



# 连接更宽广的世界

## TI Sub-GHz/2.4G 双频方案CC1310&CC1350

Kane Tian

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PMT华北技术支援组

# Agenda

- 什么是SubGHz，优势何在
- SubGHz应用领域
- TI方案介绍

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# 无线频段简介



	优势	劣势
<b>5 GHz</b>	超高数据传输速率 目前同频设备较少(仅有部分5GHz wifi)	距离太近
<b>2.4 GHz</b>	全球通用 数据速率高	同频设备太多(WIFI、蓝牙、ZigBee等)
<b>&lt;1 GHz</b>	极佳的通讯距离(低频优势) 极少的同频设备(非标所以同频设备较少)	较低的传输速率(速率越低, 距离越远) 非全球通用, 根据国家和地区有所不同

SubGHz是1GHz以内频段的统称, 在不同的国家和地区, 可能会使用不同的频段



- 美国 – FCC
  - 315/915 MHz
  - 2.4 GHz



- 欧盟 – ETSI
  - 433/868 MHz
  - 2.4 GHz



- 中国 – SRRC(简称无委)
  - 433/470~510MHz
  - 2.4 GHz

# SubGHz vs 2.4 GHz

- SubGHz 相比2.4 GHz的优势
  - SubGHz 频带相对干净(2.4GHz目前已经被WIFI、蓝牙占据)
  - SubGHz 可以用更少的功耗实现更大的覆盖范围，即使使用电池供电，也能轻松覆盖整栋房屋
  - 在SubGHz频带上，一般都有更高的发射功率
- SubGHz 相比2.4 GHz的劣势
  - 没有一个全球通用频段，不同国家和地区，可能需要使用不同频段
  - 2.4GHz可以实现更高的通讯速率

**总结: SubGHz 可以在使用电池供电的同时，实现更远的距离、更稳固的连接**



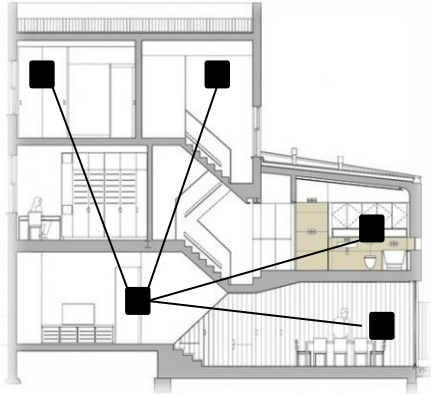
# 为什么是SubGHz



更远的距离、更稳固的连接

## 家用

覆盖整个房屋的星型网络



### Applications:

- Home Alarm, Security and Fire systems
- Home Automation
- Smart Door Locks
- HVAC control

## 楼宇/工业

通过多个星型网络或者Mesh网络覆盖整栋楼宇

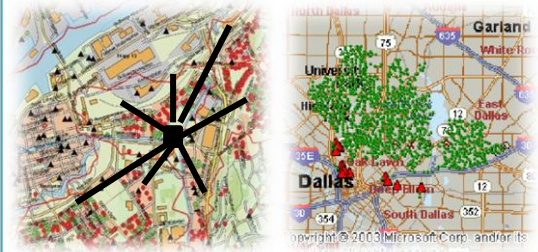


### Applications:

- Commercial building fire, security and automation
- Factory Automation
- Asset Tracking

## 户外

Mesh网络、点对点网络、或者星型网络进行覆盖



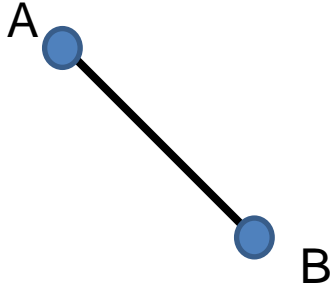
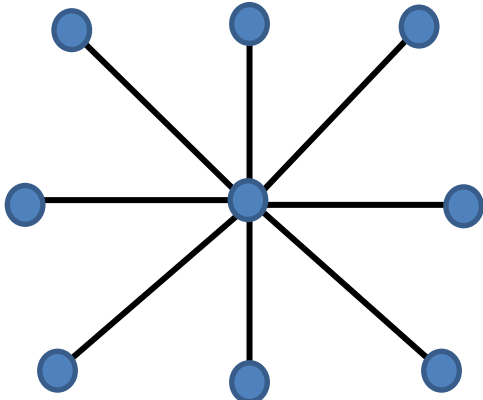
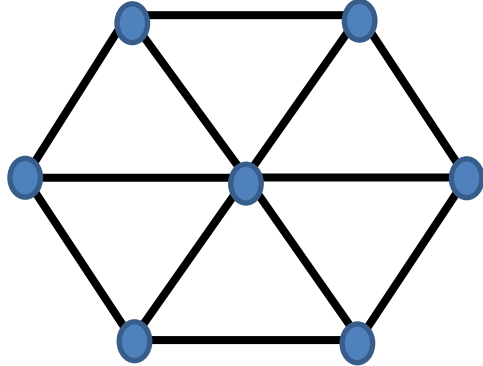
### Applications:

- Long range star: Flow meters, environmental sensors, Whole city coverage using few concentrators
- Mesh: Electric meters, powered industrial sensors, Large network up to 10k nodes

# SubGHz网络拓扑



## 三种不同的网络拓扑

点对点	星形	网状
		
software protocol	software protocol	software protocol
TI-RTOS Range Test	Contiki-6LoWPAN wM-Bus (EMEA metering) TI-MAC 2.0, TI-RTOS	TI-RTOS Contiki-6LoWPAN
use cases	use cases	use cases
Long Range Test for RF Performance Measurements, Simple Point-to-Point Network	Home & Building Automation, Metering, WAN, Long Range Cloud Connections	Long Range Cloud Connections, Metering, Home & Building Automation

# 可以选择的协议栈

网络拓扑	软件协议栈	典型应用场景	协议标准	More information
点对点	TI-RTOS	遥控器	用户自定义	TI基础包，提供射频驱动
星形	TI-MAC 2.0	家庭/楼宇/工厂自动化	IEEE802.15.4(g)	基于802.15.4
星形 (欧洲计量表协议)	wM-Bus	计量表	IEC	第三方协议栈
网状、星形	Contiki - 6LoWPAN	远距离连接到云端, 家庭/楼宇/工厂自动化	IEEE802.15.4(g) 6LoWPAN/IPv6	基于IPv6的开源协议



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- **SubGHz应用领域**
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# SubGHz 目标市场



## 智能家居



智能门锁  
灯控  
家电控制

## 超市/卖场



电子货架标(超市)  
冷链/恒温监控

## 智能电网/自动抄表



支持SigFox、Wmbus等  
常见智能电网协议

## 工业自动化



智能监控/报警器(取代  
传统有线设备)

## 物流/运输系统



ETC  
物流追踪

## 报警器



安全报警器  
烟感/气体探测器

## 农业



无人看守灌溉系统  
牧场管理

## 其它



其它无线操控的设备

# 智能家居

## 智能门锁、灯控及其他家电控制

优势：

- 有效距离远，Sub-1GHz有效距离可达300米，轻松覆盖所有户型
- 功耗低，可以使用点对点或者星形网络，采用私有协议自主控制收发，或者使用802.15.4作为底层
- CC1350可以同时支持BLE，做到无缝连接



应用场景：

- 通过Sub-1GHz网关接入云端，可以轻松远程控制门锁、家电，不必考虑手机有效距离



# 超市卖场/物流仓储

## 电子货架标签、冷链/恒温监控

### 优势

- (电子货架标签)避免手工改价可能带来的失误
- (电子货架标签)响应迅速，适应快速价格跟进
- (冷链监控)实时监测、报警
- 采用中央控制，提高可靠性，降低人力需求，节约成本

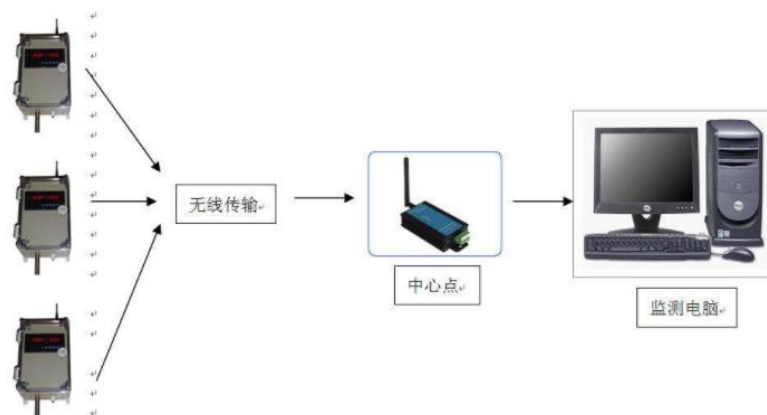


- 应用场景
- 大型商超、物流/仓储公司



# 工业自动化

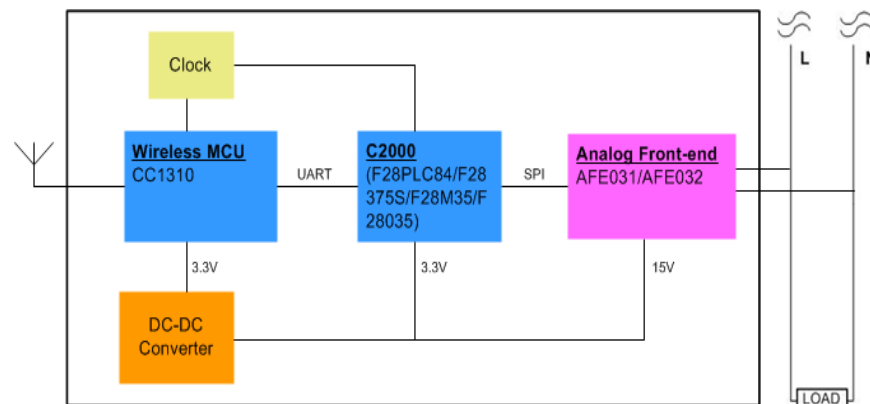
- 优势：
- 抗干扰性能强，Sub-1GHz频段设备远少于2.4GHz，避免同频干扰
- 低功耗，CC1310/50超低功耗，轻松实现1年以上待机时间
- 有效距离远，工业环境下，可以达到200m以上有效距离，降低组网难度，甚至可以达到1km以上(CC1120窄带技术)
- 允许节点数量多，可以实现1000甚至5000以上节点在同一网络内工作
- 无需线缆，方便布设
- 高可靠性，故障自动上报



# 智能电网/自动抄表

- CC1310支持Wireless M-Bus C-/T-/S-mode，可用于无线抄表领域
- CC1310支持SigFox低功耗物联网协议
- 可通过AFE031/2等模拟前端支持PLC协议(电力线通信)

- [TIDC-HYBRID-WMBUS-PLC Tools Folder](#)
- [Design Guide](#)
- **Design Files:** Schematics, BOM, Gerbers, Software, and more
- **Device Datasheets:**
  - [CC1310](#)
  - [F28PLC84](#)
  - [AFE031](#)



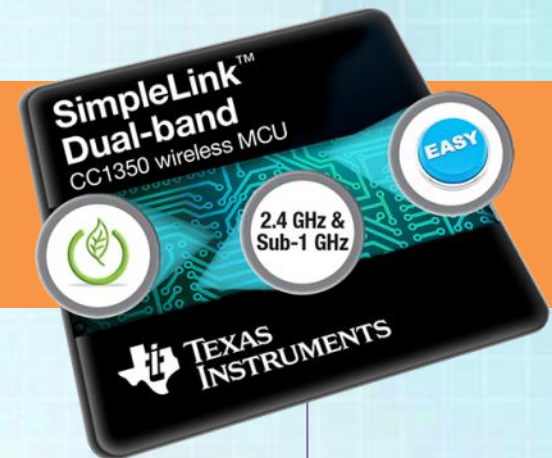
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# CC1310/1350 平台



## CC1310: Sub-1 GHz

- 可用频段: 315 MHz, 433 MHz, 470 MHz, 500 MHz, 868 MHz, 915 MHz and 920 MHz ISM bands
- Software: 6LoWPAN, wM-Bus, TI-MAC, 私有
- Flash大小可选: 32KB, 64KB, 128KB

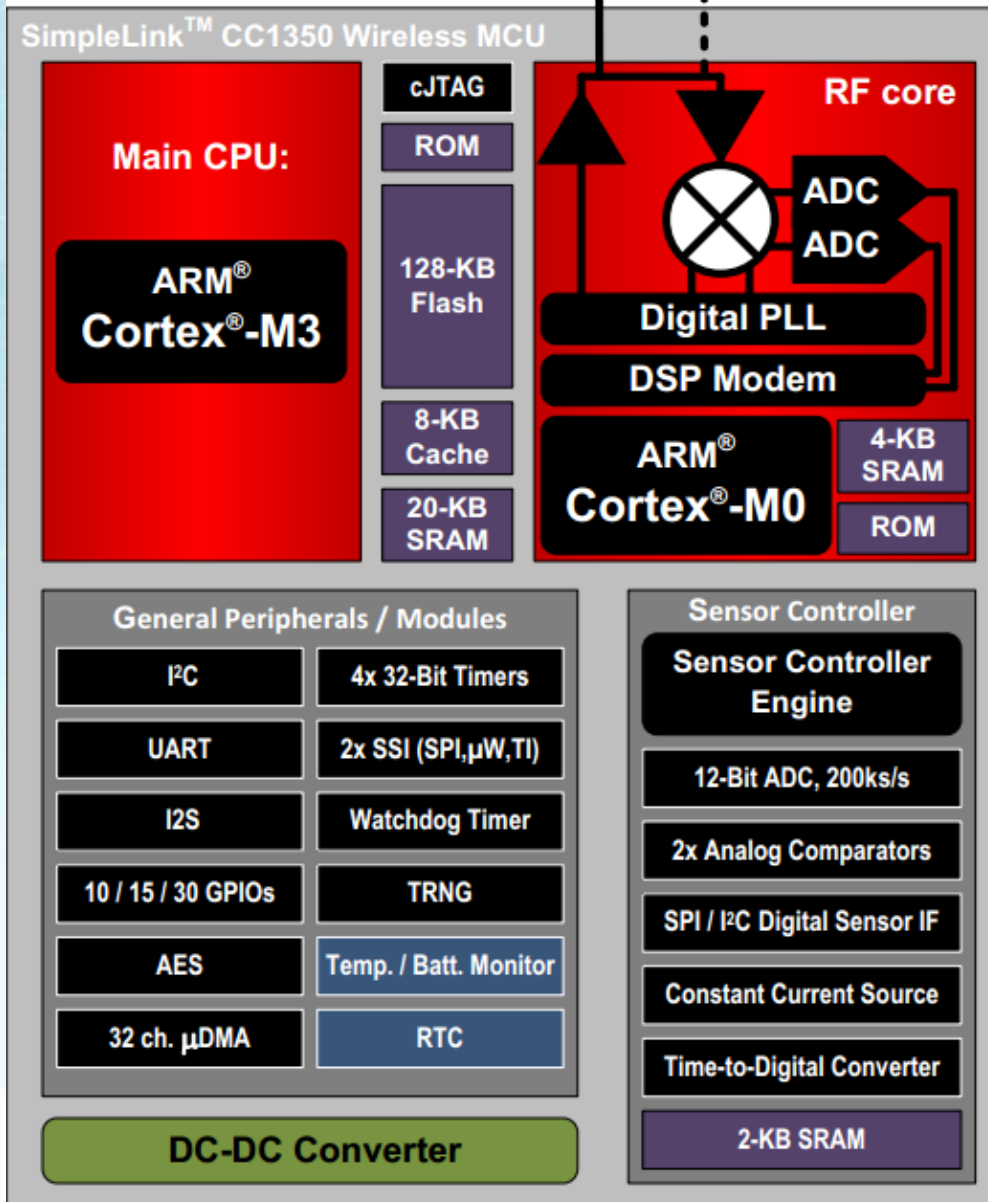


## CC1350: 双频段Sub-1GHz+2.4GHz

- 单芯片支持Sub-1GHz和2.4GHz频段
- 可用频段与CC1310相同, 同时兼容2.4GHz频段(分时双工)
- Supports: Sub-1 GHz: 6LoWPAN, wM-Bus, TI-MAC  
2.4GHz: BLE、私有2.4GHz



# CC1310/CC1350平台



## Quick Facts

### Ultra-low Power Consumption

- 61  $\mu$ A/MHz ARM Cortex M3
- 8.2  $\mu$ A/MHz Sensor Controller
- 1  $\mu$ A sleep with retention and RTC
- 5.4 mA RX
- 13.4 mA TX (+10dBm)
- <3uA while running 10 ADC samples/s

### SoCKey Features

- Autonomous sensor controller engine
- 4x4, 5x5, and 7x7 mm QFN
- 1.7 - 1.95 V or 1.8 – 3.8 V supply range
- 128 KB Flash + 8 KB Cache
- 20 KB RAM

### RF Key Features

- +9/+14 dBm output power (2.4GHz/Sub1GHz)
- -87/-120 dBm sensitivity (2.4GHz/Sub1GHz)
- Supports 2.4GHz and 915/868/433 MHz
- Pin compatible and SW compatible across protocols and frequency bands

# CC1310关键参数

## 超低功耗



- 5.5 mA Radio RX current
- 22.6 mA @ +14 dBm , 12.9 mA @ +10 dBm, Radio TX peak current
- 51  $\mu$ A / MHz ARM Cortex M3
- 0.6  $\mu$ A sleep current w/RTC + full memory retention

*Up to 20 year battery life for sensor nodes and flow meters*

## 长距离



- High sensitivity
  - -110 dBm @ 50 kbps
  - -124 dBm @ 0.625 kbps
- Strong co-existence
  - Up to 90 dB blocking
- +14 dBm output power

*Full building to city-wide RF coverage*

## 高集成度



- Sensor Controller Engine (SCE)
- 4x4 QFN
- Integrated DCDC
- On-Chip Flash
- TI-RTOS + RF Driver

*Complete 315 / 433 / 470 / 500 / 868 / 915 / 920MHz wireless MCU on a finger-tip size*

# CC1350关键参数

## 超低功耗



- 5.4 mA (SubGHz), Radio RX current
- 6.4 mA (2.4 GHz) Radio RX current
- 24.4 mA @ +14 dBm , 13.4 mA @ +10 dBm (SubGHz), Radio TX peak current
- 22.3 mA @ +9 dBm, 10.5 mA @ 0 dBm(2.4 GHz), Radio TX peak current
- 51  $\mu$ A / MHz ARM Cortex M3
- 0.6  $\mu$ A sleep current w/RTC + full memory retention

*Up to 20 year battery life for sensor nodes and flow meters*

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  - -110 dBm @ 50 kbps
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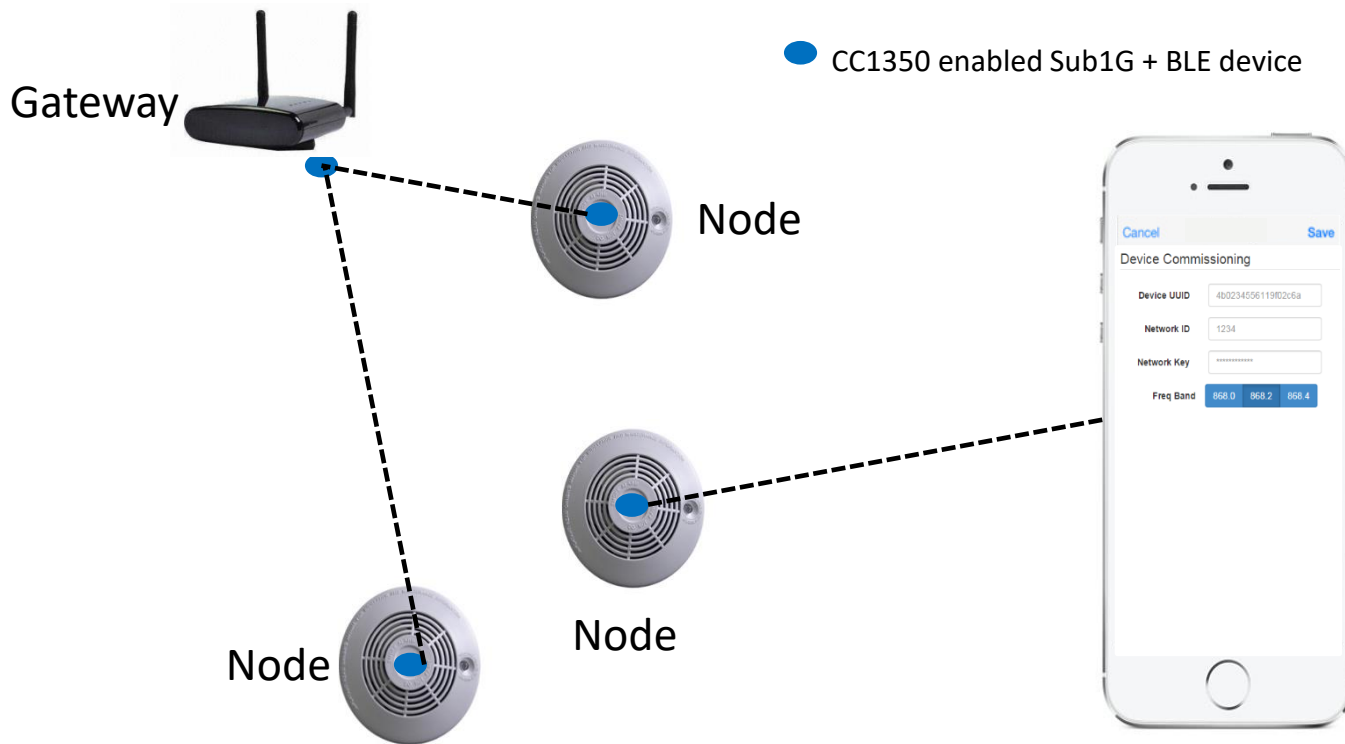
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- 4x4 QFN
- Integrated DCDC
- On-Chip Flash
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*Complete 315 / 433 / 470 / 500 / 868 / 915 / 920MHz wireless MCU on a finger-tip size*

# CC1350 目标应用&应用场景1



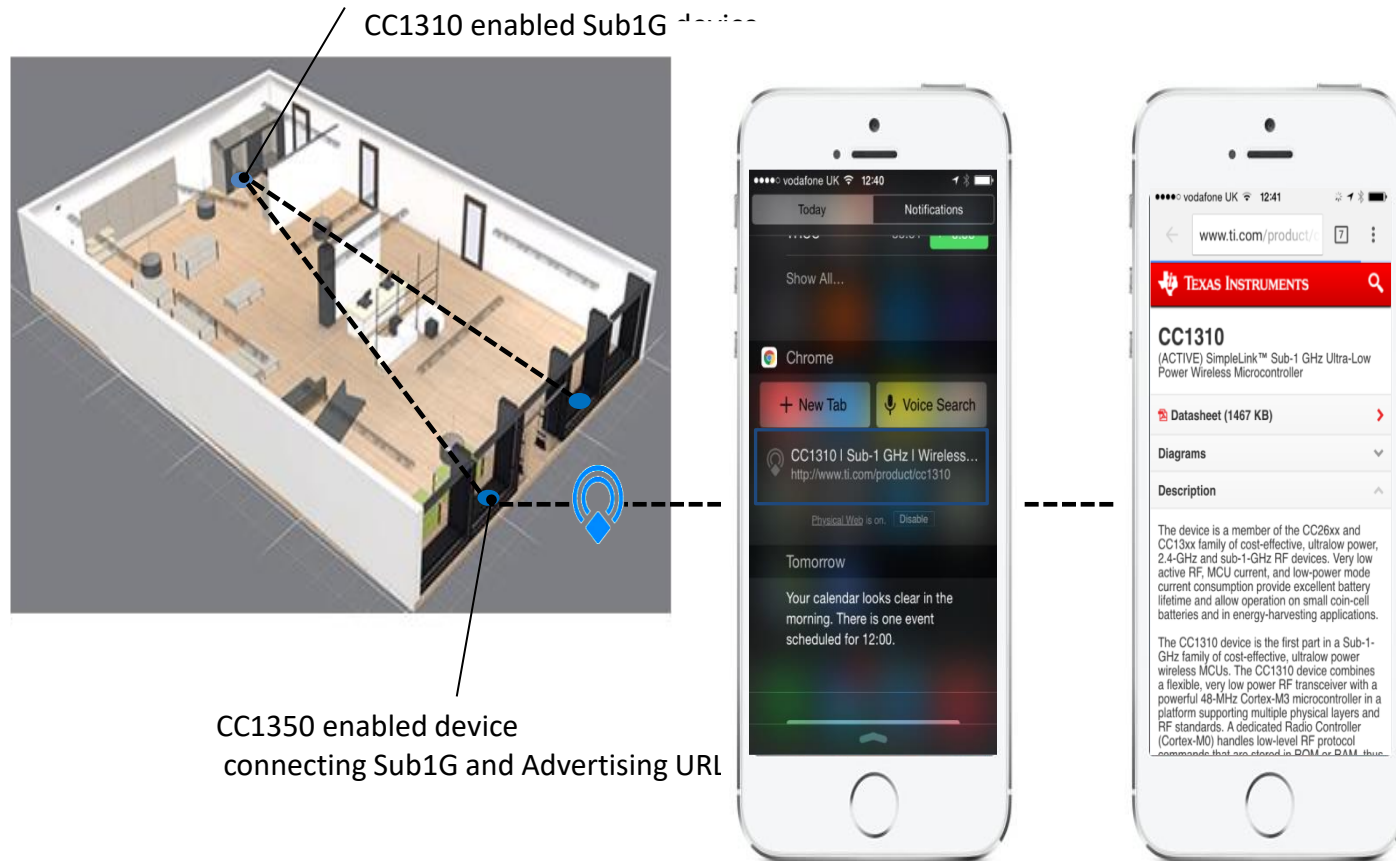
- 可以通过BLE设置SubGHz接入信息，简化设置流程



# CC1350 目标应用&应用场景2



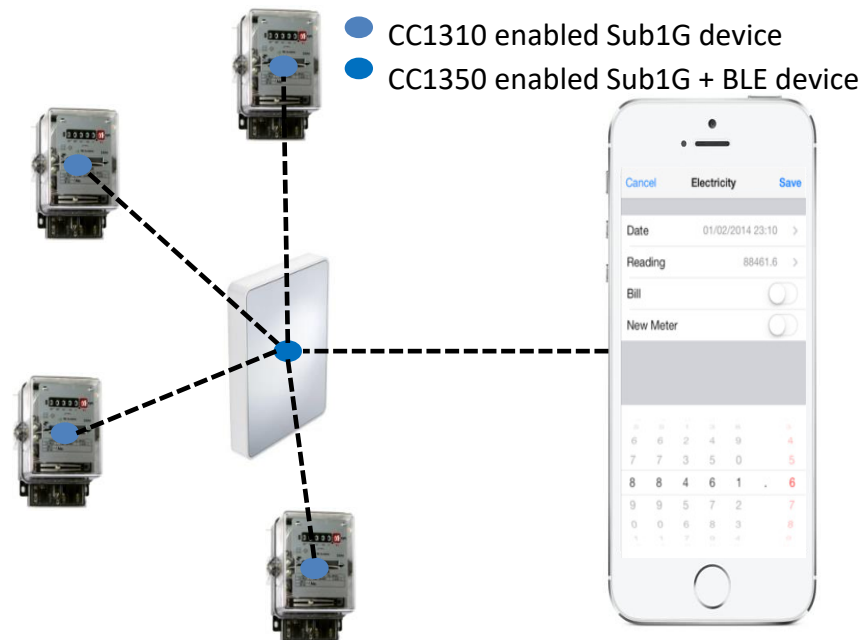
- 通过SubGHz交互数据，同时通过BLE广播向手机推送数据



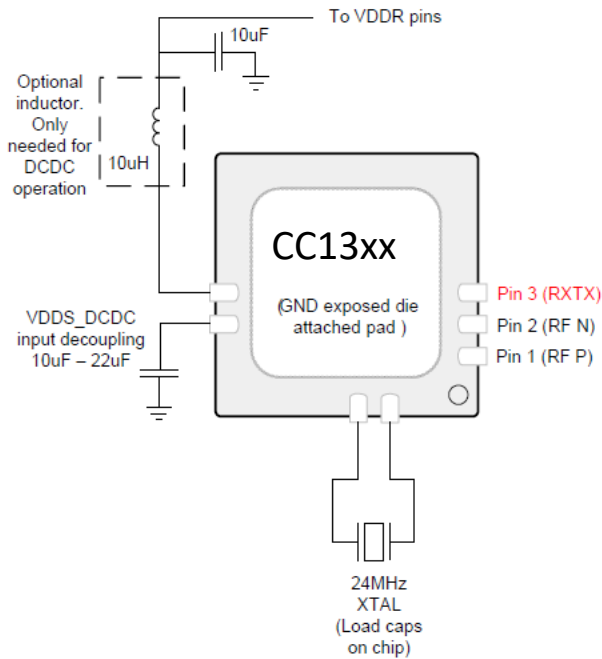
# CC1350 目标应用&应用场景3



- 整个网络使用CC1310/CC1350，通过SubGHz连接
- 可以在网关端或任意采用CC1350的节点，加入BLE广播，方便使用手机/其它手持终端实时获取查看数据，省去屏幕成本



# CC1310 射频前端配置

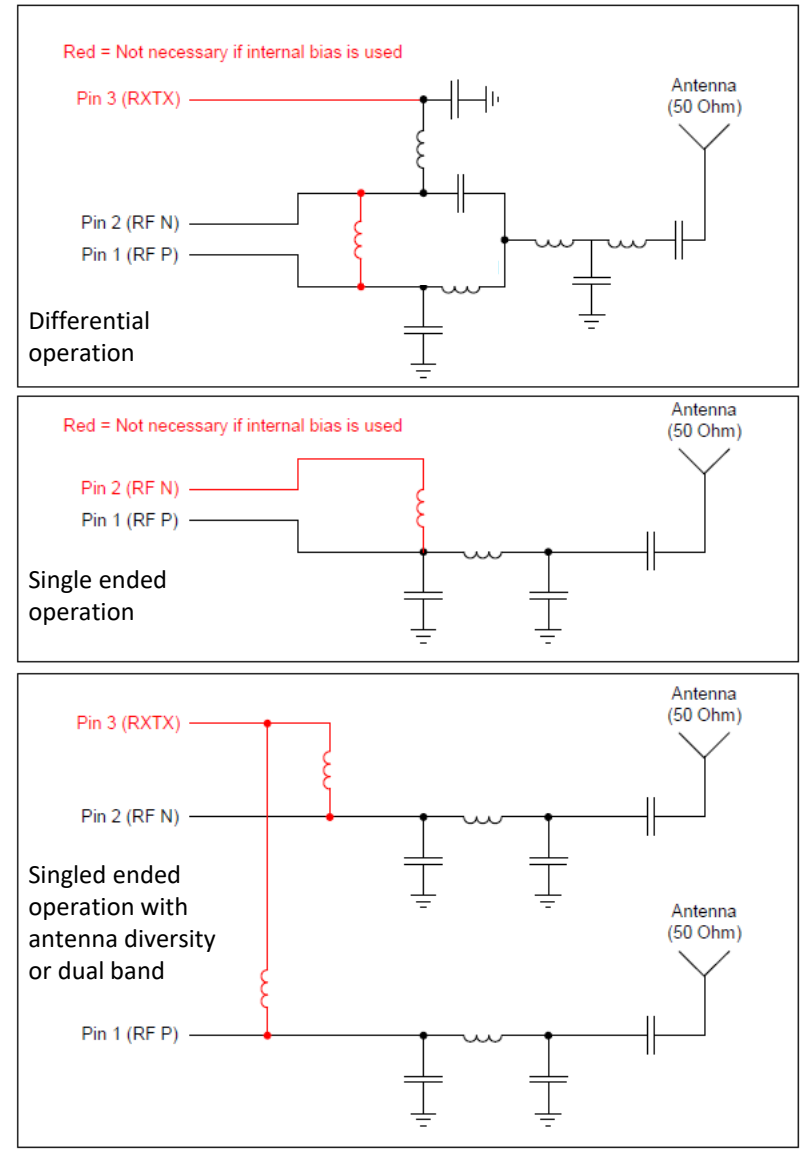


差分 and 单端:

- 约. +1 dB 接收灵敏度, +3 dB 发射功率

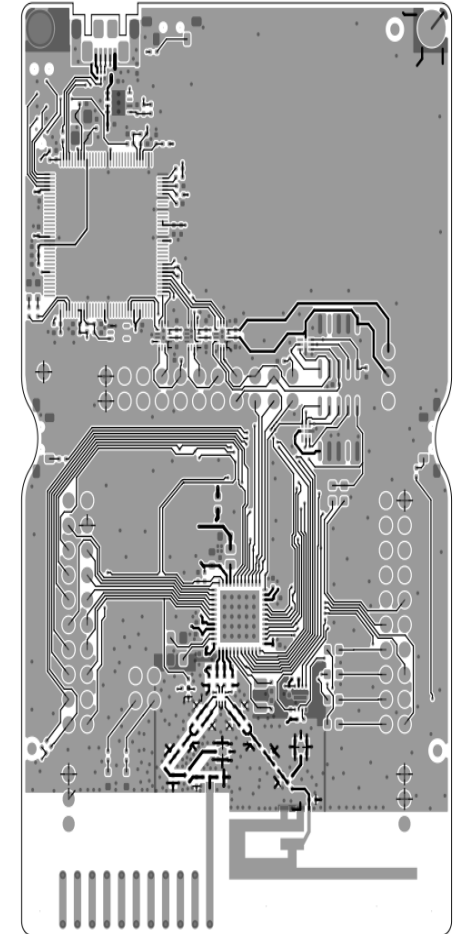
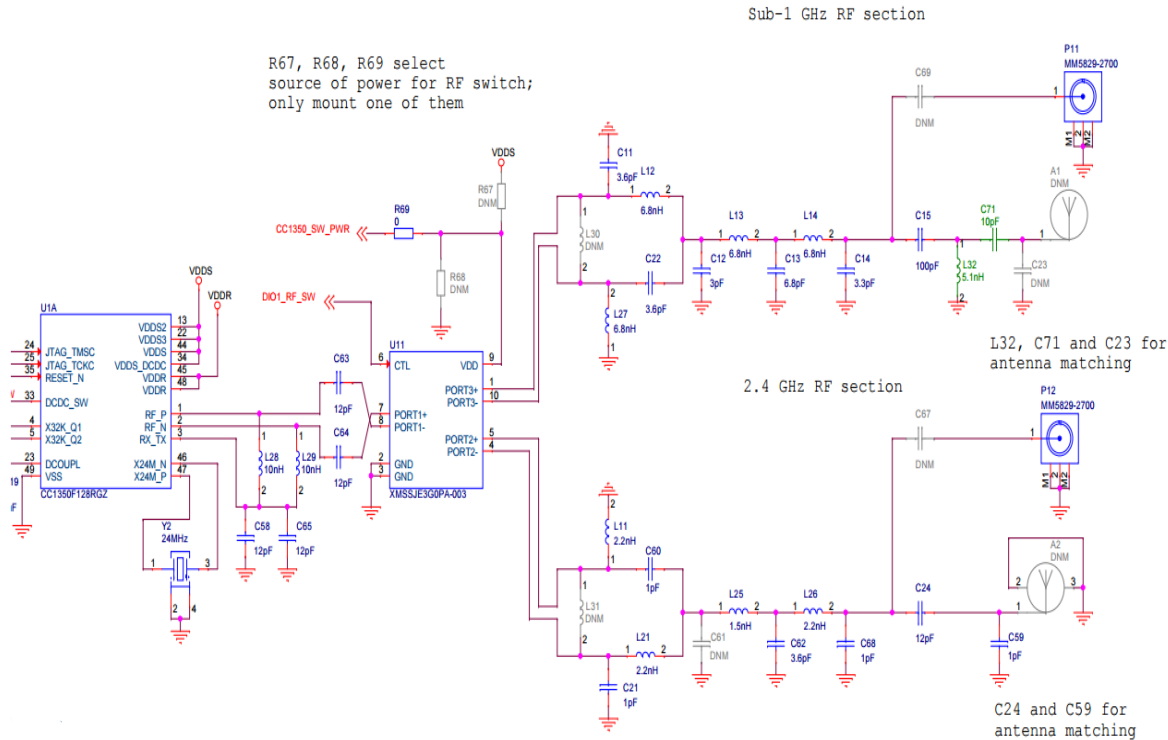
内部偏置和外部偏置:

- 约. +2 dB



# CC1350 LaunchPad RF Hardware

- 2 x Differential antennas, 2.4GHz and 868/433MHz
  - PCB antennas control by external switch
- XDS110 Debugger, with UART backchannel
- 40-pin Boosterpack interface

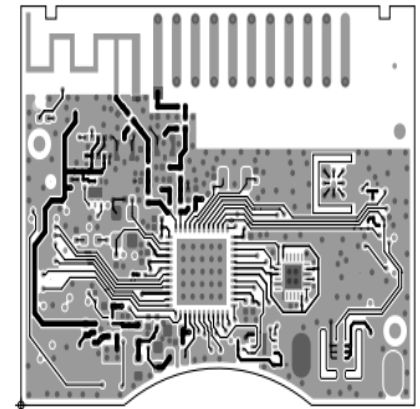
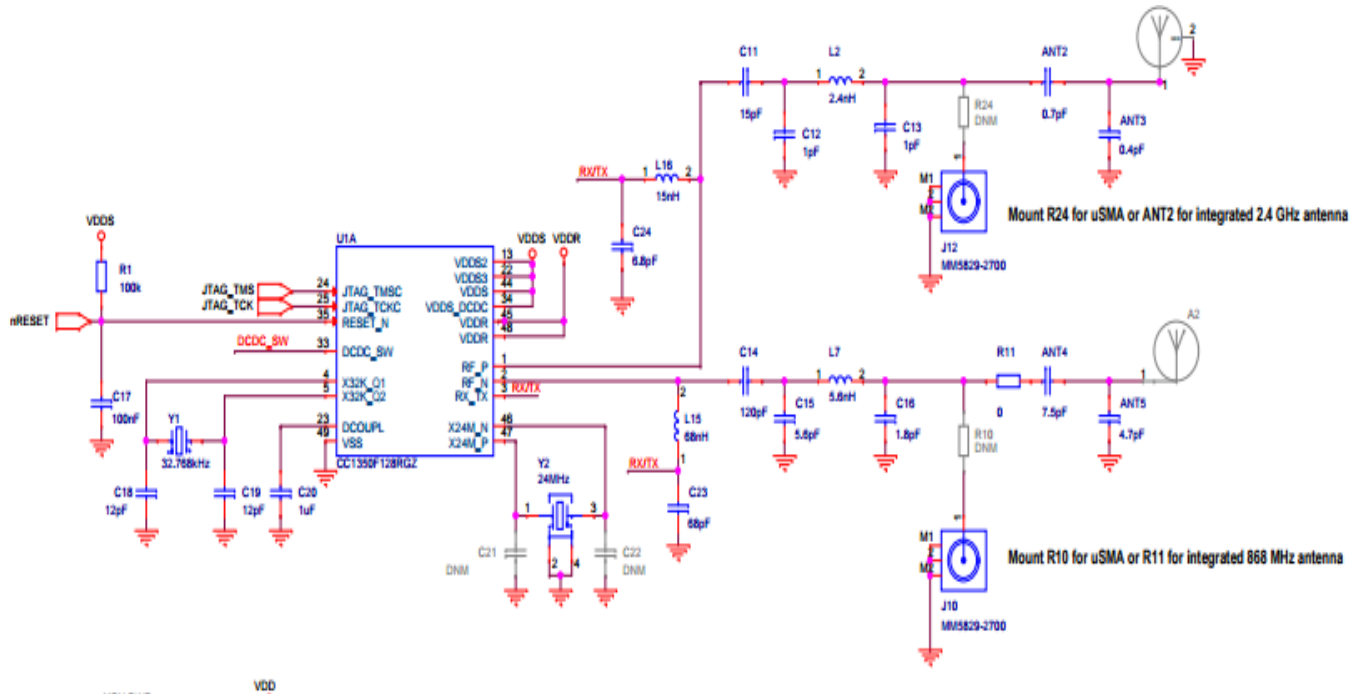




# CC1350 SensorTag RF Hardware



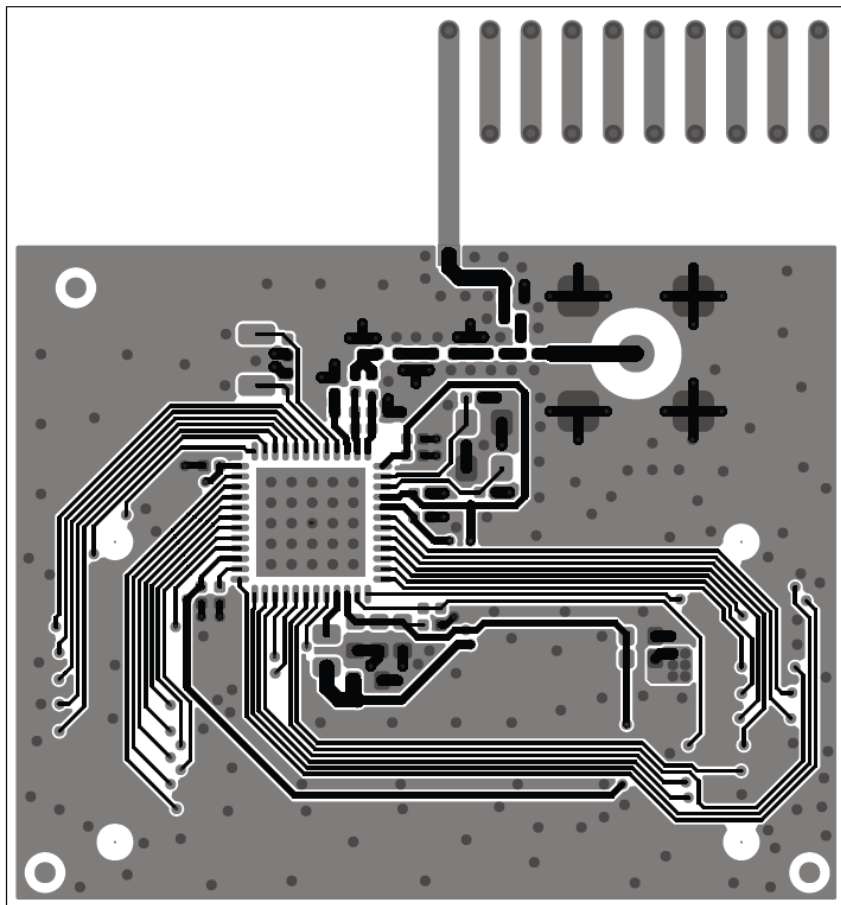
- 2 x Single ended antennas, 2.4GHz and 868/915MHz
- XDS110 Debugger, with UART backchannel
- DevPack interface



# Reference Layout

- Follow the reference layout! 😊

- 4-layer PCB for lowest harmonics at max power
  - 2- and 4-layer PCB design available
  - Board stack-up is in the reference design zip file
- Place the RF match close to the RF pins
  - Balun should be symmetrical wrt to RF ports for differential operation
- Solid ground plane
  - No signal traces underneath the RF path!
  - Keep as much signal- and power routing on the top layer as possible
- Place decoupling caps as close to the VDD pins as possible
  - Ground return paths between decoupling caps and CC13xx should be short and direct
- DC/DC-regulator must have a short and direct ground connection to CC13xx
- Balun should be symmetrical wrt to RF ports for differential operation



# TI 目前支持的无线协议

## Wireless Connectivity Portfolio

Proximity	Personal area networks		Local area networks			Neighborhood area networks
<b>NFC RFID</b> <i>Identification</i> 	<b>Bluetooth® Bluetooth LE</b> <i>Personal Connection</i> 	<b>Proprietary 2.4GHz</b> <i>Customizable</i> 	<b>ZigBee® &amp; RF4CE</b> <i>Mesh</i> 	<b>Wi-Fi®</b> <i>Existing Infrastructure</i> 	<b>6LoWPAN</b> <i>IP Mesh</i> 	<b>Sub-1 GHz Proprietary + TIMAC</b> <i>Customizable</i> 
Key Differences						
Data Up to 848 Kbps No battery to coin cell	Data or Voice Up to 3 Mbps Coin cell to AAA	Data Up to 1 Mbps Coin cell	Data Up to 256 Kbps Energy harvesting to AAA	Voice or video Up to 100 Mbps AA battery	Data Up to 256 Kbps Energy harvesting to AAA	Data Up to 1 Mbps Coin cell
Key Attributes						
<ul style="list-style-type: none"> <li>Passive operation &amp; data storage</li> <li>Dedicated multi-tag read zone</li> <li>In Portable devices</li> </ul>	<ul style="list-style-type: none"> <li>Interoperable with other Bluetooth devices</li> <li>Large install base</li> <li>In mobile devices</li> </ul>	<ul style="list-style-type: none"> <li>Customizable to application</li> <li>Robust RF</li> </ul>	<ul style="list-style-type: none"> <li>Standards based</li> <li>Self-healing mesh</li> <li>Low power</li> <li>Large area coverage</li> </ul>	<ul style="list-style-type: none"> <li>Existing infrastructure</li> <li>Standards Base</li> <li>IoT platform</li> <li>High throughput</li> </ul>	<ul style="list-style-type: none"> <li>IPv6 stack</li> <li>Ultra low power</li> <li>IoT platform</li> </ul>	<ul style="list-style-type: none"> <li>Longest range</li> <li>Customizable to application</li> <li>Robust RF</li> </ul>
cm	Up to 100m			<b>Range</b>		km



*Thank you*

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