RF430FRL152HEVM User's Guide

This document is a description of the RF430FRL152HEVM product that is designed to fully explore all of the capabilities that the RF430FRL152H device offers. To more easily experiment with all of the features of the device and the firmware that is in the ROM, a PC application is available, and its use is also described here, including software and driver installation.

The family of RF430RL15xH devices includes the RF430FRL152H, RF430FRL153H, and RF430FRL154H.

Contents

1 Introduction 3
1.1 Overview 3
1.2 What is Included 4
1.3 Required Additional Tools 4
1.4 Recommended Additional Equipment 6
1.5 Installation of the Software and Drivers 6
1.6 Update the EVM Firmware 6
2 Hardware Description 7
2.1 Block Diagram 7
2.2 Hardware Overview 8
2.3 Hardware Configurations 8
3 GUI Introduction 10
4 Overview 11
4.1 Connection to the EVM 11
4.2 Typical Sequence 11
4.3 Setup Tab 12
4.4 Demo Mode Tab 13
4.5 General Device Configuration Tab 14
4.6 Sensor Configuration Tab 17
4.7 Alarm Control Tab 18
4.8 Sensor Threshold Configuration Tab 19
4.9 View Sensor Data Tab 20
5 Setup of Demo System 21
5.1 Set up the RF430FRL152HEVM With Sensor Hub Demo Using the PC 21
5.2 Set up the RF430FRL152HEVM Demo Using the PC 22
5.3 Using the PC Application for Advanced Custom Control of the RF430FRL152HEVM 23
6 Changing Firmware System Settings 26
7 Over-the-Air Programming 27
7.1 Procedure 27
7.2 Generating a TXT File 28
8 RF430FRL152HEVM Schematics 30
9 References 34

List of Figures

1 RF430FRL152HEVM 4
2 MSP-EXP430G2 LaunchPad Development Kit With TRF7970A BoosterPack Plug-in Module 4
3 MSP-EXP430G2 Jumper Settings 5
4 TRF7970AEVM 5

Copyright © 2014–2018, Texas Instruments Incorporated

5 Sensor Hub BoosterPack Plug-in Module 6
6 RF430FRL152HEVM Block Diagram 7
7 RF430FRL152HEVM Hardware 8
8 PC Application 10
9 Setup Tab 12
10 Demo Tab 13
11 General Device Configuration Tab 14
12 Sensor Configuration Tab 17
13 Alarm Control Tab 18
14 Sensor Threshold Configuration 19
15 View Sensor Data Tab 20
16 BoosterPack Plug-in Module Configuration 21
17 Position the EVMs 23
18 Custom Sensor Configuration Tab 24
19 Custom General Device Configuration 25
20 Custom View Data 25
21 System Tab 26
22 RF Programming 27
23 RF Programming Completed 28
24 CCS TXT Generation 28
25 IAR TXT Generation 29
26 MCU Section Schematic 30
27 I^2C or SPI Translators Section Schematic 31
28 JTAG Section Schematic 32
29 Power Section Schematic 33

Trademarks

BoosterPack, MSP430, LaunchPad are trademarks of Texas Instruments.
All other trademarks are the property of their respective owners.

Copyright © 2014–2018, Texas Instruments Incorporated

1 Introduction

The RF430FRL152HEVM, including the user software, is a complete evaluation platform to evaluate the key features of the of the RF430FRL15xH devices:

- Passive communication and sensor measurement using ISO/IEC 15693
- Can program user code to FRAM memory through JTAG
- Collect sensor measurements over I^2C using the Sensor Hub BoosterPack™ plug-in module (BOOSTXL-SENSHUB)
- Can develop drivers for custom digital sensors
- Interfaces with the PC GUI application to fully experiment with application functionality

1.1 Overview

To start evaluating the RF430FRL152H device, an RF430FRL152HEVM is available. This evaluation board allows you to experiment with all of the capabilities of the low-voltage (1.5-V) dynamic tag with an MSP430™ core.

Because this dynamic tag uses ISO/IEC 15693 (NFC-capable) passive communication, it needs an ISO/IEC 15693 reader/writer to explore its full capabilities. To evaluate the device, TI recommends that you use the MSP-EXP430G2 LaunchPad development kit with the TRF7970A BoosterPack plug-in module and the PC application for the RF430FRL152HEVM. Alternate options include the TRF7970AEVM (which is no longer available from TI) or a custom NFC/RFID-capable handset.

Features and benefits of the RF430FRL152H MCU include:

- ISO/IEC 15693 RF interface
- Low-voltage MSP430 MCU (L092 based)
- Nonvolatile low-power FRAM memory (2KB)
- Sigma-delta 14-bit analog-to-digital converter
- Single-cell battery (1.5-V) operation
- Can run batteryless from RF scavenged energy provided by NFC/RFID reader
- Supports temperature measurement using a thermistor
- Single-chip solution for a contact-less sensor

The RF430FRL152HEVM is a development platform to evaluate the capabilities of the RF430FRL15xH devices and allows experimenting with all the features of the RF430FRL152H.

- Integrated PCB antenna
- Power over RF, battery, or USB
- Onboard thermistor and reference resistor for temperature measurement
- Onboard light sensor
- NFC/RFID ISO 15693 communication with NFC/RFID enabled reader/writer or smart phone
- Connector to enable compatibility with TI LaunchPad™ development kits and BoosterPack plug-in modules
- JTAG header for connection of MSP430-FET Emulation tool for programming

Copyright © 2014–2018, Texas Instruments Incorporated

1.2 What is Included

- RF430FRL152HEVM (see Figure 1)
- USB cable
- Quick start guide

1.2.1 RF430FRL152HEVM

Figure 1 shows an RF430FRL152HEVM.

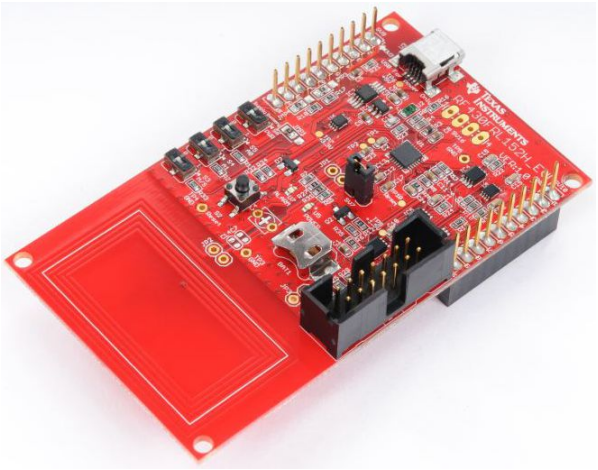


Figure 1. RF430FRL152HEVM

1.3 Required Additional Tools

- RF430FRL152HEVM Windows GUI
- TRF7970A-BNDL: MSP-EXP430G2 LaunchPad development kit with TRF7970A BoosterPack plug-in module to communicate with the RF430FRL152HEVM

  OR
- TRF7970AEVM (no longer available for purchase from TI)

1.3.1 MSP-EXP430G2 LaunchPad Development Kit With TRF7970A BoosterPack Plug-in Module

The TRF7970A-BNDL bundle is the recommended evaluation method and it is fully supported by the latest version of the RF430FRL152HEVM PC GUI.

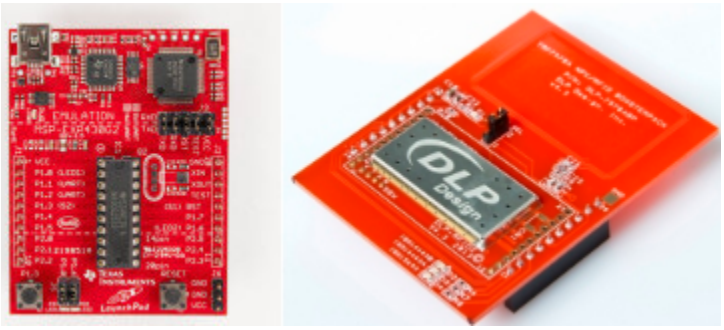


Figure 2. MSP-EXP430G2 LaunchPad Development Kit With TRF7970A BoosterPack Plug-in Module

To be used with the demo GUI, the MSP-EXP430G2 must be programmed with a special binary image (TRF7970A_BoosterPack_MSP430G2.out). This binary image can be found in the Debug folder of the zip file available at www.ti.com/lit/zip/sloc346.

Copyright © 2014–2018, Texas Instruments Incorporated

TI recommends using a tool like UniFlash to easily program the MSP430 MCU with the binary image.

Make sure to configure the jumpers as shown in Figure 3, for "HW UART".

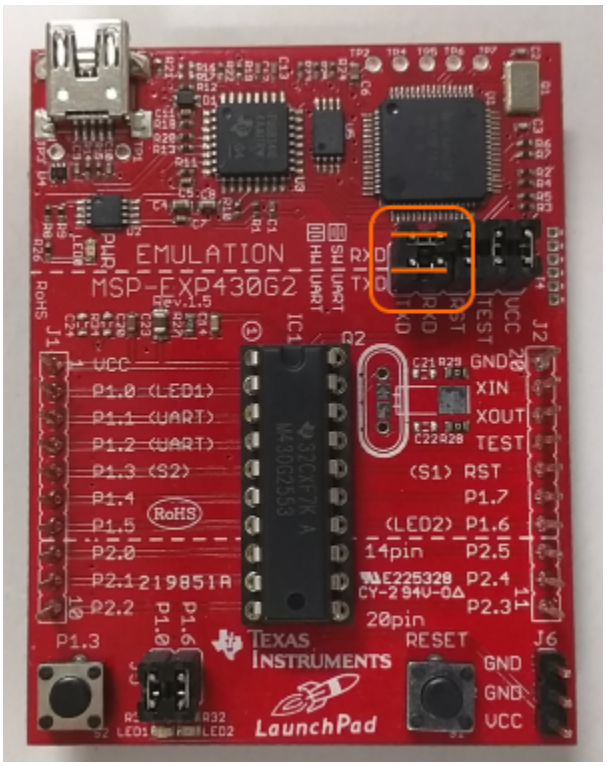


Figure 3. MSP-EXP430G2 Jumper Settings

1.3.2 TRF7970AEVM

Figure 4 shows a TRF7970AEVM. If the TRF7970AEVM firmware has not been changed since purchase, no code updates are necessary. If there are communication issues with the RF430FRL152HEVM, make sure that the TRF7970AEVM is programmed with the default EVM firmware, which can be downloaded from http://www.ti.com/lit/zip/sloc300.



Figure 4. TRF7970AEVM

Copyright © 2014–2018, Texas Instruments Incorporated

1.4 Recommended Additional Equipment

Optional recommended equipment:

- SensorHub Booster Pack
- MSP430 FET tool for code development, programming and debugging the device over JTAG

1.4.1 Sensor Hub BoosterPack Plug-in Module

Figure 5 shows the Sensor Hub BoosterPack plug-in module. This EVM has temperature, humidity, and light sensors. There is demo firmware showing how to use each of these sensors. This board can be used as a reference to develop custom functionality for digital sensors in an application.



Figure 5. Sensor Hub BoosterPack Plug-in Module

1.5 Installation of the Software and Drivers

The most recent PC GUI and user's guide are available at www.ti.com/tool/RF430FRL152HEVM.

To install the PC GUI:

1. Download the RF430FRL152HEVM Windows GUI file to the PC.
2. Run the executable and follow the prompts to install the software.
3. To run the application click on the Start menu, All Programs, then the Texas Instruments folder, then the "RF430FRL152HEVM Application" and finally the "RF430FRL152H GUI Interface" program.

The USB drivers for the TRF7970AEVM are available from the Silicon Labs website.

1.6 Update the EVM Firmware

The RF430FRL152HEVM comes loaded with firmware. However, updated firmware with fixes for the latest known erratas is available. Download this firmware from www.ti.com/lit/zip/slac691, and load the SensorHub example to have the same functionality as in the EVM.

Copyright © 2014–2018, Texas Instruments Incorporated

2 Hardware Description

2.1 Block Diagram

Figure 6 shows the EVM block diagram.

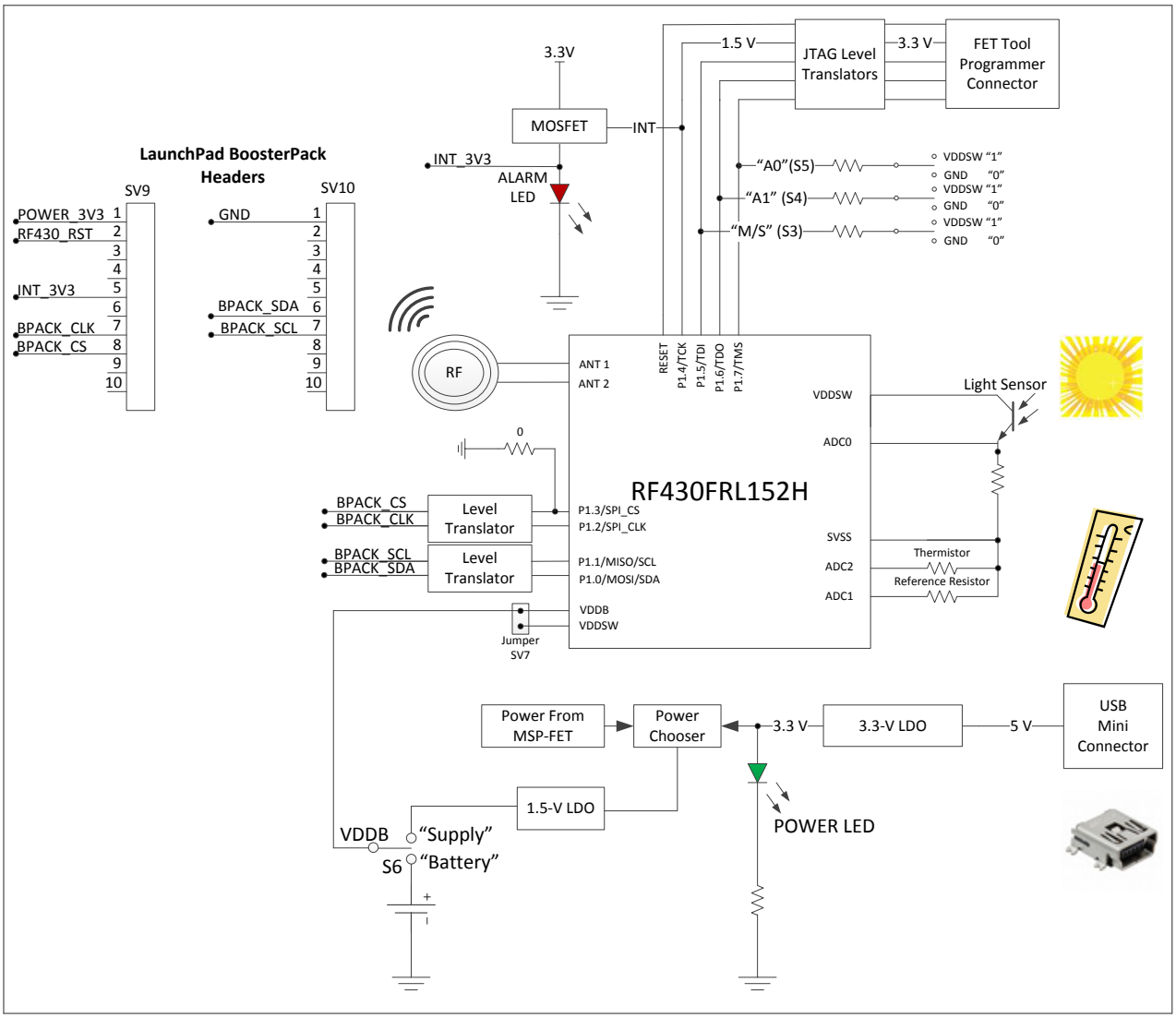


Figure 6. RF430FRL152HEVM Block Diagram

- The EVM board can be powered by RF scavenged energy, battery, FET emulator tool, or USB power. When powered through the USB connection or an MSP-FET emulation tool, switch S6 must be set to "Supply". If the EVM is powered by scavenged RF energy or a battery, switch S6 must be set to "Battery".
- Level translators are used on I^2C, SPI, and FET emulator interfaces.
- The power (green) LED should turns on only when the board is powered by a USB connection.
- Jumper SV7 is needed to bypass the internal battery switch and provide power directly to the core. This jumper should be populated for most use cases.
- When the EVM is powered by the USB connection, the Alarm LED briefly flashes at power-up or stays illuminated if there is an interrupt from the RF430FRL152H. It is normal for the Alarm LED to stay lit during MSP-FET tool programming.

Copyright © 2014–2018, Texas Instruments Incorporated

2.2 Hardware Overview

Figure 7 shows an overview of the RF430FRL152HEVM hardware.

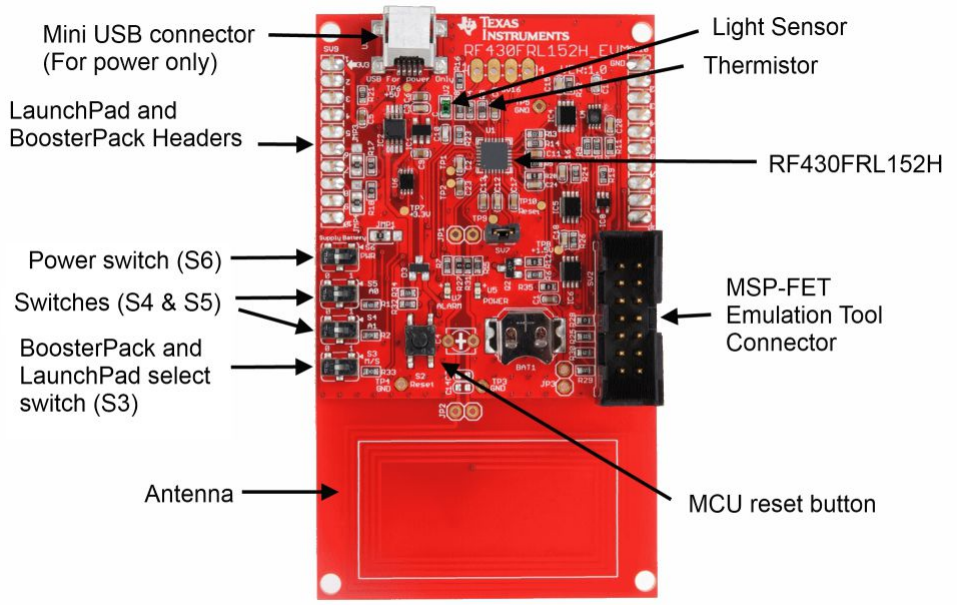


Figure 7. RF430FRL152HEVM Hardware

2.3 Hardware Configurations

2.3.1 Passive (Unpowered) Operation

In this mode, the RF430FRL152H is powered entirely from the RF field generated by the reader.

1. Set S6 to "Battery".
2. Set S3 to "S" (slave mode).
3. Make sure that USB and the MSP-FET emulation tool are not connected.
4. Place the EVM antenna on top of a NFC reader/writer to communicate.

Neither the "Alarm" or the "Power" LEDs illuminate in this mode of operation at any time. At this time a NFC/RFID reader may be used to communicate to the RF430FRL152HEVM.

2.3.2 Debugging or Programming

The following instructions show how to program the FRAM memory or debug the RF430FRL152H using a MSP-FET emulation tool. In this configuration the EVM is powered by the MSP-FET emulation tool.

1. Set switch S6 (near the BoosterPack plug-in module headers) to "Supply".
2. Connect the MSP-FET430 emulation tool to the JTAG header, SV2.
3. Start a debug session using IAR or CSS IDE.
4. Connection with the USB cable is not necessary for debugging or programming the RF430FRL152H.

Note: The Alarm LED may be illuminated during the debugging process if the USB cable is connected. This is normal behavior.

Note: If the USB cable is not connected, the power LED (U5) and the Alarm LED (7) are not illuminated even if the emulation tool is connected. This is normal behavior.

The MSP-FET emulation tool can be used to program or debug the EVM at this point.

Copyright © 2014–2018, Texas Instruments Incorporated

2.3.3 Using a BoosterPack Plug-in Module or Digital Sensors

An example of this use case is using the Sensor Hub BoosterPack plug-in module. In this configuration the EVM is powered by the USB connection.

1. Set switch S6 (near the BoosterPack plug-in module headers) to "Supply".
2. Set switch S3 to "M" (master mode).
3. Attach the BoosterPack plug-in module on top of the EVM, making sure it is in the correct orientation (pin 1 on the EVM matches pin 1 on the BoosterPack plug-in module headers).
4. Connect the USB cable to either the BoosterPack plug-in module or the RF430FRL152HEVM.

Note: When the USB cable is attached, the power LED (U5) stays illuminated. The Alarm LED (U7) should momentarily illuminate and then turn off.

Now the TRF7970AEVM can be used to communicate to the part and initiate samples of the various sensors.

2.3.4 Using a Host Controller

In this mode, the host LaunchPad development kit is connected underneath the RF430FRL152HEVM. Make sure the orientations match.

1. Set switch S6 (near the BoosterPack plug-in module headers) to "Supply" setting.
2. Set S3 to "S" (slave mode).
3. For a host that uses I^2C, S5 and S4 determine the two least significant bits of the I^2C slave address for the RF430FRL152H. For most cases, set these switches to the "0" positions.
4. For a host that uses SPI, S5 and S4 determine the SPI mode. For most cases, set these switches to the "0" positions.
5. Set S5 or S4 to desired setting at this time.
6. Connect the LaunchPad development kit and the EVM together.
7. Power either the LaunchPad development kit or the EVM by connecting either to a USB cable.

Note: When the USB cable is attached, the power LED (U5) stay illuminated. The Alarm LED (U7) should momentarily illuminate and then turn off.

2.3.5 Powering the EVM Using a Battery

1. Insert an SR66 1.5-V battery into the battery holder (BAT1).
2. Note: The first time that a battery is inserted, the battery holder may be tight. Carefully holding the board with a flat object, firmly slide in the battery. Make sure that the positive side of the battery is facing the positive (or top) side of the battery holder.
3. Set S6 to "Battery".
4. If the battery switch is open (the battery switch is inside the RF430FRL152H), SV7 needs to have a jumper to power the part. If the battery switch is closed, then SV7 does not need a jumper to power the RF430FRL152H.

Note: In this mode, the alarm and power LEDs are not illuminated. The device is still powered and operational.

Note: Also if S5, S4, or S3 positions are changed after powering the EVM, a reset is required for the changed settings to take effect. This can be done through the PC GUI or by pressing the reset switch (S2).

Note: If a battery is installed and another configuration (for example, debugging or using a BoosterPack plug-in module) is required, set switch S6 to "Supply" to disconnect the battery and not drain it.

Copyright © 2014–2018, Texas Instruments Incorporated

3 GUI Introduction

Figure 8 shows the Setup tab.

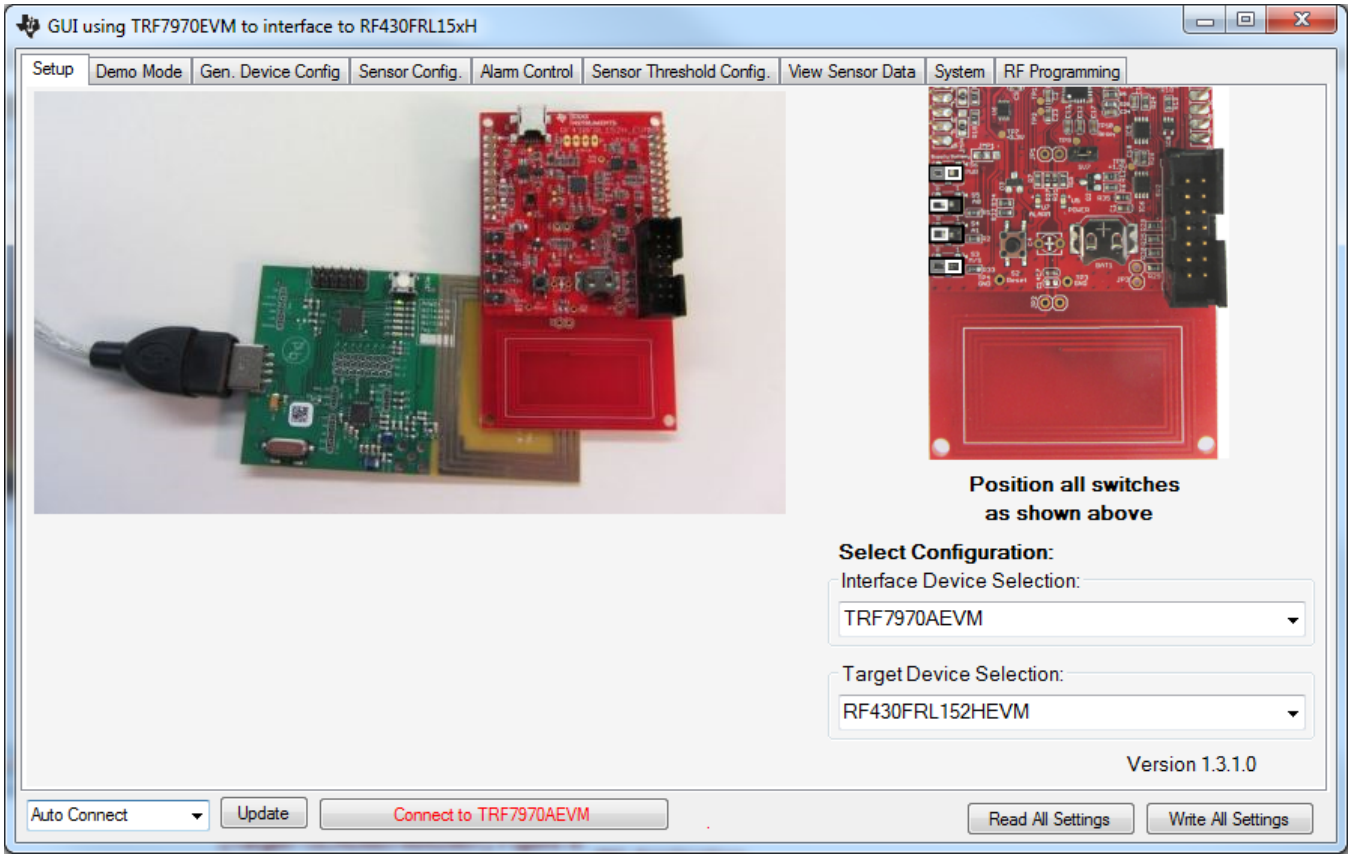


Figure 8. PC Application

Table 1. GUI Tabs

Name	Contents and Functions
Setup	Explains how to configure the system.
Demo Mode	Using an RF430FRL152HEVM, this tab allows automatic setup, measurement, and display of the thermistor and light sensor's measurements with one click of a button.
General Device Configuration	Controls that allow starting the sampling process, choosing the sensors to be used, and selecting the sampling frequency, among other options.
Sensor Configuration	Settings for the ADC for each analog sensor and also advanced settings.
Alarm Control	Settings for enabling and disabling the alarm settings.
Sensor Threshold Configuration	Settings for alarm thresholds for each sensor.
View Sensor Data	After a sampling process has completed, this tab allows the user to view the logged data.
System	Settings to the system control register can be made here.

Copyright © 2014–2018, Texas Instruments Incorporated

4 Overview

This section describes the meaning of each of the options on each tab. Remember, checking an option does not immediately cause that option to be set. It is only set after a "Write" button click is performed. Any changes that have occurred on the part, like new status, will not be visible until a "Read" button click has been done.

4.1 Connection to the EVM

Before any configuration can be done to the device using this application, a serial connection must be established. This can be done with the controls on the bottom of the application.

There is a drop-down list in which either a particular port can be chosen, if it is already known, or an automatic selection can be chosen.

When this is done, click on "Connect to TRF7970AEVM". If the connection succeeds, the text of the button changes to "Disconnect from TRF7970AEVM".

If the EVM is plugged in after the application starts, then the drop-down list does not have the currently available COM port selection. Click on the "Update" button to update the list.

4.2 Typical Sequence

In a typical sequence (for example, to do a thermistor measurement) follow these steps. These steps are more fully described in the *RF430FRL15xH Firmware User's Guide*.

1. Configure the thermistor measurement parameters:
    1. Select the thermistor sensor.
    2. Set how many times it needs to be sampled.
    3. If sampled more than one time, select the delay between the samples.
    4. Select the ADC configuration (resolution, PGA setting, and type of filter).

    These settings are written to the virtual registers in the FRAM memory using RF communication.
2. Write the start bit in the control register to start the sampling process.
3. There is a delay while the sampling process is being performed.
4. After sampling is complete, the requested measurements are stored into the log memory, typically FRAM (after the virtual registers).

Copyright © 2014–2018, Texas Instruments Incorporated

4.3 Setup Tab

1. Select the board that is being used in "Interface Device Selection".
2. Select the device that is being tested in "Target Device Selection".
3. If the RF430FRL152HEVM is selected, an option to select whether or not a Sensor Hub BoosterPack plug-in module is being used is presented. Make the selection (see Figure 9).

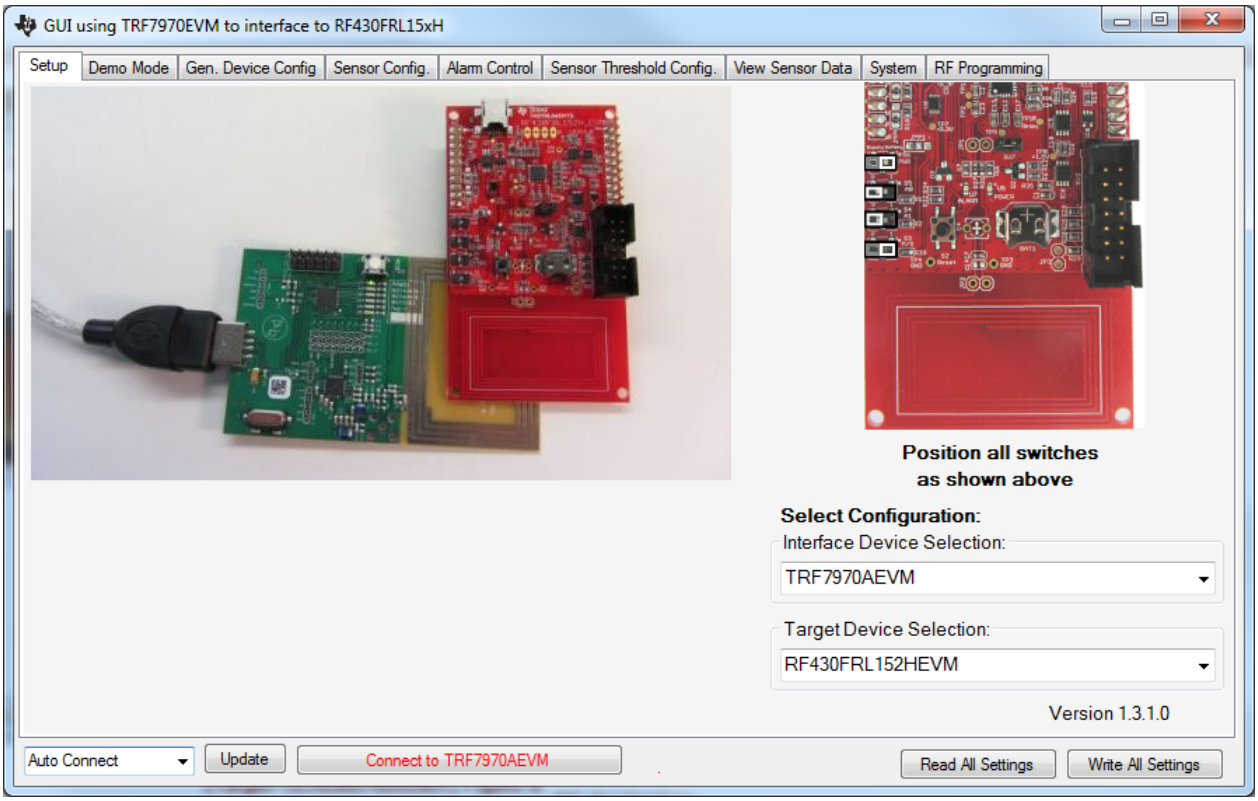


Figure 9. Setup Tab

Copyright © 2014–2018, Texas Instruments Incorporated

4.4 Demo Mode Tab

Using this page a user can easily run a sensor acquisition. After positioning the boards as shown on the Setup tab, then pressing the "Start Demo" button, measurement will be started and temperature data and other sensor data like light intensity will be shown (see Figure 10).

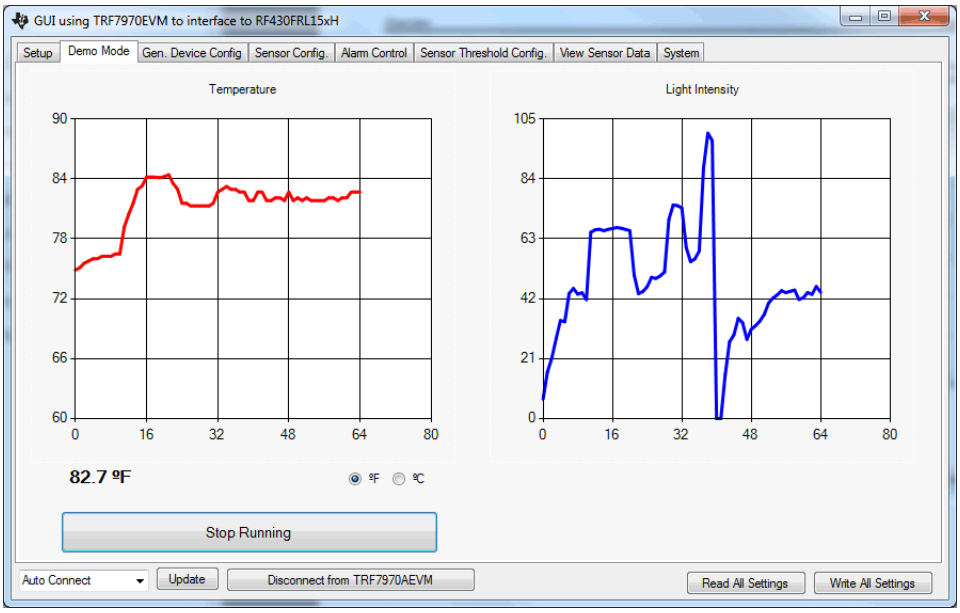


Figure 10. Demo Tab

Copyright © 2014–2018, Texas Instruments Incorporated

4.5 General Device Configuration Tab

Figure 11 shows the "Gen. Device Config" tab.

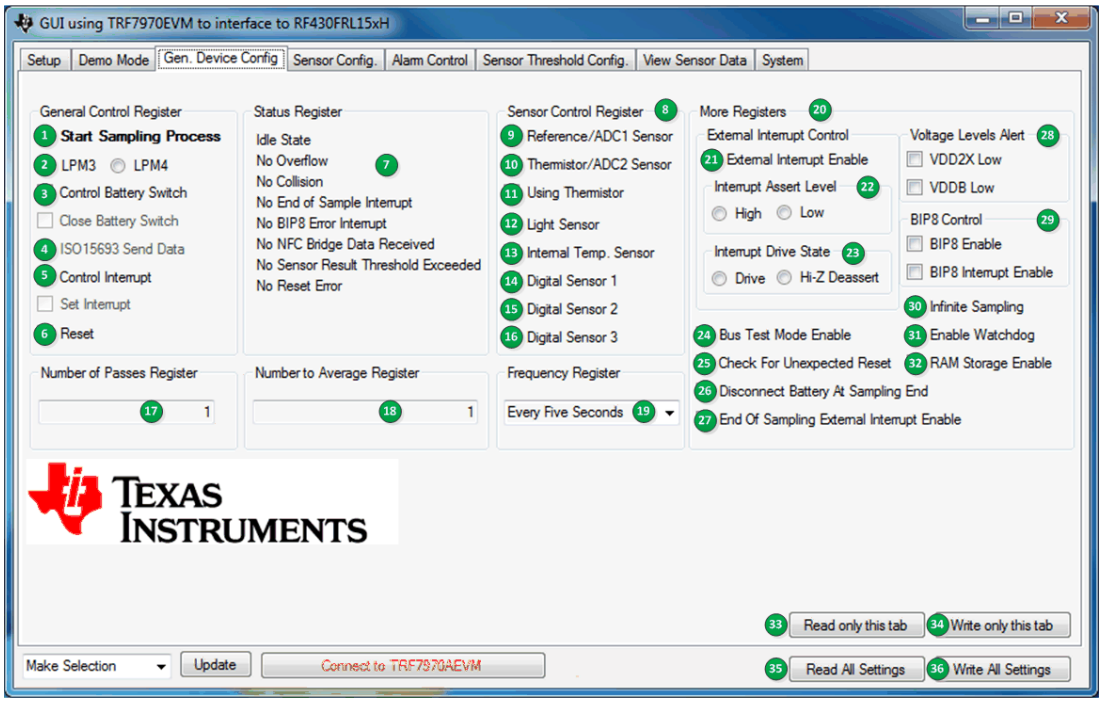


Figure 11. General Device Configuration Tab

1. Start Sampling Process

   Setting this bit causes the application ROM code to start the sampling process of all the sensors that were selected, based on all of the configurations.

2. LPM3 and LPM4

   Selects which power mode is used when the device enters idle mode.

3. Control Battery Switch and Close Battery Switch

   Controls the state of the battery switch on the device. To change the state, check "Control Battery Switch" and then to close the battery switch, check "Close Battery Switch". Otherwise, leave it unchecked, and the battery switch is set to open. The "Control Battery Switch" option is reset after the command is executed by the application ROM code.

4. ISO 15693 Send Data

   Allows sending of raw ISO/IEC 15693 commands. Disabled in the current version of the GUI.

5. Control Interrupt and Set Interrupt

   Controls the state of the external interrupt on the device. To change the state, check "Control Interrupt", and then to set the interrupt, check "Set Interrupt". Otherwise, leave it unchecked, and the interrupt and the associated flags are cleared. The "Control Interrupt" option is reset after the command is executed by the application ROM code. To generate an external interrupt manually with the GUI, more settings must be done using the "External Interrupt Control"

6. Reset

   Causes a PUC (a reset) to be generated on the device. The connection is maintained.

7. Status Register

   This group box displays any interrupt or status that have occurred on the device.

   Reset all status flags on next write resets all status to idle mode after the tab write.

8. Sensor Control Register

   Allows the selection of any sensor to be sampled. Selection of one or multiple sensors is possible.

Copyright © 2014–2018, Texas Instruments Incorporated

9. Reference / ADC1 Sensor

   Analog Input. If "Using Thermistor", check 11. This causes the input to be configured for an external reference resistor measurement. Otherwise, it can function as a stand-alone generic analog sensor (ADC1).

10. Thermistor / ADC2 Sensor

    Analog Input. If "Using Thermistor", check 11. This causes the input to be configured for an external thermistor measurement. Otherwise, it can function as a stand-alone generic analog sensor (ADC2).

11. Using Thermistor

    If using a thermistor, this option must be selected for the application ROM code to properly set up the measurement.

12. ADC0 / Light Sensor

    When using a RF430FRL152HEVM, this is an option to sample the light sensor. Otherwise, it is a generic analog sensor (ADC0).

13. Internal Temperature Sensor

    Allows sampling of the internal temperature sensor on the part.

14. Digital Sensor 1

    If using the RF430FRL152HEVM together with the Sensor Hub BoosterPack plug-in module, this samples the SHT21 temperature sensor. Otherwise, it is an option to sample a generic digital sensor.

15. Digital Sensor 2

    If using the RF430FRL152HEVM together with the Sensor Hub BoosterPack plug-in module, this samples the SHT21 humidity sensor. Otherwise, it is an option to sample a generic digital sensor.

16. Digital Sensor 3

    If using the RF430FRL152HEVM together with the Sensor Hub BoosterPack plug-in module, this option samples the ISL29023 light sensor. Otherwise, it is an option to sample a generic digital sensor.

17. Number of Passes Register

    One pass is sampling all of the selected sensors one time.

18. Averaging Register

    Any value higher than 1 causes that many samples to be averaged into one result. Averaging mode in the "Alarm Control" tab selects the type of averaging used per sensor.

19. Frequency Register

    Selects the delay to be made in between each of the sampling passes. Note this delay must not be less than the time to complete sampling all of the sensors one time. If it is less, then a "collision" occurs.

20. More Registers

    This advanced section is not required in most cases. However, it is described below.

    Gating option to enable the external GPIO interrupt.

21. Interrupt Assert Level

    The level to be driven or pulled to if there is an interrupt

22. Interrupt Drive State

    Determines if the device drives an interrupt or is high impedance (user must provide the appropriate pullup or pulldown resistor).

23. Bus Test Mode Enable

    Allows access to protected memory using an I^2C or SPI host.

Copyright © 2014–2018, Texas Instruments Incorporated

24. Check For Unexpected Reset

    If this option is selected, and an unexpected reset occurs, the reset code is logged at the end of the logging memory.

25. Disconnect Battery At Sampling End

    When the sampling process has been completed, this option causes the ROM code to open the battery switch.

26. End of Sampling External Interrupt Enable

    When the sampling process has completed, this option causes an external interrupt to be generated.

27. Voltage Levels Alert

    When these are set, it indicates that the voltage levels have gone too low on a particular rail at some point. Not self clearing.

28. BIP8 Control

    Error detection for I^2C or SPI protocol

29. Infinite Sampling

    Samples until the "Start Sampling Process" option is unchecked.

30. Enable Watchdog

    Enables the watchdog during a sampling process.

31. RAM Storage Enable

    Writes sampling results into RAM memory instead of FRAM.

32. Read only this tab

    Reads Gen. Device Config and populates the results on this tab.

33. Write only this tab

    Writes Gen. Device Config with all of the settings on this tab.

34. Read All Tabs

    Reads all of the information on all of the tabs from the virtual FRAM registers in the device using RF and populates the fields in the tabs.

35. Write All Tabs

    Writes all of the information to the virtual FRAM registers in the device over RF from all of the settings.

NOTE: Settings made on the following tabs do not take effect until a "Write only this tab" or "Write All Tabs" button is clicked:
Gen. Device Config.
Sensor Config.
Alarm Control
Sensor Threshold Config.

Likewise, the settings on these tabs are not updated until a "Read only this tab" or "Read All Tabs" button is clicked.

Copyright © 2014–2018, Texas Instruments Incorporated

4.6 Sensor Configuration Tab

The options for the four different analog sensors can be controlled from this tab (see Figure 12). The options can be changed only if the corresponding sensor is enabled in the "Gen. Device Config" tab.

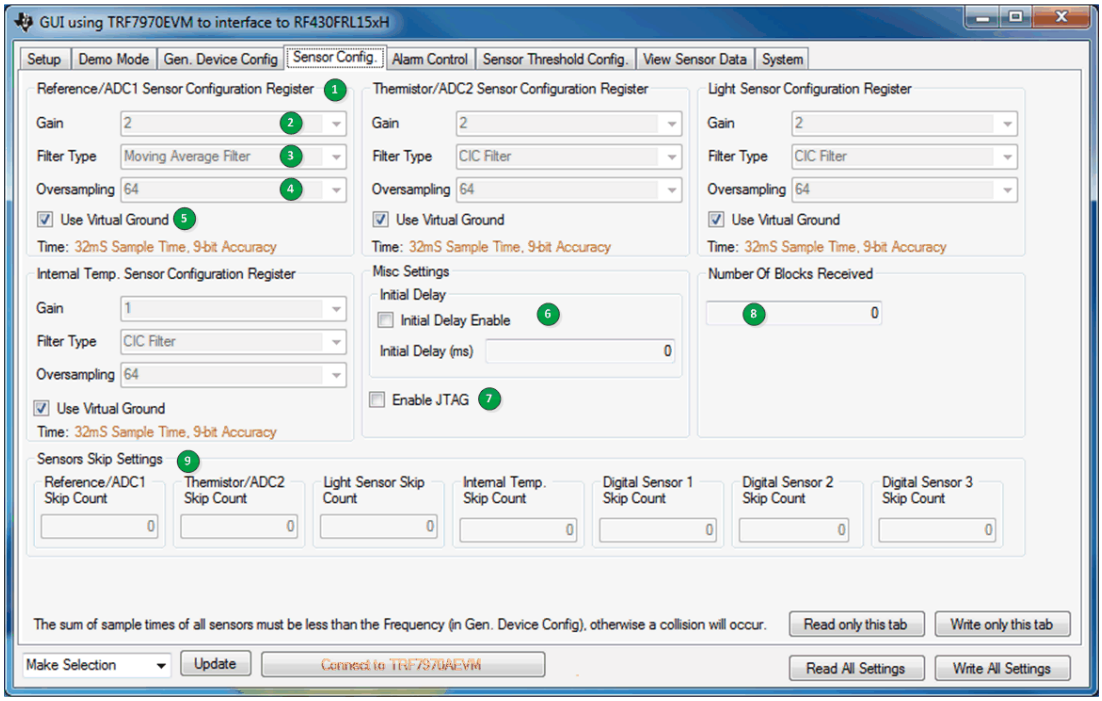


Figure 12. Sensor Configuration Tab

1. Sensor Configuration Sensor

   Allows control of the analog-to-digital configuration for a particular sensor.
2. Gain

   Selects the programmable gain amplifier (PGA) before the ADC.
3. Filter Type

   Select the filter to be used.
4. Oversampling

   Determines the resolution and time of the sample.
5. Use Virtual Ground

   If selected, raises the ADC and sensor ground level several hundred millivolts. It is recommended that this setting is consistent for all of the sensors.
6. Initial Delay Enable / Initial Delay (ms)

   Creates a delay of configured time after starting the sampling process.
7. Enable JTAG

   Because JTAG is normally disabled on the device, and if there is trouble establishing a JTAG connection, enabling this option can help establish connection. This setting takes effect only after a reset or power cycle.
8. Number of Blocks Received

   This is a counter that indicates how many ISO/IEC blocks have been received. Can be reset.
9. Sensor Skip Settings

   Allows control of the duty cycle for a sensor.

Copyright © 2014–2018, Texas Instruments Incorporated

4.7 Alarm Control Tab

The alarm control options for the four different analog sensors can be controlled from this tab (see Figure 13). The options can be changed only if the corresponding sensor is enabled in the "Gen. Device Config" tab.

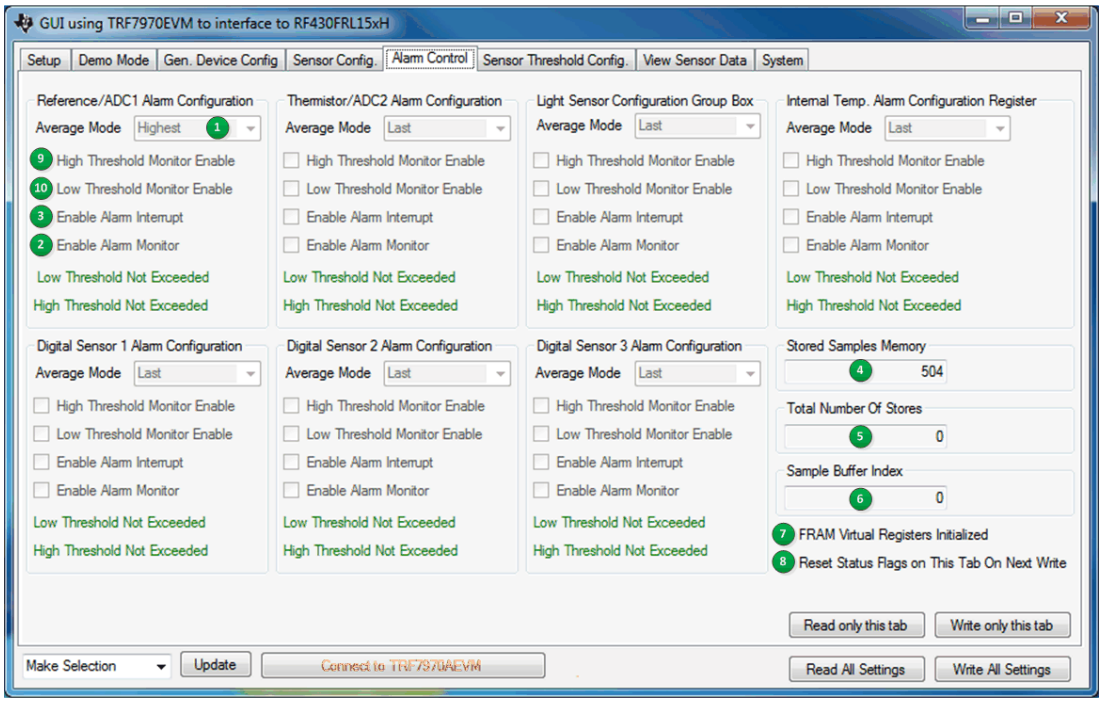


Figure 13. Alarm Control Tab

1. Averaging Mode

   True averaging is done only if the "Average" option is selected. The Lowest or Highest options store only the lowest or highest, respectively, sample for the selected sensor. The number of samples done before the result is stored is set in the "Averaging Register" setting on the "Gen. Device Config" tab. The "First" option stores the first sample of the selected sensor. If averaging is selected, during sampling passes after the first sample was stored, the remaining passes will skip this sensor.
2. Enable Alarm Monitor

   Enables a check for high or low thresholds for a particular sensor. The results are given in the labels below.
3. Enable Alarm Interrupt

   Enables a GPIO interrupt if a high or low threshold has been exceeded. The "Enable Alarm Monitor" must also be selected for this to take effect.
4. Stored Sample Memory

   Defines the length of the logged samples memory section.
5. Total Number Of Stores

   Reports how many samples were written to the log memory.
6. Sample Buffer Index

   Reports the index location of the last sample stored.
7. FRAM Virtual Registers Initialized

   If checked, indicates that the FRAM memory has been initialized.
8. Reset Status Flags on This Tab On Next Write

   Resets all of the flags on this tab the next time the "Write" button is clicked.

Copyright © 2014–2018, Texas Instruments Incorporated

9. High Threshold Monitor Enable

   Enables monitoring of that particular sensor for a sample value that exceeds or is equal to the threshold value set in "Sensor Threshold Config." tab. If the sample meets that condition, the status for that sensor (in the same group box) changes to indicate that condition.

10. Low Threshold Monitor Enable

    Enables monitoring of that particular sensor for a sample value for that is less than or equal to the threshold value set in "Sensor Threshold Config." tab. If the sample meets that condition, the status for that sensor (in the same group box) changes to indicate that condition.

4.8 Sensor Threshold Configuration Tab

Figure 14 shows the Sensor Threshold Configuration tab. A sensor must be enabled in the "Gen. Device Config" tab to allow the Sensor Threshold Configuration tab to change its threshold.

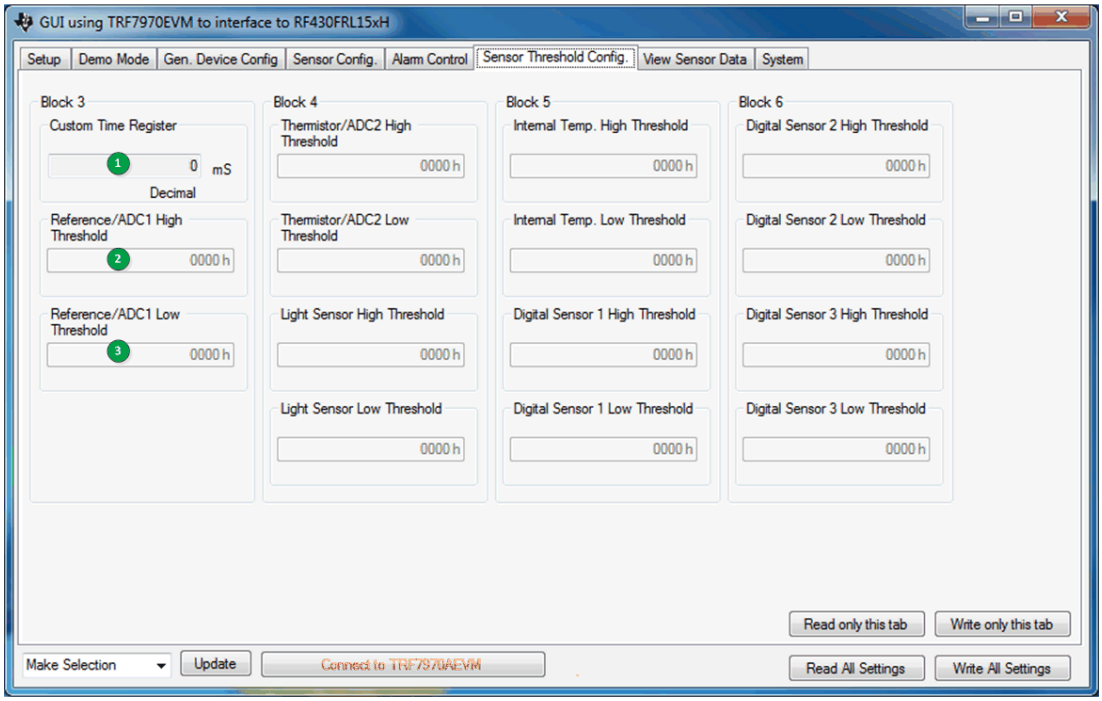


Figure 14. Sensor Threshold Configuration

1. Custom Time Register

   Available only if the "Frequency Register" has been set to the "Custom Time" option. Resolution is in milliseconds.

2. High Threshold

   If the sensor sample result meets or exceeds the high threshold set here, an alarm is generated. Operation depends on settings in the "Alarm Control" tab.

3. Low Threshold

   If the sensor sample result is lower or meets the low threshold set here, an alarm is generated. Operation depends on settings in the "Alarm Control" tab.

Copyright © 2014–2018, Texas Instruments Incorporated

4.9 View Sensor Data Tab

After a sampling process has been completed, the logged data can be viewed using this tab (see Figure 15).

Click the "Read Logged Data" button to display the results in a table to the left of the button. Make sure that you do not change any settings on the GUI before clicking the button, because the settings are used to determine what type of sampling process occurred.

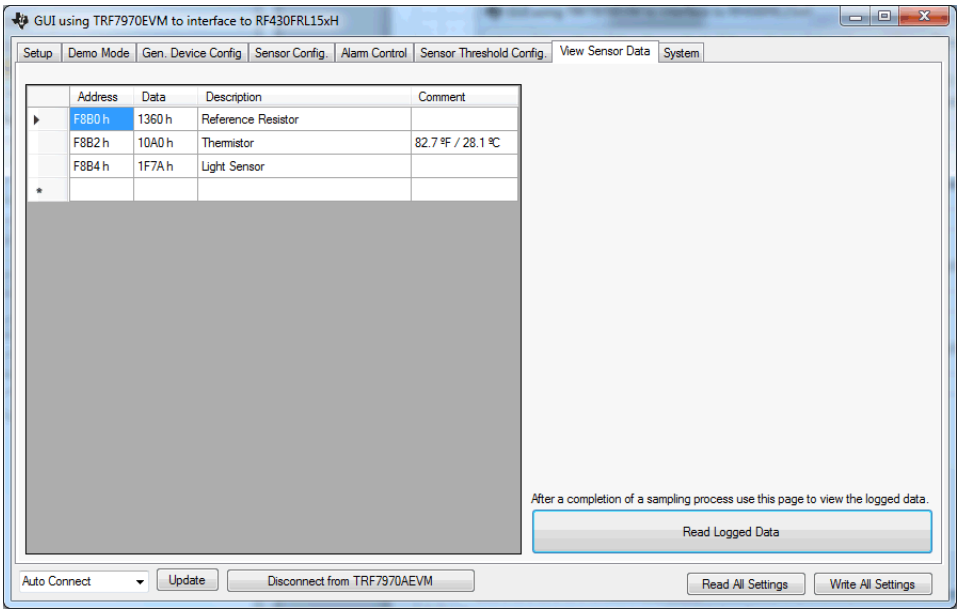


Figure 15. View Sensor Data Tab

Copyright © 2014–2018, Texas Instruments Incorporated

5 Setup of Demo System

The following sections describe how to setup a demo with and without the Sensor Hub BoosterPack plug-in module, and also for custom configuring and operation of the device.

5.1 Set up the RF430FRL152HEVM With Sensor Hub Demo Using the PC

This section describes how to setup and run the Sensor Hub BoosterPack plug-in module demo. With this setup, the RF430FRL152HEVM samples over I^2C three different sensors on the SensorHub BoosterPack plug-in module. They are temperature and humidity (SHT21) and a light sensor (ISL29023). After collecting the samples, the data is transmitted over RF to the TRF7970AEVM which reports them to the PC application. Finally the results are plotted on the graphs.

1. Connect the TRF7970AEVM to the PC with a USB cable.
2. On the RF430FRL152HEVM, use a pencil or pen to position the switches as shown in Table 2

Table 2. Switch Positions For Sensor Hub Operation

Switch ID	Position	Comment
S6	Supply	This will source power from the USB cable
S5	0	Does not matter what state this switch is in
S4	0	Does not matter what state this switch is in
S3	M	Device starts in I^2C/SPI master mode

3. Attach the Sensor Hub BoosterPack plug-in module on top of the RF430FRL152HEVM. Make sure that the orientation is correct (see Figure 16).
4. Connect the RF430FRL152HEVM to the PC using the provided USB cable. Note that this USB connection is only for the power supply, and no data is passed through it.
5. Position the RF430FRL152HEVM antenna on the antenna portion of the TRF7970AEVM as shown in Figure 16. It is recommended to have an insulator between the two antennas or to hold them at a distance from each other to prevent any short circuits.

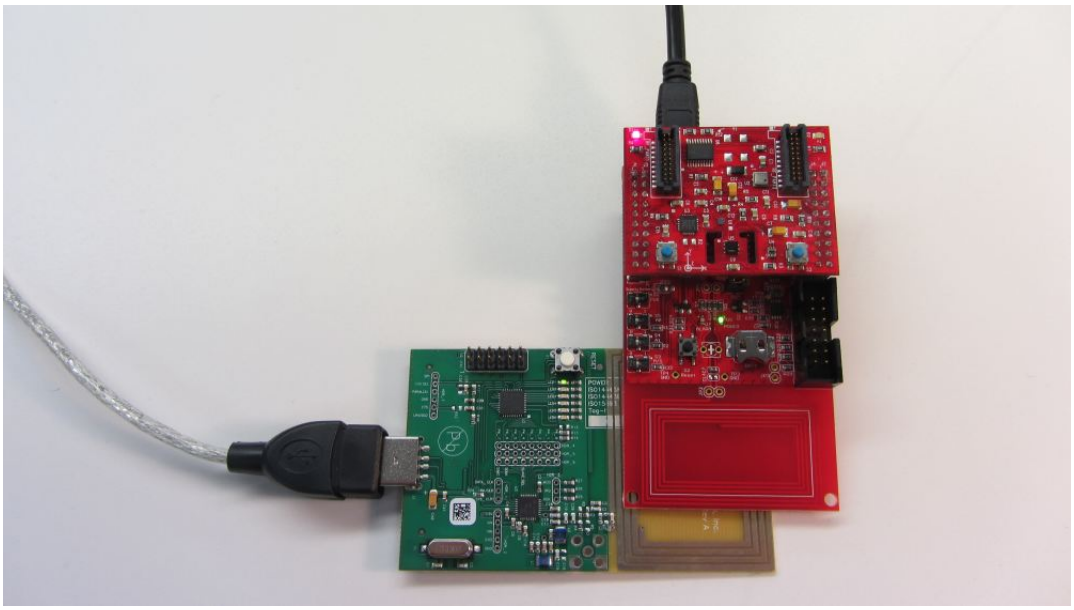


Figure 16. BoosterPack Plug-in Module Configuration

6. Open the RF430FRL15xH GUI Interface application by going to the Start menu→All Programs→Texas Instruments→RF430FRL152H GUI .
7. Click the "Connect to TRF7970AEVM" button on the bottom of the window.
8. A few seconds after you click the "Connect" button, the label next to the button should show

Copyright © 2014–2018, Texas Instruments Incorporated

"Connected to TRF7970AEVM on COMx". If this is not shown, then a connection has not been made. In this case, disconnect the TRF7970AEVM and reconnect it, then restart at step 1. If this still does not solve the problem, make sure that the TRF7970AEVM has the latest firmware downloaded from the TRF7970AEVM tool folder.

9. In the "Setup Tab", select the "With Sensor Hub BoosterPack" and "RF430FRL152HEVM" options on the Device Interface Selection.
10. Select the "Demo Mode" tab.
11. Click the "Start Sensor Hub Demo" button.
12. The GUI starts to plot the temperature and light intensity samples on the graphs.
    1. To plot these values, the PC GUI configures the RF430FRL152HEVM through the TRF7970AEVM to take three different samples from the Sensor Hub BoosterPack plug-in module. The RF430FRL152HEVM already has the drivers loaded into the FRAM to enable the measurements to be made.
    2. When the samples are complete, the PC GUI reads the result from FRAM of the RF430FRL152HEVM through the TRF7970AEVM and plots it on the graphs in the PC GUI.
13. To change the measurements, you can place your hand over the light sensor or heat the thermistor (U5).

5.2 Set up the RF430FRL152HEVM Demo Using the PC

This section describes how to setup and run the sensor demo. With this setup, the RF430FRL152HEVM samples, using the onboard ADC, two external sensors, the thermistor and the light sensor. After collecting the samples, the data is transmitted over RF to the TRF7970AEVM which reports them to the PC application. Finally the results are plotted on the graphs. In this demo the RF430FRL152HEVM is run completely wireless, with no power or data connections.

1. Connect the TRF7970AEVM to the PC with a USB cable.
2. On the RF430FRL152HEVM, use a pen or pencil to set the mini-switches as shown in Table 3.

Table 3. Switch Positions For Passive Operation

Switch ID	Position	Comment
S6	Battery	There is no need for a battery to be present
S5	0	Does not matter what state this switch is in
S4	0	Does not matter what state this switch is in
S3	S	Device starts in I^2C/SPI slave mode

3. **The RF430FRL152HEVM should not be connected to a USB cable for this demo**. If it is connected, set switch S6 to the "Supply" position. The rest of the steps are the same.

   Note: If EnergyTrace technology is used, a USB cable should not be used and the EVM must be powered from the MSP-FET tool.
4. Position the RF430FRL152HEVM antenna on the antenna portion of the TRF7970AEVM as shown in Figure 17. It is recommended to have an insulator between the two antennas or to hold them at a distance from each other to prevent any short circuits.

Copyright © 2014–2018, Texas Instruments Incorporated

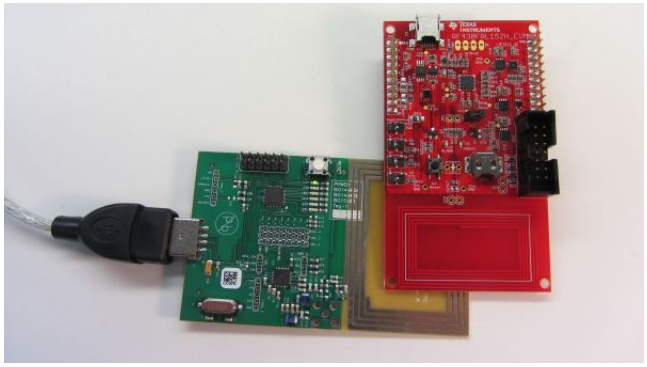


Figure 17. Position the EVMs

5. Open the RF430FRL15xH GUI Interface application by going to the Start menu→All Programs→Texas Instruments→RF430FRL152H GUI .
6. Press the "Connect to TRF7970AEVM" button on the bottom of the window.
7. A few seconds after you click the "Connect" button, the label next to the button should show "Connected to TRF7970AEVM on COMx".

   If this is not displayed, then a connection has not been made. In this case, disconnect the TRF7970AEVM and reconnect it, then restart at step 1. If this still does not solve the problem, make sure that the TRF7970AEVM has the latest firmware downloaded from the TRF7970AEVM tool folder.
8. In the "Setup Tab" select the "Without Sensor Hub BoosterPack" and "RF430FRL152HEVM" options.
9. Go to the "Demo Mode" tab.
10. Click the "Start Demo" button.
11. The GUI starts to plot the temperature and light intensity samples on the graphs.
    1. To plot these values, the PC GUI configures the RF430FRL152HEVM through the TRF7970AEVM to take two different samples from the analog thermistor and light sensors.
    2. When the samples are complete, the PC GUI reads the result from FRAM of the RF430FRL152HEVM through the TRF7970AEVM and plots it on the graphs in the PC GUI.
12. To change the measurements, you can place your hand over the light sensor or press the thermistor with a finger to affect the temperature result. The light sensor and the thermistor locations on the EVM are shown in Section 2.

    The thermistor temperature measurement may not reach the true skin temperature, because some of the heat dissipates into the EVM.

    The light sensor reading value does not increase in the presence of extra light (for example, if you shine a flashlight on it), because of design reasons with the light sensor selected for this EVM. However, the light sensor shows a change for reduced light. Note that the light sensor on the Sensor Hub BoosterPack plug-in module does not have this same limitation.

5.3 Using the PC Application for Advanced Custom Control of the RF430FRL152HEVM

This section describes how to set up the RF430FRL152HEVM for a custom sampling process. The example used here describes how to perform sampling of three sensors (reference, thermistor, and light sensor) with four passes at a rate of one sample per second. Various ADC configurations are made using the "Sensor Config." tab. This is a simple demonstration, and you can create more complex sampling processes and control as needed.

1. Follow the steps in Section 5.1 to start the PC application and connect to the TRF7970AEVM.
2. In the "Setup" tab, make sure that "Without Sensor Hub BoosterPack" and "RF430FRL152HEVM" are selected.
3. On the "Sensor Config." tab, for the reference and thermistor group boxes (near the top of the tab), make the following settings: gain of 2, filter type of CIC filter, oversampling of 256. When gain of 2 is used, the thermistor and reference input voltage does not use most of the analog voltage range. The CIC filter allows for shorter conversion times (using 256 oversampling).

Copyright © 2014–2018, Texas Instruments Incorporated

4. For the light sensor configuration, select gain of 1, CIC filter, and oversampling of 256.
5. Also on the same group boxes, select "Use Virtual Ground". Virtual ground allows the ADC module and inputs to be raised above ground voltage by several hundred mV. Raising the ground allows the ADC to more accurately measure voltages near ground. This setting must be chosen, because the RF430FRL152HEVM was designed with virtual ground powering the thermistor and light sensors (the SVSS pin is the virtual ground).
6. Figure 18 shows the "Sensor Config." tab with these settings.

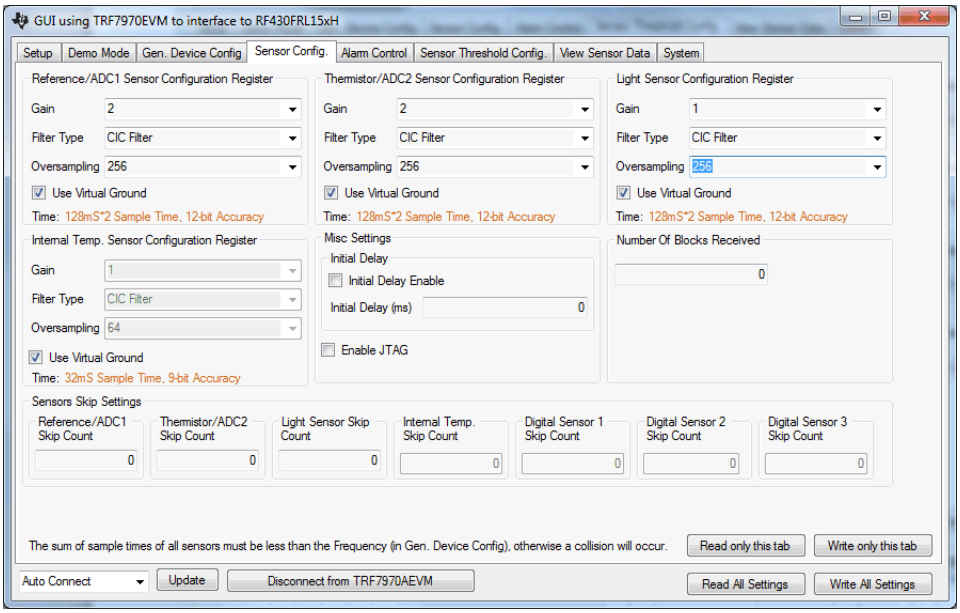


Figure 18. Custom Sensor Configuration Tab

7. Click the "Write only this tab" button on the bottom of the tab.
8. Go to the "Gen. Device Config" tab, and select the "Reference/ADC1", "Thermistor/ADC2", "Using Thermistor", and "Light Sensor" options in the "Sensor Control Register" group box. These settings determine which sensors are selected to be sampled.
9. Set "Number of Passes Register" to 4. This causes four sampling passes. A pass is sampling each of the selected sensors in the "Sensor Control Register" once, in the order that they are selected.
10. Set "Frequency Register" to the "Every Second" option. This setting causes the selected delay to occur between sampling processes.
11. Check "Start Sampling Process".
12. Figure 19 shows the "Gen. Device Config" tab with these settings.

Copyright © 2014–2018, Texas Instruments Incorporated

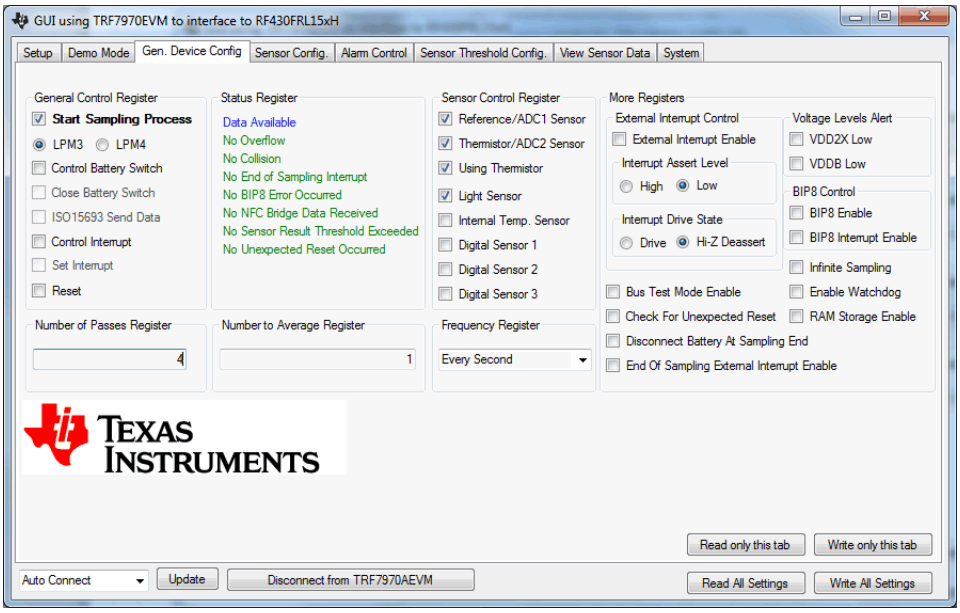


Figure 19. Custom General Device Configuration

13. Click the "Write only this tab" button.
14. The sampling process starts. You can click the "Read only this tab" button to check on the status of the sampling process. While the RF430FRL152H is still sampling, the "Status Register" displays the text "Sampling in Progress".
15. Continue to click the "Read only this tab" button until the "Status Register" displays the text "Data Available". The sampling process should take three seconds to complete.
16. When data is available, go to the "View Sensor Data" tab and click the "Read Logged Data" button. The GUI reads the logged data from the EVM and displays it (see Figure 20). This logged data is not designed to be human-readable. However, one use case of this function is to show the correlation and order of data to the sensor that took that data. In the logged data memory, the sensor that took that sample is not given and must be determined based on the configuration of the settings. However, the GUI shows which sensor is sampled and the expected order.

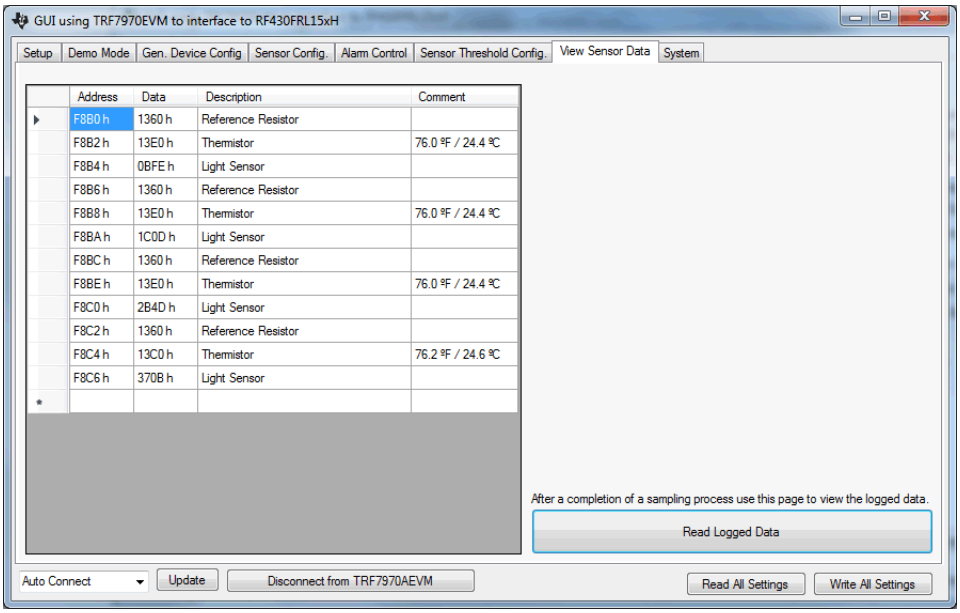


Figure 20. Custom View Data

Copyright © 2014–2018, Texas Instruments Incorporated

6 Changing Firmware System Settings

This section describes how to change the firmware system settings of the RF430FRL15xH. Figure 21 shows the System tab. Table 4 describes the available settings.

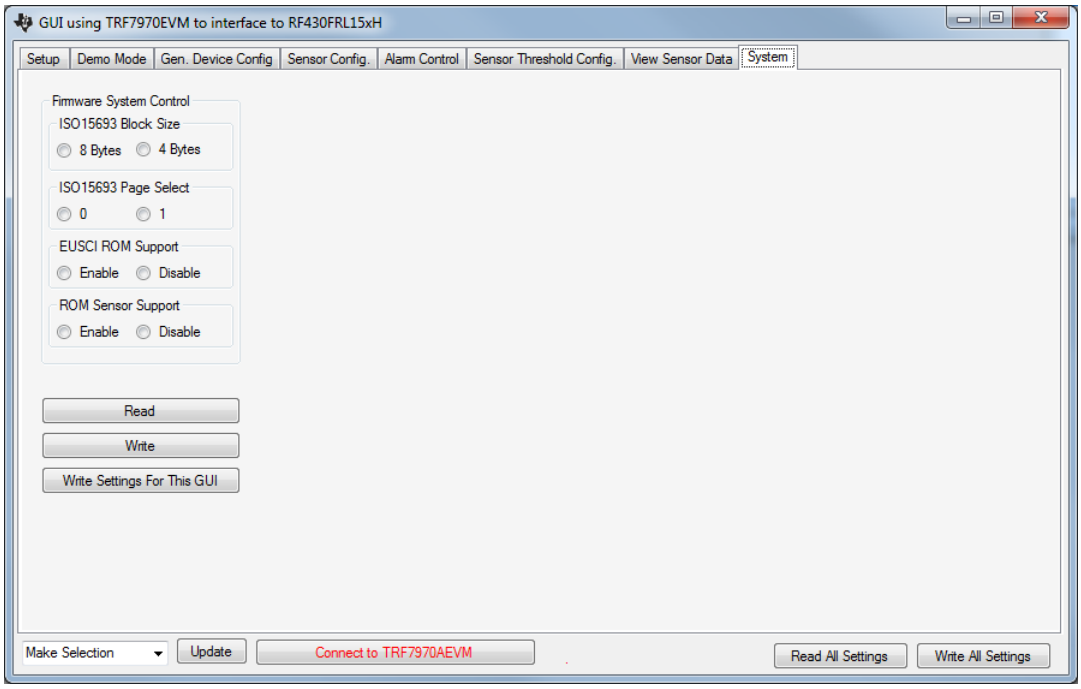


Figure 21. System Tab

Table 4. Firmware System Settings

Switch ID	Comment
Block Size	ISO/IEC 15693 RF setting. Determines the amount of bytes that can be read and written using a single block.
Page Select	RF stack setting. If 4 byte block setting is used, then to access the entire FRAM, two pages are necessary. This control switches between them. Not needed when 8 byte block size is used.
EUSCI Support	Enables or disables support for I^2C/SPI module. When disabled host controller and digital sensor ROM support is not functional. Forced off in RF430FRL153H since it does not have an eUSCI module.
Sensor Support	ROM support for using ADC (SD14) is disabled. Forced off in RF430FRL154H since it does not have an SD14 module.

To change these settings first, click the "Read" button to load the current settings. After changing them, click the "Write" button to send them over RF.

To automatically set the setting for the PC application, click "Write Settings For This GUI".

Copyright © 2014–2018, Texas Instruments Incorporated

7 Over-the-Air Programming

This section describes how to program the RF430FRL15xH using RF. Figure 22 shows the screen used for RF programming.

NOTE: The RF programmer cannot program the complete FRAM memory. This is because not all the FRAM memory is accessible over RF. The region that it can program is F867h to FFFFh.

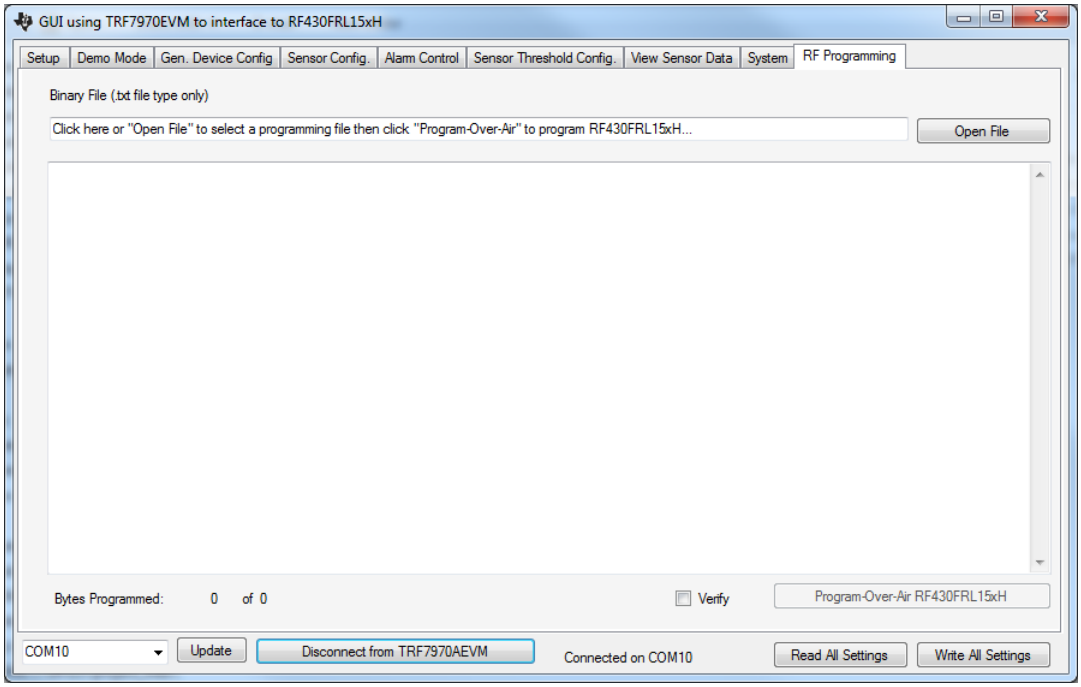


Figure 22. RF Programming

7.1 Procedure

NOTE: Only .txt format file types are accepted by this program. CCS and IAR can generate this formats (see Section 7.2 for instructions).

Follow these steps to select and program the binary file using RF (also see Figure 23).

1. Create a .txt file of the program to be programmed.
2. Click on the "Open File" button.
3. Find and select the .txt file that was created in step 1.
4. Click "Verify" if verification of programming is needed.
5. Make sure that the RF430FRL15xH is positioned above the TRF7970A reader/writer.
6. Click "Program-Over-Air RF430FRL15xH" to start the programming.
7. Status progress is provided by text in the text box and also in numerical form as "Bytes Programmed".
8. After programming completes, power down the RF430FRL15xH by removing it from the field or disconnecting the power supply. When power is applied again, the RF430FRL15xH resets and the new program takes effect.

Copyright © 2014–2018, Texas Instruments Incorporated

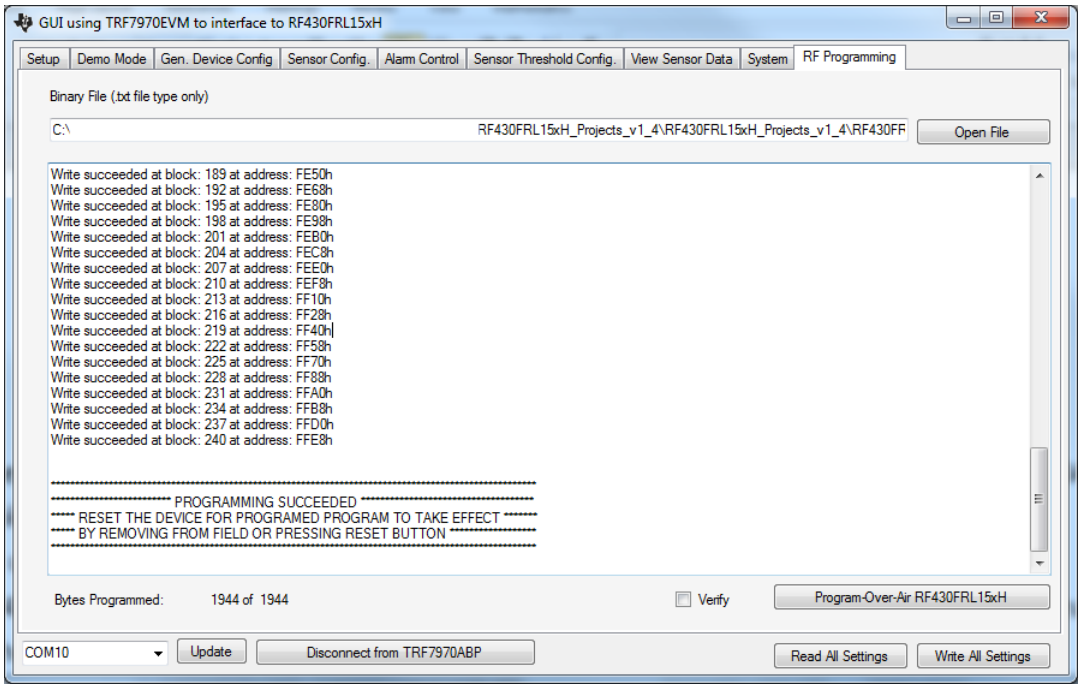


Figure 23. RF Programming Completed

7.2 Generating a TXT File

7.2.1 Using CCS

Follow these steps to generate a .txt file from CCS (see Figure 24):

1. Right click on the project.
2. Select the “Build” option.
3. In the”Post-build steps” in the “Steps” tab enter this text:
   "${CG_TOOL_HEX}" --ti_txt "${BuildArtifactFileName}" -o "${BuildArtifactFileBaseName}.txt" -order MS -romwidth 16
4. Compile the project. The .txt binary output is saved to the “Debug” folder.

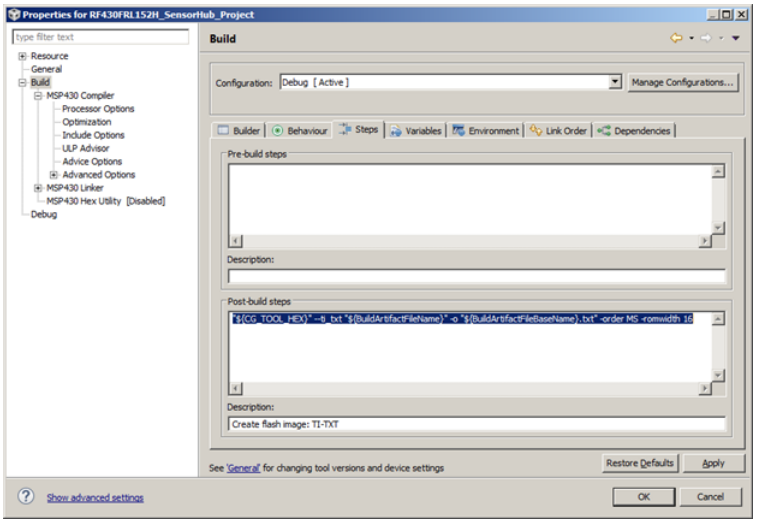


Figure 24. CCS TXT Generation

Copyright © 2014–2018, Texas Instruments Incorporated

7.2.2 Using IAR

Follow these steps to generate a .txt file from IAR (see Figure 25):

1. Right click on the project and select the “Options” setting.
2. In the “Linker” category, select the “Extra Output” tab and select “Generate extra output”.
3. Select the “msp430-txt” setting in the “Output format”. Leave “Format variant” set to “None”.
4. Compile the project. The .txt binary output is saved to the “Debug” folder.

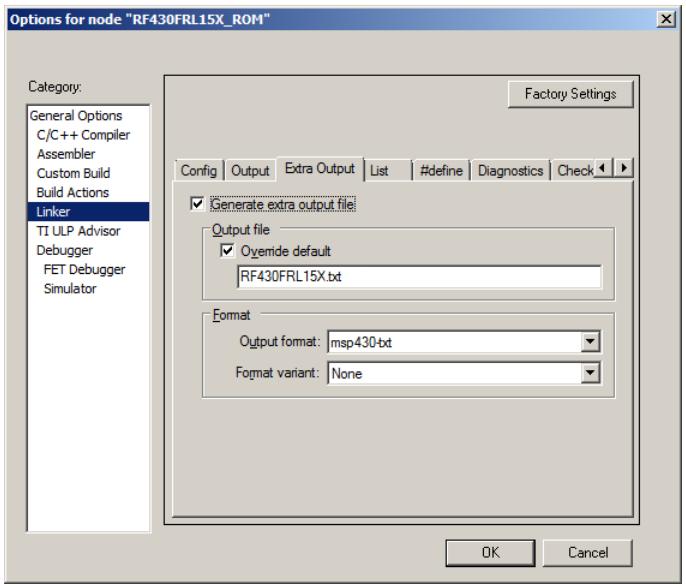


Figure 25. IAR TXT Generation

Copyright © 2014–2018, Texas Instruments Incorporated

8 RF430FRL152HEVM Schematics

A single full-sheet schematic is available here.

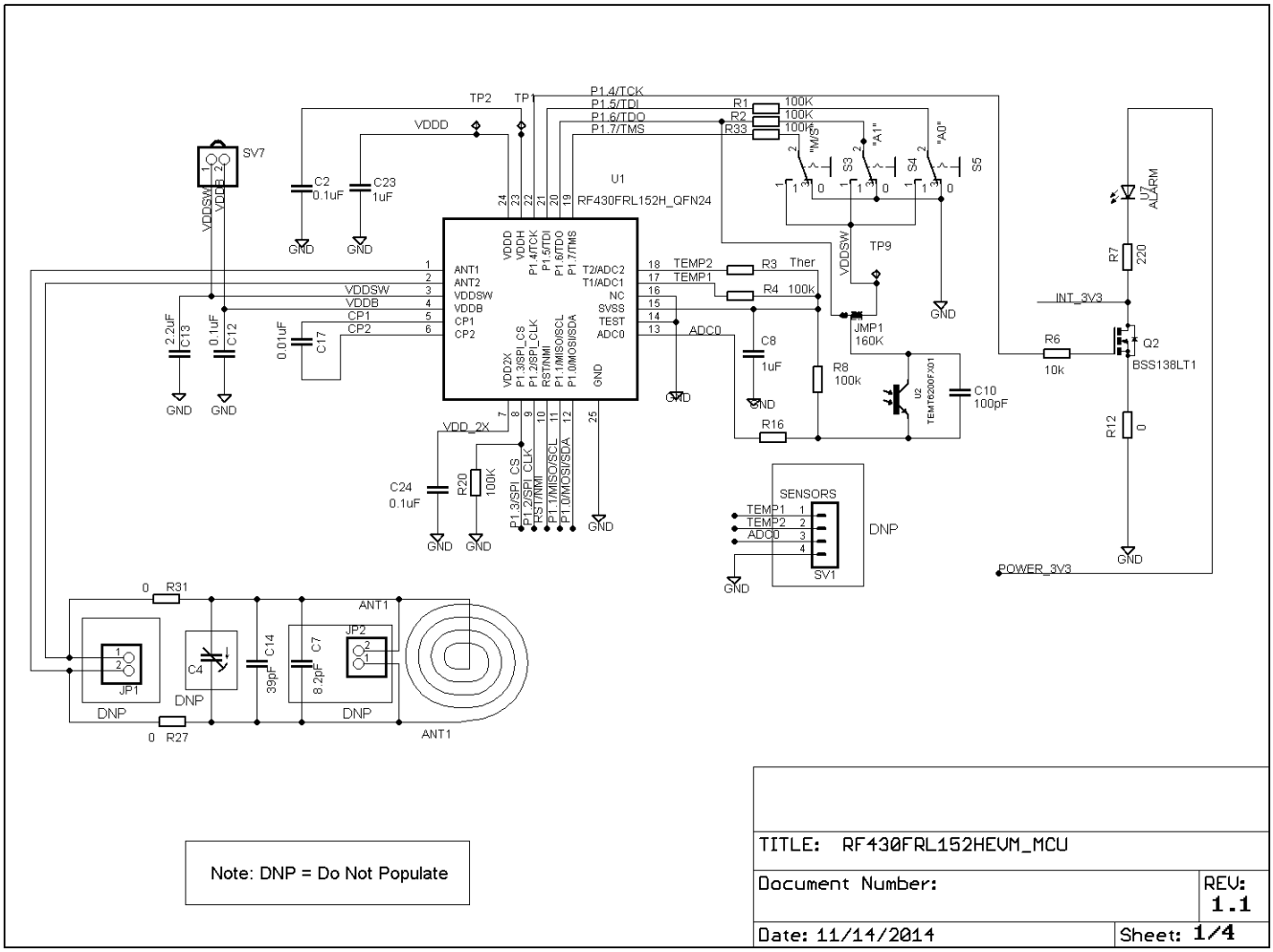


Figure 26. MCU Section Schematic

Copyright © 2014–2018, Texas Instruments Incorporated

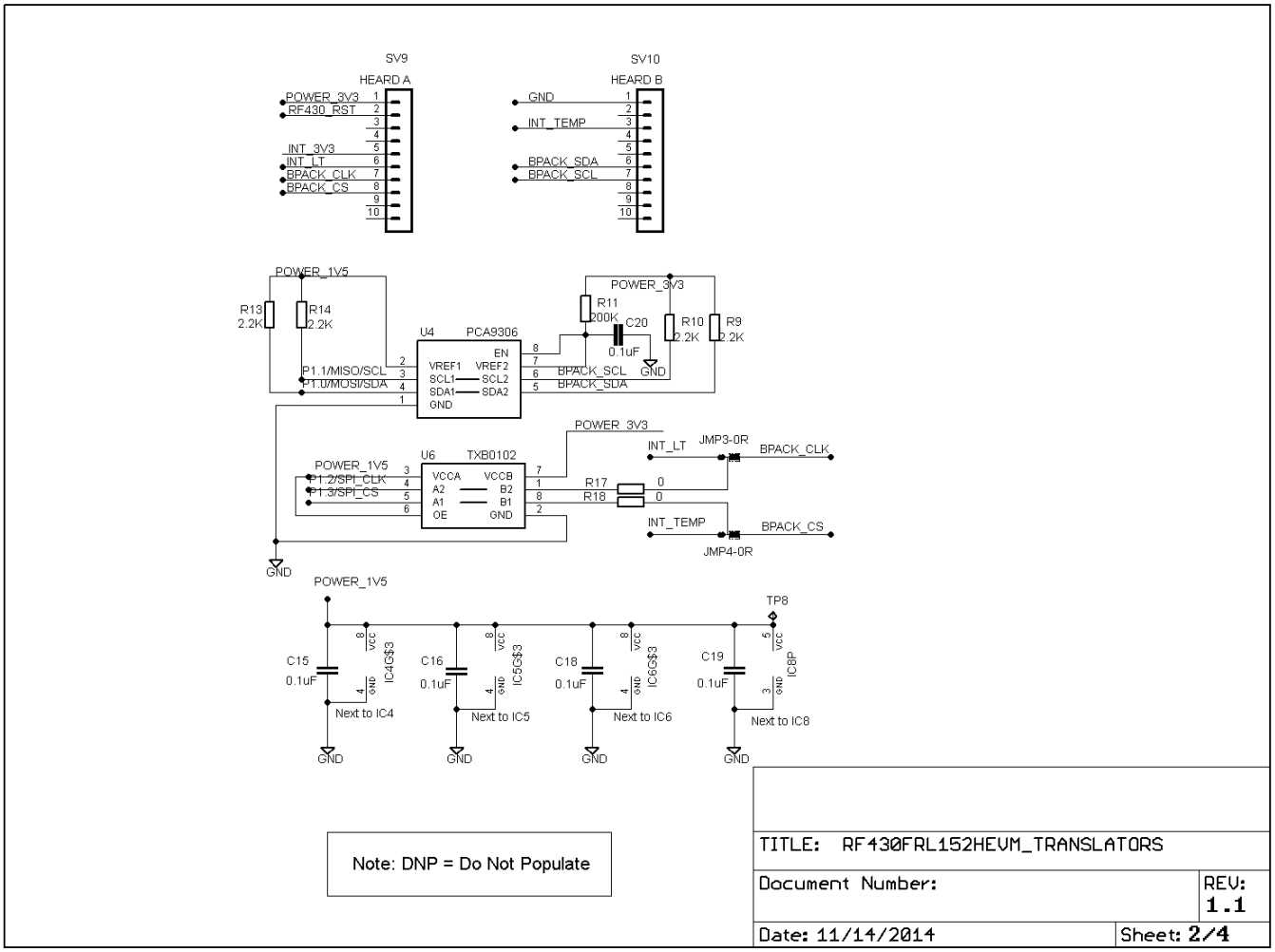


Figure 27. I²C or SPI Translators Section Schematic

Copyright © 2014–2018, Texas Instruments Incorporated

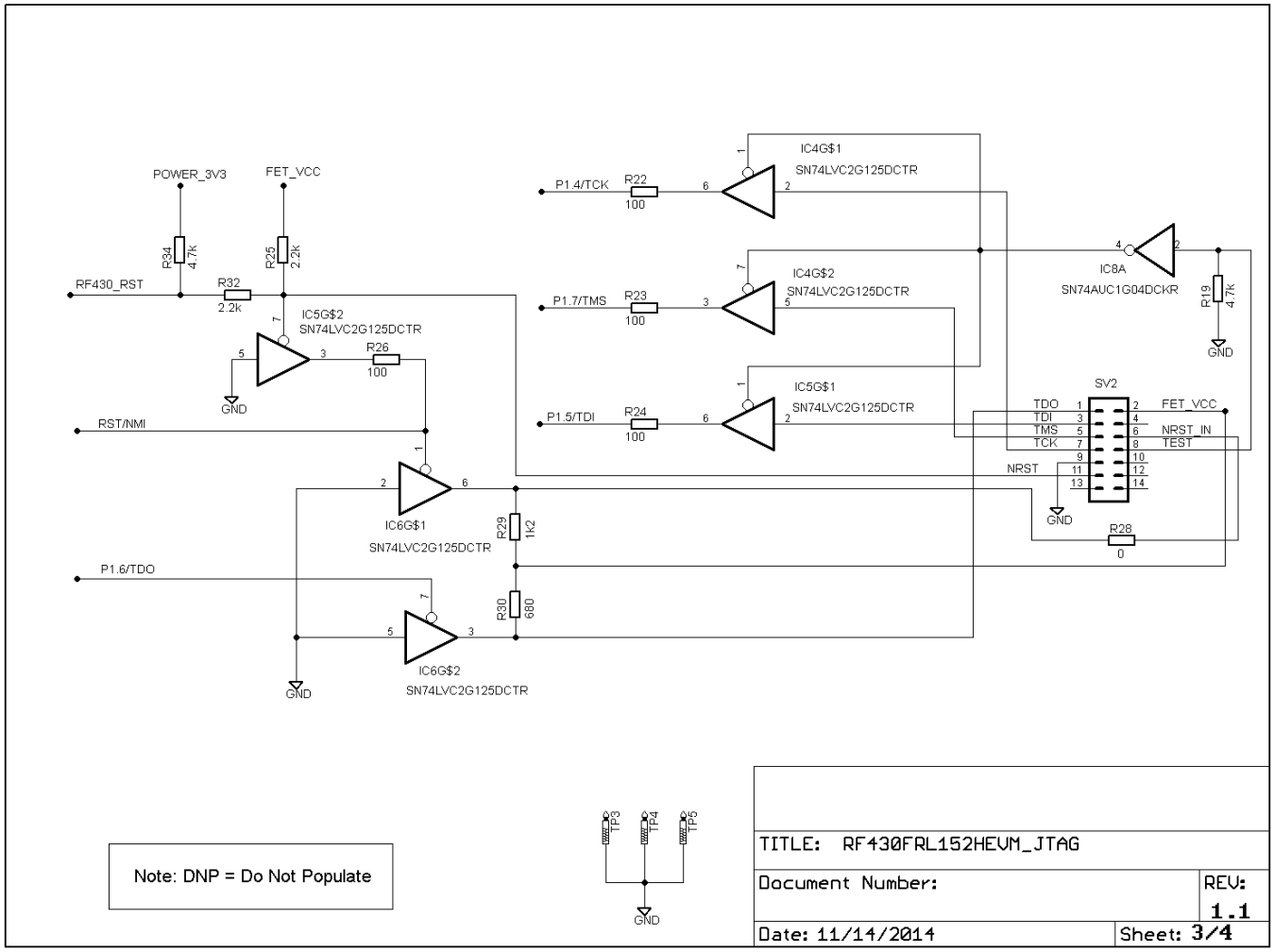


Figure 28. JTAG Section Schematic

Copyright © 2014–2018, Texas Instruments Incorporated

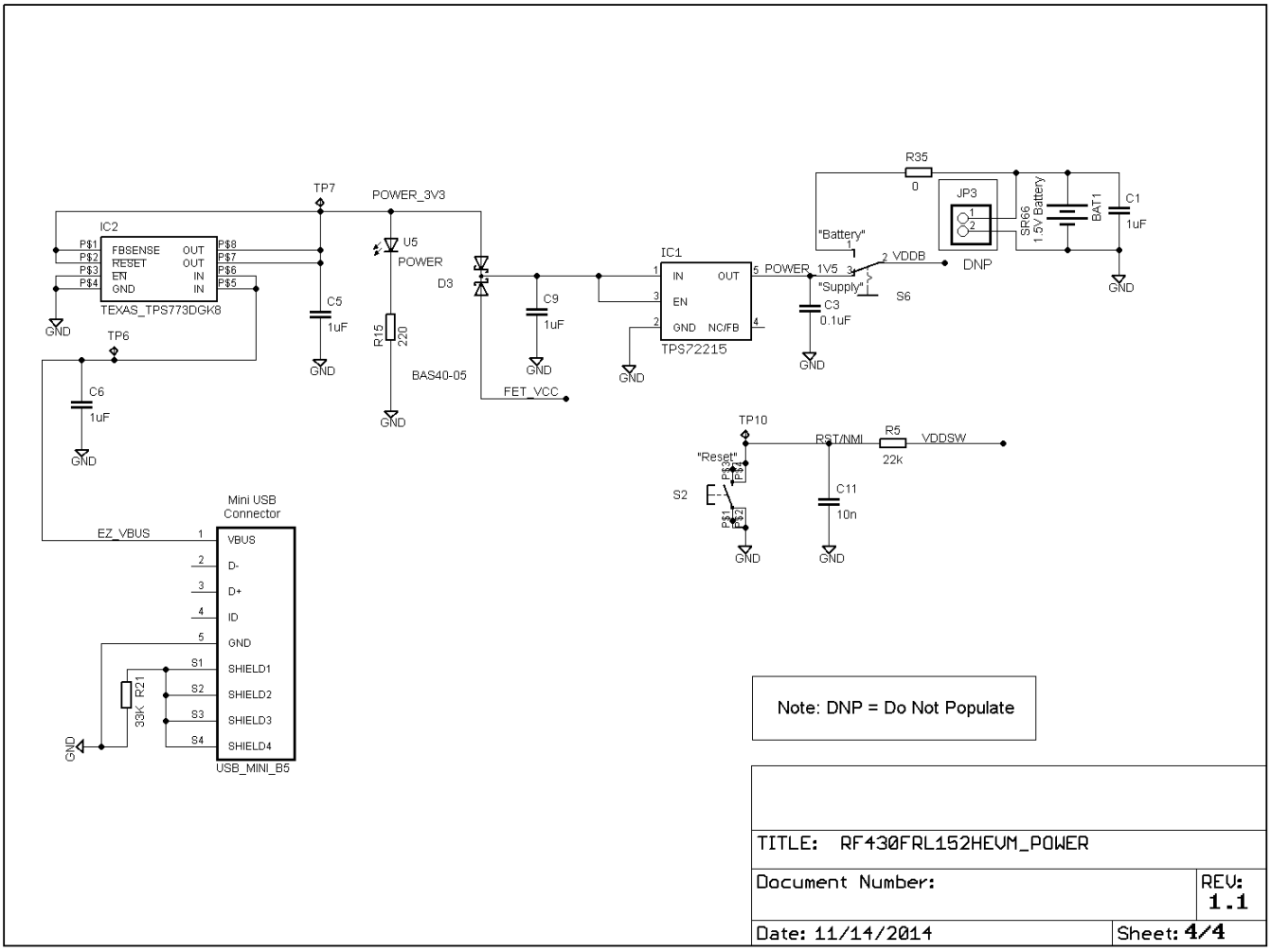


Figure 29. Power Section Schematic

Copyright © 2014–2018, Texas Instruments Incorporated

9 References

The primary sources of RF430FRL15xH information are:

1. RF430FRL152H Evaluation Module
2. Sensor Hub BoosterPack plug-in module
3. TRF7970A Evaluation Module
4. Near Field Communications Overview
5. Low-Power Microcontrollers Overview

Copyright © 2014–2018, Texas Instruments Incorporated

Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from June 30, 2017 to July 3, 2018 **Page**

- Updated recommended evaluation tools in the second paragraph in Section 1.1, *Overview* 3
- Updated Section 1.3, *Required Additional Tools* 4
- Updates to recommend TRF7970A-BNDL and moved Section 1.3.1, *MSP-EXP430G2 LaunchPad Development Kit With TRF7970A BoosterPack Plug-in Module* 4
- Removed paragraph with obsolete information about location of MSP430G2_TRF7970ABP_Binary.out in Section 1.3.1, *MSP-EXP430G2 LaunchPad Development Kit With TRF7970A BoosterPack Plug-in Module* 4
- Updated Section 1.3.2, *TRF7970AEVM* 5

Copyright © 2014–2018, Texas Instruments Incorporated

STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.

   1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM (“Software”) shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software

   1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.

2 *Limited Warranty and Related Remedies/Disclaimers*:

   2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

   2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.

   2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

3 *Regulatory Notices:*

   3.1 *United States*

      3.1.1 *Notice applicable to EVMs not FCC-Approved:*

      FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

      3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

      CAUTION

      This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

      Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

      FCC Interference Statement for Class A EVM devices

      NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 *Japan*

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。 技術適合証明を受けていないもののご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。 日本テキサス・インスツルメンツ株式会社

東京都新宿区西新宿６丁目２４番１号

西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

3.4 *European Union*

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive)*:

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

6. *Disclaimers:*

   6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.

   6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.

7. *USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS.* USER WILL DEFEND, INDEMNIFY AND HOLD TI, ITS LICENSORS AND THEIR REPRESENTATIVES HARMLESS FROM AND AGAINST ANY AND ALL CLAIMS, DAMAGES, LOSSES, EXPENSES, COSTS AND LIABILITIES (COLLECTIVELY, "CLAIMS") ARISING OUT OF OR IN CONNECTION WITH ANY HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.

8. *Limitations on Damages and Liability:*

   8.1 *General Limitations*. IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS OR THE USE OF THE EVMS , REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

   8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2018, Texas Instruments Incorporated

IMPORTANT NOTICE FOR TI DESIGN INFORMATION AND RESOURCES

Texas Instruments Incorporated ('TI") technical, application or other design advice, services or information, including, but not limited to, reference designs and materials relating to evaluation modules, (collectively, "TI Resources") are intended to assist designers who are developing applications that incorporate TI products; by downloading, accessing or using any particular TI Resource in any way, you (individually or, if you are acting on behalf of a company, your company) agree to use it solely for this purpose and subject to the terms of this Notice.

TI's provision of TI Resources does not expand or otherwise alter TI's applicable published warranties or warranty disclaimers for TI products, and no additional obligations or liabilities arise from TI providing such TI Resources. TI reserves the right to make corrections, enhancements, improvements and other changes to its TI Resources.

You understand and agree that you remain responsible for using your independent analysis, evaluation and judgment in designing your applications and that you have full and exclusive responsibility to assure the safety of your applications and compliance of your applications (and of all TI products used in or for your applications) with all applicable regulations, laws and other applicable requirements. You represent that, with respect to your applications, you have all the necessary expertise to create and implement safeguards that (1) anticipate dangerous consequences of failures, (2) monitor failures and their consequences, and (3) lessen the likelihood of failures that might cause harm and take appropriate actions. You agree that prior to using or distributing any applications that include TI products, you will thoroughly test such applications and the functionality of such TI products as used in such applications. TI has not conducted any testing other than that specifically described in the published documentation for a particular TI Resource.

You are authorized to use, copy and modify any individual TI Resource only in connection with the development of applications that include the TI product(s) identified in such TI Resource. NO OTHER LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE TO ANY OTHER TI INTELLECTUAL PROPERTY RIGHT, AND NO LICENSE TO ANY TECHNOLOGY OR INTELLECTUAL PROPERTY RIGHT OF TI OR ANY THIRD PARTY IS GRANTED HEREIN, including but not limited to any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information regarding or referencing third-party products or services does not constitute a license to use such products or services, or a warranty or endorsement thereof. Use of TI Resources may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

TI RESOURCES ARE PROVIDED "AS IS" AND WITH ALL FAULTS. TI DISCLAIMS ALL OTHER WARRANTIES OR REPRESENTATIONS, EXPRESS OR IMPLIED, REGARDING TI RESOURCES OR USE THEREOF, INCLUDING BUT NOT LIMITED TO ACCURACY OR COMPLETENESS, TITLE, ANY EPIDEMIC FAILURE WARRANTY AND ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT OF ANY THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

TI SHALL NOT BE LIABLE FOR AND SHALL NOT DEFEND OR INDEMNIFY YOU AGAINST ANY CLAIM, INCLUDING BUT NOT LIMITED TO ANY INFRINGEMENT CLAIM THAT RELATES TO OR IS BASED ON ANY COMBINATION OF PRODUCTS EVEN IF DESCRIBED IN TI RESOURCES OR OTHERWISE. IN NO EVENT SHALL TI BE LIABLE FOR ANY ACTUAL, DIRECT, SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF TI RESOURCES OR USE THEREOF, AND REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

You agree to fully indemnify TI and its representatives against any damages, costs, losses, and/or liabilities arising out of your non-compliance with the terms and provisions of this Notice.

This Notice applies to TI Resources. Additional terms apply to the use and purchase of certain types of materials, TI products and services. These include; without limitation, TI's standard terms for semiconductor products http://www.ti.com/sc/docs/stdterms.htm), evaluation modules, and samples (http://www.ti.com/sc/docs/sampterms.htm).

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2018, Texas Instruments Incorporated