

ECE212/212s Lecture Notes

Lecture: Chapter 4b

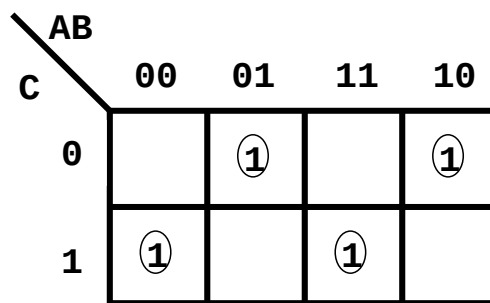
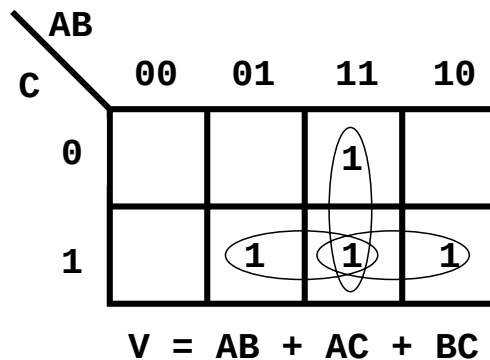
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Problem 4.23 on page 236

ckt #1

Output VW = # of 1's in A,B,C

A	B	C	V	W
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1



$$V = AB + AC + BC$$

If all gate delays are 10ns. What is the maximum clock speed at which we can run this adder? Worst case delay of adder is 120ns. $T = 120\text{ns}$. $f = \frac{1}{T} = \frac{1}{120 \times 10^{-9}\text{s}} = 8.33 \times 10^6 \text{Hz}$ Carry Look Ahead Adders
 Problem with RC adders: C_{i+1} depends on C_i from previous full adder. If the carry value could be determined without having to ripple through all previous stages, then worst case delay could be decreased. (Maximum clock speed would increase.)

When do we need a carry?

C_3	C_2	C_1	$C_0 = 0$
A_3	A_2	A_1	$A_0 = 0$
B_3	B_2	B_1	$B_0 = 0$
S_3	S_2	S_1	$S_0 = 0$

- a) When both $A_i + B_i$ are 1, C_{i+1} is 1 regardless of C_i . (Generic Condition) $A_i \cdot B_i$
b) If either A_i or B_i is 1, C_{i+1} is one only when C_i is 1. (Propagate Condition). $A_i \oplus B_i$

In Summary

C_{i+1} is 1 if it meets the generate condition or if it meets the propagate condition and C_i was 1.

$$\begin{aligned}
C_{i+1} &= G_i + P_i C_i \\
S_i &= \\
i = 0 \quad C_1 &= G_0 + P_0 C_0 \\
i = 1 \quad C_2 &= G_1 + P_1 C_1 \\
&= G_1 + P_1(G_0 + P_0 C_0) \\
&= G_1 + P_1 G_0 + P_1 P_0 C_0 \\
i = 2 \quad C_3 &= G_2 + P_2 C_2 \\
&= G_2 + P_2(G_1 + P_1 G_0 + P_1 P_0 C_0) \\
&= G_2 + P_2 G_1 + P_2 P_1 G_0 + P_2 P_1 P_0 C_0 \\
i = 3 \quad C_4 &= G_3 + P_3 C_3 \\
&= G_3 + P_3(G_2 + P_2 G_1 + P_2 P_1 G_0 + P_2 P_1 P_0 C_0) \\
&= G_3 + P_3 G_2 + P_3 P_2 G_1 + P_3 P_2 P_1 G_0 + P_3 P_2 P_1 P_0 C_0
\end{aligned}$$

Worst case delay is 4 gate delays = $4 \times 10 \text{ ns} = 40 \text{ ns}$. Maximum clock freq, $f = \frac{1}{T} = \frac{1}{40 \times 10^{-9} \text{ s}} =$

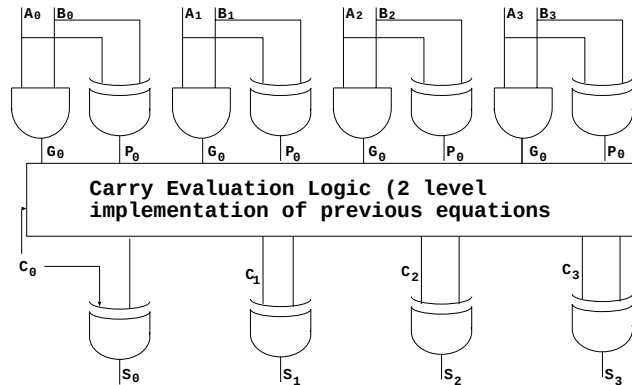


Figure 1: Structure of bordered block diagonal matrix.

$25 \times 10^6 \text{ Hz} = 25 \text{ MHz}$. Combinational Multiplier
Positive Numbers Only

			A_3	A_2	A_1	A_0
			B_3	B_2	B_1	B_0
			$A_3 \cdot B_0$	$A_2 \cdot B_0$	$A_1 \cdot B_0$	$A_0 \cdot B_0$
		$A_3 \cdot B_1$	$A_2 \cdot B_1$	$A_1 \cdot B_1$	$A_0 \cdot B_1$	
	$A_3 \cdot B_2$	$A_2 \cdot B_2$	$A_1 \cdot B_2$	$A_0 \cdot B_2$		
$A_3 \cdot B_3$	$A_2 \cdot B_3$	$A_1 \cdot B_3$	$A_0 \cdot B_3$			
S_6	S_5	S_4	S_3	S_2	S_1	S_0