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Single-Chip 24 GHz Radar Front End

[Infineon Technologies AG, Neubiberg, Germany](#)

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Infineon has put its first generation of single-chip 24 GHz radar ICs into mass production. The chip is based on a 0.18 μm SiGe:C bipolar process technology with a cut-off frequency of 200 GHz and is designed to operate in the 24 GHz ISM band. The new product family features the highest integration of radar system-on-chip transceivers on the market and a companion receive only chip, which collectively provide system designers with the flexibility to achieve cost and performance targets in a diverse range of applications.



The range of potential sensing applications for the new device family includes:

- Level monitoring in storage tanks (both solids and liquids)
- Smart lighting control
- Security systems
- Intelligent door openers
- Collision avoidance on industrial vehicles

The three devices in the family are the BGT24MTR11 with a single transmit and single receive channel, the BGT24MTR12 with a single transmit and two receive channels and the BGT24MR2, with twin receivers. Moving from a single receiver system to two or more receive channels allows implementation of systems that are able to detect not only the range and the speed of a target but also its angular position relative to the radar sensor's location.

24 GHz radar systems are well-suited to adjusting the intensity of street, industrial and office lights by detecting moving objects or people in the designated area, thus enabling energy efficient lighting. The ability of the BGT24MTR11 to cover transmit frequencies up to 26 GHz facilitates high accuracy in tank and silo level metering systems. These kinds of systems especially benefit from the use of radar, as radars are not sensitive to splashing liquid or dust. Radar-based door opening systems can easily distinguish between someone approaching the door or a passerby. Therefore very energy efficient systems can be created if radar is used for sliding doors.

Another application is intruder alarms, where 24 GHz radar can detect a person typically at a distance of up to 50 m compared to 10 m for commonly used infrared (IR) systems, thus a much bigger area can be covered with only one sensor. An additional benefit of using radar is that it is

not only able to detect that something is moving but also can determine the location and the speed of the moving object.

Figure 1 shows the block diagram of the BGT24MTR11, which can be used to represent the whole family of ICs. Infineon integrated almost the complete analog radar front end into the transceiver ICs, including a voltage controlled oscillator (VCO) with prescaler outputs for frequency control, transmitter chain including amplifiers for both transmitter (TX) and local oscillator (LO) outputs, as well as the complete receiver section including low noise amplifier (LNA) and mixer. Only the antennas are left to be implemented by the system designer.

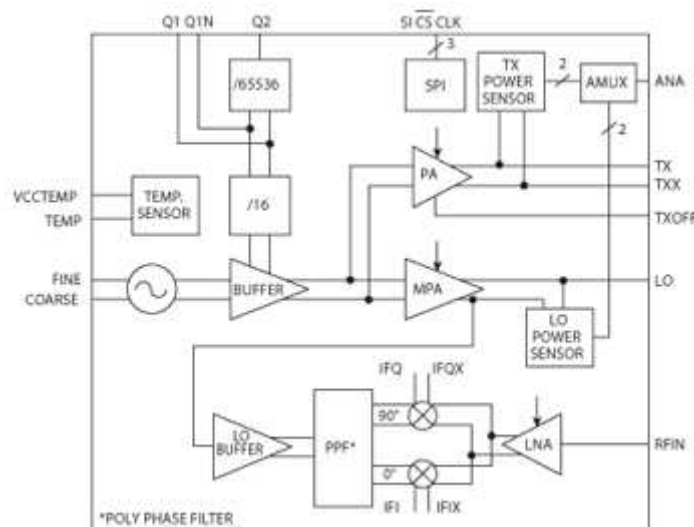


Figure 1 Block diagram of the BGT24MTR11.

The VCO is a free running, fundamental oscillator. It can be controlled by two tuning inputs, one for coarse pre-adjustment and one for fine-tuning. There are two prescalers available in the VCO section of the chip. The first prescaler has an output frequency of 1.5 GHz and can be used to feed an RF-PLL for frequency control. The second prescaler has a 23 kHz square-wave output that may be used by a microcontroller-based software loop.

The TX section consists of a power amplifier with a differential output. Its maximum output power is 11 dBm and can be reduced in eight steps down to 2 dBm. The BGT24 radar ICs have been designed with FMCW radar in mind, therefore a part of the TX signal is used as the LO-signal for the on-chip mixer. The receiver section has a single-sideband noise figure of 12 dB and a voltage conversion gain of 26 dB. The gain of the LNA can be reduced by a gain-step of 5 dB. The built-in quadrature downconversion mixer translates the RF signal directly to zero-IF.

Additionally the chip features power sensors both on TX-outputs and LO-outputs, as well as a temperature sensor that supports the implementation of a software based loop to control the VCO. The settings of the different internal building blocks can be controlled via an SPI interface. The chip is housed in a standard 32 pin RoHS compliant VQFN-package with the option of lead tip inspection. With that the solder joints can be visually inspected and no special X-ray machines or processes are needed for production assembly.

Infineon's single-chip, analog front end ICs reduce the required board area by up to 70 percent compared to discrete solutions in the market. The BGT24MTRxx family simplifies designs and improves time to market by superseding external component matching and space consuming RF transmission lines. The resulting compact design, system flexibility and cost effectiveness of the solution make the BGT24MTRxx family useful for improving performance in existing applications and replacing alternative technologies.

Infineon Technologies AG,
Neubiberg, Germany
 +49 89 234 24462,
www.infineon.com