BOOSTXL-AUDIO Audio BoosterPack™ Plug-in Module

When plugged into a LaunchPad™ development kit, the BOOSTXL-AUDIO Audio BoosterPack™ Plug-in Module adds audio input functionality from a microphone and audio output through an onboard speaker. Headphone input and output are also supported, and are automatically enabled when a plug is inserted into the BoosterPack module. This audio input/output stream lets developers experiment with the digital signal processing (DSP) and filtering capabilities of the microcontroller found on the attached LaunchPad development kit.

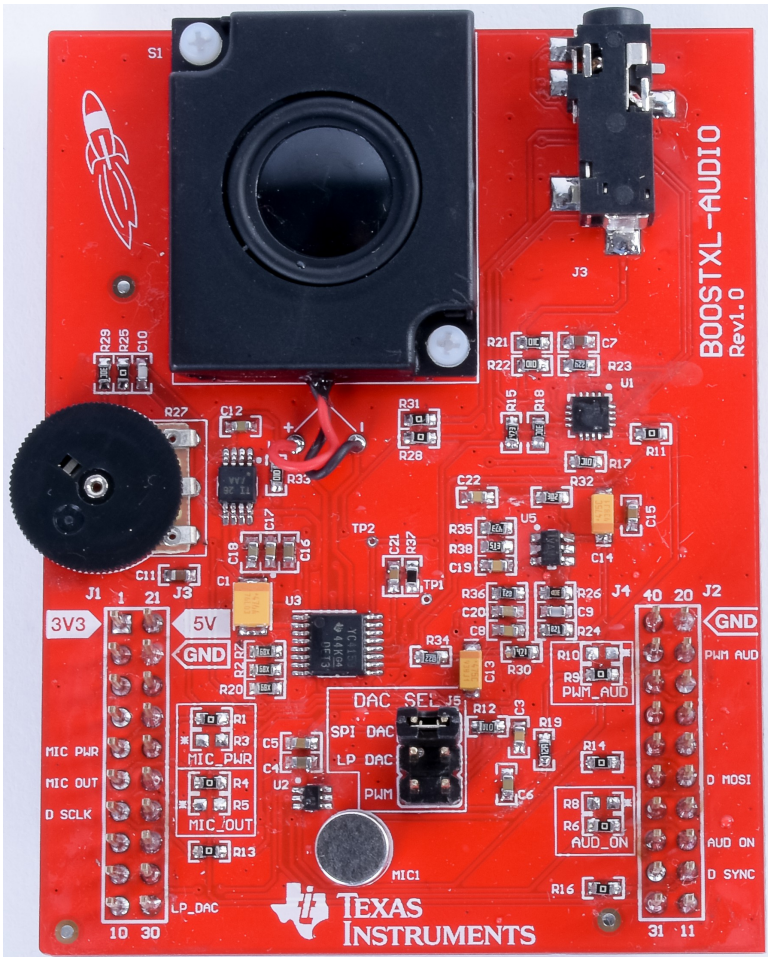


Figure 1. BOOSTXL-AUDIO BoosterPack Plug-in Module

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1 Getting Started

1.1 Introduction

When plugged into a LaunchPad development kit, the BOOSTXL-AUDIO Audio BoosterPack Plug-in Module adds audio input functionality from a microphone and audio output through an onboard speaker. Headphone input and output are also supported, and are automatically enabled when a plug is inserted into the BoosterPack module. This audio input/output stream lets developers experiment with the digital signal processing (DSP) and filtering capabilities of the microcontroller found on the attached LaunchPad development kit.

There are various options, selectable by a jumper on the BoosterPack module, for connecting the speaker to the processor on the LaunchPad development kit: (1) output audio data over SPI to the SPI DAC provided on the Audio BoosterPack module; (2) directly connecting to the DAC of the MCU on the LaunchPad kit (if available) or (3) use the PWM output of the LaunchPad kit together with a basic R/C filter on the BoosterPack module to create a simple low-cost analog audio signal.

1.2 Key Features

- TI DAC8311 14-bit digital-to-analog converter for high-quality audio output
- Onboard low-profile speaker
- Onboard microphone with front-end amplifier
- Volume control slider
- TI TS3A225E for autonomous headset type detection which supports 4-pin or 3-pin 3.5-mm audio jack headset
- 40-pin BoosterPack plug-in module standard for use with any LaunchPad development kit

1.3 What's Included

1.3.1 Kit Contents

- 1 x BOOSTXL-AUDIO BoosterPack plug-in module
- 1 x Quick start guide

1.3.2 Software Examples

- MSP-EXP430FR5994 LaunchPad development kit + BOOSTXL-AUDIO demos (see Section 3)
  - BOOSTXL-AUDIO_RecordPlayback_MSP430FR5994
  - Signal Processing with LEA TI Design

1.4 Next Steps: Looking Into the Provided Code

After the EVM features have been explored, the fun can begin. It's time to open an integrated development environment (IDE) and start looking at the code examples. Section 3 describes the example projects available to make it easy to understand the provided software. For more information on where to find and download an IDE, see Section 4.

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2 Hardware

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

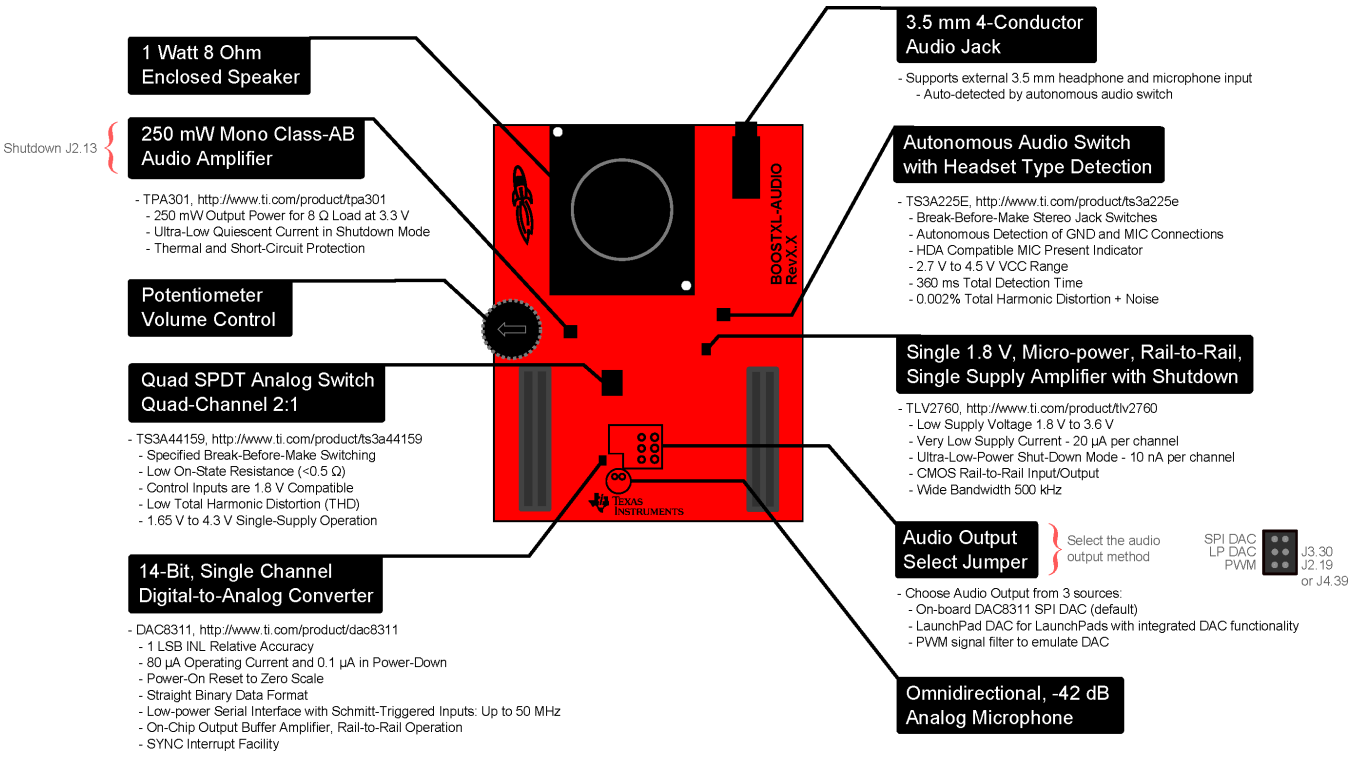


Figure 2. BOOSTXL-AUDIO Overview

2.1 Hardware Features

2.1.1 BoosterPack Pinout

Figure 3 shows the pinout of this BoosterPack module.

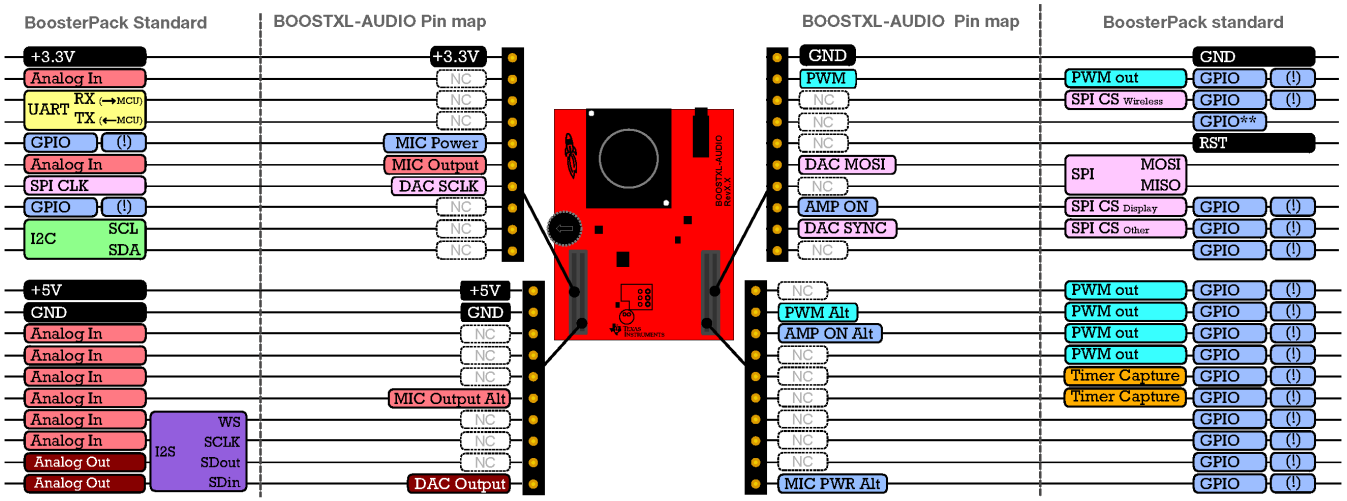


Figure 3. BoosterPack Pinout

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The audio signal processing BoosterPack kit adheres to the 40-pin LaunchPad and BoosterPack pinout standard. This standard was created to aid compatibility between LaunchPad development kit and BoosterPack module tools across the TI ecosystem.

The 40-pin standard is compatible with the 20-pin standard that is used by other LaunchPad kits like the MSP-EXP430G2 LaunchPad development kit. This allows for 40-pin BoosterPack modules to be used with 20-pin LaunchPad kits with some limited functionality.

The BOOSTXL-AUDIO supports BoosterPack module stacking with its male and female BoosterPack headers. See how many BoosterPack modules you can stack onto your LaunchPad development kit to add more functionality like wireless and battery power.

More information about compatibility can also be found at http://www.ti.com/launchpad.

2.1.2 Audio Output

There are three options to select how the audio output is generated: the onboard TI DAC8311 digital-to-analog converter (DAC), a built-in DAC on the LaunchPad development kit, or a PWM that generates audio out. Select an option by moving the J5 jumper.

2.1.2.1 TI DAC8311 14-Bit Digital-to-Analog Converter

The DAC8311 is a 14-bit low-power single-channel linear-voltage-output DAC. This DAC uses a 3-wire serial interface that operates at clock rates of up to 50 MHz and is compatible with standard SPI, QSPI, Microwire, and digital signal processor (DSP) interfaces (see Table 1). The reference designator for the DAC8311 is U2. Move jumper J5 to the SPI DAC location to use the DAC8311 to generate the audio signal.

More information on the DAC8311 DAC can be found at http://www.ti.com/product/dac8311.

Table 1. DAC8311 Pinout

BoosterPack Header Connection	Pin Function
J1.8	DAC8311 Sync
J1.9	SPI SCLK
J5.10	SPI MOSI

2.1.2.2 DAC Integrated on LaunchPad Development Kit

If the LaunchPad development kit that the user has selected has an integrated DAC that is pinned out to the BoosterPack headers (for example, the MSP-EXP430FR5994), this DAC can be used to generate audio for the BOOSTXL-AUDIO BoosterPack plug-in module. The DAC output pin is J3.30 for the output of the onboard DAC on the LaunchPad development kit. Move jumper J5 to the LP DAC location to use the onboard DAC of the LaunchPad development kit to generate the audio signal.

2.1.2.3 PWM Audio

A varying duty-cycle PWM can also generate audio. See Voice Band Audio Playback using a PWM DAC TI-Design for more information. Move jumper J5 to the PWM location to configure the audio input when using a PWM to generate the audio signal. Two pins can be used to drive the PWM audio: J2.19 (default) and J4.39 (alternate). To configure the BoosterPack module to use the alternate PWM pin, move the 0-Ω resistor on R9 to R10.

2.1.3 TI TS3A225E Audio Jack Detection

The TS3A225E is an audio-headset switch device. This device detects the presence of a headset and an analog microphone and switches a system analog microphone pin between different connectors in an audio stereo jack. The microphone connection in a stereo connector can be swapped with the ground connection depending on manufacturer. When the TS3A225E detects a certain configuration, the device automatically connects the microphone line to the appropriate pin. The device also reports the presence of an analog microphone on an audio stereo jack. The reference designator for the TS3A225E is U1.

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For more information on the TS3A225E autonomous audio switch with headset detection, see http://www.ti.com/product/TS3A225E.

2.1.4 Microphone With Front-End Amplifier

The PUI POM-2242P-C33-R omnidirectional microphone utilizes a TI TLV2760 operational amplifier to boost the output of the microphone. The human ear can hear frequencies of 0 to 20 kHz, and the operating range of the microphone is 20 Hz to 20 kHz. The reference designator for the microphone is MIC1, and the reference designator for the TLV2760 is U5. The microphone can also be powered on and off from GPIO pin J1.5 (default) or J4.31 (alternate) (see Table 2). To configure the microphone for its alternate pins, move the 0-Ω resistors on R1 and R4 to R3 and R5, respectively.

For more information on the microphone, see http://www.puiaudio.com/pdf/pom-2242p-c33-r.pdf.

Table 2. Microphone Pinout

BoosterPack Header Connection	Pin Function
J1.6	Microphone Output
J1.5	Microphone Power
J3.26(1)	Alt Microphone Output
J4.31(1)	Alt Microphone Power

(1) The alternate microphone output and power are required if also using the Sharp LCD BoosterPack plug-in module.

2.1.5 Onboard Loudspeaker

The onboard loudspeaker is a PUI ASE03008MR-LW150-R with reference designator S1. It is driven by an onboard audio amplifier, the TI TPA301, which has reference designator U4. The TPA301 is a bridge-tied load (BTL) audio power amplifier developed for low-voltage applications where internal speakers are required. Operating with a 3.3-V supply, the TPA301 can deliver 250 mW of continuous power into a BTL 8-ohm load at less than 1% total harmonic distortion plus noise throughout voice-band frequencies. The TPA301 also uses a GPIO for turning on and off the amplifier using software through pin J2.13 (default) or J4.38 (alternate). To configure the amplifier on and off switch to use J4.38, move the 0-Ω resistor on R6 to R8.

For more information on the loudspeaker, see http://www.puiaudio.com/pdf/ASE03008MR-LW150-R.pdf.

2.2 Power

The board is designed to be powered by the attached LaunchPad development kit and requires 3.3 V.

2.3 Design Files

2.3.1 Hardware

See Section 5 for the schematics. All design files including schematics, layout, bill of materials (BOM), Gerber files, and documentation are available on the BOOSTXL-AUDIO Hardware Design Files on the download page.

2.3.2 Software

All design files including TI-TXT object-code firmware images, software example projects, and documentation are available in the software folder that is specific to each LaunchPad development kit. To determine which LaunchPad development kits feature BOOSTXL-AUDIO examples, visit the download page.

2.3.3 Quick Start Guide

See the *BOOSTXL-AUDIO BoosterPack Plug-in Module Quick Start Guide* for an overview of this BoosterPack plug-in module and help getting started.

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2.4 Hardware Change Log

Table 3 lists the revision history of the BOOSTXL-AUDIO hardware releases.

Table 3. Hardware Change Log

PCB Revision	Description
Rev 1.1	Initial release
Rev 1.2	Added CE marking to silkscreen for compliance. No functional or layout change.

3 Software Examples

Two software examples are included in the MSP-EXP430FR5994 Software Examples zip folder with the MSP-EXP430FR5994 LaunchPad development kit for the Audio BoosterPack module (see Table 4).

Table 4. Software Examples

Demo Name	LaunchPad and BoosterPack Required	Description	More Details
BOOSTXL-AUDIO_ RecordPlayback_MSP430FR5994	• MSP-EXP430FR5994 • BOOSTXL-AUDIO	Demonstrates how to record and playback audio from FRAM memory using DMA	Section 3.1
tidm-filtering-signalprocessing-lea	• MSP-EXP40FR5994 • BOOSTXL-AUDIO • 430BOOST-SHARP96	Demonstrates the performance of the MSP Low-Energy Accelerator (LEA) by performing FFT and FIR	Section 3.2

To use any of the software examples with the LaunchPad development kit, you must have an integrated development environment (IDE) that supports the MSP430FR5994 device. Table 5 lists the minimum IDE requirements.

Table 5. IDE Minimum Requirements for MSP-EXP430FR5994

Code Composer Studio™ IDE	IAR Embedded Workbench® IDE
CCS v6.1.3 or later	IAR Embedded Workbench for Texas Instruments 430 6.40 or later

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

3.1 BOOSTXL-AUDIO_RecordPlayback_MSP430FR5994

This section describes the functionality and structure of the BOOSTXL-AUDIO_RecordPlayback_MSP430FR5994 demo that is included in the MSP-EXP430FR5994 Software Examples download or is more easily accessible through MSPWare (see Section 4.6).

3.1.1 Source File Structure

The project is split into multiple files (see Table 6). This makes it easier to navigate and reuse parts of it for other projects.

Table 6. Source File and Folders

Name	Description
main.c	The demo's clock, GPIO, DAC and interrupt configurations.
application/application.c	Main application loop and interrupt service routines
application/audio_collect.c	Setup, start, stop and shutdown audio collect functions
application/audio_playback.c	Setup, start and stop playback functions and interrupt service routines
application/dac8311.c	Operating modes or functions of the onboard SPI DAC
application/global.h	Global variables definitions

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Table 6. Source File and Folders (continued)

Name	Description
Library: driverlib	MSP Driver Library

3.1.2 Operation

This demo uses the built-in ADC12 on the MSP430FR5994 to sample from the output of the analog microphone on the Audio BoosterPack module. Using direct memory access (DMA), the 12-bit microphone data is stored to and retrieved from FRAM memory. During playback, the microphone data is sent through SPI to the onboard DAC to drive the audio output of the onboard speaker or headphones.

To begin recording an audio sample, press switch S1 on the MSP-EXP430FR5994 LaunchPad development kit(see Figure 4). LED1 is on while audio is being recorded, and it turns off when the recording phase is complete. You can also use headphones with an inline microphone to record audio. The BoosterPack module automatically detects the inline microphone when the headphones are plugged into the provided jack (J6) and records from it instead of the onboard microphone.

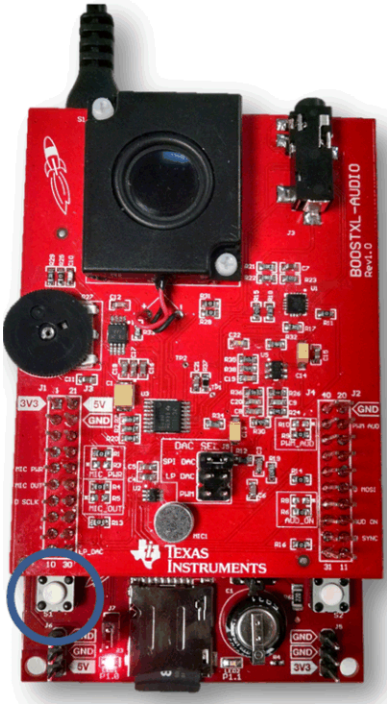


Figure 4. Record

To play the recorded audio sample, press switch S2 on the MSP-EXP430FR5994 LaunchPad development kit (see Figure 5). LED2 turns on during playback and turns off when the playback phase is complete. You can use headphones to listen to the audio playback by plugging headphones into the provided jack (J6).

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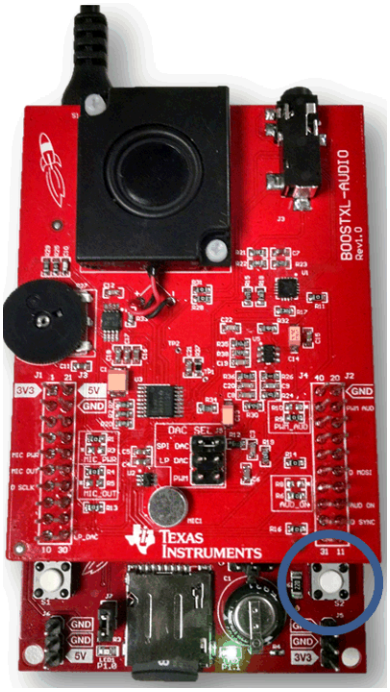


Figure 5. Playback

3.2 Filtering and Signal Processing With LEA TI Design

This section describes the functionality and structure of the tidm-filtering-signalprocessing-lea demo that is included in the MSP-EXP430FR5994 Software Examples download, or more easily accessible through MSPWare (see Section 4.6).

3.2.1 Source File Structure

The project is split into multiple files (see Table 7). This makes it easier to navigate and reuse parts of it for other projects.

Table 7. Source File and Folders

Name	Description
main.c	The demo's clock, GPIO, display and interrupt configurations.
application/application.c	Main application loop and interrupt service routines
application/audio_collect.c	Setup, start, stop and shutdown audio collect functions
application/audio_playback.c	Setup, start and stop playback functions and interrupt service routines
application/dac8311.c	Operating modes/functions of the onboard SPI DAC
application/global.h	Global variables definitions
application/fir.c	FIR filtering functions
application/FFT.c	Fast Fourier Transform filtering functions
application/FFT_430.asm	MSP430™ Fast Fourier Transform filtering functions in assembly
application/benchmark.c	Performance benchmark timer and interrupt service routines
application/fir_coefficient	FIR coefficient definitions
Library: DSPLib	MSP430 DSP Library
Library: grlib	MSP430 Graphics Library
Library: driverlib	MSP Driver Library

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3.2.2 Operation

This demo is a TI Design that highlights the signal processing capabilities and performance of the MSP430FR5994 MCU and its integrated Low Energy Accelerator (LEA). This example also uses the 430BOOST-SHARP96 BoosterPack module to display the filtered output of the audio signal and act as a user interface. To use this code example, configure the Audio BoosterPack module to use its alternate microphone power and output pins by moving the 0-Ω resistors on R1 to R3 and R4 to R5 (see Figure 6). For more information on this example, visit the TI Design page at http://www.ti.com/tool/tidm-filtering-signalprocessing.

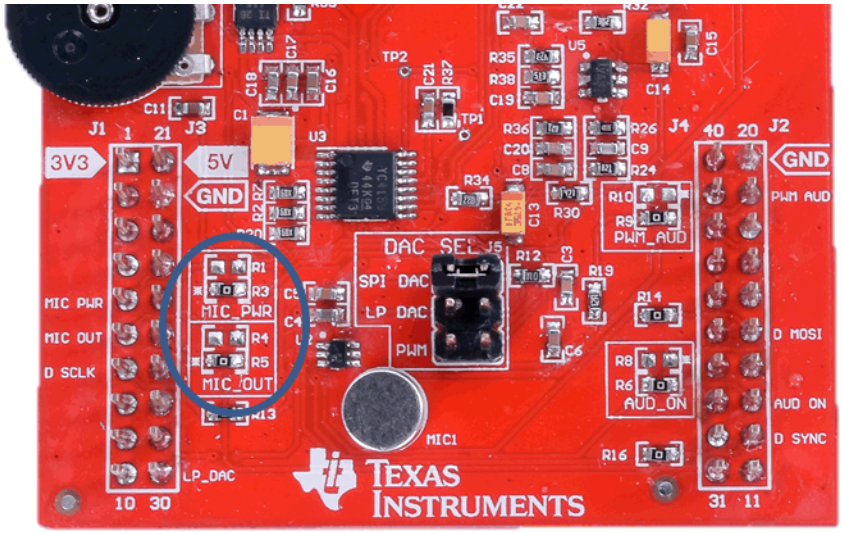


Figure 6. Alternate Microphone Configuration

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 LaunchPad portal: information about all LaunchPad development kits from TI, for all microcontrollers

4.2 TI Cloud Development Tools

TI cloud-based software development tools provide instant access to MSPWare software content and a web-based IDE.

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4.2.1 TI Resource Explorer Cloud

TI Resource Explorer Cloud (see Figure 7) provides a web interface for browsing the examples, libraries, and documentation that are found in the MSPWare software without having to download files to your local drive.

Go check out TI Resource Explorer Cloud now at https://dev.ti.com/.

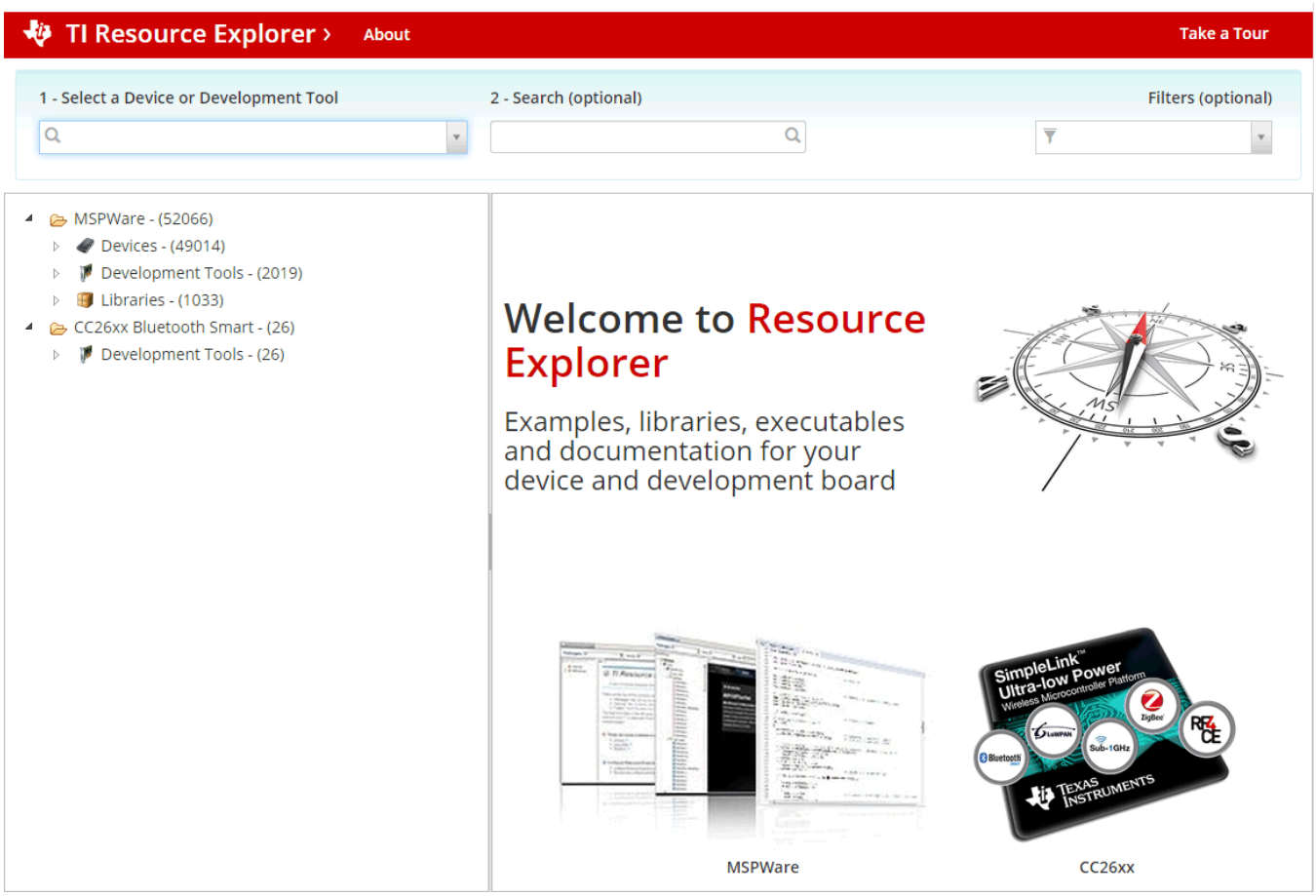


Figure 7. TI Resource Explorer Cloud

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4.2.2 Code Composer Studio Cloud IDE

Code Composer Studio Cloud (CCS Cloud) IDE (see Figure 8) is a web-based IDE that enables you to quickly create, edit, build, and debug applications for a LaunchPad development kit. No need to download and install large software packages, simply connect the LaunchPad development kit and begin. You can select from a large variety of examples in MSPWare software and Energia or develop your 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.

Go check out Code Composer Studio Cloud IDE now at https://dev.ti.com/.

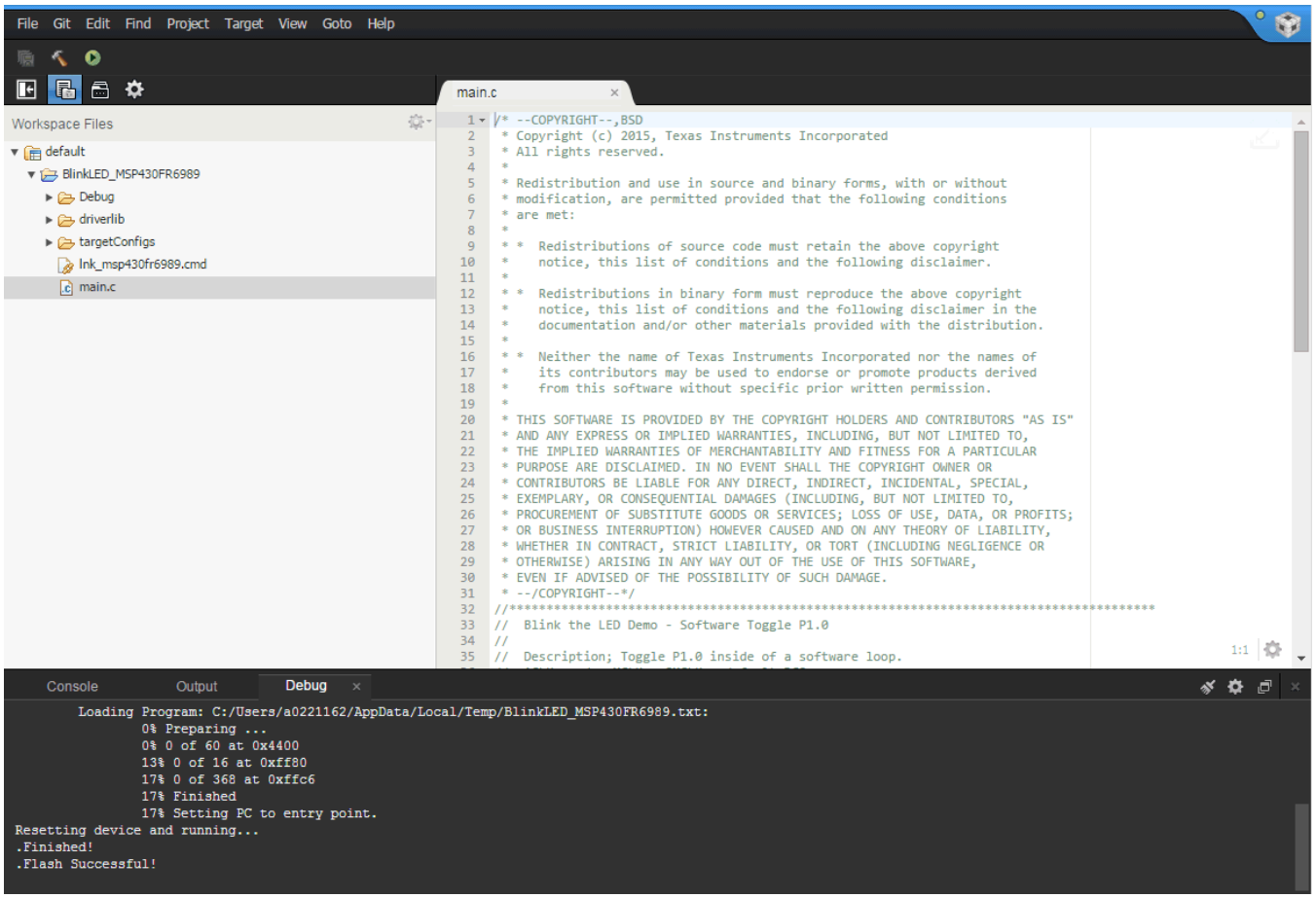


Figure 8. CCS Cloud

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4.3 Code Composer Studio IDE

Code Composer Studio IDE Desktop is a professional integrated development environment that supports TI's microcontroller and embedded processor portfolio. Code Composer Studio IDE comprises a suite of tools that are 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 and download it at http://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 the wizard to the desired demo project directory that contains main.c (see Figure 9).

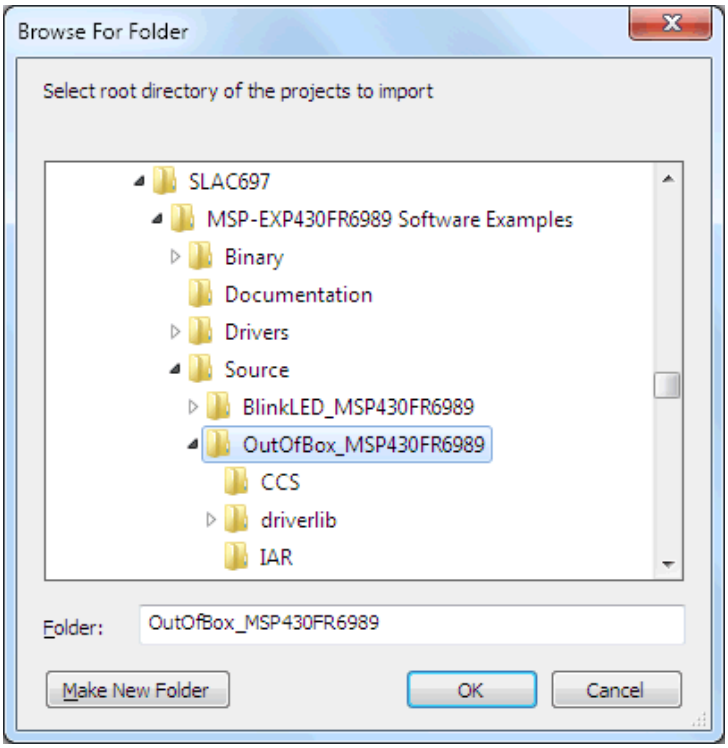


Figure 9. Directing the Project→Import Function to the Demo Project

Selecting the \CCS subdirectory also works. The CCS-specific files are located there.

When you click OK, the CCS IDE should recognize the project and allow you to import it. The indication that CCS has found it is that the project appears in the box shown in Figure 10, and it has a checkmark to the left of it.

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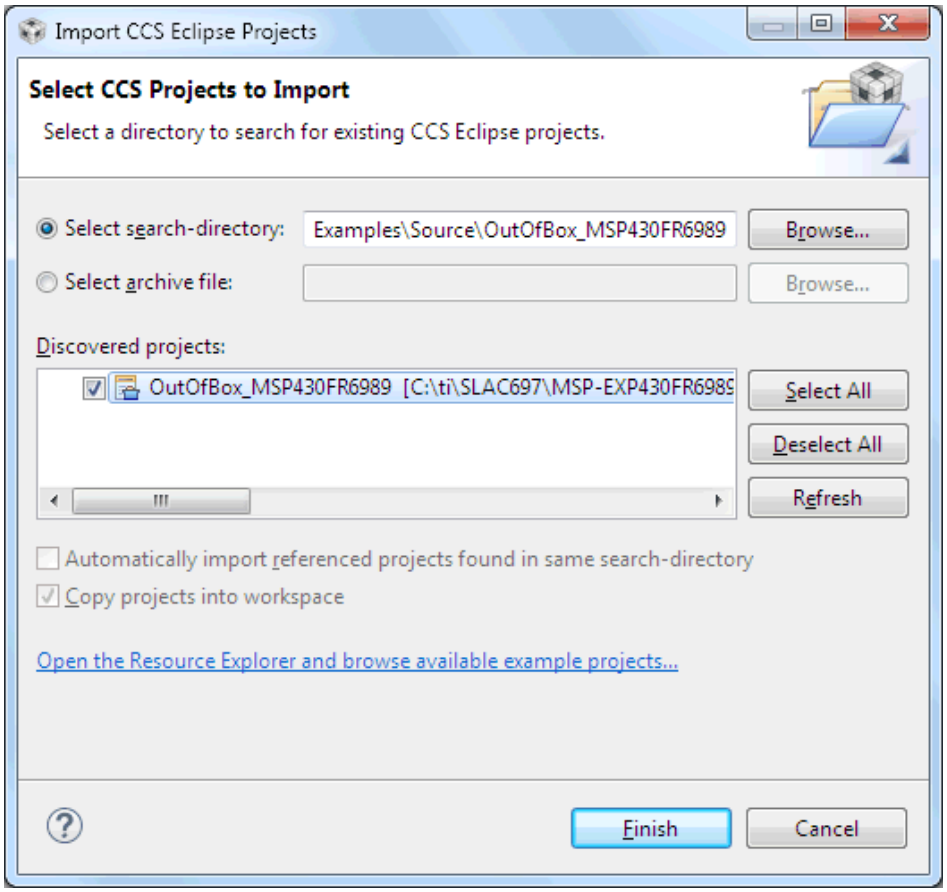


Figure 10. When CCS Has Found the Project

Sometimes the CCS IDE finds the project but does not show a checkmark. This might mean that the workspace already has a project by that name. Resolve this by renaming or deleting that project. Even if you do not see it in the CCS IDE workspace, be sure to check the workspace directory on the file system.

4.4 IAR Embedded Workbench for MSP430

IAR Embedded Workbench for MSP430 MCUs is another very powerful integrated development environment that allows you to develop and manage complete embedded application projects. It 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 IAR Embedded Workbench for MSP430 and download it at http://supp.iar.com/Download/SW/?item=EW430-EVAL.

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 MSPWare software, which contains MSP430 MCU libraries and the TI Resource Explorer. By default, these are included in a Code Composer Studio installation.

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4.5 Energia

Energia is a simple open-source 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 light-weight 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 MSPWare Software and TI Resource Explorer

MSPWare software is a complete collection of libraries and tools. It includes a driver library (driverlib), graphics library (grlib), and many other software tools. MSPWare software is optionally included in a CCS installation or can be downloaded separately. IAR users must download it separately.

MSPWare software includes the TI Resource Explorer, for easily browsing tools. For example, all of the software examples are shown in the tree (see Figure 11).

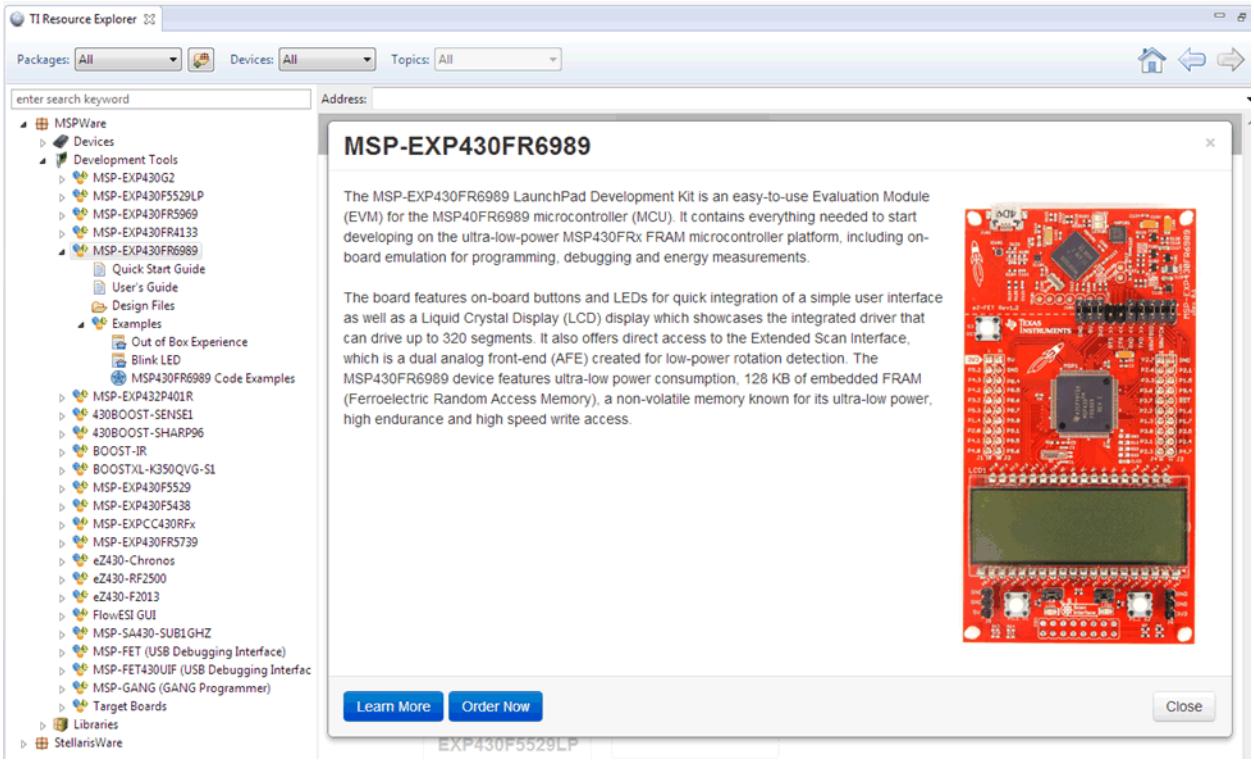


Figure 11. Software Examples in TI Resource Explorer

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 http://e2e.ti.com. If you cannot find an answer, post your 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. One example is http://www.43oh.com. You can find additional tools, resources, and support from these communities.

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5 Schematics

Figure 12 shows the schematics. All hardware design files are included in the BOOSTXL-AUDIO Hardware Design Files.

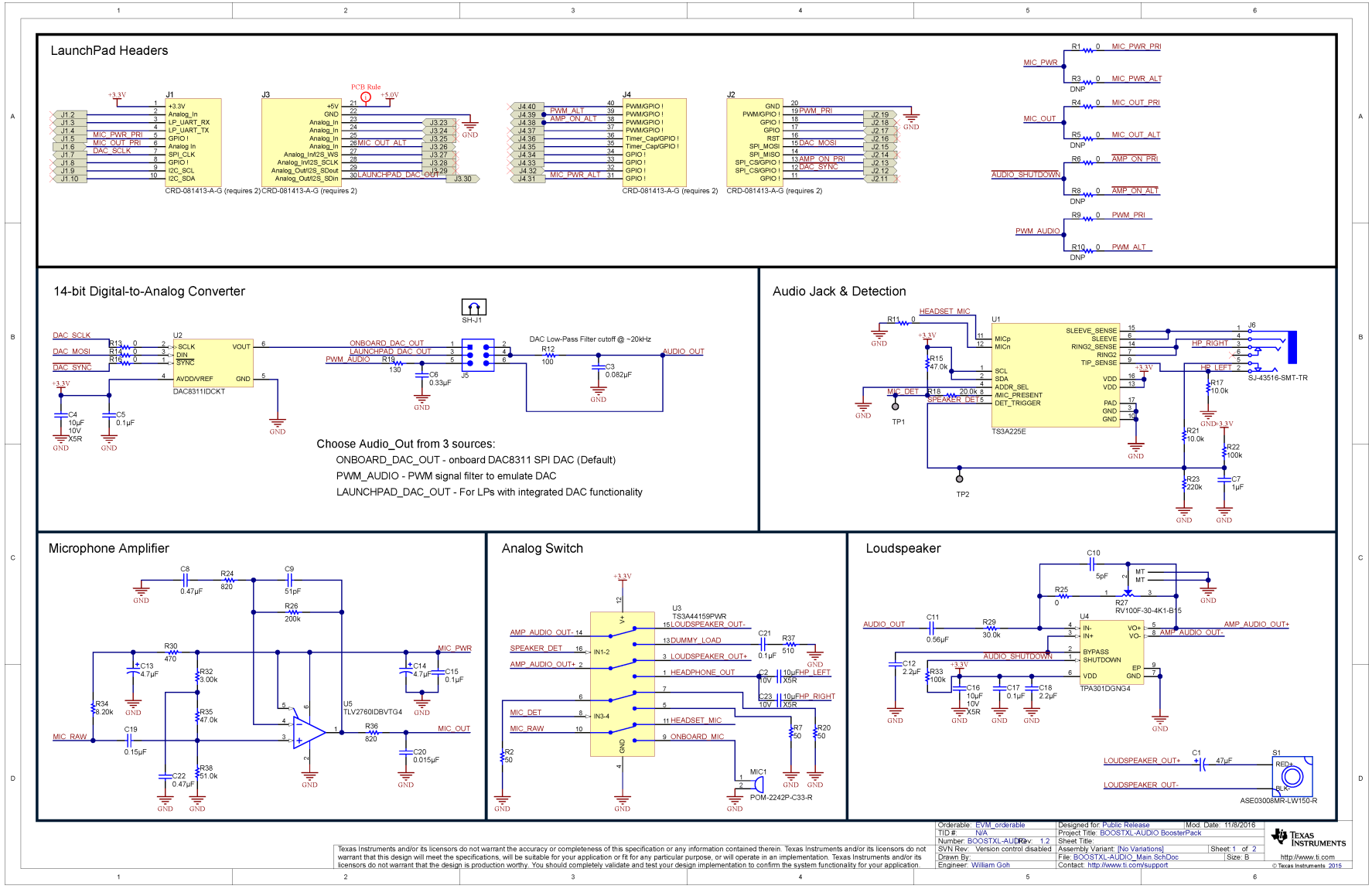


Figure 12. Schematics

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Revision History

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

Changes from March 25, 2016 to November 9, 2016 **Page**

- Changed all instances of "LEA_SC" to "LEA" 3
- Added Rev 1.2 to Table 3, *Hardware Change Log* 7
- Changed Figure 12, *Schematics* 16

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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.

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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。

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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.

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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.

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