Bit-Wise Operators

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If A and B are bytes, what does this code mean?

```
C = A & B;
```

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C = A & B;
```

The corresponding bits of A and B are ANDed together

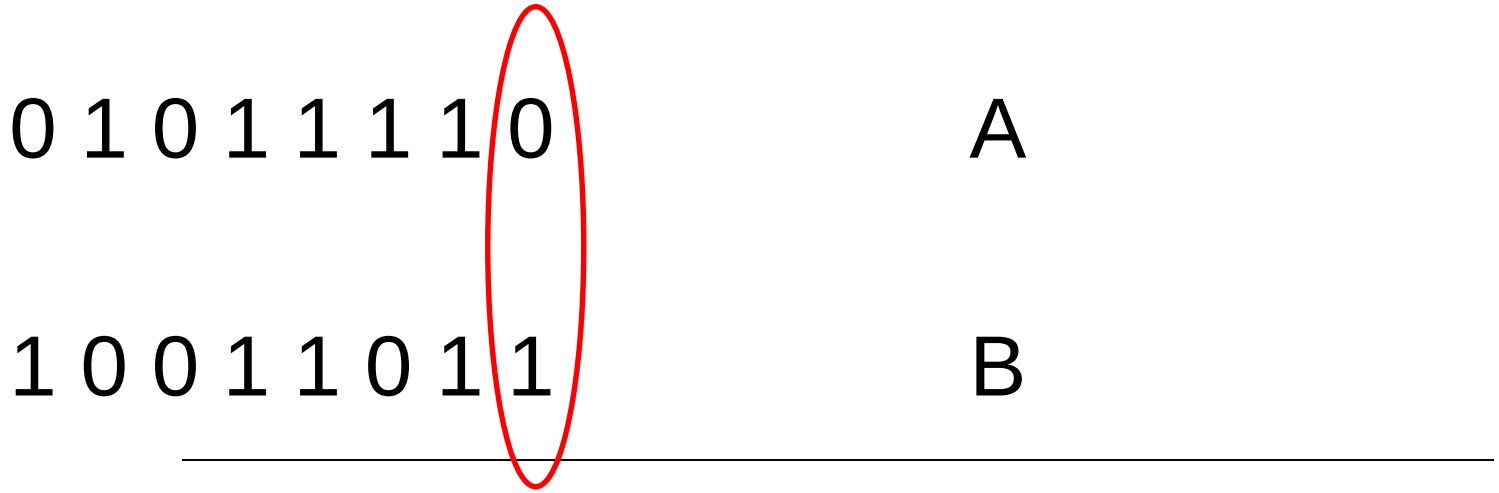
Bit-Wise AND

0 1 0 1 1 1 1 0 A

1 0 0 1 1 0 1 1 B

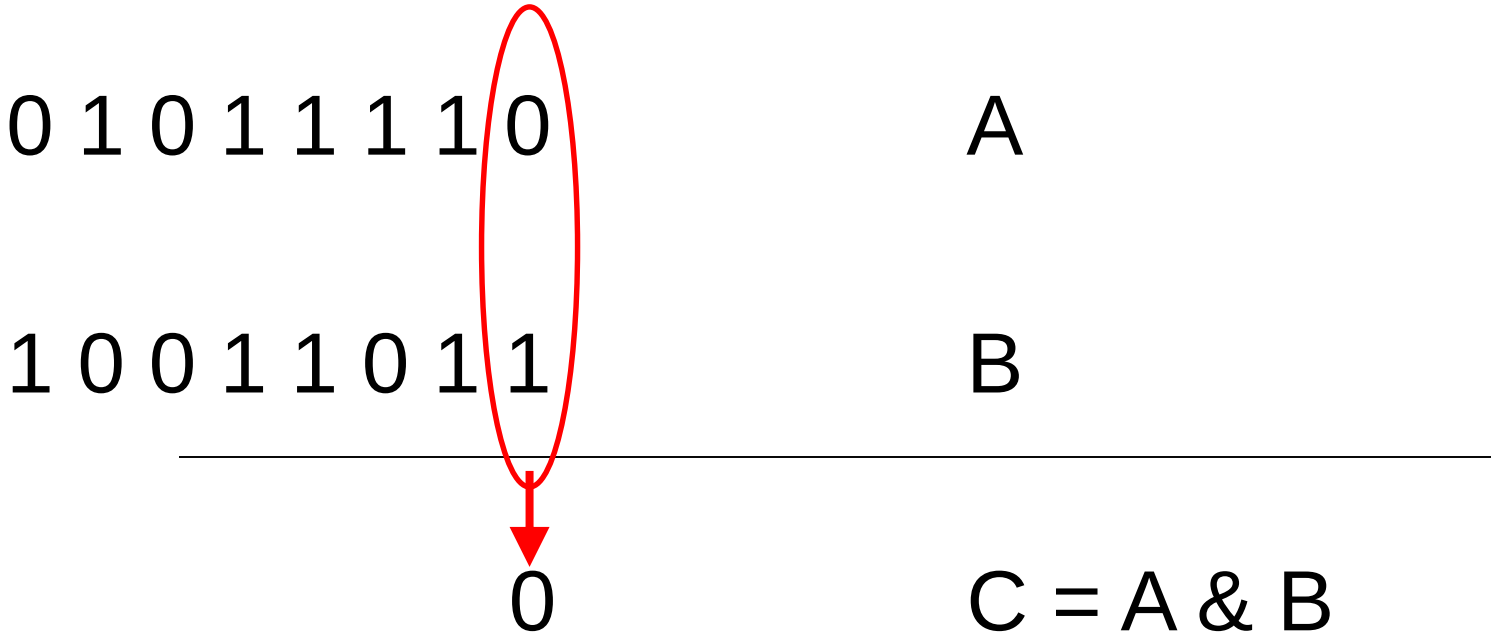
? C = A & B

Bit-Wise AND

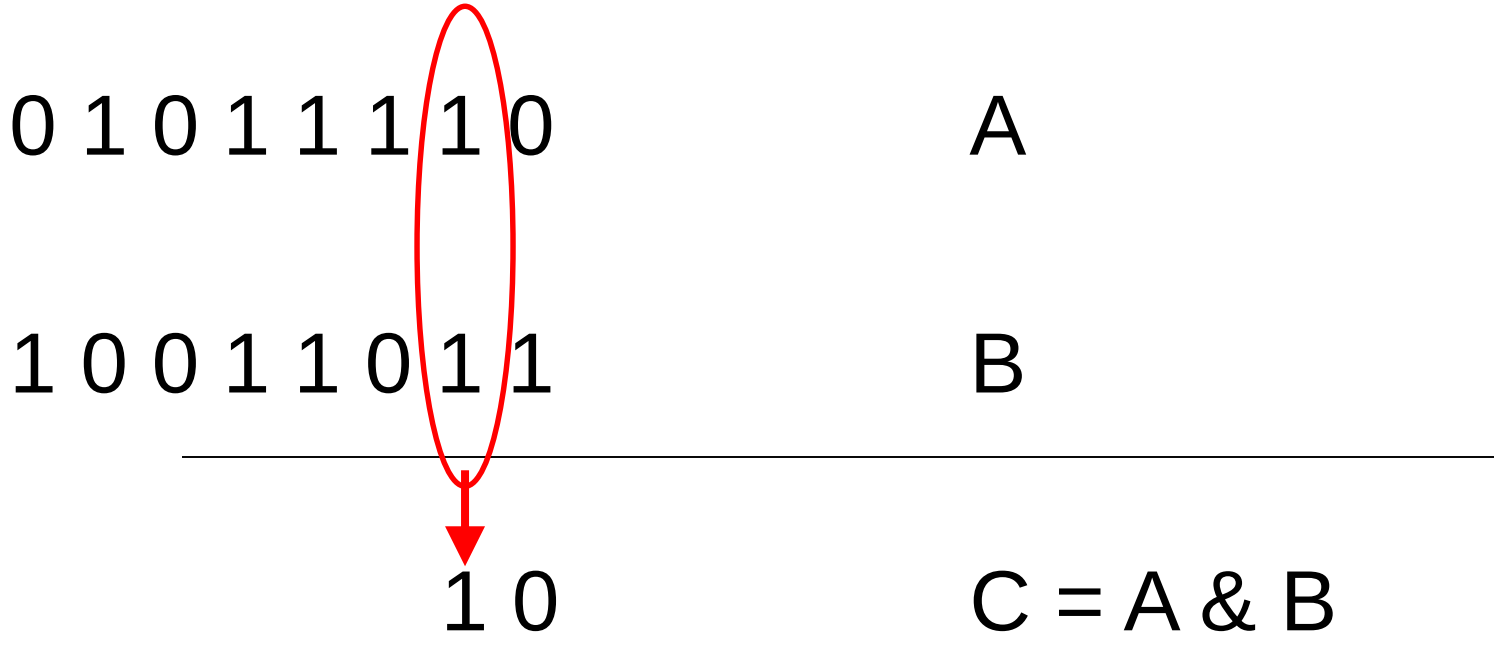


C = A & B

Bit-Wise AND



Bit-Wise AND



Bit-Wise AND

0 1 0 1 1 1 1 0 A

1 0 0 1 1 0 1 1 B

---

0 0 0 1 1 0 1 0 C = A & B

Logical AND

0 1 0 1 1 1 1 0 A

1 0 0 1 1 0 1 1 B

??? C = A && B

Logical AND

0 1 0 1 1 1 1 0  A

true

1 0 0 1 1 0 1 1 B

??? C = A && B

Logical AND

0 1 0 1 1 1 1 0 → A

true

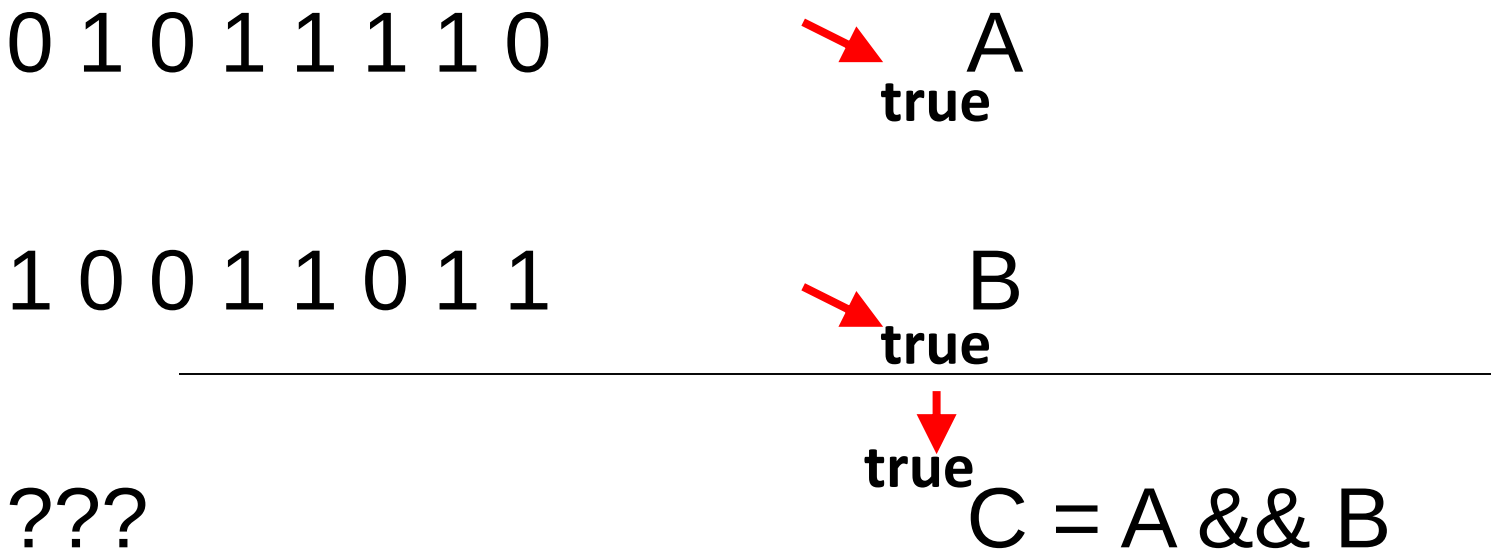
1 0 0 1 1 0 1 1 → B

true

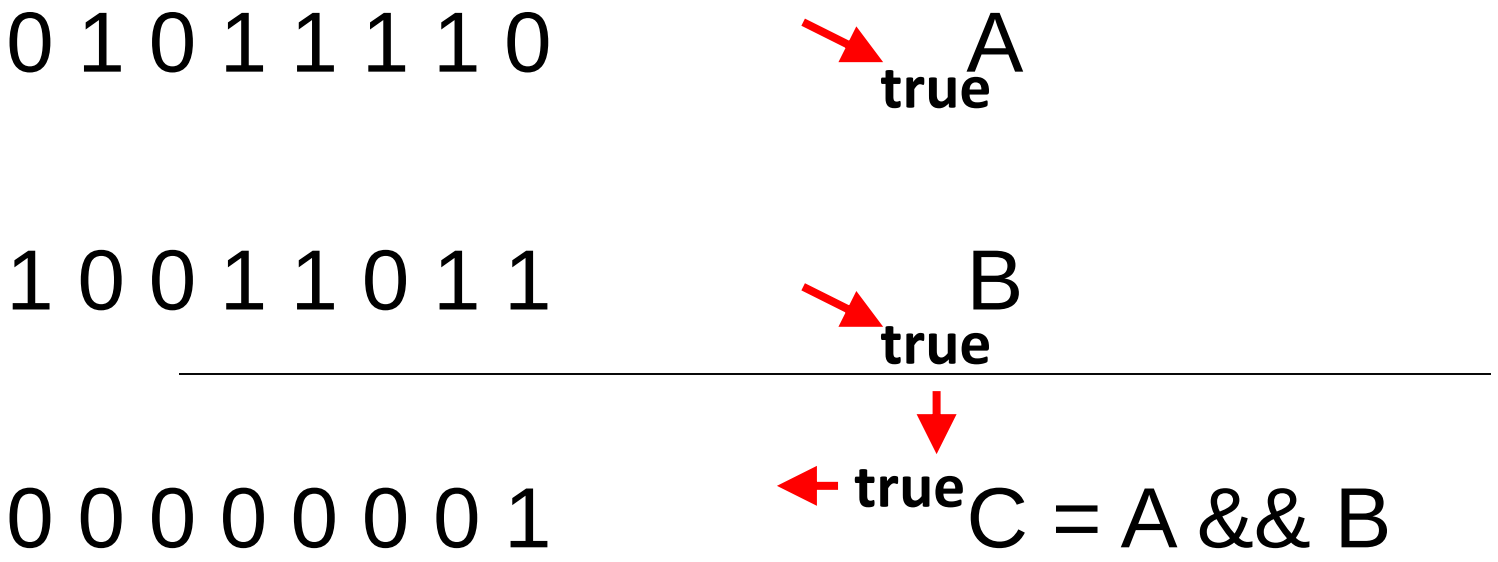
???

C = A && B

Logical AND



Logical AND



NOTE: we are assuming an 8-bit value

Representing Logical Values

Most of the time, we represent logical values using a multi-bit value. (e.g., using 8 or 16 bits). The rules are:

- A value of zero is interpreted as ***false***
- A non-zero value is interpreted as ***true***

Representing Logical Values

A logical operator will give a result of ***true*** or ***false***:

- ***false*** is represented with a value of zero (0)
- ***true*** is represented with a value of one (1)

Other Operators

	LOGICAL	Bit-Wise
• OR:	||	|
• NOT:	!	~
• XOR:		^
• Shift left:		<<
• Shift right:		>>

When coding: keep this distinction straight

Putting the Bit-Wise Operators to Work: Bit Manipulation

Assume a variable A is declared as such:

```
uint8_t A;
```

What is the code that allows us to set bit 2 of A to 1? (we start counting bits from 0)

Bit Manipulation

What is the code that allows us to set bit 2 of A to 1? (we start counting bits from 0)

```
A = A | 4;
```

Bit Manipulation

What is the code that allows us to set bit 2 of A to 0?

Bit Manipulation

What is the code that allows us to set bit 2 of A to 0?

```
A = A & 0xFB;
```

or

```
A = A & ~4;
```

Bit Shifting

```
uint8_t A = 0x5A;
uint8_t B = A << 2;
uint8_t C = A >> 5;
```

What are the values of B and C?

What mathematical operations have we performed?

Example

Suppose a sensor is connected to pins 4 and 5 of port E:

- Fill in the following code so that variable “state” will have one of the following values: 0,1,2,3

```
uint8_t state;
:
state = ????
```

Example (cont)

Suppose a sensor is connected to pins 4 and 5 of port E:

- Fill in the following code so that variable “state” will have one of the following values: 0,1,2,3

```
uint8_t state;
:
state = (GPIOE_PDIR & 0x30) >> 4;
```

Example (with only 8 bits)

```
GPIOE_PDIR:        E7   E6   E5   E4   E3   E2   E1   E0
GPIOE_PDIR&0x30:
```

Example (cont)

```
GPIOE_PDIR :      E7   E6   E5   E4   E3   E2   E1   E0
GPIOE_PDIR&0x30:   0    0   E5   E4    0    0    0    0
() >> 4:
```

Example (cont)

```
GPIOE_PDIR :       E7   E6   E5   E4   E3   E2   E1   E0
GPIOE_PDIR &0x30:  0    0   E5   E4    0    0    0    0
() >> 4:           0    0    0    0    0    0   E5   E4
```

… Back to Digital I/O