# *Software Embarcado*

# 02 - GPIO

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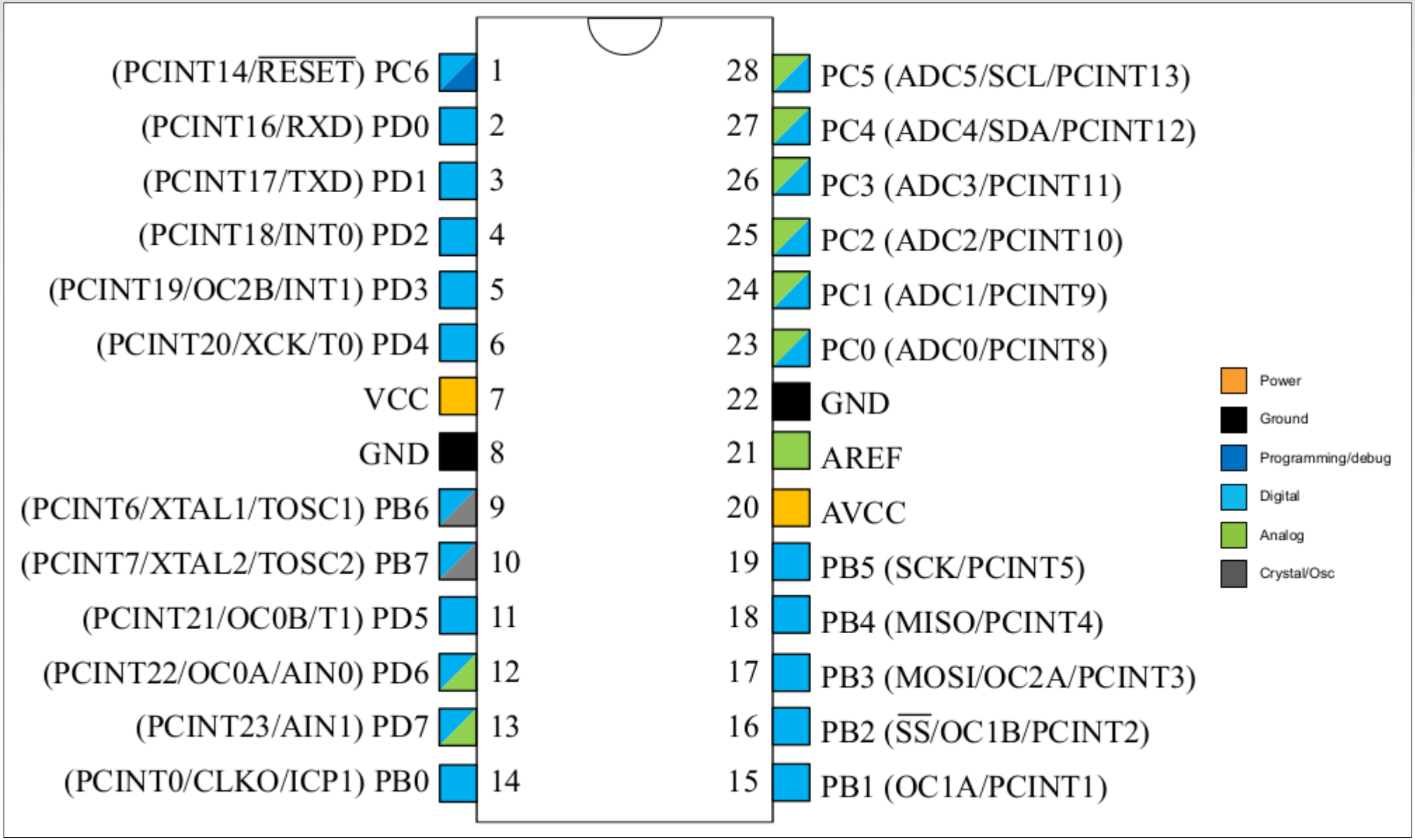
**http://github.com/fsantanna-uerj/SE**

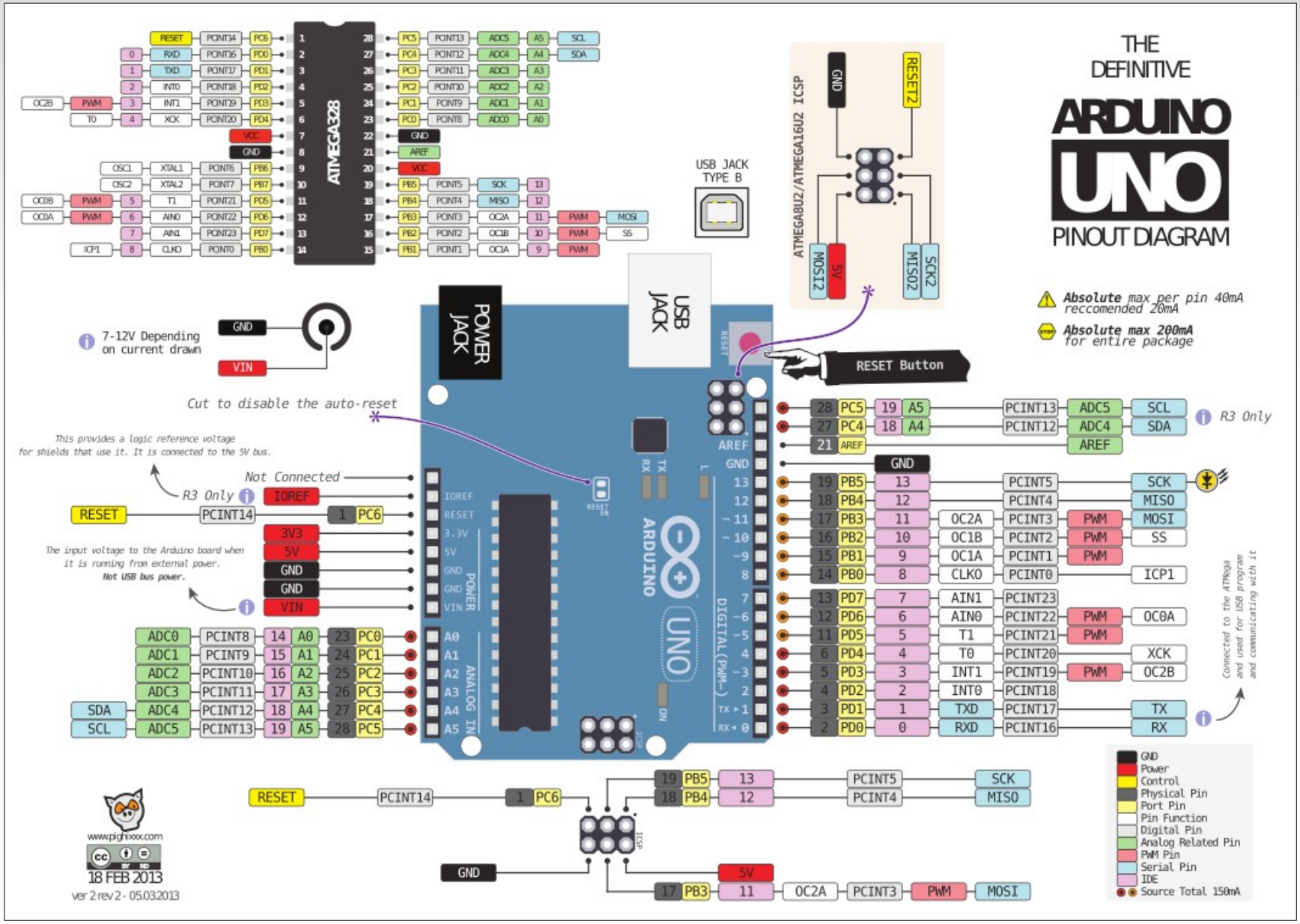
# GPIO
## General-Purpose Input/Output

- Entrada digital
- Saída digital
- Saída analógica PWM (hw ou sw)

# Pinagem do Atmega328p



# ATmega328p / Arduino UNO



# I/O Multiplexing

- Cada pino está associado a uma porta de GPIO
- Alternativamente, podem ser associados a outras funcionalidades de periféricos

**5.2.4. Port C (PC[5:0])**

Port C is a 7-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The PC[5:0] output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is not running.

**5.2.5. PC6/$\overline{\text{RESET}}$**

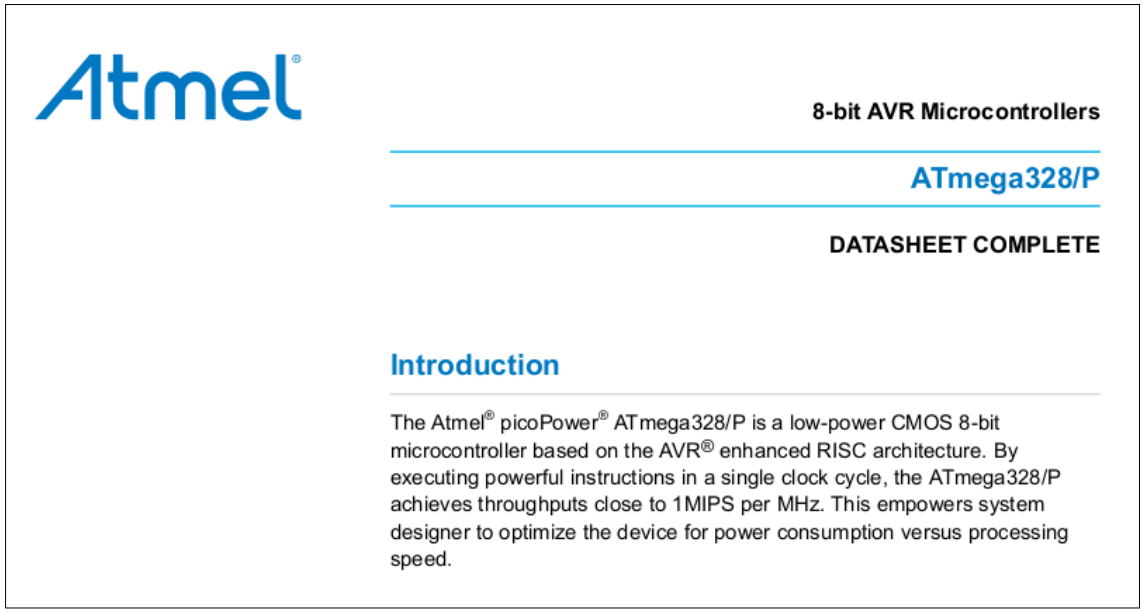
If the RSTDISBL Fuse is programmed, PC6 is used as an I/O pin. Note that the electrical characteristics of PC6 differ from those of the other pins of Port C.

If the RSTDISBL Fuse is unprogrammed, PC6 is used as a Reset input. A low level on this pin for longer than the minimum pulse length will generate a Reset, even if the clock is not running. Shorter pulses are not guaranteed to generate a Reset.

The various special features of Port C are elaborated in the *Alternate Functions of Port C* section.

# Datasheet ATmega328p

- `avr-atmega328p.pdf` (442 págs)
  - Pág 14: pinagem
  - Pág 18: porta C
  - Pág 97: portas



# Portas B,C,D

- Cada porta está associada a três registradores de 8bits (`DDRx`, `PORTx`, `PINx`)
- Cada pino individual está associado a um bit em cada registrador:
  - `DDRxn: [w]` direção do pino `n` na porta `x`
  - `PORTxn:[w]` novo valor ou configuração *pull up* do pino `n` na porta `x`
  - `PINxn: [r]` valor atual do pino `n` na porta `x`

# Portas B,C,D

**Table 18-1. Port Pin Configurations**

| DDxn | PORTxn | PUD (in MCUCR) | I/O | Pull-up | Comment |
|---|---|---|---|---|---|
| 0 | 0 | X | Input | No | Tri-state (Hi-Z) |
| 0 | 1 | 0 | Input | Yes | Pxn will source current if ext. pulled low |
| 0 | 1 | 1 | Input | No | Tri-state (Hi-Z) |
| 1 | 0 | X | Output | No | Output Low (Sink) |
| 1 | 1 | X | Output | No | Output High (Source) |

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| | DDRB7 | DDRB6 | DDRB5 | DDRB4 | DDRB3 | DDRB2 | DDRB1 | DDRB0 |
| Access | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| | PORTB7 | PORTB6 | PORTB5 | PORTB4 | PORTB3 | PORTB2 | PORTB1 | PORTB0 |
| Access | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| | PINB7 | PINB6 | PINB5 | PINB4 | PINB3 | PINB2 | PINB1 | PINB0 |
| Access | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | x | x | x | x | x | x | x | x |

# Hello World: output

- Piscar o LED a cada 1 segundo
- `github.com/fsantanna-uerj/SE/tree/master/Code/01-blink/`

```
#define LED_PIN 13

void setup () {
    pinMode(LED_PIN, OUTPUT);      // Enable pin 13 for digital output
}

void loop () {
    digitalWrite(LED_PIN, HIGH);   // Turn on the LED
    delay(1000);                   // Wait one second (1000 milliseconds)
    digitalWrite(LED_PIN, LOW);    // Turn off the LED
    delay(1000);                   // Wait one second
}
```

# Usando portas GPIO...

- Piscar o LED a cada 1 segundo
- `github.com/fsantanna-uerj/SE/tree/master/Code/01-blink/`

```
void setup() {
  DDRB = 0b00100000;
}

void loop() {
  PORTB = 0b00100000;
  delay(1000);
  PORTB = 0b00000000;
  delay(1000);
}
```

```
void setup() {
  DDRB = 1 << 5;
}

void loop() {
  PORTB = 1 << 5;
  delay(1000);
  PORTB = 0;
  delay(1000);
}
```

```
void setup() {
  DDRB |= 1 << 5;
}

void loop() {
  PORTB |= 1 << 5;
  delay(1000);
  PORTB &= ~(1 << 5);
  delay(1000);
}
```

- Ver `pinMode`, `digitalWrite`, `digitalRead`
- Ver `bit`, `bitSet`, `bitClear`, `bitRead`
- Tarefa 2 – acesso direto às portas GPIO
  - Entrada e saída