What is Gray Code?

Gray Code is a form of binary that uses a different method of incrementing from one number to the next. With Gray Code, only one bit changes state from one position to another. This feature allows a system designer to perform some error checking (i.e. if more than one bit changes, the data must be incorrect). Table 1 below illustrates the difference between Natural Binary and Gray Code:

Gray Code		Natural Binary	
0000	0	0000	0
0001	1	0001	1
0011	2	0010	2
0010	3	0011	3

Table 1

Why use Gray Code?

Gray Code is the most popular Absolute encoder output type because its use prevents certain data errors which can occur with Natural Binary during state changes. For example, in a highly capacitive circuit (or sluggish system response), a Natural Binary state change from 0011 to 0100 could cause the counter/PLC to see 0111. This sort of error is not possible with Gray Code, so the data is more reliable. In the Table 2 below, note that even from position 7 to 8, Gray Code only changes one bit state.

Table 2

How do I convert the Gray Code to Natural Binary?

On paper, the process is easy:

1) Write the Gray Code and copy the left most bit under itself.

2) Add the copied bit to the next Gray Code bit over (to the right). Remember, 0+0=0, 0+1=1, 1+0=1, 1+1=0. Drop all carries. Write result next to the copied digit from step 1.

3) Repeat step 2 until completed. See Table 3 below.

1	1	0	1	1	Gray Code
1					Natural Binary
1	**1**	0	1	1	Gray Code
1	0				Natural Binary
1	1	**0**	1	1	Gray Code
1	**0**	0			Natural Binary
1	1	0	**1**	1	Gray Code
1	0	**0**	1		Natural Binary
1	1	0	1	**1**	Gray Code
1	0	0	**1**	0	Natural Binary

Table 3

How about using software to convert Gray Code?

Again the process is very straight-forward. One way to convert Gray-code to binary is by means of a short software routine, such as the following for a 10 bit encoder:

```
BEGIN:
    set B0 through B9 = 1
    B9 = G9
    IF B9 = G8 THEN B8 = 0
    IF B8 = G7 THEN B7 = 0
    IF B7 = G6 THEN B6 = 0
    IF B6 = G5 THEN B5 = 0
    IF B5 = G4 THEN B4 = 0
    IF B4 = G3 THEN B3 = 0
    IF B3 = G2 THEN B2 = 0
    IF B2 = G1 THEN B1 = 0
    IF B1 = G0 THEN B0 = 0
DONE
```