Secure, Smart, and Low-Power Wireless Solutions For IIoT

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November 2021
The Leader in IoT
Wireless Connectivity

100% Revenue Based on IoT

#1 Share in Mesh

1st To Market with Multiprotocol, BLE Mesh, BLE 5.1

Innovation Performance, Power, CoEx, Modules, SecureVault™

Breadth and Depth of Wireless IoT Protocols

2012 ember
Software ZigBee SoC

2013 ENERGY
Low-power 32-bit MCUs

2015 telegesis
BLE Smart Modules

2015 Micrium
ZigBee/Thread Modules

2016 ZENTRI
Software RTOS

2017 WAVE
Cloud Connected Wi-Fi

2018 REDLINE SIGNALS
Smart Home Protocol

2020 Silicon Laboratories
Ultra Low Power Wi-Fi
IoT Trends Driven by Silicon Labs

**IOT LEADERSHIP**
- #1 provider of Smart Home IoT wireless software and silicon solutions
- Unmatched breadth and depth of IoT wireless technologies

**WIRELESS PRODUCT SOLUTIONS**
- Our product portfolio allows deployments across any device type and application
- 1000’s of Applications
- 10,000’s of Customers

**WORKS WITH ANY ECOSYSTEM**
- Silicon Labs wireless platform works with any smart home ecosystem
- Actively engaged with all ecosystems helping end-device and gateway partners to market

Industry Collaborations
- Project Connected Home Over IP
- Open Z-Wave
- Amazon Sidewalk
- Security
- Home Automation
- Small Appliances
- Lighting
- Operator Services
- Portable Medical

**Works with**
- Amazon
- Apple
- Google
- Ring
- Samsung SmartThings
- IKEA
- Comcast
- Xfinity
Full Coverage Enabling Unlimited Opportunities

Beyond the Fence (Smart City)

Beyond Front Door (Backyard)

In the Home

- Matter, Zigbee, Bluetooth, WiFi
- Z-Wave

Amazon Sidewalk
- Z-Wave LR

Amazon Sidewalk Wi-SUN

[Image of a circular diagram with various technologies and network connections labeled]
Industry 4.0 Presents Challenges

- Machines operate as autonomous systems
- Manual set-up, maintenance & repair processes
- Technology fragmentation increases complexity
- Security concerns raise risk to unacceptable levels

- Wireless Connectivity add the value
  - Add remote monitoring and control to machines
  - Replace cables with wireless communication links
  - Future proof equipment with OTA updates
  - Use advanced encryption to secure processes
Asset Tracking

▸ Protect your workforce, equipment and inventory across large areas with advanced, reliable wireless devices that power real-time location systems (RTLS)

How It Works

▸ Asset tags broadcast Bluetooth beacons in manufacturing facilities
▸ Bluetooth mesh or Sub-GHz nodes receive beacons and passes location data to a gateway
▸ Gateway sends relevant asset location information to a cloud application
Connected Lighting

Reduce energy consumption, customize settings by work area, and control lighting from remote locations

How It Works

▸ Large scale mesh network connects lights, luminaires, controls and switches

▸ Bluetooth mesh, Sub-GHz, Thread or Zigbee technologies are ideal for mesh networking

▸ Multiprotocol connectivity enables a multi-function IoT wireless backbone
Smart Energy Management

Generate electricity and heat water with a wireless smart energy system that provides factory operators the ability to reduce costs and better manage energy usage.

How It Works

▸ Industrial-grade LPWAN provides connectivity to solar panels, smart meters, thermostats, HVAC and environmental sensors throughout the facility.

▸ Multiprotocol Sub-GHz and Bluetooth IoT wireless network provides simultaneous long-range device-to-device communications and direct smartphone connectivity.

▸ Direct smartphone control simplifies device set-up, monitoring, and maintenance.
Process Automation

Connect machines, devices, sensors and people to a system that automates factory tasks including production, maintenance, quality control, and reporting.

How It Works

▸ LPWAN or mesh networks provide the wireless reach to factory automation sensors located throughout the premises.

▸ Bluetooth mesh, Sub-GHz, Thread or Zigbee all meet the needs of low-power sensor applications.

▸ IoT gateways provide cloud connectivity and enable remote management.
Technical solutions to the key careabouts

**Extended Battery Life**
- Ultra low-power chips & power-efficient communication stacks
- Utilization of energy harvesting technologies

**Reliable Connectivity**
- Using stacks with high forward error correction rate
- Leveraging frequency hopping and dual-band technologies

**Embedded Intelligence**
- Reducing power consumption by pre-processing the data locally
- Using embedded AI/ML to mitigate network congestion

**Built-in Security**
- Designing in parts that prevent rogue FW execution, detect tampering, meet the latest IoT security standards and have upgradable security features
Industrial automation segmentation

<table>
<thead>
<tr>
<th>MONITORING</th>
<th>INTERFACING</th>
<th>NETWORKING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proprietary</td>
<td>Proprietary</td>
<td>802.15.4 Mesh</td>
</tr>
<tr>
<td>BLE</td>
<td>Wi-Fi</td>
<td>Secure Vault</td>
</tr>
<tr>
<td>802.15.4 Mesh</td>
<td>802.15.4 Mesh</td>
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</tbody>
</table>

BT Mesh
A Complete Solution for Enabling Bluetooth Products

SoC and Modules
- Industry leading Bluetooth 5.1 and 5.2 SoCs and pre-certified modules

Stack Software
- In-house developed stacks with latest Bluetooth 5.2 and mesh features

Mobile Applications
- Reference applications and source code for iOS and Android
  Phone interoperability test program

Development Tools
- Free-of-charge development and protocol analysis tools to boost productivity
Bluetooth LE and Mesh Software

A Bluetooth 5.2 compliant Bluetooth stack, with:
- Bluetooth 5.2 Dynamix TX power control
- Bluetooth 5.1 Direction Finding
- Bluetooth 5.0 standard features
- Bluetooth 4.x features

Packed with advanced functionality
- Multiple connections and advertisers
- Concurrent advertising, scanning and LE connections
- Optimized throughput and power consumption

Built on top of the common EFR32 software platform
- Gecko bootloader
- emLib for MCU peripherals and drivers
- NVM3 key/value pair data storage with wear leveling
- RAIL radio driver

A complete Bluetooth mesh profile, supporting:
- Proxy, relaying and friend nodes
- Bluetooth mesh low power nodes (LPN)
- Low latency communications down to 10ms per hop
- Large network support up to 4096 nodes

A comprehensive Mesh Model application layer, with:
- Lighting models for On/Off, Dimming & color temperature
- Occupancy based lighting for commercial applications
- Scene, Sensor, Generic and Vendor models

Bluetooth LE support includes
- Beaconing for indoor positioning systems
- Scanning for asset tracking
- Phone connectivity
It’s More Than Just a Bluetooth Stack…

Secure Over-the-Air Updates
Helps you to easily implement secure in-field software updates

Network Co-Processor Mode
Run applications on a separate MCU and use EFR32 as a Bluetooth co-processor

Direction Finding
Direction Finding library converts raw IQ data to reliable azimuth and elevation data

Wi-Fi Co-Existence
Wi-Fi co-ex scheme significantly improves performance in co-located radio designs
BG22: Optimized Battery Powered Bluetooth LE

Secure Bluetooth 5.2 SoCs for High-Volume Products

Radio
Bluetooth 5.2
+6 dBm TX
-106.7 dBm RX (125Kbps)
AoA & AoD

Ultra-Low Power
3.5 mA TX (radio)
2.6 mA RX (radio)
1.4 µA EM2 with 32 kB RAM
0.5 µA w/ RTC in EM4

World Class Software
Bluetooth 5.2
Bluetooth mesh LPN
Direction Finding
Apple HomeKit

Compact Size
5x5 QFN40 (26 GPIO)
4x4 QFN32 (18 GPIO)
4x4 TQFN32 (18 GPIO)

ARM Cortex-M33 with TrustZone
76.8 MHz
FPU and DSP
352/512 kB of flash
32kB RAM

Peripherals Fit for Purpose
2x USART, 2x I2C, 2x PDM and GPIO
12-bit ADC (16 channels)
Built-in temperature sensor with +/- 1.5 °C
32 kHz, 500ppm PLFRCO eliminates crystal

Security
AES128/256,SHA-1, SHA-2 (256-bit)
ECC (up to 256-bit), ECDSA and ECDH
True Random Number Generator (TRNG)
Secure boot with RTSL
Secure debug with lock/unlock
Extending Battery Life in Bluetooth Applications

10+ years on a coin cell battery

Data Transfer
- Connected to a phone at 2000ms interval
- Using 2M PHY and transmitting 10 Byte/packet
- TX at 0dBm and using 1 channel
- Average current: 4.2μA

Location Services
- Advertising 10 bytes every 1000ms
- Average current: 3.7μA

5+ years on CR2032
10+ years on a CR2354
Securing Bluetooth Products with BG22

- **Hardware Accelerated Crypto**
  - Faster, more energy efficient and secure than software

- **True Random Number Generator (TRNG)**
  - Compliant with NIST SP800-90 and AIS-31

- **Secure Boot with Root of Trust and Secure Loader (RTSL)**
  - Prevents malware injection and rollback
  - Ensures authentic firmware execution and OTA updates

- **Secure Debug with Lock/Unlock**
  - Allows authenticated access for enhanced Failure Analysis (FA)

- **ARM Cortex M33 Core with TrustZone**
  - Provides cost effective hardware isolation

[www.silabs.com/security](http://www.silabs.com/security)
<table>
<thead>
<tr>
<th>Feature</th>
<th>Base</th>
<th>Mid</th>
<th>High</th>
</tr>
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<tbody>
<tr>
<td>True Random Number Generator</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Crypto Engine</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Secure Application Boot</td>
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<tr>
<td>Secure Engine</td>
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<td>Secure Boot with RTSL</td>
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<td>DPA Countermeasures</td>
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<tr>
<td>Anti-Tamper</td>
<td>—</td>
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<tr>
<td>Secure Attestation</td>
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<td>✓</td>
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<tr>
<td>Secure Key Management</td>
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<td>—</td>
<td>✓</td>
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<tr>
<td>Advanced Crypto</td>
<td>—</td>
<td>—</td>
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Selecting a BG22 Device

<table>
<thead>
<tr>
<th>Use cases</th>
<th>BG22C112</th>
<th>BG22C222</th>
<th>BG22C224</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High-volume, consumer</td>
<td>Better RF, more GPIO</td>
<td>Advanced features, higher temp rating</td>
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</table>

<table>
<thead>
<tr>
<th>Bluetooth features</th>
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<th>BG22C222</th>
<th>BG22C224</th>
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<tbody>
<tr>
<td>1M and 2M PHYs</td>
<td>1M and 2M PHYs</td>
<td>1M and 2M PHYs</td>
<td>125k and 500k LE Coded PHYs</td>
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<tr>
<td>AoA TX</td>
<td>AoA TX</td>
<td>AoA TX</td>
<td>Bluetooth mesh LPN</td>
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<td></td>
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<td>IQ sampling for AoA</td>
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<table>
<thead>
<tr>
<th>Max TX power</th>
<th>BG22C112</th>
<th>BG22C222</th>
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<tr>
<td>0 dBm</td>
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<th>RAM</th>
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<tr>
<td>32 kB</td>
<td>32 kB</td>
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<tr>
<th>Flash</th>
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<tr>
<td>352 kB</td>
<td>352 kB</td>
<td>512 kB</td>
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<table>
<thead>
<tr>
<th>Max Temperature</th>
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<tr>
<td>-40 to +85°C</td>
<td>-40 to +85°C</td>
<td>-40 to +85°C</td>
<td>-40 to +125°C (IM OPNs)</td>
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<table>
<thead>
<tr>
<th>Max GPIO</th>
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<th>BG22C222</th>
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<td>18</td>
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<tr>
<th>Package options</th>
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<tbody>
<tr>
<td>4x4 QFN32</td>
<td>4x4 QFN32</td>
<td>4x4 QFN32</td>
<td></td>
</tr>
<tr>
<td>4x4 TQFN32</td>
<td>4x4 TQFN32</td>
<td>4x4 TQFN32</td>
<td></td>
</tr>
<tr>
<td>5x5 QFN40</td>
<td>5x5 QFN40</td>
<td>5x5 QFN40</td>
<td></td>
</tr>
</tbody>
</table>

See BG22 Data Sheet for complete list of Orderable Part Numbers (OPNs).
BGM220 Bluetooth Modules

BGM220S - SiP
- 6 x 6 mm
- Up to +6 dBm TX
- Up to 25x GPIO
- Built-in antenna and RF Pin
- With or without RF shield

BGM220P - PCB
- 13 x 15mm
- Up to +8 dBm TX
- Up to 25x GPIO
- Built-in antenna
- With or without built-in LFXO

Module Features
- Built-in high performance antennas simplify RF design
- Compact SIP modules for minaturized IoT design
- Integrated DC-DC, XTALs and passives
- Extended temperature rating up to 105°C
- Regulatory certifications for major global markets
  - CE, FCC, IC,MIC and KCC
- Bluetooth 5.2 certified
  - Dynamic power control operational performance
Series 2
FG23 SoCs
FG23: Industry Leading Sub-GHz Wireless Connectivity

**High-Performance**
- + 20 dBm output power & -125.6 dBm RX
- Arm Cortex-M33 processor core

**Low Power**
- 10+ years coin cell battery operation
- Preamble Sense Mode, LESENSE

**Secure**
- Secure Vault™
- Arm PSA certified

**Optimized**
- Highly integrated MCU, PMU, RF & peripherals
- Flexible GPIO mapping

**Advanced Wireless**
- Amazon Sidewalk, Wireless M-Bus, mioty & Proprietary

## Applications
- Smart Metering
- Industrial Automation
- Smart Lighting
- Building Automation
- Hubs & Gateways
High-Performance Sub-GHz Wireless SoCs


Sub-GHz SoCs Optimized for Metering & Home/Industrial Automation Applications

High Performance Radio
- Up to +20 dBm TX
- -110dBm RX @ 920MHz, 50kbps GFSK*
- -126dBm RX @ 915MHz, 4.8kbps O-QPSK*
- RX Antenna Diversity*

Low Power
- 25 mA TX @ +14 dBm, 925 MHz*
- 85.5 mA TX @ +20 dBm, 915 MHz*
- 4.2 mA RX @ 920 MHz, 400 kbps 4-FSK*
- 26 µA/MHz*
- 1.2 µA EM2 with 16 kB RAM
- Preamble Sense

Wireless Technologies
- Amazon Sidewalk
- mioty
- Wireless M-BUS
- Proprietary

ARM® Cortex®-M33 with TrustZone®
- 78 MHz (FPU and DSP)*
- 512kB of flash
- 64kB of RAM

Security
- Secure Vault Mid
- Secure Vault High (select OPNs)

Low-power Peripherals
- EUSART, USART, I²C
- 16-bit ADC, 12-bit VDAC, ACMP
- 20 x 4 LCD Controller
- LESENSE, Pulse Counter
- Temperature sensor +/- 1.5°C

Compact Size
- 5x5 QFN40 (22/23 GPIO)
- 6x6 QFN48 (31 GPIO)

Orderable Part Number
- EFR32FG23A/B

* Feature enhancements compared to EFR32xG13
Antenna Diversity Introduction

- Uses two antenna at least a ¼ wave apart and typically 90 degrees orientation for polarization
- During multipath and/or blocking, one antenna will have better SNR and/or desired signal RSSI
- During the preamble, RX antenna diversity monitors both antennas and selects better antenna
- Improves the performance in multipath environments by about 6-8 dB
Simplified Single Ended Match – Optimized BOM

Series 1 match:
BOM price example: 13 cent

xG23 match:
BOM price example: 4 cent
Gateways in the IoT

- Gateways are a requirement for the IoT and are complex devices
  - Gateways must connect, manage a multitude of end device types with complex profiles
- Complex system Infrastructure is a barrier for IoT adoption
  - More gateways, routers, and bridges are needed
  - Crucial for IoT platforms, clouds and networks
  - Difficult to develop, install and maintain
- Only few software platform providers are at IoT gateway layer
- Abstracts wireless IoT protocol evolution for IoT services
- Enterprise gateways and access points are adding IoT radios for indoor location services
- Edge computing and Edge-to-Cloud IoT service enablement
  - Allows customers to connect to cloud services
  - Enables local on-premises computing

Let's Solve the “IoT Gateway Problem”
Unify SDK Solves the IoT Gateway Challenge

What is it?
- Network abstraction framework for IoT cloud and platform providers

What can you do with it?
- Develop a single gateway software base
- Let Unify SDK handle the protocol-specific translations
- Maintain just one code base for your cloud and platform, regardless of the devices and wireless protocols
- Z-Wave and Zigbee initially, more protocols to follow – Bluetooth, Thread, and Matter

How does it work?
- A common, well-defined data model, API, and status definitions for IoT services such as adding, updating, and removing a device
- Protocol drivers translate the common IoT services into protocol-specific formats
Embedded AI on Cortex-M devices for Smarter IoT

- **Applications in**
  - Predictive maintenance
  - Asset management
  - Occupancy sensing with environmental sensors
  - Other – Sound profiling, anti tamper, fault detection

- **Benefits of Edge AI/ML**
  - Longer battery life
  - Reduced need for bandwidth
  - Lower latency Better UX
  - Privacy & Security
  - Lower cost (Cloud, Multipurposing)
A Wide Range of Sensors

TEMPERATURE  HUMIDITY  MAGNETIC

LIGHT  PROXIMITY

Enabling existing and emerging application areas
Get More Works With On-demand

完整議程隨時重播
藍牙應用課程
工業物聯網應用課程
Thank you!

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