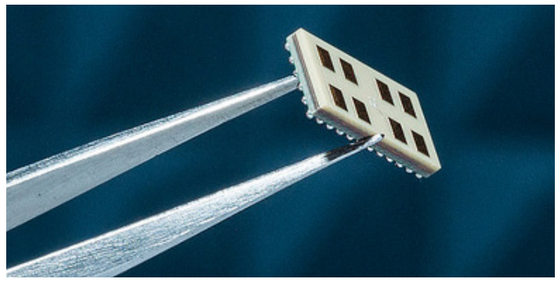
LDPC PROCESSOR FOR WIGIG/802.11AD AND 11AY

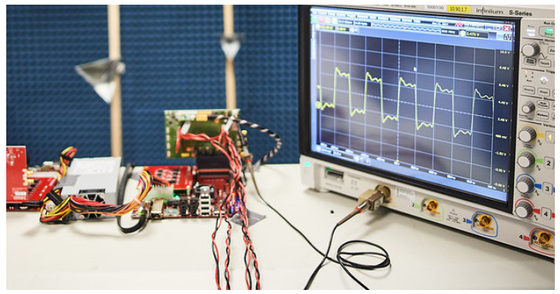
As part of the 60GHz radio baseband, imec offers a low-density parity check (LDPC) error correction processor for 802.11AD. The prototype processor is made in 28nm CMOS technology, and exhibits 25Gb/s (useful) throughput, 104Gb/s/mm^2 area efficiency, 10dB SNR, 186mW power and 6.1pJ/bit energy efficiency.



60GHz phased array transceiver IC

79GHZ AUTOMOTIVE PHASE MODULATED CMOS RADAR

The compact (3mm x 2.63mm) 79GHz radar IC is built in 28nm CMOS technology and implements two TRXs. An antenna module for indoor/short range radar (SRR) implements 2 (flip chip) ICs per module (4TX, 4RX), and stacked patch elements. The antenna design is based on a square MIMO array (2x2 or 4x4 MIMO) and features an azimuth/elevation of +/-60°.



79GHz radar

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WIRELESS COMMUNICATION AND RADAR: IMEC'S IP LICENSING OFFERING

Imec pioneers compact, high-throughput, and power efficient solutions for next-generation radar sensing and wireless communication. Wireless communication solutions target millimeter (mm)-wave applications and ultralow-power (ULP) applications, i.e. Bluetooth Low Energy (BLE) and Low-Power Wide-Area Network (LPWAN). Imec's prototype radios and building blocks are offered, through a white-box intellectual property (IP) licensing model. Our portfolio includes record-breaking ADCs, fractional-N ADPLL for 2.4GHz/sub-GHz, power management unit (PMU) for IoT applications, ultralow-power (ULP) radios, 60GHz communication for WiGig and 5G, a 60GHz LDPC processor and 79GHz radar for automotive.

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BUSINESS MODEL FOR PROTOTYPE IP WHITE-BOX LICENSING

Our prototype IP licensing model includes:

- a world-wide commercial license for modifying and using this prototype IP in licensee's products;
- a transparent technology transfer of the design databases (e.g., RTL source code, analog/RF IC design schematics and layout), measurement results and simulation results, reports and know-how on the design;
- an interactive multi-day training for licensee's designers;
- remote support by imec experts during product design by the licensee's team.

RECORD-BREAKING ADCS IN CMOS TECHNOLOGY

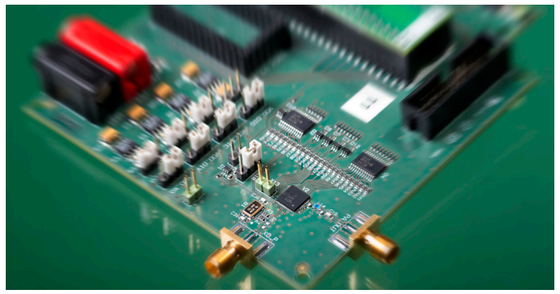
Imec offers record-breaking ADCs in CMOS technology, including efficient high-speed ADCs for mm-wave applications, and ULP successive approximation (SAR) ADCs:

	90nm UMC	9-bit	40MS/s	0.8mW
	40nm LP TSMC	10-bit	60MS/s	1.2mW
	40nm LP TSMC	11-bit	200MS/s	2mW
	40nm LP TSMC	12-bit	200MS/s	1.6mW
	28nm HPM TSMC	11-bit	400MS/s	2.1mW
	28nm HPM	14-bit	300MS/s	3.2mW
	28nm HPM	12-bit	600MS/s	14.2mW
	16nm FinFET	14-bit	400MS/s	10mW
High speed	90nm UMC	5-bit	1.25GS/s	2.5mW
High speed	90nm UMC	5-bit	1.75GS/s	2.2mW
High speed	40nm LP TSMC	6-bit	3.5GS/s	4.1mW
High speed	40nm GP TSMC	7-bit	3.5GS/s	6.2mW
High speed	28nm HPM	7-bit	3.5GS/s	6.2mW
ULP SAR ADC	90nm TSMC	5-bit	0.5-1GS/s	0.47-1.6mW
ULP SAR ADC	40nm TSMC	13-bit	6.4MS/s	46uW
ULP SAR ADC	90nm/40nm TSMC	9-bit	10MS/s	27.53uW
ULP SAR ADC	90nm TSMC	7-to-10-bit	0-8MS/s	3.56uW at 2MS/s (scales dynamically with sampling rate)

ADC offering

KEY BUILDING BLOCKS OF RADIOS: ADPLL AND PMU

Two key building blocks of wireless communication radios are available for IP white-box licensing: a fractional-N all-digital phase-locked loop (ADPLL) for 2.4GHz/sub-GHz communication, and a highly efficient power management unit (PMU) for Internet-of-Things applications. The PMU is realized in 40nm TSMC technology, the ADPLL is available in 40nm and 28nm TSMC technology.



ADPLL

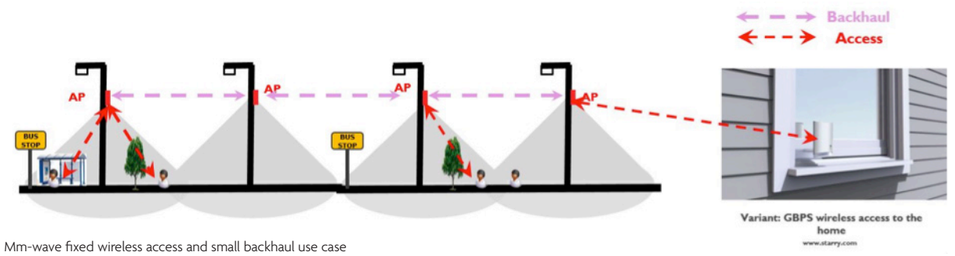
FULL ULTRALOW-POWER RADIOS FOR IOT APPLICATIONS

Imec offers full ULP radio prototypes operating in the sub-GHz, 2.4GHz, and up-to-10GHz frequency ranges. The offering includes:

- 2.4GHz low-power BLE and 802.15.4 radios, supporting Bluetooth 5 (TSMC 90nm/40nm)
- sub-GHz radios for 802.15.4g and 802.11ah HaLow (TSMC 40nm)
- 400MHz radios for implantable applications (TSMC 40nm)
- 802.15.4a compliant UWB radios (TSMC 90nm)
- Wake-up receivers for IoT applications, w. BLE support (TSMC 90nm/40nm)

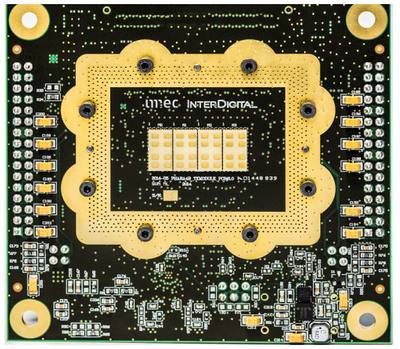
60GHZ COMMUNICATION FOR WIGIG AND 5G: RADIO FRONT-END

Imec offers 60GHz radio front-end solutions for 5G small cell backhaul and fixed wireless access (FWA), enabling multiple-user multigigabit-per-second connections. One use case combines 60GHz access to mobile devices, modems/gateways, and backhaul. Combining mm-wave FWA and small cell backhaul presents important benefits, such as drastic capacity increase and large bandwidth, and low latency. Also, mm-wave bands are lightly licensed and offer good spatial reuse. For the backhaul, imec offers a compact solution with lower installation, service deployment and maintenance costs.



Mm-wave fixed wireless access and small backhaul use case

Imec's prototype radio chip is a phased array transceiver IC in 28nm CMOS HPM, with 4 WiGig channels ranging from 57GHz to 66GHz. A 16-antenna module with 4 transceiver chips features 1.5Gb/s data communication over 150 meters, with 1.46W RX and 1.85W TX power consumption.



60GHz 16-antenna module