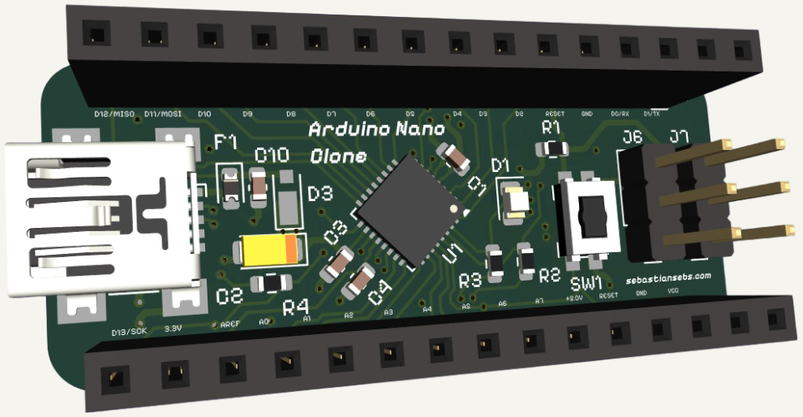
Arduino Nano from Scratch

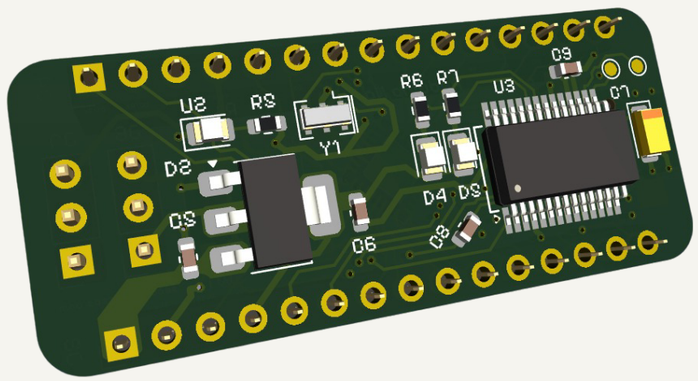
Variant: Final Version

2025-06-06
Rev #1

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.

Comments:	Company: **sebastiansebs.com**		Variant: Final Version	
	Board Name: **Arduino Nano from Scratch**		Project Name: **Arduino Nano**	
Sheet Title: Cover Page	File Name: Arduino Nano.kicad_sch	Designer: Sebastian Silva	Date: 2025-06-05	Revision: v1.0
Sheet Path: /		Reviewer:	Size: **A3**	Sheet: **1** of **8**

[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.

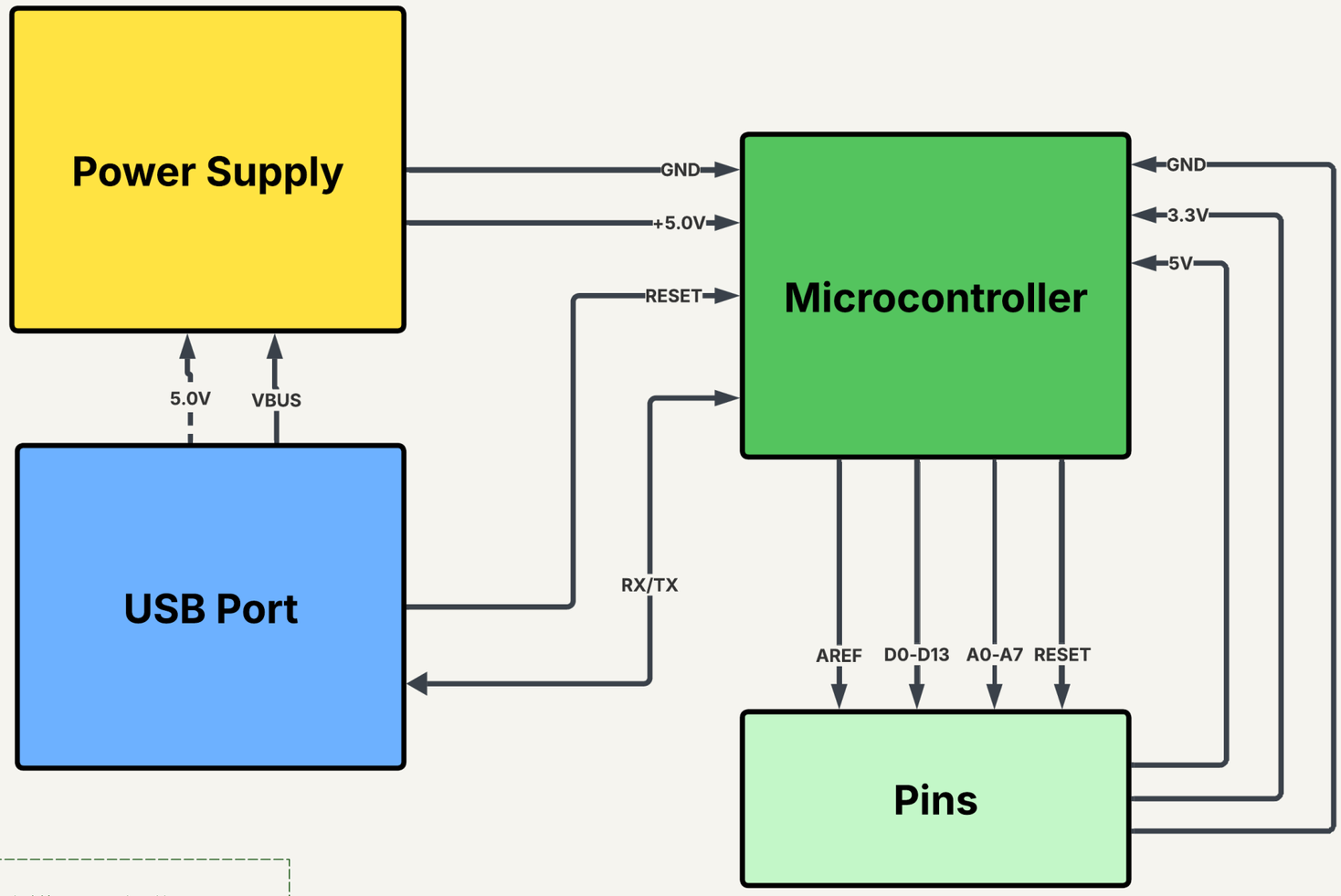
RESET/PC6 (pin 29) to RESET on J2.

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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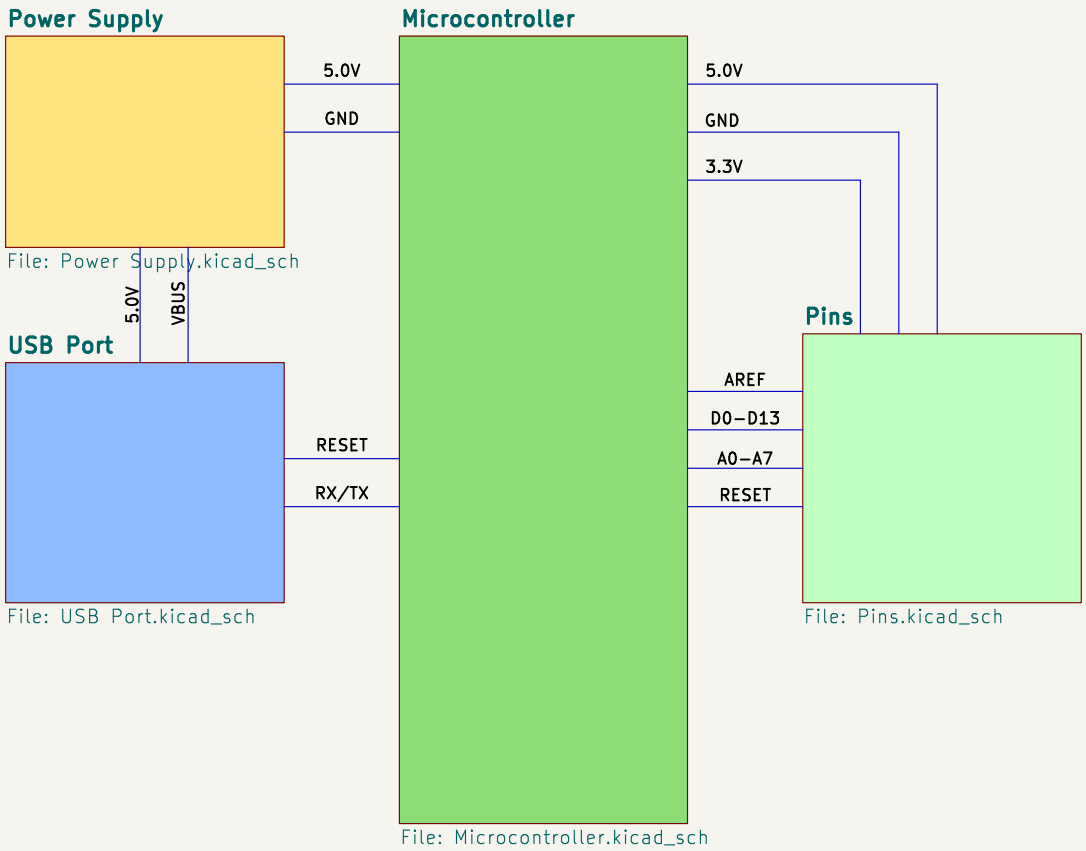
	Board Name: Arduino Nano from Scratch		Project Name: Arduino Nano	
Sheet Title: Cover Page	File Name: Block Diagram.kicad_sch	Designer: Sebastian Silva	Date: 2025-06-05	Revision: v1.0
Sheet Path: /Block Diagram/		Reviewer:	Size: A3	Sheet: 2 of 8

[3] Project Architecture



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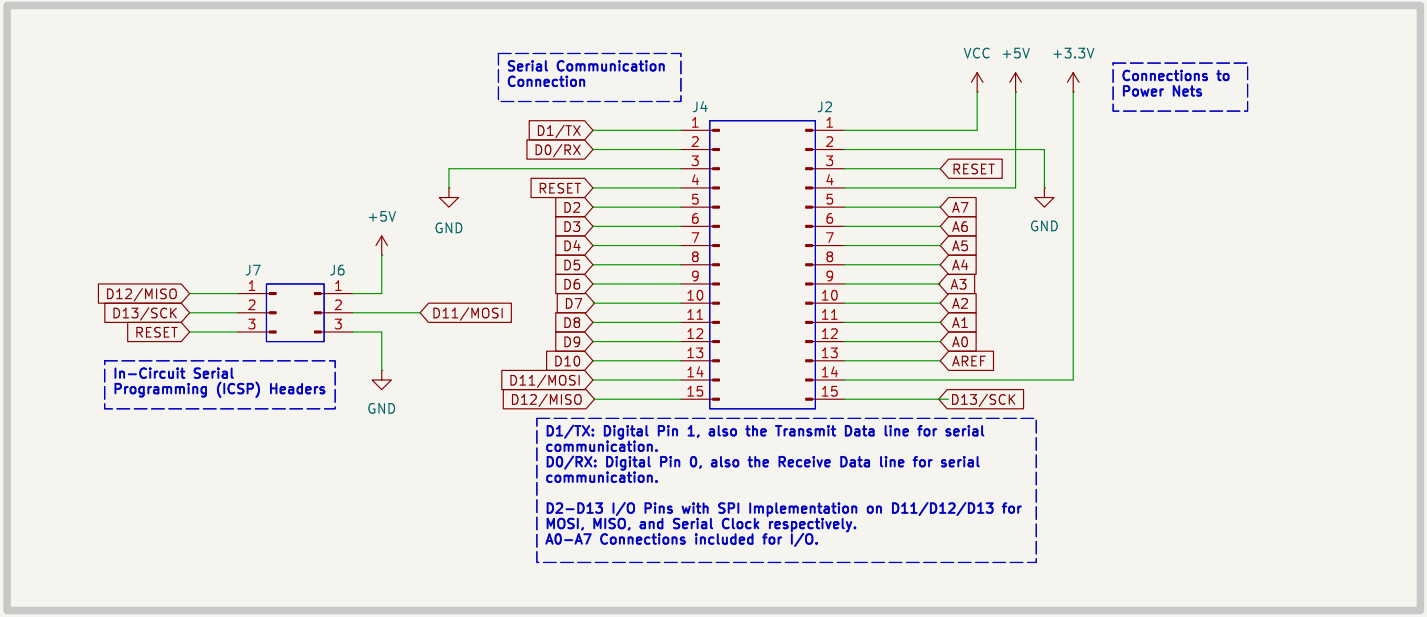
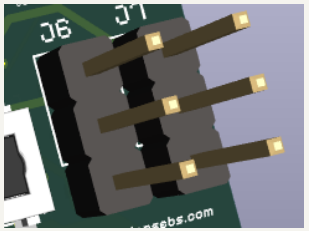
	Sheet Title: Cover Page	File Name: Project Architecture.kicad_sch	Designer: Sebastian Silva	Date: 2025-06-05 / Revision: v1.0
	Sheet Path: /Project Architecture/		Reviewer:	Size: A4 / Sheet: 3 of 8

[4] Pins





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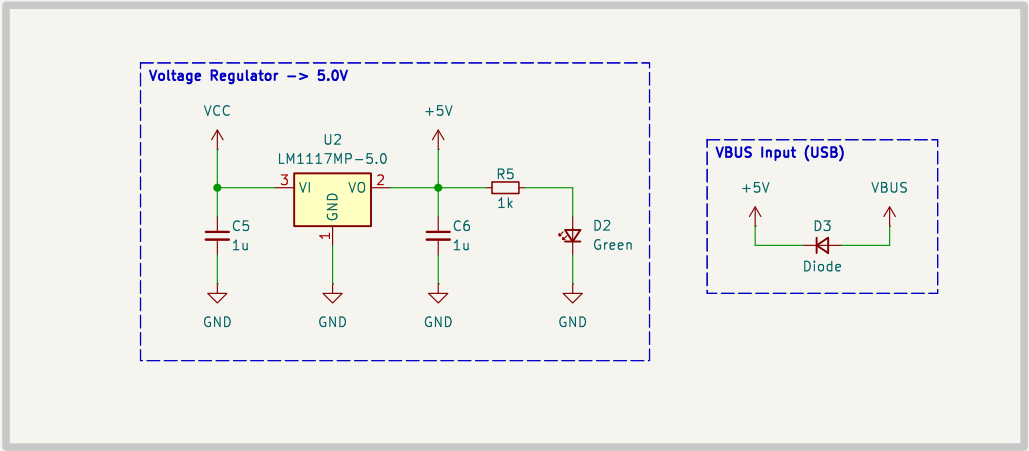
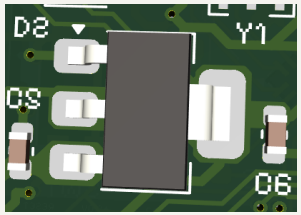
Sheet Title: Cover Page	File Name: Pins.kicad_sch	Designer: Sebastian Silva	Date: 2025-06-05	Revision: v1.0
Sheet Path: /Project Architecture/Pins/		Reviewer:	Size: **A4**	Sheet: **4** of **8**

[5] Power Supply





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Sheet Title: Cover Page	File Name: Power Supply.kicad_sch	Designer: Sebastian Silva	Date: 2025-06-05	Revision: v1.0
Sheet Path: /Project Architecture/Power Supply/		Reviewer:	Size: **A4**	Sheet: **5** of **8**

[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).

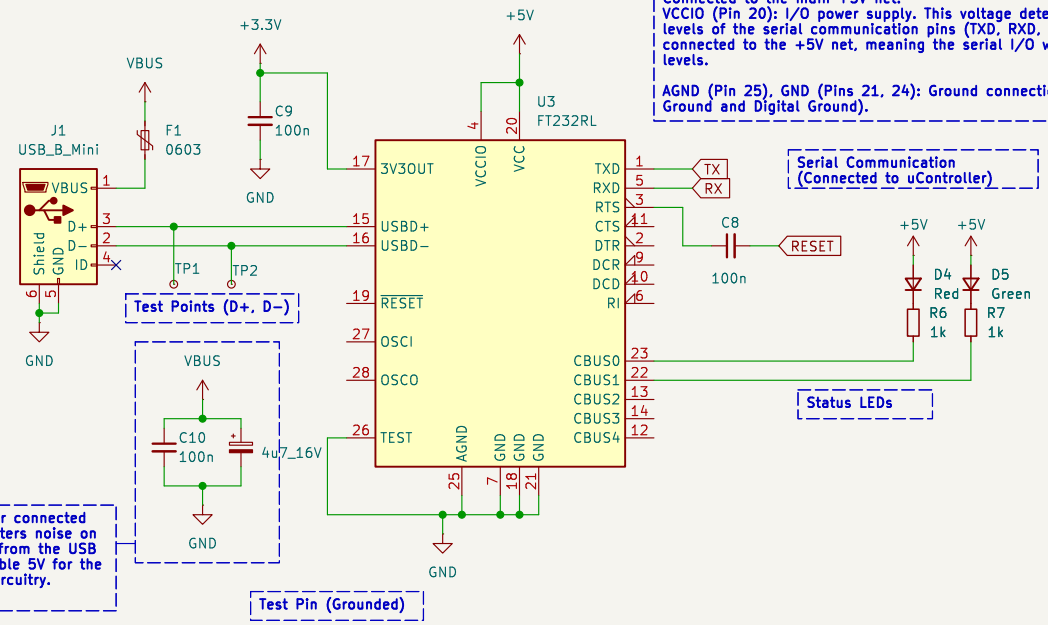
Pin 2 (D−): USB Data Minus line.
Pin 3 (D+): USB Data Plus line.

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.

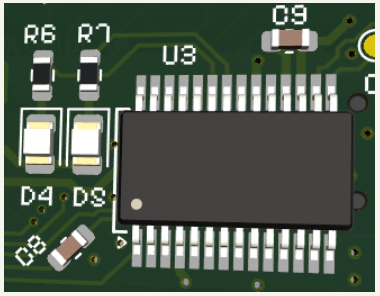
Pin 5 (GND): USB Ground.

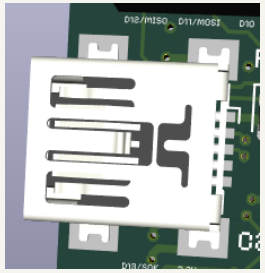
Pin 6 (Shield): Connection for the USB cable's shield, typically connected to the circuit's main ground.

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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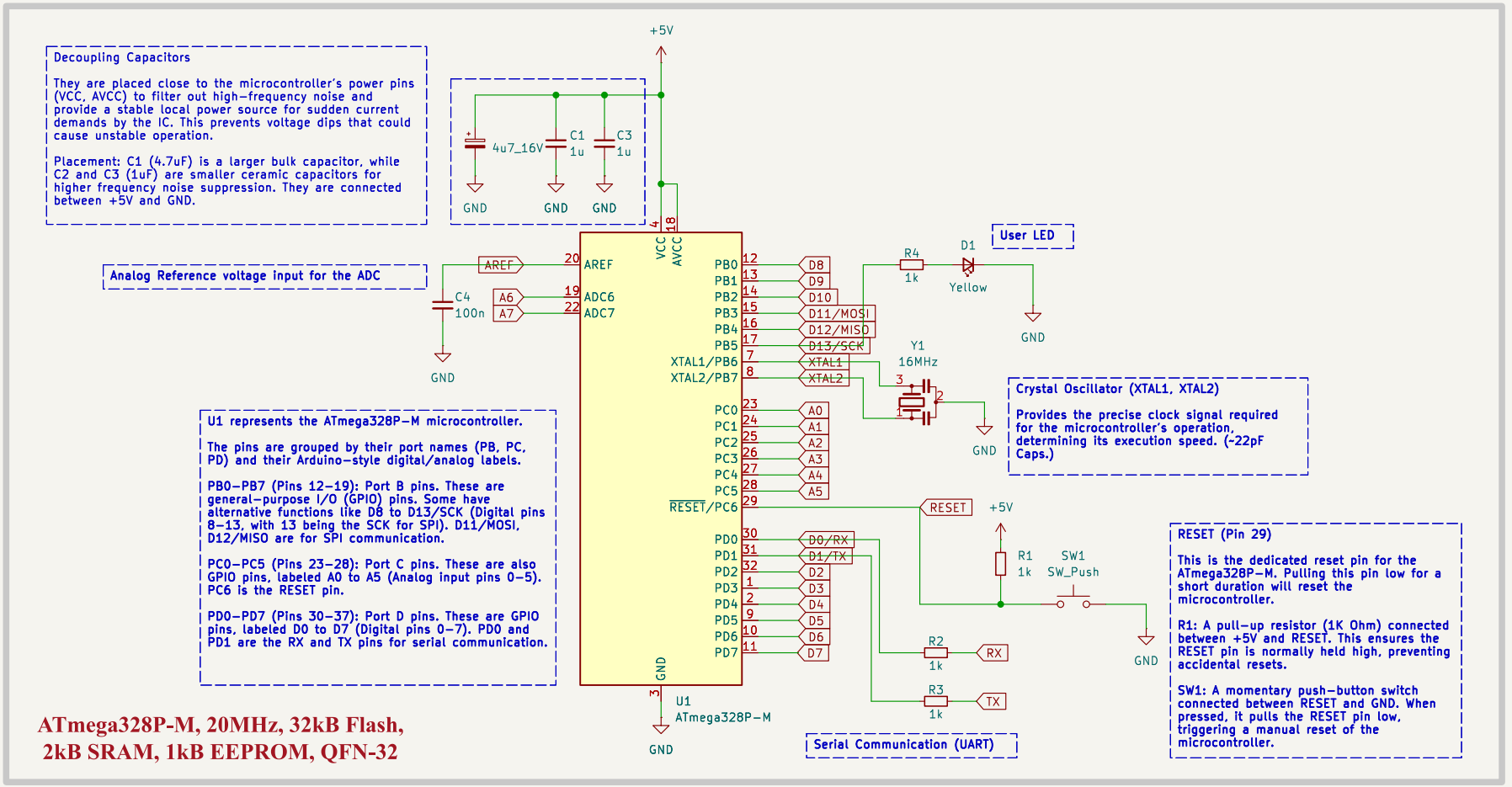
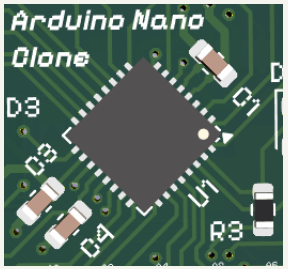
Sheet Title: Cover Page	File Name: USB Port.kicad_sch	Designer: Sebastian Silva	Date: 2025-06-05	Revision: v1.0
Sheet Path: /Project Architecture/USB Port/		Reviewer:	Size: A4	Sheet: 6 of 8

[7] Microcontroller





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Sheet Title: Cover Page	File Name: Microcontroller.kicad_sch	Designer: Sebastian Silva	Date: 2025-06-05	Revision: v1.0
Sheet Path: /Project Architecture/Microcontroller/		Reviewer:	Size: A4	Sheet: 7 of 8

[8] Revision History

DD.MM.YYYY - xxx Revision
Variant: xxx

- 6/6/2025 – Final Revision; Variant: Final version

DD.MM.YYYY - xxx Revision
Variant: xxx

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Sheet Title: Cover Page	File Name: Revision History.kicad_sch	Designer: Sebastian Silva	Date: 2025-06-05	Revision: v1.0
Sheet Path: /Revision History/		Reviewer:	Size: A4	Sheet: 8 of 8