ON Semiconductor®

RSL10

February 2017

Focus Markets and Applications

	2013	2018	CAGR
TAM*	$5,796M	$8,473M	7.9%

Automotive

- ADAS
- Sensors
- Lighting
- Connected Car (V2X)

Transdermal Drug Delivery

	2013	2018	CAGR
TAM*	$905M	$1,538M	11.2%

M-Health

- Hearing Aids
- Patient Monitoring
- Drug Delivery
- Implantables

IoT Cloud

Industrial

- Smart Buildings
- Smart Cities
- Lighting
- Metering
- Surveillance
- Thermostats
- Fire & Smoke
- Appliances

	2013	2018	CAGR
TAM*	$1,244M	$3,363M	22%

Wireless

- Smartphones
- Wireless Charging
- Wearables
  - Smart Watches
  - Fitness Bands

^	2013	2018	CAGR
TAM*	$2,970M	$6,380M	16.5%

^Excluding BT Headsets and Hearing Aids from Wearables

Automation & Control

Optimized Resource Consumption

Activity Tracking & Location Awareness

Sensor Driven Decision Analytics

Information & Analysis

Complex Autonomous Systems

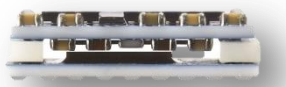
Source: IHS iSuppli, Strategy Analytics, Databeans, TSR, Gartner, Corporate Marketing and BU estimates

Note: *ON Semi TAM – see appendix for detailed definition

ON Semiconductor's Evolution Into Consumer Wireless

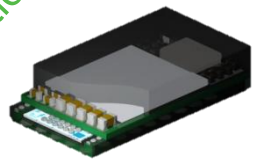
Medical & Wireless Products
Experience & Expertise

Ultra-Low-Power

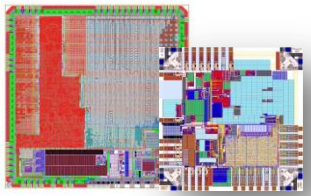


DSP Systems

Miniaturization



Advanced Packaging Technology



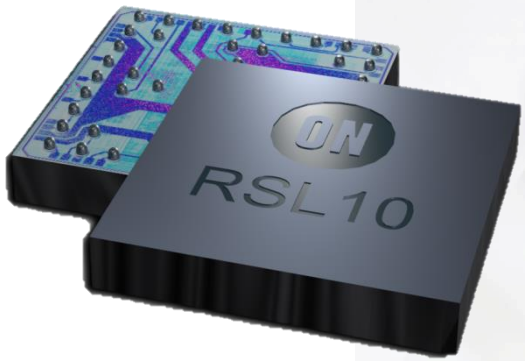
Microcontrollers/AFEs

Corporate Initiatives

- Internet of Things
- Wearables
- Consumer Electronics
- Expansion of Wireless Offerings

Introducing RSL10

Bringing ultra-low-power wireless technology to IoT and wearables



Key Features

- Industry's Lowest Dynamic and Deep Sleep power
- Lowest Peak Rx Power
- Developed using ultra-low-power technology designed for hearing aids

Ultra-Low Power Consumption

ARM CORTEX Processor Technology

Supports voltage supply range between 1.1- 3.6 V

Firmware-Over-The Air (FOTA)

LPDSP32

Highly Flexible

Smallest form-factor with embedded flash (WLCSP)

Multiple package options (WLCSP,QFN)

Competitive System Solution (~10 ext. components)

Ultra-Miniature

Bluetooth® 5

2.4 GHz

Multi-Protocol Support

Can be designed into ASIC solutions or custom modules for additional miniaturization, added integration benefits

Key Technical Features

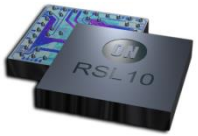
Power Consumption

- Deep Sleep: 50 nA (1.25 V)
- Supports voltage range between 1.1 V to 3.6 V
- Deep Sleep, internal 32 kHz oscillator running with interrupts from timer or external pin : 125 nA
- Tx peak (PHY) @ 0 dBm: 8.9 mA (1.25 V),
- Rx peak (PHY): 5.6 mA (1.25 V)
- Custom audio streaming protocol, 11 kHz BW, Rx: 1.6 mA (1.25 V)

Performance

- Rx Sensitivity: -94 dBm
- Transmitting Power: −17 dBm to +6 dBm
- 384 kB Flash Memory
- Dual Core Processors (ARM® Cortex®-M3 processor, LPDSP32 DSP)
- Analog and Digital Interfaces to Accommodate Various Sensors (GPIOs, LSADs, I^2C, SPI, PCM)
- User Programmable

Ultra-Miniature



- 55 nm technology
- 5.50 mm^2

Bluetooth Low Energy Technology & Multi-Protocols

Bluetooth low energy technology introduced to achieve the lowest possible power for short-range communication

Bluetooth low energy technology features

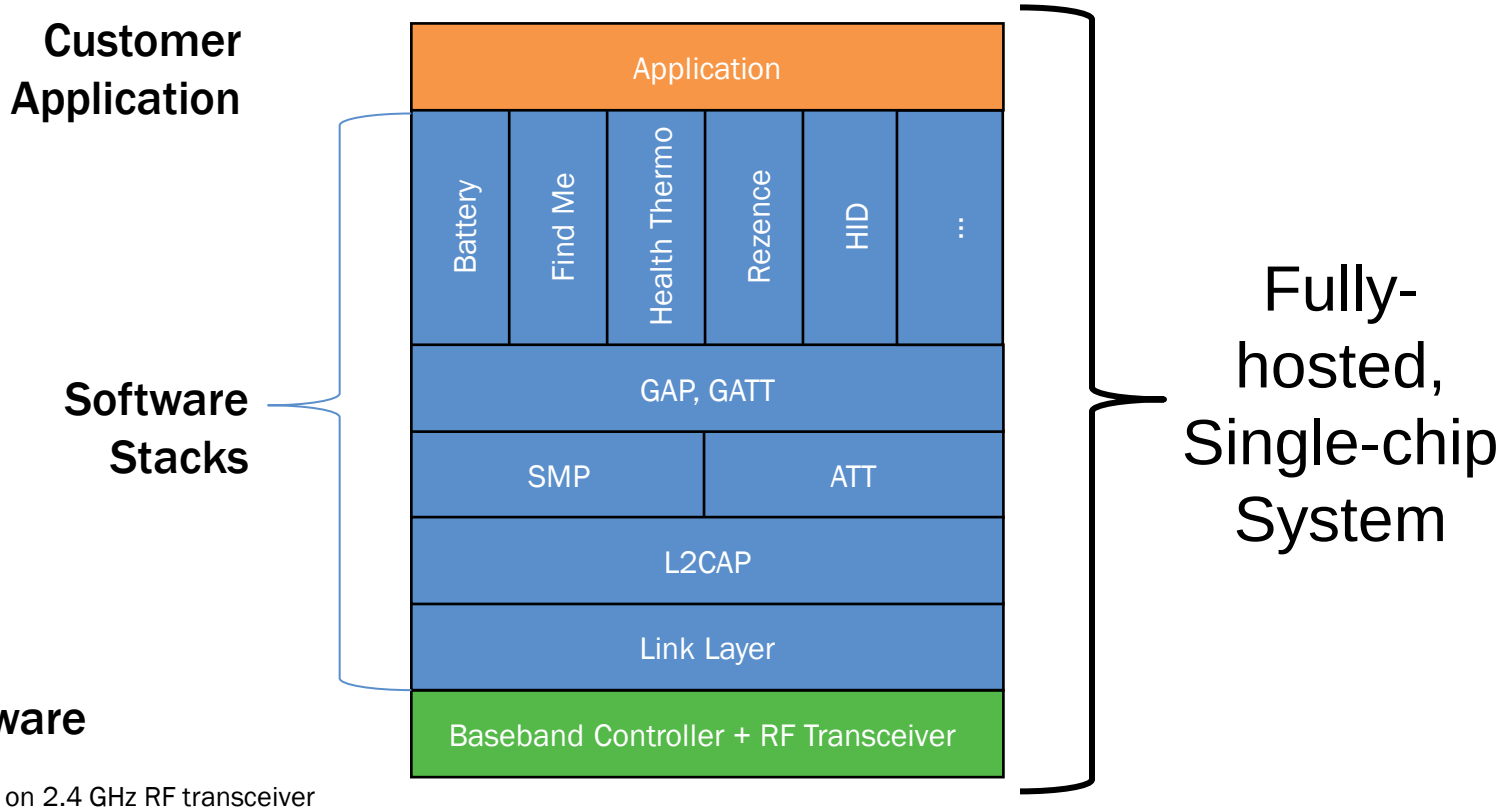
- Operates in 2.4 GHz ISM band, now with a 2 Mbps data rate (Bluetooth 5)
- Optimized for transmitting short bursts of data over long periods (as opposed to “Standard Bluetooth”, which also supports continuous data transfer)
- Easy to implement as Bluetooth low energy host already available in smart phones

Other

- Multi-protocols (e.g. custom/proprietary protocols, mesh networking, etc.)

Implementing Bluetooth Low Energy Technology

Bluetooth low energy baseband is a hybrid solution consisting of hardware and software



Hardware

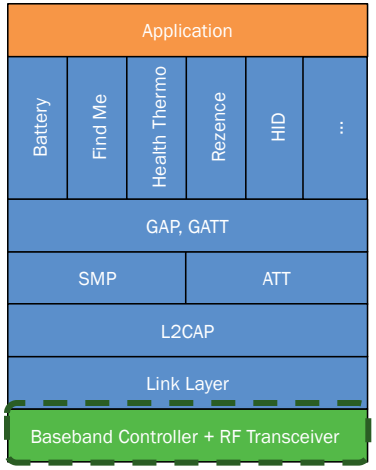
RFFE

- Based on 2.4 GHz RF transceiver
- Implements physical layer of Bluetooth low energy,
- proprietary/custom protocols

Baseband

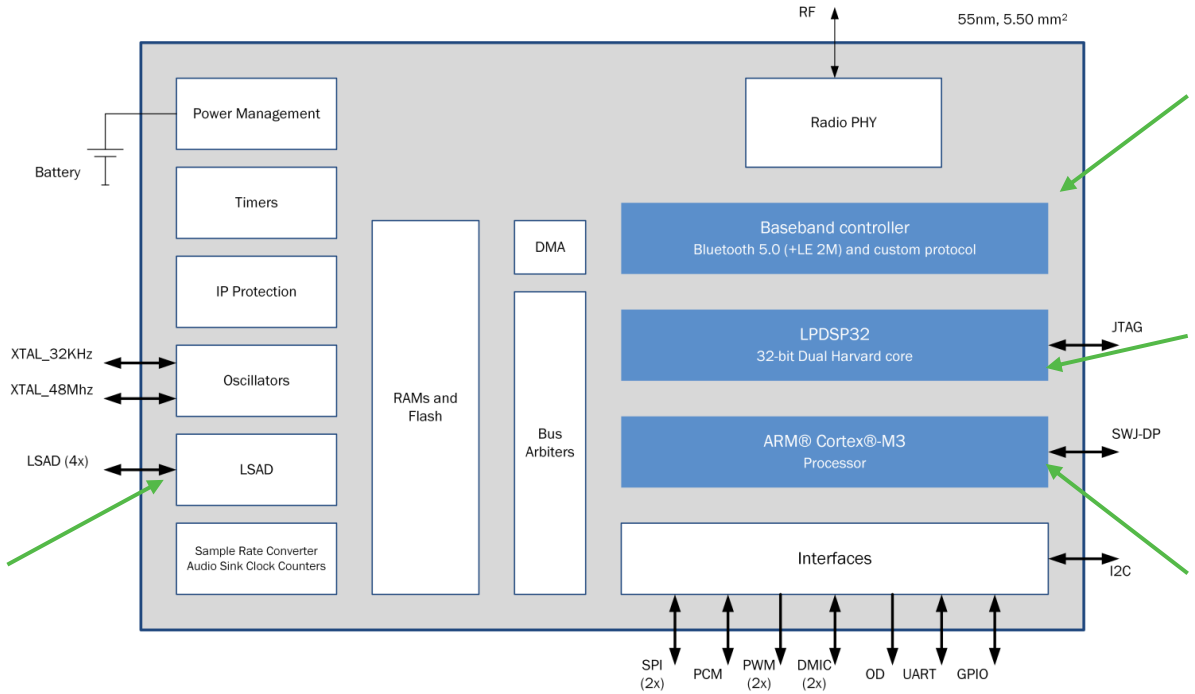
- Bluetooth 5 certified
- Incl. support for 2 Mbps RF link, custom protocols

Baseband Controller and RF Transceiver



Bringing ultra-low-power wireless technology to consumer applications, sensors, wearables, IoT, and more…

A/D converter – suitable for connection to sensors to form a single chip system



Protocols and interface to physical layers

Processor used for math routines such as audio codecs

Processor used for executing Bluetooth low energy stack and user application

RSL10 System Overview

- Master Processor: ARM® Cortex®-M3 processor
  - Data bus: 32 bit
  - Data memory: 88 kB of DRAM, distributed as follow:
    - 24 kB shared between the Bluetooth low energy stack software and the user application
    - 48 kB shared between the ARM Cortex-M3 processor and the LPDSP32
    - 16 kB acting as the exchange memory between the ARM Cortex-M3 processor and the baseband controller. This portion can be directly accessed by the ARM Cortex-M3 processor and the DMA, parallel to the baseband controller.
  - Program bus: 32 bit
- Program memory:
  - 384 kB of flash:
    - Bluetooth stack with profiles is max 128 kB
    - User application, and other non-volatile program elements have 256 kB available.
  - 32 kB of RAM:
    - Wakeup handler or a similar program running in sleep mode
    - At application boot, portions of the flash are copied into RAM (Flash overlay). The copied data includes the real-time functions of the Bluetooth low energy software stack (12-16 kB). These functions are heavily used during communication and are executed from the RAM. This minimizes the number of Flash accesses and lower the overall power consumption.
  - 4 kB of ROM: support functionalities for system operation
- ARM Cortex-M3 processor subsystem include a DMA controller (similar to Ezairo 7100)
- ARM Cortex-M3 subsystems includes the Bluetooth low energy baseband controller
- Development in C
- Max clock: 48 MHz

Key Technical Features

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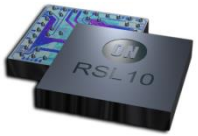
Ultra-Miniature

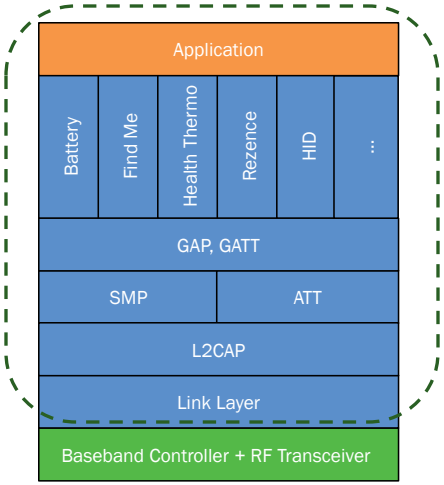


- 55 nm technology
- 5.50 mm^2

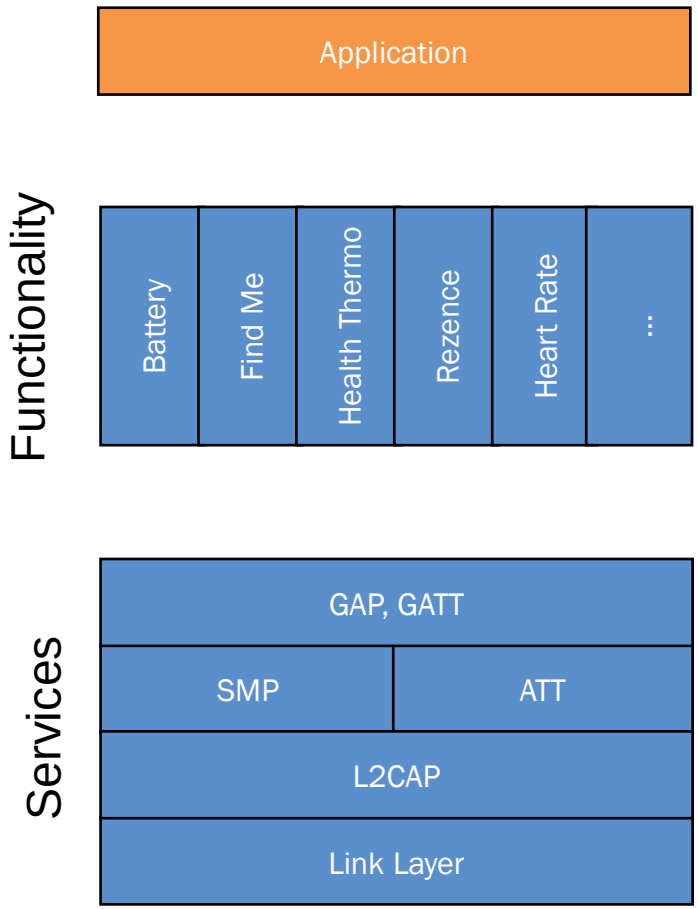
Certification

- RSL10 is Bluetooth 5 certified by Bluetooth SIG
  - 36 profiles and services certified
- FCC and ETSI compliance confirmed
  - Radiated and conducted power, EMI, interference, total emission, etc.

Bluetooth Software Development



Programming Model



Includes BLE and non-BLE code. For BLE code, the application will provide data to or receive data from a profile

Vertical slices of functionality. The profiles ensure interoperability between devices. It is recommended to use all Bluetooth SIG profiles to ensure interoperability with other Bluetooth low energy devices.

Think of these as services with certain characteristics. Basically, a profile will present data to a set of service functions who will then reformat the data, schedule the transfer and give this to (or receive this from the physical layer (the radio).

Example: How To Make A Heart Rate Monitor

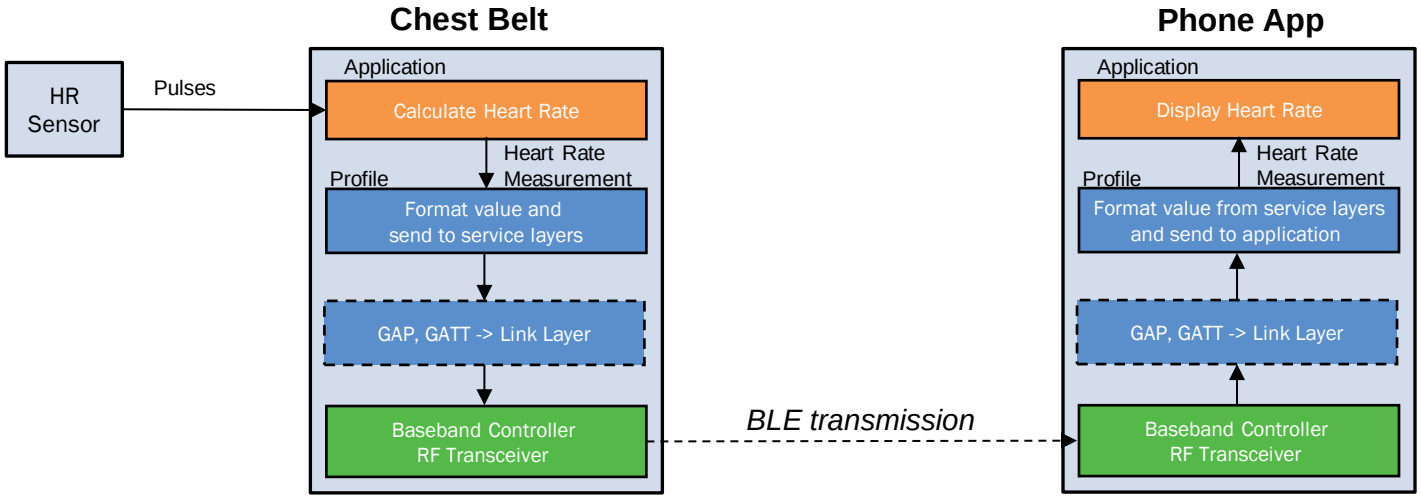
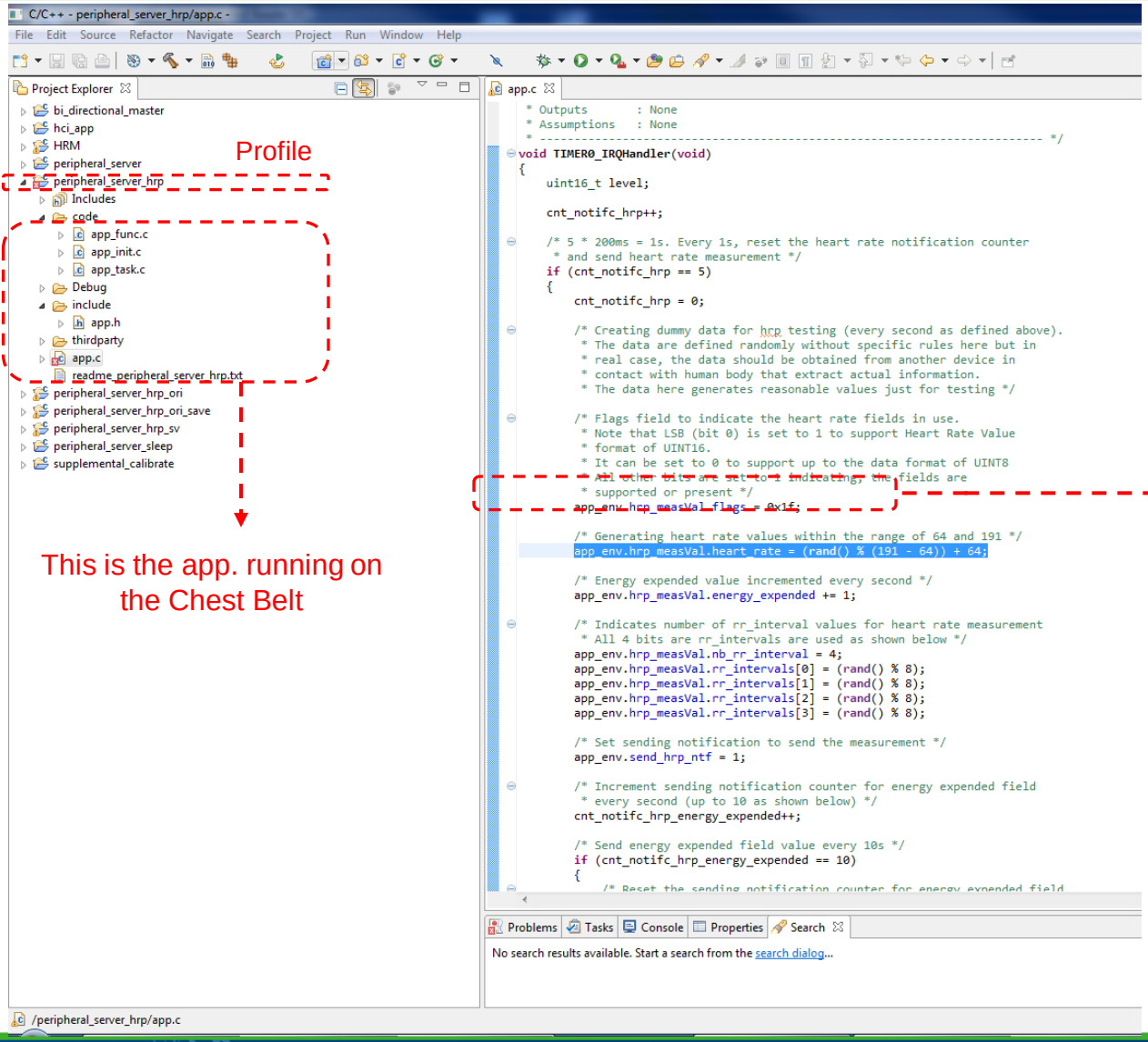


Table 2: Heart Rate Measurement Structure (struct hrs_hr_meas)

Type	Parameters	Description
uint8_t	flags	Measurement Flags
uint8_t	nb_rr_interval	RR-Interval numbers (max 4)
uint16_t [4]	rr_intervals	RR-Intervals
uint16_t	heart_rate	Heart Rate Measurement Value
uint16_t	energy_expended	Energy Expended

The heart rate monitoring profile is basically an applications interface to which you deliver or receive data. A key value is the "Heart Rate Measurement Value". This is the value that contains a measured heart rate calculated as beats per minute (bpm)

Example: How To Make A Heart Rate Monitor Based on RSL10 Sample Code



Where the heart rate value gets passed to the heart rate monitoring profile – everything below this happens "behind your back"!

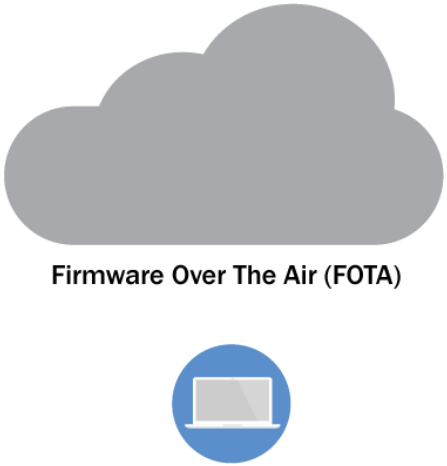
Supported Bluetooth Profiles

- Bluetooth 5 baseband
- Profiles
  - Heart Rate
  - Proximity
  - Health Thermometer
  - Time
  - Blood Pressure
  - Glucose Monitor
  - HID over GATT (HOG)
  - Alert Notification
  - Phone Alert Status
  - Running Speed
  - Cycling Speed
  - Cycling Power
  - Location and Navigation
  - Rezence (wireless charging, custom protocol defined by Alliance)

And more....

Firmware Over The Air (FOTA)

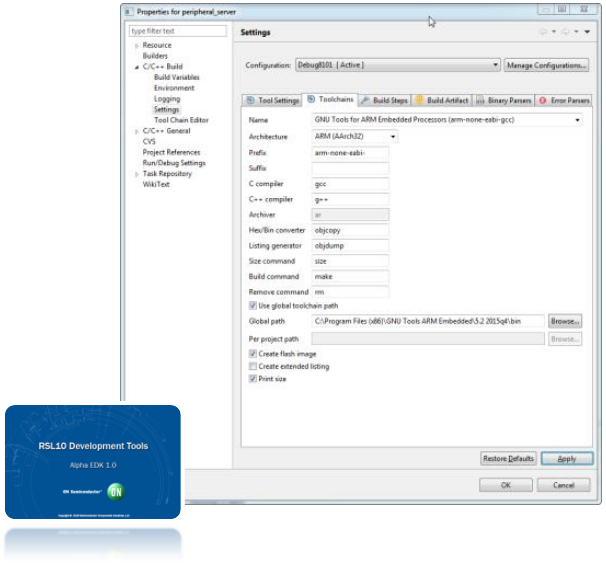
- Firmware upgradable as new releases become available
  - Accommodated via on-chip Flash
  - Sample code available for peripheral (device) and central (PC)
    - Can be incorporated into any user application to add FOTA capability
    - Provided as is



Development Tools Overview

RSL10 Integrated Development Environment (IDE)

- Includes Bluetooth protocol stacks, sample code, libraries, documentation
- ARM Cortex-M3 processor development (GNU toolchain)
- Eclipse with C Development Toolkit (CDT)
- CMSIS package (Available Q2 2017)



Available at onsemi.com

Development Hardware

- Development Board
- USB Dongle (Available Q3 2017)

RSL10 Development Board

LPDSP32 Development Tools

- Support available on request

Development Tools Overview - Technical Documentation

- Embedded in EDK
- Includes:
  - Getting Started
  - Evaluation Board Manual
  - Hardware Reference Manual
  - Firmware Reference Manual
  - Stand-Alone Flash Loader Manual
  - Software Development Tools User's Guide
  - Interface Specifications for Bluetooth Libraries
  - ARM Cortex-M3 Processor Quick Reference Card
  - Sample code Readmes

Certification

- RSL10 is Bluetooth 5 certified by Bluetooth SIG
  - QDID: D034220
  - 36 profiles and services certified
- FCC and ETSI compliance confirmed
  - Radiated and conducted power, EMI, interference, total emission, etc.

RF Measurements

- An additional cable is required for conducting RF measurements
  - Murata MXHS83QE3000 (Available here)
- The RSL10 RF port is connected to the board PCB antenna through a switch connector. The RF signal is routed to PCB antenna by default if the RF probe cable, which is not included in the package, is not plugged in.
- Once the RF probe cable is plugged in, the switch connector will disconnect the PCB antenna and connect the RF signal from RSL10 RF port to the probe cable (which has a standard SMA connection)
- The insertion loss of RF probe cable is 1.0 dB at 2.4 GHz band, max 2.6dB at 3-6GHz band. More information is available from Murata.

Availability

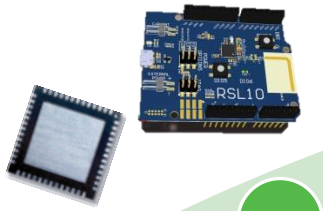
Multiple package offerings available for easy integration into any device

WLCSP

5.50 mm^2

Samples, Development Board: Now

Production: May 2017



QFN

6x6 mm

Samples, Development Board: May 2017

Production: July 2017

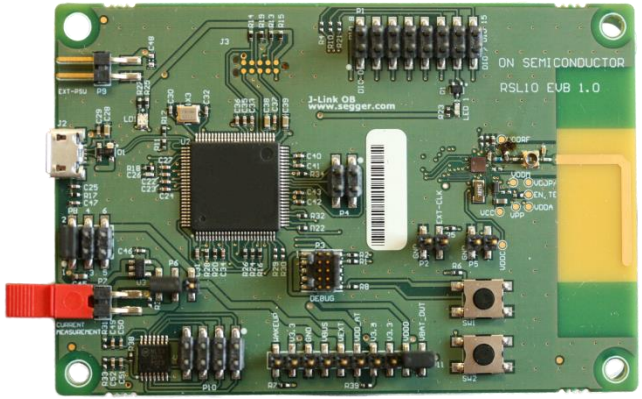
USB Dongle

with Control Panel Software* (Form Factor TBD)

Planned: Q3-2017

*The Control Panel is a SW Utility that allows the developer to monitor services and attributes in real time

Development Hardware

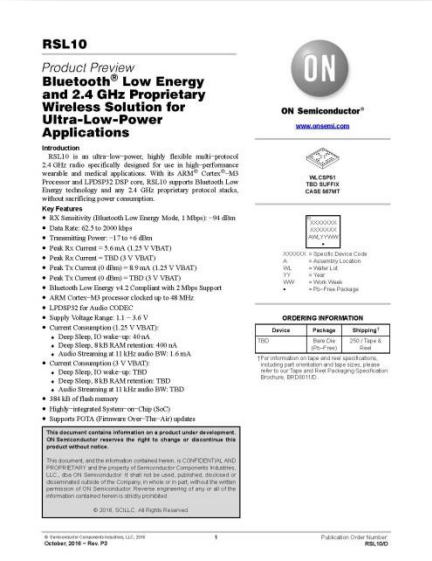


To order an RSL10 evaluation board, contact your sales representative

RSL10

Resources

RSL10
Resources



RSL10

Product Preview

Bluetooth® Low Energy and 2.4 GHz Proprietary Wireless Solution for Ultra-Low-Power Applications

ON Semiconductor®
www.onsemi.com

WLCSP51
TBD SUFFIX
CASE 567MT

ORDERING INFORMATION

Device	Package	Shipping†
TBD	Bare Die (Pb-Free)	250 / Tape & Reel

- Datasheet
- Evaluation & Development Kit (EDK)
  - Incl. software, technical documentation, etc.
- Training Videos
  - "Getting Started" Available March
- Application Notes
  - RSL10 RF Guidelines
    - Available April 2017
  - RSL10 Bluetooth Certification Guidelines
    - Available April 2017

All Available at www.onsemi.com

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Multiple package options (WLCSP,QFN)

Competitive System Solution (~10 ext. components)

Ultra-Miniature

Bluetooth® 5

2.4 GHz

Multi-Protocol Support

Can be designed into ASIC solutions or custom modules for additional miniaturization, added integration benefits

For Devices With:

Longer Battery Life

Better Performance, Advanced Features

Smaller, Lightweight Designs

Faster, Improved Wireless Functionality