

Webinar

Simplify design in new sensing applications with low-cost and low-power antenna-on-package 60-GHz mmWave radar

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Agenda

- The advantages of mmWave radar
- Functions and applications for radar sensors
- IWR6432AOP device overview
- Power consumption: Techniques and consumption in various use cases
- Design options: How to accelerate your IWR6432AOP development
- IWR6432 in action: Demonstration of IWR6432AOP in occupancy detection use cases

Why radar? | Advantages and benefits

Privacy

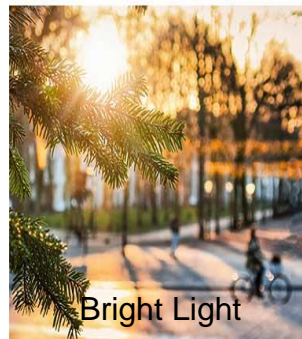
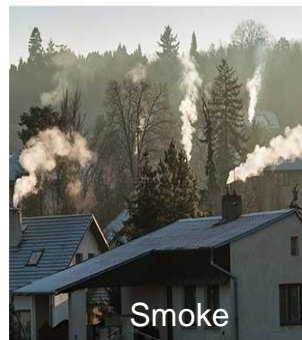
- Contactless
- No unique identifying observed

Robustness









- Environmental immunity (rain, snow, smoke, hot / cold, and more)
- No RF interference
- More secure (immune to simple tricking methods)
- False detection mitigation

Improved User Experience – Contextually aware

- Micro motion detection (i.e. typing, fidgeting, breathing and more)
- Precise localization (within 3cm)
- Direction of movement
- Counting / Tracking



Radar | Target applications and functions

-  Presence detection
-  Localization
-  Counting / tracking
-  Major / minor motion detection
-  Static object detection
-  Velocity and direction detection
-  Stance / fall detection
-  Heart & breath rate detection
-  Human vs. non-human classification

Automated doors



Mobile robots
Industrial robots



Doorbell
Security



Occupancy
detection



Personal
electronics

Overview | IWRL6432AOP (antenna on package)

Designed for **small form factor**, **low BOM** cost and **lower power** applications

Integrated Transceivers

3 Rx, 2 Tx

On-chip Processing

Arm® Cortex® - M4F; FFT HWA

Integrated Memory

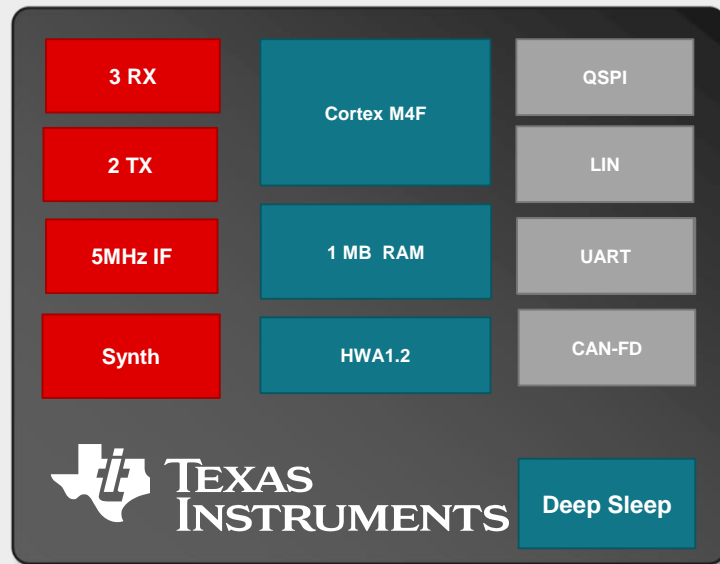
1.0 MB SRAM

High Speed Interfaces

SPI, UART, I2C, QSPI, GPIOs

Small Footprint

6.7mm x 10.9mm package



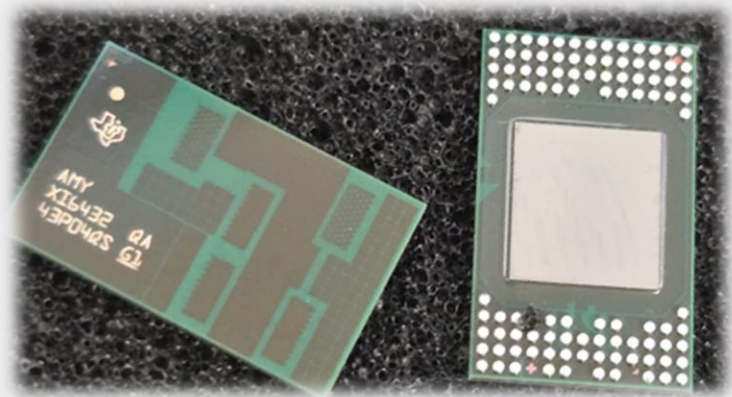
Overview | IWRL6432 Antenna on Package

All of the advantages of mmWave radar without the RF design challenges

Faster time-to-market
(No antenna design or test)

Smaller Designs
(Antenna on Package vs PCB)

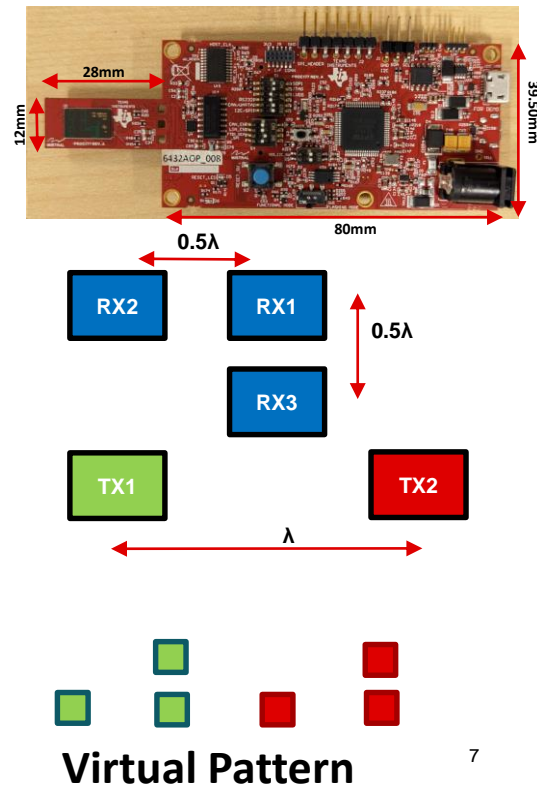
Lower System Cost
(standard FR PCB material)



Virtual Antenna Pattern

IWRL6432AOPEVM | Evaluation board

Specification	IWRL6432AOPEVM (Preliminary Antenna Specifications)
Field of View (FOV)	Az: +/-70, El: +/-60
Angular Resolution	Az: 29 degree, El: 58 degree
Antenna Bandwidth	57 – 64GHz (7GHz)
Detection Range	15m at FOV Edges (20m at Boresight) for Human
Package Size	6.7mm x 10.9mm
Additional Features	JTAG connectivity Raw data capture over DCA1000 SPI, UART, I2C Peripherals support PC connectivity over USB cable Each rail power/current measurement capability



IWRL6432AOP | Enabling low-power detection

Leverages software and hardware to minimize power consumption.

Optimized radar front end for short to mid-range applications

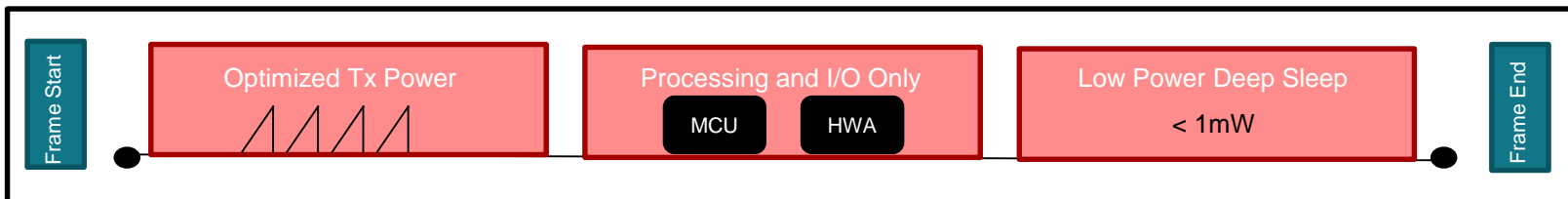
- Power amplifier for mid-range detection
- Radar-burst support for low duty cycle operation
- Feature selection for low power and optimized performance

Radar front end shut down for low-power processing only mode

- Processing time is scalable for algorithm/performance
- Radar FE can be shut down
- Intermediate power modes
- Full processing and I/O capabilities

Deep sleep power mode for microwatt-level power consumption

- No bursting, processing, or data I/O happens
- Software and hardware wakeup options
- Retains memory for fast wakeup



Radar frame

IWRL6432AOP | Low-power use cases

Leverages software and hardware to minimize power consumption.

Function	Performance	Avg Power Consumption	End Equipment
Presence Detection	7 meters (localization)	2mW	Lighting Control, Indoor Occupancy Sensors, Thermostats, Appliances
Motion Detection	15 meters	10mW	Video Doorbell, Home Surveillance
Tracking and Classification	3+ person tracking	50mW	Doors/Gates, Surveillance with classification, TV, PC, Robotic Lawn Mower

IWRL6432 | False detection mitigation

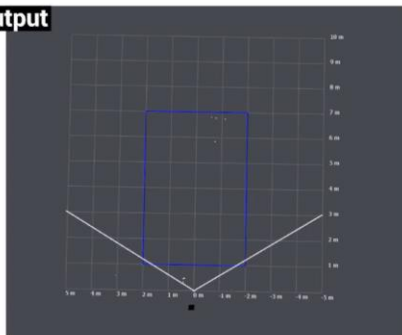
mmWave radar uses several **filtering methods** to **reduce false detections**

- Low power mode filters
 - **Location filtering:** uses coordinates to set detection area(s) and filter unwanted data points
 - **Range filtering:** uses distance from sensor to filter unwanted data points
 - **Height filtering:** uses distance above or below sensor to filter unwanted data points
 - **Doppler filtering:** removes stationary and low speed reflections
 - **Threshold filtering:** uses SNR and # of points to filter signal from noise
- High performance mode filters
 - **Classification filtering:** uses the motion signature (micro doppler) to identify an object and filter

Cause of false detection:	Low Power Mode	High Performance Mode
People/objects outside of detection area	● ●	
Trees / bushes	● ● ●	●
Animals (pets, squirrels, rabbits etc)	● ●	●
Spider web	● ●	
Insects (Wasps, Bees, Flies etc)	● ● ●	

Demo | False detection from trees / bushes

Radar Output



Doorbell Camera Output

*No presence detected.
Doorbell camera in power-saving mode.*

Scene View



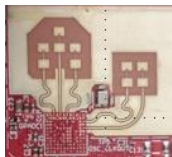
IWRL6432AOP | Design options

Reference design



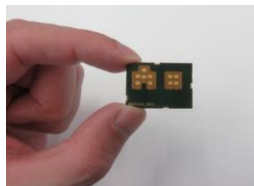
- Full reference design including radar, power management, passives, antenna etc.
- TI provides design files, layout, gerber, pcb stack, simulation and test results
- See your local sales rep for NDA – only information regarding IWRL6432 reference designs that are available today

Antenna-only reference design



- Antenna only reference design from TI
- Pre-validated antenna design from IWRL6432BOOST EVM (2-patch)
- TI provides
 - Layout
 - Dfx files
 - Simulation results
 - PCB stackup
 - Design reviews
 - Radome reviews
 - Test results (EVM only)

System-on-Module



- Pre-qualified module including power management, passives, PCB, Xtal etc.
- Customizable antenna designs
- Various sizes and radar performance



3rd party network

- New [ti.com tool](https://www.ti.com/tool) to help customers find radar partners to fill development gaps and accelerate time to market
- Select from multiple categories of capabilities and end applications
- Partners Include:
 - Turnkey designs – complete hardware & software
 - Evaluation – hardware & demo software
 - Services – hardware & software design services

Radar Developer Zone

- Example projects that include source code, and user guides
- Experiments such as: radar performance in the elements, gesture recognition as well as many others
- Communicate with TI engineers through E2E for support in development

The screenshot displays the TI Resource Explorer interface. The left sidebar shows a tree view of resources under 'mmWave radar sensors / Embedded Software / Radar Toolbox (1.20.00.11) / Example Projects / Gesture Recognition / IWRL6432 Gesture Recognition'. The main content area shows the 'IWRL6432 Gesture Recognition Users Guide' with a 'Table of Contents' section listing: Device Compatibility, Overview, Quickstart, Developer's Guide, and Need More Help?. Below this is a 'Device Compatibility' section with a warning icon and the text 'This lab is currently only compatible with the IWRL6432.' The 'Overview' section contains a paragraph: 'This lab demonstrates the use of TI mmWave sensors for gesture recognition applications. The range, velocity, and angle data from mmWave sensors can enable the detection and classification of several natural gestures. The example provided in this demo can recognize 6 distinct hand gestures: Left swipe, Right swipe, Up swipe, Down swipe, Push, and Pull at distance of 2m.' Below the text is a video player showing a person performing gestures, with a control panel on the left and a data visualization on the right. The data visualization shows 'No Gesture' detected, with plots for 'People: 0', 'Range: 0m', and 'Vel: 0m/s'. The 'Quickstart' and 'Prerequisites' sections are also visible.

Development resources



Radar Toolbox

Demonstrate and develop radar solutions
Examples, software, labs, source code

The screenshot shows the Resource Explorer interface for the Radar Toolbox. The breadcrumb path is: mmWave radar sensors / Embedded Software / Radar Toolbox (1.10.00.13) / Applications / Industrial / Level Sensing / Level Sensing Overview. The main content area features a briefcase icon and the title "Radar Toolbox for mmWave Sensors" with sub-navigation: Discover > Evaluate > Design. Below this is a "Featured Content" section with three cards: "Radar for Video Doorbells" (works with IWRL6432), "In-Cabin Radar Sensing" (works with AWRL6432), and "High End Corner Radar" (works with AWR2944). A "New Available!" banner for the IWRL6432 is also present. The left sidebar shows a navigation tree with categories like microcontrollers, development tools, and hardware kits.



Radar Academy

Learn mmWave radar fundamentals
Modules, videos, app notes

The screenshot shows the Resource Explorer interface for the Radar Academy. The breadcrumb path is: mmWave radar sensors / Training / Radar Academy (1.00.00.16) / Introduction / Fundamentals of FMCW Radar. The main content area has the title "Radar Academy" and a description: "The Radar Academy is a collection of training modules for all developers to learn about TI's radar sensor offering and the underlying mmWave Radar technology." Below the description is a search bar and a list of training modules: Introduction, Overview, Fundamentals of FMCW Radar, Terminology, Selecting the Right Radar Device, Portfolio Overview, Frequency Choice and Regulations, FMCW Radar Training Series, Radar Algorithms, and Integration Considerations. The left sidebar shows a navigation tree with categories like microcontrollers, development tools, and hardware kits.

Development resources

You can start evaluating this device leveraging the following:

Content type	Content title	Link to content or more details
Product & Samples	Product overview	http://www.ti.com/product/IWRL6432AOP
Training	On-demand training, examples, and videos	Getting started with xWRL6432 reference code, labs & experiments
Technical white papers	Technical blog for xWRL6432 Application brief	IWRL6432 low power radar enables high accuracy sensing IWRL6432 enables new functionality in battery powered proximity sensing
Development tools	Using 60-GHz radar sensors in video doorbells Overview of device Module demonstration Laptop presence and onlooker detection Design resources Design support forum	https://www.ti.com/video/6317304690112 https://www.ti.com/video/6317517176112 https://www.ti.com/video/6317353331112 https://www.ti.com/video/6317244314112 IWRL6432BOOST https://e2e.ti.com/

Visit

<http://www.ti.com/product/IWRL6432AOP>



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