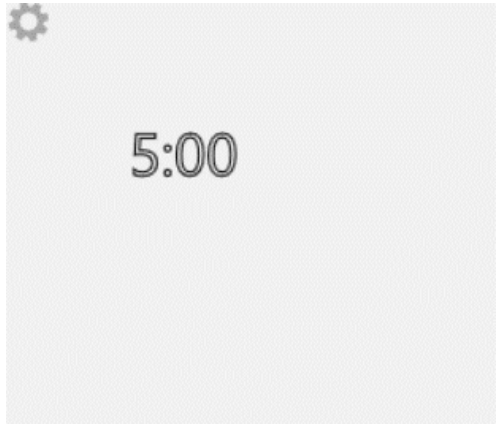
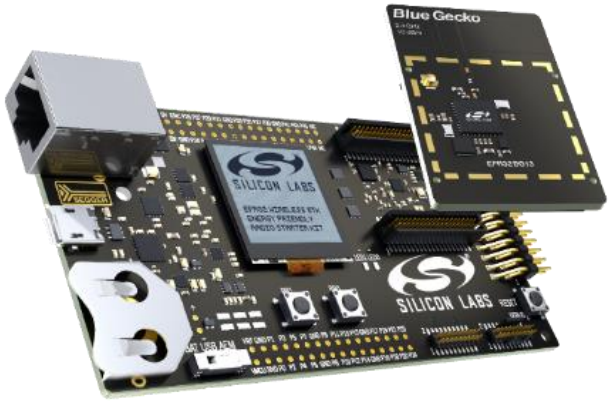
Tech Talks LIVE Schedule – Presentation will begin shortly

How to Measure and Debug Network Performance - Using Silicon Labs Network Analyzer	Thursday, May 7
RF Regulatory and Qualification Testing for Bluetooth, Zigbee & Z-Wave	Tuesday, May 12
Simplicity Studio Tips & Tricks: Our FAEs Know All The Tricks - Improve Your Life in Simplicity Studio	Thursday, May 14
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 with Minimal Code Writing	Tuesday, May 26
Overview of Silicon Labs Wi-Fi Solutions (Including Redpine Signals Wi-Fi Solutions)	Thursday, May 28



Please take the 3 question poll while waiting and be entered to receive a Wireless Starter Kit.



Recordings of previous sessions at:
https://www.Silicon Labs.com/support/training

WELCOME

Wireless Module vs SoC Tradeoffs and Decision Making Criteria

MAY 19, 2020 | JOE TILLISON, SR. MGR., REGIONAL PRODUCT MARKETING

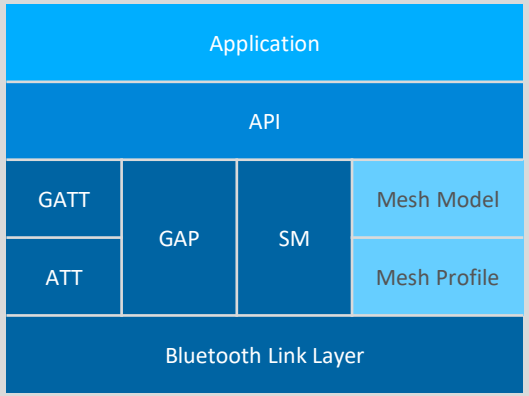
A Complete Solution for Enabling Wireless Products

SoCS AND MODULES

Industry leading wireless SoCs and certified modules

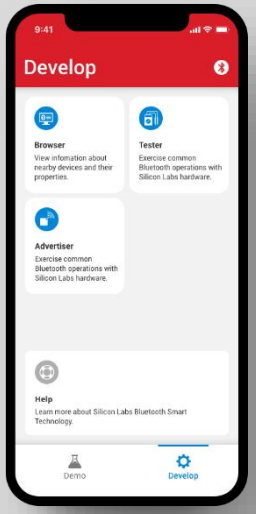
Bluetooth® zigbee THREAD

STACK SOFTWARE



In-house developed stacks with latest features

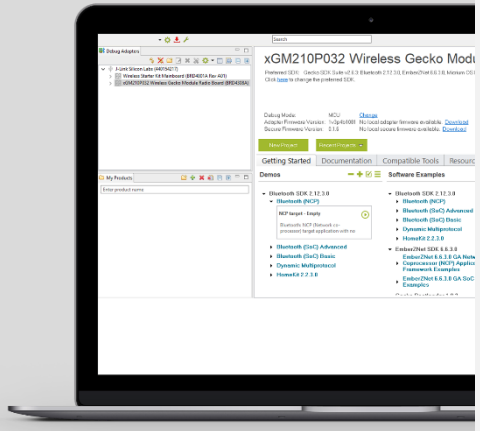
MOBILE APPLICATIONS



Reference apps and source code for iOS and Android Phone interoperability test program

Z-WAVE® Wi Fi®

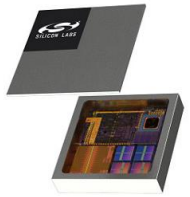
DEVELOPMENT TOOLS



Free-of-charge development and protocol analysis tools to boost productivity

Proprietary wireless

When to choose a module and when to choose an SoC?

SOC		MODULE
You want the lowest possible BoM You have very high annual volumes - and – You have large R&D budget You have equipment to measure antenna performance You have schedule for multiple rounds of prototyping to get the antenna tuning right You have experts who understand compliance testing and filing		You need to get to market fast You need to minimize design risk You don't have RF experts on staff You don't want to invest in test equipment/labs You don't want your engineering resources tied up in RF design You need the smallest size (SIP)
		 

EFR32BG22 – Minimum External BoM (AN933.2)

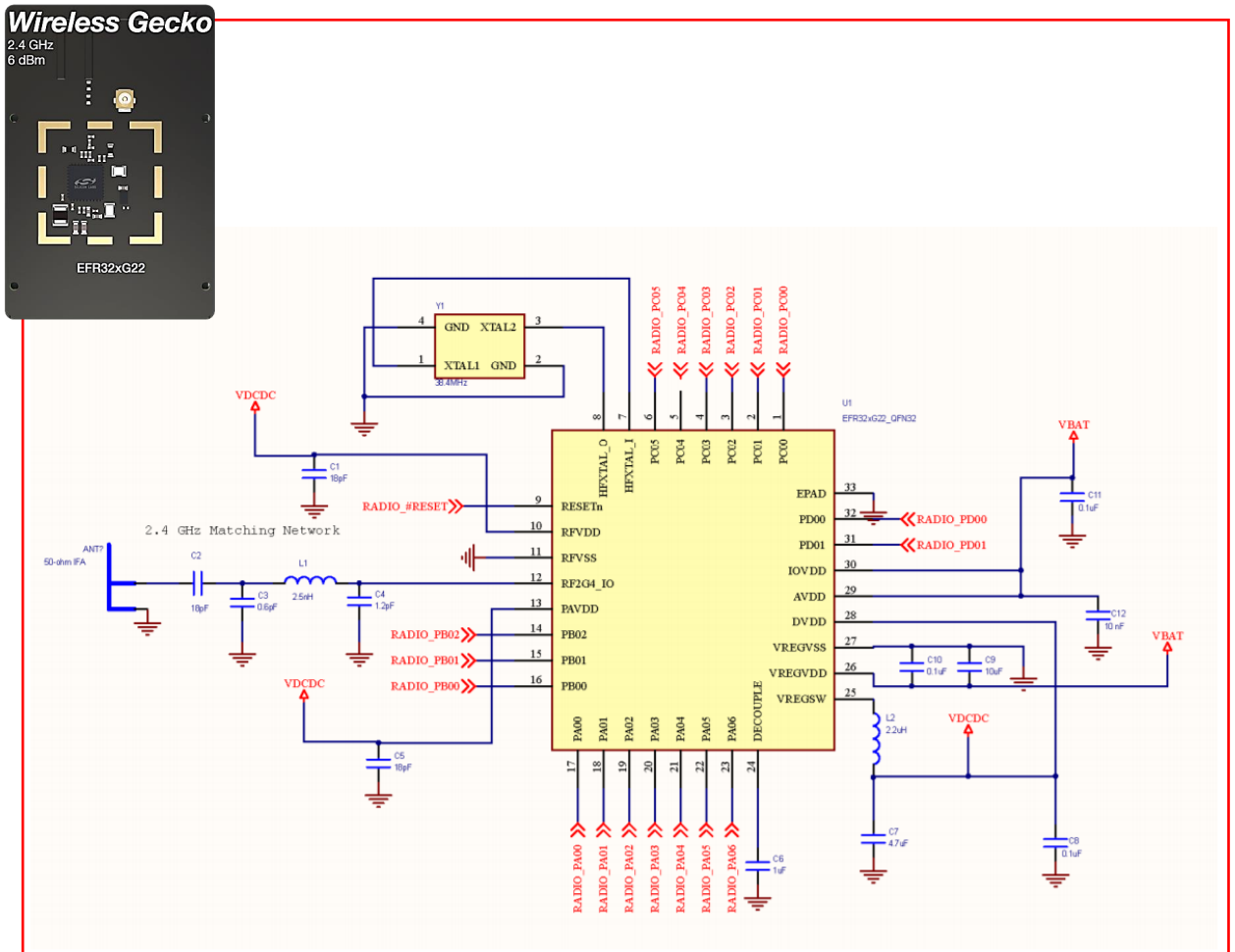


Figure 3.1. Minimal BOM 2.4 GHz Schematic for EFR32xG22

Minimum external BoM

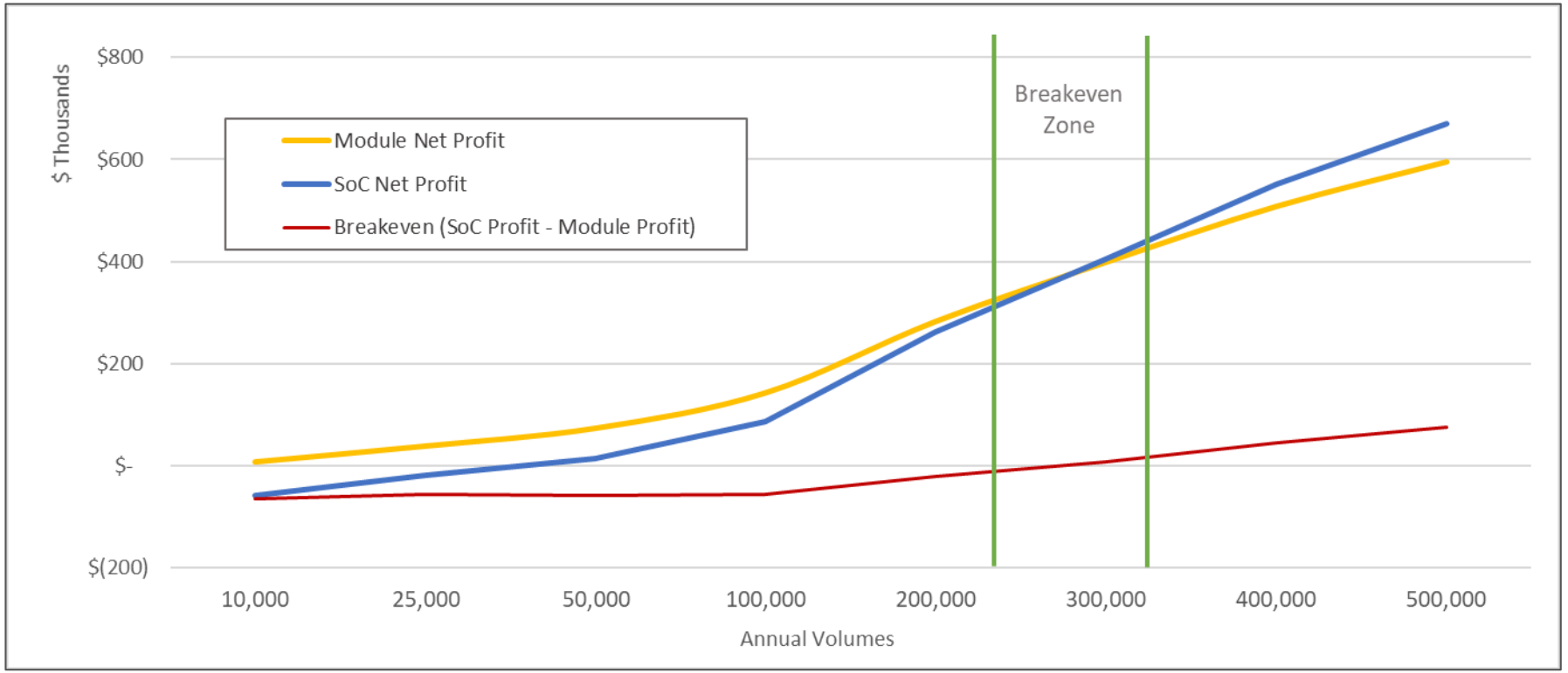
- High-freq crystal (38.4 MHz)
- 3-element antenna match plus DC blocking cap
- External L/C for DC/DC converter
- 8 decoupling caps
- Antenna (if not using trace antenna)
- Shield (optional)

Estimated BoM costs $0.30 - $0.80

Note: Competitor SoCs may require additional external components e.g. LFXO, SPI Flash, balun

https://www.silabs.com/documents/public/application-notes/an933.2-efr32-series-2-minimal-bom.pdf

Make or Buy – Example break-even analysis



	10ku			250ku			500ku		
	Price	Other	Cost/unit	Price	Other	Cost/unit	Price	Other	Cost/unit
Module	$3.85	$1.40	$5.25	$2.55	$0.06	$2.61	$2.26	$0.03	$2.29
SoC	$0.99	$10.76	$11.75	$0.86	$1.71	$2.57	$0.75	$1.39	$2.14

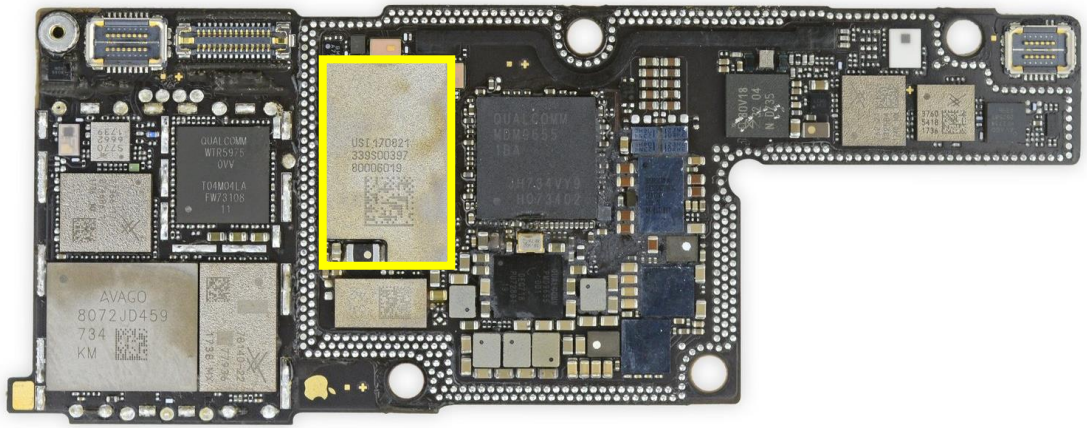
Price is the customer purchase price, Other cost is dev costs divided with quantity, Cost per unit incudes project costs. All costs and prices are approximations

Every Developer Cares about BoM Cost but …

- What is the cost of:
  - Delayed product launch
  - Sub-optimal RF design
  - Iterative compliance testing

- Module advantages:
  - ✓ Remove unknowns
  - ✓ Reduce design risk
  - ✓ Shorten time-to-market

Comparing only SoC and module pricing ignores other hidden costs.



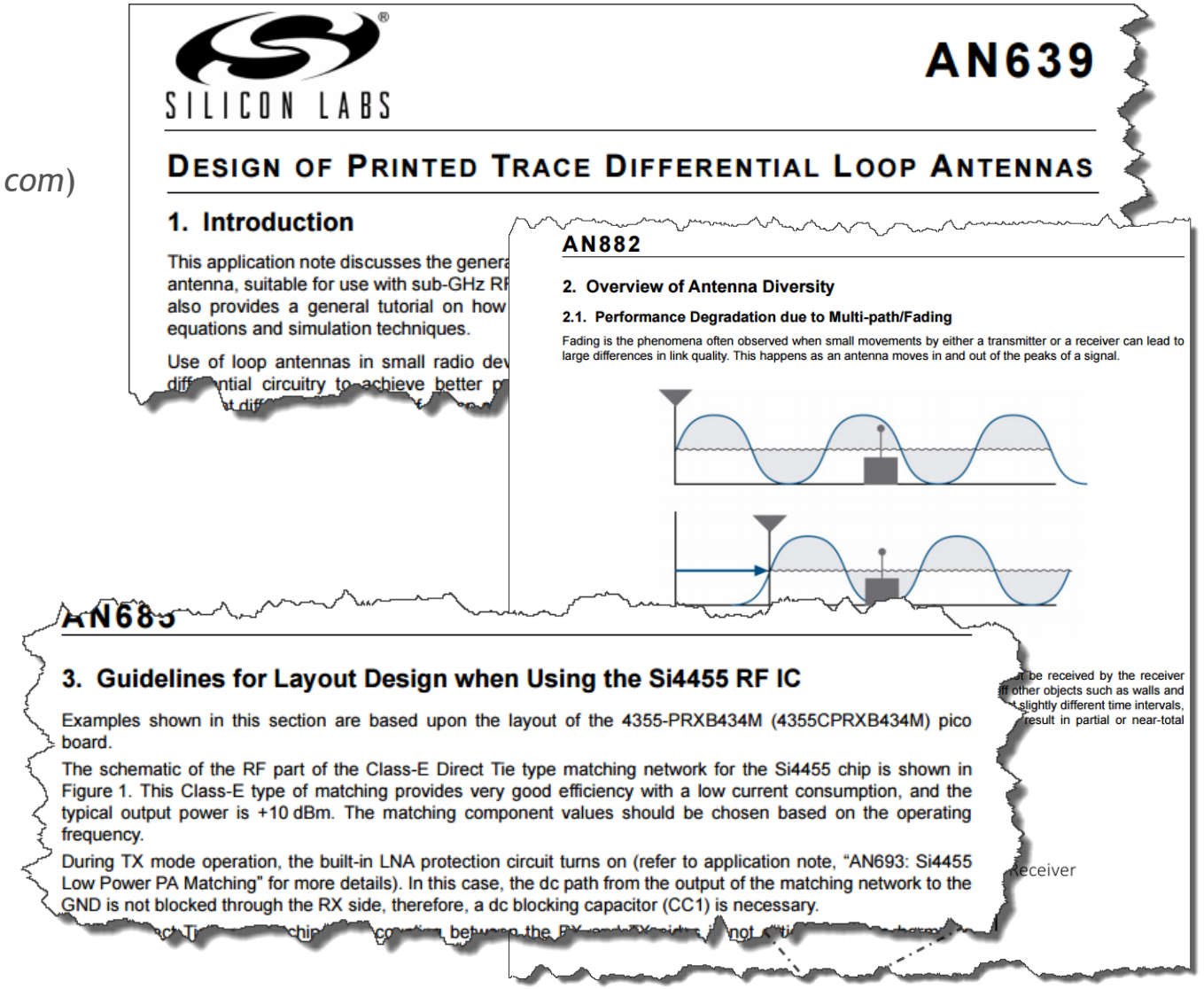
iPhone X teardown showing multiple pre-certified modules including Wi-Fi/BT module

Source: https://www.ifixit.com/Teardown/iPhone+X+Teardown/98975

Hidden Cost #1: RF Engineering

- RF Engineers have very specialized skills
- Experienced RF Engineers are expensive
  - Burdened salary = $100-200K/year *(Glassdoor.com)*
- No two RF designs are the same
- RF design challenges:
  - Antenna type
  - Antenna supplier
  - Antenna performance
  - Optimal trace shape/length
  - PCB layout/design constraints
  - PCB fab constraints
  - RF parasitics
  - Impact of housings, batteries, displays, etc.

A module design is already optimized by RF design experts


SILICON LABS

AN639

DESIGN OF PRINTED TRACE DIFFERENTIAL LOOP ANTENNAS

1. Introduction

This application note discusses the genera
antenna, suitable for use with sub-GHz RF
also provides a general tutorial on how
equations and simulation techniques.

Use of loop antennas in small radio dev
differential circuitry to achieve better p

AN882

2. Overview of Antenna Diversity

2.1. Performance Degradation due to Multi-path/Fading

Fading is the phenomena often observed when small movements by either a transmitter or a receiver can lead to large differences in link quality. This happens as an antenna moves in and out of the peaks of a signal.

AN685

3. Guidelines for Layout Design when Using the Si4455 RF IC

Examples shown in this section are based upon the layout of the 4355-PRXB434M (4355CPRXB434M) pico board.

The schematic of the RF part of the Class-E Direct Tie type matching network for the Si4455 chip is shown in Figure 1. This Class-E type of matching provides very good efficiency with a low current consumption, and the typical output power is +10 dBm. The matching component values should be chosen based on the operating frequency.

During TX mode operation, the built-in LNA protection circuit turns on (refer to application note, "AN693: Si4455 Low Power PA Matching" for more details). In this case, the dc path from the output of the matching network to the GND is not blocked through the RX side, therefore, a dc blocking capacitor (CC1) is necessary.

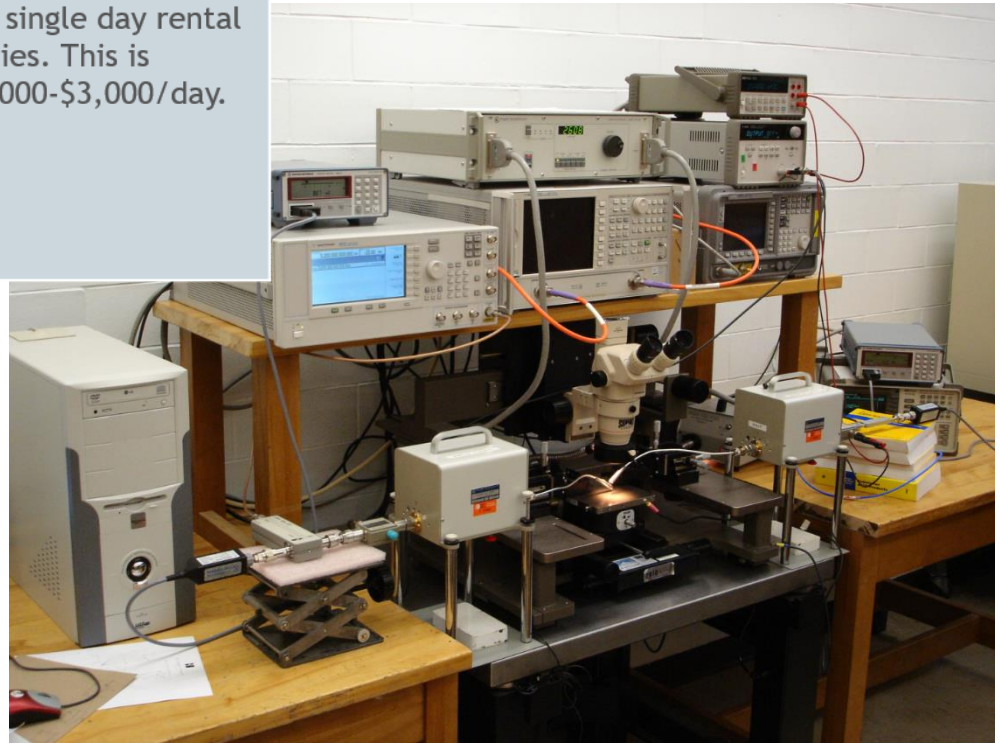
be received by the receiver
other objects such as walls and
slightly different time intervals,
result in partial or near-total

Receiver

Hidden Cost #2: Lab Equipment and Facilities

- RF design and test requires special equipment, software, and facilities

Lab Equipment	Cost to Own	Cost to Rent/Day
Calibrated traceable gain horn antenna	~$2,500	Included in a single day rental at test facilities. This is generally $1,000-$3,000/day.
Bi-conical antenna	~$2,000	
3D positioner	~$2,000	
Spectrum analyzer	~$6,000	
Wireless testing software with desired modulation	~$1,500	
RF isolated, anechoic room (5m x 5m)	~$20,000	
Wireless standard emulator, sniffer, and debug	~$20,000	



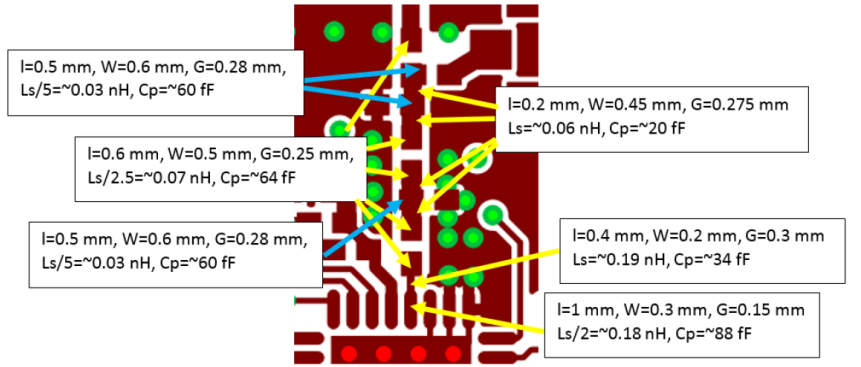
www.ni.com

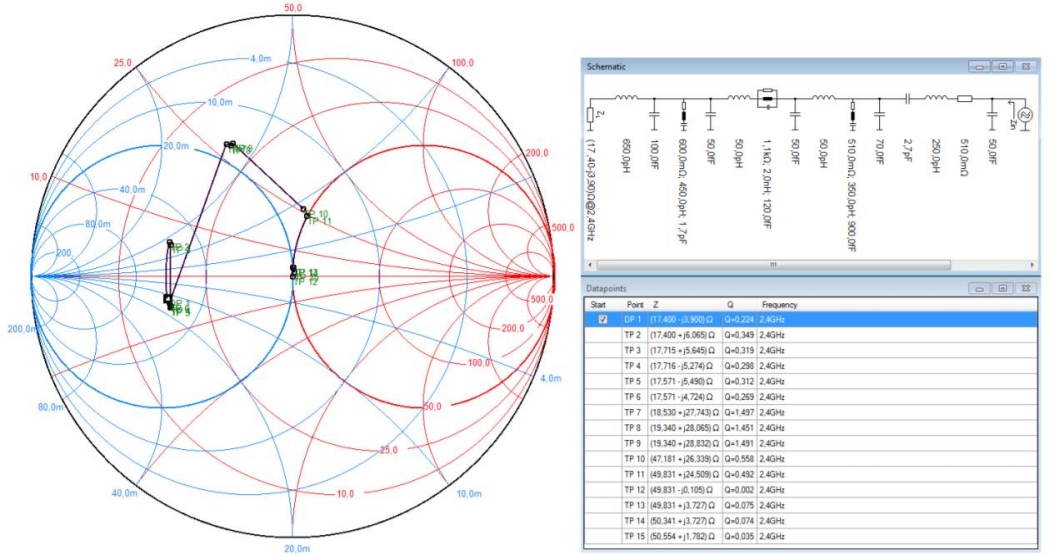
Modules designs have already been fully tested and characterized.

Hidden Cost #3: PCB Layout and Antenna Matching

- *How Hard could it be?*
  - RF layout is nuanced
  - Every component has parasitics that matter
    … including the PCB traces
  - Antenna tuning is iterative by nature
    test → redesign → fab → test again
  - PCB antenna tuning can change in the end product

Module layouts require following a few simple guidelines and the module is robust to PCB variables.

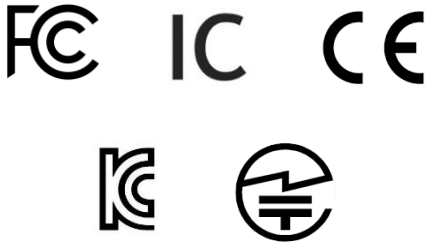




AN930.2 EFR32 Series 2 2.4 GHz Matching Guide
AN928.2: EFR32 Series 2 Layout Design Guide

Hidden Cost #4: Regulatory Approvals

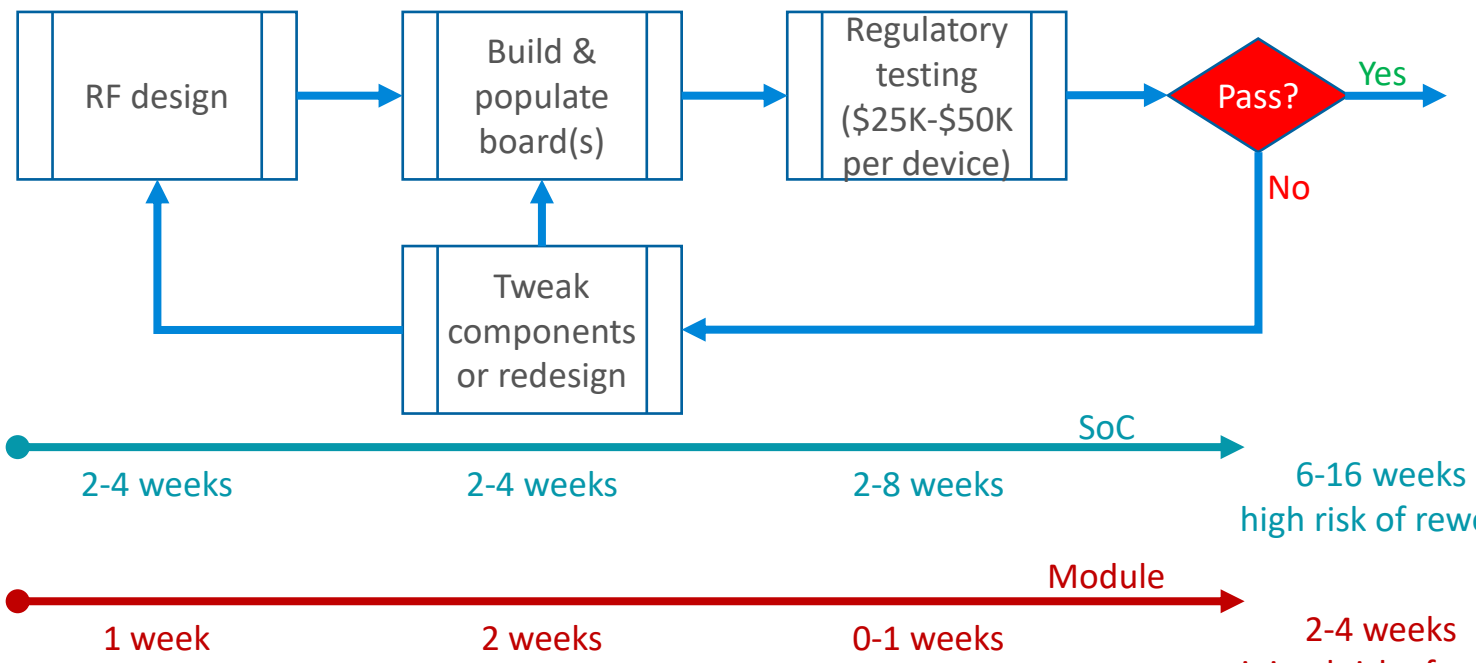
- Regulatory testing and approvals vary by country
- Every product must be tested for every country where it will be sold
- Re-certifications are necessary when standards change
- Products implementing Bluetooth®, ZigBee®, Wi-Fi® must be certified with the industry alliance



Certifying Body	Estimated Cost	Module Pre-Certification Applies (Yes / No)
FCC (US)	~$7,900	Yes
ISEDC (Canada)	~$7,900	Yes
ETSI / CE (Europe)	~$7,900	Yes; some limited testing required
S. Korea	~$4,500	Yes
Japan	~$8,600	Yes
Bluetooth®	~$8,000	Yes; Add'l membership fee required
ZigBee®	~$4,000	Yes; Add'l membership fee required

End products using pre-certified modules inherit the module's certifications

Hidden Cost #5: Lost Product Revenue from TTM Delays



EAU	Annual BOM savings*	Revenue from feature	Lost Revenue (12 weeks)**
10k	$6.5k	$83k	$21k
100k	$82k	$614k	$153k
250k	$300k	$1.4M	$360k
1M	$1.25M	$5.2M	$1.3M

**BoM only – does not include other dev. or production costs*

Modules provide a faster, safer path to revenue and market share

Hidden Cost #6: Supply Management and Quality Assurance

- SoC Component Management
  - Up to 15 components to manage
  - Inventory/demand management
  - Multiple component vendors
  - Changing lead-times
  - Variable MOQs
  - Incoming inspection
- End product RF-related quality issues
  - Random fab/test/quality issues
  - Yield issues

Module vendor manages supply chain and production issues.

- Module Production Management
  - One vendor
  - One part number
  - One lead time
  - Pre-tested and calibrated
  - 100% yield

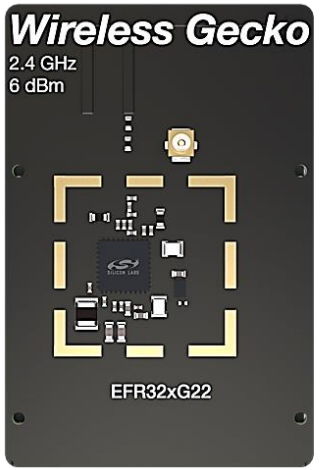
Summary

Decision Making Criteria:

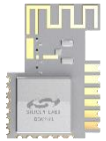
- Volume vs. cost
  - What is the break-even point?
- Availability of resources
  - RF expertise
  - Specialized software and lab equipment
- Schedule
  - Longer design time for SoC
  - Have you planned for multiple design iterations?
  - Have you planned for potential certification issues?
- Risk tolerance
  - Lost time to market
  - Lost market share

Silicon Labs can offer you the best of both worlds

- SoC:
  - Lowest BoM cost
  - AN for help with BoM selection, antenna matching, layout, etc.
  - Reference designs with source files
- Modules:
  - Fastest time to market
  - Lowest risk
- Flexibility
  - Start with a module -> follow with a cost reduction design
    - Fast to market – start generating immediate revenue
    - If volumes don’t materialize, no wasted investment
  - Use ICs for high volume projects, modules for low volume projects
    - Same software and tools – just change the target part



Silicon Labs' Bluetooth Module Families

						
	BGM13P	**BGM13S**	**BGM210P**	**BGM210L**	**BGM220P (Q3'20)**	**BGM220S (Q3'20)**
Protocols	5.1 and mesh (1M, 2M, Coded PHY and AE)	5.1 and mesh (1M, 2M, Coded PHY and AE)	5.1 and mesh 1.0 (1M, 2M, Coded PHY and AE)	5.1 and mesh 1.0 (1M, 2M, Coded PHY and AE)	5.2 and mesh 1.0 LPN (1M, 2M, Coded PHY, AE and AoA/D)	5.2 and mesh 1.0 LPN (1M, 2M, Coded PHY, AE and AoA/D)
EFR32 SoC	BG13	BG13	BG21	BG21	BG22	BG22
Antenna	Built-in or U.FL	Built-in or RF pin	Built-in or RF pin	Built-in	Built-in	Built-in or RF pin
Max TX power	+8 / +19 dBm	+8 / +18 dBm	+10 / +20 dBm	+12.5 dBm	+8 dBm	+6 dBm
Sensitivity (1M)	-94.8 dBm	-94.1 dBm	-97 dBm	-97 dBm	-98 dBm	-98 dbm
Flash (kB)	512	512	1024	1024	512	512
RAM (kB)	64	64	96	96	32	32
GPIO	25	30	20	12	24,25	25
Operating Voltage	1.8V – 3.6V	1.8V – 3.6V	1.8 – 3.8V	1.8 – 3.8V	1.71V – 3.8V	1.71V – 3.8V
Operating Temp.	-40 to +85C	-40 to +85C	-40 to +125C	-40 to +125C	-40 to +105C	-40 to +105C
Dimensions W x L x H (mm)	13.0 x 15.0 x 2.2	6.5 x 6.5 x 1.4	13.0 x 15.0 x 2.2	13.0 x 15.0 x 2.2	13.0 x 15.0 x 2.2	6 x 6 x 1.3
Certifications	BT, CE, FCC, ISED, Japan, S-Korea and Taiwan	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	BT, CE, FCC, ISED, Japan & S-Korea

Useful Links on Silabs.com

- Whitepaper: Six Hidden Costs of a Wireless SoC
- AN933.2: EFR32 Series 2 Minimal BOM
- AN930.2: EFR32 Series 2 2.4 GHz Matching Guide
- AN928.2: EFR32 Series 2 Layout Design Guide
- AN1088: Designing with an Inverted-F 2.4 GHz PCB Antenna
- Silicon Labs Wireless Products
- Wireless development kits
- Simplicity Studio Installers
- Support Resources
- Training resources

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 Opening in 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

Q&A