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## SAM IoT Wx v2 Hardware User Guide

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### Preface

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**Important:** This document is applicable to the SAM-IoT WG v2 development board, which is preconfigured to send data through the Google Cloud™ IoT Core. The SAM-IoT WG v2 development board can be reconfigured to send data to different cloud service providers.

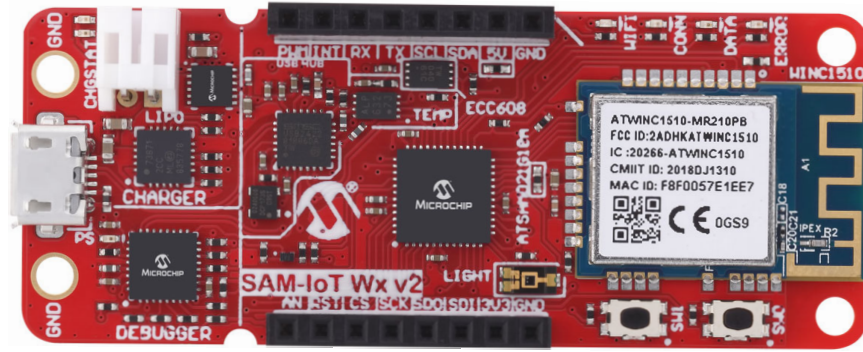
The SAM-IoT Wx v2 development board is a small and easily expandable demonstration and development platform for IoT solutions, which is based on the SAM® microcontroller architecture using Wi-Fi® technology. The development board is designed to demonstrate the design of a typical IoT application which can be simplified by dividing the problem into these blocks:

- **Smart:** Represented by the [ATSAMD21G18A](#) microcontroller
- **Secure:** Represented by the [ATECC608B](#) secure element
- **Connected:** Represented by the [ATWINC1510](#) Wi-Fi controller module

The SAM-IoT Wx v2 development board features the following elements:

- The on-board debugger (nEDBG) supplies full programming and debugging support through MPLAB® X IDE. It also provides access to a serial port interface (serial to USB bridge) and one logic analyzer channel (debug GPIO).
- The on-board debugger enumerates on the PC as a mass storage interface device for easy drag-and-drop programming, Wi-Fi configuration, and full access to the microcontroller application Command Line Interface (CLI).
- A mikroBUS™ socket enables the user to expand the board capabilities with the selection from 1000+ sensor and actuator options offered by MikroElektronika ([www.mikroe.com](http://www.mikroe.com)) through a growing portfolio of Click boards™.
- A light sensor is used to demonstrate the published data.
- Microchip [MCP9808](#) high-accuracy temperature sensor used to demonstrate published data.
- Microchip [MCP73871](#) Li-Ion/Li-Polymer battery charger with power path management.
- Microchip [USB2422T](#) USB Hub Controller - USB 2.0 USB Interface to connect the target ATSAMD21G18A MCU with PC using USB.
- [MPLAB® X IDE](#) software to discover, configure, develop, program, and debug Microchip microcontrollers.

The following figure illustrates the SAM-IoT WG v2 development board



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## 1. Introduction

### 1.1 Features

The following are key features of the SAM-IoT WG v2 development board:

- [ATSAMD21G18A](#) Arm® Cortex®-M0+ microcontroller
- [ATWINC1510](#) Wi-Fi module
- [ATECC608B](#) CryptoAuthentication™ device
- Pre-configured for Microchip accounts with cloud service providers
  - Google Cloud IoT Core
- Four user LEDs
- Two mechanical buttons
- TEMENT6000 light sensor
- [MCP9808](#) temperature sensor
- mikroBUS socket
- On-board debugger
  - Board identification in Microchip MPLAB X IDE
  - One green board power and status LED
  - Virtual serial port (USB CDC)
  - One logic analyzer channels (debug GPIO)
- Supports drag-and-drop feature
- USB and battery powered
- [USB2422T](#) USB hub
- [MIC33050](#) Buck regulator
- [MCP73871](#) Li-Ion/Li-Polymer battery charger
- Fixed 3.3V

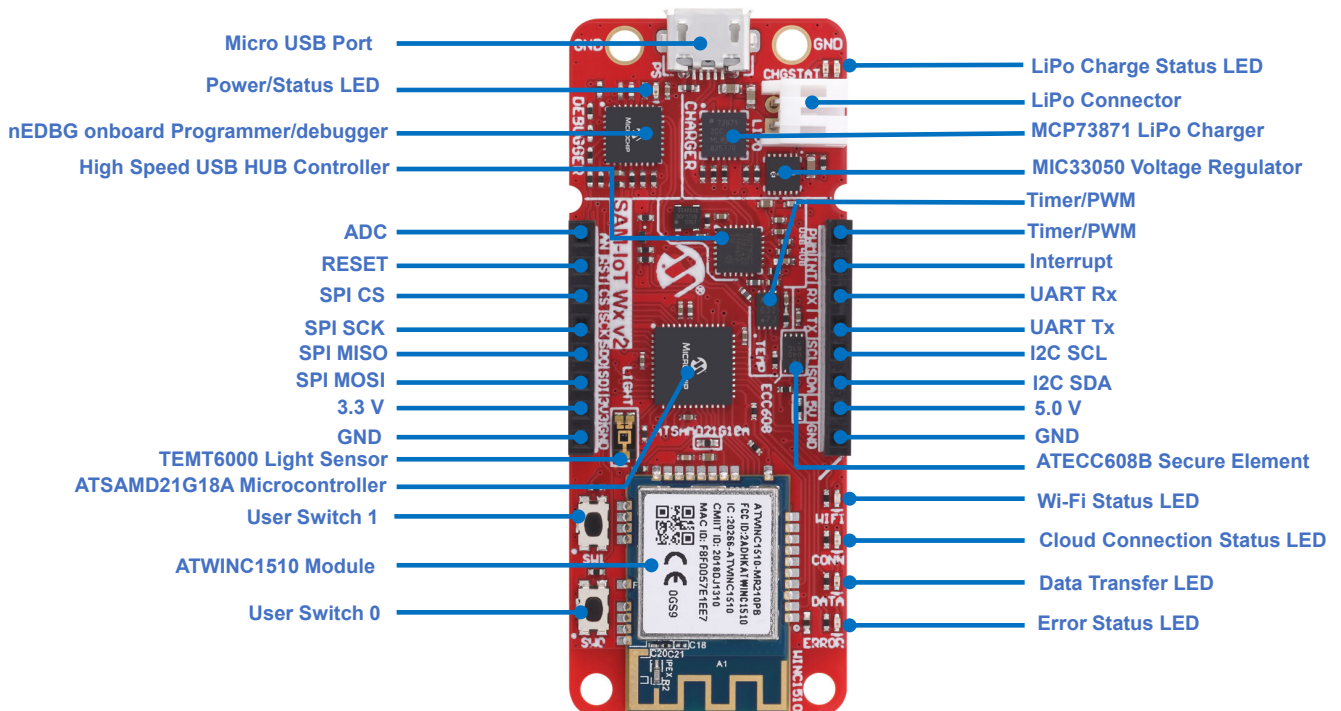
### 1.2 Board Overview

The SAM-IoT Wx v2 development board is a hardware platform used to evaluate and develop IoT solutions with the Microchip ATSAMd21G18 Arm Cortex-M0+ based Flash microcontroller, ATECC608B secure element, and the ATWINC1510 Wi-Fi controller module.

The pre-programmed demonstration application publishes data from the on-board light and temperature sensors read by the ATSAMd21G18A MCU to the cloud (every second). Any data received from the cloud over the subscribed topic is sent to the virtual serial port and can be displayed in a serial terminal application. The ATWINC1510 needs a connection to the Wi-Fi network with an internet connection. The ATECC608B is used to authenticate the hardware with the cloud to uniquely identify every board. The demonstration application source code can be modified to publish data to a personal cloud account to begin with a custom cloud application.

The following figure shows the key features and pinout of the SAM-IoT Wx v2 development board.

**Figure 1-1. SAM-IoT Wx v2 Development Board**



## 2. Getting Started

### 2.1 Quick Start

Follow these steps to exploring the SAM-IoT Wx v2 development board:

1. Connect the SAM-IoT Wx v2 development board to the computer.
2. Open the `CLICK-ME.HTM` file on the Curiosity mass storage disk and perform these actions:
  - a. Download the latest application `.hex` firmware.
  - b. Download the Wi-Fi configuration file `WIFI.cfg` by entering the required Wi-Fi credentials.
3. Drag-and-drop the application `.hex` file on the Curiosity drive and wait till update completes.
4. Drag-and-drop the `WIFI.cfg` configuration file on the Curiosity drive.

The development board will connect to the Wi-Fi network and send data to the web site (mentioned in Step 2) through a cloud provider.

### 2.2 Design Documentation and Relevant Links

The following list provides links to the relevant documents and software for the SAM-IoT Wx v2 development board.

- [MPLAB Data Visualizer](#) : A program used for processing and visualizing data. The MPLAB Data Visualizer can receive data from various sources, such as serial ports and the on-board debugger's Data Gateway Interface, as found on the Curiosity Nano and Xplained Pro boards.
- [MPLAB® X IDE](#) : A software program that runs on a PC (Windows®, Mac OS®, Linux®) to develop applications for Microchip microcontrollers and digital signal controllers. It is called the Integrated Development Environment (IDE) as it provides a single integrated environment to develop code for embedded microcontrollers.
- [Microchip Sample Store](#): Users can order device samples here.

### 3. Application User Guide

The ATSAMd21G18A microcontroller is mounted on the SAM-IoT Wx v2 development board and is pre-programmed with an application ready to publish data to a Microchip account with a cloud service provider and subscribe to data sent from [iot.microchip.com](https://iot.microchip.com) through the cloud service provider. The SAM-IoT WG v2 development board is pre-configured for Google Cloud IoT Core. The data is read from the cloud and presented to the user on [iot.microchip.com](https://iot.microchip.com).

The latest firmware and application user's guide are available for download at [EV62V87A kit page](#).

## 4. Hardware User Guide

### 4.1 On-Board Debugger Overview

The SAM-IoT Wx v2 development board contains an on-board debugger for programming and debugging. The on-board debugger is a composite USB device consisting of these interfaces:

- A debugger that can program and debug the ATSAM21G18A in MPLAB X IDE.
- A mass storage device that allows drag-and-drop programming of the ATSAM21G18A.
- A virtual serial port (CDC) that is connected to a Universal Asynchronous Receiver/Transmitter (UART) on the ATSAM21G18A and provides an easy way to communicate with the target application through terminal software.
- A Data Gateway Interface (DGI) for code instrumentation with logic analyzer channels (debug GPIO) to visualize program flow.

The on-board debugger controls a Power and Status LED (marked PS) on the SAM-IoT Wx v2 development board. The following table shows how the LED is controlled in different operation modes.

**Table 4-1. On-Board Debugger Overview**

| Operation Mode            | Power and Status LED  |
|---------------------------|---|
| Boot Loader mode          | The LED blinks slowly during power-up.  |
| Power-up                  | The LED is ON.  |
| Normal operation          | The LED is ON.  |
| Programming               | Activity indicator: The LED blinks slowly during programming/debugging.   |
| Drag-and-drop programming | Success: The LED blinks slowly for 2 seconds.<br>Failure: The LED blinks rapidly for 2 seconds.   |
| Fault                     | The LED blinks rapidly if a power fault is detected.  |
| Sleep/Off                 | The LED is OFF.<br>The on-board debugger is either in Sleep mode or powered-down.<br>This can occur if the board is externally powered. |

**Info:** Slow blinking is approximately 1 Hz, and rapid blinking is approximately 5 Hz.

#### 4.1.1 Debugger

The on-board debugger on the SAM-IoT Wx v2 development board appears as a mass storage device with a CDC on the Host computer's USB subsystem. The debugger supports full-featured programming and debugging of the ATSAM21G18A using MPLAB X IDE or other selected third-party IDEs.



**Remember:** Ensure that the firmware for the debugger is up-to-date. Firmware upgrades are done automatically when using MPLAB X IDE.

#### 4.1.2 Virtual Serial Port

The virtual serial port (CDC) is a general purpose serial bridge between the Host PC and a target device.

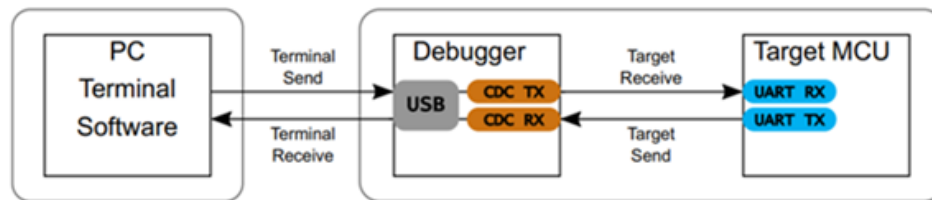
##### 4.1.2.1 Overview

The on-board debugger implements a composite USB device that includes a standard Communications Device Class (CDC) interface, which appears on the Host as a virtual serial port. The CDC can be used to stream arbitrary data in both directions between the Host computer and the target: All characters sent through the virtual serial port on the



Host computer will be transmitted as UART on the CDC TX pin of the debugger, and UART characters captured on the CDC RX pin of the debugger will be returned to the Host computer through the virtual serial port.

**Figure 4-1. CDC Connection**



**Info:** As shown above, the CDC TX pin of the debugger is connected to a UART RX pin on the target for receiving characters from the Host computer. Similarly, the CDC RX pin of the debugger is connected to a UART TX pin on the target for transmitting characters to the Host computer.

### 4.1.2.2 Operating System Support

On Windows machines, the CDC will enumerate as Curiosity Virtual COM Port and appear in the ports section of the Windows Device Manager. The COM port number can also be found there.



**Important:** On the older Windows systems, a USB driver is required for CDC. This driver is included in installations of MPLAB X IDE.

On Linux machines, the CDC will enumerate and appear as `/dev/ttyACM#`.



**Important:** The `tty*` devices belong to the `dialout` group in Linux, therefore it is necessary to become a member of that group to have permissions to access the CDC.

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#`.



**Important:** For all operating systems, ensure to use a terminal emulator that supports DTR signaling. Refer to the [Signaling](#) for additional information.

### 4.1.2.3 Limitations

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

- **Baud rate:** Must be in the range of 1200 bps to 500 kbps. Any baud rate outside this range will be set to the closest limit, 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.

### 4.1.2.4 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. As this is a virtual control signal implemented on the USB interface, it is not physically present on the board. Asserting the DTR signal from the Host will indicate to

the on-board debugger that a CDC session is active. The debugger will then 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 will disable the receiver, therefore 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.



**Remember:** Set up the terminal emulator to assert the DTR signal. Without the signal, the on-board debugger will not send or receive any data through its UART.



**Tip:** The CDC TX pin of the on-board debugger will not be driven until the CDC interface is enabled by the Host computer. Also, there are no external pull-up resistors on the CDC lines connecting the debugger and the target, which means that during power-up, these lines are floating. To avoid any glitches resulting in unpredictable behavior, such as framing errors, the target device must enable the internal pull-up resistor on the pin connected to the CDC TX pin of the debugger.

### 4.1.2.5 Advanced Use

#### CDC Override Mode

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

Dropping a text file into the mass storage drive of the on-board debugger can be used to send characters out of the CDC TX pin on the debugger. The file name and extension are trivial, but the text file must start with the characters:

```
CMD:SEND_UART=
```

The maximum message length is 50 characters. 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 previously 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 such frame will be queued up for sending to the CDC TX pin of the debugger. Transferring a small amount of data per frame can be inefficient, particularly at low-baud rates, as the on-board debugger buffers frames and not bytes. A maximum of four 64-byte frames can be active at any time. The on-board debugger will throttle the incoming frames accordingly. Sending full 64-byte frames containing data is the most efficient method.

When receiving data on the CDC RX pin of the debugger, the on-board debugger will queue up the 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 eight 64-byte frames can be active at any time.

If the Host (or the 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.

### 4.1.3 Mass Storage Device

The on-board debugger includes a simple mass storage device implementation, which is accessible for read/write operations through the Host operating system to which it is connected.

The mass storage device provides the following:

- Read access to basic text and HTML files for detailed kit information and support.

- Write access for programming Intel® HEX formatted files into the memory of the target device.
- Write access for simple text files for utility purposes.

### 4.1.3.1 Mass Storage Device Implementation

The on-board debugger implements a highly optimized variant of the FAT12 file system that has several limitations, partly due to the nature of FAT12 itself and optimizations made to fulfill its purpose for its embedded application.

The Curiosity Nano USB device is USB Chapter 9 compliant as a mass storage device but does not, in any way, fulfill the expectations of a general purpose mass storage device. This behavior is intentional.

When using the Windows operating system, the on-board debugger enumerates as a Curiosity Nano USB Device that can be found in the disk drives section of the device manager. The Curiosity drive appears in the file manager and claims the next available drive letter in the system.

The Curiosity drive contains approximately 1 MB of free space. This does not reflect the size of the Flash on the target device in any way. When programming an Intel HEX file, the binary data are encoded in ASCII with metadata providing a large overhead, therefore 1 MB is a trivially chosen value for disk size.

It is not possible to format the Curiosity drive. When programming a file to the target, the file name may appear in the disk directory listing. This is the operating system's view of the directory, which in reality has not been updated. It is not possible to read out the file contents. Removing and replugging the board will return the file system to its original state, but the target will still contain the application that has been previously programmed.

To erase the target device, copy a text file starting with `CMD:ERASE` onto the disk.

By default, the Curiosity drive contains the following read-only files for generating icons as well as reporting status, and linking to further information.

- `AUTORUN.ICO`: Icon file for the Microchip logo.
- `AUTORUN.INF`: System file required for Windows Explorer to show the icon file.
- `CLICK-ME.HTM`: Redirect to the SAM-IoT WG v2 web demonstration application.
- `KIT-INFO.HTM`: Redirect to the development board website.
- `KIT-INFO.TXT`: Text file containing details about the board's debugger firmware version, board name, USB serial number, device, and drag-and-drop support.
- `PUBKEY.TXT`: Text file containing the public key for data encryption.
- `STATUS.TXT`: Text file containing the programming status of the board.

**Info:** The `STATUS.TXT` file is dynamically updated by the on-board debugger. The contents may be cached by the OS, and therefore, do not reflect the correct status.

### 4.1.3.2 Limitations of Drag-and-Drop Programming

The NVM User Row bits included in the hex file will be ignored when using the drag-and-drop programming. However, the NVM User Row bits can be programmed using MPLAB X IDE.

### 4.1.3.3 Special Commands

Several utility commands are supported by copying text files to the mass storage disk. The file name or extension is irrelevant as the command handler reacts to content only.

**Table 4-2. Special File Commands**

| Command Content             | Description  |
|-----------------------------|--|
| <code>CMD:ERASE</code>      | Executes a chip erase of the target.   |
| <code>CMD:SEND_UART=</code> | Sends a string of characters to the CDC UART. See <a href="#">CDC Override Mode</a> .  |
| <code>CMD:RESET</code>      | Resets the target device by entering Programming mode and then exiting Programming mode immediately thereafter. Exact timing can vary according to the programming interface of the target device (debugger firmware v1.16 or latest). |

**Info:** The commands listed above are triggered by the content being sent to the mass storage emulated disk, and no feedback is provided in the case of either success or failure.

### 4.1.4 Data Gateway Interface

Data Gateway Interface (DGI) is a USB interface for transporting raw and timestamped data between the on-board debugger and Host computer-based visualization tools. [MPLAB Data Visualizer](#) is used on the Host computer to display debug GPIO data. It is available as a plug-in for MPLAB X IDE or as a stand-alone application that can be used in parallel with MPLAB X IDE.

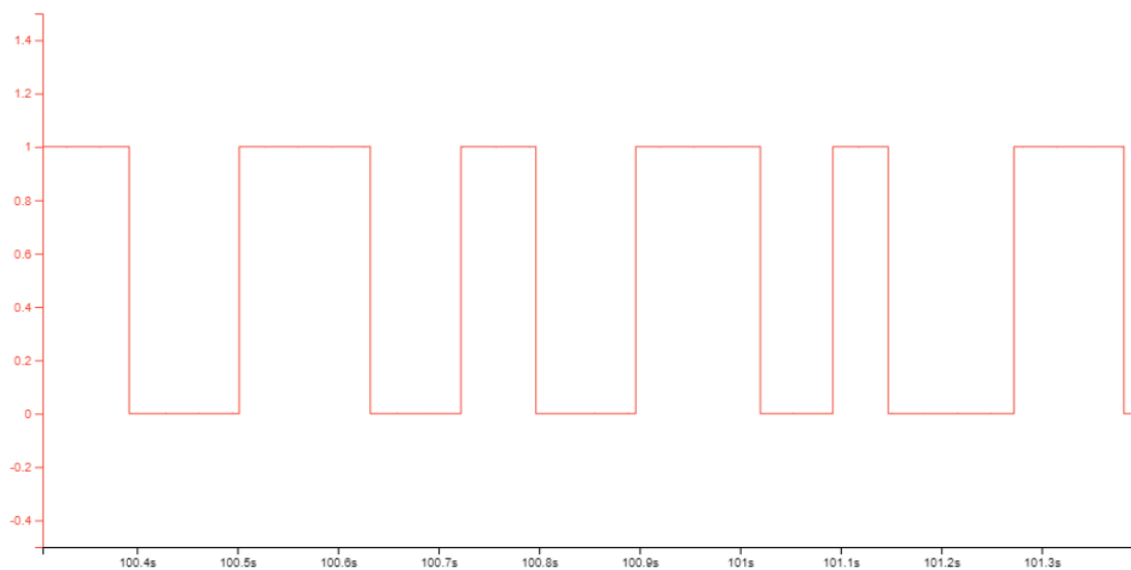
Although DGI encompasses several physical data interfaces, the SAM-IoT Wx v2 development board implementation includes a logic analyzer channel: one debug GPIO channel (also known as DGI GPIO).

#### 4.1.4.1 Debug GPIO

Debug GPIO channels are timestamped digital signal lines connecting the target application to a Host computer visualization application. They are typically used to plot the occurrence of low-frequency events on a time-axis. For example, when certain application state transitions occur.

The following figure shows the monitoring of the digital state of a mechanical switch connected to a debug GPIO in MPLAB Data Visualizer.

**Figure 4-2. Monitoring Debug GPIO with MPLAB Data Visualizer**



Debug GPIO channels are timestamped, therefore the resolution of DGI GPIO events is determined by the resolution of the DGI timestamp module.



**Important:** Although bursts of higher-frequency signals can be captured, the useful frequency range of signals for which debug GPIO can be used is up to about 2 kHz. Attempting to capture signals above this frequency will result in data saturation and overflow, which may cause the DGI session to abort.

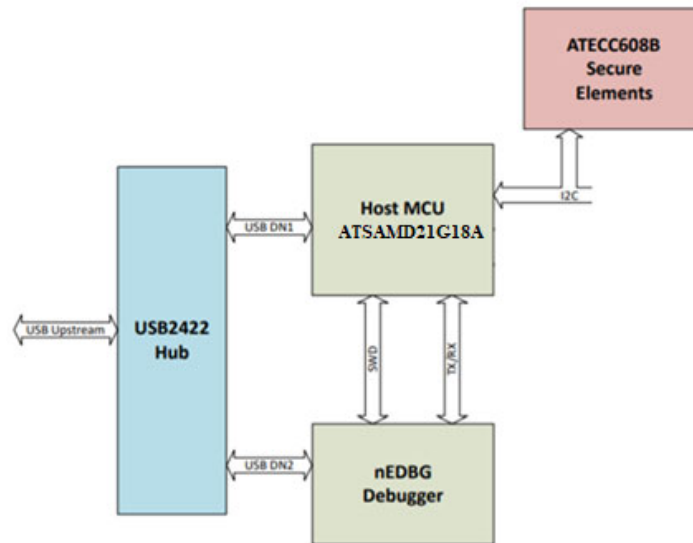
#### 4.1.4.2 Timestamping

DGI sources are timestamped as they are captured by the debugger. The timestamp counter implemented in the Curiosity Nano debugger increments at 2 MHz frequency, providing a timestamp resolution of a half microsecond.

### 4.1.5 USB HID Support

The USB hub enables the PC to communicate with the target SAMD21G18A MCU using the USB HID interface. This interface helps the PC tool to provision the ATECC608B through the SAMD21 MCU.

**Figure 4-3. USB Hub**



## 4.2 On-Board Debugger Connections

The following table provides 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. There is little contamination of the signals, hence the pins can be configured to anything the user requires.

For additional information on how to use the capabilities of the on-board debugger, refer to the [On-Board Debugger Overview](#).

**Table 4-3. On-Board Debugger Connections**

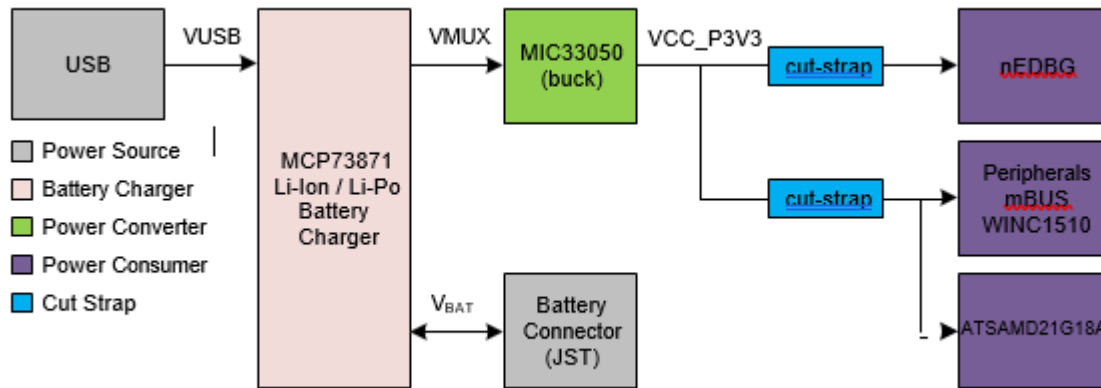
| Debugger Pin | ATSAMD21G18 Pin | Function  | Shared Functionality |
|--------------|-----------------|-----------|----------------------|
| CDC TX       | PB02            | SERCOM 5  | -                    |
| CDC RX       | PB03            | SERCOM 5  | -                    |
| DBG0         | PA31            | SWDIO     | -                    |
| DBG1         | PA30            | SWCLK     | -                    |
| DBG2         | PA28            | DGI GPIO0 | -                    |
| DBG3         | RESETN          | RESET     | -                    |

## 4.3 Power

### 4.3.1 Power Source

The development board can be powered through the USB port or by a Li-Ion/Li-Polymer battery. The development board contains one buck converter for generating 3.3V for the debugger, target, and peripherals. The maximum available current from the USB is limited to 500 mA. The current will be shared between charging the battery (if connected) and the target application section. The following figure illustrates the power supply details.

**Figure 4-4. Power Supply Block Diagram**



### 4.3.2 Battery Charger

The SAM-IoT Wx v2 development board features an MCP73871 Li-Ion/Li-Polymer charger and JST battery connector on board. The charger is configured to limit the charge current to 100 mA to prevent the overcharging of small capacity batteries. The minimum recommended battery capacity is 400 mA. The table below provides the charge status of the LEDs.



The MCP73871 Li-Ion/Li-Polymer charger has a battery charge voltage of 4.2V. Make sure the battery has the same charge voltage.

**Table 4-4. Charge Status LEDs**

| LEDs              | Function   |
|-------------------|--|
| Red (charging)    | The battery is being charged by the USB  |
| Red (discharging) | The battery voltage is low. Triggers if the voltage is under 3.1V.               |
| Green             | Charge complete  |
| Red and Green     | Timer Fault. The six-hour charge cycle has timed out before the complete charge. |

### 4.3.3 Hardware Modifications

On the bottom side of the SAM-IoT Wx v2 development board there are two cut-straps, as shown in the following figure, which are intended for current measurements. Do not leave these unconnected as this can lead to the microcontrollers being powered through the I/O's.

**Figure 4-5. VCC Cut-Straps**



The 5V supply to the mikroBUS socket is connected by default. To remove the 5V supply from the socket, desolder the 0Ω resistor (0402) below the 5V text, as shown in the following figure.

Figure 4-6. mikroBUS™ 5V Footprint



## 4.4 Components

### 4.4.1 ATSAM D21G18A

The Microchip SAM D21 is a series of low-power microcontrollers using the 32-bit Arm Cortex-M0+ processor, and ranges from 32-pins to 64-pins with up to 256-KB Flash and 32-KB SRAM. The SAM D21 operates at a maximum frequency of 48 MHz and reaches 2.46 CoreMark/MHz. They are designed for simple and intuitive migration with identical peripheral modules, hex compatible code, identical linear address map, and pin compatible migration paths between all devices in the product series. All devices include intelligent and flexible peripherals, such as an Event System for inter-peripheral signaling, support for a capacitive touch button, slider, and wheel user interfaces.

### 4.4.2 mikroBUS™ Socket

The SAM-IoT Wx v2 development board features a mikroBUS socket for expanding the functionality of the development board using MikroElektronika Click boards and other mikroBUS add-on boards. The socket is populated with two 1x8 2.54 mm pitch female headers and is ready to mount add-on boards.

**Table 4-5. mikroBUS™ Socket Pinout**

| mikroBUS™ Socket Pin | ATSAMD21G18A Pin | Function                                | Shared Functionality |
|----------------------|------------------|---|----------------------|
| AN                   | PA02             | ADC AIN0                                | -                    |
| RST                  | PA03             | GPIO                                    | -                    |
| CS                   | PA06             | SERCOM 0 SPI Chip Select                | -                    |
| SCK                  | PA05             | SERCOM 0 SPI Clock                      | -                    |
| MISO                 | PA07             | SERCOM 0 SPI MISO                       | -                    |
| MOSI                 | PA04             | SERCOM 0 SPI MOSI                       | -                    |
| +3.3V                | -                | VCC_TARGET (3.3V)                       | -                    |
| GND                  | -                | Ground                                  | -                    |
| PWM                  | PB23             | TCC3                                    | -                    |
| INT                  | PB22             | GPIO                                    | -                    |
| RX                   | PA09             | SERCOM 2 UART RX                        | -                    |
| TX                   | PA08             | SERCOM 2 UART TX                        | -                    |
| SCL                  | PA17             | SERCOM 1 I2C Clock                      | -                    |
| SDA                  | PA16             | SERCOM 1 I2C Data                       | -                    |
| +5V                  | -                | VCC_MUX <sup>(1)</sup> , MCP73871output | -                    |
| GND                  | -                | Ground                                  | -                    |

**Note:**

1. A 0Ω resistor has been soldered to connect the VCC\_MUX pin to the mikroBUS socket. If an add-on module cannot handle 5V on this pin, the 0 Ω resistor must be removed. For additional information, see [Hardware Modifications](#).

### 4.4.3 ATWINC1510 Wi-Fi Module

The ATWINC1510 Wi-Fi module is a low-power consumption IEEE® 802.11 b/g/n IoT module, specifically optimized for low-power IoT applications. The module integrates a Power Amplifier (PA), Low-Noise Amplifier (LNA), switch, power management, a printed antenna, or a micro co-ax (U.FL) connector for an external antenna resulting in a small form factor (21.7x14.7x2.1 mm) design. It is interoperable with the 802.11 b/g/n access points of various vendors. This module provides SPI ports to interface with a Host controller.



The ATWINC1510 provides internal Flash memory and multiple peripheral interfaces, including UART and SPI. The only external clock source needed for the ATWINC1510 is the built-in, high-speed crystal, or oscillator (26 MHz). The ATWINC1510 is available in a QFN package or as a certified module.

The communication interface between the ATSAMD21G18A and ATWINC1510 Wi-Fi module is the SPI, together with some enabled signals and interrupts. The rest of the connections are left unconnected.

**Table 4-6. ATWINC1510 Connections**

| ATWINC1510 Pin | ATSAMD21G18A Pin | Function              | Shared Functionality |
|----------------|------------------|-----------------------|----------------------|
| 4 RESET_N      | PB10             | GPIO                  | -                    |
| 9 GND          | -                | Ground                | -                    |
| 10 SPI_CFG     | -                | Pulled-up to VCC_WINC | -                    |
| 11 WAKE        | PA19             | GPIO                  | -                    |
| 12 GND         | -                | Ground                | -                    |
| 13 IRQN        | PA18             | EIC EXT INT 2         | -                    |
| 15 SPI_MOSI    | PA12             | SERCOM 4 SPI MOSI     | -                    |
| 16 SPI_SSN     | PA14             | SERCOM 4 SPI CS       | -                    |
| 17 SPI_MISO    | PA15             | SERCOM 4 SPI MISO     | -                    |
| 18 SPI_SCK     | PA13             | SERCOM 4 SPI Clock    | -                    |
| 20 VBAT        | -                | VCC_WINC (3.3V)       | -                    |
| 22 CHIP_EN     | PB11             | GPIO                  | -                    |
| 23 VDDIO       | -                | VCC_WINC (3.3V)       | -                    |
| 28 GND         | -                | Ground                | -                    |
| 29 PADDLE      | -                | Ground                | -                    |

### 4.4.4 ATECC608B

The ATECC608B is a secure element from the Microchip CryptoAuthentication portfolio with advanced Elliptic Curve Cryptography (ECC) capabilities. With ECDH and ECDSA being built right in, this device is ideal for the rapidly growing IoT market by easily supplying the full range of security, such as confidentiality, data integrity, and authentication to systems with MCU or MPUs running encryption or decryption algorithms. Similar to all Microchip CryptoAuthentication products, the new ATECC608B employs ultra-secure hardware-based cryptographic key storage and cryptographic countermeasures which eliminate potential backdoors linked to software weaknesses.

The ATECC608B uses TrustFLEX for TLS-based network secure authentication in addition to many more use cases. The device comes pre-configured with more use cases than just the device to cloud secure authentication Trust&GO offer. It offers a pre-architected implementation for accessory authentication, firmware validation, secure boot assistance, key rotation and more. Compatible for AWS IoT, Microsoft Azure, Google Cloud Platform and any TLS networks with code examples for WolfSSL, mBedTLS, or CycloneSSL.

The ATECC608B CryptoAuthentication device on the SAM-IoT Wx v2 development board is used to authenticate the hardware with cloud service providers to uniquely identify every board.

**Note:** 7-bit I<sup>2</sup>C address: 0x6C.

**Table 4-7. ATECC608B Connections**

| ATECC608B Pin | ATSAMD21G18A Pin | Function | Shared Functionality |
|---------------|------------------|----------|----------------------|
| SDA           | PA22             | SERCOM 3 | MCP9808              |
| SCL           | PA23             | SERCOM 3 | MCP9808              |

### 4.4.5 Temperature Sensor

The MCP9808 digital temperature sensor converts temperatures between -20°C and +100°C to a digital word.

Additional features:

- 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:
  - 0.5°C, 0.25°C, 0.125°C, 0.0625°C
- User Programmable Temperature Limits:
  - Temperature Window Limit
  - Critical Temperature Limit
- User Programmable Temperature Alert Output
- Operating Voltage Range:
  - 2.7V to 5.5V
- Operating Current:
  - 200 µA (typical)
- Shutdown Current:
  - 0.1 µA (typical)

The MCP9808 temperature sensor is connected to the ATSAMD21G18A through the I<sup>2</sup>C and a GPIO for user configurable alert output.

**Note:** The 7-bit I<sup>2</sup>C address is 0x18.

**Table 4-8. MCP9808**

| MCP9808 Pin | ATSAMD21G18A Pin | Function      | Shared Functionality |
|-------------|------------------|---------------|----------------------|
| SDA         | PA22             | SERCOM 3      | ATECC608B            |
| SCL         | PA23             | SERCOM 3      | ATECC608B            |
| Alert       | PA27             | EIC EXT INT15 | -                    |

### 4.4.6 Light Sensor

The TEMT6000X01 light sensor is mounted on the SAM-IoT Wx v2 development board for measuring the light intensity. The sensor is a current source that will induce a voltage across the series resistor, which in turn can be measured by the ATSAM21G18A ADC. The current is exponentially relative to luminance, from about 10  $\mu\text{A}$  @ 20lx to 50  $\mu\text{A}$  @ 100lx. The series resistor has a value of 10 k $\Omega$ .

**Table 4-9. ATSAM21G18A**

| ATSAMD21G18A Pin | Function | Shared Functionality |
|------------------|----------|----------------------|
| PB08             | ADC AIN2 | -                    |

### 4.4.7 LED

Four LEDs are available on the SAM-IoT Wx v2 development board that can be controlled with PWM or GPIO. The LEDs can be activated by driving the connected I/O line to GND.

**Table 4-10. LED Connections**

| ATSAMD21G18A Pin | Function | Description |
|------------------|----------|-------------|
| PA10             | GPIO     | Red LED     |
| PA11             | GPIO     | Yellow LED  |
| PA20             | GPIO     | Green LED   |
| PA21             | GPIO     | Blue LED    |

### 4.4.8 Mechanical Buttons

The SAM-IoT Wx v2 development board contains two generic user-configurable mechanical buttons. When a button is pressed, it will drive the connected I/O line to ground (GND).

**Info:** There are no pull-up resistors connected to the generic user buttons, ensure to enable the internal pull up in the ATSAM21G18A to use the buttons.

**Table 4-11. Mechanical Buttons**

| ATSAMD21G18A Pin | Description         | Shared Functionality |
|------------------|---------------------|----------------------|
| PA00             | User switch 0 (SW0) | -                    |
| PA01             | User switch 1 (SW1) | -                    |

## **5. Regulatory Approval**

### **5.1 United States**

Contains Transmitter Module FCC ID: 2ADHKATWINC1510.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy, and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

### **5.2 Canada**

Contains IC: 20266-ATWINC1510.

This device complies with Industry Canada's license-exempt RSS standards. Operation is subject to the following two conditions:

1. This device may not cause interference.
2. This device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

1. l'appareil ne doit pas produire de brouillage, et
2. l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Guidelines on Transmitter Antenna for License Exempt Radio Apparatus:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

### 5.3 Taiwan

Contains module: CCAN18LP0320T0.

注意！

依據 低功率電波輻射性電機管理辦法

第十二條 經型式認證合格之低功率射頻電機，非經許可，公司、商號或使用者均不得擅自變更頻率、加大功率或變更原設計之特性及功能。

第十四條 低功率射頻電機之使用不得影響飛航安全及干擾合法通信；經發現有干擾現象時，應立即停用，並改善至無干擾時方得繼續使用。

前項合法通信，指依電信規定作業之無線電信。

低功率射頻電機須忍受合法通信或工業、科學及醫療用電波輻射性電機設備之干擾。

### 5.4 List of Antenna Types

ATWINC1510-MR210 does not allow the use of external antennas and is tested with the PCB antenna on the module.

## 6. Hardware Revision History

This document is written to provide information about the latest available revision of the board.

### 6.1 Identifying Product ID and Revision

The revision and product identifier of the SAM-IoT Wx v2 development board can be found in two ways: Either by utilizing the MPLAB X IDE Kit Window or by looking at the sticker on the bottom side of the PCB.

By connecting a SAM-IoT Wx v2 development board to a computer with MPLAB X IDE running, the Kit Window will pop up. The first six digits of the serial number, which is listed under kit information, contain the product identifier and revision.



**Tip:** The MPLAB X IDE Kit Window can be opened in MPLAB X IDE, from the menu bar *Window > Kit Window*.

The same information can be found on the sticker on the bottom side of the PCB. Most boards will have the identifier and revision printed 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 data matrix code, containing the product identifier, revision, and serial number.

The serial number string has the following format: "nnnnrrssssssss"

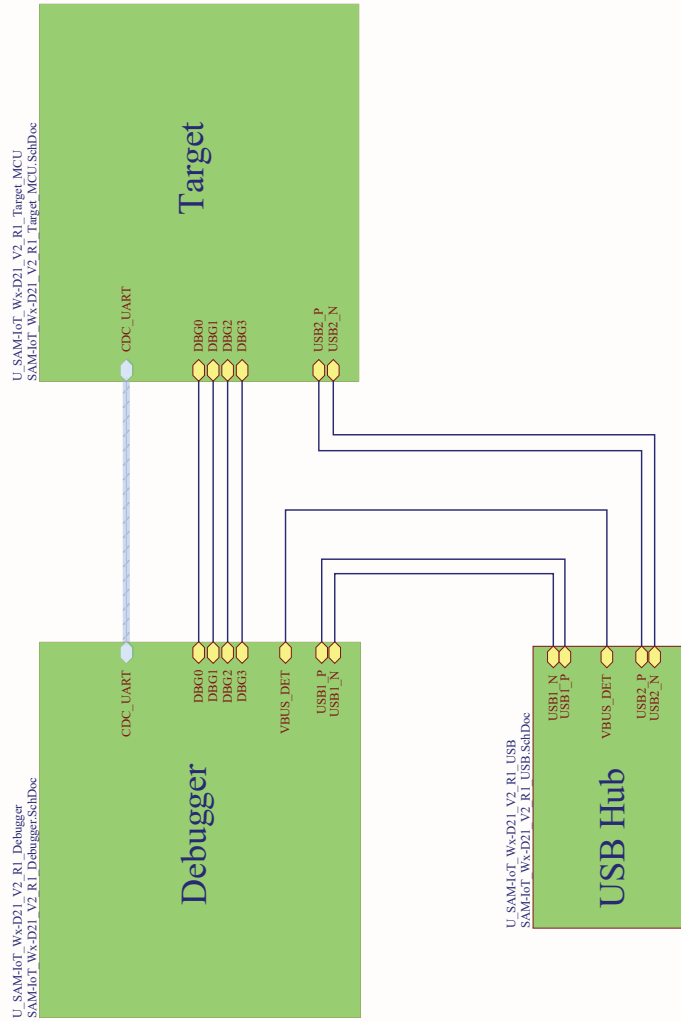
n = product identifier r = revision

s = serial number

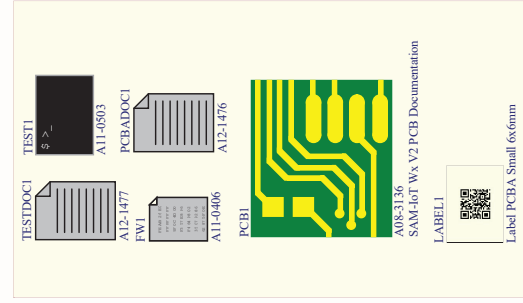
The product identifier for SAM-IoT Wx v2 development board is A09-3439.

**7. Appendix**

# SAM-**IoT Wx-D21**

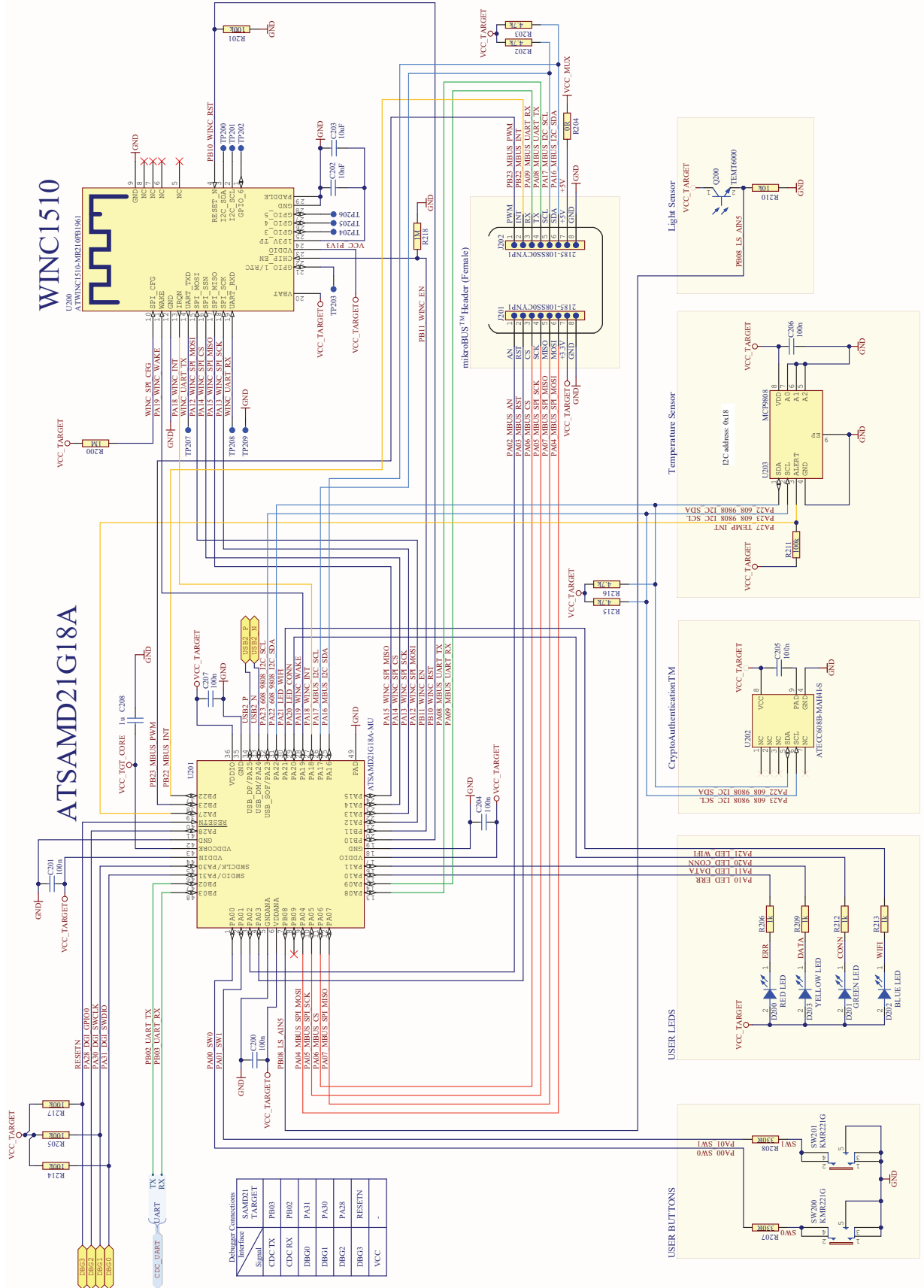


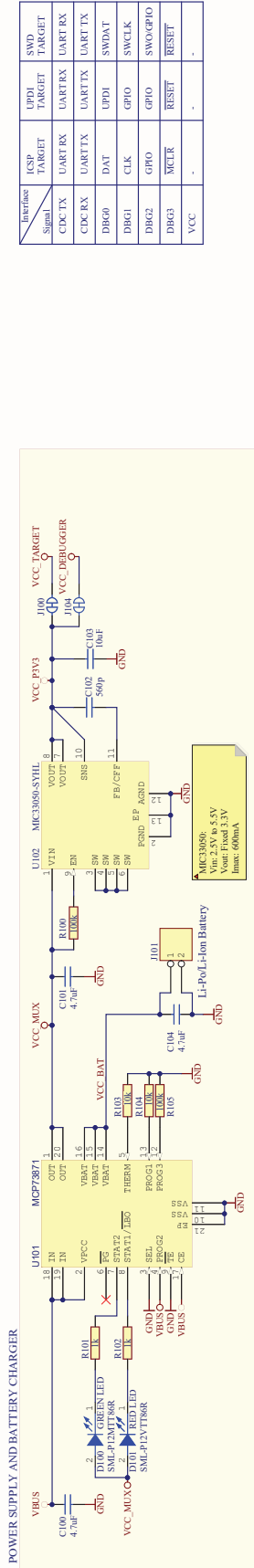
- Product: A09-3439 (EV62V87A)
- A08-2808 (Box)
  - A08-2996 (Label Outer Box)
  - A09-3440 (PCBA in ESD Bag)
  - A08-1664 (ESD Bag)
  - A08-3056 (Outer Label)
  - A09-0614 (Inner Label)
  - A09-3441 (PCBA)
- Components
- A08-3136 (PCB Doc)
  - A11-0406 (nEDBG Firmware)
  - A11-0503 (Test Software)
  - A12-1476 (PCBA Doc)
  - A12-1477 (Test Instr.)



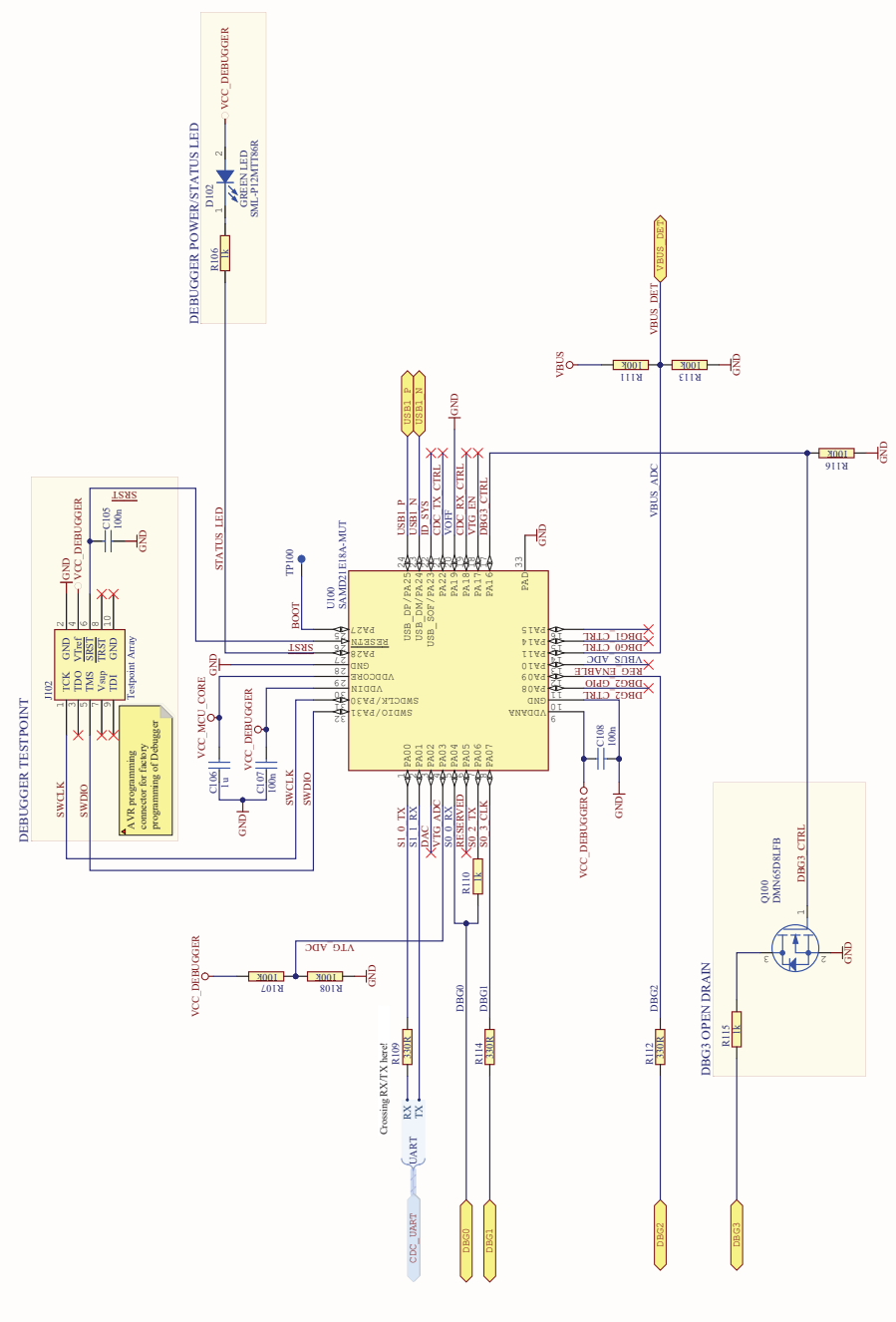
U\_SAM4IoT\_Wx-D21\_V2\_R1\_Revision\_History  
SAM-**IoT Wx-D21 V2 R1** Revision\_History.SchDoc



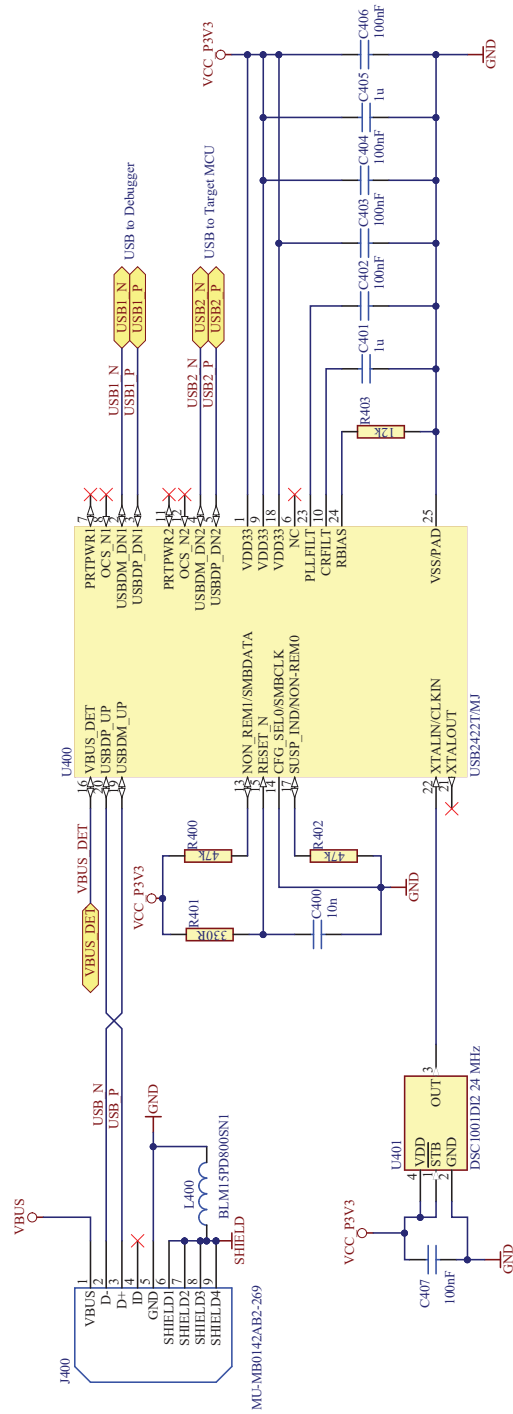




| Interface | ICSP TARGET | UPDI TARGET | SWD TARGET |
|-----------|-------------|-------------|------------|
| Signal    | UART RX     | UART RX     | UART RX    |
|           | UART TX     | UART TX     | UART TX    |
|           | DAT         | UPDI        | SWDAT      |
|           | DBG0        | GPI0        | SWCLK      |
|           | DBG1        | GPI0        | SWO_CPIO   |
|           | DBG2        | GPI0        | SWO_CPIO   |
|           | DBG3        | MCLR        | RESET      |
|           | VCC         | -           | -          |



DEBUGGER USB MICRO-B CONNECTOR



## 7.2 Assembly Drawing

Figure 7-1. SAM-IoT Wx v2 Development Board Assembly Drawing Top

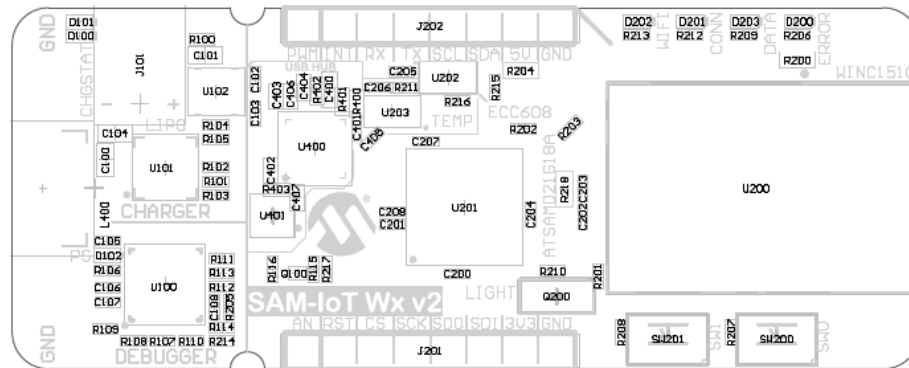
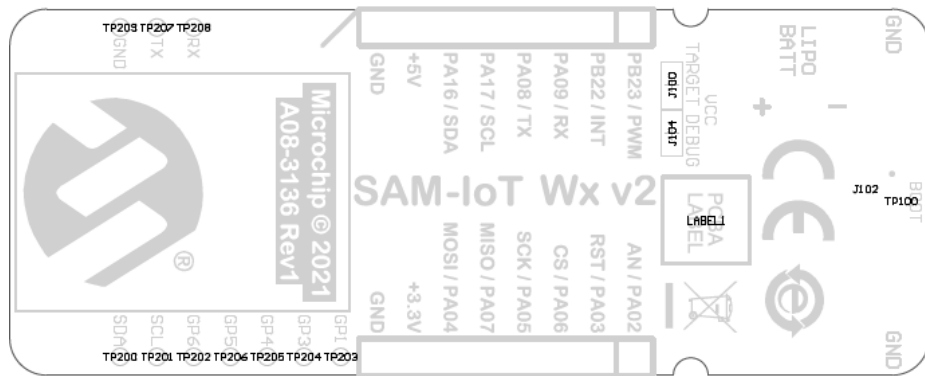


Figure 7-2. SAM-IoT Wx v2 Development Board Assembly Drawing Bottom



## 7.3 Mechanical Drawings

The following figures show the board's mechanical drawing and connector placement.

Figure 7-3. Mechanical Dimensions

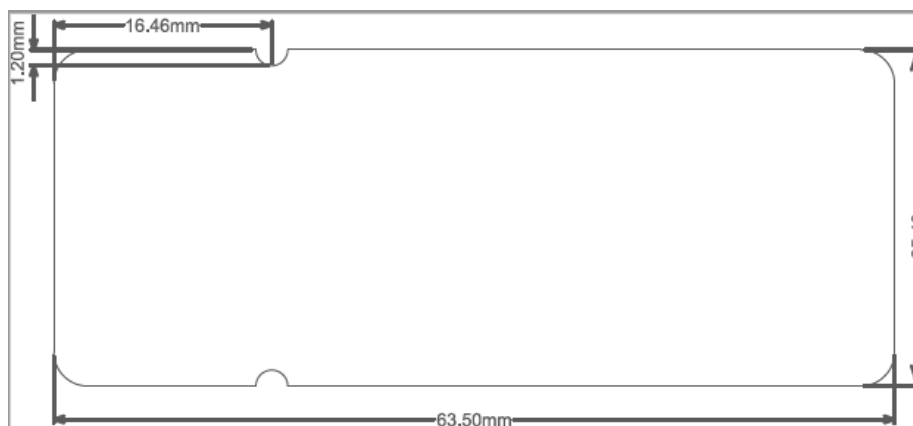
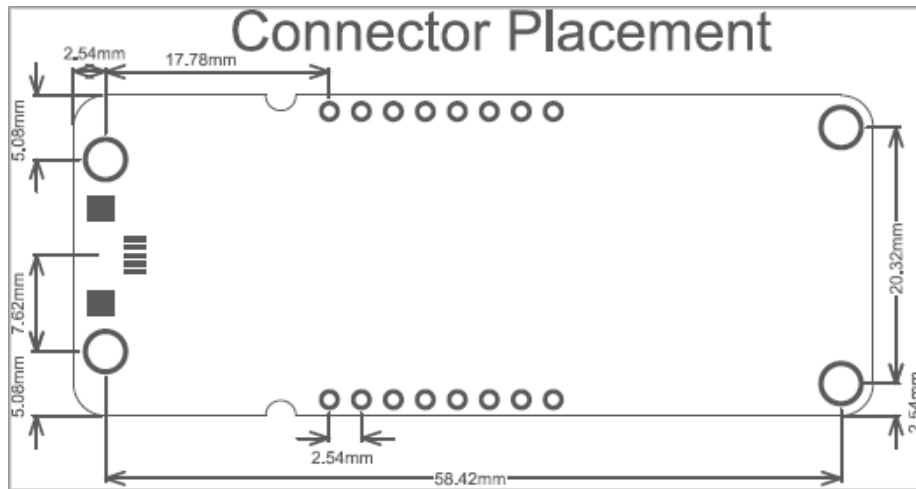


Figure 7-4. Connector Placement



### 7.4 Bill of Materials

Table 7-1. Bill of Materials

| Qty | Designator   | Description   | Value            | Manufacturer                  | MPN                |
|-----|--|---|------------------|-------------------------------|--------------------|
| 3   | C100, C101, C104   | Ceramic capacitor, SMD 0603, X5R, 10V, 10% (de31036)                                      | 4.7 uF           | WALSIN Technology Corporation | 0603X475K100CT     |
| 1   | C102   | Ceramic capacitor, SMD 0402, X7R, 50V, +/-10%   | 560p             |                               |                    |
| 2   | C103, C203   | Ceramic capacitor, SMD 0402, X5R, 6.3V, 20%   | 10 uF            | Murata                        | GRM155R60J106ME15  |
| 14  | C105, C107, C108, C200, C201, C204, C205, C206, C207, C402, C403, C404, C406, C407 | Ceramic capacitor, SMD 0402, X7R, 16V, +/-10%   | 100n             | Kemet                         | C0402C104K4RACTU   |
| 4   | C106, C208, C401, C405   | Ceramic capacitor, SMD 0402, X5R, 6.3V, +/-10% (de26942)                                  | 1u               | Kemet                         | C0402C105K9PAC     |
| 2   | C202, C400   | Ceramic capacitor, SMD 0402, X7R, 25V, 10%  | 10 nF            | Murata                        | GRM155R71E103KA01D |
| 3   | D100, D102, D201   | LED, SMD 0402, Green, Wave length = 569 nm, 2.1 mcd @ (1 mA, 1.9 Vf) $\Omega$             | GREEN LED        | ROHM                          | SML-P12MTT86R      |
| 2   | D101, D200   | LED, SMD 0402, Red, Wave length = 630 nm, 2.1mcd @ (1 mA, 1.7 Vf) $\Omega$                | RED LED          | ROHM                          | SML-P12VTT86R      |
| 1   | D202   | LED, SMD 0402, Blue, Wave length = 470 nm, 25 mcd @ (5 mA, 2.9 Vf) $\Omega$               | BLUE LED         | ROHM                          | SMLP13BC8TT86      |
| 1   | D203   | LED, SMD 0402, Yellow, Wave length = 586 nm, 7.6 mcd @ (1 mA, 1.9 Vf)                     | YELLOW LED       | ROHM                          | SML-P12YTT86R      |
| 1   | J101   | Pin Header 1x2, 2 mm THM, right entry, 100V AC/DC, 2A AC/DC (AWG #24) (Element14:9491902) | S2B-PH-K-S       | J.S.T. Mfg. Co. Ltd.          | S2B-PH-K-S         |
| 2   | J201, J202   | 1x8 receptacle pin header, 2.54 mm pitch THM, PIP   | 2185-108SS0CYNP1 | WCON                          | 2185-108SS0CYNP1   |
| 1   | J400   | USB micro AB, Surface mount signals and DIP shield  | MU-MB0142AB2-269 | Allen Creations Corp.         | MU-MB0142AB2-269   |
| 1   | L400   | FERRITE CHIP 80 $\Omega$ 1500MA 0402  | BLM15PD800SN1    | Murata                        | BLM15PD800SN1      |
| 1   | Q100   | N-channel MOSFET, DFN1006-3 (SOT883), 60V, 330 mA, 4 $\Omega$                             | DMN65D8LFB       | Diodes Incorporated           | DMN65D8LFB-7       |
| 1   | Q200   | light sensor  | TEMT6000         | Vishay                        | TEMT6000X01        |
| 12  | R100, R105, R107, R108, R111, R113, R116, R201, R205, R211, R214, R217             | Thick film resistor, SMD 0402, 1/16W, 1%  | 100k             | ASJ Holdings                  | CR10-1003-FK       |
| 9   | R101, R102, R106, R110, R115, R206, R209, R212, R213                               | Thick film resistor, SMD 0402, 1/16W, 1%  | 1k               | ASJ Holdings                  | CR10-1001-FK       |
| 3   | R103, R104, R210   | Thick film resistor, SMD 0402, 1/16W, 1%  | 10k              | Yageo                         | RC0402FR-0710KL    |
| 6   | R109, R112, R114, R207, R208, R401   | Thick film resistor, SMD 0402, 1/16W, 1%  | 330R             | Yageo                         | RC0402FR-07330RL   |
| 2   | R200, R218   | Thick film resistor, SMD 0402, 1/16W, 1%  | 1M               | Yageo                         | RC0402FR-071ML     |

.....continued

| Qty | Designator             | Description  | Value                  | Manufacturer    | MPN                    |
|-----|------------------------|--|------------------------|-----------------|------------------------|
| 4   | R202, R203, R215, R216 | Thick film resistor, SMD 0402, 1/16W, 1%   | 4.7k                   | Yageo           | RC0402FR-074K7L        |
| 1   | R204                   | RES 0.0 OHM 1/16W 0402 SMD   | 0R                     | (n/a)           | RMCF0402ZT0R00         |
| 2   | R400, R402             | Thick film resistor, SMD 0402, 1/16W, 1%   | 47k                    | Yageo           | RC0402FR-0747KL        |
| 1   | R403                   | Thick film resistor, SMD 0402, 1/16W, 1%   | 12k                    | Yageo           | RC0402FR-0712KL        |
| 2   | SW200, SW201           | Micro miniature Tact Switch for SMT  | KMR221G                | ITT Corporation | KMR221G                |
| 1   | U401                   | Standard Clock 2520 pkg MEMS OSCILLATOR, LOW POWER, 25 PPM 024.0000 MHz  | DSC1001DI2 24 MHz      | Microchip       | DSC1001DI2-024.0000T   |
| 1   | U100                   | Atmel 32-bit RISC MCU 32 pin   | SAMD21E18A-MUT         | Microchip       | ATSAMD21E18A-MUT       |
| 1   | U101                   | Load Sharing and Li-Ion/Li-Polymer Battery Charge Management Controller  | MCP73871               | Microchip       | MCP73871T-2CCI/ML      |
| 1   | U102                   | 3.3V Fixed, 4 MHz, 600 mA, Buck regulator with internal inductor with Hyper Light Load                               | MIC33050-SYHL          | Microchip       | MIC33050-SYHL-TR       |
| 1   | U200                   | IEEE 802.11 b/g/n module, 8 Mbit Flash Memory, with FEM, PCB Antenna, with Shield, with MAC, Firmware version 19.6.1 | ATWINC1510-MR210PB1961 | Microchip       | ATWINC1510-MR210PB1961 |
| 1   | U201                   | MCU 32-BIT 32 kB 256 kB 48 MHz QFN48   | ATSAMD21G18A-MU        | Microchip       | ATSAMD21G18A-MU        |
| 1   | U202                   | ATECC608B with an I <sup>2</sup> C Interface and a 8 Pin UDFN  | ATECC608B I2C          | Microchip       | ATECC608B-MAH4I-S      |
| 1   | U203                   | ±0.5C Maximum Accuracy Digital Temperature Sensor, I <sup>2</sup> C/SMBus  | MCP9808                | Microchip       | MCP9808T-E/MC          |
| 1   | U400                   | USB Hub Controller USB 2.0 USB Interface 24-QFN (4x4)  | USB2422T/MJ            | Microchip       | USB2422T/MJ            |

## **8. Revision History**

**Revision A - 06/2022**

This is the initial release of this document.



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