CPE201
Digital Design

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Class 11: POS Karnaugh Maps and Troubleshooting

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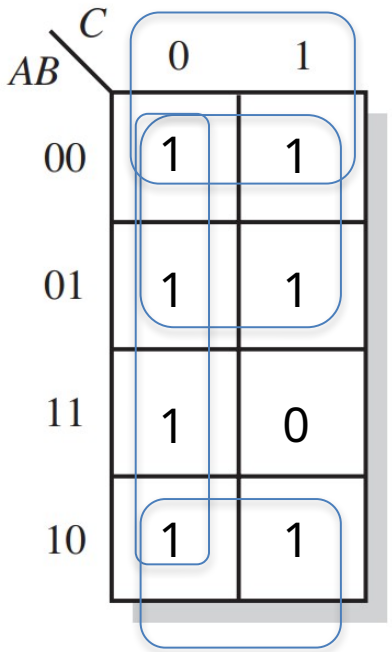
SOP Minimization Example

- B′ + A′B + ABC′
- 3 4-cell groups
- A′ + B′ + C′

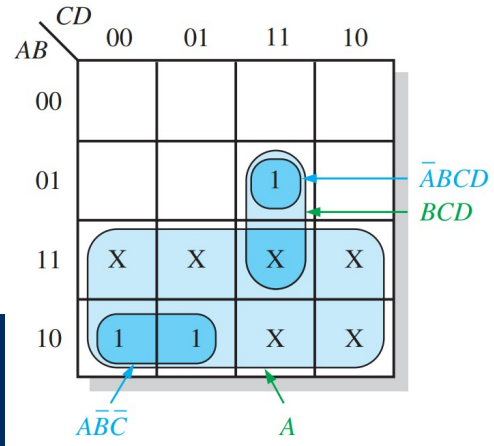


Don’t Care Condition

- Used for conditions that cannot occur
- Can be used to further simplify logic

Inputs				Output
A	*B*	*C*	*D*	*Y*
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	1
1	0	0	0	1
1	0	0	1	1
1	0	1	0	X
1	0	1	1	X
1	1	0	0	X
1	1	0	1	X
1	1	1	0	X
1	1	1	1	X

Don’t cares



Example

- Can be used to further simplif

AB \ CD	00	01	11	10
00	1	X		
01	1	1		
11	1			
10	1			

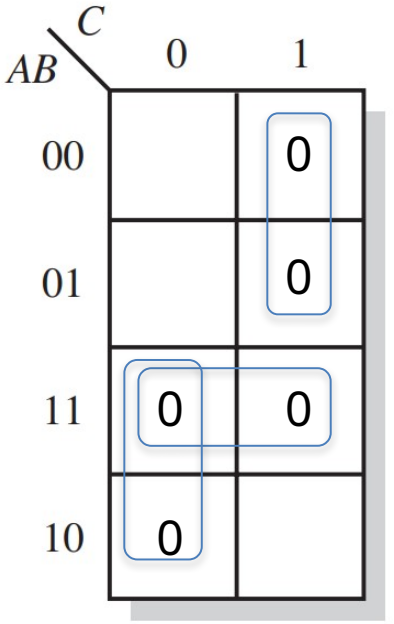
AB \ CD	00	01	11	10
00	1			
01	1	1		
11	1		X	
10	1		X	

Karnaugh Maps and POS

- All the same concepts apply, but now with 0’s
- Write all simplified terms as POS terms

Example

- (A+B+C′)(A+B′+C′)(A′+B′)(A′+B+C
- (A′+C)(A′+B′)(A+C′)

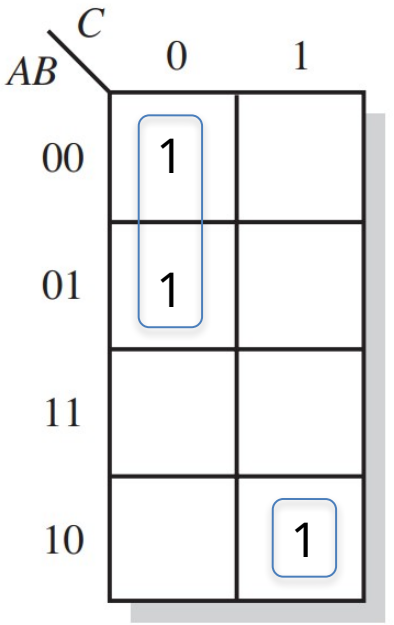


Conversions

- Same as with truth tables
  - Fill in the Karnaugh Map with what you have
  - Then group the other truth value
  - Finally write out the terms

Example

- (A+B+C′)(A+B′+C′)(A′+B′)(A′+B+C
- A′C′ + AB′C



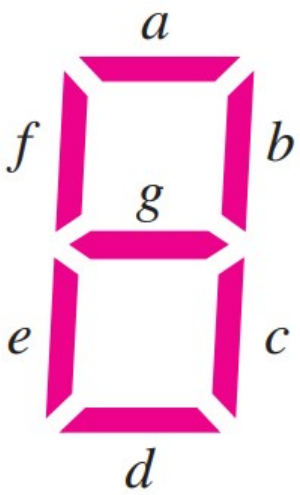
Minterms and Maxterms

- Inputs that give 1 on truth table = minterms
- Inputs that give 0 on truth table = maxterms

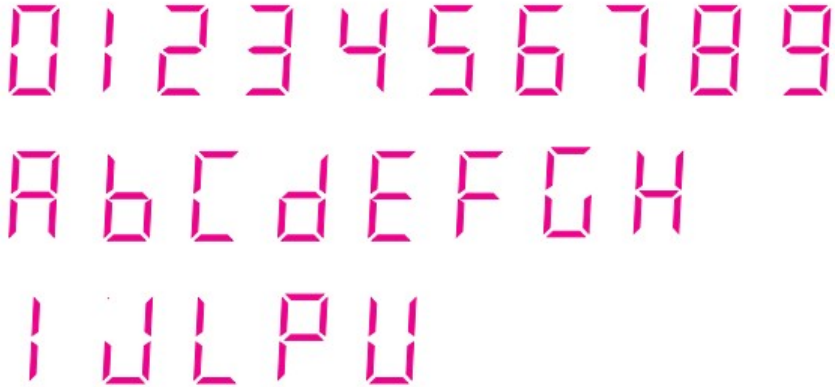
Example

A	B	C	Output	Minterm	Maxterm
0	0	0	1	m_0	
0	0	1	0		M_1
0	1	0	0		M_2
0	1	1	1	m_3	
1	0	0	1	m_4	
1	0	1	1	m_5	
1	1	0	1	m_6	
1	1	1	0		M_7

7-Segment Displays



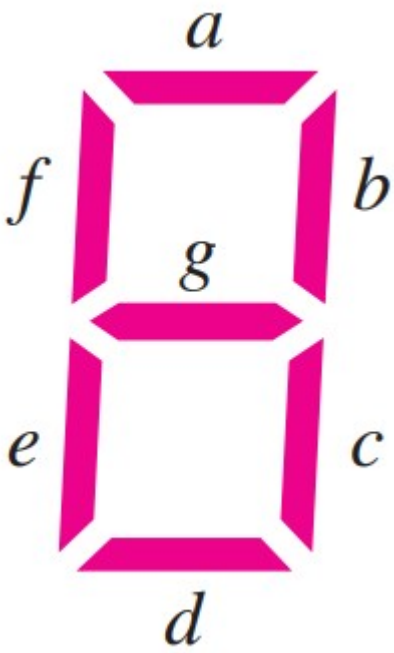
(a) Segment arrangement



(b) Formation of the ten digits and certain letters

7-Segment Displays

Symbol	Segments Active
1	b, c
2	a, b, d, e, g
7	a, b, c
A	a, b, c, e, f, g
b	c, d, e, f, g
C	a, d, e, f



Display Hex Digits

Symbol	Hex Input ($H_3H_2H_1H_0$)	Segments Active
1	0001	b, c
2	0010	a, b, d, e, g
7	0111	a, b, c
A	1010	a, b, c, e, f, g
b	1011	c, d, e, f, g
C	1100	a, d, e, f

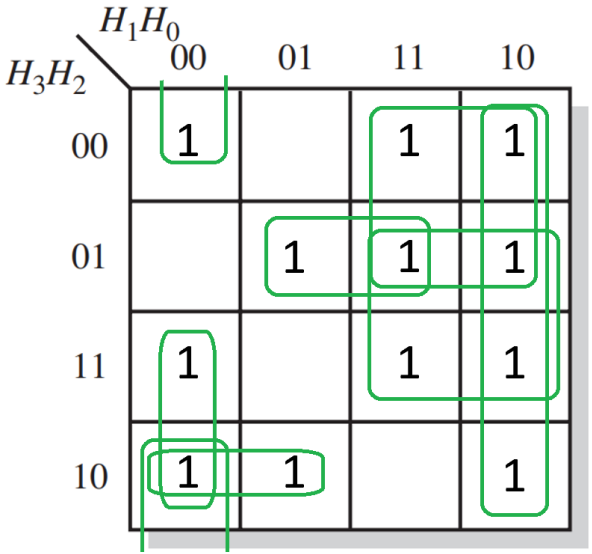
Logic for One Segment

- Segment ‘a’ is used in: 0, 2, 3, 5, 6, 7, 8, 9, A, C,

H_3H_2 \ H_1H_0	00	01	11	10
00	1		1	1
01		1	1	1
11	1		1	1
10	1	1		1

Logic for One Segment

- $H_2'H_1'H_0' + H_3H_1'H_0' + H_3H_2'H_1' + H_3'H_2H_0' + H_3'H_1 + H_2H_1 + H_1H_0'$



Troubleshooting

- Being a detective
- Never discount something that looks off
- Always test to narrow down what is wrong

The Basic Steps

- 1. Gather information on the problem
- 2. Identify the symptom and possible failures
- 3. Isolate the point(s) of failure
- 4. Apply proper tools to determine the cause of the problem
- 5. Fix the problem

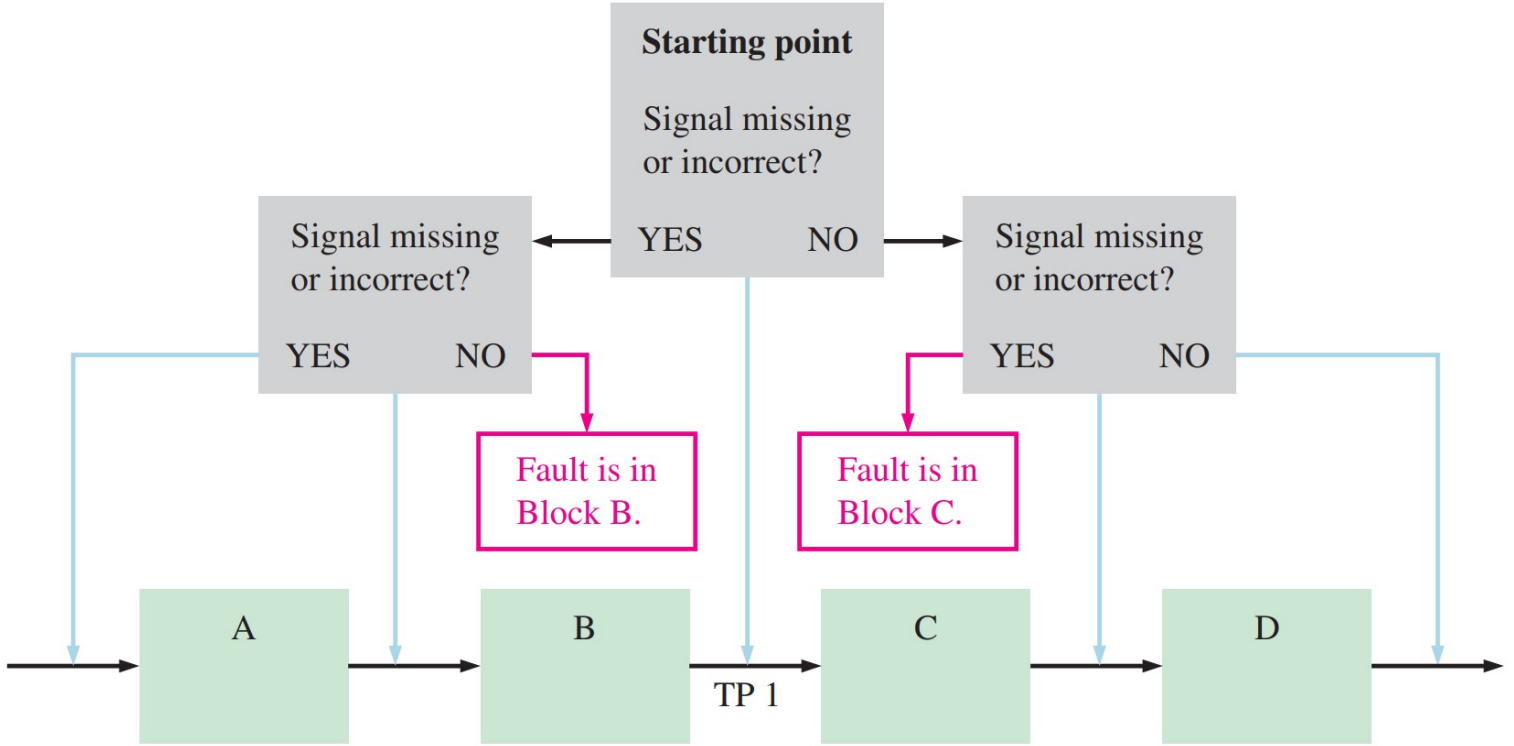
Obvious Stuff First

- Is there power to the circuit?
- Are there any loose wires/connections?
- Is there a troubleshooting guide?
- Is there a wiring diagram?

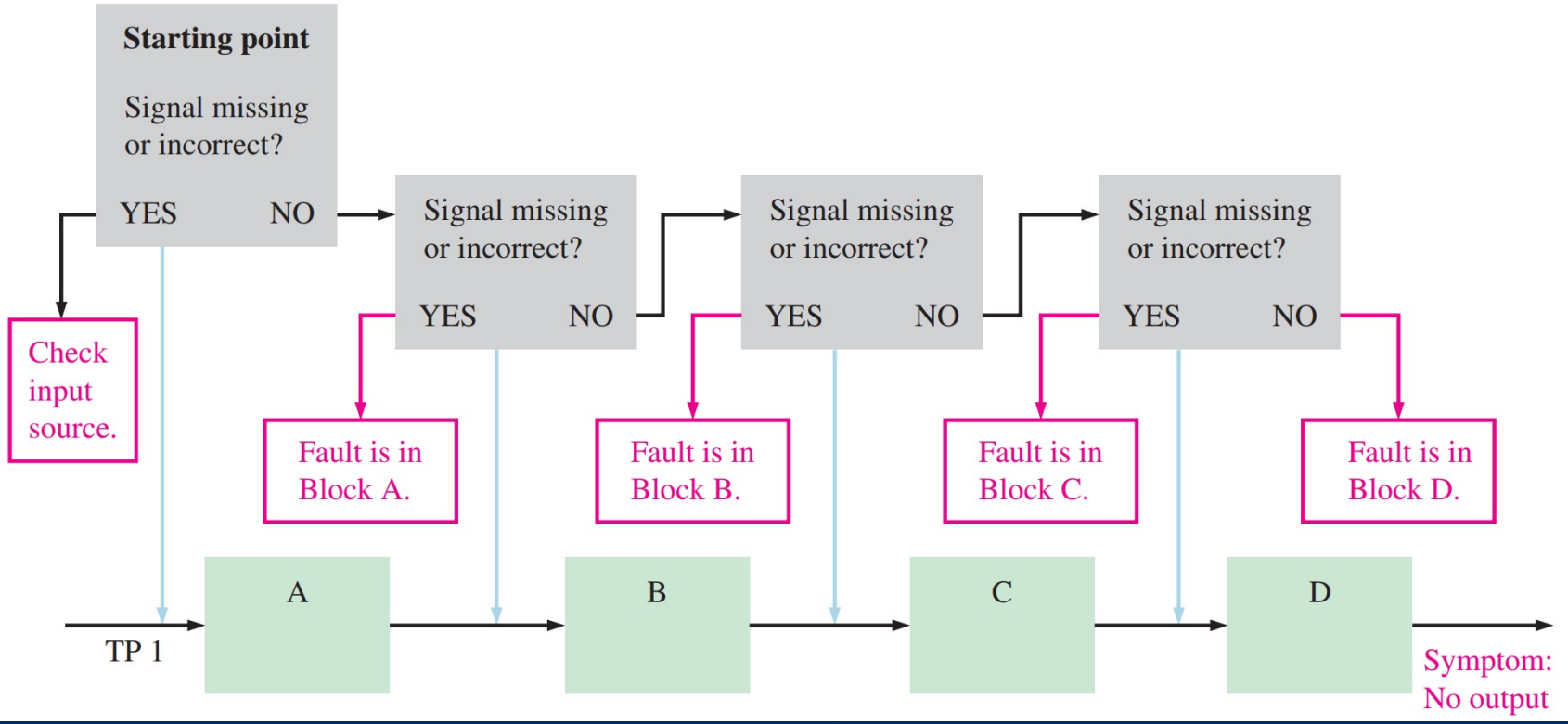
Replace/Reproduce

- Is there another circuit that works in place of this one?
  - Isolate the problem to one circuit
- Is the problem reproduceable?
- Can you change the input to make it reproduceable?

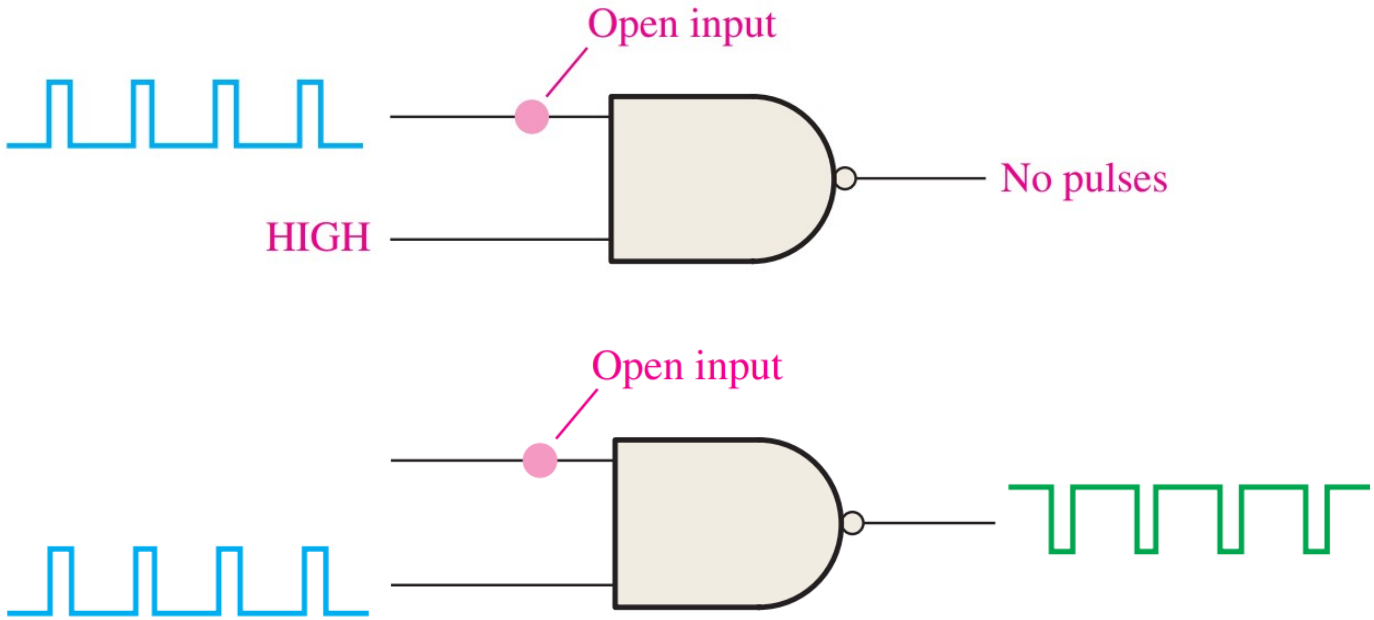
Half-Splitting Method



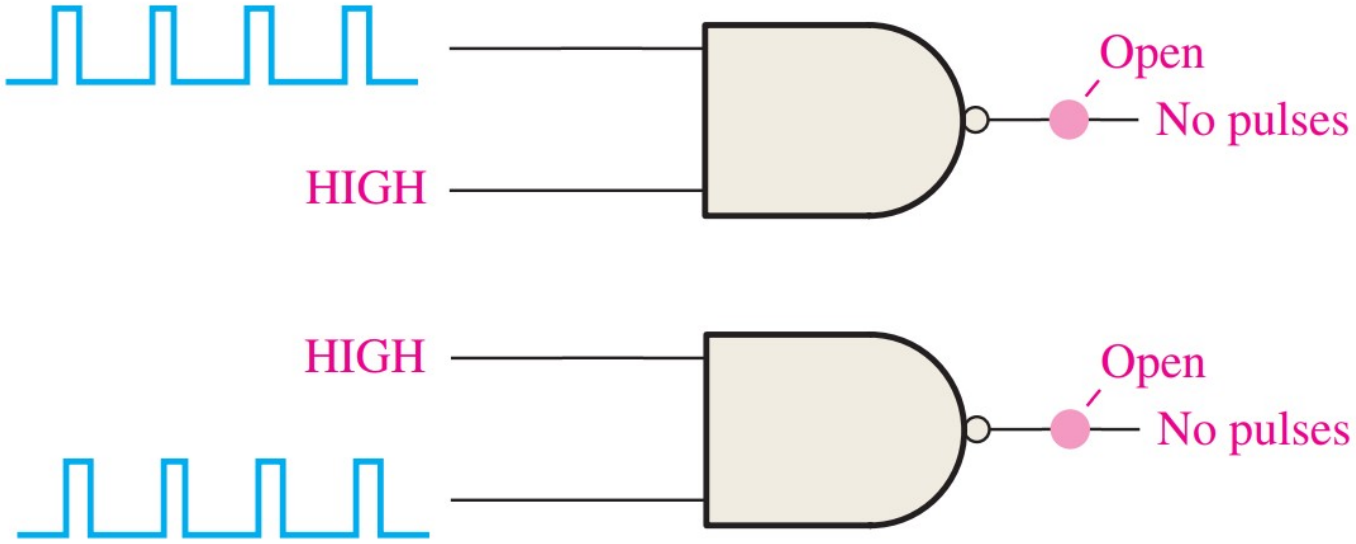
Signal-Tracing Method



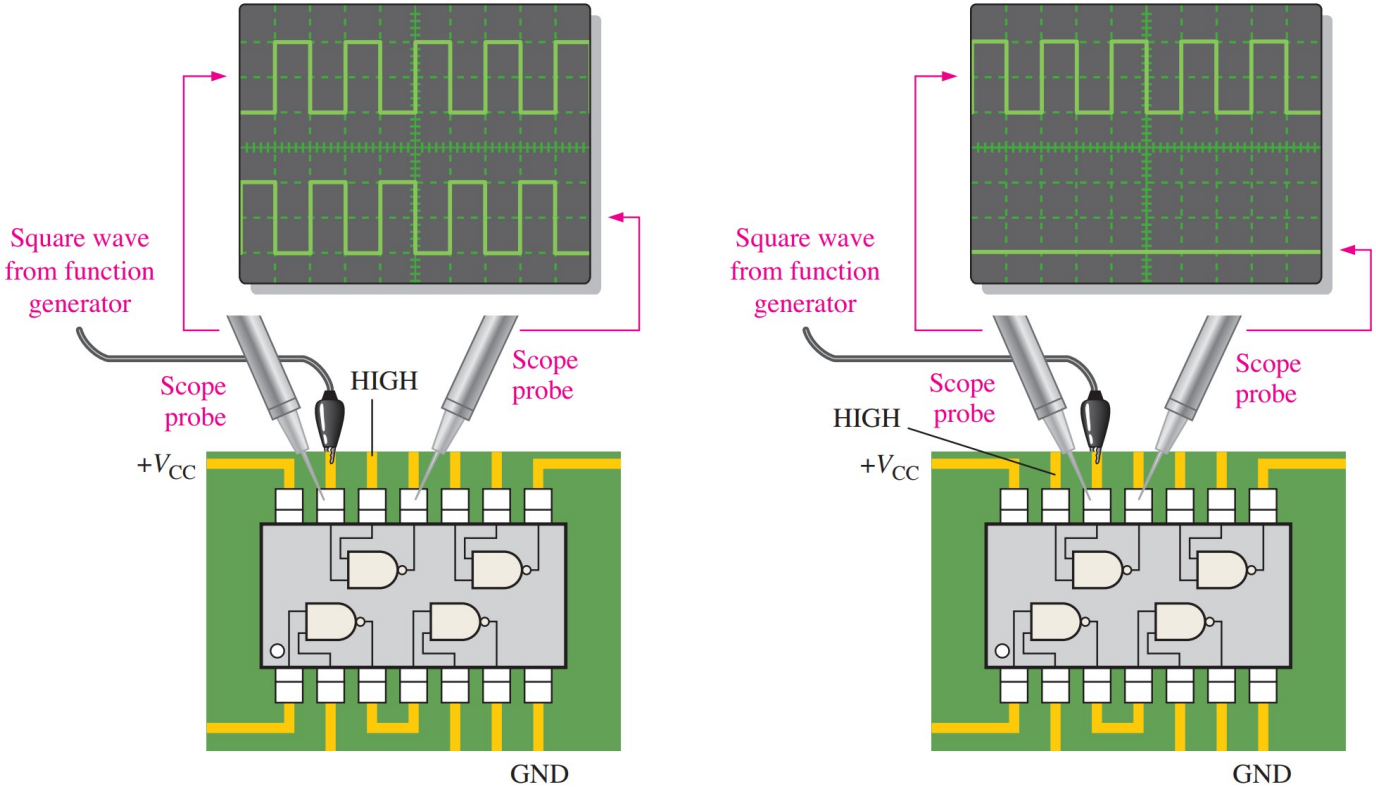
Open Circuits



Open Circuits



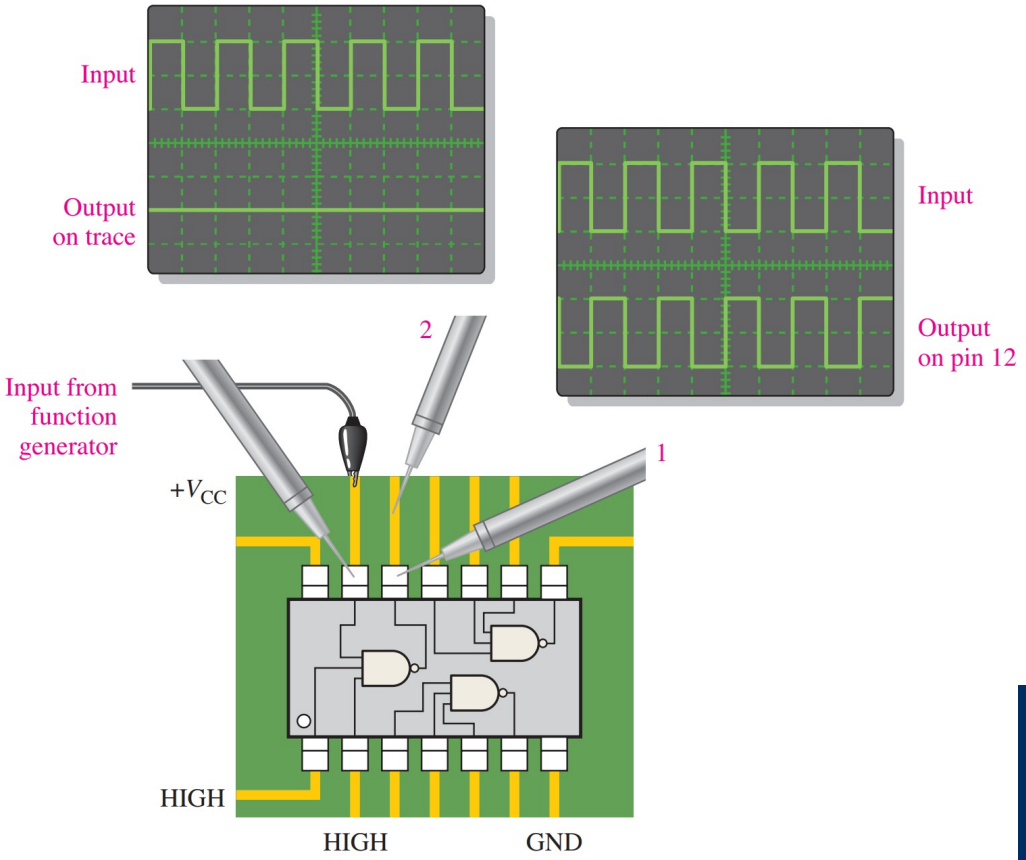
Internal Example



(a) Pin 13 input and pin 11 output OK

(b) Pin 12 input is open.

External Example



Reading

- This lecture
  - Sections 1.8, 3.9, 4.10-4.11, Ch4 Applied Logic
- Next lecture
  - Sections 5.1-5.3