



EFR32BG24 Introduction and Bluetooth Development Start Guide

APAC RA | Nov 2022



Agenda

- **Silicon Labs xG24 Product Introduction**
- **Simplicity Studio v5**
- **Bluetooth application development with SSv5**
- **Tools**
 - Multi-Node Energy Profiler
 - Network analyzer

Introducing EFR32BG24 and EFR32MG24



- 2.4GHz wireless SoC with Matter, Zigbee, OpenThread, Bluetooth and Multiprotocol
- AI/ML hardware accelerator to allow 2x to 4x faster inferencing at the edge
- Secure Vault™ protects data and device; PSA Certification Level 3
- 20-bit ADC for advanced sensing
- High performance RF for robust and reliable communication
- 1.5 MB Flash and 256 kB RAM for Matter and other future requirements
- Low active current for longer battery life

Industry's **Only** Wireless SoC with AI/ML accelerator, 20-bit ADC, and Secure Vault for **IoT Edge Devices**

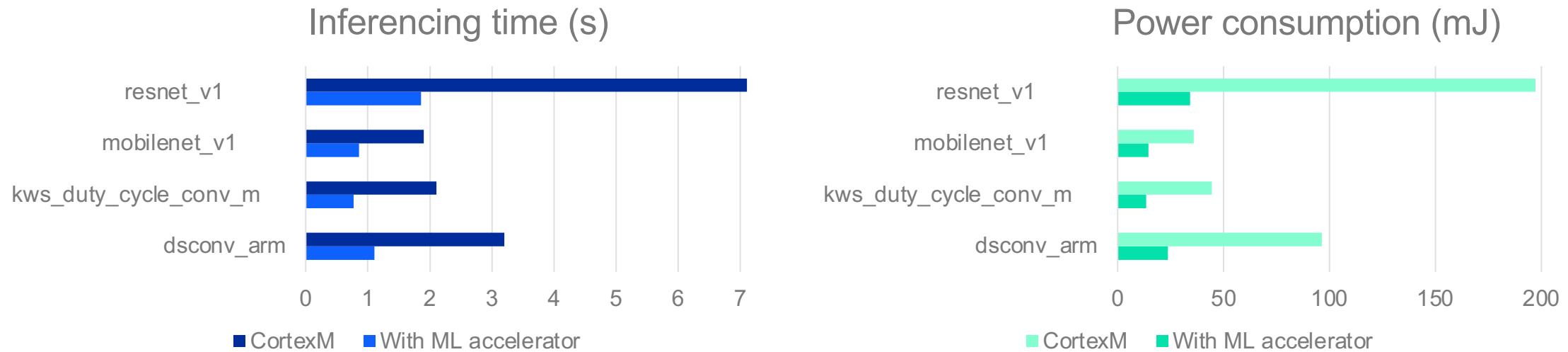
BG24 and MG24: Optimized for Battery Powered IoT Mesh Devices

- **Target Markets**
 - Smart Home
 - Gateways / Hubs
 - Building Automation
 - Lighting
 - Portable Medical Devices
 - AI/ML



- **High Performance Radio**
 - Up to +19.5 dBm TX
 - -97.6 dBm RX @ BLE 1 Mbps
 - -105.7 dBm RX @ BLE 125 kbps
 - -105.4 dBm RX @ 15.4
 - Wi-Fi Coexistence
 - RX Antenna Diversity
- **ARM® Cortex®-M33**
 - 78 MHz (FPU and DSP)
 - TrustZone®
 - Up to 1536kB of Flash
 - Up to 256kB of RAM
- **Low Power**
 - 5.0 mA TX @ 0 dBm
 - 19.1 mA TX @ +10 dBm
 - 4.4 mA RX (BLE 1 Mbps)
 - 5.1 mA RX (250 kbps 802.15.4)
 - 33.4 µA/MHz
 - 1.3 µA EM2 with 16 kB RAM
- **Dedicated Security Core**
 - Secure Vault™ - Mid / High
- **AI/ML**
 - AI/ML Hardware Accelerator
- **Low-power Peripherals**
 - EUSART, USART, I2C
 - 20-bit ADC, 12-bit DAC, ACMP
 - Temperature sensor +/- 1.5°C
 - 32kHz, 500ppm PLFRCO
- **World Class Software**
 - Matter
 - Thread
 - Zigbee
 - Bluetooth (1M/2M/LR)
 - Bluetooth mesh
 - Dynamic multiprotocol
 - Proprietary
- **SoCs and Modules**
 - 5x5 QFN40 (26 GPIO) -125°C
 - 6x6 QFN48 (28/32 GPIO) -125°C
 - 7x7 SiP Module (+10 dBm)
 - 12.9x15.0 PCB Module (+10 dBm)

Inferencing with ML hardware accelerator vs. CortexM*

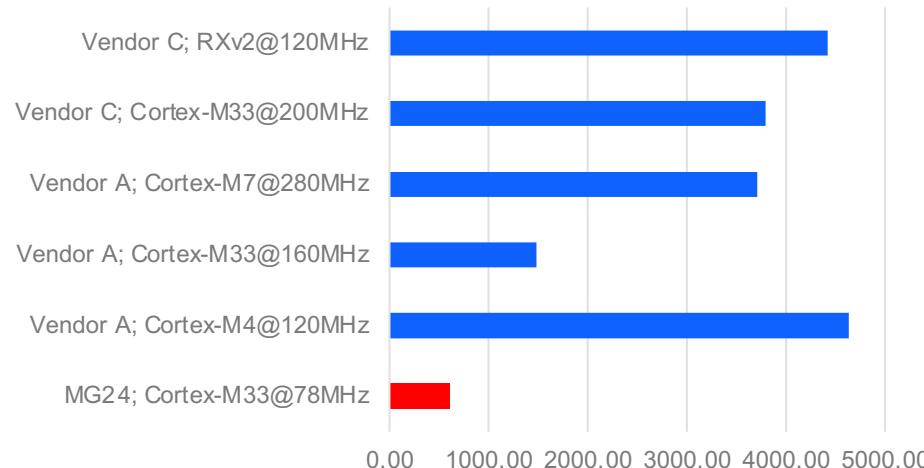


2-4x Faster Inferencing and up to 6x Lower Power Consumption (ML model dependent)

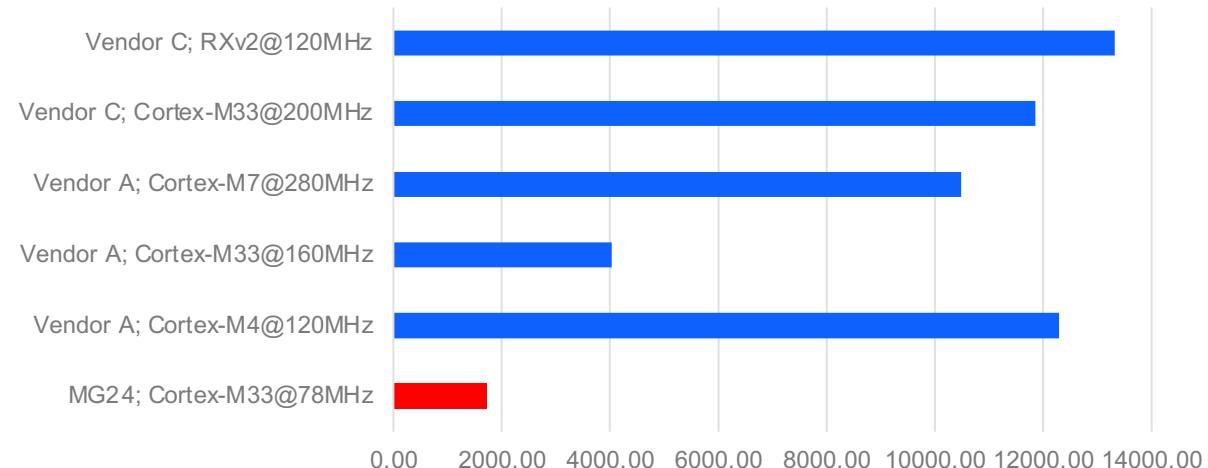
*Internal performance benchmarking with standard ML models. Results are for inferencing only (not for the complete application)

ML Perf Tiny v0.7 Performance Benchmark* for Power Efficiency

Key Word Spotting: Energy per inf (uJ)



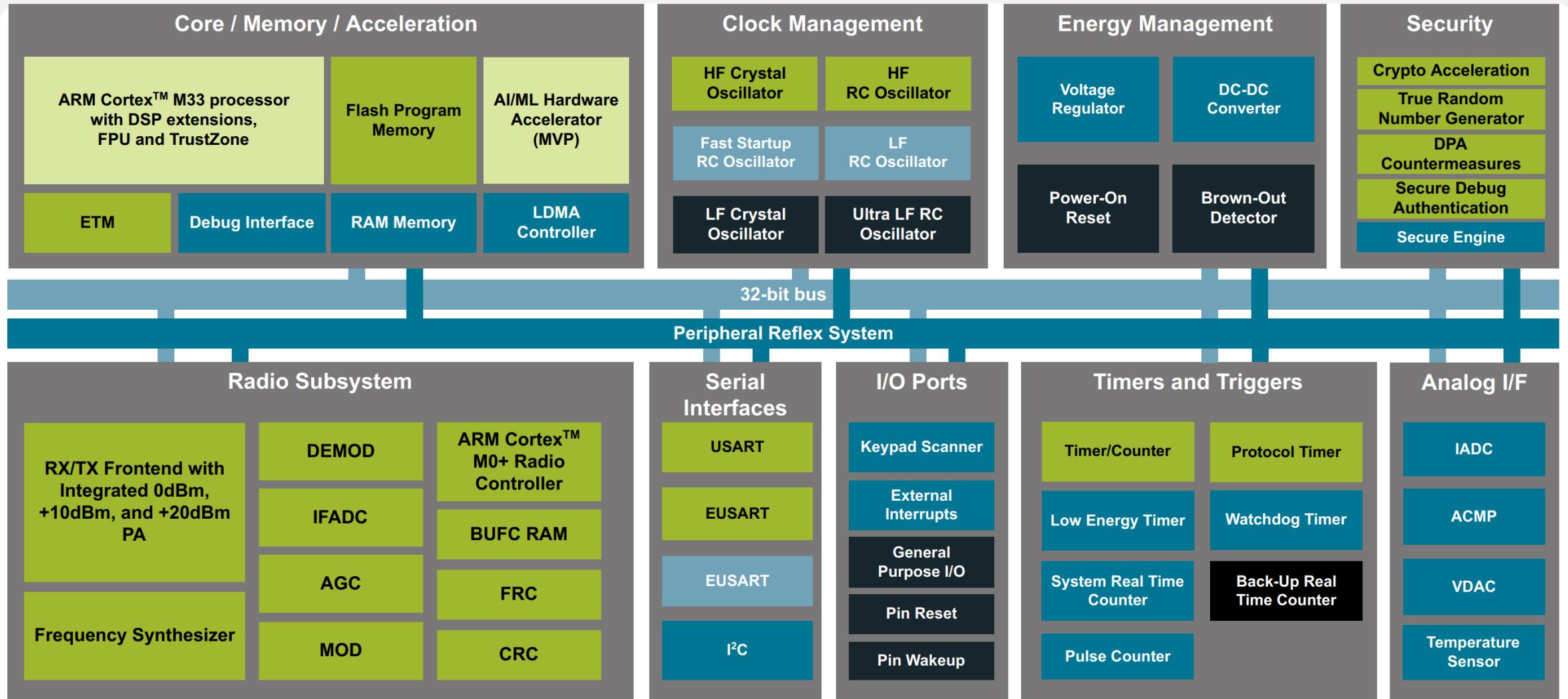
Visual Wake Word: Energy per inf (uJ)



MLPerf Tiny 0.7 benchmark results on xG24-DK2601B board; source: mlcommons.org

*Standardized performance benchmark validated by independent benchmarking body. Results are for inferencing only (not complete application).

xG24 Block Diagram



Bluetooth® SoC Lineup



BG21 (Series 2)



BG22 (Series 2)



BG24 (Series 2)

Bluetooth features	5.1 and mesh 1.0 (1M, 2M, LE Coded PHYs and AE)	5.2 and Bluetooth mesh LPN (1M, 2M, LE Coded PHYs, AE and Bluetooth direction finding)	Bluetooth Low Energy, Bluetooth mesh
Proprietary 2.4G	2(G)FSK, (G)MSK, OQPSK DSSS	2(G)FSK, (G)MSK, OQPSK DSSS	2(G)FSK, (G)MSK, OQPSK DSSS
TX / RX (1M,GFSK)	+20 dBm / -97.5 dBm	+6 dBm / -98.9 dBm	+19.5 dBm/-97.5 dBm
TX Current (MCU + radio value)	9.3 mA (0 dBm) 33.8 mA (10 dBm)	4.1 mA (0dBm) 8.2 mA (6 dBm)	5.1 mA (0 dBm) 20 mA (10 dBm)
RX Current (1M, GFSK)	8.8 mA	3.6 mA	4.4 mA
CPU / Clock Speed	Cortex M33 (80 MHz)	Cortex M33 (up to 76.8 MHz) Cortex M0+ for radio	Cortex-M33 (up to 78 MHz)
Flash (kB)	Up to 1024	Up to 512	Up to 1536
RAM (kB)	Up to 96	32	Up to 256
Sleep Current (EM2)	4.5 µA (16 kB RAM)	1.2 µA (8 kB RAM) -1.4 µA (32 kB RAM)	1.3 µA EM2 DeepSleep current (16 kB RAM)
Active Current (EM0)	50.9 µA / MHz	27 µA / MHz	32.2 µA/MHz
Security	Secure Vault - Mid Secure Vault - High	Secure Vault - Mid	Secure Vault - Mid Secure Vault - High
Operating Voltage	1.71V to 3.8V	1.71V to 3.8V	1.71 V to 3.8 V
Packages (mm)	4x4 QFN32	4x4 QFN32 4x4 TQFN32 5x5 QFN40	5x5 QFN40 6x6 QFN48

Bluetooth® Module Lineup



BGM210P



BGM210L



BGM220P



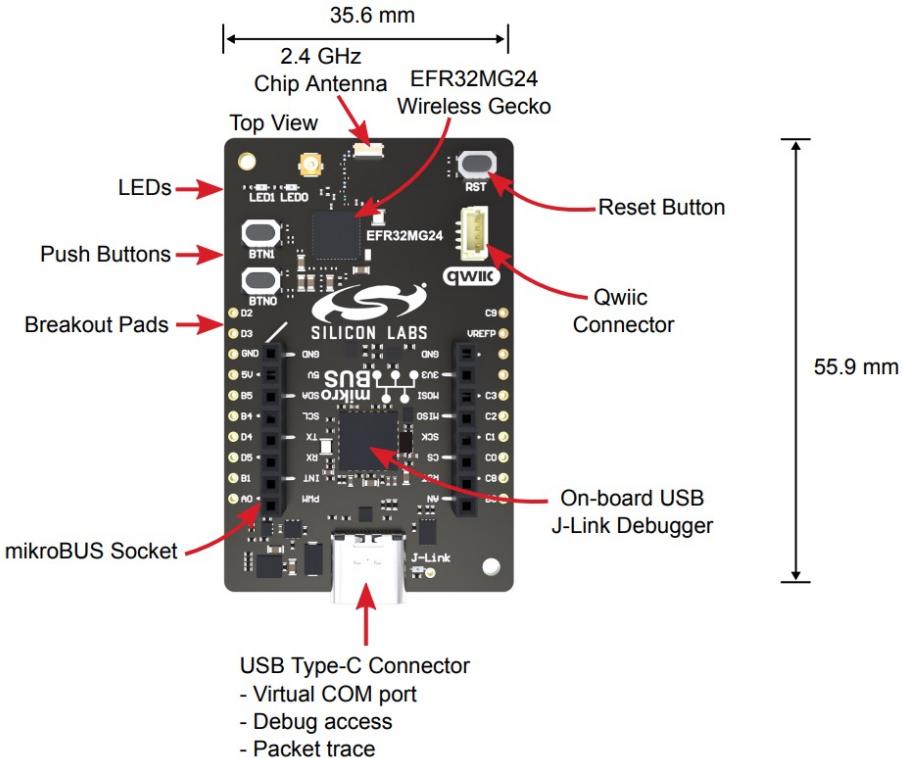
BGM220S



BGM240P

	BGM210P	BGM210L	BGM220P	BGM220S	BGM240P
Protocols	5.3 and mesh 1.0 (1M, 2M, Coded PHY and AE)	5.3 and mesh 1.0 (1M, 2M, Coded PHY and AE)	5.3 and mesh 1.0 LPN (1M, 2M, Coded PHY, AE and Bluetooth direction finding)	5.3 and mesh 1.0 LPN (1M, 2M, Coded PHY, AE and Bluetooth direction finding)	5.3 and Bluetooth mesh (1M, 2M, LE Coded PHYs, AE and Bluetooth direction finding)
EFR32 SoC	BG21	BG21	BG22	BG22	BG24
Antenna	Built-in or RF pin	Built-in	Built-in	Built-in or RF pin	Built-in or RF pin
Max TX power	+10/+20 dBm	+12.5 dBm	+8 dBm	+6 dBm	+10/+20 dBm
Sensitivity (1M)	-97 dBm	-97 dBm	-98 dBm	-98 dBm	-98.5 dBm
Flash (kB)	1024	1024	512	512	1536
RAM (kB)	96	96	32	32	256
GPIO	20	12	24,25	25	26
Operating Voltage	1.8V - to 3.8V	1.8V – 3.8V	1.8V - to 3.8V	1.8V - to 3.8V	1.8 to 3.8 V
Operating Temp.	-40 to +125°	-40 to +125°	-40 to +105°	-40 to +105°	-40 to +105°
Dimensions W x L x H (mm)	12.9 x 15.0 x 2.2	15.5 x 22.5 x 2.2	12.9 x 15.0 x 2.2	6 x 6 x 1.3	12.9 mm x 15.0 mm
Certifications	BT, CE, FCC, ISED, Japan & S-Korea	BT, CE, FCC, ISED, Japan & S-Korea	BT, CE, FCC, ISED, Japan & S-Korea	BT, CE, FCC, ISED, Japan & S-Korea	CE, UKCA, FCC, ISED, MIC, KC

xG24-EK2307A: a Powerful Prototyping Platform



- **Small Form Factor Kit**
 - Aligned with breadboard dimensions
- **Target device**
 - EFR32MG24 Wireless SoCs
 - 78 MHz operating frequency, 1536 kB flash, and 256 kB RAM
 - Best-in-class device security including Secure Boot with Root of Trust and Secure Loader (RTSL)
 - 39 MHz HFXO crystal
 - 32.768 kHz LFXO crystal
 - 2.4 GHz matching network and ceramic antenna for wireless transmission
- **On-board Board controller**
 - On-board SEGGER J-Link debugger
 - Packet trace Interface
 - Virtual COM with hardware flow control
- **USB Type-C connector for debug connection**
- **User interface features**
 - 2x push buttons
 - 2x LED
- **Mini Simplicity Debug Connector (SLSDA001A compatible) with access to:**
 - AEM
 - PTI
 - VCOM
 - SWD
- **Third-party add-on connectors**
 - mikroBus socket
 - Qwiic connector

[UG533: EFR32xG24 Explorer Kit User's Guide](#)

 Supported
 Not Supported
 — Optional or not mounted

	Explorer Kit	Development Kit	Pro Kit
Debug Speed	1.6MHz	1.6MHz	8MHz
Debug USB	Full Speed	Full Speed	High Speed
Packet Trace Interface (PTI)			2x
Breakout Pads			
Pushbuttons & User LEDs			
Virtual COM			
Coin cell battery holder	—		
On-board Sensors	—		
Battery Pack Connector	—		
Radio Board Connectors	—	—	
EXP Connectors	—	—	
Display	—	—	
Debug OUT	—	—	EFM8/32, EFR32, EZR32
Debug Ethernet	—	—	100 Mbit/s
Energy Monitor (AEM)	—	—	
3 rd Party Hardware addons		—	—

Simplified Developer Experience



▪ Simplicity Studio 5

• Interface

- ▶ Fresh, new & simplified
- ▶ Intuitive out-of-the-box experience
- ▶ Fast access to developer resources
- ▶ Linux, Mac & Windows

• Tools

- ▶ Configuration utilities
- ▶ Compiler
- ▶ Error & validation
- ▶ IDE & command line support
- ▶ Graphical hardware configurator
- ▶ Energy Profiler – visual energy analysis
- ▶ Network Analyzer – packet capture & decode

Simplicity Studio 5 – Complete Toolset for IoT Development



- **All-in-one tool for Silicon Labs IoT Development**
 - Free-of-charge
 - Code size unlimited IDE
 - Supports 8/32-bit MCUs and Wireless products
 - Windows 10, MacOS and Linux, 64-bit
- **Context-sensitive Project Launcher**
 - SDK Downloads and Updates
 - Hardware and Software Documentation
 - Pre-built Demos and Software Examples
- **Eclipse-based, C/C++ IDE**
 - Project management
 - Advanced code editor
 - Visual debugging tools
 - GNU ARM toolchain
- **Analysis and Configuration Tools**
 - Project and software component configuration
 - Protocol-specific configurators
 - Multi-node Energy Profiler
 - Network Analyzer
- **Image builder and Flash Utilities**
 - Create OTA and production binaries w/ signing
 - Stand-alone flash tool w/ CLI & GUI

Simplicity Studio 5 – Optimized Getting-Started

EFR32xG24 Explorer Kit (ID: 000440277898)

OVERVIEW EXAMPLE PROJECTS & DEMOS DOCUMENTATION COMPATIBLE TOOLS

Run a pre-compiled demo or create a new project based on a software example.

Filter on keywords

Demos

Example Projects

Solution Examples

What are Demo and Example Projects?

Wireless Technology Clear

- Bluetooth (31)
- Connect (0)
- RAIL (6)
- Thread (11)
- Zigbee (17)

Device Type Clear

- NCP (2)
- RCP (4)
- SoC (0)

Bluetooth - NCP
Network Co-Processor (NCP) target application. Runs the Bluetooth stack dynamically and provides access to it via Bluetooth API (BGAPI) using UART connection. NCP mode makes it possible to run your application on a host controller or PC.
[View Project Documentation](#) [CREATE](#)

Bluetooth - NCP
Network Co-Processor (NCP) target application. Runs the Bluetooth stack dynamically and provides access to it via Bluetooth API (BGAPI) using UART connection. NCP mode makes it possible to run your application on a host controller or PC.
[View Project Documentation](#) [RUN](#)

Bluetooth - RCP
Radio Co-Processor (RCP) target application. Runs the Bluetooth Controller (i.e. the Link Layer only) and provides access to it using the standard HCI (Host-Controller Interface) over a UART connection.
[View Project Documentation](#) [CREATE](#)

- **Guided install of SDKs and protocol-specific tools**

- Kit/Part Detection
- Technology Type

- **Quick Access to Development Resources**

- Easy access to guides, tutorials, and docs
- Pre-filtered for the target device
- Search and filter for docs, examples and demos

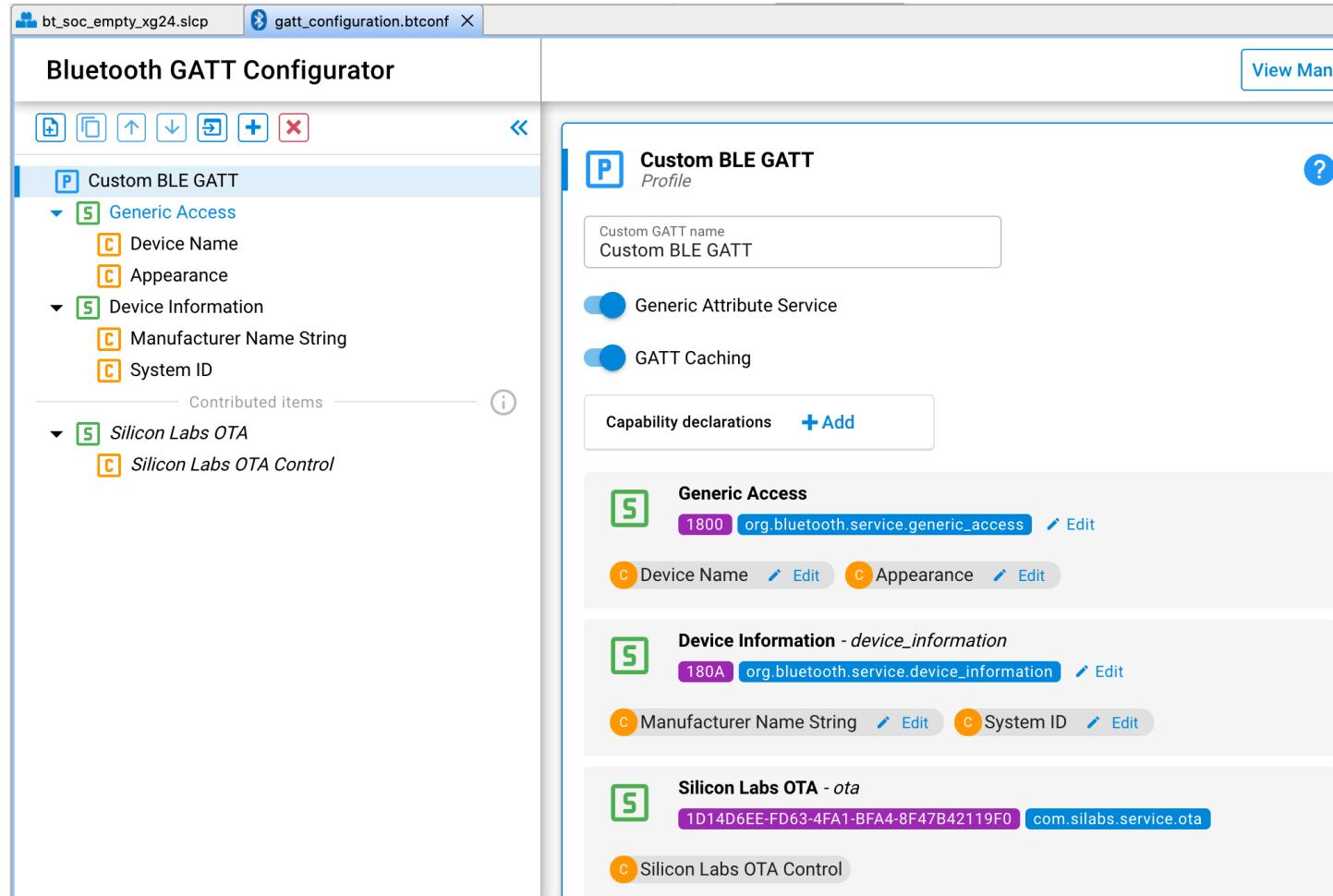
Simplicity Studio 5 – Software Components

The screenshot shows the Simplicity Studio 5 interface with the 'bt_soc_empty' project selected. The top navigation bar includes tabs for 'OVERVIEW', 'SOFTWARE COMPONENTS' (which is underlined in blue), and 'CONFIGURATION TOOLS'. Below the navigation is a filter section with checkboxes for 'Filter components by' (Configurable, Installed, Installed by you, SDK extensions). The main content area displays a tree view of software components:

- Advanced Configurators
- Application
- Bluetooth
 - Feature
 - GATT
 - Configuration
 - Client
 - Server
 - OTA
 - Stack
 - Bluetooth Core
 - Client
 - Server
 - Security Manager
 - System
- Platform
- Services

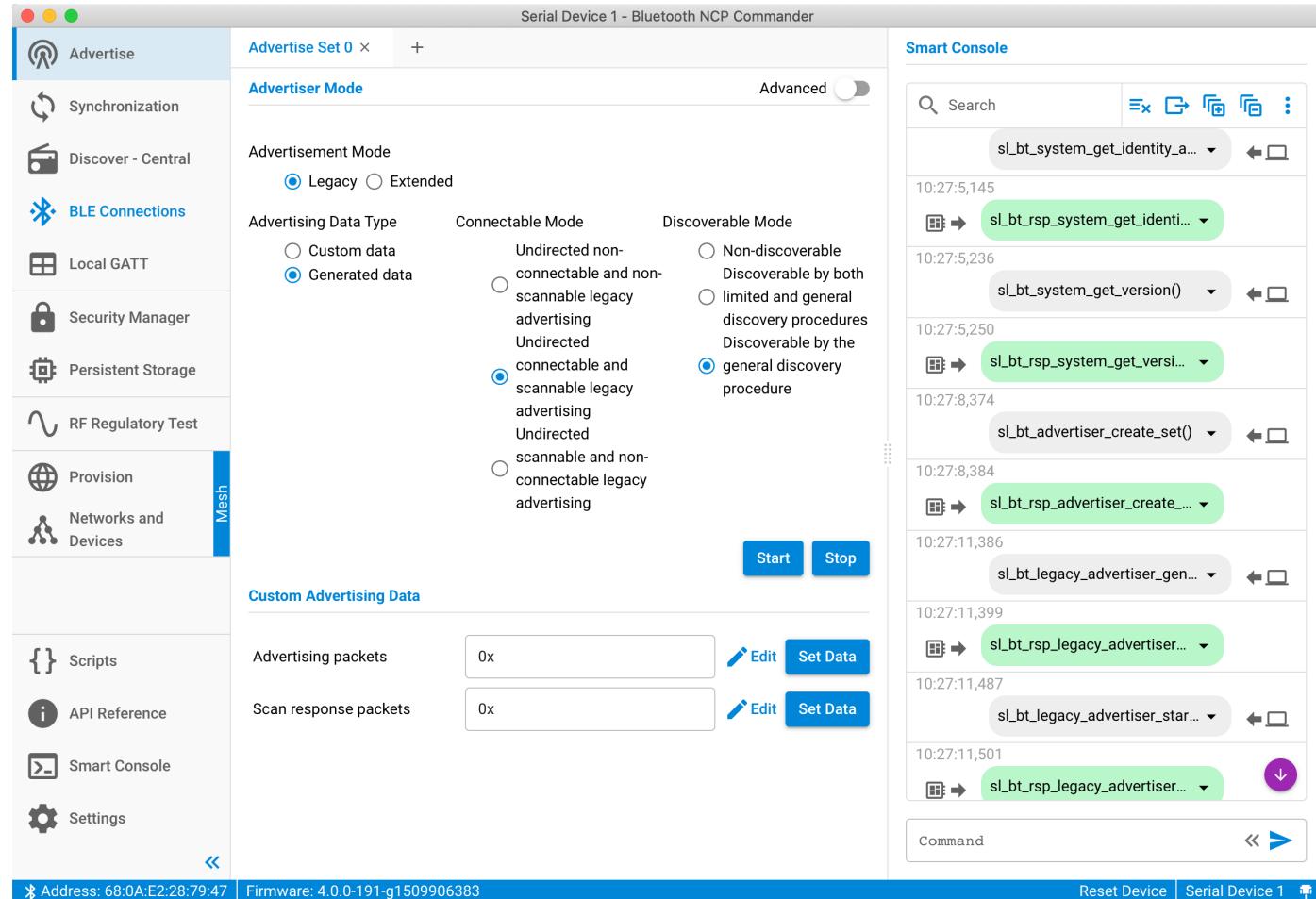
- For improving the developer experience, Silicon Labs redesigned the underlying framework of the Simplicity Studio as well as the architecture of the Gecko software development kit.
- All of the projects in the Simplicity Studio 5 are now built on a Gecko Platform component-based architecture.
- Software Components**
 - Added through the Project configurator
 - Install, uninstall, configure and instantiate
 - Automatically add source, header and autogen code

Simplicity Studio 5 – Bluetooth GATT Configurator



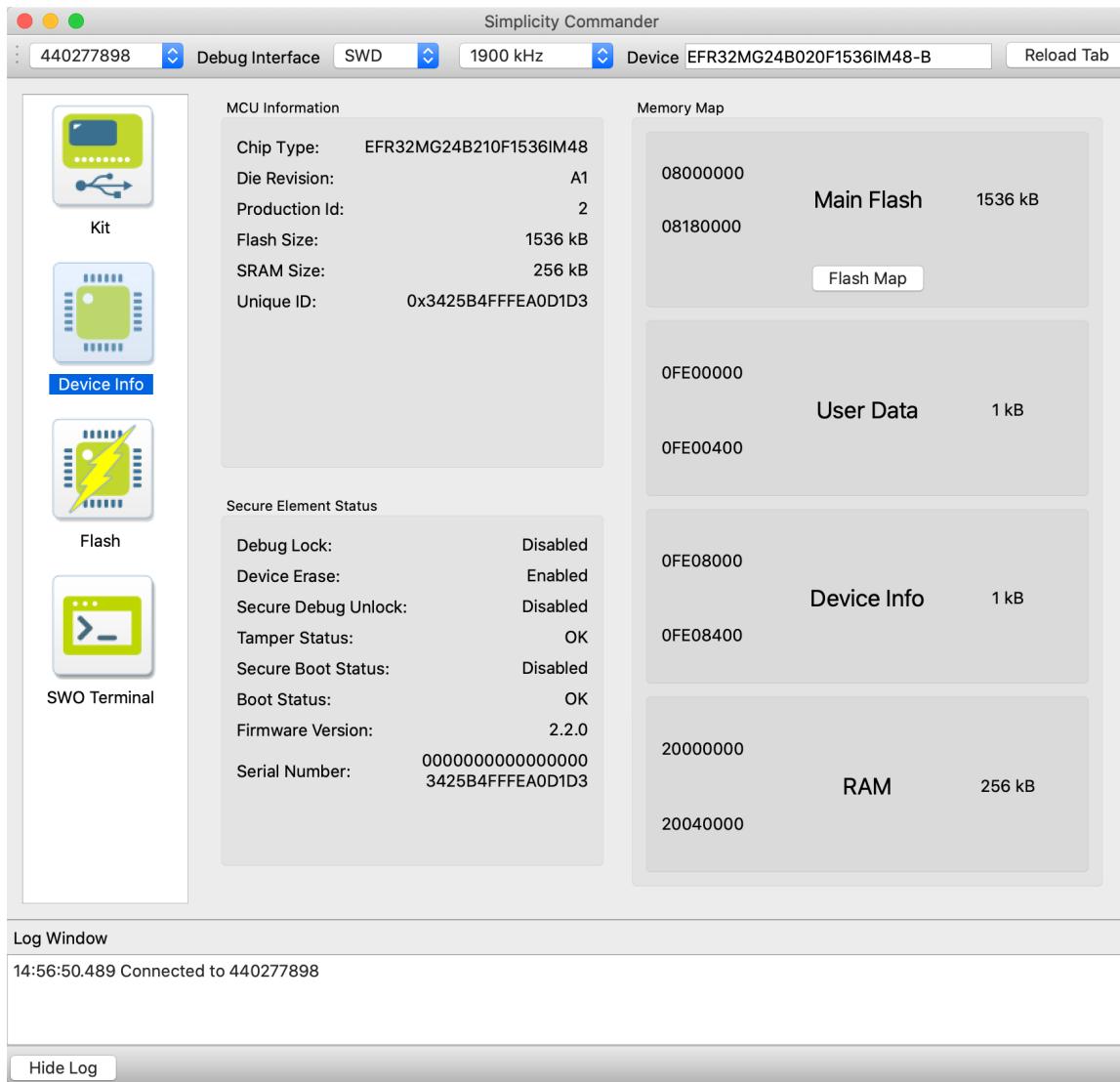
- Quickly build the GATT database for your embedded Bluetooth device
- Add services, characteristics and descriptors, either standard or custom
- Export and import the database between different projects or with GATT Configurator on EFR Connect mobile app
- Generate the GATT database on the embedded firmware as either static or dynamic implementation

Simplicity Studio 5 – Bluetooth NCP Commander



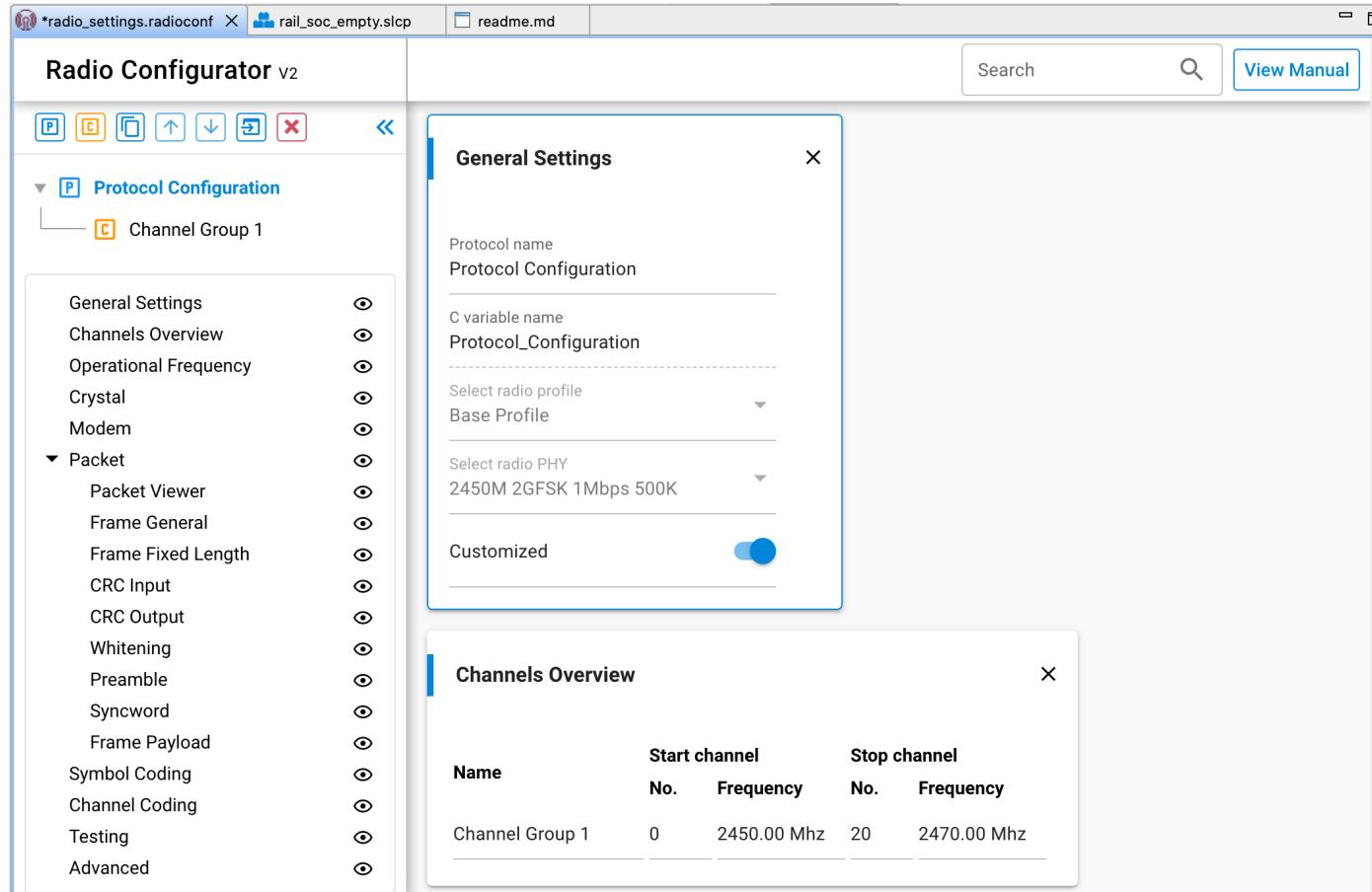
- Control the NCP target intuitively through a graphical user interface and learn the inner workings of the Bluetooth API
- Launch commands effortlessly through the smart console with built-in documentation and intellisense
- Perform the most common BLE functions (advertising, scanning, connections, DTM test)
- Manipulate the GATT database on the NCP target leveraging Dynamic GATT feature on the embedded stack
- Provision and configure Bluetooth Mesh devices

Simplicity Studio 5 – Simplicity Commander



- Program, erase and read the flash content on your device
- Use the CLI to script the commands you need
- Read, write and parse tokens or NVM3 content
- Configure and upgrade hardware kit firmware
- Secure your device by signing and encrypting firmware images, locking debug access and other options

Simplicity Studio 5 – Proprietary Radio Configurator

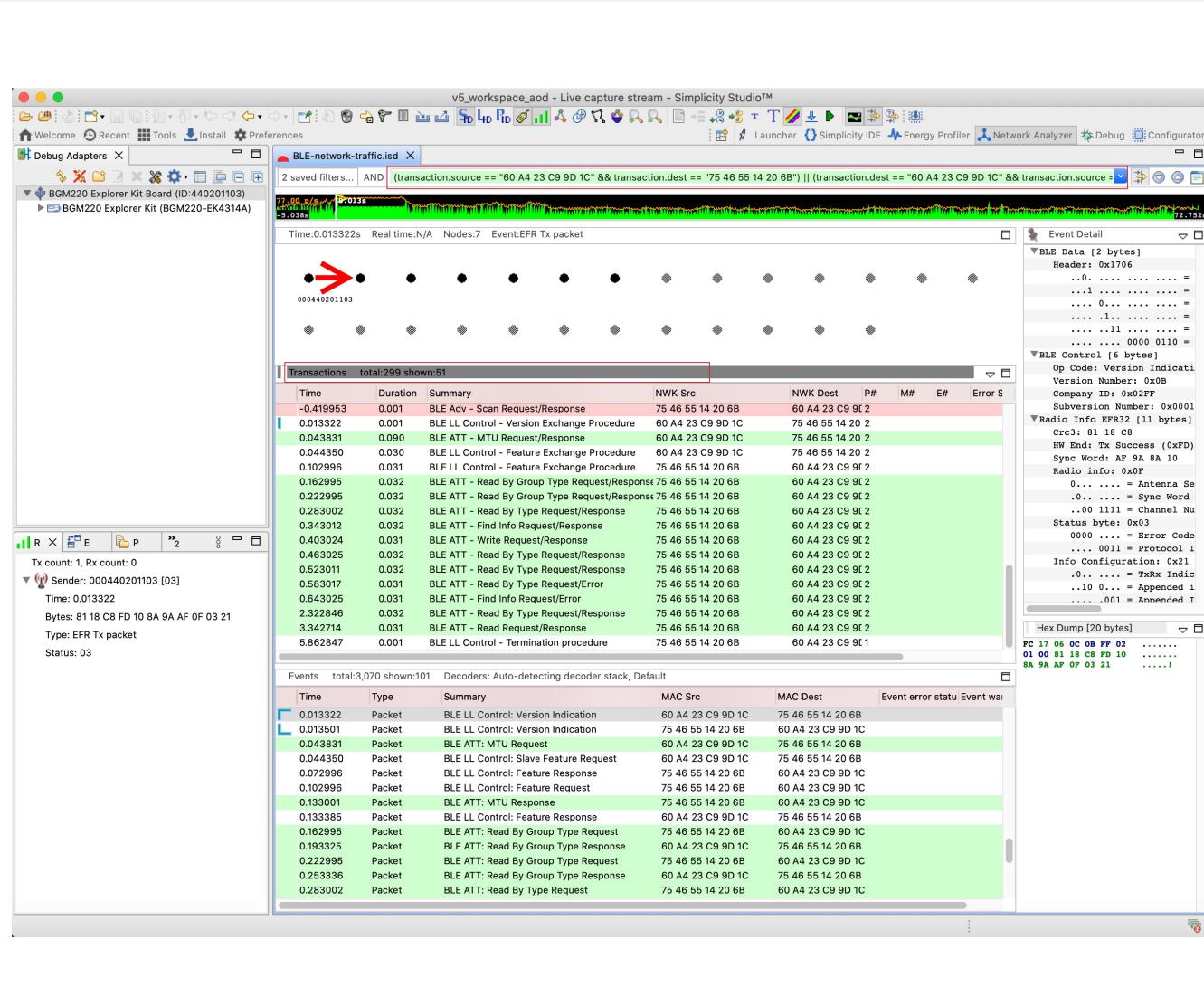


- Access all the configuration options in the radio
- Fully customize the modem to fit your needs
- Define your packet preamble, sync word and other options
- Export and import the radio configuration between different projects

Bluetooth application development with SSv5

- The Bluetooth applications in Bluetooth SDK v3.0 or later also have a new software architecture, the Bluetooth API is updated, and the GATT configurator is completely redesigned.
- The following lab will show how to create a new Bluetooth project using EFR32xG24 explorer kit and configure the stack with component based configurator.
- Then will demonstrate how to install the "iBeacon" component to extend the functionality of the example project.

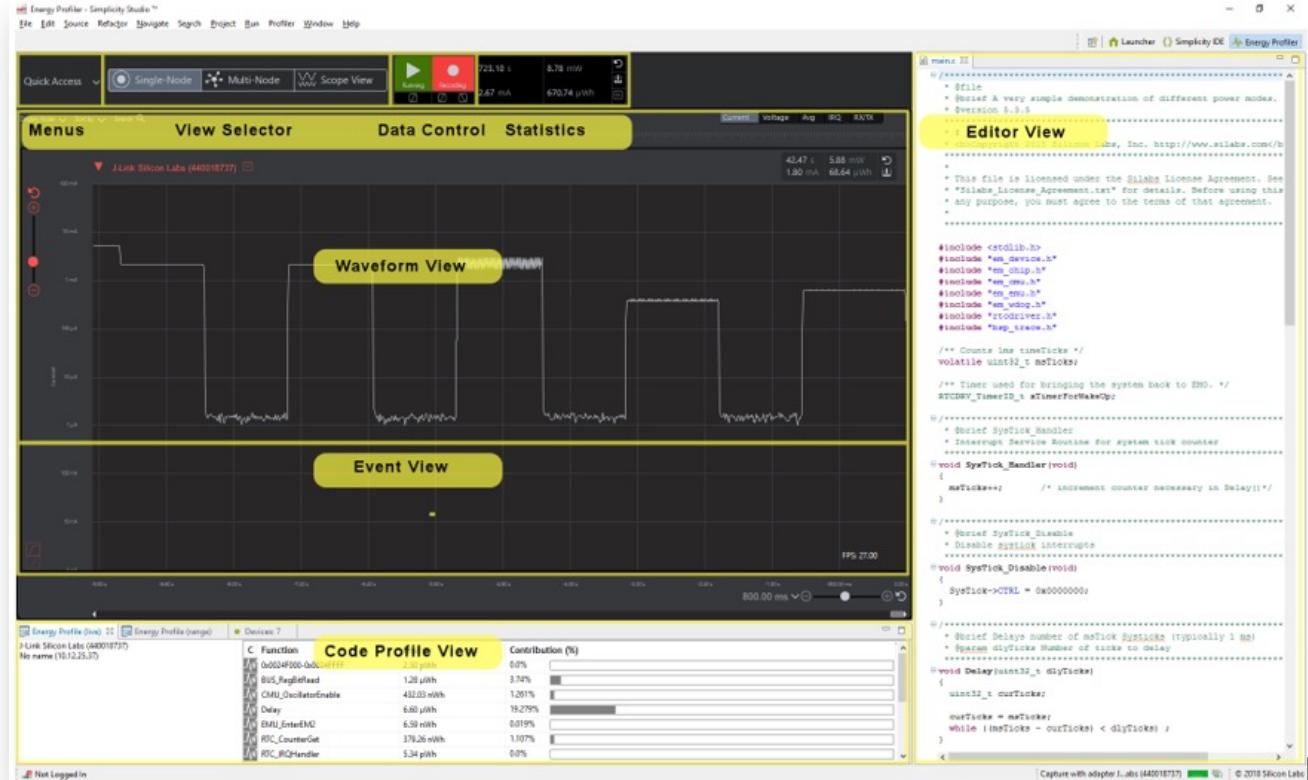
Simplicity Studio 5 – Network Analyzer



<https://docs.silabs.com/simplicity-studio-5-users-guide/latest/ss-5-users-guide-tools-network-analyzer/>

- Capture and analyze wireless network activity
 - ▶ Understand the network traffic easily
 - ▶ Debug connectivity or protocol issues
- Use any Wireless Starter kit as a sniffer
 - ▶ Live capture from multiple Ethernet networked WSTKs from a single PC
- Data directly from side-band interface (PTI) of EFR radios with detailed package Tx and Rx data
 - ▶ Timestamps
 - ▶ Link quality (LQI)
 - ▶ Receive sensitivity (RSSI)
 - ▶ CRC pass/fail results

Simplicity Studio 5 – Energy Profiler



<https://docs.silabs.com/simplicity-studio-5-users-guide/latest/ss-5-users-guide-tools-energy-profiler/>

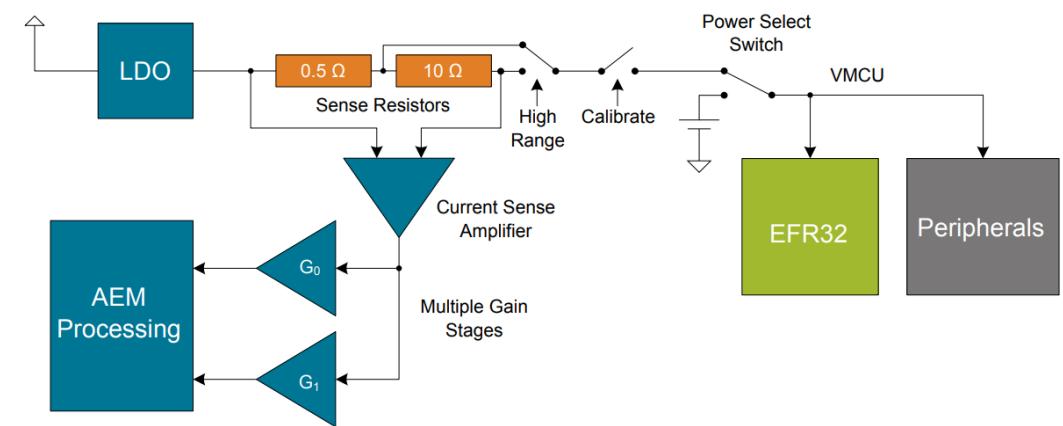
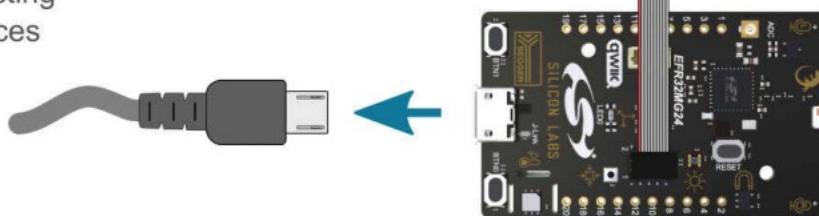
- Visualize the current consumption of your target system in real-time
- Ability to capture data simultaneously from multiple targets
- Save the energy trace for later analysis
- Correlate energy with the code running on your device
- Correlate with the radio TX/RX activity through PTI (Packet Trace Interface)

AEM Circuit



External debugger*

*USB and battery power sources
must be removed before connecting
an external debugger that sources
voltage to the VMCU net.





Thank You!

www.silabs.com

