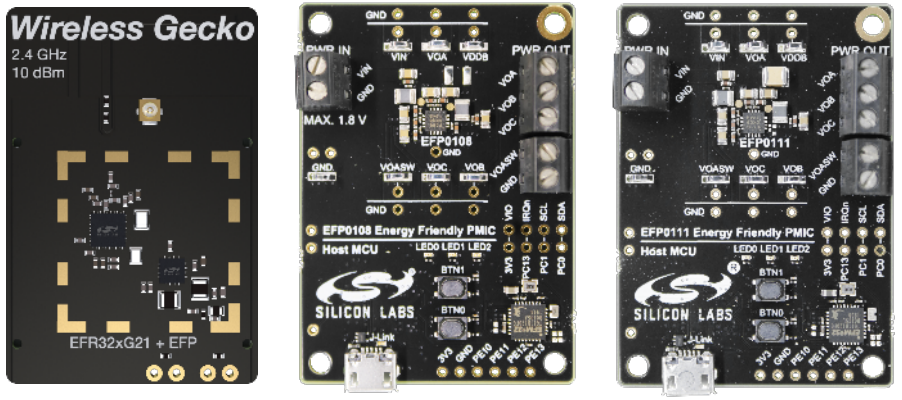
Tech Talks LIVE Schedule – Presentation will begin shortly

Silicon Labs LIVE:

Wireless Connectivity Tech Talks

Topic	Date
Wireless Module vs Wireless SoC Tradeoffs and Decision Making Criteria	Tuesday, May 19
Thunderboard BG22 Unboxing. You Have Our Kit… What Can You Do With It?	Thursday, May 21
Designing in Bluetooth using Bluetooth Xpress Modules	Tuesday, May 26
Overview of Silicon Labs Wi-Fi Solutions (Redpine Signals Wi-Fi Solutions)	Thursday, May 28
Optimize a Battery Supply Using the Energy Friendly PMIC	**Tuesday, June 2**
Zigbee Software Structure: Learn about Plugins and Callbacks	Thursday, June 4
Multiprotocol Wireless: Real Application of Dynamic Multiprotocol	Tuesday, June 9
Wireless Coexistence	Thursday, June 11

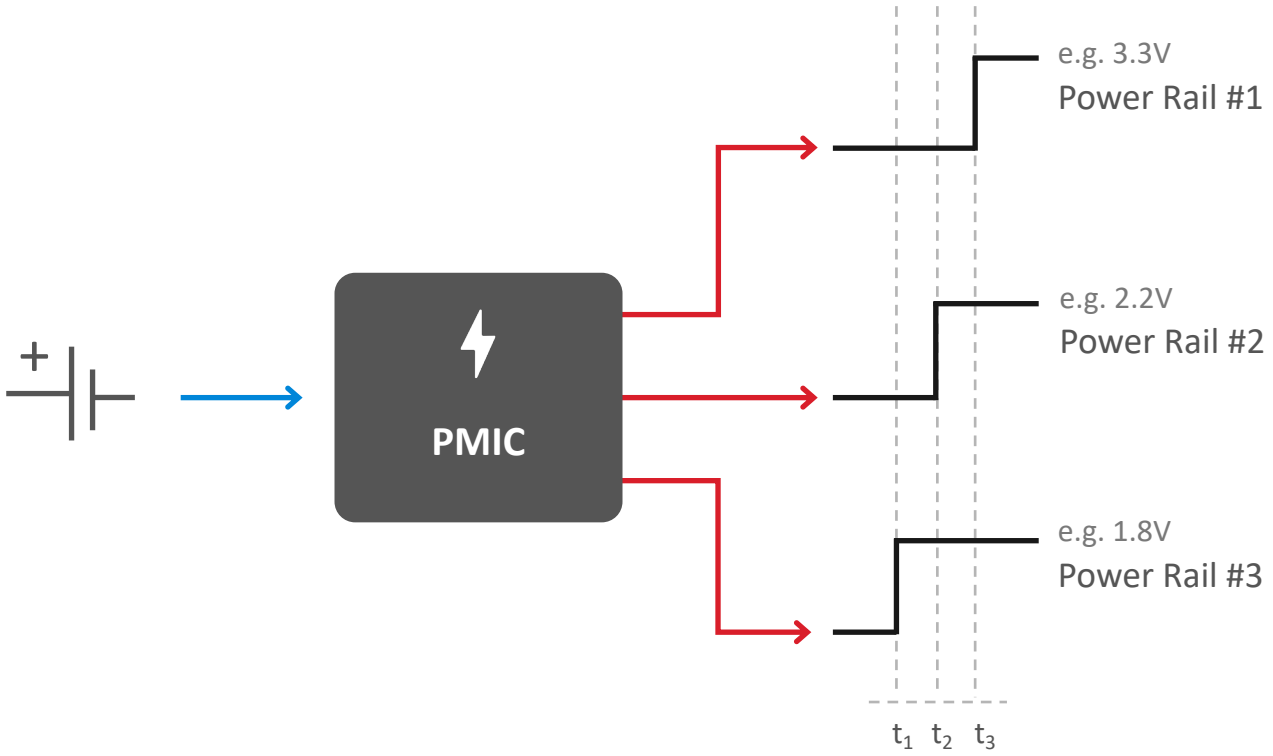


Find Past Recorded Sessions at:
https://www.silabs.com/support/training

Optimize a Battery Supply Using the Energy Friendly PMIC

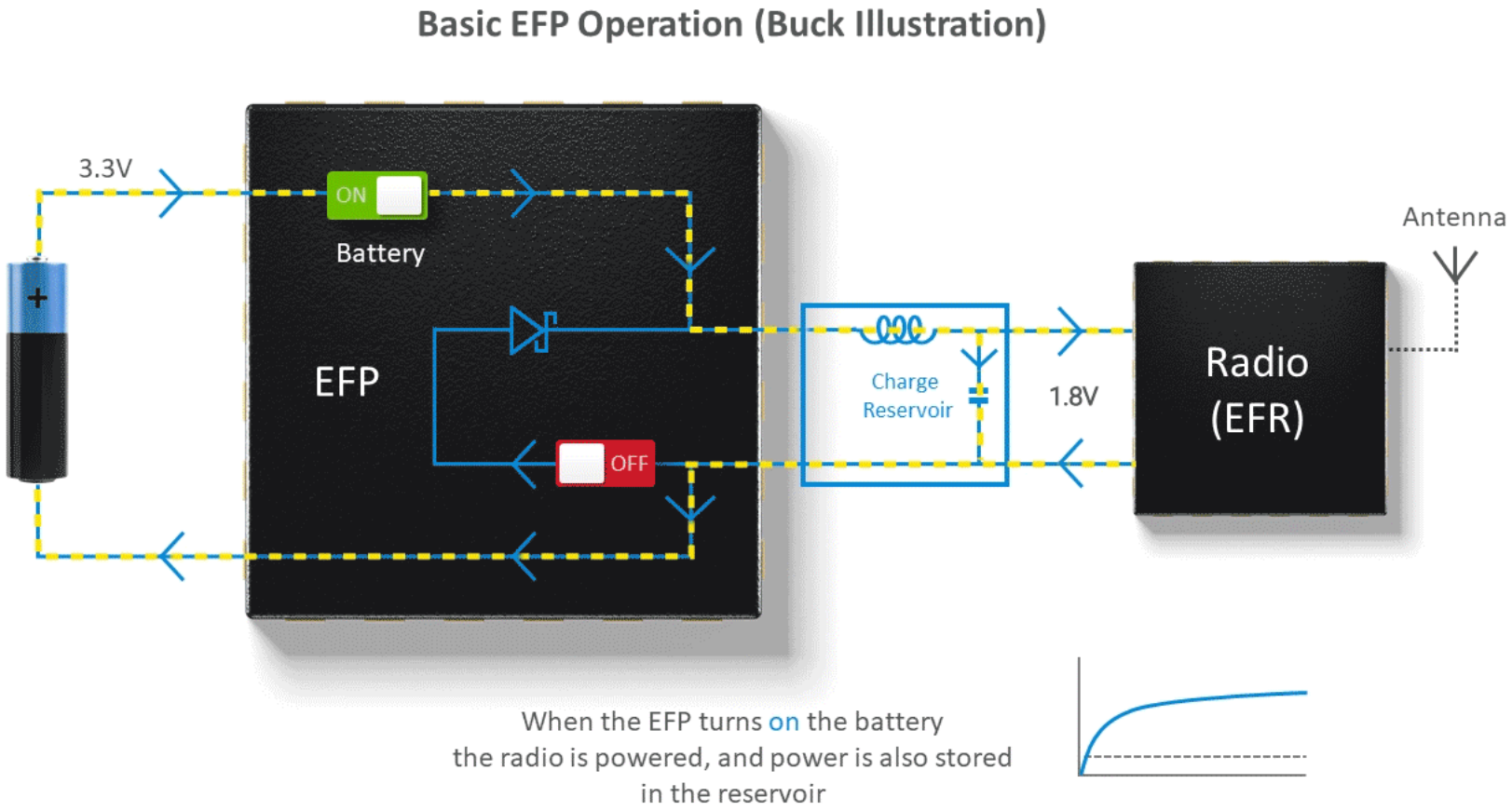
EFP01 POWER MANAGEMENT INTEGRATED CIRCUIT (PMIC)

The What and Why's of PMICs



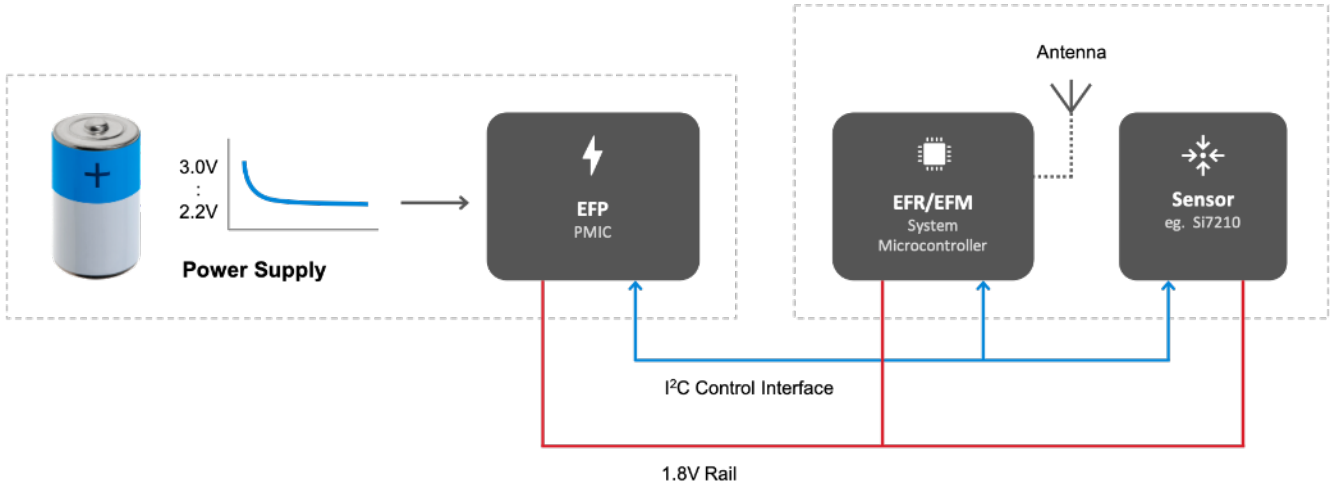
- Power Management IC (PMIC)
  - Dedicated IC with different voltage regulators
    - Can be complex, providing power to multiple ICs in an entire system
    - Or can be simple, such as and LDO, buck or boost converter
  - Can support multiple input voltages (USB, battery, etc.)
  - Can provide different output voltages
  - Can provide coulomb counting and fuel gauges
  - Can provide safety features
    - Overvoltage, undervoltage, reverse battery protection, etc
  - Can provide battery charging

PMIC Operation (Buck)



- See application note AN1187: EFP01 Design Considerations
  - https://www.silabs.com/documents/public/application-notes/an1187-efp01-design-considerations.pdf
  - Provides excellent operation theory and overview

EFP01: Dedicated PMICs Enhance Low-Power IoT Design



- Supports broad range of input voltage and battery chemistry
  - 0.8-1.8 volts and 1.8-5.5 volts
  - Extends EFR/EFM support below 1.7v and above 3.8v
- Optimized for battery operation
  - 250 nA quiescent current with one output enabled
  - Low as 30nA in EM4
  - Integrated, loss-less coulomb counter
  - Prevents primary cell corrosion - no leakage under 1.4 v
  - Inrush current control for batteries with high internal resistance
- Multiple output voltage rails (3)
  - Up to 150mA/rail max load with up to 94% efficiency
- ADC for temperature and voltage readings
- Software configurable
  - OTP configuration for stored startup configurations
  - I2C command/control interface for dynamic configuration changes
- Optimized for low power EFR32 Wireless SoCs
  - Provides reference designs with RF noise filtering
- 3x3 mm QFN20 package

Improving Visibility into Battery Health

cou·lomb

/ˈko͞oˌläm,ˈko͞oˌlōm/

noun PHYSICS

noun: **coulomb**; plural noun: **coulombs**; symbol: **C**

the SI unit of electric charge, equal to the quantity of electricity conveyed in one second by a current of one ampere.

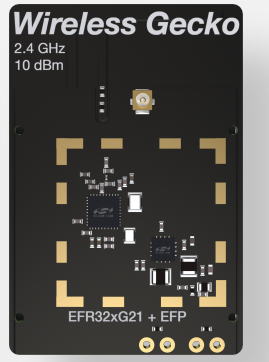
Origin

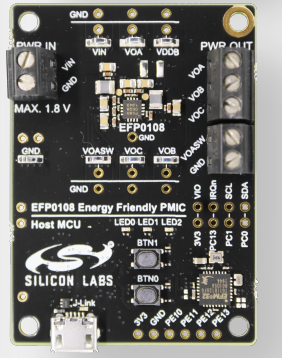
late 19th century: named after Charles-Augustin de Coulomb (1736–1806), French military engineer.

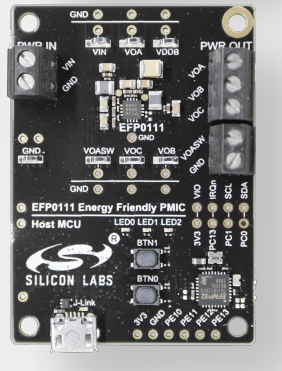
- Integrated Lossless Coulomb Counter
  - counts & stores the number of pulse switching events
- A charge-per-pulse is determined
  - Calibration is required to determine the charge-per-pulse
  - Requires a trimmed internal current load and trims need to be stored in registers
- Charge used = (number of pulse switch events) x (charge-per-pulse)
- AN1188: Coulomb Counting

EFP Family

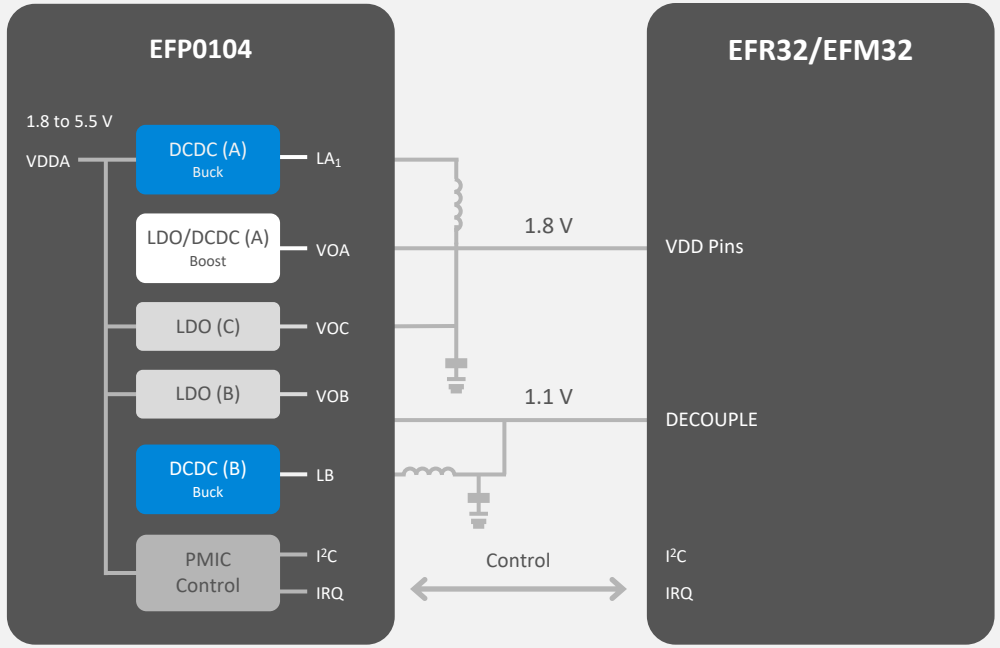
Circuit Architecture	Battery Technology		Device OPN	Benefit	Tools
	Voltage	Design			
Buck	1.80 -to- 3.60 V	Dual Alkaline	EFP0104GM20	Provides efficient conversion and wide battery range support	**SLWRB4179B** Radio Board (WSTK not included)
	2.20 -to- 3.00 V	CR2			
	2.50 -to- 3.00 V	Coin Cell			
	2.70 -to- 4.35 V	Li-Polymer			
Boost	0.80 -to- 1.60 V	Single Alkaline	EFP0108GM20	Enables operation from single cell reducing size and operational costs	**SLEVK1000A** DCDC Evaluation Board
	0.80 -to- 1.80 V	Lithium Iron-Disulphid			
Wired-Boost	1.80 -to- 3.60 V	Dual Alkaline	EFP0109GM20	Enable higher voltage operations (~ 3.3V) when using batteries that can provide high amperage	N/A
Boost/Bootstrap	2.20 -to- 3.00 V	Coin Cell	EFP0111GM20	Enables higher current operation when using coin cells	**SLEVK1000B** DCDC Evaluation Board







Buck Use Case – EFP0104



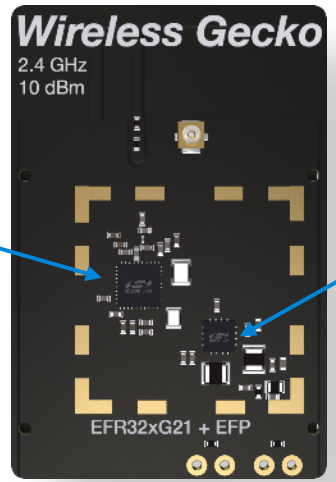
- Provides efficient operation and wide range of batteries
  - Ideal solution for batteries from 1.8 to 5.5V
  - Provides a regulated 1.8 volts for the highest efficiency
  - Provide 2 output voltage rails

Typical Battery	Battery Operating Range	Tx (max)	OPN	Development Hardware
Dual Alkaline/Zinc-Carbon Coin Cell (Lithium) Li-Ion/Li-Polymer Lithium Iron Phosphate	1.8 to 5.5 V	Up to +14 dBm @ 1.8V PAVDD	EFP0104GM20	BRD4179

Output	Mode	Output Range	Startup State
DCDC A	Buck	1.7V-5.2V	VOA=1.8V Enabled at startup
DCDC B	Buck	0.8V-1.25V	Disabled at startup
LDO C	Wired in parallel with DCDC A, not available as independent LDO		

Performance Comparison

SLWRB4179B



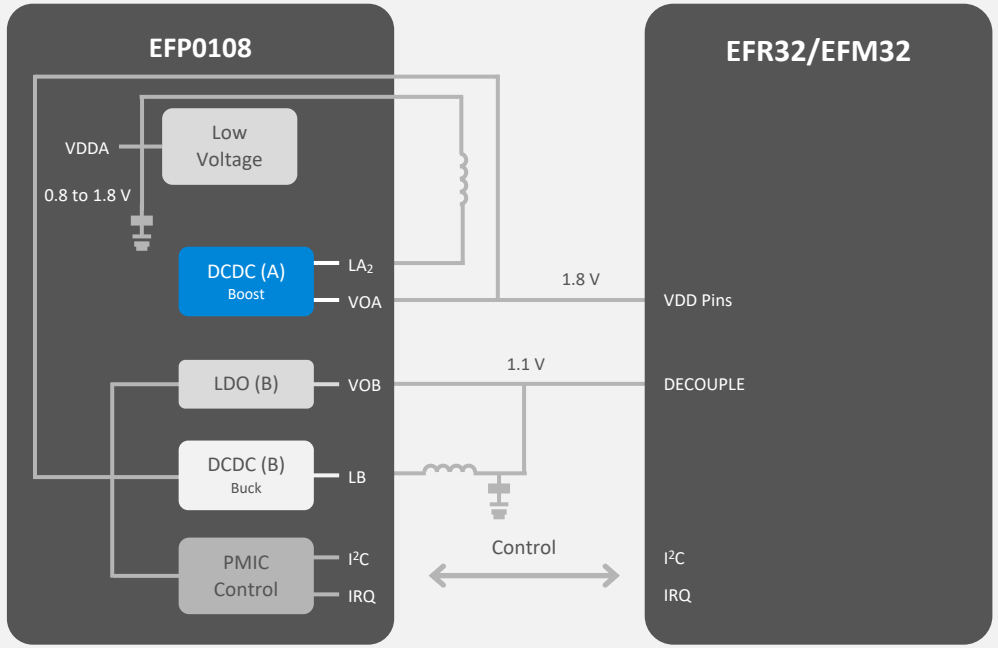
EFR32MG21

EFP0104

Condition @ 3.0 volts input		EFR32xG21	
		Without EFP01	**With** EFP01
Active Current	EM0 80 MHz HFRCO	3.7 mA	1.8 mA
Sleep Current	EM2	5.0 µA	2.6 µA
Rx Listen Current	1Mbps BLE	8.8 mA	6.0 mA
	802.15.4	9.5 mA	6.4 mA
Tx Current	0 dBm	9.3 mA	6.1 mA
	+10 dBm	33.1 mA	22.7 mA

- Substantial power savings
  - Over same design without EFP
  - Complete radio + PMIC reference design

Single Cell Boost Use Case – EFP0108



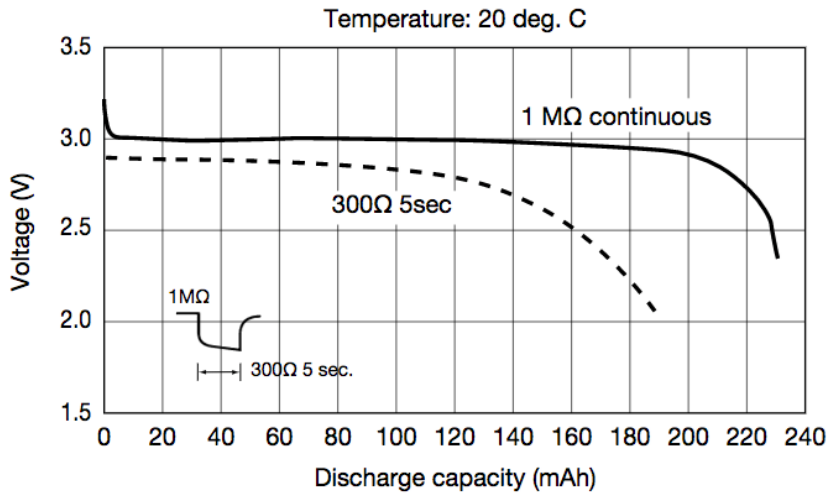
- Enables single alkaline cell operation
  - Boost 0.8 to 1.8 volts to 1.7 to 3.3 volts
    - Can support up to 10 dBm output power on EFR32 SoCs
  - Provides up to 3 output voltage rails

Typical Battery	Battery Operating Range	Tx (max)	OPN	Development Hardware
Alkaline Zinc Carbon Lithium Iron Disulphide NiMH/NiCd	0.85 to 1.8 V (at startup) 0.8 to 1.8 V (after startup)	Up to +14 dBm @ 1.8V PAVDD	EFP0108GM20	BRD8100A

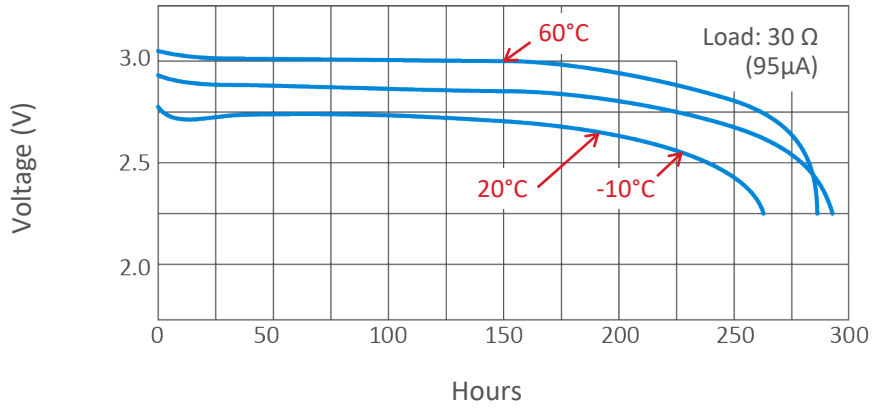
Output	Mode	Output Range	Startup State
DCDC A	Boost	1.7V-3.3V	VOA=1.8V Enabled at startup
DCDC B	Buck	0.8V-1.25V	Disabled at startup
LDO C	LDO	1.7V-3.3V	Disabled at startup

Lithium CR2032 Coin Cell Use Challenges for Wireless Products

Pulse Discharge Characteristics

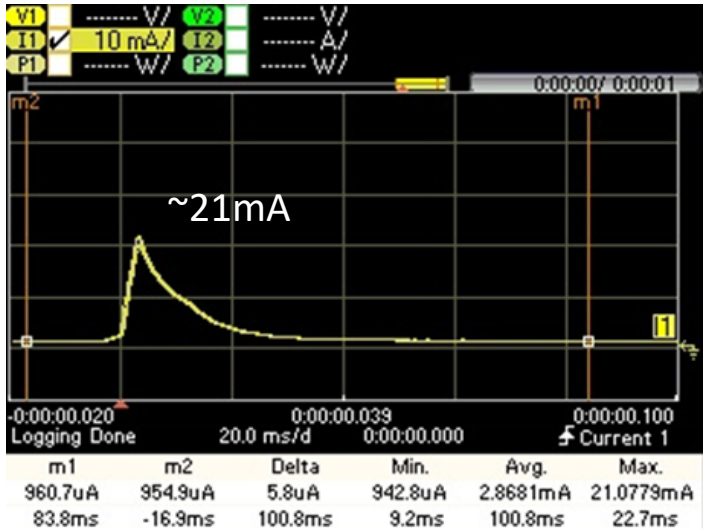


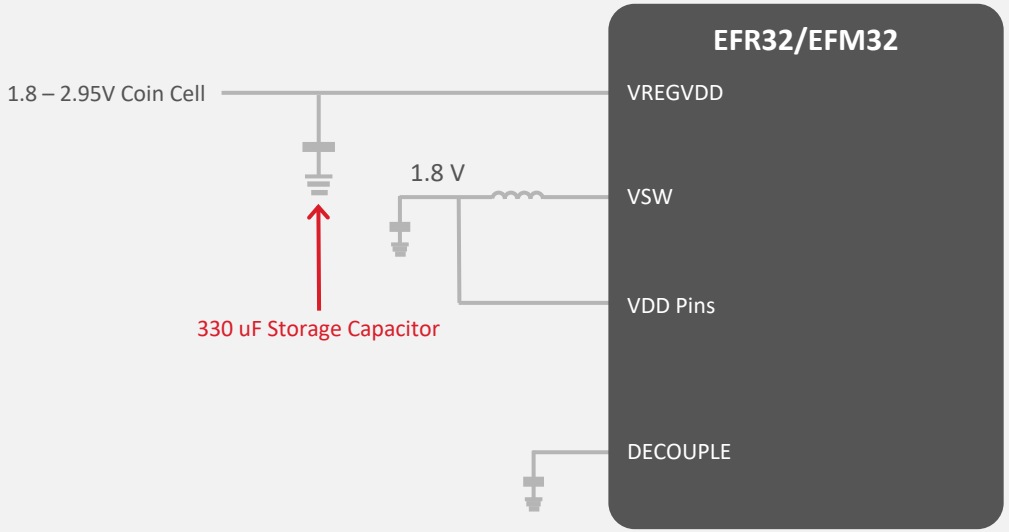
Temperature Characteristics



- Advantages of a coin cell
  - Small size
  - Low Cost
    - CR2032 is ~40 cents cheaper than a CR-2 battery
- Disadvantages of a coin cell
  - High internal impedance
    - 8 to 20 ohms over the battery lifetime
  - Wide variability in performance between manufacturers
    - Capacity, voltage, & internal resistance
  - Battery life degrades with high peak currents
    - Typically rated at 10-15mA max
    - The less peak current drawn, the more capacity available from the battery
- Summary
  - Coin cells are not well suited to sourcing high peak current applications
  - (e.g. RF transmissions)

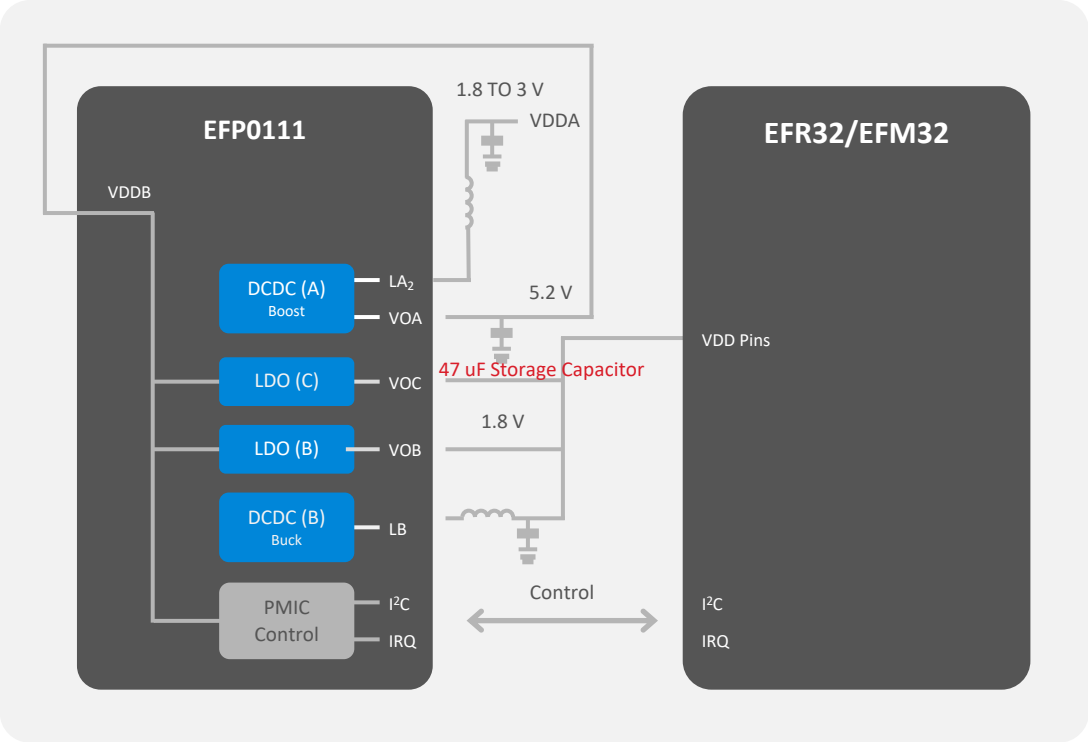
Coin Cell Solution – A Simple Approach: 1 big cap





- A large aluminum electrolytic cap is used to store charge
  - Can be large and expensive
  - Not efficient and wastes energy in battery (due to large current draw from battery)
  - Large capacitor requirement may force usage of leaky electrolytic capacitors

Boost-Bootstrap Use Case – EFP0111

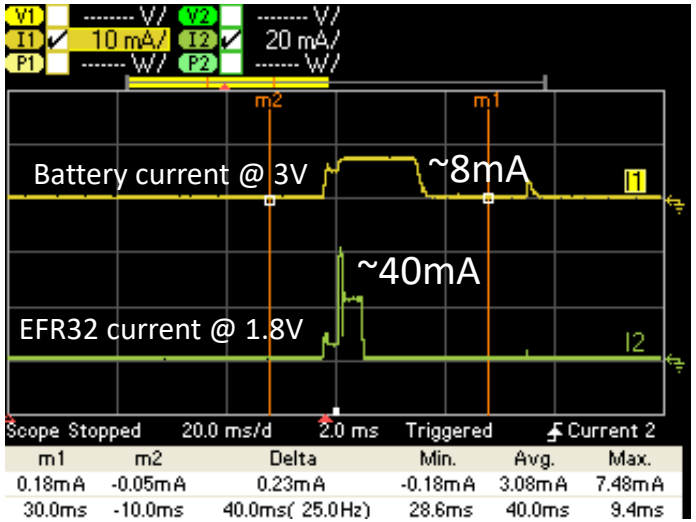


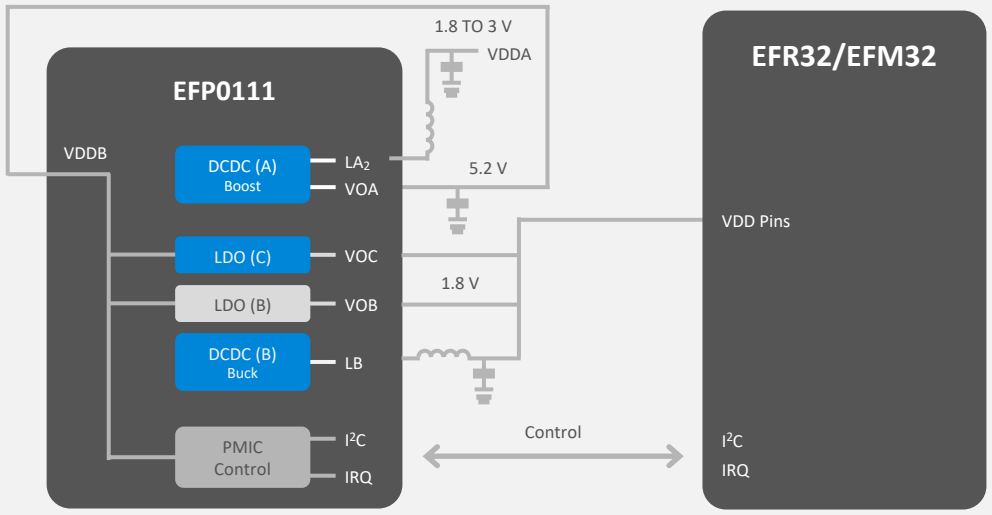
- Allows for higher current draw when using coin cell batteries
  - Ideal solution for coin cell batteries with +10 dBm or higher output power
  - Provides up to 3.3 V to support maximum transmit output power
  - Stores energy @ 5V for power bursts larger than battery can provide
    - Cap at the boost output (5V) to serve as an energy reservoir
    - Provides inrush current control to limit peak current: 10mA avg current from battery

Typical Battery	Battery Operating Range	Tx (max)	OPN	Development Hardware
Coin Cell (Lithium)	2.5 to 5.5 V (at startup) 1.5 to 5.5 V (after startup)	Up to +20 dBm @3.3V PAVDD	EFP0111GM20	BRD8100B

Output	Mode	Output Range	Startup State
DCDC A	Boost	1.7V-5.2V	VOA=5.2V, enabled at startup
DCDC B	Buck	0.8V-1.25V	VOB=1.8V, enabled at startup
LDO C	LDO	1.7V-3.3V	VOC=1.8V, enabled at startup

Coin Cell Solution - EFP0111 : Boost to 5V, then Buck to 3.3V

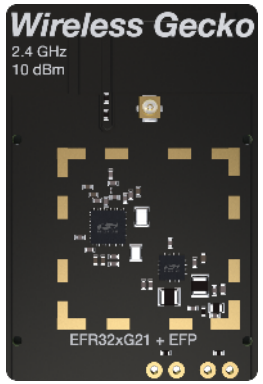




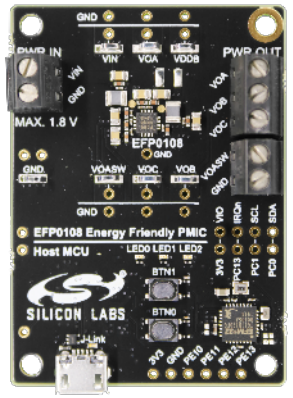
- Advantages
  - Storage cap is 4x smaller & lower cost relative to other solutions
  - Battery can run at a low pulsed current
    - Provides 30-40% increased life

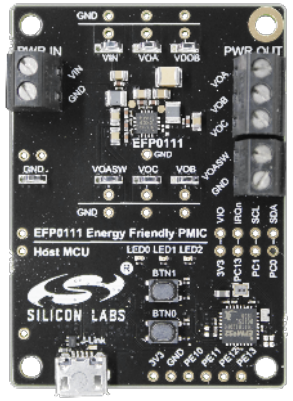
Getting Started with EFP

Development Radio Board



EFP Evaluation Boards

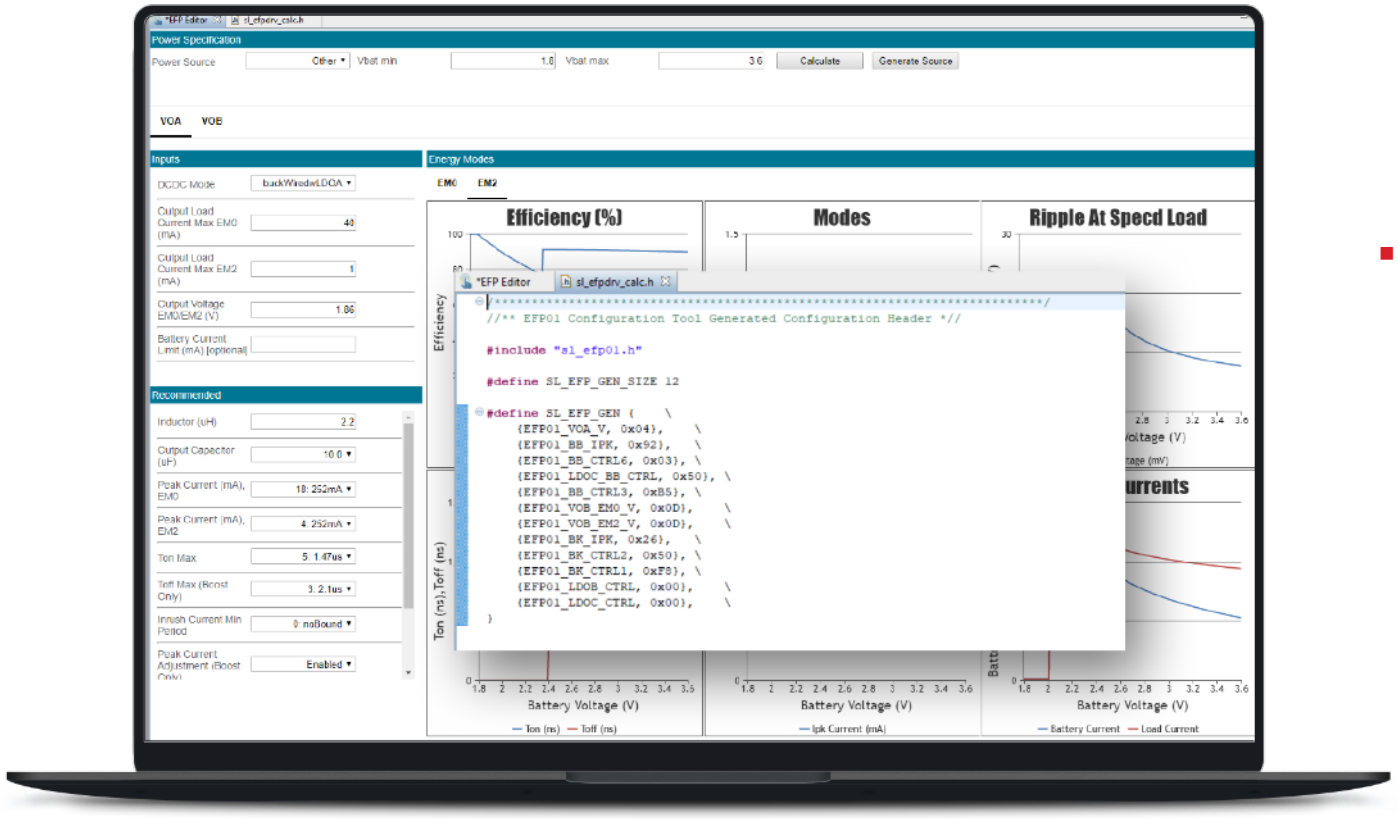




- Development Radio Board
  - Does not come with WSTK Main Board
    (must be ordered separately as part of EFR/EFM development kit)
  - Radio Board
    - SLWRB4179B - $39
    - Demonstrates EFP in buck mode with EFR32xG21 (EFP0104+EFR32xG21 @ +10 dBm)

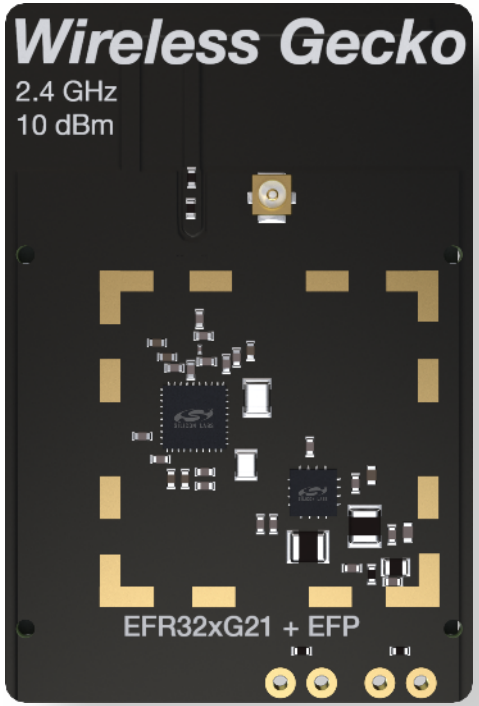
- **EFP Evaluation Boards**
  - Test points and connections for inputs and outputs
  - SLEVK1000A EFP0108 Boost Eval Board - $49
    - Eval board for 0.8 to 1.8 volt applications
  - SLEVK1000B - EFP0111 Boost/Booststrap Eval Board - $49
    - Eval board for EFR32 high output power applications using coin cell battery

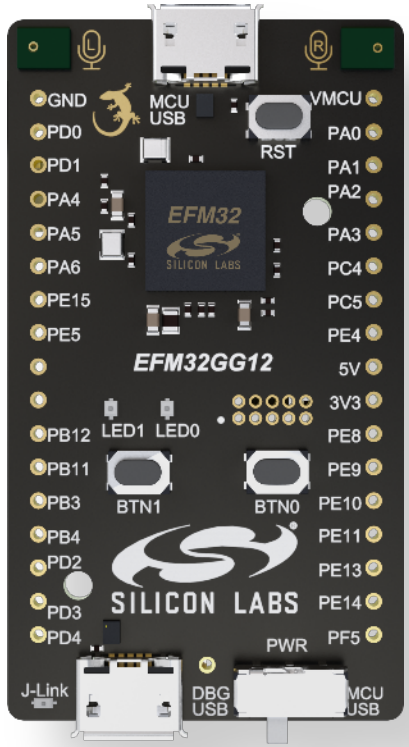
EFP Configuration Tool



- ‘One click’ source generation
  - Creates header file for inclusion into developer's project
    - sl_efpdrv_calc.h
  - EFP drivers automatically process header file at startup

Silicon Labs: Advancing What's Possible in the IoT





Bluetooth® Proprietary THREAD Wi Fi® zigbee Z-WAVE®

- PMIC provide designers increased flexibility around battery choices and input voltages for their designs.
- EFP is optimized for low power wireless IOT devices, providing flexible power modes, including the ability to run higher TX current on coin cell batteries and additional features including coulomb counting and safety features
- Silicon Labs is a one stop shop for low power wireless IoT devices including ICs, modules, eval boards, protocol stacks and IDEs.

BG22 Virtual Workshop

Learn how to develop and deploy more powerful, efficient, and secure IoT products with your own BG22 Thunderboard – free for all registrants!

New Sessions Open for June

10:00AM –11:30 AM CST - T, W, Th

(Other sessions available for Asia Pacific and Europe)

Register today! https://www.silabs.com/about-us/events/virtual-bluetooth-workshop

Join Us for a Smart Home Webinar

Register at https://www.silabs.com/applications/smart-home

Q & A Session

Thank you!