**Port B**

| **Mode** | **Behavior** |
| --- | --- |
| **Output mode** | Can both source and sink current effectively (symmetrical drive). |
| **Input + pull-up** | Pin will try to stay HIGH; if pulled LOW externally, it sources current. |
| **Reset condition** | Pins go to high-impedance mode—no driving, safe for external circuits. |
|  |  |

The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, port B pins that are externally pulled

low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes

active, even if the clock is not running.

Simple pinout(tqfp)kvmrlvdrbrblkrkmrrgrr

+-----------------------------+

VCC | 1 32 | GND

PB5 | 2 31 | PC0 (ADC0 / A0)

PB6 | 3 30 | PC1 (ADC1 / A1)

PB7 | 4 29 | PC2 (ADC2 / A2)

RESET| 5 28 | PC3 (ADC3 / A3)

VCC | 6 27 | PC4 (ADC4 / A4 / SDA)

GND | 7 26 | PC5 (ADC5 / A5 / SCL)

XTAL2 | 8 25 | PC6 (RESET input if RSTDISBL=0)

XTAL1 | 9 24 | AVCC

PD0 |10 23 | PB4 (MISO / D12)

PD1 |11 22 | PB3 (MOSI / D11 / OC2A)

PD2 |12 21 | PB2 (SS / D10 / OC1B)

PD3 |13 20 | PB1 (D9 / OC1A)

PD4 |14 19 | PB0 (D8 / ICP1)

PD5 |15 18 | PD7 (D7 / AIN1)

PD6 |16 17 | PD6 (D6 / AIN0 / OC0A)

+-----------------------------+

Power requirements

Voltage(depending on the operating modes):

Full-speed : 2.7V – 5.5V

Maximum speed : ≥ 4.5V

10 MHz operation: ≥ 2.7V

Minimum voltage for stable operation:1.8V (limited frequency)

Typically 3.3 to 5V

Limit -0.5 V to 6V

Current

| **Factor** | **Influence** |
| --- | --- |
| **Operating Voltage** | Higher voltage → higher current draw |
| **Clock Frequency** | Faster clock → more switching → more current |
| **Operating Mode** | Active mode draws the most, sleep modes save power |
| **Peripheral Usage** | ADC, timers, USART, etc., add to current consumption |
| **Temperature** | Higher temperature → higher leakage → more current |

Active Mode 1 MHz, 3V : 0.3–0.5 mA

Active Mode 20 MHz, 5V: 10–15 mA

Sleep Mode : 0.5–2 µA

I/O Pin Current (max) 40 mA per pin (recommended: ≤ 20 mA)

Total MCU Current (Vcc) ~200 mA max total (depends on temp and load)

For the firmware arduino ide can be used (c++ code)which has a preinstalled bootloader (Optiboot bootloader) .

Program stored in Flash runs on the AVR CPU.

CPU accesses data from SRAM or EEPROM via the Data Bus.

Timers, UART, SPI, ADC, etc., run in parallel with CPU.

External devices (sensors, actuators) are connected through PORT B/C/D.

Clock and reset systems ensure stable operation and timed execution.

Firmware Setup Checklist (Bare ATmega328P)

| **Step** | **Task** |
| --- | --- |
| ✅ 1 | Power the chip (Vcc + GND + decoupling caps) |
| ✅ 2 | Connect a programmer (SPI lines: MOSI, MISO, SCK, RESET) |
| ✅ 3 | Optional: Burn a bootloader (Optiboot, etc.) |
| ✅ 4 | Set fuses using avrdude (clock source, BOD, etc.) |
| ✅ 5 | Write firmware in C or assembly |
| ✅ 6 | Compile to .hex file |
| ✅ 7 | Flash using programmer (avrdude or IDE) |
| ✅ 8 | Run your embedded code 🎉 |

· ATmega328P (DIP-28 package is easiest for breadboard)

· · 16 MHz crystal oscillator or use internal 8 MHz RC

· · 2 × 22pF capacitors (for crystal)

· · 1 × 10kΩ resistor (for RESET pull-up)

· · Decoupling capacitors: 100nF (0.1µF)

· · Power supply (3.3V or 5V regulated)

· · LEDs, buttons, sensors (for testing)

· · USBasp / USBtinyISP / Arduino-as-ISP (for programming

Programming an ATmega328p without the Arduino IDE

<https://daniellethurow.com/blog/2021/6/8/programming-an-atmega328p-without-the-arduino-ide.>