SUBTRACTOR CIRCUIT

COMBINATIONAL LOGIC CIRCUITS

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TOPIC OUTLINE

Signed-Magnitude Form

1's Complement Form

2's Complement Form

SUBTRACTOR CIRCUIT

SIGNED-MAGNITUDE

0101 (+5)

1101 (−5)

sign
0 - positive
1 - negative

Binary Addition

$$\begin{array}{rll} & 1101 & (-5) \\ + & 0010 & (+2) \\ \hline & 1011 & (-3) \end{array}$$

$$\begin{array}{rll} & 0101 & (+5) \\ + & 1010 & (-2) \\ \hline & 0011 & (+3) \end{array}$$

$$\begin{array}{rll} & 101 & (5) \\ - & 010 & (2) \\ \hline & 011 & (3) \end{array}$$

$$\begin{array}{rll} & 101 & (5) \\ - & 010 & (2) \\ \hline & 011 & (3) \end{array}$$

Drawback

To subtract the smaller number from the larger one, logic circuits for **comparison** and **subtraction** are needed.

1's COMPLEMENT

To obtain the **1's complement** of a negative binary number, **invert each bit** – changing all 1s to 0s and all 0s to 1s.

Formula

$$K = (2^n - 1) - P$$

where:

K = negative number

P = positive number

Binary Addition

```
  1010   (-5)
+ 0010   (+2)
------
  1100   (-3)
  0011   (1's)
```

```
  0101   (+5)
+ 1101   (-2)
------
 10010
     1   adjustment
------
  0011   (+3)
```

Drawback

In some cases, a correction is needed which amounts to an extra addition that must be performed.

1's COMPLEMENT

To obtain the **1's complement** of a negative binary number, **invert each bit** – changing all 1s to 0s and all 0s to 1s.

Formula

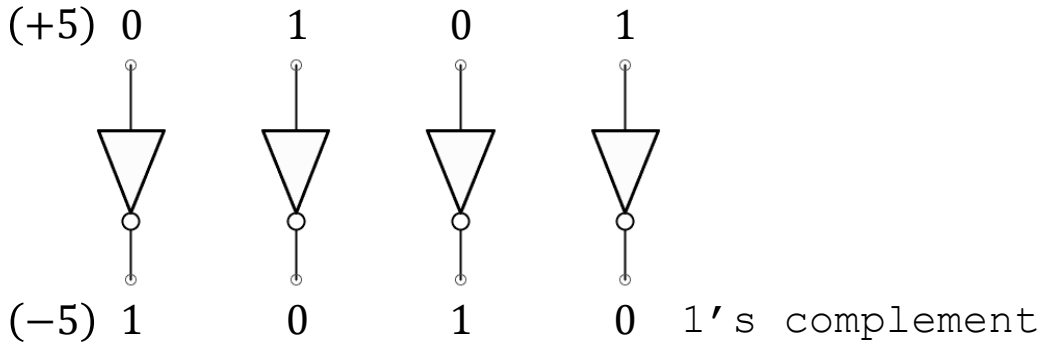
$$K = (2^n - 1) - P$$

where:

K = negative number

P = positive number

Equivalent Logic Circuit



2's COMPLEMENT

To obtain the **2's complement** of a negative number, first find its 1's complement (invert all bits), then **add 1** to the result.

Formula

$$K = 2^n - P$$

where:

K = negative number

P = positive number

Binary Addition

```
  1011   (-5)          0101   (+5)
+ 0010   (+2)        + 1110   (-2)
------             -------
  1101   (-3)          10011  (+3)
  0011   (2's)              ignore
```

Range

$$-2^{n-1} \text{ to } 2^{n-1} - 1$$

The addition process is the same, regardless of the signs of the operands.

2's COMPLEMENT

To obtain the **2's complement** of a negative number, first find its 1's complement (invert all bits), then **add 1** to the result.

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$$K = 2^n - P$$

where:

K = negative number

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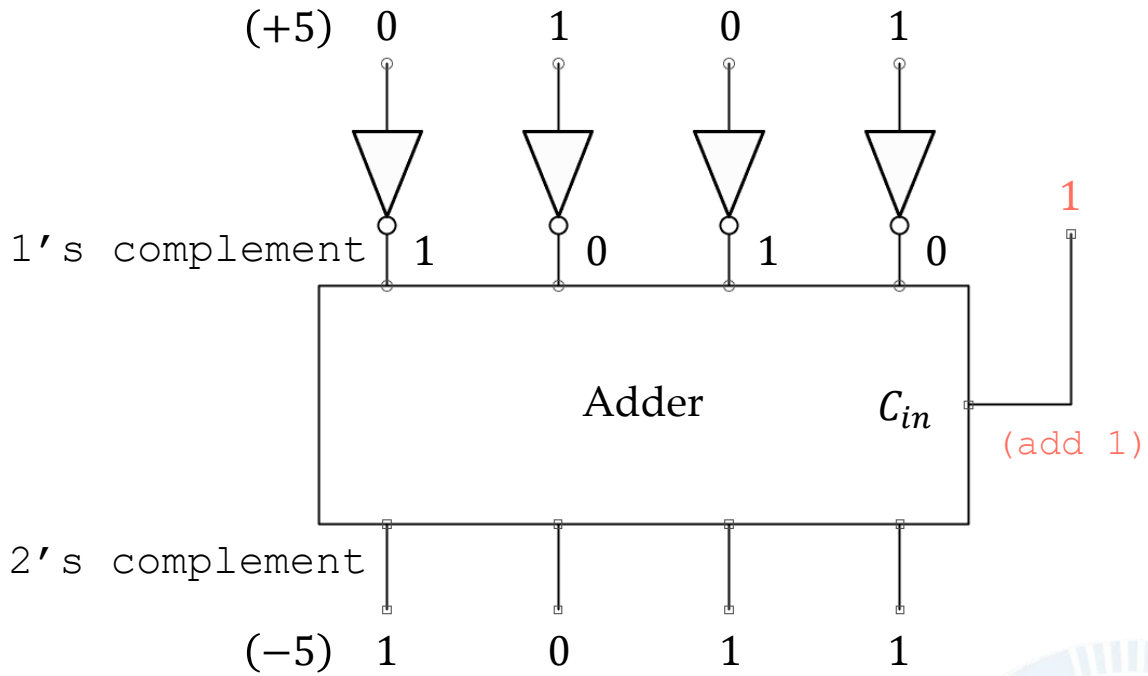
Equivalent Logic Circuit



EXERCISE

Create a block-level representation of a 2-bit binary subtractor using 2's complements method.

Solution

EXERCISE

Synthesize a 2-bit parallel binary subtractor using 2's complement method, and design a corresponding printed circuit board (PCB) layout for its implementation.

note

The use of XOR or XNOR gates is not allowed.

Solution

LABORATORY