
Solution 12.1

The function of the gate is $F = AB \vee C$. The CLK generates a clock feedthrough from Low to High. The PMOS is in the linear range and its gate capacity is divided equally between drain and source. $C_{GD} = C_f = C_g W_P / 2 = (2\text{fF}/\mu\text{m})(16)(0.05\mu\text{m})/2 = 0.8\text{fF}$ and the capacity to GND at node X (without source/drain sharing) $C_{GND} = C_{\text{eff}}(16\lambda + 16\lambda + 8\lambda) + C_g(8\lambda + 4\lambda) = (1\text{fF}/\mu\text{m})(40)(0.05\mu\text{m}) + (2\text{fF}/\mu\text{m})(12)(0.05\mu\text{m}) = 3.2\text{fF}$. The voltage change ΔV_X is generated at node X

$$\Delta V_X = \frac{C_f \cdot \Delta V_{\text{CLK}}}{C_f + C_{\text{GND}}} = \frac{(0.8\text{fF})(1.2\text{V})}{0.8\text{fF} + 3.2\text{fF}} = 0.24\text{V}.$$

The new value at node X is $1.2\text{V} + 0.24\text{V} = 1.44\text{V}$, which is above V_{DD} . This does not degrade Logical One. With the worst-case assignment $V_X = 1.2\text{V}$, $A = 1$ and $B = C = 0$, the capacity $C_X = 3.2\text{fF}$ and the capacity $C_Y = (1\text{fF}/\mu\text{m})(16\lambda) = 16 \cdot (0.05) = 0.8\text{fF}$ at node Y, the new voltage $V^* = C_X(1.2\text{V})/(C_X + C_Y) = 3.2 \cdot 1.2\text{V}/(0.8 + 3.2) = 0.96\text{V}$ results from batch sharing. However, since the maximum voltage $V_Y = V_{\text{DD}} - V_{\text{TN}} = 0.73\text{V}$ can be set at node Y, the remaining charge $Q_{\text{rest}} = C_{\text{GND}} \cdot 1.2\text{V} - C_Y \cdot 0.73\text{V} = (3.2\text{fF})(1.2\text{V}) - (0.8\text{fF})(0.73\text{V}) = 3.26\text{fC}$ remains at node X. This corresponds to a voltage $V^* = Q_{\text{rest}}/C_{\text{GND}} = 1.02\text{V} (>V_S)$.

Solution 12.2

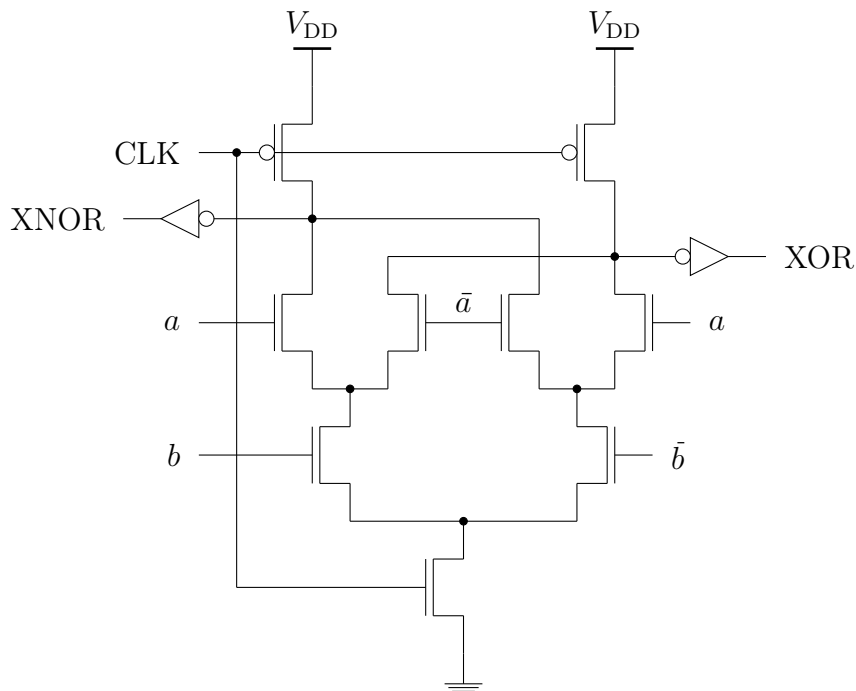
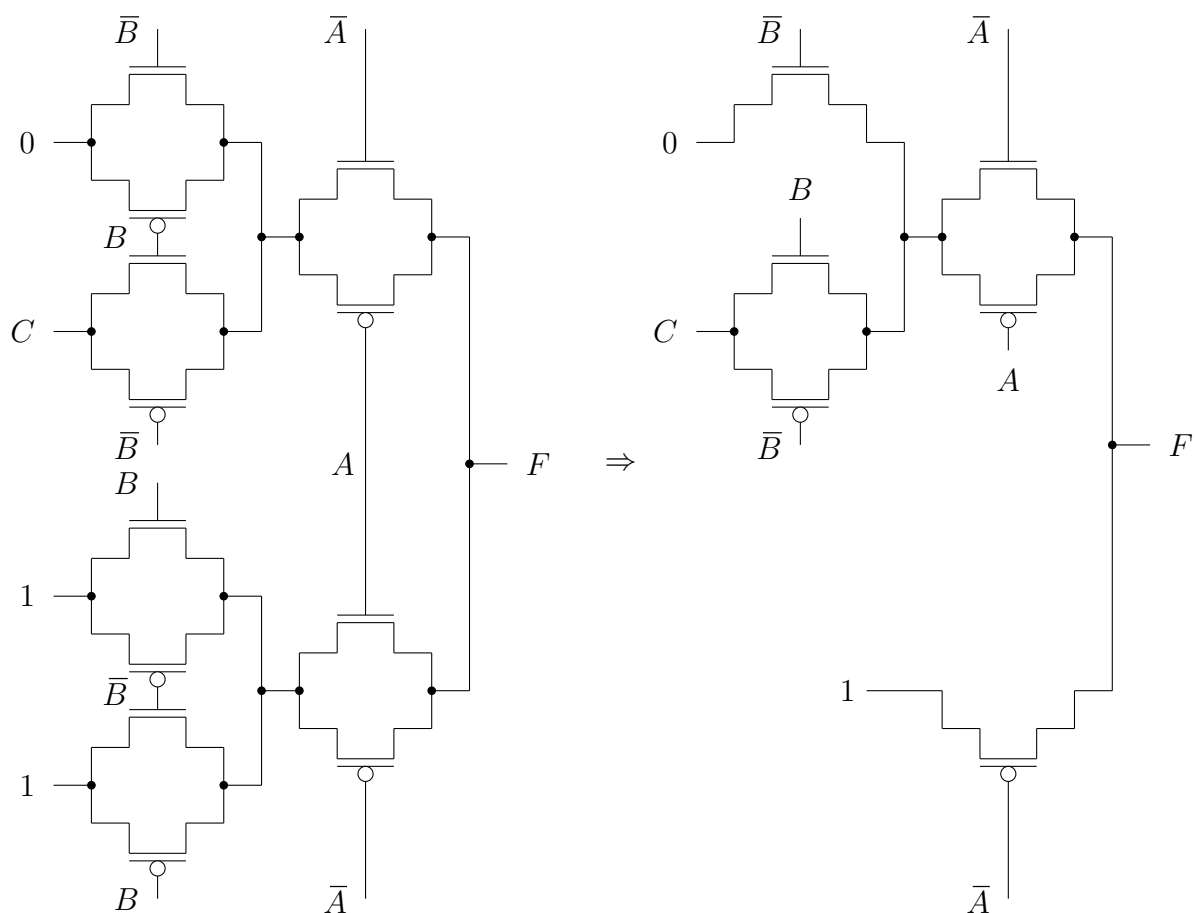


Figure 12.3: XOR/XNOR Gates in Dual Rail Domino Logic

Solution 12.3

a) $F = A + BC$

A	B	C	F
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

**Figure 12.4:** Transfer Gate: $F = A + BC$

b) $F = AB + BC + \bar{C}$

A	B	C	F
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	1

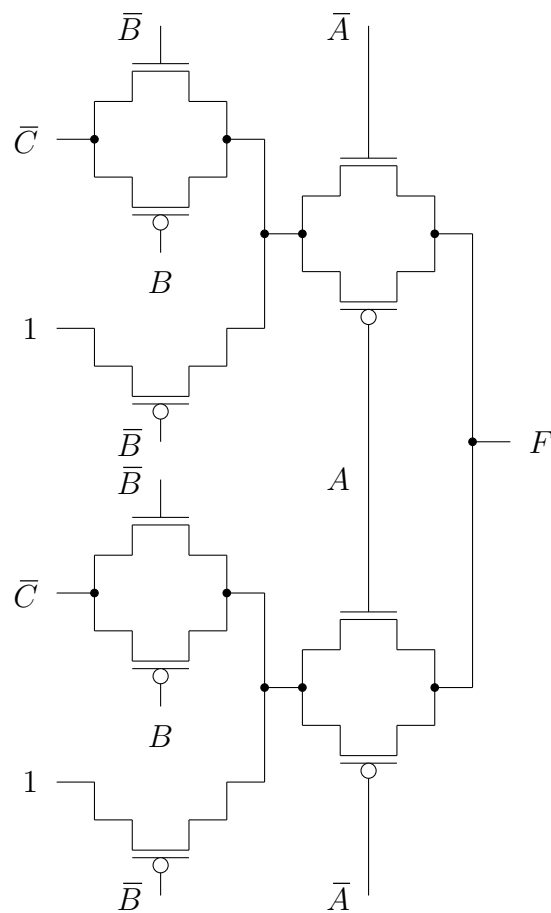


Figure 12.5: Transfer Gate: $F = AB + BC + \bar{C}$

c) $F = (\overline{A + B + C}) + \overline{A}B = \overline{A}\overline{B}\overline{C} + \overline{A}B$

A	B	C	F
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

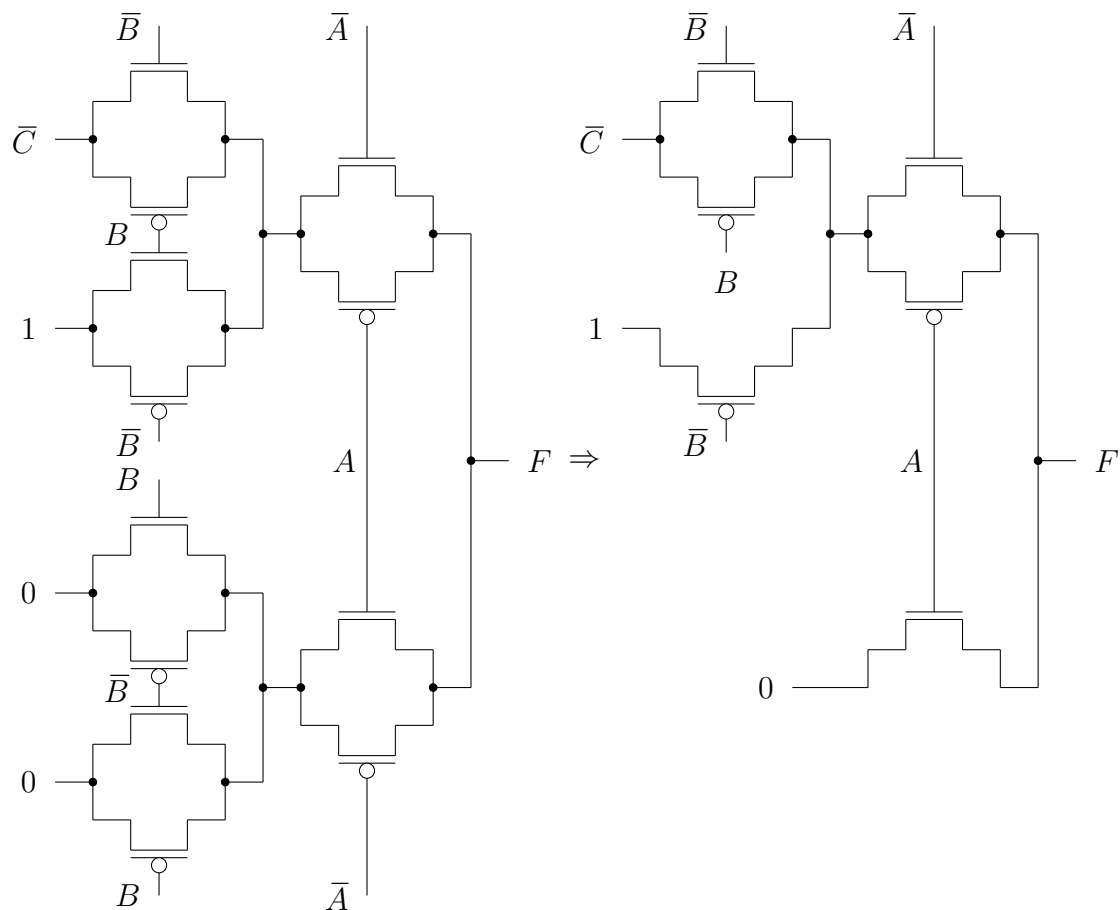


Figure 12.6: Transfer Gate: $F = (\overline{A + B + C}) + \overline{A}B$

d) $F = \overline{\overline{A + B + \overline{C}}} + \overline{A}\overline{B} = \overline{\overline{A}\overline{B}C} + \overline{A}\overline{B} = \overline{\overline{A}\overline{B}(C + 1)} = \overline{\overline{A}\overline{B}} = A + B$

A	B	C	F
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

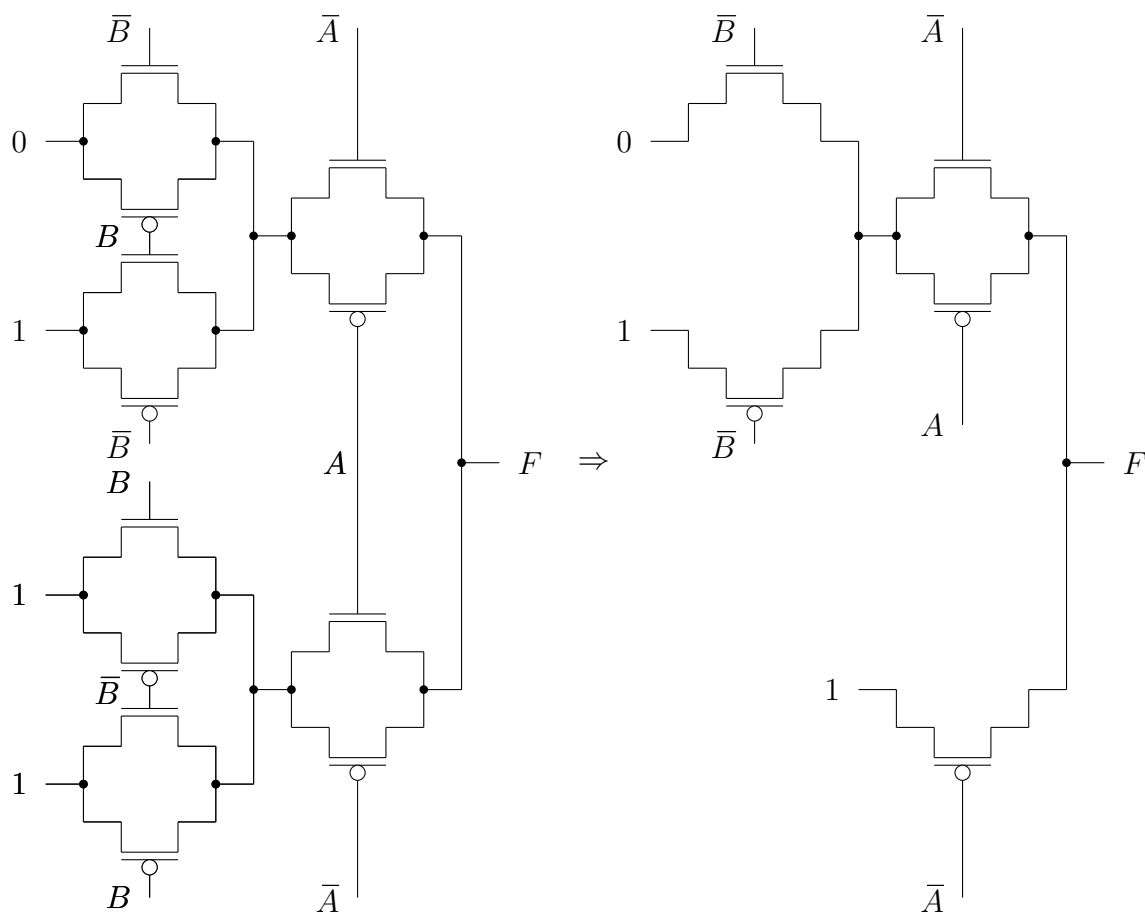


Figure 12.7: Transfer Gate: $F = \overline{\overline{A + B + \overline{C}}} + \overline{A}\overline{B}$

Solution 12.4

a)

A	B	F
0	0	Z
0	1	1
1	0	Z
1	1	Z

b)

A	B	F
0	0	1
0	1	1
1	0	0
1	1	1

c)

A	B	C	F
0	0	0	Z
0	0	1	Z
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	Z
1	1	0	0
1	1	1	Z

d)

A	B	C	F
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

Solution 12.5

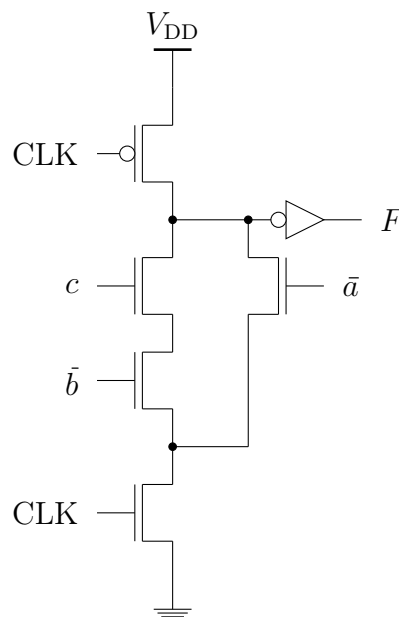


Figure 12.8: Domino Logic (a): $F = \bar{A} + \bar{B}C$

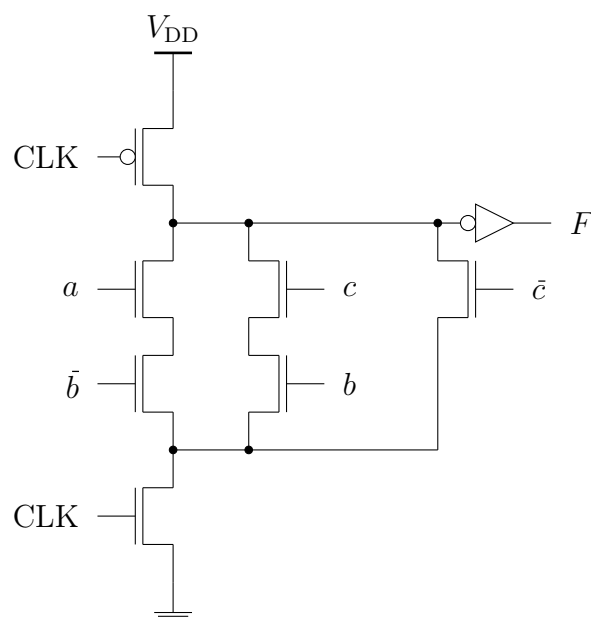


Figure 12.9: Domino Logic (b): $F = A\bar{B} + BC + \bar{C}$

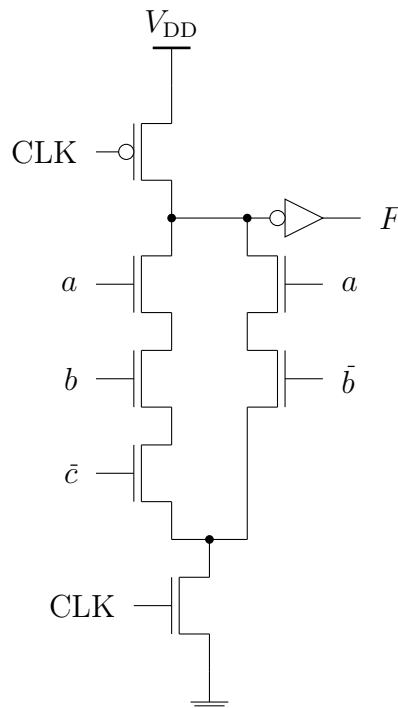


Figure 12.10: Domino Logic (c): $F = \overline{(\bar{A} + \bar{B} + C)} + A\bar{B} = ABC\bar{C} + A\bar{B}$

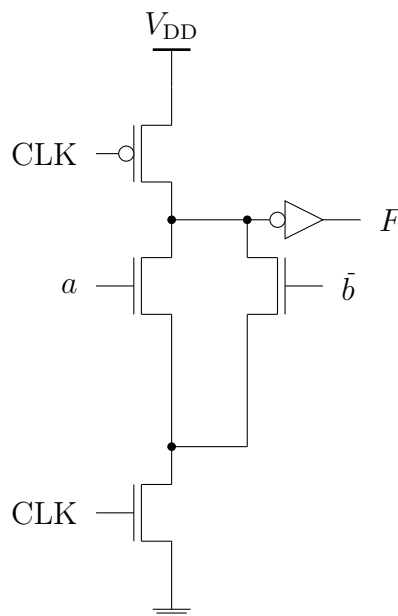


Figure 12.11: Domino Logic (d): $F = \overline{\overline{(\bar{A} + \bar{B} + C)} + \bar{A}B} = A + \bar{B}$