X4M300 Datasheet

Presence Sensor

XeThru Datasheet **by Novelda AS**

B Preliminary - May 22. 2017

Summary

The XeThru X4M300 is an industrialized sensor that complies with worldwide regulations ready for product integration.

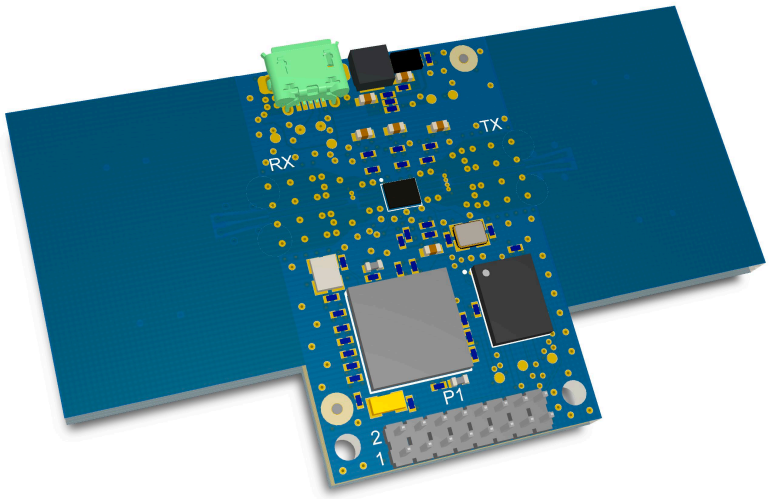
Table of Contents

List of Features 4
Order Information 5
XeThru X4M300 Presence Sensor 5
Supported Profiles 5
Sensor Operation 6
Power-up 6
Configuration 6
Running sensor directly from power-up or reset 6
IO-pins 6
Firmware Versions 6
Bootloader 6
XeThru Presence Profile 7
Overview 7
User Settings 8
Set Detection Zone 8
Sensitivity 8
LED 8
Frequency Band 9
IO-pin Control 9
Enable Noise Map 9
Adaptive Noise Map 9
Initialize Noise Map at Reset 9
Default User Settings 10
Sensor Operation in Presence Profile 10
Detect Presence 10
Measure Presence Data 10
IO-pin Functionality 11
Detection Range 11
Detection Time 13
Firmware Algorithms 13
Baseband Data Output 15
Pulse-Doppler Data Output 16
Firmware Versions 16
X4M300 Version 1.0.7 16
X4M300 Version 1.1.4 16
X4M300 Version 1.x 16
X4M300 Version 2.x 17
X4M300 HW Revisions 17
Identifying HW revision 18
X4M02 PCB rev.4 18
X4M02 PCB rev.5 18
X4M02 PCB rev.6 18
X4M02 PCB rev.10 18

Software Resources 19
XeThru Explorer 19
XeThru Module Connector 19
Module Communication Protocol Wrapper (MCP Wrapper) 19
X4M300 Firmware Binary 20
Mechanical Data 20
Electrical specification 20
X4M300 Interface Options 21
16-pin XeThru Interface Connector 21
Pin Descriptions 21
USB Connector 22
Communication Modes 22
Power System 23
Schematics and Bill of Material 23
Module User Guide 23
XeThru Module Connector 23
Placing the Sensor Module 23
Connecting the X4M300 to a Host System 24
Interfacing via USB 24
Interfacing via UART 24
Upgrading the Firmware Using the Bootloader 24
Regulatory Approval 25
CE/ETSI 25
FCC Approval 25
KCC Approval 25
MIC Approval 25
Errata 25
Errata in Firmware Version 1.0.7 25
Errata in Firmware Version 1.1.3 25
Support and Resources 25
Disclaimer 26

1 List of Features

- People detection up to 9.4 meters
  - Measures distance from sensor to person
  - Presence detection of people with no other movement than respiration
- Obstacle detection up to 9.4 meters
  - Reports distance to first static target
- Radar sensor
  - Baseband data output
  - Pulse-Doppler output
- Novelda Ultra Wide Band (UWB) Impulse Radar X4 system on a chip (SoC)
- Built-in TX and RX antennas
- Multiple interface options
  - Serial interface, UART
  - On-board USB interface
- On-board multi-color LED
- FCC certified (pending)
- CE/ETSI approved (pending)
- KCC certified (pending)
- MIC/ARIB certified (pending)



Sensor module

1.1 Order Information

Order Code	Item Description	MOQ	MPQ	Status
X4M300	X4M300 Presence Sensor FCC and ETSI version	1	1	In production
X4M301	X4M300 Presence Sensor FCC, KCC and MIC version	1	1	Available Q4 2017

MOQ: Minimum Order Quantity

MPQ: Minimum Package Quantity

Whenever this datasheet states X4M300 the description is valid for all the above order codes unless explisitly stated otherwise.

2 XeThru X4M300 Presence Sensor

The X4M300 Presence Sensor contains a profile that can detect and monitor people's movement and presence within the detection zone. The sensor module is ready for product integration.

X4M300 senses human presence by detecting all major and minor motions in a room such as a person walking and hand movements. Its extreme sensitivity enables it to detect presence up to a distance of 9.4 meters with great accuracy. It is also able to measure the distance between the device and the user, and is not susceptible to “dead spots” within the detection zone.

The X4M300 has the ability to see presence of a person with no other movements than his respiration motion. This unique ability enables implementation of products that does not lose track of a person's presence if he/she sits still for a longer time period. With the XeThru technology's ability to see through light materials it also enables products that detect a person's presence while sleeping in a bed with a blanket, duvet or clothes covering the person's body.

2.1 Supported Profiles

The following Profiles are included in X4M300:

- Presence Profile

Additional profiles may be added in future firmware upgrades.

3 Sensor Operation

3.1 Power-up

3.1.1 Configuration

Profiles and User Settings can be loaded as described in the Module Connector documentation found on www.xethru.com.

User Settings vary between different profiles and each profile has its own default settings. See the Profile description chapters for details.

User Settings can only be changed when the profile is not running. To change any setting, follow these steps:

1. Stop running profile (if any profile is running)
2. Load desired profile (if not already loaded)
3. Send settings commands
    a. User Settings such as Detection Zone, Sensitivity etc.
    b. Output Control settings that determines what messages will be sent over the serial communication link on X4M300
4. Start running profile

Switching profiles will load the default User Settings for the new profile, regardless if this new profile has been run with different User Settings earlier.

3.1.2 Running sensor directly from power-up or reset

At power-up or reset, the sensor will start with its last used settings.

3.2 IO-pins

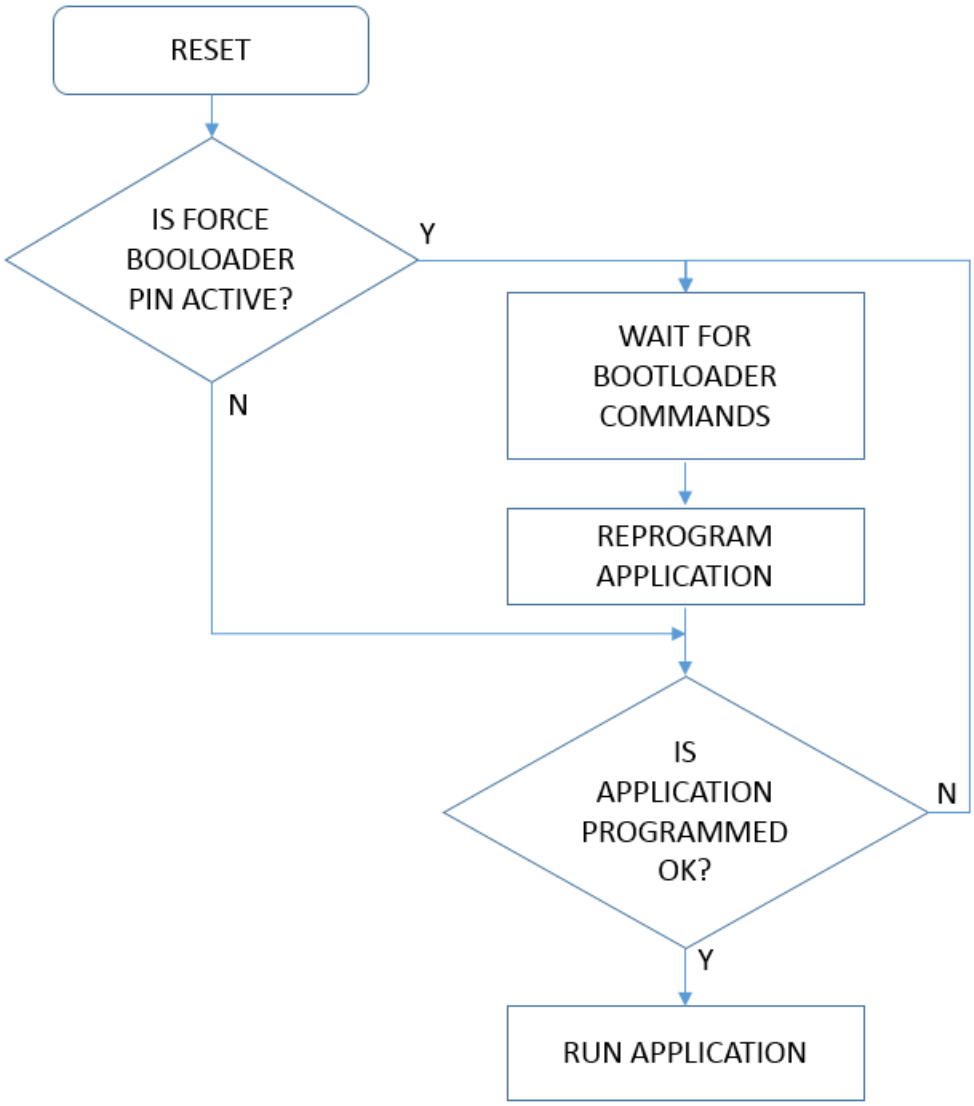
Various profiles may have different uses of IO-pins. Do not connect IO-pins that are not in use. The sensor module will pull up these IO-pins internally. Future FW upgrades of the sensor and any existing or future pin compatible products may use these unused IO-pins for other functionality.

3.3 Firmware Versions

The datasheet may describe features not yet implemented in the current firmware version of the module. The datasheet chapter Firmware Versions explains what features are implemented in which firmware versions.

3.4 Bootloader

The module has a bootloader to allow field firmware upgrades. The bootloader is locked and cannot be reprogrammed, thus it can never be erased, altered or removed from the module over the serial protocol. The bootloader can be entered through the serial protocol, and it is also possible to force the module into bootloader mode using the pin header interface. See datasheet chapter Interface Options for details.



Bootloader flowchart

If a firmware upgrade fails (eg power loss) the host providing the firmware upgrade must reinitiate the entire firmware upgrade process. The previous version of the firmware may be lost, but the bootloader will still operate as described even after a failed firmware upgrade attempt.

4 XeThru Presence Profile

4.1 Overview

The XeThru Presence Profile detects human presence in a defined detection zone. The X4M300 must be still during use and can be installed in the ceiling, on the wall, or in a product that stands still on a table, bookshelf or similar.

4.2 User Settings

4.2.1 Set Detection Zone

The upper limit of the Detection Zone sets the maximum distance for presence detection, while the lower limit sets the minimum distance.

Detection Zone parameter limits	
Minimum lower range	0.40m
Maximum upper range	9.40m
Minimum size of detection zone	0.20m
Maximum size of detection zone	9.00m

Step size between possible range settings is 5.14 cm. The desired detection zone can be set with 1 cm resolution. The actual detection zone will be set at the closest value before/after the input lower/upper range. The actual lower and upper range used by the sensor can be read back after setting the detection zone.

4.2.2 Sensitivity

Sensitivity settings	
Minimum sensitivity	0
Maximum sensitivity	9
Sensitivity step size	1

Higher sensitivty setting gives better sensing of small targets. Lower sensitivity makes the sensor more robust against false detections.

4.2.3 LED

The module has 1 multi color RGB LED. The module LED can be configured between "Full" state indication, a "Simple" indication or "Off".

Full

Initializing: Green (0.2 sec) -> Orange (0.2 sec) -> Red (0.3 sec) -> Orange (0.2 sec) -> Green (0.2 sec) -> Off (0.3 sec)
Presence: Orange (0.5 sec) -> Green (0.5 sec)
No Presence: Red (0.3 sec) -> Off (4.7 sec)
No profile running: Blue (0.2 sec) -> Off (4.7 sec)

Simple

Initializing: Green
Presence: Orange
No Presence: Red (0.3 sec) -> Off (4.7 sec)
No profile running: Blue (0.2 sec) -> Off (4.7 sec)

Off

Always: Off

4.2.4 Frequency Band

Low

In the low frequency band, X4M300 will operate in the 6.0 - 8.5 GHz band.

High

In the high frequency band, X4M300 will operate in the 7.25 - 10.20 GHz band.

4.2.5 IO-pin Control

On

When IO-pin control is On, IO-pins will operate as described in the IO-pin functionality table below.

Off

When IO-pin control is Off, IO-pins will be inputs with internal pull-up and have no function.

4.2.6 Enable Noise Map

One

Enables noise map.

Off

Disables noise map. Detailed description of noise map in Firmware Algorithms section below.

4.2.7 Adaptive Noise Map

On

Enables Noise Map adaptation. Noise Map will still not adapt in certain conditions as described in Firmware Algorithms section below.

Off

Disables Noise Map adaptation.

4.2.8 Initialize Noise Map at Reset

On

A new Noise Map will always be created at reset or when the profile is started. Sensor state will be Initializing during noise map creation.

Off

If a valid Noise Map is stored in the sensor this will be used at reset or when the profile is started. If no valid Noise Map is stored a new Noise Map will be created at reset. Noise map created with different Detection Zone are not valid.

4.2.9 Default User Settings

Default User Settings are applicable when the Presence Profile is selected, but no User Settings are specified.

User Setting	Default value
Detection zone	0.4 - 9.4 m
Sensitivity	5
LED	Full
Frequency band	Low
IO-pin control	Off
Enable Noise Map	On
Adaptive Noise Map	On
Initialize Noise Map at reset	On

4.3 Sensor Operation in Presence Profile

4.3.1 Detect Presence

There are four states in the Presence Profile:

- **No Presence:** No presence detected
- **Presence:** Presence detected
- **Initializing:** The sensor initializes after the Presence Profile is executed
- **Error:** The sensor is in an error state and requires a Profile and User Settings to be loaded

4.3.2 Measure Presence Data

When running, the following data is reported:

- **State**

When in No Presence or Presence states, the following data is measured:

- **Distance to static target:** Distance in meters to major static target closest to the sensor
- **MovementSlow:** Movements for the previous 20 seconds shown as a relative number from 0 to 100 where 100 indicates most movements, for 5.14 cm intervals in the entire detection zone
- **MovementFast:** Movements for the previous 1 seconds shown as a relative number from 0 to 100 where 100 indicates most movements, for 5.14 cm intervals in the entire detection zone

When in Presence state, the following additional data is measured:

- **Distance to closest moving target:** Distance in meters to moving target closest to the sensor
- **Direction of closest moving target:** Direction (Toward, Away or Still) of moving target closest to the sensor

Moving target means any non-still target, including a stationary person with only respiration movement, who will be reported as a moving target with No direction.

All data is updated and available over serial communication interface once per second.

4.3.3 IO-pin Functionality

IO-pin	Name	Direction	Functionality
IO1	PRESENCE	Output	High: Presence state Low: No Presence, Initializing and Error states
IO2		Input	Not in use. Do not connect
IO3		Input	Not in use. Do not connect
IO4		Input	Not in use. Do not connect
IO5		Input	Not in use. Do not connect
IO6		Input	Not in use. Do not connect

4.4 Detection Range

Detection range defines at what range and angle as seen from the sensor a person can be detected. The detection range varies with the size of the target person, the movement type of the target person and the angle between the sensor and the target person.

Detection range should not be confused with the user setting Detection Zone. Detection Zone defines at what range X4M300 is doing measurements. Detection range describes what can be detected inside the Detection Zone.

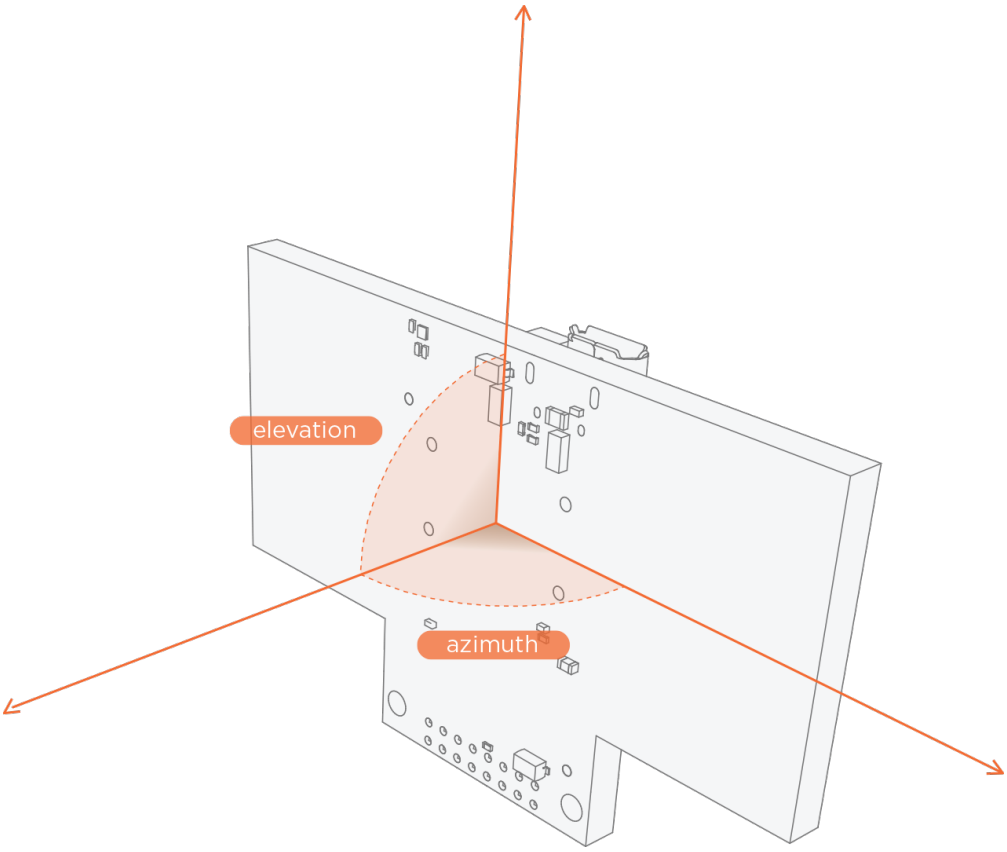
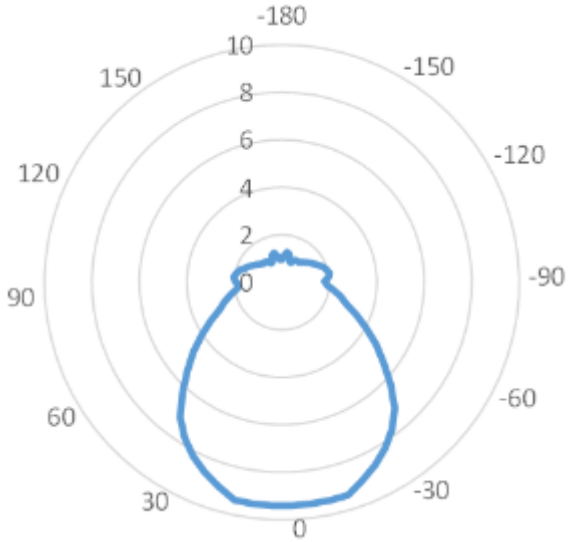


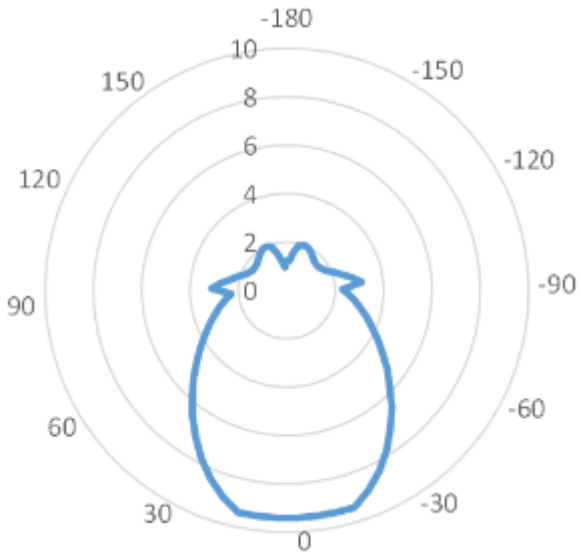
Illustration of 0° azimuth and 0° elevation

Detection range in meters for selected angles (preliminary values)

Azimuth / Elevation	0°/ 0°	0° / 45°	45° / 0°	45° / 45°	0° / 90°	90° / 0
Respiration Motion	9.40 m	5.80 m	6.20 m	3.80 m	2.30 m	1.80 m
Minor Motion	9.40 m	9.40 m	9.40 m	9.40 m	6.50 m	5.10 m
Major Motion	9.40 m	9.40 m	9.40 m	9.40 m	7.00 m	5.40 m



Respiration Motion distance in meters shown as azimuth plot at 0° elevation



Respiration Motion distance in meters shown as elevation plot at 0° azimuth

Respiration Motion is defined as a standard person's respiration movement as seen from the side or back of the person.

Minor Motion is defined in NEMA WD 7 - 2011 as a standard person waving his arm at 90°/s. Standard arm size is 3in x 3in x 15in (7.6cm x 7.6cm x 38.6cm).

Major Motion is defined in NEMA WD 7 - 2011 as a standard person walking at a speed of 4 +/- 0.5 ft/s (1.22 +/- 0.3 m/s).

A standard person is defined as having a radar cross section of 0.001 m2, that equals 5ft 7in +/- 4in (1.70 +/- 0.10 m) and 170 +/- 20 lbs (77 +/- 9 kg). Standard person height and weight is defined in NEMA WD 7 - 2011.

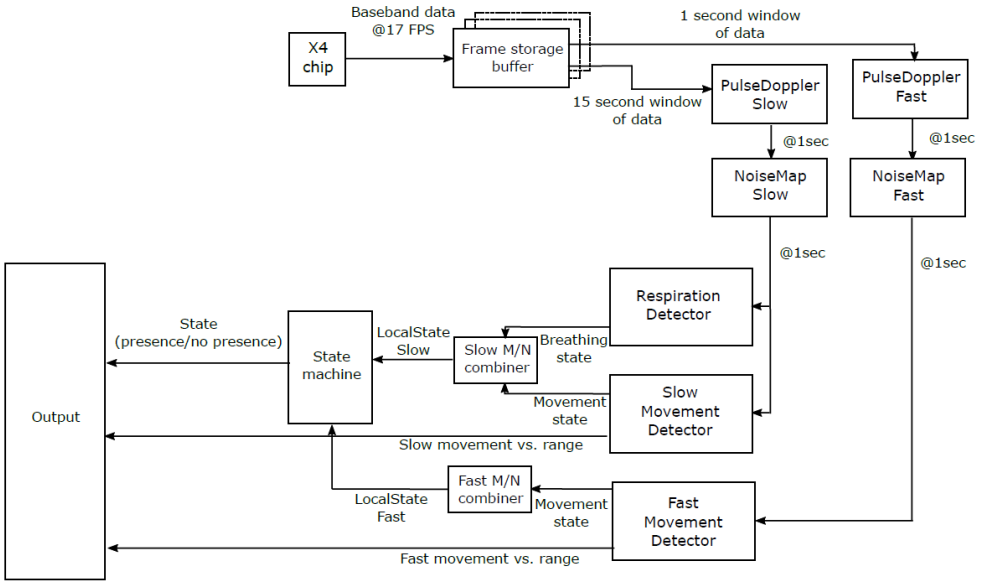
Detection range at additional azimuth and elevation angles will be available as an application note on www.xethru.com.

4.5 Detection Time

Typical detection time for this profile is:

- From No Presence to Presence state: 1.5 - 3 seconds
- From Presence to No Presence state: 50 seconds

4.6 Firmware Algorithms



Presence Profile signal processing block diagram

All firmware algorithms for presence detection are running in the X4M300. The X4 UWB radar SoC is set up to provide 17 baseband data frames per second. The radar data frames are stored in a buffer. Two Pulse-Doppler matrices are running in parallel. The Slow Pulse-Doppler matrix is using the last 20 seconds of radar frames and the Fast Pulse-Doppler matrix is using the last 1 second of radar frames.

Both Pulse-Doppler matrices have individual Noise Maps to determine if a reflection at a certain distance and frequency is above a threshold. Creating and enabling a Noise Map will give different threshold values at different distances and frequencies and is recommended to achieve the best performance. If the Noise Maps are disabled a fixed threshold value will be used for all distances and frequencies, which in most cases will result in less sensitivity to small movements and higher risk of false detections.

The Noise Maps will adapt to changes in the environment unless Noise Map Adaptation is disabled. Noise Map adaptation works continuously and will over time remove presence detection of reflectors that are stationary. The Noise Map will not adapt if a still person with breathing frequency between 10 and 30 Respirations Per Minute (RPM) is detected.

The Fast Pulse Doppler matrix with its Fast Movement Detector will detect presence quickly, typically when a person enters the Detection Zone. The Fast Movement Detector has two states, Movement or No Movement. The Fast M/N Combiner uses these states to determine the LocalStateFast. An M/N Combiner determines that M out of N detections need to be a certain value for the output to change.

Logic for Fast M/N Combiner

LocalStateFast	M/N
No Movement -> Movement	2/2
Movement -> No Movement	49/50

The Slow Pulse-Doppler matrix with its Slow Movement Detector will detect presence of stationary people. Typically when a person is in the Detection Zone with no other movements than his respiration movement. The Slow Movement Detector has three states, Breathing,

Movement and No Movement. The Slow M/N Combiner uses these states to determine the LocalStateSlow. An M/N Combiner determines that M out of N detections need to be a certain value for the output to change.

Logic for Slow M/N Combiner

LocalStateSlow	M/N
No Movement -> Movement	20/50
No Movement -> Breathing	20/50
Movement -> No Movement	31/50
Movement -> Breathing	7/7
Breathing -> No Movement	31/50
Breathing -> Movement	4/4

The State Machine determines the (global) State, which is No Presence when both LocalStateFast and LocalStateSlow is No Movement and Presence in all other local state combinations.

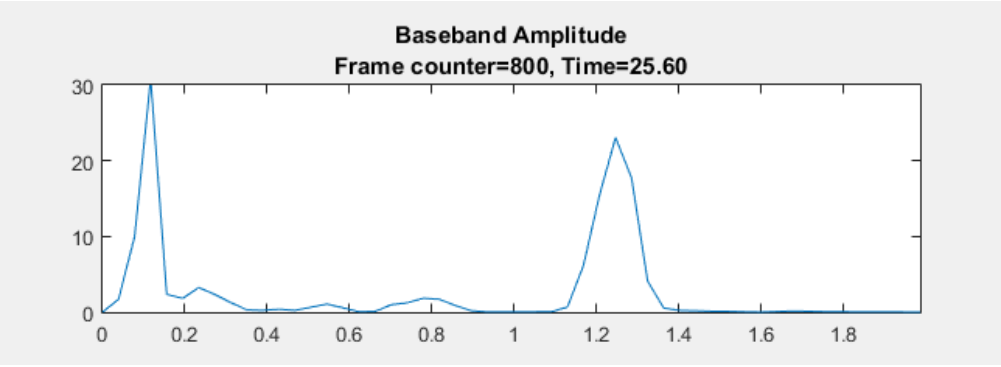
4.7 Baseband Data Output

Baseband data is generated approximately 17 times per second and shows reflection at all distances in the Radar Frames used in 5.14 cm intervals.

The length and position of Radar Frames is controlled by the actual lower and upper range determined by the Detection Zone User Setting. The Radar Frame starts 5.14 cm before the actual lower range and ends 5.14 cm after the actual upper range.

Baseband data is available as an option on the communication port.

Baseband data outputs either amplitude and phase information of reflections, or the same data represented with I and Q values.



Example of baseband data output

The example above shows the amplitude of reflections plotted for a 2 meter Radar Frame. This particular measurement shows two refelections; the first reflection is about 0.1 meter into the Radar Frame, and the second reflection is about 1.2 meter into the Radar Frame.

Refer to application notes on www.xethru.com for more detalied descriptions on how to use baseband data output.

4.8 Pulse-Doppler Data Output

TO BE DESCRIBED

5 Firmware Versions

The firmware version can be read over the serial interface. All firmware versions support upgrading to a different firmware version.

In addition to the firmware versions described in this section, additional firmware versions with potential error corrections and stability improvements should be expected.

5.1 X4M300 Version 1.0.7

First firmware version of X4M300 released to customers.

The following functions are supported:

- Presence / No Presence state
- Baseband data
- Distance to closest target
- MovementFast and MovementSlow data
- Noise Map is always initiated when the Presence profile is started
- Noise Map always adapts
- Only the low frequency band can be used

HW rev.6 and above can not use this firmware version.

5.2 X4M300 Version 1.1.4

Features are same as for previous firmware version.

Improvements:

- Slow Pulse-Doppler matrix changed from 15 to 20 seconds, which improves sensitivity to detect people that are still.
- MovementSlow data shows movements for the previous 20 seconds. Previous FW version showed movements for the previous 15 seconds.
- Improved breathing detection, which leads to less adaption of noise map, which improves sensitivity to detect people that are still.
- Support for 2MB MCU (from X4M02 HW rev.6).
- Stability improvement. Previous FW version could reset unexpectedly.
- Changed enter bootloader command key to avoid unintentional downgrades of X4M02 with 2 MB MCU to FW version 1.0.7.
- Acknowledge stop command even when no profile is loaded.

5.3 X4M300 Version 1.x

All functions from previous firmware version with exception of noise map that will not initiate at reset if this is not selected in User Settings.

These additional functions are supported:

- Pulse-Doppler data
- Direction of closest target
- Enable / disable Noise Map
- Enable / disable Noise Map adaption
- Load Noise Map
- Store Noise Map
- Stored Noise Map can be used when Presence profile is started
- Distance to first major static target
- GPIO functions

5.4 X4M300 Version 2.x

Some of these features may be introduced as a new Profile not yet documented in this datasheet.

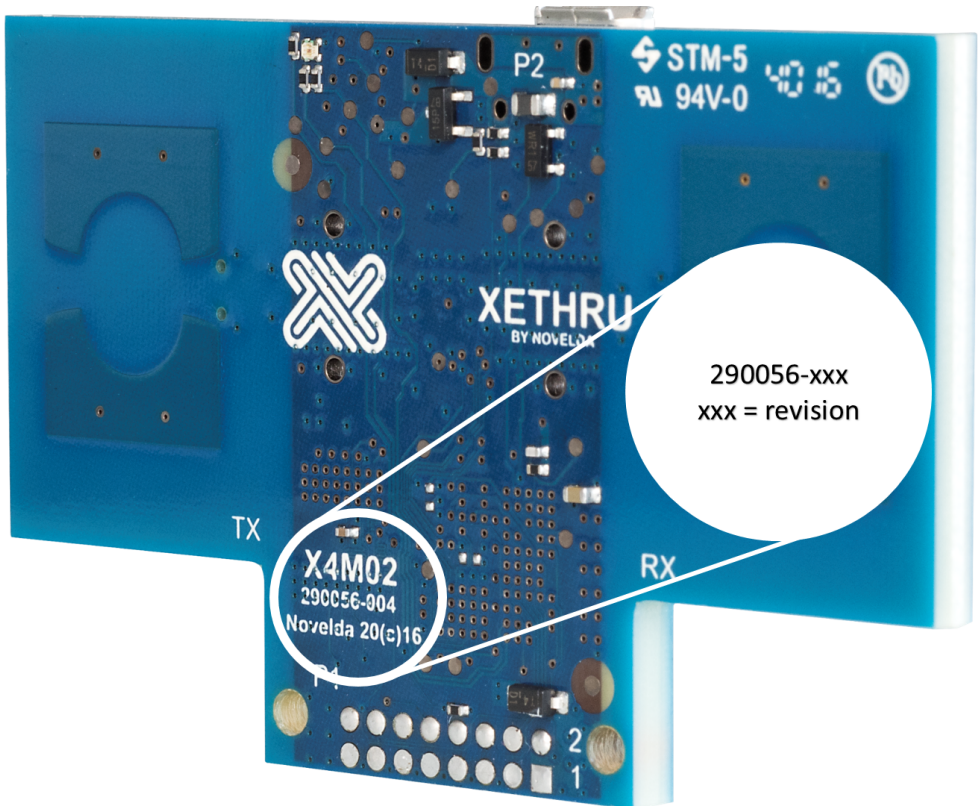
- Detection list for all moving targets in detection zone
- Radar Cross Section for all moving targets in detection zone
- Selection between low and high frequency band
- Faster response time from No Presence to Presence state

6 X4M300 HW Revisions

X4M300 uses the X4M02 hardware. This section desribes all HW revisions of X4M02 that has been used in production, the difference between them and how to identify what HW revision your X4M300 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 PCB rev.4

Initial HW revision used for production.

6.3 X4M02 PCB rev.5

- Added WiFi filter on Tx antenna.

Functionality is identical with previous HW revisions.

6.4 X4M02 PCB rev.6

- MCU change from 1MB to 2MB version.

Functionality is identical with previous HW revisions.

6.5 X4M02 PCB 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 Software Resources

7.1 XeThru Explorer

The XeThru Explorer application is a visual presentation of the protocol and data output from the sensor. It also allows for storing the measured data into a log file.

Firmware upgrades of X4M300 are deployed with new versions of XeThru Explorer.

XeThru Explorer can be downloaded from www.xethru.com.

7.2 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 X4M300 in a host microcontroller.

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

7.3 Module Communication Protocol Wrapper (MCP Wrapper)

Module Communication Protocol (MCP) is the lowest level communication protocol implementation for the XeThru modules, used on the module FW and XeThru host components, e. g. Module Connector. The MCP Wrapper goes one step further for embedded host implementation adding a wrapper with convenience methods around the MCP. Compared to Module Connector, which is a more feature rich component with logging and buffering capabilities, MCP Wrapper offers a similar interface with only the basic transport methods wrapped in a more easy-to-use interface.

Typical use for the MCP Wrapper is when implementing a host application communicating with a XeThru module on an embedded target that does not need or have available the Module Connector.

MCP Wrapper is implemented in C. Example code is available in C and C++.

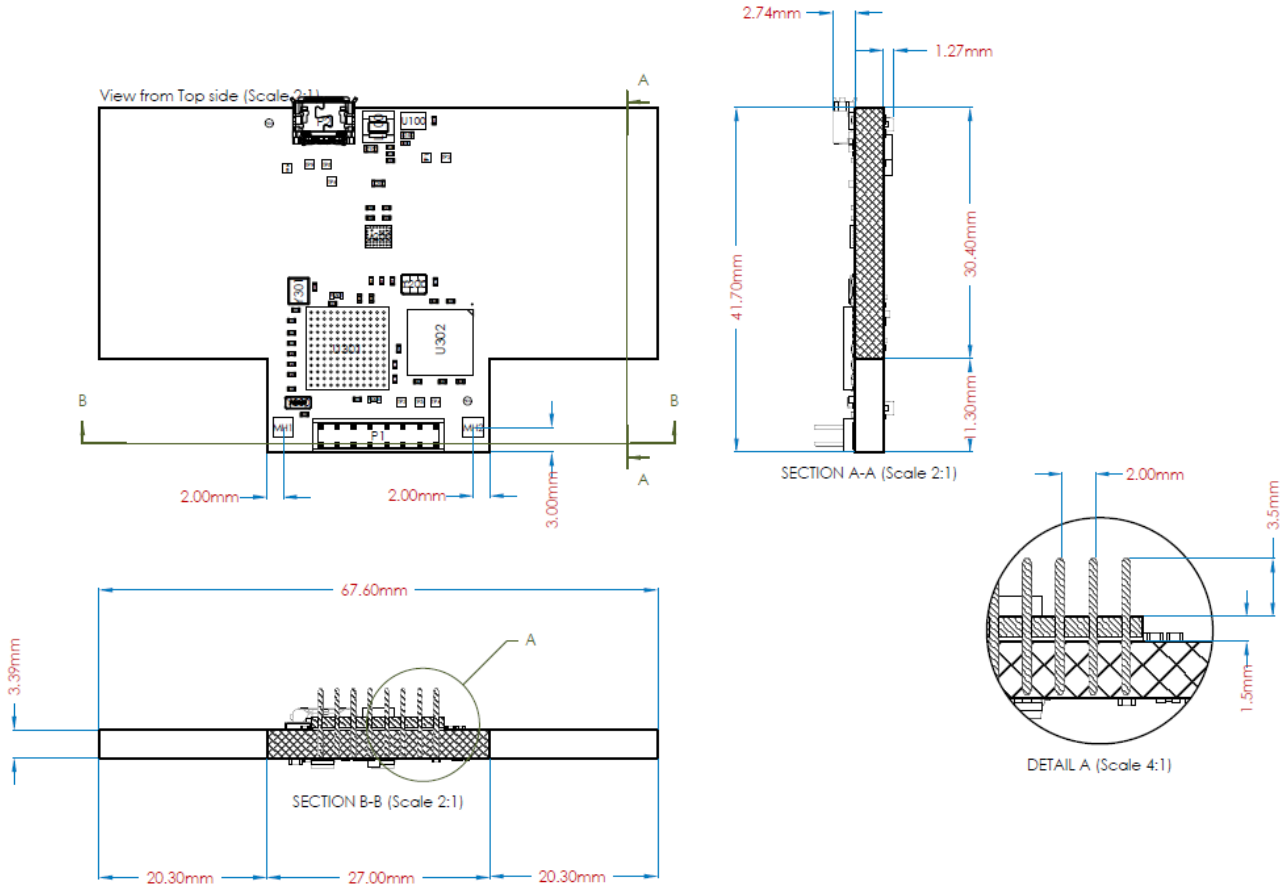
MCP Wrapper can be downloaded from www.xethru.com.

7.4 X4M300 Firmware Binary

Firmware upgrades of X4M300 can be done by using Module Connector, MCP Wrapper or any other custom implementation of the serial protocol in a scenario where the modules are deployed. In this case, the module firmware file that is used during firmware upgrade is needed.

X4M300 firmware binary can be downloaded from www.xethru.com.

8 Mechanical Data



Mechanical drawing of the sensor module (in mm)

9 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

Parameter	Value	Comment
V_{IL} max	0.8V	Maximum input low threshold voltage
Typical power consumption	TBD mW	Expected around 600 mW
Operating Temperature range	0°C to +85°C	

10 X4M300 Interface Options

10.1 16-pin XeThru Interface Connector

The X4M300 has a 16-pin connector intended for interfacing a host board.

10.1.1 Pin Descriptions

Pin descriptions

Pin no	Description	Name	Type	Usage
1	Power, 3.3-5.5V	VDD_EXT	Power	Module power input
2	Power, GND	GND	Power	Module power input
3	UART RX / Force Bootloader	RX / BOOT	Input	UART receive / Holding pin 3 low during reset or power-up will force the unit into bootloader mode
4	UART TX	TX	Output	UART transmit
5	MODE SELECT 1	MODESEL1	Input with pull-up	Mode select pin 1, ref table below for details
6	MODE SELECT 1	MODESEL2	Input with pull-up	Mode select pin 2, ref table below for details
7	Reset	nRESET	Input with pull-up	Active low module MCU reset
8	No Connect	N.C	N/A	Leave unconnected
9	No Connect	N.C	N/A	Leave unconnected
10	No Connect	N.C	N/A	Leave unconnected

Pin no	Description	Name	Type	Usage
11	IO1	IO1	I/O	Functionality is Profile specific
12	IO2	IO2	I/O	Functionality is Profile specific
13	IO3	IO3	I/O	Functionality is Profile specific
14	IO4	IO4	I/O	Functionality is Profile specific
15	IO5	IO5	I/O	Functionality is Profile specific
16	IO6	IO6	I/O	Functionality is Profile specific

The connector is a 2x8 2.00mm pitch male pin header.

10.2 USB Connector

The X4M300 is fitted with a USB micro type B connector type supporting USB 2.0 High Speed.

10.3 Communication Modes

The sensor module will always use USB communication if USB power is present.

Additional communication modes can be selected at power-up or reset. The procedure is as follows seen from the host system outside the sensor:

1. Assert nRESET (set low for at least 1ms)
2. Set communication mode according to table below on pin 5 and 6.
3. Release nRESET (set high)
4. Hold communication mode level for at least 10 ms.
5. Set IO configuration of pins 3, 4, 5 and 6 to comply with the selected communication mode.
6. Selected communication is now activated on the sensor module

When USB is used this takes precedence over the table below. The use of USB is detected by the presence of power at the USB 5V power wire at startup. To change communication mode X4M300 need to be reset.

Mode	MODESEL1 (Pin 5)	MODESEL2 (Pin 6)	Comments
Reserved	Low	Low	Not supported
Reserved	Low	High	Not supported
Reserved	High	Low	Not supported
UART	High/Open (*)	High/Open (*)	Default UART settings are 115200 baud rate, 8 data bits, 1 stop bit , no parity This is the default mode. Enabled when pin 5 and pin 6 are left open.

(*) MODSEL1 and MODSEL2 has pull-up resistors and can be left open if a "High" is required.

Not supported modes should not be selected. Future firmware versions may use these modes.

10.4 Power System

There are 2 possible ways to power the sensor: Through pins 1 and 2 on the 16-pin interface connector or via USB. Both power sources may be connected at the same time. When powering via the USB connector this will always take precedence over the 16-pin connector.

11 Schematics and Bill of Material

Schematics and Bill of Material for X4M300 is available from www.xethru.com.

12 Module User Guide

12.1 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 X4M300 in a host microcontroller.

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

12.2 Placing the Sensor Module

The sensor module should be protected from enviromental 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 that 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 algoroithms in the sensor module are sensitive to vibrations. If vibrations occur, the sensor may report presence 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.

12.3 Connecting the X4M300 to a Host System

The X4M300 can be connected to a host system in two ways:

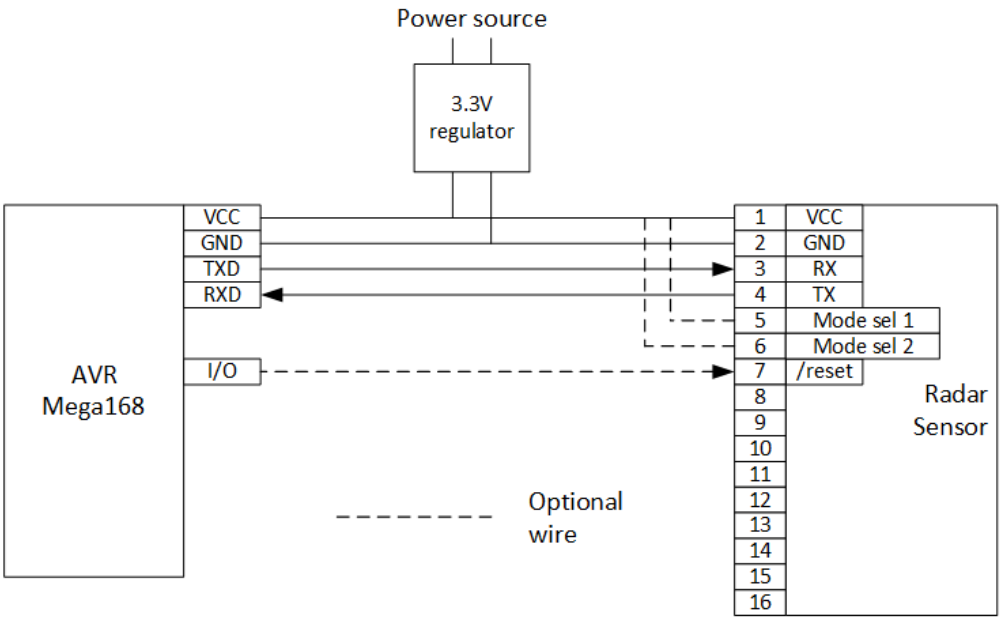
1. Via USB
2. Via the interface connector using the UART interface

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.

12.3.1 Interfacing via USB

When interfacing via USB, this interface will take precedence over others. X4M300 uses a standard Micro USB-B connector.

12.3.2 Interfacing via UART



Atmel AVR (ATmega168) shown as example host

12.4 Upgrading the Firmware Using the Bootloader

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

LED will be purple during firmware upgrades.

13 Regulatory Approval

X4M300 is designed to meet UWB RF specifications of FCC, ETSI, KCC and MIC.

This datasheet may describe several variants of X4M300 with different ordering codes. Not all ordering codes will meet all regulatory specifications.

Some regulatory specifications also specify how the sensor is used. Users of X4M300 must check regulatory requirements for their own use case and determine whether the regulatory approvals obtained from Novelda are sufficient for their product.

13.1 CE/ETSI

This chapter will cover the CE/ETSI approval of the X4M300.

13.2 FCC Approval

This chapter will cover the FCC approval of the X4M300.The X4M300 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 15.517, 15.521 and 15.209.

13.3 KCC Approval

This chapter will cover the KCC approval of the X4M300.

13.4 MIC Approval

This chapter covers the MIC approval of the X4M300, which is for Japan: Ministry of internal affairs and communication (MIC)

14 Errata

14.1 Errata in Firmware Version 1.0.7

X4M300 can unexpectedly reset.

14.2 Errata in Firmware Version 1.1.3

There are no known errata in this FW version.

15 Support and Resources

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

16 Disclaimer

Novelda™, XeThru™ and others are registered trademarks or trademarks of Novelda AS. Other terms and product names may be trademarks of others.

DISCLAIMER: The information in this document is provided in connection with Novelda products. No license, express or implied, by estoppel or otherwise, to any intellectual property right is granted by this document or in connection with the sale of Novelda products. EXCEPT AS SET FORTH IN THE NOVELDA TERMS AND CONDITIONS OF SALES LOCATED ON THE NOVELDA WEBSITE, NOVELDA ASSUMES NO LIABILITY WHATSOEVER AND DISCLAIMS ANY EXPRESS, IMPLIED OR STATUTORY WARRANTY RELATING TO ITS PRODUCTS INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR NON-INFRINGEMENT. IN NO EVENT SHALL NOVELDA BE LIABLE FOR ANY DIRECT, INDIRECT, CONSEQUENTIAL, PUNITIVE, SPECIAL OR INCIDENTAL DAMAGES (INCLUDING, WITHOUT LIMITATION, DAMAGES FOR LOSS AND PROFITS, BUSINESS INTERRUPTION, OR LOSS OF INFORMATION) ARISING OUT OF THE USE OR INABILITY TO USE THIS DOCUMENT, EVEN IF NOVELDA HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. Novelda makes no representations or warranties with respect to the accuracy or completeness of the contents of this document and reserves the right to make changes to specifications and products descriptions at any time without notice. Novelda does not make any commitment to update the information contained herein. Unless specifically provided otherwise, Novelda products are not suitable for, and shall not be used in, automotive applications. Novelda products are not intended, authorized, or warranted for use as components in applications intended to support or sustain life.

SAFETY-CRITICAL, MILITARY, AND AUTOMOTIVE APPLICATIONS DISCLAIMER: Novelda products are not designed for and will not be used in connection with any applications where the failure of such products would reasonably be expected to result in significant personal injury or death (“Safety-Critical Applications”) without an Novelda officer's specific written consent. Safety-Critical Applications include, without limitation, life support devices and systems, equipment or systems for the operation of nuclear facilities and weapons systems. Novelda products are not designed nor intended for use in military or aerospace applications or environments unless specifically designated by Novelda as military-grade. Novelda products are not designed nor intended for use in automotive applications unless specifically designated by Novelda as automotive-grade.