DELKIN DEVICES®

Industrial CompactFlash

C600 Series

Engineering Specification

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1.0 Product Overview

Delkin's Industrial C600 Series CompactFlash memory cards feature significant performance and robustness upgrades for industrial applications. These cards have superior features such as:

- Static and Global Wear Leveling
- BCH ECC error correction 6 or 8 bit / 512 Byte sector or 24 bit /1024 Byte double-sector with additional CRC
- Power loss detection and sudden power fail management
- Read disturb management
- Up to50 MB/sec sustained write speed*
- Industrial temperature (-40 to 85˚C) operating range
- Compliant with CompactFlash Specification Rev. 4.1, and compatible with 5.0 specifications, Type 1, and ATA/ATAPI-7
- Operating modes – PIO 0 – 6, MDMA 0 – 6, UDMA 0 – 6 in True-IDE mode
- Compliant with European Union Directive 2002/95/EC (RoHS)
- Shock: 10g's for 11ms, MIL-STD-810, Method 516.6
- Vibration: 20Hz to 2,000Hz, 7.7GRMS, MIL-STD-810, Method 514.6
- Humidity: 5 - 95% RH, non-condensing
- Altitude: 80,000 feet
- Capacities supported
    - SLC: 128MB - 64GB
- Supports 3.3-Volt and 5-Volt operation
- Fixed Drive and removable configurations available
- Solid State – no moving parts
- Ultrasonic welded case – No press fit components
- Available upon request – Custom CIS, mechanical features, programming, duplication, labels and packaging
- All capacity configurations are available with proprietary conformal coating

*Dependent on card capacity, host configuration and testing equipment.

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The Industrial C600 Series CompactFlash cards are manufactured in the USA at our own facilities in Poway, California. The cards are supported by Delkin's locked-down Bill of Materials that ensures consistent product performance and future compatibility. Delkin's Industrial line of CompactFlash is the perfect solution for enterprises demanding specific higher qualitative and performance functions in a widely accepted, time-tested form factor.

Applications:

- Industrial Computers
- Embedded Systems
- Data Acquisition
- Automotive
- Flight Systems
- Manufacturing
- Military
- Telecommunications
- Agriculture
- Gaming

Optional Conformal Coating

Delkin's proprietary conformal coating defends data integrity in harsh environments. Delkin utilizes a low-viscosity silicon elastomer that thoroughly covers exposed board and component surfaces with a protective coating. This process shields memory electronics from moisture and contamination, preventing metal corrosion and insulating conductors against electrical leakage. The coating also ruggedizes devices against the vibration, shock, and thermal stress of severe-service applications. Conformal coating is available as an option for Delkin industrial flash memory products in many form factors, including solid state drives, CompactFlash, Secure Digital, removable and embedded USB, PCMCIA, and mSATA.

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1.1 Part Numbers

Delkin Devices Industrial C600 Series CompactFlash cards are available in the following Configurations:

Capacity *	Configuration	Part Number
128MB	SLC, Industrial Temp, Fixed Drive, DMA ON	CE12TQPF3-FD000-D
	SLC, Industrial Temp, Fixed Drive, DMA OFF	CE12TQPF3-F1000-D
	SLC, Industrial Temp, Removable, DMA ON	CE12TQPF3-XX000-D
	SLC, Industrial Temp, Removable DMA, OFF	CE12TQPF3-X1000-D
256MB	SLC, Industrial Temp, Fixed Drive, DMA ON	CE25TQNF3-FD000-D
	SLC, Industrial Temp, Fixed Drive, DMA OFF	CE25TQNF3-F1000-D
	SLC, Industrial Temp, Removable, DMA ON	CE25TQNF3-XX000-D
	SLC, Industrial Temp, Removable DMA, OFF	CE25TQNF3-X1000-D
512MBGB	SLC, Industrial Temp, Fixed Drive, DMA ON	CE51TQMF3-FD000-D
	SLC, Industrial Temp, Fixed Drive, DMA OFF	CE51TQMF3-F1000-D
	SLC, Industrial Temp, Removable, DMA ON	CE51TQMF3-XX000-D
	SLC, Industrial Temp, Removable DMA, OFF	CE51TQMF3-X1000-D
1GB	SLC, Industrial Temp, Fixed Drive, DMA ON	CE0GTQHF3-FD000-D
	SLC, Industrial Temp, Fixed Drive, DMA OFF	CE0GTQHF3-F1000-D
	SLC, Industrial Temp, Removable, DMA ON	CE0GTQHF3-XX000-D
	SLC, Industrial Temp, Removable DMA, OFF	CE0GTQHF3-X1000-D
2GB	SLC, Industrial Temp, Fixed Drive, DMA ON	CE02TQSF3-FD000-D
	SLC, Industrial Temp, Fixed Drive, DMA OFF	CE02TQSF3-F1000-D
	SLC, Industrial Temp, Removable, DMA ON	CE02TQSF3-XX000-D
	SLC, Industrial Temp, Removable DMA, OFF	CE02TQSF3-X1000-D
4 GB	SLC, Industrial Temp, Fixed Drive, DMA ON	CE04TQSF3-FD000-D
	SLC, Industrial Temp, Fixed Drive, DMA OFF	CE04TQSF3-F1000-D
	SLC, Industrial Temp, Removable, DMA ON	CE04TQSF3-XX000-D
	SLC, Industrial Temp, Removable DMA, OFF	CE04TQSF3-X1000-D
8 GB	SLC, Industrial Temp, Fixed Drive, DMA ON	CE08TQJGS-FD000-D
	SLC, Industrial Temp, Fixed Drive, DMA OFF	CE08TQJGS-F1000-D
	SLC, Industrial Temp, Removable, DMA ON	CE08TQJGS-XX000-D
	SLC, Industrial Temp, Removable DMA, OFF	CE08TQJGS-X1000-D

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16 GB	SLC, Industrial Temp, Fixed Drive, DMA ON	CE16TQJGS-FD000-D
	SLC, Industrial Temp, Fixed Drive, DMA OFF	CE16TQJGS-F1000-D
	SLC, Industrial Temp, Removable, DMA ON	CE16TQJGS-XX000-D
	SLC, Industrial Temp, Removable DMA, OFF	CE16TQJGS-X1000-D
32 GB	SLC, Industrial Temp, Fixed Drive, DMA ON	CE32TNKGS-FD000-D
	SLC, Industrial Temp, Fixed Drive, DMA OFF	CE32TNKGS-F1000-D
	SLC, Industrial Temp, Removable, DMA ON	CE32TNKGS-XX000-D
	SLC, Industrial Temp, Removable DMA, OFF	CE32TNKGS-X1000-D
64 GB	SLC, Industrial Temp, Fixed Drive, DMA ON	CE64TNJGS-FD000-D
	SLC, Industrial Temp, Fixed Drive, DMA OFF	CE64TNJGS-F1000-D
	SLC, Industrial Temp, Removable, DMA ON	CE64TNJGS-XX000-D
	SLC, Industrial Temp, Removable DMA, OFF	CE64TNJGS-X1000-D

Notes:

To add optional Conformal Coating, change the 000 in the part number to 0**5**0.

The CompactFlash cards are manufactured at our facilities in Poway, California USA. Many custom configurations are available including custom CHS, mechanical features, labels and packaging.

*Usable capacities are within 10% of the gross capacity figures shown above, which is typical with all NAND flash devices, as a small portion of the total is needed for controller firmware and spare block reserves.

1.2 Mechanical Specifications

Delkin Devices Industrial C600 Series cards are Type I CompactFlash cards.

1.3 Dimensions

Length:	36.4 ± 0.15 mm (1.433 ±.006 in.)
Width:	42.80 ± 0.10 mm (1.685 ±.004 in.)
Thickness Including Label Area:	3.3 mm ± 0.10 mm (.130 ± .004 in.)
Weight:	12.0 g typical

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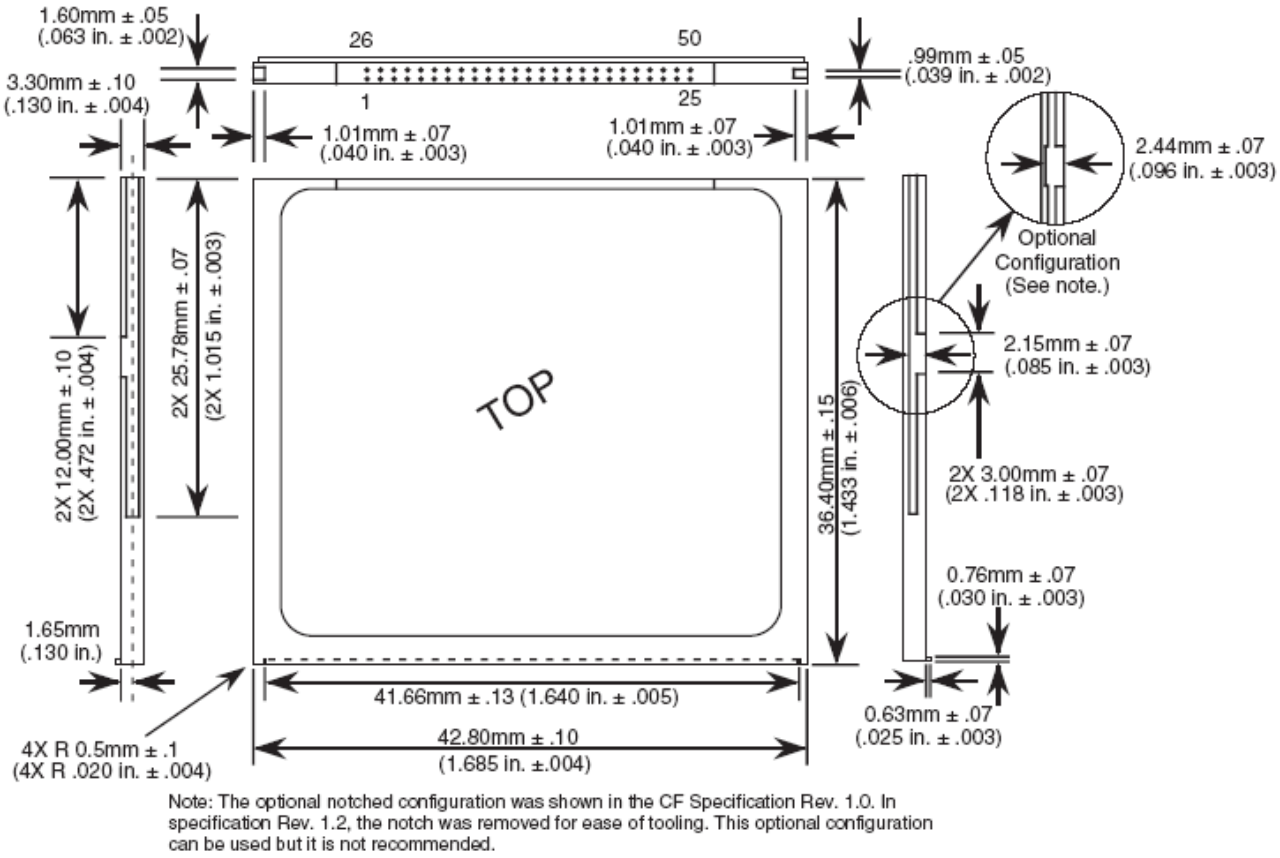

Note: The optional notched configuration was shown in the CF Specification Rev. 1.0. In specification Rev. 1.2, the notch was removed for ease of tooling. This optional configuration can be used but it is not recommended.

Figure 1. CF Card Dimensions

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2.0 Product Specifications

2.1 System Performance

Parameter	Value
Data Transfer Rate	Up to 65 MB/s
Sustained Read	Up to 65 MB/s
Sustained Write	Up to 50 MB/s

Note: All values dependent on configuration and testing environment.

2.2 Reliability

Parameter	Value
Endurance**	Contact Delkin for TBW modeling on specific applications and usage models
MTBF***	Up to 2,000,000 hours at 0°C
Data Retention	10 Years when up to 10% of the P/E cycles have been consumed 1 year when 100% of the P/E cycles have been consumed
Connector Durability	10,000 insertion cycles

**Endurance estimates based on the Enterprise Workload per JEDEC JESD219A. The figures provided are estimates and not guarantees of endurance. Actual results may vary depending on usage, operating temperature and other conditions.
*** Dependent on configuration, testing environment and operating temperature.

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2.3 Environmental Specifications

Features	Operating
Storage Temperature	-50 ~ 100°C
Industrial Operating Temperature	-40 ~ 85°C
Humidity	5% – 95% RH, non-condensing
Vibration	20Hz to 2000Hz (MIL-STD-810, Method 514.5)
Shock	10g's for 11ms (MIL-STD-810, Method 516.6)
Altitude	80,000 feet max.

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3.0 CF Card Interface

3.1 Card Pin Assignment

	Memory card mode		I/O card mode		True IDE mode	
Pin No.	Signal Name	I/O	Signal Name	I/O	Signal Name	I/O
1	GND	—	GND	—	GND	—
2	D3	I/O	D3	I/O	D3	I/O
3	D4	I/O	D4	I/O	D4	I/O
4	D5	I/O	D5	I/O	D5	I/O
5	D6	I/O	D6	I/O	D6	I/O
6	D7	I/O	D7	I/O	D7	I/O
7	-CE1	I	-CE1	I	-CS0	I
8	A10	I	A10	I	A10	I
9	-OE	I	-OE	I	-ATASEL	I
10	A9	I	A9	I	A9	I
11	A8	I	A8	I	A8	I
12	A7	I	A7	I	A7	I
13	Vcc	—	Vcc	—	Vcc	—
14	A6	I	A6	I	A6	I
15	A5	I	A5	I	A5	I
16	A4	I	A4	I	A4	I
17	A3	I	A3	I	A3	I
18	A2	I	A2	I	A2	I
19	A1	I	A1	I	A1	I
20	A0	I	A0	I	A0	I
21	D0	I/O	D0	I/O	D0	I/O
22	D1	I/O	D1	I/O	D1	I/O
23	D2	I/O	D2	I/O	D2	I/O
24	WP	O	-IOIS16	O	-IOCS16	O
25	-CD2	O	-CD2	O	-CD2	O
26	-CD1	O	-CD1	O	-CD1	O
27	D11	I/O	D11	I/O	D11	I/O
28	D12	I/O	D12	I/O	D12	I/O

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	Memory card mode		I/O card mode		True IDE mode	
Pin No.	Signal Name	I/O	Signal Name	I/O	Signal Name	I/O
29	D13	I/O	D13	I/O	D13	I/O
30	D14	I/O	D14	I/O	D14	I/O
31	D15	I/O	D15	I/O	D15	I/O
32	-CE2	I	-CE2	I	-CS1	I
33	-VS1	O	-VS1	O	-VS1	O
34	-IORD	I	-IORD	I	-IORD	I
35	-IOWR	I	-IOWR	I	-IOWR	I
36	-WE	I	-WE	I	-WE	I
37	RDY/-BSY	O	-IREQ	O	INTRQ	O
38	Vcc	—	Vcc	—	Vcc	—
39	-CSEL	I	-CSEL	I	-CSEL	I
40	-VS2	O	-VS2	O	-VS2	O
41	RESET	I	RESET	I	-RESET	I
42	-WAIT	O	-WAIT	O	IORDY	O
43	-INPACK	O	-INPACK	O	DMARQ	O
44	-REG	I	-REG	I	-DMACK	I
45	BVD2	I/O	-SPKR	I/O	-DASP	I/O
46	BVD1	I/O	-STSCHG	I/O	-PDIAG	I/O
47	D8	I/O	D8	I/O	D8	I/O
48	D9	I/O	D9	I/O	D9	I/O
49	D10	I/O	D10	I/O	D10	I/O
50	GND	—	GND	—	GND	—

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3.2 Card Pin Explanation

Signal Name	Direction	Pin Number	Description
A10 to A0 (PC Card Memory mode)	I	8, 10, 11, 12, 14,15, 16, 17, 18, 19, 20	Address bus is A10 to A0. A10 is MSB and A0 is LSB.
A10 to A0 (PC Card Memory mode)			
A2 to A0 (True IDE mode)		18, 19, 20	Address bus is A10 to A0. Only A2 to A0 are used, A10 to A3 should be grounded by the host.
BVD1 (PC Card Memory mode)	I/O	46	BVD1 outputs the battery voltage status in the card. This output line is constantly driven to a high state since a battery is not required for this product.
-STSCHG (PC Card I/O mode)			-STSCHG is used for changing the status of Configuration and status register in attribute area.
-PDIAG (True IDE mode)			-PDIAG is the Pass Diagnostic signal in Master/Slave handshake protocol.
BVD2 (PC Card Memory mode)	I/O	45	BVD2 outputs the battery voltage status in the card. This output line is constantly driven to a high state since a battery is not required for this product.
-SPKR (PC Card I/O mode)			-SPKR outputs speaker signals. This output line is constantly driven to a high state since this product does not support the audio function.
-DASP (True IDE mode)			-DASP is the Disk Active/Slave Present signal in the Master/Slave handshake protocol.
-CD1, -CD2 (PC Card Memory mode)	O	26, 25	-CD1 and -CD2 are the card detection signals. -CD1 and -CD2 are connected to ground, so host can detect that the card is inserted or not.
-CD1, -CD2 (PC Card I/O mode)			
-CD1, -CD2 (True IDE mode)			

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Signal Name	Direction	Pin Number	Description
-CE1, -CE2 PC Card Memory mode) Card Enable	I	7, 32	-CE1 and -CE2 are low active card select signals. Byte/Word/Odd byte modes are defined by combination Card Enable of -CE1, -CE2 and A0.
-CE1, -CE2 (PC Card I/O mode) Card Enable			
-CS0, -CS1 (True IDE mode) Card Enable			-CE2 is used for select the Alternate Status Register and the Device Control Register while -CE1 is the chip select for the other task file registers.
-CSEL (PC Card Memory mode)	I	39	This signal is not used.
-CSEL (PC Card I/O mode)			
-CSEL (True IDE mode)			This 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.
D15 to D0 (PC Card Memory mode)	I/O	31, 30, 29, 28, 27, 49, 48, 47, 6, 5, 4, 3, 2, 23, 22, 21	Data bus is D15 to D0. D0 is the LSB of the even byte of the word. D8 is the LSB of the odd byte of the word.
D15 to D0 (PC Card I/O mode)			
D15 to D0 (True IDE mode)			
GND (PC Card Memory mode)	—	1, 50	Ground
GND (PC Card I/O mode)			
GND (True IDE mode)			
-INPACK (PC Card Memory mode)	O	43	This signal is not used and should not be connected at the host.

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Signal Name	Direction	Pin Number	Description
-INPACK (PC Card I/O mode) Input Acknowledge			This signal is asserted low by this card when the card is selected and responding to an I/O read cycle at the address that is on the address bus during -CE and-IORD are low. This signal is used for the input data buffer control.
DMARQ (True IDE mode)			This signal is a DMA Request that is used for DMA data transfers between host and device.
-IORD (PC Card Memory mode)	I	34	This signal is not used.
-IORD (PC Card I/O mode)			-IORD is used for control of read data in I/O task file area. This card does not respond to -IORD until I/O card interface setting up.
-IORD (True IDE mode)			-IORD is used for control of read data in I/O task file area. This card does not respond to -IORD until True IDE interface setting up.
-IOWR (PC Card Memory mode)	I	35	This signal is not used.
-IOWR (PC Card I/O mode)			-IOWR is used for control of data write in I/O task file area. This card does not respond to -IOWR until I/O card interface setting up.
-IOWR (True IDE mode)			-IOWR is used for control of data write in I/O task file area. This card does not respond to -IOWR until True IDE interface setting up.
-OE (PC Card Memory mode)	I	9	-OE is used for the control of reading register's data in attribute area or task file area.
-OE (PC Card I/O mode)			-OE is used for the control of reading register's data in attribute area.
-ATASEL (True IDE mode)			To enable True IDE mode this input should be grounded by the host.
RDY/-BSY (PC Card Memory mode)	O	37	The signal is RDY/-BSY pin. RDY/-BSY pin turns low level during the card internal initialization operation at Vcc applied or reset applied, so next access to the card should be after the signal turned high level.

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Signal Name	Direction	Pin Number	Description
-IREQ (PC Card I/O mode)			This signal is active low -IREQ pin. The signal of low level indicates that the card is requesting software service to host, and high level indicates that the card is not requesting.
INTRQ (True IDE mode)			This signal is the active high Interrupt Request to the host.
-REG (PC Card Memory mode)	I	44	-REG is used during memory cycles to distinguish between task file and attribute memory accesses. Attribute memory select High for task file, Low for attribute memory is accessed.
-REG (PC Card I/O mode)			-REG is constantly low when task file or attribute memory is accessed.
-DMACK (True IDE mode)			This is a DMA Acknowledge signal by the host in response to DMARQ to initiate DMA transfers.
RESET (PC Card Memory mode)	I	41	This signal is active high RESET pin. If this signal is asserted high, the card internal initialization begins to operate. During the card internal initialization RDY/-BSY is low. After the card internal initialization RDY/-BSY is high.
RESET (PC Card I/O mode)			This signal is active high RESET pin. If this signal is asserted high, the card internal initialization begins to operate. In this mode, RDY/-BSY signal cannot be used, so using Status Register the Ready/Busy status can be confirmed.
-RESET (True IDE mode)			This signal is active low -RESET pin. If this signal is asserted low, all the registers in this card are reset. In this mode, RDY/-BSY signal cannot be used, so using status register the Ready/Busy status can be confirmed.
Vcc (PC Card Memory mode)	—	13, 38	+5 V, +3.3 V power.
Vcc (PC Card I/O mode)			
Vcc (True IDE mode)			

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Signal Name	Direction	Pin Number	Description
-VS1, -VS2 (PC Card Memory mode)	O	33, 40	These signals are intended to notify Vcc requirement to host. -VS1 is held grounded and -VS2 is non-connected in this card.
-VS1, -VS2 (PC Card I/O mode)			
-VS1, -VS2 (True IDE mode)			
-WAIT (PC Card Memory mode)	O	42	This signal is active low -WAIT pin. In this card this signal is constantly high level.
-WAIT (PC Card I/O mode)			
IORDY (True IDE mode)			This output signal may be used as IORDY. In this card this signal is constantly high impedance.
-WE (PC Card Memory mode)	I	36	-WE is used for the control of writing register's data in attribute memory area or task file area.
-WE (PC Card I/O mode)			-WE is used for the control of writing register's data in attribute memory area.
-WE (True IDE mode)			This input signal is not used and should be connected to Vcc by the host.
WP (PC Card Memory mode)	O	24	WP is held low because this card does not have write-protect switch.
-IOIS16 (PC Card I/O mode)			-IOIS16 is asserted when task file registers are accessed in 16-bit mode.
-IOCS16 (True IDE mode)			This output signal is asserted low when this device is expecting a word data transfer cycle.

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4.0 Electrical Interface

4.1 Absolute Maximum Conditions

Parameter	Symbol	Conditions
Input Power	Vcc	-0.3V min. to 6.7V Max
Voltage on any pin except Vcc with respect to GND	V	-0.3V min. to Vcc + 0.3V Max

4.2 Input Power

Voltage	Maximum Average RMS Active Current	Maximum Average RMS Sleep Current	Measurement Method
3.135-3.465V	110 mA	3 mA	3.3V at 25ºC[1]
4.5-5.5V	75 mA	3 mA	5.0V at 25ºC[1]

4.3 Input Leakage Current

Type	Parameter	Symbol	Conditions	Min	Typ	Max	Units
IxZ	Input Leakage Current	IL	VHI = Vcc / VIL = GND	-1		1	µA
IxU	Pull Up Resistor	RPU1	Vcc = 5.0V	50k		500k	Ohm
IxD	Pull Down Resister	RPD1	Vcc = 5.0V	50k		500k	Ohm

4.4 Input Characteristics

Type	Parameter	Symbol	Min	Typ	Max	Min	Typ	Max	Units
			Vcc = 3.3V			Vcc = 5.0V			
1	Input Voltage CMOS	Vih Vil	2.4		0.6	4.0		0.8	Volts
2	Input Voltage CMOS	Vih Vil	1.5		0.6	2.0		0.8	Volts
3	Input Voltage CMOS Schmitt Trigger	Vth Vtl		1.8 1.0			2.8 2.0		Volts

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4.5 Output Drive Type

All outputs drive types are CMOS level.

4.6 Output Drive Characteristics

Type	Parameter	Symbol	Conditions	Min	Typ	Max	Units
O1	Output Voltage	Voh Vol	Ioh = -4 mA Iol = 4 mA	Vcc -0.8V		GND +0.4V	Volts
02	Output Voltage	Voh Vol	Ioh = -8 mA Iol = 8 mA	Vcc -0.8V		GND +0.4V	Volts

4.7 Interface/Bus Timing

There are two types of bus cycles and timing sequences that occur in the PCMCIA type interface, a direct mapped I/O transfer and a memory access. The two timing sequences are explained in detail in the PCMICA PC Card Standard. Delkin's CompactFlash Card conforms to the timing in that reference document.

4.8 CF-ATA Command Description

This section defines the software requirements and the format of the commands the host sends to the CompactFlash cards. Commands are issued to the CompactFlash 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. These are three classes of command acceptance, all dependent on the host not issuing commands unless the CompactFlash card is not busy (BSY=0).

4.8.1 CF-ATA Command set

The following table summarizes the CF-ATA command set with the paragraphs that follow describing the individual commands and the tasks file for each.

Class	COMMAND	Code	FR	SC	SN	CY	DH	LBA
1	Check Power Mode	E5h or 98h	-	-	-	-	D	-
1	Execute Drive Diagnostic	90h	-	-	-	-	D	-
1	Erase Sector(s)	C0h	-	Y	Y	Y	Y	Y
1	Flush Cache	E7h	-	-	-	-	D	-
2	Format Track	50h	-	Y	-	Y	Y	Y

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Class	COMMAND	Code	FR	SC	SN	CY	DH	LBA
1	Identify Device	ECh	-	-	-	-	D	-
1	Idle	E3h or 97h	-	Y	-	-	D	-
1	Idle Immediate	E1h or 95h	-	-	-	-	D	-
1	Initialize Drive Parameters	91h	-	Y	-	-	Y	-
1	Key Management Structure Read	B9 Feature 0-127	C	C	C	C	D C	-
1	Key Management Read Keying Material	B9 Feature 80	C	C	C	C	D C	-
2	Key Management Change Key Management Value	B9 Feature 81	C	C	C	C	D C	-
1	NOP	00h	-	-	-	-	D	-
1	Read Buffer	E4h	-	-	-	-	D	-
1	Read DMA	C8h	-	Y	Y	Y	Y	Y
1	Read Long Sector	22h or 23h	-	-	Y	Y	Y	Y
1	Read Multiple	C4h	-	Y	Y	Y	Y	Y
1	Read Sector(s)	20h or 21h	-	Y	Y	Y	Y	Y
1	Read Verify Sector(s)	40h or 41h	-	Y	Y	Y	Y	Y
1	Recalibrate	1Xh	-	-	-	-	D	-
1	Request Sense	03h	-	-	-	-	D	-
1	Security Disable Password	F6h	-	-	-	-	D	-
1	Security Erase Prepare	F3h	-	-	-	-	D	-
1	Security Erase Unit	F4h	-	-	-	-	D	-
1	Security Freeze Lock	F5h	-	-	-	-	D	-
1	Security Set Password	F1h	-	-	-	-	D	-
1	Security Unlock	F2h	-	-	-	-	D	-
1	Seek	7Xh	-	-	Y	Y	Y	Y
1	Set Features	EFh	Y	-	-	-	D	-
1	Set Multiple Mode	C6h	-	Y	-	-	D	-
1	Set Sleep Mode	E6h or 99h	-	-	-	-	D	-
1	Standby	E2h or 96h	-	-	-	-	D	-
1	Standby Immediate	E0h or 94h	-	-	-	-	D	-
1	Translate Sector	87h	-	Y	Y	Y	Y	Y
1	Wear Level	F5h	-	-	-	-	Y	-
2	Write Buffer	E8h	-	-	-	-	D	-
2	Write DMA	CAh	-	Y	Y	Y	Y	Y
2	Write Long Sector	32h or 33h	-	-	Y	Y	Y	Y
3	Write Multiple	C5h	-	Y	Y	Y	Y	Y

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Class	COMMAND	Code	FR	SC	SN	CY	DH	LBA
3	Write Multiple w/o Erase	CDh	-	Y	Y	Y	Y	Y
2	Write Sector(s)	30h or 31h	-	Y	Y	Y	Y	Y
2	Write Sector(s) w/o Erase	38h	-	Y	Y	Y	Y	Y
3	Write Verify	3Ch	-	Y	Y	Y	Y	Y

1. FR = Features Register
2. SC = Sector Count Register
3. SN = Sector Number Register
4. CY = Cylinder Register
5. DH = Card/Drive/Head Register
6. LBA = Logical Block Address Mode Supported (see command description for use).
7. Y = The register contains a valid parameter for this command.
8. For the Drive/Head Register:
   - Y – both the CompactFlash card and head parameters are used;
   - D – only the CompactFlash card parameter is valid and not the head parameter.

4.8.2 Check Power Mode – 98H or E5H

Bit –>	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Command (7)	98h or E5h							
C/D/H (6)	X			Drive	X			
Cyl High (5)	X							
Cyl Low (4)	X							
Sec Num (3)	X							
Sec Cnt (2)	X							
Feature (1)	X							

- This command checks the power mode.
- Because Delkin's CompactFlash card can recover from sleep in 200ms, idle mode is never enabled.
- CompactFlash card sets BSY, sets the Sector Count Register to 00H, Clears BSY and generates an interrupt.

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4.8.3 Execute Drive Diagnostics – 90H

Bit –>	7	6	5	4	3	2	1	0
Command (7)	90H							
C/D/H (6)	X			Drive	X			
Cyl High (5)	X							
Cyl Low (4)	X							
Sec Num (3)	X							
Sec Cnt (2)	X							
Feature (1)	X							

This command performs the internal diagnostic test implemented by the CompactFlash card.

If in PCMCIA configuration this command runs only on the CompactFlash card which is addressed by the Drive/Head register when the diagnostic command is issued. This is because PCMCIA card interface does not allow for direct inter-drive communication (such as the ATA PDIAG and DASP signals). If in True IDE mode the Drive bit is ignored and the diagnostic command is executed by both the master and the slave with the master responding with status for both devices.

The Diagnostic codes shown below are returned in the Error register at the end of the command.

Diagnostic Codes

Code	Error Type
01H	No Error Detected
02H	Formatter Device Error
03H	Sector Buffer Error
04H	ECC Circuitry Error
05H	Controlling Microprocessor Error
8XH	Slave Error in True IDE mode

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4.8.4 Erase Sector(s) – C0H

Bit –>	7	6	5	4	3	2	1	0
Command (7)	C0H							
C/D/H (6)	1	LBA	1	Drive	Head (LBA 27-24)			
Cyl High (5)	Cylinder High (LBA 23-16)							
Cyl Low (4)	Cylinder Low (LBA 15-8)							
Sec Num (3)	Sector Number (LBA 7-0)							
Sec Cnt (2)	Sector Count							
Feature (1)	X							

This command is used to pre-erase and condition data sectors in advance of a Write without Erase or Write Multiple without Erase command. There is no data transfer associated with this command but a Write Fault error status can occur.

4.8.5 Flush Cache – E7h

Bit ->	7	6	5	4	3	2	1	0
Command (7)	E7h							
C/D/H (6)	X			Drive	X			
Cyl High (5)	X							
Cyl Low (4)	X							
Sec Num (3)	X							
Sec Cnt (2)	X							
Feature (1)	X							

This command causes the card to complete writing data from its cache. The card returns status with RDY=1 and DSC=1 after the data in the write cache buffer is written to the media. If the Compact Flash Card does not support the Flush Cache command, the Compact Flash Card shall return command aborted.

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4.8.6 Format Track – 50H

Bit –>	7	6	5	4	3	2	1	0
Command (7)	50H							
C/D/H (6)	1	LBA	1	Drive	Head (LBA 27-24)			
Cyl High (5)	Cylinder High (LBA 23-16)							
Cyl Low (4)	Cylinder Low (LBA 15-8)							
Sec Num (3)	X (LBA 7-0)							
Sec Cnt (2)	Count (LBA mode only)							
Feature (1)	X							

This command writes the desired head and cylinder of the selected drive with a vendor unique data pattern (typically FFH or 00H). To remain host backward compatible, the CompactFlash card expects a sector buffer of data from the host to follow the command with the same protocol as the Write Sector(s) command although the information in the buffer is not used by the CompactFlash card. If LBA=1 then the number of sectors to format is taken from Sec Cnt register (0=256). The use of this command is not recommended.

4.8.7 Identify Drive - ECH

Bit –>	7	6	5	4	3	2	1	0
Command (7)	ECH							
C/D/H (6)	X	X	X	Drive	X			
Cyl High (5)	X							
Cyl Low (4)	X							
Sec Num (3)	X							
Sec Cnt (2)	X							
Feature (1)	X							

The Identify Drive command enables the host to receive parameter information from the CompactFlash card. This command has the same protocol as the Read Sector(s) command.

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Identify Drive Information

Word Address	Default Value	Total Bytes	Data Field Type Information
0	848Ah	2	General configuration - signature for the CompactFlash Card
	0XXX	2	General configuration – Bit Significant with ATA-4 definitions
1	XXXXh	2	Default number of cylinders
2	0000h	2	Reserved
3	00XXh	2	Default number of heads
4	0000h	2	Obsolete
5	0000h	2	Obsolete
6	XXXXh	2	Default number of sectors per track
7-8	XXXXh	4	Number of sectors per card (Word 7 = MSW, Word 8 = LSW)
9	XXXXh	2	Obsolete
10-19	aaaa	20	Serial number in ASCII (Right Justified)
20	0000h	2	Obsolete
21	0000h	2	Obsolete
22	0004h	2	Number of ECC bytes passed on Read/Write Long Commands
23-26	aaaa	8	Firmware revision in ASCII. Big Endian Byte Order in Word
27-46	aaaa	40	Model number in ASCII (Left Justified) Big Endian Byte Order in Word
47	XXXXh	2	Maximum number of sectors on Read/Write Multiple command
48	0000h	2	Reserved
49	XX00h	2	Capabilities
50	0000h	2	Reserved
51	0X00h	2	PIO data transfer cycle timing mode
52	0000h	2	Obsolete
53	000Xh	2	Field Validity
54	XXXXh	2	Current numbers of cylinders
55	XXXXh	2	Current numbers of heads
56	XXXXh	2	Current sectors per track
57-58	XXXXh	4	Current capacity in sectors (LBAs)(Word 57 = LSW, Word 58 = MSW)
59	01XXh	2	Multiple sector setting
60-61	XXXXh	4	Total number of sectors addressable in LBA Mode
62	0000h	2	Reserved
63	0X0Xh	2	Multiword DMA transfer. In PCMCIA mode this value shall be 0h
64	00XXh	2	Advanced PIO modes supported
65	XXXXh	2	Minimum Multiword DMA transfer cycle time per word. In PCMCIA mode this value shall be 0h

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Word Address	Default Value	Total Bytes	Data Field Type Information
66	XXXXh	2	Recommended Multiword DMA transfer cycle time. In PCMCIA mode this value shall be 0h
67	XXXXh	2	Minimum PIO transfer cycle time without flow control
68	XXXXh	2	Minimum PIO transfer cycle time with IORDY flow control
69-127	0000h	116	Reserved
128	XXXXh	2	Security status
129-159	0000h	64	Vendor unique bytes
160-255	0000h	172	Reserved

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5.0 Comparing CF-ATA to PC Card-ATA and True IDE

This section details the differences between CF-ATA when compared to the *PC Card-ATA* and *True IDE*.

5.1 Electrical Differences

5.1.1 TTL Compatibility

CF is not TTL compatible, it is a purely CMOS interface. Refer to Electrical Specification section covered earlier in this document.

5.1.2 Pull Up Resistor Input Leakage Current

The minimum pull up input leakage current is 50K ohms rather than the 10K ohms stated in the PCMCIA specification.

5.2 Functional Differences

5.2.1 Additional Set Features Codes in CF-ATA

The following *Set Features* codes provide additional functionality in CF-ATA, but are not standard in PC Card-ATA or True IDE:

1. 69H, Accepted for backward compatibility
2. 96H, Accepted for backward compatibility
3. 97H, Accepted for backward compatibility
4. 9AH, Set the host current source capability

5.2.2 Additional Commands in CF-ATA

The following commands provide additional functionality in CF-ATA, but are not standard PC Card-ATA commands.

PC Card-ATA and True IDE define the following command codes as *vendor unique*:

1. C0H, Erase Sectors
2. 87H, Translate Sector
3. F5H, Wear Level

PC Card-ATA and True IDE define the following command codes as *reserved*:

1. 03H, Request Sense
2. 38H, Write Without Erase
3. CDH, Write Multiple Without Erase

5.2.3 Idle Timer

The CF-ATA Idle timer uses an increment value of 5 ms, rather than the 5 second minimum increment value specified in PC Card-ATA/True IDE.

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5.2.4 Recovery from Sleep Mode

For CF devices, recovery from sleep mode is accomplished by issuing another command to the device. A hardware or software reset is not required.

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6.0 SMART Functionality

Delkin Devices Industrial C600 Series CF cards support the following SMART commands, determined by the Feature Register value.

Value	Command
D0h	SMART Read Data
D1h	SMART Read Attribute Thresholds
D2h	SMART Enable / Disable Attribute Autosave
D5h	SMART Read Log
D6h	SMART Write Log
D8h	SMART Enable Operations
D9h	SMART Disable Operations
DAh	Return Status
E0h	SMART Read Remap Data
E1h	SMART Read Wear Level Data

SMART commands with Feature Register values not mentioned in the above table are not supported and will be aborted.

6.1 SMART Data Structure

The following 512 bytes make up the device SMART data structure. Users can obtain the data using the “Read Data” command (D0h.)

Byte	Value	Description
0 – 1	0010h	SMART structure version
2 – 361		Attribute entries 1 to 30 (12 bytes each)
362	00h	Off-line data collection status (no off-line data collection)
363	00h	Self-test execution status byte (self-test completed)
364 – 365	0000h	Total time in seconds to complete off-line data collection activity
366	00h	Vendor specific
367	00h	Off-line data collection capability (no off-line data collection)
368 – 369	0003h	SMART capability
370	00h	Error logging capability (no error logging)
371	00h	Vendor specific

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372	00h	Short self-test routine recommended polling time (in minutes)
373	00h	Extended self-test routine recommended polling time (in minutes)
374 – 385	00h	Reserved
386 – 387	0004h	SMART Structure Version
388 – 391		Firmware “Commit” Counter
392 - 395		Firmware Wear Level Threshold
396		Global Wear Leveling Active
397		Global Bad Block Management active (returns 0 if bad block management is still at local chip level, and returns 1 if global bad block management has begun.)
398 – 401		Average Flash Block Erase Count
402 – 405		Number of Flash Blocks involved in the Wear Leveling
406 – 409		Number of total ECC errors during firmware initialization
410 – 413		Number of correctable ECC errors during firmware initialization
414 – 510	00h	Vendor specific
511		Data structure checksum

6.1.1 Spare Block Count Attribute

This attribute gives information about the amount of available spare blocks.

Offset	Value	Description
0	196	Attribute ID – Reallocation Count
1 – 2	0003h	Flags – Pre-fail type, attribute value is updated during normal operation
3		Attribute value. The value returned here is the percentage of remaining spare blocks summed over all flash chips, i.e. (100 x current spare blocks / initial spare blocks)
4		Attribute value (worst value)
5 – 7		Sum of the initial number of spare blocks for all flash chips
8 – 10		Sum of the current number of spare blocks for all flash chips
11	00h	Reserved

This attribute is used for the SMART Return Status command. If the attribute value field is less than the spare block threshold (set with the –tsbc preformat option), the SMART Return Status command will indicate a threshold exceeded condition.

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6.1.2 Spare Block Count Worst Chip Attribute Threshold

This attribute gives information about the amount of available spare blocks on the flash chip that has the lowest current number of spare blocks.

Offset	Value	Description
0	213	Attribute ID – Spare Block Count Worst Chip (vendor specific)
1 – 2	0002h	Flags – Advisory type, attribute value is updated during normal operation
3	64h	Attribute value. This value is fixed at 100.
4	64h	Attribute value (worst value)
5 – 7		Initial number of spare blocks for the flash chip with the lowest current number of spare blocks.
8 – 10		Current number of spare blocks for the flash chip with the lowest current number of spare blocks.
11	00h	Reserved

6.1.3 Erase Count Attribute

This attribute gives information about the amount of flash block erases that have been performed.

Offset	Value	Description
0	229	Attribute ID – Erase Count Usage (vendor specific)
1 – 2	000Xh	Flags – Pre-fail or Advisory type, attribute value is updated during normal operation
3		Attribute value. The value returned here is an estimation of the remaining card life, in percent, based on the number of flash block erases compared to the target number of erase cycles per block.
4		Attribute value (worst value)
5 - 10		Estimated total number of block erases.
11	00h	Reserved

This attribute is used for the SMART Return Status command. If the attribute value field is less than the erase count threshold (set with the –tec preformat option), the SMART Return Status command will indicate a threshold exceeded condition.

The target number of erase cycles per flash block is taken from the –mbec preformat option, or if this option is absent, from the MaxBlockEraseCount column in the Device Description file.

The attribute type (pre-fail or advisory) can be set with the –ecwl preformat option.

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6.1.4 Total ECC Errors Attribute

This attribute gives information about the total number of ECC errors that have occurred on flash read commands during firmware runtime. This attribute is not used for the SMART Return Status command.

Offset	Value	Description
0	203	Attribute ID – Number of ECC Errors
1 – 2	0002h	Flags – Advisory type, attribute value is updated during normal operation
3	64h	Attribute value. This value is fixed at 100.
4	64h	Attribute value (worst value)
5 – 8		Total number of ECC errors (correctable and uncorrectable)
9 – 10		---
11	00h	Reserved

6.1.5 Correctable ECC Errors Attribute

This attribute gives information about the total number of correctable ECC errors that have occurred on flash read commands during firmware runtime. This attribute is not used for the SMART Return Status command.

Offset	Value	Description
0	204	Attribute ID – Number of corrected ECC Errors
1 – 2	0002h	Flags – Advisory type, attribute value is updated during normal operation
3	64h	Attribute value. This value is fixed at 100.
4	64h	Attribute value (worst value)
5 – 8		Total number of correctable ECC errors
9 - 10		---
11	00h	Reserved

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6.1.6 UDMA CRC Errors Attribute

This attribute gives information about the total number of UDMA CRC errors that have occurred on flash read commands. This attribute is not used for the SMART Return Status command.

Offset	Value	Description
0	199	Attribute ID – UDMA CRC error rate
1 – 2	0002h	Flags – Advisory type, attribute value is updated during normal operation
3	64h	Attribute value. This value is fixed at 100.
4	64h	Attribute value (worst value)
5 – 8		Total number of UDMA CRC errors
9 – 10		---
11	00h	Reserved

6.1.7 Total Number of Reads Attribute

This attribute gives information about the total number of flash read commands. This can be useful for interpretation of the number of correctable or total ECC errors. This attribute is not used for the SMART Return Status command.

Offset	Value	Description
0	232	Attribute ID – Number of Reads (vendor specific)
1 – 2	0002h	Flags – Advisory type, attribute value is updated during normal operation
3	64h	Attribute value. This value is fixed at 100.
4	64h	Attribute value (worst value)
5 – 10		Total number of flash read commands
11	00h	Reserved

6.1.8 Power On Count Attribute

Offset	Value	Description
0	12	Attribute ID – Power On Count
1 – 2	0002h	Flags – Advisory type, attribute value is updated during normal operation
3	64h	Attribute value. This value is fixed at 100.
4	64h	Attribute value (worst value)
5 – 8		Number of Power On cycles

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9 – 10		---
11	00h	Reserved

6.1.9 Total LBA's Written Attribute

This attribute gives the total amount of data written to the disk, in units of 32MB (65536 sectors.) This number can be converted to Terabytes written (TBW) by dividing the raw attribute value by 2^{31}.

Offset	Value	Description
0	241	Attribute ID – Total LBA's Written (vendor specific)
1 – 2	0002h	Flags – Advisory type, attribute value is updated during normal operation
3	64h	Attribute value. This value is fixed at 100.
4	64h	Attribute value (worst value)
5 – 10		Total number of LBA's written to the disk, divided by 65536
11	00h	Reserved

6.1.10 Total LBA's Read Attribute

This attribute gives the total amount of data read from the disk, in units of 32MB (65536 sectors.) This number can be converted to Terabytes read (TBW) by dividing the raw attribute value by 2^{31}.

Offset	Value	Description
0	242	Attribute ID – Total LBA's Read (vendor specific)
1 – 2	0002h	Flags – Advisory type, attribute value is updated during normal operation
3	64h	Attribute value. This value is fixed at 100.
4	64h	Attribute value (worst value)
5 – 10		Total number of LBA's read from the disk, divided by 65536
11	00h	Reserved

6.1.11 Anchor Block Status Attribute

This attribute reports how many times the Anchor Block of the card has been re-written, either by the Anchor Block repair routine or by a firmware update.

Offset	Value	Description
0	214	Attribute ID – Anchor Block Status (vendor specific)
1 – 2	0002h	Flags – Advisory type, attribute value is updated during normal operation
3	64h	Attribute value. This value is fixed at 100.
4	64h	Attribute value (worst value)

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5 – 8		Anchor Block Write Count
9 – 10		---
11	00h	Reserved

6.1.12 Trim Status Attribute

This attribute gives percent ratio for the disk space that is currently in the trimmed state, reported as the attribute value. The range for the attribute value is 1 to 99, and does not reach 100 even for a fully trimmed card since the management blocks are also counted, which do not have trim status.

Offset	Value	Description
0	215	Attribute ID – Trim Status (vendor specific)
1 – 2	0002h	Flags – Advisory type, attribute value is updated during normal operation
3	64h	Attribute value.
4	64h	Attribute value (worst value)
5 – 10		---
11	00h	Reserved

6.2 SMART Read Attribute Thresholds

COMMAND CODE – B0h with a Feature Register value of D1h

PROTOCOL – PIO data in

INPUTS -

Register	7	6	5	4	3	2	1	0
Features	D1h							
Sector Count								
Sector Number								
Cylinder Low	4Fh							
Cylinder High	C2h							
Device / Head	1	1	1	D				
Command	B0h							

NORMAL OUTPUTS – None required

ERROR OUTPUTS – Aborted if either the signature in the Cylinder registers is invalid or if SMART is not enabled.

DESCRIPTION – This command returns one sector of SMART attribute thresholds. The data structure returned is:

Offset	Value	Description
0 - 1	0010h	SMART structure version
2 – 361		Attribute threshold entries 1 to 30 (12 bytes each)

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362 – 379	00h	Reserved
380 – 510	00h	----
511		Data structure checksum

6.2.1 Spare Block Count Attribute Threshold

Offset	Value	Description
0	196	Attribute ID – Reallocation Count
1		Spare Block Count Threshold as defined in preformat
2 – 11	00h	Reserved

6.2.2 Spare Block Count Worst Chip Attribute Threshold

Offset	Value	Description
0	213	Attribute ID – Spare Block Count Worst Chip (vendor specific)
1	00h	No threshold for the Spare Block Count Worst Chip Attribute
2 – 11	00h	Reserved

6.2.3 Erase Count Attribute Threshold

Offset	Value	Description
0	229	Attribute ID – Erase Count Usage (vendor specific)
1		Erase Count Threshold as defined in performat
2 – 11	00h	Reserved

6.2.4 Total ECC Errors Attribute Threshold

Offset	Value	Description
0	203	Attribute ID – Number of ECC errors
1	00h	No threshold for the Total ECC Errors Attribute
2 – 11	00h	Reserved

6.2.5 Correctable ECC Errors Attribute

Offset	Value	Description
0	204	Attribute ID – Number of corrected ECC errors
1	00h	No threshold for the Correctable ECC Errors Attribute
2 – 11	00h	Reserved

6.2.6 UDMA CRC Errors Attribute

Offset	Value	Description
0	199	Attribute ID – UDMA CRC error rate
1	00h	No threshold for the UDMA CRC Errors Attribute
2 – 11	00h	Reserved

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6.2.7 Total Number of Reads Attribute

Offset	Value	Description
0	232	Attribute ID – Number of Reads (vendor specific)
1	00h	No threshold for the Total Number of Reads Attribute
2 – 11	00h	Reserved

6.2.8 Power On Count Attribute

Offset	Value	Description
0	12	Attribute ID – Power On Count
1	00h	No threshold for the Power On Count Attribute
2 – 11	00h	Reserved

6.2.9 Total LBAs Written Attribute

Offset	Value	Description
0	241	Attribute ID – Total LBAs Written (vendor specific)
1	00h	No threshold for the Total LBAs Written Attribute
2 – 11	00h	Reserved

6.2.10 Total LBAs Read Attribute

Offset	Value	Description
0	242	Attribute ID – Total LBAs Read (vendor specific)
1	00h	No threshold for the Total LBAs Read Attribute
2 – 11	00h	Reserved

6.2.11 Anchor Block Status Attribute

Offset	Value	Description
0	214	Attribute ID – Anchor Block Status (vendor specific)
1	00h	No threshold for the Anchor Block Status Attribute
2 – 11	00h	Reserved

6.2.12 Trim Status Attribute

Offset	Value	Description
0	215	Attribute ID – Trim Status (vendor specific)
1	00h	No threshold for the Trim Status Attribute
2 – 11	00h	Reserved

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6.3 SMART Return Status

COMMAND CODE – B0h with a Feature Register value of DAh

PROTOCOL – non-data

INPUTS -

Register	7	6	5	4	3	2	1	0
Features	DAh							
Sector Count								
Sector Number								
Cylinder Low	4Fh							
Cylinder High	C2h							
Device / Head	1	1	1	D				
Command	B0h							

NORMAL OUTPUTS – Returns a status indication as described below.

ERROR OUTPUTS – Aborted if either the signature in the Cylinder registers is invalid or if SMART is not enabled.

DESCRIPTION – This command checks the device reliability status. If a threshold exceeded condition exists for either the Spare Block Count attribute or the Erase Count attribute, the device will set the Cylinder Low register to F4h and the Cylinder High register to 2Ch. If no threshold exceeded condition exists, the device will set the Cylinder Low register to F4h and the Cylinder High register to C2h.

6.4 SMART Read Log

COMMAND CODE – B0h with a Feature Register value of D5h

PROTOCOL – PIO data in.

INPUTS -

Register	7	6	5	4	3	2	1	0
Features	D5h							
Sector Count	Number of sectors to be read							
Sector Number	Log address							
Cylinder Low	4Fh							
Cylinder High	C2h							
Device / Head	1	1	1	D				
Command	B0h							

NORMAL OUTPUTS – None required.

ERROR OUTPUTS – Aborted if either the signature in the Cylinder registers, the Log address or the number of sectors is invalid, or if SMART is not enabled.

DESCRIPTION – This command will return data of the SMART log. The following Log addresses are defined:

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Address	Description
0x00	Log Directory
0x80 – 0x9F	Host Vendor Specific Logs
0xA0	SMART Wear Level Data
0xA1	SMART Remap Data
0xA2	Reserved

The Log Directory (at Log address 0) returns one sector that shows the number of sectors for Log addresses 1 to 255:

Offset	Value	Description
0 - 1	1	SMART Logging Version
256 – 319	16	Number of sectors in the logs at addresses 0x80 – 0x9F
320 – 321	4	Number of sectors in the logs at address 0xA0
322 – 323	1	Number of sectors in the logs at address 0xA1
324 – 325	1	Number of sectors in the logs at address 0xA2

All other bytes in the Log Directory are zero.

The Host Vendor Specific Logs can be used by the host to store and retrieve arbitrary data.

The SMART Wear Level Data and SMART Remap Data Logs return the same data that is also returned by the SMART Read Wear Level Data and SMART Read Remap Data commands.

6.5 SMART Write Log

COMMAND CODE – B0h with a Feature Register value of D6h

PROTOCOL – PIO data out.

INPUTS -

Register	7	6	5	4	3	2	1	0
Features	D6h							
Sector Count	Number of sectors to be written							
Sector Number	Log address							
Cylinder Low	4Fh							
Cylinder High	C2h							
Device / Head	1	1	1	D				
Command	B0h							

NORMAL OUTPUTS – None required.

ERROR OUTPUTS – Aborted if either the signature in the Cylinder registers, the Log address or the number of sectors is invalid, or if SMART is not enabled.

DESCRIPTION – This command can be used to write data into the SMART log (see section 6.4 for the definition of the log addresses.) Writes are allowed only to the Host Vendor Specific logs, all other log addresses can only be read.

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6.6 SMART Read Remap Data

COMMAND CODE – B0h with a Feature Register value of E0h

PROTOCOL – PIO data in.

INPUTS -

Register	7	6	5	4	3	2	1	0
Features	E0h							
Sector Count	01h							
Sector Number								
Cylinder Low	4Fh							
Cylinder High	C2h							
Device / Head	1	1	1	D				
Command	B0h							

NORMAL OUTPUTS – None required.

ERROR OUTPUTS – Aborted if either the signature in the Cylinder registers is invalid, if the Sector Count is not 1, or if SMART is not enabled.

DESCRIPTION – This command returns one sector of spare block information. The information is the initial number of blocks (directly after the preformat) per flash chip available for bad block remap, and the current number of blocks per flash chip available for bad block remap. The layout of the returned sector is:

Offset	Description
0 - 31	Initial number of replacement blocks for chips 0 – 15, 2 bytes per entry
32 – 63	Current number of replacement blocks for chips 0 – 15, 2 bytes per entry
64 - 511	----

6.7 SMART Read Wear Level Data

COMMAND CODE – B0h with a Feature Register value of E1h

PROTOCOL – PIO data in.

INPUTS -

Register	7	6	5	4	3	2	1	0
Features	E1h							
Sector Count	04h							
Sector Number								
Cylinder Low	4Fh							
Cylinder High	C2h							
Device / Head	1	1	1	D				
Command	B0h							

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NORMAL OUTPUTS – None required.

ERROR OUTPUTS – Aborted if either the signature in the Cylinder registers is invalid, if the Sector Count is not 4, or if SMART is not enabled.

DESCRIPTION – This command will return four sectors of information regarding the status of the wear leveling. The information returned is the distribution of the blocks into the 1024 possible wear level classes. The layout of the returned sector is:

Offset	Description
0 - 3	Marker Bytes, fixed value 0xFFFFFFFF
4 – 5	Lowest Wear Level Class
6 – 7	Highest Wear Level Class
8 – 15	Wear Level Class entry 1
16 – 23	Wear Level Class entry 2
24 – 31	Wear Level Class entry 3
….	….
2040 - 2047	Wear Level Class entry 255

Each Wear Level Class entry consists of this data:

Offset	Description
0 - 3	Wear Level Class Index
4 – 7	Number of blocks in this Wear Level Class

Unused Wear Level Class entries are zero.

A block moves from one wear level class into the next when it reaches the number of erases that is specified as the “Wear Level Threshold” in the preformat. A common threshold number is 4095, this means that blocks in wear level class 0 have seen 0 to 4095 erases, blocks in wear level class 1 have seen 4096 to 8191 erases, and so on. Using this information, statements about the wear of the card and of the estimated remaining life can be made.

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WARNING: This product may contain chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm. For more information go to www.p65warnings.ca.gov.

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