INSTRUMENTED BICYCLE

Infineon Sensors

POLITECNICO DI TORINO

Contents

1 Radar

https://www.infineon.com/dgdl/Infineon-24GHz%20Radar%20Sensors-SG-v01_00-EN.pdf?fileId=5546d46262b31d2e01633ab942783b1d (page 2)

BGT24MTR11	BGT24MR2	BGT24MTR12	BGT24LTR11
› Transceiver 1Tx+1Rx/ IQ differential › RF_{in} 24.0-26.0 GHz › 500 mW @3.3 V › 4.5 x 5.5 mm -VQFN-32	› Twin receiver 2Rx/ IQ differential › RF_{in} 24.0-26.0 GHz › 300 mW @3.3 V › 4.5 x 5.5 mm -VQFN-32	› Transceiver 1Tx+2Rx/IQ differential › RF_{in} 24.0-26.0 GHz › 700 mW @3.3 V › 4.5 x 5.5 mm -VQFN-32 › VCO integrated, SPI › Power/temp sensor	› Transceiver (1Tx+1Rx) › Single- ended › BITE Tested › RF_{in} 24.0 – 24.25 GHz › 150 mW @3.3 V › 2.4 x 2.4 mm -TSNP-16

The BGT24LTR11N16 key features

- 24 GHz transceiver MMIC
- Fully integrated low phase noise V_{CO}
- Built in temperature compensation circuit for V_{CO} stabilization, no PLL needed
- Low power consumption
- Fully ESD protected device
- Single ended RF and IF terminals
- 200 GHz bipolar SiGe:C technology B7HF200
- Single supply voltage 3.3 V
- Divider output for PLL operation
- Smallest 24 GHz transceiver in the market

https://www.infineon.com/dgdl/Infineon-Sensor_Solutions_BR-2018_30072018-SG-v01_02-EN.pdf?fileId=5546d462636cc8fb0164229c09f51bbe (page 59)

Sense2GOL (BGT24LTR11 + XMC1300)	Distance2Go (BGT24MTR11 + XMC4200)	Position2Go (BGT24MTR12 + XMC4700)
› Capability to detect motion, speed and direction of movement (approaching or retreating) Precise measurement of object detection compared to PIR › Operates in harsh environments and detects through non-metallic materials › Low power mode for enhanced battery life › One of the world's smallest complete radar + MCU development kit › BGT24LTR11 – 24 GHz highly integrated RF MMIC › XMC1300 ARM® Cortex®-M0 –32-bit industrial microcontroller › Debug over cortex 10 pin debug connector › Integrated multiple element patch antennas	› Capability to detect distance of multiple targets › Capability to detect motion, speed and direction of movement (approaching or retreating) › Operates in harsh environments and detects through non-metallic materials › BGT24MTR11 – 24 GHz highly integrated RF MMIC › XMC4200 ARM® Cortex®-M4 –32-bit industrial microcontroller › Debug over cortex 10 pin debug connector › Integrated multiple element patch antennas	› Capability to detect position of multiple targets › Capability to detect distance of multiple targets › Capability to detect motion, speed and direction of movement (approaching or retreating) › Operates in harsh environments and detects through non-metallic materials › BGT24MTR12 – 24 GHz highly integrated RF MMIC › XMC4700 ARM® Cortex®-M4 –32-bit industrial microcontroller › Debug over cortex 10 pin debug connector › Integrated multiple element patch antennas
Main applications › Security › Lighting control › Automatic door opener › Vital sensing	**Main applications** › Drone: soft landing/obstacle avoidance › Smart toilets › Tank level sensing › Intelligent switches	**Main applications** › Drone/robots: obstacle avoidance › Security › People tracking (IoT, smart home) › Vital sensing
Board dimensions › 25 mm x 25 mm (pictured with the Segger Debugger break-off board for reprogramming)	**Board dimensions** › Board 36 mm x 45 mm	**Board dimensions** › Board 50 mm x 45 mm
Kit contents › User's manual › SW GUI to operate kit › Schematic and bill-of-materials of module	**Kit contents** › User's manual › SW GUI to operate kit › FMCW FW and SW [1] › Doppler FW and SW [1] › Schematic and bill-of-materials of module	**Kit contents** › User's manual › SW GUI to operate kit › FMCW FW and SW › Doppler FW and SW › Schematic and bill-of-materials of module

Position2Go

https://www.infineon.com/cms/en/product/evaluation-boards/demo-position2go/

Parametrics	DEMO POSITION2GO
Configuration	BGT24MTR12 ; XMC4700
Description	Radar demo board based on the BGT24MTR12– Fast chirp FMCW for tracking (Angle, distance, speed, and direction of movement detection)
Family	Radar
Product Description	Infineon radar demo board based on the BGT24MTR12 using Fast chirp FMCW for tracking (Angle, distance, speed, and direction of movement detection)
Target Application	Industrial
Type	Demo Board

Distance2Go

https://www.infineon.com/cms/en/product/evaluation-boards/demo-distance2go/

Parametrics	DEMO DISTANCE2GO
Configuration	XMC4200 ; BGT24MTR11
Description	Radar demo board based on the BGT24MTR11– FMCW & doppler (distance, speed, and direction of movement detection)
Family	Radar
Product Description	Infineon radar demo board based on the BGT24MTR11– FMCW & Doppler (distance, speed, and direction of movement detection)
Target Application	Industrial
Type	Demo Board

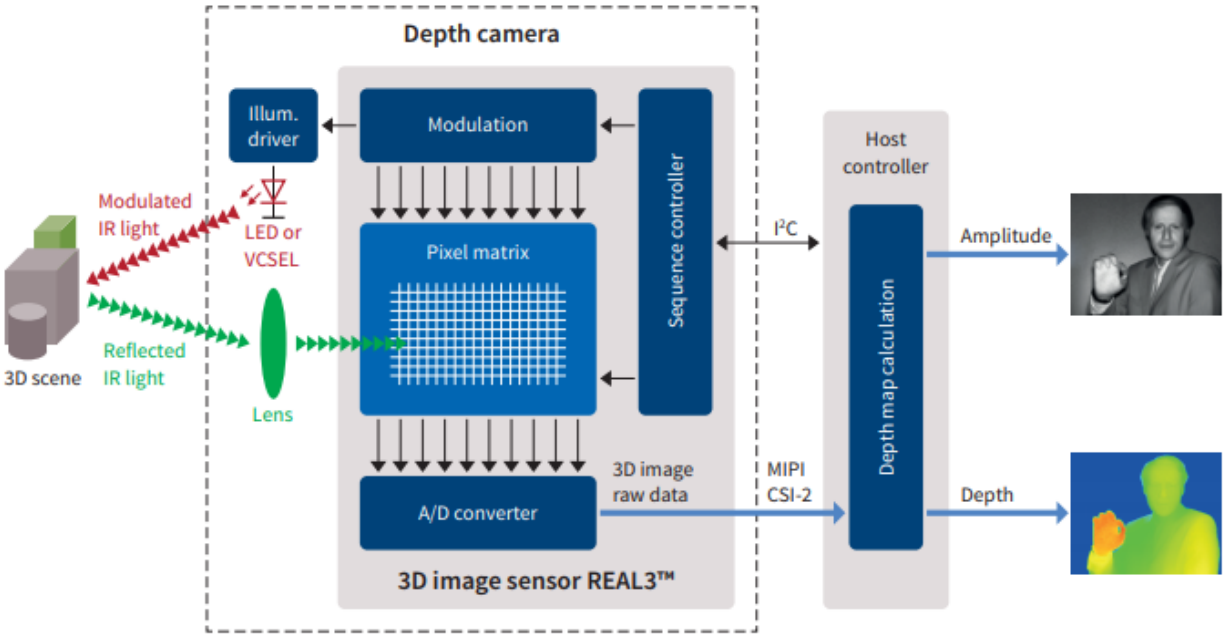
2 Lidar

No demo boards.

3 3D Image Sensor REAL3™

Link: https://www.infineon.com/cms/en/product/sensor/3d-image-sensor-real3/#!support
Measures in 3D
depth and amplitude in every pixel by using 1 infrared flash light source.
reliable distance information and a grey scale picture of the complete scene simultaneously.
Full operation in bright sunlight and darkness
Minimum power consumption
Fast data acquisition for real-time operation
simple and robust design of camera module.
- imager
- flash illumination component, no need of mechanical baseline

Block diagram:



3D reference camera

To evaluate Infineon's REAL3 time-of-flight technology, a set of 3D reference cameras are available. The **CamBoard pico** family has been designed by our development partner pmd technologies and comes along with a powerful SDK providing a high quality depth map for evaluation and application software development.

	Pico Flexx	Monstar
		
Dimensions	68mm x 17mm x 7.35 mm	62 mm x 66 mm x 29 mm
Weight	8 g	142 g
Field of view (H X V)	62 X 45	100 X 85
Resolution	224 X 171 (38k) PX	352 X 287 (100K) PX
Measurement range	0.1 – 4 m	0.5 – 6 m
framerate	Up to 45 fps	Up to 60 fps
interface	USB2.0 / USB3.0 (data & power)	USB3.0 (data & power)
Operating System	Windows 7/8/10 Linux/ARM Ubuntu Linux 16.04 + Qt5.5 macOS Android/ARM	Windows 7/8/10 Linux/ARM Ubuntu Linux 16.04 + Qt5.5 macOS
Software	Royale SDK(C/C++ based, supports Matlab, Python, DotNet, CAPI, OpenCV, OpenNI2, ROS)	Royale SDK(C/C++ based, supports Matlab, Python, DotNet, CAPI, OpenCV, OpenNI2, ROS)

4 Magnetic Position Sensor

4.1 3D Magnetic Sensor

ideally suited for the measurement of three dimensional movement within a magnetic field, linear slide movement as well as 360° angle rotation.

Smallest, fully featured 3D magnetic sensor 2GO evaluation kits with optional joystick adapter, rotation knob and linear slider round up our broadest portfolio. Our 2GO kits are ready-to-use plug-and-play boards.

3D-movement
e.g. top column module

Angle measurement
e.g. control button

Linear measurement
e.g. gear stick

Product summary

Parameter	TLV493D-A1B6	TLE493D-A1B6	TLE493D-A2B6 [1]	TLE493D-W2B6 A0 to A3	Unit
Supply voltage	2.9–3.5	2.9–3.5	2.8–3.5	2.8–3.5	V
Typ. supply current – power down mode	7	7	7	7	nA
Typ. supply current – fast mode	3.7	3.7	3.7	3.4	mA
Minimum usable magnetic linear range	±130 (typ.)	60	160	±160	mT
Maximum magnetic resolution	130	130	130	130/65 (two ranges)	µT/LSB
x to y channel lifetime matching drift	±9	±9	±3.5	±3.5	%
x/y to z channel lifetime matching drift	±15	±15	±15	±15	%
I²C protocol	2	1	1 or 2	1 or 2	Byte

Hall Sensor	TLV493D-A1B6	TLE493D-W2B6 (A0-A3)	TLE493D-A2B6
Production Samples	Available	Available	Available
Temperature Range	-40 to 125°C	-40 to 125°C	-40 to 125°C
Magnetic Linear Range	typ. ±130mT	min. ±160mT min. ±100mT[1)]	min. ±160mT min. ±100mT[1)]
Resolution	98µT/LSB	130uT/LSB 65uT/LSB[1)]	130uT/LSB 65uT/LSB[1)]
Offset drift	± 1mT	X,Y: ±0.45mT Z: ±0.45mT	X,Y: ±0.45mT Z: ±1.6mT[2)]
Matching drift	X/Y: typ. ±5% XY/Z: typ. ±20%	X/Y: ±3.5% XY/Z: ±15%	X/Y: ±3.5% XY/Z: ±15%
Safety	No	Yes	No
Wake up	No	Yes	No
Comment	• Low Power	• Pre-defined Startup ID: A0-A3	• Flex Speed

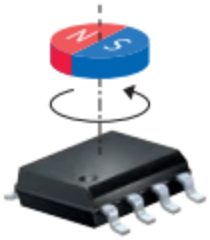
4.2 Hall Switch

conventional block commutation – and Hall switches are the perfect fit here

4.3 Angle Sensor

https://www.infineon.com/dgdl/Infineon-Sensor_Solutions_BR-2018_30072018-SG-v01_02-EN.pdf?fileId=5546d462636cc8fb0164229c09f51bbe (page29)

Angle sensors detect the orientation of an applied magnetic field by measuring sine and cosine angle components with monolithically integrated magneto resistive elements.



Technologies:

IGMR: combines magneto resistive sensing elements with integrated circuits in one chip. These devices can determine the absolute orientation of a magnetic field over the full range between 0° and 360° with high angular accuracy and resolution. These products offer the benefits of integrated, fast signal processing, short delay times and multiple interface options.

IAMR: ideal for applications with the highest accuracy requirements. iAMR technology offers the best performance over temperature, lifetime and magnetic field range. All products are pre-calibrated and ready to use.

ITMR: Infineon Tunneling Magneto Resistive (iTMR) technology offers high sensing sensitivity with a high output voltage so that no internal amplifier is required. Because of this the sensor can be connected directly to the microcontroller without any further amplification. In addition, iTMR technology shows a very low temperature drift reducing external calibration and compensation efforts. The iTMR technology is also well known for its low current consumption.

Product	Technology	Die configuration	ISO 26262	Sin/cos output	Angle output	Second interface	Accuracy	Package
TLE5009	GMR	Single die	Ready	Analog sin/cos	–	–	0.9°	DSO-8
TLE5009A16(D)	GMR	Dual die	Ready	Analog sin/cos	–	–	1.0°	TDSO-16
TLE5011	GMR	Single die	Ready	SSC (SPI)	–	–	1.6°	DSO-8
TLI5012B	GMR	Single die	Ready	SSC (SPI)	SSC (SPI)	PWM/IIF/SPC/HSM	1.9°	DSO-8
TLE5012B(D)	GMR	Single & dual die	Ready	SSC (SPI)	SSC (SPI)	PWM/IIF/SPC/HSM	1.0°	DSO-8/ TDSO-16
TLE5014C16(D)	GMR	Single & dual die	Compliant	–	SPC	–	1.0°	TDSO-16
TLE5014P16(D)	GMR	Single & dual die	Compliant	–	PWM	–	1.0°	TDSO-16
TLE5014S16(D)	GMR	Single & dual die	Compliant	–	SENT	–	1.0°	TDSO-16
TLE5109A16(D)	AMR	Single & dual die	Ready	Analog sin/cos	–	–	0.5°	TDSO-16
TLE5309D	AMR + GMR	Dual die	Ready	Analog sin/cos	SSC (SPI)	–	AMR 0.5°, GMR 1.0°	TDSO-16
TLE5501	TMR	Single die	Compliant	Analog sin/cos	–	–	1.0°	DSO-8

<table>
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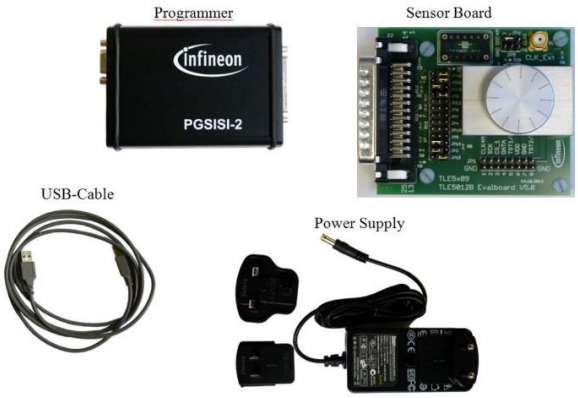
<td>TLE5009 EVALKIT
 
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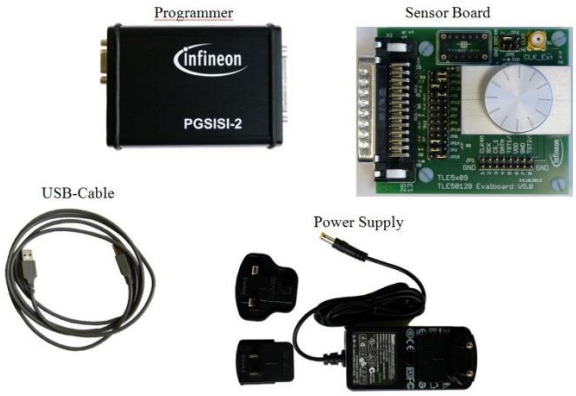
<td>TLE5012B EVALKIT
 
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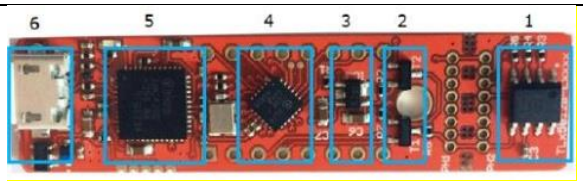
<tr>
<td>Sensor 2GO kits:
Smallest, fully featured, budget-priced evaluation boards
- Plug-and-measure evaluation board
- First measurements possible within minutes
- Mechanical adapter for 3D magnetic sensor (joystick/rotation knob/linear slider) available for quick evaluation
Sensor combined with an ARM® Cortex®-M0 CPU
Consists on-board debugger
ready-to-use plug-and-play boards</td>
<td> 
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<td colspan="2">https://www.infineon.com/dgdl/Infineon-TLE5012B_Exxxx-DS-v02_01-EN.pdf?fileId=db3a304334fac4c601350f31c43c433f</td>
</tr>
<tr>
<td>TLE5012B E1000 version: automotive predefined variant with SSC & IIF communication protocols Incremental Interface (IIF)

The TLE5012B-E1000 is preconfigured for Incremental Interface and fast angle update period (42.7 µs). It is
most suitable for BLDC motor commutation.
• Autocalibration mode 1 enabled.
• Prediction enabled.
• Hysteresis is set to 0.703°.
• 12bit mode, one count per 0.088° angle step.
• Incremental Interface A/B mode.</td>
<td>TLE5012B E5000 version: automotive predefined variant with SSC & PWM communication protocols Pulse-Width-Modulation (PWM)

The TLE5012B-E5000 is preconfigured for Pulse-Width-Modulation interface. It is most suitable for steering angle and actuator position sensing.
• Filter update period is 85.4 µs.
• PWM frequency is 244 Hz.
• Autocalibration, Prediction, and Hysteresis are disabled.</td>
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<tr>
<td>TLI5012B E1000 version: industrial predefined variant with SSC & IIF communication protocols</td>
<td>TLE5012B E9000 version: automotive predefined variant with SSC & SPC communication protocols Short-PWM-Code (SPC)

The TLE5012B-E9000 is preconfigured for Short-PWM-Code interface. It is most suitable for steering angle and</td>
</tr>
</table>

	actuator position sensing. • Filter update period is 85.4 µs. • Autocalibration, Prediction, and Hysteresis are disabled. • SPC unit time is 3 µs. • SPC interface is set to open-drain output.

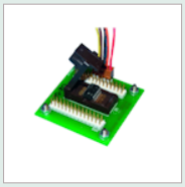
4.4 Linear Hall IC

linear Hall ICs family is the ideal choice for highly accurate angular and linear position detection and current measurement applications.

5 Tire Pressure Sensor (TPMS)

https://www.infineon.com/cms/en/product/sensor/integrated-automotive-pressure-sensor/tire-pressure-sensor-tpms/#!boards

Pressure Range	100...450kPa	100...900kPa	100...1300kPa	SP27 100-1300kPa (Non-TPMS Product)
Product Type	SP370-25-106-0	SP370-25-116-0	SP370-23-156-0	SP270-25-256-0
Key Benefit	•single-pressure •field-programmable via LF •RF datarate up to 20kBit/s	•automatic pressure •field-programmable via LF •RF datarate up to 20kBit/s	•single-pressure •RF datarate up to 10kBit/s	•without accelerometer sensing •without wireless communication capabilities (RF and LF)

Image	Board	Family	Description	Status
	SP37-434-8 EVAL BOARD	Sensor	The SP37 development kit enables evaluation of the entire feature set of the tire pressure sensor SP37, such as RF transmitter functionality and LF receiver functionality; additionally it allows software development and in-circuit debugging. The development kit includes the required evaluation hardware, SP37 devices, an integrated software development environment, documentation and a selection of sample software. • SP37	

Parametrics	SP37-434-8 EVAL BOARD
Additional Features	Optimized Measurement
Configuration	SP37
Dimensions	180x100x20
Family	Sensor
Input Type	DC
Interfaces	USB2.0 ; RS232
Mounting	Surface Mount (SMD) ; Through Hole
Product Description	The SP37 development kit enables evaluation of the entire feature set of the tire pressure sensor SP37, such as RF transmitter functionality and LF receiver functionality; additionally it allows software development and in-circuit debugging. The development kit includes the required evaluation hardware, SP37 devices, an integrated software development environment, documentation and a selection of sample software.
Product Name	SP37 development kit
Qualification	Automotive
Supply Voltage min max	1.9 V 3.6 V
Target Application	Automotive
Type	Evaluation Board

6 Magnetic Speed Sensor

measure speed in safety and powertrain applications such as speedometers, ABS.

The sensors use a ferromagnetic gear tooth or encoder structure to measure linear or rotational speed and position. Hall sensor measuring rotational speed with a gear tooth and a magnetic encoder wheel.

https://www.infineon.com/dgdl/Infineon-Sensor_Solutions_BR-2018_30072018-SG-v01_02-EN.pdf?fileId=5546d462636cc8fb0164229c09f51bbe (page 38)

TLE4922

Highly robust, easy-to-use mono-Hall speed sensor with twist-independent mounting

This sensor is specially designed to provide an easy-to-use, robust and cost-effective solution for vehicle or industrial speed sensing applications. The TLE4922 can therefore be back-biased using a simple, low-cost bulk magnet, while providing a good air gap performance and switching accuracy. Its hidden adaptive hysteresis and calibration algorithm enables good accuracy over air gap jumps and immunity to vibration and run-out events. Thanks to its mono-cell design, the TLE4922 is the perfect choice for applications requiring twist-independent mounting. As a result, the TLE4922 is well suited for replacing passive sensors, such as Variable Reluctance Sensors (VRS), in automotive and 2-wheeler applications by providing the user with higher accuracy and a better jitter performance. The improved EMC, ESD and temperature robustness are perfectly suited for use in the harsh environmental conditions prevalent in automotive or dedicated industrial applications. The TLE4922 comes in a thin 4-pin SSO-4-1 package using a standard 3-wire voltage interface.

Features

- Large operating air gap capability
- Twist-independent mounting
- Hidden adaptive hysteresis
- Low current consumption
- Reverse magnetic polarity capability
- Advanced protection technology
  - Reverse voltage protection at V_S-pin
  - Short-circuit protection
  - Overtemperature protection
- Wide operating temperature ranges of -40°C ≤ T_j ≤ ±150°C
- High ESD robustness up to ±4 kV HBM
- 3-wire PWM voltage interface

Applications

- 2-wheeler
- Automotive vehicle speed

www.infineon.com/magnetic-sensors

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7 MEMS Microphones

https://www.infineon.com/cms/en/product/sensor/mems-microphones/#!boards

Infineon XENSIV™ MEMS microphones introduce a new performance class for digital MEMS microphones that overcomes existing audio chain limitations. IM69D130 is designed for applications where low self-noise (high SNR), wide dynamic range, low distortions and a high acoustic overload point are required.

FEATURES

- 2x IM69D130 Digital MEMS microphone in stereo mode configuration
  - Dynamic range of 105dBSignal to noise ratio of 69dB(A) SNR
  - <1% total harmonic distortions up to 128dBSPL
  - Acoustic overload point at 130dBSPL
  - Sensitivity (±1dB) and phase(±2° @1kHz) matched
  - Flat frequency response with low-frequency roll-off at 28Hz
  - Very fast analog to digital conversion speed (6µs latency @1kHz)
  - Power optimized modes determined by PDM clock frequency
  - Omnidirectional pickup pattern
- Interface to Infineon My IoT Adapter
- PDM and I^2S output configuration
- Flexibility to develop a custom application with Arduino or Raspberry PI