

Low-Power RF Guide



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RF made easy

Texas Instruments (TI) offers a wide selection of cost-effective, low-power RF solutions for proprietary and standard-based wireless applications for use in industrial and consumer applications. Our portfolio includes RF transceivers, RF transmitters, RF front end, network processors and System-on-Chips as well as various software solutions for the sub-1 and 2.4-GHz frequency bands.

In addition, TI provides a large selection of support collateral such as development tools, technical documentation, reference designs, application expertise, customer support, third party and university programs.

Additionally, the Low-Power RF E2E Online Community provides you with technical support forums, videos and blogs, and the chance to openly and freely interact with fellow engineers.

With a broad selection of product solutions, end application possibilities, and range of technical support TI offers the broadest low-power RF portfolio.

We make RF easy!

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New products are listed in **bold red**.



Low-Power RF focuses mainly on five major application areas:

- Metering/Smart Meter
- Remote Controls
- Home Automation and Lighting
- Alarm, Security and Active RFID
- Consumer

Below is a list of applications within each of these categories as well as appropriate RF ICs and solutions.

Metering/Smart Meter

Automatic meter reading
Heat cost allocation
Smart energy (HAN, NAN, WAN)
Infrastructure

Solutions:

Proprietary, Wireless M-Bus

- CC1020
- CC1101
- CC1110
- SimpliciTI™
- 6LoWPAN

IEEE 802.15.4/ZigBee®

- CC2430/CC2530
- CC2520
- ZigBee PRO stack and Smart Energy Profile
- CC2590/91
- 6LoWPAN

Alarm, Security, and Active RFID

Passive IR (PIR) Detectors

Fire and Smoke Detectors

Keypads

Solutions:

- CC1101
- CC1110
- CC1150
- CC1020
- SimpliciTI

Remote Controls

Solutions:

- RF4CE/RemoTI™
- RF4CE Software Stack
 - CC2430/CC2530
 - CC2520
 - CC2590/91

Proprietary

- CC2510/11
- CC2500
- SimpliciTI

Consumer

Gaming
Wireless audio
Sports and leisure

Solutions:

- SimpliciTI
- CC2500
- CC2510/11
- CC2590/91
- CC2550

Home Automation and Lighting

HVAC

Thermostats

Door and blinds control

Garage door control

Light switches and control

Motion detection

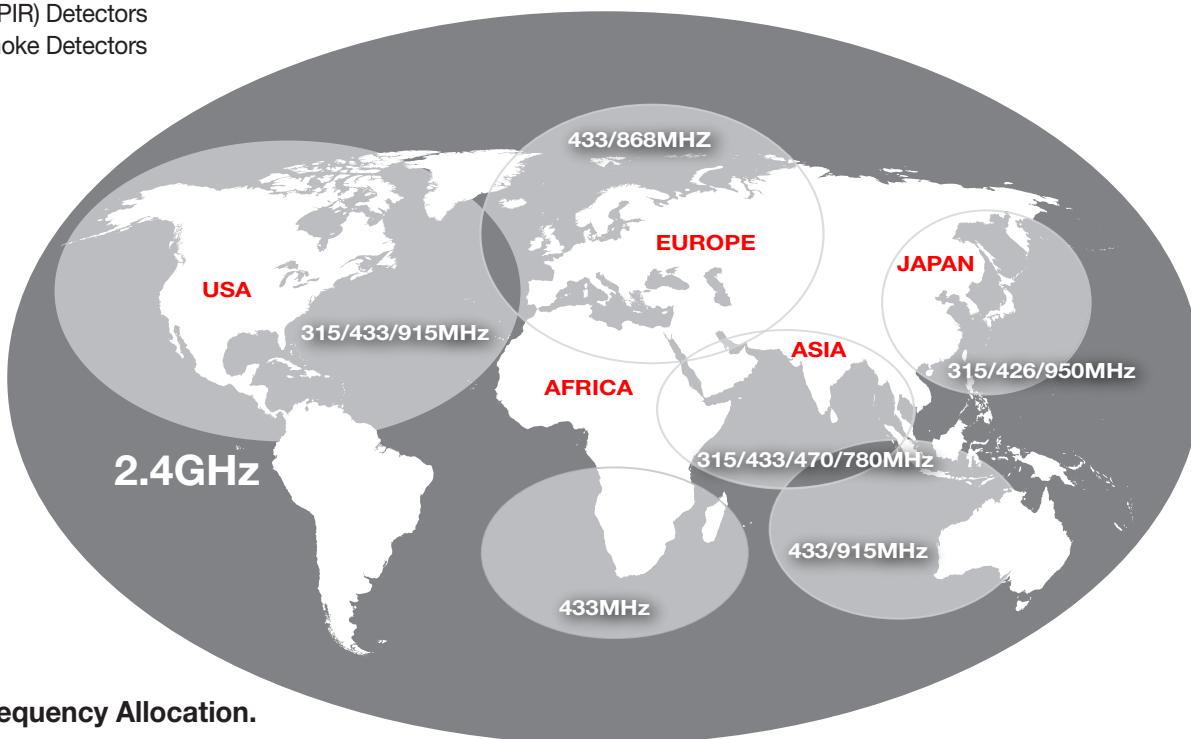
Energy harvesting

Solutions:

- IEEE 802.15.4 and ZigBee
- CC2430/CC2530
 - CC2520
 - ZigBee PRO stack and Home Automation Profile
 - CC2590/91
 - 6LoWPAN

Other (Proprietary, Wireless M-Bus, io-homecontrol®)

- CC1101
- CC1110
- CC1150
- CC1020



Global Frequency Allocation.

→ CC1020/CC1021

Narrowband RF transceiver CC1020/CC1021

Get samples, datasheets, evaluation modules and application notes at: www.ti.com/sc/device/CC1020 and www.ti.com/sc/device/CC1021

A true single-chip, narrowband UHF transceiver

The industry's first true single-chip FSK/GFSK and OOK RF transceiver that meets the stringent requirements of multi-channel narrowband applications in the 402 to 470-MHz and 804 to 940-MHz frequency bands. The CC1020 is designed to comply with the EN 300 220, ARIB STD-T67 standards and FCC CFR47 part 15. The CC1021 is identical to the CC1020 except that it can be used with minimum 50-kHz channel spacing.

Key features

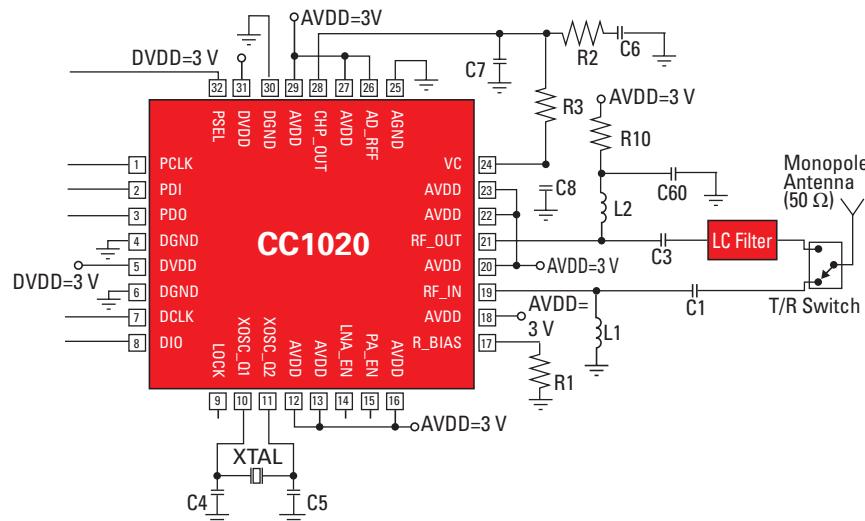
- Channel spacing down to 12.5 kHz
- Blocking performance (71 dB at ± 2 MHz)
- High receiver sensitivity (up to -118 dBm for 12.5-kHz channel spacing)
- Programmable output power up to +10 dBm
- Low receive and transmit current consumption
- Programmable carrier sense indicator and digital RSSI output
- Programmable frequency in <300-Hz steps

Benefits

- Ideal for narrowband applications
- Perfect for battery-operated industrial systems requiring long range and good noise immunity
- Suitable for listen-before-talk systems
- Suitable for frequency hopping systems

Applications

- Narrowband applications in the 426/429/433/868/915/950-MHz ISM/SDR band
- Automatic meter reading
- Wireless alarm and security systems
- Home automation
- Low-power telemetry
- Remote keyless entry



CC1020 functional block diagram.

Development tools and software

- CC1020/CC1070DK-433 MHz Development Kit
- CC1020/CC1070DK-868 MHz Development Kit
- CC1020EMK-433 MHz Evaluation Module Kit
- CC1020EMK-868 MHz Evaluation Module Kit

General characteristics

Parameter	(433/868 MHz, 3.0 V, 25°C)	Min	Typ	Max	Unit	Condition
Operating conditions						
Frequency range	402	—	470	MHz	Programmable in less than 300-Hz steps	
	804	—	960	MHz	Programmable in less than 600-Hz steps	
Data rate	0.45	—	153.6	kBaud		
Operating voltage	2.3	3.0	3.6	V		
TX mode						
Output power 433/868	-20	—	+10/+5	dBm		
FSK separation	0	—	108/216	kHz		
*ACP, 12.5/25 kHz	—	-46 -49	—	dBc		
OBW, 99.9%, 12.5/25 kHz	—	7.5 9.6	—	kHz	12.5-kHz spacing: 2.4 kBaud, ± 2.025 kHz 25-kHz spacing: 4.8 kBaud ± 2.475 kHz	
RX mode						
Sensitivity OOK, 2, 4/4, 8 kBaud	—	-116/-107	—	dBm	Manchester coded data	
Sensitivity FSK, 2.4 kBaud*	—	-118	—	dBm	12.5-kHz spacing: 12.288-kHz receiver filter bandwidth, jammer at $\pm 12.5/\pm 25$ -kHz offset	
Image channel rejection, calibrated	—	49/52	—	dB		
Blocking, ± 2 MHz	—	64/71	—	dB		
Blocking, ± 10 MHz	—	75/78	—	dB		
Power consumption						
Current consumption, RX	—	19.9	—	mA		
Current consumption, TX 433/868	—	16.2/20.5	—	mA	0-dBm output power	
Current consumption, power down	—	0.2	1.8	μA		

* The CC1021 is identical to the CC1020 except that it can be used with minimum 50-kHz channel spacing.



Integrated multi-channel RF transceiver

CC1101

Get samples, datasheets, evaluation modules and application notes at: www.ti.com/sc/device/CC1101

Integrated solution provides low cost and high performance

The CC1101 is a highly integrated, multi-channel RF transceiver designed for low-power wireless applications in the 315/433/868/915-MHz ISM bands. The CC1101 is an upgrade of the CC1100 transceiver with improvements for spurious response, close-in phase noise, input saturation level, output power ramping and extended frequency range.

Key features

- Sub-1 GHz FSK/GFSK/MSK/ASK/OOK RF transceiver
- 1.2 to 500-kBaud data rate
- Low-power, low system cost
- Sleep current: 200 nA
- 90- μ s PLL lock time: 240 μ s from sleep to RX/TX
- On-chip support for sync word detection, address check, flexible packet length and automatic CRC checking
- Separate 64-byte RX and TX data FIFOs (enable burst mode data transmission)
- Suitable for systems targeting compliance with EN 300 200 (Europe) and FCC CFR Part 15 (U.S.)

Benefits

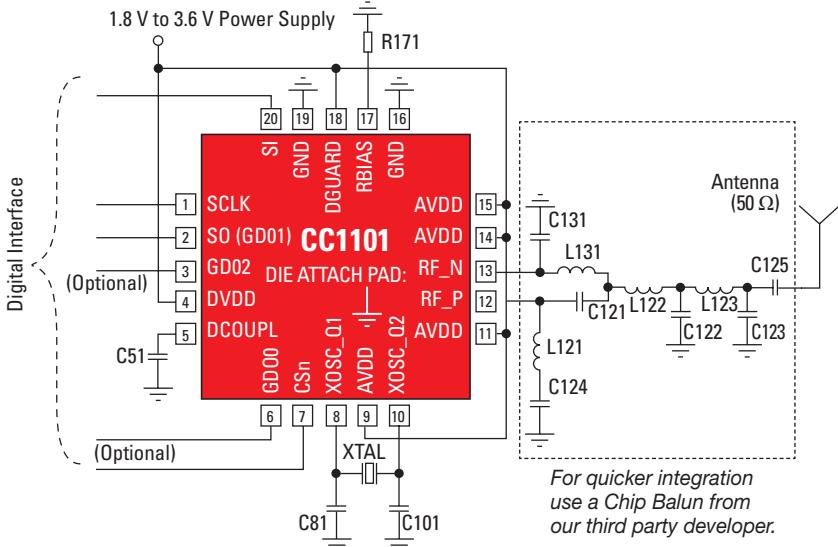
- Fast development time and low system cost
- Flexible optimization of range power
- Enables use of inexpensive microcontroller
- Enables adaptive channel selection with increased robustness and coexistence of the wireless link
- Small size solution

Applications

- Wireless alarm and security systems
- Automatic meter reading
- Industrial monitoring and control
- Home and building automation

Development tools and software

- CC1101DK-433 MHz Development Kit



The CC1101 is pin and register compatible with the 2.4-GHz CC2500 transceiver. Please see page 12.

- CC1101DK-868/915 MHz Development Kit
- CC1101EMK-433 MHz Evaluation Module Kit
- CC1101EMK-868/915 MHz Evaluation Module Kit
- SimpliciTI™ software protocol
- Wireless M-Bus

General Characteristics

Parameter (433/868 MHz, 3.0 V, 25°C)	Min	Typ	Max	Unit	Condition
Operating conditions:					
Frequency range	300	—	348	MHz	
	387	—	464	MHz	
	779	—	928	MHz	
Operating temperature range	-40	—	+85	°C	
Operating supply voltage	1.8	—	3.6	V	
Data rate (programmable)	1.2	—	500	kBaud	
Output power (programmable)	-30	—	+12	dBm	
Receiver sensitivity, 1.2 kBaud	—	-113	—	dBm	1.2 kBaud, 868 MHz, 1% packet error rate
Power consumption					
Current consumption RX, 868 MHz	—	14.7	—	mA	Input well above sensitivity limit
Current consumption TX	—	15.0	—	mA	0 dBm
	—	30.0	—	mA	12 dBm
Current consumption, power down	—	<1	—	μA	

→ CC1100E

Integrated multi-channel RF transceiver CC1100E

NEW

Get samples, datasheets, evaluation modules and application notes at: www.ti.com/sc/device/CC1100E

Integrated solution provides low cost and high performance

The CC1100E is a highly integrated, multi-channel RF transceiver designed for low-power wireless applications in the 470-MHz and 950-MHz ISM bands.

Key features

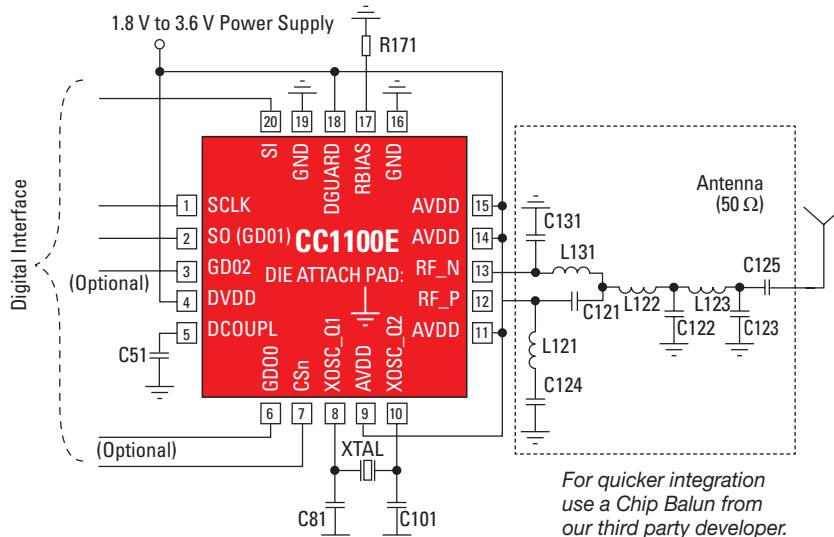
- Sub-1 GHz FSK/GFSK/MSK/ASK/OOK RF Transceiver
- 1.2 to 500-kBaud data rate
- Low-power, low system cost
- Sleep current: -200 nA
- 90- μ s PLL lock time: -240 μ s from sleep to RX/TX
- On-chip support for sync word detection, address check, flexible packet length and automatic CRC checking
- Separate 64-byte RX and TX data FIFOs (enable burst mode data transmission)

Benefits

- Fast development time and low system cost
- Flexible optimization of range power
- Enables use of inexpensive microcontroller
- Enables adaptive channel selection with increased robustness and coexistence of the wireless link
- Small size solution

Applications

- Automatic meter reading



For quicker integration
use a Chip Balun from
our third party developer.

Functional block diagram.

General Characteristics

Parameter	(433/868 MHz, 3.0 V, 25°C)	Min	Typ	Max	Unit	Condition
Operating conditions:						
Frequency range	470	—	510	MHz		
	950	—	960	MHz		
	470	—	510	MHz		
Operating temperature range	-40	—	+85	°C		
Operating supply voltage	1.8	—	3.6	V		
Data rate (programmable)	1.2	—	500	kBaud		
Output power (programmable)	-30	—	+12	dBM		
Receiver sensitivity, 1.2 kBaud	—	-112	—	dBM	1% packet error rate	
Power consumption						
Current consumption RX	—	16	—	mA	Input well above sensitivity limit	
Current consumption TX	—	15.0	—	mA	0 dBm	
	—	30.0	—	mA	12 dBm	
Current consumption, power down	—	<1	—	μA		



RF System-on-Chip Solution

CC1110F8/F16/F32

Get samples, datasheets, evaluation modules and application notes at: www.ti.com/sc/device/CC1110F8

Radio, MCU and Flash

all-in-one chip

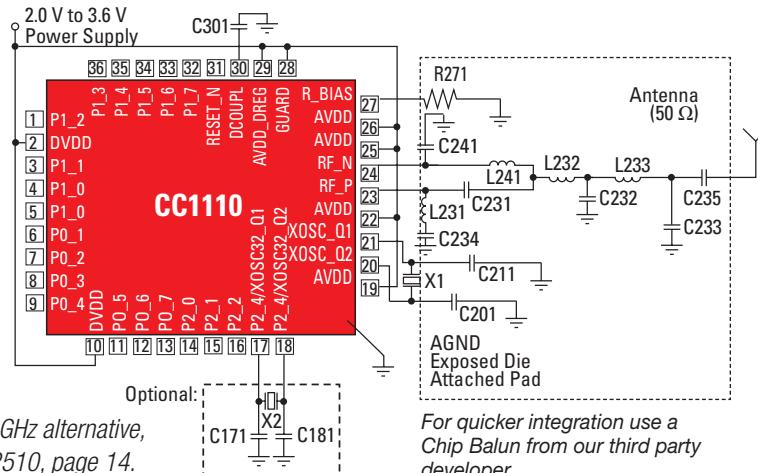
The CC1110Fx family consists of three System-on-Chips designed for low-power and low-voltage wireless communication applications. With a 315/433/868/915-MHz radio transceiver, a single-cycle 8051 MCU, 8/16/32-kB Flash memory and additional peripherals, these unique all-in-one devices make it easier than ever to finish your design faster while offering numerous application possibilities.

Key features

- High-performance, low-power 8051 MCU core, typically with 8x the performance of a standard 8051
 - Utilizes the high-performance CC1101 RF transceiver core
 - 8/16/32-kB in-system programmable Flash
 - 1/2/4-kB SRAM (with data retention in all power modes)
 - 8- to 12-bit ADC, 21 general purpose I/O pins, on-chip timers
 - Very few external components required
 - Four flexible power modes for reduced power consumption
 - Very fast transition times from sleep modes to active mode enables ultra-low average power consumption in low duty-cycle systems
 - In deep-sleep modes the system can wake up on external interrupts or real-time counter events
 - Low current consumption
 - AES-128 encryption coprocessor
 - Powerful DMA functionality
 - Real-time clock with low-power 32.768-kHz crystal oscillator or internal 34-kHz RC Oscillator

Benefits

- Complete solution on one single chip
 - Ideal for low-power, battery operated systems
 - Robust and secure link with very good coexistence



*For 2.4-GHz alternative,
see CC2510, page 14.*

*For quicker integration use a
Chip Balun from our third party
developer.*

Applications

- Alarm and security
 - Automatic meter reader
 - Smart metering
 - Wireless audio
 - Consumer electronics

Development tools and software

- CC1110/CC1111DK Development Kit
 - CC1110EMK-433 MHz Evaluation Module Kit
 - CC1110EMK-868/915 MHz Evaluation Module Kit
 - SimpliciTI™ software protocol
 - Wireless M-Bus

General characteristics

Parameter	Min	Typ	Max	Unit	Condition
(433/868 MHz, 3.0 V, 25°C)					
Operating conditions					
Frequency range	300	—	348	MHz	
	391	—	464	MHz	
	782	—	928	MHz	
Operating temperature range	-40	—	+85	°C	
Operating supply voltage	2.0	—	3.6	V	
Data rate (programmable)	1.2	—	500	kBaud	
Output power (programmable)	-30	—	10	dBm	
Reciever sensitivity	—	-111	—	dBm	1.2 kBaud, 868 MHz, 1% packet error rate
Current consumption					
MCU active and RX mode	—	17	—	mA	System clock at 203 kHz
MCU active and TX mode, 0 dBm	—	20/21	—	mA	MCU running at full speed (26 MHz), radio in TX mode, 0-dBm output power
Power mode 2	—	0.5	—	µA	32 kHz RC-oscillator (or 32.768-kHz crystal oscillator) and sleep timer running
Power mode 3	—	0.3	—	µA	No clocks running, power On Reset (POR) active, can wake up on external interrupt
Wake-up and timing					
From power mode 2 or 3 to active	—	100	—	µs	Digital regulator and high-speed oscillators off, start-up of regulator and high-speed RC Oscillator
From active to RX or TX	—	90	—	µs	Time from enabling 26-MHz crystal oscillator and the radio part until RX or TX starts

→ CC1111

RF System-on-Chip with integrated full-speed USB controller

CC1111F8/F16/F32

Get samples, datasheets, evaluation modules and application notes at: www.ti.com/CC1111F8

Radio, MCU, Flash and USB all-in-one chip

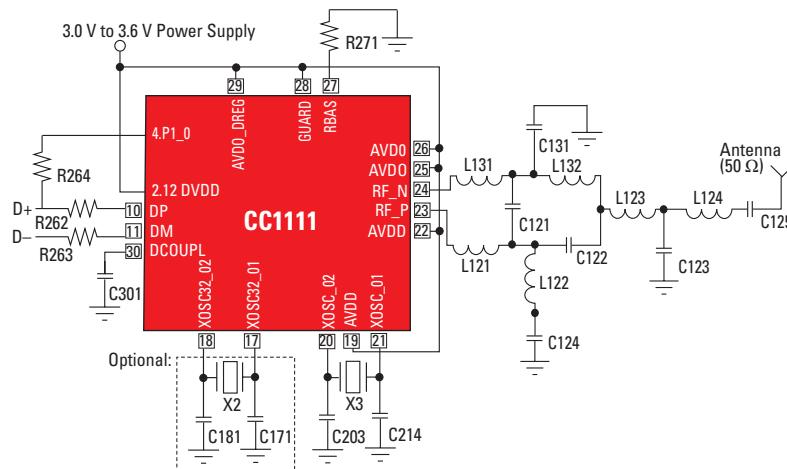
The CC1111 is a System-on-Chip with USB controller for low-power wireless applications in the 315/433/868/915-MHz frequency bands. The CC1111 combines the excellent performance of the industry-leading CC1101 RF transceiver with an enhanced MCU, full-speed USB 2.0, 32-kByte Flash memory, 4-kBytes RAM, 128-bit AES hardware encryption and many other powerful features.

Key features

- Full-speed USB 2.0 with 1-kB USB FIFO, 12-Mbps transfer rate, five bi-directional endpoints with support for bulk, interrupt and isochronous transfers
- Sub-1 GHz RF transceiver identical to the CC1101:
 - Highly configurable with support for 1.2 to 500kBaud data rate and FSK, MSK, GFSK and OOK/ASK modulation
- Very low current consumption:
 - 0.3 µA in lowest power mode
- 8/16/32-kB in-system programmable flash
- 1/2/4-kB SRAM (with data retention in all power modes)
- Excellent receiver sensitivity and robustness
- 128-bit AES supported in hardware coprocessor
- 8-channel, 8- to 14-bit ADC with up to eight inputs
- Industry standard I²S interface for digital audio data, full duplex, mono and stereo support, configurable sample rate and sample size
- Direct memory access which reduces MCU load

Benefits

- Complete solution on one single chip
- Ideal for low-power battery operated systems



CC1111 functional block diagram.

- Robust and secure link with very good coexistence
- Powerful and flexible development tools and reference designs available

Applications

- Alarm and security applications
- Automatic meter reading
- Industrial monitoring and control
- Home and building automation

Development tools and software

- CC1110/CC1111DK Development Kit
- CC1111EMK-868/915 Evaluation Module Kit
- SimpliciTI software protocol

General characteristics

Parameter	(433/868 MHz, 3.0 V, 25°C)	Min	Typ	Max	Unit	Condition
Operating conditions						
Frequency range	300	—	348	—		
	391	—	464	—		
	782	—	928	—	MHz	
Operating temperature range	0	—	85	—	°C	
Operating supply voltage	3.0	—	3.6	—	V	
Data rate (programmable)	1.2	—	500	—	kBaud	
Output power (programmable)	-30	—	10	—	dBm	
Receiver sensitivity	—	-110	—	—	dBm	1.2 kBaud, 1% packet error rate
Current consumption						
MCU active and RX mode	—	19	—	—	mA	
MCU active and TX mode, 0 dBm	—	20/21	—	—	mA	
Power mode 2	—	0.5	—	—	µA	
Power mode 3	—	0.3	—	—	µA	
Wake-up and timing						
From power mode 2 or 3 to active	—	100	—	—	µs	Digital regulator and high-speed oscillators off, start-up of regulator and high-speed RC oscillator
From active to RX or TX	—	90	—	—	µs	Time from enabling 26-MHz crystal oscillator and the radio part until RX or TX starts



Multi-channel RF transmitter

CC1150

Get samples, datasheets, evaluation modules and application notes at: www.ti.com/sc/device/CC1150

Integrated solution provides low cost and high performance

The CC1150 is a highly integrated, multi-channel RF transmitter designed for low-power wireless applications in the 315/433/868/915-MHz ISM band.

Key features

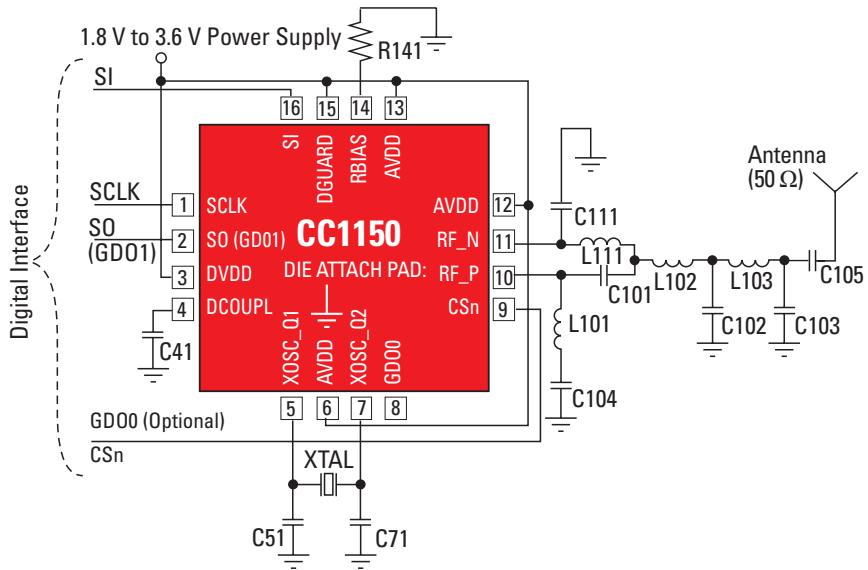
- Best-in-class price/performance ratio
- Many powerful digital features:
 - Full packet handling including preamble generation, sync word insertion, flexible packet length and automatic CRC generation
- Reference design with two-layer PCB with all components mounted on the same side
- Programmable high data rate from 1.2 to 500 kBaud
- Programmable output power up to +12 dBm
- Low-transmit current consumption
- Fast startup time (0.3 µs)
- Packaging: very small footprint 4x4 mm, 20-pin QLP package

Benefits

- Fast development time and low system cost
- Flexible optimization of range vs power
- Enables use of inexpensive microcontroller
- Small solution size

Applications

- Home and building automation
- Automatic meter reading
- Wireless alarm and security systems
- Industrial monitoring and control
- Wireless sensor networks
- Consumer electronics



CC1150 functional block diagram.

Development tools and software

- CC1150EMK-433 MHz Evaluation Module Kit
- CC1150EMK-868/915 MHz Evaluation Module Kit
- CC1101DK-433 MHz Development Kit
- CC1101DK-868/915 MHz Development Kit
- SimpliciTI software protocol
- SimpliciTI software protocol

General characteristics

Parameter (433/868 MHz, 3.0 V, 25°C)	Min	Typ	Max	Unit
Operating conditions				
Frequency range	300	—	348	MHz
	400	—	464	MHz
	800	—	928	MHz
Output power (programmable) ^w	-30	—	+10	dBm
Operating temperature range	-40	—	+85	°C
Operating supply voltage	1.8	—	3.6	V
Data rate (programmable)	1.2	—	500	kBaud
Power consumption				
Current consumption TX, (+10 dBm) 433 MHz	—	26.4	—	mA
Current consumption TX, (0 dBm) 433 MHz	—	14.9	—	mA
Current consumption, power down	—	<1	—	µA



CC430

The all new CC430 combines leading MCU and Low-Power RF Technology

CC430

www.ti.com/cc430

Bringing personal and industrial wireless networking to the mass market, the CC430 technology platform offers the industry's lowest-power, single-chip radio-frequency (RF) solution for microcontroller (MCU)-based applications. By making RF design easy, small, performance rich and power efficient, the CC430 platform helps advance applications including RF networking, energy harvesting, industrial monitoring and tamper detection, personal wireless networks, automatic metering infrastructure (AMI) and heat cost allocators.

Key features

- Best of both worlds:
Newest MSP430 MCU and leading Low-Power RF IC provides smarter, low-power applications with more flexibility
- Smaller is better:
Leading integration means smaller products, easier manufacturing and lower systems cost
- Making RF easy:
Complete ecosystem for MCU and RF ease of use and fast time to market

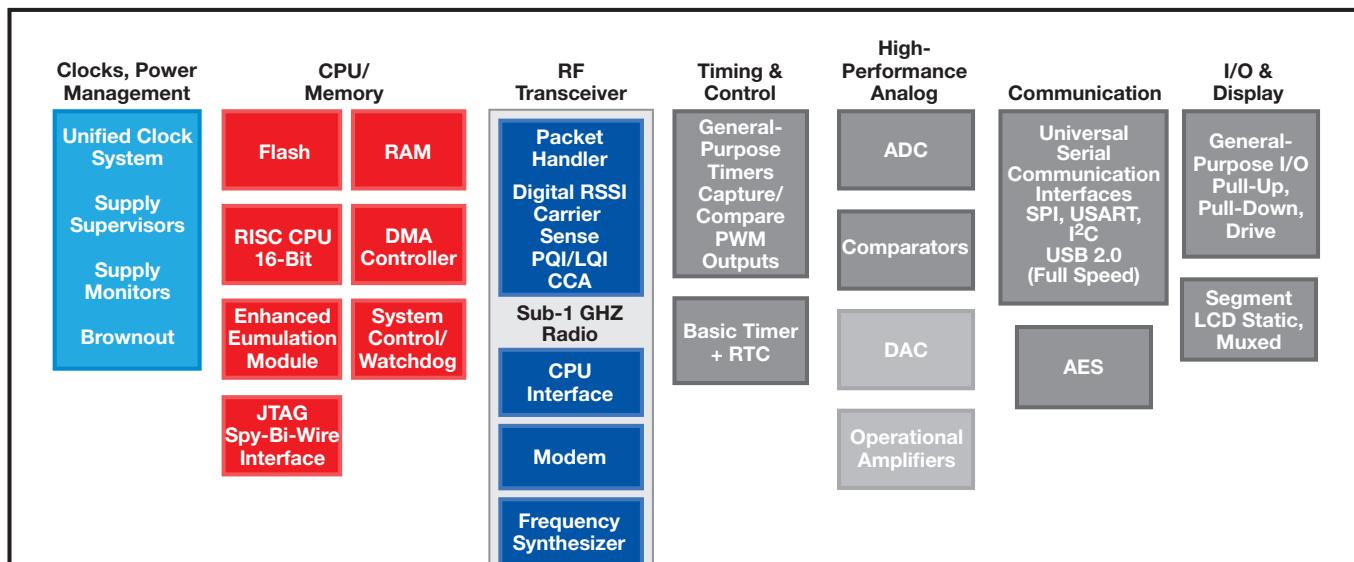
Applications

- Energy harvesting
- Industrial monitoring/tamper detection
- Personal wireless networks
- Heat cost allocators
- Automatic metering infrastructure (AMI)

Visit the CC430 Technology Blog on TI's E2E Online Community and join the journey towards the release!

community.ti.com

High integration reduces complexity, lets designers do more with less



CC430 —high integration reduces complexity, lets designers do more with less.

*Expected release date, 4Q 2009.



High data-rate RF transceiver

CC2400

Get samples, datasheets, evaluation modules and application notes at: www.ti.com/sc/device/CC2400

The CC2400 is a low supply voltage (1.6 to 3.6 V), 1-Mbps RF transceiver designed for low-power wireless applications in the 2.4-GHz ISM band.

Key features

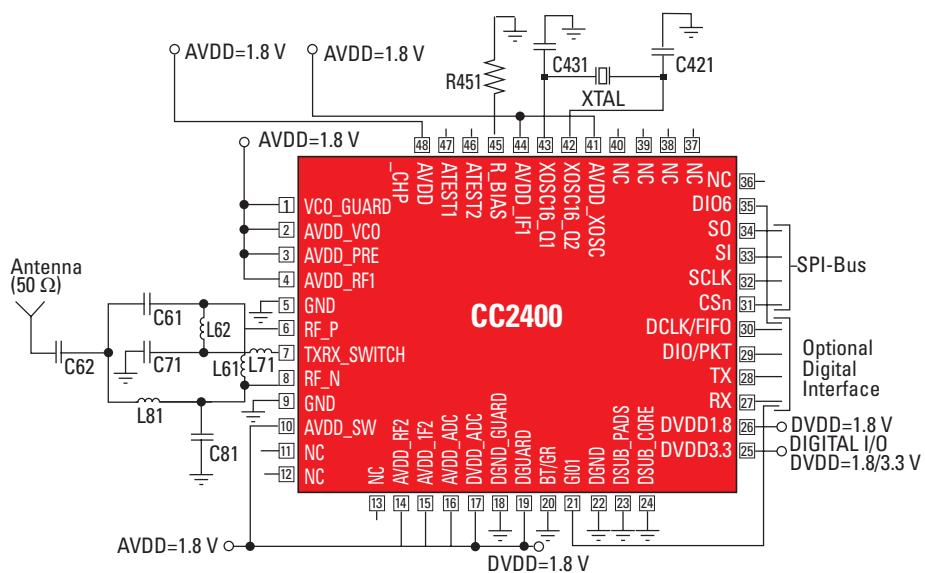
- Very few external components required
 - Reference design with two-layer PCB with all components mounted on the same side
 - Very low supply voltage: 1.6 to 3.6 V
 - High sensitivity PER: -101 dBm at 10 kBaud PER: -87 dBm at 1 Mbps
 - Programmable data rate: 10 kBaud, 250 kBaud and 1 Mbps
 - Programmable output power up to 0 dBm
 - Low receive and transmit current consumption
 - Many powerful digital features:
 - Full packet handling including preamble generation, sync word insertion/detection, address check, flexible packet length and automatic CRC
 - Digital RSSI output
 - Very good selectivity and blocking performance

Benefits

- High data rate (1 Mbps)
 - Fast development time and low system cost
 - Flexible optimization of range vs power
 - Enables increased robustness and coexistence of the wireless link

Applications

- Wireless VoIP solutions
 - High data-rate consumer electronics
 - Wireless game controllers
 - Wireless keyboard/mouse
 - Wireless audio



For a 2.4-GHz alternative, see CC2500, page 12.

Development tools and software

- CC2400DK Development Kit
 - CC2400EMK Evaluation Module Kit

General characteristics

Parameter	Min	Typ	Max	Unit
Operating conditions				
Frequency range	2400	—	2483	MHz
Data rate	10.0	—	1000.0	kBaud
Operating voltage (chip core)	1.6	—	2.0	V
Operating I/O voltage	1.6	—	3.6	V
Operating temperature	-40	—	85	°C
RX mode				
Receiver sensitivity, 10 kBaud, BER 10-3	—	-101	—	dBm
Receiver sensitivity, 1 Mbps, BER 10-3	—	-87	—	dBm
Current consumption				
Current consumption, RX	—	23	—	mA
Current consumption, TX, 0 dBm	—	19	—	mA
Current consumption, TX, -5 dBm	—	15	—	mA
Current consumption, TX, -20 dBm	—	11	—	mA
Current consumption, power down	—	1.5	—	µA

→ CC2500

Low-power, highly integrated RF transceiver

CC2500

Get samples, datasheets, evaluation modules and application notes at: www.ti.com/sc/device/CC2500

The CC2500 is a highly integrated, multi-channel RF transceiver designed for low-power wireless applications in the 2.4-GHz ISM band.

Key features

- Excellent selectivity and out-of-band blocking performance
- Many powerful digital features:
 - Full packet handling including preamble generation, sync word insertion/detection, address check, flexible packet length and automatic CRC
- Programmable carrier sense indicator, digital RSSI output
- Very few low-cost external components required
- Reference design with two-layer PCB with all components mounted on the same side
- 2-FSK, GFSK, MSK, OOK

Benefits

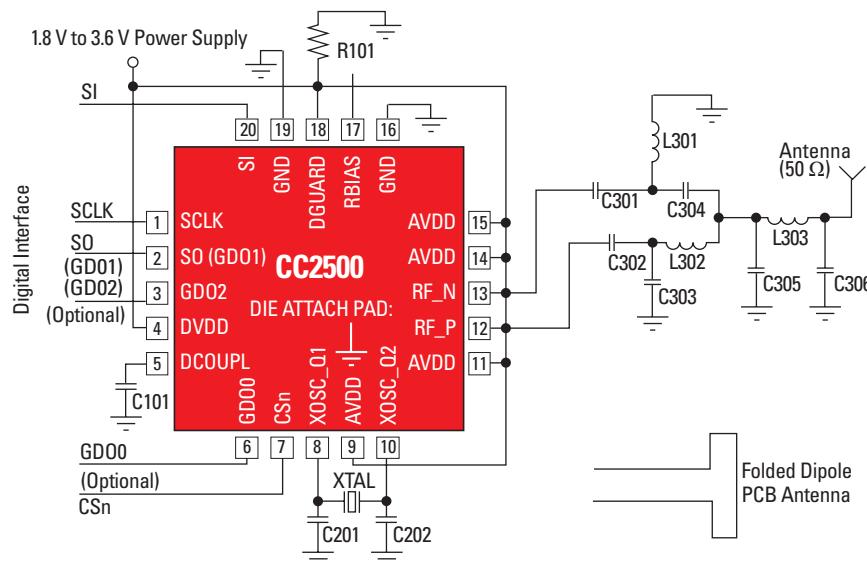
- Fast development time and low system cost
- Only needs an inexpensive microcontroller
- Adaptive channel selection with increased robustness and coexistence of the wireless link
- Robust and secure link with very good coexistence with *Bluetooth*[®] and WiFi

Applications

- Wireless game controllers
- Wireless keyboard/mouse
- Consumer electronics
- Wireless audio
- Sports and leisure equipment
- RF-enabled remote controls

Development tools and software

- CC2500/CC2550DK Development Kit
- CC2500EMK Evaluation Module Kit
- ez430-RF2500 MSP430 Wireless Development Tool
- SimpliciTITM Software Protocol



The CC2500 is pin and register compatible with the sub-1 GHz CC1101 transceiver, please see page 5.

General characteristics

Parameter	(433/868 MHz, 3.0 V, 25°C)	Min	Typ	Max	Unit	Condition
Operating conditions						
Frequency range	2400	—	2483.5	MHz		
Data rate (programmable)	1.2	—	500	kBaud		
Sensitivity, 2.4 kBaud	—	-104	—	dBm	Optimized sensitivity	
Sensitivity, 250 kBaud	—	-89	—	dBm	Optimized sensitivity	
Output power (programmable)	-30	—	1	dBm		
Operating supply voltage	1.8	—	3.6	V		
Current consumption						
RX input signal at the sensitivity limit, 2.4 kBaud	—	17.0	—	mA		
RX input well above sensitivity limit, 2.4 kBaud	—	14.5	—	mA		
RX input signal at the sensitivity limit, 250 kBaud	—	16.6	—	mA	Current optimized	
RX input well above sensitivity limit, 250 kBaud	—	13.3	—	mA	Current optimized	
Current consumption, TX, 0 dBm	—	21.2	—	mA		
Current consumption, TX, -12 dBm	—	11.1	—	mA		
Current consumption, power down	—	<1	—	μA		



Low-power, highly integrated RF transmitter

CC2550

Get samples, datasheets and application notes at: www.ti.com/sc/device/CC2550

The CC2550 is a highly integrated, multi-channel RF transmitter designed for low-power, one-way wireless applications in the 2.4-GHz ISM band.

Key features

- Reference design with two-layer PCB with all components mounted on the same side
- Programmable data rate from 1.2 to 500 kBaud
- Programmable output power
- Low transmit current consumption
- Many powerful digital features:
 - Full packet handling including preamble generation, sync word insertion/detection, address check, flexible packet length and automatic CRC
- Very few external components required
- 2-FSK, GFSK, MSK, OOK
- Packaging: Very small footprint 4x4 mm, 16-pin QFP package

Benefits

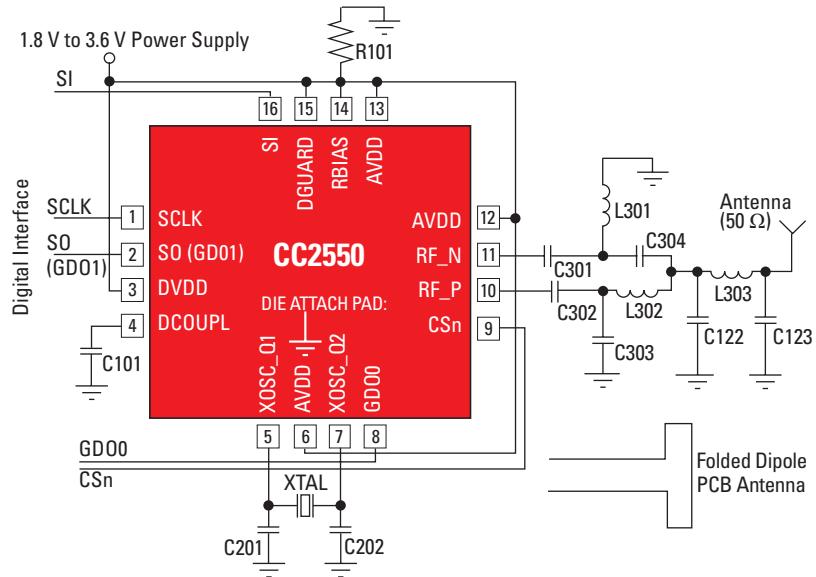
- Fast development time and low system cost
- Flexible optimization of range vs power
- Small size solution
- Robust and secure link with very good coexistence with Bluetooth® and WiFi

Applications

- Wireless game controllers
- Wireless keyboard/mouse
- Consumer electronics
- Wireless audio
- Sports and leisure equipment

Development tools and software

- CC2500/CC2550DK Development Kit
- CC2550EMK Evaluation Module Kit
- SimpliciT™ Software Protocol



For a sub-1 GHz alternative, see CC1150, page 9.

General characteristics

Parameter	Min	Typ	Max	Unit
Operating conditions				
Frequency range	2400	—	2483.5	MHz
Operating supply voltage	1.8	—	3.6	V
Data rate (programmable)	1.2	—	500	kBaud
Output power (programmable)	-30	—	1	dBm
Current consumption				
Current consumption, TX, 0 dBm	—	19.4	—	mA
Current consumption, TX, -12 dBm	—	11.2	—	mA
Current consumption, power down	—	<1	—	µA



CC2510

System-on-Chip RF solution CC2510F8/F16/F32

Get samples, datasheets, evaluation modules and application notes at: www.ti.com/sc/device/CC2510F8

The CC2510Fx is a true System-on-Chip device designed for low-power and low-voltage wireless communication applications. The CC2510Fx combines the excellent performance of the CC2500 RF transceiver with an industry-standard enhanced 8051 MCU, 8/16/32 kB of in-system programmable Flash memory, 1/2/4 kB of RAM and many other powerful peripherals.

Key features

- High-performance, low-power 8051 MCU core with in-system programmable Flash and SRAM
- Four flexible power modes for reduced power consumption and very fast transition times from sleep modes to active mode
- Excellent selectivity and out-of-band blocking performance, and AES-128 encryption coprocessor
- 2-FSK, GFSK, MSK, OOK

Benefits

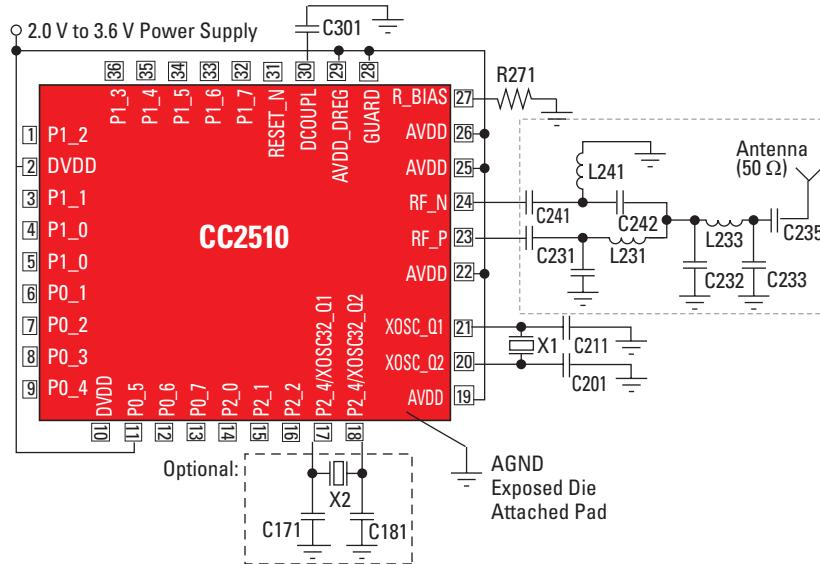
- Complete solution on single chip
- Ideal for low-power, battery operated systems
- Robust and secure link with very good coexistence

Applications

- Consumer electronics
- Wireless keyboard/mouse
- Wireless gaming accessories
- Wireless voice audio
- Sports and leisure equipment
- Remote controls

Development tools and software

- CC2510/CC2511DK Development Kit
- CC2510EMK Evaluation Module Kit
- SimpliciTI™ Software Protocol



For sub-1 GHz alternative, see CC1110 page 7.

General characteristics

Parameter	Min	Typ	Max	Unit	Condition
Operating conditions					
Frequency range	2400	—	2483.5	MHz	
Operating temperature range	-40	—	+85	°C	
Operating supply voltage	2.0	—	3.6	V	
Data rate (programmable)	1.2	—	500	kBaud	
Output power (programmable)	-30	—	1	dBm	
Receiver sensitivity, 2.4 kBaud	—	-103	—	dBm	2-FSK, 203-kHz RX filter bandwidth, 1% PER
Receiver sensitivity, 250 kBaud	—	-90	—	dBm	2-FSK, 540-kHz RX filter bandwidth, 1% PER
Current consumption					
MCU active and RX mode	—	17.4	—	mA	MCU running at full speed (26 MHz), radio in RX mode 2.4 kBaud
MCU active and TX mode, 0 dBm	—	26	—	mA	MCU running at full speed (26 MHz), radio in TX mode, 0-dBm output power
Power mode 2	—	0.5	1	µA	32-kHz RC oscillator (or 32.768-kHz crystal oscillator), sleep timer running and digital regulator off
Power mode 3	—	0.3	1	µA	No clocks running, digital regulator off
Wake-up and timing					
From power mode 2 or 3 to active	—	100	—	µs	Digital regulator and high-speed oscillators off, Start-up of regulator and high-speed RC oscillator
From power mode 1 to active	—	4	—	µs	Digital regulator on and high-speed oscillator off 32-kHz RC oscillator (or 32.768-kHz crystal oscillator) running



System-on-Chip with integrated full-speed USB-certified controller

CC2511F8/F16/F32

Get samples, datasheets, evaluation modules and application notes at: www.ti.com/sc/device/CC2511F8

The CC2511Fx is a powerful 2.4-GHz System-on-Chip that includes a full-speed USB controller. These unique ICs shorten time to market and allow designers to build tiny USB devices that communicate wirelessly with PC peripherals.

Key features

- Full-speed USB with 1-kB USB FIFO, 12 Mbps transfer rate, 5 bidirectional endpoints with support for bulk, interrupt and isochronous transfers
- High-performance, low-power 8051 MCU core with in-system programmable Flash, SRAM and full-speed USB controller
- Four flexible power modes for reduced power consumption and very fast transition times from sleep modes to active mode
- Excellent selectivity and out-of-band blocking performance, and AES-128 encryption coprocessor
- 2-FSK, GFSK, MSK, OOK

Benefits

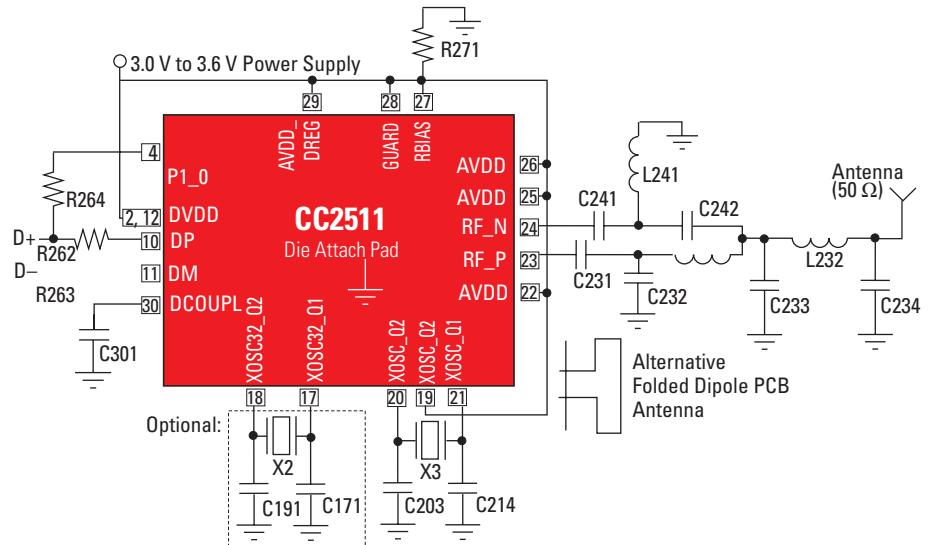
- Complete solution on single chip
- Ideal for low-power, battery-operated systems
- Robust and secure link with very good coexistence

Applications

- Consumer electronics
- Wireless keyboard/mouse
- Wireless gaming accessories
- Wireless voice audio
- Sports and leisure equipment
- RF-enabled remote controls

Development tools and software

- CC2510/CC2511DK Development Kit
- CC2511EMK Evaluation Module Kit
- SimpliciTI™ Software Protocol



For sub-1 GHz alternative, see CC1111 on page 8.

General characteristics

Parameter	Min	Typ	Max	Unit	Condition
Operating conditions					
Frequency range	2400	—	2483.5	MHz	
Operating temperature range	0	—	+85	°C	
Operating supply voltage	3.0	—	3.6	V	
Data rate (programmable)	1.2	—	500	kbps	
Output power (programmable)	-30	—	1	dBm	
Receiver sensitivity, 2.4 kBaud	—	-103	—	dBm	2-FSK, 203-kHz RX filter bandwidth, 1% PER
Receiver sensitivity, 250 kBaud	—	-90	—	dBm	2-FSK, 540-kHz RX filter bandwidth, 1% PER
Current consumption					
MCU active and RX mode	—	17.4	—	mA	MCU running at full speed (26 MHz), radio in RX mode 2.4 kBaud
MCU active and TX mode, 0 dBm	—	26	—	mA	MCU running at full speed (2 MHz), radio in TX mode, 0-dBm output power
Power mode 2	—	0.5	1	μA	32-kHz RC oscillator (or 32.768-kHz crystal oscillator), sleep timer running and digital regulator off
Power mode 3	—	0.3	1	μA	No clocks running, digital regulator off
Wake-up and timing					
From power mode 2 or 3 to active	—	100	—	μs	Digital regulator and high-speed oscillators off, start-up of regulator and high-speed RC oscillator
From active to RX or TX	—	4	—	μs	Digital regulator on and high-speed oscillator off, 32-kHz RC oscillator (or 32.768-kHz crystal oscillator) running

→ CC2590, CC2591

2.4 GHz RF front end

CC2590, CC2591

Get samples, datasheets, evaluation modules and application notes at: www.ti.com/sc/device/CC2590
and www.ti.com/sc/device/CC2591

CC2590 and CC2591 are 2.4-GHz range extenders specially designed for all existing and future 2.4-GHz RF transceivers and System-on-Chip solutions from TI. CC2590/CC2591 increase the link budget by providing a power amplifier for improved output power and an LNA with low noise figure for improved receiver sensitivity. They contain PA, LNA, switches, RF-matching, and balun for simple design of high-performance wireless applications.

Key features

CC2590

- Up to +14-dBm output power
- 22-mA transmit current at 3 V at +12-dBm output power
- 4.6-dB LNA noise figure including RX/TX switch and antenna match

CC2591

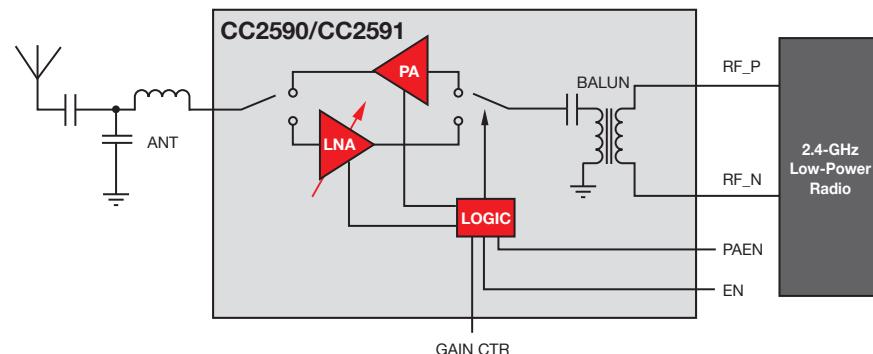
- Up to +22-dBm output power
- Up to +28-dB increased link budget
- 112-mA transmit current at 3 V at +20-dBm output power
- 4.8-dB LNA noise figure including RX/TX switch

CC2590/CC2591

- Seamless interface to TI's 2.4-GHz Low-Power RF devices
- 6-dB typ improved sensitivity on CC24xx, CC2500, CC2510 and CC2511
- Very few external components: integrated PA, LNA, switches, inductors, balun and matching network
- Low receive current: 3.4 mA in HIGH gain mode, 1.7 mA in LOW gain mode
- 100 nA in power down
- Digital control of LNA gain by HGM pin
- Packaging: RoHS-compliant, 4x4 mm QFN-16

Development tools

- CC2590EMK Evaluation Module Kit
- CC2430-CC2590EMK Evaluation Module Kit
- CC2591EMK Evaluation Module Kit



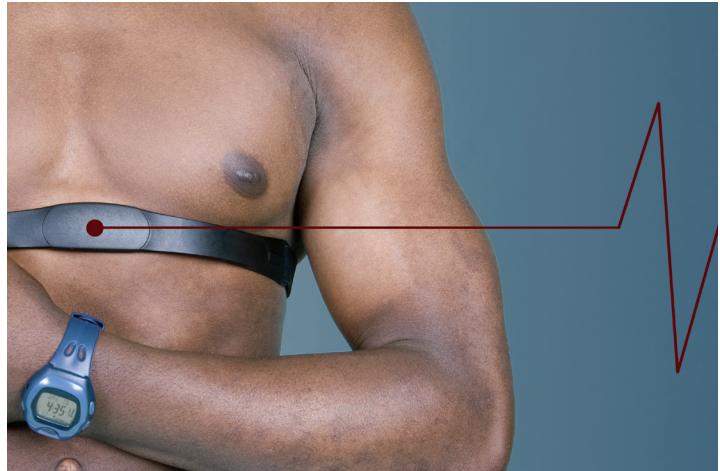
CC2590/CC2591 block diagram.

CC2590 general characteristics

Parameter	Min	Typ	Max	Unit
Supply range	2.0	—	3.6	V
Frequency range	2400	—	2483.5	MHz
Ambient temperature range	-40	—	85	°C
Power down current	—	0.1	0.3	µA
RX mode				
Receive current, high gain mode	—	3.4	4	mA
Receive current, low gain mode	—	1.8	2	mA
Gain, high gain mode	—	11.4	—	dB
Gain, low gain mode	—	0	—	dB
Input, 1-dB compression, high gain mode	—	-21	—	dB
Noise figure, high gain mode	—	4.6	—	dB
TX mode				
Transmit current, 12-dBm output power	—	22	—	mA
Output power	—	12	—	dBm
Power added efficiency, PAE	—	23	—	%
Output 1-dB compression	—	10.4	—	dBm

CC2591 general characteristics

Parameter	Min	Typ	Max	Unit
Supply range	2.0	—	3.6	V
Frequency range	2400	—	2483.5	MHz
Ambient temperature range	-40	—	85	°C
Power down current	—	0.1	0.3	µA
RX mode				
Receive current, high gain mode	—	3.4	4	mA
Receive current, low gain mode	—	1.7	2	mA
Gain, high gain mode	—	11	—	dB
Gain, low gain mode	—	1	—	dB
Noise figure, high gain mode	—	4.8	—	dB
Input, 1-dB compression, high gain mode	—	-17	—	dB
TX mode				
Transmit current, 20-dBm output power	—	100	—	mA
Output power	—	20	—	dBm
Power added efficiency, PAE	—	33	—	%
Output 1-dB compression	—	19	—	dBm



Why Bluetooth low energy:

Compared to classic *Bluetooth*-enabled products, *Bluetooth* low energy enables the use of coin cells and energy harvesting solutions where applications can operate more than a year on a tiny button cell battery without recharging.

Dual-mode vs single-mode:

Dual-mode devices can communicate with legacy *Bluetooth* as well as *Bluetooth* low energy devices and supports both protocols. Single-mode devices only support *Bluetooth* low energy and is optimized for low-power, low-cost solutions.

Why *Bluetooth* low energy from TI:

- TI provides both dual-mode and single-mode solutions.
- TI has demonstrated the world's first single-chip (controller, host and application on one 6x6mm device) single-mode *Bluetooth* low energy device
- TI has announced a \$99 single-mode *Bluetooth* low energy development kit and a royalty-free protocol stack

CC2540 *Bluetooth* low energy features and benefits:

- | | |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> - One-chip integrated solution - Flash-based - Complete solution - Ultra-low power consumption | <ul style="list-style-type: none"> Lower cost and smaller physical size Flexibility for developers Device firmware can be updated in the field if necessary Persistent data can be stored on-chip TI provides IC, protocol stack, basic profile software and applications support Very long battery life Can use coin cells or alkaline batteries, no need for rechargeable batteries |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Application areas:

Sports and fitness equipment

Medical and health

Mobile accessories

www.ti.com/bluetoothlowenergy



ZigBee Overview

ZigBee/IEEE 802.15.4

ZigBee enables companies to have a simple, reliable, low-power, worldwide wireless public standard optimized for the unique needs of remote monitoring and control applications.

ZigBee mesh networking

ZigBee supports self-healing mesh networking which is a decentralized network topology very similar to the Internet. It allows nodes to find new routes throughout the network if one route fails making ZigBee a very robust solution.

Application areas

ZigBee 802.15.4 can be used in any monitoring and control application that requires a wireless link:

- Home, building and industrial automation
- Energy harvesting
- Home control/security
- Medical/patient monitoring
- Logistics and asset tracking
- Sensor networks and active RFID

- Advanced metering
- Commercial building automation

Z-Stack™ – TI's industry leading ZigBee protocol stack

Z-Stack supports ZigBee-2007, including both the ZigBee and ZigBee PRO feature sets and smart energy and supports multiple platforms, including the CC2430 System-on-Chip, CC2431 System-on-Chip with location engine and CC2520 + MSP430 platform.

TI's newest version of Z-Stack introduces a new application feature called SimpleAPI. SimpleAPI has only 10 API calls to learn, which drastically simplifies the development of ZigBee applications. Z-Stack features include:

- SimpleAPI
- Z-Stack protocol stack extensions
- Z-Tool™ (debug tool)

**For more information on TI's ZigBee software offering, see page 29.*

ZigBee RF4CE

ZigBee® RF4CE is designed for a wide range of remotely-controlled audio/visual consumer electronics products to enable RF communication between remote controls, TVs and set-top boxes.

RemoTI™ is TI's solution for ZigBee RF4CE and is a complete solution offering hardware and software support for TI's Low-Power RF product portfolio.

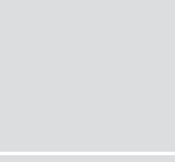
For more information on ZigBee RF4CE and RemoTI see page 26.

Three paths to ZigBee

TI offers three ZigBee-compliant platforms for all its IEEE 802.15.4 radios to provide designers with a solution where only the application needs to be added.

All three solutions are built on the CC2420/CC2520 radio and feature excellent coexistence.

These compliant platforms will shorten time to market and simplify system design and ZigBee end-product certification.

Complete ZigBee® Solution	System-on-chip Small footprint High integration Low cost	Co-processor Flexible Easy to use Reduced time to market	Dual-chip Ultra low-power or High performance
Application	CC2530/1	Any Processor (e.g. MSP430 or Stellaris ARM)	MSP430 or Stellaris™ ARM
Protocol stack		CC2530/1 based co-processor with embedded stack and uart/spi/usb interface	
Radio		CC2520	
RF front end (optional)	CC2590 / CC2591	CC2590 / CC2591	CC2590 / CC2591



RF transceiver for IEEE 802.15.4/ZigBee

CC2420

Get samples, datasheets, evaluation modules and application notes at: www.ti.com/sc/device/CC2420

The CC2420 is the leading ZigBee/IEEE 802.15.4 RF transceiver on the market designed specifically for low-power, low-voltage RF applications in the 2.4-GHz unlicensed ISM band. It exceeds the standard's requirements for selectivity and ensures long communication range as well as effective, reliable communication.

Key features

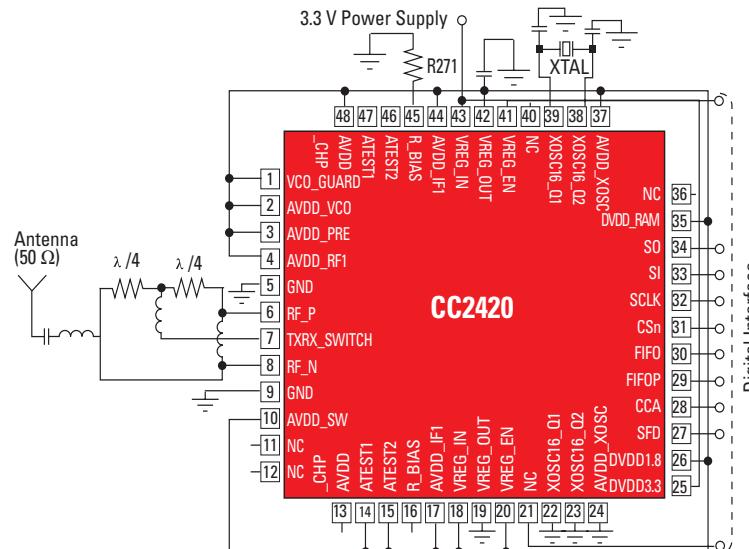
- True single-chip 2.4-GHz IEEE 802.15.4/ZigBee RF transceiver
- Very few external components required
- No external RF switch/filter needed
- Packet handling with RX and TX data buffering
- Digital RSSI/LQI support
- Hardware MAC encryption and authentication (AES-128)
- Low current consumption:
 - RX: 18.8 mA, TX: 17.4 mA
- Low supply voltage with internal voltage regulator:
 - 2.1 V to 3.6 V
- Programmable output power
- Excellent selectivity and blocking performance
- DSSS modem with 2M chips/s and 250-kbps effective data rate
- Packaging: QLP-48 7x7 mm

Benefits

- Low system cost and small footprint
- Hardware support offloads microcontroller
- Excellent coexistence with Bluetooth® and WiFi

Applications

- Home and building automation
- Industrial monitoring and control
- Sensor networks
- Consumer electronics



CC2420 functional block diagram.

Development tools and software

- CC2420DK Development Kit
- CC2420ZDK ZigBee Development Kit
- CC2420+MSP430 ZigBee/IEEE 802.15.4 Development Kit
- CC2420EMK ZigBee/IEEE 802.15.4 Evaluation Module Kit
- Z-Stack™ Software
- TIMAC
- SimpliciT™ Software Protocol

General characteristics

Parameter	Min	Typ	Max	Unit
Operating conditions				
Frequency range	2400	—	2483.5	MHz
Data rate	—	250	—	kBaud
Operating voltage	2.1	—	3.6	V
Operating temperature	-40	—	85	°C
Nominal output power in TX mode	0	—	—	dBm
RX mode				
Receiver sensitivity	-95	—	dBm	—
Adjacent channel rejection, + 5 MHz	45	—	dB	—
Adjacent channel rejection, - 5 MHz	30	—	dB	—
Adjacent channel rejection, + 10 MHz	54	—	dB	—
Adjacent channel rejection, - 10 MHz	53	—	dB	—
Channel rejection >±15 MHz	62	—	dB	—
Current consumption:				
Current consumption, RX	—	18.8	—	mA
Current consumption, TX, -10 dBm	—	11	—	mA
Current consumption, TX, -5 dBm	—	14	—	mA
Current consumption, TX, 0 dBm	—	17.4	—	mA
Current consumption, voltage regulator off	—	0.02	1	mA

→ CC2430

RF System-on-Chip for IEEE 802.15.4/ZigBee

CC2430F32/F64/F128

Get samples, datasheets, evaluation modules and application notes at: www.ti.com/sc/device/CC2430

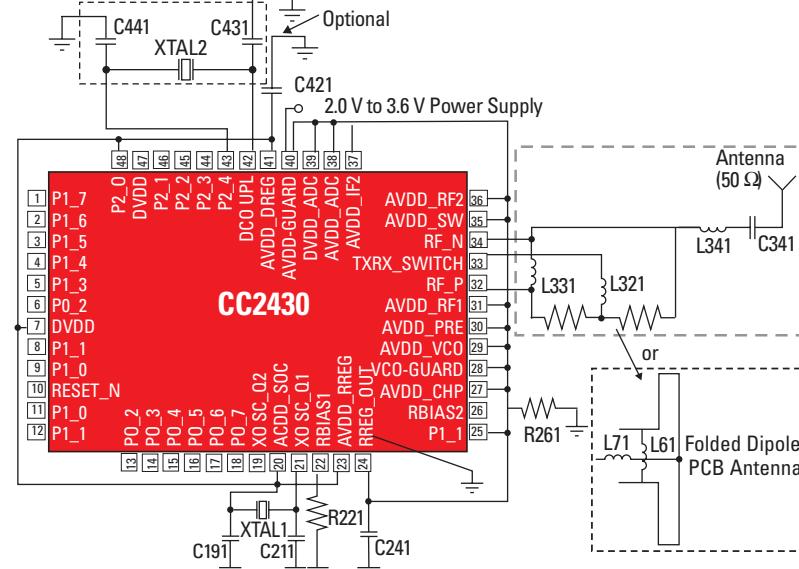
The CC2430 is a true System-on-Chip solution for ZigBee and combines the excellent performance of the leading CC2420 RF transceiver with an industry-standard enhanced 8051 MCU, 32/64/128-kByte Flash, 8 kB of RAM and many other powerful features. Combined with TI's leading ZigBee protocol stack (Z-Stack™), the CC2430 is the market's most competitive ZigBee solution.

Key features

- 32-MHz, single-cycle, low-power 8051 MCU
- Four flexible power modes for reduced power consumption
- 8-kByte SRAM, 4 kByte with data retention in all power modes
- One IEEE 802.15.4 MAC timer, one general 16-bit timer and two 8-bit timers
- Digital RSSI/LQI support
- Hardware AES encryption engine
- 2.4-GHz IEEE 802.15.4 compliant RF transceiver
- 32/64/128-kByte in-system programmable Flash
- Industry leading ZigBee protocol stack (Z-Stack) available
- Excellent selectivity and blocking performance
- DSSS modem with 2M chips/s and 250-kBaud effective data rate
- Packaging: QLP-48 RoHS-compliant, 7x7 mm QLP-48

Benefits

- Ultra-low power, ideal for battery-operated systems
- Hardware support offloads microcontroller
- Flexible solution that fits both IEEE 802.15.4 and ZigBee applications
- Excellent coexistence with Bluetooth® and WiFi
- Very small footprint
- Very few external components required



CC2430 functional block diagram.

Applications

- Home and building automation
- Industrial monitoring and control
- Sensor networks
- Intelligent toys
- Consumer electronics

Development tools and software

- CC2430DK Development Kit
- CC2430ZDK ZigBee Development Kit
- CC2430EMK Evaluation Module Kit
- Z-Stack™ Software
- TIMAC
- SimpliciT™ Software Protocol
- RF4CE

General characteristics

Parameter	Min	Typ	Max	Unit	Condition
Operating conditions					
Frequency range	2400	—	2483.5	MHz	
Operating temperature range	-40	—	+85	°C	
Operating supply voltage	2.0	—	3.6	V	
Radio bit rate	—	250	—	kBaud	
Receiver sensitivity	—	-92	—	dBm	
Adjacent channel rejection (+5 MHz/-5 MHz)	—	41/30	—	dB	
Alternate channel rejection (+10 MHz/-10 MHz)	55/53	—	—	dB	
Interfering channel rejection (+15 MHz/-15 MHz)	55/53	—	—	dB	
Nominal output power in TX mode	—	0	—	dBm	
Current consumption					
MCU active and RX mode	—	27	—	mA	MCU running at full speed (32 MHz), radio in RX mode
MCU active and TX mode, 0 dBm	—	27	—	mA	MCU running at full speed (32 MHz), radio in TX mode, 0-dBm output power
Power mode 2	—	0.5	—	μA	32-kHz oscillator and sleep time running
Power mode 3	—	0.3	—	μA	No clocks running, power on reset (POR) active, can wake-up on external interrupt.
Wake-up and timing					
From power mode 2 or 3 to active	—	120	—	μs	



RF System-on-Chip with location engine for IEEE 802.15.4/ZigBee

CC2431

Get samples, datasheets, evaluation modules and application notes at: www.ti.com/sc/device/CC2431

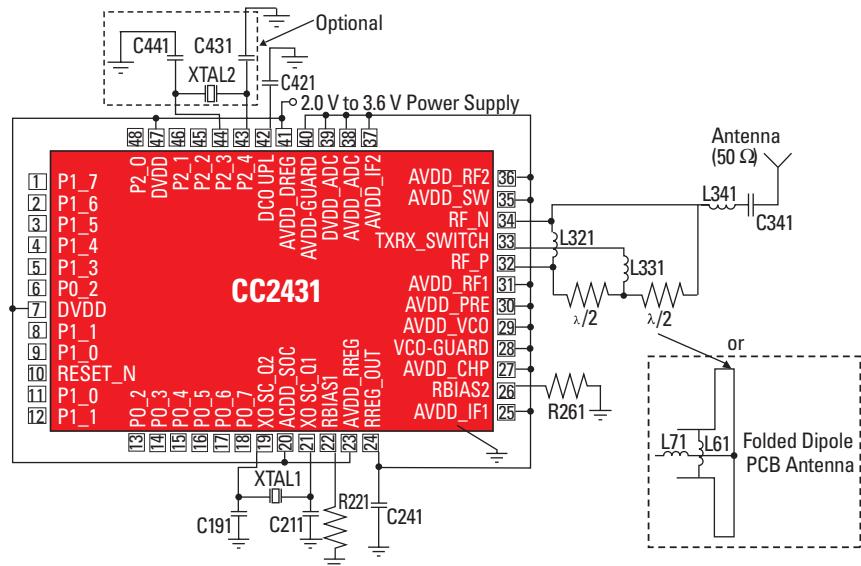
The CC2431 with location engine is a true System-on-Chip for ZigBee/IEEE 802.15.4 wireless sensor networking solutions. It combines the excellent performance of the industry leading CC2420 RF transceiver with an enhanced 8051 MCU, 8-kB RAM, 128-kB Flash, memory and many other powerful features. The CC2431 is the market's most competitive solution for low-power wireless sensor networking.

Key features

- RSSI-based flexible location engine
- Fully pin compatible with CC2430
- 32-MHz single-cycle low-power 8051 MCU
- Four flexible power modes for reduced power consumption
- 8-kB SRAM, 4 kB with data retention in all power modes
- One IEEE 802.15.4 MAC timer, one general 16-bit timer and two 8-bit timers
- Digital RSSI/LQI support
- Hardware AES encryption engine
- 2.4-GHz IEEE 802.15.4 compliant RF transceiver
- 128-kB in-system programmable Flash
- Industry leading ZigBee protocol stack (Z-Stack™) available
- Excellent selectivity and blocking performance
- DSSS modem with 2M chips/s and 250-kBps effective data rate
- Very few external components required
- Packaging: RoHS-compliant, 7x7 mm QLP-48

Benefits

- Same hardware/module as for CC2430 can be used
- Ultra-low power, ideal for battery-operated systems
- Hardware support offloads MCU
- Flexible solution that fits both IEEE 802.15.4 and ZigBee applications
- Excellent coexistence with Bluetooth® and WiFi
- Very small footprint



CC2431 functional block diagram.

Applications

- Asset tracking
- Inventory control
- Container/pallet tracking
- Security
- Access and control systems
- Commissioning networks

General characteristics

See CC2430 page 20 for general characteristics

Location Engine	Min	Typ	Max	Unit	Condition
Location range	—	—	—	—	64 m x 64 m
Reference node location resolution	0.25	—	—	m	
RSSI resolution	0.5	—	—	dB	
Number of reference nodes used in calculation	3	—	16	—	
Location error	—	3	—	m	The recommended density of 3 m reference nodes is one per 100 m ²

Development tools and software

- CC2431DK Development Kit
- CC2431ZDK ZigBee Development Kit
- CC2431EMK Evaluation Module Kit
- Z-Stack™ Software
- TIMAC
- SimpliciTITM Software Protocol

→ CC2520

RF transceiver for IEEE 802.15.4/ZigBee CC2520

Get samples, datasheets, evaluation modules and application notes at: www.ti.com/sc/device/CC2520

The CC2520 is TI's second generation ZigBee/IEEE 802.15.4 RF transceiver for the 2.4-GHz unlicensed ISM band. This chip enables industrial-grade applications by offering state-of-the-art noise immunity, excellent link budget, operation up to 125°C and low-voltage operation.

In addition, the CC2520 provides extensive hardware support for packet handling, data buffering, burst transmissions, data encryption, data authentication, clear channel assessment, link quality indication and packet timing information. These features reduce the load on the host controller.

Key features

- State-of-the-art noise immunity with minimum 48-dB adjacent channel rejection
- Excellent link budget (103 dB)
- Extended temp range (-40°C to +125°C)
- Extensive IEEE 802.15.4 MAC hardware support
- CC2420 interface compatibility mode
- AES-128 security module

Benefits

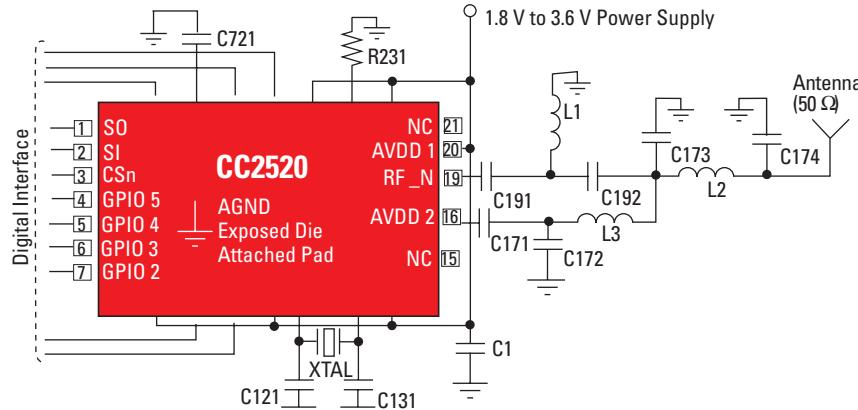
- Enables industrial applications in the 2.4-GHz ISM band
- Excellent coexistence with Bluetooth® and WiFi
- Hardware support offloads MCU

Applications

- Industrial monitoring and control
- Home and building automation
- Low-power wireless sensor networks
- Set-top boxes and remote controls

Development tools and software

- CC2520DK Development Kit
- Z-Stack™ Software
- TIMAC
- SimpliciTI™ Software Protocol



CC2520 functional block diagram.

General characteristics

Parameter	Min	Typ	Max	Unit
Operating conditions				
Frequency range	2394	2483.5	2507	MHz
Data rate	—	250	—	kBaud
Operating voltage	1.8	—	3.6	V
Operating temperature	-40	—	125	°C
Output power	-18	—	5	dBm
RX mode				
Receiver sensitivity	—	-98	—	dBm
Adjacent channel rejection, +5 MHz	—	49	—	dB
Adjacent channel rejection, -5 MHz	—	49	—	dB
Adjacent channel rejection, +10 MHz	—	54	—	dB
Adjacent channel rejection, -10 MHz	—	54	—	dB
Current consumption				
Current consumption, RX	—	22	—	mA
Current consumption, TX, +5 dBm	—	33	—	mA
Current consumption, TX, 0 dBm	—	25	—	mA
Current consumption, power down	—	<1	—	µA



NEW

2.4-GHz IEEE 802.15.4/ZigBee®/RF4CE System-on-Chip solution CC2530

Get samples, evaluation modules and application notes at: www.ti.com/sc/device/CC2530

The CC2530 is a cost-effective, low power, and true System-on-Chip solution specifically tailored to IEEE 802.15.4, ZigBee, and RF4CE applications.

The CC2530 comes in four different versions: CC2530-F32/64/128/256, with 32/64/128/256-KB flash memory respectively and combines a fully integrated high-performance RF transceiver with an industry-standard enhanced 8051 MCU, 8-KB RAM and other powerful supporting features and peripherals.

Key features

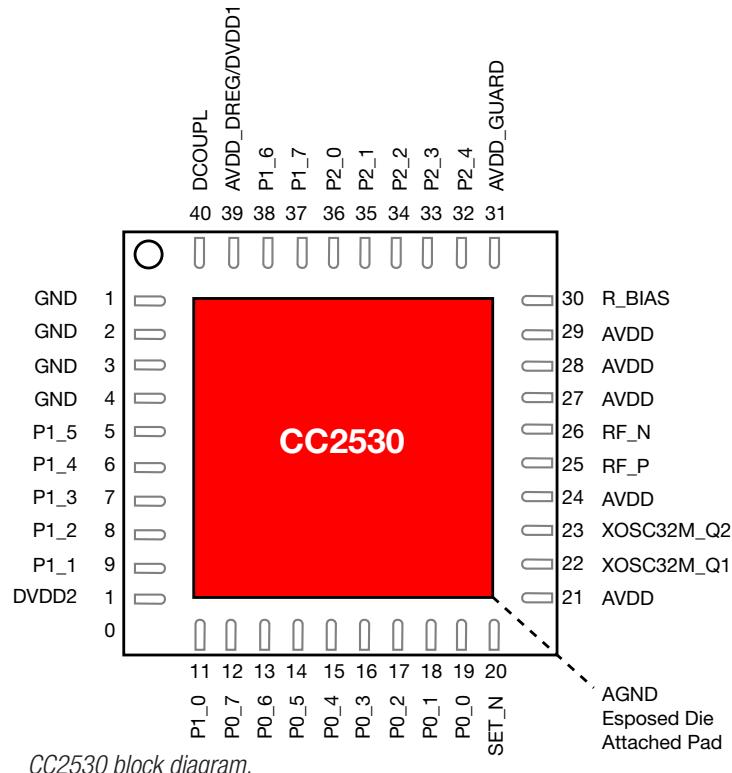
- Up to 256-kB flash with 20K erase cycles to support over-the-air updates, large applications
- 8-kB RAM for more complex applications and ZigBee profiles
- Programmable output power up to +4.5 dBm
- Less than 1- μ A current consumption in power down with sleep timer running
- Includes powerful address recognition and packet processing engine

Key benefits

- Supports ZigBee/ZigBee PRO, ZigBee RF4CE, 6LoWPAN, WirelessHART, and all 802.15.4-based solutions
- Excellent receiver sensitivity and programmable output power
- Very low current consumption in RX, TX, and multiple low-power modes ensure long battery lifetime
- Best-in-class selectivity and blocking performance (50-dB ACR)

Applications

- Smart energy/automated meter reading
- Remote controls
- Home/building automation
- Consumer products
- Industrial control and monitoring
- Low-power wireless sensor networks



General characteristics

Parameter	Min	Typ	Max	Unit
Operating conditions				
Frequency range	2400	—	2483.6	MHz
Operating temperature range	-40	—	125	°C
Operating supply voltage	2.0	—	3.6	V
Radio bit rate	—	250	—	kBaud
Receiver sensitivity	—	-97	—	dBm
Adjacent channel rejection	—	49/49	—	dB
Alternate channel rejection	—	57/57	—	dB
Blocking	—	57/57	—	dB
Nominal output power in TX mode	—	+4.5	—	dBm
Current consumption				
MCU active and RX mode	—	25	—	mA
MCU active and TX mode, +4 dBm	—	34	—	mA
Power mode 1	—	105	—	μA
Power mode 2	—	1	—	μA
Power mode 3	—	0.4	—	μA
Wake-up and timing				
From power mode 2 or 3 to active	—	120	—	μs
From active to RX or TX	—	192	—	μs



CC2531

2.4 GHz USB enabled IEEE 802.15.4/ZigBee/RF4CE System-on-Chip solution

CC2531

NEW

Get samples, evaluation modules and application notes at: www.ti.com/sc/device/CC2531

The CC2531 is a USB enabled SoC solution for IEEE 802.15.4, ZigBee and RF4CE applications which enables USB dongles or USB upgradable network nodes to be built with low total bill-of-material costs. The CC2531 combines the performance of a leading RF transceiver with an industry-standard enhanced 8051 MCU, in-system programmable flash memory, 8-KB RAM, and many other powerful features. Combined with the golden-unit-status RemoTI (RF4CE) and Z-Stack (ZigBee PRO) from TI, the CC2531 provides a robust and complete ZigBee USB dongle or firmware upgradable network node.

Key features

- Up to 256 Kb Flash / 8Kb of RAM
- Excellent link budget (101.5 dB)
- 49dB adjacent channel rejection (best in class)
- Four flexible power modes
- Extended temperature range: -40 to +125 degrees C
- AES-128 security module
- Fully compatible with the CC259x range extenders

USB

- USB 2.0 certified full speed device (12 Mbps)
- 5 highly flexible endpoints
- 1-KB dedicated FIFO
- No 48-MHz crystal required
- Certified CC2531 USB dongle reference design

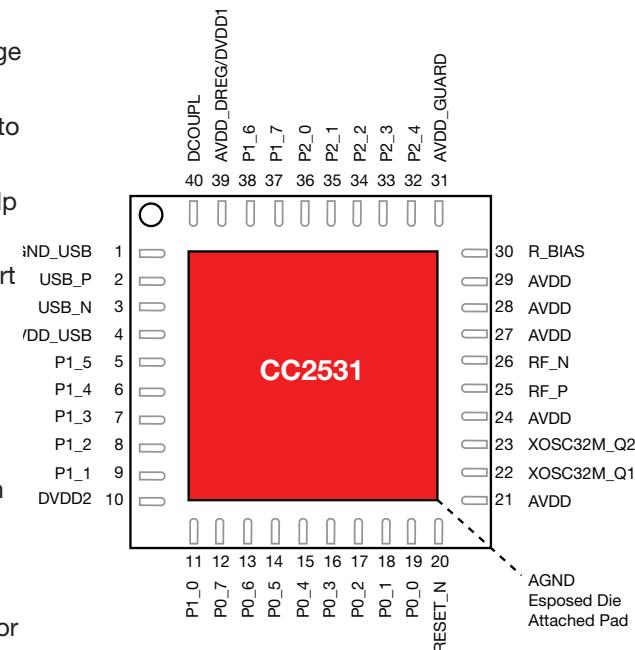
Key benefits

- 2X FLASH over closest competitor
- Supports ZigBee PRO, ZigBee RF4CE, and more
- 400m+ LOS range with CC2530EM dev boards
- 12dB better than closest competitor filters interference from a jammer over 4x closer
- Lowest current consumption power down mode for long battery life low duty-cycle applications
- Widest temperature range for superior robustness

- Efficient security takes up little FLASH or MCU cycles
- Reduced part list and lower BOM cost
- Ideal for Gateway or Bridge device
- Simple low-cost solution to 1000+ meter range
- Allows smaller PCB to help miniaturize product
- Provides legacy IR support with no added cost

Applications

- Smart energy/automated meter reading
- Remote controls
- Home/building automation
- Consumer products
- Industrial control and monitoring
- Low-power wireless sensor networks



CC2531 block diagram.

General characteristics

Parameter	Min	Typ	Max	Unit
Operating conditions				
Frequency range	2400	—	2483.6	MHz
Operating temperature range	-40	—	125	°C
Operating supply voltage	2.0	—	3.6	V
Radio bit rate	—	250	—	kBaud
Receiver sensitivity	—	-97	—	dBm
Adjacent channel rejection	—	49/49	—	dB
Alternate channel rejection	—	57/57	—	dB
Blocking	—	57/57	—	dB
Nominal output power in TX mode	—	+4.5	—	dBm
Current consumption				
MCU active and RX mode	—	25	—	mA
MCU active and TX mode, +4 dBm	—	34	—	mA
Power mode 1	—	105	—	µA
Power mode 2	—	1	—	µA
Power mode 3	—	0.4	—	µA
Wake-up and timing				
From power mode 2 or 3 to active	—	120	—	µs
From active to RX or TX	—	192	—	µs



ZigBee® Processor

CC2480

Get samples, datasheets and application notes at: www.ti.com/sc/device/cc2480a1

The CC2480 is a cost-effective and simple-to-use 2.4-GHz RF ZigBee front end. It is ideal for application developers that have their own MCU preference and want to add ZigBee functionality, without having to learn the complexities of a full ZigBee stack.

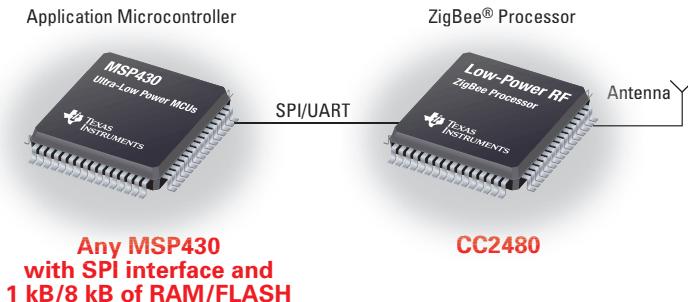
The ZigBee processor communicates to the host processor via an SPI or UART command interface. The host processor converses with the ZigBee processor using an easy-to-use protocol.

Key features

- Easy-to-use ZigBee processor
- Integrated 2.4-GHz, IEEE 802.15.4 compliant radio
- Integrated ZigBee 2006 compliant stack
- Supports TI's Z-Stack™ Software and SimpleAPI
- Excellent radio performance
- Low power consumption, very few low-cost external components needed
- Packaging: RoHS-compliant, 7x7 mm QLP-48

Benefits

- Shorten time to market
- Lower development cost
- Enable system partitioning: the ZigBee processor handles all network related activities while the host MCU can focus on the application
 - Easy integration with existing systems
 - Short development time
- Very good coexistence with Bluetooth® and Wifi
- Very few external components needed



Applications

- Home and building automation
- Industrial monitoring and control
- Sensor networks
- Intelligent toys
- Consumer electronics

Development tools

- eZ430-RF2480 Evaluation Module

→ ZigBee RF4CE - RemoTI™ Network Protocol

RemoTI™ Change infrared to RF with RemoTI

ZigBee® RF4CE is designed for a wide range of remotely-controlled audio/visual consumer electronics products to enable RF communication between remote controls, TVs and set-top boxes.



RemoTI Network Protocol from Texas Instruments

The RemoTI Network Protocol is the industry leading ZigBee RF4CE software architecture and provides a complete solution for developing ZigBee RF4CE compliant products with TI's industry leading CC2530 IEEE/802.15.4 System-on-Chip. The RemoTI Network Protocol provides:

- A low-cost feature-enriched solution for ZigBee RF4CE products with TI's best-in-class CC2530 System-on-Chip
- Full application profile support in an easy-to-use package
- Four flexible power modes drawing as little as $0.4\mu\text{A}$ in quiescent mode thus reducing power consumption and extending system lifetime for battery powered devices
- Extensive worldwide support and tools to ensure development of ZigBee RF4CE-based products is simple, fast and can be completed at minimal cost

RemoTI development kits:

- Simple remote control form factor
- Easy-to-use receiver board w/PC interface and GUI
- Legacy IR support
- Suite of development tools available

www.ti.com/rf4ce

Development Tools



TI offers a large selection of development kits and tools that enable both software and hardware designers and engineers to quickly get started with their low-power RF devices.

The table below gives an overview of the development kits available for each of the LPRF RF ICs.

Development tools

Part number	Development kit (DK)	Evaluation module kit (EMK)	Other compatible mother boards
CC1020	CC1020-CC1070DK433 CC1020-CC1070DK868	CC1020EMK433 CC1020EMK868	—
CC1070	CC1020-CC1070DK433 CC1020-CC1070DK868	CC1070EMK433 CC1070EMK868	—
CC1101	CC1101DK433 CC1101DK868-915	CC1101EMK433 CC1101EMK868-915	MSP430FG4618 Exp Board MSP430F5438 Exp Board*
CC1150	—	CC1150EMK433 CC1150EMK868	MSP430FG4618 Exp Board MSP430F5438 Exp Board*
CC1110	CC1110-CC1111DK	CC1110EMK433 CC1110EMK868-915	—
CC1111	CC1110-CC1111DK	CC1111EMK868-915	—
CC2500	CC2500-CC2550DK	CC2500EMK	MSP430FG4618 Exp Board MSP430F5438 Exp Board*
CC2550	CC2500-CC2550DK	CC2550EMK	MSP430FG4618 Exp Board MSP430F5438 Exp Board*
CC2510	CC2510-CC2511DK	CC2510EMK	—
CC2511	CC2510-CC2511DK	CC2511EMK	—
	—	—	—
CC2520	CC2520DK	CC2520EMK	MSP430F5438 Exp Board*
CC2430	CC2430DK CC2430ZDK CC2430DBK	CC2430EMK	—
CC2431	CC2431DK CC2431ZDK	CC2431EMK	—
CC2530	CC2530-CC2531DK CC2530ZDK	CC2530EMK	—
CC2531	CC2530-CC2531DK	CC2531EMK	—
CC2590	—	CC2590EMK CC2430-CC2590EMK	—
CC2591	—	CC2591EMK CC2430-CC2591EMK CC2520-CC2591EMK	—

*Not released yet

eZ430-RF development tools

Part number	Description
eZ430-RF2500	Low-cost development tool with CC2500 and MSP430F2274
eZ430-RF2480	Low-cost ZigBee demonstration and development tool with a CC2480 ZigBee network processor and MSP430F2274

PC tools

Part number	Description
SmartRF™ Studio	Application for controlling the RF ICs from the PC and to find appropriate register settings for the radio.
RF Protocol Packet Sniffer	Simple packet sniffer application. Communicates with an evaluation board that captures packets on the specified channel. The sniffer parses and displays the packets.
Flash Programmer	Use this application to program Intel HEX files on the System-on-Chips or to update the firmware on the evaluation boards.



Development Tools FAQ

What is a DK?

A Development Kit (DK) contains the basic hardware that is necessary to start development of an RF system. In most configurations, a development kit consists of two evaluation boards, two small RF modules, antennas and cables. The RF modules can be plugged into the evaluation board – enabling direct access to the radio's features from a PC.

What is an EMK?

An Evaluation Module Kit (EMK) is a small kit that contains two RF modules (we also call them evaluation modules) and antennas. The EMK3 is exactly the same piece of hardware that is being used in characterization of the radio, and it is possible to get the same performance from these boards as what is stated in the part's datasheet. The EMK can be ordered separately and can be used as add-ons to existing kits, compatible motherboards or other boards with matching connectors. The modules are equipped with two 2x10 sockets from Samtec (SFM-110-02-SM-D-A-K-TR) matched with headers from Samtec (TFM-110-02-SM-D-A-K-TR).

What is a DBK?

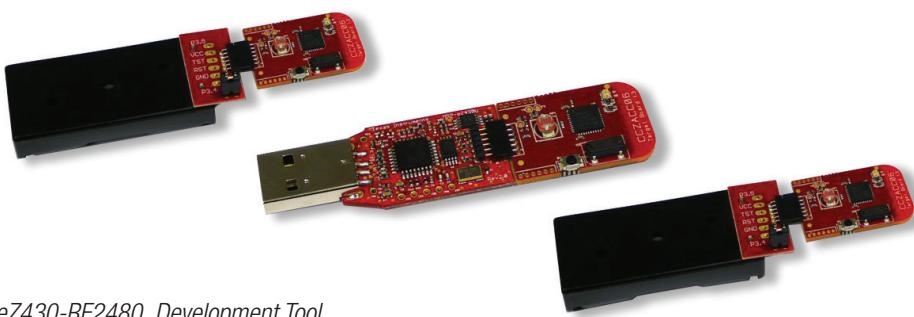
A Demonstration Board Kit (DBK) usually contains one single board with a radio and peripherals – i.e. a complete functional reference board for the device. A DBK is typically used as an additional node in ZigBee development kits.

What is a ZDK?

A ZigBee Development Kit (ZDK) is very similar to a normal development kit, but it contains more nodes and they come preprogrammed with a ZigBee demo application, giving you ZigBee directly out of the box. The ZDK also contains extended evaluation periods of several development tools and a trial version of and advanced ZigBee Network Analyzer from Daintree.

What can I do with a DK?

When the RF modules are connected to the evaluation board, it is possible to control the radio from the PC using SmartRF Studio. Most of the development kits also come preprogrammed with a Packet Error Rate



eZ430-RF2480 Development Tool.

test application, which makes it easy to perform practical range testing with the radios. In addition, the development kits are very flexible platforms and it is easy to connect your own peripherals and controllers to breakout pins on the boards. The development kit would also serve as a known good platform during test and verification of your own system.

For development kits with System-on-Chips, the evaluation boards make it possible to debug and program the chip with no additional hardware. The kit also gives access to useful user interfaces for testing of the various peripherals and capabilities of the SoC. The hardware in the kit can also be used as an RF packet sniffer.

Why do I need the EB?

The Evaluation Board (EB) is a very flexible test and development platform. It makes it easy to perform basic functional RF tests, e.g.: use SmartRF Studio + EB + EM to send packets that are received by your own system. Use your own system to send packets and receive the packets using SmartRF Studio + EB + EM.

It lets you test your own software with known good RF hardware, by simply connecting your own MCU to the EB with a radio connected.

You can also do it the other way around, by connecting the EB to your own hardware and use SmartRF Studio to exercise the RF design.

What is the MSP430 Experimenter Board?

The Experimenter Boards are versatile development boards for MSP430 with a lot of external peripherals, making it

easy to experiment and make prototypes to explore the many features of the MSP430 peripherals. These boards are also equipped with connectors for the RF evaluation modules. Note that due to the pin out of the connectors, only a subset of the evaluation modules can be used with the boards. See the table for more information. You will find schematics, software examples and Application Notes for the Experimenter's Boards on the MSP430 Development Tools web pages.

What is the difference between eZ430-RF2500 and eZ430-RF2480?

The eZ430-RF2500 has a target board with a CC2500 RF transceiver, whereas the eZ430-RF2480 has a target board with the CC2480 ZigBee network processor. The eZ430-RF2480 has three nodes (one connected to the PC and two battery operated nodes) and is preprogrammed with a simple application demonstrating a temperature sensor network using the ZigBee network protocol to send messages. The eZ430-RF2500 contains two nodes (one connected to the PC and one battery operated node) and is preprogrammed with a simple wireless sensor application using SimpliciTI™ as the RF transport layer. Both kits contain the same eZ430 emulator dongle.

Are the MSP430 Experimenter's Boards compatible with SmartRF Studio or the RF Protocol Packet Sniffer? No

Are the eZ430-RF tools compatible with SmartRF Studio or the RF Protocol Packet Sniffer? No

Software



In addition to the comprehensive hardware portfolio, TI also provides supporting software ranging from simple application examples to the ZigBee Z-Stack™ Software.

SimpliciTI™ Network Protocol www.ti.com/simpliciti

SimpliciTI is a simple low-power RF network protocol aimed at small (<256 nodes) RF networks. Such networks typically contain battery operated devices, which require long battery life, low data rate and low duty cycle. They usually have a limited number of nodes talking directly to each other or through an access point or a range extender. Access points and range extenders are not required, but provide extra functionality such as storing and forwarding messages. With SimpliciTI the MCU resource requirements are minimal which results in a low system cost.

SimpliciTI was designed for easy implementation and out-of-the-box deployment on several TI RF platforms such as the MSP430 family of low-power MCUs and the CC11xx/CC25xx transceivers and SoCs.

TIMAC – IEEE 802.15.4 medium access control software stack

www.ti.com/timac

TIMAC is ideal when you need a wireless point-to-point or point-to-multipoint solution based on a standard (e.g. multiple sensors reporting directly to a master).

TIMAC is:

- A standardized wireless protocol for battery powered and/or mains powered nodes
- Support for acknowledgement and retransmission
- Suitable for applications with low data-rate requirements (about 100 kbps effective data rate)
- Support for IEEE 802.15.4-2003
- Support for IEEE 802.15.4-2006
- Multiple platforms
- Easy application development
- Easy porting

TIMAC is distributed as object code free of charge. There are no royalties for using TIMAC.

Z-Stack™ – ZigBee protocol stack

www.ti.com/z-stack

In December 2006, TI's ZigBee stack, Z-Stack, was one of the first ZigBee stacks to be certified for the ZigBee 2006 specification. The certification ensures that products developed on this platform will be fully interoperable with other platforms that have been ZigBee 2006 certified.

Z-Stack supports multiple platforms including the CC2430 System-on-Chip, CC2431 System-on-Chip with location engine and CC2420 + MSP430 platform.

SimpleAPI

SimpleAPI was introduced with Z-Stack version 1.4.2 and drastically simplifies the development of ZigBee applications.

It has only 10 function calls targeted toward network formation, binding, sending and receiving data.

In addition, stack configuration can be done via NVRAM parameters instead of having pre-compiled values in code. Configuration can be done using a PC-based tool or by an external microcontroller.

Software resources

Name	Description	Web link
SimpliciTI™ Network Protocol	SimpliciTI is a simple low-power RF network protocol aimed at small RF networks	www.ti.com/simpliciti
TIMAC	IEEE 802.15.4 medium access control software stack	www.ti.com/timac
Z-Stack™ Software	ZigBee® protocol stack	www.ti.com/z-stack
MSP430 Code Library for Low-Power RF	The code library provides functions to facilitate the interfacing of an MSP430 MCU to CC1100/2500 RF IC	www.ti.com/ccmsplib
SmartRF™ Studio	SmartRF® Studio is a Windows application made to evaluate and configure the RF ICs	www.ti.com/smartrfstudio
Packet Sniffer	The packet sniffer enables the developer to monitor the packages sent over the air. It is a very useful tool that can be used for SimpliciTI, IEEE 802.15.4, and ZigBee applications	www.ti.com/packetsniffer
Flash Programmer	The flash programmer is used to program TI's SoC solutions	See tool folder of your preferred SoC part
Example Libraries	The example libraries include the most basic functionality needed to establish a link between two devices	See tool folder of your preferred SoC part
USB Libraries	USB interface libraries for devices with built-in USB interface (CC2511, CC1111)	See tool folder of your preferred SoC part

**Low-Power RF application notes**

To access any of the following application notes, type the URL: www-s.ti.com/sc/techlit/litnumber and replace the lit number with the number in the lit number column below.

Application notes title	Literature number
AN001 - SRD Regulations for License Free Transceiver Operation	swra090
AN002 - Optimizing CC400/CC900/CC1000 for Low LO Leakage	swra089
AN003 - SRD Antennas	swra088
AN009 - CC1000 Micro Controller Interfacing	swra082
AN010 - Using CC1000 for the Konnex Standard	swra081
AN011 - Programming CC1000 Frequency for Best Sensitivity	swra080
AN014 - Frequency Hopping Systems	swra077
AN015 - RF Modem Reference Design	swra076
AN016 - CC1000/CC1050 Used With On-Off Keying	swra075
AN017 - Low Power Systems Using the CC1010	swra074
AN018 - CC1000 Debugging Hints	swra073
AN019 - Crystal Oscillator Issues for CC1000 and CC1010	swra072
AN021 - Voltage Level Conversion	swra071
AN022 - CC1020 Crystal Frequency Selection	swra070
AN023 - CC1020 MCU Interfacing	swra069
AN024 - Frequency Hopping Protocol	swra068
AN025 - CC1020 RF	swra067
AN026 - Wireless Audio	swra066
AN027 - Temperature Compensation	swra065
AN028 - Improved LC Filter	swra064
AN029 - CC1020/CC1021 Automatic Frequency Control (AFC)	swra063
AN030 - CC1020/1021 Received Signal Strength Indicator	swra062
AN031 - Mono Audio Link	swra061
AN032 - 2.4 GHz Regulations	swra060
AN033 - Porting of RF Blinking LED Software Example to CC2420 - MSP430	swra059
AN035 - CC2400 FIFO Usage	swra058
AN036 - CC1020 1021 Spurious Emission	swra057
AN037 - CC2420 with External PA (Rev. B)	swra056
AN039 - Using CC1100/CC1150 in European 433/868 MHz Bands	swra054
AN40 - Folded Dipole Antenna for CC2400, CC2420 and CC2430	swra093
AN41 - CC2420 Coexistence	swra094
AN042 - CC2431 Location Engine	swra095

Application notes title	Literature number
AN043 - 2.4 GHz PCB Antenna for USB Dongle (Rev. A)	swra117
AN045 - Z-Tool	swra119
AN047 - CC1100 CC2500 Wake on Radio	swra126
AN048 - 2.4GHz Antenna (Rev. A)	swra092
AN049 - Software for CC1100/CC2500 and MSP430	swra141
AN50 - Using the CC1101 in the European 868MHz SRD Band	swra146
AN053 - Measuring Power Consumption with CC2430 & Z-Stack	swra144
AN054 - Anaren Balun Optimized for CC2420	swra155
AN055 - Anaren Balun Optimized for CC2430	swra156
AN056 - Gang-Pro CC and Production Programming of the CC2430	swra147
AN057 – Measuring Power Consumption on eZ430-RF2480	swra177
AN058 – Antenna Selection Guide	swra161
AN062 - TI-MAC and Z-Stack modifications for using CC2591 RF Front End w/CC2430	swra208
AN063 - Using CC2591 RF Front End with CC2430	swra212
AN064 - Two Way Audio Communications Using the CC2510	swra225
AN065 - Using CC2591 RF Front End with CC2520	swra229
AN066 - TI-MAC modifications for using CC2591 PA/LNA with MSP430F2618+CC2520	swra230
AN067 - Wireless MBUS Implementation with CC1101 and MSP430	swra234
AN068 - Design Steps and Results for Changing PCB Layer Thickness	swra236
AN069 - Low Cost Long Range One Way Audio Communications at 900 MHz	swra237

Low-Power RF design notes



To access any of the following design notes, type the URL: www-s.ti.com/sc/techlit/litnumber and replace the lit number with the number in the lit number column below.

Design notes title	Literature number	Design notes title	Literature number
Antenna Measurement with Network Analyzer	DN001 (swra096)	Using AES Encryption in CC11xFx, CC243x, and CC251xFx	DN108 (swra120k)
Practical Sensitivity Testing	DN002 (swra097)	DN109 Using I2S in CC11xFx and CC251xFx	DN109 (swra183)
Implementation of Microstrip Balun for CC2420, CC243x, and CC2480	DN003 (swra088)	State Transition Times on CC11xFx and CC251xFx	DN110 (swra191)
Folded Dipole Antenna for CC25xx	DN004 (swra118)	Current Consumption for a Polling Receiver	DN111 (swra207)
CC11xx Sensitivity versus Frequency Offset and Crystal Accuracy	DN005 (swra122b)	Using UART in CC11xFx CC243x and CC251xFx	DN112 (swra222a)
CC11XX Settings for FCC 15.247 Solutions	DN006 (swra123a)	CC11xFx CC243xFx CC251xFx SPI Interface	DN113 (swra223)
2.4 GHz Inverted F Antenna	DN007 (swru120b)	Using Constants in Code with Z-Stack	DN200 (swra104)
868 MHz and 915 MHz PCB Antenna	DN008 (swru121a)	Using the Direct Join Request Feature in Z-Stack	DN201 (swru124a)
Upgrade from CC1100 to CC1101	DN009 (swra145)	Choosing Optimal ZigBee Stack TX Power	DN202 (swra218)
Close-in Reception with CC1101	DN010 (swra147a)	SmartRF04®EB Troubleshooting	DN300 (swra105a)
RF Module Testing using SmartRF® Studio	DN011 (swra149a)	Code Export from SmartRF® Studio	DN301 (swra106)
Programming Output Power on CC1100 and CC1150	DN012 (swra150a)	Register View in SmartRF® Studio	DN302 (swra107)
Programming Output Power on CC1101	DN013 (swra151a)	Cleanup of Installed PC tools	DN303 (swra108)
Programming Output Power on CC2500 and CC2550	DN014 (swra152)	Interfacing CC1100 - CC2500 to the MSP430	DN400 (swra116)
Permanent Frequency Offset Compensation	DN015 (swra159a)	Interfacing CC1020/1 to the MSP430	DN401 (swra115)
Compact 868/915 MHz Antenna Design	DN016 (swra160a)	Simple Audio Loopback Using CC251X	DN402 (swra138)
CC11xx 868/915 MHz RF Matching	DN017 (swra168a)	Packet Transmission Basics	DN500 (swra109b)
Range Measurements in an Open Field Environment	DN018 (swra169a)	PATABLE Access	DN501 (swra110a)
Powering LPW Products	DN019 (swra173)	CRC Implementation	DN502 (swra111b)
Programming Output Power on CC243x	DN020 (swra171)	SPI Access	DN503 (swra112b)
CC2500 and CC2510/CC2511 Sensitivity versus Frequency Offset and Crystal Accuracy	DN021 (swra181)	FEC Implementation	DN504 (swra113a)
CC11xx OOK ASK Register Settings	DN022 (swra215)	RSSI Interpretation and Timing	DN505 (swra114b)
868 MHz and 915 MHz PCB Inverted-F Antenna	DN023 (swra228a)	GDO Pin Usage	DN506 (swra121a)
868 MHz and 915 MHz Meandering Monopole PCB Antenna	DN024 (swra227a)		
Using the ADC to Measure Supply Voltage	DN101 (swra100a)		
SoC Temperature Sensor	DN102 (swra101a)		
Upgrade from CC2510/11 Preview to Release part	DN105 (swra159)		
Power Modes in CC111xFx, CC243x, and CC251xFx	DN106 (swra162a)		
DMA and Radio Configuration	DN107 (swra164)		



Low-Power RF Developer Network

The TI Low-Power RF Developer Network is a worldwide community of respected, experienced, and well established companies servicing the low-power RF market in the sub-1 GHz and 2.4-GHz ISM frequency bands.

This network consists of recommended companies, RF consultants and independent design houses that provide scalable projects from antenna circuit-board layout to turnkey system design and FCC or ETSI compliance testing.

Benefits include:

- A faster design-to-production schedule and experience with the TI Low-power RF product portfolio
- RF circuit, low-power RF and ZigBee design services
- Low-Power RF and ZigBee module solutions
- Development tools for testing and troubleshooting RF systems
- RF certification services and RF circuit manufacturing
- Online search tool to determine suitable RF development partners

To find a suitable partner for your design and test project go to:

www.ti.com/lprfnetwork

Are you interested in becoming a TI development partner?

Send an email to **m.grazier@ti.com** for more information.

Featured third party developers**Europe****Amber Europe:**

Amber Wireless GmbH is a German electronics company specializing in the design, manufacturing and marketing of compact short range radio modules and modems for rapid implementation of cable-free data links and have become one of the leading suppliers for ISM/SRD radio modules and radio modems in Europe.

Low-Power RF ICs:

CC1020, CC1100, CC2400, CC2420, CC2520

Contact details:

Contact: Wolfgang Esch
Email: wolfgang.esch@amber-wireless.de
Phone: 0049-2203-6991950
URL: <http://www.amber-wireless.de/>

Radiocrafts:

Radiocrafts designs, manufactures and markets standard RF modules for operation in the license-free ISM bands at 315 / 433 / 429 / 868 / 915 MHz and 2.4 GHz.

Low-Power RF ICs:

CC2420, CC1020, CC2430, CC2431, CC2400, CC1000

Contact details:

Contact: Peder Martin Evjen
Email: radiocrafts@radiocrafts.com
Phone: (+47) 4000 5195
URL: <http://www.radiocrafts.com>

Sensinode 6LowPAN:

Sensinode is the pioneer IP-based wireless sensor network solution provider and offers seamless internet integration to embedded device and chip manufacturers through all industries on a worldwide level.

Low-Power RF ICs:

CC2430, CC1100, CC1110

Contact details:

Phone: +358 10 387 8680
URL: www.sensinode.com

United States**LS Research:**

L.S. Research provides complete design services for product development including embedded firmware, RF design, antenna design, analog/digital design, PCB layout, and prototyping. L.S. Compliance provides FCC, CE, and ETSI testing services.

Low-Power RF ICs:

CC2430, CC2500, CC2550, CC2510, CC1100, CC1110, CC2511, CC2431, CC1020, CC242

Contact details:

Contact: Bill Steinike
Email: bsteinike@lsr.com
Phone: 262-375-4400 ext.103
URL: <http://www.lsr.com/>

Awarepoint:

Awarepoint is providing its Real-Time Awareness Solutions® to healthcare clients that include prestigious teaching institutions, premiere independents, military facilities and members of major integrated delivery networks.

Low-Power RF ICs:

CC2430, CC2431

Contact details:

Toll-Free: 1-888-860-FIND (888-860-3463)
Phone: (858) 345-5000
URL: www.awarepoint.com

Asia**Infotech/Holy Stone Enterprise Co.,LTD**

Holy Stone is incorporated as the professional agent of electronic components and parts in Asia since 1981 and provides customers with professional technologies as well as produces MLCC with their own brand name since 1994.

Low-Power RF ICs:

CC2500, CC2550, CC2510, CC1100, CC1110, CC2511, CC2430, CC2431, CC1020, CC2420,

Contact details:

Phone: 886-2-26270383
Fax: 886-2-27981737
E-mail: inquiry@holystone.com.tw

Low-Power RF Online Community



TI's new Online Community has been created to provide you with technical support forums, videos and blogs, and the chance to openly and freely interact with fellow engineers.

With the Low-Power RF Online Community you can:

- ▶ Exchange ideas, share knowledge and ask questions about RF-related topics
- ▶ View our latest videos covering basic RF knowledge to deep technical content
- ▶ Interact with fellow engineers from all over the world

Forums	Latest post	Threads	Posts
Low Power RF FAQs A place to review and discuss some Low Power RF FAQs. For new questions, please use the other forums.	FAQ: Clocking the... by Kjetil 10-06-2008 7:16 AM	187	200
Low Power RF Hardware RF ICs, RF Testing, Output Power, Selectivity, Sensitivity, Blocking, Packet Error Rate, etc.	Re: switch by VJ 10-06-2008 8:53 AM	63	266
Low Power RF News & Announcements What's new with TI LPRF?	Re: Alektronra and... by LPRF Rocks the World... 10-03-2008 7:29 AM	3	26
Low Power RF Open Discussion Forum Join the conversation! This area is open to all topics LPRF.	Re: Total no of... by Kjetil 10-04-2008 12:07 PM	16	57
Low Power RF Software Problems, questions, or just want to talk about SimpliciTI, Z-Stack, TIMAC?	CC2480 using with... by KRIP 10-06-2008 10:46 AM	132	656
Low Power RF Systems & Architecture An open forum to discuss LPW Systems, Regulations, Zigbee, RF Troubleshooting and Debugging, etc.	Re: CC2430:Reset... by marcob 10-03-2008 7:29 AM	7	29

Popular Tags

- 802.15.4 MAC AN antenna
- CC1100 CC1101
- CC1110 cc1111
- CC1150 CC2420
- CC2430
- CC2431
- cc2480 CC2500
- CC2510 cc2511
- CC2520 CC2550 DN
- FAQ MSP430 rssi
- simpliciti SmartRF04EB
- Zigbee Z-Stack

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Active

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www.ti.com/lprf-forum

 Product comparison guide sub-1 GHz

Features/Product	CC1020	CC1021	CC1101	CC1150	CC1110	CC1111	CC1100E
Product type	Transceiver	Transceiver	Transceiver	Transmitter	SoC	SoC	Transceiver
Programmable frequency	402 to 470 MHz 804 to 960 MHz	402 to 470 MHz 804 to 960 MHz	300 to 348 MHz 387 to 464 MHz 779 to 928 MHz	300 to 348 MHz 400 to 464 MHz 800 to 928 MHz	300 to 348 MHz 391 to 464 MHz 782 to 928 MHz	300 to 348 MHz 391 to 464 MHz 782 to 928 MHz	470 to 510 MHz 950 to 960 MHz
Supply voltage	2.3 to 3.6 V	2.1 to 3.6 V	1.8 to 3.6 V	1.8 to 3.6 V	2.0 to 3.6 V	3.0 to 3.6 V	1.8 to 3.6 V
Current consumption (RX) 0 dBm (TX)	19.9/19.9 mA 16.2/20.5 mA	19.9/19.9 mA 16.2/20.5 mA	15.0 mA 14.7 mA	— 14.5/15.9 mA	17 mA 31 mA	17 mA 31 mA	15.5 mA 16.6 mA
FSK data rate (max)	153.6 kbps	153.6 kbps	500 kbps	500 kbps	500 kbps	500 kbps	500 kbps
Modulation format	FSK/OOK/GFSK	FSK/GFSK/OOK	FSK/GFSK/MSK/OOK/ ASK	FSK/GFSK/MSK/OOK/ ASK	FSK/GFSK/MSK/OOK/ ASK	FSK/GFSK/MSK/OOK/ ASK	FSK/GFSK/MSK/OOK/ ASK
Receiver sensitivity (FSK)	-118 dBm	-109 dBm	-111 dBm	—	-111 dBm	-111 dBm	-112 dBm
Programmable output power ranging from	-20 to 10 dBm	-20 to 10 dBm	-30 to 12 dBm	-30 to 10 dBm	-30 to 12 dBm	-30 to 12 dBm	-30 to 11 dBm
Multi-channel systems/ frequency hopping protocols	✓	✓	✓	✓	✓	✓	✓
RSSI output	Digital	Digital	Digital	—	Digital	Digital	Digital
Integrated bit synchronizer	✓	✓	✓	—	✓	✓	✓
Internal RF switch/IF filter	✓	✓	✓	—	✓	✓	✓
Antenna connection	Single ended	Single ended	Differential	Differential	Differential	Differential	Differential
Package type	QFN-32	QFN-32	QLP-20	QLP-16	QLP-36	QLP-36	QLP-20
Complies with EN 300 220 and FCC CFR 47, part 15	✓	✓	✓	✓	✓	✓	✓
Narrow band (12.5/25 kHz)	✓	—	—	—	—	—	—
Integrated MCU	—	—	—	—	✓	✓	✓
USB	—	—	—	—	—	✓	✓
AES encryption/ authentication	—	—	—	—	✓	✓	✓
Program memory	—	—	—	—	8/16/32-kB Flash	8/16/32-kB Flash	8/16/32-kB Flash
Data memory	—	—	—	—	124-kB SRAM	124-kB SRAM	124-kB SRAM

Product comparison guide 2.4 GHz



Features/Product	CC2400	CC2520	CC2430	CC2431	CC2550	CC2500	CC2510	CC2511	CC2590 CC2591	CC2480	CC253x
Product type	Transceiver	Transceiver	SoC	SoC	Transmitter	Transceiver	SoC	SoC	RF front end	ZigBee® processor	SoC
Programmable frequency, MHz	2400 to 2483	2394 to 2507	2400 to 2483	2400 to 483	2400 to 2483	2400 to 2483	2400 to 2483	2400 to 2483	2400 to 2483.5	2400 to 2483.5	2400 to 2483
Frequency resolution	1 MHz	1 MHz	1 MHz	1 MHz	427 Hz	427 Hz	427 Hz	427 Hz	—	5 MHz	1 MHz
Operating supply voltage	1.6 to 2.0 V	1.8 to 3.8 V	2.0 to 3.6 V	2.0 to 3.6 V	1.8 to 3.6 V	1.8 to 3.6 V	2.0 to 3.6 V	3.0 to 3.6 V	2.0 to 3.6 V	2.0 to 3.6 V	2.0 to 3.6
Current consumption (RX 0 dBm (TX))	24.0 mA 19 mA	18.5 mA 25.8 mA	27 mA 27 mA	27 mA 24.7 mA	N/A 22.8 mA	12.8 mA 21.6 mA	19.8 mA 23 mA	22 mA 3.4 mA	1.8 mA 27 mA	27 mA 27 mA	20.5 mA 29 mA
Data rate (max)	1.0 Mbps	250 kbps	250 kbps	250 kbps	500 kbps	500 kbps	500 kbps	500 kbps	—	250 kbps	250 kbps
Receiver sensitivity	-101 dBm at 10 kbps BER = 10-3 85 dBm at 1 Mbps	-98 dBm	-92 dBm at PER < 1%	-94 dBm at PER < 1%	N/A	-89 dBm at 250 kbps 1% PER -99 dBm at 10 kbps	-88 dBm at 250 kbps 1% PER -99 dBm at 10 kbps	-88 dBm at 250 kbps 1% PER -99 dBm at 10 kbps	—	-92 dBm at PER < 1%	-97 dBm at PER < 1%
Programmable output power ranging from	-25 to 0 Mbps	-20 to 5 dBm	-25 to 0 dBm	-24 to 0 dBm	-20 to 1 dBm	-20 to 1 dBm	-30 to 1 dBm	-30 to 1 dBm	—	0 dBm	-28 to +4.5 dBm
Multi-channel systems	FHSS	DSSS	DSSS	DSSS	FHSS	FHSS	FHSS	FHSS	—	DSSS	DSSS
RSSI output	Digital	Digital	Digital	Digital	—	Digital	Digital	Digital	—	Digital	Digital
Integrated bit synchronizer	✓	✓	✓	✓	—	✓	✓	✓	—	✓	✓
Integrated packet handling	✓	✓	✓	✓	✓	✓	✓	✓	—	✓	✓
Data buffering	32 bytes FIFO	128 bytes TX 128 bytes RX	128 bytes TX 128 bytes RX DMA	128 bytes TX 128 bytes RX DMA	64 bytes	64 bytes TX 64 bytes RX	128 bytes TX 128 bytes RX DMA	128 bytes TX 128 bytes RX DMA	—	✓	128 TX 128 RX DMA
Internal RF switch/IF Filter	✓	✓	✓	✓	—	✓	✓	✓	—	✓	—
RF chip interface	Differential	Differential	Differential	Differential	Differential	Differential	Differential	Differential	—	Differential	Differential
Package type	QFN-48 7x7 mm	QLP-48 7x7 mm	QLP-48 7x7 mm	QLP-48 7x7 mm	QLP-16 4x4 mm	QLP-20 4x4 mm	QLP-36 6x6 mm	QLP-36 6x6 mm	QFN-16 QFN-48	QFN-48	QFN-40 6x6 mm
Complies with EN 300 220, FCC CFR 47, part 15 and ARIB STD-T66	✓	✓	✓	✓	✓	✓	✓	✓	—	✓	✓
Integrated MCU	—	—	✓	✓	—	—	✓	✓	—	—	✓
IEEE 802.15.4 compliant	—	✓	✓	✓	—	—	—	—	—	✓	✓
USB	—	—	—	—	—	—	—	✓	—	—	CC2531
AES encryption/authentication	—	✓	✓	✓	—	—	✓	✓	—	✓	✓
Program memory	—	—	32/64/128-kB Flash	128-kB Flash	—	—	32-kB Flash	32-kB Flash	—	✓	32/64/128 256-kB Flash
Data memory	—	768 bytes	4 kB + 4 kB SRAM	4 kB + 4 kB SRAM	—	—	4-kB SRAM	4-kB SRAM	—	—	8-kB SRAM

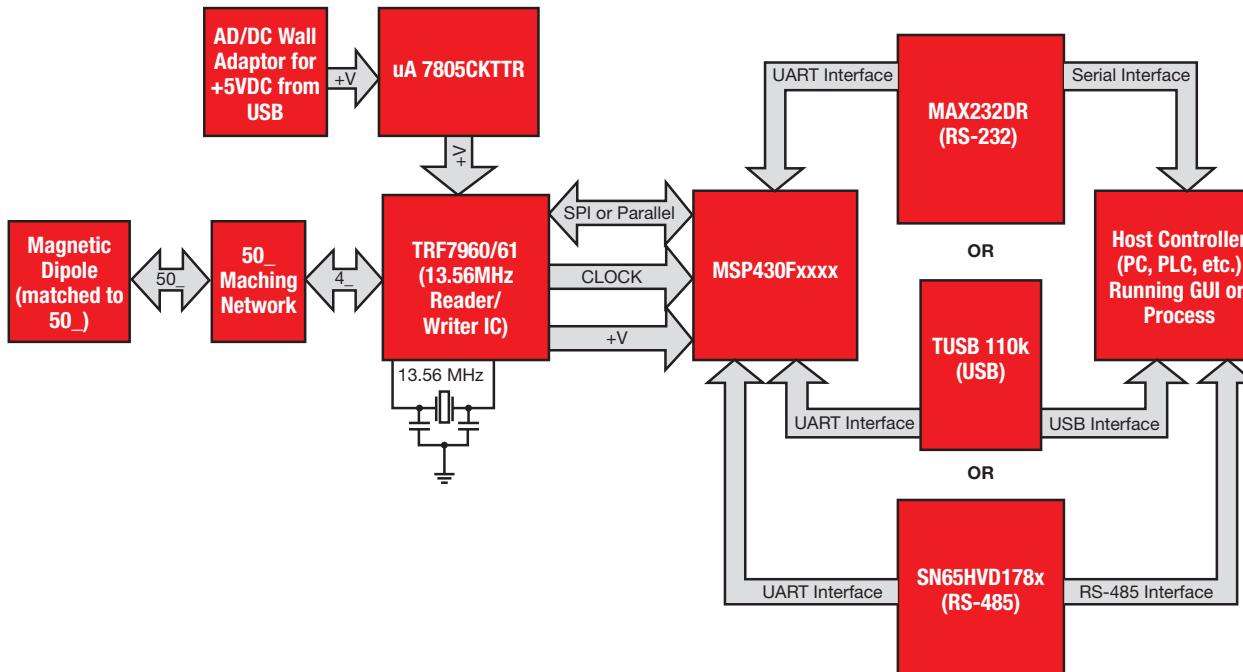
→ HF Reader ICs product comparison guide

TI's Radio Frequency Identification Systems is an industry leader in RFID technology, and the world's largest integrated manufacturer of TI-RFid™ tags, TI-RFid smart labels, and TI-RFid reader systems. With more than 500 million RFID tags manufactured, TI-RFid technology is used in a broad range of RFID applications worldwide. TI is an active member of many standards bodies, including EPCglobal, ISO, ISO/IEC, ECMA International, ETSI, and several national standardization bodies working to drive the adoption of global standards for RFID technology.

Product comparison guide for HF Reader ICs

Part number	TRF7960	TRF7961
Operating frequency	13.56 MHz	13.56 MHz
Supported protocols	ISO 15693 ISO 18000-3 (Mode 1) ISO 14443A & B Tag-it™ HF	ISO 15693 ISO 18000-3 (Mode 1) Tag-it HF
Operating voltage	2.7 V to 5.5 VDC	2.7 V to 5.5 VDC
Current consumption	Transmit: 200 mW at 110 mA, typ. 100 mW at 70 mA, typ. Active (RX only) 10 mA, typ. Stand-by: 12 µA Power down: <1 µA	Transmit: 200 mW at 110 mA, typ. 100 mW at 70 mA, typ. Active (RX only) 10 mA, typ. Stand-by: 120 µA Power down: <1 µA
Transmitter power	Adjustable power, 100 mW or 200 mW at 5 VDC	Adjustable power, 100 mW or 200 mW at 5 VDC
Transmitter modulation	ASK, adjustable 8% to 30% 00K	ASK, adjustable 8% to 30% 00K
Communication interface	Parallel 8-bit or 4-wire SPI	Parallel 8-bit or 4-wire SPI
Operating temperature	-40°C to +100°C	-40°C to +110°C
Storage temperature	-55°C to +150°C	-55°C to +150°C
Package	32-pin QFN (5mm x 5mm)	32-pin QFN (5mm x 5mm)
Packing/delivery	Tape-on reel, 250 or 3000 per reel	Tape-on reel, 250 or 3000 per reel

www.ti.com/rfid



Fixed Reader



MSP430 family of ultra-low-power microcontrollers

MSP430F54xx(A)

The MSP430F54xx(A) is the newest Flash-based family featuring the lowest power consumption up to 25 MIPS with 1.8 to 3.6-V operation starting at 12 MIPS. New features include an innovative power management module for optimizing power consumption, an internally controlled voltage regulator, and 2x more memory than previous devices.

The MSP430F54xx(A) and other members of the MSP430 family support several wireless protocol software stacks including ZigBee, TIMAC 802.15.4 and SimpliciTI™. Memory requirements and code availability information for the software are shown on page 39.

Key features

- Low supply-voltage range
 - 1.8-V to 3.6-V interfaces
- Ultra-low power consumption
 - Active mode (AM): 165 μ A/MHz at 8 MHz
 - Standby mode (LPM3 RTC mode): 2.60 μ A
 - Off mode (LPM4 RAM retention): 1.69 μ A
 - Shutdown mode (LPM5): 0.1 μ A
- Wake-up from standby mode in less than 5 μ s
- 16-bit RISC architecture
 - Extended memory operations
 - Up to 18-MHz system clock (MSP430F543x, MSP430F541x)
 - Up to 25-MHz system clock (MSP430F543xA, MSP430F541xA)

- Flexible power management system
 - Fully integrated LDO with programmable regulated core supply voltage
 - Supply voltage supervision, monitoring, and brownout
 - Unified clock system interfaces
 - FLL control loop for frequency stabilization
 - Low-power/low-frequency internal clock source (VLO)
 - Low-frequency trimmed internal reference source (REFO) interfaces
 - 32-kHz crystals
 - High-frequency crystals up to 32 MHz
- 16-bit timer0_A5 with five capture/compare registers
- 16-Bit timer1_A3 with three capture/compare registers
- 16-bit timer_B7 with seven capture/compare shadow registers
- Up to four universal serial communication interfaces
- Enhanced UART supporting auto-baudrate detection
 - IrDA encoder and decoder
 - Synchronous SPI
 - I²C
- 12-bit analog-to-digital (A/D) Converter
 - Internal reference
 - Sample and hold
 - Autoscan feature
 - 12 external channels, 4 internal channels
- Hardware multiplier supporting 32-bit operations
- Serial onboard programming, no external programming voltage needed
- Three channel internal DMA
- Basic timer with real-time clock feature

Key benefits

- Ideal for low-power, battery power applications
 - Ultra-low standby current at 1.5 μ A (RTC Mode)
- 32.768-kHz crystal oscillator active
- <5- μ s wakeup to stable 25-MHz internal DCO
- RAM and peripheral setup maintained, all interrupts usable
 - Lowest active-mode current at 160 μ A/MHz
- Four level user-configurable core voltage tailored to application needs for maximum power savings
- Expanded memory/peripheral mapping
- Peripheral module enhancements
- Offers higher integration enabling USB, RF and more in future family members
- Leading code density and execution efficiency

Applications

- Portable consumer and white goods
- Sensors and Security
- Automated metering reading
- Smoke, fire and motion detection
- Human interface controls
 - Voice activation
 - Security systems
 - Automated thermostat
- Portable medical instrumentation

Development tools and software

- MSP-FET430U5x100 (FET + Target Board Bundle)

<http://focus.ti.com/docs/toolsw/folders/print/msp-fet430u5x100.htm>



Product selection tables

Flash-Based F1xx MCU Platform (V_{CC} , 1.8 - 3.6V), Up to 8 MIPS

(F) Flash	Program (kB)	SRAM (kB)	I/O	16-Bit Timers		BOR	SVS	(UART/SPI)	DMA	MPY (16 x 16)	Comp_A+	Temp Sensor	ADC Ch/Res	Additional Features	Packages	Price*		
				A	B													
x11x1	MSP430F1101A	1	128	14	3	—	✓	—	—	—	—	✓	—	slope	—	20 DGV, DW, PW, 24 RGE	1.25	
	MSP430C1101	1	128	14	3	—	✓	—	—	—	—	✓	—	slope	—	20 DW, PW, 24 RGE	0.75	
	MSP430F1111A	2	128	14	3	—	✓	—	—	—	—	✓	—	slope	—	20 DGV, DW, PW, 24 RGE	1.70	
	MSP430C1111	2	128	14	3	—	✓	—	—	—	—	✓	—	slope	—	20 DW, PW, 24 RGE	1.40	
	MSP430F1121A	4	256	14	3	—	✓	—	—	—	—	✓	—	slope	—	20 DGV, DW, PW, 24 RGE	2.10	
	MSP430C1121	4	256	14	3	—	✓	—	—	—	—	✓	—	slope	—	20 DW, PW, 24 RGE	1.90	
F11x2	MSP430F1122	4	256	14	3	—	✓	✓	—	—	—	—	✓	5ch, ADC10	—	20 DW, PW, 32 RHB	2.50	
	MSP430F1132	8	256	14	3	—	✓	✓	—	—	—	—	✓	5ch, ADC10	—	20 DW, PW, 32 RHB	2.80	
F12x2	MSP430F122	4	256	22	3	—	✓	—	—	1	—	—	✓	—	slope	—	28 DW, PW, 32 RHB	2.65
	MSP430F123	8	256	22	3	—	✓	—	—	1	—	—	✓	—	slope	—	28 DW, PW, 32 RHB	2.85
F12x2	MSP430F1222	4	256	22	3	—	✓	✓	—	1	—	—	✓	8ch, ADC10	—	28 DW, PW, 32 RHB	2.95	
	MSP430F1232	8	256	22	3	—	✓	✓	—	1	—	—	✓	8ch, ADC10	—	28 DW, PW, 32 RHB	3.15	
F13x	MSP430F133	8	256	48	3	3	✓	—	—	1	—	—	✓	✓	8ch, ADC12	—	64 PM, PAG, RTD	3.75
	MSP430F135	16	512	48	3	3	✓	—	—	1	—	—	✓	✓	8ch, ADC12	—	64 PM, PAG, RTD	4.50
C13x1	MSP430C1331	8	256	48	3	3	✓	—	—	1	—	—	✓	—	slope	—	64 PM, RTD	2.50
	MSP430C1351	16	512	48	3	3	✓	—	—	1	—	—	✓	—	slope	—	64 PM, RTD	2.85
F14x	MSP430F147	32	1024	48	3	7	✓	—	—	2	—	✓	✓	✓	8ch, ADC12	—	64 PM, PAG, RTD	6.30
	MSP430F148	48	2048	48	3	7	✓	—	—	2	—	✓	✓	✓	8ch, ADC12	—	64 PM, PAG, RTD	7.15
F14x1	MSP430F149	60	2048	48	3	7	✓	—	—	2	—	✓	✓	✓	8ch, ADC12	—	64 PM, PAG, RTD	7.55
	MSP430F1471	32	1024	48	3	7	✓	—	—	2	—	✓	✓	—	slope	—	64 PM, RTD	5.75
F14x1	MSP430F1481	48	2048	48	3	7	✓	—	—	2	—	✓	✓	—	slope	—	64 PM, RTD	6.65
	MSP430F1491	60	2048	48	3	7	✓	—	—	2	—	✓	✓	—	slope	—	64 PM, RTD	7.00
F15x	MSP430F155	16	512	48	3	3	✓	✓	✓	1 with I ² C	✓	—	✓	✓	8ch, ADC12	(2) DAC12	64 PM, RTD	6.20
	MSP430F156	24	1024	48	3	3	✓	✓	✓	1 with I ² C	✓	—	✓	✓	8ch, ADC12	(2) DAC12	64 PM, RTD	6.95
F15x	MSP430F157	32	1024	48	3	3	✓	✓	✓	1 with I ² C	✓	—	✓	✓	8ch, ADC12	(2) DAC12	64 PM, RTD	7.35
	MSP430F167	32	1024	48	3	7	✓	✓	✓	2 with I ² C	✓	✓	✓	✓	8ch, ADC12	(2) DAC12	64 PM, RTD	8.45
F16x	MSP430F168	48	2048	48	3	7	✓	✓	✓	2 with I ² C	✓	✓	✓	✓	8ch, ADC12	(2) DAC12	64 PM, RTD	9.35
	MSP430F169	60	2048	48	3	7	✓	✓	✓	2 with I ² C	✓	✓	✓	✓	8ch, ADC12	(2) DAC12	64 PM, RTD	9.95
F16x	MSP430F1610	32	5120	48	3	7	✓	✓	✓	2 with I ² C	✓	✓	✓	✓	8ch, ADC12	(2) DAC12	64 PM, RTD	10.35
	MSP430F1611	48	10240	48	3	7	✓	✓	✓	2 with I ² C	✓	✓	✓	✓	8ch, ADC12	(2) DAC12	64 PM, RTD	10.85
F16x	MSP430F1612	55	5120	48	3	7	✓	✓	✓	2 with I ² C	✓	✓	✓	✓	8ch, ADC12	(2) DAC12	64 PM, RTD	11.20

*Prices are quoted in U.S. dollars in quantities of 100 and represent year 2009 suggested resale pricing. All prices are subject to change.

Customers are advised to obtain the most current and complete pricing information from TI prior to placing orders.

TI may verify final pricing prior to accepting any order.

See www.ti.com/msp430 for additional information

Product Selection Tables

Flash-Based F2xx MCU Platform (V_{CC} , 1.8 - 3.6V), Up to 16 MIPS

(F) Flash	Program (kB)	SRAM (kB)	I/O	16-Bit Timers		BOR	SVS	USI: I ² C/SPI	USCI		DMA	MPY (16 x 16)	Comp A+	Temp Sensor	ADC Ch/Res	Additional Features	Packages	Price*			
				A	B				Ch A: UART/LIN/IrDA/SPI	Ch B: I ² C/SPI											
F20xx	MSP430F2001	1	128	10	2	—	✓	✓	—	—	—	—	—	✓	—	slope	—	14 PW, N, 16 RSA	0.70		
	MSP430F2011	2	128	10	2	—	✓	✓	—	—	—	—	—	✓	—	slope	—	14 PW, N, 16 RSA	0.80		
	MSP430F2002	1	128	10	2	—	✓	✓	—	✓	—	—	—	—	✓	8ch, ADC10	—	14 PW, N, 16 RSA	1.05		
	MSP430F2012	2	128	10	2	—	✓	✓	—	✓	—	—	—	—	✓	8ch, ADC10	—	14 PW, N, 16 RSA	1.15		
	MSP430F2003	1	128	10	2	—	✓	✓	—	✓	—	—	—	—	✓	4ch, SD16	—	14 PW, N, 16 RSA	1.50		
	MSP430F2013	2	128	10	2	—	✓	✓	—	✓	—	—	—	—	✓	4ch, SD16	—	14 PW, N, 16 RSA	1.65		
F21xx	MSP430F2101	1	128	16	3,2	—	✓	✓	—	—	—	—	—	—	✓	—	slope	—	20 DGV, DW, PW, 24 RGE	0.90	
	MSP430F2111	2	128	16	3,2	—	✓	✓	—	—	—	—	—	—	✓	—	slope	—	20 DGV, DW, PW, 24 RGE	1.00	
	MSP430F2121	4	256	16	3,2	—	✓	✓	—	—	—	—	—	—	✓	—	slope	—	20 DGV, DW, PW, 24 RGE	1.35	
	MSP430F2131	8	256	16	3,2	—	✓	✓	—	—	—	—	—	—	✓	—	slope	—	20 DGV, DW, PW, 24 RGE	1.70	
	MSP430F2112	2	256	22	3,2	—	✓	✓	—	—	1	1	—	—	✓	✓	8ch, ADC10	—	28 PW, 32 RHB	1.95	
	MSP430F2122	4	512	22	3,2	—	✓	✓	—	—	1	1	—	—	✓	✓	8ch, ADC10	—	28 PW, 32 RHB	2.10	
	MSP430F2132	8	512	22	3,2	—	✓	✓	—	—	1	1	—	—	✓	✓	8ch, ADC10	—	28 PW, 32 RHB	2.20	
F22x2	MSP430F2232	8	512	32	3	3	✓	✓	—	—	1	1	—	—	—	✓	12ch, ADC10	—	38 DA, 40 RHA	2.40	
	MSP430F2252	16	512	32	3	3	✓	✓	—	—	1	1	—	—	✓	12ch, ADC10	—	38 DA, 40 RHA	2.70		
	MSP430F2272	32	1024	32	3	3	✓	✓	—	—	1	1	—	—	✓	12ch, ADC10	—	38 DA, 40 RHA	3.10		
F22x4	MSP430F2234	8	512	32	3	3	✓	✓	—	—	1	1	—	—	—	✓	12ch, ADC10	(2) OPAMP	38 DA, 40 RHA	2.65	
	MSP430F2254	16	512	32	3	3	✓	✓	—	—	1	1	—	—	✓	12ch, ADC10	(2) OPAMP	38 DA, 40 RHA	2.95		
	MSP430F2274	32	1024	32	3	3	✓	✓	—	—	1	1	—	—	✓	12ch, ADC10	(2) OPAMP	38 DA, 40 RHA	3.35		
F23x0	MSP430F2330	8	1024	32	3	3	✓	✓	—	—	1	1	—	✓	✓	—	slope	—	40 RHA	2.30	
	MSP430F2350	16	2048	32	3	3	✓	✓	—	—	1	1	—	✓	✓	—	slope	—	40 RHA	2.65	
	MSP430F2370	32	2048	32	3	3	✓	✓	—	—	1	1	—	✓	✓	—	slope	—	40 RHA	2.95	
F23x	MSP430F233	8	1024	48	3	3	✓	✓	✓	✓	—	1	1	—	✓	✓	✓	8ch, ADC12	—	64 PM, 64 RGC	3.00
	MSP430F235	16	2048	48	3	3	✓	✓	✓	✓	—	1	1	—	✓	✓	✓	8ch, ADC12	—	64 PM, 64 RGC	3.60
F24x/2410	MSP430F247	32	4096	48	3	7	✓	✓	✓	✓	—	2	2	—	✓	✓	✓	8ch, ADC12	—	64 PM, 64 RGC	5.05
	MSP430F248	48	4096	48	3	7	✓	✓	✓	✓	—	2	2	—	✓	✓	✓	8ch, ADC12	—	64 PM, 64 RGC	5.75
	MSP430F249	60	2048	48	3	7	✓	✓	✓	✓	—	2	2	—	✓	✓	✓	8ch, ADC12	—	64 PM, 64 RGC	5.90
	MSP430F2410	56	4096	48	3	7	✓	✓	✓	✓	—	2	2	—	✓	✓	✓	8ch, ADC12	—	64 PM, 64 RGC	6.05
F24x1	MSP430F2471	32	4096	48	3	7	✓	✓	✓	✓	—	2	2	—	✓	✓	—	slope	—	64 PM, 64 RGC	4.60
	MSP430F2481	48	4096	48	3	7	✓	✓	✓	✓	—	2	2	—	✓	✓	—	slope	—	64 PM, 64 RGC	5.30
	MSP430F2491	60	2048	48	3	7	✓	✓	✓	✓	—	2	2	—	✓	✓	—	slope	—	64 PM, 64 RGC	5.45
F241x	MSP430F2416	92	4096	48/64	3	7	✓	✓	✓	✓	—	2	2	—	✓	✓	✓	8ch, ADC12	—	64 PM, 80 PN, 113 ZQW	6.95
	MSP430F2417	92	8192	48/64	3	7	✓	✓	✓	✓	—	2	2	—	✓	✓	✓	8ch, ADC12	—	64 PM, 80 PN, 113 ZQW	7.60
	MSP430F2418	116	8192	48/64	3	7	✓	✓	✓	✓	—	2	2	—	✓	✓	✓	8ch, ADC12	—	64 PM, 80 PN, 113 ZQW	7.95
	MSP430F2419	120	4096	48/64	3	7	✓	✓	✓	✓	—	2	2	—	✓	✓	✓	8ch, ADC12	—	64 PM, 80 PN, 113 ZQW	7.60
F261x	MSP430F2616	92	4096	48/64	3	7	✓	✓	✓	✓	—	2	2	✓	✓	✓	✓	8ch, ADC12	(2) DAC12	64 PM, 80 PN, 113 ZQW	8.85
	MSP430F2617	92	8192	48/64	3	7	✓	✓	✓	✓	—	2	2	✓	✓	✓	✓	8ch, ADC12	(2) DAC12	64 PM, 80 PN, 113 ZQW	9.50
	MSP430F2618	116	8192	48/64	3	7	✓	✓	✓	✓	—	2	2	✓	✓	✓	✓	8ch, ADC12	(2) DAC12	64 PM, 80 PN, 113 ZQW	9.85
	MSP430F2619	120	4096	48/64	3	7	✓	✓	✓	✓	—	2	2	✓	✓	✓	✓	8ch, ADC12	(2) DAC12	64 PM, 80 PN, 113 ZQW	9.50

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See www.ti.com/msp430 for additional information



Product selection tables

Flash-based x4xx MCU Platform (V_{CC} , 1.8 - 3.6V), Up to 8 MIPS (unless noted²)

	(C) Rom (F) Flash	Pro- gram (kB)	SRAM (kB)	I/O	A	B	16-Bit Timers		Watchdog	BOR	SVS	USART (UART/ SPI)	USCI		LCD Seg- ments	DMA	MPY (16 x 16)	Comp A+	Temp Sensor	ADC Ch/ Res	Additional Features	Packages	Price*
													Cha A: UART/ LIN/ IrDA/ I ² C/ SPI	Cha B: I ² C/ SPI									
F41xx	MSP430FW423	8	256	48	3,5	—	✓	✓	✓	✓	✓	—	—	—	96	—	—	✓	—	slope	Flow-meter	64 PPM	4.70
	MSP430FW425	16	512	48	3,5	—	✓	✓	✓	✓	✓	—	—	—	96	—	—	✓	—	slope	Flow-meter	64 PPM	6.20
	MSP430FW427	32	1024	48	3,5	—	✓	✓	✓	✓	✓	—	—	—	96	—	—	✓	—	slope	Flow-meter	64 PPM	5.60
F42xx	MSP430FE423	8	256	14	3	—	✓	✓	✓	✓	✓	1	—	—	128	—	✓	—	✓	(3) SD16	E-meter	64 PPM	4.85
	MSP430FE425	16	512	14	3	—	✓	✓	✓	✓	✓	1	—	—	128	—	✓	—	✓	(3) SD16	E-meter	64 PPM	5.45
	MSP430FE427	32	1024	14	3	—	✓	✓	✓	✓	✓	1	—	—	128	—	✓	—	✓	(3) SD16	E-meter	64 PPM	5.95
MSP430FE4232	MSP430FE4242	8	256	14	3	—	✓	✓	✓	✓	✓	1	—	—	128	—	✓	—	✓	(2) SD16	E-meter	64 PPM	3.70
	MSP430FE4242	12	512	14	3	—	✓	✓	✓	✓	✓	1	—	—	128	—	✓	—	✓	(2) SD16	E-meter	64 PPM	3.95
F42x0	MSP430F4250	16	256	32	3	—	✓	✓	—	—	—	—	—	—	56	—	—	—	✓	5ch, SD16	DAC12	48 DL, RGZ	3.90
	MSP430F4260	24	256	32	3	—	✓	✓	—	—	—	—	—	—	56	—	—	—	✓	5ch, SD16	DAC12	48 DL, RGZ	4.35
	MSP430F4270	32	256	32	3	—	✓	✓	—	—	—	—	—	—	56	—	—	—	✓	5ch, SD16	DAC12	48 DL, RGZ	4.75
FG42x0	MSP430FG4250	16	256	32	3	—	✓	✓	—	—	—	—	—	—	56	—	—	—	✓	5ch, SD16	DAC12, (2) OPAMP	48 DL, RGZ	4.20
	MSP430FG4260	24	256	32	3	—	✓	✓	—	—	—	—	—	—	56	—	—	—	✓	5ch, SD16	DAC12, (2) OPAMP	48 DL, RGZ	4.65
	MSP430FG4270	32	256	32	3	—	✓	✓	—	—	—	—	—	—	56	—	—	—	✓	5ch, SD16	DAC12, (2) OPAMP	48 DL, RGZ	5.10
F43x	MSP430F435	16	512	48	3	3	✓	✓	✓	✓	✓	1	—	—	128/160	—	—	✓	✓	8ch, ADC12	—	80 PN, 100 PZ	5.60
	MSP430F436	24	1024	48	3	3	✓	✓	✓	✓	✓	1	—	—	128/160	—	—	✓	✓	8ch, ADC12	—	80 PN, 100 PZ	5.90
	MSP430F437	32	1024	48	3	3	✓	✓	✓	✓	✓	1	—	—	128/160	—	—	✓	✓	8ch, ADC12	—	80 PN, 100 PZ	6.15
F41x2	MSP430F4152	16	512	56	2	—	✓	✓	✓	✓	✓	—	—	—	144	—	y	8ch, ADC10	—	64 PPM, 48 RGZ	2.40		
	MSP430F4132	8KB	512B	56	2	—	✓	✓	✓	✓	✓	—	—	—	144	—	y	8ch, ADC10	—	64 PPM, 48 RGZ	2.15		
F43x1	MSP430F4351	16	512	48	3	3	✓	✓	✓	✓	✓	1	—	—	128/160	—	—	✓	✓	slope	—	80 PN, 100 PZ	5.10
	MSP430F4361	24	1024	48	3	3	✓	✓	✓	✓	✓	1	—	—	128/160	—	—	✓	✓	slope	—	80 PN, 100 PZ	5.40
	MSP430F4371	32	1024	48	3	3	✓	✓	✓	✓	✓	1	—	—	128/160	—	—	✓	✓	slope	—	80 PN, 100 PZ	5.65
FG43x	MSP430FG437	32	1024	48	3	3	✓	✓	✓	✓	✓	1	—	—	128	✓	—	✓	✓	12ch, ADC12	(2) DAC12, (3) OPAMP	80 PN	8.15
	MSP430FG438	48	2048	48	3	3	✓	✓	✓	✓	✓	1	—	—	128	✓	—	✓	✓	12ch, ADC12	(2) DAC12, (3) OPAMP	80 PN	9.20
	MSP430FG439	60	2048	48	3	3	✓	✓	✓	✓	✓	1	—	—	128	✓	—	✓	✓	12ch, ADC12	(2) DAC12, (3) OPAMP	80 PN	9.95
F44x	MSP430F447	32	1024	48	3	7	✓	✓	✓	✓	✓	2	—	—	160	—	✓	✓	✓	8ch, ADC12	—	100 PZ	7.15
	MSP430F448	48	2048	48	3	7	✓	✓	✓	✓	✓	2	—	—	160	—	✓	✓	✓	8ch, ADC12	—	100 PZ	8.10
	MSP430F449	60	2048	48	3	7	✓	✓	✓	✓	✓	2	—	—	160	—	✓	✓	✓	8ch, ADC12	—	100 PZ	8.80
xG461x	MSP430FG4616	92	4096	80	3	7	✓	✓	✓	✓	✓	1	1	1	160	✓	✓	✓	✓	12ch, ADC12	(2) DAC12, (3) OPAMP	100 PZ, 113 ZOW	11.85
	MSP430FG4617	92	8192	80	3	7	✓	✓	✓	✓	✓	1	1	1	160	✓	✓	✓	✓	12ch, ADC12	(2) DAC12, (3) OPAMP	100 PZ, 113 ZOW	12.45
	MSP430FG4618	116	8192	80	3	7	✓	✓	✓	✓	✓	1	1	1	160	✓	✓	✓	✓	12ch, ADC12	(2) DAC12, (3) OPAMP	100 PZ, 113 ZOW	12.95
MSP430CG4616	MSP430FG4619	120	4096	80	3	7	✓	✓	✓	✓	✓	1	1	1	160	✓	✓	✓	✓	12ch, ADC12	(2) DAC12, (3) OPAMP	100 PZ, 113 ZOW	12.45
	MSP430CG4617	92	4096	80	3	7	✓	✓	✓	✓	✓	1	1	1	160	✓	✓	✓	✓	12ch, ADC12	(2) DAC12, (3) OPAMP	100 PZ	9.60
	MSP430CG4618	116	8192	80	3	7	✓	✓	✓	✓	✓	1	1	1	160	✓	✓	✓	✓	12ch, ADC12	(2) DAC12, (3) OPAMP	100 PZ	10.50
MSP430CG4619	MSP430CG4619	120	4096	80	3	7	✓	✓	✓	✓	✓	1	1	1	160	✓	✓	✓	✓	12ch, ADC12	(2) DAC12, (3) OPAMP	100 PZ	10.10
	MSP430F4783 ¹	48	2480	72	3	3	WDT+	✓	✓	✓	—	2	2	160	—	32x32	✓	✓	(3) SD16	—	100 PZ	9.40	
	MSP430F4793 ¹	60	2560	72	3	3	WDT+	✓	✓	✓	—	2	2	160	—	32x32	✓	✓	(3) SD16	—	100 PZ	10.00	
MSP430F4784 ¹	MSP430F4784 ¹	48	2048	72	3	3	WDT+	✓	✓	✓	—	2	2	160	—	32x32	✓	✓	(4) SD16	—	100 PZ	10.10	
	MSP430F4794 ¹	60	2560	72	3	3	WDT+	✓	✓	✓	—	2	2	160	—	32x32	✓	✓	(4) SD16	—	100 PZ	10.70	
	MSP430F47166 ¹	92	4096	72	3	3	✓	✓	✓	✓	—	2	2	160	✓	✓	✓	✓	(6) SD16	RTC	100 PZ	TBD	
MSP430F47176 ¹	MSP430F47176 ¹	92	8192	72	3	3	✓	✓	✓	✓	—	2	2	160	✓	✓	✓	✓	(6) SD16	RTC	100 PZ	TBD	
	MSP430F47186 ¹	116	8192	72	3	3	✓	✓	✓	✓	—	2	2	160	✓	✓	✓	✓	(6) SD16	RTC	100 PZ	TBD	
	MSP430F47196 ¹	120	4096	72	3	3	✓	✓	✓	✓	—	2	2	160	✓	✓	✓	✓	(6) SD16	RTC	100 PZ	TBD	
MSP430F47167 ¹	MSP430F47167 ¹	92	4096	72	3	3	✓	✓	✓	✓	—	2	2	160	✓	✓	✓	✓	(7) SD16	RTC	100 PZ	TBD	
	MSP430F47177 ¹	92	8192	72	3	3	✓	✓	✓	✓	—	2	2	160	✓	✓	✓	✓	(7) SD16	RTC	100 PZ	TBD	
	MSP430F47187 ¹	116	8192	72	3	3	✓	✓	✓	✓	—	2	2	160	✓	✓	✓	✓	(7) SD16	RTC	100 PZ	TBD	
MSP430F47197 ¹	MSP430F47197 ¹	120	4096	72	3	3	✓	✓	✓	✓	—	2	2	160	✓	✓	✓	✓	(7) SD16	RTC	100 PZ	TBD	

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New products are listed in bold red. Preview products are listed in bold blue.

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Up to 16 MIPS

Product selection tables

Flash-based x4xx MCU Platform (V_{CC} 1.8-3.6V), Up to 8 MIPS (unless noted²) (continued)

(C) Rom (F) Flash	Program (kB)	SRAM (kB)	I/O	16-Bit Timers		Watchdog	BOR	SVS	USART (UART/ SPI)	USCI		LCD Segments	MPY (16 x 16)	Comp_A+	Temp Sensor	ADC Ch/ Res	Additional Features	Packages	Price*	
				A	B					Ch A: UART/ LIN/ IrDA/ SPI	Ch B: I2C/ SPI									
x41x	MSP430F412	4	256	48	3	—	✓	✓	✓	—	—	96	—	—	✓	—	slope	—	64 PM, RTD	3.25
	MSP430C412	4	256	48	3	—	✓	✓	✓	—	—	96	—	—	✓	—	slope	—	64 PM, RTD	2.40
	MSP430F413	8	256	48	3	—	✓	✓	✓	—	—	96	—	—	✓	—	slope	—	64 PM, RTD	3.70
	MSP430C413	8	256	48	3	—	✓	✓	✓	—	—	96	—	—	✓	—	slope	—	64 PM, RTD	2.65
	MSP430F415	16	512	48	3,5	—	✓	✓	✓	—	—	96	—	—	✓	—	slope	—	64 PM, RTD	4.25
	MSP430F417	32	1024	48	3,5	—	✓	✓	✓	—	—	96	—	—	✓	—	slope	—	64 PM, RTD	4.90
F42x	MSP430F423	8	256	14	3	—	✓	✓	✓	1	—	128	—	✓	—	✓	(3) SD16	—	64 PM	5.65
	MSP430F425	16	512	14	3	—	✓	✓	✓	1	—	128	—	✓	—	✓	(3) SD16	—	64 PM	6.20
	MSP430F427	32	1024	14	3	—	✓	✓	✓	1	—	128	—	✓	—	✓	(3) SD16	—	64 PM	6.75

² Prices are quoted in U.S. dollars in quantities of 100 and represent year 2008 suggested resale pricing. All prices are subject to change.

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¹ Up to 16 MIPSSee www.ti.com/msp430 for additional informationFlash-Based x5xx MCU Platform (V_{CC} 1.8-3.6V), Up to 25 MIPS

(F) Flash	Program (kB)	SRAM (kB)	I/O	16-Bit		Watchdog and RTC	PMM, (BOR SVS, SVM, LDO)	USCI		Ch A: UART/LIN/ IrDA/SPI	Ch B: PC/ SPI	DMA	MPY (32 x 32)	Comp A	Temp Sensor	ADC Ch/Res	Addtl. Features	Packages	Price*
				A	B			Ch A: UART/LIN/ IrDA/SPI	Ch B: PC/ SPI										
MSP430F5418	128	16	64	5, 3	7	✓	✓	2	2	✓	✓	—	✓	16ch ADC12A	—	80 PN	\$4.15		
MSP430F5419	128	16	83	5, 3	7	✓	✓	4	4	✓	✓	—	✓	16ch ADC12A	—	100 PZ	\$4.55		
MSP430F5435	192	16	64	5, 3	7	✓	✓	2	2	✓	✓	—	✓	16ch ADC12A	—	80 PN	\$4.85		
MSP430F5436	192	16	83	5, 3	7	✓	✓	4	4	✓	✓	—	✓	16ch ADC12A	—	100 PZ	\$5.35		
MSP430F5437	256	16	64	5, 3	7	✓	✓	2	2	✓	✓	—	✓	16ch ADC12A	—	80 PN	\$5.50		
MSP430F5438	256	16	83	5, 3	7	✓	✓	4	4	✓	✓	—	✓	16ch ADC12A	—	100 PZ	\$6.10		

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Project		Version		Flash/ROM (kB)		RAM (kB)		Source Code	
SimpliciTI ¹	AP Data Hub	1.0.3		6		1		http://www.ti.com/simpliciti	
TIMAC 802.15.4 ²	MSA_MSP430	1.2.1		26		2.3		http://www.ti.com/timac	
ZigBee Coordinator ^{3, 4}	SampleApp (used for table)	1.4.3		49		3.9		http://www.ti.com/z-stack	
ZigBee End Device ^{3, 4}	SampleApp (used for table)	1.4.3		37.7		3.3		http://www.ti.com/z-stack	
ZigBee Coordinator ^{2, 4}	GenericApp	1.4.3		53.5		4.5		http://www.ti.com/z-stack	
ZigBee End Device ^{2, 4}	GenericApp	1.4.3		42.3		3.8		http://www.ti.com/z-stack	

¹ Compiled for the MSP430F2274, ² Compiled for the MSP-EXP4304618, ³ Compiled for the MSP-EXP4304619, ⁴ Compiled without support for the ZTOOL

Product selection tables

Interface

Device	Description	Key Specifications	Smallest Package	Price*
SN65HVD32	3.3 V, 1 Mbps, full-duplex RS-485 transceiver	8 mA (max) I_Q , 1 μ A standby mode, 15 kV ESD protection, true fail-safe, up to 256 nodes	SOIC-14	1.35
SN65HVD12	3.3 V, 1 Mbps, RS-485 transceiver, half-duplex	15.5 mA (max) I_Q , 1 μ A standby mode, 16 kV ESD protection, true fail-safe, up to 256 nodes	SOIC-8	1.30
SN65HVD3085E	5 V, low-power, 1 Mbps RS-485 transceiver	0.9 mA (max) I_Q , 1 nA shutdown mode, 15 kV ESD protection, true fail-safe, up to 256 nodes	MSOP-8	0.90
SN65HVD234	3.3 V, CAN transceiver with sleep mode	6 mA (max) I_Q , 16 kV ESD protection, -36 V to +36 V bus-fault protection with 50 nA sleep mode	SOIC-8	1.45
SN65HVD1050	5 V, CAN transceiver with optimized EMC	10 mA I_Q , 16 kV ESD protection, -27 V to +40 V bus-fault protection, dominant time-out feature	SOIC-8	0.55
SN65HVD1786	5 V, half-duplex, 1Mbps RS-485 transceiver	\pm 70V protected, 6mA (max), 5 μ A star 16kV ESD protection, wide -20 to +25 common mode	SOIC-8	1.85
SN65HVD1781	3.3-5V, half-duplex, 1Mbps, RS485 transciever	\pm 70V protected, 6mA (max), 5 μ A, 16kV ESD protection, weide -20 tc +25 common mode	SOIC-8	1.85

*Suggested resale price in U.S. dollars in quantities of 1,000.

Low dropout (LDO) regulators, positive-voltage, single-output devices

Device ¹	I_Q (μ A)	V_{DD} at I_Q (mV)	I_{OUT} (mA)	Output Options			Adj. (V)	Min V_{IN} (V)	Max V_{IN} (V)	Accuracy (%)	Features ²	C_0 ³	Comments	Package(s)				Price*
				Fixed Voltage (V)											WCSP	SC70	SOT23	QFN
TPS780xxxy	0.5	130	150	1.5 - 4.2, EEPROM ⁴	1.22 to 5.25	2.2	5.5	3	EN,DVS	1 μ F	MSP430, lowest I_Q			x	x			0.65
TPS781xxxy	1	130	150	1.5 - 4.2, EEPROM	1.22 to 5.25	2.2	5.5	3	EN,DVS	1 μ F	MSP430 low I_Q			x	x			0.50
TPS782xx	1	130	150	2.3,2.5,2.7,2.8,3.0,3.3	1.22 to 5.25	2.2	5.5	3	EN	1 μ F	MSP430 low I_Q			x	x			0.43
TPS797xx	1.2	105	50	1.8, 3.0, 3.3		1.8	5.5		EN,PG	0.47 μ F	MSP430 low I_Q							0.34
TPS715xx	3.2	415	50	1.8, 1.9, 2.3, 2.5, 3.0, 3.3, 4.5, 5.0	1.2 to 15	2.5	24	4	—	0.47 μ F	High V_{IN} '		x					0.34
TPS714xx	3.2	670	50	3.3	1.2 to 9	2.5	10	4	—	0.47 μ F	High V_{IN} '		x		x			0.34
TPS715Axx	3.2	670	80	3.3	1.2 to 15	2.5	24	4	—	0.47 μ F	High V_{IN} '				x			0.44
TPS720xx	32	110	350	1.05, 1.2, 1.3, 1.5, 1.8		1.1	4.4	2	EN, Vbias	2.2 μ F	Vbias, low noise high PSRR	x		x	x			0.48
TPS799xx	40	100	200	1.2, 1.3, 1.5, 1.8, 1.85, 1.9, 1.95, 2.0, 2.1, 2.5, 2.6, 2.7, 2.75, 2.8, 2.85, 3.0, 3.15, 3.2, 3.3, 4.2, 4.5	1.2 to 5.5	2.7	6.5	2	EN	2.2 μ F	Low noise high PSRR	x		x	x			0.30
TPS734xx	44	125	250	1.8, 3.0, 3.3	1.2 to 6.0	2.7	6.5	2	EN	2 μ F	Low noise high PSRR			x	x			0.40
TPS735xx	46	250	500	2.5, 3.3	1.2 to 6.0	2.7	6.5	2	EN	2 μ F	Low noise high PSRR				x			0.05
TPS717xx	50	170	150	0.9, 1.0, 1.1, 1.2, 1.3, 1.5, 1.8, 1.85, 1.9, 2.1, 2.5, 2.6, 2.7, 2.8, 2.85, 2.9, 3.0, 3.3, 4.5	0.9 to 6.0	2.5	6.5	3	EN	1 μ F	Low noise high PSRR		x		x			0.45
TPS728xx	50	230	200	0.9 - 3.6, EEPROM4		2.7	6.5		EN, DVS	1 μ F	DVS	x		x				0.49
TPS718xx	90	230	200	1.2/3.3, 1.8/2.7, 1.2/2.5, 2.8/2.8, 2.8/3.0	0.9 to 6.0	2.5	6.5	3	EN, Dual	1 μ F	Dual low noise high PSRR	x		x				0.70
TPS719xx	90	230	200	1.3/2.8, 1.8/1.2, 2.6/1.5, 2.8/2.8, 2.85/2.85, 3.3/2.8, 3.3/3.3, 3.6/3.15	0.9 to 6.0	2.5	6.5	3	EN, Dual	1 μ F	Dual low noise high PSRR	x		x				0.70

¹xx represents the voltage option. For example, 33 represents the 3.3-V option. ²BP = bypass pin for noise reduction capacitor, EN = active high enable, fixed voltages. Minimum quantities apply. Please contact TI. /EN = active low enable, PG = Power Good, SS = soft-start pin, SVS = supply voltage supervisor, TR = tracking. ³C = ceramic, T = tantalum, No Cap = capacitor-free LDO. The adjustable output voltage option is represented by 01. ⁴EEPROM programmable at the factory, allowing production of custom *Suggested resale price in U.S. dollars in quantities of 1,000.

Temperature sensors

Device	Description	Power (max)	Key Specifications	Smallest Pkg.	Price*
TMP102	Digital temperature sensor in SOT-23-6	10 μ A, 1 μ A SHDN	I ² C interface, 1.4 V to 3.6 V, 0.5°C accurate from -25°C to +85°C	SOT-23-6	0.80
TMP121/123	High accuracy, read-only temp sensor	50 μ A, 1 μ A/3 μ A SHDN	SPI interface, 2.7 V to 5.5 V, 2°C accurate from -25°C to +85°C	SOT-23-6	0.90
TMP122	Fully programmable temp sensor	75 μ A, 1 μ A SHDN	SPI interface, 2.7 V to 5.5 V, 2°C accurate from -25°C to +85°C, programmable high/low thresholds	SOT-23-6	0.99
TMP105/106	Chipscale digital temperature sensor	85 μ A, 3 μ A SHDN	World's smallest digital temp sensor, I ² C interface, 2.7 V to 5.5 V, 2°C accurate from -25°C to +85°C	WCSP	0.85
TMP75	Digital temp sensor w/2-wire interface	85 μ A, 3 μ A SHDN	I ² C Interface, 2.7 V to 5.5 V, 1.5°C accurate from -25°C to +85°C, drop-in replacement for LM75	MSOP-8	0.70
TMP275	Highest accuracy temp sensor	85 μ A, 3 μ A SHDN	I ² C interface, 2.7 V to 5.5 V, 0.5°C accurate from -25°C to +100°C with 3.3 V supply	MSOP-8	1.25
TMP300	Resistor programmable temp switch	110 μ A SHDN	10 mV/C analog output, 1.8 V to 18 V, \pm 2°C (typ) trip point accuracy, programmable hysteresis	SC-70	0.80

*Suggested resale price in U.S. dollars in quantities of 1,000

Product selection tables



Operational amplifiers

Device	Description	Key specifications	Package(s)	Price*
OPA333	Ultra-low power, zero-drift in SC-70	1.8 V to 5.5 V, 17 μ A I_Q , 350 kHz GBW, 5 μ V (max) V_{OS} , RRIO <i>proposed single channel W CSP package for release Q4 '09</i>	SC-70, SOT23, DFN	0.95
OPA379	Low noise, μ Power, SC-70	1.8 V to 5.5 V, 5 μ A max I_Q , 100 kHz GBW, 1mV (max) V_{OS} , RRIO	SC-70, SOT23, S08	0.75
TLV2401	Sub-1 μ A	2.5 V to 16 V, 88 nA I_Q , 5.5 kHz GBW, 1.2 mV (max) V_{OS} , RRIO	SOT23	0.6
OPA349	Best speed/power, nanoPower, SC-70	1.8 V to 5.5 V, 1 μ A I_Q , 70 kHz GBW, RRIO	SC-70	0.75
TLV2381	Good speed/power, wide supply range	2.5 V to 16 V, 20 μ A (max) I_Q 160 kHz GBW, RRIO	SOT23	0.60
TLV2760	Fast, μ Power	2.5 V to 16 V, 20 μ A I_Q 500 kHz GBW, RRIO	SOT-23	0.65
OPA336	High precision, μ Power	2.3 V to 5.5 V, 20 μ A I_Q , 100 kHz GBW, 60 μ V V_{OS} , RRIO	SOT23	0.40
OPA347	μ Power, SC-70 (dual in chipscale)	2.3 V to 5.5 V, 20 μ A I_Q , 350 kHz GBW, 2 μ V/ $^{\circ}$ C (max) drift, RRIO	SC-70, WCSP	0.48
TLV2450	μ Power with SHDN	2.7 V to 6 V, 35 μ A I_Q , 220 kHz GBW, 1.5 mV (max) V_{OS} , RRIO	SOT23	0.65
OPA348	Fastest μ Power op amp in SC-70	2.1 V to 5.5 V, 65 μ A max I_Q , 1 MHz GBW, 35 nV/ \sqrt{Hz} noise, 125 $^{\circ}$ C, RRIO	SC-70	0.45
TLV341A	SC-70 with SHDN	1.5 V to 5 V, 200 μ A (max) I_Q , 2.3 MHz, 0.9 V/ μ s, 3 nA (max) I_B , 1.7 mV (max) V_{OS} , RRIO	SC-70	0.45
OPA334	Highest precision, with SHDN	2.7 V, 350 μ A (max) I_Q , 2 MHz GBW, 5 μ V (max) offset, 0.0 μ V/ $^{\circ}$ C (max) drift	SOT23	1.00
OPA373	Low cost, performance, SHDN	2.7 V to 5.5 V, 750 A (max) I_Q , 6.5 MHz GBW, 5 V/ μ s slew rate, RRIO	SOT23	0.36
OPA363	1.8 V, high CMRR, precision, low distortion	1.8 V, 90 dB CMRR (typ), 750 μ A (max) I_Q , 7 MHz GBW, 500 μ V (max) V_{OS} , RRIO, SHDN	SOT23	0.60
OPAy369	nanopower, Zero-Crossover Amplifier	1.8V to 5.5V, 800/700nA I_Q (single/dual), excellent DC precision, 3.6uVp-p noise (0.1 to 10Hz)	SC70 and SOT23 (dual)	0.80
OPAy376	Low noise, low quiescent current, Precision op amp e-trim TM series	2.2V to 5.5V, 760uA I_Q , 5.5MHz GBW, 7.5nV per rHz at 1kHz, RRO	SC70, SOT23, WCSP (Dual)	0.65 (single)
OPAy347	Micropower rail-to-rail op amp	2.3V to 5.5V, 20uA I_Q , 350kHz GBW, RRIO	SC70, SOT23, WCSP (Dual)	0.55 (single)
TLV2780	1.3 V operation, low noise	1.3 V to 3.6 V, 820 μ A (max) I_Q , 8 MHz GBW, 4.3 V/ μ s slew rate, RRIO	SOT23	0.70

Instrumentation amplifiers

Device	Description	Power	Key Specifications	Package	Price*
INA321	μ Power, SHDN	40 μ A	2.7 V to 5.5 V, 40 μ A I_Q , 200 μ V typ V_{OS} , 94 dB CMRR, 10 pA I_B , RRO, G = 5 to 1k	MSOP-8	1.05
INA322	μ Power, low cost, SHDN	40 μ A, 1 μ A SD	2.7 V to 5.5 V, 40 μ A I_Q , (I_Q μ A in SD), 2 mV typ V_{OS} , 500 kHz BW, RRO, G = 5 to 1 k	MSOP-8	0.85
INA122	μ Power, RRO, CM to GND	85 μ A	2.2 V to 36 V, 85 μ A (max) V_{OS} , 3 μ V/ $^{\circ}$ C (max) drift, G = 5 to 1k	SOIC-8	2.10
INA126	Low noise, μ Power, precision	175 μ A	2.7 V to 36 V, 175 μ A/channel I_Q , 250 μ V (max) V_{OS} , 3 μ V/ $^{\circ}$ C (max) drift, G = 5 to 1k	MSOP-8	1.05
INA118	High precision, μ Power, G = 1 to 10000	385 μ A	2.7 V to 36 V, 385 μ A (max) I_Q , 107 dB (min) CMRR, 55 μ V (max) V_{OS} , 0.7 μ V/ $^{\circ}$ C (max) drift	SOIC-8	4.14
INA331	Low power, high speed, precision, SHDN	415 μ A, 0.01 μ A SD	2.7 V to 5.5 V, 415 μ A (max) I_Q (0.01 μ A in SD), 2 MHz BW, 5 V/ μ s, RRO, G = 5 to 1k	MSOP-8	1.10
INA125	Low power, internal reference, SHDN	460 μ A	2.7 V to 36 V, 460 μ A (max) I_Q , 250 V (max) V_{OS}	SOIC-8	2.05
INA332	Low power, high speed, SHDN	490 μ A, 0.01 μ A SD	2.7 V to 5.5 V, 490 μ A (max) I_Q (0.01 μ A in SD), 2 MHz BW, 5 V/ μ s, RRO, G = 5 to 1 k	MSOP-8	0.85
INA132	Low power difference amp	185 μ A	2.7 V to 36 V, 185 μ A (max) I_Q , 250 V (max) V_{OS} , 90 dB CMR, 0.001% non-linearity	SOIC-8	1.05
INA152	Difference amp with rail-rail output	650 μ A	2.7 V to 20 V, 650 μ A (max) I_Q , 250 V typ V_{OS} , 3 μ V/ $^{\circ}$ C drift, 94 dB CMR, 0.001% non-linearity	MSOP-8	1.20
INA333	Noise free, precision, low power	50 μ A	1.8 V to 5.5 V, 20 μ V offset, 50 nV/ $^{\circ}$ C drift, RFI filtered inputs	MSOP-8	1.80

References

Device	Description	Power (max)	Key Specifications	Package	Price*
REF33xx	Very low power series reference	5 μ A	0.15% initial accuracy, 30 ppm/ $^{\circ}$ C (max) drift, \pm 5 mA output, 1.25 V, 1.8 V, 2.048 V, 2.5 V, 3.0 V, 3.3 V	SC70-3	0.85
REF30xx	Low power, low drift series reference	50 μ A	0.2% initial accuracy, 50 ppm/ $^{\circ}$ C (max) drift, \pm 25 mA output, 1.25 V, 2.048 V, 2.5 V, 3.0 V, 3.3 V, 4.096 V	SOT23-3	0.60
REF32xx	Ultra-low drift series reference	100 μ A	0.2% initial accuracy, 7 ppm/ $^{\circ}$ C (max) drift, \pm 10 mA output, 1.25 V, 2.048 V, 2.5 V, 3.0 V, 3.3 V, 4.096 V	SOT23-3	1.70
REF29xx	Low power, low cost series reference	50 μ A	2% initial accuracy, 100 ppm/ $^{\circ}$ C (max) drift, \pm 25 mA output, 1.25 V, 2.048 V, 2.5 V, 3.0 V, 3.3 V, 4.096 V	SOT23-3	0.49

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D093008

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