



**802.15.4 MAC  
User's Guide  
For CC2530/CC2533**

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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 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 and 1.7) of SmartRF05EB boards. Figure 1 shows the Rev. 1.3 board on the left and the Rev. 1.7 board on the right.

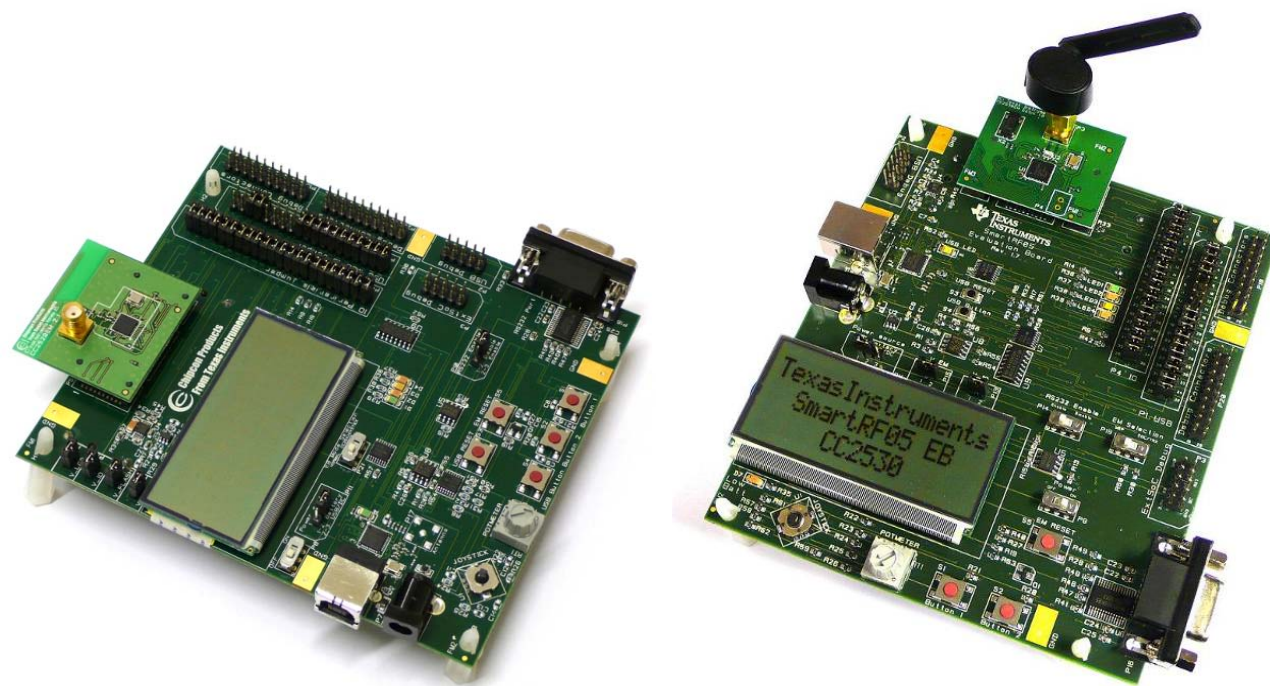


Figure 1: SmartRF05 Evaluation Boards – Rev 1.3 and Rev 1.7

## 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:

- Texas Instruments [TIMAC-CC2530-1.4.0](#)
- Texas Instruments [SmartRF Flash Programmer](#)
- IAR Embedded Workbench for 8051 ( <http://www.iar.com> )

## 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-CC2530-1.4.0.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 8.10. When considering use of a different version of EW8051, it will be necessary to verify that installed project and library files are compatible with those 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 6.0\8051\drivers\Texas Instruments\* to locate needed files.
- Navigate to the sample application project directory:  
*C:\Texas Instruments\TIMAC-CC2530-1.4.0\Projects\mac\sample\cc2530\IAR Project*
- Launch the IAR Embedded Workshop: double click on the **msa\_cc2530.eww** file:

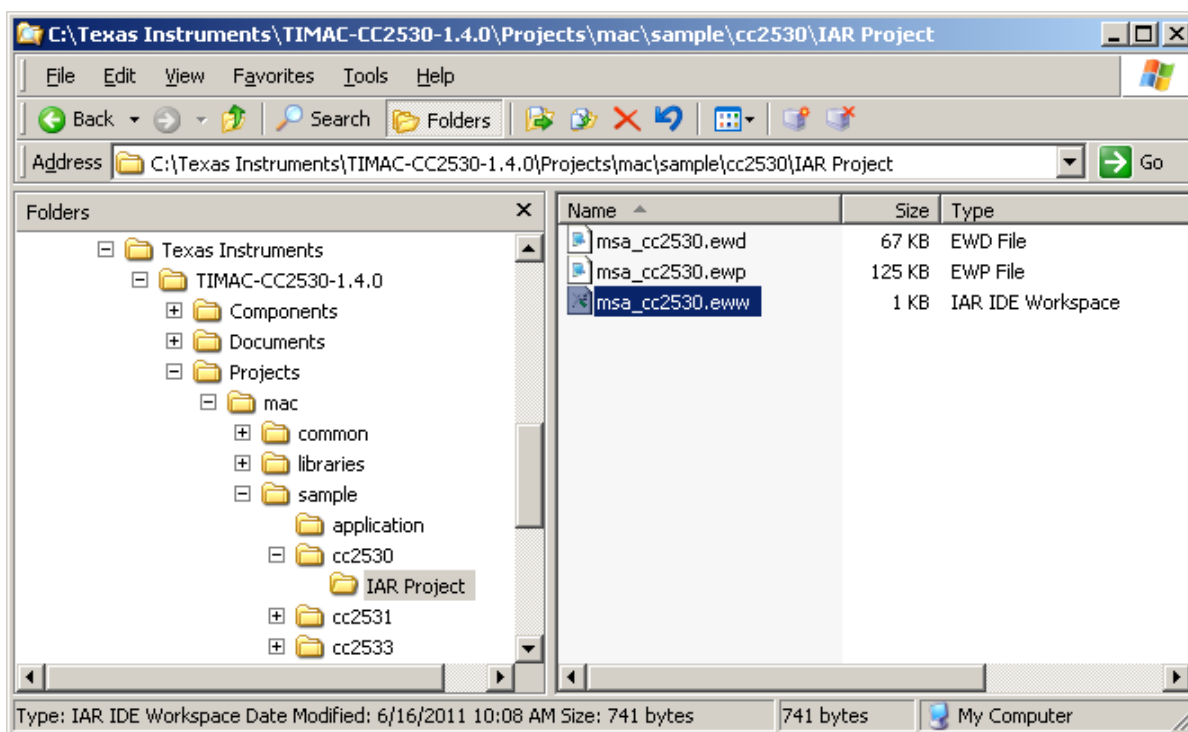


Figure 3: Launch the Sample Application Project

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

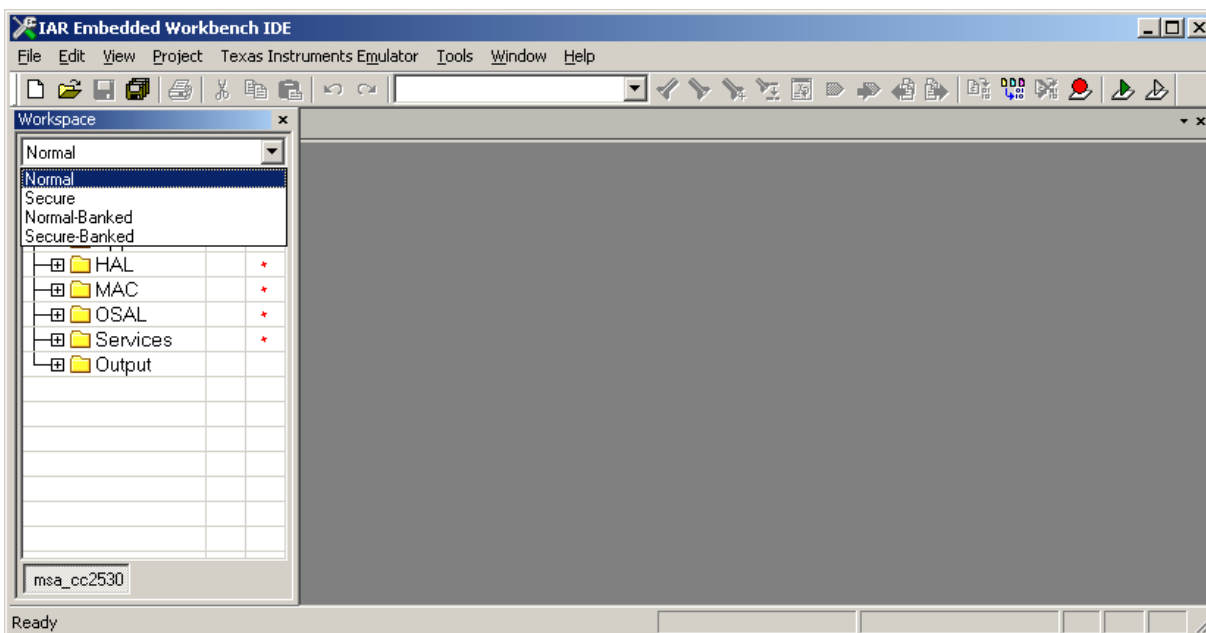


Figure 4: Select a Sample Application Configuration

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

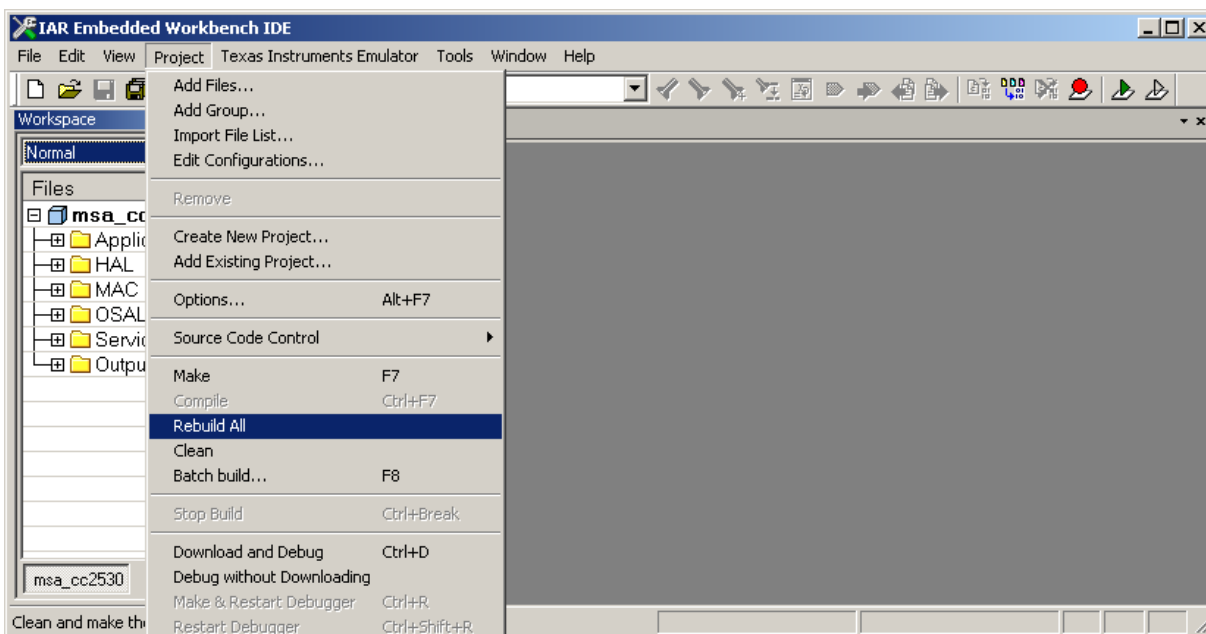


Figure 5: Build the Sample Application

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

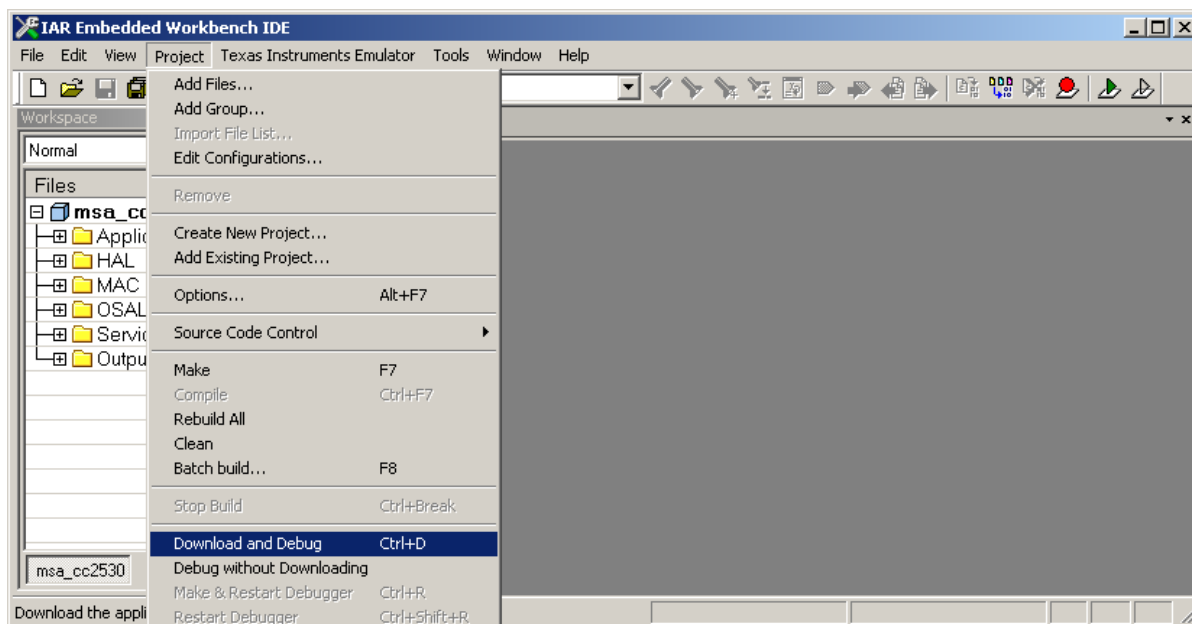


Figure 6: Download the Sample Application

- Select the **Debug** menu and click on **Stop Debugging** to exit the debugger:

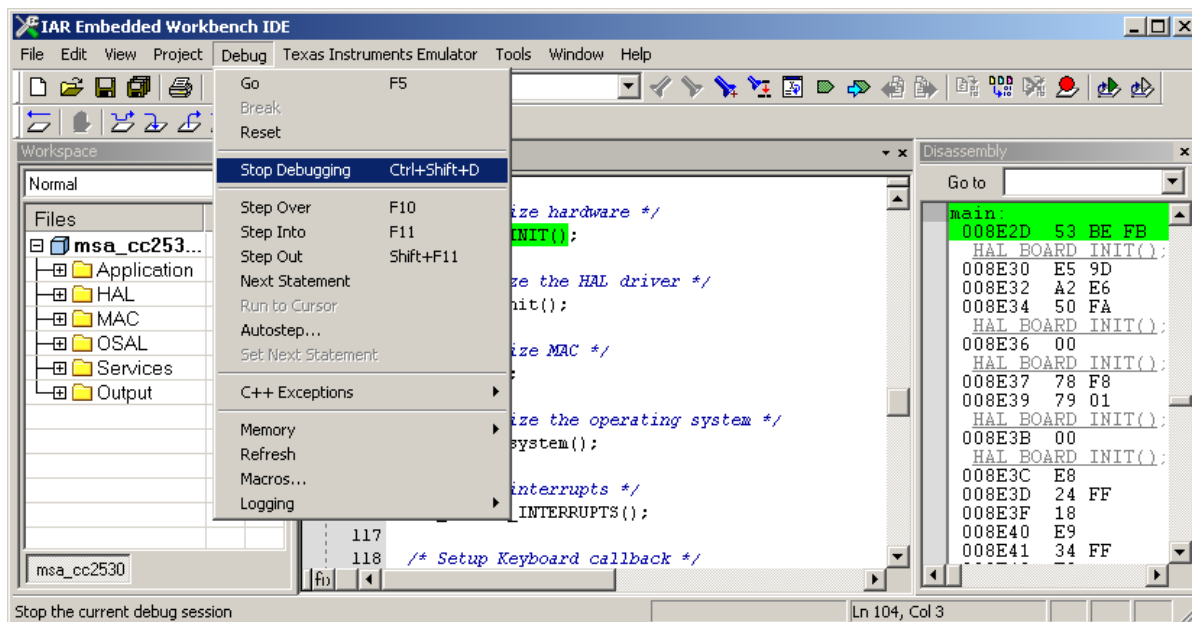


Figure 7: Exit Debugger to Finish Download

- Remove power from the SmartRF05EB by switching P8 to the OFF position. 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.

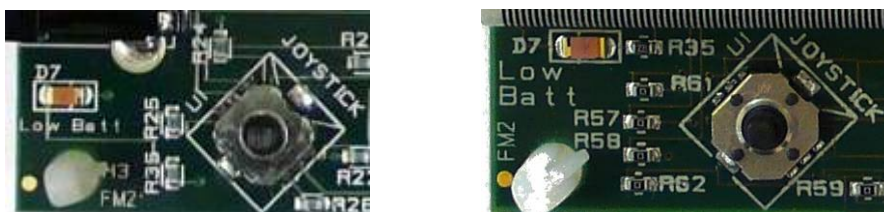


Figure 8: SmartRF05EB Joystick on Rev 1.3 / 1.7 Boards

Joystick/Button	Software Mapping	Description
<i>UP</i>	SW1	Joystick UP
<i>RIGHT</i>	SW2	Joystick RIGHT
<i>DOWN</i>	SW3	Joystick DOWN
<i>LEFT</i>	SW4	Joystick LEFT
<i>PRESS</i>	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
<i>D1/LED1</i>	LED1	Green
<i>D2/LED2</i>	LED2	Red
<i>D3/LED3</i>	LED3	Yellow
<i>D4/LED4</i>	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 EM RESET (S5) button on each board. LED1 on each board should blink several times per second to indicate that it is waiting to start or join a network.

#### 5.3.1. Starting a Network

Press SW1 on one of the boards. LED1 should stop blinking and stay lit. This device is now configured as an IEEE 802.15.4 Coordinator. Label this board as the 'Coordinator'. If LED1 begins blinking, the device found an existing network to join and did not become a Coordinator. Press EM RESET again to reset the board and retry. If the problem persists, reprogram the boards to use a different radio channel (see Section 6).

#### 5.3.2. Associating Devices

Press SW1 on the remaining boards. Their LED1 should begin blinking about once per second to indicate that they have associated to the Coordinator as End-Devices. Label these boards as 'End-Device'. At this point, a simple "star" network has been formed, with all devices waiting to send and/or receive data with their associated device.

#### 5.3.3. Sending Application Data

After all devices have successfully associated, data can be transmitted between the Coordinator and End-Devices. To begin transmitting data, press SW2 on the Coordinator. LED1 on the Coordinator toggles quickly, indicating that data is being transmitted. LED3 on the End-Devices toggles a little slower, indicating that data is being received.

Pressing SW2 on a device while it is transmitting data stops the transmission. Press SW2 on the Coordinator. LED1 stops blinking on the Coordinator (no data transmitted) and LED3 stops blinking on the End-Devices (no data received).

To transmit data to the Coordinator, press SW2 on one End-Device. LED1 on that End-Device toggles quickly to indicate that data is being transmitted. LED3 on the Coordinator toggles a little slower to indicate that data is being received. Press SW2 on remaining End-Devices to start data transmission – LED3 on the Coordinator now toggles faster, indicating increased received data.

## 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.