

Arduino Nano from Scratch

2025-06-06

Variant: Final Version

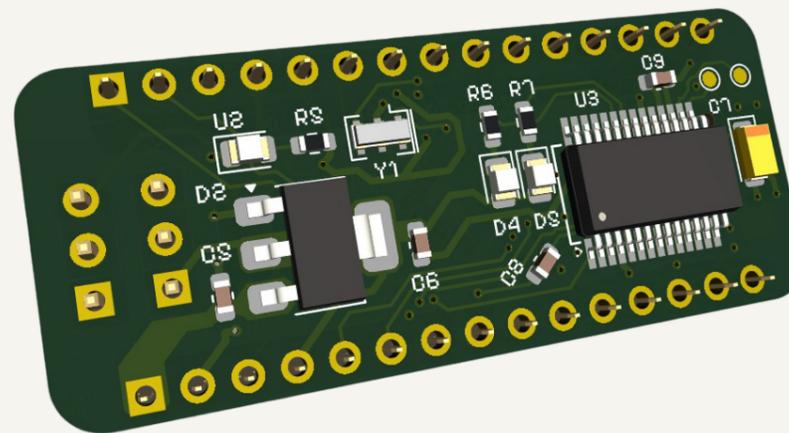
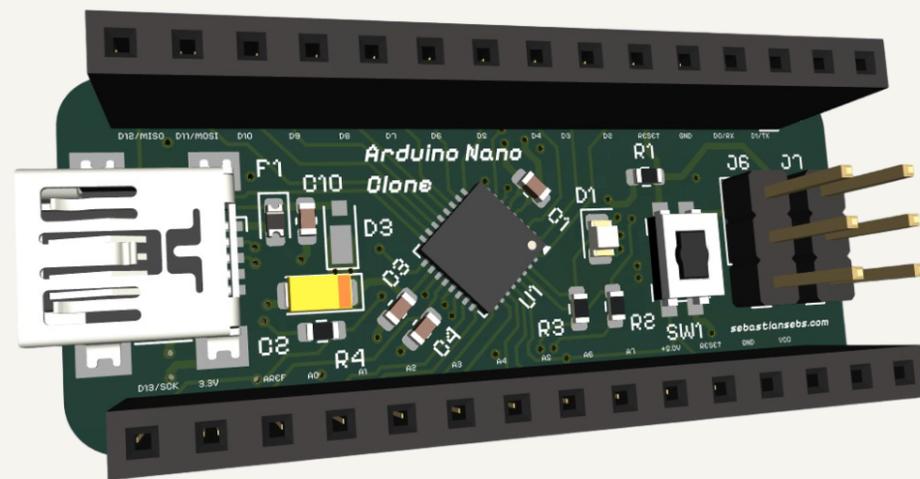
Rev #1

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TOP VIEW

BOTTOM VIEW

NOTES



This project presents a custom microcontroller development board centered around the ATmega328P-M, offering a compact and versatile platform for embedded systems.

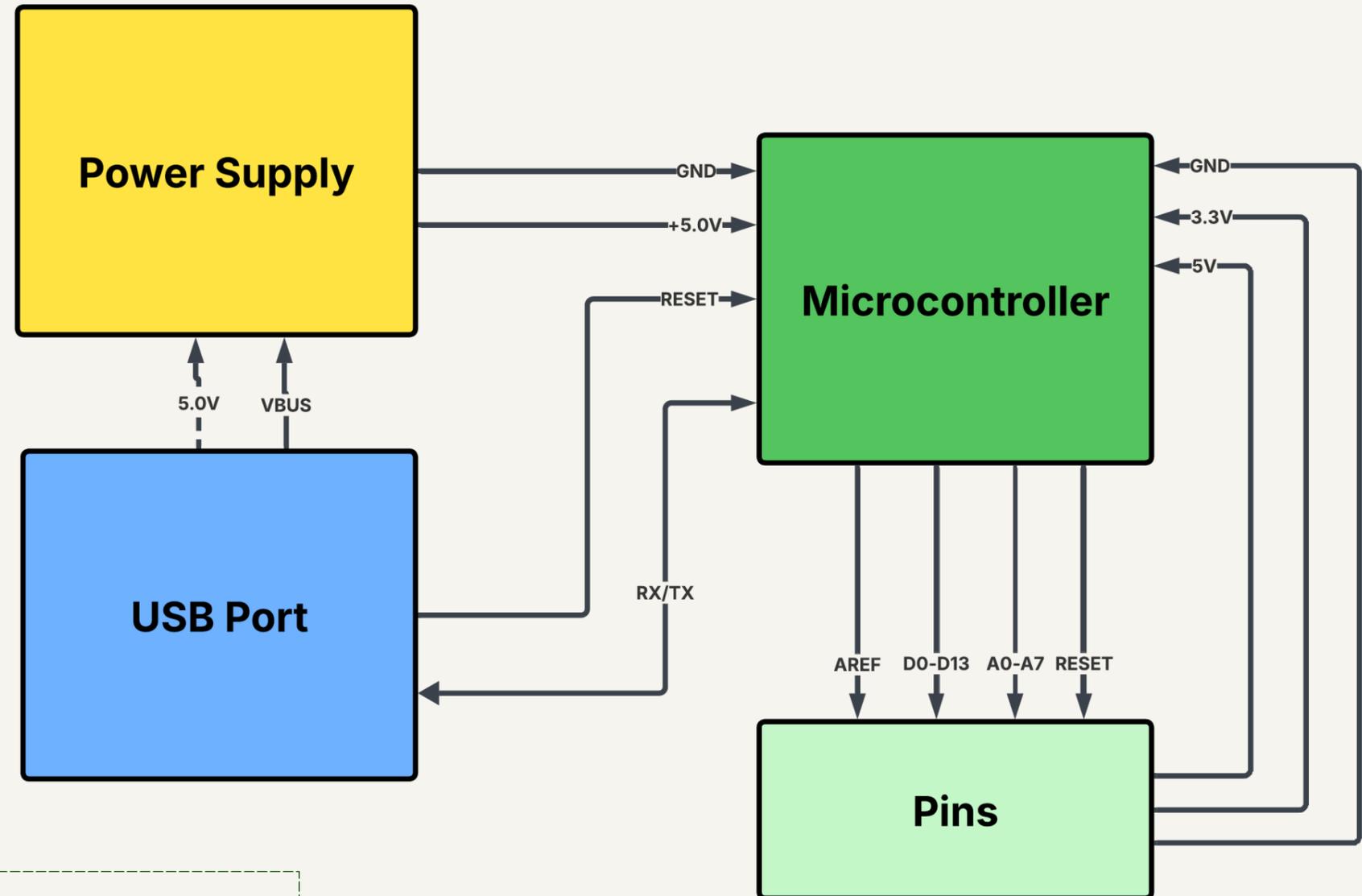
It seamlessly integrates a regulated 5V power supply, a USB-to-serial converter for programming and communication, and robust pin headers that break out all essential digital and analog I/O (SPI, UART), enabling flexible interfacing for various applications.

DESIGN CONSIDERATIONS

DESIGN NOTE: Example text for informational design notes.	DESIGN NOTE: Example text for debug notes.	DESIGN NOTE: Example text for cautionary design notes.	DESIGN NOTE: Example text for critical design notes.	LAYOUT NOTE: Example text for critical layout guidelines.
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	Sheet Title: Cover Page		Board Name: Arduino Nano from Scratch		Project Name: Arduino Nano	
Sheet Path: /		File Name: Arduino Nano.kicad_sch		Designer: Sebastian Silva		Date: 2025-06-05
		Reviewer:		Revision: v1.0		
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[2] Block Diagram



DESIGN NOTE:
Power Supply

+5V (from LM1117 output) connects to VCC, AVCC, and the +5V net in the Microcontroller schematic.
GND (from Power Supply) connects to GND in the Microcontroller schematic.

DESIGN NOTE:
USB - Power Supply

VBUS (from USB) can either directly power the system (if the LM1117 is bypassed or only used for VCC in) or be fed into the VCC input of the LM1117 in the power supply schematic.
VBUS is acting as an alternative 5V source.
A common approach for Arduino Nano is for VBUS to go into the LM1117's input if it's the primary power source, or to bypass it if 5V is directly from USB.

DESIGN NOTE:
USB - Microcontroller

TX connects to RX of the ATmega328P-M.
RX connects to TX of the ATmega328P-M.
DTR connects to RESET of the ATmega328P-M via a 100nF capacitor. This capacitor is crucial for automatic reset during programming.

DESIGN NOTE:
Pins - Microcontroller

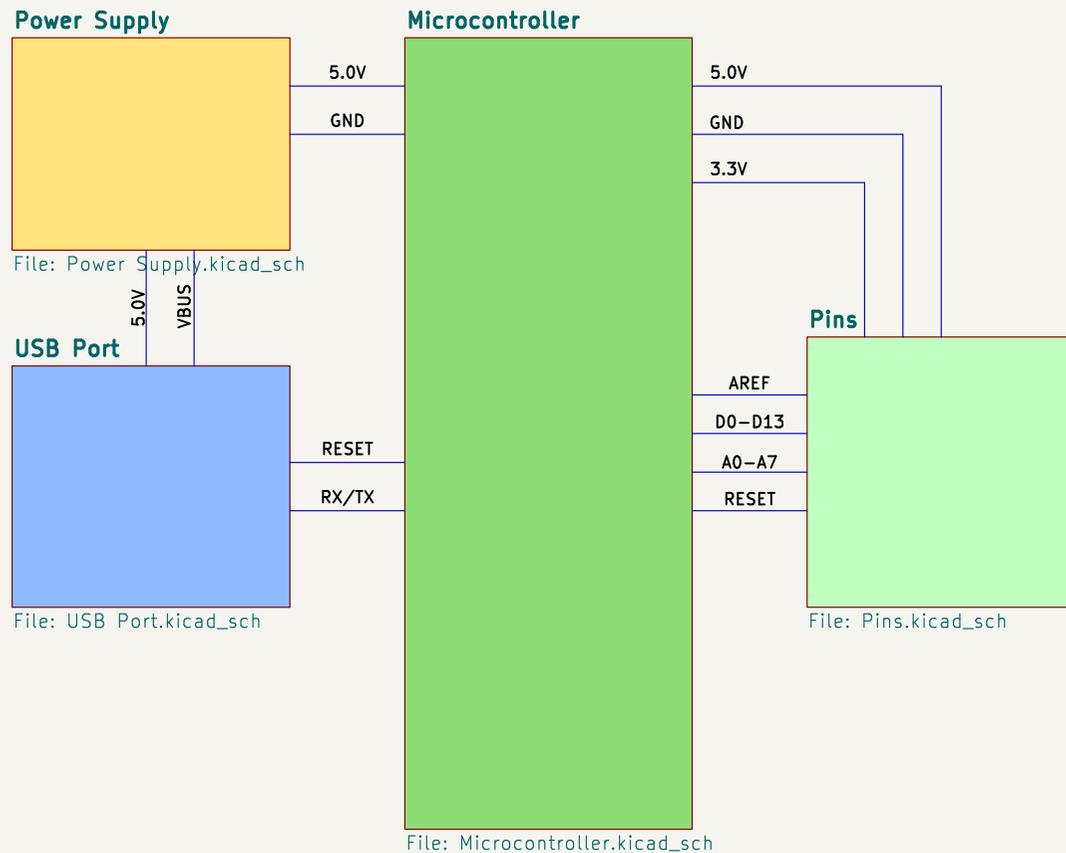
Direct map presented between J pins and Microcontroller.
RESET/PC6 (pin 29) to RESET on J2.
AREF (pin 20) to AREF on J2.
+5V (from main power rail) to +5V on J2 and J4.
+3.3V (if used, e.g., from FT232RL 3V3OUT) to +3.3V on J2.
GND to GND on J2 and J4.

Target specifications:

Input voltage: 5V

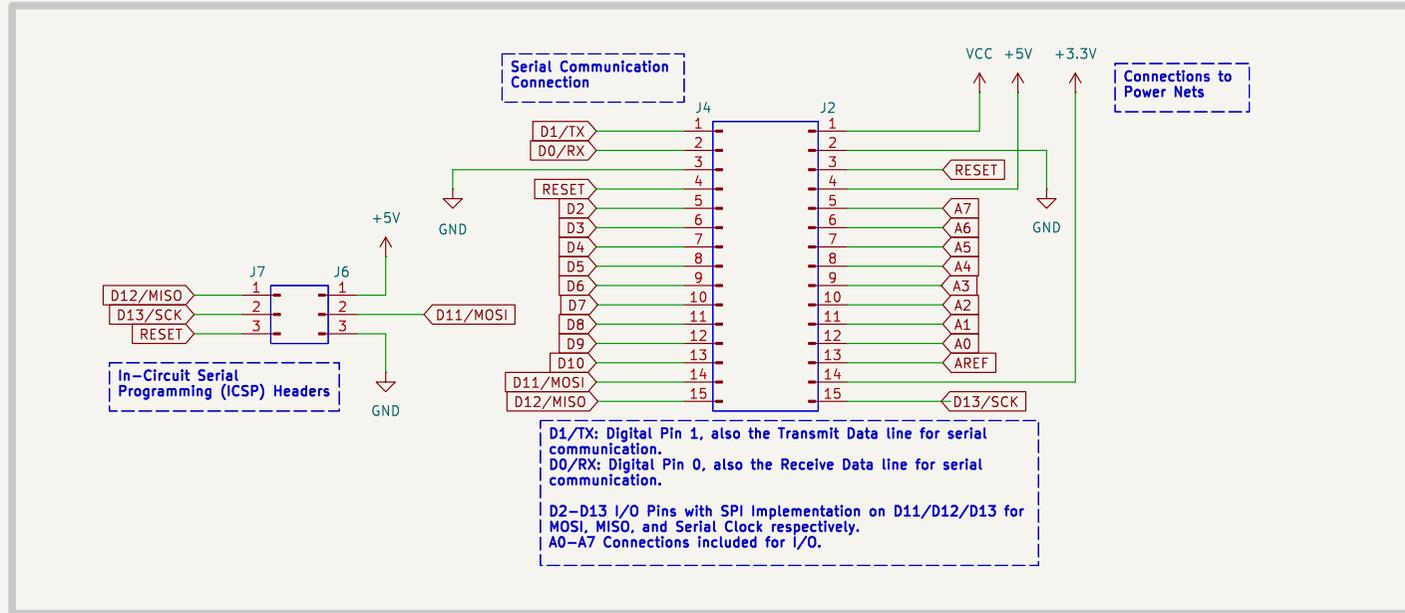
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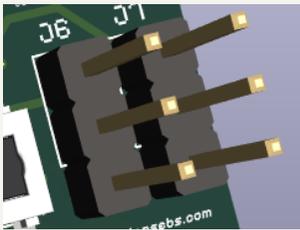
[3] Project Architecture



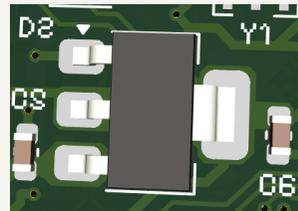
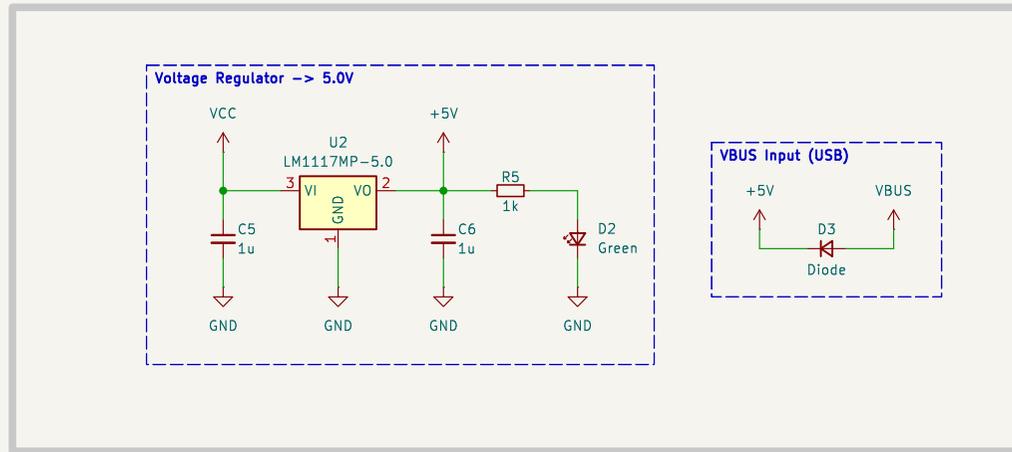
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	Sheet Path: /Project Architecture/		Reviewer:	Size: A4	Sheet: 3 of 8

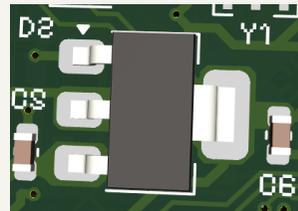
[4] Pins



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[5] Power Supply



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Sheet Path: /Project Architecture/Power Supply/		File Name: Power Supply.kicad_sch	Designer: Sebastian Silva	Date: 2025-06-05	Revision: v1.0	
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[6] USB Port

USB0+ (Pin 15), USB0- (Pin 16): These are the differential USB data lines, connected directly to D+ and D- from the USB connector.

3.3V Output:

3V3OUT (Pin 17): A regulated 3.3V output from the FT232RL's internal regulator. Can be used to power 3.3V logic components or provided as a 3.3V rail for other parts of the circuit.

C9 (100n): A decoupling capacitor connected between 3V3OUT and GND to stabilize the 3.3V output.

FT232RL USB UART IC

Main USB-to-Serial converter integrated circuit. It handles the USB protocol on one side and converts it to standard UART (serial) signals on the other, allowing a microcontroller to communicate with a computer over USB.

VCC (Pin 4): Main 5V power supply input for the FT232RL's internal logic. Connected to the main +5V net.

VCCIO (Pin 20): I/O power supply. This voltage determines the voltage levels of the serial communication pins (TXD, RXD, etc.). Here, it's connected to the +5V net, meaning the serial I/O will operate at 5V logic levels.

AGND (Pin 25), GND (Pins 21, 24): Ground connections for the IC (Analog Ground and Digital Ground).

USB Mini-B receptacle, the physical connector for a USB cable from a computer.

Pin 1 (VBUS): The +5V power supplied by the USB host. This net is used to power the FT232RL chip and can also be passed on to the rest of the circuit (e.g., to a voltage regulator).

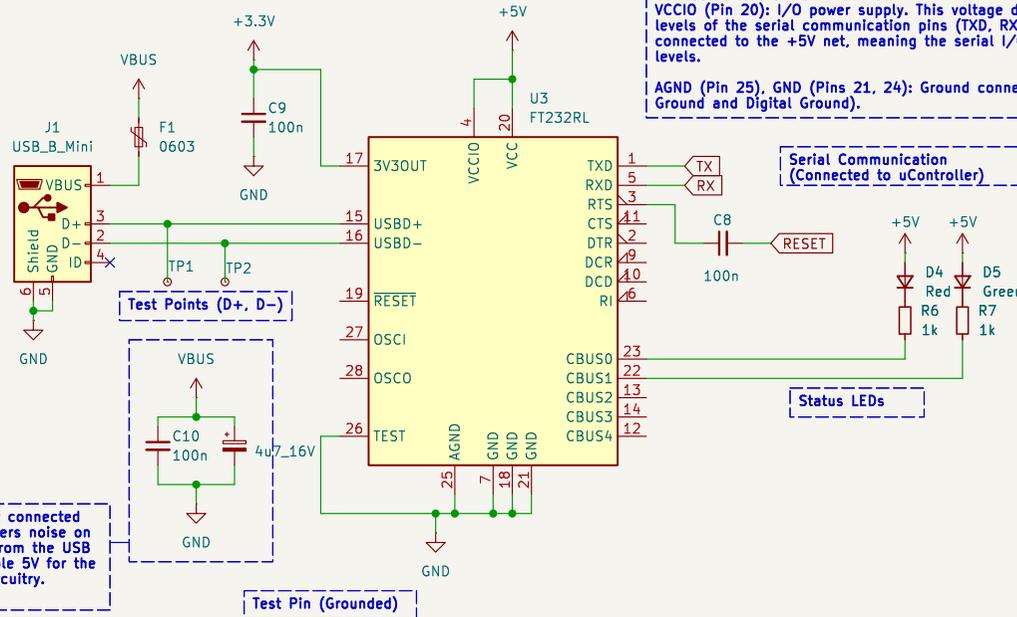
Pin 2 (D-): USB Data Minus line.
Pin 3 (D+): USB Data Plus line.

Pin 4 (ID): ID pin for USB On-The-Go (OTG). For Mini-B, it's typically unconnected or tied to GND if not used for OTG. Here it appears unconnected to other components.

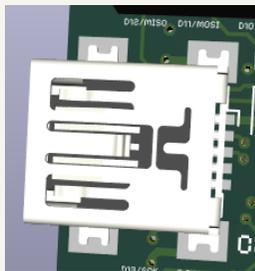
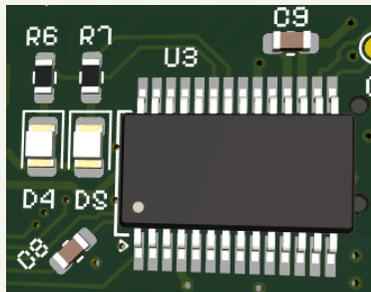
Pin 5 (GND): USB Ground.

Pin 6 (Shield): Connection for the USB cable's shield, typically connected to the circuit's main ground.

F1: A fuse, placed in series with the VBUS line from the USB connector. It protects the USB host port (computer) from overcurrent in case of a short circuit or fault on the connected device.



C10: A decoupling capacitor connected between VBUS and GND. Filters noise on the incoming VBUS supply from the USB cable, ensuring a more stable 5V for the FT232RL and subsequent circuitry.



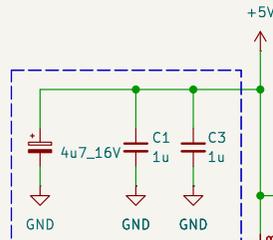
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[7] Microcontroller

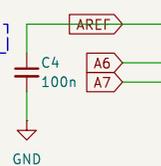
Decoupling Capacitors

They are placed close to the microcontroller's power pins (VCC, AVCC) to filter out high-frequency noise and provide a stable local power source for sudden current demands by the IC. This prevents voltage dips that could cause unstable operation.

Placement: C1 (4.7uF) is a larger bulk capacitor, while C2 and C3 (1uF) are smaller ceramic capacitors for higher frequency noise suppression. They are connected between +5V and GND.



Analog Reference voltage input for the ADC



U1 represents the ATmega328P-M microcontroller.

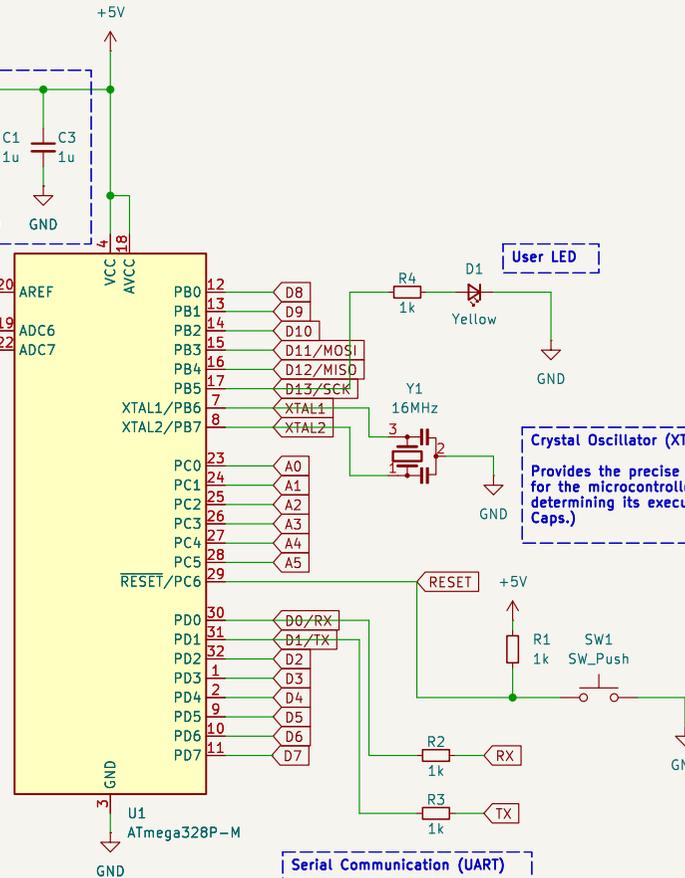
The pins are grouped by their port names (PB, PC, PD) and their Arduino-style digital/analog labels.

PB0–PB7 (Pins 12–19): Port B pins. These are general-purpose I/O (GPIO) pins. Some have alternative functions like D8 to D13/SCK (Digital pins 8–13, with 13 being the SCK for SPI). D11/MOSI, D12/MISO are for SPI communication.

PC0–PC5 (Pins 23–28): Port C pins. These are also GPIO pins, labeled A0 to A5 (Analog input pins 0–5). PC6 is the RESET pin.

PD0–PD7 (Pins 30–37): Port D pins. These are GPIO pins, labeled D0 to D7 (Digital pins 0–7). PD0 and PD1 are the RX and TX pins for serial communication.

ATmega328P-M, 20MHz, 32kB Flash, 2kB SRAM, 1kB EEPROM, QFN-32



Crystal Oscillator (XTAL1, XTAL2)
Provides the precise clock signal required for the microcontroller's operation, determining its execution speed. (~22pF Caps.)

RESET (Pin 29)
This is the dedicated reset pin for the ATmega328P-M. Pulling this pin low for a short duration will reset the microcontroller.
R1: A pull-up resistor (1K Ohm) connected between +5V and RESET. This ensures the RESET pin is normally held high, preventing accidental resets.
SW1: A momentary push-button switch connected between RESET and GND. When pressed, it pulls the RESET pin low, triggering a manual reset of the microcontroller.

Serial Communication (UART)



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Sheet Path: /Project Architecture/Microcontroller/	Reviewer:	Size: A4	Sheet: 7 of 8	

[8] Revision History

DD.MM.YYYY - xxx Revision
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- 6/6/2025 – Final Revision; Variant: Final version

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