



140GHz high-resolution on-chip radar for vital signs monitoring, smart industry, consumer and ADAS applications

High-frequency radar enables fine-grained detection in many use cases. Extremely small form factor and low-cost is realized by integrating the antenna's on-chip.

For certain applications, high-frequency radar offers the ideal trade-off regarding performance, cost, energy usage and dimensions. Radar systems with carrier waves exceeding 100 GHz:

- Detect tiny movements thanks to enhanced depth resolution.
- Measure speed more accurately thanks to Doppler shifts.
- Are exceptionally compact, especially when antennas are integrated on the radar chip.

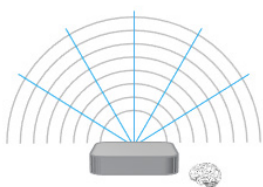
Imec has built an extensive 140GHz radar technology portfolio, including system know how, hardware and algorithm IP, geared

to applications such as in-cabin vital signs monitoring, gesture recognition, AR/VR, robotics and advanced driver assistance systems (ADAS). It can be accessed through licensing or joining a bilateral or collaborative R&D program.

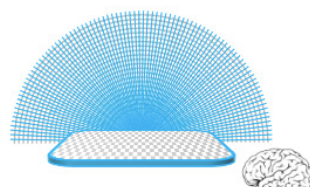
Introducing imec's 140GHz radar chip

The main components of imec's 140GHz radar chip are:

- Transceiver with integrated antennas
- Low-power phase-locked loop to generate the FMCW modulated carrier wave



Today's radar



Neuromorphic imaging radar

Towards high-resolution imaging radar.



A future vision

Both are designed in **28nm bulk CMOS technology**, enabling high integration and low-cost volume production.

This extremely compact system achieves superior radar performance:

- +11.5 dBm effective isotropic radiated power (EIRP) per TX element
- 10 GHz bandwidth
- > 15 mm range resolution and sub-mm range accuracy
- wideband transition to and from the antenna

This highly sensitive radar can be equipped with **advanced machine-learning algorithms to enable high-fidelity feature extraction**. And it can easily be combined with complementing sensing modalities into multi-sensor systems.

140GHz radar applications

Because of its high sensitivity, 140GHz radar is ideal for **monitoring small movements such as people's vital signs and gestures**. Obvious use cases are, therefore, driver and patient monitoring, AR/VR, and human-machine interaction.

However, there's also rising interest in using **140 GHz to map a car's environment in ADAS or even autonomous driving applications**. Its higher angular resolution would be the perfect complement for 79GHz radar systems. For this application, imec has also developed radar transceiver IP compatible with off-chip antenna approaches, enabling larger antenna arrays and as a result covering longer ranges (>100m).

Such 140GHz imaging radar leverages the Multiple Input Multiple Output (MIMO) technique using several transceiver chips and beamforming to send out narrow beams that gather a wealth of data that results in point clouds that accurately represent the environment. It enables the system to **detect relatively small targets, such as pedestrians or bikes, even when partially masked by larger objects or in adverse weather conditions**. With a long range and wide field of view. And based on compact, robust and low-cost semiconductor technology.

Advanced 140GHz radar development kit available for potential partners:

- 4x4 MIMO front-end: 2x dual-TX chip, 4x single-RX chip, 1x PLL chip
- Supports duty-cycling, full power management
- Includes 6-DoF gyroscope & accelerometer
- Includes Xilinx Zynq 7000 and Ethernet I/O



Imec's 140 GHz radar demo platform

Why work with imec?

Would your application benefit from on-chip high-frequency radar? Build on imec's expertise by licensing our hardware design or algorithm IP. Get access to our 140GHz radar development kit to explore new applications. Or partake in a bilateral or collaborative R&D program to get early access to new designs or to co-develop your next-generation radar solution.

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