802.15.4 MAC
User's Guide
For CC2530/CC2533

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Texas Instruments, Inc.
San Diego, California USA

Version	Description	Date
1.0	Initial release.	06/18/2009
1.1	Added CC2533 S1 and Joystick operation changes.	03/28/2010

Table of Contents

Table of Figures

Table of Tables

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 SmartRF05 evaluation boards, fitted with CC2530EM radio modules (as shown below), may be used to demonstrate or develop IEEE 802.15.4 applications based on the TIMAC software package. Everything needed to get started is in the CC2530 Development Kit. These boards provide a rich development platform, including an LCD display and RS232 serial port. TIMAC supports two revisions (1.3 and1.7) of SmartRF05EB boards. Figure 1 shows the Rev. 1.3 board on the left and the Rev. 1.7 board on the right.

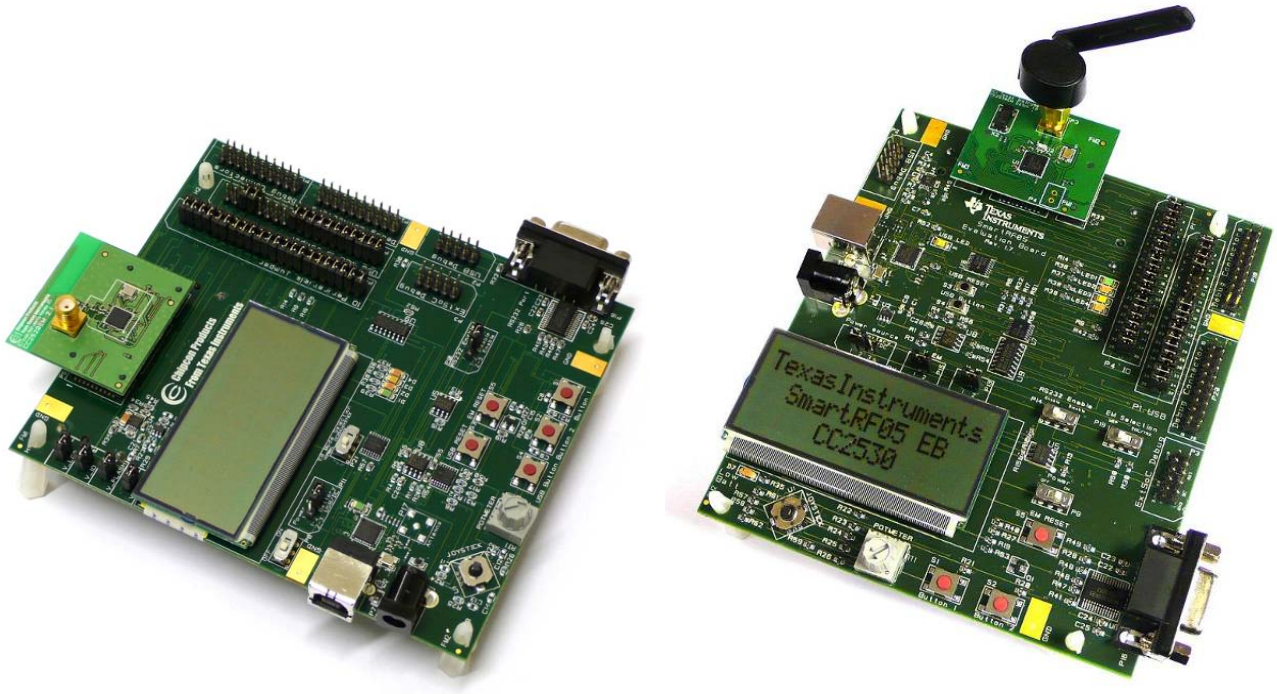

Figure 1: SmartRF05 Evaluation Boards – Rev 1.3 and Rev 1.7

2.3. Cables

All necessary cabling has been included with the development kit. To support program download and debugging with SmartRF05EB, a USB cable should be connected between each target board to the host PC. An RS232 cable may be also connected between the serial port on SmartRF05EB (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 of CC2530-based devices. The Texas Instruments ***SmartRF Flash Programmer***, is a tool that provides various programming capabilities when using SmartRF05-based development kits. Required support for TIMAC target development software:

- IAR EW8051 *Embedded Workbench for 8051*
- Texas Instruments *SmartRF Flash Programmer*
- Texas Instruments *TIMAC-CC2530-1.3.1*

4. Product Installation Procedures

4.1. Install TIMAC Package

Install the TIMAC files and programs from the downloaded package. Run the windows-based installation program, ***TIMAC-CC2530-1.3.1.exe***, which will create the required directory structure and load all software and documentation files. After installation, be sure to review the README file for a summary of new features and changes with this TIMAC release.

4.2. Install IAR EW8051 Package

Obtain and install ***Embedded Workbench for 8051*** from IAR Systems. The project and library files included in this release of TIMAC were built and tested with EW8051 version 7.51A. When considering an upgrade to a newer version of EW8051, it will be necessary to verify that installed project and library files are compatible with the newer development tools.

4.3. Install SmartRF Flash Programmer Package

Obtain and install the ***SmartRF Flash Programmer*** from Texas Instruments. Connect one of the SmartRF05EB boards to the PC (via USB cable) and run this program. This will install required Windows drivers and verify that the PC is ready to communicate with the SmartRF05EB boards.

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 CC2530 – banked and non-banked. The banked configuration is used when developing larger applications that require up to 256 Kbytes of program memory (using CC2530F256 devices). The non-banked configuration is provided for smaller applications, using up to 64 Kbytes of memory, and targeting CC2530F64 or CC2533F64 devices.

5.1. Building the Sample Application

- Make sure all software and tools have been installed (Sections 4.1 through 4.3)
- Connect a SmartRF05EB board to the development PC with a USB cable.
- Power up the SmartRF05EB. There are 3 ways to supply power to the board: batteries, USB connection, or a DC power supply. To provide power from batteries, pins ***1-2*** of jumper block **P11** must be connected. Otherwise, connect pins ***2-3*** to use USB or a DC supply (note below the slight P11 difference on Rev 1.3 and Rev 1.7 boards). The board can be turned **ON** or **OFF** using switch **P8.**

Figure 2: Power Switch and Power Source Selection (Rev 1.3 / Rev 1.7)

- If prompted by Windows for a SmartRF05EB device driver, don't let Windows connect to Windows Update. Let Windows try to find the driver automatically. If that fails, browse to: ***C:\Program Files\IAR Systems\Embedded Workbench 5.3\8051\drivers\Texas Instruments*** to locate needed files.
- Navigate to the sample application project directory:
  C:\Texas Instruments\TIMAC-CC2530-1.3.1\Projects\mac\sample\cc2530\IAR Project
- Launch the IAR Embedded Workshop: double click on the **msa_cc2530.eww** file:

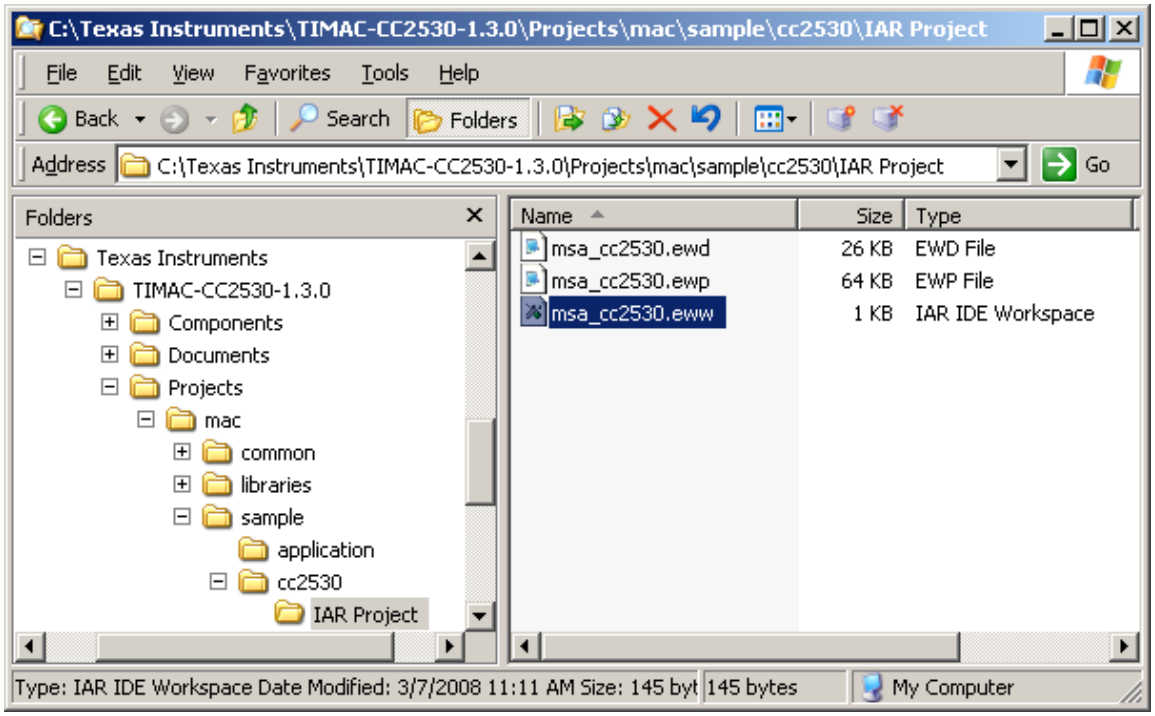

Figure 3: Launch the Sample Application Project

- Select the **CC2530EB Object** configuration from the ***Workspace*** pull-down menu. In this example, the non-banked configuration for the CC2530EB is selected:

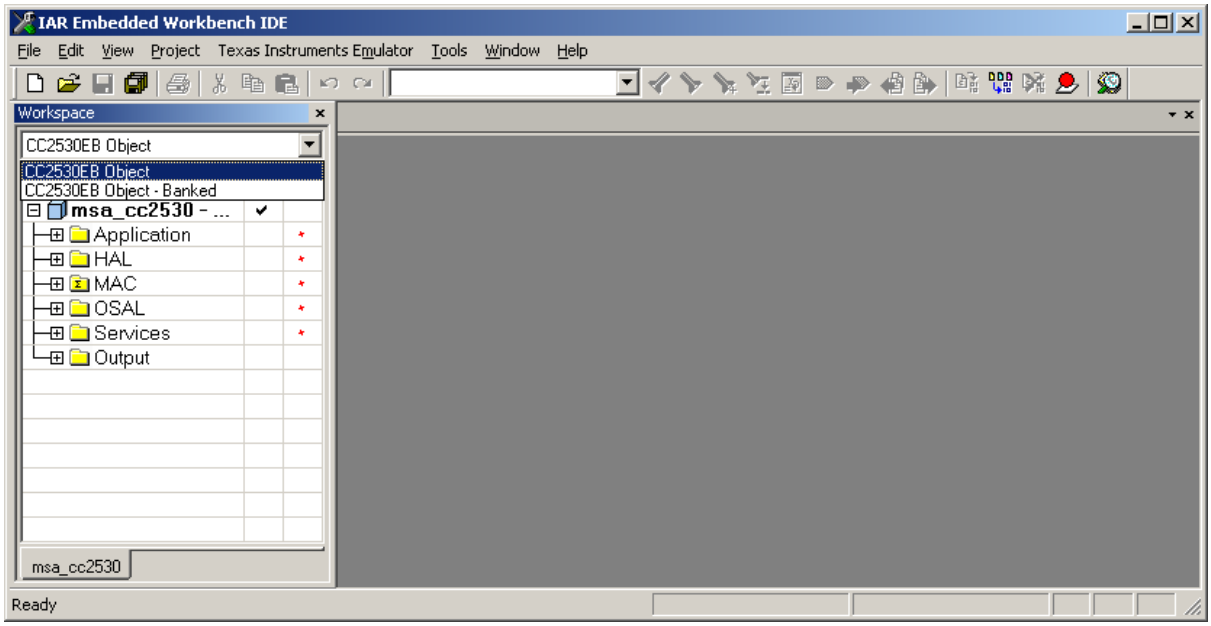

Figure 4: Select a Sample Application Configuration

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

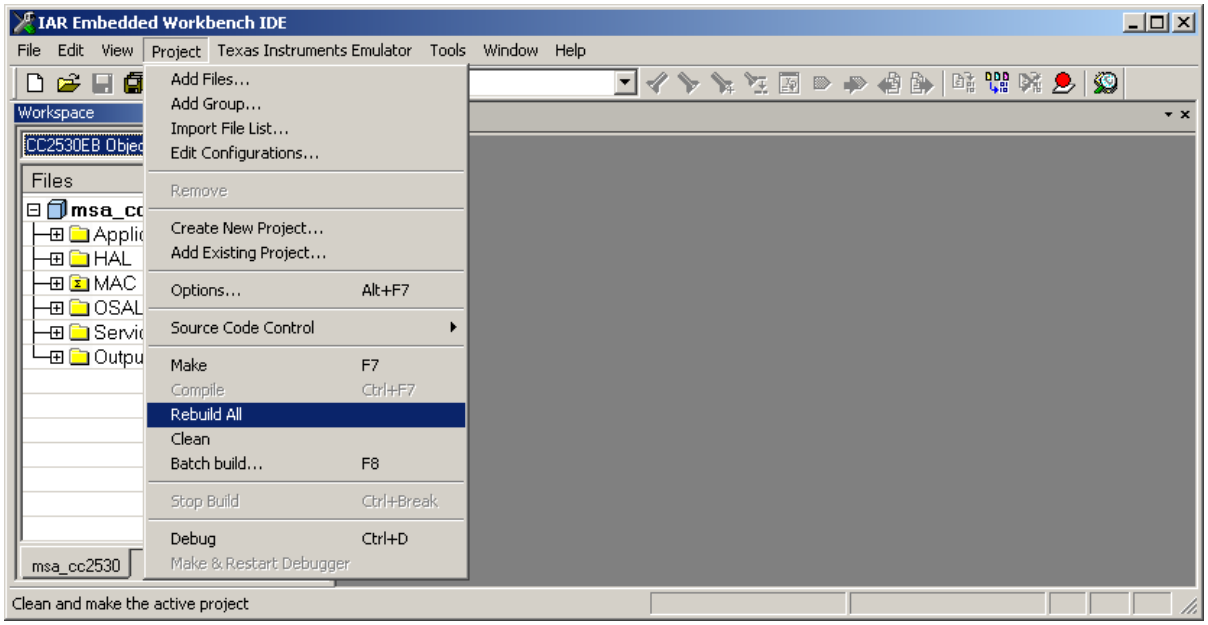

Figure 5: Build the Sample Application

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

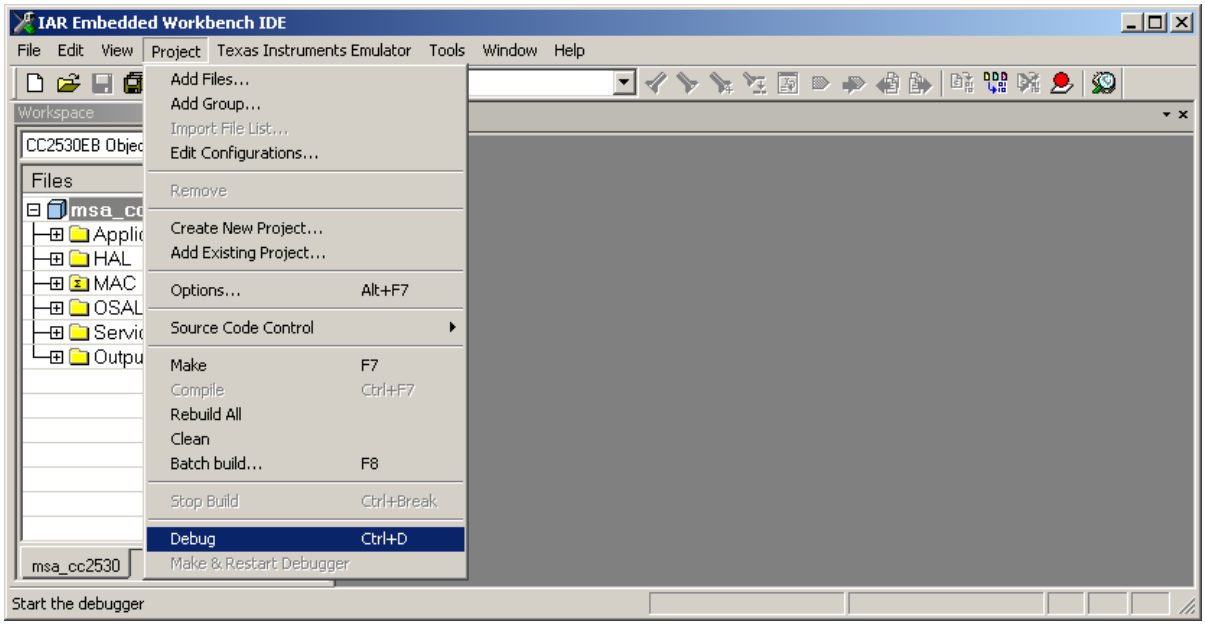

Figure 6: Download the Sample Application

- 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.

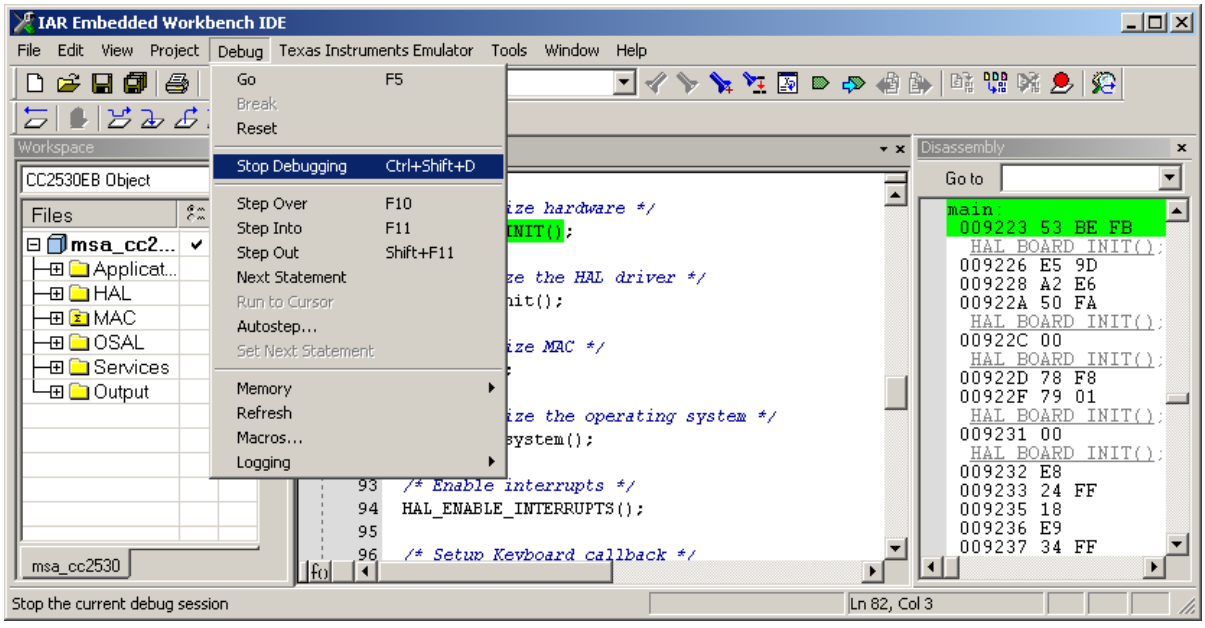

Figure 7: Exit Debugger to Finish Download

- Remove power from the SmartRF05EB by switching P8 to OFF. Disconnect the SmartRF05EB from the USB cable and set it aside.
- Repeat the previous steps to program more CC2530EM boards. At least two boards must be programmed to run the TIMAC sample application.

5.2. Switches and LEDs

The TIMAC Sample Application requires user input via switches and displays status on LEDs located on the SmartRF05 development boards. Switches and LEDS are illustrated below in pairs of screenshots - Figures 8 and 9 show Rev 1.3 boards on the left and Rev 1.7 boards on the right.

The TIMAC Sample Application requires user input via switches. CC2530 development boards have a 5-position joystick, designated U1, which provides logical switch inputs as shown in the table below. Pressing the joystick toward the U1 label (up position) activates the SW1 input. Switch inputs SW2 – SW4 result from pressing the joystick to the right, down (away from U1), and left positions, respectively. SW5 occurs when the joystick is pressed straight down when in the center position.

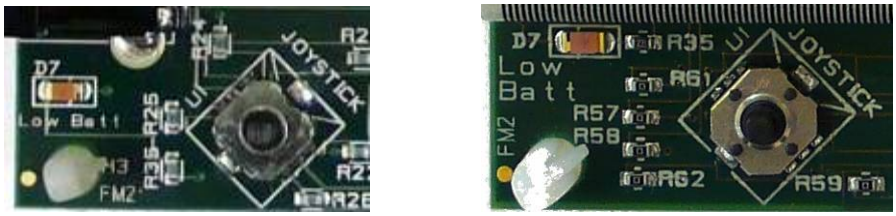

Figure 8: SmartRF05EB Joystick on Rev 1.3 / 1.7 Boards

Joystick/Button	Software Mapping	Description
UP	SW1	Joystick UP
RIGHT	SW2	Joystick RIGHT
DOWN	SW3	Joystick DOWN
LEFT	SW4	Joystick LEFT
PRESS	SW5	Joystick CENTER

Table 1: Joystick/Button Logical Switch Mapping

TIMAC sample applications use “logical” LEDs to display status information. SmartRF05EB boards have four 4 colored LEDs, referred to in application software as LED1 - LED4.

Figure 9: SmartRF05EB LEDs on Rev 1.3 / 1.7 Boards

LED	Software Mapping	Color
D1/LED1	LED1	Green
D2/LED2	LED2	Red
D3/LED3	LED3	Yellow
D4/LED4	LED4	Blue/Red

Table 2: Logical LED Mapping on Rev 1.3 / 1.7 Boards

5.3. Running the Sample Application

To begin execution of the TIMAC sample application, apply power to each programmed board and press the RESET (S5) button on each board. LED1 should blink on both boards.

5.3.1. Associating Devices

Press the joystick "up" (or SW1 on CC2533) 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" (or SW1 on CC2533). 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 (or any joystick toggle on CC2533) 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 (or any joystick toggle on CC2533) 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.