Discussion of the Intermediate test

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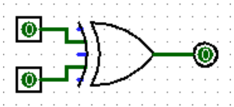
XOR gate



A	**B**	**X**
0	0	0
0	1	1
1	0	1
1	1	0

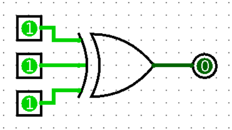
Three interpretations:

1. One and only only one input active
2. Odd number of inputs active
3. Inputs are not equivalent

All tree interpretations are the same for 2 inputs...

Multi-input XOR gate

... but not for 3 and more inputs ...



A	B	C	X		
			One of three XOR[1]	Odd no. of inputs $A \oplus B \oplus C$[2]	Non-equivalence $A \not\equiv B \vee B \not\equiv C$
0	0	0	0	0	0
0	0	1	1	1	1
0	1	0	1	1	1
0	1	1	0	0	1
1	0	0	1	1	1
1	0	1	0	0	1
1	1	0	0	0	1
1	1	1	**0**	**1**	0

[1] Logisim

[2] Circuit manufacturers

IC manufacturer’s interpretation

$$A \oplus B \oplus C$$

Nexperia **74LVC1G386**

3-input EXCLUSIVE-OR gate

5 Functional diagram

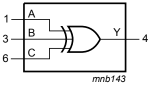


Figure 1. Logic symbol

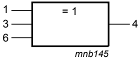


Figure 2. IEC logic symbol

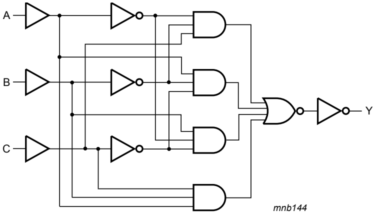


Figure 3. Logic diagram

IC manufacturer's interpretation

$$A \oplus B \oplus C$$

Nexperia **74LVC1G386**

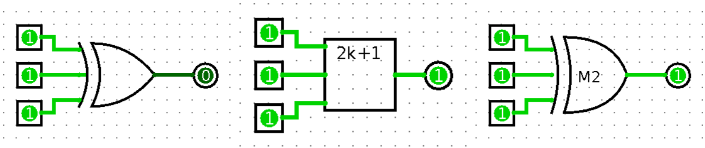
3-input EXCLUSIVE-OR gate

Table 4. Function table [1]

Input			Output
A	B	C	Y
L	L	L	L
L	L	H	H
L	H	L	H
L	H	H	L
H	L	L	H
H	L	H	L
H	H	L	L
H	H	H	H

[1] H = HIGH voltage level;
L = LOW voltage level

Logisim interpretation



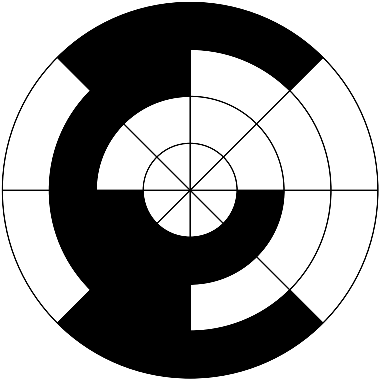
But if there are more than two specified inputs, the XOR gate will emit 1 only when there is exactly one 1 input, whereas the Odd Parity gate will emit 1 if there are an odd number of 1 inputs.

http://www.cburch.com/logisim/docs/2.1.0/libs/gates/xor.html

Gray codes

Number	Gray code	Binary positional
0	0000	0000
1	0001	0001
2	0011	0010
3	0010	0011
4	0110	0100
5	0111	0101
6	0101	0110
7	0100	0111
8	1100	1000
9	1101	1001
A	1111	1010
B	1110	1011
C	1010	1100
D	1011	1101
E	1001	1110
F	1000	1111

Uses of Gray code



By jjbeard - Encoder_disc.png, Public Domain

Deciphering assembler

```
LDC  D1
ST   A1
LDC  D2
ST   A2
LD   A1
SUB  A2
```

```
LDC  12
ST   20
LDC  14
ST   21
LD   20
SUB  21
```

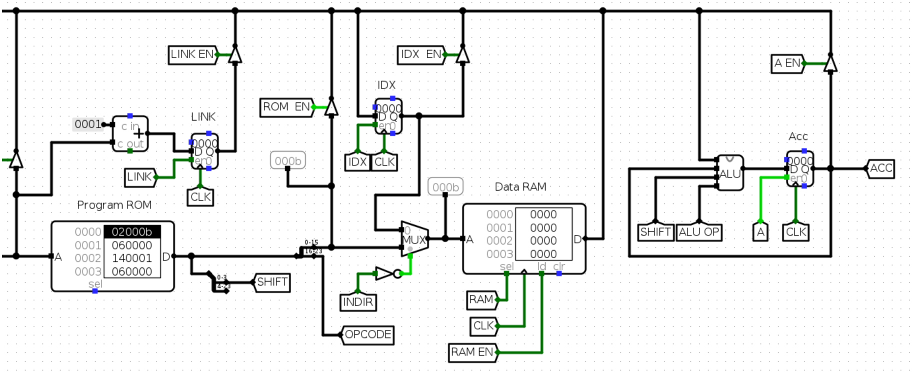
- $A \leftarrow 12$
- $A \rightarrow [20]$; [20] is now 12
- $A \leftarrow 14$
- $A \rightarrow [21]$; [21] is now 14
- $A \leftarrow [20]$; A is now 12
- $A \leftarrow A - [21]$; A is now 12 - 14

Answer:

$12 - 14 = -2 = \mathrm{FFFE}_{16}$

Active signals during instruction execution

Instruction: LDC → opcode: **02**000B



Conversion of number systems

- quaternary (base-4) → hexadecimal

$$4^2 = 16$$

$$01\ 21\ 33\ 10\ 22_4 \rightarrow 19F4A_{16}$$

- binary → quaternary (base-4)
- ternary → nonary (base-9)