



Microchip Touch Bridge Kit

Microchip Touch Bridge Kit User Guide

Preface



Important: Notice to customers

All documentation becomes dated, and this manual is no exception. Microchip tools and documentation are constantly evolving to meet customer needs, so some actual dialogs and/or tool descriptions may differ from those in this document. Refer to our website (www.microchip.com) to obtain the latest documentation available.

Documents are identified with a “DS” number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is “DSXXXXXA”, where “XXXXX” is the document number and “A” is the revision level of the document.

For the most up-to-date information on development tools, see the MPLAB® IDE online help. Select the Help menu and then Topics to open a list of available online help files.

The Microchip Touch Bridge (MTB) - [EV96R35A](#) - is a tuning bridge for touch designs offering wired (USB) and wireless Bluetooth® (BT) touch tuning. The MTB will be the bridge for all touch solutions from Microchip, from turnkey touch products to MCUs running Microchip’s touch library.

- Touch turnkey products families (MTCH, CAP and AT42QT)
- Touch library solutions covering PIC®, AVR®, SAM and PIC32 MCUs

The Microchip Touch Bridge firmware is provided through [MPLAB Discover](#) and upgraded in features.

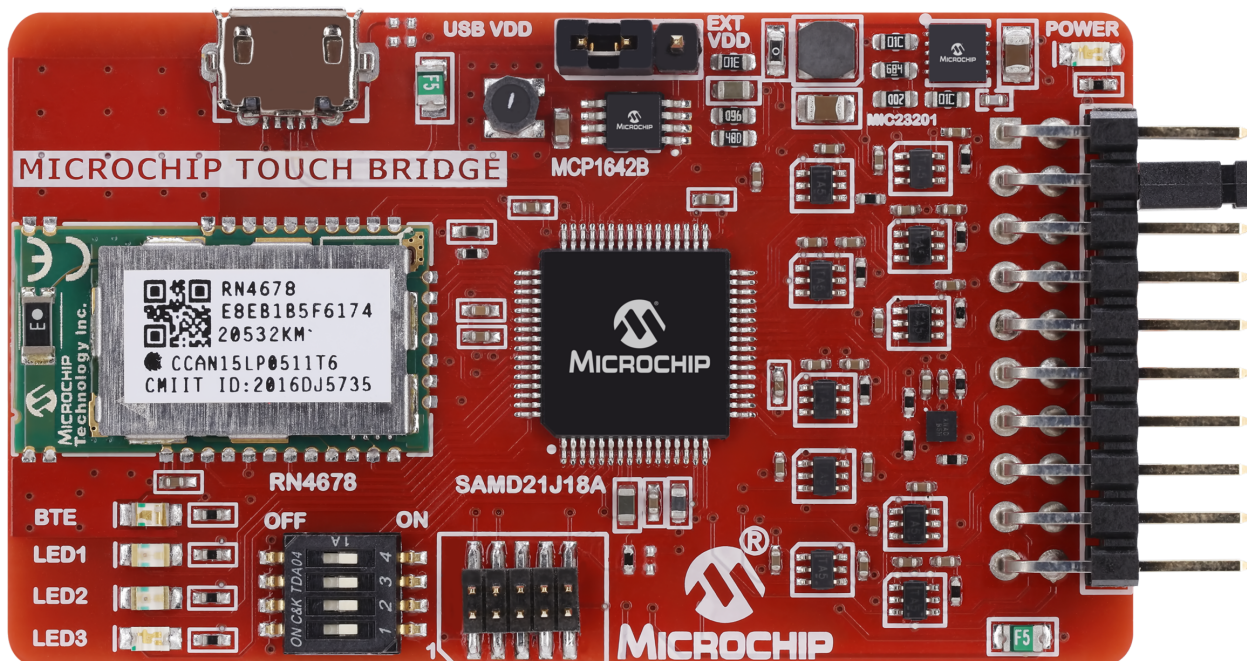


Table of Contents

Preface.....	1
1. Introduction.....	3
1.1. Features and Overview.....	3
2. Getting Started.....	4
2.1. Quick Start.....	4
3. Microchip Touch Bridge.....	5
3.1. Power Supply.....	5
3.2. Jumper Selection.....	6
3.3. Host MCU.....	7
3.4. Communication.....	7
3.5. Mode Selection.....	8
3.6. Firmware User Guide.....	10
4. LEDs.....	17
5. Microchip Touch Bridge Extension Header.....	18
5.1. MCP2221 Header	18
6. Documentation and Relevant Links.....	20
7. Schematic.....	21
8. Hardware Revision History and Known Issues	24
8.1. Identifying Product ID and Revision	24
9. Revision 4.....	25
10. Revision History.....	26
The Microchip Website.....	27
Product Change Notification Service.....	27
Customer Support.....	27
Product Identification System.....	28
Microchip Devices Code Protection Feature.....	28
Legal Notice.....	28
Trademarks.....	29
Quality Management System.....	30
Worldwide Sales and Service.....	31

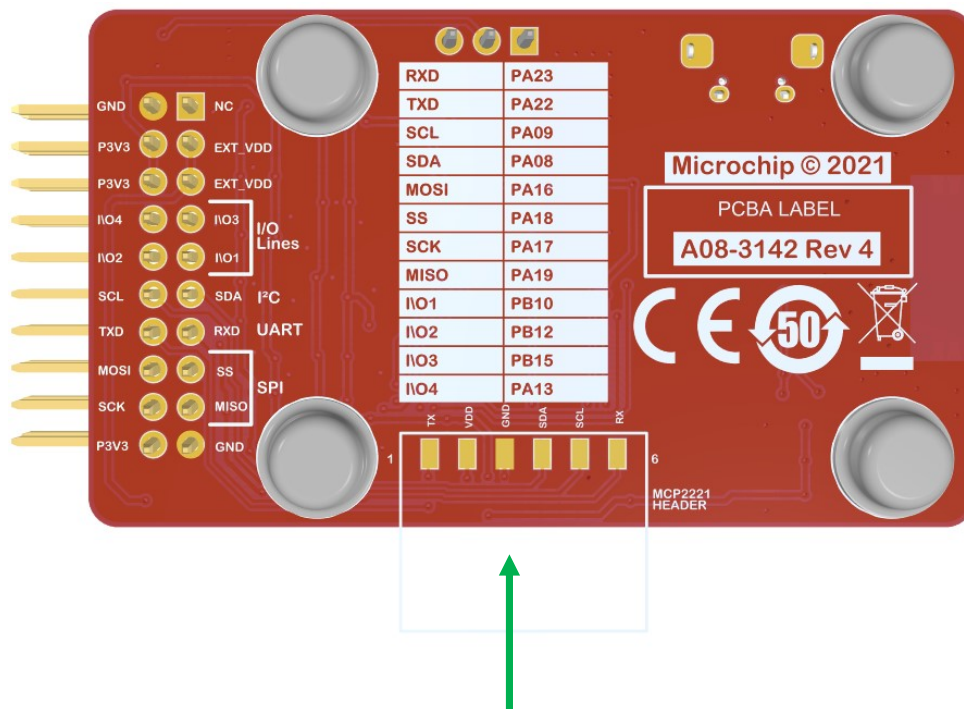
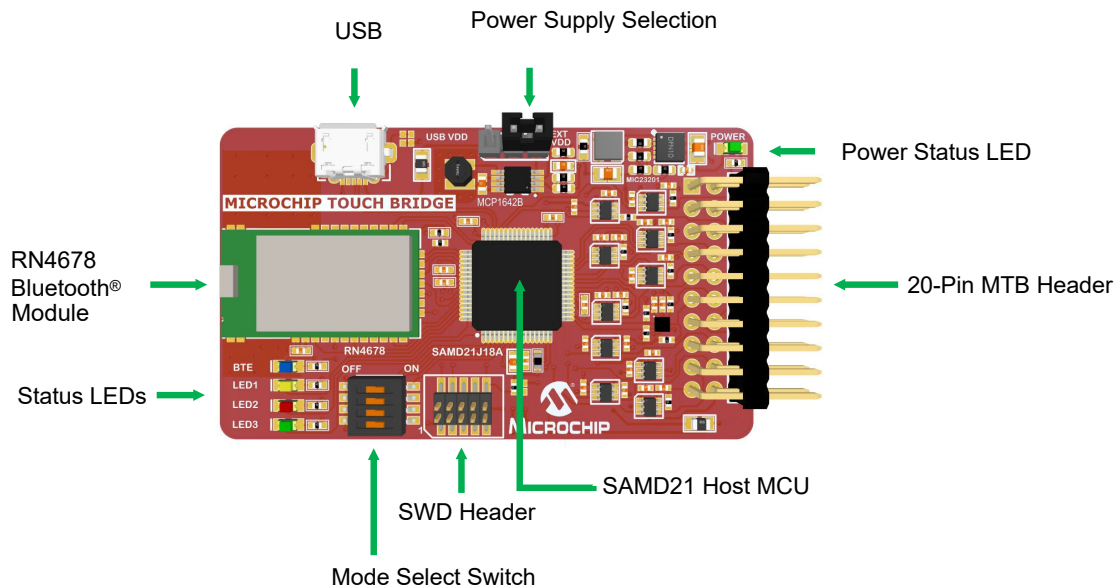
1. Introduction

1.1 Features and Overview

- Input Supply Range 1.8-5V
- Built-in Bluetooth® [RN4678](#) Module
- [ATSAMD21](#) Programmable Host Device
- Level Shifter between Host MCU and External Touch Devices to Enable Tuning on All Voltage Rails
- Communication Supports to PC for Visualization:
 - USB
 - Bluetooth
- Communication Ports to Target Device:
 - UART
 - SPI
 - I²C
 - GPIO
- Header to Connect Target Board
- Header Option to the Kit as [MCP2221A Breakout Module](#)
- LEDs for Comm's Status

2. Getting Started

2.1 Quick Start



Option for
MCP2221 Header

3. Microchip Touch Bridge

The Microchip Touch Bridge (MTB) is the universal bridge for all Microchip touch solutions, including turnkey products and touch library-based applications on MCUs. A bridge is used during the development process to read out raw data and adjust settings accordingly.

For data visualization and real-time tuning, use the [MPLAB Data Visualizer](#).

Use the links below to find training videos and step-by-step guides:

- [MPLAB Discover](#)
- [Microchip Developer Help](#) (restricted access)

3.1 Power Supply

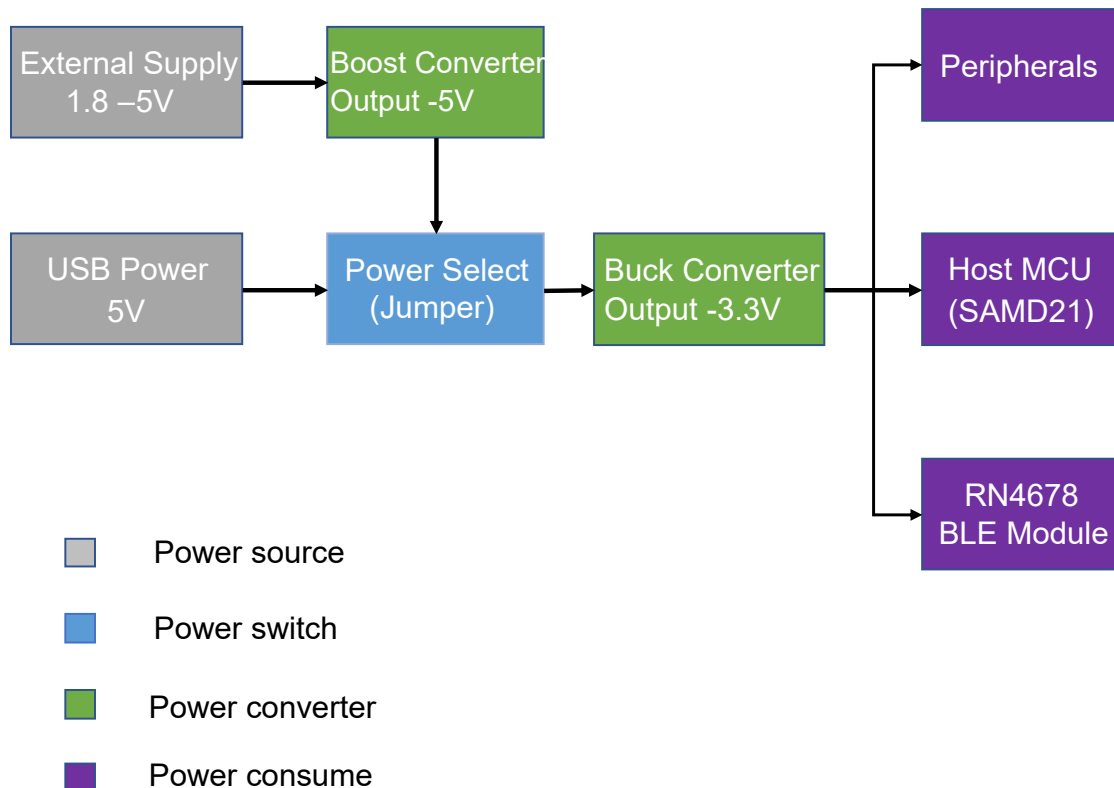
The board can be powered alternatively through:

- USB power
- External power source

The supply connector switch J2 offers both options.

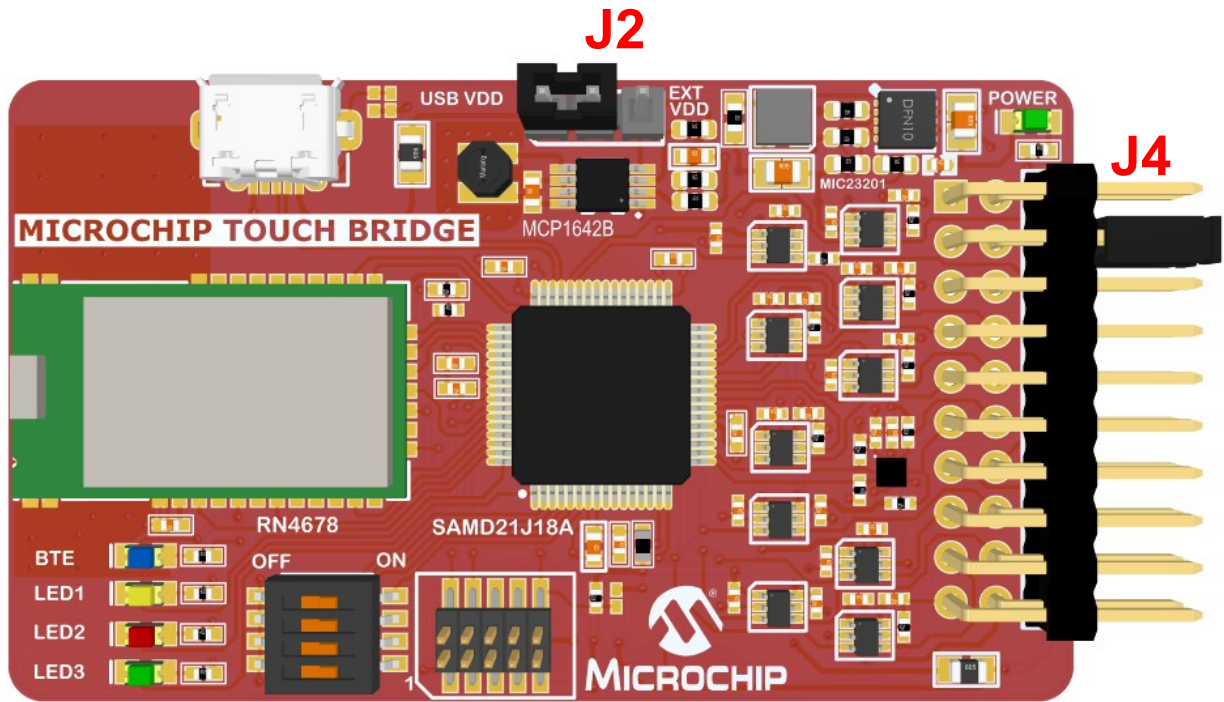
The MTB has a boost converter ([MCP1642B-ADJI/MS](#)) which generates a constant output voltage of 5V with varying input from 1.8V to 5V as well as a buck converter ([MIC23201](#)) which will convert 5V down to 3.3V on targeted sections.

Power Supply Block Diagram



3.2 Jumper Selection

Make sure that the selected power supply between the V-USB and EXT V_{DD} and the board jumper configuration are combined, as shown in the image below.



Header	INPUT SUPPLY = VUSD	INPUT SUPPLY = EXT VDD
J2 PIN 1-2	Short	Open
J2 PIN 2-3	Open	Short
J4 PIN 3-4	Short	Open

Power Supply Selection

USB Powered Bridge and Target	External Supply Powered Bridge and Target
When powering the MTB from a USB source, insert JS1 between J2 header Pin1-2 and insert JS2 between J4 header Pin 3-4	When powering the MTB from an external source (with a supply voltage of 1.8-5V), feed to J4 Pin:3 and supply GND to Pin:19. Do not place jumper JS2.

	USB Supply to Bridge and Target Board	External Supply to Bridge and Target Board	USB Supply to Bridge and External Supply to Target Board
--	---------------------------------------	--	--

Microchip Touch Bridge Kit

Microchip Touch Bridge

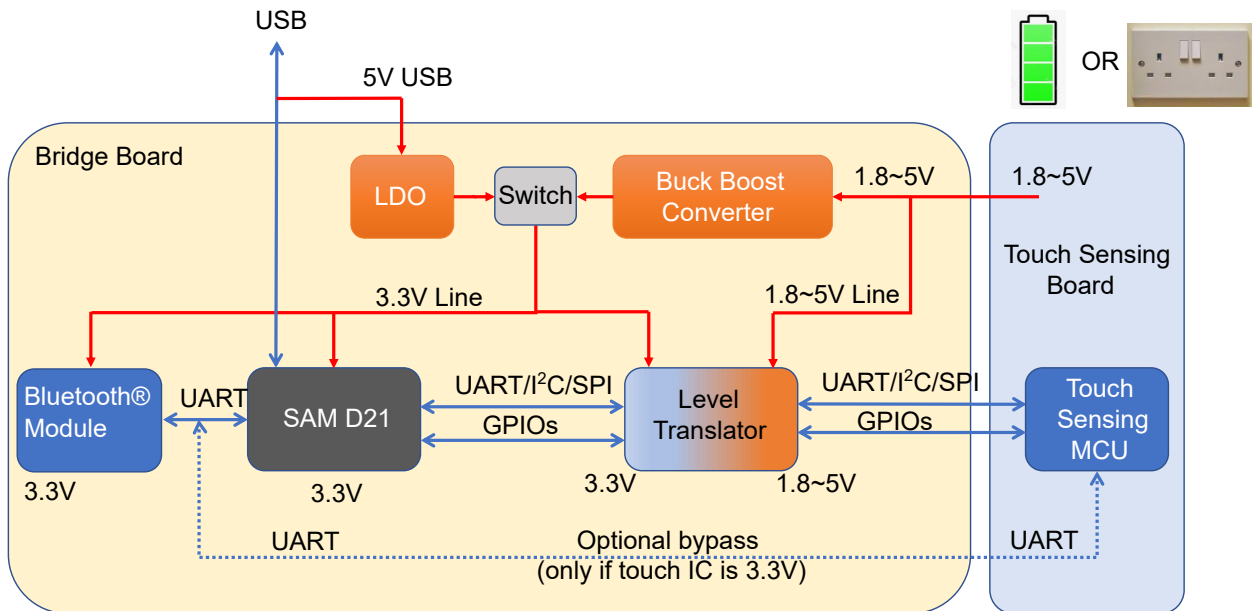
Jumper J2	Short PIN 1-2	Short PIN 2-3	Short PIN 1-2
Jumper J4	Short PIN 3-4	Open PIN 3-4	Open PIN 3-4
EXTV_{DD}	-	EXTV _{DD} to J4 Pin 3 and GND Pin 19	EXTV _{DD} to J4 Pin 3 and GND Pin 19

3.3 Host MCU

SAMD21J18 is a flexible, easy-to-use, low-power consumption Microchip SAM D21 Arm® Cortex®-M0+ based microcontroller and the ideal host controller for the MTB. It drives all supported communication protocols from the client and transfers data to the PC side and vice versa. Host firmware can be programmed to SAMD21 using drag and drop programming. Connect the MTB via USB to a Windows® 10 PC and drop a .hex file onto the created drive for drag and drop programming. Alternatively, use an MCHP external debugger like [Power debugger](#), [Atmel-ICE](#) via [SWD header J1](#).

Use [MPLAB Discover](#) to download the latest firmware for the MTB with features added by Microchip over time.

Figure 3-1. Block Diagram



3.4 Communication

3.4.1 Communication to PC Bluetooth®

The [RN4678](#) is a fully certified Bluetooth Dual Mode (BR/EDR/LE) module, enabling easy-to-use classic Bluetooth and Bluetooth Smart capability. In the MTB Standard UART interface at 115200, the baud rate is set to send and receive data to the RN4678 Bluetooth module. With the default firmware, the RN4678 Bluetooth module will connect to any PC with these settings without the need for flow control.

USB

The USB peripheral support in the SAMD21 device offers both peripheral device and embedded Host modes having eight endpoints/pipes (each address having one input and one output endpoint). The USB peripheral uses Direct Memory Access (DMA), which reads and writes to the internal SRAM during a USB transaction without CPU intervention to optimize the endpoint/pipe data transfers. In addition, the USB peripheral also has support for ping-pong operation and multi-packet transfers, reducing the number of software interventions and interruptions required to manage a USB transaction.

3.4.2 Communication to Host MCU

Various communication protocols like UART, I²C, SPI and GPIO lines are available on the MTB to transmit and receive data from the client-side Touch MCUs.

Communication	Pin Name	HOST MCU Pin
I ² C	SDA	PA08
	SCL	PA09
UART	TXD	PA22
	RXD	PA23
SPI	MISO	PA19
	SS	PA18
	SCK	PA17
	MOSI	PA16
I/O Pin	GPIO 1	PB10
	GPIO 2	PB12
	GPIO 3	PB15
	GPIO 4	PA13

3.5 Mode Selection

3.5.1 Mode of Operation

Select the Application mode by using the switch settings (Mode Selector switch). Change the switch settings as needed and power up the board.

Switch Mode	SW4	SW3	SW2	SW1	Mode of Operation	Bluetooth	USB COM	USB MSD	CAP Bridge
0	OFF	OFF	OFF	OFF	UART Bypass-9600	N	Y	N	N
1	OFF	OFF	OFF	ON	UART Bypass-19200	N	Y	N	N
2	OFF	OFF	ON	OFF	UART Bypass-38400	N	Y	N	N
3	OFF	OFF	ON	ON	UART Bypass-115200	N	Y	N	N
4	OFF	ON	OFF	OFF	UART Bypass-9600	Y	N	N	N
5	OFF	ON	OFF	ON	UART Bypass-19200	Y	N	N	N
6	OFF	ON	ON	OFF	UART Bypass-38400	Y	N	N	N
7	OFF	ON	ON	ON	UART Bypass-115200	Y	N	N	N
8	ON	OFF	OFF	OFF	Reserved	N	N	N	N
9	ON	OFF	OFF	ON	Reserved	N	N	N	N
10	ON	OFF	ON	OFF	Reserved	N	N	N	N
11	ON	OFF	ON	ON	Reserved	N	N	N	N
12	ON	ON	OFF	OFF	Reserved	N	N	N	N
13	ON	ON	OFF	ON	Test mode	N	N	N	N
14	ON	ON	ON	OFF	Cap Bridge	N	N	N	Y

Microchip Touch Bridge Kit

Microchip Touch Bridge

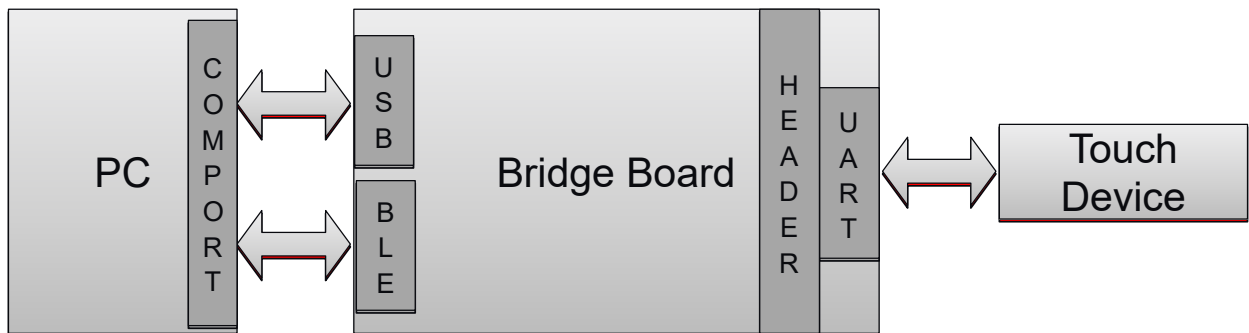
15	ON	ON	ON	ON	Bootloader	N	N	Y	N
----	----	----	----	----	------------	---	---	---	---

Notes:

1. The bootloader is never bypassed. So, if there is no valid application present in the application region of Flash, the control remains in Bootloading until a valid .hex file is dropped.
2. A power recycle is required after changing a Mode Select, implying that after choosing a Mode Select, first open, then short the J2 Pin Jumper.

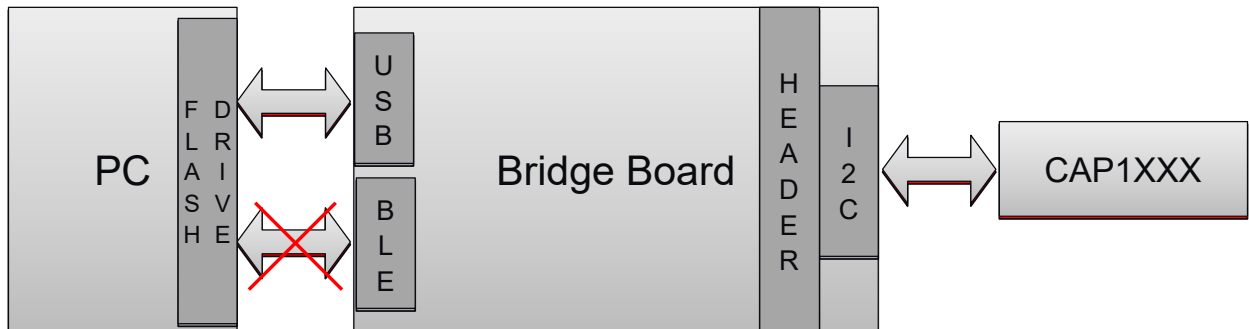
3.5.1.1 UART Bypass Mode

In UART Bypass mode, the data on the Header UART lines are transmitted to the PC through USB or Bluetooth. The baud rate mentioned in the table applies only to the interface between the bridge board and the target device. The baud rate for USB-CDC and Bluetooth is always 115200. The default firmware will either send data through USB or Bluetooth as selected by the user (see [3.5.1. Mode of Operation](#) overview for more information), not through both simultaneously, preventing any race condition of data written from PC to client device. The data received are sent to the PC without processing.



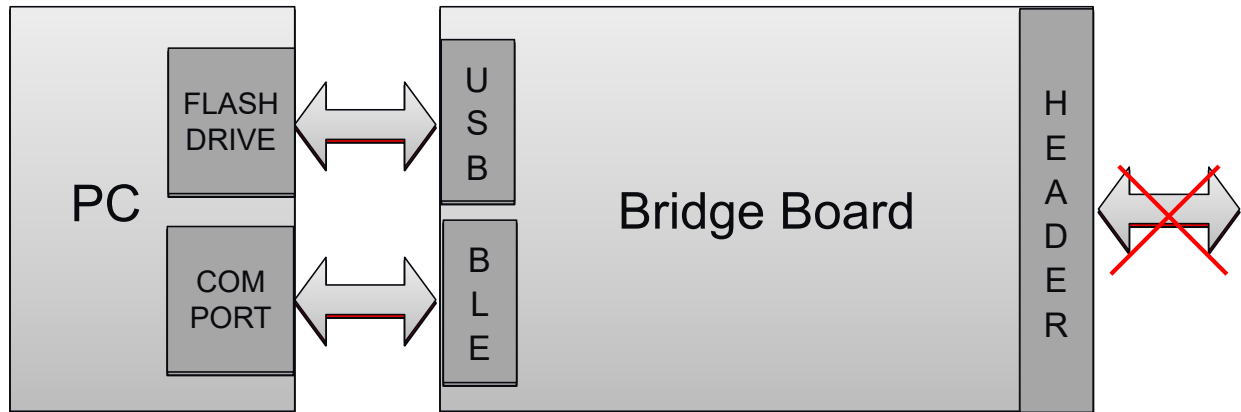
3.5.1.2 CAP Turnkey Products Bridge Mode

In this mode, the USB interface of the Microchip Touch Bridge board can talk to [CAP1xxx GUI](#) and CAP1xxx touch devices.



3.5.1.3 Bootloader Mode

In this mode, the USB interface of Microchip Touch Bridge acts like a USB Flash drive. The user can copy the .hex file to this drive which will upgrade the application firmware of Microchip Touch Bridge. Refer to [3.6.1.1. Flash Memory](#) for more information.



3.6 Firmware User Guide

All information provided in this chapter enables users to build bridge firmware for MTB usage beyond touch. Consider that the bridge firmware provided by Microchip covers all these aspects and details. For using the MTB as a touch tuning bridge, skip to [4. LEDs](#).

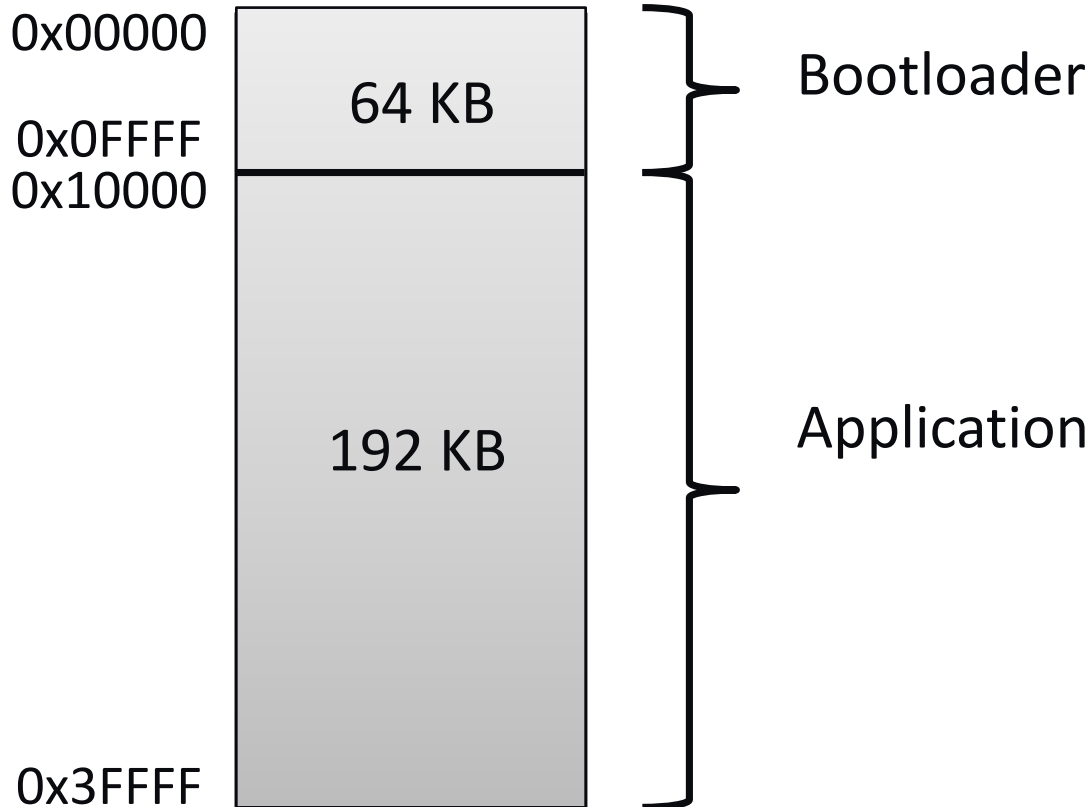
Both Application and Bootloader are based on the Harmony 3 framework for device configuration and communication drivers.

3.6.1 Bootloader

When Bootloader mode is selected (see [3.5. Mode Selection](#) for details), the USB enumerates as a standard USB Flash drive. It is possible to upgrade the application firmware by dragging and dropping the application `.hex` file.

3.6.1.1 Flash Memory

The memory between Application and Bootloader is split as follows.



3.6.1.2 Overview

Bootloader firmware uses the following primary modules:

- USB Mass Storage Device (MSD) Class
- Hex Parser
- Virtual File System
- Drivers:
 - SERCOM UART for Bluetooth
 - NVMCTRL

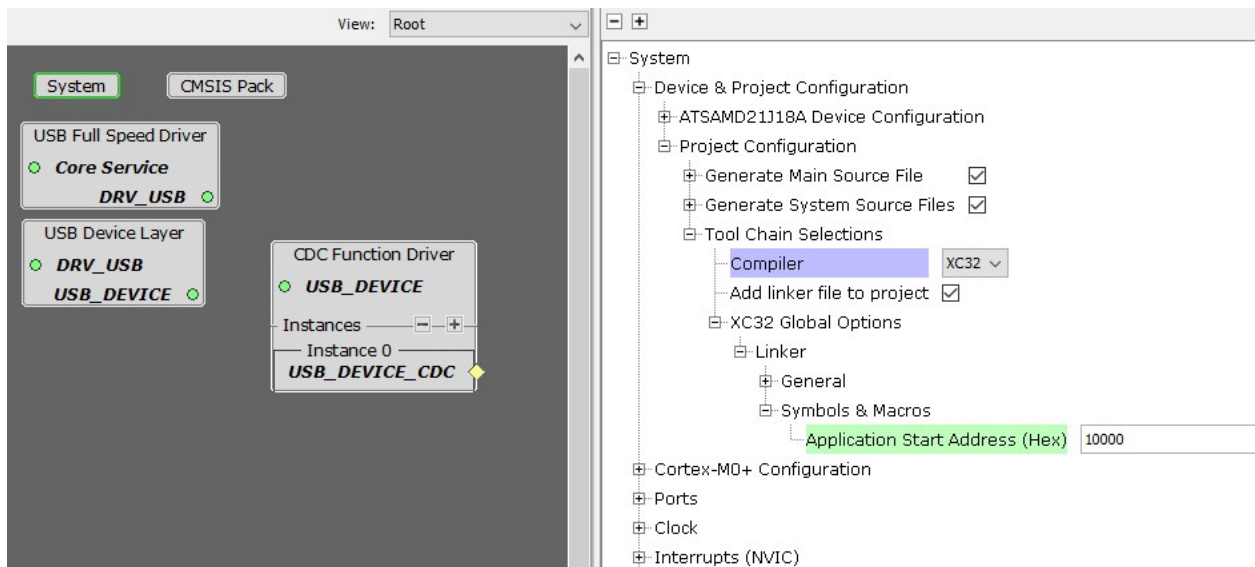
Harmony 3's USB MSD class is used. The file system used by USB MSD is implemented virtually for 1 MB size supporting the memory to drop .hex file for SAMD21 device.

The Virtual File System and Hex Parser code keep looking for .hex files from PC. If the user drops a .hex file, then the .hex file is parsed to extract the Flash memory content and written to Flash memory using NVMCTRL drivers. The status is updated continuously in the Bluetooth COMPORT at a 115200 baud rate.

3.6.1.3 Preparing Application Firmware

When dropping the application firmware, build the application with ROM region starting address set at 0x10000. If the ROM Starting address is not set properly, then the programming will not work correctly.

Select the starting application address in H3 to 0x10000 in the "system" component as follows:



3.6.1.4 Debug Output

In Bootloader mode, the device sends various debug information on BLE COM PORT. The baud rate is 115200.

3.6.2 Touch Bridge Application

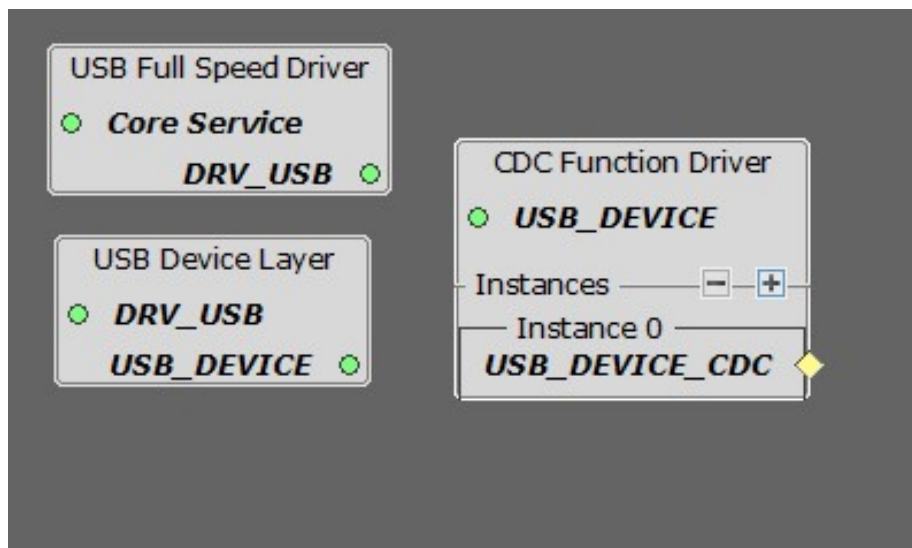
3.6.2.1 Firmware Components

3.6.2.1.1 USB

USB can enumerate in two interfaces, either CDC or CAPBridge. The descriptors are stored in two different files and depend on the 4-way switch status: switch mode 0-12 for CDC and CAP Bridge select switch mode 14 (refer to [3.5. Mode Selection](#) table for more information).

File `usb_device_init_data_cdc.c` contains the descriptors for CDC Interface and file `usb_device_init_data_capBridge` contains the descriptor details for CAP Bridge interface.

Use the standard Harmony 3 USB CDC drivers for CDC configuration and USB enumeration. For CapBridge configuration, vendor class is used and vendor/product IDs are hardcoded to match the CAP1xxx PC software. The code related to USB CDC and CAPBridge is present in `usbApp.c` file.



3.6.2.1.2 Bluetooth®

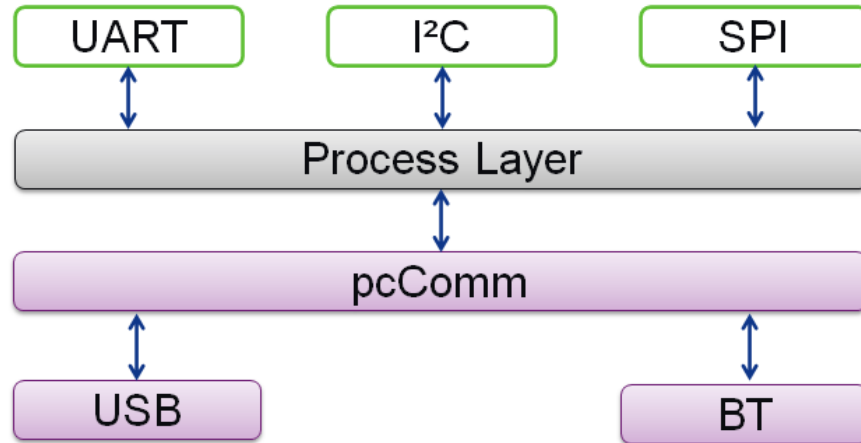
Use the standard UART interface at a 115200 baud rate to talk to the RN4678 Bluetooth module. Flow control is not used in the default firmware.

3.6.2.1.3 Touch Device Interfaces

Use the standard driver function from Harmony 3 for interfaces like I²C, SPI, UART and GPIO on the header side.

3.6.2.2 MTB Application Overview

The figure below represents important blocks of the Bridge application.



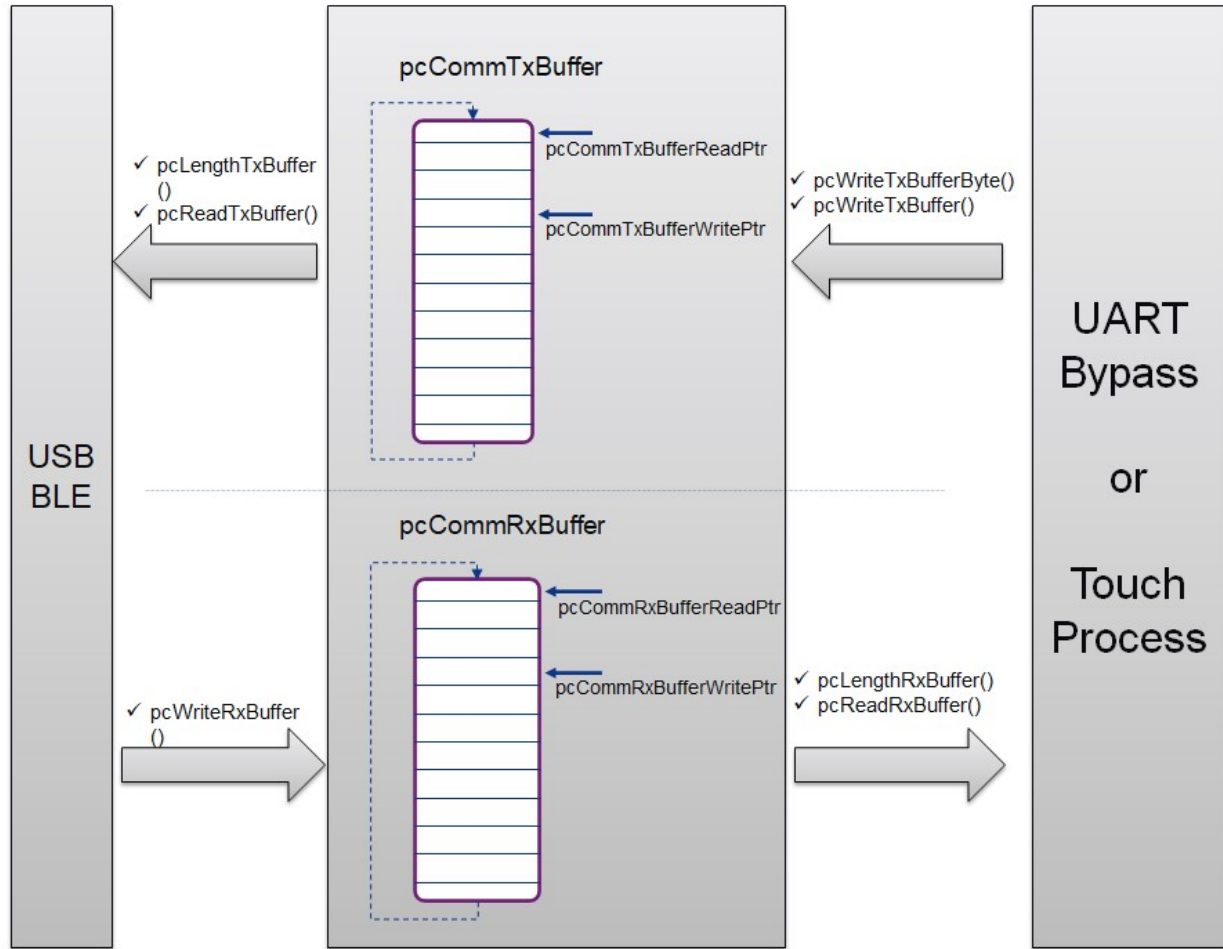
3.6.2.2.1 pcComLayer

This layer has two circular buffers: one to transmit data to the PC and another to receive data from the PC. A set of APIs accesses the circular buffers and can be used to write or read from both Transmit buffers. The pcComm layer is not used in CAPBridge mode.

The pcComm layer is accessed by:

- USB/BLE layer to:
 - Write data to RX buffer
 - Read data to TX buffer
- Touch process (or Bypass mode) to:
 - Write data to TX buffer
 - Read data to RX buffer

TX and RX terms are related to MCU.



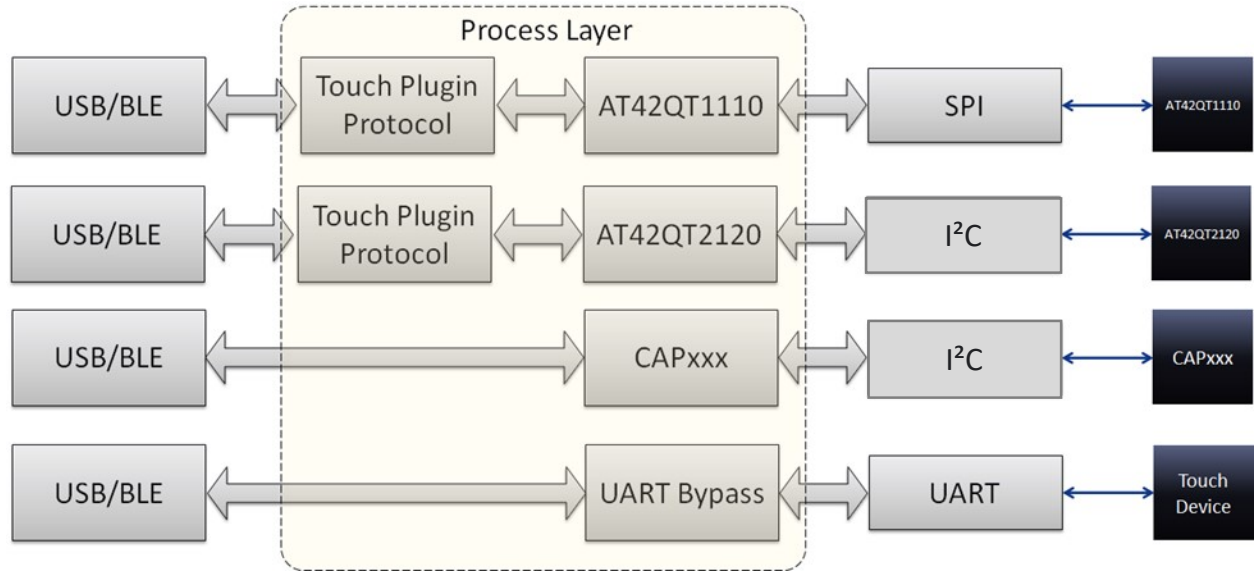
3.6.2.2.2 Process Layer

This layer changes dynamically depending on the mode. All the processing related to data is implemented in this layer.

For example, in UART Bypass mode, this layer copies data from the UART to the pcComm layer and vice-versa. In CAPBridge mode, this layer processes the commands received from CAP GUI and sends corresponding I²C commands to CAP devices.

If the bridge board is connected to a touch turnkey device (exemplary AT42QT2120), the memory map of the turnkey device is kept in this layer. It also contains the actual driver for the target device. In addition to that, this layer also contains the driver that talks to MPLAB Data Visualizer Touch Plug-in. This layer helps in receiving the data from the turnkey device and repacking the data before transmitting it to MPLAB Data Visualizer. Similarly, if the user modifies data or settings in Touch Plug-in (MPLAB DV GUI) they are sent to the target device through this layer.

The image below shows some examples of Process Layer. The possible combinations are not limited.



3.6.2.2.3 USB

The entire application related to the USB is implemented in the `usbApp.c` file.

In CDC mode:

- Copies data from the pcCOMM layer to the USB peripheral and performs the following steps:
 - Checking for new data to be transmitted
 - If new data is available in pcCOMM, that data is sent to PC
- Copies data from the USB peripheral to the pcCOMM buffer and performs the following steps:
 - Checking for new data from PC
 - If new data are received from PC, that data is copied to the pcCOMM buffer

In CAPBridge mode:

- USB interacts directly with the I²C drivers to read/write data to the CAP devices. The address and read/write instructions from the CAP GUI are directly routed to the I²C drivers. The `capBridge.c` files handle this part.

Other than the data transaction, the handling of USB connect/disconnect, COMPORT open/close, etc., are also handled in this layer.

3.6.2.2.4 Bluetooth®

The entire application related to Bluetooth is implemented in the `btApp.c` file.

- Sends data from the pcCOMM layer to the RN4678 module
 - Checks for new data to be transmitted
 - If new data is available in pcCOMM, then it sends the data to the PC
- Copies data from the RN4678 module to the pcCOMM buffer
 - Checks for new data from the PC
 - If new data is received from the PC, it copies the data to pcCOMM buffer

Other than the data transaction, the handling of COMPORT open/close, etc., is also handled in this layer.

3.6.2.2.5 UART, I²C, SPI

The blocks UART, I²C, SPI provide wrapper functionality to the Harmony 3 drives for simple communication with other layers.

3.6.2.2.6 LED

There are four LEDs present on the board:

- Blue
- Red

- Green
- Yellow

The firmware provides standard APIs to perform blink operations on Red, Green and Yellow LEDs. The Blue LED is controlled directly by Bluetooth.

3.6.2.2.7 Time

Provides periodic interrupt for time reference, which proves useful if debug data from Touch turnkey parts needs to be read periodically.

3.6.2.3 File Overview

Functionalities are kept in different files based on their purpose and for easier maintenance.

File Name	Category	Description
<code>touchI2C.c</code>	Driver	A wrapper function is implemented on top of the H3 driver. Provides useable APIs to read/write to the I ² C client device.
<code>touchSPI.c</code>	Driver	A wrapper function is implemented on top of the H3 driver. Provides useable APIs to read/write to SPI client device.
<code>touchUART.c</code>	Driver	A wrapper function is implemented on top of H3 driver. Provides useable APIs to read/write UART device.
<code>pcComm</code>	pcComm layer	Provides a circular buffer for transferring data between multiple layers
<code>btApp.c</code>	Bluetooth layer	Contains logic to interact with the RN4678 module. It uses a Standard H3 UART driver to data transfer with the RN4678 module.
<code>usbApp.c</code>	USB layer	Contains logic to interact with the USB Host. It uses a standard H3 USB driver to transfer data between Microchip touch bridge and PC Host.
<code>capBridge.c</code>	Process layer	Logic to route address, read/write commands from CAP GUI to CAP device is available in this layer
<code>Uartbypass.c</code>	Process layer	Bridges UART data between the USB/Bluetooth and Header
<code>at42qt2120.c</code>	Process layer	Contains all the information and drivers related to AT42QT2120

4. LEDs

There are four LEDs in the Microchip Touch Bridge kit.

LED	Color	Purpose
Bluetooth LED	Blue	Connected to the RN4678 Bluetooth module
LED1	Yellow	Connected to the PB03 of the host MCU
LED2	Red	Connected to the PA00 of the host MCU
LED3	Green	Connected to the PA01 of the host MCU
LED Power	Green	Bridge MCU power status

5. Microchip Touch Bridge Extension Header

Pin Number	Pin Name	Description
1	NC	Not Connected
2	GND	Ground
3	EXT_V _{DD}	External power pin
4	V _{DD} _P3V3	Internal power pin
5	EXT_V _{DD}	External power pin
6	V _{DD} _P3V3	Internal power pin
7	P1V8_5V GPIO3	General purpose I/O pin
8	P1V8_5V GPIO4	General purpose I/O pin
9	P1V8_5V GPIO1	General purpose I/O pin
10	P1V8_5V GPIO2	General purpose I/O pin
11	P1V8_5V_I2C_SDA	Data pin for I ² C interface
12	P1V8_5V_I2C_SCL	Clock pin for I ² C interface
13	P1V8_5V_UART_S_TX_M_RX	Receiver pin of the UART host device
14	P1V8_5V_UART_S_RX_M_TX	Transmitter pin of the UART host device
15	P1V8_5V_SPI_SS	Client Select for SPI. This pin must not connect to anything else.
16	P1V8_5V_SPI_MOSI	SPI host out, client in pin
17	P1V8_5V_SPI_MISO	SPI host in, client out pin
18	P1V8_5V_SPI_SCK	SPI clock pin
19	GND	Ground
20	V _{DD} _P3V3	Power pin

5.1 MCP2221 Header

Use MTB as an alternate for the [MCP2221A Breakout Module](#) by mounting a J5 SMD female header. The following table describes the pin details.

Pin Number	Pin Name	Description
1	TXD	Transmitter pin of the UART host device
2	V _{DD}	Ground
3	GND	External power pin
4	SDA	Data pin for I ² C interface
5	SCL	Clock pin for I ² C interface

Microchip Touch Bridge Kit

Microchip Touch Bridge Extension Header

.....continued

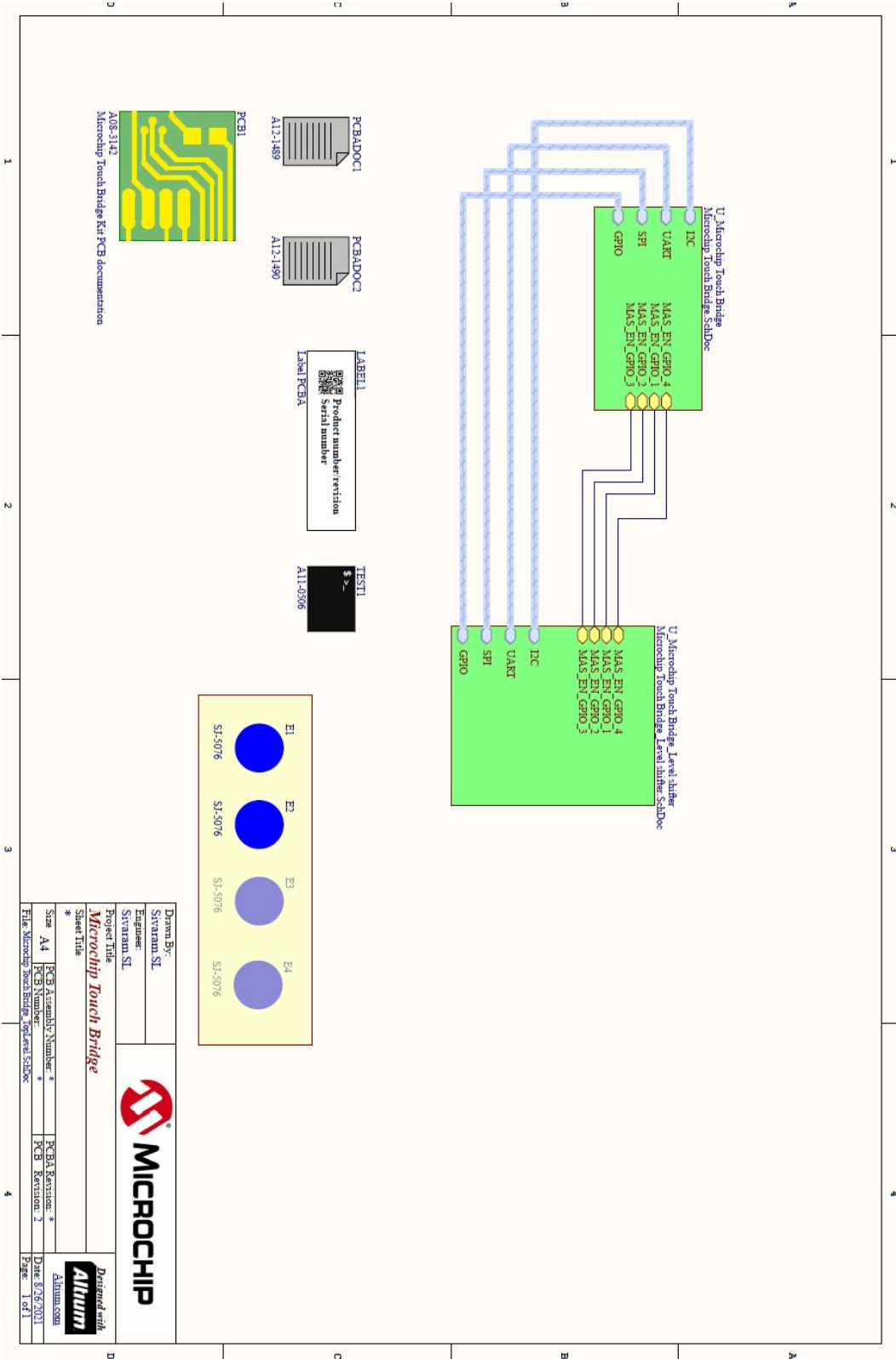
Pin Number	Pin Name	Description
6	RXD	Receiver pin of the UART host device

6. Documentation and Relevant Links

Software/IDE

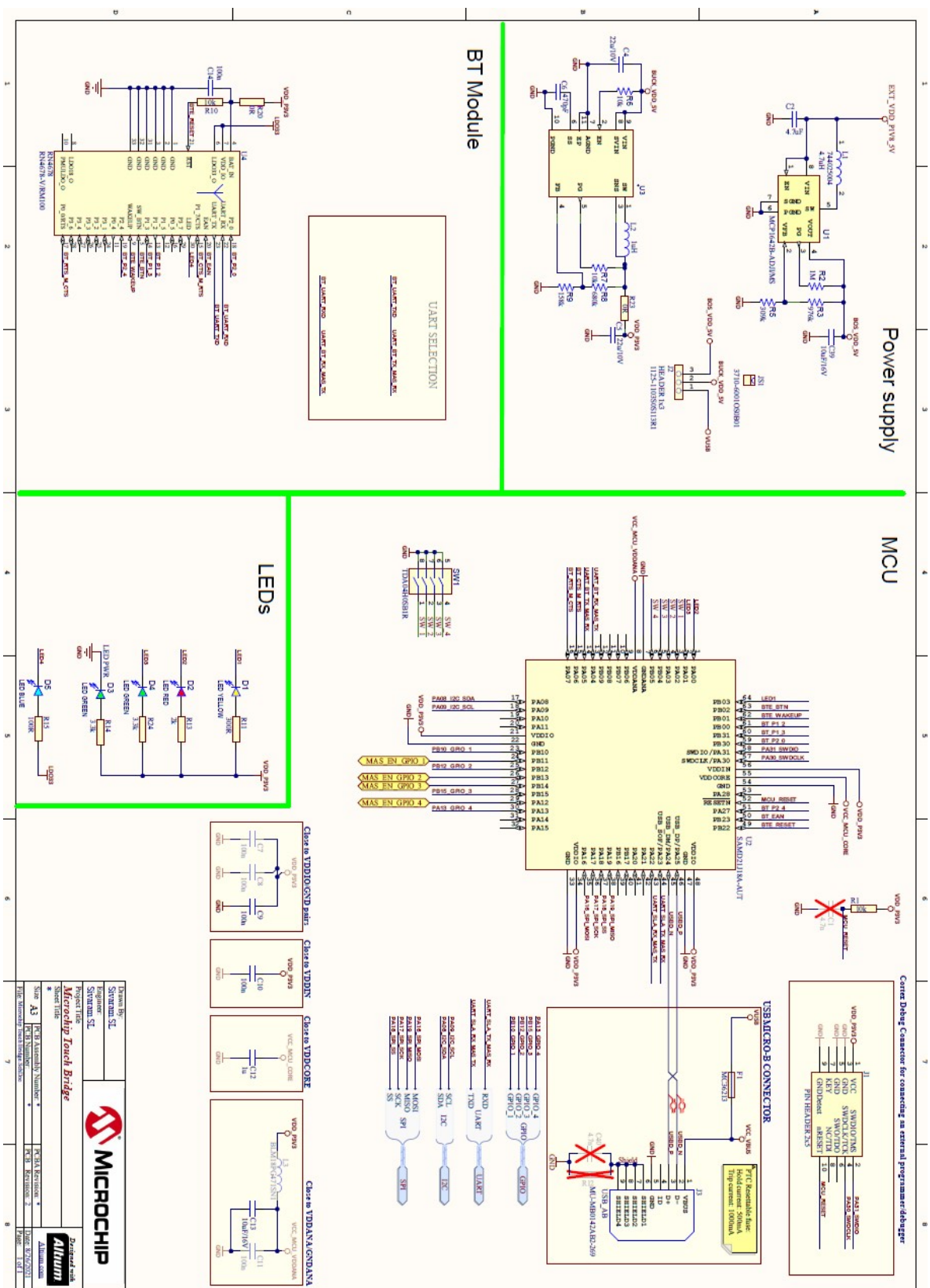
- **MPLAB® X IDE:** MPLAB® X IDE is a software program that runs on a PC (Windows®, Mac OS®, Linux®) to develop applications for Microchip microcontrollers and digital signal controllers. It is called an Integrated Development Environment (IDE) because it provides a single integrated "environment" to develop code for embedded microcontrollers.
- **MPLAB® Code Configurator:** MPLAB® Code Configurator (MCC) is a free, graphical programming environment that generates seamless, easy-to-understand C code to be inserted into your project. Using an intuitive interface enables and configures a rich set of peripherals and functions specific to your application.
- **MPLAB Harmony v3:** MPLAB® Harmony v3 is a fully integrated embedded software development framework providing flexible and interoperable software modules that allowing to dedicate your resources to creating applications for our 32-bit PIC® and SAM devices, rather than dealing with device details, complex protocols, and library integration challenges. It works seamlessly with MPLAB X Integrated Development Environment (IDE) and the MPLAB XC32 Compiler to enable a smooth transition and maximum code reuse between PIC32 MCUs and SAM MCUs and MPUs. MPLAB® Harmony v3 has drivers, demo code, and Data Visualizer supporting data streaming and advanced debugging.
- **Atmel START:** Atmel START is an online tool that helps the user to select and configure software components and tailor your embedded application in a usable and optimized manner.
- **Microchip Studio:** Free IDE for the development of C/C++ and assembler code for microcontrollers.
- **MPLAB® Data Visualizer:** Troubleshooting your code's run-time behavior has never been easier. MPLAB® Data Visualizer is a free debugging tool that graphically displays run-time variables in an embedded application. Available as a plug-in for MPLAB X Integrated Development Environment (IDE) or a stand-alone debugging tool, it can receive data from various sources such as the [Embedded Debugger Data Gateway Interface \(DGI\)](#) and COM ports. You can also track your application's run-time behavior using a terminal or graph. To get started with visualizing data, check out the [Curiosity Nano Development Platform](#) and [Xplained Pro Evaluation Kits](#).
- **Design Documentation:** Package containing CAD source, schematics, BOM, assembly drawings, 3D plots, layer plots, etc.
- **Hardware User's Guide:** PDF version of this user's guide.
- **Microchip Touch Bridge Kit:** On Microchip's website.

7. Schematic



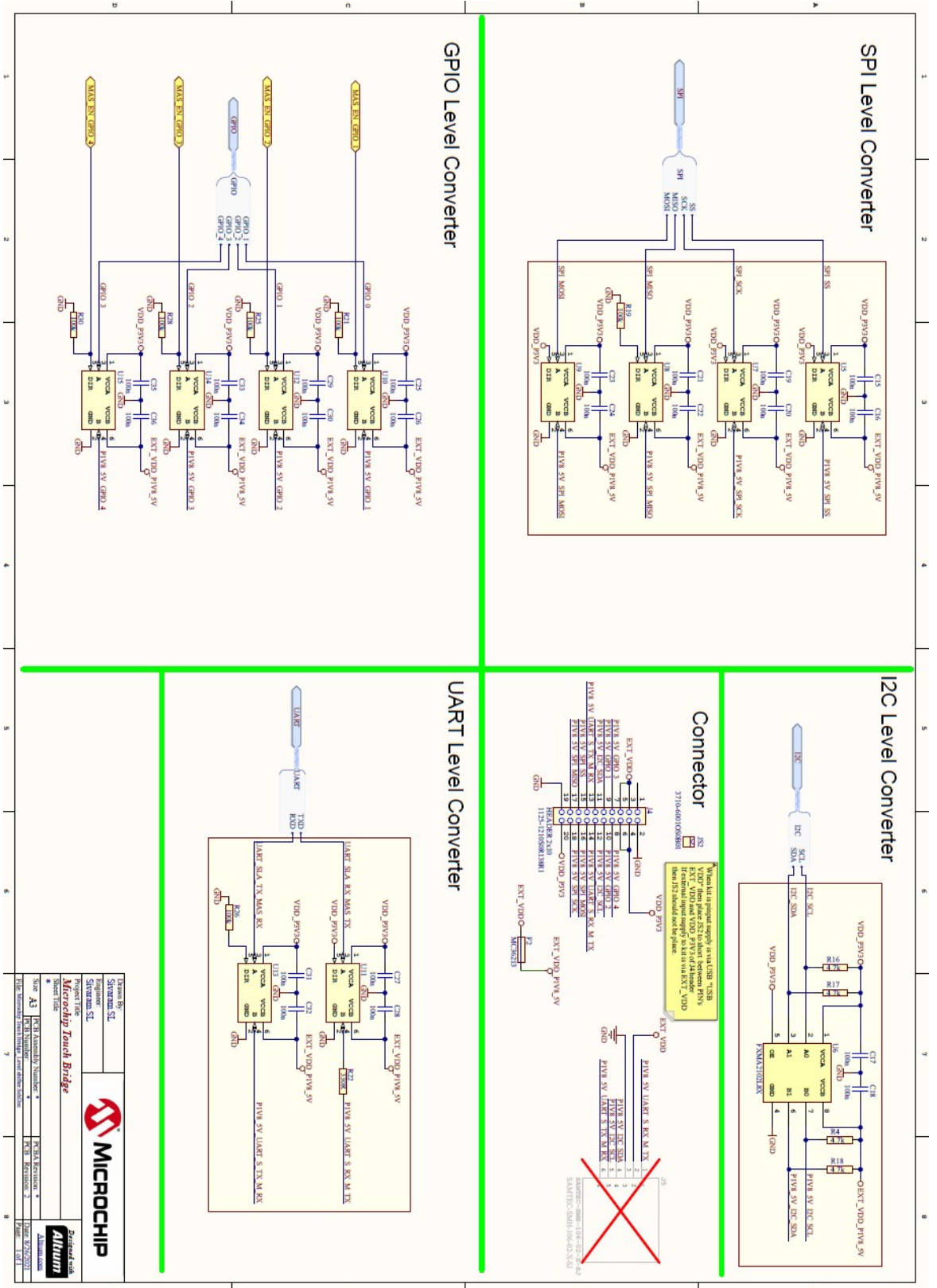
Microchip Touch Bridge Kit

Schematic



Microchip Touch Bridge Kit

Schematic



8. Hardware Revision History and Known Issues

8.1 Identifying Product ID and Revision

When an Evaluation board is connected to a computer with MPLAB running, an information window with the serial number is shown. The first six digits of the serial number contain the product identifier and revision. Information about connected evaluation boards is also shown in the window.

The same information can be found on the sticker on the bottom side of the PCB. Most kits have stickers with 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 a serial number string.

The serial number string has the following format:

```
"nnnnrrssssssssss"
```

n = product identifier r = revision

r = revision

s = serial number

The product identifier for the Microchip Touch Bridge is [A08-3142](#) (restricted access).

9. Revision 4

Revision 4 of Microchip Touch Bridge ([A08-3142](#)/04 - restricted access) is the initially released version. There are no known issues.

10. Revision History

Doc.rev.	Date	Comment
A	11/2021	Initial document release

The Microchip Website

Microchip provides online support via our website at www.microchip.com/. This website is used to make files and information easily available to customers. Some of the content available includes:

- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip design partner program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

Product Change Notification Service

Microchip's product change notification service helps keep customers current on Microchip products. Subscribers will receive email notification whenever there are changes, updates, revisions or errata related to a specified product family or development tool of interest.

To register, go to www.microchip.com/pcn and follow the registration instructions.

Customer Support

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Embedded Solutions Engineer (ESE)
- Technical Support

Customers should contact their distributor, representative or ESE for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in this document.

Technical support is available through the website at: www.microchip.com/support

Product Identification System

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.

PART NO.
 Device [X]⁽¹⁾ -X /XX
 Tape Temperature Package
 and Reel Range

Device:	Device A, Feature A, (Package A) Device B, Feature B, (Package B)	
Tape & Reel Option:	Blank	= Tube
	T	= Tape & Reel
Temperature Range:	I	= -40°C to +85°C (Industrial)
	E	= -40°C to +125°C (Extended)
Package:	AA	= Package AA
	BB	= Package BB

Examples:

- MCPXXXXXAT-E/AA: Tape and Reel, Extended temperature, XAA package
- MCPXXXXXBT-E/BB: Tape and Reel Extended temperature, XBB package

Notes:

1. Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. Check with your Microchip Sales Office for package availability with the Tape and Reel option.
2. Small form-factor packaging options may be available. Please check www.microchip.com/packaging for small-form factor package availability, or contact your local Sales Office.

Microchip Devices Code Protection Feature

Note the following details of the code protection feature on Microchip products:

- Microchip products meet the specifications contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is secure when used in the intended manner, within operating specifications, and under normal conditions.
- Microchip values and aggressively protects its intellectual property rights. Attempts to breach the code protection features of Microchip product is strictly prohibited and may violate the Digital Millennium Copyright Act.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of its code. Code protection does not mean that we are guaranteeing the product is “unbreakable”. Code protection is constantly evolving. Microchip is committed to continuously improving the code protection features of our products.

Legal Notice

This publication and the information herein may be used only with Microchip products, including to design, test, and integrate Microchip products with your application. Use of this information in any other manner violates these terms. Information regarding device applications is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. Contact your local Microchip sales office for additional support or, obtain additional support at www.microchip.com/en-us/support/design-help/client-support-services.

THIS INFORMATION IS PROVIDED BY MICROCHIP "AS IS". MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY

OR OTHERWISE, RELATED TO THE INFORMATION INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY, AND FITNESS FOR A PARTICULAR PURPOSE, OR WARRANTIES RELATED TO ITS CONDITION, QUALITY, OR PERFORMANCE.

IN NO EVENT WILL MICROCHIP BE LIABLE FOR ANY INDIRECT, SPECIAL, PUNITIVE, INCIDENTAL, OR CONSEQUENTIAL LOSS, DAMAGE, COST, OR EXPENSE OF ANY KIND WHATSOEVER RELATED TO THE INFORMATION OR ITS USE, HOWEVER CAUSED, EVEN IF MICROCHIP HAS BEEN ADVISED OF THE POSSIBILITY OR THE DAMAGES ARE FORESEEABLE. TO THE FULLEST EXTENT ALLOWED BY LAW, MICROCHIP'S TOTAL LIABILITY ON ALL CLAIMS IN ANY WAY RELATED TO THE INFORMATION OR ITS USE WILL NOT EXCEED THE AMOUNT OF FEES, IF ANY, THAT YOU HAVE PAID DIRECTLY TO MICROCHIP FOR THE INFORMATION.

Use of Microchip devices in life support and/or safety applications is entirely at the buyer's risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights unless otherwise stated.

Trademarks

The Microchip name and logo, the Microchip logo, Adaptec, AnyRate, AVR, AVR logo, AVR Freaks, BesTime, BitCloud, CryptoMemory, CryptoRF, dsPIC, flexPWR, HELDO, IGLOO, JukeBlox, KeeLoq, Kleer, LANCheck, LinkMD, maXStylus, maXTouch, MediaLB, megaAVR, Microsemi, Microsemi logo, MOST, MOST logo, MPLAB, OptoLyzer, PIC, picoPower, PICSTART, PIC32 logo, PolarFire, Prochip Designer, QTouch, SAM-BA, SenGenuity, SpyNIC, SST, SST Logo, SuperFlash, Symmetricom, SyncServer, Tachyon, TimeSource, tinyAVR, UNI/O, Vectron, and XMEGA are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

AgileSwitch, APT, ClockWorks, The Embedded Control Solutions Company, EtherSynch, Flashtec, Hyper Speed Control, HyperLight Load, IntelliMOS, Libero, motorBench, mTouch, Powermite 3, Precision Edge, ProASIC, ProASIC Plus, ProASIC Plus logo, Quiet- Wire, SmartFusion, SyncWorld, Temux, TimeCesium, TimeHub, TimePictra, TimeProvider, TrueTime, WinPath, and ZL are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Adjacent Key Suppression, AKS, Analog-for-the-Digital Age, Any Capacitor, AnyIn, AnyOut, Augmented Switching, BlueSky, BodyCom, CodeGuard, CryptoAuthentication, CryptoAutomotive, CryptoCompanion, CryptoController, dsPICDEM, dsPICDEM.net, Dynamic Average Matching, DAM, ECAN, Espresso T1S, EtherGREEN, GridTime, IdealBridge, In-Circuit Serial Programming, ICSP, INICnet, Intelligent Paralleling, Inter-Chip Connectivity, JitterBlocker, Knob-on-Display, maxCrypto, maxView, memBrain, Mindi, MiWi, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, MultiTRAK, NetDetach, NVM Express, NVMe, Omniscient Code Generation, PICDEM, PICDEM.net, PICkit, PICtail, PowerSmart, PureSilicon, QMatrix, REAL ICE, Ripple Blocker, RTAX, RTG4, SAM-ICE, Serial Quad I/O, simpleMAP, SimpliPHY, SmartBuffer, SmartHLS, SMART-I.S., storClad, SQL, SuperSwitcher, SuperSwitcher II, Switchtec, SynchroPHY, Total Endurance, TSHARC, USBCheck, VariSense, VectorBlox, VeriPHY, ViewSpan, WiperLock, XpressConnect, and ZENA are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

The Adaptec logo, Frequency on Demand, Silicon Storage Technology, Symmcom, and Trusted Time are registered trademarks of Microchip Technology Inc. in other countries.

GestIC is a registered trademark of Microchip Technology Germany II GmbH & Co. KG, a subsidiary of Microchip Technology Inc., in other countries.

All other trademarks mentioned herein are property of their respective companies.

© 2021, Microchip Technology Incorporated and its subsidiaries. All Rights Reserved.

ISBN: 978-1-5224-9252-8

AMBA, Arm, Arm7, Arm7TDMI, Arm9, Arm11, Artisan, big.LITTLE, Cordio, CoreLink, CoreSight, Cortex, DesignStart, DynamiQ, Jazelle, Keil, Mali, Mbed, Mbed Enabled, NEON, POP, RealView, SecurCore, Socrates, Thumb, TrustZone, ULINK, ULINK2, ULINK-ME, ULINK-PLUS, ULINKpro, μ Vision, Versatile are trademarks or registered trademarks of Arm Limited (or its subsidiaries) in the US and/or elsewhere.

Quality Management System

For information regarding Microchip's Quality Management Systems, please visit www.microchip.com/quality.

Worldwide Sales and Service

AMERICAS	ASIA/PACIFIC	ASIA/PACIFIC	EUROPE
Corporate Office 2355 West Chandler Blvd. Chandler, AZ 85224-6199 Tel: 480-792-7200 Fax: 480-792-7277 Technical Support: www.microchip.com/support Web Address: www.microchip.com	Australia - Sydney Tel: 61-2-9868-6733 China - Beijing Tel: 86-10-8569-7000 China - Chengdu Tel: 86-28-8665-5511 China - Chongqing Tel: 86-23-8980-9588 China - Dongguan Tel: 86-769-8702-9880 China - Guangzhou Tel: 86-20-8755-8029 China - Hangzhou Tel: 86-571-8792-8115 China - Hong Kong SAR Tel: 852-2943-5100 China - Nanjing Tel: 86-25-8473-2460 China - Qingdao Tel: 86-532-8502-7355 China - Shanghai Tel: 86-21-3326-8000 China - Shenyang Tel: 86-24-2334-2829 China - Shenzhen Tel: 86-755-8864-2200 China - Suzhou Tel: 86-186-6233-1526 China - Wuhan Tel: 86-27-5980-5300 China - Xian Tel: 86-29-8833-7252 China - Xiamen Tel: 86-592-2388138 China - Zhuhai Tel: 86-756-3210040	India - Bangalore Tel: 91-80-3090-4444 India - New Delhi Tel: 91-11-4160-8631 India - Pune Tel: 91-20-4121-0141 Japan - Osaka Tel: 81-6-6152-7160 Japan - Tokyo Tel: 81-3-6880-3770 Korea - Daegu Tel: 82-53-744-4301 Korea - Seoul Tel: 82-2-554-7200 Malaysia - Kuala Lumpur Tel: 60-3-7651-7906 Malaysia - Penang Tel: 60-4-227-8870 Philippines - Manila Tel: 63-2-634-9065 Singapore Tel: 65-6334-8870 Taiwan - Hsin Chu Tel: 886-3-577-8366 Taiwan - Kaohsiung Tel: 886-7-213-7830 Taiwan - Taipei Tel: 886-2-2508-8600 Thailand - Bangkok Tel: 66-2-694-1351 Vietnam - Ho Chi Minh Tel: 84-28-5448-2100	Austria - Wels Tel: 43-7242-2244-39 Fax: 43-7242-2244-393 Denmark - Copenhagen Tel: 45-4485-5910 Fax: 45-4485-2829 Finland - Espoo Tel: 358-9-4520-820 France - Paris Tel: 33-1-69-53-63-20 Fax: 33-1-69-30-90-79 Germany - Garching Tel: 49-8931-9700 Germany - Haan Tel: 49-2129-3766400 Germany - Heilbronn Tel: 49-7131-72400 Germany - Karlsruhe Tel: 49-721-625370 Germany - Munich Tel: 49-89-627-144-0 Fax: 49-89-627-144-44 Germany - Rosenheim Tel: 49-8031-354-560 Israel - Ra'anana Tel: 972-9-744-7705 Italy - Milan Tel: 39-0331-742611 Fax: 39-0331-466781 Italy - Padova Tel: 39-049-7625286 Netherlands - Drunen Tel: 31-416-690399 Fax: 31-416-690340 Norway - Trondheim Tel: 47-72884388 Poland - Warsaw Tel: 48-22-3325737 Romania - Bucharest Tel: 40-21-407-87-50 Spain - Madrid Tel: 34-91-708-08-90 Fax: 34-91-708-08-91 Sweden - Gothenberg Tel: 46-31-704-60-40 Sweden - Stockholm Tel: 46-8-5090-4654 UK - Wokingham Tel: 44-118-921-5800 Fax: 44-118-921-5820