

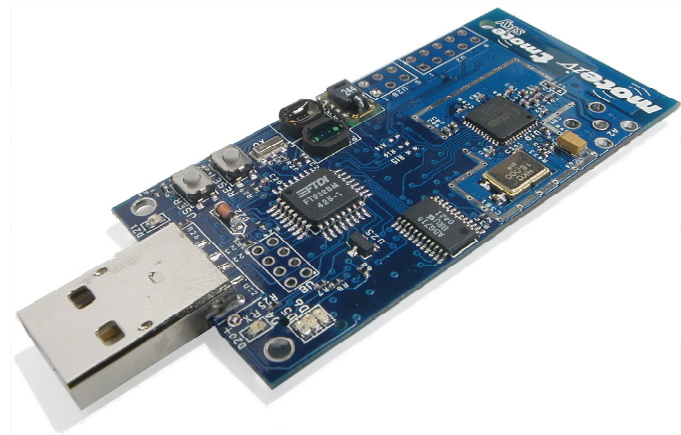


**Ultra low power IEEE 802.15.4 compliant wireless sensor module**

Humidity, Light, and Temperature sensors with USB

## Product Description

Tmote Sky is an ultra low power wireless module for use in sensor networks, monitoring applications, and rapid application prototyping. Tmote Sky leverages industry standards like USB and IEEE 802.15.4 to interoperate seamlessly with other devices. By using industry standards, integrating humidity, temperature, and light sensors, and providing flexible interconnection with peripherals, Tmote Sky enables a wide range of mesh network applications. Tmote



Sky is a drop-in replacement for Moteiv's successful Telos design. Tmote Sky includes increased performance, functionality, and expansion. With TinyOS support out-of-the-box, Tmote Sky leverages emerging wireless protocols and the open source software movement. Tmote Sky is part of a line of modules featuring on-board sensors to increase robustness while decreasing cost and package size.

## Key Features

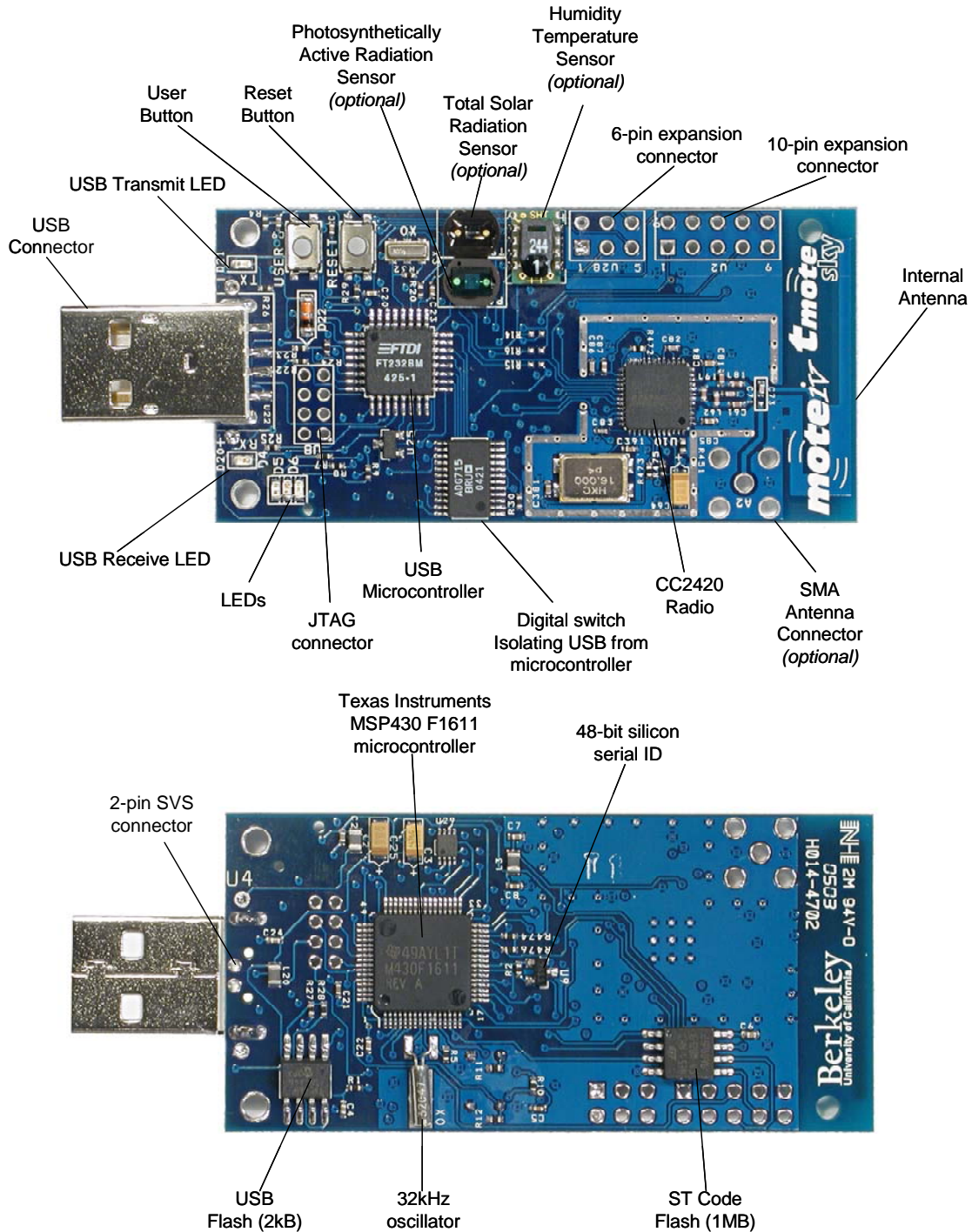
- 250kbps 2.4GHz IEEE 802.15.4 Chipcon Wireless Transceiver
- Interoperability with other IEEE 802.15.4 devices
- 8MHz Texas Instruments MSP430 microcontroller (10k RAM, 48k Flash)
- Integrated ADC, DAC, Supply Voltage Supervisor, and DMA Controller
- Integrated onboard antenna with 50m range indoors / 125m range outdoors
- Integrated Humidity, Temperature, and Light sensors
- Ultra low current consumption
- Fast wakeup from sleep (<math><6\mu\text{s}</math>)
- Hardware link-layer encryption and authentication
- Programming and data collection via USB
- 16-pin expansion support and optional SMA antenna connector
- TinyOS support : mesh networking and communication implementation
- Complies with FCC Part 15 and Industry Canada regulations
- Environmentally friendly – complies with RoHS regulations

## Table of Contents

Product Description.....	1
Key Features.....	1
Table of Contents.....	2
Module Description .....	3
Power .....	4
Typical Operating Conditions .....	4
Mechanical Characteristics .....	5
Block Diagram.....	6
Schematic .....	7
Microprocessor .....	9
Description .....	9
Typical Operating Conditions .....	9
PC Communication .....	9
Programming.....	10
Block Diagram.....	12
Radio.....	13
Description .....	13
Typical Operating Conditions .....	14
Measured Output Power .....	14
Antenna.....	15
Internal Antenna without Battery Pack.....	15
Internal Antenna with Battery Pack.....	15
Radiation Pattern .....	16
External Flash.....	17
Typical Operating Conditions .....	17
Flash Hardware Write Protection .....	18
Sensors.....	19
Humidity/Temperature Sensor .....	19
Light Sensors .....	20
Expansion Connector.....	21
Internal Temperature and Voltage Monitoring.....	23
Agency Certification .....	24
FCC Certification.....	24
OEM Labeling requirement .....	24
FCC Notices.....	25
General Information .....	25
Document History.....	26
Product Status Definitions.....	26
Disclaimer .....	27
Address Information .....	28
Headquarters .....	28

## Module Description

The Tmote Sky module is a low power “mote” with integrated sensors, radio, antenna, microcontroller, and programming capabilities.



**Figure 1 : Front and Back of the Tmote Sky module**

## Power

Tmote Sky may be powered by two AA batteries. The module was designed to fit the two AA battery form factor. AA cells may be used in the operating range of 2.1 to 3.6V DC, however the voltage must be at least 2.7V when programming the microcontroller flash or external flash.

If the Tmote Sky module is plugged into the USB port for programming or communication, it will receive power from the host computer. The mote operating voltage when attached to USB is 3V. If Tmote will always be attached to a USB port, no battery pack is necessary.

The 16-pin expansion connector (described in the Section on page 17) can provide power to the module. Any of the battery terminal connections may also provide power to the module. At no point should the input voltage exceed 3.6V—doing so may damage the microcontroller, radio, or other components.

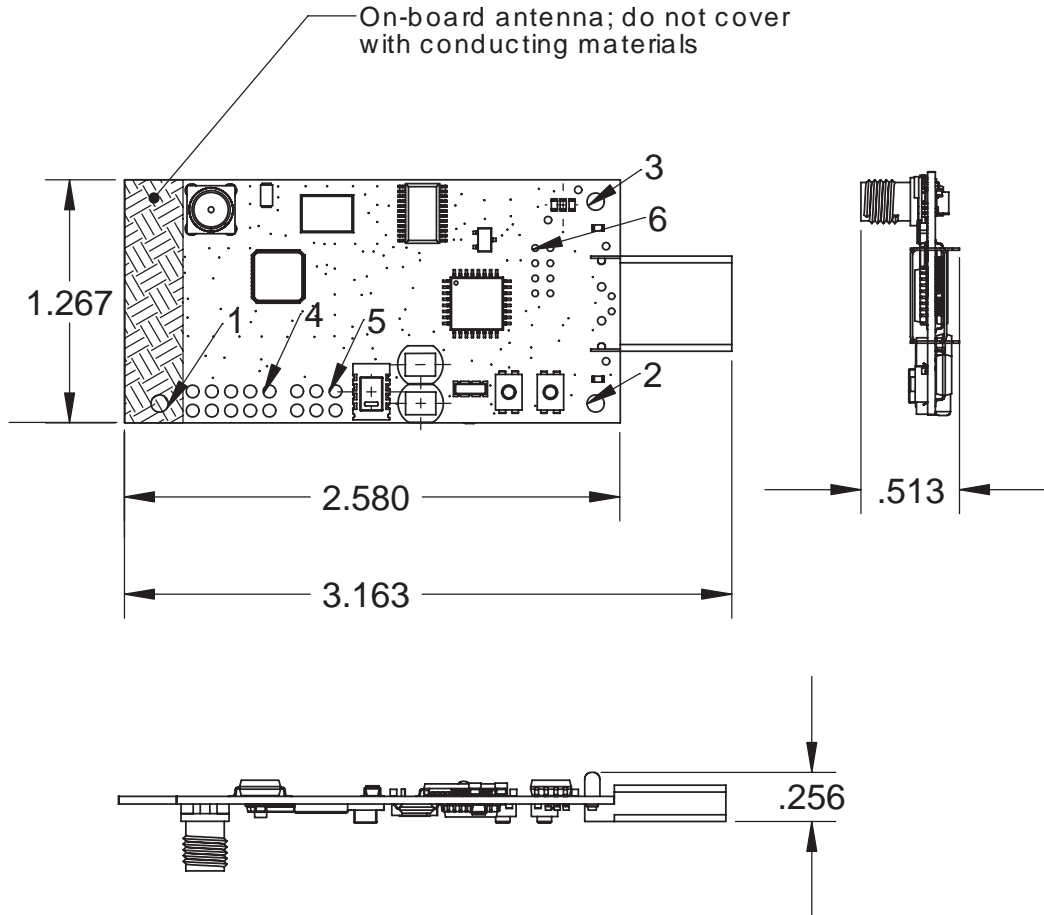
## Typical Operating Conditions

	MIN	NOM	MAX	UNIT
Supply voltage	2.1		3.6	V
Supply voltage during flash memory programming	2.7		3.6	V
Operating free air temperature	-40		85	°C
Current Consumption: MCU on, Radio RX		21.8	23	mA
Current Consumption: MCU on, Radio TX		19.5	21	mA
Current Consumption: MCU on, Radio off		1800	2400	µA
Current Consumption: MCU idle, Radio off		54.5	1200	µA
Current Consumption: MCU standby		5.1	21.0	µA



**Caution!** ESD sensitive device. Precaution should be used when handling the device in order to prevent permanent damage.

### Mechanical Characteristics



Tag	X	Y	Size	Notes
1	0.183	0.099	Ø 0.090	Mounting hole, do not use metal fixture
2	2.454	0.099	Ø 0.090	Mounting hole
3	2.454	1.151	Ø 0.090	Mounting hole
4	0.755	0.162	Ø 0.066	Pin 1 of 10-pin 0.1in rect IDC connector
5	1.099	0.163	Ø 0.066	Pin 1 of 6-pin 0.1in rect IDC connector
6	2.139	0.909	Ø 0.034	Pin 1 of 8-pin 2mm rect JTAG connector

**Figure 2 : Physical dimensions of Tmote Sky.**  
**All units are in inches unless otherwise noted.**

	MIN	NOM	MAX	UNIT
Width	1.24	1.26	1.29	in
Length	2.55	2.58	2.60	in
Height (without battery pack and SMA antenna)	0.24	0.26	0.27	in

### Block Diagram

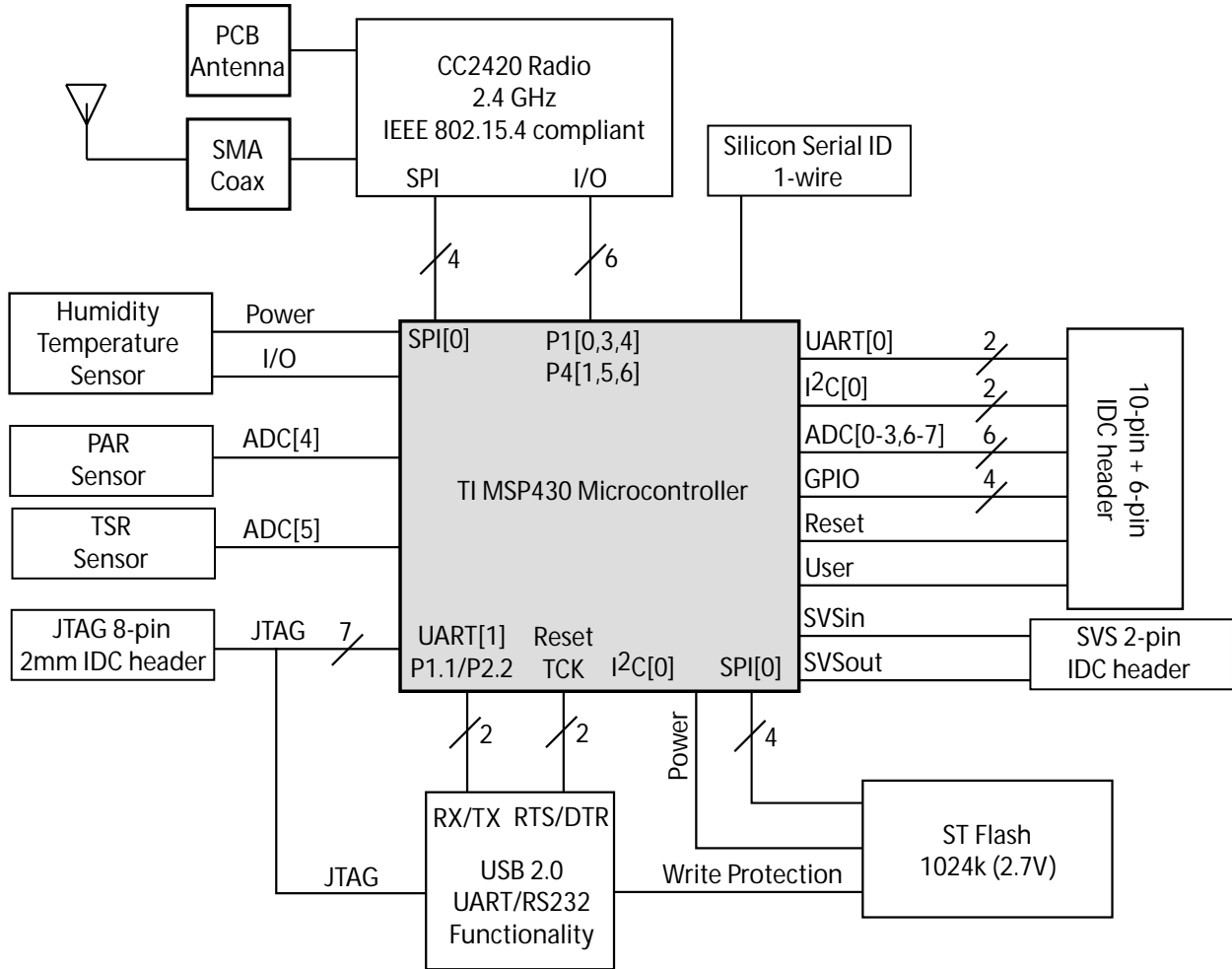
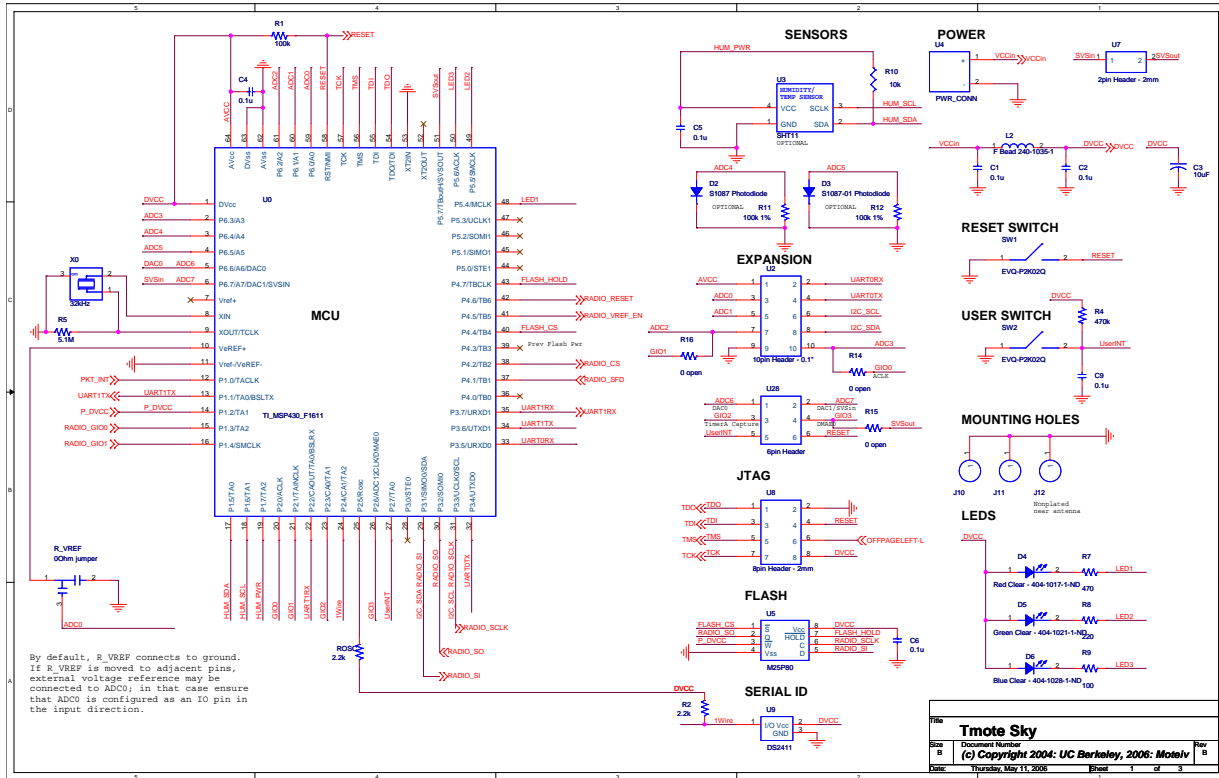


Figure 3 : Functional Block Diagram of the Tmote Sky module, its components, and buses

Schematic



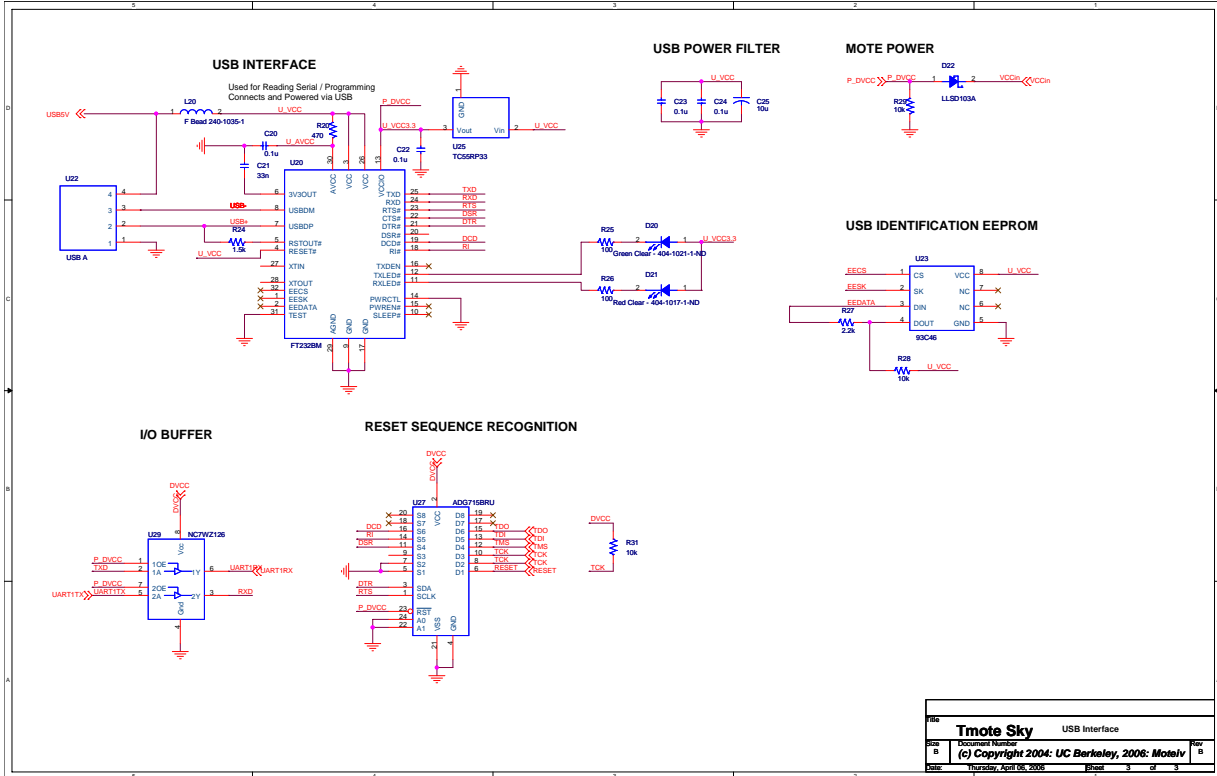
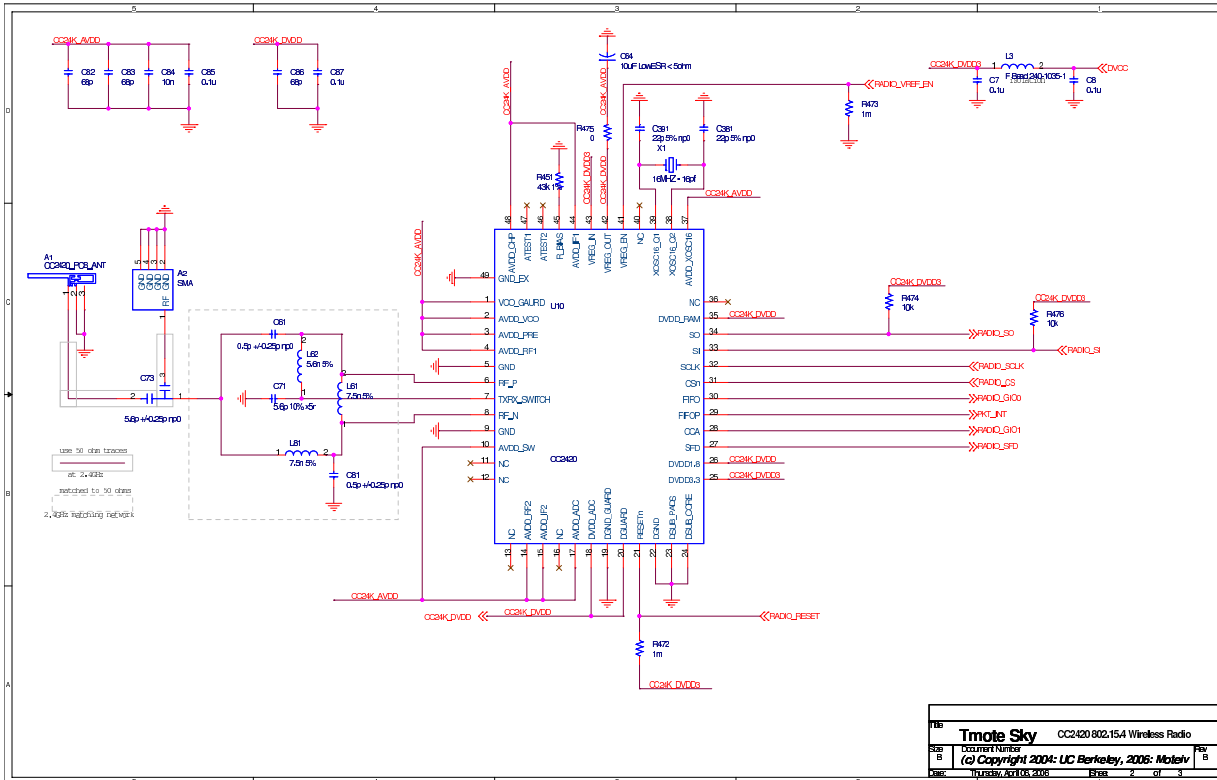


Figure 4 : Schematics for the Tmote Sky module



## Microprocessor

### Description

The low power operation of the Tmote Sky module is due to the ultra low power Texas Instruments MSP430 F1611 microcontroller featuring 10kB of RAM, 48kB of flash, and 128B of information storage. This 16-bit RISC processor features extremely low active and sleep current consumption that permits Tmote to run for years on a single pair of AA batteries. The MSP430 has an internal digitally controlled oscillator (DCO) that may operate up to 8MHz. The DCO may be turned on from sleep mode in 6 $\mu$ s, however 292ns is typical at room temperature. When the DCO is off, the MSP430 operates off an eternal 32768Hz watch crystal. Although the DCO frequency changes with voltage and temperature, it may be calibrated by using the 32kHz oscillator.

In addition to the DCO, the MSP430 has 8 external ADC ports and 8 internal ADC ports. The ADC internal ports may be used to read the internal thermistor or monitor the battery voltage. A variety of peripherals are available including SPI, UART, digital I/O ports, Watchdog timer, and Timers with capture and compare functionality. The F1611 also includes a 2-port 12-bit DAC module, Supply Voltage Supervisor, and 3-port DMA controller.

The features of the MSP430 F1611 are presented in detail in the Texas Instruments MSP430x1xx Family User's Guide available at <http://ti.com/msp430>.

### Typical Operating Conditions

	MIN	NOM	MAX	UNIT
Supply voltage during program execution	1.8		3.6	V
Supply voltage during flash memory programming	2.7		3.6	V
Operating free air temperature	-40		85	$^{\circ}$ C
Low frequency crystal frequency		32.768		kHz
Active current at Vcc = 3V, 1MHz		500	600	$\mu$ A
Sleep current in LPM3 Vcc = 3V, 32.768kHz active		2.6	3.0	$\mu$ A
Wake up from LPM3 (low power mode)			6	$\mu$ s

### PC Communication

Tmote Sky uses a USB controller from FTDI to communicate with the host computer. In order to communicate with the mote, the FTDI drivers must be installed on the host. FTDI provides drivers for Windows, Linux, BSD, Macintosh, and Windows CE. These drivers are included on the Moteiv CD shipped with your order. Windows users will need the Virtual Com Port (VCP) drivers. They may also be downloaded from FTDI's website at: <http://www.ftdichip.com/>

Tmote Sky appears as a COM port in Windows' device manager (or as a device in `/dev` in Linux, OSX, and BSD). Multiple Tmote Sky motes may be connected to a single computer's USB ports at the same time. Each mote will receive a different COM port identifier. In the example below, one Tmote is connected and assigned COM6 "USB Serial Port".

An application may read from Tmote Sky by opening the COM port assigned to the Tmote Sky mote. Tmote communicates with the host PC through USART1 on the TI MSP430.

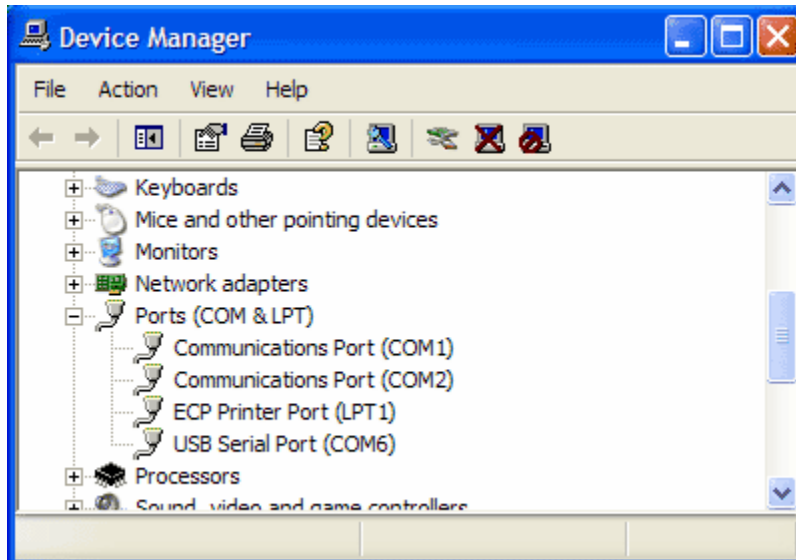


Figure 5 : Device Manager showing Tmote Sky installed as COM6

The `motelist` command line utility lists all of the Tmote Sky notes currently connected to a computer. This utility optionally lists previously connected notes that the system has cached. Invoke `motelist` with the `-h` option for more information.

```
> motelist
Reference  CommPort  Description
-----
M49WD0S6  COM6      Moteiv tmote sky
```

**NOTE:** Tmote Sky uses an I<sup>2</sup>C digital switch to prevent unwanted conventional serial port signals from reaching the TI microcontroller. The I<sup>2</sup>C protocol must be implemented and sent over the RTS and DTR lines in order to obtain direct access between the Tmote Sky and USB controller. The UART lines do not use the I<sup>2</sup>C switch allowing direct communication (but not programming or JTAG) without additional software.

## Programming

The Tmote Sky module is programmed through the onboard USB connector. A modified version of the MSP430 Bootstrap Loader, `mSP430-bs1`, programs the microcontroller's flash. Tmote has a unique hardware circuit that prevents the mote from spuriously resetting. This hardware circuit makes it necessary to have a special sequence sent to the module in order to program it.

By invoking `mSP430-bs1`, verify you have the patched BSL by looking for the "telos" keyword. Version 1.39-telos-7 or later is required for Tmote Sky.

```
> mSP430-bs1
MSP430 Bootstrap Loader Version: 1.39-telos-7
Use -h for help
```

To communicate with Tmote Sky, the MSP430 Bootstrap Loader requires a set of options to provide the proper signals to the microcontroller to initiate programming. For convenience, the options have been folded into a single Tmote flag:

```
--tmote
```

To program a Tmote Sky module on COM3 (or `/dev/ttyUSB2` in Linux) with an application image named `app.ihex`, invoke the MSP430 Bootstrap loader with the following options.

```
> msp430-bsl --tmote -c 2 -r -e -I -p app.ihex
MSP430 Bootstrap Loader Version: 1.39-telos-7
Mass Erase...
Transmit default password ...
Invoking BSL...
Transmit default password ...
Current bootstrap loader version: 1.61 (Device ID: f16c)
Changing baudrate to 38400 ...
Program ...
2742 bytes programmed.
Reset device ...
```

If you are using TinyOS, it has support for programming Tmote Sky. After compiling your application, you may install it with the following command

```
> make tmote install.x bsl,n
```

Where `x` is the 16-bit address assigned to the mote and `n` is the COM port that Tmote Sky is currently using. Note that not including “`bsl`” or “`bsl,n`” will program automatically using the `bsl` to the first Telos mote found on the USB bus using the `motelist` command.

For more information about the options in the MSP430 Bootstrap loader, invoke `msp430-bsl` with the `-h` option to display the help information.

`Motelist` and `msp430-bsl` are available from Moteiv Corporation at <http://www.moteiv.com> in the “Support” section.



**NOTE:** `msp430-bsl` starts counting from 0, but COM ports in Windows start counting at 1. If Tmote Sky is connected to COM3 in Windows, you must program it using “`-c 2`” or “`bsl,2`” when invoking `msp430-bsl`. In Linux, Tmote Sky will appear as `/dev/ttyUSB2` and may be programmed using “`-c 2`” or “`bsl,2`”.

### Block Diagram

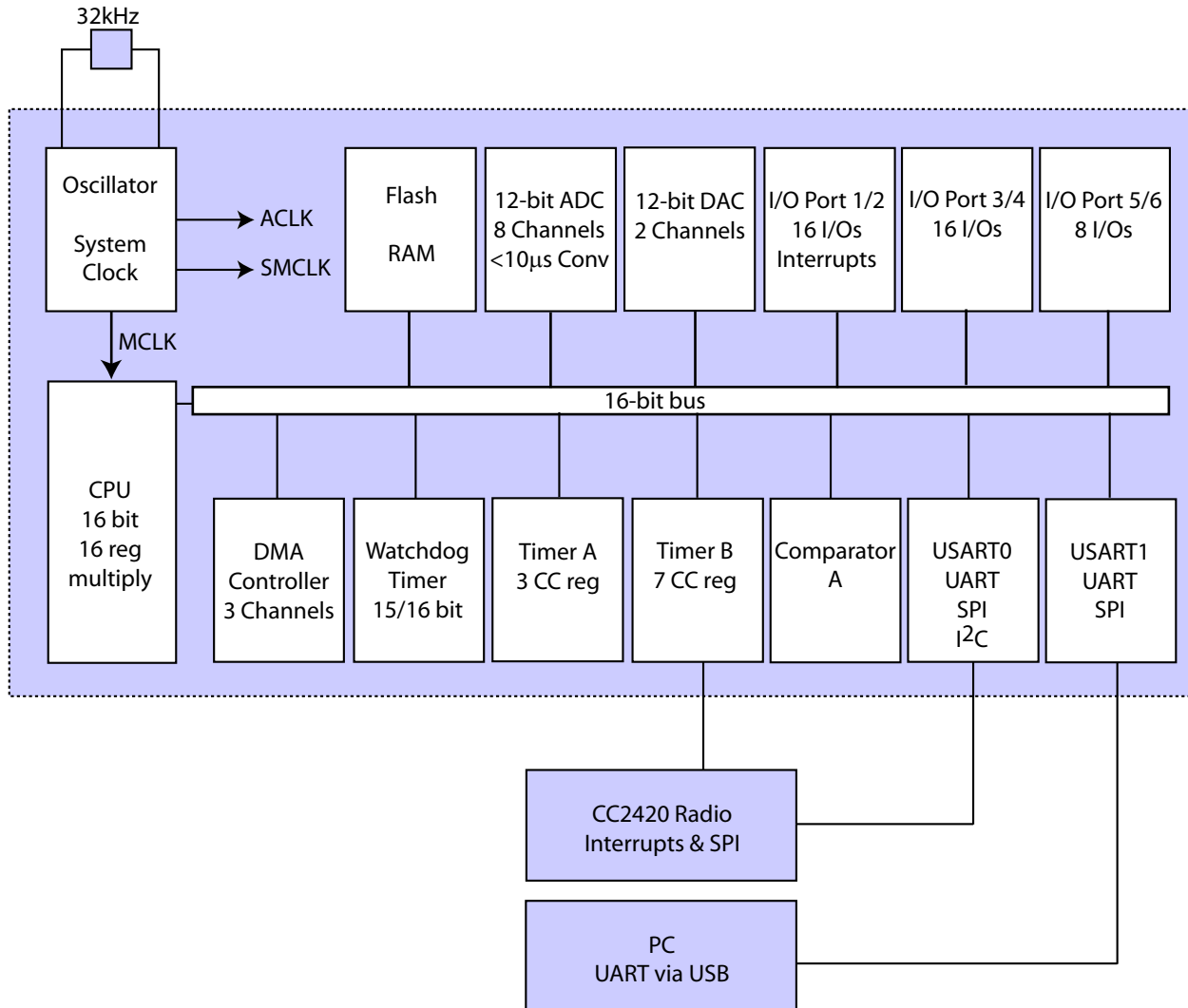


Figure 6 : Block diagram of the TI MSP430 microcontroller and its connection to other peripherals in the Tmote Sky module

## Radio

### Description

Tmote Sky features the Chipcon CC2420 radio for wireless communications. The CC2420 is an IEEE 802.15.4 compliant radio providing the PHY and some MAC functions. With sensitivity exceeding the IEEE 802.15.4 specification and low power operation, the CC2420 provides reliable wireless communication. The CC2420 is highly configurable for many applications with the default radio settings providing IEEE 802.15.4 compliance. Features and usage of the CC2420 is available in Chipcon's datasheet at <http://www.chipcon.com>

The CC2420 is controlled by the TI MSP430 microcontroller through the SPI port and a series of digital I/O lines and interrupts (see the Schematics on page 7 for more information). The radio may be shut off by the microcontroller for low power duty cycled operation.

The CC2420 has programmable output power. Common CC2420 register values and their corresponding current consumption and output power are shown in Figure 7.

PA_LEVEL	TXCTRL register	Output Power [dBm]	Current Consumption [mA]
31	0xA0FF	0	17.4
27	0xA0FB	-1	16.5
23	0xA0F7	-3	15.2
19	0xA0F3	-5	13.9
15	0xA0EF	-7	12.5
11	0xA0EB	-10	11.2
7	0xA0E7	-15	9.9
3	0xA0E3	-25	8.5

Figure 7 : Output power configuration for the CC2420

The CC2420 provides a digital received signal strength indicator (RSSI) that may be read any time. Additionally, on each packet reception, the CC2420 samples the first eight chips, calculates the error rate, and produces a link quality indication (LQI) value with each received packet. A mapping from RSSI to the RF level in dBm is shown in Figure 8.

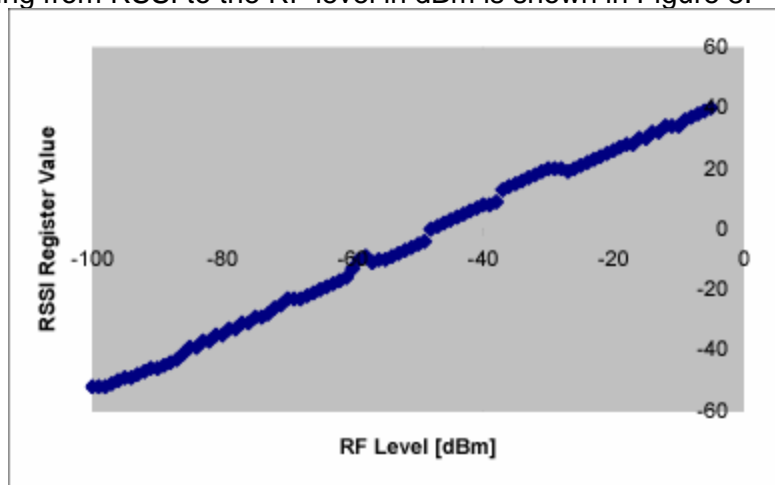


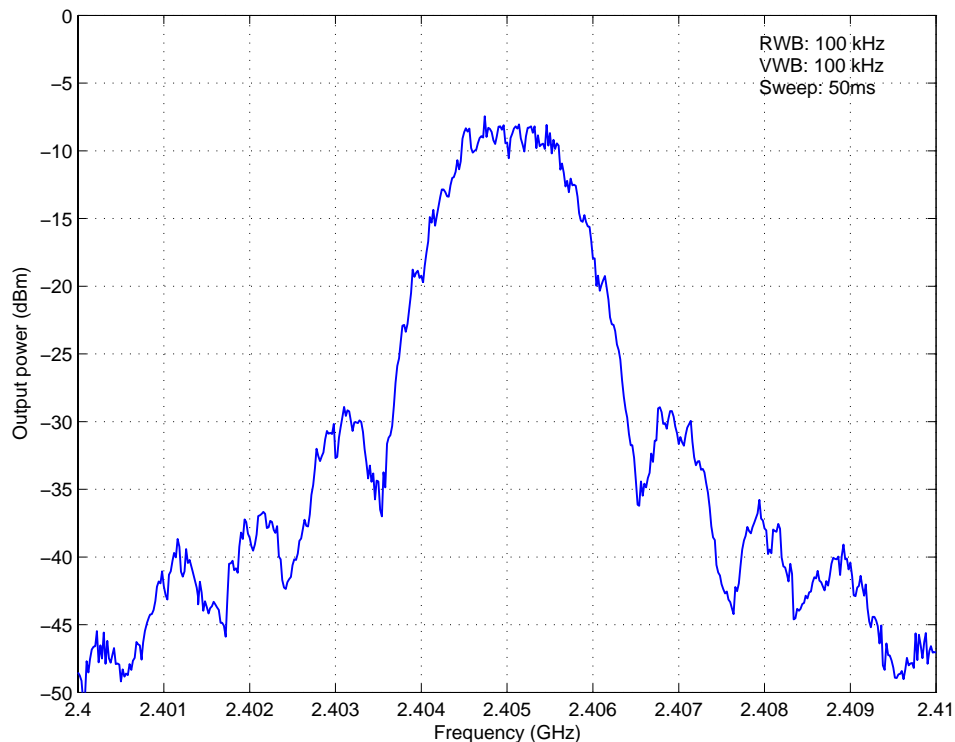
Figure 8 : Received Signal Strength Indicator mapping to RF Power [dBm]

### Typical Operating Conditions

	MIN	NOM	MAX	UNIT
Supply voltage during radio operation (Vreg on)	2.1		3.6	V
Operating free air temperature	-40		85	°C
RF frequency range	2400		2483.5	MHz
Transmit bit rate	250		250	kbps
Nominal output power	-3	0		dBm
Programmable output power range		40		dBm
Receiver sensitivity	-90	-94		dBm
Current consumption: Radio transmitting at 0 dBm		17.4		mA
Current consumption: Radio receiving		19.7		mA
Current consumption: Radio on, Oscillator on		365		μA
Current consumption: Idle mode, Oscillator off		20		μA
Current consumption: Power Down mode, Vreg off			1	μA
Voltage regulator current draw	13	20	29	μA
Radio oscillator startup time		580	860	μs

### Measured Output Power

The RF output power of the Tmote Sky module from the CC2420 radio is shown in Figure 9. For this test, the Tmote Sky module is transmitting at 2.405GHz (IEEE 802.15.4 channel 11) using the O-QPSK modulation with DSSS. The CC2420 programmed output power is set to 0 dBm. The measured output power of the entire modulated spectrum is 2.4 dBm.



**Figure 9 : Measured RF output power over the modulated spectrum from the Tmote Sky module**

## Antenna

Tmote Sky's internal antenna is an Inverted-F microstrip design protruding from the end of the board away from the battery pack. The Inverted-F antenna is a wire monopole where the top section is folded down to be parallel with the ground plane. Although not a perfect omnidirectional pattern, the antenna may attain 50-meter range indoors and upwards of 125-meter range outdoors. Measurements of the internal antenna's performance with and without a battery pack are show in Figure 10 and Figure 11. Approximate radiation patterns for the Inverted-F antenna as provided by Chipcon AS are shown in Figure 12 and Figure 13.

### Internal Antenna without Battery Pack

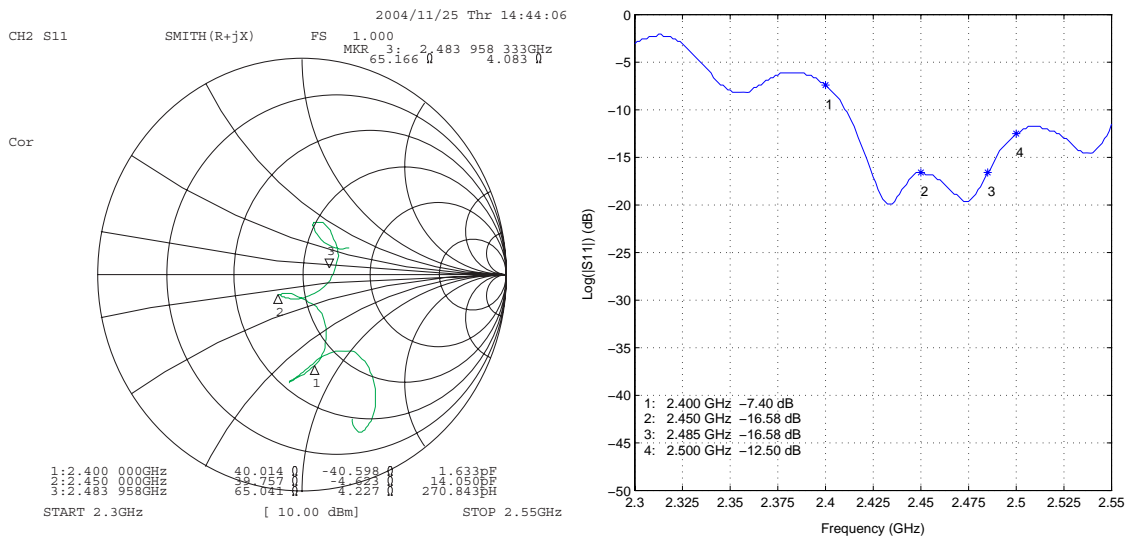


Figure 10 : S11 measurements for the internal inverted-F antenna when no battery pack is present

### Internal Antenna with Battery Pack

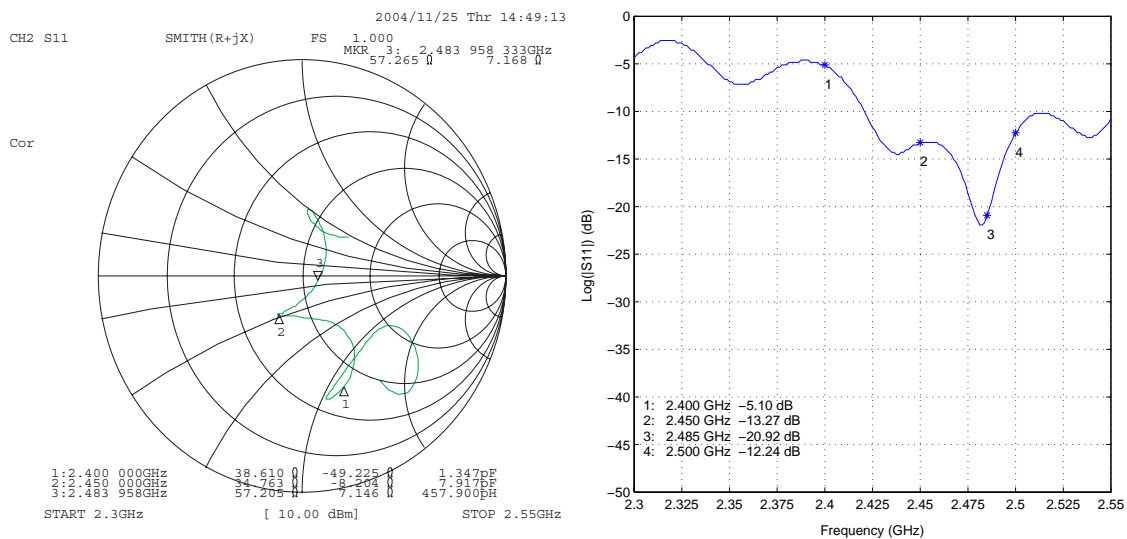


Figure 11 : S11 measurements for the internal inverted-F antenna with battery pack underneath

### Radiation Pattern

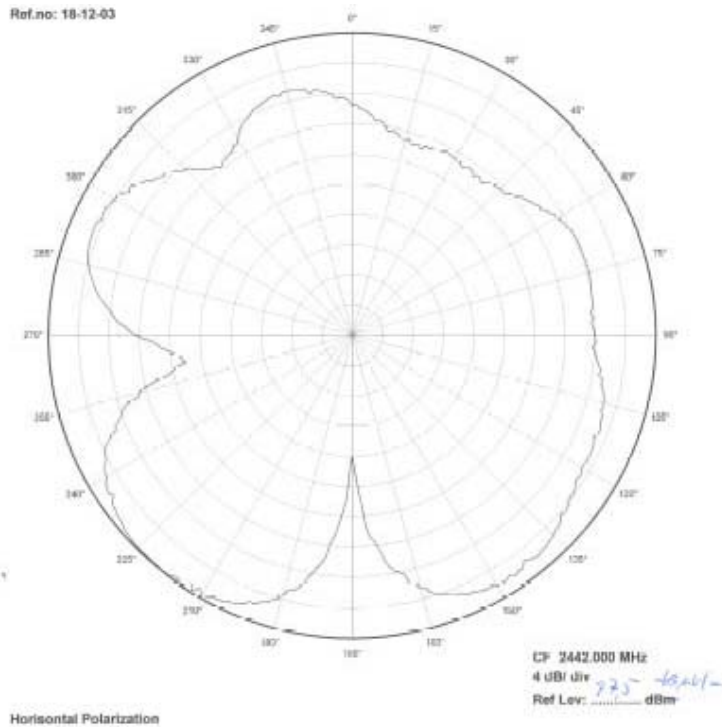


Figure 12 : Radiated pattern of the Inverted-F antenna with horizontal mounting (from Chipcon AS)

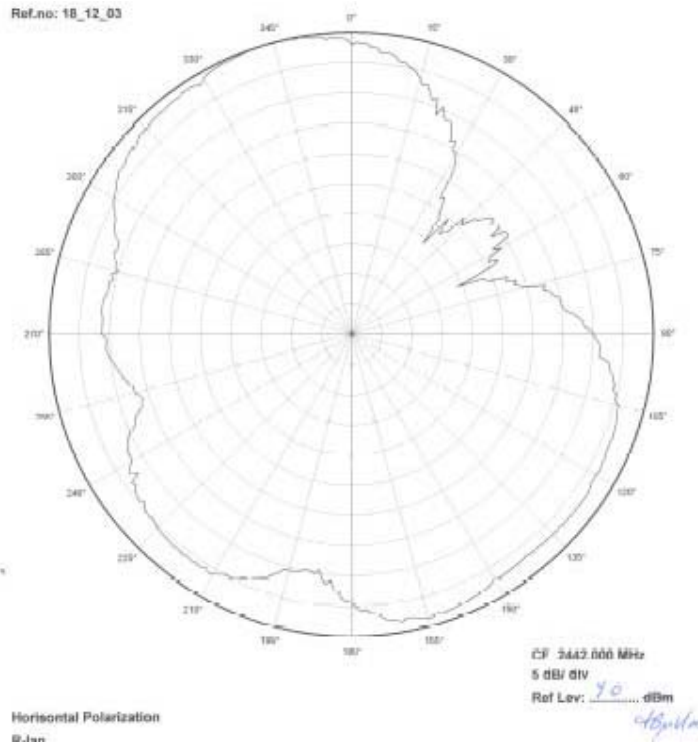


Figure 13 : Radiated pattern of the Inverted-F antenna with vertical mounting (from Chipcon AS)



## External Flash

Tmote Sky uses the ST M25P80 40MHz serial code flash for external data and code storage. The flash holds 1024kB of data and is decomposed into 16 segments, each 64kB in size. The flash shares SPI communication lines with the CC2420 transceiver. Care must be taken when reading or writing to flash such that it is interleaved with radio communication, typically implemented as a software arbitration protocol for the SPI bus on the microcontroller.

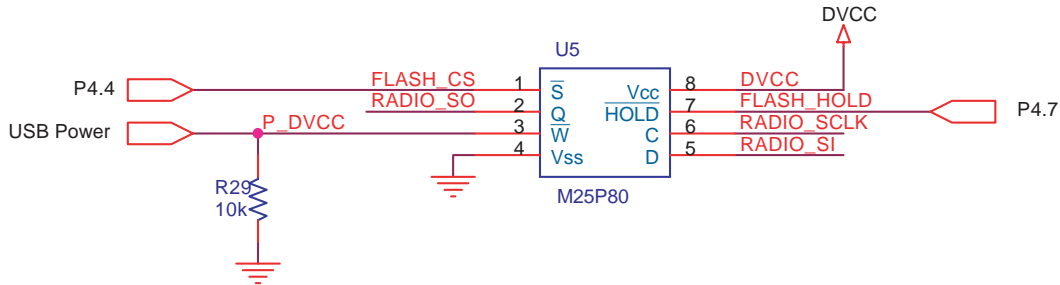


Figure 14 : External serial flash schematic

## Typical Operating Conditions

	MIN	NOM	MAX	UNIT
Supply voltage during flash memory programming	2.7		3.6	V
Operating free air temperature	-40		85	°C
Erase/Programming cycles			100,000	cycles
Data Retention			20	years
Active current (READ)			4	mA
Active current (WRITE/ERASE)			20	mA
Standby current		8	50	µA
Deep Power Down current		1	10	µA

**!** **NOTE:** The ST M25P-series of code flash always starts in the standby state. For low power applications, the flash must be sent a command at boot time to place it in the deep power down mode. If using TinyOS, the flash is automatically put into deep power down mode and must be instructed to exit deep power down mode the first time the flash is accessed. See the ST M25P80 datasheet for more information.  
<http://www.st.com/stonline/books/pdf/docs/8495.pdf>

### Flash Hardware Write Protection

The flash includes hardware write protection functionality. The write protection exists on a sector basis as shown in Figure 16. The hardware write protection pin (Pin 3 of the M25P80 shown in Figure 14) only disables write protection when the module is powered by the USB port. When connected to USB, the status register must be updated by removing the write protect and block protect bits in Figure 15. The write protected segments may only be changed after the module connected to USB and the write protect bit is cleared.

Tmote Sky ships with sector 15 (the upper sixteenth sector) write protected and the SRWD bit set. In sector 15 is the “Golden Image” and factor metadata. The “Golden Image” is a factory program image that includes network reprogramming so that Tmote Sky may always return to a known good state, even if loaded with a malfunctioning program image. When Tmote Sky is connected to the USB, the “Golden Image” may be changed. See the TinyOS Deluge documentation in `tinynos-1.x/docs` of the TinyOS distribution included with Tmote.

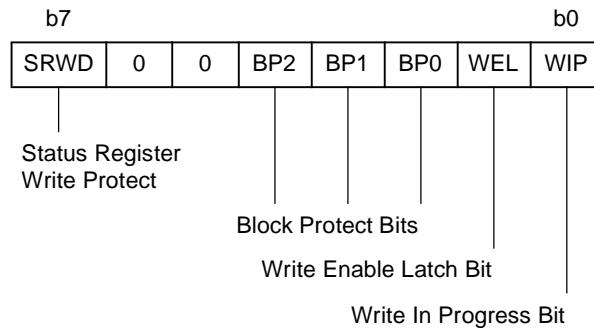


Figure 15 : ST M25P80 Status Register contents (from ST).

Status Register Content			Memory Content (Sectors)	
BP2 Bit	BP1 Bit	BP0 Bit	Protected Area	Unprotected Area
0	0	0	None	All sectors (0-15)
0	0	1	Upper sixteenth (15)	Lower fifteen-sixteenths (0-14)
0	1	0	Upper eighth (14-15)	Lower seven-eighths (0-13)
0	1	1	Upper quarter (12-15)	Lower three-quarters (0-11)
1	0	0	Upper half (8-15)	Lower half (0-7)
1	0	1	All sectors (0-15)	None
1	1	0	All sectors (0-15)	None
1	1	1	All sectors (0-15)	None

Figure 16 : Write protection settings for the ST M25P80 flash. Tmote Sky modules are shipped with the gray setting (001).

**NOTE:** When programming data to write protected segments of external flash, do not disconnect the module before the programming is completely. If the module is disconnected from the USB, the write may be interrupted or the status register may not be updated to reflect the new write protection settings.

## Sensors

### Humidity/Temperature Sensor

The optional humidity/temperature sensor is manufactured by Sensirion AG. The SHT11 and SHT15 models may be directly mounted on the Tmote Sky module in the U3 component position.

The SHT11/SHT15 sensors are calibrated and produce a digital output. The calibration coefficients are stored in the sensor's onboard EEPROM. The difference between the SHT11 and SHT15 model is that the SHT15 produces higher accuracy readings as shown in Figure 18. The sensor is produced using a CMOS process and is coupled with a 14-bit A/D converter. The low power relative humidity sensor is small in size and may be used for a variety of environmental monitoring applications.

More information can be found in the SHT1x datasheet available at <http://www.sensirion.com>

Parameter	MIN	TYP	MAX	Units
<b>Humidity</b>				
Resolution	0.5	0.03	0.03	%RH
	8	12	12	Bit
Repeatability		±0.1		%RH
Range	0		100	%RH
<b>Temperature</b>				
Resolution	0.04	0.01	0.01	°C
	0.07	0.02	0.02	°F
	12	14	14	bit
Repeatability		±0.1		°C
		±0.2		°F
Range	-40		123.8	°C
	-40		254.9	°F

Figure 17 : Sensirion relative humidity and temperature performance specifications

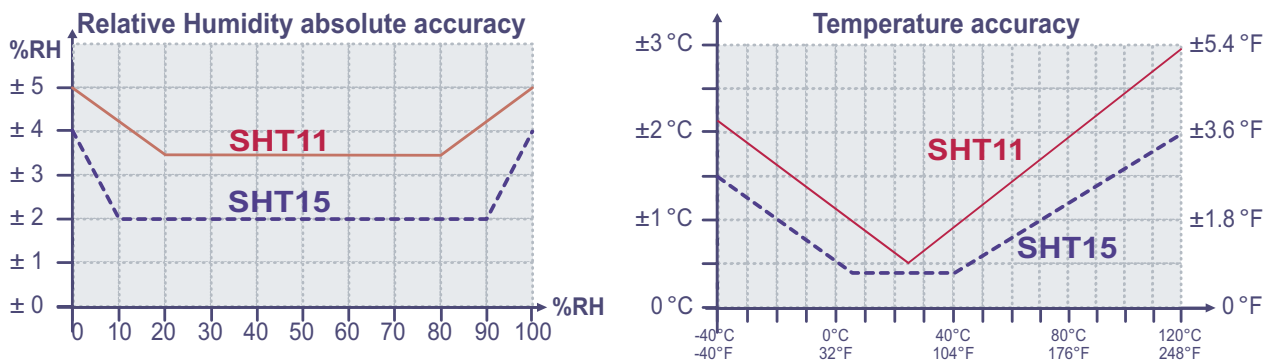


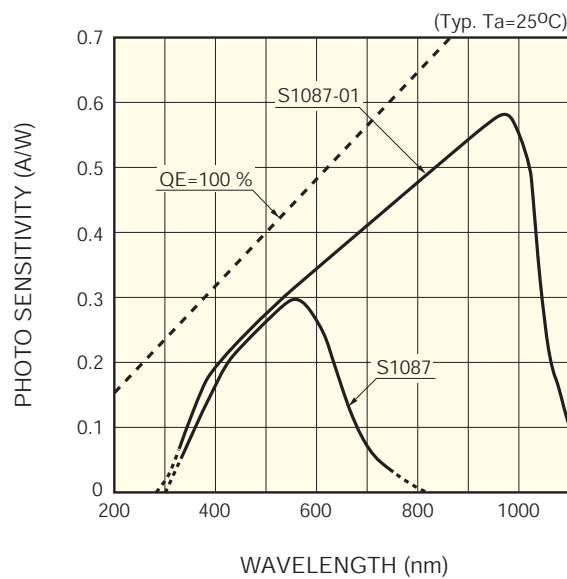
Figure 18 : Accuracy of Sensirion relative humidity and temperature sensors (courtesy Sensirion)

### Light Sensors

A variety of light sensors may be used with Tmote Sky. Tmote Sky has connections for two photodiodes. Moteiv currently uses photodiodes from Hamamatsu Corporation (<http://www.hamamatsu.com>)

If your mote is populated with light photodiodes, the default diodes are the S1087 for sensing photosynthetically active radiation and the S1087-01 for sensing the entire visible spectrum including infrared

Although these photodiodes from Hamamatsu have been tested with Tmote Sky, any photodiode with similar physical dimensions may be used with Tmote Sky.



**Figure 19 : Photo Sensitivity of the Light sensors on Tmote Sky(from Hamamatsu)**

## Expansion Connector

Tmote Sky has two expansion connectors and a pair of onboard jumpers that may be configured so that additional devices (analog sensors, LCD displays, and digital peripherals) may be controlled by the Tmote Sky module. On the far side of the board from the USB connector is a 10-pin IDC header at position U2 and a 6-pin IDC header at U28. The 10-pin connector has the same connections as Tmote Sky and is the primary connector. It provides digital input and output signals as well as analog inputs. Peripherals may be connected to the 10-pin connector using an IDC header, an IDC ribbon cable, or by designing a printed circuit board that solders directly on to the IDC header providing a robust connection to the module. An additional 6-pin (U28) header provides access to the exclusive features of Tmote Sky. Two additional ADC inputs are provided that may be reconfigured by software to be two 12-bit DAC outputs. ADC7 may also act as the input to the supply voltage supervisor. The user interface elements—the reset and user buttons—are exported by the 6-pin header for use in external interfaces and packaging.

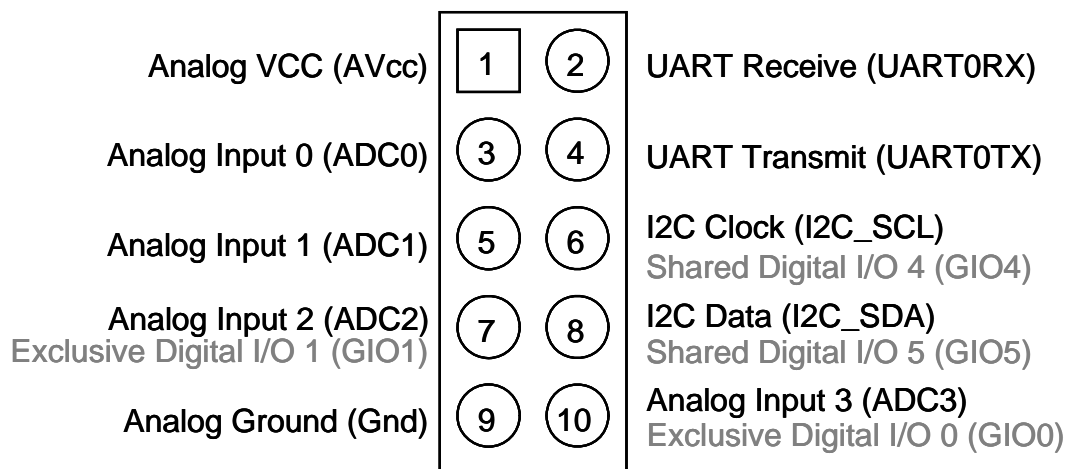


Figure 20 : Functionality of the 10-pin expansion connector (U2).  
Alternative pin uses are shown in gray.

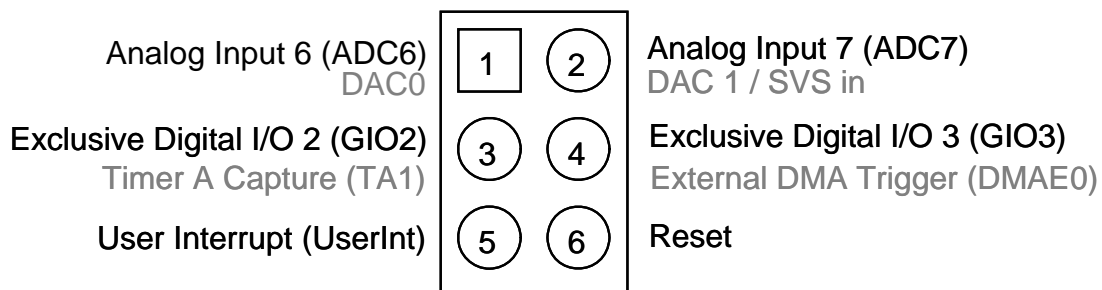


Figure 21 : Functionality of the 6-pin expansion connector (U28).



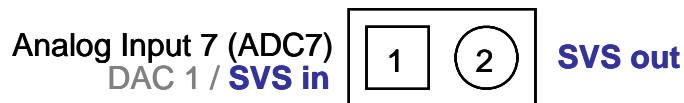
**NOTE:** The I<sup>2</sup>C pins are shared with the radio's data input pin and the radio clock. Care must be taken by application developers to multiplex operations on the I<sup>2</sup>C bus and the radio.

If expansion pin 10 (ADC3) is used to generate microcontroller interrupts instead of digital I/O and analog input functionality, R14 must be populated with a 0 ohm resistor to enable the pin for digital I/O (GIO0) on the microcontroller. R16 must be populated with a 0 ohm resistor to enable GIO1. R14 and R16 are located on the top side of Tmote Sky between the USB controller and the radio.

**!** **NOTE:** When R14/R16 is populated (GIO0/GIO1 enabled), ADC3/ADC2 will not provide reliable readings if an application reverts to using the ADC input instead of the digital I/O port input on the microcontroller. R14/R16 are not required for digital I/O functionality from ADC3/ADC2; they are only needed if an interrupt request must be generated by an external device on these pins. R14/R16 should be removed when using ADC3/ADC2 for analog input.

The 6-pin IDC header also has an optional jumper, R15. By installing a 0 ohm resistor at R15, GIO3 is directly connected to SVSout. By making GIO3 an input and using the SVS features of the microcontroller, the SVSout function can be exported via pin 4 of U28.

A separate Supply Voltage Supervisor (SVS) 2-pin IDC header is provided underneath the USB connector at position U7. The SVS header allows add-on boards to be built that connect to the positive and negative battery terminals and the SVS pins in order to provide power the module and use the microcontroller's advanced SVS functionality for boost converters, solar systems, and rechargeable systems. The SVS header is shown in Figure 22 and includes the SVSin and SVSout pins from the microcontroller.

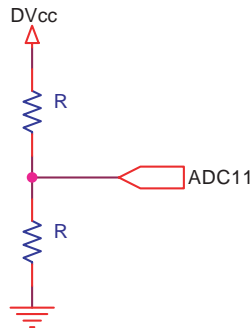


**Figure 22 : Functionality of the 2-pin Supply Voltage Supervisor connector (U7).**

### Internal Temperature and Voltage Monitoring

The MSP430 microcontroller has internal temperature and voltage sensors that may be used through the microcontroller's ADC interface.

The voltage port (input 11) on the 12-bit ADC monitors the output from a voltage divider.



Voltage monitoring for Tmote Sky modules.

Converting the ADC units to a voltage reading can be done with the following formula:

$$DV_{cc} = \frac{ADCCounts}{4096} \times V_{ref} \times \frac{2R}{R}$$

The temperature input is a temperature diode connected to internal ADC port 10. When using the temperature sensor, the sample period must be greater than 30  $\mu$ s. The temperature sensor offset error can be large, and may need to be calibrated for most applications. The typical response of the temperature sensor is shown in Figure 23.

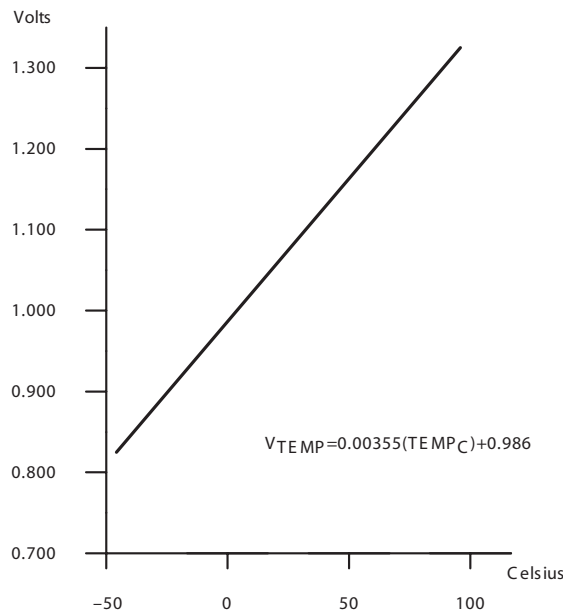


Figure 23 : Typical response of the internal temperature sensor. Results vary and the sensor should be calibrated for most applications. Response curve from Texas Instruments.

## Agency Certification

### FCC Certification

The Tmote Sky module complies with Part 15 of the FCC rules and regulations. Compliance with the labeling requirements, FCC notices and antenna usage guidelines is required.

To fulfill FCC Certification requirements, the OEM must comply with the following regulations:

1. The system integrator must ensure that the text on the external label provided with this device is placed on the outside of the final product [Figure 26].
2. The Tmote Sky module may be used only with approved antennas that have been tested with this module.

### FCC OEM Labeling requirement

Contains FCC ID: TOQTMOTESKY

The enclosed device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference and (2) this device must accept any interference received, including interference that may cause undesired operation

**Figure 24 Required FCC label for OEM products containing the Tmote Sky module.**

The Original Equipment Manufacturer (OEM) must ensure that FCC labeling requirements are met. This includes a clearly visible label on the outside of the final product enclosure that displays the contents shown in Figure 24.

### Industry Canada OEM Labeling Requirement


To satisfy Industry Canada labeling requirements, the following text must be placed on the exterior of the end product:


Contains IC: 6142A-TMOTESKY


**Figure 25: Required Industry Canada label for OEM products containing the Tmote Sky module**



## Regulatory Notices

 **IMPORTANT:** The Tmote Sky module has been certified by the FCC for use with other products without any further certification (as per FCC section 2.1091). Changes or modifications not expressly approved by Moteiv Corporation could void the user's authority to operate the equipment.

 **IMPORTANT:** OEMs must test final product to comply with unintentional radiators (FCC section 15.107 and 15.109) before declaring compliance of their final product to Part 15 of the FCC Rules.

 **IMPORTANT:** The RF module has been certified for remote and base radio applications. If the module will be used for portable applications, the device must undergo SAR testing. This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures: Re-orient or relocate the receiving antenna, Increase the separation between the equipment and receiver, Connect equipment and receiver to outlets on different circuits, or Consult the dealer or an experienced radio/TV technician for help.

## General Information

### Document History

Revision	Date	Notes
1.0	2005/02/23	Initial Release
1.0.1	2005/12/28	Added FCC and IC regulatory information
1.0.2	2006/02/06	Updated contact information
1.0.3	2006/10/05	Updated schematics to reflect the RoHS production boards
1.0.4	2006/11/13	Updated schematics, figures, and disclaimer

### Product Status Definitions

Data Sheet Identification	Product Status	Definition
Advance Information	Planned or under development	This data sheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	Engineering samples or first production	This data sheet contains preliminary data, and supplementary data will be published at a later date. Moteiv reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.
No Identification Noted	Full production	This data sheet contains the final specifications. Moteiv reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.
Obsolete	Not in production	This data sheet contains specifications on a product that has been discontinued by Moteiv. The data sheet is printed for reference information only. Moteiv no longer supports this product.



## Low Power Wireless Sensor Module

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**Low Power Wireless Sensor Module**

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