the same as the PC Card Memory Mode signal.
18,19,20	I			A02 - A00	In True IDE Mode, only A[02:00] are used to select the one of eight registers in the Task File, the remaining address lines should be grounded by the host.
46	I/O	BVD1			This signal is asserted high, as BVD1 is not supported.
			-STSCHG		This signal is asserted low to alert the host to changes in the READY and Write Protect states, while the I/O interface is configured. Its use is controlled by the Card Configuration and Status Register.
				Status Changed - PDIAG	In the True IDE Mode, this input / output is the Pass Diagnostic signal in the Master / Slave handshake protocol.
45	I/O	BVD2			This signal is asserted high, as BVD2 is not supported.
			-SPKR		This line is the Binary Audio output from the card. If the Card does not support the Binary Audio function, this line should be held negated.
				-DASP	In the True IDE Mode, this input/output is the Disk Active/Slave Present signal in the Master/Slave handshake protocol.
26,25	O	-CD1, -CD2			These Card Detect pins are connected to ground on the CompactFlash Storage Card. They are used by the host to determine that the CompactFlash Storage Card is fully inserted into its socket.
			-CD1, -CD2		This signal is the same for all modes.
				-CD1, -CD2	This signal is the same for all modes.

Pin	Dir.	Signal Name			Description
		PC Card Memory Mode	PC Card IO Mode	True IDE Mode	
7,32	I	-CE1, -CE2 Card Enable			These input signals are used both to select the card and to indicate to the card whether a byte or a word operation is being performed. -CE2 always accesses the odd byte of the word. -CE1 accesses the even byte or the Odd byte of the word depending on A0 and -CE2. A multiplexing scheme based on A0, -CE1, -CE2 allows 8-bit hosts to access all data on D0-D7. While (-) DMACK is asserted, -CE1 and -CE2 shall be held negated and the width of the transfers shall be 16 bits.
			-CE1, -CE2 Card Enable		This signal is the same as the PC Card Memory Mode signal.
				-CS0, -CS1 Card Enable	In the True IDE Mode, -CS0 is the address range select for the task file registers while -CS1 is used to select the Alternate Status Register and the Device Control Register. While -DMACK is asserted, -CS0 and -CS1 shall be held negated and the width of the transfers shall be 16 bits.
39	I	-CSEL			This signal is not used for this mode, but should be connected by the host to PC Card A25 or grounded by the host.
			-CSEL		This signal is not used for this mode, but should be connected by the host to PC Card A25 or grounded by the host.
				-CSEL	This internally pulled up signal is used to configure this device as a Master or a Slave when configured in the True IDE Mode. When this pin is grounded, this device is configured as a Master. When the pin is open, this device is configured as a Slave.
31,30,29,28 , 27,49,48,47 , 6,5,4,3,2, 23, 22, 21	I/O	D15 - D00			These lines carry the Data, Commands and Status information between the host and the controller. D00 is the LSB of the Even Byte of the Word. D08 is the LSB of the Odd Byte of the Word.
			D15 - D00		This signal is the same as the PC Card Memory Mode signal.
				D15 - D00	In True IDE Mode, all Task File operations occur in byte mode on the low order bus D[7:0] while all data transfers are 16 bit using D[15:0].
1,50	--	GND			Ground. This signal is the same for all This signal is the same for all
			GND		Ground. This signal is the same for all This signal is the same for all
				GND	Ground. This signal is the same for all This signal is the same for all

Pin	Dir.	Signal Name			Description
		PC Card Memory Mode	PC Card IO Mode	True IDE Mode	
43	O	-INPACK			This signal is not used in this mode.
			-INPACK		The Input Acknowledge signal is asserted by the CompactFlash Storage Card when the card is selected and responding to an I/O read cycle at the address that is on the address bus. This signal is used by the host to control the enable of any input data buffers between the CompactFlash Storage Card and the CPU. Hosts that support a single socket per interface logic, such as for Advanced Timing Modes and Ultra DMA operation may ignore the -INPACK signal from the device and manage their input buffers based solely on Card Enable signals.
				DMARQ	In True IDE Mode, DMARQ shall not be driven when the device is not selected in the Drive-Head register. While a DMA operation is in progress, -CS0 (-CE1) and -CS1 (-CE2) shall be held negated and the width of the transfers shall be 16 bits. If there is no hardware support for True IDE DMA mode in the host, this output signal is not used and should not be connected at the host. In this case, the BIOS must report that DMA mode is not supported by the host so that device drivers will not attempt to access in DMA mode. A host that does not support DMA mode and implements both PC Card and True IDE modes of operation need not alter the PC Card mode connections while in True IDE mode as long as this does not prevent proper operation in any mode.
34	I	-IORD			This signal is not used in this mode.
			-IORD		This is an I/O Read strobe generated by the host. This signal gates I/O data onto the bus from the CompactFlash Storage Card when the card is configured to use the I/O interface.
				-IORD	In True IDE Mode, while Ultra DMA mode is not active, this signal has the same function as in PC Card I/O Mode.
35	I	-IOWR			This signal is not used in this mode.
			-IOWR		The I/O Write strobe pulse is used to clock I/O data on the Card Data bus into the CompactFlash Storage Card controller registers when the CompactFlash Storage Card is configured to use the I/O interface. The clocking shall occur on the negative to positive edge of the signal (trailing edge).

Pin	Dir.	Signal Name			Description
		PC Card Memory Mode	PC Card IO Mode	True IDE Mode	
				-IOWR	In True IDE Mode, while Ultra DMA mode protocol is not active, this signal has the same function as in PC Card I/O Mode. When Ultra DMA mode protocol is supported, this signal must be negated before entering Ultra DMA mode protocol.
9	I	-OE			This is an Output Enable strobe generated by the host interface. It is used to read data from the CompactFlash Storage Card in Memory Mode and to read the CIS and configuration registers. This signal should be left floating at power-up to set PC card mode.
			-OE		In PC Card I/O Mode, this signal is used to read the CIS and configuration registers.
				-ATA SEL	To enable True IDE Mode this input should be grounded by the host.
37	O	READY			In Memory Mode, this signal is set high when the CompactFlash Storage Card is ready to accept a new data transfer operation and is held low when the card is busy. At power up and at Reset, the READY signal is held low (busy) until the CompactFlash Storage Card has completed its power up or reset function. No access of any type should be made to the CompactFlash Storage Card during this time. Note, however, that when a card is powered up and used with RESET continuously disconnected or asserted, the Reset function of the RESET pin is disabled. Consequently, the continuous assertion of RESET from the application of power shall not cause the READY signal to remain continuously in the busy state.
			-IREQ		I/O Operation - After the CompactFlash Storage Card has been configured for I/O operation, this signal is used as -Interrupt Request. This line is strobed low to generate a pulse Mode Interrupt or held low for a level Mode interrupt.
				INTRQ	In True IDE Mode signal is the active high Interrupt Request to the host.
44	I	-REG Attribute Memory Select			This signal is used during Memory Cycles to distinguish between Common Memory and Register (Attribute) Memory accesses. High for Common Memory, Low for Attribute Memory. In PC Card Memory Mode, when Ultra DMA Protocol is supported by the host and the host has enabled Ultra DMA protocol on the card the, host shall keep the -REG signal negated during the execution of any DMA Command by the device.

Pin	Dir.	Signal Name			Description
		PC Card Memory Mode	PC Card IO Mode	True IDE Mode	
			-REG		The signal shall also be active (low) during I/O Cycles when the I/O address is on the Bus. In PC Card I/O Mode, when Ultra DMA Protocol is supported by the host and the host has enabled Ultra DMA protocol on the card the, host shall keep the -REG signal asserted during the execution of any DMA Command by the device.
				-DMACK	A host that does not support DMA mode and implements both PC Card and True-IDE modes of operation need not alter the PC Card mode connections while in True-IDE mode as long as this does not prevent proper operation all modes.
41	I	RESET			The CompactFlash Storage Card is Reset when the RESET pin is high with the following important exception: The host may leave the RESET pin open or keep it continually high from the application of power without causing a continuous Reset of the card. Under either of these conditions, the card shall emerge from power-up having completed an initial Reset. The CompactFlash Storage Card is also Reset when the Soft Reset bit in the Card Configuration Option Register is set.
			RESET		This signal is the same as the PC Card Memory Mode signal.
				RESET	In the True IDE Mode, this input pin is the active low hardware reset from the host.
13,38	--	V _{CC}			+5 V, +3.3 V power. This signal is the same for all.
			V _{CC}		+5 V, +3.3 V power. This signal is the same for all.
				V _{CC}	+5 V, +3.3 V power. This signal is the same for all.
33, 40	O	-VS1 -VS2			Voltage Sense Signals. -VS1 is grounded on the Card and sensed by the Host so that the CompactFlash Storage Card CIS can be read at 3.3 volts. -VS2 is reserved by PCMCIA for a secondary voltage and is not connected on the Card.
			-VS1 -VS2		This signal is the same for all modes.
				-VS1 -VS2	This signal is the same for all modes.
42	O	-WAIT			The -WAIT signal is driven low by the CompactFlash Storage Card to signal the host to delay completion of a memory or I/O cycle that is in progress.
			-WAIT		This signal is the same as the PC Card Memory Mode signal.

Pin	Dir.	Signal Name			Description
		PC Card Memory Mode	PC Card IO Mode	True IDE Mode	
				IORDY	In True IDE Mode, except in Ultra DMA modes, this output signal may be used as IORDY.
36	I	-WE			This is a signal driven by the host and used for strobing memory write data to the registers of the CompactFlash Storage Card when the card is configured in the memory interface mode. It is also used for writing the configuration registers.
			-WE		In PC Card I/O Mode, this signal is used for writing the configuration registers.
				-WE	In True IDE Mode, this input signal is not used and should be connected to V_{CC} by the host.
24	O	WP			Memory Mode - The CompactFlash Storage Card does not have a write protect switch. This signal is held low after the completion of the reset initialization sequence.
			-IOIS16		I/O Operation - When the CompactFlash Storage Card is configured for I/O Operation Pin 24 is used for the -I/O Selected is 16 Bit Port (-IOIS16) function. A Low signal indicates that a 16-bit or odd byte only operation can be performed at the addressed port.
				-IOCS16	In True IDE Mode, this output signal is asserted low when this device is expecting a word data transfer cycle.

12. DC CHARACTERISTICS

Following Tables define all D.C. Characteristics for the CF Storage Card using the conditions listed below.

VCC = 5V ±10%; VCC = 3.3V ± 5%;

TABLE 9: ABSOLUTE MAXIMUM CONDITIONS

Parameter	Symbol	Conditions
Operating Temperature Range	T _{AMB}	0°C to +70°C
Input Power	V _{CC}	-0.3V min. to 6.5V max.
Voltage on any pin except V _{CC} with respect to GND.	V	-0.5V min. to V _{CC} + 0.5V max.

TABLE 10: INPUT POWER

Voltage	Maximum Average RMS Current	Measurement Method	
		Power Level 0	Power Level 1
3.3V ± 5%	75 mA	500 mA	3.3V -25°C
5.0V ± 10%	100 mA	500 mA	5.0V -25°C

TABLE 11: INPUT LEAKAGE CURRENT

Type	Parameter	Symbol	Conditions	Min	Max	Units
I _{xZ}	Input Leakage Current	IL	V _{ih} = V _{CC} V _{il} = Gnd	-1	1	µA
I _{xU}	Pull-Up Resistor	RPU1	V _{CC} = 5.0V	50k	500k	Ohm
I _{xD}	Pull-Down Resistor	RPD1	V _{CC} = 5.0V	50k	500k	Ohm

TABLE 12: INPUT CHARACTERISTICS

Type	Parameter	Symbol	Min	TYP	Max	Min	TYP	Max	Units
			V _{CC} = 3.3 V			V _{CC} = 5.0 V			
1	Input Voltage CMOS	V _{ih} V _{il}	2.4		0.6	4.0		0.8	Volts
2	Input Voltage CMOS	V _{ih} V _{il}	1.5		0.6	2.0		0.8	Volts
3	Input Voltage CMOS Schmitt Trigger	V _{th} V _{tl}		1.8 1.0			2.8 2.0		Volts

TABLE 13: OUTPUT DRIVE TYPE

Type	Output Type	Valid Conditions
OTx	Totempole	I _{oh} & I _{ol}
OZx	Tri-State N-P Channel	I _{oh} & I _{ol}
OPx	P-Channel Only	I _{oh} Only
ONx	N-Channel Only	I _{ol} Only

TABLE 14: OUTPUT DRIVE CHARACTERISTICS

Type	Parameter	Symbol	Conditions	Min	Max	Units
1	Output Voltage	Voh Vol	Ioh = -4 mA Iol = 4 mA	V _{CC} -0.8V	Gnd +0.4V	Volts
2	Output Voltage	Voh Vol	Ioh = -4 mA Iol = 4 mA	V _{CC} -0.8V	Gnd +0.4V	Volts
3	Output Voltage	Voh Vol	Ioh = -4 mA Iol = 4 mA	V _{CC} -0.8V	Gnd +0.4V	Volts
X	Tri-State Leakage Current	Ioz	Voh = V _{CC} Vol = Gnd	-10	10	μA

13. AC CHARACTERISTICS

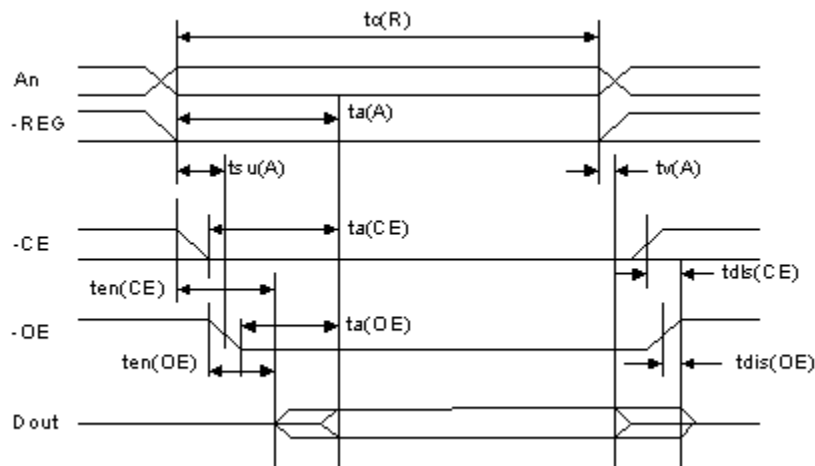
There are two types of bus cycles and timing sequences that occur in the PC Card type interface, direct mapped I/O transfer and memory access. The two timing sequences are detailed in the PCMCIA PC Card Standard. The CompactFlash Storage Card will conform to the timing in that reference document.

Attribute Memory access time is defined as 300 ns. Detailed timing specs are shown below.

TABLE 15: ATTRIBUTE MEMORY READ TIMING SPECIFICATION (PCMCIA MODE)

Speed Version			300 ns	
Item	Symbol	IEEE Symbol	Min ns.	Max ns.
Read Cycle Time	tc(R)	tAVAV	300	
Address Access Time	ta(A)	tAVQV		300
Card Enable Access Time	ta(CE)	tELQV		300
Output Enable Access Time	ta(OE)	tGLQV		150
Output Disable Time from CE	tdis(CE)	tEHQZ		100
Output Disable Time from OE	tdis(OE)	tGHQZ		100
Address Setup Time	tsu(A)	tAVGL	30	
Output Enable Time from CE	ten(CE)	tELQNZ	5	
Output Enable Time from OE	ten(OE)	tGLQNZ	5	
Data Valid from Address Change	tv(A)	tAXQX	0	

FIGURE 5: ATTRIBUTE MEMORY READ TIMING SPECIFICATION (PCMCIA MODE)



The Card Configuration write access time is defined as 250 ns. Detailed timing specifications are shown below.

TABLE 16: ATTRIBUTE MEMORY WRITE TIMING (PCMCIA MODE)

Speed			
Item	Symbol	IEEE Symbol	ns
Write Cycle Time	$t_{c(W)}$	t_{AVAV}	250
Write Pulse Width	$t_{w(WE)}$	t_{WLWH}	150
Address Setup Time	$t_{su(A)}$	t_{AVWL}	30
Write Recovery Time	$t_{rec(WE)}$	t_{WMax}	30
Data Setup Time for WE	$t_{su(D-WEH)}$	t_{DVWH}	80
Data Hold Time	$t_{h(D)}$	t_{WMDX}	30

FIGURE 6: ATTRIBUTE MEMORY WRITE TIMING (PCMCIA MODE)

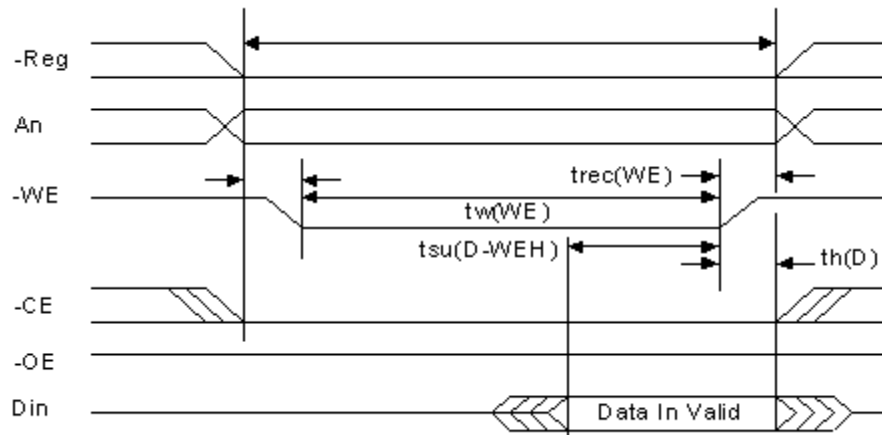
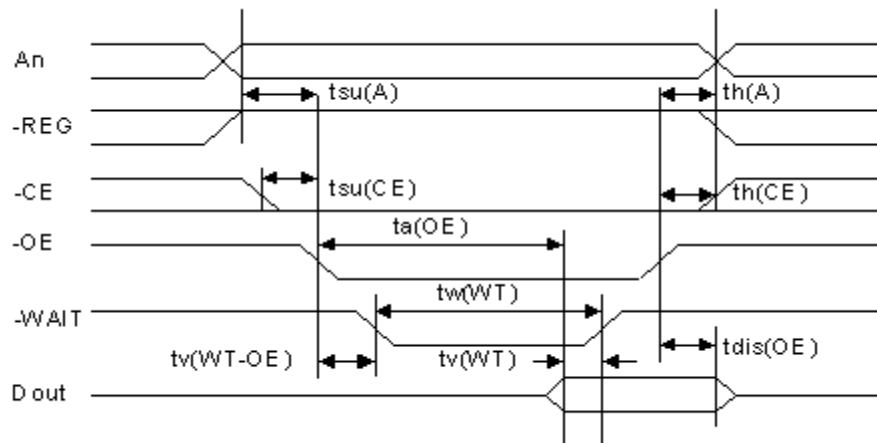


TABLE 17: COMMON MEMORY READ TIMING SPECIFICATION (PCMCIA MODE)

Cycle Time Mode:	Symbol	IEEE Symbol	250 ns		120 ns		100 ns.		80 ns	
			Min (ns)	Max (ns)	Min (ns)	Max (ns)	Min (ns)	Max (ns)	Min (ns)	Max (ns)
Output Enable Access Time	ta(OE)	tGLQV		125		60		50		45
Output Disable Time from OE	tdis(OE)	tGHQZ		100		60		50		45
Address Setup Time	tsu(A)	tAVGL	30		15				10	
Address Hold Time	th(A)	tGHAX	20		15				10	
CE Setup before OE	tsu(CE)	tELGL	0		0				0	
CE Hold following OE	th(CE)	tGHEH	20		15				10	
Wait Delay Falling from OE	tv(WT-OE)	tGLWTV		35		35		35		na ¹⁴
Data Setup for Wait Release	tv(WT)	tQVWTH		0		0		0		na ¹⁴
Wait Width Time ¹⁵	tw(WT)	tWTLWTH		350		350		350 (3000 for CF+)		na ¹⁴

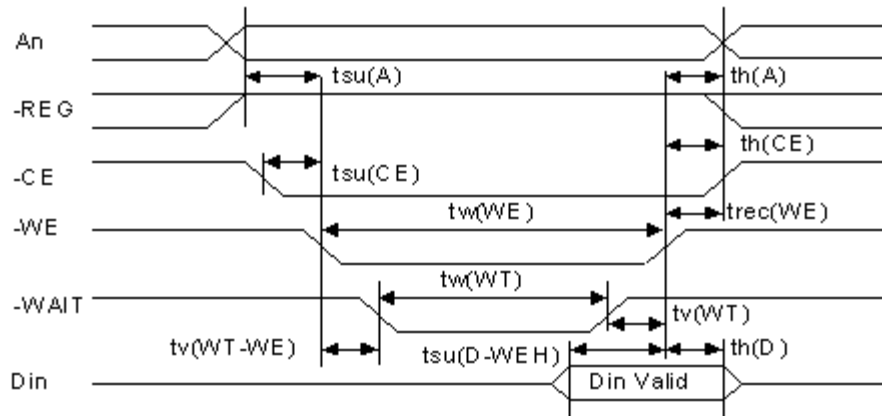
FIGURE 7: COMMON MEMORY READ TIMING SPECIFICATION (PCMCIA MODE)

¹⁴ WAIT is not supported in this mode.

¹⁵ The maximum load on -WAIT is 1 LSTTL with 50 pF (40pF below 120nsec Cycle Time) total load. All times are in nanoseconds. Dout signifies data provided by the CompactFlash Storage Card or CF+ Card to the system. The -WAIT signal may be ignored if the -OE cycle to cycle time is greater than the Wait Width time. The Max Wait Width time can be determined from the Card Information Structure. The Wait Width time meets the PCMCIA specification of 12 μ s but is intentionally less in this specification.

TABLE 18: COMMON MEMORY WRITE TIMING (PCMCIA MODE)

Cycle Time Mode	Symbol	IEEE Symbol	250 ns		120 ns		100 ns		80 ns	
			Min (ns)	Max (ns)	Min (ns)	Max (ns)	Min (ns)	Max (ns)	Min (ns)	Max (ns)
Data Setup before WE	tsu (D-WEH)	tDVWH	80		50		40		30	
Data Hold following WE	th(D)	tWMDX	30		15		10		10	
WE Pulse Width	tw(WE)	tWLWH	150		70		60		55	
Address Setup Time	tsu(A)	tAVWL	30		15		10		10	
CE Setup before WE	tsu(CE)	tELWL	0		0		0		0	
Write Recovery Time	trec(WE)	tWMax	30		15		15		15	
Address Hold Time	th(A)	tGHAX	20		15		15		15	
CE Hold following WE	th(CE)	tGHEH	20		15		15		10	
Wait Delay Falling from WE	tv (WT-WE)	tWLWTV		35		35		35		na ¹⁶
WE High from Wait Release	tv(WT)	tWTHWH	0		0		0		na ¹⁶	
Wait Width Time ¹⁷	tw (WT)	tWTLWTH		350		350		350 (3000 for CF+)		na ¹⁶

FIGURE 8: COMMON MEMORY WRITE TIMING (PCMCIA MODE)

¹⁶ WAIT is not supported in this mode.

¹⁷ The maximum load on -WAIT is 1 LSTTL with 50 pF (40pF below 120nsec Cycle Time) total load. All times are in nanoseconds. Din signifies data provided by the system to the CompactFlash Storage Card. The -WAIT signal may be ignored if the -WE cycle to cycle time is greater than the Wait Width time. The Max Wait Width time can be determined from the Card Information Structure. The Wait Width time meets the PCMCIA specification of 12 μ s but is intentionally less in this specification.

14. TRUE IDE PIO MODE READ/WRITE TIMING

The timing diagram for True IDE mode of operation in this section is drawn using the conventions in the ATA-4 specification, which are different from the conventions used in the PCMCIA PC Card specification and earlier versions of this specification. Signals are shown with their asserted state as high regardless of whether the signal is actually negative or positive true. Consequently, the -IOR, the -IOWR and the -IOCS16 signals are shown in the diagram inverted from their electrical states on the bus.

TABLE 19: TRUE IDE PIO MODE READ/WRITE TIMING

	Item	Mode					
		0	1	2	3	4	6
t0	Cycle time (min)	600	383	240	180	120	80
t1	Address Valid to -IOR/-IOWR setup (min)	70	50	30	30	25	10
t2	-IOR/-IOWR (min)	165	125	100	80	70	55
t2	-IOR/-IOWR (min) Register (8 bit)	290	290	290	80	70	55
t2i	-IOR/-IOWR recovery time (min)	-	-	-	70	25	20
t3	-IOWR data setup (min)	60	45	30	30	20	15
t4	-IOWR data hold (min)	30	20	15	10	10	5
t5	-IOR data setup (min)	50	35	20	20	20	10
t6	-IOR data hold (min)	5	5	5	5	5	5
T6Z	-IOR data tristate (max)	30	30	30	30	30	20
t7	Address valid to -IOCS16 assertion (max)	90	50	40	n/a	n/a	n/a
t8	Address valid to -IOCS16 released (max)	60	45	30	n/a	n/a	n/a
t9	-IOR/-IOWR to address valid hold	20	15	10	10	10	10
tRD	Read Data Valid to IORDY active (min), if IORDY initially low after tA	0	0	0	0	0	0
tA	IORDY Setup time	35	35	35	35	35	n/a
tB	IORDY Pulse Width (max)	1250	1250	1250	1250	1250	n/a
tC	IORDY assertion to release (max)	5	5	5	5	5	n/a

TABLE 20: TRUE IDE MULTIWORD DMA MODE READ/WRITE TIMING

	Item	Mode 0 (ns)	Mode 1 (ns)	Mode 2 (ns)	Mode 4 (ns)
tO	Cycle time (min)	480	150	120	80
tD	-IOR \bar{D} / -IOWR asserted width (min)	215	80	70	55
tE	-IOR \bar{D} data access (max)	150	60	50	45
tF	-IOR \bar{D} data hold (min)	5	5	5	5
tG	-IOR \bar{D} /-IOWR data setup (min)	100	30	20	10
tH	-IOWR data hold (min)	20	15	10	5
tI	DMACK to -IOR \bar{D} /-IOWR setup (min)	0	0	0	0
tJ	-IOR \bar{D} / -IOWR to -DMACK hold (min)	20	5	5	5
tKR	-IOR \bar{D} negated width (min)	50	50	25	20
tKW	-IOWR negated width (min)	215	50	25	20
tLR	-IOR \bar{D} to DMARQ delay (max)	120	40	35	35
tLW	-IOWR to DMARQ delay (max)	40	40	35	35
tM	CS(1:0) valid to -IOR \bar{D} / -IOWR	50	30	25	5
tN	CS(1:0) hold	15	10	10	10
tZ	-DMACK	20	25	25	25

15. CARD CONFIGURATION

The CompactFlash Storage Cards are identified by appropriate information in the Card Information Structure (CIS). The following configuration registers are used to coordinate the I/O spaces and the Interrupt level of cards that are located in the system. In addition, these registers provide a method for accessing status information about the CompactFlash Storage Card that may be used to arbitrate between multiple interrupt sources on the same interrupt level or to replace status information that appears on dedicated pins in memory cards that have alternate use in I/O cards.

Please refer to the Appendix for complete information of the CIS offsets, content and functions.

(Note - Offsets 01Eh - CISTPL_MANFID & offset 12Ah-CISTPL_VERS_1 reflect Netlist)

The host can access the CompactFlash Card in the following modes:

15.1. PCMCIA MEMORY MODE

For the Attribute Memory Read function, signals -REG and -OE shall be active and -WE inactive during the cycle. As in the Main Memory Read functions, the signals -CE1 and -CE2 control the even-byte and odd-byte address, but only the even-byte data is valid during the Attribute Memory access.

15.2. ATTRIBUTE MEMORY FUNCTION

Attribute memory is a space where CompactFlash Storage Card identification and configuration information are stored, and is limited to 8-bit wide accesses only at even addresses. The card configuration registers are also located here. For CompactFlash Storage Cards, the base address of the card configuration registers is 200h.

15.3. COMMON MEMORY FUNCTION

The Common Memory can be accessed in the Byte/Word/Odd Byte modes in PC Card Memory Mode. The -REG signal must be de-asserted when accessing the Common Memory. The CF Card is mapped to PC Card Memory Mode by the Index bits in the Configuration Option Register. The Common Memory transfer to or from the CompactFlash Storage Card can be either 8 or 16 bits. The CompactFlash Storage Card permits both 8 and 16-bit accesses to all of its Common Memory addresses. The CompactFlash Storage Card or the CF+ Card may request the host to extend the length of a memory write cycle or extend the length of a memory read cycle until data is ready by asserting the -WAIT signal at the start of the cycle.

15.4. PCMCIA IO MODE

The CompactFlash Card can be accessed by Byte/Word/Odd Byte modes in PC Card I/O Mode. The CF Card is mapped to PC Card I/O Mode by the Index bits in the Configuration Option Register. The index bits also select Contiguous I/O, Primary I/O, or Secondary I/O mapping when using the PC Card I/O Mode.

15.5. TRUE IDE MODE I/O TRANSFER FUNCTION

The CompactFlash Storage Card can be configured in a True IDE Mode of operation. The CompactFlash Storage Card is configured in this mode only when the -OE input signal is grounded by the host during the power off to power on cycle. Optionally, CompactFlash Storage Cards may support the following optional detection methods:

The card is permitted to monitor the -OE (-ATA SEL) signal at any time(s) and switch to PC Card mode upon detecting a high level on the pin.

The card is permitted to re-arbitrate the interface mode determination following a transition of the (-)RESET pin.

The card is permitted to monitor the -OE (-ATA SEL) signal at any time(s) and switch to True IDE mode upon detection of a continuous low level on pin for an extended period of time.

(In this mode, no Memory or Attribute Registers are accessible to the host. CompactFlash Storage Cards permit 8 bit PIO mode data accesses if the user issues a Set Feature Command to put the CompactFlash Storage Card in 8 bit Mode.)

16. CONFIGURATION REGISTERS IN THE ATTRIBUTE MEMORY

TABLE 21: CONFIGURATION REGISTERS IN THE ATTRIBUTE MEMORY

Name	Description
Configuration Option Register (Base + 00h in Attribute Memory)	The Configuration Option Register is used to configure the cards interface, address decoding and interrupt and to issue a soft reset to the CompactFlash Storage Card.
Card Configuration and Status Register (Base + 02h in Attribute Memory)	The Card Configuration and Status Register contain information about the Card's condition.
Pin Replacement Register (Base + 04h in Attribute Memory)	This register is used for providing the signal state of -IREQ when the CF Card is configured in the PC Card I/O Mode.
Socket and Copy Register (Base + 06h in Attribute Memory)	This register contains additional configuration information. This register is always written by the system before writing the card's Configuration Index Register. This register is not required for CFs. If present, it is optional for a CF Card to allow setting bit D4 (Drive number) to 1. If two drives are supported, it is intended for use only when two cards are co-located at either the primary or the secondary addresses in PC Card I/O mode. The availability and capabilities of this register are described in the Card Information Structure of the CF Card.

17. CF-ATA DRIVE REGISTER SET DEFINITION AND PROTOCOL

The CompactFlash Storage Card can be configured as a high performance I/O device through the addressing modes mentioned below. The communication to or from the CompactFlash Storage Card is done using the Task File registers, which provide all the necessary registers for control and status information related to the storage medium.

17.1. ADDRESSING MODES

TABLE 22: ADDRESSING MODES

Name	Description
Memory Mapped Addressing	When the CompactFlash Storage Card registers are accessed via memory references, the registers appear in the common memory space window of 0-2K bytes.
Standard IO Addressing	In this mode the CompactFlash Storage Card Registers can be accessed via the standard PC-AT disk I/O address spaces 1F0h-1F7h, 3F6h-3F7h (primary) or 170h- 177h, 376h-377h (secondary) with IRQ 14 (or other available IRQ).
True IDE Mode Addressing	The CompactFlash Storage Card is configured in the True IDE Mode using any system decoded 16-byte I/O block using any available IRQ.

17.2. CF-ATA TASK-FILE REGISTERS

The following section describes the hardware registers used by the host software to issue commands to the CompactFlash device. These registers are often collectively referred to as the "task file." (Note: In accordance with the PCMCIA PC Card specification: each of the registers below that is located at an odd offset address may be accessed in the PC Card Memory or PC Card I/O modes at its normal address and also the corresponding even address (normal address -1) using data bus lines (D15-D8) when -CE1 is high and -CE2 is low unless -IOIS16 is high (not asserted by the card) and an I/O cycle is being performed. In the True IDE mode of operation, the size of the transfer is based solely on the register being addressed. All registers are 8 bit only except for the Data Register, which is normally 16 bits, but can be programmed to use 8-bit transfers for Non-DMA operations using the Set Features command. The data register is also 8 bits during a portion of the Read Long and Write Long commands, which exist solely for historical reasons and should not be used.)

TABLE 23: CF-ATA TASK-FILE REGISTERS

Name	Description	
Data Register	The Data Register is a 16-bit register, and it is used to transfer data blocks between the CompactFlash Storage Card data buffer and the Host. This register overlaps the Error Register. Data Register Access below describes the combinations of data register access and is provided to assist in understanding the overlapped Data Register and Error/Feature Register rather than to attempt to define general PCMCIA PC Card word and byte access modes and operations. See the PCMCIA PC Card Standard, for further definitions of the Card Accessing Modes for I/O and Memory cycles.	
Error Register	This register contains additional information about the source of an error when an error is indicated in bit 0 of the Status register.	
Feature Register	This register provides information regarding features of the CompactFlash Storage Card that the host can utilize. This register is also accessed in PC Card modes on data bits D15-D8 during a write operation to Offset 0 with -CE2 low and -CE1 high.	
Sector Count Register	This register contains the numbers of sectors of data requested to be transferred on a read or write operation between the host and the CompactFlash Storage Card. If the value in this register is zero, a count of 256 sectors is specified. If the command was successful, this register is zero at command completion. If not successfully completed, the register contains the number of sectors that need to be transferred in order to complete the request.	
Sector Number	This register contains the starting sector number or bits 7-0 of the Logical Block Address (LBA) for any CompactFlash Storage Card data access for the subsequent command.	
Cylinder Low	This register contains the low order 8 bits of the starting cylinder address or bits 15-8 of the Logical Block Address.	
Cylinder High	This register contains the high order bits of the starting cylinder address or bits 23-16 of the Logical Block Address	
Drive/Head	The Drive/Head register is used to select the drive and head. It is also used to select LBA addressing instead of cylinder/head/sector addressing.	
Status & Alternate Status Registers	These registers return the CompactFlash Storage Card status when read by the host. Reading the Status register does clear a pending interrupt while reading the Auxiliary Status register does not. The status bits are described as follows:	
	<table border="1"> <tr> <td>Device Control Register</td> <td>This register is used to control the CompactFlash Storage Card interrupt request and to issue an ATA soft reset to the card. This register can be written even if the device is BUSY.</td> </tr> </table>	Device Control Register
Device Control Register	This register is used to control the CompactFlash Storage Card interrupt request and to issue an ATA soft reset to the card. This register can be written even if the device is BUSY.	

Name	Description	
	Card (Drive) Address Register	This register is provided for compatibility with the AT disk drive interface. It is recommended that this register not be mapped into the host's I/O space because of potential conflicts on Bit 7.

18. CF-ATA COMMAND SET

This section defines the software requirements and commands the host sends to the CompactFlash Storage Cards. Commands are issued to the CompactFlash Storage Card by loading the required registers in the command block with the supplied parameters, and then writing the command code to the Command Register. The manner in which a command is accepted varies. There are three classes (see Table 48: CF-ATA Command Set) of command acceptance, all dependent on the host not issuing commands unless the CompactFlash Storage Card is not busy (BSY=0). All commands listed in this specification shall be implemented. Commands can be implemented as "no operation" to meet this requirement. The Security Mode feature set (command codes F1, F2, F3, F4, F5, and F6) should not be implemented unless the device is intended to be used in an embedded, non-removable application. The Security Mode feature set was not designed for removable devices and certain problems may be encountered when using these commands in a removable application. This specification introduces some new commands and features. If these commands are used on an older CF card, an Invalid Command Error may occur.

Upon receipt of a Class 1 command, the CompactFlash Storage Card sets BSY within 400 ns.

Upon receipt of a Class 2 command, the CompactFlash Storage Card sets BSY within 400 ns, sets up the sector buffer for a write operation, sets DRQ within 700 ms, and clears BSY within 400 ns of setting DRQ.

Upon receipt of a Class 3 command, the CompactFlash Storage Card sets BSY within 400 ns, sets up the sector buffer for a write operation, sets DRQ within 20 ms (assuming no re-assignments), and clears BSY within 400 ns of setting DRQ.

CF-ATA Command Set summarizes the CF-ATA command set with the paragraphs that follow describing the individual commands and the task file for each. For further description of the commands, please refer to the CompactFlash Association Specification for "CF+ and CompactFlash Specification, Revision 4".

TABLE 24: COMMAND SET

No.	Class	Command Set	Code	FR	SC	SN	CY	DH	LBA
1	1	Check Power Mode	E5H, 98H	-	-	-	-	D	-
2	1	Execute Drive Diagnostic	90H	-	-	-	-	D	-
3	1	Erase Sector(s)	C0H	-	Y	Y	Y	Y	Y
4	2	Format Track	50H	-	Y	-	Y	Y	Y
5	1	Identify Device	ECH	-	-	-	-	D	-
6	1	Idle	E3H, 97H	-	Y	-	-	D	-
7	1	Idle Immediate	E1H, 95H	-	-	-	-	D	-
8	1	Initialize Drive Parameters	91H	-	Y	-	-	Y	-
9	1	NOP	00h	-	-	-	-	D	-
10	1	Read Buffer	E4H	-	-	-	-	D	-
11	1	Read DMA	C8h	-	Y	Y	Y	Y	Y
12	1	Read Multiple	C4H	-	Y	Y	Y	Y	Y
13	1	Read Long Sector	22H, 23H	-	-	Y	Y	Y	Y
14	1	Read Sector(s)	20H, 21H	-	Y	Y	Y	Y	Y
15	1	Read Verify Sector(s)	40H, 41H	-	Y	Y	Y	Y	Y
16	1	Recalibrate	1XH	-	-	-	-	D	-
17	1	Request Sense	03H	-	-	-	-	D	-
18	1	Seek	7XH	-	-	Y	Y	Y	Y
19	1	Set Features	EFH	Y	-	-	-	D	-
20	1	Set Multiple Mode	C6H	-	Y	-	-	D	-
21	1	Set Sleep Mode	E6H, 99H	-	-	-	-	D	-
22	1	Stand By	E2H, 96H	-	-	-	-	D	-
23	1	Stand By Immediate	E0H, 94H	-	-	-	-	D	-
24	1	Translate Sector	87H	-	Y	Y	Y	Y	Y
25	1	Wear Level	F5H	-	-	-	-	Y	-
26	2	Write Buffer	E8H	-	-	-	-	D	-
27	2	Write DMA	CAh	-	Y	Y	Y	Y	Y
28	2	Write Long Sector	32H, 33H	-	-	Y	Y	Y	Y
29	3	Write Multiple	C5H	-	Y	Y	Y	Y	Y
30	3	Write Multiple w/o Erase	CDH	-	Y	Y	Y	Y	Y
31	3	Write Sector(s)	30H, 31H	-	Y	Y	Y	Y	Y
32	3	Write Sector(s) w/o Erase	38H	-	Y	Y	Y	Y	Y
33	3	Write Verify	3CH	-	Y	Y	Y	Y	Y

TABLE 25: IDENTIFY DEVICE INFORMATION

Word Address	Default Value (Hex)	Bytes	Data Field Type Information
0	848A	2	General configuration bit-significant information
1	XXXX	2	Default number of cylinders
2	0000	2	Reserved
3	00XX	2	Default number of heads
4	0000	2	Number of unformatted bytes per track
5	0200	2	Number of unformatted bytes per sector
6	XXXX	2	Default number of sectors per track
7 to 8	XXXX	4	Number of sectors per card
9	0000	2	Reserved
10	XXXX	2	Manufacturer
11	2D	1	Product Type
	41	1	Flash Manufacturer
12	44	1	Flash Architecture ("D" - Dual Plane)
	55	1	DMA Support ("U" - Ultra DMA Enabled)
13	41	1	Feature Set ("A" - Auto Detect)
	xx	1	Capacity (GB)
14	32	1	Number of channels ("2" - Dual channel)
	00	1	Customer designator
15	00	1	Customer designator
	20	1	space
16	31	1	Manufacturing Year ("1" - 2011)
	32	1	Test Station Number ("2" - Station 2)
17 to 19	303030303031	6	ESN (start from 000001 and increments)
20	0001	2	Buffer type (single ported)
21	0001	2	Buffer size in 512 byte increments
22	0004	2	# ECC bytes passed on Read/Write Long Commands
23 to 26	362f31332f3037	8	Firmware revision (8 ASCII characters) - "4/14/08"
27 to 46	4e65746c69737420466c61736820 76312e30	40	Model Number (40 ASCII characters) - "Netlist Flash v2.0"
47	0001	2	Maximum of 1 sector on Read/Write Multiple command
48	0000	2	Double Word not supported
49	0300	2	Capabilities: DMA Supported, LBA supported
50	0000	2	Reserved
51	0200	2	PIO data transfer cycle timing mode 2
52	0000	2	DMA data transfer cycle timing mode not Supported
53	0001	2	Data Fields 54 to 58 are valid
54	XXXX	2	Number of current logical cylinders
55	XXXX	2	Number of current logical heads
56	XXXX	2	Number of current logical sectors per track
57 to 58	XXXX	4	Current Capacity in sectors
59	010X	2	Multiple sector setting is valid
60 to 61	XXXX	4	Total number of sectors addressable in LBA Mode
62 to 255	0000	388	Reserved

19. APPENDIX I (STANDARDS AND SPECIFICATIONS)

Copies of the following PCMCIA standards can be obtained from:

2635 North First St., Ste. 209
San Jose, CA 95131 USA

Phone: 408-433-2273

Fax: 408-433-9558

Copies of the following ATA standards can be purchased from:

ANSI or Global Engineering Documents
11 West 42nd Street Inverness Way East
New York, NY 10036 USA Englewood, CO 80112-5704

Tel: 212 642-4900

Tel: 800 854-7179

Outside USA and Canada 303 792-2181

International Sales Fax: 303 397-2740.

20. APPENDIX II (CIS)

TABLE 26: APPENDIX II (CIS)

Address	Data	7	6	5	4	3	2	1	0	Description of Contents	CIS Function	
000H	01H	CISTPL_DEVICE								Device info tuple	Tuple code	
002H	03H	TPL_LINK								Link length is 3 byte	Link to next tuple	
004H	D9H	Device Type			W	Speed					Type = D:I/O device WPS = 1:no W switch Speed = 1: 250ns	Device type, WPS, speed
006H	01H	#address units-1			unit size						2 Kbytes of address space	Device size
008H	FFH	CISTPL_END								End of CISTPL_DEVICE	End marker	
00AH	1Ch	CISTPL_DEVICE_OC								Common memory other operating conditions tuple	Tuple code	
00CH	04H	TPL_LINK								Link length is 4 byte	Link to next tuple	
00EH	02H	Ext Reserved				3V	M				3V = 1: dual voltage card, conditions for 3.3V operation M=0: conditions without wait	Other Conditions information
010H	D9H	Device Type			W	Speed					Type = D:I/O device WPS = 1:no W switch Speed = 1: 250ns	Device type, WPS, speed
012H	01H	#address units-1			unit size						2 Kbytes of address space	Device size
014H	FFH	CISTPL_END								End of CISTPL_DEVICE_OC	End marker	
016H	18H	CISTPL_JEDEC_C								JEDEC programming info tuple	Tuple code	
018H	02H	TPL_LINK								Link length is 2 byte	Link to next tuple	
01AH	DFH	JEDEC ID								Device manufacturer ID	Manufacturer ID	
01CH	01H	JEDEC Info								Manufacturer specific ID	Manufacturer info	
01EH	20H	CISTPL_MANFID								manufacturer ID tuple	Tuple code	
020H	04H	TPL_LINK								Link length is 4 bytes	Link to next tuple	
022H	00H	TPLMID_MANF								PC Card manufacturer code		Manufacturer ID
024H	00H											
026H	00H	TPLMID_CARD								Manufacturer specific info		Manufacturer info
028H	00H											
02AH	21H	CISTPL_FUNCID								Function ID tuple	Tuple code	
02CH	02H	CISTPL_LINK								Link length is 2 byte	Link to next tuple	
02EH	04H	TPLFID_FUNCTION								Fixed disk drive	Function code	
030H	01H	Reserved						R	P	R=0: no expansion ROM P=1: configure at POST		System init byte TPLFID_SYSINIT
032H	22H	CISTPL_FUNCCE								Function Extension tuple	Tuple code	
034H	02H	CISTPL_LINK								Link length is 2 byte	Link to next tuple	
036H	01H	Disk function extension tuple								Disk interface information	TPLFE_TYPE	
038H	01H	Disk interface type								PC card ATA interface	TPLFE_DATA	
03AH	22H	CISTPL_FUNCCE								Function Extension tuple	Tuple code	
03CH	03H	CISTPL_LINK								Link length is 3 byte	Link to next tuple	

Address	Data	7	6	5	4	3	2	1	0	Description of Contents	CIS Function		
03EH	02H	Disk function extension tuple								PC card ATA basic features	TPLFE_TYPE		
040H	04H	Reserved			D	U	S	V		D=0: single drive on card U=0: no unique serial number S=1: silicon device V=0 no V _{pp} required	TPLFE_TYPE		
042H	07H	R	I	E	N	P				I=0: twin IOIS16# unspecified E=0: index bit not emulated N=0: I/O includes 0x3F7 P=7: sleep, standby, idle supported	TPLFE_TYPE		
044H	1AH	CISTPL_CONFIG								Configuration Tuple	Tuple code		
046H	05H	TPL_LINK								Link length is 5 bytes	Link to next tuple		
048H	01H	RFS		RMS				RAS		RFS: reserved RMS: 1 byte register mask RAS: 2 bytes base address	Size of fields TPCC_SZ		
04AH	07H	TPCC_LAST								Last configuration entry is 07H	Last entry index		
04CH	00H	TPCC_RADAR (LSB)								Configuration registers are located at 0200H	Configuration register location		
04EH	02H	TPCC_RADAR (MSB)											
050H	0FH	TPCC_RMSK								Configuration registers 0 to 3 are present	Configuration register present mask		
052H	1BH	CISTPL_CFTABLE_ENTRY								Configuration tuple	Tuple code		
054H	0BH	CISTPL_LINK								Link length is 11 bytes	Link to next tuple		
056H	C0H	I	D	Configuration Index								Memory mapped configuration index = 0 I=1: Interface byte follows D=1: Default entry	Configuration Table Index Byte TPCE_INDX
058H	C0H	W	R	P	B	Interface type					W=1: wait required R=1: ready/busy active P=0: WP not used B=0: BVD1, BVD2 not used Type=0: Memory interface	Interface Description TPCE_IF	
05AH	A1H	M	M	S	IR	IO	T	Power		M=1: misc info present MS=1: 2 byte memory length IR=0: no interrupt is used IO=0: no I/O space is used T=0: no timing info specified Power=1: V _{CC} info, no V _{pp}	Feature Selection Byte TPCE_FS		
05CH	27H	R	DI	PI	AI	SI	HV	LV	NV	DI: no power-down current PI=1: peak current info AI: no average current info SI: no static current info HV=1: max voltage info LV=1: min voltage info NV=1: nominal voltage info	Power Description Structure Parameter Selection Byte TPCE_PD		
05EH	55H	X	Mantissa				Exponent			Nominal voltage 5.0V			
060H	4DH	X	Mantissa				Exponent			Minimum voltage 4.5V			
062H	5DH	X	Mantissa				Exponent			Maximum voltage 5.5V			

Address	Data	7	6	5	4	3	2	1	0	Description of Contents	CIS Function
064H	75H	X	Mantissa			Exponent				Peak current 80 mA	
066H	08H	Length in 256 byte units (LSB)			Length of memory is 2 Kbytes			Memory space descr. TPCE_MC			
068H	00H	Length in 256 byte units (MSB)									
06AH	21H	X	R	P	RO	A	T			X=0: no more misc fields P=1: power-down supported RO=0: read/write media A=0: audio not supported T=1: max twins is 1	Miscellaneous features TPCE_MI
06CH	1BH	CISTPL_CFTABLE_ENTRY			Configuration tuple			Tuple code			
06EH	06H	CISTPL_LINK			Link length is 6 bytes			Link to next tuple			
070H	00H	I	D	Configuration Index			Memory mapped configuration index = 0			TPCE_INDx	
072H	01H	M	MS		IR	IO	T	Power		Power=1: V _{CC} info, no V _{PP}	TPCE_FS
074H	21H	R	DI	PI	AI	SI	HV	LV	NV	PI=1: peak current info NV=1: nominal voltage info	TPCE_PD
076H	B5H	X	Mantissa			Exponent				X=1: extension byte present	
078H	1EH	X	Extension							Nominal voltage 3.30V	
07AH	4DH	X	Mantissa			Exponent				Peak current 45 mA	
07CH	1BH	CISTPL_CFTABLE_ENTRY			Configuration Tuple			Tuple code			
07EH	0DH	CISTPL_LINK			Link length is 13 bytes			Link to next tuple			
080H	C1H	I	D	Configuration Index			I/O mapped, index=1 I=1: Interface byte follows D=1: Default entry			TPCE_INDx	
082H	41H	W	R	P	B	Interface type			W=0: wait not required R=1: ready/busy active P=0: WP not used B=0: BVD1, BVD2 not used Type=1: I/O interface	TPCE_IF	
084H	99H	M	MS		IR	IO	T	Power		M=1: misc info present MS=0: no memory space info IR=1: interrupt is used IO=1: I/O space is used T=0: no timing info specified Power=1: V _{CC} info, no V _{PP}	TPCE_FS
086H	27H	R	DI	PI	AI	SI	HV	LV	NV	DI: no power-down current PI=1: peak current info AI: no average current info SI: no static current info HV=1: max voltage info LV=1: min voltage info NV=1: nominal voltage info	TPCE_PD
088H	55H	X	Mantissa			Exponent				Nominal voltage 5.0V	
08AH	4DH	X	Mantissa			Exponent				Minimum voltage 4.5V	

Address	Data	7	6	5	4	3	2	1	0	Description of Contents	CIS Function	
08CH	5DH	X	Mantissa			Exponent				Maximum voltage 5.5V		
08EH	75H	X	Mantissa			Exponent				Peak current 80 mA		
090H	64H	R	S	E	IO					S=1: support 16 bit hosts E=1: support 8 bit hosts IO=4: address lines decoded	TPCE_IO	
092H	F0H	S	P	L	M	V	B	I	N	S=1: interrupt sharing logic P=1:pulse mode supported L=1:level mode supported M=1: masks V..N present V=0: no vendor unique IRQ B=0: no bus error IRQ I=0: no I/O check IRQ N=0:no NMI	TPCE_IR	
094H	FFH	1RQ7...0									Interrupt signal may be assigned to any host IRQ	
096H	FFH	1RQ15...8										
098H	21H	X	R	P	RO	A	T			X=0: no more misc fields P=1: power-down supported RO=0: read/write media A=0: audio not supported T=1: max twins is 1	TPCE_MI	
09AH	1BH	CISTPL_CFTABLE_ENTRY									Configuration Tuple	Tuple code
09CH	06H	CISTPL_LINK									Link length is 6 bytes	Link to next tuple
09EH	01H	I	D	Configuration Index						I/O mapped, index = 1	TPCE_INDx	
0A0H	01H	M	MS		IR	IO	T	Power		Power=1: V _{CC} info, no V _{PP}	TPCE_FS	
0A2H	21H	R	DI	PI	AI	SI	HV	LV	NV	PI=1: peak current info NV=1: nominal voltage info	TPCE_PD	
0A4H	B5H	X	Mantissa			Exponent				X=1: extension byte present		
0A6H	1EH	X	Extension							Nominal voltage 3.30V		
0A8H	4DH	X	Mantissa			Exponent				Peak current 45 mA		
0AAH	1BH	CISTPL_CFTABLE_ENTRY									Configuration tuple	Tuple code
0ACH	12H	CISTPL_LINK									Link length is 18 bytes	Link to next tuple
0AEH	C2H	I	D	Configuration Index						I/O mapped, index=2 I=1: Interface byte follows D=1: Default entry	TPCE_INDx	
0B0H	41H	W	R	P	B	Interface type			W=0: wait not required R=1: ready/busy active P=0: WP not used B=0:BVD1, BVD2 not used Type=1: I/O interface	TPCE_IF		
0B2H	99H	M	MS		IR	IO	T	Power		M=1: misc info present MS=0: no memory space info IR=1: interrupt is used IO=1: I/O space is used T=0: no timing info specified Power=1: V _{CC} info, no V _{PP}	TPCE_FS	

Address	Data	7	6	5	4	3	2	1	0	Description of Contents	CIS Function
0B4H	27H	R	DI	PI	AI	SI	HV	LV	NV	DI: no power-down current PI=1: peak current info AI: no average current info SI: no static current info HV=1: max voltage info LV=1: min voltage info NV=1: nominal voltage info	TPCE_PD
0B6H	55H	X	Mantissa			Exponent				Nominal voltage 5.0V	
0B8H	4DH	X	Mantissa			Exponent				Minimum voltage 4.5V	
0BAH	5DH	X	Mantissa			Exponent				Maximum voltage 5.5V	
0BCH	75H	X	Mantissa			Exponent				Peak current 80 mA	
0BEH	EAH	R	S	E	IO					R=1: range follows S=1: support 16 bit hosts E=1: support 8 bit hosts IO=10: 10 lines decoded	TPCE_IO
0C0H	61H	LS		AS		NR				LS=1: 1 byte length AS=2: 2 byte address NR=1: 2 address ranges	
0C2H	F0H	Base address 1 (LSB)						Address range 1			0x1F0 to 0x1F7
0C4H	01H	Base address 1 (MSB)									
0C6H	07H	Address range 1 length									
0C8H	F6H	Base address 2 (LSB)						Address range 2			0x3F6 to 0x3F7
0CAH	03H	Base address 2 (MSB)									
0CCH	01H	Address range 2 length									
0CEH	EEH	S	P	L	M	IRQN				S=1: interrupt sharing logic P=1:pulse mode supported L=1:level mode supported M=0: masks V..N not present IRQN=14: use interrupt 14	TPCE_IR
0D0H	21H	X	R	P	RO	A	T			X=0: no more misc fields P=1: power-down supported RO=0: read/write media A=0: audio not supported T=1: max twins is 1	TPCE_MI
0D2H	1BH	CISTPL_CFTABLE_ENTRY						Configuration Tuple			Tuple code
0D4H	06H	CISTPL_LINK						Link length is 6 bytes			Link to next tuple
0D6H	02H	I	D	Configuration Index			I/O mapped, index=2			TPCE_INDx	
0D8H	01H	M	MS		IR	IO	T	Po we r		Power=1: V _{CC} info, no V _{PP}	TPCE_FS
0DAH	21H	R	DI	PI	AI	SI	HV	LV	NV	PI=1: peak current info NV=1: nominal voltage info	TPCE_PD
0DCH	B5H	X	Mantissa			Exponent				X=1: extension byte present	
0DEH	1EH	X	Extension						Nominal voltage 3.30V		
0E0H	4DH	X	Mantissa			Exponent				Peak current 45 mA	

Address	Data	7	6	5	4	3	2	1	0	Description of Contents	CIS Function	
0E2H	1BH	CISTPL_CFTABLE_ENTRY								Configuration tuple	Tuple code	
0E4H	12H	CISTPL_LINK								Link length is 18 bytes	Link to next tuple	
0E6H	C3H	I	D	Configuration Index						I/O mapped, index=3 I=1: Interface byte follows D=1: Default entry	TPCE_INDx	
0E8H	41H	W	R	P	B	Interface type				W=0: wait not required R=1: ready/busy active P=0: WP not used B=0: BVD1, BVD2 not used Type=1: Memory interface	TPCE_IF	
0EAH	99H	M	M	S	IR	IO	T	Power		M=1: misc info present MS=0: no memory space info IR=1: interrupt is used IO=1: I/O space is used T=0: no timing info specified Power=1: V _{CC} info, no V _{PP}	TPCE_FS	
0ECH	27H	R	DI	PI	AI	SI	HV	LV	NV	DI: no power-down current PI=1: peak current info AI: no average current info SI: no static current info HV=1: max voltage info LV=1: min voltage info NV=1: nominal voltage info	TPCE_PD	
0EEH	55H	X	Mantissa				Exponent		Nominal voltage 5.0V			
0F0H	4DH	X	Mantissa				Exponent		Minimum voltage 4.5V			
0F2H	5DH	X	Mantissa				Exponent		Maximum voltage 5.5V			
0F4H	75H	X	Mantissa				Exponent		Peak current 80 mA			
0F6H	EAH	R	S	E	IO						R=1: range follows S=1: support 16 bit hosts E=1: support 8 bit hosts IO=10: 10 lines decoded	TPCE_IO
0F8H	61H	LS	AS	NR							LS=1: 1 byte length AS=2: 2 byte address NR=1: 2 address ranges	
0FAH	70H	Base address 1 (LSB)								Address range 1 0x170 to 0x177		
0FCH	01H	Base address 1 (MSB)										
0FEH	07H	Address range 1 length										
100H	76H	Base address 2 (LSB)								Address range 2 0x376 to 0x377		
102H	03H	Base address 2 (MSB)										
104H	01H	Address range 2 length										
106H	EEH	S	P	L	M	IRQN				S=1: interrupt sharing logic P=1: pulse mode supported L=1: level mode supported M=0: masks V..N not present IRQN=14: use interrupt 14	TPCE_IR	

Address	Data	7	6	5	4	3	2	1	0	Description of Contents	CIS Function
108H	21H	X	R	P	RO	A	T			X=0: no more misc fields P=1: power-down supported RO=0: read/write media A=0: audio not supported T=1: max twins is 1	TPCE_MI

21. REVISION HISTORY

Revision	Date	Author	Notes
1v0	March 22, 2012	HS	First Revision
1v1	March 6, 2014	BR	Modified part numbers

Disclaimer of Warranties and Liability

Netlist, Inc. reserves the right to make changes to specifications and product descriptions such as, but not limited to, numbers, parameters and other technical information contained herein at any time, with or without notice. Netlist disclaims all warranties, express or implied, concerning the information on this datasheet. Netlist disclaims all liability for any harm alleged to arise from the use of the information on this datasheet.

© Netlist, Inc., 2014. All rights reserved. 175 Technology, Suite 150, Irvine, CA 92618