

## Epic Core

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### Product Description

The Epic Core is an integrated, mote-in-package module that offers a full-featured mote in a compact form factor. Designed with platform builders in mind, the Epic Core integrates all of the key components of today's deeply embedded wireless systems, including a low-power microcontroller, IEEE 802.15.4-compatible radio, 16-Mbit flash memory, and unique hardware ID in a form factor occupying less than 1 square inch, making the Epic Core a 6LoWPAN/IPv6-ready, drop-in solution that is easy to integrate into new or existing platform designs.

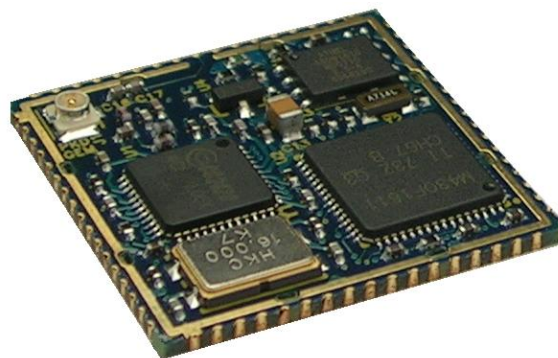
The Epic Core dramatically reduces the time to design and debug new platforms by providing a fully open-source design and exposing nearly every internal electrical signal, allowing designers to understand the module, probe many of its internal signals, and track power flows using standard test equipment. The module can be socketed for prototyping breadboards, hand-soldered for small pilot runs, and machine-assembled for high-volume production.

### Highlights

- TI MSP430F1611 Mixed-Signal Microcontroller
- TI CC2420 IEEE 802.15.4-Compatible Radio
- Atmel AT45DB161D 16-Mbit DataFlash®
- Maxim DS2411 Globally-Unique Silicon ID

### Applications

The Epic Core is suitable for a broad range of low-power sensing and actuation applications, allowing platform designers and system builders to focus on the unique characteristics of their application rather than low-level hardware details or networking functionality. Dozens of platforms have been built around the Epic Core including systems for home energy tracking, solar-powered environmental monitoring, body-worn activity sensing, and mobile air-quality sampling. The Epic Core module is available as a part in both OrCAD and Eagle library formats. A platform integration guide provides essential details for incorporating the module into custom hardware designs.



The Epic Core provides an optimized RF section and two options for antenna integration, reducing or eliminating the level of RF engineering required to integrate the module into a new design. An onboard U.FL connector allows off-the-shelf 50  $\Omega$  antennas with pigtail termination to be directly connected to the module. A PCB RF port allows board or chip antennas to be interfaced to the module.

- 68-Pin Leadless Chip Carrier Package (LCC-68)
- Sleep Current Typically 9 $\mu$ A at 3 V
- Full TinyOS/b1ip Platform Support
- Fully Open-Source Hardware Design

The Epic Core is also suitable for teaching and experimentation. Since the module exposes nearly every internal signal, it is well-suited to teaching the fundamentals of embedded system design, including bus protocols, sensing and sampling, flash memory storage, ADC, DAC, PWM, JTAG, and low-power operation. The Epic Core has already been used in several wireless sensor network courses and research testbeds.

The Epic Core is a fully-supported platform under the open-source TinyOS operating system and is the primary target platform for the Berkeley Low-Power IPv6 (b1ip) network stack, making fully open-source, Internet-capable platform design within easy reach.

## System

MCU	MSP430F1611IRTD
Flash	48 KB
RAM	10 KB
Clock	4/8 MHz
Wakeup	6 $\mu$ s (typ)
Radio	CC2420RTRC
Frequency	2.400 to 2.483 GHz in 1 MHz steps
Modulation	O-QPSK (MSK)
RX Sens	-94 dBm (typ) @ 1% PER
TX Power	-25 to 0 dBm (max), programmable
Wakeup	629 $\mu$ s (typ)
Flash	AT45DB161D-MU-2.5
Density	16 Mbit, 512/528 byte page (nom)
Type	NOR architecture

## Interfaces

ADC	8 ADC channels, 12-bits External reference input (+/-)
DAC	2 DAC channels, 12-bits (shared with ADC lines)
I/O <sup>†</sup>	8 general-purpose 8 interrupt-capable 5 special-function
I2C	1 port (shared with SPI0)
JTAG	TDI/O, TCLK, TMS, TCK, RST
1-Wire <sup>®</sup>	1 port (shared with DS2411)
RF	U.FL or PCB port (50 $\Omega$ ) RX/TX switch signal (1.8 V logic) SFD (start-of-frame delimiter) CCA (clear channel assessment) ATEST1 and ATEST2 internal signals
SPI	1 port (SPI1, shared with UART1) <sup>‡</sup> 1 port (SPI0, shared with radio, flash, I2C bus)
UART	1 port (UART1, shared with SPI1) <sup>‡</sup> 1 port (UART0, shared with SPI0)
XTAL	Lines for external MCU XTAL Lines for internal radio XTAL exported

<sup>†</sup>See Epic Core schematic. Some lines shared/multi-function.

<sup>‡</sup>SPI1 and UART1 are unused but share common hardware.

## Electrical

Parameter	Min	Typ	Max	Units
Supply Voltage	2.7	3.0	3.6	V
System Sleep		9		$\mu$ A
MCU Sleep		2.6		$\mu$ A
Active (Core)		500		$\mu$ A
Radio Sleep		1		$\mu$ A
Receive		19.7		mA
Transmit		17.4		mA
Flash Sleep		5.4		$\mu$ A
Read		7		mA
Write/Erase		12		mA

## Mechanical

Land Pattern	SMD 68 pins (LCC-68)
Dimensions	24.1 mm x 24.1 mm x 2.5 mm
w/RF shield	24.1 mm x 24.1 mm x 3.5 mm
Operating Temp	-40 to +85°C
Storage Temp	-50 to +125°C
Humidity	0 to 100% RH

## Software Support

```
TinyOS make epic [install [minipro]]  
GNU/GCC msp430-gcc toolchain
```

## Supporting Hardware and Tools

Minipro	USB programmer stick
Prog/Charger	USB programmer/Li+ charger
Breakout	Jumper access to all pins
Developers Kit	Epic Core (5) and tools

## Ordering Information

EPIC-CORE-U.FL	RF output via U.FL conn
EPIC-CORE-PCB	RF output via PCB pad

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