Introduction to Wireless Connectivity Solutions

MSP430 Day
Peng He, Catalog Connectivity China

May, 2013

Texas Instruments

Agenda

- Intro to WCS technologies
- 2013 technology & application focus
- Why is RF Performance important
- TI RF Performance Line
- RF Development Kit for China
- Sub1-GHz in China
- Demo

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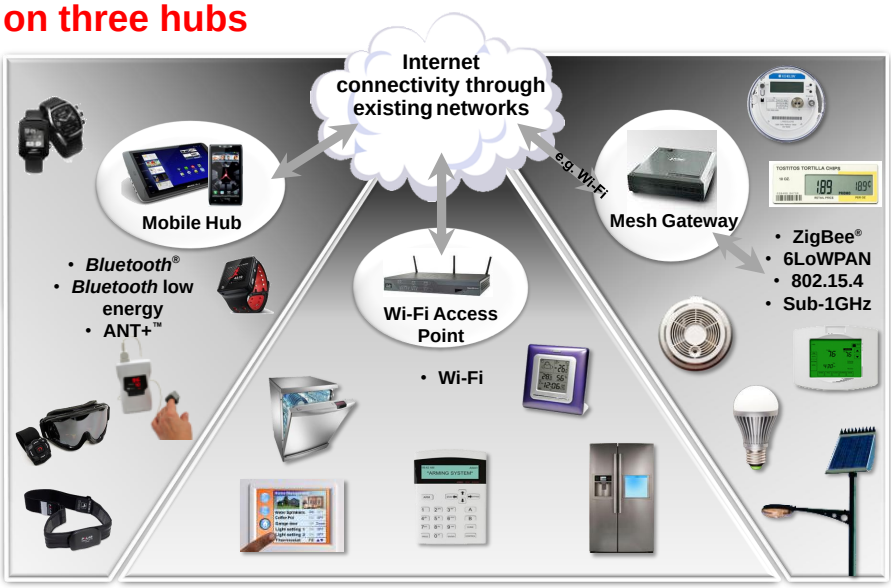
TI's "Internet of Things" opportunity focused on three hubs



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Wireless connectivity strategy

World Leader in Low Power Connectivity

Embedded Connectivity Solutions

Wi Fi

Radar

Bluetooth

GPS

Low Power RF

ZigBee™

Bluetooth LOW ENERGY

6LoWPAN

ANT+

<1GHz

RF4CE

PurePath™ Wireless Audio

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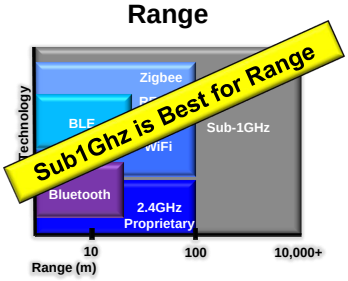
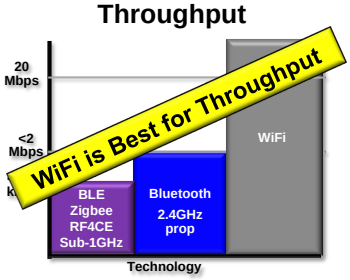
Choosing the Right Technology

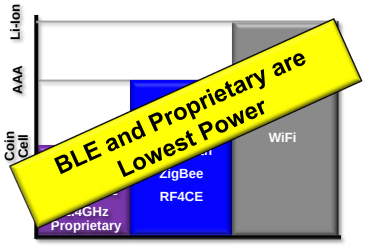
Range



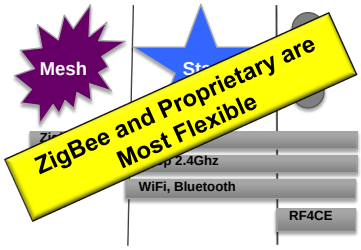
Throughput



Typical power source



Typical topology



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2013 Connectivity Focused EEs

	End Equipment	Solution
	Wireless gadgets for Smartphone TAM Y13: 10Mu+ Many products in the market	Focused Product: CC2541 CC256x
	Wi-Fi connected devices TAM Y13: Market in China just starting now	Focused Product: CC3000
	Smart Energy / Home automation TAM Y13: 50-60M (Smart Meters)	Focused Product: CC110L, CC1100E CC1120
	Wireless Lightning TAM Y13: 2Mu+ Products start to ramp in market	Focused Product: CC2530

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BT use cases & TI products

Low Power Sensors

CC2540/1

CC2540/1 + 8/16 bit MCU

- 1 year+ on Coin Cell Battery
- No Apple MFi Royalties
- Less than 100Kbps data rate

Data

CC2560/4 + MSP430

- Supports new and old phones (BT and BLE)
- Up to 3Mbps data rate

Music

CC2560/4 + 32 Bit MCU

- Use A2DP Profile to stream music from phones
- Use Stellaris or any other ARM Cortex M3/M4

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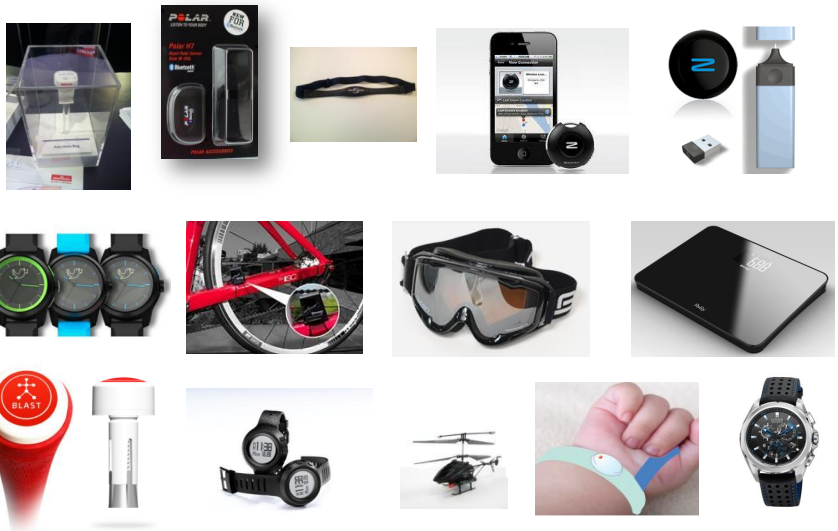
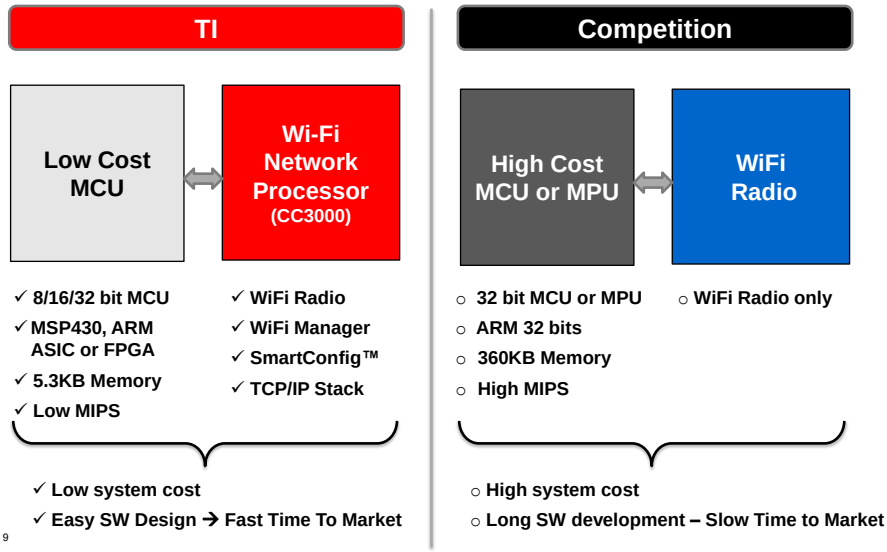
TI Bluetooth low energy inside:



CC3000 makes Wifi easier:



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Wifi: Ideal applications for CC3000

Good Fit	Low Fit	Background
Home 	Enterprise 	CC3000 focused on Personal Security only
Wall-powered or Battery powered with triggered operation 	Battery powered and always Connected 	CC3000 supports active and shutdown modes
Sensor and control Audio Low Res Video 	High-resolution video 	CC3000 throughput 4Mbps - TCP 7Mbps - UDP

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Wireless Lighting Control

- ZLL- ZigBee Light Link
- Wireless control of
  - Lights (LED, CFL …)
  - Light switches and dimmers
  - Sensors (Daylight, Occupancy)
- Easy to install Touch Link System
  - Scalable
  - Low Power, Low Cost
  - Secure reliable mesh network (vs. Wifi and BT)
  - Direct control via RC or switch
  - Remote Monitoring via Internet
- Supported devices:

- **Light switches**
- **Dimmers**
- **Sensors**

- **Remote controls**
- **Gateway**

- **Light bulbs**
- **Light fixtures**

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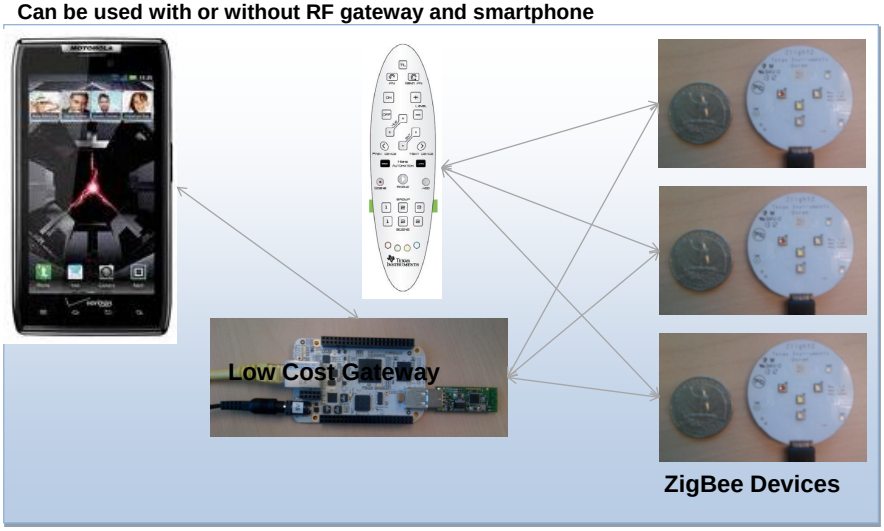
ZLL use cases:

Can be used with or without RF gateway and smartphone



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GET CONNECTED

SUB-1GHZ: ROBUSTNESS & LONG RANGE

Technical introduction, Sub-1GHz

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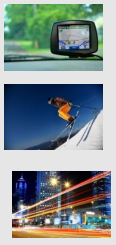
The industry's broadest wireless connectivity portfolio

Supported standards						
13.4KHz /13.56MHz	Sub 1GHz	2.4GHz to 5GHz				Satellite
RFID NFC ISO14443A/B ISO15693	SimpliciTI 6LoWPAN W-MBus	SimpliciTI PurePath Wireless	ZigBee® 6LoWPAN RF4CE	*Bluetooth*® technology *Bluetooth*® low energy ANT	Wi-Fi	GPS
Example applications						
						
Product line up						
TMS37157 TRF796x TRF7970	CC1110 CC1190 CC11xL CC430 CC112X CC120X CC1180	CC2500 CC2543/44/45 CC2590/91 CC8520/21 CC2530/31	CC2530 CC2530ZNP CC2531 CC2533 CC2520	CC2560/4 CC2540/1	WL1271/3 WL 18xx CC3000	CC4000

Red = SimpleLink family

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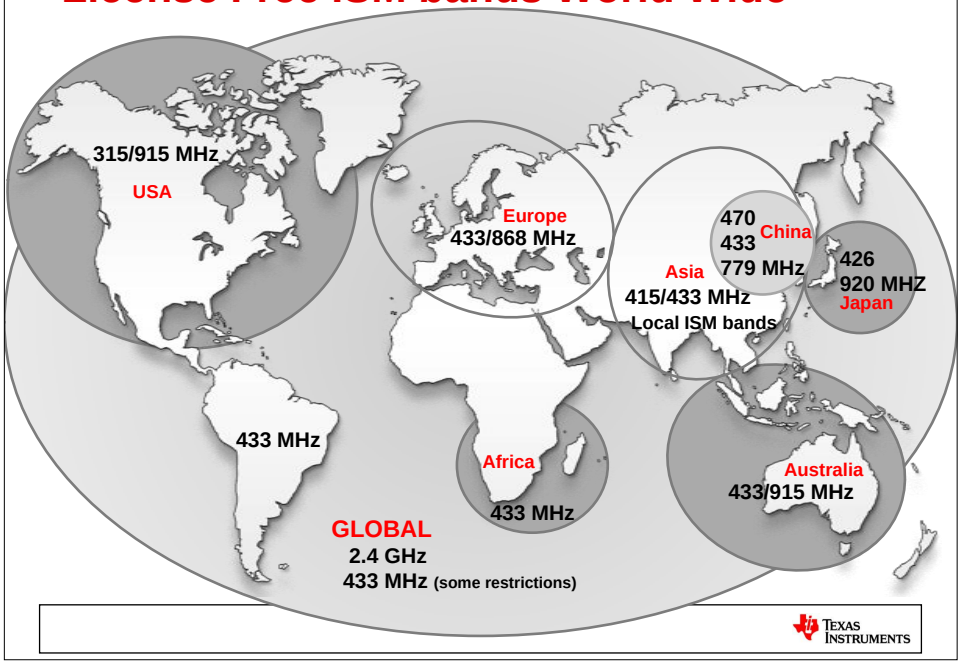
License Free ISM bands World Wide



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Why Sub-1GHz RF technology

Long Range

- Radio range, up to several kilometers
- New technology from TI makes it more reliable

Co-existence

Rapidly growing number of RF devices requires good co-existence properties

License Free Radio Communication

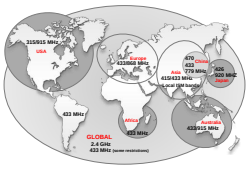
ISM (Industrial, Scientific and Medical)

- License free RF bands
- Available worldwide
- No need for subscription or fees

Battery life

On small Lithium cells, designed to last up to 15 years

Sub-1GHz
Robustness, long range



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Sub-1GHz target markets

Sub1-GHz product platforms

Sub-1 GHz
RF Performance Line

- Industry's highest RF performance
- Best in class sensitivity, selectivity and blocking
- Innovative new features reduce current consumption

Sub-1 GHz
RF Value Line

- Great performance at low cost with same RF performance as CC1101
- High datarate
- Low cost reference design with compact PCB antenna

Performance Line – Value Proposition

Setting new standards in sub1GHz landscape:

- **Industry's highest performance and most reliable sub-1GHz Wireless Link to assure great range also in difficult environments**
- **Industry's most advanced feature set to achieve low power and allow ease of use**

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Performance Line – Value Proposition

- Reliability: - Why?
  - The deployment of Wireless connectivity increases drastically
  - Possible interferers move closer to each other
  - Wireless EcoSystems are evolving with the need to bridge between different technologies and frequency bands

→ **Performance Line is specifically designed to provide a *future proof Wireless Sub-1GHz link* to handle the challenge of RF *Co-existence* and *Interference***

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Performance Line – Link Reliability

- **Reliability**: Achieved by:
  - Unique best in class **Blocking Performance**
    - Filter out interference outside the frequency band
  - Unique best in class **Selectivity Performance**
    - Filter out interference in the same frequency band

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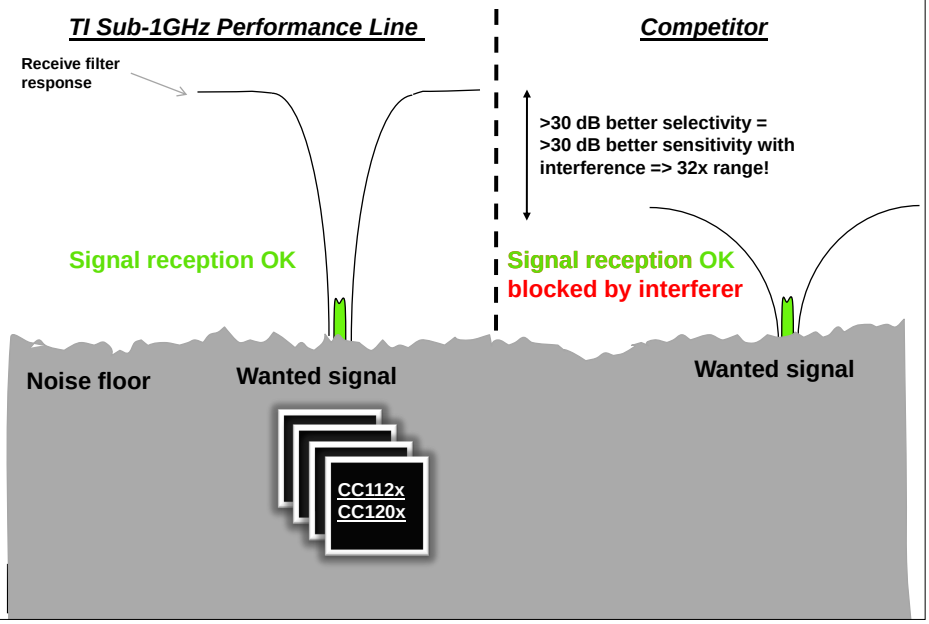
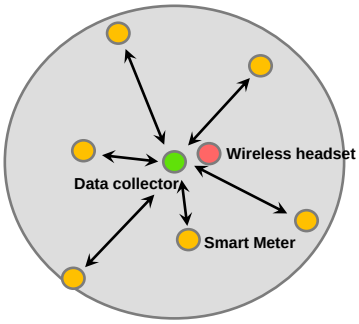
Selectivity Performance – how it works



Co-existence – how it works

Example: Star network with central data collector in a smart meter system

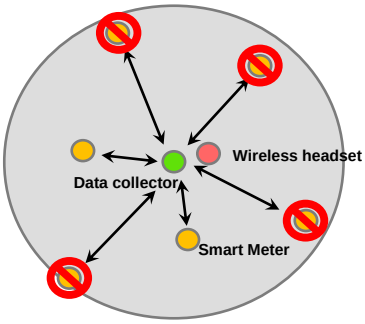
TI Sub-1GHz Performance Line



No range reduction for data collector

- Less data collectors needed
- Longer links possible
- Fewer re-transmissions

Competitor



Data collector range is reduced

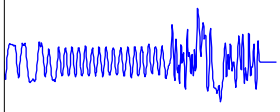
- More data collectors needed
- Temporary interference will result in higher packet loss, more re-transmissions needed

Performance Line – Link Reliability

- **Reliability**: Achieved by:
  - Unique best in class **Blocking Performance**
  - Unique best in class **Selectivity Performace**
  - Highest **Noise Immunity Performance**

Noise Immunity – Traditional Receiver

- A bit demodulator generates a bit stream and compare to a programmed sync word, e.g. '1101...1', to identify the start of a packet
- The bit demodulator needs a long preamble to find the bit timing and compensate for frequency offset. This limits the performance!
- If you input only noise on the bit demodulator, it will produce a bit sequence on the output.
- Using a 16 bit sync word, it will be a $1/2^{16}$=1/65536 probability that the sync word will appear in this bit stream, leading to false sync detect => less reliable communication and more load on the host MCU



Bit demodulator

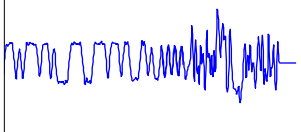
1 1 0 1 .. 1

SYNC DETECTED
- **Data Demodulation Start**

Noise Immunity - WaveMatch

- No false triggering of the sync word due to Noise given by interferes
- Ultra high sensitivity, down to -127dBm at 1.2kbps
- Extremely quick settling: 0.5 byte preamble (only needed for gain settling – AGC) including Automatic Frequency Compensation (AFC)
- Also usable as a high performance Preamble Detector

WaveMatch detector



SYNC DETECTED
- **Bit Timing Found**
- **Frequency Offset found**
- **Data Demodulation Start**

Performance Line – Link Reliability

- **Reliability**: Achieved by:
  - Unique best in class **Blocking Performance**
  - Unique best in class **Selectivity Performace**
  - Highest **Noise Immunity Performance**

  => **Highest Link Budget**: **High Sensitivity** and **Output Power** retained in the today's Wireless landscape

→ **TI's Performance Line makes systems future proof**

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Performance Line – Value Proposition

Setting new standards in sub1GHz landscape:

- **Industry's highest reliable sub1GHz Wireless Link to assure great range also in difficult environments**
- **Industry's most advanced feature set to achieve low power and allow ease of use**

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Performance Line – Value Proposition

- Feature Set for Low Power and Ease of Use:
  - Long battery life becomes mandatory
  - Increasing battery life goes with lower RF performance
    - NOT with the Performance Line
  - Highest integration and preprocessing on the RF side off-loads the MCU

→ **Performance Line is specifically designed to provide a *future proof Wireless sub1GHz link* to handle battery requirements, future protocols and offloading the application MCU**

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Performance Line – Feature Set

- Feature Set:
  - **Lowest RX Power Performance –** WaveMatch/SniffMode

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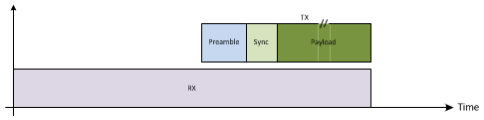
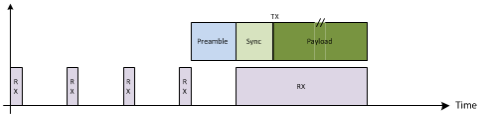
RX Sniff Mode with <3mA RX current

In typical RF systems the packet consists of preamble, sync and payload

- **Traditional receiver**: Radio must stay in RX continuously to make sure the transmitted packet is received, settling the receiver during the preamble



- **WaveMatch receiver**: The fast settling receiver does not need the long preamble, and can automatically duty cycle RX to greatly reduce average power consumption when searching for packets, without sacrificing RF performance!



LOWEST RX current with keeping highest PERFORMANCE

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Performance Line – Feature Set

- **Feature Set**:

  - **Lowest RX Power Performance** – WaveMatch/SniffMode
  - **Low external BOM** while keeping **Performance**
    - No SAW, no external VCO tank, no calibration during manufacturing needed
  - **Greatest Packet Support Performance**
    - IEEE802.15.4g, WMBus, IO HomeControl, KNX-RF, full flexibility on RF parameters to support all legacy protocols

→ **TI's Performance Line makes systems future proof**

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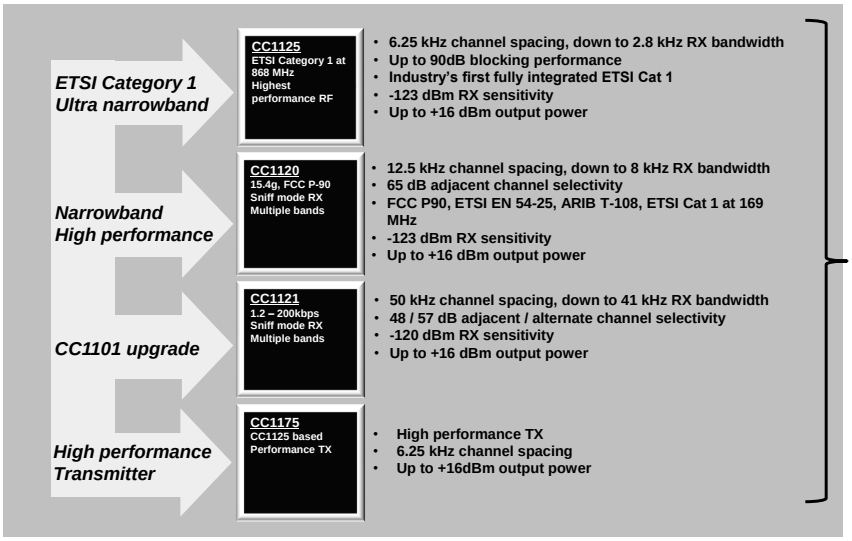
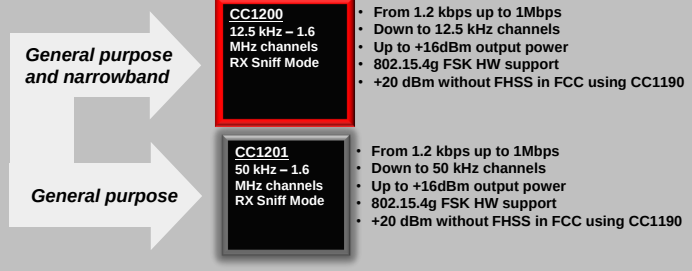
Sub-1 GHz Performance Line Portfolio



Performance Line CC120x introduction

Production | Sampling | Development | Future

Pin2Pin and register compatible with CC112x family



CC1200
- Higher datarates than CC112x and CC1101 – up to 1Mbps
- Supports all 802.15.4g FSK modes, also 400kHz channels not supported by CC112x
- 802.15.4g HW packet handling: CRC16/32, FEC, DualSync ++
- AES security support

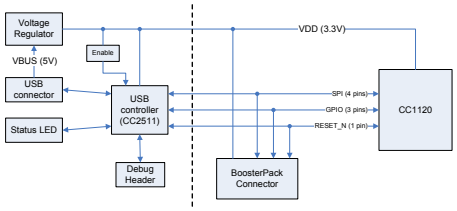
Performance line feature matrix

	CC1121	CC1201	CC1120	CC1200	CC1125
Narrow band (12.5 / 25 kHz channels)			•	•	•
Up to 200 kbps datarate	•	•	•	•	•
Up to 1 Mbps datarate		•		•	
AES security HW support		•		•	
802.15.4g FSK mandatory mode (50kbps)	•	•	•	•	•
802.15.4g FSK 100 kbps	•	•	•	•	•
802.15.4g FSK all rates		•		•	
802.15.4g HW packet support: DualSync (two concurrent sync words) CRC and Whitening Forward Error Correction (FEC)	•	• • •	•	• • •	•
WMBUS all modes (C, N, S, T)	•	•	•	•	•
WaveMatch and RX SniffMode	•	•	•	•	•
ETSI Category 1 at 868 MHz					•
ETSI Category 1 at 169 MHz			•	•	•

Sub1-GHz long range RF: CC1120

New $10 development kit for China!

Ideal for: Metering, Alarm & Security, Industrial applications



- New develpment platform for CC1120 @433MHz
- Works stand-alone or with MSP430 Launchpad
- Purpose:
  - Evaluate RF performance with SmartRF tools
  - Develop prototypes and write code using MSP430 LaunchPad

- Supported software tools
  - SmartRF Studio 7 PC tool for generation RF settings & testing (free download)
  - Packet sniffer PC software (free download)
  - IAR Embedded workbench or CCS for code development on MSP430

- Kit content
  - 2 x CC1120 433Mhz development boards
  - 2 x USB cables

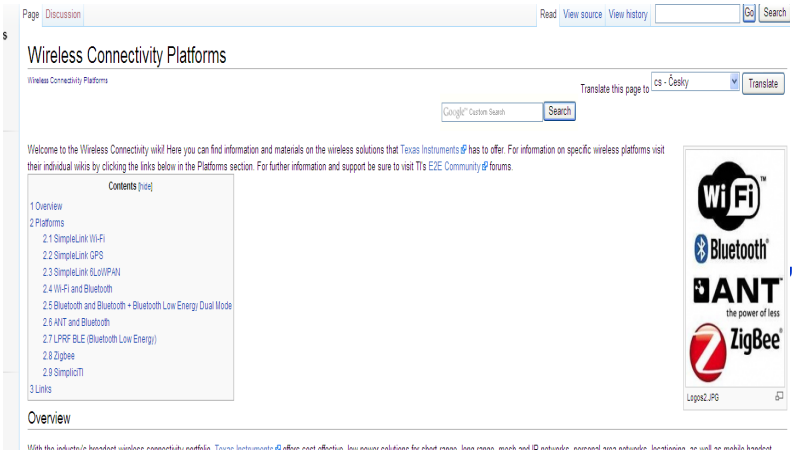
ISM Frequency Bands In China - RF Solution Overview

Frequency Band	Transmission Power Limit	Occupied Bandwidth	Equipment Type	TI LPRF Device
314 – 316 MHz	10 mW	≤ 400 kHz	Wireless control devices, not to be used for wireless control toys and models	• Value Line CC11xL • CC111x/CC110x • CC430F5xxx • Performance Line CC112x / CC120x
430 – 434 MHz (note 1)	10 mW	≤ 400 kHz		
779 – 787 MHz	10 mW	none		
470 – 510 MHz	50 mW	≤ 200 kHz	Metering for sivil usage	• CC1100E • CC1100E + CC1190 • Performance Line CC112x/CC120x (note 2)

Note 1 - Many regions in the world, including North America and Europe, have an ISM band around 433 MHz.

Note 2 - The CC112x and CC120x devices cover up to 480 MHz of this band.

Wireless Connectivity Wiki



www.ti.com/connectivitywiki

Local Forum

http://www.deyisupport.com/question_answer/f/45.aspx

Conclusion and Summary

- Industry's highest performance RF family that provides the most **reliable** link in today's and tomorrow's RF environments
- Rich **feature set** to improve **ease-of-use** and drastically **reduce power consumption** in battery operated systems
- High flexibility for **future proof** systems, support for legacy and upcoming RF protocols
- Order kits and samples:

  www.ti.com/rfperformanceline

Demo

Appendix:
Technical and feature-set detail

- Performance line deepdive on selected features that enable High Performance and Low Power

Performance line benefits

Feature	Benefit
Industry leading RF blocking and selectivity: • 65dB adjacent channel rejection at 12.5kHz offset • 90dB blocking	First pass installation success. The RF chip market is growing 30%YoY, and robust RF is the key to communicate reliably in presence of interference => lower field install cost The first fully integrated ETSI Category 1 radio on the market. Significant cost reduction compared to todays discrete solutions
High output power (up to +16dBm) and excellent sensitivity (-123dBm @1.2kbps)	Long range, 10's of kilometers out-of-the-box with the development kit
WaveMatch; Advanced DSP sync detector with high sensitivity and strong noise immunity	More reliable links, no false sync detects in noise
Advanced RX sniff mode. Quick startup and settling time.	<3mA RX sniff mode current consumption. Extended battery life.

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What is RF Performance?

- Sensitivity, output power, selectivity and blocking in a practical application using LPRF Performance line radios

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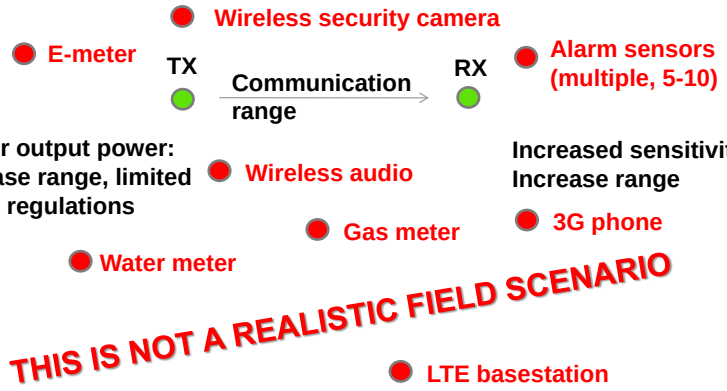
Sensitivity and output power

Interference can severly limit communication range!
The ability to operate in a hostile RF environment will be the key to a successful installation



Higher output power: Increase range, limited by RF regulations

Increased sensitivity: Increase range

Wireless audio

Gas meter

3G phone

Water meter

THIS IS NOT A REALISTIC FIELD SCENARIO

LTE basestation

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"First pass" installation success

Why coexistence with RF interference is so important

IMS predicts a > 20% CAGR for proprietary Low Power RF IC shipments

"The UK (alone) is expected to witness a 109 % growth in smart electricity meter unit shipments from 2010 to 2017," Frost and Sullivan

Photo: Samsung Galaxy SII

LTE / 4G mobile approaching ISM bands with high bandwidth data streaming

LTE Band	Uplink (MHz)	Downlink (MHz)	Main Region
1	1920 - 1980	2110 - 2170	Asia, Europe
2	1850 - 1910	1930 - 1990	Americas, Asia
3	1710 - 1785	1805 - 1880	Am., Asia, Europe
4	1710 - 1755	2110 - 2155	Americas
5	824 - 849	869 - 894	Americas
6	830 - 840	875 - 885	Japan
7	2500 - 2570	2620 - 2690	Asia, Europe
8	**880 - 915**	**925 - 960**	**Asia, Europe**
9	1749.9 - 1784.9	1844.9 - 1879.9	Japan
10	1710 - 1770	2110 - 2170	Americas
11	1427.9 - 1452.9	1475.9 - 1500.9	Japan
12	698 - 716	728 - 746	USA
13	777 - 787	746 - 756	USA
14	788 - 798	758 - 768	USA
17	704 - 716	734 - 746	USA
18	815 - 830	860 - 875	Japan
19	830 - 845	875 - 890	Japan
20	**832 - 862**	**791 - 821**	**Europe**
21	1447.9 - 1462.9	1495.5 - 1510.9	Japan
22	3410 - 3500	3510 - 3600	

The success and acceptance of connected devices depends on RF performance and co-existence

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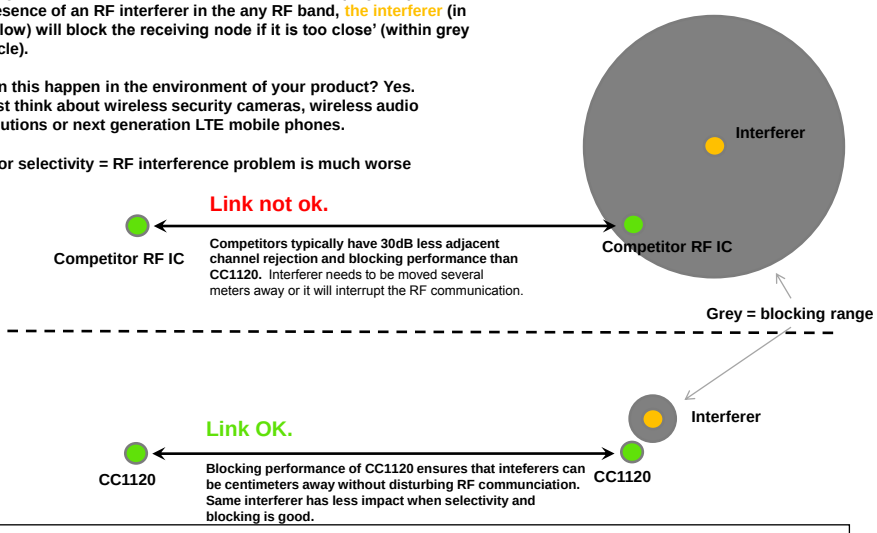
Good RF selectivity maintains good range

Poor selectivity will reduce practical range and require interfering RF systems to be physically moved away

Imagine RF communication between two nodes (in green). In presence of an RF interferer in the any RF band, the interferer (in yellow) will block the receiving node if it is too close' (within grey circle).

Can this happen in the environment of your product? Yes. Just think about wireless security cameras, wireless audio solutions or next generation LTE mobile phones.

Poor selectivity = RF interference problem is much worse



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RX SniffMode - detail

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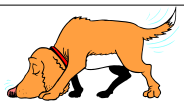
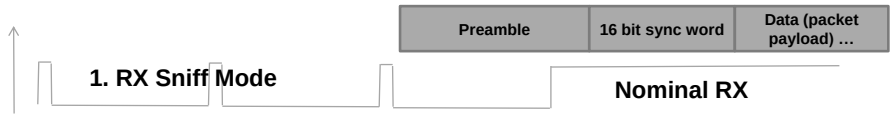
How RF Sniff Mode Works

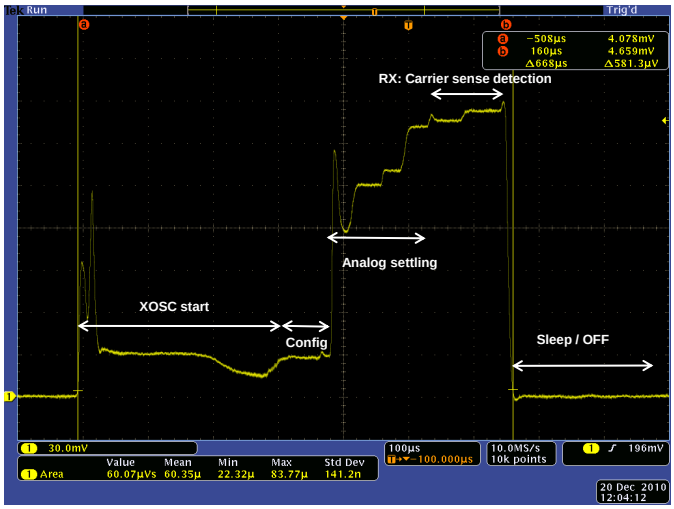


- The CC112X receiver requires only **4 bit** preamble for settling including frequency offset compensation (AFC) and automatic gain control (AGC)
- RF Sniff Mode is enabled by using **autonomous** WOR together with **automatic** RX termination based on fast Carrier Sense detection
- In RF Sniff Mode the fast settling and reliable energy detection is combined with a longer preamble to run **automated** duty cycling of the receiver
- The duty cycling is **transparent to the user** and does not impact the RF performance (sensitivity, selectivity, robustness etc.)
- Average power consumption depends on data rate and preamble length
  - Example: 1.2kbps with 4 byte preamble reduces average receive current from 21mA to <3mA



Fast Wakeup Timing and CS Detection

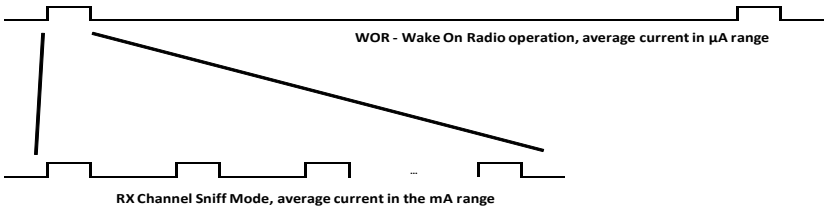
- Fast Carrier Sense (CS) detection enables ultra low power receive
- 150 µs from IDLE to RX
- Low power settings are available to trade performance vs power



Y-axis: 30mV/div = 3mA/div, X-axis: 100us/div

RX Sniff Mode and WOR

- RX Sniff Mode is used to greatly reduce active RX current
- Wake On Radio (WOR) is used to duty cycle the receiver for ultra low power receive protocols



Antenna Diversity

- CC112x and CC120x supports antenna diversity
- The diversity function use GPIO to control an external RF switch
- The diversity decision can be based on RSSI / Carrier sense or preamble detect
- Due to the fast settling receiver with WaveMatch architecture, a normal length preamble can be used (2-3 bytes). Competing radio solutions typically require 8 or more bytes of preamble for antenna diversity
- Preamble detector gives a more accurate signal detection than RSSI. The preamble detector uses the high performance WaveMatch feature

IEEE 802.15.4g support

- PHY support
- Packet automation on CC120x to simplify FW / SW when used with 802.15.4g FSK standard

IEEE 802.15.4g Smart Utility Networks (SUN)

- A physical layer (PHY) amendment to the existing IEEE 802.15.4 standard and only those MAC modifications (to 802.15.4) needed to support its implementation
  - Mandatory PHY: (Multi Rate) **MR-FSK**
  - Optional PHY's: **MR-OFDM** and MR-O-QPSK (DSSS)
- Targeting outdoor wireless Smart Utility Networks (SUN)
  - Primarily smart grid wireless networks, expected to be widely used in metering and home automation applications
  - Generally applicable to low power low cost wireless systems
- Operation in any of the regionally available license exempt frequency bands
  - Sub-1 GHz, 1.4 GHz and 2.4 GHz frequency bands are included

TI Effort Within IEEE 802.15.4g SUN

- TI has an excellent position and is strongly committed to IEEE 802.15.4
- TI has been actively participating in 802.15.4 since 2003 (Industry's first 802.15.4 Transceiver) and in 802.15.4g since January 2009
- TI is actively participating in 802.15.4g with primarily focus on **FSK** and **OFDM** based PHY specifications
- TI will provide high performance and power efficient 802.15.4g compliant solutions using the **MR-FSK** and **MR-OFDM** PHY specifications
- **FSK** based systems are today widely deployed and well proven in the field
  - The established eco system around FSK ensures good solution availability and low cost
  - TI has extensive experience with FSK based radios and provides a broad product portfolio and a strong roadmap of FSK radio solutions at both sub-1 GHz and 2.4 GHz ISM bands
  - Offering and roadmap includes; RF transceivers, transmitters, system-on-chip devices, network processors and protocol/network SW
- **OFDM** based solutions will complement FSK based solutions
  - Higher performance and improved spectral efficiency
  - Less complex and lower power than 802.11g and WiMAX
  - Due to risk of changes / clarifications in the standard, TI has chose to support OFDM initially with DSP SW based solution using I/Q front-end radio

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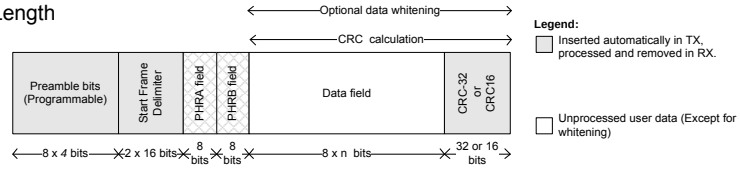
IEEE 802.15.4g support

- 15.4g defines a mandatory mode of operation (50 kbps) with a defined packet structure
- 15.4g also defines a wide set of optional features
- CC120x supports all mandatory features and has extensive support for optional features
- Features supported:
  - Packet header decoding
  - CRC16/32
  - Whitening
  - Frame Length
  - (cont')



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IEEE 802.15.4g support cont'

- FEC support with CC112x / CC120x **DualSync**
  - 15.4g distinguish between FEC / non-FEC packets based on the sync word / SFD
  - CC112x / CC120x can search **concurrently for two** different 16 bit sync words / SFDs => DualSync
  - For CC120x, based on the detected SFD, FEC is enabled or disabled to allow a system of mixed FEC and non-FEC nodes
- ModeSwitch
  - A bit in the 15.4g header indicates that the next packet will have a different format (different PHY parameters)
  - The fast-settling performance line receivers can be re-configured on-the-fly and restarted to support any switch in operation mode

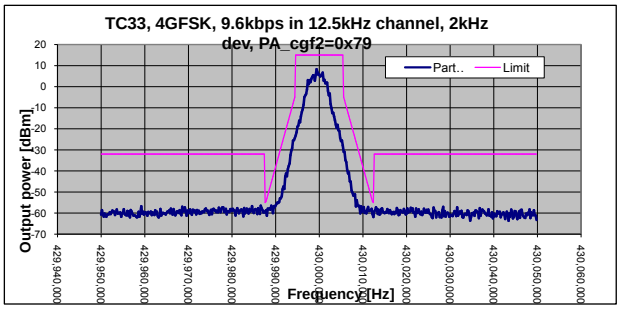
Bit string index	0	1–2	3	4	5–15
Bit mapping	MS	R_1–R_0	FCS	DW	L_{10}–L_0
Field name	Mode Switch	Reserved	FCS Type	Data Whitening	Frame Length

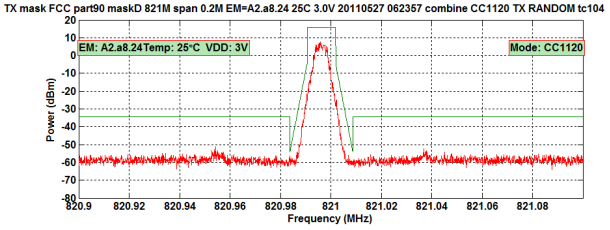
Bit string index	0	1–2	3	4–10	11–14	15
Bit mapping	MS	M_1–M_0	FEC	As defined in Figure 114	B_3–B_0	PC
Field name	Mode Switch	Mode Switch Parameter Entry	New Mode FEC	New Mode	Checksum	Parity Check

TEXAS INSTRUMENTS

High spectrum efficiency

- For spectrum efficiency Performance Line is able to operate using **4.8 kbps in 6.25 kHz channels and 9.6 kbps in 12.5 kHz channels** with excellent performance
- The FCC **Narrowbanding mandate** require this for all bands below 510 MHz!
- Plot shows measured data (pink line shows FCC Part 90 mask)





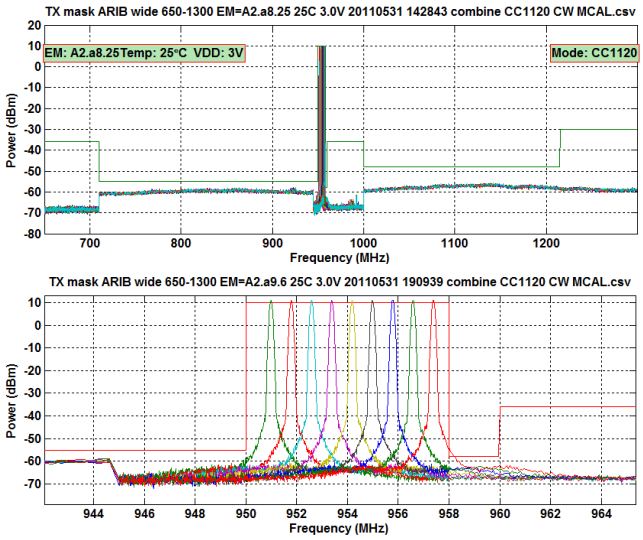
TEXAS INSTRUMENTS

Japan: Full ARIB T-96 compliance

Support for all channels in strict 955 MHz ARIB T-96 regulation

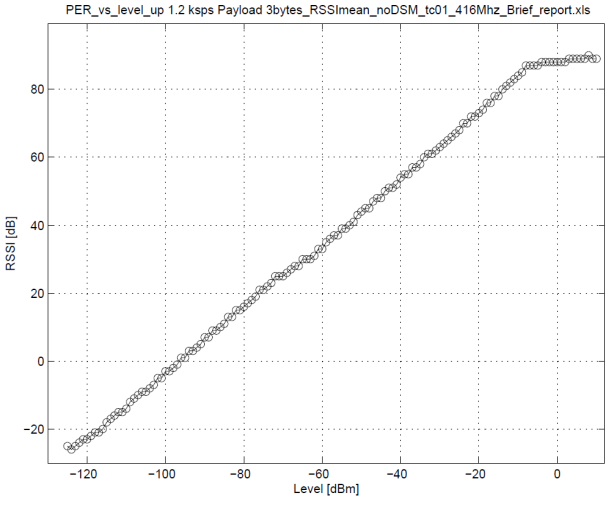
Slight backoff required for top channel

Similar requirement for new 920 MHz T-108 band



RSSI linearity

- Good correlation between input signal and RSSI value
- Linear and monotonic
- High dynamic range!
- Fully digital RSSI readout
- Can append RSSI to received packet

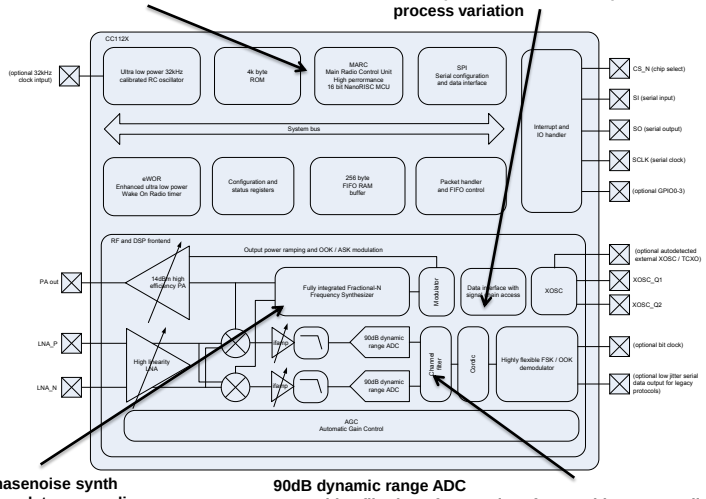


Block diagram and application circuit

CC112x and CC120x Block Diagram

16 bit ULP MCU running from ROM
=>new performance features: RX sniff mode, eWor

Full digital signal processing
=>stable performance over temperature, voltage and process variation



Ultra low phasenoise synth
=> Full RF regulatory compliance

90dB dynamic range ADC
=> Enables filtering of strong interferers with accurate digital filters

Digital vs. Analog filters

- Analog filters are very sensitive to changes in voltage, temperature and process (chip to chip variation)
- Digital filters are mathematical operations that are a funtion of the clock frequency, i.e. no drift / shift vs. temperature, VDD or process
- Figure top right from competitor datasheet shows how the usable channel bandwidth is greatly reduced by VDD and temp variation. Adding frequency error from crystal inaccuracy will reduce the usable receive bandwidth impacting the system performance
- CC112x use full digital signal processing: No issue with varation of filter response!

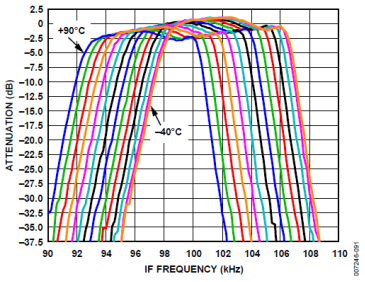
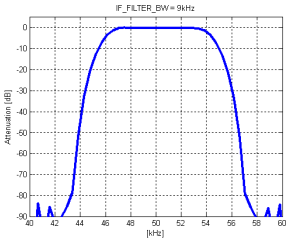


Figure 26. Variation of IF Filter Response with Temperature (IF_FILTER_BW = 9 kHz, Temperature Range is –40°C to +90°C in 10° Steps)



TEXAS INSTRUMENTS

Companion devices

- Low cost antennas, range extention and DC/DC for lower power consumption

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Antenna Evaluation Kit

CC-ANTENNA-DK
Price $49

Antenna reference designs (PCB, Chip and Wire antennas)

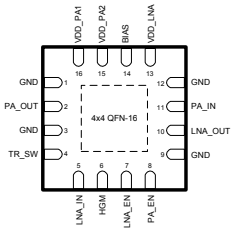
13 low cost antennas and 3 calibration boards.

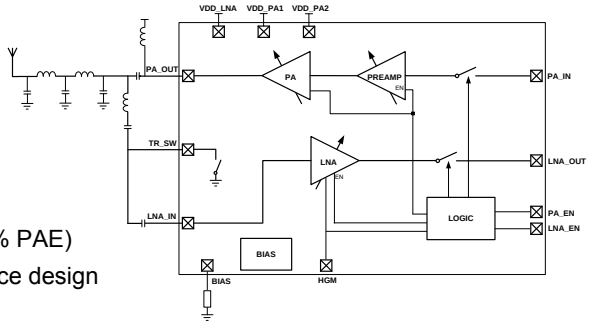
Frequency ranges from 136 MHz to 2.48 GHz.

See also DN031
www.ti.com/lit/swra328

CC1190 Highly Integrated RF Front End

- 850 – 950 MHz RF Front End
- Range Extender for CC10xx, CC11xx, CC12xx
- Up to +27dBm (0.5 W) output power
- High power efficiency at +20 dBm and +27 dBm
- 1 dB output power variation over the whole temp range (-40 to +85 C)
- 2.0-3.7 V Operation
- 2.9 dB Noise Figure
- LNA Bypass Mode
- 50 nA in Power Down
- QFN-16, 4x4mm
- 3mA LNA Current
- 300mA, 3V, +27dBm (50% PAE)
- CC112x+CC1190 reference design available on ti.com

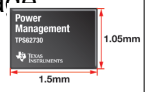


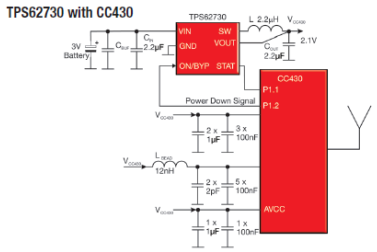


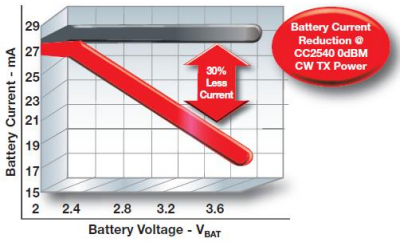
TPS62730 – Tailored DC/DC for LPRF

Achieve 20-30% power savings in low-power RF devices

- Ultra-low-power bypass-mode with typical 30-nA current consumption supports sleep and low-power modes of modern RF transceivers
- DC/DC operation mode provides a regulated output voltage consuming typical 25-µA quiescent current
- Fit both sub GHz and 2.4GHz LPRF devices
- 19.6mA at +10 dBm output power with CC112x







TEXAS INSTRUMENTS

LPRF Performance Line Performance tables

- Leading RF performance in the industry

TEXAS INSTRUMENTS

RF Performance Comparison #1

PARAMETER	CC1020	CC1101	CC1121	CC1201	CC1120	CC1200	UNIT
Sensitivity (1.2kbps)	-118	-116	-120	-120	-123	-122	dBm
Max P_{out} (170/4xx/9xx MHz)	10/5	12	16/15/14	16/15/14	16/15/14	16/15/14	dBm
I_{RX} RX Sniff Mode	N.A.	N.A.	3*	3*	3*	3*	mA
I_{RX} Normal Mode / low power mode	19.9	16.0	22 / 17	22 / 17	22 / 17	22 / 17	mA
I_{TX} +10dBm normal / low power mode	27	31	34 / 32	34 / 32	34 / 32	34 / 32	mA
I_{SLEEP}	0.2	0.3	0.3	0.3	0.3	0.3	uA
Voltage Range	2.3 – 3.6	1.8 – 3.6	2.0 – 3.6	2.0 – 3.6	2.0 – 3.6	2.0 – 3.6	V
Package	7x7 QFN32	4x4 QFN20	5x5 QFN32	5x5 QFN32	5x5 QFN32	5x5 QFN32	

** RX Sniff mode significantly reduce the average power consumption by autonomously checking the channel for RF activity and only go to full receive mode when a signal is detected. Full performance is kept in RX Sniff Mode, the power consumption is a trade-off with settling time (preamble length)*

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RF Performance Comparison #2

PARAMETER	CC1020	CC1101	CC1121**	CC1201***	CC1120**	CC1200***	UNIT
Adj. Ch. Selectivity	32	28	60	54	64	55	dB
Alt. Ch. Selectivity	41	37	60	54	66	55	dB
Image Rejection Uncalibrated	31	23	60	54	66	53	dB
Blocker Rejection*	50 - 78	62	83	86	89	90	dB
IIP3 (max gain) IIP3 (max gain – 3dB)	-18 -15		>-14 >-8	>-14 >-8	>-14 >-8	>-14 >-8	dBm
Phase noise 10 kHz	-90	-90	-111	-107	-111	-107	dBc/Hz
Phase noise 100 kHz	-110	-92	-116	-108	-116	-108	dBc/Hz
Phase noise 1 MHz	-114	-107	-135	-127	-135	-127	dBc/Hz

Blocker Rejection is 10MHz and above from center freq. ** For 170 MHz * For 400 MHz*

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RF frequency band support

PARAMETER	CC1020	CC1101	CC1121	CC1201	CC1120	CC1125	CC1200	UNIT
Frequency Range	402 - 480 804 – 960	300 – 348 387 – 464 779 – 928 **CC1100E:** 470 – 510 950 – 960	820 – 960 410 – 480 164 – 192	820 – 960 410 – 480 164 – 192	820 – 960 410 – 480 164 – 192	820 – 960 410 – 480 164 – 192 Sampling* 273 – 320 205 – 240 136 – 170	820 – 960 410 – 480 164 – 192	MHz
Packet Handling	No	YES	YES	YES	YES	YES	YES	
FIFO Size	-	2x64	2x128	2x128	2x128	2x128	2x128	Byte
WOR	No	YES	YES	YES	YES	YES	YES	
MIN PREAMBLE	3	2	0.5	0.5	0.5	0.5	0.5	Byte
MIN Ch BW	12.5	58	41	41	8	3	10	kHz

*: Frequency bands supported by silicon. Samples are available, but these bands are not yet released

Regulatory compliance:

PARAMETER	CC1020	CC1101 / CC1100E	CC1121	CC1201	CC1120	CC1200
ARIB T30	•				•	•
ARIB T67	•				•	•
ARIB T108	•		•	•	•	•
ETSI EN 300-220	•	•	•	•	•	•
FCC Part 15	•	•	•	•	•	•
FCC Part 24	•				•	•
FCC Part 90 (Mask D, E, G, J)					•	•
FCC Part 101					•	•
ETSI EN 54-25	•				•	•