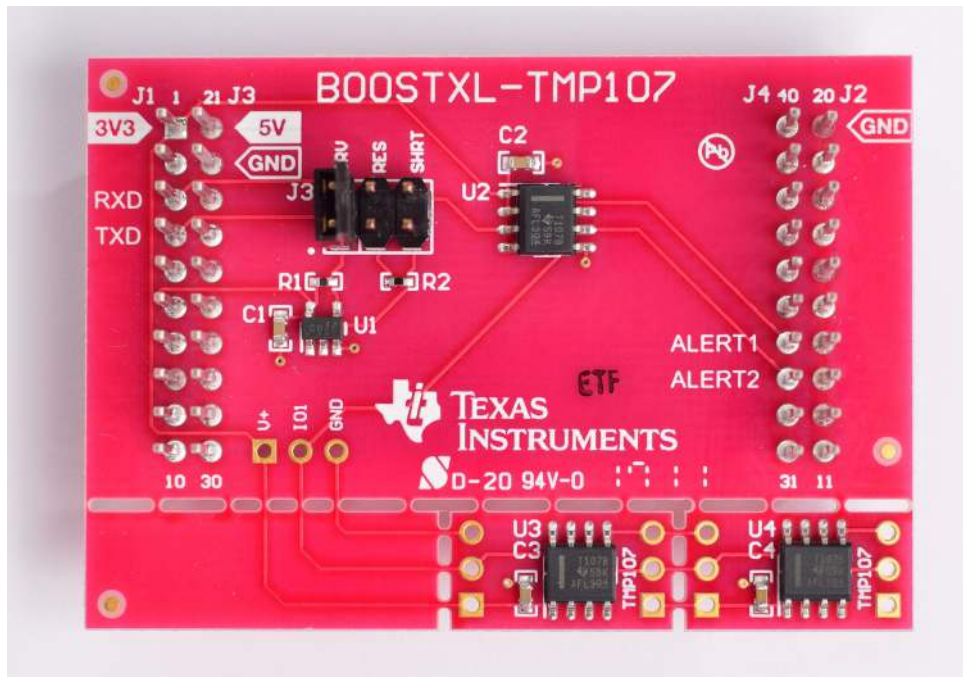


## **BOOSTXL-TMP107 User's Guide**

The BOOSTXL-TMP107 BoosterPack™ (see [Figure 1](#)) is an easy-to-use plug-in module that adds high-accuracy temperature sensors to your LaunchPad™ development kit. Two of the three temperature sensors can be disconnected from the main board, and strung together in a chain using 3-conductor wiring.



**Figure 1. BOOSTXL-TMP107**

## Contents

1	Getting Started .....	3
1.1	Key Features .....	3
1.2	What Is Included .....	3
2	Hardware.....	3
2.1	Hardware Features .....	4
2.2	Power.....	6
2.3	Design Files .....	6
2.4	Hardware Change Log .....	6
3	Software Examples .....	7
3.1	LibraryTestBench .....	7
3.2	OutOfBox_MSP-EXP430FR6989.....	8
3.3	OutOfBox_MSP-EXP430F5529LP .....	10
4	Additional Resources .....	11
4.1	TI LaunchPad™ Portal .....	11
4.2	Download CCS, IAR, or Energia .....	11
4.3	MSP430Ware™ and TI Resource Explorer.....	11
4.4	TI E2E™ Community .....	11
5	Schematics.....	12

## List of Figures

1	BOOSTXL-TMP107 .....	1
2	BOOSTXL-TMP107 Overview .....	3
3	BoosterPack™ Pinout.....	4
4	J3 Header.....	5
5	Breakable PCB.....	5
6	Console Output From Compiled LibraryTestBench Demonstration.....	8
7	BOOSTXL-TMP107 and FR6989.....	9
8	Example Output from MSP Application UART .....	10
9	Schematics.....	12

## List of Tables

1	Hardware Change Log .....	6
2	Software Examples.....	7
3	IDE Minimum Requirements for MSP-EXP430F5529LP .....	7
4	Source File and Folders .....	7
5	Source File and Folders .....	8
6	Source File and Folders .....	10

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## 1 Getting Started

### 1.1 Key Features

- TI TMP107 temperature sensors (quantity 3)
  - One temperature sensor on the main section of the PCB
  - Two temperature sensors on perforated sections of the PCB
- Choice of three driver circuits for software evaluation
- Utilizes universal asynchronous receiver/transmitter (UART) of the host microcontroller
- TI SN74LVC1G07 open drain driver
- 40-pin BoosterPack standard for use with any LaunchPad kit

### 1.2 What Is Included

#### 1.2.1 Kit Contents

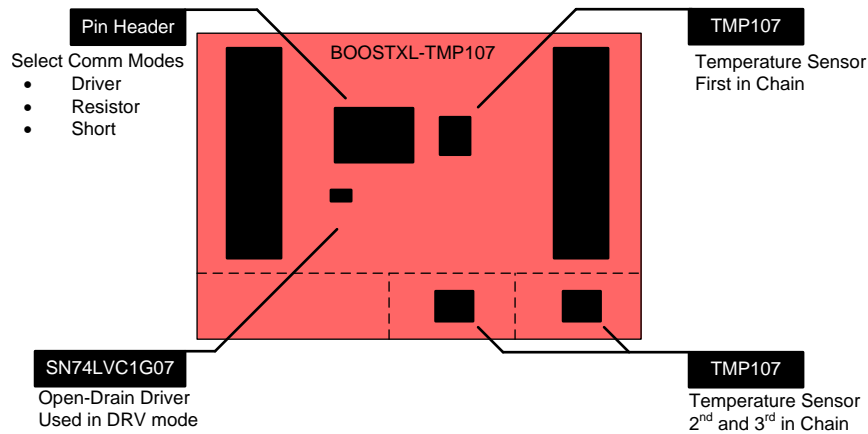
- 1× BOOSTXL-TMP107

#### 1.2.2 Software Examples

- TMP107 Library Test Bench
- OutOfBox\_MSP-EXP430FR6989
- OutOfBox\_MSP-EXP430F5529LP

## 2 Hardware

Figure 2 is an overview of the BOOSTXL-TMP107 hardware.

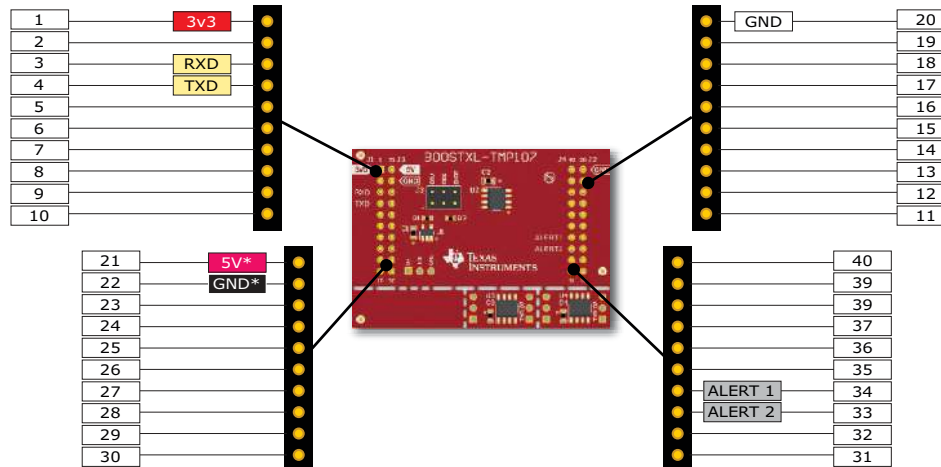


**Figure 2. BOOSTXL-TMP107 Overview**

## 2.1 Hardware Features

### 2.1.1 BoosterPack™ Pinout

Figure 3 shows the pinout of the BoosterPack Module.



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**Figure 3. BoosterPack™ Pinout**

The TMP107 BoosterPack adheres to the 40-pin LaunchPad and BoosterPack standard (see Figure 3). A standard was created to aid compatibility between LaunchPad and BoosterPack tools across the TI ecosystem.

The 40-pin standard is compatible with the 20-pin standard that is used by other LaunchPads like the MSP-EXP430G2. This allows for the 20-pin LaunchPads to be used with 40-pin BoosterPacks with some limited functionality.

More information about compatibility is found at <http://www.ti.com/launchpad>.

### 2.1.2 TMP107 Temperature Sensor (U2–U4)

BOOSTXL-TMP107 features three TMP107 temperature sensors. The sensors are connected to one another sequentially using a unique one-wire bus. Device U2 is the first in the communication chain, and resides on the main section of the PCB. Device U3 and U4 follow U2, and reside on the breakable sections of the PCB. Each device independently measures and reports temperature on the bus, which can support up to 32 TMP107 devices.

### 2.1.3 Communication Modes Pin Header (J3)

The TMP107 one-wire communication interface is compatible with UART. However, it is necessary to combine the transmit (TX) and receive (RX) lines of UART in order to create the bidirectional bus which TMP107 uses. BOOSTXL-TMP107 offers three methods of creating this bidirectional bus.

1. The first method makes use of the open-drain driver SN74LVC1G07 U1 and the pullup resistor R1. This is the method presented in the TMP107 data sheet, and it provides the most robust communication regardless of UART host. To use this mode, connect the shunt across pins 1 and 2.
2. The second method uses 10-k $\Omega$  series resistor R2 to simultaneously act as a pullup (since the TX pin idles high) and a current limiter. This method has lower cost and complexity than the first method. This method works with all UART hosts, and works well with MSP430 in the BOOSTXL-TMP107 examples. To use this mode, connect the shunt across pins 3 and 4.
3. The third method directly connects the TX line, and requires special programming of the UART Master to avoid bus collision from the two drivers. This method uses no additional components, but only works with microcontrollers which have been specially programmed. To use this mode, connect the shunt across pins 5 and 6, and **uncomment** line 71 in *hal.h* which reads “#define TMP107\_OneWireUART.”

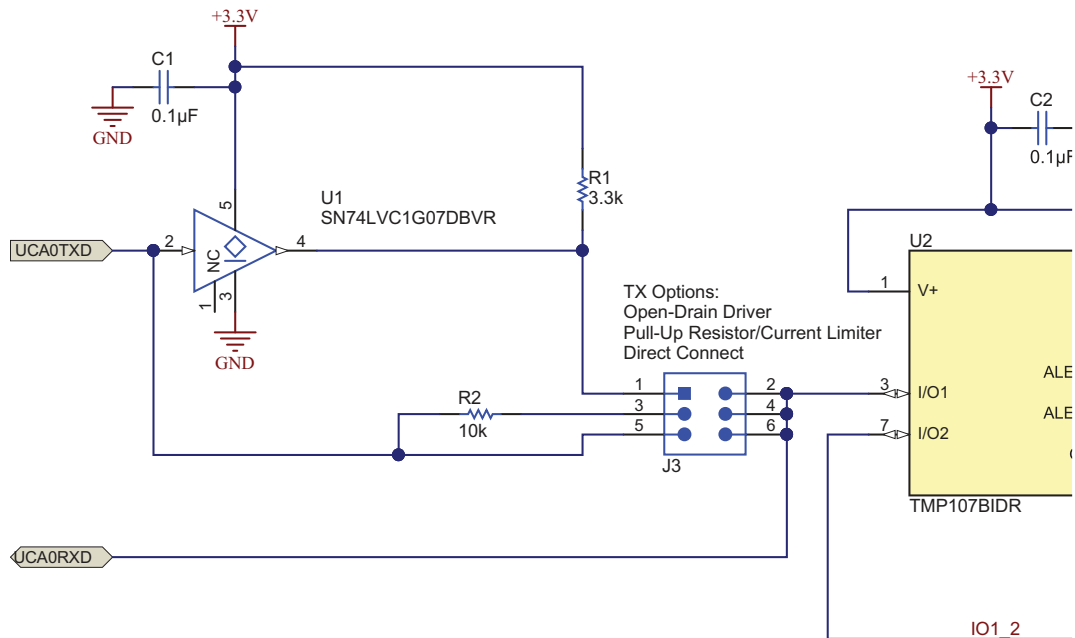


Figure 4. J3 Header

### 2.1.4 Breakable PCB

The BOOSTXL-TMP107 PCB features perforations that allow sections to be separated. The second and third TMP107 devices (U3 and U4) may be removed for remote temperature sensing. These modules only require three-conductor cabling between them and the main BoosterPack module. The TMP107 features a push-pull output capable of sourcing or sinking up to 1 mA. This push-pull output allows it to drive more than 6 feet of ribbon cable between sensor nodes.

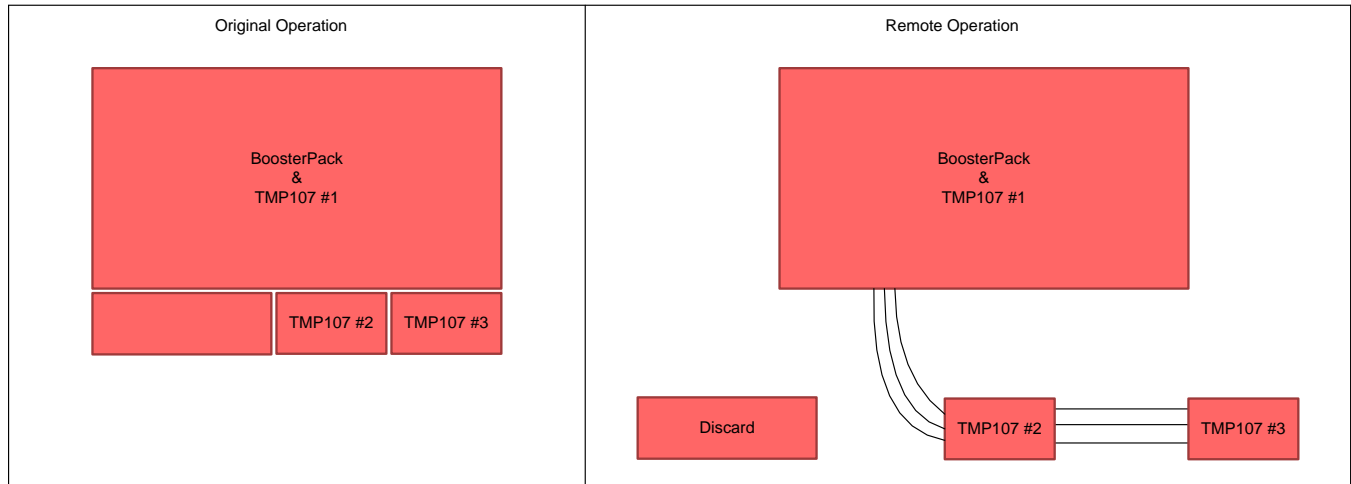


Figure 5. Breakable PCB

## 2.2 Power

The board was designed to be powered by the attached LaunchPad, and requires only the 3.3-V power rail.

## 2.3 Design Files

### 2.3.1 Hardware

Schematics are found in [Section 5](#). All design files including schematics, layout, bill of materials (BOM,) Gerber files, and documentation are available on the [BOOSTXL-TMP107](#) 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 LaunchPad-specific software folders. To see which LaunchPads feature BOOSTXL-TMP107 examples, check the [BOOSTXL-TMP107](#) download page.

## 2.4 Hardware Change Log

[Table 1](#) lists the hardware change log.

**Table 1. Hardware Change Log**

PCB Revision	Description
Rev A	Initial Release

### 3 Software Examples

Table 2 lists the software examples.

**Table 2. Software Examples**

Demonstration Name	LaunchPad™ Required	Description	More Details
LibraryTestBench	N/A	Evaluate TMP107 library on your development PC.	<a href="#">Section 3.1</a>
OutOfBox_MSP-EXP430FR6989	MSP-EXP430FR6989	Demonstrates reading TMP107 temperatures and displaying them on LCD.	<a href="#">Section 3.2</a>
OutOfBox_MSP-EXP430F5529LP	MSP-EXP430F5529LP	Demonstrates reading TMP107 temperatures and printing them to UART.	<a href="#">Section 3.3</a>

Table 3 displays the IDE minimum requirements for MSP-EXP430F5529LP.

**Table 3. IDE Minimum Requirements for MSP-EXP430F5529LP**

Code Composer Studio IDE	IAR Embedded Workbench IDE
v6.1 or later	7.10 or later

#### 3.1 LibraryTestBench

This section describes the functionality and structure of the LibraryTestBench demonstration included in TMP107-Firmware-Library.

##### 3.1.1 Source File Structure

Table 4 lists the source files and folders.

**Table 4. Source File and Folders**

Name	Description
how-to-compile.txt	A hint as to how the test bench can be used
tb_tmp107.c	Test bench which demonstrates select library features
tmp107.c	TMP107 library
tmp107.h	TMP107 library header

##### 3.1.2 Operation

This demonstration is intended to be compiled and run on your development PC. The tb\_tmp107.c file contains the main() program loop which contains calls to the TMP107 Library (tmp107.c.) Library functions which would normally access the hardware, instead print to console the packets that are sent to the hardware. This demonstration can be used to:

- Evaluate or test features of the TMP107 Library
- Generate command data to be sent by the bus master to the TMP107
- Convert temperature data to Celsius
- Encode and decode bus addresses

Command data generated by the library is able to be hard-coded into your application. This demonstration can also be used to check your understanding of the TMP107. The output of the demonstration is shown in [Figure 6](#).

```

GlobalAddressInit:
0x55 Calibration Byte
0x95 Command Byte
0x0D Byte 1

DecodeTemperatureResult(0x1AB0): 26.687500

TMP107_Encode5bitAddress(0x01): 0x08
TMP107_Encode5bitAddress(0x03): 0x18
TMP107_Encode5bitAddress(0x1F): 0xF8

TMP107_Encode5bitAddress(0x08): 0x01
TMP107_Encode5bitAddress(0x0D): 0x01
TMP107_Encode5bitAddress(0x0B): 0x01
TMP107_Encode5bitAddress(0xF8): 0x1F
  
```

**Figure 6. Console Output From Compiled LibraryTestBench Demonstration**

## 3.2 OutOfBox\_MSP-EXP430FR6989

This section describes the functionality and structure of OutOfBox\_MSP-EXP430FR6989 demonstration that is included in TMP107-Firmware-Library.

### 3.2.1 Source File Structure

[Table 5](#) lists the source files and folders.

**Table 5. Source File and Folders**

Name	Description
driverlib	Device drive library
.project	CCS project files
hal_LCD.c	LCD library
hal_LCD.h	LCD library header
hal_tmp107.c	Hardware abstraction layer for TMP107 library
hal_tmp107.h	Hardware abstraction layer header for the TMP107 library
main.c	Main source file of the demonstration
tmp107.c	TMP107 library
tmp107.h	TMP107 library header



### 3.2.2 Operation

This demonstration uses the LCD on the MSP-EXP430F6989 LaunchPad to display temperature data. It begins by querying the TMP107 bus for the last device in the bus. If the number of devices on the bus has recently changed, or if new TMP107 devices are being used, hold the pushbutton S1 to initialize the bus addresses instead. After either LastDevice query or AddressInit occurs, a global read operation is then performed on the bus to retrieve temperature data from all TMP107 devices. This temperature data is displayed sequentially on the LCD using the battery indicator bars to indicate (in binary) the current device.

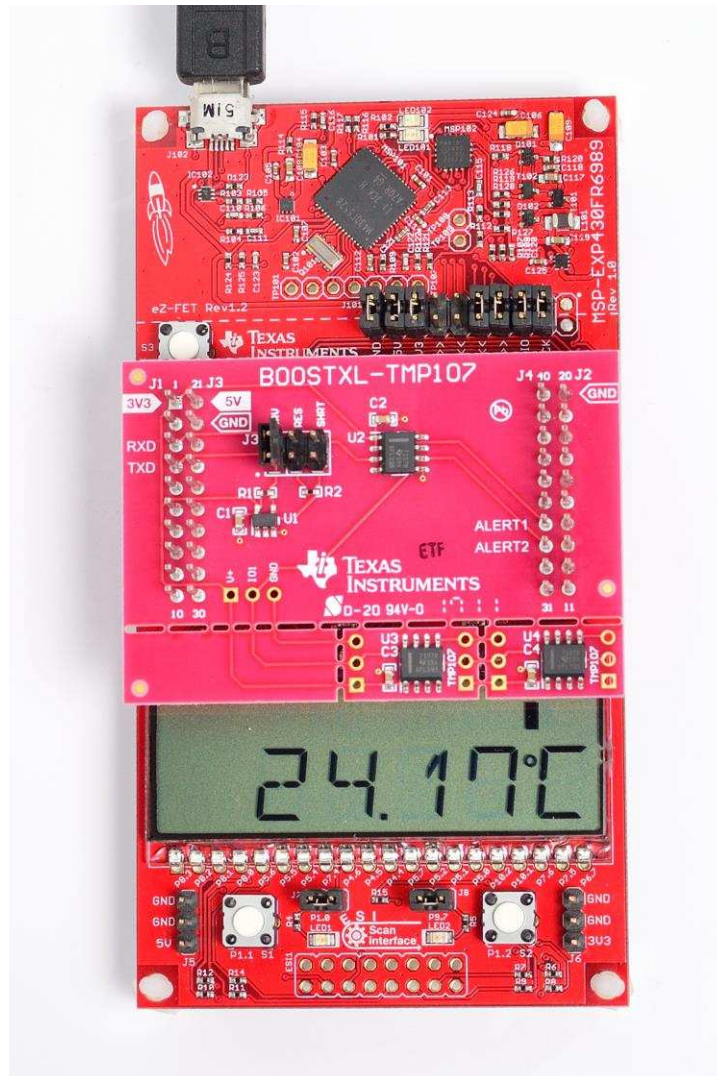


Figure 7. BOOSTXL-TMP107 and FR6989

### 3.3 OutOfBox\_MSP-EXP430F5529LP

This section describes the functionality and structure of OutOfBox\_MSP-EXP430F5529LP demonstration that is included in TMP107-Firmware-Library.

#### 3.3.1 Source File Structure

Table 6 lists the source files and folders.

**Table 6. Source File and Folders**

Name	Description
driverlib	Device drive library
.project	CCS project files
hal.c	Hardware abstraction layer for the TMP107 library
hal.h	Hardware abstraction layer header for the TMP107 library
main.c	Main source file of the demonstration
tmp107.c	TMP107 library
tmp107.h	TMP107 library header

#### 3.3.2 Operation

This demonstration uses the MSP application UART to report temperature data to the PC. The MSP application UART is a virtual COM port that is made available by the LaunchPad. Monitor this COM port using a terminal application, such as PuTTY. See Figure 8 for an example of MSP application UART output. The demonstration begins by querying the TMP107 bus for the last device in the bus. If the number of devices on the bus has recently changed, or if new TMP107 devices are being used, hold the pushbutton S1 to initialize the bus addresses instead. After either LastDevice query or AddressInit occurs, a global read operation is then performed on the bus to retrieve temperature data from all TMP107 devices. This temperature data is then printed to the MSP application UART, and LED1 flashes to indicate how many TMP107 devices were found.

```
temp 0: 24.000000

temp 1: 23.984375

temp 2: 24.234375
```

**Figure 8. Example Output from MSP Application UART**

## 4 Additional Resources

### 4.1 TI LaunchPad™ Portal

More information about LaunchPads, supported BoosterPacks, and available resources is found at [TI's LaunchPad portal](#): information about all LaunchPads from TI, for all MCUs.

### 4.2 Download CCS, IAR, or Energia

Although the files can be viewed with any text editor, more can be done with the projects if they are opened with a development environment like *Code Composer Studio™* (CCS), IAR, or Energia.

### 4.3 MSP430Ware™ and TI Resource Explorer

[MSP430Ware](#) is a complete collection of code examples, software libraries, data sheets, and other design resources for all MSP devices delivered in a convenient package – essentially everything developers need to become MSP experts. It includes a driver library (driverlib), graphics library (glib), and many other software tools. MSPWare is optionally included in a CCS installation or can be downloaded separately. IAR users must download it separately.

TI Resource Explorer is a tool that allows you to easily browse through and quickly find what you need inside MSPWare. Example projects can also be imported into your workspace with one click. Now available in the *TI Cloud Tools* collection, the *TI Resource Explorer Cloud* is instantly accessible at [dev.ti.com](#).

### 4.4 TI E2E™ Community

Search the TI E2E™ forums at <http://e2e.ti.com>. If you cannot find your answer, post your question to the community.

## 5 Schematics

Figure 9 shows the schematics. All hardware design files are found on the [download page](#).

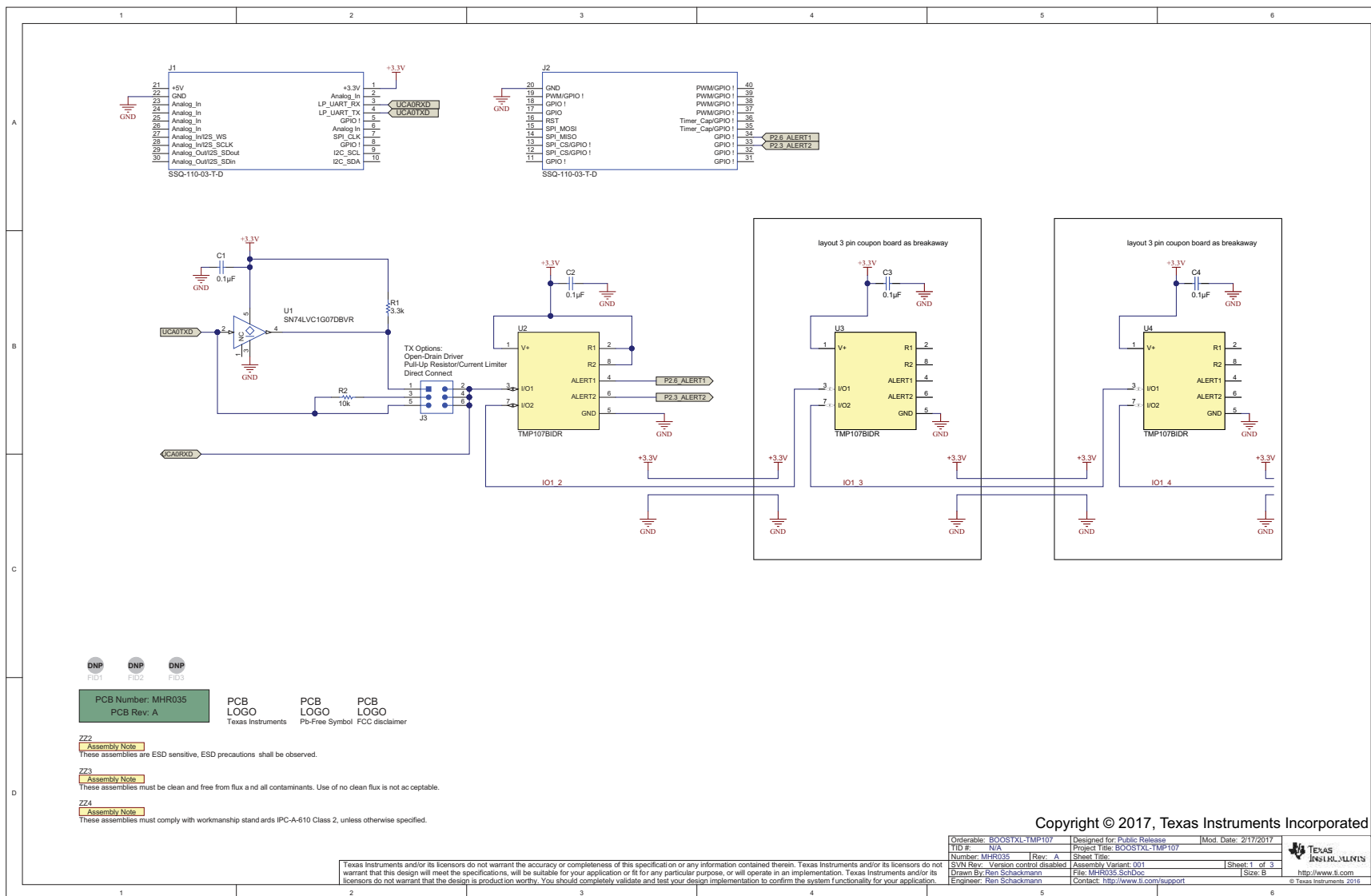


Figure 9. Schematics

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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

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## 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/lstds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/lstds/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/lstds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/lstds/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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#### 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.

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