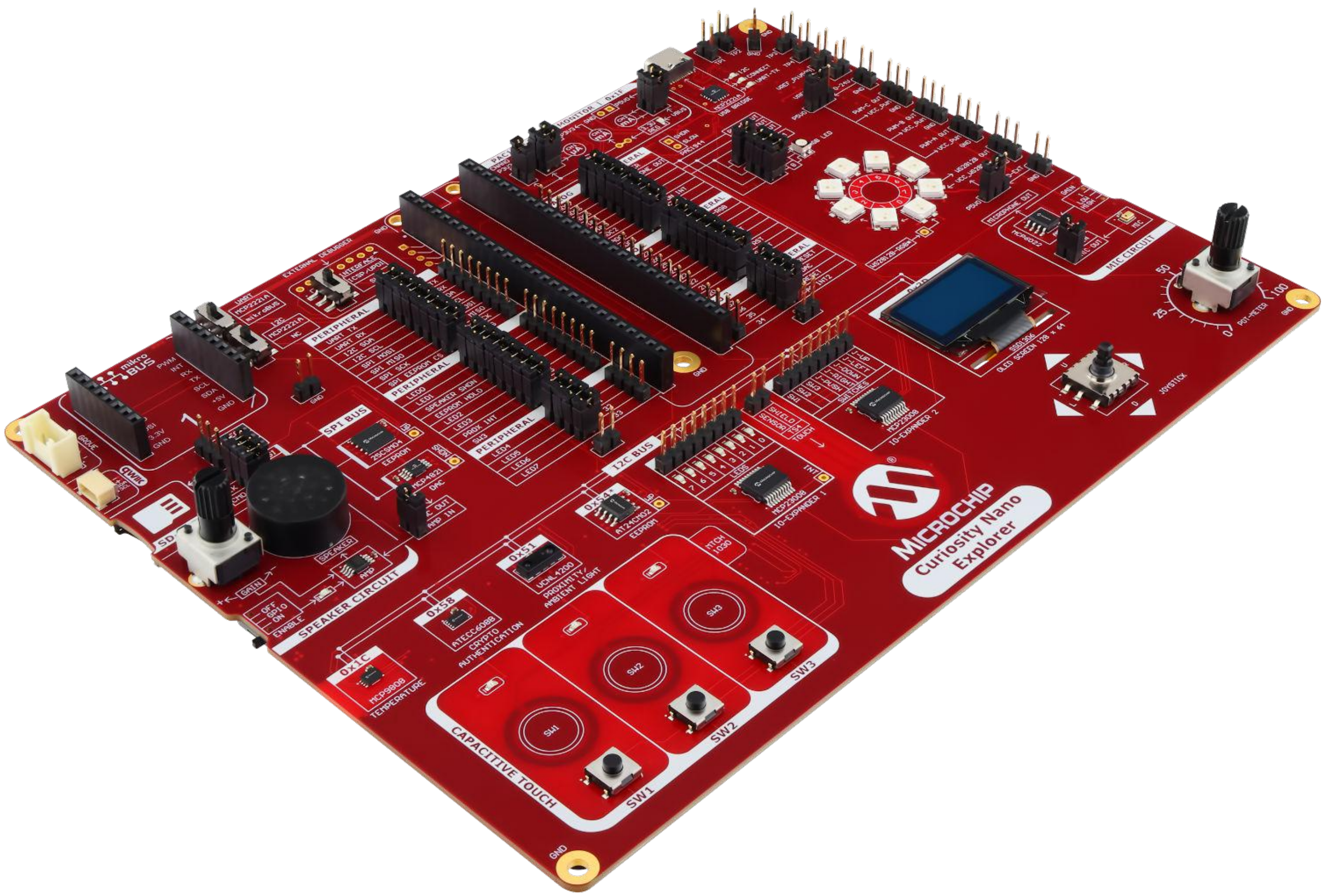
Curiosity Nano Explorer User Guide

Curiosity Nano Explorer User Guide [EV58G97A]

Preface



- **Website** - Purchase this product, kit information, latest user guide, and design documentation
- **Explorer Pinouts for all Curiosity Nanos** - Explorer Pinouts for all CNANO boards
- **Schematics** - Board schematics and history
- **Altium Project** - Altium Design files for the latest board revision
- **Design Documentation** - Production files for every revision
- **Curiosity Nano Explorer Online Errata** - Latest revision history and known issues for all board revisions

> **Info:** Links to the latest version of this document:
> - **Curiosity Nano Explorer Online User Guide**
> - **Curiosity Nano Explorer PDF User Guide**

Table of Contents

1. Introduction

Kit Introduction, Kit Contents, Terminology, Image Legend.

1.1 Curiosity Nano Explorer

The Curiosity Nano Explorer lives up to its name by providing extensive on-board features that allow users to explore and experiment with the microcontroller peripherals of their Curiosity Nano development board. It also serves as an ideal platform to become familiar with Microchip's software offerings, including MCC Melody.

A wide selection of input and output options:

- **INPUTS include** Touch (and mechanical) buttons, a potentiometer, a joystick, a temperature sensor, a proximity sensor, an ambient light sensor, and a microphone
- **OUTPUTS include** LEDs (simple yellow, standard RGB, and WS2812B RGB), an OLED display, and a speaker

Solid support for serial communication:

- I^2C Bus with eight clients
- SPI Bus with three clients
- UART connection

Microchip's complementary technologies:

- Touch controller with three touch buttons and a separate touch button for use with microcontrollers featuring a touch peripheral
- ECC608 provides CryptoAuthentication™ features
- Power Monitoring by the PAC1944 enables the measurement of various power domains

Finally, if anything is missing on the Explorer, its functionality can be expanded via mikroBUS™, Grove or Qwiic® sockets.

1.2 Kit Contents

The Curiosity Nano Explorer kit contains:

- One Curiosity Nano Explorer development board
- 20 separable 100-mil jumper wires for pin remapping
- Ten additional pin jumpers
- One 1x8 (100-mil) right-angled pin header to connect external programmer/debuggers
- One joystick cap

1.3 Terminology

This user guide uses the following terminology:

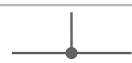
Table 1-1. Terminology

Term	Explanation
Explorer	The Curiosity Nano Explorer development board
CNANO	The connected Curiosity Nano development board
CNANO Socket	A socket with two 1x28 pin header sockets to connect any Curiosity Nano development board to the Curiosity Nano Explorer

1.4 Image Legend

The symbols and colors below are used throughout the user guide.

Figure 1-1. Block Figure Legend

Symbol	Description
	Pin jumper mounted on pin header
	Pin header
	Pin header socket
	Pin header footprint
	Pin header footprint with cut-strap
	Cut-strap (0402 SMD sized)
	Circuit simplification
	Connection point
	Click to return to "Board Overview"
CNANO	CNANO Socket

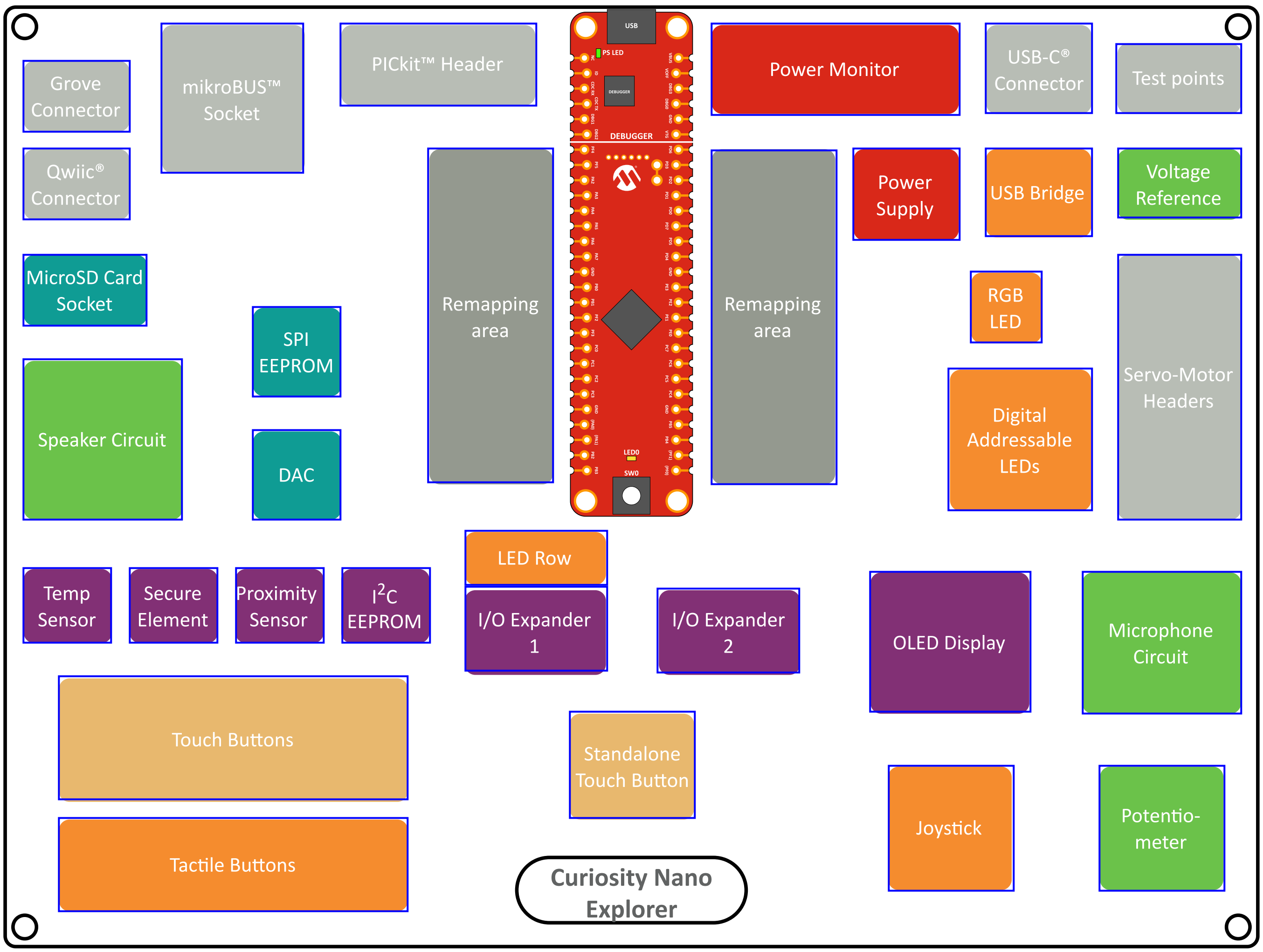
Color	Description
Microcontroller	Target MCU or debugger
Power	Power supply component or circuit
Analog	Analog component or circuit
I^2C	I^2C connection
SPI	SPI connection
UART	UART connection
Peripheral	Other peripherals, ex. LEDs, buttons
Touch	Capacitive touch
Pin Mapping	Pin labels, net names or pin remapping
External Connectivity	Connectors and headers

2. Board Overview

Block Diagram, Board Image, Feature List.

2.1 Block Diagram

Figure 2-1. Explorer Overview

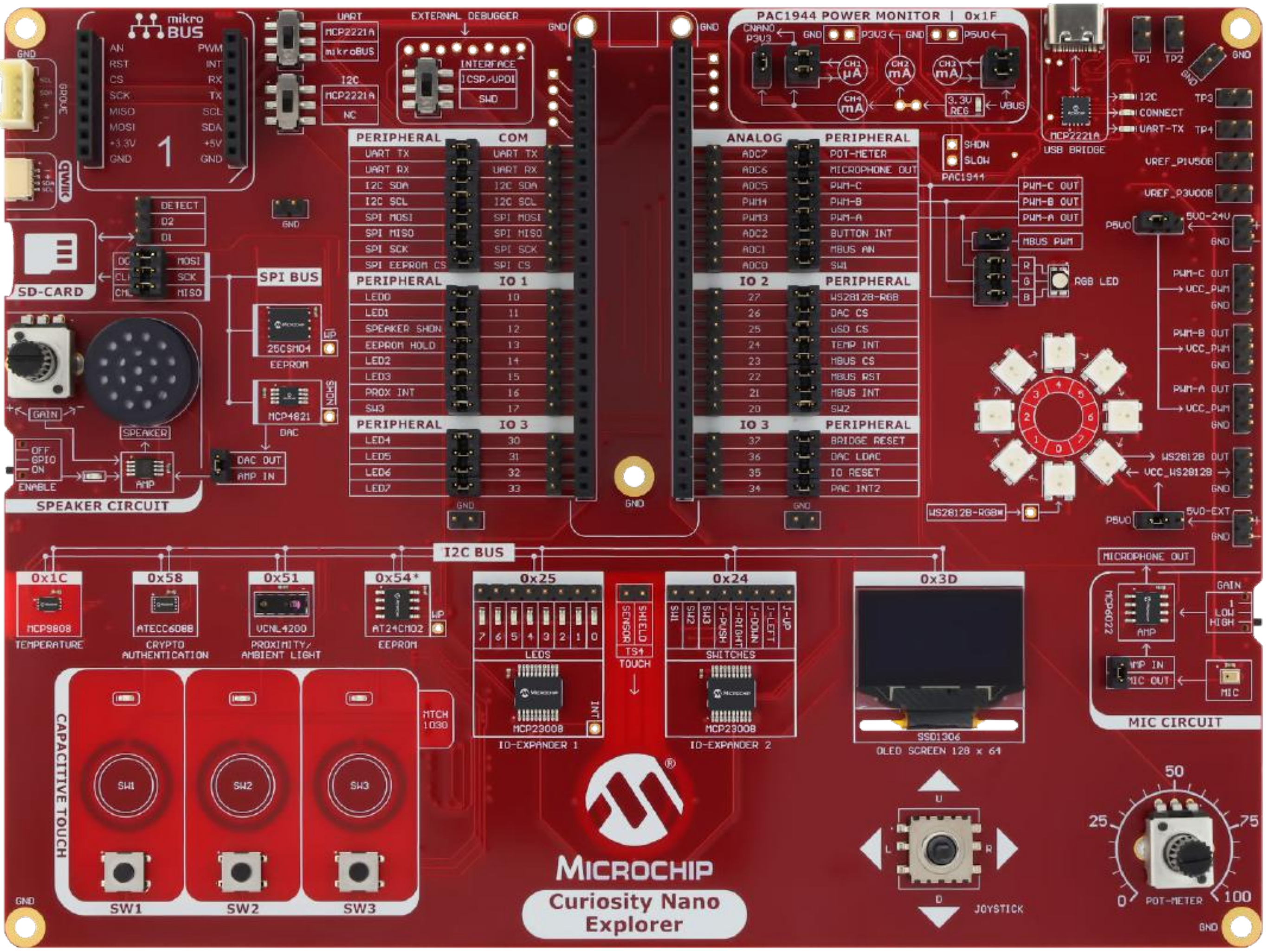


Tip:

- Swiftly navigate to your desired topic by clicking the corresponding block in the diagram above
- Click the symbol in other block diagrams to return to the Explorer overview image

2.2 Board Image

Figure 2-2. Explorer Image



2.3 Feature List

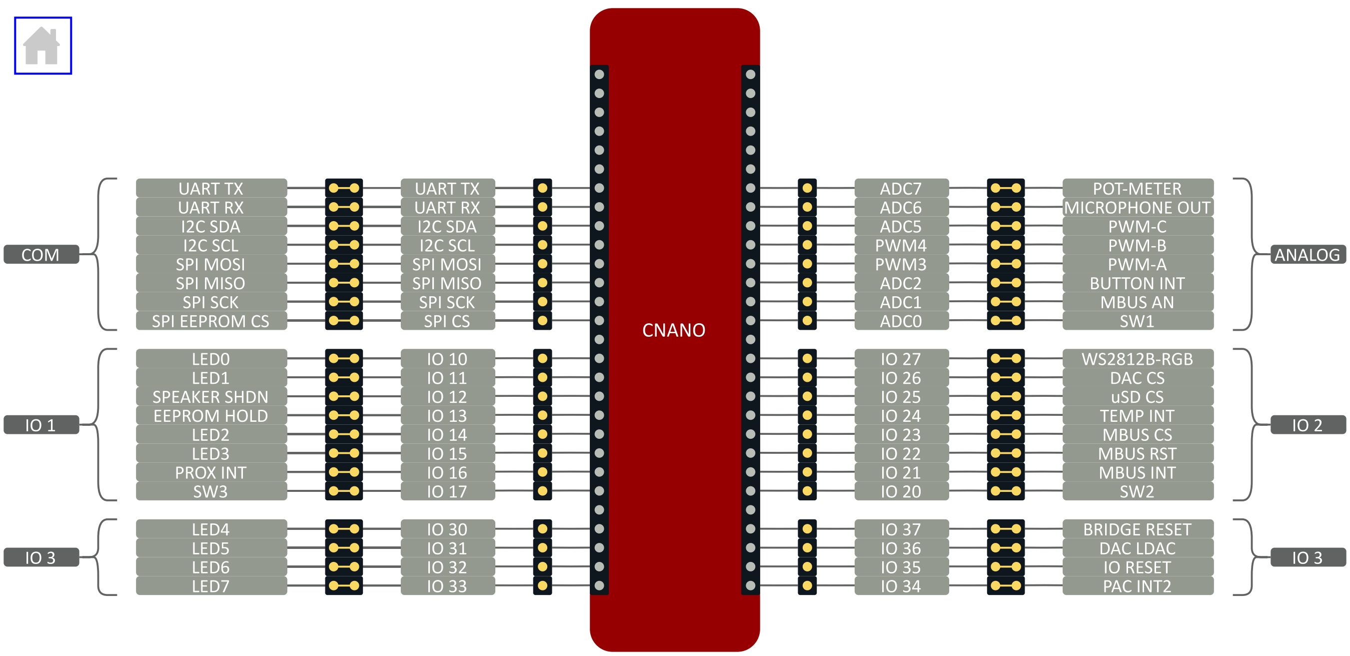
- Curiosity Nano socket
  - Supports all Curiosity Nano development boards
  - Fully remappable pinout
- On-board peripherals
  - MCP2221A USB to UART/I^{2}C-Bridge
  - PAC1944 power monitor
  - ATECC608B secure element
  - MCP4821 12-bit digital-to-analog converter
  - MTCH1030 touch controller
  - Two serial EEPROMs (AT24CM02 and 25CSM04)
  - Two MCP23008 I^{2}C I/O-expanders
  - MicroSD card socket
- Multiple input options
  - MCP9808 temperature sensor
  - Microphone and amplifier (MCP6062) with adjustable gain
  - Joystick
  - Potentiometer
  - Push buttons
  - Touch buttons
  - Proximity/ambient light sensor
- Multiple output options
  - LED row with eight yellow LEDs
  - OLED display
  - One RGB LED
  - Eight digital addressable LEDs
  - Three external PWM outputs for servomotors
  - Speaker and class-D amplifier with adjustable gain
- External connectivity options
  - Grove I^{2}C connector
  - mikroBUS™ socket
  - Qwiic® I^{2}C connector
- Multiple power sources
  - On-board USB Type-C® connector
  - USB powered from connected CNANO
  - External power options for addressable LEDs and servomotors
- On-board Power Supplies
  - MIC33153 4 MHz PWM 1.2A internal inductor buck switcher power module to power 3.3V peripherals
  - MCP1754 3.3V 150 mA LDO to power USB bridge and power monitor circuitry
  - MIC2008 high-side power switch for slew rate control and over-current protection
- MCP1501 user-remappable voltage references, 1.5V and 3.0V

3. Pinout and Remapping

Pinout and Remapping Area, Different Types of Remapping.

Tip: The mapping between Explorer and any Curiosity Nano development board can be found in the **Curiosity Nano Explorer Pinouts** document.

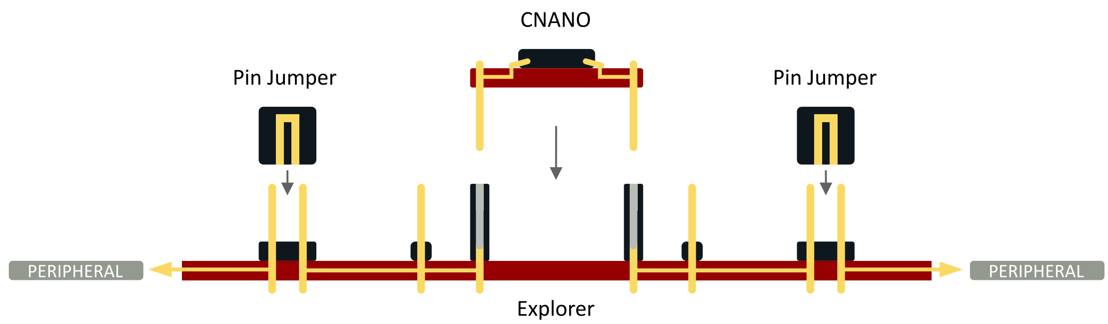
Figure 3-1. Pinout, Remapping Area and CNANO Socket



Connections to the CNANO socket are divided into five sections - COM, analog, IO1, IO2 and IO3. Standard functionality is assigned to each pin in the COM and analog section Curiosity Nano development boards. Pins in the I/O sections are numbered with a <section><pin-number> format, ex: “IO 26” indicates section 2 pin 6.

Info: Curiosity Nano development boards with low pin count microcontrollers may not implement the standard functionality in the COM and analog sections.

Figure 3-2. Explorer to CNANO Connections

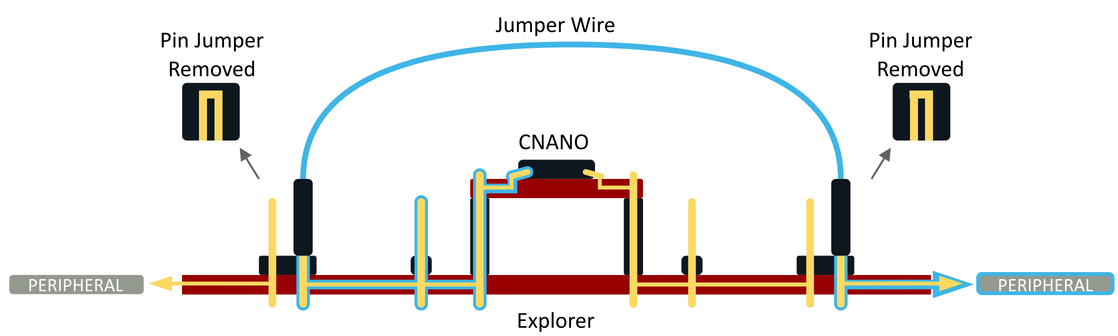


Tip: Connect your measuring tool to the innermost pin header for easy access to any signal on the Explorer. Use the custom test points for access with longer measurement probes.

3.1 CNANO Socket Remapping

The Explorer’s connections to the CNANO socket are fully remappable. Any peripheral can be connected to any pin on the socket.

Figure 3-3. Peripheral to CNANO Pin Remapping

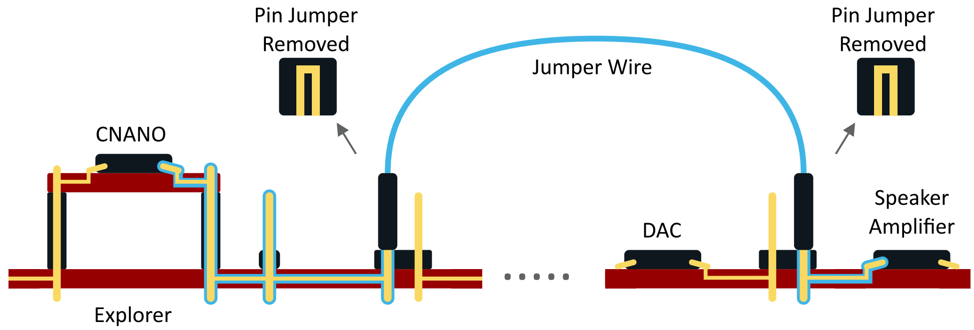


Tip: Peripheral connections are labeled on the silkscreen.

3.2 Direct Remapping

Many peripherals on the Explorer can be remapped by connecting a pin directly to the CNANO socket using a jumper wire. For example, if your CNANO's microcontroller has a DAC (Digital-to-Analog Converter) output, you can directly connect it to the speaker amplifier.

Figure 3-4. Direct peripheral remapping



3.3 Custom Test Points

The Explorer features four customizable test points available on the board edge. The test points are labeled TP1, TP2, TP3 and TP4 on the silkscreen.

Easily measure any signal by connecting a jumper wire between the innermost pin header in the remapping area and a test point.

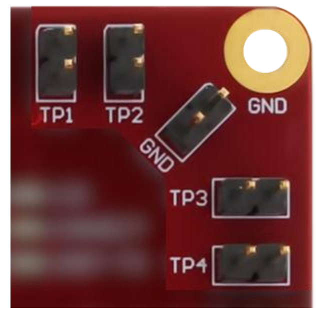
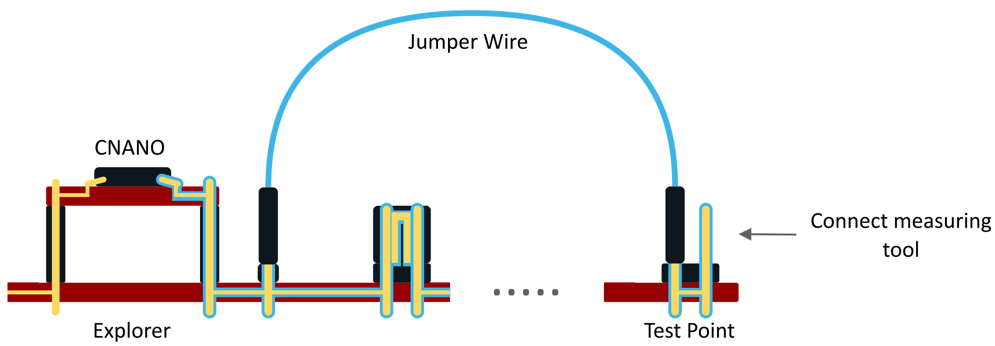


Figure 3-5. Connecting Net to Test Point



Tip: A pin header with ground connections is available next to the test points.

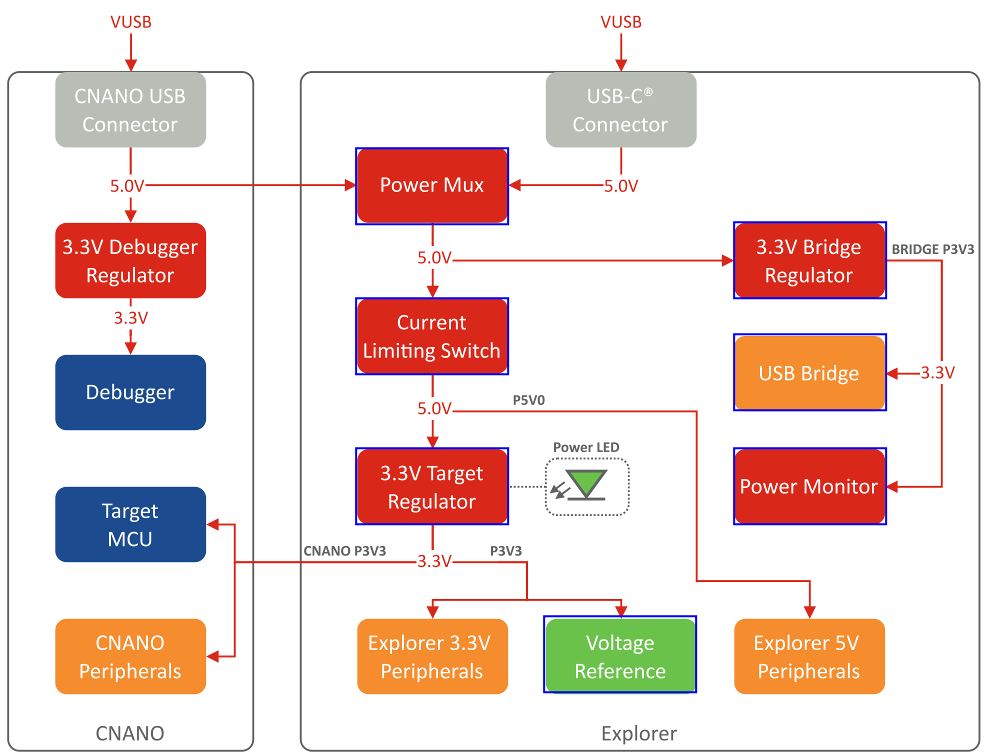
4. Power Supply and Monitor

Power supply, Power Monitor.

Power Supply Power Monitor

4.1 Power Supply

Figure 4-1. Power Supply Overview



Important: The Explorer powers the CNANO at 3.3V, and all the pins connected to the CNANO socket are designed for use with 3.3V I/O pins.

The Explorer's power supply features:

- A power multiplexer allows power supplied from the on-board USB-C® connector or the CNANO
- On-board power monitoring for voltage and current measurement with four channels
- A current limiting switch with a soft start to protect the board, the current limit set at 2A
- Dedicated 3.3V regulator to power the CNANO and 3.3V peripherals
- 5V peripherals powered directly by USB voltage
- Fixed 3.3V for the CNANO. Its target regulator is disabled while connected to the Explorer.

Table 4-1. Power Domain Specifications

Power Domain	Vnom	Vmin - Vmax	Imax
P5V0	5.0V	4.4–5.5V	2.0A
P3V3	3.30V	3.22–3.38V	1.2A
CNANO P3V3	3.30V	3.22–3.38V	1.2A
BRIDGE P3V3	3.30V	3.23–3.37V	150 mA

4.1.1 Power Sources

The two main power sources are:

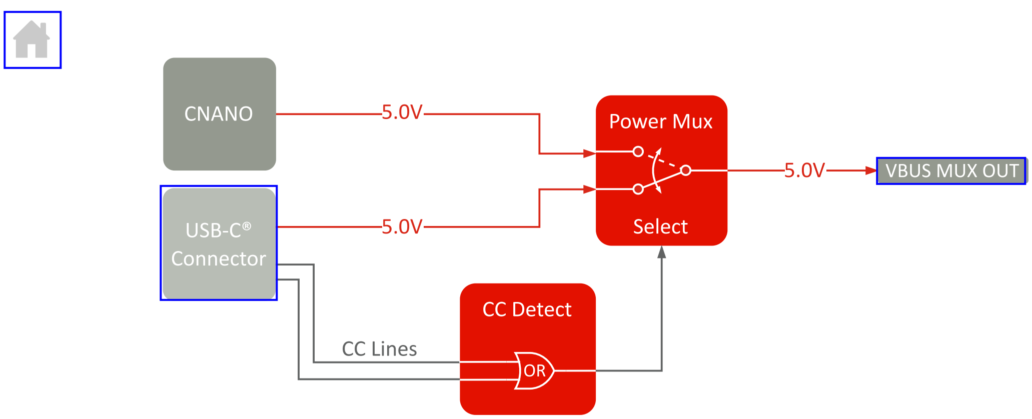
- The USB connector on the CNANO
- The USB-C connector on the Explorer

Current limitations:

- The CNANO's VBUS output has a current limitation of 500 mA
- The Explorer's USB-C connector can sink different amounts of currents based on the USB source (up to 3.0A from a USB-C source)
- Both USB inputs are fed into a power multiplexer, with output current limited to 2.0A

Info: The current is drawn from the Explorer's USB-C input when both USB connectors are powered.

Figure 4-2. Power MUX Overview



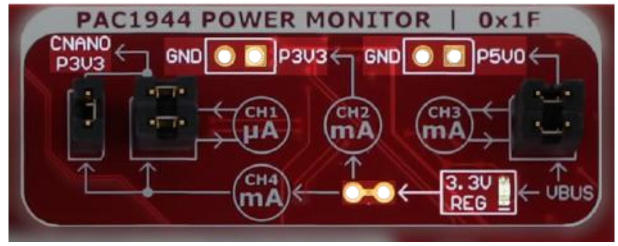
4.1.2 Power Domains

There are four main power domains on the Explorer.

P5V0

This power domain powers the following:

- RGB LED
- Digital Addressable LEDs circuit (default power option)
- Servomotor circuit (default power option)
- Internal LED on the Proximity and Ambient Light Sensor
- +5V pin of the mikroBUS™ Socket



The P5V0 power domain is available on the unmounted 1x2 pin header J508.

BRIDGE P3V3

This power domain is independent of the three other domains and powers:

- USB Bridge circuit
- Power Monitor circuit

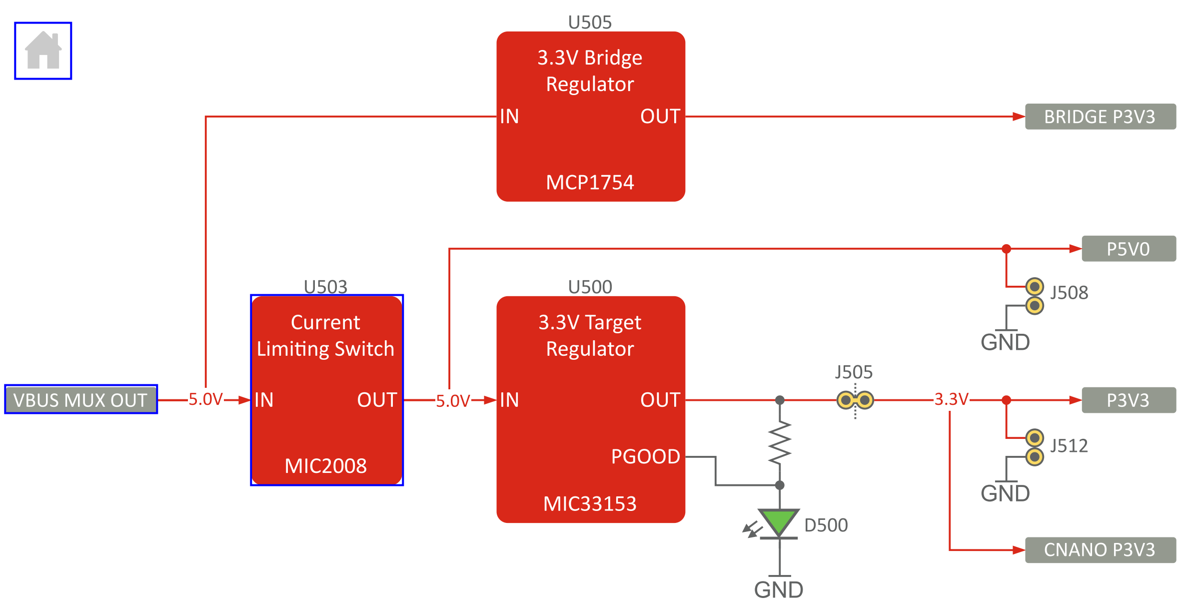
P3V3

This power domain powers almost all of the peripherals on the Explorer except the ones listed above. The P3V3 power domain is available from the unmounted 1x2 pin header J512.

CNANO P3V3

Powered by the same regulator as P3V3, separated for dedicated power measurement of the CNANO. It powers the CNANO's external power input. See 4.1.4. CNANO Power Configuration for more details.

Figure 4-3. Power Domains Overview



4.1.3 Current Limiting Switch

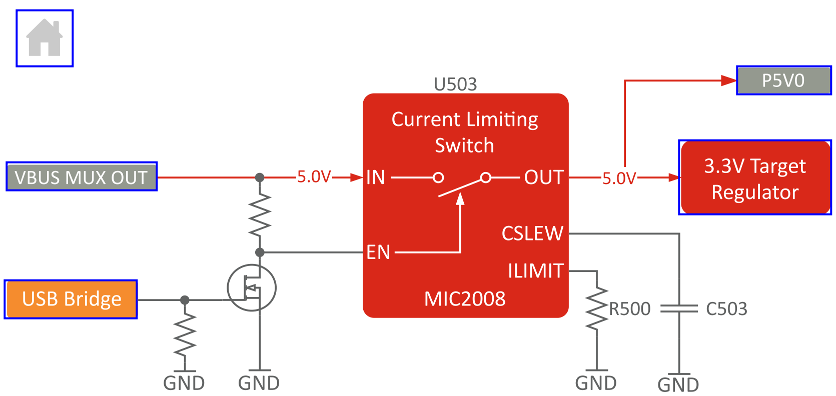
A MIC2008 current limiting switch with an adjustable slew rate is mounted on the board to ensure a steady slew rate and prevent large inrush currents. The switch has been configured with the following limits using external components on the board:

- Slew rate: 2 V/ms
- Current limit: 2.0A

Info: MIC2008 current limit range: 0.2–2.0A.

Resistor R500 sets the current limit and capacitor C503 the slew rate. The user may alter the current limit and/or slew rate by changing the mounted resistor/capacitor. See the MIC2008 data sheet for more information on calculating the current limit and slew rate.

Figure 4-4. Current Limiting Switch



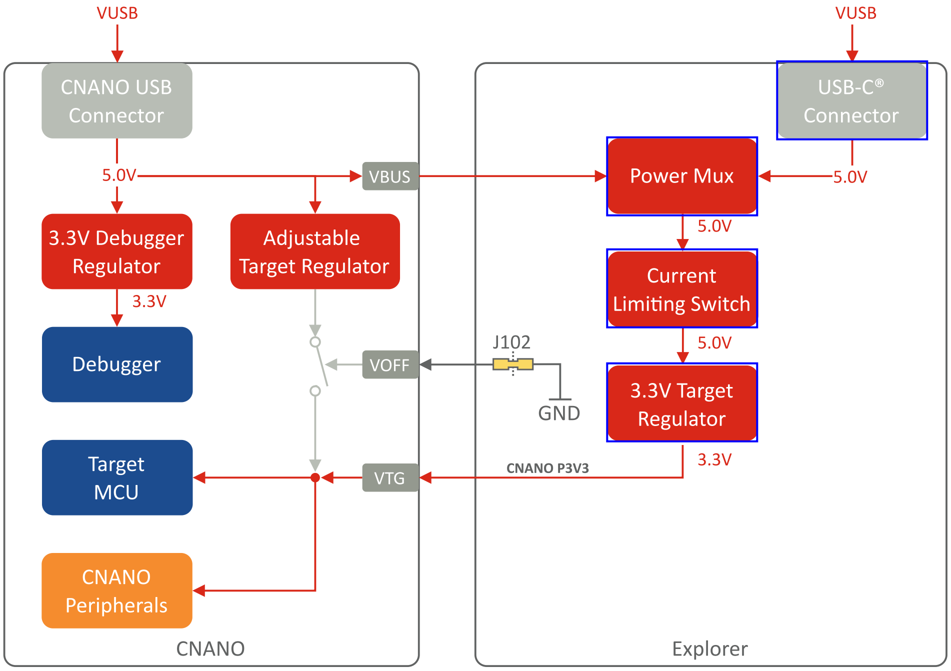
4.1.4 CNANO Power Configuration

The Explorer supplies the CNANO with a fixed 3.3V. When connected to the Explorer, the on-board regulator of the CNANO is disabled by pulling the VOFF pin low, ensuring no logic level mismatches between the CNANO and the Explorer.

Info: The CNANO's on-board debugger is only powered when the CNANO USB is connected to power.

Important: When connected to the Explorer, the adjustable target voltage feature of the CNANO is disabled.

Figure 4-5. Power Configuration of the Connected CNANO


VUSB
VUSB
CNANO USB Connector
USB-C® Connector
5.0V
VBUS
Power Mux
5.0V
3.3V Debugger Regulator
Adjustable Target Regulator
5.0V
Current Limiting Switch
3.3V
5.0V
J102
Debugger
VOFF
GND
3.3V Target Regulator
Target MCU
VTG
CNANO P3V3
3.3V
CNANO Peripherals
CNANO
Explorer

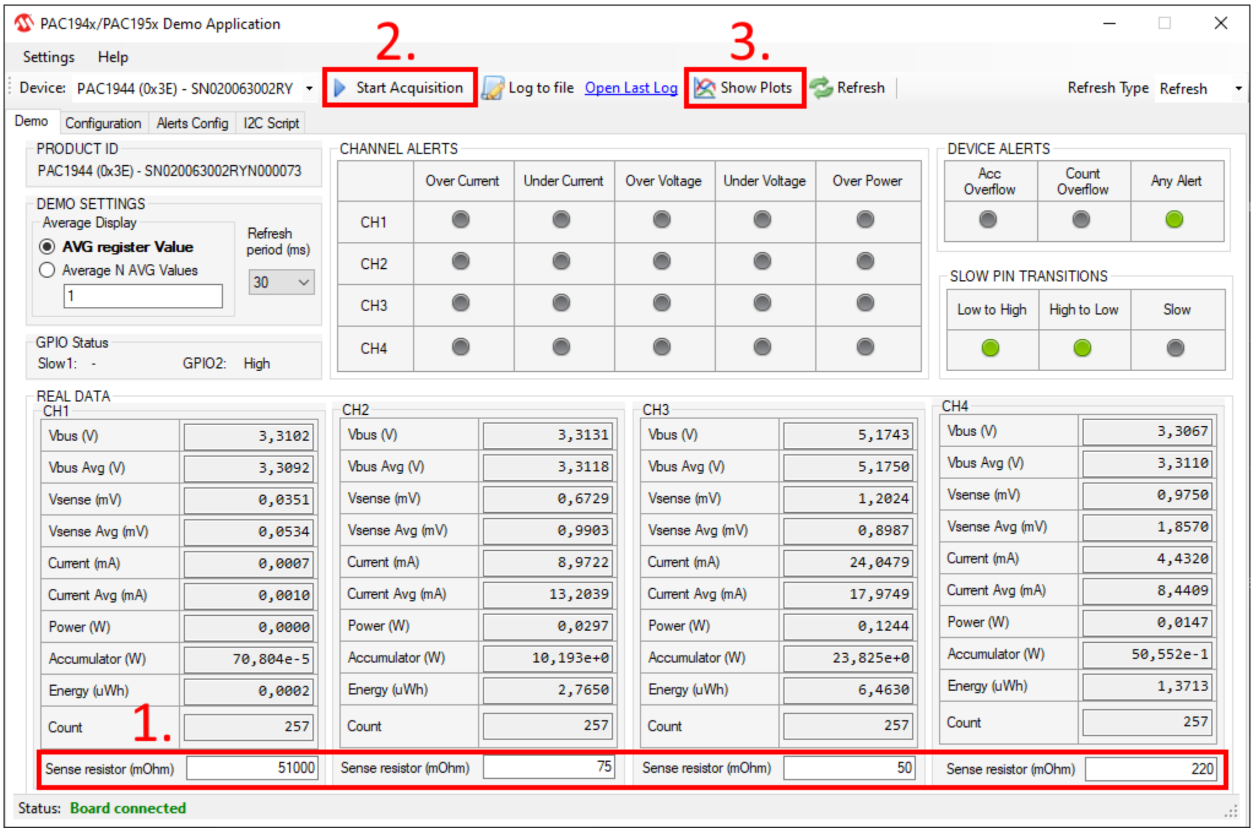
4.2 Power Monitor

4.2.1 Getting Started with Power Monitor

The on-board PAC1944 quad-channel power monitor circuit allows tracking of the power consumption of peripherals on the Explorer. The measurement data can be accessed through the USB bridge MCP2221A.

To read and visualize power data, download and install the PAC194x/PAC195x Demo Application.

Figure 4-6. PAC194x/PAC195x Demo Application



Open the application and perform the following steps to get started:

1. Configure sense resistor values.
   a. Channel 1: 51000.
   b. Channel 2: 75.
   c. Channel 3: 50.
   d. Channel 4: 220.
2. Start Acquisition.
3. Press "Show Plots" to visualize the data.

Important: Set the I^2C slide switch to the "NC" position while using the demo application to isolate the PAC1944 and MCP2221A from the rest of the I^2C bus on the board.

4.2.2 Power Measurement Channels

The four PAC1944 measurement channels are set up to measure three main power domains on the Explorer - P5V0 (CH3), P3V3 (CH2), and CNANO P3V3 (CH1 and CH4).

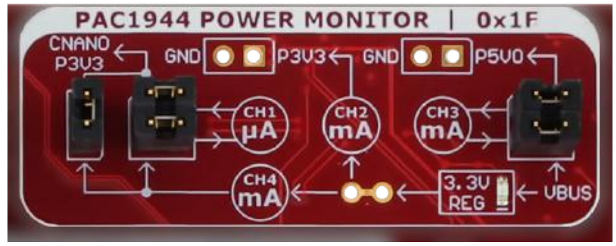


Figure 4-7. Measurement Channels

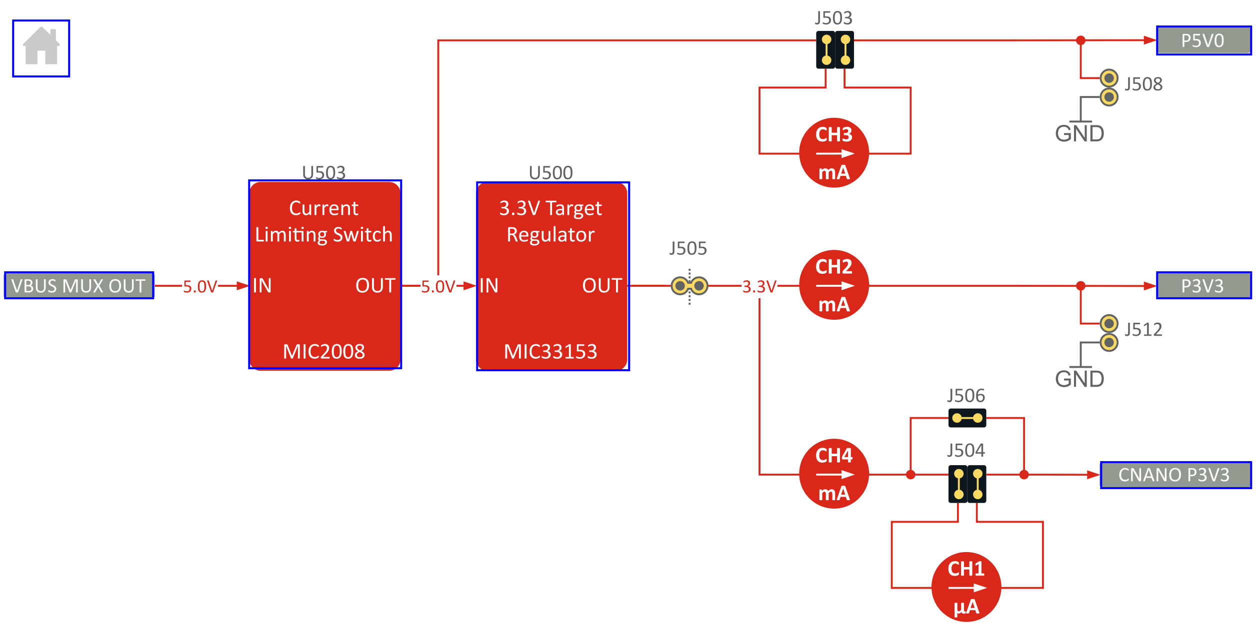


Table 4-2. Measurement Channel Specifications

Default Power Domain	Channel	Current Sense Range	Current Sense Resolution	Sense Resistor
P5V0 (mA)	CH3	≤ 2.00A	30.5 µA	0.050Ω
P3V3 (mA)	CH2	≤ 1.33A	20.3 µA	0.075Ω
CNANO P3V3 (mA)	CH4	≤ 455 mA	6.94 µA	0.220Ω
CNANO P3V3 (µA)	CH1	≤ 1.96 mA	29.9 nA	51.0Ω

Tip: An overview of which peripherals are connected to which power domain is available in the section 4.1.2. Power Domains.

Measure CNANO P3V3 Power

CH1 and CH4 measure current to the CNANO P3V3 power domain. CH1 is intended for µA measurements, and CH4 for mA measurements. The user can change which channel is in use by placing or removing the pin jumper on pin header J506.

Important: The sense resistor for CH1 is 51Ω. Currents above 2 mA will cause a significant voltage drop in the voltage supplied to the attached CNANO.

Figure 4-8. Currents Above 2 mA (CH1 bypassed)

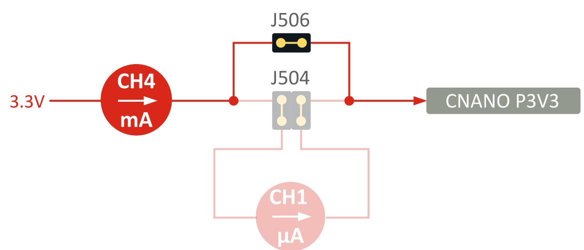
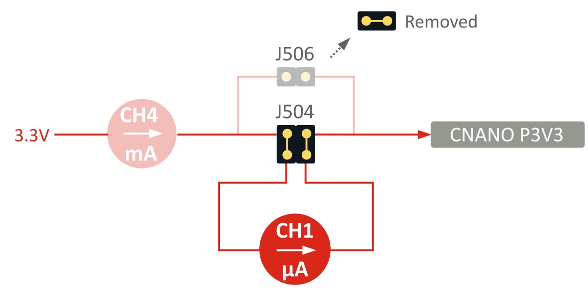


Figure 4-9. Currents Below 2 mA (CH1 connected)



Measure External Power

CH1 and CH3 can be disconnected from their default connections to measure current from external sources.

WARNING Remember to connect the GND from the Explorer to the GND of the external source. Do not apply voltages above 9V to the current measurement channels.

Figure 4-10. Connect External Source to CH1 (µA)

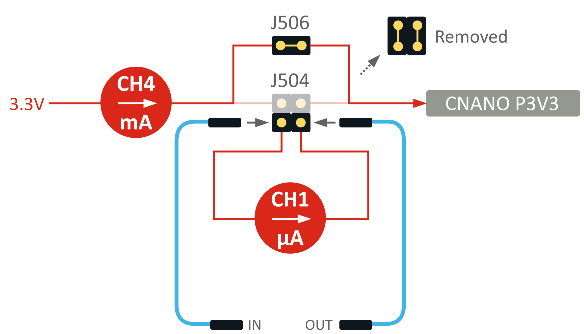
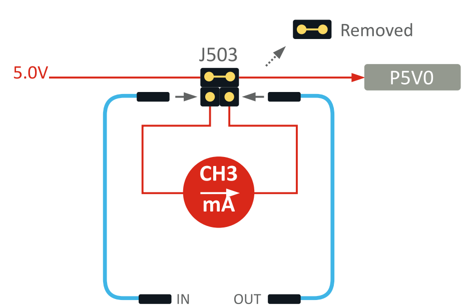
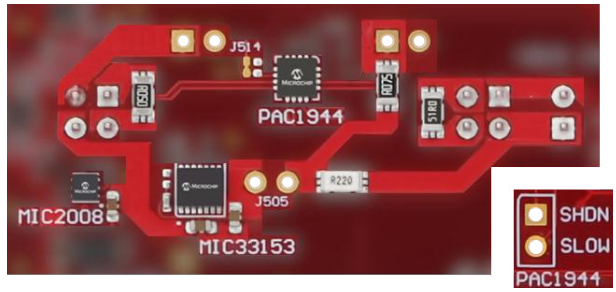


Figure 4-11. Connect External Source to CH3 (mA)



4.2.3 Quad Channel Precision Power Monitor



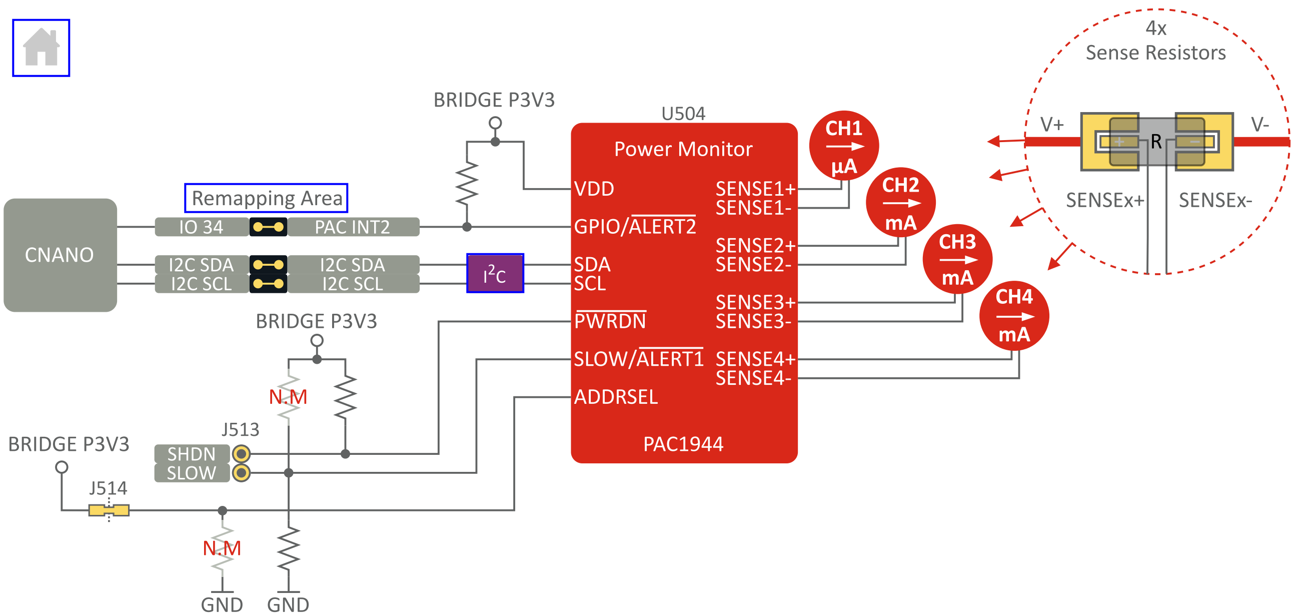
The PAC1944 may also be accessed by the microcontroller on the CNANO using the I²C bus.

Feature overview:

- High-side current monitor with four channels
- 100 mV full-scale range
- 0-9V full-scale range
- 16-bit resolution
- On-chip accumulation of 30-bit power results from energy measurement

Important: Set the I²C slide switch to the "MCP2221A" position to connect the PAC1944 and MCP2221A to the rest of the I²C bus on the board.

Figure 4-12. Power Monitor Overview



5. Buttons and LEDs

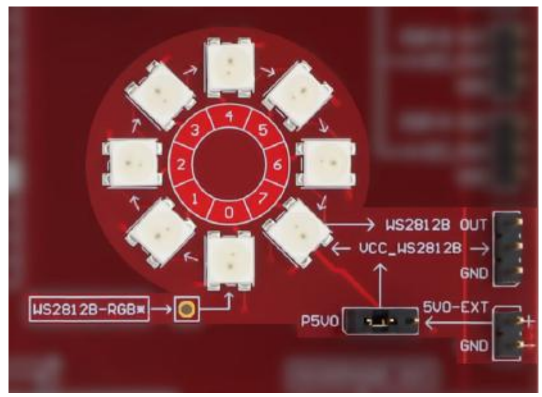
Digital Addressable LEDs, RGB LED, LED Row, Joystick, Tactile- and Touch Buttons.

Digital Addressable LEDs | RGB LED | LED Row and I/O Expander 1 | Buttons, Joystick and I/O Expander 2 | Touch Controller | Standalone Touch Button

5.1 Digital Addressable LEDs

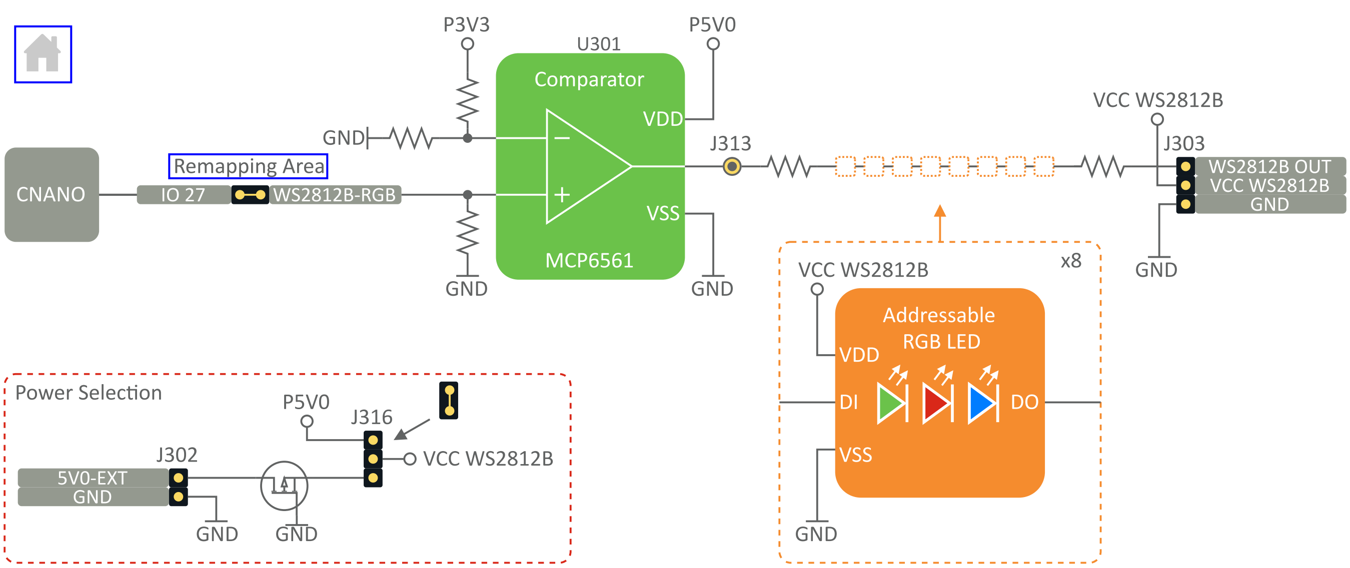
The Explorer features eight serially addressable RGB LEDs. These LEDs behave similarly to WS2812B LEDs. Comparator U301 (MCP6561) connects the control signal from the CNANO socket and acts as a logic-level translator.

- Extend the LED strip using pin header J303
- Select power source using pin header J316
- Supply external power through pin header J302



Tip: The LED strip input is available through the pin header footprint J313.

Figure 5-1. Addressable LED Circuit



Important: Long LED strips consume a lot of current, and it is recommended to use an external supply to power LED strips attached to the board.

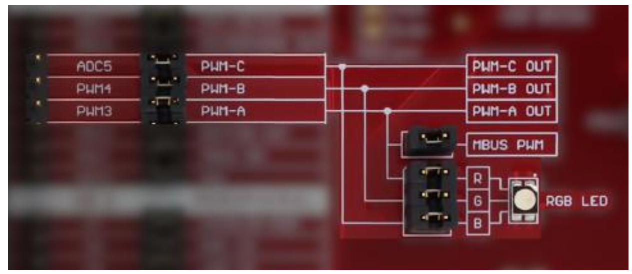
Tip: Check out the PIC® and AVR® examples for driving WS2812 or similar LEDs on MPLAB® Discover.

Related information: 10.2. Addressable LEDs Timing and Format.

5.2 RGB LED

An RGB LED is connected to the PWM outputs from the CNANO socket.

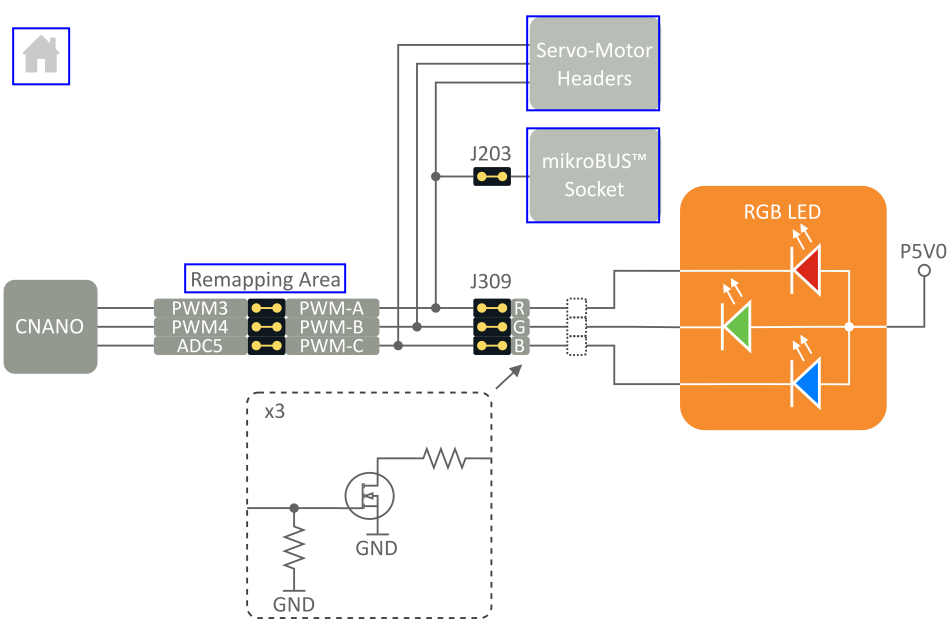
CAUTION The LED is very bright when driven at full power - do not stare at it.



The PWM outputs from the CNANO socket are shared between the servomotor driver and the mikroBUS™ socket. Disconnect the different channels by removing the jumper caps from J203 and J309.

- Pin header J309 connects the RGB LED to the CNANO socket
- Pin header J203 connects the mikroBUS™ PWM channel to the CNANO socket

Figure 5-2. RGB LED Overview



Tip: Check out the PIC and AVR examples for driving RGB LEDs on MPLAB Discover.

5.3 LED Row and I/O Expander 1

LED Row

The Explorer features eight controllable yellow LEDs. Turn the LED on by pulling the pin low (active-low).

The eight LEDs can be controlled in three different ways:

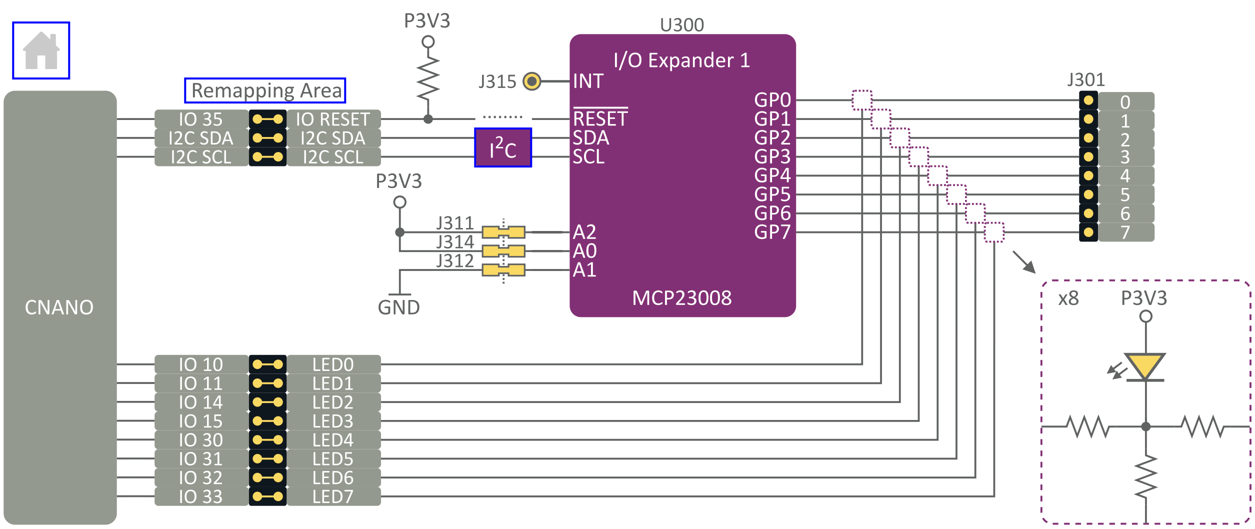
1. From the Remapping Area.
2. From I/O Expander 1 via the I^{2}C Bus.
3. From the 1x8 pin header (J301).

I/O Expander 1

Configure the GP pin as output and low to turn on an LED with the I/O Expander.

Info: Each LED is connected to a resistor network, ensuring that there are no short circuits if controlled from multiple sides at once.

Figure 5-3. LED Row Connections



Info: I/O Expander 1's 7-bit I^{2}C address: 0x25.

5.4 Buttons, Joystick and I/O Expander 2

Tactile and Touch Buttons

Three tactile and three touch buttons are available as user inputs on the Explorer. The buttons are connected in a group of one LED, one tactile, and one touch button. The grouping is shown on the silkscreen. Pressing any button in the same group will assert the same signal and activate the LED.

The button signals can be accessed in three different ways:

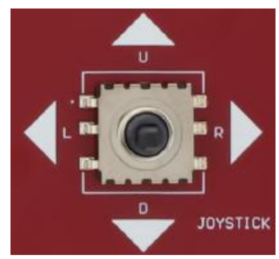
1. From the Remapping Area.
2. From I/O Expander 2 via the I^2C Bus.
3. From the 1x8 pin header (J401).

Tip: See section 5.5. Touch Controller for more information on the touch buttons.

Joystick

The joystick signals can be accessed in two different ways:

1. From I/O Expander 2 via the I^2C Bus.
2. From the 1x8 pin header (J401).

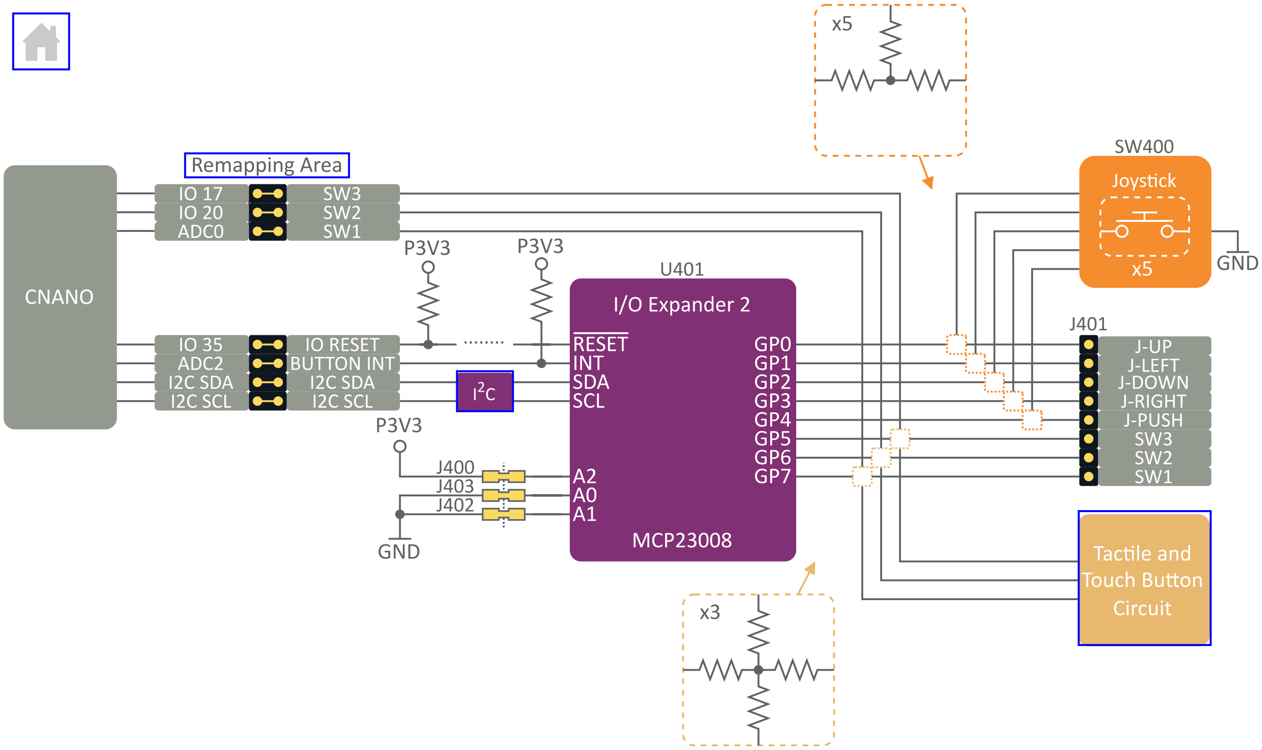


I/O Expander 2

Configure the GP pins as inputs with internal pull-ups to read the button states with the I/O Expander.

Info: Each button signal is connected to a resistor network, ensuring there are no short circuit if a pin is set high while pressing the button.

Figure 5-4. Buttons and Joystick Connections



Info: I/O Expander 2's 7-bit I²C address: 0x24.

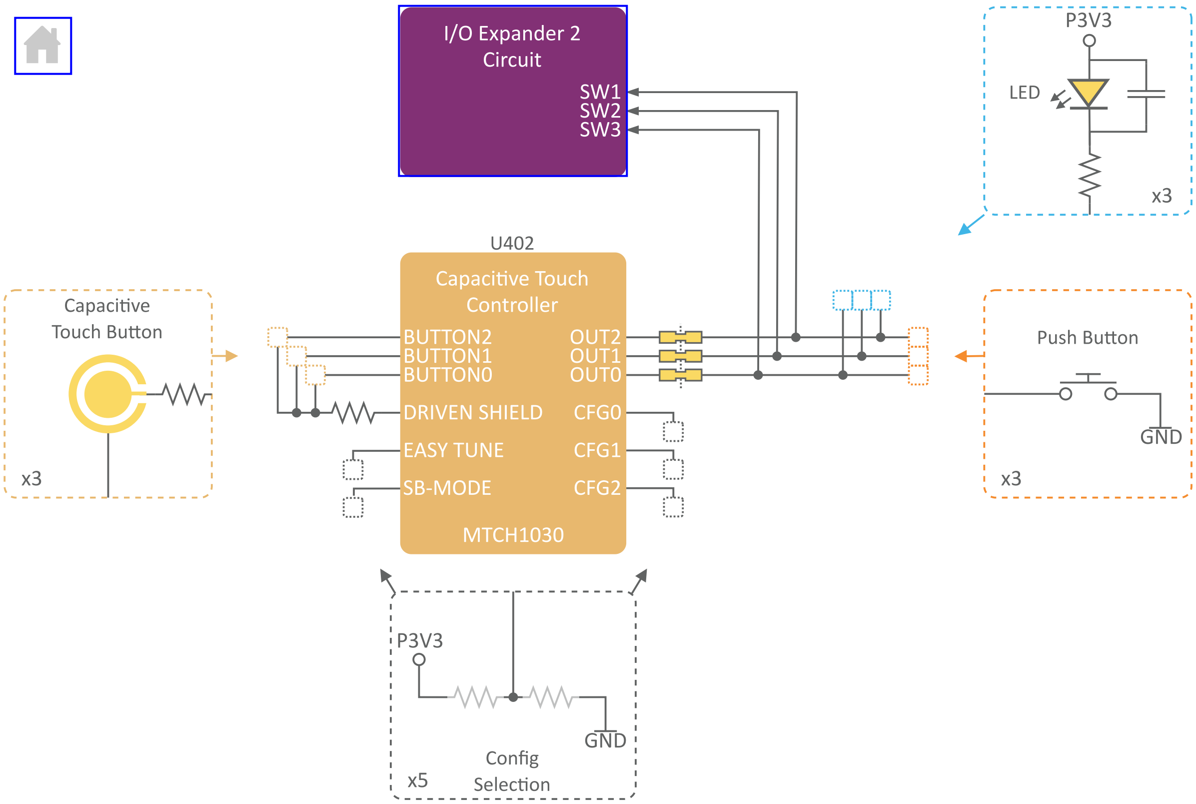
5.5 Touch Controller

The three touch buttons are connected to the MTCH1030 touch controller. The touch buttons are sensed using capacitive touch sensors with active shields utilizing the Driven Shield Plus feature.

Response time, oversampling, touch sensistivity, easy tune, and single-button mode are configured through resistors networks on the bottom side of the Explorer. The parameters are read by the touch controller during power-up and only the single-button mode can be altered at run-time.

Info: OUTx pin indicates the touch detection state of BUTTONx. The pin idles in a high-impedance state. When the touch button is pressed, it switches to output-low.

Figure 5-5. MTCH1030 Connections



Info: The MTCH1030 enables anti-touch recalibration if a touch button pressed for more than 8s. This causes the OUTx pin to revert to a high-impedance state.

The MTCH1030 touch controller on the Explorer is configured as follows:

- Measurement Period: Back-to-back measurements (minimum period)
- Oversampling: Eight samples per measurement cycle
- Sensitivity: 0-63
- Easy Tune: Disabled
- Single-Button Mode: Disabled

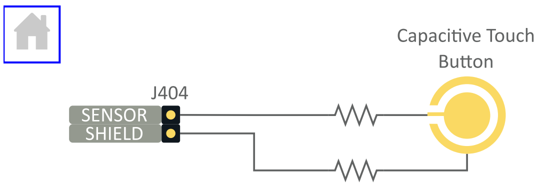
Tip: Touch sensor data captured with MTCH1030 can be visualized using the MPLAB® Data Visualizer, see section 10.1. MTCH1030 Touch Tune Data.

5.6 Standalone Touch Button

Underneath the Microchip logo is a single standalone capacitive touch button with an optional active shield.

If the microcontroller on the CNANO supports capacitive touch sensing, the standalone capacitive touch button can be used by connecting it to the remapping area from the 1x2 pin header J404. See section Direct Remapping. The sensor and shield pins are labeled in the silkscreen next to the pin header.

Figure 5-6. Standalone Touch Button



Tip: Generate code with the capacitive touch library in MCC Melody and visualize touch sensor data in MPLAB® Data Visualizer.

6. Serial Communication

USB Bridge, UART, I^{2}C and SPI Peripherals.

USB Bridge | UART Peripherals | I^{2}C Peripherals | SPI Peripherals

6.1 USB Bridge

The MCP2221A is a USB-to-UART/I^{2}C serial converter. It bridges the gap between a computer's USB port and the I^{2}C and UART interfaces on the Explorer.

When the on-board USB-C® is disconnected, the USB bridge is held in reset. You can keep the USB bridge in reset using the MCU on the CNANO by pulling IO-37 on the Explorer low.

Tip: When not in use, it is recommended to disconnect the bridge reset from the CNANO socket by removing the jumper cap on IO-37.

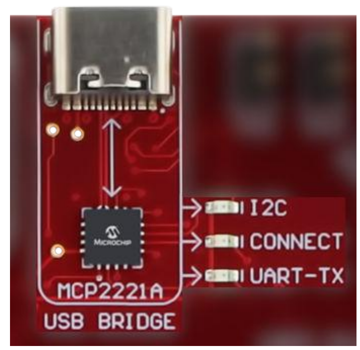
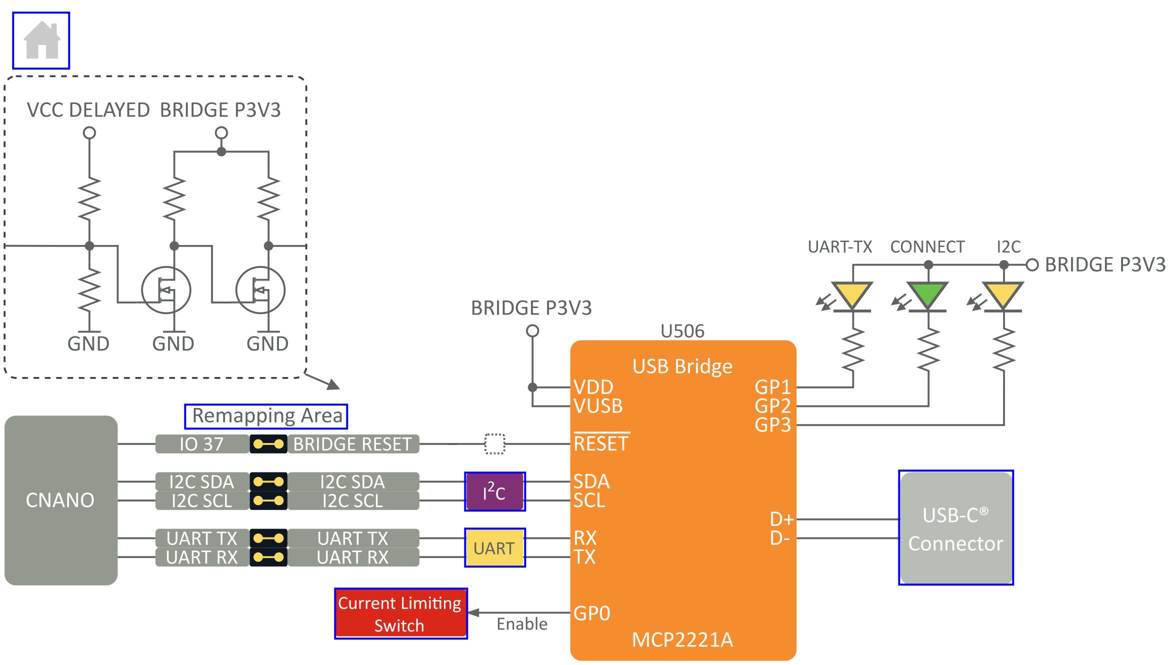


Figure 6-1. USB Bridge Overview



Tip: Drivers, CLI tools and apps are available to interface with the MCP2221A on its web page.

The USB bridge can be disconnected from the main I²C bus on the Explorer using slide switch S500. When disconnected, the USB bridge and the power monitor IC are isolated on their own I²C bus.

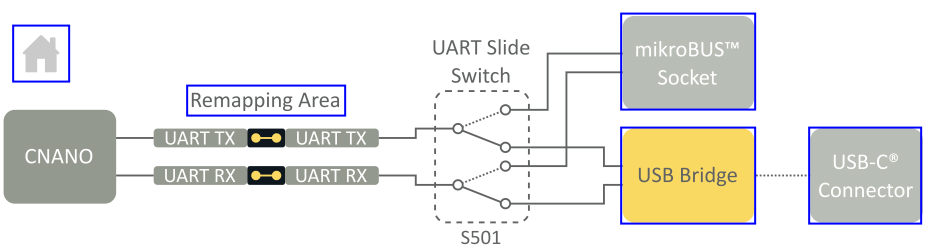
Important: The USB bridge is only able to act as an I²C host.

The UART connection to the CNANO socket is shared between the USB bridge and the mikroBUS™ socket. Use slide switch S501 to select the connected UART.

6.2 UART Peripherals

The CNANO's default UART pins are shared between the USB bridge and the mikroBUS™ socket. Only one of the connections is active at any time. Select which pins are connected to the CNANO socket using slide switch S501.

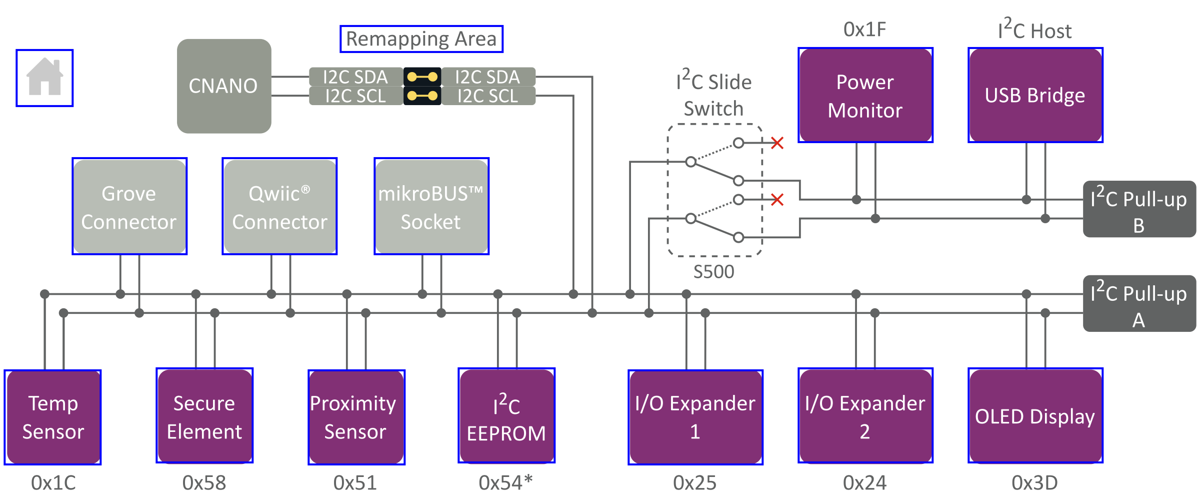
Figure 6-2. UART Overview



6.3 I²C Peripherals

6.3.1 I²C Bus

Figure 6-3. I²C Bus Overview



The Explorer features an I^2C bus with several attached devices and external connectivity options. All connected devices are compatible with Standard Mode (100 kHz) and Fast Mode (400 kHz) I^2C. The bus is designed to meet the rise-time requirements for both modes. The SDA and SCL signals are connected to the COM section of the CNANO socket.

Tip: Connecting I^2C extension boards with pull-ups will impact bus performance.

The Explorer's I^2C bus can be split into two separate buses using slide switch S500. Each bus has its own set of pull-ups - I^2C pull-ups A and B.

When the I^2C bus is split, the USB bridge and the power monitor ICs are isolated from the main I^2C bus, with the USB bridge acting as the host to communicate with the power monitor IC.

Important: The USB bridge is only able to act as an I^2C host.

Table 6-1. I^2C Electrical Characteristics

Parameter	Value
I^2C Pull-up A	2.7 kΩ
I^2C Pull-up B	5.1 kΩ
I^2C bus with Pull-ups A and B	
I^2C bus capacitance[1]	130 pF
Rise-time[2]	~200 ns
I^2C bus with Pull-up A isolated	
I^2C bus capacitance[1]	95 pF
Rise-time[2]	~220 ns
I^2C bus with Pull-up B isolated	
I^2C bus capacitance[1]	35 pF
Rise-time[2]	~150 ns

Note:
[1]Bus capacitance calculated using measured rise time with equation 1 from I^2C-bus specification and user manual.
[2]Rise time is defined as the time it takes for I^2C bus to rise from 0.3*VDD to 0.7*VDD.

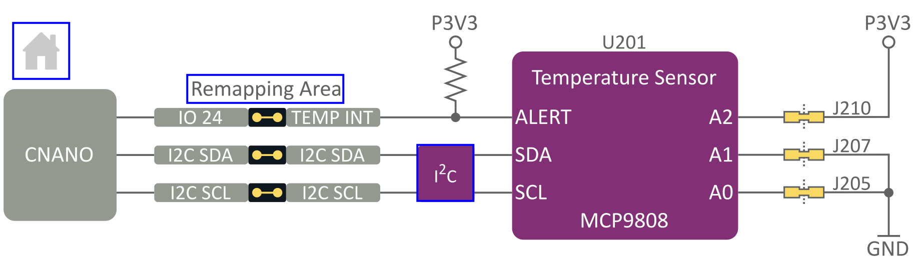
6.3.2 Temperature Sensor

MCP9808 is a digital temperature sensor connected to the Explorer's I^{2}C bus. The alert pin is connected to the CNANO socket IO-24.

- Accuracy:
  - ±0.25°C (typical) from -40°C to +125°C
  - ±0.5°C (maximum) from -20°C to +100°C
- User selectable measurement resolution:
  - 0.0625°C
  - 0.125°C
  - 0.25°C
  - 0.5°C
- User programmable temperature limits:
  - Temperature window limit
  - Critical temperature limit

Info: 7-bit I^{2}C address: 0x1C.

Figure 6-4. Temperature Sensor



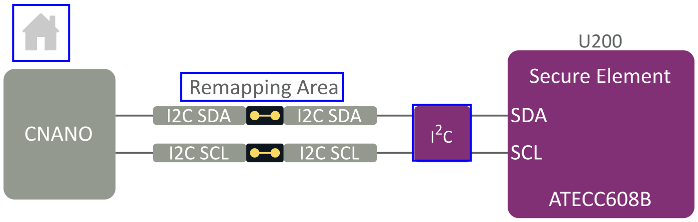
6.3.3 Secure Element

ATECC608B is a secure element in the Microchip CryptoAuthentication™ family and is connected to the Explorer's I^{2}C bus.

- Supports advanced Elliptic Curve Cryptography (ECC)
- Protected storage for up to 16 keys, certificates or data
- Internal random number generator
- Secure boot support

Info: 7-bit I^{2}C address: 0x58.

Figure 6-5. Secure Element



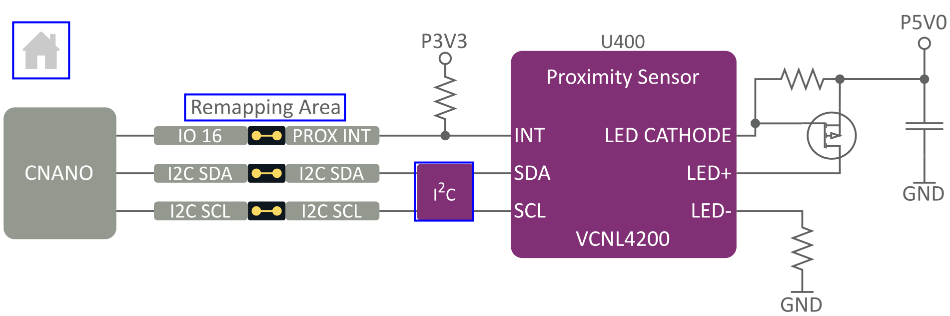
6.3.4 Proximity and Ambient Light Sensor

VCNL4200 is a proximity sensor (PS) and ambient light sensor (ALS) connected to the Explorer's I^{2}C bus.

- Programmable emitter current
- 16-bit resolution ALS
- 12-bit/16-bit resolution PS
- Detection distance of up to 1.5m
- Interrupt function available for ALS and PS with upper and lower thresholds

Info: 7-bit I^{2}C address: 0x51.

Figure 6-6. Proximity and Ambient Light Sensor



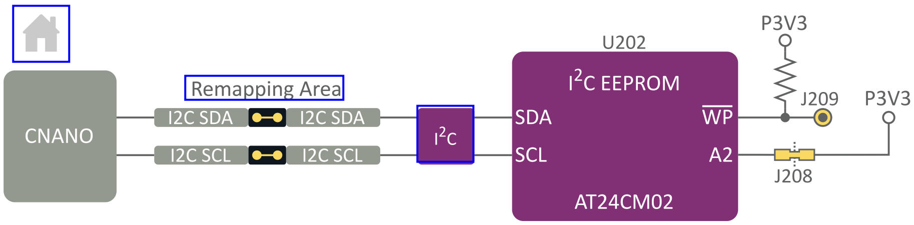
6.3.5 2 Mb Serial EEPROM

AT24CM02 is a 2 Mb Serial EEPROM connected to the Explorer's I^{2}C bus.

- 1024 pages of 256 bytes each
- Random, byte and sequential read modes
- Byte and page write modes
- Built in error detection and correction
- Hardware write protection

Info: 7-bit I²C address: 0x54 - 0x57.

Figure 6-7. I²C EEPROM



Info: The write protect pin is available through pin header footprint J209 and can be remapped to the CNANO socket.

6.3.6 I/O Expanders

The Explorer features two MCP23008 I/O expanders connected to the I²C bus.

- 8-bit bidirectional I/O port
- I/O pins default to input
- Configurable interrupt output pin

I/O Expander 1 is set up to control the LED row containing eight yellow LEDs.

- See chapter 5.3. LED Row and I/O Expander 1 for more information.

I/O Expander 2 is set up to read the status of the joystick and tactile or touch buttons.

- See chapter 5.4. Buttons, Joystick and I/O Expander 2 for more information.

6.3.7 OLED Display Module

The Explorer features an OLED display connected to the I²C bus.

- SSD1306 display driver
- 1.30" screen size with 128x64 pixel resolution
- Fast response time (≦ 10 µs)
- Typical brightness: 120 cd/m²

Info: 7-bit I²C address: 0x3D.

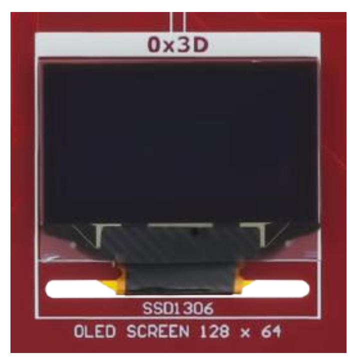
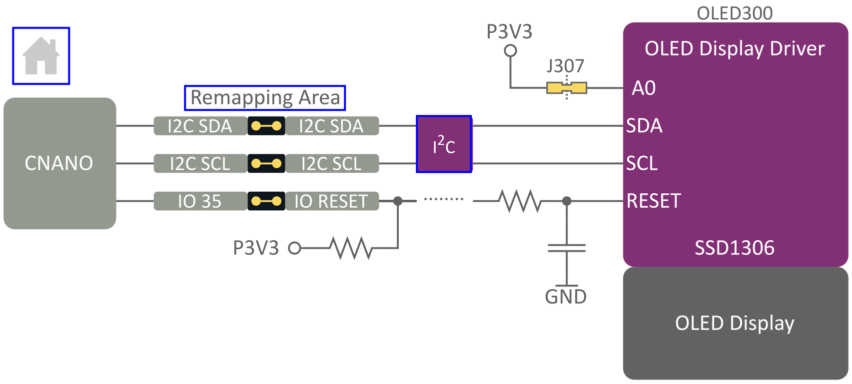


Figure 6-8. OLED Display

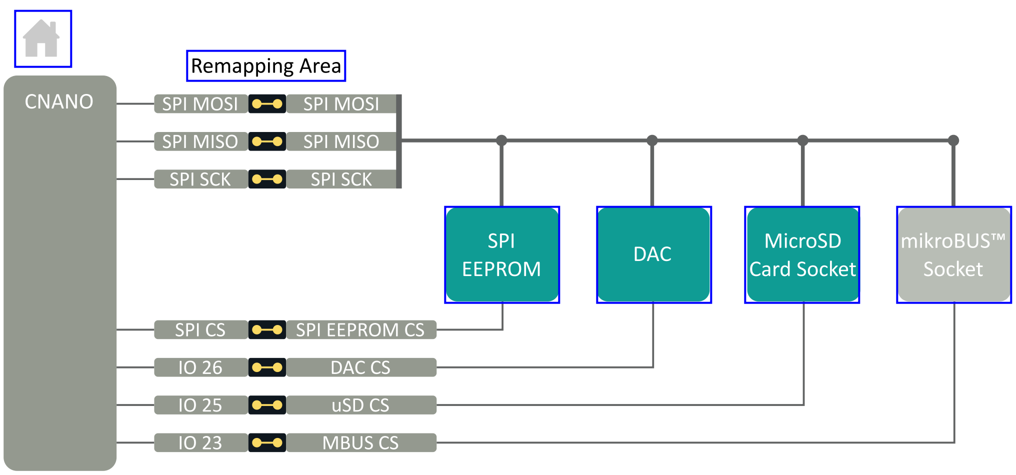


6.4 SPI Peripherals

6.4.1 SPI Bus

The Explorer features an SPI bus with several peripherals and a MikroBus socket attached. The individual Chip Select (CS) pins and the mutual SPI bus pins are routed to the CNANO socket.

Figure 6-9. SPI Bus Overview



Info: A 47 kΩ pull-up resistor (R221) is mounted on the MISO line close to the microSD card socket, causing the MISO line to idle high.

6.4.2 Digital-to-Analog Converter

MCP4821 is a single-channel 12-bit Digital-to-Analog converter (DAC) with internal voltage reference. The DAC is connected to the SPI bus on the Explorer.

- SPI with 20 MHz clock support
- 2.048V Internal voltage reference (V_{ref})
- DAC output, limited by supply voltage (3.3V)
- Synchronous update of DAC output using the $\overline{\text{LDAC}}$ pin

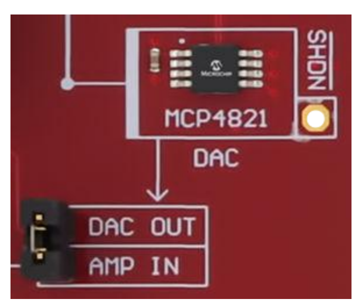
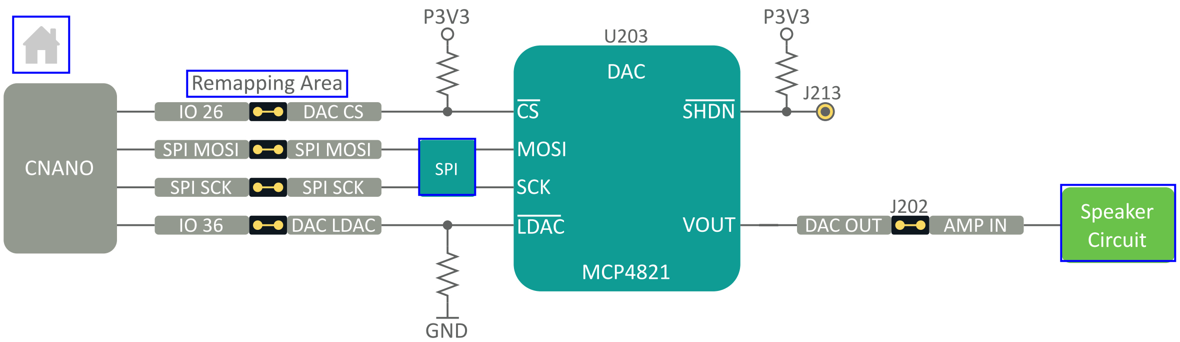


Table 6-2. Programmable Gain

Gain Selection	Ideal Output Range	LSb Size
2.048V	0.0-2.0475V	0.5 mV
4.096V	0.0-3.299V	1.0 mV

Figure 6-10. DAC Overview



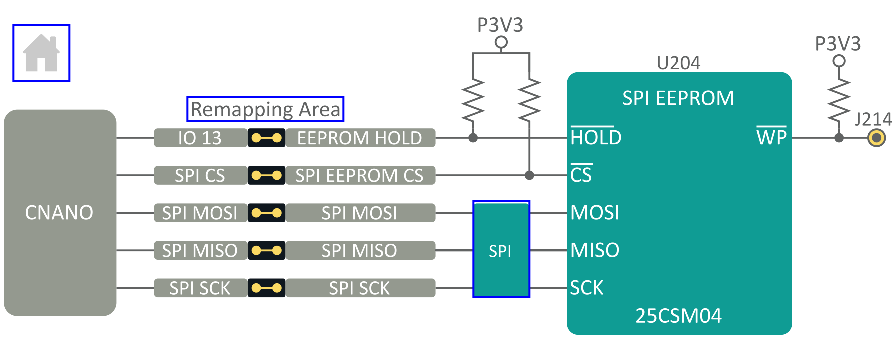
Tip: The DAC output is connected to the speaker circuit by default. It can be remapped using pin header J202.

6.4.3 4 Mb Serial EEPROM

25CSM04 is a 4Mb Serial EEPROM connected to the Explorer's SPI bus.

- SPI with up to 8 MHz clock support
- 2048 pages of 256 bytes each
- Byte or sequential reads
- Byte or page writes
- Built-in Error Correction Code (ECC)
- Configurable software and/or hardware write protection

Figure 6-11. SPI EEPROM

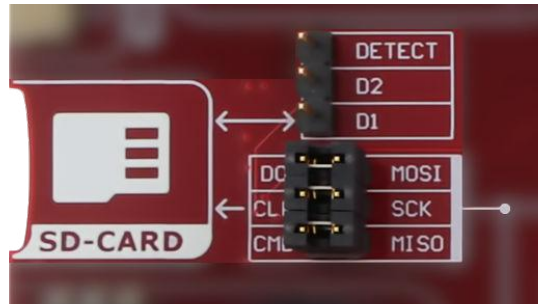


Tip: Enable the hardware write-protected feature by pulling the $\overline{\text{WP}}$ pin low.

6.4.4 microSD Card Socket

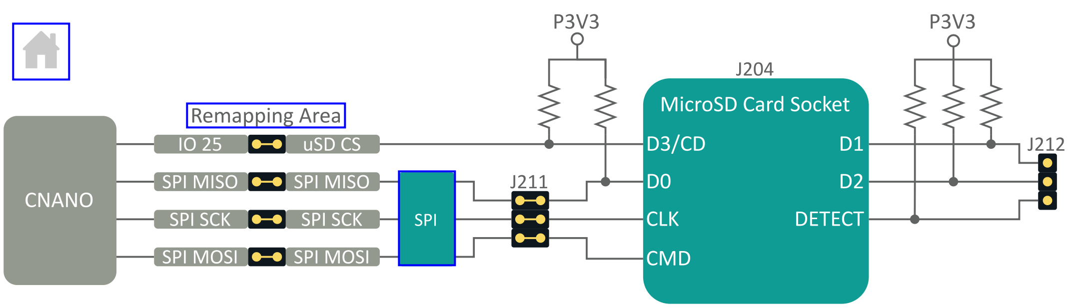
The Explorer features a microSD card socket connected to its SPI bus. Only pins required for an SPI connection to a microSD card are connected to the CNANO socket.

All pins of the microSD card socket are available on pin headers close to the microSD card socket. The pin headers allow devices with a dedicated high-speed multimedia interface to fully utilize all data lines of a connected microSD card.



Tip: D1, D2, and the card detect pins are routed to a separate pin header (J212). With no card inserted, the card-detect pin is low.

Figure 6-12. microSD Card



Info: A 47 kΩ pull-up resistor (R221) is mounted on the MISO line close to the microSD card socket, causing the MISO line to idle high.

7. Analog Peripherals

Microphone Circuit, Speaker Circuit, Rotary Potentiometer, Voltage Reference.

Microphone Circuit | Speaker Circuit | Rotary Potentiometer | Voltage Reference

7.1 Microphone Circuit

A MEMS microphone is available as an analog input peripheral on the Explorer and is connected to its amplifier through the 1x2 pin header J206.

The dual operational amplifier MCP6022 is used to amplify the signal from the microphone with three selectable gain stages. The gain stages are 1, 221 (low) and 1001 (high), selectable using the slide switch S200.

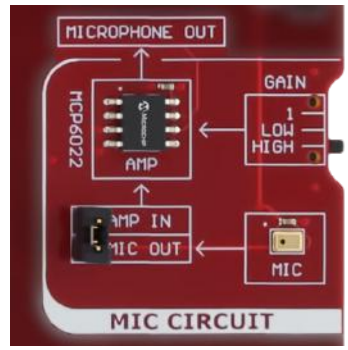
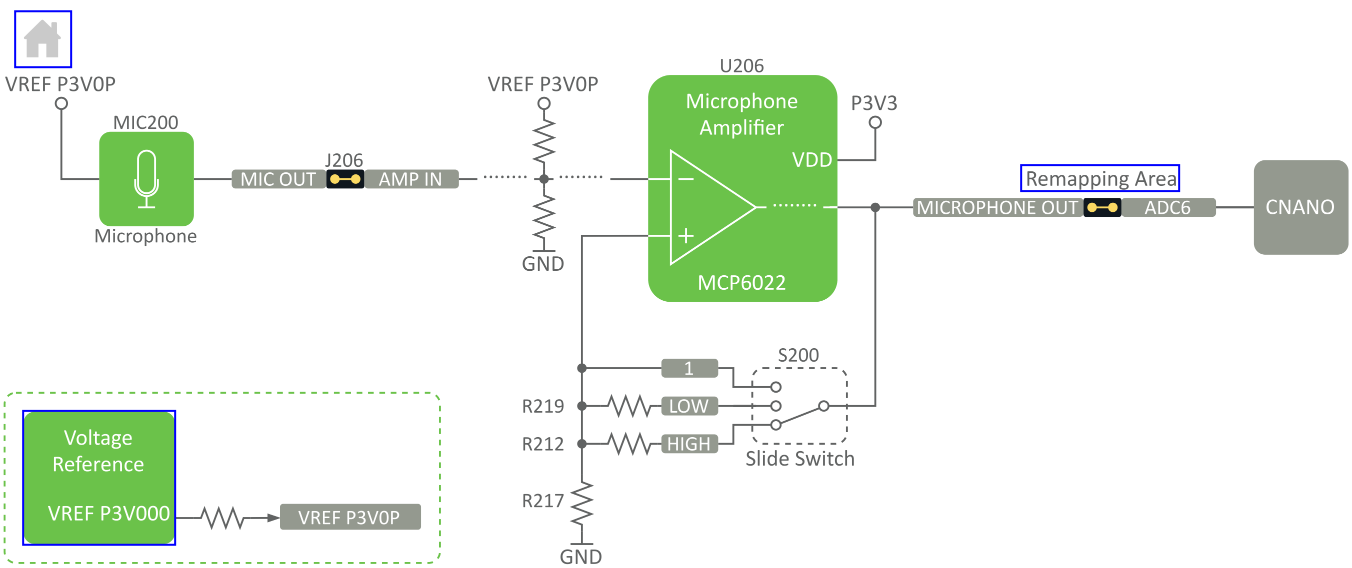


Figure 7-1. Microphone Circuit Overview

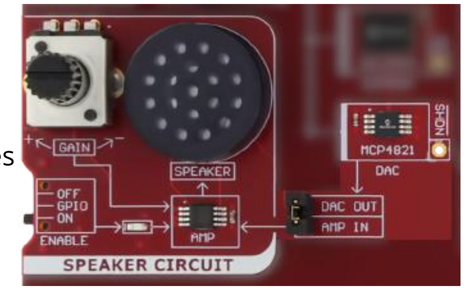


Tip: The microphone output can be disconnected from the amplifier and accessed directly through the 1x2 pin header J206.

7.2 Speaker Circuit

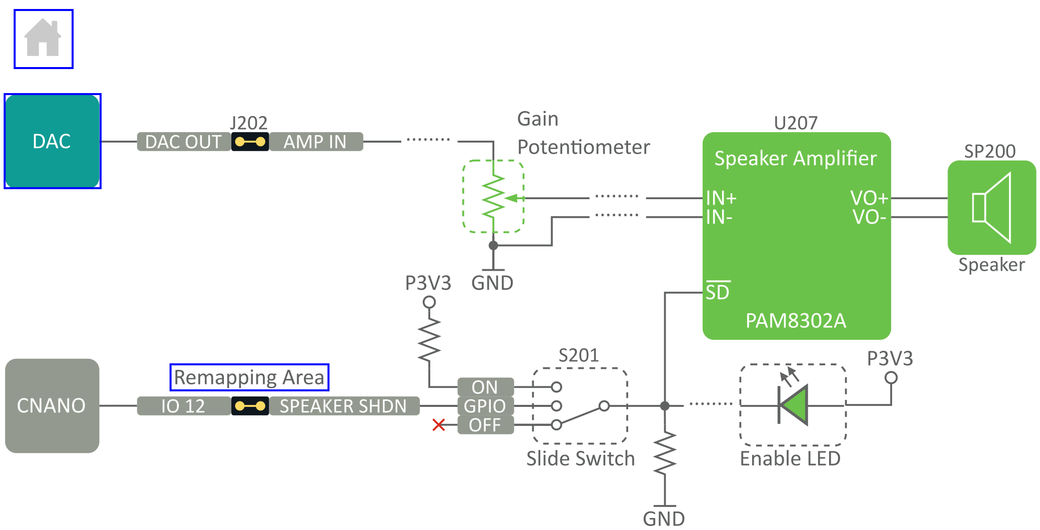
The Explorer features an 8Ω, 0.2W miniature speaker. The speaker amplifier input signal is, by default, connected to the output of the 12-bit DAC MCP4821.

A Class-D mono amplifier drives the speaker. Volume control is implemented with the rotary potentiometer R210, which provides an approximate logarithmic gain control for the amplifier input.



> **Tip:** Pin header J202 can be used to remap the speaker input signal and/or DAC output.

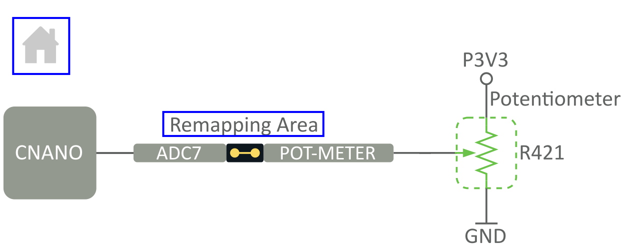
Figure 7-2. Speaker Circuit Overview



7.3 Rotary Potentiometer

A 10 kΩ ±20% rotary potentiometer is available to the user as an analog input (R421). The voltage output varies between 0V and 3.3V. The voltage output increases when turning the potentiometer clockwise.

Figure 7-3. Rotary Potentiometer



7.4 Voltage Reference

The MCP1501 voltage reference circuit serves two purposes.

- Power supply for the MEMS microphone
- Two accurate buffered voltage references, 1.50V and 3.00V, based on the MCP6V02 dual operational amplifier

Figure 7-4. Voltage Reference Overview

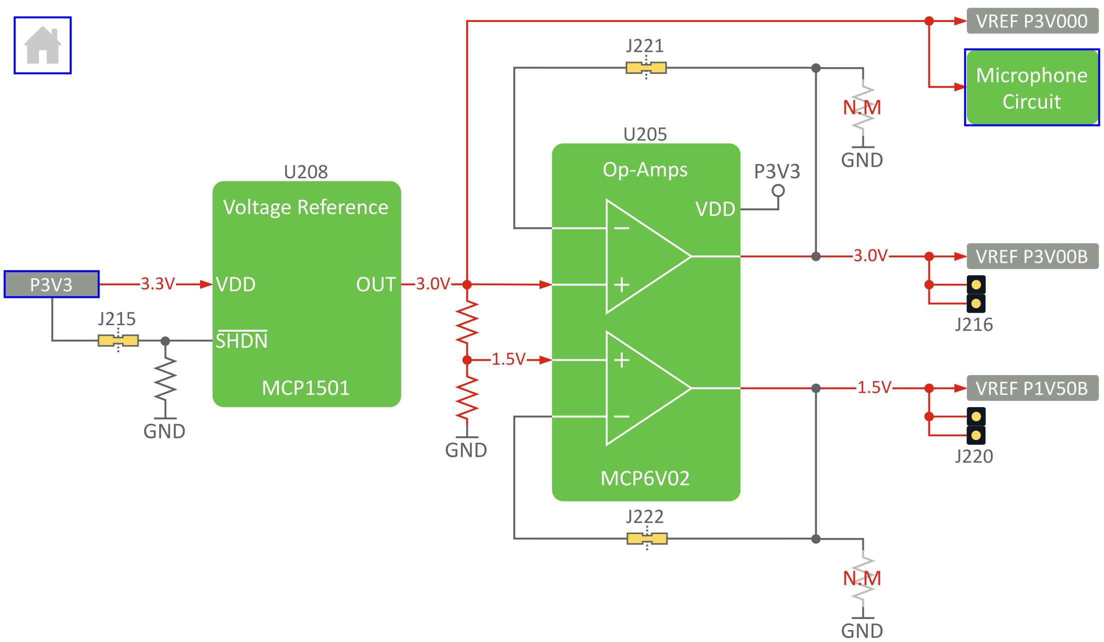


Table 7-1. Voltage Domain Specifications

Voltage Reference	Vnom	Vmin - Vmax	Imax
VREF P3V000	3.000V	2.997-3.003V	20 mA
VREF P3V00B	3.00V	2.997-3.003V	5 mA
VREF P1V50B	1.50V	1.49-1.51V	5 mA

8. External Connectivity

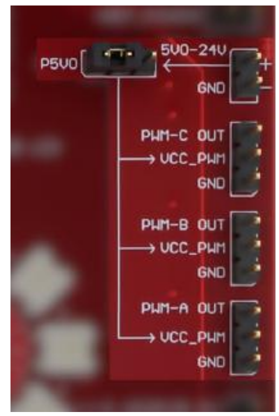
Servomotor Headers, MikroBUS™, Grove, Qwiic®, PICkit™ Header.

Servo-Motor Headers | MikroBUS™ Socket | Grove | Qwiic® | PICkit™ Header

8.1 Servomotor Headers

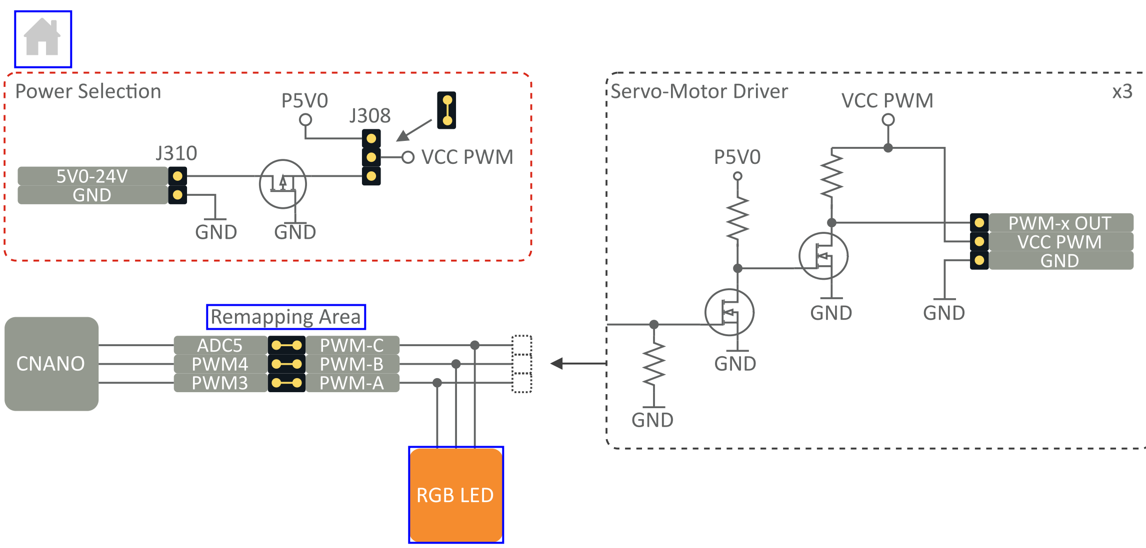
The Explorer features three-pin headers compatible with typical servomotor pinouts. The control signal of each pin header has a MOSFET-driven open drain output.

The 5V supply on the board usually supplies the control signal and power output on the pin headers. External power can be supplied through pin header J310. Select between on-board and external power using pin header J308.



Info: The RGB LED will light up when driving servomotors and can be disconnected by removing pin jumpers from J309.

Figure 8-1. Servomotor Driver Circuit



Important:
Servomotors usually require high currents. It is recommended to use an external supply to power servomotors.

The circuit is rated for external power in the range of 5-24V.

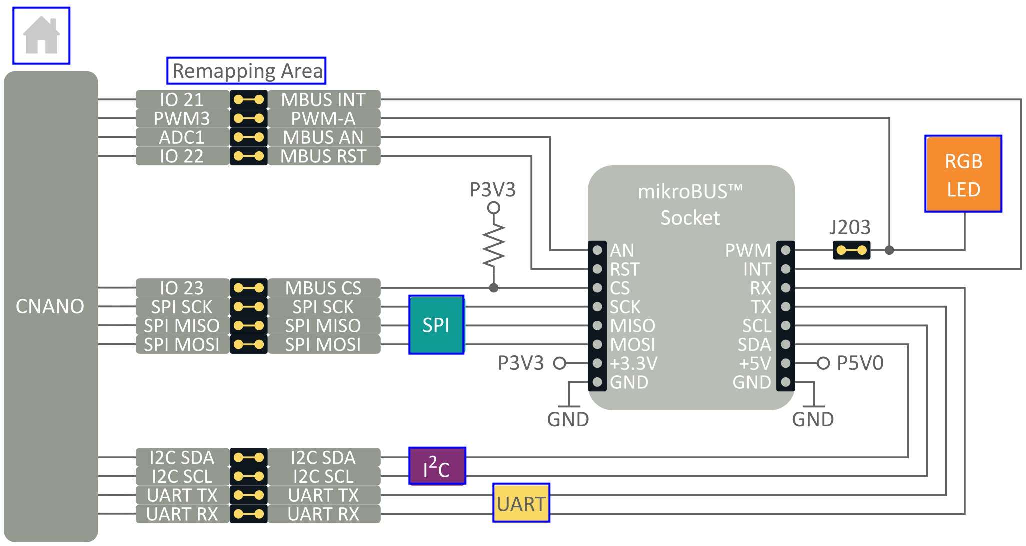
8.2 MikroBUS™ Socket

The Explorer features a mikroBUS™ socket for Mikroelektronika Click boards™. The socket is connected to the Explorer's main I²C and SPI bus.

UART pins are shared between the USB bridge and the mikroBUS™ socket. Select your UART connections using the slide-switch S501.

The PWM pin is shared with the single RGB LED and servomotor driver and can be remapped with pin header J203.

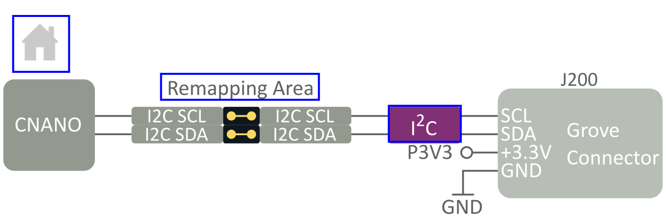
Figure 8-2. MikroBUS™ Socket



8.3 Grove

The Explorer features a Grove connector. The Grove system allows rapid prototyping using modular building blocks with many modules to choose from.

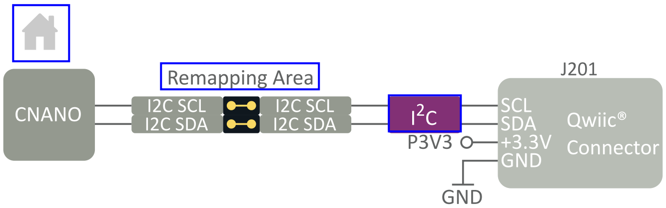
Figure 8-3. Grove Connector



8.4 Qwiic®

The Explorer includes a 4-pin Qwiic® connector for easy daisy-chaining of multiple devices within the SparkFun Qwiic Connect System.

Figure 8-4. Qwiic Connector



8.5 PICkit™ Header

The Explorer has a 1x8 PICkit™-compatible connector footprint connected to the CNANO's debug pins.

A slide switch (S100) allows the user to select the programming interface for the connected CNANO. Position 1 for UPDI/ICSP™ and position 2 for SWD.

To use a PICkit™ with the Explorer, the user must insert the included 1x8 right-angled pin header into the staggered footprint J122.

Tip: For repeated use, it is recommended to solder in the 1x8 right-angled pin header.

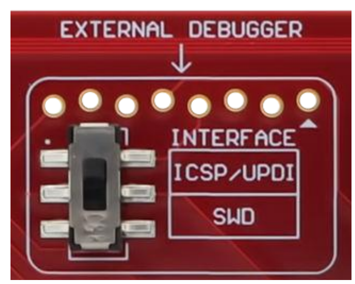
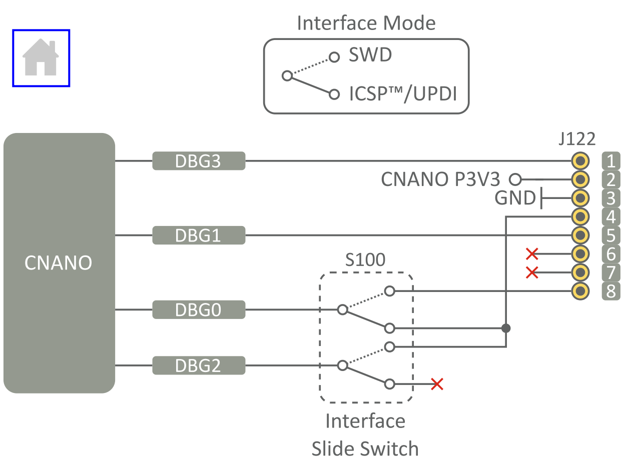


Figure 8-5. Overview



9. Revision History

Hardware and Document Revision History.

9.1 Identifying Product ID and Revision

There are two ways to find the revision and product identifier of the Curiosity Nano Explorer: The MPLAB® X IDE Kit Window or the sticker on the bottom of the PCB.

The Kit Window appears in MPLAB X IDE when connecting a Curiosity Nano development board to the computer. An additional page for the Curiosity Nano Explorer shows when the CNANO is plugged into the socket on the board.

The first nine digits of the serial number, listed under kit information, contain the product identifier and revision.

Tip: If closed, the Kit Window can be opened in MPLAB X IDE through the menu bar **Window** > **Kit Window**.

The same information is found on the sticker on the bottom side of the PCB. The data matrix code on the sticker contains a string with the product identifier 02-00630, revision, and serial number.

The product identifier and revision are also printed in plain text as 02-00630/rr, where "rr" represents the revision. The serial number is printed on the following line.

The string in the data matrix code has the following format:

```
"nnnnnnnrrssssssssss"
n = product identifier
r = revision
s = serial number
```

9.2 Hardware Revision History and Errata

This user guide provides information about the latest available revision of the board. Revision history and errata are available in the **Curiosity Nano Explorer Online Errata**.

9.3 Document Revision History

Doc. Rev.	Date	Comments
A	6/2024	Initial document release

10. Appendix

MTCH1030 Touch Tune Data, Addressable LEDs Timing and Format, Schematics, Assembly Drawing.

Schematics, and assembly drawing for the latest board revision are available as a PDF here.

10.1 MTCH1030 Touch Tune Data

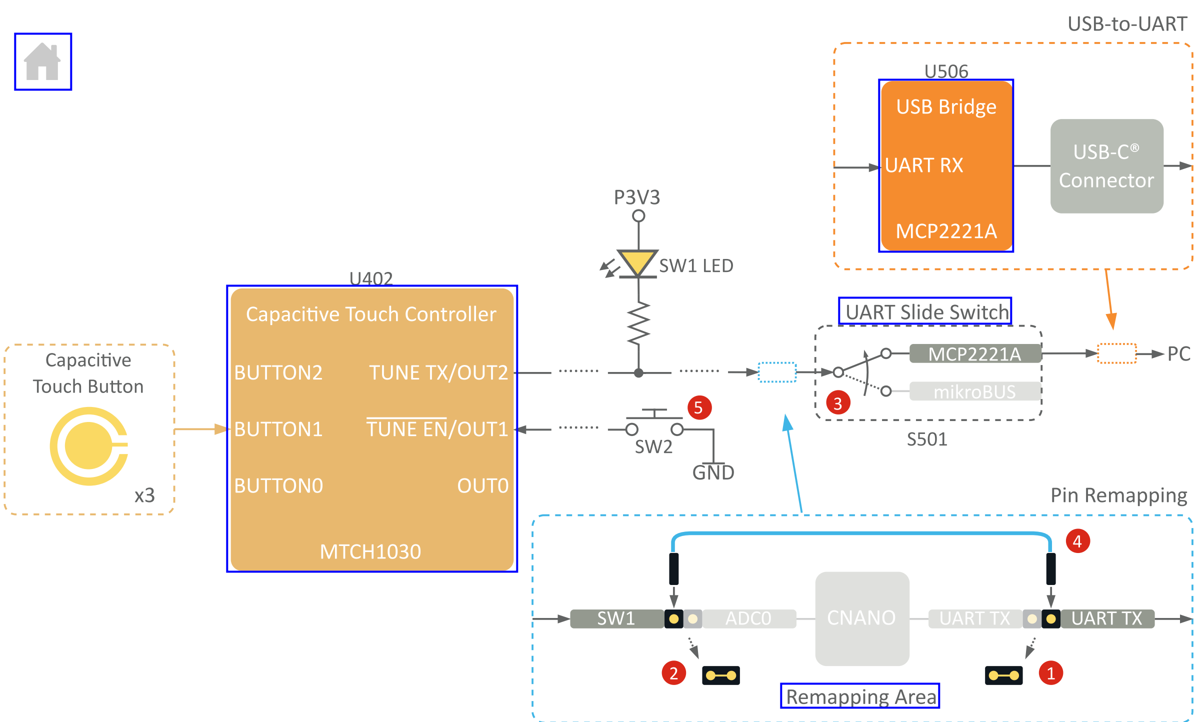
Touch sensor data captured with MTCH1030 can be visualized using the MPLAB® Data Visualizer. UART data is output from MTCH1030 on the SW1 pin on the Explorer and can be streamed to the Data Visualizer through the on-board USB bridge.

Important: Power off the Explorer before making any changes to the pin mapping.

To stream data from the MTCH1030, follow the steps below:

1. Remove the UART TX jumper cap in the pin remapping area.
2. Remove the SW1 jumper cap in the pin remapping area.
3. Ensure that the UART slide switch (S501) is set to connect the Explorer UART to the MCP2221A.
4. Connect the peripheral side of both SW1 and UART TX using a jumper wire.
5. Keep the mechanical SW2 button pressed while powering on the Explorer.
6. Follow the steps in the MTCH1030 data sheet appendix to configure the Data Visualizer.

Figure 10-1. Enabling Touch Tune Data



Related information: 5.5. Touch Controller

10.2 Addressable LEDs Timing and Format

Luckilight manufactures the eight digital addressable LEDs on the Explorer. The manufacturer part number is FR5050RGB4C-F1A. They behave similarly to WS2812B LEDs but with slightly different timing information.

Table 10-1. Timing Characteristics

Data Transfer Time		
Parameter	Min. [µs]	Max. [µs]
T (Meta code cycle)[1]	1.2	--
T0H	0.2	0.4
T0L	0.8	--
T1L	0.7	1.0
T1H	0.2	--
Treset	>200	--

Note:
[1]The minimum requirement for the period is 1.2 µs.

Figure 10-2. Sequence Chart

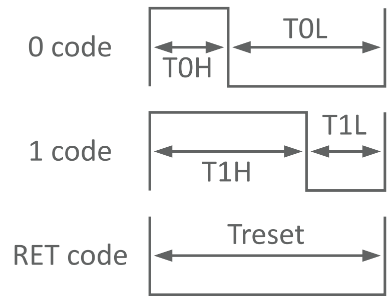


Table 10-2. 24-bit Data Format

G7	G6	G5	G4	G3	G2	G1	G0	R7	R6	R5	R4	R3	R2	R1	R0	B7	B6	B5	B4	B3	B2	B1	B0

The data bits must be sent one by one, starting with G7.

Related information: 5.1. Digital Addressable LEDs

10.3 Schematics

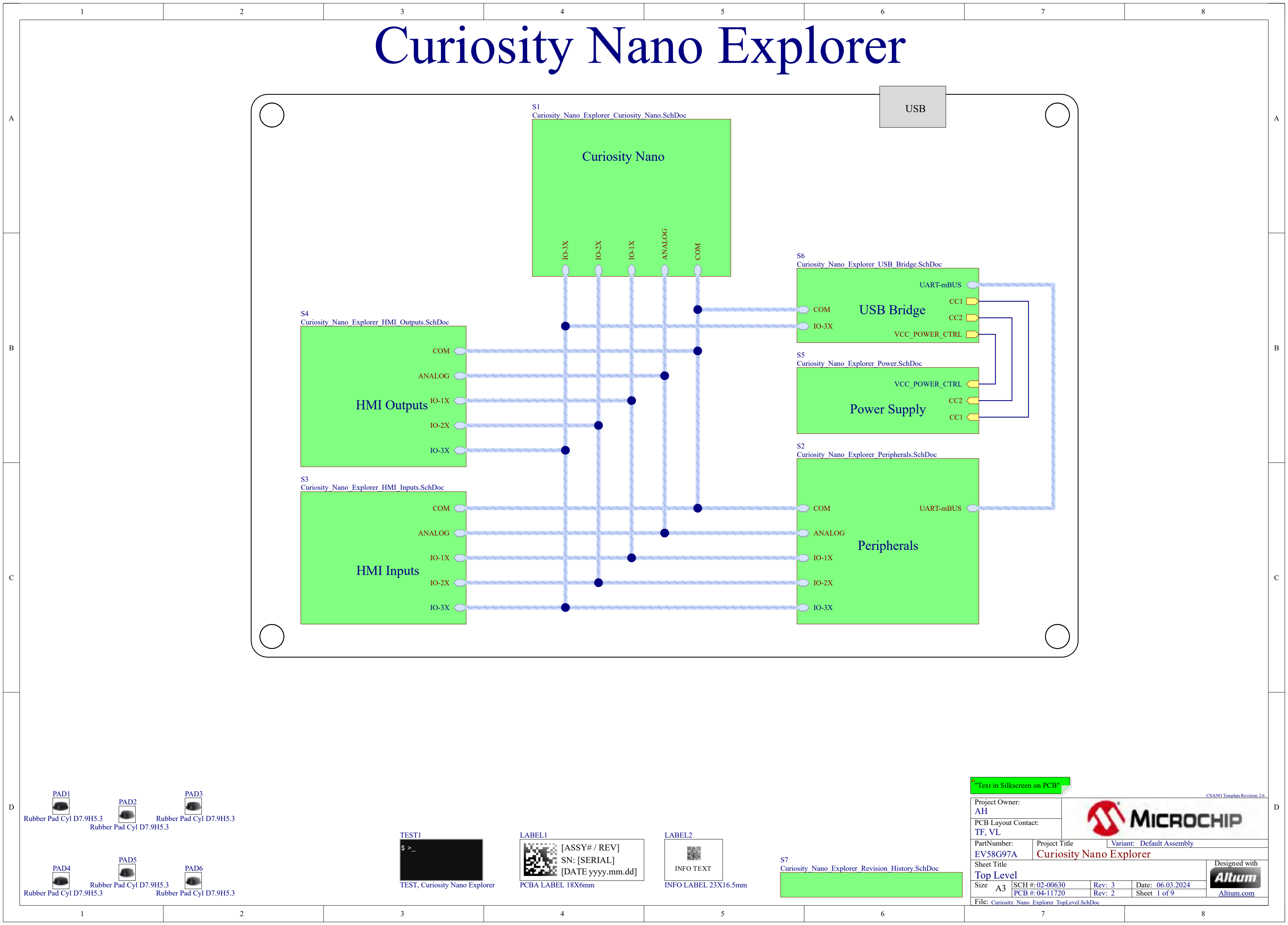
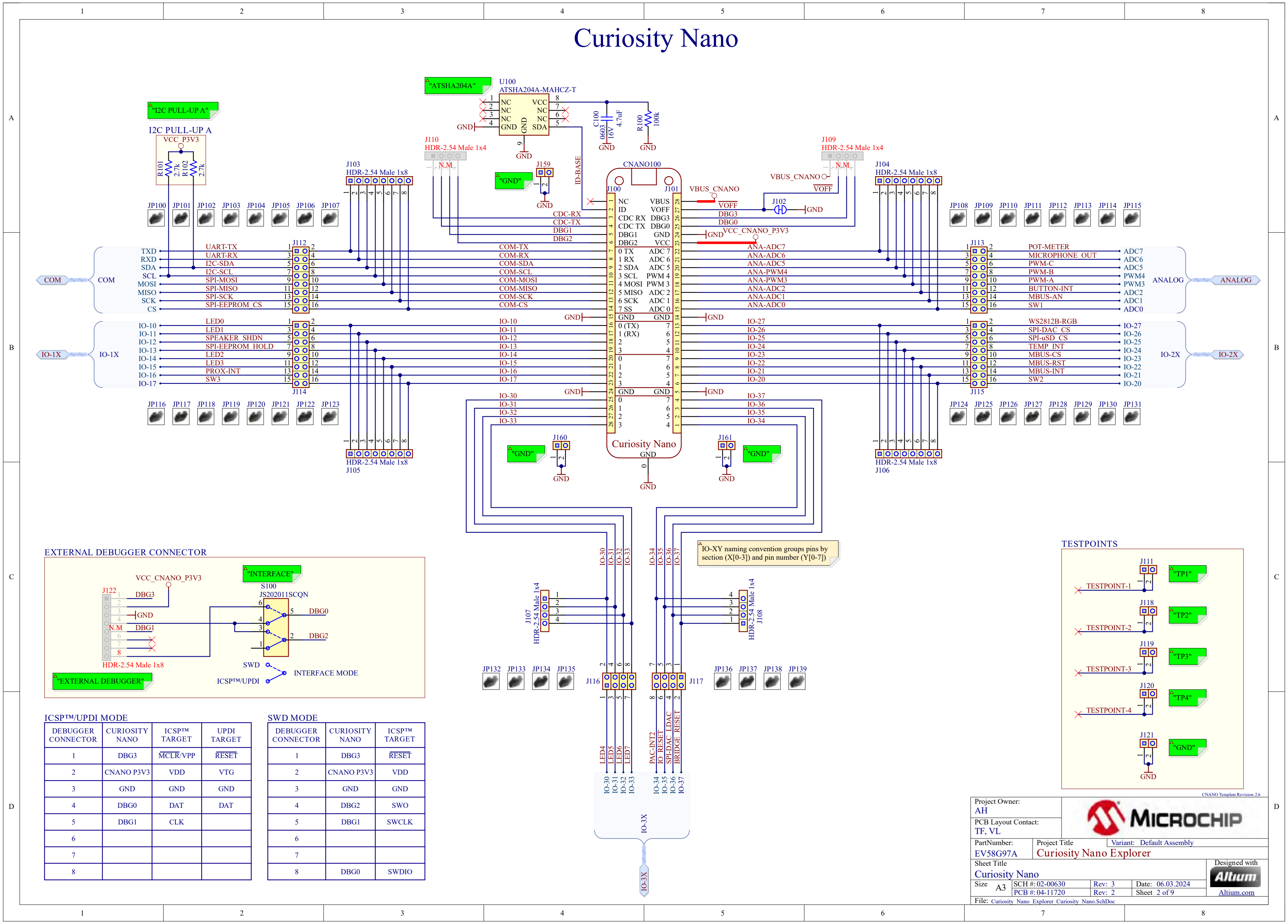


Figure 10-3. CNANO Socket



ICSP™/UPDI MODE

DEBUGGER CONNECTOR	CURIOSITY NANO	ICSP™ TARGET	UPDI TARGET
1	DBG3	MCLR/VPP	RESET
2	CNANO P3V3	VDD	VTG
3	GND	GND	GND
4	DBG0	DAT	DAT
5	DBG1	CLK	
6			
7			
8			

SWD MODE

DEBUGGER CONNECTOR	CURIOSITY NANO	ICSP™ TARGET
1	DBG3	RESET
2	CNANO P3V3	VDD
3	GND	GND
4	DBG2	SWO
5	DBG1	SWCLK
6		
7		
8	DBG0	SWDIO

Figure 10-4. Peripherals

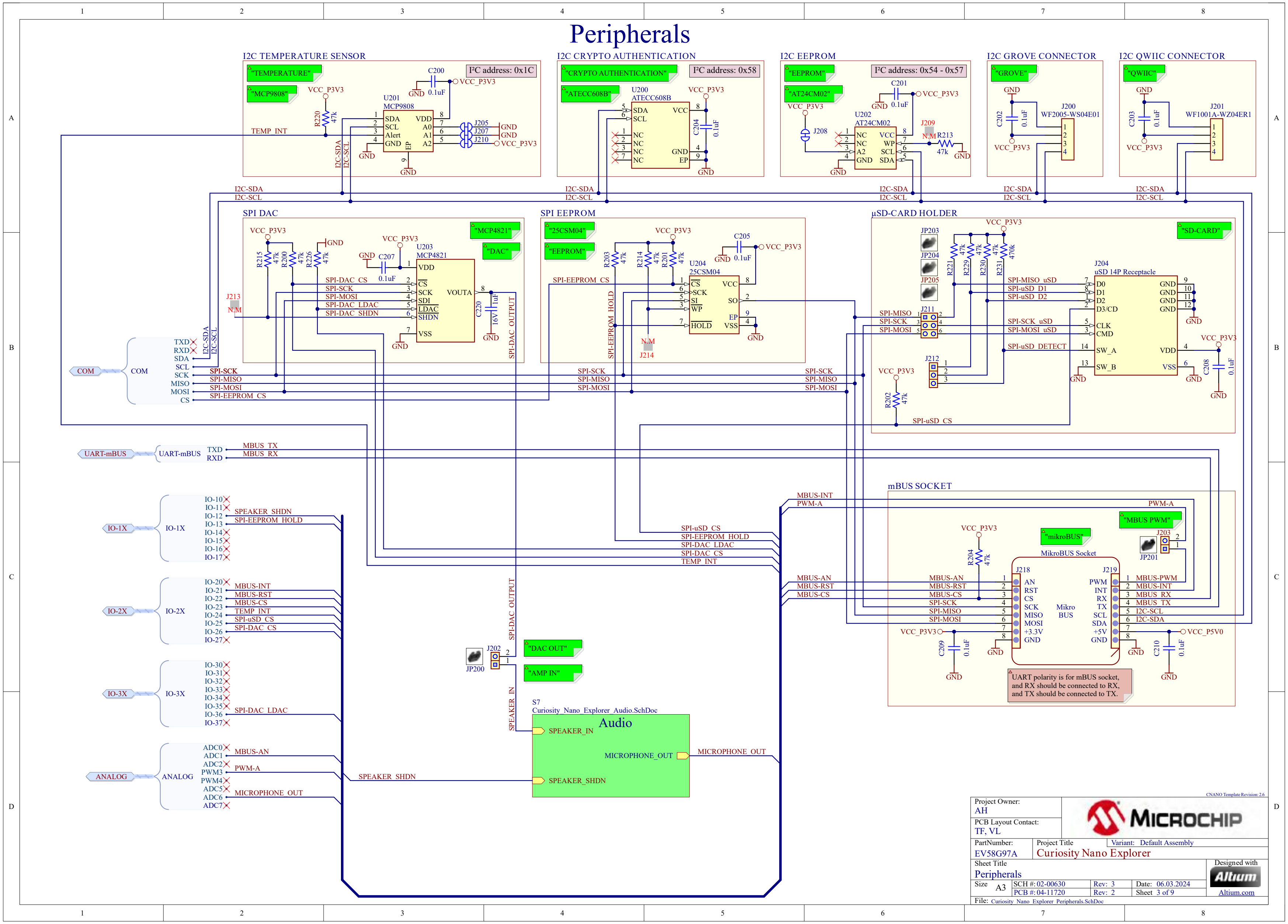


Figure 10-5. Audio

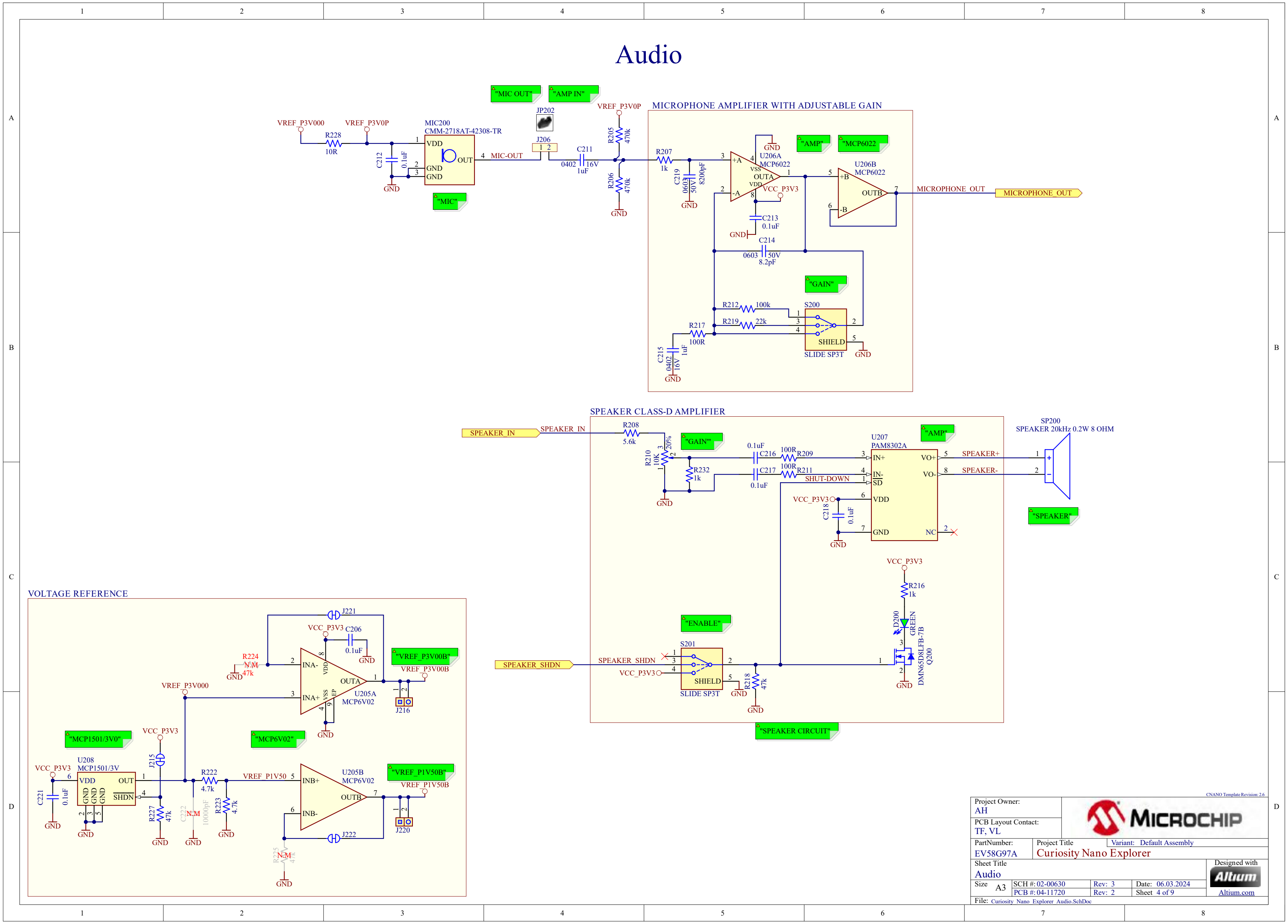


Figure 10-6. Outputs

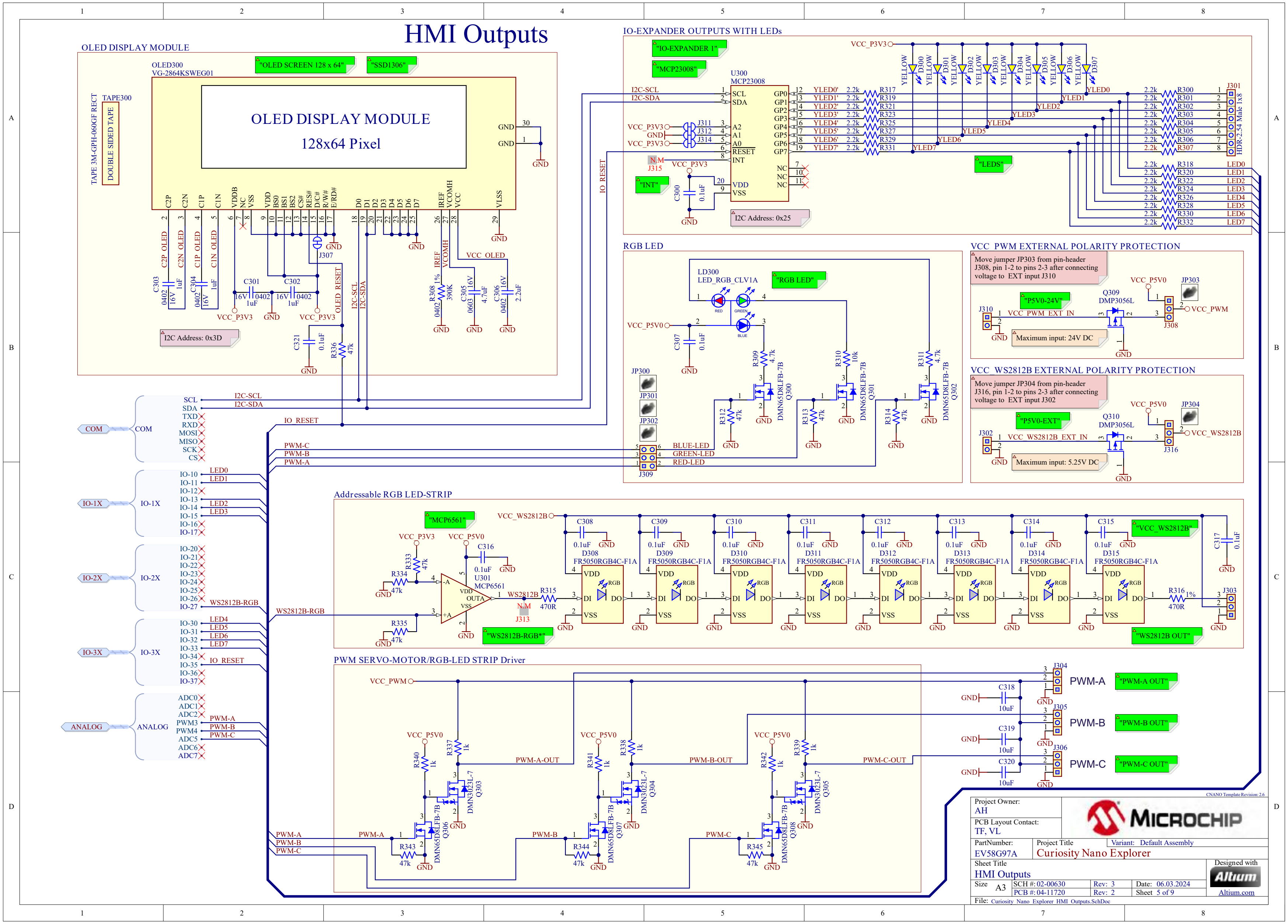


Figure 10-7. Inputs

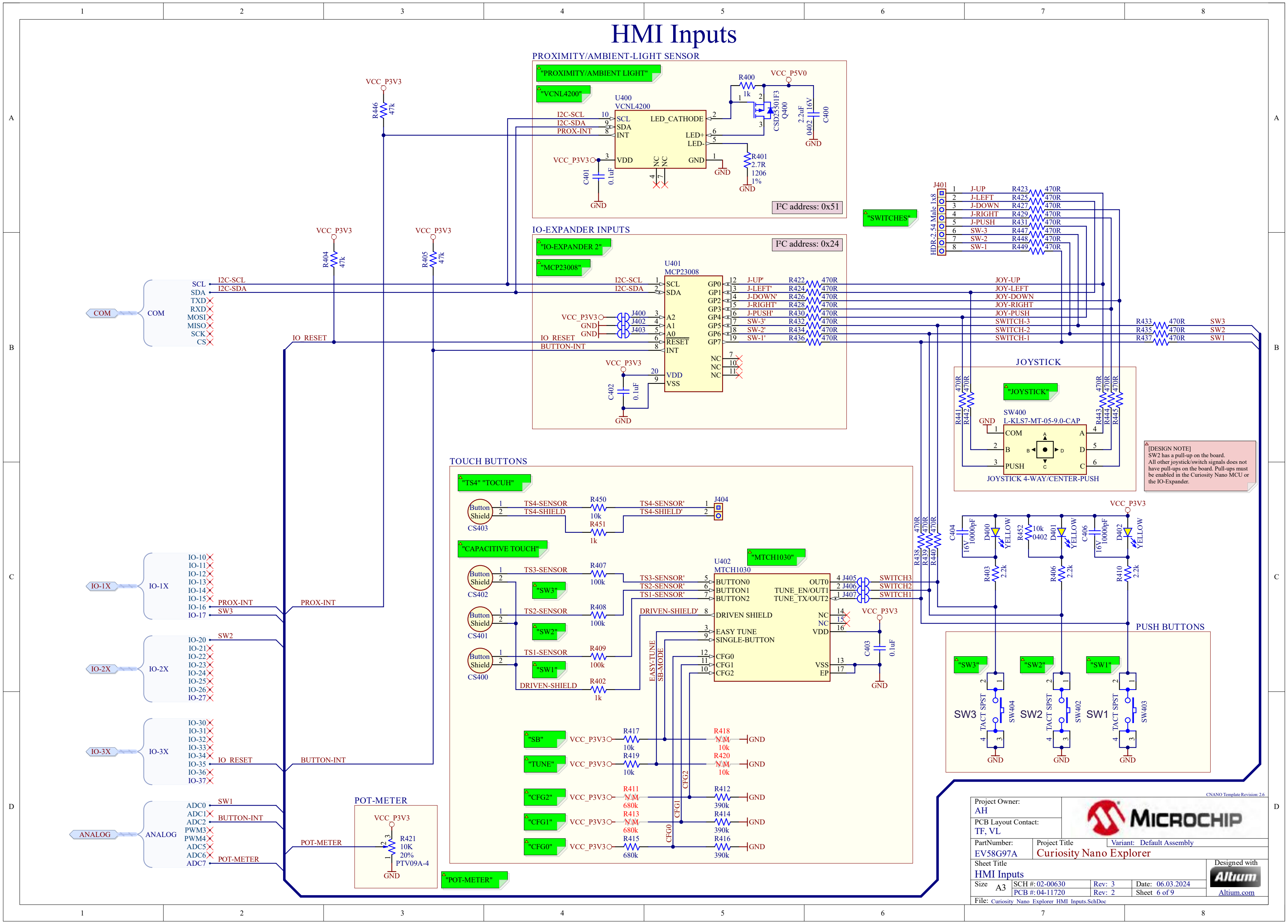


Figure 10-8. USB Bridge

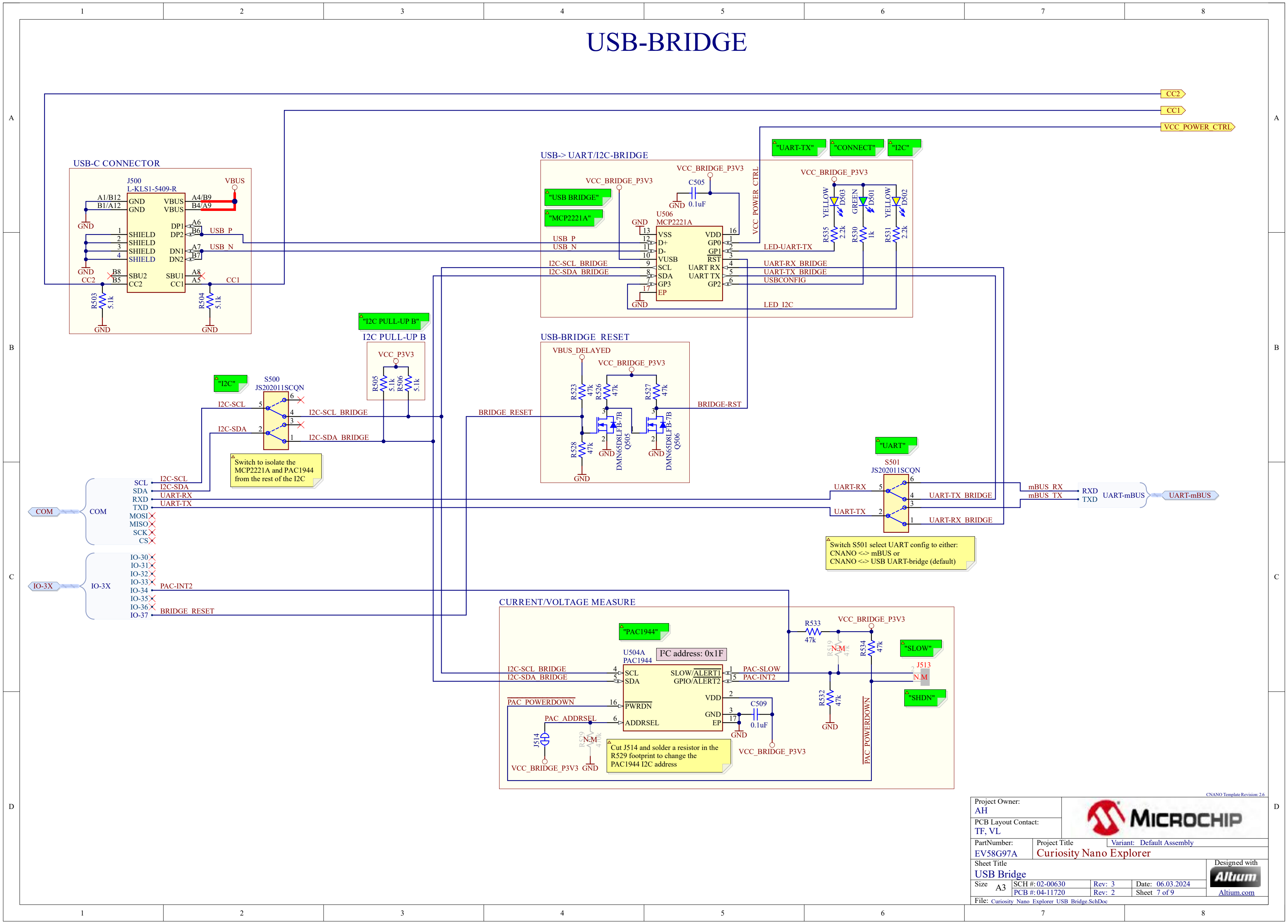
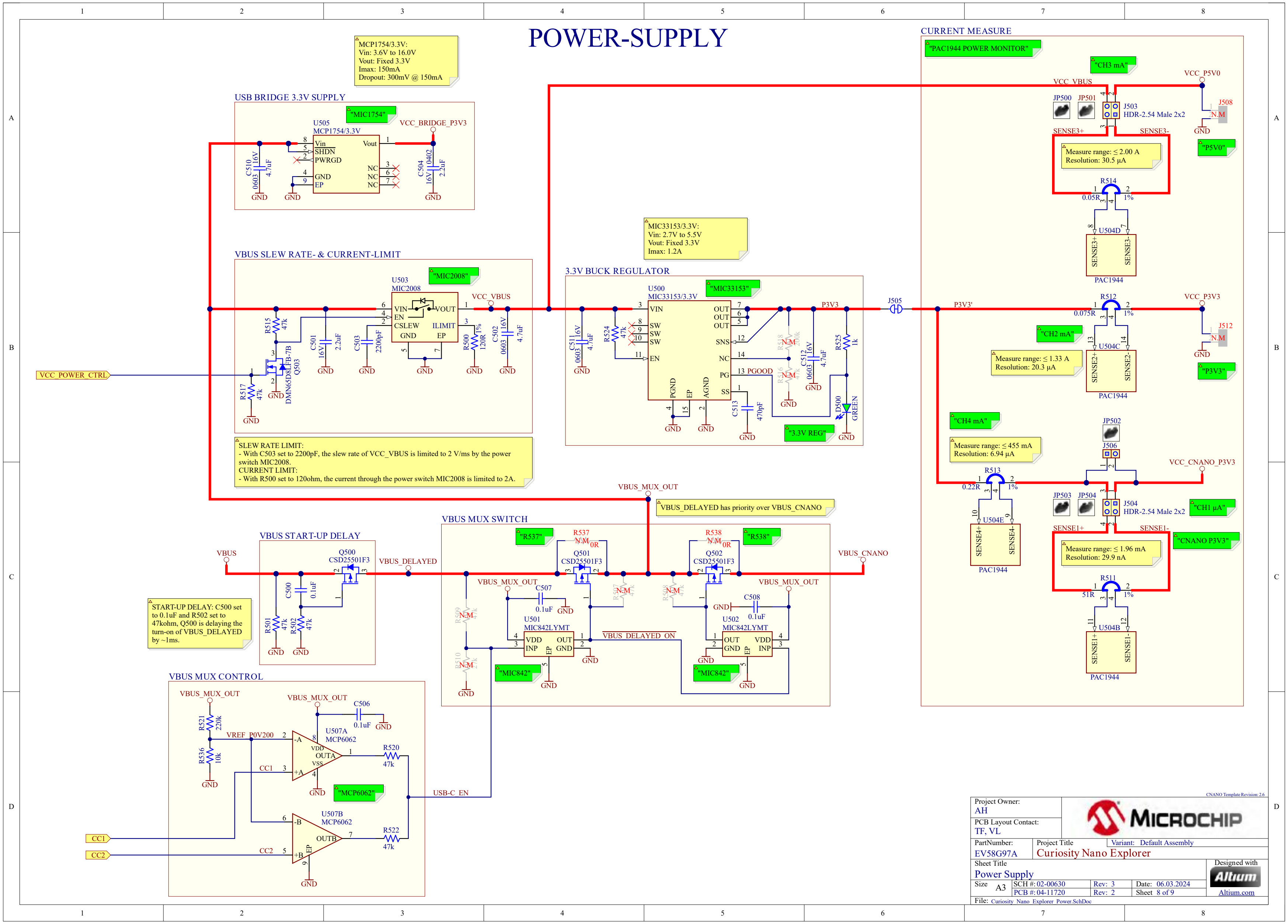


Figure 10-9. Power Supply



10.4 Assembly Drawings

Figure 10-10. Curiosity Nano Explorer Top Assembly

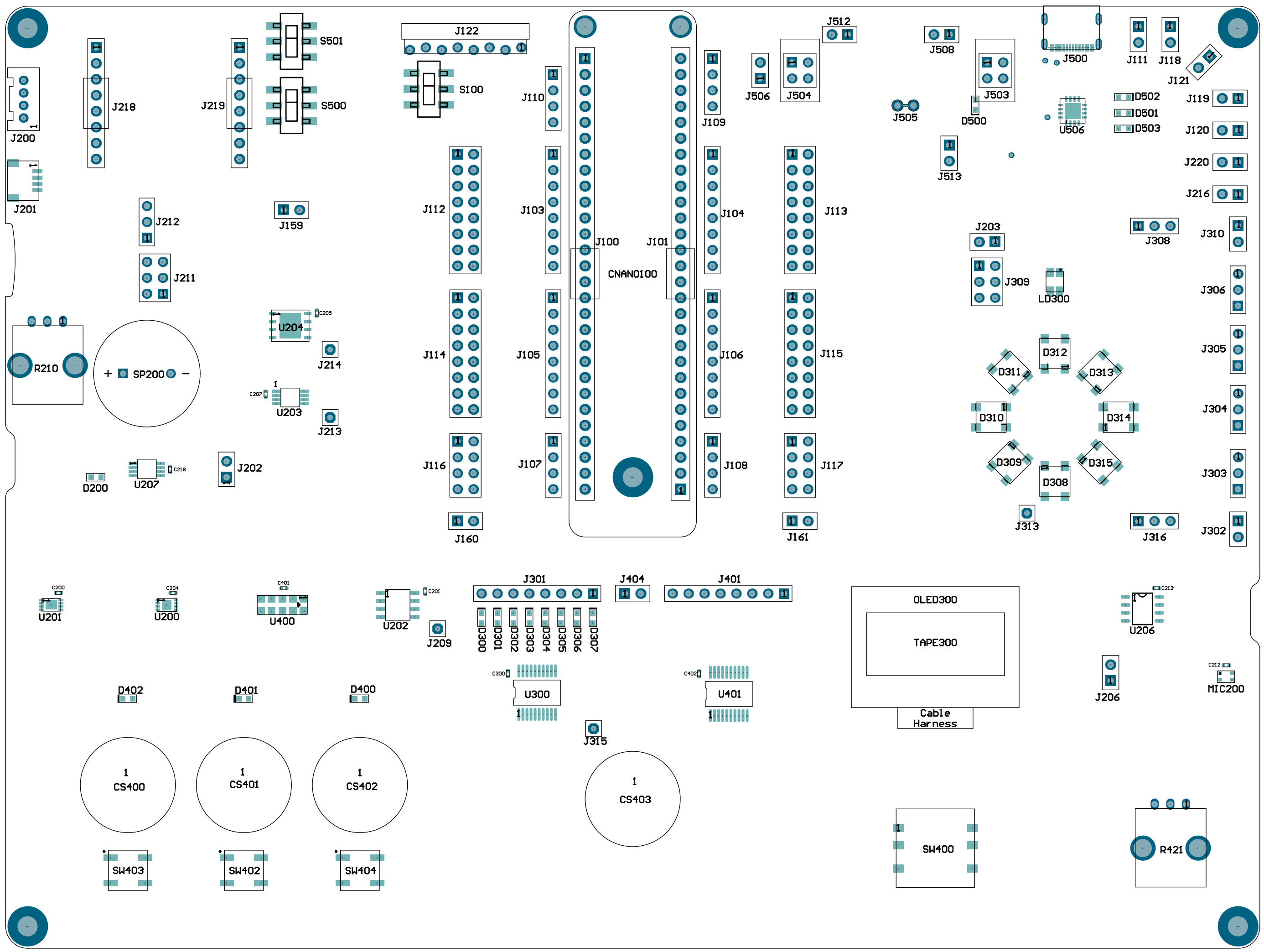
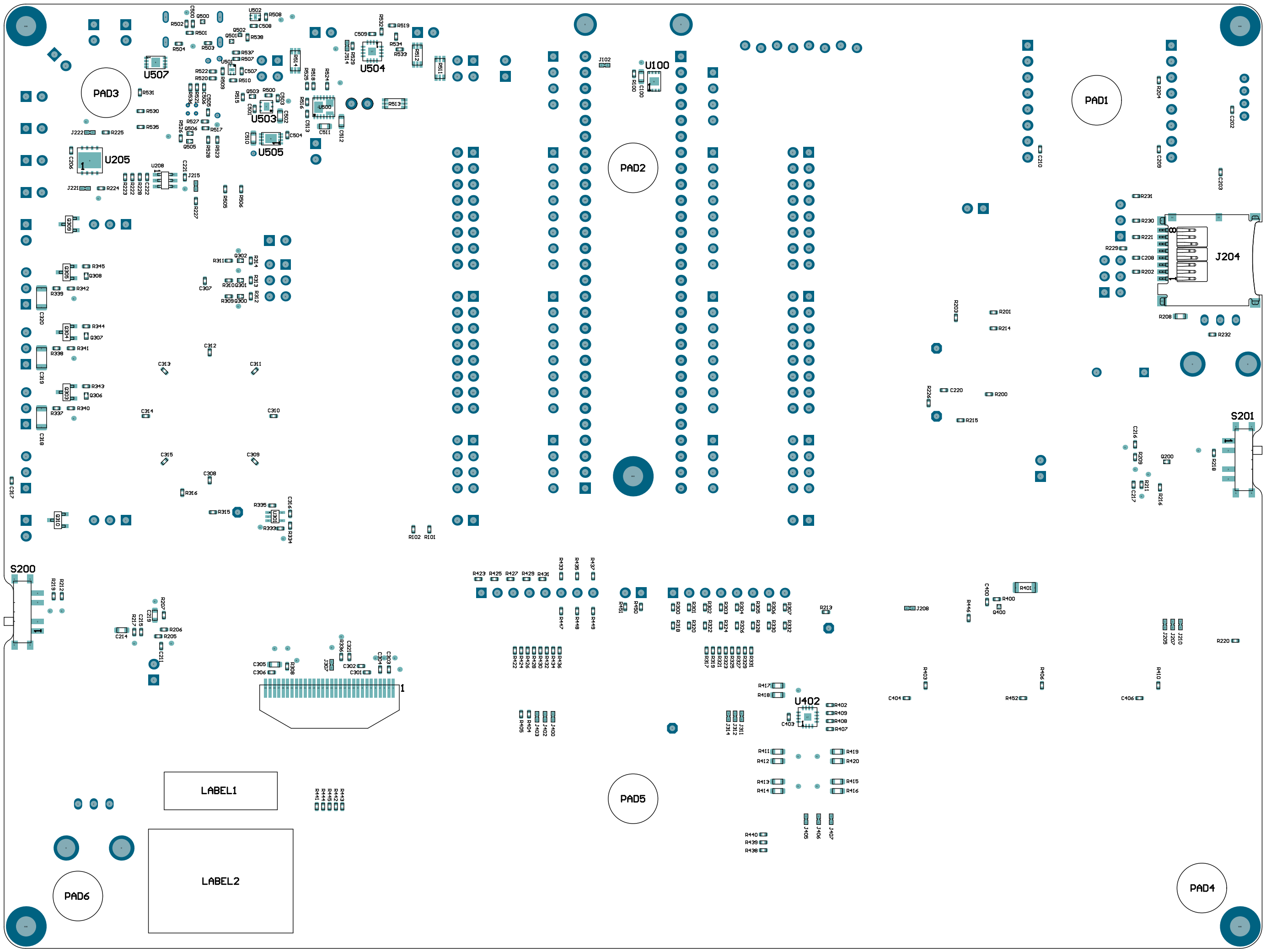


Figure 10-11. Curiosity Nano Explorer Bottom Assembly



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