

Industrial radar sensing

April 2018

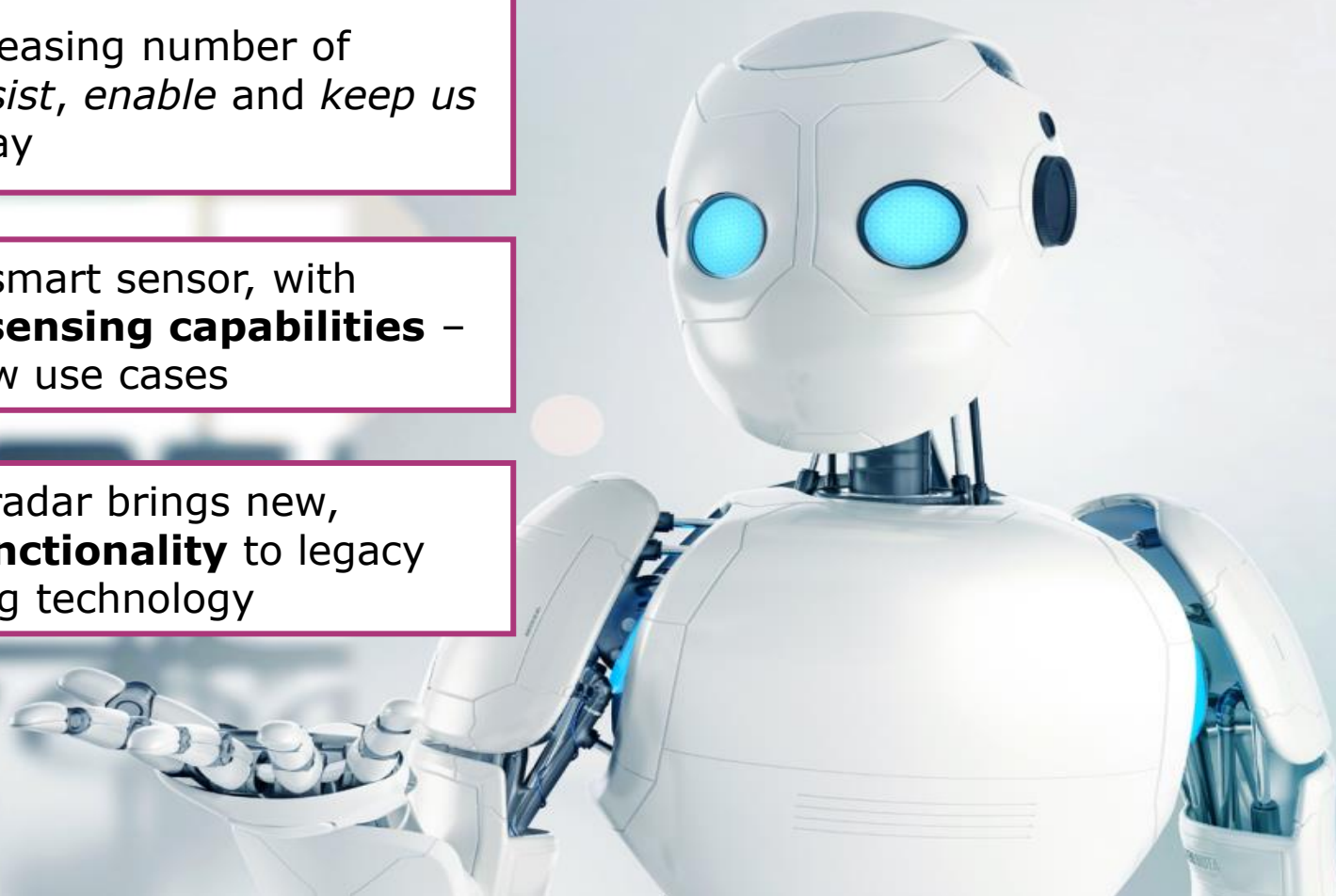


The world is getting smarter

> An ever increasing number of **sensors** *assist, enable and keep us safe* everyday

> **Radar** is a smart sensor, with **advanced sensing capabilities** – enabling new use cases

> In addition radar brings new, **smarter functionality** to legacy basic sensing technology



Agenda

- 1 Introduction to radar
- 2 Use case and applications for 24 GHz radar
- 3 Radar benefits
- 4 Product availability and ecosystem
- 5 Support

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Radar is everywhere

At **home**, your **commute**, at **work**



We make life **easier**, **safer** and **greener**



Introduction to radar

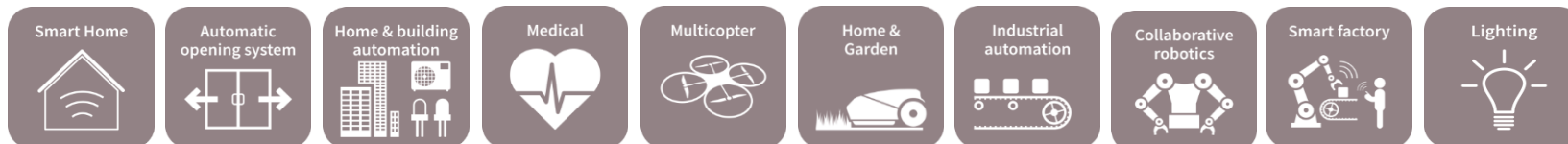
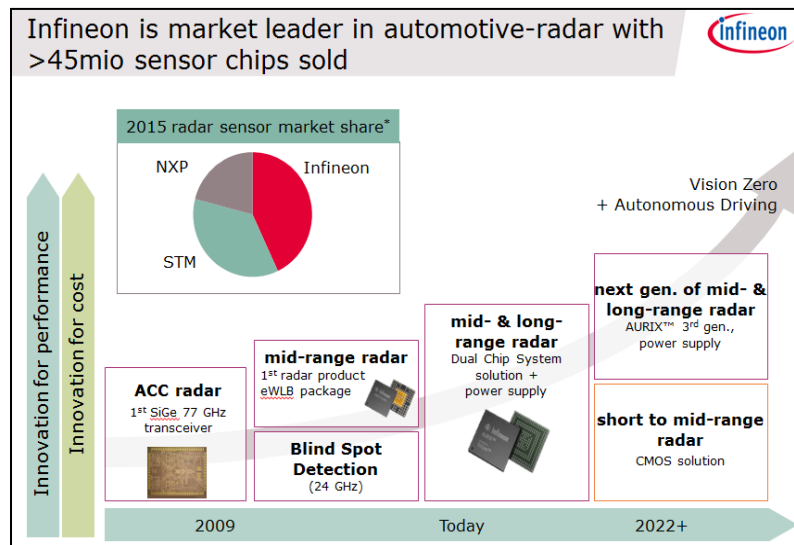
What is Radar?

- › “Radar” is an acronym for **R**adio **D**etection **A**nd **R**anging
- › Radar uses radio waves to detect *presence, direction, distance, and speed*

Infineon experience within Radar?

- › **No.1 global position** in automotive Radar
- › Over **10 year experience**
- › Multiple Markets **from automotive to industrial** supported

Multiple **applications** supported

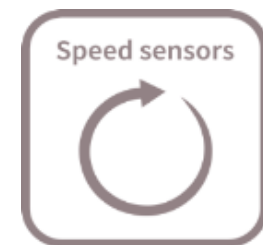
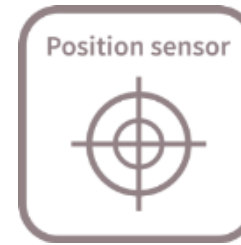
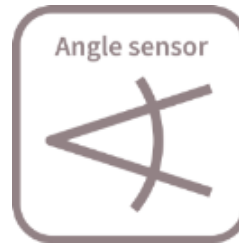


What Radar does and how it does it

What

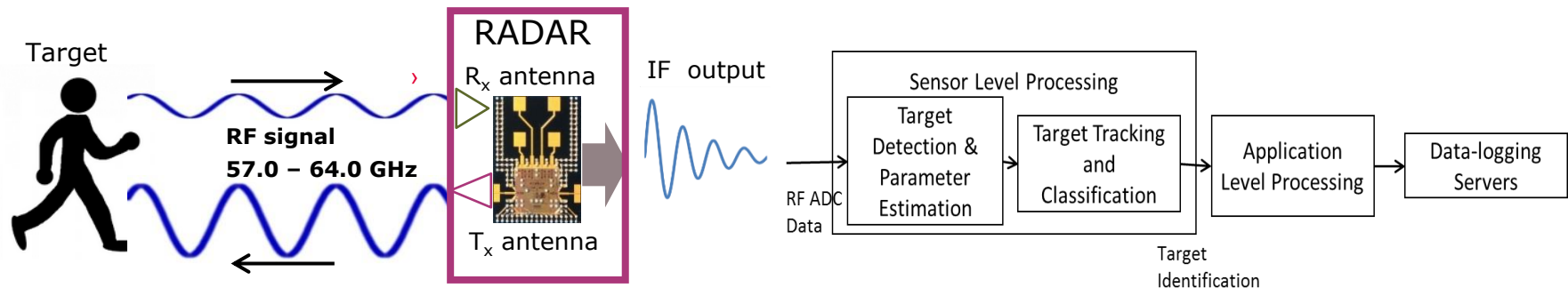
Radar uses RF waves to detect targets and depending on the **algorithm and antenna** design is capable of measuring:

- Movement
- Velocity / speed
- Distance / range
- Presence
- Angle of arrival

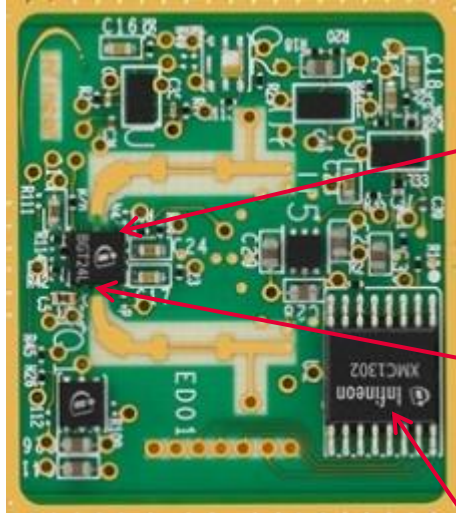


How

Radio-frequency (RF) energy is transmitted and reflected as an echo from an object, which determines the direction and distance of the object



Basic overview of a Radar system



Transmitter

Generates a RF electrical signal

Receiver

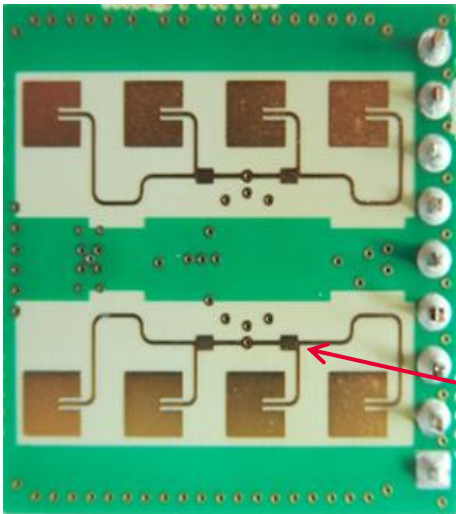
Converts the RF electrical signals into low frequency signals

Signal processor

Extracts *distance*, *Speed*, and *angle* information from the signal

Antennas

Converts electrical energy to electro-magnetic waves



Required to operate the radar:

Software algorithm:

- › To provide the Radar with a process or set of rules to follow:

GUI:

- › Required to interact with the Radar

Radar basics – modulation / algorithm

Depending on the Radar capabilities, and operating mode working with the Radar, Radar can work in a number of different ways. Below are 3 main industrial Radar operating modes

Radar operating mode (in order of complexity)	Movement	Velocity	Distance	Presence
<u>Doppler</u> Continuous wave (CW)	✓	✓		
<u>FSK</u> Frequency shift key	✓	✓	✓ moving target only	
<u>FMCW</u> Frequency modulated continuous wave	✓	✓	✓	✓



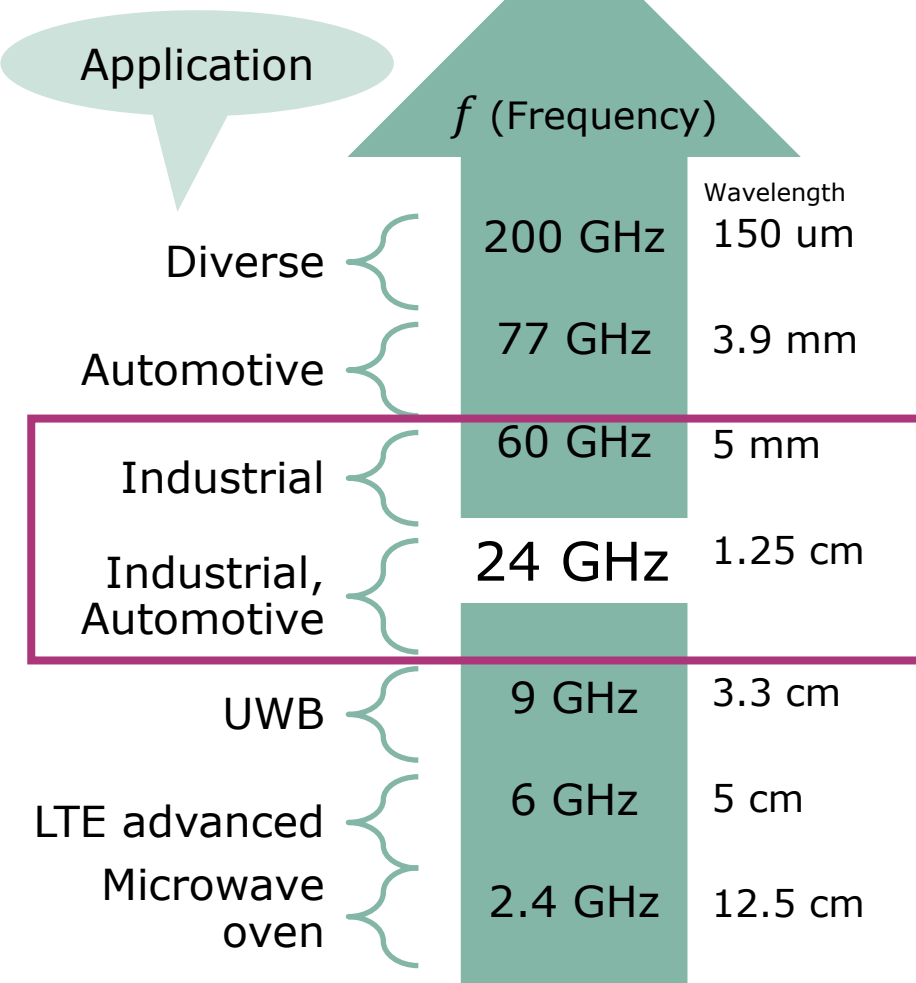
As the complexity of the algorithm increases, so can the cost of solution and processing power required to operate it

Frequency/wavelength for operation

All radar operates in a specific frequency band ranging from 300 MHz up to 300 GHz

Each frequency bracket can impact the Radar in the following ways:

- › **Physical antenna size**
- › **The range / distance required of the application**
- › **Global band availability**
- › **Interference from other RF**
- › **Wavelength**
- › **Ability to penetrate walls**



The higher the frequency, the shorter the wavelength.
The shorter the wavelength, the higher the resolution / accuracy

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Radar detection modes / use case examples

	Software	Capability	User case
Simple presence detection	<ul style="list-style-type: none"> › Doppler 	<ul style="list-style-type: none"> › Motion › Speed › Direction 	<ul style="list-style-type: none"> › Door opener › Security › Lighting › Traffic control › Vital sensing
Intermediate presence detection	<ul style="list-style-type: none"> › Doppler › FMCW › FSK 	<ul style="list-style-type: none"> › Motion › Speed › Direction › Distance 	<ul style="list-style-type: none"> › Street lighting › Security alarm › Smart home › HVAC › Vital sensing
Advanced obstacle detection / vital sensing	<ul style="list-style-type: none"> › FMCW › FSK › Micro doppler 	<ul style="list-style-type: none"> › Motion › Speed › Direction › Distance › Angle 	<ul style="list-style-type: none"> › UAV / copter › Robotics › People counting › Vital Sensing

Application / use case advantages

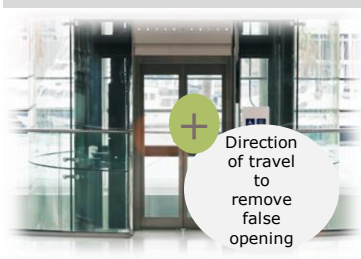
Applications for Radar

Basic movement detection

Smart appliances



Door opening



Security



Lighting



Traffic



Advanced motion detection & sensing

Streetlighting



Multicopter



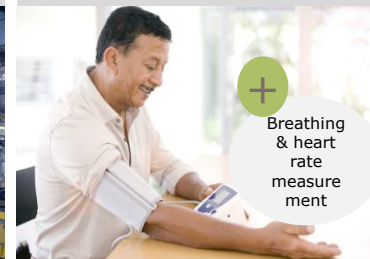
HVAC controls



Robotics



Vital sensing



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Technology comparison

- > Radar provides unique advantages over alternative technology, such as Passive infrared (PIR) and laser., per the overview below

Features	24 GHz Sensor	Infrared	Ultrasonic	Laser
Application flexibility	●	●	●	●
Resistance to moisture, dirt and temperature	●	●	●	●
Speed detection	●	●	●	●
Accuracy sensitivity	●	●	●	●
Resolution	●	●	●	●
Direction capability	●	●	●	●
Distance measurement	●	●	●	●
Penetration of materials	●	●	●	●
Size of solution	●	●	●	●
Cost	●	●	●	●

KEY

● Best ● Good ● Weak

- > However, to really understand the benefits of Radar, you need to look closely at each use case and technology
- > **For example**, one Radar feature is its ability to operate outdoor in all weather conditions. This ability is a huge value add in outdoor lighting applications, but the same feature doesn't bring the same value to indoor robotic vacuum cleaners

24 GHz unique advantages – use case



Use case example:

Indoor lighting applications requiring simple presence detection

Features	24 GHz	5.8 GHz	PIR	Ultra-sonic	Laser
Speed, direction, and distance information	●	●	●	●	●
Resistance to moisture dirt and temperature	●	●	●	●	●
Sensitivity	●	●	●	●	●
Suitability for Indoor (wall penetration)	●	●	●	●	●
Size of solution	●	●	●	●	●
Penetration of material	●	●	●	●	●
Cost of solution	●	●	●	●	●

KEY



Best



Good



Weak

In conclusion:

Using Radar your solution when compared to alternative technology will have the following advantages:

- Small - antennas 4x smaller than 5.8 GHz
- Discrete – No PIR dome
- Concealed (if necessary)
- Not impacted by temperature & dust
- Sensitive enough to remain on when needed!

(no more waving to Wake the lights that went out!!)

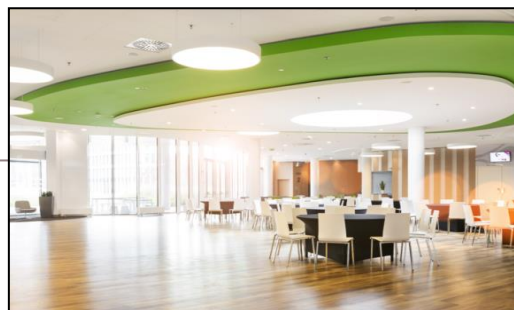


Other use case comparison slides available – ask for Radar value proposition slides

Indoor lighting – advantages of radar

Example of the benefits of Radar in **indoor lighting**:
other use cases available- security, smart street lighting, automatic door opening, multicopter, home & garden robotics

Application requirements	Benefits of Radar
<ul style="list-style-type: none"> › Suitable range / coverage for given area › Lights to remain on without need for human to move to “wake” PIR sensor › Discrete design aesthetics to fit with surroundings › Energy efficient minimizing wasted electricity 	<ul style="list-style-type: none"> › Detection range of 270 m² compared to 30 m² for Infrared* › Potential to detect presence not just motion with the right software solution › Replace unsightly PIR box with hidden Radar sensor › Lights dimmed down automatically saving electricity



*estimate

Agenda

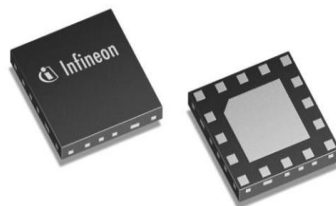
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24 GHz Radar ecosystem with Infineon

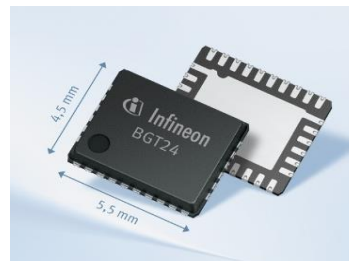
Features

- > 24 GHz ISM band operation for motion, speed, direction movement and distance measurements
- > 4 MMIC chips available

IFX MMIC



MMIC



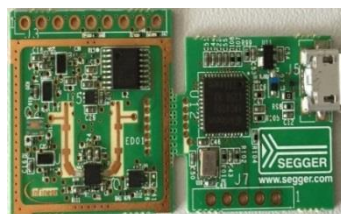
Benefits

- > Long range distance detection of moving objects up to 30 m
- > Wide range speed detection up to more than ± 100 km/h

Features

- > 3 system boards available
- > All include 24 GHz radar and XMC™ microcontroller
- > Kit contains user manual, GUI, MATLAB compiler and Gerber files
- > Requires software

IFX development kit



Software

Demokit with SW, reference design

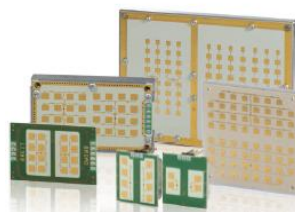
Benefits

- > Capability to detect motion, speed and direction of movement (approaching or retreating), distance and Angle of arrival based on hardware
- > FW/SW available for each radar mode

Features

- > Complete module, including radar MMIC, antenna options, MCU signal processing options, and SW options (Doppler, FSK and FMCW versions available)

Partner modules using IFX chip



Module (RF module; RF module + MCU including SW)

Benefits

- > Ease of design
- > Turn-key solution for customers with limited radar/RF/SW know-how

Infineon Radar chipset offerings

Ease of design integration →

BGT24MTR12	BGT24MTR11	BGT24MR2	BGT24LTR11
<ul style="list-style-type: none"> › Transceiver 1T_x+2R_x / IQ differential › As TR11 › 700 mW @3.3 V › 4.5x5.5 mm -VQFN-32 	<ul style="list-style-type: none"> › Transceiver 1T_x+1R_x/ IQ differential › VCO integrated, SPI › Power/temp sensor › <u>RF_{in} 24.0-26.0 GHz</u> › 500 mW @3.3 V › 4.5x5.5 mm -VQFN-32 	<ul style="list-style-type: none"> › Twin receiver 2R_x/ IQ differential › <u>RF_{in} 24.0-26.0 GHz</u> › 300 mW @3.3 V › 4.5x5.5 mm -VQFN-32 	<ul style="list-style-type: none"> › Transceiver (1T_x+1R_x) › Single-ended › BITE tested › RF_{in} 24.0 – 24.25 GHz › 150 mW @3.3 V › 2.4 x 2.4 mm -TSNP-16
		<p>Reduced power, lower cost, smaller footprint</p>	

MTR11 Vs LTR11 comparison

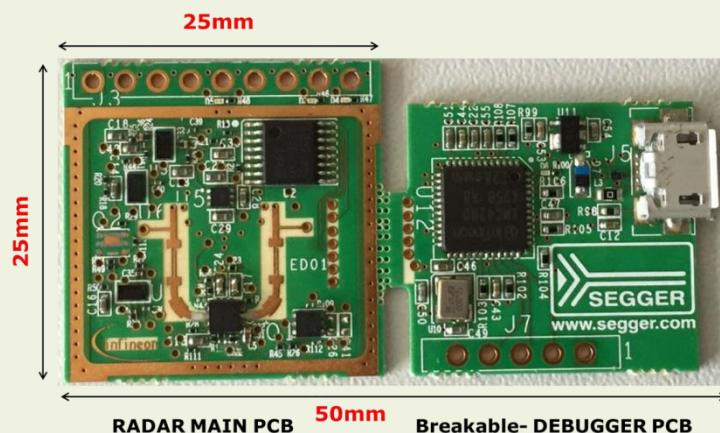
	BGT24MTR11		BGT24LTR11	
	500 mW	Power consumption	150 mW	Lower power
Adjustable power	11 dBm, adjustable	Output power	6 dBm, fixed	
Longer range	26 dB, adjustable	Conversion gain	22 dB, fixed	
	1.5 GHz and 23 kHz	Prescaler outputs	2.3 MHz (possibly additional 1.5 GHz output)	
	Differential	IF outputs	Single-ended	
	T _x differential R _x single-ended	RF outputs	T _x + R _x single-ended	
	SPI control power sensors	Supporting functions	Temperature sensor	Internal temp sensor
	External frequency control required	Doppler radar	Autonomously inside ISM-band	
	Fine and coarse tuning	FMCW radar	Single tuning pin only	
	5.5 mm x 4.5 mm	Package size	2.4 mm x 2.4 mm	Smaller form factor



Similar chips, with different value-add per application

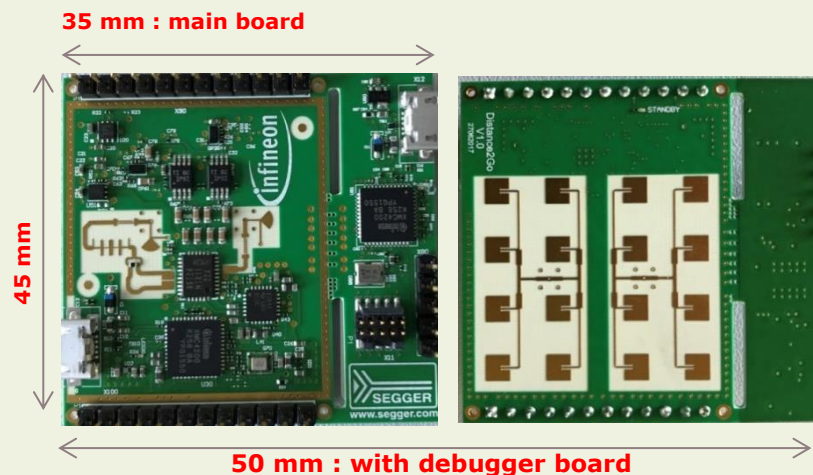
Industrial Radar development kits

Sense2goL



- › $1T_x-1R_x$: BGT24LTR11
- › CW (doppler only)
- › Speed measurement
- › Presence detection
- › Direction of movement

Distance2Go



- › $1T_x-1R_x$: BGT24MTR11
- › FMCW
- › Distance measurement
- › Speed measurement
- › Presence detection
- › Direction of movement

Infineon Radar board & Chip selection guide

Basic motion detection
Motion
Speed
Direction

Intermediate
Motion
Speed
Direction
Distance

Advanced 3D sensing
Motion
Speed
Direction
Distance
Angle

Boards: Sense2GoL
Products:
 BGT24LTR11 & BGT24MTR11
Operation: Doppler

Applications:

- > lighting, security, door openers, Vital sensing

Key benefits:

- > High sensitivity
- > Small size
- > Can be hidden
- > Robust to environmental conditions
- > Provides speed and direction information
- > Long detection range
- > Adjustable FOV and distance with antenna design

Boards: Distance2Go
Products:
 BGT24LTR11 & BGT24MTR11
Operation: FMCW & FSK

Applications:

- > Smart toilets
- > Drone soft landing
- > Drone collision avoidance
- > Robotics collision avoidance
- > Level sensing
- > Smart switches
- > Vital sensing (from a distance)

Key benefits:

- Basic Motion PLUS+*
- > Insensitive to vibrations
 - > Resolution not degrading with target distance

Boards: Position2Go
Products:
 BGT24MTR11, BGT24MR2, BGT24MTR12
Operation: FMCW & FSK

Applications:

- > Drone collision avoidance
- > Robotics collision avoidance
- > Vital sensing (from a distance)
- > HVAC, SMART Home, IOT

Key benefits:

- Intermediate PLUS+*
- > Ability to track people
 - > Positioning of target(s)



For Turnkey solutions please see our "Partner Module Matrix"

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Industrial radar solutions support

Summary of key arguments

- › Radar Increases the accuracy and performance of your **sensing applications**
- › **IFX MMIC chips** and partner **turnkey solutions available** now
- › Broad range of **evaluation/demo boards** to support design
- › Use case specific advantages over other legacy technology
- › Regional infrastructure and support available

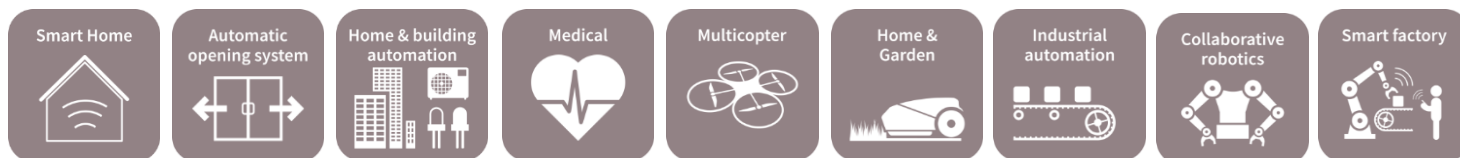
Internet / intranet sites

www.infineon.com/24GHz

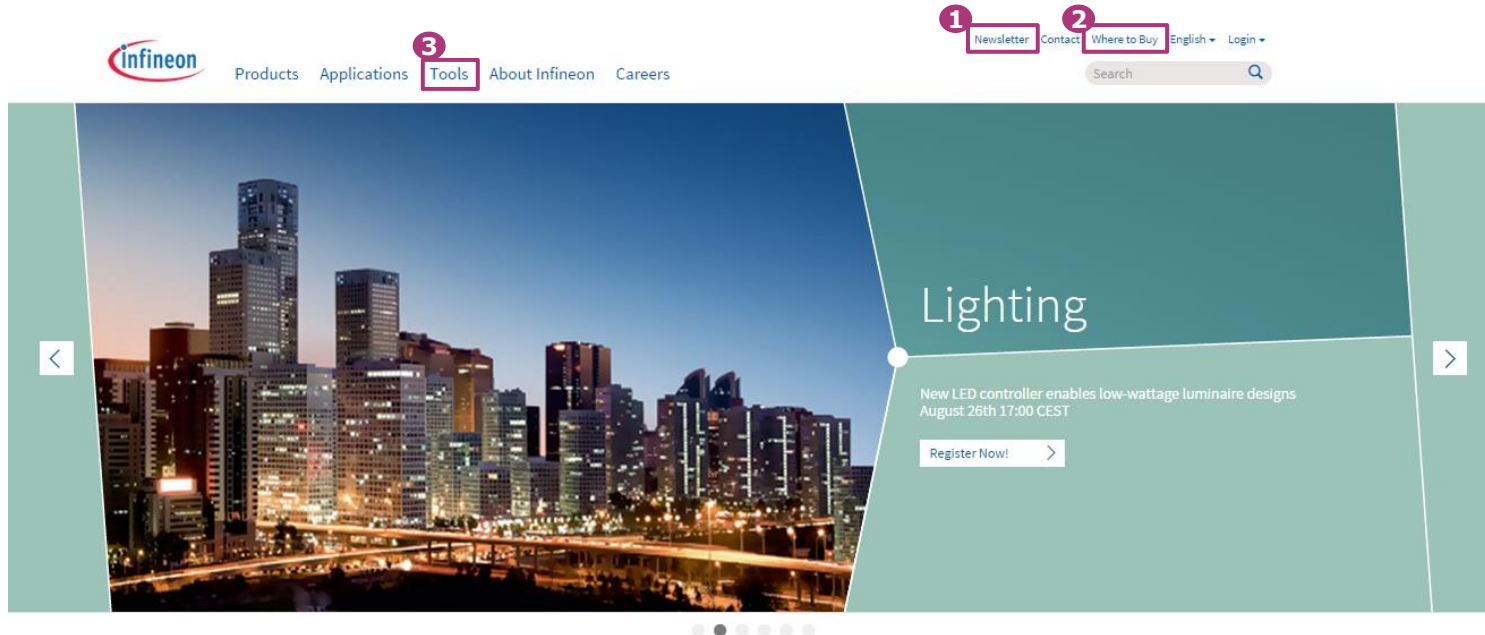
Key contacts

- › Support
24ghzsupport@infineon.com

Target applications



Support Online tools and services



- 1 **Subscribe to Newsletter**
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- 3 **Tools, Finders and Selectors**
- 4 **Support**



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