Chapter 1
Introduction to CMOS Circuits

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MOS Transistor

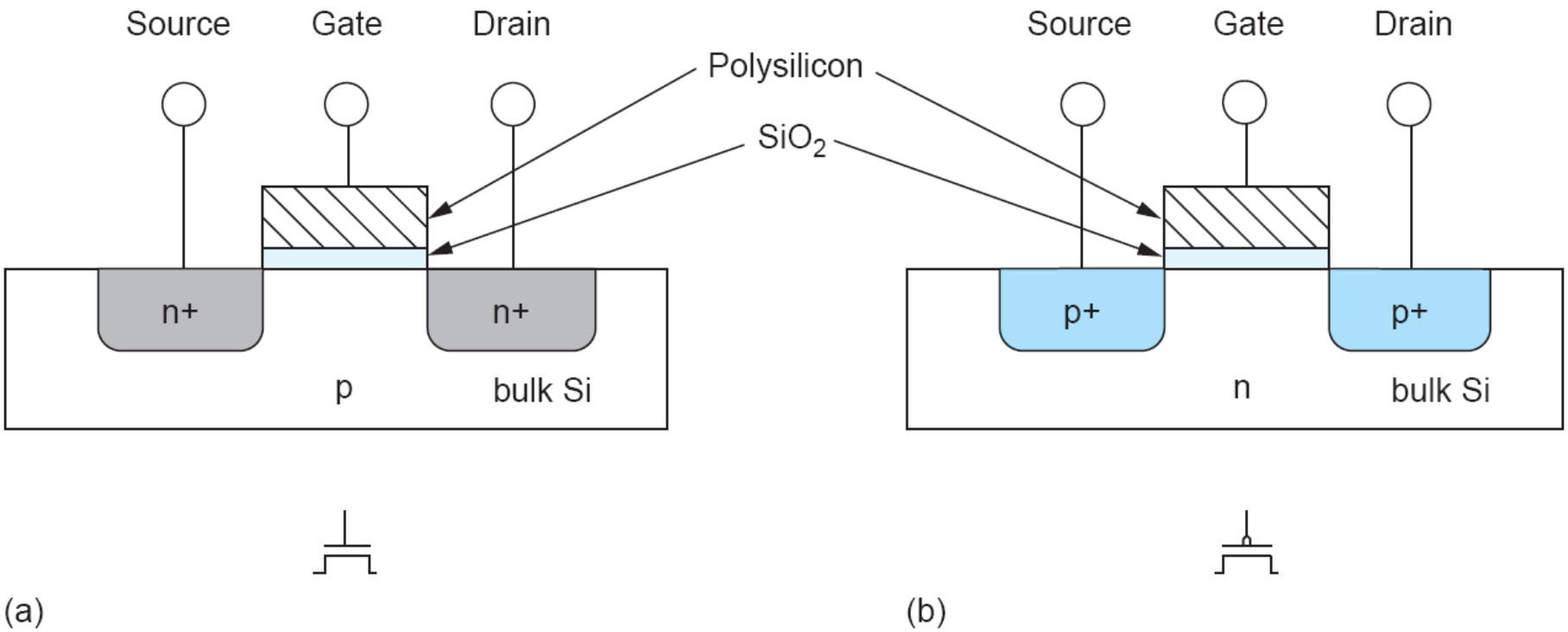


FIGURE 1.9 nMOS transistor (a) and pMOS transistor (b)

MOS Switches

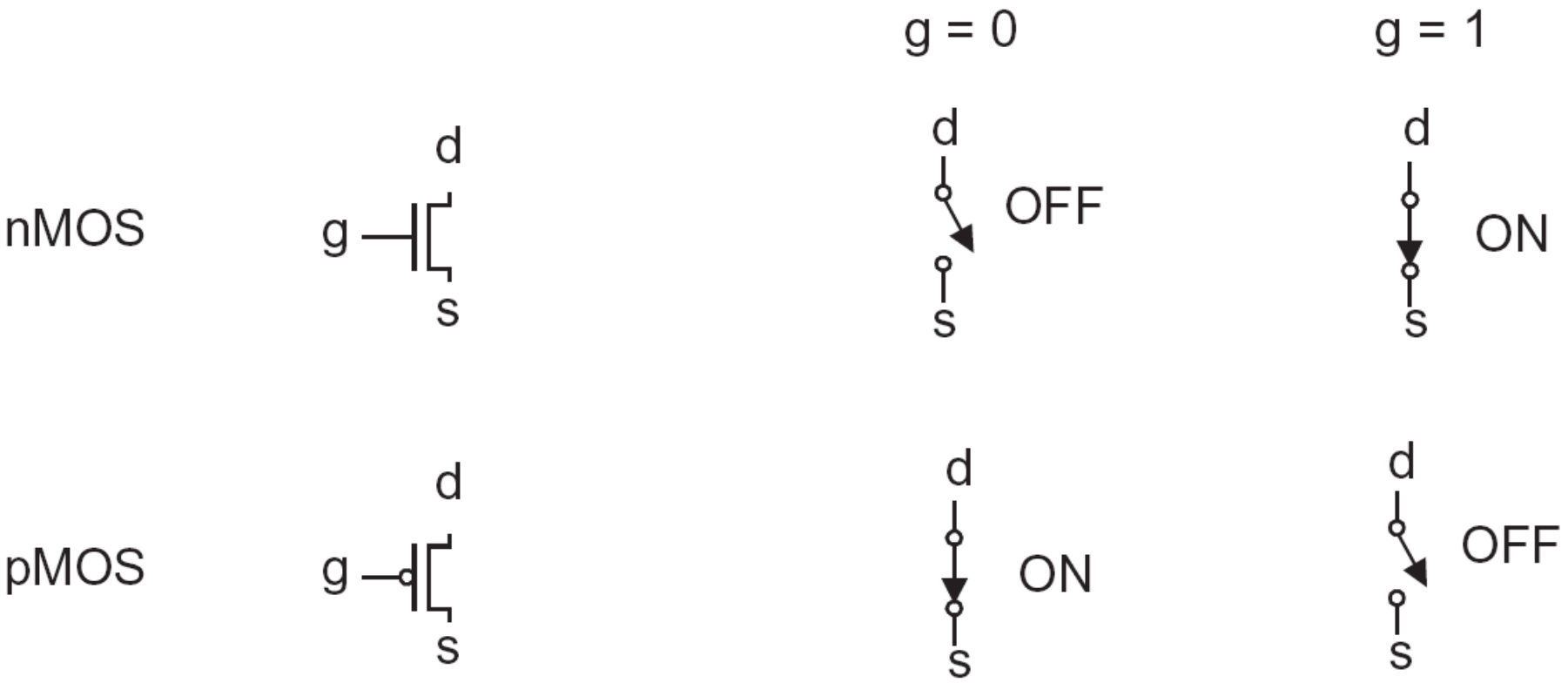


FIGURE 1.10 Transistor symbols and switch-level models

CMOS Static Logic

- Restored logic

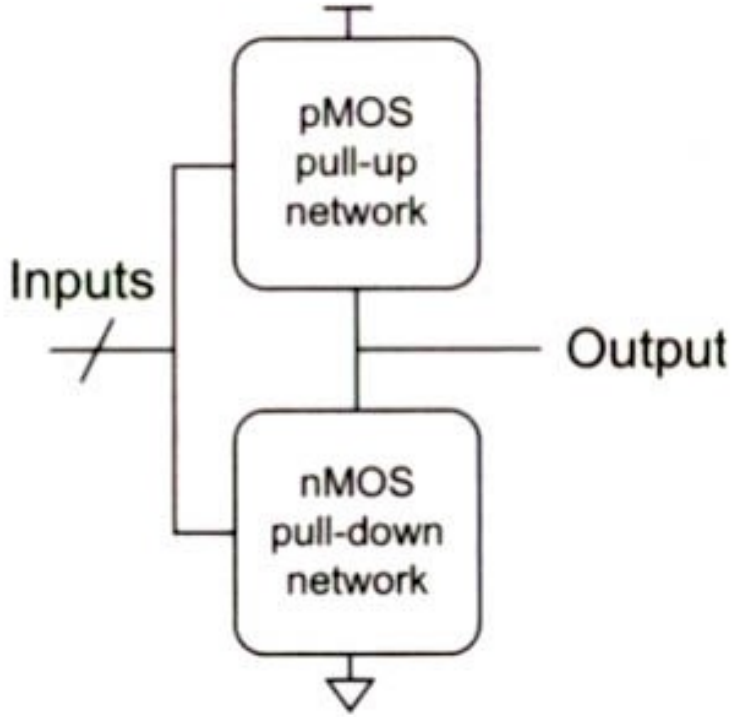


Table 1.3 Output states of CMOS logic gate

	pull-up OFF	pull-up ON
pull-down OFF	Z	1
pull-down ON	0	crowbarred (X)

CMOS Inverter

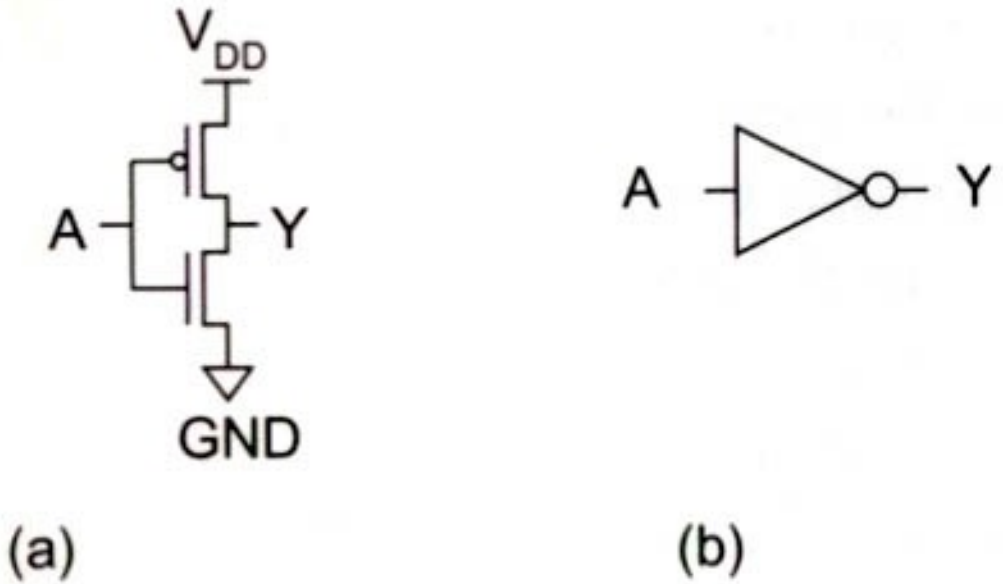
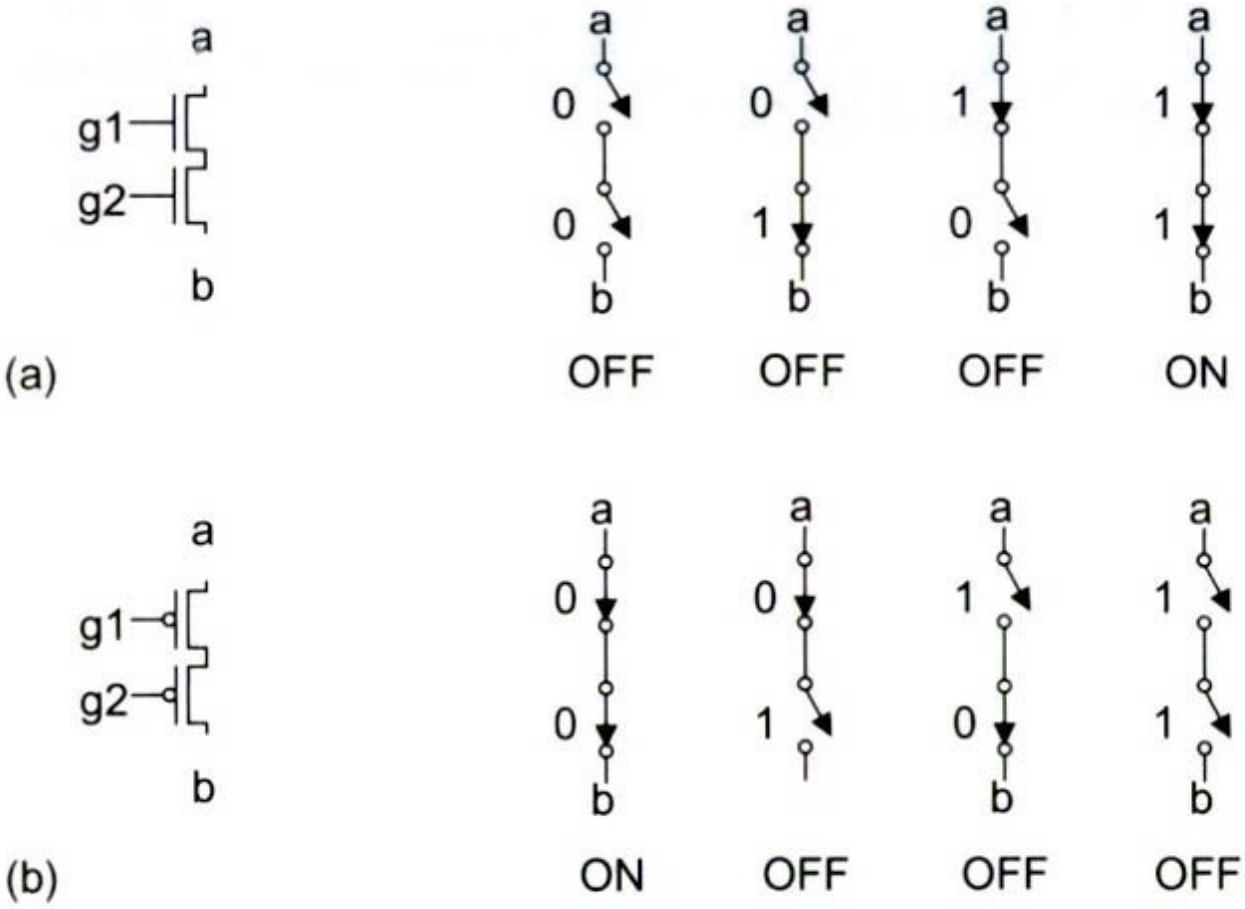
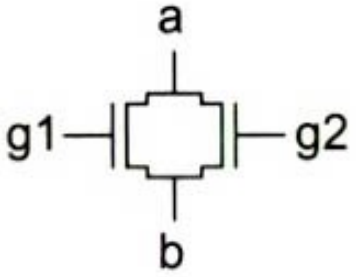


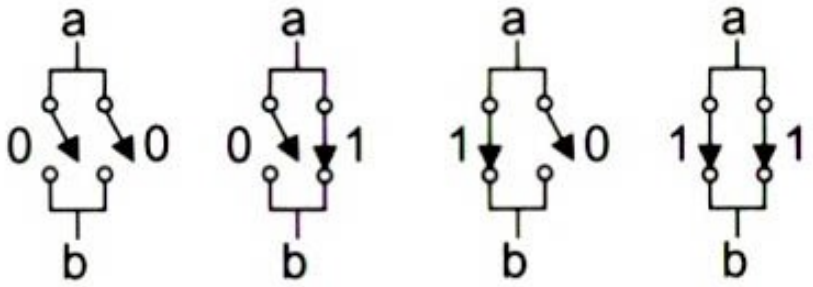
FIGURE 1.11
Inverter schematic
(a) and symbol
(b) $Y = \overline{A}$

Series Connection of Switches



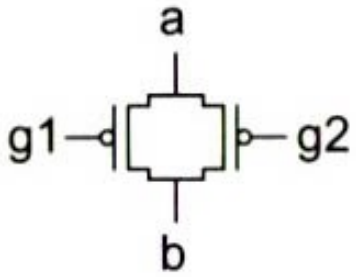
Parallel Connection of Switches

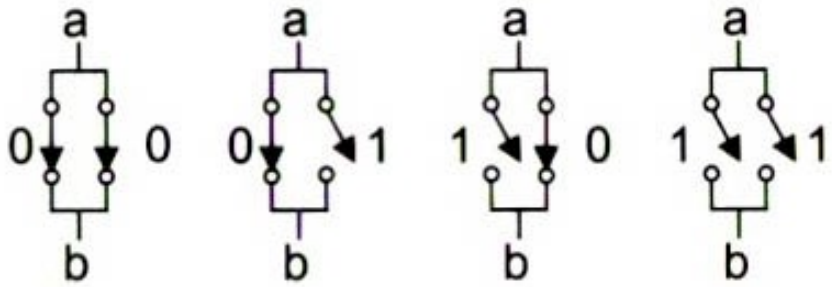




(c)

OFF ON ON ON





(d)

ON ON ON OFF

NAND Gate

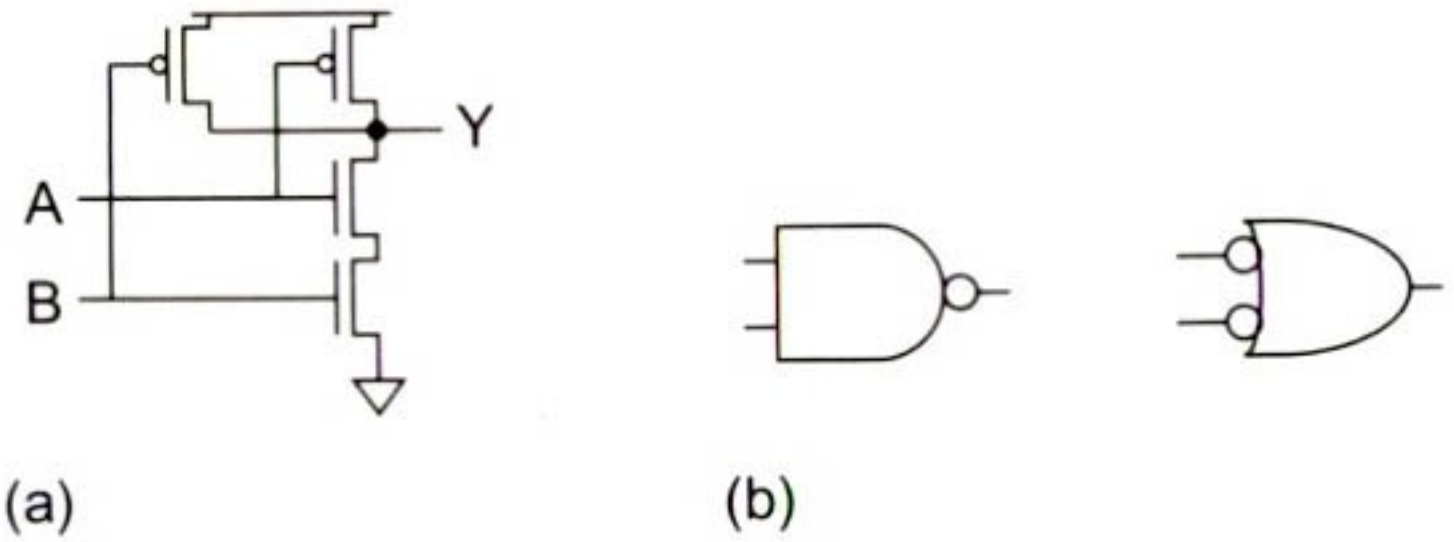


FIGURE 1.12 2-input NAND gate schematic (a) and symbol (b) $Y = \overline{A \cdot B}$

NOR Gate

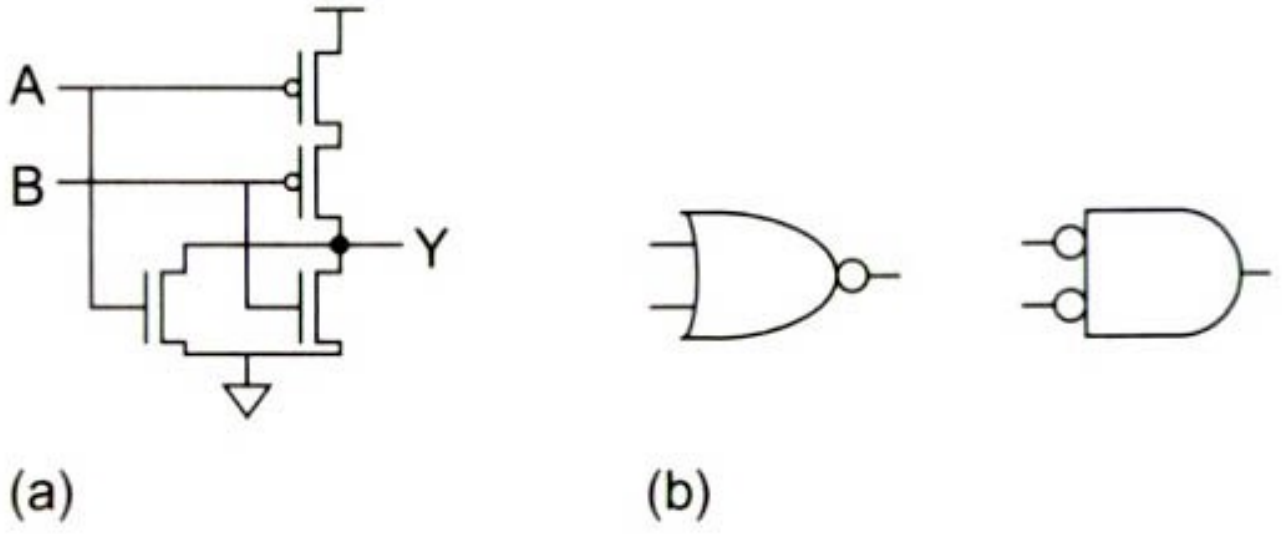


FIGURE 1.16 2-input NOR gate schematic (a) and symbol (b) $Y = \overline{A + B}$

Compound Gates

- NMOS first, AND => serial connection, OR => parallel connection
- PMOS is the dual of NMOS.
- Note that the gate has an inverting output.

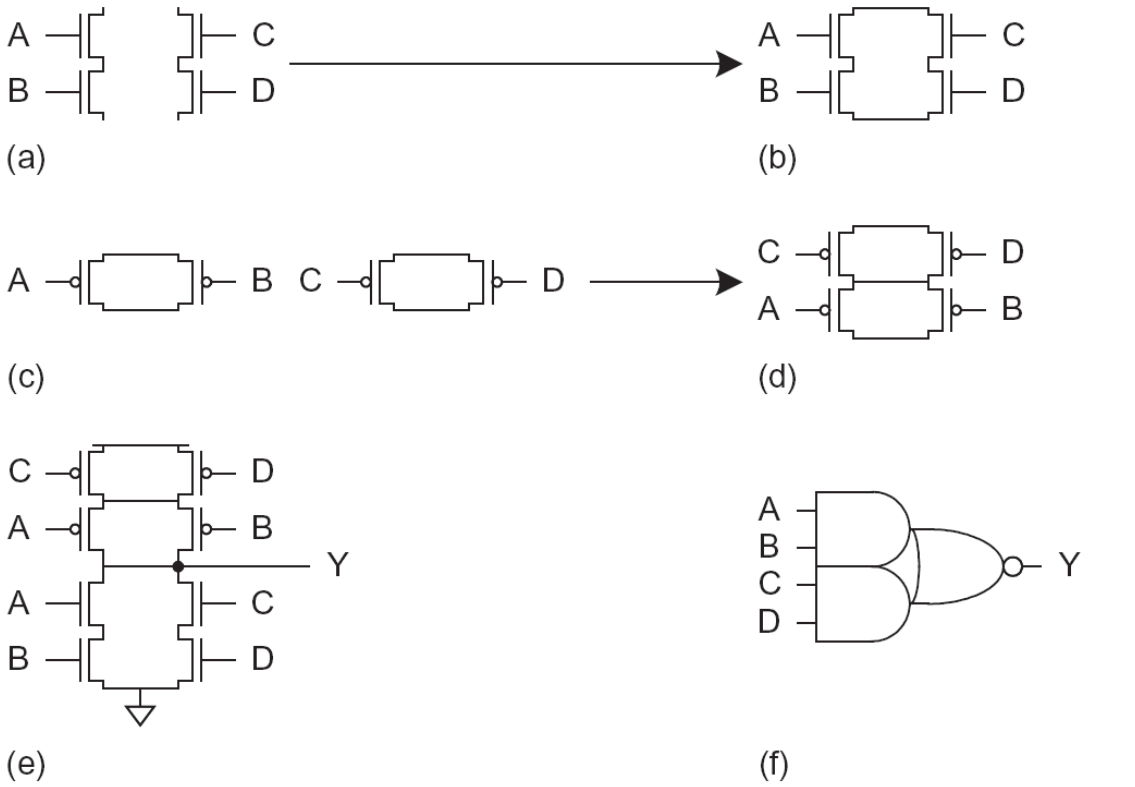


FIGURE 1.18 CMOS compound gate for function $Y = \overline{(A \cdot B) + (C \cdot D)}$

Another Example

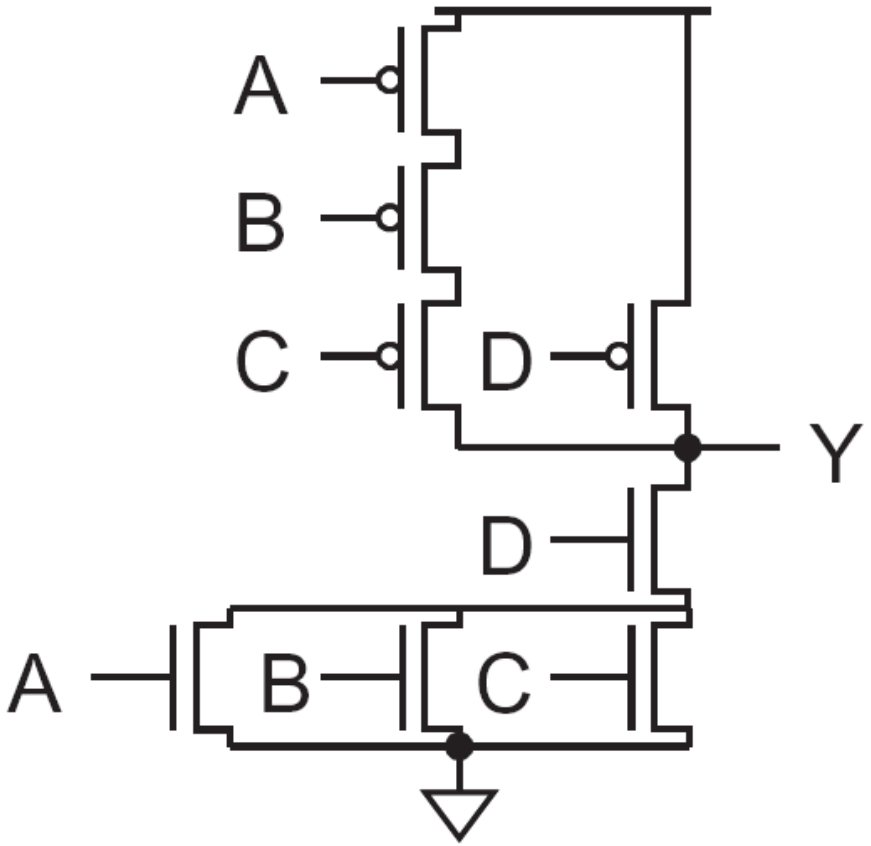


FIGURE 1.19
CMOS compound gate for function
$Y = \overline{(A + B + C) \cdot D}$

Pass Transistors

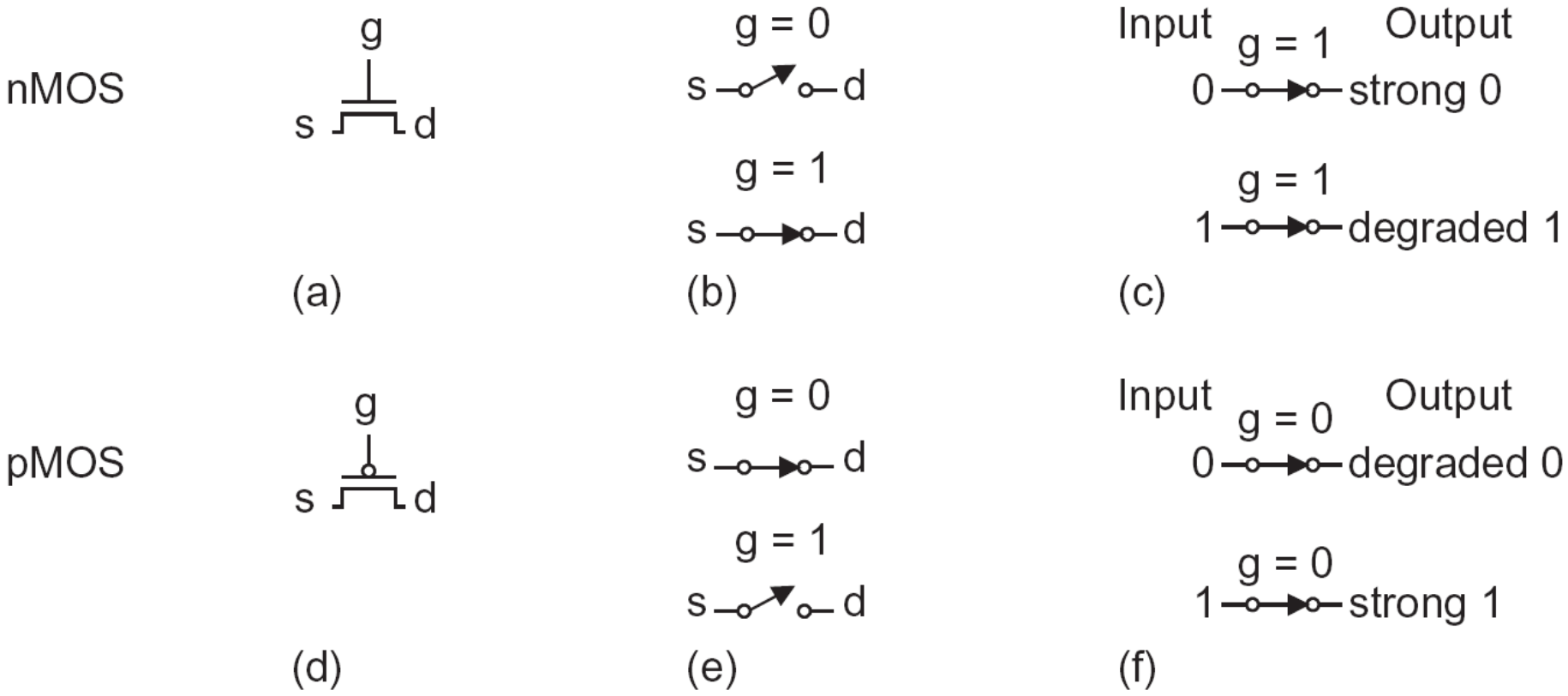


FIGURE 1.20 Pass transistor strong and degraded outputs

CMOS Switch

- Transmission Gate

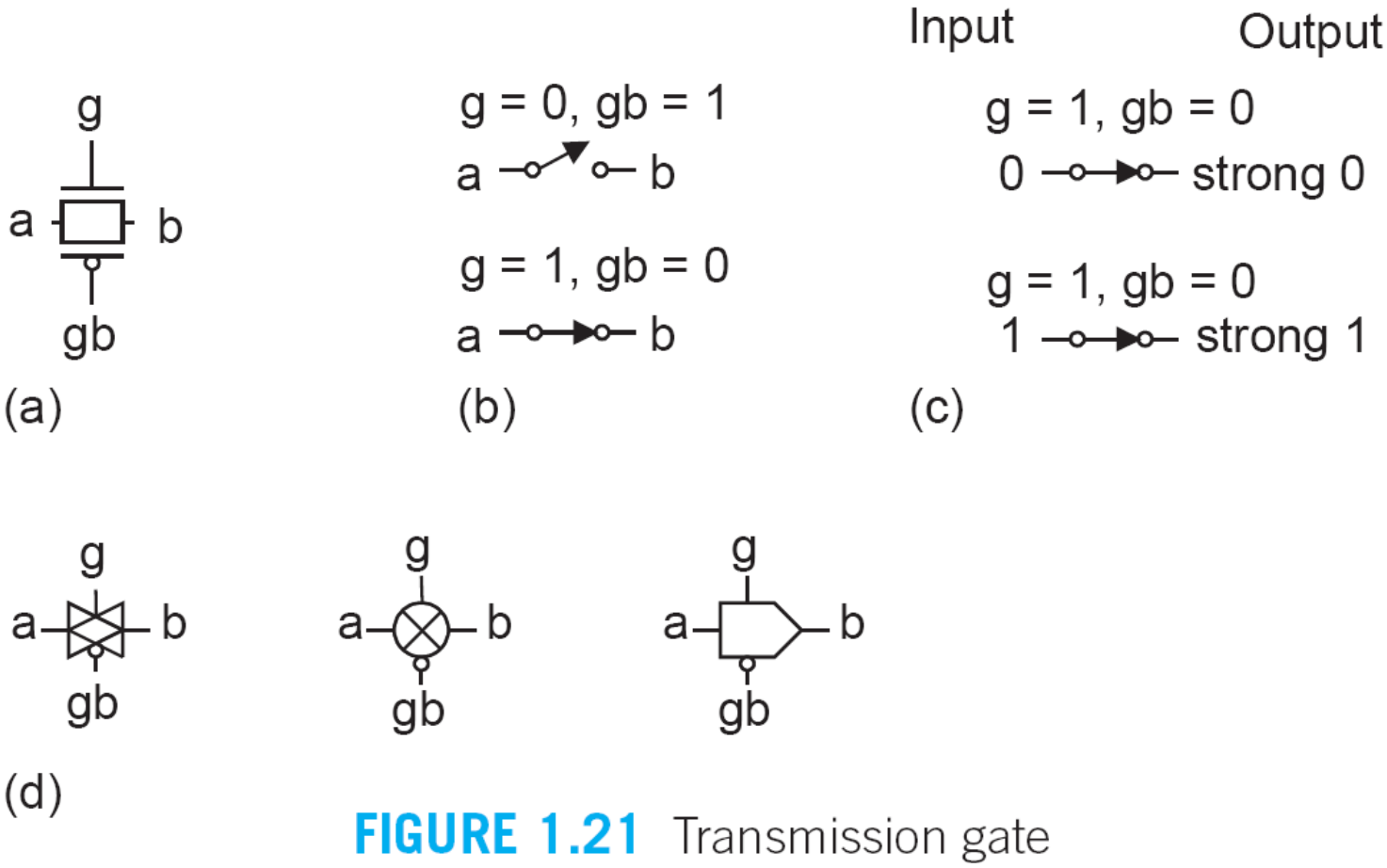


FIGURE 1.21 Transmission gate

Tri-state Inverter

- Bus driver

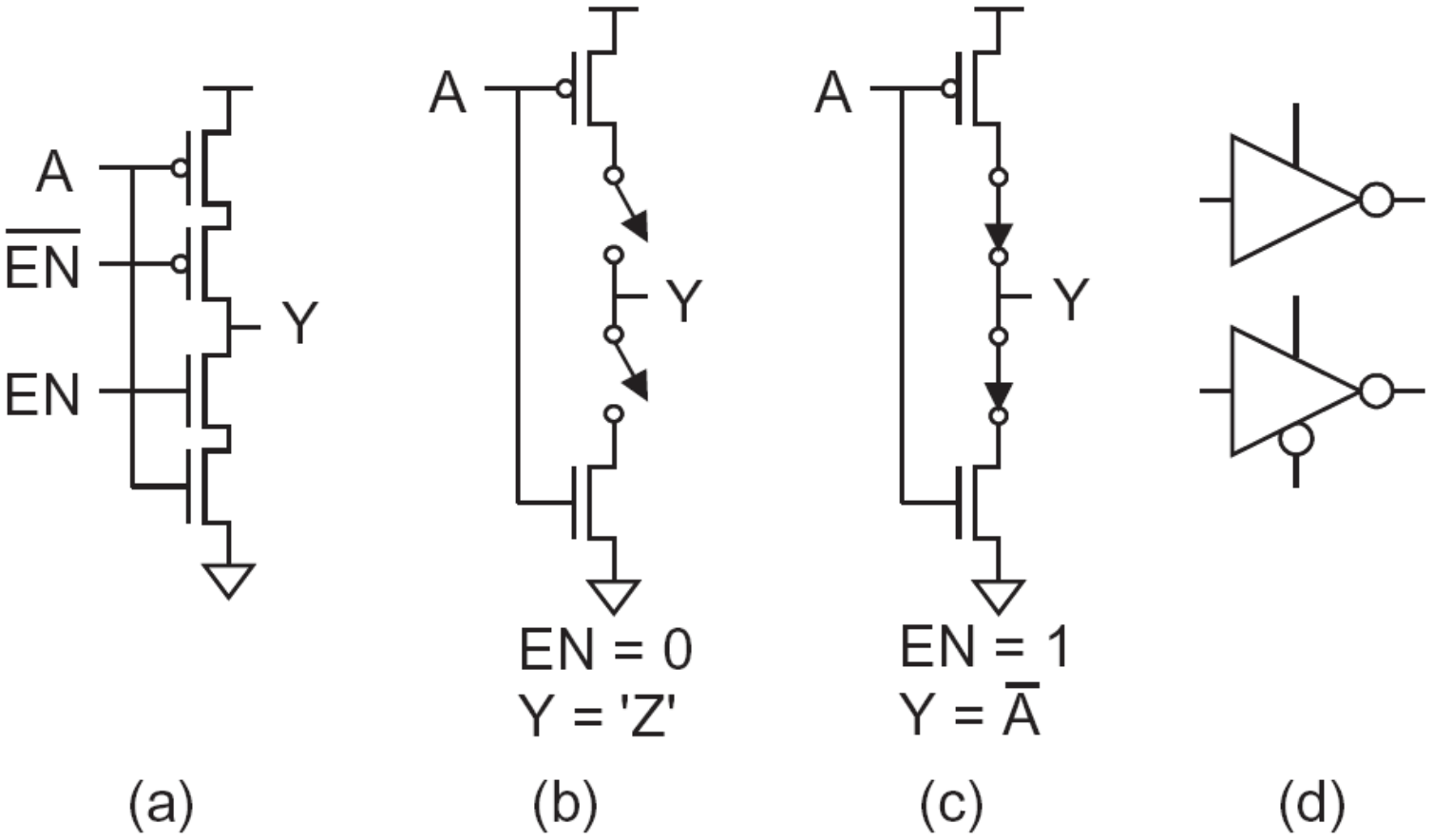


FIGURE 1.27 Tristate Inverter

Multiplexer

- Use transmission gates to build a 2-to-1 multiplexer.
- Note that transmission gates are "bilateral" devices, hence this multiplexer can also be looked upon as a 1-to-2 demultiplexer depending on which end is the driving (more forceful) end.

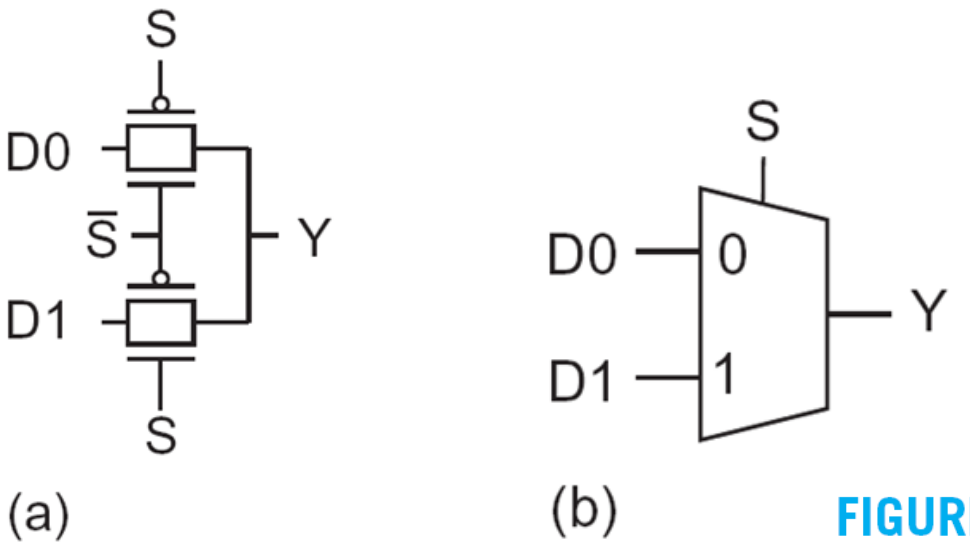


FIGURE 1.28 Transmission gate multiplexer

Static Inverting Multiplexer

- $Y = \overline{(D0 \bullet S' + D1 \bullet S)}$

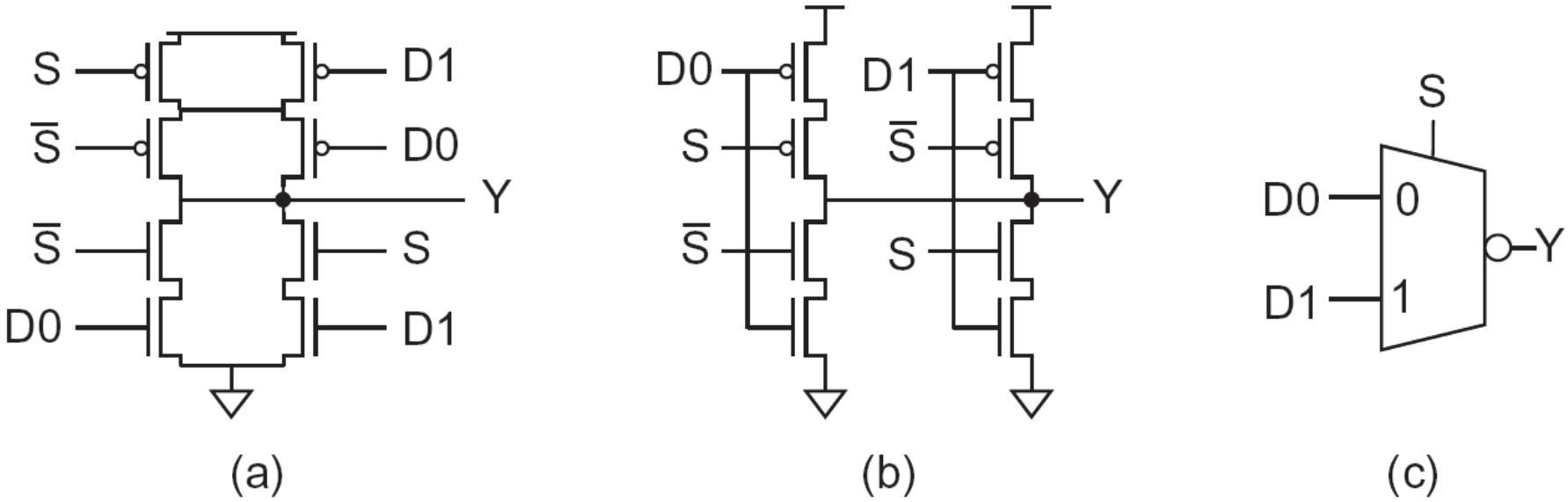


FIGURE 1.29 Inverting multiplexer

4:1 Multiplexer

FIGURE 1.30 4:1 multiplexer