Intelligent automation with the new antenna-on-package (AoP) mmWave sensors

Simplifying Sensing with Industrial mmWave Sensors

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Webinar Outline

• mmWave technology benefits
• TI mmWave portfolio and offering
• Antenna on package benefits and specs
• Key markets
• Q&A
mmWave Sensors – Technology Overview

What is mmWave sensing?
- Electromagnetic waves used for detecting the world around the sensor
- mmWave sensors measure high accuracy range, velocity and angle of remote objects

When to use mmWave sensing?
- High precision range measurement – tank level probing, displacement sensing, and vibration monitoring
- Smarter infrastructure – occupancy sensing, traffic monitoring, lighting control, gesture recognition
- Advanced navigation for mobile transport – robotics, drone sense and avoid, landing assistance, forklift collision avoidance
- Automotive - Adaptive cruise control, automatic emergency brake, lane change assist, and more

Benefits of mmWave sensing
- mmWave technology is robust against environmental influences such as bad light and weather conditions and extreme temperatures
- RFCMOS technology enables analog/digital integration in a low-power, small, single-chip solution
- Unprecedented accuracy using highly linear signal generation, ultrawide resolution, and robust calibration/monitoring of RF sensing
IWR mmWave Sensors

TI's single chip mmWave sensors integrate a DSP, MCU and RF front-end to detect range, velocity and angle.

Level sensing
Measure tank fluid level with unprecedented accuracy for inventory control and early leak detection.

Forklifts
Detect objects in obstructed views for intelligent safety.

Robotics
Unprecedented accuracy at the micrometer level.

Intelligent street lighting
Sensing performance that improves pedestrian safety and provides power/cost savings through intelligent triggering of lighting.

People counting
Detect people in a zone of interest and trigger actions.

Perimeter security
Enabling security systems with motion sensitive detection and tracking.

Drones
Enable autonomous flight for building, land surveying and delivering packages.

Doors & Gates
Open doors for approaching people and ignore by passing people.

Traffic monitoring
Detect traffic location and volume more accurately.
TI mmWave Portfolio
TI Innovation – Single-Chip CMOS

Discrete Multi-Chip mmWave Sensor
- Complex and critical signal routes
- Unconventional packaging
- Prone to noise
- Lack of system level monitoring
- Crude implementation of safety

TI Single-Chip mmWave Sensor
- Smaller in size
- Simpler design
- Built in monitoring (SIL)
- High resolution and accuracy
- Programmable core with differentiated SDK/Algorithms
- Lower Power

TI Single-Chip mmWave Sensor w/Integrated Antenna-on-Package
- Smallest in size
- Simplest design
- Built in monitoring (SIL)
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Discrete – RF front-end only

Single chip – integrated DSP

Integrated Antenna-on-package
Connectivity ecosystem

Functional Mode configuration with Regular IWR6843 ISK

Basic Use Case

SW Development, Long range People counting, Surveillance, Industrial Transport, Robotics

Functional Mode configuration with IWR6843 ISK-ODS

Basic Use Case

SW Development (short distance People counting, gesture, Proximity, robotics, automated doors etc)

Functional Mode configuration with IWR6843AOP

Basic Use Case

SW Development (short distance People counting, gesture, Proximity, robotics, Automated doors etc)

With DCA1000 data capture card on a Camera mount stand

Data Collection System / Algo Development

TI Information – Selective Disclosure
mmWave Sensors available in 60GHz band – with AoP!

**New Products**
Including Antenna-on-Package!
- Enable the design of your next generation RF sensor without antenna expertise
- Leverage sensors in any applications per 60GHz regulations

**Evaluation Modules**
Evaluate performance with modular EVM
- Prototype with multiple antennas and AoP
- Designed for modular reuse with multiple 3P antennas
- User Guide and EVM unboxing video all available on TI.com

**Technical Documents**
Documents designed to educate
- Guides to help get started using various tools and answer FAQs
- Application notes to address software, hardware and manufacturing

**Tools & Software**
Enable self evaluation and prototyping
- Use sensing estimator for analyzing performance trade-offs
- Leverage the same SDK as 77GHz
- Use application-specific algorithms in open source

TI Information – Selective Disclosure
Antenna on Package (AoP)
Antenna-on-Package Design

- Next level of innovation in intelligent autonomy at the edge for new and existing industrial systems
- Reduces complexities of radio frequency design and simplifies manufacturing process
- Meaningful savings of system space and cost
  - 75% smaller than 24-GHz
Key Benefits

- Small form factor
  - Integrates antenna directly in the package
  - 15mm x 15mm footprint
  - 75% smaller than 24GHz and 40% smaller than 60 GHz non AOP

- Reduced design and manufacturing cost and complexity for system design/ faster time to market
  - Simple / cheaper FR4 board design
  - Customers do not need EM & RF expertise
  - Saves approximately 3-6 months of antenna development time
  - Estimated savings ~50% of system cost vs. non AOP* @ 10KU

- Higher efficiency (lower loss) compared to modules with similar antennas
  - Zero board routing loss*
  - ~+2dBi total gain* from AOP board vs. non-AOP

- Opportunity for Certification reuse
  - Similar layout and acceptable RF performance characteristics
  - Antenna type must be the same
  - Antenna gain must be the same or less

*TI's estimated pricing and not actual pricing from vendors.
Antenna-on-Package Superset device specs*

<table>
<thead>
<tr>
<th>Operation Mode</th>
<th>MIMO</th>
<th>TX Beam Steering</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Angle</strong></td>
<td><strong>0° (Boresight)</strong></td>
<td><strong>0° (Boresight)</strong></td>
</tr>
<tr>
<td><strong>Maximum Range Detection of Human</strong></td>
<td><strong>50m</strong></td>
<td><strong>65m</strong></td>
</tr>
<tr>
<td><strong>Maximum Range Detection of Car</strong></td>
<td><strong>100m</strong></td>
<td><strong>135m</strong></td>
</tr>
<tr>
<td>+/- 65°</td>
<td><strong>15m</strong></td>
<td>+/- 65°</td>
</tr>
<tr>
<td><strong>Maximum Range</strong></td>
<td><strong>30m</strong></td>
<td><strong>45m</strong></td>
</tr>
</tbody>
</table>

- Mid range (100m+) detection and object tracking supported by advanced algorithms
- Perimeter Security/Surveillance Augmentation
- People Counting
- Traffic Monitoring
- Fully programmable with MCU & DSP
- SW compatible with 77GHz portfolio
- Superset for IWR6843
Mission Board- Features

- Stand alone AOP board
- Mates with carrier board for debugging and flashing

- Data streaming and configuration via UART
- Flashing of binary through UART
- Powered using onboard USB connector
- Small form factor, 22 x 23 mm
- Flashing and functional SOP mode available through SOP switch
- Onboard PMIC, QSPI flash and EEPROM

Features on production board is subject to change
Scalable SW platform

• Software scalability for customers from IWR6843 to 6843 AOP

• Processing chain that scales from FFT-only to FFT + DSP

• APIs and Drivers maintained across all 60GHz and AOP variants

• Out of the Box software for AOP devices
Key Markets
Industrial Radar – “Building Automation”

Building Security and Video surveillance

Adjacent/Reuse:
- Stand/Sit/lying
- Vital Signs
- Outdoor security
- HVAC
- Elevators

Learn More about mmWave for People Counting

Highlights
- Long range motion detection and tracking
- False detection mitigation
- Motion tracking in low/no visibility

Automated Doors and Gates

Adjacent/Reuse:
- Stand/Sit/lying

Learn More about mmWave for Automated doors

Highlights
- One sensor for multiple lanes due to wider FoV
- AOA capability prevents false triggers
- Velocity of arrival can be measured to open door faster or slower
- Motion tracking to prevent false trigger
Industrial Radar – “Robotics”

Zone Occupancy / Area Scanner

Adjacent/Reuse:
- Presence Detection in PE applications
- EV charging
- Empty parking spots

Learn More about mmWave for Area Scanning

Autonomous Robotics

Adjacent/Reuse:
- Vacuum cleaners
- Lawn mowers
- Forklifts
- Construction equipment
- Agriculture equipment

Learn More about mmWave for Robotics

Highlights
- Can sense and alert workers in danger zone
- Autonomous decisions can be implemented in machine using radar
- Using range and velocity measurements various levels of shutdown can be implemented

Highlights
- Small footprint for sleek robot designs
- Ability to see various materials (glass, plastic, carton, etc.)
- Interfaces with Robotics Operation System (ROS)
- Can sense and avoid object even in low/no visibility
- Detection of multiple objects over a wide field of view
- User programmable field of view

Link to video
Industrial Radar – “Gesture”

Gesture recognition

Adjacent/Reuse:
- PE applications
- Medical

Learn More about mmWave for Gesture

Highlights
- Small footprint to fit into small products
- Ability to see through casing
- Close range motion tracking for no-touch control
- Programmable user configuration for various application

Link to video
Visit www.ti.com/iwr