

Week 3: SECDED example ⚡

- SECDED scheme: Even SECDED
- Number of bits to protect (m): 5 bits
- Example bit-sequence:
0 1 0 0 1
- Number of parity bits required (p):
 - Using formula: $2^p \geq m + p + 1$
- $m = 5$; $p = ?$
 - If $p = 4$:
- $2p = 24 = 16 \geq m + p + 1 = 5 + 4 + 1 = 10$
- Five (5) data bits: D1, D2, D3, D4, D5
- Four (4) parity bits: P1, P2, P3, P4
- One SECDED Parity bit: P0
- Total number of bits: Ten (10)
 - Numbered 0 – 9
- What's the position of these bits?
 - P1 at $2^{(1-1)} = 2^0 = \text{position } 1$
 - P2 at $2^{(2-1)} = 2^1 = \text{position } 2$
 - P3 at $2^{(3-1)} = 2^2 = \text{position } 4$
 - P4 at $2^{(4-1)} = 2^3 = \text{position } 8$
 - P0 at position 0

Positions OCCUPIED by Parity Bits

Bit #	9	8	7	6	5	4	3	2	1	0
Data/Parity		P4				P3		P2	P1	P0

Positions OCCUPIED by Data Bits

Bit #	9	8	7	6	5	4	3	2	1	0
Data/Parity	D5	P4	D4	D3	D2	P3	D1	P2	P1	P0

Positions PROTECTED by Parity Bits – P1

Bit #	9	8	7	6	5	4	3	2	1	0
Data/Parity	D5	P4	D4	D3	D2	P3	D1	P2	P1	P0

Positions PROTECTED by Parity Bits – P1

Bit #	9	8	7	6	5	4	3	2	1	0
Data/Parity	D5	P4	D4	D3	D2	P3	D1	P2	P1	P0

Positions PROTECTED by Parity Bits – P1

Bit #	9	8	7	6	5	4	3	2	1	0
Data/Parity	D5	P4	D4	D3	D2	P3	D1	P2	P1	P0

Positions PROTECTED by Parity Bits – P1

Bit #	9	8	7	6	5	4	3	2	1	0
Data/Parity	D5	P4	D4	D3	D2	P3	D1	P2	P1	P0

Positions PROTECTED by Parity Bits – P1

Bit #	9	8	7	6	5	4	3	2	1	0
Data/Parity	D5	P4	D4	D3	D2	P3	D1	P2	P1	P0

Positions PROTECTED by Parity Bits – P1

Bit #	9	8	7	6	5	4	3	2	1	0
Data/Parity	D5	P4	D4	D3	D2	P3	D1	P2	P1	P0

Positions PROTECTED by Parity Bits – P1

Bit #	9	8	7	6	5	4	3	2	1	0
Data/Parity	D5	P4	D4	D3	D2	P3	D1	P2	P1	P0

Positions PROTECTED by Parity Bits – P1

Bit #	9	8	7	6	5	4	3	2	1	0
Data/Parity	D5	P4	D4	D3	D2	P3	D1	P2	P1	P0

Positions PROTECTED by Parity Bits – P1

Bit #	9	8	7	6	5	4	3	2	1	0
Data/Parity	D5	P4	D4	D3	D2	P3	D1	P2	P1	P0

Positions PROTECTED by Parity Bits – P1

Bit #	9	8	7	6	5	4	3	2	1	0
Data/Parity	D5	P4	D4	D3	D2	P3	D1	P2	P1	P0

Positions PROTECTED by Parity Bits – P1

Positions PROTECTED by Parity Bits – P2

Bit #	9	8	7	6	5	4	3	2	1	0
Data/Parity	D5	P4	D4	D3	D2	P3	D1	P2	P1	P0

Positions PROTECTED by Parity Bits – P2

Bit #	9	8	7	6	5	4	3	2	1	0
Data/Parity	D5	P4	D4	D3	D2	P3	D1	P2	P1	P0

Positions PROTECTED by Parity Bits – P2

Positions PROTECTED by Parity Bits – P2

Bit #	9	8	7	6	5	4	3	2	1	0
Data/Parity	D5	P4	D4	D3	D2	P3	D1	P2	P1	P0

Positions PROTECTED by Parity Bits – P2

Bit #	9	8	7	6	5	4	3	2	1	0
Data/Parity	D5	P4	D4	D3	D2	P3	D1	P2	P1	P0

Positions PROTECTED by Parity Bits – P2

Bit #	9	8	7	6	5	4	3	2	1	0
Data/Parity	D5	P4	D4	D3	D2	P3	D1	P2	P1	P0

Positions PROTECTED by Parity Bits – P2

Bit #	9	8	7	6	5	4	3	2	1	0
Data/Parity	D5	P4	D4	D3	D2	P3	D1	P2	P1	P0

Positions PROTECTED by Parity Bits – P2

Bit #	9	8	7	6	5	4	3	2	1	0
Data/Parity	D5	P4	D4	D3	D2	P3	D1	P2	P1	P0

Positions PROTECTED by Parity Bits – P2

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Positions PROTECTED by Parity Bits

Bit #	9	8	7	6	5	4	3	2	1	0
Data/Parity	D5	P4	D4	D3	D2	P3	D1	P2	P1	P0
	0		1	0	0		1			
P1										
P2										
P3										
P4										
P0										

Positions PROTECTED by Parity Bits

Bit #	9	8	7	6	5	4	3	2	1	0
Data/Parity	D5	P4	D4	D3	D2	P3	D1	P2	P1	P0
	0		1	0	0		1			
P1	0		1		0		1			
P2			1	0			1			
P3			1	0	0					
P4	0									
P0										

Positions PROTECTED by Parity Bits

Bit #	9	8	7	6	5	4	3	2	1	0
Data/Parity	D5	P4	D4	D3	D2	P3	D1	P2	P1	P0
	0		1	0	0		1			
P1	0		1		0		1		0	
P2			1	0			1			
P3			1	0	0					
P4	0									
P0										

Positions PROTECTED by Parity Bits

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Bit #	9	8	7	6	5	4	3	2	1	0
Data/Parity	D5	P4	D4	D3	D2	P3	D1	P2	P1	P0
	1		1	1	1		1			
P1	1		1		1		1		1	
P2			1	1			1	1		
P3			1	1	1	1				
P4		1	1							
P0	1	1	1	1	1	1	1	1	1	1

1-Bit Corrupt at position 5 (D2)

Bit #	9	8	7	6	5	4	3	2	1	0
Data/Parity	D5	P4	D4	D3	D2	P3	D1	P2	P1	P0
	0	0	1	0	1	1	1	0	0	1
P1										
P2										
P3										
P4										
P0	0	0	1	0	1	1	1	0	0	1

0010111001 No longer even parity. Error detected.

1-Bit Corrupt at position 5 (D2)

P1: Error detected.

1-Bit Corrupt at position 5 (D2)

Bit #	9	8	7	6	5	4	3	2	1	0
Data/Parity	D5	P4	D4	D3	D2	P3	D1	P2	P1	P0
	0	0	1	0	1	1	1	0	0	1
P1	0		1		1		1		0	
P2			1	0			1	0		
P3										
P4										
P0	0	0	1	0	1	1	1	0	0	1

P2: All Good

1-Bit Corrupt at position 5 (D2)

Bit #	9	8	7	6	5	4	3	2	1	0
Data/Parity	D5	P4	D4	D3	D2	P3	D1	P2	P1	P0
	0	0	1	0	1	1	1	0	0	1
P1	0		1		1		1		0	
P2			1	0			1	0		
P3			1	0	1	1				
P4										
P0	0	0	1	0	1	1	1	0	0	1

P3: Error Detected

1-Bit Corrupt at position 5 (D2)

P4: All Good

1-Bit Corrupt at position 5 (D2)

Bit #	9	8	7	6	5	4	3	2	1	0
Data/Parity	D5	P4	D4	D3	D2	P3	D1	P2	P1	P0
	0	0	1	0	1	1	1	0	0	1
P1	0		1		1		1		0	
P2			1	0			1	0		
P3			1	0	1	1				
P4	0	0								
P0	0	0	1	0	1	1	1	0	0	1

Since SECDED parity said there was an error, and Hamming says there is an error, there must be a single error (we know it can't be two bit flips, or SECDED parity would say there was no error. We assume 3 or more bit flips is so unlikely that it won't happen)

1-Bit Corrupt at position 5 (D2)

Bit #	9	8	7	6	5	4	3	2	1	0
Data/Parity	D5	P4	D4	D3	D2	P3	D1	P2	P1	P0
	0	0	1	0	1	1	1	0	0	1
P1	0		1		1		1		0	
P2			1	0			1	0		
P3			1	0	1	1				
P4	0	0								
P0	0	0	1	0	1	1	1	0	0	1

Only bit 5 is common to P1 & P3 so error is bit 5. Other bits which are common, are also present in other parities, which report the sequence as correct.

2-Bits corrupt at position 5 and 7 (D2 and D4)

Bit #	9	8	7	6	5	4	3	2	1	0
Data/Parity	D5	P4	D4	D3	D2	P3	D1	P2	P1	P0
	0		0	0	1		1			
P1	0		0		1		1		0	
P2			0	0			1	0		
P3			0	0	1	1				
P4	0	0								
P0	0	0	0	0	1	1	1	0	0	1

Hamming thinks bit 2 is in error. But we know more than one error has occurred as SECDED parity hasn't detected an error. So we can't trust Hamming results. We have detected that multiple errors have occurred - but we can't correct it.