

BLUETOOTH LOW ENERGY

GETTING STARTED

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TABLE OF CONTENTS

- 1. Introduction 4
- 2. What is Bluetooth low energy 5
 - 2.1 Classic Bluetooth vs. Bluetooth low energy 6
 - 2.2 Backwards compatibility 7
 - 2.3 More information 7
- 3. Bluegiga's Bluetooth low energy products 8
 - 3.1 BLE112 single mode module 8
 - 3.2 BLED112 single mode USB dongle 9
 - 3.3 Bluetooth low energy stack suite 10
 - 3.4 More information 11
- 4. Contact information 12

1 Introduction

This document is meant to provide a short introduction to *Bluetooth* low energy technology and to Bluegiga's *Bluetooth* low energy products. The purpose of this document is not to give a deep technology or product overview, but should act more as an introduction to both of them and give the necessary information to continue studying.

The document is organized into two sections. Firstly a quick introduction to *Bluetooth* low energy technology is given and then the Bluegiga's *Bluetooth* low energy product family is discussed.

2 What is Bluetooth low energy

Bluetooth low energy is a new, open standard developed by the *Bluetooth* SIG. It's targeted to address the needs of new modern wireless applications such as ultra low power consumption, fast connection times, reliability and security. *Bluetooth* low energy consumes 10-20 times less power and is able to transmit data 50 times quicker than classical *Bluetooth* solutions.

Video:

[How Bluetooth low energy technology works?](#)

Bluetooth low energy is designed for new emerging applications and markets, but it still embraces the very same benefits we already know from the classical, well established *Bluetooth* technology:

- **Robustness and reliability** - The adaptive frequency hopping technology used by *Bluetooth* low energy allows the device to quickly hop within a wide frequency band, not just to reduce interference but also to identify crowded frequencies and avoid them. On addition to broadcasting *Bluetooth* low energy also provides a reliable, connection oriented way of transmitting data.
- **Security** - Data privacy and integrity is always a concern in wireless, mission critical applications. Therefore *Bluetooth* low energy technology is designed to incorporate high level of security including authentication, authorization, encryption and man-in-the-middle protection.
- **Interoperability** - *Bluetooth* low energy technology is an open standard maintained and developed by the *Bluetooth* SIG. Strong qualification and interoperability testing processes are included in the development of technology so that wireless device manufacturers can enjoy the benefit of many solution providers and consumers can feel confident that equipment will communicate with other devices regardless of manufacturer.
- **Global availability** - Based on the open, license free 2.4GHz frequency band, *Bluetooth* low energy technology can be used in world wide applications.

There are two types of *Bluetooth* low energy devices:

- Single-mode devices that only support *Bluetooth* low energy and are optimized for low-power, low-cost and small size solutions.
- Dual-mode devices that support *Bluetooth* low energy and classical *Bluetooth* technologies and are interoperable with all the previously *Bluetooth* specification versions.

Key features of *Bluetooth* low energy wireless technology include:

- Ultra-low peak, average and idle mode power consumption
- Ability to run for years on standard, coin-cell batteries
- Low cost
- Multi-vendor interoperability
- Enhanced range

Bluetooth low energy is also meant for markets and applications, such as:

- [Automotive](#)
- [Consumer electronics](#)
- [Smart energy](#)
- [Entertainment](#)
- [Home automation](#)
- [Security & proximity](#)
- [Sports & fitness](#)

2.1 Classic Bluetooth vs. Bluetooth low energy

The table below shows a high level comparison between classic *Bluetooth* (also known as *Bluetooth BR/EDR*) and *Bluetooth* low energy technologies.

Technical specification	Classic <i>Bluetooth</i> technology	<i>Bluetooth</i> low energy technology
Radio frequency	2.4GHz	2.4GHz
Distance/Range	~10-100 meters	~10-100 meters
Symbol rate	1-3Mbps	1Mbps
Application throughput	0.7 – 2.1Mbps	305kbps
Nodes/Active slaves	7	Unlimited
Security	56 to 128 bit	128-bit AES
Robustness	FHSS	FHSS
Latency (from not connected state to send data)	100+ ms	<6ms
Government regulation	Worldwide	Worldwide
Certification body	Bluetooth SIG	Bluetooth SIG
Voice capable	Yes	No
Network topology	Point-to-point, scatternet	Point-to-point, star
Power consumption	1 (reference value)	0.01 to 0.5 (use case dependent)
Service discover	Yes	Yes
Profile concept	Yes	Yes
Primary use cases	Mobile phones, headsets, stereo audio, automotive, PCs etc.	Mobile phones, gaming, PCs, sport & fitness, medical, automotive, industrial, automation, home electronics etc.
Profiles	Serial Port, Hands-Free, OBEX, A2DP etc.	Proximity profile, Battery status, Weight scale, Heart rate monitor, Humidity etc.

2.2 Backwards compatibility

Bluetooth low energy single mode devices are not inter-operable with classic *Bluetooth* devices such as *Bluetooth* 2.1 + EDR devices. Single mode devices are only compliant with other single mode devices or dual-mode devices.

The dual mode devices on the other hand are backwards compatible and can be connected to all other *Bluetooth* devices, even those supporting the very old 1.0 standard. The dual mode devices typically are mobile phones and PCs which are not as power constrained as the single mode devices and need to support uses cases like hands-free or stereo headset connectivity.

If specification versions are used, then all *Bluetooth* v.4.0 are inter-operable with each other, but NOT all *Bluetooth* v.4.0 devices are inter-operable with older specification versions.

2.3 More information

Want to learn more about *Bluetooth* low energy technology? Please have a look at the following material and links:

How it works (video):

- <http://www.youtube.com/watch?v=r6Re7-kldhs>

Bluetooth low energy specifications:

- <https://www.bluetooth.org/Technical/Specifications/adopted.htm>

Bluetooth low energy at Wikipedia:

- http://en.wikipedia.org/wiki/Bluetooth_low_energy

Bluetooth SIG's *Bluetooth* low energy web sites:

- <https://www.bluetooth.org/Events/Training/LowEnergyTraining.htm>
- <http://bluetooth.com/Pages/Low-Energy.aspx>

3 Bluegiga's Bluetooth low energy products

3.1 BLE112 single mode module

BLE112, *Bluetooth* low energy module is a single mode device targeted for low power sensors and accessories. BLE112 offers all *Bluetooth* low energy features: radio, stack, profiles and application space for customer applications, so external processor is not needed. The module also provides flexible hardware interfaces to connect sensors, simple user interfaces or even displays directly to the module.

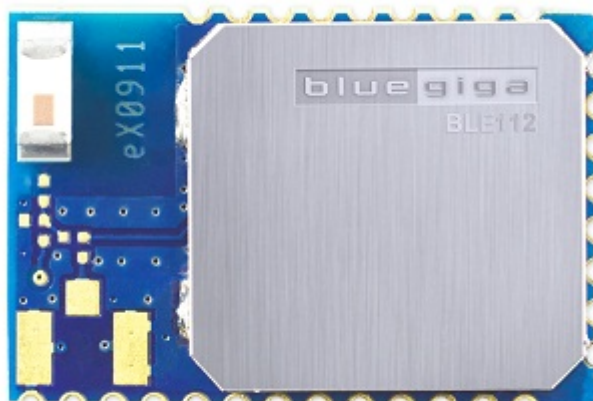
In-module software development can be done with Bluegiga's BGProfile Toolkit™ offering environment for rapid *Bluetooth* profile development. Bluegiga's BGScript™ enables developers to automate in-module software functions making *Bluetooth* low energy application development extremely simple.

BLE112 can be powered directly with a standard 3V coin cell battery or pair of AAA batteries. In lowest power sleep mode it consumes only 400nA and will wake up in few hundred microseconds.

KEY FEATURES

- *Bluetooth* v.4.0, single mode compliant
 - Supports master and slave modes
 - 4+ simultaneous connection in master mode
- Integrated *Bluetooth* low energy stack
 - GAP, GATT, L2CAP, SMP
 - *Bluetooth* low energy profiles
- Radio performance
 - Transmit power : +4 dBm to -23dBm
 - Receiver sensitivity: -87dBm to -93dBm
- Ultra low current consumption
 - Transmit: 27mA (0 dBm)
 - Sleep mode 3: 0.4uA
- Programmable 8051 processor for embedding full applications
- *Bluetooth* end product, CE, FCC and IC and Telec qualified

PHYSICAL OUTLOOK



3.2 BLED112 single mode USB dongle

BLED112, *Bluetooth* low energy USB Dongle is a single mode USB device enabling *Bluetooth* low energy connectivity for PC's and other devices with a USB port.

BLED112 *Bluetooth* Dongle integrates all *Bluetooth* 4.0 single mode features. The USB dongle can simulate standard USB device, virtual COM port or USB HID device. The HID can be used for accessories like keyboards and mice, because no driver is needed. The COM port emulation enables simple host application development using a simple application programming interface.

The BLED112 can be used for *Bluetooth* low energy development. With two BLE112 dongles you can quickly prototype new low energy application profiles by utilizing Bluegiga BGProfile Toolkit and also automate in-module software functions with BGScript.

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- Radio performance
 - TX power: +4 dBm to -23dBm
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- USB, USB HID and virtual COM port emulation
- *Bluetooth* end product, CE, FCC and IC and Telec qualified

PHYSICAL OUTLOOK



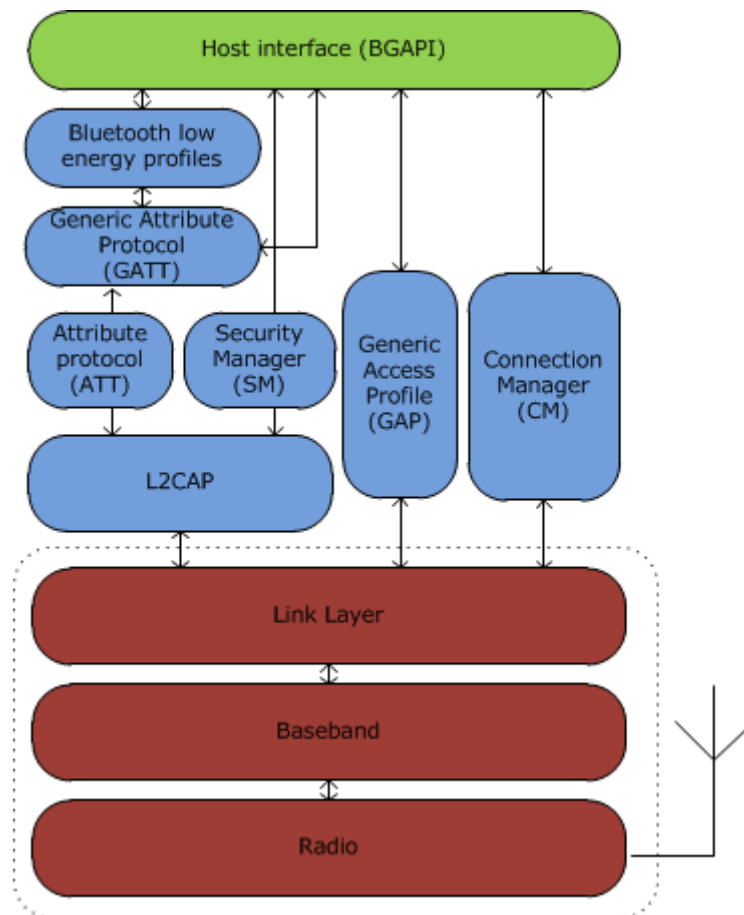
3.3 Bluetooth low energy stack suite

Bluegiga's *Bluetooth* low energy stack suite is not just an implementation of an embedded *Bluetooth* low energy stack and profiles, but rather a complete application development platform for Bluegiga's *Bluetooth* low energy products allowing rapid development of complete *Bluetooth* low energy applications even without a deep understanding of the technology.

The *Bluetooth* low energy stack suite consists of several components:

- *Bluetooth* low energy single mode stack
- Binary based host communication API and C library (BGAPI)
- BGScript™ scripting language and interpreter
- *Bluetooth* low energy profile toolkit

The *Bluetooth* low energy single mode stack is a full, embedded implementation of *Bluetooth* v.4.0 compatible stack software and it's dedicated for Bluegiga's *Bluetooth* low energy modules. The stack implements all mandatory functionality for a single mode device and the different components of the stack are illustrated in the figure below.



The *Bluetooth* low energy stack exposes a software interface called BGAPI, which can be used to send configuration and control commands to the stack, receive responses and events from the stack and finally send and receive data. BGAPI is a binary based software interface, which is used for example when the application code is executed on an external host. The host, for example a low power microcontroller, can interface to the *Bluetooth* low energy hardware via UART, SPI or USB interfaces and can send the BGAPI commands to the *Bluetooth* low energy stack. The stack responds to these commands using the same binary protocol and in some cases also generates events.

The BGAPI provides access to the following layers:

- **Attribute client** - Provides an interface to discover, read and write remote attributes
- **Attribute database** - A class to access the local attribute database
- **Connection** - Provides an interface to manage Bluetooth low energy connections

- **Generic Access Profile** - GAP allows the management of discoverability and connectability modes and is responsible of opening and controlling connections
- **Hardware** - An interface to access the various hardware layers such as timers, ADC and other hardware interfaces
- **Persistent Store** - Enables users to access the parameters of the radio hardware and read/write data to non-volatile memory
- **Security manager** - Provides access to the Bluetooth low energy security functions
- **System** - Various system functions, such as querying the hardware status or reset it

However many *Bluetooth* low energy applications are very simple and the use of external host processors is unnecessary. To support these use cases and to allow simple application code to be executed directly on the *Bluetooth* low energy hardware a BGScript™ scripting language and script interpreter can be used. The script interpreter runs on the *Bluetooth* low energy hardware and is responsible of passing the commands and response between the *Bluetooth* low energy stack and the actual script. When the BGScript approach is used the BGAPI host interface is not needed or is it available.

The final tool in the stack suite is the *Bluetooth* low energy profile toolkit, which can be used to model and generate the GATT databases, which are the basis of *Bluetooth* low energy profiles. The profile toolkit actually consists of a simple XML based profile template, which describes the GATT data base, attributes and access rights and a simple compiler, which converts the XML into binary image and generates API commands to read and write attributes.

3.4 More information

More information about the products can be found from:

- [Bluegiga web pages](#)
- [Bluegiga Tech Forum](#)

4 Contact information

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