

Stellaris[®] 2.4 GHz ZigBee[®] Wireless Kit

The Stellaris 2.4 GHz ZigBee Wireless Kit (DK-EM2-2520Z) provides an easy way to evaluate the capabilities of Texas Instruments' CC2520 radio transceiver and ZigBee protocol using the highly integrated DK-LM3S9B96 development platform.

Requirements

- You have a Stellaris DK-LM3S9B96 development platform (sold separately)
- You have a Stellaris 2.4 GHz ZigBee Wireless Kit (DK-EM2-2520Z)
- You have the Stellaris DK-LM3S9B96 Development Kit Documentation and Software CD
- You have downloaded the supplemental installer for the 2.4 GHz ZigBee software development package (for more information, go here: www.ti.com/stellariswireless)

Kit Contents

The Stellaris 2.4 GHz ZigBee Wireless Kit includes the following components:

- 1 DK-LM3S9B96-EM2 Expansion Board
- 1 CC2520EM Low Power 2.4 GHz Radio Transceiver evaluation module
- 1 antenna for use with CC2520EM
- 2 CC2530EM Low Power SoC 2.4 GHz ZigBee modules
- 2 SmartRF05BB battery boards
- 2 antennas for use with CC2530EMs
- 1 CC-Debugger for reprogramming CC2530EM if needed
- Stellaris EM2 Expansion Board Documentation and Software CD



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These components provide everything required to set up a three-node, 2.4 GHz ZigBee sensor network.

The following instructions describe how to run a simple 2.4-GHz ZigBee sensor network example using the DK-LM3S9B96-EM2 with the CC2520EM transceiver and two battery boards with CC2530EM modules as supplied in the Stellaris 2.4 GHz ZigBee Wireless Kit.

To set up the 2.4-GHz sensor network example, you must do the following steps:

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Step 1: Set Up the DK-LM3S9B96 Development Board and the EM2 Expansion Board

The EM2 expansion board interfaces to the DK-LM3S9B96 development board via the Extended Peripheral Interface (EPI) connector. To start setting up the DK-LM3S9B96 development board, do the following:

1. Power down the DK-LM3S9B96 board
2. Remove any board that is currently fitted to the expansion connector.

Boards that might be installed in this location are the SDRAM expansion board, the EPI Signal breakout board, the Flash and SRAM memory expansion board, or the FPGA expansion board. See the figure on the next page for reference.

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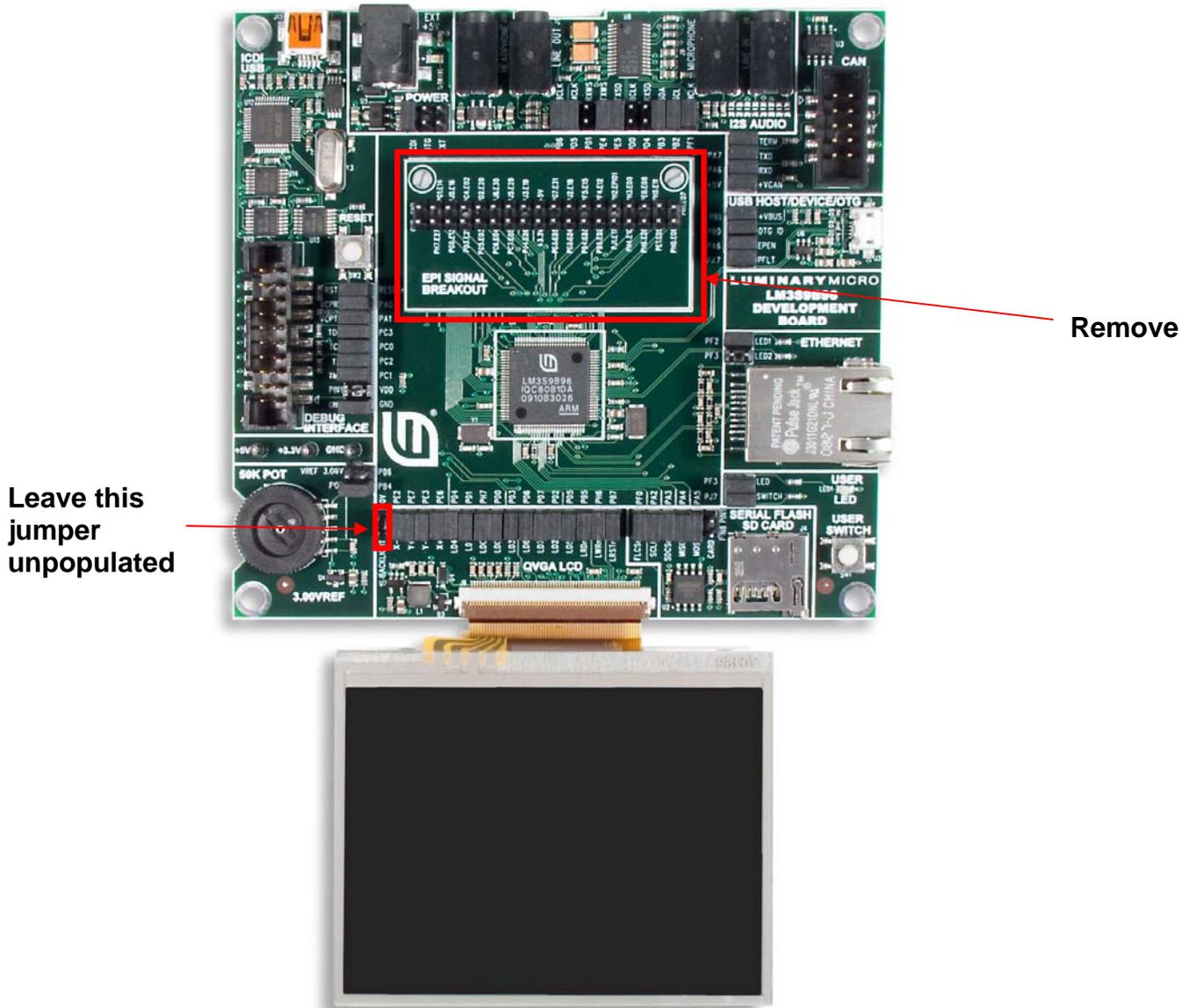


Figure 1. DK-LM3S9B96 Development Board

3. Replace all but the leftmost (BACKLIGHT) jumpers in the QVGA LCD block near the bottom edge of the DK-LM3S9B96 board if you removed a Flash and SRAM expansion board or an FPGA expansion board.
4. Once the jumpers are in place, fit the EM2 expansion board onto the DK-LM3S9B96 development board. There is a male EPI connector on the bottom side of the EM2

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expansion board that connects to the female EPI expansion connector of the DK-LM3S9B96 development board (J2).

5. Once the EM2 expansion board is connected to the EPI interface, connect the antenna to your CC2520EM radio transceiver daughter board.
6. Connect the CC2520EM radio transceiver to the top (MOD1) pair of connectors on the EM2 expansion board.

The final assembly looks like this.



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Step 2: Install Device Drivers and LM Flash Programmer

The following instructions assume that you have already installed the debug and virtual COM port device drivers for the DK-LM3S9B96 board. If you have not yet installed these drivers, see the *LM3S9B96 Development Kit ReadMe First (READMEFirst-DK-LM3S9B96.pdf)* which you can find on the CD which is included in the DK-LM3S9B96 package.

Additionally, these instructions assume that you have installed the “LM Flash Programmer” tool. The LM Flash Programmer tool is needed in order to download example applications to the DK-LM3S9B96 board. The LM Flash Programmer tool is included on the DK-LM3S9B96 software CD and also on the CD that is included with the DK-EM2-2520Z wireless kit. In either case, navigate to the “Tools” menu on one of these CDs and double-click “LMFlashProgrammer.msi” to install the application.

Step 3: Install StellarisWare Software

If you have not done so already, install the StellarisWare software release for DK-LM3S9B96 and the supplemental installer which adds ZigBee wireless function from the CD supplied with the Stellaris 2.4 GHz ZigBee Wireless Kit or DK-LM3S9B96-EM2 expansion board.

The base StellarisWare release can be installed using the following file on the CD (where xxxx is the software release number):

```
\Tools\StellarisWare\SW-DK-LM3S9B96-xxxx
```

Once this is installed, add the ZigBee support files for the EM2 expansion board by running this file:

```
\Tools\StellarisWare\SW-DK-LM3S9B96-EM2-CC2520-ZStack-xxxx
```

Be sure to install the ZigBee support files in exactly the same directory as you used for the base StellarisWare files to ensure that the added files appear in the correct place in the directory tree. You should also verify that the version numbers for the base StellarisWare and supplemental installers are the same.

Once you have completed these steps you should find the StellarisWare software in C:\StellarisWare (assuming you chose the default installation path) with subdirectories.

Step 4: Download and Install the Z-Stack Supplemental Installer

The Z-Stack supplemental installer places the example application and the example code into the StellarisWare tree.

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For more information on how to download the Z-Stack supplemental installer, go to this URL:

www.ti.com/stellariswireless

If StellarisWare and the DK-LM3S9B96-EM2-CC2520-ZStack-xxxx.exe supplemental installer are installed in the default installation directory, you can find the Z-Stack application source in the following location:

C:\StellarisWare\boards\dk-lm39b96-em2-cc2520-zstack

Once you have completed these steps, you should find the StellarisWare software in C:\StellarisWare (assuming you chose the default installation path) with subdirectories as shown in the next figure.



Directory structure after installation of StellarisWare for DK-LM3S9B96 and the EM2/ZigBee support package

Step 5: Flash the Example Application

The example application sets up the DK-LM3S9B96 as a ZigBee coordinator device and a sensor data collector. Two end devices running a sensor application send messages to the collector. The collector application shows a representation of the ZigBee network on the DK-LM3S9B96 display and information about each ZigBee node.

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Use the LM Flash Programmer tool to flash the “zstack_collector.bin” file to the DK-LM3S9B96. Assuming you installed StellarisWare in the default directory, this binary can be found under C:\StellarisWare\boards\dk-lm3s9b96-em2-cc2520-zstack\zstack_collector. This directory contains subdirectories for each supported toolchain and each of these contains a copy of the executable built with those tools.

When the flash programming completes, reset the DK-LM3S9B96 and the application should run and show a “Waiting” message on the display for a few moments. Once the device becomes a ZigBee coordinator and establishes a network, the coordinator node is shown as a red circle on the display.

With the ZigBee coordinator running, we can now set up the sensor devices that will be joined to the network.

Step 6: Set Up the SmartRF05BB/CC2530EM Sensor Board



The Stellaris 2.4 GHz ZigBee Wireless Kit includes two SmartRF05BB battery boards, two CC2530EM ZigBee modules, and antennas. Do the following to set up the boards:

1. With the power switch OFF, install AA batteries into the back of the battery boards.

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2. Then attach the CC2530EM modules to the battery board as shown.
3. Install the antennas onto each CC2530EM board.
4. Arrange the jumpers and switches on the battery board as follows:
 - Header P7 should have one jumper installed across the top two pins as shown in the photo above.
 - Power switch should be to the right (OFF position).
 - “EM Selection” switch should be to the right (SOC position).

Once the sensors are assembled, turn on as follows:

1. Press and hold down the “joystick” switch on the battery board in the center position while turning on the power by sliding the power switch to the left. The joystick switch can be pressed in the center, or toggled in any one of four directions.

LEDs on the battery board begin flashing.

2. Continue to hold the joystick center down for about 2 seconds.
3. Release the center joystick button.

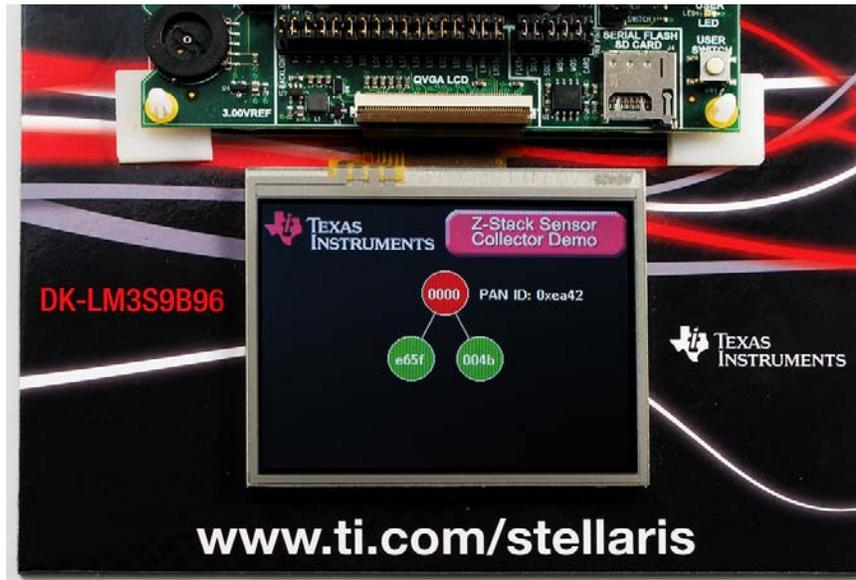
The LEDs continue to flash in different patterns until the sensor joins the ZigBee network. Once the network is joined, the LEDs begin flashing rapidly. This should take a few seconds.

4. Once the LEDs are flashing rapidly, toggle the joystick down and then release.

A new green circle appears on the DK-LM3S9B96 display. This green circle represents the sensor node that just joined the network.

Repeat steps 1-4 for the second sensor assembly. When you are finished, the display shows one red circle and two green circles:

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1. Use a stylus to tap one of the ZigBee nodes shown on the DK-LM3S9B96 display. (A stylus works best on the display screen.) A small window appears showing information about the sensor.



2. Tap the "OK" button to dismiss the information box and redisplay the network tree.
3. Turn off one of the sensor boards and after a few seconds its node disappears from the display.

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4. Turn the sensor back on, this time without pressing the center button. The LEDs begin blinking rapidly indicating the sensor has automatically rejoined the same network.
5. Toggle the switch down and the node reappears on the display.

Here are some things to note about this demonstration:

The CC2530EM sensor application does not have an absolute temperature reference. Therefore, the firmware “calibrates” the temperature to 22° C when the sensor is turned on, no matter what the actual temperature is. This means that whenever you turn on the sensors, you will always see the temperature displayed at about 22° C, even if the board is hotter or colder than 22° C. Once the sensor is turned on and reporting actual temperature, you will see the reported temperature change accordingly as you alter the temperature of the board.

When you first turn on the sensor board to join a new network, you hold down the center button to tell the firmware to search for and join a new network. Once you turn the sensor off, and back on again later without holding down the center button, the sensor rejoins the previous network. This allows the sensor to join almost immediately after it has been powered off and then back on again.

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References

The following references are included on either the Stellaris LM3S9B96 Development Kit Documentation and Software CD or the Stellaris LM3S9B96 EM2 Expansion Board Documentation and Software CD. They are also available for download at the www.ti.com/stellaris or www.ti.com/zigbee web sites:

- *Stellaris LM3S9B96 Development Kit User's Manual*
- *DK-LM3S9B96 Firmware Development Package User's Guide*
- DK-LM3S9B96 Firmware Development Package
- *Stellaris[®] Peripheral Driver Library User's Guide*
- *Stellaris LM3S9B96 Microcontroller Data Sheet*
- *Z-Stack Developer's Guide* (publication number SWRA176)
- *Z-Stack Application Programming Interface* (publication number SWRA195)
- *Simple API for Z-Stack* (publication number SWRA196)

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