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.

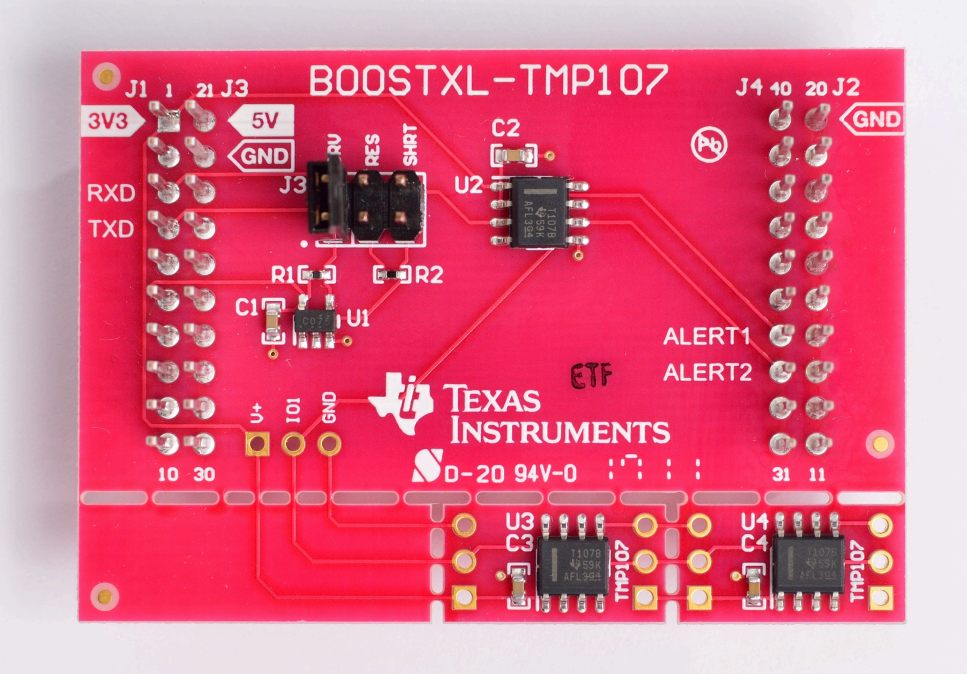

Figure 1. BOOSTXL-TMP107

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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.

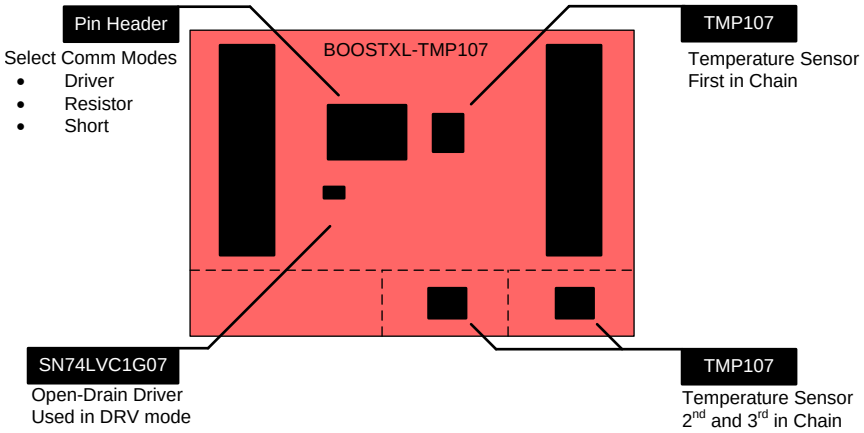

Figure 2. BOOSTXL-TMP107 Overview

2.1 Hardware Features

2.1.1 BoosterPack™ Pinout

Figure 3 shows the pinout of the BoosterPack Module.

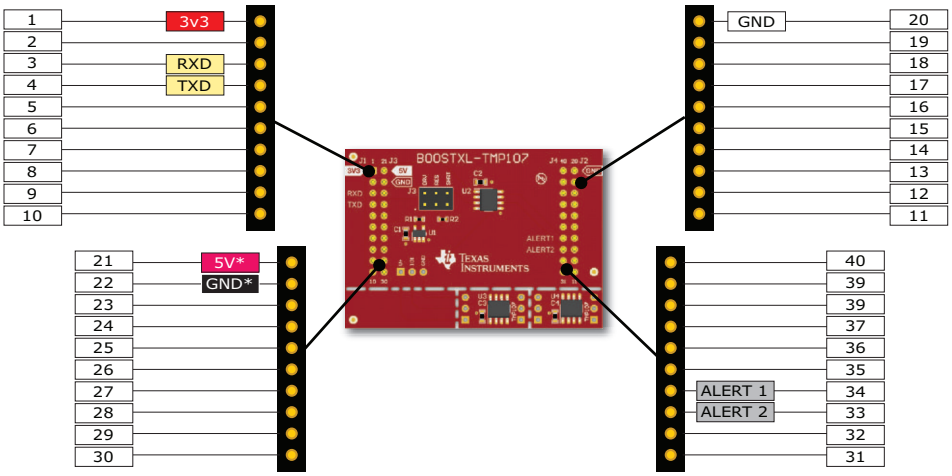

Figure 3. BoosterPack™ Pinout

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-kΩ 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.”

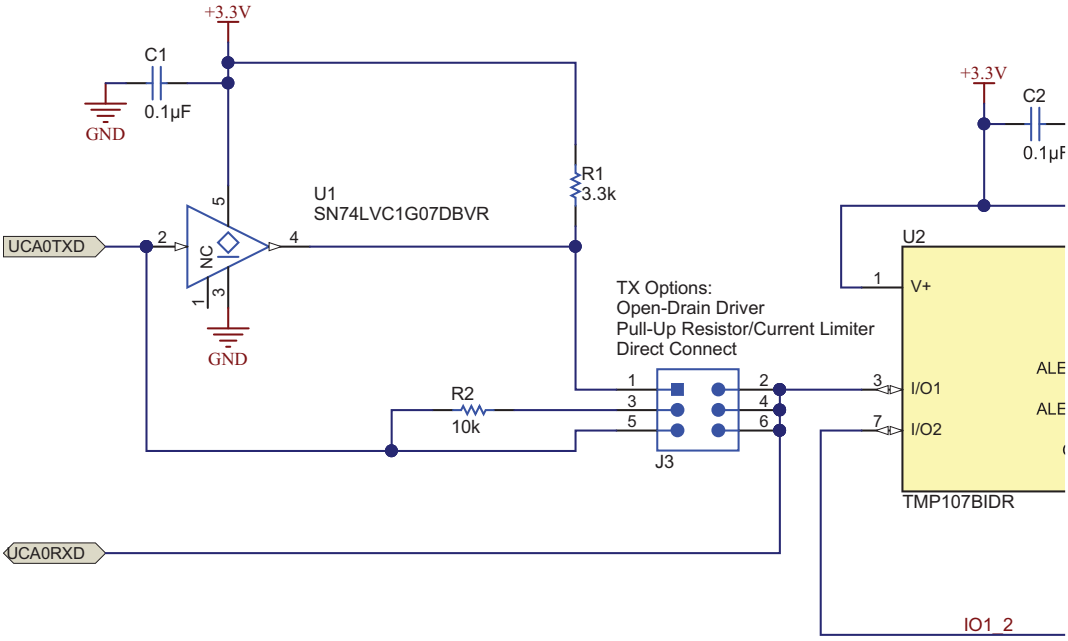

Figure 4. J3 Header

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.

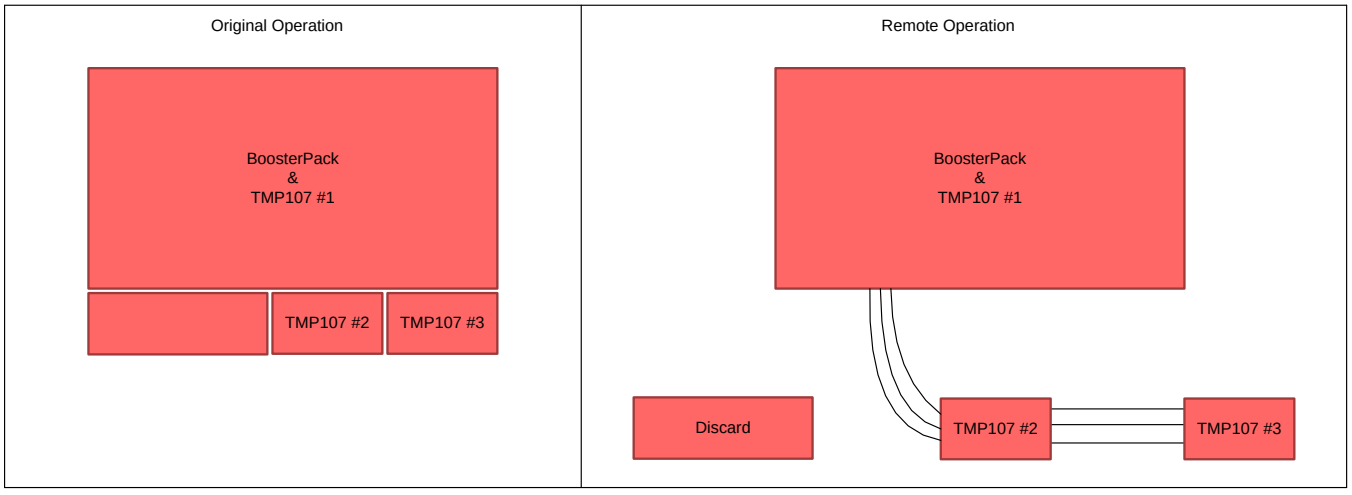

Figure 5. Breakable PCB

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.	Section 3.1
OutOfBox_MSP-EXP430FR6989	MSP-EXP430FR6989	Demonstrates reading TMP107 temperatures and displaying them on LCD.	Section 3.2
OutOfBox_MSP-EXP430F5529LP	MSP-EXP430F5529LP	Demonstrates reading TMP107 temperatures and printing them to UART.	Section 3.3

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.

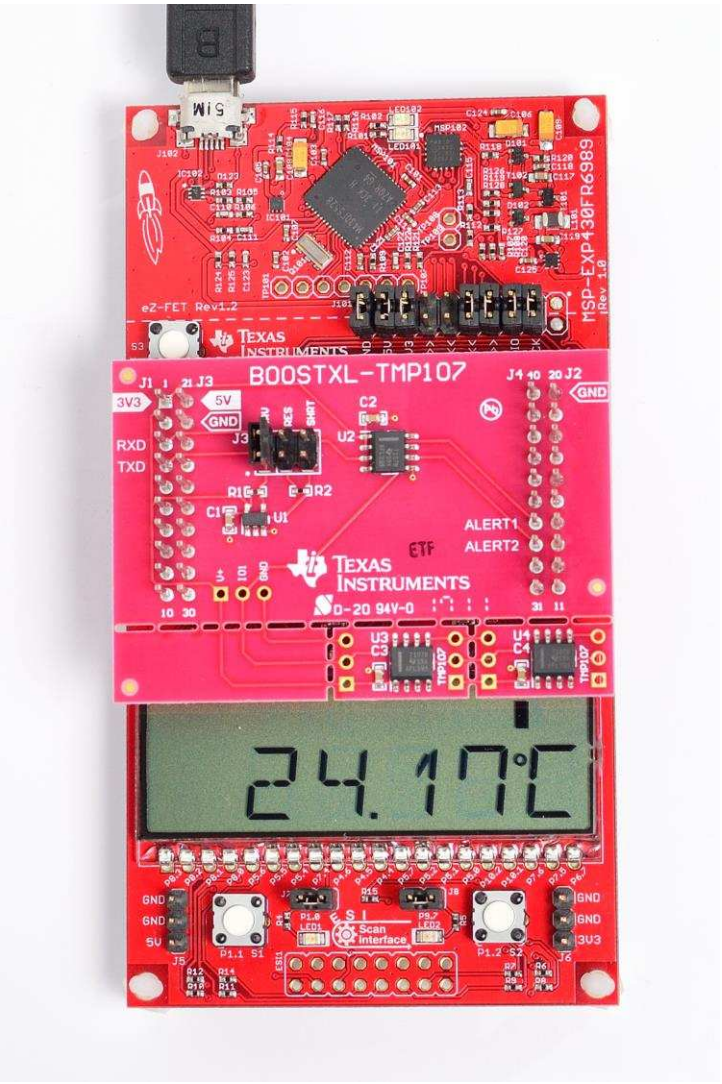

Figure 7. BOOSTXL-TMP107 and FR6989

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 (grlib), 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.

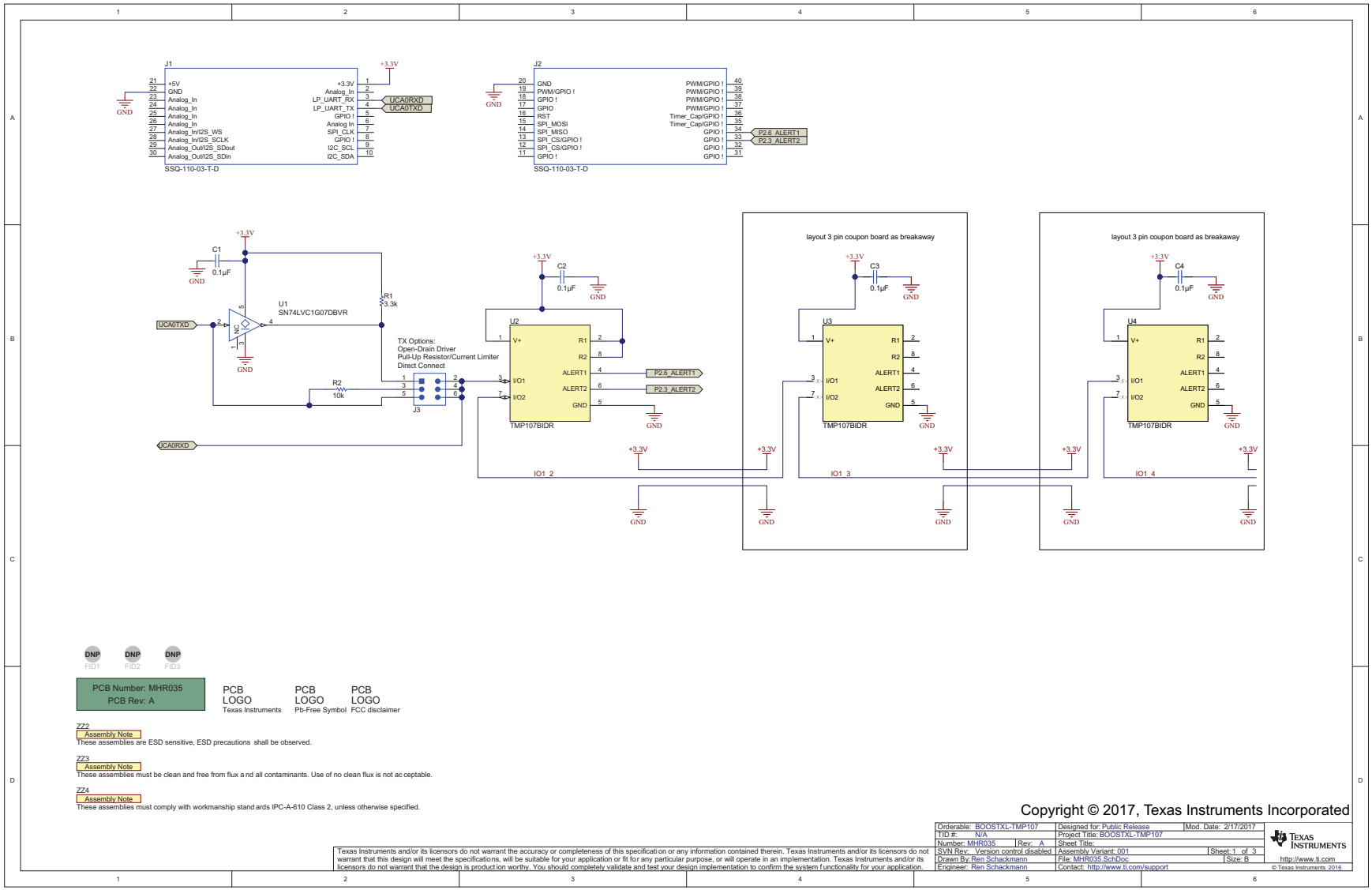

Figure 9. Schematics

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