



X4M02 Datasheet

X4 radar sensor module

XeThru Datasheet **by Novelda AS**

A Preliminary - July 11, 2017

Summary

X4M02 is an industrialized UWB radar module intended for custom application development



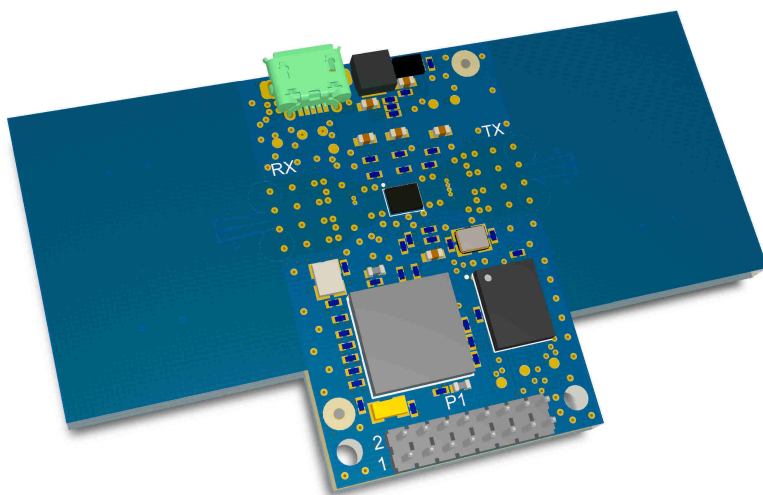
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1 List of Features

- Radar sensor using X4 UWB radar SoC
- Built-in antennas
- Multiple interface options
 - USB
 - UART
 - SPI
 - I2C
- Single supply voltage, 3.3 - 5.5V
- On-board multi-color LED
- FCC certified (pending)
- CE/ETSI approved (pending)



1.1 Order Information

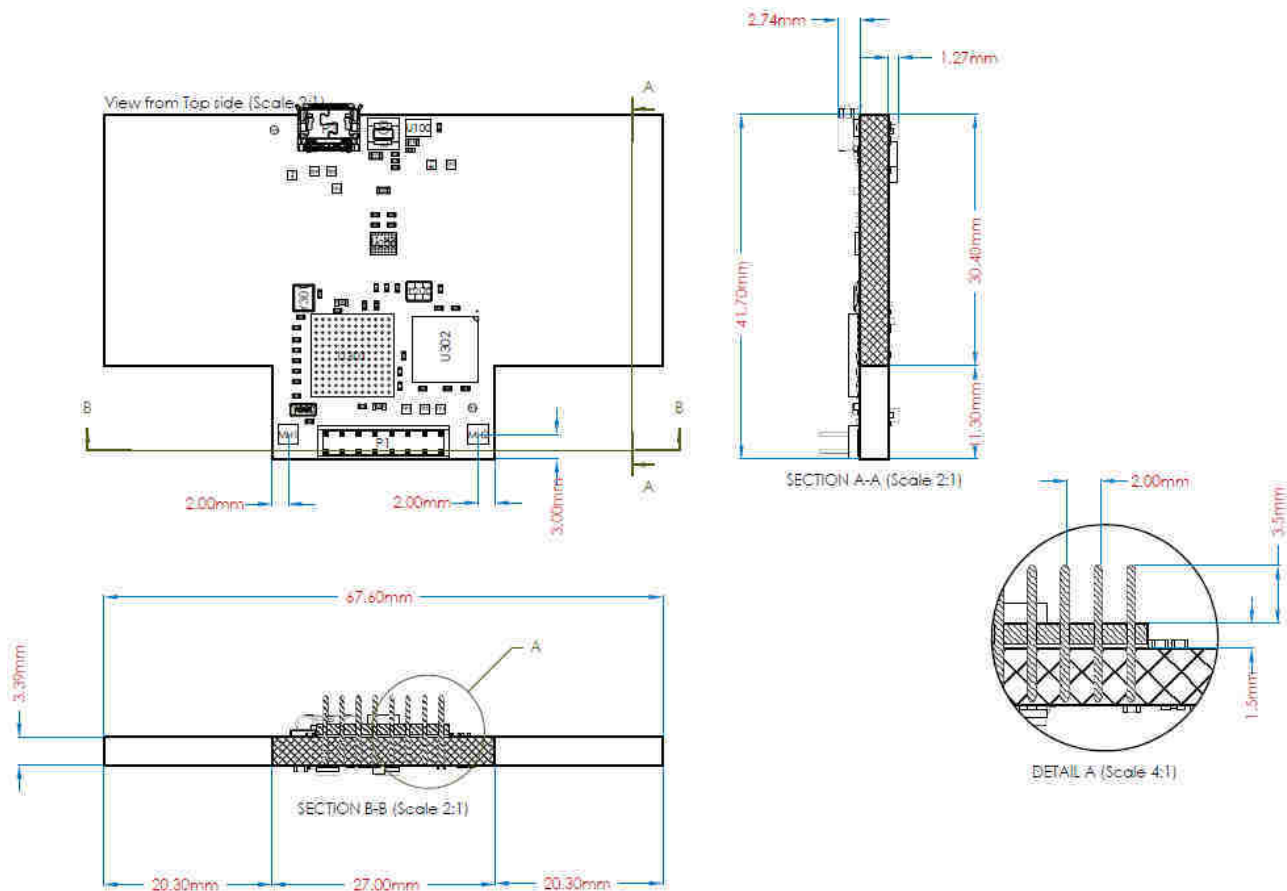
| Order Code | Item Description | MOQ | MPQ |
|------------|-----------------------|-----|-----|
| X4M02 | X4M02 X4 Radar Sensor | 1 | 1 |

MOQ: Minimum Order Quantity

MPQ: Minimum Package Quantity



2 Mechanical Data



Mechanical drawing of the sensor module (in mm)

3 Antenna

X4M02 has two differential antennas optimized for the X4 UWB radar SoC, one for transmit and one for receive. The antennas are directional patch antennas with integrated WiFi filter (filtenna) optimized for frequencies between 6.0 and 8.5 GHz with a typical opening angle of 65° azimuth and elevation.

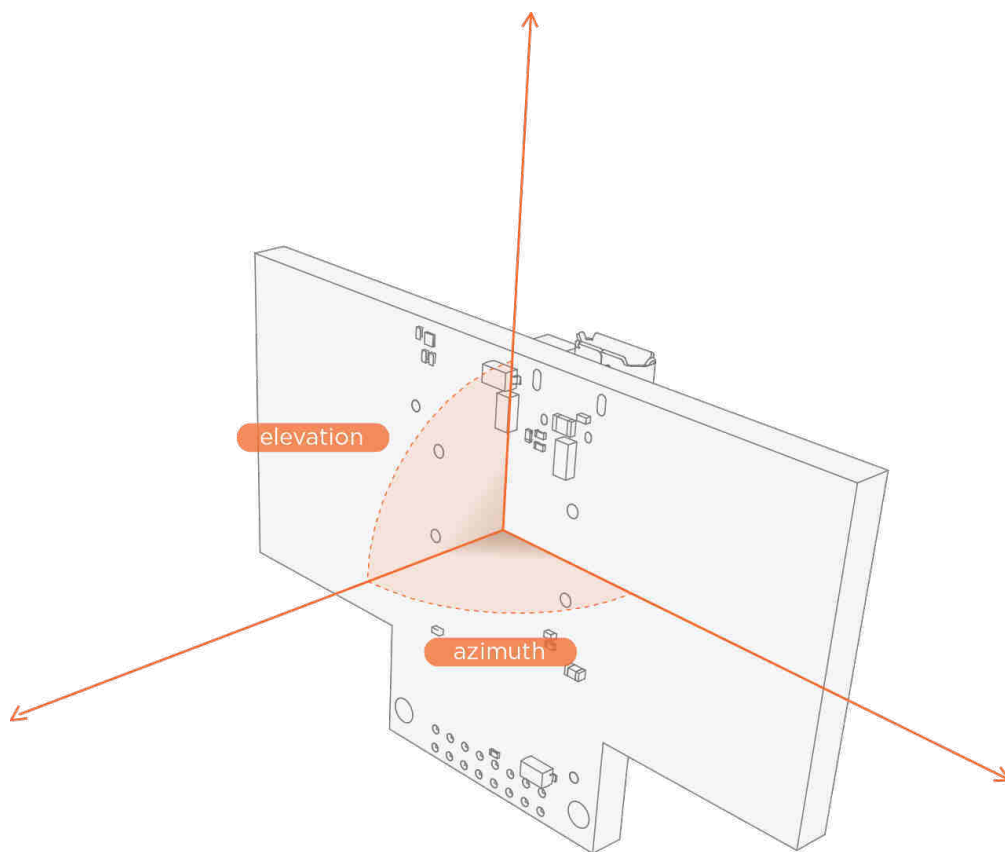
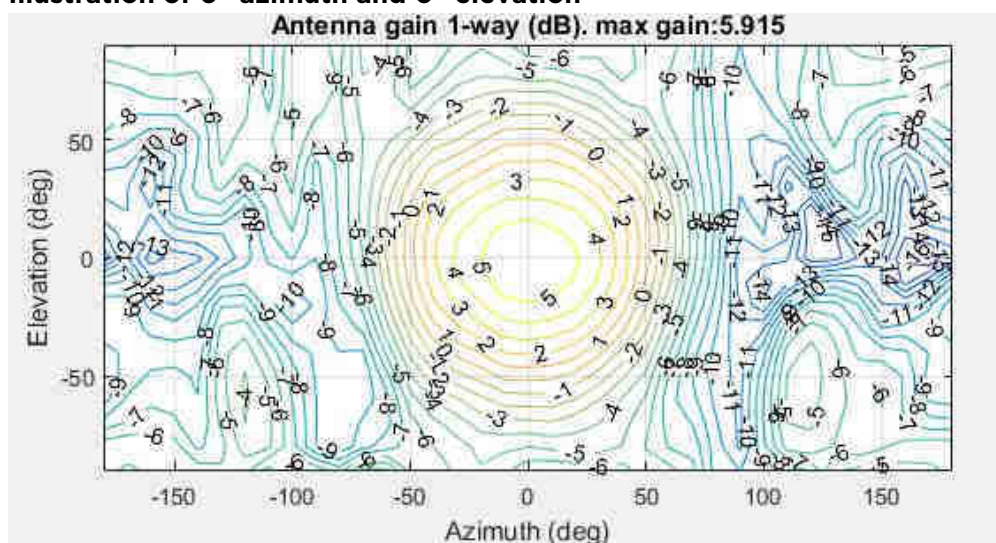


Illustration of 0° azimuth and 0° elevation



X4M02 antenna plot

4 Connectors

4.1 16-pin XeThru Interface Connector

The 16-pin header is compatible with other XeThru sensors such as X2M200 and can be used to power and communicate with X4M02. I/O voltage is 3.0V. Refer to the X4M02 schematics and the Atmel SAM S70 datasheet for additional details of operation.



| Pin | Name | Type |
|-----|----------------|--------------------|
| 1 | VCC_EXT | Power, 3.3 - 5.5V |
| 2 | GND | Power |
| 3 | MOSI/RX | I/O |
| 4 | MISO/TX | I/O |
| 5 | SCLK | I/O |
| 6 | nSS | I/O |
| 7 | nRESET | Input with pull-up |
| 8 | IO7 /WAKEUP | I/O |
| 9 | IO8/SWCLK | I/O |
| 10 | IO9/SWDIO | I/O |
| 11 | IO1 | I/O |
| 12 | IO2 | I/O |
| 13 | IO3 | I/O |
| 14 | IO4 | I/O |
| 15 | IO5 | I/O |
| 16 | IO6 | I/O |

4.2 USB Connector

USB micro type B connector supporting USB 2.0 High Speed. This connector can be used to power and communicate with X4M02.

5 Electrical Specification

| Parameter | Value | Comment |
|---------------------------|-------------|--------------------------------------|
| Supply Voltage VDD_EXT | 3.3 - 5.5V | |
| Supply Voltage USB | 4.5 - 5.5V | |
| IO-voltage range, nominal | -0.3 - 3.3V | |
| V _{IH} min | 2.0V | Minimum input high threshold voltage |
| V _{IL} max | 0.8V | Maximum input low threshold voltage |
| Typical power consumption | TBD mW | Expected around 600 mW |



| Parameter | Value | Comment |
|-----------------------------|--------------|---------|
| Operating Temperature range | 0°C to +85°C | |

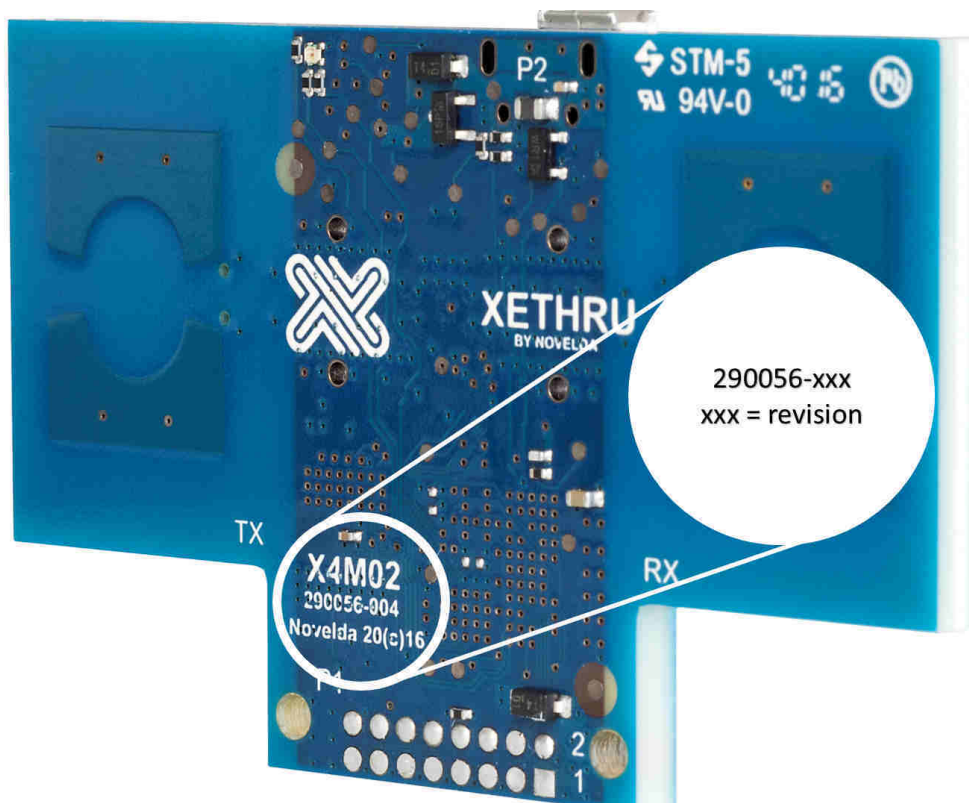
Power consumption of X4M02 is dependent of firmware running in the MCU.

6 X4M02 HW Revisions

X4M02 uses the X4M02 hardware. This section describes all HW revisions of X4M02 that has been used in production, the difference between them and how to identify what HW revision your X4M02 is.

Some FW versions may require a specific HW revision. If applicable, this will be described in the FW version section of this datasheet.

6.1 Identifying HW revision



How to identify HW revision of X4M02

6.2 X4M02 rev.4

Initial HW revision used for production of X4M300.

6.3 X4M02 rev.5

- Added WiFi filter on Tx antenna.



Functionality is identical with previous HW revisions.

6.4 X4M02 rev.6

Initial HW revision used for production of X4M200.

- MCU change from 1MB to 2MB version.

Functionality is identical with previous HW revisions.

6.5 X4M02 rev.10

This is a future HW revision not yet in production. This HW revisions is required to meet the requirements for FCC and ETSI regulation.

- Added metal shield box on X4 UWB radar SoC.
- Replaced 12 MHz crystal with 12 MHz oscillator.
- Added components for EMI suppression.
- Added additional decoupling for MCU and SDRAM.
- Added filter on VDDPLLUSB domain.
- Improved MCU power delivery routing.
- Increased thickness of inner copper layers from 17 to 35 μm .

Functionality is identical with previous HW revisions.

7 Module User Guide

7.1 Placing the Sensor Module

The sensor module should be protected from environmental surroundings such as moisture. Most firmware algorithms assumes the sensor to be still with no movement or vibrations during operation.

When placing the sensor, pay attention to the following:

- Point the sensor in the direction of the object or zone to monitor
- Be aware of indirect reflections. An object 1 meter away may also give additional reflections via the floor, the ceiling or walls at longer distances
- Nearby metallic objects should be avoided, especially in the signal path to the sensor's observation area
- The sensor can be placed on static (non-moving) surfaces such as:
 - On a desk
 - On a wall
 - Behind a wall (*)
 - In the ceiling
 - Behind the ceiling (*)

Firmware algorithms in the sensor module are sensitive to vibrations. If vibrations occur, the sensor may report movement in an empty detection zone.

If a sensor casing is required, the material should be of a kind that does not attenuate the high frequency signals in the sensor's main direction. Recommended materials are ABS and other types of non-conductive plastics (*).



(*): Different materials will attenuate the signal. Application note regarding this topic is found at www.xethru.com.

7.2 Connecting the X4M02 to a Host System

The X4M02 can be connected to a host system in two ways:

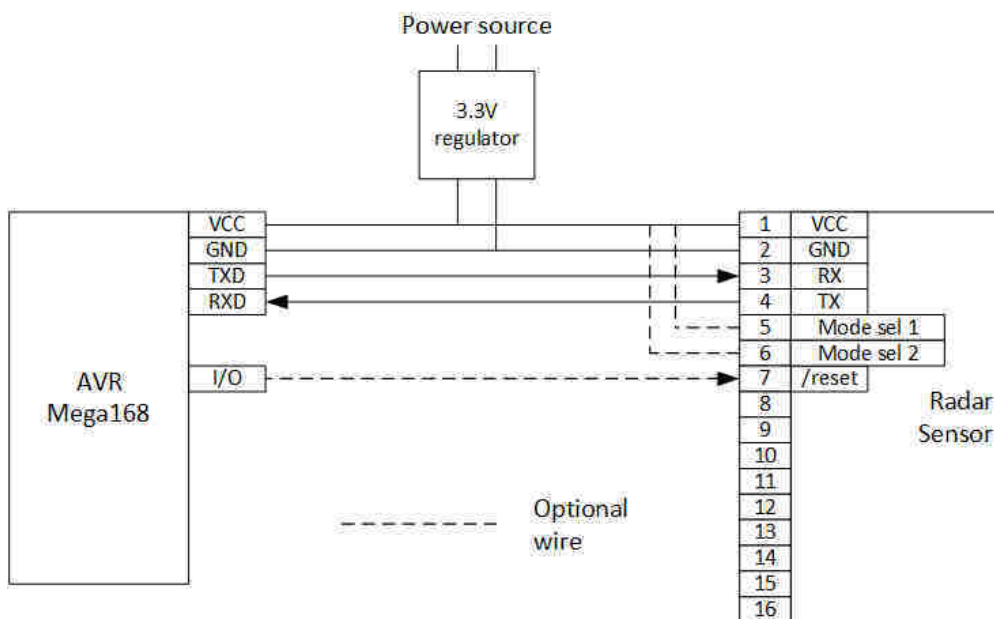
1. Via USB
2. Via the interface connector using the UART interface

Some Profiles have GPIO interface that can be enabled and operate as the only control interface for a sensor module. The GPIO interface is described in the Profile chapters of this datasheet.

7.2.1 Interfacing via USB

When interfacing via USB, this interface will take precedence. X4M02 uses a standard Micro USB-B connector.

7.2.2 Interfacing via UART



Atmel AVR (ATmega168) shown as example host

7.3 Upgrading the Firmware Using the Bootloader

The module's firmware may be update over USB or the serial port. XeThru Explorer can be used to update the module firmware.

LED will be purple during firmware upgrades.

8 Regulatory Approval

X4M02 is designed to meet UWB RF specifications of FCC and ETSI.



Some regulatory specifications also specify how the sensor is used. Users of X4M02 must check regulatory requirements for their own use case and determine whether the regulatory approvals obtained from Novelda are sufficient for their product.

8.1 CE/ETSI

This chapter will cover the CE/ETSI approval of the X4M02.

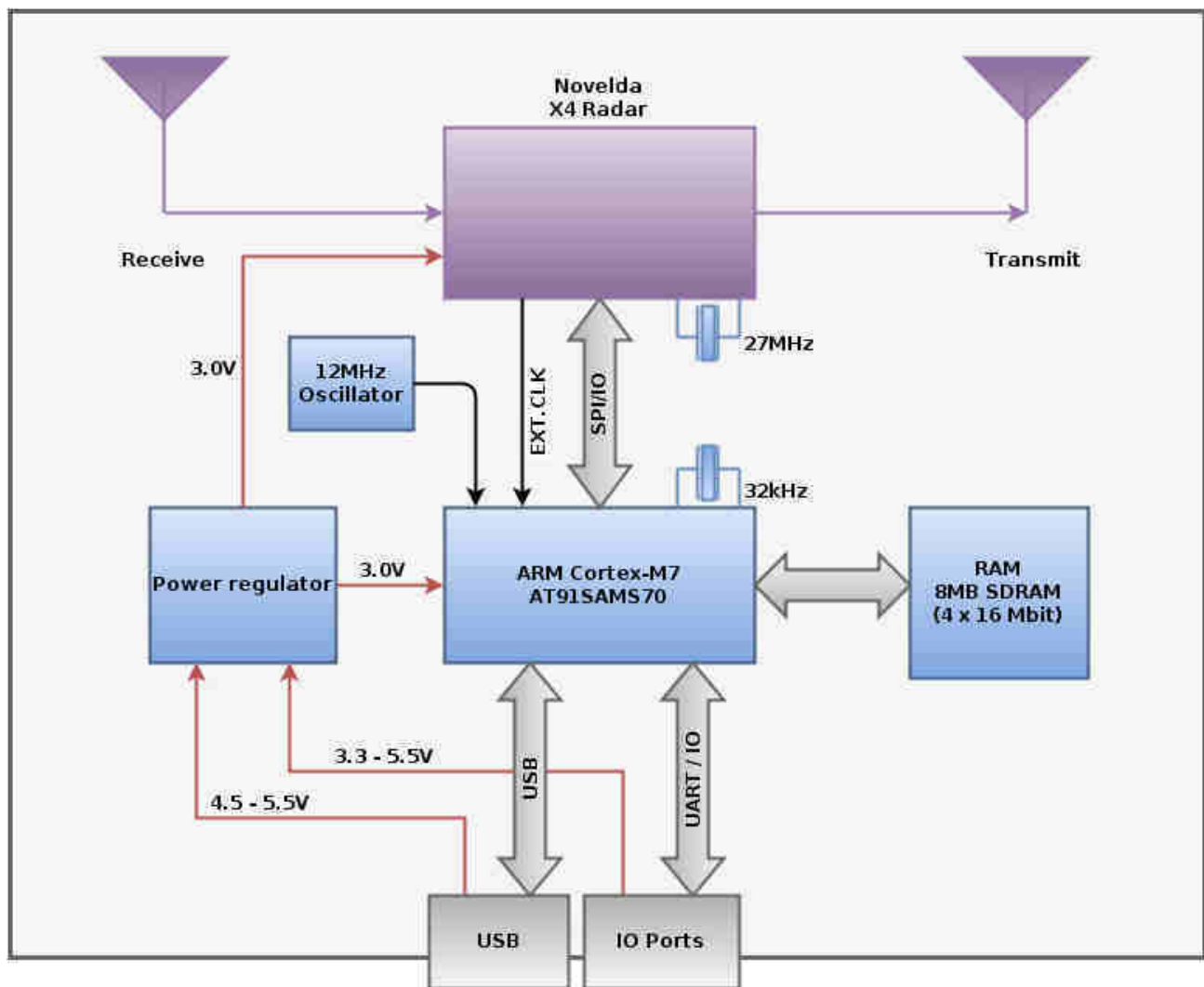
8.2 FCC Approval

FCC approval of X4M02 is pending.

The X4M02 module meets FCC Part 15 requirements for UWB transmission equipment intended for unlicensed indoor use or outdoor use when not permanently installed as specified in FCC Part 15.519, 15.521 and 15.209.

FCC ID: 2AD9QX4M02 (FCC Approval listing pending).

8.2.1 X4M02 Block Diagram



Module clock and power system

Clocks:



The systems clocks are derived from a 12 MHz crystal oscillator connected to the main microcontroller, and a 27 MHz oscillator connected to the Novelda X4 UWB impulse radar chip. The communication between the microcontroller and the X4 radar chip uses SPI protocol. The SPI communication clock is set up to run at 50 MHz.

Mean output power of X4M02 depends on the Pulse Repetition Frequency (PRF) and tx_power settings in the X4 radar chip. PRF is set to 15.875 MHz and tx_power is set to Medium (2) in X4M02. Both the PRF and tx_power can be changed by the microcontroller but cannot be changed to comply with FCC regulations. For further description of the radar chip, please refer to the X4 datasheet.

Power:

The module is powered externally from either the USB port or an external power supply. If both power sources are connected, the USB takes precedence over the external power.

Antennas:

The antennas are embedded onto the PCB and cannot be changed by users. Please refer to the Antenna chapter in the X4M02 datasheet for details on the antennas.

8.2.2 Radar Functional Description

The module uses the Novelda X4 impulse radar chip. Please refer to the X4 datasheet for a detailed description.

8.2.3 FCC Regulatory Notices

Modification Statement

Novelda AS has not approved any changes or modifications to this device by the user. Any changes or modifications could void the user's authority to operate the equipment.

Interference 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 interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

RF Exposure

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

FCC Class B Digital Device Notice

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.

Labelling Requirements for the Host Device

The host device shall be properly labelled to identify the modules within the host device. The certification label of the module shall be clearly visible at all times when installed in the host device, otherwise the host device must be labelled to display the FCC ID of the module, preceded by the words "Contains transmitter module", or the word "Contains", or similar wording expressing the same meaning, as follows:

Contains FCC ID: 2AD9QX4M02

9 Schematics, Bill of Material and PCB Layout

Schematics, bill of material and PCB layout files for X4M02 can be downloaded from www.xethru.com.

10 Software Resources

10.1 XeThru Embedded Platform (XEP)

The XeThru Embedded Platform (XEP) is an open source code project that will run on the X4M03 and X4M02 radar development kits to support occupancy and respiration monitoring applications.

XEP comes as a ready-to-go Atmel Studio 7 project and implements all core functionalities for easy hardware module implementation.

XeThru Embedded Platform can be downloaded from www.xethru.com.

10.2 XeThru Module Connector

The XeThru Module Connector is a software used to communicate with all XeThru radar sensor modules from a host computer through a serial interface. XeThru Module Connector makes a complete API of the modules available in host environments such as MATLAB, Python, C++ and C. This makes it easy to start streaming and analyzing radar data on multiple levels (raw radar data, baseband data, pulse doppler data, detection lists, respiration and presence) and directly to an environment ideally suited for development of new algorithms.

XeThru Module Connector includes all documentation necessary to implement the serial protocol of X4M02 in a host microcontroller.

XeThru Module Connector can be downloaded from www.xethru.com.



11 Support and Resources

Development support, resources, links to development partners and resellers can be found on Novelda's web site www.xethru.com.

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Regulatory Information USA

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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.

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.

RF exposure safety

The X4M05 is a radio transmitter and receiver.

It is designed not to exceed the emission limits for exposure to radio frequency (RF) energy set by the Federal Communications Commission.

Labelling Requirements for the Host Device

The host device shall be properly labelled to identify the modules within the host device. The certification label of the module shall be clearly visible at all times when installed in the host device, otherwise the host device must be labelled to display the FCC ID of the module, preceded by the words "Contains transmitter module", or the word "Contains", or similar wording expressing the same meaning, as follows:

Contains FCC ID: 2AD9QX4M05

UWB devices may not be employed for the operation of toys. Operation onboard an aircraft, a ship or a satellite is prohibited.

Regulatory Information Canada

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Les changements ou modifications non expressément approuvés par la partie responsable de la conformité pourraient annuler l'autorisation de l'utilisateur d'utiliser l'équipement.

This device complies with Industry Canada's licence-exempt RSSs. Operation is subject to the following two conditions: (1) This device may not cause interference; and (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.

RF exposure safety

The X4M05 is a radio transmitter and receiver.

It is designed not to exceed the emission limits for exposure to radio frequency (RF) energy set by the ISED.

*Le X4M05 est un émetteur et un récepteur radio.
Il est conçu pour ne pas dépasser les limites d'émission pour l'exposition à l'énergie radiofréquence (RF) établie par l'ISDE.*

Labelling Requirements for the Host Device

The host device shall be properly labelled to identify the modules within the host device. The certification label of the module shall be clearly visible at all times when installed in the host device, otherwise the host device must be labelled to display the IC of the module, preceded by the words "Contains transmitter module", or the word "Contains", or similar wording expressing the same meaning, as follows:

Contains IC: 22782-X4M05

Le équipement hôte doit être correctement étiqueté pour identifier les modules dans l'équipement. L'étiquette de certification du module doit être clairement visible en tout temps lorsqu'il est installé dans l'hôte, l'équipement hôte doit être étiqueté pour afficher l'IC du module, précédé des mots "Contient le module émetteur", ou le mot "Contient", ou un libellé similaire exprimant la même signification, comme suit:

Contains IC: 22782-X4M05

CAN ICES-3 (B)/NMB-3(B)