PIC32CM LS00 Curiosity Nano+ Touch Evaluation Kit

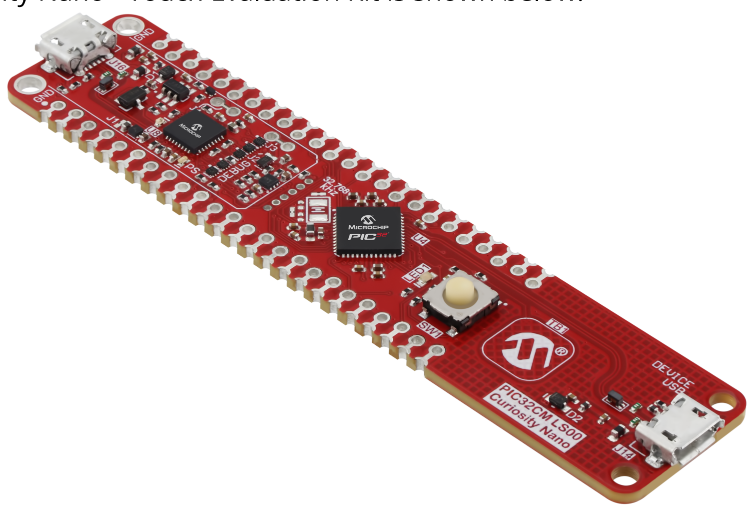
EV41C56A

Preface

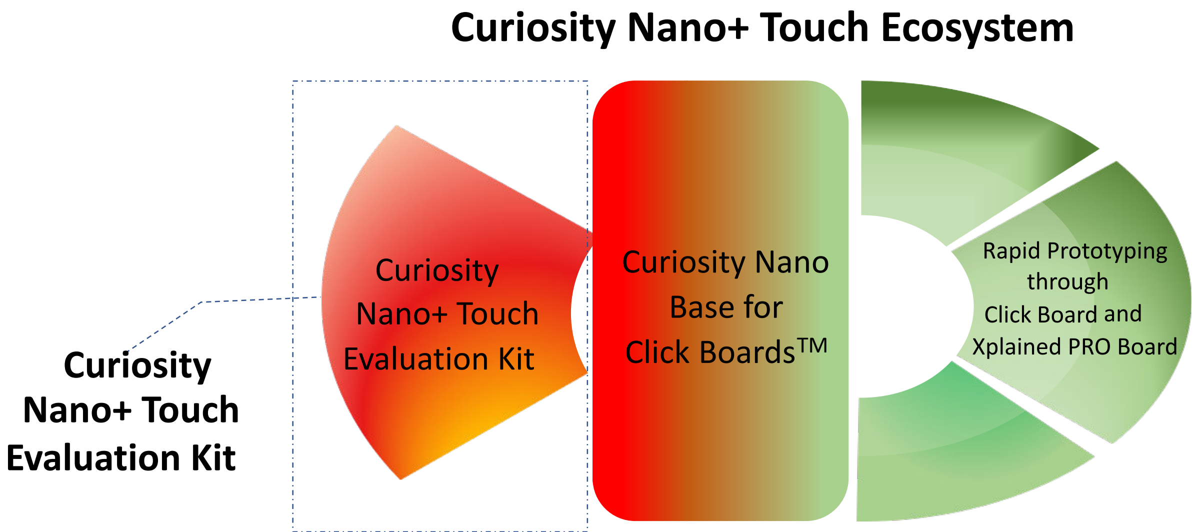
The PIC32CM LS00 Curiosity Nano+ Touch Evaluation Kit (EV41C56A) is a hardware platform which uses the PIC32CM5164LS00048 microcontroller. The evaluation kit provides an easy access to the microcontroller features and can be used to develop custom applications.

The PIC32CM LS00 Curiosity Nano+ Touch Evaluation kit comes pre-programmed with a stand-alone demonstration application and uses power provided by its micro-USB connections. The evaluation kit can be used as a stand-alone discovery element and may also be combined with expansion elements for quick prototyping.

The PIC32CM LS00 Curiosity Nano+ Touch Evaluation Kit is shown below:



Each PIC32CM LS00 Curiosity Nano+ Touch Evaluation Kit is compatible with the Curiosity Nano Base for Click boards™, AC164162. The base for Click boards includes: a Curiosity Nano+ Touch socket, three mikroBUS™ sockets, and an Xplained Pro socket. The Curiosity Nano+ Touch Evaluation kit, Curiosity Nano Base for Click boards, and the interface boards enable developers to effortlessly expand their designs with sensors, connectivity modules and so on.



The evaluation kit is supported by the MPLAB® X Integrated Development Environment (IDE). The Curiosity Nano+ Touch series of evaluation kits include an on-board Nano debugger, nEDBG. No external tools are required to program or debug the microcontroller.

Table of Contents

1. Introduction

1.1 Processor Overview

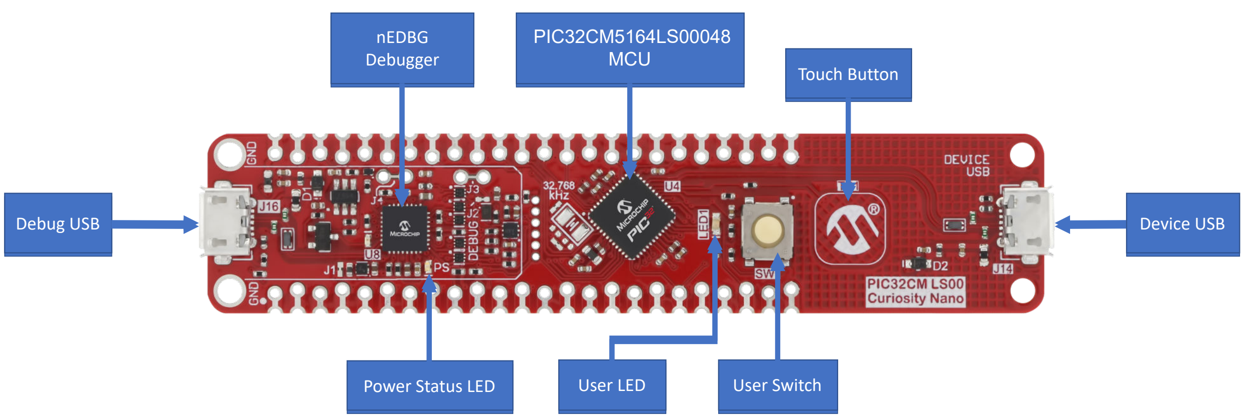
The PIC32CM LS00 Curiosity Nano+ Touch Evaluation Kit uses the PIC32CM5164LS00048 MCU and its key features are as follows:

- For performance
  - An entry level Arm® Cortex®-M23
  - picoPower® Technology and sleep modes
- For security
  - Arm TrustZone technology
  - Hardware crypto (AES256, SHA256, GCM)
  - Immutable secure boot
  - DICE security standard
  - Anti-tamper detection
- For touch input
  - An ultra-low power and enhanced Peripheral Touch Controller (PTC)
  - Driven shield and parallel acquisition/boost mode for superior water tolerance
  - Excellent noise immunity and four times faster response time

1.2 Kit Overview

The PIC32CM LS00 Curiosity Nano+ Touch Evaluation Kit is a hardware platform to evaluate the PIC32CM5164LS00048 MCU.

Figure 1-1. PIC32CMLS00 Curiosity Nano+ Touch Evaluation Kit Overview



1.3 Features

The following are key features of the PIC32CM LS00 Curiosity Nano+ Touch Evaluation Kit:

- The PIC32CM5164LS00048 microcontroller
- One user application yellow LED
- One user application mechanical button
- One user application touch button
- USB for device control
  - Can be used for powering the board

- USB for debugger
  - Can be used for powering the board
  - Must be used to program or debug the board
- On-board nano debugger (nEDBG)
  - Board identification in MPLAB X IDE
  - One green power/status LED
  - Programming and debugging
  - Communications Device Class (CDC) virtual COM port
  - One logic analyzer DGI GPIO
  - The target device is programmed and debugged by the on-board Nano debugger, hence no external programmer or debugging tool is required
- Adjustable target voltage
  - MIC5353 LDO regulator controlled by the on-board debugger
  - 1.7V to 3.6V output voltage
  - 500 mA maximum output current (limited by ambient temperature and output voltage)

2. Getting Started

2.1 Curiosity Nano+ Touch Quick Start

Users need to follow these steps to explore the Curiosity Nano+ Touch platform:

1. Download MPLAB X IDE.
2. Launch MPLAB X IDE.
3. Connect a USB cable (Standard-A to Micro-B or Micro-AB) between the PC and the debug USB port on the kit.

When the Curiosity Nano+ Touch Evaluation Kit is connected to the computer for the first time, the operating system will install a software driver.

The drivers for the kit are included with MPLAB X IDE. The driver file supports both 32-bit and 64-bit versions of Microsoft® Windows® XP, Windows Vista®, Windows 7, Windows 8, and Windows 10.

3. Curiosity Nano+ Touch

The Curiosity Nano+ Touch is an evaluation platform that provides a set of small boards with access to most of the microcontroller's I/O. The platform consists of a series of low pin-count microcontroller (MCU) boards, which are integrated with MPLAB X IDE to present relevant user's guides, application notes, data sheets, and example codes. The platform features a virtual COM port (CDC) for serial communication to a Host PC, and a Data Gateway Interface (DGI) GPIO.

3.1 On-board Debugger

The on-board debugger is a USB-enabled device with a debug application, a data gateway, and a virtual COM port.

Together with MPLAB X IDE, the on-board debugger interface can program and debug the microcontroller target.

A Data Gateway Interface (DGI) is available for use with logic analyzer channels for code instrumentation and to visualize program flow. DGI GPIOs can be graphed using the MPLAB Data Visualizer. The MPLAB Analyzer is available for download from the Microchip web site.

A virtual COM port is connected to a UART peripheral on the target processor. The virtual port provides an easy way to communicate with the target application through terminal software.

The on-board debugger controls one power/status LED (marked PS). The following table describes how the LED is controlled in different operational modes.

Table 3-1. On-Board Debugger LED Control

Operation Mode	Status LED
Bootloader mode	LED blink at 1 Hz during power up
Power-up	LED is lit, constant.
Normal operation	LED is lit, constant.
Programming	Activity indicator, the LED flashes slowly during programming or debugging.
Fault	The LED flashes fast if a power fault is detected.
Sleep/Off	LED is OFF. The on-board debugger is either in Sleep mode or Power-Down mode. This will occur only if the kit is externally powered.

3.1.1 Virtual COM Port

A virtual communications port is provided by a general-purpose USB serial bridge between the host PC and the target device.

3.1.1.1 Overview

The debugger implements a sophisticated USB device that includes a standard Communications Device Class (CDC) interface, which appears on the host as a virtual COM port.

CDC can be used to stream arbitrary data in both directions between the host and the target. Characters sent from the host will appear in UART form on the CDC TX pin, and UART characters sent into the CDC RX pin will be sent back to the host.

On Windows machines, the CDC will enumerate as the Curiosity virtual COM port and appear in the 'ports' section of the device manager. The COM port number is usually shown as well.

Notes:

- On the older version of Windows, a USB driver is required for CDC. This driver is included in the MPLAB X IDE installations.
- On Linux machines, the CDC will enumerate and appear as `/dev/ttyACM#`.
- On MAC machines, the CDC will enumerate and appear as `/dev/tty.usbmodem#`.

Depending on which terminal program is used, it will appear in the available list of modems as `usbmodem#`.

3.1.1.2 Limitations

Not all UART features are implemented in the debugger CDC. The following constraints exist:

- Baud rate – Must be in the range of 1200 bps to 500 kbps. Values outside this range will be forced to compliance without warning. Baud rate can be changed on-the-fly.
- Character format – Only 8-bit characters are supported.
- Parity – It can be odd, even, or none.
- Hardware flow control – Not supported.
- Stop bits – One or two bits are supported.

3.1.1.3 Signaling

During USB enumeration, the host OS will start both communication and data pipes of the CDC interface. At this point, it is possible to set and read baud rate and other UART parameters of the CDC, but data sending and receiving will not be enabled.

On the host PC, when a terminal connects it must assert the Data Terminal Ready (DTR) signal. This is a virtual control signal that is implemented on the USB interface but not in hardware on the debugger.

Asserting DTR from the host will indicate to the debugger that a CDC session is active, and it will enable necessary level shifters and start the CDC data send and receive mechanisms.

Disserting the DTR signal will not disable the level shifters, but it will disable the receiver. Without a DTR signal present no further data will be streamed to the host. Data packets that are queued by the debug processor, for the target MCU, will continue to be sent; but no further data will be accepted.

3.1.1.4 Advanced Use

When the CDC is in normal operation, the on-board debugger is a true UART bridge between the host and the device. However, under certain use cases, the debugger can override the basic operating mode and use the CDC pins for other purposes.

Dropping a `.txt` extension text file into the debugger's mass storage drive can be used to send characters out of the CDC TX pin. The text file must start with the characters: `CMD:SEND_UART=`.

The maximum message length is 50 characters, and all remaining data in the frame is ignored. If the CDC is already active or has been configured, the recently used baud rate still applies. The default baud rate is 9600 bps.

USB-Level Framing Considerations

Sending data from the host to the CDC can be done byte-wise or in blocks. Blocks will be chunked into 64-byte USB frames. Each frame will be queued up for sending to the CDC TX pin.

The debugger buffers frames, not bytes, so sending a small amount of data per frame can be inefficient, particularly at low-baud rates. A maximum of 4 x 64-byte frames can be active at any time, the debugger will throttle the incoming frames accordingly. Sending full 64-byte data frames data is the most efficient.

When receiving data from the target, the debugger will queue data bound for the host. When a 64-byte frame is filled, the data is sent to the USB queue for transmission. Incomplete frames are pushed to the USB queue at approximately 100 ms intervals, triggered by USB start-of-frame tokens. Up to 8 x 64-byte frames can be active at any time.

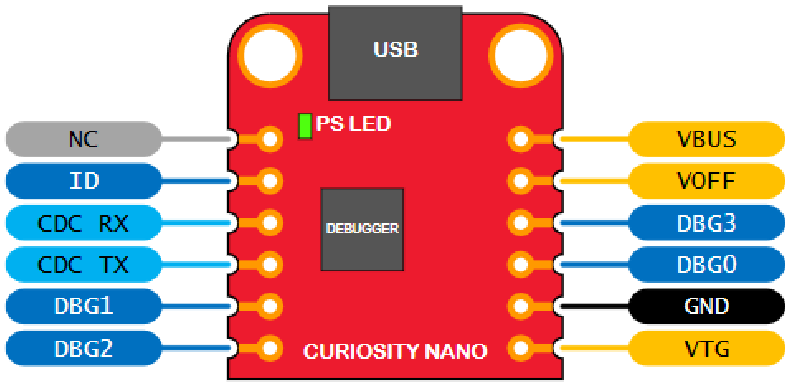
If the application software running on the host fails to receive data fast enough, an overrun will occur. An overrun will cause the last-filled buffer frame to be recycled. A full frame of data will be lost because of an overrun.

To prevent an overrun, the user must ensure that the CDC data pipe is being read continuously; or the incoming data rate must be reduced.

3.2 Curiosity Nano+ Touch Standard Pinout

Twelve edge connections on Curiosity Nano+ Touch have a standardized pinout. The program and debug pins have distinct functions depending on the target programming interface as shown in the following figure.

Figure 3-1. Curiosity Nano+ Touch Debugger Standard Pinout

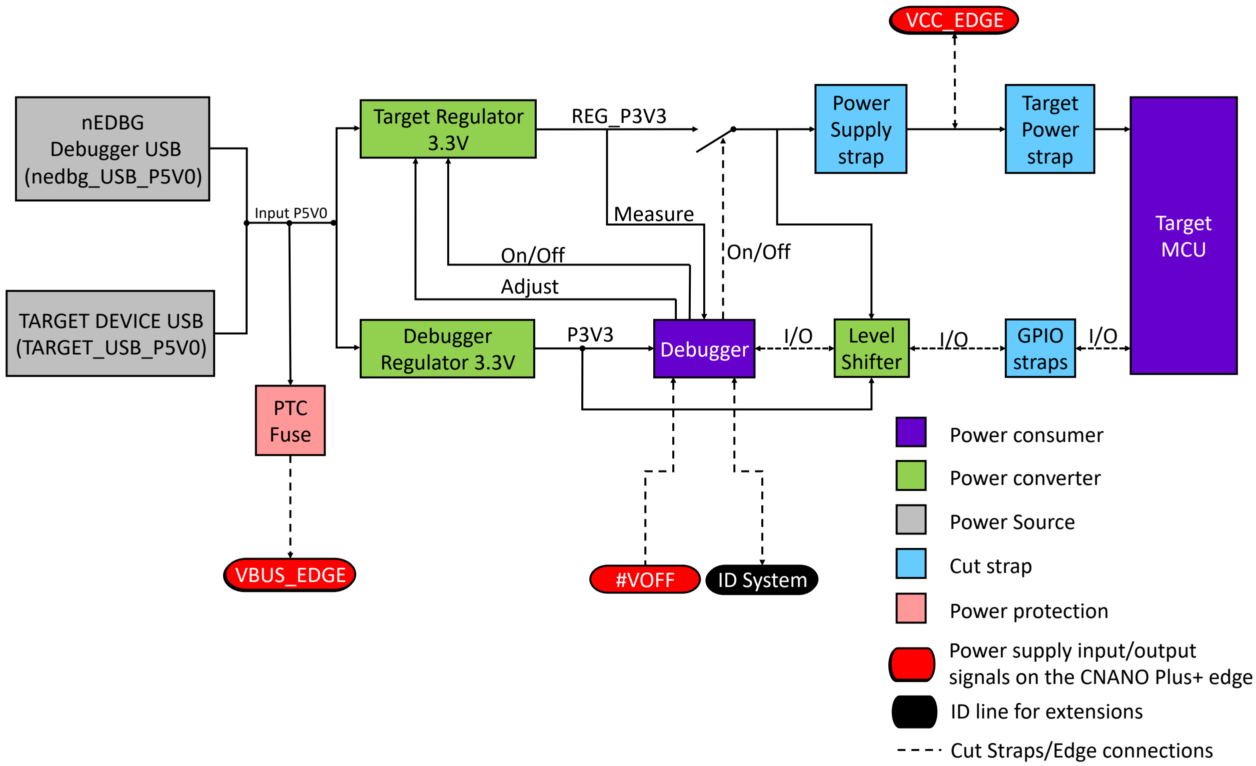


3.3 Power Supply

The debug circuitry is powered by the USB connector closest to the PS LED. If target programming or debugging is required, power must be provided to the debug circuitry. The target processor can be powered through either of the two USB connectors. The USB specification allows the USB connector voltage to vary between 4.4V-5.25V. The Curiosity Nano+ Touch contains two regulators for generating 3.3V for the debugger and an adjustable regulator for the target.

The following figure shows the power supply system on the PIC32CM LS00 Curiosity Nano+ Touch Evaluation Kit.

Figure 3-2. Power Supply Block Diagram



3.3.1 Target Voltage Regulator

The voltage regulator for the target processor is a MIC5353 variable output LDO. The on-board debugger can adjust the voltage output that is supplied to the target section by manipulating the LDO's feedback voltage.

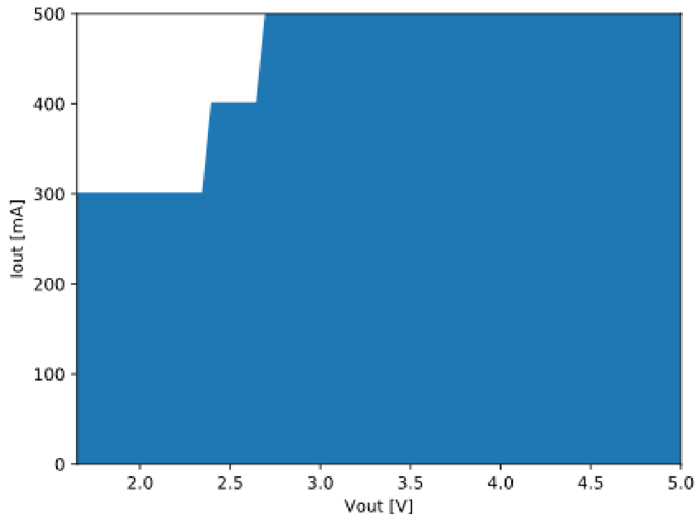
The hardware implementation is limited to an approximate voltage range of 1.7V-5.1V. Additional output voltage limits are configured in the debugger firmware to ensure that the voltage output does not exceed the MCU hardware limits.

The voltage limits configured in the on-board debugger for the PIC32CM LS00 Curiosity Nano+ Touch are 1.7V-3.6V. The target voltage is set to 3.3V in production and can be changed using MPLAB X IDE. Any change to the target voltage will be persistent between power cycles.

The MIC5353 supports a maximum current load of 500 mA. It is an LDO regulator in a small package, placed on a small PCB, and the thermal shutdown condition can be reached at lower loads than 500 mA.

The maximum current load depends on the input voltage, output voltage set point, as well as the ambient temperature. The following figure shows the safe operational area for the regulator given an input voltage of 5.1V and an ambient temperature of 23°C.

Figure 3-3. Target Regulator Safe Operation Area



3.3.2 External Supply

The PIC32CM LS00 Curiosity Nano+ Touch can be powered by an external voltage instead of the on-board target regulator. When the voltage off (VOFF) pin is shorted to ground (GND), the on-board debugger firmware disables the target regulator, and it is safe to apply an external voltage to the VTG pin.

WARNING Applying an external voltage to the VTG pin without shorting VOFF to GND may cause permanent damage to the kit.

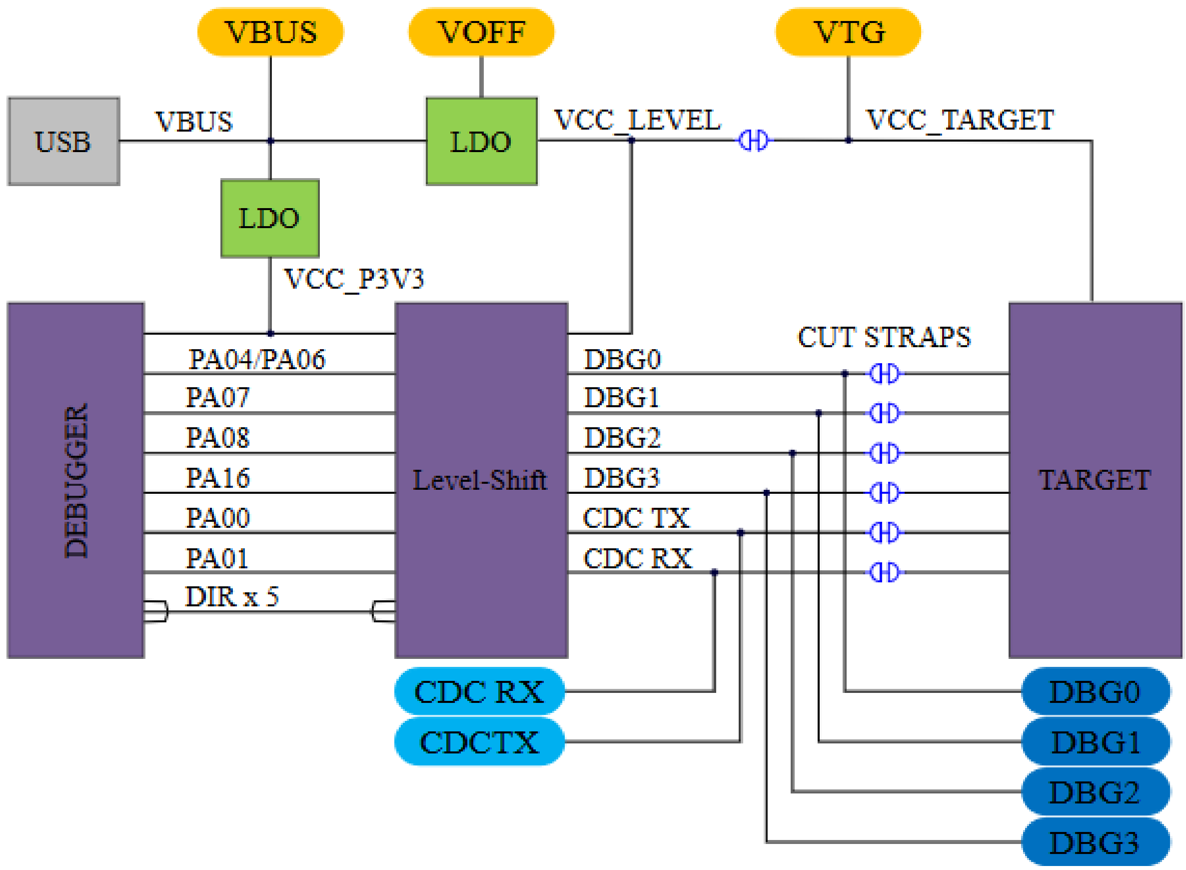
WARNING Absolute maximum external voltage is 5.5V for the level shifters on board. Applying a higher voltage may cause permanent damage to the kit.

Programming, debugging, and data streaming are still possible while using the external power. The debugger and signal level shifters will be powered from the USB cable. Both regulators, the debugger, and the level shifters are powered down when the USB cable is removed.

3.4 Disconnecting the On-Board Debugger

The following block diagram shows connections between the debugger and the PIC32CM5164LS00048 microcontroller. The oval boxes represent connections to the board edge on the PIC32CM LS00 Curiosity Nano+ Touch. The signal names are shown in following figure and printed in silkscreen on the bottom side of the board.

Figure 3-4. On-Board Debugger Connections

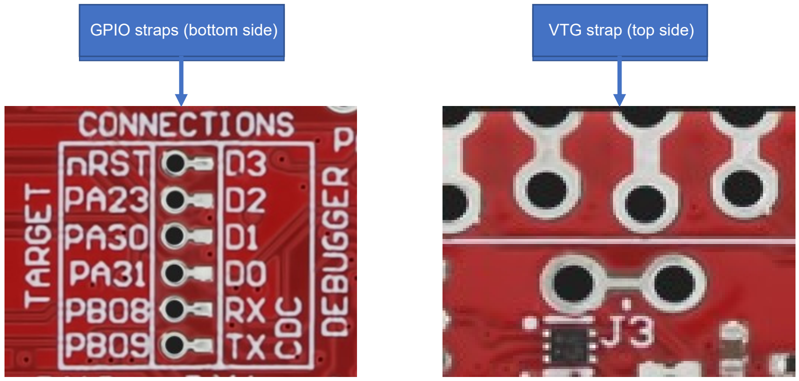


By cutting the GPIO straps with a sharp tool, as shown in the following figure, all I/O connected between the debugger and the MCU can be disconnected. To disconnect the target regulator, cut the VTG strap.

Notes:

- Cutting the connections to the debugger will disable programming, debugging, and data streaming. The signals will also be disconnected from the board edge next to the on-board debugger section.
- Solder 0Ω resistors across the footprints or short-circuit traces with tin solder to reconnect any cut signals.

Figure 3-5. Location of GPIO and VTG Straps



3.5 Current Measurement

The PIC32CM LS00 microcontroller is connected to the target voltage supply (VTG) through a cut-strap as shown in the Disconnecting the On-Board Debugger section.

To measure the power consumption of the target and the peripherals, cut the strap trace and connect an ammeter across the open. The ammeter can be connected between the target VTG pad edge connector and an external power supply for easy measurement. Alternatively, an external power supply can be used as described in External Supply.

Tip: The nEDBG level shifters will draw a small amount of current even when they are not in use. Disconnect the nEDBG and level shifters as described in Disconnecting the On-Board Debugger to prevent any current leakage.

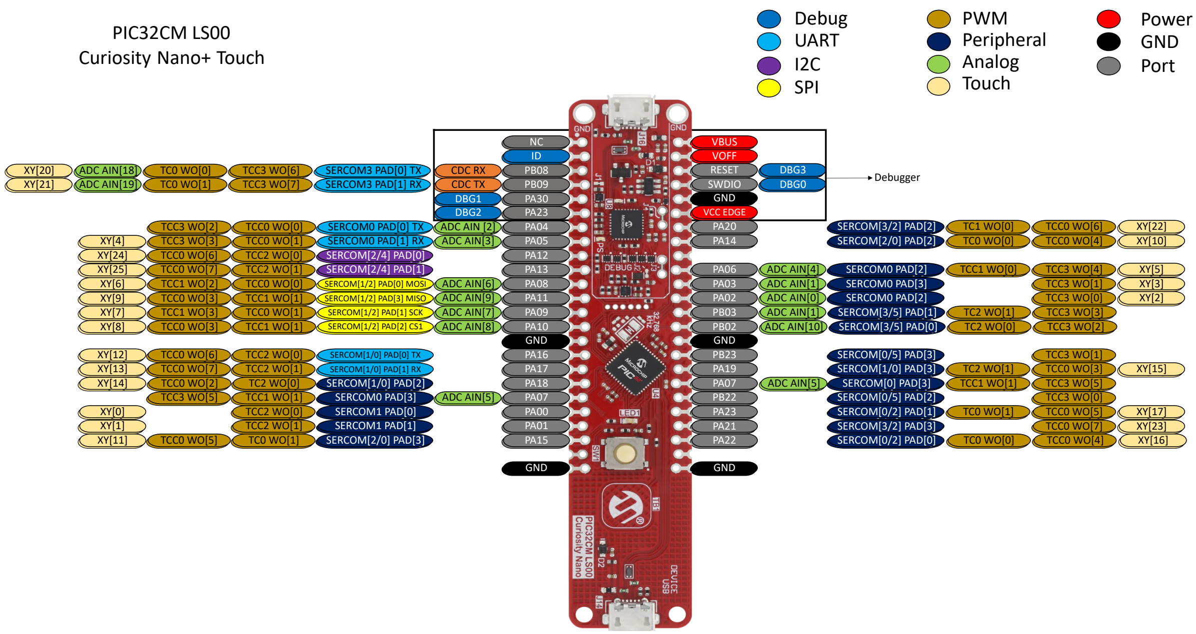
4. Hardware

4.1 Connectors

4.1.1 PIC32CM LS00 Curiosity Nano+ Touch Pinout

Excluding the USB peripheral control pins, PA24 and PA25, most of the PIC32CM5164LS00048 I/O pins are accessible through the edge connectors on the PIC32CM LS00 Curiosity Nano+ Touch Evaluation Kit. The following figure shows the evaluation kit pin out.

Figure 4-1. PIC32CM LS00 Curiosity Nano+ Touch Pinout



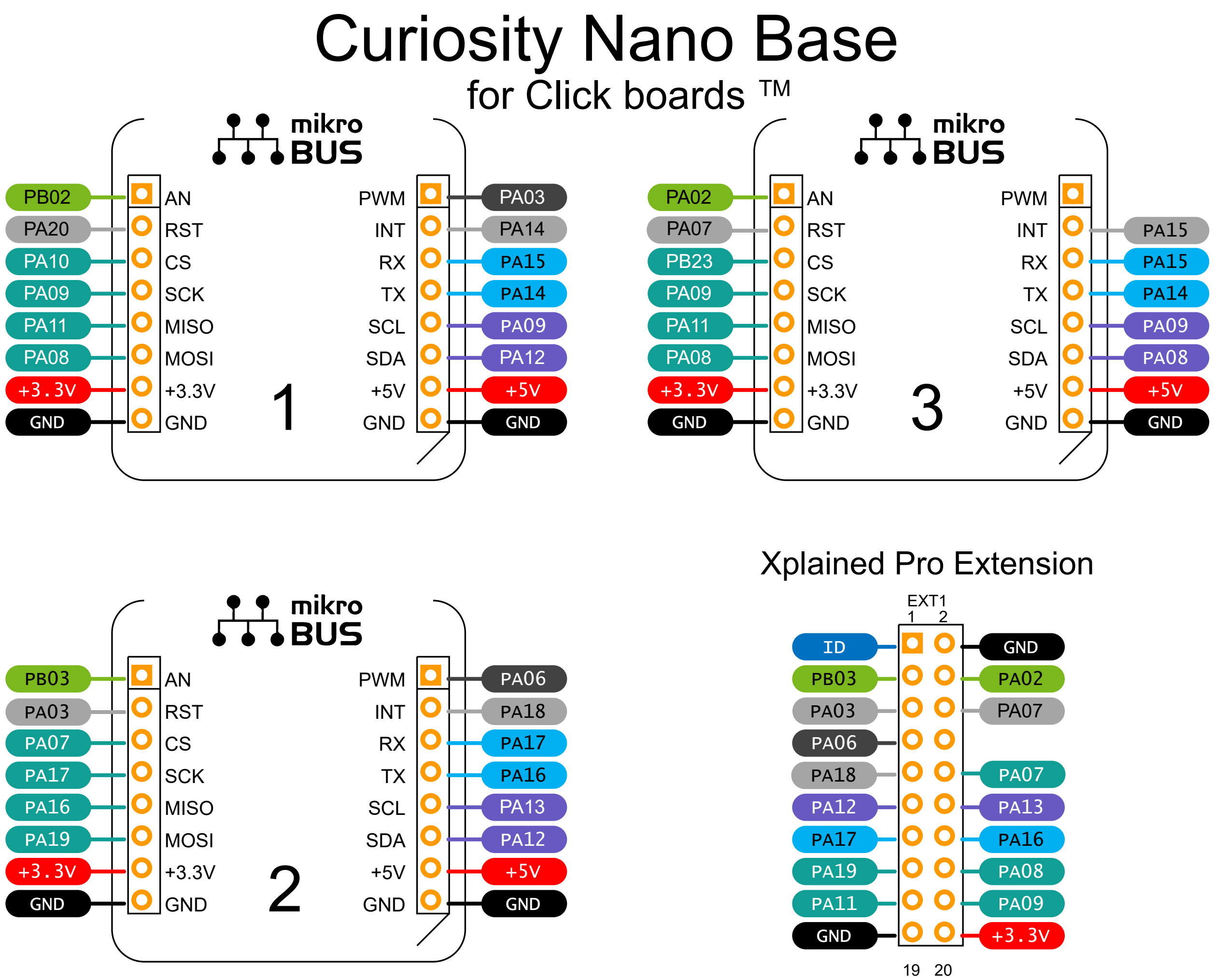
Note: The PA30 and PA31 pins are only available at the edge connector in the debugger section if the cut straps on the bottom have continuity.

4.1.2 PIC32CM LS00 Curiosity Nano+ Touch Base Quick Reference

The following figure shows a simplified reference to enable quicker development with the Curiosity Nano+ Touch Base for Click boards™, AC164162.

For additional information, visit https://www.microchip.com/en-us/development-tool/ac164162.

Figure 4-2. PIC32CM LS00 Curiosity Nano + Touch Connections to the Curiosity Nano Base for Click board™



4.2 Peripherals

4.2.1 User LED

One yellow LED is available on the PIC32CM LS00 Curiosity Nano+ Touch Evaluation Kit. The user application can use this LED and is controlled as a GPIO. The LED can be activated by driving the connected I/O line to the GND.

Table 4-1. LED Connection

PIC32CM5164LS00048 Pin	Function	Shared Functionality
PA15	Yellow LED	GPIO1 (Pin 22 on the Edge Connector)

4.2.2 Mechanical Button

The PIC32CM LS00 Curiosity Nano+ Touch Evaluation Kit has one mechanical button for a generic users application input. When the switch is pressed, the associated I/O line will be driven to ground (GND).

Table 4-2. Mechanical Switch

PIC32CM5164LS00048 Pin	Function	Shared Functionality
PA23	Mech Button	DBG2 and GPIO6 (Pin 29 on the Edge Connector)

4.2.3 Touch Button

The PIC32CM LS00 Curiosity Nano+ Touch Evaluation Kit has one QTouch button with a driven shield. The QTouch button is implemented using the built-in Peripheral Touch Controller (PTC) of the MCU.

These PTC I/O lines are accessible through the edge connector and may be repurposed to GPIO. For this, users need to desolder the R20 and R34, and then populate the R35 and R36.

Table 4-3. Touch Button

PIC32CM5164LS00048 Pin	Function	Shared Functionality
PA22	QTouch Button	GPIO4 (Pin 27 on the Edge Connector)
PA21	QTouch Button Shield	GPIO5 (Pin 28 on the Edge Connector)

4.2.4 Device USB

The PIC32CM LS00 Curiosity Nano+ Touch Evaluation Kit has a second micro-USB connector for dedicated application use. This port will not provide power to the debug circuitry.

Table 4-4. Device USB

PIC32CM5164LS00048 Pin	Function	Shared Functionality
PA25	USB_P	None
PA24	USB_N	None

4.2.5 Crystal Oscillator

The PIC32CM LS00 Curiosity Nano+ Touch Evaluation Kit has the option for a 32.768 kHz crystal. By default, the crystal is not connected; instead, the GPIOs are routed to the edge connector.

To use a crystal oscillator, some hardware modifications are required. The two I/O lines routed to the edge connector must be disconnected through the J12 and J13 cut points. Disconnecting the GPIO route will reduce the chance of crystal contention and remove excessive line capacitance.

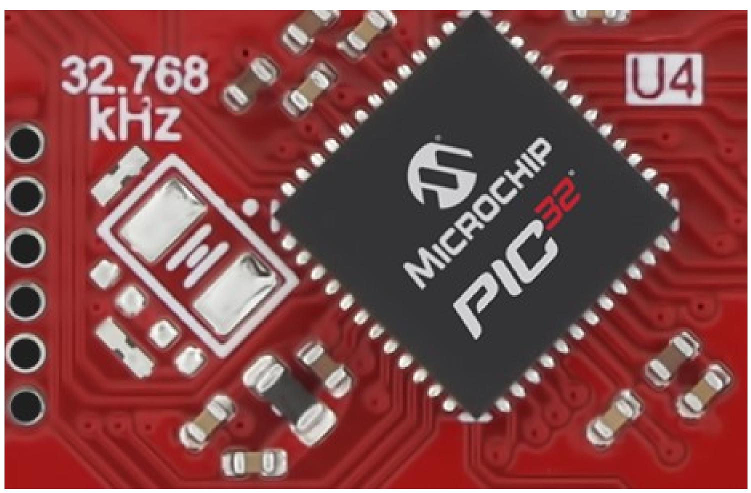


Table 4-5. Crystal Connections

PIC32CM5164LS00048 Pin	Function	Shared Functionality
PA00	XIN32	GPIO3 (Pin 20 on the Edge Connector)
PA01	XOUT32	GPIO2 (Pin 21 on the Edge Connector)

4.3 On-Board Debugger Implementation

The PIC32CM LS00 Curiosity Nano+ Touch Evaluation Kit features an on-board debugger that can be used to program and debug the MCU through a serial wire debug (SWD) line.

The on-board debugger also includes a virtual com port interface over UART and DGI GPIO. Microchip's Data Visualizer can be used as a front-end for the CDC and DGI GPIO. MPLAB X IDE can be used as a nEDBG front-end for programming and debugging.

4.3.1 On-Board Debugger Connections

The following table provides the connection details between the target and the debugger section. All connections between the target and the debugger are tri-stated if the debugger is not actively using the interface.

For additional information on how to use the capabilities of the on-board debugger, refer to the 3. Curiosity Nano+ Touch.

Table 4-6. Connection Details between the Target and Debugger

PIC32CM5164LS00048 Pin	Debugger Pin	Function	Shared Functionality
PB08	CDC TX	UART TX (PIC32CM5164LS00048 RX line)	Edge Connector
PB09	CDC RX	UART RX (PIC32CM5164LS00048 TX line)	Edge Connector
PA31	DBG0	SWDATA	Edge Connector
PA30	DBG1	SWCLK	Edge Connector
PB23	DBG2	GPIO	Mech Button and Edge Connector
nRESET	DBG3	nRESET	Edge Connector
VCC_TARGET	VCC_LEVEL	1.7 - 3.6V	Edge Connector
GND	GND	Common Ground	Edge Connector

5. Hardware Revision History

This user guide provides the latest available revision of the evaluation kit. This chapter contains information about known issues, a revision history of older revisions, and how older revisions differ from the latest revision.

5.1 Identifying Product ID and Revision

The revision and product identifier of Curiosity Nano+ Touch boards can be found by looking at the sticker on the bottom of the PCB. The revision information is also available through the MPLAB X IDE.

By connecting a Curiosity Nano+ Touch board to a computer, with MPLAB X IDE running, an information window will pop up. The serial number string is shown in the kit details and has the following format:

“nnnnrrssssssssss"

n = product identifier

r = revision

s = serial number

The first six digits of the serial number, which is listed under kit details, contain the product identifier and revision. The same information can be found on the sticker on the bottom of the PCB. The printed identifier on the board typically has the identifier and revision in plain text as A09-nnnn\rr. Where, nnnn is the identifier and rr is the revision.

Boards with limited space have a sticker with only a QR code. The QR code contains the serial number string.

6. Schematics

Figure 6-1. Top Level

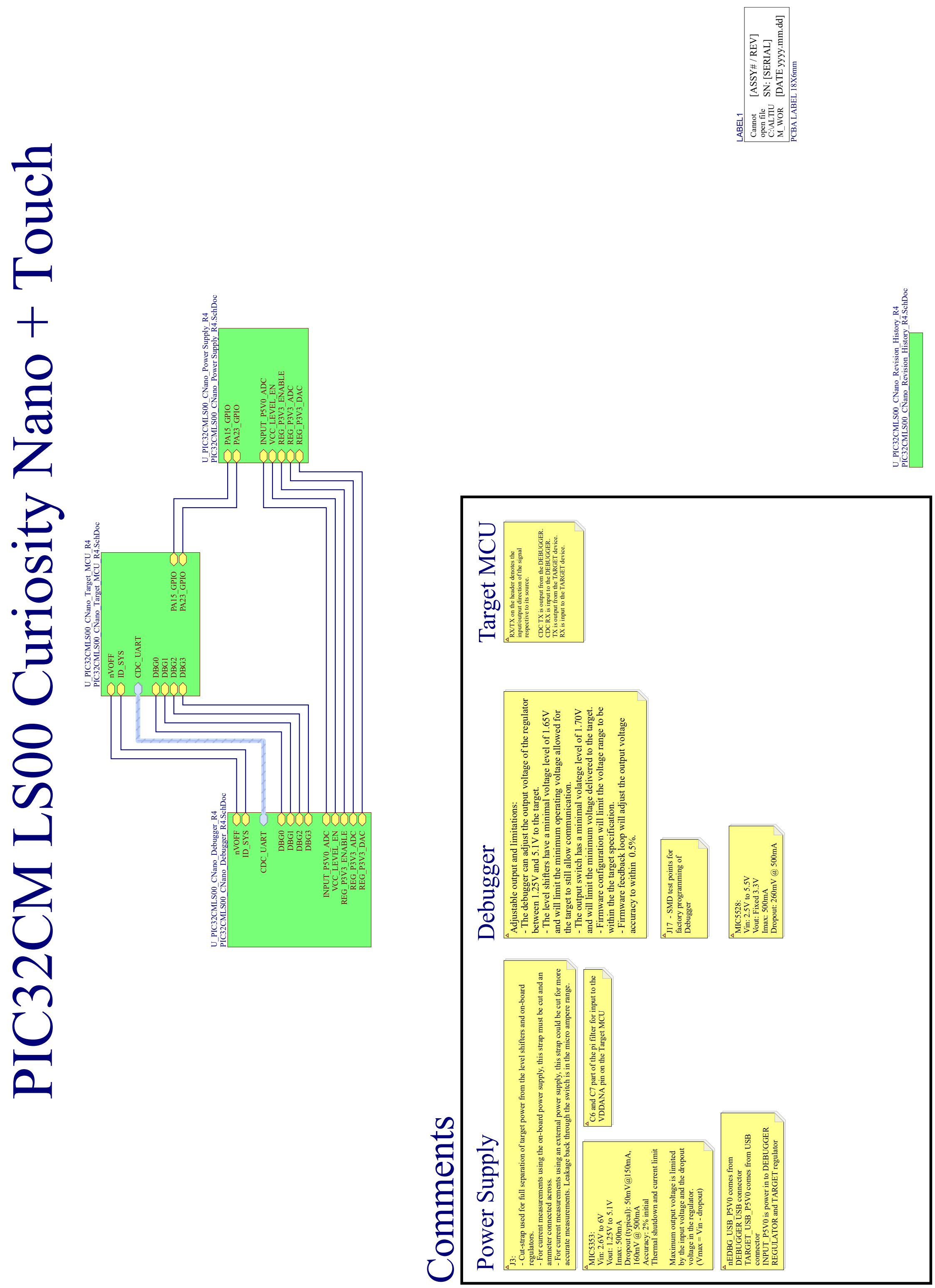


Figure 6-2. Power Supply

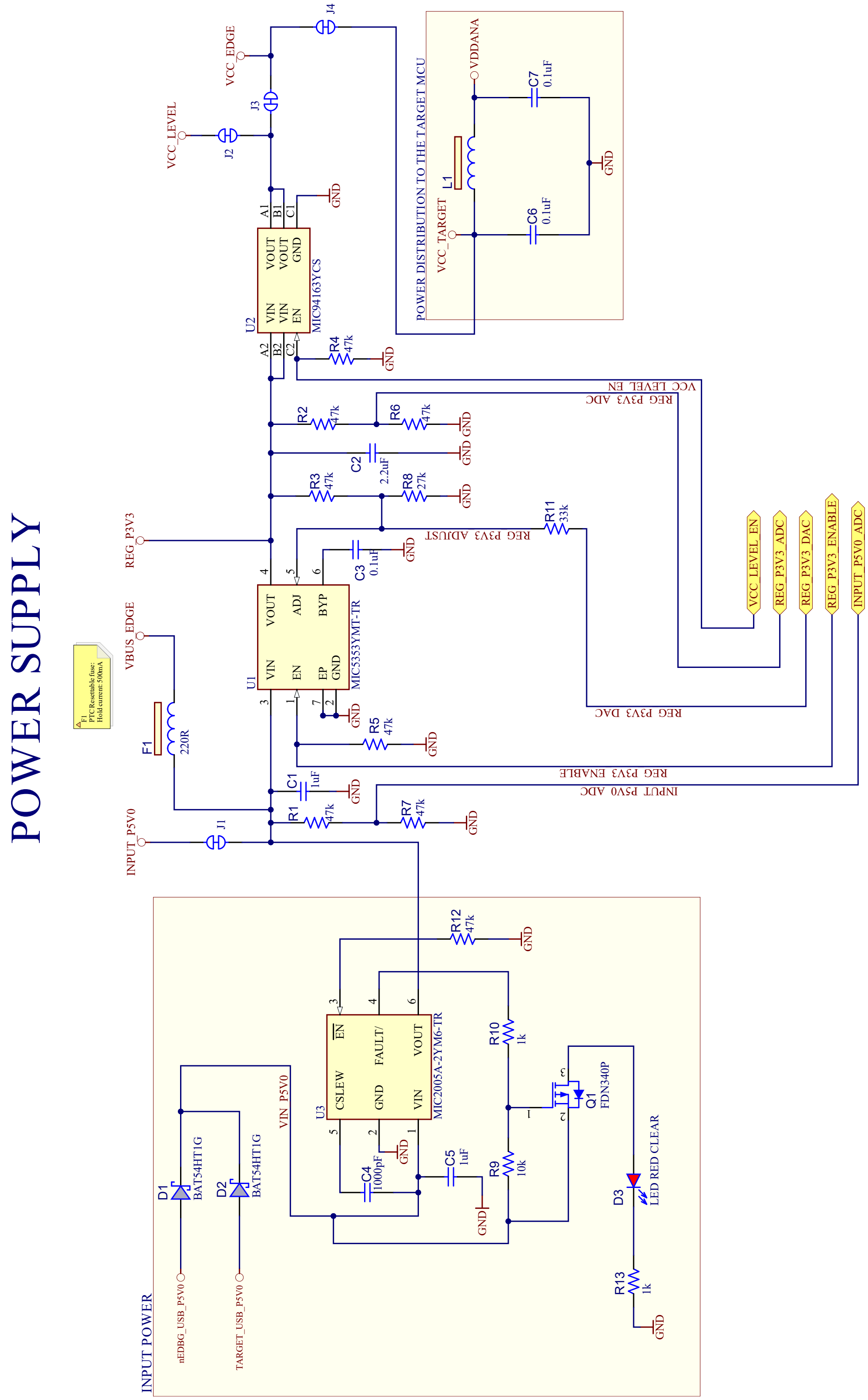


Figure 6-3. Target MCU

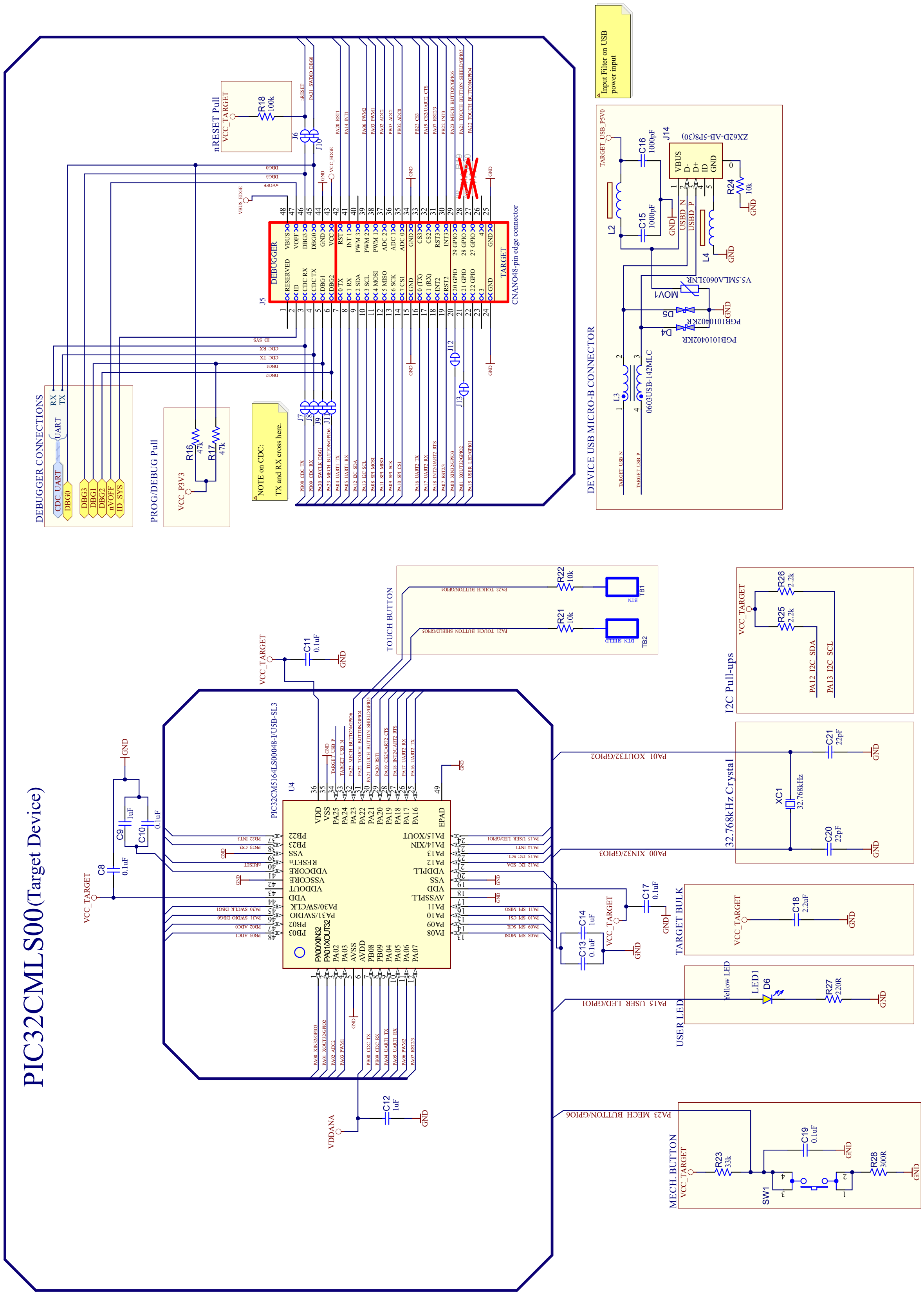
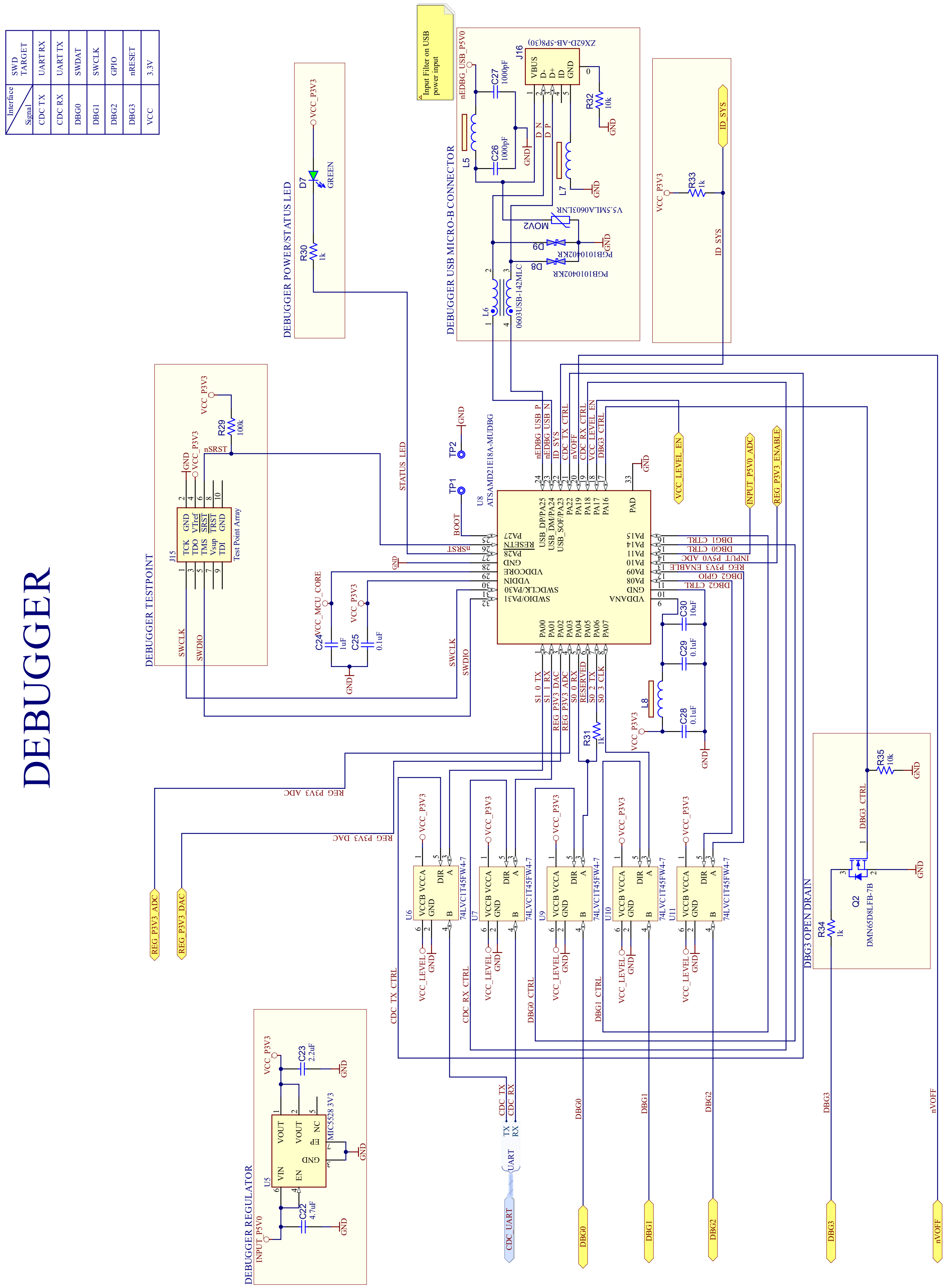


Figure 6-4. Debugger



7. Revision History

Revision A - 06/2024

This is the Initial released version of this document.

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