User's Guide

BOOSTXL-BASSENSORS User's Guide

Ren Schackmann

ABSTRACT

The Building Automation Systems Sensors BoosterPack™ Plug-in Module kit (BOOSTXL-BASSENSORS) is an easy-to-use module for adding digital sensors to your LaunchPad™ development kit design. SimpleLink™ microcontroller (MCU) LaunchPad development kit developers can use this BoosterPack plug-in module to start developing sensor applications using the onboard temperature, humidity, ambient light, or magnetic flux sensor.

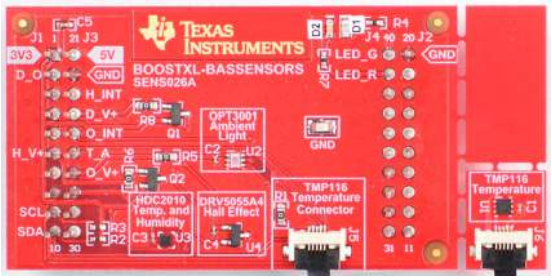

Figure 1-1. BOOSTXL-BASSENSORS Plug-in Module

Table of Contents

Trademarks

1 Getting Started

1.1 Introduction

The Building Automation Systems Sensors BoosterPack Plug-in Module kit (BOOSTXL-BASSENSORS) is an easy-to-use module for adding digital sensors to the LaunchPad development kit design. For these SimpleLink MCU LaunchPad development kits, engineers can use this BoosterPack plug-in module to start developing sensor applications using the onboard temperature, humidity, ambient light, and magnetic flux sensors.

1.2 Key Features

- High-Accuracy Temperature Sensor (TMP116)
- Combined Temperature and Humidity Sensor (HDC2010)
- Ambient Light Sensor (OPT3001)
- Hall Effect Sensor (DRV5055-Q1)
- Works With TI LaunchPad Development Kits

1.3 What's Included

1.3.1 Kit Contents

- 1x BOOSTXL-BASSENSORS BoosterPack plug-in module
- 1x quick start guide

1.4 Next Steps: Looking Into the Provided Code

The next steps after reviewing the EVM features are to open an integrated development environment (IDE) and start looking at the code examples. Section 3 describes the example projects available for the user to understand the provided software.

2 Hardware

Figure 2-1 shows an overview of the BoosterPack plug-in module.

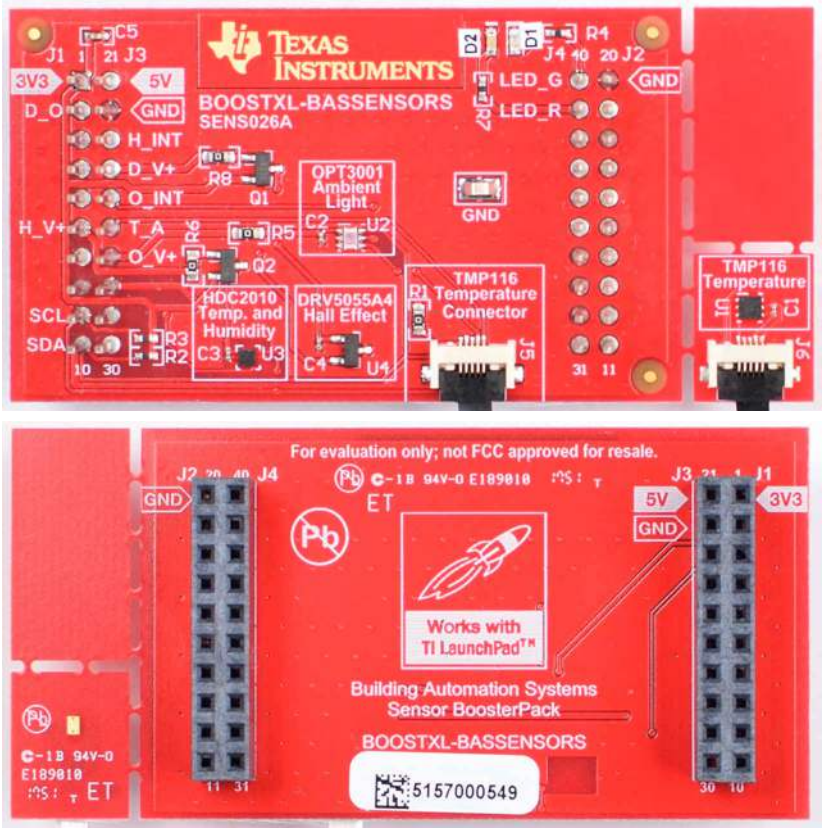

Figure 2-1. BOOSTXL-BASSENSORS Overview

2.1 Hardware Features

2.1.1 BoosterPack™ Plug-in Module Pinout

Figure 2-2 shows the pinout of the BoosterPack plug-in module.

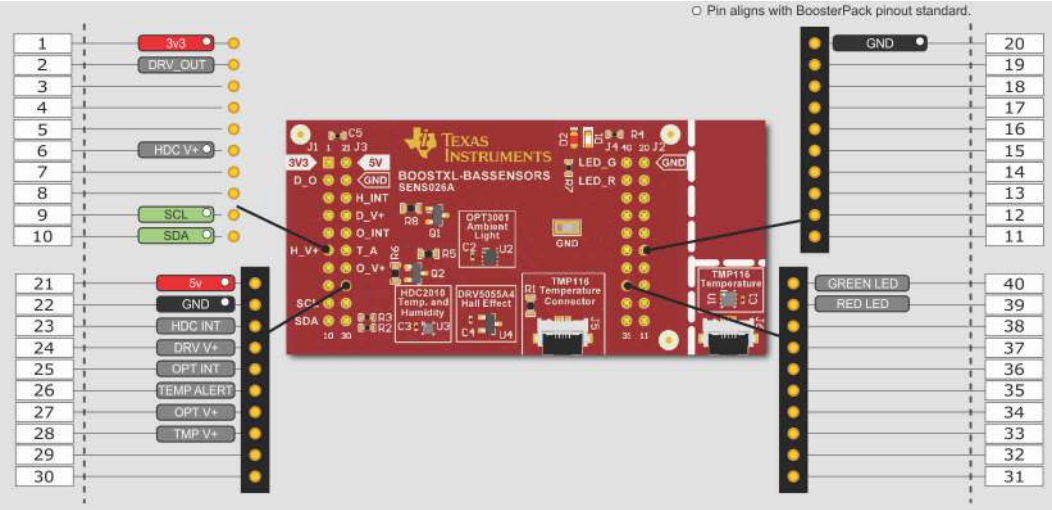

Figure 2-2. BoosterPack™ Plug-In Module Pinout

The Building Automation Systems Sensors BoosterPack plug-in module adheres to the 40-pin LaunchPad development kit and BoosterPack plug-in module pinout standard. A standard was created to aid compatibility between LaunchPad development kits and BoosterPack plug-in modules across the TI ecosystem.

The 40-pin standard on the BOOSTXL-BASSENSORS is compatible with the 20-pin standard that is used by other LaunchPad development kits like the MSP-EXP430G2 LaunchPad development kit. This compatibility allows for 40-pin BoosterPack plug-in modules to be used with 20-pin LaunchPad development kits.

The BOOSTXL-BASSENSORS BoosterPack plug-in module has both male and female headers to support stacking on top. The user must carefully consider stacking other BoosterPack plug-in modules near the BASSensors BoosterPack plug-in module as heat, shade, and electromagnetic fields can adversely affect the sensors readings.

For more information on EVM compatibility with TI LaunchPad development kits, refer to www.ti.com/launchpad.

2.1.2 I2C Addresses

Device	7 bit Address	Hex
OPT3001	1000100	44
TMP116	1001000	48
HDC2010	1000000	40

2.1.3 TI OPT3001 Light Sensor

The OPT3001 is a digital ambient light sensor (ALS) that measures the intensity of light as visible by the human eye. Covering the sensor with a finger or shining a flashlight on it changes the output of the OPT3001. The digital output is reported over an I^2C- and System Management Bus (SMBus)-compatible, 2-wire serial interface. The reference designator for the OPT3001 is U1. Table 2-1 lists the pin connections of the OPT3001.

For more information on the OPT3001 light sensor, refer to the OPT3001 product folder.

Table 2-1. OPT3001 Pinout

BoosterPack™ Plug-in Module Header Connection	Pin Function
J1.9(1)	I^2C SCL
J1.10(1)	I^2C SDA

Table 2-1. OPT3001 Pinout (continued)

BoosterPack™ Plug-in Module Header Connection	Pin Function
J1.27	OPT3001 V+ Supply Pin
J1.25	OPT3001 INT Pin

(1) I²C Pins are shared amongst the TMP116, HDC2010, and OPT3001.

2.1.4 TI TMP116 Temperature Sensor

The TMP116 is a 16-bit digital local temperature sensor that measures the ambient temperature or the temperature of an object in direct contact. Despite being a contact sensor, the sensitivity and accuracy of the TMP116 is high enough to detect a change in temperature from a hand placed near the sensor. The digital output is reported over an I²C- and SMBus-compatible, 2-wire serial interface. The reference designator for the TMP116 is U1. Table 2-2 lists the pin connections of the TMP116.

In order to use the TMP116, the included ribbon cable must be connected. The metal contacts of the cable must face down in the connector to make electrical contact. The black tab on the cable should be face up.

For more information on the TMP116 temperature sensor, refer to the TMP116 product folder.

Table 2-2. TMP116 Pinout

BoosterPack™ Plug-in Module Header Connection	Pin Function
J1.9(1)	I²C SCL
J1.10(1)	I²C SDA
J1.28	TMP116 V+ Supply Pin
J1.26	TMP116 ALERT Pin

(1) I2C Pins are shared amongst TMP116, HDC2010, and OPT3001.

2.1.5 TI HDC2010 Humidity Sensor

The TI HDC2010 is an integrated temperature and humidity sensor that measures ambient temperature and relative humidity in RH%. The sensor can detect an increase in moisture and temperature in a person's breath. The digital output is reported over an I²C- and SMBus-compatible 2-wire serial interface. The reference designator for the HDC2010 is U3. Table 2-3 lists the pin connections of the HDC2010. Note that Pin J1.28 must drive a Logic Low or zero to enable gate Q2 and power HDC2010.

For more information on the HDC2010 humidity sensor, refer to the HDC2010 product folder.

Table 2-3. HDC2010 Pinout

BoosterPack™ Plug-in Module Header Connection	Pin Function
J1.9(1)	I²C SCL
J1.10(1)	I²C SDA
J1.6	Enable HDC2010 3.3V Supply (Inverted)
J1.23	HDC2010 INT Pin

(1) I2C Pins are shared amongst TMP116, HDC2010, and OPT3001.

2.1.6 TI DRV5055-Q1 Hall Effect Sensor

The TI DRV5055-Q1 Hall EffectSensor measures the strength of magnetic fields in one axis. Placing a magnet near the sensor increases the sensor output. The output of the sensor is an analog voltage which must be sampled by an ADC and converted to milliTesla. The reference designator for the DRV5055-Q1 is U4. Table 2-4 lists the pin connections of the DRV5055-Q1. Note that Pin J1.24 must drive a Logic Low or zero to enable gate Q1 and power DRV5055.

Table 2-4. DRV5055-Q1 Pinout

BoosterPack™ Plug-in Module Header Connection	Pin Function
J1.2	DRV5055-Q1 Analog Output
J1.24	Enable DRV5055-Q1 3.3-V Supply (Inverted)

Hall-effect sensor orientation, magnet orientation, and the displacement between the sensor and magnet are all very important in design when using a Hall-effect sensor for position sensing. The diagrams below give a basic idea of what the magnetic field detected by the sensor might look according to these parameters. For predicting what the field might look like in a design, you can use various simulation programs like Finite Element Method Magnetics , FEMM, or ANSYS. Alternatively, the TI's Magnetic Sensing Proximity Tool can be used to get quick approximations.

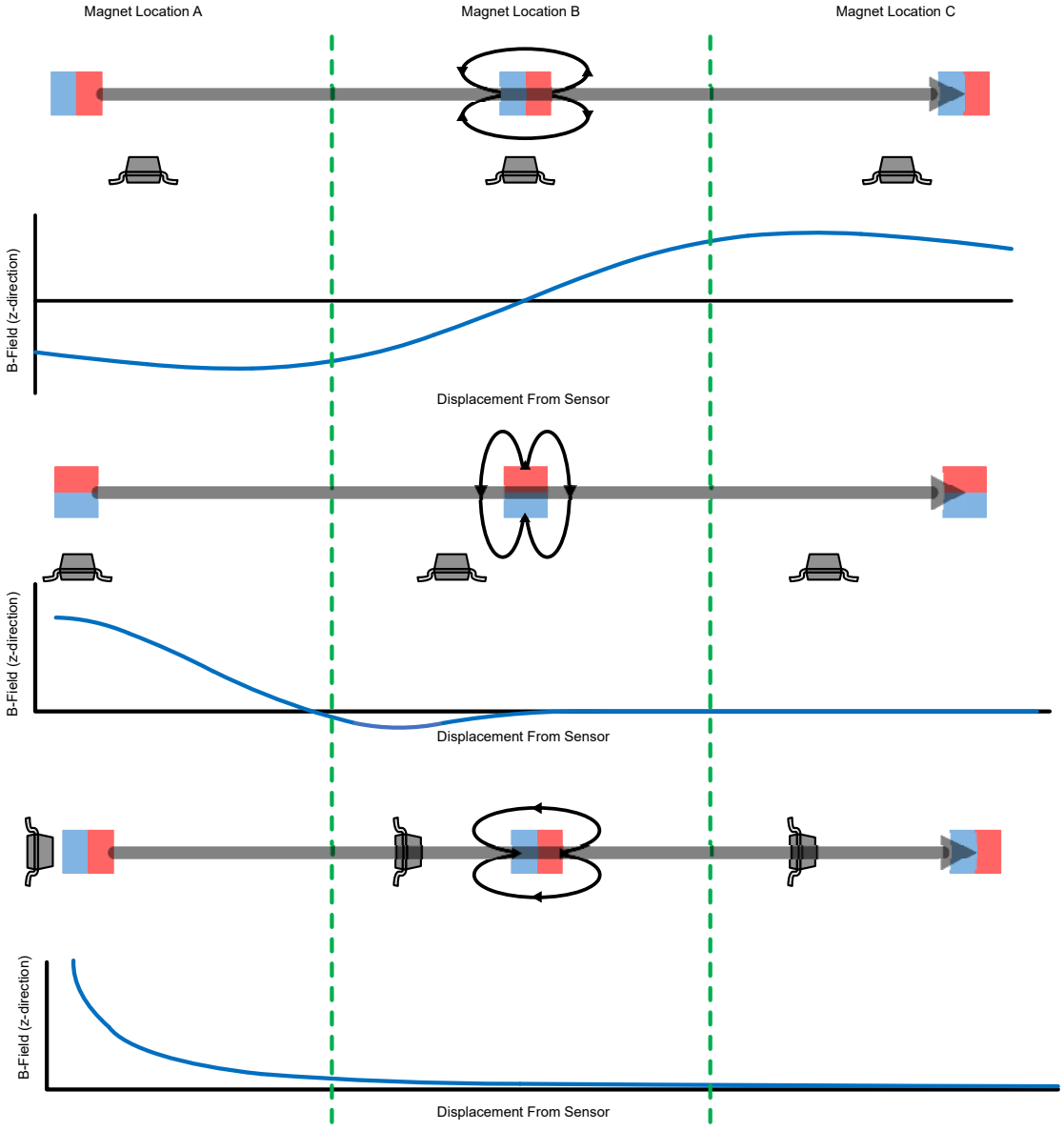

Figure 2-3. B-Field Characteristic With Respect to Magnet and Sensor Placement

For more information on the DRV5055-Q1 hall effect sensor, refer to the DRV5055-Q1 product folder.

2.2 Power

The board is designed to be powered by the attached LaunchPad development kit.

2.2.1 LaunchPad™ Development Kit Default Power

Power is provided through the 3V3 (J1.1) pin on the BoosterPack plug-in module headers. The 3V3 pin powers everything on the BASSensors BoosterPack plug-in module.

2.3 Design Files

2.3.1 Hardware

Schematics can be found in Section 5. All design files including schematics, layout, bill of materials (BOM), Gerber files, and documentation are available on the BOOSTXL-BASSENSORS Hardware Design Files on the download page.

2.3.2 Software

All design files including software example projects, and documentation are available in the software folders that are specific to each LaunchPad development kit. To see which LaunchPad development kits feature BOOSTXL-BASSENSORS examples, visit the download page.

2.4 Hardware Change Log

Table 2-5 lists the hardware revision history.

Table 2-5. Hardware Change Log

PCB Revision	Description
Rev 1.0	Initial release

3 Software Examples

The following software examples are included with the Sensor and Actuator Plugin for SimpleLink MCU SDKs (see Table 3-1). These examples can be found in the SIMPLELINK-SDK-SENSOR-ACTUATOR-PLUGIN, which is commonly installed as C:\ti\sail. Note that the SimpleLink SDK for your MCU must be installed alongside the SAIL plugin. Within the sail folder, the software examples are located in examples/rtos/[LaunchPad]/sail/. The software examples are compatible with the following LaunchPads:

- CC1310_LAUNCHXL
- CC2640R2_LAUNCHXL
- CC3220S_LAUNCHXL
- CC3220SF_LAUNCHXL
- MSP_EXP432E401Y
- MSP_EXP432P401R

Table 3-1. Software Examples

Demo Name	LaunchPad™ / BoosterPack™ Required	Description	More Details
adcdrv5055	SimpleLink MCU / BOOSTXL-BASSENSORS	Samples voltage from DRV5055-Q1 using MCU Onboard ADC, convert voltage to milliTesla and report using UART.	Section 3.1
i2chdc2010	SimpleLink MCU / BOOSTXL-BASSENSORS	Sample data from HDC2010 using I2C, convert to temperature/humidity and report using UART.	Section 3.2
i2copt3001	SimpleLink MCU / BOOSTXL-BASSENSORS	Sample data from OPT3001 using I2C, convert to lux and report using UART.	Section 3.3
i2ctmp116	SimpleLink MCU / BOOSTXL-BASSENSORS	Sample data from TMP116 using I2C, convert to temperature and report using UART.	Section 3.4

To use one of the software examples with the LaunchPad development kit, the user must have an integrated development environment (IDE) that supports the SimpleLink MCU devices (see Table 3-2).

Table 3-2. IDE Minimum Requirements

Code Composer Studio™ IDE	IAR Embedded Workbench® for ARM® IDE	ARM® Keil® µVision® IDE
v7.1.0	v7.80.3	MDK-ARM v5

For more details on how to get started quickly, and where to download the latest CCS, IAR, and Keil IDEs, see Section 4.

3.1 DRV5055-Q1 Software Example

This section describes the functionality and structure of the adcdrv5055 demo that is included in the SIMPLELINK-SDK-SENSOR-ACTUATOR-PLUGIN. The example files are located in ti/sail_x_xx_xx_xx/examples/rtos/[LaunchPad]/sail/adcdrv5055

3.1.1 Source File Structure

The project is split into multiple files (see Table 3-4). This makes it easier to navigate and reuse parts of it for other projects. On select LaunchPads, FreeRTOS examples are available in addition to the TI-RTOS shown here. Look for the freertos folder adjacent to the tirtos folder and reference the files inside there instead.

Table 3-3. Source File and Folders

Name	Description
tirtos/ccs	CCS project files used for importing this Software Example into Code Composer Studio software
tirtos/gcc	CCS project files used for importing this Software Example into Code Composer Studio software using the gcc compiler
tirtos/iar	IAR project files used for importing this Software example into IAR Embedded Workbench
adcdrv5055.c	Contains MainThread for RTOS application and function which queries ADC connected to DRV5055-Q1
Board.h	Definitions for this LaunchPad development kit and BoosterPack plug-in module combination
[LaunchPad].c	Initialization for the selected LaunchPad development kit
[LaunchPad].h	Definitions for the selected LaunchPad development kit
ccfg.c	Customer Configuration file
README.html	Information about using and running the example software

3.2 HDC2010 Software Example

This section describes the functionality and structure of the i2chdc2010 demo that is included in the SIMPLELINK-SDK-SENSOR-ACTUATOR-PLUGIN. The example files are located in ti/sail_x_xx_xx_xx/examples/rtos/[LaunchPad]/sail/i2chdc2010

3.2.1 Source File Structure

The project is split into multiple files (see Table 3-4). This makes it easier to navigate and reuse parts of it for other projects. On select LaunchPads, FreeRTOS examples are available in addition to the TI-RTOS shown here. Look for the freertos folder adjacent to the tirtos folder and reference the files inside there instead.

Table 3-4. Source File and Folders

Name	Description
tirtos/ccs	CCS project files used for importing this Software Example into Code Composer Studio software
tirtos/gcc	CCS project files used for importing this Software Example into Code Composer Studio software using the gcc compiler
tirtos/iar	IAR project files used for importing this Software example into IAR Embedded Workbench
i2chdc2010.c	Contains MainThread for RTOS application and function which queries HDC2010 using I2C
Board.h	Definitions for this LaunchPad development kit and BoosterPack plug-in module combination
[LaunchPad].c	Initialization for the selected LaunchPad development kit
[LaunchPad].h	Definitions for the selected LaunchPad development kit
ccfg.c	Customer Configuration file
README.html	Information about using and running the example software

3.3 OPT3001 Software Example

This section describes the functionality and structure of the i2copt3001 demo that is included in the SIMPLELINK-SDK-SENSOR-ACTUATOR-PLUGIN. The example files are located in ti/sail_x_xx_xx_xx/examples/rtos/[LaunchPad]/sail/i2copt3001.

3.3.1 Source File Structure

The project is split into multiple files (see Table 3-4). This makes it easier to navigate and reuse parts of it for other projects. On select LaunchPads, FreeRTOS examples are available in addition to the TI-RTOS shown here. Look for the freertos folder adjacent to the tirtos folder and reference the files inside there instead.

Table 3-5. Source File and Folders

Name	Description
tirtos/ccs	CCS project files used for importing this Software Example into Code Composer Studio software
tirtos/gcc	CCS project files used for importing this Software Example into Code Composer Studio software using the gcc compiler
tirtos/iar	IAR project files used for importing this Software example into IAR Embedded Workbench
i2copt3001.c	Contains MainThread for RTOS application and function which queries OPT3001 using I2C
Board.h	Definitions for this LaunchPad development kit and BoosterPack plug-in module combination
[LaunchPad].c	Initialization for the selected LaunchPad development kit
[LaunchPad].h	Definitions for the selected LaunchPad development kit
ccfg.c	Customer Configuration file
README.html	Information about using and running the example software

3.4 TMP116 Software Example

This section describes the functionality and structure of the i2ctmp116 demo that is included in the SIMPLELINK-SDK-SENSOR-ACTUATOR-PLUGIN. The example files are located in ti/sail_x_xx_xx_xx/examples/rtos/[LaunchPad]/sail/i2ctmp116.

3.4.1 Source File Structure

The project is split into multiple files (see Table 3-4). This makes it easier to navigate and reuse parts of it for other projects. On select LaunchPads, FreeRTOS examples are available in addition to the TI-RTOS shown here. Look for the freertos folder adjacent to the tirtos folder and reference the files inside there instead.

Table 3-6. Source File and Folders

Name	Description
tirtos/ccs	CCS project files used for importing this Software Example into Code Composer Studio software
tirtos/gcc	CCS project files used for importing this Software Example into Code Composer Studio software using the gcc compiler
tirtos/iar	IAR project files used for importing this Software example into IAR Embedded Workbench
i2ctmp116.c	Contains MainThread for RTOS application and function which queries TMP116 using I2C
Board.h	Definitions for this LaunchPad development kit and BoosterPack plug-in module combination
[LaunchPad].c	Initialization for the selected LaunchPad development kit
[LaunchPad].h	Definitions for the selected LaunchPad development kit
ccfg.c	Customer Configuration file
README.html	Information about using and running the example software

4 Additional Resources

4.1 TI LaunchPad™ Development Kit Portal

More information about LaunchPad development kits, supported BoosterPack plug-in modules, and available resources can be found at:

- TI's LaunchPad portal: Information about all LaunchPad development kits from TI, for all microcontrollers

4.2 TI Cloud Development Tools

TI's Cloud-based software development tools provide instant access to SimpleLink SDK content and a web-based IDE.

4.2.1 TI Resource Explorer Cloud

TI Resource Explorer Cloud provides a web interface for browsing examples, libraries, and documentation found in the SimpleLink SDK without having to download files to the local drive (see Figure 4-1).

Learn more about TI Resource Explorer Cloud at https://dev.ti.com/.

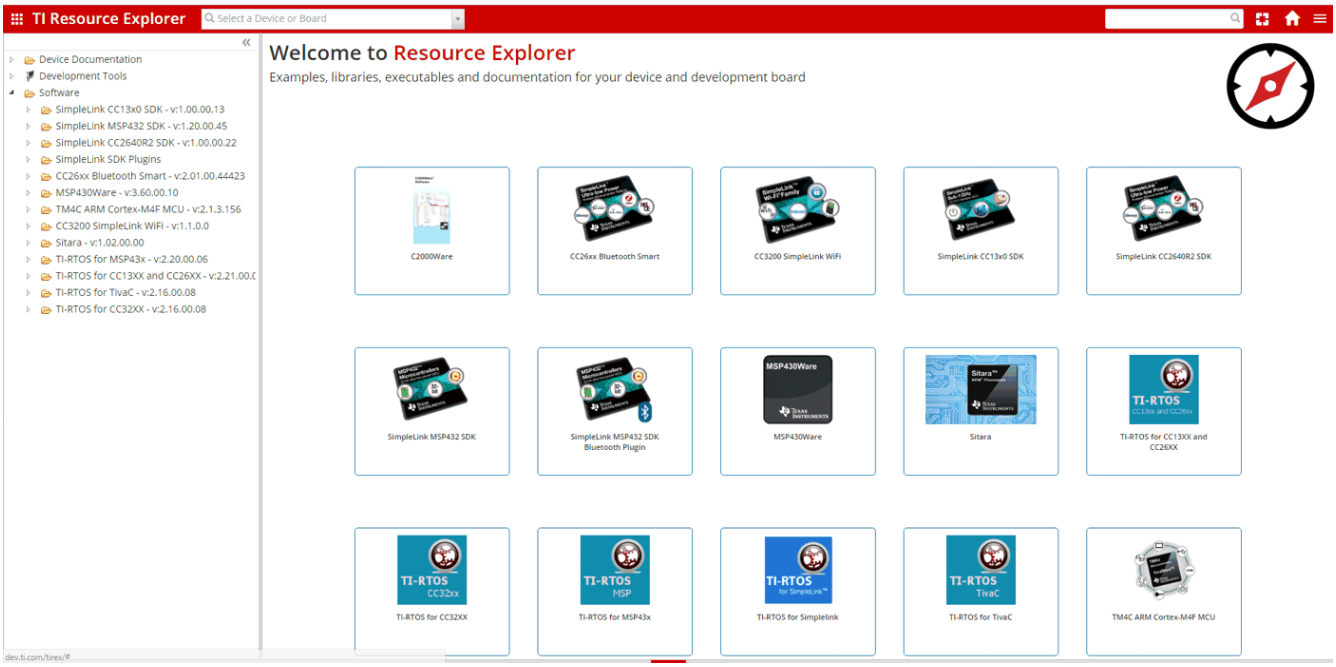

Figure 4-1. TI Resource Explorer Cloud

4.2.2 Code Composer Studio™ Cloud IDE

Code Composer Studio Cloud (CCS Cloud) IDE is a web-based IDE that lets you quickly create, edit, build, and debug applications for the LaunchPad development kit (see Figure 4-2). There is no need to download and install large software packages. You simply connect the LaunchPad development kit and begin. The user can choose to select from a large variety of examples in the SimpleLink MSP432 SDK and Energia or develop their own application. CCS Cloud IDE supports debug features such as execution control, breakpoints, and viewing variables.

A full comparison between CCS IDE Cloud and CCS Desktop is available here.

Learn more about Code Composer Studio Cloud IDE at https://dev.ti.com/.

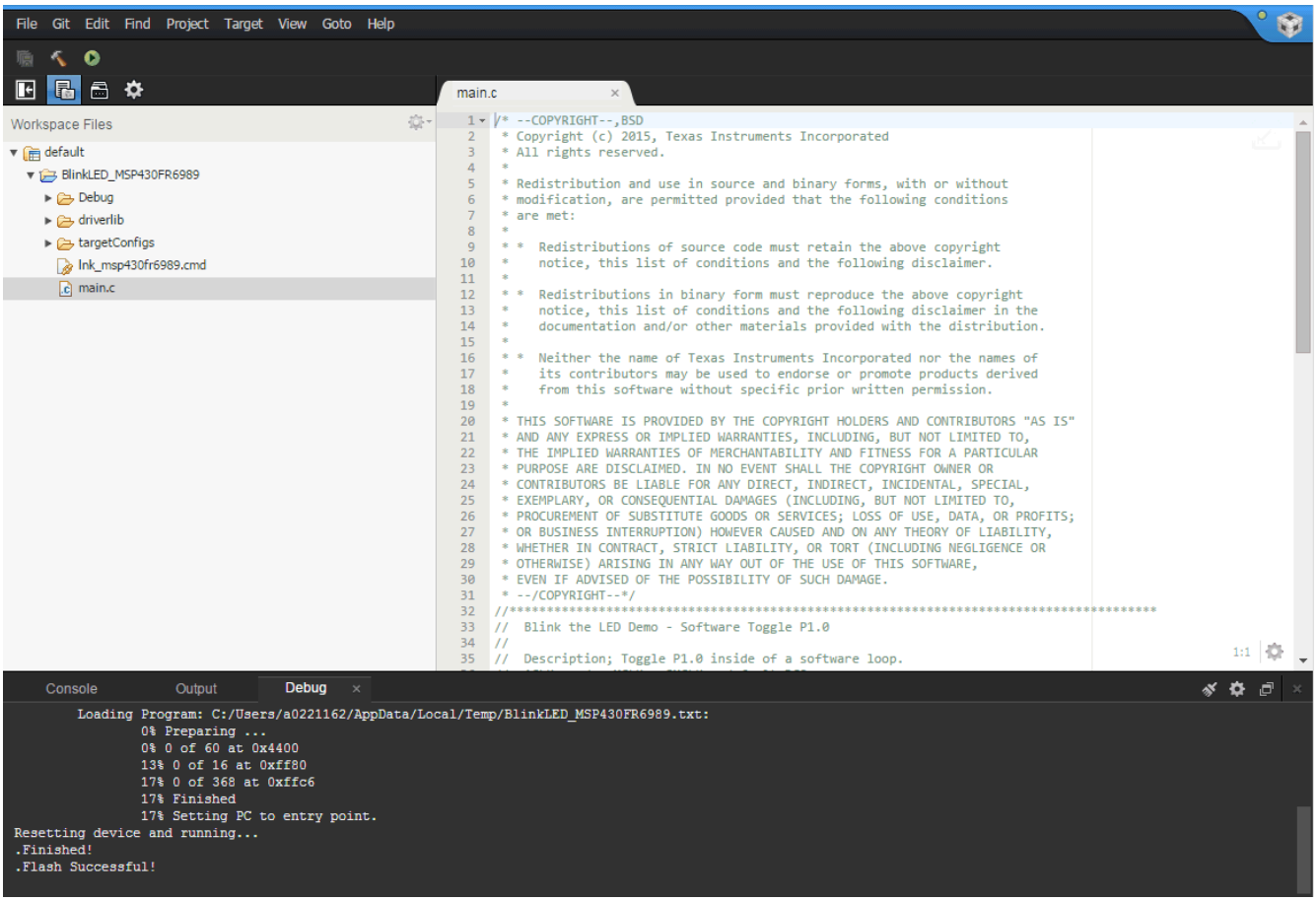

Figure 4-2. CCS Cloud

4.3 Code Composer Studio™ IDE

Code Composer Studio IDE Desktop is a professional integrated development environment that supports TI's microcontroller and Embedded Processors portfolio. Code Composer Studio IDE comprises a suite of tools used to develop and debug embedded applications. It includes an optimizing C/C++ compiler, source code editor, project build environment, debugger, profiler, and many other features.

Learn more about CCS IDE and download it at www.ti.com/tool/ccstudio.

CCS IDE v6.1 or higher is required. When CCS has been launched, and a workspace directory chosen, use Project>Import Existing CCS Eclipse Project. Direct it to the project directory that contains the main.c of the desired demo (see Figure 4-3).

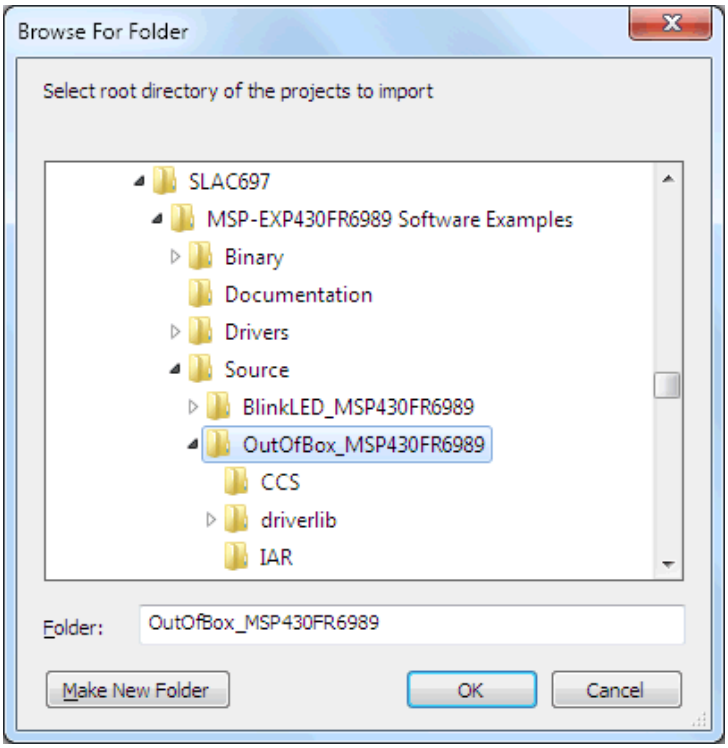

Figure 4-3. Directing the Project>Import Function to the Demo Project

The user can also select the \CCS subdirectory. The CCS-specific files are located there.

When the user clicks OK, the CCS recognizes the project and allows the import.

The project appears in the Import CCS Eclipse Projects window and has a checkmark to the left of it if the CCS found the project (see Figure 4-4).

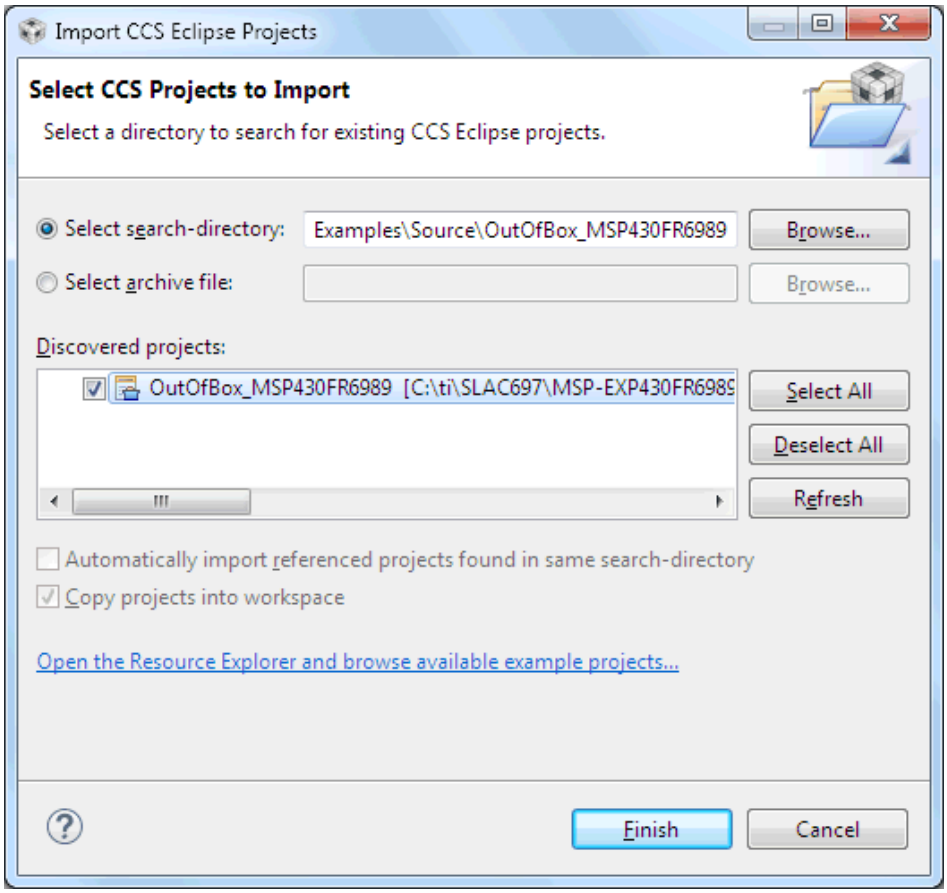

Figure 4-4. When CCS Has Found the Project

Sometimes the CCS IDE finds the project but does not show a checkmark. This may mean that the workspace already has a project by that name. The user can either rename or delete that project to fix this issue. If the project does not appear in the CCS IDE workspace, make sure to check the workspace directory on the file system.

4.4 IAR Embedded Workbench® for TI MSP430™ MCUs

IAR Embedded Workbench for MSP430™ MCUs is another very powerful integrated development environment that allows you to develop and manage complete embedded application projects. IAR Embedded Workbench integrates the IAR C/C++ Compiler, IAR Assembler, IAR ILINK Linker, editor, project manager, command line build utility, and IAR C-SPY® Debugger.

Learn more about the IAR Embedded Workbench for MSP430 MCUs and download the software at www.iar.com/.

IAR 6.10 or higher is required. To open the demo in IAR, click File>Open>Workspace…, and browse to the *.eww workspace file inside the \IAR subdirectory of the desired demo. All workspace information is contained within this file.

The subdirectory also has an *.ewp project file. This file can be opened into an existing workspace by clicking Project>Add-Existing-Project….

Although the software examples have all of the code required to run them, IAR users may download and install MSP430Ware™ software that contains MSP430 MCU libraries and the TI Resource Explorer. These are already included in a Code Composer Studio IDE installation unless the user selected otherwise.

4.5 Energia

Energia is a simple, open-source, and community-driven code editor that is based on the Wiring and Arduino framework. Energia provides unmatched ease of use through very high-level APIs that can be used across hardware platforms. Energia is a lightweight IDE that does not have the full feature set of Code Composer Studio IDE or IAR Embedded Workbench IDE. However, Energia is great for anyone who wants to get started very quickly or who does not have significant coding experience.

Learn more about Energia and download it at www.energia.nu.

4.6 SimpleLink™ MSP432 SDK, MSP430Ware™ Software, and TI Resource Explorer

The MSP432 device is part of the SimpleLink microcontroller (MCU) platform, which consists of Wi-Fi®, Bluetooth® low energy, Sub-1 GHz, and host MCUs. All share a common, easy-to-use development environment with a single core software development kit (SDK) and rich tool set. A one-time integration of the SimpleLink platform lets you add any combination of devices from the portfolio into your design. The ultimate goal of the SimpleLink platform is to achieve 100 percent code reuse when your design requirements change. For more information, visit www.ti.com/simplelink.

For the 16-bit MSP430 MCUs, the MSP430Ware software package is used. MSP430Ware software is a complete collection of libraries and tools. It includes a driver library (driverlib) graphics library (grlib), and many other software tools. MSP430Ware software is optionally included in a Code Composer Studio IDE installation or can be downloaded separately. IAR users must download it separately.

Both the SimpleLink MSP432 SDK and the MSP430Ware software are included in the TI Resource Explorer for easily browsing tools, documents, examples, and more (see Figure 4-5).

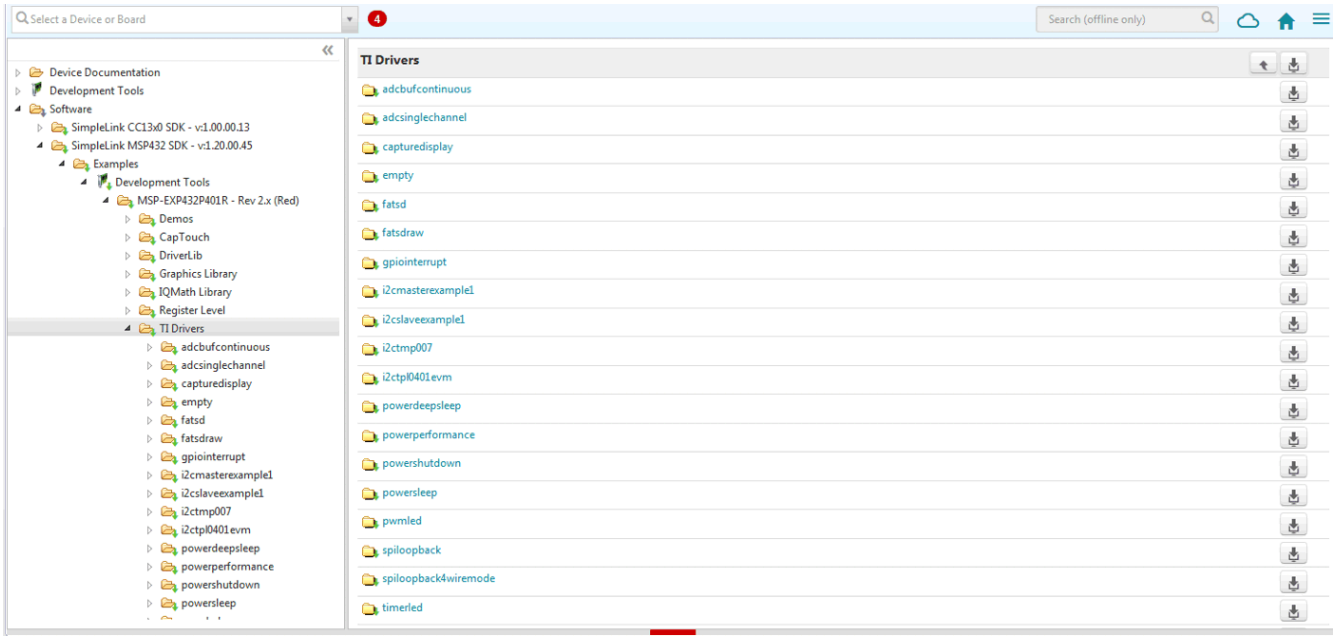

Figure 4-5. TI Drivers Software Examples in TI Resource Explorer

Inside TI Resource Explorer, these examples and many more can be found and easily imported into Code Composer Studio IDE with one click.

4.7 The Community

4.7.1 TI E2E™ Online Community

Search the forums at e2e.ti.com for helping building your EVM boards. If you cannot find the answer, post a question to the community.

4.7.2 Community at Large

Many online communities focus on the LaunchPad development kit and BoosterPack plug-in module ecosystem like www.43oh.com. You can find additional tools, resources, and support from these communities.

5 Schematics

Figure 5-1 shows the schematic. Hardware design files can be found in the BOOSTXL-BASSENSORS Hardware Design Files.

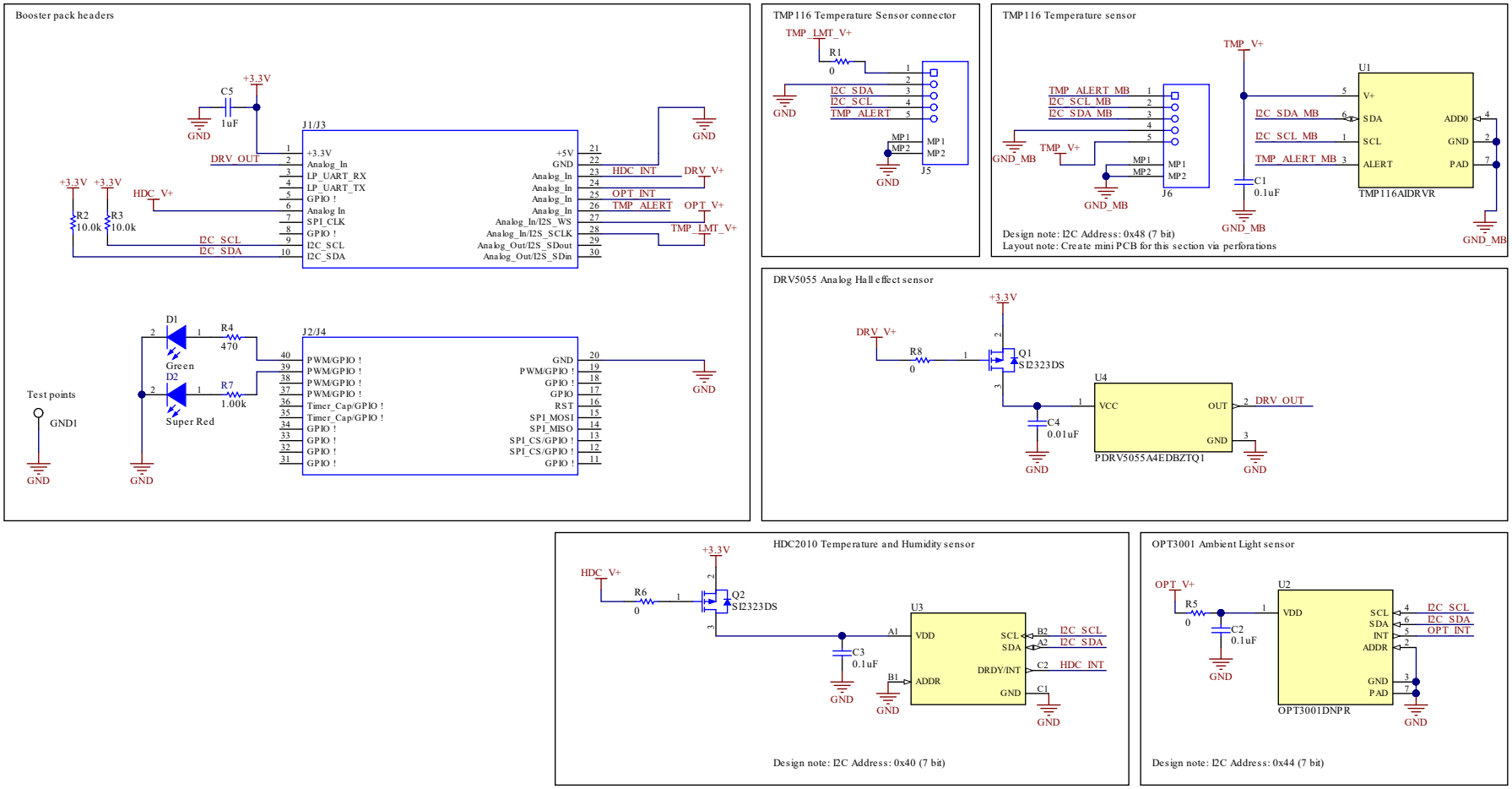

Figure 5-1. Schematics

6 Revision History

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

Changes from Revision A (February 2019) to Revision B (September 2022)	Page
• Added content to the *TI DRV5055-Q1 Hall Effect Sensor* section	5

Changes from Revision * (June 2018) to Revision A (February 2019)	Page
• Changed OPT3001, TMP116, HDC2010, and DRV5055-Q1 pinout tables	4
• Added note for the HDC2010 J1.28 pin	5
• Added note for the HDC2010 J1.24 pin	5

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.

WARNING

Evaluation Kits 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 shall operate the Evaluation Kit within TI’s recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI’s recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI’s instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGREDATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

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 2 4 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

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265