## Introduction

The ATMUBX0A module is based on Decawave's DW1000 Ultra Wideband (UWB) transceiver IC, which is an IEEE 802.15.4- 2011 UWB implementation. It integrates UWB and Bluetooth® antenna, all RF circuitry, Nordic Semiconductor nRF52832 and a motion sensor.

## Key Features

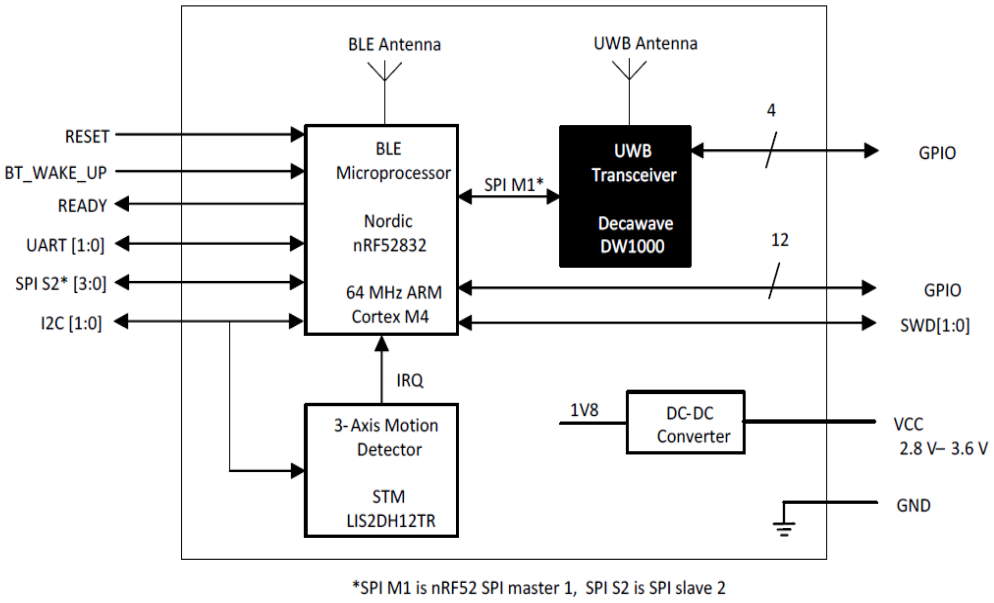
- Ranging accuracy to within 10cm.
- UWB Channel 5 printed PCB antenna (6.5 GHz)
- 6.8 Mbps data rate
- 60 m line-of-sight range typical
- IEEE 802.15.4-2011 UWB compliant
- Nordic Semiconductor nRF52832
- Bluetooth connectivity
- Bluetooth chip antenna
- Motion sensor: 3-axis accelerometer
- Current consumption optimised for low power sleep mode: <15µA
- Supply voltage: 2.8 V to 3.6 V
- Size: 19.1 mm x 26.2 mm x 2.6 mm

## Key Benefits

- Enables anchors, tags & gateways to quickly get an entire RTLS system running
- Accelerates product designs for faster Time-to-Market & reduced develop
- Ready-to-go embedded firmware to minimise software development
- Over-the-air updates
- User API to ATMUBX0A firmware (available as a library) for user code cu
- On-board Bluetooth SMART for connectivity to phones/tablets/PCs

• SPI, UART and Bluetooth APIs to access ATMUBX0A firmware from an external device

• Low-power hardware design and software architecture for longer battery life




High Level Block Diagram

# 1 OVERVIEW

The block diagram on page 1 of this data sheet shows the major sections of the ATMUBX0A. An overview of these blocks is given below.

## 1.1 UWB Transceiver DW1000

The module has a DW1000 UWB transceiver mounted on the PCB. The DW1000 uses a 38.4 MHz reference crystal. The crystal has been trimmed in production to reduce the initial frequency error to approximately 3 ppm, using the DW1000 IC's internal on-chip crystal trimming circuit.

Always-On (AON) memory can be used to retain DW1000 configuration data during the lowest power operational states when the on-chip voltage regulators are disabled. This data is uploaded and downloaded automatically. Use of DW1000 AON memory is configurable.

The on-chip voltage and temperature monitors allow the host to read the voltage on the VDDAON pin and the internal die temperature information from the DW1000.

See the DW1000 Datasheet [2] for more detailed information on device functionality, electrical specifications and typical performance.

## 1.2 Bluetooth Microprocessor Nordic nRF52832

The nRF52832 is an ultra-low power 2.4 GHz wireless system on chip (SoC) integrating the nRF52 Series 2.4 GHz transceiver and an ARM Cortex-M4 CPU with 512kB flash memory and 64kB RAM.

See the nRF52832 Datasheet[1] for more detailed information on device functionality, electrical specifications and typical performance.

## 1.3 Power Supply and Power management

The power management circuit consists of a switch mode regulator. It is a buck convertor or step down convertor. The input voltage to the ATMUBX0A can be in the range 2.8V to 3.6V. Outputs from the convertor provides 1.8V which is required by the DW1000[2]

## 1.4 Three Axis Motion Detector STMicroelectronics LIS2DH12TR

The LIS2DH12 is an ultra-low-power high performance three-axis linear accelerometer with digital I2C/SPI serial interface standard output. The LIS2DH12 has user-selectable full scales of ±2g/±4g/±8g/±16g and is capable of measuring accelerations with output data rates from 1 Hz to 5.3 kHz. The self-test capability allows the user to check the functionality of the sensor in the final application. The device may be configured to generate interrupt signals by detecting two independent inertial wake-up/free-fall events as well as by the position of the device itself. The LIS2DH12 is guaranteed to operate over an extended temperature range from -40 °C to +85 °C.

See the LIS2DH12TR Datasheet[4] for more detailed information on device functionality, electrical specifications and typical performance.

### 1.5 Software on board

The ATMUBX0A module comes pre-loaded with embedded firmware which provides two-way ranging (TWR) and real time location system (RTLS) functionality. See the details in the ATMUBX0A Firmware User Guide [6]. The module can be configured and controlled via its API, which can be accessed through a number of different interfaces, allowing flexibility to the product designer. The details of the API are described in the ATMUBX0A Firmware API Guide [5]. Decawave also provides the module firmware in the form of binary libraries and some source code. A build environment is provided, so that the user can customise the operation and if required add their own functions[6].

## 2 ATMUBX0A PIN CONNECTIONS

### 2.1 Pin Numbering

ATMUBX0A module pin assignments are as follows (viewed from top):

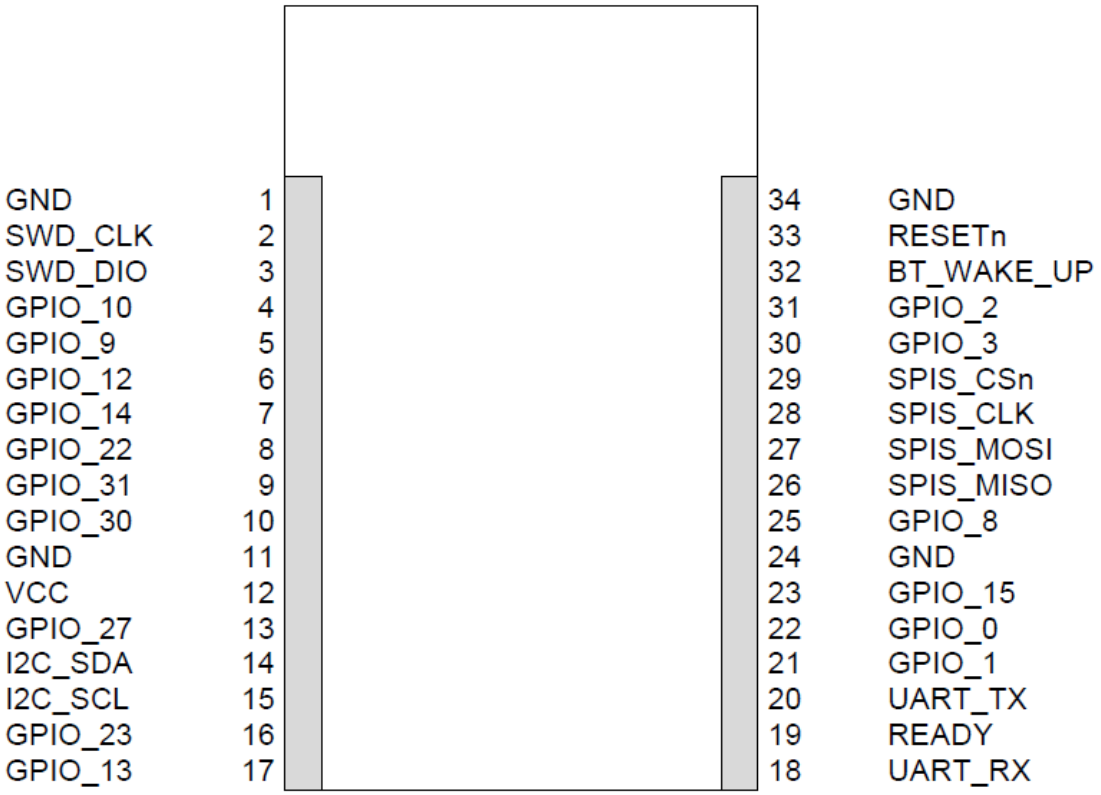



Figure 1: ATMUBX0A Pin Diagram

## 2.2 Pin Descriptions

Pin details are given in

Table 1: ATMUBX0A Pin functions

| SIGNAL NAME | PIN | I/O (Default) | DESCRIPTION | REFERENCE (Pin designation) |
|---|---|---|---|---|
| **Digital Interface** | | | | |
| SWD_CLK | 2 | DI | Serial wire debug clock input for debug and programming of Nordic Processor | [N] SWDCLK |
| SWD_DIO | 3 | DIO | Serial wire debug I/O for debug and programming of Nordic Processor | [N] SWDIO |
| GPIO_10 | 4 | DIO | General purpose I/O pin. | [N] P0.10 |
| GPIO_9 | 5 | DIO | General purpose I/O pin. | [N] P0.9 |
| GPIO_12 | 6 | DIO | General purpose I/O pin. | [N] P0.12 |
| GPIO_14 | 7 | DIO | General purpose I/O pin. | [N] P0.14 |
| GPIO_22 | 8 | DIO | General purpose I/O pin. | [N] P0.22 |
| GPIO_31 | 9 | DIO | General purpose I/O pin. ADC function of nRF52 | [N] P0.31 |
| GPIO_30 | 10 | DIO | General purpose I/O pin. ADC function of nRF52 | [N] P0.30 |
| GPIO_27 | 13 | DIO | General purpose I/O pin. | [N] P0.27 |
| I2C_SDA (Master) | 14 | DIO | Master I2C Data Line. | [N] P0.29 |
| I2C_SCL (Master) | 15 | DO | Master I2C Clock Line | [N] P0.28 |
| GPIO_23 | 16 | DIO | General purpose I/O pin. | [N] P0.23 |
| GPIO_13 | 17 | DIO | General purpose I/O pin. | [N] P0.13 |
| UART_RX | 18 | DI | UART_RX | [N] P0.11 |
| READY | 19 | DO | Generated interrupt from the device.<br>Indicates events such as SPI data ready, or location data ready.<br>See the function dwm_int_cfg() in the DWM1001 Firmware API Guide for details[5]. | [N] P0.26 |
| UART_TX | 20 | DO | UART_TX, This is also the ADC function of the nRF52 | [N] P0.05 |
| GPIO_1 | 21 | DIO | General purpose I/O pin of the DW1000.<br>It may be configured for use as a SFDLED driving pin that can be used to light a LED when SFD (Start Frame Delimiter) is found by the receiver. Refer to the DW1000 User Manual [1] for details of LED use. | [DW] GPIO1 |
| GPIO_0 | 22 | DIO | General purpose I/O pin of the DW1000.<br>It may be configured for use as a RXOKLED driving pin that can be used to light a LED on reception of a good frame. Refer to the DW1000 User Manual [1] for details of LED use. | [DW] GPIO0 |
| GPIO_15 | 23 | DIO | General purpose I/O pin. | [N] P0.15 |
| GPIO_8 | 25 | DIO | General purpose I/O pin. | [N] P0.08 |

| | | | | |
|---|---|---|---|---|
| SPIS_MISO | 26 | DI | Configured as a SPI slave this pin is the SPI data output. Refer to Datasheet for more details [1]. | [N] P0.07 |
| SPIS_MOSI | 27 | DO | Configured as a SPI slave this pin is the SPI data input. Refer to Datasheet for more details [1]. | [N] P0.06 |
| SPIS_CLK | 28 | DI | Configured as a SPI slave this pin is the SPI clock. This is also the ADC function of the nRF52 | [N] P0.04 |
| SPIS_CSn | 29 | DI | Configured as a SPI slave this pin is the SPI chip select. This is an active low enable input. The high-to-low transition on SPICSn signals the start of a new SPI transaction. This is also the ADC function of the nRF52 | [N] P0.03 |
| GPIO_3 | 30 | DO | This pin is configured for use as a TXLED driving pin that can be used to light a LED during transmit mode. Refer to the DW1000 User Manual [2] for details of LED use. | [DW] GPIO3 |
| GPIO_2 | 31 | DO | This pin is configured for use as a RXLED driving pin that can be used to light a LED during receive mode. Refer to the DW1000 User Manual [2] for details of LED use. | [DW] GPIO2 |
| BT_WAKE_UP | 32 | DI | When this pin is asserted to its active low state the Bluetooth device will advertise its availability for 20 seconds by broadcasting advertising packets. This is also the ADC function of the nRF52. | [N] P0.02 |
| RESETn | 33 | DI | Reset pin. Active Low Input. | [N] P0.21 |
| **Power Supplies** | | | | |
| VCC | 12 | P | External supply for the module. 2.8V - 3.6V | |
| **Ground** | | | | |
| GND | 1, 11, 24, 34 | G | Common ground. | |

Table 2: Explanation of Abbreviations

| ABBREVIATION | EXPLANATION |
|---|---|
| DI | Digital Input |
| DIO | Digital Input / Output |
| DO | Digital Output |
| G | Ground |
| P | Power Supply |
| N | nRF52832 |
| DW | DW1000 |
| *Note: Any signal with the suffix 'n' indicates an active low signal.* | |

Table 3: Internal nRF52832 pins used and their function

| nRF52832 Pin | Function |
|---|---|
| PO.19 | DW_IRQ |
| PO.16 | DW_SCK |
| PO.20 | DW_MOSI |
| PO.18 | DW_MISO |
| PO.17 | DW_SPI_CS |
| PO.24 | DW_RST |
| PO.25 | ACC_IRQ |
| PO.29 | I2C_SDA |
| PO.28 | I2C_SCL |

DW1000's GPIOs 5,6 control the DW1000 SPI mode configuration. Within the ATMUBX0A module, those GPIOs are unconnected and will be internally pulled down. Consequently, SPI will be set to mode 0. For more details, please refer to DW1000 data sheet [2].

Table 4: I2C slave devices address I2C

| I2C slave device | Address |
|---|---|
| LIS2DH12 | 0X19 |

# 3 ELECTRICAL SPECIFICATIONS

The following tables give detailed specifications for the ATMUBX0A module. Tamb = 25 ˚C for all specifications given.

## 3.1 Nominal Operating Conditions

Table 5: ATMUBX0A Operating Conditions

| Parameter | Min. | Typ. | Max. | Units | Condition/Note |
|---|---|---|---|---|---|
| Operating temperature | -40 | | +85 | ˚C | |
| Supply voltage VCC | 2.8 | 3.3 | 3.6 | V | Normal operation |
| Voltage on VDDIO for programming OTP | 3.7 | 3.8 | 3.9 | V | Note that for programming the OTP in the DWM1001 this supply is connected to the VDDIO test point which is underneath the PCB. (See Figure 6) |

## 3.2 DC Characteristics

Table 6: ATMUBX0A DC Characteristics

| Parameter | Min. | Typ. | Max. | Units | Condition/Note |
|---|---|---|---|---|---|
| Supply current in DEEP SLEEP mode | | 4 | | µA | All peripherals in lowest power consumption mode<br>Achievable where RTC and accelerometer are disabled with custom firmware. |
| Supply current in DEEP SLEEP mode | | 12 | | µA | RTC and accelerometer operational, all other peripherals in lowest power consumption mode* |
| Supply current in IDLE mode | | 13 | | mA | MCU and DW1000 awake |
| TX peak current | | 111 | | mA | |
| TX mean current | | 82 | | mA | |
| RX peak current | | 154 | | mA | |
| RX mean current | | 134 | | mA | |
| Current in Bluetooth® discovery mode | | 6 | | mA | |
| Digital input voltage high | 0.7 x VCC | | VCC | V | |
| Digital input voltage low | GND | | 0.3 x VCC | V | |
| Digital output voltage high | 0.7 x VCC | | VCC | V | |
| Digital output voltage low | GND | | 0.3 x VCC | V | |

* Using a ranging update rate of 1 Hz

## 3.3 Receiver Sensitivity Characteristics

Tamb = 25 ˚C, 20 byte payload. These sensitivity figures assume an antenna gain of 0 dBi and should be modified by the antenna characteristics, depending on the orientation of the ATMUBX0A.

Table 8: ATMUBX0A Typical Receiver Sensitivity Characteristics

| Packet Error Rate | Data Rate | Receiver Sensitivity | Units | Condition/Note | | |
|---|---|---|---|---|---|---|
| 1% | 6.8 Mbps | -98*(-92) | dBm/500 MHz | Preamble 128 | Carrier frequency offset ±10 ppm | All measurements performed on Channel 5, PRF 64 MHz |
| 10% | 6.8 Mbps | -99*(-93) | dBm/500 MHz | Preamble 128 | | |

*equivalent sensitivity with Smart TX Power enabled. This is enabled in the onboard firmware.

## 3.4 Transmitter AC Characteristics

### 3.4.1 Absolute Maximum Ratings

Table 10: ATMUBX0A Absolute Maximum Ratings

| Parameter | Min. | Max. | Units |
|---|---|---|---|
| Supply voltage | 2.8 | 3.9 | V |
| Receiver power | | 0 | dBm |
| Temperature - Storage temperature | -40 | +85 | °C |
| Temperature – Operating temperature | -40 | +85 | °C |
| ESD (Human Body Model) | | 2000 | V |
| ATMUBX0A pins other than VCC, VDDIO and GND | | 3.6 | Note that 3.6 V is the max voltage that may be applied to these pins |

Stresses beyond those listed in this table may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions beyond those indicated in the operating conditions of the specification is not implied. Exposure to the absolute maximum rating conditions for extended periods may affect device reliability.

## 4. FCC Statement

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and

(2) This device must accept any interference received, including interference that may cause undesired operation.

Attention that changes or modification not expressly approved by the party responsible for compliance could void the user’s authority to operate the equipment.

Note: This product 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 product 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 product 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.

Please take attention that changes or modification not expressly approved by the party responsible for compliance could void the user’s authority to operate the equipment.

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment.

The module is limited to OEM installation ONLY

The OEM integrator is responsible for ensuring that the end-user has no manual instruction to remove or install module.

When the FCC identification number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following: “Contains FCC ID: XXXXX-YYYYYYYYY” and the information should be also contained in the devices’ user manual.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. The devices must be installed and used in strict accordance with the manufacturer’s instructions as described in the user documentation that comes with the product. This device is intended only for OEM integrators under the followingconditions:The transmitter module may not be co-located with any other transmitter or antenna.
This device is approved under Part 15.519 for handheld use.
The use of antennas mounted on outdoor structures, e.g., antennas mounted on the outside of a building or on a telephone pole, or any fixed outdoors infrastructure is prohibited. Antennas may be mounted only on the hand held UWB device.
UWB devices may not be employed for the operation of toys. Operation onboard an aircraft, a ship or a satellite is prohibited.