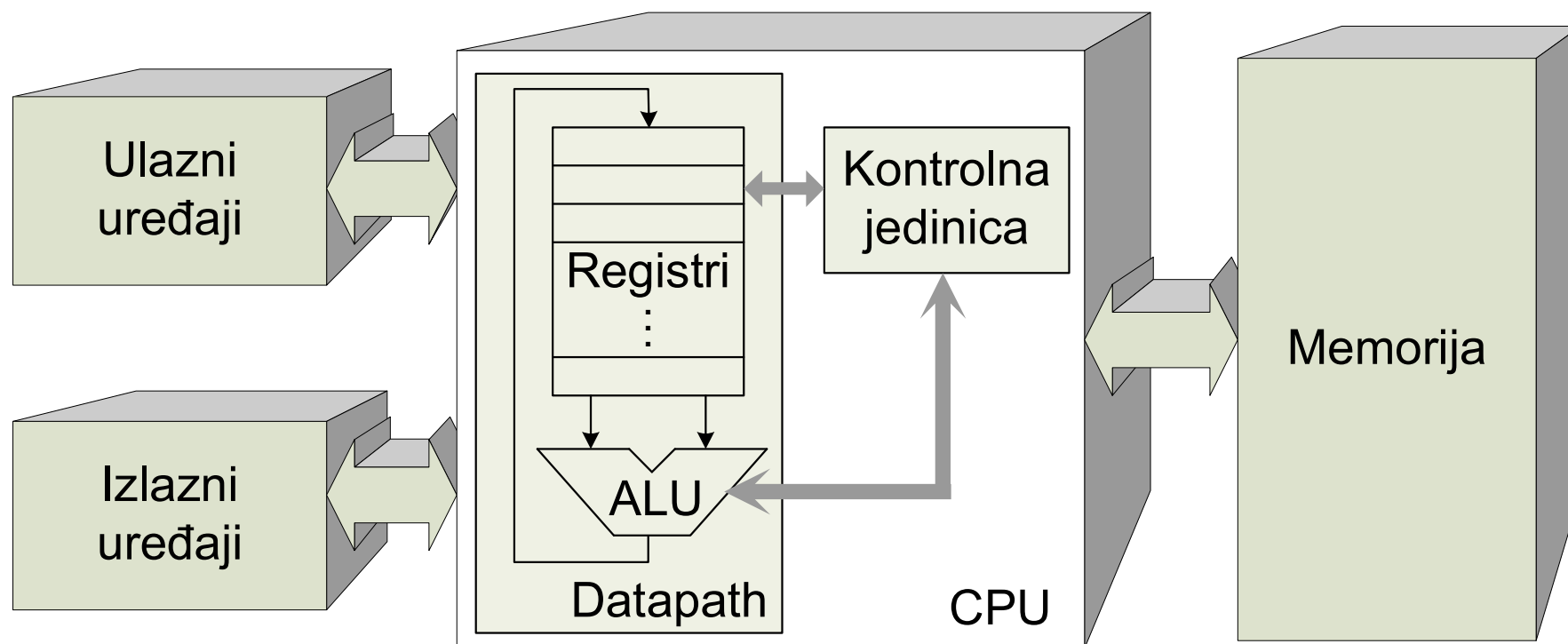




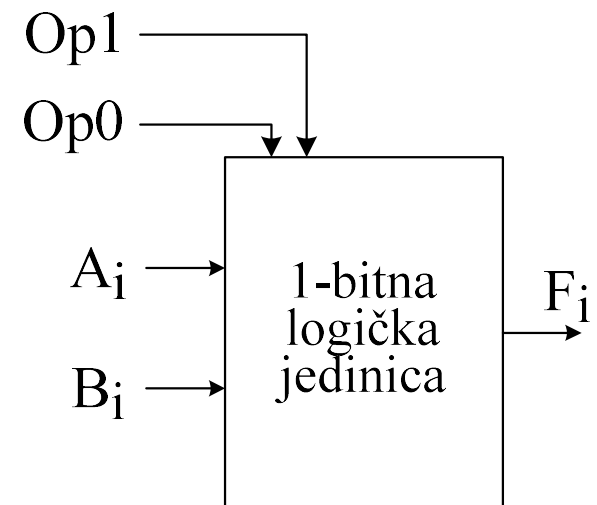
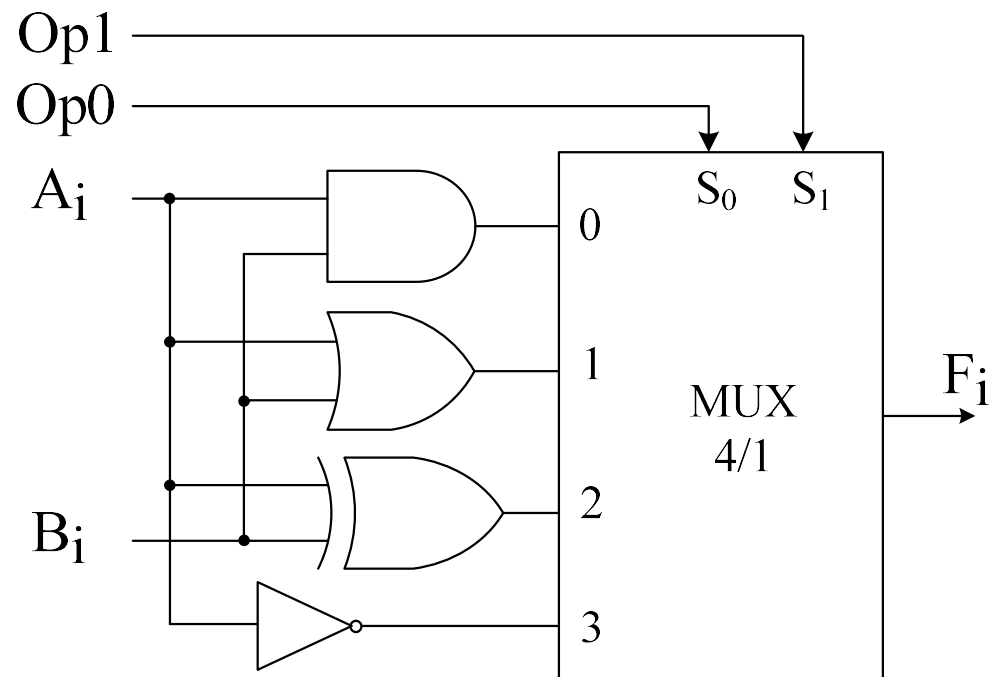
Osnovi računarstva I

**Centralna procesorska jedinica
I dio: Datapath (Procesorska jed.)**

Sažeti pogled na logičku strukturu računarskog sistema

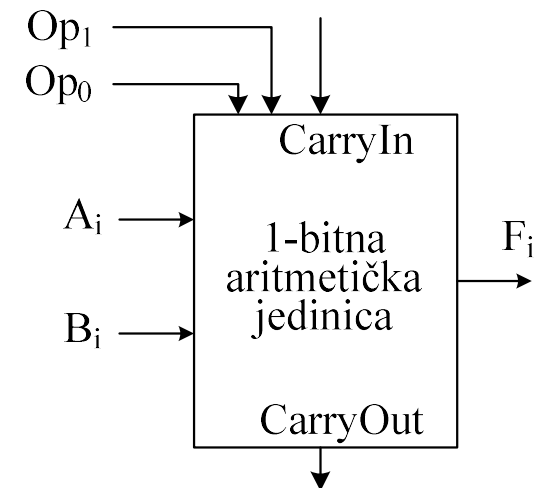
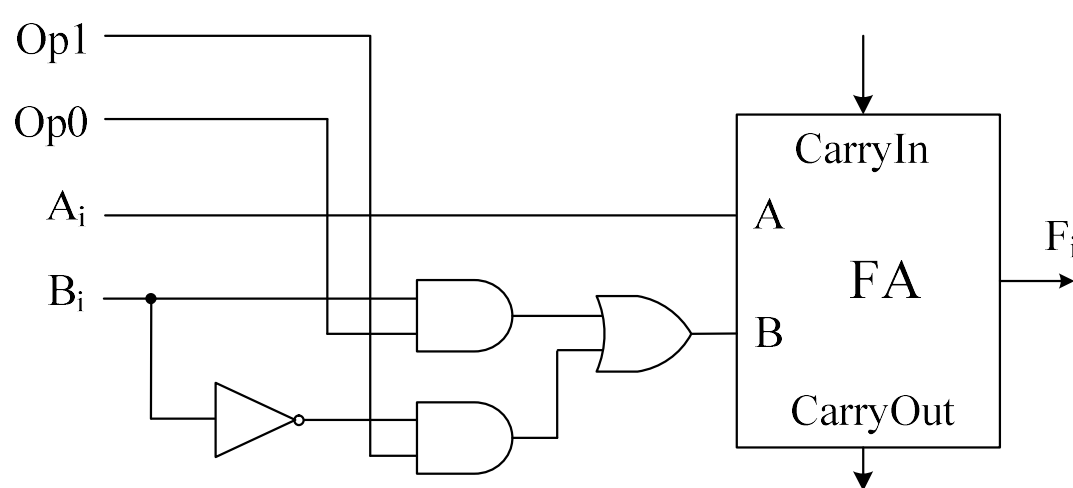


1-bitna logička jedinica



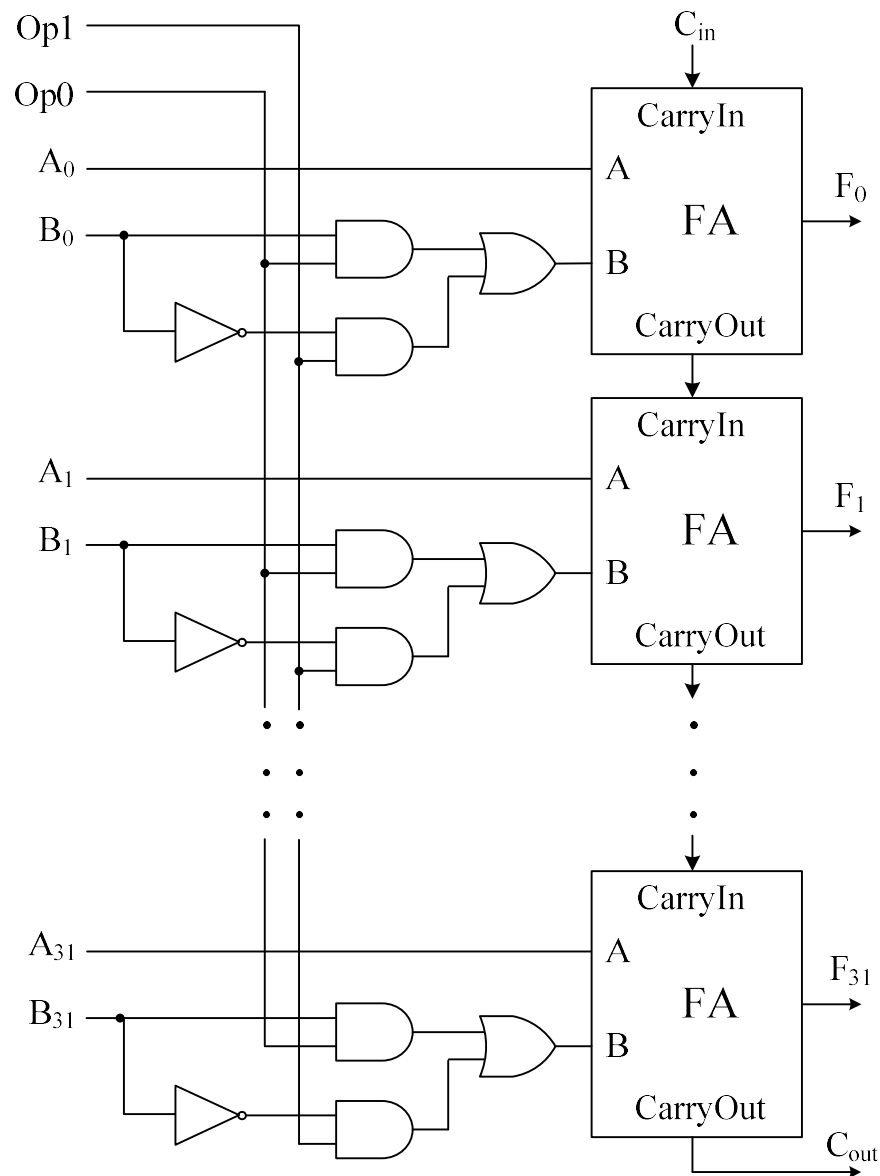
Op1	Op0	F_i
0	0	$A_i \wedge B_i$
0	1	$A_i \vee B_i$
1	0	$A_i \oplus B_i$
1	1	$\bar{A}_i = \text{com}(A_i)$

1-bitna aritmetička jedinica



Op1	Op0	F _i
0	0	$A_i + \text{CarryIn}_i$
0	1	$A_i + B_i + \text{CarryIn}_i$
1	0	$A_i + \bar{B}_i + \text{CarryIn}_i$
1	1	$A_i + 1 + \text{CarryIn}_i$

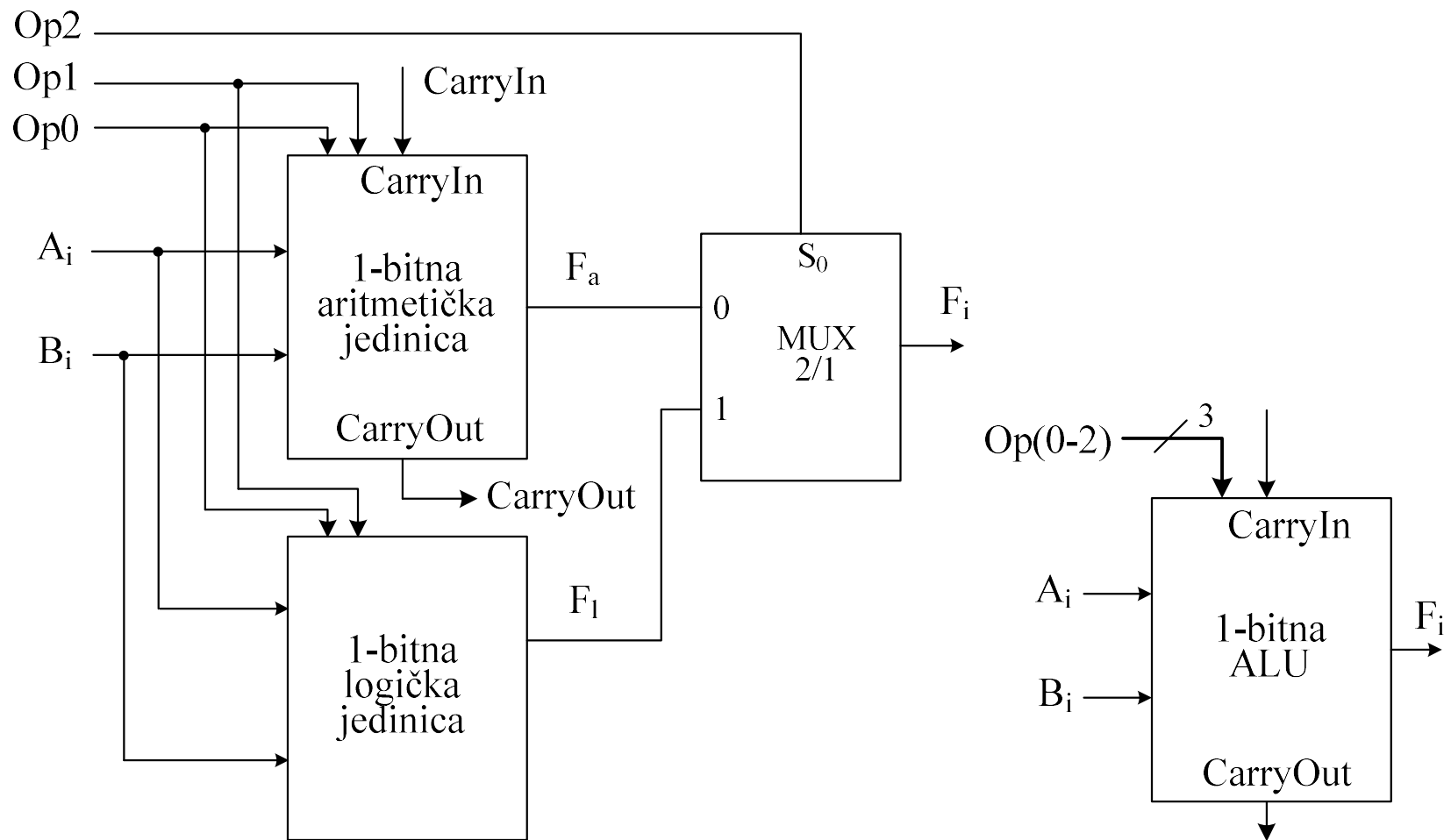
32-bitna aritmetička jedinica



Op1	Op0	F_i
0	0	$A_i + \text{CarryIn}_i$
0	1	$A_i + B_i + \text{CarryIn}_i$
1	0	$A_i + \bar{B}_i + \text{CarryIn}_i$
1	1	$A_i + 1 + \text{CarryIn}_i$

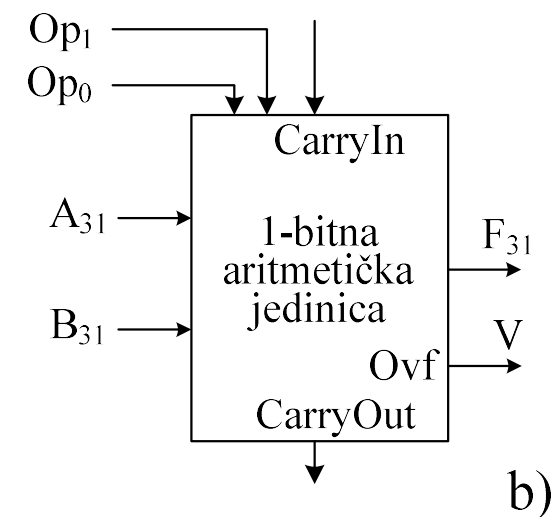
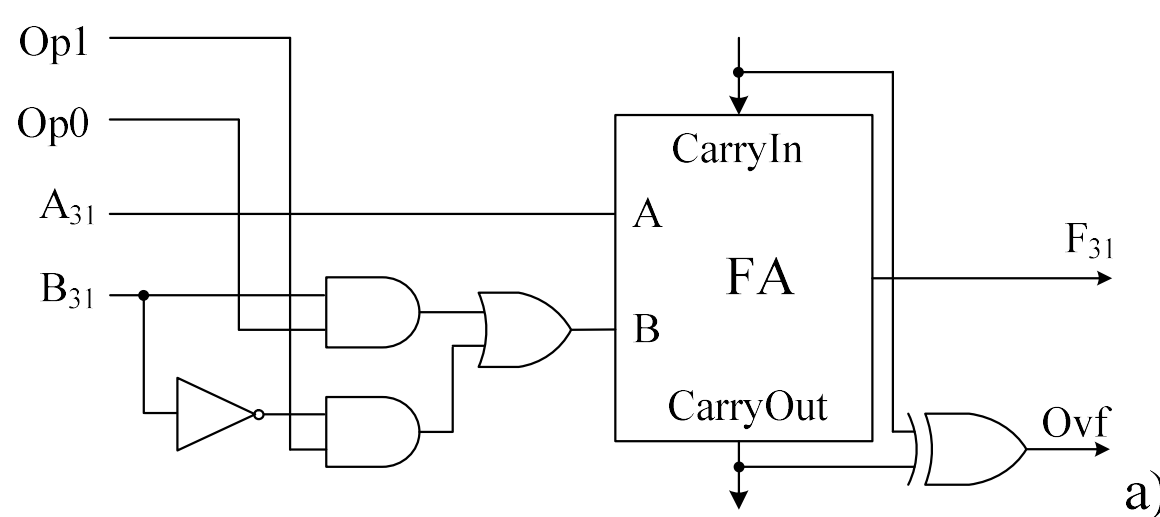
Op1	Op0	C_{in}	F
0	0	0	A
0	0	1	A+1
0	1	0	A+B
0	1	1	A+B+1
1	0	0	$A + \bar{B}$
1	0	1	$A + \bar{B} + 1 = A - B$
1	1	0	$A + 11..1 = A - 1$
1	1	1	$A - 1 + 1 = A$

1-bitna ALU

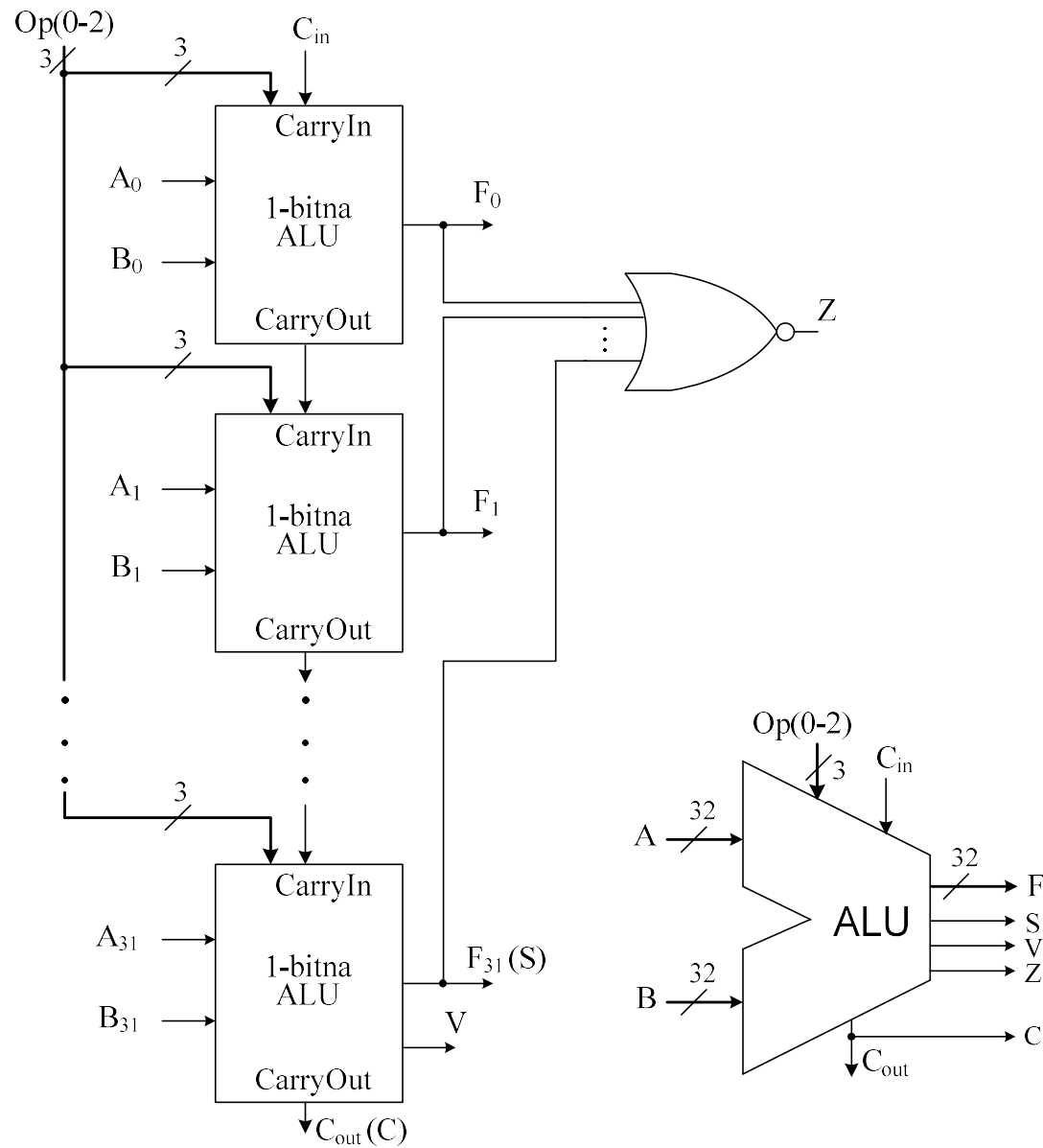


1-bitna aritmetička jedinica na MSB modifikovana u cilju detektovanja Overflow-a (generisanja V bita)

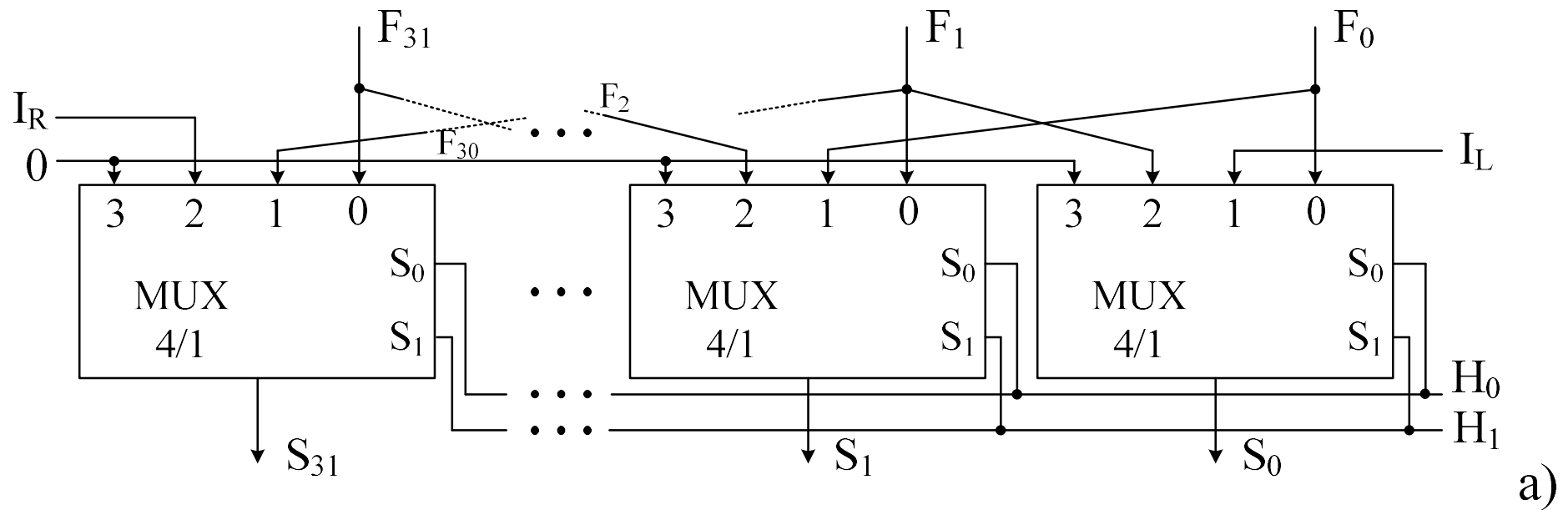
Napomena: $Ovf = CarryIn_{31} \oplus CarryOut_{31} = CarryIn_{31} \oplus C_{out}$



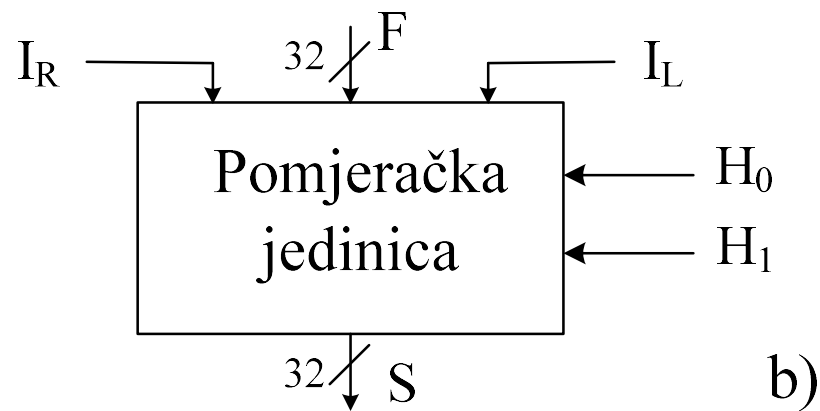
32-bitna ALU

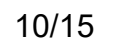


Pomjeračka jedinica



H1	H0	S
0	0	$S \leftarrow F$
0	1	$S \leftarrow \text{shl}(F)$
1	0	$S \leftarrow \text{shr}(F)$
1	1	$S \leftarrow 0$







Kontrolna riječ

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A			B			D			F			H			

Bin. kod	A	B	D	F		H
				$C_{in}=0$	$C_{in}=1$	
000	Ulaz	Ulaz	Izlaz	$F=A$	$F=A+1$	$S \leftarrow F$
001	R1	R1	R1	$F=A+B$	$F=A+B+1$	$S \leftarrow \text{shl}(F)$
010	R2	R2	R2	$F = A + \bar{B}$	$F=A-B$	$S \leftarrow \text{shr}(F)$
011	R3	R3	R3	$F=A-1$	$F=A$	$S \leftarrow 0$
100	R4	R4	R4	$F = A \wedge B$	$\times$	$S \leftarrow \text{rlc}(F)$
101	R5	R5	R5	$F = A \vee B$	$\times$	$S \leftarrow \text{rol}(F)$
110	R6	R6	R6	$F = A \oplus B$	$\times$	$S \leftarrow \text{ror}(F)$
111	R7	R7	R7	$F = \bar{A}$	$\times$	$S \leftarrow \text{rrc}(F)$



Nazivi osnovnih aritmetičkih i logičkih operacija

Operacija	Naziv	Značenje
$F=A$	TSF	TranSFer – Prevođenje
$F=A+1$	INC	INCrement – Inkrementiranje
$F=A-1$	DEC	DECrement – Dekrementiranje
$F=A+B$	ADD	ADDition – Sabiranje
$F=A-B$	SUB	SUBstraction – Oduzimanje
$F = A \wedge B$	AND	Logička I operacija
$F = A \vee B$	OR	Logička ILI operacija
$F = A \oplus B$	XOR	EX-ILI operacija
$F = \bar{A}$	COM	COMplement – Komplementiranje



Primjer: Napisati kontrolne riječi koje definišu sljedeće mikrooperacije:

a) $R2 \leftarrow R4 + R5$

Polje:	A	B	D	F	H
Simbol:	R4	R5	R2	$F=A+B$	$S=F$
Kontrolna riječ:	100	101	010	0010	000

b) $R5 \leftarrow R1 - R3$

Polje:	A	B	D	F	H
Simbol:	R1	R3	R5	$F=A-B$	$S=F$
Kontrolna riječ:	001	011	101	0101	000

c) $R1 \leftarrow$ srednja vrijednost pozitivnih brojeva smještenih u R2 i R4

Polje:	A	B	D	F	H
Simbol:	R2	R4	R1	$F=A+B$	$S=\text{shr}(F)$
Kontrolna riječ:	010	100	001	0010	010

Primjer: Napisati kontrolne riječi koje definišu mikrooperaciju:

$$R7 \leftarrow 2R2 - R4$$

Rješenje: 1. Izvršavanja zadate mikrooperacije zahtijeva najprije upotrebu pomjeračke jedinice (u cilju izračunavanja $2R2$), a potom upotrebu ALU (u cilju izračunavanja razlike $(2R2) - R4$).

2. Dizajn datapatha diktira da pomjeračka jedinica radi sa rezultatom ALU, tako da se, u cilju formiranja 1 kontrolne riječi, najprije mora upotrijebiti ALU, a potom pomjeračka jedinica, što NE odgovara zahtjevima zadatka !!

⇒ Mikrooperacija se implementira sa 2 kontrolne riječi:

$$R2 \leftarrow 2R2$$

Polje:	A	B	D	F	H
Simbol:	R2	–	R2	F=A	S=shl(F)
Kontrolna riječ:	010	000	010	0000	001

$$R7 \leftarrow R2 - R4$$

Polje:	A	B	D	F	H
Simbol:	R2	R4	R7	F=A–B	S=F
Kontrolna riječ:	010	100	111	0101	000



Napomena: Veoma slična (naoko malo različita) mikrooperacija

$$R7 \leftarrow 2(R2 - R4)$$

zahtijeva najprije upotrebu ALU (u cilju izračunavanja razlike R2 i R4), a potom i pomjeračke jedinice (u cilju izračunavanja 2-struke razlike).

Dizajn datapatha diktira da pomjeračka jedinica radi sa rezultatom ALU, tako da se, u cilju formiranja 1 kontrolne riječi, najprije mora upotrijebiti ALU, a potom pomjeračka jedinica, što odgovara zahtijevima zadatka !!

⇒ Mikrooperacija se implementira 1 kontrolnom riječi

Polje:	A	B	D	F	H
Simbol:	R2	R4	R7	F=A-B	S=shl(F)
Kontrolna riječ:	010	100	111	0101	001