X4C007 - Datasheet

Ultra Wideband (UWB) Impulse Radar Sensor

Rev. C - Advance - TBD-2020

Key Features

- Complete Ultra Wideband (UWB) impulse radar sensor module.
- Accurate human presence detection with very high sensitivity.
- Programmable detection range from 0.3 to 1.6 m.
- Sees through any material except metal, operates at sub 10 GHz.
- Low power consumption, typically less than 2 mW in No Presence state.
- Advanced power management enabling low power duty cycle controlled operation.
- Industrial operating temperature range, -40°C to +85°C.
- Designed for world-wide regulatory compliance.
- Bi-phase coding of transmitted pulses for spectrum spreading.
- Built-in antennas, no external circuitry required.
- I2C interface for small form factor systems.
- Requires few external components enabling small form-factor systems with low BOM cost.

Product Description

The X4C007 is an Ultra Wideband (UWB) short-range impulse radar sensor module, designed for unlicensed operation in world-wide markets.The X4C007 contains all required circuitry, such as antennas, clocks, etc. and can be connected directly to existing systems through a standard I2C interface.
The X4C007 sensor is extremly sensitive and can detect human presence based on respiration motion alone. The sensor accurately detects presence within the detection zone and has fully configurable range limits.
The sensor reports presence state as well as range to target when presence is detected.

Applications

- Human presence detection for computing devices such as laptops, 2-in-1s, monitors, etc.

Ordering Information

For orders, please contact Novelda sales through the contact form on our webpage:

https://www.novelda.com

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1. Electrical Characteristics

1.1. Absolute Maximum Ratings

Parameter	Min	Max	Unit
Supply voltage, all domains	-0.3	3.6	V
Input voltage, digital I/O	-0.3	3.6	V

Table 1.1. Absolute maximum ratings

Parameter	Standard	Max	Unit
Storage temperature	JESD22-A103C	150	°C
ESD, CDM	JESD22-C101E	TBD	V
ESD, HBM	JS-001-2012	TBD	V

Table 1.2. Environmental sensitivity

1.2. General Operating Conditions

Parameter		Min	Typ	Max	Unit
VDD	Supply voltage, all domains[1]	1.8		3.3	V
T_{amb}	Ambient operating temperature	-30		85	°C

[1] ±10% variation allowed beyond nominal range.

Table 1.3. General operating conditions

1.3. Current Consumption

Parameter		Min	Typ	Max	Unit
$I_{acquire}$	Data acquisition current		72		mA
$I_{process}$	Signal processing current		2		mA
I_{sleep}	Sleep current		260		µA
$I_{powerdown}$	Enable pin pulled low[1]		11 + (VDD / 10^{-3})		mA

[1] 100kohm pull-up on Enable signal.

Table 1.4. Current consumption when the system is idle. Numbers are given as examples only, actual idle mode current will depend on configuration

1.4. Specification of Clock Sources

1.4.1. Internal Low Power Oscillator (LPOSC)

Parameter		Min	Typ	Max	Unit
F_{tol}	Absolute frequency accuracy	10		30	%
F_{LPOSC}	Output frequency		27		MHz

Table 1.5. Low power oscillator (LPOSC) specification

1.4.2. Crystal Oscillator (XOSC)

Parameter		Min	Typ	Max	Unit
$F_{fundamental}$	Crystal frequency		27		MHz

Parameter		Min	Typ	Max	Unit
F_{tol}	Frequency accuracy		±40		ppm

Table 1.6. Crystal oscillator specification

2. Inter-Integrated Circuit (I2C)

This section specifies the I2C interface and the I2C bootloader which enables communication between the X4 and an external host for transfer of radar and configuration data. The X4 I2C interface supports a maximum clock frequency of 400 kHz and the default device 7-bit slave address is 0x5A.

2.1. I2C Specification

Parameter	Min	Max	Unit
Maximum I2C clock frequency		400	kHz
7-bit I2C slave address	0x5A		

Table 2.1. I2C Specification

2.2. I2C Commands

After boot, the X4 will by default enable the I2C bootloader. This bootloader can be used to upload program data to the internal memory of the X4. Typically, this program will be a sensor profile provided by Novelda which configures the sensor and enables signal processing. When the host has completed the transfer of the program to the X4´s internal memory, it must initiate a soft reset to start executing the uploaded program. The profile may implement its own I2C commands in addition to the ones described below.

Note that the memory in the X4 is not retained through a power cycle or when the Enable pin is pulled low. After such events, the host must upload the program data through the bootloader again.

This section will describe the protocol used by the bootloader.

2.2.1. Writing commands and data

All bytes written to the X4 I2C device are stored in IDATA (0x80 to 0xFF). All bytes written in the same transaction are stored consecutively and processed after the next STOP condition on the I2C bus. The core I2C functionality processes the following commands:

Command	Length	Byte #0	Byte #1	Byte #2
NOP	1	0x00		
Set data pointer	3	0x01	Address (MSB)	Address (LSB)
Write data	3 + N	0x02	Data length	Data[0]
Soft reboot	1	0x03		
Data pointer control	2	0x04	0x38: stationary 0x39: auto-increment (default)	

Table 2.2. I2C Bootloader Commands

2.2.2. Reading data

When the master reads data, the X4 slave device will respond with the byte at the current data pointer address in SRAM, then increment the data pointer address if configured to do so.

3. Implementation and Layout

3.1. Typical Application Circuit

The following figure shows the X4C007 in a typical application circuit with a single radar sensor.

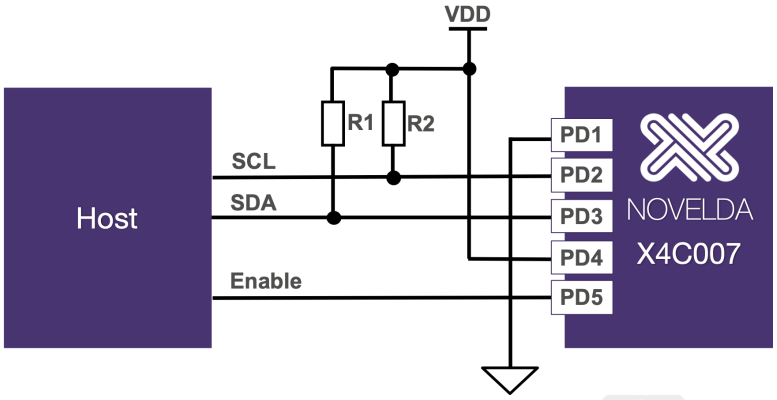

Figure 3.1. Typical application circuit diagram

3.2. Mechanical Specifications

3.2.1. Physical Dimension and Pinout

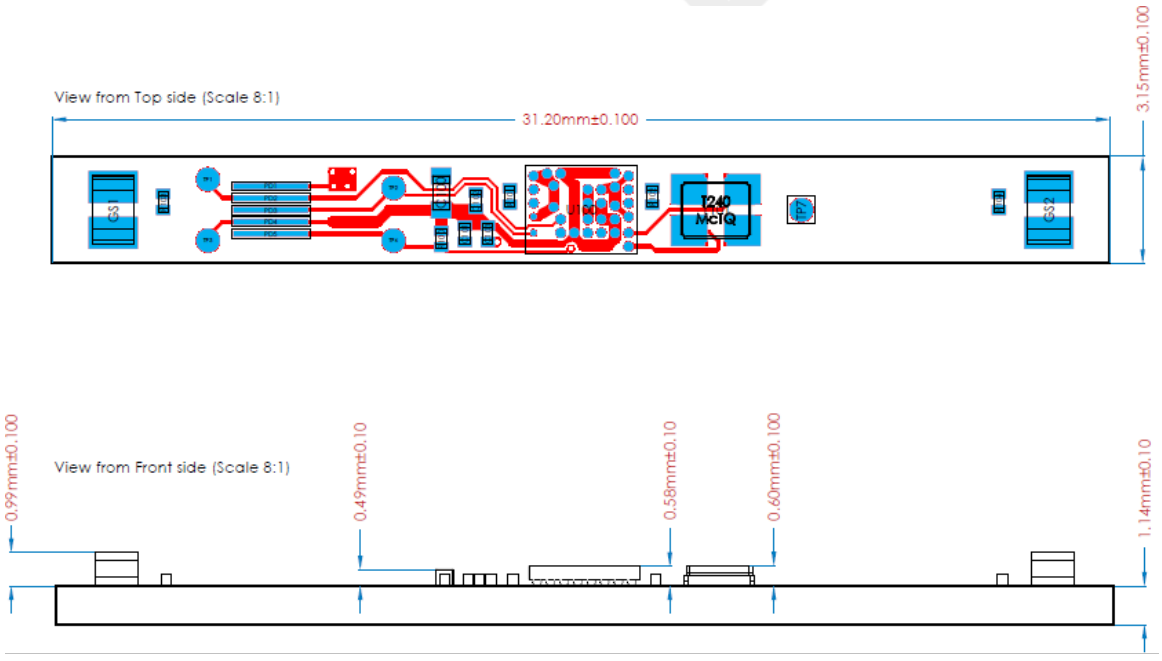

Figure 3.2. Physical Dimesions

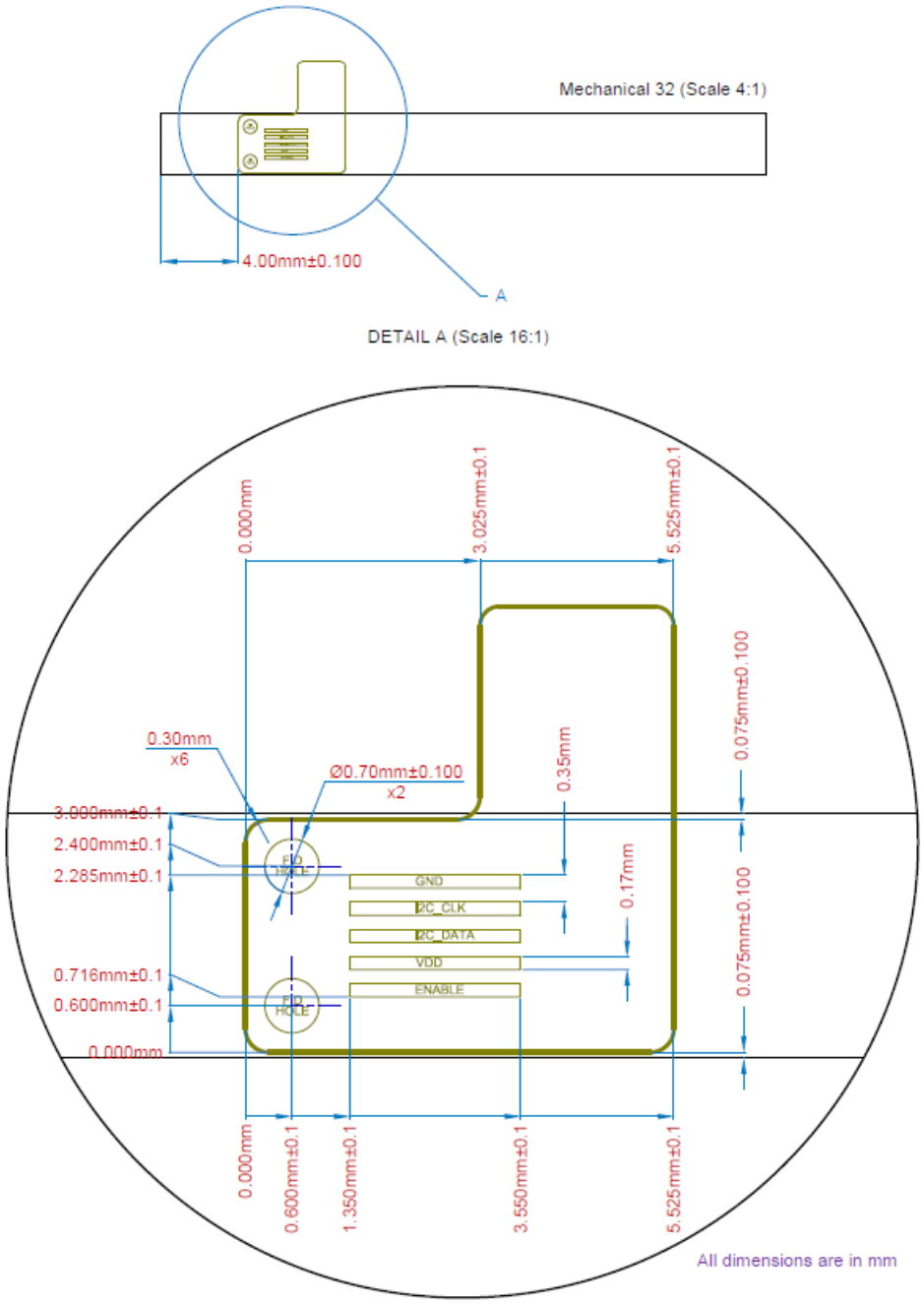

Figure 3.3. Flexible Flat Cable Footprint

Connector Pad	Signal Name	Function
PD1	GND	System ground
PD2	SCL	I2C Clock Input
PD3	SDA	I2C Data Signal
PD4	VDD	Supply Voltage
PD5	Enable	Enable pin, active high, internal 100k pull-up

Table 3.1. Pinout

3.2.2. Product Integrations Guidelines

The X4C007 is designed for integration with the end product and has requirements for material and spacing as shown below in order to deliver best possible directivity and sensitivity. The sensor is designed to accept some spacing variations to the required metal backplane, and the airgap to front material of plastics, glass, carbon etc. The metal backplane must have a minimum size equal to the sensor, and preferably be larger.

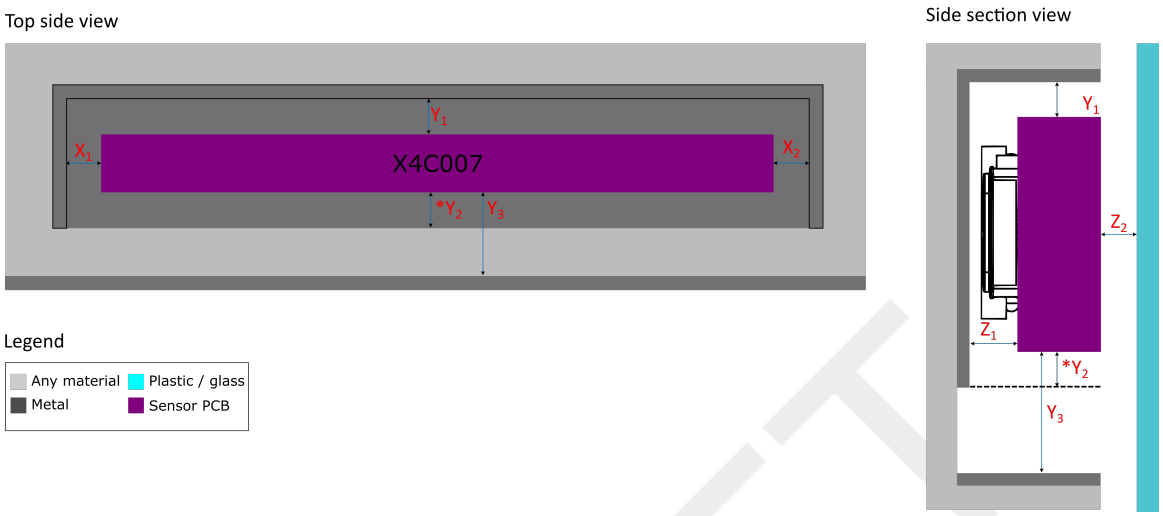

Figure 3.4. Product Integrations Guidelines

Parameter	Min	Max	Unit
X_1	0	1	mm
X_2	0	1	mm
Y_1	0	1	mm
Y_2 [1]	0		mm
Y_3	0	5	mm
Spacing from PCB component side to metal backplate, Z_1	0.75	0.95	mm
Spacing from PCB component side to metal backplate, Z_2	0	0.3	mm

[1]Sensor can extend below Y2 minimum value by 1 mm, if material below metal cavity is metal, e.g. aluminium foil.

Table 3.2. Product Integrations Guidelines

4. Regulatory Compliance Notices

This section outlines the various regulatory notices applicable for operation in certain regions.

4.1. United States (FCC) Regulatory Notices

4.1.1. UWB Device Notice

UWB devices may not be employed for the operation of toys. Operation onboard an aircraft, a ship or a satellite is prohibited. This module is to be used in handheld applications.

4.1.2. Modification Statement

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

4.1.3. 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 harmful interference, and
2. This device must accept any interference, including interference that may cause undesired operation of the device.

4.1.4. RF Exposure

This device complies with the FCC RF exposure limits and has been evaluated in compliance with portable exposure condition.

There is no limitation as to which distance can be used from the human body.

4.1.5. 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.

4.1.6. Compliance of Host Devices

The module has been evaluated in portable stand-alone conditions. For different operational conditions from a stand-alone modular transmitter in a host (multiple, simultaneously transmitting modules or other transmitters in a host), additional testing may be required (collocation, retesting…).

The modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. If the grantee markets their product as being Part 15 Subpart B compliant (when it also contains unintentional-radiator digital circuity), then the grantee shall provide a notice stating that the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed. The end product with an embedded module may also need to pass the FCC Part 15 unintentional emission testing requirements and be properly authorized per FCC Part 15.

4.1.7. Labelling requirements for the Host Device

The host device shall be properly labelled to identify the modules with 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: 2AD9QX4C007

4.2. Canada (ISED) Regulatory Notices

4.2.1. Modification Statement

UChanges 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.

4.2.2. Interference Statement

This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada’s licence-exempt RSS(s). 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.

L’émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d’Innovation, Sciences et Développement économique 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;
2. L’appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d’en compromettre le fonctionnement.

4.2.3. RF Exposure

This device complies with the ISED RF exposure limits and has been evaluated in compliance with portable exposure condition.

There is no limitation as to which distance can be used from the human body.

Cet appareil est conforme aux limites d'exposition RF d'ISDE et a été évalué conformément aux conditions d'exposition portable.

Il n'y a aucune limitation quant à la distance qui peut être utilisée par rapport au corps humain.

4.2.4. 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-X4C007

L’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:

Contient IC:22782-X4C007

4.2.5. CAN ICES-003(B)

This Class B digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de Classe B est conforme à la norme NMB-003 du Canada.

5. Disclaimer

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Document History

Rev.	Release date	Change description
C - Advance	TBD-2020	• Added section: Regulatory Compliance Notices • Removed section: XeThru Presence Minimal Profiles. This is moved to a separate document.
B - Advance	02-Dec-2019	• Added section: Electrical Characteristics. • Added section: I2C Bootloader. • Added section: XeThru Presence Minimal Profiles. • Added section: Application Schematic • Updated Mechanical Data section with new physical dimensions, connector pinout and integration guidelines.
A - Advance	19-Feb-2019	Initial release of X4C007 datasheet - Advance information.