

## Deduction of $f = r \oplus p \oplus q$

### Truth Table

$r$	$p$	$q$	$f$
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1

### Step 1: Write the canonical sum of products (SOP)

From the truth table,  $f = 1$  for minterms where

$$(r, p, q) = (0, 0, 1), (0, 1, 0), (1, 0, 0), (1, 1, 1)$$

which correspond to minterms:

$$m_1, m_2, m_4, m_7$$

Therefore, the SOP expression is:

$$f = r'p'q + r'pq' + rp'q' + rpq$$

### Step 2: Recognize the XOR pattern

The above expression matches the standard 3-variable XOR:

$$f = r \oplus p \oplus q$$

since  $f = 1$  when an odd number of inputs are 1.

### Step 3: Final expression

$$f = r \oplus p \oplus q$$

## Raspberry Pi Pico Pin Connections

Signal	Pin Number	Description
$r$	GPIO 14	Push button input with pull-down resistor
$p$	GPIO 15	Push button input with pull-down resistor
$q$	GPIO 16	Push button input with pull-down resistor
$f$ (Output)	GPIO 17	LED output

*Note: Connect push buttons between the respective GPIO pins and 3.3V with internal pull-down enabled. Connect an LED (with suitable resistor) to GPIO 17 for output indication.*