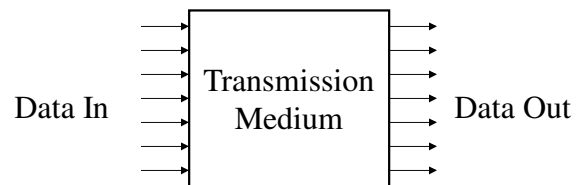
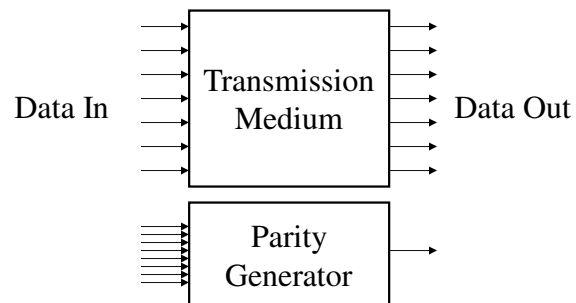


Error Detection with Parity



Error Detection with Parity



Error Correcting Code – by Design

Start with Bit Position = Column Number

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

Error Correcting Code – by Design

Start with Bit Position = Column Number

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

1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
1	1	1	1	0	0	0	0	1	1	1	1	0	0	0
1	1	0	0	1	1	0	0	1	1	0	0	1	1	0
1	0	1	0	1	0	1	0	1	0	1	0	1	0	1

Error Correcting Code – by Design

Start with Bit Position = Column Number

D_{10}	D_9	D_8	D_7	D_6	D_5	D_4	P_3	D_3	D_2	D_1	P_2	D_0	P_1	P_0
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
1	1	1	1	0	0	0	0	1	1	1	1	0	0	0
1	1	0	0	1	1	0	0	1	1	0	0	1	1	0
1	0	1	0	1	0	1	0	1	0	1	0	1	0	1

Function	→	D_{10}	D_9	D_8	D_7	D_6	D_5	D_4	P_3	D_3	D_2	D_1	P_2	D_0	P_1	P_0
Column Number	→	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Column Number in Binary	→	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
		1	1	1	1	0	0	0	0	1	1	1	1	0	0	0
		1	1	0	0	1	1	0	0	1	1	0	0	1	1	0
		1	0	1	0	1	0	1	0	1	0	1	0	1	0	1

Four Bit Column Identifier? Then
build four parity sets

	D ₁₀	D ₉	D ₈	D ₇	D ₆	D ₅	D ₄	P ₃	D ₃	D ₂	D ₁	P ₂	D ₀	P ₁	P ₀
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Parity set 0:	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
all columns	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0
where LSB of	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0
column number	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
is '1'															
	Columns 15, 13, 11, 9, 7, 5, 3, 1														

Four Bit Column Identifier? Then
build four parity sets

	D ₁₀	D ₉	D ₈	D ₇	D ₆	D ₅	D ₄	P ₃	D ₃	D ₂	D ₁	P ₂	D ₀	P ₁	P ₀
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Parity set 1:	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
all columns	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0
where second	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0
bit of	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
column number															
is '1'															
	Columns 15, 14, 11, 10, 7, 6, 3, 2														

Four Bit Column Identifier? Then
build four parity sets

	D ₁₀	D ₉	D ₈	D ₇	D ₆	D ₅	D ₄	P ₃	D ₃	D ₂	D ₁	P ₂	D ₀	P ₁	P ₀
Parity set 2:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
all columns	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
where third	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0
bit of	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0
column number	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
is '1'															

Columns 15, 14, 13, 12, 7, 6, 5, 4

Four Bit Column Identifier? Then
build four parity sets

	D ₁₀	D ₉	D ₈	D ₇	D ₆	D ₅	D ₄	P ₃	D ₃	D ₂	D ₁	P ₂	D ₀	P ₁	P ₀
Parity set 3:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
all columns	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
where fourth	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0
bit of	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0
column number	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
is '1'															

Columns 15, 14, 13, 12, 11, 10, 9, 8

Finally – Add Parity Across Entire Data Set

Parity set PT:	D ₁₀	D ₉	D ₈	D ₇	D ₆	D ₅	D ₄	P ₃	D ₃	D ₂	D ₁	P ₂	D ₀	P ₁	P ₀
all columns	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
with data or	→ 1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
parity bits	1	1	1	1	0	0	0	1	1	1	1	0	0	0	0
	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0
	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1

Columns 15, 14, 13, 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1

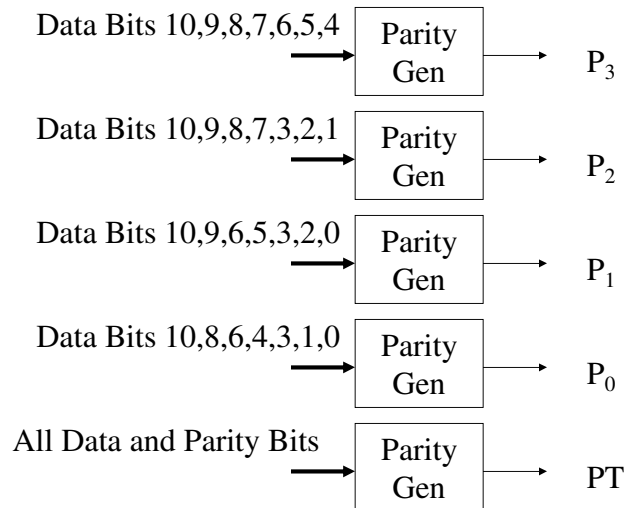
SECDED Coding Scheme

PT – parity across whole word

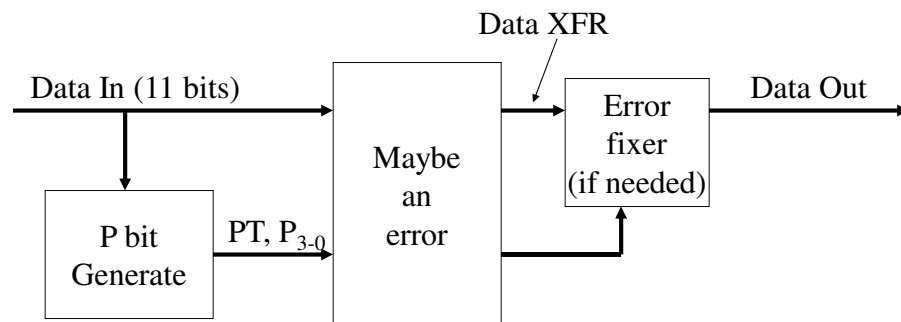
Pk – parity bits on set basis (any Pk nonzero = error)

PT	PK	Situation
Good	Good	No error – accept data as passed
Good	Bad	Two bits in error
Bad	Good	PT in error
Bad	Bad	Single bit error – corrected (Error in column P ₃ P ₂ P ₁ P ₀)

To Create Parity Bits for Scheme



Test System



Start point: set up correct
values in parity bits, data bits

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

For demonstration: make one bit wrong

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

0	0	1	0	1	0	1	0	1	0	1	1	0	0	1	
PT	D_{10}	D_9	D_8	D_7	D_6	D_5	D_4	P_3	D_3	D_2	D_1	P_2	D_0	P_1	P_0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0
	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0
	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="border-left: 1px solid black; border-right: 1px solid black; height: 20px; width: 100%;"></div> </div>														
	P_T	P_3	P_2	P_1	P_0										
	0														

[illegible]

Check Parity two for correctness

0	0	1	0	1	0	1 ⁰	0	0	1	0	1	1	0	0	1
PT	D ₁₀	D ₉	D ₈	D ₇	D ₆	D ₅	D ₄	P ₃	D ₃	D ₂	D ₁	P ₂	D ₀	P ₁	P ₀
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0
1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0
1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
P _T	P ₃	P ₂	P ₁	P ₀											
		0	1	0											

Check Parity three for correctness

0	0	1	0	1	0	1 ⁰	0	0	1	0	1	1	0	0	1
PT	D ₁₀	D ₉	D ₈	D ₇	D ₆	D ₅	D ₄	P ₃	D ₃	D ₂	D ₁	P ₂	D ₀	P ₁	P ₀
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0
1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0
1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
P _T	P ₃	P ₂	P ₁	P ₀											
		1	0	1	0										

Check Parity - Total for correctness

⁰
 PT 0 1 0 1 0 0 0 1 0 1 1 0 0 1
 D₁₀ D₉ D₈ D₇ D₆ D₅ D₄ P₃ D₃ D₂ D₁ P₂ D₀ P₁ P₀

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

P_T P₃ P₂ P₁ P₀
 1 1 0 1 0