



# ECC Algorithm

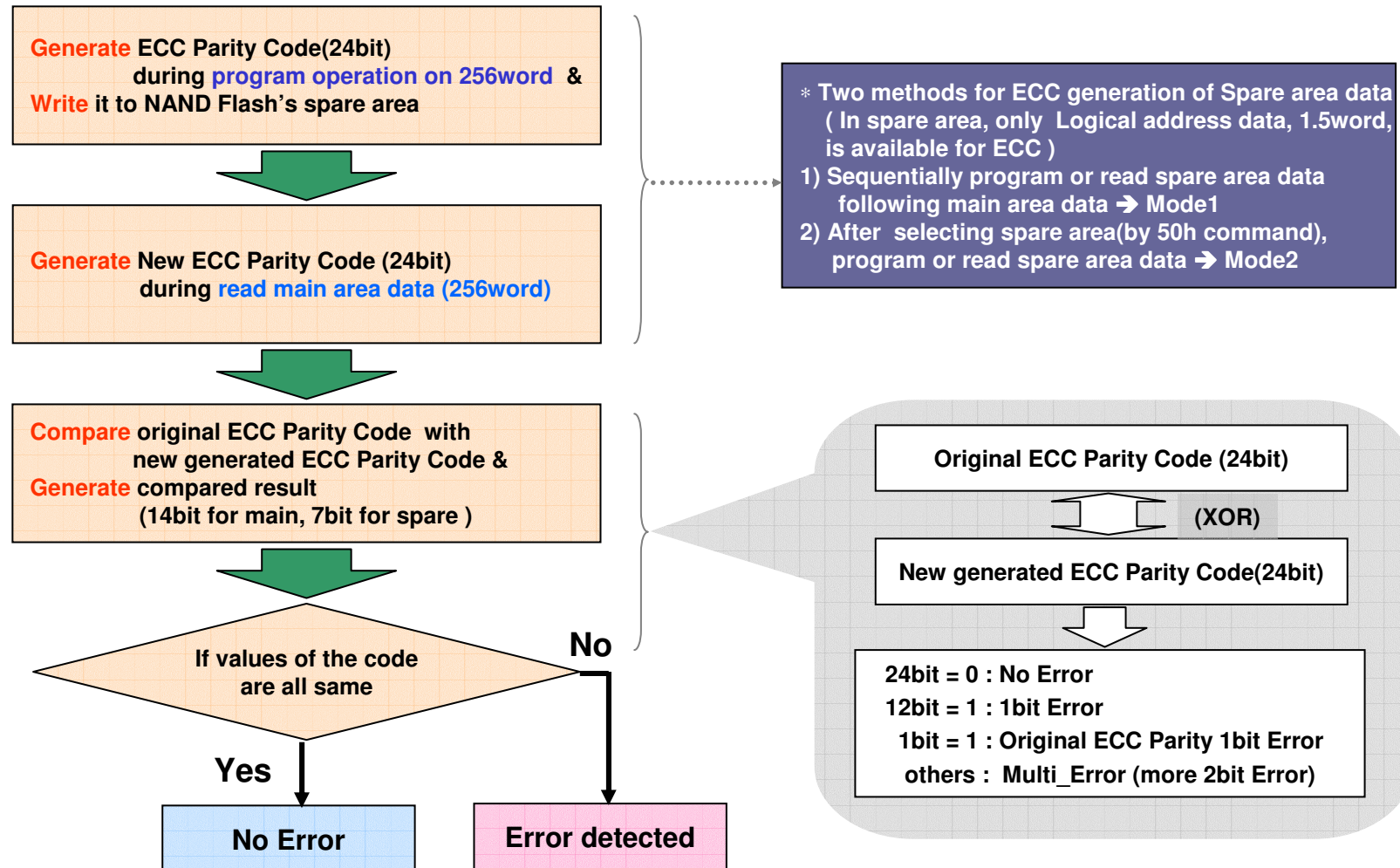
## (256Word)

Flash Planning Group  
Memory Division  
Samsung Electronics Co., Ltd

This is only example algorithm for SW ECC.  
In case of OneNAND which supports HW ECC, parity bit position can be changed.

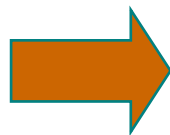
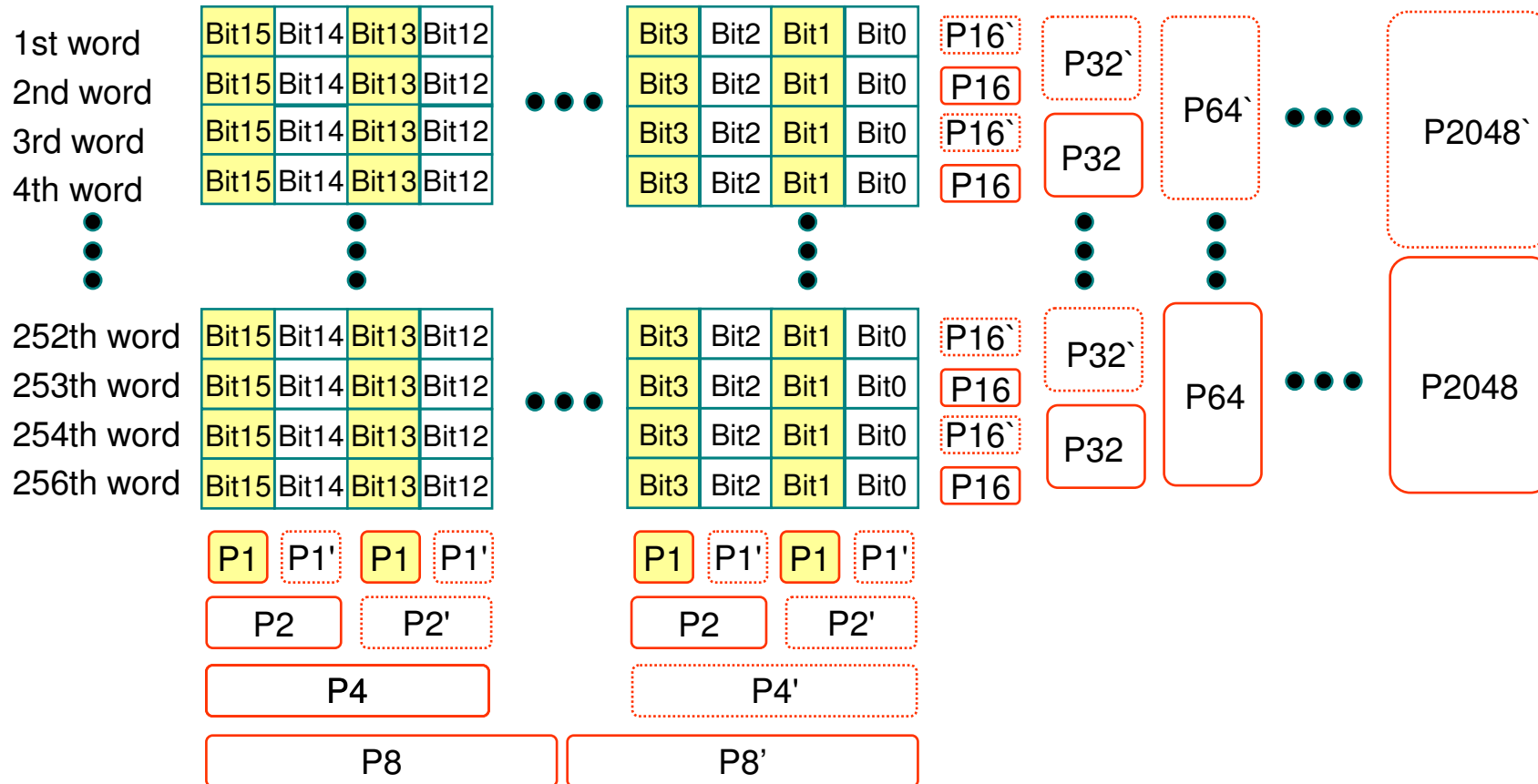
# Processing Procedure

For 256Word



# Parity Generation for Main Array (Column)

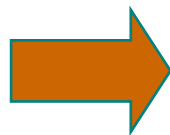
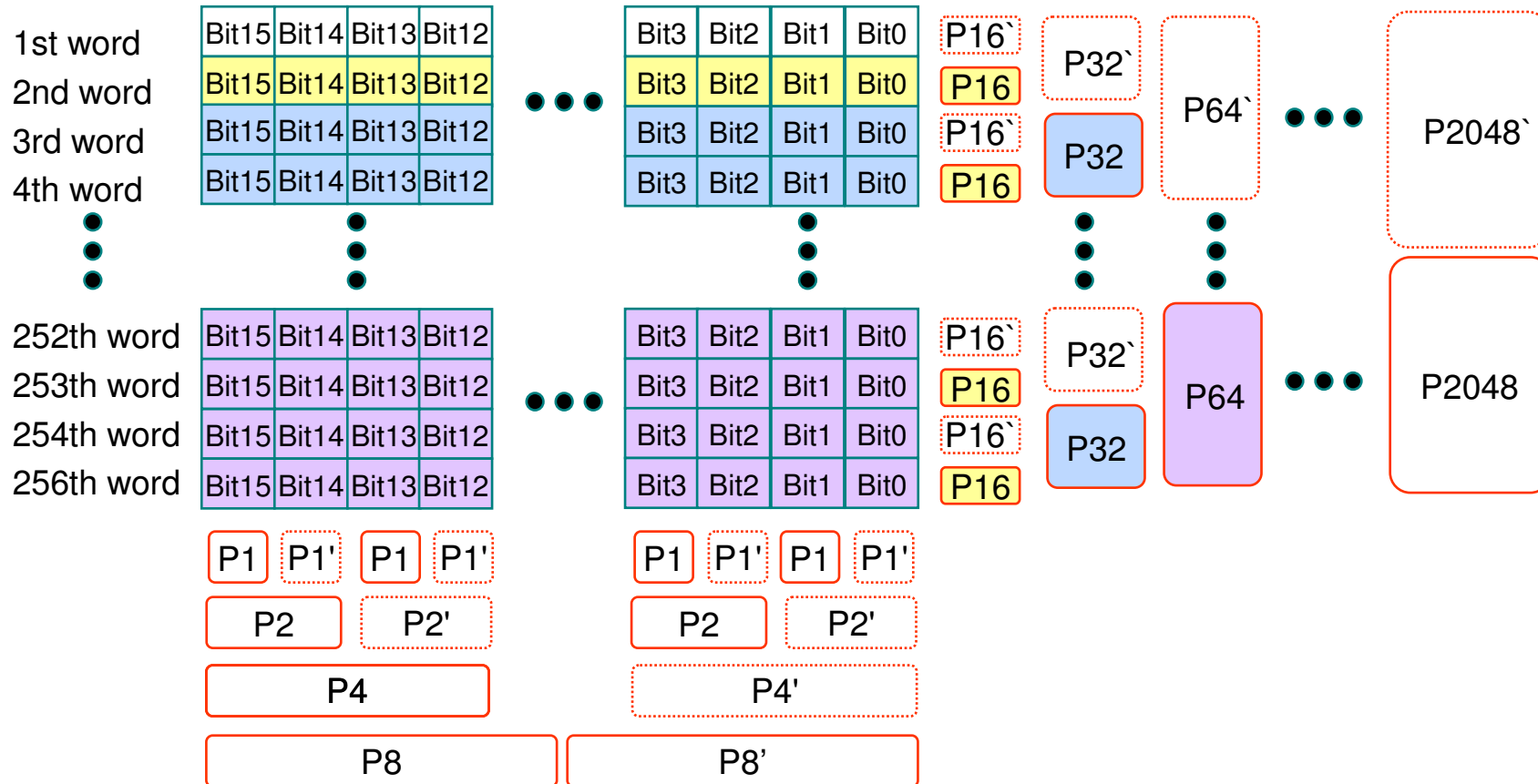
For 256Word



$P1 = \text{bit15} \oplus \text{bit13} \oplus \text{bit11} \oplus \text{bit9} \oplus \text{bit7} \oplus \text{bit5} \oplus \text{bit3} \oplus \text{bit1} \oplus P1$   
 $P2 = \text{bit15} \oplus \text{bit14} \oplus \text{bit11} \oplus \text{bit10} \oplus \text{bit7} \oplus \text{bit6} \oplus \text{bit3} \oplus \text{bit2} \oplus P2$   
 $P4 = \text{bit15} \oplus \text{bit14} \oplus \text{bit13} \oplus \text{bit12} \oplus \text{bit7} \oplus \text{bit6} \oplus \text{bit5} \oplus \text{bit4} \oplus P4$   
 $P8 = \text{bit15} \oplus \text{bit14} \oplus \text{bit13} \oplus \text{bit12} \oplus \text{bit11} \oplus \text{bit10} \oplus \text{bit9} \oplus \text{bit8} \oplus P8$

# Parity Generation for Main Array (Row)

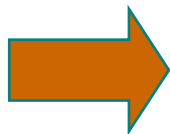
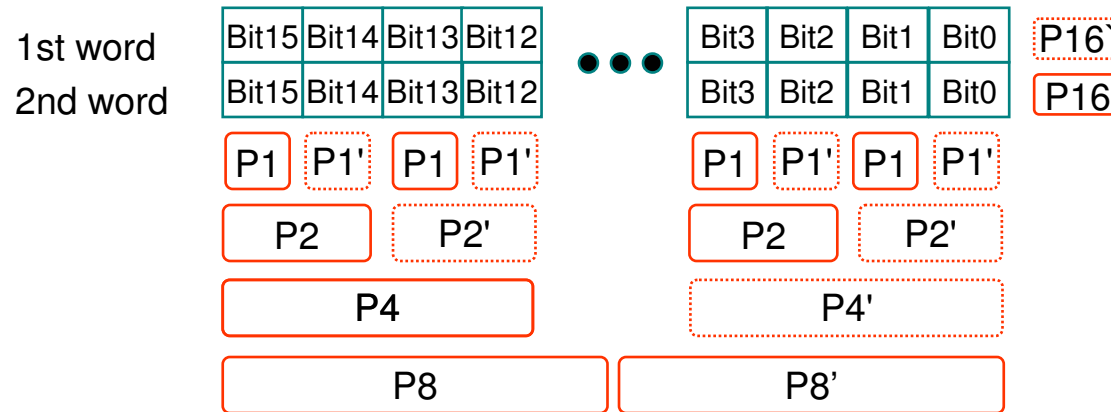
For 256Word



$$\begin{aligned}
 \mathbf{P16} = & \text{bit15} \oplus \text{bit14} \oplus \text{bit13} \oplus \text{bit12} \oplus \text{bit11} \oplus \text{bit10} \oplus \text{bit9} \oplus \text{bit8} \oplus \\
 & \text{bit7} \oplus \text{bit6} \oplus \text{bit5} \oplus \text{bit4} \oplus \text{bit3} \oplus \text{bit2} \oplus \text{bit1} \oplus \text{bit0} \oplus \mathbf{P16} \\
 & \vdots
 \end{aligned}$$

# Parity Generation for Spare Array (Logical Address)

For 256Word



$$\begin{aligned}
 P1\_s &= \text{bit15} \oplus \text{bit13} \oplus \text{bit11} \oplus \text{bit9} \oplus \text{bit7} \oplus \text{bit5} \oplus \text{bit3} \oplus \text{bit1} \oplus P1 \\
 P2\_s &= \text{bit15} \oplus \text{bit14} \oplus \text{bit11} \oplus \text{bit10} \oplus \text{bit7} \oplus \text{bit6} \oplus \text{bit3} \oplus \text{bit2} \oplus P2 \\
 P4\_s &= \text{bit15} \oplus \text{bit14} \oplus \text{bit13} \oplus \text{bit12} \oplus \text{bit7} \oplus \text{bit6} \oplus \text{bit5} \oplus \text{bit4} \oplus P4 \\
 P8\_s &= \text{bit15} \oplus \text{bit14} \oplus \text{bit13} \oplus \text{bit12} \oplus \text{bit11} \oplus \text{bit10} \oplus \text{bit9} \oplus \text{bit8} \oplus P8 \\
 P16\_s &= \text{bit15} \oplus \text{bit14} \oplus \text{bit13} \oplus \text{bit12} \oplus \text{bit11} \oplus \text{bit10} \oplus \text{bit9} \oplus \text{bit8} \oplus \\
 &\quad \text{bit7} \oplus \text{bit6} \oplus \text{bit5} \oplus \text{bit4} \oplus \text{bit3} \oplus \text{bit2} \oplus \text{bit1} \oplus \text{bit0} \oplus P16
 \end{aligned}$$

# ECC CODE FORMAT STANDARD

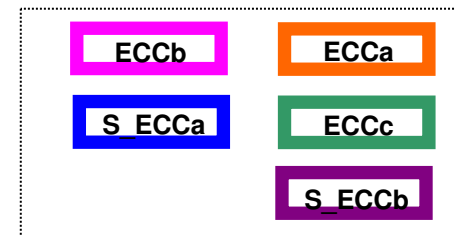
For 256Word

## ■ X16 org. NAND Flash

- ECC Code for Main area and LSN data

P1~P8 : Column Parity , P16~P2048 : Row Parity  
 P1\_s: Column Parity , P2\_s~P16\_s : Row Parity

	I/O15	I/O14	I/O13	I/O12	I/O11	I/O10	I/O9	I/O8	I/O7	I/O6	I/O5	I/O4	I/O3	I/O2	I/O1	I/O0
ECCa + ECCb	~P2048	~P2048`	~P1024	~P1024`	~P512	~P512`	~P256	~P256`	~P128	~P128`	~P64	~P64`	~P32	~P32`	~P16	~P16`
ECCc +S_ECCa	~P4_s	~P4`s	~P2_s	~P2`s	~P1_s	~P1`s	~P16_s	~P16`s	~P8	~P8`	~P4	~P4`	~P2	~P2`	~P1	~P1`
S_ECCb	BI (Bad Block Information)								1	1	1	1	1	1	~P8_s	~P8`s

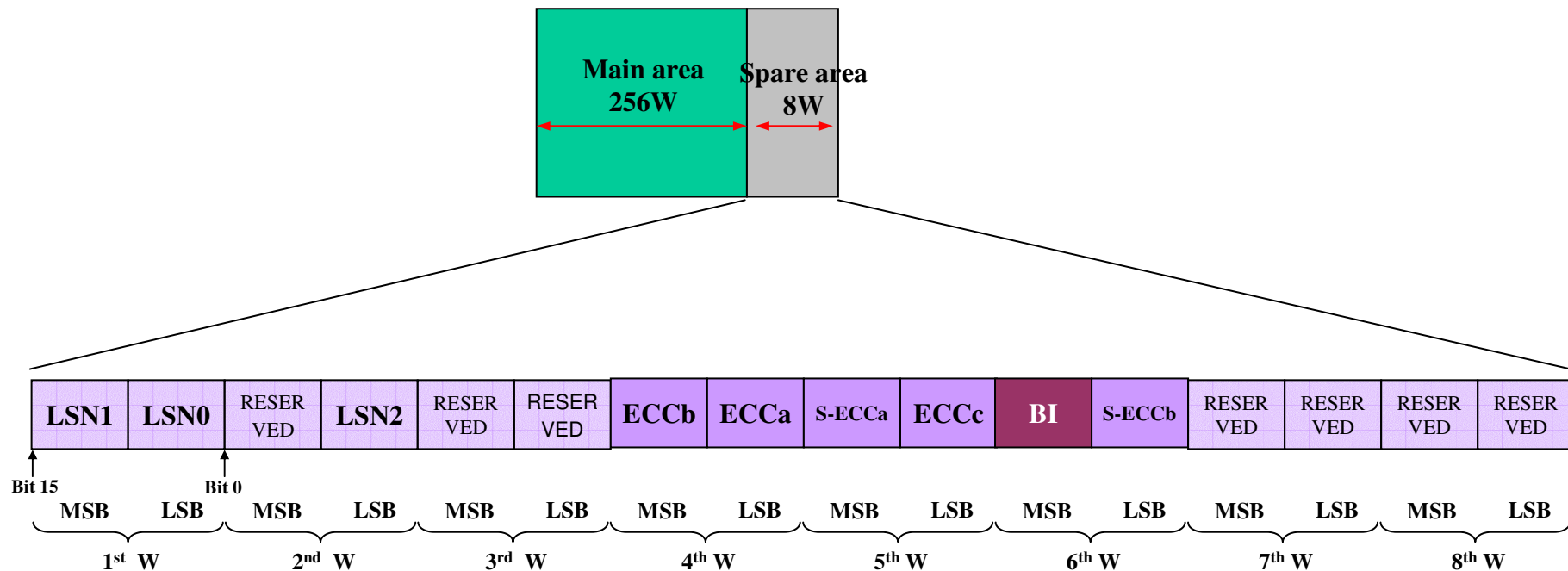


# SPARE AREA ASSIGNMENT STANDARD

For 256Word

## Small Page(264W) & X16 org. NAND Flash

- Device : 64Mb, 128Mb, 256Mb, 512Mb, 1Gb DDP



- > LSN : Logical Sector Number
- > ECCa,ECCb,ECCc : ECC code for Main area data
- > S\_ECCa,S\_ECCb : ECC code for LSN data
- > BI : Bad block Information

# Compare Result Table

For 256Word

- For Main Array 256Word

Stored ECC(in Spare area) [P2048P2048'P1024P1024'...P2P2'P1P1']

⊕ Computed data's ECC result [P2048P2048'P1024P1024'...P2P2'P1P1']

	No Error	1bit Error	ECC Parity 1bit Error	Multi_Error
XORed Results	24 bits : 0	12 bits : 1	1 bit : 1	Others

error position is  
P2048P1024P512...P4P2P1

- For Spare Array 1.5Word

Stored ECC(in Spare area) [P16P16'P8P8'P4P4'P2P2'P1P1']

⊕ Computed LSN's ECC result [P16P16'P8P8'P4P4'P2P2'P1P1']

	No Error	1bit Error	ECC Parity 1bit Error	Multi_Error
XORed Results	10 bits : 0	5 bits : 1	1 bit : 1	Others

error position is  
P16P8P4P2P1