

Bit-Wise Operators

Questions?

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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

0 1 0 1 1 1 1 0

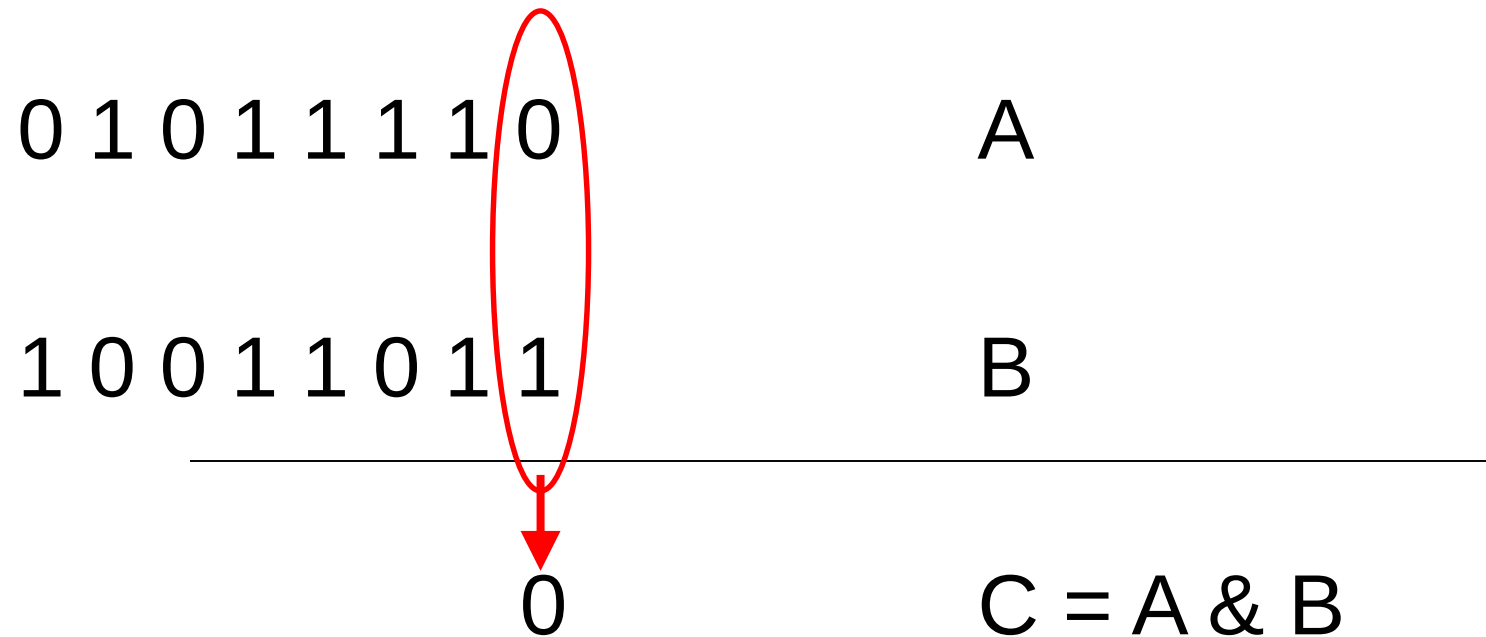
A

1 0 0 1 1 0 1 1

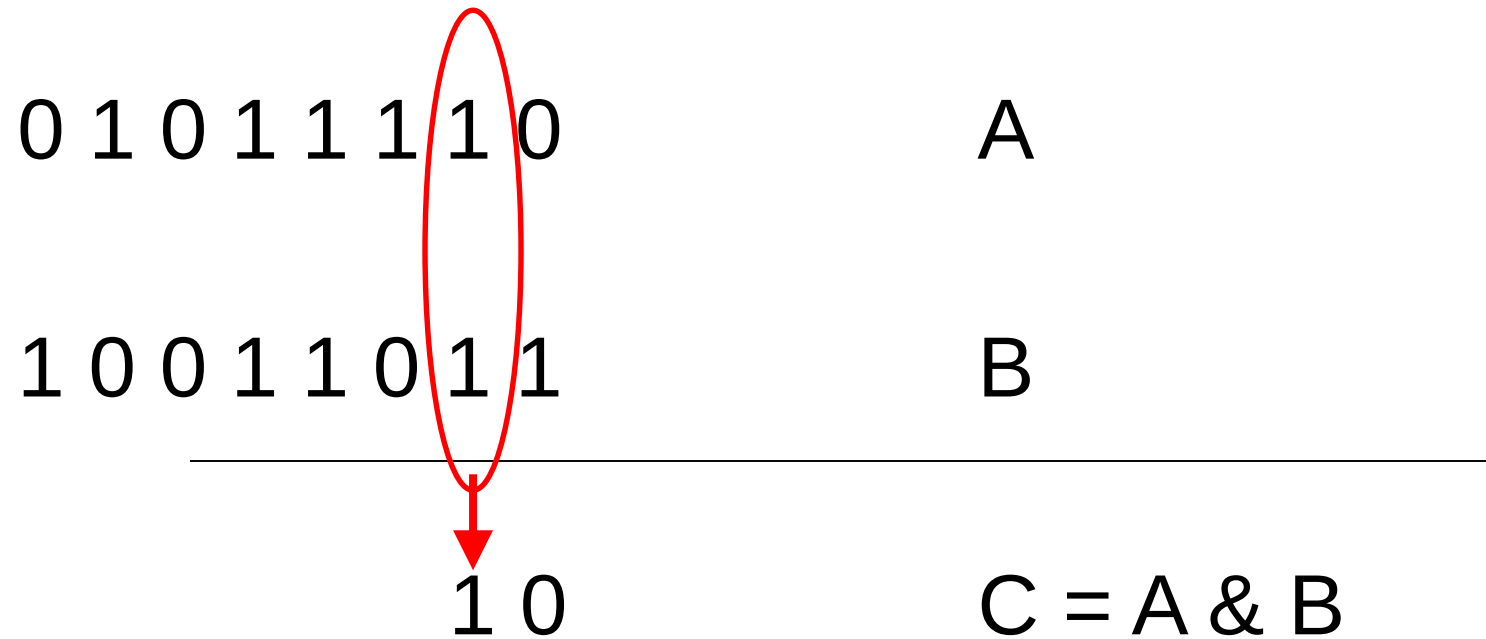
B

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

0 1 0 1 1 1 1 0

 A
true

1 0 0 1 1 0 1 1

 B
true

???

 true
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

0 0 0 0 0 0 0 1

 **true** **C = A && B**

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 = (PINE & 0x30) >> 4;
```

Example (cont)

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

Example (cont)

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

Example (cont)

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

... Back to Digital I/O