

Chap 1

Binary Systems

類比Analog

- 類比信號是一種連續性變化的電氣或物理量。
- 大自然中大部分的物理量皆屬於「類比性質」。
- 例如：溫度變化、壓力變化、音量變化、頻率變化、光變化等等。



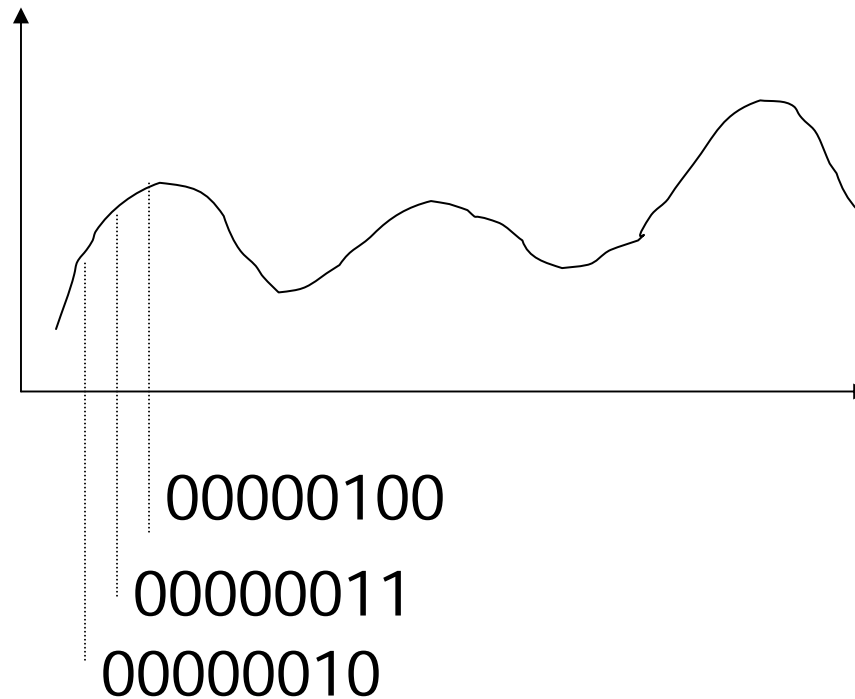
數位Digital

- 0與1
- 計算機可以處理



A/D與D/A

- A/D: 類比信號經過取樣以數位訊號儲存。
- D/A: 數位訊號經過合成以類比信號輸出。



Binary Number

TABLE 1-1
Powers of Two

n	2 ⁿ	n	2 ⁿ	n	2 ⁿ
0	1	8	256	16	65,536
1	2	9	512	17	131,072
2	4	10	1,024	18	262,144
3	8	11	2,048	19	524,288
4	16	12	4,096	20	1,048,576
5	32	13	8,192	21	2,097,152
6	64	14	16,384	22	4,194,304
7	128	15	32,768	23	8,388,608

Table 1-1 Powers of Two

Number of Different Bases

Decimal (base 10)	Binary (base 2)	Octal (base 8)	Hexadecimal (base 16)
00	0000	00	0
01	0001	01	1
02	0010	02	2
03	0011	03	3
04	0100	04	4
05	0101	05	5
06	0110	06	6
07	0111	07	7
08	1000	10	8
09	1001	11	9
10	1010	12	A
11	1011	13	B
12	1100	14	C
13	1101	15	D
14	1110	16	E
15	1111	17	F

十進制

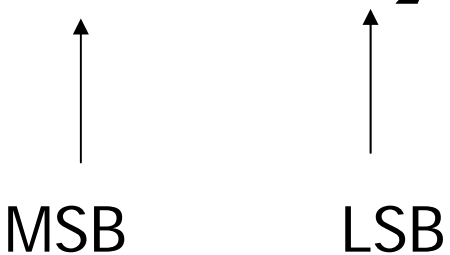
- $4623_{10} = 4 \times 10^3 + 6 \times 10^2 + 2 \times 10^1 + 3 \times 10^0$

- 4623_{10}

↑ ↑
MSB LSB


- LSB: least significant bit
- MSB: most significant bit

二進制

- Binary Number System
- 逢2進位
- $10010110_2 = 1 \times 2^7 + 1 \times 2^4 + 1 \times 2^2 + 1 \times 2^1$
- 10010110_2


MSB LSB

八進制

- Octal Number System
- 逢8進位
- 0 1 2 3 4 5 6 7
- $216_8 = 2 \times 8^2 + 1 \times 8^1 + 6 \times 8^0$


MSB

LSB

十六進制

- 逢16進位
- 0 1 2 3 4 5 6 7 8 9 A B C D E F
- 1 bit = 代表0或1
- 1 byte = 8 bits
- $FF = F \times 16^1 + F \times 16^0$

Number Base Conversion

- Decimal number to binary number
- Binary number to Octal number
- Binary number to hexadecimal

直接轉換

- 二進制 $(101.01)_2$ 轉換為十進制
- $1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 + 0 \times 2^{-1} + 1 \times 2^{-2} = (5.25)_{10}$
- 十六進制 $(2D.6)_{16}$ 轉換為十進制
- $2 \times 16^1 + D \times 16^0 + 6 \times 16^{-1} = (45.375)_{10}$

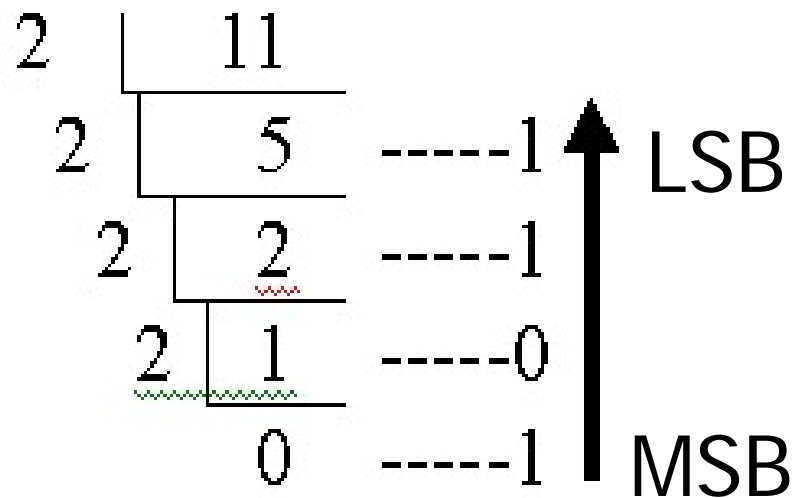
間接轉換

- 二進制 $(101101.011)_2$ 轉換為十六進制
- $(101101.011)_2 = (\underline{0010} \ \underline{1101}.\underline{0110})_2 = (2D.6)_{16}$
- 十六進制 $(7E.5)_{16}$ 轉換為二進制
- $(7E.5)_{16} = (\underline{0111} \ \underline{1110}.\underline{0101})_2 = (1111110.0101)_2$
- 二進制轉換為八進制
- 十六進制轉換為八進制
- 八進制轉換為二進制
- 八進制轉換為十六進制

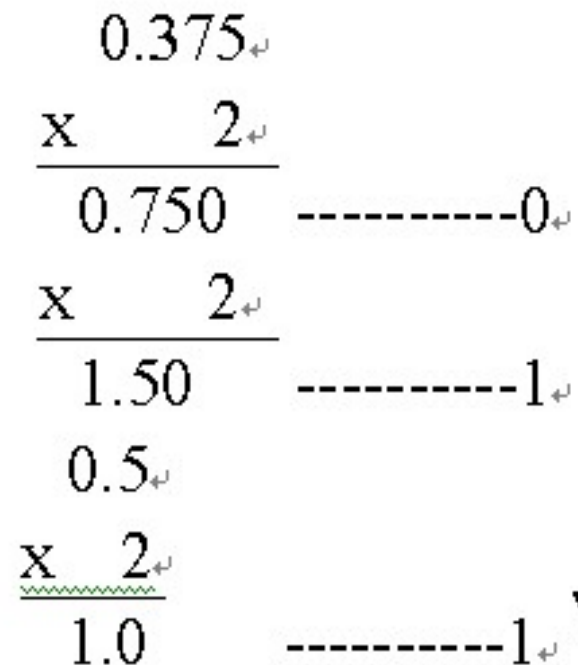
運算轉換

- 十進制 $(11.375)_{10}$ 轉換為二進制 $(1011.011)_2$

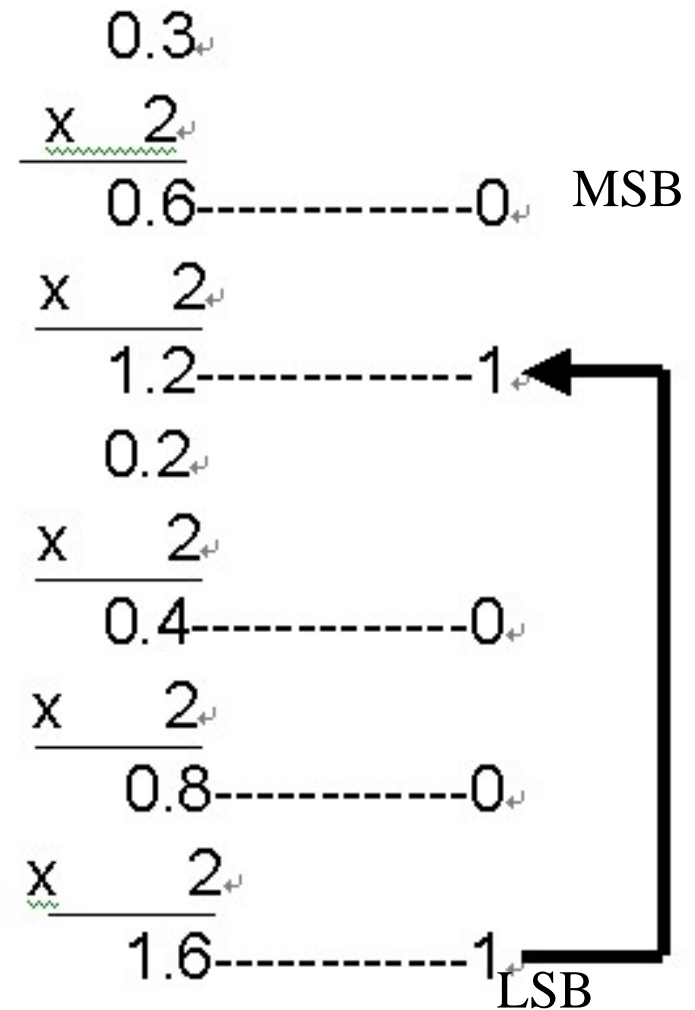
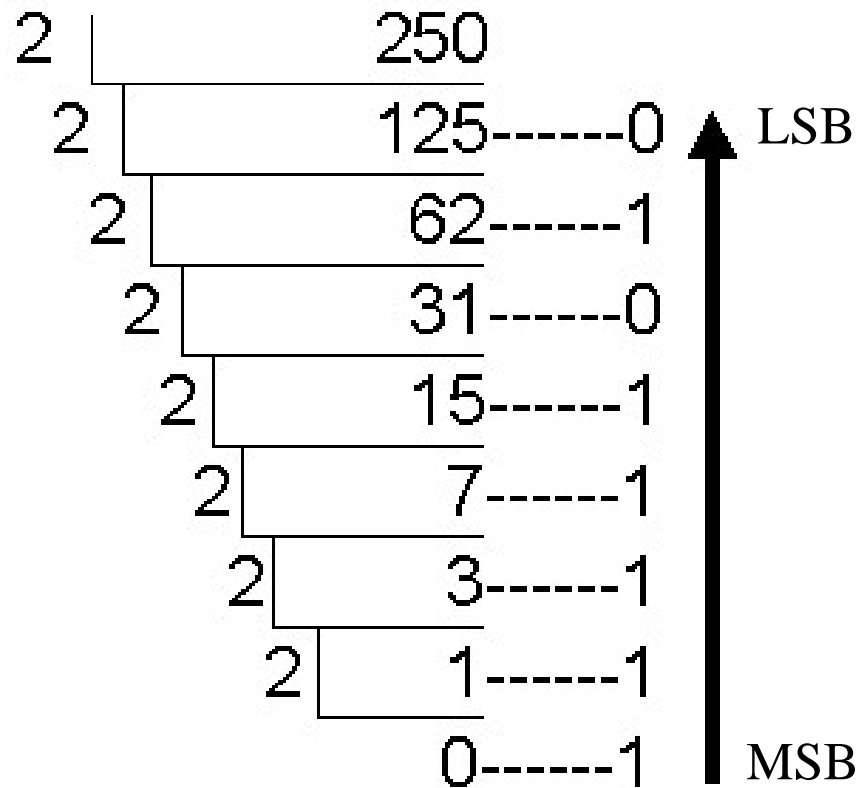
整數部分



小數部分



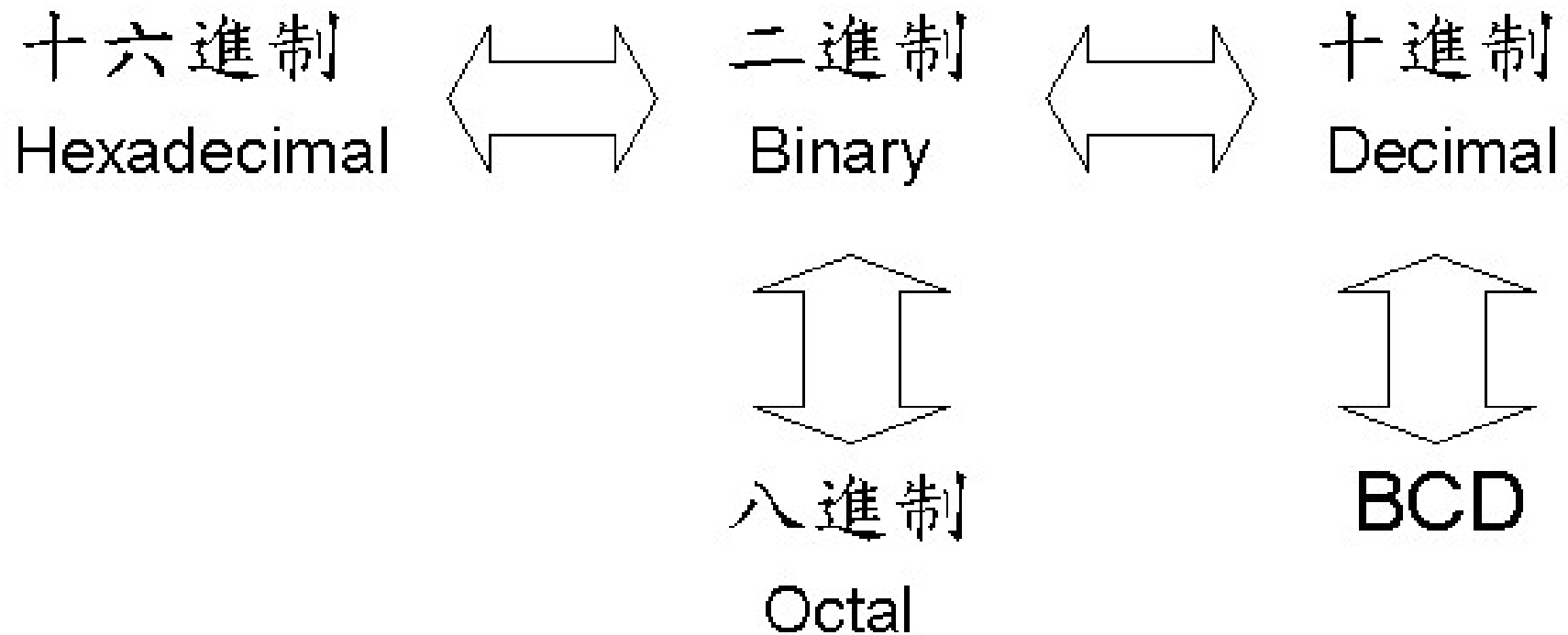
十進制 $(250.3)_{10}$ 轉換為二進制



運算轉換

- 十進制轉換為十六進制
- 十進制轉換為八進制

轉換流程圖



Signed Binary Number

Decimal	Signed 2's Complement	Signed 1's Complement	Signed Magnitude
+7	0111	0111	0111
+6	0110	0110	0110
+5	0101	0101	0101
+4	0100	0100	0100
+3	0011	0011	0011
+2	0010	0010	0010
+1	0001	0001	0001
+0	0000	0000	0000
-0	—	1111	1000
-1	1111	1110	1001
-2	1110	1101	1010
-3	1101	1100	1011
-4	1100	1011	1100
-5	1011	1010	1101
-6	1010	1001	1110
-7	1001	1000	1111
-8	1000	—	—

Table 3-9 Signed Binary Numbers

Sign extension

Binary-Coded Decimal (BCD)

TABLE 1-3
Binary-Coded Decimal (BCD)

Decimal Symbol	BCD Digit
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001

Table 1-3 Binary-Coded Decimal (BCD)

BCD addition

- $4 + 5$
- $7 + 6$
- $9 + 8$

Grey Code

Binary code	Grey code	Decimal equivalent
0000	0000	0
0001	0001	1
0010	0011	2
0011	0010	3
0100	0110	4
0101	0111	5
0110	0101	6
0111	0100	7
1000	1100	8
1001	1101	9
1010	1111	10
1011	1110	11
1100	1010	12
1101	1011	13
1110	1001	14
1111	1000	15

Homework:

請找出其規律性

$$Y = x \oplus (x \gg 1)$$

American Standard Code for Information Interchange (ASCII)

B ₇ B ₆ B ₅ B ₄	B ₃ B ₂ B ₁							
	000	001	010	011	100	101	110	111
0000	NULL	DLE	SP	0	@	P	`	p
0001	SOH	DC1	!	1	A	Q	a	q
0010	STX	DC2	"	2	B	R	b	r
0011	ETX	DC3	#	3	C	S	c	s
0100	EOT	DC4	\$	4	D	T	d	t
0101	ENQ	NAK	%	5	E	U	e	u
0110	ACK	SYN	&	6	F	V	f	v
0111	BEL	ETB	'	7	G	W	g	w
1000	BS	CAN	(	8	H	X	h	x
1001	HT	EM	)	9	I	Y	i	y
1010	LF	SUB	*	:	J	Z	j	z
1011	VT	ESC	+	;	K	[	k	{
1100	FF	FS	,	<	L	\	l	|
1101	CR	GS	-	=	M	]	m	}
1110	SO	RS	.	>	N	^	n	~
1111	SI	US	/	?	O	_	o	DEL

American Standard Code for Information Interchange (ASCII)

Control Characters:

NULL	NULL	DLE	Data link escape
SOH	Start of heading	DC1	Device control 1
STX	Start of text	DC2	Device control 2
ETX	End of text	DC3	Device control 3
EOT	End of transmission	DC4	Device control 4
ENQ	Enquiry	NAK	Negative acknowledge
ACK	Acknowledge	SYN	Synchronous idle
BEL	Bell	ETB	End of transmission block
BS	Backspace	CAN	Cancel
HT	Horizontal tab	EM	End of medium
LF	Line feed	SUB	Substitute
VT	Vertical tab	ESC	Escape
FF	Form feed	FS	File separator
CR	Carriage return	GS	Group separator
SO	Shift out	RS	Record separator
SI	Shift in	US	Unit separator
SP	Space	DEL	Delete

Error-Detecting Code

	With even parity	With odd parity
ASCII A= 100_0001	0 100_0001	1 100_0001
ASCII T= 101_0100	1 101_0100	0 101_0100

Digital Computer

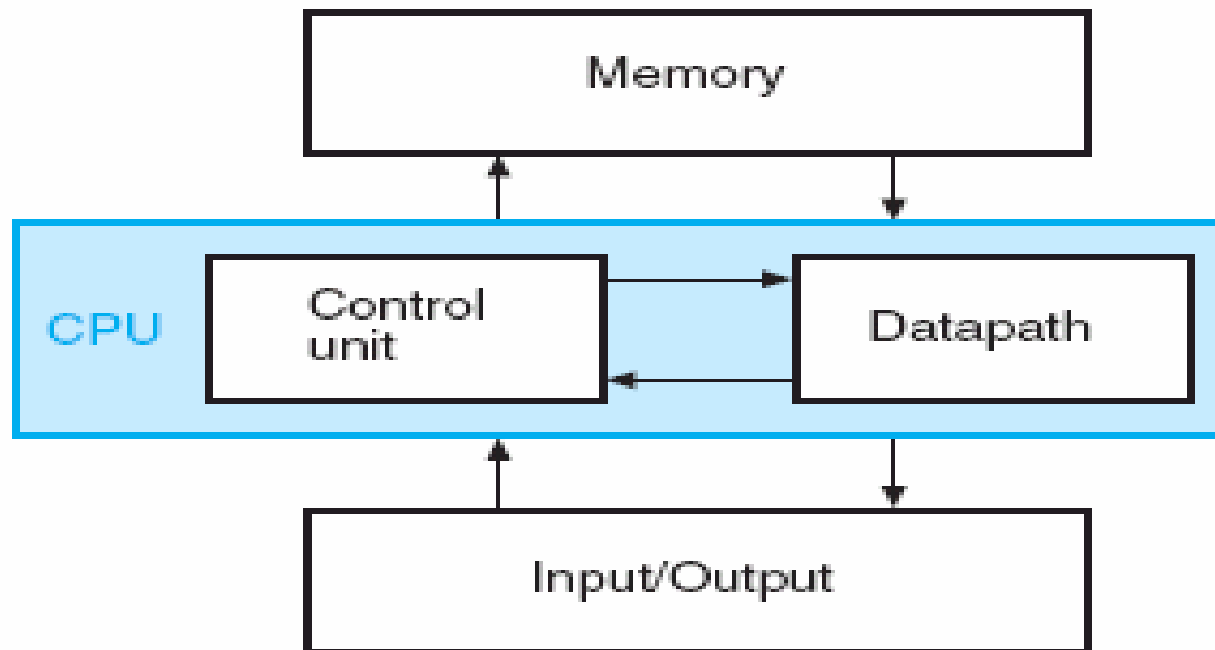
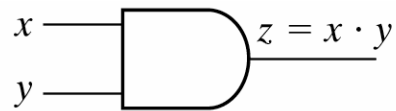
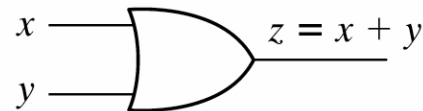


Fig. 1-2 Block Diagram of a Digital Computer

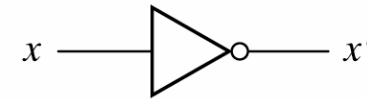
Basic logic gate



(a) Two-input AND gate



(b) Two-input OR gate



(c) NOT gate or inverter

Fig. 1-4 Symbols for digital logic circuits

Truth Tables for the Three Basic Logic Operations

AND		
X	Y	Z = X · Y
0	0	0
0	1	0
1	0	0
1	1	1

OR		
X	Y	Z = X + Y
0	0	0
0	1	1
1	0	1
1	1	1

NOT	
X	Z = \bar{X}
0	1
1	0

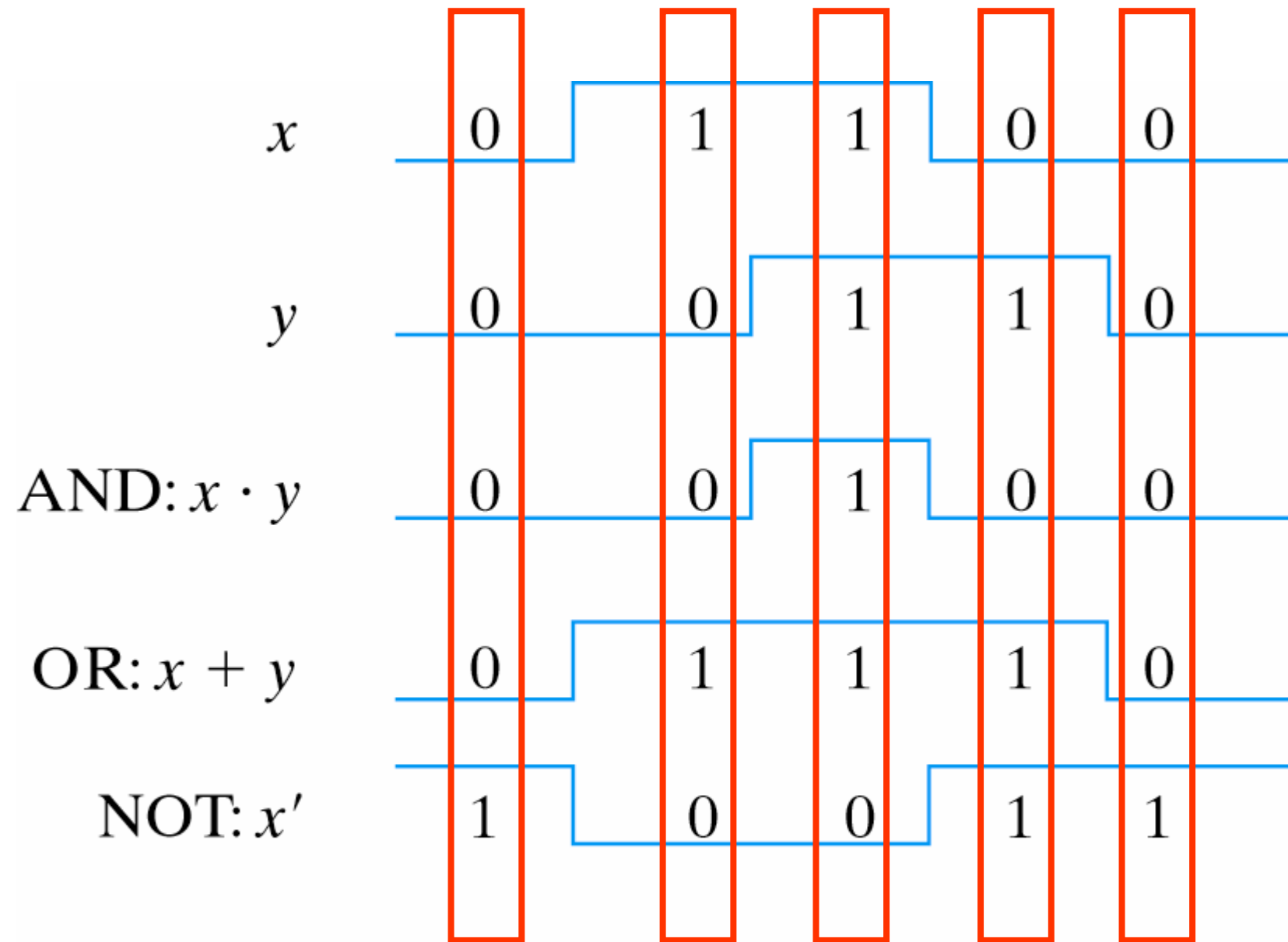
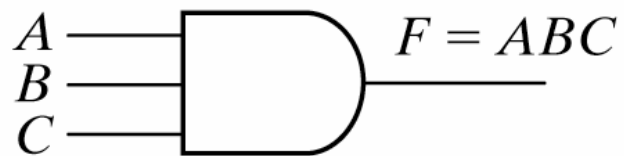
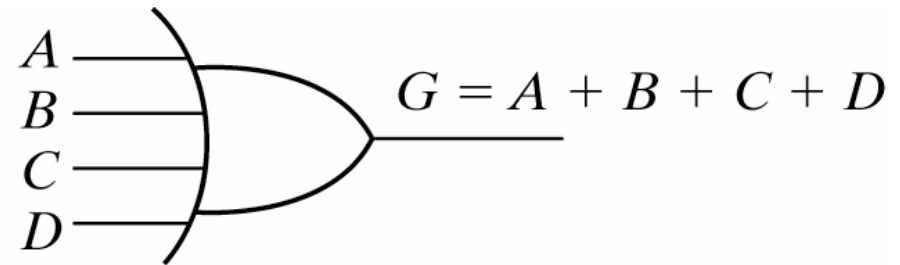


Fig. 1-5 Input-output signals for gates



(a) Three-input AND gate



(b) Four-input OR gate

Fig. 1-6 Gates with multiple inputs