

## Stellaris® 13.56 MHz RFID Wireless Kit

The Stellaris® 13.56 MHz RFID Wireless Kit (DK-EM2-7960R) can be used with the Stellaris® DK-LM3S9B96 Development Board or the DK-LM3S9D96 Development Board. (each sold separately) to enable RFID capabilities. For the remainder of this document, all references will be to the DK-LM3S9x96 including references to directories, documents, files, and so on. The RFID wireless kit contains the Stellaris EM2 Expansion Board (DK-LM3S9B96-EM2) and the TRF7960TB HF RFID Reader Module which connect to the DK-LM3S9x96 development board using the Stellaris microcontroller's External Peripheral Interface (EPI).

## TRF7960TB HF RFID Reader Module

### Requirements

- You have a Stellaris DK-LM3S9x96 development platform (sold separately)
- You have a Stellaris 13.56 MHz RFID Wireless Kit (DK-EM2-7960R)
- You have the Stellaris DK-LM3S9x96 Development Kit Documentation and Software CD
- You have the supplemental installer for the 13.56 MHz RFID software development package (if so, skip Prerequisite on page 2)

### Kit Contents

The Stellaris 13.56 MHz RFID Wireless Kit includes the following components:

- 1 DK-LM3S9B96-EM2 Expansion Board
- 1 TRF7960TB HF RFID Reader Module
- 2 ISO/IEC 14443A (MIFARE® 1K Classic) contactless smart cards
- ISO/IEC 15693 inlay variety pack
- Stellaris EM2 Expansion Board Documentation and Software CD



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These components provide everything required to demonstrate communication with ISO/IEC 14443A (MIFARE® 1K Classic) contactless smart cards using the TRF7960TB EM board.

## Prerequisite: Download the RFID Supplemental Installer

The RFID supplemental installer requires U.S. Government export approval before it can be downloaded. This process can take several days. If you have not already done so, you should download the installer from the website so that you have the installer package when you are ready to install and set up your wireless kit. Submit your download request at the [www.ti.com/sw-dk-em2-7960r](http://www.ti.com/sw-dk-em2-7960r) website.

Follow these suggestions to avoid delays:

- Allow at least one to two business days for processing.
- Download instructions are sent via e-mail message once approved. Look for a message from [myregistered\\_software@list.ti.com](mailto:myregistered_software@list.ti.com).
- Provide complete information and fill in all blanks.
- Do not use abbreviations.
- Download the RFID supplemental installer only, do not run the RFID supplemental installer until Step 5.

## Get Started

To set up the RFID sample application, you must do the following steps:

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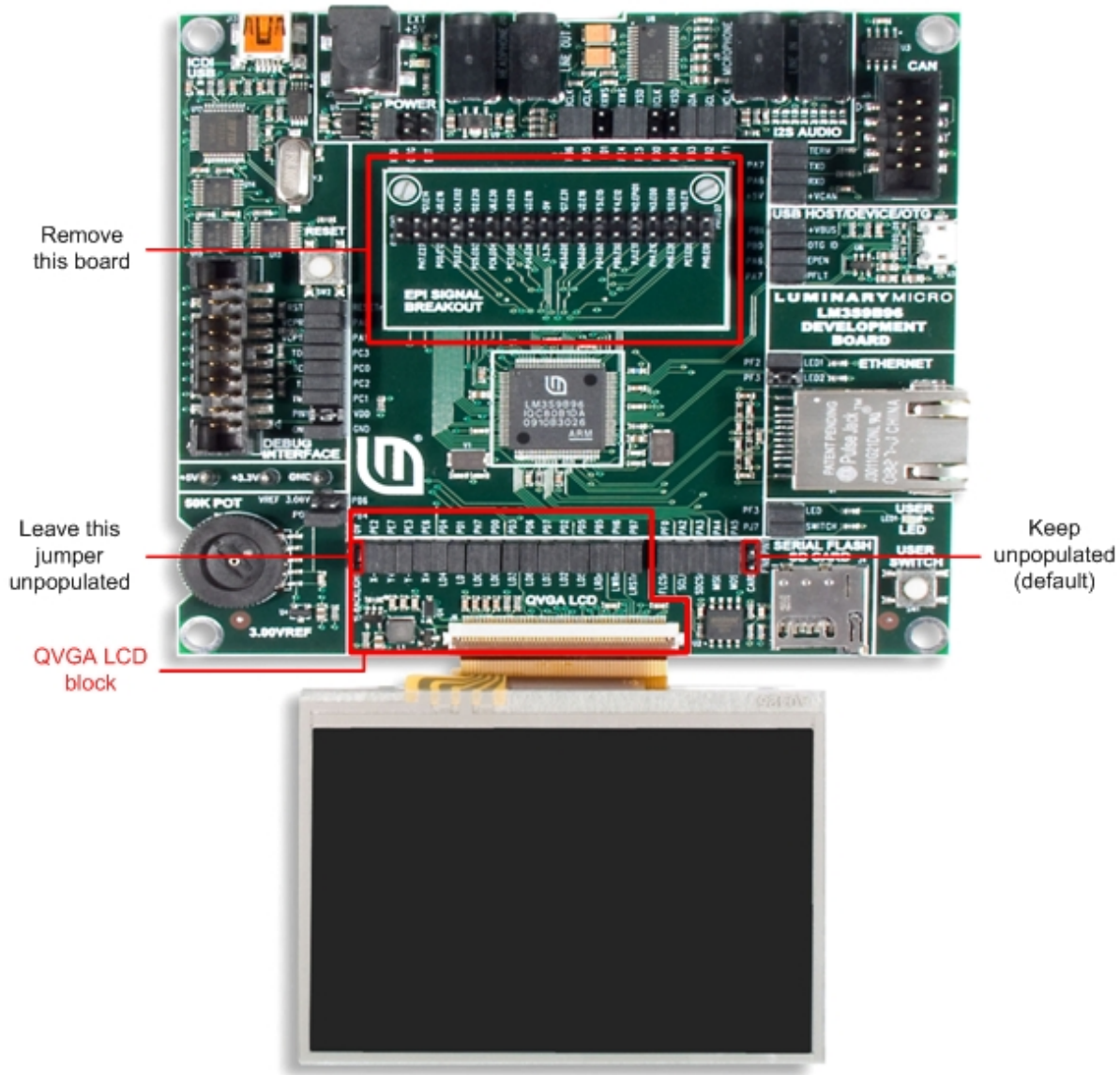
## Step 1: Set Up the DK-LM3S9x96 Development Board and the EM2 Expansion Board

The TRF7960TB HF RFID Reader Module interfaces to the DK-LM3S9x96 development board using the DK-LM3S9B96-EM2 expansion board to access the Extended Peripheral Interface (EPI) connector. To set up the DK-LM3S9x96 development board, do the following:

1. Power down the DK-LM3S9x96 board.
2. Remove any board that is currently fitted to the expansion connector.

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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 for reference.



**DK-LM3S9x96 Development Board**

3. Replace all but the leftmost (BACKLIGHT) jumpers in the QVGA LCD block near the bottom edge of the DK-LM3S9x96 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-LM3S9x96 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-LM3S9x96 development board (J2).

5. Connect the TRF7960R radio transceiver to the bottom (MOD2) pair of connectors on the EM2 expansion board.

The final assembly looks like this.





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## Step 2: Verify PC Device Drivers and LM Flash Programmer Installation

The steps below assume that you have already installed the debug and virtual COM port device drivers for the DK-LM3S9x96 board. If you have not yet installed these drivers, see the *LM3S9x96 Development Kit ReadMe First* (READMEFirst-DK-LM3S9x96.pdf) which you can find on the CD which is included in the DK-LM3S9x96 package.

Additionally, these steps assume that you have installed the “LM Flash Programmer” tool. This is required to download example applications to the DK-LM3S9x96 board and is also included on both the DK-LM3S9x96 software CD and the CD that is included with the Stellaris 13.56 MHz RFID Wireless Kit. In all cases, navigate to the “Tools” menu on the CD and double-click “LMFlashProgrammer.msi” to install the application.

The DK-LM3S9x96 Development Kit Documentation and Software CD and LM Flash Programmer installer are also available for download from the [www.ti.com/software\\_updates](http://www.ti.com/software_updates) web site.

## Step 3: Install StellarisWare Software

If you have not done so already, install the StellarisWare software release for the DK-LM3S9x96 by launching the following file on the CD (where xxxx is the software release number):

```
\Tools\StellarisWare\SW-DK-LM3S9x96 -xxxx.exe
```

## Step 4: Run the RFID Supplemental Installer

After you install the StellarisWare release, you must add RFID wireless function to the EM2 expansion board by running the RFID supplemental installer that you downloaded previously. Navigate to the directory where you downloaded this file and double-click the file to launch the installer (xxxx is the release number):

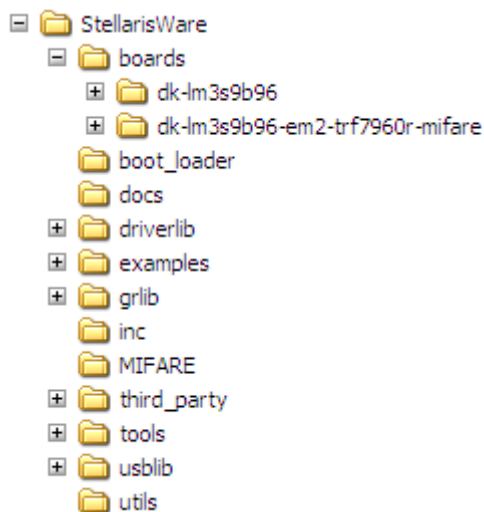
```
SW-DK-LM3S9x96 -EM2-TRF7960R-MIFARE-xxxx.exe
```

Follow the installer prompts and install the RFID support files in the same directory that 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 release and supplemental installer are the same.

Once you have completed these steps, the StellarisWare software will be located in C:\StellarisWare (if you selected the default installation path) with subdirectories as shown in the next figure.

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**Directory structure after installation of StellarisWare for DK-LM3S9x96 and the EM2/RFID support package**

If you used the default installation directory, you can then find the RFID application source in the following location:

C:\StellarisWare\boards\dk-lm3s9b96-em2-trf7960r-mifare

## Step 5. Flash the Example Application

Use the LM Flash Programmer tool (installed in Step 2) to flash the “rfid\_mifare.bin” file to the DK-LM3S9x96 board. If you installed StellarisWare in the default directory, this binary can be found under C:\StellarisWare\boards\dk-lm3s9b96-em2-trf7960r-mifare. This directory contains subdirectories for each supported toolchain and each of these subdirectories contains a copy of the executable built with those tools.

When the flash programming completes, reset the DK-LM3S9x96 and the application starts to run. The application tries to detect and authenticate any MIFARE Classic cards.

## Step 6. Operate the Example Application

The “rfid\_mifare” example application demonstrates communication with up to 2 ISO/IEC 14443A (MIFARE® 1K Classic) contactless smart cards using the TRF7960TB EM board connected to the LM3S9x96 development board to access the smart cards. The application can read and write blocks on the ISO/IEC 14443A (MIFARE® 1K Classic) contactless smart cards that are provided with the TRF7960TB EM module. The application continuously attempts to detect and authenticate to any MIFARE Classic cards using a hard-coded key (FF FF FF FF FF FF) and then displays the data for up to two cards. The application allows the user to format, erase, increment, or decrement any block on the card that is writable.

You can operate the example application either via GUI or command line interface.

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## GUI Interface

The “rfid\_mifare” example application uses the LCD and touchscreen to allow users to easily access some basic features of the ISO/IEC 14443A (MIFARE® 1K Classic) contactless smart cards. See the following figure that shows the GUI interface.



DK-EM2-7960R GUI Display

The lower right corner displays the number of cards in the field that were detected by using an ISO 14443A anti-collision algorithm. If an ISO/IEC 14443A (MIFARE® 1K Classic) contactless smart card is found and authenticated, then the blocks in the current sector including the access permissions and the card's UID are displayed.

Select a block by pressing the value firmly on the screen. This highlights the selected block and allows you to perform an action on that block. Only a selected block can be modified.

You can modify a properly formatted block with the increment and decrement buttons, and any writable block can be formatted or erased.

**Note:** If the card is moved and the application loses connection while a block is selected, the application removes the selection and you must select the block again.

The application allows the following actions on all data blocks on an ISO/IEC 14443A formatted (MIFARE® 1K Classic) smart card: format, erase, and increment/decrement value.

### Format Block

Formats the block according to the ISO/IEC 14443A standard and sets the value to zero.

### Erase Block

Erases the block by filling the raw block with all zero values which makes it an invalid format for the ISO/IEC 14443A standard and causes it to be displayed as “-----”.

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## Increment/Decrement Block Value

Reads and then increments or decrements the block value by one and writes the value back out as a properly formatted ISO/IEC 14443A standard block.

## Command Line Interface

The application also provides a simple, serial command line interface, so that the raw block data can be read and full 32-bit values can be written to blocks. You can access the command line interface via HyperTerm or any serial console application. The command line supports these features using the following three commands: read, raw, and write (described in detail below).

**Note:** The card number is an index of the card to access and the valid values are 0 and 1. The block number is an index of the block number to access and also starts with 0 and goes up to the number of valid blocks. The default command prompt may not be visible when you first start the application because it is displayed on power up. Reset the DKLM3S9x96 board or press the “Enter” key to redisplay the prompt.

Example: Default command prompt.

```
rfid_mifare
-----
>
```

**read** <card index> <block index>

Displays the value on the *card index* and in the *block index* specified in the command line.

Example: Reading block 2 on card index 0 (first card).

```
> read 0 2
Reading Block 2
Value: 0101012f Address: 00
>
```

**raw** <card index> <block index>

Displays the raw block data on the *card index* and in the *block index* specified in the command line.

Example: Reading raw data from block 2 on card index 0.

```
> raw 0 2
Reading RAW Block Data 2
Value: 0101012f fefefed0 0101012f ff00ff00
>
```

**write** <card index> <block index> <value>

Writes a *value* to the *card index* and to the *block index* specified in the command line. The



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value is assumed to be hexadecimal and does not require the “0x” prefix, and can be up to a 32-bit value.

Example: Writing block 5 on card index 1 (second card).

```
> write 1 5 0x123456789
Writing Block 5 with 23456789
Block written

>
```

## help

Displays the list of valid commands.

Example: Help display.

```
> help
```

Available commands

-----

```
help  : Display list of commands
h      : alias for help
?      : alias for help
read   : Read a block value from the card.
         read <card> <block>

raw    : Read the raw data from a block
         raw <card> <block>

write  : Write a value to block
         write <card> <block> <value> [addr]
```

## Useful Tips

The ISO/IEC 14443A (MIFARE® 1K Classic) contactless smart cards are “proximity” cards and should be relatively close to the antenna. For best results, lay the card on the antenna area to program. Programming works best if the card maintains a static position.

This kit works with these cards:



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## References

The following references are included on the Stellaris LM3S9x96 Development Kit Documentation and Software CD and are also available for download at the [www.ti.com/stellaris](http://www.ti.com/stellaris) web site:

- *Stellaris LM3S9x96 Development Kit User's Manual*
- *DK-LM3S9x96 Firmware Development Package User's Guide*
- DK-LM3S9x96 Firmware Development Package
- *Stellaris<sup>®</sup> Peripheral Driver Library User's Guide*
- *Stellaris LM3S9x96 Microcontroller Data Sheet*

Additional information and references for the TRF7960TB RFID Reader Module are available for download from the <http://focus.ti.com/docs/toolsw/folders/print/trf7960tb.html> web site including:

- *TRF7960TB HF RFID Reader Module Users Guide/Application Note*
- TRF7960TB HF RFID Reader Module Schematic and Board Files
- *TRF7960 Multi-Standard Fully Integrated 13.56-MHz RFID Analog Front End and Data-Framing Reader System Data Sheet* (publication number SLOU186)

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