EXCESS -3 &GRAY CODES

The Excess-3 representation of a number is based on BCD. It is formed by taking the number in BCD and adding the binary code for 3 to each of the 4-bit groups. Thus if we take the number 739, the BCD representation of it is: 0111 0011 1001. The binary for 3 (in 4 bits) is 0011. To give the Excess-3 for 739 this is added to each of the BCD code groups.

0111 0011 1001 + 0011 0011 0011 1010 0110 1100

Thus the Excess-3 code for 739 is 1010 0110 1100.

Gray Code

This is a variable weighted code and is cyclic. This means that it is arranged so that every transition from one value to the next value involves only one bit change. The gray code is sometimes referred to as reflected binary, because the first eight values compare with those of the last 8 values, but in reverse order. The gray code is often used in mechanical applications such as shaft encoders.

Modulo 2 Arithmetic This is binary addition with the carry ignored.

Converting Gray Code to Binary

A. write down the number in gray code

B. the most significant bit of the binary number is the most significant bit of the gray code

C. add (using modulo 2) the next significant bit of the binary number to the next significant bit of the gray coded number to obtain the next binary bit

D. repeat step C till all bits of the gray coded number have been added modulo 2

the resultant number is the binary equivalent of the gray number

Example, convert 1101101 in gray code to binary

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

1. 1101101
2. 1101101 1 copy down the MSB
3. 1101101 10 1 modulo2 1 = 0
4. 1101101 100 0 modulo2 0 = 0

3/4 1101101 1001 0 modulo2 1 = 1

3/4 1101101 10010 1 modulo2 1 = 0

3/4 1101101 100100 0 modulo2 0 = 0

3/4 1101101 1001001 0 modulo2 1 = 1

the answer is 1001001

Converting Binary to Gray

A. write down the number in binary code

B. the most significant bit of the gray number is the most significant bit of the binary code

C. add (using modulo 2) the next significant bit of the binary number to the next significant bit of the binary number to obtain the next gray coded bit

D. repeat step C till all bits of the binary coded number have been added modulo 2

the resultant number is the gray coded equivalent of the binary number

Example, convert 1001001 in binary code to gray code

Binary Gray

1. 1001001

2. 1001001 1 copy down the msb

3. 1001001 11 1 modulo2 0 = 1

4. 1001001 110 0 modulo2 0 = 0

3/4 1001001 1101 0 modulo2 1 = 1

3/4 1001001 11011 1 modulo2 0 = 1

3/4 1001001 110110 0 modulo2 0 = 0

3/4 1001001 1101101 0 modulo2 1 = 1

The answer is 1101101

Excess 3 to Gray Code

In many applications, it is desirable to have a code that is BCD as well as unit distance. A unit distance code derives its name from the fact that there is only one bit change between two consecutive numbers. The excess 3 gray code is such a code, the values for zero and nine differ in only 1 bit, and so do all values for successive numbers.

Outputs from linear devices or angular encoders may be coded in excess 3 gray code to obtain multi-digit BCD numbers.

Decimal	Excess 3 Gray
0	0010
1	0110
2	0111
3	0101
4	0100
5	1100
6	1101
7	1111
8	1110
9	1010