XENSIV™ BGT60CUTR13AIP CMOS radar SMD module

60 GHz FMCW short range radar/field disturbing sensor

About this document

Scope and purpose

This document describes the function, circuitry, and performance of the full modular certified surface-mounted device (SMD) reference design for the XENSIV™ BGT60CUTR13AIP CMOS radar sensor. It also provides integration guidelines for host product manufacturers to integrate the radar module into their products, and documentation of the test modes used in the FCC and CE certification process.

Intended audience

The intended audience for this document are host product manufacturers who intend to integrate the Infineon XENSIV™ BGT60CUTR13AIP CMOS radar SMD module into their design.

About this product group

Target applications

HVAC, smart home and building, smart TV, smart displays, security cameras, lighting, security devices, wearables, robotics, healthcare devices, etc.

Product family

XENSIV™ 60 GHz CMOS radar sensors for IoT

FCC ID: 2AYSQBGT60CUTR13-A

CE

Manufacturer Information:
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Safety precautions

Note: Please note the following warnings regarding the hazards associated with development systems.

Table 1 Safety precautions

	**Caution:** *The evaluation or reference board contains parts and assemblies sensitive to electrostatic discharge (ESD). Electrostatic control precautions are required when installing, testing, servicing or repairing the assembly. Component damage may result if ESD control procedures are not followed. If you are not familiar with electrostatic control procedures, refer to the applicable ESD protection handbooks and guidelines.*

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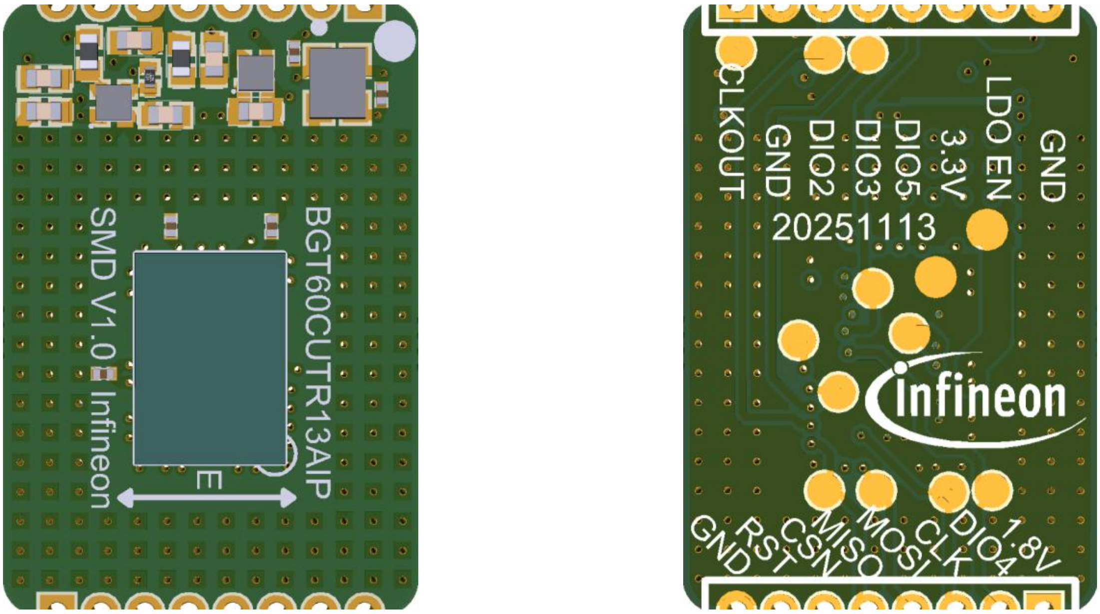
1 The board at a glance

The XENSIV™ BGT60CUTR13AIP CMOS radar surface-mount device (SMD) module featuring the key component XENSIV™ BGT60CUTR13AIP 60 GHz CMOS radar sensor [1] is optimized for fast prototyping and system integrations as well as initial product feature evaluation. The board offers developers the flexibility to choose their own platform depending on their preferred use cases.

The sensor supports various use cases, serving a broad application spectrum, such as motion and presence detection, localization, tracking, people counting, proximity sensing, vital sensing, gesture sensing, etc. These use cases target applications, such as HVAC, notebooks, smart TVs, smart speakers, wearables, smart home and automations for comfort, energy savings and security/safety functions.

1.1 Main features

As shown in Figure 1, Infineon's XENSIV™ BGT60CUTR13AIP CMOS radar sensor is mounted on the top side of the module printed circuit board (PCB). The radar device is a system-on-chip (SoC) with Antenna-in-Package (AIP) design featuring a single transmitter and three receiver antennas. Additionally, the board is equipped with supporting components, such as two LDOs, an 80 MHz crystal resonator, two ferrite beads, 11 capacitors, and one resistor.



Top view | Bottom view

Figure 1 XENSIV™ BGT60CUTR13AIP SMD V1.0 PCB top and bottom views

The half stamp holes on two sides of the BGT60CUTR13AIP SMD V1.0 board act as PCB pad connectors, providing access to the most important signals of the module. A top view with pin description of the half stamp holes is displayed in Figure 2.

An electromagnetic band gap (EBG) structure [4] around the radar SoC reduces the impact of the supporting components (resistors, capacitors, etc.) on the RF performance by acting as stabilizing counterpart to the radar SoC's antennas in the radar near field. Additionally, undesired side reflections are reduced as the EBG structure attenuates lateral RF signal propagation through the PCB.

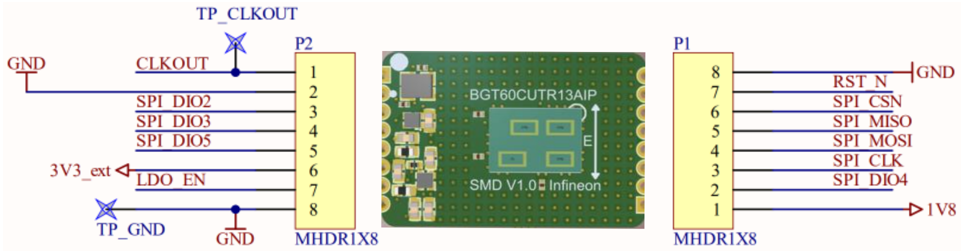


Figure 2 XENSIV™ BGT60CUTR13AIP 60 GHz CMOS radar sensor SMD V1.0 with pin description

The radar SoC is a frequency modulated continuous wave (FMCW) radar acting according to the superheterodyne principle with a phase-locked loop (PLL) controlled RF signal in the range of 57 GHz to 64 GHz. The RF signal acts as input to the transmitter (TX) and as local oscillator (LO) frequency feeding the receiver (RX) downconverter stages. The field of view (FoV) of the built-in antenna system is ±60° [3]. With a typical effective isotropic radiated power (EIRP) of 16.2 dBm, the module can be used for presences detection, people counting, and tracking applications up to 20 m distance. The module can be either operated in full autonomous mode or controlled by an external microcontroller unit (MCU).

Besides enabling fast prototyping and feature evaluations, the SMD module is FCC (full modular) and CE certified. It is designed for easy integration by host manufacturers to simplify certification processes and reduce certification costs.

The main features of the module are as follows:

- Small-sized form factor board of 17.7 x 12 mm²
  - Flexible platform selection via PCB-on-PCB soldering (module PCB on host PCB)
  - Low-cost FR4 laminate and minimized bill of materials (BOM)
- Short range radar system-on-chip BGT60CUTR13AIP
  - Integrated antennas (1TX, 3RX) via Antenna-in-Package design
  - On-chip signal processing via integrated hardware acceleration
- Optimized power supply circuitry
  - Features two on-module LDOs plus radar SoC built-in LDOs
    - Radar operation robust to noisy module input voltage (V_{in})
    - Single input voltage (V_{in}) allowing battery powered operation (e.g., 3 V/4.5 V)
  - Power consumption dependent on configuration (<1 mW achievable [6])
- Easy to get started
  - Full autonomous operation with 3 internal (on-chip ROM) configurations
  - Software support for development and visualization of product performance with 7 additional predefined configurations
  - Highly flexible configuration of FMCW modulation for advanced users
- Pre-certified (FCC/CE) module for low-effort and low-cost integration into host products

The key parameters of the three internal configurations are listed in Table 2. These configurations are stored in the internal Read Only Memory (ROM) mask of the radar SoC. More information on the internal configurations is available in Section 2.2.1 and the radar SoC's user guide [2]. Test results of the three internal configurations executed on this module are documented in Section 3.3. Information on the seven additional configurations is provided in the XENSIV™ Radar Visualization Tool [6].

Table 2 Key parameters of internal configurations

Parameter	Internal configuration 0 (indoor presence and motion detection)	Internal configuration 1 (outdoor motion detection)	Internal configuration 2 (ultra-low-power motion detection)	Notes or conditions
Range	10 m (Typical value)	20 m (typical value)	20 m (typical value)	T_A = 20°C; V_{in} = 3.3 V; test result in Figure 12
Power consumption	78mW (Static case: Independent of target detections)	• 5.1 mW (Dynamic case: No target detections) • 44 mW (Dynamic case: Permanent target detections)	2.0 mW (Static case: Independent of target detections)	T_A = 20°C; V_{in} = 3.3 V; test result in Table 7

2 System and functional description

This section provides the high-level system functionality of the XENSIV™ BGT60CUTR13AIP CMOS radar SMD module and states the interface requirements to get started with the module.

As the BGT60CUTR13AIP radar sensor is a complex system-on-chip [1], [2], [3], the best approach to get started depends on the users' radar know how and the application.

This section guides starting from the lowest effort approach to opening possibilities for advanced users.

2.1 Getting started

As a primary approach, learn about the module by starting to work with the XENSIV™ BGT60CUTR13AIP Connected Sensor Kit (CSK) [5]. The KIT_CSK_BGT60CUTR13 (Figure 3) includes:

- Rapid IoT Connect Developer Kit (CYSBSYSKIT-DEV-01)
- XENSIV™ BGT60CUTR13AIP Wing (EVAL_60CUTR13_WING)

The XENSIV™ BGT60CUTR13AIP Wing board can be plugged onto the Rapid IoT Connect Developer Kit. The BGT60CUTR13AIP SMD module described in this user guide is one-to-one integrated into the BGT60CUTR13AIP Wing board.

The Infineon's Rapid IoT Connect Developer Kit features a PSOC™ 6 MCU (Arm® Cortex®-M4) compatible with Infineon embedded software solutions. Software support [6] for evaluation is accessible via Infineon Developer Center (IDC) Launcher [7]. Advanced users can develop their own embedded radar applications based on available examples in the ModusToolbox™ software [8].

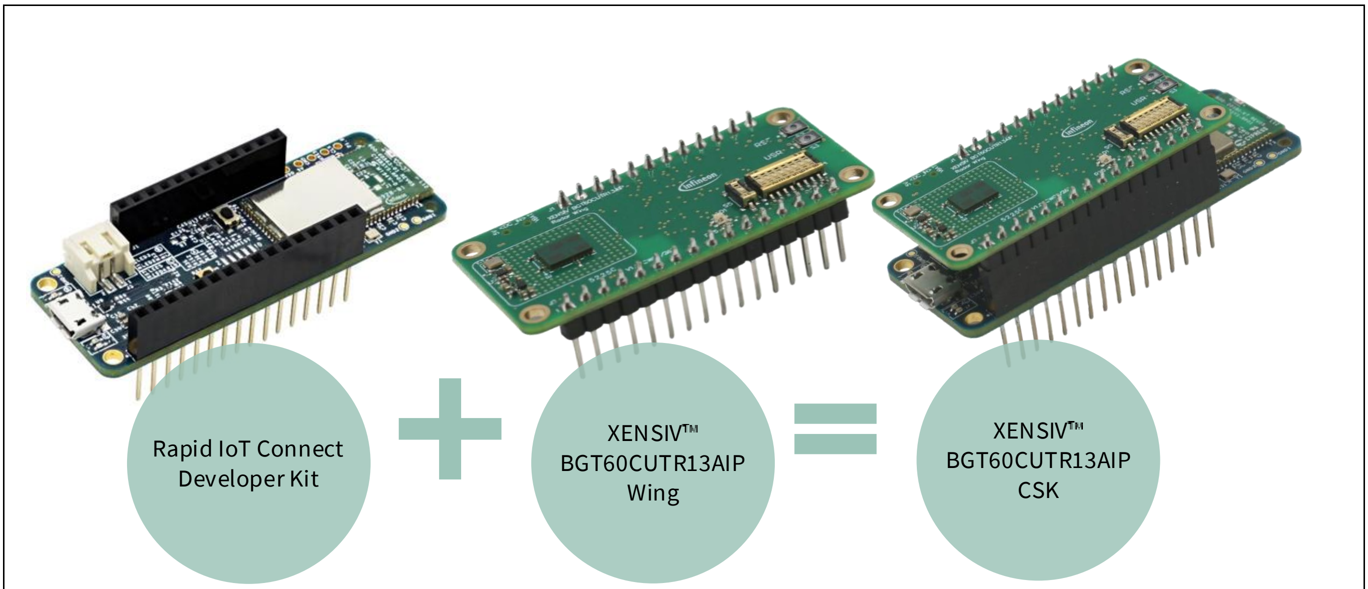


Figure 3 XENSIV™ BGT60CUTR13AIP Connected Sensor Kit

Summarizing, via CSK, IDC, and ModusToolbox™, you can instantly start to evaluate radar applications and learn about the radar SoC's operation modes via dedicated software tools. More details on radar operation modes follow in Section 2.2.

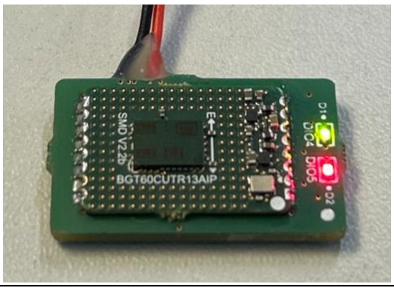
As a next approach, you can start designing your own carrier board for PCB-on-PCB soldering according to your requirements, similar to the example of Figure 4. The key benefits of this approach are:

- Instant development and testing of radar applications via XENSIV™ BGT60CUTR13AIP CSK [5]

- Parallelization of independent software and hardware (carrier board) development tracks
- Final hardware featuring performance optimized and pre-certified XENSIV™ BGT60CUTR13AIP CMOS radar SMD module

As a last approach, you can merge software and hardware development tracks to a new product featuring the pre-certified XENSIV™ BGT60CUTR13AIP CMOS radar SMD module. For more guidelines on certification processes, contact Infineon's regional support.

A minimalistic carrier demonstrator board with the module soldered on top is shown in Figure 4. The battery-powered demonstrator board runs in full autonomous mode without any MCU. Presence detection and radar active status are indicated by two LEDs, D1 and D2. For more information on the carrier demonstrator board and general guidelines on carrier board design is provided in Section 2.3.



- DIO4/5 LEDs active
- Battery power supply (GND/V_{ext}) to carrier board wired from top side
- Complementing test hardware with battery pack is shown in Figure 9

Figure 4 SMD module on minimalistic carrier demonstrator board

*Note: PCB pictures in this report may show development version number V2.2b.
The final version V1.0 and developer version V2.2b are 100% identical.*

2.2 BGT60CUTR13AIP radar operation modes

This section summarizes the basic operation modes of the radar SoC, which also apply to this module. Every detail about the XENSIV™ BGT60CUTR13AIP radar's operation is described in its user guide [2].

The radar SoC is controlled by a frame sequencer (SEQ) together with a finite state machine (FSM), the latter working based on the status in the 32-bit register space of the control subsystem. The FSM, the overarching control unit of the radar SoC, triggers the frame sequencer to execute defined radar frames. These radar frames are stored in the sequence buffer memory (SEQ_BUFFER).

The key difference of the different operation modes is how the 32-bit registers and the sequence buffer memory are loaded, and if a host MCU is part of the solution. For solutions without MCU or with low-level MCU, the radar SoC's integrated hardware acceleration (HWA) is utilized to cover the processing chain starting from raw ADC samples to angle estimation and target detection.

The radar SoC can be operated in three different modes:

- **On-chip autonomous mode:** Radar SoC with HWA (no MCU required)
- **On-chip enhanced solution:** Radar SoC with HWA (and limited code on host MCU)
- **Premium turnkey software solution:** Radar SoC with MCU (SPI data forwarding, advanced processing on MCU)

The three operation modes are described in Section 2.2. See the CSK kit user guide for CMOS radar [5].

2.2.1 On-chip autonomous mode: Radar SoC with HWA only (no MCU required)

To operate the module in full autonomous mode, the module's input voltage V_{in} is required and RST_N needs to be set to logic level HIGH. After applying V_{in} and the LDO outputs become active, the radar SoC performs a hardware reset and then checks the pin levels of DIO2 and DIO3. Based on the settings of DIO2 and DIO3 on the carrier board, the radar SoC loads the corresponding internal configuration as shown in Table 3 and starts operation. Reference schematics for carrier board design and interface details are described in Section 2.3.

Table 3 XENSIV™ BGT60CUTR13AIP internal configurations

Configuration	DIO3	DIO2	Note or purpose
Configuration 0	0	0	Indoor presence and motion detection
Configuration 1	0	1	Outdoor motion detection
Configuration 2	1	0	Ultra-low-power motion detection
N.A.	1	1	Internal configurations disabled

These internal configurations are optimized for common radar use cases. Detailed descriptions, test results, and power profiles on radar SoC level are available in the radar SoC's user guide [2]. Test results and power profiles on module level are summarized in Section 3.3.

All configurations utilize the radar SoC's embedded hardware acceleration (HWA) based processing. On a positive detection result, DIO4 is raised to logic level HIGH to notify the carrier board about the positive motion or presence event. Upon a following negative motion or presence event, DIO4 is pulled again to logic level LOW. This operation mode is designed for very simple, low-cost (no MCU) applications requiring solely a high/low statement from the module.

During operation, the radar SoC switches between active and low power states. In addition to the detection result on DIO4, the radar SoC indicates its current power state via high/low on DIO5.

An example for a minimalistic carrier board for full autonomous operation without MCU is shown in Figure 4 and further described in Section 2.3.

This operation mode can be evaluated using the XENSIV™ BGT60CUTR13AIP Connected Sensor Kit [5] and the supporting XENSIV™ Radar Visualization Tool [6].

2.2.2 On-chip enhanced solution: Radar SoC with HWA (and limited code on MCU)

Compared to the previous mode (Section 2.2.1), this mode covers applications in which a high/low statement indicating the detection result is not sufficient. Therefore, a low-level MCU (Arm® Cortex®-M0) is required to further process the radar SoC's output (e.g., target angle and distance) for localization of three to four targets. The results are transferred via an SPI bus, in which the MCU must act as SPI host.

The startup in this mode can be equal to Section 2.2.1, utilizing the radar SoC's internal configurations and HWA. Alternatively, the internal configurations can be disabled, and a custom configuration can be transferred from the host MCU to the radar SoC instead.

This operation mode can be evaluated using the XENSIV™ BGT60CUTR13AIP Connected Sensor Kit [5] and the supporting XENSIV™ Radar Visualization Tool [6] where seven additional radar configuration settings are supported to cover varieties of application needs on the varying levels of performance and power consumption.

2.2.3 Premium turnkey solution: Radar SoC with MCU (SPI data forwarding to MCU, advanced processing on MCU)

Premium turnkey solution uses advanced algorithms (use case optimized detection chain and tracker) achieving high performance and accuracy on multi-person scenarios. While the on-chip enhanced solution makes use of on-chip detections eliminating/minimizing the need of an external MCU, the turnkey solution is heavily optimized to achieve the best performance using classical detection and tracking algorithms. While the turnkey solution achieves the best performance in the market, the on-chip enhanced solution further optimizes for cost. Therefore, these solutions enable the right cost/performance ratios needed for different application use cases.

This operation mode can be evaluated using the XENSIV™ BGT60CUTR13AIP Connected Sensor Kit [5], supporting XENSIV™ Radar Configuration/Visualization Tools [6], and supporting XENSIV™ Radar Presence Detection and Tracking Algo Libraries in the ModusToolbox™ [8].

2.3 Module interface and carrier board recommendations

The XENSIV™ BGT60CUTR13AIP SMD module requires a carrier board to start up in the modes described in Section 2.2. This section describes the interface and potential use cases based on a minimalistic example.

Figure 5 shows the top view of a minimalistic carrier demonstrator board and schematic with recommended landing pattern. The module can be soldered onto the carrier board as shown in Figure 4. In case the two jumpers connecting DIO2/DIO3 and GND are mounted as displayed, the radar SoC would start up in internal configuration 0 as defined in Table 3.

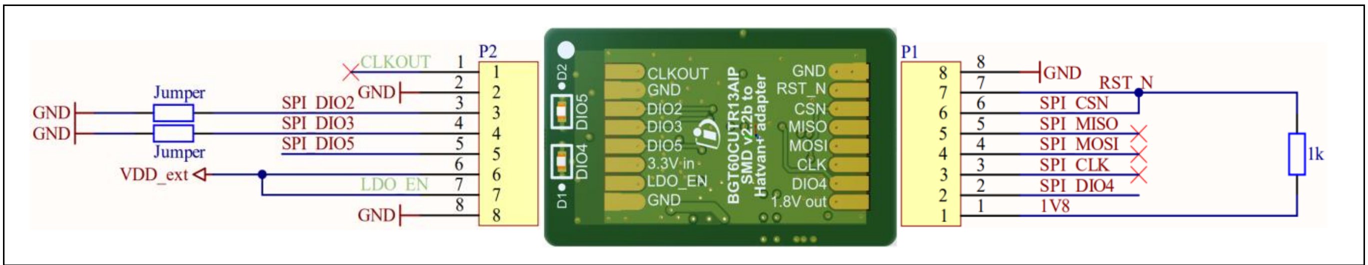


Figure 5 Minimalistic carrier demonstrator board top view

Table 4 summarizes the schematic requirements and options for carrier board designs. V_{in} and LDO_EN can be connected to the same power supply of the carrier board. For designs with MCU on carrier board, LDO_EN can also be connected to the MCU for additional power saving options.

RST_N should be connected to V_{ref} 1.8 V via a 1 kΩ pull-up resistor. For carrier board designs without SPI interface, SPI_CSN should be pulled up to 1.8V as well.
For carrier board designs with SPI interface, V_{ref} 1.8 V can additionally be used as logic level reference for SPI (CSN, MISO, MOSI, CLK) and/or digital input and output (I/O) pins. In this case, SPI_CSN should be controlled by the external MCU and therefore not connected to the 1 kΩ pull-up resistor.

The radar SoC is equipped with internal pull-ups on DIO2 and DIO3. To enable one of the three internal configurations, the respective DIOs must be pulled to GND. To disable the internal configurations, DIO2 and DIO3 can be left open or alternatively connected to the MCU for arbitrary I/O functionalities and Quad-SPI [2]. DIO4 and DIO5 are the SoC's default pins for I/O signals.

The use of CLKOUT is optional, the default configuration on the carrier board should be N.C. (not connected).

Table 4 Carrier board landing pattern pin requirements

Pin	Operation mode 2.2.1 (on-chip autonomous mode)	Operation mode 2.2.2 (on-chip enhanced solution)	Operation mode 2.2.3 (premium turnkey solution)
V_{IN}	DC power supply	DC power supply	DC power supply
LDO_EN	DC power supply	DC power supply/MCU	DC power supply/MCU
GND	GND	GND	GND
V_{REF} 1.8 V	RST_N via pull-up resistor	• RST_N via pull-up resistor • (to SPI as IO level reference)	• RST_N via pull-up resistor • (to SPI/DIO as IO level reference)
RST_N	1.8 V via 1kΩ pull-up resistor	1.8 V via 1kΩ pull-up resistor	1.8 V via 1kΩ pull-up resistor
SPI_CSN	1.8 V via 1kΩ pull-up resistor	• MCU for SPI • (V_{REF} 1.8 V)	• MCU for SPI • (V_{REF} 1.8 V)
SPI (CLK, MOSI, MISO)	N.C.	• MCU for SPI • (V_{REF} 1.8 V)	• MCU for SPI • (V_{REF} 1.8 V)
DIO2/3	N.C./GND	• N.C./MCU • (V_{REF} 1.8 V)	• N.C./MCU • (V_{REF} 1.8 V)
DIO4/5	PLDs, counters, comparators, etc.	• MCU • (V_{REF} 1.8 V)	• MCU • (V_{REF} 1.8 V)
CLKOUT	N.C.	N.C.	Optional use, default N.C.

Figure 6 shows the dimensions of the recommended landing pattern for carrier board designs.

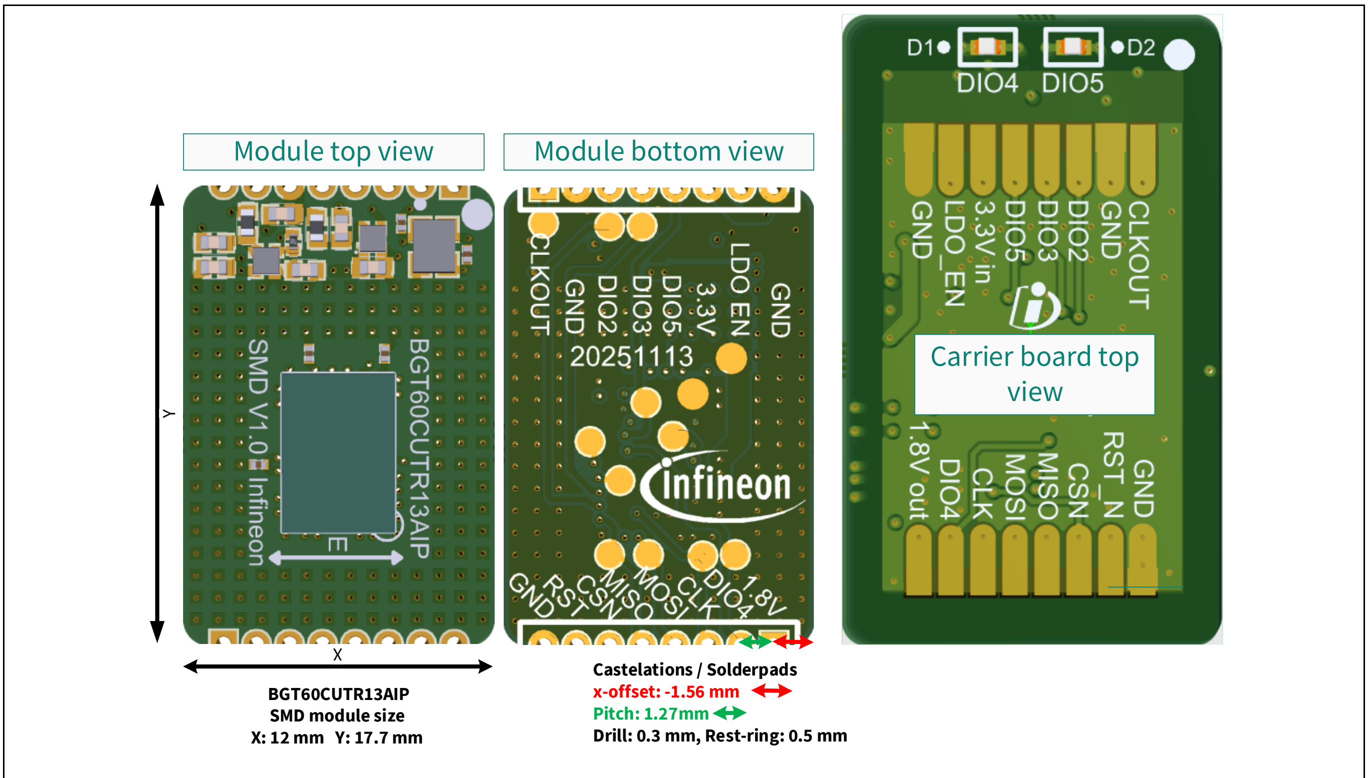


Figure 6 Landing pattern dimensions

In on-chip autonomous mode without MCU, low-cost logic components, such as programmable logic devices (PGAs) can be utilized to fine tune applications, e.g., via counters, delays, and other logic blocks based on the radar SoC's DIO4 and DIO5 outputs. You can develop individual hardware designs with fitting logic components and interface to their host product.

The purpose of the schematics in Figure 7 is to speed up designing your own carrier board with LED demonstrator features for DIO4 (target detections) and DIO5 (power active state).

A 3.3 V output LDO U1 (onsemi NCP163AMX330TBG) drives LEDs D1 and D2 (PICOLED LED-SMD-SMLP13BC8T green/red) together with a transistor Q1 (Infineon BSD840NH6327XTSA1), acting as non-inverting buffer. In this schematic, the LDO's input is connected to the common DC power supply VDD_{ext} of the carrier board. Therefore, the minimum input voltage to the module changes to VDD_{ext} = 4.3 V, the minimum input voltage of the LDO U1.

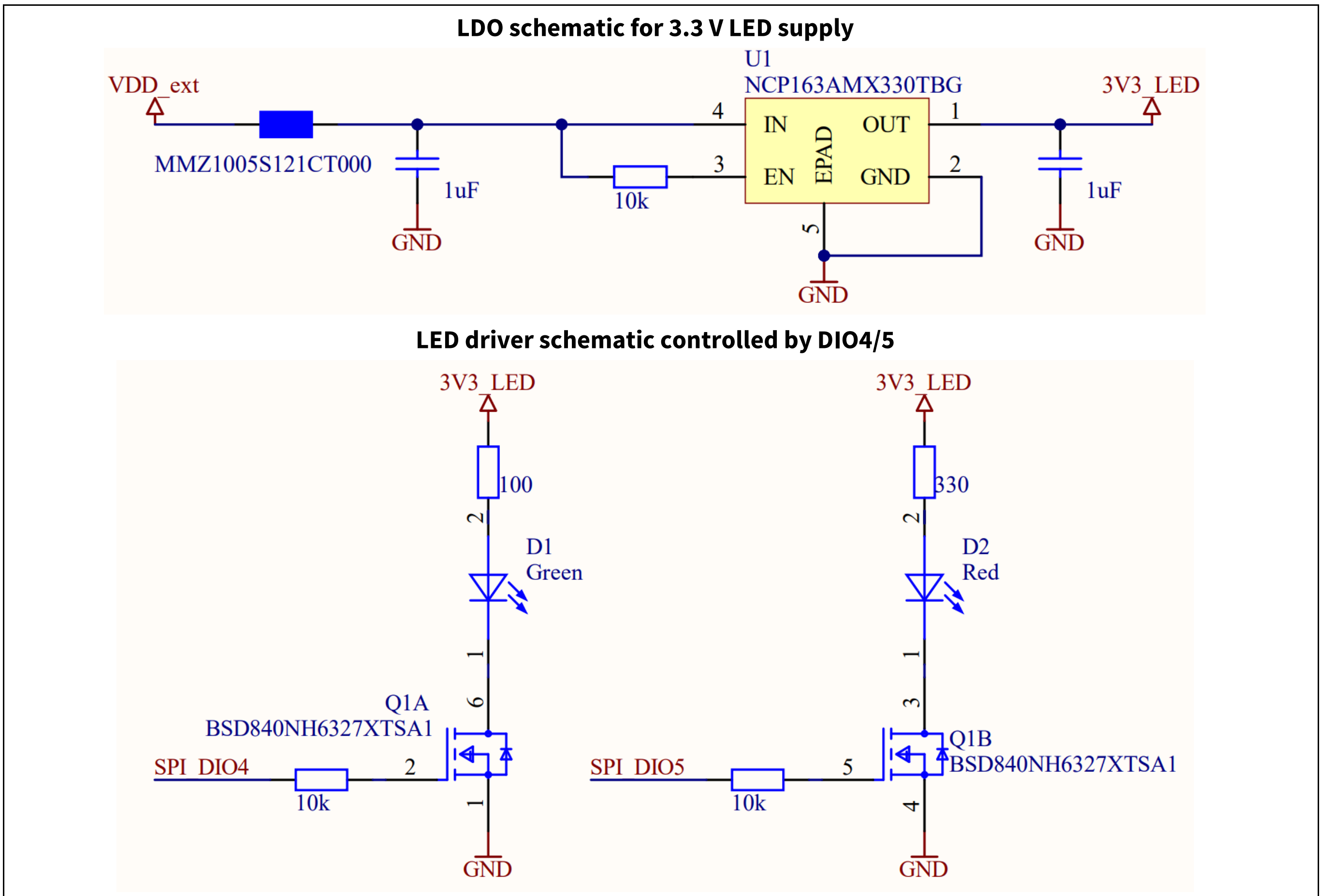


Figure 7 LED demonstrator schematics

3 System performance

The module's system performance has been tested and certified in two certification modes (CM1/CM2) operating in frequency bands F_{B1} and F_{B2} respectively. CM1 and CM2 work under FCC and CE regulations. To cover a broad range of applications, CM1 and CM2 have been defined to operate at the limits of the respective regulations regarding frequency range, duty-cycle, and continuous transmitter on-times.

Table 5 lists the key parameters and their associated regulations.

Table 5 Certification mode specification

Parameter	Symbol	Values		Unit	Note
		Min.	Max.		
Certification Mode 1 (CM1)					
CM1 operating frequency band	F_{B1}	61.0	61.5	GHz	• FCC § 15.255(c)(2)(v) • CE EN 305 550-1 V2.1.0, 4.3.3.3
CM1 operating frequency range	F_{R1}	61.0	61.5	GHz	Utilized bandwidth within F_{B1}
CM1 FMCW chirp slope rate	SL_1	–	36.8	MHz/µs	Single chirp
Certification Mode 2 (CM2)					
CM2 operating frequency band	F_{B2}	57	61.56	GHz	• FCC § 15.255(c)(2)(ii) • CE EN 305 550-1 V2.1.0, 4.3.3.3
CM2 operating frequency range	F_{R2}	59.44	61.56	GHz	Utilized bandwidth in F_{B2}
CM2 FMCW chirp slope rate	SL_2	–	39.2	MHz/µs	Single chirp
CM2 duty-cycle	DC_2	–	50	%	• On radar frame level • FCC § 15.255(c)(2)(ii)
CM2 continuous transmitter time	T_{RFon2}	–	16.5	ms	• On radar frame level • FCC § 15.255(c)(2)(ii)

- All configurations within the specification of Table 5 are a subset of CM1 or CM2 mode. The internal configurations in Section 2.2 are each a subset of CM2. More guidance on certification compliance, testing and integration is provided in Integration instructions, FCC , and CE sections

3.1 Test modes

In addition to the specifications in Table 5, each certification mode (CM1/CM2) is split into three test modes to enable or simplify certain measurements. The characteristics of these test modes are summarized in Table 6. To set any of the test modes, see the radar SoC's user guide [2].

In continuous wave (CW) mode, the radar SoC permanently transmits at a single frequency. Measurements in pulsed mode operation can be affected by measurement equipment limitations. For parameters, such as fundamental EIRP, harmonics, and spurious signals, these limitations can be overcome in CW mode. The CW mode is only an assisting test mode and not designed for application scenarios. The CW mode must not be used above 25°C ambient temperature to avoid thermal problems.

In timing mode, the radar runs pulses as in the application, but its chirps send only at a single frequency. This mode simplifies timing measurements using a spectrum analyzers' zero span mode.

Finally, the application-mode is the configuration optimized for the application. While the CW mode simplifies the analysis of certain RF parameters under worst case conditions (100% duty-cycle), the application mode is in the end, the sole relevant mode for the certification process.

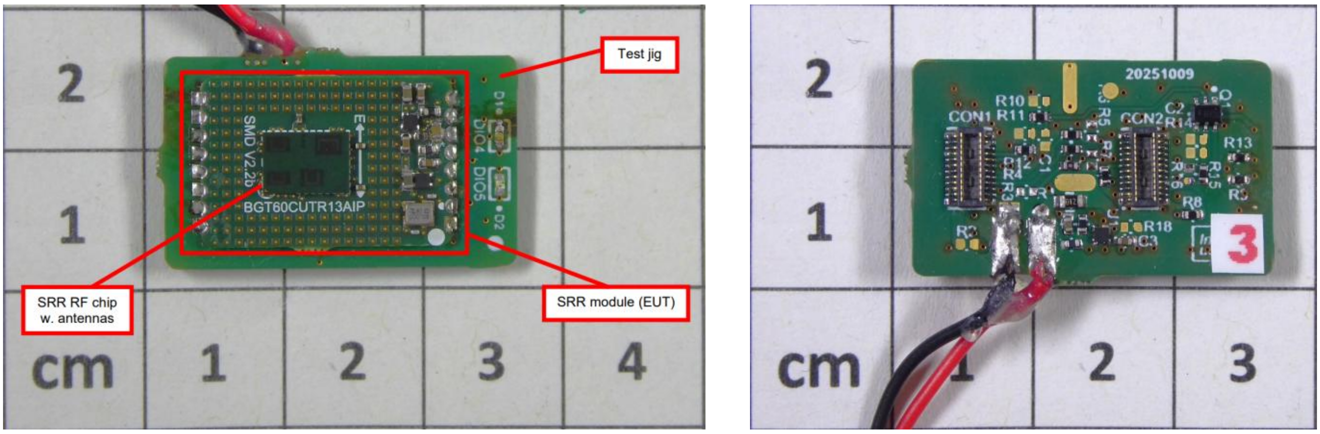
Bandwidth measurements for certification purposes are measured in application-mode and crucial application parameters, such as angular error, range and power consumption. Results on the application parameters are described in Section 3.3.

Table 6 Test mode specifications

Test mode	Transmitter behavior	Measurement purpose
CW mode	• TX continuous wave • Unmodulated at single frequency F_S – F_{S1} = 61.25 GHz in **CM1** – F_{S2} = 60.5 GHz in **CM2**	• EIRP (worst case) • Harmonics (worst case) • Spurious (worst case)
Timing mode	• TX pulsed • Modulated at single frequency F_S (0Hz chirp bandwidth) – F_{S1} = 61.25 GHz in **CM1** – F_{S2} = 60.5 GHz in **CM2**	• Certification – Duty-cycling – Transmitter RF-on/off time
Application mode	• TX pulsed • Modulated over frequency range – FR1 = 61.0-61.5 GHz in **CM1** – FR2 = 59.44-61.56 GHz in **CM2**	• Certification – EIRP – Harmonics – Spurious – Bandwidth • Application – Angular error – Range – Power consumption

3.2 Test hardware

The module requires a carrier board providing the minimum interfaces as described in Section 2.3. For the test results, described in the Section 3.3, the test carrier board shown in Figure 8 is used.



EUT on test carrier board: Front view — EUT on test carrier board: Bottom view

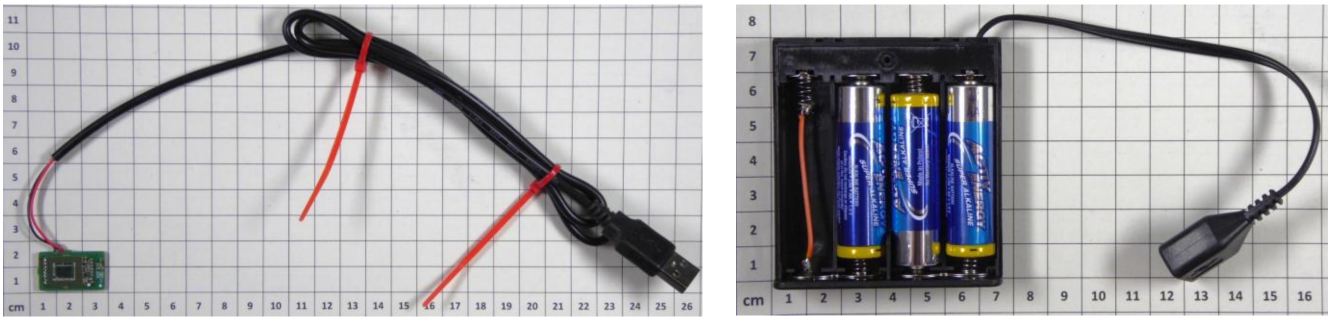
Figure 8 Test carrier board

Note: PCB pictures in this report may show development version number V2.2b.
The final version V1.0 and developer version V2.2b are 100% identical.

This test carrier board features two LEDs and the module on the top side. Cables for voltage VDD_{ext} and GND are soldered to the bottom side. VDD_{ext} is directly connected to V_{in} on the module.

Further components to drive the LEDs and an optional SPI interface via Hirose connectors CON1 and CON2 are mounted on the bottom side.

The certification modes CM1 and CM2 of Table 5, or any other configuration, can be programmed via an external MCU board interfacing via the Hirose connectors. The internal operation modes described in Section 2.2 can be set by grounding DIO2/3 via 0 Ω jumpers on the bottom side.



EUT mounted on test jig
with attached power supply cabling

Battery pack
(3 AA batteries and 1 short)

Figure 9 Battery power supply for test carrier board

Note: PCB pictures in this report may show development version number V2.2b.
The final version V1.0 and developer version V2.2b are 100% identical.

Any external DC supply can provide proper voltage and power, the power requirements depends on the operation mode can be used to supply the carrier board and module. For most tests, a battery pack supplying VDD_{ext} = 4.5 V is used, as shown in Figure 9.

3.3 Test results

Certification-related test results are available in the FCC [10] and CE [11] test reports. This section focuses on the complementing key performance parameters of the module:

- Angular error
- Range
- Power consumption

To analyze the angular error, the module is characterized along the E- and H-planes of the radar SoC. Therefore, as shown in the setup diagram in Figure 10, the carrier board is mounted on a gimbal in an anechoic RF chamber. A corner reflector is placed opposite the carrier board. The radiation emitted by the TX antenna is reflected by the corner reflector and received via the RX antennas. Therefore, the angular error is an evaluation on system performance.

The evaluation is split into two measurements: one for E- and H-planes respectively. The gimbal sweeps the predefined angles and for each angle step, the radar SoC performs a radar measurement in application mode.

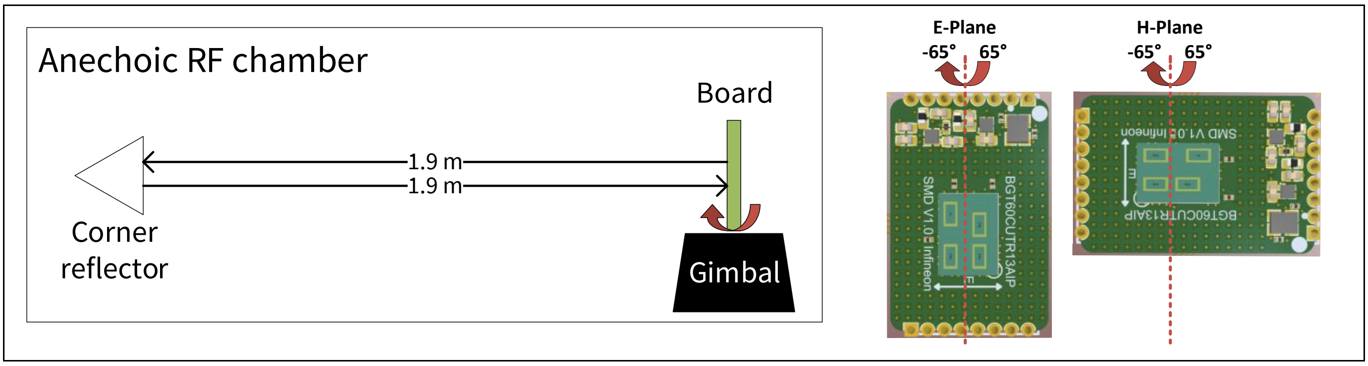


Figure 10 Anechoic chamber setup for angular error measurements

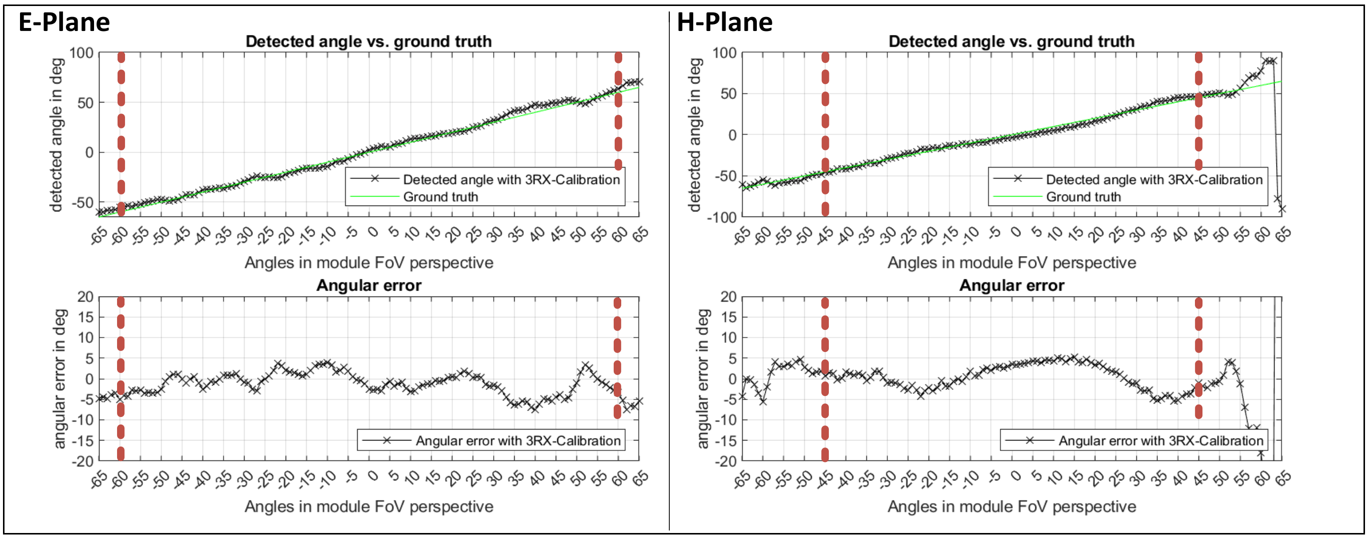


Figure 11 Angular error plots: E- and H-planes with marked FoV

Figure 11 shows the angular error plots for E- and H-planes respectively. For E-plane, the maximum angular error is <10° over the full FoV_E of 120°. For H-plane, the same requirement is met for FoV_H = 90°.

Figure 12 shows the range plot for the three internal configurations over the FoV. Internal configuration 0 is a dedicated indoor use case where the maximum range is reduced to a typical range of 10 m by on-chip range masking. Additionally, configuration 0 runs two separate radar frames for indoor presence detection (detecting micro motions, e.g., gestures/breathing of a sitting person) and indoor motion detection (detecting moving targets inside the room). If the configuration is started in on-chip autonomous mode (Section 2.2.1), the radar SoC will raise DIO4 for positive target detections. In case the configuration is started via the on-chip enhanced solution, target information can additionally be read out via SPI.

The same scenarios apply also for internal configuration 0 and 1. Internal configuration 1 is a dedicated outdoor use case with a typical range of 20 m, with focus on tracking moving targets.

Internal configuration 2 is a generic ultra-low-power motion detection case, indicating presence/motion of targets within a typical range of 20 m, without the tracking capabilities of configuration 1.

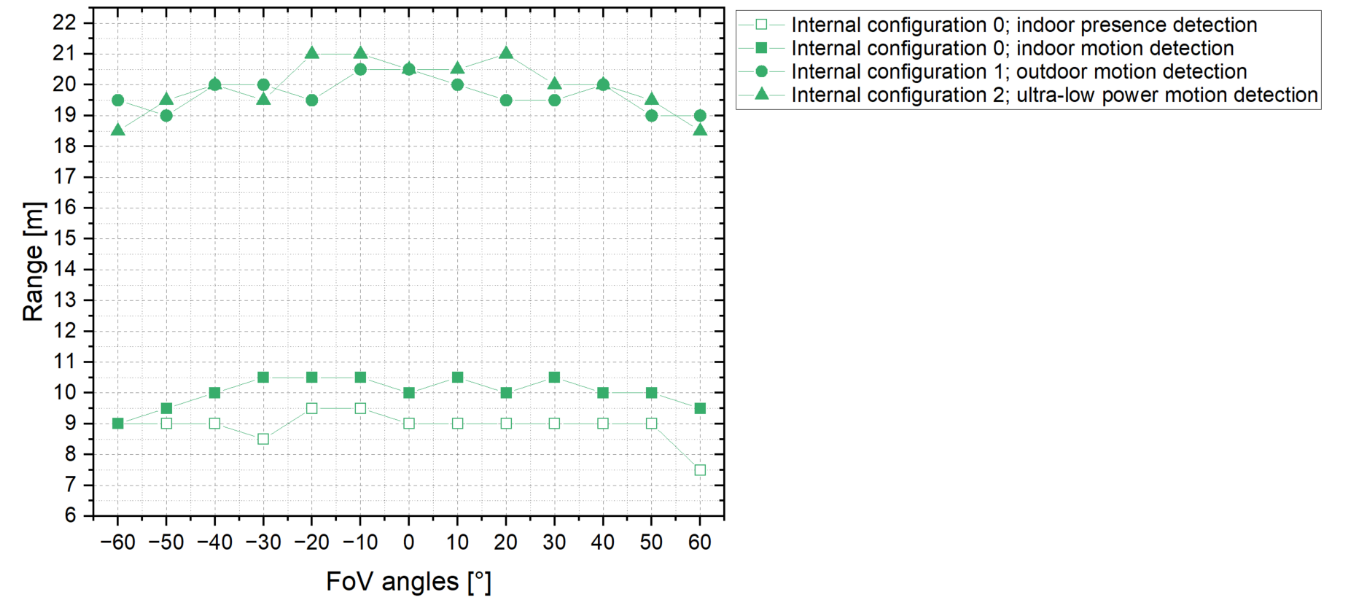


Figure 12 Range of internal configurations under nominal conditions

Table 7 summarizes the average power consumption of the three internal configurations over the module's input voltage range V_{in}. Configurations 0 and 2 have static radar frame timings and therefore a static power consumption. Configuration 1 features dynamic tracking of targets, the radar SoC will scan the environment in shorter periodic time intervals in case of target detections.

All measurements of Table 7 are performed with a Joulescope JS220 in continuous operation.

Table 7 Average power consumption

Parameter	V_{in} = 2.6 V	V_{in} = 3.3 V	V_{in} = 4.7 V	Unit	Note or test condition
Internal configuration 0; indoor presence and motion detection	62	78	113	mW	**Static case: In depth of target detections;** T_A = 20°C; Time interval = 250 ms

Parameter	V_{in} = 2.6 V	V_{in} = 3.3 V	V_{in} = 4.7 V	Unit	Note or test condition
Internal configuration 1; outdoor motion detection	3.9	5.1	7.1	mW	**Static case: No target detections;** T_A = 20°C; Time interval = 1 s
Internal configuration 1; outdoor motion detection	35	44	63	mW	**Static case: Permanent target detections;** T_A = 20°C; Time interval = 100 ms
Internal configuration 2; ultra-low-power motion detection	1.6	2.0	2.9	mW	**Static case: In depth of target detections;** T_A = 20°C; Time interval = 500 ms
Deep sleep power consumption	<1			mW	T_A = 20°C

In Figure 13, the dynamic power consumption of internal configuration 0 is shown. Within an interval of 250 ms, one motion detection followed by two presence detection frames are executed by the radar SoC. This configuration scans the environment with a high frame rate.

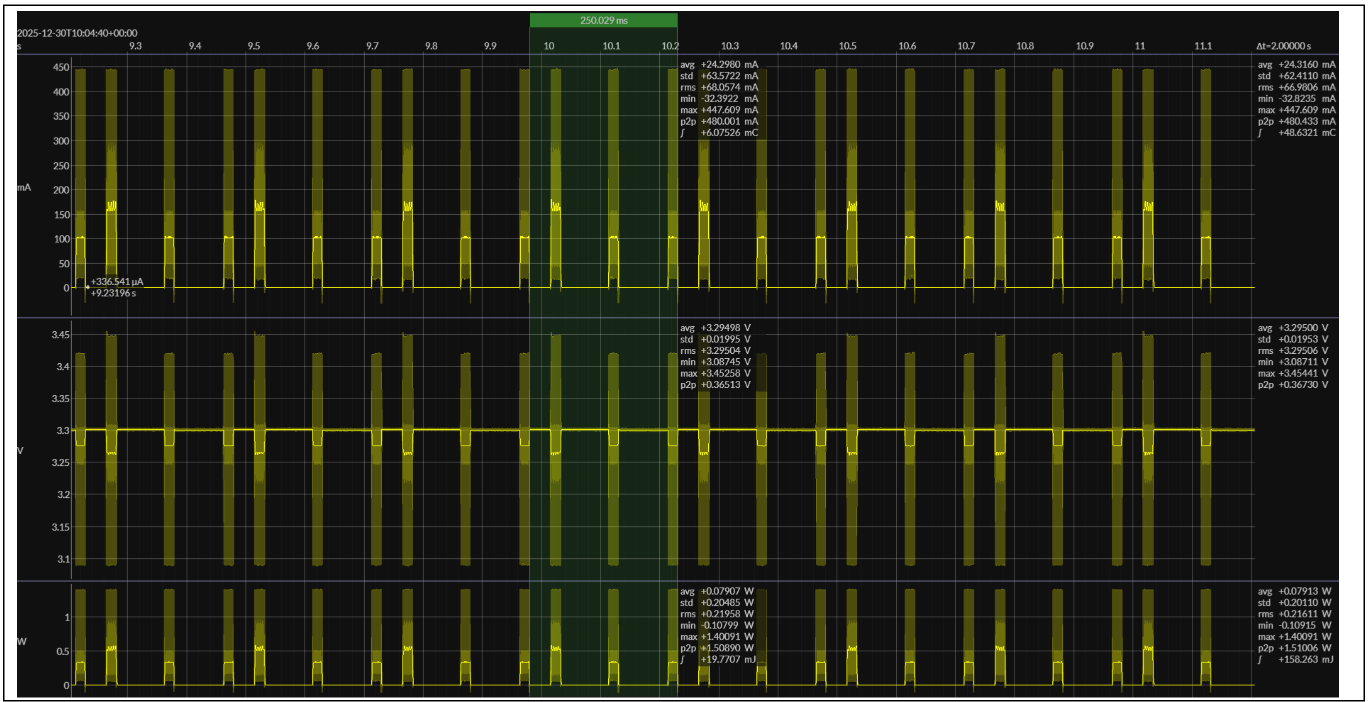


Figure 13 Dynamic power consumption: internal configuration 0; indoor presence and motion detection (time interval = 250 ms)

Figure 13 and the following figures are captures taken with the Joulescope UI. The Joulescope JS220 is connected in series between the power supply and the module to measure the current consumption (row 1, in milliampere). Additionally, the JS220 is sensing V_{in} at the module input (row 2, in volt). In row 3, the resulting dynamic power consumption in milliwatts is plotted.

[Figure 14](#) shows the dynamic power consumption of internal configuration 1 without a moving target in the FoV. In this case, the module consumes 5.1 mW on average for V_{in} = 3.3 V, scanning the environment in 1 s intervals. In between radar frames, the radar SoC goes into deep sleep mode (blue marker), in deep sleep, the module's current consumption is <200 µA and therefore the module's power consumption is <1 mW for the full input voltage operating range. Under typical conditions, the radar SoC's current consumption in deep sleep mode is ~90 µA. Additional current is consumed by the surrounding components, mostly the quiescent currents of the LDOs.

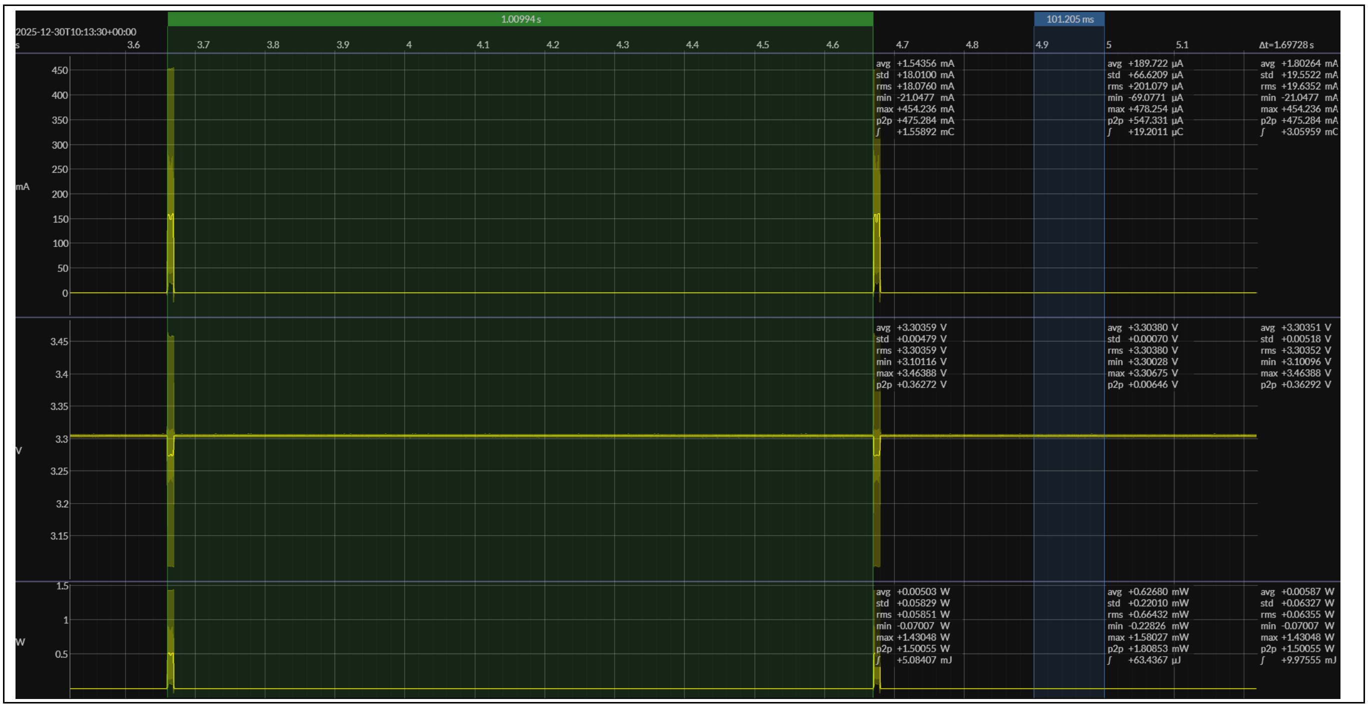


Figure 14 **Dynamic power consumption: internal configuration 1; outdoor motion detection; without target detections (time interval = 1 s)**

In internal configuration 1, upon a positive target detection event, the radar SoC will execute at least nine further radar frames with 100 ms periodicity. If none of the further nine radar frames result in a positive target detection event, the radar SoC will step back to power saving 1 s time intervals between radar frames, as shown in [Figure 15](#).

The timings of internal configuration 1 are dynamic and in consequence is its power consumption. Therefore, the average power consumption in [Table 7](#) is stated for the minimal case (no events, 1 s time interval) and the maximum case (permanent events, 100 ms time interval).

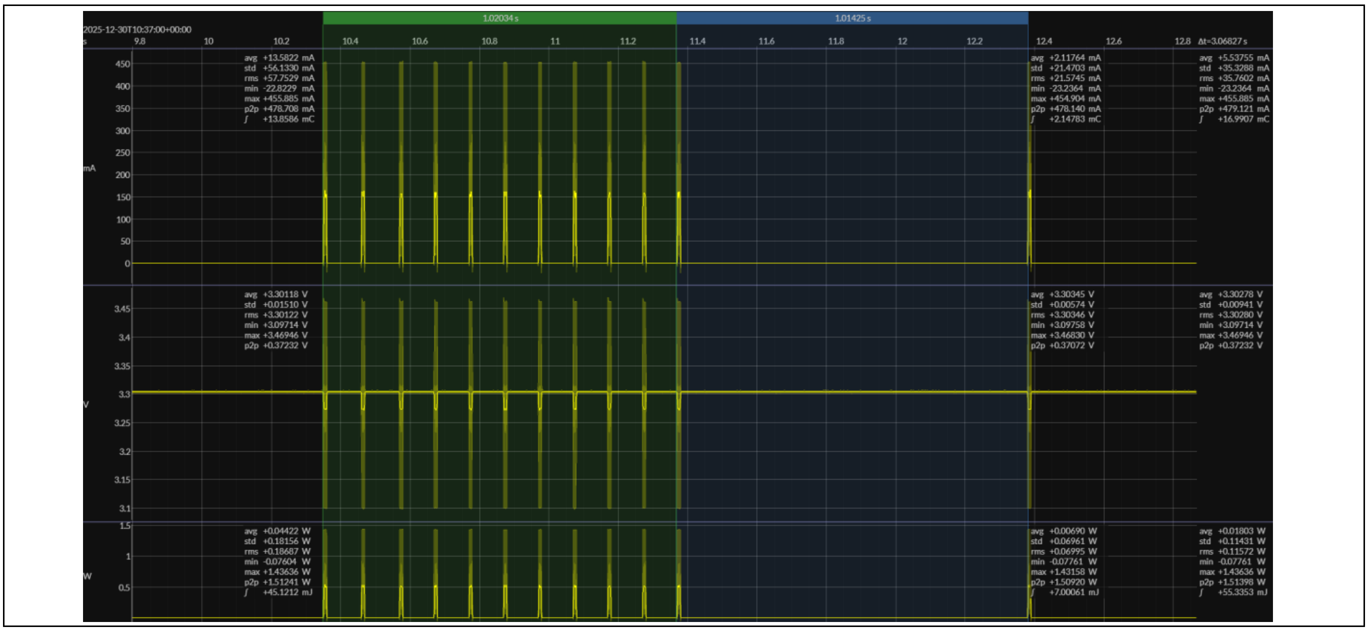


Figure 15 Dynamic power consumption: internal configuration 1; outdoor motion detection; with single target detection (time interval = 100 ms)

Figure 16 shows the dynamic power consumption of internal configuration 2. The motion detection frames are executed every 500 ms. For V_{in} = 3.3 V, the module consumes 2.0 mW average power consumption in this configuration.

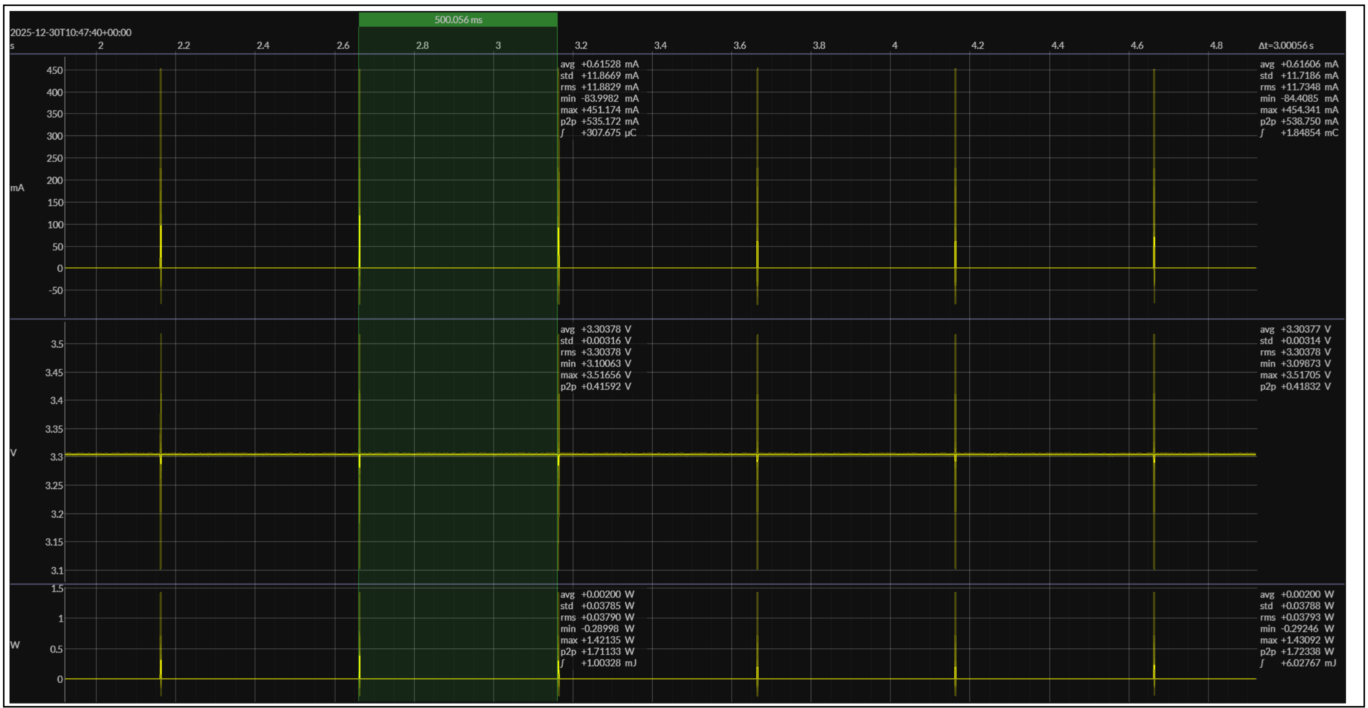


Figure 16 Dynamic power consumption: internal configuration 2; ultra-low-power motion detection (timer interval = 500 ms)

4 System design

This section covers detailed information on the PCB design and components of the module.

Figure 17 shows the schematic overview of the XENSIV™ BGT60CUTR13AIP SMD module. The individual blocks are highlighted in the next section.

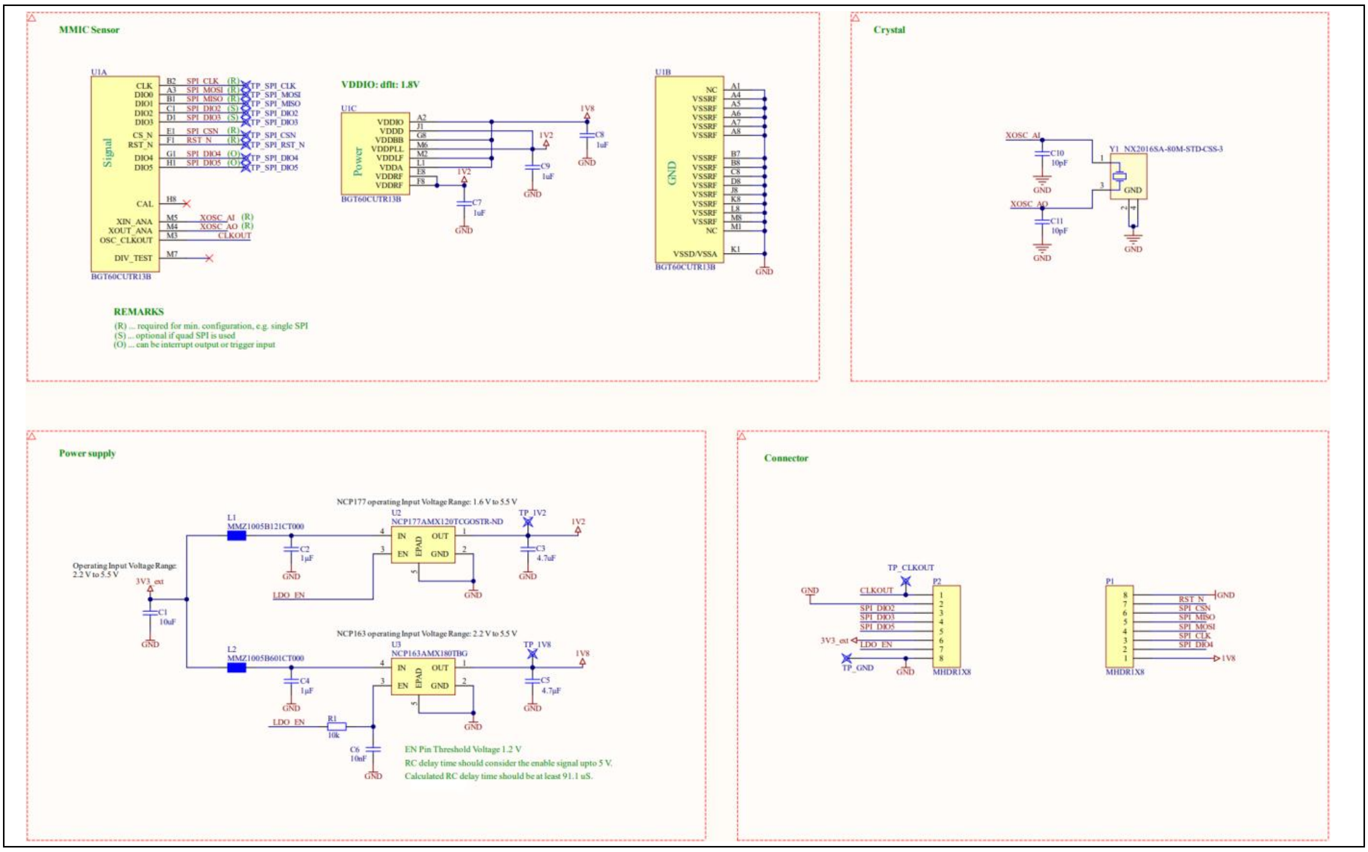


Figure 17 Schematic overview of XENSIV™ BGT60CUTR13AIP SMD module

4.1 Schematics

Figure 18 shows the power supply circuitry of the radar module. Information on LDO evaluation and general guidance on power supply circuitry for radar SoCs is available in a dedicated application note [9]. The purpose of the RC pair of R1 and C6 is to delay the LDO_EN signal for the 1.8 V LDO, as it is recommended that the radar SoC be supplied first with 1.2 V on startup.

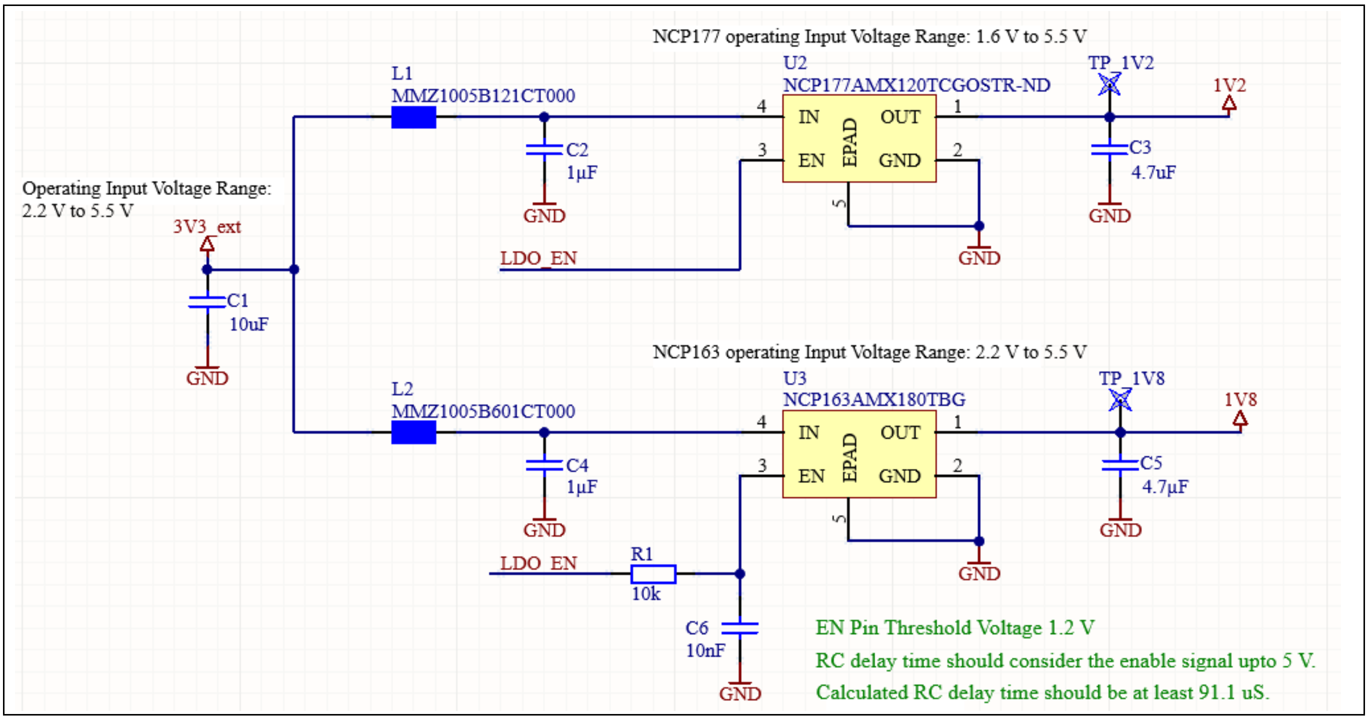


Figure 18 Schematic of the XENSIV™ BGT60CUTR13AIP SMD module power supply circuitry

The radar SoC requires a stable reference clock with low-phase jitter and low-phase noise. Therefore, the module employs an 80 MHz NDK NX2016SA-80M-STD-CSS-3 XTAL resonator as shown in Figure 19.

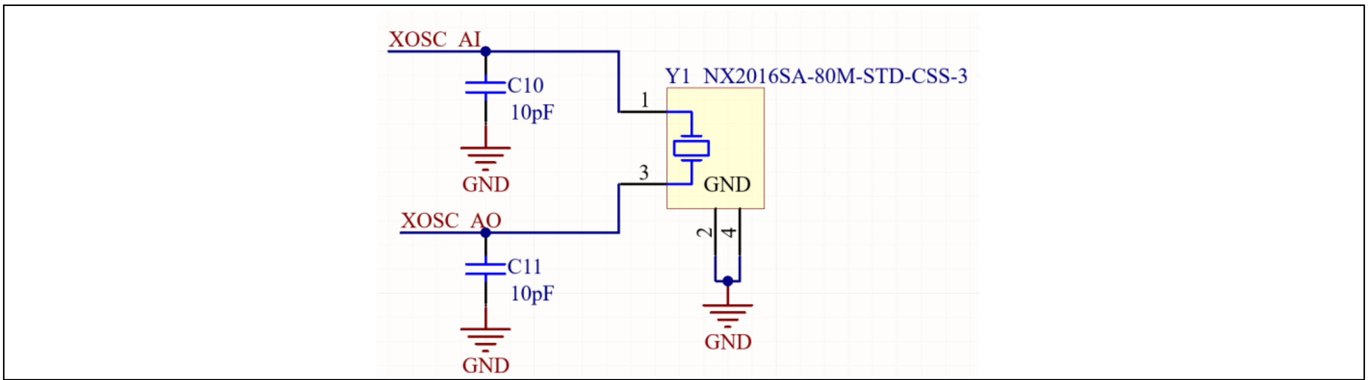


Figure 19 Schematic of the XENSIV™ BGT60CUTR13AIP SMD module XTAL resonator circuitry

Figure 20 shows the schematic around the radar SoC with additional blocking capacitors. Capacitors C7, C8, and C9 are the only components that are placed with the radar SoC inside the EBG structure.

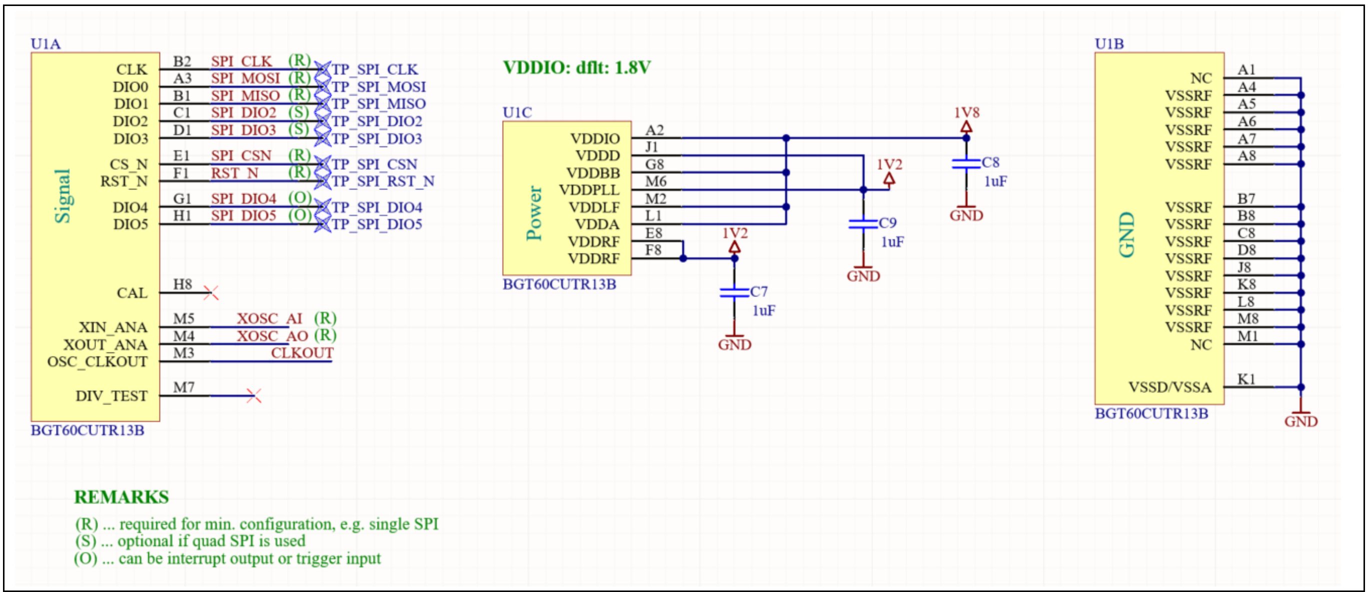


Figure 20 Schematic of the XENSIV™ BGT60CUTR13AIP SMD module radar SoC circuitry

Figure 21 shows the interface to the carrier board on the module side.

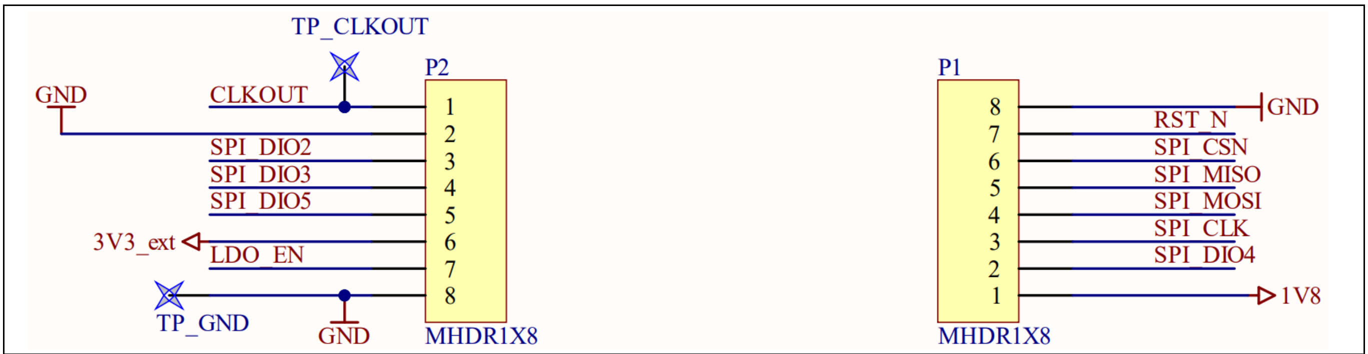


Figure 21 Schematic of the XENSIV™ BGT60CUTR13AIP SMD module half stamp hole connectors

4.2 Layout

To reduce the sensitivity of the radar sensor with integrated antennas towards PCB design and to provide more consistent performance within a holder and radome, an EBG structure is adopted in the PCB layout. The EBG structure is an RF structure tuned to the 60 GHz band, requiring a dedicated thickness, and dielectric constant of the top dielectricum. The EBG structure on the module has been optimized for the used FR4 PCB stack. The top layer layout is shown in Figure 22, while the dimensions of the EBG structure are shown in detail in Figure 23.

The following are the key dimensions of the EBG structure:

- Full through via hole size (d) of 0.2 mm (no blind vias)
- Distance between neighboring via center (p): 0.85 mm
- EBG pad dimension (w): 0.5 mm
- Layer thickness between top layer and ground layer beneath (l): 0.33-0.38 mm

For more information on electromagnetic band gap, see the application note on EBG structures [4].

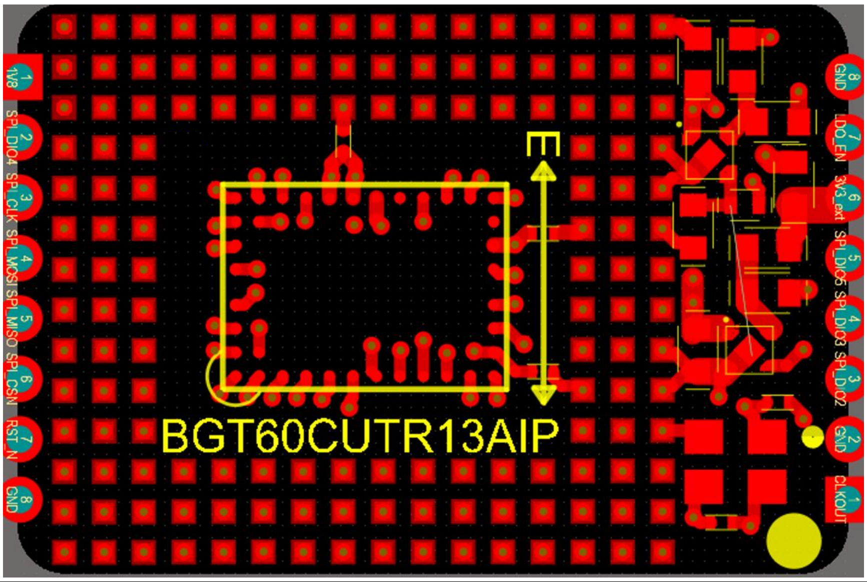


Figure 22 Top layer view of XENSIV™ BGT60CUTR13AIP SMD module layout

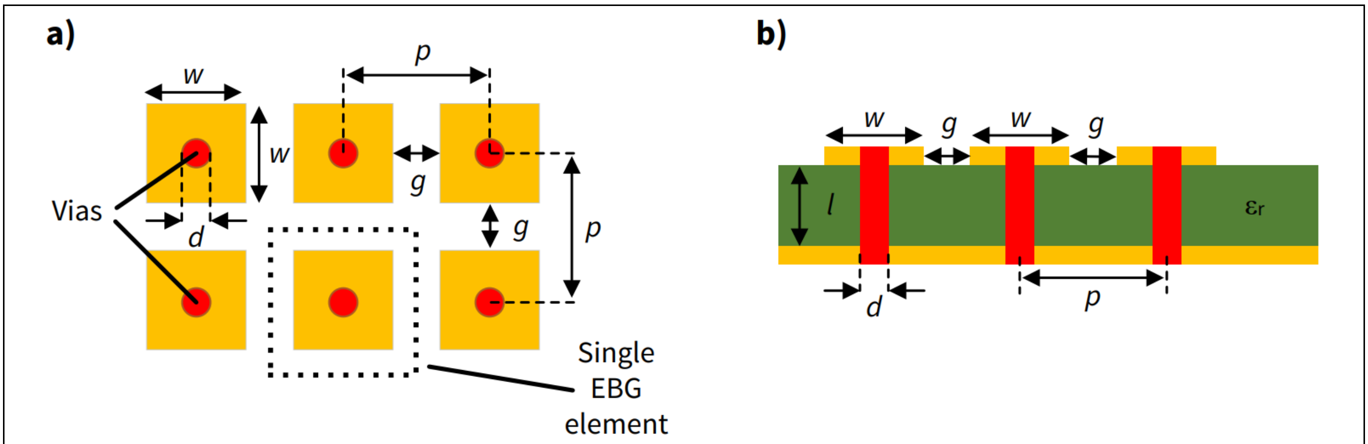


Figure 23 Grid of EBG elements with corresponding design parameters in a) top and b) side views

It is important to highlight that the EBG design is only valid for the specific PCB layer stack defined by the substrate material underneath the EBG pads (described by its relative permittivity) and the thickness of this substrate layer. Deviations from one or both parameters can impact the radiation characteristic of the individual antennas and the overall sensor performance.

The showcased performance in this document can only be expected when using the identical PCB layer stack as shown in Figure 24, consisting of four metal layers.

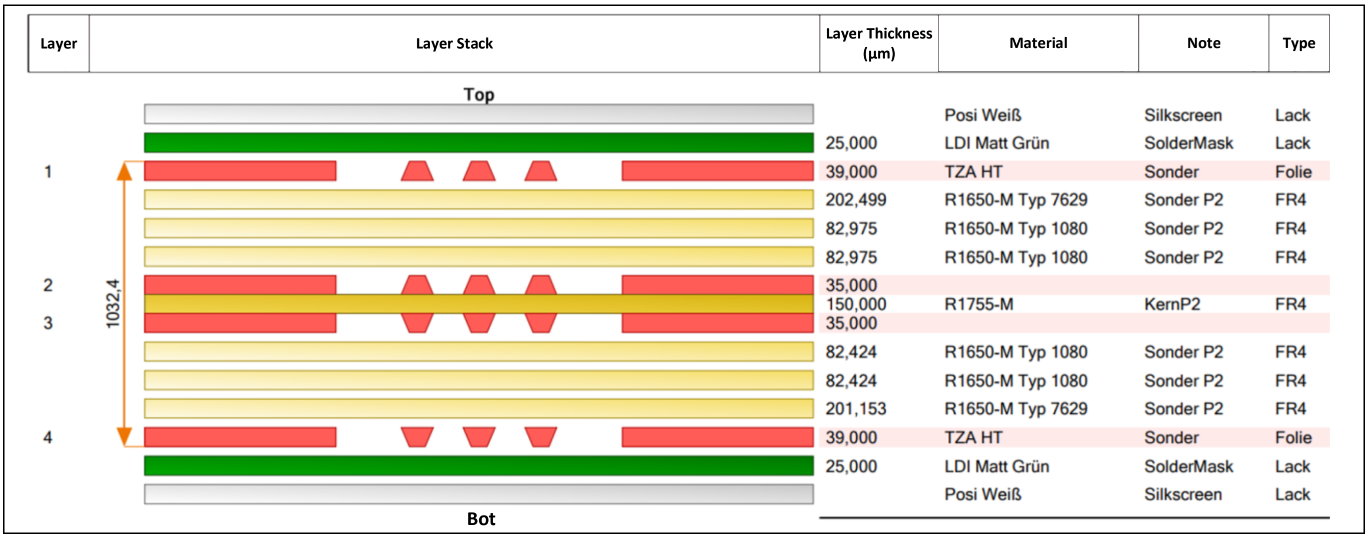


Figure 24 PCB Layer stack

4.3 Bill of materials

This chapter contains the bill of materials (BOM) of the certified module.

Table 8 Bill of materials

Ref designator	Description	Value/Type
C1	Capacitor	10 µF/0402
C2, C4	Capacitor	1 µF/0402
C3, C5	Capacitor	4.7 µF/0402
C6	Capacitor	10nF/0402
C7, C8, C9	Capacitor	1 µF/0201
C10, C11	Capacitor	10 pF/0201
R1	Resistor	10 kΩ/0201
L1	SMD ferrite bead	MMZ1005S121CT000/0402
L2	SMD ferrite bead	MMZ1005B601CT000/0402
U2	NCP177 - LDO 500 mA, XDFN4	NCP177AMX120TCGOSTR-ND
U3	NCP163 - LDO 250 mA, XDFN4, ultra-low-noise, high PSRR	NCP163AMX180TBG
Y1	Crystal, automotive and industrial grade ceramic base SMD	NX2016SA-80M-STD-CSS-3
U1	Radar SoC	XENSIV™ BGT60CUTR13AIP

5 Integration instructions

This section provides guidance on the integration of the full modular certified module into host products.

5.1 Integration of radar module into the host product to avoid interference

For integration of the module into the host application, it is important to ensure that the emissions from the host electronics are not inadvertently impacting the module and preventing proper operation. Conversely, the module emissions should not affect the operation of other parts of the host product.

To avoid interference, it is recommended to place the radar module inside the host product as far as technically feasible from other electronics that have been identified as susceptible to RF emissions or identified to be a potential source of such emissions. Such potential sources include other intentional transmitters or digital electronics operating at MHz clock rates.

Additionally, proper host product design and choice of appropriate materials are required to minimize reflections of the radar signal inside the host product, and therefore to avoid interference. More guidance on product design and materials is given in Section 5.2.

5.2 Radome design and integration guide

A radome is a radar sensor enclosure or cover to protect the sensor or hide it from the product outlook. However, the radome will impact on the radar performance, reducing the signal strength of the detected radar targets. The objective of this document is to provide guidelines on radome design to ensure the expected performance of the radar system. For further information, it is recommended to read the general white paper on radar wave propagation through materials [12].

5.2.1 Material considerations

The dielectric properties of the radome material (dielectric losses and relative permittivity value) at the operating frequency range must be considered. In case no data is available, the dielectric properties can be evaluated by measurement.

Recommendations

- Dielectric materials with low dielectric loss and low relative permittivity (e.g., plastic, such as Teflon, plexiglass, polycarbonate, or ABS). The higher the relative permittivity of a material, the stronger the impact on the sensor performance can be
- A list of materials and their characteristics are available in the white paper [12]. Nevertheless, it is recommended to evaluate the material properties of the specific material used since the properties can vary for different vendors and manufacturers

To be avoided

- Metals – solid metals, but even thin foils like aluminum foil will hinder radiation through the material. Some paint colors contain tiny metal particles which greatly reduce radar signal strength as well
- Materials with high dielectric loss absorb the radar signal inside the radome and therefore reduce signal strength and radar performance
- Materials with unknown dielectric properties at the sensor operating frequency introduce a risk of decreased sensor performance

5.2.2 Mechanical considerations

The distance between the radar SoC and the radome should be half the free-space wavelength (λ/2 ≈ 2.5 mm at 60 GHz), or integer multiples λ/2. See Figure 25 and white paper [12] for details.

Placing any components in proximity to the radar SoC should be avoided. This includes dielectric materials like the radome. Components placed in the antenna near-field will not only block radiation but also affect important antenna characteristics like the antenna impedance. In consequence, the antenna matching will be affected. This can lead to a reduced power radiated by the antenna, which again will reduce the detection range.

The radome should be formed by an isotropic homogeneous material and provide smooth surfaces for the whole sensor FoV. Avoid holes, drills, or other modifications on the radome in the field of view of the radar. Any radome placed in front of the sensor will at least have a minor impact on the antenna characteristics and sensor performance.

The exact impact of radome on sensor performance can only be determined by electromagnetic (EM) simulations or measurements. The recommended thickness of the radome to achieve reasonable sensor performance is half the wavelength inside the radome material $\lambda_{radome}/2$ or integer multiples of $\lambda_{radome}/2$. The wavelength inside the radome material depends on the operating frequency and the material properties:

$$\lambda_{\text{radome}}/2 = \frac{\lambda}{2\sqrt{\varepsilon_r}} = \frac{c_0}{2f\sqrt{\varepsilon_r}}$$

Equation 1

A tilt between the sensor surface and the radome surface may result in a tilt of the effective radar FoV. This effect can be utilized for specific applications, but in general it is recommended to avoid any tilt between sensor surface and radome.

The above guidelines help to avoid typical mistakes for radome scenarios and to provide suitable performance for many applications. Optimizing a radome for maximum sensor performance for a specific application is a complex task and will require EM simulations. For support on EM simulations or guidance on measurements, contact Infineon’s regional support.

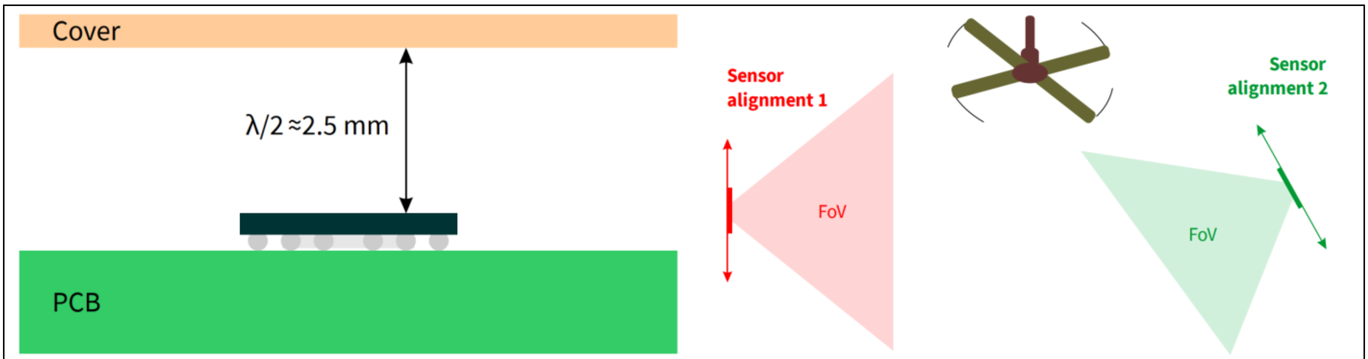


Figure 25 Radar sensor spacing and sensor tilting

Placement and orientation of the radar sensor are tools to adjust the field of view (FoV) according to the application and environment requirements. A shown on the right side of Figure 25, simple tilting of the sensor towards the floor shapes the FoV in the manner that a fan at the ceiling will no longer be detected. While the radar SoC’s postprocessing is designed to cope with undesired targets, such as fans, placement, and orientation should still be considered during the host product development.

Mount the whole radar system rigidly to avoid vibrations. Avoid vibrations between the radome and the radar antennas at all costs.

5.2.3 Summary

This section briefly summarizes points regarding radome design and sensor integration for the XENSIV™ BGT60CUTR13AIP SMD module:

- Be aware of radome impact on sensor performance. Adding a radome or cover will always have some impact on the sensor performance
- Consider the sensor placement and radome design early in system or product design
- Select materials with low dielectric loss and low permittivity if possible
- Avoid materials with unknown dielectric properties at the radar sensor operating frequency
- Dielectric properties must not change overtime or condition (e.g., moisture)
- Choose the recommended value for radome thickness: half wavelength inside radome material, see Equation 1
- Avoid tilting the radome with respect to the sensor if wide FoV in both E- and H planes are required. Tilting the radome will reduce the FoV in this plane
- Try to avoid placing metallic or dielectric components in proximity to the radar sensor
- Avoid placing metallic objects in the sensor FoV
- The exact impact of a radome can only be evaluated by EM simulations or measurements of the actual hardware

5.3 Angle correction and calibration

Despite following all integration guidelines, the integration of the module into a host product can still have an impact on the angle detection performance. In case the performance after integration is insufficient, the angle detection accuracy can be improved by two powerful processes, deemed to be embedding the effects of the radome:

- Angle correction
- Angle calibration

For support and tools for angle correction and calibration, contact Infineon's regional support.

5.4 Spurious emission testing

This section lists the recommended spurious emissions test ranges relevant for FCC and CE module integration processes. Further details on module integrations tests are provided for FCC in Section 6.7 and for CE in Section 7.3.

The following frequency test ranges are derived from the radar's internal signals:

- 50 kHz to 200 MHz test range, containing the following ranges with margin
  - RCOSC frequency range: 71 kHz to 84 kHz
  - SPI frequency range: ≤50 MHz
  - XTAL and frequency doubler frequency range: 80 MHz to 160 MHz
- 55 GHz to 66 GHz test range (57 GHz to 64 GHz fundamental range H1 with margin)
- 112 GHz to 130 GHz test range (114 GHz to 128 GHz second harmonic range H2 with margin)

- 169 GHz to 190 GHz test range (171 GHz to 192 GHz third harmonic range H3 with margin)

If the final host product features further co-located intentional radiators (e.g., Bluetooth®, WLAN) besides this module, the above-mentioned list should be complemented by the following test range:

- 57 GHz to 64 GHz fundamental range ±H1 of co-located intentional radiator

The module integration tests must be performed in the final host product in application mode, with all other electrical components of the host product active.

6 FCC compliance

The reference module has been certified at FCC per rules as stated in Section 6.1.

Host product manufacturers are advised to contact Infineon's regional support to initiate processes according to FCC Section 2.933 Change in identification of equipment.

Host product manufacturers are advised to carefully read this section and follow the guidelines according to KDB 996369 D04, or the latest updates of it.

6.1 List of applicable FCC rules

The modular transmitter is tested according to the following rules:

- FCC Rules and Regulations Part 15, Subpart A – General
  - Part 15, Subpart A, Section 15.31 Measurement standards
- FCC Rules and Regulations Part 15, Subpart C – Intentional Radiators
  - Part 15, Subpart C, Section 15.203 Antenna requirements
  - Part 15, Subpart C, Section 15.204 External radio frequency power amplifiers and antenna modifications
  - Part 15, Subpart C, Section 15.205 Restricted bands of operation
  - Part 15, Subpart C, Section 15.207 Conducted limits
  - Part 15, Subpart C, Section 15.209 Radiated emission limits, general requirements
  - Part 15, Subpart C, Section 15.255 Operation within the band 57 GHz to 71 GHz
- Constraints according to Part 15, Subpart C, Section 15.255 (a) and (b)
  - (a) General. Operation under the provisions of this section is not permitted for equipment used on satellites.
  - (b) Operation on aircraft. Operation on aircraft is permitted under the following conditions:
    - (1) When the aircraft is on the ground.
    - (2) While airborne, only in closed exclusive on-board communication networks within the aircraft, with the following exceptions:
      - (i) Equipment shall not be used in wireless avionics intra-communication (WAIC) applications where external structural sensors or external cameras are mounted on the outside of the aircraft structure.
      - (ii) Except as permitted in paragraph (b)(3) of Section 15.255, equipment shall not be used on aircraft where there is little attenuation of RF signals by the body/fuselage of the aircraft.
      - (iii) Field disturbance sensor/radar devices may only operate in the frequency band 59.3-71.0 GHz while installed in passengers' personal portable electronic equipment (e.g., smartphones, tablets) and shall comply with paragraph (b)(2)(i) of Section 15.255, and relevant requirements of paragraphs (c)(2) through (c)(4) of Section 15.255.
    - (3) Field disturbance sensors/radar devices deployed on unmanned aircraft may operate within the frequency band 60-64 GHz, provided that the transmitter not exceed 20 dBm peak EIRP. The sum of continuous transmitter off-times of at least two milliseconds shall equal at least 16.5 milliseconds within any contiguous interval of 33 milliseconds. Operation shall be limited to a maximum of 121.92 meters (400 feet) above ground level.

6.2 Specific operation use conditions

- The module is classified for use in fixed equipment. See Section 6.4
- The module is certified in two certification modes. See Table 5.
- The module's environmental conditions are listed in Table 9.

Table 9 FCC environmental conditions

Parameter	Symbol	Values			Unit	Notes or conditions
		Min.	Typ.	Max.		
Ambient temperature	T_A	–20	–	65	°C	–
Input voltage	V_{in}	2.6	3.3	4.7	V	Module has been tested from 2.2 V to 5.4 V

6.3 Trace antenna design

Not applicable.

6.4 RF exposure considerations

- The performed human exposure evaluation is described in the human exposure test report filed with this application [10]
- The module is classified for use in fixed equipment

The host product operating conditions must be such that there is a minimum separation distance of 20 cm (or possibly greater than 20 cm) between the module and nearby persons.

The host product manufacturer is required to provide the following text in its end user manual:
"In order to comply with FCC RF Exposure requirements, this device must be operated with a minimum separation distance of 20 cm between the equipment and a person's body."

6.5 Antennas

- The antenna is integrated into the radar package (Antenna-in-Package)
- Type: Linear polarized strip patch array antenna with a typical gain of 3 dBi
- All measurements were performed radiated only. Conducted measurements are not applicable for Antenna-in-Package designs

6.6 Label and compliance information

- The module does not have an FCC label attached to it
- The host product manufacturer is advised to provide a physical label or e-label stating "Contains Transmitter Module FCC ID 2AYSQBGT60CUTR13-A"
- The label attached to the final product must be visible from outside
- An example for an FCC label is shown in Figure 26

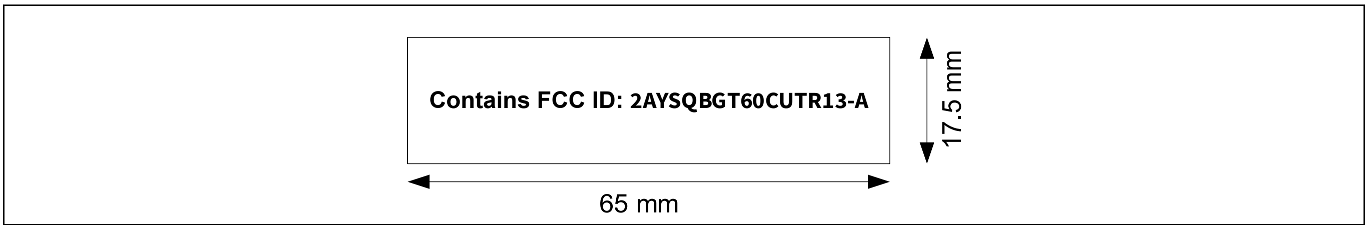


Figure 26 FCC ID label example

6.7 Information on test modes and additional testing requirements

- For test modes, see Section 3.1
- The host manufacturer must follow the integration instructions in Sections 5.1 and 5.2. The final host product must comply with applicable FCC regulations
- The host manufacturer must ensure that the composite-system end product complies with the FCC requirements by a technical assessment or evaluation of the FCC rules and to KDB Publication 996369
- The host manufacturer must perform module integration tests as specified below:

For FCC module integration tests in the final host product, the test ranges stated in Section 5.4 must be checked for spurious emissions. If the final host product features further co-located intentional radiators (e.g., Bluetooth®, WLAN), simultaneous transmission compliance measurements (all intentional radiators activated) are required.

For simplicity in spurious emission testing, it is recommended to cover the full range of 9 kHz to 200 GHz at a certification test house.

In addition to the spurious emission measurements, the host product manufacturer must repeat the fundamental (EIRP) measurement.

In case the host product manufacturer does not use one of the internal configurations listed in Table 3, the user-defined configuration must be a subset of one of the certification modes CM1/CM2 defined in Table 5. In this case, the host product manufacturer must repeat additional occupied bandwidth (OBW) measurements:

- Subset of CM1: OBW according to FCC § 15.255(c)(2)(v)
- Subset of CM2: OBW according to FCC § 15.255(c)(2)(ii)

When implementing a user-defined configuration as subset of CM2, the host product manufacturer must additionally repeat the transmitter RF-on/off time measurements in timing mode (see Table 6) to verify compliance with FCC § 15.255(c)(2)(ii).

For support in implementing the timing mode for measurement purposes, contact Infineon's regional support.

6.8 Additional testing, Part 15 Subpart B disclaimer

- The modular transmitter is only FCC authorized for the specific rule parts listed in the grant of certification
- The host manufacturer is responsible for compliance with any other FCC rules that apply to the host, not covered by the modular transmitter grant of certification

6.9 Notes

Attention: The host product manufacturer must provide the following text to the end-user.

Changes or modifications not expressly approved by the party responsible for compliance could prevent the user's authority to operate the equipment.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- This device may not cause interference
- This device must accept any interference, including interference that may cause undesired operation of the device

7 CE compliance

This section provides information on the module's CE certification, label information, and guidance on module integration for the certification modes CM1/CM2 defined in Table 5.

The EC-Declaration of Conformity is shown in Figure 27.

Infineon Technologies AG

EC-Declaration of Conformity

Manufacturer:	Infineon Technologies AG
Address	Am Campeon 1-15 85579 Neubiberg, Germany

This declaration of conformity is issued under our sole responsibility.

We declare that the product

Type:	Short Range Radar (SRR) module
Model:	BGT60CUTR13AIP SMD
Hardware Revision:	V1.0
Software Revision:	not applicable
Intended use:	various Short Range Radar (SRR) use cases (e.g. motion/presence detection in consumer applications)

complies with the essential requirements of the RED 2014/53/EU Directive if used for its intended use and that the following standards have been applied:

3.1a – Health and safety Applied standard(s)	EN 62311:2008-09 IEC 62368-1:2023 EN IEC 62368-1:2024+A11:2024
3.1b – Electromagnetic compatibility Applied standard(s)	EN 301 489-1 V2.2.3 EN 301 489-3 V2.3.2
3.2 – Efficient use of radio frequency spectrum Applied standard(s)	DRAFT EN 305 550 V2.1.0
Notified Body / -Number:	CSA Group Bayern GmbH / 1948 Straubinger Strasse 100, 94447 Plattling, Germany
Certification number:	ZS 26 004879891 001

Place and date of the declaration of conformity:
Neubiberg, 19th of February 2026

Andreas Kopetz, Vice President – PL Head Radar

Figure 27 EC-Declaration of Conformity

7.1 CE rules

- Frequency band
  - Certification Mode 1: Range 61.0 GHz to 61.5 GHz
    (Band 61.0 GHz to 61.5 GHz according to EN 305 550-1 V2.1.0, Section 4.3.3.3)
  - Certification Mode 2: Range 59.44 GHz to 61.56 GHz
    (Band 57 GHz to 64 GHz according to EN 305 550-1 V2.1.0, Section 4.3.3.3)
- Mean radiated power
  - Certification Mode 1: EIRP +7.0 dBm
    (Per EN 305 550-1 V2.1.0, Section 4.3.3.3)
  - Certification Mode 2: EIRP +3.2 dBm
    (Per EN 305 550-1 V2.1.0, Section 4.3.3.3)
- Ambient temperature range: –20°C to +65°C

For an overview of all applicable rules and standards, see the CE test reports [11].

7.2 Label information

If the module is produced and integrated into a final product by a third party, the third party must update the CE label information (manufacturer name/address, see example in Figure 28) accordingly and clearly display the **CE label** plus the model name “**BGT60CUTR13AIP SMD**” on the final product’s **packaging** and in the **user manual**.

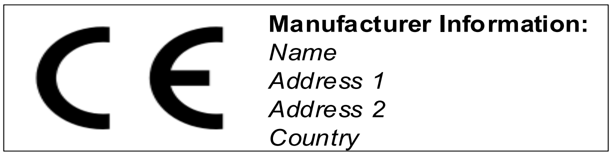


Figure 28 CE label example

7.3 Integration of the radar module into the host product

For integration of the full CE RED qualified short range radar (SRR) module into the host application, it is important to ensure that the emissions from the host electronics are not inadvertently impacting the module and preventing proper operation. Conversely, the module emissions should not affect the operation of other parts of the host product.

To reduce the impact of the module on emissions, the host product manufacturer is advised to follow the guidelines of Section 5.1 and Section 5.2.

The final host product must comply with applicable CE regulations.

It is highly recommended to verify the final product by performing module integration tests on the entire host product. These module integration tests should be performed with the host product configured in typical operation modes to measure the fundamental frequency and spot-checking spurious emissions for compliance with all applicable rules.

In case the final product contains further intentional radiators (e.g., Bluetooth®, WLAN), all intentional radiators must be activated during the module integration tests to verify the functionality and compliance with CE RED regulations, including the coexistence of all participating systems.

Further recommendations on spurious emission spot-checking are listed in Section 5.4.

For CE, only spurious in 30 MHz to 130 GHz need to be considered.

For simplicity in spurious emission testing, it is recommended to cover the full range of 30 MHz to 130 GHz at a certification test house.

References

[1] Infineon Technologies AG: *XENSIV™ BGT60CUTR13AIP webpage;* Available online

[2] Infineon Technologies AG: *XENSIV™ BGT60CUTR13AIP user guide; Available soon*

[3] Infineon Technologies AG: *XENSIV™ BGT60CUTR13AIP datasheet;* Available online

[4] Infineon Technologies AG: *AN155366: Electromagnetic bandgap (EBG) structure application note;* Available online

[5] Infineon Technologies AG: *XENSIV™ BGT60CUTR13AIP Connected Sensor Kit;* Available online

[6] Infineon Technologies AG: *XENSIV™ BGT60CUTR13AIP Visualization Tool;* Available via IDC [7]

[7] Infineon Technologies AG: *Infineon Developer Center (IDC) Launcher;* Available online

[8] Infineon Technologies AG: *ModusToolbox™ Software;* Available online

[9] Infineon Technologies AG: *AN202244: Designing a low-noise, load-independent power supply for short-range radars application note;* Available soon

[10] Infineon Technologies AG: *FCC test reports*; Available upon request

[11] Infineon Technologies AG: *CE test reports*; Available upon request

[12] Infineon Technologies AG: *Radar wave propagation through materials white paper*; Available online

Glossary

AAF
anti-aliasing filter (AAF)

AC
alternating current (AC)

ADC
analog-to-digital converter (ADC)

AIP
antenna-in-package (AIP)

BOM
bill of materials (BOM)

CE
Conformité Européenne (CE)

CSK
connected sensor kit (CSK)

CW
continuous wave (CW)

EBG
electromagnetic bandgap (EBG)

EIRP
effective isotropic radiated power (EIRP)

EM
electromagnetic (EM)

FCC
Federal Communications Commission (FCC)

FMCW
frequency modulated continuous wave (FMCW)

FoV
field of view (FoV)

HPF
high pass filter (HPF)

HWA
hardware acceleration (HWA)

LDO
low-dropout regulator (LDO)

LO
local oscillator (LO)

LS
level shifters (LS)

MADC
multichannel analog-digital converter (MADC)

MCU
microcontroller unit (MCU)

MMIC
monolithic microwave integrated circuit (MMIC)

N.C.
not connected (N.C.)

PA
power amplifier (PA)

PCB
printed circuit board (PCB)

PLD
programmable logic device (PLD)

PLL
phase-locked loop (PLL)

RCOSC
RC oscillator (RCOSC)

RED
Radio Equipment Directive (RED)

RD
range doppler (RD)

ROM
Read Only Memory (ROM)

RX
receiver (RX)

RF
radio frequency (RF)

SMD
surface-mounted device (SMD)

SoC
System-on-Chip (SoC)

SRR
short range radar (SRR)

TX
transmitter (TX)

ULP
ultra-low-power (ULP)

XTAL
quartz crystal (XTAL)

XOSC
crystal oscillator (XOSC)

Revision history

Document revision	Date	Description of changes
1.00	2026-02-13	Initial release

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