Low Power RF for Academia

Low Power RF tools for Wireless Projects

TEXAS INSTRUMENTS

The Low-Power RF (LPRF) devices operate at sub-1 GHz or 2.4 GHz ISM frequency bands providing robust digital communication using proprietary and industry standards, such as IEEE 802.15.4.

Applications include home automation and security, PC peripherals, remote control, industrial process monitoring, and wireless sensor networks. Typical data rates are in the range 1.2K to 500K bps.
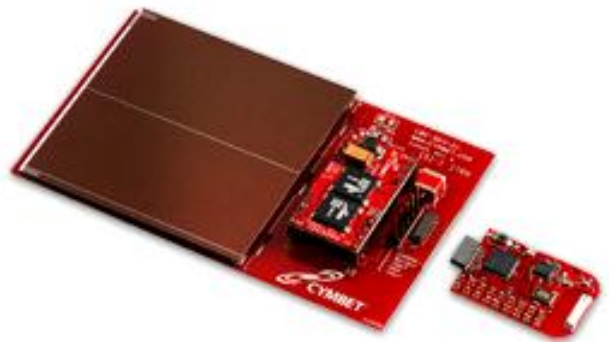
Device Nomenclature:

CCXXXX

The [EZ430-RF2500-SEH](#) Development Tool MSP430 Solar Energy Harvesting Dev Tool, **$149**

LPRF devices cover 2 frequency ranges:
CC10XX/CC11xx - Sub 1 GHz, ISM (Industrial, Scientific and Medical) and frequency bands at 315, 433, 868 and 915 MHz.

CC24xx and CC25xx -2.4 GHz, ISM and SRD band: 2,400 - 2,483.5 MHz.

With 2 types of radio:
CCxx0x Transceiver
CC2x2x 802.15.4 Transceiver
CCxx1x System-on-Chip (SoC)
CC2x3x 802.15.4 SoC
CC2x8x Z-Accel

And some with extra functionality:
CC2431 Hardware location engine
CC2511 USB controller on-chip
CC1101 Improved performance

Using the CC11xx and CC25xx devices, you can develop your own proprietary MAC and network layers. With the free downloadable software and a development kit, you are able to test range, data rates and modulation/transmission techniques straight out of the box. Once you are satisfied with the performance of the radio, you can connect your own MCU to a transceiver, or program the System-on-Chip ("SoC") CPU, to start developing your project immediately.

With CPU, memory, power management, and peripherals all in one chip, these SoC devices are ideal for teaching SoC design concepts and programming.

About ZigBee[®]
ZigBee is an international protocol defined by an alliance of companies, including TI. It has been developed to ensure interoperability between different devices in an ad-hoc wireless network, which is optimized for low-power, many nodes, and ease of configuration. For teaching purposes, it may be more educational to configure classroom networks manually or by using TI's simpliciTI.

ZigBee is useful if:
- you are developing a large network with hundreds of nodes, multiple hops, or it is an evolving "ad-hoc" network
- you need interoperability between manufacturers

TEXAS INSTRUMENTS

Protocols

Peer to Peer / Star Networks

Proprietary
In some cases, it may be desirable to develop your own networking protocol. To help you do this, TI provides an MSP430-CC library, so that you can easily interface the MSP430 to one of the CCxx0x devices.
Who is it suitable for?
This is suitable for undergraduate or postgraduate projects with specific wireless requirements which cannot be met by the simpliciTI or Z-Accel.
Compatible Hardware:
- CCxx0x EMK + MSP430 Experimenters board*.
- eZ430-RF2500
Software Required:
IAR Embedded Workbench for MSP430 (can be modified to work with CCE)
For more information, see document: SWRA141

Simplici TI
SimpliciTI is a simple low-power RF network protocol aimed at small RF networks. Access point and range extenders are not required, but provide extra functionality such as store and forward messages.
Who is it suitable for?
Undergraduate projects, to develop simple peer-to-peer or star networks with only one hop.
Compatible Hardware:
- CCxx0x EMK + MSP430 Experimenters board*
- eZ430-RF2500
Software Required:
IAR Embedded Workbench for MSP430 or CCE
For more information:
http://focus.ti.com/docs/toolsw/folders/print/simpliciti.html

TI MAC
The Medium Access Control stack offers full 802.15.4 compatibility. It also offers easy migration to ZigBee if required.
Who is it suitable for?
Post graduates or professors, who want to develop and analyze complex peer-to-peer or star networks with only one hop. It is suited for low data rate applications.
Compatible Hardware:
- CC243x DK
- CC2520 DK / ZDK
Software Required:
IAR embedded workbench
For more information: www.ti.com/timac

All protocols and software, except IAR Embedded Workbench, are free to download.

* The MSP430 Experimenters Board requires a programmer to program the MSP430.
Suitable programmers:
MSP-FET430UIF
http://focus.ti.com/docs/toolsw/folders/print/msp-fet430uif.html
MSP-FET430PI http://focus.ti.com/docs/toolsw/folders/print/msp-fet43
For ZigBee information: http://www.zigbee.org/

Mesh Networks

Z-Accel
Z-Accel is a solution where TI's Z-Stack, runs on a ZigBee Processor and the application runs on an external microcontroller.
Who is it suitable for?
Undergraduate projects; develop simple mesh networks with more than one hop & develop ZigBee compliant networks.
Compatible Hardware:
- eZ430-RF2480
Software Required:
IAR Embedded Workbench
For more information, see document: SWRA176

Z-Stack
Z-Stack is compliant with both the ZigBee 2007 (ZigBee PRO) and ZigBee® 2006 specification. Z-Stack™ supports ZigBee on the CC243x SoC and supports both ZigBee and ZigBee PRO when combining an MSP430 (F2418. F2618, or F4618) with the CC2x20.
Who is it suitable for?
Analyze the performance of complex networks, where there is more than one hop, or to analyze the interoperability of Zigbee products. Suited for very low data rate applications.
Compatible Hardware:
- CC2520 DK
- CC243x DK / ZDK
Software Required:
IAR embedded workbench
For more information: www.ti.com/z-stack

Additional Software

Smart RF Studio
http://focus.ti.com/docs/toolsw/folders/print/smartrftm-studio.html
This application allows you to perform basic transmission tests and generate register settings for LPRF devices.
Compatible with: All CCxxxx development kits

TI Flash Programmer
http://www.ti.com/litv/zip/swrc044e
This simple program allows you to use the SmartRF04EB to place your application into the flash of the SoC.
Compatible with: CCxx1x / CC243x development kits

IAR Embedded Workbench for 8051
http://www.iar.com
The IAR 8051 is a compiler for 8051 MCUs. Using this software you can program the SoC with your application.
Compatible with: CCxx1x / CC2x3x development kits

Packet Sniffer:
http://focus.ti.com/docs/toolsw/folders/print/packet-sniffer.html
PC software application used to display and store RF packets captured with a listening RF Device.
Compatible with: The web-link above lists the supported combinations of protocols and RF Devices.

CCE (Code Composer Essentials) for SimpliciTI
http://focus.ti.com/docs/toolsw/folders/print/msp-cce430pro.html\
The recommended software development environment for MSP430 MCUs
Compatible with: MSP430- based development platforms

![Texas Instruments logo]

Radios

CC11xx Family & CC25xx Family

Features:

- Configurable Modem
- Data rates up to 500 kbps
- Selectable Modulation techniques:
  MSK, FSK, GFSK, ASK and OOK
- Forward Error Correction for increased range
- Hardware support for data whitening
- Hardware support for packet handling and burst transmissions
- RSSI and LQI calculated
- Wake on Radio
- 64-byte transmit/receive FIFOs

eZ430 RF Kits
The new eZ430 RF kits provide a complete low-cost development platform (shown right). The target board can be removed for the programmer, and be powered using the battery adapter. The target boards include a MSP430 MCU, CC2xxx device (depending on the kit ordered), chip-antenna, switch and access to the MSP430 pins. Further target boards can also be ordered separately.

EMK – Evaluation Module Kit
The EMK normally contains two EM's and antennae (shown right). The EM contains the minimum components for a RF part to function. With a tested RF section, and the complete pin-out available, it removes the need for RF design when prototyping.

Note: A SmartRF04EB is required to program the SoC Ems

DK – Development Kit
The development kit contains everything required to fully test and RF link, and to develop software for the SoC devices.
Most development kits contain two EM's and two EB's (evaluation boards). These evaluation boards allow you to use our Smart RF Studio software to perform RF tests and measurements for all devices. They also allow you to program the SoC devices using our flash programming tools.

The CC2431 DK contains more EM's and a number of BB's (battery boards), which allow you to easily power the SoC devices.

ZDK – Zigbee Development Kit
Like the development kit, the ZDK contains two EM's and two EB's (evaluation boards). The ZDK also contains a number of DB's (shown right), which contains a CC2430 and programmer, and can be USB or battery powered. The DB is a smaller target board for use in ZigBee applications.

CC2x2x Family & CC2x3x Family

Features:

- Supported by TI's 802.15.4 MAC and ZigBee stack
- Data rate: 250 kbps
- DSSS (Direct Sequence Spread Spectrum)
- 128(RX) + 128(TX) byte data buffering
- Digital RSSI / LQI support
- Hardware MAC encryption (AES-128)
- Battery monitor

System-on-Chip: CCxx1x, CC2x3x devices

The SoC uses an enhanced 8051 core: standard 8051 instructions execute faster than the standard 8051 by using one clock per instruction cycle instead of the usual 12.
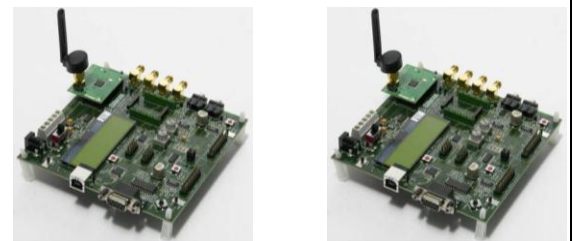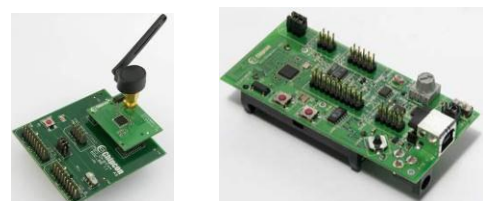

USB Programmer   Target Board

Above: Two **EM's**

Above: Two **SmartRF04EB's**

Above: left- **CC2430 BB and EM**, right- **CC2430DB**

![Texas Instruments logo]

Development Kits

Sub-1 GHz CC1101 *Transceiver*	Part #	Freq:	Contains:	Price $
	CC1101EMK	-868	2x CC1100 EM + Antennae	99
		-433		
	CC1101DK	-868	2x EB, 2x CC1100EM,	499
CC1110 *SOC*	CC1110-CC1111DK	-433	1x CC1150EM + Antennae 2x EB, 2x CC1110 EM (433MHz), 2x CC1110 EM (868MHz),	649
			1x CC1111 EM (868MHz) + Antennae	
2.4 GHz CC2500 *Transceiver*	Part #		Contains:	Price $
	eZ430-RF2500		1x USB Programmer, 2x Target Boards,	49
			1x Battery Adapter	
	eZ430-RF2500T		1x Target Board, 1x Battery Adapter	20
	eZ430-RF2500-SEH		1x Solar Panel + eZ430-RF2500	149
	CC2500EMK		2x CC2500 EM + Antennae	100
	CC2500-CC2550DK		2x EB, 2x CC2500EM, 1x 2550EM + Antennae	490
CC2510	CC2510-CC2511DK		2x EB, 2x CC2510EM,	649
SOC			1x CC2511EM + Antenna	
ZigBee/802.15.4 CC2430	Part #		Contains:	Price $
	CC2430DK		2x EB, 2x CC2430 EM + Antennae	540
SOC - 802.15.4	CC2430ZDK		2x EB, 2x CC2430 EM, 5x CC2430 DB + Antennae	1499
CC2431 *SOC - 802.15.4*	CC2431DK *Location Engine*		2x EB, 2x CC2430 EM, 10x BB 10x CC2431EM + Antennae	999
	CC2431ZDK		2x EB, 2x CC2430 EM, 10x CC2431 EM 10x BB, 5x CC2430 DB + Antennae	1999
CC2520 *802.15.4*	CC2520DK		3xEB, 3x CC2520 EM, 2xMSP Boards, MSP430 Programmer + Antennae	649
CC2480 *Z-Accel*	eZ430-RF2480		1x USB Programmer, 3x Target Boards 2x Battery Adapter	99

For a full list of kits and more detailed information about low-power RF devices, please download the Wireless Connectivity Guide www.ti.com/wirelessconnectivityguide
Website: www.ti.com/lpw

Prices Valid as of 1st August 2009

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