3.12 Sum-of-products form

Sum-of-products

Circuits are commonly designed by creating a simplified expression in sum-of-products form, then converting to a simple c

A ***product term*** is an ANDing of (one or more) variables, like ab'c. A product term is sometimes called just a *product* or just expression in ***sum-of-products*** form consists solely of an ORing of product terms, like ab'c + ab.

Due to similarities with regular algebra, convention uses the word "product" for AND and "sum" for OR; hence the name "sur But AND is not really multiplication (product), and OR is not really addition (sum).

PARTICIPATION ACTIVITY 3.12.1: Products.

Choose Yes if the item is a product term.

1) abc

○ Yes

○ No

2) a'b'cd

○ Yes

○ No

3) a + bc

○ Yes

○ No

4) a

○ Yes

○ No

PARTICIPATION ACTIVITY 3.12.2: Sum-of-products form.

Choose Yes if the expression is in sum-of-products form.

1) abc' + abc + ab'c

○ Yes

○ No

2) abc' + c

○ Yes

○ No

3) a + c

○ Yes

○ No

4) ab

○ Yes

○ No

5) a

○ Yes

○ No

6) a(b + c)

○ Yes

○ No

7) (a + b)(b' + c)

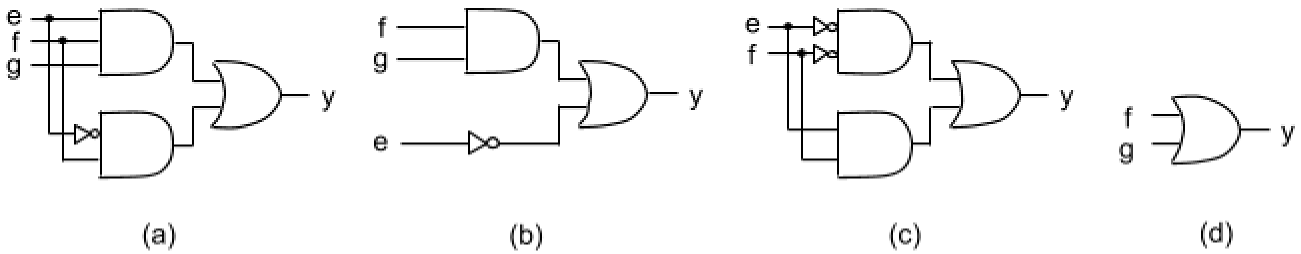
○ Yes

○ No

Converting sum-of-products to a circuit

A sum-of-products equation can be easily converted to a circuit, consisting of a column of AND gates (one gate per produc by an OR gate, which is known as a ***two-level circuit***. (The NOT gates preceding the AND gates aren't considered a level).

PARTICIPATION ACTIVITY 3.12.3: Converting a sum-of-products equation into a two-level circuit.



(a) (d) (c) (b)

y = fg + e'

y = efg + e'f

y = e'f' + ef

$$y = f + g$$

Reset

Converting to sum-of-products before creating a circuit

Circuits are commonly created by multiplying out an initial expression into sum-of-products form, then creating a two-level

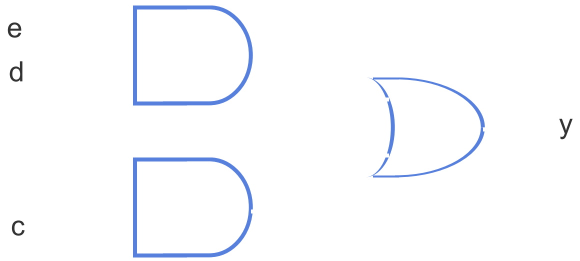
PARTICIPATION ACTIVITY 3.12.4: Multiplying out an expression to sum-of-products, before creating a circuit.

Start □ 2x speed

Goal: Sound alarm (set output y = 1) if alarm is enabled (e = 1) AND (door is open (d = 1) OR window is open (c = 1)).

$y = e\,(d + c)$

$y = ed + ec$



PARTICIPATION ACTIVITY 3.12.5: Multiplying out expressions to convert to sum-of-products form.

Transform to sum-of-products form. Simplify when possible.
Type only the ? part.

1) $y = a(b + b'c)$
$y = ab + ?$

Check Show answer

2) $y = c(a + b)$
$y = ac + ?$

Check Show answer

3) $y = ab(c + d)$
$y = abc + ?$

Check Show answer

4) $y = ac(b + a)$
$y = abc + ?$

Check Show answer

5) $y = a + c(b + ab')$
$y = ? + bc + ab'c$

Check Show answer

Check Show answer

6) y = a'(b + b'c)
y = a'b + ?

Check Show answer

7) y = (a' + b)(c + d)
y = a'c + a'd + ?

Check Show answer

Example: Interrupt logic component

A processor executes computer programs. Various devices (like keyboards or USB ports) surrounding a processor may rec processor to execute a sub-program on behalf of that device, a request known as an ***interrupt***. Devices may be in two categ priority and high-priority, and the processor may disable either category or both.

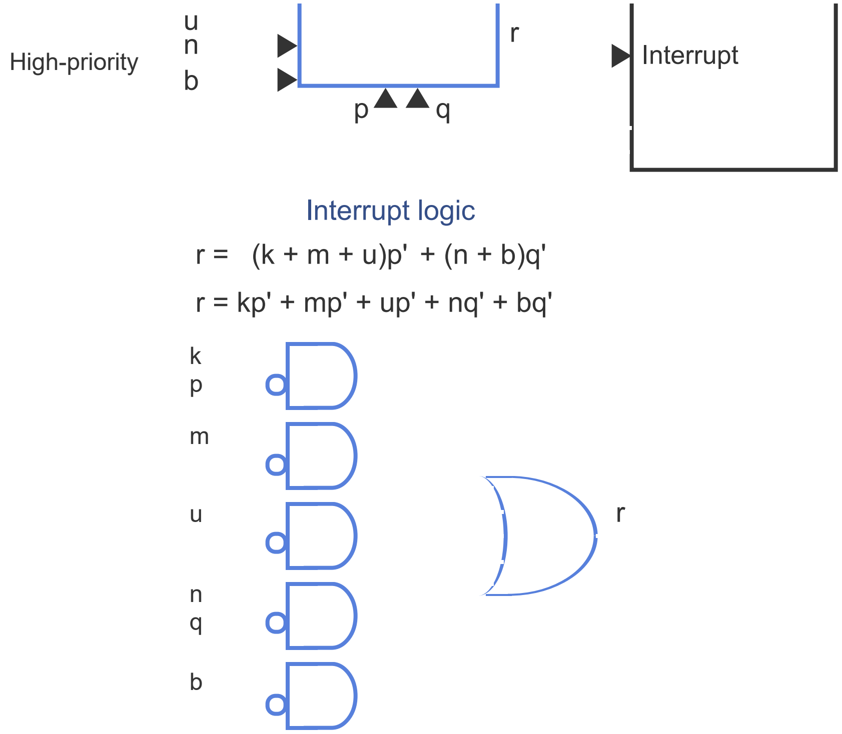
- Low-priority: keyboard (k = 1), mouse (m = 1), USB port (u = 1). Disable all: p = 1.
- High-priority: network interface (n = 1), battery backup (b = 1). Disable all: q = 1.

An interrupt logic component determines whether interrupt requests from devices result in an actual interrupt to the proces

PARTICIPATION ACTIVITY 3.12.6: Multiplying out an expression into sum-of-products form before creating a circuit: An interrupt logic example.

Start □ 2x speed

Low-priority
k
m
Interrupt logic
Processor



Interrupt logic

r = (k + m + u)p' + (n + b)q'

r = kp' + mp' + up' + nq' + bq'

PARTICIPATION ACTIVITY 3.12.7: Interrupt logic example.

Consider the above interrupt logic example.

1) How many inputs does the interrupt logic component have?

Check Show answer

2) How many outputs does the interrupt

logic component have?

Check Show answer

3) Did the designer originally capture the interrupt logic's behavior as a sum-of-products equation? Type yes or no.

Check Show answer

4) How many product terms are in the sum-of-products form of the interrupt logic's equation?

Check Show answer

5) How many AND gates are in the interrupt logic's circuit?

Check Show answer

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