

KFG2G16Q2A KFH4G16Q2A

2Gb OneNAND A-die

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Revision History

Document Title

OneNAND

Revision History

<u>Revision No.</u>	<u>History</u>	<u>Draft Date</u>	<u>Remark</u>
0.0	1. Initial issue.	Jul. 13, 2007	Advanced
0.1	1. Corrected errata. 2. Chapter 3.3.1 Cold Reset Mode Operation revised. 3. Chapter 5.9 AC Characteristics for Load/Program/Erase Performance revised. 4. Chapter 6.18 Cold Reset Timing revised.	Sep. 06, 2007	Preliminary
0.2	1. Corrected errata. 2. Chapter 3.3 Reset Mode Operation revised. 3. Chapter 5.1 AC Test Conditions revised. 4. Chapter 5.9 AC Characteristics for Load/Program/Erase Performance tINTW removed. 5. Chapter 6.13 Program Operation Timing tINTW removed. 6. Chapter 6.17 Block Erase Operation Timing tINTW removed.	Oct. 30, 2007	Preliminary
1.0	1. Corrected errata. 2. Chapter 5.7 AC Characteristics for Asynchronous Write tCH revised.	Dec. 17, 2007	Final
1.1	1. Chapter 1.4 Product Features revised. 2. Chapter 2.8.4 Version ID Register F002h revised. 3. Chapter 2.8.22 Interrupt Status Register F241h (R/W) revised. 4. Chapter 3.4.4 Data Protection Operation Flow Diagram revised. 5. Chapter 3.4.4 All Block Unlock Flow Diagram revised. 6. Chapter 5.7 AC Characteristics for Asynchronous Write revised. 7. Chapter 5.8 AC Characteristics for Burst Write Operation revised.	Mar. 25, 2008	Final
1.11	1. Chapter 2.8.21 : Description of OTP Lock status and 1st block OTP Lock status revised. 2. Chapter 3.6 Load Operation Flow Chart Diagram revised. 3. Chapter 3.8 Cache Read Flow Chart revised. 4. Chapter 3.9.5 Synchronous Burst Block Read Operation Flow Chart revised. 5. Chapter 3.12 Copy-Back Program Operation Flow Chart revised. 6. Chapter 3.12.1 Copy-Back Program Operation with Random Data Input Flow Chart revised. 7. Chapter 3.13.1 Block Erase Operation Flow Chart revised. 8. Chapter 3.13.3 Multi Block Erase/ Multi Block Erase Verify Read Flow Chart revised. 9. Chapter 3.13.4 Erase Suspend and Erase Resume Operation Flow Chart revised. 10. Chapter 3.14.1 OTP Block Read Operation Flow Chart revised. 11. Chapter 3.14.2 OTP Block Program Operation Flow Chart revised. 12. Chapter 3.14.3 OTP Block Lock Operation Flow Chart revised. 13. Chapter 3.14.4 1st Block OTP Lock Operation Flow Chart revised. 14. Chapter 3.14.5 OTP and 1st Block OTP Lock Operation Flow Chart revised.	Apr. 07, 2008	Final
1.2	1. Chapter 3.4.3.1 Unlocked NAND Array Write Protection State revised. 2. Chapter 3.4.3.3 Locked-tight NAND Array Write Protection State revised. 3. Chapter 3.4.4 All Block Unlock Flow Diagram revised. 4. Chapter 7.1.3 Determining Rp value revised.	Dec. 09, 2008	Final

<u>Revision No.</u>	<u>History</u>	<u>Draft Date</u>	<u>Remark</u>
1.3	1. Corrected errata. 2. Chapter 2.8.18 Command Register F220h(R/W) revised. 3. Chpater 3.4.3 NAND Array Write Protection States revised. 4. Chapter 3.4.3.3 Locked-tight NAND Array Write Protection State revised.	Dec. 16, 2008	Final

1.0 INTRODUCTION

This specification contains information about the Samsung Electronics Company OneNAND™, Flash memory product family. Section 1.0 includes a general overview, revision history, and product ordering information.

Section 2.0 describes the OneNAND device. Section 3.0 provides information about device operation. Electrical specifications and timing waveforms are in Sections 4.0 through 6.0. Section 7.0 provides additional application and technical notes pertaining to use of the OneNAND. Package dimensions are found in Section 8.0.

Density	Part No.	Vcc(core & IO)	Temperature	PKG
2Gb	KFG2G16Q2A-DEBx	1.8V(1.7V~1.95V)	Extended	63FBGA(LF)
4Gb	KFH4G16Q2A-DEBx	1.8V(1.7V~1.95V)	Extended	63FBGA(LF)

1.1 Flash Product Type Selector

Samsung offers a variety of Flash solutions including NAND Flash, OneNAND™ and NOR Flash. Samsung offers Flash products both component and a variety of card formats including RS-MMC, MMC, CompactFlash, and SmartMedia.

To determine which Samsung Flash product solution is best for your application, refer the product selector chart.

Application Requires	Samsung Flash Products		
	NAND	OneNAND™	NOR
Fast Random Read			•
Fast Sequential Read	•	•	
Fast Write/Program	•	•	
Multi Block Erase		• (Max 64 Blocks)	•
Erase Suspend/Resume		•	•
Copyback	• (EDC)	• (ECC)	
Lock/Unlock/Lock-Tight		•	•
ECC	External (Hardware/Software)	Internal	X
Scalability	•	•	

Part Number Breakdown:

- KF**: Samsung OneNAND Memory
- 16**: Density
 - 2G : 2Gb
 - 4G : 4Gb
- Q**: Operating Voltage Range
 - Q : 1.8V(1.7 V to 1.95V)
- 2**: Page Architecture
 - 2 : 2KB Page
- A**: Version
 - A : 2nd Generation
- : Separator
- D**: Package
 - D : FBGA(Lead Free)
- E**: Operating Temperature Range
 - E : Extended Temp. (-30 °C to 85 °C)
- x**: Product Line designator
 - B : Include Bad Block
 - D : Daisy Sample
- x**: Speed
 - 6 : 66MHz
 - 8 : 83MHz

1.4 Product Features

Device Architecture

- Design Technology: A die
- Supply Voltage: 1.8V (1.7V ~ 1.95V)
- Host Interface: 16 bit
- 5KB Internal BufferRAM: 1KB BootRAM, 4KB DataRAM
- SLC NAND Array: (2K+64)B Page Size, (128K+4K)B Block Size

Device Performance

- Host Interface Type:
 - Synchronous Burst Read
 - Up to 66MHz / 83MHz clock frequency
 - Linear Burst 4-, 8-, 16-, 32-words with wrap around
 - Continuous 1K words Sequential Burst
 - Synchronous Burst Block Read
 - Up to 66MHz / 83MHz clock frequency
 - Linear Burst 4-, 8-, 16-, 32-, 1K-words with no-wrap
 - Continuous (1K words) 64 Page Sequential Burst
 - Synchronous Write
 - Up to 66MHz / 83MHz clock frequency
 - Linear Burst 4-, 8-, 16-, 32-, 1K-words with wrap around
 - Continuous 1K words Sequential Burst
 - Asynchronous Random Read
 - 76ns access time
 - Asynchronous Random Write
 - Latency 3,4(Default),5,6 and 7.
 - 1~40MHz : Latency 3 available
 - 1~66MHz : Latency 4,5,6 and 7 available
 - Over 66MHz : Latency 6,7 available.
 - Up to 4 sectors using Sector Count Register
 - Cold/Warm/Hot/NAND Flash Core Reset
 - up to 64 Blocks
 - Typical Power,
 - Standby current : 10uA (Single)
 - Synchronous Burst Read current(66MHz/83MHz, single) : 20/25mA
 - Synchronous Burst Write current(66MHz/83MHz, single) : 20/25mA
 - Load current : 30mA
 - Program current : 25mA
 - Erase current : 20mA
 - Multi Block Erase current : 20mA
 - Data retention 10year after 10K Program/Erase Cycles
 - Data retention 1 year after 100K Program/Erase Cycles
- Programmable Burst Read Latency:
- Multiple Sector Read/Write:
- Multiple Reset Modes:
- Multi Block Erase:
- Low Power Dissipation:
- Reliability

System Hardware

- Voltage detector generating internal reset signal from Vcc
- Hardware reset input ($\overline{RP}$)
- Data Protection Modes
 - Write Protection for BootRAM
 - Write Protection for NAND Flash Array
 - Write Protection during power-up
 - Write Protection during power-down
 - 1st block OTP
- User-controlled One Time Programmable(OTP) area
- Internal 2bit EDC / 1bit ECC
- Internal Bootloader supports Booting Solution in system
- Handshaking Feature
 - INT pin indicates Ready / Busy
 - Polling the interrupt register status bit
 - by ID register
- Detailed chip information

Packaging

- 2G products 63ball, 10mm x 13mm x max 1.0mm t , 0.8mm ball pitch FBGA
- 4G DDP products 63ball, 10mm x 13mm x max 1.2mm t , 0.8mm ball pitch FBGA

1.5 General Overview

OneNAND™, is a monolithic integrated circuit with a NAND Flash array using a NOR Flash interface. This device includes control logic, a NAND Flash array, and 5KB of internal BufferRAM. The BufferRAM reserves 1KB for boot code buffering (BootRAM) and 4KB for data buffering (DataRAM), split between 2 independent buffers. It has a x16 Host Interface and a random access time speed of ~76ns.

The device operates up to a maximum host-driven clock frequency of 66MHz / 83MHz for synchronous reads at Vcc(or Vccq. Refer to chapter 4.2) with minimum 6-clock latency. Below 40MHz it is accessible with minimum 3-clock latency. Appropriate wait cycles are determined by programmable read latency.

OneNAND provides for multiple sector read operations by assigning the number of sectors to be read in the sector counter register. The device includes one block-sized OTP (One Time Programmable) area and user-controlled 1st block OTP(Block 0) that can be used to increase system security or to provide identification capabilities.

The attached datasheets are prepared and approved by SAMSUNG Electronics. SAMSUNG Electronics CO., LTD. reserve the right to change the specifications. SAMSUNG Electronics will evaluate and reply to your requests and questions about device. If you have any questions, please contact the SAMSUNG branch office near you.

2.0 DEVICE DESCRIPTION

2.1 Detailed Product Description

The OneNAND is an advanced generation, high-performance NAND-based Flash memory.

It integrates on-chip a single-level-cell (SLC) NAND Flash Array memory with two independent data buffers, boot RAM buffer, a page buffer for the Flash array, and a one-time-programmable block.

The combination of these memory areas enable high-speed pipelining of reads from host, BufferRAM, Page Buffer, and NAND Flash Array.

Clock speeds up to 66MHz / 83MHz with a x16 wide I/O yields a 108MByte/second bandwidth.

The OneNAND also includes a Boot RAM and boot loader. This enables the device to efficiently load boot code at device startup from the NAND Array without the need for off-chip boot device.

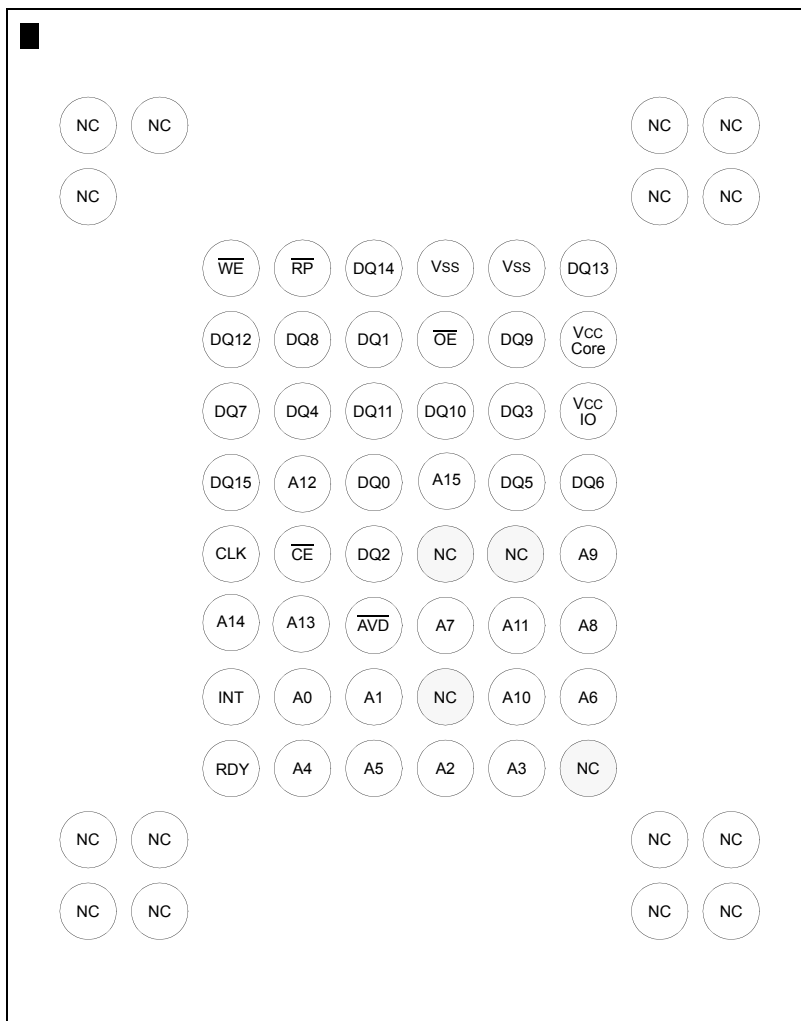
One block of the NAND Array is set aside as an OTP memory area, and 1st Block (Block 0) can be used as OTP area. This area, available to the user, can be configured and locked with secured user information.

On-chip controller interfaces enable the device to operate in systems without NAND Host controllers.

2.2 Definitions

B (capital letter)	Byte, 8bits
W (capital letter)	Word, 16bits
b (lower-case letter)	Bit
ECC	Error Correction Code
Calculated ECC	ECC that has been calculated during a load or program access
Written ECC	ECC that has been stored as data in the NAND Flash array or in the BufferRAM
BufferRAM	On-chip internal buffer consisting of BootRAM and DataRAM
BootRAM	A 1KB portion of the BufferRAM reserved for Boot Code buffering
DataRAM	A 4KB portion of the BufferRAM reserved for Data buffering
Sector	Part of a Page of which 512B is the main data area and 16B is the spare data area. It is also the minimum Load/Program/Copy-Back Program unit during a 1~4 sector operation is available.
Data unit	Possible data unit to be read from memory to BufferRAM or to be programmed to memory. - 528B of which 512B is in main area and 16B in spare area - 1056B of which 1024B is in main area and 32B in spare area - 1584B of which 1536B is in main area and 48B in spare area - 2112B of which 2048B is in main area and 64B in spare area

2.3.2 4Gb Product (KFH4G16Q2A)



(TOP VIEW, Balls Facing Down)
63ball FBGA OneNAND Chip
63ball, 10mm x 13mm x max 1.2mm, 0.8mm ball pitch FBGA

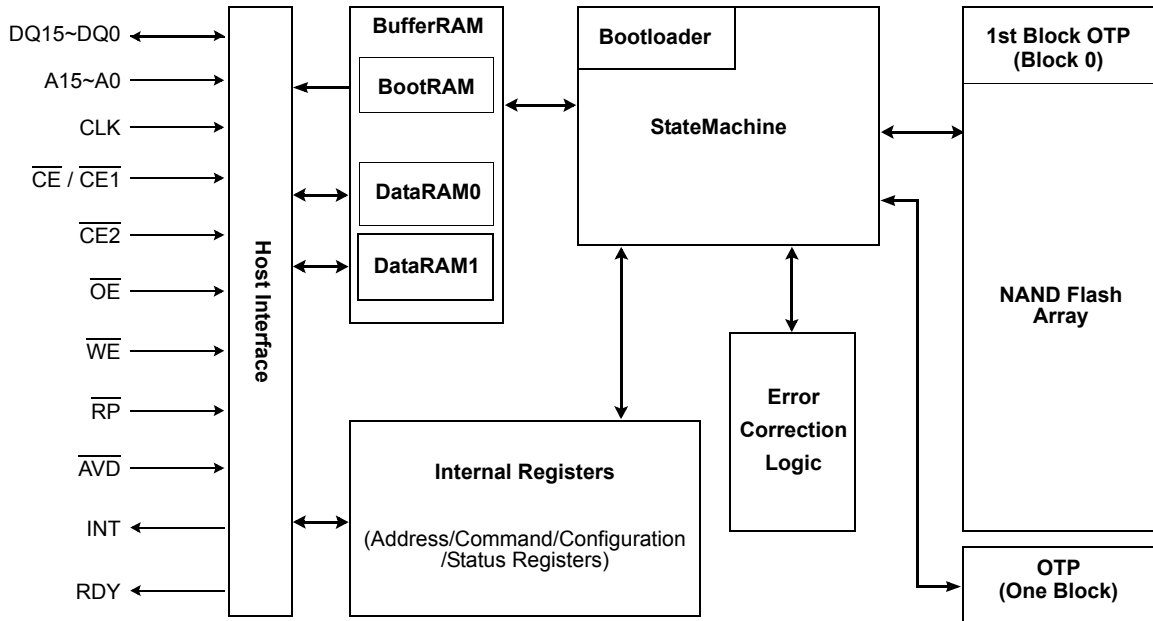
2.4 Pin Description

Pin Name	Type	Name and Description
Host Interface		
A15~A0	I	Address Inputs - Inputs for addresses during read and write operation, which are for addressing BufferRAM & Register.
DQ15~DQ0	I/O	Data Inputs/Outputs - Inputs data during program and commands for all operations, outputs data during memory array/register read cycles. Data pins float to high-impedance when the chip is deselected or outputs are disabled.
INT	O	Interrupt Notifies the Host when a command is completed. After power-up, it is at hi-z condition. Once IOBE is set to 1, it does not float to hi-z condition even when CE is disabled or OE is disabled.
RDY	O	Ready Indicates data valid in synchronous read modes and is activated while $\overline{CE}$ is low
CLK	I	Clock CLK synchronizes the device to the system bus frequency in synchronous read mode. The first rising edge of CLK in conjunction with $\overline{AVD}$ low latches address input.
$\overline{WE}$	I	Write Enable $\overline{WE}$ controls writes to the bufferRAM and registers. Data is latched on the $\overline{WE}$ pulse's rising edge
$\overline{AVD}$	I	Address Valid Detect Indicates valid address presence on address inputs. During asynchronous read operation, all addresses are valid while $\overline{AVD}$ is low, and during synchronous read operation, all addresses are latched on CLK's rising edge while $\overline{AVD}$ is held low for one clock cycle. > Low : for asynchronous mode, indicates valid address; for burst mode, causes starting address to be latched on rising edge on CLK > High : device ignores address inputs
$\overline{RP}$	I	Reset Pin When low, $\overline{RP}$ resets internal operation of OneNAND. $\overline{RP}$ status is don't care during power-up and bootloading. When high, $\overline{RP}$ level must be equivalent to Vcc-IO / Vccq level.
$\overline{CE}$	I	Chip Enable $\overline{CE}$ -low activates internal control logic, and $\overline{CE}$ -high deselects the device, places it in standby state, and places DQ in Hi-Z.
$\overline{OE}$	I	Output Enable $\overline{OE}$ -low enables the device's output data buffers during a read cycle.
Power Supply		
VCC-Core / Vcc		Power for OneNAND Core This is the power supply for OneNAND Core.
VCC-IO / Vccq		Power for OneNAND I/O This is the power supply for OneNAND I/O Vcc-IO / Vccq is internally separated from Vcc-Core / Vcc.
VSS		Ground for OneNAND
etc.		
DNU		Do Not Use Leave it disconnected. These pins are used for testing.
NC		No Connection Lead is not internally connected.

NOTE :

Do not leave power supply(Vcc-Core/Vcc-IO, VSS) disconnected.

2.5 Block Diagram



2.6 Memory Array Organization

The OneNAND architecture integrates several memory areas on a single chip.

2.6.1 Internal (NAND Array) Memory Organization

The on-chip internal memory is a single-level-cell (SLC) NAND array used for data storage and code. The internal memory is divided into a main area and a spare area.

Main Area

The main area is the primary memory array. This main area is divided into Blocks of 64 Pages. Within a Block, each Page is 2KB and is comprised of 4 Sectors. Within a Page, each Sector is 512B and is comprised of 256 Words.

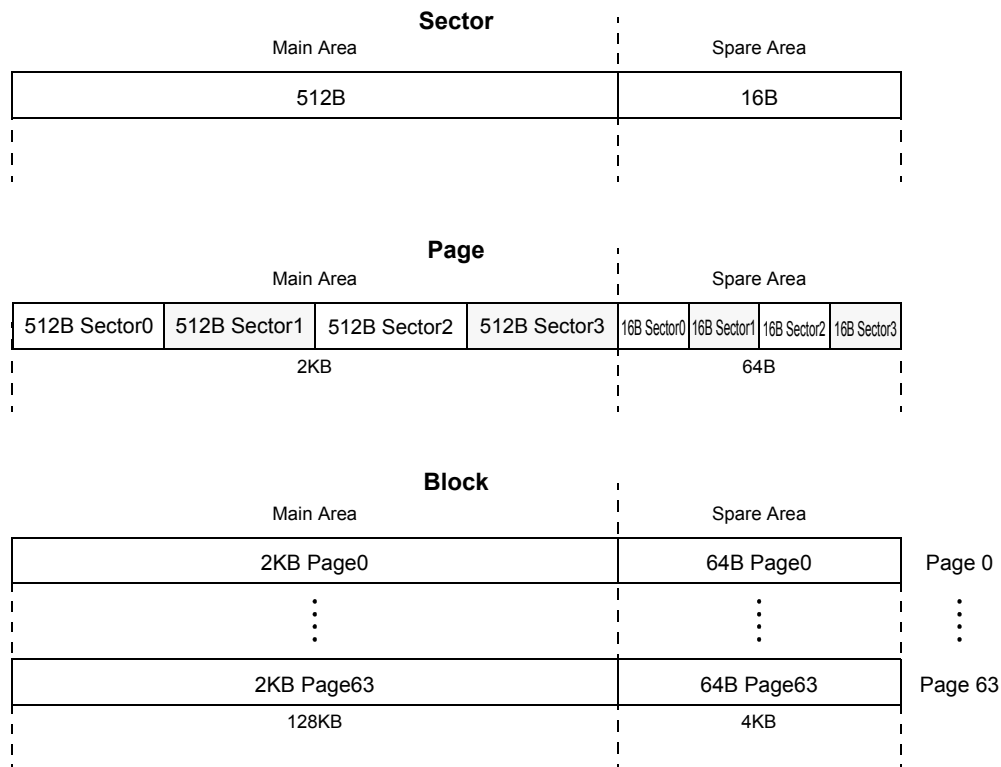
Spare Area

The spare area is used for invalid block information and ECC storage. Spare area internal memory is associated with corresponding main area memory. Within a Block, each Page has four 16B Sectors of spare area. Each spare area Sector is 8 words.

Internal Memory Array Information

Area	Block	Page	Sector
Main	128KB	2KB	512B
Spare	4KB	64B	16B

Internal Memory Array Organization

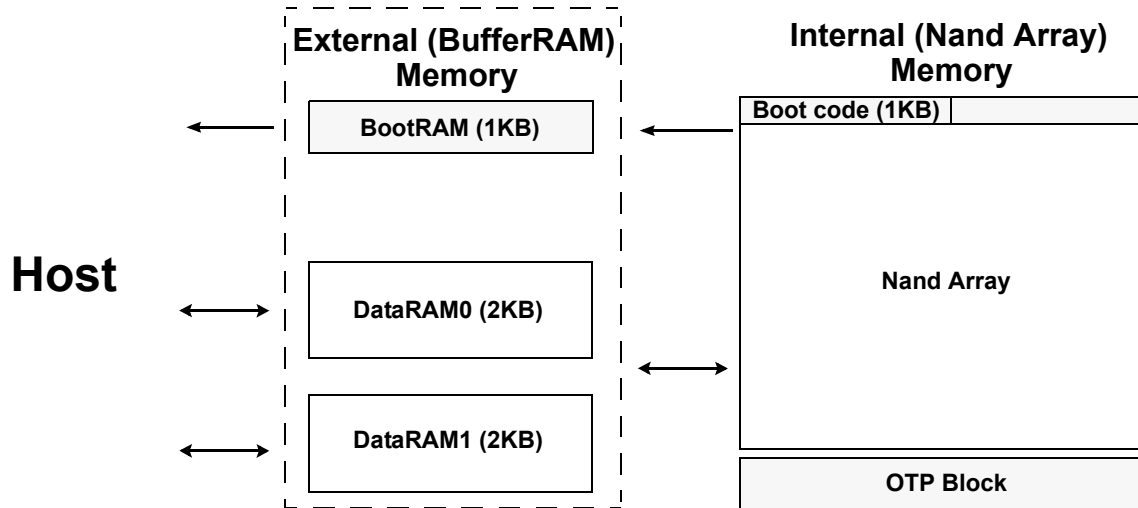


2.6.2 External (BufferRAM) Memory Organization

The on-chip external memory is comprised of 3 buffers used for Boot Code storage and data buffering.

The BootRAM is a 1KB buffer that receives Boot Code from the internal memory and makes it available to the host at start up.

There are two independent 2KB bi-directional data buffers, DataRAM0 and DataRAM1. These dual buffers enable the host to execute simultaneous Read-While load, and Write-While-program operations after Boot Up. During Boot Up, the BootRam is used by the host to initialize the main memory, and deliver boot code from NAND Flash core to host.

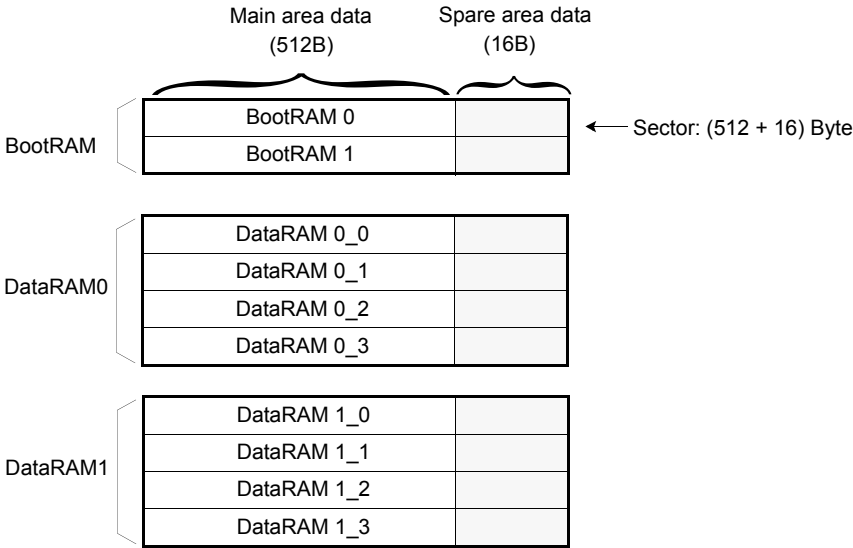


The external memory is divided into a main area and a spare area. Each buffer is the equivalent size of a Sector. The main area data is 512B. The spare area data is 16B.

External Memory Array Information

Area		BootRAM	DataRAM0	DataRAM1
Total Size		1KB+32B	2KB+64B	2KB+64B
Number of Sectors		2	4	4
Sector	Main	512B	512B	512B
	Spare	16B	16B	16B

External Memory Array Organization



2.7 Memory Map

The following tables are the memory maps for the OneNAND.

2.7.1 Internal (NAND Array) Memory Organization

The following tables show the Internal Memory address map in word order.

Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block0	0000h	0000h~00FFh	128KB	Block32	0020h	0000h~00FFh	128KB
Block1	0001h	0000h~00FFh	128KB	Block33	0021h	0000h~00FFh	128KB
Block2	0002h	0000h~00FFh	128KB	Block34	0022h	0000h~00FFh	128KB
Block3	0003h	0000h~00FFh	128KB	Block35	0023h	0000h~00FFh	128KB
Block4	0004h	0000h~00FFh	128KB	Block36	0024h	0000h~00FFh	128KB
Block5	0005h	0000h~00FFh	128KB	Block37	0025h	0000h~00FFh	128KB
Block6	0006h	0000h~00FFh	128KB	Block38	0026h	0000h~00FFh	128KB
Block7	0007h	0000h~00FFh	128KB	Block39	0027h	0000h~00FFh	128KB
Block8	0008h	0000h~00FFh	128KB	Block40	0028h	0000h~00FFh	128KB
Block9	0009h	0000h~00FFh	128KB	Block41	0029h	0000h~00FFh	128KB
Block10	000Ah	0000h~00FFh	128KB	Block42	002Ah	0000h~00FFh	128KB
Block11	000Bh	0000h~00FFh	128KB	Block43	002Bh	0000h~00FFh	128KB
Block12	000Ch	0000h~00FFh	128KB	Block44	002Ch	0000h~00FFh	128KB
Block13	000Dh	0000h~00FFh	128KB	Block45	002Dh	0000h~00FFh	128KB
Block14	000Eh	0000h~00FFh	128KB	Block46	002Eh	0000h~00FFh	128KB
Block15	000Fh	0000h~00FFh	128KB	Block47	002Fh	0000h~00FFh	128KB
Block16	0010h	0000h~00FFh	128KB	Block48	0030h	0000h~00FFh	128KB
Block17	0011h	0000h~00FFh	128KB	Block49	0031h	0000h~00FFh	128KB
Block18	0012h	0000h~00FFh	128KB	Block50	0032h	0000h~00FFh	128KB
Block19	0013h	0000h~00FFh	128KB	Block51	0033h	0000h~00FFh	128KB
Block20	0014h	0000h~00FFh	128KB	Block52	0034h	0000h~00FFh	128KB
Block21	0015h	0000h~00FFh	128KB	Block53	0035h	0000h~00FFh	128KB
Block22	0016h	0000h~00FFh	128KB	Block54	0036h	0000h~00FFh	128KB
Block23	0017h	0000h~00FFh	128KB	Block55	0037h	0000h~00FFh	128KB
Block24	0018h	0000h~00FFh	128KB	Block56	0038h	0000h~00FFh	128KB
Block25	0019h	0000h~00FFh	128KB	Block57	0039h	0000h~00FFh	128KB
Block26	001Ah	0000h~00FFh	128KB	Block58	003Ah	0000h~00FFh	128KB
Block27	001Bh	0000h~00FFh	128KB	Block59	003Bh	0000h~00FFh	128KB
Block28	001Ch	0000h~00FFh	128KB	Block60	003Ch	0000h~00FFh	128KB
Block29	001Dh	0000h~00FFh	128KB	Block61	003Dh	0000h~00FFh	128KB
Block30	001Eh	0000h~00FFh	128KB	Block62	003Eh	0000h~00FFh	128KB
Block31	001Fh	0000h~00FFh	128KB	Block63	003Fh	0000h~00FFh	128KB

Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block64	0040h	0000h~00FFh	128KB	Block96	0060h	0000h~00FFh	128KB
Block65	0041h	0000h~00FFh	128KB	Block97	0061h	0000h~00FFh	128KB
Block66	0042h	0000h~00FFh	128KB	Block98	0062h	0000h~00FFh	128KB
Block67	0043h	0000h~00FFh	128KB	Block99	0063h	0000h~00FFh	128KB
Block68	0044h	0000h~00FFh	128KB	Block100	0064h	0000h~00FFh	128KB
Block69	0045h	0000h~00FFh	128KB	Block101	0065h	0000h~00FFh	128KB
Block70	0046h	0000h~00FFh	128KB	Block102	0066h	0000h~00FFh	128KB
Block71	0047h	0000h~00FFh	128KB	Block103	0067h	0000h~00FFh	128KB
Block72	0048h	0000h~00FFh	128KB	Block104	0068h	0000h~00FFh	128KB
Block73	0049h	0000h~00FFh	128KB	Block105	0069h	0000h~00FFh	128KB
Block74	004Ah	0000h~00FFh	128KB	Block106	006Ah	0000h~00FFh	128KB
Block75	004Bh	0000h~00FFh	128KB	Block107	006Bh	0000h~00FFh	128KB
Block76	004Ch	0000h~00FFh	128KB	Block108	006Ch	0000h~00FFh	128KB
Block77	004Dh	0000h~00FFh	128KB	Block109	006Dh	0000h~00FFh	128KB
Block78	004Eh	0000h~00FFh	128KB	Block110	006Eh	0000h~00FFh	128KB
Block79	004Fh	0000h~00FFh	128KB	Block111	006Fh	0000h~00FFh	128KB
Block80	0050h	0000h~00FFh	128KB	Block112	0070h	0000h~00FFh	128KB
Block81	0051h	0000h~00FFh	128KB	Block113	0071h	0000h~00FFh	128KB
Block82	0052h	0000h~00FFh	128KB	Block114	0072h	0000h~00FFh	128KB
Block83	0053h	0000h~00FFh	128KB	Block115	0073h	0000h~00FFh	128KB
Block84	0054h	0000h~00FFh	128KB	Block116	0074h	0000h~00FFh	128KB
Block85	0055h	0000h~00FFh	128KB	Block117	0075h	0000h~00FFh	128KB
Block86	0056h	0000h~00FFh	128KB	Block118	0076h	0000h~00FFh	128KB
Block87	0057h	0000h~00FFh	128KB	Block119	0077h	0000h~00FFh	128KB
Block88	0058h	0000h~00FFh	128KB	Block120	0078h	0000h~00FFh	128KB
Block89	0059h	0000h~00FFh	128KB	Block121	0079h	0000h~00FFh	128KB
Block90	005Ah	0000h~00FFh	128KB	Block122	007Ah	0000h~00FFh	128KB
Block91	005Bh	0000h~00FFh	128KB	Block123	007Bh	0000h~00FFh	128KB
Block92	005Ch	0000h~00FFh	128KB	Block124	007Ch	0000h~00FFh	128KB
Block93	005Dh	0000h~00FFh	128KB	Block125	007Dh	0000h~00FFh	128KB
Block94	005Eh	0000h~00FFh	128KB	Block126	007Eh	0000h~00FFh	128KB
Block95	005Fh	0000h~00FFh	128KB	Block127	007Fh	0000h~00FFh	128KB

Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block128	0080h	0000h~00FFh	128KB	Block160	00A0h	0000h~00FFh	128KB
Block129	0081h	0000h~00FFh	128KB	Block161	00A1h	0000h~00FFh	128KB
Block130	0082h	0000h~00FFh	128KB	Block162	00A2h	0000h~00FFh	128KB
Block131	0083h	0000h~00FFh	128KB	Block163	00A3h	0000h~00FFh	128KB
Block132	0084h	0000h~00FFh	128KB	Block164	00A4h	0000h~00FFh	128KB
Block133	0085h	0000h~00FFh	128KB	Block165	00A5h	0000h~00FFh	128KB
Block134	0086h	0000h~00FFh	128KB	Block166	00A6h	0000h~00FFh	128KB
Block135	0087h	0000h~00FFh	128KB	Block167	00A7h	0000h~00FFh	128KB
Block136	0088h	0000h~00FFh	128KB	Block168	00A8h	0000h~00FFh	128KB
Block137	0089h	0000h~00FFh	128KB	Block169	00A9h	0000h~00FFh	128KB
Block138	008Ah	0000h~00FFh	128KB	Block170	00AAh	0000h~00FFh	128KB
Block139	008Bh	0000h~00FFh	128KB	Block171	00ABh	0000h~00FFh	128KB
Block140	008Ch	0000h~00FFh	128KB	Block172	00ACh	0000h~00FFh	128KB
Block141	008Dh	0000h~00FFh	128KB	Block173	00ADh	0000h~00FFh	128KB
Block142	008Eh	0000h~00FFh	128KB	Block174	00AEh	0000h~00FFh	128KB
Block143	008Fh	0000h~00FFh	128KB	Block175	00AFh	0000h~00FFh	128KB
Block144	0090h	0000h~00FFh	128KB	Block176	00B0h	0000h~00FFh	128KB
Block145	0091h	0000h~00FFh	128KB	Block177	00B1h	0000h~00FFh	128KB
Block146	0092h	0000h~00FFh	128KB	Block178	00B2h	0000h~00FFh	128KB
Block147	0093h	0000h~00FFh	128KB	Block179	00B3h	0000h~00FFh	128KB
Block148	0094h	0000h~00FFh	128KB	Block180	00B4h	0000h~00FFh	128KB
Block149	0095h	0000h~00FFh	128KB	Block181	00B5h	0000h~00FFh	128KB
Block150	0096h	0000h~00FFh	128KB	Block182	00B6h	0000h~00FFh	128KB
Block151	0097h	0000h~00FFh	128KB	Block183	00B7h	0000h~00FFh	128KB
Block152	0098h	0000h~00FFh	128KB	Block184	00B8h	0000h~00FFh	128KB
Block153	0099h	0000h~00FFh	128KB	Block185	00B9h	0000h~00FFh	128KB
Block154	009Ah	0000h~00FFh	128KB	Block186	00BAh	0000h~00FFh	128KB
Block155	009Bh	0000h~00FFh	128KB	Block187	00BBh	0000h~00FFh	128KB
Block156	009Ch	0000h~00FFh	128KB	Block188	00BCh	0000h~00FFh	128KB
Block157	009Dh	0000h~00FFh	128KB	Block189	00BDh	0000h~00FFh	128KB
Block158	009Eh	0000h~00FFh	128KB	Block190	00BEh	0000h~00FFh	128KB
Block159	009Fh	0000h~00FFh	128KB	Block191	00BFh	0000h~00FFh	128KB

Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block128	0080h	0000h~00FFh	128KB	Block160	00A0h	0000h~00FFh	128KB
Block129	0081h	0000h~00FFh	128KB	Block161	00A1h	0000h~00FFh	128KB
Block130	0082h	0000h~00FFh	128KB	Block162	00A2h	0000h~00FFh	128KB
Block131	0083h	0000h~00FFh	128KB	Block163	00A3h	0000h~00FFh	128KB
Block132	0084h	0000h~00FFh	128KB	Block164	00A4h	0000h~00FFh	128KB
Block133	0085h	0000h~00FFh	128KB	Block165	00A5h	0000h~00FFh	128KB
Block134	0086h	0000h~00FFh	128KB	Block166	00A6h	0000h~00FFh	128KB
Block135	0087h	0000h~00FFh	128KB	Block167	00A7h	0000h~00FFh	128KB
Block136	0088h	0000h~00FFh	128KB	Block168	00A8h	0000h~00FFh	128KB
Block137	0089h	0000h~00FFh	128KB	Block169	00A9h	0000h~00FFh	128KB
Block138	008Ah	0000h~00FFh	128KB	Block170	00AAh	0000h~00FFh	128KB
Block139	008Bh	0000h~00FFh	128KB	Block171	00ABh	0000h~00FFh	128KB
Block140	008Ch	0000h~00FFh	128KB	Block172	00ACh	0000h~00FFh	128KB
Block141	008Dh	0000h~00FFh	128KB	Block173	00ADh	0000h~00FFh	128KB
Block142	008Eh	0000h~00FFh	128KB	Block174	00AEh	0000h~00FFh	128KB
Block143	008Fh	0000h~00FFh	128KB	Block175	00AFh	0000h~00FFh	128KB
Block144	0090h	0000h~00FFh	128KB	Block176	00B0h	0000h~00FFh	128KB
Block145	0091h	0000h~00FFh	128KB	Block177	00B1h	0000h~00FFh	128KB
Block146	0092h	0000h~00FFh	128KB	Block178	00B2h	0000h~00FFh	128KB
Block147	0093h	0000h~00FFh	128KB	Block179	00B3h	0000h~00FFh	128KB
Block148	0094h	0000h~00FFh	128KB	Block180	00B4h	0000h~00FFh	128KB
Block149	0095h	0000h~00FFh	128KB	Block181	00B5h	0000h~00FFh	128KB
Block150	0096h	0000h~00FFh	128KB	Block182	00B6h	0000h~00FFh	128KB
Block151	0097h	0000h~00FFh	128KB	Block183	00B7h	0000h~00FFh	128KB
Block152	0098h	0000h~00FFh	128KB	Block184	00B8h	0000h~00FFh	128KB
Block153	0099h	0000h~00FFh	128KB	Block185	00B9h	0000h~00FFh	128KB
Block154	009Ah	0000h~00FFh	128KB	Block186	00BAh	0000h~00FFh	128KB
Block155	009Bh	0000h~00FFh	128KB	Block187	00BBh	0000h~00FFh	128KB
Block156	009Ch	0000h~00FFh	128KB	Block188	00BCh	0000h~00FFh	128KB
Block157	009Dh	0000h~00FFh	128KB	Block189	00BDh	0000h~00FFh	128KB
Block158	009Eh	0000h~00FFh	128KB	Block190	00BEh	0000h~00FFh	128KB
Block159	009Fh	0000h~00FFh	128KB	Block191	00BFh	0000h~00FFh	128KB

Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block256	0100h	0000h~00FFh	128KB	Block288	0120h	0000h~00FFh	128KB
Block257	0101h	0000h~00FFh	128KB	Block289	0121h	0000h~00FFh	128KB
Block258	0102h	0000h~00FFh	128KB	Block290	0122h	0000h~00FFh	128KB
Block259	0103h	0000h~00FFh	128KB	Block291	0123h	0000h~00FFh	128KB
Block260	0104h	0000h~00FFh	128KB	Block292	0124h	0000h~00FFh	128KB
Block261	0105h	0000h~00FFh	128KB	Block293	0125h	0000h~00FFh	128KB
Block262	0106h	0000h~00FFh	128KB	Block294	0126h	0000h~00FFh	128KB
Block263	0107h	0000h~00FFh	128KB	Block295	0127h	0000h~00FFh	128KB
Block264	0108h	0000h~00FFh	128KB	Block296	0128h	0000h~00FFh	128KB
Block265	0109h	0000h~00FFh	128KB	Block297	0129h	0000h~00FFh	128KB
Block266	010Ah	0000h~00FFh	128KB	Block298	012Ah	0000h~00FFh	128KB
Block267	010Bh	0000h~00FFh	128KB	Block299	012Bh	0000h~00FFh	128KB
Block268	010Ch	0000h~00FFh	128KB	Block300	012Ch	0000h~00FFh	128KB
Block269	010Dh	0000h~00FFh	128KB	Block301	012Dh	0000h~00FFh	128KB
Block270	010Eh	0000h~00FFh	128KB	Block302	012Eh	0000h~00FFh	128KB
Block271	010Fh	0000h~00FFh	128KB	Block303	012Fh	0000h~00FFh	128KB
Block272	0110h	0000h~00FFh	128KB	Block304	0130h	0000h~00FFh	128KB
Block273	0111h	0000h~00FFh	128KB	Block305	0131h	0000h~00FFh	128KB
Block274	0112h	0000h~00FFh	128KB	Block306	0132h	0000h~00FFh	128KB
Block275	0113h	0000h~00FFh	128KB	Block307	0133h	0000h~00FFh	128KB
Block276	0114h	0000h~00FFh	128KB	Block308	0134h	0000h~00FFh	128KB
Block277	0115h	0000h~00FFh	128KB	Block309	0135h	0000h~00FFh	128KB
Block278	0116h	0000h~00FFh	128KB	Block310	0136h	0000h~00FFh	128KB
Block279	0117h	0000h~00FFh	128KB	Block311	0137h	0000h~00FFh	128KB
Block280	0118h	0000h~00FFh	128KB	Block312	0138h	0000h~00FFh	128KB
Block281	0119h	0000h~00FFh	128KB	Block313	0139h	0000h~00FFh	128KB
Block282	011Ah	0000h~00FFh	128KB	Block314	013Ah	0000h~00FFh	128KB
Block283	011Bh	0000h~00FFh	128KB	Block315	013Bh	0000h~00FFh	128KB
Block284	011Ch	0000h~00FFh	128KB	Block316	013Ch	0000h~00FFh	128KB
Block285	011Dh	0000h~00FFh	128KB	Block317	013Dh	0000h~00FFh	128KB
Block286	011Eh	0000h~00FFh	128KB	Block318	013Eh	0000h~00FFh	128KB
Block287	011Fh	0000h~00FFh	128KB	Block319	013Fh	0000h~00FFh	128KB

Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block320	0140h	0000h~00FFh	128KB	Block352	0160h	0000h~00FFh	128KB
Block321	0141h	0000h~00FFh	128KB	Block353	0161h	0000h~00FFh	128KB
Block322	0142h	0000h~00FFh	128KB	Block354	0162h	0000h~00FFh	128KB
Block323	0143h	0000h~00FFh	128KB	Block355	0163h	0000h~00FFh	128KB
Block324	0144h	0000h~00FFh	128KB	Block356	0164h	0000h~00FFh	128KB
Block325	0145h	0000h~00FFh	128KB	Block357	0165h	0000h~00FFh	128KB
Block326	0146h	0000h~00FFh	128KB	Block358	0166h	0000h~00FFh	128KB
Block327	0147h	0000h~00FFh	128KB	Block359	0167h	0000h~00FFh	128KB
Block328	0148h	0000h~00FFh	128KB	Block360	0168h	0000h~00FFh	128KB
Block329	0149h	0000h~00FFh	128KB	Block361	0169h	0000h~00FFh	128KB
Block330	014Ah	0000h~00FFh	128KB	Block362	016Ah	0000h~00FFh	128KB
Block331	014Bh	0000h~00FFh	128KB	Block363	016Bh	0000h~00FFh	128KB
Block332	014Ch	0000h~00FFh	128KB	Block364	016Ch	0000h~00FFh	128KB
Block333	014Dh	0000h~00FFh	128KB	Block365	016Dh	0000h~00FFh	128KB
Block334	014Eh	0000h~00FFh	128KB	Block366	016Eh	0000h~00FFh	128KB
Block335	014Fh	0000h~00FFh	128KB	Block367	016Fh	0000h~00FFh	128KB
Block336	0150h	0000h~00FFh	128KB	Block368	0170h	0000h~00FFh	128KB
Block337	0151h	0000h~00FFh	128KB	Block369	0171h	0000h~00FFh	128KB
Block338	0152h	0000h~00FFh	128KB	Block370	0172h	0000h~00FFh	128KB
Block339	0153h	0000h~00FFh	128KB	Block371	0173h	0000h~00FFh	128KB
Block340	0154h	0000h~00FFh	128KB	Block372	0174h	0000h~00FFh	128KB
Block341	0155h	0000h~00FFh	128KB	Block373	0175h	0000h~00FFh	128KB
Block342	0156h	0000h~00FFh	128KB	Block374	0176h	0000h~00FFh	128KB
Block343	0157h	0000h~00FFh	128KB	Block375	0177h	0000h~00FFh	128KB
Block344	0158h	0000h~00FFh	128KB	Block376	0178h	0000h~00FFh	128KB
Block345	0159h	0000h~00FFh	128KB	Block377	0179h	0000h~00FFh	128KB
Block346	015Ah	0000h~00FFh	128KB	Block378	017Ah	0000h~00FFh	128KB
Block347	015Bh	0000h~00FFh	128KB	Block379	017Bh	0000h~00FFh	128KB
Block348	015Ch	0000h~00FFh	128KB	Block380	017Ch	0000h~00FFh	128KB
Block349	015Dh	0000h~00FFh	128KB	Block381	017Dh	0000h~00FFh	128KB
Block350	015Eh	0000h~00FFh	128KB	Block382	017Eh	0000h~00FFh	128KB
Block351	015Fh	0000h~00FFh	128KB	Block383	017Fh	0000h~00FFh	128KB

Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block384	0180h	0000h~00FFh	128KB	Block416	01A0h	0000h~00FFh	128KB
Block385	0181h	0000h~00FFh	128KB	Block417	01A1h	0000h~00FFh	128KB
Block386	0182h	0000h~00FFh	128KB	Block418	01A2h	0000h~00FFh	128KB
Block387	0183h	0000h~00FFh	128KB	Block419	01A3h	0000h~00FFh	128KB
Block388	0184h	0000h~00FFh	128KB	Block420	01A4h	0000h~00FFh	128KB
Block389	0185h	0000h~00FFh	128KB	Block421	01A5h	0000h~00FFh	128KB
Block390	0186h	0000h~00FFh	128KB	Block422	01A6h	0000h~00FFh	128KB
Block391	0187h	0000h~00FFh	128KB	Block423	01A7h	0000h~00FFh	128KB
Block392	0188h	0000h~00FFh	128KB	Block424	01A8h	0000h~00FFh	128KB
Block393	0189h	0000h~00FFh	128KB	Block425	01A9h	0000h~00FFh	128KB
Block394	018Ah	0000h~00FFh	128KB	Block426	01AAh	0000h~00FFh	128KB
Block395	018Bh	0000h~00FFh	128KB	Block427	01ABh	0000h~00FFh	128KB
Block396	018Ch	0000h~00FFh	128KB	Block428	01ACh	0000h~00FFh	128KB
Block397	018Dh	0000h~00FFh	128KB	Block429	01ADh	0000h~00FFh	128KB
Block398	018Eh	0000h~00FFh	128KB	Block430	01AEh	0000h~00FFh	128KB
Block399	018Fh	0000h~00FFh	128KB	Block431	01AFh	0000h~00FFh	128KB
Block400	0190h	0000h~00FFh	128KB	Block432	01B0h	0000h~00FFh	128KB
Block401	0191h	0000h~00FFh	128KB	Block433	01B1h	0000h~00FFh	128KB
Block402	0192h	0000h~00FFh	128KB	Block434	01B2h	0000h~00FFh	128KB
Block403	0193h	0000h~00FFh	128KB	Block435	01B3h	0000h~00FFh	128KB
Block404	0194h	0000h~00FFh	128KB	Block436	01B4h	0000h~00FFh	128KB
Block405	0195h	0000h~00FFh	128KB	Block437	01B5h	0000h~00FFh	128KB
Block406	0196h	0000h~00FFh	128KB	Block438	01B6h	0000h~00FFh	128KB
Block407	0197h	0000h~00FFh	128KB	Block439	01B7h	0000h~00FFh	128KB
Block408	0198h	0000h~00FFh	128KB	Block440	01B8h	0000h~00FFh	128KB
Block409	0199h	0000h~00FFh	128KB	Block441	01B9h	0000h~00FFh	128KB
Block410	019Ah	0000h~00FFh	128KB	Block442	01BAh	0000h~00FFh	128KB
Block411	019Bh	0000h~00FFh	128KB	Block443	01BBh	0000h~00FFh	128KB
Block412	019Ch	0000h~00FFh	128KB	Block444	01BCh	0000h~00FFh	128KB
Block413	019Dh	0000h~00FFh	128KB	Block445	01BDh	0000h~00FFh	128KB
Block414	019Eh	0000h~00FFh	128KB	Block446	01BEh	0000h~00FFh	128KB
Block415	019Fh	0000h~00FFh	128KB	Block447	01BFh	0000h~00FFh	128KB

Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block448	01C0h	0000h~00FFh	128KB	Block480	01E0h	0000h~00FFh	128KB
Block449	01C1h	0000h~00FFh	128KB	Block481	01E1h	0000h~00FFh	128KB
Block450	01C2h	0000h~00FFh	128KB	Block482	01E2h	0000h~00FFh	128KB
Block451	01C3h	0000h~00FFh	128KB	Block483	01E3h	0000h~00FFh	128KB
Block452	01C4h	0000h~00FFh	128KB	Block484	01E4h	0000h~00FFh	128KB
Block453	01C5h	0000h~00FFh	128KB	Block485	01E5h	0000h~00FFh	128KB
Block454	01C6h	0000h~00FFh	128KB	Block486	01E6h	0000h~00FFh	128KB
Block455	01C7h	0000h~00FFh	128KB	Block487	01E7h	0000h~00FFh	128KB
Block456	01C8h	0000h~00FFh	128KB	Block488	01E8h	0000h~00FFh	128KB
Block457	01C9h	0000h~00FFh	128KB	Block489	01E9h	0000h~00FFh	128KB
Block458	01CAh	0000h~00FFh	128KB	Block490	01EAh	0000h~00FFh	128KB
Block459	01CBh	0000h~00FFh	128KB	Block491	01EBh	0000h~00FFh	128KB
Block460	01CCh	0000h~00FFh	128KB	Block492	01ECh	0000h~00FFh	128KB
Block461	01CDh	0000h~00FFh	128KB	Block493	01EDh	0000h~00FFh	128KB
Block462	01CEh	0000h~00FFh	128KB	Block494	01EEh	0000h~00FFh	128KB
Block463	01CFh	0000h~00FFh	128KB	Block495	01EFh	0000h~00FFh	128KB
Block464	01D0h	0000h~00FFh	128KB	Block496	01F0h	0000h~00FFh	128KB
Block465	01D1h	0000h~00FFh	128KB	Block497	01F1h	0000h~00FFh	128KB
Block466	01D2h	0000h~00FFh	128KB	Block498	01F2h	0000h~00FFh	128KB
Block467	01D3h	0000h~00FFh	128KB	Block499	01F3h	0000h~00FFh	128KB
Block468	01D4h	0000h~00FFh	128KB	Block500	01F4h	0000h~00FFh	128KB
Block469	01D5h	0000h~00FFh	128KB	Block501	01F5h	0000h~00FFh	128KB
Block470	01D6h	0000h~00FFh	128KB	Block502	01F6h	0000h~00FFh	128KB
Block471	01D7h	0000h~00FFh	128KB	Block503	01F7h	0000h~00FFh	128KB
Block472	01D8h	0000h~00FFh	128KB	Block504	01F8h	0000h~00FFh	128KB
Block473	01D9h	0000h~00FFh	128KB	Block505	01F9h	0000h~00FFh	128KB
Block474	01DAh	0000h~00FFh	128KB	Block506	01FAh	0000h~00FFh	128KB
Block475	01DBh	0000h~00FFh	128KB	Block507	01FBh	0000h~00FFh	128KB
Block476	01DCh	0000h~00FFh	128KB	Block508	01FCh	0000h~00FFh	128KB
Block477	01DDh	0000h~00FFh	128KB	Block509	01FDh	0000h~00FFh	128KB
Block478	01DEh	0000h~00FFh	128KB	Block510	01FEh	0000h~00FFh	128KB
Block479	01DFh	0000h~00FFh	128KB	Block511	01FFh	0000h~00FFh	128KB

Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block512	0200h	0000h~00FFh	128KB	Block544	0220h	0000h~00FFh	128KB
Block513	0201h	0000h~00FFh	128KB	Block545	0221h	0000h~00FFh	128KB
Block514	0202h	0000h~00FFh	128KB	Block546	0222h	0000h~00FFh	128KB
Block515	0203h	0000h~00FFh	128KB	Block547	0223h	0000h~00FFh	128KB
Block516	0204h	0000h~00FFh	128KB	Block548	0224h	0000h~00FFh	128KB
Block517	0205h	0000h~00FFh	128KB	Block549	0225h	0000h~00FFh	128KB
Block518	0206h	0000h~00FFh	128KB	Block550	0226h	0000h~00FFh	128KB
Block519	0207h	0000h~00FFh	128KB	Block551	0227h	0000h~00FFh	128KB
Block520	0208h	0000h~00FFh	128KB	Block552	0228h	0000h~00FFh	128KB
Block521	0209h	0000h~00FFh	128KB	Block553	0229h	0000h~00FFh	128KB
Block522	020Ah	0000h~00FFh	128KB	Block554	022Ah	0000h~00FFh	128KB
Block523	020Bh	0000h~00FFh	128KB	Block555	022Bh	0000h~00FFh	128KB
Block524	020Ch	0000h~00FFh	128KB	Block556	022Ch	0000h~00FFh	128KB
Block525	020Dh	0000h~00FFh	128KB	Block557	022Dh	0000h~00FFh	128KB
Block526	020Eh	0000h~00FFh	128KB	Block558	022Eh	0000h~00FFh	128KB
Block527	020Fh	0000h~00FFh	128KB	Block559	022Fh	0000h~00FFh	128KB
Block528	0210h	0000h~00FFh	128KB	Block560	0230h	0000h~00FFh	128KB
Block529	0211h	0000h~00FFh	128KB	Block561	0231h	0000h~00FFh	128KB
Block530	0212h	0000h~00FFh	128KB	Block562	0232h	0000h~00FFh	128KB
Block531	0213h	0000h~00FFh	128KB	Block563	0233h	0000h~00FFh	128KB
Block532	0214h	0000h~00FFh	128KB	Block564	0234h	0000h~00FFh	128KB
Block533	0215h	0000h~00FFh	128KB	Block565	0235h	0000h~00FFh	128KB
Block534	0216h	0000h~00FFh	128KB	Block566	0236h	0000h~00FFh	128KB
Block535	0217h	0000h~00FFh	128KB	Block567	0237h	0000h~00FFh	128KB
Block536	0218h	0000h~00FFh	128KB	Block568	0238h	0000h~00FFh	128KB
Block537	0219h	0000h~00FFh	128KB	Block569	0239h	0000h~00FFh	128KB
Block538	021Ah	0000h~00FFh	128KB	Block570	023Ah	0000h~00FFh	128KB
Block539	021Bh	0000h~00FFh	128KB	Block571	023Bh	0000h~00FFh	128KB
Block540	021Ch	0000h~00FFh	128KB	Block572	023Ch	0000h~00FFh	128KB
Block541	021Dh	0000h~00FFh	128KB	Block573	023Dh	0000h~00FFh	128KB
Block542	021Eh	0000h~00FFh	128KB	Block574	023Eh	0000h~00FFh	128KB
Block543	021Fh	0000h~00FFh	128KB	Block575	023Fh	0000h~00FFh	128KB

Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block576	0240h	0000h~00FFh	128KB	Block608	0260h	0000h~00FFh	128KB
Block577	0241h	0000h~00FFh	128KB	Block609	0261h	0000h~00FFh	128KB
Block578	0242h	0000h~00FFh	128KB	Block610	0262h	0000h~00FFh	128KB
Block579	0243h	0000h~00FFh	128KB	Block611	0263h	0000h~00FFh	128KB
Block580	0244h	0000h~00FFh	128KB	Block612	0264h	0000h~00FFh	128KB
Block581	0245h	0000h~00FFh	128KB	Block613	0265h	0000h~00FFh	128KB
Block582	0246h	0000h~00FFh	128KB	Block614	0266h	0000h~00FFh	128KB
Block583	0247h	0000h~00FFh	128KB	Block615	0267h	0000h~00FFh	128KB
Block584	0248h	0000h~00FFh	128KB	Block616	0268h	0000h~00FFh	128KB
Block585	0249h	0000h~00FFh	128KB	Block617	0269h	0000h~00FFh	128KB
Block586	024Ah	0000h~00FFh	128KB	Block618	026Ah	0000h~00FFh	128KB
Block587	024Bh	0000h~00FFh	128KB	Block619	026Bh	0000h~00FFh	128KB
Block588	024Ch	0000h~00FFh	128KB	Block620	026Ch	0000h~00FFh	128KB
Block589	024Dh	0000h~00FFh	128KB	Block621	026Dh	0000h~00FFh	128KB
Block590	024Eh	0000h~00FFh	128KB	Block622	026Eh	0000h~00FFh	128KB
Block591	024Fh	0000h~00FFh	128KB	Block623	026Fh	0000h~00FFh	128KB
Block592	0250h	0000h~00FFh	128KB	Block624	0270h	0000h~00FFh	128KB
Block593	0251h	0000h~00FFh	128KB	Block625	0271h	0000h~00FFh	128KB
Block594	0252h	0000h~00FFh	128KB	Block626	0272h	0000h~00FFh	128KB
Block595	0253h	0000h~00FFh	128KB	Block627	0273h	0000h~00FFh	128KB
Block596	0254h	0000h~00FFh	128KB	Block628	0274h	0000h~00FFh	128KB
Block597	0255h	0000h~00FFh	128KB	Block629	0275h	0000h~00FFh	128KB
Block598	0256h	0000h~00FFh	128KB	Block630	0276h	0000h~00FFh	128KB
Block599	0257h	0000h~00FFh	128KB	Block631	0277h	0000h~00FFh	128KB
Block600	0258h	0000h~00FFh	128KB	Block632	0278h	0000h~00FFh	128KB
Block601	0259h	0000h~00FFh	128KB	Block633	0279h	0000h~00FFh	128KB
Block602	025Ah	0000h~00FFh	128KB	Block634	027Ah	0000h~00FFh	128KB
Block603	025Bh	0000h~00FFh	128KB	Block635	027Bh	0000h~00FFh	128KB
Block604	025Ch	0000h~00FFh	128KB	Block636	027Ch	0000h~00FFh	128KB
Block605	025Dh	0000h~00FFh	128KB	Block637	027Dh	0000h~00FFh	128KB
Block606	025Eh	0000h~00FFh	128KB	Block638	027Eh	0000h~00FFh	128KB
Block607	025Fh	0000h~00FFh	128KB	Block639	027Fh	0000h~00FFh	128KB

Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block640	0280h	0000h~00FFh	128KB	Block672	02A0h	0000h~00FFh	128KB
Block641	0281h	0000h~00FFh	128KB	Block673	02A1h	0000h~00FFh	128KB
Block642	0282h	0000h~00FFh	128KB	Block674	02A2h	0000h~00FFh	128KB
Block643	0283h	0000h~00FFh	128KB	Block675	02A3h	0000h~00FFh	128KB
Block644	0284h	0000h~00FFh	128KB	Block676	02A4h	0000h~00FFh	128KB
Block645	0285h	0000h~00FFh	128KB	Block677	02A5h	0000h~00FFh	128KB
Block646	0286h	0000h~00FFh	128KB	Block678	02A6h	0000h~00FFh	128KB
Block647	0287h	0000h~00FFh	128KB	Block679	02A7h	0000h~00FFh	128KB
Block648	0288h	0000h~00FFh	128KB	Block680	02A8h	0000h~00FFh	128KB
Block649	0289h	0000h~00FFh	128KB	Block681	02A9h	0000h~00FFh	128KB
Block650	028Ah	0000h~00FFh	128KB	Block682	02AAh	0000h~00FFh	128KB
Block651	028Bh	0000h~00FFh	128KB	Block683	02ABh	0000h~00FFh	128KB
Block652	028Ch	0000h~00FFh	128KB	Block684	02ACh	0000h~00FFh	128KB
Block653	028Dh	0000h~00FFh	128KB	Block685	02ADh	0000h~00FFh	128KB
Block654	028Eh	0000h~00FFh	128KB	Block686	02AEh	0000h~00FFh	128KB
Block655	028Fh	0000h~00FFh	128KB	Block687	02AFh	0000h~00FFh	128KB
Block656	0290h	0000h~00FFh	128KB	Block688	02B0h	0000h~00FFh	128KB
Block657	0291h	0000h~00FFh	128KB	Block689	02B1h	0000h~00FFh	128KB
Block658	0292h	0000h~00FFh	128KB	Block690	02B2h	0000h~00FFh	128KB
Block659	0293h	0000h~00FFh	128KB	Block691	02B3h	0000h~00FFh	128KB
Block660	0294h	0000h~00FFh	128KB	Block692	02B4h	0000h~00FFh	128KB
Block661	0295h	0000h~00FFh	128KB	Block693	02B5h	0000h~00FFh	128KB
Block662	0296h	0000h~00FFh	128KB	Block694	02B6h	0000h~00FFh	128KB
Block663	0297h	0000h~00FFh	128KB	Block695	02B7h	0000h~00FFh	128KB
Block664	0298h	0000h~00FFh	128KB	Block696	02B8h	0000h~00FFh	128KB
Block665	0299h	0000h~00FFh	128KB	Block697	02B9h	0000h~00FFh	128KB
Block666	029Ah	0000h~00FFh	128KB	Block698	02BAh	0000h~00FFh	128KB
Block667	029Bh	0000h~00FFh	128KB	Block699	02BBh	0000h~00FFh	128KB
Block668	029Ch	0000h~00FFh	128KB	Block700	02BCh	0000h~00FFh	128KB
Block669	029Dh	0000h~00FFh	128KB	Block701	02BDh	0000h~00FFh	128KB
Block670	029Eh	0000h~00FFh	128KB	Block702	02BEh	0000h~00FFh	128KB
Block671	029Fh	0000h~00FFh	128KB	Block703	02BFh	0000h~00FFh	128KB

Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block704	02C0h	0000h~00FFh	128KB	Block736	02E0h	0000h~00FFh	128KB
Block705	02C1h	0000h~00FFh	128KB	Block737	02E1h	0000h~00FFh	128KB
Block706	02C2h	0000h~00FFh	128KB	Block738	02E2h	0000h~00FFh	128KB
Block707	02C3h	0000h~00FFh	128KB	Block739	02E3h	0000h~00FFh	128KB
Block708	02C4h	0000h~00FFh	128KB	Block740	02E4h	0000h~00FFh	128KB
Block709	02C5h	0000h~00FFh	128KB	Block741	02E5h	0000h~00FFh	128KB
Block710	02C6h	0000h~00FFh	128KB	Block742	02E6h	0000h~00FFh	128KB
Block711	02C7h	0000h~00FFh	128KB	Block743	02E7h	0000h~00FFh	128KB
Block712	02C8h	0000h~00FFh	128KB	Block744	02E8h	0000h~00FFh	128KB
Block713	02C9h	0000h~00FFh	128KB	Block745	02E9h	0000h~00FFh	128KB
Block714	02CAh	0000h~00FFh	128KB	Block746	02EAh	0000h~00FFh	128KB
Block715	02CBh	0000h~00FFh	128KB	Block747	02EBh	0000h~00FFh	128KB
Block716	02CCh	0000h~00FFh	128KB	Block748	02ECh	0000h~00FFh	128KB
Block717	02CDh	0000h~00FFh	128KB	Block749	02EDh	0000h~00FFh	128KB
Block718	02CEh	0000h~00FFh	128KB	Block750	02EEh	0000h~00FFh	128KB
Block719	02CFh	0000h~00FFh	128KB	Block751	02EFh	0000h~00FFh	128KB
Block720	02D0h	0000h~00FFh	128KB	Block752	02F0h	0000h~00FFh	128KB
Block721	02D1h	0000h~00FFh	128KB	Block753	02F1h	0000h~00FFh	128KB
Block722	02D2h	0000h~00FFh	128KB	Block754	02F2h	0000h~00FFh	128KB
Block723	02D3h	0000h~00FFh	128KB	Block755	02F3h	0000h~00FFh	128KB
Block724	02D4h	0000h~00FFh	128KB	Block756	02F4h	0000h~00FFh	128KB
Block725	02D5h	0000h~00FFh	128KB	Block757	02F5h	0000h~00FFh	128KB
Block726	02D6h	0000h~00FFh	128KB	Block758	02F6h	0000h~00FFh	128KB
Block727	02D7h	0000h~00FFh	128KB	Block759	02F7h	0000h~00FFh	128KB
Block728	02D8h	0000h~00FFh	128KB	Block760	02F8h	0000h~00FFh	128KB
Block729	02D9h	0000h~00FFh	128KB	Block761	02F9h	0000h~00FFh	128KB
Block730	02DAh	0000h~00FFh	128KB	Block762	02FAh	0000h~00FFh	128KB
Block731	02DBh	0000h~00FFh	128KB	Block763	02FBh	0000h~00FFh	128KB
Block732	02DCh	0000h~00FFh	128KB	Block764	02FCh	0000h~00FFh	128KB
Block733	02DDh	0000h~00FFh	128KB	Block765	02FDh	0000h~00FFh	128KB
Block734	02DEh	0000h~00FFh	128KB	Block766	02FEh	0000h~00FFh	128KB
Block735	02DFh	0000h~00FFh	128KB	Block767	02FFh	0000h~00FFh	128KB

Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block768	0300h	0000h~00FFh	128KB	Block800	0320h	0000h~00FFh	128KB
Block769	0301h	0000h~00FFh	128KB	Block801	0321h	0000h~00FFh	128KB
Block770	0302h	0000h~00FFh	128KB	Block802	0322h	0000h~00FFh	128KB
Block771	0303h	0000h~00FFh	128KB	Block803	0323h	0000h~00FFh	128KB
Block772	0304h	0000h~00FFh	128KB	Block804	0324h	0000h~00FFh	128KB
Block773	0305h	0000h~00FFh	128KB	Block805	0325h	0000h~00FFh	128KB
Block774	0306h	0000h~00FFh	128KB	Block806	0326h	0000h~00FFh	128KB
Block775	0307h	0000h~00FFh	128KB	Block807	0327h	0000h~00FFh	128KB
Block776	0308h	0000h~00FFh	128KB	Block808	0328h	0000h~00FFh	128KB
Block777	0309h	0000h~00FFh	128KB	Block809	0329h	0000h~00FFh	128KB
Block778	030Ah	0000h~00FFh	128KB	Block810	032Ah	0000h~00FFh	128KB
Block779	030Bh	0000h~00FFh	128KB	Block811	032Bh	0000h~00FFh	128KB
Block780	030Ch	0000h~00FFh	128KB	Block812	032Ch	0000h~00FFh	128KB
Block781	030Dh	0000h~00FFh	128KB	Block813	032Dh	0000h~00FFh	128KB
Block782	030Eh	0000h~00FFh	128KB	Block814	032Eh	0000h~00FFh	128KB
Block783	030Fh	0000h~00FFh	128KB	Block815	032Fh	0000h~00FFh	128KB
Block784	0310h	0000h~00FFh	128KB	Block816	0330h	0000h~00FFh	128KB
Block785	0311h	0000h~00FFh	128KB	Block817	0331h	0000h~00FFh	128KB
Block786	0312h	0000h~00FFh	128KB	Block818	0332h	0000h~00FFh	128KB
Block787	0313h	0000h~00FFh	128KB	Block819	0333h	0000h~00FFh	128KB
Block788	0314h	0000h~00FFh	128KB	Block820	0334h	0000h~00FFh	128KB
Block789	0315h	0000h~00FFh	128KB	Block821	0335h	0000h~00FFh	128KB
Block790	0316h	0000h~00FFh	128KB	Block822	0336h	0000h~00FFh	128KB
Block791	0317h	0000h~00FFh	128KB	Block823	0337h	0000h~00FFh	128KB
Block792	0318h	0000h~00FFh	128KB	Block824	0338h	0000h~00FFh	128KB
Block793	0319h	0000h~00FFh	128KB	Block825	0339h	0000h~00FFh	128KB
Block794	031Ah	0000h~00FFh	128KB	Block826	033Ah	0000h~00FFh	128KB
Block795	031Bh	0000h~00FFh	128KB	Block827	033Bh	0000h~00FFh	128KB
Block796	031Ch	0000h~00FFh	128KB	Block828	033Ch	0000h~00FFh	128KB
Block797	031Dh	0000h~00FFh	128KB	Block829	033Dh	0000h~00FFh	128KB
Block798	031Eh	0000h~00FFh	128KB	Block830	033Eh	0000h~00FFh	128KB
Block799	031Fh	0000h~00FFh	128KB	Block831	033Fh	0000h~00FFh	128KB

Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block832	0340h	0000h~00FFh	128KB	Block864	0360h	0000h~00FFh	128KB
Block833	0341h	0000h~00FFh	128KB	Block865	0361h	0000h~00FFh	128KB
Block834	0342h	0000h~00FFh	128KB	Block866	0362h	0000h~00FFh	128KB
Block835	0343h	0000h~00FFh	128KB	Block867	0363h	0000h~00FFh	128KB
Block836	0344h	0000h~00FFh	128KB	Block868	0364h	0000h~00FFh	128KB
Block837	0345h	0000h~00FFh	128KB	Block869	0365h	0000h~00FFh	128KB
Block838	0346h	0000h~00FFh	128KB	Block870	0366h	0000h~00FFh	128KB
Block839	0347h	0000h~00FFh	128KB	Block871	0367h	0000h~00FFh	128KB
Block840	0348h	0000h~00FFh	128KB	Block872	0368h	0000h~00FFh	128KB
Block841	0349h	0000h~00FFh	128KB	Block873	0369h	0000h~00FFh	128KB
Block842	034Ah	0000h~00FFh	128KB	Block874	036Ah	0000h~00FFh	128KB
Block843	034Bh	0000h~00FFh	128KB	Block875	036Bh	0000h~00FFh	128KB
Block844	034Ch	0000h~00FFh	128KB	Block876	036Ch	0000h~00FFh	128KB
Block845	034Dh	0000h~00FFh	128KB	Block877	036Dh	0000h~00FFh	128KB
Block846	034Eh	0000h~00FFh	128KB	Block878	036Eh	0000h~00FFh	128KB
Block847	034Fh	0000h~00FFh	128KB	Block879	036Fh	0000h~00FFh	128KB
Block848	0350h	0000h~00FFh	128KB	Block880	0370h	0000h~00FFh	128KB
Block849	0351h	0000h~00FFh	128KB	Block881	0371h	0000h~00FFh	128KB
Block850	0352h	0000h~00FFh	128KB	Block882	0372h	0000h~00FFh	128KB
Block851	0353h	0000h~00FFh	128KB	Block883	0373h	0000h~00FFh	128KB
Block852	0354h	0000h~00FFh	128KB	Block884	0374h	0000h~00FFh	128KB
Block853	0355h	0000h~00FFh	128KB	Block885	0375h	0000h~00FFh	128KB
Block854	0356h	0000h~00FFh	128KB	Block886	0376h	0000h~00FFh	128KB
Block855	0357h	0000h~00FFh	128KB	Block887	0377h	0000h~00FFh	128KB
Block856	0358h	0000h~00FFh	128KB	Block888	0378h	0000h~00FFh	128KB
Block857	0359h	0000h~00FFh	128KB	Block889	0379h	0000h~00FFh	128KB
Block858	035Ah	0000h~00FFh	128KB	Block890	037Ah	0000h~00FFh	128KB
Block859	035Bh	0000h~00FFh	128KB	Block891	037Bh	0000h~00FFh	128KB
Block860	035Ch	0000h~00FFh	128KB	Block892	037Ch	0000h~00FFh	128KB
Block861	035Dh	0000h~00FFh	128KB	Block893	037Dh	0000h~00FFh	128KB
Block862	035Eh	0000h~00FFh	128KB	Block894	037Eh	0000h~00FFh	128KB
Block863	035Fh	0000h~00FFh	128KB	Block895	037Fh	0000h~00FFh	128KB

Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block896	0380h	0000h~00FFh	128KB	Block928	03A0h	0000h~00FFh	128KB
Block897	0381h	0000h~00FFh	128KB	Block929	03A1h	0000h~00FFh	128KB
Block898	0382h	0000h~00FFh	128KB	Block930	03A2h	0000h~00FFh	128KB
Block899	0383h	0000h~00FFh	128KB	Block931	03A3h	0000h~00FFh	128KB
Block900	0384h	0000h~00FFh	128KB	Block932	03A4h	0000h~00FFh	128KB
Block901	0385h	0000h~00FFh	128KB	Block933	03A5h	0000h~00FFh	128KB
Block902	0386h	0000h~00FFh	128KB	Block934	03A6h	0000h~00FFh	128KB
Block903	0387h	0000h~00FFh	128KB	Block935	03A7h	0000h~00FFh	128KB
Block904	0388h	0000h~00FFh	128KB	Block936	03A8h	0000h~00FFh	128KB
Block905	0389h	0000h~00FFh	128KB	Block937	03A9h	0000h~00FFh	128KB
Block906	038Ah	0000h~00FFh	128KB	Block938	03AAh	0000h~00FFh	128KB
Block907	038Bh	0000h~00FFh	128KB	Block939	03ABh	0000h~00FFh	128KB
Block908	038Ch	0000h~00FFh	128KB	Block940	03ACh	0000h~00FFh	128KB
Block909	038Dh	0000h~00FFh	128KB	Block941	03ADh	0000h~00FFh	128KB
Block910	038Eh	0000h~00FFh	128KB	Block942	03AEh	0000h~00FFh	128KB
Block911	038Fh	0000h~00FFh	128KB	Block943	03AFh	0000h~00FFh	128KB
Block912	0390h	0000h~00FFh	128KB	Block944	03B0h	0000h~00FFh	128KB
Block913	0391h	0000h~00FFh	128KB	Block945	03B1h	0000h~00FFh	128KB
Block914	0392h	0000h~00FFh	128KB	Block946	03B2h	0000h~00FFh	128KB
Block915	0393h	0000h~00FFh	128KB	Block947	03B3h	0000h~00FFh	128KB
Block916	0394h	0000h~00FFh	128KB	Block948	03B4h	0000h~00FFh	128KB
Block917	0395h	0000h~00FFh	128KB	Block949	03B5h	0000h~00FFh	128KB
Block918	0396h	0000h~00FFh	128KB	Block950	03B6h	0000h~00FFh	128KB
Block919	0397h	0000h~00FFh	128KB	Block951	03B7h	0000h~00FFh	128KB
Block920	0398h	0000h~00FFh	128KB	Block952	03B8h	0000h~00FFh	128KB
Block921	0399h	0000h~00FFh	128KB	Block953	03B9h	0000h~00FFh	128KB
Block922	039Ah	0000h~00FFh	128KB	Block954	03BAh	0000h~00FFh	128KB
Block923	039Bh	0000h~00FFh	128KB	Block955	03BBh	0000h~00FFh	128KB
Block924	039Ch	0000h~00FFh	128KB	Block956	03BCh	0000h~00FFh	128KB
Block925	039Dh	0000h~00FFh	128KB	Block957	03BDh	0000h~00FFh	128KB
Block926	039Eh	0000h~00FFh	128KB	Block958	03BEh	0000h~00FFh	128KB
Block927	039Fh	0000h~00FFh	128KB	Block959	03BFh	0000h~00FFh	128KB

Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block960	03C0h	0000h~00FFh	128KB	Block992	03E0h	0000h~00FFh	128KB
Block961	03C1h	0000h~00FFh	128KB	Block993	03E1h	0000h~00FFh	128KB
Block962	03C2h	0000h~00FFh	128KB	Block994	03E2h	0000h~00FFh	128KB
Block963	03C3h	0000h~00FFh	128KB	Block995	03E3h	0000h~00FFh	128KB
Block964	03C4h	0000h~00FFh	128KB	Block996	03E4h	0000h~00FFh	128KB
Block965	03C5h	0000h~00FFh	128KB	Block997	03E5h	0000h~00FFh	128KB
Block966	03C6h	0000h~00FFh	128KB	Block998	03E6h	0000h~00FFh	128KB
Block967	03C7h	0000h~00FFh	128KB	Block999	03E7h	0000h~00FFh	128KB
Block968	03C8h	0000h~00FFh	128KB	Block1000	03E8h	0000h~00FFh	128KB
Block969	03C9h	0000h~00FFh	128KB	Block1001	03E9h	0000h~00FFh	128KB
Block970	03CAh	0000h~00FFh	128KB	Block1002	03EAh	0000h~00FFh	128KB
Block971	03CBh	0000h~00FFh	128KB	Block1003	03EBh	0000h~00FFh	128KB
Block972	03CCh	0000h~00FFh	128KB	Block1004	03ECh	0000h~00FFh	128KB
Block973	03CDh	0000h~00FFh	128KB	Block1005	03EDh	0000h~00FFh	128KB
Block974	03CEh	0000h~00FFh	128KB	Block1006	03EEh	0000h~00FFh	128KB
Block975	03CFh	0000h~00FFh	128KB	Block1007	03EFh	0000h~00FFh	128KB
Block976	03D0h	0000h~00FFh	128KB	Block1008	03F0h	0000h~00FFh	128KB
Block977	03D1h	0000h~00FFh	128KB	Block1009	03F1h	0000h~00FFh	128KB
Block978	03D2h	0000h~00FFh	128KB	Block1010	03F2h	0000h~00FFh	128KB
Block979	03D3h	0000h~00FFh	128KB	Block1011	03F3h	0000h~00FFh	128KB
Block980	03D4h	0000h~00FFh	128KB	Block1012	03F4h	0000h~00FFh	128KB
Block981	03D5h	0000h~00FFh	128KB	Block1013	03F5h	0000h~00FFh	128KB
Block982	03D6h	0000h~00FFh	128KB	Block1014	03F6h	0000h~00FFh	128KB
Block983	03D7h	0000h~00FFh	128KB	Block1015	03F7h	0000h~00FFh	128KB
Block984	03D8h	0000h~00FFh	128KB	Block1016	03F8h	0000h~00FFh	128KB
Block985	03D9h	0000h~00FFh	128KB	Block1017	03F9h	0000h~00FFh	128KB
Block986	03DAh	0000h~00FFh	128KB	Block1018	03FAh	0000h~00FFh	128KB
Block987	03DBh	0000h~00FFh	128KB	Block1019	03FBh	0000h~00FFh	128KB
Block988	03DCh	0000h~00FFh	128KB	Block1020	03FCh	0000h~00FFh	128KB
Block989	03DDh	0000h~00FFh	128KB	Block1021	03FDh	0000h~00FFh	128KB
Block990	03DEh	0000h~00FFh	128KB	Block1022	03FEh	0000h~00FFh	128KB
Block991	03DFh	0000h~00FFh	128KB	Block1023	03FFh	0000h~00FFh	128KB

Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block1024	0400h	0000h~00FFh	128KB	Block1056	0420h	0000h~00FFh	128KB
Block1025	0401h	0000h~00FFh	128KB	Block1057	0421h	0000h~00FFh	128KB
Block1026	0402h	0000h~00FFh	128KB	Block1058	0422h	0000h~00FFh	128KB
Block1027	0403h	0000h~00FFh	128KB	Block1059	0423h	0000h~00FFh	128KB
Block1028	0404h	0000h~00FFh	128KB	Block1060	0424h	0000h~00FFh	128KB
Block1029	0405h	0000h~00FFh	128KB	Block1061	0425h	0000h~00FFh	128KB
Block1030	0406h	0000h~00FFh	128KB	Block1062	0426h	0000h~00FFh	128KB
Block1031	0407h	0000h~00FFh	128KB	Block1063	0427h	0000h~00FFh	128KB
Block1032	0408h	0000h~00FFh	128KB	Block1064	0428h	0000h~00FFh	128KB
Block1033	0409h	0000h~00FFh	128KB	Block1065	0429h	0000h~00FFh	128KB
Block1034	040Ah	0000h~00FFh	128KB	Block1066	042Ah	0000h~00FFh	128KB
Block1035	040Bh	0000h~00FFh	128KB	Block1067	042Bh	0000h~00FFh	128KB
Block1036	040Ch	0000h~00FFh	128KB	Block1068	042Ch	0000h~00FFh	128KB
Block1037	040Dh	0000h~00FFh	128KB	Block1069	042Dh	0000h~00FFh	128KB
Block1038	040Eh	0000h~00FFh	128KB	Block1070	042Eh	0000h~00FFh	128KB
Block1039	040Fh	0000h~00FFh	128KB	Block1071	042Fh	0000h~00FFh	128KB
Block1040	0410h	0000h~00FFh	128KB	Block1072	0430h	0000h~00FFh	128KB
Block1041	0411h	0000h~00FFh	128KB	Block1073	0431h	0000h~00FFh	128KB
Block1042	0412h	0000h~00FFh	128KB	Block1074	0432h	0000h~00FFh	128KB
Block1043	0413h	0000h~00FFh	128KB	Block1075	0433h	0000h~00FFh	128KB
Block1044	0414h	0000h~00FFh	128KB	Block1076	0434h	0000h~00FFh	128KB
Block1045	0415h	0000h~00FFh	128KB	Block1077	0435h	0000h~00FFh	128KB
Block1046	0416h	0000h~00FFh	128KB	Block1078	0436h	0000h~00FFh	128KB
Block1047	0417h	0000h~00FFh	128KB	Block1079	0437h	0000h~00FFh	128KB
Block1048	0418h	0000h~00FFh	128KB	Block1080	0438h	0000h~00FFh	128KB
Block1049	0419h	0000h~00FFh	128KB	Block1081	0439h	0000h~00FFh	128KB
Block1050	041Ah	0000h~00FFh	128KB	Block1082	043Ah	0000h~00FFh	128KB
Block1051	041Bh	0000h~00FFh	128KB	Block1083	043Bh	0000h~00FFh	128KB
Block1052	041Ch	0000h~00FFh	128KB	Block1084	043Ch	0000h~00FFh	128KB
Block1053	041Dh	0000h~00FFh	128KB	Block1085	043Dh	0000h~00FFh	128KB
Block1054	041Eh	0000h~00FFh	128KB	Block1086	043Eh	0000h~00FFh	128KB
Block1055	041Fh	0000h~00FFh	128KB	Block1087	043Fh	0000h~00FFh	128KB

Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block1088	0440h	0000h~00FFh	128KB	Block1120	0460h	0000h~00FFh	128KB
Block1089	0441h	0000h~00FFh	128KB	Block1121	0461h	0000h~00FFh	128KB
Block1090	0442h	0000h~00FFh	128KB	Block1122	0462h	0000h~00FFh	128KB
Block1091	0443h	0000h~00FFh	128KB	Block1123	0463h	0000h~00FFh	128KB
Block1092	0444h	0000h~00FFh	128KB	Block1124	0464h	0000h~00FFh	128KB
Block1093	0445h	0000h~00FFh	128KB	Block1125	0465h	0000h~00FFh	128KB
Block1094	0446h	0000h~00FFh	128KB	Block1126	0466h	0000h~00FFh	128KB
Block1095	0447h	0000h~00FFh	128KB	Block1127	0467h	0000h~00FFh	128KB
Block1096	0448h	0000h~00FFh	128KB	Block1128	0468h	0000h~00FFh	128KB
Block1097	0449h	0000h~00FFh	128KB	Block1129	0469h	0000h~00FFh	128KB
Block1098	044Ah	0000h~00FFh	128KB	Block1130	046Ah	0000h~00FFh	128KB
Block1099	044Bh	0000h~00FFh	128KB	Block1131	046Bh	0000h~00FFh	128KB
Block1100	044Ch	0000h~00FFh	128KB	Block1132	046Ch	0000h~00FFh	128KB
Block1101	044Dh	0000h~00FFh	128KB	Block1133	046Dh	0000h~00FFh	128KB
Block1102	044Eh	0000h~00FFh	128KB	Block1134	046Eh	0000h~00FFh	128KB
Block1103	044Fh	0000h~00FFh	128KB	Block1135	046Fh	0000h~00FFh	128KB
Block1104	0450h	0000h~00FFh	128KB	Block1136	0470h	0000h~00FFh	128KB
Block1105	0451h	0000h~00FFh	128KB	Block1137	0471h	0000h~00FFh	128KB
Block1106	0452h	0000h~00FFh	128KB	Block1138	0472h	0000h~00FFh	128KB
Block1107	0453h	0000h~00FFh	128KB	Block1139	0473h	0000h~00FFh	128KB
Block1108	0454h	0000h~00FFh	128KB	Block1140	0474h	0000h~00FFh	128KB
Block1109	0455h	0000h~00FFh	128KB	Block1141	0475h	0000h~00FFh	128KB
Block1110	0456h	0000h~00FFh	128KB	Block1142	0476h	0000h~00FFh	128KB
Block1111	0457h	0000h~00FFh	128KB	Block1143	0477h	0000h~00FFh	128KB
Block1112	0458h	0000h~00FFh	128KB	Block1144	0478h	0000h~00FFh	128KB
Block1113	0459h	0000h~00FFh	128KB	Block1145	0479h	0000h~00FFh	128KB
Block1114	045Ah	0000h~00FFh	128KB	Block1146	047Ah	0000h~00FFh	128KB
Block1115	045Bh	0000h~00FFh	128KB	Block1147	047Bh	0000h~00FFh	128KB
Block1116	045Ch	0000h~00FFh	128KB	Block1148	047Ch	0000h~00FFh	128KB
Block1117	045Dh	0000h~00FFh	128KB	Block1149	047Dh	0000h~00FFh	128KB
Block1118	045Eh	0000h~00FFh	128KB	Block1150	047Eh	0000h~00FFh	128KB
Block1119	045Fh	0000h~00FFh	128KB	Block1151	047Fh	0000h~00FFh	128KB

Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block1152	0480h	0000h~00FFh	128KB	Block1184	04A0h	0000h~00FFh	128KB
Block1153	0481h	0000h~00FFh	128KB	Block1185	04A1h	0000h~00FFh	128KB
Block1154	0482h	0000h~00FFh	128KB	Block1186	04A2h	0000h~00FFh	128KB
Block1155	0483h	0000h~00FFh	128KB	Block1187	04A3h	0000h~00FFh	128KB
Block1156	0484h	0000h~00FFh	128KB	Block1188	04A4h	0000h~00FFh	128KB
Block1157	0485h	0000h~00FFh	128KB	Block1189	04A5h	0000h~00FFh	128KB
Block1158	0486h	0000h~00FFh	128KB	Block1190	04A6h	0000h~00FFh	128KB
Block1159	0487h	0000h~00FFh	128KB	Block1191	04A7h	0000h~00FFh	128KB
Block1160	0488h	0000h~00FFh	128KB	Block1192	04A8h	0000h~00FFh	128KB
Block1161	0489h	0000h~00FFh	128KB	Block1193	04A9h	0000h~00FFh	128KB
Block1162	048Ah	0000h~00FFh	128KB	Block1194	04AAh	0000h~00FFh	128KB
Block1163	048Bh	0000h~00FFh	128KB	Block1195	04ABh	0000h~00FFh	128KB
Block1164	048Ch	0000h~00FFh	128KB	Block1196	04ACh	0000h~00FFh	128KB
Block1165	048Dh	0000h~00FFh	128KB	Block1197	04ADh	0000h~00FFh	128KB
Block1166	048Eh	0000h~00FFh	128KB	Block1198	04AEh	0000h~00FFh	128KB
Block1167	048Fh	0000h~00FFh	128KB	Block1199	04AFh	0000h~00FFh	128KB
Block1168	0490h	0000h~00FFh	128KB	Block1200	04B0h	0000h~00FFh	128KB
Block1169	0491h	0000h~00FFh	128KB	Block1201	04B1h	0000h~00FFh	128KB
Block1170	0492h	0000h~00FFh	128KB	Block1202	04B2h	0000h~00FFh	128KB
Block1171	0493h	0000h~00FFh	128KB	Block1203	04B3h	0000h~00FFh	128KB
Block1172	0494h	0000h~00FFh	128KB	Block1204	04B4h	0000h~00FFh	128KB
Block1173	0495h	0000h~00FFh	128KB	Block1205	04B5h	0000h~00FFh	128KB
Block1174	0496h	0000h~00FFh	128KB	Block1206	04B6h	0000h~00FFh	128KB
Block1175	0497h	0000h~00FFh	128KB	Block1207	04B7h	0000h~00FFh	128KB
Block1176	0498h	0000h~00FFh	128KB	Block1208	04B8h	0000h~00FFh	128KB
Block1177	0499h	0000h~00FFh	128KB	Block1209	04B9h	0000h~00FFh	128KB
Block1178	049Ah	0000h~00FFh	128KB	Block1210	04BAh	0000h~00FFh	128KB
Block1179	049Bh	0000h~00FFh	128KB	Block1211	04BBh	0000h~00FFh	128KB
Block1180	049Ch	0000h~00FFh	128KB	Block1212	04BCh	0000h~00FFh	128KB
Block1181	049Dh	0000h~00FFh	128KB	Block1213	04BDh	0000h~00FFh	128KB
Block1182	049Eh	0000h~00FFh	128KB	Block1214	04BEh	0000h~00FFh	128KB
Block1183	049Fh	0000h~00FFh	128KB	Block1215	04BFh	0000h~00FFh	128KB

Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block1216	04C0h	0000h~00FFh	128KB	Block1248	04E0h	0000h~00FFh	128KB
Block1217	04C1h	0000h~00FFh	128KB	Block1249	04E1h	0000h~00FFh	128KB
Block1218	04C2h	0000h~00FFh	128KB	Block1250	04E2h	0000h~00FFh	128KB
Block1219	04C3h	0000h~00FFh	128KB	Block1251	04E3h	0000h~00FFh	128KB
Block1220	04C4h	0000h~00FFh	128KB	Block1252	04E4h	0000h~00FFh	128KB
Block1221	04C5h	0000h~00FFh	128KB	Block1253	04E5h	0000h~00FFh	128KB
Block1222	04C6h	0000h~00FFh	128KB	Block1254	04E6h	0000h~00FFh	128KB
Block1223	04C7h	0000h~00FFh	128KB	Block1255	04E7h	0000h~00FFh	128KB
Block1224	04C8h	0000h~00FFh	128KB	Block1256	04E8h	0000h~00FFh	128KB
Block1225	04C9h	0000h~00FFh	128KB	Block1257	04E9h	0000h~00FFh	128KB
Block1226	04CAh	0000h~00FFh	128KB	Block1258	04EAh	0000h~00FFh	128KB
Block1227	04CBh	0000h~00FFh	128KB	Block1259	04EBh	0000h~00FFh	128KB
Block1228	04CCh	0000h~00FFh	128KB	Block1260	04ECh	0000h~00FFh	128KB
Block1229	04CDh	0000h~00FFh	128KB	Block1261	04EDh	0000h~00FFh	128KB
Block1230	04CEh	0000h~00FFh	128KB	Block1262	04EEh	0000h~00FFh	128KB
Block1231	04CFh	0000h~00FFh	128KB	Block1263	04EFh	0000h~00FFh	128KB
Block1232	04D0h	0000h~00FFh	128KB	Block1264	04F0h	0000h~00FFh	128KB
Block1233	04D1h	0000h~00FFh	128KB	Block1265	04F1h	0000h~00FFh	128KB
Block1234	04D2h	0000h~00FFh	128KB	Block1266	04F2h	0000h~00FFh	128KB
Block1235	04D3h	0000h~00FFh	128KB	Block1267	04F3h	0000h~00FFh	128KB
Block1236	04D4h	0000h~00FFh	128KB	Block1268	04F4h	0000h~00FFh	128KB
Block1237	04D5h	0000h~00FFh	128KB	Block1269	04F5h	0000h~00FFh	128KB
Block1238	04D6h	0000h~00FFh	128KB	Block1270	04F6h	0000h~00FFh	128KB
Block1239	04D7h	0000h~00FFh	128KB	Block1271	04F7h	0000h~00FFh	128KB
Block1240	04D8h	0000h~00FFh	128KB	Block1272	04F8h	0000h~00FFh	128KB
Block1241	04D9h	0000h~00FFh	128KB	Block1273	04F9h	0000h~00FFh	128KB
Block1242	04DAh	0000h~00FFh	128KB	Block1274	04FAh	0000h~00FFh	128KB
Block1243	04DBh	0000h~00FFh	128KB	Block1275	04FBh	0000h~00FFh	128KB
Block1244	04DCh	0000h~00FFh	128KB	Block1276	04FCh	0000h~00FFh	128KB
Block1245	04DDh	0000h~00FFh	128KB	Block1277	04FDh	0000h~00FFh	128KB
Block1246	04DEh	0000h~00FFh	128KB	Block1278	04FEh	0000h~00FFh	128KB
Block1247	04DFh	0000h~00FFh	128KB	Block1279	04FFh	0000h~00FFh	128KB

OneNAND2G(KFG2G16Q2A-DEBx)
OneNAND4G(KFH4G16Q2A-DEBx)

FLASH MEMORY

Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block1280	0500h	0000h~00FFh	128KB	Block1312	0520h	0000h~00FFh	128KB
Block1281	0501h	0000h~00FFh	128KB	Block1313	0521h	0000h~00FFh	128KB
Block1282	0502h	0000h~00FFh	128KB	Block1314	0522h	0000h~00FFh	128KB
Block1283	0503h	0000h~00FFh	128KB	Block1315	0523h	0000h~00FFh	128KB
Block1284	0504h	0000h~00FFh	128KB	Block1316	0524h	0000h~00FFh	128KB
Block1285	0505h	0000h~00FFh	128KB	Block1317	0525h	0000h~00FFh	128KB
Block1286	0506h	0000h~00FFh	128KB	Block1318	0526h	0000h~00FFh	128KB
Block1287	0507h	0000h~00FFh	128KB	Block1319	0527h	0000h~00FFh	128KB
Block1288	0508h	0000h~00FFh	128KB	Block1320	0528h	0000h~00FFh	128KB
Block1289	0509h	0000h~00FFh	128KB	Block1321	0529h	0000h~00FFh	128KB
Block1290	050Ah	0000h~00FFh	128KB	Block1322	052Ah	0000h~00FFh	128KB
Block1291	050Bh	0000h~00FFh	128KB	Block1323	052Bh	0000h~00FFh	128KB
Block1292	050Ch	0000h~00FFh	128KB	Block1324	052Ch	0000h~00FFh	128KB
Block1293	050Dh	0000h~00FFh	128KB	Block1325	052Dh	0000h~00FFh	128KB
Block1294	050Eh	0000h~00FFh	128KB	Block1326	052Eh	0000h~00FFh	128KB
Block1295	050Fh	0000h~00FFh	128KB	Block1327	052Fh	0000h~00FFh	128KB
Block1296	0510h	0000h~00FFh	128KB	Block1328	0530h	0000h~00FFh	128KB
Block1297	0511h	0000h~00FFh	128KB	Block1329	0531h	0000h~00FFh	128KB
Block1298	0512h	0000h~00FFh	128KB	Block1330	0532h	0000h~00FFh	128KB
Block1299	0513h	0000h~00FFh	128KB	Block1331	0533h	0000h~00FFh	128KB
Block1300	0514h	0000h~00FFh	128KB	Block1332	0534h	0000h~00FFh	128KB
Block1301	0515h	0000h~00FFh	128KB	Block1333	0535h	0000h~00FFh	128KB
Block1302	0516h	0000h~00FFh	128KB	Block1334	0536h	0000h~00FFh	128KB
Block1303	0517h	0000h~00FFh	128KB	Block1335	0537h	0000h~00FFh	128KB
Block1304	0518h	0000h~00FFh	128KB	Block1336	0538h	0000h~00FFh	128KB
Block1305	0519h	0000h~00FFh	128KB	Block1337	0539h	0000h~00FFh	128KB
Block1306	051Ah	0000h~00FFh	128KB	Block1338	053Ah	0000h~00FFh	128KB
Block1307	051Bh	0000h~00FFh	128KB	Block1339	053Bh	0000h~00FFh	128KB
Block1308	051Ch	0000h~00FFh	128KB	Block1340	053Ch	0000h~00FFh	128KB
Block1309	051Dh	0000h~00FFh	128KB	Block1341	053Dh	0000h~00FFh	128KB
Block1310	051Eh	0000h~00FFh	128KB	Block1342	053Eh	0000h~00FFh	128KB
Block1311	051Fh	0000h~00FFh	128KB	Block1343	053Fh	0000h~00FFh	128KB

Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block1344	0540h	0000h~00FFh	128KB	Block1376	0560h	0000h~00FFh	128KB
Block1345	0541h	0000h~00FFh	128KB	Block1377	0561h	0000h~00FFh	128KB
Block1346	0542h	0000h~00FFh	128KB	Block1378	0562h	0000h~00FFh	128KB
Block1347	0543h	0000h~00FFh	128KB	Block1379	0563h	0000h~00FFh	128KB
Block1348	0544h	0000h~00FFh	128KB	Block1380	0564h	0000h~00FFh	128KB
Block1349	0545h	0000h~00FFh	128KB	Block1381	0565h	0000h~00FFh	128KB
Block1350	0546h	0000h~00FFh	128KB	Block1382	0566h	0000h~00FFh	128KB
Block1351	0547h	0000h~00FFh	128KB	Block1383	0567h	0000h~00FFh	128KB
Block1352	0548h	0000h~00FFh	128KB	Block1384	0568h	0000h~00FFh	128KB
Block1353	0549h	0000h~00FFh	128KB	Block1385	0569h	0000h~00FFh	128KB
Block1354	054Ah	0000h~00FFh	128KB	Block1386	056Ah	0000h~00FFh	128KB
Block1355	054Bh	0000h~00FFh	128KB	Block1387	056Bh	0000h~00FFh	128KB
Block1356	054Ch	0000h~00FFh	128KB	Block1388	056Ch	0000h~00FFh	128KB
Block1357	054Dh	0000h~00FFh	128KB	Block1389	056Dh	0000h~00FFh	128KB
Block1358	054Eh	0000h~00FFh	128KB	Block1390	056Eh	0000h~00FFh	128KB
Block1359	054Fh	0000h~00FFh	128KB	Block1391	056Fh	0000h~00FFh	128KB
Block1360	0550h	0000h~00FFh	128KB	Block1392	0570h	0000h~00FFh	128KB
Block1361	0551h	0000h~00FFh	128KB	Block1393	0571h	0000h~00FFh	128KB
Block1362	0552h	0000h~00FFh	128KB	Block1394	0572h	0000h~00FFh	128KB
Block1363	0553h	0000h~00FFh	128KB	Block1395	0573h	0000h~00FFh	128KB
Block1364	0554h	0000h~00FFh	128KB	Block1396	0574h	0000h~00FFh	128KB
Block1365	0555h	0000h~00FFh	128KB	Block1397	0575h	0000h~00FFh	128KB
Block1366	0556h	0000h~00FFh	128KB	Block1398	0576h	0000h~00FFh	128KB
Block1367	0557h	0000h~00FFh	128KB	Block1399	0577h	0000h~00FFh	128KB
Block1368	0558h	0000h~00FFh	128KB	Block1400	0578h	0000h~00FFh	128KB
Block1369	0559h	0000h~00FFh	128KB	Block1401	0579h	0000h~00FFh	128KB
Block1370	055Ah	0000h~00FFh	128KB	Block1402	057Ah	0000h~00FFh	128KB
Block1371	055Bh	0000h~00FFh	128KB	Block1403	057Bh	0000h~00FFh	128KB
Block1372	055Ch	0000h~00FFh	128KB	Block1404	057Ch	0000h~00FFh	128KB
Block1373	055Dh	0000h~00FFh	128KB	Block1405	057Dh	0000h~00FFh	128KB
Block1374	055Eh	0000h~00FFh	128KB	Block1406	057Eh	0000h~00FFh	128KB
Block1375	055Fh	0000h~00FFh	128KB	Block1407	057Fh	0000h~00FFh	128KB

Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block1408	0580h	0000h~00FFh	128KB	Block1440	05A0h	0000h~00FFh	128KB
Block1409	0581h	0000h~00FFh	128KB	Block1441	05A1h	0000h~00FFh	128KB
Block1410	0582h	0000h~00FFh	128KB	Block1442	05A2h	0000h~00FFh	128KB
Block1411	0583h	0000h~00FFh	128KB	Block1443	05A3h	0000h~00FFh	128KB
Block1412	0584h	0000h~00FFh	128KB	Block1444	05A4h	0000h~00FFh	128KB
Block1413	0585h	0000h~00FFh	128KB	Block1445	05A5h	0000h~00FFh	128KB
Block1414	0586h	0000h~00FFh	128KB	Block1446	05A6h	0000h~00FFh	128KB
Block1415	0587h	0000h~00FFh	128KB	Block1447	05A7h	0000h~00FFh	128KB
Block1416	0588h	0000h~00FFh	128KB	Block1448	05A8h	0000h~00FFh	128KB
Block1417	0589h	0000h~00FFh	128KB	Block1449	05A9h	0000h~00FFh	128KB
Block1418	058Ah	0000h~00FFh	128KB	Block1450	05AAh	0000h~00FFh	128KB
Block1419	058Bh	0000h~00FFh	128KB	Block1451	05ABh	0000h~00FFh	128KB
Block1420	058Ch	0000h~00FFh	128KB	Block1452	05ACh	0000h~00FFh	128KB
Block1421	058Dh	0000h~00FFh	128KB	Block1453	05ADh	0000h~00FFh	128KB
Block1422	058Eh	0000h~00FFh	128KB	Block1454	05AEh	0000h~00FFh	128KB
Block1423	058Fh	0000h~00FFh	128KB	Block1455	05AFh	0000h~00FFh	128KB
Block1424	0590h	0000h~00FFh	128KB	Block1456	05B0h	0000h~00FFh	128KB
Block1425	0591h	0000h~00FFh	128KB	Block1457	05B1h	0000h~00FFh	128KB
Block1426	0592h	0000h~00FFh	128KB	Block1458	05B2h	0000h~00FFh	128KB
Block1427	0593h	0000h~00FFh	128KB	Block1459	05B3h	0000h~00FFh	128KB
Block1428	0594h	0000h~00FFh	128KB	Block1460	05B4h	0000h~00FFh	128KB
Block1429	0595h	0000h~00FFh	128KB	Block1461	05B5h	0000h~00FFh	128KB
Block1430	0596h	0000h~00FFh	128KB	Block1462	05B6h	0000h~00FFh	128KB
Block1431	0597h	0000h~00FFh	128KB	Block1463	05B7h	0000h~00FFh	128KB
Block1432	0598h	0000h~00FFh	128KB	Block1464	05B8h	0000h~00FFh	128KB
Block1433	0599h	0000h~00FFh	128KB	Block1465	05B9h	0000h~00FFh	128KB
Block1434	059Ah	0000h~00FFh	128KB	Block1466	05BAh	0000h~00FFh	128KB
Block1435	059Bh	0000h~00FFh	128KB	Block1467	05BBh	0000h~00FFh	128KB
Block1436	059Ch	0000h~00FFh	128KB	Block1468	05BCh	0000h~00FFh	128KB
Block1437	059Dh	0000h~00FFh	128KB	Block1469	05BDh	0000h~00FFh	128KB
Block1438	059Eh	0000h~00FFh	128KB	Block1470	05BEh	0000h~00FFh	128KB
Block1439	059Fh	0000h~00FFh	128KB	Block1471	05BFh	0000h~00FFh	128KB

OneNAND2G(KFG2G16Q2A-DEBx)
OneNAND4G(KFH4G16Q2A-DEBx)

FLASH MEMORY

Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block1472	05C0h	0000h~00FFh	128KB	Block1504	05E0h	0000h~00FFh	128KB
Block1473	05C1h	0000h~00FFh	128KB	Block1505	05E1h	0000h~00FFh	128KB
Block1474	05C2h	0000h~00FFh	128KB	Block1506	05E2h	0000h~00FFh	128KB
Block1475	05C3h	0000h~00FFh	128KB	Block1507	05E3h	0000h~00FFh	128KB
Block1476	05C4h	0000h~00FFh	128KB	Block1508	05E4h	0000h~00FFh	128KB
Block1477	05C5h	0000h~00FFh	128KB	Block1509	05E5h	0000h~00FFh	128KB
Block1478	05C6h	0000h~00FFh	128KB	Block1510	05E6h	0000h~00FFh	128KB
Block1479	05C7h	0000h~00FFh	128KB	Block1511	05E7h	0000h~00FFh	128KB
Block1480	05C8h	0000h~00FFh	128KB	Block1512	05E8h	0000h~00FFh	128KB
Block1481	05C9h	0000h~00FFh	128KB	Block1513	05E9h	0000h~00FFh	128KB
Block1482	05CAh	0000h~00FFh	128KB	Block1514	05EAh	0000h~00FFh	128KB
Block1483	05CBh	0000h~00FFh	128KB	Block1515	05EBh	0000h~00FFh	128KB
Block1484	05CCh	0000h~00FFh	128KB	Block1516	05ECh	0000h~00FFh	128KB
Block1485	05CDh	0000h~00FFh	128KB	Block1517	05EDh	0000h~00FFh	128KB
Block1486	05CEh	0000h~00FFh	128KB	Block1518	05EEh	0000h~00FFh	128KB
Block1487	05CFh	0000h~00FFh	128KB	Block1519	05EFh	0000h~00FFh	128KB
Block1488	05D0h	0000h~00FFh	128KB	Block1520	05F0h	0000h~00FFh	128KB
Block1489	05D1h	0000h~00FFh	128KB	Block1521	05F1h	0000h~00FFh	128KB
Block1490	05D2h	0000h~00FFh	128KB	Block1522	05F2h	0000h~00FFh	128KB
Block1491	05D3h	0000h~00FFh	128KB	Block1523	05F3h	0000h~00FFh	128KB
Block1492	05D4h	0000h~00FFh	128KB	Block1524	05F4h	0000h~00FFh	128KB
Block1493	05D5h	0000h~00FFh	128KB	Block1525	05F5h	0000h~00FFh	128KB
Block1494	05D6h	0000h~00FFh	128KB	Block1526	05F6h	0000h~00FFh	128KB
Block1495	05D7h	0000h~00FFh	128KB	Block1527	05F7h	0000h~00FFh	128KB
Block1496	05D8h	0000h~00FFh	128KB	Block1528	05F8h	0000h~00FFh	128KB
Block1497	05D9h	0000h~00FFh	128KB	Block1529	05F9h	0000h~00FFh	128KB
Block1498	05DAh	0000h~00FFh	128KB	Block1530	05FAh	0000h~00FFh	128KB
Block1499	05DBh	0000h~00FFh	128KB	Block1531	05FBh	0000h~00FFh	128KB
Block1500	05DCh	0000h~00FFh	128KB	Block1532	05FCh	0000h~00FFh	128KB
Block1501	05DDh	0000h~00FFh	128KB	Block1533	05FDh	0000h~00FFh	128KB
Block1502	05DEh	0000h~00FFh	128KB	Block1534	05FEh	0000h~00FFh	128KB
Block1503	05DFh	0000h~00FFh	128KB	Block1535	05FFh	0000h~00FFh	128KB

Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block1536	0600h	0000h~00FFh	128KB	Block1568	0620h	0000h~00FFh	128KB
Block1537	0601h	0000h~00FFh	128KB	Block1569	0621h	0000h~00FFh	128KB
Block1538	0602h	0000h~00FFh	128KB	Block1570	0622h	0000h~00FFh	128KB
Block1539	0603h	0000h~00FFh	128KB	Block1571	0623h	0000h~00FFh	128KB
Block1540	0604h	0000h~00FFh	128KB	Block1572	0624h	0000h~00FFh	128KB
Block1541	0605h	0000h~00FFh	128KB	Block1573	0625h	0000h~00FFh	128KB
Block1542	0606h	0000h~00FFh	128KB	Block1574	0626h	0000h~00FFh	128KB
Block1543	0607h	0000h~00FFh	128KB	Block1575	0627h	0000h~00FFh	128KB
Block1544	0608h	0000h~00FFh	128KB	Block1576	0628h	0000h~00FFh	128KB
Block1545	0609h	0000h~00FFh	128KB	Block1577	0629h	0000h~00FFh	128KB
Block1546	060Ah	0000h~00FFh	128KB	Block1578	062Ah	0000h~00FFh	128KB
Block1547	060Bh	0000h~00FFh	128KB	Block1579	062Bh	0000h~00FFh	128KB
Block1548	060Ch	0000h~00FFh	128KB	Block1580	062Ch	0000h~00FFh	128KB
Block1549	060Dh	0000h~00FFh	128KB	Block1581	062Dh	0000h~00FFh	128KB
Block1550	060Eh	0000h~00FFh	128KB	Block1582	062Eh	0000h~00FFh	128KB
Block1551	060Fh	0000h~00FFh	128KB	Block1583	062Fh	0000h~00FFh	128KB
Block1552	0610h	0000h~00FFh	128KB	Block1584	0630h	0000h~00FFh	128KB
Block1553	0611h	0000h~00FFh	128KB	Block1585	0631h	0000h~00FFh	128KB
Block1554	0612h	0000h~00FFh	128KB	Block1586	0632h	0000h~00FFh	128KB
Block1555	0613h	0000h~00FFh	128KB	Block1587	0633h	0000h~00FFh	128KB
Block1556	0614h	0000h~00FFh	128KB	Block1588	0634h	0000h~00FFh	128KB
Block1557	0615h	0000h~00FFh	128KB	Block1589	0635h	0000h~00FFh	128KB
Block1558	0616h	0000h~00FFh	128KB	Block1590	0636h	0000h~00FFh	128KB
Block1559	0617h	0000h~00FFh	128KB	Block1591	0637h	0000h~00FFh	128KB
Block1560	0618h	0000h~00FFh	128KB	Block1592	0638h	0000h~00FFh	128KB
Block1561	0619h	0000h~00FFh	128KB	Block1593	0639h	0000h~00FFh	128KB
Block1562	061Ah	0000h~00FFh	128KB	Block1594	063Ah	0000h~00FFh	128KB
Block1563	061Bh	0000h~00FFh	128KB	Block1595	063Bh	0000h~00FFh	128KB
Block1564	061Ch	0000h~00FFh	128KB	Block1596	063Ch	0000h~00FFh	128KB
Block1565	061Dh	0000h~00FFh	128KB	Block1597	063Dh	0000h~00FFh	128KB
Block1566	061Eh	0000h~00FFh	128KB	Block1598	063Eh	0000h~00FFh	128KB
Block1567	061Fh	0000h~00FFh	128KB	Block1599	063Fh	0000h~00FFh	128KB

Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block1600	0640h	0000h~00FFh	128KB	Block1632	0660h	0000h~00FFh	128KB
Block1601	0641h	0000h~00FFh	128KB	Block1633	0661h	0000h~00FFh	128KB
Block1602	0642h	0000h~00FFh	128KB	Block1634	0662h	0000h~00FFh	128KB
Block1603	0643h	0000h~00FFh	128KB	Block1635	0663h	0000h~00FFh	128KB
Block1604	0644h	0000h~00FFh	128KB	Block1636	0664h	0000h~00FFh	128KB
Block1605	0645h	0000h~00FFh	128KB	Block1637	0665h	0000h~00FFh	128KB
Block1606	0646h	0000h~00FFh	128KB	Block1638	0666h	0000h~00FFh	128KB
Block1607	0647h	0000h~00FFh	128KB	Block1639	0667h	0000h~00FFh	128KB
Block1608	0648h	0000h~00FFh	128KB	Block1640	0668h	0000h~00FFh	128KB
Block1609	0649h	0000h~00FFh	128KB	Block1641	0669h	0000h~00FFh	128KB
Block1610	064Ah	0000h~00FFh	128KB	Block1642	066Ah	0000h~00FFh	128KB
Block1611	064Bh	0000h~00FFh	128KB	Block1643	066Bh	0000h~00FFh	128KB
Block1612	064Ch	0000h~00FFh	128KB	Block1644	066Ch	0000h~00FFh	128KB
Block1613	064Dh	0000h~00FFh	128KB	Block1645	066Dh	0000h~00FFh	128KB
Block1614	064Eh	0000h~00FFh	128KB	Block1646	066Eh	0000h~00FFh	128KB
Block1615	064Fh	0000h~00FFh	128KB	Block1647	066Fh	0000h~00FFh	128KB
Block1616	0650h	0000h~00FFh	128KB	Block1648	0670h	0000h~00FFh	128KB
Block1617	0651h	0000h~00FFh	128KB	Block1649	0671h	0000h~00FFh	128KB
Block1618	0652h	0000h~00FFh	128KB	Block1650	0672h	0000h~00FFh	128KB
Block1619	0653h	0000h~00FFh	128KB	Block1651	0673h	0000h~00FFh	128KB
Block1620	0654h	0000h~00FFh	128KB	Block1652	0674h	0000h~00FFh	128KB
Block1621	0655h	0000h~00FFh	128KB	Block1653	0675h	0000h~00FFh	128KB
Block1622	0656h	0000h~00FFh	128KB	Block1654	0676h	0000h~00FFh	128KB
Block1623	0657h	0000h~00FFh	128KB	Block1655	0677h	0000h~00FFh	128KB
Block1624	0658h	0000h~00FFh	128KB	Block1656	0678h	0000h~00FFh	128KB
Block1625	0659h	0000h~00FFh	128KB	Block1657	0679h	0000h~00FFh	128KB
Block1626	065Ah	0000h~00FFh	128KB	Block1658	067Ah	0000h~00FFh	128KB
Block1627	065Bh	0000h~00FFh	128KB	Block1659	067Bh	0000h~00FFh	128KB
Block1628	065Ch	0000h~00FFh	128KB	Block1660	067Ch	0000h~00FFh	128KB
Block1629	065Dh	0000h~00FFh	128KB	Block1661	067Dh	0000h~00FFh	128KB
Block1630	065Eh	0000h~00FFh	128KB	Block1662	067Eh	0000h~00FFh	128KB
Block1631	065Fh	0000h~00FFh	128KB	Block1663	067Fh	0000h~00FFh	128KB

Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block1664	0680h	0000h~00FFh	128KB	Block1696	06A0h	0000h~00FFh	128KB
Block1665	0681h	0000h~00FFh	128KB	Block1697	06A1h	0000h~00FFh	128KB
Block1666	0682h	0000h~00FFh	128KB	Block1698	06A2h	0000h~00FFh	128KB
Block1667	0683h	0000h~00FFh	128KB	Block1699	06A3h	0000h~00FFh	128KB
Block1668	0684h	0000h~00FFh	128KB	Block1700	06A4h	0000h~00FFh	128KB
Block1669	0685h	0000h~00FFh	128KB	Block1701	06A5h	0000h~00FFh	128KB
Block1670	0686h	0000h~00FFh	128KB	Block1702	06A6h	0000h~00FFh	128KB
Block1671	0687h	0000h~00FFh	128KB	Block1703	06A7h	0000h~00FFh	128KB
Block1672	0688h	0000h~00FFh	128KB	Block1704	06A8h	0000h~00FFh	128KB
Block1673	0689h	0000h~00FFh	128KB	Block1705	06A9h	0000h~00FFh	128KB
Block1674	068Ah	0000h~00FFh	128KB	Block1706	06AAh	0000h~00FFh	128KB
Block1675	068Bh	0000h~00FFh	128KB	Block1707	06ABh	0000h~00FFh	128KB
Block1676	068Ch	0000h~00FFh	128KB	Block1708	06ACh	0000h~00FFh	128KB
Block1677	068Dh	0000h~00FFh	128KB	Block1709	06ADh	0000h~00FFh	128KB
Block1678	068Eh	0000h~00FFh	128KB	Block1710	06AEh	0000h~00FFh	128KB
Block1679	068Fh	0000h~00FFh	128KB	Block1711	06AFh	0000h~00FFh	128KB
Block1680	0690h	0000h~00FFh	128KB	Block1712	06B0h	0000h~00FFh	128KB
Block1681	0691h	0000h~00FFh	128KB	Block1713	06B1h	0000h~00FFh	128KB
Block1682	0692h	0000h~00FFh	128KB	Block1714	06B2h	0000h~00FFh	128KB
Block1683	0693h	0000h~00FFh	128KB	Block1715	06B3h	0000h~00FFh	128KB
Block1684	0694h	0000h~00FFh	128KB	Block1716	06B4h	0000h~00FFh	128KB
Block1685	0695h	0000h~00FFh	128KB	Block1717	06B5h	0000h~00FFh	128KB
Block1686	0696h	0000h~00FFh	128KB	Block1718	06B6h	0000h~00FFh	128KB
Block1687	0697h	0000h~00FFh	128KB	Block1719	06B7h	0000h~00FFh	128KB
Block1688	0698h	0000h~00FFh	128KB	Block1720	06B8h	0000h~00FFh	128KB
Block1689	0699h	0000h~00FFh	128KB	Block1721	06B9h	0000h~00FFh	128KB
Block1690	069Ah	0000h~00FFh	128KB	Block1722	06BAh	0000h~00FFh	128KB
Block1691	069Bh	0000h~00FFh	128KB	Block1723	06BBh	0000h~00FFh	128KB
Block1692	069Ch	0000h~00FFh	128KB	Block1724	06BCh	0000h~00FFh	128KB
Block1693	069Dh	0000h~00FFh	128KB	Block1725	06BDh	0000h~00FFh	128KB
Block1694	069Eh	0000h~00FFh	128KB	Block1726	06BEh	0000h~00FFh	128KB
Block1695	069Fh	0000h~00FFh	128KB	Block1727	06BFh	0000h~00FFh	128KB

Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block1728	06C0h	0000h~00FFh	128KB	Block1760	06E0h	0000h~00FFh	128KB
Block1729	06C1h	0000h~00FFh	128KB	Block1761	06E1h	0000h~00FFh	128KB
Block1730	06C2h	0000h~00FFh	128KB	Block1762	06E2h	0000h~00FFh	128KB
Block1731	06C3h	0000h~00FFh	128KB	Block1763	06E3h	0000h~00FFh	128KB
Block1732	06C4h	0000h~00FFh	128KB	Block1764	06E4h	0000h~00FFh	128KB
Block1733	06C5h	0000h~00FFh	128KB	Block1765	06E5h	0000h~00FFh	128KB
Block1734	06C6h	0000h~00FFh	128KB	Block1766	06E6h	0000h~00FFh	128KB
Block1735	06C7h	0000h~00FFh	128KB	Block1767	06E7h	0000h~00FFh	128KB
Block1736	06C8h	0000h~00FFh	128KB	Block1768	06E8h	0000h~00FFh	128KB
Block1737	06C9h	0000h~00FFh	128KB	Block1769	06E9h	0000h~00FFh	128KB
Block1738	06CAh	0000h~00FFh	128KB	Block1770	06EAh	0000h~00FFh	128KB
Block1739	06CBh	0000h~00FFh	128KB	Block1771	06EBh	0000h~00FFh	128KB
Block1740	06CCh	0000h~00FFh	128KB	Block1772	06ECh	0000h~00FFh	128KB
Block1741	06CDh	0000h~00FFh	128KB	Block1773	06EDh	0000h~00FFh	128KB
Block1742	06CEh	0000h~00FFh	128KB	Block1774	06EEh	0000h~00FFh	128KB
Block1743	06CFh	0000h~00FFh	128KB	Block1775	06EFh	0000h~00FFh	128KB
Block1744	06D0h	0000h~00FFh	128KB	Block1776	06F0h	0000h~00FFh	128KB
Block1745	06D1h	0000h~00FFh	128KB	Block1777	06F1h	0000h~00FFh	128KB
Block1746	06D2h	0000h~00FFh	128KB	Block1778	06F2h	0000h~00FFh	128KB
Block1747	06D3h	0000h~00FFh	128KB	Block1779	06F3h	0000h~00FFh	128KB
Block1748	06D4h	0000h~00FFh	128KB	Block1780	06F4h	0000h~00FFh	128KB
Block1749	06D5h	0000h~00FFh	128KB	Block1781	06F5h	0000h~00FFh	128KB
Block1750	06D6h	0000h~00FFh	128KB	Block1782	06F6h	0000h~00FFh	128KB
Block1751	06D7h	0000h~00FFh	128KB	Block1783	06F7h	0000h~00FFh	128KB
Block1752	06D8h	0000h~00FFh	128KB	Block1784	06F8h	0000h~00FFh	128KB
Block1753	06D9h	0000h~00FFh	128KB	Block1785	06F9h	0000h~00FFh	128KB
Block1754	06DAh	0000h~00FFh	128KB	Block1786	06FAh	0000h~00FFh	128KB
Block1755	06DBh	0000h~00FFh	128KB	Block1787	06FBh	0000h~00FFh	128KB
Block1756	06DCh	0000h~00FFh	128KB	Block1788	06FCh	0000h~00FFh	128KB
Block1757	06DDh	0000h~00FFh	128KB	Block1789	06FDh	0000h~00FFh	128KB
Block1758	06DEh	0000h~00FFh	128KB	Block1790	06FEh	0000h~00FFh	128KB
Block1759	06DFh	0000h~00FFh	128KB	Block1791	06FFh	0000h~00FFh	128KB

Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block1792	0700h	0000h~00FFh	128KB	Block1824	0720h	0000h~00FFh	128KB
Block1793	0701h	0000h~00FFh	128KB	Block1825	0721h	0000h~00FFh	128KB
Block1794	0702h	0000h~00FFh	128KB	Block1826	0722h	0000h~00FFh	128KB
Block1795	0703h	0000h~00FFh	128KB	Block1827	0723h	0000h~00FFh	128KB
Block1796	0704h	0000h~00FFh	128KB	Block1828	0724h	0000h~00FFh	128KB
Block1797	0705h	0000h~00FFh	128KB	Block1829	0725h	0000h~00FFh	128KB
Block1798	0706h	0000h~00FFh	128KB	Block1830	0726h	0000h~00FFh	128KB
Block1799	0707h	0000h~00FFh	128KB	Block1831	0727h	0000h~00FFh	128KB
Block1800	0708h	0000h~00FFh	128KB	Block1832	0728h	0000h~00FFh	128KB
Block1801	0709h	0000h~00FFh	128KB	Block1833	0729h	0000h~00FFh	128KB
Block1802	070Ah	0000h~00FFh	128KB	Block1834	072Ah	0000h~00FFh	128KB
Block1803	070Bh	0000h~00FFh	128KB	Block1835	072Bh	0000h~00FFh	128KB
Block1804	070Ch	0000h~00FFh	128KB	Block1836	072Ch	0000h~00FFh	128KB
Block1805	070Dh	0000h~00FFh	128KB	Block1837	072Dh	0000h~00FFh	128KB
Block1806	070Eh	0000h~00FFh	128KB	Block1838	072Eh	0000h~00FFh	128KB
Block1807	070Fh	0000h~00FFh	128KB	Block1839	072Fh	0000h~00FFh	128KB
Block1808	0710h	0000h~00FFh	128KB	Block1840	0730h	0000h~00FFh	128KB
Block1809	0711h	0000h~00FFh	128KB	Block1841	0731h	0000h~00FFh	128KB
Block1810	0712h	0000h~00FFh	128KB	Block1842	0732h	0000h~00FFh	128KB
Block1811	0713h	0000h~00FFh	128KB	Block1843	0733h	0000h~00FFh	128KB
Block1812	0714h	0000h~00FFh	128KB	Block1844	0734h	0000h~00FFh	128KB
Block1813	0715h	0000h~00FFh	128KB	Block1845	0735h	0000h~00FFh	128KB
Block1814	0716h	0000h~00FFh	128KB	Block1846	0736h	0000h~00FFh	128KB
Block1815	0717h	0000h~00FFh	128KB	Block1847	0737h	0000h~00FFh	128KB
Block1816	0718h	0000h~00FFh	128KB	Block1848	0738h	0000h~00FFh	128KB
Block1817	0719h	0000h~00FFh	128KB	Block1849	0739h	0000h~00FFh	128KB
Block1818	071Ah	0000h~00FFh	128KB	Block1850	073Ah	0000h~00FFh	128KB
Block1819	071Bh	0000h~00FFh	128KB	Block1851	073Bh	0000h~00FFh	128KB
Block1820	071Ch	0000h~00FFh	128KB	Block1852	073Ch	0000h~00FFh	128KB
Block1821	071Dh	0000h~00FFh	128KB	Block1853	073Dh	0000h~00FFh	128KB
Block1822	071Eh	0000h~00FFh	128KB	Block1854	073Eh	0000h~00FFh	128KB
Block1823	071Fh	0000h~00FFh	128KB	Block1855	073Fh	0000h~00FFh	128KB

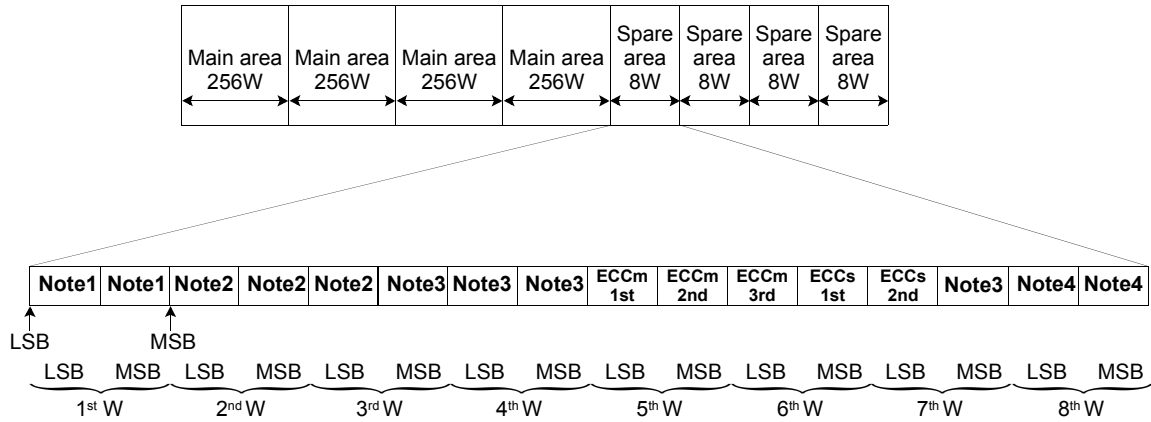
Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block1856	0740h	0000h~00FFh	128KB	Block1888	0760h	0000h~00FFh	128KB
Block1857	0741h	0000h~00FFh	128KB	Block1889	0761h	0000h~00FFh	128KB
Block1858	0742h	0000h~00FFh	128KB	Block1890	0762h	0000h~00FFh	128KB
Block1859	0743h	0000h~00FFh	128KB	Block1891	0763h	0000h~00FFh	128KB
Block1860	0744h	0000h~00FFh	128KB	Block1892	0764h	0000h~00FFh	128KB
Block1861	0745h	0000h~00FFh	128KB	Block1893	0765h	0000h~00FFh	128KB
Block1862	0746h	0000h~00FFh	128KB	Block1894	0766h	0000h~00FFh	128KB
Block1863	0747h	0000h~00FFh	128KB	Block1895	0767h	0000h~00FFh	128KB
Block1864	0748h	0000h~00FFh	128KB	Block1896	0768h	0000h~00FFh	128KB
Block1865	0749h	0000h~00FFh	128KB	Block1897	0769h	0000h~00FFh	128KB
Block1866	074Ah	0000h~00FFh	128KB	Block1898	076Ah	0000h~00FFh	128KB
Block1867	074Bh	0000h~00FFh	128KB	Block1899	076Bh	0000h~00FFh	128KB
Block1868	074Ch	0000h~00FFh	128KB	Block1900	076Ch	0000h~00FFh	128KB
Block1869	074Dh	0000h~00FFh	128KB	Block1901	076Dh	0000h~00FFh	128KB
Block1870	074Eh	0000h~00FFh	128KB	Block1902	076Eh	0000h~00FFh	128KB
Block1871	074Fh	0000h~00FFh	128KB	Block1903	076Fh	0000h~00FFh	128KB
Block1872	0750h	0000h~00FFh	128KB	Block1904	0770h	0000h~00FFh	128KB
Block1873	0751h	0000h~00FFh	128KB	Block1905	0771h	0000h~00FFh	128KB
Block1874	0752h	0000h~00FFh	128KB	Block1906	0772h	0000h~00FFh	128KB
Block1875	0753h	0000h~00FFh	128KB	Block1907	0773h	0000h~00FFh	128KB
Block1876	0754h	0000h~00FFh	128KB	Block1908	0774h	0000h~00FFh	128KB
Block1877	0755h	0000h~00FFh	128KB	Block1909	0775h	0000h~00FFh	128KB
Block1878	0756h	0000h~00FFh	128KB	Block1910	0776h	0000h~00FFh	128KB
Block1879	0757h	0000h~00FFh	128KB	Block1911	0777h	0000h~00FFh	128KB
Block1880	0758h	0000h~00FFh	128KB	Block1912	0778h	0000h~00FFh	128KB
Block1881	0759h	0000h~00FFh	128KB	Block1913	0779h	0000h~00FFh	128KB
Block1882	075Ah	0000h~00FFh	128KB	Block1914	077Ah	0000h~00FFh	128KB
Block1883	075Bh	0000h~00FFh	128KB	Block1915	077Bh	0000h~00FFh	128KB
Block1884	075Ch	0000h~00FFh	128KB	Block1916	077Ch	0000h~00FFh	128KB
Block1885	075Dh	0000h~00FFh	128KB	Block1917	077Dh	0000h~00FFh	128KB
Block1886	075Eh	0000h~00FFh	128KB	Block1918	077Eh	0000h~00FFh	128KB
Block1887	075Fh	0000h~00FFh	128KB	Block1919	077Fh	0000h~00FFh	128KB

Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block1920	0780h	0000h~00FFh	128KB	Block1952	07A0h	0000h~00FFh	128KB
Block1921	0781h	0000h~00FFh	128KB	Block1953	07A1h	0000h~00FFh	128KB
Block1922	0782h	0000h~00FFh	128KB	Block1954	07A2h	0000h~00FFh	128KB
Block1923	0783h	0000h~00FFh	128KB	Block1955	07A3h	0000h~00FFh	128KB
Block1924	0784h	0000h~00FFh	128KB	Block1956	07A4h	0000h~00FFh	128KB
Block1925	0785h	0000h~00FFh	128KB	Block1957	07A5h	0000h~00FFh	128KB
Block1926	0786h	0000h~00FFh	128KB	Block1958	07A6h	0000h~00FFh	128KB
Block1927	0787h	0000h~00FFh	128KB	Block1959	07A7h	0000h~00FFh	128KB
Block1928	0788h	0000h~00FFh	128KB	Block1960	07A8h	0000h~00FFh	128KB
Block1929	0789h	0000h~00FFh	128KB	Block1961	07A9h	0000h~00FFh	128KB
Block1930	078Ah	0000h~00FFh	128KB	Block1962	07AAh	0000h~00FFh	128KB
Block1931	078Bh	0000h~00FFh	128KB	Block1963	07ABh	0000h~00FFh	128KB
Block1932	078Ch	0000h~00FFh	128KB	Block1964	07ACh	0000h~00FFh	128KB
Block1933	078Dh	0000h~00FFh	128KB	Block1965	07ADh	0000h~00FFh	128KB
Block1934	078Eh	0000h~00FFh	128KB	Block1966	07AEh	0000h~00FFh	128KB
Block1935	078Fh	0000h~00FFh	128KB	Block1967	07AFh	0000h~00FFh	128KB
Block1936	0790h	0000h~00FFh	128KB	Block1968	07B0h	0000h~00FFh	128KB
Block1937	0791h	0000h~00FFh	128KB	Block1969	07B1h	0000h~00FFh	128KB
Block1938	0792h	0000h~00FFh	128KB	Block1970	07B2h	0000h~00FFh	128KB
Block1939	0793h	0000h~00FFh	128KB	Block1971	07B3h	0000h~00FFh	128KB
Block1940	0794h	0000h~00FFh	128KB	Block1972	07B4h	0000h~00FFh	128KB
Block1941	0795h	0000h~00FFh	128KB	Block1973	07B5h	0000h~00FFh	128KB
Block1942	0796h	0000h~00FFh	128KB	Block1974	07B6h	0000h~00FFh	128KB
Block1943	0797h	0000h~00FFh	128KB	Block1975	07B7h	0000h~00FFh	128KB
Block1944	0798h	0000h~00FFh	128KB	Block1976	07B8h	0000h~00FFh	128KB
Block1945	0799h	0000h~00FFh	128KB	Block1977	07B9h	0000h~00FFh	128KB
Block1946	079Ah	0000h~00FFh	128KB	Block1978	07BAh	0000h~00FFh	128KB
Block1947	079Bh	0000h~00FFh	128KB	Block1979	07BBh	0000h~00FFh	128KB
Block1948	079Ch	0000h~00FFh	128KB	Block1980	07BCh	0000h~00FFh	128KB
Block1949	079Dh	0000h~00FFh	128KB	Block1981	07BDh	0000h~00FFh	128KB
Block1950	079Eh	0000h~00FFh	128KB	Block1982	07BEh	0000h~00FFh	128KB
Block1951	079Fh	0000h~00FFh	128KB	Block1983	07BFh	0000h~00FFh	128KB

Block	Block Address	Page and Sector Address	Size	Block	Block Address	Page and Sector Address	Size
Block1984	07C0h	0000h~00FFh	128KB	Block2016	07E0h	0000h~00FFh	128KB
Block1985	07C1h	0000h~00FFh	128KB	Block2017	07E1h	0000h~00FFh	128KB
Block1986	07C2h	0000h~00FFh	128KB	Block2018	07E2h	0000h~00FFh	128KB
Block1987	07C3h	0000h~00FFh	128KB	Block2019	07E3h	0000h~00FFh	128KB
Block1988	07C4h	0000h~00FFh	128KB	Block2020	07E4h	0000h~00FFh	128KB
Block1989	07C85h	0000h~00FFh	128KB	Block2021	07E5h	0000h~00FFh	128KB
Block1990	07C6h	0000h~00FFh	128KB	Block2022	07E6h	0000h~00FFh	128KB
Block1991	07C7h	0000h~00FFh	128KB	Block2023	07E7h	0000h~00FFh	128KB
Block1992	07C8h	0000h~00FFh	128KB	Block2024	07E8h	0000h~00FFh	128KB
Block1993	07C9h	0000h~00FFh	128KB	Block2025	07E9h	0000h~00FFh	128KB
Block1994	07CAh	0000h~00FFh	128KB	Block2026	07EAh	0000h~00FFh	128KB
Block1995	07CBh	0000h~00FFh	128KB	Block2027	07EBh	0000h~00FFh	128KB
Block1996	07CCh	0000h~00FFh	128KB	Block2028	07ECh	0000h~00FFh	128KB
Block1997	07CDh	0000h~00FFh	128KB	Block2029	07EDh	0000h~00FFh	128KB
Block1998	07CEh	0000h~00FFh	128KB	Block2030	07EEh	0000h~00FFh	128KB
Block1999	07CFh	0000h~00FFh	128KB	Block2031	07EFh	0000h~00FFh	128KB
Block2000	07D0h	0000h~00FFh	128KB	Block2032	07F0h	0000h~00FFh	128KB
Block2001	07D1h	0000h~00FFh	128KB	Block2033	07F1h	0000h~00FFh	128KB
Block2002	07D2h	0000h~00FFh	128KB	Block2034	07F2h	0000h~00FFh	128KB
Block2003	07D3h	0000h~00FFh	128KB	Block2035	07F3h	0000h~00FFh	128KB
Block2004	07D4h	0000h~00FFh	128KB	Block2036	07F4h	0000h~00FFh	128KB
Block2005	07D5h	0000h~00FFh	128KB	Block2037	07F5h	0000h~00FFh	128KB
Block2006	07D6h	0000h~00FFh	128KB	Block2038	07F6h	0000h~00FFh	128KB
Block2007	07D7h	0000h~00FFh	128KB	Block2039	07F7h	0000h~00FFh	128KB
Block2008	07D8h	0000h~00FFh	128KB	Block2040	07F8h	0000h~00FFh	128KB
Block2009	07D9h	0000h~00FFh	128KB	Block2041	07F9h	0000h~00FFh	128KB
Block2010	07DAh	0000h~00FFh	128KB	Block2042	07FAh	0000h~00FFh	128KB
Block2011	07DBh	0000h~00FFh	128KB	Block2043	07FBh	0000h~00FFh	128KB
Block2012	07DCh	0000h~00FFh	128KB	Block2044	07FCh	0000h~00FFh	128KB
Block2013	07DDh	0000h~00FFh	128KB	Block2045	07FDh	0000h~00FFh	128KB
Block2014	07DEh	0000h~00FFh	128KB	Block2046	07FEh	0000h~00FFh	128KB
Block2015	07DFh	0000h~00FFh	128KB	Block2047	07FFh	0000h~00FFh	128KB

2.7.2 Internal Memory Spare Area Assignment

The figure below shows the assignment of the spare area in the Internal Memory NAND Array.



Spare Area Assignment in the Internal Memory NAND Array Information

Word	Byte	Note	Description
1	LSB	1	Invalid Block information in 1st and 2nd page of an invalid block
	MSB		
2	LSB	2	Managed by internal ECC logic for Logical Sector Number data
	MSB		
3	LSB	3	Reserved for future use
	MSB		
4	LSB	3	Reserved for future use
	MSB		
5	LSB		Dedicated to internal ECC logic. Read Only. (Note 5) ECCm 1st for main area data
	MSB		Dedicated to internal ECC logic. Read Only. (Note 5) ECCm 2nd for main area data
6	LSB		Dedicated to internal ECC logic. Read Only. (Note 5) ECCm 3rd for main area data
	MSB		Dedicated to internal ECC logic. Read Only. (Note 5) ECCs 1st for 2nd word of spare area data
7	LSB		Dedicated to internal ECC logic. Read Only. (Note 5) ECCs 2nd for 3rd word of spare area data
	MSB	3	Reserved for future use
8	LSB	4	Available to the user (Note 6)
	MSB		

NOTE 5 :
In case of ECC Bypass Mode, user can program in ECC Area.

NOTE 6 :
For all blocks, 8th word is available to the user.
However, in case of OTP Block, 8th word of sector 0, page 0 is reserved as OTP Locking Bit area.
Therefore, in case of OTP Block, user usage on this area is prohibited.

2.7.3 External Memory (BufferRAM) Address Map

The following table shows the External Memory address map in Word and Byte Order.
 Note that the data output is unknown while host reads a register bit of reserved area.

Division	Address (word order)	Address (byte order)	Size (total 128KB)			Usage	Description
Main area (64KB)	0000h~00FFh	00000h~001FEh	512B	1KB	R	BootM 0	BootRAM Main sector0
	0100h~01FFh	00200h~003FEh	512B			BootM 1	BootRAM Main sector1
	0200h~02FFh	00400h~005FEh	512B	4KB	R/W	DataM 0_0	DataRAM Main page0/sector0
	0300h~03FFh	00600h~007FEh	512B			DataM 0_1	DataRAM Main page0/sector1
	0400h~04FFh	00800h~009FEh	512B			DataM 0_2	DataRAM Main page0/sector2
	0500h~05FFh	00A00h~00BFEh	512B			DataM 0_3	DataRAM Main page0/sector3
	0600h~06FFh	00C00h~00DFEh	512B			DataM 1_0	DataRAM Main page1/sector0
	0700h~07FFh	00E00h~00FFEh	512B			DataM 1_1	DataRAM Main page1/sector1
	0800h~08FFh	01000h~011FEh	512B			DataM 1_2	DataRAM Main page1/sector2
	0900h~09FFh	01200h~013FEh	512B			DataM 1_3	DataRAM Main page1/sector3
	0A00h~7FFFh	01400h~0FFFEh	59K	59K	-	Reserved	Reserved
Spare area (8KB)	8000h~8007h	10000h~1000Eh	16B	32B	R	BootS 0	BootRAM Spare sector0
	8008h~800Fh	10010h~1001Eh	16B			BootS 1	BootRAM Spare sector1
	8010h~8017h	10020h~1002Eh	16B	128B	R/W	DataS 0_0	DataRAM Spare page0/sector0
	8018h~801Fh	10030h~1003Eh	16B			DataS 0_1	DataRAM Spare page0/sector1
	8020h~8027h	10040h~1004Eh	16B			DataS 0_2	DataRAM Spare page0/sector2
	8028h~802Fh	10050h~1005Eh	16B			DataS 0_3	DataRAM Spare page0/sector3
	8030h~8037h	10060h~1006Eh	16B			DataS 1_0	DataRAM Spare page1/sector0
	8038h~803Fh	10070h~1007Eh	16B			DataS 1_1	DataRAM Spare page1/sector1
	8040h~8047h	10080h~1008Eh	16B			DataS 1_2	DataRAM Spare page1/sector2
	8048h~804Fh	10090h~1009Eh	16B			DataS 1_3	DataRAM Spare page1/sector3
	8050h~8FFFh	100A0h~11FFEh	8032B	8032B	-	Reserved	Reserved
Reserved (24KB)	9000h~BFFFh	12000h~17FFEh	24KB	24KB	-	Reserved	Reserved
Reserved (8KB)	C000h~CFFFh	18000h~19FFEh	8KB	8KB	-	Reserved	Reserved
Reserved (16KB)	D000h~EFFFh	1A000h~1DFFEh	16KB	16KB	-	Reserved	Reserved
Registers (8KB)	F000h~FFFFh	1E000h~1FFFEh	8KB	8KB	R or R/W	Registers	Registers

2.7.4 External Memory Map Detail Information

The tables below show Word Order Address Map information for the BootRAM and DataRAM main and spare areas.

• BootRAM(Main area)

-0000h~01FFh: 2(sector) x 512byte(NAND main area) = 1KB

0000h~00FFh(512B) BootM 0 (sector 0 of page 0)	0100h~01FFh(512B) BootM 1 (sector 1 of page 0)
--	--

• DataRAM(Main area)

-0200h~09FFh: 8(sector) x 512byte(NAND main area) = 4KB

0200h~02FFh(512B) DataM 0_0 (sector 0 of page 0)	0300h~03FFh(512B) DataM 0_1 (sector 1 of page 0)	0400h~04FFh(512B) DataM 0_2 (sector 2 of page 0)	0500h~05FFh(512B) DataM 0_3 (sector 3 of page 0)
0600h~06FFh(512B) DataM 1_0 (sector 0 of page 1)	0700h~07FFh(512B) DataM 1_1 (sector 1 of page 1)	0800h~08FFh(512B) DataM 1_2 (sector 2 of page 1)	0900h~09FFh(512B) DataM 1_3 (sector 3 of page 1)

• BootRAM(Spare area)

-8000h~800Fh: 2(sector) x 16byte(NAND spare area) = 32B

8000h~8007h(16B) BootS 0 (sector 0 of page 0)	8008h~800Fh(16B) BootS 1 (sector 1 of page 0)
---	---

• DataRAM(Spare area)

-8010h~804Fh: 8(sector) x 16byte(NAND spare area) = 128B

8010h~8017h(16B) DataS 0_0 (sector 0 of page 0)	8018h~801Fh(16B) DataS 0_1 (sector 1 of page 0)	8020h~8027h(16B) DataS 0_2 (sector 2 of page 0)	8028h~802Fh(16B) DataS 0_3 (sector 3 of page 0)
8030h~8037h(16B) DataS 1_0 (sector 0 of page 1)	8038h~803Fh(16B) DataS 1_1 (sector 1 of page 1)	8040h~8047h(16B) DataS 1_2 (sector 2 of page 1)	8048h~804Fh(16B) DataS 1_3 (sector 3 of page 1)

*NAND Flash array consists of 2KB page size and 128KB block size.

2.7.5 External Memory Spare Area Assignment

Buf.	Word Address	Byte Address	F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
BootS 0	8000h	10000h	BI															
	8001h	10002h	Managed by Internal ECC logic															
	8002h	10004h	Reserved for the future use								Managed by Internal ECC logic							
	8003h	10006h	Reserved for the current and future use															
	8004h	10008h	ECC Code for Main area data (2 nd)								ECC Code for Main area data (1 st)							
	8005h	1000Ah	ECC Code for Spare area data (1 st)								ECC Code for Main area data (3 rd)							
	8006h	1000Ch	FFh(Reserved for the future use)								ECC Code for Spare area data (2 nd)							
	8007h	1000Eh	Free Usage															
BootS 1	8008h	10010h	BI															
	8009h	10012h	Managed by Internal ECC logic															
	800Ah	10014h	Reserved for the future use								Managed by Internal ECC logic							
	800Bh	10016h	Reserved for the current and future use															
	800Ch	10018h	ECC Code for Main area data (2 nd)								ECC Code for Main area data (1 st)							
	800Dh	1001Ah	ECC Code for Spare area data (1 st)								ECC Code for Main area data (3 rd)							
	800Eh	1001Ch	FFh(Reserved for the future use)								ECC Code for Spare area data (2 nd)							
	800Fh	1001Eh	Free Usage															
DataS 0_0	8010h	10020h	BI															
	8011h	10022h	Managed by Internal ECC logic															
	8012h	10024h	Reserved for the future use								Managed by Internal ECC logic							
	8013h	10026h	Reserved for the current and future use															
	8014h	10028h	ECC Code for Main area data (2 nd)								ECC Code for Main area data (1 st)							
	8015h	1002Ah	ECC Code for Spare area data (1 st)								ECC Code for Main area data (3 rd)							
	8016h	1002Ch	FFh(Reserved for the future use)								ECC Code for Spare area data (2 nd)							
	8017h	1002Eh	Free Usage															
DataS 0_1	8018h	10030h	BI															
	8019h	10032h	Managed by Internal ECC logic															
	801Ah	10034h	Reserved for the future use								Managed by Internal ECC logic							
	801Bh	10036h	Reserved for the current and future use															
	801Ch	10038h	ECC Code for Main area data (2 nd)								ECC Code for Main area data (1 st)							
	801Dh	1003Ah	ECC Code for Spare area data (1 st)								ECC Code for Main area data (3 rd)							
	801Eh	1003Ch	FFh(Reserved for the future use)								ECC Code for Spare area data (2 nd)							
	801Fh	1003Eh	Free Usage															

Equivalent to 1word of NAND Flash

Buf.	Word Address	Byte Address	F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
DataS 0_2	8020h	10040h	BI															
	8021h	10042h	Managed by Internal ECC logic															
	8022h	10044h	Reserved for the future use								Managed by Internal ECC logic							
	8023h	10046h	Reserved for the current and future use															
	8024h	10048h	ECC Code for Main area data (2 nd)								ECC Code for Main area data (1 st)							
	8025h	1004Ah	ECC Code for Spare area data (1 st)								ECC Code for Main area data (3 rd)							
	8026h	1004Ch	Reserved for the future use								ECC Code for Spare area data (2 nd)							
	8027h	1004Eh	Free Usage															
DataS 0_3	8028h	10050h	BI															
	8029h	10052h	Managed by Internal ECC logic															
	802Ah	10054h	Reserved for the future use								Managed by Internal ECC logic							
	802Bh	10056h	Reserved for the current and future use															
	802Ch	10058h	ECC Code for Main area data (2 nd)								ECC Code for Main area data (1 st)							
	802Dh	1005Ah	ECC Code for Spare area data (1 st)								ECC Code for Main area data (3 rd)							
	802Eh	1005Ch	Reserved for the future use								ECC Code for Spare area data (2 nd)							
	802Fh	1005Eh	Free Usage															
DataS 1_0	8030h	10060h	BI															
	8031h	10062h	Managed by Internal ECC logic															
	8032h	10064h	Reserved for the future use								Managed by Internal ECC logic							
	8033h	10066h	Reserved for the current and future use															
	8034h	10068h	ECC Code for Main area data (2 nd)								ECC Code for Main area data (1 st)							
	8035h	1006Ah	ECC Code for Spare area data (1 st)								ECC Code for Main area data (3 rd)							
	8036h	1006Ch	Reserved for the future use								ECC Code for Spare area data (2 nd)							
	8037h	1006Eh	Free Usage															
DataS 1_1	8038h	10070h	BI															
	8039h	10072h	Managed by Internal ECC logic															
	803Ah	10074h	Reserved for the future use								Managed by Internal ECC logic							
	803Bh	10076h	Reserved for the current and future use															
	803Ch	10078h	ECC Code for Main area data (2 nd)								ECC Code for Main area data (1 st)							
	803Dh	1007Ah	ECC Code for Spare area data (1 st)								ECC Code for Main area data (3 rd)							
	803Eh	1007Ch	Reserved for the future use								ECC Code for Spare area data (2 nd)							
	803Fh	1007Eh	Free Usage															
DataS 1_2	8040h	10080h	BI															
	8041h	10082h	Managed by Internal ECC logic															
	8042h	10084h	Reserved for the future use								Managed by Internal ECC logic							
	8043h	10086h	Reserved for the current and future use															
	8044h	10088h	ECC Code for Main area data (2 nd)								ECC Code for Main area data (1 st)							
	8045h	1008Ah	ECC Code for Spare area data (1 st)								ECC Code for Main area data (3 rd)							
	8046h	1008Ch	Reserved for the future use								ECC Code for Spare area data (2 nd)							
	8047h	1008Eh	Free Usage															

Buf.	Word Address	Byte Address	F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
DataS 1_3	8048h	10090h	BI															
	8049h	10092h	Managed by Internal ECC logic															
	804Ah	10094h	Reserved for the future use								Managed by Internal ECC logic							
	804Bh	10096h	Reserved for the current and future use															
	804Ch	10098h	ECC Code for Main area data (2 nd)								ECC Code for Main area data (1 st)							
	804Dh	1009Ah	ECC Code for Spare area data (1 st)								ECC Code for Main area data (3 rd)							
	804Eh	1009Ch	Reserved for the future use								ECC Code for Spare area data (2 nd)							
	804Fh	1009Eh	Free Usage															

NOTE :

- BI: Bad block Information

>Host can use complete spare area except BI and ECC code area. For example,

Host can write data to Spare area buffer except for the area controlled by ECC logic at program operation.

>In case of 'with ECC' mode, OneNAND automatically generates ECC code for both main and spare data of memory during program operation, but does not update ECC code to spare bufferRAM during load operation.

>When loading/programming spare area, spare area BufferRAM address(BSA) and BufferRAM sector count(BSC) is chosen via Start buffer register as it is.

2.8 Registers

Section 2.8 of this specification provides information about the OneNAND2G registers.

2.8.1 Register Address Map

This map describes the register addresses, register name, register description, and host accessibility.

Address (word order)	Address (byte order)	Name	Host Access	Description
F000h	1E000h	Manufacturer ID	R	Manufacturer identification
F001h	1E002h	Device ID	R	Device identification
F002h	1E004h	Version ID	R	N/A
F003h	1E006h	Data Buffer size	R	Data buffer size
F004h	1E008h	Boot Buffer size	R	Boot buffer size
F005h	1E00Ah	Amount of buffers	R	Amount of data/boot buffers
F006h	1E00Ch	Technology	R	Info about technology
F007h~F0FFh	1E00Eh~1E1FEh	Reserved	-	Reserved for user
F100h	1E200h	Start address 1	R/W	Chip address for selection of NAND Core in DDP & Block address
F101h	1E202h	Start address 2	R/W	Chip address for selection of BufferRAM in DDP
F102h	1E204h	Start address 3	R/W	Destination Block address for Copy back program
F103h	1E206h	Start address 4	R/W	Destination Page & Sector address for Copy back program
F104h	1E208h	Start address 5	R/W	Number of Page in Synchronous Burst Block Read
F105h	1E20Ah	Start address 6	-	N/A
F106h	1E20Ch	Start address 7	-	N/A
F107h	1E20Eh	Start address 8	R/W	NAND Flash Page & Sector address
F108h~F1FFh	1E210h~1E3FEh	Reserved	-	Reserved for user
F200h	1E400h	Start Buffer	R/W	Buffer Number for the page data transfer to/from the mem- ory and the start Buffer Address The meaning is with which buffer to start and how many buffers to use for the data transfer
F201h~F207h	1E402h~1E40Eh	Reserved	-	Reserved for user
F208h~F21Fh	1E410h~1E43Eh	Reserved	-	Reserved for vendor specific purposes
F220h	1E440h	Command	R/W	Host control and memory operation commands
F221h	1E442h	System Configuration 1	R, R/W	memory and Host Interface Configuration
F222h	1E444h	System Configuration 2	-	N/A
F223h~F22Fh	1E446h~1E45Eh	Reserved	-	Reserved for user
F230h~F23Fh	1E460h~1E47Eh	Reserved	-	Reserved for vendor specific purposes
F240h	1E480h	Controller Status	R	Controller Status and result of memory operation
F241h	1E482h	Interrupt	R/W	Memory Command Completion Interrupt Status
F242h~F24Bh	1E484h~1E496h	Reserved	-	Reserved for user
F24Ch	1E498h	Start Block Address	R/W	Start memory block address in Write Protection mode

Address (word order)	Address (byte order)	Name	Host Access	Description
F24Dh	1E49Ah	Reserved	-	Reserved for user
F24Eh	1E49Ch	Write Protection Status	R	Current memory Write Protection status (unlocked/locked/tight-locked)
F24Fh~FEFFh	1E49Eh~1FDFEh	Reserved	-	Reserved for user
FF00h	1FE00h	ECC Status Register	R	ECC status of sector
FF01h	1FE02h	ECC Result of main area data	R	ECC error position of Main area data error for first selected Sector
FF02h	1FE04h	ECC Result of spare area data	R	ECC error position of Spare area data error for first selected Sector
FF03h	1FE06h	ECC Result of main area data	R	ECC error position of Main area data error for second selected Sector
FF04h	1FE08h	ECC Result of spare area data	R	ECC error position of Spare area data error for second selected Sector
FF05h	1FE0Ah	ECC Result of main area data	R	ECC error position of Main area data error for third selected Sector
FF06h	1FE0Ch	ECC Result of spare area data	R	ECC error position of Spare area data error for third selected Sector
FF07h	1FE0Eh	ECC Result of main area data	R	ECC error position of Main area data error for fourth selected Sector
FF08h	1FE10h	ECC Result of spare area data	R	ECC error position of Spare area data error for fourth selected Sector
FF09h~FFFFh	1FE12h~1FFFEh	Reserved	-	Reserved for vendor specific purposes

2.8.2 Manufacturer ID Register F000h (R)

This Read register describes the manufacturer's identification.
Samsung Electronics Company manufacturer's ID is 00ECh.

F000h, default = 00ECh

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
ManufID															

2.8.3 Device ID Register F001h (R)

This Read register describes the device.

F001h, see table for default.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
DeviceID															

Device Identification

Register information	Description
DeviceID [1:0] Vcc	00 = 1.8V, 01/10/11 = reserved
DeviceID [2] Muxed/Demuxed	0 = Muxed, 1 = Demuxed
DeviceID [3] Single/DDP	0 = Single, 1 = DDP
DeviceID [7:4] Density	0000 = 128Mb, 0001 = 256Mb, 0010 = 512Mb, 0011 = 1Gb, 0100 = 2Gb, 0101=4Gb
DeviceID [8] Bottom Boot	0 = Bottom Boot

Device ID Default

Device	DeviceID[15:0]
KFG2G16Q2A	0044h
KFH4G16Q2A	005Ch

2.8.4 Version ID Register F002h

This Register is reserved for internal use.

2.8.5 Data Buffer Size Register F003h (R)

This Read register describes the size of the Data Buffer.

F003h, default = 0800h

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
DataBufSize															

Data Buffer Size Information

Register information	Description
DataBufSize	Total data buffer size in Words equal to 2 buffers of 1024 Words each (2 x 1024 = 2 ¹¹) in the memory interface

2.8.6 Boot Buffer Size Register F004h (R)

This Read register describes the size of the Boot Buffer.

F004h, default = 0200h

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
BootBufSize															

Register Information	Description
BootBufSize	Total boot buffer size in Words equal to 1 buffer of 512 Words (1 x 512 = 2 ⁹) in the memory interface

2.8.7 Number of Buffers Register F005h (R)

This Read register describes the number of each Buffer.

F005h, default = 0201h

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
DataBufAmount								BootBufAmount							

Number of Buffers Information

Register Information	Description
DataBufAmount	The number of data buffers = 2 (2 ^N , N=1)
BootBufAmount	The number of boot buffers = 1 (2 ^N , N=0)

2.8.8 Technology Register F006h (R)

This Read register describes the internal NAND array technology.

F006h, default = 0000h

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Tech															

Technology Information

Technology	Register Setting
NAND SLC	0000h
NAND MLC	0001h
Reserved	0002h ~ FFFFh

2.8.9 Start Address1 Register F100h (R/W)

This Read/Write register describes the NAND Flash block address which will be loaded, programmed, or erased.

F100h, default = 0000h

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
DFS	Reserved(0000)				FBA ¹⁾										

NOTE :

1) Bit 0 should be fixed 'low' at 2X Program and 2X Cache Program.

Device	Number of Block	FBA
2Gb	2048	FBA[10:0]
4Gb DDP	4096	DFS[15] & FBA[10:0]

Start Address1 Information

Register Information	Description
FBA	NAND Flash Block Address
DFS	Flash Core of DDP (Device Flash Core Select)

2.8.10 Start Address2 Register F101h (R/W)

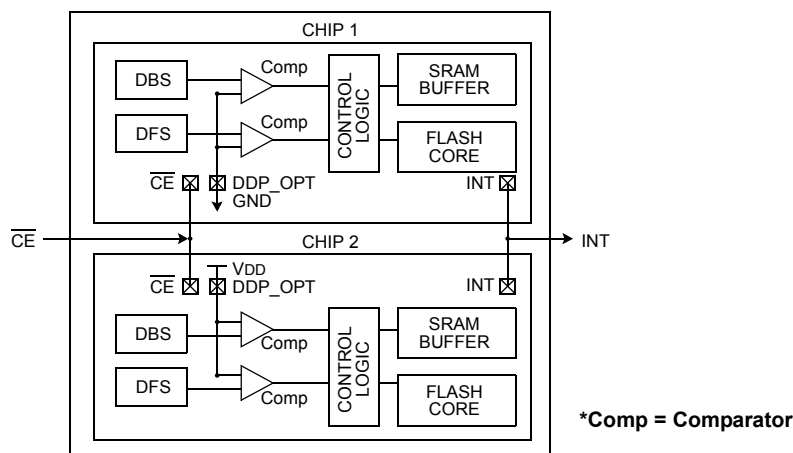
This Read/Write register describes the BufferRAM of DDP (Device BufferRAM Select)

F101h, default = 0000h

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
DBS	Reserved(0000000000000000)														

Start Address2 Information

Register Information	Description
DBS	BufferRAM and Register of DDP (Device BufferRAM Select)



In the case of writing Register, both registers in chip1 and chip2 will be written regardless of DBS. Reading out from Register of chip1/chip2 follows the DBS setting.

In using DDP chip, BootRAM of Chip 1 will always be selected regardless of DBS.

Reading and Writing on the DataRAM of DDP chip is different. Only the DataRAM selected by DBS will be written and read out.

2.8.11 Start Address3 Register F102h (R/W)

This Read/Write register describes the NAND Flash destination block address which will be copy back programmed. Also, this register indicates the block address for the first page to be read in Cache Read Operation.

F102h, default = 0000h

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved(000000)						FCBA									

Device	Number of Block	FBA
2Gb	2048	FCBA[10:0]

Start Address3 Information

Register Information	Description
FCBA	NAND Flash Copy Back Block Address & Block Address for the first page to be read in Cache Read Operation

2.8.12 Start Address4 Register F103h (R/W)

This Read/Write register describes the NAND Flash destination page address in a block and the NAND Flash destination sector address in a page for copy back programming. Also, this register describes the first page and sector address to be loaded in Cache Read Operation.

F103h, default = 0000h

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved(00000000)								FCPA				FCSA			

Start Address4 Information

Item	Description	Default Value	Range
FCPA	NAND Flash Copy Back Page Address & First Page Address of Cache Read	000000	000000 ~ 111111, 6 bits for 64 pages
FCSA	NAND Flash Copy Back Sector Address & First Sector Address of Cache Read	00	00 ~ 11, 2 bits for 4 sectors

2.8.13 Start Address5 Register F104h (R/W)

This Read/Write register describes the number of page in Synchronous Burst Block Read.

F104h, default = 0000h

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved(0000000000)										FPC					

Flash Page Count (FPC) Information

FPC	Number of Page
000000 (Default)	64 page
000011	3 page
000100	4 page
..	..
111111	63 page

NOTE :

Synchronous Burst Block Read are NOT able to be performed with 1 or 2pages.

2.8.14 Start Address6 Register F105h

This register is reserved for future use.

2.8.15 Start Address7 Register F106h

This register is reserved for future use.

2.8.16 Start Address8 Register F107h (R/W)

This Read/Write register describes the NAND Flash start page address in a block for a page load, copy back program, or program operation and the NAND Flash start sector address in a page for a load, copy back program, or program operation.

F107h, default = 0000h

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved (00000000)								FPA ¹⁾						FSA ²⁾	

NOTE :

1) In case of '2X Cache Program', the host programs data on same FPA of different Planes.

2) In case of 'Synchronous Burst Block Read', 'Cache Read Operation', '2X Program' and '2X Cache Program', FSA has to be set to 00.

Start Address8 Information

Item	Description	Default Value	Range
FPA	NAND Flash Page Address	000000	000000 ~ 111111, 6 bits for 64 pages
FSA	NAND Flash Sector Address	00	00 ~ 11, 2 bits for 4 sectors

2.8.17 Start Buffer Register F200h (R/W)

This Read/Write register describes the BufferRAM Sector Count (BSC) and BufferRAM Sector Address (BSA).

The BufferRAM Sector Count (BSC) field specifies the number of sectors to be loaded, programmed, or copy back programmed. At 00 value (the default value), the number of sector is "4". If the internal RAM buffer reaches its maximum value of 11, it will count up to 0 value to meet the BSC value. For example, if BSA = 1101, BSC = 00, then the selected BufferRAM will count up from '1101 → 1110 → 1111 → 1100'.

The BufferRAM Sector Address (BSA) is the sector 0~3 address in the internal BootRAM and DataRAM where data is placed.

F200h, default = 0000h

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved(0000)				BSA				Reserved(000000)						BSC	

NOTE :

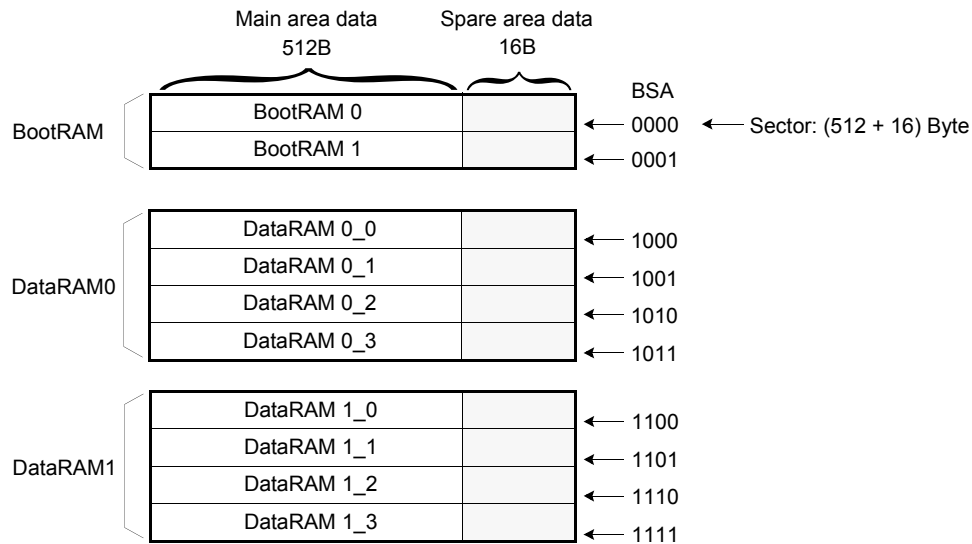
In case of 'Cache Read', BSA has to be set to 1000 or 1100. And BSC has to be set to 00.

In case of 'Synchronous Burst Block Read', BSA has to be set to 1000 . And BSC has to be set to 00.

In case of '2X Program' or '2X Cache Program', BSA has to be set to 1000. And BSC has to be set to 00.

Start Address8 Information

Item	Description
BSA[3]	Selection bit between BootRAM and DataRAM
BSA[2]	Selection bit between DataRAM0 and DataRAM1
BSA[1:0]	Selection bit between Sector0 and Sector1 in the internal BootRAM Selection bit between Sector0 to Sector3 in the internal DataRAM



BSC	Number of Sectors
01	1 sector
10	2 sector
11	3 sector
00	4 sector

2.8.18 Command Register F220h (R/W)

Command can be issued by two following methods, and user may select one way or the other to issue appropriate command;

1. Write command into Command Register when INT is at ready state. INT will automatically turn to busy state as command is issued. Once the desired operation is completed, INT will go back ready state.
2. Write 0000h to INT bit of Interrupt Status Register, and then write command into Command Register. Once the desired operation is completed, INT will go back to ready state.
(00F0h and 00F3h may be accepted during busy state of some operations. Refer to the rightmost column of the command register table below.)

F220h, default = 0000h

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Command															

CMD	Operation	Acceptable command during busy
0000h	Load single/multiple sector data unit into buffer	00F0h, 00F3h
0013h	Load single/multiple spare sector into buffer	00F0h, 00F3h
0080h	Program single/multiple sector data unit from buffer ¹⁾	00F0h, 00F3h
001Ah	Program single/multiple spare data unit from buffer	00F0h, 00F3h
001Bh	Copy back Program operation	00F0h, 00F3h
007Dh	2X Program operation ²⁾	00F0h, 00F3h
007Fh	2X Cache Program operation ²⁾	00F0h, 00F3h
0023h	Unlock NAND array a block	00F0h, 00F3h
002Ah	Lock NAND array a block	00F0h, 00F3h
002Ch	Lock-tight NAND array a block	00F0h, 00F3h
0027h	All Block Unlock ³⁾	00F0h, 00F3h
0071h	Erase Verify Read	00F0h, 00F3h
000Eh	Cache Read	00F0h, 00F3h
000Ch	Finish Cache Read	00F0h, 00F3h
000Ah	Synchronous Burst Block Read	00F0h, 00F3h
0094h	Block Erase	00F0h, 00F3h
0095h	Multi-Block Erase	00F0h, 00F3h
00B0h	Erase Suspend	00F0h, 00F3h
0030h	Erase Resume	00F0h, 00F3h
00F0h	Reset NAND Flash Core	-
00F3h	Reset OneNAND ³⁾	-
0065h	OTP Access	00F0h, 00F3h

NOTE :

- 1) 0080h programs both main and spare area, while 001Ah programs only spare area. Refer to chapter 5.9 for NOP limits in issuing these commands. When using 0080h and 001Ah command, Read-only part in spare area must be masked by FF. (Refer to chapter 2.7.2)
- 2) '2X Program' is executed by '007D'. This command can be used alone and used for ending '2X Cache Program'.
'2X Cache Program' is executed by '007F'. This command cannot be used alone and must be ended by '007D' for the last page program of cache program. (Refer to 6.14 and 6.15)
- 3) If any blocks are changed to locked-tight state, the all block unlock command will fail. In order to use all block unlock command again, a cold reset is needed.
- 4) 'Reset OneNAND' (=Hot reset) command makes the registers and NAND Flash core into default state.

2.8.18.1 Two Methods to Clear Interrupt Register in Command Input

To clear Interrupt Register in command input, user may select one from either following methods.

First method is to turn INT to low by manually writing 0000h to INT bit of Interrupt Register. ¹⁾

Second method is input command while INT is high, and the device will automatically turn INT to low. ¹⁾
(Second method is equivalent with method used in general NAND Flash)

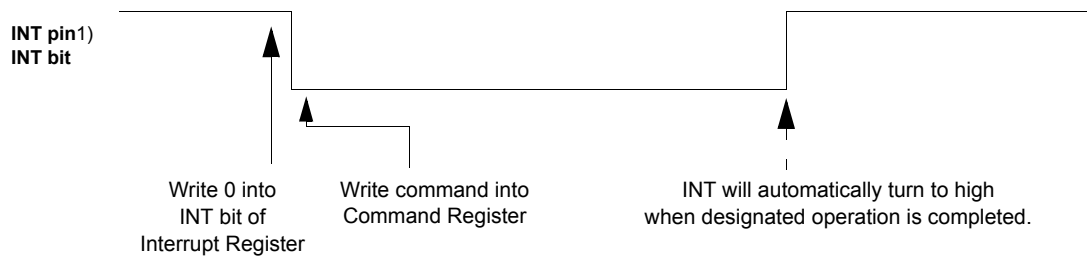
User may choose the desirable method to clear Interrupt Register.

Method 1: Manually set INT=0 before writing command into Command Register: Manual INT Mode

(1) Clear Interrupt Register (F241h) by writing 0000h into INT bit of Interrupt Register. This operation will make INT pin turn low. ¹⁾

(2) Write command into Command Register. This will make the device to perform the designated operation.

(3) INT pin will turn back to high once the operation is completed. ¹⁾

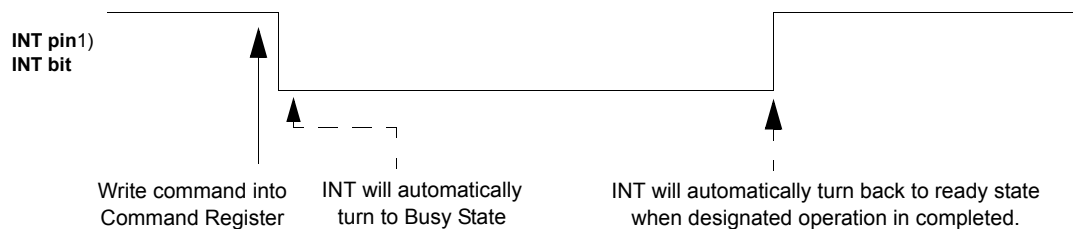


NOTE : 1) INT pin polarity is based on 'IOBE=1 and INT pol=1 (default)' setting

Method 2: Write command into Command Register at INT ready state: Auto INT Mode

(1) Write command into Command Register. This will automatically turn INT from high to low. ¹⁾

(2) INT pin will turn back to high once the operation is completed. ¹⁾



NOTE : 1) INT pin polarity is based on 'IOBE=1 and INT pol=1 (default)' setting

2.8.19 System Configuration 1 Register F221h (R, R/W)

This Read/Write register describes the system configuration.

F221h, default =40C0h

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
R/W	R/W			R/W			R/W	R/W	R/W	R/W	R/W	R	R/W	R/W	R
RM	BRWL			BL			ECC	RDY pol	INT pol	IOBE	RDY Conf	Reserved	HF	WM	BWPS

Read Mode (RM)

RM	Read Mode
0	Asynchronous read(default)
1	Synchronous read

Read Mode Information[15]

Item	Definition	Description
RM	Read Mode	Selects between asynchronous read mode and synchronous read mode

Burst Read Write Latency (BRWL)

BRWL	Latency Cycles (Read/Write)		
	under 40MHz (HF=0)	40MHz~66MHz (HF=0)	over 66MHz (HF=1)
000~010	Reserved		
011	3(up to 40MHz. min)	3(N/A)	3(N/A)
100 (default)	4	4(min.)	4(N/A)
101	5	5	5(N/A)
110	6	6	6(min.)
111	7	7	7

* Default value of BRWL and HF value is BRWL=4, HF=0.

For host frequency over 66MHz, BRWL should be 6 or 7 while HF is 1.

For host frequency range of 40MHz~66MHz, BRWL should be set to 4~7 while HF is 0.

For host frequency under 40MHz, BRWL should be set to 3~7 while HF is 0.

Burst Read Write Latency (BRWL) Information[14:12]

Item	Definition	Description
BRWL	Burst Read Latency / Burst Write Latency	Specifies the access latency in the burst read / write transfer for the initial access

Burst Length (BL)

BL	Burst Length(Main)	Burst Length(Spare)
000	Continuous(default)	
001	4 words	
010	8 words	
011	16 words	
100	32 words	N/A
101	1K words (Block Read Only)	N/A
110~111	Reserved	

NOTE :

- 1) For normal synchronous burst read, setting BL=000 (continuous) will read 1K words depending on the number of clocks. In using Synchronous Burst Block-Read, setting BL=000 (continuous) will read the amount of data in a block set by number of page register.
- 2) Even in using Synchronous Burst Block Read, it is possible to use above burst length by setting BL register by following the above table.

Burst Length (BL) Information[11:9]

Item	Definition	Description
BL	Burst Length	Specifies the size of the burst length during a synchronous linear burst read and wrap around. And also burst length during a synchronous linear burst write

Error Correction Code (ECC) Information[8]

Item	Definition	Description
ECC	Error Correction Code Operation	0 = with correction (default) 1 = without correction (bypassed)

RDY Polarity (RDYpol) Information[7]

Item	Definition	Description
RDYpol	RDY signal polarity	1 = high for ready (default) 0 = low for ready

INT Polarity (INTpol) Information[6]

INTpol	INT bit of Interrupt Status Register	INT Pin output
0	0 (busy)	High
	1 (ready)	Low
1 (default)	0 (busy)	Low
	1 (ready)	High

I/O Buffer Enable (IOBE)

IOBE is the I/O Buffer Enable for the INT and RDY signals. At startup, INT and RDY outputs are High-Z. Bits 6 and 7 become valid after IOBE is set to "1". IOBE can be reset by a Cold Reset or by writing "0" to bit 5 of System Configuration1 Register.

I/O Buffer Enable Information[5]

Item	Definition	Description
IOBE	I/O Buffer Enable for INT and RDY signals	0 = disable (default) 1 = enable

RDY Configuration (RDY conf)

RDY Configuration Information[4]

Item	Definition	Description
RDY conf	RDY configuration	0=active one clock before valid data(default) 1=active with valid data

HF Enable (HF)

HF	Description
0	HF Disable (default, 66Mhz and under)
1	HF Enable (over 66MHz)

HF Information[2]

Item	Definition	Description
HF	High Frequency	Selects between HF Disable and HF Enable

Write Mode (WM)

WM	Write Mode
0	Asynchronous Write(default)
1	Synchronous Write

Write Mode Information[1]

Item	Definition	Description
WM	Write Mode	Selects between asynchronous Write Mode and synchronousWrite Mode

MRS(Mode Register Setting) Description

RM	WM	Mode Description
0	0	Asynch Read & Asynch Write (Default)
1	0	Sync Read & Asynch Write
1	1	Sync Read & Synch Write
Other Case		Reserved ¹⁾

NOTE :

1) Operation not guaranteed for cases not defined in above table.

Boot Buffer Write Protect Status(BWPS)

Boot Buffer Write Protect Status Information[0]

Item	Definition	Description
BWPS	Boot Buffer Write Protect Status	0=locked(fixed)

2.8.20 System Configuration 2 Register F222h

This register is reserved for future use.

2.8.21 Controller Status Register F240h (R)

This Read register shows the overall internal status of the OneNAND and the controller.

F240h, default = 0000h

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
OnGo	Lock	Load	Prog	Erase	Error	Sus	Reserved	RSTB	OTPL	OTP _{BL}	Plane1 Previous	Plane1 Current	Plane2 Previous	Plane2 Current	TO (0)

OnGo

This bit shows the overall internal status of the OneNAND device.

In 2X Cache Program Operation, OnGo bit shows the overall status of 2X Cache Program process.

OnGo Information[15]

Item	Definition	Description
OnGo	Internal Device Status	0 = ready 1 = busy

Lock

This bit shows whether the host is loading data from the NAND Flash array into the locked BootRAM or whether the host is performing a program/erase of a locked block of the NAND Flash array.

Lock Information[14]

Lock	Locked/Unlocked Check Result
0	Unlocked
1	Locked

Load

This bit shows the Load Operation status.

Load Information[13]

Item	Definition	Description
Load	Load Operation status	0 = ready (default) 1 = busy or error (see controller status output modes)

Program

This bit shows the Program Operation status.

In 2X Cache Program Operation, 'Prog' bit shows the overall status of 2X Cache Program process.

Program Information[12]

Item	Definition	Description
Prog	Program Operation status	0 = ready (default) 1 = busy or error (see controller status output modes)

Erase

This bit shows the Erase Operation status.

Erase Information[11]

Item	Definition	Description
Erase	Erase Operation status	0 = ready (default) 1 = busy or error (see controller status output modes)

Error

This bit shows the overall Error status, including Load Reset, Program Reset, and Erase Reset status.

In case of 2X Cache Program, Error bit will show the accumulative error status of 2X Cache Program operation, so that if an error occurs during 2X Cache Program, this bit will stay as Fail status, until the end of 2X Cache Program.

In case of 2X Program, Error bit will indicate the 2X Program fail, regardless of Plane1 or Plane2.

Error Information[10]

Error	Sector/Page Load/Program/CopyBack, Program/2X Program/2X Cache Program Result and Invalid Command Input
0	Pass
1	Fail

Erase Suspend (Sus)

This bit shows the Erase Suspend status.

Sus Information[9]

Sus	Erase Suspend Status
0	Erase Resume(Default)
1	Erase Suspend, Program Ongoing(Susp.), Load Ongoing(Susp.), Program Fail(Susp.), Load Fail(Susp.), Invalid Command(Susp.)

Reset / Busy (RSTB)

This bit shows the Reset Operation status.

RSTB Information[7]

Item	Definition	Description
RSTB	Reset Operation Status	0 = ready (default) 1 = busy (see controller status output modes)

OTP Lock Status (OTP_L)

This bit shows whether the OTP block is locked or unlocked. Locking the OTP has the effect of a 'write-protect' to guard against accidental re-programming of data stored in the OTP block.

The OTP_L status bit is automatically updated at power-on and it must be referred only on chip1 within DDP.

OTP Lock Information[6]

OTPL	OTP Locked/Unlocked Status
0	OTP Block Unlock Status(Default)
1	OTP Block Lock Status(Disable OTP Program/Erase)

1st Block OTP Lock Status (OTP_{BL})

This bit shows whether the 1st Block OTP is locked or unlocked.

Locking the 1st Block OTP has the effect of a 'Program/Erase protect' to guard against accidental re-programming of data stored in the 1st block.

The OTP_{BL} status bit is automatically updated at power-on and it must be referred only on chip1 within DDP.

OTP Lock Information[5]

OTPBL	1st Block OTP Locked/Unlocked Status
0	1st Block OTP Unlock Status(Default)
1	1st Block OTP Lock Status(Disable 1st Block OTP Program/Erase)

Plane1 Previous

This bit shows the previous program status of Plane1 at 2X Cache Program. This value is invalid only at the first 'Read Controller Status Register' step of 2X Cache Program and 2X Interleave Cache Program operation. (Refer to 6.15 and 6.16)

Plane1 Previous Information[4]

Plane1 Previous	Status of previous program on Plane1
0	Pass
1	Fail

Plane1 Current

This bit shows the current program status of Plane1 at Final 2X Cache Program, and 2X Program, and 2X Interleave Cache Program. During 2X Cache Program prior to '2X Program' command, which will be Final 2X Cache Program, this bit will be invalid (fixed to 0).

Plane1 Current Information[3]

Plane1 Current	Status of current program on Plane1
0	Pass
1	Fail

Plane2 Previous

This bit shows the previous program status of Plane2 at 2X Cache Program. This value is invalid only at the first 'Read Controller Status Register' step of 2X Cache Program and 2X Interleave Cache Program operation. (Refer to 6.15 and 6.16)

Plane2 Previous Information[2]

Plane2 Previous	Status of previous program on Plane2
0	Pass
1	Fail

Plane2 Current

This bit shows the current program status of Plane2 at Final 2X Cache Program, and 2X Program, and 2X Interleave Cache Program. During 2X Cache Program prior to '2X Program' command, which will be Final 2X Cache Program, this bit will be invalid (fixed to 0).

Plane2 Current Information[1]

Plane2 Current	Status of current program on Plane2
0	Pass
1	Fail

Time Out (TO)

This bit determines if there is a time out for load, program, copy back program, and erase operations. It is fixed at 'no time out'.

TO Information[0]

Item	Definition	Description
TO	Time Out	0 = no time out

Controller Status Register Output Modes

Mode	Controller Status Register [15:0]														
	[15]	[14]	[13]	[12]	[11]	[10]	[9]	[7]	[6]	[5]	[4]	[3]	[2]	[1]	[0]
	OnGo	Lock	Load	Prog	Erase	Error	Sus	RSTB	OTPL (note4)	OTPL _{BL} (note5)	Plane1 Previous	Plane1 Current	Plane2 Previous	Plane2 Current	TO
Load / Cache Read Ongoing	1	0	1	0	0	0	0	0	0/1	0/1	0	0	0	0	0
Program Ongoing	1	0	0	1	0	0	0	0	0/1	0/1	0	0	0	0	0
Erase Ongoing	1	0	0	0	1	0	0	0	0/1	0/1	0	0	0	0	0
Reset Ongoing	1	0	0	0	0	0	0	1	0/1	0/1	0	0	0	0	0
Multi-Block Erase Ongoing	1	0	0	0	1	0	0	0	0/1	0/1	0	0	0	0	0
Erase Verify Read Ongoing	1	0	0	0	0	0	0	0	0/1	0/1	0	0	0	0	0
Load / Cache Read OK	0	0	0	0	0	0	0	0	0/1	0/1	0	0	0	0	0
Program OK	0	0	0	0	0	0	0	0	0/1	0/1	0	0	0	0	0
Erase OK	0	0	0	0	0	0	0	0	0/1	0/1	0	0	0	0	0
Erase Verify Read OK ³⁾	0	0	0	0	0	0	0	0	0/1	0/1	0	0	0	0	0
Load Fail ¹⁾	0	0	1	0	0	1	0	0	0/1	0/1	0	0	0	0	0
Program Fail	0	0	0	1	0	1	0	0	0/1	0/1	0	0	0	0	0
Erase Fail	0	0	0	0	1	1	0	0	0/1	0/1	0	0	0	0	0
Cache Read Fail	1	0	1	0	0	1	0	0	0/1	0/1	0	0	0	0	0
Erase Verify Read Fail ³⁾	0	0	0	0	1	1	0	0	0/1	0/1	0	0	0	0	0
Load Reset ²⁾	0	0	1	0	0	1	0	1	0/1	0/1	0	0	0	0	0
Program Reset	0	0	0	1	0	1	0	1	0/1	0/1	0	0	0	0	0
Erase Reset	0	0	0	0	1	1	0	1	0/1	0/1	0	0	0	0	0
Erase Suspend	0	0	0	0	1	0	1	0	0/1	0/1	0	0	0	0	0
Program Lock	0	1	0	1	0	1	0	0	0/1	0/1	0	0	0	0	0
Erase Lock	0	1	0	0	1	1	0	0	0/1	0/1	0	0	0	0	0
Load Lock(Buffer Lock)	0	1	1	0	0	1	0	0	0/1	0/1	0	0	0	0	0
OTP Program Fail(Lock)	0	1	0	1	0	1	0	0	1	1	0	0	0	0	0
OTP Program Fail	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
OTP Erase Fail	0	1	0	0	1	1	0	0	0/1	0/1	0	0	0	0	0
Program Ongoing(Susp.)	1	0	0	1	1	0	1	0	0/1	0/1	0	0	0	0	0
Load Ongoing(Susp.)	1	0	1	0	1	0	1	0	0/1	0/1	0	0	0	0	0
Program Fail(Susp.)	0	0	0	1	1	1	1	0	0/1	0/1	0	0	0	0	0
Load Fail(Susp.)	0	0	1	0	1	1	1	0	0/1	0/1	0	0	0	0	0
Invalid Command	0	0	0	0	0	1	0	0	0/1	0/1	0	0	0	0	0
Invalid Command(Susp.)	0	0	0	0	1	1	1	0	0/1	0/1	0	0	0	0	0

NOTE :

- 1) ERm and/or ERs bits in ECC status register at Load Fail case is 10. (2bits error - uncorrectable)
- 2) ERm and ERs bits in ECC status register at Load Reset case are 00. (No error)
- 3) Multi Block Erase status should be checked by Erase Verify Read operation.
- 4) "1" for OTP Block Lock, "0" for OTP Block Unlock.
- 5) "1" for 1st Block OTP Lock, "0" for 1st Block OTP Unlock.

Controller Status Register Output Modes (Continued)

Mode	Controller Status Register [15:0]														
	[15]	[14]	[13]	[12]	[11]	[10]	[9]	[7]	[6]	[5]	[4]	[3]	[2]	[1]	[0]
	OnGo	Lock	Load	Prog	Erase	Error	Sus	RSTB	OTPL (note1)	OTPB.L (note2)	Plane1 Previous	Plane1 Current	Plane2 Previous	Plane2 Current	TO
Program Fail on 2X Program (Plane1)	0	0	0	1	0	1	0	0	0/1	0/1	0	1	0	0	0
Program Fail on 2X Program (Plane2)	0	0	0	1	0	1	0	0	0/1	0/1	0	0	0	1	0
Program Fail on 2X Program (Plane1 & Plane2)	0	0	0	1	0	1	0	0	0/1	0/1	0	1	0	1	0
Previous Program Fail During 2X Cache Program (Plane1)	1	0	0	1	0	1	0	0	0/1	0/1	1	(Note3)	0	0	0
Previous Program Fail During 2X Cache Program (Plane2)	1	0	0	1	0	1	0	0	0/1	0/1	0	0	1	(Note3)	0
Previous Program Fail During 2X Cache Program (Plane1 & Plane2)	1	0	0	1	0	1	0	0	0/1	0/1	1	(Note3)	1	(Note3)	0
Program Fail After Final 2X Cache Program	0	0	0	1	0	1	0	0	0/1	0/1	(Note4)				0

NOTE :

- 1) "1" for OTP Block Lock, "0" for OTP Block Unlock.
- 2) "1" for 1st Block OTP Lock, "0" for 1st Block OTP Unlock.
- 3) This value is invalid in this case. Host can recognize the status of the only previous operation.
- 4) Plane previous value is updated immediately after INT goes to ready state.
After Final 2X Cache Program operation by '2X Program Command' is completed, Current and Previous Program pass/fail status on both Plane1 and Plane2 will be updated.

2.8.22 Interrupt Status Register F241h (R/W)

This Read/Write register shows status of the OneNAND interrupts.
 In DDP, INT register will not be written if DBS, DFS is not set.

F241h, defaults = 8080h after Cold Reset; 8010h after Warm/Hot Reset

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
INT	Reserved(0000000)							RI	WI	EI	RSTI	Reserved(0000)			

Interrupt (INT)

This is the master interrupt bit. The INT bit is wired directly to the INT pin on the chip. Upon writing '0' to the INT bit, the INT pin goes low if INTpol is high and goes high if INTpol is low.

INT Interrupt [15]

Status	Conditions	Default State		Valid State	Interrupt Function
		Cold	Warm/hot		
		1	1	0	off
sets itself to '1'	One or more of RI, WI, RSTI and EI is set to '1', or 0065h, 0023h, 0071h, 002Ah, 0027h and 002Ch commands are completed.			0→1	Pending
clears to '0'	'0' is written to this bit, Cold/Warm/Hot reset is being performed, or command is written to Command Register in INT auto mode			1→0	off

Read Interrupt (RI)

This is the Read interrupt bit.

RI Interrupt [7]

Status	Conditions	Default State		Valid State	Interrupt Function
		Cold	Warm/hot		
		1	0	0	off
sets itself to '1'	At the completion of an Load Operation (0000h, 000Eh, 000Ch, 000Ah, 0013h, Load Data into Buffer, or boot is done)			0→1	Pending
clears to '0'	'0' is written to this bit, Cold/Warm/Hot reset is being performed, or command is written to Command Register in INT auto mode			1→0	off

Write Interrupt (WI)

This is the Write interrupt bit.

WI Interrupt [6]

Status	Conditions	Default State		Valid State	Interrupt Function
		Cold	Warm/hot		
		0	0	0	off
sets itself to '1'	At the completion of an Program Operation (0080h, 001Ah, 001Bh, 007Dh, 007Fh)			0→1	Pending
clears to '0'	'0' is written to this bit, Cold/Warm/Hot reset is being performed, or command is written to Command Register in INT auto mode			1→0	off

Erase Interrupt (EI)

This is the Erase interrupt bit.

EI Interrupt [5]

Status	Conditions	Default State		Valid State	Interrupt Function
		Cold	Warm/hot		
		0	0	0	off
sets itself to '1'	At the completion of an Erase Operation (0094h, 0095h, 0030h)			0→1	Pending
clears to '0'	'0' is written to this bit, Cold/Warm/Hot reset is being performed, or command is written to Command Register in INT auto mode			1→0	off

Reset Interrupt (RSTI)

This is the Reset interrupt bit.

RSTI Interrupt [4]

Status	Conditions	Default State		Valid State	Interrupt Function
		Cold	Warm/hot		
		0	1	0	off
sets itself to '1'	At the completion of an Reset Operation (00B0h, 00F0h, 00F3h or warm reset is released)			0→1	Pending
clears to '0'	'0' is written to this bit, or command is written to Command Register in INT auto mode			1→0	off

2.8.23 Start Block Address Register F24Ch (R/W)

This Read/Write register shows the NAND Flash block address in the Write Protection mode. Setting this register precedes a 'Lock Block' command, 'Unlock Block' command, or 'Lock-Tight' Command.

F24Ch, default = 0000h

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved(000000)					SBA										

Device	Number of Block	SBA
2Gb	2048	[10:0]

SBA Information[10:0]

Item	Definition	Description
SBA	Start Block Address	Precedes Lock Block, Unlock Block, or Lock-Tight commands

2.8.24 End Block Address Register F24Dh

This register is reserved for future use.

2.8.25 NAND Flash Write Protection Status Register F24Eh (R)

This Read register shows the Write Protection Status of the NAND Flash memory array.
To read the write protection status, FBA(DFS and DBS also in case of DDP) has to be set before reading the register.

F24Eh, default = 0002h

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved(00000000000000)													US	LS	LTS

Write Protection Status Information[2:0]

Item	Definition	Description
US	Unlocked Status	1 = current NAND Flash block is unlocked
LS	Locked Status	1 = current NAND Flash block is locked Or First Block of NAND Flash Array is Locked to be OTP
LTS	Locked-Tight Status	1 = current NAND Flash block is locked-tight

2.8.26 ECC Status Register FF00h (R)

This Read register shows the Error Correction Status. The OneNAND can detect 1- or 2-bit errors and correct 1-bit errors. 3-bit or more error detection and correction is not supported.

ECC can be performed on the NAND Flash main and spare memory areas. The ECC status register can also show the number of errors in a sector as a result of an ECC check in during a load operation. ECC status bits are also updated during a boot loading operation. ECC registers will be reset when another command is issued.

FF00h, default = 0000h

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
ERm3		ERs3		ERm2		ERs2		ERm1		ERs1		ERm0		ERs0 ¹⁾	

NOTE :

1) After Synchronous Block Burst Read operation, DQ[0] shows accumulated 1bit error.

Error Status

ERm, ERs	ECC Status
00	No Error
01	1 bit error(correctable)
10	2 bit error (uncorrectable)
11	Reserved

ECC Information[15:0]

Item	Definition	Description
ERm0	1st selected sector of the main BufferRAM	Status of errors in the 1st selected sector of the main BufferRAM as a result of an ECC check during a load operation. Also updated during a Bootload operation.
ERm1	2nd selected sector of the main BufferRAM	Status of errors in the 2nd selected sector of the main BufferRAM as a result of an ECC check during a load operation. Also updated during a Bootload operation.
ERm2	3rd selected sector of the main BufferRAM	Status of errors in the 3rd selected sector of the main BufferRAM as a result of an ECC check during a load operation. Also updated during a Bootload operation.
ERm3	4th selected sector of the main BufferRAM	Status of errors in the 4th selected sector of the main BufferRAM as a result of an ECC check during a load operation. Also updated during a Bootload operation.
ERs0	1st selected sector of the spare BufferRAM	Status of errors in the 1st selected sector of the spare BufferRAM as a result of an ECC check during a load operation. Also updated during a Bootload operation.
ERs1	2nd selected sector of the spare BufferRAM	Status of errors in the 2nd selected sector of the spare BufferRAM as a result of an ECC check during a load operation. Also updated during a Bootload operation.
ERs2	3rd selected sector of the spare BufferRAM	Status of errors in the 3rd selected sector of the spare BufferRAM as a result of an ECC check during a load operation. Also updated during a Bootload operation.
ERs3	4th selected sector of the spare BufferRAM	Status of errors in the 4th selected sector of the spare BufferRAM as a result of an ECC check during a load operation. Also updated during a Bootload operation.

2.8.27 ECC Result of 1st Selected Sector, Main Area Data Register FF01h (R)

This Read register shows the Error Correction result for the 1st selected sector of the main area data. ECCposWord0 is the error position address in the Main Area data of 256 words. ECCposIO0 is the error position address which selects 1 of 16 DQs. ECCposWord0 and ECCposIO0 are also updated at boot loading.

FF01h, default = 0000h

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved(0000)				ECCposWord0								ECCposIO0			

2.8.28 ECC Result of 1st Selected Sector, Spare Area Data Register FF02h (R)

This Read register shows the Error Correction result for the 1st selected sector of the spare area data. ECClogSector0 is the error position address for 1.5 words of 2nd and 3rd words in the spare area. ECCposIO0 is the error position address which selects 1 of 16 DQs. ECClogSector0 and ECCposIO0 are also updated at boot loading.

FF02h, default = 0000h

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved(0000000000)										ECClogSector0		ECCposIO0			

2.8.29 ECC Result of 2nd Selected Sector, Main Area Data Register FF03h (R)

This Read register shows the Error Correction result for the 2nd selected sector of the main area data. ECCposWord1 is the error position address in the Main Area data of 256 words. ECCposIO1 is the error position address which selects 1 of 16 DQs. ECCposWord1 and ECCposIO1 are also updated at boot loading.

FF03h, default = 0000h

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved(0000)				ECCposWord1								ECCposIO1			

2.8.30 ECC Result of 2nd Selected Sector, Spare Area Data Register FF04h (R)

This Read register shows the Error Correction result for the 2nd selected sector of the spare area data. ECClogSector1 is the error position address for 1.5 words of 2nd and 3rd words in the spare area. ECCposIO1 is the error position address which selects 1 of 16 DQs. ECClogSector1 and ECCposIO1 are also updated at boot loading.

FF04h, default = 0000h

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved(0000000000)										ECClogSector1		ECCposIO1			

2.8.31 ECC Result of 3rd Selected Sector, Main Area Data Register FF05h (R)

This Read register shows the Error Correction result for the 3rd selected sector of the main area data. ECCposWord2 is the error position address in the Main Area data of 256 words. ECCposIO2 is the error position address which selects 1 of 16 DQs. ECCposWord2 and ECCposIO2 are also updated at boot loading.

FF05h, default = 0000h

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved(0000)				ECCposWord2								ECCposIO2			

2.8.32 ECC Result of 3rd Selected Sector, Spare Area Data Register FF06h (R)

This Read register shows the Error Correction result for the 3rd selected sector of the spare area data. ECClogSector2 is the error position address for 1.5 words of 2nd and 3rd words in the spare area. ECCposIO2 is the error position address which selects 1 of 16 DQs. ECClogSector2 and ECCposIO2 are also updated at boot loading.

FF06h, default = 0000h

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved(0000000000)										ECClogSector2		ECCposIO2			

2.8.33 ECC Result of 4th Selected Sector, Main Area Data Register FF07h (R)

This Read register shows the Error Correction result for the 4th selected sector of the main area data. ECCposWord3 is the error position address in the Main Area data of 256 words. ECCposIO3 is the error position address which selects 1 of 16 DQs. ECCposWord3 and ECCposIO3 are also updated at boot loading.

FF07h, default = 0000h

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved(0000)				ECCposWord3								ECCposIO3			

2.8.34 ECC Result of 4th Selected Sector, Spare Area Data Register FF08h (R)

This Read register shows the Error Correction result for the 4th selected sector of the spare area data. ECClogSector3 is the error position address for 1.5 words of 2nd and 3rd words in the spare area. ECCposIO3 is the error position address which selects 1 of 16 DQs. ECClogSector3 and ECCposIO3 are also updated at boot loading.

FF08h, default = 0000h

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved(0000000000)										ECClogSector3		ECCposIO3			

ECC Log Sector

ECClogSector0~ECClogSector3 indicates the error position in the 2nd word and LSB of 3rd word in the spare area.
Refer to note 2 in chapter 2.7.2

ECClogSector Information [5:4]

ECClogSector	Error Position
00	2nd word
01	3rd word
10, 11	Reserved

3.0 DEVICE OPERATION

This section of the datasheet discusses the operation of the OneNAND device. It is followed by AC/DC Characteristics and Timing Diagrams which may be consulted for further information.

The OneNAND supports a limited command-based interface in addition to a register-based interface for performing operations on the device.

3.1 Command Based Operation

The command-based interface is active in the boot partition. Commands can only be written with a boot area address. Boot area data is only returned if no command has been issued prior to the read.

The entire address range, except for the boot area, can be used for the data buffer. All commands are written to the boot partition. Writes outside the boot partition are treated as normal writes to the buffers or registers.

The command consists of one or more cycles depending on the command. After completion of the command the device starts its execution. Writing incorrect information including address and data to the boot partition or writing an improper command will terminate the previous command sequence and make the device enter the ready status.

The defined valid command sequences are stated in Command Sequences Table.

Command based operations are mainly used when OneNAND is used as Booting device, and all command based operations only supports asynchronous reads and writes. With DDP, command based operation except reset is applicable only on chip1.

Command Sequences

Command Definition		Cycles	1st cycle	2nd cycle
Reset OneNAND	Add	1	BP ¹⁾	
	Data		00F0h	
Load Data into Buffer ²⁾	Add	2	BP	BP
	Data		00E0h	0000h ³⁾
Read Identification Data ⁵⁾	Add	2	BP	XXXXh ⁴⁾
	Data		0090h	Data

NOTE :

- 1) BP(Boot Partition) : BootRAM Area [0000h ~ 01FFh, 8000h ~ 800Fh].
- 2) Load Data into Buffer operation is available within a block(128KB) (Chip1 only in case of DDP)
- 3) Load 2KB unit into DataRAM0. Current Start address(FPA) is automatically incremented by 2KB unit after the load.
- 4) 0000h -> Data is Manufacturer ID (Chip1 only in case of DDP)
0001h -> Data is Device ID (Chip1 only in case of DDP)
0002h -> Current Block Write Protection Status (Chip1 only in case of DDP)
- 5) WE toggling can terminate 'Read Identification Data' operation.

3.1.1 Reading Data From Buffer

The buffer memory can be read by addressing a Read to the desired buffer area.

3.1.2 Writing Data to Buffer

The buffer memory can be written to by addressing a Write to a desired buffer area.

3.1.3 Reset OneNAND Command

The Reset command is given by writing 00F0h to the boot partition address. Reset will return all default values into the device.

3.1.4 Load Data Into Buffer Command

Load Data into Buffer command is a two-cycle command. Two sequential designated command activates this operation. Sequentially writing 00E0h and 0000h to the boot partition [0000h~01FFh, 8000h~800Fh] will load one page to DataRAM0. This operation refers to FBA and FPA. FSA, BSA, and BSC are not considered.

At the end of this operation, FPA will be automatically increased by 1. So continuous issue of this command will sequentially load data in next page to DataRAM0. This page address increment is restricted within a block.

The default value of FBA and FPA is 0. Therefore, initial issue of this command after power on will load the first page of memory, which is usually boot code.

3.1.5 Read Identification Data Command

The Read Identification Data command consists of two cycles. It gives out the devices identification data according to the given address. The first cycle is 0090h to the boot partition address and second cycle is read from the addresses specified in Identification Data Description Table.

Identification Data Description

Address	Data Out
0000h	Manufacturer ID (00ECh)
0001h	Device ID ¹⁾
0002h	Current Block Write Protection Status ²⁾

NOTE :

1) Refer to Device ID Register (Chapter 2.8.3)

2) To read the write protection status, FBA has to be set before issuing this command.

3.2 Device Bus Operation

The device bus operations are shown in the table below.

Operation	$\overline{CE}$	$\overline{OE}$	$\overline{WE}$	ADD0~15	DQ0~15	$\overline{RP}$	CLK	$\overline{AVD}$
Standby	H	X	X	X	High-Z	H	X	X
Warm Reset	X	X	X	X	High-Z	L	X	X
Asynchronous Write	L	H	L	Add. In	Data In	H	L	X
Asynchronous Read	L	L	H	Add. In	Data Out	H	L	 or L
Load Initial Burst Read	L	H	H	Add. In	X	H		
Burst Read	L	L	H	X	Burst Data Out	H		X
Terminate Burst Read Cycle	H	X	H	X	High-Z	H	X	X
Terminate Burst Read Cycle via $\overline{RP}$	X	X	X	X	High-Z	L	X	X
Terminate Current Burst Read Cycle and Start New Burst Read Cycle		H	H	Add In	High-Z	H		
Load Initial Burst Write	L	H	L	Add. In	X	H		
Burst Write	L	H	X	X	Burst Data In	H		X
Terminate Burst Write Cycle	H	X	X	X	High-Z	H	X	X
Terminate Burst Write Cycle via $\overline{RP}$	X	X	X	X	High-Z	L	X	X
Terminate Current Burst Write Cycle and Start New Burst Write Cycle		H	L	Add In	High-Z	H		

NOTE :

L=VIL (Low), H=VIH (High), X=Don't Care.

3.3 Reset Mode Operation

The One NAND has 4 reset modes: Cold/Warm/Hot Reset, and NAND Flash Array Reset. Section 3.3 discusses the operation of these reset modes.

The Register Reset Table shows the which registers are affected by the various types or Reset operations.

Internal Register Reset Table

	Internal Registers	Default	Cold Reset	Warm Reset (RP)	Hot Reset (00F3h)	Hot Reset (BP-F0h)	NAND Flash Core Reset (00F0h)
F000h	Manufacturer ID Register (R)	00ECh	N/A	N/A	N/A	N/A	N/A
F001h	Device ID Register (R): OneNAND	(Note 3)	N/A	N/A	N/A	N/A	N/A
F002h	Version ID Register (R)	N/A	N/A	N/A	N/A	N/A	N/A
F003h	Data Buffer size Register (R)	0800h	N/A	N/A	N/A	N/A	N/A
F004h	Boot Buffer size Register (R)	0200h	N/A	N/A	N/A	N/A	N/A
F005h	Amount of Buffers Register (R)	0201h	N/A	N/A	N/A	N/A	N/A
F006h	Technology Register (R)	0000h	N/A	N/A	N/A	N/A	N/A
F100h	Start Address1 Register (R/W): DFS, FBA	0000h	0000h	0000h	0000h	0000h	N/A
F101h	Start Address2 Register (R/W): DBS	0000h	0000h	0000h	0000h	0000h	N/A
F102h	Start Address3 Register (R/W): FCBA	0000h	0000h	0000h	0000h	0000h	N/A
F103h	Start Address4 Register (R/W): FCPA, FCSA	0000h	0000h	0000h	0000h	0000h	N/A
F104h	Start Address5 Register (R/W): FPC	0000h	0000h	0000h	0000h	0000h	N/A
F107h	Start Address8 Register (R/W): FPA, FSA	0000h	0000h	0000h	0000h	0000h	N/A
F200h	Start Buffer Register (R/W): BSA, BSC	0000h	0000h	0000h	0000h	0000h	N/A
F220h	Command Register (R/W)	0000h	0000h	0000h	0000h	0000h	N/A
F221h	System Configuration 1 Register (R/W)	40C0h	40C0h	(Note1a)	(Note1a)	(Note1a)	N/A
F240h	Controller Status Register (R) (Note1b) (Note4)	0000h	0000h	0000h	0000h	0000h	N/A
F241h	Interrupt Status Register (R/W)	-	8080h	8010h	8010h	8010h	N/A
F24Ch	Start Block Address (R/W) : SBA	0000h	0000h	0000h	N/A	N/A	N/A
F24Dh	End Block Address: N/A	N/A	N/A	N/A	N/A	N/A	N/A
F24Eh	NAND Flash Write Protection Status (R) (Note5)	0002h	0002h	0002h	N/A	N/A	N/A
FF00h	ECC Status Register (R) (Note2)	0000h	0000h	0000h	0000h	0000h	N/A
FF01h	ECC Result of Sector 0 Main area data Register(R)	0000h	0000h	0000h	0000h	0000h	N/A
FF02h	ECC Result of Sector 0 Spare area data Register (R)	0000h	0000h	0000h	0000h	0000h	N/A
FF03h	ECC Result of Sector 1 Main area data Register(R)	0000h	0000h	0000h	0000h	0000h	N/A
FF04h	ECC Result of Sector 1 Spare area data Register (R)	0000h	0000h	0000h	0000h	0000h	N/A
FF05h	ECC Result of Sector 2 Main area data Register(R)	0000h	0000h	0000h	0000h	0000h	N/A
FF06h	ECC Result of Sector 2 Spare area data Register (R)	0000h	0000h	0000h	0000h	0000h	N/A
FF07h	ECC Result of Sector 3 Main area data Register(R)	0000h	0000h	0000h	0000h	0000h	N/A
FF08h	ECC Result of Sector 3 Spare area data Register (R)	0000h	0000h	0000h	0000h	0000h	N/A

NOTE :

1a) RDYpol, RDY conf, INTpol, IOBE are reset by Cold reset. The other bits are reset by cold/warm/hot reset.

1b) The other bits except OTP_L and OTP_{BL} are reset by cold/warm/hot reset.

2) ECC Status Register & ECC Result Registers are reset when any command is issued.

3) Refer to Device ID Register F001h.

4) Resetting during IDLE state, this is valid. But resetting during BUSY state, refer to Chapter 2.8.21.

5) To read NAND Flash Write Protection status, Block Address register must be written before.

3.3.1 Cold Reset Mode Operation

See Timing Diagram 6.18

At system power-up, the voltage detector in the device detects the rising edge of Vcc and releases an internal power-up reset signal. This triggers bootcode loading. Bootcode loading means that the boot loader in the device copies designated sized data (1KB) from the beginning of memory into the BootRAM. This sequence is the Cold Reset of OneNAND.

The POR(Power On Reset) triggering level is typically 1.5V. Boot code copy operation activates 400us after POR. Therefore, the system power should reach 1.7V within 400us from the POR triggering level for bootcode data to be valid.

It takes approximately 70us to copy 1KB of bootcode. Upon completion of loading into the BootRAM, it is available to be read by the host. The INT pin is not available until after IOBE = 1 and IOBE bit can be changed by host.

3.3.2 Warm Reset Mode Operation

See Timing Diagrams 6.19

A Warm Reset means that the host resets the device by using the $\overline{RP}$ pin. When the a $\overline{RP}$ low is issued, the device logic stops all current operations and executes internal reset operation and resets current NAND Flash core operation synchronized with the falling edge of $\overline{RP}$.

During an Internal Reset Operation, the device initializes internal registers and makes output signals go to default status. The BufferRAM data is kept unchanged after Warm/Hot reset operations.

The device guarantees the logic reset operation in case $\overline{RP}$ pulse is longer than tRP min(200ns). The device may reset if tRP < tRP min(200ns), but this is not guaranteed.

Warm reset will abort the current NAND Flash core operation. During a warm reset, the content of memory cells being altered is no longer valid as the data will be partially programmed or erased.

Warm reset has no effect on contents of BootRAM and DataRAM.

3.3.3 Hot Reset Mode Operation

See Timing Diagram 6.20

A Hot Reset means that the host resets the device by Reset command. The reset command can be either Command based or Register Based. Upon receiving the Reset command, the device logic stops all current operation and executes an internal reset operation and resets the current NAND Flash core operation.

During an Internal Reset Operation, the device initializes internal registers and makes output signals go to default status. The BufferRAM data is kept unchanged after Warm/Hot reset operations.

Hot reset has no effect on contents of BootRAM and DataRAM.

3.3.4 NAND Flash Core Reset Mode Operation

See Timing Diagram 6.21

The Host can reset the NAND Flash Core operation by issuing a NAND Flash Core reset command. NAND Flash core reset will abort the current NAND Flash core operation. During a NAND Flash core reset, the content of memory cells being altered is no longer valid as the data will be partially programmed or erased.

NAND Flash Core Reset has an effect on neither contents of BootRAM and DataRAM nor register values.

3.4 Write Protection Operation

The OneNAND can be write-protected to prevent re-programming or erasure of data.
The areas of write-protection are the BootRAM, and the NAND Flash Array.

3.4.1 BootRAM Write Protection Operation

At system power-up, voltage detector in the device detects the rising edge of Vcc and releases the internal power-up reset signal which triggers bootcode loading. And the designated size data(1KB) is copied from the first page of the first block in the NAND flash array to the BootRAM.

After the bootcode loading is completed, the BootRAM is always locked to protect the boot code from the accidental write.

3.4.2 NAND Flash Array Write Protection Operation

The device has both hardware and software write protection of the NAND Flash array.

Hardware Write Protection Operation

The hardware write protection operation is implemented by executing a Cold or Warm Reset. On power up, the NAND Flash Array is in its default, locked state. The entire NAND Flash array goes to a locked state after a Cold or Warm Reset.

Software Write Protection Operation

The software write protection operation is implemented by writing a Lock command (002Ah) or a Lock-tight command (002Ch) to command register (F220h).

Lock (002Ah) and Lock-tight (002Ch) commands write protects the block defined in the Start Block Address Register F24Ch.

3.4.3 NAND Array Write Protection States

There are three lock states in the NAND Array: unlocked, locked, and locked-tight.

OneNAND 2Gb supports lock/unlock/lock-tight by one block, and All Block Unlock at once. If any blocks are changed to locked-tight state, the all block unlock command will fail. In order to use all block unlock command again, a cold reset is needed.

Write Protection Status

The current block Write Protection status can be read in NAND Flash Write Protection Status Register(F24Eh). There are three bits - US, LS, LTS -, which are not cleared by hot reset. These Write Protection status registers are updated when FBA is set, and when Write Protection command is entered.

The followings summarize locking status.

example)

In default, [2:0] values are 010.

-> If host executes unlock block operation, then [2:0] values turn to 100.

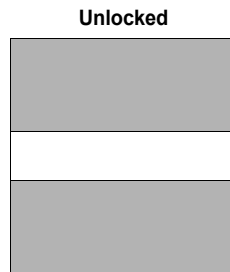
-> If host executes lock-tight block operation, then [2:0] values turn to 001.

3.4.3.1 Unlocked NAND Array Write Protection State

An Unlocked block can be programmed or erased. The status of an unlocked block can be changed to locked or locked-tight using the appropriate software command. (locked-tight state can be achieved via lock-tight command which follows lock command)

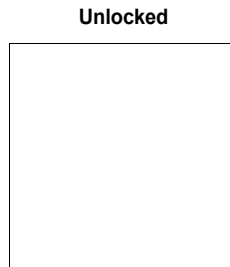
Only one block can be released from lock state to unlock state with Unlock command and addresses. The unlocked block can be changed with new lock command. Therefore, each block has its own lock/unlock/lock-tight state.

If any blocks are changed to locked-tight state, the all block unlock command will fail. In order to use all block unlock command again, a cold reset is needed.



Unlock Command Sequence:

Start block address+Unlock block command (0023h)



All Block Unlock Command Sequence:

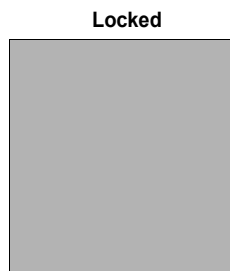
Start block address(000h)+All Block Unlock command (0027h)

NOTE :

Even though SBA is fixed to 000h, Unlock will be done for all block.

3.4.3.2 Locked NAND Array Write Protection State

A Locked block cannot be programmed or erased. All blocks default to a locked state following a Cold or Warm Reset. Unlocked blocks can be changed to locked using the Lock block command. The status of a locked block can be changed to unlocked or locked-tight using the appropriate software command.



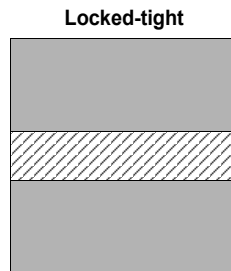
Lock Command Sequence:

Start block address+Lock block command (002Ah)

3.4.3.3 Locked-tight NAND Array Write Protection State

A block that is in a locked-tight state can only be changed to locked state after a Cold or Warm Reset. Unlock and Lock command sequences will not affect its state. This is an added level of write protection security. If any blocks are changed to locked-tight state, the all block unlock command will fail. In order to use all block unlock command again, a cold reset is needed.

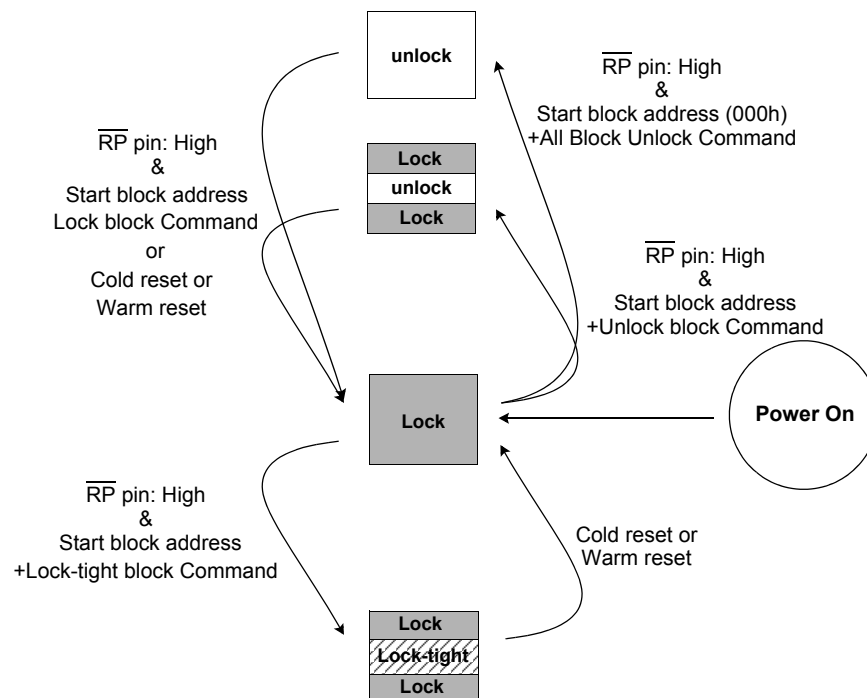
A block must first be set to a locked state before it can be changed to locked-tight using the Lock-tight command.



Lock-Tight Command Sequence:

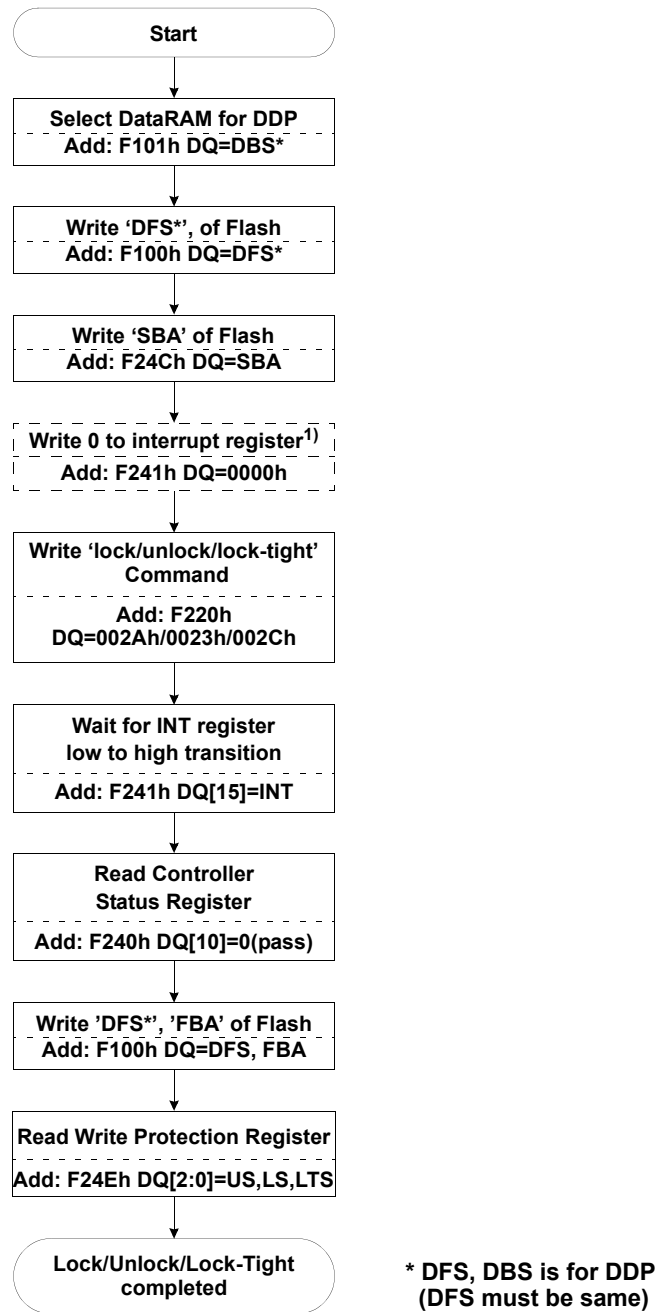
Start block address+Lock-tight block command (002Ch)

3.4.4 NAND Flash Array Write Protection State Diagram



NOTE : If the 1st Block is set to be OTP, Block 0 will always be Lock Status

Data Protection Operation Flow Diagram

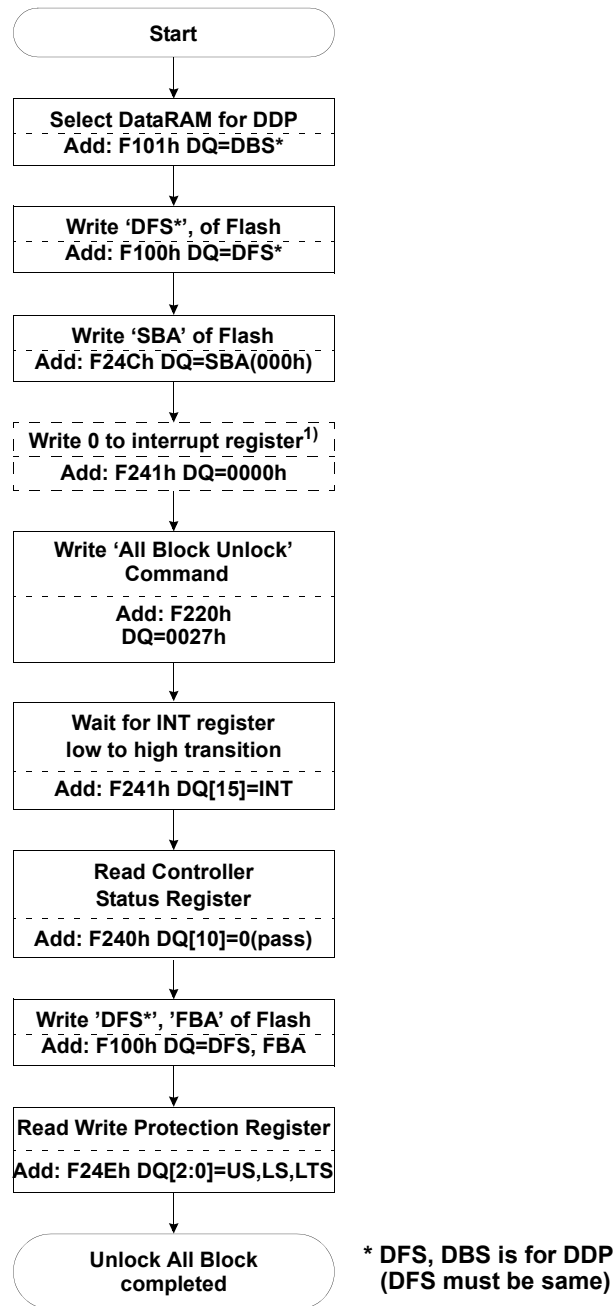


* Samsung strongly recommends to follow the above flow chart

NOTE :

1) 'Write 0 to interrupt register' step may be ignored when using INT auto mode. Refer to chapter 2.8.18.1

All Block Unlock Flow Diagram



* Samsung strongly recommends to follow the above flow chart

** If any blocks are changed to locked-tight state, the all block unlock command will fail.
In order to use all block unlock command again, a cold reset is needed.

NOTE :

1) 'Write 0 to interrupt register' step may be ignored when using INT auto mode. Refer to chapter 2.8.18.1

OneNAND2G(KFG2G16Q2A-DEBx)

OneNAND4G(KFH4G16Q2A-DEBx)

FLASH MEMORY

3.5 Data Protection During Power Down Operation

See Timing Diagram 6.22

The device is designed to offer protection from any involuntary program/erase during power-transitions. RP pin which provides hardware protection must be kept at VIL before Vcc drops to 1.5V.

3.6 Load Operation

See Timing Diagrams 6.12

The Load operation is initiated by setting up the start address from which the data is to be loaded. The Load command is issued in order to initiate the load.

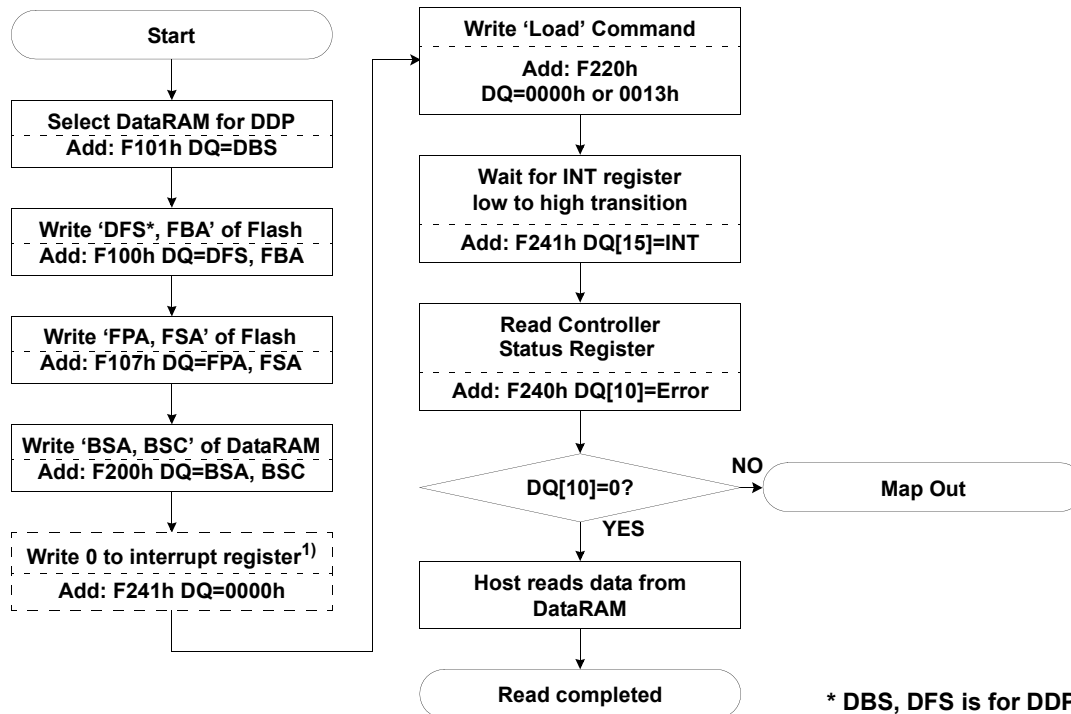
During a Load operation, the device:

- Transfers the data from NAND Flash array into the BufferRAM
- ECC is checked and any detected and corrected error is reported in the status response as well as any unrecoverable error.

Once the BufferRAM has been filled, an interrupt is issued to the host so that the contents of the BufferRAM can be read. The read from the BufferRAM can be an asynchronous read mode or synchronous read mode. The status information related to load operation can be checked by the host if required.

The device has a dual data buffer memory architecture (DataRAM0, DataRAM1), each 2KB in size. Each DataRAM buffer has 4 Sectors. The device is capable of independent and simultaneous data-read operation from one data buffer and data-load operation to the other data buffer. Refer to the information for more details in section 3.15.1, "Read-While-Load Operation".

Load Operation Flow Chart Diagram



NOTE :

1) 'Write 0 to interrupt register' step may be ignored when using INT auto mode. Refer to chapter 2.8.18.1

3.7 Read Operation

See Timing Diagrams 6.1, 6.2, 6.5, 6.6, 6.7 and 6.8

The device has two read modes; Asynchronous Read and Synchronous Burst Read.

The initial state machine automatically sets the device into the Asynchronous Read Mode (RM=0) to prevent the spurious altering of memory content upon device power up or after a Hardware reset. No commands are required to retrieve data in Asynchronous Read Mode.

The Synchronous Read Mode is enabled by setting RM bit of System Configuration1 Register (F221h) to Synchronous Read Mode (RM=1). See Section 2.8.19 for more information about System Configuration1 Register.

3.7.1 Asynchronous Read Mode Operation (RM=0, WM=X)

See Timing Diagrams 6.5, 6.6, 6.7 and 6.8

In an Asynchronous Read Mode, data is output with respect to a logic input, $\overline{AVD}$.

Output data will appear on DQ15-DQ0 when a valid address is asserted on A15-A0 while driving $\overline{AVD}$ and $\overline{CE}$ to VIL. $\overline{WE}$ is held at VIH. The function of the $\overline{AVD}$ signal is to latch the valid address.

Address access time from $\overline{AVD}$ low (tAA) is equal to the delay from valid addresses to valid output data.

The Chip Enable access time (tCE) is equal to the delay from the falling edge of $\overline{CE}$ to valid data at the outputs.

The Output Enable access time (tOE) is the delay from the falling edge of $\overline{OE}$ to valid data at the output.

3.7.2 Synchronous Read Mode Operation (RM=1, WM=X)

See Timing Diagrams 6.1 and 6.2

In a Synchronous Read Mode, data is output with respect to a clock input.

The device is capable of a continuous linear burst operation and a fixed-length linear burst operation of a preset length. Burst address sequences for continuous and fixed-length burst operations are shown in the table below.

Burst Address Sequences

	Start Addr.	Burst Address Sequence(Decimal)				
		Continuous Burst	4-word Burst	8-word Burst	16-word Burst	32-word Burst
Wrap around	0	0-1-2-3-4-5-6-...-0-1...	0-1-2-3-0...	0-1-2-3-4-5-6-7-0...	0-1-2-3-4-...-13-14-15-0...	0-1-2-3-4-...-29-30-31-0...
	1	1-2-3-4-5-6-7-...-1-2...	1-2-3-0-1...	1-2-3-4-5-6-7-0-1...	1-2-3-4-5-...-14-15-0-1...	1-2-3-4-5-...-30-31-0-1...
	2	2-3-4-5-6-7-8-...-2-3...	2-3-0-1-2...	2-3-4-5-6-7-0-1-2...	2-3-4-5-6-...-15-0-1-2...	2-3-4-5-6-...-31-0-1-2...
	.	.	.	.	.	.
	.	.	.	.	.	.

In the burst mode, the initial word will be output asynchronously, regardless of BRWL. While the following words will be determined by BRWL value.

The latency is determined by the host based on the BRWL bit setting in the System Configuration 1 Register. The default BRWL is 4 latency cycles. At clock frequencies of 40MHz or lower, latency cycles can be reduced to 3. BRWL can be set up to 7 latency cycles.

The BRWL registers can be read during a burst read mode by using the $\overline{AVD}$ signal with an address.

3.7.2.1 Continuous Linear Burst Read Operation

See Timing Diagram 6.2

First Clock Cycle

The initial word is output at t_{I/A} after the rising edge of the first CLK cycle. The RDY output indicates the initial word is ready to the system by pulsing high. If the device is accessed synchronously while it is set to Asynchronous Read Mode, the first data can still be read out.

Subsequent Clock Cycles

Subsequent words are output (Burst Access Time from Valid Clock to Output) t_{BA} after the rising edge of each successive clock cycle, which automatically increments the internal address counter.

Terminating Burst Read

The device will continue to output sequential burst data until the system asserts $\overline{CE}$ high, or $\overline{RP}$ low, wrapping around until it reaches the designated address (see Section 2.7.3 for address map information). Alternately, a Cold/Warm/Hot Reset, or a WE low pulse will terminate the burst read operation.

Synchronous Read Boundary

Division	Add.map(word order)	
BootRAM Main(0.5KW)	0000h~01FFh	Not Support
BufferRAM0 Main(1KW)	0200h~05FFh	
BufferRAM1 Main(1KW)	0600h~09FFh	
Reserved Main	0A00h~7FFFh	Not Support
BootRAM Spare(16W)	8000H~800Fh	
BufferRAM0 Spare(32W)	8010h~802Fh	
BufferRAM1 Spare(32W)	8030h~804Fh	Not Support
Reserved Spare	8050h~8FFFh	
Reserved Register	9000h~EFFFh	
Register(4KW)	F000h~FFFFh	Not Support

* Reserved area is not available on Synchronous read

3.7.2.2 4-, 8-, 16-, 32-Word Linear Burst Read Operation

See Timing Diagram 6.1

An alternate Burst Read Mode enables a fixed number of words to be read from consecutive address.

The device supports a burst read from consecutive addresses of 4-, 8-, 16-, and 32-words with a linear-wrap around. When the last word in the burst has been reached, assert $\overline{CE}$ and $\overline{OE}$ high to terminate the operation.

In this mode, the start address for the burst read can be any address of the address map with one exception. The device does not support a 32-word linear burst read on the spare area of the BufferRAM.

3.7.2.3 Programmable Burst Read Latency Operation

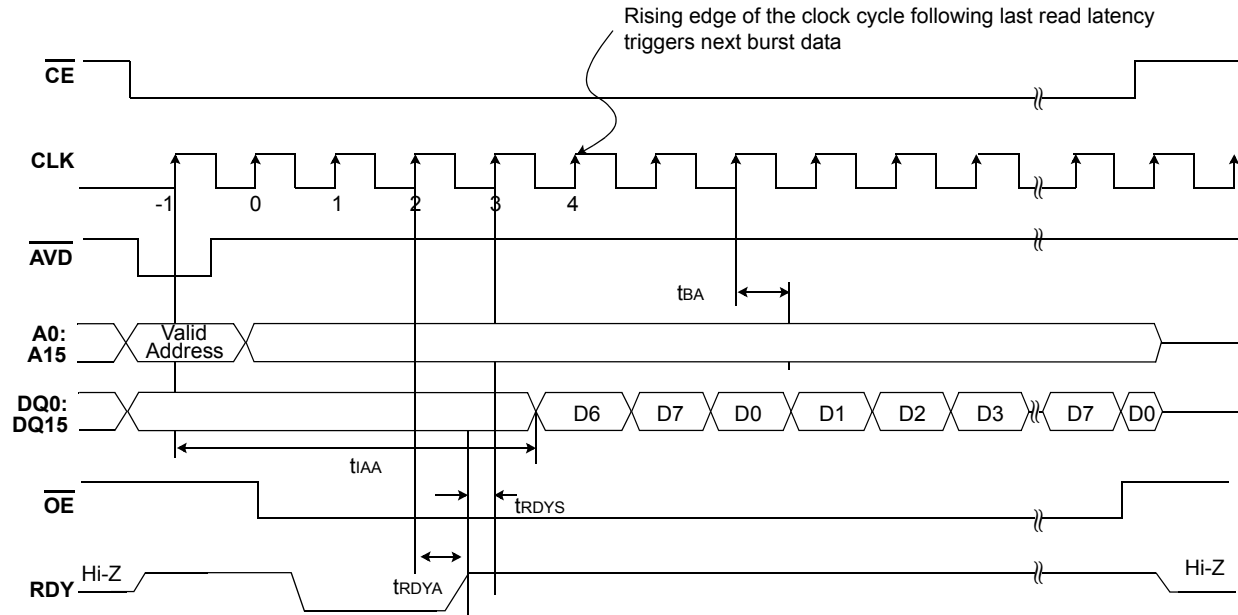
See Timing Diagrams 6.1 and 6.2

Upon power up, the number of initial clock cycles from Valid Address ($\overline{AVD}$) to initial data defaults to four clocks.

The number of clock cycles (n) which are inserted after the clock which is latching the address. The host can read the first data with the (n+1)th rising edge.

The number of total initial access cycles is programmable from three to seven cycles. After the number of programmed burst clock cycles is reached, the rising edge of the next clock cycle triggers the next burst data.

Four Clock Burst Read Latency (BRWL=4 case)



NOTE :

BRWL=4, HF=0 is recommended for 40MHz~66MHz. For frequency over 66MHz, BRWL should be 6 or 7 while HF=1. Also, for frequency under 40MHz, BRWL can be reduced to 3, and HF=0.

3.7.3 Handshaking Operation

The handshaking feature allows the host system to simply monitor the RDY signal from the device to determine when the initial word of burst data is ready to be read.

To set the number of initial cycles for optimal burst mode, the host should use the programmable burst read latency configuration (see Section 2.8.19, "System Configuration1 Register").

The rising edge of RDY which is derived at one cycle prior of data fetch clock indicates the initial word of valid burst data.

3.7.4 Output Disable Mode Operation

When the $\overline{CE}$ or $\overline{OE}$ input is at V_{IH} , output from the device is disabled.

The outputs are placed in the high impedance state.

3.8 Cache Read Operation (RM=X, WM=X)

A Normal Load Operation(0000h) consists of sequential operation of 'sensing from NAND Flash Array to Page Buffer' and 'transferring from Page Buffer to DataRAM'.

Cache Read is a method of improving the data read throughput performance of the device by allowing new data to be transferred from the NAND Flash Array memory into a Page Buffer while the previous data that was requested is transferred from the Page Buffer to the DataRAM. This method is called Transfer-While Sensing Operation.

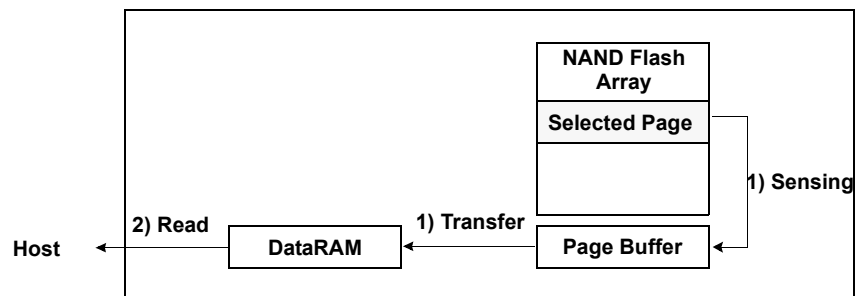
This ability to simultaneously sense a new page shortens the read cycle resulting in performance increase to 108Mbytes/second.

Cache Read Mode is designed to continuously read massive data from random address at a high speed.

The characteristics of Cache read is as follows;

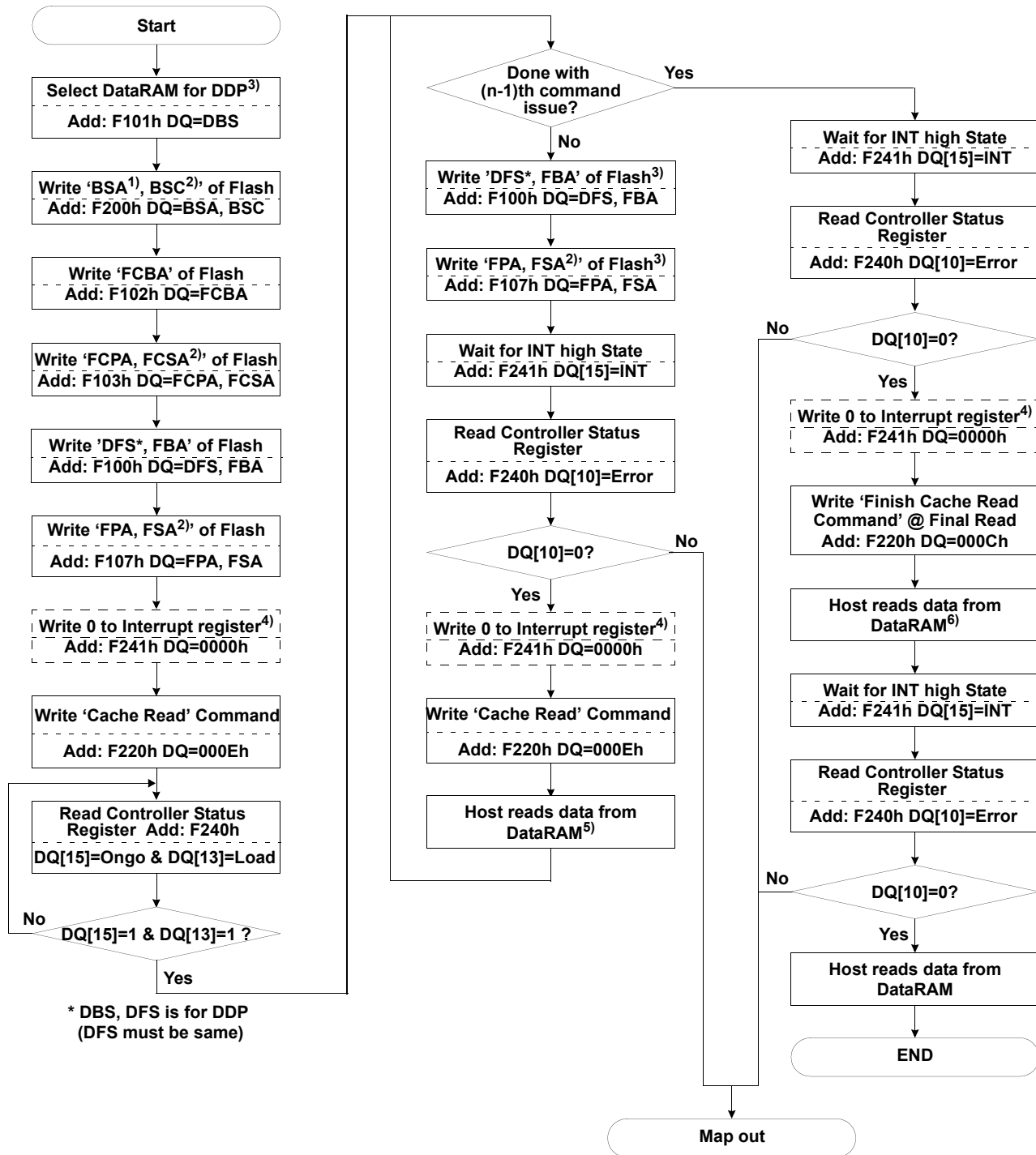
- Before entering 'First Cache Read Command(000Eh)', address of two pages which will be read will be set on address registers. The register information follows on next line.
- Register used for first page is Copy-back registers (FCBA, FCPA and FCSA). and the registers used for addressing second page and following cache read are normal address registers(FBA, FPA and FSA). At Cache Read Operation, FCSA and FSA must be set to "00".
- BSA setting is only required once at 'First Cache Read' cycle. From the following cycles, BSA will be automatically switched to select DataRAM0 and DataRAM1 alternately.
- BSC must be fixed as "00"
- To eliminate performance degradation during Ready state(INT high state) due to register setting time, setting registers (FBA, FPA and FSA) during busy state(INT low state) is possible from third address setting onwards.
- Inputting other commands, which is not related to Cache Read, between 'First Cache Read Command' and 'Finish Cache Read Command' will fail the Cache Read operation.
- In case of performing Cache Read at INT auto mode, INT low setting is not necessary. INT will automatically go to low when Cache Read command is issued.
- If host changes DBS or DFS to access the other chip for DDP while performing cache read operation, it will fail the cache read operation.

Transfer-While Sensing Operation



A Cache-Read flow chart is on the following page.

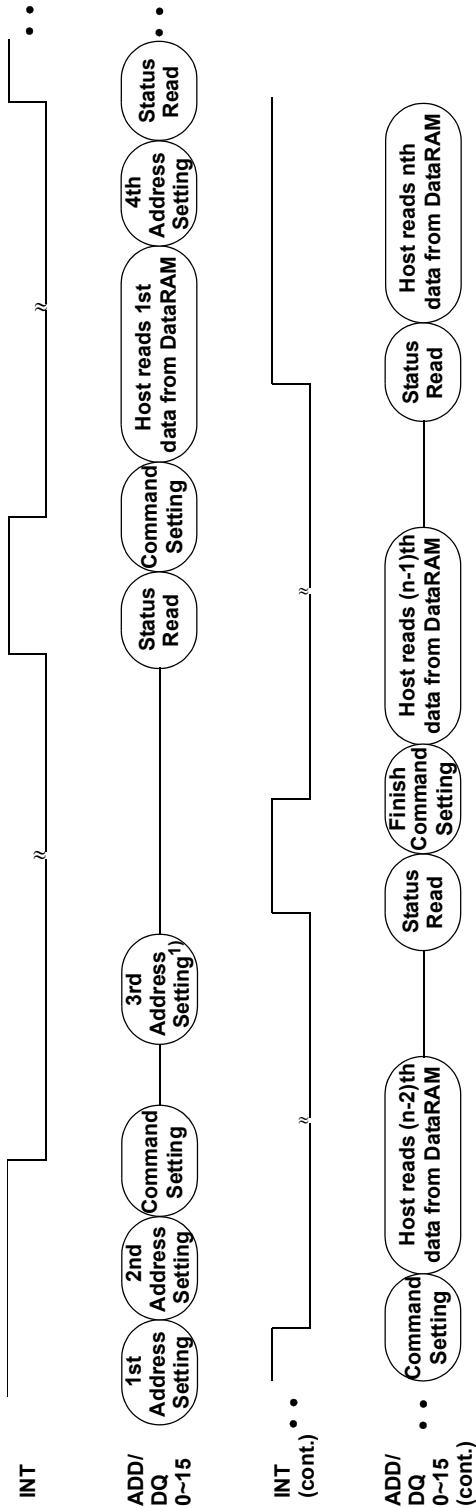
Cache Read Flow Chart



NOTE :

- 1) In case of first cycle cache read, BSA must be set to 1000 or 1100, and from second cycle cache read, BSA will automatically be switched between DataRAM0 and DataRAM1.
- 2) BSC, FSA and FCSA must be set to "00".
- 3) These steps can also be set during INT=High, before next 'Cache Read Command'
- 4) 'Write 0 to interrupt register' step may be ignored when using INT auto mode. Refer to chapter 2.8.18.1
- 5) When host reads data from DataRAM, host should start from the DataRAM of the first set BSA, and then next DataRAM alternately, as the number of Cache Read.

Cache Read Diagram



- 1st Address Setting : Address Setting Operation for first page load(FCBA, FCPA, FCSA, and BSA).
- 2nd~nth Address Setting : Address Setting Operation from 2nd~nth page load(FBA and FPA).
- Command Setting : It consists of writing 0 to Interrupt register and writing command to Command register.
(In INT auto mode, writing 0 to Interrupt register may be ignored)
- Status Read : It consists of INT high state checking and Controller Status Register checking step.
- Host read 1st~nth data from DataRAM : During this step, Host can read data from DataRAM by any read mode which supported by OneNAND.
- Finish Command Setting : If host want to finish Cache Read, Host can finish Cache Read by issuing Finish Command.
- Controller Status Register Status: During Cache Read - Ongoing / Load
ECC Error during Cache Read - Ongoing / Load / Error
ECC Error at Finish Cache Read - Load / Error

NOTE :

1) 3rd~nth address can be set during INT=low, and also during INT=High, before next 'Cache Read Command'.

3.9 Synchronous Burst Block Read Operation (RM=1,WM=X)

See Timing Diagram 6.3 and 6.4

OneNAND is internally composed of two DataRAMs and NAND Flash Array. And for host to read data from NAND Cell Array, load operation which moves data from NAND Cell Array to DataRAM is required. After this load operation, host may use various read mode, such as synchronous burst read or asynchronous read, to read data from OneNAND.

But these types of read mode require issuing of address and Load Command for each page, and CPU had the burden of calculating address to be read. To solve this burden, Synchronous Burst Block Read Mode is introduced, which enables host to read the data of succeeding page with CLK toggle, after initial address setting and command input. This Synchronous Burst Block Read is intended to transfer continuous massive data in NAND Flash Array at high speed, and it sequentially reads out data only from Main Area, where large sized data is stored.

The addresses set for Synchronous Burst Block Read is Start Page Address(FPA), Number of Page(FPC) and BSA. Note that the number of page set by FPC should not exceed the block boundary, since page wrap-around is not supported. And from the start page address to desired number of page, Synchronous Burst Block Read will output data by CLK toggle and $\overline{CE}$ enable/disable. FPC must be set from 3pages to 64pages. (Refer to 2.8.13)

The Host can access OneNAND during Synchronous Burst Block Read in between every 1-page of read cycle. When host accesses DataRAMs, the start address of DataRAMs must be a multiple of 4 in order to prevent from data corruption. In doing this, INT pin or bit is used as indicator signal. Thus, before host reads 1-page data from DataRAM, host must confirm INT pin or bit return low to high, and then enable $\overline{CE}$ to read 1-page of data. And when host read operation for this 1-page is done, INT will automatically turn low. Note that INT auto mode is a mandatory option for Synchronous Burst Block Read, and $\overline{WE}$ must always be set high throughout this operation.

Therefore, the steps are as follows;

1. Host will deassert $\overline{CE}$ of OneNAND after checking the indicator(INT pin / bit) turn low.
2. And then assert the $\overline{CE}$ of other device to perform another operation.
3. Then disable this other device by deasserting $\overline{CE}$ when desired operation is done.
4. Once the host confirms the INT pin or bit of OneNAND turn low to high, host may read the data of following page by asserting $\overline{CE}$ (refer to synchronous burst block read operation timing).

Note that return of INT pin to high implies the internal load operation from NAND Flash Array to DataRAM is complete. Also, when the host is not accessing other device, this assert/deassert of $\overline{CE}$ step is necessary.

To read data from this loaded 1 page, same 4, 8, 16, 32, continuous (1K word) linear burst read operation of synchronous burst read may be utilized.

In conclusion, by supporting indicator signal such as INT pin or bit, host may access other device without terminating continuous linear synchronous burst block read, while using continuous linear burst read mode as synchronous block read within 1 block between every (n) page and (n+1) page. (refer to synchronous burst block read boundary)

3.9.1 Burst Address Sequence During Synchronous Burst Block Read Mode

In a Synchronous Burst Block Read, data is output with respect to a clock input.

OneNAND is capable of a continuous linear burst operation within one block size and a fixed-length linear burst operation of a preset length. Note that only INT pin is valid indicator signal for continuous linear burst read operation but both INT pin and bit are valid for a fixed-length linear burst operation.

Same as the normal burst mode, the initial word will be output asynchronously, regardless of BRWL. While the following words will be determined by BRWL value.

The latency is determined by the host based on the BRWL bit setting in the System Configuration 1 Register. The default BRWL is 4 latency cycles. At clock frequencies of 40MHz or lower, latency cycles can be reduced to 3, at frequency range from 40MHz to 66MHz, latency cycle should be over 4. And at 83MHz frequency, BRWL should be set to 6. BRWL can be set up to 7 latency cycles.

The BRWL registers can be read during a burst read mode by using the $\overline{\text{AVD}}$ signal with an address.

3.9.2 Continuous Linear Burst Read Operation During Synchronous Burst Block Read Mode

First Clock Cycle

The initial word is output at tIAA after the rising edge of the first CLK cycle. The RDY output indicates the initial word is ready to the system by pulsing high. If the device is accessed synchronously while it is set to Asynchronous Read Mode, the first data can still be read out.

Subsequent Clock Cycles

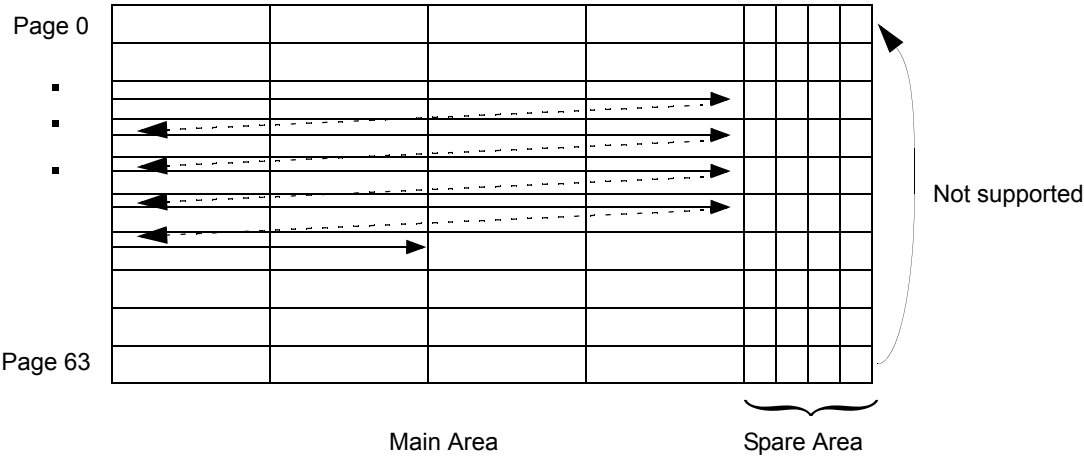
Subsequent words are output (Burst Access Time from Valid Clock to Output) tBA after the rising edge of each successive clock cycle, which automatically increments the internal address counter.

Terminating Synchronous Burst Block Read

The device will continue to output sequential burst data until the system resets (Cold/Warm/Hot Reset), wrapping around until it reaches the designated address (see Section 3.9.1 for burst address sequence). Asserting WE low is prohibited during Synchronous Burst Block Read operation.

Synchronous Burst Block Read Boundary

Read Sequence for Single Plane Device
note that only main area data is read.



3.9.3 4-, 8-, 16-, 32-, 1K- Word Linear Burst Read Operation During Synchronous Burst Block Read Mode

Same as normal linear burst read, synchronous burst block read enables a fixed number of words to be read from consecutive address.

The device supports a burst read from consecutive addresses of 4-, 8-, 16-, 32- and 1K-words with no wrap.
(note that wrap-around is not supported in Synchronous Burst Block Read)

3.9.4 Programmable Burst Read Latency Operation During Synchronous Burst Block Read Mode

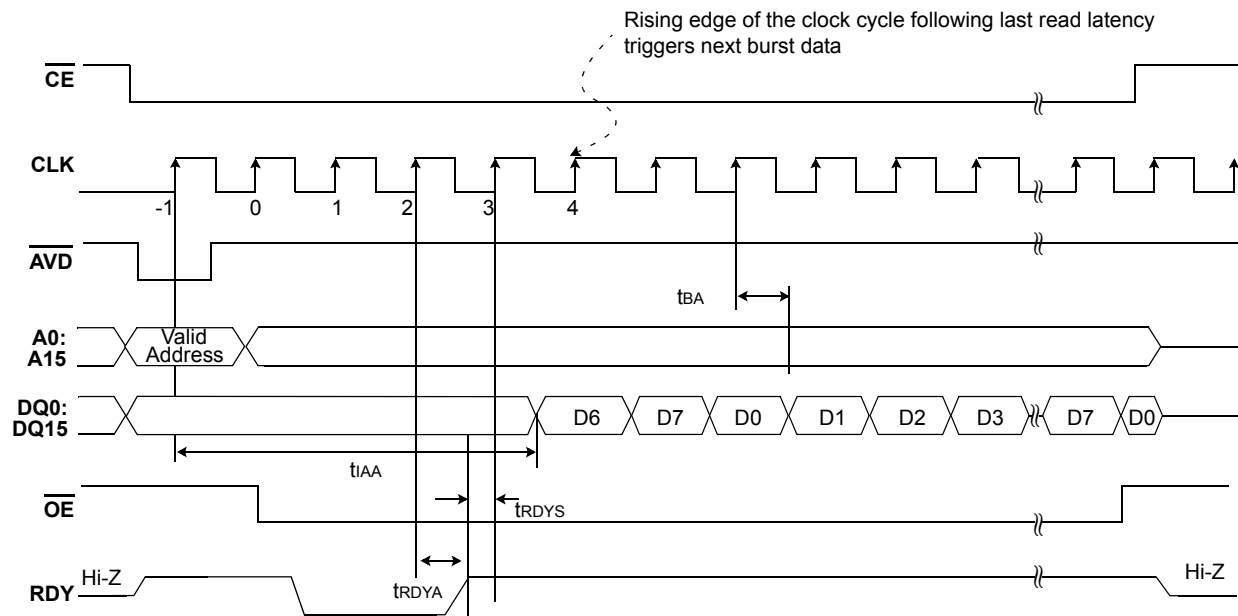
Synchronous burst block read mode have programmable burst read latency just same manner as normal synchronous burst read mode.

Upon power up, the number of initial clock cycles from Valid Address ($\overline{AVD}$) to initial data defaults to four clocks.

The number of clock cycles (n) which are inserted after the clock which is latching the address. The host can read the first data with the (n+1)th rising edge.

The number of total initial access cycles is programmable from three to seven cycles. After the number of programmed burst clock cycles is reached, the rising edge of the next clock cycle triggers the next burst data.

Four Clock Burst Read Latency (default condition)



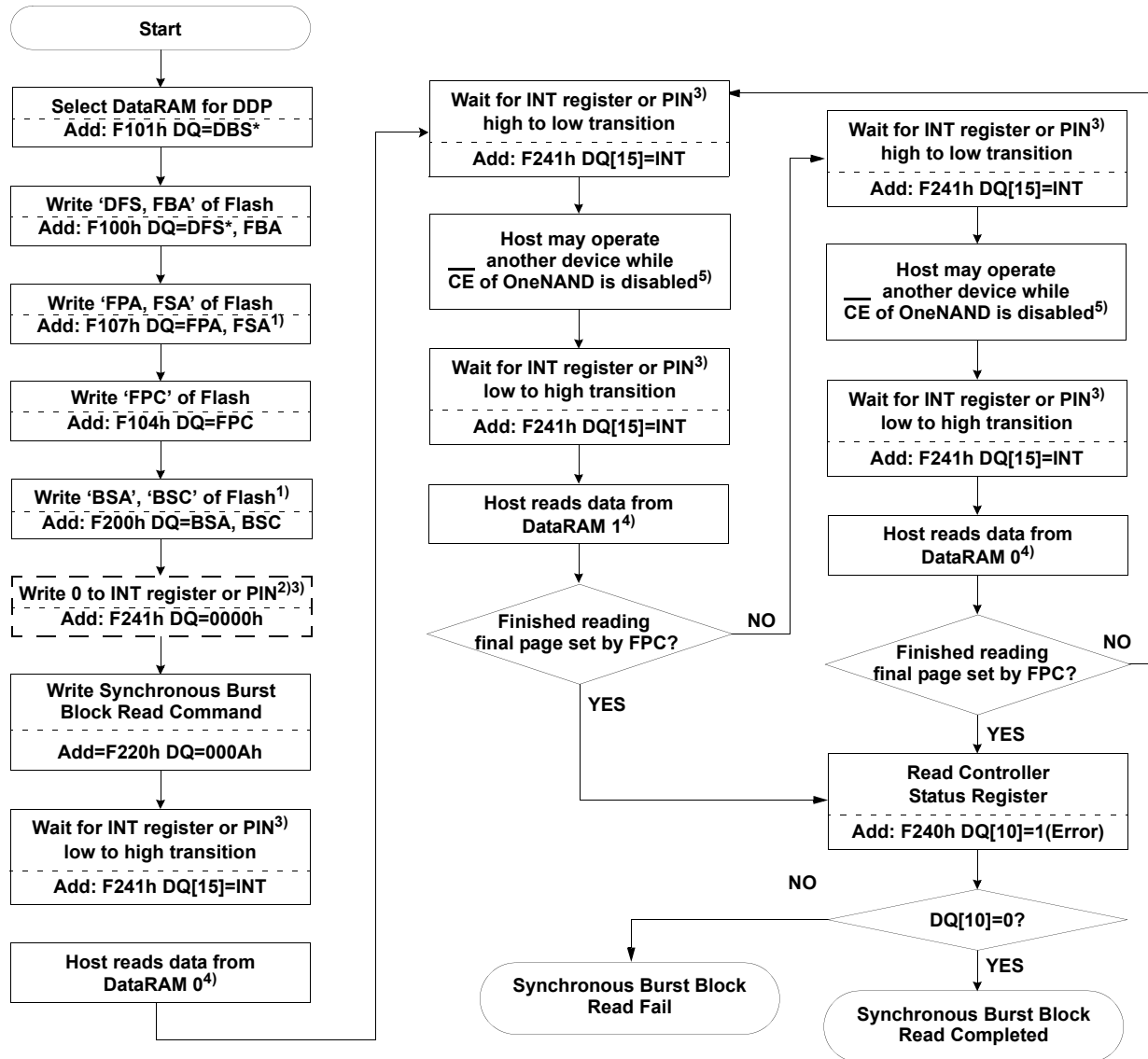
3.9.5 Handshaking Operation During Synchronous Burst Block Read Mode

The handshaking feature allows the host system to simply monitor the RDY signal from the device to determine when the initial word of burst data is ready to be read.

To set the number of initial cycles for optimal burst mode, the host should use the programmable burst read latency configuration (see Section 2.8.19, "System Configuration1 Register").

The rising edge of RDY which is derived at one cycle prior of data fetch clock indicates the initial word of valid burst data.

Synchronous Burst Block Read Operation Flow Chart



* DBS, DFS is for DDP

NOTE :

- 1) These registers must be set as BSA=1000, BSC=00 and FSA=00.
- 2) INT auto mode is mandatory for Synchronous Burst Block Read Operation.
- 3) For the continuous synchronous burst block read, only INT PIN is available. For the other fixed number of words linear burst block read, both INT register and INT pin are available.
- 4) While reading data from DataRAM, all normal synchronous burst read mode is supported for the main area.
- 5) At this time, host should disable the $\overline{CE}$ of OneNAND in order to operate another device. Even if host does not operate another device, $\overline{CE}$ should be disabled during INT low.

3.10 Synchronous Write(RM=1, WM=1)

See Timing Diagram 6.10

Burst mode operations enable high-speed synchronous read and write operations. Burst operations consist of a multi-clock sequence that must be performed in an ordered fashion. After $\overline{CE}$ goes low, the address to access is latched on the next rising edge of $\overline{clk}$ that $\overline{ADV}$ is low. During this first clock rising edge, $\overline{WE}$ indicates whether the operation is going to be a read ($\overline{WE}$ = high) or write ($\overline{WE}$ = low). The size of a burst can be specified in the BL as either a fixed length or continuous. Fixed-length bursts consist of 4, 8, 16, and 32 words. Continuous burst write has the ability to start at a specified address and burst within the designated DataRAM. The latency count stored in the BRWL defines the number of clock cycles that elapse before the initial data value is transferred between the processor and OneNAND device.

The RDY output will be asserted as soon as a burst is initiated, and will be de-asserted to indicate when data is to be transferred into (or out of) the memory. The processor can access other devices without incurring the timing penalty of the initial latency for a new burst by suspending burst mode. Bursts are suspended by stopping $\overline{clk}$. $\overline{clk}$ can be stopped high or low. Note that the RDY output will continue to be active, and as a result no other devices should directly share the RDY connection to the controller.

To continue the burst sequence, $\overline{clk}$ is restarted after valid data is available on the bus.

Same as the normal burst mode, the latency is determined by the host based on the BRWL bit setting in the System Configuration 1 Register. The default BRWL is 4 latency cycles. At clock frequencies of 40MHz or lower, latency cycles can be reduced to 3, at frequency range from 40MHz to 66MHz, latency cycle should be over 4. And at 83MHz frequency, BRWL should be set to 6. BRWL can be set up to 7 latency cycles.

3.11 Program Operation

See Timing Diagram 6.13

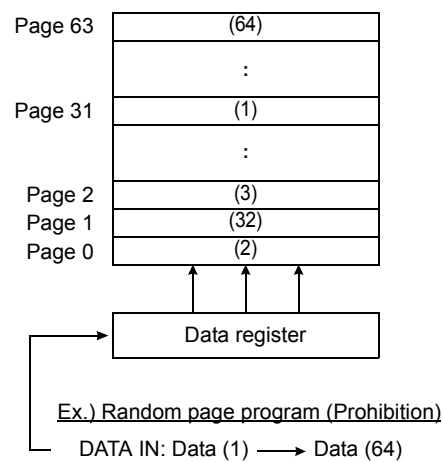
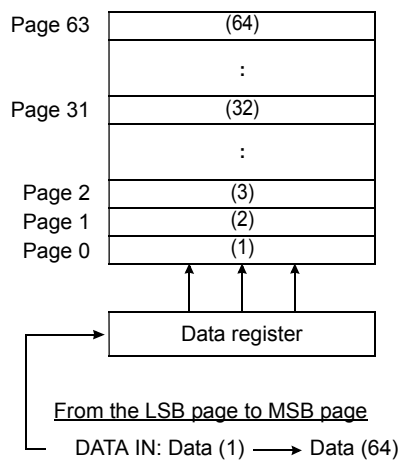
The Program operation is used to program data from the on-chip BufferRAMs into the NAND FLASH memory array.

The device has two 2KB data buffers, each 1 Page (2KB + 64B) in size. Each page has 4 sectors of 512B each main area and 16B spare area. The device can be programmed in units of 1~4 sectors.

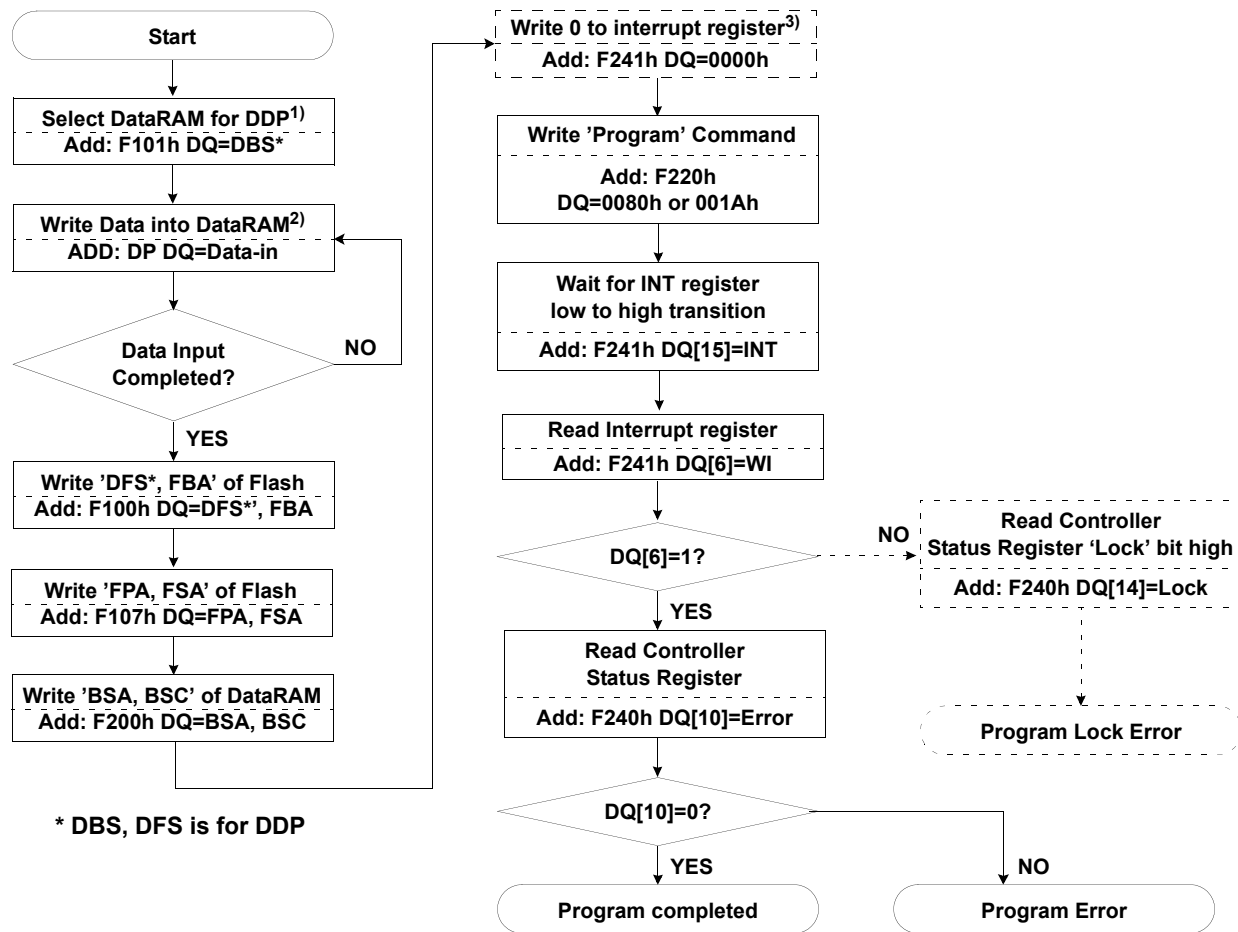
The architecture of the DataRAMs permits a simultaneous data-write operation from the Host to one of data buffers and a program operation from the other data buffer to the NAND Flash Array memory. Refer to Section 3.15.2, "Write While Program Operation", for more information.

Addressing for program operation

Within a block, the pages must be programmed consecutively from the LSB (least significant bit) page of the block to MSB (most significant bit) pages of the block. Random page address programming is prohibited.



Program Operation Flow Diagram



⊛ : If program operation results in an error, map out the block including the page in error and copy the target data to another block.

NOTE :

- 1) DBS must be set before data input.
- 2) Data input could be done anywhere between "Start" and "Write Program Command".
- 3) 'Write 0 to interrupt register' step may be ignored when using INT auto mode. Refer to chapter 2.8.18.1

During the execution of the Internal Program Routine, the host is not required to provide any further controls or timings. Furthermore, all commands, except a Reset command, will be ignored. A reset during a program operation will cause data corruption at the corresponding location.

If a program error is detected at the completion of the Internal Program Routine, map out the block, including the page in error, and copy the target data to another block. An error is signaled if DQ10 = "1" of Controller Status Register(F240h) .

Data input from the Host to the DataRAM can be done at any time during the Internal Program Routine after "Start" but before the "Write Program Command" is written.

3.11.1 2X Program Operation

See Timing Diagram 6.14

The 2X Program is an extension of Program Operation. Since the device is equipped with two DataRAMs, and two-plane NAND Flash memory array, these two components enable simultaneous programming of 4KB.

Plane1 has only even blocks such as block0, block2, block4 while Plane2 has only odd blocks such as block1, block3, block5.

In normal program, two DataRAMs can be utilized to use dual buffering scheme to enhance program performance.

In 2X program, since 4KB data is to be programmed into NAND Flash Array, dual-operation is implemented in another way;

The 2X Program and 2X Cache Program operations are only performed based on pair blocks which are consecutive.

1. 4KB Data write from host to DataRAMs.
2. 2X program command(007Dh) issue.
3. 4KB data will be transferred to each page buffer in two-plane NAND Flash Array at the same time.
4. The data will be placed on same page of respective blocks.

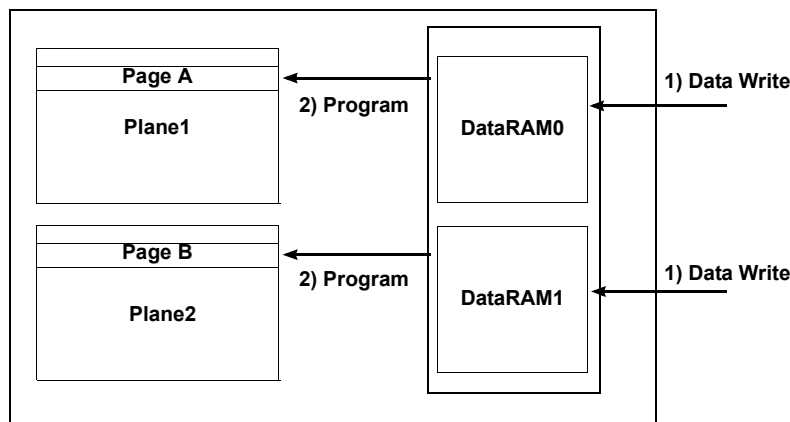
If the host wants to program data under 4 sector size, unwanted area to be programmed must be written to all '1's.
(BSC must be set to 00, which is 4sectors.)

Although host only set FBA(i.e. even block in Plane1) and BSA (i.e. DataRAM0) for the first page to execute this operation, the second page data on DataRAM1 are programmed onto an odd block in Plane2 at the same time.

If one of two consecutive blocks is mapped out by invalid block management, the remaining block must be used for normal program.

This 2X Program is also used for 'Final 2X Cache Program'.

Note that 2X Program command cannot be performed on OTP block and 1st block OTP.

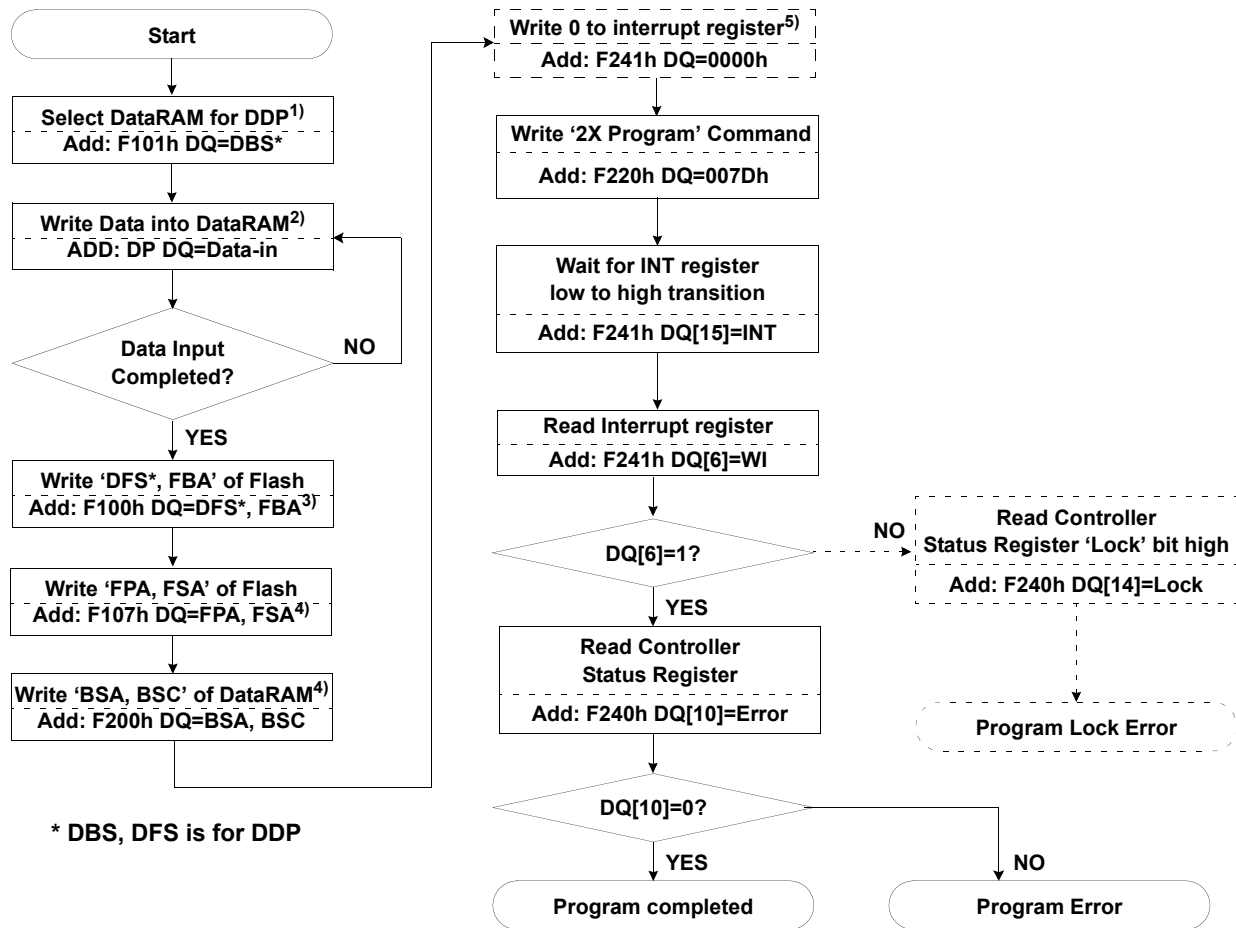


NOTE :

The page number of Page A and Page B is identical in different block.

If Page A is i th page of block $2j$, Page B must be i th page of block $2j+1$. ($j=0,1,2,3\dots$)

2X Program Operation Flow Diagram



⊛ : If program operation results in an error, map out the block including the page in error and copy the target data to another block.

NOTE :

- 1) DBS must be set before data input.
- 2) Data input could be done anywhere between "Start" and "Write Program Command".
- 3) FBA must be an even block.
- 4) These registers must be set as BSA=1000, BSC=00 and FSA=00.
- 5) 'Write 0 to interrupt register' step may be ignored when using INT auto mode. Refer to chapter 2.8.18.1

3.11.2 2X Cache Program Operation

See Timing Diagram 6.15

The 2X Cache Program Operation is invented to accomplish continuous 2X Program Operation efficiently by hiding transferring time from DataRAM to page buffer.

1. 4KB Data write from host to DataRAMs.
2. 2X Cache Program command issue. This will turn INT pin to busy state¹⁾, OnGo bit sets to '1'.
(Note that before issuing '2X Cache Program Command', host should make sure that the target blocks are unlocked.)
3. 4KB data will be transferred to each page buffer in two-plane NAND Flash Array at the same time.
4. When this transfer operation is complete, programming into NAND Flash Array will automatically start, and at the same time, INT bit will turn to '1' to indicate that DataRAMs are now ready to be written with next 4KB data.
5. When second 4KB is written to two DataRAMs, another 2X Cache Program command is issued and INT bit will go to '0'¹⁾.

Note 1) this is for INT auto mode, for INT manual mode case, user should write 0 to INT bit before issuing any command.

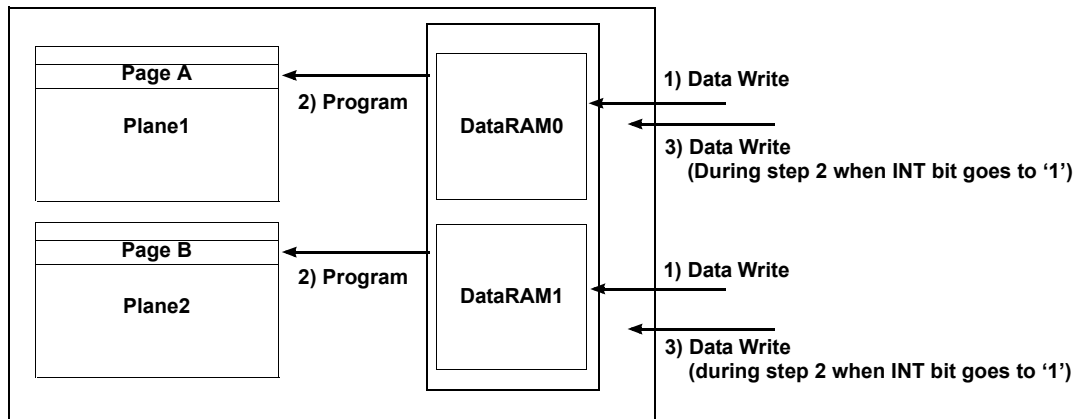
If host wants to program data under 4 sector size, unwanted area to be programmed must be written to all '1's.

(BSC must be set to 00, which is 4sectors.)

When INT bit goes to '1' after second data transfer from DataRAMs to Page Buffers are complete, user may check the Status Register to check the 2X program status. During 2X Cache Program, Error bit shows the status of previous program operation.

For the final 4KB program of 2X Cache Program scheme, host should issue 2X Program Command(007Dh). When the final two pages are programmed, INT bit will turn to '1' and OnGo status bit - which indicates the overall 2X Cache Program ongoing status - will go to '0'. At the completion of 2X Cache Program operation, Error bit will show the pass/fail status overall status of 2X program, and Plane1 previous[4] ~ Plane2 current[1] bit will show where the error occurred accordingly.

Note that 2X Cache Programm command cannot be performed on OTP block and 1st block OTP.

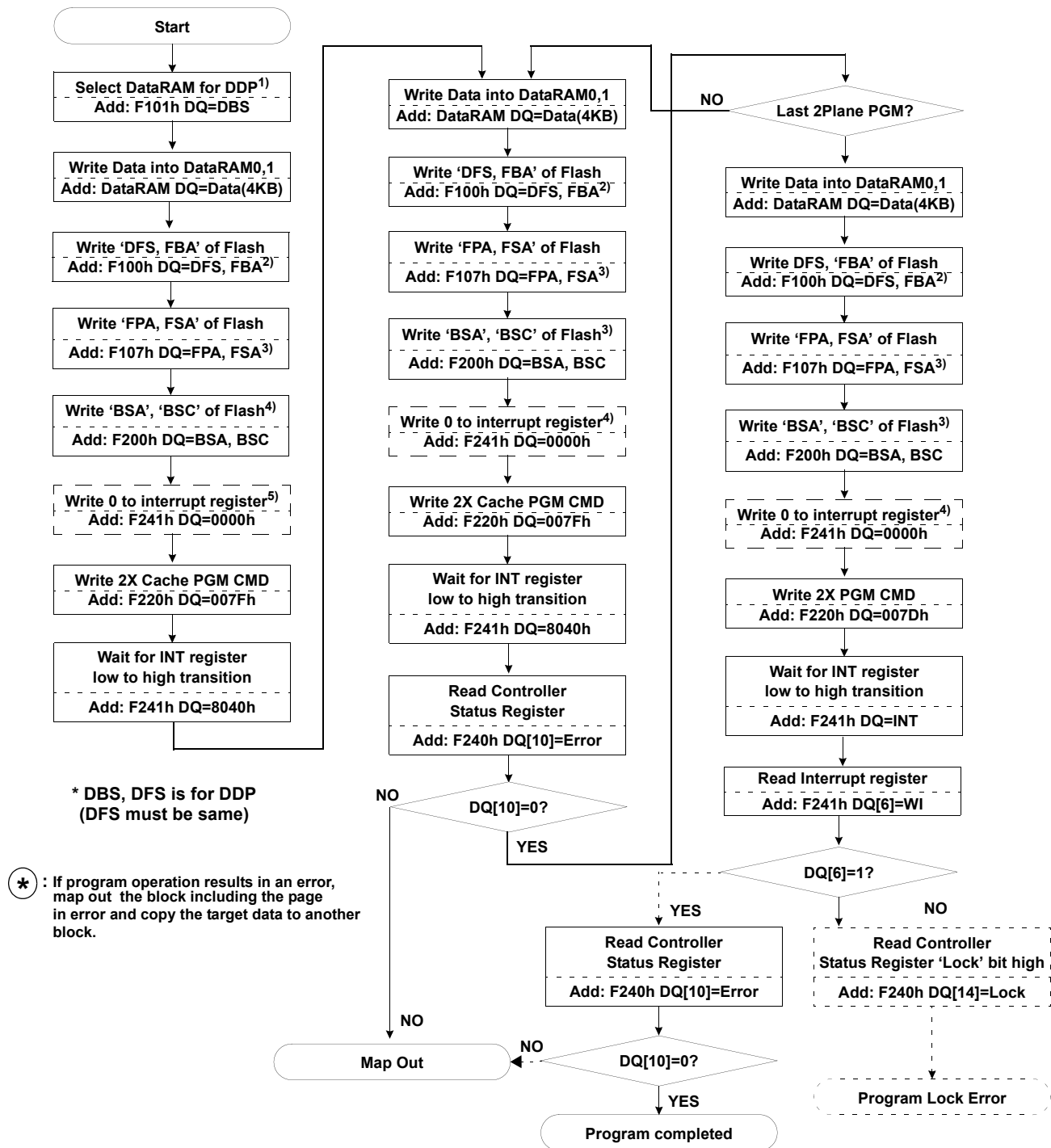


NOTE :

The page number of Page A and Page B is identical in different block.

If Page A is i th page of block $2j$, Page B must be i th page of block $2j+1$. ($j=0,1,2,3...$)

2X Cache Program Operation Flow Diagram



3.11.3 2X Interleave Cache Program Operation

See Timing Diagram 6.16

The 2X Interleave Cache Program is available only on DDP. Host can write data on a chip while programming another chip with this operation.

2X Interleave Cache Program is executed as following:

1. 4KB Data are written from host to DataRAMs in Chip1.
2. 2X Cache Program command issue. This will turn INT pin to busy state¹⁾, OnGo bit sets to '1'.
(Note that before issuing '2X Cache Program Command', host should make sure that the target blocks are unlocked.)
3. 4KB data will be trasfered to each page buffer in two-plane NAND Flash Array at the same time.
4. While these data are transferring, Host can write another 4KB Data to DataRAM in Chip2.
5. When the transfer operation is completed, programming into NAND Flash Array will automatically start, and at the same time, INT bit will turn to '1' to indicate that DataRAMs are now ready to be written with next 4KB data.
6. Second 4KB is writable on Chip1 when INT1 goes to '1'.
7. When second 4KB is written to two DataRAMs of Chip1, another 2X Cache Program command is issued and INT1 bit will go to '0'¹⁾ again.

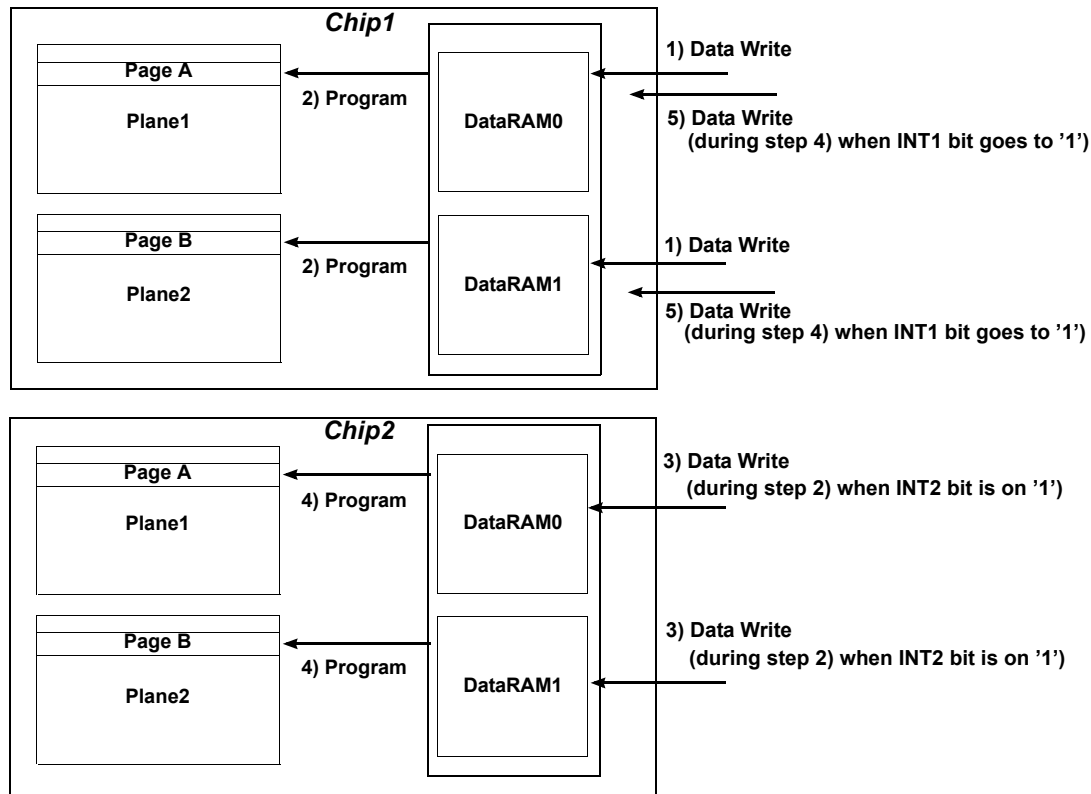
NOTE

1) this is for INT auto mode, for INT manual mode case, user should write 0 to INT bit before issuing any command.

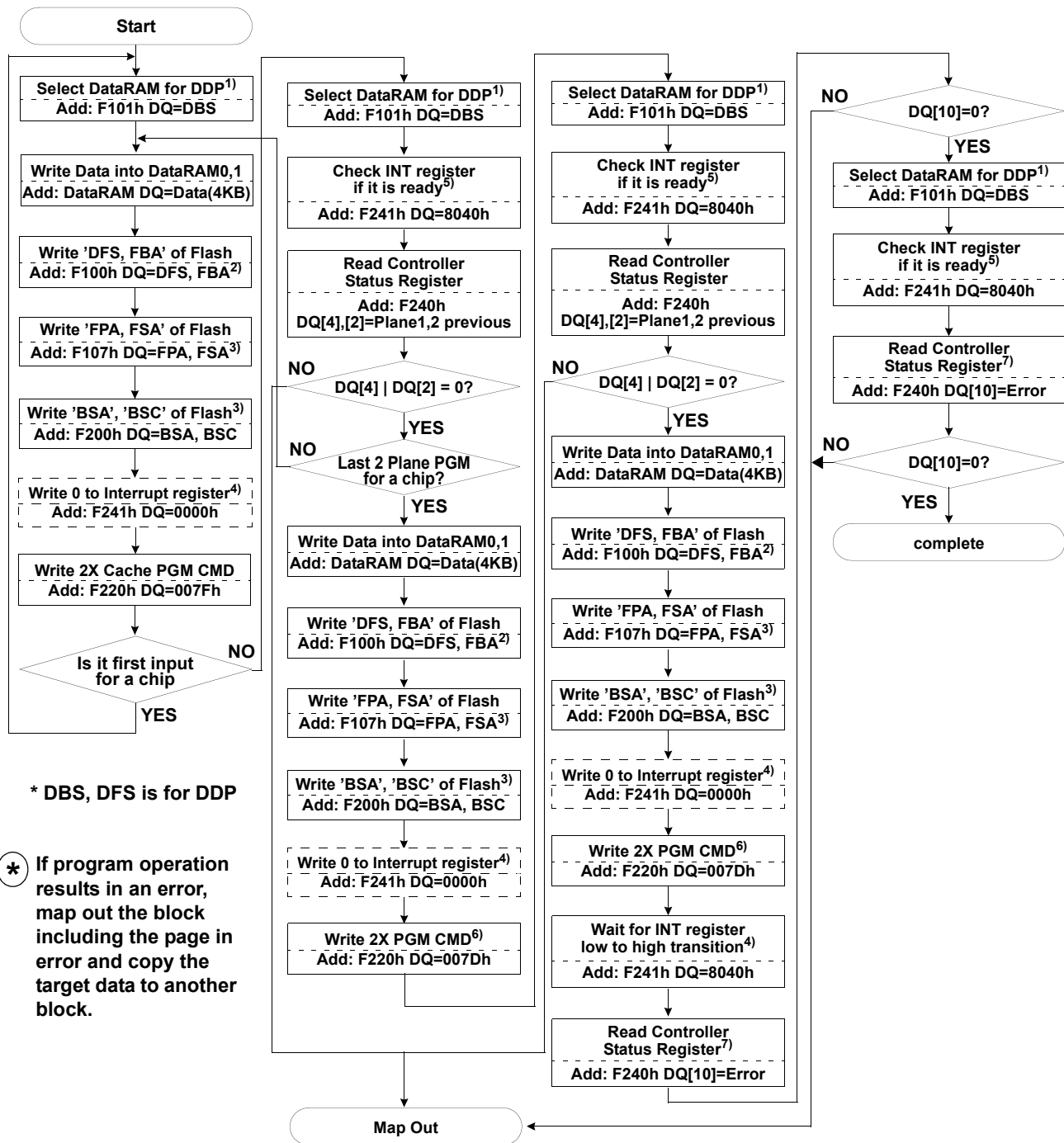
When INT bit goes to '1' after second data transfer from DataRAMs to Page Buffers are completed, user may check the Status Register to check the 2X program status. During 2X Cache Program, Plane1/2 previous bit shows the status of previous program operation.

For the final 4KB program of 2X Interleave Cache Program scheme, host should issue 2X Program Command(007Dh) on each chip. If the host issues 007Dh on only a chip, another chip will be on operation as it isn't finished. Ongo status bit will show the ongoing status of each chip. Its operation is same as 2X Cache Program operation on each chip. Error bit will show the pass/fail status of each chip of 2X Interleave Cache program, and Plane1 previous[4] ~ Plane2 current[1] bit will show where the error occurred accordingly .

Note that OTP block and 1st block OTP cannot be 2X Interleave Cache Programmed.



2X Interleave Cache Program Operation Flow Diagram



NOTE :

- 1) DBS must be set before data input.
- 2) FBA must be an even block.
- 3) These registers must be set as BSA=1000, BSC=00 and FSA=00.
- 4) 'Write 0 to interrupt register' step may be ignored when using INT auto mode. Refer to chapter 2.8.18.1.
- 5) Host is strongly recommended to see the INT register(F241h) of each chip.
- 6) Once '2X PGM command' is issued onto a chip, the same command(2X PGM) must be issued onto another chip.
If not, Samsung can not guarantee the following operation.
- 7) If error bit is set at this step, DQ[1]~[4] should be checked in order to find where the error occurred.

3.12 Copy-Back Program Operation

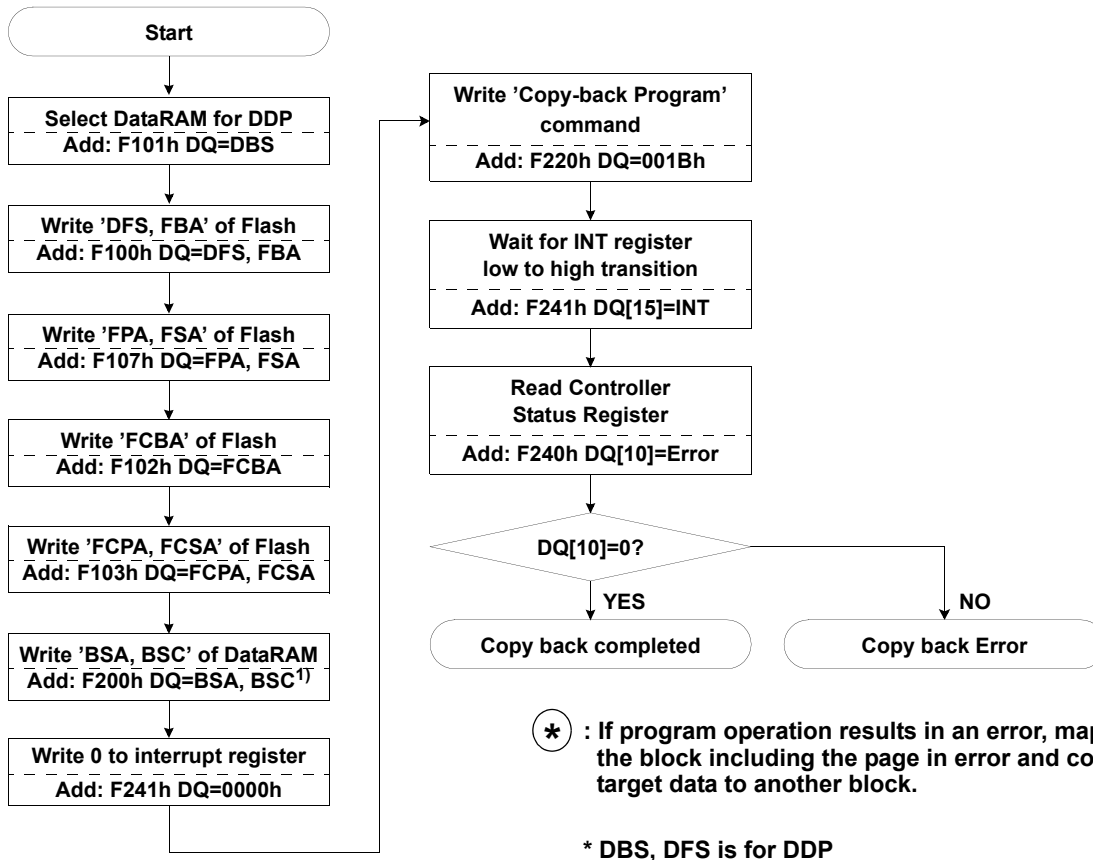
The Copy-Back program is configured to quickly rewrite data stored in one page without utilizing memory other than OneNAND. Since the time-consuming cycles of serial access and re-loading cycles are removed, the system performance is improved. The benefit is especially obvious when a portion of block is updated and the rest of the block also need to be copied to the newly assigned free block.

Data from the source page is saved in one of the on-chip DataRAM buffers and then programmed directly into the destination page. The DataRAM is overwritten the previous data using the Buffer Sector Address (BSA) and Buffer Sector Count (BSC).

The Copy-Back Program Operation does this by performing sequential page-reads without a serial access and executing a copy-program using the address of the destination page.

In DDP, copy-back program must be executed within each chip.

Copy-Back Program Operation Flow Chart



NOTE :

- 1) Selected DataRAM by BSA & BSC is used for Copy back operation, so previous data is overwritten.
- 2) FBA, FPA and FSA should be input prior to FCBA, FCPA and FCSA.
- 3) 'Write 0 to interrupt register' step may be ignored when using INT auto mode. Refer to chapter 2.8.18.1

The Copy-Back steps shown in the flow chart are:

- Data is read from the NAND Array using Flash Block Address (FBA), Flash Page Address (FPA) and Flash Sector Address (FSA). FBA, FPA, and FSA identify the source address to read data from NAND Flash array.
- The BufferRAM Sector Count (BSC) and BufferRAM Sector Address (BSA) identifies how many sectors and the location of the sectors in DataRAM that are used.
- The destination address in the NAND Array is written using the Flash Copy-Back Block Address (FCBA), Flash Copy-Back Page Address (FCPA), and Flash Copy-Back Sector Address (FCSA).
- The Copy-Back Program command is issued to start programming.
- Upon completion of copy-back programming to the destination page address, the Host checks the status to see if the operation was successfully completed. If there was an error, map out the block including the page in error and copy the target data to another block.

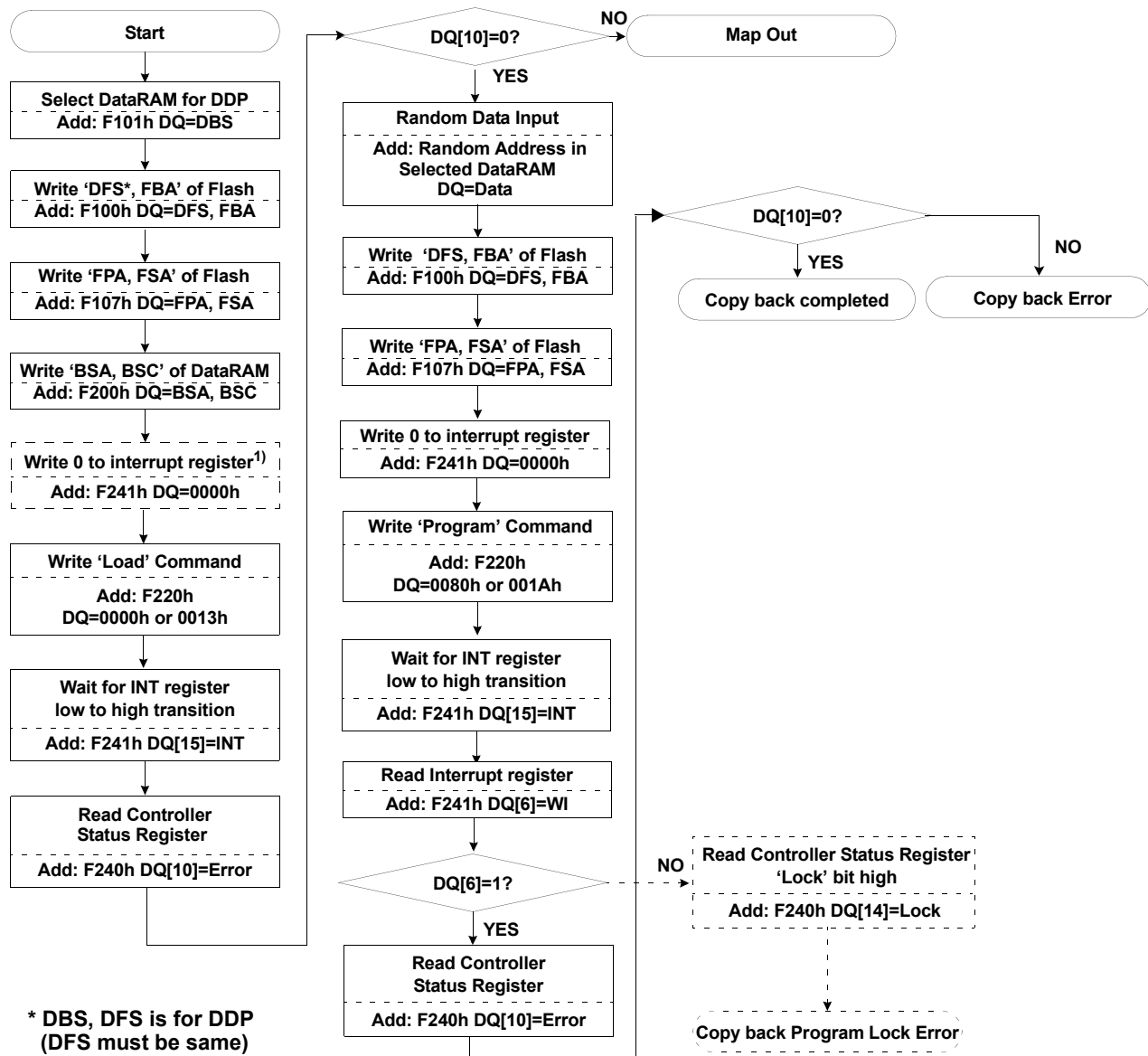
3.12.1 Copy-Back Program Operation with Random Data Input

The Copy-Back Program Operation with Random Data Input in OneNAND consists of 2 phase, Load data into DataRAM, Modify data and program into designated page. Data from the source page is saved in one of the on-chip DataRAM buffers and modified by the host, then programmed into the destination page.

As shown in the flow chart, data modification is possible upon completion of load operation. ECC is also available at the end of load operation. Therefore, using hardware ECC of OneNAND, accumulation of 1 bit error can be avoided.

Copy-Back Program Operation with Random Data Input will be effectively utilized at modifying certain bit, byte, word, or sector of source page to destination page while it is being copied.

Copy-Back Program Operation with Random Data Input Flow Chart



NOTE :

1) 'Write 0 to interrupt register' step may be ignored when using INT auto mode. (Refer to chapter 2.8.18.1)

3.13 Erase Operation

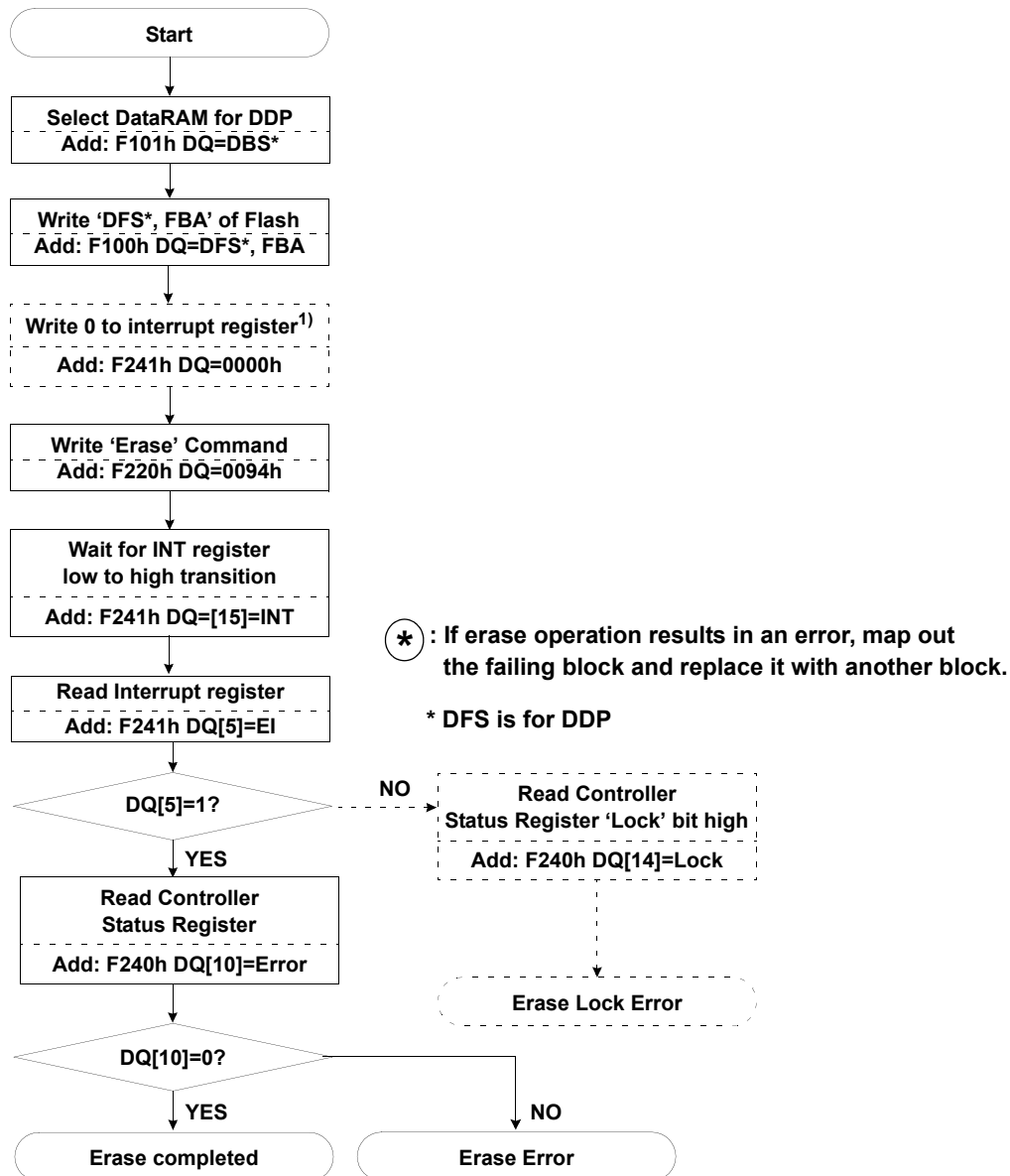
There are multiple methods for erasing data in the device including Block Erase and Multi-Block Erase.

3.13.1 Block Erase Operation

See Timing Diagram 6.17

The Block Erase Operation is done on a block basis. To erase a block is to write all 1's into the desired memory block by executing the Internal Erase Routine. All previous data is lost.

Block Erase Operation Flow Chart



NOTE :

1) 'Write 0 to interrupt register' step may be ignored when using INT auto mode. Refer to chapter 2.8.18.1

In order to perform the Internal Erase Routine, the following command sequence is necessary.

- The Host selects Flash Core of DDP chip.
- The Host sets the block address of the memory location.
- The Erase Command initiates the Internal Erase Routine. During the execution of the Routine, the host is not required to provide further controls or timings. During the Internal erase routine, all commands, except the Reset command and Erase Suspend Command, written to the device will be ignored.

A reset during an erase operation will cause data corruption at the corresponding location.

3.13.2 Multi-Block Erase Operation

See Timing Diagram 6.17

Using Multi-Block Erase, the device can be erased up to 64 multiple blocks simultaneously.

Multiple blocks can be erased by issuing a Multi-Block Erase command and writing the block address of the memory location to be erased. The final Flash Block Address (FBA) and Block Erase command initiate the internal multi block erase routine. During a Multi-Block Erase, the OnGo bit of the Controller Status Register is set to '1'(busy) from the time that the first block address to be latched is written to the time that the actual erase operation finishes.

During block address latch sequence, issuing of other commands except Block Erase, and Multi Block Erase at INT=High will abort the current operation. So to speak, It will cancel the previously latched addresses of Multi Block Erase Operation. On the other hand, Other command issue at INT=low will be ignored.

A reset during an erase operation will cause data corruption at the address location being operated on during the reset.

Despite a failed block during Multi-Block Erase operation, the device will continue the erase operation until all other specified blocks are erased.

Erase Suspend Command issue during Multi Block Erase Address latch sequence is prohibited.

Locked Blocks

If there are locked blocks in the specified range, the Multi-Block Erase operation works as the follows.

Case 1: All specified blocks except BA(2) will be erased.

[BA(1)+0095h] + [BA((2), locked))+0095h] + ... + [BA(N-1)+0095h] + [BA(N)+0094h]

Case 2: Multi-Block Erase Operation fails to start if the last Block Erase command is put together with the locked block address until right command and address input are issued.

[BA(1)+0095h] + [BA(2)+0095h] + ... + [BA(N-1)+0095h] + [BA((N), locked))+0094h]

Case 3: All specified blocks except BA(N) are erased.

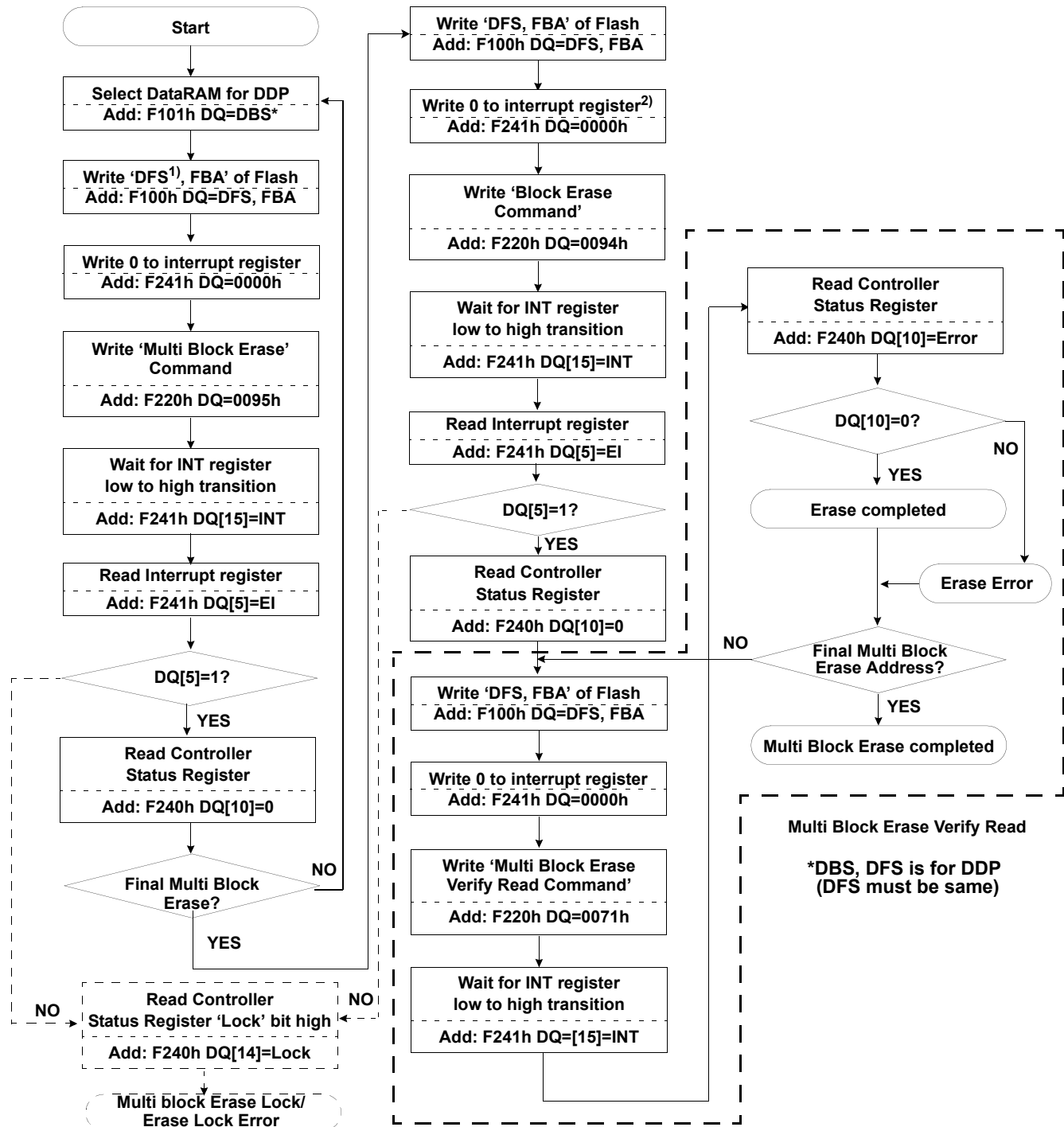
[BA(1)+0095h] + [BA(2)+0095h] + ... + [BA(N-1)+0095h] + [BA(N, locked)+0094h] + [BA(N+1)+0094h]

3.13.3 Multi-Block Erase Verify Read Operation

After a Multi-Block Erase Operation, verify Erase Operation result of each block with Multi-Block Erase Verify Command combined with address of each block.

If a failed address is identified, it must be managed by firmware.

Multi Block Erase/ Multi Block Erase Verify Read Flow Chart



NOTE :
 1) DFS should be a fixed value, for Multi Block Erase is performed within a single chip.
 2) 'Write 0 to interrupt register' step may be ignored when using INT auto mode. Refer to chapter 2.8.18.1

3.13.4 Erase Suspend / Erase Resume Operation

The Erase Suspend/Erase Resume Commands interrupt and restart a Block Erase or Multi-Block Erase operation so that user may perform another urgent operation on the block that is not being designated by Erase/Multi-Block Erase Operation.

Erase Suspend During a Block Erase Operation

When Erase Suspend command is written during a Block Erase or Multi-Block Erase operation, the device requires a maximum of 500us to suspend erase operation. Erase Suspend Command issue during Block Address latch sequence is prohibited.

After the erase operation has been suspended, the device is ready for the next operation including a load, program, copy-back program, Lock, Unlock, Lock-tight, Hot Reset, NAND Flash Core Reset, Command Based Reset, Multi-Block Erase Read Verify, or OTP Access.

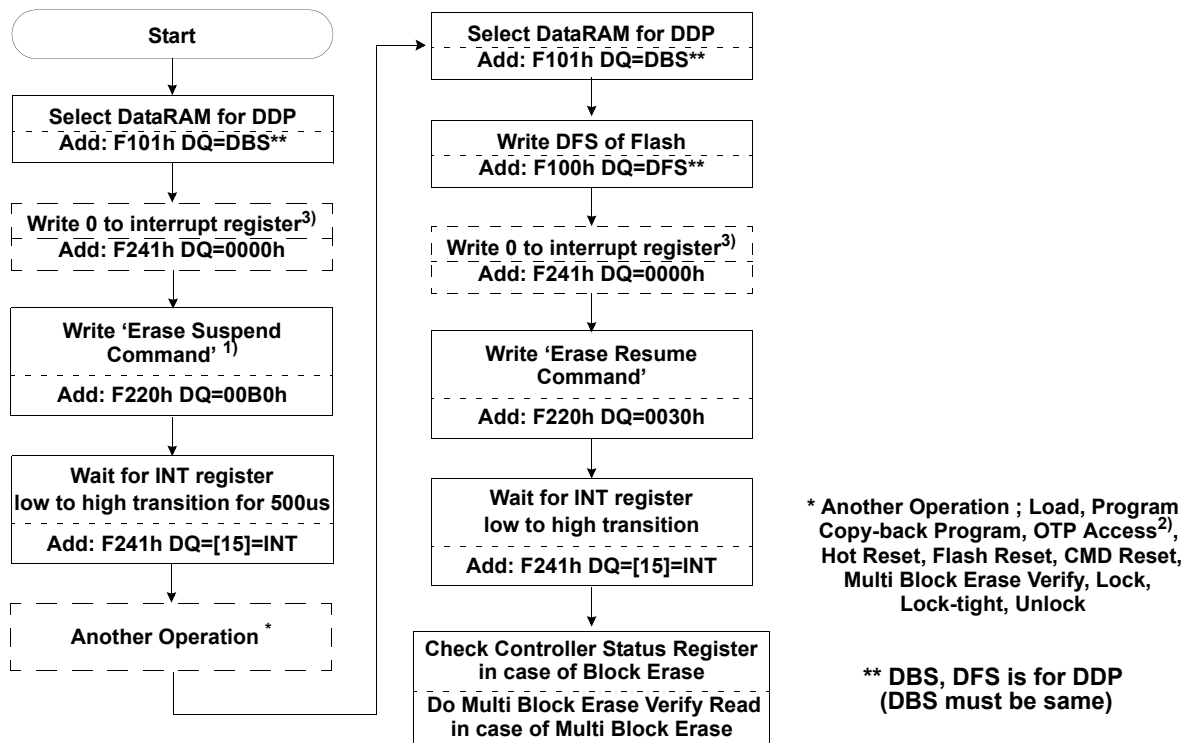
The subsequent operation can be to any block that was NOT being erased.

A special case arises pertaining Erase Suspend to the OTP. A Reset command is used to exit from the OTP Access mode. If the Reset-triggered exit from the OTP Access Mode happens during an Erase Suspend Operation, the erase routine could fail. Therefore to exit from the OTP Access Mode without suspending the erase operation stop, a 'NAND Flash Core Reset' command should be issued.

For the duration of the Erase Suspend period the following commands are not accepted:

- Block Erase/Multi-Block Erase/Erase Suspend

Erase Suspend and Erase Resume Operation Flow Chart



NOTE :

- 1) Erase Suspend command input is prohibited during Multi Block Erase address latch period.
- 2) If OTP access mode exit happens with Reset operation during Erase Suspend mode, Reset operation could hurt the erase operation. So if a user wants to exit from OTP access mode without the erase operation stop, Reset NAND Flash Core command should be used.
- 3) 'Write 0 to interrupt register' step may be ignored when using INT auto mode. Refer to chapter 2.8.18.1

Erase Resume

When the Erase Resume command is executed, the Block Erase will restart. The Erase Resume operation does not actually resume the erase, but starts it again from the beginning.

When an Erase Suspend or Erase Resume command is executed, the addresses are in Don't Care state.

For Multi Block Erase, Erase suspend/Resume can be operated after final Erase command (0094h) is issued. Therefore, Erase Resume operation does not actually resume from the erased block, but resumes the multi block erase from the beginning.

3.14 OTP Operation

One Block of the NAND Flash Array memory is reserved as a One-Time Programmable Block memory area.

Also, 1st Block of NAND Flash Array can be used as OTP.

Within DDP, OTP and 1st OTP block operations are valid solely on chip1.

The OTP block can be read, programmed and locked using the same operations as any other NAND Flash Array memory block.

OTP block cannot be erased. Note that 2X program and 2X cache program command cannot be performed on OTP and 1st block OTP area.

OTP block is fully-guaranteed to be a valid block.

Entering the OTP Block

The OTP block is separately accessible from the rest of the NAND Flash Array by using the OTP Access command instead of the Flash Block Address (FBA).

Exiting the OTP Block

To exit the OTP Access Mode, a Cold-, Warm-, Hot-, or NAND Flash Core Reset operation is performed.

Exiting the OTP Block during an Erase Operation

If the Reset-triggered exit from the OTP Access Mode happens during an Erase Suspend Operation, the erase routine could fail. Therefore to exit from the OTP Access Mode without suspending the erase operation stop, a 'NAND Flash Core Reset' command should be issued.

The OTP Block Page Assignments

OTP area is one block size (128KB+4KB, 64 Pages) and is divided into two areas. The 50-page User Area is available as an OTP storage area. The 14-page Manufacturer Area is programmed by the manufacturer prior to shipping the device to the user.

OTP Block Page Allocation Information

Area	Page	Use
User	0 ~ 49 (50 pages)	Designated as user area
Manufacturer	50 ~ 63 (14 pages)	Used by the device manufacturer

Three Possible OTP Lock Sequence (Refer to Chapter 3.14.3~3.14.5 for more information)

Since OTP Block and 1st Block OTP can be locked only by programming into 8th word of sector0, page0 of the spare memory area of OTP, OTP Block and 1st Block OTP lock sequence is restricted into three following cases.

NOTE :

that user should be careful, because locking OTP Block before locking 1st Block OTP will disable locking 1st Block OTP.

1) OTP Block Lock Only :

Once the OTP Block is locked, 1st Block OTP Lock is impossible.

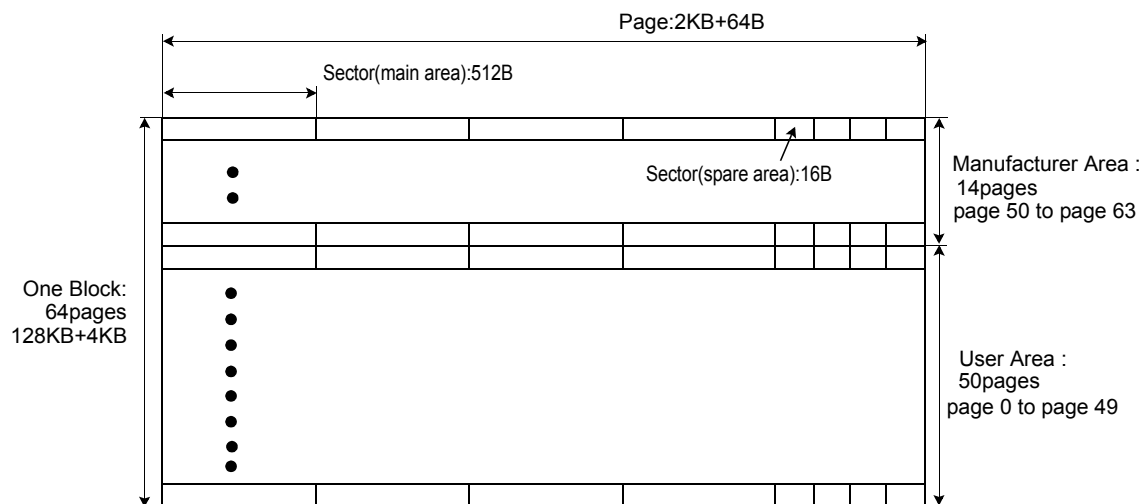
2) 1st Block OTP Lock, and then Lock OTP Block afterwards :

Locking 1st Block OTP does not lock the OTP block, so that OTP Block Lock can be performed thereafter.

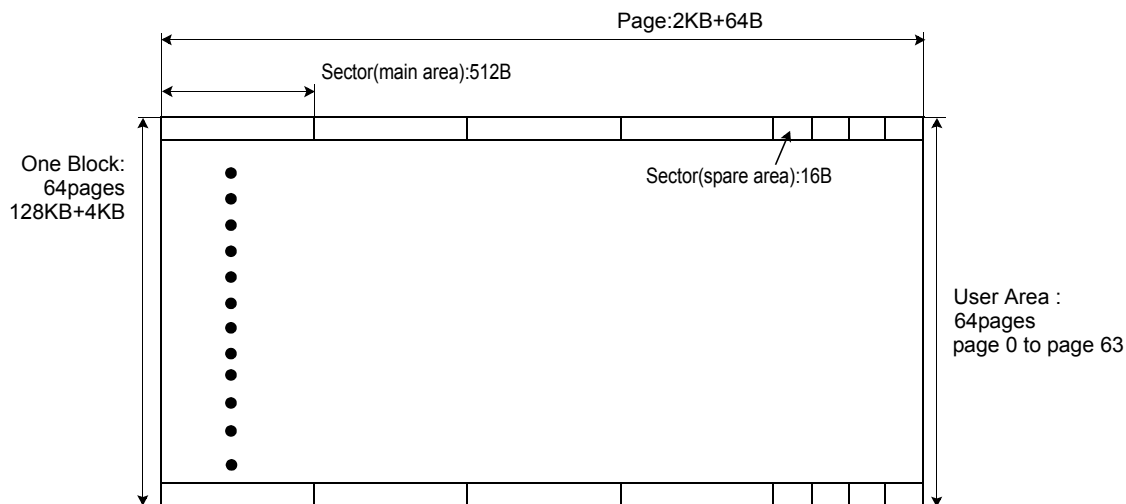
3) OTP Block Lock and 1st Block OTP Lock simultaneously:

This simultaneous operation can be done by programming into 8th word of sector0, page0 of the spare memory area of OTP.

OTP Block Area Structure



1st Block OTP Area Structure



3.14.1 OTP Block Load Operation

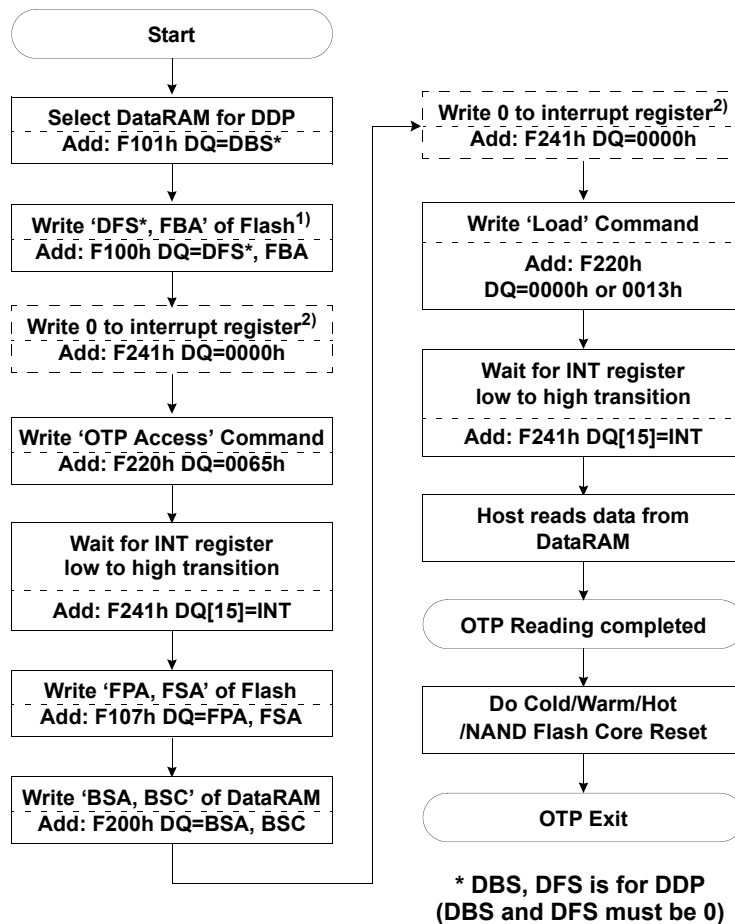
An OTP Block Load Operation accesses the OTP area and transfers identified content from the OTP to the DataRAM on-chip buffer, thus making the OTP contents available to the Host.

The OTP area is a separate part of the NAND Flash Array memory. It is accessed by issuing OTP Access command(65h) instead of a Flash Block Address (FBA) command.

After being accessed with the OTP Access Command, the contents of OTP memory area are loaded using the same operations as a normal load operation to the NAND Flash Array memory (see section 3.6 for more information).

To exit the OTP access mode following an OTP Block Load Operation, a Cold-, Warm-, Hot-, or NAND Flash Core Reset operation is performed.

OTP Block Read Operation Flow Chart



NOTE :

- 1) FBA(NAND Flash Block Address) could be omitted or any address in a single die package.
FBA must be an address of a chip containing OTP block that is supposed to be accessed in DDP.
- 2) 'Write 0 to interrupt register' step may be ignored when using INT auto mode. Refer to chapter 2.8.18.1

3.14.2 OTP Block Program Operation

An OTP Block Program Operation accesses the OTP area and programs content from the DataRAM on-chip buffer to the designated page(s) of the OTP.

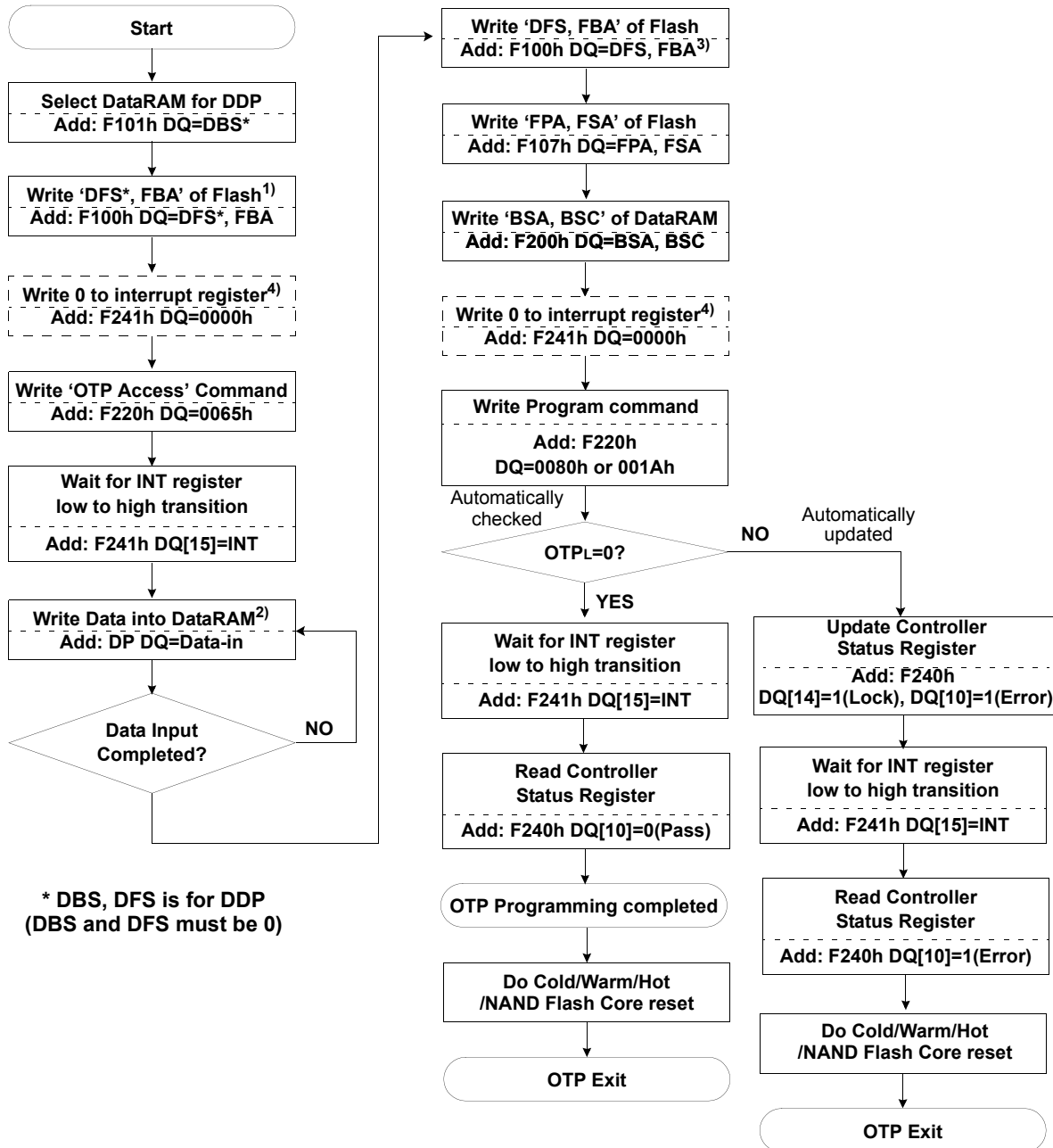
A memory location in the OTP area can be programmed only one time (no erase operation permitted).

The OTP area is programmed using the same sequence as normal program operation after being accessed by the command (see section 3.8 for more information).

Programming the OTP Area

- Issue the OTP Access Command
- Write data into the DataRAM (data can be input at anytime between the "Start" and "Write Program" commands)
- Issue a Flash Block Address (FBA) which is unlocked area address of NAND Flash Array address map.
- Issue a Write Program command to program the data from the DataRAM into the OTP
- When the OTP Block programming is complete,
do a Cold-, Warm-, Hot-, NAND Flash Core Reset to exit the OTP Access mode.

OTP Block Program Operation Flow Chart



NOTE :

- 1) FBA(NAND Flash Block Address) could be omitted or any address.
- 2) Data input could be done anywhere between "Start" and "Write Program Command".
- 3) FBA should point the unlocked area address among NAND Flash Array address map.
- 4) 'Write 0 to interrupt register' step may be ignored when using INT auto mode. Refer to chapter 2.8.18.1

3.14.3 OTP Block Lock Operation

Even though the OTP area can only be programmed once without erase capability, it can be locked when the device starts up to prevent any changes from being made.

Unlike the main area of the NAND Flash Array memory, **once the OTP block is locked, it cannot be unlocked, for locking bit for both blocks lies in the same word of OTP area.**

Therefore, if OTP Block is locked prior to 1st Block OTP lock, 1st Block OTP cannot be locked.

Locking the OTP

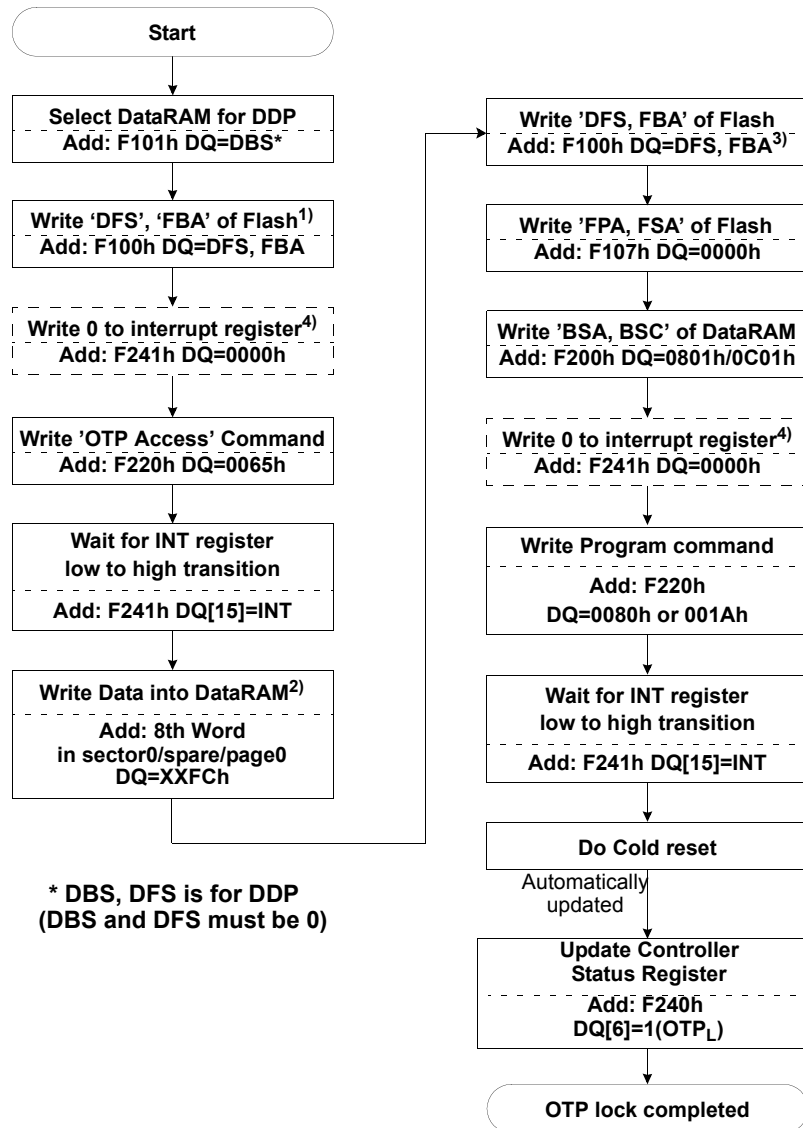
Programming to the OTP area can be prevented by locking the OTP area. Locking the OTP area is accomplished by programming **XXFCh** to 8th word of sector0 in page0 spare area in the OTP block.

At device power-up, this word location is checked and if **XXFCh** is found, the OTP_L bit of the Controller Status Register is set to "1", indicating the OTP is locked. When the Program Operation finds that the status of the OTP is locked, the device updates the Error Bit of the Controller Status Register as "1" (fail).

OTP Lock Operation Steps

- Issue the OTP Access Command
- Fill data to be programmed into DataRAM (data can be input at anytime between the "Start" and "Write Program" commands)
- Write '**XXFCh**' data into the 8th word of sector0 in page0 spare area of the DataRAM.
- Issue a Flash Block Address (FBA) which is unlocked area address of NAND Flash Array address map.
- Issue a Program command to program the data from the DataRAM into the OTP
- When the OTP lock is complete, do a Cold Reset to exit the OTP Access mode and update OTP lock bit[6].
- OTP lock bit[6] of the Controller Status Register will be set to "1" and the OTP will be locked.

OTP Block Lock Operation Flow Chart



NOTE :

- 1) FBA(NAND Flash Block Address) could be omitted or any address.
- 2) Data input could be done anywhere between "Start" and "Write Program Command".
- 3) FBA should point the unlocked area address among NAND Flash Array address map.
- 4) 'Write 0 to interrupt register' step may be ignored when using INT auto mode. Refer to chapter 2.8.18.1

3.14.4 1st Block OTP Lock Operation

1st Block could be used as OTP, for secured booting operation.

1st Block OTP can be accessed just as any other NAND Flash Array Blocks before it is locked, however, once 1st Block is locked to be OTP, 1st Block OTP cannot be erased or programmed.

Note that OTP Block can be locked freely after locking 1st Block OTP.

Locking the 1st Block OTP

Programming to the 1st Block OTP area can be prevented by locking the OTP area. Locking the OTP area is accomplished by programming **XXF3h** to 8th word of sector0 in page0 spare area in the OTP block.

At device power-up, this word location is checked and if **XXF3h** is found, the OTP_{BL} bit of the Controller Status Register is set to "1", indicating the 1st Block is locked. When the Program Operation finds that the status of the 1st Block is locked, the device updates the Error Bit of the Controller Status Register as "1" (fail).

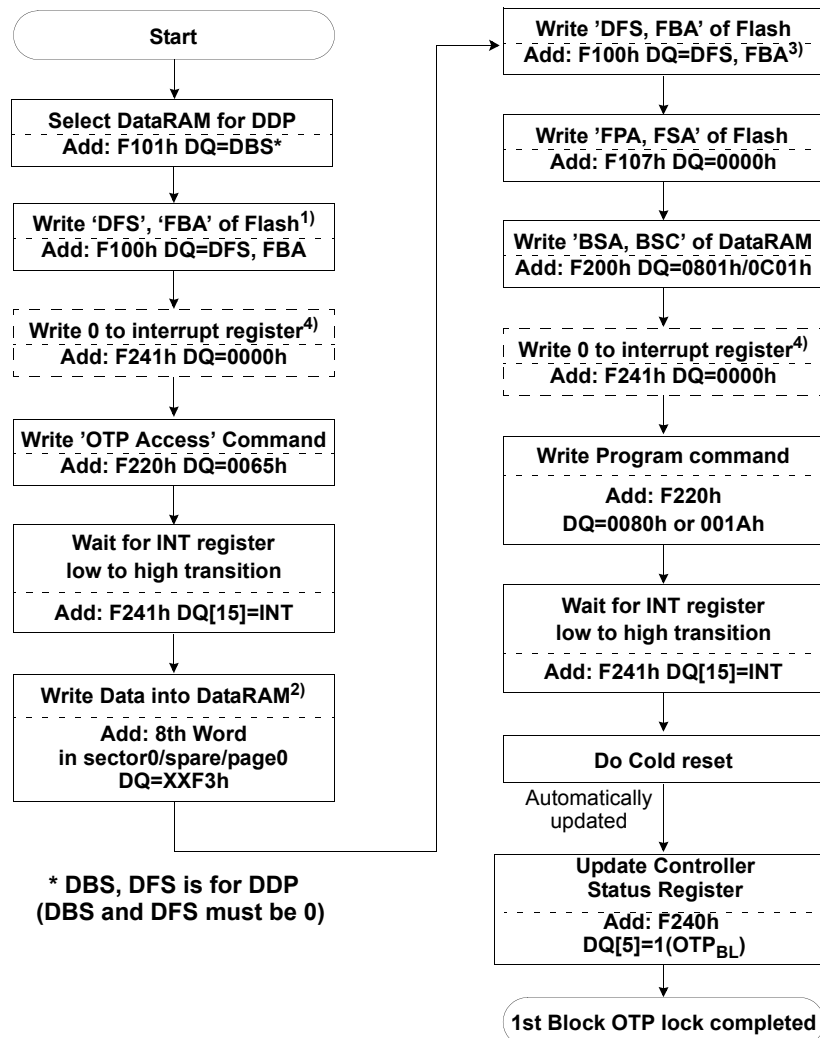
1st Block OTP Lock Operation Steps

- Issue the OTP Access Command
- Fill data to be programmed into DataRAM (data can be input at anytime between the "Start" and "Write Program" commands)
- Write '**XXF3h**' data into the 8th word of sector0 in page0 spare area of the DataRAM.
- Issue a Flash Block Address (FBA) which is unlocked area address of NAND Flash Array address map.
- Issue a Program command to program the data from the DataRAM into the OTP
- When the 1st Block OTP lock is complete, do a Cold Reset to exit the OTP Access mode and update 1st Block OTP lock bit[5].
- 1st Block OTP lock bit[5] of the Controller Status Register will be set to "1" and the 1st Block will be locked.

Even though the OTP area can only be programmed once without erase capability, it can be locked when the device starts up to prevent any changes from being made.

Unlike other remaining main area of the NAND Flash Array memory, **once the 1st block OTP is locked, it cannot be unlocked.**

1st Block OTP Lock Operation Flow Chart



NOTE :

- 1) FBA(NAND Flash Block Address) could be omitted or any address.
- 2) Data input could be done anywhere between "Start" and "Write Program Command".
- 3) FBA should point the unlocked area address among NAND Flash Array address map.
- 4) 'Write 0 to interrupt register' step may be ignored when using INT auto mode. Refer to chapter 2.8.18.1

3.14.5 OTP and 1st Block OTP Lock Operation

OTP and 1st Block can be locked simultaneously, for locking bit lies in the same word of OTP area.

1st Block OTP can be accessed just as any other NAND Flash Array Blocks before it is locked, however, once 1st Block is locked to be OTP, 1st Block OTP cannot be erased or programmed. Also, OTP area can only be programmed once without erase capability, it can be locked when the device starts up to prevent any changes from being made.

Locking the OTP and 1st Block OTP

Programming to the OTP area and 1st Block OTP area can be prevented by locking the OTP area. Locking the OTP area is accomplished by programming **XXF0h** to 8th word of sector0 in page0 spare area in the OTP block.

At device power-up, this word location is checked and if **XXF0h** is found, the OTP_L and OTP_{BL} bit of the Controller Status Register is set to "1", indicating the OTP and 1st Block is locked. When the Program Operation finds that the status of the OTP and 1st Block is locked, the device updates the Error Bit of the Controller Status Register as "1" (fail).

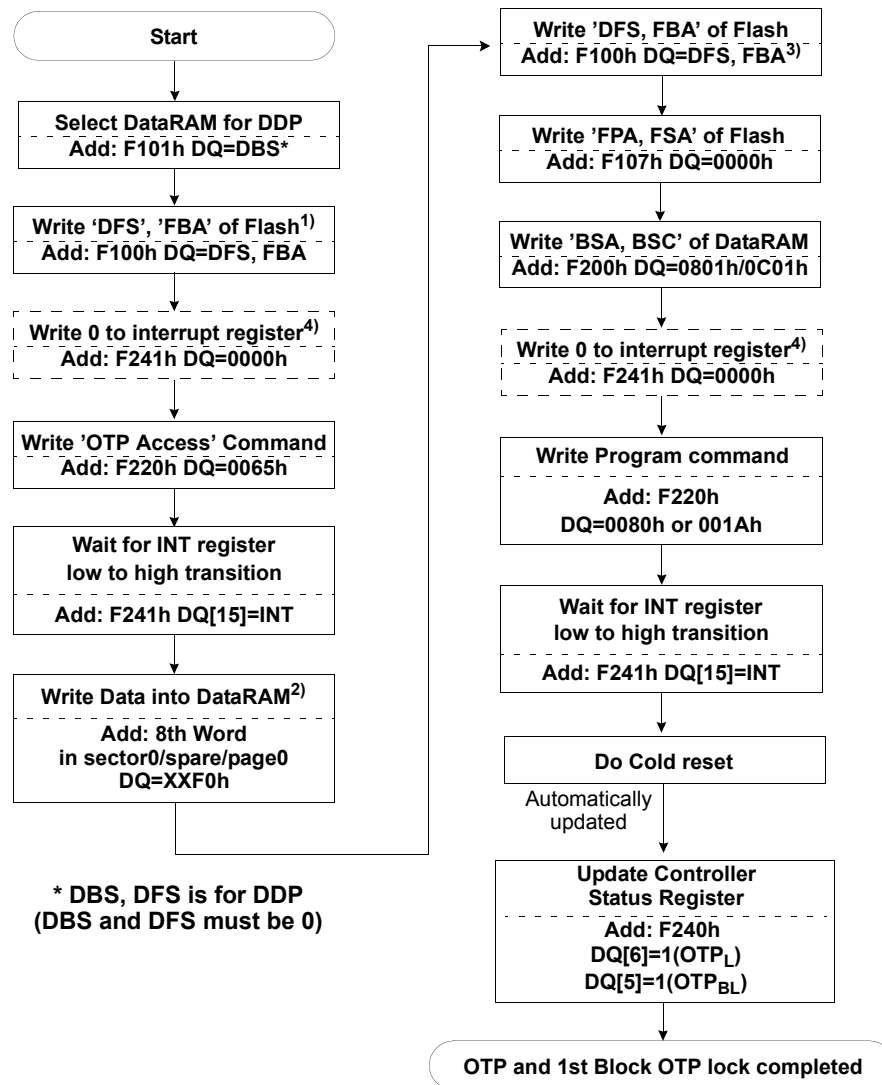
OTP and 1st Block OTP simultaneous Lock Operation Steps

- Issue the OTP Access Command
- Fill data to be programmed into DataRAM (data can be input at anytime between the "Start" and "Write Program" commands)
- Write **'XXF0h'** data into the 8th word of sector0 in page0 spare area of the DataRAM.
- Issue a Flash Block Address (FBA) which is unlocked area address of NAND Flash Array address map.
- Issue a Program command to program the data from the DataRAM into the OTP
- When the 1st Block OTP lock is complete, do a Cold Reset to exit the OTP Access mode and update 1st Block OTP lock bit[5] and OTP lock bit[6].
- 1st Block OTP lock bit[5] and OTP lock bit[6] of the Controller Status Register will be set to "1" and the OTP and 1st Block will be locked.

Even though the OTP area can only be programmed once without erase capability, it can be locked when the device starts up to prevent any changes from being made.

Unlike other remaining main area of the NAND Flash Array memory, **once the OTP block and the 1st block OTP are locked, it cannot be unlocked.**

OTP and 1st Block OTP Lock Operation Flow Chart



NOTE :

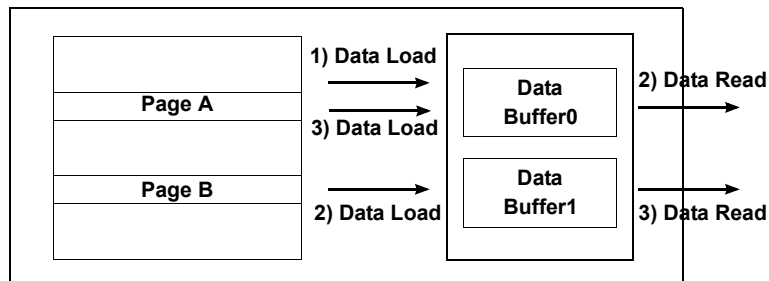
- 1) FBA(NAND Flash Block Address) could be omitted or any address.
- 2) Data input could be done anywhere between "Start" and "Write Program Command".
- 3) FBA should point the unlocked area address among NAND Flash Array address map.
- 4) 'Write 0 to interrupt register' step may be ignored when using INT auto mode. Refer to chapter 2.8.18.1

3.15 Dual Operations

The device has independent dual data buffers on-chip (except during the Boot Load period) that enables higher performance read and program operation.

3.15.1 Read-While-Load Operation

This operation accelerates the read performance of the device by enabling data to be read out by the host from one DataRAM buffer while the other DataRAM buffer is being loaded with data from the NAND Flash Array memory.

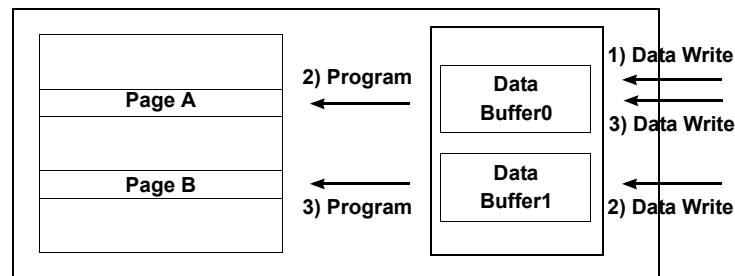


The dual data buffer architecture provides the capability of executing a data-read operation from one of DataRAM buffers during a simultaneous data-load operation from Flash to the other buffer. Simultaneous load and read operation to same data buffer is prohibited. See sections 3.6 and 3.7 for more information on Load and Read Operations.

If host sets FBA, FSA, or FPA while loading into designated page, it will fail the internal load operation. Address registers should not be updated until internal operation is completed.

3.15.2 Write-While-Program Operation

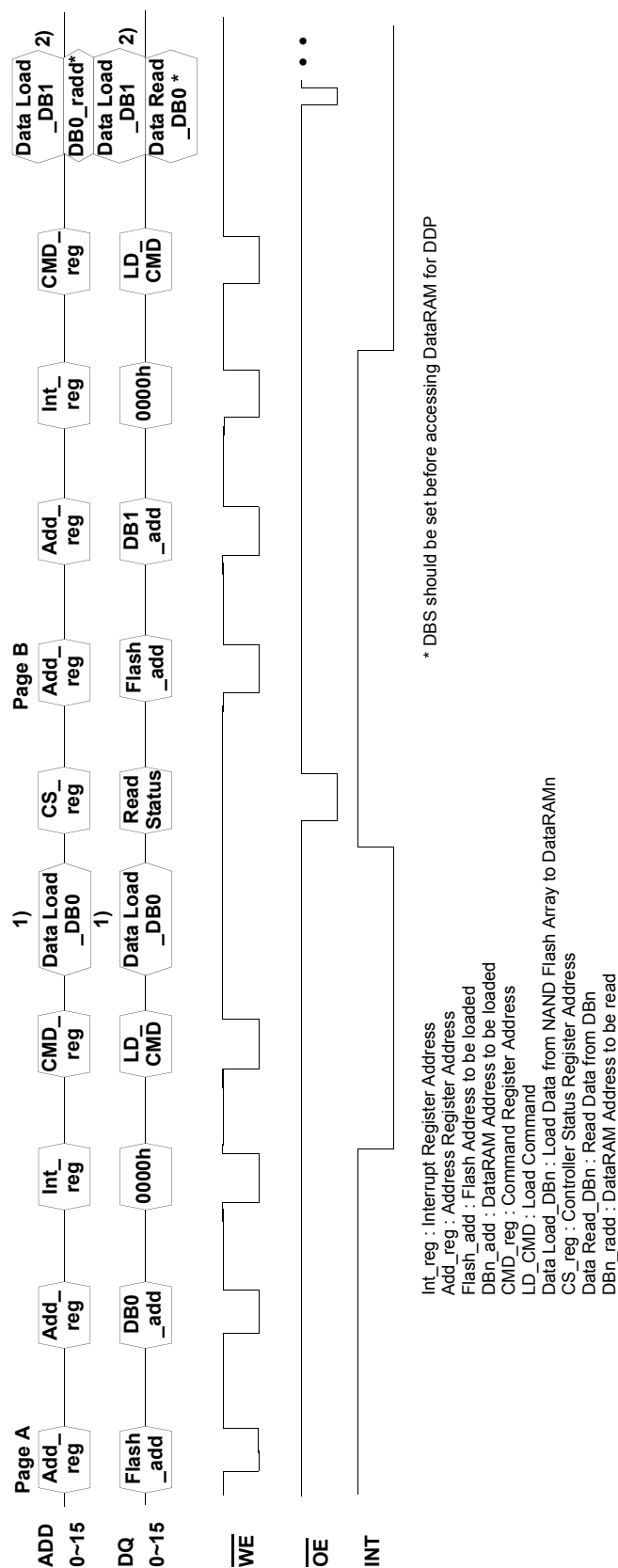
This operation accelerates the programming performance of the device by enabling data to be written by the host into one DataRAM buffer while the NAND Flash Array memory is being programmed with data from the other DataRAM buffer.



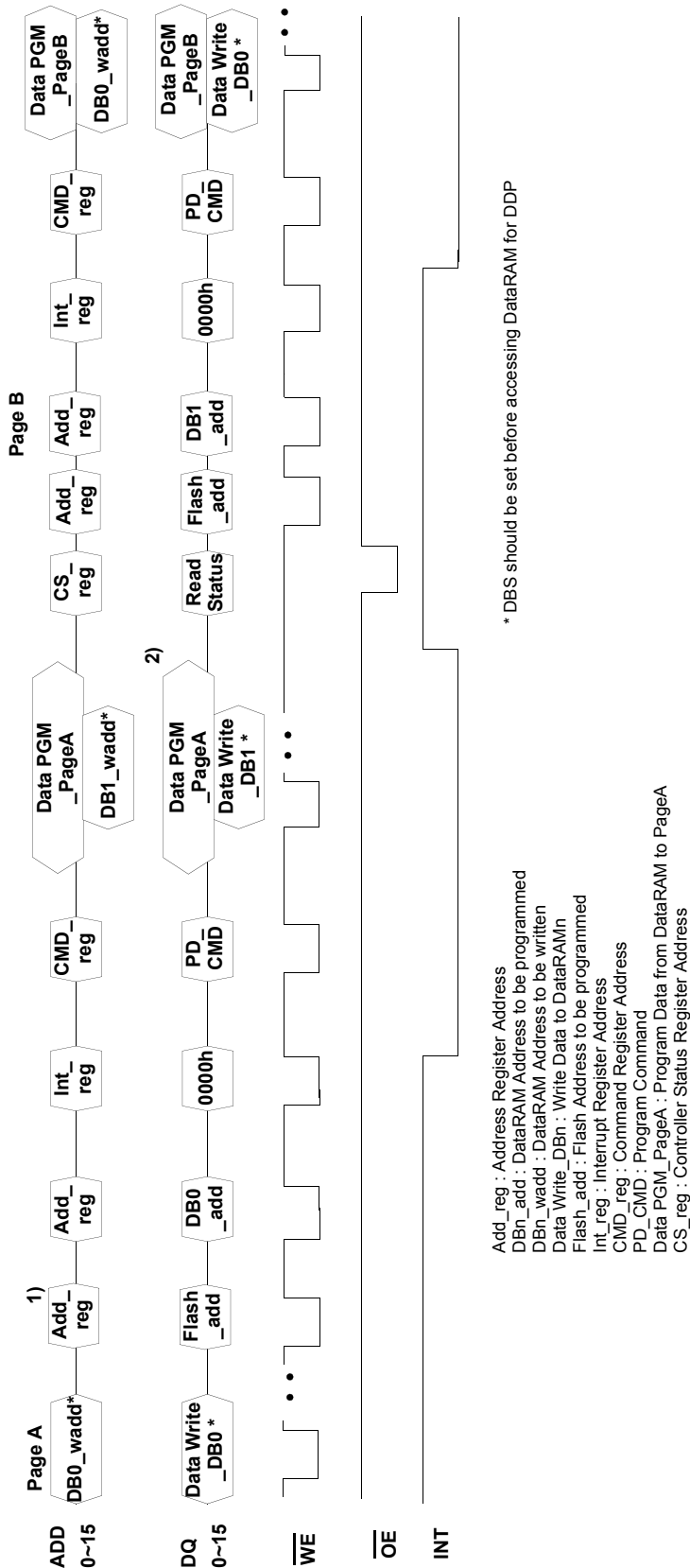
The dual data buffer architecture provides the capability of executing a data-write operation to one of DataRAM buffers during simultaneous data-program operation to Flash from the other buffer. Simultaneous program and write operation to same data buffer is prohibited. See sections 3.8 for more information on Program Operation.

If host sets FBA, FSA, or FPA while programming into designated page, it will fail the internal program operation. Address registers should not be updated until internal operation is completed.

Read While Load Diagram



Write While Program Diagram



3.16 ECC Operation

The OneNAND device has on-chip ECC with the capability of detecting 2 bit errors and correcting 1-bit errors in the NAND Flash Array memory main and spare areas.

As the device transfers data from a BufferRAM to the NAND Flash Array memory Page Buffer for Program Operation, the device initiates a background operation which generates an Error Correction Code (ECC) of 24bits for each sector main area data and 10bits for 2nd and 3rd word data of each sector spare area.

During a Load operation from the NAND Flash Array memory Page, the on-chip ECC engine generates a new ECC. The 'Load ECC result' is compared to the originally 'Program ECC' thus detecting the number and position of errors. Single-bit error is corrected.

ECC is updated by the device automatically. After a Load Operation, the Host can determine whether there was error by reading the 'ECC Status Register' (refer to section 2.8.26).

Error types are divided into 'no error', '1bit correctable error', and '2bit error uncorrectable error'.

OneNAND supports 2bit EDC even though 2bit error seldom or never occurs. Hence, it is not recommended for Host to read 'ECC Status Register' for checking ECC error because the built-in Error Correction Logic of OneNAND automatically corrects ECC error.

When the device reads the NAND Flash Array memory main and spare area data with an ECC operation, the device doesn't place the newly generated ECC for main and spare area into the buffer. Instead it places the ECC which was generated and written during the program operation into the buffer.

An ECC operation is also done during the Boot Loading operation.

3.16.1 ECC Bypass Operation

In an ECC bypass operation, the device does not generate ECC as a background operation. The result does not indicate error position (refer to the ECC Result Table).

In a Program Operation the ECC code to NAND Flash Array memory spare area is not updated.

During a Load operation, the on-chip ECC engine does not generate a new ECC internally. Also the ECC Status & Result to Registers are invalid. The error is not corrected and detected by itself, so that ECC bypass operation is not recommended for host.

ECC bypass operation is set by the 9bit of System Configuration 1 Register (see section 2.8.19)

In case of ECC Bypass, user can program in ECC Area.

ECC Code and ECC Result by ECC Operation

Operation	Program operation	Load operation		
	ECC Code Update to NAND Flash Array Spare Area	ECC Code at BufferRAM Spare Area	ECC Status & Result Update to Registers	1bit Error
ECC operation	Update	Pre-written ECC code ⁽¹⁾ loaded	Update	Correct
ECC bypass	Not update	Pre-written code ⁽¹⁾ loaded	Invalid	Not correct

NOTE :

1) Pre-written ECC code : ECC code which is previously written to NAND Flash Spare Area in program operation.

3.17 Invalid Block Operation

Invalid blocks are defined as blocks in the device's NAND Flash Array memory that contain one or more invalid bits whose reliability is not guaranteed by Samsung.

The information regarding the invalid block(s) is called the Invalid Block Information. Devices with invalid block(s) have the same quality level as devices with all valid blocks and have the same AC and DC characteristics.

An invalid block(s) does not affect the performance of valid block(s) because it is isolated from the bit line and the common source line by a select transistor.

The system design must be able to mask out the invalid block(s) via address mapping. The 1st block, which is placed on 00h block address, is always fully guaranteed to be a valid block.

Due to invalid marking, during load operation for indentifying invalid block, a load error may occur.

3.17.1 Invalid Block Identification Table Operation

A system must be able to recognize invalid block(s) based on the original invalid block information and create an invalid block table.

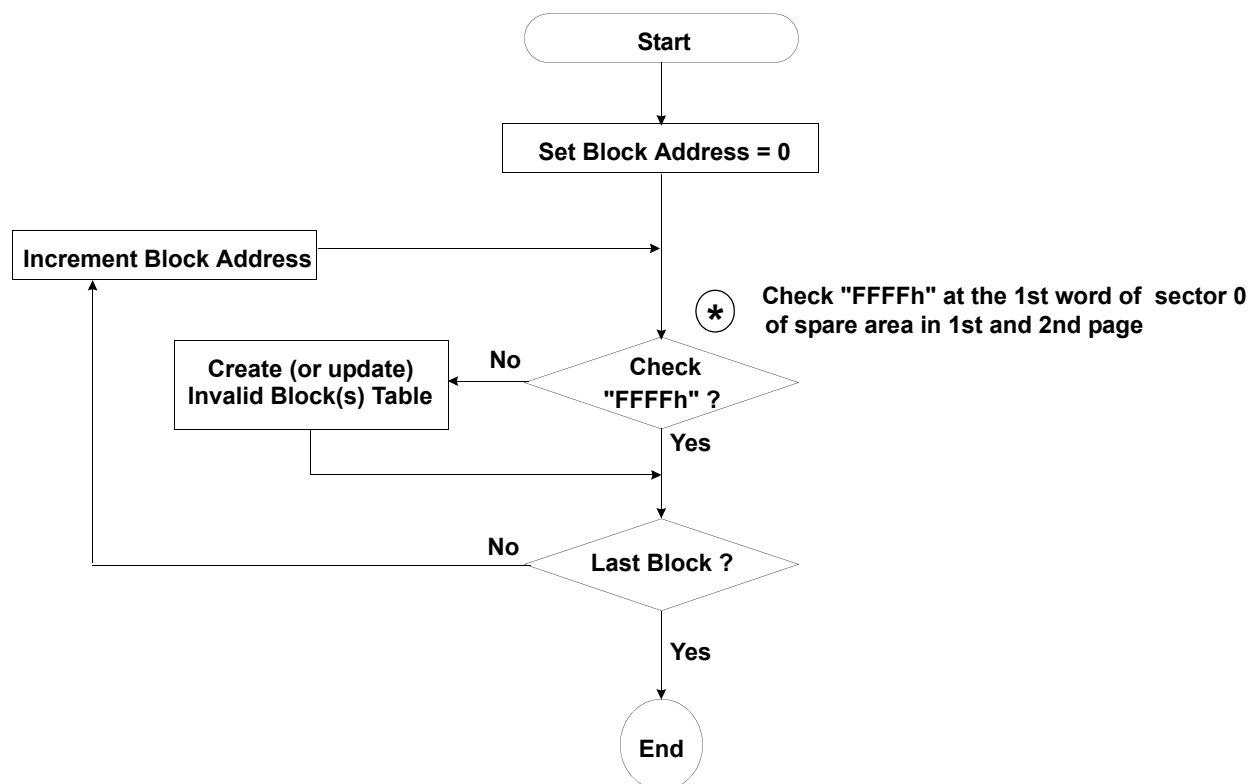
Invalid blocks are identified by erasing all address locations in the NAND Flash Array memory except locations where the invalid block(s) information is written prior to shipping.

An invalid block(s) status is defined by the 1st word in the spare area. Samsung makes sure that either the 1st or 2nd page of every invalid block has non-FFFFh data at the 1st word of sector0.

Since the invalid block information is also erasable in most cases, it is impossible to recover the information once it has been erased. Any intentional erase of the original invalid block information is prohibited.

The following suggested flow chart can be used to create an Invalid Block Table.

Invalid Block Table Creation Flow Chart



3.17.2 Invalid Block Replacement Operation

Within its life time, additional invalid blocks may develop with NAND Flash Array memory. Refer to the device's qualification report for the actual data.

The following possible failure modes should be considered to implement a highly reliable system.

In the case of a status read failure after erase or program, a block replacement should be done. Because program status failure during a page program does not affect the data of the other pages in the same block, a block replacement can be executed with a page-sized buffer by finding an erased empty block and reprogramming the current target data and copying the rest of the replaced block.

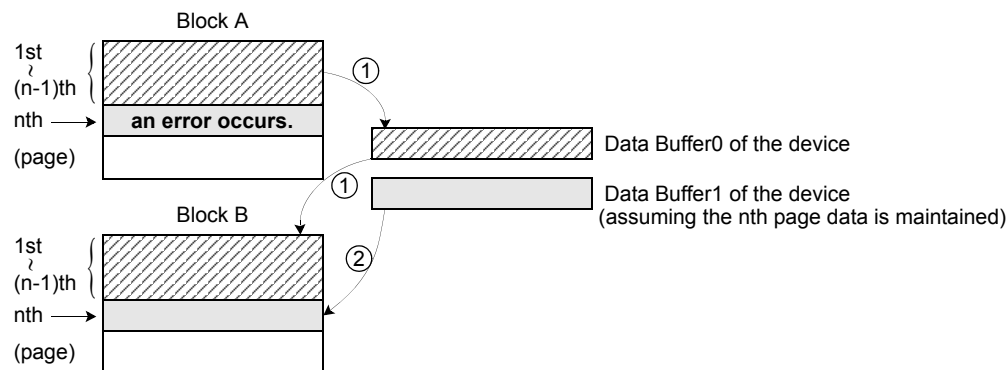
Block Failure Modes and Countermeasures

Failure Mode	Detection and Countermeasure sequence
Erase Failure	Status Read after Erase --> Block Replacement
Program Failure	Status Read after Program --> Block Replacement
Single Bit Failure in Load Operation	Error Correction by ECC mode of the device

Referring to the diagram for further illustration, when an error happens in the nth page of block 'A' during program operation, copy the data in the 1st ~ (n-1)th page to the same location of block 'B' via data buffer0.

Then copy the nth page data of block 'A' in the data buffer1 to the nth page of block 'B' or any free block. Do not further erase or program block 'A' but instead complete the operation by creating an 'Invalid Block Table' or other appropriate scheme.

Block Replacement Operation Sequence



4.0 DC CHARACTERISTICS

4.1 Absolute Maximum Ratings

Parameter		Symbol	Rating	Unit
Voltage on any pin relative to Vss	Vcc	Vcc	-0.5 to + 2.45	V
	All Pins	V _{IN}	-0.5 to + 2.45	
Temperature Under Bias	Extended	T _{bias}	-30 to +125	°C
	Industrial		-40 to +125	
Storage Temperature		T _{stg}	-65 to +150	°C
Short Circuit Output Current		I _{os}	5	mA
Recommended Operating Temperature	T _A (Extended Temp.)		-30 to +85	°C
	T _A (Industrial Temp.)		-40 to +85	

NOTE :

- 1) Minimum DC voltage is -0.5V on Input/ Output pins. During transitions, this level should not fall to POR level(typ. 1.5V@1.8V device).
Maximum DC voltage may overshoot to Vcc+2.0V for periods <20ns.
- 2) Permanent device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceeded. Functional operation should be restricted to the conditions detailed in the operational sections of this data sheet. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

4.2 Operating Conditions

Voltage reference to GND

Parameter	Symbol	KFG2G16Q2A			Unit
		Min	Typ.	Max	
Supply Voltage	Vcc-core / Vcc	1.7	1.8	1.95	V
	Vcc- IO / Vccq				
	Vss	0	0	0	V

NOTE :

- 1) Vcc-Core (or Vcc) should reach the operating voltage level prior to or at the same time as Vcc-IO (or Vccq).

4.3 DC Characteristics

Parameter	Symbol	Test Conditions	RMS Value			Unit
			Min	Typ	Max	
Input Leakage Current	I _{LI}	V _{IN} =V _{SS} to V _{CC} , V _{CC} =V _{CCmax}	Single	- 1.0	-	+ 1.0
			DDP	- 2.0	-	+ 2.0
Output Leakage Current	I _{LO}	V _{OUT} =V _{SS} to V _{CC} , V _{CC} =V _{CCmax} , CE or OE=V _{IH} (Note 1)	Single	- 1.0	-	+ 1.0
			DDP	- 2.0	-	+ 2.0
Active Asynchronous Read Current (Note 2)	I _{CC1}	CE=V _{IL} , OE=V _{IH}	-	8	15	mA
Active Burst Read Current (Note 2)	I _{CC2R}	CE=V _{IL} , OE=V _{IH} , WE=V _{IH}	66MHz	-	20	30
			83MHz	-	25	35
			1MHz	-	3	4
			66MHz (DDP)	-	30	38
			83MHz (DDP)	-	35	45
			1MHz (DDP)	-	3	4
Active Burst Write Current (Note 2)	I _{CC2W}	CE=V _{IL} , OE=V _{IH} , WE=V _{IL}	66MHz	-	20	30
			83MHz	-	25	35
			1MHz	-	3	4
			66MHz (DDP)	-	30	38
			83MHz (DDP)	-	35	45
			1MHz (DDP)	-	3	4
Active Asynchronous Write Current (Note 2)	I _{CC3}	CE=V _{IL} , OE=V _{IH}	Single	-	8	15
			DDP	-	17	25
Active Load Current (Note 3)	I _{CC4}	CE=V _{IL} , OE=V _{IH} , WE=V _{IH}	-	30	40	mA
Active Program Current (Note 3)	I _{CC5}	CE=V _{IL} , OE=V _{IH} , WE=V _{IH}	-	25	35	mA
Active Erase Current (Note 3)	I _{CC6}	CE=V _{IL} , OE=V _{IH} , WE=V _{IH}	-	20	30	mA
Multi Block Erase Current (Note 3)	I _{CC7}	CE=V _{IL} , OE=V _{IH} , WE=V _{IH} , 64blocks	-	20	30	mA
Standby Current	I _{SB}	CE= RP=V _{CC} ± 0.2V	Single	-	10	50
			DDP	-	20	100
Input Low Voltage	V _{IL}	-	-0.5	-	0.4	V
Input High Voltage (Note 4)	V _{IH}	-	V _{CCq} -0.4	-	V _{CCq} +0.4	V
Output Low Voltage	V _{OL}	I _{OL} = 100 μA, V _{CC} =V _{CCmin} , V _{CCq} =V _{CCqmin}	-	-	0.2	V
Output High Voltage	V _{OH}	I _{OH} = -100 μA, V _{CC} =V _{CCmin} , V _{CCq} =V _{CCqmin}	V _{CCq} -0.1	-	-	V

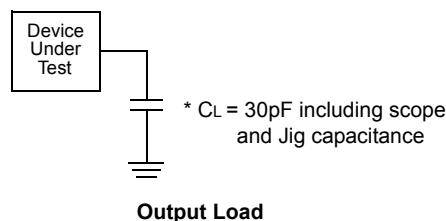
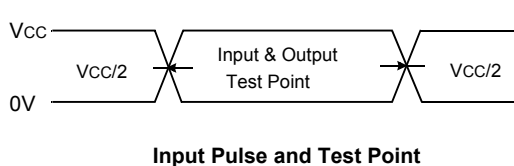
NOTE :

- 1) CE should be V_{IH} for RDY. IOBE should be '0' for INT.
- 2) I_{CC} active for Host access
- 3) I_{CC} active for Internal operation. (without host access)
- 4) V_{CCq} is equivalent to V_{CC}-IO

5.0 AC CHARACTERISTICS

5.1 AC Test Conditions

Parameter		Value (66MHz)	Value (83MHz)
Input Pulse Levels		0V to V _{CC}	0V to V _{CC}
Input Rise and Fall Times	CLK	3ns	2ns
	other inputs	5ns	2ns
Input and Output Timing Levels		V _{CC} /2	V _{CC} /2
Output Load		C _L = 30pF	C _L = 30pF



5.2 Device Capacitance

CAPACITANCE(T_A = 25 °C, V_{CC} = 1.8V, f = 1.0MHz)

Item	Symbol	Test Condition	Single		DDP		Unit
			Min	Max	Min	Max	
Input Capacitance	C _{IN1}	V _{IN} =0V	-	10	-	20	pF
Control Pin Capacitance	C _{IN2}	V _{IN} =0V	-	10	-	20	pF
Output Capacitance	C _{OUT}	V _{OUT} =0V	-	10	-	20	pF
INT Capacitance	C _{INT}	V _{OUT} =0V	-	10	-	20	pF

NOTE :

Capacitance is periodically sampled and not 100% tested.

5.3 Valid Block Characteristics

Parameter		Symbol	Min	Typ.	Max	Unit
Valid Block Number	Single	N _{vB}	2008	-	2048	Blocks
	DDP		4016	-	4096	Blocks

NOTE :

- 1) The device may include invalid blocks when first shipped. Additional invalid blocks may develop while being used. The number of valid blocks is presented with both cases of invalid blocks considered. Invalid blocks are defined as blocks that contain one or more bad bits. Do not erase or program factory-marked bad blocks.
- 2) The 1st block, which is placed on 00h block address, is guaranteed to be a valid block up to 1K program/erase cycles with 1bit/512Byte ECC.

5.4 AC Characteristics for Synchronous Burst Read

See Timing Diagrams 6.1, 6.2 and 6.3.

Parameter	Symbol	66MHz		83MHz		Unit
		Min	Max	Min	Max	
Clock	CLK	1	66	1	83	MHz
Clock Cycle	tCLK	15	-	12	-	ns
Initial Access Time	tIAA	-	70	-	70	ns
Burst Access Time Valid Clock to Output Delay	tBA	-	11	-	9	ns
AVD Setup Time to CLK	tAVDS	5	-	4	-	ns
AVD Hold Time from CLK	tAVDH	2	-	2	-	ns
Address Setup Time to CLK	tACS	5	-	4	-	ns
Address Hold Time from CLK	tACH	6	-	6	-	ns
Data Hold Time from Next Clock Cycle	tBDH	3	-	2	-	ns
Output Enable to Data	tOE	-	20	-	20	ns
$\overline{CE}$ Disable to Output & RDY High Z	tCEZ ¹⁾	-	20	-	20	ns
$\overline{OE}$ Disable to Output High Z	tOEZ ¹⁾	-	15	-	15	ns
$\overline{CE}$ Setup Time to CLK	tCES	6	-	4.5	-	ns
CLK High or Low Time	tCLKH/L	tCLK/3	-	5	-	ns
CLK ²⁾ to RDY valid	trDYO	-	11	-	9	ns
CLK to RDY Setup Time	trDYA	-	11	-	9	ns
RDY Setup Time to CLK	trDYS	4	-	3	-	ns
$\overline{CE}$ low to RDY valid	tCER	-	15	-	15	ns

NOTE :

- 1) If $\overline{OE}$ is disabled at the same time or before $\overline{CE}$ is disabled, the output will go to high-z by tOEZ.
 If $\overline{CE}$ is disabled at the same time or before $\overline{OE}$ is disabled, the output will go to high-z by tCEZ.
 If $\overline{CE}$ and $\overline{OE}$ are disabled at the same time, the output will go to high-z by tOEZ.
 2) It is the following clock of address fetch clock.

5.5 AC Characteristics for Asynchronous Read

See Timing Diagrams 6.5, 6.6, 6.7 and 6.8.

Parameter	Symbol	KFG2G16Q2A/ KFH4G16Q2A/		Unit
		Min	Max	
Access Time from $\overline{CE}$ Low	tCE	-	76	ns
Asynchronous Access Time from $\overline{AVD}$ Low	tAA	-	76	ns
Asynchronous Access Time from address valid	tACC	-	76	ns
Read Cycle Time	tRC	76	-	ns
$\overline{AVD}$ Low Time	tAVDP	12	-	ns
Address Setup to rising edge of $\overline{AVD}$	tAAVDS	7	-	ns
Address Hold from rising edge of $\overline{AVD}$	tAAVDH	6	-	ns
Output Enable to Output Valid	tOE	-	20	ns
$\overline{CE}$ Disable to Output & RDY High Z ¹⁾	tCEZ	-	20	ns
$\overline{OE}$ Disable to Output High Z ¹⁾	tOEZ	-	15	ns
$\overline{CE}$ Low to RDY Valid	tCER	-	15	ns
$\overline{WE}$ Disable to $\overline{AVD}$ Enable	tWEA	15	-	ns

NOTE :

- 1) If $\overline{OE}$ is disabled at the same time or before $\overline{CE}$ is disabled, the output will go to high-z by tOEZ.
If $\overline{CE}$ is disabled at the same time or before $\overline{OE}$ is disabled, the output will go to high-z by tCEZ.
If $\overline{CE}$ and $\overline{OE}$ are disabled at the same time, the output will go to high-z by tOEZ.
These parameters are not 100% tested.

5.6 AC Characteristics for Warm Reset ($\overline{RP}$), Hot Reset and NAND Flash CoreReset

See Timing Diagrams 6.19, 6.20 and 6.21.

Parameter	Symbol	Min	Max	Unit
$\overline{RP}$ & Reset Command Latch to BootRAM Access	tReady1 (BootRAM)	-	5	μ s
$\overline{RP}$ & Reset Command Latch(During Load Routines) to INT High (Note1)	tReady2 (NAND Flash Array)	-	10	μ s
$\overline{RP}$ & Reset Command Latch(During Program Routines) to INT High (Note1)	tReady2 (NAND Flash Array)	-	20	μ s
$\overline{RP}$ & Reset Command Latch(During Erase Routines) to INT High (Note1)	tReady2 (NAND Flash Array)	-	500	μ s
$\overline{RP}$ & Reset Command Latch(NOT During Internal Routines) to INT High (Note1)	tReady2 (NAND Flash Array)	-	10	μ s
$\overline{RP}$ Pulse Width (Note2)	tRP	200	-	ns

NOTE :

- 1) These parameters are tested based on INT bit of interrupt register. Because the time on INT pin is related to the pull-up and pull-down resistor value.
2) The device may reset if tRP < tRP min(200ns), but this is not guaranteed.

5.7 AC Characteristics for Asynchronous Write

See Timing Diagrams 6.9.

Parameter	Symbol	Min	Max	Unit
$\overline{WE}$ Cycle Time	t _{WC}	70	-	ns
Address Setup Time	t _{AWES}	0	-	ns
Address Hold Time	t _{AH}	30	-	ns
Data Setup Time	t _{DS}	25	-	ns
Data Hold Time	t _{DH}	0	-	ns
$\overline{CE}$ Setup Time	t _{CS}	0	-	ns
$\overline{CE}$ Hold Time	t _{CH}	0	-	ns
$\overline{WE}$ Pulse Width	t _{WPL}	40	-	ns
$\overline{WE}$ Pulse Width High	t _{WPH}	30	-	ns
$\overline{CE}$ Disable to Output & RDY High Z	t _{CEZ}	-	20	ns

5.8 AC Characteristics for Burst Write Operation

See Timing Diagrams 6.10 and 6.11.

Parameter	Symbol	66MHz		83MHz		Unit
		Min	Max	Min	Max	
Clock	CLK ¹⁾	1	66	1	83	MHz
Clock Cycle	t _{CLK}	15	-	12	-	ns
AVD Setup to CLK	t _{AVDS}	5	-	4	-	ns
AVD Hold Time from CLK	t _{AVDH}	2	-	2	-	ns
Address Setup Time to CLK	t _{ACS}	5	-	4	-	ns
Address Hold Time from CLK	t _{ACH}	6	-	6	-	ns
Data Setup Time to CLK	t _{WDS}	5	-	4	-	ns
Data Hold Time from CLK	t _{WDH}	2	-	2	-	ns
$\overline{WE}$ Setup Time to CLK	t _{WES}	5	-	4	-	ns
$\overline{WE}$ Hold Time from CLK	t _{WEH}	3	-	3	-	ns
CLK High or Low Time	t _{CLKH/L}	t _{CLK} /3	-	5	-	ns
$\overline{CE}$ high pulse width	t _{CEHP}	10	-	10	-	ns
CLK to RDY Valid	t _{RDYO}	-	11	-	9	ns
CLK to RDY Setup Time	t _{RDYA}	-	11	-	9	ns
RDY Setup Time to CLK	t _{RDYS}	4	-	3	-	ns
$\overline{CE}$ low to RDY valid	t _{CER}	-	15	-	15	ns
Clock to $\overline{CE}$ disable	t _{CEH}	2	t _{CLK} - 4.5	2	t _{CLK} - 4.5	ns
$\overline{CE}$ Setup Time to CLK	t _{CES}	6	-	4.5	-	ns
$\overline{CE}$ Disable to Output & RDY High Z	t _{CEZ}	-	20	-	20	ns

NOTE :

1) Target Clock frequency is 83Mhz

5.9 AC Characteristics for Load/Program/Erase Performance

See Timing Diagrams 6.12, 6.13, and 6.17

Parameter		Symbol	Min	Typ	Max	Unit
Spare Load time(Note 1, Note2)		tRD1	-	23	35	μs
Sector Load time(Note 1, Note4)						
Page Load time(Note 1)		tRD2	-	30	45	μs
Spare Program time(Note 1, Note3)		tPGM1	-	205	720	μs
Sector Program time(Note 1, Note4)						
Page Pogram time(Note 1)		tPGM2	-	220	750	μs
OTP Access Time(Note 1)		tOTP	-	500	700	ns
Lock/Unlock/Lock-tight (Note 1)		tLOCK	-	500	700	ns
All Block Unlock Time		tABU	-	2	3	μs
Erase Suspend Time (Note 1)		tESP	-	400	500	μs
Erase Resume Time(Note 1)	1 Block	tERS1	-	1.5	2	ms
	2~64 Blocks	tERS2		4	6	ms
Number of Partial Program Cycles in the page (Including main and spare area)		NOP	-	-	4	cycles
Block Erase time (Note 1)	1 Block	tBERS1	-	1.5	2	ms
	2~64 Blocks	tBERS2	-	4	6	ms
Multi Block Erase Verify Read time(Note 1)		tRD3	-	70	100	μs

NOTE :

- 1) These parameters are tested based on INT bit of interrupt register. Because the time on INT pin is related to the pull-up and pull-down resistor value.
- 2) Spare Load time is little bit less than Sector Load time.
- 3) Spare Program time is same as Sector program time.
- 4) 2/3 sector Load/Program time is between Sector Load/Program time and Page Load/Program time.

5.10 AC Characteristics for INT Auto Mode

See Timing Diagrams 6.23

Parameter	Symbol	Min	Max	Unit
Command Input to INT Low	t _{WB}	-	200	ns

5.11 AC Characteristics for Synchronous Burst Block Read

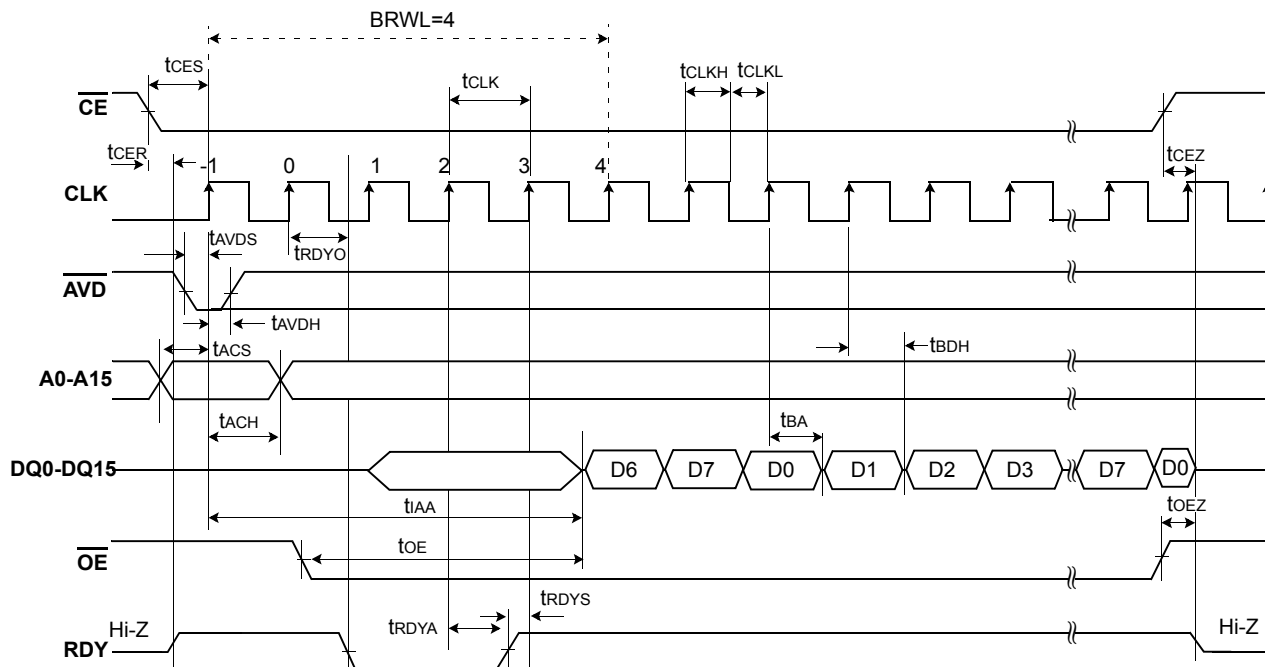
See Timing Diagrams 6.3, 6.4

Parameter	Symbol	Typ.	Max	Unit
INT Low Period During Synch Burst Block Read	t _{INTL}	1	-	us

6.0 TIMING DIAGRAMS

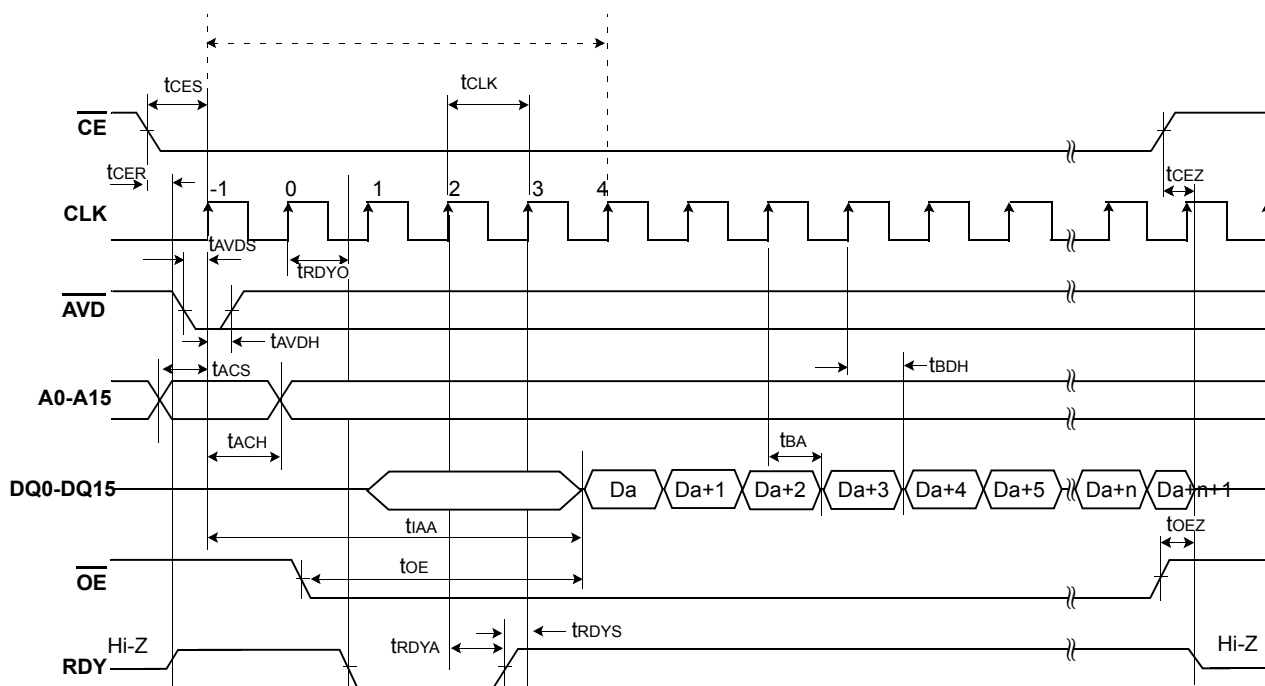
6.1 8-Word Linear Burst Read Mode with Wrap Around

See AC Characteristics Table 5.4



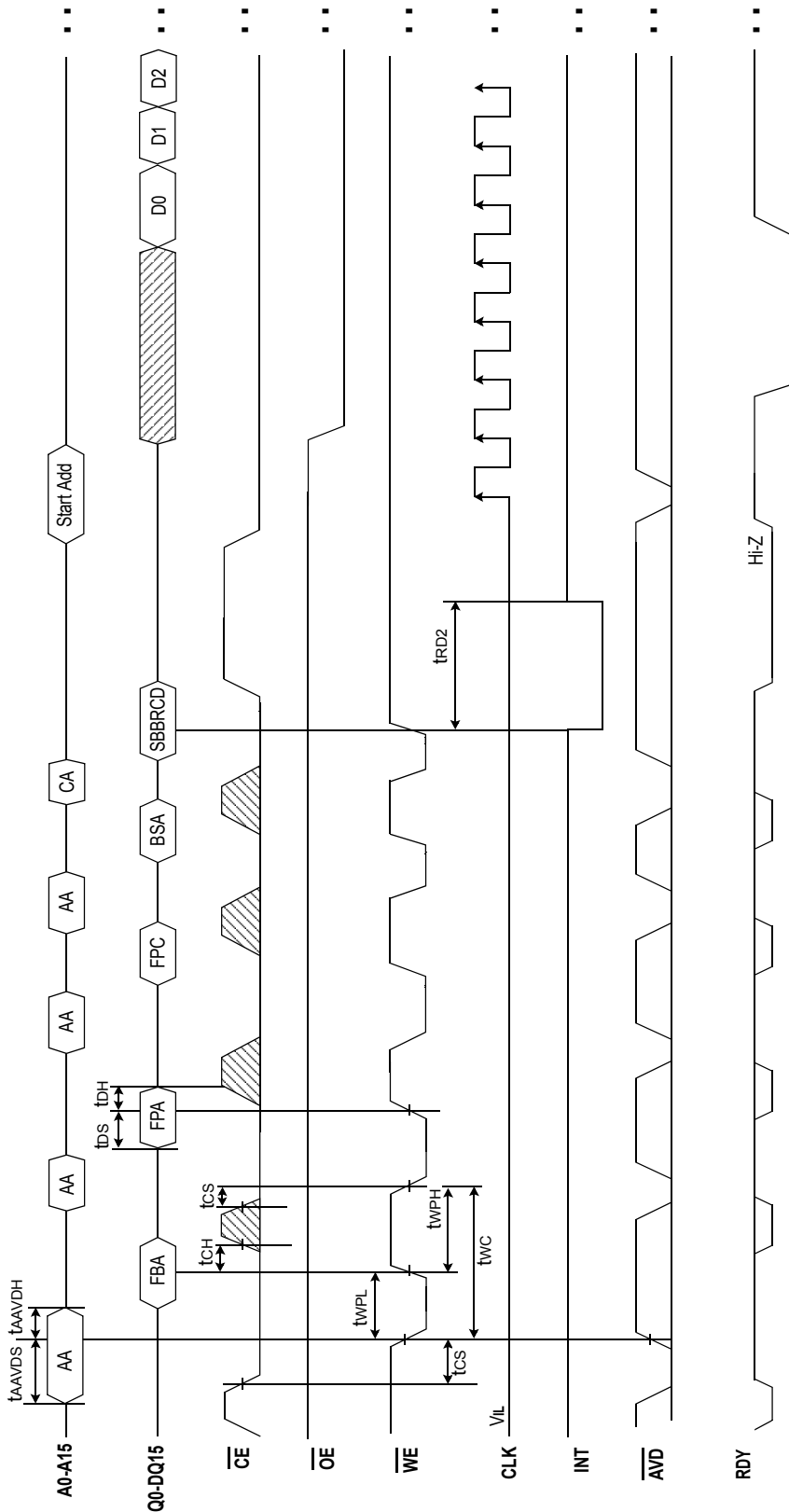
6.2 Continuous Linear Burst Read Mode with Wrap Around

See AC Characteristics Table 5.4



6.3 Synchronous Burst Block Read Operation Timing

See AC Characteristics table 5.4 and 5.7.



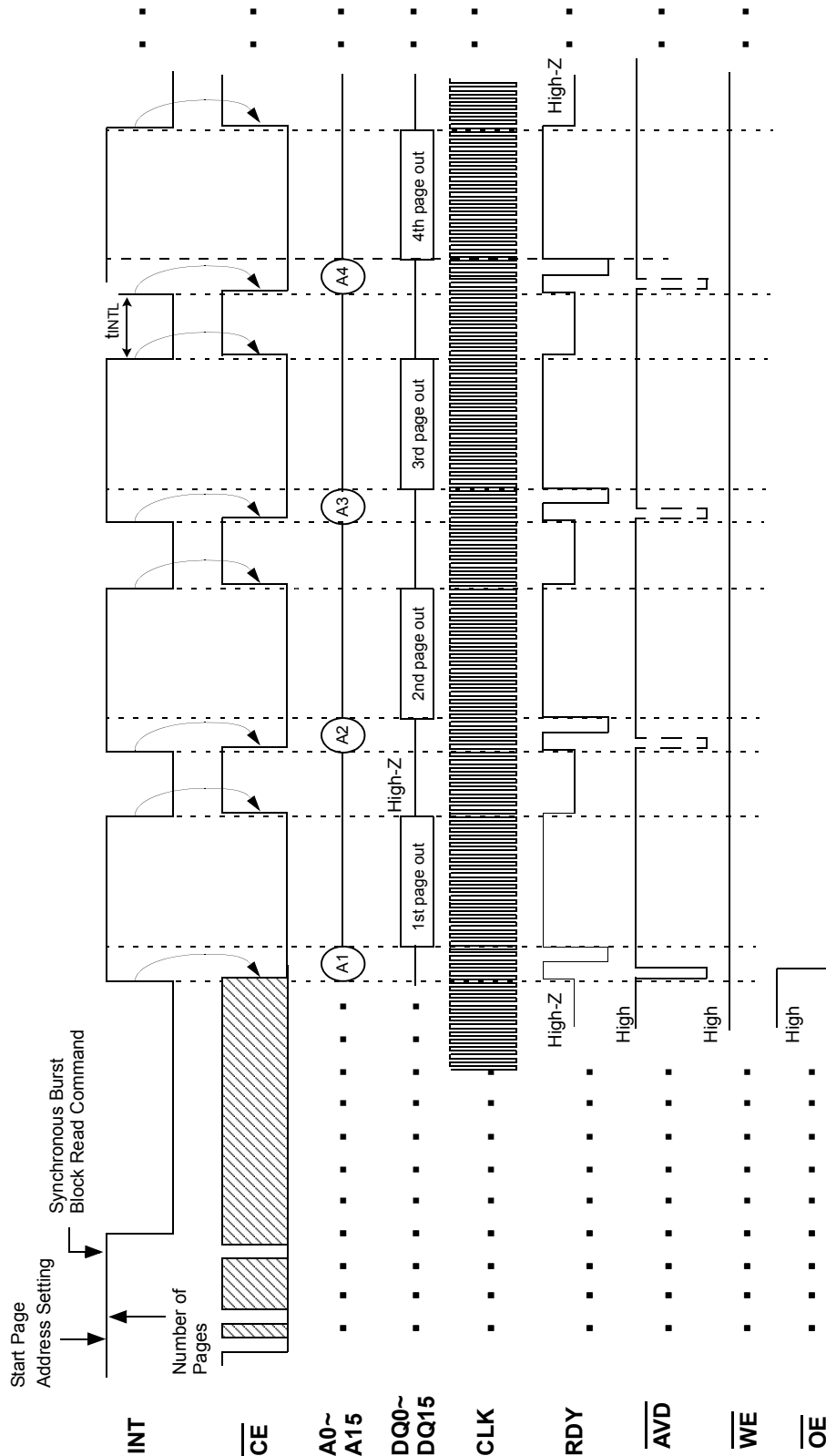
NOTE : Asynchronous write was used in this timing diagram. Synchronous write is also possible.

- 1) AA = Address of address register
- CA = Address of command register
- SBBRCD = Synchronous Burst Block Read Command
- FBA = Flash Block Address
- FPA = Flash Page Address
- BSA = BufferRAM Sector Address
- FPC = Number of Flash Page to be read (3pages ~ 64pages)

6.4 Synchronous Burst Block Read Timing

See AC Characteristics table 5.11

Case 1 : BL=1K word synchronous burst block read



INT: Indicator for DataRAM's Status (Ready=High, Busy=Low)

RDY: Indicator for Latency of Sync Burst Block Read

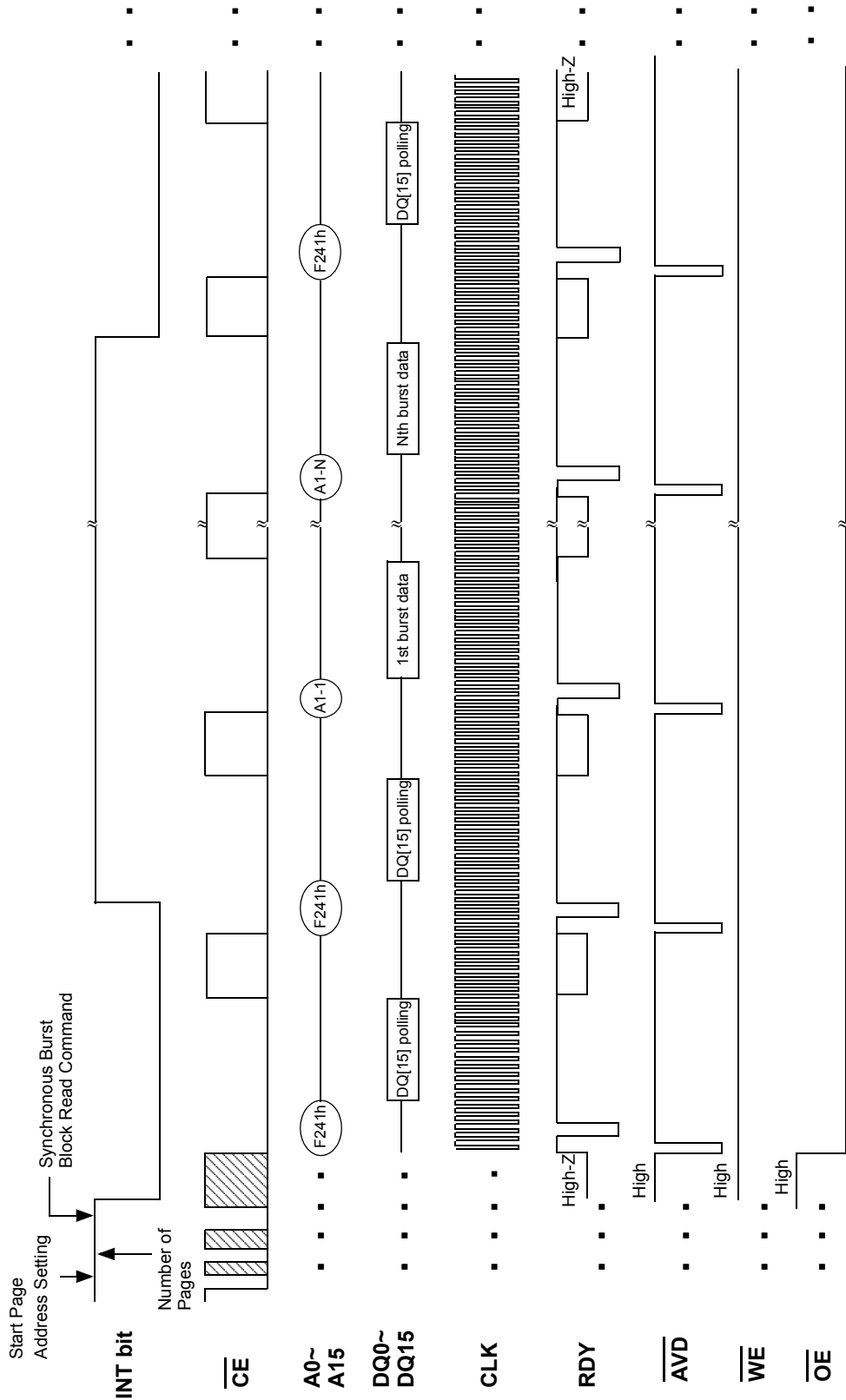
Burst Length: 4, 8, 16, 32, 1K Word, and Continuous Synchronous Burst Block Read

A1~A4: For the fixed number of words linear burst block read, A1~A4 are start address of the each DataRAM.

For detailed timing diagram, refer to Chapter 6.3

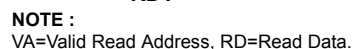
WE must be set high throughout the operation.

Case 2 : Host reads INT bit for Ready/Busy State indicator



NT bit : Indicator for DataRAM's Status (Ready=1, Busy=0)
RDY: Indicator for Latency of Sync Burst Block Read
Burst Length: 4, 8, 16, 32, 1K Word Synchronous Burst Block Read are available.
A1-1 ~ A1-N: Address where each burst data initiates, and this may differ for different settings of BSA and BL.
N can be calculated by 1024w / BL.
Therefore, for above case, BSA=0200h and BL=8word. So that N=128, A1-1=0200h, A1-2=0208h ... A1-128=05F8h.
WE must be set high throughout the operation.

See AC Characteristics Table 5.5

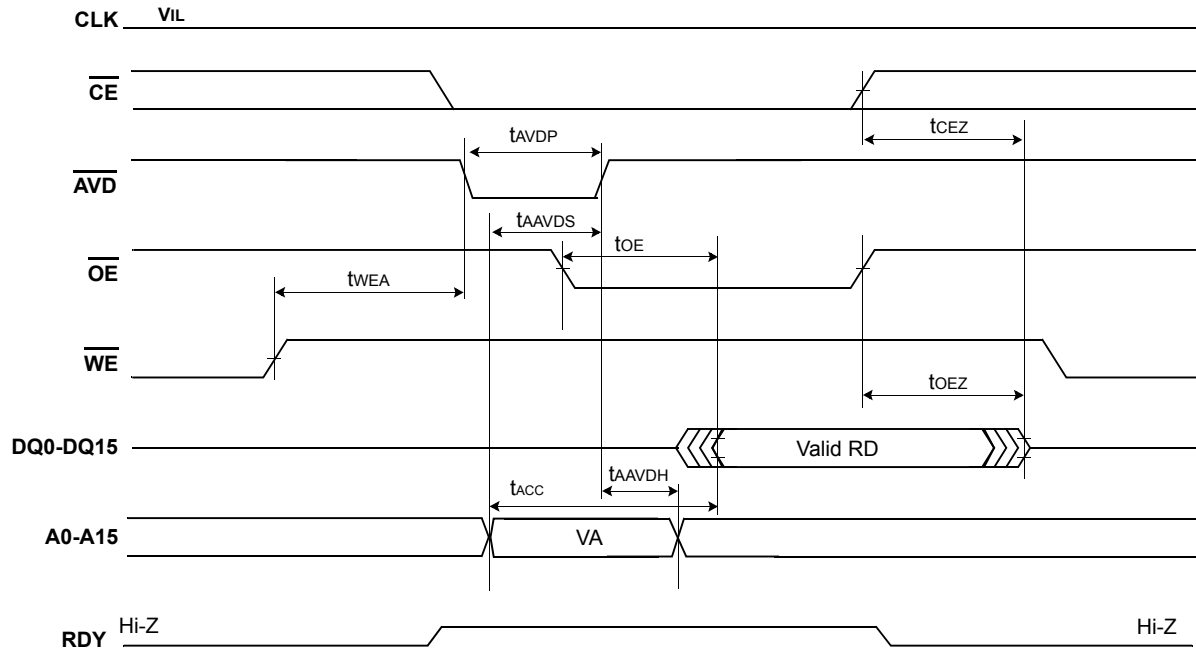


See AC Characteristics Table 5.5



6.7 Asynchronous Read (VA and $\overline{\text{AVD}}$ Transition After $\overline{\text{CE}}$ Low)

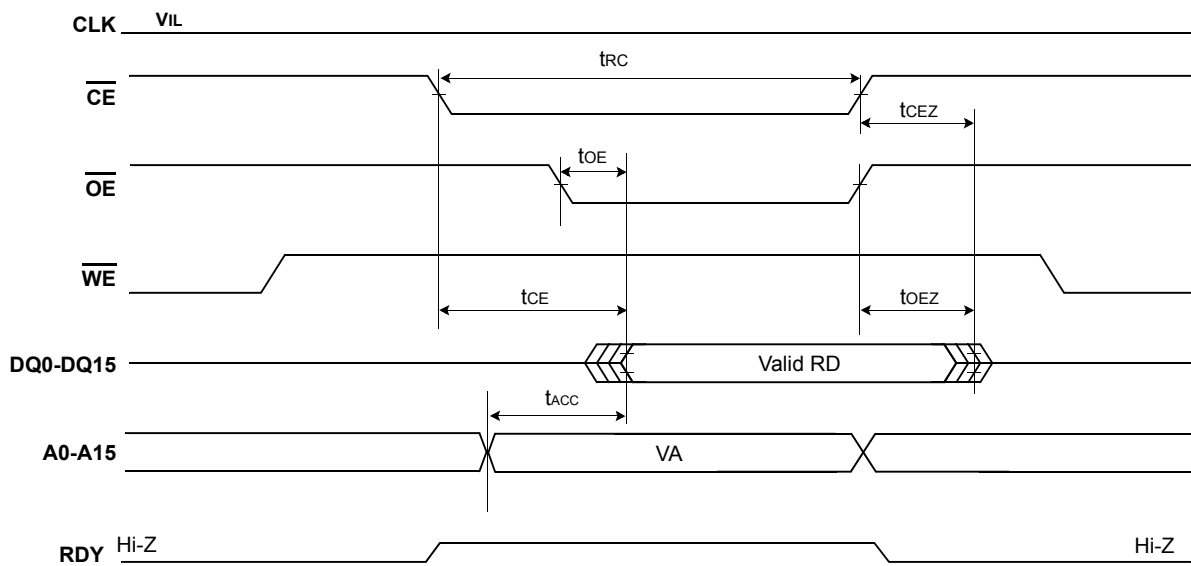
See AC Characteristics Table 5.5



NOTE :
VA=Valid Read Address, RD=Read Data.

6.8 Asynchronous Read ($\overline{\text{AVD}}$ is tied to $\overline{\text{CE}}$)

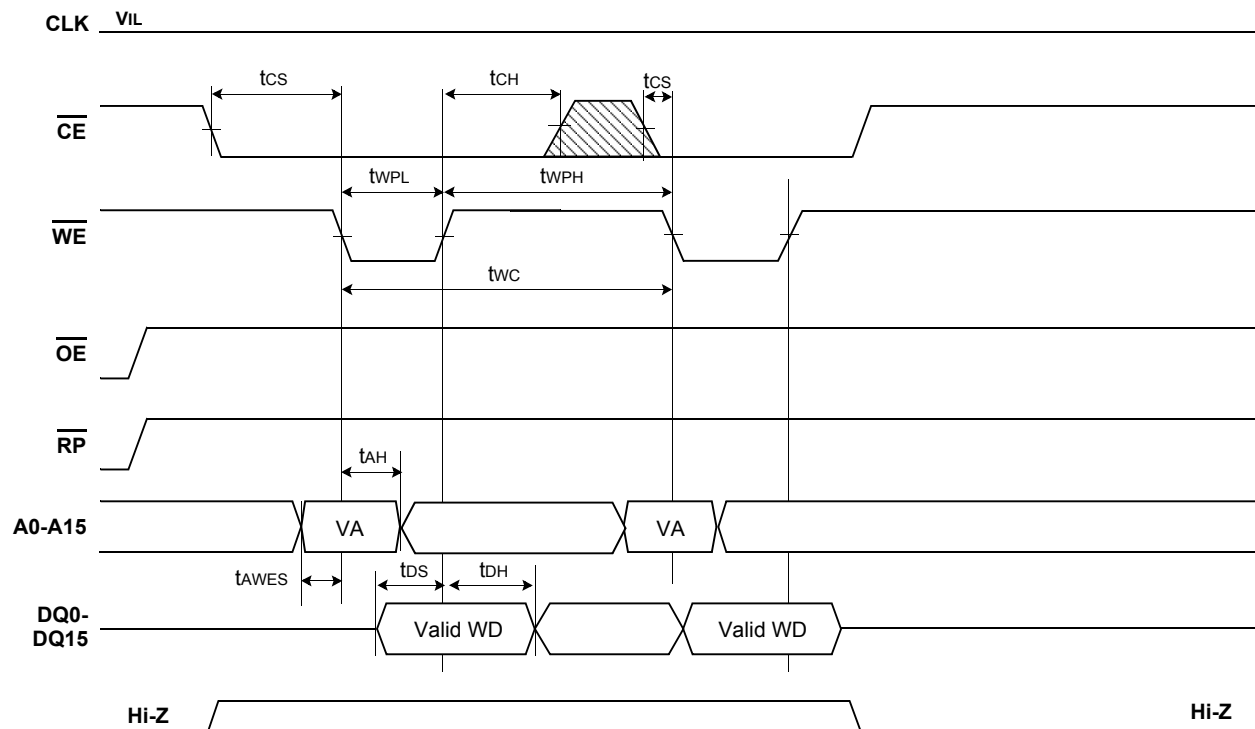
See AC Characteristics Table 5.5



NOTE :
VA=Valid Read Address, RD=Read Data.

6.9 Asynchronous Write

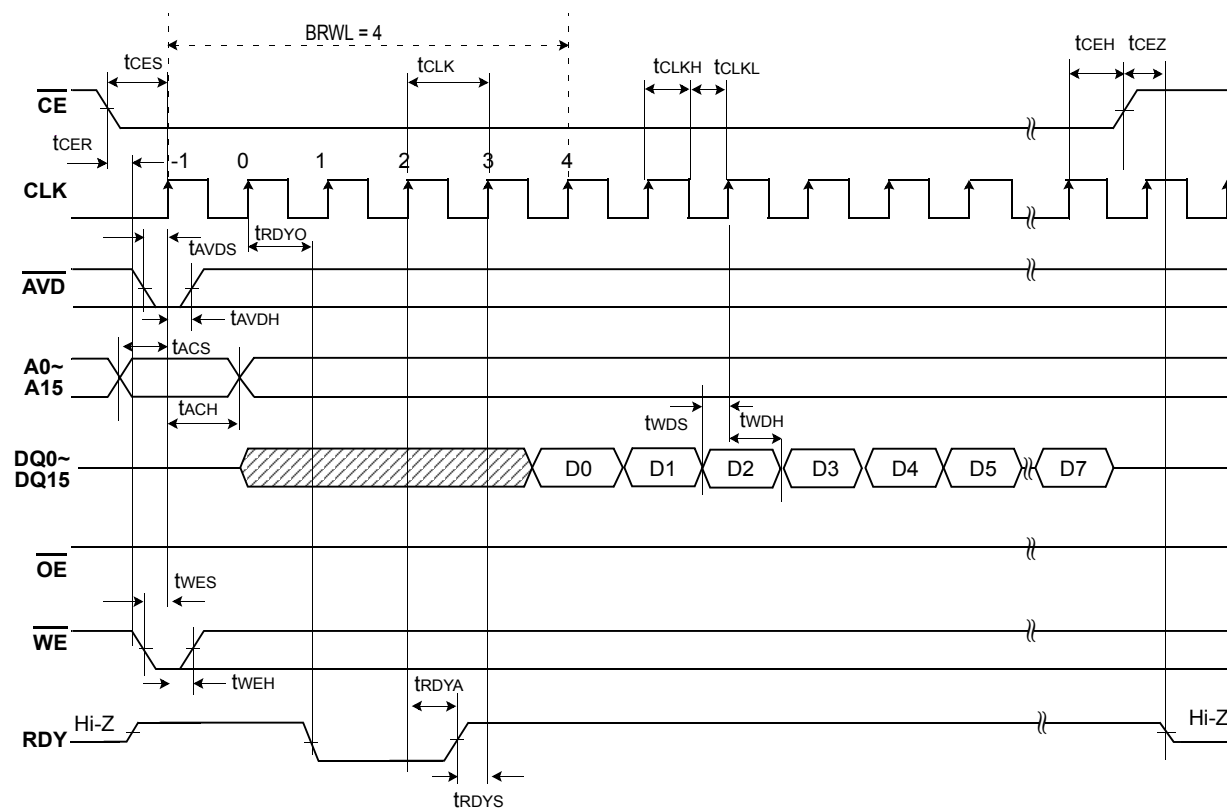
See AC Characteristics Table 5.7



NOTE :
VA=Valid Read Address, WD=Write Data.

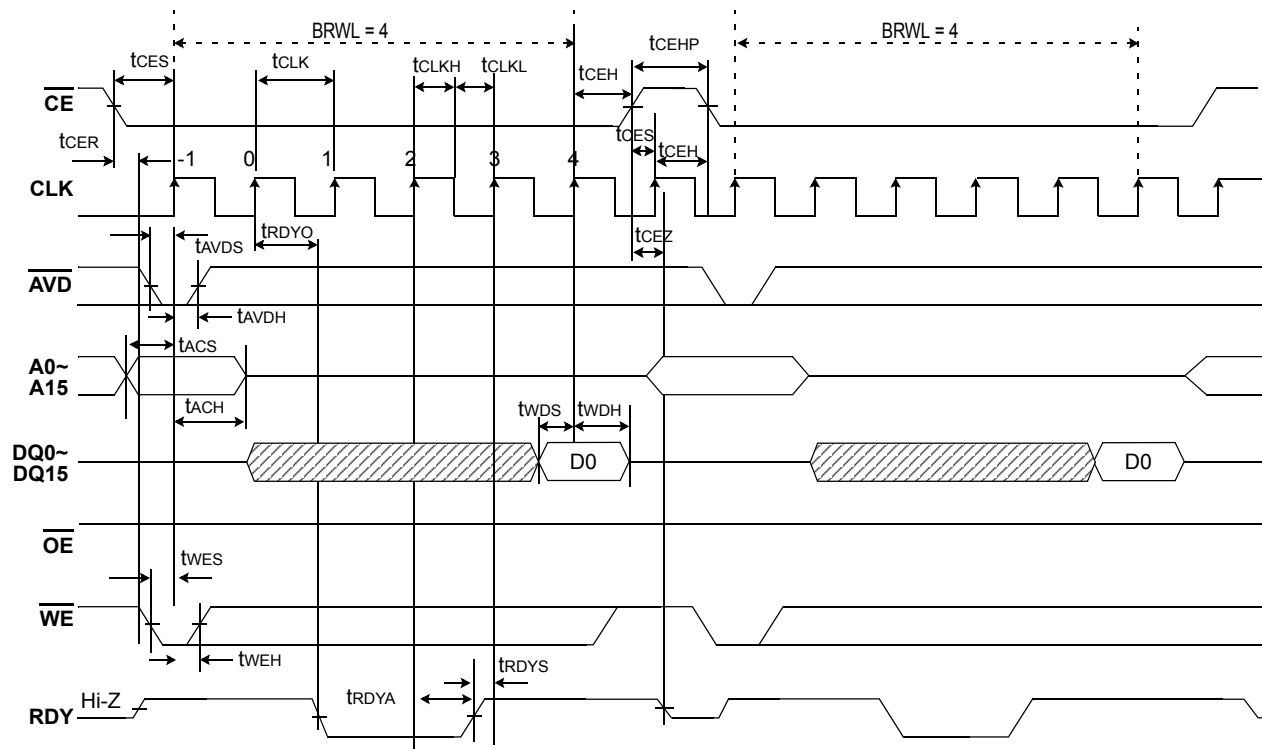
6.10 8-Word Linear Burst Write Mode

See AC Characteristics Table 5.8



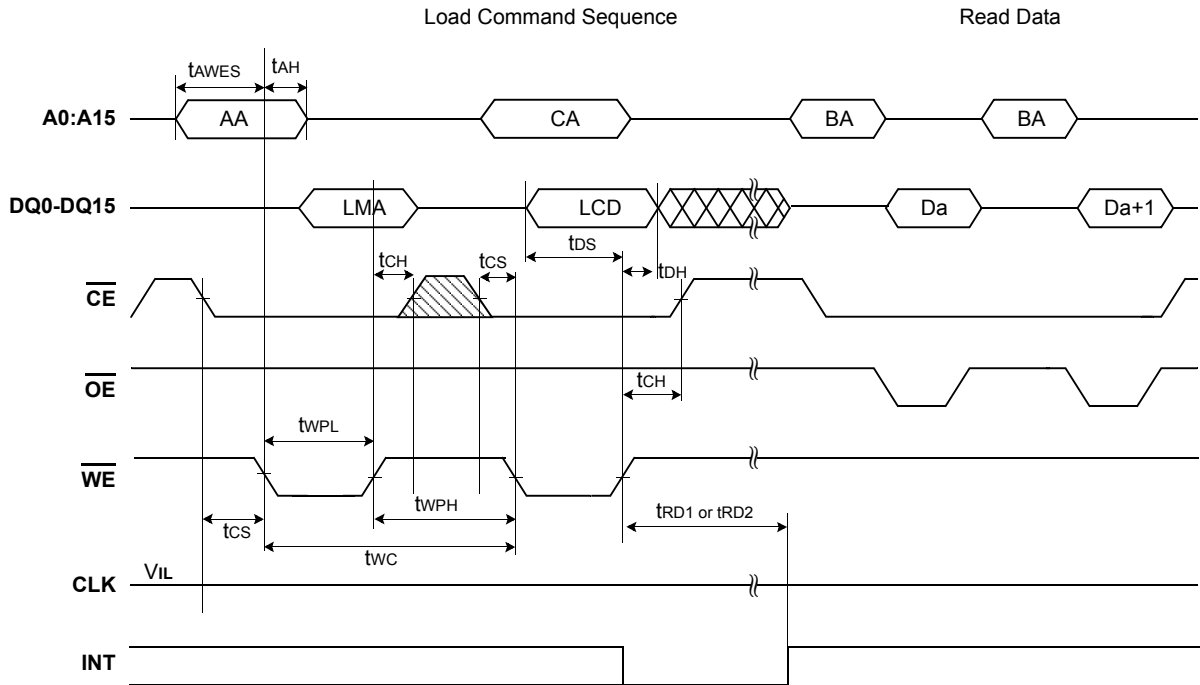
6.11 Start Initial Burst Write Operation

See AC Characteristics Table 5.8



6.12 Load Operation Timing

See AC Characteristics Tables 5.7 and 5.9

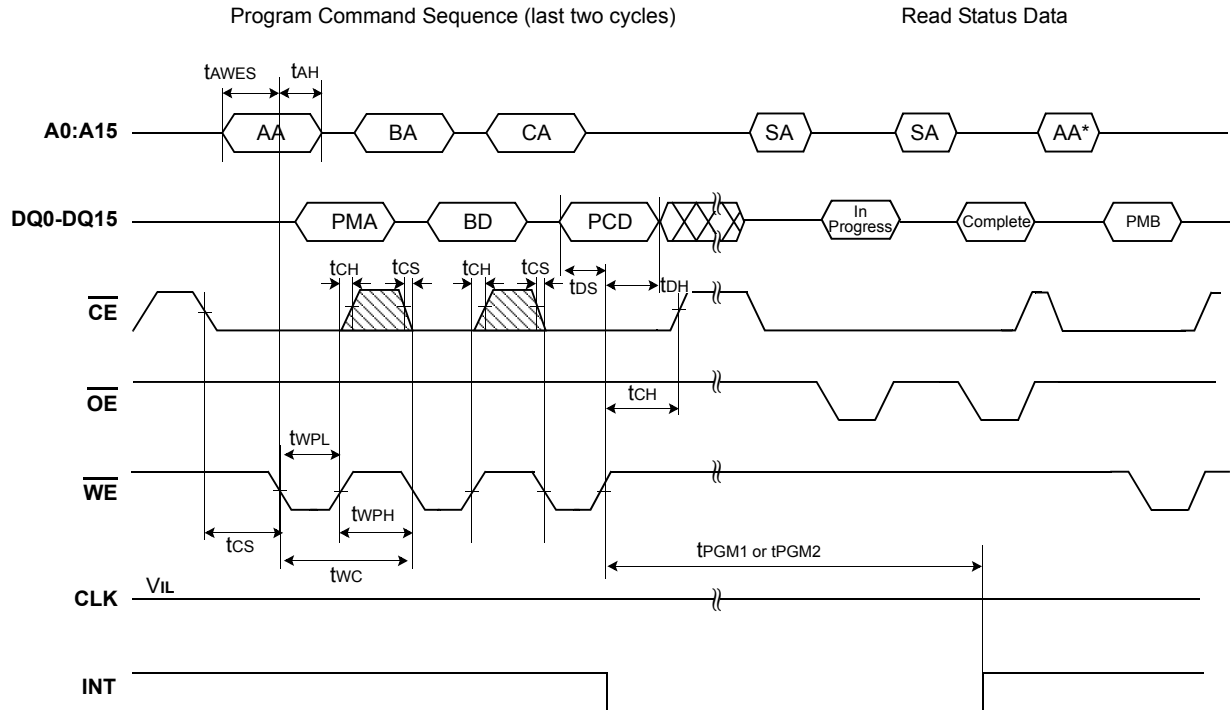


NOTE :

- 1) AA = Address of address register
CA = Address of command register
PCD = Program Command
PMA = Address of memory to be programmed
BA = Address of BufferRAM to load the data
BD = Program Data
SA = Address of status register
AA* = Address of Start Address1 Register(for Flash Block Address)
PMB = DFS & FBA(Flash Block address) of memory to be programmed next time
- 2) "In progress" and "complete" refer to status register
- 3) Status reads in this figure is asynchronous read, but status read in synchronous mode is also supported.

6.13 Program Operation Timing

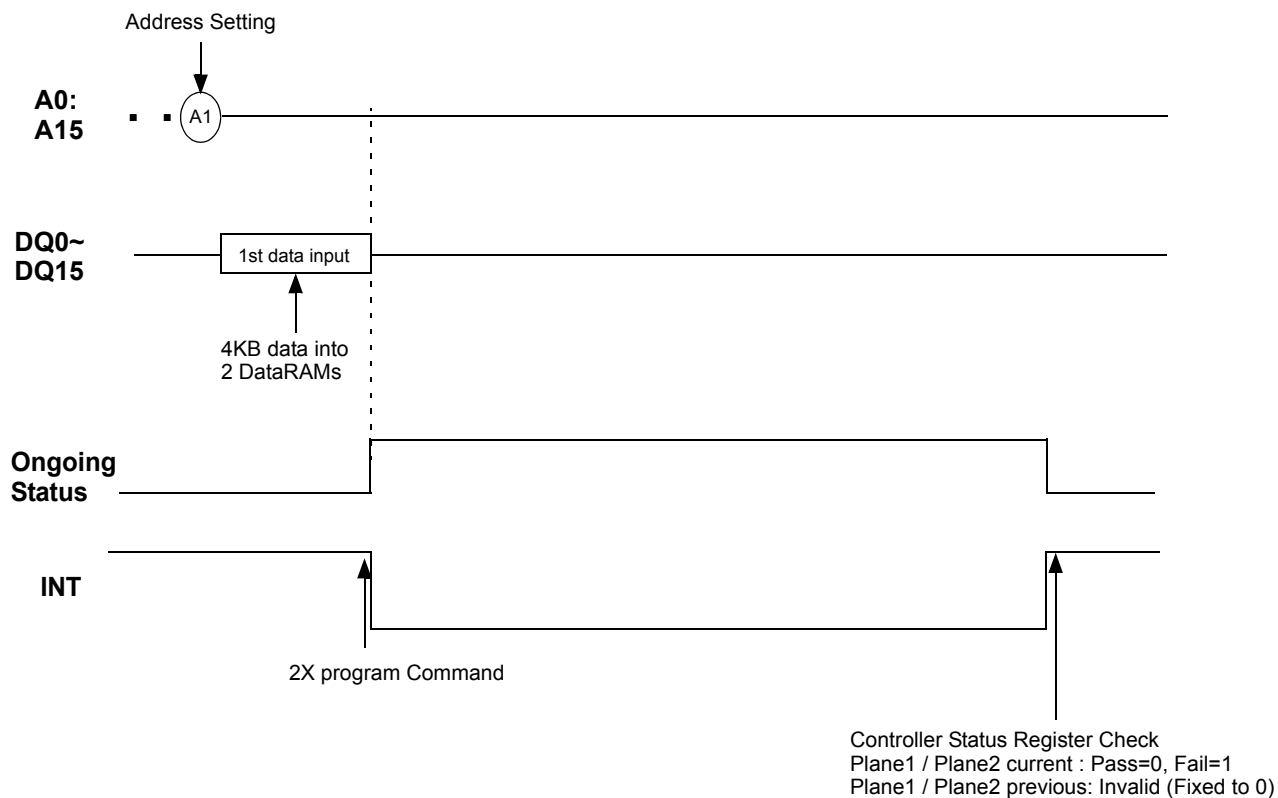
See AC Characteristics Tables 5.7 and 5.9



NOTE :

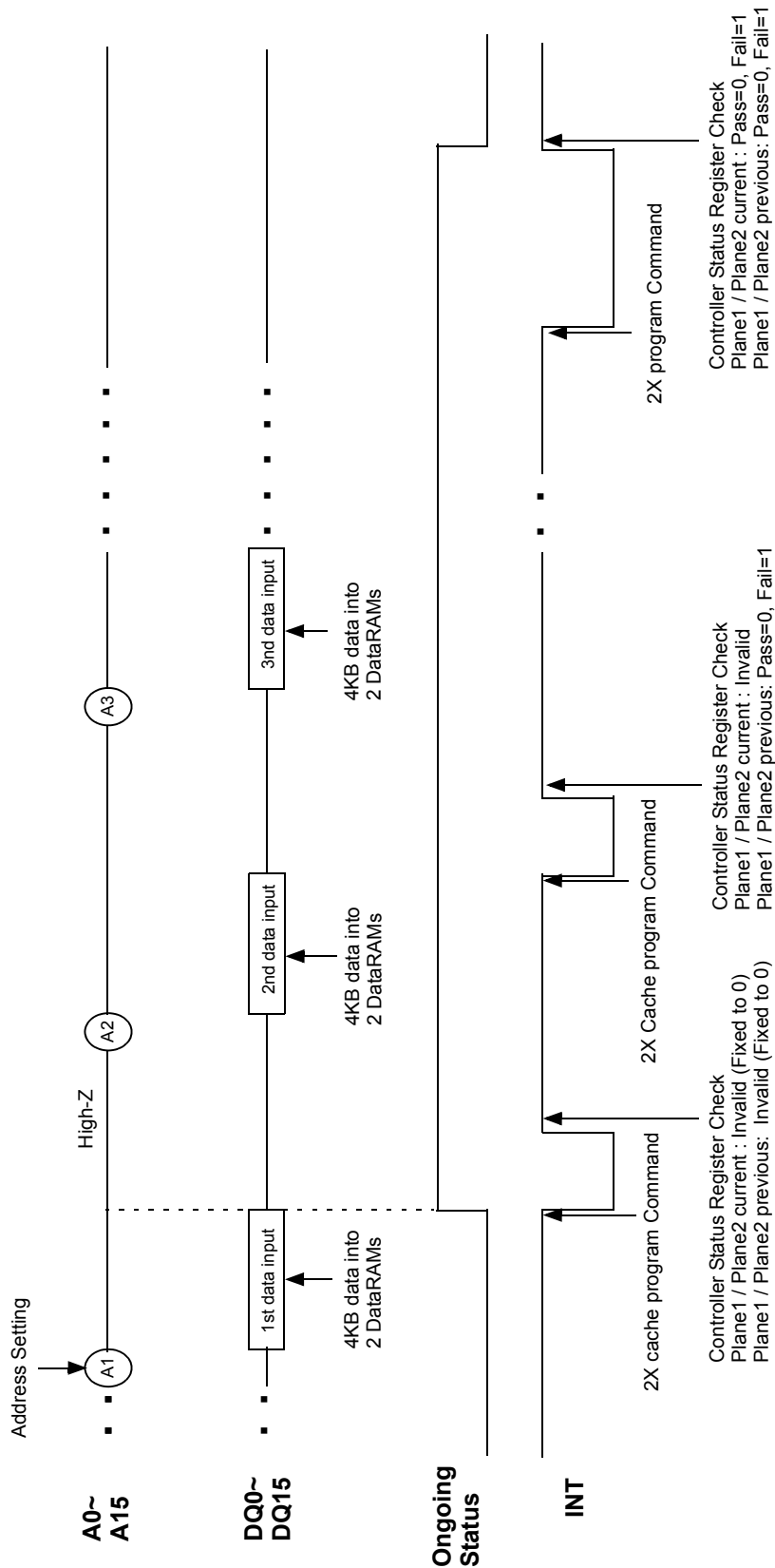
- 1) AA = Address of address register
CA = Address of command register
PCD = Program Command
PMA = Address of memory to be programmed
BA = Address of BufferRAM to load the data
BD = Program Data
SA = Address of status register
AA* = Address of Start Address1 Register(for Flash Block Address)
PMB = DFS & FBA(Flash Block address) of memory to be programmed next time
- 2) "In progress" and "complete" refer to status register
- 3) Status reads in this figure is asynchronous read, but status read in synchronous mode is also supported.

6.14 2X Program Operation Timing



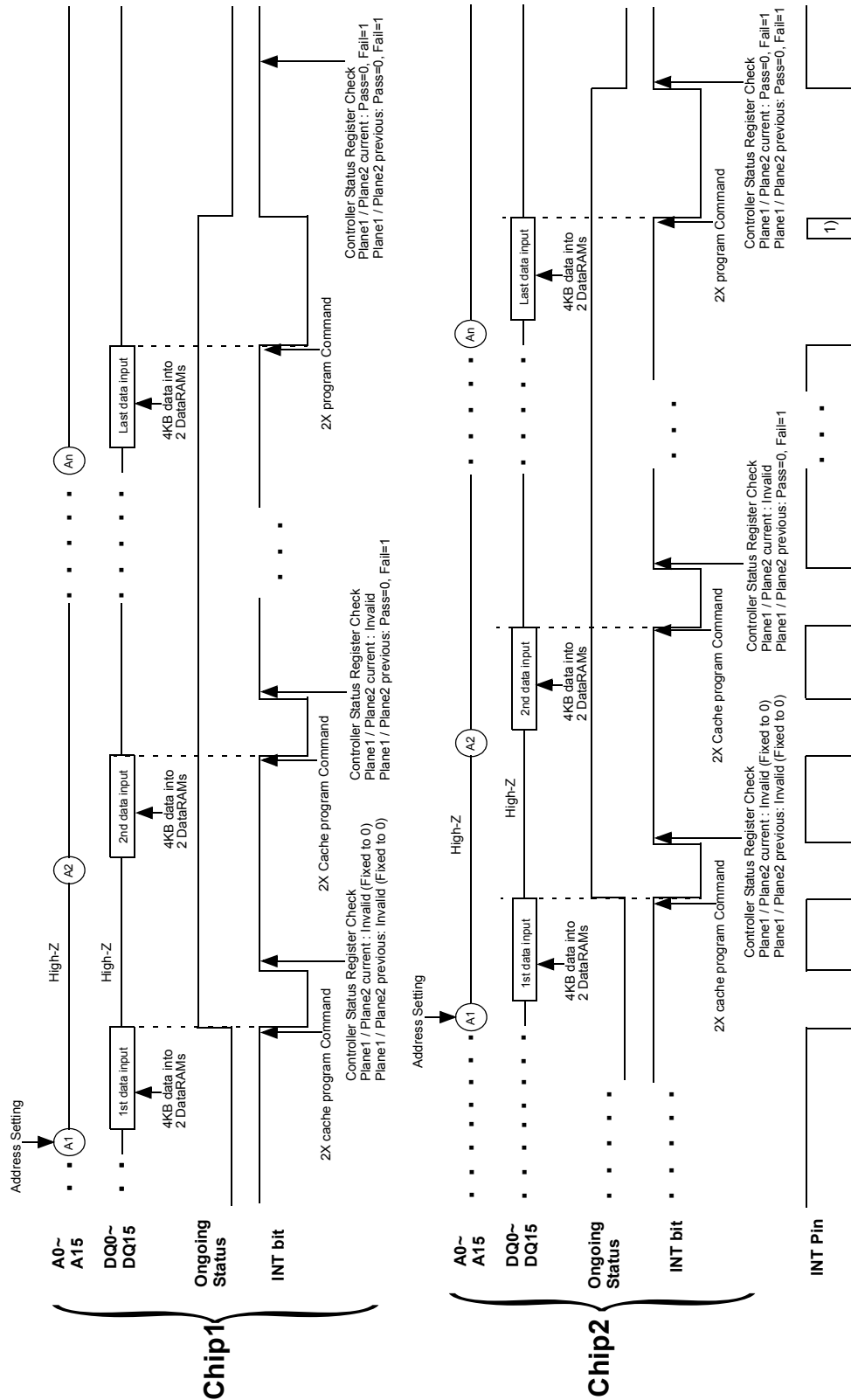
A1 : Address of DataRAM to be written.
INT: Indicator for DataRAM's Status (Ready=High, Busy=Low)
Ongoing Status : Indicated by OnGo bit in Controller Status Register [15] (F240h)
4KB data input : Asynch Write / Synch Write available.
Command input and INT pin behavior is based on 'INT auto mode'.
In 'INT manual mode', writing '0' to interrupt register is required before command issue.

6.15 2X Cache Program Operation Timing



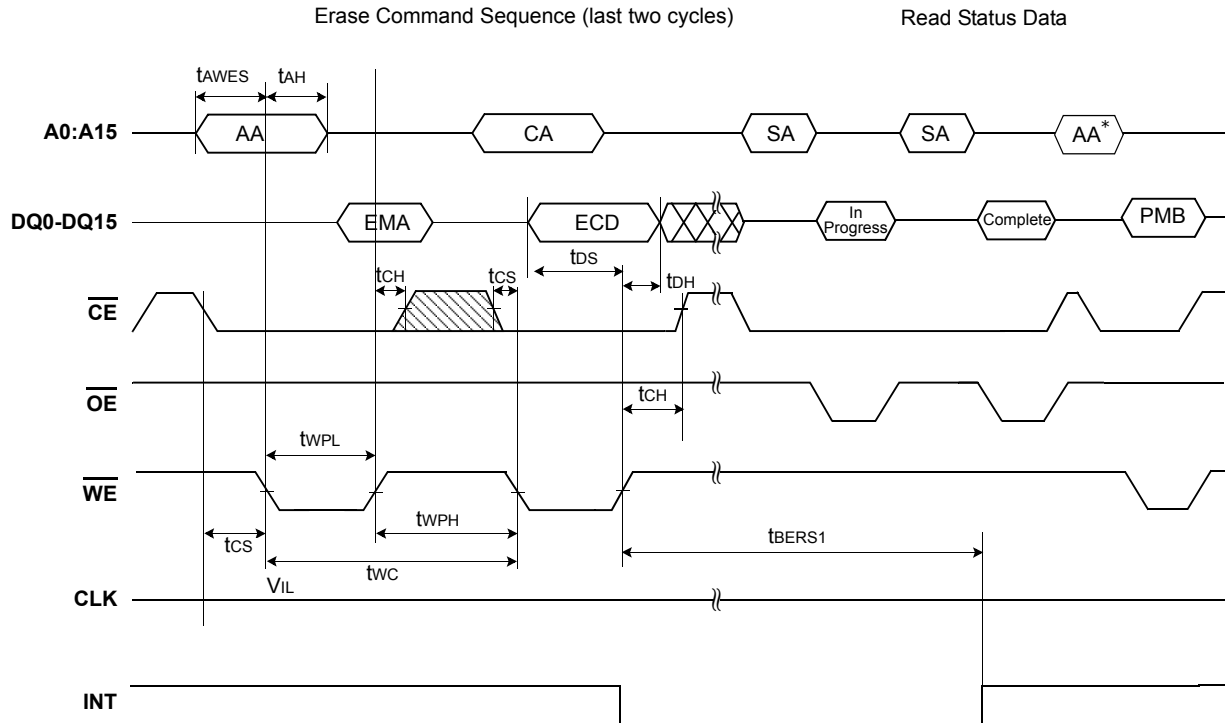
A1, A2, A3 : Address of DataRAM to be written.
INT: Indicator for DataRAM's Status (Ready=High, Busy=Low)
Ongoing Status : Indicated by OnGo bit in Controller Status Register [15] (F240h)
4KB data input : Asynch Write / Synch Write available.
Command input and INT pin behavior is based on 'INT' auto mode'.
In 'INT manual mode', writing '0' to interrupt register is required before command issue.

6.16 2X Interleave Cache Program Operation Timing



6.17 Block Erase Operation Timing

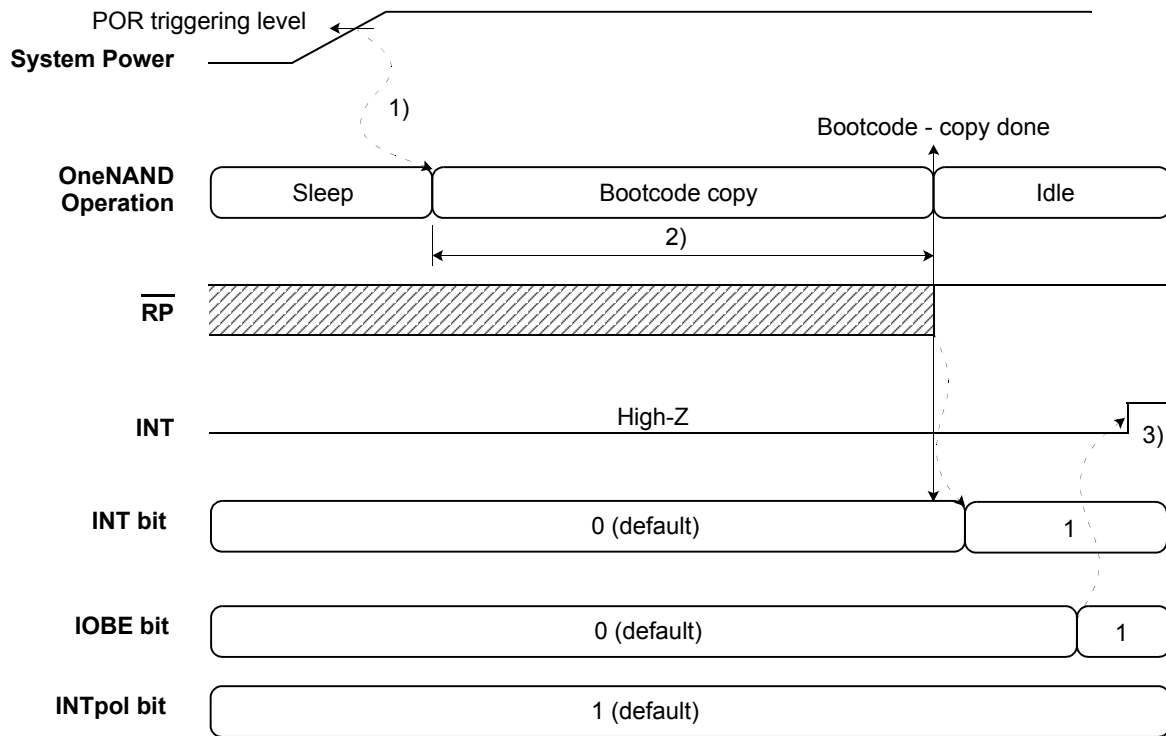
See AC Characteristics Tables 5.7 and 5.9



NOTE :

- 1) AA = Address of address register
CA = Address of command register
ECD = Erase Command
EMA = Address of memory to be erased
SA = Address of status register
AA* = Address of Start Address1 Register(for Flash Block Address)
PMB = DFS & FBA(Flash Block address) of memory to be programmed next time
- 2) "In progress" and "complete" refer to status register
- 3) Status reads in this figure is asynchronous read, but status read in synchronous mode is also supported.

6.18 Cold Reset Timing

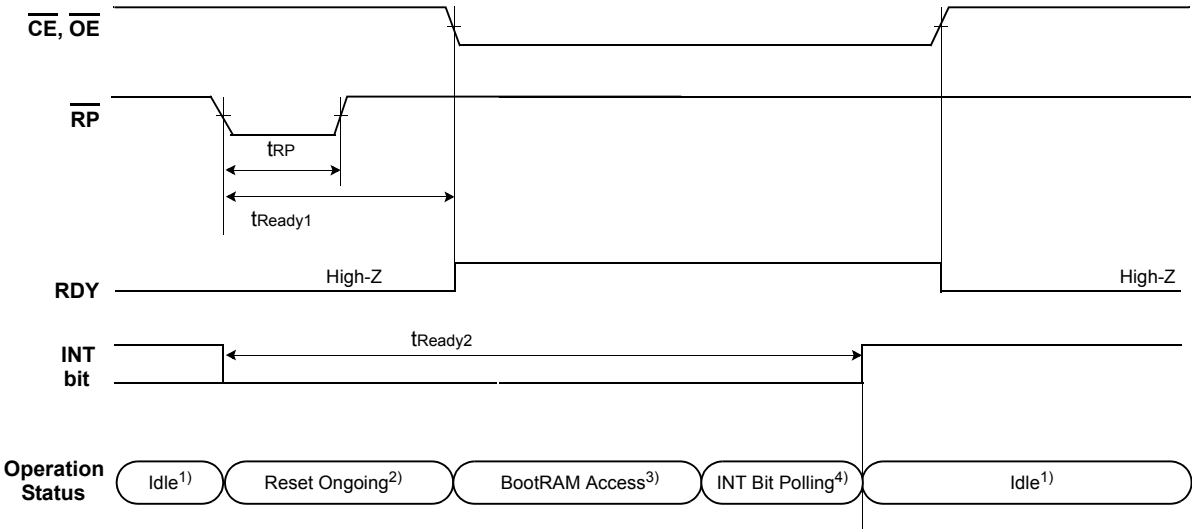


NOTE :

- 1) Bootcode copy operation starts 400us later than POR activation.
The system power should reach Vcc after POR triggering level(typ. 1.5V) within 400us for valid boot code data.
- 2) 1K bytes Bootcode copy takes 70us(estimated) from sector0 and sector1/page0/block0 of NAND Flash array to BootRAM.
Host can read Bootcode in BootRAM(1K bytes) after Bootcode copy completion.
- 3) INT register goes 'Low' to 'High' on the condition of 'Bootcode-copy done' and RP rising edge.
If RP goes 'Low' to 'High' before 'Bootcode-copy done', INT register goes to 'Low' to 'High' as soon as 'Bootcode-copy done'

6.19 Warm Reset Timing

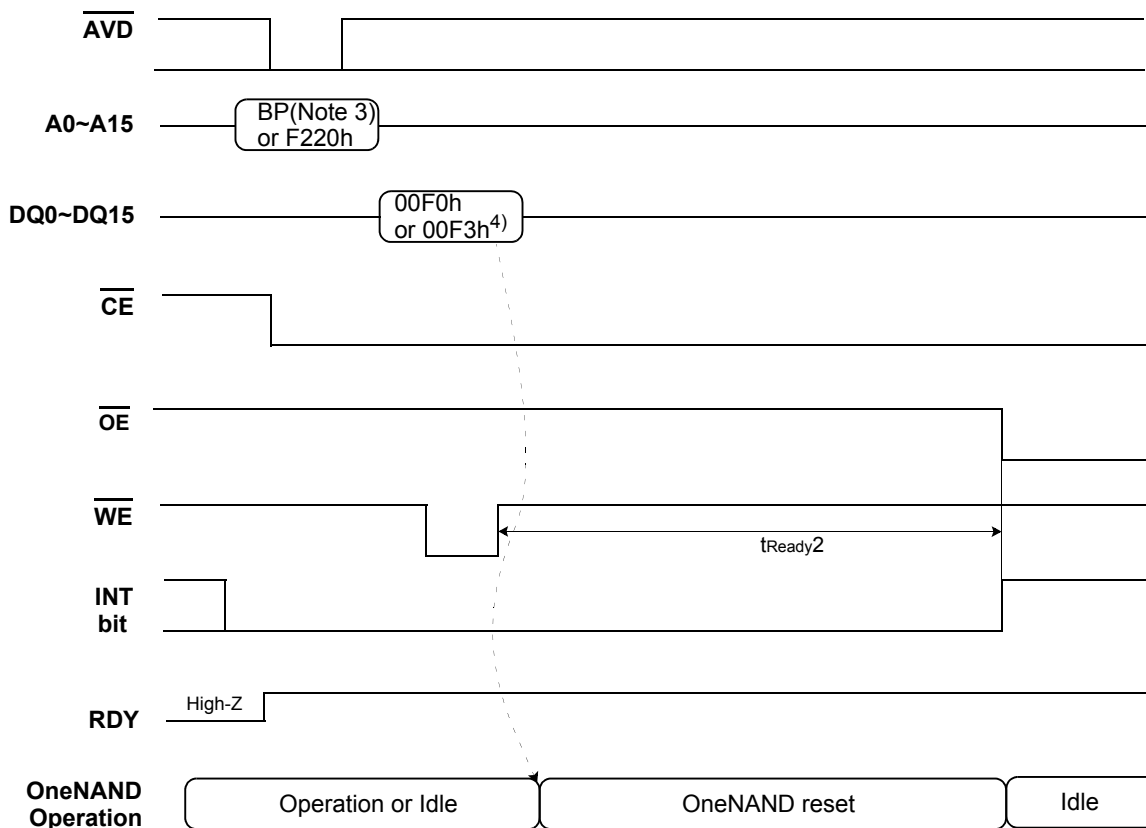
See AC Characteristics Table 5.6



- NOTE :**
- 1) The status which can accept any register based operation(Load, Program, Erase command, etc).
 - 2) The status where reset is ongoing.
 - 3) The status allows only BootRAM(BL1) read operation for Boot Sequence.(refer to 7.2.2 Boot Sequence)
 - 4) To read BL2 of Boot Sequence, Host should wait INT until becomes ready. and then, Host can issue load command. (refer to 7.2.2 Boot Sequence, 7.1 Methods of Determining Interrupt status)

6.20 Hot Reset Timing

See AC Characteristics Table 5.6

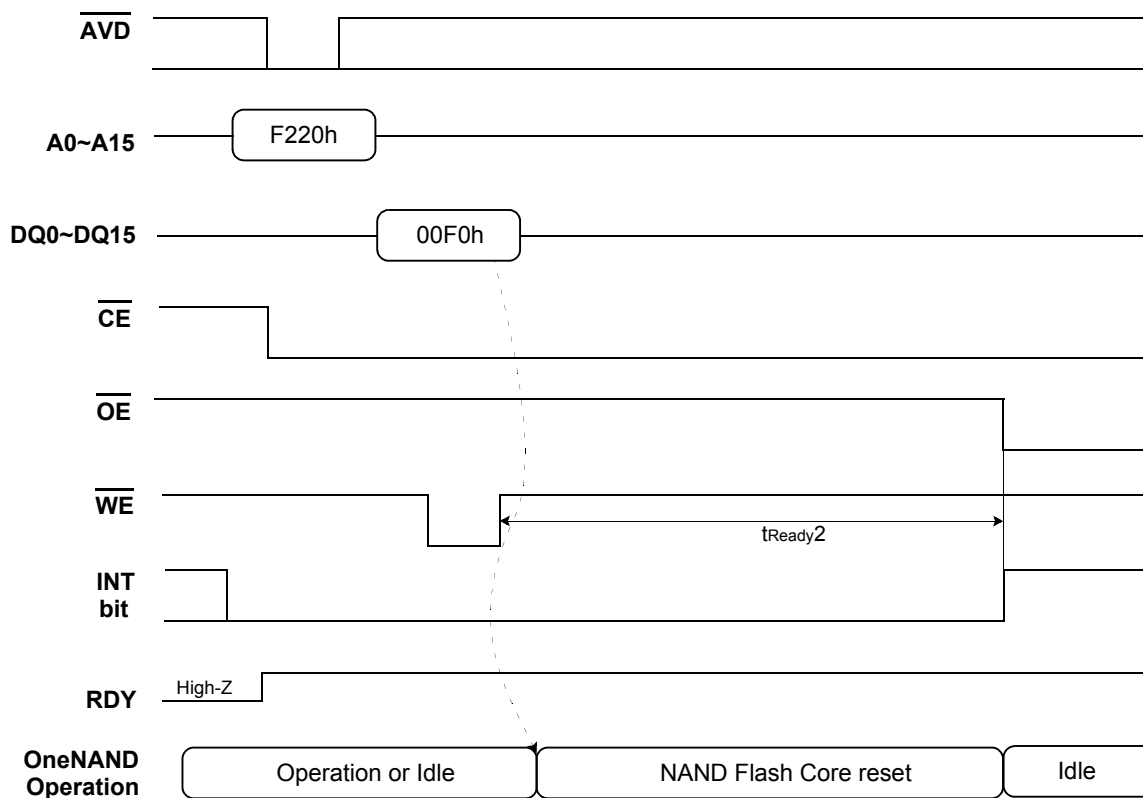


NOTE :

- 1) Internal reset operation means that the device initializes internal registers and makes output signals go to default status and bufferRAM data are kept unchanged after Warm/Hot reset operations.
- 2) Reset command : Command based reset or Register based reset
- 3) BP(Boot Partition): BootRAM area [0000h~01FFh, 8000h~80FFh]
- 4) 00F0h for BP, and 00F3h for F220h

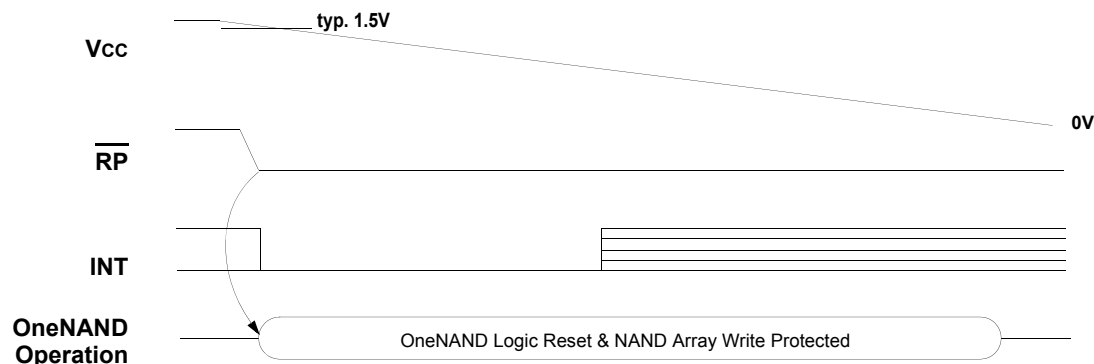
6.21 NAND Flash Core Reset Timing

See AC Characteristics Table 5.6



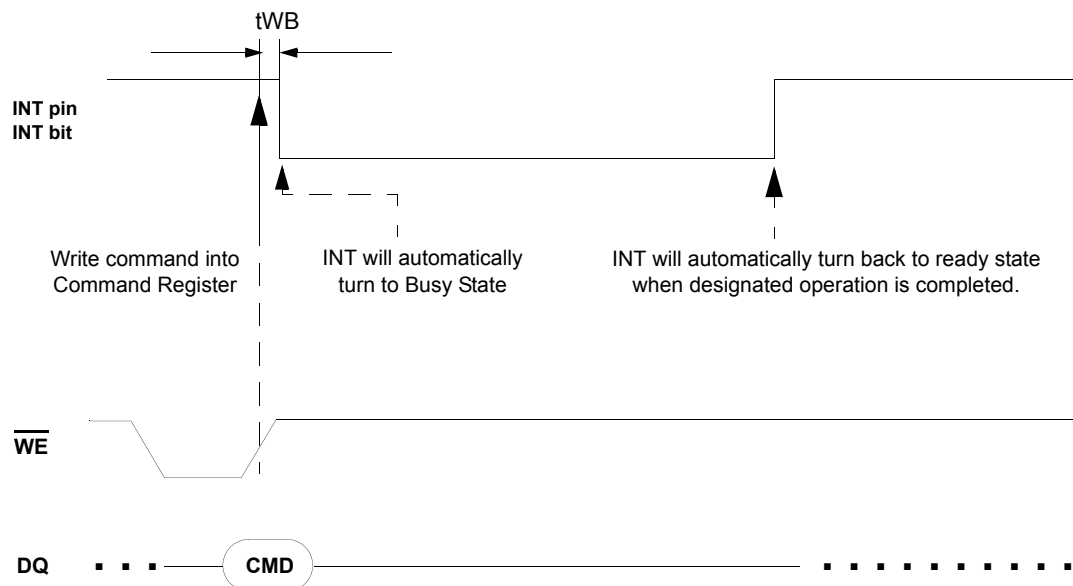
6.22 Data Protection Timing During Power Down

The device is designed to offer protection from any involuntary program/erase during power-transitions. $\overline{RP}$ pin provides hardware protection and must be kept at V_{IL} before V_{CC} drops to 1.5V



6.23 INT auto mode

See AC Characteristics Table 5.10



NOTE : INT pin polarity is based on 'IOBE=1 and INT pol=1 (default)' setting

7.0 TECHNICAL AND APPLICATION NOTES

From time-to-time supplemental technical information and application notes pertaining to the design and operation of the device in a system are included in this section. Contact your Samsung Representative to determine if additional notes are available.

7.1 Methods of Determining Interrupt Status

There are two methods of determining Interrupt Status on the OneNAND. Using the INT pin or monitoring the Interrupt Status Register Bit.

The OneNAND INT pin is an output pin function used to notify the Host when a command has been completed. In 'Cache Read', 'Synchronous Burst Block Read' and '2X Cache Program' cases, INT pin notifies that only transferring from DataRAM to page buffer is completed. This provides a hardware method of signaling the completion of a program, erase, or load operation.

In its normal state, the INT pin is high if the INT polarity bit is default. In case of normal INT mode, before a command is written to the command register, the INT bit must be written to '0' so the INT pin transitions to a low state indicating start of the operation. In case of 'INT auto mode', INT bit is written to '0' automatically right after command issued. Upon completion of the command operation by the OneNAND's internal controller, INT returns to a high state.

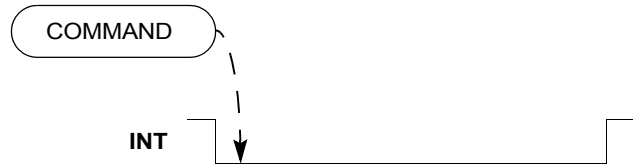
INT pin is a DQ-type output except 'Reset' and '2X program' in DDP allowing two INT outputs to be Or-tied together. In case of 'Reset' and '2X Program' in DDP, INT pin operates as an open drain with 50k ohm. INT does not float to a hi-Z condition when $\overline{CE}$ is disabled or $\overline{OE}$ is disabled. Refer to section 2.8 for additional information about INT.

INT can be implemented by tying INT to a host GPIO or by continuous polling of the Interrupt status register.

	INT Type (Mono)	INT Type (DDP)
General Operation	DQ type	DQ type
Reset Operation (Warm,Hot and Flash Core Reset) and 2X Program	DQ type	Open drain (with 50Kohm)

7.1.1 The INT Pin to a Host General Purpose I/O

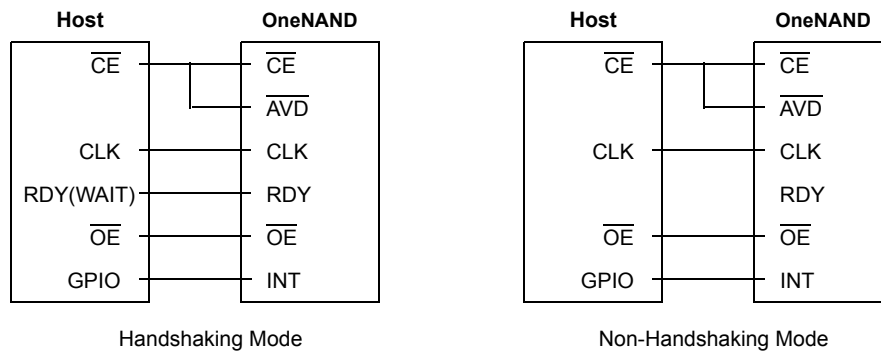
INT can be tied to a Host GPIO to detect the rising edge of INT, signaling the end of a command operation.



This can be configured to operate either synchronously or asynchronously as shown in the diagrams below.

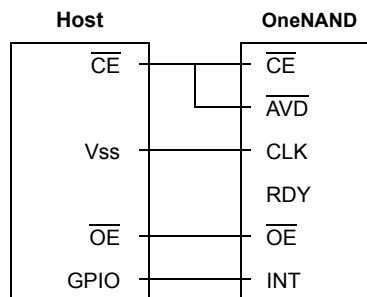
Synchronous Mode Using the INT Pin

When operating synchronously, INT is tied directly to a Host GPIO. RDY could be connected as one of following guides.



Asynchronous Mode Using the INT Pin

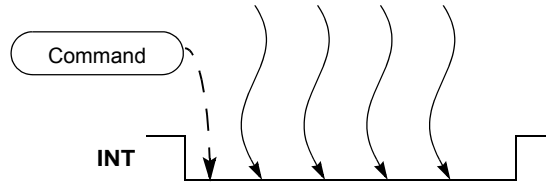
When configured to operate in an asynchronous mode, $\overline{CE}$ and $\overline{AVD}$ of the OneNAND are tied to $\overline{CE}$ of the Host. CLK is tied to the Host Vss (Ground). RDY is NOT connected. $\overline{OE}$ of the OneNAND and Host are tied together and INT is tied to a GPIO.



7.1.2 Polling the Interrupt Register Status Bit

An alternate method of determining the end of an operation is to continuously monitor the Interrupt Status Register Bit instead of using the INT pin.

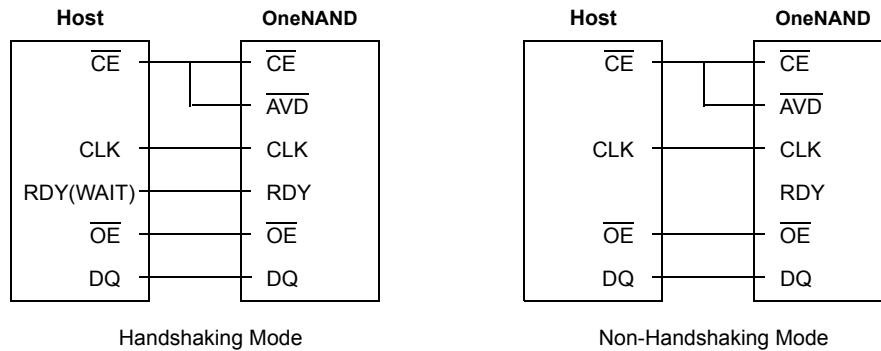
When using interrupt register instead of INT pin, INT must be unconnected.



This can be configured in either a synchronous mode or an asynchronous mode.

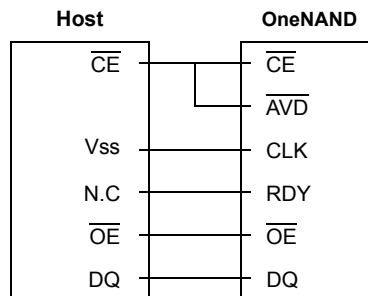
Synchronous Mode Using Interrupt Status Register Bit Polling

When operating synchronously, $\overline{CE}$ and $\overline{AVD}$ of the OneNAND are tied to $\overline{CE}$ of the Host, CLK, $\overline{OE}$, and DQ pins on the host and OneNAND are tied together. RDY could be connected as one of following guides.



Asynchronous Mode Using Interrupt Status Register Bit Polling

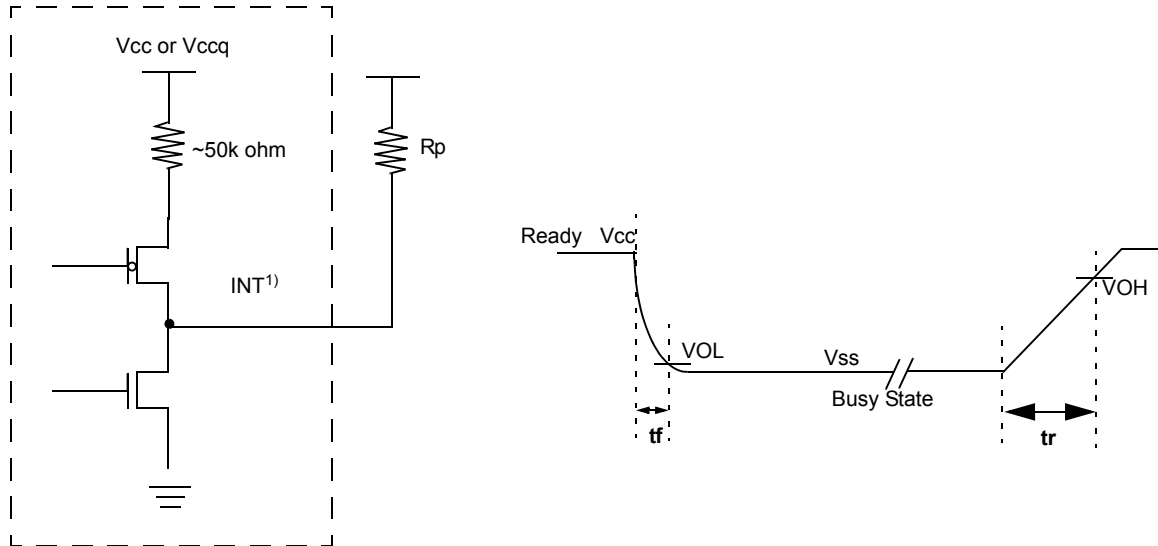
When configured to operate in an asynchronous mode, $\overline{CE}$ and $\overline{AVD}$ of the OneNAND are tied to $\overline{CE}$ of the Host. CLK is tied to the Host Vss (Ground). RDY is NOT connected. $\overline{OE}$ and DQ of the OneNAND and Host are tied together.



7.1.3 Determining Rp Value (DDP, QDP only)

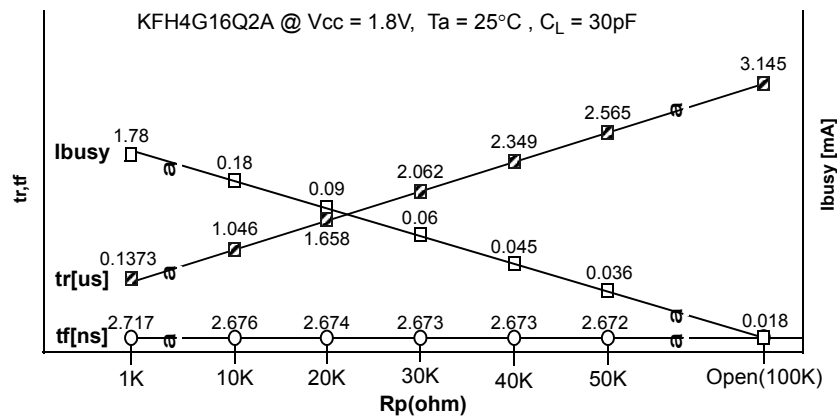
For general operation, INT operates as normal output pin, so that t_F is equivalent to t_R (below 10ns). But since INT operates as open drain with 50k ohm for Reset (Hot/Warm/NAND Flash Core) operations case and '2X program operation (007Dh) case at DDP option, the pull-up resistor value is related to $t_r(\text{INT})$. And appropriate value can be obtained with the following reference charts.

INT pol = 'High' (Default)

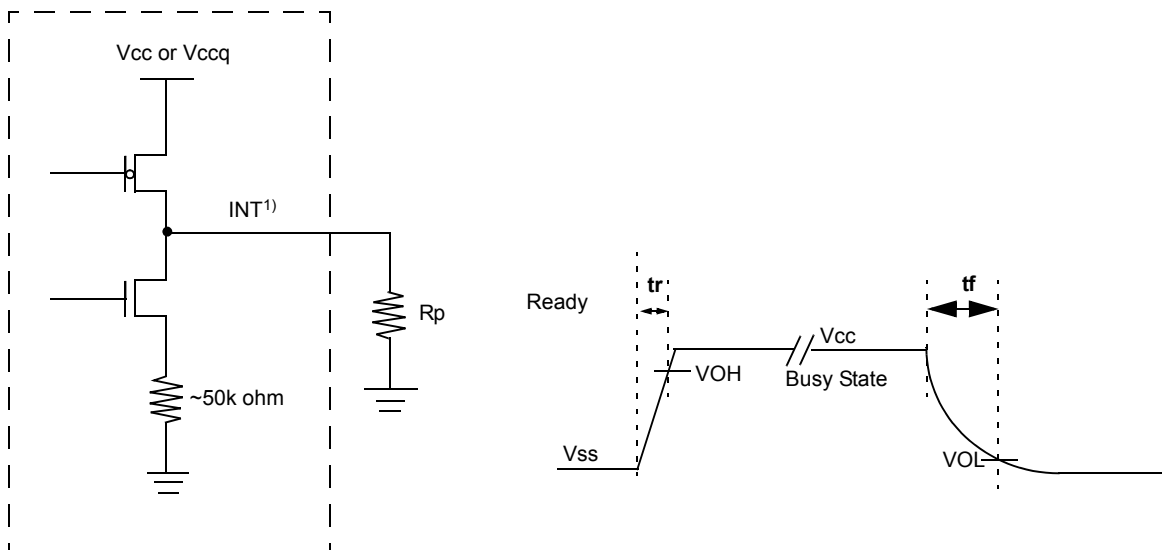


NOTE :

1) Refer to chapter 2.8.10 Start Address Register F101h DDP Block Diagram

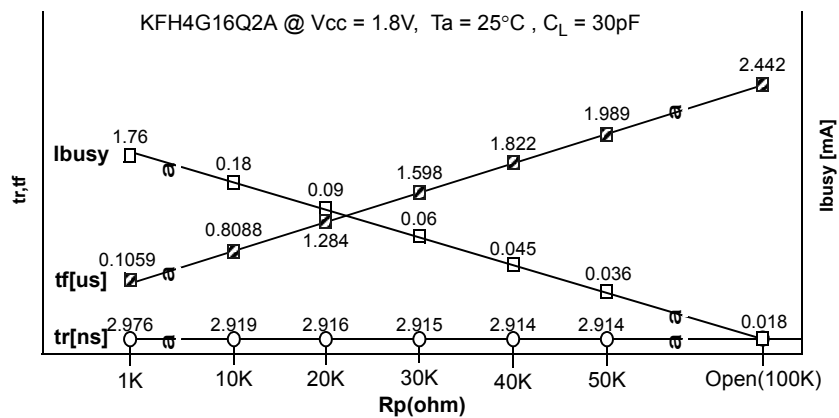


INT pol = 'Low'



NOTE :

1) Refer to chapter 2.8.10 Start Address Register F101h DDP Block Diagram



7.2 Boot Sequence

One of the best features OneNAND has is that it can be a booting device itself since it contains an internally built-in boot loader despite the fact that its core architecture is based on NAND Flash. Thus, OneNAND does not make any additional booting device necessary for a system, which imposes extra cost or area overhead on the overall system.

As the system power is turned on, the boot code originally stored in NAND Flash Array is moved to BootRAM automatically and then fetched by CPU through the same interface as SRAM's or NOR Flash's if the size of the boot code is less than 1KB. If its size is larger than 1KB and less than or equal to 3KB, only 1KB of it can be moved to BootRAM automatically and fetched by CPU, and the rest of it can be loaded into one of the DataRAMs whose size is 2KB by Load Command and CPU can take it from the DataRAM after finishing the code-fetching job for BootRAM. If its size is larger than 3KB, the 1KB portion of it can be moved to BootRAM automatically and fetched by CPU, and its remaining part can be moved to DRAM through two DataRAMs using dual buffering and taken by CPU to reduce CPU fetch time.

A typical boot scheme usually used to boot the system with OneNAND is explained at Partition of NAND Flash Array and OneNAND Boot Sequence. In this boot scheme, boot code is comprised of BL1, where BL stands for Boot Loader, BL2, and BL3. Moreover, the size of the boot code is larger than 3KB (the 3rd case above). BL1 is called primary boot loader in other words. Here is the table of detailed explanations about the function of each boot loader in this specific boot scheme.

7.2.1 Boot Loaders in OneNAND

Boot Loaders in OneNAND

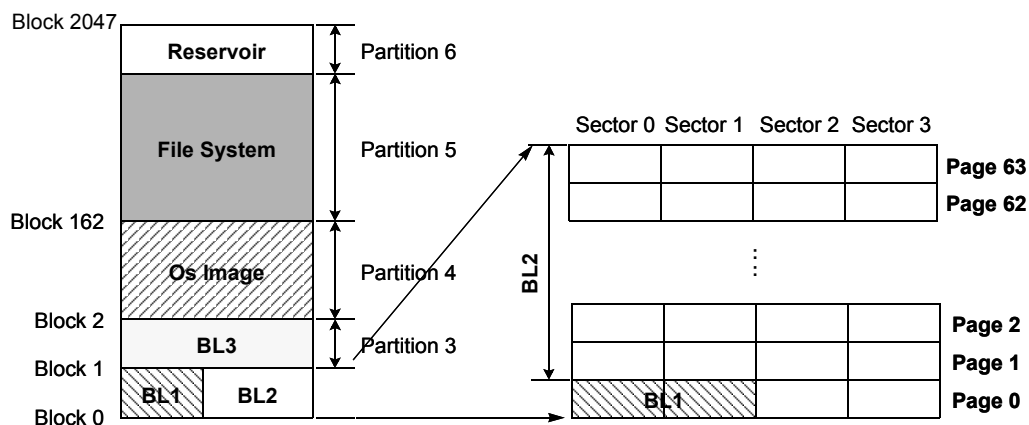
Boot Loader	Description
BL1	Moves BL2 from NAND Flash Array to DRAM through two DataRAMs using dual buffering
BL2	Moves OS image (or BL3 optionally) from NAND Flash Array to DRAM through two DataRAMs using dual buffering
BL3 (Optional)	Moves or writes the image through USB interface

NAND Flash Array of OneNAND is divided into the partitions as described at Partition of NAND Flash Array to show where each component of code is located and how much portion of the overall NAND Flash Array each one occupies. In addition, the boot sequence is listed below and depicted at Boot Sequence.

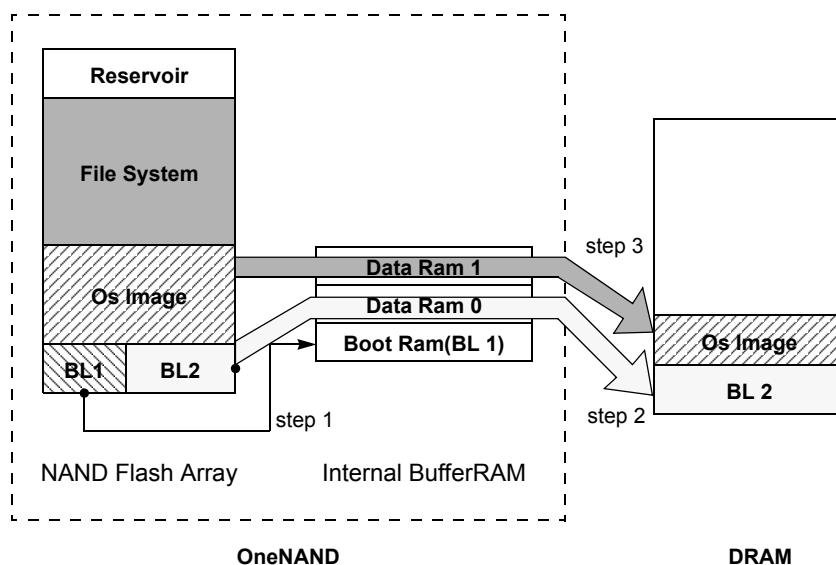
7.2.2 Boot Sequence

Boot Sequence :

1. Power is on
BL1 is loaded into BootRAM
2. BL1 is executed in BootRAM
BL2 is loaded into DRAM through two DataRAMs using dual buffering by BL1
3. BL2 is executed in DRAM
OS image is loaded into DRAM through two DataRAMs using dual buffering by BL2
4. OS is running



Partition of NAND Flash array



NOTE :
Step 2 and Step 3 can be copied into DRAM through two DataRAMs using dual buffering

OneNAND Boot Sequence

8.0 PACKAGE DIMENSIONS

