- Distinguish between the number system or system base and the binary representation of the digits used in the system.

- Weighted codes associate a weight with the bit position.

- For non weighted number codes a weight can not be associated with a bit position.

- In self-complementing codes, the binary representations of number equidistant from the centre of the range are bit complements of each other.

- In cyclic number codes only one bit changes in going from a number to the next number in the sequence.

- In reflective codes, the leading bit changes at the midpoint and the codes in the second half repeat the first half in reverse order.

- The Gray code in the most common example of cyclic codes.

A 4 bit binary code can represent $2^4 = 16$ distinct numbers.
A valid and non weighted representation might be:

0	1011
1	1010
2	0110
3	etc.

A random assignment.

A weighted code is one where a bit, d, in a specific position, w, always has a specific weight and a decimal digit, N is computed from:

$$N = d_3w_3 + d_2w_2 + d_1w_1 + d_0w_0$$

0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	etc.

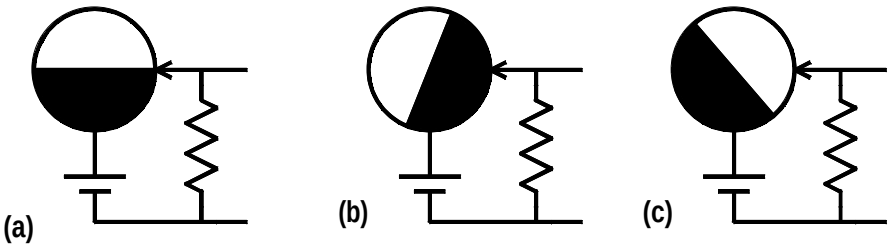
Decimal	BCD = 8421	7421	4221	$84\overline{21}$
0	0000	0000	0000	0000
1	0001	0001	0001	0111
2	0010	0010	0010	0110
3	0011	0011	0011	0101
4	0100	0100	1000	0100
5	0101	0101	0111	1011
6	0110	0110	1100	1010
7	0111	1000	1101	1001
8	1000	1001	1110	1000
9	1001	1010	1111	1111

The common weighted decimal codes.
BCD is Binary Coded Decimal.

Non weighted binary codes.
A number, N, can not be expressed in the form

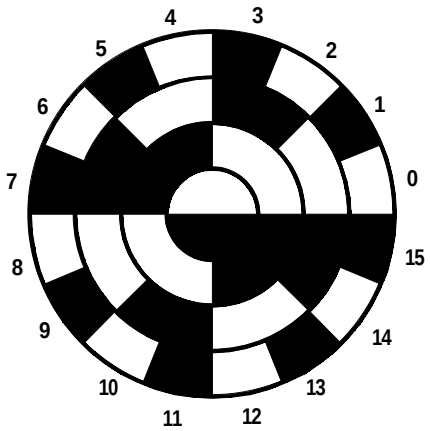
$$N = d_3w_3 + d_2w_2 + d_1w_1 + d_0w_0.$$

Advantages in measureement and sensing systems.
BUT
Arithmetic is very difficult using non weighted codes.

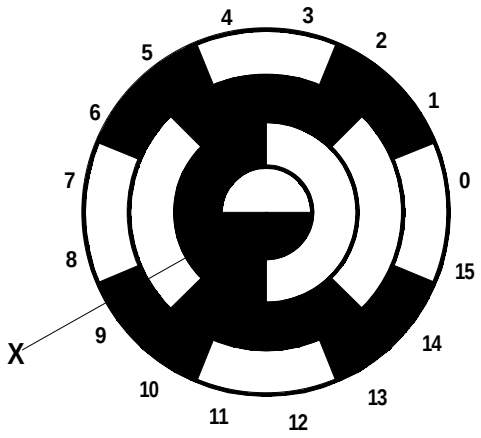


Measure the angle of a shaft by using
a set of brush contacts and a segmented metal disk
or a set of optical sensors and a disk having transparent and opaque sectors

Higher angular resolution is obtained by sub-dividing the sectors
A binary division causes problems.

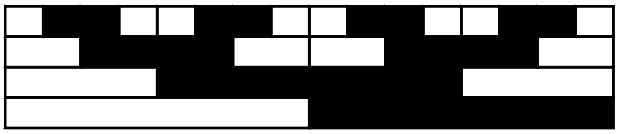


Consider the output on each side of 0°, say 1° and 359°. The outputs would be 0000 and 1111.
Imperfect alignment gives jumps to intermee-diate values.



Use a Gray code to to code the sectors.
Only one bit changes state at each border between sectors
Maximum ambiguity is $\pm$ one sector.

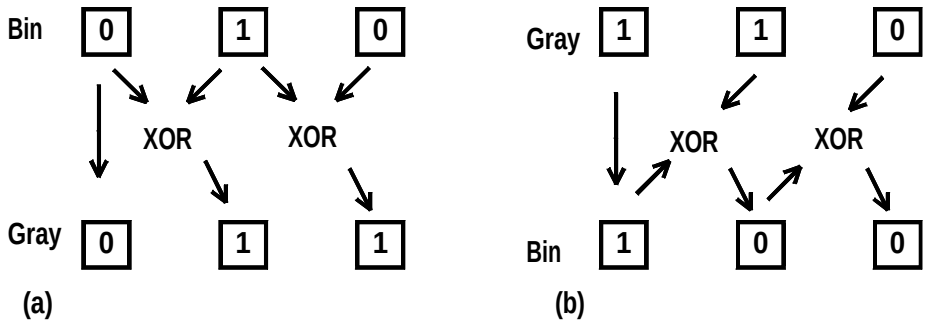
There is a smooth progression through the position codes as the sectors rotate with no discontinuous jumps to distant position codes.



The Gray code can also be used to encode a linear position sensor.

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

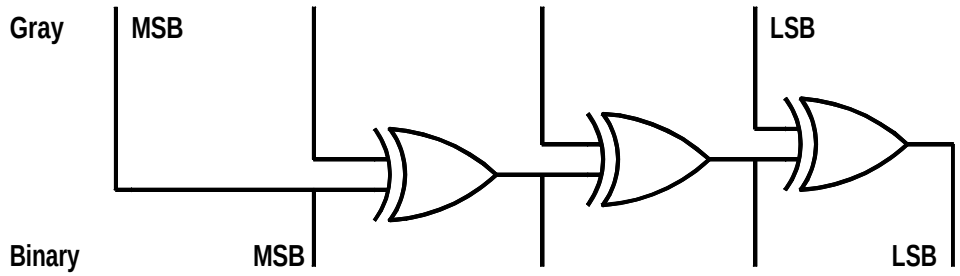
The Gray code is cyclic and reflective.



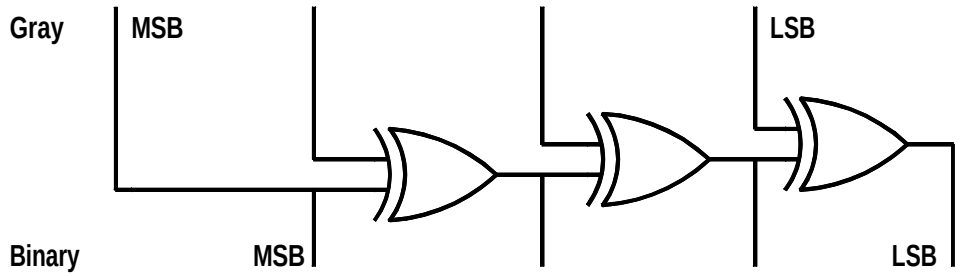
The algorithms used for converting:

- From binary to Gray and

- From Gray to binary.



A circuit for converting a four bit Gray code to a 4 bit Binary code.



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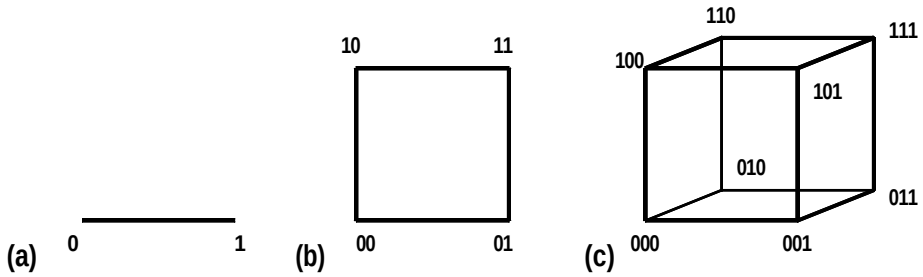

A Gray code sequence is a path through each of the vertices once only and which returns to the starting point and which is reflective.

Such a path is called a Hamiltonian path

No. of bits	1	2	3
Codes	0	00	000
	1	01	001
		11	011
		10	010
			110
			111
			101
			100

The reflective and cyclic requirements give a simple way of writing down the representations of the Gray codes.