

Next-Gen high-accuracy fast ranging Bluetooth 5.1 0.8V ULP radio in TSMC 40nm

Preliminary Product Brief

Imec's Next-Gen BLE Radio is a silicon-proven design featuring high-accuracy fast phase-based ranging and a digital-intensive receiver architecture to achieve ultra-low power consumption AFE (<3.8mW), low nominal supply operation (0.8V) and small area (<1mm²).

Description

Imec's 2.4GHz Next-Gen BLE 5.x radio delivers best-in-class performance at world's lowest power consumption. The analog-front end (AFE) features the novel high-accuracy phase-based ranging (distance measurement) method and the AFE supports Bluetooth 5.1, 5, 4.2, 4.0 and IEEE 802.15.4 (Thread, Zigbee). It complies with the FCC and ETSI regulations and delivers an output power up of 2dBm.

The AFE implements features for fast phase-based ranging, allowing for high-accuracy distance measurements (<30cm in multi-path environment) with fast ranging speed (<6ms over 80MHz) for secure access, indoor positioning, asset tracking and many other applications.

The ULP radio uses an advanced digital transmitter and a dual-mode zero-IF IQ as well as a single-branch phase-tracking receiver architecture for ULP modes. The novel transceiver architecture achieves ultra low power consumption at 0.8V nominal voltage supply, boosting battery lifetimes. The front-end consists of a zero-IF I/Q receiver and a Class-D PA. The system clock is provided by a 32MHz crystal oscillator. The fractional-N ADPLL consists of a Digital Controlled Oscillator (DCO), divider with I/Q LO signal generation, phase quantizer and Digital to Time Converter (DTC). It has extensive self-calibration such as DCO bank selection and 2-point gain calibration. A complete digital baseband (DBB) and a microcontroller test system are implemented on FPGA to allow for full-system evaluation with standard test equipment such as Bluetooth CMW/CBT testing.

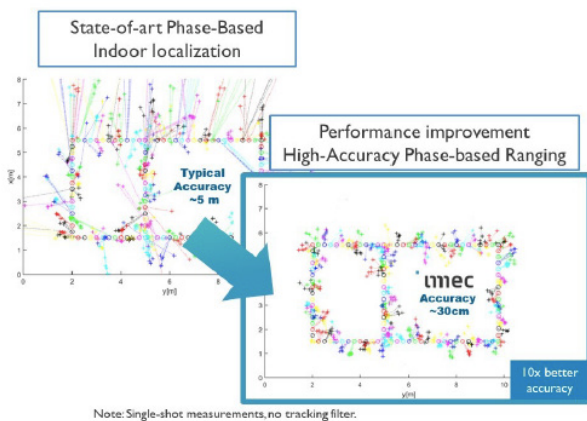
Key features

- Multi-standard 2.4GHz AFE
 - Bluetooth Low Energy (BLE) 4.0, 4.2, 5, 5.1 & beyond
 - IEEE 802.15.4 (Thread, Zigbee)
- Fast phase-based ranging (distance measurement) support
 - For high accuracy multi-carrier phase difference (MCPD) distance measurement technique for indoor positioning, secure access, etc.
 - Accuracy <30cm in practical multi-path environment
 - Fast ranging speed: <6ms over 80MHz
- Advanced architecture for nm-CMOS
 - Dual mode AFE for phase-tracking receiver / IQ receiver
 - All-Digital PLL (ADPLL), digital transmitter and digital PA
 - TSMC 40nm ULP, at 0.8V nominal supply
- Low cost
 - <0.9mm² AFE silicon area
 - On-chip matching & antenna switch IP available (separate deliverable)
- Ultra-low power consumption Rx: <3.8mW BLE
 - Tx AFE: <6.7mW @ 2dBm
- Best-in-class performance
 - Sensitivity: -96dBm PER (1Mbps)
 - Interference robust: ACR @2nd and 3rd channels: 40/43 dB (IMPHY, I/Q)
 - No image issue (zero-IF architecture)
- Designed in TSMC 40nm ULP for 0.8V nominal supply

Applications

- Location Services - Secure Access, Item Finding, Asset Tracking, Wayfinding (Indoor Positioning)
- Smart watches and wearables
- Smart phone accessories
- Hearing aids and audio applications
- Remote controllers
- Home and commercial automation
- Wireless sensor nodes

Novel high accuracy and fast phase-based ranging (distance measurement)

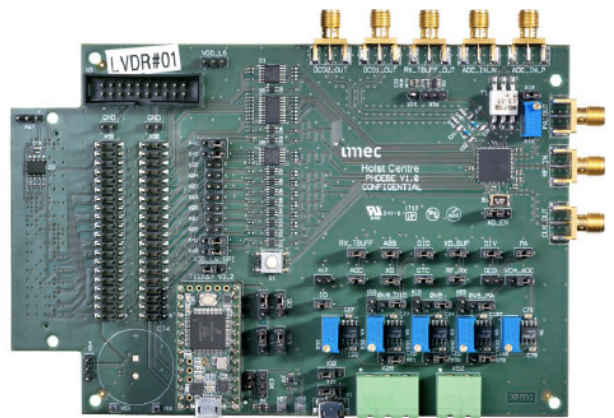


High-accuracy phase-based ranging (distance measurement) significantly improves accuracy versus the state-of-the-art phase-based or signal-strength-based narrowband methods for applications such as indoor localization. The measurement on a Bluetooth radio above illustrates this for an in-door positioning use case, where a mobile node is following an 8-figure shape and positioning results are plotted.

Evaluation boards

Imec provides evaluation boards on request to prospective customers and partners interested in licensing Imec's radio designs and IP. -) Phoebe 3.0 PCB: Allows evaluation of the 2.4 GHz BLE AFE for BER- and PER-based performance

Specifications	
Frequency band	2.4-2.48 GHz
Power consumption	Rx: <3.8mW Tx AFE: <6.7mW @ 2dBm
PLL locking time (cold start)	<5us
Tx output power (Max)	2dBm (max)
Tx FSK Error (BLE 4.0)	<3%
Tx spurious emission	<-50dBm
Rx sensitivity	Adjacent Channel Rejection (ACR) Adjacent C/I: -40dBc @2MHz Alternate C/I: -43dBc @3MHz
Out-of-band blocker	>-17dBm
Nominal supply	0.8V
Technology	TSMC 40nm ULP CMOS
Area (core)	<0.9mm ²



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