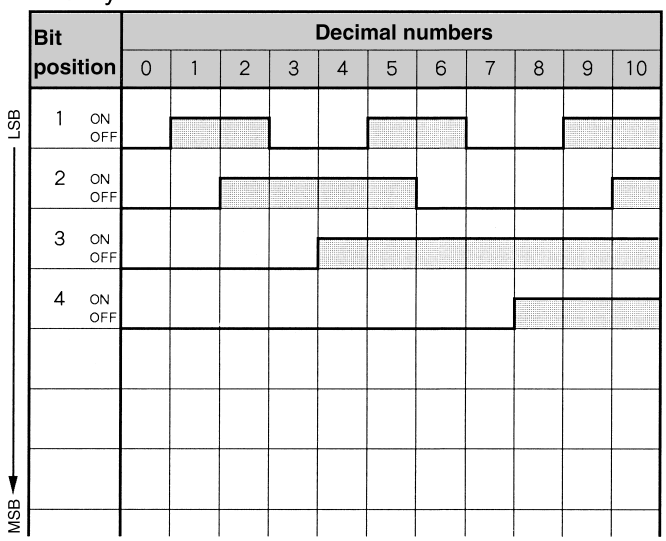
Mechanism of absolute rotary encoder

■ Mechanism of absolute rotary encoder

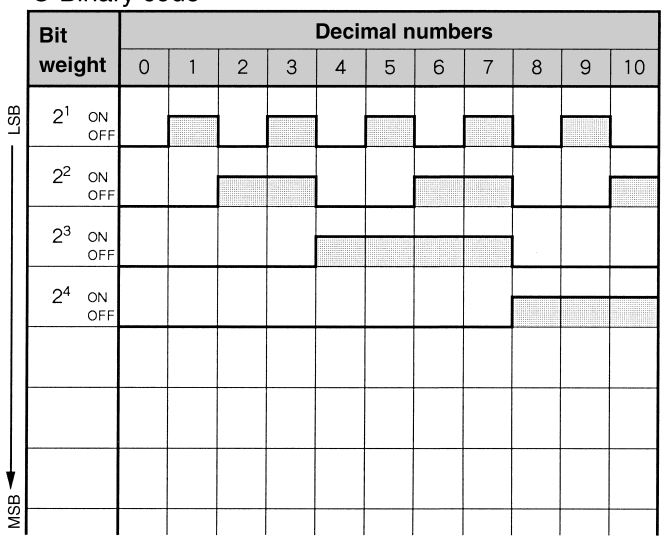
Based on a reference position, the absolute rotary encoder provides absolute angles of rotation. Through parallel encoding, these angles are expressed in Gray codes.
The absolute encoder uses no counter for determining angles. Precision is not affected by electrical noise or vibration called "chattering". In case of power shut-down, correct angles are generated upon power recovery. A machine controlled by the encoder can be easily set up. It need not be initialized to its home position.

■ What is the Gray code?

● Gray code



● Binary code



* "ON" denotes the period when signal is generated by tran sistor and electrical current is supplied.

The above figures show how decimal numbers are coded in two methods.
In binary coding, two or more contiguous bits change their status to express a decimal number incremented by one. In Gray coding, only one bit changes its status to express the same increment.
Bit - wise response to input signal varies between the encoder and the device connected. In binary coding, this may cause erroneous reading or omission of certain bits.

■ List of output codes

Decimal number	bit 10	9	8	7	6	5	4	3	2	1
0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	1
2	0	0	0	0	0	0	0	0	1	1
31	0	0	0	0	0	1	0	0	0	0
32	0	0	0	0	1	1	0	0	0	0
37	0	0	0	0	1	1	0	1	1	1
38	0	0	0	0	1	1	0	1	0	1
63	0	0	0	0	1	0	0	0	0	0
64	0	0	0	1	1	0	0	0	0	0
75	0	0	0	1	1	0	1	1	1	0
76	0	0	0	1	1	0	1	0	1	0
127	0	0	0	1	0	0	0	0	0	0
128	0	0	1	1	0	0	0	0	0	0
151	0	0	1	1	0	1	1	1	0	0
152	0	0	1	1	0	1	0	1	0	0
217	0	0	1	0	1	1	0	1	0	1
218	0	0	1	0	1	1	0	1	1	1
255	0	0	1	0	0	0	0	0	0	0
256	0	1	1	0	0	0	0	0	0	0
435	0	1	0	1	1	0	1	0	1	0
436	0	1	0	1	1	0	1	1	1	0
511	0	1	0	0	0	0	0	0	0	0
512	1	1	0	0	0	0	0	0	0	0
871	1	0	1	1	0	1	0	1	0	0
872	1	0	1	1	0	1	1	1	0	0
1022	1	0	0	0	0	0	0	0	0	1
1023	1	0	0	0	0	0	0	0	0	0

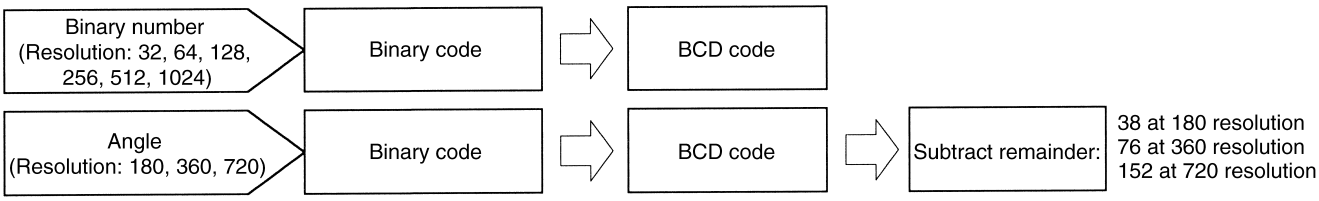
Resolution 1024
Resolution 512
Resolution 256
Resolution 128
Resolution 64
Resolution 32
Resolution 180
Resolution 360
Resolution 720

"1" and "0" denote the status of transistor output as follows: "1" = ON "0" = OFF

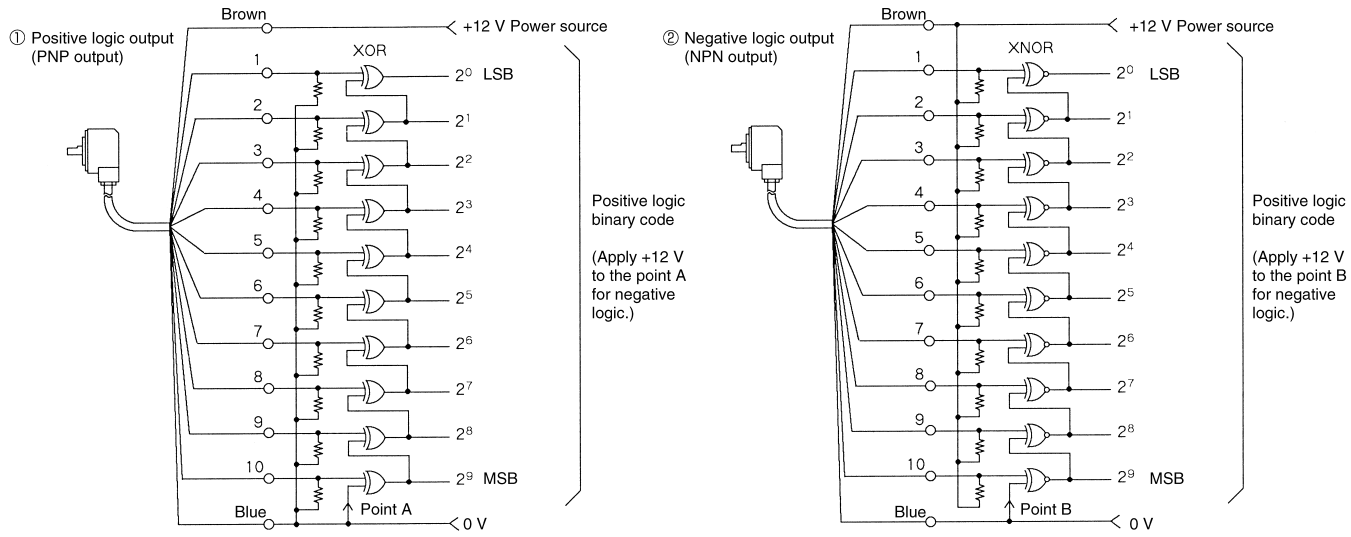
5bit → Resolution 32
6bit → Resolution 64
7bit → Resolution 128
8 bit (Resolution 180, 256)
9 bit (Resolution 360, 512)
10 bit (Resolution 720, 1024)

Conversion of output codes

Gray codes can be converted to binary codes or BCD codes ad follows:



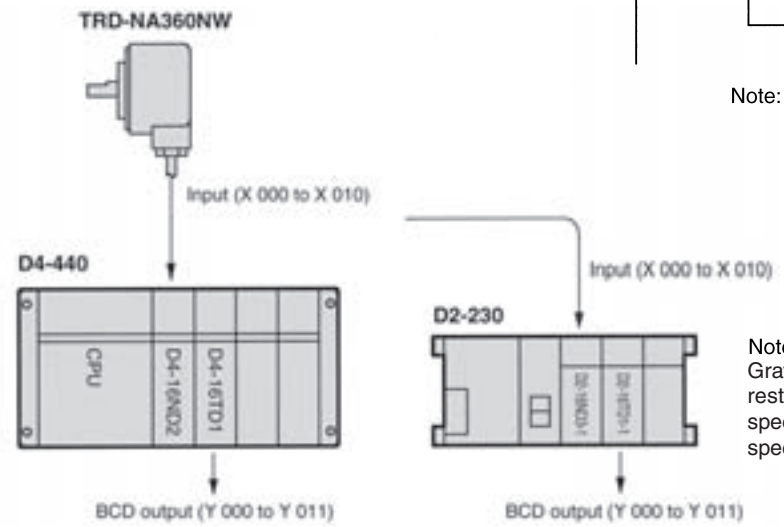
Converting a Gray code to a binary code at 1,024 resolution

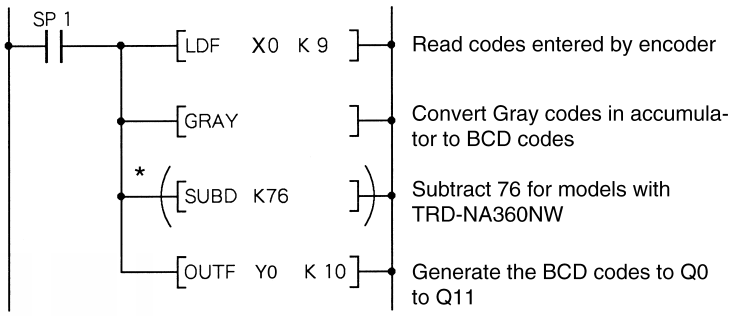


● Gray to binary conversion by PLC

Between TRD-NA and D4-450,440/D2-250,240

TRD-NA360NW output	D4-450,440/D2-250,240 input
Red LSB	X 000
Orange	X 001
Yellow	X 002
Green	X 003
Purple	X 004
Gray	X 005
White	X 006
Black/White	X 007
Red/White MSB	X 010





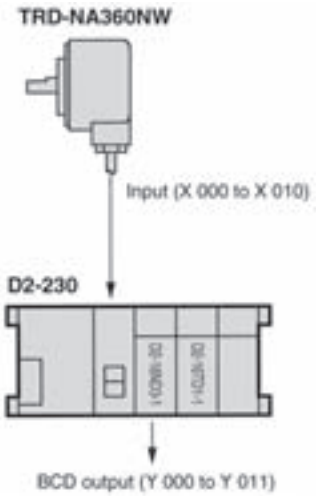
Note: Subtract 76 when using TRD-NA360□ models with 360 resolution. This is not necessary on other models. Omit the SUBC command for TRD-NA512□ models at 512 resolution and TRD-NA1024□ models at 1024 resolution.

Note
Gray to binary conversion by PLC is restricted by its program execution speed. At 20 ms/scan, set the encoder speed to 8 rpm or less.

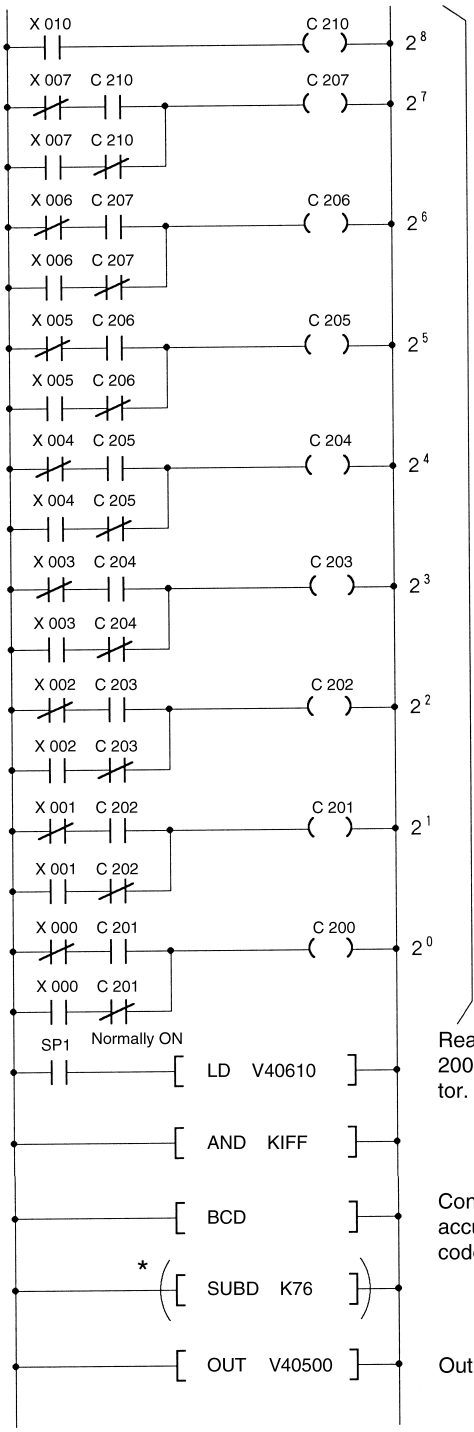
Mechanism of absolute rotary encoder

Between TRD-NA and D2-230

TRD-NA360NW output	D2-230 input
Red LSB	X 000
Orange	X 001
Yellow	X 002
Green	X 003
Purple	X 004
Gray	X 005
White	X 006
Black/White	X 007
Red/White MSB	X 010



Note
Gray to binary conversion by PLC is restricted by its execution speed. At 20 ms/scan, set the encoder speed to 8 rpm or less.



Circuit converts Gray codes from the absolute encoder to binary codes.

Read 16 bits of registers 200 to 217 to accumulator.

Convert binary codes in accumulator to BCD codes

Output to Y0 to Y017

Note: Subtract 76 when using TRD-NA360□ models with 360 resolution. This is not necessary on other models.

Gray Code (GRAY)

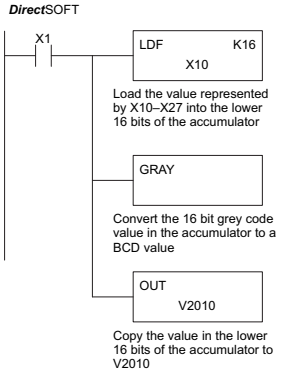
☒ 230
☑ 240
☑ 250-1
☑ 260

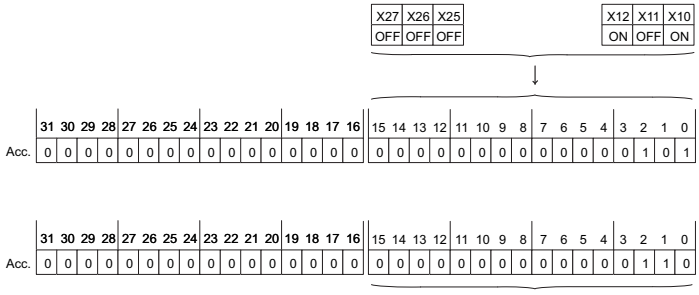
DS	Used
HPP	Used

GRAY

The Gray code instruction converts a 16-bit gray code value to a BCD value. The BCD conversion requires 10 bits of the accumulator. The upper 22 bits are set to "0". This instruction is designed for use with devices (typically encoders) that use the grey code numbering scheme. The Gray Code instruction will directly convert a gray code number to a BCD number for devices having a resolution of 512 or 1024 counts per revolution. If a device having a resolution of 360 counts per revolution is to be used you must subtract a BCD value of 76 from the converted value to obtain the proper result. For a device having a resolution of 720 counts per revolution you must subtract a BCD value of 152.

In the following example, when X1 is ON the binary value represented by X10–X27 is loaded into the accumulator using the Load Formatted instruction. The gray code value in the accumulator is converted to BCD using the Gray Code instruction. The value in the lower 16 bits of the accumulator is copied to V2010.





Handheld Programmer Keystrokes

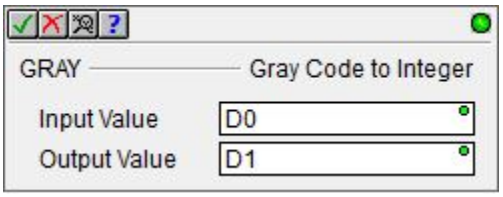
$ STR	→	B 1	ENT							
SHFT	L ANDST	D 3	F 5	→	B 1	A 0	→	B 1	G 6	ENT
SHFT	G 6	R ORN	A 0	Y MLS	ENT					
GX OUT	→	SHFT	V AND	C 2	A 0	B 1	A 0	ENT		

Gray Code	BCD
0000000000	0000
0000000001	0001
0000000011	0002
0000000010	0003
0000000110	0004
0000000111	0005
0000000101	0006
0000000100	0007
.	.
.	.
.	.
1000000001	1022
1000000000	1023

DoMore Software Help File

Topic: DMD0024

GRAY - Gray Code to Integer



The Gray Code to Integer instruction (GRAY) converts a 16 bit Gray code value to an integer value. This instruction is designed for use with devices that use the gray code numbering scheme.

Gray codes are often used in linear encoders and rotary encoders in preference to straightforward binary encoding. This avoids the possibility that, when several bits change in the binary representation of an angle, a misread could result from some of the bits changing before others. Rotary encoders especially benefit from the cyclic nature of Gray codes, because the first and last values of the sequence differ by only one bit.

The Gray Code to Integer instruction will directly convert a gray code number to an integer for devices having a resolution of 512 or 1024 counts per revolution.

For a device having a resolution of 360 counts per revolution you must subtract 76 from the converted value to obtain the correct result (360-Excess-76 Gray Code).

For a device having a resolution of 720 counts per revolution you must subtract 152 from the converted value to obtain the correct result (720-Excess-152 Gray Code).

Gray Code	Binary	Decimal
0000	0000	0
0001	0001	1
0011	0010	2
0010	0011	3
0110	0100	4
0111	0101	5
0101	0110	6
0100	0111	7
1100	1000	8
1101	1001	9
1111	1010	10
1110	1011	11
1010	1100	12
1011	1101	13
1001	1110	14
1000	1111	15
.	...	...
1 0000 0001	1 1111 1110	510
1 0000 0000	1 1111 1111	511
.	...	...
10 0000 0001	11 1111 1110	1022
10 0000 0000	11 1111 1111	1023

Parameters:

Note: Use the F9 key (Element Browser) or Down-Arrow key (Auto-Complete) at any time to see a complete list of the memory locations that are valid in the current field of the instruction.

Input Value - designates the memory location that contains the Gray code value. This can be any constant value or any readable numeric location.

Output Value - designates a memory location to store the converted value. This can be any writable numeric location.

See Also:

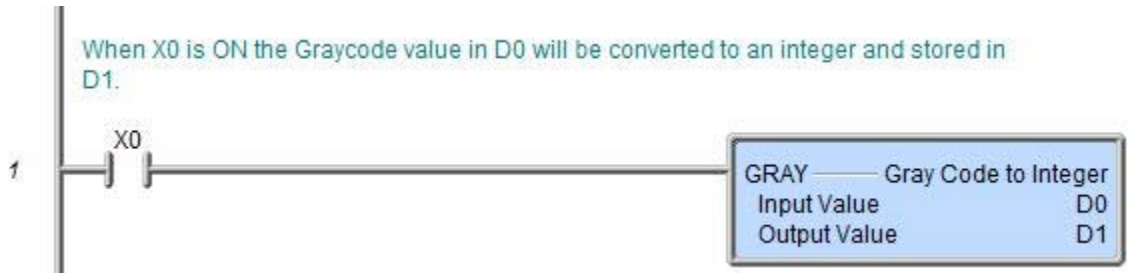
- FREQCNT - Frequency Counter
- FREQTMR - Frequency Timer

- GRAY - Gray Code to Integer
- SCALE - Scale Value
- SEG - Hex/BCD to 7 Segment Display

- STR2INT - Convert String to Integer
- STR2REAL - Convert String to Real

- SWAPB - Swap Bytes

Rung Example:



Data Handling

Absolute Encoder (ABSE) Instruction

Mnemonic (Keyboard Shortcut) = ABSE **Icon/Button =** 

Purpose Decodes Bit Pattern from Gray Code or Binary Absolute Encoder.

Instruction Parameters

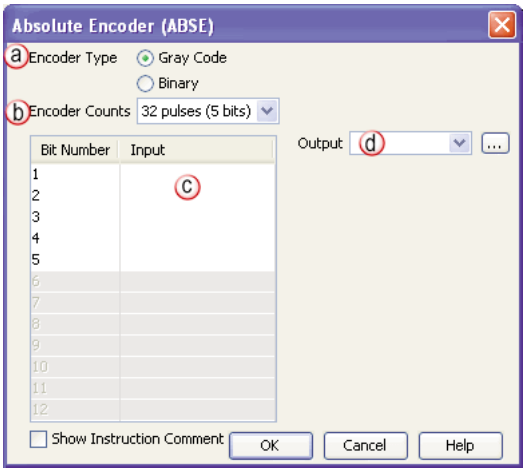
Parameter	Parameter Type	Requirements	Description
Enable	Ladder Input	Must Have	**Level-driven. When Enable is ON, the instruction will operate every scan. When Enable is OFF, instruction is not solved and its outputs are not updated.**
Encoder Type	Selectable Option		**Selects Gray Code or Binary Encoder type.**
Encoder Counts	Drop-down Menu Selection		**Selects one of these Resolutions for the Absolute Encoder:** • 32 pulses (5 bits) • 64 pulses (6 bits) • 128 pulses (7 bits) • 180 pulses (8 bits) • 256 pulses (8 bits) • 360 pulses (9 bits) • 512 pulses (9 bits) • 720 pulses (10 bits) • 1024 pulses (10 bits) • 2048 pulses (11 bits) • 4096 pulses (12 bits)
Input	Boolean Tag / Constant		**Discrete Input Tags assigned to the Absolute Encoder Inputs. The number of required Tags depends on selected Encoder Counts.**
Output	Numerical Tag		**Current Encoder position.**

Note: *The Output Tag Value is not forced to zero when the Enable is turned OFF. The Output Tag will contain the last value Written by the Instruction until it is overwritten by another Instruction or from an external device.*

Note: *Tag Values are updated immediately as each Ladder Rung is executed, top to bottom. However, Tag Values representing physical Outputs are only applied to the physical Output after the END statement of the last Task to be scanned is reached. Outputs in Remote Base Groups have additional limitations regarding Update Intervals.*

Instruction Configuration

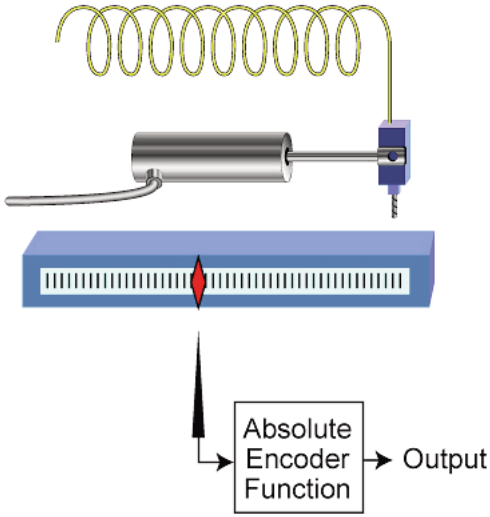
When Absolute Encoder Instruction is selected the window shown on the right opens with defaults shown.



Parameter Configuration Table											
Absolute Encoder ABSE **(ABSE)**		Boolean	Integer, 8 Bit Unsigned	Integer, 16 Bit	Integer, 16 Bit Unsigned	Integer, 16 Bit BCD	Integer, 32 Bit	Integer, 32 Bit BCD	Float, 32 Bit	String	Constant	**Notes:**
a	Encoder Type											**Select Gray Code or Binary Encoder type.**
b	Encoder Counts											**Select Encoder Resolution.**
c	Input	✓									✓	**Enter a Value or Tag for each Input.**
d	Output		✓	✓	✓	✓	✓	✓	✓			**Select an Output Tag.**

Application Example

In the following example, the current table position is calculated based on the Encoder Resolution and the bit pattern of the Gray Code bit pattern fed into the ABSE instruction.



Rung Example