Presentation Will Begin Shortly

4:00

BLUETOOTH

FEB 29TH	Small Bluetooth Devices - How to Minimize Size without Compromising Performance and Reliability
APR 4TH	Bluetooth LE Application Development Journey
MAY 9TH	Unboxing Silicon Labs' Latest Bluetooth SoC for Energy Harvesting
JUN 13TH	Explore Bluetooth Channel Sounding

Welcome

Unboxing Silicon Labs' Latest Bluetooth SoC for Energy Harvesting

Introduction

Tristan Cool – Silicon Labs

- Tristan is a Product Marketing Manager on the Industrial IoT Team. Over the past 4 years, Tristan has been helping our leading asset tracking, condition monitoring and smart building customers migrate their designs to battery-less. Tristan's role is to advance the Ambient IoT / Energy Harvesting product roadmap.

Bruno Damien – e-peas

- Bruno is Marketing Director of Ecosystem and Partners at e-peas, leading the relation-ship with key partners involved in the implementation of energy harvesting solutions based upon e-peas products. He is a veteran of semiconductor industry having leading roles as Technical support , Sales director and Marketing Director at various major OEMs. Working for e-peas for the past 2 years.

Agenda

01 The Problem with Batteries..

02 Alternative energy sources for Ambient IoT

03 Unboxing xG22E

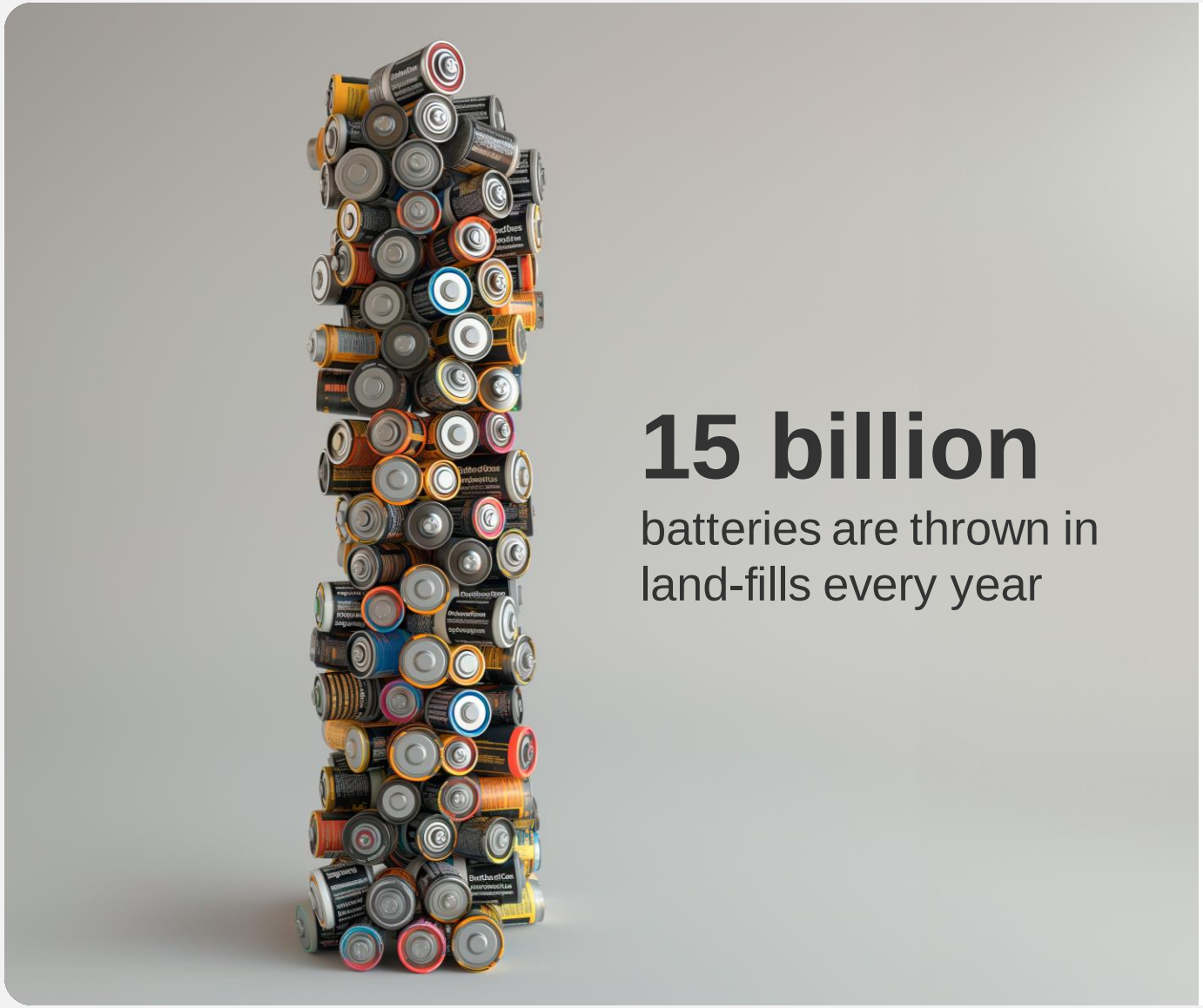
04 Resources: xG22E Explorer Kit e-peas Shields

05 Q&A

The problem with batteries...

Tristan Cool

The Problem with Batteries for IoT



15 billion

batteries are thrown in land-fills every year

More than 15 billion batteries are thrown in land-fills around the world every year (900,000 tons of hazardous waste)

The average household purchases over 90 batteries annually most have much less than 10-year lifetime

Batteries are slowing down the growth of IoT

- 25 billion IoT devices predicted by 2025 would require 6 million battery replacements every day
- In industrial setting with 1,000 sensors, the annual replacement of over 350 batteries—typically exceeding one per day—incurs significant recurring costs, often surpassing the batteries' own price.
- IoT is compromised when sensor polling rate, payload size, transmission rate and range are lowered due to lack of power.
- Systems need to integrate energy awareness decision making

Battery regulations

- National Electric Code (**NEC**) is introducing **new requirements on battery collection and recycling** as well as mandating the **elimination of batteries** in certain devices.
- **More and more countries** are following the movement (NEC US, NEC Europe, Japan, Australia, Canada)
- [17 AUG 2023] – **European Commission – Batteries Regulation**
- **Biden-Harris Administration Announces $62 Million to Lower Battery Recycling Costs Across the Nation**
- These upcoming regulations impact IoT device design.

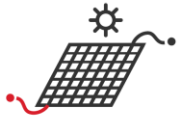
  This is the beginning of a new era of IoT product development

Source:

https://www.lightnowblog.com/2023/05/2023-nec-prohibits-battery-only-wall-light-switches/

https://environment.ec.europa.eu/news/new-law-more-sustainable-circular-and-safe-batteries-enters-force-2023-08-17_en

Energy Harvest – Application Profiles

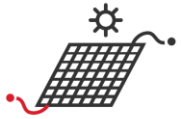


SOLAR - OUTDOOR

LOGISTICS / LIVESTOCK TRACKING

- Bluetooth /Bluetooth Long Range
- 802.15.4 Mesh

- 10 mW/cm²



SOLAR - INDOOR

ASSET TRACKING / SMART BUILDING SENSORS

- Bluetooth
- 802.15.4 Mesh

- 10 µW/cm²

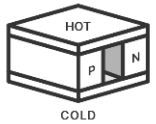
KINETIC PULSE

SMART SWITCHES

- Bluetooth / Bluetooth Mesh
- 802.15.4 Mesh

- 120~300 µJ/press

Energy Harvest – Application Profile

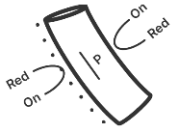


THERMAL

MACHINE MONITORING

- Bluetooth / Bluetooth Mesh
- 802.15.4 Mesh

- 1-10 mW/cm²

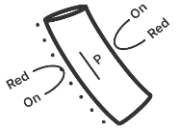


VIBRATION / PIEZO

FACTORY AUTOMATION / AGRICULTURE / TPMS

- Bluetooth
- 802.15.4 Mesh

- 100 µW/cm²



INDUCTION

ELECTRIC SUB-METERING

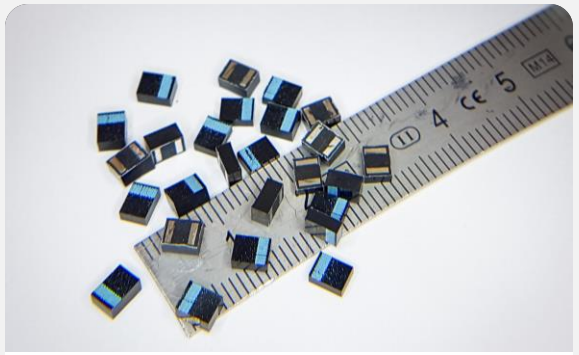
- Zigbee Green Power
- 802.15.4 Mesh

- 100 µW/cm²

Alternative Battery/Storage

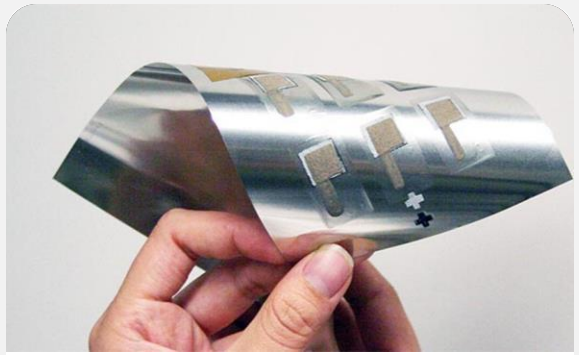
CONVENTIONAL BATTERY

- Environmentally harmful
- Lithium
- Nickel-Cadmium
- Nickel-Metal-Hydrate
- Silver Oxide
  1.2~3V cells



MICRO BATTERY

- Solid-state design
- Embedded
- Surface-mount
- Customizable
  2.2~3V cells



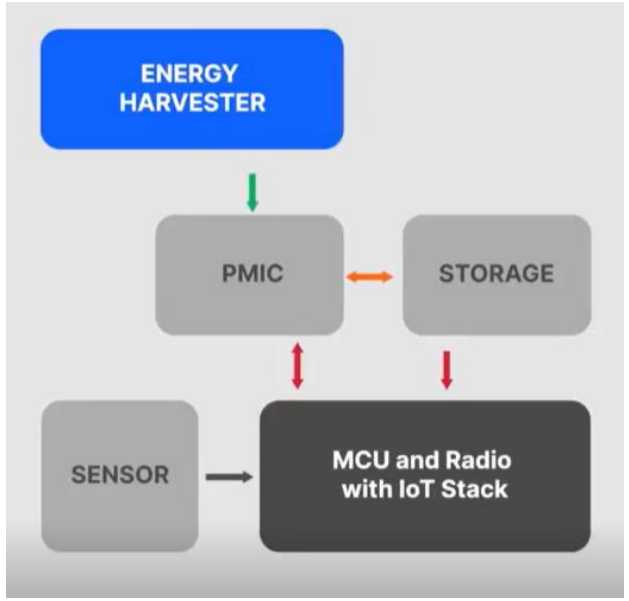
PRINTED BATTERY

- Printed anode/cathode
- Pliable thin-film
- Customizable

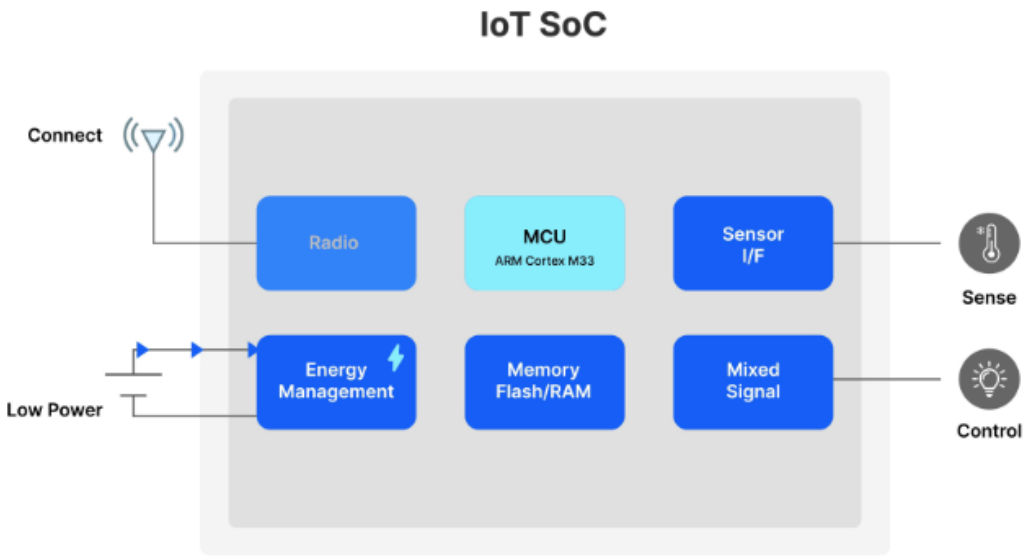
SUPER CAPACITORS

- Environmentally friendly
- Quick energy delivery
- Several hours of self-discharge

Understanding IoT Architectures for Energy Harvesting



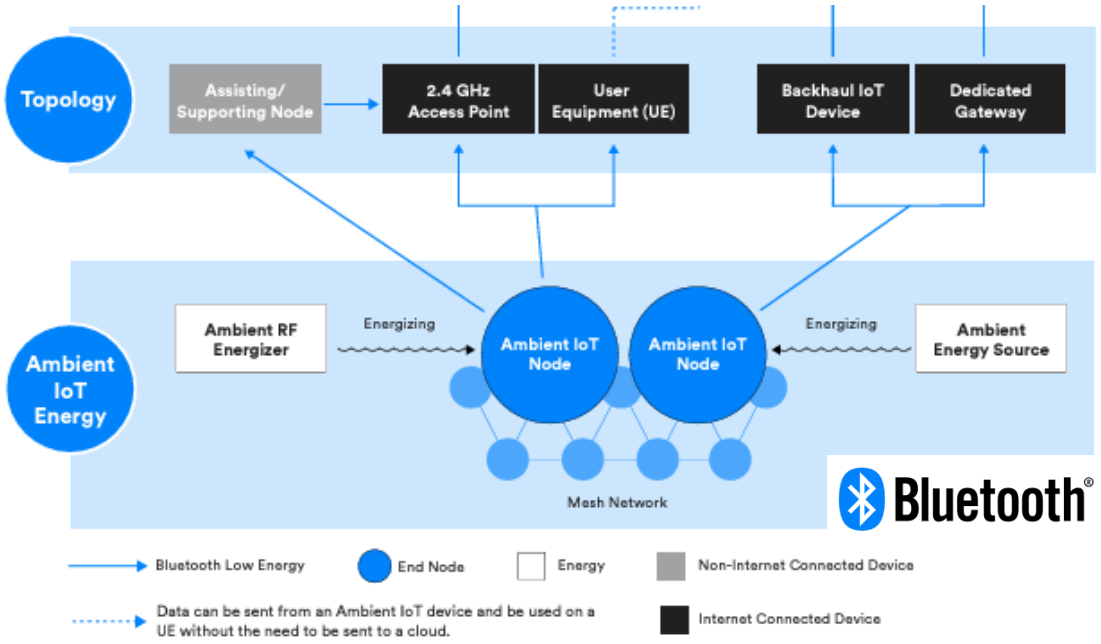
- **Energy Harvester:** harness ambient energy
- **Storage:** energy bank
- **PMIC:** power management and transformation
- **MCU and Radio:**
  - Application and communication
  - energy-based decision making ; sleep and wake control



The IoT SoC Platform is responsible for:

- assessing available energy
- determining when to wake up peripheral systems
- executing system actions...or remain asleep.
- Managing communication payload and transmitting

‘Ambient IoT’ for ‘Energy Harvesting’



- BTSIG preparing for battery-less, energy-harvested IoT
  - FEB, 2024 – *The Role of Bluetooth Technology in the Ambient IoT*
  - Reference link

- CSA launching ZGP 1.1.2 - 24Q2 GSDK
  - MARCH, 2024 – *CSA Releases Green Power 1.1.2 for Zigbee-based Energy-Harvesting Technology*
  - Reference link

Unboxing xG22E

Tristan Cool

Introducing EFR32xG22E

- **Ultra-fast, Low-Energy cold-start**
  - Power on Reset (PoR) in 8ms
  - Consumes less than 150µJ
- **Ultra-fast, Low-Energy deep sleep wake-up**
  - EM4 wakeup in less than 1.83ms
  - Consumes 16.6µJ in wake-up energy
  - 10+ year coin cell battery operation for ultra-low power or extended storage applications
- **Power-efficient energy mode transition**
  - Optimized for smooth transitions in and out of energy modes
  - Mitigates current spikes or in-rush to prevent harm to batteries or alternate storage
- **Reliable Wireless and Long Range**
  - Multiprotocol 2.4 GHz wireless SoC with High-Performance RF
    - Bluetooth LE, Proprietary, Zigbee, and Zigbee Green Power
- **Pin compatible with xG22 and xG27 SoCs**
  - Pin compatible QFN32 and QFN40 packages for easy migration and rapid time to market

xG22E: Ideal for Ultra-low Energy, Ambient IoT, and Energy-Harvesting

Bluetooth® Proprietary zigbee

- **5x5 QFN40 (26 GPIO), AEC-Q100**
- **4x4 QFN32 (18 GPIO)**

DIFFERENTIATED FEATURES

- **Efficient, Low-Energy Cold Start**
  - Boot-up time less than 8ms
  - Energy consumption under 150uJ
- **Low-Energy Deep Sleep wake-up**
  - Consuming less than 17uJ
- **Power-efficient energy mode transition**
  - Optimized to smoothly transition out of energy modes
  - Mitigates current spikes or inrush
- **RFSense with OOK mode**
  - Ultra low-power receive mode to wake-up MCU from EM2 or EM4
  - Results in longer battery life
- **PLFRCO**
  - Eliminates need for 32 KHz XTAL and lowers overall system cost
- **16-bit ADC**
  - Up to 14-bit ENOB for better analog sensing

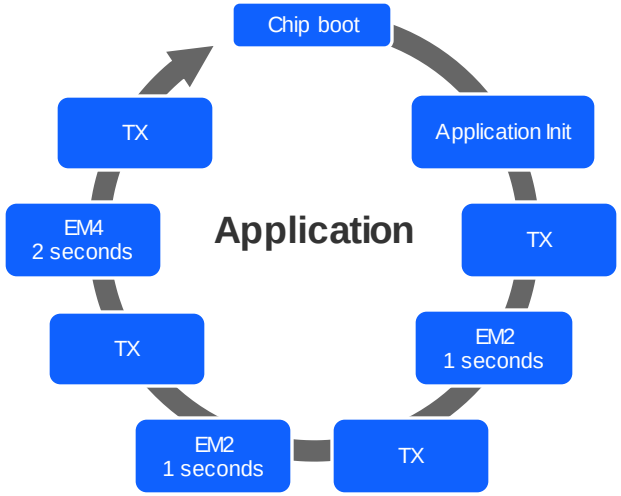
DEVICE SPECIFICATIONS

- **High Sensitivity 2.4 GHz Radio**
  - -Up to +6 dBm TX
  - -98.9 dBm RX @ BLE 1 Mbps
  - -106.7 dBm RX @ BLE 125 kbps
  - -102.3 dBm RX @ 15.4
- **Efficient ARM® Cortex®-M33**
  - Operating Frequency: Up to 76.8 MHz
  - 512kB Flash, 32kB RAM
  - Low Power
  - 27 µA/MHz
  - 3.4 mA TX @ 0 dBm
  - 2.5 mA RX (BLE 1 Mbps)
  - 1.4 µA EM2 sleeps
  - 0.17 µA EM4
- **Secure**
  - Secure Vault Base
  - ARM ® TrustZone
- **Wide Operating Range**
  - 1.71 to 3.8 volts
  - +125ºC operating temperature
- **PLFRCO**
  - 500 PPM LFRCO

xG22E Optimizations

COLD START

- **Efficient, Low-Energy Cold Start**
  - Boot-up time less than 8ms
  - Energy consumption under 150uJ
- **For energy-harvest devices that require booting up from *zero-power level***



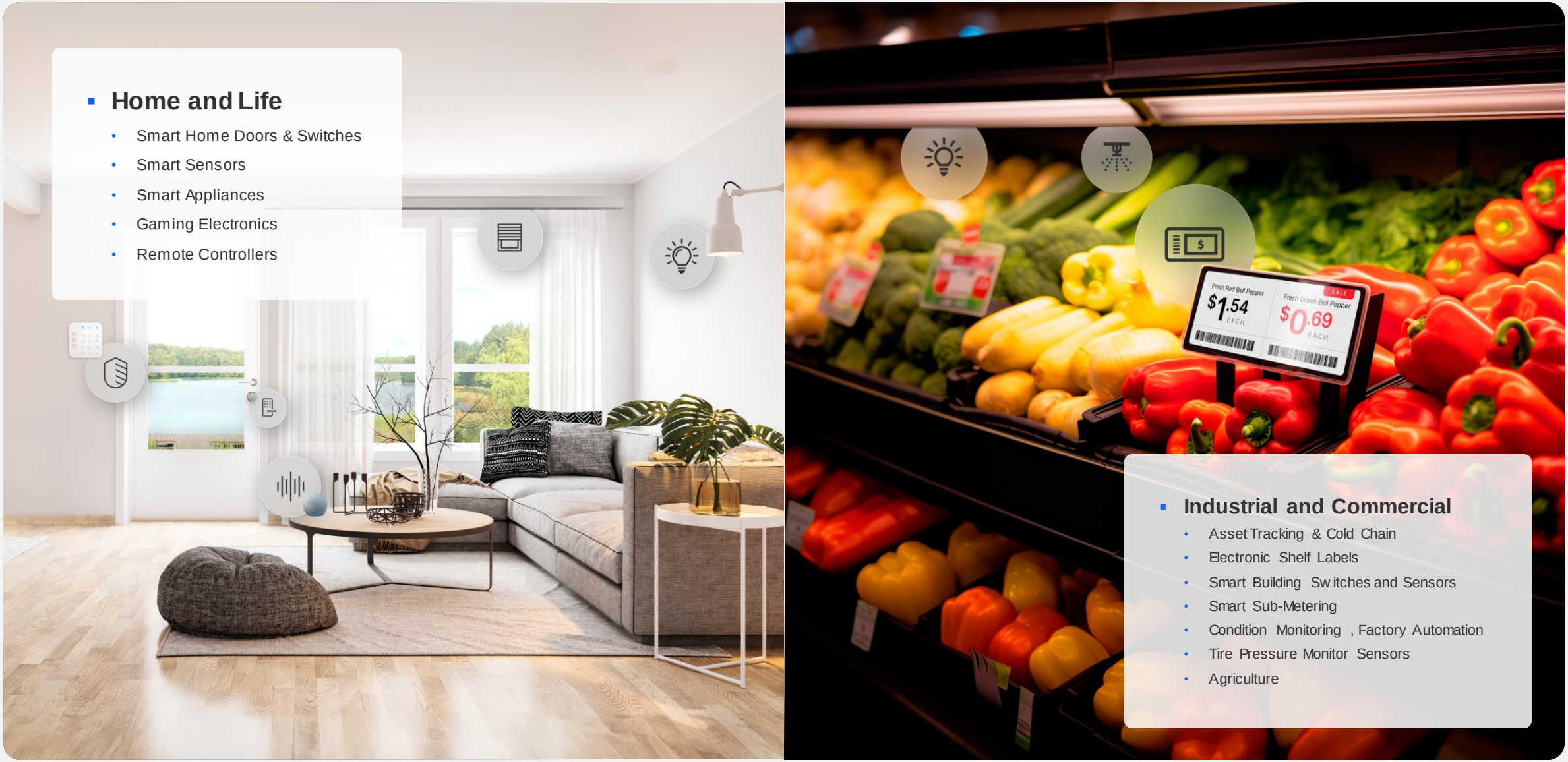
ENERGY MODE SLEEP WAKE-UP

- **Low-Energy Deep Sleep wake-up ; Smooth energy mode transitions**
  - Consuming less than 17uJ
  - Current in-rush spikes mitigated between rapid energy mode transition to protect batteries and capacitors
- **For devices that spend extremely lengthy periods in deep sleep with *frequent* wake-ups between Tx**
  - Extends battery-life
  - Allows for energy-based wake decision making for energy-harvesting
  - Multi-source wake-up (RF Sense, GPIO, RTC)

xG22
Startup time: 18.8 ms
Startup Energy: 185 uJ
EM4 wake-up: 9.2 ms
EM4 energy: 76.7 uJ

xG22E
Startup time: 8.01 ms *(-42%)*
Startup Energy: 150 uJ *(-19%)*
EM4 wake-up: 1.83 ms *(-80%)*
EM4 wake-up energy: 16.6 uJ *(-78%)*

Target Markets and Applications



- **Home and Life**
  - Smart Home Doors & Switches
  - Smart Sensors
  - Smart Appliances
  - Gaming Electronics
  - Remote Controllers

- **Industrial and Commercial**
  - Asset Tracking & Cold Chain
  - Electronic Shelf Labels
  - Smart Building Switches and Sensors
  - Smart Sub-Metering
  - Condition Monitoring , Factory Automation
  - Tire Pressure Monitor Sensors
  - Agriculture

SILICON LABS

xG22E Value Proposition

- **Minimize Battery Replacement and Recharging**
  - Low run-time and wake-up currents in sleep modes
  - Extended battery life for ultra-low power beacon applications and sensors
- **Compatibility with variety of power sources, power management and harvesters**
  - Exploration into new battery technologies and super-capacitors
  - Compatible with multitude of power management IC's (built-in DC-DC Converter and Voltage Regulator)
  - Integration with energy-harvesting hardware
- **Silicon Lab's first part in Ambient IoT and energy-harvesting**
  - Multiple configurations for energy – DC-DC bypass, LFRCO, Radio PA, etc.
  - Based on existing Series 2 catalogue – pin-to-pin compatible. Short turnaround time to market!
  - Compliant with CSA's energy-harvesting protocol Zigbee Green Power 1.1.2
- **Multiple deep sleep wake-up options**
  - RFSense, GPIO and RTC wake-up sources from deepest EM4 sleep mode.
- **Silicon Labs' Proven Application Expertise**
  - Partner reference designs
  - Simplicity Studio streamlines the development process, reducing costs and accelerating time-to-revenue

Resources

Getting Started with EFR32xG22E

- **NEW Explorer Kit – June 2024**
  - Isolated debug circuit for lowest power
  - mikroBus socket
  - Qwiic connector
- **Contents**
  - 1x Explorer board

Part Number	Description
EK2710A - BRD2710A	EFR32MG22E Explorer Kit

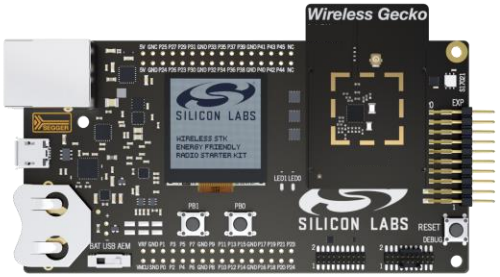
NEW Explorer Kit Shield – TBA (24Q3)

- mikroBus socket
- Qwiic connector
- E-peas PMIC shields

Contents

- 1 Explorer board
- 3x Energy Shields

Part Number	Description
EK8200A	EFR32xG22E Explorer e-peas shield
BRD8201A	Alternate battery and super-capacitors
BRD8202A	AEM0300 PMIC for kinetic pulse sources
BRD8203A	AEM13920 PMIC for dual energy source



Radio Board kits – May 2024

- Uses existing WSTK boards
- Uses existing software tools

Contents

- 1x radio board

Part Number	Description
xG22E-RB4415A	EFR32xG22E 2.4 GHz +6 dBm Radio Board (QFN40)
SLWRBRD4415A	

Introducing xG22E Explorer Kit e-peas Shields for energy-harvesting

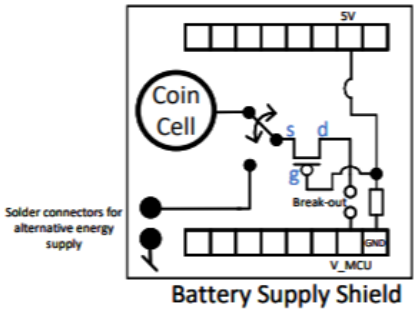
SILICON LABS

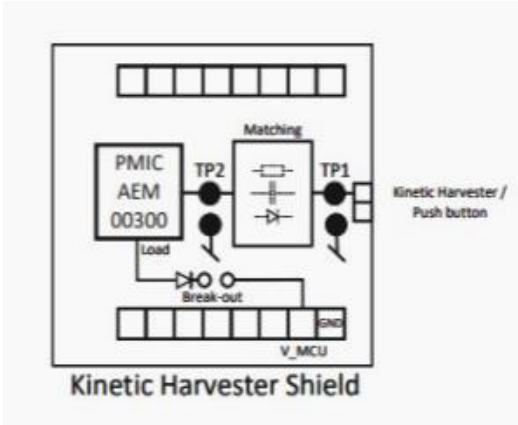
e-peas semiconductors

NEW Explorer Kit: redesigned to minimize leakage and isolation of debugger circuit

Shield interface expansion boards:
A: Transistor rectifier
B: Diode rectifier
C: Over-voltage protection
D: Additional input capacitance

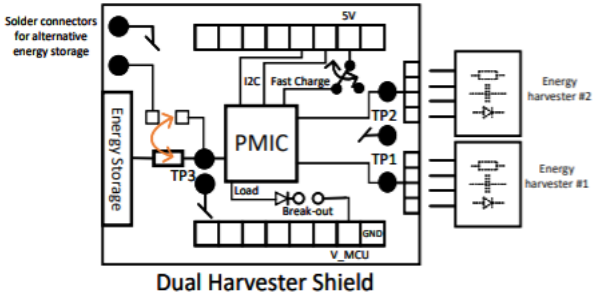
Shield #1 for alternative battery technologies and storage options with measurements





Shield #2 dedicated for evaluating kinetic/pulse harvest generators with measurements.

Shield #3 for dual harvest sources (PV, Thermal, Vibration, bricks) with measurements



e-peas

Bruno Damien

e-peas Company Overview

Bruno DAMIEN

Ecosystem and Partners Marketing Director

bruno.damien@e-peas.com

tech talks

BLUETOOTH

e-peas semiconductors

Bruno Damien

Bruno Damien

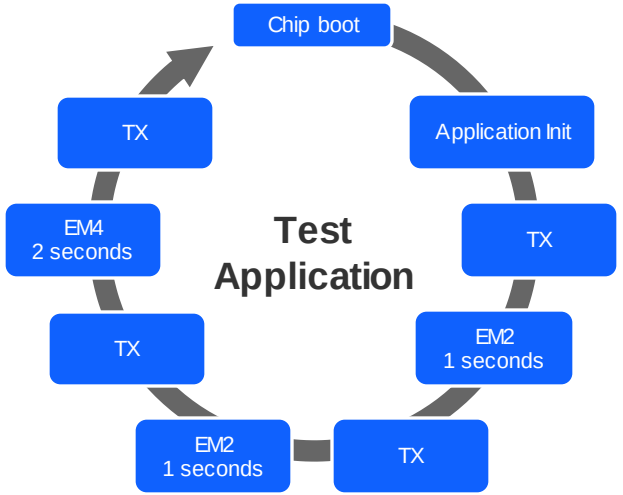
Reference Materials

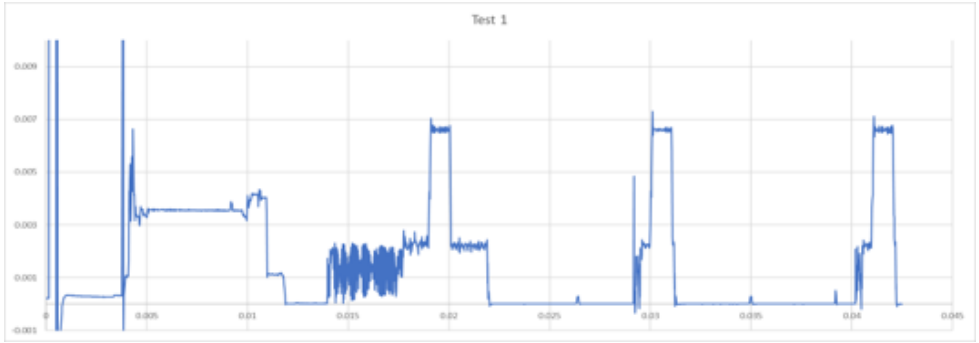
- **Website / Announcements:**
  - silabs.com/wireless/energy-harvesting
  - silabs.com/blog/building-a-more-sustainable-connected-world-with-xg22e

- **WorksWith:**
  - 2023 – IOT104 – *Energy Harvesting for Low Power Wireless*
  - 2022 – APP104 – *Factory Monitoring with Thermal Harvesting*
  - 2020 – EH202 – *Building Energy Harvest Devices*

- **Reference Designs / White-papers:**
  - Thermal Energy example
  - Kinetic Switch example
  - PV Cell example

- **Additional resources:**
  - resources.mouser.com/energy-harvesting
  - Power Electronics News – energy harvesting





- **REFERENCE EXAMPLES:**
  - Zigbee Green Power for kinetic push buttons - github
  - Bluetooth for solar asset tags - github

Q&A

Thank you

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