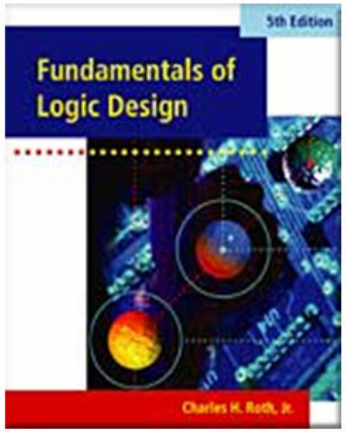
FIGURES FOR

CHAPTER 4

APPLICATIONS OF BOOLEAN ALGEBRA MINTERM AND MAXTERM EXPANSIONS



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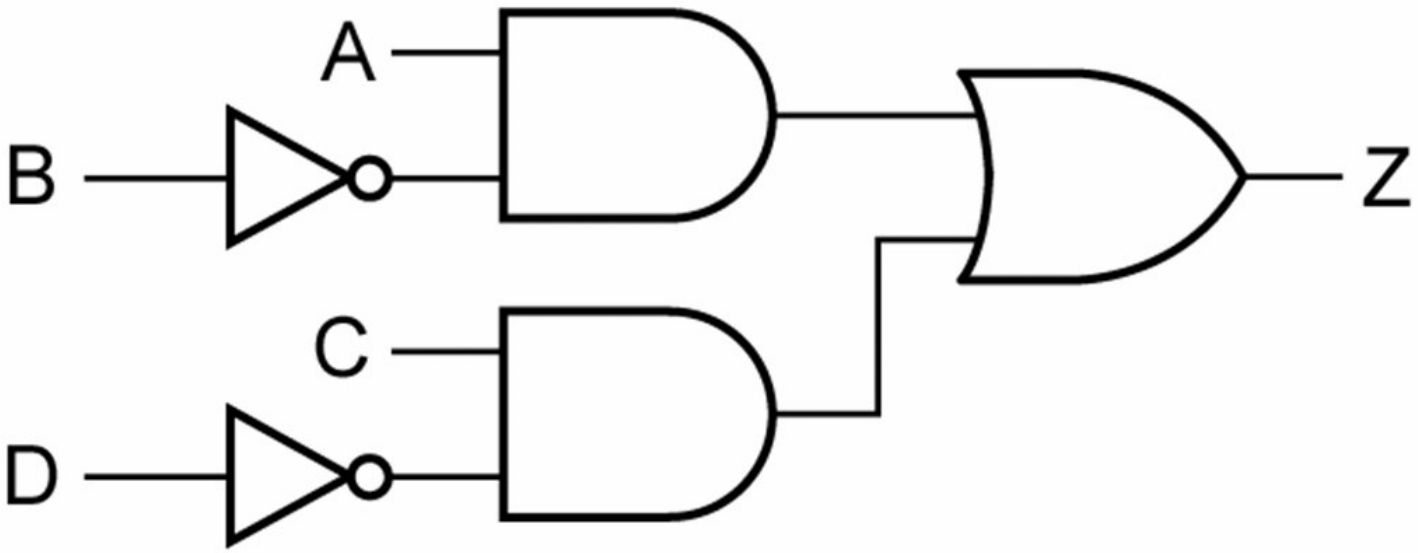

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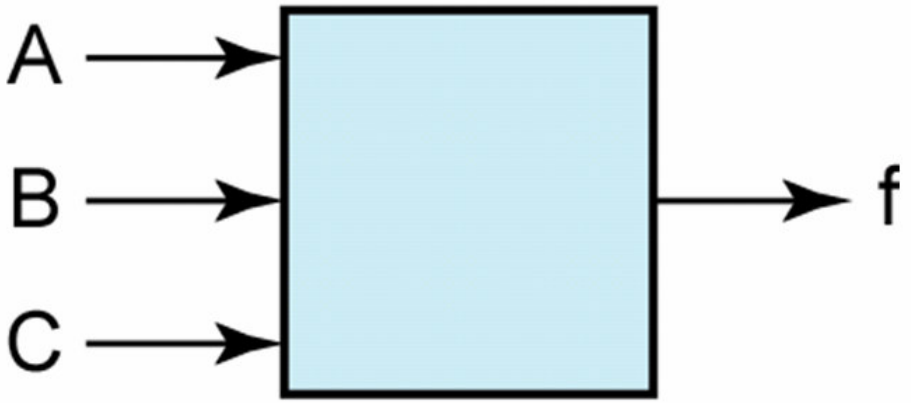

(a)

A B C	f	f′
0 0 0	0	1
0 0 1	0	1
0 1 0	0	1
0 1 1	1	0
1 0 0	1	0
1 0 1	1	0
1 1 0	1	0
1 1 1	1	0

(b)

Figure 4-1: **Combinational Circuit with Truth Table**

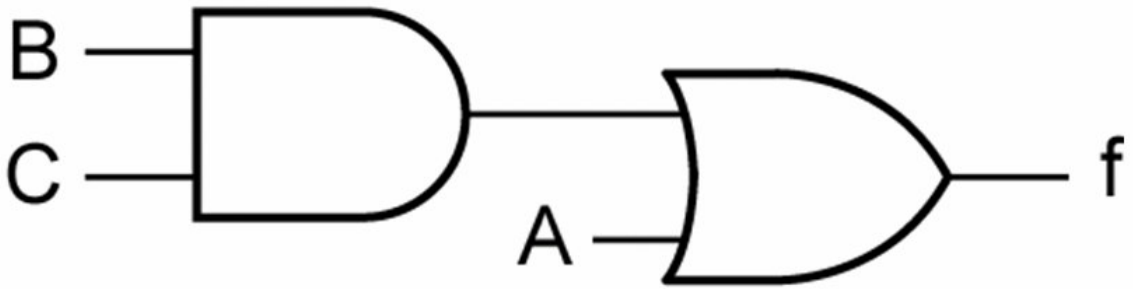

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Table 4-1 Minterms and Maxtems for Three Variables

Row No.	A B C	Minterms	Maxterms
0	0 0 0	$A'B'C' = m_0$	$A + B + C = M_0$
1	0 0 1	$A'B'C = m_1$	$A + B + C' = M_1$
2	0 1 0	$A'BC' = m_2$	$A + B' + C = M_2$
3	0 1 1	$A'BC = m_3$	$A + B' + C' = M_3$
4	1 0 0	$AB'C' = m_4$	$A' + B + C = M_4$
5	1 0 1	$AB'C = m_5$	$A' + B + C' = M_5$
6	1 1 0	$ABC' = m_6$	$A' + B' + C = M_6$
7	1 1 1	$ABC = m_7$	$A' + B' + C' = M_7$

$$
\begin{aligned}
f &= a'b' + a'd + acd' \\
&= a'b'(c + c')(d + d') + a'd(b + b')(c + c') + acd'(b + b') \\
&= a'b'c'd' + a'b'c'd + a'b'cd' + a'b'cd + \cancel{a'b'c'd} + \cancel{a'b'cd} \\
&\quad + a'bc'd + a'bcd + abcd' + ab'cd' \qquad (4\text{-}9)
\end{aligned}
$$

$$
\begin{aligned}
f &= a'b'c'd' + a'b'c'd + a'b'cd' + a'b'cd + a'bc'd + a'bcd + abcd' + ab'cd' \\
&\quad 0\,0\,0\,0 \quad 0\,0\,0\,1 \quad 0\,0\,1\,0 \quad 0\,0\,1\,1 \quad 0\,1\,0\,1 \quad 0\,1\,1\,1 \quad 1\,1\,1\,0 \quad 1\,0\,1\,0 \\
f &= \sum m(0, 1, 2, 3, 5, 7, 10, 14) \qquad (4\text{-}10)
\end{aligned}
$$

Minterm Expansion (p. 89)

$$f = a'(b'+d) + acd'$$

$$= (a' + cd')(a + b' + d) = (a' + c)(a' + d')(a + b' + d)$$

$$= (a' + bb' + c + dd')(a' + bb' + cc' + d')(a + b' + cc' + d)$$

$$= (a' + bb' + c + d)(a' + bb' + c + d')(\cancel{a' + bb' + c + d'})(a' + bb' + c' + d')$$
$$(a + b' + cc' + d)$$

$$= (a' + b + c + d)(a' + b' + c + d)(a' + b + c + d')(a' + b' + c + d')$$
$$\quad 1000 \qquad\qquad 1100 \qquad\qquad 1001 \qquad\qquad 1101$$
$$(a' + b + c' + d')(a' + b' + c' + d')(a + b' + c + d)(a + b' + c' + d)$$
$$\quad 1011 \qquad\qquad 1111 \qquad\qquad 0100 \qquad\qquad 0110$$

$$= \prod M(4, 6, 8, 9, 11, 12, 13, 15) \qquad (4\text{-}11)$$

Maxterm Expansion (p. 90)

Table 4-2. General Truth Table for Three Variables

A	B	C	F
0	0	0	a_0
0	0	1	a_1
0	1	0	a_2
0	1	1	a_3
1	0	0	a_4
1	0	1	a_5
1	1	0	a_6
1	1	1	a_7

$$F = a_0m_0 + a_1m_1 + a_2m_2 + \cdots + a_7m_7 = \sum_{i=0}^{7} a_im_i$$

Table 4-3. Conversion of Forms

GIVEN FORM \ DESIRED FORM	Minterm Expansion of F	Maxterm Expansion of F	Minterm Expansion of F'	Maxterm Expansion of F'
Minterm Expansion of F	———	maxterm nos. are those nos. not on the minterm list for F	list minterms not present in F	maxterm nos. are the same as minterm nos. of F
Maxterm Expansion of F	minterm nos. are those nos. not on the maxterm list for F	———	minterm nos. are the same as maxterm nos. of F	list maxterms not present in F

Table 4-4. Application of Table 4-3

GIVEN FORM	DESIRED FORM: Minterm Expansion of f	Maxterm Expansion of f	Minterm Expansion of f'	Maxterm Expansion of f'
$f = \sum m(3, 4, 5, 6, 7)$	———	$\prod M(0, 1, 2)$	$\sum m(0, 1, 2)$	$\prod M(3, 4, 5, 6, 7)$
$f = \prod M(0, 1, 2)$	$\sum m(3, 4, 5, 6, 7)$	———	$\sum m(0, 1, 2)$	$\prod M(3, 4, 5, 6, 7)$

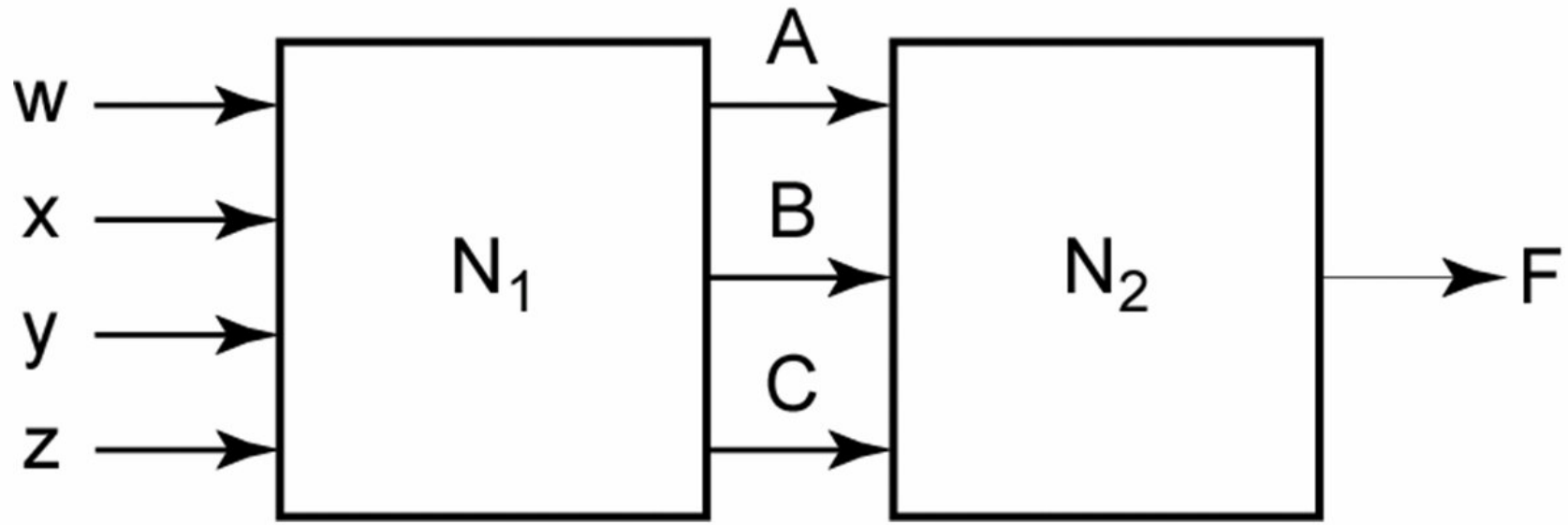

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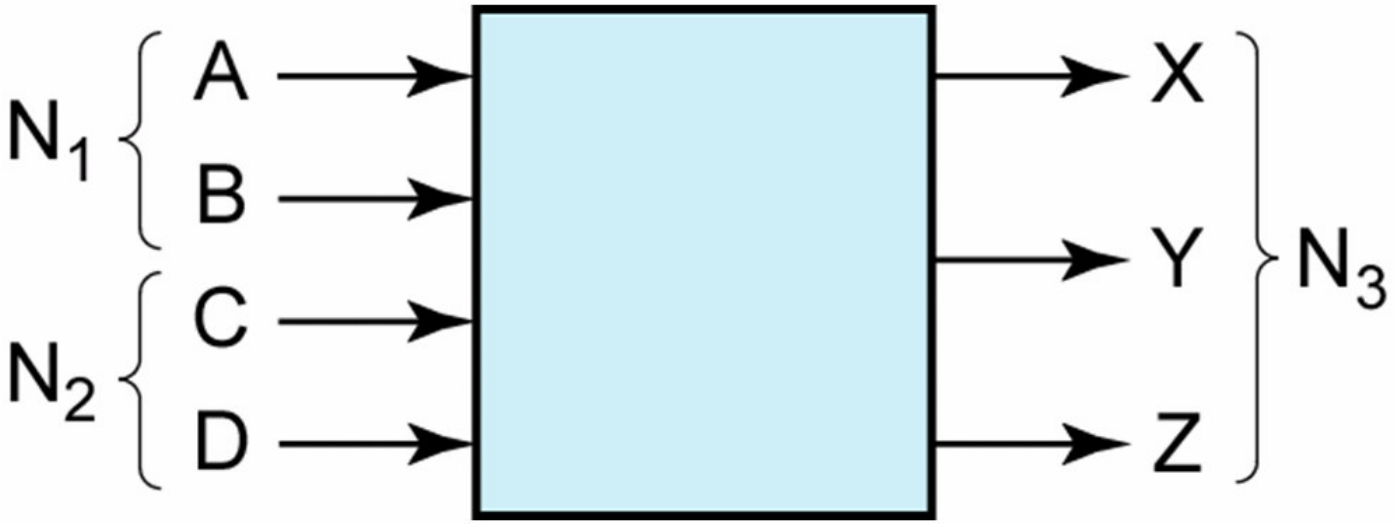
Table 4-5. Truth Table with Don't Cares

A	*B*	*C*	*F*
0	0	0	1
0	0	1	X
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	X
1	1	1	1



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TRUTH TABLE:

N_1		N_2		N_3		
A	B	C	D	X	Y	Z
0	0	0	0	0	0	0
0	0	0	1	0	0	1
0	0	1	0	0	1	0
0	0	1	1	0	1	1
0	1	0	0	0	0	1
0	1	0	1	0	1	0
0	1	1	0	0	1	1
0	1	1	1	1	0	0

TRUTH TABLE:

N_1		N_2		N_3		
A	B	C	D	X	Y	Z
1	0	0	0	0	1	0
1	0	0	1	0	1	1
1	0	1	0	1	0	0
1	0	1	1	1	0	1
1	1	0	0	0	1	1
1	1	0	1	1	0	0
1	1	1	0	1	0	1
1	1	1	1	1	1	0

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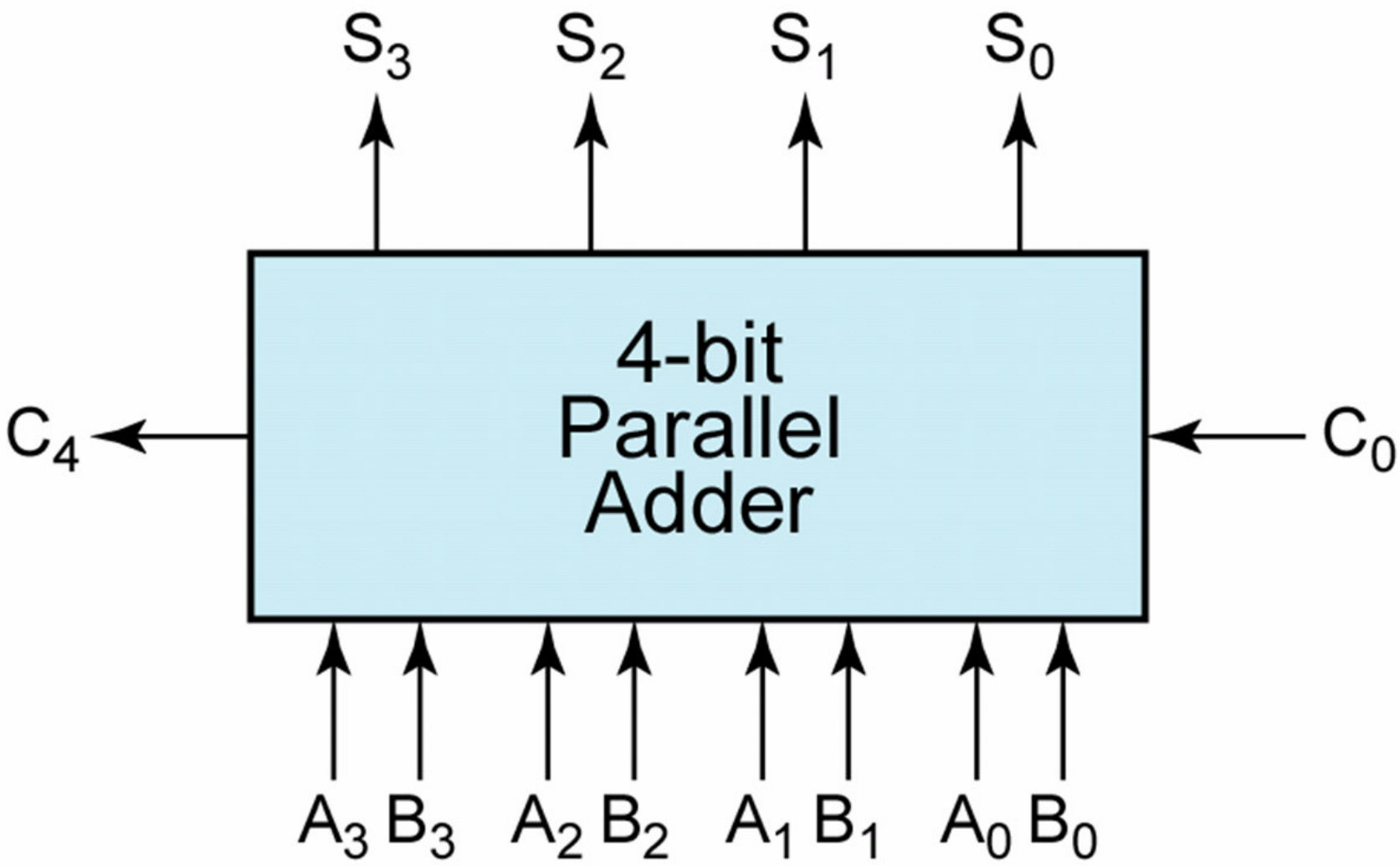


Figure 4-2: **Parallel Adder for 4-Bit Binary Numbers**

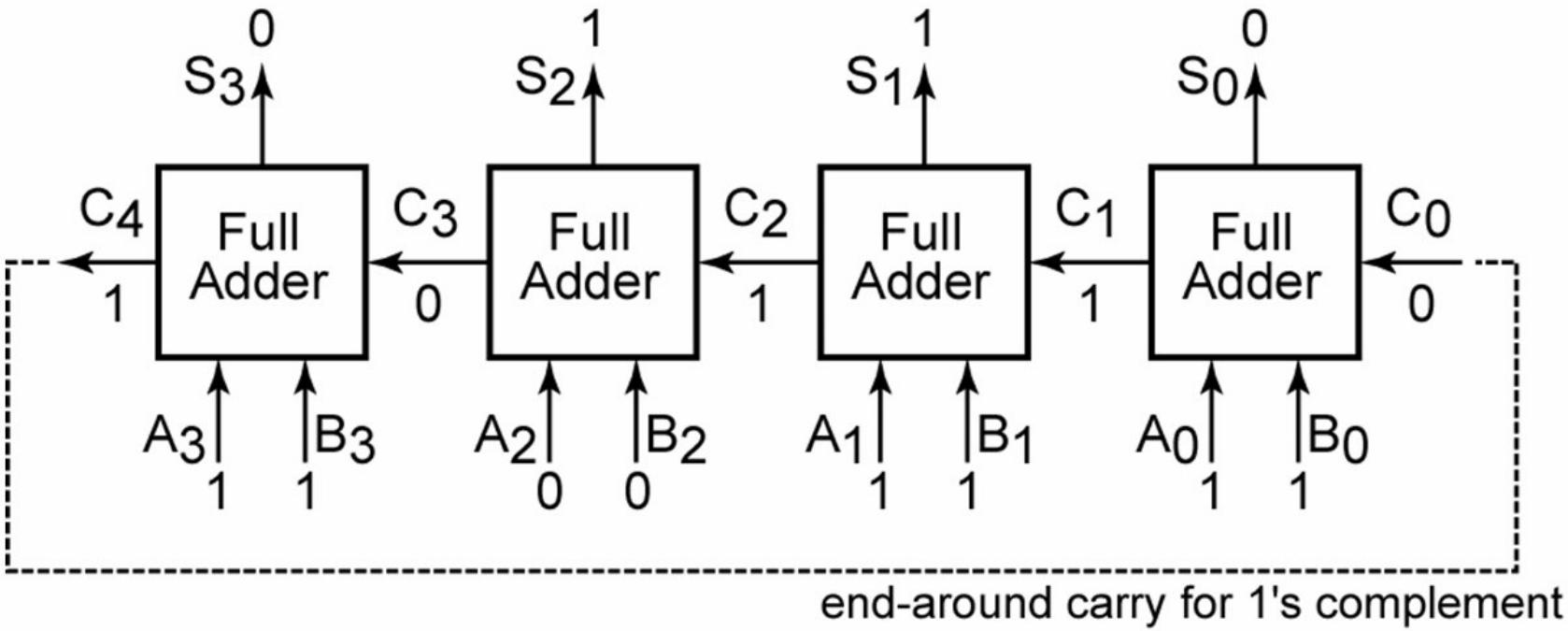
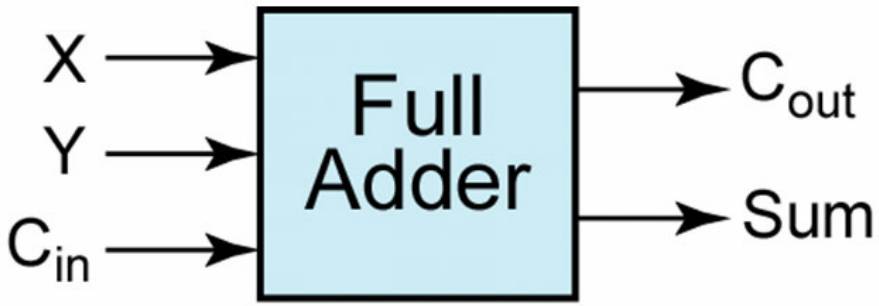


Figure 4-3: **Parallel Adder Composed of Four Full Adders**



X	Y	C_{in}	C_{out}	Sum
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

Figure 4-4: **Truth Table for a Full Adder**

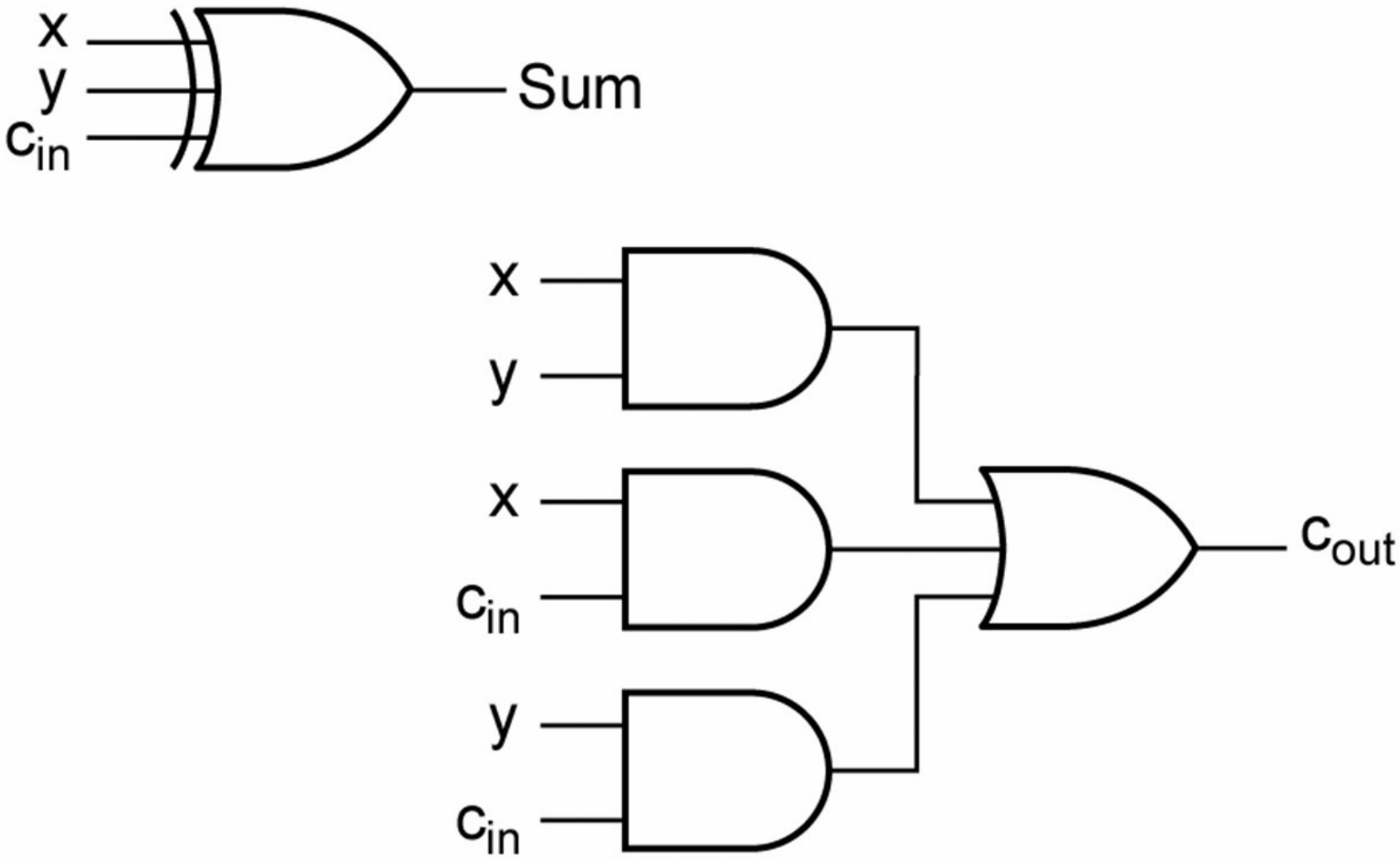


Figure 4-5: **Implementation of Full Adder**

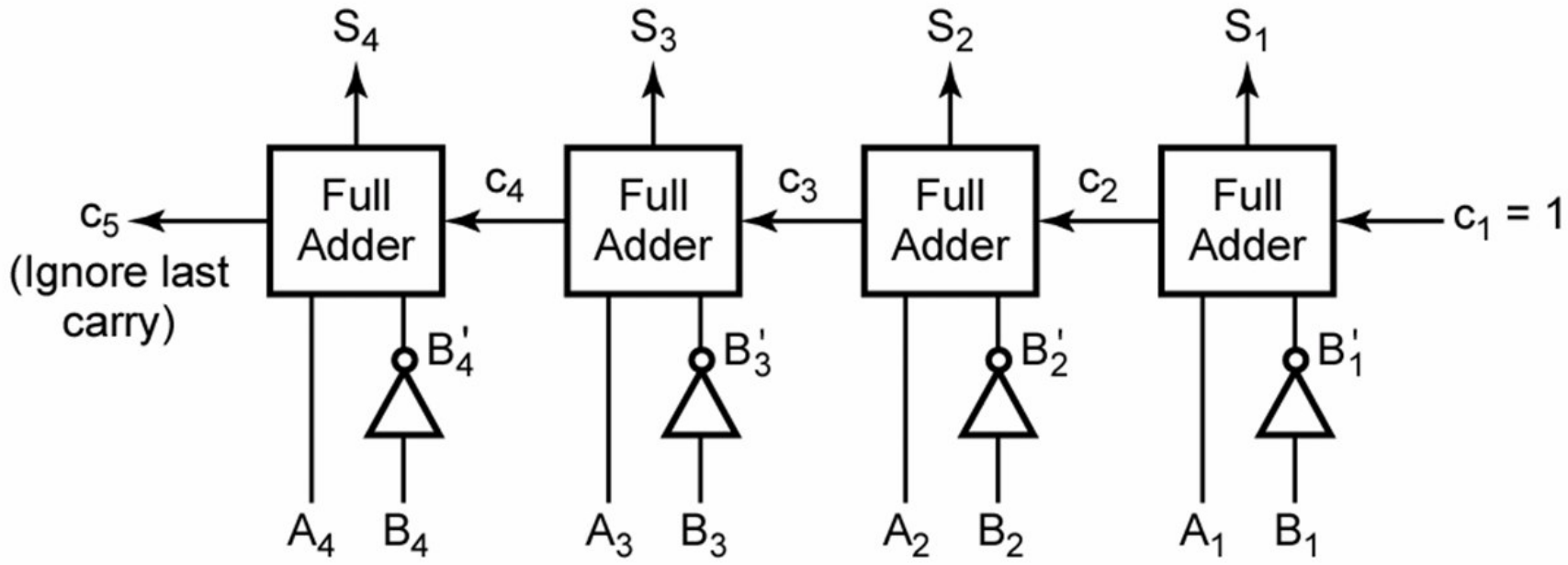


Figure 4-6: **Binary Subtracter Using Full Adders**

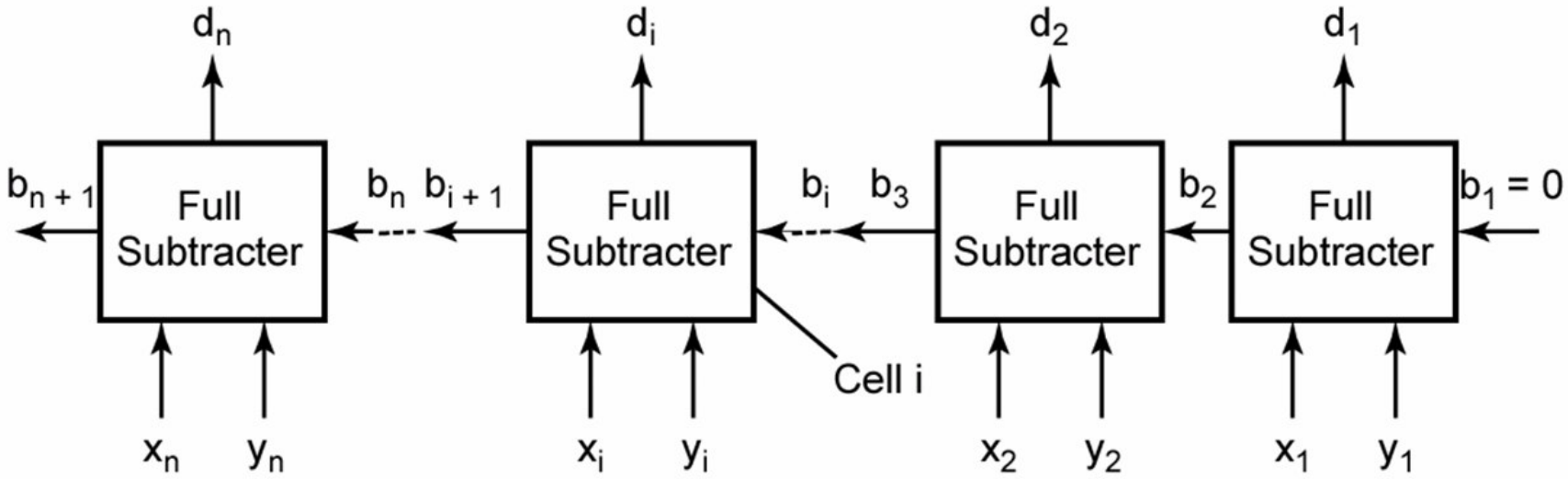


Figure 4-7: **Parallel Subtracter**

Table 4.6. Truth Table for Binary Full Subtracter

x_i	y_i	b_i	b_{i+1}	d_i
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	1	0
1	0	0	0	1
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1