1 Product Information

1.1 Features

- Integrated onboard antennas with a field of view of 110° x 50°, optimized for 57 to 61 GHz to simplify CE and FCC certification
- Detailed 3D point cloud generation of both static and moving targets, accessible through UART interface
- Compact 20 x 25 mm size, SMT-solderable or connectable via 10-pin FFC, powered by 1.8V single supply with 1.8V or 3.3V IO supply options
- Calibration-free setup – preprogrammed, pre-calibrated, and tested for instant deployment
- Fully compatible with TI's low-power SDK, allowing for further development flexibility
- Utilize the pre-programmed firmware functionality or begin developing custom applications

1.2 Description

The V-LD3-RFB sensor module is based on the innovative low-power IWRL6432 chipset from Texas Instruments and is perfectly suited for human detection and multi-object tracking applications up to 20 meters.

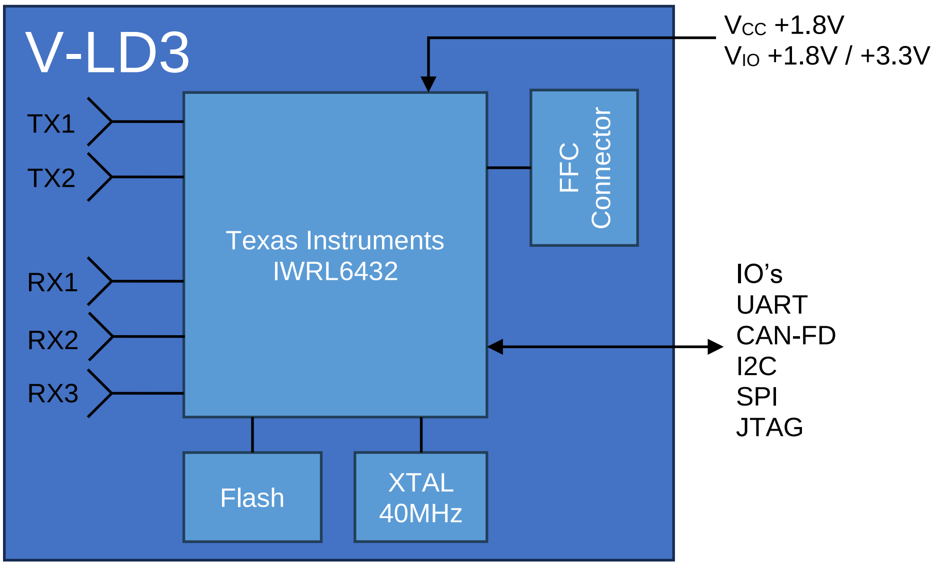
The V-LD3-RFB is fully compatible with Texas Instruments' latest low-power SDK and comes preprogrammed with TI's innovative motion and presence detection demo, including a human/non-human classifier. It features optimized onboard antennas and is pre-calibrated and tested, further simplifying its use.

RFbeam leverages its extensive expertise to help customers bring certified radar solutions to market, offering support with certification and radome design.

Additionally, RFbeam provides an evaluation kit offering full access to all pins, including SPI RAW data capture, JTAG connector, and CAN interface. The kit is based on an interface PCB, onto which the V-LD3 is mounted using spring-loaded contacts. Simply connect a USB-C cable to your host and start evaluating the extensive features of Texas Instruments' IWRL6432 chipset for your end product.

1.3 Block Diagram

Figure 1: Block diagram



1.4 Characteristics

Parameter	Conditions / Notes	Symbol	Min	Typ	Max	Unit
Operating conditions						
Supply voltage		V_{CC}	1.71	1.8	1.89	V
IO voltage	For 1.8V interface	V_{IO}	1.71	1.8	1.89	V
	For 3.3V interface	V_{IO}	3.135	3.3	3.465	V
Supply current	Depending on configuration	I_{CC}			1360	mA
IO current	Depending on configuration	I_{IO}			90	mA
Operating temperature		T_{Op}	-40		+85	°C
Storage temperature		T_{St}	-40		+105	°C
RF frontend						
Transmitter frequency	Configurable	f_{TR}	57		64	GHz
Output power	EIRP	P_{TX}		20		dBm
RX/TX antenna gain	Single antenna	G_{ANT}		9		dBi
RX/TX antenna frequency	Single antenna	f_{Ant}	57		61	GHz
Horizontal –12dB beam width	E-Plane	W_{φ}		50		°
Vertical –12dB beam width	H-Plane	W_{θ}		110		°
Spurious emissions	According to ETSI 305 550	P_{Spur}		-30		dBm
Interface						
Voltage output high level voltage		$V_{OH@6mA}$	V_{IO}-0.45			V
Voltage output low level voltage		$V_{OL@6mA}$			0.45	V
Voltage input high level voltage Digital IO's	V_{IO} = 1.8V	$V_{IHIO1V8}$	1.17			V
	V_{IO} = 3.3V	$V_{IHIO3V3}$	2.25			V
Voltage input low level voltage Digital IO's	V_{IO} = 1.8V	$V_{ILIO1V8}$			0.54	V
	V_{IO} = 3.3V	$V_{ILIO3V3}$			0.62	V
Voltage input high level voltage nRESET / SOP0	V_{IO} = 1.8V	$V_{IHRS1V8}$	0.96			V
	V_{IO} = 3.3V	$V_{IHRS3V3}$	1.57			V
Voltage input low level voltage nRESET / SOP0	V_{IO} = 1.8V	$V_{ILRS1V8}$			0.2	V
	V_{IO} = 3.3V	$V_{ILRS3V3}$			0.3	V
Body						
Outline dimensions				20 x 25 x 2		mm^3
Weight				6		g
Connector top				10-pin, FFC connector, 0.5mm		
Connector bottom				24-pin, SMT mountable		
ESD rating						
Electrostatic discharge	Human body model class 2	V_{ESD}			2000	V

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2 Antenna Information

The V-LD3 module integrates 2 transmit (TX) and 3 receive (RX) antennas optimized for operation in the 57–61 GHz frequency range. All antennas are implemented as 1×3 patch arrays and are arranged to enable precise 3D localization of objects.

Note:
The antennas can also operate in the extended frequency range of 61–64 GHz; however, performance is significantly reduced outside the specified band. This configuration is not recommended by RFbeam.

2.1 Antenna array geometry

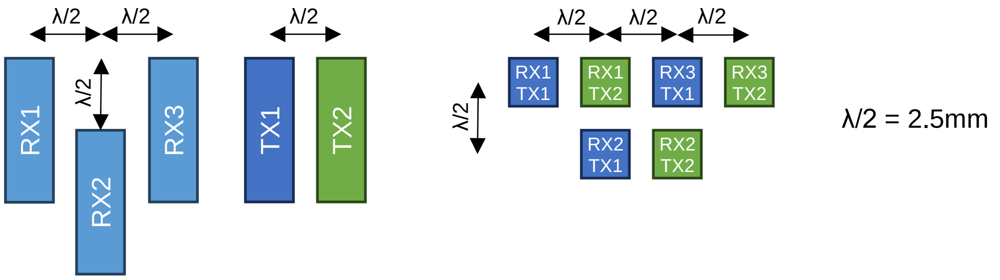
The IWRL6432 chipset supports both TDM and BPM MIMO configurations to enhance object detection capabilities. Antenna placement plays a crucial role in achieving optimal performance and must be considered when configuring the chipset.

When using the Texas Instruments out-of-the-box demo, antenna configuration is straightforward thanks to the integrated CLI interface. The antenna geometry can be specified using a dedicated command.

Recommended CLI command for V-LD3 antenna geometry

```
antGeometryCfg 1 0 0 1 1 2 1 1 0 2 1 3 2.5 2.5
```

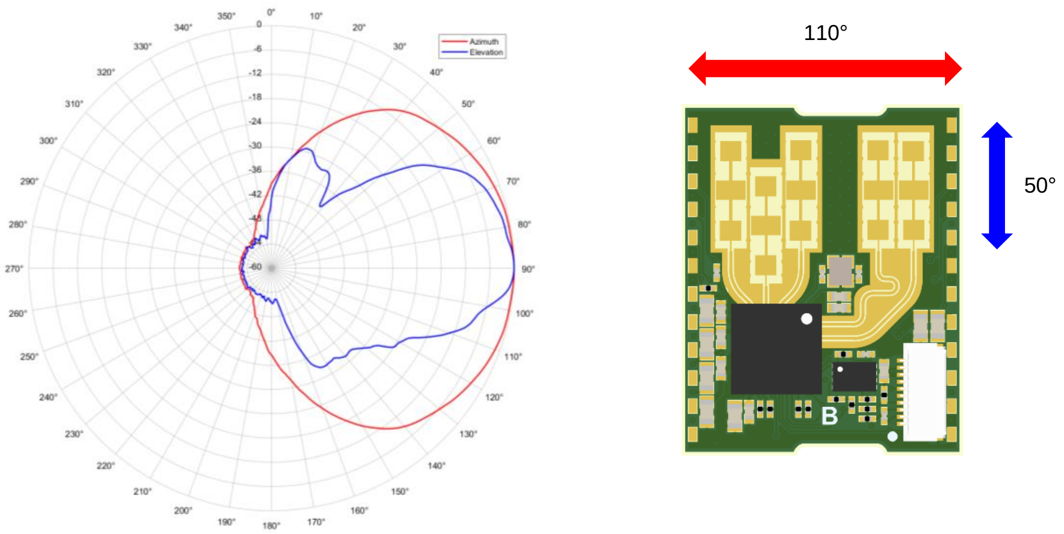
Figure 2: Antenna layout and virtual array representation



2.2 Radiation pattern

This diagram shows the module sensitivity in both azimuth and elevation directions. It incorporates the characteristics of all TX and RX antennas over a frequency sweep from 58.5 to 60.5 GHz. The field of view (FoV) is specified at –12 dB, which corresponds to half the detection distance.

Figure 3: Overall antenna diagram and FoV @ -12dB points



3 Pin Configurations and Functions

The V-LD3 module can operate as a standalone sensor when connected via a 10-pin, 0.5 mm pitch FFC cable to the FFC connector located on the top side of the module. This interface provides all necessary signals for configuring the IWRL6432 chipset, reading sensor data, and performing firmware updates via the integrated bootloader.

Alternatively, the module can be directly mounted onto a PCB using the SMT solder pads on the underside. This integration method provides access to additional I/O pins of the IWRL6432, enabling advanced development and debugging options. Available interfaces include:

- JTAG for programming and debugging
- SPI for raw data streaming
- I²C for peripheral communication
- CAN-FD for bus-based applications
- ADC input for simple analog measurements

These flexible connectivity options make the V-LD3 suitable for both rapid prototyping and integration into custom hardware platforms.

Figure 4: V-LD3 Top and bottom view

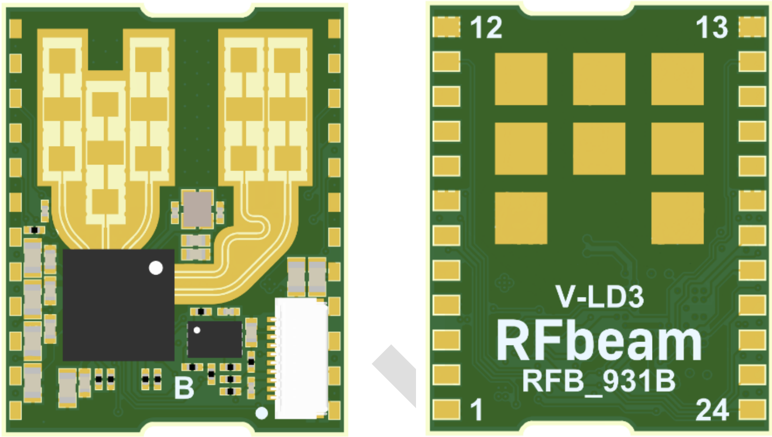


Table 1: Pin function description

Bottom SMT Pin #	Top FFC Pin#	IWRL6432 Pin#	Type	Name	Description	Pullup (PU) / Pulldown (PD)
5	1, 10	-	Power	VCC	+1.8V core power supply	-
6	8	-	Power	VIO	+1.8V/+3.3V VIO supply	-
7, 12, 13, 18	2, 9	-	Power	GND	Ground	-
1	3	-	Input	nRESET	Active-low reset	PU – 10kΩ
2	4	-	Input	SOP0	Boot mode selection (low = bootloader)	PU – 10kΩ
3	5	E10	Output	UART TX	UART transmit, RS232_TX	
4	6	F11	Input	UART RX	UART receive, RS232_RX	PU – 100kΩ
8	-	G11	Input	JTAG TDI	JTAG test data input	-
9	-	E12	Input	JTAG TMS	JTAG test mode select	-
10	-	E11	Output	JTAG TDO	JTAG test data output	-
11	-	C12	Input	JTAG TCK	JTAG test clock input	-
14	7	J10	IO	GPIO 5	General purpose I/O	-
15	-	H10	IO	I2C SDA	I2C data line	-
16	-	M10	IO	I2C SCL	I2C clock line	-
17	-	M6	Input	ADC1	GPADC input 1	PD – 100kΩ
19	-	J11	Input	CAN RX	CAN-FD receive	PU – 100kΩ
20	-	L12	Output	CAN TX	CAN-FD transmit signal	-
21	-	D11	IO	SPI nCS	SPIA chip select 0, active-low	PU – 10kΩ
22	-	D10	IO	SPI SCLK	SPIA clock	PU – 10kΩ
23	-	C11	IO	SPI MISO	SPIA master in, slave out	-
24	-	B12	IO	SPI MOSI	SPIA master out, slave in	-
Thermal	-	-	Power	Thermal	Thermal pads, connected to GND	-

4 Application Information

4.1 Overview

The V-LD3-RFB module combines RFbeam's factory-calibrated antenna design with Texas Instruments' IWRL6432 chipset to deliver high-performance radar sensing in the 60 GHz ISM band. It supports MIMO operation for generating high-resolution 3D data of both moving and stationary objects.

Out of the box, the module is preprogrammed with TI's Motion and Presence Detection Demo, which leverages advanced signal processing and classification techniques. Configuration is handled via UART using standard .cfg files and CLI commands—well-known within the TI radar ecosystem.

For more advanced use cases, the V-LD3 supports firmware customization using the Low Power Radar SDK, the dedicated development platform for the IWRL6432. This SDK includes a broad collection of application examples, such as gesture recognition, object tracking, and presence detection, serving as a starting point for your own custom firmware.

Complementing the SDK, TI's Radar Toolbox provides additional development resources, including reference applications, visualization and plotting tools, MATLAB integration, and performance evaluation utilities.
All relevant I/O for configuration and data communication is available via UART, as well as additional interfaces exposed through the SMT pads (SPI, JTAG, I²C, CAN-FD, and ADC).

The Low Power Radar SDK and Radar Toolbox are continuously maintained and will remain the primary software environments supporting the IWRL6432 family—ensuring long-term flexibility, extensibility, and support for your development.

4.2 Pre-calibration

To ensure optimal out-of-the-box performance, RFbeam performs factory-side antenna calibration for the V-LD3 module. This eliminates the need for expensive end-of-the-line calibration for OEM integrators in most applications.

In collaboration with Texas Instruments, RFbeam will support an upcoming feature in the Radar Toolbox that allows storing multiple antenna calibration sets in a flash-based lookup table. These precomputed calibrations are optimized for various sweep bandwidths and can be selected by the customer over the CLI interface.

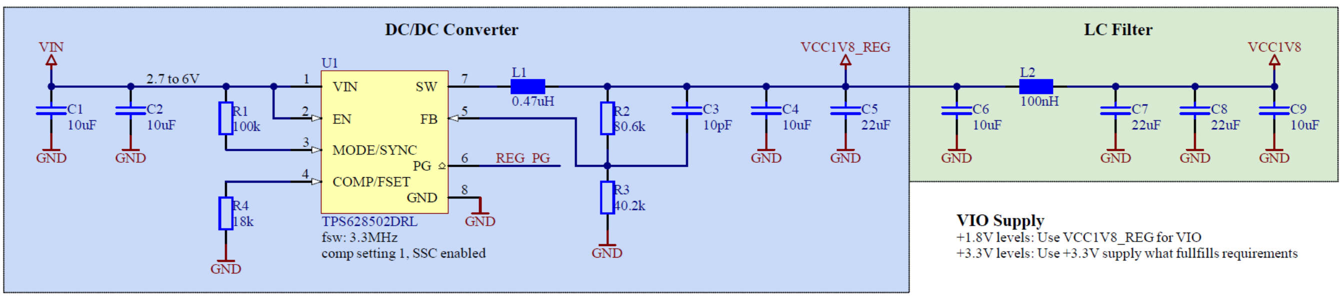
This approach enables end customers to achieve precise performance without the need to perform calibration within their specific end product or application.

Full functionality is still under development, and RFbeam will support it as soon as the feature is released in the upcoming Radar Toolbox.

4.3 Power supply

The V-LD3 uses the BOM optimized topology described by Texas Instruments with the option of a 1.8V or 3.3V design for the IO voltage. We recommend the use of the following reference design for the 1.8V supply. VIO can also be supplied from this supply if working with 1.8V there.

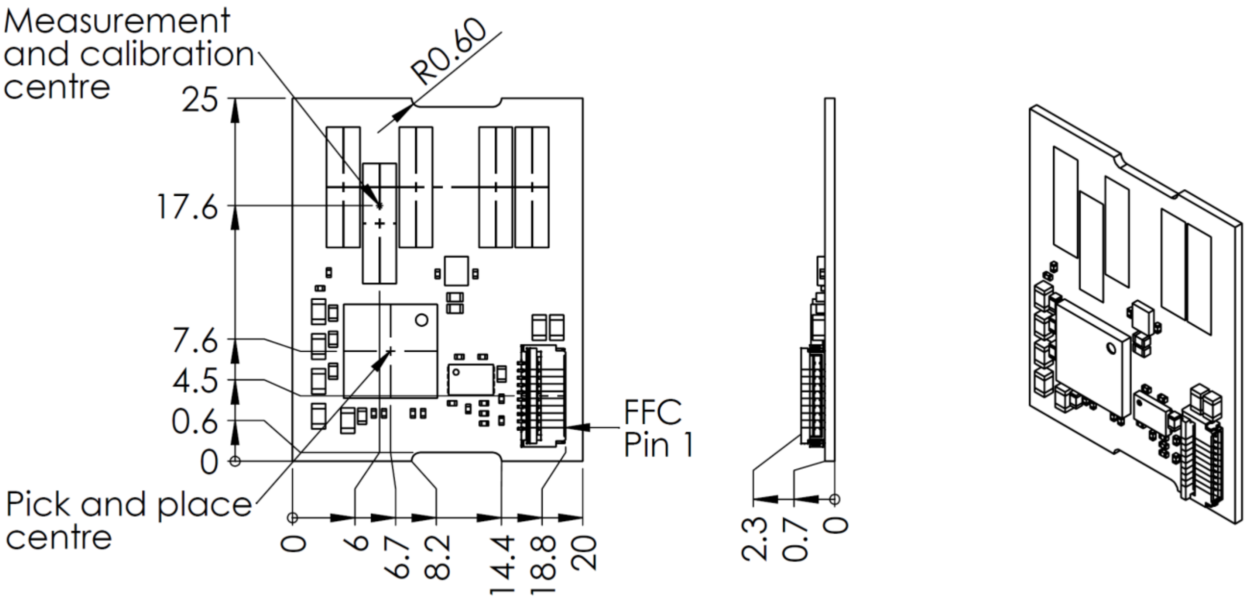
Figure 5: Recommended 1.8V power supply



5 Package Information

5.1 Outline Dimensions

Figure 6: Outline dimensions in mm

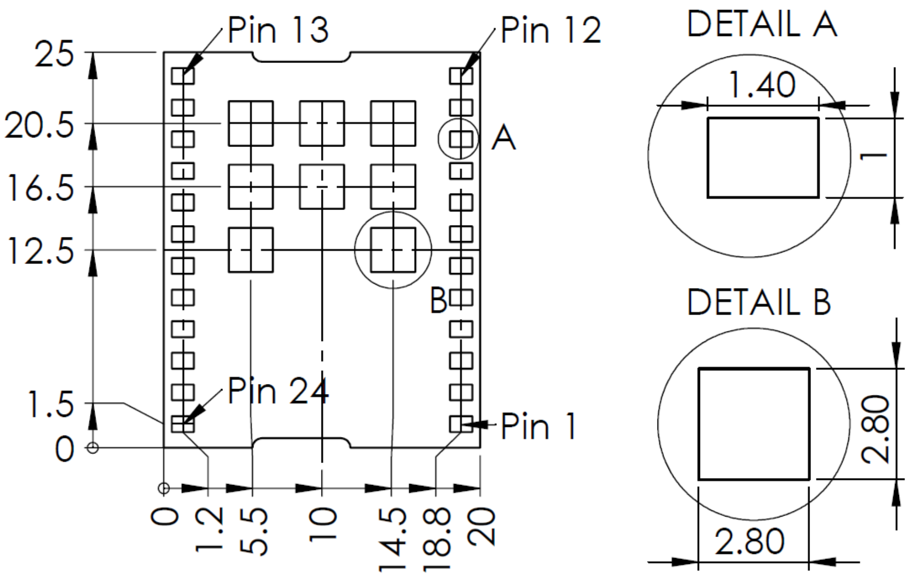


5.2 Footprint

RFbeam recommends defining the solder mask openings to be 100 µm larger than the copper pads on all sides to ensure reliable soldering and alignment.

Paste mask openings should be adjusted in cooperation with the assembly partner, taking into account the stencil thickness and the specific solder paste used. To avoid excess solder and ensure proper thermal contact, it is strongly recommended to use a segmented paste mask pattern for the thermal pads.
This approach improves solder joint reliability, reduces void formation, and supports efficient heat dissipation from the module to the PCB.

Figure 7: Recommended footprint in mm top view

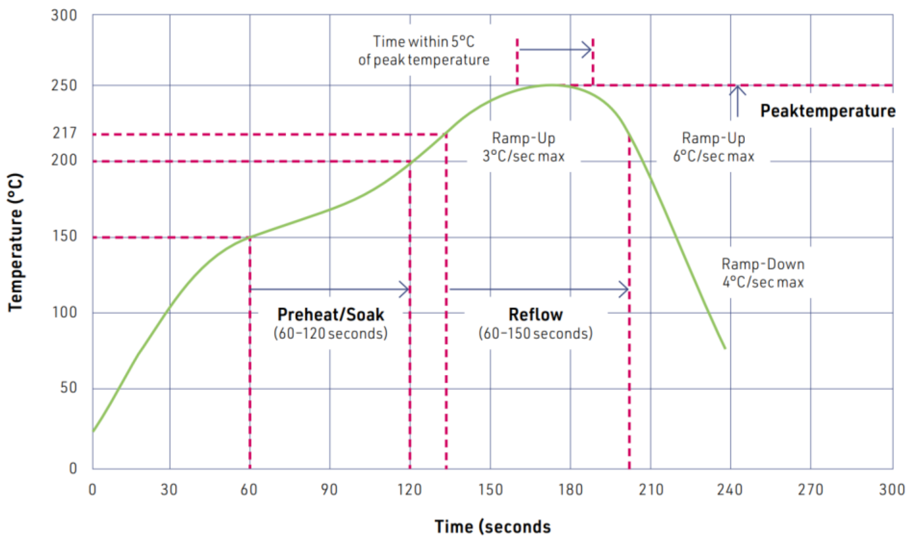


5.3 SMT Guidelines

For all soldering processes, the optimal reflow profile for a PCB assembly depends on several factors, which depend not only on the RFbeam sensor, but also on the selected solder paste and the size and layout of all other components as well as the PCB layer structure.

Note:
Repeated reflow soldering processes are not recommended. To avoid falling off, the modules should be soldered in the last reflow process step.

Figure 8: Typical reflow profile



5.4 Tape and reel information

To be defined

6 Order Information

The ordering number consists of different parts with the structure below.

Figure 9: Ordering number structure

Product	–	Customer	–	HW variant	Supply	–	SW variant
= V-LD3		= RFB for standard products		= 00 for standard variant	= A for mixed version		= 01 for standard variant

Table 2: Available ordering numbers

Ordering number	Description
V-LD3-RFB-00A-01	Standard V-LD3 sensor module with default TI firmware
V-LD3-EVAL-RFB-00H	Standard V-LD3 evaluation kit

7 Revision History

04/2025 – Revision A: - Initial version

RFbeam does not assume any responsibility for use of any circuitry described, no circuit patent licenses are implied and RFbeam reserves the right at any time without notice to change said circuitry and specifications.

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