802.15.4 MAC
User's Guide
For CC2430

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Version	Description	Date
1.0	Initial release.	06/01/2006
1.1	Updated for v1.2.0 release.	03/28/2007
1.2	Added code banking support.	06/09/2008
1.3	Updated for v1.3.0 release.	06/18/2009

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1. Introduction

1.1. Scope

This document is a user's guide for Texas Instruments' TIMAC™ software and accompanying sample application. TIMAC is an implementation of the IEEE 802.15.4 MAC specification. The sample application demonstrates how devices can associate and transmit application data using the Texas Instruments TIMAC.

2. Product Package Description

2.1. Installation Package Contents

The downloaded TIMAC installation package contains all of the documentation and software required to install, configure, and develop applications using TIMAC. The package employs a Microsoft Windows-based installation application which guides the installation process.

2.2. Development Boards

Two Texas Instruments SmartRF04EB boards, each fitted with a CC2430EM evaluation module, may be used to demonstrate or develop IEEE 802.15.4 applications based on the TIMAC software package. Everything you need to get started is in the CC2430 Development Kit. These boards provide a rich development platform, including an LCD display and RS232 serial port.

Figure 1: SmartRF04EB Evaluation Board with CC2430EM

TIMAC also provides support for Texas Instruments CC2430DB boards which can be obtained individually CC2430 Development Board or as part of a kit CC2430 ZigBee Development Kit. These boards provide a compact demonstration platform - no LCD display or 9-pin serial port.

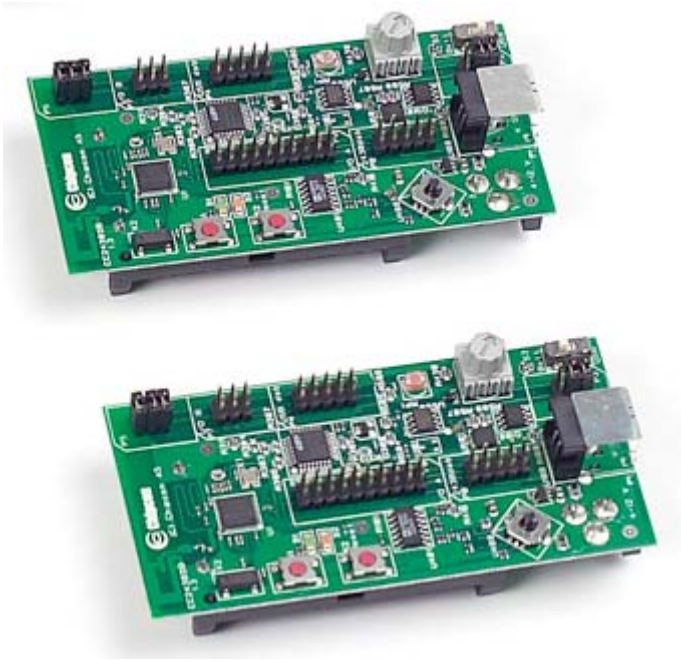

Figure 2: CC2430DB Development Boards

2.3. Cables

All necessary cabling has been included with the development kit. To support program download and debugging of SmartRF04EB boards, a USB cable can be connected from each target board to the host PC. RS232 cables may be connected between the serial port on SmartRF04EB boards (9-pin) and the host. Note: RS232 cables are not required for the TIMAC Sample Application.

3. Installation Requirements

3.1. Target Development System Requirements

TIMAC libraries and sample application projects are used with the IAR Embedded Workbench (EW8051) suite of software development tools. These tools support project management, compiling, assembling, linking, downloading, and debugging for various 8051-based processors, including the Texas Instruments CC2430. Required support for the TIMAC target development :

- IAR EW8051 (http://www.iar.com/)

4. Product Installation Procedures

4.1. Install TIMAC Package

Install the Texas Instruments TIMAC files and programs from the downloaded package. Run the windows-based installation program, ***TIMAC-CC2430-1.3.0.exe***, which will create the required directory structure and load all software and documentation files. Review the README file for a synopsis of new features and changes with this release.

4.2. Install IAR EW8051 Package

Install the Embedded Workbench for 8051 from IAR Systems: http://www.iar.com/. The project and library files included in this release of the TIMAC were built and tested with EW8051 version 7.51A. When considering an upgrade to a newer version of EW8051, it is necessary to verify that installed project and library files are compatible with the newer development tools.

5. Using the TIMAC Sample Application

The remainder of this document describes building and running the TIMAC sample application. The sample application demonstrates association between two IEEE 802.15.4 devices in a non-beaconed network and transmitting application data between associated devices.

The TIMAC sample application provides support for two different memory configurations on the CC2430 – banked and non-banked. The banked configuration is used when developing larger applications that require up to 128 Kbytes of program memory (using CC2430F128 devices). The non-banked configuration is provided for smaller applications, using up to 64 Kbytes of memory, and targeting CC2430F64 devices.

5.1. Building the Sample Application

- Make sure all software and tools have been installed (Sections 4.1 and 4.2)
- Navigate to the sample application project directory:
  C:\Texas Instruments\TIMAC-CC2430-1.3.0\Projects\mac\sample\cc2430\IAR Project
- Launch the IAR Embedded Workshop: double click on the **msa_cc2430.eww** file:

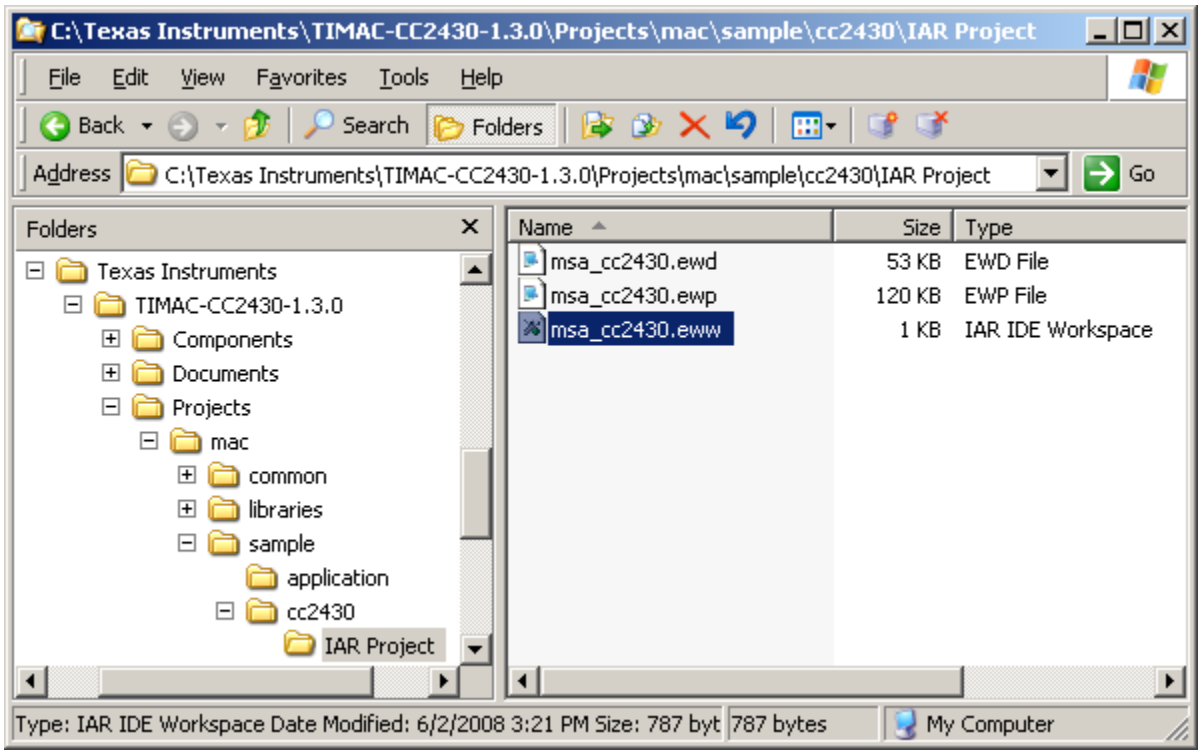

Figure 3: Launch the Sample Application Project

- According to the development board being used, select either the **CC2430DB Object** or **CC2430EB Object** configuration from the ***Workspace*** pull-down menu. In this example, the non-banked configuration for the CC2430EB is selected:

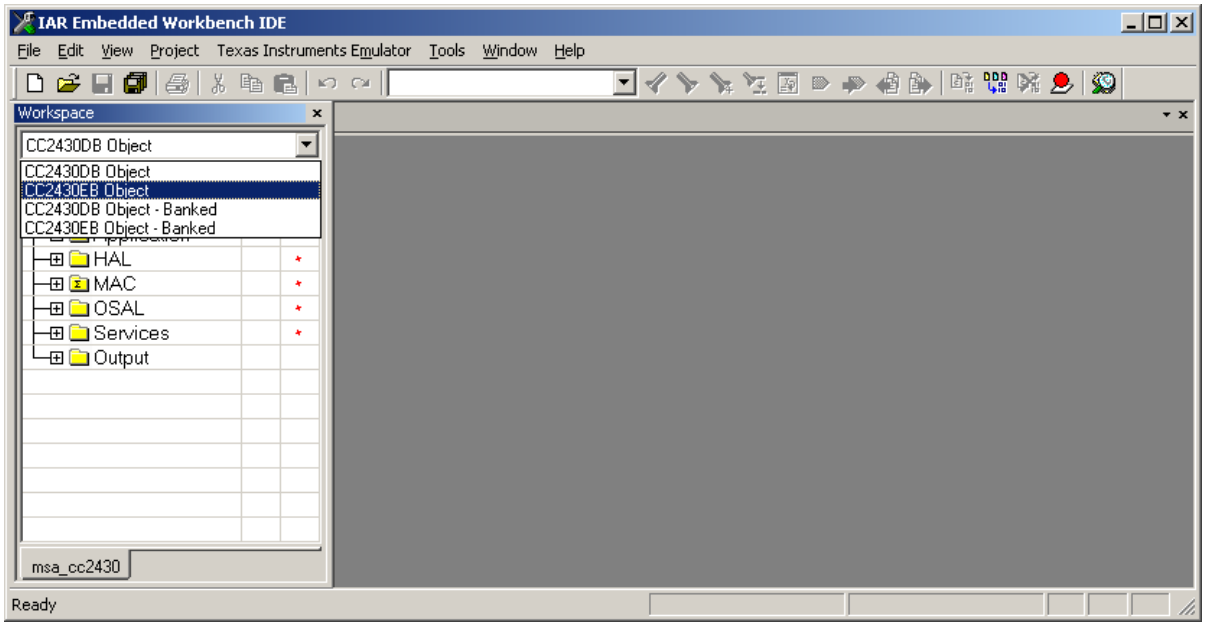

Figure 4: Select a Sample Application Configuration

- Build the application - pull down the ***Project*** menu and click on **Rebuild All**:

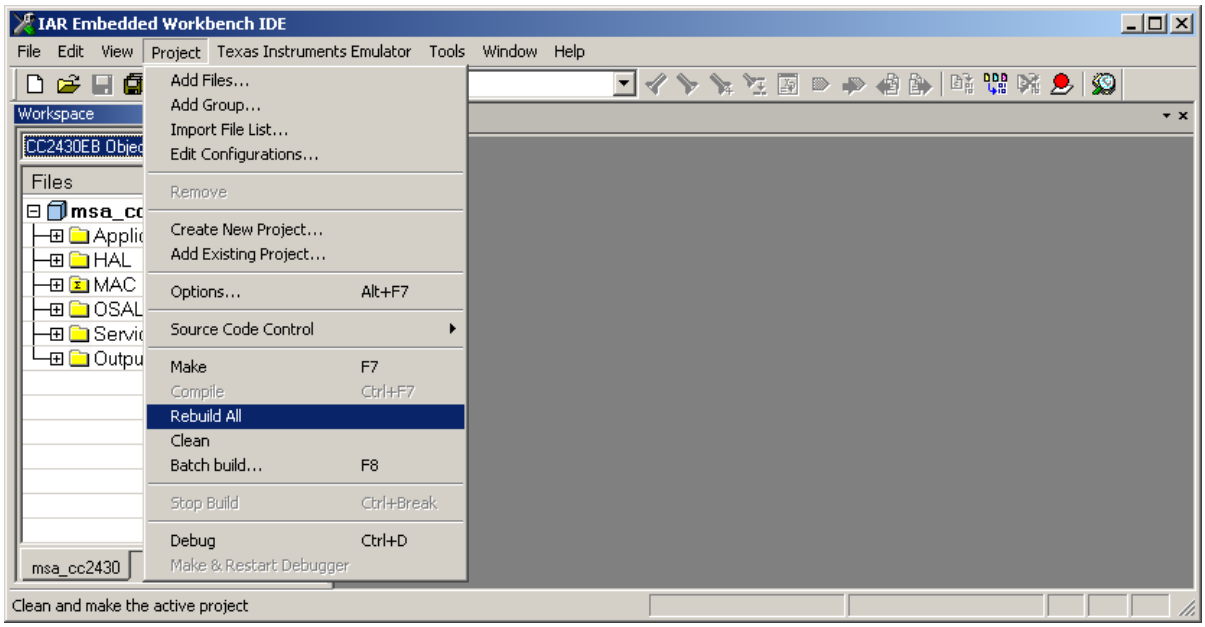

Figure 5: Build the Sample Application

- Connect a development board to the host PC with a USB cable. Apply power by moving switch S3 toward the CC2430EM board. If Windows needs to install a driver, browse to: ***C:\Program Files\IAR Systems\Embedded Workbench 5.3\8051\drivers\Texas Instruments*** to locate the necessary files.

- Download the application - pull down the ***Project*** menu and click on **Debug**:

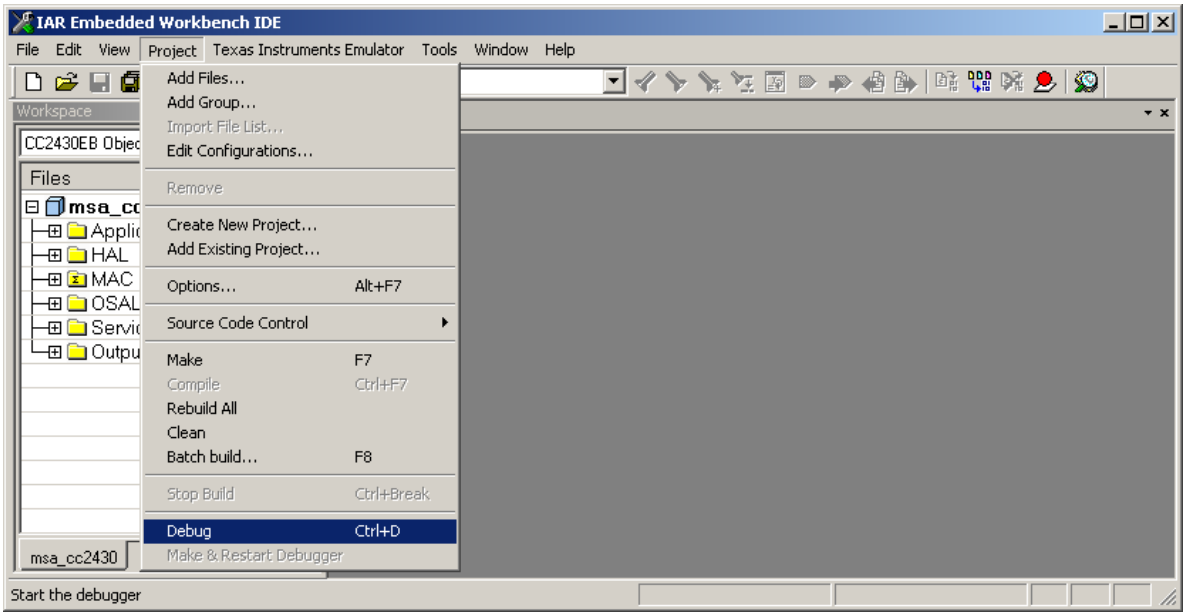

Figure 6: Download the Sample Application

- Select the ***Debug*** menu and click on **Stop Debugging** to exit the debugger. Disconnect the development board and repeat these procedures on a second board.

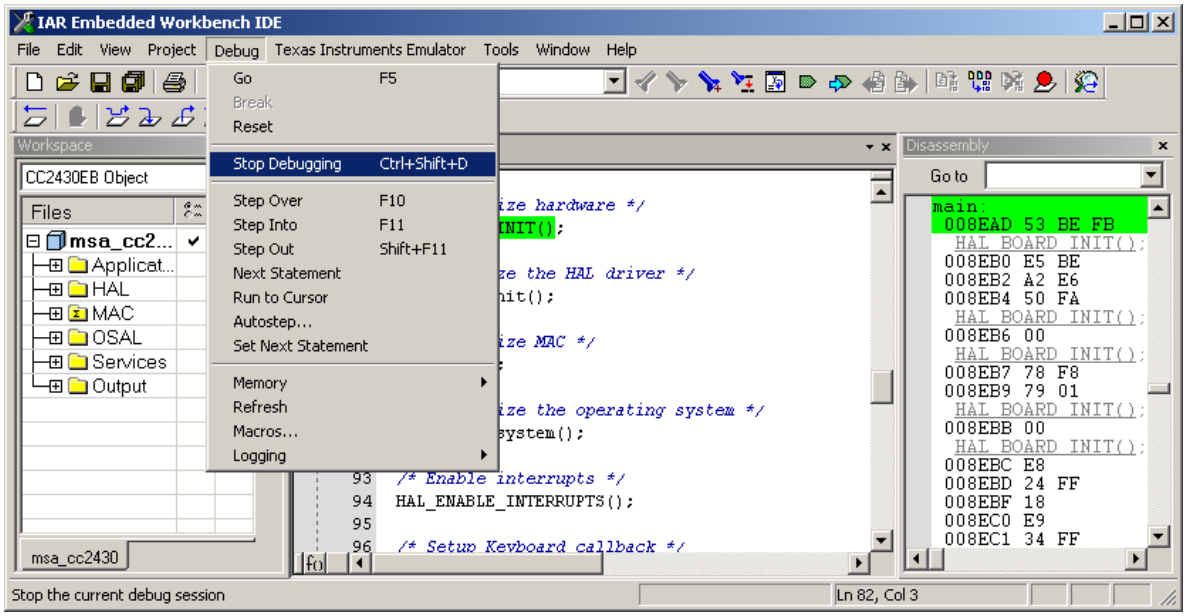

Figure 7: Exit Debugger to Finish Download

5.2. Switches and LEDs

The TIMAC Sample Application requires user input via switches. The CC2430 development boards have a 5-position joystick, designated U400, which provides logical switch inputs as shown in the table below. Pressing the joystick toward the U400 label (up position) activates the SW1 input. Switch inputs SW2 – SW4 result from pressing the joystick to the right, down (away from U400), and left positions, respectively. SW5 occurs when the joystick is pressed straight down when in the center position.

Figure 8: Joystick

SWITCH	JOYSTICK
SW1	up position
SW2	right position
SW3	down position
SW4	left position
SW5	press middle

The TIMAC sample application display various operational status LEDs, commonly referred to as LED1-LED4. The SmartRF04EB has 4 colored LEDs, designated 1 - 4. The CC2430EM module does not have connections to the red LED (2) or the blue LED (4). Therefore, LEDs 1 and 3 are used to provide all logical LED1-LED4 indications as shown in the table below:

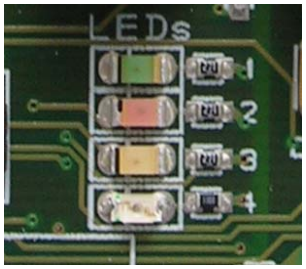

Figure 9: SmartRF04EB LEDs

LED	LABEL	COLOR
LED1	***1***	Green
LED2	***3***	Yellow
LED3	***3***	Yellow
LED4	***1***	Green

The CC2430DB has 2 colored LEDs, designated D1 and D2. D1 and D2 are used to provide all logical LED1-LED4 indications as shown in the table below:

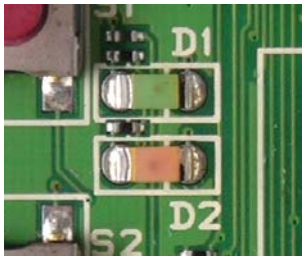

Figure 10: CC2430DB LEDs

LED	LABEL	COLOR
LED1	***D1***	Green
LED2	***D2***	Red
LED3	***D2***	Red
LED4	***D1***	Green

5.3. Running the Sample Application

To begin execution of the TIMAC sample application, apply power to each programmed board and press the RESET (S2) button on each board. LED1 should blink on both boards.

5.3.1. Associating Devices

Press the joystick "up" (SW1) on one of the boards. LED1 should stop blinking and stay lit. This board is now configured as an IEEE 802.15.4 coordinator. Label this board as the 'coordinator'.

Note: If LED1 begins blinking, the board found an existing network to associate to. Reset each board and retry. If the problem persists, reprogram the boards using a different channel (See Section 6).

On the second board, press the joystick "up" (SW1). LED1 should begin blinking. This board has associated to the 802.15.4 coordinator as an end device. Label this board as the 'end device.'

5.3.2. Sending Application Data

After both boards have successfully associated, data can be transmitted between the coordinator and the end device. To begin transmitting data, press the joystick to the right (SW2) on the coordinator. LED1 on the coordinator will blink indicating data is being transmitted. LED3 on the end device will blink indicating data is being received.

Next, press the joystick to the right (SW2) on the end device. This will cause the end device to transmit data to the coordinator. LED1 and LED3 will blink on both boards. This indicates both boards are transmitting and receiving data from each other.

Pressing the joystick to the right (on either board) while data is being transmitted stops the process of transmitting data. Press the joystick right on the coordinator. Notice that LED1 stopped blinking on the coordinator and LED3 stopped blinking on the end device.

6. Channel Selection

The 802.15.4 specification defines 16 channels in the 2.4 GHz frequency range. These channels are assigned numbers 11 through 26. The TIMAC Sample Application defaults to channel 11, but the user can select a different channel by changing the *MSA_MAC_CHANNEL* in the **msa.h** header file. *MSA_MAC_CHANNEL* can be set to MAC_CHAN_*XX* where *XX* is a number from 11-26 indicating the desired channel.

Applicable Documents

TIMAC Documents

1. 802.15.4 MAC API, TI Document SWRA192
2. MAC Sample Application Design, TI Document SWRA200

Other Documents

3. IEEE Std 802.15.4-2006, Part 15.4: Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Low-Rate Wireless Personal Area Networks (WPANs), September 8, 2006.