Grey Code and Binary Code

From the previous articles, you may have noticed the use of the grey code instead of the binary code in absolute shaft encoders. This is another type of digital code. It has the important characteristic that only one bit changes between one code and the next. Binary code, on the other hand, can have a large number of changes between one code and the next. See the table below for examples binary code and grey code for the codes from 0 to 15 for a four bit code. As can be clearly seen in the binary code, when moving from the number 7 to 8, all four bits change. However, at any change in the grey code between one number and the next, only one bit changes.

Number	Binary Code	Grey Code
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

Study the following rules for developing the grey code.

1. *Start with a word that contains all zeros.*
2. *Go to the least significant bit and toggle it (i.e., change it from 0 to 1 or from 1 to 0).*
3. *If the resulting code has not been used before (i.e., is unique), then keep the resulting code and proceed to the next.*
4. *Otherwise, if the code is not unique, then undo the change and move to the next significant bit and toggle it.*
5. *Repeat the steps above until all codes have been generated.*

The resolution of the absolute shaft encoder can be calculated as shown in the equation shown below:

$$\Delta\theta = \frac{360^\circ}{2^n}$$, *where:*

- *n is the number of bits used in the absolute shaft encoder, and*
- $\Delta\theta$ *is the resolution of the shaft encoder in degrees.*

For example, an absolute shaft encoder with 14 bits has an angular resolution of around 0.022 degrees.