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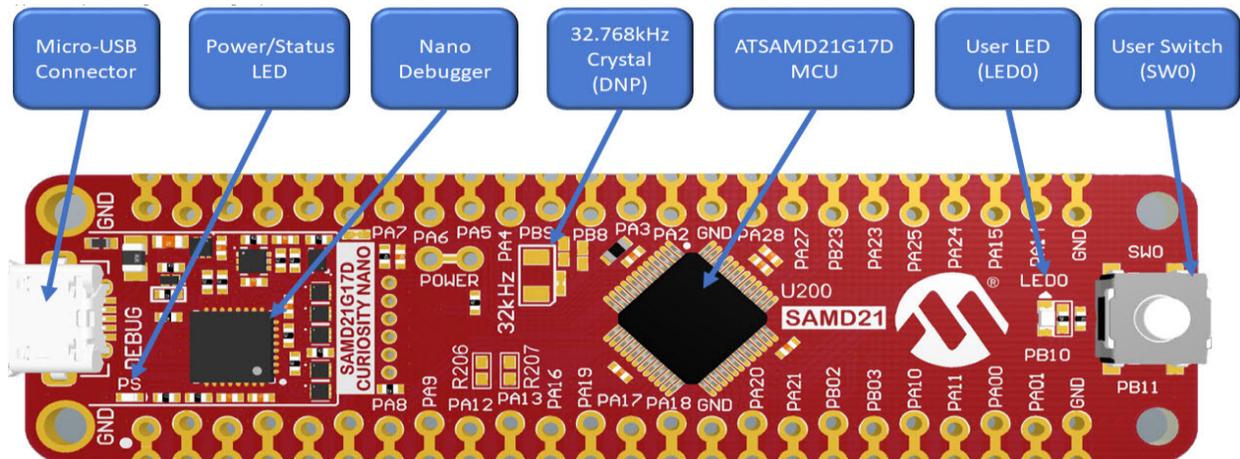
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1. Introduction

Kit Overview

The SAM D21 Curiosity Nano evaluation kit is a hardware platform used to evaluate the SAMD21G17D MCU.

Figure 1-1. SAM D21 Curiosity Nano Evaluation Kit Overview



1.1 Features

The following are features of the SAM D21 Curiosity Nano evaluation kit:

- SAMD21G17D microcontroller
- One yellow user LED
- One mechanical user switch
- On-Board Nano Debugger
 - Board identification in MPLAB X IDE
 - One green power/status LED
 - Programming and debugging
 - Virtual COM port (CDC)
 - One logic analyzer (DGI GPIO)
- USB powered
- Adjustable target voltage
 - MIC5353 LDO regulator controlled by the On-Board Nano 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 Quick Start

Users need to follow these steps to explore the Curiosity Nano 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 kit is connected to the computer for the first time, the operating system will install a driver software. 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.

After the Curiosity Nano board is powered, the green status LED will be lit and MPLAB X IDE will auto-detect which Curiosity Nano board is connected. MPLAB X IDE will populate relevant information like data sheets and kit documentation in the kit window. The SAMD21G17D device is programmed and debugged by the On-Board Nano Debugger, hence external programmer or debugger tool is not required.

3. Curiosity Nano

Curiosity Nano is an evaluation platform that provides a set of small boards with access to most of the microcontroller I/Os. The platform consists of a series of low pin-count microcontroller (MCU) boards, which are integrated with MPLAB X IDE to present relevant user 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 Nano Debugger

The SAM D21 Curiosity Nano contains an On-Board Nano Debugger for programming and debugging. The On-Board Nano Debugger is a complex USB device consists of several interfaces, such as a debugger, a mass storage device, a data gateway, and a Virtual COM port (CDC). Together with MPLAB X IDE, the On-Board Nano Debugger interface can program and debug SAMD21G17D. An DGI is available for use with the logic analyzer channels for code instrumentation to visualize program flow. DGI GPIOs can be graphed using the Data Visualizer. The Virtual COM port is connected to a UART on the SAMD21G17D and it provides an easy way to communicate with the target application through terminal software. The On-Board Nano Debugger controls one Power/Status LED (marked PS) on the SAM D21 Curiosity Nano evaluation board. The following table describes how the LED is controlled in different operation modes.

Table 3-1. On-Board Nano Debugger LED Control

Operation Mode	Status LED
Boot Loader 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 Nano 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 general-purpose USB serial bridge between a host PC and a target device.

3.1.1.1 Overview

The debugger implements a complex USB device that includes a standard Communications Device Class (CDC) interface, which appears on the host as a Virtual COM Port. The 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 here.

Note: On the older version of Windows systems a USB driver is required for CDC. This driver is included in Atmel® Studio and 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

All UART features are not implemented in the debugger CDC and constraints are as follows:

- Baud rate: Must be in the range of 1200 bps to 500 kbps. Values outside this range will be capped to these values, without warning. Baud rate can be changed on-the-fly.
- Character format: Only 8-bit characters are supported.
- Parity: 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. When a terminal connects on the host, it must assert the 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 its level shifters (if available), and start the CDC data send and receive mechanisms. Deasserting the DTR signal will not disable the level shifters, but it will disable the receiver, hence no further data will be streamed to the host. Data packets that are already queued up for sending to the target will continue to be sent out, but no further data will be accepted.

3.1.1.4 Advanced Use

When the CDC Override mode is in normal operation, the On-Board Nano 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 text file (with extension `.txt`) 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. The default baud rate used in this mode is 9600 bps, but if the CDC is already active or has been configured, the recently used baud rate still applies.

USB-Level Framing Considerations

Sending data from the host to the CDC can be done byte-wise or in blocks, which will be chunked into 64-byte USB frames. Each frame will be queued up for sending to the CDC TX pin. Sending a small amount of data per frame can be inefficient, particularly at low-baud rates, because the debugger buffers frames, not bytes. 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 frames containing data is the most efficient. When receiving data from the target, the debugger will queue up incoming bytes into 64-byte frames, which are sent to the USB queue for transmission to the host when they are full. Incomplete frames are also 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 host or software running on it, fails to receive data fast enough, an overrun will occur. When this happens the last-filled buffer frame will be recycled instead of being sent to the USB queue, and a full frame of data will be lost. To prevent this occurrence, the user must ensure that the CDC data pipe is being read continuously, or the incoming data rate must be reduced.

Note: Mass storage disk is not supported during this release.

3.1.2 Mass Storage Disk

Not supported at this time.

3.2 Curiosity Nano Standard Pinout

The twelve edge connections closest to the USB connector on Curiosity Nano kits have a standardized pinout. The program and debug pins have different functions depending on the target programming interface as shown in the following table and figure.

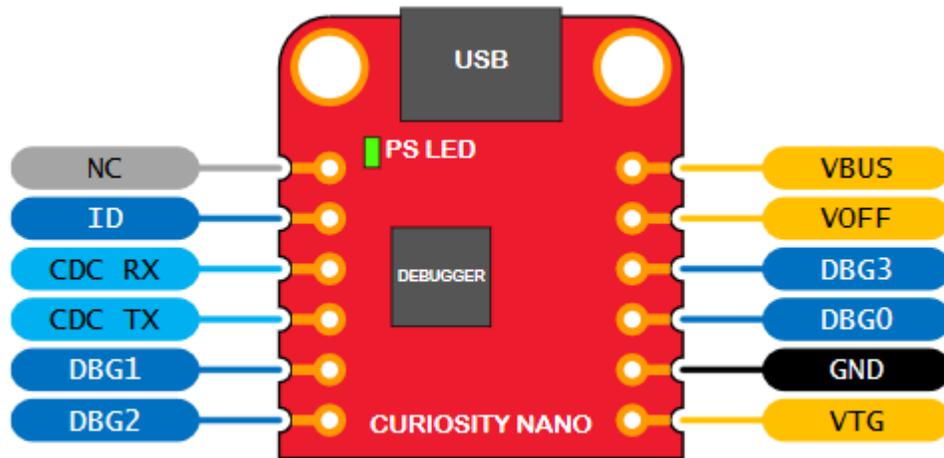
Table 3-2. Curiosity Nano Standard Pinout

Debugger Signal	ICSP Target	Description
NC	-	No connect.
ID	-	ID line for extensions.
CDC RX	UART TX	USB CDC RX line.
CDC TX	UART RX	USB CDC TX line.
DBG1	SWCLK	Debug clock line
DBG2	GPIO	DGI GPIO

.....continued

Debugger Signal	ICSP Target	Description
VTG	-	Target voltage
GND	-	Common ground.
DBG0	SWDATA	Debug data line.
DBG3	nRESET	Reset line
VOFF	-	Voltage Off input.
VBUS	-	VBUS voltage for external use.

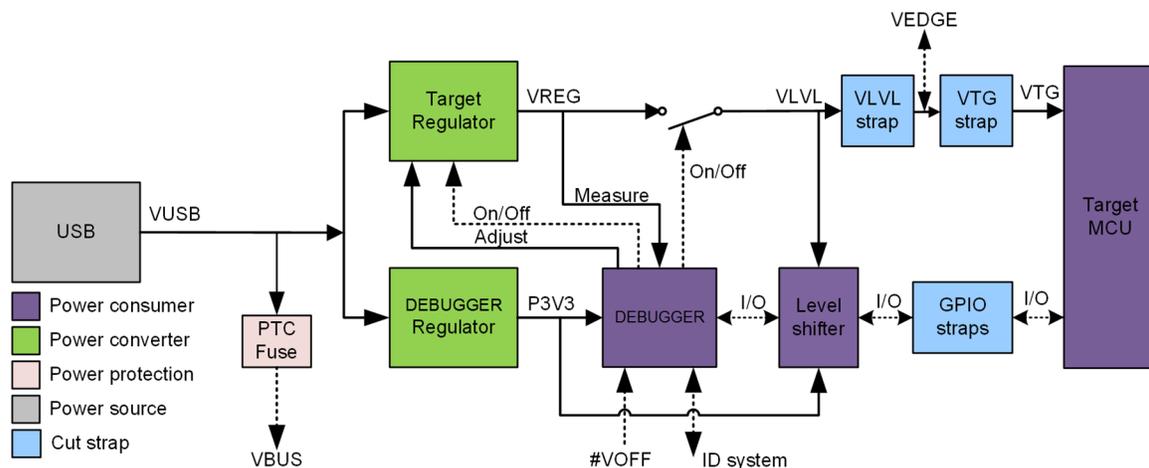
Figure 3-1. Curiosity Nano Standard Pinout



3.3 Power Supply

The evaluation kit is powered through the USB port and it contains two regulators for generating 3.3V for the debugger and an adjustable regulator for the target. The voltage from the USB connector can vary between 4.4V-5.25V (according to the USB specification) and will limit the maximum voltage to the target. The following figure shows the power supply system on the SAM D21 Curiosity Nano.

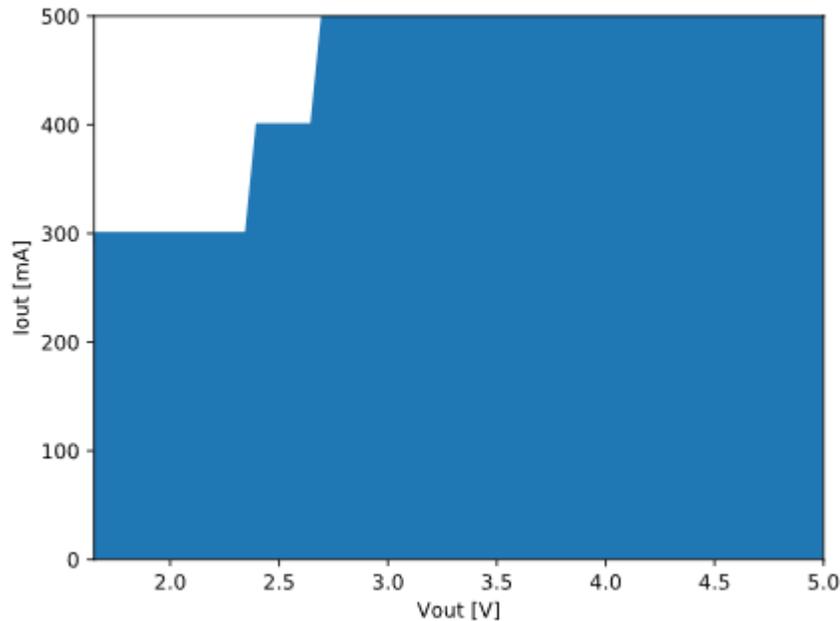
Figure 3-2. Power Supply Block Diagram



3.3.1 Target Voltage Regulator

The target voltage regulator is a MIC5353 variable output LDO. The On-Board Nano Debugger can adjust the voltage output that is supplied to the kit target section by manipulating the MIC5353's feedback voltage. The hardware implementation is limited to an approximate voltage range from 1.7V-5.1V. Additional output voltage limits are configured in the debugger firmware to ensure that the output voltage never exceeds the hardware limits of the SAMD21G17D microcontroller. The voltage limits configured in the On-Board Nano Debugger on the SAM D21 Curiosity Nano are 1.7V-3.6 V. The target voltage is set to 3.3V in production and can be changed through Atmel Studio. Any change to the target voltage done in Atmel Studio is persistent, even through a power toggle. 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, set output voltage, and the ambient temperature. The following figure shows the safe operation area for the regulator with 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 SAM D21 Curiosity Nano evaluation kit 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 Nano Debugger firmware disables the target regulator and it is safe to apply an external voltage to the VTG pin.



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



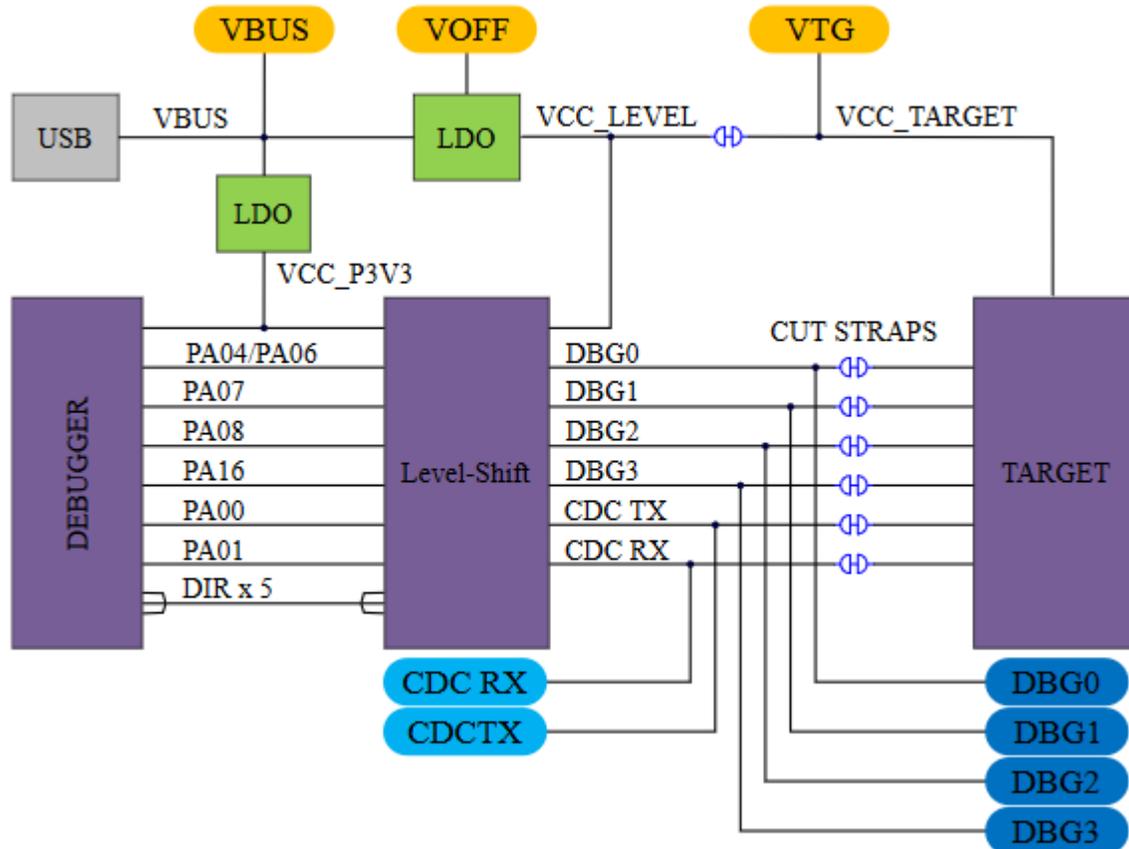
Absolute maximum external voltage is 5.5V for the level shifters on board. Applying a higher voltage may cause permanent damage to the kit.

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 Nano Debugger

The following block diagram shows connections between the debugger and the SAMD21G17D microcontroller. The round boxes represent connections to the board edge on the SAM D21 Curiosity Nano. The signal names are shown in Figure 3-1 and printed in silkscreen on the bottom side of the board.

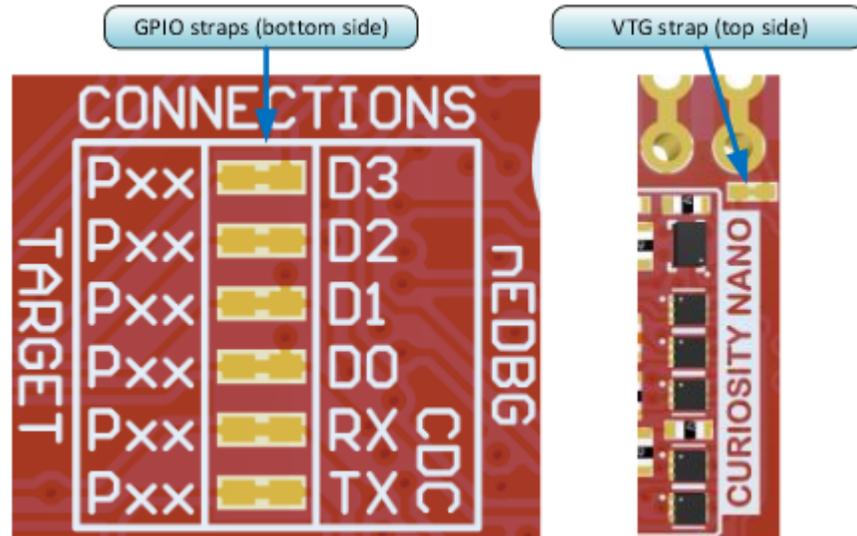
Figure 3-4. On-Board Nano Debugger Connections



By cutting the GPIO straps with a sharp tool, as shown in the following figure, all I/Os connected between the debugger and the SAMD21G17D can be disconnected. To disconnect the target regulator, cut the VTG strap.

Notes:

1. Cutting the connections to the debugger will disable programming, debugging, data streaming, and the target power supply. The signals will also be disconnected from the board edge next to the On-Board Nano Debugger section.
2. Solder in 0Ω resistors across the footprints or short-circuit them with tin solder to reconnect any cut signals.



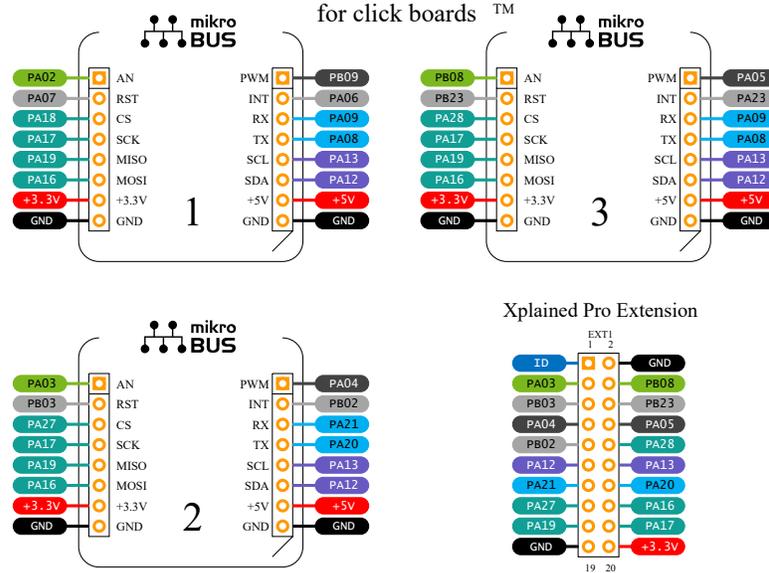
3.5 Current Measurement

The power to the SAMD21G17D is connected from the on-board power supply to the target voltage supply (VTG) with a cut strap as shown in [Disconnecting the On-Board Debugger](#). To measure the power consumption of the SAMD21G17D and other peripherals connected to the board, cut the strap and connect an ammeter over the strap. 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 on-board level shifters will draw a small amount of current even when they are not in use. Disconnect the On-Board Nano Debugger and level shifters as described in [Disconnecting the On-Board Debugger](#) to prevent any current leakage.

Curiosity Nano Base



4.2 Peripherals

4.2.1 LED

One yellow LED is available on the SAM D21 Curiosity Nano evaluation kit, which can be controlled either with a GPIO or PWM. The LED can be activated by driving the connected I/O line to the GND.

Table 4-1. LED Connection

SAMD21G17D	Function	Shared Functionality
PB10	Yellow LED0	None

4.2.2 Mechanical Switch

The SAM D21 Curiosity Nano has one mechanical switch, a generic user configurable switch. When this switch is pressed, it will drive the I/O line to ground (GND).

Note: No pull-up resistor is connected to the generic user switch. Ensure that the internal pull-up is enabled in the SAMD21G17D to use the switch.

Table 4-2. Mechanical Switch

SAMD21G17D	Function	Shared Functionality
PB11	User switch SW0	DBG2 and Edge connector

4.2.3 Crystal

The SAM D21 Curiosity Nano board has the option for a 32.768 kHz crystal, and by default this crystal is not connected to the SAMD21G17D, as GPIOs are routed out to the edge connector. To use the crystal, some hardware modifications are required. The two I/O lines routed to the edge connector must be disconnected to reduce the chance of contention to the crystal, and to remove excessive capacitance on the lines.

Table 4-3. Crystal Connections

SAMD21G17D pin	Function	Shared Functionality
PA00	XIN32	Edge connector

.....continued		
SAM D21G17D pin	Function	Shared Functionality
PA01	XOUT32	Edge connector

4.3 On-Board Nano Debugger Implementation

The SAM D21 Curiosity Nano features an On-Board Nano Debugger that can be used to program and debug the SAMD21G17D using a Serial wire debug (SWD). The On-Board Nano Debugger also includes a Virtual Com port interface over UART and DGI GPIO. MPLAB X IDE can be used as a front-end for the On-Board Nano Debugger for programming and debugging. Data Visualizer can be used as a front-end for the CDC and DGI GPIO.

4.3.1 On-Board Nano 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 as long as the debugger is not actively using the interface, therefore little contamination of the signals and the pins can be configured to the application requirements. For additional information on how to use the capabilities of the On-Board Nano Debugger, see [Curiosity Nano](#).

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

SAM D21G17D pin	Debugger pin	Function	Shared Functionality
PB22	CDC TX	UART TX (SAM D21G17D RX line)	Edge Connector
PA22	CDC RX	UART RX (SAM D21G17D TX line)	Edge Connector
PA31	DBG0	SWDATA	Edge Connector
PA30	DBG1	SWCLK	Edge Connector
PB11	DBG2	GPIO	Edge Connector and SW0
nRESET	DBG3	nRESET	Edge Connector
VCC_TARGET	VCC_LEVEL	1.7V-3.6V supply voltage	Edge Connector
GND	GND	Common ground	Edge Connector

5. Hardware Revision History

This user guide provides the latest available revision of the 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 boards can be found in two ways; either through the MPLAB X IDE or by looking at the sticker on the bottom of the PCB. By connecting a Curiosity Nano board to a computer with MPLAB X IDE running, an information window will pop up. 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. Most kits will print 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, which contains a serial number string. The serial number string has the following format:

“nnnnrrsssssssss”

n = product identifier

r = revision

s = serial number

6. Schematics

Figure 6-1. Target Microcontroller (SAMD21G17D)

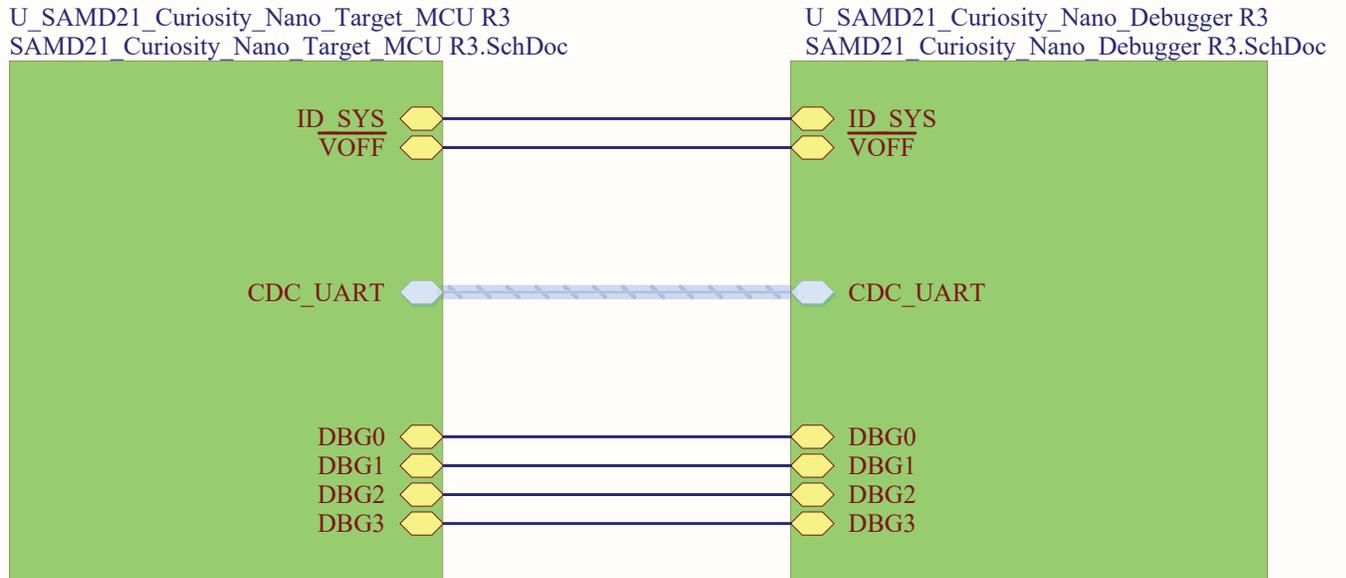


Figure 6-2. Debugger

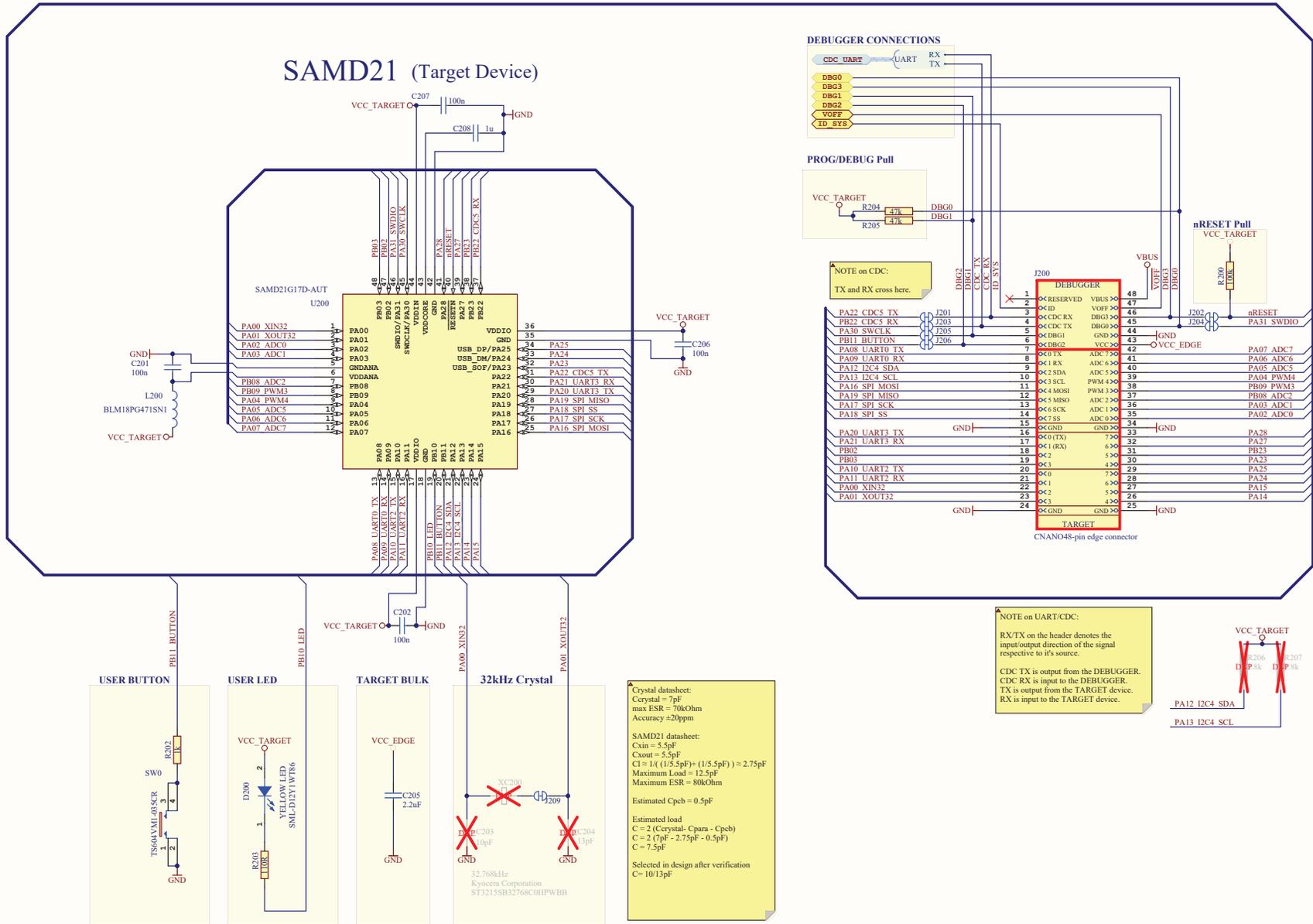
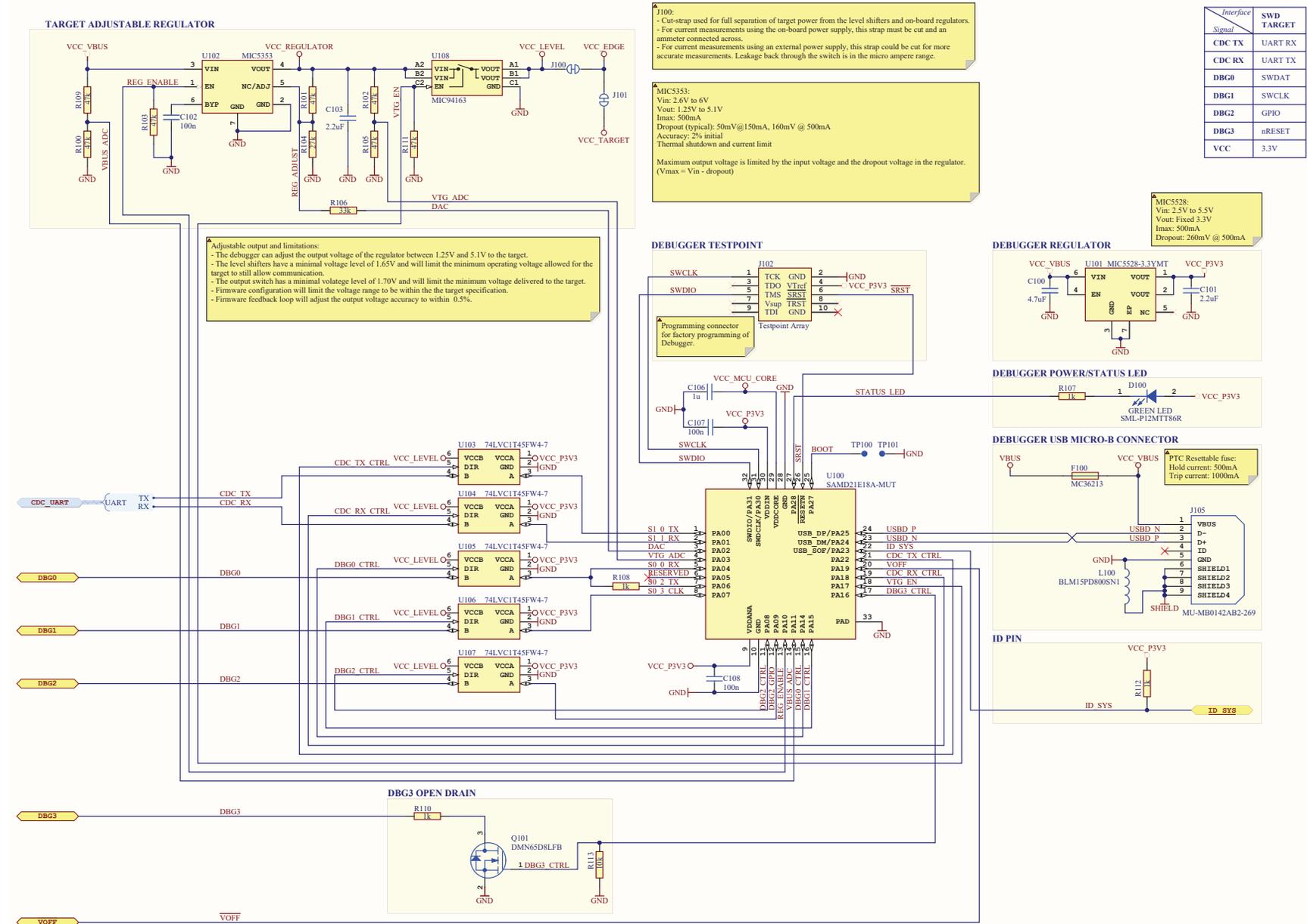


Figure 6-3. Debugger



7. Document Revision History

Revision D - 09/2020

Updated the figures in the following sections:

- [SAM D21G17D Curiosity Nano Pinout](#)
- [SAM D21G17D Curiosity Nano Base Quick Reference](#)

Revision C - 07/2020

Updated the figures in the following section, and added a note:

- [SAM D21G17D Curiosity Nano Pinout](#)

Added a new section:

- [SAM D21G17D Curiosity Nano Base Quick Reference](#)

Revision B - 04/2020

Updated the pin names for the SAM D21G17D in the [Connection Details between the Target and Debugger Section Table](#).

Revision A - 12/2019

This is the initial released version of this document.

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