IWRL6432WMOD mmWave Radar Module For Motion and Presence Detection

1 Features

- **Ease of Use**
  - Integrated IWRL6432W mmWave sensor
  - Small module size: 31mm x 15mm
  - Quad Flat Module (QFM) - 4 x 9 LGA Grid
  - Easy to mount 30-pad Land Grid Array (LGA)
  - Easy to integrate - 18 signals interface
  - Simple Configurable APIs (via SPI) to configure Range, Motion Sensitivity, Update rate via external MCU
  - Motion and Presence detection indication via GPIO
  - Integrated 3 receive channels and 2 transmit antennas etched on PCB
  - Integrated power distribution network
  - Integrated 40MHz XTAL
- **FMCW Transceiver**
  - On-chip integrated PLL, transmitter, receiver, baseband and ADC
  - Frequency Modulated Continuous Wave operation
  - 5MHz IF bandwidth, real-only Rx channels
  - Ultra-accurate chirp engine based on fractional-N PLL
- **Antenna**
  - Field of View (FoV): ± 60° (Azimuth); ± 60° (Elevation)
  - 57GHz - 61.5GHz antenna coverage with 4.5GHz continuous bandwidth
- **Certifications**
  - Targeted modular certification with FCC, RED, TELEC certifications
- **Performance**
  - Human Presence Detection Range typically up to:
    - At 0°: 15m
    - At edge of FoV: 8m
  - Built-in low power modes for power saving
- **Power management**
  - 3.3V VCC and VIO operation
  - Built-in 1.8V regulator on module
  - Built-in on-chip LDO network for enhanced PSRR
  - BOM-Optimized mode
- **Host Interface**
  - SPI
    - Host PC interface using TI mmWave uDFP
    - Interfaces with external MCU
- **Other interfaces**
  - Presence Indication
  - Wake Up Request
- **Temperature operating range**
  - Industrial grade temperature range: –40°C to 85°C

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2 Applications

- Air conditioner
- Automated door/gate
- Gaming
- Home theater & entertainment
- IP network camera
- Occupancy detector
- PC/Notebooks
- Portable electronics
- Refrigerators and freezers
- Smart watches
- Tablets
- Televisions
- Thermostat
- Video doorbell

3 Description

Texas Instruments introduces the IWRL6432WMOD, the radar module presenting a significant advancement in low-power industrial radar technology. This compact 31mm × 15mm module integrates a 60GHz patch antenna, on-board power management, flash memory, passives and crystal, eliminating the need for specialized mmWave system design expertise while providing simple software configuration options for range, sensitivity, and regions of interest. The module is distinguished by its comprehensive targeted certification with FCC, RED, TELEC that eliminates cost and effort for certification at the end product. Additionally the module provides either SPI based point cloud data outputs or GPIO based presence indication which aids flexible implementation. By addressing customer readiness challenges and enabling autonomous operation across applications such as motion sensing, occupancy detection, and smart home devices, this TI-designed, supported, and distributed device significantly reduces development complexity and accelerates time-to-market for customers seeking to embed mmWave radar sensor capabilities in their products.

Table 3-1. Packaging Information

ORDERABLE PART NUMBER(1)	PACKAGE	BODY SIZE(2)	PACKAGING INFORMATION	DESCRIPTION
XI6432BAFCLIMBBR	MBB (QFM, 30)	31mm x 15mm	Tape & Reel	Pre-Production; Deep sleep enabled; Authenticated boot capable
IWRL6432BAFCLIMBBR	MBB (QFM, 30)	31mm x 15mm	Tape & Reel	Production; Deep sleep enabled; Authenticated boot capable

1. For more information, see Device Nomenclature
2. For more information, see Mechanical, Packaging, and Orderable Information

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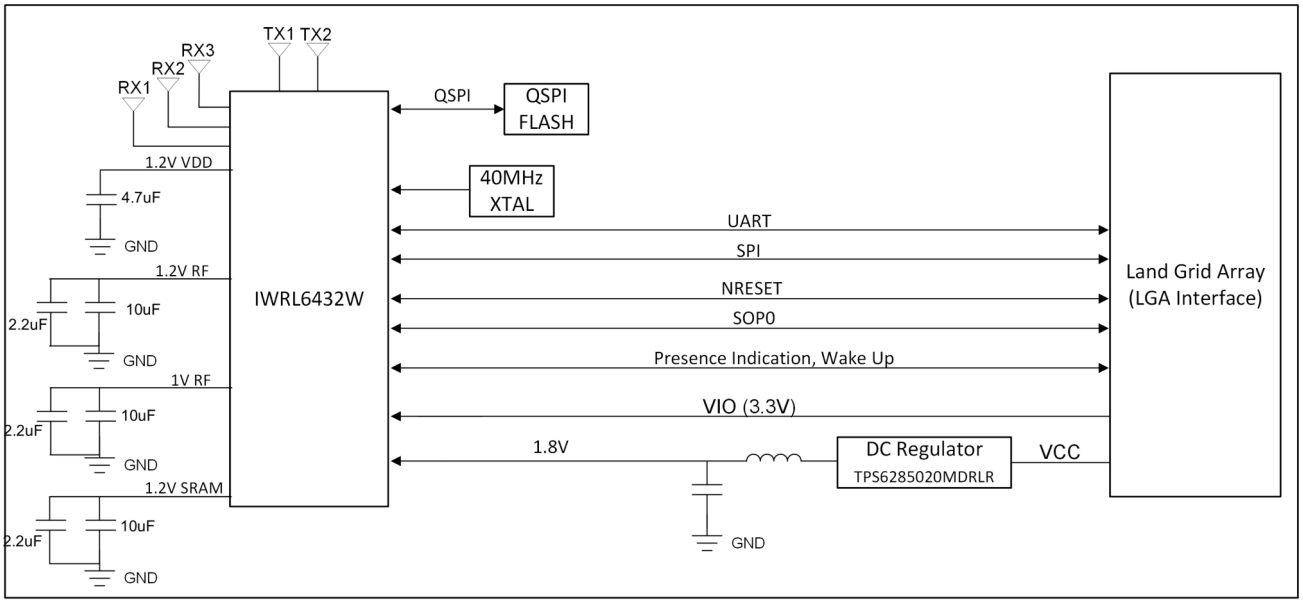
4 Functional Block Diagram



IWRL6432WMOD

Figure 4-1. Functional Block Diagram

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5 Terminal Configurations and Functions

5.1 Pin Diagrams

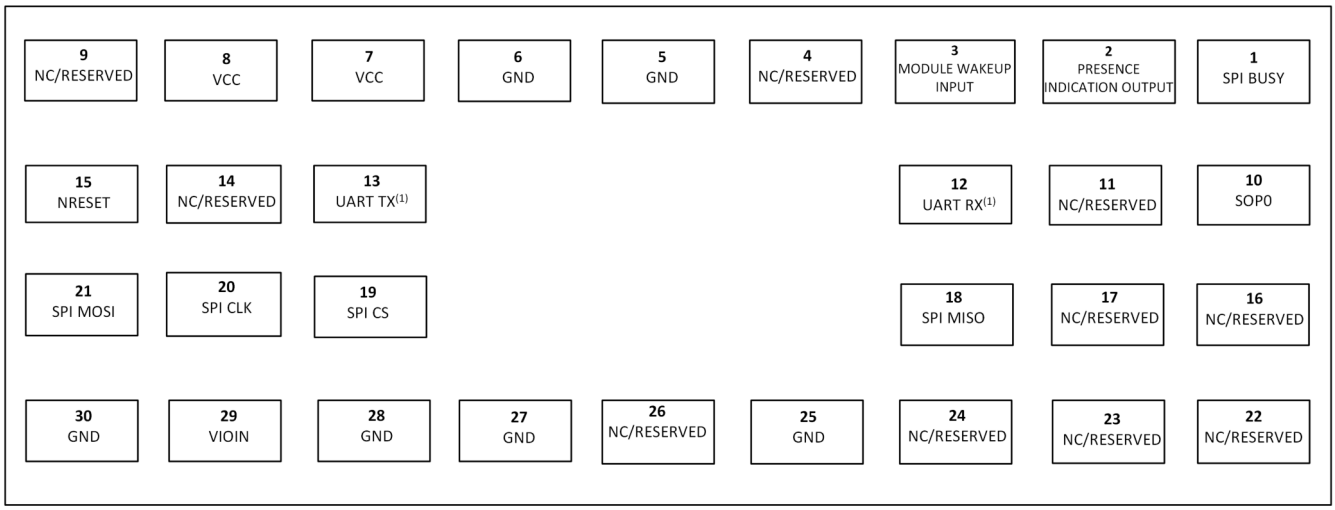

Figure 5-1. IWRL6432WMOD Pin Diagram (Top View)

1. UART TX and UART RX - For uDFP patch updates only. This is not the application interface.

5.2 Signal Descriptions

Note

All digital IO pins of the device (except NRESET) are non-failsafe; hence, care needs to be taken that they are not driven externally without the VIO supply being present to the device.

Table 5-1. Power Supply Signal Descriptions

SIGNAL NAME	DESCRIPTION	PIN TYPE	PIN
VCC	3.3V Supply	PWR	7, 8
VIOIN	3.3V supply	PWR	29
GND	GND	GND	5, 6, 25, 27, 28, 30
SPI BUSY	Host interrupt / SPI host clock request signal	O	1
SPI MOSI	SPI MOSI	I	21
SPI MISO	SPI MISO	O	18
SPI CLK	SPI Clock	I	20
SPI CS	SPI Chip Select	I	19
UART TX (1)	UART Transmit Data	O	13
UART RX (1)	UART Receive Data	I	12
SOP0	Sense On Power	A	10
NRESET	NRESET input	A	15
Presence Indication Output	Output for presence indication in the Region Of Interest	O	2
Module Wake Up Input	Input signal to wakeup the IWRL6432W	I	3
NC	No Connnection	-	4, 9, 11, 14, 16, 17, 22, 23, 24, 26

1. For uDFP patch updates only. This is not the application interface.

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6 Specifications

6.1 Absolute Maximum Ratings

PARAMETERS[1] [2]		MIN	MAX	UNIT
VCC	Input Supply Voltage (3.3V)	–0.5	3.8	V
VIOIN	I/O supply (3.3V): All CMOS I/Os operate on the same VIOIN voltage level	–0.5	3.8	V
T_J	Operating temperature range	–40	85	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) All voltage values are with respect to GND, unless otherwise noted.

6.2 Recommended Operating Conditions

		MIN	NOM	MAX	UNIT
VCC	Input Supply Voltage	3.135	3.3	3.465	V
VIOIN	I/O supply (3.3V): All CMOS I/Os can operate on this supply.	3.135	3.3	3.465	V
V_{IH}	Voltage Input High (3.3Vmode)	2.25			V
V_{IL}	Voltage Input Low (3.3Vmode)			0.62	V
V_{OH}	High-level output threshold (I_{OH} = 6mA)	VIOIN – 450			mV
V_{OL}	Low-level output threshold (I_{OL} = 6mA)			450	mV
NRESET, SOP0	V_{IL} (3.3V Mode)			0.3	V
	V_{IH} (3.3V Mode)	1.57			

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6.3 System Topologies

The following the system topologies are supported.

- Topology 1: Autonomous mode, with ability to send Presence Detect via GPIO
- Topology 2: Secondary Device mode, under control of external MCU

6.3.1 Autonomous Mode

In Autonomous mode, the radar's chirping configuration, which sets the range, sensitivity and user-defined detection parameters for the radar, are pre-stored in the module serial flash. The application software boots up and reads the configuration from the flash and gives a Presence/No Presence indication via GPIO (Presence Detect GPIO) . For example, this GPIO can be used to turn ON/OFF a simple lighting relay circuit. Refer to uDFP or BP-IWRL6432WMOD user guide for steps to store the configuration to flash using SPI.

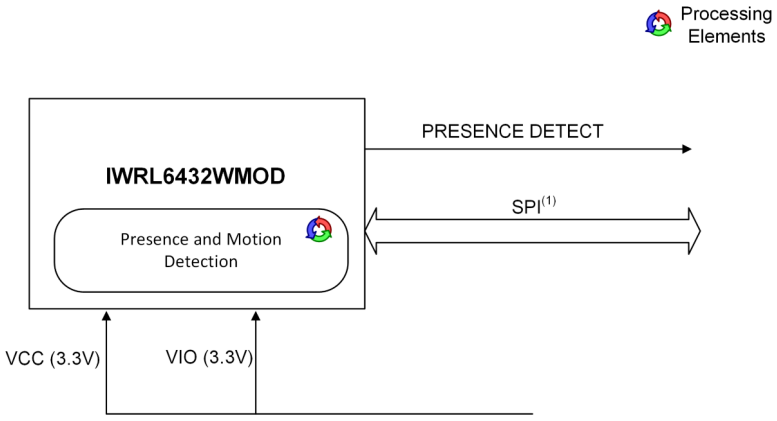

Figure 6-1. Autonomous Mode

1. Only for storing the configuration on to the flash. The interface shall be used only once during the production.

6.3.2 Secondary Device Mode

In Secondary Device mode, the IWRL6432WMOD is interfaced with an external Host MCU . SPI is the primary host communication interface to configure the module. The host is required to integrate the "mmWaveuLink/ uLINK" library to control the module in its system software. The host sends the configuration (SPI Messages) to the module through the SPI interface. The module provides presence detection through a dedicated GPIO (Presence Indication Output) . In this mode the module can also send out point cloud information to the host via the same SPI interface. The host can interpret the point cloud data to perform higher order processing like tracking.

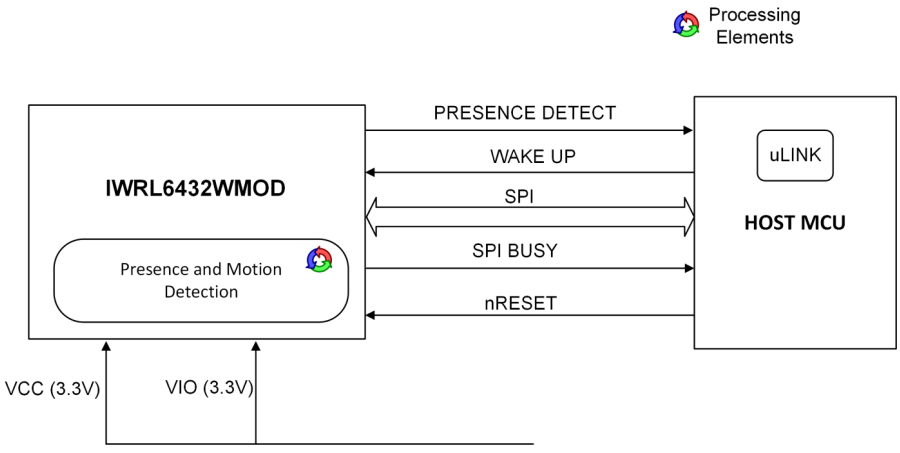

Figure 6-2. Secondary Device Mode

6.4 Module Power Management

The module can be powered using a 3.3V input supply.

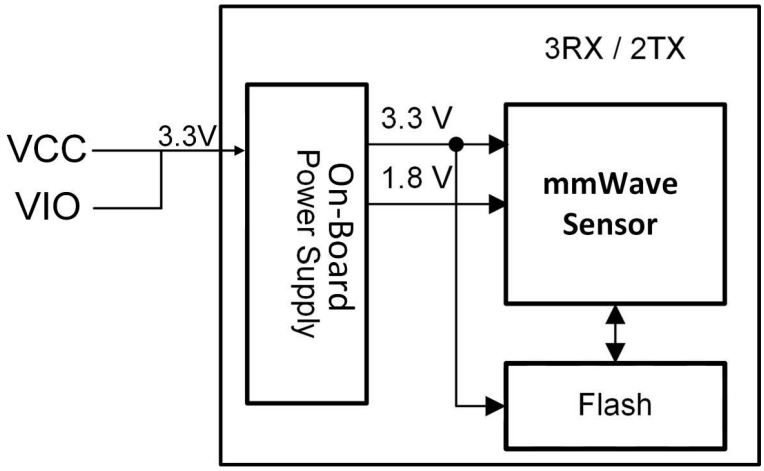

Figure 6-3. Module Power Management (3.3V I/O Topology)

6.5 Peak Current Requirement per Voltage Rail

Table 6-1 provides the max split rail current numbers.

Table 6-1. Maximum Peak Current per Voltage Rail

Supply Voltage Rail (V)	Maximum Current (mA) (1)
VCC (3.3V)	1000
VIO (3.3V)	90

1. The exact VIOIN current depends on the peripherals used and the frequency of operation.

6.6 RF Specification

The following specifications are for recommended operating conditions (unless otherwise noted)

PARAMETER			MIN	TYP	MAX	UNIT
Antenna	Single transmitter output power (EIRP)			12.4		dBm
	Effective isotropic noise figure (EINF)			9.6		dB
	Frequency range		57		61.5	GHz
	Bandwidth			4.5		GHz
	Antenna gain (1)			4.4		dBi
	Field of View	Azimuth		120		Degrees
		Elevation		120		Degrees
	Azimuthal Angular Resolution (2)			19		Degrees
	Maximum Adult Human Presence Detection Range	Boresight		15		m
		+/- 60°		8		

1. For more details please refer to Transmitter Gain Plots.
2. For resolving objects near boresight with similar RCS.

6.7 Antenna Position

The module uses a single-element patch antenna for its three receiver and two transmitter antenna. The antenna array has been defined in a way that the angular resolution is maximized in azimuthal plane.

6.7.1 2D Antenna Array With 3D Detection Capability

The TX2 antenna placed λ/2 below the TX1 antenna in the elevation plane, as shown in Figure 6-4. This antenna geometry has a two rows, six element virtual antenna array with six elements in the azimuthal plane and two elements in the elevation plane as shown in Figure 6-5. This antenna is capable of detecting the range, angle and velocity in both azimuthal and elevation plane.

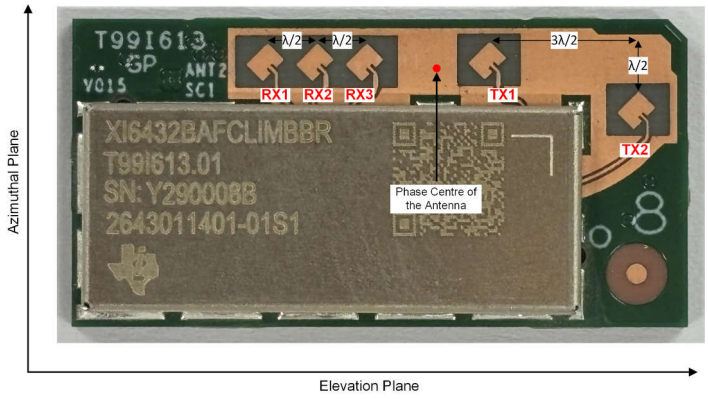

Figure 6-4. 2D Antenna Patch Array Geometry

Figure 6-5 shows the geometry of the virtual antenna array with each index depicting multiplication factor for λ/2. Position 0, 1, and 2 represents placement of virtual antenna originated from combination of all 3 RX (RX1, RX2, RX3) and TX1. Position 3, 4, and 5 represents placement of virtual antenna originated from combination of all 3 RX (RX1, RX2, RX3) and TX2.

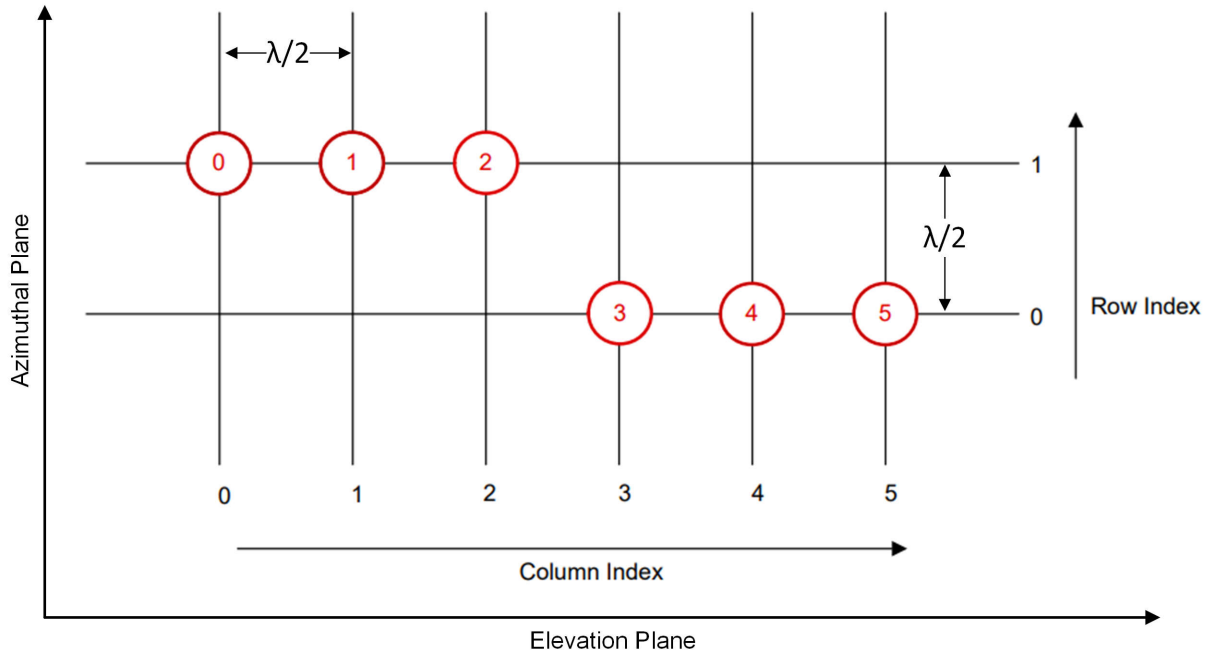

Figure 6-5. 2D Antenna - Virtual Array

The virtual antenna forms a two dimensional array with six elements in the azimuth and two elements in the elevation. The six elements in the azimuth direction, yields an angular resolution of 19 degrees in azimuthal plane. This enables 3-dimensional detection capability of the mmWave sensor.

6.8 Antenna Gain Plot

This section depicts transmitter and receiver antenna gain plot in azimuth and elevation planes

6.8.1 Transmitter Gain Plots

Transmitter Gain Plots shows typical antenna gain plots for the two transmitters in both Azimuth and Elevation planes. The Y axis shows the antenna gain in dBi and X axis shows the angle in degrees.

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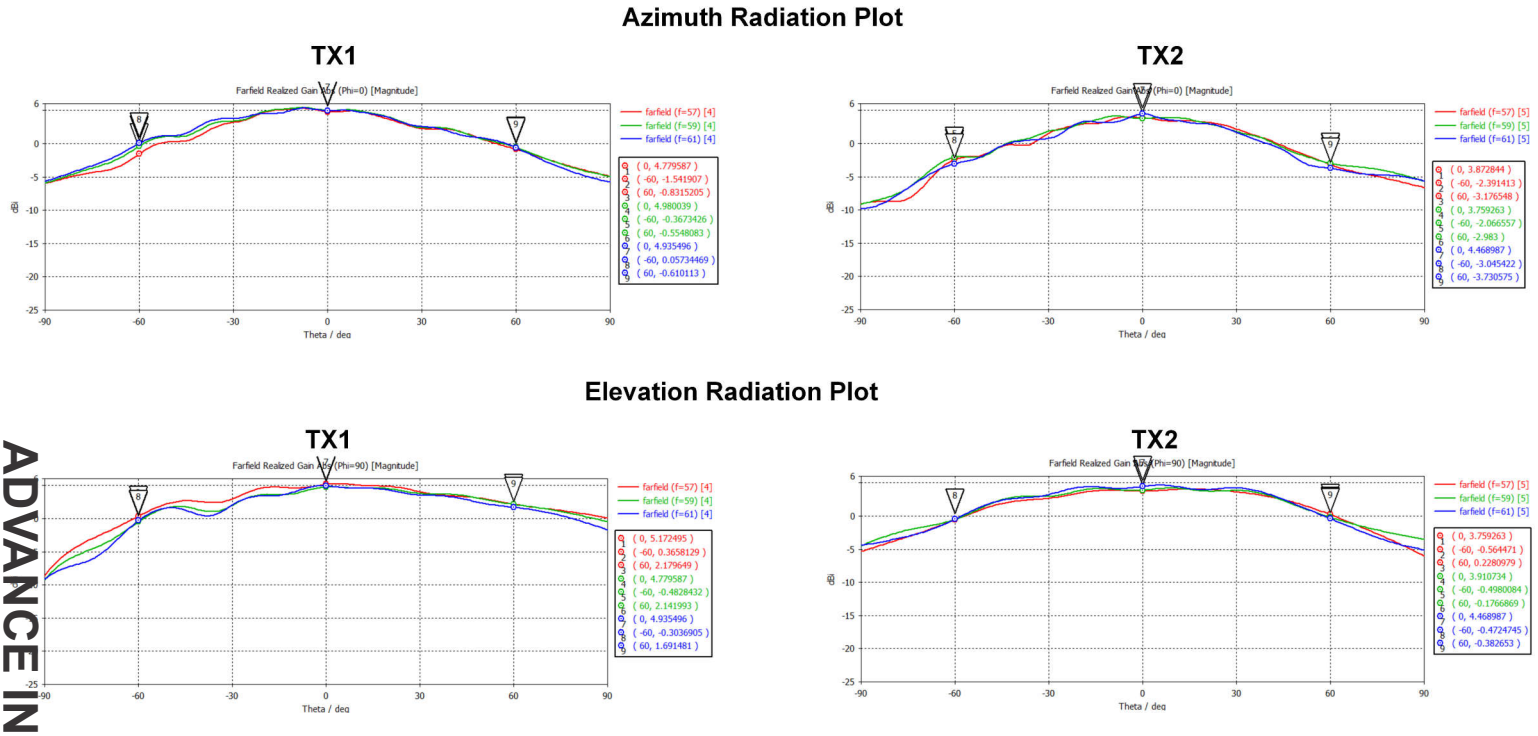

Figure 6-6. Transmitter Antenna Gain Plot

6.8.2 Receiver Gain Plot

Receiver Antenna Gain Plot shows typical antenna gain plots for the three receivers in both azimuth and elevation planes. The Y axis shows the antenna gain in dBi and X axis shows the angle in degrees.

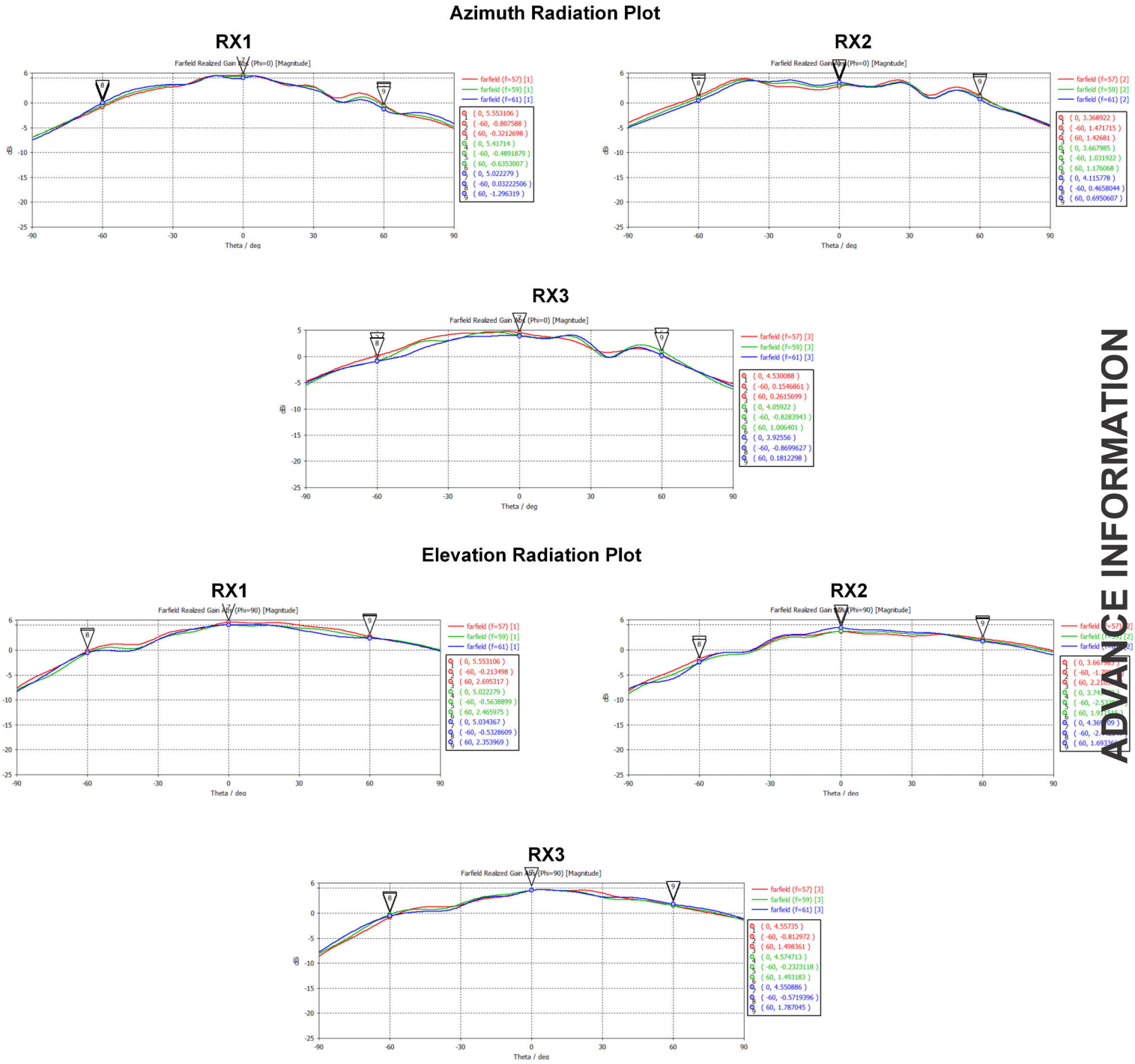

Figure 6-7. Receiver Antenna Gain Plot

6.9 Thermal Resistance Characteristics

Table 6-2. Thermal Resistance Characteristics for QFM Package [MBB0030A]

THERMAL METRICS(1)		°C/W(2)(3)
$R\Theta_{JC}$	Junction-to-case (Top)	29.0
$R\Theta_{JB}$	Junction-to-board	21.6
$R\Theta_{JA}$	Junction-to-free air	34.8

Table 6-2. Thermal Resistance Characteristics for QFM Package [MBB0030A] (continued)

THERMAL METRICS(1)		°C/W(2)(3)
Psi_{JT}	Junction-to- top	18.3
Psi_{JB}	Junction-to-board	21.4

1. For more information about traditional and new thermal metrics, see *Semiconductor and IC Package Thermal Metrics*.
2. °C/W = degrees Celsius per watt.
3. These values are based on a JEDEC-defined 2S2P system (with the exception of the Theta JC [$R\Theta_{JC}$] value, which is based on a JEDEC-defined 1S0P system) and will change based on environment as well as application. For more information, see these EIA/JEDEC standards:
   - JESD51-2, *Integrated Circuits Thermal Test Method Environmental Conditions - Natural Convection (Still Air)*
   - JESD51-3, *Low Effective Thermal Conductivity Test Board for Leaded Surface Mount Packages*
   - JESD51-7, *High Effective Thermal Conductivity Test Board for Leaded Surface Mount Packages*
   - JESD51-9, *Test Boards for Area Array Surface Mount Package Thermal Measurements*

6.10 Timing and Switching Characteristics

6.10.1 Power Supply Sequencing and Reset Timing

The IWRL6432WMOD device expects all external voltage rails to be stable before nRESET release. Figure 6-8 describes the device wake-up sequence.

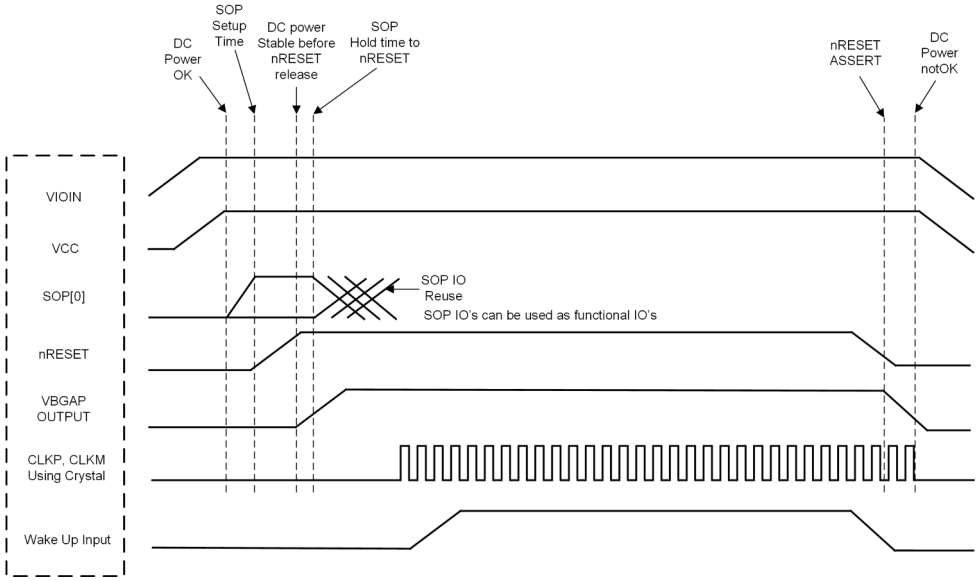

Figure 6-8. Module Wake-up Sequence

6.10.2 MultiChannel buffered / Standard Serial Peripheral Interface (McSPI)

The McSPI module is a multichannel transmit/receive, controller/peripheral synchronous serial bus

6.10.2.1 SPI Timing Conditions

Table 6-3 presents timing conditions for McSPI

Table 6-3. McSPI Timing Conditions

		MIN	TYP	MAX	UNIT
Input Conditions					
t_R	Input rise time	1		3	ns
t_F	Input fall time	1		3	ns

Table 6-3. McSPI Timing Conditions (continued)

		MIN	TYP	MAX	UNIT
Output Conditions					
C_{LOAD}	Output load capacitance	2		15	pF

6.10.2.2 SPI—Peripheral Mode

6.10.2.2.1 Timing and Switching Requirements for SPI - Peripheral Mode

Table 6-4 and Table 6-5 present timing requirements for SPI -Peripheral Mode.

Table 6-4. SPI Timing Requirements - Peripheral Mode

NO.(1) (3)	PARAMETER	DESCRIPTION	MIN	MAX	UNIT
SS1	$t_{c(SPICLK)}$	Cycle time, SPI_CLK	24.6		ns
SS2	$t_{w(SPICLKL)}$	Typical Pulse duration, SPI_CLK low	0.45*P2		ns
SS3	$t_{w(SPICLKH)}$	Typical Pulse duration, SPI_CLK high	0.45*P2		ns
SS4	$t_{su(SIMO-SPICLK)}$	Setup time, SPI_D[x] valid before SPI_CLK active edge	3		ns
SS5	$t_{h(SPICLK-SIMO)}$	Hold time, SPI_D[x] valid after SPI_CLK active edge	1		ns
SS8	$t_{su(CS-SPICLK)}$	Setup time, SPI_CS[x] valid before SPI_CLK first edge	5		ns
SS9	$t_{h(SPICLK-CS)}$	Hold time, SPI_CS[x] valid after SPI_CLK last edge	5		ns
SS10	sr	Input Slew Rate for all pins	1	3	ns
SS11	Cb	Capacitive load on D0 and D1	2	15	pF

Table 6-5. SPI Switching Characteristics Peripheral Mode

NO.	PARAMETER	DESCRIPTION	MIN	MAX	UNIT
SS6	$t_{d(SPICLK-SOMI)}$	Delay time, SPI_CLK active edge to McSPI_somi transition	0	5.77	ns
SS7	$t_{sk(CS-SOMI)}$	Delay time, SPI_CS[x] active edge to McSPI_somi transition	5.77		ns

1. P = This timing applies to all configurations regardless of SPI_CLK polarity and which clock edges are used to drive output data and capture input data.
2. P = SPICLK period.
3. PHA = 0; SPI_CLK phase is programmable with the PHA bit of the SPI_CH(i)CONF register.

6.10.2.2.2 Timing and Switching Characteristics for SPI Output Timings—Secondary Mode

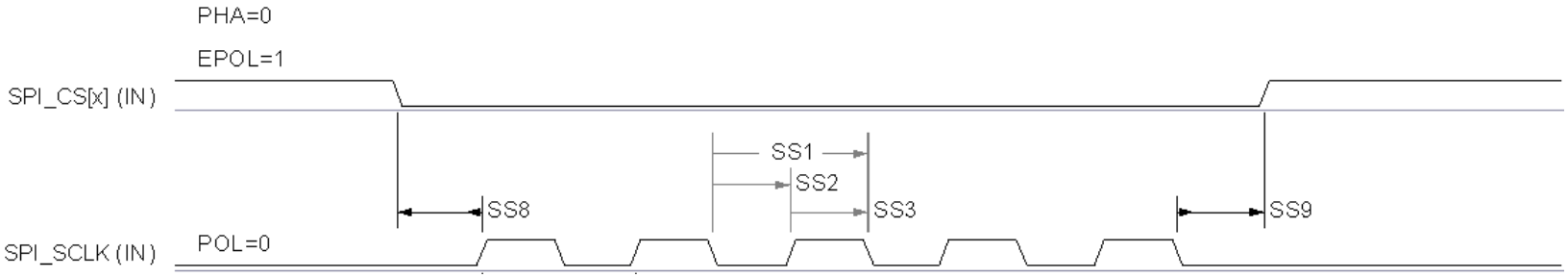

Figure 6-9. SPI Timing - Peripheral mode Receive

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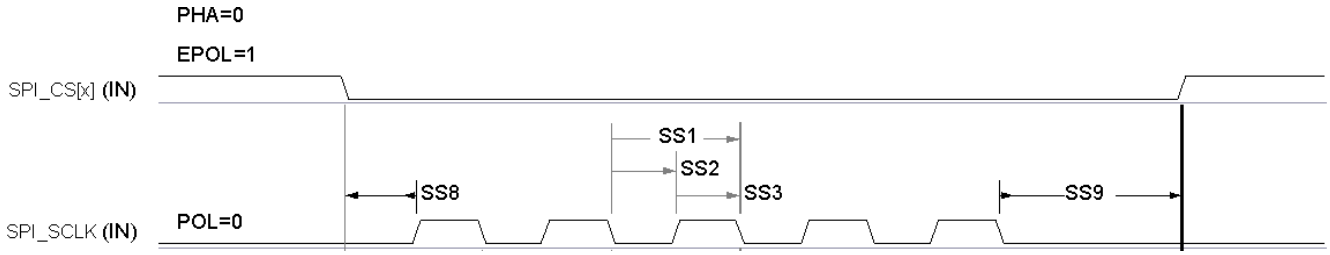


Figure 6-10. SPI Timing - Peripheral mode Transmit

6.10.3 Dedicated Input/Output

This section highlights the timing and switching characteristics for module wakeup input and presence indication output.

6.10.3.1 Switching Characteristics for Output Timing versus Load Capacitance (C_L)

Table 6-6 lists the switching characteristics of output timing relative to load capacitance.

Table 6-6. Switching Characteristics for Output Timing versus Load Capacitance (C_L)

PARAMETER[1]		TEST CONDITIONS		UNIT
t_r	Max rise time	C_L = 20pF	3.3	ns
		C_L = 50pF	7.2	
		C_L = 75pF	10.5	
t_f	Max fall time	C_L = 20pF	3.1	ns
		C_L = 50pF	6.6	
		C_L = 75pF	9.6	

1. The rise/fall time is measured as the time taken by the signal to transition from 10% and 90% of VIOIN voltage.

6.10.4 Serial Communication Interface (SCI)

Note

The UART interface are used for uDFP patch updates only. This is not the application interface.

6.10.4.1 SCI Timing Requirements

		MIN	TYP	MAX	UNIT
f(baud)	Supported baud rate at 20pF		115.2[1]		kBaud

1. Maximum supported standard baud rate.

7 Detailed Description

7.1 Overview

Texas Instruments introduces the IWRL6432WMOD, the radar module presenting a significant advancement in low-power industrial radar technology. This compact 31mm × 15mm module integrates a 60GHz patch antenna, on-board power management, flash memory, and crystal, eliminating the need for specialized mmWave system design expertise while providing simple software configuration options for range, sensitivity, and regions of interest. The module is distinguished by its comprehensive targeted certification with FCC, RED, TELEC that eliminates cost and effort for certification at the end product. Additionally the module provides either SPI based point cloud data outputs or GPIO based presence indication which aids flexible implementation. By addressing customer readiness challenges and enabling autonomous operation across applications such as motion sensing, occupancy detection, and smart home devices, this TI-designed, supported, and distributed device significantly reduces development complexity and accelerates time-to-market for customers seeking to embed mmWave radar sensor capabilities in their products.

7.1.1 Module Images

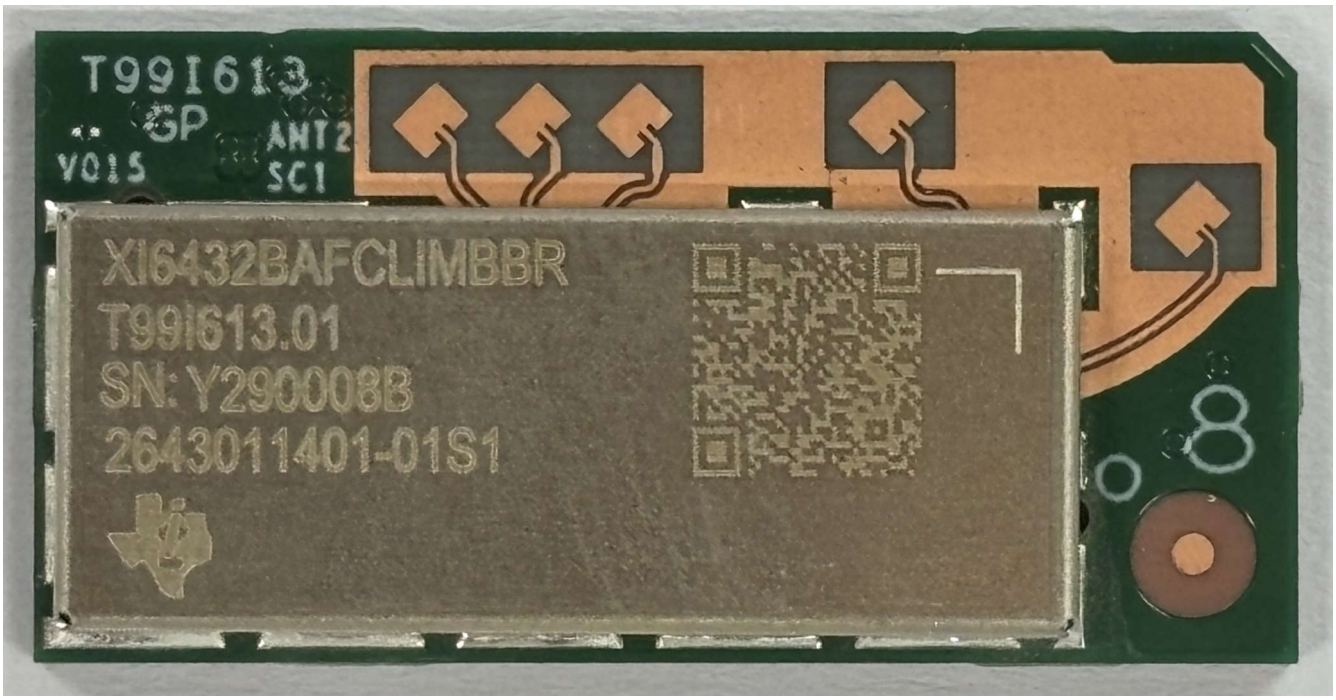


Figure 7-1. Top Side of the Module

ADVANCE INFORMATION

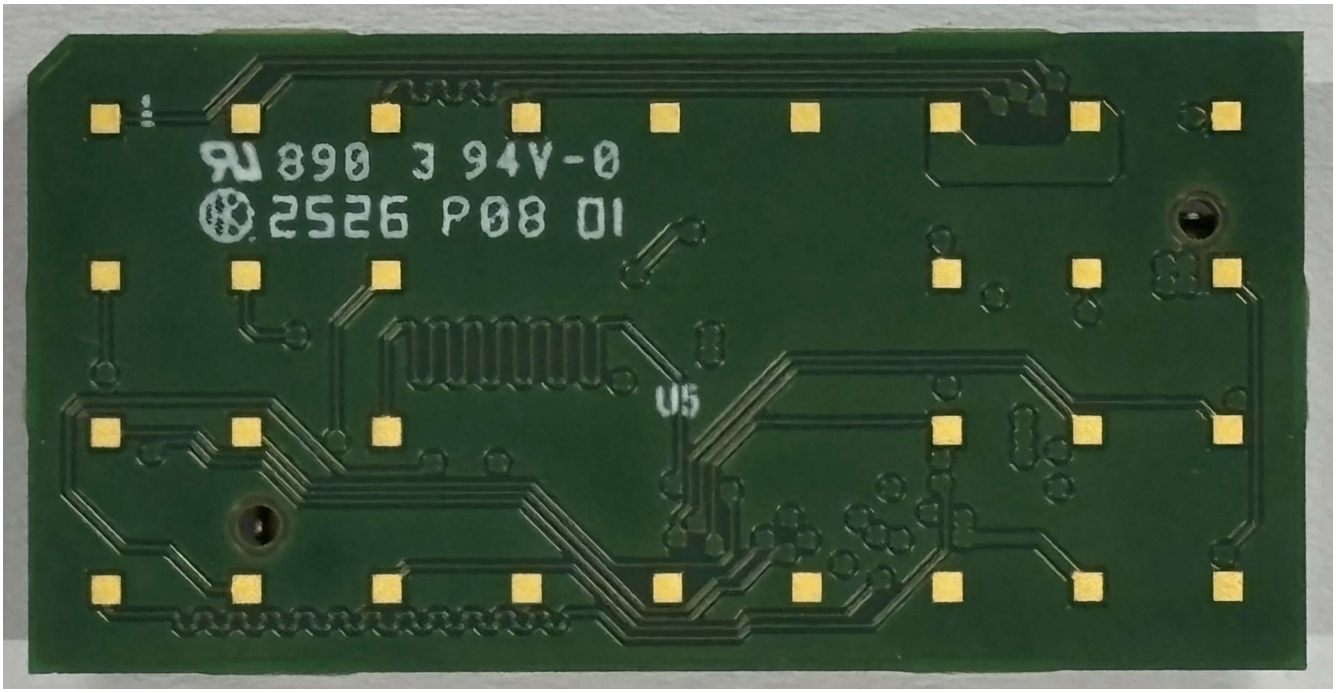
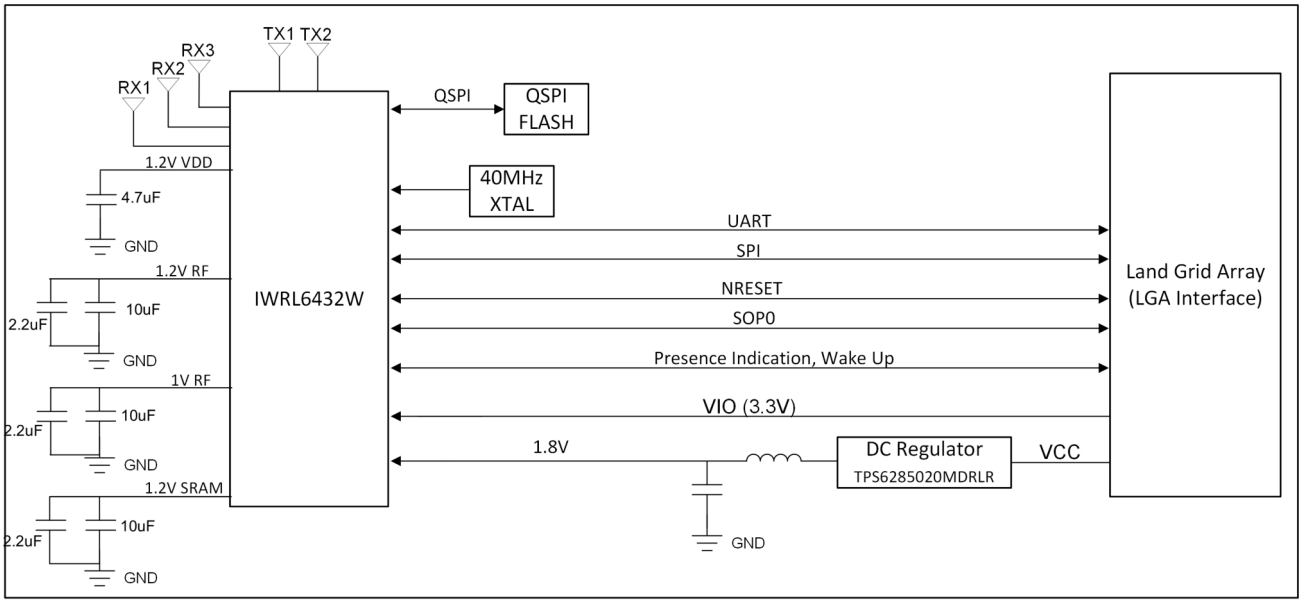


Figure 7-2. Bottom Side of the Module

7.2 Functional Block Diagram



IWRL6432WMOD

Figure 7-3. Functional Block Diagram

7.3 Subsystems

7.3.1 Host Interface

The host can interface with the module through SPI interface.

The device communicates with the host radar processor over the following control signals:

- **Serial Peripheral Interface (SPI)** - Synchronous serial communication protocol used for communication between the host processor and the IWRL6432WMOD.
- **SPI_BUSY** - Output which the IWRL6432WMOD uses to indicate to the host that it is busy and cannot accept any commands from host.
- **PRESENCE_DETECT** - Output which the IWRL6432WMOD uses to indicate whether there is a Presence detected or not.
- **WAKE_UP** - Input which the host uses to control whether the IWRL6432WMOD is allowed to go to Deep Sleep mode or not.

7.3.2 Software

The IWRL6432WMOD comes with a presence and motion detection software that is pre-programmed in the external flash that is part of the module. The module can be configured to set of desired configuration based on the customer use-cases for max range, detection sensitivity , motion sensitivity and region of interest using set of simple APIs that are defined as part of the uDevice Firmware Package(uDFP).

More details of the APIs and the sequence to be followed to configure the module can be found in the documentation available in the uDFP package

<MMWAVE_UDFP_INSTALL_PATH>\Host\mmWaveULink_Interface_Control_Document.pdf

8 Applications, Implementation, and Layout

Note

Information in the following Applications section is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

8.1 Application Information

Application information can be found on Industrial mmWave radar sensors.

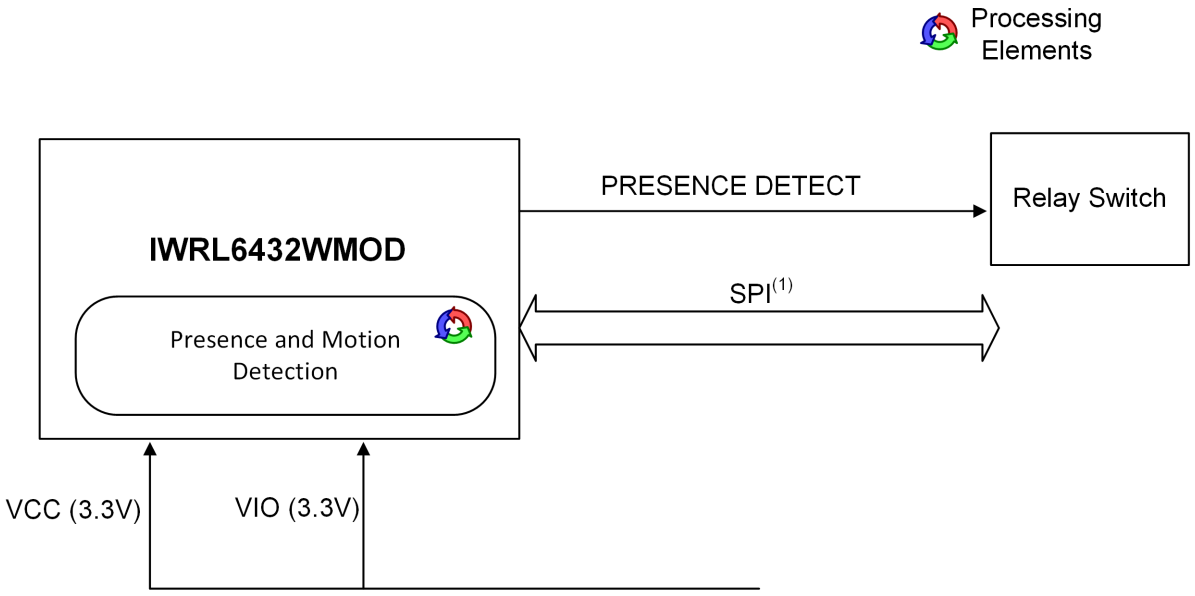


Figure 8-1. Autonomous Mode Example

1. Only for storing the configuration on to the flash. The interface shall be used only once during the production.

ADVANCE INFORMATION

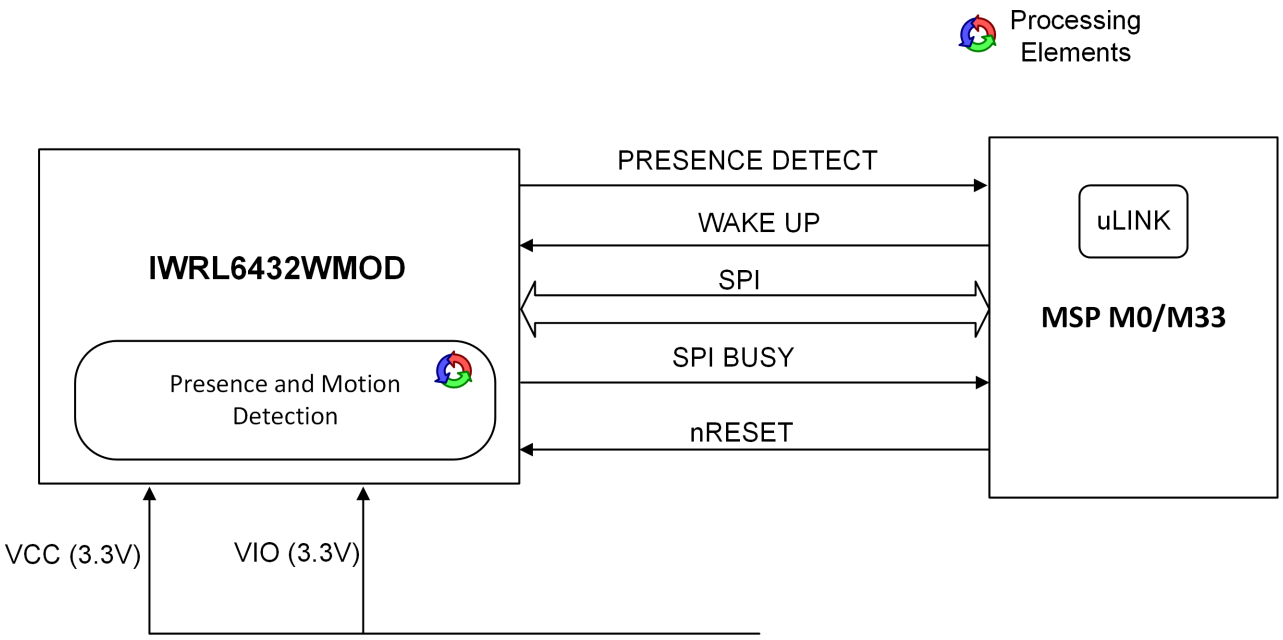


Figure 8-2. Secondary Device Mode Example

8.2 Test Results

In an open space the module was placed for the test. The configuration used for this test is elaborated in Figure 8-3.

Table 8-1. Test Results

Azimuthal Angle	Presence Detection
0°	15m
+45°	13m
-45°	12m
+60°	9m
-60°	7m

ADVANCE INFORMATION

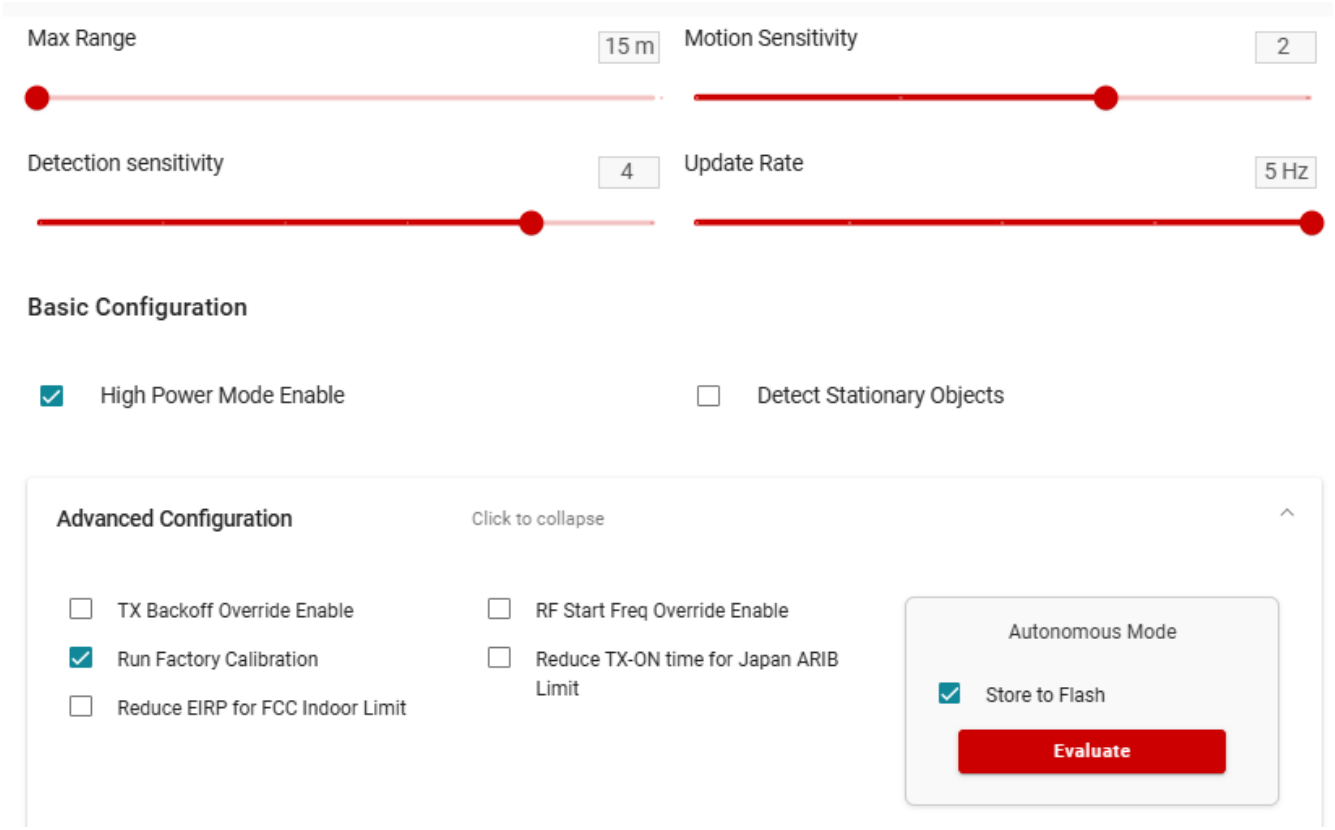


Figure 8-3. Test Configuration

9 Device and Documentation Support

TI offers an extensive line of development tools. Tools and software to evaluate the performance of the device, generate code, and develop solutions follow.

9.1 Device Nomenclature

To designate the stages in the product development cycle, TI assigns prefixes to the part numbers of all microprocessors (MPUs) and support tools. Each device has one of three prefixes: X, P, or null (no prefix) (for example, *IWRL6432W*). Texas Instruments recommends two of three possible prefix designators for its support tools: TMDX and TMDS. These prefixes represent evolutionary stages of product development from engineering prototypes (TMDX) through fully qualified production devices and tools (TMDS).

Device development evolutionary flow:

X Experimental device that is not necessarily representative of the final device's electrical specifications and may not use production assembly flow.

P Prototype device that is not necessarily the final silicon die and may not necessarily meet final electrical specifications.

null Production version of the silicon die that is fully qualified.

Support tool development evolutionary flow:

TMDX Development-support product that has not yet completed Texas Instruments internal qualification testing.

TMDS Fully-qualified development-support product.

X and P devices and TMDX development-support tools are shipped against the following disclaimer:

"Developmental product is intended for internal evaluation purposes."

Production devices and TMDS development-support tools have been characterized fully, and the quality and reliability of the device have been demonstrated fully. TI's standard warranty applies.

Predictions show that prototype devices (X or P) have a greater failure rate than the standard production devices. Texas Instruments recommends that these devices not be used in any production system because their expected end-use failure rate still is undefined. Only qualified production devices are to be used.

TI device nomenclature also includes a suffix with the device family name. This suffix indicates the package type (for example, MBB0030A), the temperature range (for example, blank is the default commercial temperature range). Figure 9-1 provides a legend for reading the complete device name for any *IWRL6432WMOD* device.

For orderable part numbers of *IWRL6432WMOD* devices in the MBB0030A package types, see the Package Option Addendum of this document (when available), the TI website (www.ti.com), or contact your TI sales representative.

For additional description of the device nomenclature markings on the die, see the *Device Marking*.

ADVANCE INFORMATION

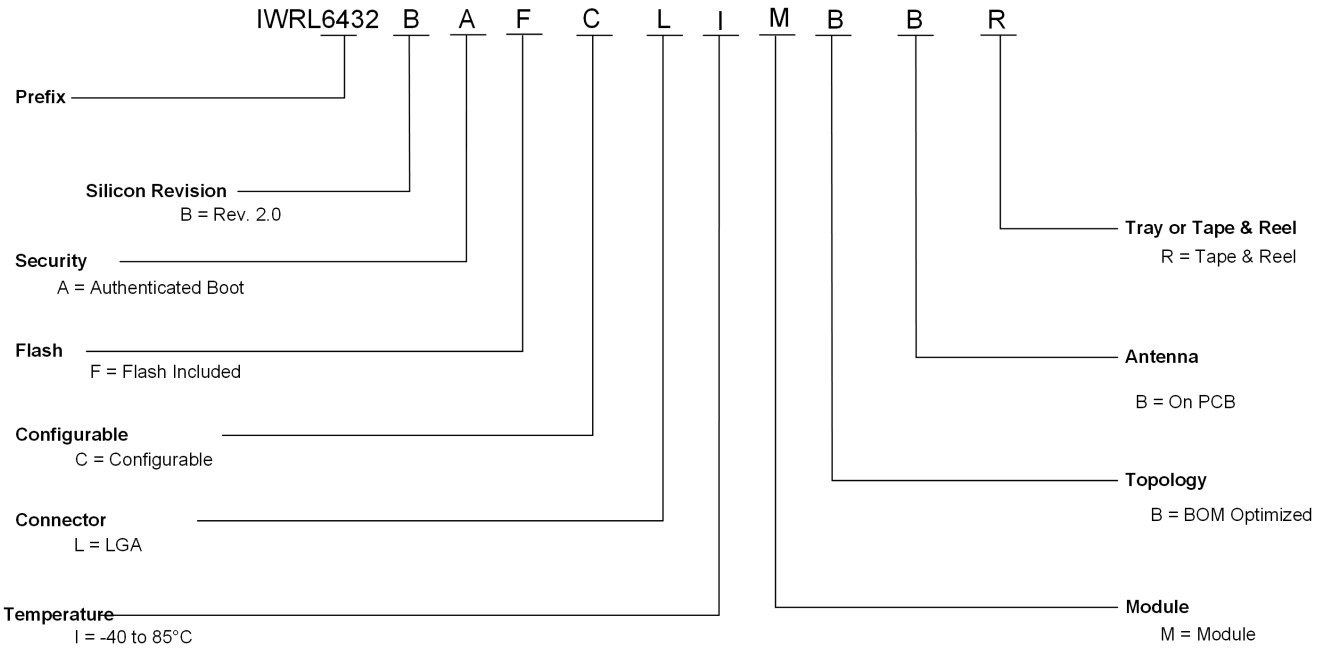


Figure 9-1. Production Device Nomenclature

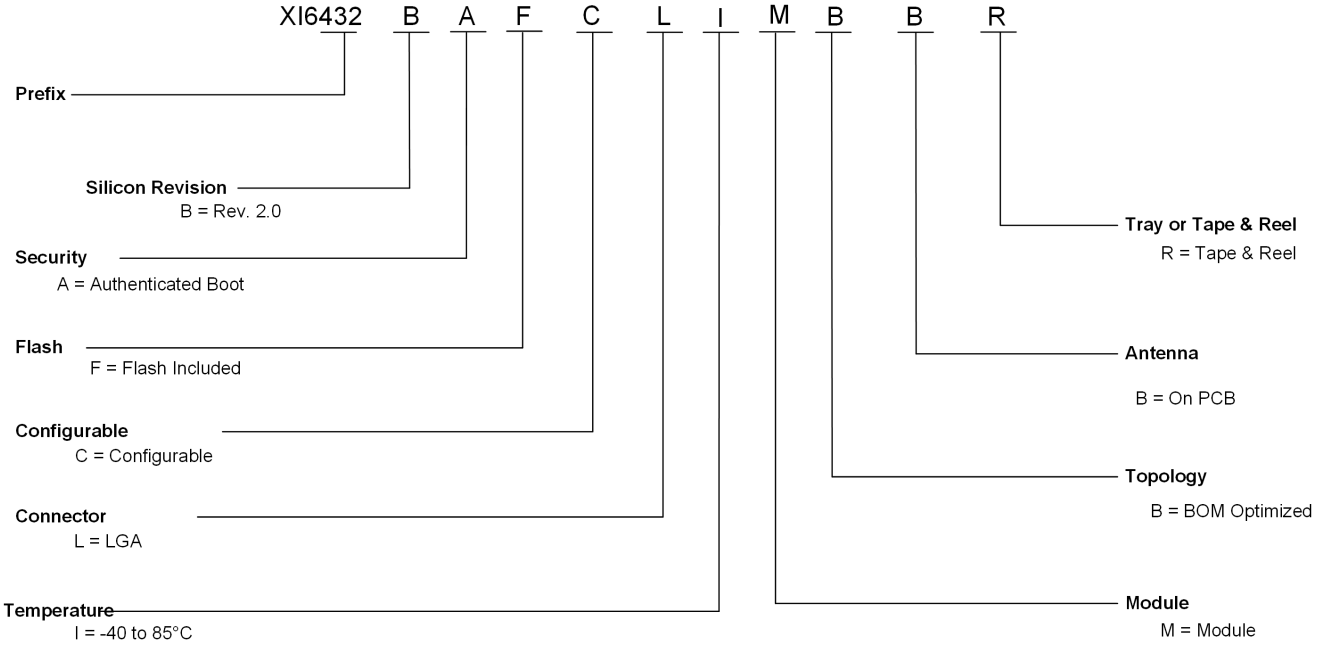


Figure 9-2. Pre-production Device Nomenclature

9.2 Device Marking

Figure 9-3 shows an example of the IWRL6432WMOD Radar Device's package symbolization.

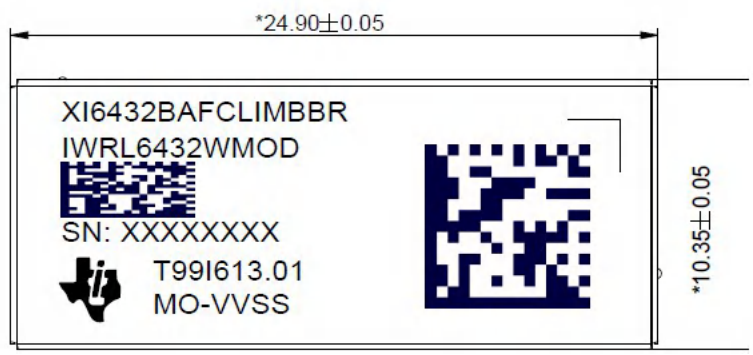


Figure 9-3. Example of Device Part Markings

This identifying number contains the following information:

- **Line 1:** Orderable Part Number
- **Line 2:** Generic Part Number
- **Line 3:** Barcode
- **Line 4:** Serial Number
- **Line 5:** TI Logo
- **Line 5:** Manufacturer Part Number

9.3 Documentation Support

To receive notification of documentation updates, navigate to the device product folder on ti.com. Click on *Notifications* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

The current documentation that describes the peripherals, and other technical collateral follows.

- IWRL6432WMOD device datasheet

9.4 Support Resources

TI E2E™ support forums are an engineer's go-to source for fast, verified answers and design help—straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

Linked content is provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's Terms of Use.

9.5 Trademarks

E2E™ is a trademark of Texas Instruments.
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9.6 Electrostatic Discharge Caution

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

9.7 Glossary

TI Glossary	This glossary lists and explains terms, acronyms, and definitions.

ADVANCE INFORMATION

10 Reflow Information

This section provides information about reflow guidelines for reflow soldering.

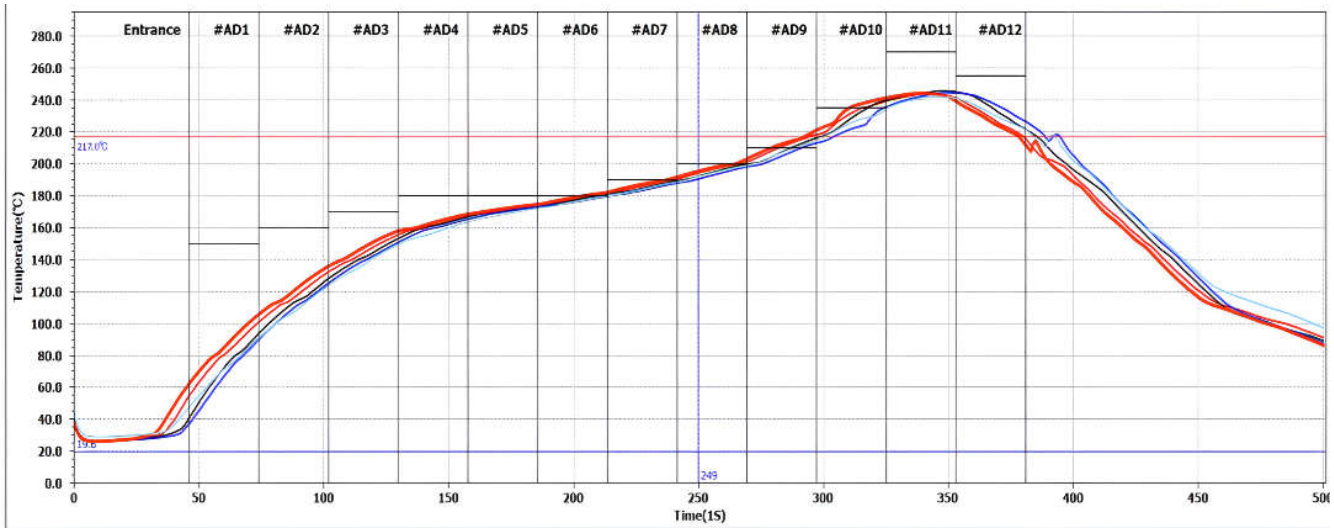


Figure 10-1. Module Reflow Profile

PARAMETER		MIN	TYP	MAX	UNIT
Pre-Heat/ Soak time (t_s)	150°C (T_{smin})- 180°C (T_{smax})	60		120	sec
Reflow	Over 217°C (T_L)	50		90	sec
Ramp-Up Rate(T_L to T_P)		0		3	°C/sec
Peak Temperature (T_P)		240		250	°C
Ramp-Down Rate (T_P to T_L)		-3		0	°C/sec
O_2 Content				3000	PPM

- t_s - Soak Time
- T_{smin} - Minimum Soak Temperature
- T_{smax} - Maximum Soak Temperature
- T_L - Liquidous Temperature
- T_P - Peak Temperature

11 Revision History

DATE	REVISION	NOTES
December 2025	*	Initial Release

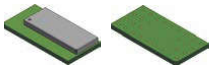
12 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, see the left-hand navigation.

ADVANCE INFORMATION

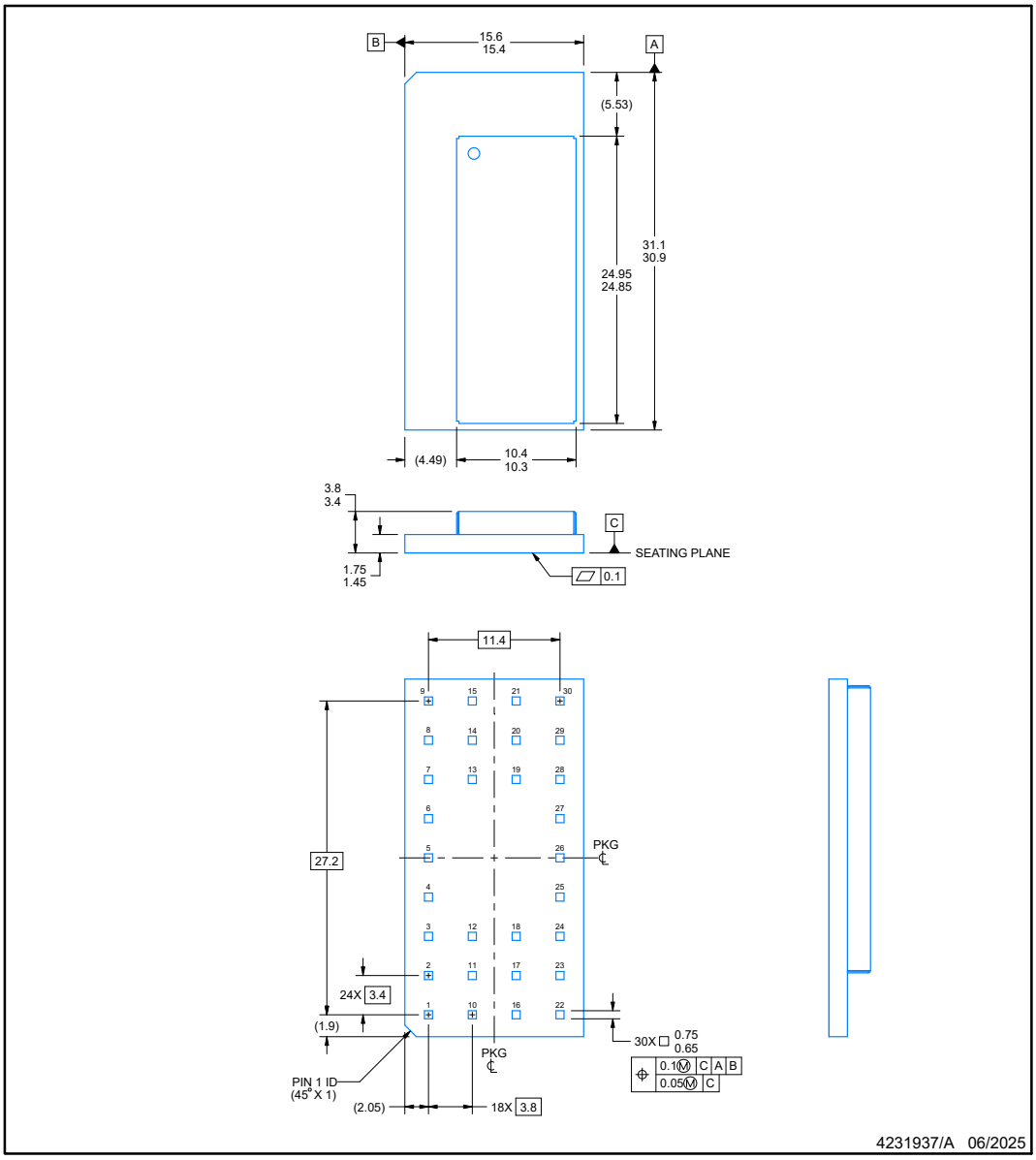
PACKAGE OUTLINE

MBB0030A



QFM - 3.8 mm max height

QUAD FLATPACK MODULE - NO LEAD



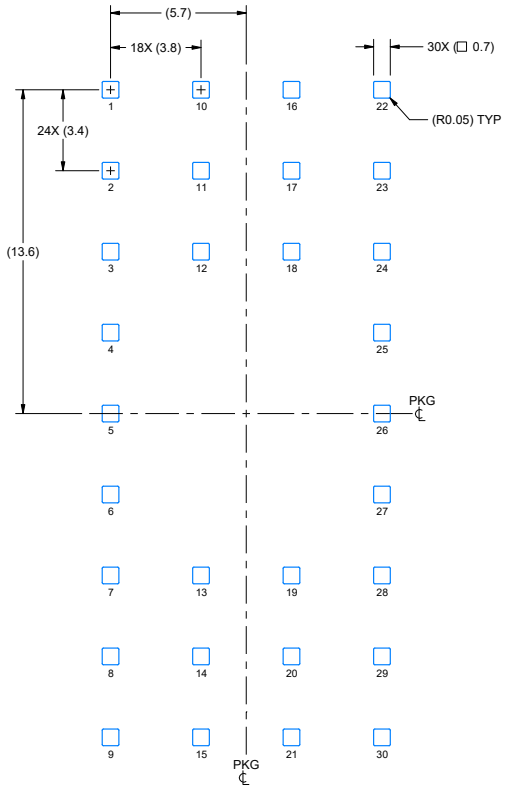
NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

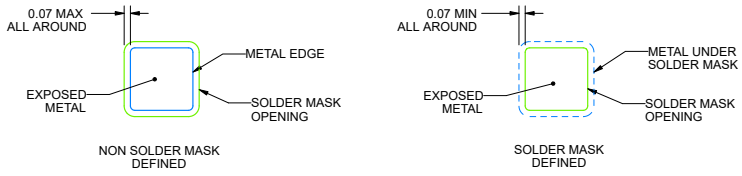
EXAMPLE BOARD LAYOUT

MBB0030A — **QFM - 3.8 mm max height**

QUAD FLATPACK MODULE - NO LEAD



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 4X



SOLDER MASK DETAILS

4231937/A 06/2025

NOTES: (continued)

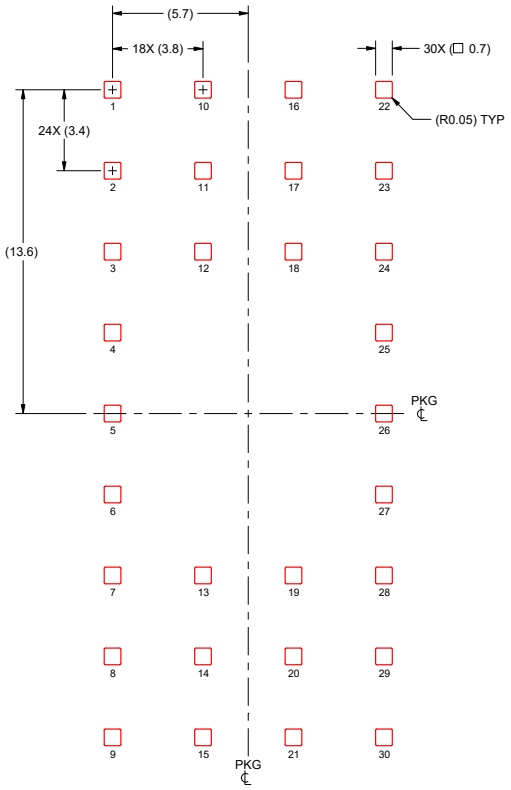
3. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).

ADVANCE INFORMATION

EXAMPLE STENCIL DESIGN

MBB0030A — **QFM - 3.8 mm max height**

QUAD FLATPACK MODULE - NO LEAD



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 4X

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NOTES: (continued)

4. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
XI6432BAFCLIMBBR	Active	Preproduction	QFM (MBB) | 30	600 | LARGE T&R	In-Work	Call TI	Call TI	-40 to 85	

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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Last updated 10/2025