AN3909

ATA8352 Getting Started Guide

Introduction

The ATA8352 Getting Started Guide provides an overview of the Microchip ATA8352 Impulse-Radio Ultra-Wideband (IR-UWB) Transceiver. In addition, new users get a general overview about the following:

- How to start an application development using demo kits
- Implementing Demo software

ATA8352 UWB Device Overview

The ATA8352 device is a low-power ultra-wide-band (UWB) transceiver with an integrated security layer for secure distance bounding, localization and point-to-point data communication. The ATA8352 UWB device's digital transmitting circuitry ensures maximum flexibility in the generation of UWB pulse signals.

The transmitter can perform the following functions:

- Generate accurate pulse durations ranging from <1 ns to >10 ns with controlled envelope shape

- Generate a carrier frequency between 6.2 GHz and 8.3 GHz
- Ensure ETSI and FCC regulation compliance with programmable transmitted peak output power up to a typical value of 11 dBm

The ATA8352 UWB device front-end (FE) receiver provides an excellent sensitivity to guarantee a superior link budget for the RF communication. The digital base band signal processing unit ensures a highly stable sub nanosecond time-of-arrival (ToA) estimation. The ATA8352 UWB device includes a MAC layer for a secure distance-bounding measurement and data communication for proximity-based access control. The layer can be configured to ensure different degrees of security while providing a sufficient number of distance measurements to be run in one secure access control session.

Table of Contents

1. Quick References

1.1 Reference Documentation

For further details, refer to the following:

- *ATA8352 Impulse-Radio Ultra-Wideband (IR-UWB) Transceiver Data Sheet* (DS70005450)
- *ATA8352 Impulse-Radio Ultra-Wideband (IR-UWB) Transceiver User's Guide* (DS50003125)
- *AN3781 ATA8352 Software Application Development Application Note*
- *ATA8352 Demo and evaluation Kit User Guide*
- *AN3770 ATA8352 Module Application Note*
- *AT6491 Getting Started with SAM C21 SMART ARM Based Microcontroller Application Note* (42466A)
- *SAM C20/C21 Family Data Sheet* (DS60001479)
- *Microchip Debugger Atmel-ICE (ATATMEL-ICE) User Guide* (42330C)
- *Getting Started with Microchip Studio 7* (DS50002712)

1.2 Hardware Requirements

- ATSAMC21-XPRO Board
- ATA8352 UWB Xplained Pro Extension Board
- ATOLED1 Xplained Pro Board

1.3 Software Requirements

- SAM-C21 Demo Software
- Microchip Studio 7.0
- UWB Application Kit Demo software
- `ATA8352_VRPR_Demo.zip` software package
- `ATA8352_RXTX_Demo.zip` software package
- `ATA8352_TDoA_Demo.zip` software package

1.4 Acronyms and Abbreviations

Table 1-1. Acronyms and Abbreviations

Acronyms	Abbreviations
DGI	Data Gateway Interface
DS-TWR	Double-Sided-Two-Way-Ranging
ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission
FLL	Frequency Lock Loop
HW	Hardware
MCU	Micro-Controller Unit
MPU	Memory Protection Unit

Acronyms	Abbreviations
..........continued	
PR	Prover
RF	Radio Frequency
RX	Receiver
SMA	Sub Miniature Version A
SSID	Secure Session Identifier
SW	Software
SWD	Serial Wire Debugger
ToA	Time of Arrival
TDoA	Time Difference of Arrival
TFBGA	Thin Fine-Pitch Ball Grid Array
TX	Transmitter
USB	Universal Serial Bus
UWB	Ultra-Wide Band
VR	Verifier
XTAL	External Crystal

2. ATA8352 UWB Device

The ATA8352 UWB device is a highly integrated low-power IR-UWB transceiver with an integrated security layer for secure distance bounding and data communication between two devices.

The ATA8352 transceiver includes fully-digital transmitting circuitry to provide maximum flexibility in generating UWB pulse signals.

- The transmitter can accurately generate pulse durations ranging from less than 1 ns to more than 10 ns, with a controlled envelope shape and a carrier frequency from around 6.2 GHz to 8.3 GHz.
- The receiver is characterized by a high-gain and low-power wideband analog radio frequency front-end and a high-speed and low-power digital baseband processor.

The ATA8352 UWB device features:

- Low-power secure ranging technology
- Spectrum of transmission is compliant to UWB regulations of ETSI (EN 302 065-3 V2.1.0) and FCC (Title 47, part 15)
- UWB data communication up to 1 Mbps
- Single distance measurement with 4 cm resolution
- Distance measurement method is secured against multiple-attack scenarios, for example, Cicada Attack, Early Detect/Late Commit, Preamble Injection
- Tailored for industrial and home appliance applications for localization and secure distance bounding
- Fast SPI interface (24 MHz) for communication between the ATA8352 and a host microcontroller
- RX and TX peak power allows coin cell battery applications with an external DC-DC converter
- Operating conditions:
  - IC core voltage is 1.25V
  - I/O voltage range is 2.0V to 3.5V
  - Temperature range is -40°C to +105°C
- Package details:
  - 33 pins, thin profile fine pitch ball grid array (TFBGA)
  - Size: 4.5 mm x 4.5 mm
  - Ball pitch: 0.65 mm
  - Ball diameter: 0.4 mm

The secure distance-bounding and data transmission layer in the ATA8352 UWB device can operate with any microcontroller that can provide cryptographically secure random number generation and authentication routines. The ATA8352 UWB device supports three different operating modes:

- Verifier/Prover (VR/PR): For distance-bounding and localization applications, the device is switched into autonomous operating modes, handling receive and transmit operation during the measurement period. The device can operate as a verifier by transmitting and receiving the measurement pulses as well as challenge and response data. On the other side, the device can operate as a prover to receive and re-transmit the measurement pulses creating the response data.
- Receive/Transmit (RX/TX): For data communication, the device supports Transmit and Receive modes to establish a bidirectional communication between the ATA8352 UWB devices.
- Time Difference of Arrival (TDoA): The TDoA operation uses the RX and TX data communication with timestamp capturing, a specialized header and footer section in payload format. The timestamp capturing occurs at different positions while transmitting or receiving a TDoA data telegram. The TDoA implementation supports wired and wireless synchronization, and scheduled data telegram transmission. Measure the time difference between a transmitter (Tag) and several receivers (Anchors).

Note: For more details about modes, packets, features and device overview, refer to the *ATA8352 Impulse-Radio Ultra-Wideband (IR-UWB) Transceiver Data Sheet* and *ATA8352 Impulse-Radio Ultra-Wideband (IR-UWB) Transceiver User's Guide*.

3.   ATA8352 UWB Demo and Evaluation Kits

The ATA8352 UWB demo and evaluation kit is available in two variants with the same functionality:

- ATA8352 UWB Demo Kit variant A
- ATA8352 UWB Demo Kit variant B

Note: The only difference between the demo kit variant A and variant B is the board for the prover node.

The following sections describe variant A and variant B.

3.1   ATA8352 UWB Demo Kit – Variant A

The ATA8352 UWB demo kit variant A uses two ATSAMC21-XPRO boards, one for the Verifier node and one for the Prover node to control the operation of the ATA8352 UWB device. The following figure shows the components and the assembly. All boards are pre-programmed and start the demo application by applying power to the boards.

Figure 3-1. ATA8352 UWB Demo Kit Variant A with ATA8352 UWB Xplained Pro Extension Board
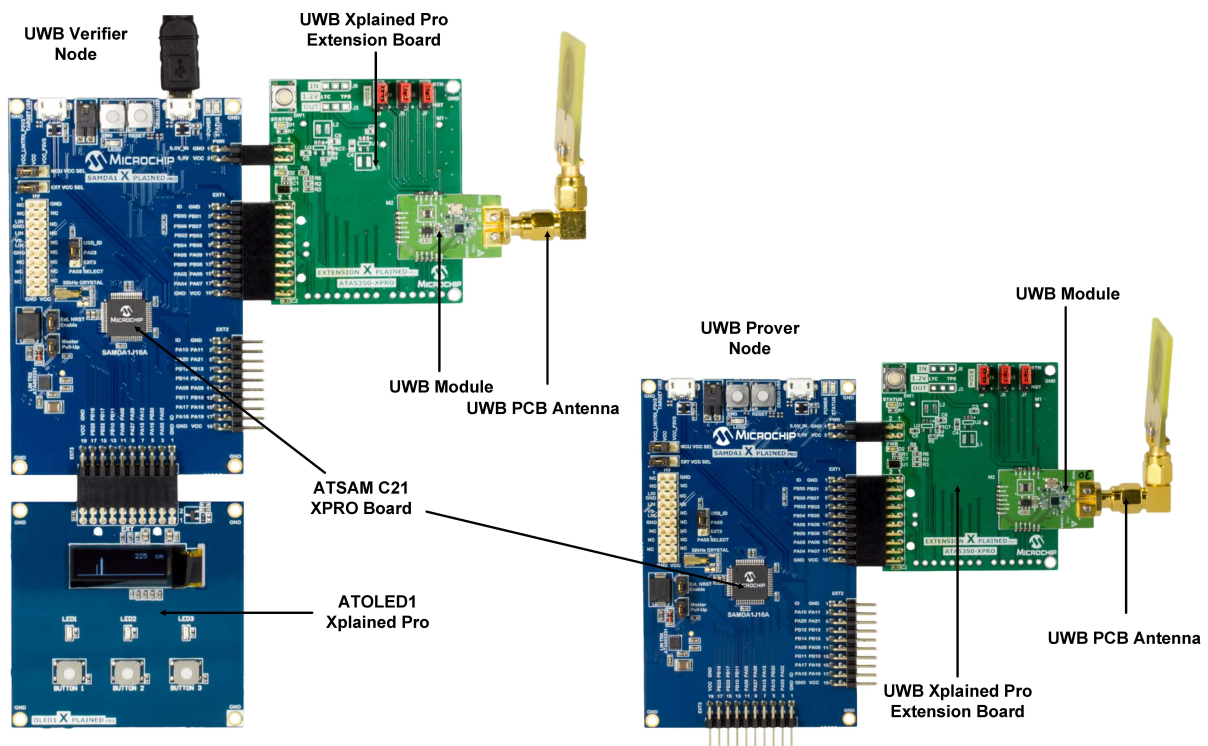
The following components are used for the Verifier and the Prover nodes:

- Verifier Node:
    - One ATSAMC21-XPRO board
    - One ATOLED1 Xplained Pro
    - One UWB Xplained Pro Extension board with ATA8352 module
    - One UWB PCB antenna with SMA connector
    - One USB cable for 5V USB supply and for connection to a PC with Microchip Studio 7
- Prover Node:
    - One ATSAMC21-XPRO board
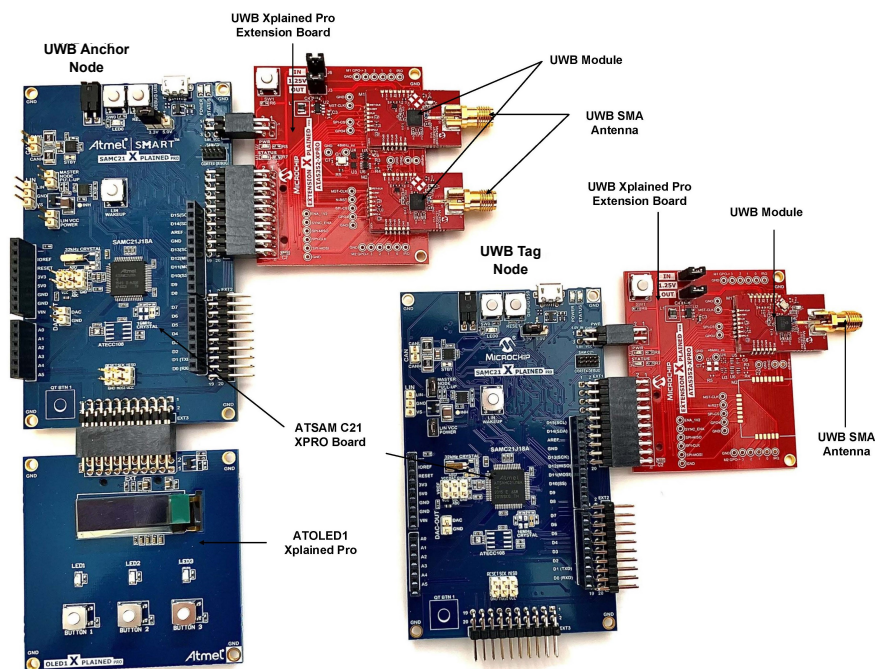   - One UWB Xplained Pro Extension board with ATA8352 module

 – One UWB PCB antenna with SMA connector
 – One USB cable for 5V USB supply and for connection to a PC with Microchip Studio 7

The TDoA and DS-TWR demo applications are running on the same ATA8352 demo kit but with two ATA8352 modules populated on the UWB Xplained Pro Extension board. One node is used as Tag node and the other node is the Anchor node, as shown in the following figure. The demo applications are developed using Microchip Studio 7 for the ATSAMC21-XPRO board. Connect both nodes to the PC with a USB cable. The PC terminal application uses a virtual COM port connection to log the measurement data.

For the COM port connection, use the following settings:

 • Data rate – 115.2 Kbaud
 • 8-bit data
 • no parity
 • 1 stop bit

Figure 3-2. ATA8352 UWB Module Variant A for TDoA Mode and ATA8352 UWB Xplained Pro Extension Board

The following components are used for the Anchor node and the Tag node:

 • Anchor Node:
     – One ATSAMC21-XPRO board
     – One ATOLED1 Xplained Pro
     – One UWB Xplained Pro Extension board with two ATA8352 Module
     – One UWB antenna with SMA connector
     – One USB cable for 5V USB supply and for connection to a PC with Microchip Studio 7
 • Tag Node
     – One ATSAMC21-XPRO board
     – One UWB Xplained Pro Extension board with one ATA8352 Module
     – Two UWB antenna with SMA connector
     – One USB cable for 5V USB supply and for connection to a PC with Microchip Studio 7

3.2 ATA8352 UWB Demo Kits – Variant B

The ATA8352 UWB demo kit variant B uses the ATSAMC21-XPRO board for the Verifier node. The variant B uses up to five ATAUWB-EK1 boards for the Prover nodes, with an embedded ATSAMC21-XPRO board to control the operation of the ATA8352 UWB device. The following components are used for the following nodes.

- Verifier Node:
    - ATSAMC21-XPRO board
    - One ATOLED1 Xplained Pro Extension board
    - One UWB Xplained Pro Extension board with ATA8352 module
    - One UWB antenna with SMA connector
    - One USB cable for 5V USB supply and for connection to a PC with Microchip Studio 7

- Prover Node – Up to 5 ATAUWB-EK1 boards with:
    - ATSAMC21-XPRO board
    - ATA8352 module. For more details, refer to the *AN3770 ATA8352 Module Application Note*
    - CAN and LIN driver IC
    - 12V supply with DC/DC converter for 5V, 3.3V and 1.25V supply
    - USB connector for 5V supply
    - MCP2221A USB COM port driver with 5V USB supply

Figure 3-3. ATA8352 Demo Kit Variant B
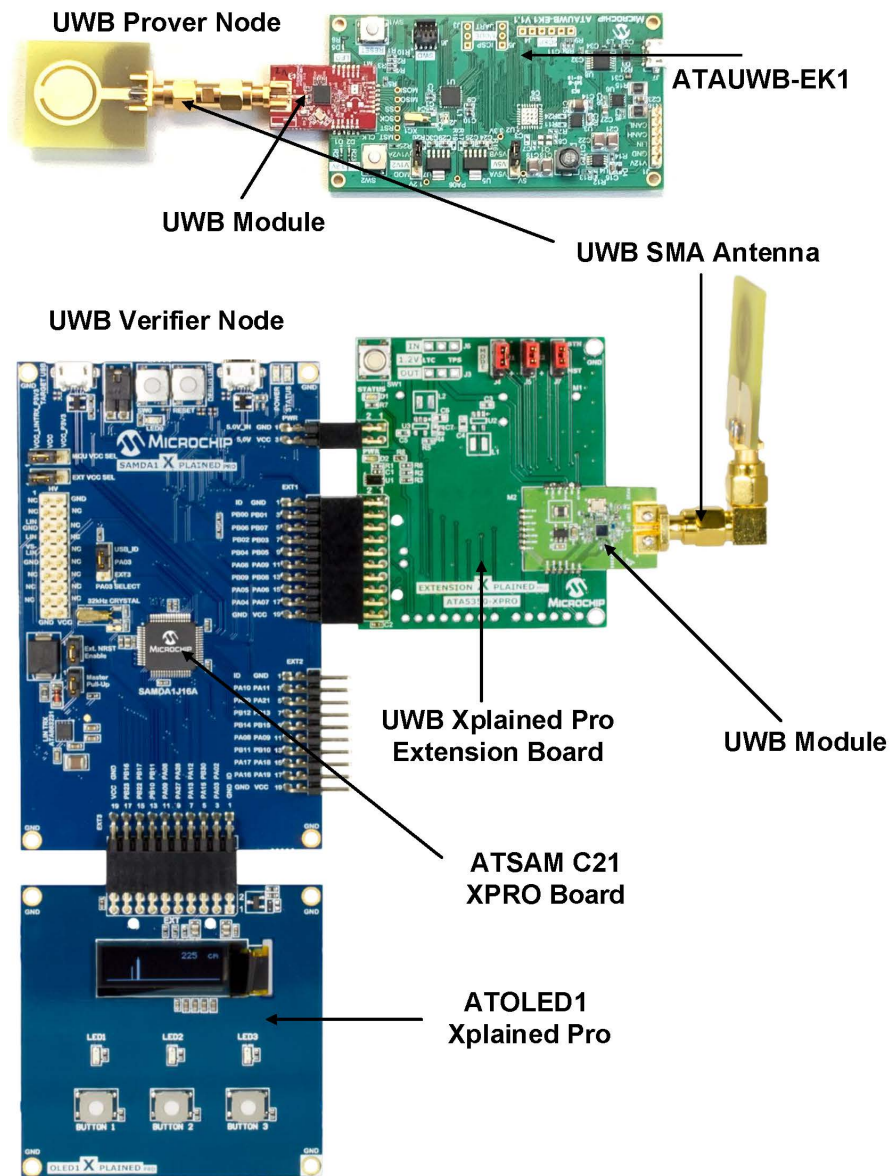
Notes:

1. For more information about ATA8352 UWB device, refer to the *ATA8352 Impulse-Radio Ultra-Wideband (IR-UWB) Transceiver Data Sheet* and the *ATA8352 Impulse-Radio Ultra-Wideband (IR-UWB) Transceiver Users Guide* .

2. For more information about the ATA8352 UWB Xplained Pro Extension board, such as the schematic, pin description and register description, refer to the *AN3770 ATA8352 Module Application Note*.
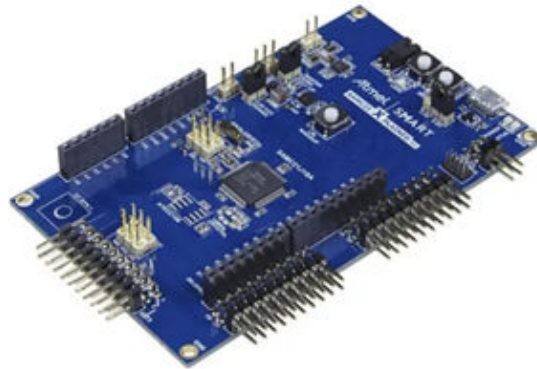
3.3   ATA8352 UWB Demo Kit Features

The ATA8352 UWB demo kits node contains the following devices:

- Host Controller board, ATSAMC21-XPRO board
 - ARM Cortex-M0+ CPU running at up to 48 MHz

- Single-cycle hardware multiplier
- Micro trace buffer
- Memory protection unit (MPU)
- ATSAMC21J18A MCU (256 Kbytes Flash, 32 Kbytes SRAM, LIN and CAN_FD)

**Figure 3-4. ATSAMC21 XPRO Board**

- ATOLED1 Xplained Pro Board (Optional)
  - UG-2832HSWEG04 monochrome OLED display
    - 28 x 32 pixels
    - Controlled by 4-wire SPI interface, up to 100 MHz
  - Three LEDs
  - Three Mechanical Push button
  - Xplained Pro hardware identification system

**Figure 3-5. ATOLED1 Xplained Pro Board**
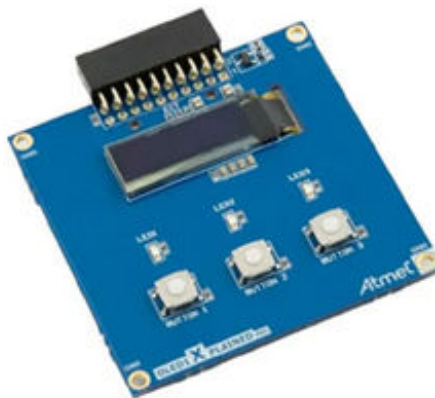
- UWB Xplained Pro Extension Board
  - UWB Xplained Pro Extension Board – Single module with one UWB module
  - UWB Xplained Pro Extension Board – Double module supporting two UWB modules

Figure 3-6. ATA8352 UWB Xplained Pro Extension Board
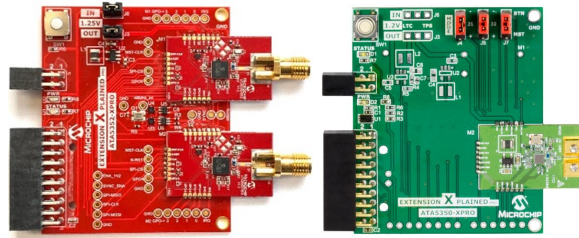
- ATA8352 UWB Module
  - PCB dimension is 17 mm to 27.93 mm
  - Contains an SMA connector

Figure 3-7. ATA8352 UWB Module
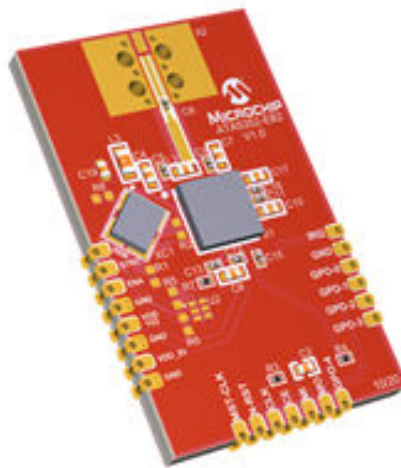
- SMA Antenna
  - Connect the supplied antenna to the SMA connector shown in the above ATA8352 UWB module. To achieve the best results, ensure the planes of the antenna at both ends of the radio link are parallel to each other.

Figure 3-8. SMA Antenna

- ATAUWB-EK1
  - ATSAMC21E16A MCU (256 Kbytes Flash, 32 Kbytes SRAM, LIN and CAN-FD) or
  - PIC18F26K80 (64 Kbytes Flash, 3.5 KB SRAM, LIN and CAN) (Optional)

Figure 3-9. ATAUWB-EK1
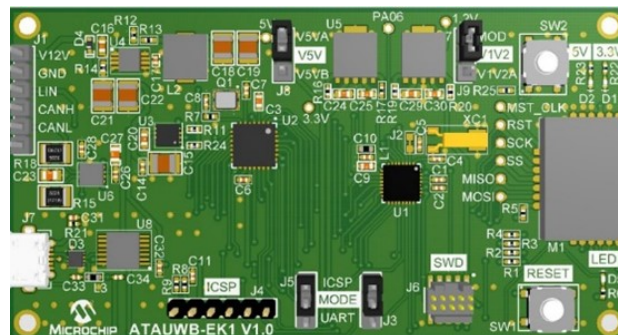
4. ATA8352 UWB Power-Up

The ATA8352 UWB device is powered via the ATSAMC21-XPRO (host MCU) board. The host controller ATSAMC21-XPRO board could be powered either with a mini USB cable from a DC power supply (or battery), or a personal computer through a USB Debug port. The LED labeled POWER on the host MCU board will illuminate green, when power is supplied to the board.

The host MCU board has a 3-pin header labeled VCC_SEL on the board. This header can be used to select between 3.3V and 5.0V as the supply voltage for the ATSAMC21J18A, peripherals and extension headers by placing a jumper on pin 1-2 or pin 2-3, respectively. This jumper must always be set on 3.3V to avoid any damage on the ATA8352 UWB device.

Note: For more information about the power-up, DC/DC converter schematic of host MCU board and UWB module, refer to the *ATA8352 Demo and Evaluation Kit User Guide* and the *AT6491 Getting Started with SAM C21 SMART ARM Based Microcontroller Application Note*.

5. Hardware Tools and Development

The ATA8352 UWB device is connected to a host MCU using an SPI communication link with additional control lines for interrupt and reset functions. In addition, the device has 5 GPOx lines, which are optionally used in test and debug modes to measure and observe the internal device operation.

The SAM C21 MCU can be debugged and programmed with the help of a debugger (ATATMEL-ICE) or direct USB connection between the MCU host controller debug USB port and a computer. For more information, refer to the *Microchip Debugger Atmel-ICE (ATATMEL-ICE) User Guide*.

5.1 Debugging with ATATMEL-ICE Development Tool

The ATATMEL-ICE is a powerful development tool for debugging and programming ARM Cortex-M-based Microchip SAM and Microchip AVR microcontrollers with on-chip debug capability. The user can program and debug the ATSAMC21 MCU using the debug system (EDBG) on the ATSAMC21-XPRO board, which does not require the debugger, while the ATAUWB-EK1 does not contain EDBG and requires the debugger.

For debugging with the ATATMEL-ICE development tool, perform the following steps:

1. Install Microchip Studio version 7 or later on the user computer because the ATATMEL-ICE debugger unit requires a front-end debugging environment.

Figure 5-1. ATATMEL-ICE Debugger

2. Connect the ATATMEL-ICE to the host computer using the USB cable provided or with a certified Micro-USB cable.
3. The tool must connect to the port corresponding to the pinout of the target. In the current document, the target is SAM, which is also illustrated in the following figure.

Figure 5-2. ATATMEL-ICE Debugger SAM Probe Connection

4. The ATATMEL-ICE contains a USB 2.0-compliant controller, and operates in both Full-speed and High-speed modes.
   Note: For best results, connect the ATATMEL-ICE directly to a USB-compliant high-speed hub on the host computer.

5. After connecting the ATATMEL-ICE to the computer, launch Microchip Studio.

6. On the Microchip Studio Device Programming windows, select ATATMEL-ICE in the Tool tab.

7. Look for ATSAMC21E16A, which is used as a host MCU in ATAUWB-EK1.

8. Click the Apply button (see Figure 5-4) and both of the green LEDs on the ATAUWB-EK1 boards turn ON, as illustrated in the following figure.
   **Notes:**
   - If the green LED is still OFF, check the error message in Microchip studio and follow the instructions in the error message.
   - The ATAUWB-EK1 needs a separate power source (through the mini USB port, which is connected to a personal computer), while the ATATMEL-ICE debugger is not able to power up the ATAUWB-EK1.

Figure 5-3. ATATMEL-ICE Debugger Connects to ATAUWB-EK1 via SAM Probe Connection
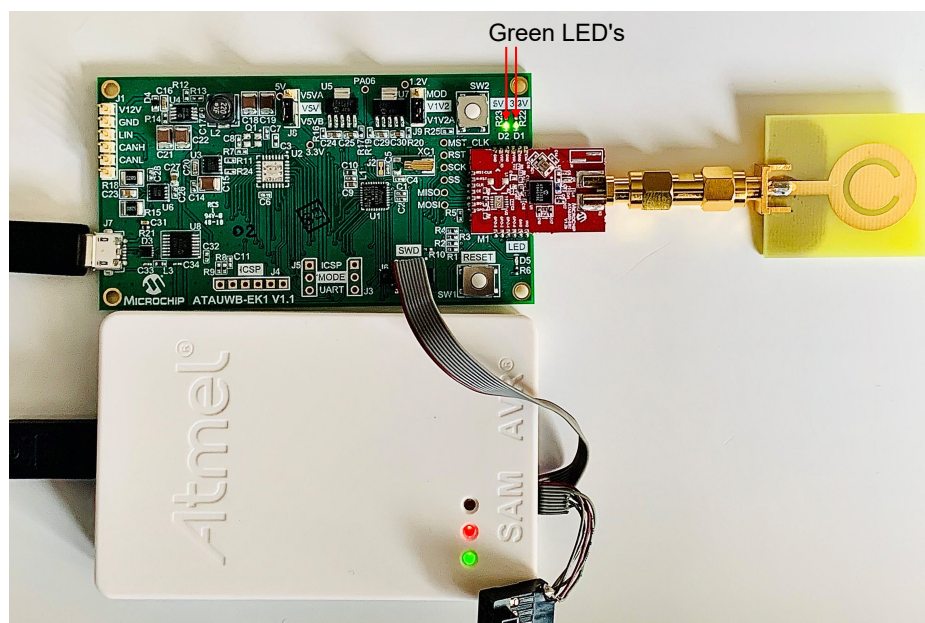
9. If the connections are correct and the green LEDs turn on, click the Read tab on the Device signature. The MCU board signature displays in the Device signature tab, which is 0x1101040C for the current example, as illustrated in the following figure.
   Note: The ATAUWB-EK1, which is used as a prover board in variant B, cannot be programmed or debugged through the COM port. The host controller on this board is debugged and programmed with the ATATMEL-ICE debugger. It is recommended that the same process described in this section be followed. The only difference is, use the ATSAMC21E16A as the host controller on the ATAUWB-EK1.

Figure 5-4. Microchip Studio Device Programming Windows
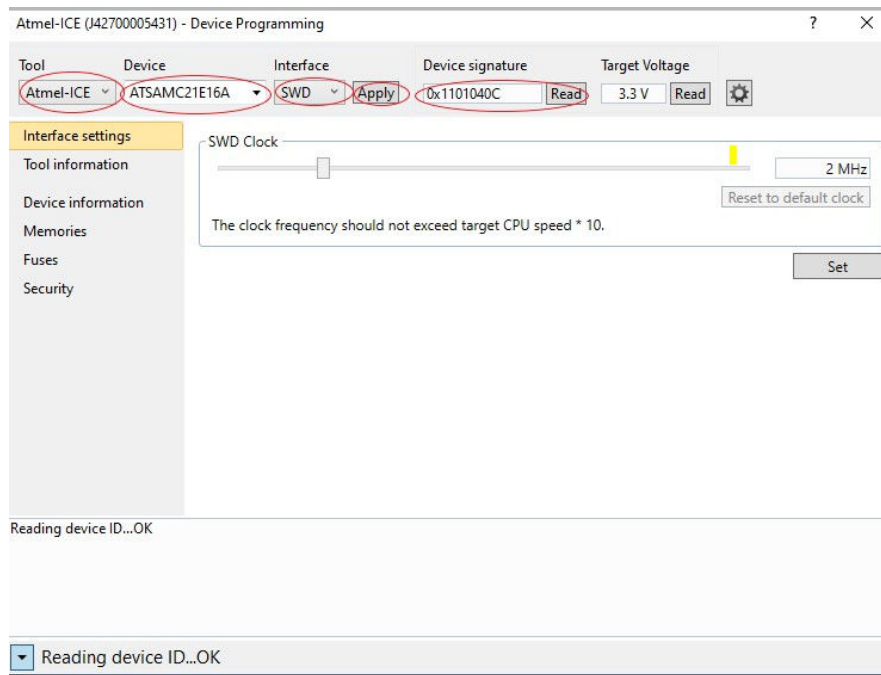
Note: For more information, refer to the *AT6491 Getting Started with SAM C21 SMART ARM Based Microcontroller Application Note* and *www.microchip.com*.

5.2 Debugging with ATSAMC21-XPRO EDBG Interface

For debugging the ATSAMC21 through the EDBG interface on the ATSAMC21-XPRO board, perform the following steps:

1. Attach the ATSAMC21-XPRO board to a computer by using a USB (A-to-Micro B convertor) cable.
2. Launch Microchip Studio on the computer. If the board was successfully enumerated, the board image displays in Microchip Studio as shown in the following figure.
   **Note:** The board can be identified by the last four digits of its serial number (see the sticker on the bottom of the board). In actual example, the last four digits are "0567".

Figure 5-5. Microchip Studio Starting Windows
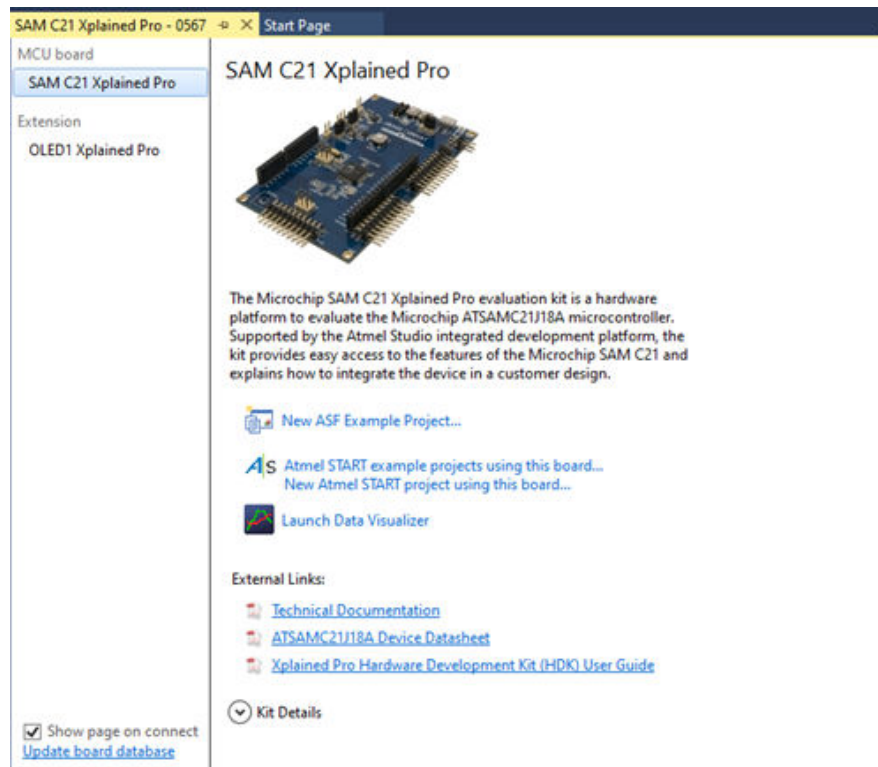
3. Configure the debugger in Microchip Studio to discover and connect to the target EDBG IC on the ATSAMC21-XPRO board.

   3.1. Click on the Device Programming tab, which is highlighted by a red circle on the top of the following figure.

   3.2. In the Device Programming window, select the EDBG target from the drop-down list. Further processes are the same as described in 5.1 Debugging with ATATMEL-ICE Development Tool.

**Figure 5-6. EDBG and MCU Number on Device Programming Windows**
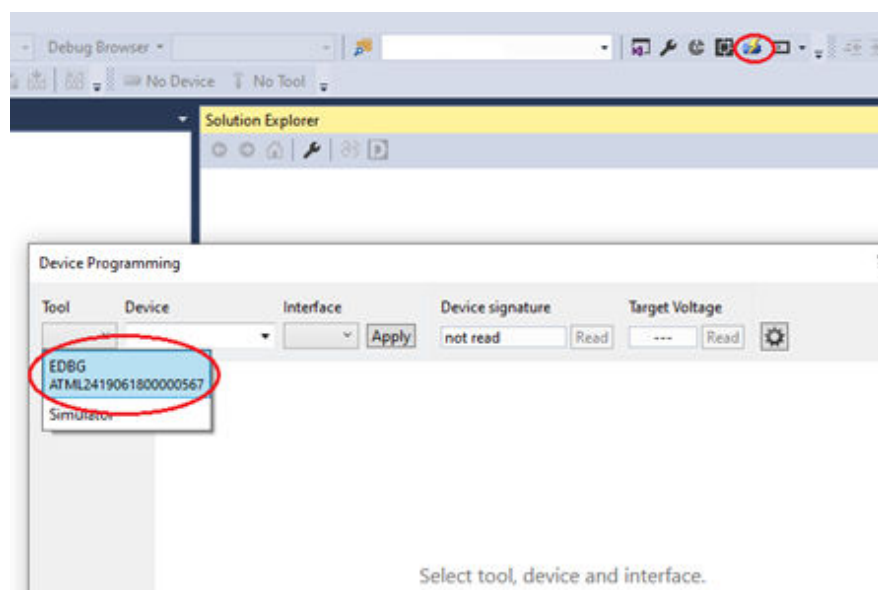
6. Software and Development Tools

To show the implementation and getting started with demo software, select the ATA8352 demo kit variant A (see 3.1 ATA8352 UWB Demo Kit – Variant A).

The following figure illustrates the ATA8352 demo kit variant A single module breakout XPRO overview.

Figure 6-1. ATA8352 Demo Kit Variant A Single Module Breakout XPRO Overview
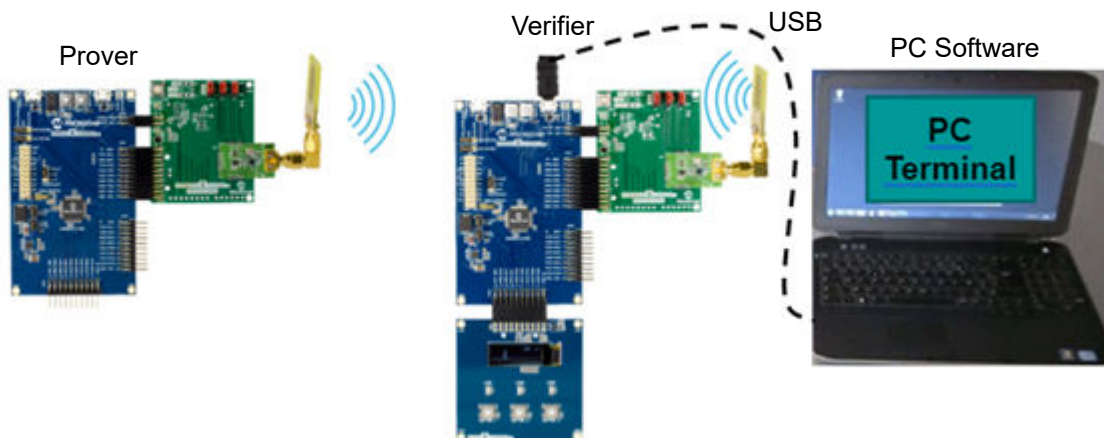
Notes:
- All the demo software is written in Microchip Studio 7, and the user can use this IDE for modification and debugging.
- For data transmission, distance-bounding and localization applications, switch the device into multiple operating modes that handle receive and transmit operations during the measurement period. For example, implementing software VR/PR mode is selected here.

Figure 6-2. Microchip Studio Starting Page Contains VR/PR Demo Program
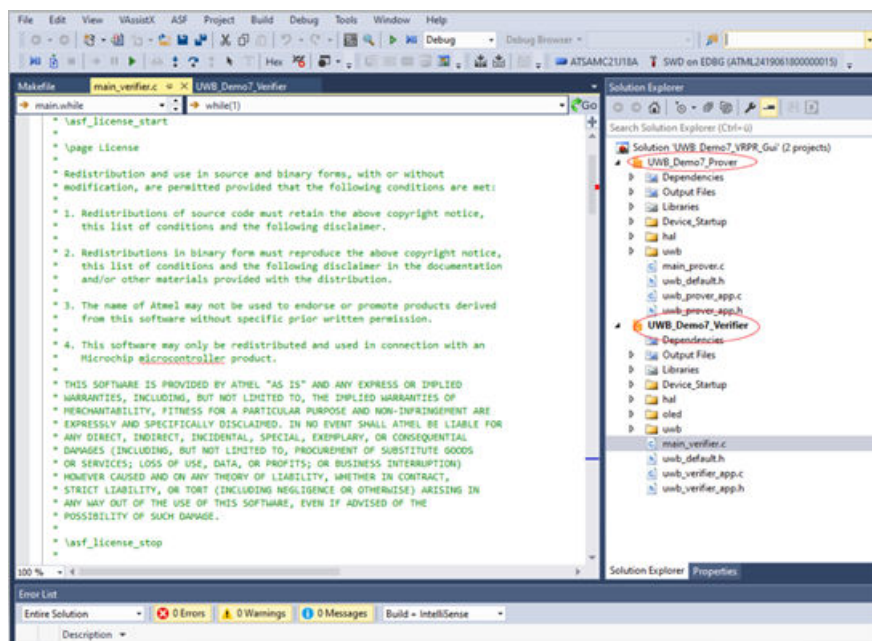
To program the ATA8352 demo kit variant A, perform the following steps:

1. Select the correct folder depending on the target node, and click the Device Programming button, which is highlighted with a red circle on top of the Microchip Studio windows, as illustrated in the following figure.

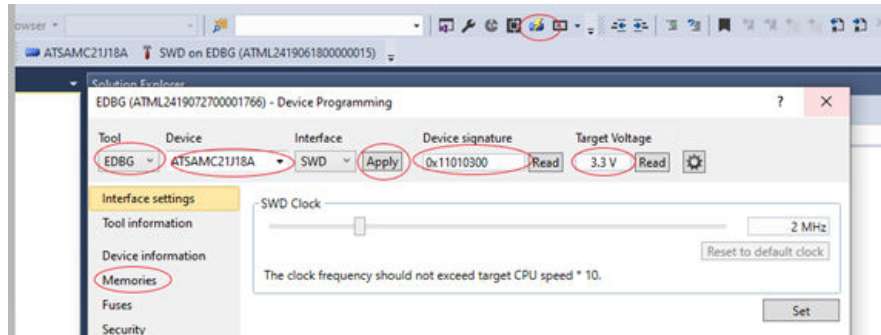2. Click the Tool option, then select EDBG from the drop-down list and the ATSAMC21-XPRO board number (see Figure 5-6).

Figure 6-3. Microchip Studio 7 Device Programming Windows for UWB Application Kit

3. In the Device tab, select the MCU host controller as ATSAMC21J18A.

4. Click the Apply button, as illustrated in the above figure. The status LED on the MCU host controller board turns ON, as illustrated in the following figure. The Microchip Studio reads the device signature. In the case of an unsuccessful try, check the power or connections between the terminal PC and the host controller board.

Figure 6-4. ATSAMC21-XPRO Board Status LED (Yellow)
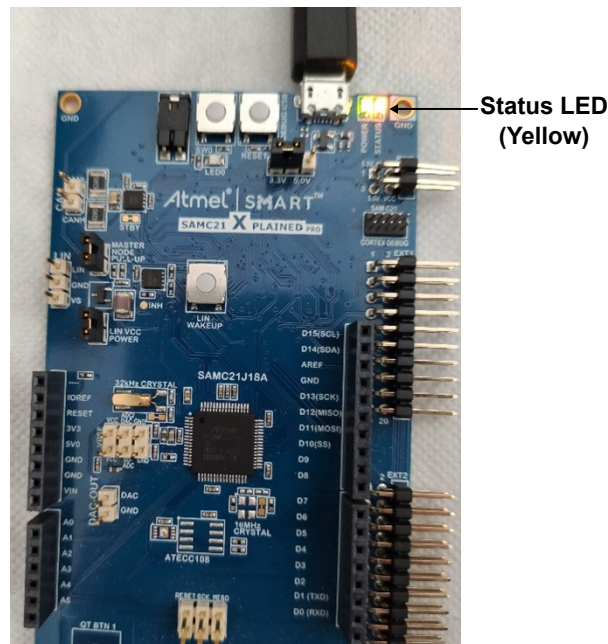
5. Click the Memories tab and a new window appears, as illustrated in the following figure. Now, the device is ready for programming.
   Note: The user must check the file to ensure that the correct software is selected for programming. In the case of an incorrect address, the user must type or browse for the correct address manually.

6. Click the Program button. Microchip Studio flashes the host controller and the ATA8352 UWB device is ready for transmission.

Figure 6-5. Microchip Studio 7 Memory Flash Window
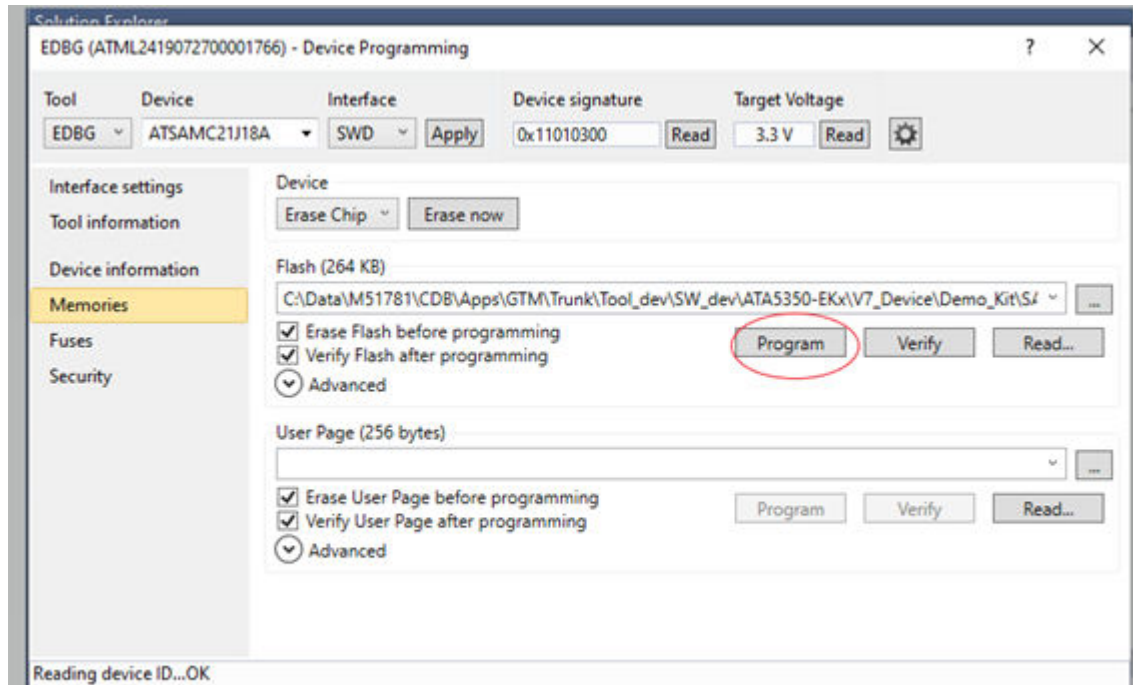
7. Repeat the same process for another node.

7.   Document Revision History

Revision	Date	Section	Description
A	04/2021	Document	Initial Revision

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