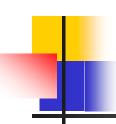
# Digital Logic Design



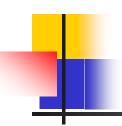
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## 1-7. Binary codes

- Digital systems use signals that have two distinct values and circuit elements that have two stable states.
- Any discrete element of information that is distinct among a group of quantities can be represented with a binary code (i.e., a pattern of 0's and 1's).
- An n-bit binary code is a group of n bits that assumes up to 2<sup>n</sup> distinct combinations of 1's and 0's, with each combination representing one element of the set that is being coded.



### BCD code

- We are more accustomed to the decimal system, and is straight binary assignment as listed in Table1-4. this is called binary coded decimal(BCD).
- 1010~1111 are not used and have no meaning in BCD code.

$$Ex:(185)_{10} = (1011001)_2$$

$$= (0001 \ 1000 \ 0101)_{BCD}$$

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



## **BCD Addition**

• When the binary sum is greater than or equal to 1010, the addition of 6 to the binary sum converts it to the correct digit and also produces a carry as required.

### One digit addition:

### two digits addition:

BCD carry	1	] 1⁴		
		1000		184
	+0101	0111	0110	+576
Binary sum	0111	10000	1010 >9	
Add 6		0110	0110+6	
BCD sum	0111	0110	0000	760

## **BCD Subtraction**

Consider the addition

(+375)+(-240)=+135, done in the signed-complement system: 10's complement of 240 is 760 while +9 represent that it is -ve

(+3470) + (-8750) = +5280, done in the signed-complement system: 10's complement of 8750 is 1250 while +9 represent that it is -ve

So taking again 10's complements and put minus due to 0's remainder so the final answer is (-5280)

## Other Decimal Codes

- The BCD,8-4-2-1, and the 2-4-2-1 codes are examples of weighted codes.
- The excess-3 codes are examples of selfcomplementing codes.

Ex. 
$$(395)_{10} = (0110 \ 1100 \ 1000)_{\text{excess-3}}$$
  
9's complement self-complementing  
 $(604)_{10} = (1001 \ 0011 \ 0111)_{\text{excess-3}}$ 

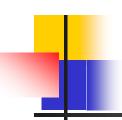
it is obviously to know the self-complementing that the excess-3 code of 9's complement of 395 is complementing the excess-3 of 395 directly. So does the 2421 code.



# Other Decimal Codes

Table1-5
Four Different Binary Codes for the Decimal Digits

Decimal	BCD			
Digit	8421	2421	Excess-3	8 4-2-1
0	0000	0000	0011	0000
1	0001	0001	0100	0111
$2 \longrightarrow 8 \times 0 + 4 \times 1 + (-2) \times 1 + (-1) \times 0 = 2$	0010	0010	0101	0 1 1 0
3	0011	0011	0110	0 1 0 1
4	0100	0100	0111	0 1 0 0
<sup>5</sup> weight	0101	1011	1000	1011
6	0110	1100	1001	1010
$7 \longrightarrow 2 \times 1 + 4 \times 1 + 2 \times 0 + 1 \times 1 = 7$	0111	1101	1010	1001
8	1000	1110	1011	1000
9	1001	1111	1100	1111
	1010	0101	0000	0001
Unused bit	1011	0110	0001	0010
Combinations	1100	0111	0010	0011
	1101	1000	1101	1 1 0 0
	1110	1001	1110	1 1 0 1
	1111	1010	1111	1110



# **Gray Code**

The advantage of the Gray code over the straight binary number sequence is that only one bit in the code group changes when one number to the next.

EX: from 7 to 8
Gray code changes from 0100 to 1100.

Gray code	de se sip	Decimal equivalent
0000	$(0\ 1\ 1\ 1)_2$	0
0001	\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	1
0011	xor	2
0010	++++	3
0110	$(01\ 0\ 0)_{Gra}$	y 4
0111	1 1 1	5
0101	/ / / xor	6
0100	(01 1 1)	7
1100	$(01\ 1\ 1)_2$	8
1101		9
1111		10
1110		11
1010		12
1011		13
1001		14
1000		15