

THNATxxxxBAI Series

Flash Memory Card ATA

OUTLINE

The THNAT***BAI series Flash Memory Card ATA is a flash technology based with ATA interface memory card. It is constructed with flash disk controller chip and Toshiba NAND flash memory device. The Flash Memory Card ATA operates in both 5-Volt and 3.3-Volt power supplies. It comes in capacity of , 16MB, 32MB, 64MB, 128MB, 192MB, 256MB, 320MB, 512MB, 640MB, 768MB, 1.02GB, 1.28GB, 1.53GB, 1.79GB and up to 2.04GB unformatted card. Emulating IDE hard disk drives and being substantially compatible with PCMCIA-ATA standard, it is a perfect choice of solid-state mass-storage cards for battery backup handheld devices or industrial application, or the applications which require high environment tolerance with high data reliability.

Features :

PC Card compliant

Substantially compatible with PC Card standard and PC Card ATA
Support for CIS implemented with 256 bytes of attribute memory

High performance in ATA PIO mode4

Host to Card : max 16.6MB/s theoretically
Sustained write up : max 1.5MB/s (16MB and 32MB)
: max 3.2MB/s (64MB up to 2.04GB)
Sustained read : max 6.5MB/s
Note: need to set Host on ATA PIO mode4 to perform above speed.

Card Capacity

Card capacity of 16, 32, 64, 128, 192, 256, 320, 512, 640, 768MB, 1.02, 1.28, 1.53, 1.79GB and up to 2.04GB

Industrial grade and High reliability

Support industrial grade temperature operation
Support ECC function to detect and correct data error automatically

Single power

Single +5 Volt or +3.3 Volt power supply.

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1. Production Specifications

1.1 Products Models

Product Model	Unformatted	Cylinder	Head	Sector
THNAT016MBAI	16MB	0248	04	32
THNAT032MBAI	32MB	0496	04	32
THNAT064MBAI	64MB	0978	04	32
THNAT128MBAI	128MB	0978	08	32
THNAT192MBAI	192MB	0733	16	32
THNAT256MBAI	256MB	0978	16	32
THNAT320MBAI	320MB	0814	16	48
THNAT512MBAI	512MB	0993	16	63
THNAT640MBAI	640MB	1241	16	63
THNAT768MBAI	768MB	1489	16	63
THNAT1G02BAI	1.02GB	1985	16	63
THNAT1G28BAI	1.28GB	2481	16	63
THNAT1G53BAI	1.53GB	2966	16	63
THNAT1G79BAI	1.79GB	3470	16	63
THNAT2G04BAI	2.04GB	3954	16	63

1.2 Operating voltage

5V +/- 10% or 3.3V +/- 10%

1.3 Power consumption

5V operation

Write operation: 45 mA (Typ)
Read operation: 35 mA (Typ)
Sleep mode: 1.5mA 2.2mA(Max)

3.3V operation

Write operation: 40 mA (Typ)
Read operation: 30 mA (Typ)
Sleep mode: 1.3mA 1.8mA(Max)

1.4 Performance (in ATA PIO mode 4)

Card to Host: 16.6 MB/s theoretically
Sustained write : max 1.5 MB/s (16MB and 32MB)
max 3.2 MB/s (64MB to 2.04GB)
Sustained read: max 6.5 MB/s

1.5 Card dimensions

Type II card: 85.6mm(L) × 54mm(W) × 5.0mm(H)
Weight: 50g

1.6 Environment conditions

Operating temperature: -40°C to 85°C
Storage temperature: -45°C to 90°C

2. Interface signal assignments

ATA Pin Assignments

Pin	Memory Only Card Interface			I/O and Memory Card Interface			True IDE interface		
	Signal	I/O	Function	Signal	I/O	Function	Signal	I/O	Function
1	GND	DC	Ground	GND	DC	Ground	GND	DC	Ground
2	D3	I/O	Data bit 3	D3	I/O	Data bit 3	D3	I/O	Data bit 3
3	D4	I/O	Data bit 4	D4	I/O	Data bit 4	D4	I/O	Data bit 4
4	D5	I/O	Data bit 5	D5	I/O	Data bit 5	D5	I/O	Data bit 5
5	D6	I/O	Data bit 6	D6	I/O	Data bit 6	D6	I/O	Data bit 6
6	D7	I/O	Data bit 7	D7	I/O	Data bit 7	D7	I/O	Data bit 7
7	CE1#	I	Card Enable	CE1#	I	Card Enable	CS1#	I	Chip Select 1
8	A10	I	Address bit 10	A10	I	Address bit 10	--	--	--
9	OE#	I	Output Enable	OE#	I	Output Enable	GND	DC	Ground
10	A11	--	--	A11	--	--	--	--	--
11	A9	I	Address bit 9	A9	I	Address bit 9	--	--	--
12	A8	I	Address bit 8	A8	I	Address bit 8	--	--	--
13	A13	--	--	A13	--	--	--	--	--
14	A14	--	--	A14	--	--	--	--	--
15	WE#	I	Write Enable	WE#	I	Write Enable	--	--	--
16	READY	O	Ready	IREQ#1	O	Interrupt Request	IREQ	O	Interrupt Request
17	VCC	DC	Supply Voltage	VCC	DC	Supply Voltage	VCC	DC	Supply Voltage
18	VPP1	--	--	VPP1	--	--	--	--	--
19	A16	--	--	A16	--	--	--	--	--
20	A15	--	--	A15	--	--	--	--	--
21	A12	--	--	A12	--	--	--	--	--
22	A7	I	Address bit 7	A7	I	Address bit 7	--	--	--
23	A6	I	Address bit 6	A6	I	Address bit 6	--	--	--
24	A5	I	Address bit 5	A5	I	Address bit 5	--	--	--
25	A4	I	Address bit 4	A4	I	Address bit 4	--	--	--
26	A3	I	Address bit 3	A3	I	Address bit 3	--	--	--
27	A2	I	Address bit 2	A2	I	Address bit 2	A2	I	Address 2
28	A1	I	Address bit 1	A1	I	Address bit 1	A1	I	Address 1
29	A0	I	Address bit 0	A0	I	Address bit 0	A0	I	Address 0
30	D0	I/O	Data bit 0	D0	I/O	Data bit 0	D0	I/O	Data bit 0
31	D1	I/O	Data bit 1	D1	I/O	Data bit 1	D1	I/O	Data bit 1
32	D2	I/O	Data bit 2	D2	I/O	Data bit 2	D2	I/O	Data bit 2
33	WP	O	Write Protect	IOIS16#	O	I/O Port Is 16-bit	IOIS16#	O	I/O Port Is 16-bit
34	GND	DC	Ground	GND	DC	Ground	GND	DC	Ground
35	GND	DC	Ground	GND	DC	Ground	GND	DC	Ground
36	CD1#	O	Card Detect	CD1#	O	Card Detect	--	--	--
37	D11	I/O	Data bit 11	D11	I/O	Data bit 11	D11	I/O	Data bit 11
38	D12	I/O	Data bit 12	D12	I/O	Data bit 12	D12	I/O	Data bit 12
39	D13	I/O	Data bit 13	D13	I/O	Data bit 13	D13	I/O	Data bit 13

	Memory Only Card Interface			I/O and Memory Card Interface			True IDE interface		
Pin	Signal	I/O	Function	Signal	I/O	Function	Signal	I/O	Function
40	D14	I/O	Data bit 14	D14	I/O	Data bit 14	D14	I/O	Data bit 14
41	D15	I/O	Data bit 15	D15	I/O	Data bit 15	D15	I/O	Data bit 15
42	CE2#	I	Card Enable	CE2#	I	Card Enable	CS2#	I	Chip Select 2
43	VS1	O	Voltage Sense 1	VS1	O	Voltage Sense 1	--	--	--
44	RFU	--	--	IORD#	I	I/O Read	IORD#	I	I/O Read
45	RFU	--	--	IOWR#	I	I/O Write	IOWR#	I	I/O Write
46	A17	--	--	A17	--	--	--	--	--
47	A18	--	--	A18	--	--	--	--	--
48	A19	--	--	A19	--	--	--	--	--
49	A20	--	--	A20	--	--	--	--	--
50	A21	--	--	A21	--	--	--	--	--
51	VCC	DC	Supply Voltage	VCC	DC	Supply Voltage	VCC	DC	Supply Voltage
52	VPP2	--	--	VPP2	--	--	--	--	--
53	A22	--	--	A22	--	--	--	--	--
54	A23	--	--	A23	--	--	--	--	--
55	A24	--	--	A24	--	--	--	--	--
56	A25	--	--	A25	--	--	--	--	--
57	VS2#	O	Voltage Sense 2	VS2#	O	Voltage Sense 2	--	--	--
58	RESET	I	Card Reset	RESET	I	Card Reset	RESET	I	Card Reset
59	WAIT#	O	Extend bus cycle	WAIT#	O	Extend bus cycle	IORDY	O	I/O Channel Ready
60	RFU	--	--	INPACK	I	Input Port Acknowledgement	--	--	--
61	REG	I	Register select	REG	I	Register select & I/O Enable	--	--	--
62	BVD2	O	Battery Voltage Detect 2	SPKR#	O	Audio Digital Waveform	DASP	O	Drive Active or Slave Present
63	BVD1	O	Battery Voltage Detect 1	STSCHG#	O	Card Status Changed	PDIAG	O	Passed Diagnostics
64	D8	I/O	Data bit 8	D8	I/O	Data bit 8	D8	I/O	Data bit 8
65	D9	I/O	Data bit 9	D9	I/O	Data bit 9	D9	I/O	Data bit 9
66	D10	I/O	Data bit 10	D10	I/O	Data bit 10	D10	I/O	Data bit 10
67	CD2#	O	Card Detect	CD2#	O	Card Detect	--	--	--
68	GND	DC	Ground	GND	DC	Ground	GND	DC	Ground

3. Interface signal descriptions

Signal Name	Dir.	Pin	Description
BVD2 (PC Card Memory Mode)	I/O	62	This output line is always driven to high state in Memory Mode since a battery is not required for this product.
–SPKR (PC CARD I/O Mode)			This output line is always driven to high state in I/O Mode since this product does not support the audio function.
–DASP (True IDE Mode)			In the True IDE Mode, this input/output is the Disk Active/Slave Present signal in the Master/Slave handshake protocol.
–CD1,–CD2 (PC Card Memory Mode)	O	36,67	These card detect pins are connected to the ground on the ATA Storage Card. They are used by the host to determine that the ATA storage Card is fully inserted into its socket.
–CD1,–CD2 (PC Card I/O Mode)			
–CD1,–CD2 (True IDE Mode)			
D[15:0] (PC Card Memory Mode)	I/O	41,40,39,38,37,66,65,64,6,5,4,3,2,32,31,30	These lines carry the Data, Commands, and Status information between the host and the controller. D00 is the LSB of the Odd Byte of the World.
D[15:0] (PC Card I/O Mode)			
D[15:0] (True IDE Mode)			In True IDE Mode, all Task File operations occur in byte mode on the lower order bus D00–D07 while all data transfers are 16 bit using D00–D15.
–IOWR (PC Card Memory Mode)	I	45	This signal is not used in this mode.
–IOWR (PC Card I/O Mode)			The I/O Write Strobe pulse is used to clock I/O data on the Card Data bus into the ATA Storage Card controller registers when the ATA Storage Card is configured to use the I/O interface. The clocking will occur on the negative to the positive edge of the signal (trailing edge).
–IOWR (True IDE Mode)			
–IORD (PC Card Memory Mode)	I	44	This signal is not used in this mode.
–IORD (PC Card I/O Mode)			This is an I/O Read strobe generated by the host. This signal gates I/O data onto the bus from the ATA Storage Card when the card is configured to use the I/O interface.
–IORD (True IDE Mode)			
–WE (PC Card Memory Mode)	I	15	This signal driven by the host and used for strobing memory write data to the registers of the ATA Storage Card when the card is configured in the memory interface mode. It is also used for writing the configuration registers.
–WE (PC Card I/O Mode)			In PC Card I/O Mode, this signal is used for writing the configuration registers.
–WE (True IDE Mode)			In True IDE Mode this input signal is not used and should be connected to VCC by the host.
–OE (PC Card Memory Mode)	I	9	This is an output Enable strobe generated by the host interface. It is used to read data from the ATA Storage Card in Memory Mode and to read the CIS and configuration registers.
–OE (PC Card I/O Mode)			In PC Card I/O Mode this input, this signal is used to read the CIS and configuration registers.
–OE (True IDE Mode)			To enable True IDE Mode this input should be grounded by the host.
–CSEL (PC Card Memory Mode)	I	56	This signal is not used for this mode.
–CSEL (PC Card I/O Mode)			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.
–CSEL (True IDE Mode)			

Signal Name	Dir.	Pin	Description
RDY/-BSY (PC Card Memory Mode)	O	16	In Memory Mode this signal is set high when the ATA Storage Card is ready to accept a new data transfer operation and held low when the card is busy. The Host memory card socket must provide a pull-up resistor. At power up and at Reset, the RDY/-BSY is held low (busy) until the ATA Storage Card has completed its power up or reset function. No access of any type should be made to the ATA Storage Card during this time. The RDY/-BSY signal is held high (disabled from being busy) whenever the following condition is true: The ATA Storage Card has been powered up with +RESET continuously disconnected or asserted.
-IREQ (PC Card I/O Mode)			I/O Operation- After the ATA Storage 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 (True IDE Mode)			In True IDE Mode signal is the active high Interrupt Request to the host.
A[24:11]	I	55,54,53,50,49,48,47,46,19,20,14,13,21,10	No used.
A[10:0] (PC Card Memory Mode)	I	8,11,12,22,23,24,25,26,27,28,29	These address lines along with the -REG signal are used to select the following: The I/O port address registers within the ATA Storage Card, the memory mapped port address registers within the ATA Storage Card, a byte in the card's information structure and its configuration control and status registers.
A[10:0] (PC Card I/O Mode)			In True IDE Mode only A[2:0] are used to select the one of eight registers in the Task File, the remaining address lines should be grounded by the host .
A[2:0] (True IDE Mode)			
-CE1,-CE2 (PC Card Memory Mode) Card Enable	I	7,42	These input signals are used 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 the A0 and -CE2. A multi-plexing scheme based on A0, -CE1, -CE2 allows 8 bit hosts to access all data on D0-D7.
-CE1,-CE2 (PC Card I/O Mode) Card Enable			
-CS0,-CS1 (True IDE Mode)			In the True IDE Mode CS0 is the chip select for the task file registers while CS1 is used to select the Alternate Status Register and the Device Control Register.
-REG (PC Card Memory Mode)	I	61	This signal is used during Memory Cycles to distinguish between the Common Memory and Register (Attribute) Memory accesses. High for Common Memory, Low for Attribute Memory.
-REG (PC Card I/O Mode)			The signal must also be active (low) during I/O Cycles when the I/O address is on the Bus.
-REG (True IDE Mode)			In the True IDE Mode this input signal is not used and should be connected to VCC by the host.

Signal Name	Dir.	Pin	Description
WP (PC Card Memory Mode) Write Protect	O	33	Memory Mode– The ATA Storage Card does not have a write protect switch. This signal is held low after the addressed port.
–IOIS 16 (PC Card I/O Mode)			I/O Operation– When the ATA 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.
–IOIS 16 (True IDE Mode)			In True IDE Mode this output signal is asserted low when this device is expecting a word data transfer cycle.
–INPACK (PC Card Memory Mode)	O	60	This signal is not used in this mode.
–INPACK (PC Card I/O Mode) Input Acknowledge			The Input Acknowledge signal is asserted by the ATA Storage Card when the card is selected by 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 ATA Storage Card and the CPU.
–INPACK (True IDE Mode)			In True IDE Mode this output signal is not used and should not be connected at the host.
BVD1 (PC Card Memory Mode)	I/O	63	This signal is asserted high as the BVD1 signal since a battery is not used with this product.
–STSCHG (PC Card I/O Mode) Status Changed			This signal is asserted low to alert the host to changes in the RDY/–BSY and Write Protect states, while the I/O interface is configured. Its use is controlled by the Card Config and Status Register.
–PDIAG (True IDE Mode)			In the True IDE Mode, this input / output is the Pass Diagnostic signal in the Master / Slave handshake protocol.
–WAIT (PC Card Memory Mode)	O	59	The –WAIT signal is driven low by the ATA Storage Card to signal the host to delay completion of a memory or I/O cycle that is in progress.
–WAIT (PC Card I/O Mode)			
–WAIT (True IDE Mode)			In True IDE Mode this output signal may be used as IORDY.
GND (PC Card Memory Mode)	--	1,34, 35,68	Ground.
GND (PC Card I/O Mode)			
GND (True IDE Mode)			
VCC (PC Card Memory Mode)	--	17,51	+5V, +3.3V power
VCC (PC Card I/O Mode)			
VCC (True IDE Mode)			
–VS1	O	43 57	Voltage Sense Signals. –VS1 is grounded so that the ATA Storage Card CIS can be read at 3.3 volts and –VS2 is reserved by PCMCIA for a secondary voltage.
–VS2 (PC Card Memory Mode)			
–VS1			
–VS2 (PC Card I/O Mode)			
–VS1			
–VS2 (True IDE Mode)			
RESET (PC Card Memory Mode)	I	58	When the pin is high this signal Resets the ATA Storage Card. The ATA Storage Card is Reset only at power up if this pin is left high or open from power up. The ATA Storage Card is also Reset when the Soft Reset bit in the Card Configuration Option Register is set.
RESET (PC Card I/O Mode)			
RESET (True IDE Mode)			In the True IDE Mode this input pin is the active low hardware reset from the host.

4. Access Specifications

4.1 Attribute access specifications

When CIS-ROM region or Configuration register region is accessed, read and write operations are executed under the condition of $\text{-REG} = \text{"L"}$ as follows. That region can be accessed by Byte/World/Old-byte modes, which are defined by PC card standard specifications.

Attribute Read Access Mode

Mode	-REG	-CE2	-CE1	A0	-OE	-WE	D8 to D15	D0 to D7
Standby mode	x	H	H	x	x	x	High-Z	High-Z
Byte access(8-bit)	L	H	L	L	L	H	High-Z	even byte
	L	H	L	H	L	H	High-Z	invalid
Word access(16-bit)	L	L	L	x	L	H	invalid	even byte
Odd byte access(8-bit)	L	L	H	x	L	H	invalid	High-Z

Note: x: L or H

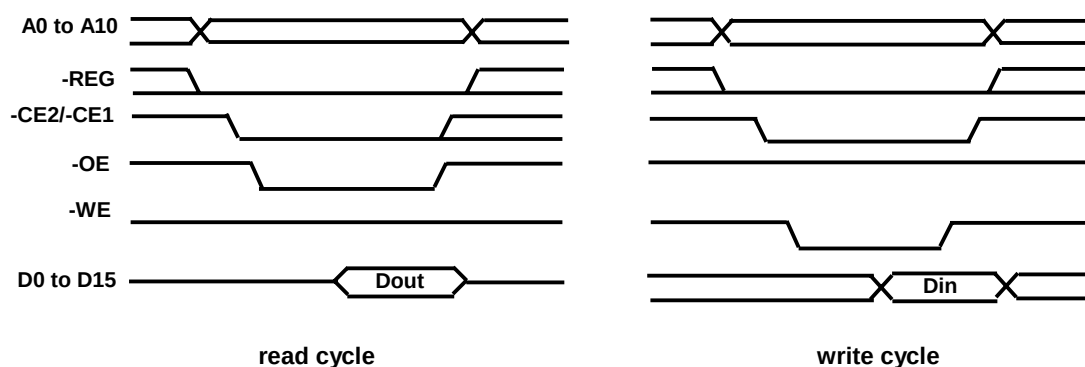
Attribute Write Access Mode

Mode	-REG	-CE2	-CE1	A0	-OE	-WE	D8 to D15	D0 to D7
Standby mode	x	H	H	x	x	x	Don't care	Don't care
Byte access(8-bit)	L	H	L	L	H	L	Don't care	even byte
	L	H	L	H	H	L	Don't care	Don't care
Word access(16-bit)	L	L	L	x	H	L	Don't care	even byte
Odd byte access(8-bit)	L	L	H	x	H	L	Don't care	Don't care

Note: x: L or H

Note: write CIS-ROM region is invalid.

Attribute Access Timing



4.2 Task File register access specifications

There are two cases of Task File register mapping, one is mapped I/O address area, the other is mapped Memory address area. Each case of Task File registers read and write operations is executed under the condition as follows. That area can be accessed by Byte/Word/Odd Byte modes, which are defined by PC card standard specifications.

4.2.1 I/O address map

Task File Register Read Access Mode (1)

Mode	-REG	-CE2	-CE1	A0	-IORD	-IOWR	-OE	-WE	D8 to D15	D0 to D7
Standby mode	x	H	H	x	x	x	x	x	High-Z	High-Z
Byte access(8-bit)	L	H	L	L	L	H	H	H	High-Z	even byte
	L	H	L	H	L	H	H	H	High-Z	odd byte
Word access(16-bit)	L	L	L	x	L	H	H	H	odd byte	even byte
Odd byte access(8-bit)	L	L	H	x	L	H	H	H	odd byte	High-Z

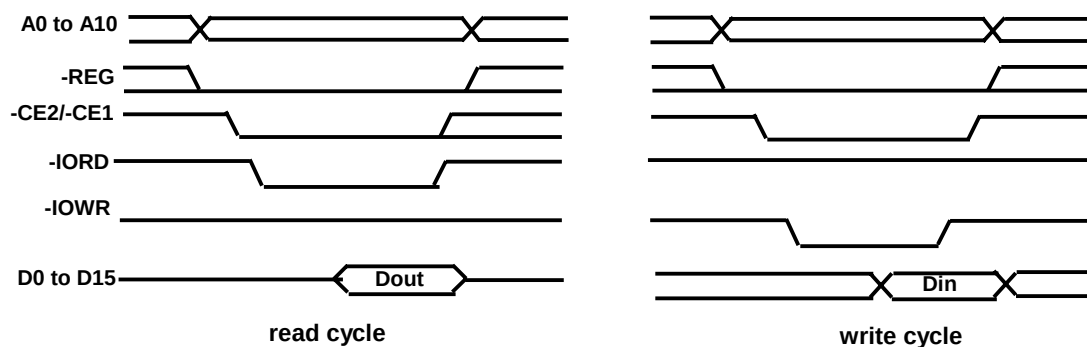
Note: x: L or H

Task File Register Write Access Mode (1)

Mode	-REG	-CE2	-CE1	A0	-IORD	-IOWR	-OE	-WE	D8 to D15	D0 to D7
Standby mode	x	H	H	x	x	x	x	x	Don't care	Don't care
Byte access(8-bit)	L	H	L	L	H	L	H	H	Don't care	even byte
	L	H	L	H	H	L	H	H	Don't care	odd byte
Word access(16-bit)	L	L	L	x	H	L	H	H	odd byte	even byte
Odd byte access(8-bit)	L	L	H	x	H	L	H	H	odd byte	Don't care

Note: x: L or H

Task File Register Access Timing (1)



4.2.2 Memory address map

Task File Register Read Access Mode (2)

Mode	-REG	-CE2	-CE1	A0	-OE	-WE	-IORD	-IOWR	D8 to D15	D0 to D7
Standby mode	x	H	H	x	x	x	x	x	High-Z	High-Z
Byte access(8-bit)	H	H	L	L	L	H	H	H	High-Z	even byte
	H	H	L	H	L	H	H	H	High-Z	odd byte
Word access(16-bit)	H	L	L	x	L	H	H	H	odd byte	even byte
Odd byte access(8-bit)	H	L	H	x	L	H	H	H	odd byte	High-Z

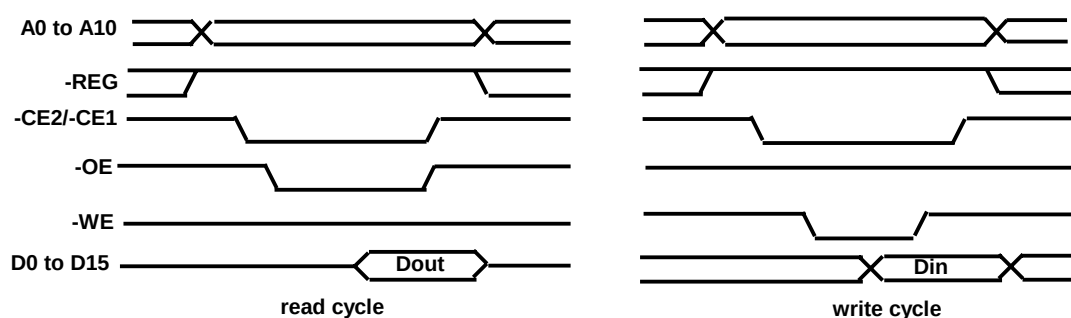
Note: x: L or H

Task File Register Write Access Mode (2)

Mode	-REG	-CE2	-CE1	A0	-OE	-WE	-IORD	-IOWR	D8 to D15	D0 to D7
Standby mode	x	H	H	x	x	x	x	x	Don't care	Don't care
Byte access(8-bit)	H	H	L	L	H	L	H	H	Don't care	even byte
	H	H	L	H	H	L	H	H	Don't care	odd byte
Word access(16-bit)	H	L	L	x	H	L	H	H	odd byte	even byte
Odd byte access(8-bit)	H	L	H	x	H	L	H	H	odd byte	Don't care

Note: x: L or H

Task File Register Access Timing (2)



4.3 True IDE Mode

The card can be configured in a True IDE. This card is configured in this mode only when the $\overline{\text{OE}}$ input signal is asserted GND by the host. In this True IDE mode Attribute Registers are not accessible from the host. Only I/O operation to the task file and data register is allowed. If this card is configured during power on sequence, data register is accessed in word (16-bit). The card permits 8-bit accessed if the user issues a Set Feature Command to put the device in 8-bit mode.

True IDE Mode Read I/O Function

Mode	$\overline{\text{CE2}}$	$\overline{\text{CE1}}$	A0 to A2	$\overline{\text{IORD}}$	$\overline{\text{OWR}}$	D8 to D15	D0 to D7
Invalid mode	L	L	x	x	x	High-Z	High-Z
Standby mode	H	H	x	x	x	High-Z	High-Z
Data register access	H	L	0	L	H	odd byte	even byte
Alternate status access	L	H	6H	L	H	High-Z	status out
Other task file access	H	L	1-7H	L	H	High-Z	data

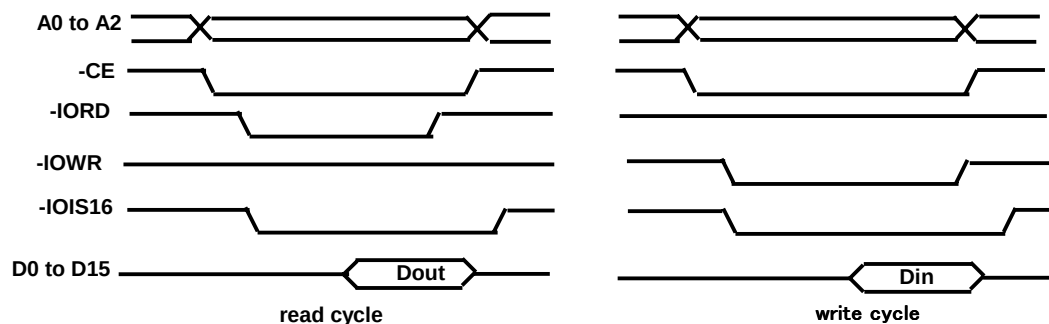
Note: x: L or H

True IDE Mode Write I/O Function

Mode	$\overline{\text{CE2}}$	$\overline{\text{CE1}}$	A0 to A2	$\overline{\text{IORD}}$	$\overline{\text{OWR}}$	D8 to D15	D0 to D7
Invalid mode	L	L	x	x	x	don't care	don't care
Standby mode	H	H	x	x	x	don't care	don't care
Data register access	H	L	0	H	L	odd byte	even byte
Control register access	L	H	6H	H	L	don't care	control in
Other task file access	H	L	1-7H	H	L	don't care	data

Note: x: L or H

True IDE Mode I/O Access Timing



5. Configuration register specifications

This card supports four Configuration registers for the purpose of the configuration and observation of this card. These registers can be used in memory card mode and I/O card mode. In True IDE mode, these registers can not be used.

5.1 Configuration Option register(Address 200H)

This register is used for the configuration of the card configuration status and for the issuing soft reset to the card.

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
SRESET	LevIREQ	INDEX					

Note: initial value: 00H

Name	R/W	Function
SRESET	R/W	Setting this bit to “1”, places the card in the reset state (Card Hard Reset). This operation is equal to Hard Reset, except this bit is not cleared. Then this bit set to “0”, places the card in the reset state of Hard Reset (This bit is set to “0” by Hard Reset). Card configuration status is reset and the card internal initialized operation starts when Card Hard Reset is executed, so next access to the card should be the same sequence as the power on sequence.
LevIREQ (HOST→)	R/W	This bit sets to “0” when pulse mode interrupt is selected, and “1” when level mode interrupt is selected.
INDEX (HOST→)	R/W	This bits is used for select operation mode of the card as follows. When Power on, Card Hard Reset and Soft Reset, this data is “000000” for the purpose of Memory card interface recognition.

INDEX bit assignment

INDEX bit

5	4	3	2	1	0	Card mode	Task File register address	Mapping mode
0	0	0	0	0	0	Memory card	0H to FH, 400H to 7FFH	Memory mapped
0	0	0	0	0	1	I/O card	xx0H to xxFH	contiguous I/O mapped
0	0	0	0	1	0	I/O card	1F0H to 1F7H,3F6H to 3F7H	primary I/O mapped
0	0	0	0	1	1	I/O card	1F0H to 177H,376H to 3F7H	Secondary I/O mapped

5.2 Configuration and Status register (Address 202H)

This register is used for observing the state of the card.

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
CHGED	SIGCHG	IOIS8	0	0	PWD	INTR	0

Note: initial value: 00H

Name	R/W	Function
CHGED (CARD->)	R	This bit indicates that CRDY/-BSY bit on Pin Replacement register is set to "1". When CHGED bit is set to "1", -STSCHG pin is held "L" at the condition of SIGCHG bit set to "1" and the card configured for the I/O interface.
SIGCHG (HOST->)	R/W	This bit is set or reset by the host for enabling and disabling the status-change signal (-STSCHG pin). When the card is configured I/O card interface and this bit is set "1", -STSCHG pin is controlled by CHGED bit. If this bit is set to "0", -STSCHG pin is kept "H".
IOIS8 (HOST->)	R/W	The host sets this field to "1" when it can provide I/O cycles only with on 8 bit data bus (D7 to D0).
PWD (HOST->)	R/W	When this bit is set to "1", the card enters sleep state (Power Down mode). When this bit is reset to "0", the card transfers to idle state (active mode). RRDY/BSY bit on Pin Replacement Register becomes BUSY when this bit is changed. RRDY/BSY will not become Ready until the power state requested has been entered. This card automatically powers down when it is idle and powers back up when it receives a command.
INTR (CARD->)	R	This bit indicates the internal state of the interrupt request. This bit state is available whether I/O card interface has been configured or not. This signal remains true until the condition, which caused the interrupt request, has been serviced. If the -IEN bit in the Device Control Register disables interrupts, this bit is a zero.

5.3 Pin Replacement register (Address 204H)

This register is used for providing the state of -IREQ signal when the card configured I/O card interface.

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
0	0	CRDY/-BSY	0	1	1	RRDY/-BSY	0

Note: initial value: 0CH

Name	R/W	Function
CRDY/-BSY (HOST->)	R/W	This bit is set to "1" when the RRDY/-BSY bit changes state. The host may also write this bit.
RRDY/-BSY (HOST->)	R	When read, this bit indicates +READY pin states. When written, this bit is used for CRDY/-BSY bit masking.

5.4 Socket and Copy register (Address 206H)

This register is used for identification of the card from the other cards. Host can read and write this register. Host should set this register before this card's Configuration Option register set.

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
0	0	0	DRV#	0	0	0	0

Note: initial value: 00H

Name	R/W	Function
DRV# (HOST->)	R/W	These fields are used for the configuration of the plural cards. When host configures the plural cards, written the card's copy number in this field. In this way, host can perform the card's master/slave organization.

5.5 CIS information

CIS information of THNATxxxxBA/BAI series Flash card ATA are defined as follows.

Address	Data	Description of contents	CIS function
000H	01h	CISTPL_DEVICE	Tuple code
002H	03h	TPL_LINK	Tuple link
004H	D9h	Device information	Tuple data
006H	01h	Device information	Tuple data
008H	ffh	END MARKER	End of Tuple
00AH	1ch	CISTPL_DEVICE_OC	Tuple code
00CH	04h	TPL_LINK	Tuple link
00EH	03h	Conditions information	Tuple data
010H	D9h	Device information	Tuple data
012H	01h	Device information	Tuple data
014H	ffh	END MARKER	End of Tuple
016H	18h	CISTPL_JEDEC_C	Tuple code
018H	02h	TPL_LINK	Tuple link
01AH	dfh	PCMCIA's manufacture's JEDEC ID code	Tuple data
01CH	01h	PCMCIA's JEDEC device code	Tuple data
01EH	20h	CISTPL_MANFID	Tuple code
020H	04h	TPL_LINK	Tuple link
022H	98h	Low byte of manufacturer's ID code	Tuple data
024H	00h	High byte of manufacturer's ID code	Tuple data
026H	00h	Low byte of product code	Tuple data
028H	00h	High byte of product code	Tuple data
02AH	15h	CISTPL_VERS_1	Tuple code
02CH	20h	TPL_LINK	Tuple link
02EH	04h	TPLL_V1_MAJOR	Tuple data
030H	01h	TPLL_V1_MINOR	Tuple data
032H	54h	'T' (Vender Specific Strings)	Tuple data
034H	4fh	'O' (Vender Specific Strings)	Tuple data
036H	53h	'S' (Vender Specific Strings)	Tuple data
038H	48h	'H' (Vender Specific Strings)	Tuple data
03AH	49h	'I' (Vender Specific Strings)	Tuple data
03CH	42h	'B' (Vender Specific Strings)	Tuple data
03EH	41h	'A' (Vender Specific Strings)	Tuple data
040H	20h	' ' (Vender Specific Strings)	Tuple data
042H	54h	'T' (Vender Specific Strings)	Tuple data
044H	48h	'H' (Vender Specific Strings)	Tuple data
046H	4eh	'N' (Vender Specific Strings)	Tuple data
048H	41h	'A' (Vendor Specific Strings)	Tuple data
04AH	54h	'T' (Vender Specific Strings)	Tuple data
04CH	30h	'0' (Card capacity dependent strings)	Tuple data
04EH	30h	'0' (Card capacity dependent strings)	Tuple data

Address	Data	Description of contents	CIS function
050H	30h	'0' (Card capacity dependent strings)	Tuple data
052H	4dh	'0' (Card capacity dependent strings)	Tuple data
054H	42h	'B' (Vender Specific Strings)	Tuple data
056H	42h	'A' (Vender Specific Strings)	Tuple data
058H	20h	'I'	Tuple data
05AH	00h	Null Terminator	Tuple data
05CH	00h	Reserved (Vender Specific Strings)	Tuple data
05EH	00h	Reserved (Vender Specific Strings)	Tuple data
060H	00h	Reserved (Vender Specific Strings)	Tuple data
062H	00h	Reserved (Vender Specific Strings)	Tuple data
064H	00h	Reserved (Vender Specific Strings)	Tuple data
066H	00h	Reserved (Vender Specific Strings)	Tuple data
068H	00h	Reserved (Vender Specific Strings)	Tuple data
06AH	00h	Reserved (Vender Specific Strings)	Tuple data
06CH	FFh	END MARKER	End of Tuple
06EH	21h	CISTPL_FUNCID	Tuple code
070H	02h	TPL_LINK	Tuple link
072H	04h	IC Card function code	Tuple data
074H	01h	System initialization bit mask	Tuple data
076H	22h	CISTPL_FUNCE	Tuple code
078H	02h	TPL_LINK	Tuple link
07AH	01h	Type of extended data	Tuple data
07CH	01h	Function information	Tuple data
07EH	22h	CISTPL_FUNCE	Tuple code
080H	03h	TPL_LINK	Tuple link
082H	02h	Type of extended data	Tuple data
084H	0ch	Function information	Tuple data
086H	0fh	Function information	Tuple data
088H	1ah	CISTPL_CONFIG	Tuple code
08AH	05h	TPL_LINK	Tuple link
08CH	01h	Size field	Tuple data
08EH	03h	Index number of last entry	Tuple data
090H	00h	Configuration register base address (Low)	Tuple data
092H	02h	Configuration register base address (High)	Tuple data
094H	0fh	Configuration register present mask	Tuple data
096H	1bh	CISTPL_CFTABLE_ENTRY	Tuple code
098H	08h	TPL_LINK	Tuple link
09AH	c0h	Configuration Index Byte	Tuple data
09CH	c0h	Interface Descriptor	Tuple data
09EH	a1h	Feature Select	Tuple data

Address	Data	Description of contents	CIS function
0A0H	01h	Vcc Selection Byte	Tuple data
0A2H	55h	Nom V Paramete	Tuple data
0A4H	08h	Memory length (256 byte pages)	Tuple data
0A6H	00h	Memory length (256 byte pages)	Tuple data
0A8H	20h	Misc features	Tuple data
0AAH	1bh	CISTPL_CFTABLE_ENTRY	Tuple code
0ACH	06h	TPL_LINK	Tuple link
0AEH	00h	Configuration Index Byte	Tuple data
0B0H	01h	Feature Select	Tuple data
0B2H	21h	Vcc Selection Byte	Tuple data
0B4H	b5h	Nom V Parameter	Tuple data
0B6H	1eh	Nom V Parameter	Tuple data
0B8H	4dh	Peak I Parameter	Tuple data
0BAH	1bh	CISTPL_CFTABLE_ENTRY	Tuple code
0BCH	0ah	TPL_LINK	Tuple link
0BEH	c1h	Configuration Index Byte	Tuple data
0C0H	41h	Interface Descriptor	Tuple data
0C2H	99h	Feature Select	Tuple data
0C4H	01h	Vcc Selection Byte	Tuple data
0C6H	55h	Nom V Parameter	Tuple data
0C8H	64h	I/O param	Tuple data
0CAH	f0h	IRQ parameter	Tuple data
0CCH	Ffh	IRQ request mask	Tuple date
0CEH	Ffh	IRQ request mask	Tuple data
0D0H	20h	Misc features	Tuple data
0D2H	1bh	CISTPL_CFTABLE_ENTRY	Tuple code
0D4H	06h	TPL_LINK	Tuple link
0D6H	01h	Configuration Index Byte	Tuple data
0D8H	01h	Feature Select	Tuple data
0DAH	21h	Vcc Selection Byte	Tuple data
0DCH	b5h	Nom V Parameter	Tuple data
0DEH	1eh	Nom V Parameter	Tuple data
0E0H	4dh	Peak I Parameter	Tuple data
0E2H	1bh	CISTPL_CFTABLE_ENTRY	Tuple code
0E4H	0fh	TPL_LINK	Tuple link
0E6H	c2h	Configuration Index Byte	Tuple data
0E8H	41h	Interface Descriptor	Tuple data
0EAH	99h	Feature Select	Tuple data
0ECH	01h	Vcc Selection Byte	Tuple data
0EEH	55h	Nom V Parameter	Tuple data
0F0H	eah	I/O param	Tuple data
0F2H	61h	I/O range length and size	Tuple data

Address	Data	Description of contents	CIS function
0F4H	f0h	Base address	Tuple data
0F6H	01h	Base address	Tuple data
0F8H	07h	Address length	Tuple data
0FAH	f6h	Base address	Tuple data
0FCH	03h	Base address	Tuple data
0FEH	01h	Address length	Tuple data
100H	eeh	IRQ parameter	Tuple data
102H	20h	Misc features	Tuple data
104H	1bh	CISTPL_CFTABLE_ENTRY	Tuple code
106H	06h	TPL_LINK	Tuple link
108H	02h	Configuration Index Byte	Tuple data
10AH	01h	Feature Select	Tuple data
10CH	21h	Vcc Selection Byte	Tuple data
10EH	b5h	Nom V Parameter	Tuple data
110H	1eh	Nom V Parameter	Tuple data
112H	4dh	Peak I Parameter	Tuple data
114H	1bh	CISTPL_CFTABLE_ENTRY	Tuple code
116H	0fh	TPL_LINK	Tuple link
118H	c3h	Configuration Index Byte	Tuple data
11AH	41h	Interface Descriptor	Tuple data
11CH	99h	Feature Select	Tuple data
11EH	01h	Vcc Selection Byte	Tuple data
120H	55h	Nom V Parameter	Tuple data
122H	eah	I/O param	Tuple data
124H	61h	I/O range length and size	Tuple data
126H	70h	Base address	Tuple data
128H	01h	Base address	Tuple data
12AH	07h	Address length	Tuple data
12CH	76h	Base address	Tuple data
12EH	03h	Base address	Tuple data
130H	01h	Address length	Tuple data
132H	eeh	IRQ parameter	Tuple data
134H	20h	Misc features	Tuple data
136H	1bh	CISTPL_CFTABLE_ENTRY	Tuple code
138H	06h	TPL_LINK	Tuple link
13AH	03h	Configuration Index Byte	Tuple data
13CH	01h	Feature Select	Tuple data
13EH	21h	Vcc Selection Byte	Tuple data
140H	b5h	Nom V Parameter	Tuple data
142H	1eh	Nom V Parameter	Tuple data
144H	4dh	Peak I Parameter	Tuple data
146H	14h	CISTPL_NO_LINK	Tuple code
148H	00h	TPL_LINK	Tuple link
14AH	Ffh	CISTPL_END	End of Tuple

6. Task File register specification

These registers are used for reading and writing the storage data in this card. These registers are mapped five types by the configuration of INDEX in Configuration Option register. The decoded addresses are shown as follows.

Memory map (INDEX=0)

-REG	A10	A9 to A4	A3	A2	A1	A0	Offset	-OE=L	-WE=L
1	0	x	0	0	0	0	0H	Data register	Data register
1	0	x	0	0	0	1	1H	Error register	Feature register
1	0	x	0	0	1	0	2H	Sector count register	Sector count register
1	0	x	0	0	1	1	3H	Sector number register	Sector number register
1	0	x	0	1	0	0	4H	Cylinder low register	Cylinder low register
1	0	x	0	1	0	1	5H	Cylinder high register	Cylinder high register
1	0	x	0	1	1	0	6H	Drive head register	Drive head register
1	0	x	0	1	1	1	7H	Status register	Command register
1	0	x	1	0	0	0	8H	Dup. even data register	Dup. even data register
1	0	x	1	0	0	1	9H	Dup. odd data register	Dup. odd data register
1	0	x	1	1	0	1	DH	Dup. error register	Dup. feature register
1	0	x	1	1	1	0	EH	Alt. status register	Device control register
1	0	x	1	1	1	1	FH	Drive address register	Reserved
1	1	x	x	x	x	0	8H	Even data register	Even data register
1	1	x	x	x	x	1	9H	Odd data register	Odd data register

Contiguous I/O map (INDEX=1)

-REG	A10 to A4	A3	A2	A1	A0	Offset	-IORD=L	-IOWR=L
0	x	0	0	0	0	0H	Data register	Data register
0	x	0	0	0	1	1H	Error register	Feature register
0	x	0	0	1	0	2H	Sector count register	Sector count register
0	x	0	0	1	1	3H	Sector number register	Sector number register
0	x	0	1	0	0	4H	Cylinder low register	Cylinder low register
0	x	0	1	0	1	5H	Cylinder high register	Cylinder high register
0	x	0	1	1	0	6H	Drive head register	Drive head register
0	x	0	1	1	1	7H	Status register	Command register
0	x	1	0	0	0	8H	Dup. even data register	Dup. even data register
0	x	1	0	0	1	9H	Dup. odd data register	Dup. odd data register
0	x	1	1	0	1	DH	Dup. error register	Dup. feature register
0	x	1	1	1	0	EH	Alt. status register	Device control register
0	x	1	1	1	1	FH	Drive address register	Reserved

Primary I/O map (INDEX=2)

-REG	A10	A9 to A4	A3	A2	A1	A0	-IORD=L	-IOWR=L
0	x	1FH	0	0	0	0	Data register	Data register
0	x	1FH	0	0	0	1	Error register	Feature register
0	x	1FH	0	0	1	0	Sector count register	Sector count register
0	x	1FH	0	0	1	1	Sector number register	Sector number register
0	x	1FH	0	1	0	0	Cylinder low register	Cylinder low register
0	x	1FH	0	1	0	1	Cylinder high register	Cylinder high register
0	x	1FH	0	1	1	0	Drive head register	Drive head register
0	x	1FH	0	1	1	1	Status register	Command register
0	x	3FH	0	1	1	0	Alt. status register	Device control register
0	x	3FH	0	1	1	1	Drive address register	Reserved

Secondary I/O map (INDEX=3)

-REG	A10	A9 to A4	A3	A2	A1	A0	-IORD=L	-IOWR=L
0	x	17FH	0	0	0	0	Data register	Data register
0	x	17FH	0	0	0	1	Error register	Feature register
0	x	17FH	0	0	1	0	Sector count register	Sector count register
0	x	17FH	0	0	1	1	Sector number register	Sector number register
0	x	17FH	0	1	0	0	Cylinder low register	Cylinder low register
0	x	17FH	0	1	0	1	Cylinder high register	Cylinder high register
0	x	17FH	0	1	1	0	Drive head register	Drive head register
0	x	17FH	0	1	1	1	Status register	Command register
0	x	37FH	0	1	1	0	Alt. status register	Device control register
0	x	37FH	0	1	1	1	Drive address register	Reserved

True IDE Mode I/O map

-CE2	-CE1	A2	A1	A0	-IORD=L	-IOWR=L
1	0	0	0	0	Data register	Data register
1	0	0	0	1	Error register	Feature register
1	0	0	1	0	Sector count register	Sector count register
1	0	0	1	1	Sector number register	Sector number register
1	0	1	0	0	Cylinder low register	Cylinder low register
1	0	1	0	1	Cylinder high register	Cylinder high register
1	0	1	1	0	Drive head register	Drive head register
1	0	1	1	1	Status register	Command register
0	1	1	1	0	Alt. status register	Device control register
0	1	1	1	1	Drive address register	Reserved

1.Data register: This register is a 16-bit register that has read/write ability, and it is used for transferring 1 sector data between the card and the host. This register can be accessed in word mode and byte mode. This register overlaps the Error or Feature register.

bit15	bit14	bit13	bit12	bit11	bit10	bit9	bit8	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
D0 to D15															

2.Error register: This register is a read only register, and it is used for analyzing the error content at the card accessing. This register is valid when the BSY bit in Status register and Alternate Status register are set to “0”(Ready).

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
BBK	UNC	“0”	IDNF	“0”	ABRT	“0”	AMNF

bit	Name	Function
7	BBK(Bad Block detected)	This bit is set when a Bad Block is detected in requester ID field.
6	UNC(Data ECC error)	This bit is set when Uncorrectable error is occurred at reading the card.
4	IDNF(ID Not Found)	The requested sector ID is in error or cannot be found.
2	ABRT(ABoRTed command)	This bit is set if the command has been aborted because of the card status condition.(Not ready, Write fault, Invalid command, etc.)
0	AMNF(Address Mark Not Found)	This bit is set in case of a general error.

3.Feature register: This register is write-only register, and provides information regarding features of the drive that the host wishes to utilize.

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
Feature byte							

4.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 card. If the value of this register is zero, a count of 256 sectors is specified. In plural sector transfer, if not successfully completed, the register contains the number of sectors, which need to be transferred in order to complete, the request.

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
Sector count byte							

5.Sector number register: This register contains the starting sector number, which is started by following sector transfer command.

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
Sector number byte							

6.Cylinder low register: This register contains the low 8-bit of the starting cylinder address, which is started by following sector transfer command.

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
Cylinder low byte							

7.Cylinder high register: This register contains the high 8-bit of the starting cylinder address, which is started by following sector transfer command.

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
Cylinder high byte							

8.Drive head register: This register is used for selecting the Drive number and Head number for the following command.

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
Obsolete	LBA	Obsolete	DRV	Head number			

bit	Name	Function
7	Obsolete	This bit is normally set to "1".
6	LBA	LBA is a flag to select either Cylinder/Head/Sector (CHS) or Logical Block Address (LBA) mode. When LBA =0, CHS mode is selected. When LBA=1, LBA mode is selected. In LBA mode, the Logical Block Address is interrupted as follows: LBA07–LBA00: Sector Number Register D7–D0. LBA15–LBA08: Cylinder Low Register D7–D0. LBA23–LBA16: Cylinder High Register D7–D0. LBA27–LBA24: Drive / Head Register bits HS3–HS0.
5	Obsolete	This bit is normally set to "1".
4	DRV(DriVe select)	This bit is used for selecting the Master (Card 0)and Slave(Card 1) in Master/Slave organization. The card is set to be Card 0 or 1 by using DRV# of the Socket and Copy register.
3	Head number	This bit is used for selecting the Head number for the following command. Bit 3 is MSB.

9.Status register: This register is read only register, and it indicates the card status of command execution. When this register is read in configured I/O card mode (INDEX=1,2,3) and level interrupt mode, -IREQ is negated.

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
BSY	DRDY	DWF	DSC	DRQ	CORR	IDX	ERR

bit	Name	Function
7	BSY(BuSY)	This bit is set when the card internal operation is executing. When this bit is set to "1", other bits in this register are invalid.
6	DRVY(Drive ReaDY)	If this bit and DSC bit are set to "1", the card is capable of receiving the read or write or seek requests. If this bit is set to "0", the card prohibits these requests.
5	DWF(Drive Write Fault)	This bit is set if this card indicates the write fault status.
4	DSC(Drive Seek Complete)	This bit is set when the drive seeks complete.
3	DRQ(Data ReQuest)	This bit is set when the information can be transferred between the host and Data register. This bit is cleared when the card receives the other command.
2	CORR(CORReCted data)	This bit is set when a correctable data error has been occurred and the data has been corrected.
1	IDX(InDeX)	This bit is always set to "0".
0	ERR(ERRor)	This bit is set when the previous command has ended in some type of error. The error information is set in the error register. This bit is cleared by the next command.

10.Alternate status register: This register is the same as Status register in physically, so the bit assignment refers to previous item of Status register. But this register is different from Status register that -IREQ is not negated when data read.

11.Command register: This register is write only register, and it is used for writing the command to execute the requested operation. The command codes are written in the command register, after the parameter is written in the Task File when the card is in Ready state.

Command	Command code	Used parameter						
		FR	SC	SN	CY	DR	HD	LBA
Check power mode	E5H or 98H	N	N	N	N	Y	N	N
Execute drive diagnostic	90H	N	N	N	N	Y	N	N
Erase sector	C0H	N	Y	Y	Y	Y	Y	Y
Format track	50H	N	Y	N	Y	Y	Y	Y
Identify Drive	ECH	N	N	N	N	Y	N	N
Idle	E3H or 97H	N	Y	N	N	Y	N	N
Idle immediate	E1H or 95H	N	N	N	N	Y	N	N
Initialize drive parameters	91H	N	Y	N	N	Y	Y	N
Read buffer	E4H	N	N	N	N	Y	N	N
Read multiple	C4H	N	Y	Y	Y	Y	Y	Y
Read long sector	22H or 23H	N	N	Y	Y	Y	Y	Y
Read sector	20H or 21H	N	Y	Y	Y	Y	Y	Y
Read verify sector	40H or 41H	N	Y	Y	Y	Y	Y	Y
Recalibrate	1XH	N	N	N	N	Y	N	N
Request sense	03H	N	N	N	N	Y	N	N
Seek	7XH	N	N	Y	Y	Y	Y	Y
Set features	EFH	Y	N	N	N	Y	N	N
Set multiple mode	C6H	N	Y	N	N	Y	N	N
Set sleep mode	E6H or 99H	N	N	N	N	Y	N	N
Stand by	E2H or 96H	N	N	N	N	Y	N	N
Stand by immediate	E0H or 94H	N	N	N	N	Y	N	N
Translate sector	87H	N	Y	Y	Y	Y	Y	Y
Wear level	F5H	N	N	N	N	Y	Y	N
Write buffer	E8H	N	N	N	N	Y	N	N
Write long sector	32H or 33H	N	N	Y	Y	Y	Y	Y
Write multiple	C5H	N	Y	Y	Y	Y	Y	Y
Write multiple w/o erase	CDH	N	Y	Y	Y	Y	Y	Y
Write sector	30H or 31H	N	Y	Y	Y	Y	Y	Y
Write sector w/o erase	38H	N	Y	Y	Y	Y	Y	Y
Write verify	3CH	N	Y	Y	Y	Y	Y	Y

Note: FR: Feature register

SC: Sector Count register

SN: Sector Number register

CY: Cylinder register

DR: DRV bit of Drive Head register

HD: Head Number of Drive Head register

LBA: Logical Block Address Mode Supported

Y: The register contains a valid parameter for this command

N: The register does not contain a valid parameter for this command

12. Device control register: This register is write only register, and it is used for controlling the card interrupt request and issuing an ATA soft reset to the card.

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
x	x	x	x	1	SRST	nIEN	0

bit	Name	Function
7to 4	X	don't care
3	1	This bit is set to "1".
2	SRST(Software ReSeT)	This bit is set to "1" in order to force the card to perform Task File Reset operation. This does not change the Card Configuration registers as a Hardware Reset does. The card remains in Reset until this bit is reset to "0".
1	nIEN(Interrupt Enable)	This bit is used for enabling -IREQ. When this bit is set to "0", -IREQ is enabled. When this bit is set to "1", -IREQ is disabled.
0	0	This bit is set to "0".

13.Drive Address register: This register is read only register, and it is used for confirming the drive status. This register is provides for compatibility with the AT disk drive interface. It is recommended that this register is not mapped into the host's I/O space because of potential conflicts on bit7.

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
x	nWTG	nHS3	nHS2	nHS1	nHS0	nDS1	nDS0

bit	Name	Function
7	X	This bit remains tri-state when host read access
6	nWTG(WriTing Gate)	This bit is set as 0
5 to 2	nHS3-0(Head Select3-0)	These bits is the negative value of Head Select bits(bit 3 to 0)in Drive/Head register.
1	nDS1(Idrive Select1)	This bit is 0 when drive 1 is active and selected.
0	nDS0(Idrive Select0)	This bit is 0 when drive 0 is active and selected.

7. ATA Command specifications

This table summarizes the ATA command set with the paragraphs. Following shows the supported commands and command codes, which are written in command registers.

7.1 ATA Command Set

No.	Command set	Code	FR	SC	SN	CY	DR	HD	LBA
1	Check power mode	E5H or 98H	—	—	—	—	Y	—	—
2	Execute drive diagnostic	90H	—	—	—	—	Y	—	—
3	Erase sector(s)	C0H	—	Y	Y	Y	Y	Y	Y
4	Format track	50H	—	Y	—	Y	Y	Y	Y
5	Identify Drive	ECH	—	—	—	—	Y	—	—
6	Idle	E3H or 97H	—	Y	—	—	Y	—	—
7	Idle immediate	E1H or 95H	—	—	—	—	Y	—	—
8	Initialize drive parameters	91H	—	Y	—	—	Y	Y	—
9	Read buffer	E4H	—	—	—	—	Y	—	—
10	Read multiple	C4H	—	Y	Y	Y	Y	Y	Y
11	Read long sector	22H,23H	—	—	Y	Y	Y	Y	Y
12	Read sector(s)	20H,21H	—	Y	Y	Y	Y	Y	Y
13	Read verify sector(s)	40H, 41H	—	Y	Y	Y	Y	Y	Y
14	Recalibrate	1XH	—	—	—	—	Y	—	—
15	Request sense	03H	—	—	—	—	Y	—	—
16	Seek	7XH	—	—	Y	Y	Y	Y	Y
17	Set features	EFH	Y	—	—	—	Y	—	—
18	Set multiple mode	C6H	—	Y	—	—	Y	—	—
19	Set sleep mode	E6H or 99H	—	—	—	—	Y	—	—
20	Stand by	E2H or 96H	—	—	—	—	Y	—	—
21	Stand by immediate	E0H or 94H	—	—	—	—	Y	—	—
22	Translate sector	87H	—	Y	Y	Y	Y	Y	Y
23	Wear level	F5H	—	—	—	—	Y	Y	—
24	Write buffer	E8H	—	—	—	—	Y	—	—
25	Write long sector	32H or 33H	—	—	Y	Y	Y	Y	Y
26	Write multiple	C5H	—	Y	Y	Y	Y	Y	Y
27	Write multiple w/o erase	CDH	—	Y	Y	Y	Y	Y	Y
28	Write sector	30H or 31H	—	Y	Y	Y	Y	Y	Y
29	Write sector w/o erase	38H	—	Y	Y	Y	Y	Y	Y
30	Write verify	3CH	—	Y	Y	Y	Y	Y	Y

Note: FR: Feature Register

SC: Sector Count register (00H to FFH)

SN: Sector Number register (01H to 20H)

CY: Cylinder Low/High register

DR: Drive bit of Drive/Head register

HD: Head No.(0 to 3) of Drive/Head register

LBA: Logical Block Address Mode supported

Y: Set up

— : Not set up

1. Check Power Mode (code: E5H or 98H): This command checks the power mode.
2. Execute Drive Diagnostic (code: 90H): This command performs the internal diagnostic tests implemented by the Card.
3. Erase Sector(s) (code: C0H): This command is used to erase data sectors.
4. Format Track (code: 50H): 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 card expects one sector (512Bytes) of data from the host to follow the command with same protocol as the Write Sector Command.
5. Identify Drive (code: ECH): This command enables the host to receive parameter information from the Card.

Identify Drive Information

Word address	Default value	Total bytes	Data field type information
0	848AH	2	General configuration bit-significant information
1	XXXX	2	Default number of cylinders
2	0000H	2	Reserved
3	00XXH	2	Default number of heads
4	0000H	2	Number of unformatted bytes per track
5	XXXX	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(Word7=MSW,Words=LSW)
9	0000H	2	Reserved
10 to 19	XXXX	20	Serial number in ASCII
20	0001H	2	Buffer type(single ported)
21	0004H	2	Buffer size in 512 byte increments
22	0004H	2	# of ECC bytes passed on Read/Write Long Commands
23 to 46	XXXX	48	Firmware revision in ASCII etc.
47	0001H	2	Maximum of 1 sector on Read/Write Multiple command
48	0000H	2	Double Word not supported
49	0200H	2	Capabilities: DMA NOT Supported(bit 8), LBA supported
50	0000H	2	Reserved
51	0200H	2	PIO data transfer cycle timing mode 2
52	0000H	2	DMA data transfer cycle timing mode not Supported
53 to 58	XXXX	12	Reserved
59	0101H	2	Multiple sector setting is valid
60 to 61	XXXX	4	Total number of sectors addressable in LBA Mode
62 to 255	0000H	388	Reserved

6.Idle (code: E3H or 97H): This command causes the Card to set BSY, enter the Idle mode, clear BSY and generate an interrupt. If sector count is non-zero, the automatic power down mode is enabled. If the sector count is zero, the automatic power mode is disabled.

7.Idle Immediate (code: E1H or 95H): This command causes the Card to set BSY, enter the Idle(Read) mode, clear BSY and generate an interrupt.

8.Initialize Drive Parameters (code: 91H): This command enables the host to set the number of sectors per track and the number of heads per cylinder.

9.Read Buffer (code: E4H): This command enables the host to read the current contents of the card's sector buffer.

10. Read Multiple (code: C4H): This command performs similarly to the Read Sectors command. Interrupts are not generated on each sector, but on the transfer of a block which contains the number of sectors defined by a Set Multiple command.
11. Read Long Sector (code 22H or 23H): This command performs similarly to the Read Sector(s) command except that it returns 516 bytes of data instead of 512 bytes.
12. Read Sector(s) (code 20H, 21H): This command reads from 1 to 256 sectors as specified in the Sector Count register. A sector count of 0 requests 256 sectors. The transfer beings specified in the Sector Number register.
13. Read Verify Sector(s) (code: 40H or 41H): This command is identical to the Read Sectors command, except that DRQ is never set and no data is transferred to the host.
14. Recalibrate (code: 1XH): This command is effectively a NOP command to the Card and is provided for compatibility purposes.
15. Request Sense (code: 03H): This command requests an extended error code after command ends with an error.
16. Seek (code: 7XH): This command is effectively a NOP command to the Card although it does perform a range check.
17. Set Features (code: EFH): This command is used by the host to establish or select certain features.

Feature	Operation
01H	Enable 8-bit data transfers.
55H	Disable Read Look Ahead.
66H	Disable Power on Reset (POR) establishment of defaults at Soft Reset.
81H	Disable 8-bit data transfers.
BBH	4 bytes of data apply on Read/Write Long commands.
CCH	Enable Power on Reset (POR) establishment of defaults at Soft Reset.

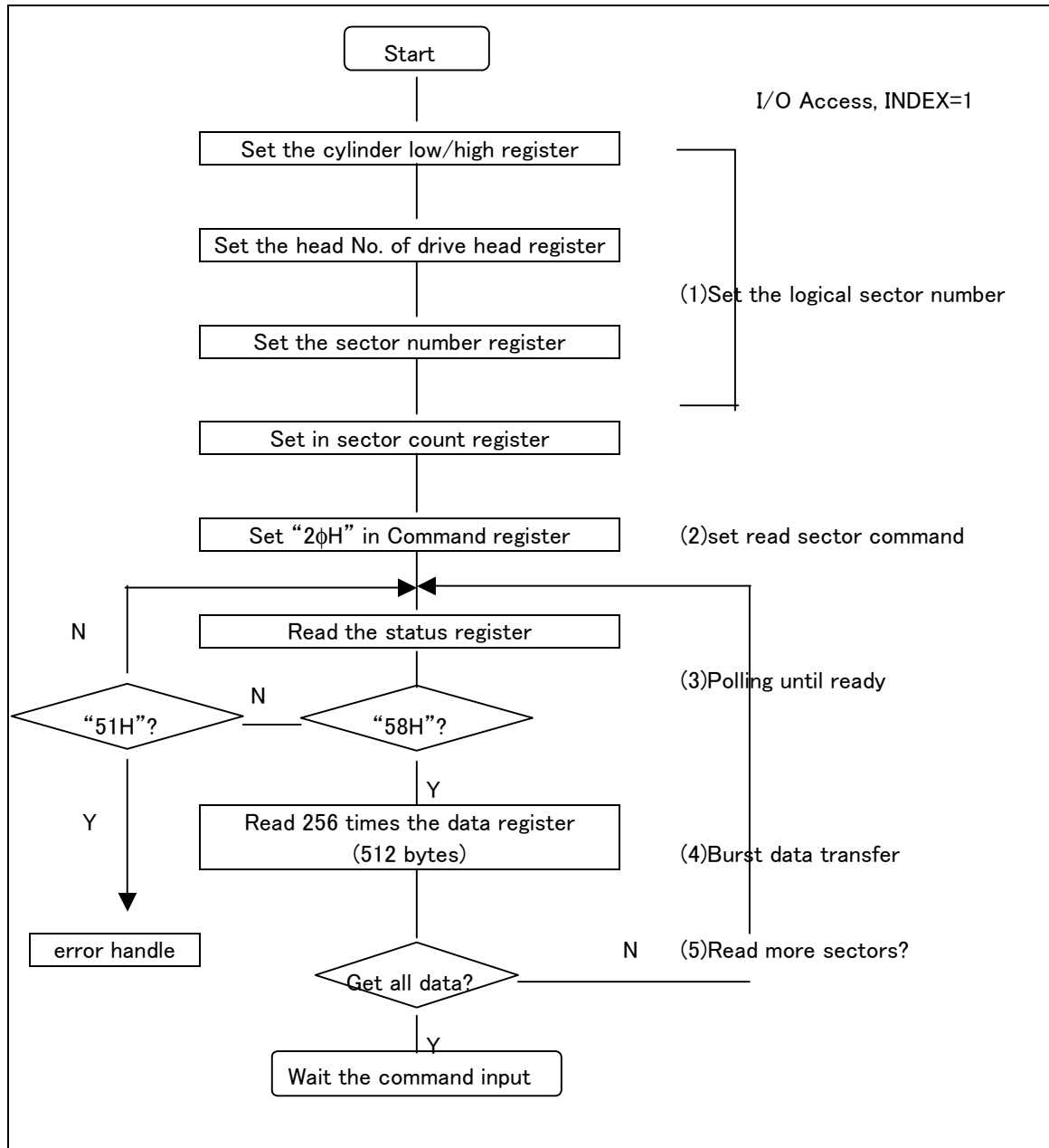
18. Set Multiple Mode (code: C6H): This command enables the Card to perform Read and Write Multiple operations and establishes the block count for these commands.
19. Set Sleep Mode (code: E6H or 99H): This command causes the Card to set BSY, enter the Sleep mode, clear BSY and generate an interrupt.
20. Stand By (code: E2H or 96H): This command causes the Card to set BSY, enter the Sleep mode (which corresponds to the ATA "Standby" Mode), clear BSY and return the interrupt immediately.
21. Stand By Immediate (code: E0H or 94H): This command causes the Card to set BSY, enter the Sleep mode (which corresponds to the ATA "Standby" Mode), clear BSY and return the interrupt immediately.
22. Translate Sector (code: 87H): This command allows the host a method of determining the exact number of times a use sector has been erased and programmed.

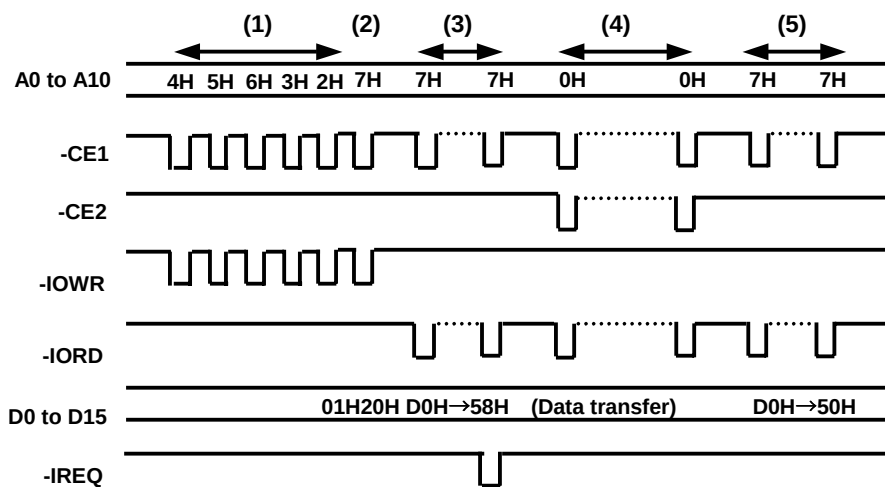
23. Wear Level (code: F5H): This command effectively a NOP command and only implemented for backward compatibility. The Sector Count Register will always be returned with a 00H indicating Wear Level is not needed.
24. Write Buffer (code: E8H): This command enables the host to overwrite contents of the Card's sector buffer with any data pattern desired.
25. Write Long Sector (code: 32H or 33H): This command is provided for compatibility purposes and is similar to the Write Sector(s) command except that it writes 516 bytes instead of 512 bytes.
26. Write Multiple (code: C5H): This command is similar to the Write Sectors command. Interrupts are not presented on each sector, but on the transfer of a block which contains the number of sectors defined by Set Multiple command.
27. Write Multiple without Erase (code: CDH): This command is similar to the Write Multiple command with the exception that an implied erase before write operation is not performed.
28. Write Sector(s): (code: 30H or 31H): This command writes from 1 to 256 sectors as specified in the Sector Count register. A sector count of zero requests 256 sectors. The transfer begins at the sector specified in the Sector Number register.
29. Write Sector(s) without Erase (code: 38H): This command is similar to the Write Sector(s) command with the exception that an implied erase before write operation is not performed.
30. Write Verify (code: 3CH): This command is similar to the Write Sector(s) command, except each sector is verified immediately after being written.

7.2 Sector Transfer Protocol

7.2.1 Sector read

Sector read procedure after the card configured I/O interface is shown as follows.

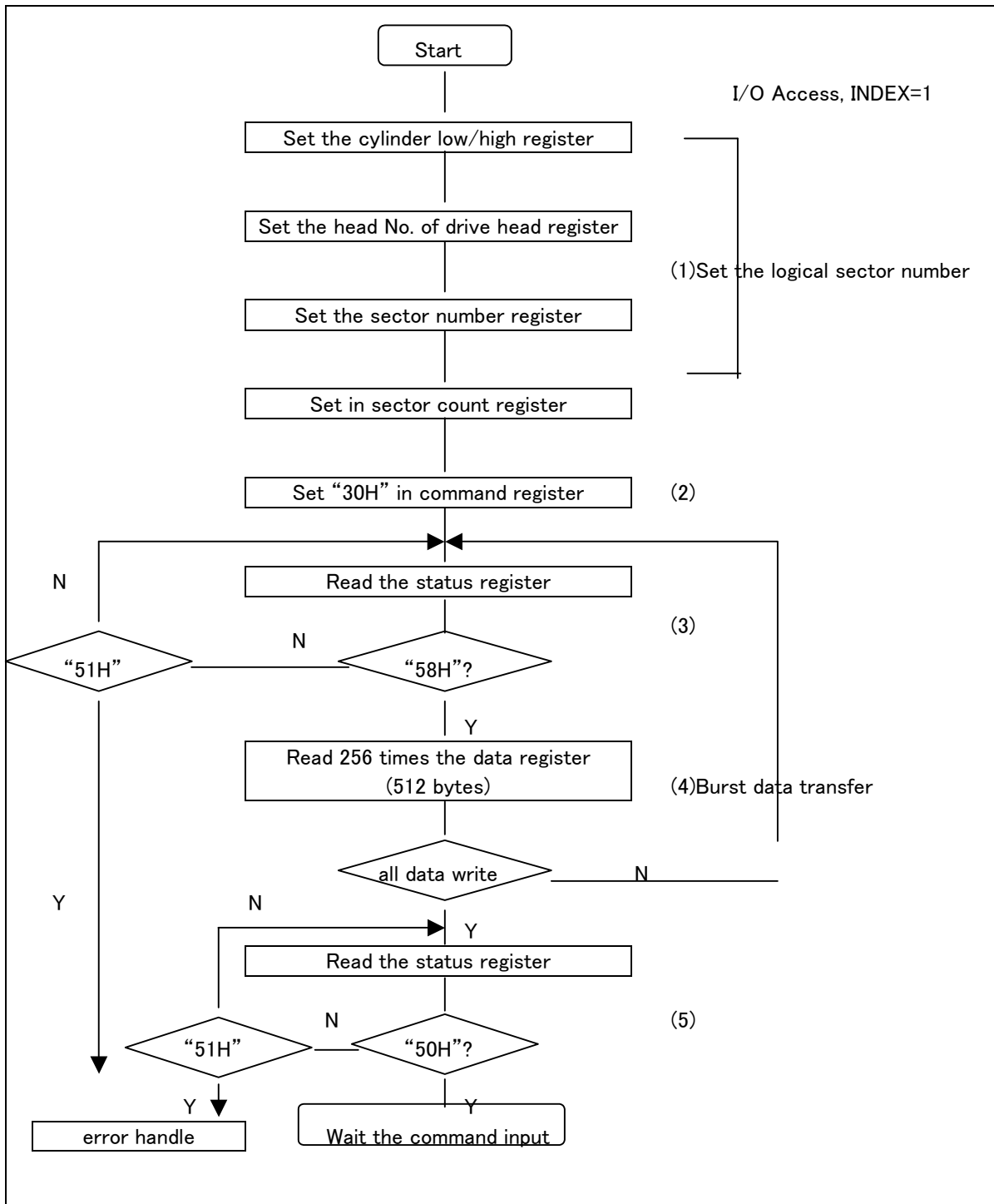


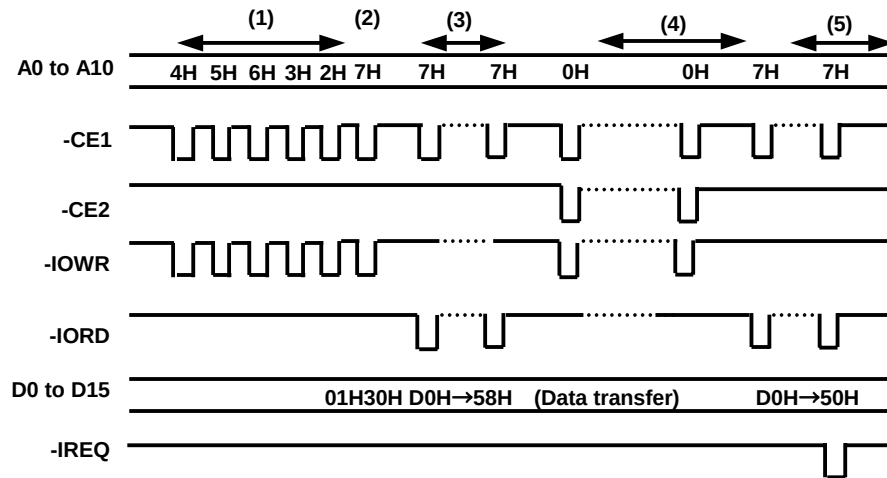


Sector read timing

7.2.2 Sector write

Write sector procedure after the card configured I/O interface is shown as follows.





Sector write timing

8. Card System performance

Item	Performance
Set up times (Reset to ready)	400 ms (max) *1
Set up times (Sleep to idle)	100 μ s (max)
Set up times (Deep power down to idle)	4 ms (max)
Data transfer rate to/from host	16.6 Mbyte/s burst (max), theoretically
Sustained read transfer rate	6.5 Mbyte/s (max), actually *2
Sustained write transfer rate	1.5 Mbyte/s (max), actually <16MB,32MB> *2
Sustained write transfer rate	3.2 Mbyte/s (max), actually <64MB~2.04GB> *2
Controller overhead (Command to DRQ)	4 ms (max)
Data transfer cycle end to ready(Sector write)	500 μ s (typ), 50 ms (max)

Note:

1. This parameter will be changed for different capacity and NAND type flash memory, the typical set up time for 2 Giga Bytes flash card is 325ms.
2. The actual transfer rate is measured under ATA PIO mode 4 with single Cycle time as 120ns.

9. Electrical Specification

9.1 DC Absolute Maximum Ratings

Parameter	Symbol	Value	Unit	Note
All input/output voltages	V _{in} , V _{out}	-0.3 to V _{CC} +0.3	V	
V _{CC} voltage	V _{CC}	-0.6 to 6	V	
Operation temperature range	T _{opr}	-40 to 85	°C	
Storage temperature range	T _{stg}	-45 to 90	°C	

9.2 DC Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Unit
Operation temperature	T _a	-40	25	85	°C
V _{CC} voltage	V _{CC}	4.5	5.0	5.5	V
		3.0	3.3	3.6	V

9.3 DC Characteristics

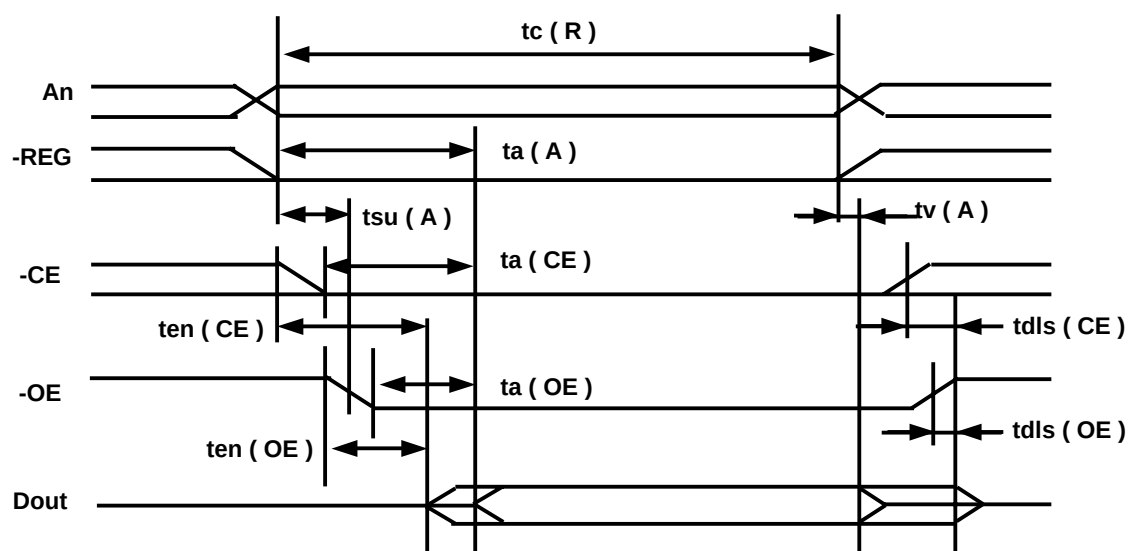
Conditions: $V_{CC} = 5V \pm 10\%$, $V_{CC} = 3.3V \pm 10\%$
 $T_a = -40^\circ\text{C}$ to 85°C

Parameter	Symbol	Min	Typ	Max	Unit	Condition
Input voltage	V_{IH}	$0.7 \cdot V_{CC}$ 2	—	—	V	$V_{CC}=3.3V$ $V_{CC}=5V$
	V_{IL}	—	—	$0.2 \cdot V_{CC}$ 0.8	V	$V_{CC}=3.3V$ $V_{CC}=5V$
Schmitt circuit	V_{T+}			2.5 2.0	V	$V_{CC}=3.3V$ $V_{CC}=5V$
	V_{T-}	0.9 0.8	— —	— —	V	$V_{CC}=3.3V$ $V_{CC}=5V$
Output voltage (4mA)	V_{OH}	$V_{CC}-0.8$	—	—	V	$I_{OH}=-4mA$
	V_{OL}	—	—	GND+0.4	V	$I_{OL}=4mA$
Input leakage current	I_{LI}	—	—	1	μA	—
Output leakage current	I_{LO}	—	—	1	μA	$V_{OUT}=\text{high impedance}$
Pull-up current (Resistivity)	$-I_{PU}$	—	43(75)	—	$\mu A(k\Omega)$	$V_{Force}=3.3V$
Pull-down current (Resistivity)	$-I_{PD}$	—	-48/(206)	—	$\mu A(k\Omega)$	$V_{Force}=0V$
Sleep mode current	I_{CCS}	—	1.3 1.5	1.8 2.2	mA	@3.3 V @ 5 V
Operating Current @3.3V Write operation Read operation	I_{CCO}		40 30		mA	@3.3V operation
Operating Current @ 5V Write operation Read operation			45 35			@ 5 V operation

9.4 AC Characteristics ($T_a = -40$ to $+85^\circ\text{C}$, $V_{CC} = 5V \pm 10\%$, $V_{CC} = 3.3V \pm 10\%$)

9.4.1 Attribute Memory Read AC Characteristics

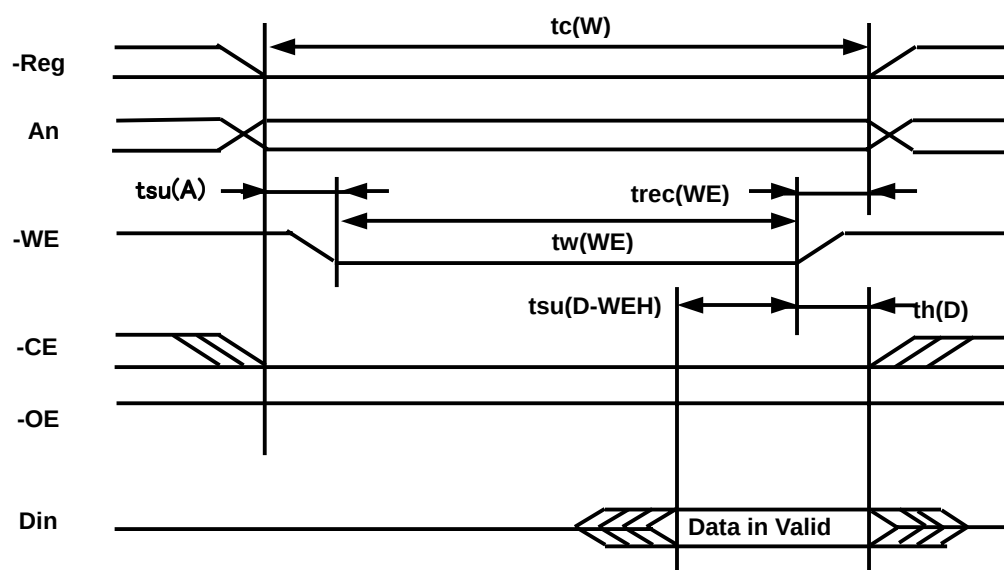
Parameter	Symbol	Min	Typ	Max	Unit
Read cycle time	t_{CR}	250	—	—	ns
Address access time	$t_{a(A)}$	—	—	250	ns
-CE access time	$t_{a(CE)}$	—	—	250	ns
-OE access time	$t_{a(OE)}$	—	—	125	ns
Output disable time(-CE)	$t_{dis(CE)}$	—	—	100	ns
Output disable time(-OE)	$t_{dis(OE)}$	—	—	100	ns
Output enable time(-CE)	$t_{en(CE)}$	5	—	—	ns
Output enable time(-OE)	$t_{en(OE)}$	5	—	—	ns
Data valid time(A)	$t_v(A)$	0	—	—	ns
Address setup time	$t_{su(A)}$	30	—	—	ns



Attribute Memory Read Timing

9.4.2 Attribute Memory Write AC Characteristics

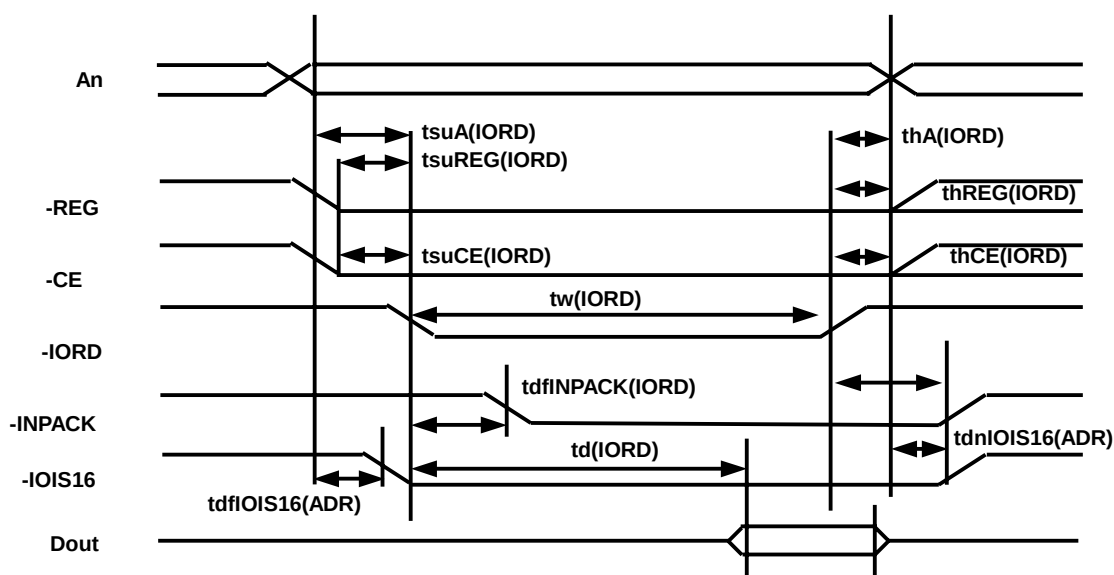
Parameter	Symbol	Min	Typ	Max	Unit
Write cycle time	tCW	250	—	—	ns
Write pulse time	tw(WE)	150	—	—	ns
Address setup time	tsu(A)	30	—	—	ns
Data setup time (-WE)	tsu(D-WEH)	80	—	—	ns
Data hold time	th(D)	30	—	—	ns
Write recover time	trec(WE)	30	—	—	ns



Attribute Memory Write Timing

9.4.3 I/O Access Read AC Characteristics

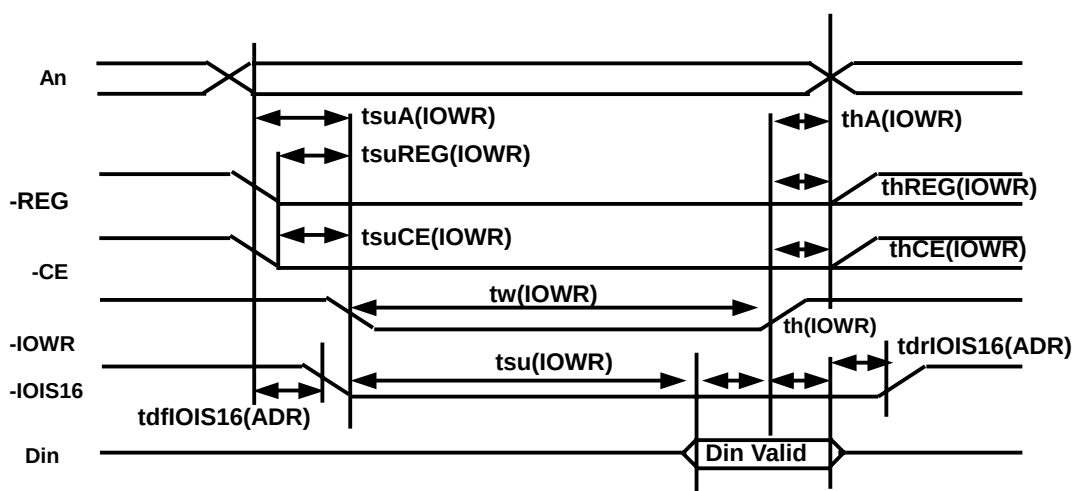
Parameter	Symbol	Min	Typ	Max	Unit
Data delay after $\neg$ IOR	td(IORD)	—	—	100	ns
Data hold following $\neg$ IOR	th(IORD)	0	—	—	ns
$\neg$ IOR pulse width	tw(IORD)	165	—	—	ns
Address setup before $\neg$ IOR	tsuA(IORD)	70	—	—	ns
Address hold following $\neg$ IOR	thA(IORD)	20	—	—	ns
$\neg$ CE setup before $\neg$ IOR	tsuCE(IORD)	5	—	—	ns
$\neg$ CE hold following $\neg$ IOR	thCE(IORD)	20	—	—	ns
$\neg$ REG setup before $\neg$ IOR	tsuREG(IORD)	5	—	—	ns
$\neg$ REG hold following $\neg$ IOR	thREG(IORD)	0	—	—	ns
$\neg$ INPACK delay falling from $\neg$ IOR	tdfINPACK(IORD)	0	—	45	ns
$\neg$ INPACK delay rising from $\neg$ IOR	tdrINPACK(IORD)	—	—	45	ns
$\neg$ IOIS16 delay falling from address	tdfIOIS16(ADR)	—	—	35	ns
$\neg$ IOIS16 delay rising from address	tdrIOIS16(ADR)	—	—	35	ns



I/O Access Read Timing

9.4.4 I/O Access Write AC Characteristics

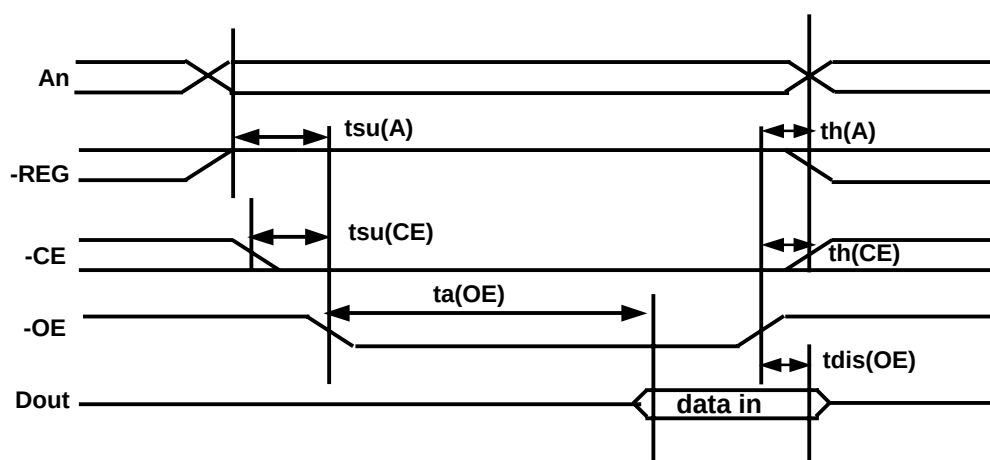
Parameter	Symbol	Min	Typ	Max	Unit
Data setup before -IOWR	tsu(IOWR)	60	—	—	ns
Data hold following -IOWR	th(IOWR)	30	—	—	ns
-IOWR pulse width	tw(IOWR)	165	—	—	ns
Address setup before -IOWR	tsuA(IOWR)	70	—	—	ns
Address hold following -IOWR	thA(IOWR)	20	—	—	ns
-CE setup before -IOWR	tsuCE(IOWR)	5	—	—	ns
-CE hold following -IOWR	thCE(IOWR)	20	—	—	ns
-REG setup before -IOWR	tsuREG(IOWR)	5	—	—	ns
-REG hold following -IOWR	thREG(IOWR)	0	—	—	ns
-IOIS16 delay falling from address	tdfIOIS16(ADR)	—	—	35	ns
-IOIS16 delay rising from address	tdrIOIS16(ADR)	—	—	35	ns



I/O Access Write Timing

9.4.5 Common Memory Access Read AC Characteristics

Parameter	Symbol	Min	Typ	Max	Unit
-OE access time	ta(OE)	—	—	125	ns
Output disable time (-OE)	tdis(OE)	—	—	100	ns
Address setup time	tsu(A)	30	—	—	ns
Address hold time	th(A)	20	—	—	ns
-CE setup time	tsu(CE)	0	—	—	ns
-CE hold time	th(CE)	20	—	—	ns

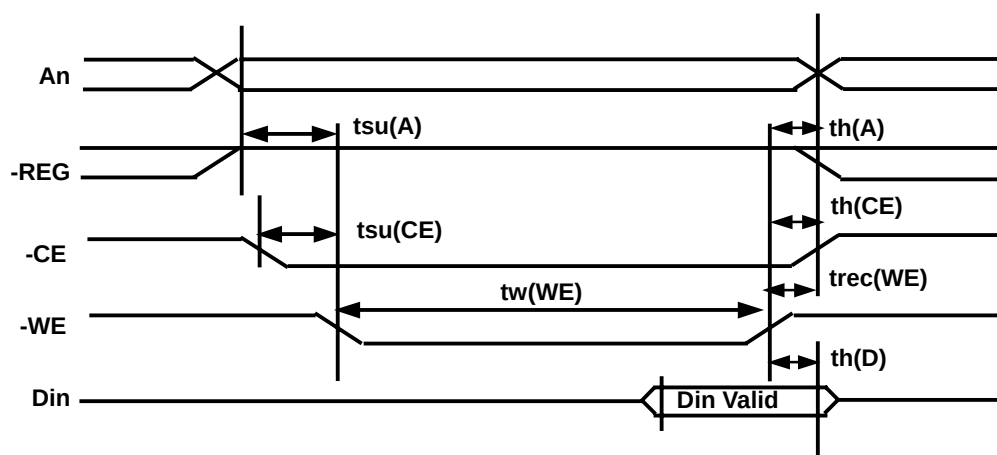


Common Memory Access Read Timing

data in

9.4.6 Common Memory Access Write AC Characteristic

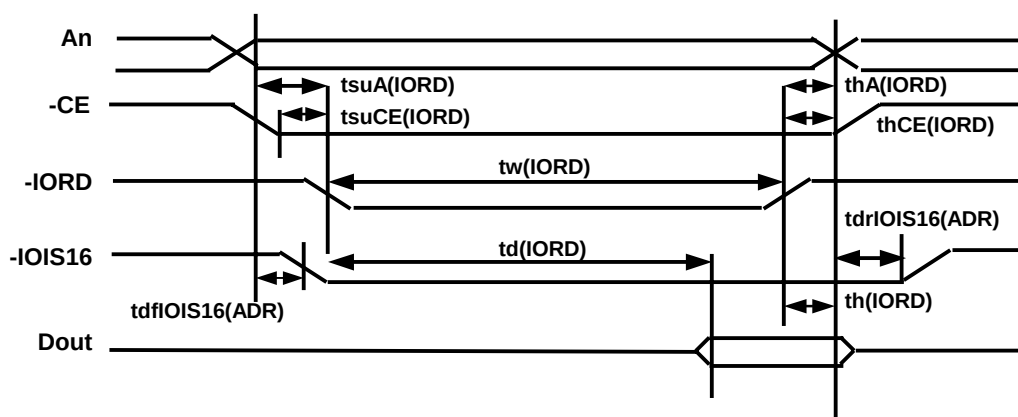
Parameter	Symbol	Min	Typ	Max	Unit
Data setup time (-WE)	$t_{su}(D-WEH)$	80	—	—	ns
Data hold time	$t_h(D)$	30	—	—	ns
Write pulse time	$t_w(WE)$	150	—	—	ns
Address setup time	$t_{su}(A)$	30	—	—	ns
-CE setup time	$t_{su}(CE)$	0	—	—	ns
Write recover time	$t_{rec}(WE)$	30	—	—	ns
-CE hold following -WE	$t_h(CE)$	0	—	—	ns



Common Memory Access Write Timing

9.4.7 True IDE Mode Access Read AC Characteristics

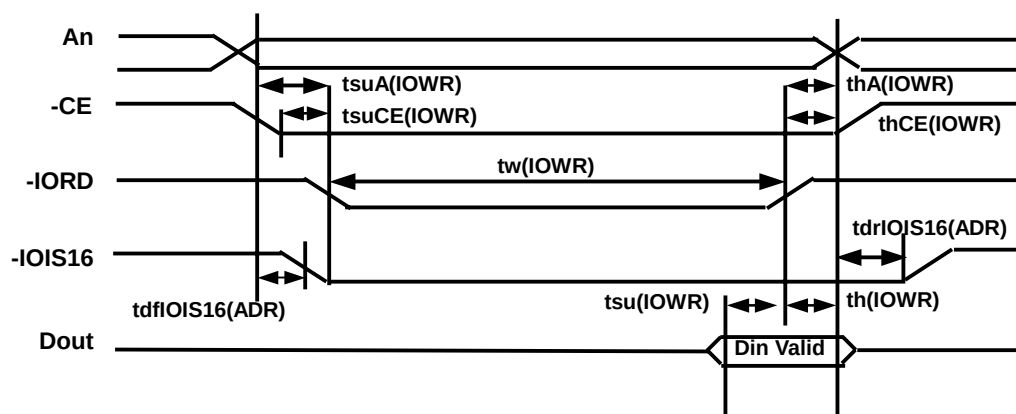
Parameter	Symbol	Min	Typ	Max	Unit
Data delay after IORD	td(IORD)	—	—	100	ns
Data hold following IORD	th(IORD)	0	—	—	ns
IORD width time	tw(IORD)	165	—	—	ns
Address setup before IORD	tsuA(IORD)	70	—	—	ns
Address hold following IORD	thA(IORD)	20	—	—	ns
CE setup before IORD	tsuCE(IORD)	5	—	—	ns
CE hold following IORD	thCE(IORD)	20	—	—	ns
IOIS16 delay falling from address	tdflIOIS16(ADR)	—	—	35	ns
IOIS16 delay rising from address	tsflIOIS16(ADR)	—	—	35	ns



True IDE Mode Access Read Timing

9.4.8 True IDE Mode Access Write AC Characteristics

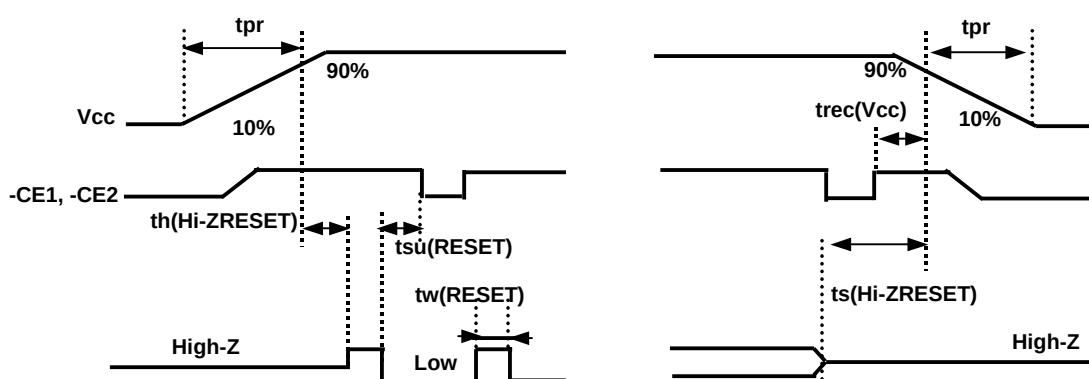
Parameter	Symbol	Min	Typ	Max	Unit
Data setup before IOWR	tsu(IOWR)	60	—	—	ns
Data hold following IOWR	th(IOWR)	30	—	—	ns
IOWR width time	tw(IOWR)	165	—	—	ns
Address setup before IOWR	tsuA(IOWR)	70	—	—	ns
Address hold following IOWR	thA(IOWR)	20	—	—	ns
CE setup before IOWR	tsuCE(IOWR)	5	—	—	ns
CE hold following IOWR	thCE(IOWR)	20	—	—	ns
IOIS16 delay falling from address	tdfIOIS16(ADR)	—	—	35	ns
IOIS16 delay rising from address	tsfIOIS16(ADR)	—	—	35	ns



True IDE Mode Access Write Timing

9.4.9 Reset Characteristics (only Memory Card Mode or I/O Card Mode)

Parameter	Symbol	Min	Typ	Max	Unit
Reset setup time	$t_{su}(\text{RESET})$	100	—	—	ms
-CE recover time	$t_{rec}(\text{VCC})$	1	—	—	μs
VCC rising up time	t_{pr}	0.1	—	100	ms
VCC falling down time	t_{pf}	3	—	300	ms
Reset pulse width	$t_w(\text{RESET})$	10	—	—	μs
	$t_h(\text{Hi-ZRESET})$	1	—	—	ms
	$t_s(\text{Hi-ZRESET})$	0	—	—	ms

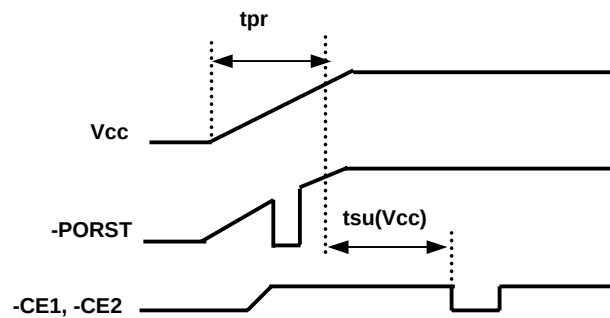


Hard Reset Timing

9.4.10 Power on Reset Characteristics

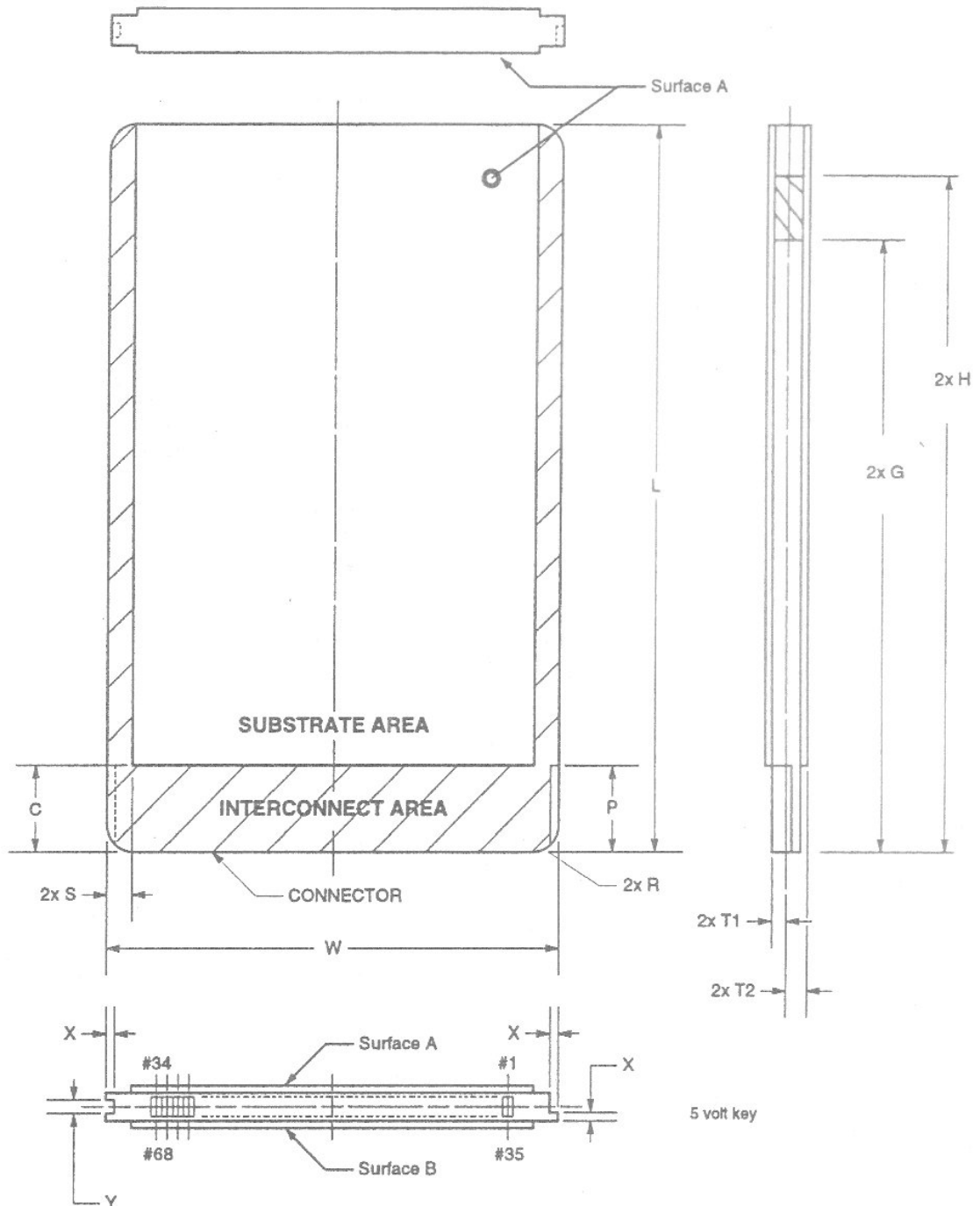
Power on reset sequence must need by -PORST at the rising of V_{CC} .

Parameter	Symbol	Min	Typ	Max	Unit	Test conditions
-CE setup time	$t_{su}(V_{CC})$	100	—	—	ms	
VCC rising up time	t_{pr}	0.1	—	100	ms	



Power on Reset Timing

10. Physical Specifications



C MIN	L $\pm$ 0.20	P MIN	R $\pm$ 0.10	S MIN	T1 $\pm$ 0.05	T2 MAX
10.0	85.60	10.0	0.60	3.0	1.65	2.50
W $\pm$ 0.10	X $\pm$ 0.05	Y $\pm$ 0.05	Z $\pm$ 0.05	G $\pm$ 0.60	H $\pm$ 0.60	
54.0	1.00	1.60	2.10	65.60	79.60	

Type II PC card dimensions

11. Attention for Card Use

- In the reset or power off, the information of all registers is cleared.
- Notice that the card insertion/removal should not be executed during host is active, if the card is used in True IDE mode.
- After the card hard reset, soft reset, or power on reset, ATA reset, command applied the card cannot access during +RDY/-BSY pin is “low” level. Flash card can't be operated in this case.
- Before the card insertion V_{CC} can not be supplied to the card. After confirmation that -CD1, -CD2 pins are inserted, supply V_{CC} to the card.

Note:

-OE must be kept at the V_{CC} level during power on reset in memory card mode and I/O card mode. -OE must be kept constantly at the GND level in True IDE mode.