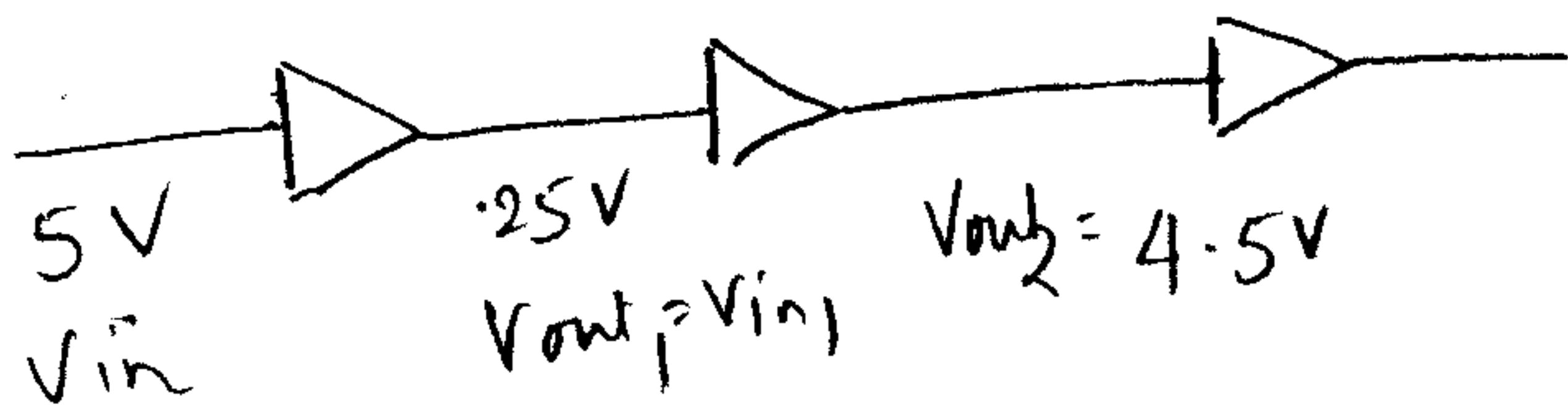


Ans 1: (a) Yes this logic can be safely used to implement all Boolean functions. From the transfer function, given  $V_{in} = V_{DD} = 5V$  and  $V_{in} = 0V$  we can get  $V_{out} = 2.5V$  and  $V_{out} = 4.75V$  which can be safely classified as logic-low and logic-high. Thus safe implementation upto three levels of logic are possible.

(b) No, this logic can't be safely and efficiently used to implement all Boolean functions. Take an inverter chain:



There is a decrease in voltage and at one point, the voltage will go to  $2.5V$ , after that there is no voltage restoration.  $2.5V$  can't be classified as either logic-high or logic-low.

$$\text{Ans 2: } f(a, b, c, d) = \sum (0, 4, 5, 6, 7, 11, 12, 14, 15) + d(2, 3, 13)$$

$cd\backslash ab$	00	01	11	10
00	1 1	1 1	1 0	
01		1	X	
11	X	1	1	1
10	X	1 1	1	

- ①  $b -$
- ②  $cd$
- ③  $\bar{a} \bar{d}$

$$f(a, b, c, d) = (b + cd + \bar{a}\bar{d})$$

$$3. f(a,b,c) = \sum(1, 2, 4, 5) + d(3)$$

$$\begin{array}{r} \\ \Sigma=1 \\ \hline 001 \\ 010 \\ 100 \\ \hline 011 \\ \Sigma=2 \\ 101 \end{array}$$

$$\begin{array}{r} \\ 0x1 \\ x01 \\ 01x \\ 10x \end{array}$$

	0x1	x01	01x	10x
001	✓	✓		
010				✓
100			✓	
101		✓		✓

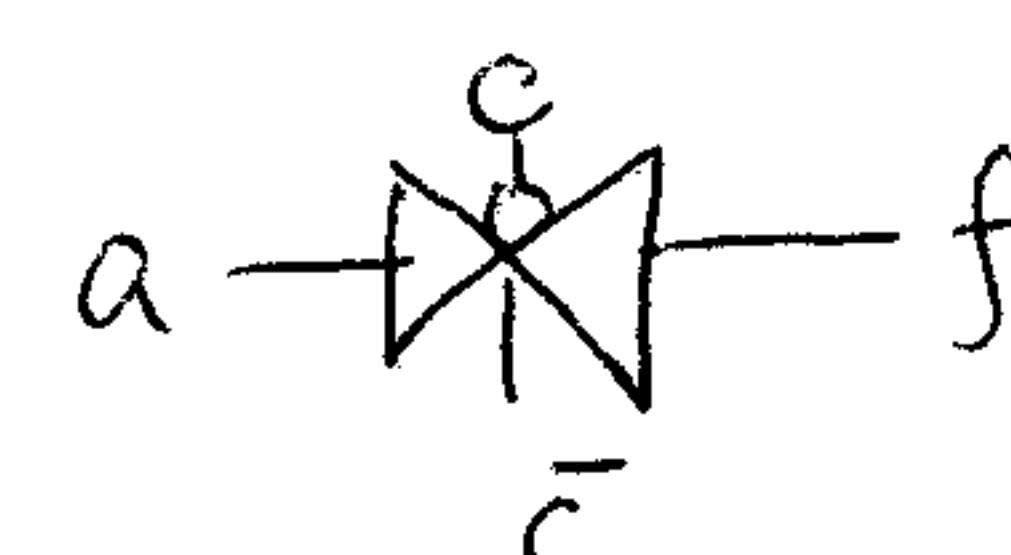
$$f(a,b,c) = \bar{b}c + \bar{a}b + a\bar{b}$$

OR

$$= \bar{a}c + \bar{a}b + ab$$

5. No, by comparing the truth table of Transmission Gate and 2-input NAND gate, we can find that NAND does not

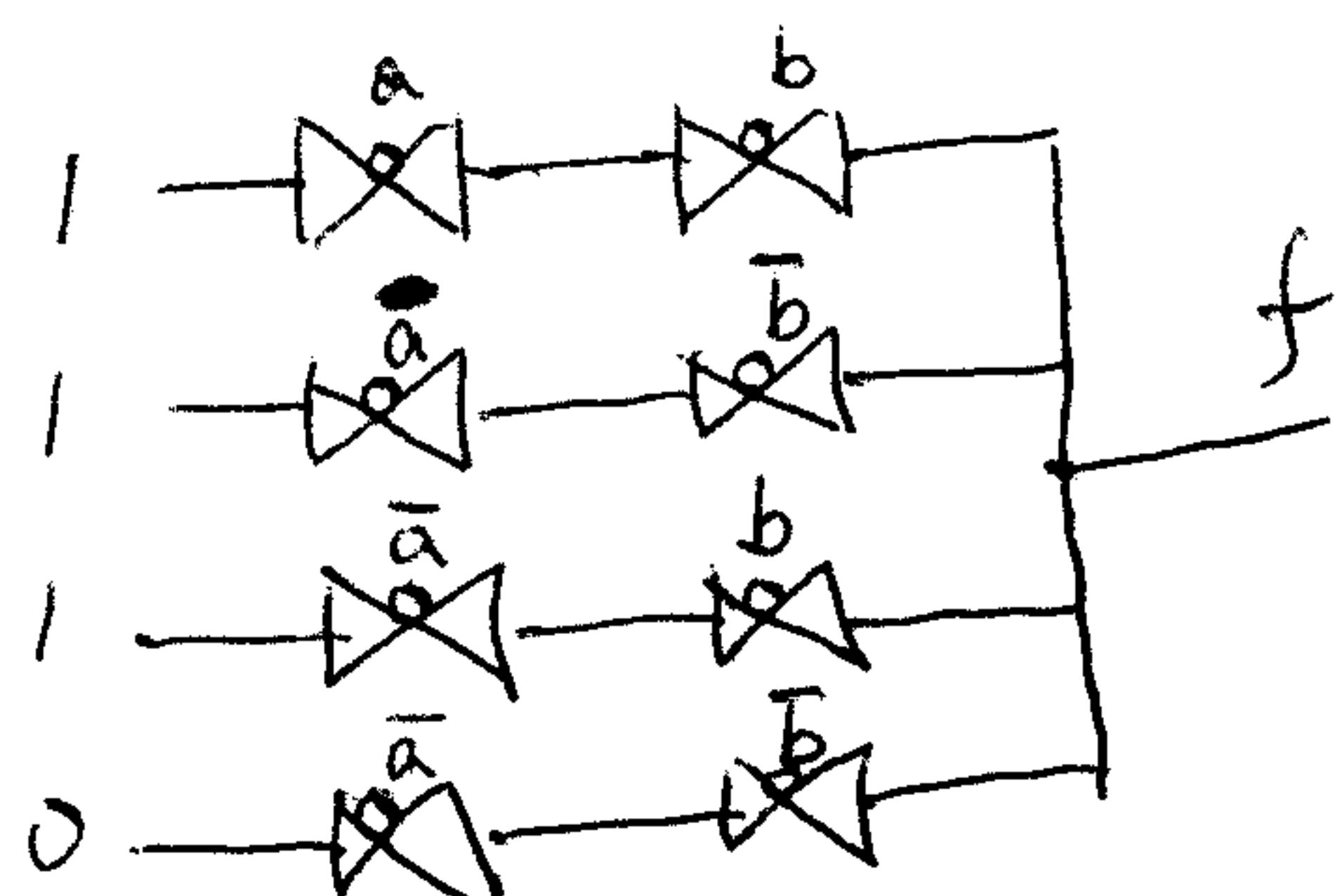
a	b	f	a	c	f
0	0	1	0	0	0
0	1	1	0	1	High-Z
1	0	1	1	0	1
1	1	0	1	1	High-Z.



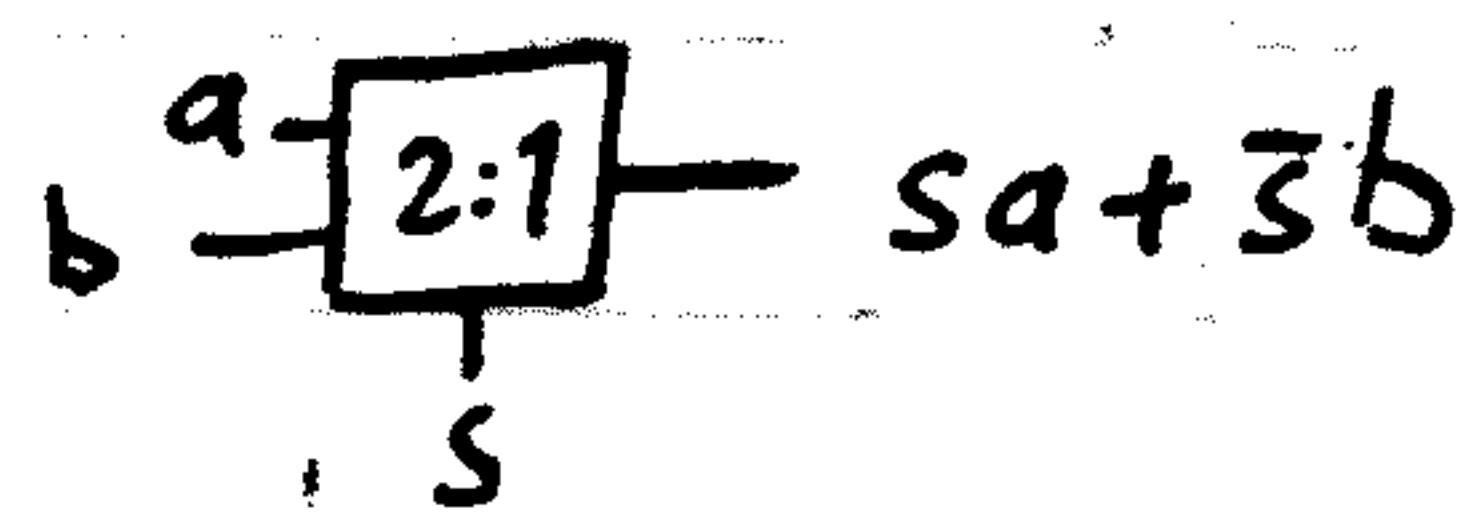
have High-Z,  
which is necessary  
for TG.



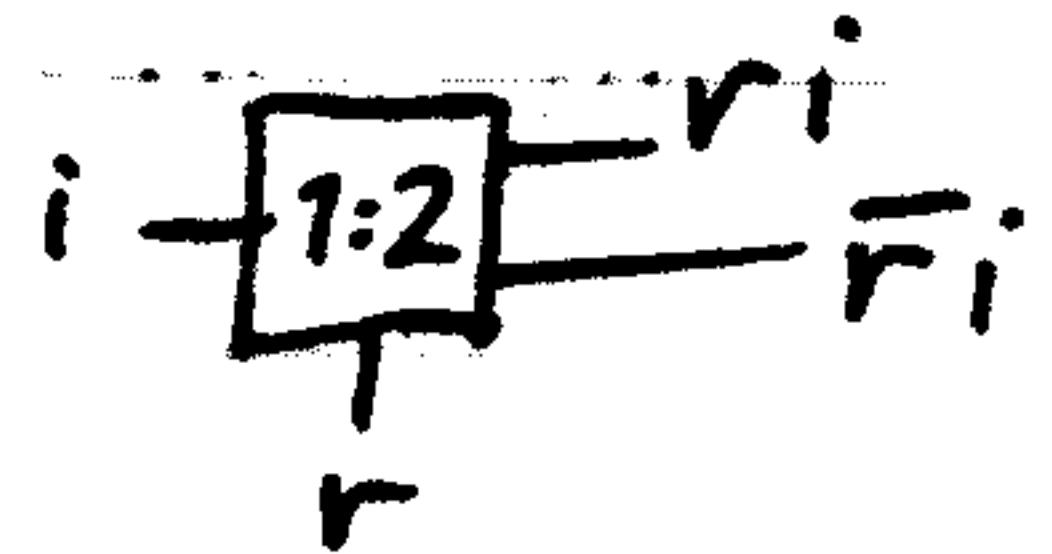
6. Yes.



4) For 2:1 MUX

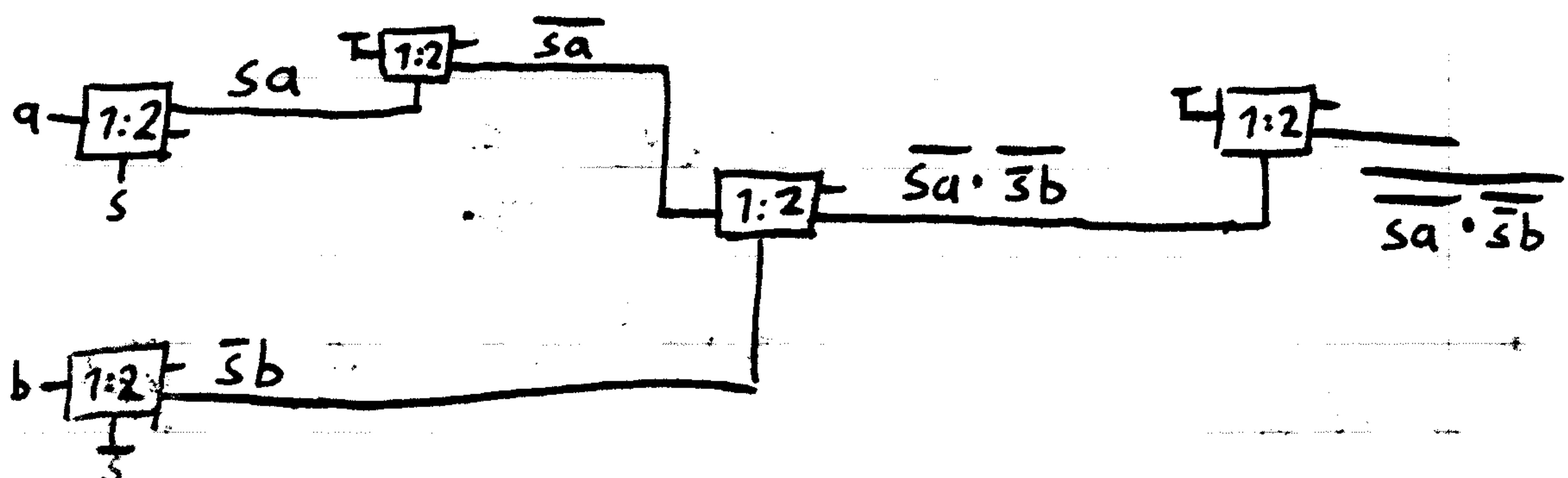


Can use 1:2 DEMUX only



Building blocks:  $r_i, f_i$

$$f = sa + \bar{s}b = \overline{\overline{sa + \bar{s}b}} = \overline{\overline{sa} \cdot \overline{\bar{s}b}}$$

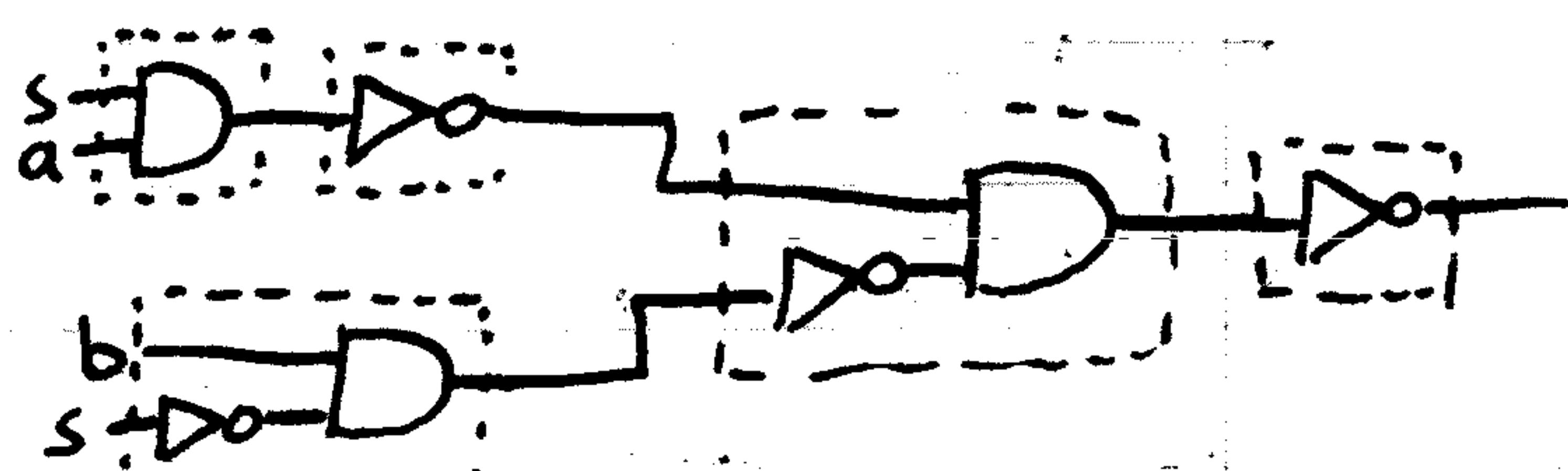


Could also view problem this way:

$$p - \boxed{1:2} - f = \frac{p}{q} D - f$$

$$\boxed{1:2} - f = p - \rightarrow D - f$$

$$p - \boxed{1:2} - f = q \rightarrow D - f$$



7)

$$a \xrightarrow{q} f = a \xrightarrow{q} b \xrightarrow{q} f$$

$$b \xrightarrow{q} f = b \xrightarrow{q} a \xrightarrow{q} f$$

$$b \xrightarrow{q} [2:1] f = a \xrightarrow{s} b \xrightarrow{q} f$$

$$c_0 \xrightarrow{[FA]} c_i = b \xrightarrow{q} c_i \xrightarrow{D} s$$

$$c_0 = \overline{b} \oplus \overline{c_i} \oplus \overline{c_i} \cdot b$$

$$c_0 \xrightarrow{[3CC]} c_i = a \xrightarrow{q} c_i \xrightarrow{q} s$$

$$c_0 = \overline{a_2 b_2} \oplus \overline{a_1 b_1} \oplus \overline{a_0 b_0} \xrightarrow{Q} c_i$$

$$a_{5..3} b_{5..3} \xrightarrow{[3CC]} x_3$$

$$a_{5..3} b_{5..3} \xrightarrow{[3CC]} x_2$$

$$a_{2..0} b_{2..0} \xrightarrow{[3CC]} x_3$$

$$WMUX$$

$$Q \ x_3 \\ S_{5..3}$$

$$a \xrightarrow{q} b \xrightarrow{q} WMUX \xrightarrow{s} \dots$$

$$\begin{aligned} a_0 &\xrightarrow{2:1} f_0 \\ b_0 &\xrightarrow{2:1} f_1 \\ a_1 &\xrightarrow{2:1} f_2 \\ b_1 &\xrightarrow{2:1} f_3 \\ a_2 &\xrightarrow{2:1} f_4 \\ b_2 &\xrightarrow{2:1} f_5 \\ a_3 &\xrightarrow{2:1} f_6 \\ b_3 &\xrightarrow{2:1} f_7 \end{aligned}$$