K9XXG08UXA

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Document Title

1G x 8 Bit / 2G x 8 Bit / 4G x 8 Bit NAND Flash Memory

Revision History

Revision No	<u>History</u>	Draft Date	<u>Remark</u>
0.0	1. Initial issue	Nov. 09. 2005	Advance
0.1	Leaded part is eliminated tRHW is defined	Jan. 10. 2006	Preliminary
1.0	1.Comment of "Addressing for program operation" is added (p.17)	Mar. 7. 2006	Final
1.1	1. 4GB DSP is added	July 18th 2006	

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1G x 8 Bit / 2G x 8 Bit / 4G x 8 Bit NAND Flash Memory

PRODUCT LIST

Part Number	Vcc Range	Organization	PKG Type	
K9K8G08U0A-Y			TSOP1	
K9WAG08U1A-Y	2.70 ~ 3.60V	X8	1301 1	
K9WAG08U1A-I	2.70 ~ 3.00V	Xo	52TLGA	
K9NBG08U5A-P			TSOP1-DSP	

FEATURES

Voltage Supply

- 2.70V ~ 3.60V

Organization

Memory Cell Array: (1G + 32M) x 8bit
Data Register: (2K + 64) x 8bit
Automatic Program and Erase
Page Program: (2K + 64)Byte
Block Erase: (128K + 4K)Byte

Page Read Operation
Page Size: (2K + 64)Byte
Random Read: 25µs(Max.)
Serial Access: 25ns(Min.)
* K9NBG08U5A: 50ns(Min.)

• Fast Write Cycle Time

- Page Program time : 200μs(Typ.)
- Block Erase Time : 1.5ms(Typ.)

• Command/Address/Data Multiplexed I/O Port

• Hardware Data Protection

- Program/Erase Lockout During Power Transitions

• Reliable CMOS Floating-Gate Technology

- Endurance : 100K Program/Erase Cycles(with 1bit/512Byte ECC)

Data Retention : 10 YearsCommand Driven Operation

• Intelligent Copy-Back with internal 1bit/528Byte EDC

• Unique ID for Copyright Protection

• Package :

- K9K8G08U0A-PCB0/PIB0

48 - Pin TSOP I (12 x 20 / 0.5 mm pitch)

- K9WAG08U1A-PCB0/PIB0

48 - Pin TSOP I (12 x 20 / 0.5 mm pitch)

- K9WAG08U1A-ICB0/IIB0

52 - Pin TLGA (12 x 17 / 1.0 mm pitch)

- K9NBG08U5A-PCB0/PIB0

48 - Pin TSOP I (12 x 20 / 0.5 mm pitch)

GENERAL DESCRIPTION

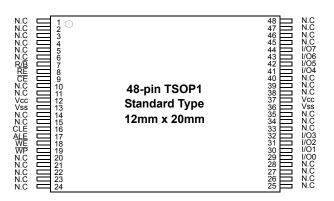
Offered in 1G x 8bit, the K9K8G08U0A is a 8G-bit NAND Flash Memory with spare 256M-bit. Its NAND cell provides the most cost-effective solution for the solid state application market. A program operation can be performed in typical 200µs on the (2K+64)Byte page and an erase operation can be performed in typical 1.5ms on a (128K+4K)Byte block. Data in the data register can be read out at 25ns(K9NBG08U5A: 50ns) cycle time per Byte. The I/O pins serve as the ports for address and data input/output as well as command input. The on-chip write controller automates all program and erase functions including pulse repetition, where required, and internal verification and margining of data. Even the write-intensive systems can take advantage of the K9K8G08U0A's extended reliability of 100K program/erase cycles by providing ECC(Error Correcting Code) with real time mapping-out algorithm. The K9K8G08U0A is an optimum solution for large nonvolatile storage applications such as solid state file storage and other portable applications requiring non-volatility.

An ultra high density solution having two 8Gb stacked with two chip selects is also available in standard TSOPI package and another ultra high density solution having two 16Gb TSOPI package stacked with four chip selects is also available in TSOPI-DSP.



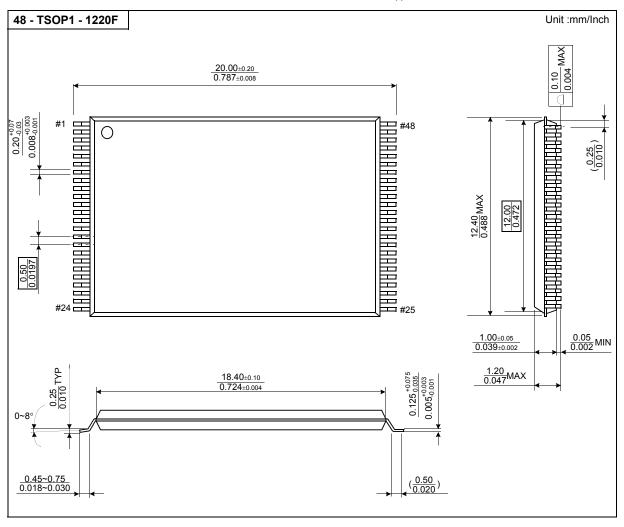
PIN CONFIGURATION (TSOP1)

K9K8G08U0A-PCB0/PIB0



PACKAGE DIMENSIONS

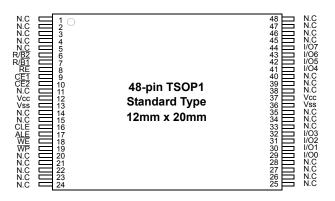
48-PIN LEAD FREE PLASTIC THIN SMALL OUT-LINE PACKAGE TYPE(I)





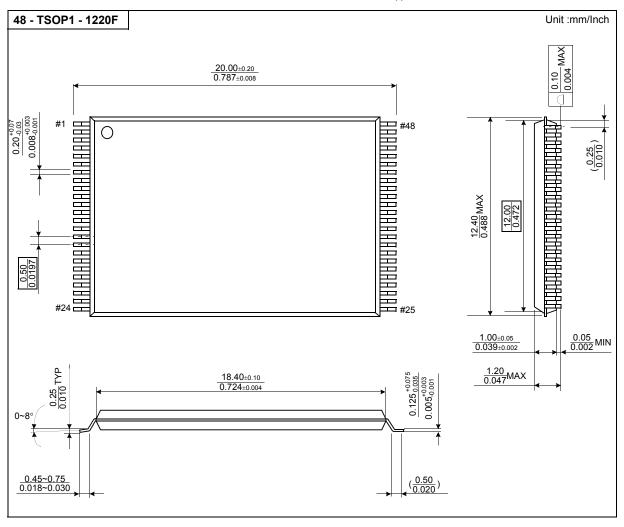
PIN CONFIGURATION (TSOP1)

K9WAG08U1A-PCB0/PIB0



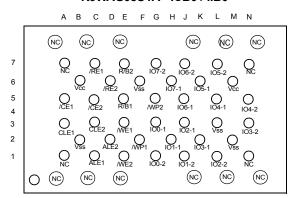
PACKAGE DIMENSIONS

48-PIN LEAD FREE PLASTIC THIN SMALL OUT-LINE PACKAGE TYPE(I)

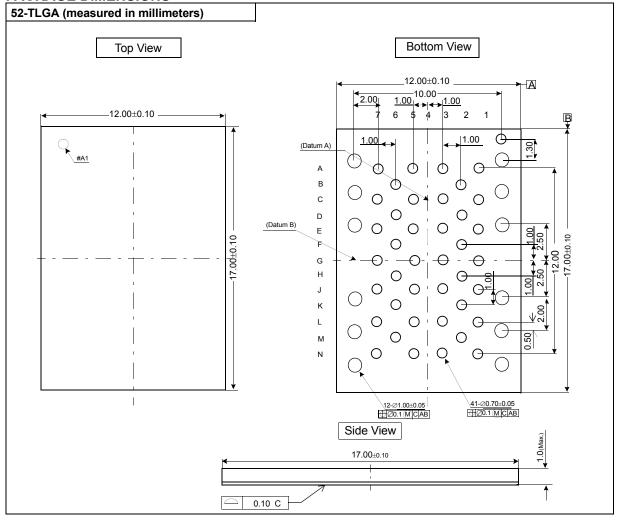




K9WAG08U1A - ICB0 / IIB0



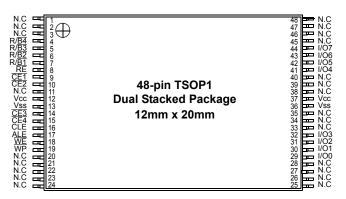
PACKAGE DIMENSIONS





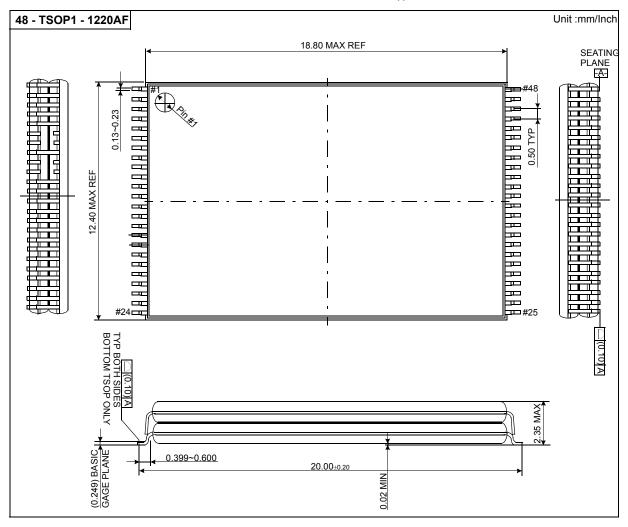
PIN CONFIGURATION (TSOP1-DSP)

K9NBG08U5A-PCB0/PIB0



PACKAGE DIMENSIONS

48-PIN LEAD FREE PLASTIC THIN SMALL OUT-LINE PACKAGE TYPE(I)





PIN DESCRIPTION

Pin Name	Pin Function
I/O0 ~ I/O7	DATA INPUTS/OUTPUTS The I/O pins are used to input command, address and data, and to output data during read operations. The I/O pins float to high-z when the chip is deselected or when the outputs are disabled.
CLE	COMMAND LATCH ENABLE The CLE input controls the activating path for commands sent to the command register. When active high, commands are latched into the command register through the I/O ports on the rising edge of the WE signal.
ALE	ADDRESS LATCH ENABLE The ALE input controls the activating path for address to the internal address registers. Addresses are latched on the rising edge of WE with ALE high.
CE / CE1	CHIP ENABLE The CE / CE1 input is the device selection control. When the device is in the Busy state, CE / CE1 high is ignored, and the device does not return to standby mode in program or erase operation. Regarding CE / CE1 control during read operation , refer to 'Page Read' section of Device operation.
CE2	CHIP ENABLE The CE2 input enables the second K9K8G08U0A
RE	READ ENABLE The RE input is the serial data-out control, and when active drives the data onto the I/O bus. Data is valid tREA after the falling edge of RE which also increments the internal column address counter by one.
WE	WRITE ENABLE The WE input controls writes to the I/O port. Commands, address and data are latched on the rising edge of the WE pulse.
WP	WRITE PROTECT The WP pin provides inadvertent program/erase protection during power transitions. The internal high voltage generator is reset when the WP pin is active low.
R/B / R/B1	READY/BUSY OUTPUT The R/B / R/B1 output indicates the status of the device operation. When low, it indicates that a program, erase or random read operation is in process and returns to high state upon completion. It is an open drain output and does not float to high-z condition when the chip is deselected or when outputs are disabled.
Vcc	POWER Vcc is the power supply for device.
Vss	GROUND
N.C	NO CONNECTION Lead is not internally connected.

 $\ensuremath{\text{NOTE}}$: Connect all Vcc and Vss pins of each device to common power supply outputs.

Do not leave Vcc or Vss disconnected.

There are two \overline{CE} pins (\overline{CE} 1 & \overline{CE} 2) in the K9WAG08U1A and four \overline{CE} pins (\overline{CE} 1 & \overline{CE} 2 & \overline{CE} 3 & \overline{CE} 4) in the K9NBG08U5A. There are two R/\overline{B} pins (R/\overline{B} 1 & R/\overline{B} 2) in the K9WAG08U1A and four R/\overline{B} pins (R/\overline{B} 1 & R/\overline{B} 2 & R/\overline{B} 3 & R/\overline{B} 4) in the K9NBG08U5A.



Figure 1. K9K8G08U0A Functional Block Diagram

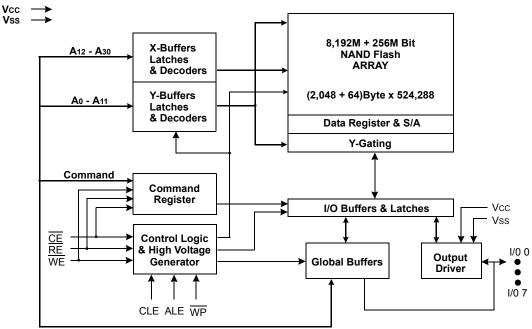
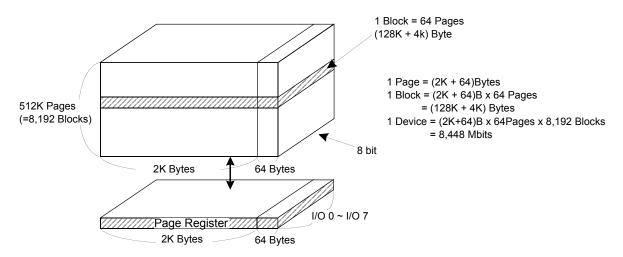


Figure 2. K9K8G08U0A Array Organization



	I/O 0	I/O 1	I/O 2	I/O 3	I/O 4	I/O 5	I/O 6	I/O 7
1st Cycle	Ao	A 1	A ₂	Аз	A4	A 5	A ₆	A 7
2nd Cycle	A8	A 9	A 10	A11	*L	*L	*L	*L
3rd Cycle	A 12	A 13	A14	A 15	A 16	A 17	A18	A 19
4th Cycle	A20	A21	A22	A23	A24	A25	A26	A27
5th Cycle	A28	A 29	A 30	*L	*L	*L	*L	*L

Column Address Column Address Row Address Row Address Row Address

NOTE: Column Address: Starting Address of the Register.

 $^{^{\}star}$ The device ignores any additional input of address cycles than required.



^{*} L must be set to "Low".

Product Introduction

The K9K8G08U0A is a 8,448Mbit(8,858,370,048 bit) memory organized as 524,288 rows(pages) by 2,112x8 columns. Spare 64x8 columns are located from column address of 2,048~2,111. A 2,112-byte data register is connected to memory cell arrays accommodating data transfer between the I/O buffers and memory during page read and page program operations. The memory array is made up of 32 cells that are serially connected to form a NAND structure. Each of the 32 cells resides in a different page. A block consists of two NAND structured strings. A NAND structure consists of 32 cells. Total 1,081,344 NAND cells reside in a block. The program and read operations are executed on a page basis, while the erase operation is executed on a block basis. The memory array consists of 8,192 separately erasable 128K-byte blocks. It indicates that the bit by bit erase operation is prohibited on the K9K8G08U0A.

The K9K8G08U0A has addresses multiplexed into 8 I/Os. This scheme dramatically reduces pin counts and allows system upgrades to future densities by maintaining consistency in system board design. Command, address and data are all written through I/O's by bringing WE to low while CE is low. Those are latched on the rising edge of WE. Command Latch Enable(CLE) and Address Latch Enable(ALE) are used to multiplex command and address respectively, via the I/O pins. Some commands require one bus cycle. For example, Reset Command, Status Read Command, etc require just one cycle bus. Some other commands, like page read and block erase and page program, require two cycles: one cycle for setup and the other cycle for execution. The 1056M byte physical space requires 31 addresses, thereby requiring five cycles for addressing: 2 cycles of column address, 3 cycles of row address, in that order. Page Read and Page Program need the same five address cycles following the required command input. In Block Erase operation, however, only the three row address cycles are used. Device operations are selected by writing specific commands into the command register. Table 1 defines the specific commands of the K9K8G08U0A.

In addition to the enhanced architecture and interface, the device incorporates copy-back program feature from one page to another page without need for transporting the data to and from the external buffer memory. Since the time-consuming serial access and data-input cycles are removed, system performance for solid-state disk application is significantly increased.

The K9WAG08U1A is composed of two K9K8G08U0A chips which are selected separately by each $\overline{CE}1$ and $\overline{CE}2$ and the K9NBG08U5A is composed of four K9K8G08U0A chips which are selected separately by each $\overline{CE}1$, $\overline{CE}2$, $\overline{CE}3$ and $\overline{CE}4$. Therefore, in terms of each \overline{CE} , the basic operations of K9WAG08U0A and K9NBG08U5A are same with K9K8G08U0A except some AC/DC charateristics.

Table 1. Command Sets

Function	1st Cycle	2nd Cycle	Acceptable Command during Busy
Read	00h	30h	
Read for Copy Back	00h	35h	
Read ID	90h	-	
Reset	FFh	-	0
Page Program	80h	10h	
Two-Plane Page Program ⁽⁴⁾	80h11h	81h10h	
Copy-Back Program	85h	10h	
Two-Plane Copy-Back Program ⁽⁴⁾	85h11h	81h10h	
Block Erase	60h	D0h	
Two-Plane Block Erase	60h60h	D0h	
Random Data Input ⁽¹⁾	85h	-	
Random Data Output ⁽¹⁾	05h	E0h	
Read Status	70h		0
Read EDC Status ⁽²⁾	7Bh		0
Chip1 Status ⁽³⁾	F1h		0
Chip2 Status ⁽³⁾	F2h		0

NOTE: 1. Random Data Input/Output can be executed in a page.

- 2. Read EDC Status is only available on Copy Back operation.
- ${\it 3. \ } \ \ \text{Interleave-operation between two chips is allowed}.$
 - It's prohibited to use F1h and F2h commands for other operations except interleave-operation.
- 4. Any command between 11h and 81h is prohibited except 70h, F1h, F2h and FFh .

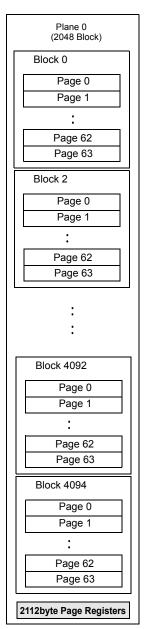
Caution: Any undefined command inputs are prohibited except for above command set of Table 1.

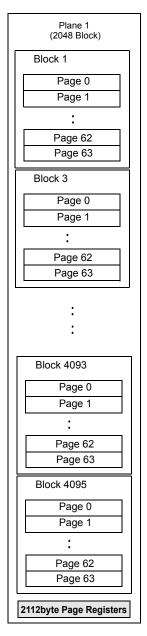


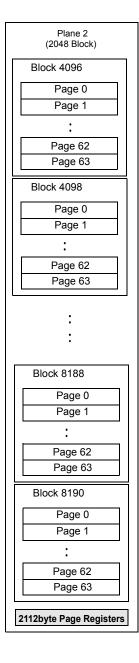
Memory Map

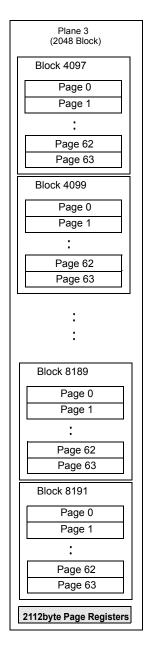
K9K8G08U0A is arranged in four 2Gb memory planes. Each plane contains 2,048 blocks and 2112 byte page registers. This allows it to perform simultaneous page program and block erase by selecting one page or block from each plane. The block address map is configured so that two-plane program/erase operations can be executed by dividing the memory array into plane 0~1 or plane 2~3 separately.

For example, two-plane program/erase operation into plane 0 and plane 2 is prohibited. That is to say, two-plane program/erase operation into plane 0 and plane 1 or into plane 2 and plane 3 is allowed









ABSOLUTE MAXIMUM RATINGS

Р	arameter	Symbol	Rating	Unit
		Vcc	-0.6 to +4.6	
Voltage on any pin relative	to VSS	Vin	-0.6 to +4.6	V
		VI/O	-0.6 to Vcc+0.3 (<4.6V)	
Tomporatura Undar Diag	K9XXG08UXA-XCB0	TBIAS	-10 to +125	
Temperature Under Bias	K9XXG08UXA-XIB0	IBIAS	-40 to +125	
Ctorogo Tomporatura	K9XXG08UXA-XCB0	Tstg	-65 to +150	°C
Storage Temperature	K9XXG08UXA-XIB0	ISIG	-05 (0 + 150	30
Short Circuit Current		los	5	mA

NOTE

- 1. Minimum DC voltage is -0.6V on input/output pins. During transitions, this level may undershoot to -2.0V for periods <30ns.

 Maximum DC voltage on input/output pins is Vcc+0.3V which, during transitions, 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 as detailed in the operational sections of this data sheet. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

RECOMMENDED OPERATING CONDITIONS

(Voltage reference to GND, K9XXG08UXA-XCB0 :Ta=0 to 70°C, K9XXG08UXA-XIB0:Ta=-40 to 85°C)

Parameter	Symbol	Min	Тур.	Max	Unit
Supply Voltage	Vcc	2.7	3.3	3.6	V
Supply Voltage	Vss	0	0	0	V

DC AND OPERATING CHARACTERISTICS (Recommended operating conditions otherwise noted.)

Parameter		Symbol	Test Conditions	Min	Тур	Max	Unit
Operating	Page Read with Serial Access	Icc1	tRC=25ns(K9NBG08U5A: 50ns) CE=VIL, IOUT=0mA			0.5	
Current	Program	Icc2	-	-	25	35	mA
	Erase	Icc3	-				
Stand-by C	urrent(TTL)	Is _B 1	CE=ViH, WP=0V/Vcc	-	-	1	
Stand-by C	urrent(CMOS)	IsB2	CE=Vcc-0.2, WP=0V/Vcc	-	20	100	
Input Leakage Current		put Leakage Current ILI		-	-	±20	μΑ
Output Lea	kage Current	llo	Vout=0 to Vcc(max)	-	-	±20	
Input High \	/oltage	VIH ⁽¹⁾	-	0.8xVcc	-	Vcc+0.3	
Input Low V	ut Low Voltage, All inputs V _{IL} ⁽¹⁾		-	-0.3	-	0.2xVcc	V
Output High Voltage Level		Vон	Іон=-400μА	2.4	-	-	V
Output Low Voltage Level		Vol	IoL=2.1mA	-	-	0.4	
Output Low	Current(R/B)	IoL(R/B)	VoL=0.4V	8	10	-	mA

- NOTE: 1. VIL can undershoot to -0.4V and VIH can overshoot to VCC +0.4V for durations of 20 ns or less.
 - 2. Typical value is measured at Vcc=3.3V, TA=25 $^{\circ}$ C. Not 100% tested.
 - 3. The typical value of the K9WAG08U1A's ISB2 is $40\mu A$ and the maximum value is $200\mu A$.
 - 4. The typical value of the K9NBG08U5A's ISB2 is $80\mu A$ and the maximum value is $400\mu A$.
 - 5. The maximum value of K9WAG08U1A-P's ILI and ILO is $\pm 40 \mu A$, the maximum value of K9WAG08U1A-I's ILI and ILO is $\pm 20 \mu A$.
 - 6. The maximum value of K9NBG08U5A's ILI and ILO is $\pm 80 \mu \text{Å}$.



VALID BLOCK

Parameter	Symbol	Min	Тур.	Max	Unit
K9K8G08U0A	N∨B	8,032	-	8,192	Blocks
K9WAG08U1A	N∨B	16,064*	-	16,384*	Blocks
K9NBG08U5A	N∨B	32,128*		32,768*	Blocks

- NOTE:

 1. The device may include initial 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. Refer to the attached technical notes for appropriate management of invalid 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.
- 3. The number of valid block is on the basis of single plane operations, and this may be decreased with two plane operations.

 * : Each K9K8G08U0A chip in the K9WAG08U1A and K9NBG08U5A has Maximun 160 invalid blocks.

AC TEST CONDITION

(K9XXG08UXA-XCB0: Ta=0 to 70°C, K9XXG08UXA-XIB0:Ta=-40 to 85°C, K9XXG08UXA: Vcc=2.7V~3.6V unless otherwise noted)

Parameter	K9XXG08UXA				
Input Pulse Levels	0V to Vcc				
Input Rise and Fall Times	5ns				
Input and Output Timing Levels	Vcc/2				
	1 TTL GATE and CL=50pF (K9K8G08U0A-P/K9WAG08U1A-I)				
Output Load	1 TTL GATE and CL=30pF (K9WAG08U1A-P)				
	1 TTL GATE and CL=30pF (K9NBG08U5A-P)				

CAPACITANCE(TA=25°C, VCC=3.3V, f=1.0MHz)

Item	Symbol	Test	Min		Max		Unit
item	Symbol	Condition	IVIIII	K9K8G08U0A	K9WAG08U1A*	K9NBG08U5A	Oilit
Input/Output Capaci-	Cı/o	VIL=0V	-	20	40	80	pF
Input Capacitance	Cin	VIN=0V	-	20	40	80	pF

NOTE : Capacitance is periodically sampled and not 100% tested. K9WAG08U1A-IXB0's capacitance(I/O, Input) is 20pF.

MODE SELECTION

CLE	ALE	CE	WE	RE	WP	Mode	
Н	L	L	F	Н	Х	Read Mode	Command Input
L	Н	L	F	Н	Х		Address Input(5clock)
Н	L	L	F	Н	Н	Write Mode	Command Input
L	Н	L	F	Н	Н		Address Input(5clock)
L	L	L		Н	Н	Data Input	
L	L	L	Н	▼	Х	Data Output	
Х	Х	Х	Х	Н	Х	During Read(Busy)
Х	Х	Х	Х	Х	Н	During Program(Busy)	
Х	Х	Х	Х	Х	Н	During Erase(Busy)	
Х	X ⁽¹⁾	Х	Х	Х	L	Write Protect	
Х	Х	Н	Х	Х	0V/Vcc ⁽²⁾	Stand-by	

NOTE: 1. X can be VIL or VIH.

2. WP should be biased to CMOS high or CMOS low for standby.



Program / Erase Characteristics

Parameter	Symbol	Min	Тур	Max	Unit
Program Time	tprog	-	200	700	μS
Dummy Busy Time for Two-Plane Page Program	tdbsy	-	0.5	1	μS
Number of Partial Program Cycles	Nop	-	-	4	cycles
Block Erase Time	tBERS	-	1.5	2	ms

 $[\]textbf{NOTE}: 1.$ Typical value is measured at Vcc=3.3V, TA=25°C. Not 100% tested.

AC Timing Characteristics for Command / Address / Data Input

		M	in	М	ax	
Parameter	Symbol	K9NBG08U5A	K9K8G08U0A	K9NBG08U5A	K9K8G08U0A	Unit
		KANDGUOUSA	K9WAG08U1A	Kanagooda	K9WAG08U1A	
CLE Setup Time	tcls(1)	25	12	-	-	ns
CLE Hold Time	tclh	10	5	-	-	ns
CE Setup Time	tcs ⁽¹⁾	35	20	-	-	ns
CE Hold Time	tсн	10	5	-	-	ns
WE Pulse Width	twp	25	12	-	-	ns
ALE Setup Time	tals(1)	25	12	-	-	ns
ALE Hold Time	talh	10	5	-	-	ns
Data Setup Time	tDS ⁽¹⁾	20	12	-	-	ns
Data Hold Time	tон	10	5	-	-	ns
Write Cycle Time	twc	45	25	-	-	ns
WE High Hold Time	twn	15	10	-	-	ns
Address to Data Loading Time	tadl(2)	70	70	-	-	ns

NOTES: 1. The transition of the corresponding control pins must occur only once while WE is held low
2. tADL is the time from the WE rising edge of final address cycle to the WE rising edge of first data cycle



^{2.} Typical program time is defined as the time within which more than 50% of the whole pages are programmed at 3.3V Vcc and 25°C temperature.

AC Characteristics for Operation

		M	in	М	ax	
Parameter	Symbol	K9NBG08U5A	K9K8G08U0A	KONDCOOLEA	K9K8G08U0A	Unit
		NUNDGUOUDA	K9WAG08U1A	K9NBG08U5A	K9WAG08U1A	
Data Transfer from Cell to Register	tr		-	20	20	μS
ALE to RE Delay	tar	10	10		-	ns
CLE to RE Delay	tclr	10	10		-	ns
Ready to RE Low	trr	20	20		-	ns
RE Pulse Width	trp	25	12		-	ns
WE High to Busy	twв	-	-	100	100	ns
Read Cycle Time	trc	50	25	-	-	ns
RE Access Time	trea	-	-	30	20	ns
CE Access Time	tcea	-	-	45	25	ns
RE High to Output Hi-Z	trhz	-	-	100	100	ns
CE High to Output Hi-Z	tcHz	-	-	30	30	ns
RE High to Output hold	trhoh	15	15	-	-	ns
RE Low to Output hold	trloh	-	5	-	-	ns
CE High to Output hold	tсон	15	15	-	-	ns
RE High Hold Time	treh	15	10	-	-	ns
Output Hi-Z to RE Low	tır	0	0	-	-	ns
RE High to WE Low	trhw	100	100	-	-	ns
WE High to RE Low	twhr	60	60	-	-	ns
Device Resetting Time(Read/Program/Erase)	trst	-	-	5/10/500(1)	5/10/500(1)	μS

NOTE: 1. If reset command(FFh) is written at Ready state, the device goes into Busy for maximum 5µs.



NAND Flash Technical Notes

Initial Invalid Block(s)

Initial invalid blocks are defined as blocks that contain one or more initial invalid bits whose reliability is not guaranteed by Samsung. The information regarding the initial invalid block(s) is called the initial invalid block information. Devices with initial invalid block(s) have the same quality level as devices with all valid blocks and have the same AC and DC characteristics. An initial 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 initial invalid block(s) via address mapping. 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.

Identifying Initial Invalid Block(s)

All device locations are erased(FFh) except locations where the initial invalid block(s) information is written prior to shipping. The initial invalid block(s) status is defined by the 1st byte in the spare area. Samsung makes sure that either the 1st or 2nd page of every initial invalid block has non-FFh data at the column address of 2048. Since the initial invalid block information is also erasable in most cases, it is impossible to recover the information once it has been erased. Therefore, the system must be able to recognize the initial invalid block(s) based on the original initial invalid block information and create the initial invalid block table via the following suggested flow chart(Figure 3). Any intentional erasure of the original initial invalid block information is prohibited.

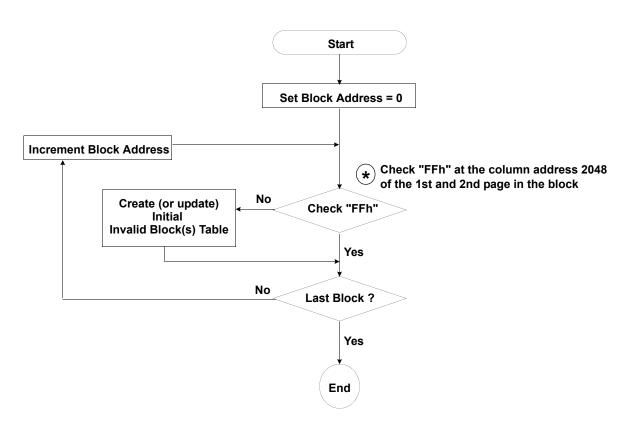


Figure 3. Flow chart to create initial invalid block table.

NAND Flash Technical Notes (Continued)

Error in write or read operation

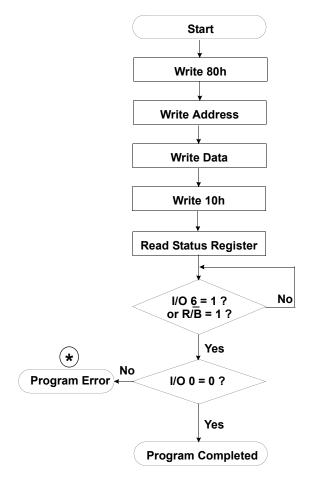
Within its life time, additional invalid blocks may develop with NAND Flash memory. Refer to the qualification report for the actual data. The following possible failure modes should be considered to implement a highly reliable system. In the case of status read failure after erase or program, block replacement should be done. Because program status fail during a page program does not affect the data of the other pages in the same block, 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. In case of Read, ECC must be employed. To improve the efficiency of memory space, it is recommended that the read or verification failure due to single bit error be reclaimed by ECC without any block replacement. The said additional block failure rate does not include those reclaimed blocks.

	Failure Mode	Detection and Countermeasure sequence		
Write	Erase Failure	Status Read after Erase> Block Replacement		
vvrite	Program Failure	Status Read after Program> Block Replacement		
Read	Single Bit Failure	Verify ECC -> ECC Correction		

ECC

: Error Correcting Code --> Hamming Code etc. Example) 1bit correction & 2bit detection

Program Flow Chart



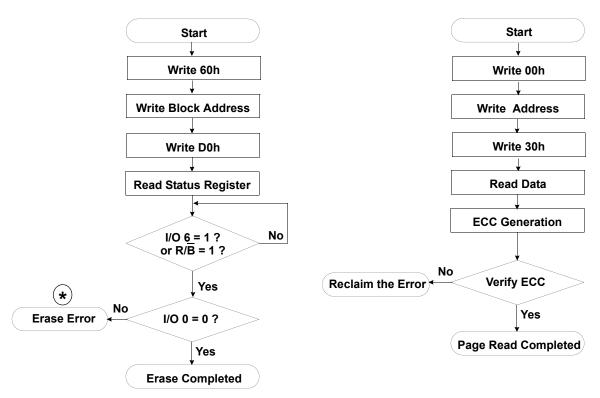
* : If program operation results in an error, map out the block including the page in error and copy the target data to another block.



NAND Flash Technical Notes (Continued)

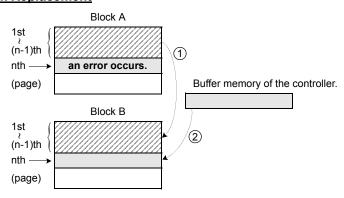
Erase Flow Chart

Read Flow Chart



* : If erase operation results in an error, map out the failing block and replace it with another block.

Block Replacement



^{*} Step1

When an error happens in the nth page of the Block 'A' during erase or program operation.

Copy the data in the 1st \sim (n-1)th page to the same location of another free block. (Block 'B')

Then, copy the nth page data of the Block 'A' in the buffer memory to the nth page of the Block 'B'.

Do not erase or program to Block 'A' by creating an 'invalid Block' table or other appropriate scheme.



^{*} Step2

^{*} Step3

^{*} Step4

NAND Flash Technical Notes (Continued)

Copy-Back Operation with EDC & Sector Definition for EDC

Generally, copy-back program is very powerful to move data stored in a page without utilizing any external memory. But, if the source page has one bit error due to charge loss or charge gain, then without EDC, the copy-back program operation could also accumulate bit errors.

K9K8G08U0A supports copy-back with EDC to prevent cumulative bit errors. To make EDC valid, the page program operation should be performed on either whole page(2112byte) or sector(528byte). Modifying the data of a sector by Random Data Input before Copy-Back Program must be performed for the whole sector and is allowed only once per each sector. Any partial modification smaller than a sector corrupts the on-chip EDC codes.

A 2,112-byte page is composed of 4 sectors of 528-byte and each 528-byte sector is composed of 512-byte main area and 16-byte spare area.

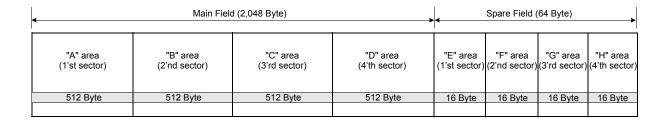
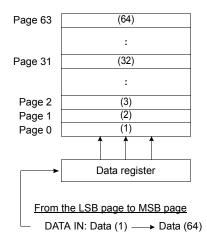


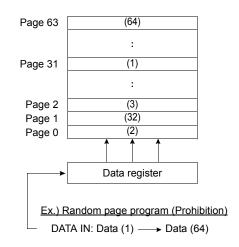
Table 2. Definition of the 528-Byte Sector

Sector	Main Field	I (Column 0~2,047)	Spare Field (Column 2,048~2,111)		
Sector	Area Name	Column Address	Area Name	Column Address		
1'st 528-Byte Sector	"A"	0 ~ 511	"E"	2,048 ~ 2,063		
2'nd 528-Byte Sector	"B"	512 ~ 1,023	"F"	2,064 ~ 2,079		
3'rd 528-Byte Sector	"C"	1,024 ~ 1,535	"G"	2,080 ~ 2,095		
4'th 528-Byte Sector	"D"	1,536 ~ 2,047	"H"	2,096 ~ 2,111		

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. In this case, the definition of LSB page is the LSB among the pages to be programmed. Therefore, LSB doesn't need to be page 0.







Interleave Page Program

K9K8G08U0A is composed of two K9F4G08U0As. K9K8G08U0A provides interleaving operation between two K9F4G08U0As.

This interleaving page program improves the system throughput almost twice compared to non-interleaving page program.

At first, the host issues page program command to one of the K9F4G08U0A chips, say K9F4G08U0A(chip #1). Due to this K9K8G08U0A goes into busy state. During this time, K9F4G08U0A(chip #2) is in ready state. So it can execute the page program command issued by the host.

After the execution of page program by K9F4G08U0A(chip #1), it can execute another page program regardless of the K9F4G08U0A(chip #2). Before that the host needs to check the status of K9F4G08U0A(chip #1) by issuing F1h command. Only when the status of K9F4G08U0A(chip #1) becomes ready status, host can issue another page program command. If the K9F4G08U0A(chip #1) is in busy state, the host has to wait for the K9F4G08U0A(chip #1) to get into ready state.

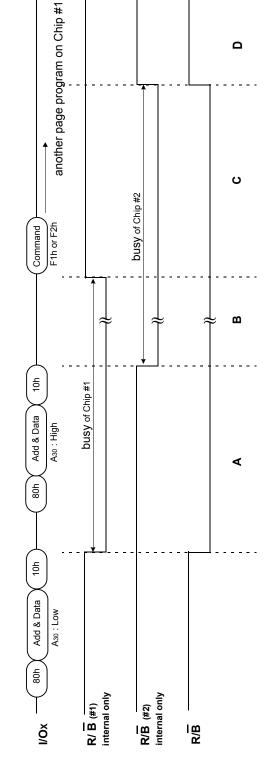
Similarly, K9F4G08U0A chip(chip #2) can execute another page program after the completion of the previous program. The host can monitor the status of K9F4G08U0A(chip #2) by issuing F2h command. When the K9F4G08U0A(chip #2) shows ready state, host can issue another page program command to K9F4G08U0A(chip #2).

This interleaving algorithm improves the system throughput almost twice. The host can issue page program command to each chip individually. This reduces the time lag for the completion of operation.

NOTES: During interleave operations, 70h command is prohibited.



Interleave Page Program



State A: Chip #1 is executing a page program operation and chip #2 is in ready state. So the host can issue a page program command to chip #2.

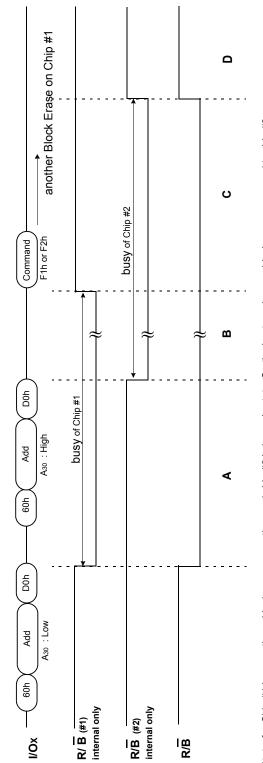
State B: Both chip #1 and chip #2 are executing page program operation.

State C: Page program on chip #1 is terminated, but page program on chip #2 is still operating. And the system should issue F1h command to detect the status of chip #1. If chip #1 is ready, status I/O6 is "1" and the system can issue another page program command to chip #1. State D: Chip #1 and Chip #2 are ready.

According to the above process, the system can operate page program on chip #1 and chip #2 alternately.

Ctatue	Č	Operation	Status Command / Data	nand / Data	
Olaius			F1h	F2h	
A	Chip 1 : Busy, Chip 2 : Ready	Chip 2 : Ready	8xh	Cxh	
В	Chip 1: Busy, Chip 2: Busy	Chip 2 : Busy	8xh	8xh	
O	Chip 1 : Ready, Chip 2 : Busy	Chip 2 : Busy	Cxh	8xh	
٥	Chip 1 : Ready, Chip 2 : Ready	Chip 2 : Ready	Cxh	Cxh	

Interleave Block Erase



State A: Chip #1 is executing a block erase operation, and chip #2 is in ready state. So the host can issue a block erase command to chip #2. State B: Both chip #1 and chip #2 are executing block erase operation.

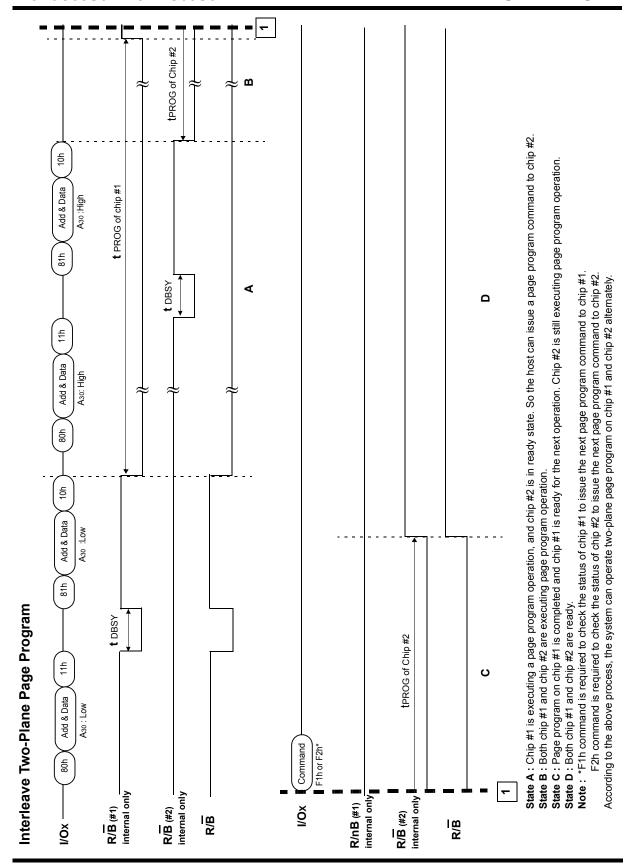
State C: Block erase on chip #1 is terminated, but block erase on chip #2 is still operating. And the system should issue F1h command to detect the status of chip #1. If chip #1 is ready, status I/O6 is "1" and the system can issue another block erase command to chip #1.

State D: Chip #1 and Chip #2 are ready.

According to the above process, the system can operate block erase on chip #1 and chip #2 alternately.

Ctatue	Citation	Status Command / Data	mand / Data
olatus	Operation	F1h	F2h
Α	Chip 1 : Busy, Chip 2 : Ready	8xh	Cxh
В	Chip 1: Busy, Chip 2: Busy	8xh	8xh
O	Chip 1 : Ready, Chip 2 : Busy	Cxh	8xh
۵	Chip 1 : Ready, Chip 2 : Ready	Cxh	Cxh







t BERS of chip #2 Ω ۵ D0h t BERS of chip #1 A30 :High Add 60h ⋖ A30 : High Add 60h DOh tBERS of chip #2 ပ A30 :Low Add Interleave Two-Plane Block Erase 60h A30: Low Add Command F1h or F2h* 60h internal only Ţ internal only ŏ/ internal only internal only R/B (#2) R/BI R/BI R/B (#1) R/B (#2) R/B (#1) ĕ

State A: Chip #1 is executing a block erase operation, and chip #2 is in ready state. So the host can issue a block erase command to chip #2.

State B: Both chip #1 and chip #2 are executing block erase operation.

State C: Block erase on chip #1 is completed and chip #1 is ready for the next operation. Chip #2 is still executing block erase operation.

State D: Both chip #1 and chip #2 are ready.

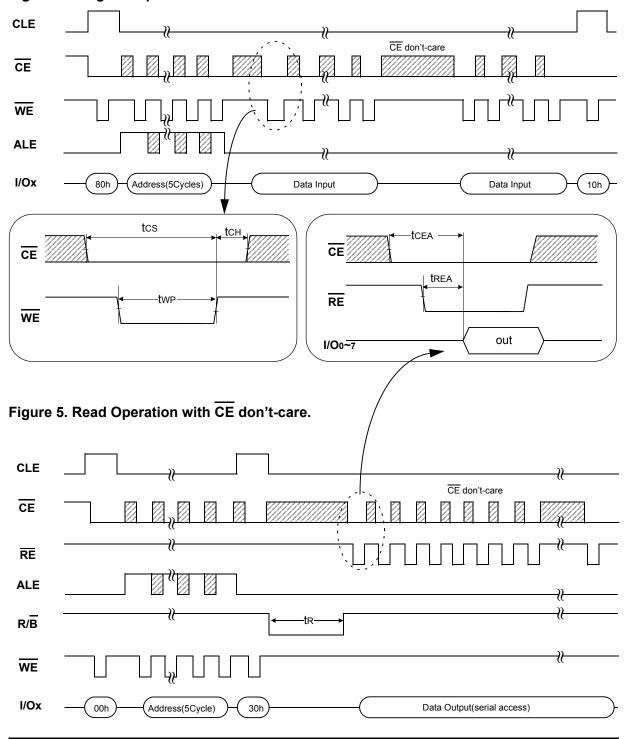
Note: *F1h command is required to check the status of chip #1 to issue the next block erase command to chip #1. F2h command is required to check the status of chip #2 to issue the next block erase command to chip #2.

As the above process, the system can operate two-plane block erase on chip #1 and chip #2 alternatively.

System Interface Using CE don't-care.

For an easier system interface, $\overline{\text{CE}}$ may be inactive during the data-loading or serial access as shown below. The internal 2,112byte data registers are utilized as separate buffers for this operation and the system design gets more flexible. In addition, for voice or audio applications which use slow cycle time on the order of μ -seconds, de-activating $\overline{\text{CE}}$ during the data-loading and serial access would provide significant savings in power consumption.

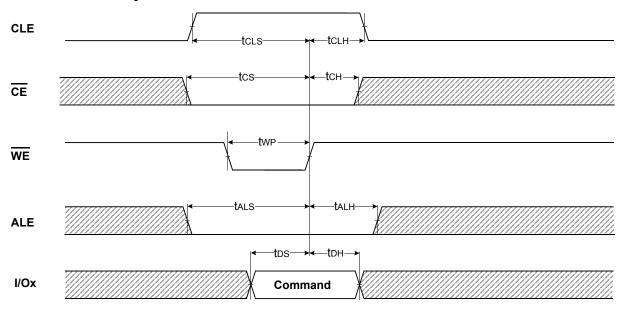
Figure 4. Program Operation with CE don't-care.



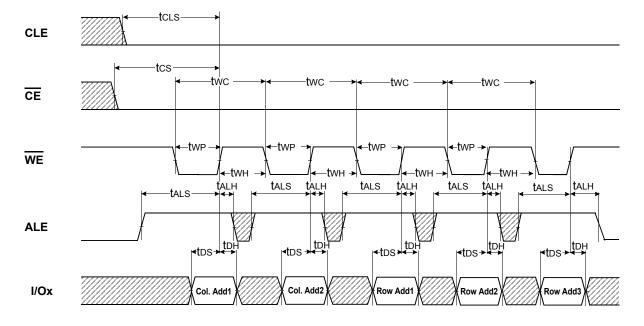
NOTE

Device	I/O	DATA			ADDRESS		
Device	I/Ox	Data In/Out	Col. Add1	Col. Add2	Row Add1	Row Add2	Row Add3
K9K8G08U0A	I/O 0 ~ I/O 7	2,112byte	A0~A7	A8~A11	A12~A19	A20~A27	A28~A30

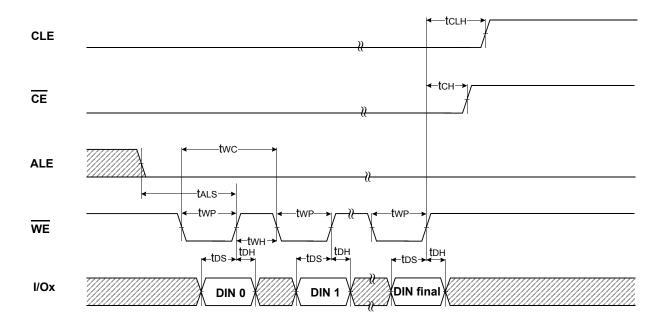
Command Latch Cycle



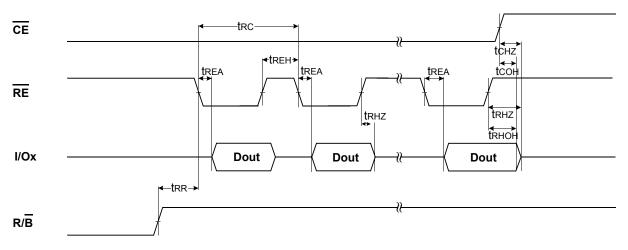
Address Latch Cycle



Input Data Latch Cycle

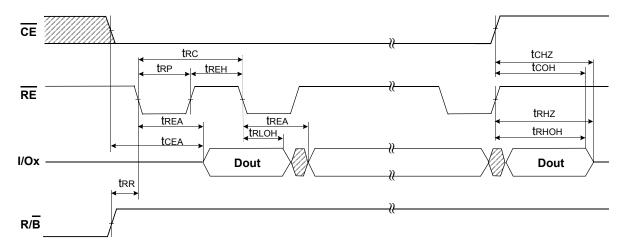


* Serial access Cycle after Read(CLE=L, WE=H, ALE=L)



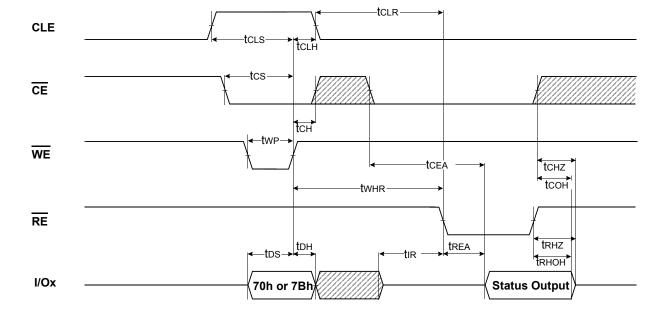
 $\label{eq:NOTES:Transition} \begin{tabular}{ll} NOTES: Transition is measured at $\pm 200mV$ from steady state voltage with load. This parameter is sampled and not 100% tested. tRLOH is valid when frequency is higher than 33MHz. tRHOH starts to be valid when frequency is lower than 33MHz. \end{tabular}$

Serial Access Cycle after Read(EDO Type, CLE=L, $\overline{\text{WE}}$ =H, ALE=L)



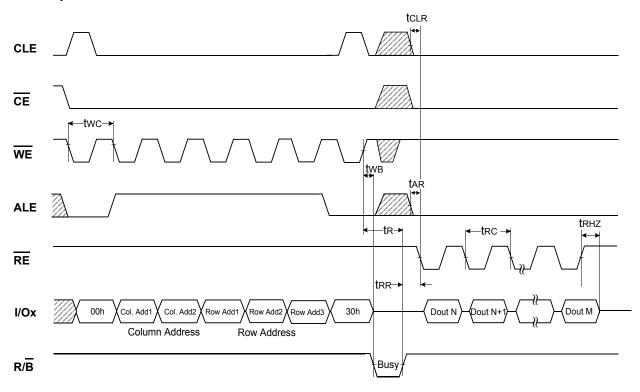
NOTES: Transition is measured at ±200mV from steady state voltage with load. This parameter is sampled and not 100% tested. tRLOH is valid when frequency is higher than 33MHz. tRHOH starts to be valid when frequency is lower than 33MHz.

Status Read Cycle & EDC Status Read Cycle

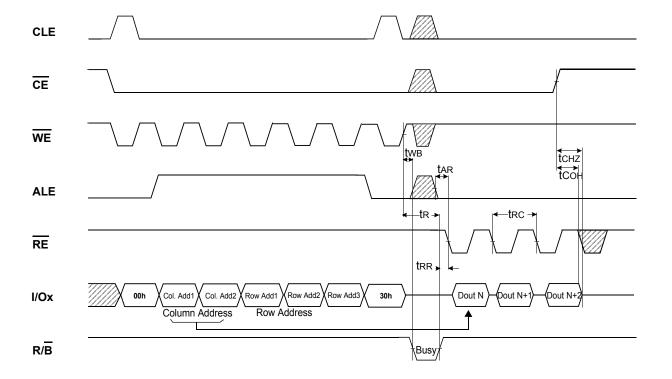


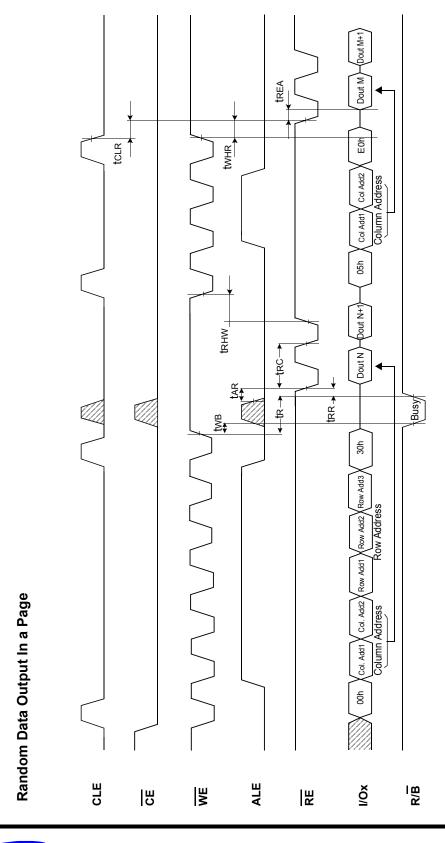


Read Operation



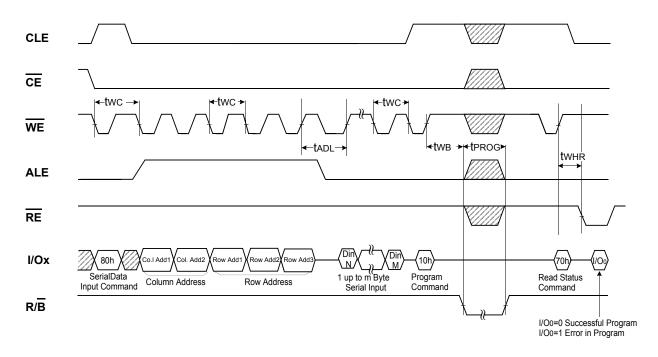
Read Operation(Intercepted by $\overline{\text{CE}}$)



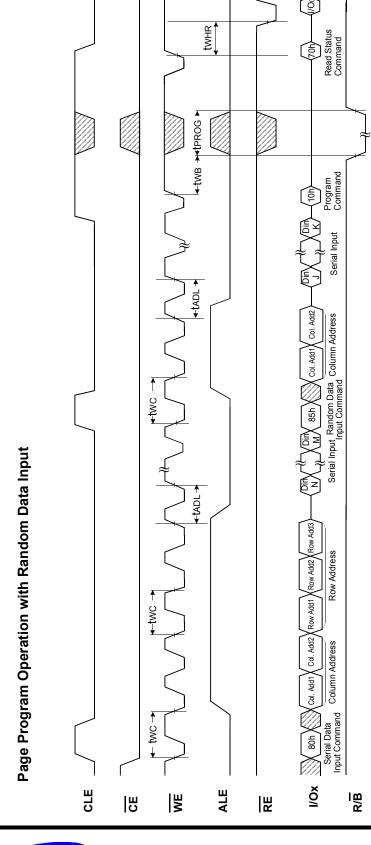




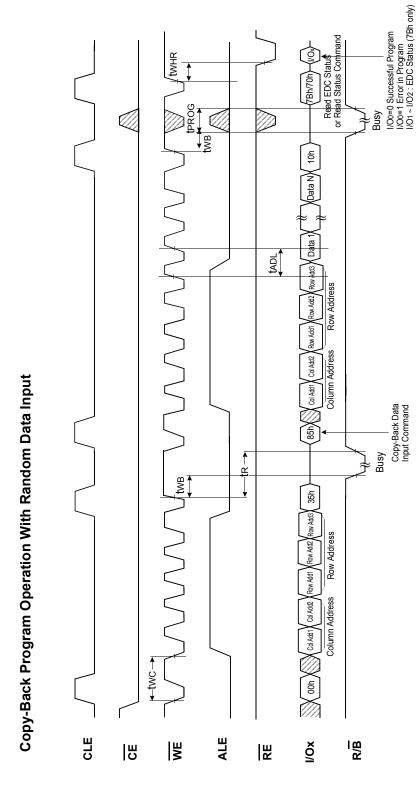
Page Program Operation



NOTES: tADL is the time from the $\overline{\text{WE}}$ rising edge of final address cycle to the $\overline{\text{WE}}$ rising edge of first data cycle.



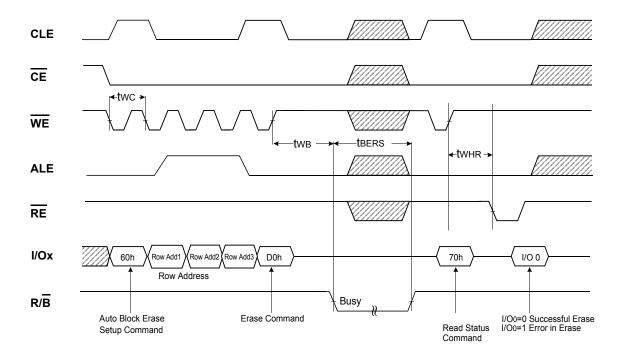
NOTES: 1. tADL is the time from the WE rising edge of final address cycle to the WE rising edge of first data cycle. 2. For EDC operation, only one time random data input is possible at the same address.



NOTES: 1. tADL is the time from the WE rising edge of final address cycle to the WE rising edge of first data cycle. 2. For EDC operation, only one time random data input is possible at the same address.

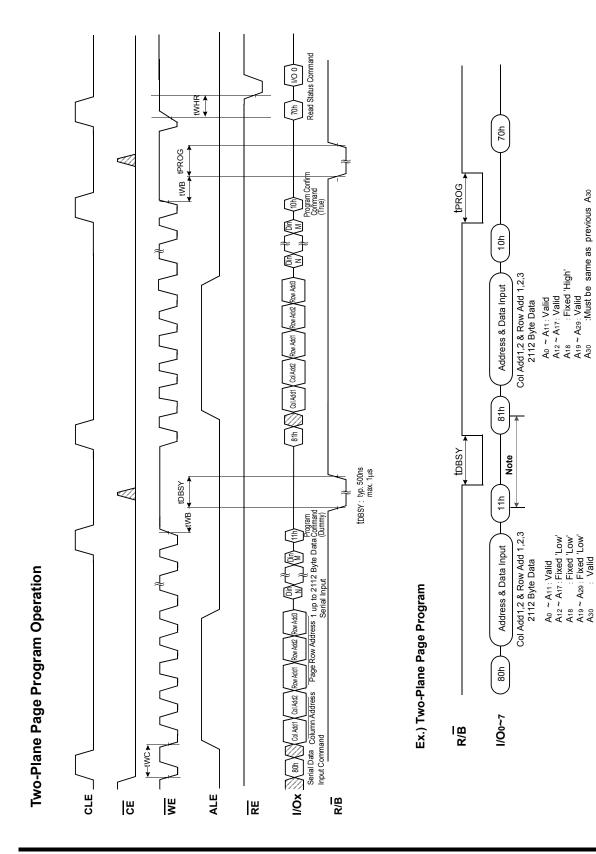


Block Erase Operation



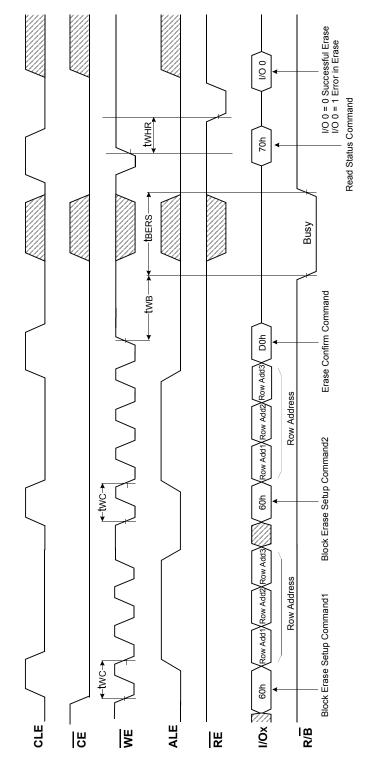


Note: Any command between 11h and 81h is prohibited except 70h and FFh.



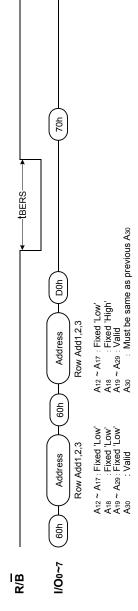
SAMSUNG

Two-Plane Block Erase Operation



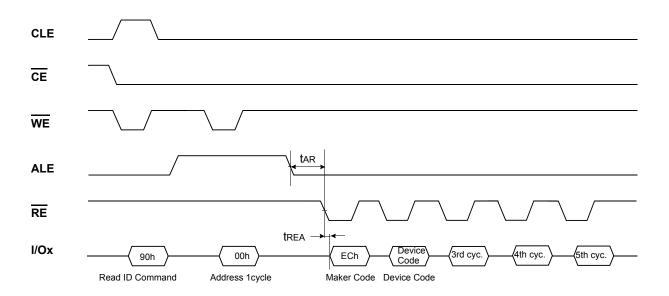
* For Two-Plane Erase operation, Block address to be erased should be repeated before "D0H" command.

Ex.) Address Restriction for Two-Plane Block Erase Operation





Read ID Operation



Device	Device Code(2nd Cycle)	3rd Cycle	4th Cycle	5th Cycle			
K9K8G08U0A	D3h	51h	95h	58h			
K9WAG08U1A	Same as K9K8G08U0A in it						
K9NBG08U5A		Same as Nanoguouda in it					

ID Definition Table

90 ID : Access command = 90H

	Description
1st Byte	Maker Code
2 nd Byte	Device Code
3 rd Byte	Internal Chip Number, Cell Type, Number of Simultaneously Programmed Pages, Etc
4 th Byte	Page Size, Block Size, Redundant Area Size, Organization, Serial Access Minimum
5 th Byte	Plane Number, Plane Size

3rd ID Data

	Description	1/07	I/O6	I/O5	I/O4	I/O3	I/O2	I/O1	I/O0
Internal Chip Number	1 2 4 8							0 0 1 1	0 1 0 1
Cell Type	2 Level Cell 4 Level Cell 8 Level Cell 16 Level Cell					0 0 1 1	0 1 0 1		
Number of Simultaneously Programmed Pages	1 2 4 8			0 0 1 1	0 1 0 1				
Interleave Program Between multiple chips	Not Support Support		0 1						
Cache Program	Not Support Support	0 1							

4th ID Data

	Description	I/O7	I/O6	I/O5	I/O4	I/O3	I/O2	I/O1	I/O0
Page Size (w/o redundant area)	1KB 2KB 4KB 8KB							0 0 1 1	0 1 0 1
Block Size (w/o redundant area)	64KB 128KB 256KB 512KB			0 0 1 1	0 1 0 1				
Redundant Area Size (byte/512byte)	8 16						0 1		
Organization	x8 x16		0 1						
Serial Access Minimum	50ns/30ns 25ns Reserved Reserved	0 1 0 1				0 0 1 1			



5th ID Data

	Description	1/07	I/O6 I	/O5	I/O4	I/O3	I/O2	I/O1	I/O0
	1					0	0		
Diana Number	2					0	1		
Plane Number	4					1	0		
	8					1	1		
	64Mb		0	0	0				
	128Mb		0	0	1				
	256Mb		0	1	0				
Plane Size	512Mb		0	1	1				
(w/o redundant Area)	1Gb		1	0	0				
	2Gb		1	0	1				
	4Gb		1	1	0				
	8Gb		1	1	1				
Reserved		0						0	0



Device Operation

PAGE READ

Page read is initiated by writing 00h-30h to the command register along with five address cycles. After initial power up, 00h command is latched. Therefore only five address cycles and 30h command initiates that operation after initial power up. The 2,112 bytes of data within the selected page are transferred to the data registers in less than $20\mu s(tR)$. The system controller can detect the completion of this data transfer(tR) by analyzing the output of R/B pin. Once the data in a page is loaded into the data registers, they may be read out in 25ns(K9NBG08U5A:50ns) cycle time by sequentially pulsing \overline{RE} . The repetitive high to low transitions of the \overline{RE} clock make the device output the data starting from the selected column address up to the last column address.

The device may output random data in a page instead of the consecutive sequential data by writing random data output command. The column address of next data, which is going to be out, may be changed to the address which follows random data output command. Random data output can be operated multiple times regardless of how many times it is done in a page.

Figure 6. Read Operation

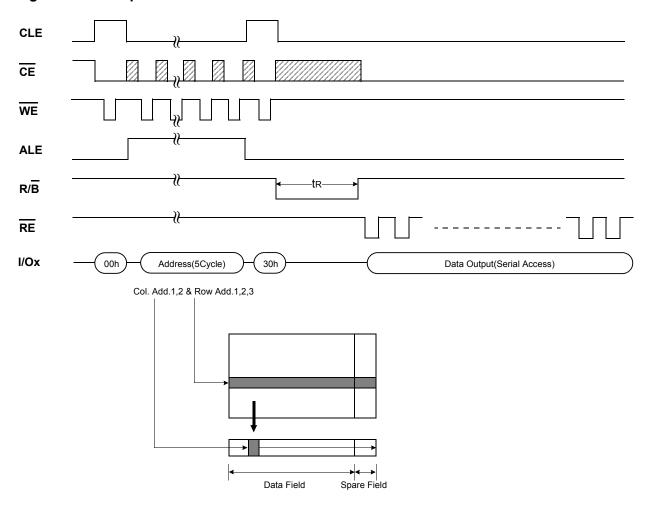
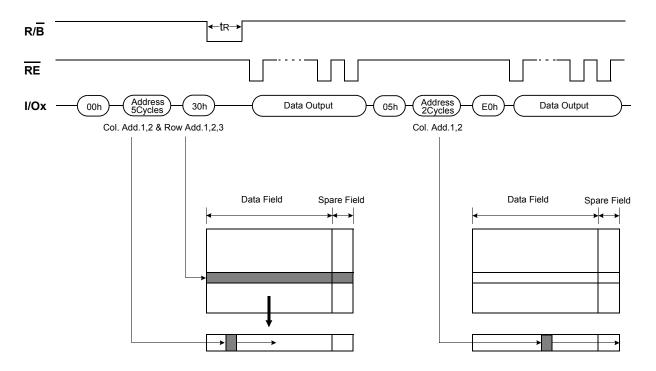


Figure 7. Random Data Output In a Page



PAGE PROGRAM

The device is programmed basically on a page basis, but it does allow multiple partial page programming of a word or consecutive bytes up to 2,112, in a single page program cycle. The number of consecutive partial page programming operation within the same page without an intervening erase operation must not exceed 4 times for a single page. The addressing should be done in sequential order in a block. A page program cycle consists of a serial data loading period in which up to 2,112bytes of data may be loaded into the data register, followed by a non-volatile programming period where the loaded data is programmed into the appropriate cell. The serial data loading period begins by inputting the Serial Data Input command(80h), followed by the five cycle address inputs and then serial data loading. The words other than those to be programmed do not need to be loaded. The device supports random data input in a page. The column address for the next data, which will be entered, may be changed to the address which follows random data input command(85h). Random data input may be operated multiple times regardless of how many times it is done in a page. Modifying the data of a sector by Random Data Input before Copy-Back Program must be performed for the whole sector and is allowed only once per each sector. Any partial modification smaller than a sector corrupts the on-chip EDC codes. The Page Program confirm command(10h) initiates the programming process. Writing 10h alone without previously entering the serial data will not initiate the programming process. The internal write state controller automatically executes the algorithms and timings necessary for program and verify, thereby freeing the system controller for other tasks. Once the program process starts, the Read Status Register command may be entered to read the status register. The system controller can detect the completion of a program cycle by monitoring the R/B output, or the Status bit(I/O 6) of the Status Register. Only the Read Status command and Reset command are valid while programming is in progress. When the Page Program is complete, the Write Status Bit(I/O 0) may be checked(Figure 8). The internal write verify detects only errors for "1"s that are not successfully programmed to "0"s. The command register remains in Read Status command mode until another valid command is written to the command register.

Figure 8. Program & Read Status Operation

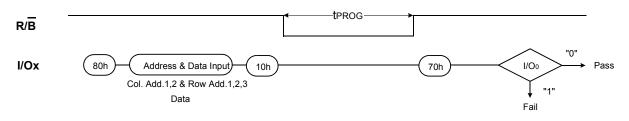
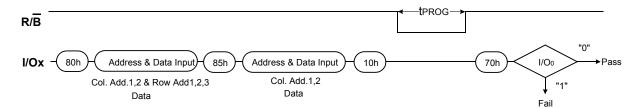




Figure 9. Random Data Input In a Page



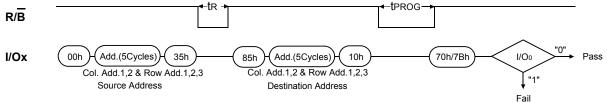
Copy-Back Program

The Copy-Back program is configured to quickly and efficiently rewrite data stored in one page without utilizing an external memory. 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 a block is updated and the rest of the block also need to be copied to the newly assigned free block. The operation for performing a copy-back program is a sequential execution of page-read without serial access and copying-program with the address of destination page. A read operation with "35h" command and the address of the source page moves the whole 2,112-byte data into the internal data buffer. As soon as the device returns to Ready state, Page-Copy Data-input command (85h) with the address cycles of destination page followed may be written. The Program Confirm command (10h) is required to actually begin the programming operation. During tPROG, the device executes EDC of itself. Once the program process starts, the Read Status Register command (70h) or Read EDC Status command (78h) may be entered to read the status register. The system controller can detect the completion of a program cycle by monitoring the R/B output, or the Status bit(I/O 6) of the Status Register. When the Copy-Back Program is complete, the Write Status Bit(I/O 0) and EDC Status Bits (I/O 1 ~ I/O 2) may be checked(Figure 10 & Figure 11& Figure 12). The internal write verification detects only errors for "1"s that are not successfully programmed to "0"s and the internal EDC checks whether there is only 1-bit error for each 528-byte sector of the source page. More than 2-bit error detection is not available for each 528-byte sector. The command register remains in Read Status command mode or Read EDC Status command mode until another valid command is written to the command register.

During copy-back program, data modification is possible using random data input command (85h) as shown in Figure 11. But EDC status Bits are not available during copy back for some bits or bytes modified by Random Data Input operation.

However, in case of the 528 byte sector unit modification, EDC status bits are available.

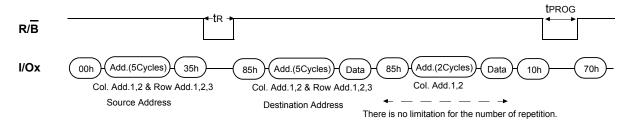
Figure 10. Page Copy-Back Program Operation



Note: 1. Copy-Back Program operation is allowed only within the same memory plane.

2. On the same plane, It's prohibited to operate copy-back program from an odd address page(source page) to an even address page(target page) or from an even address page(source page) to an odd address page(target page). Therefore, the copy-back program is permitted just between odd address pages or even address pages.

Figure 11. Page Copy-Back Program Operation with Random Data Input



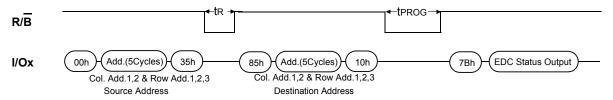
Note: 1. For EDC operation, only one time random data input is possible at the same address.



EDC OPERATION

Note that for the user who use Copy-Back with EDC mode, only one time random data input is possible at the same address during Copy-Back program or page program mode. For the user who use Copy-Back without EDC, there is no limitation for the random data input at the same address.

Figure 12. Page Copy-Back Program Operation with EDC & Read EDC Status

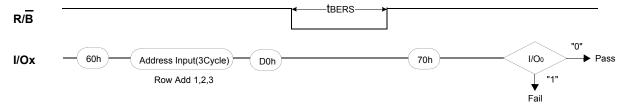


BLOCK ERASE

The Erase operation is done on a block basis. Block address loading is accomplished in three cycles initiated by an Erase Setup command(60h). Only address A₁₈ to A₃₀ is valid while A₁₂ to A₁₇ is ignored. The Erase Confirm command(D0h) following the block address loading initiates the internal erasing process. This two-step sequence of setup followed by execution command ensures that memory contents are not accidentally erased due to external noise conditions.

At the rising edge of $\overline{\text{WE}}$ after the erase confirm command input, the internal write controller handles erase and erase-verify. When the erase operation is completed, the Write Status Bit(I/O 0) may be checked. Figure 13 details the sequence.

Figure 13. Block Erase Operation



Two-Plane Page Program

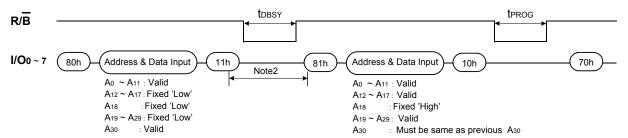
Two-Plane Page Program is an extension of Page Program, for a single plane with 2112 byte page registers. Since the device is equipped with four memory planes, activating the two sets of 2112 byte page registers enables a simultaneous programming of two pages. But there is some restriction, two-plane program operations can be executed by dividing the memory array into plane 0~1 or plane 2~3 separately. For example, two-plane program operation into plane 0 and plane 2 is prohibited. That is to say, two-plane program operation into plane 0 and plane 1 or into plane 2 and plane 3 is allowed.

After writing the first set of data up to 2112 byte into the selected page register, Dummy Page Program command (11h) instead of actual Page Program command (10h) is inputted to finish data-loading of the first plane. Since no programming process is involved, R/B remains in Busy state for a short period of time(tDBSY). Read Status command (70h) may be issued to find out when the device returns to Ready state by polling the Ready/Busy status bit(I/O 6). Then the next set of data for the other plane is inputted after the 81h command and address sequences. After inputting data for the last plane, actual True Page Program(10h) instead of dummy Page Program command (11h) must be followed to start the programming process. The operation of R/B and Read Status is the same as that of Page Program. Althought two planes are programmed simultaneously, pass/fail is not available for each page when the program operation completes. Status bit of I/O 0 is set to "1" when any of the pages fails.

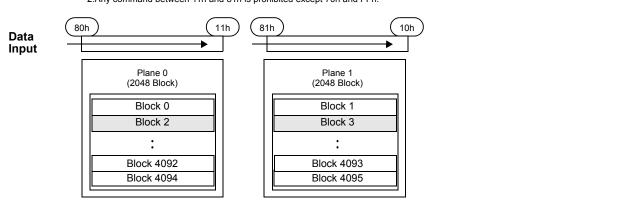
Restriction in addressing with Two-Plane Page Program is shown is Figure 14.



Figure 14. Two-Plane Page Program



NOTE: 1. It is noticeable that same row address except for A₁₈ is applied to the two blocks 2.Any command between 11h and 81h is prohibited except 70h and FFh.



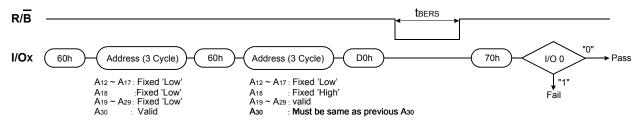
NOTE: It is an example for two-plane page program into plane 0~1(In this case, A₃₀ is low), and the method for two-plane page program into plane 2 ~3 is same. two-plane page program into plane 0&2(or plane 0&3, or plane 1&2, or plane 1&3) is prohibited.

Two-Plane Block Erase

Basic concept of Two-Plane Block Erase operation is identical to that of Two-Plane Page Program. Up to two blocks, one from each plane can be simultaneously erased. Standard Block Erase command sequences (Block Erase Setup command(60h) followed by three address cycles) may be repeated up to twice for erasing up to two blocks. Only one block should be selected from each plane. The Erase Confirm command(D0h) initiates the actual erasing process. The completion is detected by monitoring R/B pin or Ready/Busy status bit (I/O 6).

Two-plane erase operations can be executed by dividing the memory array into plane 0~1 or plane 2~3 separately. For example, two-plane erase operation into plane 0 and plane 2 is prohibited. That is to say, two-plane erase operation into plane 0 and plane 1 or into plane 2 and plane 3 is allowed.

Figure 15. Two-Plane Block Erase Operation



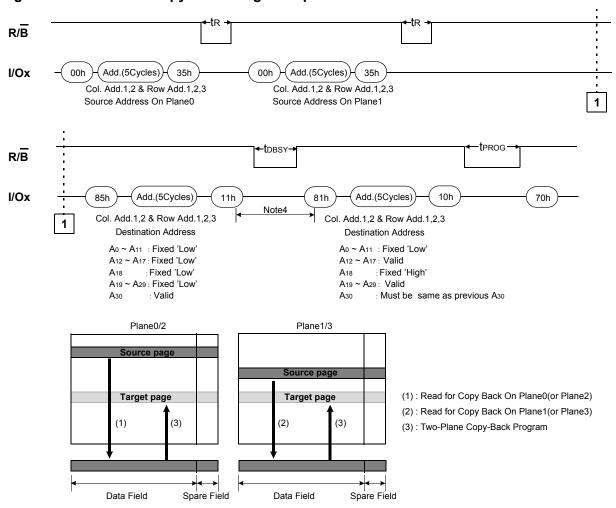
NOTE: Two-plane block erase into plane 0&2(or plane 0&3, or plane 1&2, or plane 1&3) is prohibited.



Two-Plane Copy-Back Program

Two-Plane Copy-Back Program is an extension of Copy-Back Program, for a single plane with 2112 byte page registers. Since the device is equipped with four memory planes, activating the two sets of 2112 byte page registers enables a simultaneous programming of two pages.

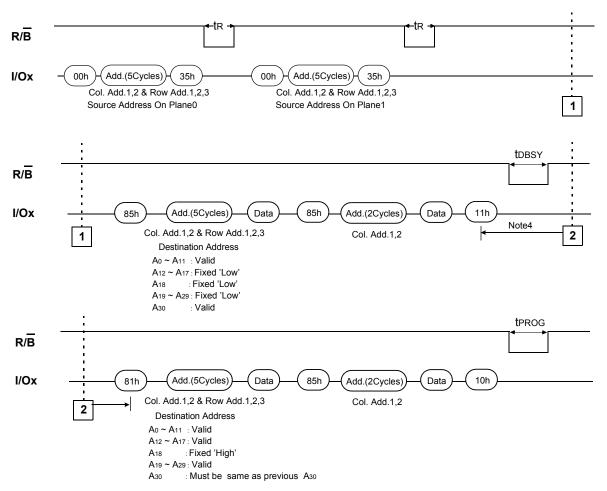
Figure 16. Two-Plane Copy-Back Program Operation



Note: 1. Copy-Back Program operation is allowed only within the same memory plane.

- 2. On the same plane, It's prohibited to operate copy-back program from an odd address page(source page) to an even address page(target page) or from an even address page(source page) to an odd address page(target page). Therefore, the copy-back program is permitted just between odd address pages or even address pages.
- 3. Two-plane copy-back page program into plane 0&2(or plane 0&3, or plane 1&2, or plane 1&3) is prohibited.
- 4. Any command between 11h and 81h is prohibited except 70h and FFh.

Figure 17. Two-Plane Copy-Back Program Operation with Random Data Input



Note: 1. Copy-Back Program operation is allowed only within the same memory plane.

- 2. On the same plane, It's prohibited to operate copy-back program from an odd address page(source page) to an even address page(target page) or from an even address page(source page) to an odd address page(target page). Therefore, the copy-back program is permitted just between odd address pages or even address pages.
- 3. EDC status Bits are not available during copy back for some bits or bytes modified by Random Data Input operation. In case of the 528 byte plane unit modification, EDC status bits are available.
- 4. Any command between 11h and 81h is prohibited except 70h and FFh.

READ STATUS

The device contains a Status Register which may be read to find out whether program or erase operation is completed, and whether the program or erase operation is completed successfully. After writing 70h command to the command register, a read cycle outputs the content of the Status Register to the I/O pins on the falling edge of \overline{CE} or \overline{RE} , whichever occurs last. This two line control allows the system to poll the progress of each device in multiple memory connections even when R/B pins are common-wired. \overline{RE} or \overline{CE} does not need to be toggled for updated status. Refer to Table 3 for specific Status Register definitions. The command register remains in Status Read mode until further commands are issued to it. Therefore, if the status register is read during a random read cycle, the read command(00h) should be given before starting read cycles.

Table 3. Status Register Definition for 70h Command

I/O	Page Program	Block Erase	Read	D	efinition
I/O 0	Pass/Fail	Pass/Fail	Not use	Pass : "0"	Fail : "1"
I/O 1	Not use	Not use	Not use	Don't -cared	
I/O 2	Not use	Not use	Not use	Don't -cared	
I/O 3	Not Use	Not Use	Not Use	Don't -cared	
I/O 4	Not Use	Not Use	Not Use	Don't -cared	
I/O 5	Not Use	Not Use	Not Use	Don't -cared	
I/O 6	Ready/Busy	Ready/Busy	Ready/Busy	Busy : "0"	Ready: "1"
I/O 7	Write Protect	Write Protect	Write Protect	Protected : "0"	Not Protected : "1"

NOTE: 1. I/Os defined 'Not use' are recommended to be masked out when Read Status is being executed.

2. Status Register Definition for F1h & F2h command is same as that of 70h command.

READ EDC STATUS

Read EDC status operation is only available on 'Copy Back Program'. The device contains an EDC Status Register which may be read to find out whether there is error during 'Read for Copy Back'. After writing 7Bh command to the command register, a read cycle outputs the content of the EDC Status Register to the I/O pins on the falling edge of $\overline{\text{CE}}$ or $\overline{\text{RE}}$, whichever occurs last. This two line control allows the system to poll the progress of each device in multiple memory connections even when $\overline{\text{R/B}}$ pins are common-wired. $\overline{\text{RE}}$ or $\overline{\text{CE}}$ does not need to be toggled for updated status. Refer to table 4 for specific Status Register definitions. The command register remains in EDC Status Read mode until further commands are issued to it.

Table 4. Status Register Definition for 7Bh Command

I/O	Copy Back Program	Page Program	Block Erase	Read	Definition
I/O 0	Pass/Fail of Copy Back Program	Pass/Fail	Pass/Fail	Not use	Pass : "0", Fail : "1"
I/O 1	EDC Status	Not use	Not use	Not use	No Error : "0", Error : "1"
I/O 2	Validity of EDC Status	Not use	Not use	Not use	Valid : "1", Invalid : "0"
I/O 3	Not Use	Not Use	Not Use	Not Use	Don't -cared
I/O 4	Not Use	Not Use	Not Use	Not Use	Don't -cared
I/O 5	Not Use	Not Use	Not Use	Not Use	Don't -cared
I/O 6	Ready/Busy of Copy Back Program	Ready/Busy	Ready/Busy	Ready/Busy	Busy: "0", Ready: "1"
I/O 7	Write Protect of Copy Back Program	Write Protect	Write Protect	Write Protect	Protected: "0", Not Protected: "1"

NOTE: 1. I/Os defined 'Not use' are recommended to be masked out when Read Status is being executed.

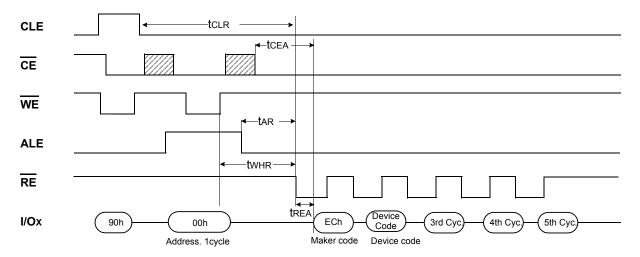
More than 2-bit error detection isn't available for each 528 Byte sector.
 That is to say, only 1-bit error detection is available for each 528 Byte sector.



Read ID

The device contains a product identification mode, initiated by writing 90h to the command register, followed by an address input of 00h. Five read cycles sequentially output the manufacturer code(ECh), and the device code and 3rd, 4th, 5th cycle ID respectively. The command register remains in Read ID mode until further commands are issued to it. Figure 18 shows the operation sequence.

Figure 18. Read ID Operation



Device	Device Code(2nd Cycle)	3rd Cycle	4th Cycle	5th Cycle	
K9K8G08U0A	D3h	51h	95h	58h	
K9WAG08U1A		Samo as KOK9C	09110A in it		
K9NBG08U5A	Same as K9K8G08U0A in it				

RESET

The device offers a reset feature, executed by writing FFh to the command register. When the device is in Busy state during random read, program or erase mode, the reset operation will abort these operations. The contents of memory cells being altered are no longer valid, as the data will be partially programmed or erased. The command register is cleared to wait for the next command, and the Status Register is cleared to value C0h when \overline{WP} is high. If the device is already in reset state a new reset command will be accepted by the command register. The R/\overline{B} pin transitions to low for tRST after the Reset command is written. Refer to Figure 19 below.

Figure 19. RESET Operation

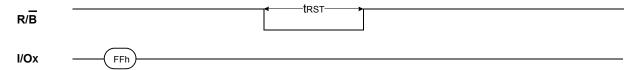


Table 5. Device Status

	After Power-up	After Reset
Operation mode	00h Command is latched	Waiting for next command



READY/BUSY

The device has a R/\overline{B} output that provides a hardware method of indicating the completion of a page program, erase and random read completion. The R/\overline{B} pin is normally high but transitions to low after program or erase command is written to the command register or random read is started after address loading. It returns to high when the internal controller has finished the operation. The pin is an open-drain driver thereby allowing two or more R/\overline{B} outputs to be Or-tied. Because pull-up resistor value is related to $tr(R/\overline{B})$ and current drain during busy(ibusy), an appropriate value can be obtained with the following reference chart(Fig.20). Its value can be determined by the following guidance.

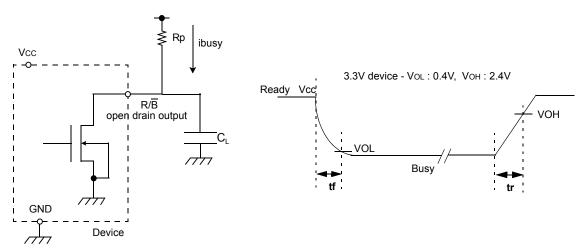
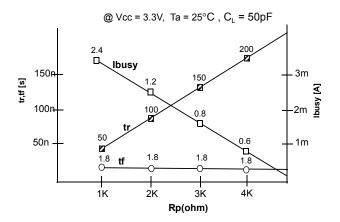


Figure 20. Rp vs tr ,tf & Rp vs ibusy



Rp value guidance

Rp(min, 3.3V part) =
$$\frac{\text{Vcc}(\text{Max.}) - \text{VoL}(\text{Max.})}{\text{IoL} + \Sigma \text{IL}} = \frac{3.2\text{V}}{8\text{mA} + \Sigma \text{IL}}$$

where IL is the sum of the input currents of all devices tied to the R/\overline{B} pin.

Rp(max) is determined by maximum permissible limit of tr



Data Protection & Power up sequence

The device is designed to offer protection from any involuntary program/erase during power-transitions. An internal voltage detector disables all functions whenever Vcc is below about 2V. $\overline{\text{WP}}$ pin provides hardware protection and is recommended to be kept at ViL during power-up and power-down. A recovery time of minimum 100 μ s is required before internal circuit gets ready for any command sequences as shown in Figure 21. The two step command sequence for program/erase provides additional software protection.

Figure 21. AC Waveforms for Power Transition

