



SanDisk



Abridged Version

Product Manual

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1 Introduction

1.1 General Description

The SanDisk iNAND Module is a very small, flash storage device, designed specifically for storage applications that put a premium on small form factor, low power and low cost. Flash is the ideal storage medium for portable, battery-powered devices. It features low power consumption and is non-volatile, requiring no power to maintain the stored data. It also has a wide operating range for temperature, shock and vibration.

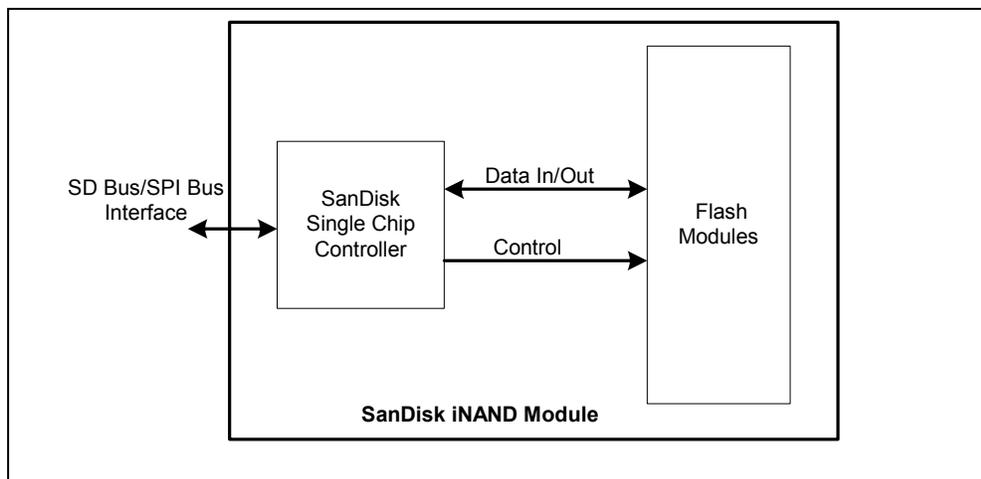
iNAND is well-suited to meet the needs of small, low power, electronic devices. With a form factor measuring 12mm by 18mm by 1.2mm, iNAND is expected to be used in a wide variety of portable devices like mobile phones, pagers, and voice recorders.

To support this wide range of applications, the iNAND is offered with an SD Interface. The SD interface product is fully compatible with iNAND modules, and provides a 4-bit data bus for maximum performance. For compatibility with existing controllers, the iNAND module offers, in addition to these interfaces, an alternate communication-protocol based on the SPI standard.

These interfaces allow for easy integration into any design, regardless of which type of microprocessor is used. All device and interface configuration data (such as maximum frequency and module identification) are stored on the device.

The iNAND module provides up to 4 GB of memory using SanDisk Flash memory chips, which were designed by SanDisk especially for use in mass storage applications. In addition to the mass-storage-specific flash memory chip, the iNAND module includes an intelligent controller, which manages interface protocols, data storage and retrieval, error correction code (ECC) algorithms, defect handling and diagnostics, power management, wear leveling, and clock control. Figure 1-1 is a block diagram of the SanDisk iNAND module with SD Interface.

Figure 1-1 SanDisk iNAND Block Diagram



1.2 Features

The SanDisk iNAND Module features include:

- ▶ **Up to 4 GB of data storage**
- ▶ **SD-protocol compatible**
- ▶ **Supports SPI mode**
- ▶ **Designed for portable and stationary applications needing high performance, reliable data storage**
- ▶ **Voltage range 2.7 to 3.6V**
- ▶ **Variable clock rate 0-25 MHz**
- ▶ **Data transfer rate**
 - Up to 12.5 MB/sec data transfer rate (using 4 parallel data lines)
- ▶ **Correction of memory-field errors**
- ▶ **Built-in write protection features (permanent and temporary)**
- ▶ **Application-specific commands**
- ▶ **Standard footprint across all capacities**

1.3 iNAND Module Standard

SanDisk iNAND devices are fully compatible with the *SD Card Physical Layer System Specification, Version 1.10*. This specification is available from the SD Card Association.

SD Card Association
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www.sdcard.org

1.4 Functional Description

The SanDisk iNAND device contains a high-level, intelligent subsystem as shown in Figure 1-1. This intelligent (microprocessor) subsystem provides many capabilities not found in other types of memory modules. These capabilities include the following.

- Host independence from details of erasing and programming flash memory
- Sophisticated system for managing defects (analogous to systems found in magnetic disk drives)
- Sophisticated system for error recovery including a powerful ECC
- Power management for low-power operation

1.5 Independent Flash Technology

The 512-byte sector size of the SanDisk iNAND Module is the same as that in an IDE magnetic disk drive. To write or read a sector (or multiple sectors), the host computer software simply issues a read or write command to the iNAND Module. This command contains the address. The host software then waits for the command to complete. The host software does not get involved in the details of how the flash memory is erased, programmed or read. This is extremely important as flash devices are expected to get increasingly complex in the future. Because the iNAND Module uses an intelligent on-board controller, the host system software will not require changing as new flash memory evolves. In other words, systems that support iNAND technology today will be able to access future iNAND devices built with new flash technology without having to update or change host software.

1.6 Defect and Error Management

SanDisk iNAND modules contain a sophisticated defect-and-error management system. This system is analogous to the systems found in magnetic disk drives and in many cases offers enhancements. For instance, disk drives do not typically perform a read after write to confirm the data is written correctly because of the performance penalty that would be incurred. iNAND modules do a read after write under margin conditions to verify that the data is written correctly. In the rare case that a bit is found to be defective, the module replaces this bad bit with a spare bit within the sector header. If necessary, iNAND devices will even replace the entire sector with a spare sector. This is completely transparent to the host and does not consume any user data space.

The iNAND Module's soft-error-rate specification is much better than the magnetic disk drive specification. In the extremely rare case a read error does occur, iNAND devices have innovative algorithms to recover the data. This is similar to using retries on a disk drive but is much more sophisticated. The last line of defense is to employ a powerful ECC to correct the data. If ECC is used to recover data, defective bits are replaced with spare bits to ensure they do not cause any future problems. These defect and error management systems coupled with the solid-state construction give iNAND devices unparalleled reliability.

1.7 Wear Leveling

Wear leveling is an intrinsic part of the erase pooling functionality of the iNAND Module, using NAND memory. The Wear Level command is supported as a NOP operation to maintain backward compatibility with existing software utilities.

1.8 Automatic Sleep Mode

A unique feature of the SanDisk iNAND Module is automatic entrance and exit from sleep mode. Upon completion of an operation, the module enters the sleep mode to conserve power if no further commands are received in less than five milliseconds (ms). The host does not have to take any action for this to occur. However, in order to achieve the lowest sleep current, the host needs to shut down its clock to the module. In most systems, the iNAND Module is in sleep mode except when the host is accessing it, thus conserving power.

When the host is ready to access the device in sleep mode, any command issued to it will cause it to exit sleep, and respond.

2 Product Specifications

2.1 Overview

In this section, all values are defined at an ambient temperature and nominal supply voltage unless otherwise stated.

2.2 System Environmental Specifications

Table 2-1 defines the environmental specifications for the SanDisk iNAND device.

Table 2-1 System Environmental Specifications

Temperature	Operating	-25° C to 85° C
	Non-operating	-40° C to 85° C
Humidity	Operating	8% to 95%, non-condensing
	Non-operating	8% to 95%, non-condensing
ESD Protection		+/- 2kV, Human Body Model
Vibration	Operating	15 G peak-to-peak max.
	Non-operating	15 G peak-to-peak max.
Shock	Operating	1,000 G max.
	Non-operating	1,000 G max.
Altitude (relative to sea level)	Operating	80,000 feet max.
	Non-operating	80,000 feet max.

2.3 Typical Card Power Requirements

Table 2-2 Card Power Requirements (Ta=25°C@3.0V)

VDD (ripple: max, 60mV peak-to-peak)		2.7 V – 3.6 V	
	Value	Measurement	Average
Sleep	250	uA	Typical
Read	65	mA	Typical
Write	75	mA	Typical

2.4 System Performance

The iNAND Module performance values in Table 2-3 were measured using the following conditions.

- Voltage range 2.7 V to 3.6 V
- Temperature -25° C to 85° C
- Independent of the iNAND Module clock frequency

Table 2-3 System Performance

Timing	Maximum Value
Block Read Access Time	100 ms
Block Write Access Time	250 ms
ACMD1 to Ready after Power-up	1000 ms

2.5 System Reliability and Maintenance

Table 2-4 Reliability and Maintenance Specifications

MTBF	>1,000,000 hours
Preventative Maintenance	None
Data Reliability	<1 non-recoverable error in 10 ¹⁴ bits read

2.6 Physical Specifications

The SanDisk iNAND Module is a 56-pin, thin fine-pitched ball grid array (BGA). See Figure 2-1 (56-pin) for physical specifications and dimensions. See Figure 2-2 for a top view of the pin definitions.

Figure 2-1 iNAND Module Specifications (18 x 12mm Package)

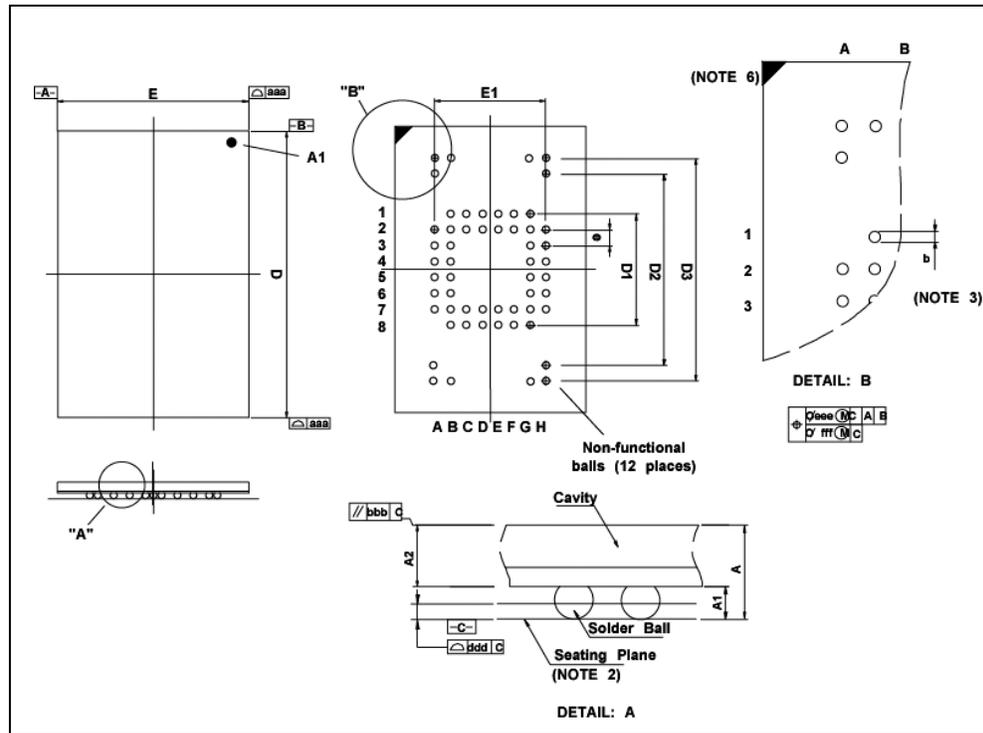


Table 2-5 iNAND Package Specifications (18 x 12mm Package)

Symbol	Dimension in millimeters			Dimension in inches		
	Minimum	Nominal	Maximum	Minimum	Nominal	Maximum
A	---	---	1.20 or 1.40	---	---	0.047
A1	0.30	0.35	0.38	0.012	0.014	0.015
A2	0.69	0.74	0.79	0.027	0.029	0.031
D	17.90	18.00	18.10	0.705	0.709	0.713
E	11.90	12.00	12.10	0.469	0.472	0.476
D1	---	7.00	---	---	0.276	---
D2	---	11.00	---	---	0.433	---
D3	---	13.00	---	---	0.512	---
E1	---	7.00	---	---	0.276	---
e	---	1.00	---	---	0.039	---
b	0.45	0.50	0.55	0.018	0.020	0.022
aaa	0.10			0.004		
bbb	0.10			0.004		
ddd	0.15			0.006		
eee	0.25			0.010		
fff	0.10			0.004		
MD/ME	12/11			12/11		

3 iNAND Module Interface Description

3.1 General Description of Pins

Table 3-1 contains the SanDisk iNAND Module functional ball assignment.

Table 3-1 iNAND Module Ball Assignment

Pin No.	Name	Type ¹	Description	Comment
SD Bus Mode				
H6, F1, C1, A2, A6	VDD	S	Supply Voltage	
H7, H2, D1, B1, A7	VSS	S	Supply Voltage Ground	
G2	DAT0	I/O	Data Line [Bit 0]	
G3	DAT1	I/O	Data Line [Bit 1]	
G6	DAT2	I/O	Data Line [Bit 2]	
G5	DAT3	I/O	Data Line [Bit 3]	
G1	CLK	I	Clock	
G4	CMD	I/O	Command/Response	
B5	WPB	I	Defines I/F	Connect to VDD
G7	RSTB	I	Defines I/F	Connect to VDD
B2	RDY/BSY		NC	
B3	SEL_A	I	Defines I/F	Connect to VDD
B4	SEL_B	I	Defines I/F	Connect to VDD
G8	VCORE	--	Power supply filter capacitor	
SPI Mode				
H6, F1, C1, A2, A6	VDD	S	Supply Voltage	
H7, H2, D1, B1, A7	VSS	S	Supply Voltage Ground	
G2	DataOut	I/O	Device to Host Data and Status	
G3	DAT1	I/O	Unused	Pull up to VDD
G6	DAT2	I/O	Unused	Pull up to VDD
G5	CS	I	Chip Select (Active low)	
G1	CLK	I	Clock	
G4	DataIn	I	Host to Device Commands and Data	

¹ Type Key: S=power supply; I=input; O=output using push-pull drivers; PP=I/O using push-pull drivers

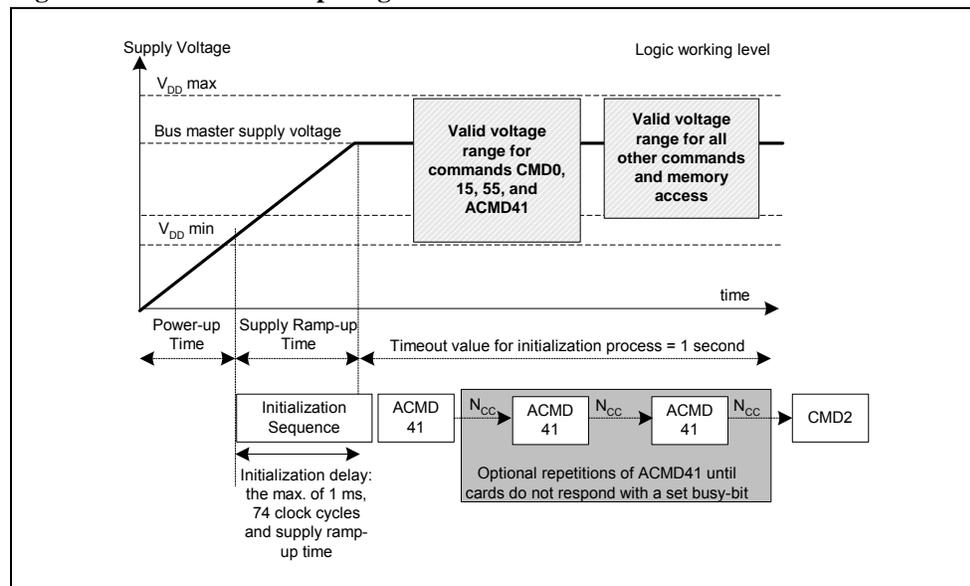
Pin No.	Name	Type ¹	Description	Comment
B5	WPB	I	Write Protect (Active low)	Connect to VDD
G7	RSTB	I	Reset (Active low)	Connect to VDD
B2	RDY/BSY		NC	
B3	SEL_A	I	Defines I/F	Connect to VDD
B4	SEL_B	I	Defines I/F	Connect to VDD
G8	VCORE	--	Power supply capacitor	

3.2 Electrical Characteristics

3.2.1 Power-up

The power-up of the iNAND Module bus is handled locally in each and in the bus master.

Figure 3-1 Power-up Diagram



After power up, including hot insertion (i.e., inserting a module when the bus is operating) the iNAND Module enters the idle state. During this state the iNAND Module ignores all bus transactions until ACMD41 is received (ACMD command type shall always precede with CMD55).

ACMD41 is a special synchronization command used to negotiate the operation voltage range and to poll the modules until they are out of their power-up sequence. Besides the operation voltage profile of the modules, the response to ACMD41 contains a busy flag, indicating that the module is still working on its power-up procedure and is not ready for identification. This bit informs the host that the module is not ready. The host has to wait (and continue to poll the modules, each one on his turn) until this bit is cleared. The maximum period of power up procedure of single module shall not exceed one second.

Getting individual modules, and the entire iNAND system, out of idle state is up to the responsibility of the bus master. Since the power up time and the supply ramp-up-time depend on application parameters such as the maximum number of modules, bus length and power supply unit, the host must ensure that the power is built-up to the operating level (the same level which will be specified in ACMD41) before ACMD41 is transmitted.

After power up, the host starts the clock and sends the initializing sequence on the CMD line. This sequence is a contiguous stream of logical “1”s. The sequence length is the maximum of 1-msec, 74 clocks or the supply ramp-up-time; the additional 10 clocks (over the 64 clocks after what the module should be ready for communication) are provided to eliminate power-up synchronization problems.

3.2.2 Bus Operating Conditions

SPI Mode bus operating conditions are identical to iNAND mode bus operating conditions. Table 3-3 lists the power supply voltages. The CS (chip select) signal timing is identical to the input signal timing.

Table 3-3 Bus Operating Conditions Summary

Parameter	Symbol	Min	Max	Unit	Remark
General					
Peak voltage on all lines	---	-0.3	$V_{DD} + 0.3$	V	
All Inputs					
Input leakage current	---	-10	10	uA	
All Outputs					
Output leakage current	---	-10	10	uA	
Power Supply Voltage					
Supply voltage	V_{DD}	2.7	3.6	V	
Supply voltage differentials (V_{SS1}, V_{SS2})	---	-0.3	0.3	V	
Power-up time	---	---	250	mS	From 0 V to V_{DD} min.

3.2.3 Bus Signal Line Load

The total capacitance, C_L , of the clock line in the iNAND bus is the sum of the bus-master capacitance (C_{HOST}), the bus capacitance (C_{BUS}) itself and the capacitance (C_{CARD}) of each module connected to this line:

$$C_L = C_{HOST} + C_{BUS} + N * C_{CARD}$$

where N is the number of connected modules.

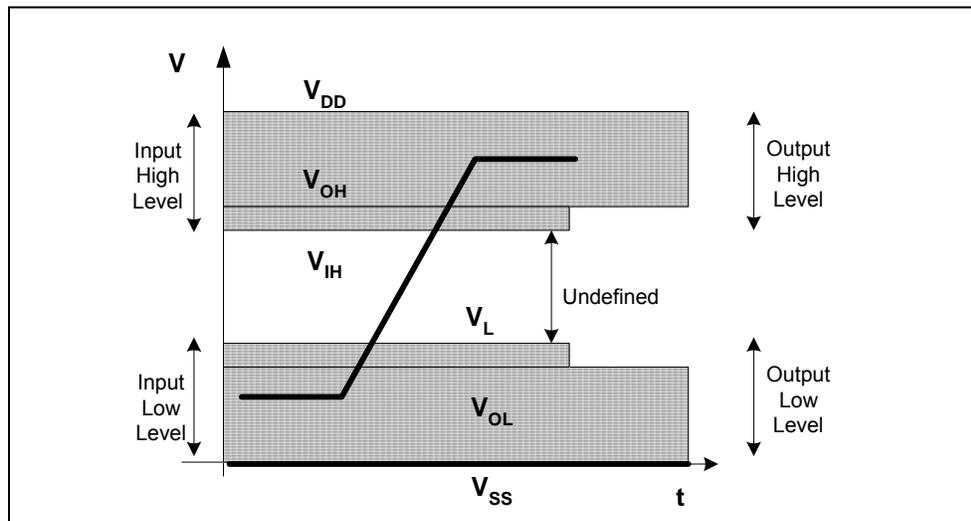
Requiring the sum of the host and bus capacitances not to exceed 30 pF for up to 10 modules, and 40 pF for up to 30 modules, Table 3-4 values must not be exceeded.

Table 3-4 Host and Bus Capacities

Parameter	Symbol	Min.	Max.	Unit	Remark
Pull-up resistance	R_{CMD} , R_{DAT}	10	100	k Ω	Prevents bus floating
Bus signal line capacitance	C_L	---	250	pF	$f_{PP} \leq 5$ MHz, 21
Bus signal line capacitance	C_L	---	100	pF	$f_{PP} \leq 20$ MHz, 7 modules
Signal module capacitance	C_{CARD}	---	10	pF	
Max. signal line inductance	---	---	16	nH	$f_{PP} \leq 20$ MHz
Pull-up resistance inside module (pin 1)	R_{DAT3}	10	90	k Ω	

3.2.4 Bus Signal Levels

All signal levels are related to the supply voltage because the bus can have a variable supply voltage.

Figure 3-2 Bus Signal Levels

To meet the requirements of the JEDEC specification JESD8-1A, the module input and output voltages are within the specified ranges in Table 3-5 for any V_{DD} of the allowed voltage range.

Table 3-5 Input/Output Voltage

Parameter	Symbol	Min.	Max.	Unit	Conditions
Output high voltage	V_{OH}	$0.75 \cdot V_{DD}$	---	V	$I_{OH} = -100 \mu A @ V_{DD}$ (minimum)
Output low voltage	V_{OL}	---	$0.125 \cdot V_{DD}$	V	$I_{OL} = 100 \mu A @ V_{DD}$ (minimum)
Input high voltage	V_{IH}	$0.625 \cdot V_{DD}$	$V_{DD} + 0.3$	V	---
Input low voltage	V_{IL}	$V_{SS} - 0.3$	$0.25 \cdot V_{DD}$	V	---

3.2.5 Bus Timing

The dataIn/dataOut timing is illustrated in Figure 3-3; bus timing parameter values are shown in Table 3-6.

Figure 3-3 Data In/Out Referenced to Clock Timing

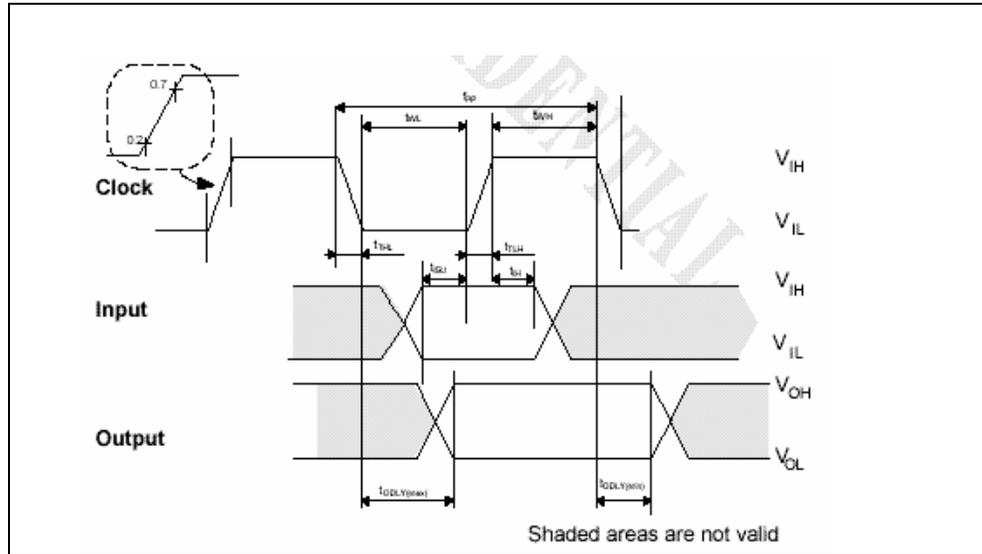


Table 3-6 Bus Timing Parameter Values

Parameter	Symbol	Min	Max	Unit	Remark
Clock (CLK) – all values referred to min. V_{IH} and max. V_{IL}					
Clock Freq. Data Transfer Mode	f_{PP}	0	25	MHz	$C_L \leq 100$ pF (7 modules)
Clock Freq. ID Mode	f_{OD}	0/100	400	kHz	$C_L \leq 250$ pF (21 modules)
Clock Low Time	t_{WL}	10	---	ns	$C_L \leq 100$ pF (7 modules)
Clock High Time	t_{WH}	10	---	ns	$C_L \leq 100$ pF (7 modules)
Clock Rise Time	t_{TLH}	---	10	ns	$C_L \leq 100$ pF (10 modules)
Clock Fall Time	t_{THL}	---	10	ns	$C_L \leq 100$ pF (7 modules)
Clock Low Time	t_{WL}	50	---	ns	$C_L \leq 250$ pF (21 modules)
Clock High Time	t_{WH}	50	---	ns	$C_L \leq 250$ pF (21 modules)
Clock Rise Time	t_{TLH}	---	50	ns	$C_L \leq 250$ pF (21 modules)
Clock Fall Time	t_{THL}	---	50	ns	$C_L \leq 250$ pF (21 modules)
Inputs CMD, DAT – referenced to CLK					
Input setup time	t_{ISU}	5	---	ns	$C_L \leq 25$ pF (1 module)
Input hold time	t_{IH}	5	---	ns	$C_L \leq 25$ pF (1 module)
Outputs CMD, DAT – referenced to CLK					
Output delay time during Data Transfer mode	t_{OSU}	0	14	ns	$C_L \leq 25$ pF (1 module)

Parameter	Symbol	Min	Max	Unit	Remark
Clock (CLK) – all values referred to min. V_{IH} and max. V_{IL}					
Output delay time during Identification mode	t_{ODLY}	0	50	ns	$C_L \leq 25$ pF (1 module)

3.3 Data Interchange Format and Module Sizes

In general, a file system will form the structure for iNAND Module data. The SD Card File System Specification, published by the SD Association, describes the file format system that is implemented in the SanDisk iNAND Module.

Table 3-7 User Area DOS Image Parameters

Capacity*	Total LBAs	Number of Partition System Area Sectors	Total Partition Sectors	User Data Sectors	User Data Bytes
256 MB	501,632	157	501,149	500,992	256,507,904
512 MB	1,003,264	279	1,002,727	1,002,448	513,253,376
1 GB	2,006,528	523	2,005,675	2,005,152	1,026,637,824
2 GB	4,013,056	523	4,011,595	4,011,072	2,053,668,864
4 GB	8,027,136	8192	8,018,944	8,012,708	4,102,506,496

* 1 megabyte (MB)= 1 million bytes; 1 gigabyte (GB)= 1 billion bytes. Some of the listed capacity is used for formatting and other functions, and thus is not available for data storage.

Appendix A Ordering Information

A.1 iNAND Module

To order SanDisk products directly from SanDisk, call (408) 542-0595.

Part Number	Block Size¹
SDINB1-256	256 MB
SDINB1-512	512 MB
SDINB1-1024	1024 MB
SDINB1-2048	2048 MB
SDINB1-4096	4096 MB

¹ 1 megabyte (MB)= 1 million bytes; 1 gigabyte (GB)= 1 billion bytes. Some of the listed capacity is used for formatting and other functions, and thus is not available for data storage.

Appendix B SanDisk Worldwide Sales Offices

To order SanDisk products directly from SanDisk, call (408) 542-0595.

SanDisk Corporate Headquarters

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Sunnyvale, CA 94089
Tel: 408-542-0500
Fax: 408-542-0503
<http://www.sandisk.com>

U.S. OEM Sales Offices

Southwest/Northwest USA & Mexico

140 Caspian Court
Sunnyvale, CA 94089
Tel: 408-542-0730
Fax: 408-542-0410

North Central USA/South America

134 Cherry Creek Circle, Suite 150
Winter Springs, FL 32708
Tel: 407-366-6490
Fax: 407-366-5945

Northeastern USA/Canada

620 Herndon Pkwy. Suite 200
Herndon, VA 22070
Tel: 703-481-9828
Fax: 703-437-9215

International OEM Sales Offices

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Karlsruher Str. 2C
D-30519 Hannover, Germany
Tel: 49-511-875-9131
Fax: 49-511-875-9187

Northern/Central/Southern Europe

Rudolf-Diesel-Str. 3
40822 Mettmann, Germany
Tel: 49-210-495-3433
Fax: 49-210-495-3434

Japan

8F Nisso Bldg. 15
2-17-19 Shin-Yokohama,
Kohoku-ku
Yokohama 222-0033,
Japan
Tel: 81-45-474-0181
Fax: 81-45-474-0371

Asia/Pacific Rim

Suite 902-903
Bank of East Asia Harbour View Centre
56 Gloucester Road
Wanchai Hong Kong
Tel: 852-2712-0501
Fax: 852-2712-9385

Appendix C Limited Warranty

I. WARRANTY STATEMENT

SanDisk warrants its products to be free of any defects in materials or workmanship that would prevent them from functioning properly for one year from the date of purchase. This express warranty is extended by SanDisk Corporation.

II. GENERAL PROVISIONS

This warranty sets forth the full extent of SanDisk's responsibilities regarding the SanDisk iNAND. In satisfaction of its obligations hereunder, SanDisk, at its sole option, will repair, replace or refund the purchase price of the product.

NOTWITHSTANDING ANYTHING ELSE IN THIS LIMITED WARRANTY OR OTHERWISE, THE EXPRESS WARRANTIES AND OBLIGATIONS OF SELLER AS SET FORTH IN THIS LIMITED WARRANTY, ARE IN LIEU OF, AND BUYER EXPRESSLY WAIVES ALL OTHER OBLIGATIONS, GUARANTIES AND WARRANTIES OF ANY KIND, WHETHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR INFRINGEMENT, TOGETHER WITH ANY LIABILITY OF SELLER UNDER ANY CONTRACT, NEGLIGENCE, STRICT LIABILITY OR OTHER LEGAL OR EQUITABLE THEORY FOR LOSS OF USE, REVENUE, OR PROFIT OR OTHER INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING WITHOUT LIMITATION PHYSICAL INJURY OR DEATH, PROPERTY DAMAGE, LOST DATA, OR COSTS OF PROCUREMENT OF SUBSTITUTE GOODS, TECHNOLOGY OR SERVICES. IN NO EVENT SHALL THE SELLER BE LIABLE FOR DAMAGES IN EXCESS OF THE PURCHASE PRICE OF THE PRODUCT, ARISING OUT OF THE USE OR INABILITY TO USE SUCH PRODUCT, TO THE FULL EXTENT SUCH MAY BE DISCLAIMED BY LAW.

SanDisk's products are not warranted to operate without failure. Accordingly, in any use of products in life support systems or other applications where failure could cause injury or loss of life, the products should only be incorporated in systems designed with appropriate redundancy, fault tolerant or back-up features.

III. WHAT THIS WARRANTY COVERS

For products found to be defective within one year of purchase, SanDisk will have the option of repairing or replacing the defective product, if the following conditions are met:

- A. A warranty registration card for each defective product was submitted and is on file at SanDisk. If not, a warranty registration card must accompany each returned defective product. This card is included in each product's original retail package.
- B. The defective product is returned to SanDisk for failure analysis as soon as possible after the failure occurs.
- C. An incident card filled out by the user, explaining the conditions of usage and the nature of the failure, accompanies each returned defective product.
- D. No evidence is found of abuse or operation of products not in accordance with the published specifications, or of exceeding storage or maximum ratings or operating conditions.

All failing products returned to SanDisk under the provisions of this limited warranty shall be tested to the product's functional and performance specifications. Upon confirmation of failure, each product will be analyzed, by whatever means necessary, to determine the root cause of failure. If the

root cause of failure is found to be not covered by the above provisions, then the product will be returned to the customer with a report indicating why the failure was not covered under the warranty.

This warranty does not cover defects, malfunctions, performance failures or damages to the unit resulting from use in other than its normal and customary manner, misuse, accident or neglect; or improper alterations or repairs.

SanDisk reserves the right to repair or replace, at its discretion, any product returned by its customers, even if such product is not covered under warranty, but is under no obligation to do so.

SanDisk may, at its discretion, ship repaired or rebuilt products identified in the same way as new products, provided such cards meet or exceed the same published specifications as new products. Concurrently, SanDisk also reserves the right to market any products, whether new, repaired, or rebuilt, under different specifications and product designations if such products do not meet the original product's specifications.

IV. RECEIVING WARRANTY SERVICE

According to SanDisk's warranty procedure, defective product should be returned only with prior authorization from SanDisk Corporation. Please contact SanDisk's Customer Service department at 408-542-0595 with the following information: product model number and description, serial numbers, nature of defect, conditions of use, proof of purchase and purchase date. If approved, SanDisk will issue a Return Material Authorization or Product Repair Authorization number. Ship the defective product to:

SanDisk Corporation
Attn: RMA Returns
(Reference RMA or PRA #)
140 Caspian Court
Sunnyvale, CA 94089

V. STATE LAW RIGHTS

SOME STATES DO NOT ALLOW THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, OR LIMITATION ON HOW LONG AN IMPLIED WARRANTY LASTS, SO THE ABOVE LIMITATIONS OR EXCLUSIONS MAY NOT APPLY TO YOU. This warranty gives you specific rights and you may also have other rights that vary from state to state.

Appendix D Disclaimer of Liability

D.1 SanDisk Corporation Policy

SanDisk Corporation general policy does not recommend the use of its products in life support applications wherein a failure or malfunction of the product may directly threaten life or injury. Accordingly, in any use of products in life support systems or other applications where failure could cause damage, injury or loss of life, the products should only be incorporated in systems designed with appropriate redundancy, fault tolerant or back-up features.

SanDisk shall not be liable for any loss, injury or damage caused by use of the Products in any of the following applications:

- Special applications such as military related equipment, nuclear reactor control, and aerospace
- Control devices for automotive vehicles, train, ship and traffic equipment
- Safety system for disaster prevention and crime prevention
- Medical-related equipment including medical measurement device