

## Stellaris<sup>®</sup> 2.4 GHz SimpliCI<sup>®</sup> Wireless Kit

The Stellaris 2.4 GHz SimpliCI Wireless Kit (DK-EM2-2500S) provides an easy way to evaluate the capabilities of Texas Instruments' CC2500 radio transceiver and SimpliCI 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 SimpliCI Wireless Kit (DK-EM2-2500S)
- You have the Stellaris DK-LM3S9B96 Development Kit Documentation and Software CD

### Kit Contents

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

- 1 DK-LM3S9B96-EM2 Expansion Board
- 1 CC2500EM Low Power 2.4 GHz Radio Transceiver evaluation module
- 1 antenna for use with CC2500EM
- 2 eZ430-RF4300T development boards, one with USB emulator, one with battery board
- Stellaris EM2 Expansion Board Documentation and Software CD



DK-EM2-2500S 2.4 GHz SimpliCI Wireless Kit

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

The following instructions describe how to run a simple 2.4-GHz radio network example using the DK-LM3S9B96-EM2 with the CC2500EM transceiver and two eZ430-RF2500T boards as supplied in the Stellaris 2.4 GHz SimpliciTI Wireless Kit. The SimpliciTI protocol is also supported by several other transceivers and system-on-chip radio parts operating in different frequency bands and the supplied software allows these to be used to interoperate with DK-LM3S9B96. If you purchased the DK-LM3S9B96-EM2 expansion board and a radio module other than CC2500EM, see “Appendix A – Using Other Radio Transceivers” on page 10 for information on setting up the particular board and radio that you want to use.

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

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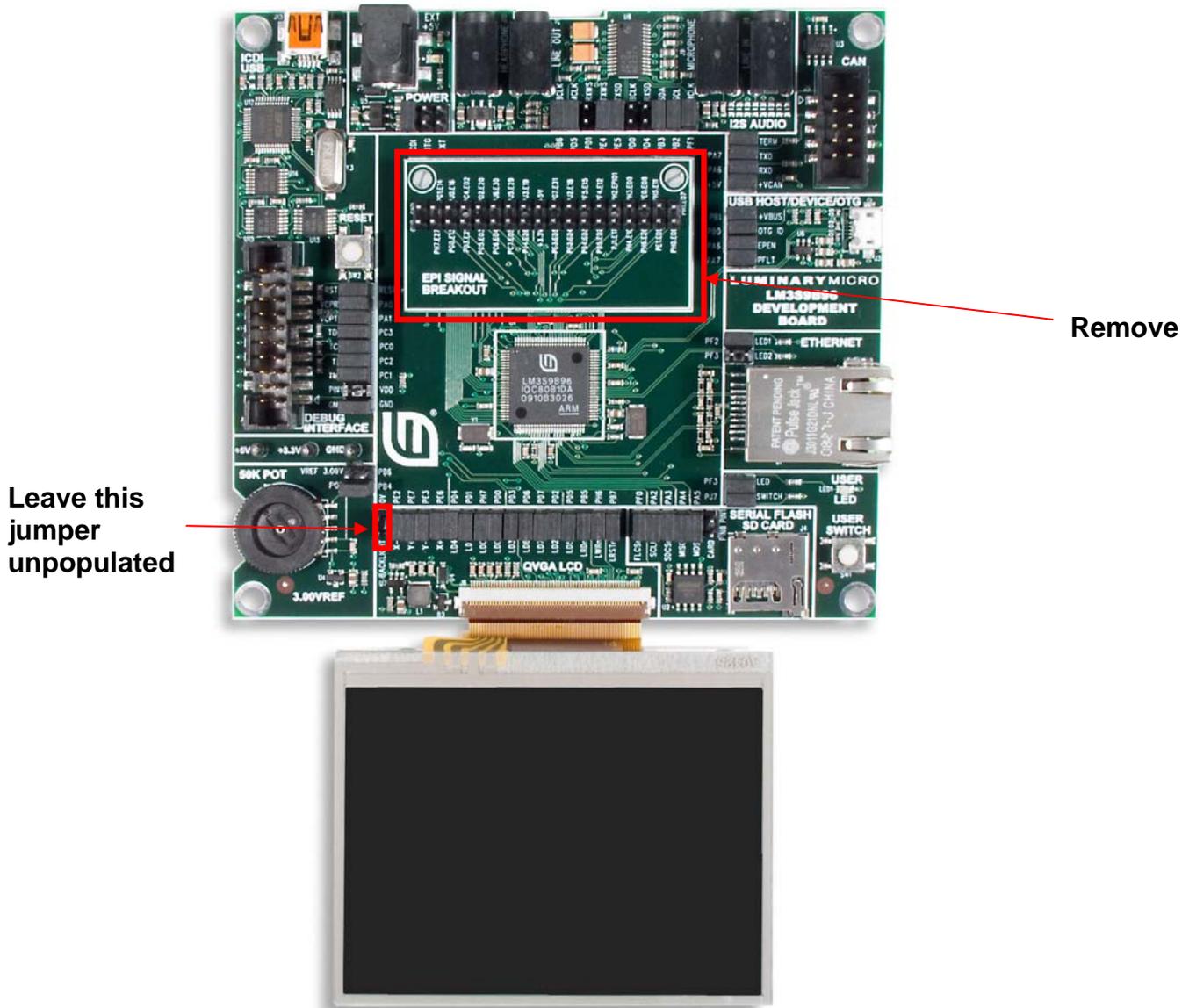
## Step 1: Set Up the LM3S9B96 Development Board and the EM2 Expansion Board

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 photo on the next page for reference.

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**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 CC2500EM radio transceiver daughter board.
6. Connect the CC2500EM 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. This is required to download example applications to the DK-LM3S9B96 board and is also included on both the DK-LM3S9B96 software CD and the CD that is included with the DK-LM3S9B96-EM2 expansion board and Stellaris 2.4 GHz SimpliciTI Wireless Kit. In all cases, navigate to the “Tools” menu on the CD 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 SimpliciTI wireless function from the CD supplied with the Stellaris 2.4 GHz SimpliciTI 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.exe file
```

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

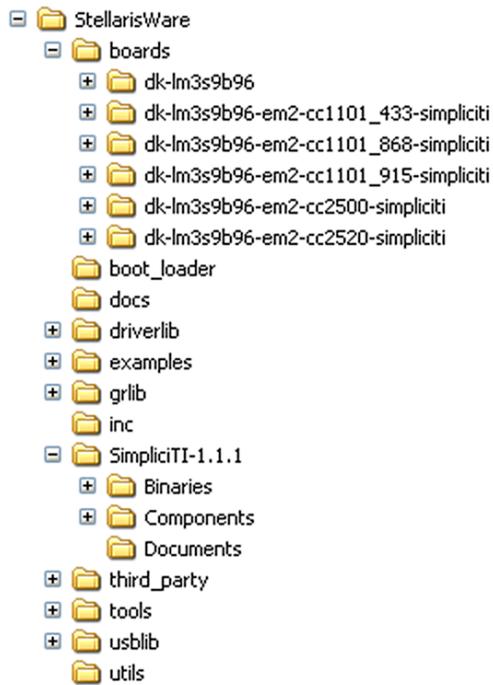
```
\Tools\StellarisWare\SW-DK-LM3S9B96-EM2-xxxx.exe
```

Be sure to install the SimpliciTI 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 as shown in the next figure.

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

## Step 4: Flash the Example Application

The example application sets up the DK-LM3S9B96 as an access point for a simple SimpliciTI wireless network. Two end devices send messages to the access point and toggle an “LED” shown on the DK-LM3S9B96 display.

Use the LM Flash Programmer tool to flash the “simpliciti\_hub\_ap.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-cc2500-simpliciti\simpliciti\_hub\_ap. This directory contains subdirectories for each supported toolchain and each of these contains a copy of the executable built with those tools.

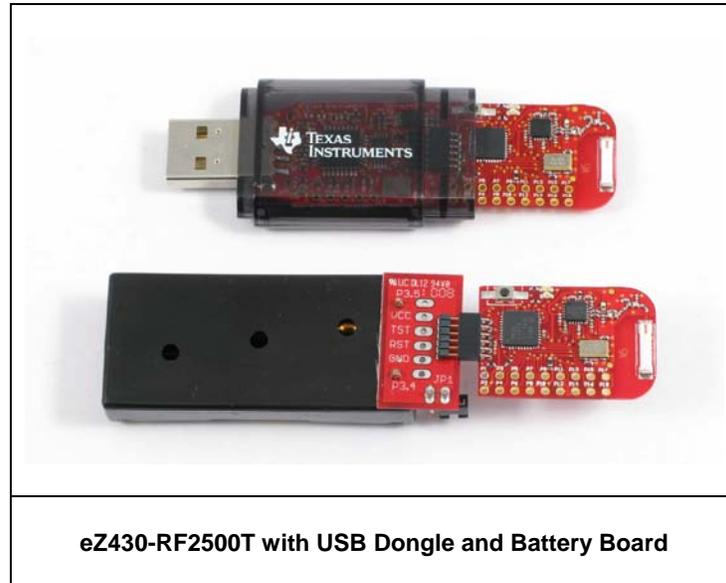
When the flash programming completes, reset the DK-LM3S9B96 and the application should run and show two “LEDs” on the display and a button labeled “Change Channel”.

With the access point running, we can now set up the end devices that will communicate with it.

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## Step 5: Set Up the eZ430-RF2500T Board



The Stellaris 2.4 GHz SimpliCI Wireless Kit includes two eZ430-RF2500T boards. These can be powered either via a USB dongle or battery board, both of which are provided in the kit. The boards are pre-programmed as end devices for the “Access Point as Data Hub” SimpliCI example application.

Attach one eZ430-RF2500T to the battery board with orientation as shown in the image above. Make sure that 2 AAA batteries are installed, then power the board by installing jumper JP1.

Both LEDs on the board should light then turn off. If the LEDs are flashing, this indicates an inability to connect to the access point on the DK-LM3S9B96, so reset the DK-LM3S9B96.

Pressing the button on the eZ430-RF2500T should cause the green LED on the eZ430-RF2500T and “LED1” on the DK-LM3S9B96 display to toggle. If both LEDs on the DK-LM3S9B96 begin flashing, this indicates that an automatic radio channel change has taken place. Press the button on the eZ430-RF2500T again to have it detect the new channel and reinitiate communication with the access point.

Set up a second end device by connecting the second eZ430-RF2500T to the USB dongle and installing this in an available USB port on your PC. This device should behave in exactly the same way as the first eZ430-RF2500.

**Note:** The red LED on the eZ430-RF2500T might toggle if it does not receive acknowledgement packets from the DK-LM3S9B96. This occurs when a radio channel change occurs at the access point, either because the 'Change Channel' button

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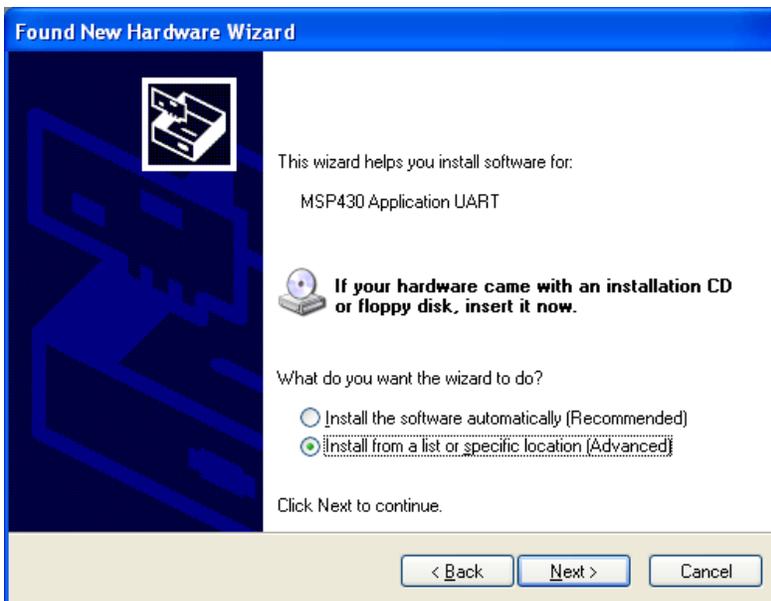
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was pressed or because the access point determined that there was noise on the current channel.

When you plug in the USB dongle of the board for the first time, Windows starts the Found New Hardware Wizard and asks if Windows can connect to Windows Update to search for software. Select “No, not this time,” and then click Next.



Next, the Found New Hardware Wizard asks from where to install the software. Select “Install from a list or specific location (Advanced)” and click Next.

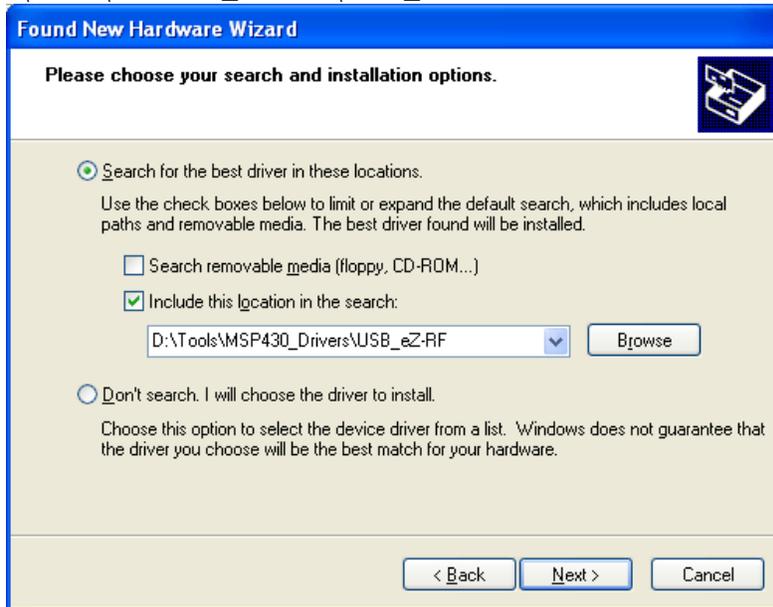


Make sure the “Documentation and Software” CD that came with the development kit is in

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your CD-ROM drive. Select “Search for the best driver in these locations,” and check the “Include this location in the search path” option. Click “Browse” and navigate to the directory “\Tools\MSP430\_Drivers\USB\_eZ-RF” on the CD then click Next.



Windows finishes installing the drivers for “MSP430 Application UART.” When the driver install is finished; the Found New Hardware Wizard window appears like the one below. Click Finish to close the dialog box.



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## Appendix A – Using Other Radio Transceivers

The Stellaris 2.4 GHz SimpliciTI Wireless Kit includes hardware allowing evaluation of a 2.4 GHz radio network using the CC2500EM radio transceiver. The software release, however, includes software and pre-built application binaries for the following radio transceivers and frequency bands:

- CC1101EM 433 MHz
- CC1101EM 868 MHz
- CC1101EM 915 MHz
- CC2500EM 2.4 GHz
- CC2520EM 2.4 GHz (802.15.4)

A directory exists beneath C:\StellarisWare\boards containing sample application code supporting each of these modules and frequencies. The eZ430-RF2500T boards supplied in the kit only interoperate with CC2500EM so, to configure a network using any of the other radio modules, requires additional hardware which can be purchased from TI. The following table indicates board and radio combinations that interoperate with each of the StellarisWare configurations described above.

Stellaris Configuration	Interoperable Configurations	Binaries Provided?
CC1101EM 433MHz	DK-LM3S9B96 + EM2 + CC1101:433EM	Yes
	SmartRF04EB + CC1110:433EM	Yes
	EXP430FG4618 + CC1101:433EM + USB Debug Interface	No <sup>1</sup>
	CC1111EM USB Dongle	No
	EM430F6137RF900	No
	FET430F6137RF900	No

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Stellaris Configuration	Interoperable Configurations	Binaries Provided?
CC1101EM 868MHz	DK-LM3S9B96 + EM2 + CC1101:868/915EM	Yes
	eZ430-Chronos 868MHz Development Tool	No <sup>2</sup>
	SmartRF04EB + CC1110:868/915EM	Yes
	EXP430FG4618 + CC1101:868/915EM + USB Debug Interface	No <sup>1</sup>
	CC1111EM USB Dongle	No
	EM430F6137RF900	No
	FET430F6137RF900	No
CC1101EM 915MHz	DK-LM3S9B96 + EM2 + CC1101:433EM	Yes
	eZ430-Chronos 915MHz Development Tool	No <sup>2</sup>
	SmartRF04EB + CC1110:868/915EM	Yes
	EXP430FG4618 + CC1101:868/915EM + USB Debug Interface	No <sup>1</sup>
	CC1111EM USB Dongle	No
	EM430F6137RF900	No
	FET430F6137RF900	No
CC2500EM	DK-LM3S9B96 + EM2 + CC2500EM	Yes
	eZ430-RF2500	Yes

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Stellaris Configuration	Interoperable Configurations	Binaries Provided?
CC2500EM (continued)	SmartRF04EB + CC2510EM	Yes
	EXP430FG4618 + CC2500EM + USB Debug Interface	No <sup>1</sup>
	CC2511EM USB Dongle	No
CC2520EM	DK-LM3S9B96 + EM2 + CC2520EM	Yes
	SmartRF05EB + CC2530EM	Yes
	SmartRF05EB + MSP430F2618 + CC2520	No
	SmartRF04EB + CC2430EM	Yes
	SmartRF04EB + CC2431EM	No
	CC2430DB	No

<sup>1</sup> The StellarisWare package includes pre-built applications for several EXP430FG4618 configurations. Unfortunately, SmartRF Flash Programmer does not currently support programming this board. FETPro Lite is a freeware tool from Elprotronic that could be used to download binaries onto the [EXP430FG4618](http://www.ti.com/exp430fg4618)

<sup>2</sup> Although pre-built SimpliciTI examples are not provided for eZ430-Chronos, an example access point which communicates with the default sport watch firmware is provided.

For some of these combinations, pre-built applications are provided in the C:\StellarisWare\SimpliciTI-1.1.1\Binaries directory and these can be flashed to the target board using the supplied SmartRF Flash Programmer tool (found on the CD in the \Tools\SmartRF\_Flash\_Programmer directory). If no pre-built binaries supporting your desired combination are provided, you must download the SimpliciTI-1.1.1 package from <http://www.ti.com/simpliciti>

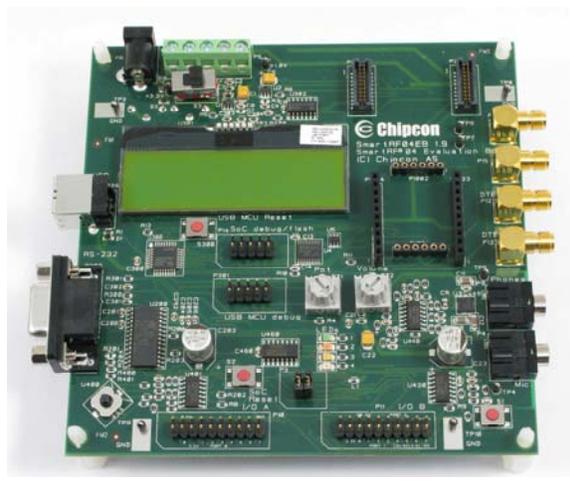
This package includes example applications and SimpliciTI stack source supporting all the boards described above. To build and run applications on these boards, you must either have Code Composer Studio (for MSP430-based radios and boards) or IAR Embedded Workbench (for either MSP430 or 8051-based radios and boards). Information on obtaining an evaluation license for these toolchains is included in the SimpliciTI package documentation.

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The boards shown below have pre-built binaries.



**SmartRF05EB**



**SmartRF04EB**



**EXP430FG4618 + CC1101:868EM + USB Debug Interface**



**eZ430-Chronos Development Tool**

## Appendix B – Using the eZ430-Chronos Access Point Example

The eZ430-Chronos Development Tool comes pre-programmed with sports watch functionality that includes SimpliciTI low power RF communication capability and a Stellaris example application is provided which communicates with the watch and displays various data transmitted by it. Interoperation with eZ430-Chronos requires that you use a CC1101:868/915 radio transceiver evaluation module (purchased separately) attached to your DK-LM3S9B96 and EM2 expansion board.

If you have previously reprogrammed the eZ430-Chronos, see the documentation that came with the kit and replace the default sports watch application image before proceeding.

### eZ430-Chronos Access Point Example Application

The “simpliciti\_chronos” example application included in the StellarisWare release for the DK-LM3S9B96-EM2 provides a wireless access point for the eZ430-Chronos sports watch and displays data sent from the watch in each of its three SimpliciTI radio modes – “ACC”, “Ppt,” and “Sync”.

If you installed StellarisWare in the default installation directory, you can find the simpliciti\_chronos application source in the following location:

```
C:\StellarisWare\boards\dk-lm3s9b96-em2-cc1101_<freq>-simpliciti\simpliciti_chronos
```

where <freq> is either 868 or 915 depending on the version of the eZ430-Chronos that you are using.

Lower level subdirectories contain binaries for the application built with each supported toolchain. These binaries can be downloaded to the DK-LM3S9B96 board using the LM Flash Programmer tool. A graphic of the eZ430-Chronos watch displays on the LCD while you run the simpliciti\_chronos application which waits for incoming connection requests from the sport watch.

To start radio communication, press the bottom left (#) button on the watch until either “ACC,” “Ppt,” or “Sync” is displayed, then press the bottom right (down arrow) button to enable the radio transceiver. A flashing icon appears on the right of the watch display to indicate that the radio is active.

To switch between watch modes, press the bottom right button once again to disable the radio, then use the bottom left button to cycle to the desired mode.

In “ACC” mode, the DK-LM3S9B96 receives X,Y,Z accelerometer data from the watch and displays this on the screen using a 2D drawing surface. You can draw on this surface by tilting the watch forward and backward or from side to side. The drawing position is controlled by the X and

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Y readings and the color of the drawing by the Z reading. In this mode, presses on the watch's "\*", "#", and up arrow buttons are also indicated on the DK-LM3S9B96 display.

In "PPT" mode, only the watch button presses are indicated on the DK-LM3S9B96 display.

In "Sync" mode, the DK-LM3S9B96 display shows the current time, date, alarm time, temperature, and altitude received from the watch. A button on the touchscreen allows the watch display mode to toggle between "Metric" (24 hour) and "Imperial" (12 hour) formats.

## 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](http://www.ti.com/stellaris) or [www.ti.com/simpliciti](http://www.ti.com/simpliciti) web sites:

- [\*Stellaris LM3S9B96 Development Kit User's Manual\*](#) (publication number spmu036)
- *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*
- [\*SimpliciTI Overview\*](#) (publication number swru130b)

The following documents are available on the DK-LM3S9B96-EM2 Documentation and Software CD:

- *SimpliciTI API* (\StellarisWare\SimpliciTI-1.1.1\Documents)
- *SimpliciTI Sample Application User's Guide* (\StellarisWare\SimpliciTI-1.1.1\Documents)
- *SimpliciTI Specification* (\StellarisWare\SimpliciTI-1.1.1\Documents)
- *SimpliciTI Developers Notes* (\StellarisWare\SimpliciTI-1.1.1\Documents)

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DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>	Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>	Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>	Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>	Energy	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>	Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>	Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>	Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>	Space, Avionics & Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
RF/IF and ZigBee® Solutions	<a href="http://www.ti.com/lprf">www.ti.com/lprf</a>	Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>
		Wireless	<a href="http://www.ti.com/wireless-apps">www.ti.com/wireless-apps</a>

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