

# K9F2G08X0C

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**Document Title****256M x 8 Bit NAND Flash Memory****Revision History**

| <b><u>Revision No</u></b> | <b><u>History</u></b>                             | <b><u>Draft Date</u></b> | <b><u>Remark</u></b> |
|---------------------------|---|--------------------------|----------------------|
| 0.0                       | 1. Initial issue                                  | Aug. 12, 2009            | Advance              |
| 0.1                       | 1. DC Parameter is chagned<br>2. Typo is modified | Dec. 9, 2009             | Advance              |

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## 1.0 Introduction

### 1.1 PRODUCT LIST

| Part Number  | Vcc Range  | Organization | PKG Type |
|--------------|------------|--------------|----------|
| K9F2G08U0C-S | 2.7 ~ 3.6v | x8           | TSOP1    |
| K9F2G08U0C-H | 2.7 ~ 3.6v | x8           | 63 FBGA  |

### 1.2 FEATURES

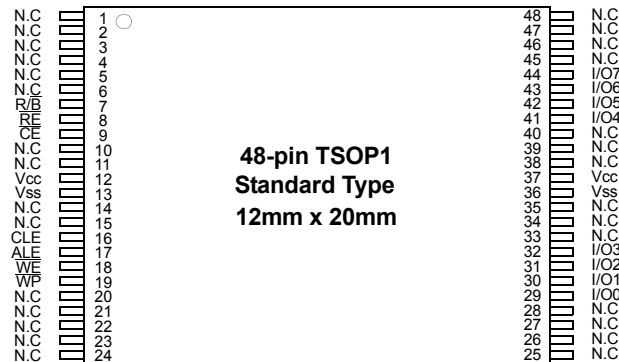
- Voltage Supply
  - 3.3V device(K9F2G08U0C): 2.70V ~ 3.60V
- Organization
  - Memory Cell Array : (256M + 8M) x 8bit
  - Data Register : (2K + 64) x 8bit
- Automatic Program and Erase
  - Page Program : (2K + 64)Byte
  - Block Erase : (128K + 4K)Byte
- Page Read Operation
  - Page Size : (2K + 64)Byte
  - Random Read : 35μs(Max.)
  - Serial Access : 30ns(Min.)
- Fast Write Cycle Time
  - Page Program time : 250μs(Typ.)
  - Block Erase Time : 2ms(Typ.)
- Command/Address/Data Multiplexed I/O Port
- Hardware Data Protection
  - Program/Erase Lockout During Power Transitions
- Reliable CMOS Floating-Gate Technology
  - Endurance & Data Retention : Refor to the gualification report
  - ECC regnirement : 1 bit / 528bytes
- Command Driven Operation
- Unique ID for Copyright Protection
- Package :
  - K9F2G08U0C-SCB0/SIB0 : Pb-FREE PACKAGE  
48 - Pin TSOP I (12 x 20 / 0.5 mm pitch)
  - K9F2G08U0C-HCB0/HIB0 : Pb-FREE PACKAGE  
63 - ball FBGA (9 x 11 / 0.8 mm pitch)

### 1.3 GENERAL DESCRIPTION

Offered in 256Mx8bit, the K9F2G08X0C is a 2G-bit NAND Flash Memory with spare 64M-bit. Its NAND cell provides the most cost-effective solution for the solid state application market. A program operation can be performed in typical 250μs on the (2K+64)Byte page and an erase operation can be performed in typical 2ms on a (128K+4K)Byte block. Data in the data register can be read out at 30ns 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 K9F2G08X0C's extended reliability of 100K program/erase cycles by providing ECC(Error Correcting Code) with real time mapping-out algorithm. The K9F2G08X0C is an optimum solution for large nonvolatile storage applications such as solid state file storage and other portable applications requiring non-volatility.

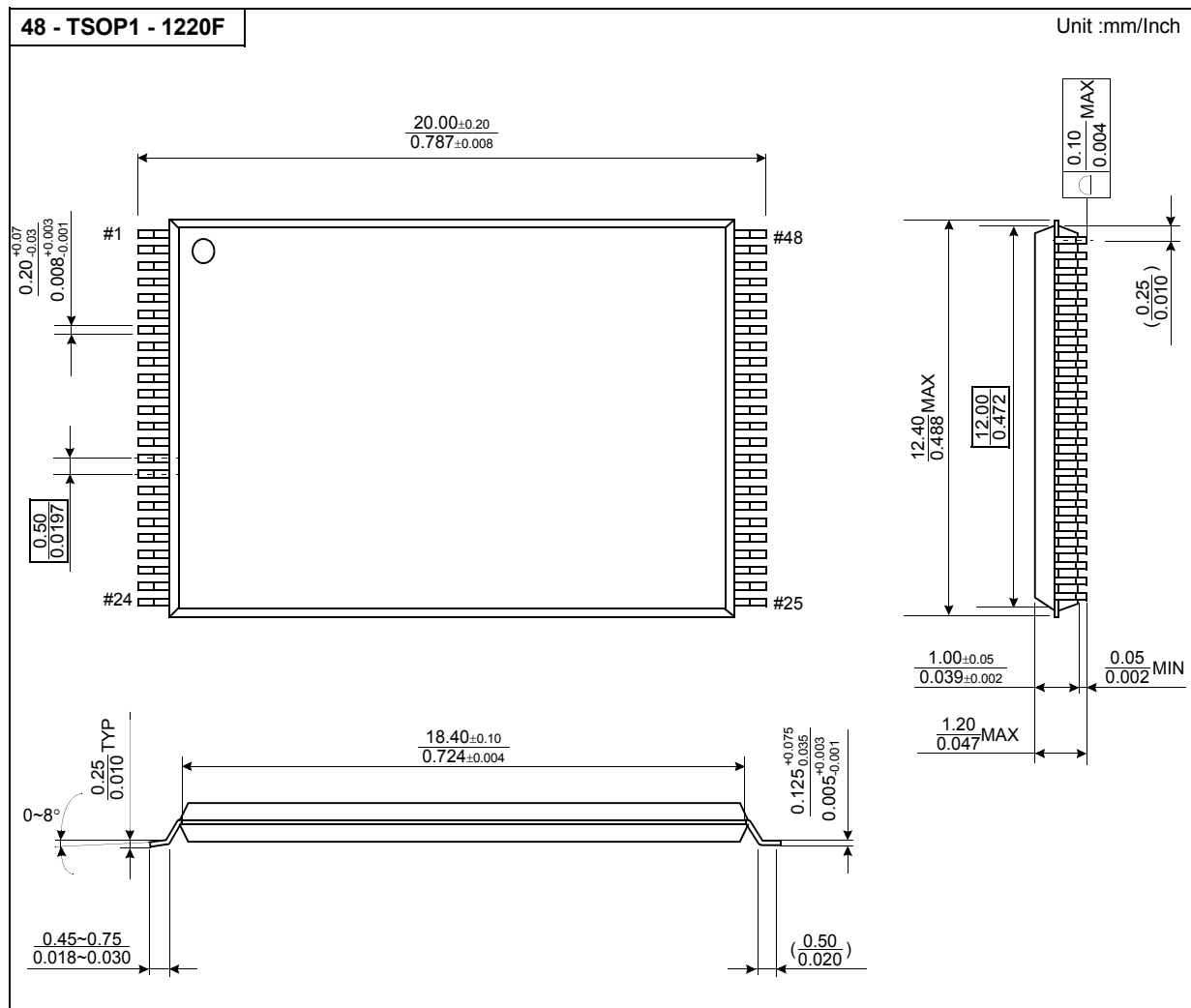
## 1.4 PIN CONFIGURATION (TSOP1)

K9F2G08X0C-HCB0/HIB0

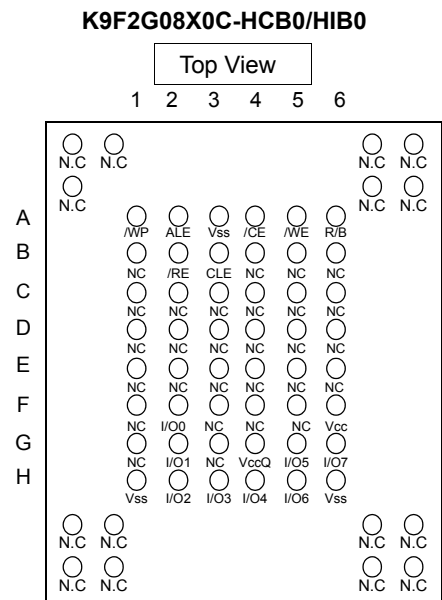


## PACKAGE DIMENSIONS

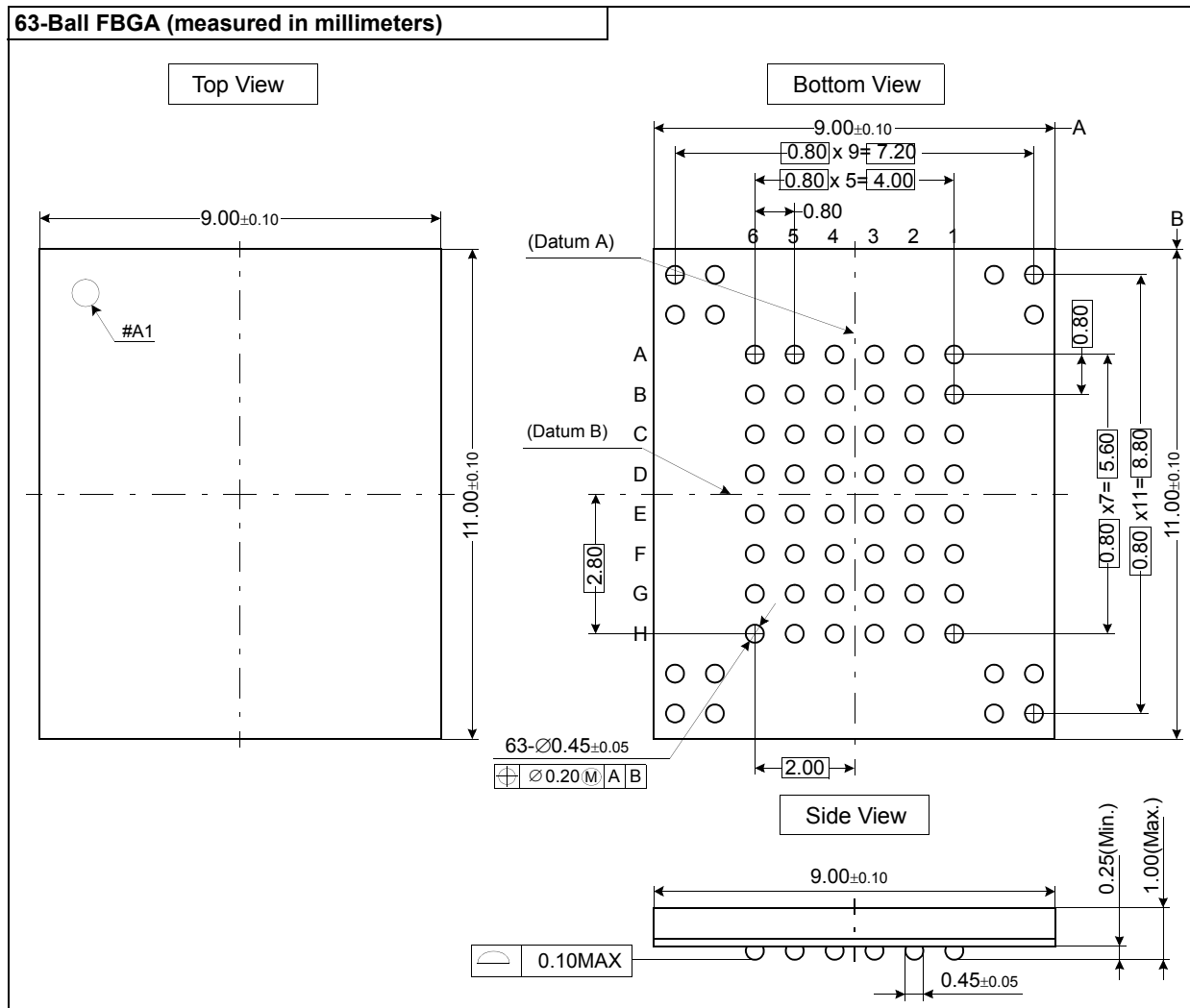
## 48-PIN LEAD/LEAD FREE PLASTIC THIN SMALL OUT-LINE PACKAGE TYPE(I)



1.5 PIN CONFIGURATION (FBGA)



## 1.5.1 PACKAGE DIMENSIONS



## 1.6 PIN DESCRIPTION

| Pin Name                            | Pin Function  |
|-------------------------------------|---|
| I/O <sub>0</sub> ~ I/O <sub>7</sub> | <b>DATA INPUTS/OUTPUTS</b><br>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                                 | <b>COMMAND LATCH ENABLE</b><br>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 $\overline{WE}$ signal.   |
| ALE                                 | <b>ADDRESS LATCH ENABLE</b><br>The ALE input controls the activating path for address to the internal address registers. Addresses are latched on the rising edge of $\overline{WE}$ with ALE high.   |
| $\overline{CE}$                     | <b>CHIP ENABLE</b><br>The $\overline{CE}$ input is the device selection control. When the device is in the Busy state, $\overline{CE}$ high is ignored, and the device does not return to standby mode in program or erase operation.   |
| $\overline{RE}$                     | <b>READ ENABLE</b><br>The $\overline{RE}$ 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 $\overline{RE}$ which also increments the internal column address counter by one.  |
| $\overline{WE}$                     | <b>WRITE ENABLE</b><br>The $\overline{WE}$ input controls writes to the I/O port. Commands, address and data are latched on the rising edge of the $\overline{WE}$ pulse.   |
| $\overline{WP}$                     | <b>WRITE PROTECT</b><br>The $\overline{WP}$ pin provides inadvertent program/erase protection during power transitions. The internal high voltage generator is reset when the $\overline{WP}$ pin is active low.  |
| R/ $\overline{B}$                   | <b>READY/BUSY OUTPUT</b><br>The R/ $\overline{B}$ 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                                 | <b>POWER</b><br>Vcc is the power supply for device.   |
| Vss                                 | <b>GROUND</b>   |
| N.C                                 | <b>NO CONNECTION</b><br>Lead is not internally connected.   |

**NOTE :** Connect all Vcc and Vss pins of each device to common power supply outputs.  
Do not leave Vcc or Vss disconnected.

## 2.0 Product Introduction

NAND Flash Memory 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  $\overline{WE}$  to low while  $\overline{CE}$  is low. Those are latched on the rising edge of  $\overline{WE}$ . 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.- 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 K9G2G08U0C.

**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       | -         | O                              |
| Page Program                          | 80h       | 10h       |                                |
| Copy-Back Program                     | 85h       | 10h       |                                |
| Two-Plane Page Program <sup>(2)</sup> | 80h---11h | 81h---10h |                                |
| Block Erase                           | 60h       | D0h       |                                |
| Random Data Input <sup>(1)</sup>      | 85h       | -         |                                |
| Random Data Output <sup>(1)</sup>     | 05h       | E0h       |                                |
| Read Status                           | 70h       | -         | O                              |
| Read Status 2                         | F1h       | -         | O                              |

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

2. Any command between 11h and 81h is prohibited except 70h/F1h and FFh.

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



## 2.1 ABSOLUTE MAXIMUM RATINGS

| Parameter                          |                 | Symbol            | Rating                                 | Unit |
|------------------------------------|-----------------|-------------------|--|------|
| Voltage on any pin relative to VSS |                 | V <sub>CC</sub>   | -0.6 to +4.6                           | V    |
|                                    |                 | V <sub>IN</sub>   | -0.6 to +4.6                           |      |
|                                    |                 | V <sub>IO</sub>   | -0.6 to V <sub>CC</sub> + 0.3 (< 4.6V) |      |
| Temperature Under Bias             | K9F2G08X0C-XCB0 | T <sub>BIAS</sub> | -10 to +125                            | °C   |
|                                    | K9F2G08X0C-XIB0 |                   | -40 to +125                            |      |
| Storage Temperature                | K9F2G08X0C-XCB0 | T <sub>STG</sub>  | -65 to +150                            | °C   |
|                                    | K9F2G08X0C-XIB0 |                   |  |      |
| Short Circuit Current              |                 | I <sub>OS</sub>   | 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 V<sub>CC</sub>+0.3V which, during transitions, may overshoot to V<sub>CC</sub>+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.

## 2.2 RECOMMENDED OPERATING CONDITIONS

(Voltage reference to GND, K9F2G08X0C-XCB0 :T<sub>A</sub>=0 to 70°C, K9F2G08X0C-XIB0:T<sub>A</sub>=-40 to 85°C)

| Parameter      | Symbol          | 3.3V |      |     | Unit |
|----------------|-----------------|------|------|-----|------|
|                |                 | Min  | Typ. | Max |      |
| Supply Voltage | V <sub>CC</sub> | 2.7  | 3.3  | 3.6 | V    |
| Supply Voltage | V <sub>SS</sub> | 0    | 0    | 0   | V    |

## 2.3 DC AND OPERATING CHARACTERISTICS(Recommended operating conditions otherwise

| Parameter                     |                              | Symbol                         | Test Conditions  | 3.3V                |     |                      | Unit |
|-------------------------------|------------------------------|--------------------------------|--|---------------------|-----|----------------------|------|
|                               |                              |                                |  | Min                 | Typ | Max                  |      |
| Operating Current             | Page Read with Serial Access | I <sub>CC1</sub>               | t <sub>RC</sub> =30ns<br>C <sub>E</sub> =V <sub>IL</sub> , I <sub>OUT</sub> =0mA | -                   | 20  | 35                   | mA   |
|                               | Program                      | I <sub>CC2</sub>               | -  |                     |     |                      |      |
|                               | Erase                        | I <sub>CC3</sub>               | -  |                     |     |                      |      |
| Stand-by Current(TTL)         |                              | I <sub>SB1</sub>               | C <sub>E</sub> =V <sub>IH</sub> , W <sub>P</sub> =0V/V <sub>CC</sub>             | -                   | -   | 1                    | μA   |
| Stand-by Current(CMOS)        |                              | I <sub>SB2</sub>               | C <sub>E</sub> =V <sub>CC</sub> -0.2, W <sub>P</sub> =0V/V <sub>CC</sub>         | -                   | 10  | 50                   |      |
| Input Leakage Current         |                              | I <sub>LI</sub>                | V <sub>IN</sub> =0 to V <sub>CC</sub> (max)                                      | -                   | -   | ±10                  |      |
| Output Leakage Current        |                              | I <sub>LO</sub>                | V <sub>OUT</sub> =0 to V <sub>CC</sub> (max)                                     | -                   | -   | ±10                  | V    |
| Input High Voltage            |                              | V <sub>IH</sub> <sup>(1)</sup> | -  | 0.8xV <sub>CC</sub> | -   | V <sub>CC</sub> +0.3 |      |
| Input Low Voltage, All inputs |                              | V <sub>IL</sub> <sup>(1)</sup> | -  | -0.3                | -   | 0.2xV <sub>CC</sub>  |      |
| Output High Voltage Level     |                              | V <sub>OH</sub>                | K9F2G08B0C: I <sub>OH</sub> =-100μA<br>K9F2G08U0C: I <sub>OH</sub> =-400μA       | 2.4                 | -   | -                    |      |
| Output Low Voltage Level      |                              | V <sub>OL</sub>                | K9F2G08B0C: I <sub>OL</sub> =100μA<br>K9F2G08U0C: I <sub>OL</sub> =2.1mA         | -                   | -   | 0.4                  |      |
| Output Low Current(R/B)       |                              | I <sub>OL</sub> (R/B)          | K9F2G08B0C: V <sub>OL</sub> =0.1V<br>K9F2G08U0C: V <sub>OL</sub> =0.4V           | 8                   | 10  | -                    | mA   |

noted.)

- NOTE : 1. V<sub>IL</sub> can undershoot to -0.4V and V<sub>IH</sub> can overshoot to V<sub>CC</sub> +0.4V for durations of 20 ns or less.  
2. Typical value is measured at V<sub>CC</sub>= 3.3V, T<sub>A</sub>=25°C. Not 100% tested.

## 2.4 VALID BLOCK

| Parameter  | Symbol | Min   | Typ. | Max   | Unit   |
|------------|--------|-------|------|-------|--------|
| K9F2G08X0C | NvB    | 2,008 | -    | 2,048 | 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/528Byte ECC.
3. The number of valid block is on the basis of single plane operations, and this may be decreased with two plane operations.

## 2.5 AC TEST CONDITION

(K9F2G08X0C-XCB0 :TA=0 to 70°C, K9F2G08X0C-XIB0:TA=-40 to 85°C,  
K9F2G08U0C: Vcc=2.7V~3.6V unless otherwise noted)

| Parameter                      | K9F2G08X0C             |
|--------------------------------|------------------------|
| Input Pulse Levels             | 0V to Vcc              |
| Input Rise and Fall Times      | 5ns                    |
| Input and Output Timing Levels | Vcc/2                  |
| Output Load                    | 1 TTL GATE and CL=50pF |

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

| Item                     | Symbol           | Test Condition      | Min | Max | Unit |
|--------------------------|------------------|---------------------|-----|-----|------|
| Input/Output Capacitance | C <sub>I/O</sub> | V <sub>IL</sub> =0V | -   | 10  | pF   |
| Input Capacitance        | C <sub>IN</sub>  | V <sub>IN</sub> =0V | -   | 10  | pF   |

NOTE : Capacitance is periodically sampled and not 100% tested.

## 2.7 MODE SELECTION

| CLE | ALE              | $\overline{\text{CE}}$ | $\overline{\text{WE}}$ | $\overline{\text{RE}}$ | $\overline{\text{WP}}$ | Mode                 |                       |
|-----|------------------|------------------------|------------------------|------------------------|------------------------|----------------------|-----------------------|
| H   | L                | L                      |                        | H                      | X                      | Read Mode            | Command Input         |
| L   | H                | L                      |                        | H                      | X                      |                      | Address Input(5clock) |
| H   | L                | L                      |                        | H                      | H                      | Write Mode           | Command Input         |
| L   | H                | L                      |                        | H                      | H                      |                      | Address Input(5clock) |
| L   | L                | L                      |                        | H                      | H                      | Data Input           |                       |
| L   | L                | L                      | H                      |                        | X                      | Data Output          |                       |
| X   | X                | X                      | X                      | H                      | X                      | During Read(Busy)    |                       |
| X   | X                | X                      | X                      | X                      | H                      | During Program(Busy) |                       |
| X   | X                | X                      | X                      | X                      | H                      | During Erase(Busy)   |                       |
| X   | X <sup>(1)</sup> | X                      | X                      | X                      | L                      | Write Protect        |                       |
| X   | X                | H                      | X                      | X                      | 0V/Vcc <sup>(2)</sup>  | Stand-by             |                       |

NOTE : 1. X can be V<sub>IL</sub> or V<sub>IH</sub>.

2.  $\overline{\text{WP}}$  should be biased to CMOS high or CMOS low for standby.

## 2.8 Program / Erase Characteristics

| Parameter                        | Symbol            | Min | Typ | Max | Unit   |
|----------------------------------|-------------------|-----|-----|-----|--------|
| Program Time                     | t <sub>PROG</sub> | -   | 250 | 750 | μs     |
| Number of Partial Program Cycles | Nop               | -   | -   | 4   | cycles |
| Block Erase Time                 | t <sub>BERS</sub> | -   | 2   | 10  | ms     |

## NOTE :

1. Typical value is measured at V<sub>cc</sub>=3.3V, T<sub>A</sub>=25°C. Not 100% tested.
2. Typical program time is defined as the time within which more than 50% of the whole pages are programmed at 3.3V V<sub>cc</sub> and 25°C temperature.

## 2.9 AC Timing Characteristics for Command / Address / Data Input

| Parameter                             | Symbol                          | Min | Max | Unit |
|---------------------------------------|---------------------------------|-----|-----|------|
| CLE Setup Time                        | t <sub>CLS</sub> <sup>(1)</sup> | 15  | -   | ns   |
| CLE Hold Time                         | t <sub>CLH</sub>                | 5   | -   | ns   |
| $\overline{\text{CE}}$ Setup Time     | t <sub>CS</sub> <sup>(1)</sup>  | 20  | -   | ns   |
| $\overline{\text{CE}}$ Hold Time      | t <sub>CH</sub>                 | 5   | -   | ns   |
| $\overline{\text{WE}}$ Pulse Width    | t <sub>WP</sub>                 | 15  | -   | ns   |
| ALE Setup Time                        | t <sub>ALS</sub> <sup>(1)</sup> | 15  | -   | ns   |
| ALE Hold Time                         | t <sub>ALH</sub>                | 5   | -   | ns   |
| Data Setup Time                       | t <sub>DS</sub> <sup>(1)</sup>  | 15  | -   | ns   |
| Data Hold Time                        | t <sub>DH</sub>                 | 5   | -   | ns   |
| Write Cycle Time                      | t <sub>WC</sub>                 | 30  | -   | ns   |
| $\overline{\text{WE}}$ High Hold Time | t <sub>WH</sub>                 | 10  | -   | ns   |
| Address to Data Loading Time          | t <sub>ADL</sub> <sup>(2)</sup> | 100 | -   | ns   |

NOTES : 1. The transition of the corresponding control pins must occur only once while  $\overline{\text{WE}}$  is held low

2. t<sub>ADL</sub> 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

## 2.10 AC Characteristics for Operation

| Parameter                                     | Symbol | Min | Max                     | Unit |
|---|--------|-----|-------------------------|------|
| Data Transfer from Cell to Register           | tr     | -   | 35                      | μs   |
| ALE to $\overline{RE}$ Delay                  | tAR    | 10  | -                       | ns   |
| CLE to $\overline{RE}$ Delay                  | tCLR   | 10  | -                       | ns   |
| Ready to $\overline{RE}$ Low                  | tRR    | 20  | -                       | ns   |
| $\overline{RE}$ Pulse Width                   | tRP    | 15  | -                       | ns   |
| $\overline{WE}$ High to Busy                  | tWB    | -   | 100                     | ns   |
| Read Cycle Time                               | tRC    | 30  | -                       | ns   |
| $\overline{RE}$ Access Time                   | tREA   | -   | 20                      | ns   |
| $\overline{CE}$ Access Time                   | tCEA   | -   | 25                      | ns   |
| $\overline{RE}$ High to Output Hi-Z           | tRHZ   | -   | 100                     | ns   |
| $\overline{CE}$ High to Output Hi-Z           | tCHZ   | -   | 30                      | ns   |
| $\overline{CE}$ High to ALE or CLE Don't Care | tCSD   | 0   | -                       | ns   |
| $\overline{RE}$ High to Output Hold           | tRHOH  | 15  | -                       | ns   |
| $\overline{RE}$ Low to Output Hold            | tRLOH  | 5   | -                       | ns   |
| $\overline{CE}$ High to Output Hold           | tCOH   | 15  | -                       | ns   |
| $\overline{RE}$ High Hold Time                | tREH   | 10  | -                       | ns   |
| Output Hi-Z to $\overline{RE}$ Low            | tIR    | 0   | -                       | ns   |
| $\overline{RE}$ High to $\overline{WE}$ Low   | tRHW   | 100 | -                       | ns   |
| $\overline{WE}$ High to $\overline{RE}$ Low   | tWHR   | 60  | -                       | ns   |
| Device Resetting Time(Read/Program/Erase)     | tRST   | -   | 5/10/500 <sup>(1)</sup> | μs   |

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

### 3.0 NAND Flash Technical Notes

#### 3.1 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/528Byte ECC**.

#### 3.2 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.

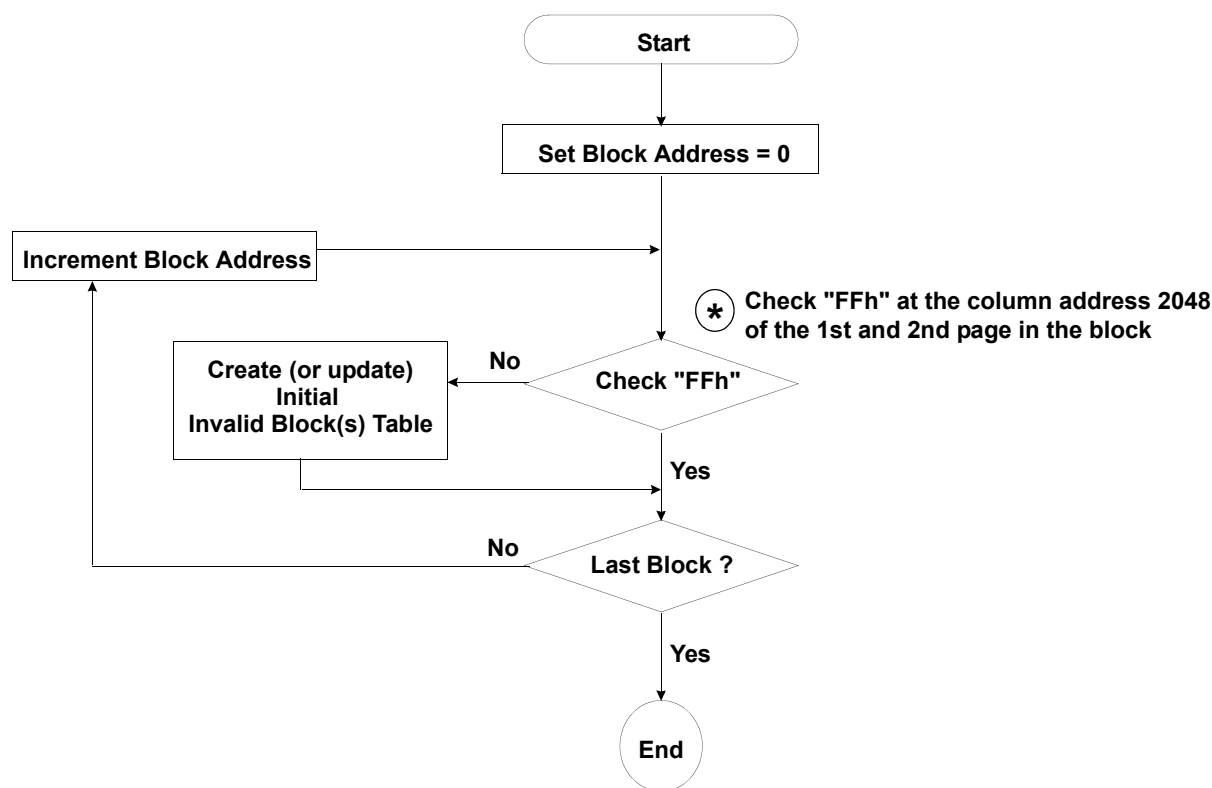


Figure 3. Flow chart to create initial invalid block table

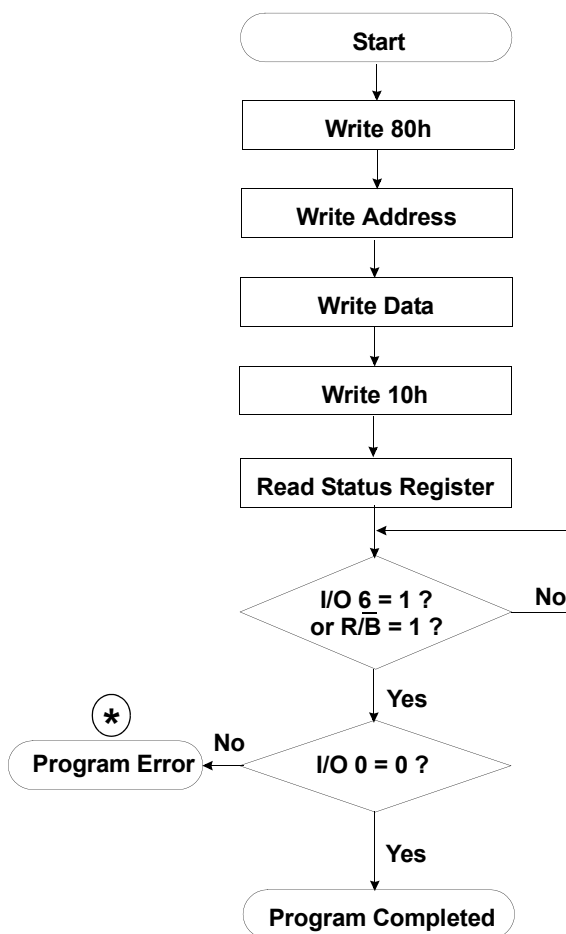
**NAND Flash Technical Notes** (Continued)**3.3 Error in write or read operation**

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.

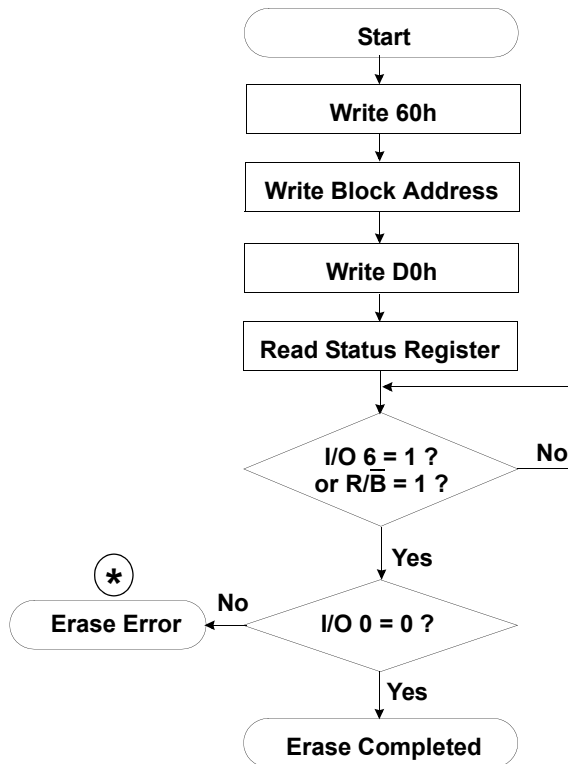
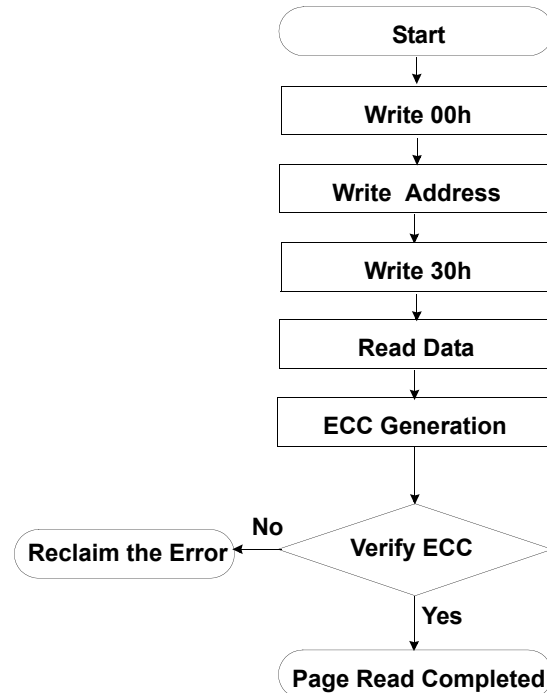
| Failure Mode |                    | Detection and Countermeasure sequence           |
|--------------|--------------------|---|
| Write        | Erase Failure      | Status Read after Erase --> Block Replacement   |
|              | Program Failure    | Status Read after Program --> Block Replacement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

**ECC**

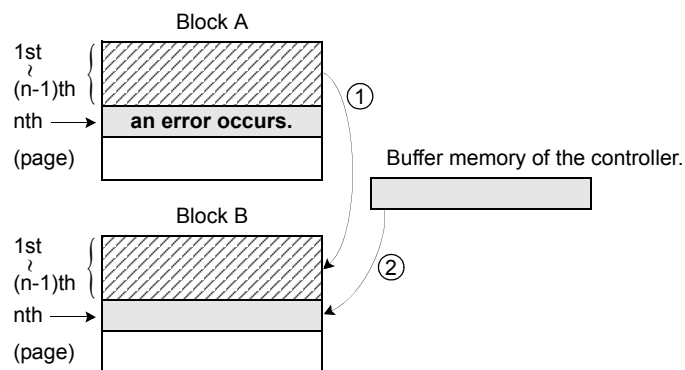
: Error Correcting Code --> Hamming Code etc.  
Example) 1bit correction & 2bit detection

**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.

\* Step2

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

\* Step3

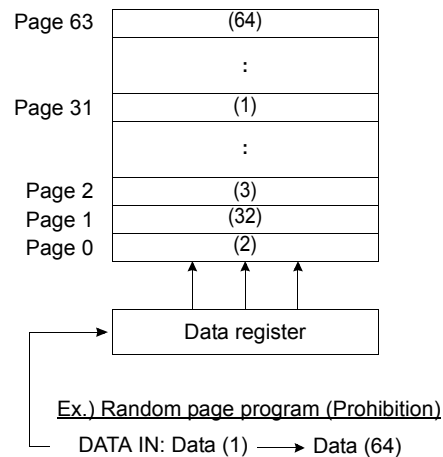
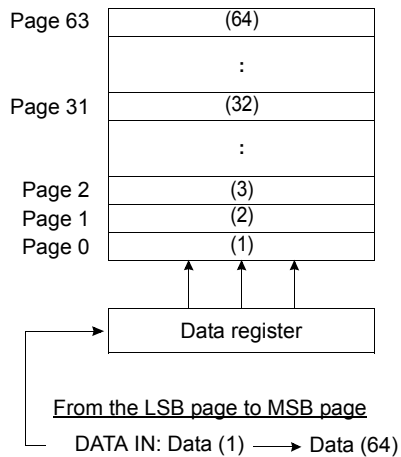
Then, copy the nth page data of the Block 'A' in the buffer memory to the nth page of the Block 'B'.

\* Step4

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

### 3.4 Addressing for program operation

Within a block, the pages must be programmed consecutively from the LSB(least significant bit) page of the block to the 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.





#### 4.0 System Interface Using CE don't-care.

For an easier system interface,  $\overline{CE}$  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  $\mu$ -seconds, de-activating  $\overline{CE}$  during the data-loading and serial access would provide significant savings in power consumption.

Figure 4. Program Operation with  $\overline{CE}$  don't-care.

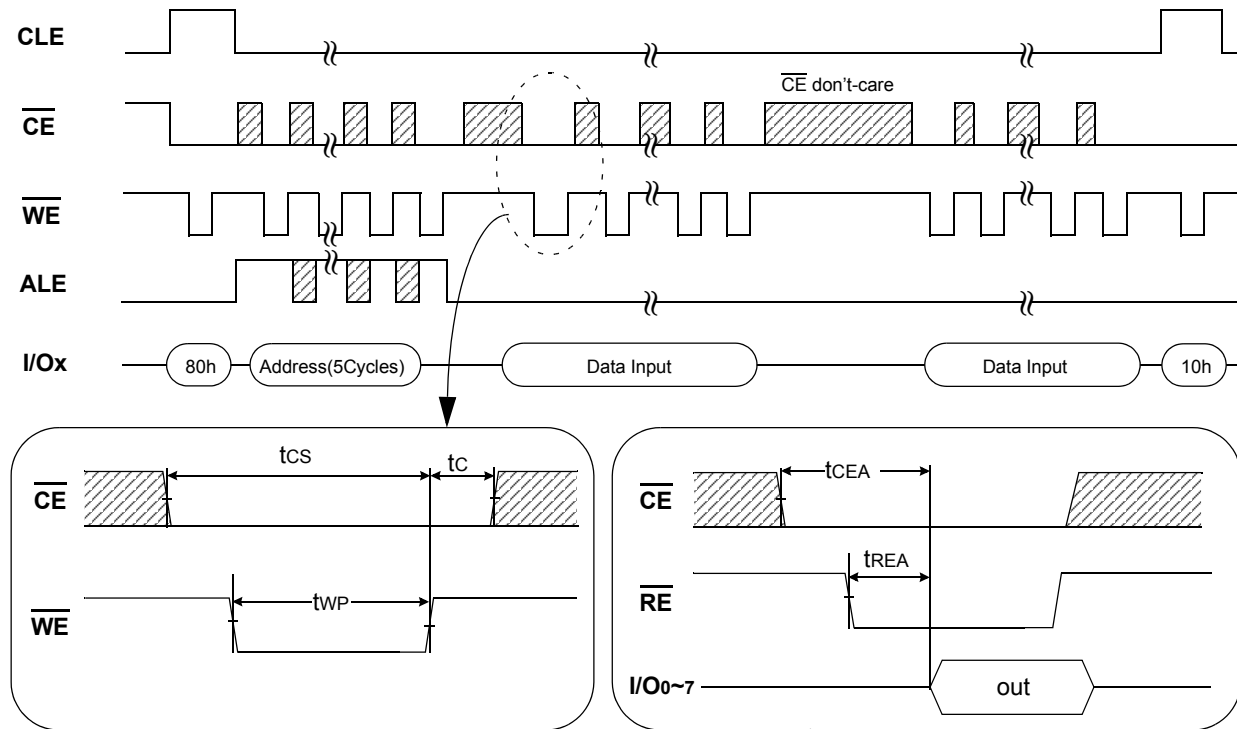
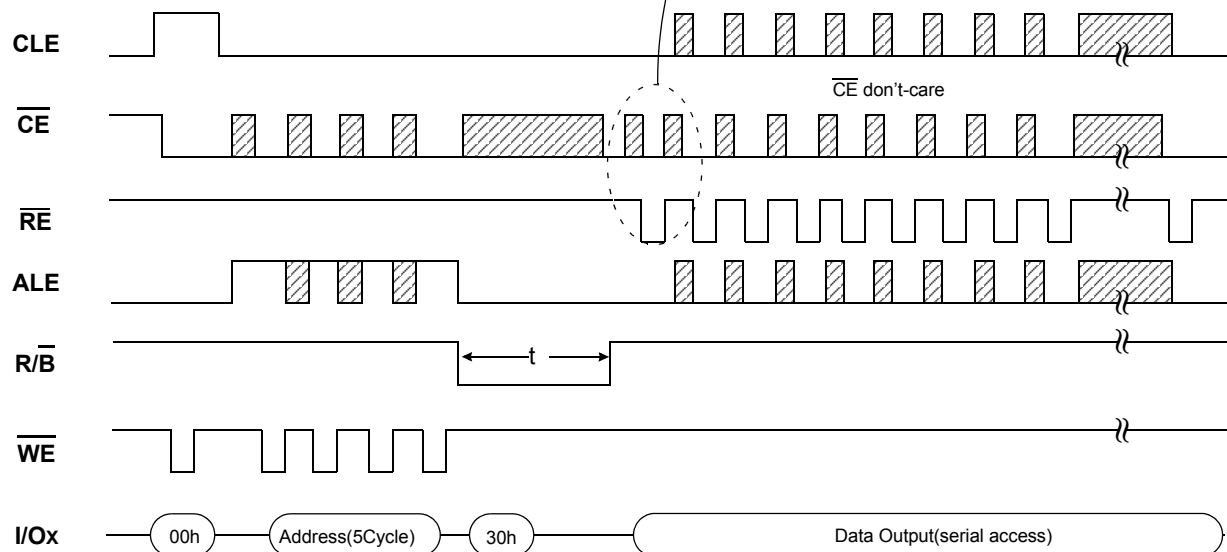


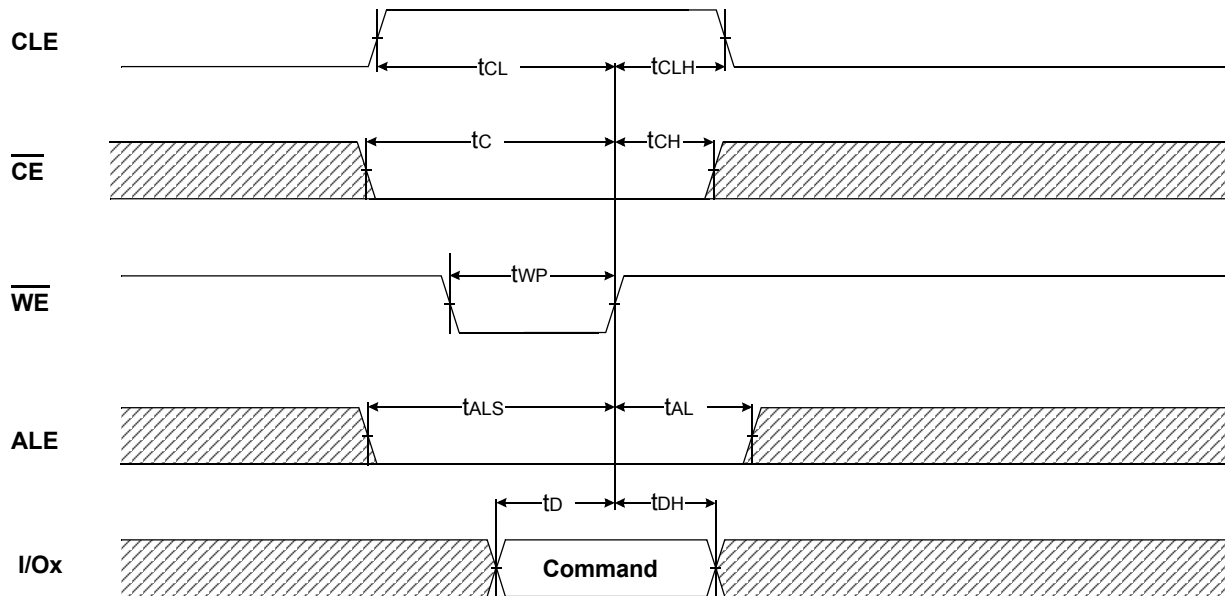
Figure 5. Read Operation with  $\overline{CE}$  don't-care.



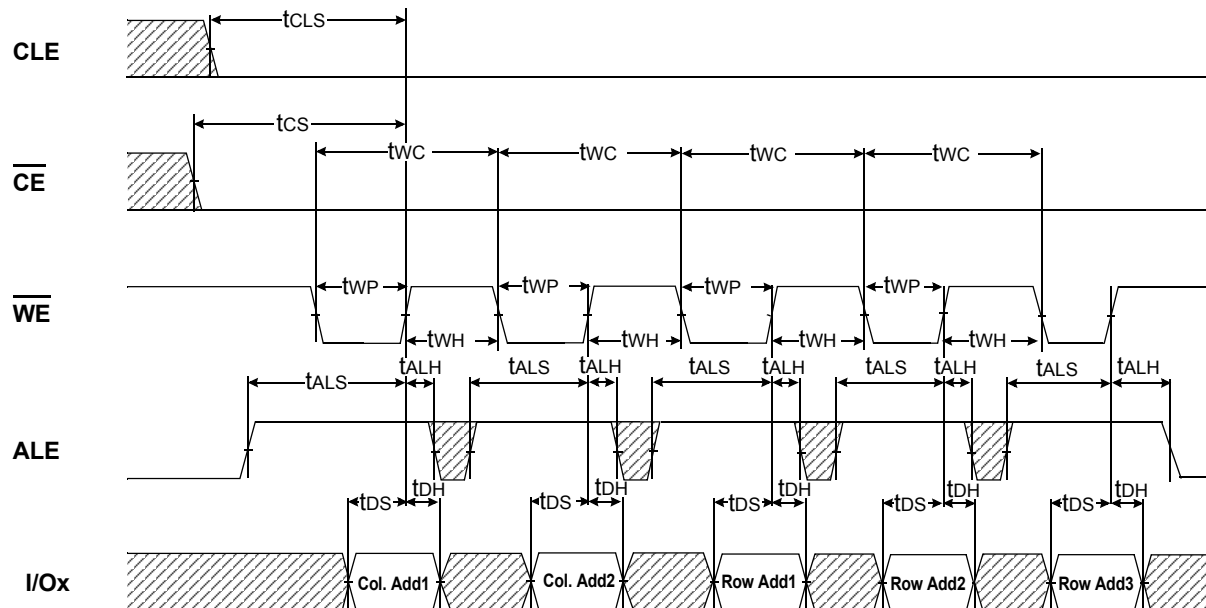
## NOTE

| Device     | I/O           | DATA        | ADDRESS   |           |          |          |          |
|------------|---------------|-------------|-----------|-----------|----------|----------|----------|
|            | I/Ox          | Data In/Out | Col. Add1 | Col. Add2 | Row Add1 | Row Add2 | Row Add3 |
| K9F2G08X0B | I/O 0 ~ I/O 7 | 2,112byte   | A0~A7     | A8~A11    | A12~A19  | A20~A27  | A28      |

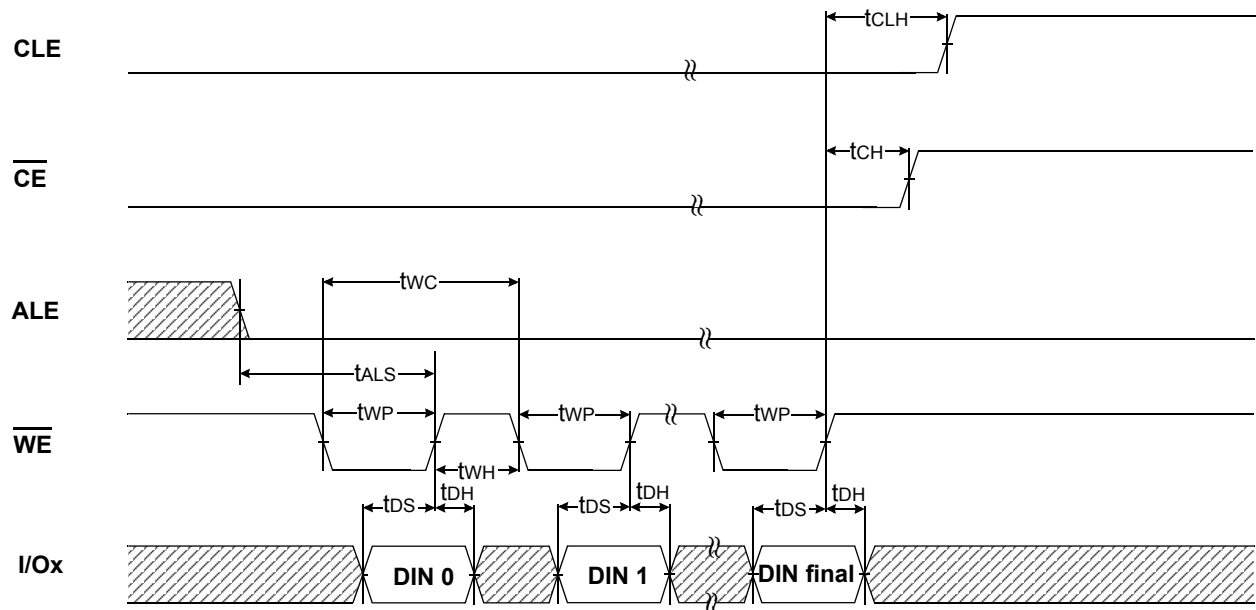
## 4.1 Command Latch Cycle



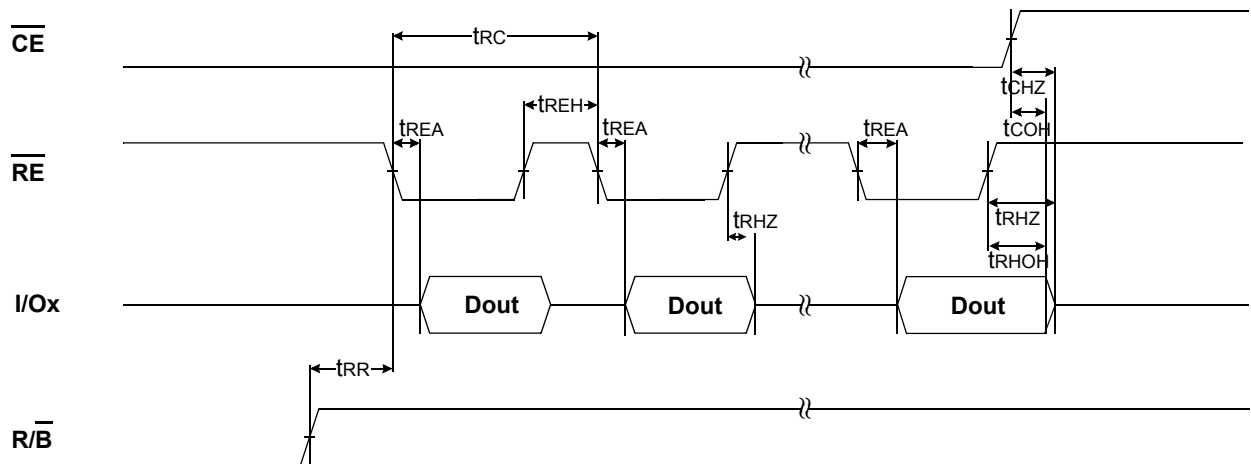
## 4.2 Address Latch Cycle



## 4.3 Input Data Latch Cycle

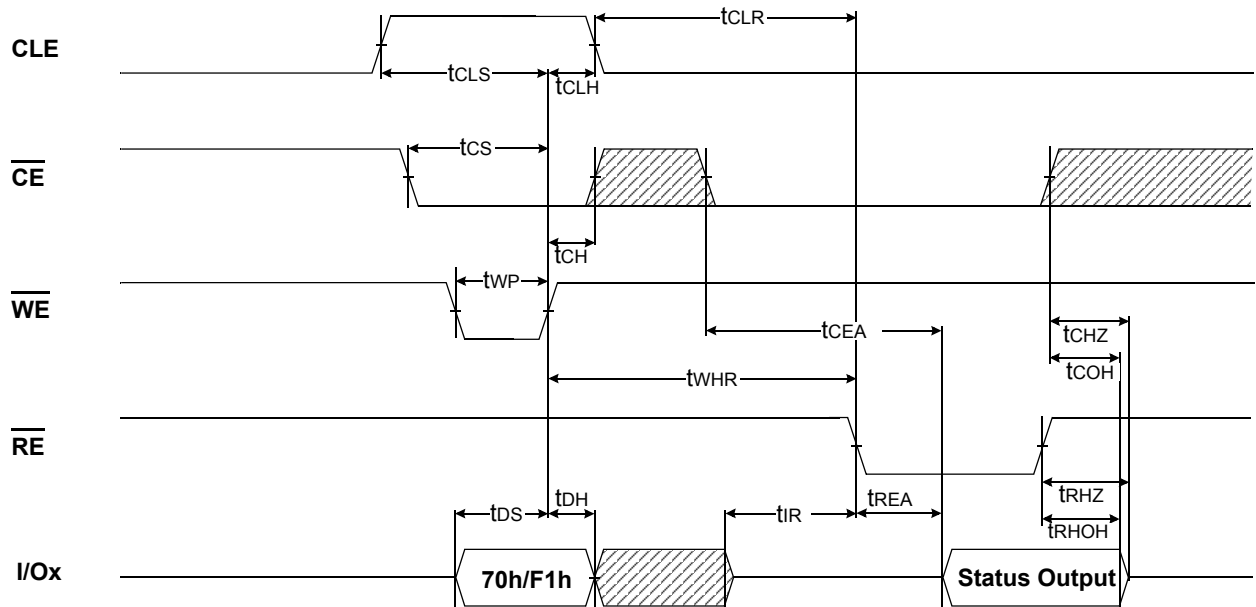


\* Serial Access Cycle after Read (CLE=L, WE=H, ALE=L)

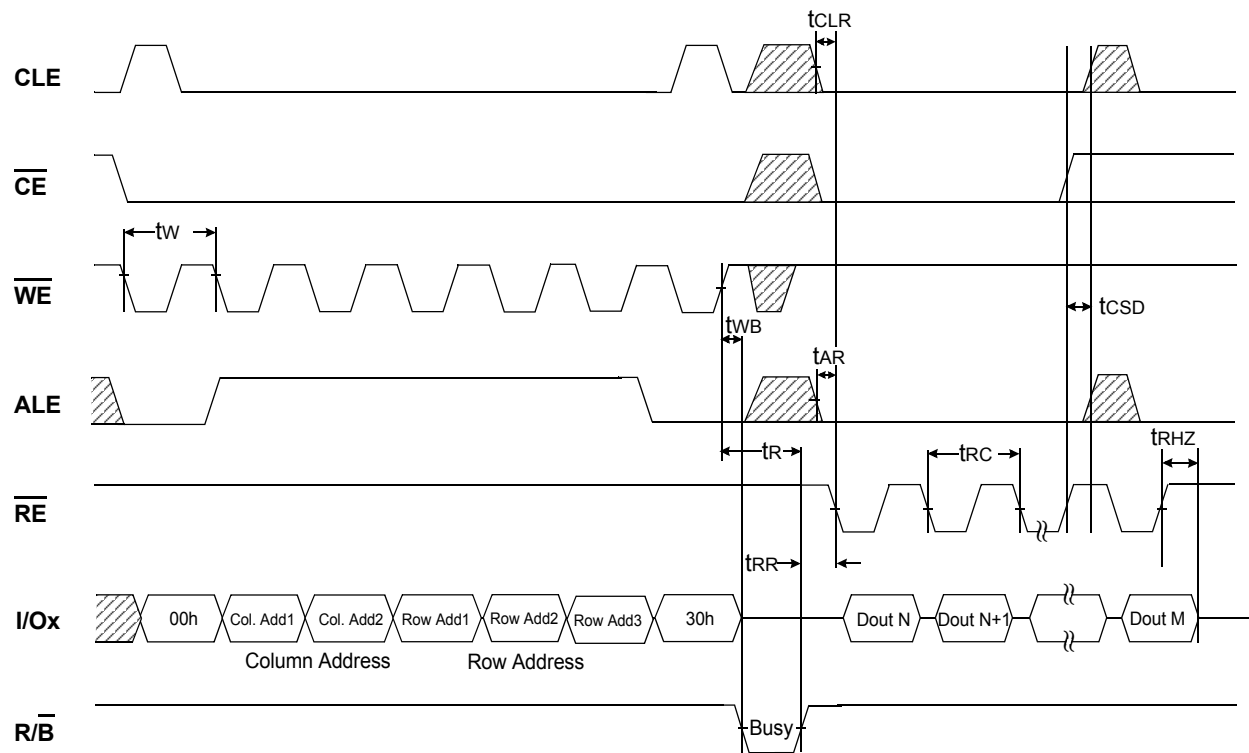


NOTES : Transition is measured at  $\pm 200\text{mV}$  from steady state voltage with load.  
 This parameter is sampled and not 100% tested.  
 $t_{RLOH}$  is valid when frequency is higher than 33MHz.  
 $t_{RHOH}$  starts to be valid when frequency is lower than 33MHz.

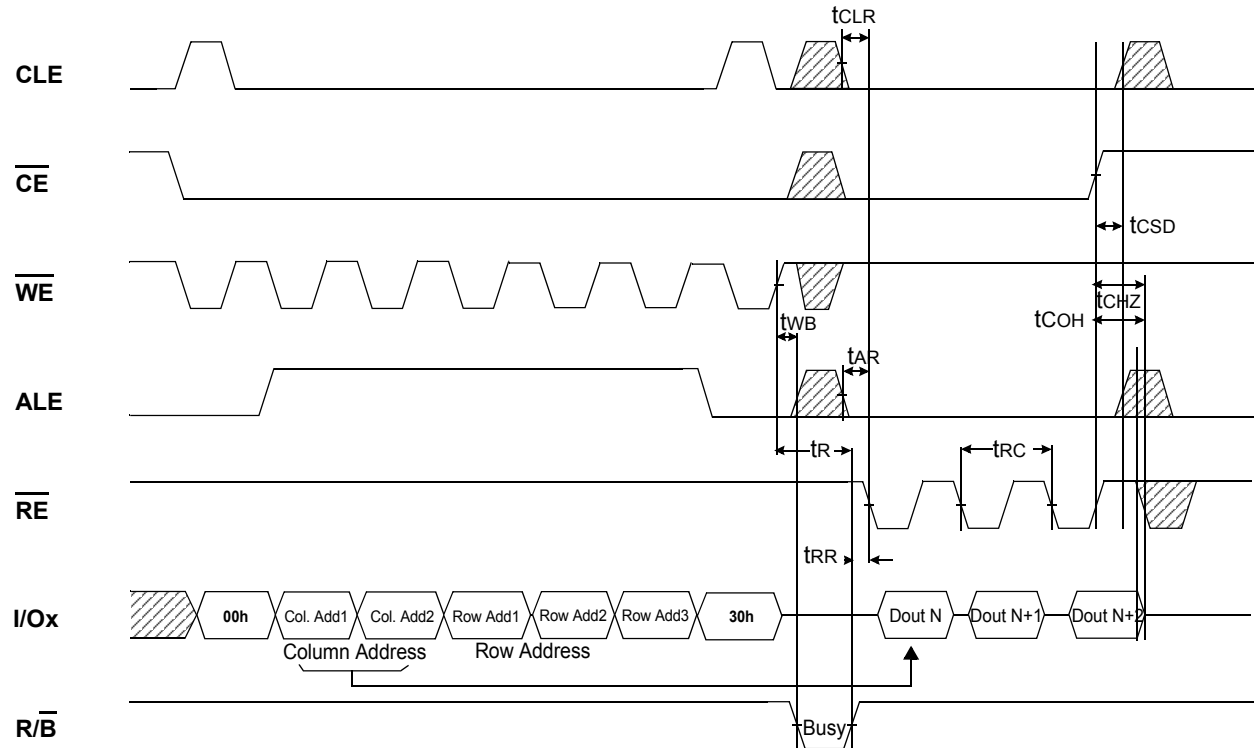
## 4.4 Status Read Cycle



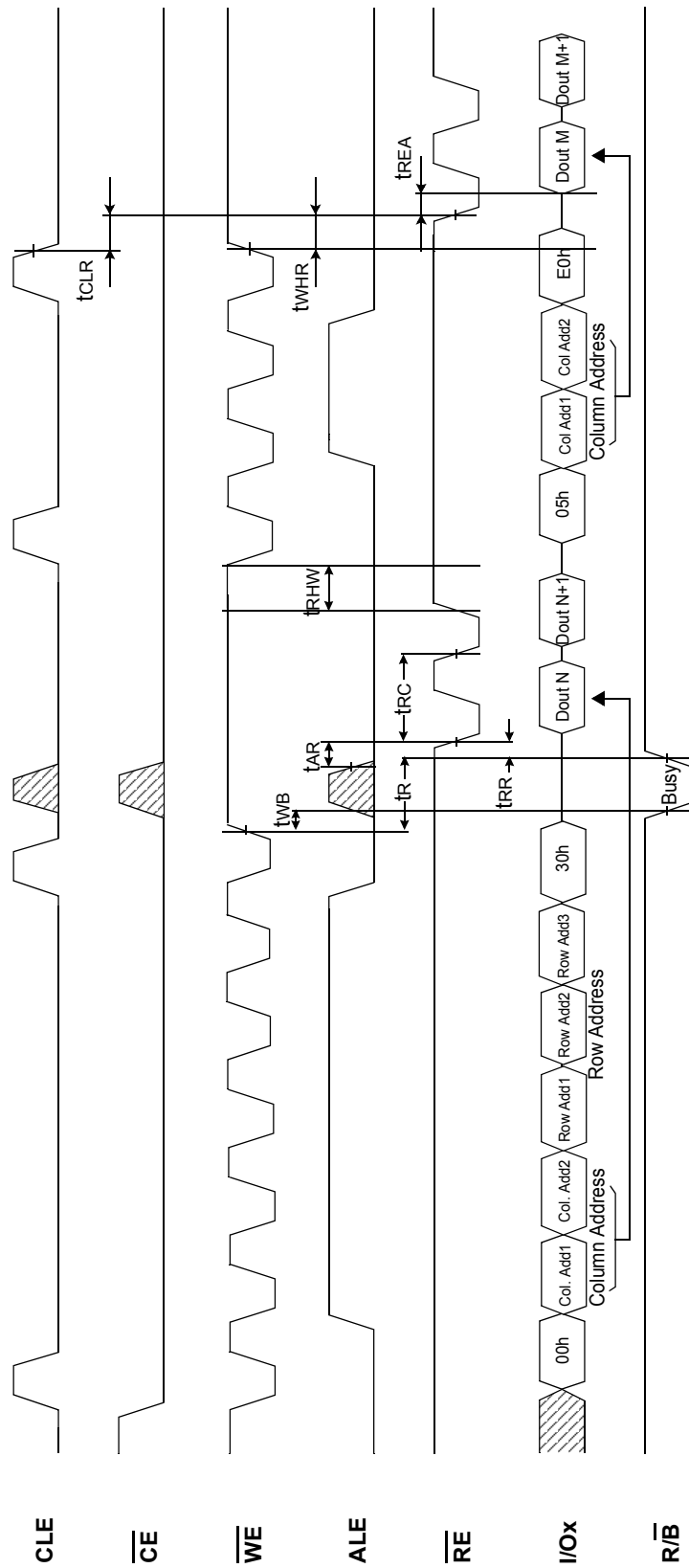
## 4.5 Read Operation



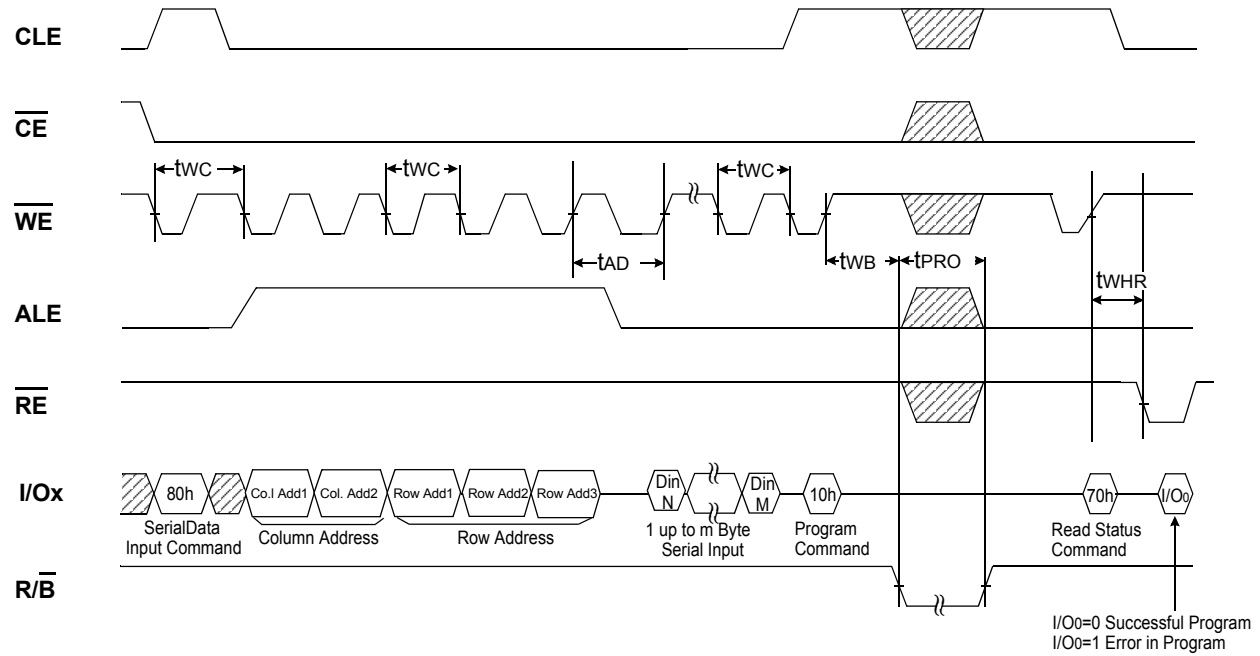
## 4.6 Read Operation (Intercepted by CE)



## 4.7 Random Data Output In a Page



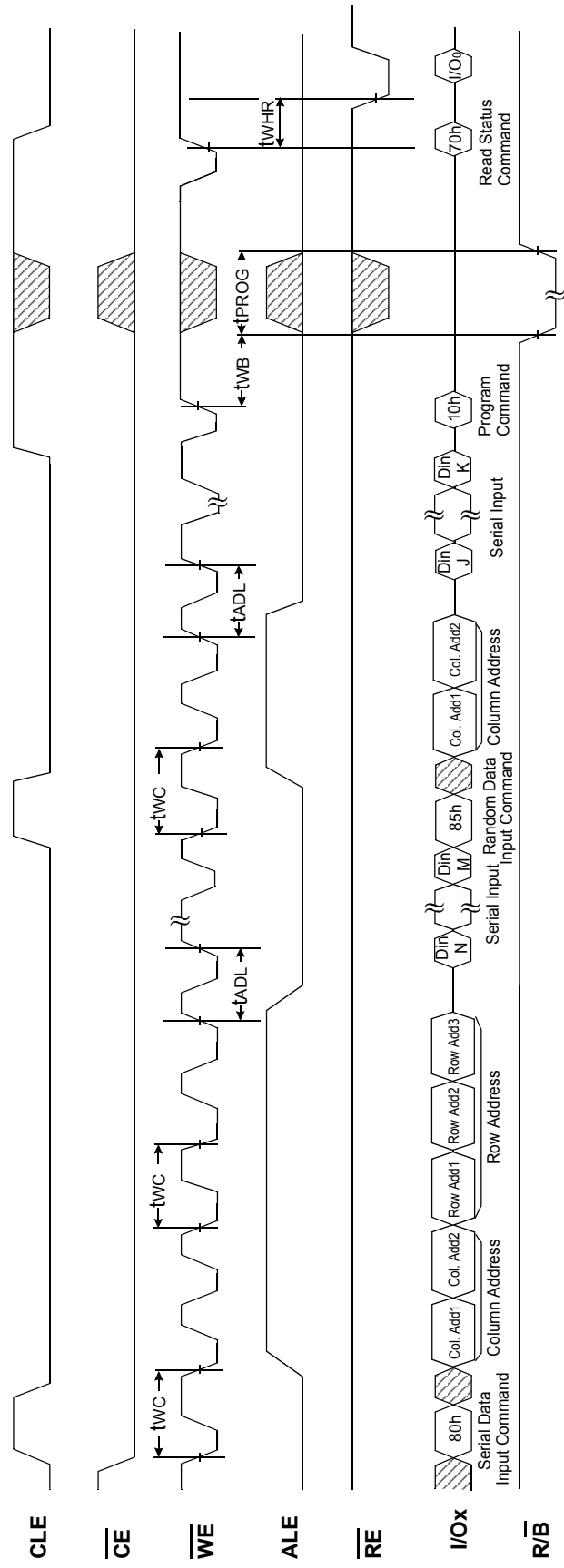
## 4.8 Page Program Operation



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

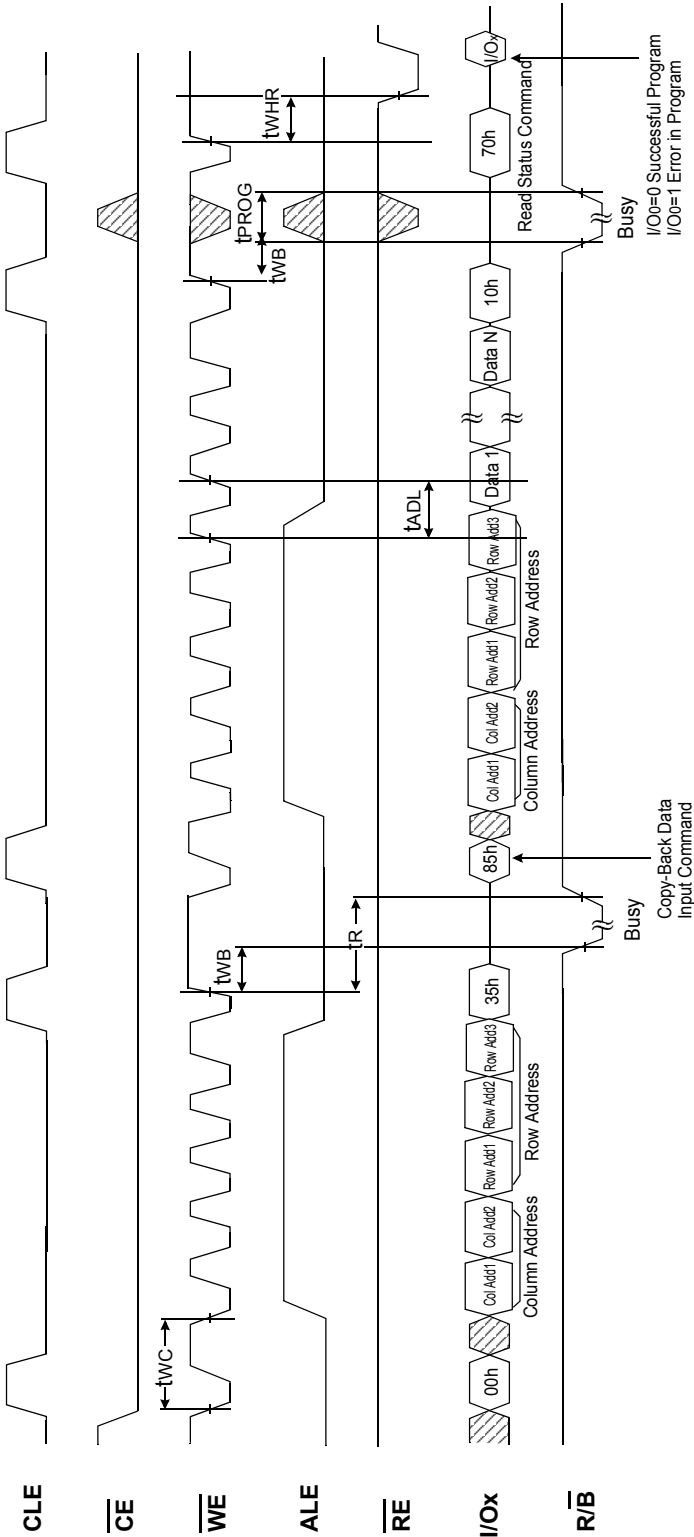


4.9 Page Program Operation with Random Data Input



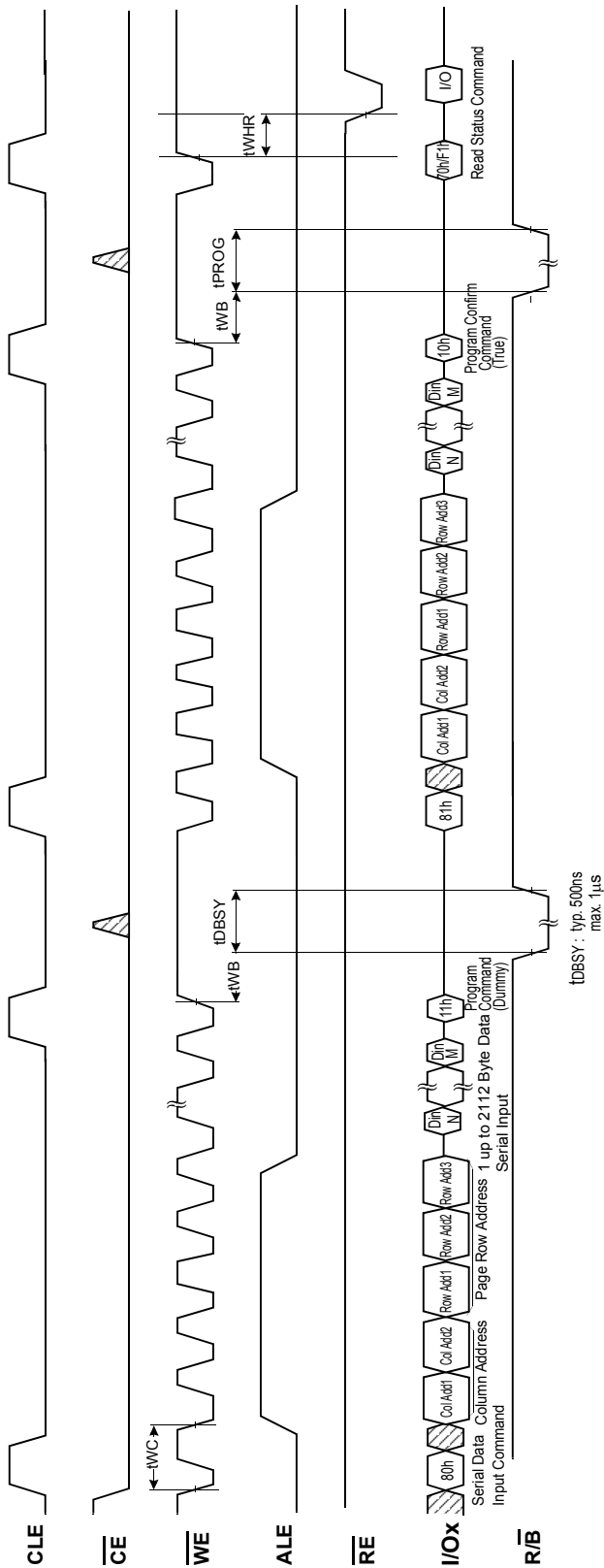
NOTES : tADL is the time from the WE rising edge of final address cycle to the WE rising edge of first data cycle.

4.10 Copy-Back Program Operation With Random Data Input

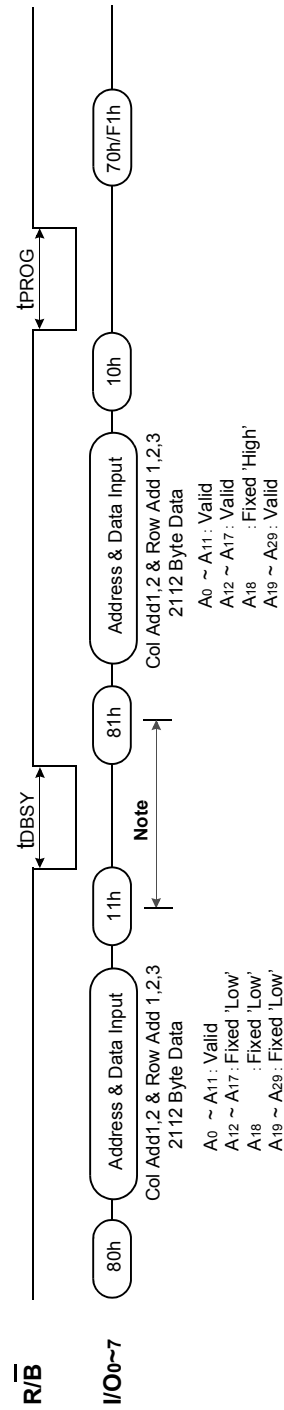


NOTES : tADL is the time from the  $\overline{WE}$  rising edge of final address cycle to the  $\overline{WE}$  rising edge of first data cycle.

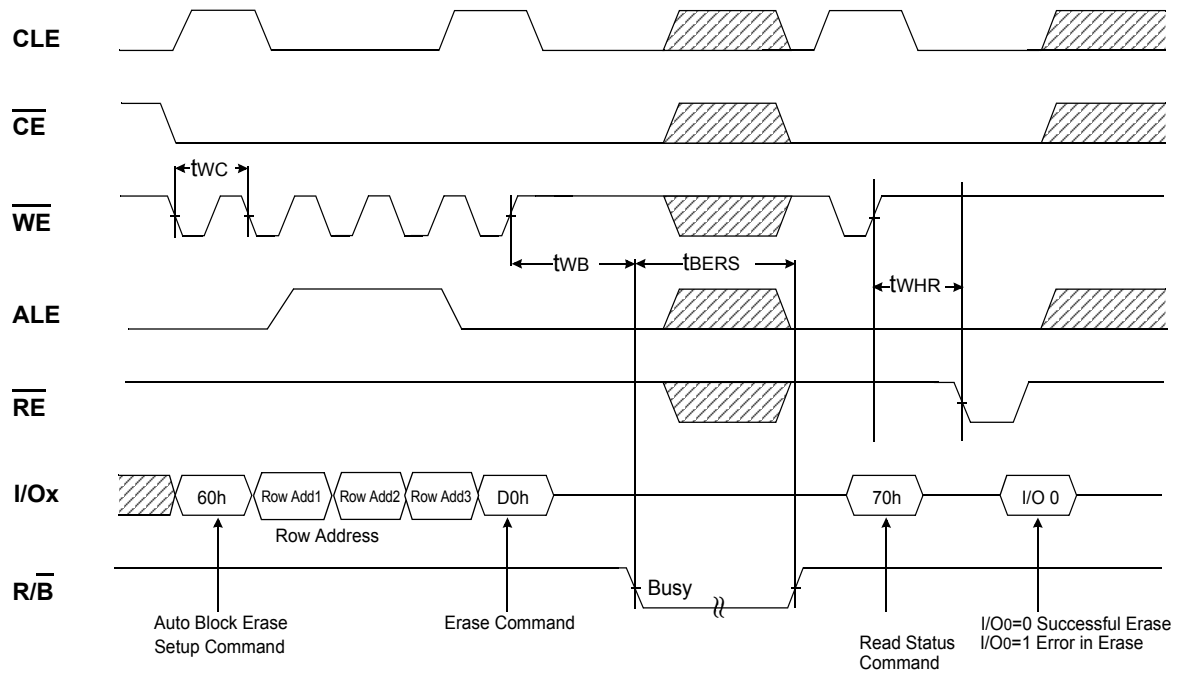
4.11 Two-Plane Page Program operatoin



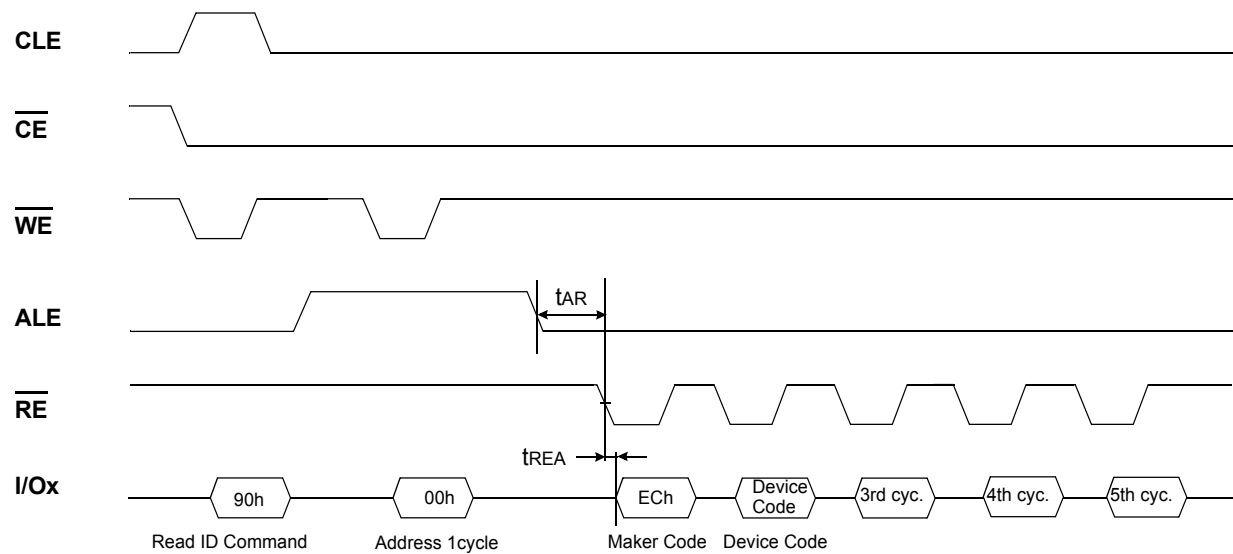
Ex.) Two-Plane Page Program



## 4.12 Block Erase Operation



4.13 Read ID Operation



| Device     | Device Code (2nd Cycle) | 3rd Cycle | 4th Cycle | 5th Cycle |
|------------|-------------------------|-----------|-----------|-----------|
| K9F2G08U0C | DAh                     | 10h       | 15h       | 44h       |

## ID Definition Table

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

## 3rd ID Data

|   | Description   | I/O7 | I/O6 | I/O5 | I/O4 | I/O3 | I/O2 | I/O1 | I/O0 |
|---|---------------|------|------|------|------|------|------|------|------|
| Internal Chip Number                      | 1             |      |      |      |      |      |      | 0    | 0    |
|   | 2             |      |      |      |      |      |      | 0    | 1    |
|   | 4             |      |      |      |      |      |      | 1    | 0    |
|   | 8             |      |      |      |      |      |      | 1    | 1    |
| Cell Type                                 | 2 Level Cell  |      |      |      |      | 0    | 0    |      |      |
|   | 4 Level Cell  |      |      |      |      | 0    | 1    |      |      |
|   | 8 Level Cell  |      |      |      |      | 1    | 0    |      |      |
|   | 16 Level Cell |      |      |      |      | 1    | 1    |      |      |
| Number of Simultaneously Programmed Pages | 1             |      |      | 0    | 0    |      |      |      |      |
|   | 2             |      |      | 0    | 1    |      |      |      |      |
|   | 4             |      |      | 1    | 0    |      |      |      |      |
|   | 8             |      |      | 1    | 1    |      |      |      |      |
| Interleave Program Between multiple chips | Not Support   |      | 0    |      |      |      |      |      |      |
|   | Support       |      | 1    |      |      |      |      |      |      |
| Cache Program                             | Not Support   | 0    |      |      |      |      |      |      |      |
|   | Support       | 1    |      |      |      |      |      |      |      |

## 4th ID Data

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

## 5th ID Data

|                                    | Description | I/O7 | I/O6 | I/O5 | I/O4 | I/O3 | I/O2 | I/O1 | I/O0 |
|------------------------------------|-------------|------|------|------|------|------|------|------|------|
| Plane Number                       | 1           |      |      |      |      | 0    | 0    |      |      |
|                                    | 2           |      |      |      |      | 0    | 1    |      |      |
|                                    | 4           |      |      |      |      | 1    | 0    |      |      |
|                                    | 8           |      |      |      |      | 1    | 1    |      |      |
| Plane Size<br>(w/o redundant Area) | 64Mb        |      | 0    | 0    | 0    |      |      |      |      |
|                                    | 128Mb       |      | 0    | 0    | 1    |      |      |      |      |
|                                    | 256Mb       |      | 0    | 1    | 0    |      |      |      |      |
|                                    | 512Mb       |      | 0    | 1    | 1    |      |      |      |      |
|                                    | 1Gb         |      | 1    | 0    | 0    |      |      |      |      |
|                                    | 2Gb         |      | 1    | 0    | 1    |      |      |      |      |
|                                    | 4Gb         |      | 1    | 1    | 0    |      |      |      |      |
|                                    | 8Gb         |      | 1    | 1    | 1    |      |      |      |      |
| Reserved                           |             | 0    |      |      |      |      |      | 0    | 0    |

## 5.0 Device Operation

### 5.1 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  $35\mu\text{s}(t_R)$ . The system controller can detect the completion of this data transfer( $t_R$ ) 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  $30\text{ns}$  cycle time by sequentially pulsing RE. The repetitive high to low transitions of the 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**

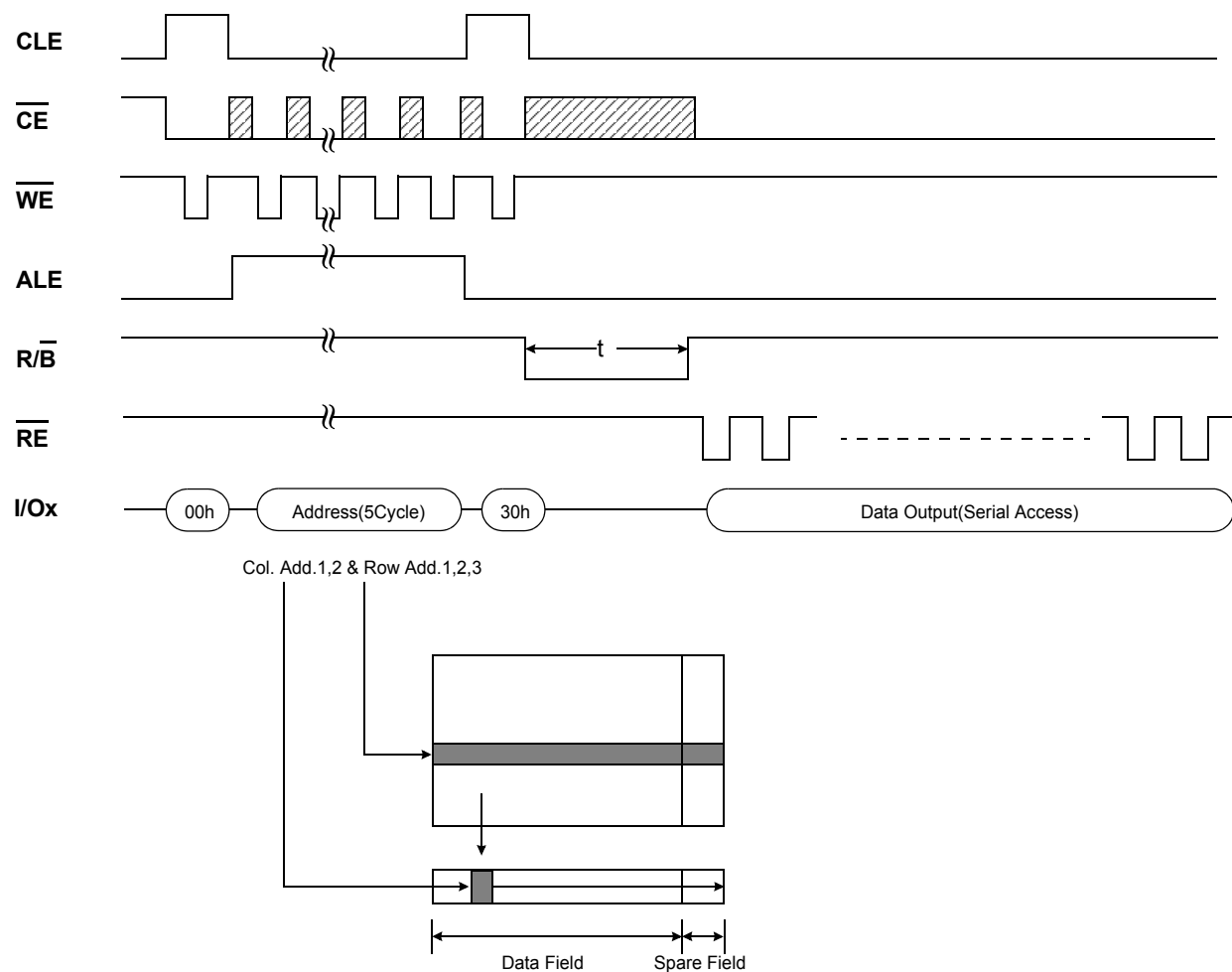
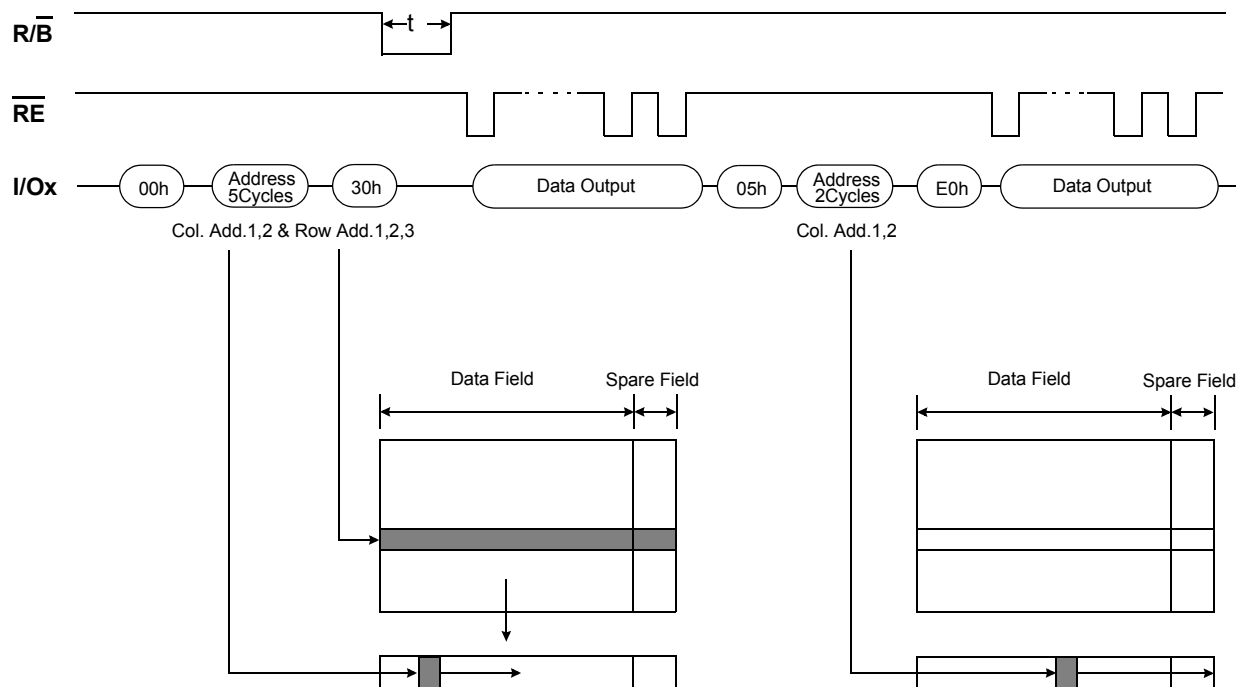




Figure 7. Random Data Output In a Page



## 5.2 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 2,112 bytes 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. 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 &amp; Read Status Operation

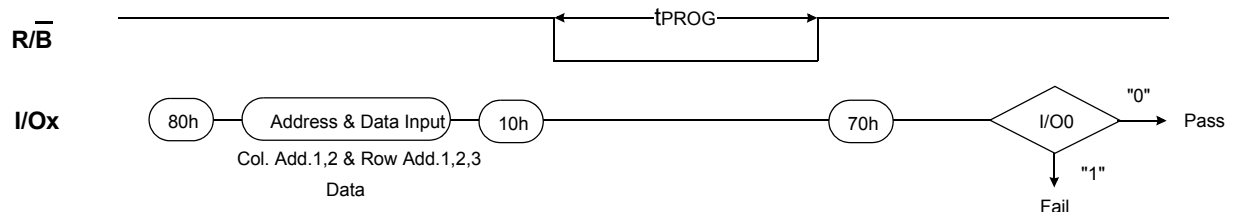
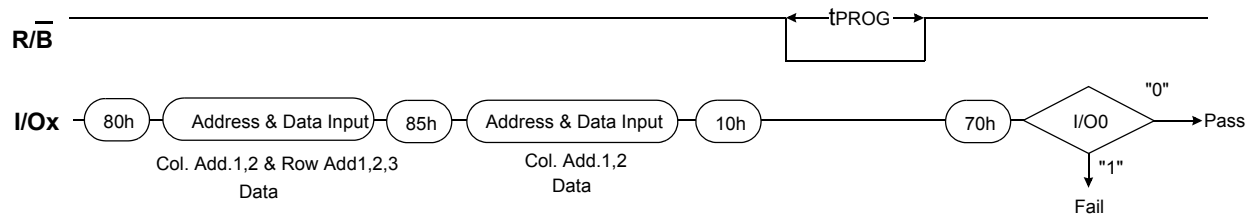


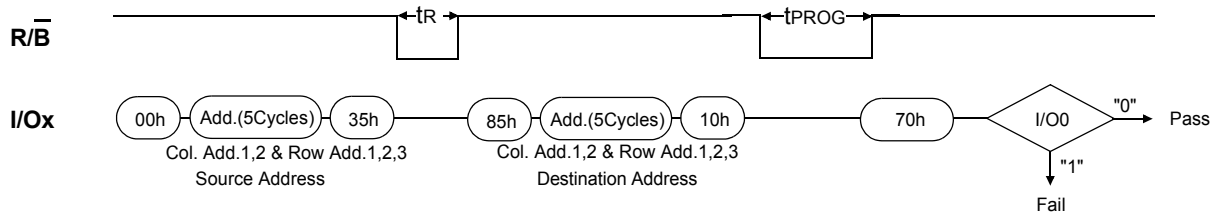
Figure 9. Random Data Input In a Page



### 5.3 Copy-Back Program

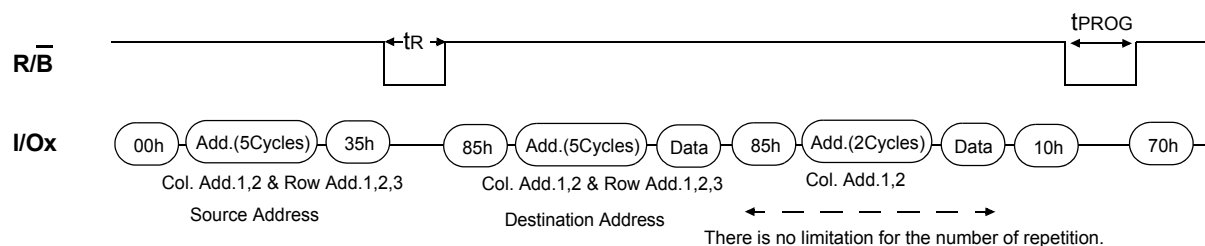
Copy-Back program with Read for Copy-Back is configured to quickly and efficiently rewrite data stored in one page without data re-loading when the bit error is not in data stored. Since the time-consuming re-loading cycles are removed, the system performance is improved. The benefit is especially obvious when a portion of a block is updated and the rest of the block also needs to be copied to the newly assigned free block. Copy-Back operation is a sequential execution of Read for Copy-Back and of copy-back program with the destination page address. 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. A bit error is checked by sequential reading the data output. In the case where there is no bit error, the data do not need to be reloaded. Therefore Copy-Back program operation is initiated by issuing Page-Copy Data-Input command (85h) with destination page address. Actual programming operation begins after Program Confirm command (10h) is issued. Once the program process starts, the Read Status Register command (70h) 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) may be checked(Figure 10 & Figure 11). The command register remains in Read 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.

Figure 10. Page Copy-Back Program Operation



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

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



## 5.4 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/F1h 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 and Table 4 for specific F1h 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. Read Status Register Definition for 70h Command

| I/O   | Page Program  | Block Erase   | Read          | Definition                               |
|-------|---------------|---------------|---------------|--|
| 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 : I/Os defined 'Not use' are recommended to be masked out when Read Status is being executed.

Table 4. Read Status 2 Register Definition for F1h Command

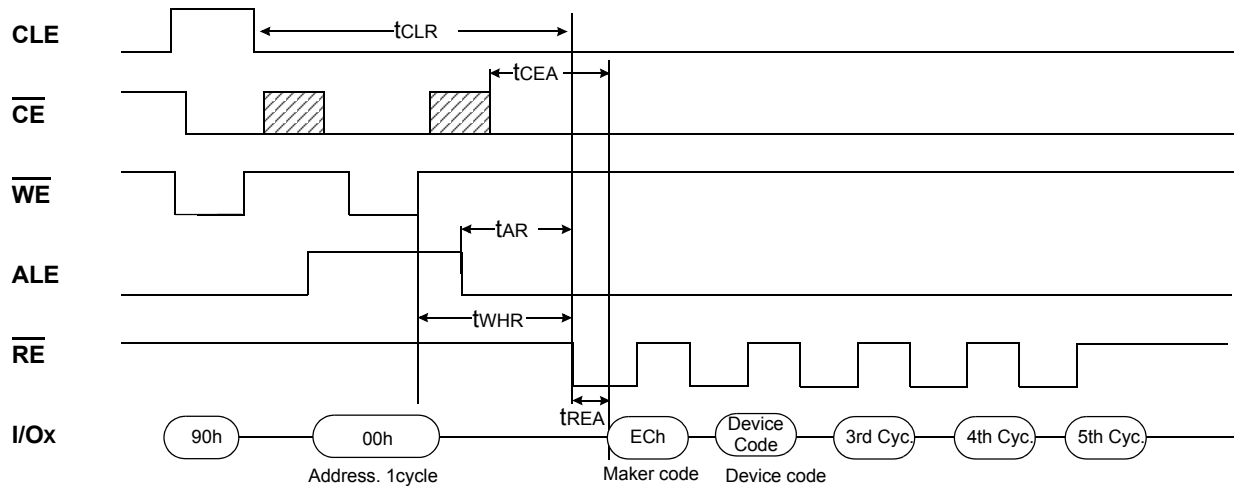
| I/O No. | Page Program     | Block Erase      | Read          | Definition                               |
|---------|------------------|------------------|---------------|--|
| I/O 0   | Chip Pass/Fail   | Chip Pass/Fail   | Not use       | Pass : "0"      Fail : "1"               |
| I/O 1   | Plane0 Pass/Fail | Plane0 Pass/Fail | Not use       | Pass : "0"      Fail : "1"               |
| I/O 2   | Plane1 Pass/Fail | Plane1 Pass/Fail | Not use       | Pass : "0"      Fail : "1"               |
| 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 : I/Os defined 'Not use' are recommended to be masked out when Read Status is being executed.

5.5 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 17. Read ID Operation



| Device     | Device Code (2nd Cycle) | 3rd Cycle | 4th Cycle | 5th Cycle |
|------------|-------------------------|-----------|-----------|-----------|
| K9F2G08U0C | DAh                     | 10h       | 15h       | 44h       |

5.6 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/B pin changes to low for tRST after the Reset command is written. Refer to Figure 19 below.

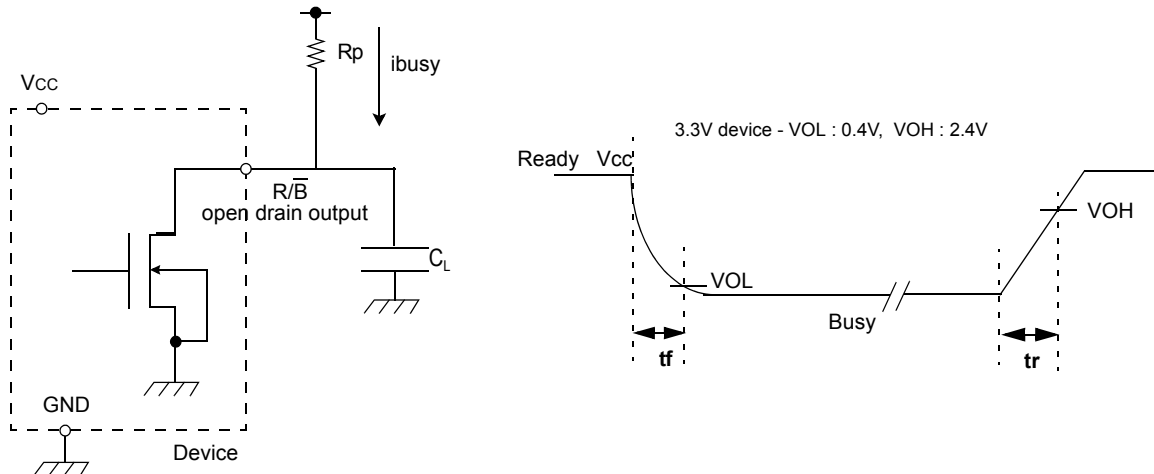
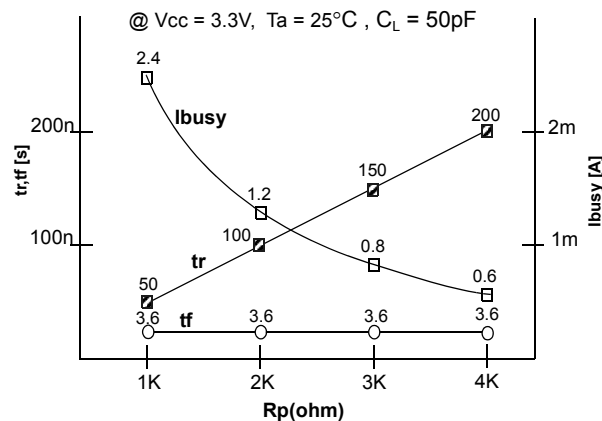
Figure 18. RESET Operation



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

## 5.7 READY/BUSY

The device has a  $\overline{R/B}$  output that provides a hardware method of indicating the completion of a page program, erase and random read completion. The  $\overline{R/B}$  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  $\overline{R/B}$  outputs to be Or-tied. Because pull-up resistor value is related to  $t_r(\overline{R/B})$  and current drain during busy( $i_{\text{busy}}$ ), an appropriate value can be obtained with the following reference chart(Fig.19). Its value can be determined by the following guidance.

Figure 19.  $R_p$  vs  $t_r$ ,  $t_f$  &  $R_p$  vs  $i_{\text{busy}}$  **$R_p$  value guidance**

$$R_p(\text{min, 3.3V part}) = \frac{V_{\text{cc}}(\text{Max.}) - V_{\text{OL}}(\text{Max.})}{I_{\text{OL}} + \Sigma I_L} = \frac{3.2\text{V}}{8\text{mA} + \Sigma I_L}$$

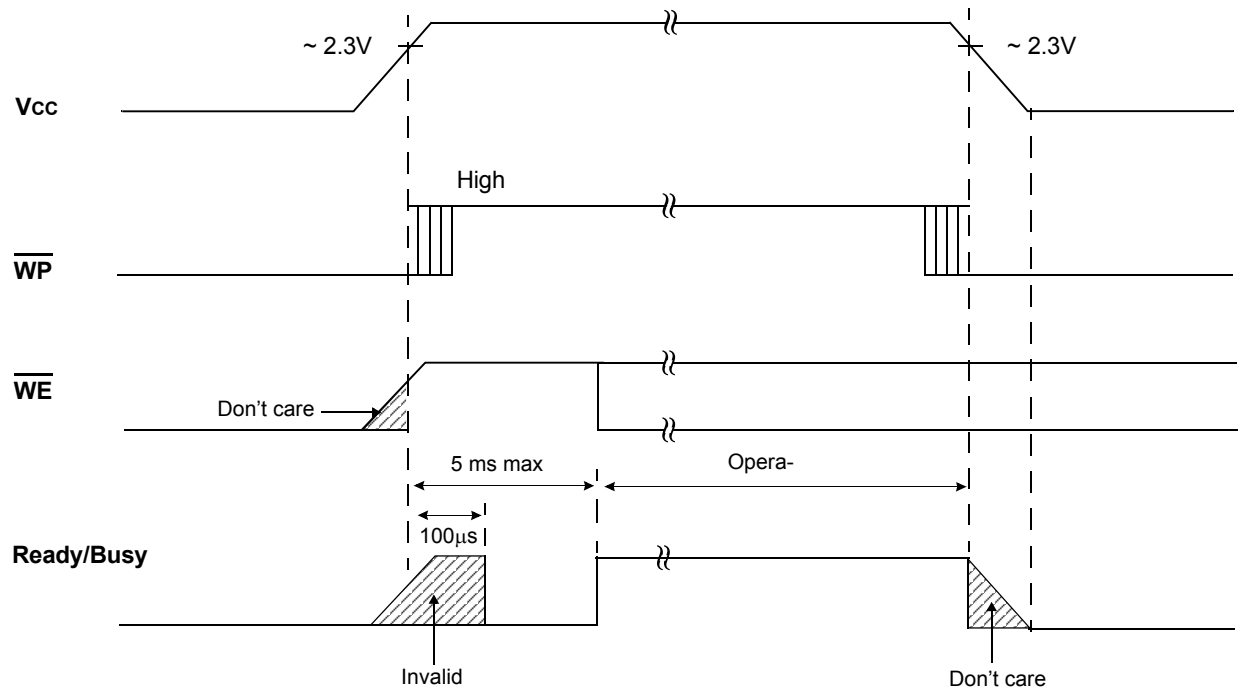
where  $I_L$  is the sum of the input currents of all devices tied to the  $\overline{R/B}$  pin.

$R_p(\text{max})$  is determined by maximum permissible limit of  $t_r$

## 6.0 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  $V_{CC}$  is below about 2V(3.3V device).  $\overline{WP}$  pin provides hardware protection and is recommended to be kept at  $V_{IL}$  during power-up and power-down. A recovery time of minimum 100 $\mu$ s is required before internal circuit gets ready for any command sequences as shown in Figure 20. The two step command sequence for program/erase provides additional software protection.

Figure 19. AC Waveforms for Power Transition



Note :During the initialization, the device consumes a maximum current of 30mA (ICC1)

## 7.0 Backward Compatibility Information

The below table shows key parameters which are different with previous product, so that the host could use make or modify its firmware without misunderstanding of compatibility. But the below table don't have all the difference with previous product, but only key parameters' changing which can be defined to have an effect on developing NAND firmware or hardware.

|                                  | Previous Generation Product  | Current Generation Device  |
|----------------------------------|--|--|
| <b>Part ID</b>                   | <b>K9F2G08U0B</b>  | <b>K9F2G08U0C</b>  |
| <b>Features &amp; Operations</b> | 1. tR: 25us / tPROG(200us typ, 700us Max)<br>tERS(1.5ms Typ, 10ms Max)<br>2. tRC/tWC: 25ns<br>3. 2 Plane Program: support<br>4. 2Plane Copy-back Program: Support<br>5. 2Plane Erase: Support<br>6. EDO: Support | 1. tR: 35us / tPROG(250us typ, 750us Max)<br>tERS(2ms Typ, 10ms Max)<br>2. tRC/tWC: 30ns<br>3. 2 Plane Program: support<br>4. 2Plane Copy-back Program: N/A<br>5. 2Plane Erase: Support<br>6. EDO: N/A |
| <b>AC &amp; DC Parameters</b>    | 1. ICC1 : 15mA(typ)/ 30mA(max)<br>2. ICC2 : 15mA(typ)/ 30mA(max)<br>3. ICC3 : 15mA(typ)/ 30mA(max)   | 1. ICC1 : 20mA(typ)/ 35mA(max)<br>2. ICC2 : 20mA(typ)/ 35mA(max)<br>3. ICC3 : 20mA(typ)/ 35mA(max)   |
| <b>Technical Notes</b>           |  |  |