



imec

embracing a better life

# COMPACT & HIGH-RESOLUTION 140GH RADAR WITH ON-CHIP ANTENNAS

**Imec is a center of excellence in the design of high-resolution, compact radar sensing solutions based on low-cost standard foundry technology. One of these is a compact and highly sensitive 140GHz radar system that opens up completely new opportunities for small-motion based detection in various fields, such as vital signs detection and human-machine interaction applications. Imec can help you develop your next-generation 140GHz radar solution.**

Key differentiators of imec's 140GHz radar are its small size and high radar performance – in terms of resolution and motion sensitivity. These properties are mainly enabled by the radar's high RF frequency (140GHz) and bandwidth (10GHz). The ultra-fine accuracy of this radar makes it an excellent fit for high precision detection of small motions, even micro-skin motions. Think about vital signs detection (heartbeat monitoring and breathing), human-machine interfacing (enabled by gesture recognition), and for driver monitoring or non-contact health checks. Being extremely compact, the radar can be integrated invisibly in small devices such as laptops, smartwatches, screen bezels or small home automation systems.

Some of these applications may require a fine angular resolution to accurately reveal the target's orientation with respect to the radar. For these applications, we design complete multiple-input multiple-output (MIMO) radar systems with multiple transceiver chips. Signal processing and machine learning techniques are used to detect and classify motions, for example in the case of hand gestures.

The main building blocks of the radar system are a fast-chirp frequency modulated continuous wave (FMCW) chirp generator based on a highly linear phase-locked loop (PLL), and a transceiver chip (TX, RX) featuring on-chip antennas. Both the PLL and transceiver are designed in 28nm bulk CMOS technology, ensuring a low-cost, highly integrated solution.

Interested companies can either license the PLL and/or transceiver IP, or partake in a bilateral or collaborative R&D program. This will give them early access to a world-class design, and the chance to codevelop the technology with their application.

## KEY FEATURES AND BENEFITS

### 140GHz design and antenna-on-chip

- Extremely compact due to small wavelength ( $\lambda=2.1\text{mm}$ )
- High motion sensitivity (i.e. high phase response)
- No need to design a complex mm-wave antenna module
- Bulk CMOS technology for easy SoC co-integration

### Superior radar performance

- +11.5dBm EIRP (measured for a single TX element)
- Large bandwidth (10GHz)
- Range resolution better than 15mm and sub-mm range accuracy
- Wideband transition to/from antenna

### Improved machine learning and sensor fusion

- High-fidelity radar data for improved feature extraction
- Easy to co-integrate low-cost radar as a part of a multiple-sensor fusion platform

## APPLICATION FIELDS

The 140GHz radar is your ideal solution for applications that require ultra-compact devices with high radar performance, i.e., high resolution and high sensitivity for small motions. Some examples:

### Accurate finger / hand gesture detection

- Ultra-compact human-machine interface (HMI) – e.g. for screen bezels, smartwatches, tablets, small home automation systems
- Future augmented and virtual reality (AR/VR) solutions with intuitive motion detection and object interaction

### High-quality vital signs detection for health monitoring

- Gesture recognition
- Non-contact driver monitoring and health monitoring
- Heartbeat monitoring
- Respiration monitoring
- Heart rate variability

### Radar-based imaging for smart professional buildings

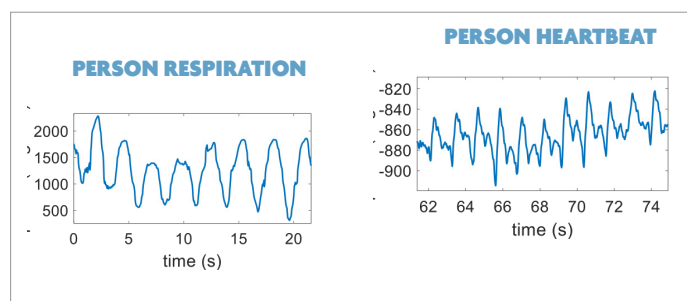
- Fine-resolution person detection
- Person-robot interactions
- Surveillance and security applications

## OFFER

- IP licensing
- Collaborative R&D for chip design and application development

## DEVELOP YOUR NEXT-GENERATION RADAR SOLUTION

Imec has a proven track record in developing a broad range of top-notch radar sensors for different application fields, including a 8GHz UWB radar for smart building applications, a 79GHz for automotive, and a single-chip 140GHz radar for vital signs detection and gesture recognition. Contact us if you are interested in one of these solutions.



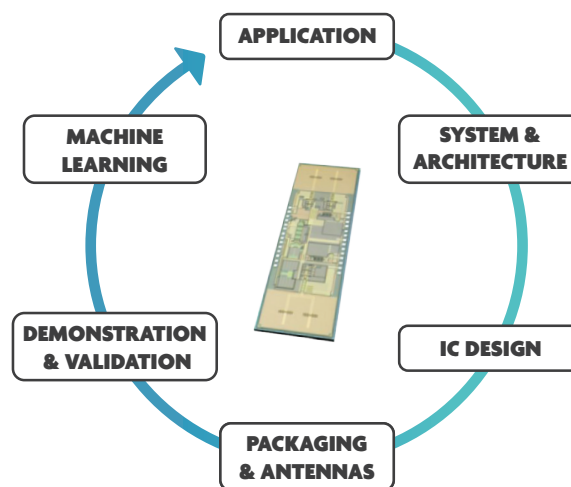
Measured vital signs.



The 140GHz radar's ability to sense gestures enables intuitive interaction between human and device.

Technology	28nm CMOS
Antenna	on chip
Frequency [GHz]	140
Bandwidth [GHz]	10
Range resolution [cm]	1.5
Channels	1 TX - 1 RX
EIRP or TX power [dBm]	11.5 (EIRP) Angular resolution = xx in case of 4x4MIMO Doppler resolution
RX gain [dB]	80
Noise Figure [dB]	8
IF Bandwidth [MHz]	17
Chip size [mm <sup>2</sup> ]	6.5
Power consumption [mW]	500 mW

Features of imec's 140GHz radar single-transceiver IC



Imec's radar design cycle

CONTACT US  
**WWW.CONTACTIMEC.COM**

DISCLAIMER - This information is provided 'AS IS', without any representation or warranty. Imec is a registered trademark for the activities of IMEC International (a legal entity set up under Belgian law as a "stichting van openbaar nut"), imec Belgium (IMEC vzw supported by the Flemish Government), imec the Netherlands (Stichting IMEC Nederland, part of Holst Centre which is supported by the Dutch Government), imec Taiwan (IMEC Taiwan Co.) and imec China (IMEC Microelectronics (Shanghai) Co. Ltd.) and imec India (Imec India Private Limited), imec Florida (IMEC USA nanoelectronics design center).