

UiO • Institutt for informatikk

Det matematisk-naturvitenskapelige fakultet

IN1020

Binær addisjon



Binær adder

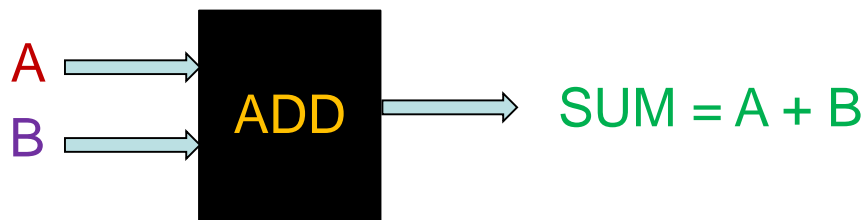
En av de mest brukte digitale kretser

Vanlige anvendelser:

Mikroprosessor ALU / Xbox / mikserbord / digitalt kommunikasjonsutstyr / AD-DA omformere osv...

- Basis for addisjon / subtraksjon / multiplikasjon / divisjon og mange andre matematiske operasjoner
- All form for filtrering / signalbehandling

Prosedyren for binær addisjon er identisk med prosedyren for desimal addisjon.



Eksempel: Legger sammen $A=5$ og $B=13$:

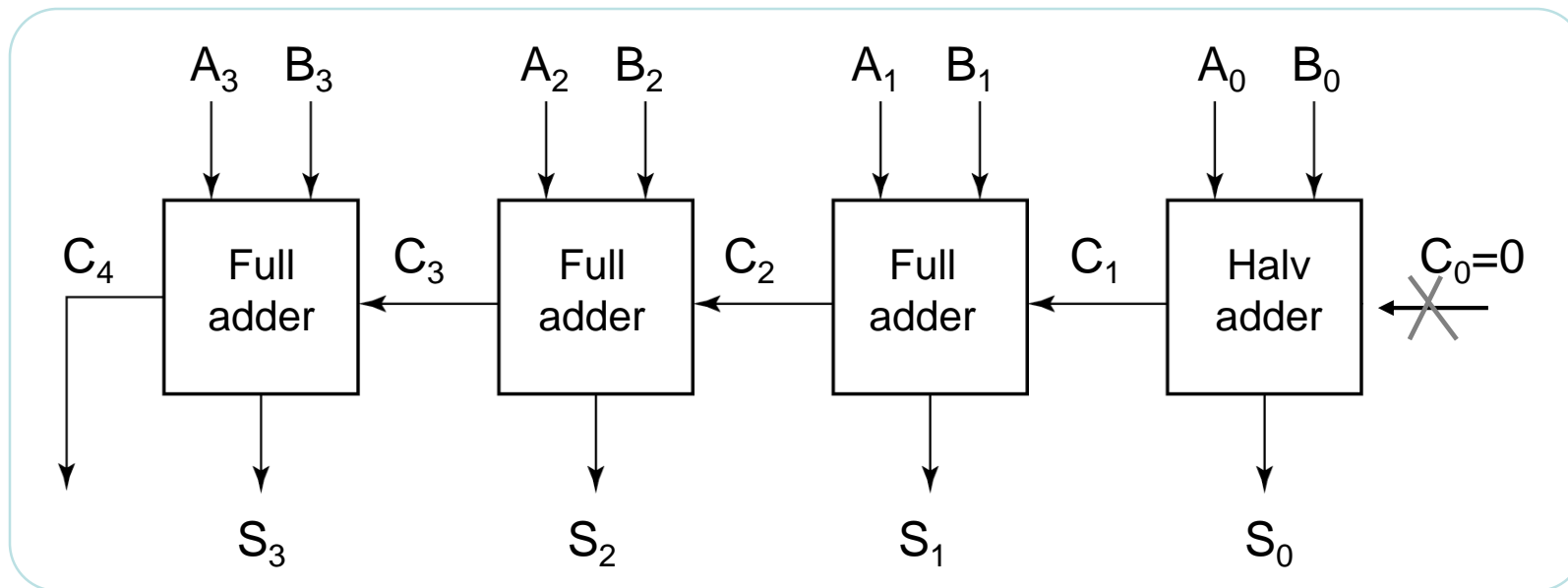
MENTE		1	1	0	1	
	Tallverdi	Bit 4 16	Bit 3 8	Bit 2 4	Bit 1 2	Bit 0 1
A	5	0	0	1	0	1
B	13	0	1	1	0	1
SUM	18	1	0	0	1	0
		Fulladder	Fulladder	Fulladder	Fulladder	Halvadder

Et adder system

Systemelementer:

Halvadder: Tar ikke mente inn

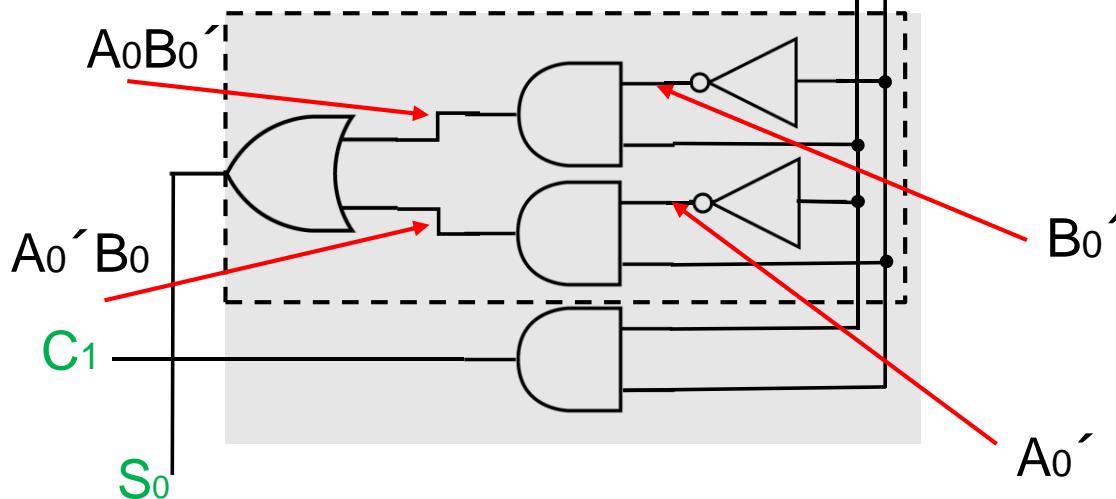
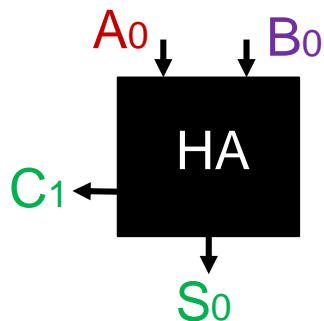
Fulladder: Tar mente inn



Halvadder HA (ingen mente inn)

Adderer sammen de to minst signifikante bittene A_0 og B_0 .

2 innganger og 2 utganger



A_0	B_0	Verdi	C_1	S_0
0	0	0	0	0
0	1	1	0	1
1	0	1	0	1
1	1	2	1	0

FUNKSJON

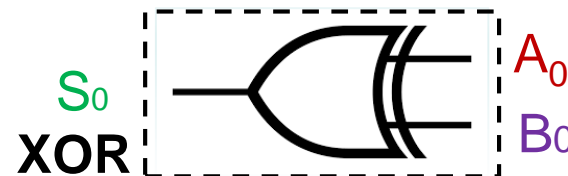
AND

XOR

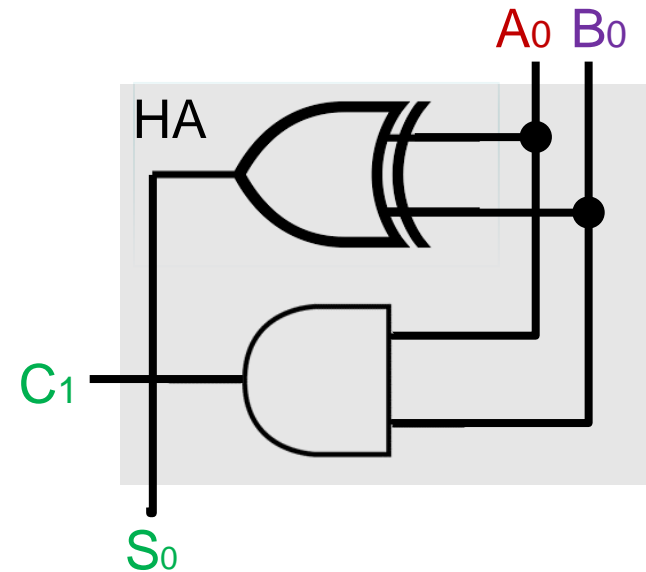
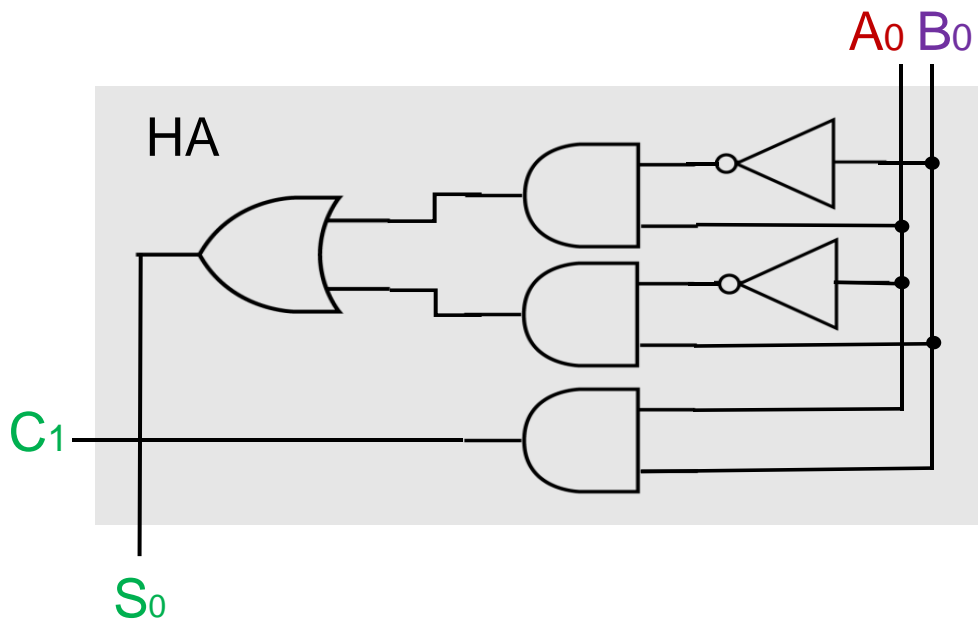
$$A_0 B_0$$

$$A_0' B_0 + A_0 B_0'$$

$S_0 = A_0' B_0 + A_0 B_0'$		
$A \setminus B$	$B=0$	$B=1$
$A=0$	0	1
$A=1$	1	0

$$A_0 \oplus B_0 \equiv A_0' B_0 + A_0 B_0'$$


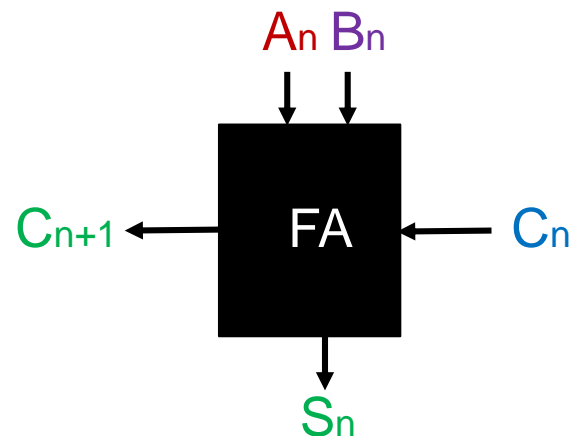
Halvadder implementasjon



Fulladder FA SUM

Adderer sammen bit A_n , B_n og C_n

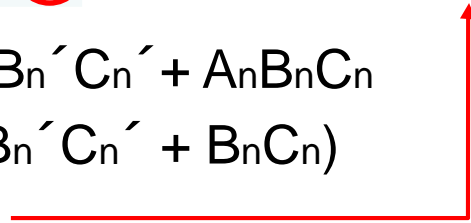
A_n	B_n	C_n	C_{n+1}	S_n
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1



$A_n \oplus B_n \oplus C_n$				
	$B_n C_n$	$B_n C_n$	$B_n C_n$	$B_n C_n$
A_n	=00	=01	=11	=10
$A_n=0$	0	1	0	1
$A_n=1$	1	0	1	0

$$\begin{aligned}
 S_n &= A_n' (B_n \oplus C_n) + A_n (B_n \oplus C_n)' \\
 &= A_n \oplus (B_n \oplus C_n) \\
 &= A_n \oplus B_n \oplus C_n \\
 &= (A_n \oplus B_n) \oplus C_n
 \end{aligned}$$

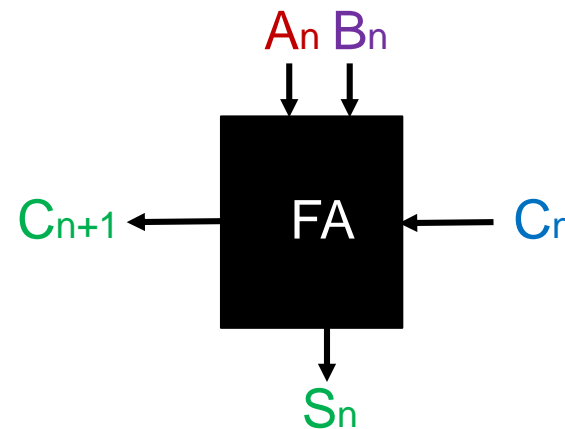
$$\begin{aligned}
 S_n &= A_n' B_n' C_n + A_n' B_n C_n' + A_n B_n' C_n' + A_n B_n C_n \\
 &= A_n' (B_n' C_n + B_n C_n') + A_n (B_n' C_n' + B_n C_n) \\
 &= A_n' (B_n \oplus C_n) + A_n (B_n \oplus C_n)' \\
 &= A_n \oplus (B_n \oplus C_n)
 \end{aligned}$$



Fulladder FA MENTE

Adderer sammen bit A_n , B_n og C_n

3 innganger og 2 utganger



A_n	B_n	C_n	C_{n+1}	S_n
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

$C_{n+1} = B_n C_n + A_n C_n + A_n B_n$				
	$B_n C_n$	$B_n C_n$	$B_n C_n$	$B_n C_n$
A_n	=00	=01	=11	=10
$A_n=0$	0	0	1	0
$A_n=1$	0	1	1	1

$$C_{n+1} = B_n C_n + A_n C_n + A_n B_n$$

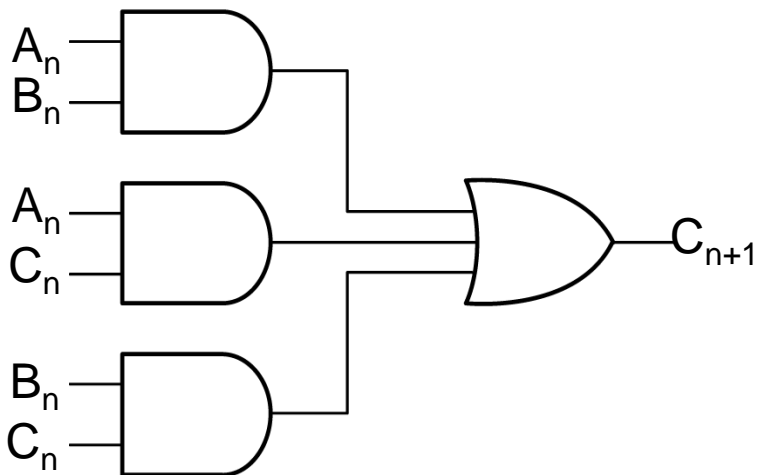
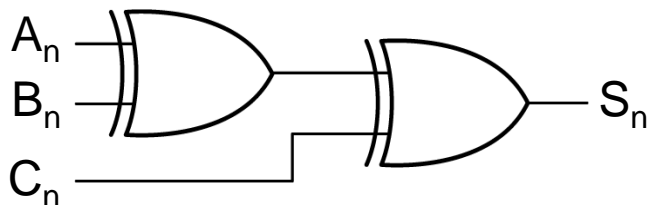
$$C_{n+1} = C_n(A_n \oplus B_n) + A_n B_n$$

$$\begin{aligned} C_{n+1} &= A_n' B_n C_n + A_n B_n' C_n + A_n B_n C_n' + A_n B_n C_n \\ &= C_n(A_n' B_n + A_n B_n') + A_n B_n(C_n' + C_n) \\ &= C_n(A_n \oplus B_n) + A_n B_n \end{aligned}$$

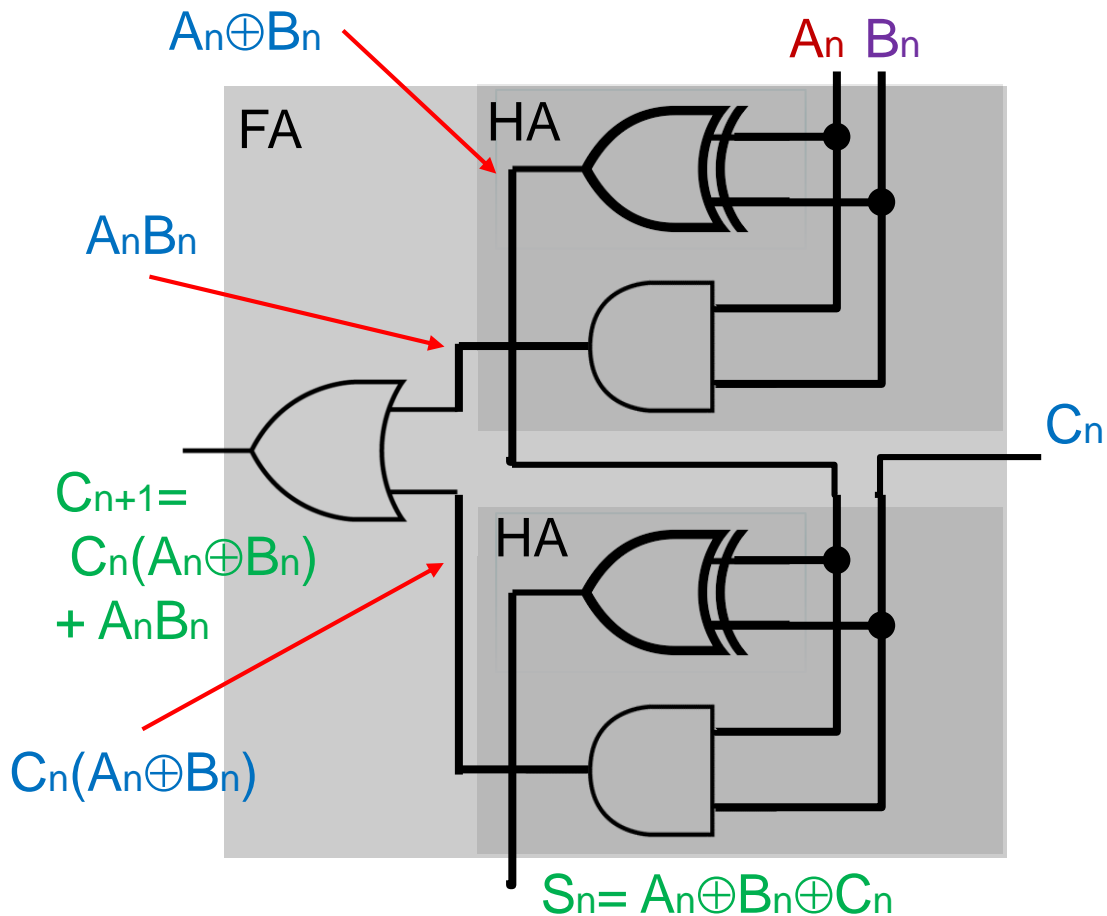
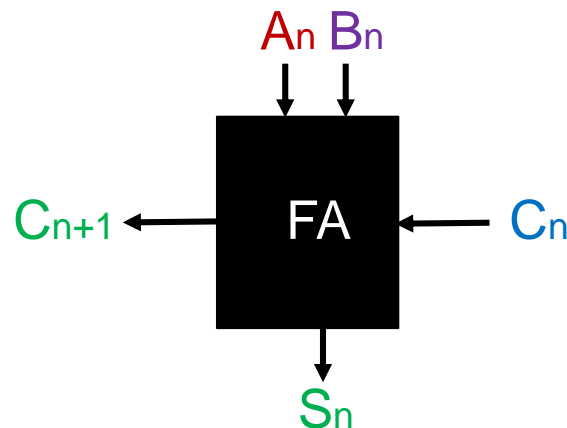
Fulladder FA

Adderer sammen bit A_n , B_n og C_n

$$S_n = A_n \oplus B_n \oplus C_n$$



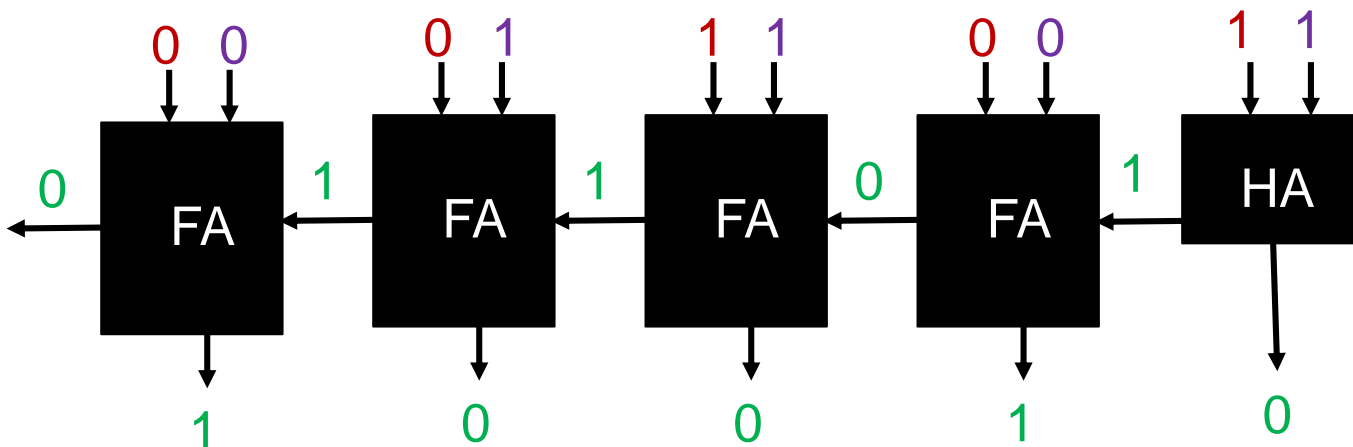
$$C_{n+1} = B_n C_n + A_n C_n + A_n B_n$$



Eksempel: Legger sammen $A=5$ og $B=13$:

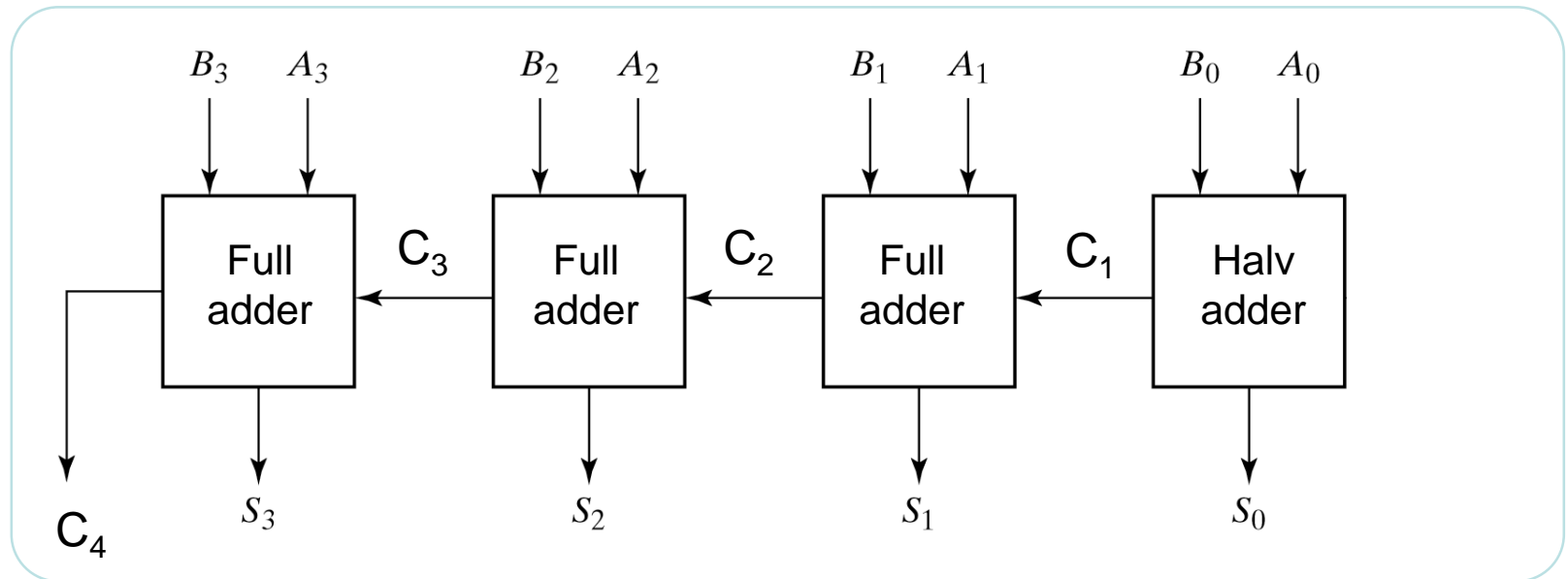
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Fulladder Fulladder Fulladder Fulladder Halvadder



Menteforplantning

4-bits binær adder



Menteforplantning

Portforsinkelse gir menteforplantning (rippeladder)

Eksempel

Adderer 0101 og 1011

