Preface

The SAME51J20A Curiosity Nano Evaluation Kit (EV76S68A) is a hardware platform used to evaluate the
SAME51J20A microcontroller (MCU), and it is supported by the MPLAB® X Integrated Development Environment
(IDE). The evaluation kit provides easy access to the features of the SAME51J20A to integrate the device into a
custom design. The Curiosity Nano series of evaluation kits includes an On-Board Nano Debugger, therefore no
external tools are necessary to program the SAME51J20A device. The SAME51J20A Curiosity Nano Evaluation Kit
is shown in the following figure.
Table of Contents

Preface ........................................................................................................................................................... 1

1. Introduction ............................................................................................................................................. 3
   1.1. Features ....................................................................................................................................... 3
   1.2. Kit Overview ................................................................................................................................. 3

2. Getting Started ........................................................................................................................................ 4
   2.1. Curiosity Nano Quick Start ........................................................................................................... 4

3. Curiosity Nano ......................................................................................................................................... 5
   3.1. On-Board Debugger ..................................................................................................................... 5
   3.2. Curiosity Nano Standard Pinout ................................................................................................... 6
   3.3. Power Supply ............................................................................................................................... 7
   3.4. Disconnecting the On-Board Debugger ....................................................................................... 8
   3.5. Current Measurement ................................................................................................................ 10

4. Hardware ...............................................................................................................................................11
   4.1. Connectors ................................................................................................................................. 11
   4.2. Peripherals ................................................................................................................................. 12
   4.3. On-Board Debugger Implementation ......................................................................................... 13

5. Hardware Revision History ....................................................................................................................15
   5.1. Identifying Product ID and Revision ........................................................................................... 15

6. Schematics ............................................................................................................................................16

7. Revision History ...................................................................................................................................19

The Microchip Website .................................................................................................................................. 20

Product Change Notification Service ........................................................................................................... 20

Customer Support .................................................................................................................................... 20

Microchip Devices Code Protection Feature ............................................................................................... 20

Legal Notice ............................................................................................................................................... 20

Trademarks ............................................................................................................................................... 21

Quality Management System ..................................................................................................................... 21

Worldwide Sales and Service ....................................................................................................................... 22
1. **Introduction**

The SAME51J20A Curiosity Nano Evaluation Kit is a hardware platform used to evaluate the SAME51J20A microcontroller (MCU). Supported by the MPLAB® X Integrated Development Environment (IDE), the kit provides easy access to the features of the SAME51J20A, and explains how to integrate the device into a custom design. The Curiosity Nano series of evaluation kits include an on-board debugger. No external tools are necessary to program the SAME51J20A.

1.1 **Features**

- SAME51J20A microcontroller
- One user LED (yellow)
- One mechanical user switch
- On-board 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 debugger
  - 1.8-3.6v output voltage
  - 500 mA maximum output current (limited by ambient temperature and output voltage)

1.2 **Kit Overview**

The SAME51J20A Curiosity Nano evaluation kit is a hardware platform used to evaluate the SAME51J20A, as shown in the figure below.

*Figure 1-1. SAME51J20A*
2. **Getting Started**

2.1 **Curiosity Nano Quick Start**

Follow these steps to exploring 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 user computer for the first time, the operating system will perform a driver software installation. The driver file supports both 32-bit and 64-bit versions of Microsoft® Windows® XP, Windows Vista®, Windows 7, Windows 8, and Windows 10. The drivers for the kit are included with MPLAB X IDE.

Once 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 present relevant information, such as data sheets and kit documentation. The SAME51J20A device is programmed and debugged by the on-board debugger, therefore no external programmer or debugger tool is required.
3. Curiosity Nano

The Curiosity Nano 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 guides, application notes, data sheets, and example code. 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 SAME51J20A Curiosity Nano contains an on-board debugger for programming and debugging. The on-board debugger is a composite USB device of several interfaces: a debugger, a mass storage device, a data gateway, and a virtual COM port (CDC). Together with MPLAB X IDE, the on-board debugger interface can program and debug the SAME51J20A. 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 Data Visualizer. The Virtual COM port is connected to a UART on the SAME51J20A and provides an easy way to communicate with the target application through terminal software. The on-board debugger controls one Power/Status LED (marked PS) on the SAME51J20A Curiosity Nano board. The following table shows how the LED is controlled in different operation modes.

<table>
<thead>
<tr>
<th>Operation Mode</th>
<th>Status LED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boot Loader mode</td>
<td>LED blink at 1 Hz during power up.</td>
</tr>
<tr>
<td>Power-up</td>
<td>LED is lit - constant.</td>
</tr>
<tr>
<td>Normal operation</td>
<td>LED is lit - constant.</td>
</tr>
<tr>
<td>Programming</td>
<td>Activity indicator; the LED flashes slowly during programming or debugging.</td>
</tr>
<tr>
<td>Fault</td>
<td>The LED flashes fast if a power fault is detected.</td>
</tr>
<tr>
<td>Sleep/Off</td>
<td>LED is Off. The on-board debugger is either in Sleep mode or powered down. This can occur if the kit is externally powered.</td>
</tr>
</tbody>
</table>

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 composite 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.

Tip: On older Windows systems a USB driver is required for the CDC. This driver is included in 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#.

3.1.2 Limitations

Not all UART features are implemented in the debugger CDC. The constraints are outlined here:

- **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.
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 back the 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 the hardware on the debugger. Asserting a 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. Dasserting 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

In CDC Override mode 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 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 baud rate last used 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 divided 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, since the debugger buffers per frame, not byte. 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 the 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.

3.2 Curiosity Nano Standard Pinout

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

<table>
<thead>
<tr>
<th>Debugger Signal</th>
<th>ICSP Target</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NC</td>
<td>-</td>
<td>No connect.</td>
</tr>
<tr>
<td>ID</td>
<td>-</td>
<td>ID line for extensions.</td>
</tr>
<tr>
<td>CDC RX</td>
<td>UART TX</td>
<td>USB CDC RX line.</td>
</tr>
<tr>
<td>CDC TX</td>
<td>UART RX</td>
<td>USB CDC TX line.</td>
</tr>
<tr>
<td>DBG1</td>
<td>SWCLK</td>
<td>Debug clock line</td>
</tr>
<tr>
<td>DBG2</td>
<td>GPIO</td>
<td>DGI GPIO</td>
</tr>
</tbody>
</table>
### Debugger Signal

<table>
<thead>
<tr>
<th>Debugger Signal</th>
<th>ICSP Target</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>VTG</td>
<td>-</td>
<td>Target voltage</td>
</tr>
<tr>
<td>GND</td>
<td>-</td>
<td>Common ground.</td>
</tr>
<tr>
<td>DBG0</td>
<td>SWDATA</td>
<td>Debug data line.</td>
</tr>
<tr>
<td>DBG3</td>
<td>nRESET</td>
<td>Reset line</td>
</tr>
<tr>
<td>VOFF</td>
<td>-</td>
<td>Voltage Off input.</td>
</tr>
<tr>
<td>VBUS</td>
<td>-</td>
<td>VBUS voltage for external use.</td>
</tr>
</tbody>
</table>

Figure 3-1. Curiosity Nano Standard Pinout

---

### 3.3 Power Supply

The kit is powered through the USB port and 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 to 5.25V (according to the USB specification) and will limit the maximum voltage to the target. The following figure shows the entire power supply system on the SAME51J20A Curiosity Nano.

Figure 3-2. Power Supply Block Diagram

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#### 3.3.1 Target Regulator

The target voltage regulator is a MIC5353 variable output LDO. The on-board debugger can adjust the voltage output that is supplied to the kit target section by manipulating the feedback voltage of the MIC5353. The hardware implementation is limited to an approximate voltage range from 1.8V to 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 SAME51J20A microcontroller. The voltage limits configured in the on-board debugger on the SAME51J20A Curiosity Nano are 1.8V–3.6V. The target voltage is set to 3.3V in production and can be changed through MPLAB X IDE. Any change to the target voltage done in MPLAB X IDE 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**

![Target Regulator Safe Operation Area](image)

### 3.3.2 External Supply

The SAME51J20A Curiosity Nano 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 the VOFF to GND may cause permanent damage to the kit.

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

Programming, debugging, and data streaming is still possible while using 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 all the connections between the debugger and the SAME51J20A microcontroller. The rounded boxes represent connections to the board edge on the SAME51J20A Curiosity Nano. The signal names are shown in the following figure and printed in silkscreen on the bottom side of the board.
By cutting the GPIO straps with a sharp tool, as shown in the following figure, all I/O connected between the debugger and the SAME51J20A are completely disconnected. To completely disconnect the target regulator, cut the VTG strap shown in the following figure:

Figure 3-5. Location of GPIO Straps and VTG Strap

Tip:
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 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 SAME51J20A 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 SAME51J20A 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.

**Important:** The on-board level shifters will draw a small amount of current even when they are not in use. A maximum of 10 μA can be drawn from the VTG net and an additional 2 μA can be drawn from each I/O pin connected to a level shifter for a total of 20 μA. Disconnect the on-board debugger and level shifters as described in Disconnecting the On-Board Debugger to prevent any leakage.
4. **Hardware**

4.1 **Connectors**

4.1.1 **SAME51J20A Curiosity Nano Pinout**

All of the SAME51J20A I/O pins are accessible at the edge connectors on the SAME51J20A Curiosity Nano except the button and LED (PA15, PA14). The following figure shows the kit pinout. The RA30 and RA31 pins are only available at the edge connector in the debugger section as long as the straps on the bottom are not cut.

**Figure 4-1. SAME51J20A Curiosity Nano Pinout**

Note: Not all pin functions are listed in the diagram. Additional functions are available on these pins, for a list of additional functions please consult the latest data sheet available at www.microchip.com.

4.1.2 **SAME51J20A Curiosity Nano Base Quick Reference**

The SAME51J20A is compatible with the Curiosity Nano Base for click boards™ (AC164162). The following figure shows a simplified reference to enable quicker development. For additional information, visit www.microchip.com/developmenttools/ProductDetails/AC164162.
4.2 Peripherals

4.2.1 LED
One yellow user LED is available on the SAME51J20A Curiosity Nano kit that can be controlled with either GPIO or PWM. The LED can be activated by driving the connected I/O line to GND.

Table 4-1. LED Connection

<table>
<thead>
<tr>
<th>SAME51J20A</th>
<th>Function</th>
<th>Shared Functionality</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA14</td>
<td>Yellow LED0</td>
<td>None</td>
</tr>
</tbody>
</table>

4.2.2 Mechanical Switch
The SAME51J20A Curiosity Nano has one mechanical switch. This is a generic user configurable switch. When the switch is pressed, it will drive the I/O line to ground (GND).
Tip: There is no pull-up resistor connected to the generic user switch. Remember to enable the internal pull-up in the SAME51J20A to use the switch.

Table 4-2. Mechanical Switch

<table>
<thead>
<tr>
<th>SAME51J20A</th>
<th>Function</th>
<th>Shared Functionality</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA15</td>
<td>User Switch SW0</td>
<td>None</td>
</tr>
</tbody>
</table>

4.2.3 Crystal

The SAME51J20A Curiosity Nano board has a 32.768 kHz crystal.

By default, the crystal is populated and connected to the SAME51J20A and these pins are not usable as a GPIO. To use the crystal, no hardware modifications are required.

Table 4-3. Crystal Connections

<table>
<thead>
<tr>
<th>SAME51J20A pin</th>
<th>Function</th>
<th>Shared Functionality</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA00</td>
<td>XIN32</td>
<td>None</td>
</tr>
<tr>
<td>PA01</td>
<td>XOUT32</td>
<td>None</td>
</tr>
</tbody>
</table>

4.3 On-Board Debugger Implementation

The SAME51J20A Curiosity Nano features an on-board debugger that can be used to program and debug the SAME51J20A using a Serial Wire Debug (SWD). The on-board 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 debugger for programming and debugging. A data visualizer can be used as a front-end for the CDC and DGI GPIO.

4.3.1 On-Board Debugger Connections

The following table shows the connections 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 there is 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 debugger, see Curiosity Nano.

Table 4-4. On-Board Debugger Connections

<table>
<thead>
<tr>
<th>SAME51J20A pin</th>
<th>Debugger pin</th>
<th>Function</th>
<th>Shared Functionality</th>
</tr>
</thead>
<tbody>
<tr>
<td>PB17</td>
<td>CDC TX</td>
<td>UART TX (SAME51J20A RX line)</td>
<td>Edge Connector</td>
</tr>
<tr>
<td>PB16</td>
<td>CDC RX</td>
<td>UART RX (SAME51J20A TX line)</td>
<td>Edge Connector</td>
</tr>
<tr>
<td>PA31</td>
<td>DBG0</td>
<td>SWDATA</td>
<td>Edge Connector</td>
</tr>
<tr>
<td>PA30</td>
<td>DBG1</td>
<td>SWCLK</td>
<td>Edge Connector</td>
</tr>
<tr>
<td>PB30</td>
<td>DBG2</td>
<td>SWO</td>
<td>Edge Connector</td>
</tr>
<tr>
<td>nRESET</td>
<td>DBG3</td>
<td>nRESET</td>
<td>Edge Connector</td>
</tr>
<tr>
<td>VCC_TARGET</td>
<td>VCC_LEVEL</td>
<td>1.8-3.6v supply voltage</td>
<td>Edge Connector</td>
</tr>
<tr>
<td>GND</td>
<td>GND</td>
<td>Common ground</td>
<td>Edge Connector</td>
</tr>
</tbody>
</table>

4.3.2 Extra Ports

This implementation has two pins that are not brought out to the edge connector, the access to these are provided as surface mount test points.
<table>
<thead>
<tr>
<th>Pin</th>
<th>Port</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>PA24</td>
<td>USB/DM, CAN0/TX, TC5/VO[0], SERCOM3 &amp; SERCOM5 -PAD[2], CCL/IN[8]</td>
</tr>
<tr>
<td>46</td>
<td>PA25</td>
<td>USB/DP, CAN0/RX, TC5/VO[1], SERCOM3 &amp; SERCOM5 -PAD[3], CCL/OUT[2]</td>
</tr>
</tbody>
</table>
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 side 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, contains the product identifier and revision. The same information can be found on the sticker on the bottom side 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:

"nnnnrrssssssssss"

n = product identifier
r = revision
s = serial number
6. Schematics

SAME51 Curiosity Nano

Program / Debug Interface

IDE

Terminal

Data Visualizer

Serial / CDC port

USB

SERIAL

IDE

SWD

PB16

PB17

USART3 TX

USART3 RX

PB16

PB17

PA31

Debug GPIO 0

Debug GPIO 1

DBG0

DBG1

DBG2

DBG3

ID_SYS

VOFF

S1

SAME51_Curiosity_Nano_DEBUGGER_R3.SchDoc

S2

SAME51_Curiosity_Nano_Target_MCU_R3.SchDoc

S3


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User Guide

DS70005432A-page 16
7. Revision History

Rev. A (08/2020)
This is the initial released version of this document.
The Microchip Website

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