

The Excess-3 Code (XS3):

20

2024

Tuesday

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 M T W T F S S M T W T F S S
 1 2 3 4 5 6 7 8 9 10 11
 12 13 14 15 16 17 18 19 20 21 22 23 24 25
 26 27 28 29

The Excess-3 Code is derived by adding 3 to each decimal digit and then converting the result to four bit binary, since no definite weights can be assigned to the four digit position. Excess-3 code is an unweighted code. For example, excess-3 code for the decimal 3, 4 and 5 is

$$\begin{array}{r} 3 \\ + 3 \\ \hline 6 \rightarrow 0110 \end{array} \quad \begin{array}{r} 4 \\ + 3 \\ \hline 7 \rightarrow 0111 \end{array} \quad \begin{array}{r} 5 \\ + 3 \\ \hline 8 \rightarrow 1000 \end{array}$$

Excess-3 codes are given in table

Table 1: Excess-3 Code

Decimal	Binary	Excess-3
0	0000	0011
1	0001	0100
2	0010	0101
3	0011	0110
4	0100	0111
5	0101	1000
6	0110	1001
7	0111	1010
8	1000	1011
9	1001	1100

We note that ten of a possible 16 code combinations are used in the Excess-3 code. The six invalid combinations are 0000, 0001, 0010, 1101, 1110 and 1111.

Most important features of excess-3 code is its self complementing property. We illustrate it by taking an example:

- Excess-3 Code for decimal 4 is 0111.
- The one's complement of this 1000.
- But it is Excess+3 Code for decimal, 5.
- And 5 is the 9's complement of 4.

Thus we conclude that 1's complement (here 1000) of each excess-3 number (here 0111) is the Excess-3 Code for the 9's complement of the corresponding decimal digit (here 5).

Ex- Convert $(643)_{10}$ into its XS-3 Code.

Decimal number	6	4	3
Add 3 to each bit	+3	+3	+3
Sum	9	7	6
Convert to BCD Code	↓	↓	↓
	1001	0111	0110 ← XS-3 Code

Which is XS3 Code for $(643)_{10}$.

Excess-3 Addition!

To Add in XS3, add the binary number. If there is no carry out from the four bit group, subtract 0011 (=3) to get the XS3 code for the digit. If there is a carry out, add 0011 (=3) to get the XS3 code for the digit.

Ex- Add 3 and 2 in XS3.

3 =	0	1	1	0	← Excess-3 for 3
2 =	0	1	0	1	← Excess-3 for 2
Sum:	1	0	1	1	← No carry, Note it's
Subtract:	0	0	1	1	not XS3 code for 5.
5 =	1	0	0	0	← Excess-3 code for 5.

Ex-2 Add 7 and 6 in XS3

$$7 = 0011010 \leftarrow \text{Excess-3 for 7}$$

$$6 = 0010011 \leftarrow \text{Excess-3 for 6}$$

$$\text{Sum: } \begin{array}{r} 0011010 \\ + 0010011 \\ \hline 0101101 \end{array} \leftarrow \text{Carry is there. Note}$$

\therefore Add: $\begin{array}{r} 0101101 \\ + 0000001 \\ \hline 1110110 \end{array}$ it is not XS3 code for 13

$$13 = 1110110 \leftarrow \text{Excess-3 code for 13}$$

OR we can show in the following way

$$7 = 0011010$$

$$6 = 0010011$$

$$\text{Sum: } \begin{array}{r} 0011010 \\ + 0010011 \\ \hline 0101101 \end{array}$$

$$\text{Add: } \begin{array}{r} 0101101 \\ + 0001001 \\ \hline 1110110 \end{array} = 13 \text{ in XS-3 Code}$$

Ex-3 Add 34 and 19 in XS3

$$34 \rightarrow 01100111 \leftarrow \text{XS3 for 34}$$

$$+ 19 \rightarrow 01001100 \leftarrow \text{XS3 for 19}$$

$$\begin{array}{r} 01100111 \\ + 01001100 \\ \hline 10110011 \\ \leftarrow \text{Carry} \\ + 00010011 \\ \hline 11000110 \end{array}$$

11000110 which in XS3 code for 53.

Excess-3 Subtraction:

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a) For +ve result: For example, Subtract 19 from 34.
 34 ← Minuend Subtrahend's 9's Complement = 99 - 19 = 80
 - 19 ← Subtrahend
 + 15 result

XS3 of above Complement = 1011 0011
 XS3 of minuend = 0110 0111
 Add 9's Complement = 1011 0011
 +

Carry ←	10001	1010	← No carry
	0001	1010	
		+ 1	EAC

Add 0011 in it as there was carry in it → 0001 1011 ← Subtract 0011 from it as there was no carry in it
 + 0011
 0100 1000 ← Result which is XS3 of 15.

(b) For -ve result: For example, Subtract 34 from 19.
 In this case one more step is taken. Result does not give true value as in case (a) but we have to take 9's complement of the result to get the true value.

19 Minuend XS3 of Minuend = 0100 1100
 - 34 Subtrahend XS3 of 9's Complement of Subtrahend (99 - 34 = 65) = 1001 1000
 - 15

No carry in it →	1101	0100	Carry in
	+ 1	Carry	
	1110	0100	
	0011	0011	
	1011	0111	O/P

9's complement or binary 1's complement of output (O/P)

→ 0100 1000 ← true result XS3 of 15.

8421, Excess-3 and Gray Codes

Code	Advantages	Disadvantages
8421	Weighted (each bit position has a fixed value) Conversion to decimal numbers easy.	Rules of binary addition do not apply. Not efficient because only 10 out of 16 possible configurations are utilised
Excess-3	Self Complementing	unweighted
Gray Code	Each progressive number differs by only one bit; therefore useful for I/O devices such as shift encoders	unweighted Rules of binary addition do not apply.

25 Sunday

0001

1001

+

0110

1110

1100

1100

0110

1101

0110

1101

0110

1101

0110

1101

0110

1101