430BOOST-ADS1118 Booster Pack

This user's guide describes the characteristics, operation, and use of the 430BOOST-ADS1118 Booster Pack, a quick and low-cost solution to evaluate and develop the ADS1118 for temperature measurement applications using type K thermocouples. This document also includes the schematic, printed circuit board (PCB) layout, and a bill of materials (BOM).

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1 430BOOST-ADS1118 Booster Pack Overview

1.1 Description

The 430BOOST-ADS1118 Booster Pack provides a quick and low-cost solution to evaluate and develop the ADS1118 for temperature measurement applications using type K thermocouples. To quickly get started, this booster pack comes with preloaded firmware for the MSP430G2553 device. The software also provides a fully commented source code for users to get started developing applications. Figure 1 shows an overview of the booster pack hardware.

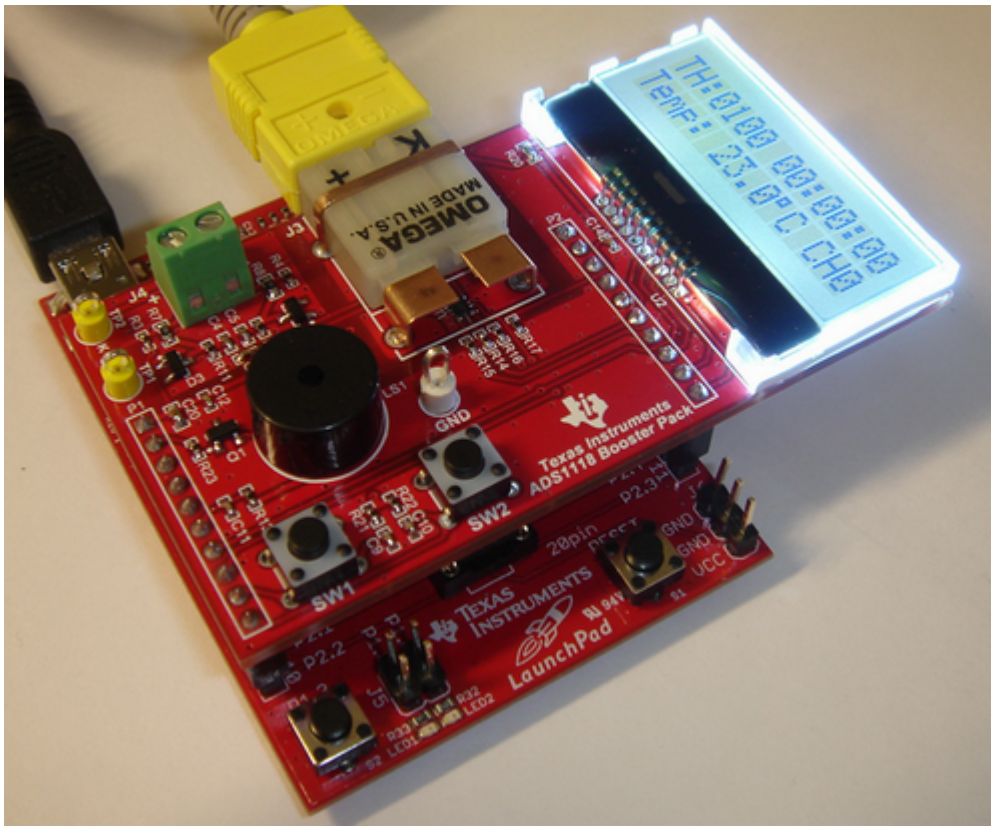

Figure 1. 430BOOST-ADS1118 BoosterPack Overview

1.2 Features

- Actual temperature display in °C or °F
- Threshold temperature display
- Programmable threshold temperature
- Programmable countdown timer
- Optional input channel
- Optional UART communication

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2 ADS1118 Information

The ADS1118 is a precision analog-to-digital converter (ADC). This device features an onboard reference and oscillator, as well as 16 bits of resolution. The ADS1118 can perform up to 860 samples per second (SPS) and has an onboard programmable gain amplifier (PGA) that allows input ranges from ±256 mV to ±6.144 V. This device also contains an input multiplexer that allows each input to be used with reference to ground, or as two differential inputs. The ADS1118 datasheet (SBAS457) contains all relevant analog and digital electrical information pertaining to the device. This booster pack demonstrates how an MSP430 and ADS1118 can be integrated into one system.

2.1 Type K Thermocouple

A thermocouple consists of two conductors of different materials that produce a voltage in the vicinity of the point where the two conductors are in contact. The voltage produced depends on, but is not necessarily proportional to, the difference of temperature of the junction to other parts of those conductors. Thermocouples require a stable voltage reference and some form of ice point or cold junction compensation. The integration of an internal voltage reference, multiplexer, and temperature sensor make the ADS1118 an ideal option for thermocouple measurements. Type K is the most common general-purpose thermocouple with a sensitivity of approximately 41 µV/°C. A type K thermocouple is inexpensive, and a wide variety of probes are available in the −200°C to +1250°C (–330°F to +2460°F) range. For more information about thermocouple measurement with the ADS1118, see Application Report SBAA189, *Precision Thermocouple Measurement with the ADS1118*.

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3 Getting Started

3.1 Requirements

The ADS1118 Booster Pack requires LaunchPad rev1.4 or higher; see www.ti.com/launchpadwiki for more information. The ADS1118 Booster Pack also requires a MSP430G2553 device (included). This device is preprogrammed with the user experience firmware (see Section 6).

3.2 Configuring LaunchPad

1. For LaunchPad rev1.4 or earlier, cross jump the UART lines; see SLAU318, *MSP-EXP430G2 LaunchPad Experimenter Board User's Guide*, for more information.
2. For LaunchPad rev1.5, switch to hardware UART through J3 jumpers, as shown in Figure 2.

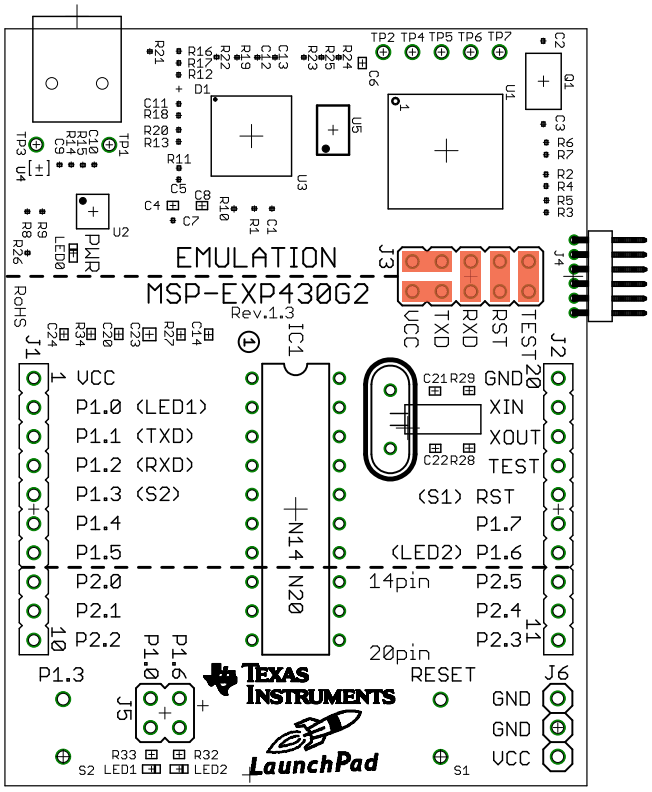

Figure 2. J3 Jumper

3. Remove P1.6 and P1.0, as shown in Figure 3.

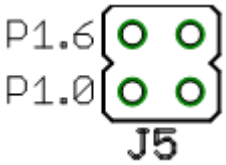

Figure 3. J5 Jumper

4. Replace the existing LaunchPad device with the MSP430G2553 device inside the ADS1118 Booster Pack. This device has been preloaded with the user experience firmware.

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5. Insert the ADS1118 Booster Pack on top of the LaunchPad as shown in Figure 4.

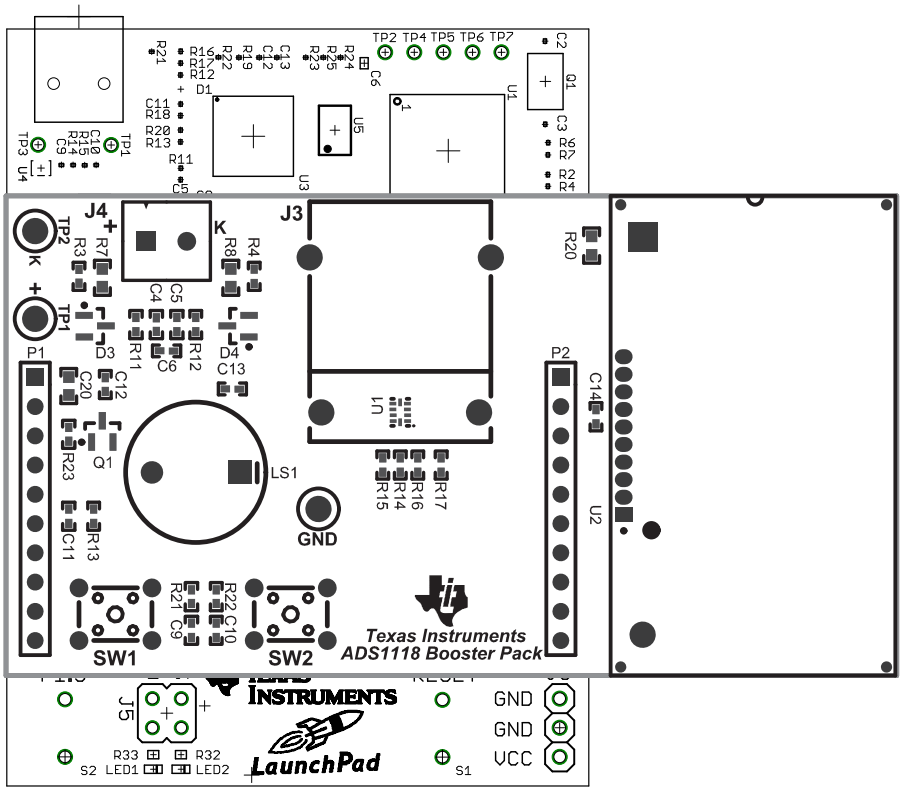

Figure 4. Booster Pack on Top of the LaunchPad

6. Connect a type K thermocouple probe to J3 on the ADS1118 BoosterPack, as shown in Figure 5

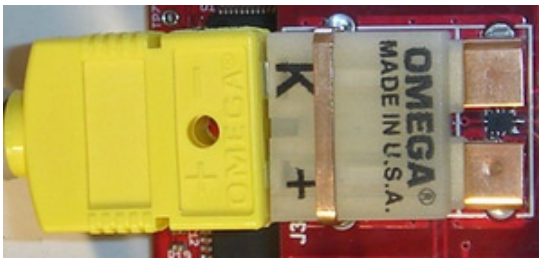

Figure 5. Connect Thermocouple

7. Connect hardware as shown in Figure 6.

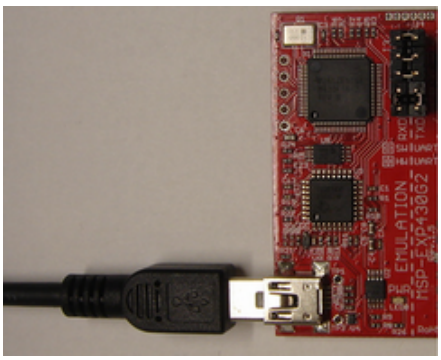

Figure 6. Connect USB

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4 Obtaining Software Packages

Download the latest software packages from www.ti.com/ADS1118boosterpack.

Download the two software packages. One package contains the source code and the other package contains the binaries for the MSP430G2553 firmware.

4.1 Redownloading or Modifying Firmware

This step is optional. To get started, if you have used the preloaded MSP430G2553 device inside the ADS1118 BoosterPack, this step can be used to reload the firmware with a newer version or to a blank device. The quickest way to redownload the firmware image is to run *MSP430Flasher.bat* inside the firmware directory.

To modify the firmware, see Section 6 regarding supported compilers.

4.2 Starting the Demo Application

1. Read real-time temperature on LCD. Press S2 on LaunchPad for switching temperature display at °C or °F as shown in Figure 7.

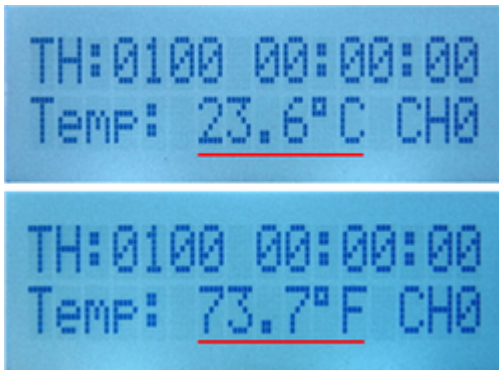

Figure 7. Display Real-Time Temperature

2. Set threshold temperature (see Section 5.1).
3. Set timer (see Section 5.2).
4. Change input channel (see Section 5.3).

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5 User Experience Application

Use buttons SW1, SW1, and S2 to set threshold temperature and timer. The input channel can be changed by buttons S2 and SW2.

5.1 Set Threshold Temperature

The threshold temperature is set by SW1 and S2. If a threshold temperature is set, then when the real-time temperature is greater than the threshold temperature, the buzzer sounds an audio alarm.

A threshold setting state machine is used to set the threshold temperature. In the threshold temperature setting mode, the set bit flashes, as shown in Figure 8. Press the SW1 button and the ADS1118 Booster Pack enters the threshold temperature setting mode. Press S2 to change the set value of the set bit. Detailed steps are listed following Figure 8.

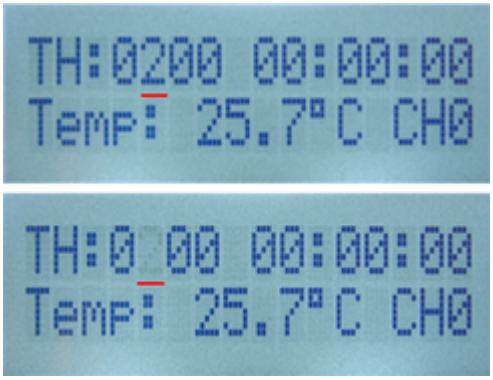

Figure 8. Flashing Hundreds Bit of the Threshold Temperature

1. Press the SW1 Button to let the ADS1118 Booster Pack enter the threshold temperature setting mode. The hundreds bit of the threshold temperature flashes.
2. Press S2 to change the setting of the flashing hundreds digit of the threshold temperature. Continue to press S2 until the required value is entered.
3. After the hundreds bit of the threshold temperature has been configured, press SW1 to set the tens digit of the threshold temperature. Press S2 to change the value of flashing bit until the required value is entered.
4. After the tens digit of the threshold temperature has been configured, press SW1 to set the ones bit of the threshold temperature. Press S2 to change the value of flashing bit until the required value is entered.
5. Finally, press SW1 to end the threshold temperature configuration and save the set value as the threshold temperature.

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5.2 Set Timer

A timer-setting state machine is used to set the countdown time. When the timer counts down, at the last three seconds, the buzzer gives a continuous buzz as an alarm. Set the timer by pressing SW2 to change the setting digit and pressing S2 to change the value of that digit. The following list shows the detailed steps.

1. When SW2 is pressed at the first time, the ADS1118 Booster Pack enters time setup mode. The tens bit of the minutes flashes, as shown in Figure 9.

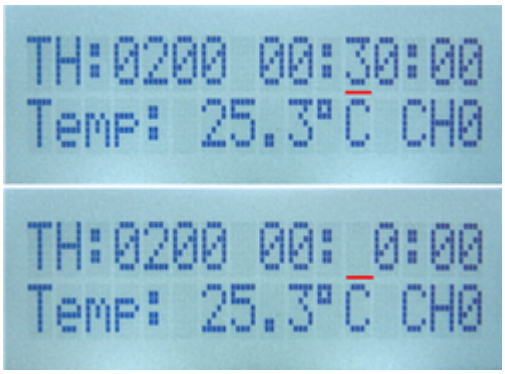

Figure 9. Set Timer

2. Press S2 to change the value of the flashing bit. Continue to press S2 until the required bit value is entered.
3. After the tens bit of the minutes has been configured, press SW1 to set the ones bit of the timer. Press S2 to change the value of flashing bit until the required value is entered.
4. After the ones bit of the minutes has been configured, press SW1 to set the seconds bit of the timer. Press S2 to change the value of flashing bit until the required value is entered.
5. Finally, press SW2 to end the timer setup and save the set value to the timer. The timer counts down the time until the time is 00:00:00.

5.3 Change Input Channel

The ADS1118 Booster Pack has two differential input channels. Analog input AIN0/AIN1 is configured for channel zero (CH0). Analog input AIN2/AIN3 is configured for channel one (CH1). Both channels have the same RC filter circuit. CH0 uses a type K thermocouple connector. CH1 uses a generic two-terminal block, J4, as shown in Figure 10. Change the channel by pressing two buttons, S2 on the LaunchPad and SW2 on the ADS1118 Booster Pack. The following list shows the detailed steps.

1. Press and hold the S2 button.
2. Press SW2 on the ADS1118 Booster Pack.
3. Release both buttons. The ADS1118 input channel is now changed.

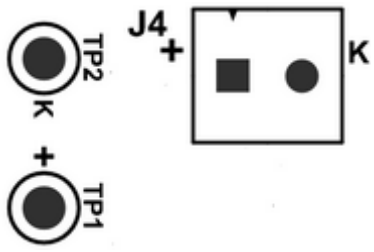

Figure 10. CH1 Input on Board

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6 Rebuild Software Project

This software package includes project files that allow customers to recompile the code for user development. These project files are located inside the *430BOOST-ADS1118-SFT-A.zip* source folder. The source code was developed and compiled using Code Composer Studio™ (CCStudio), version 5.3. CCStudio is an integrated development environment (IDE) for Texas Instruments embedded processor families. CCStudio information is available online at http://www.ti.com/tool/ccstudio. The software package is available for download at http://processors.wiki.ti.com/index.php/Download_CCS.

The default sample rate of the ADS1118 is 128 SPS. However, if the sample rate must be changed, then the ADC_CON definition inside the ADS1118.h file must be changed, then recompiled, and then the firmware redownload. The following code shows two examples of the CH0 and CH1 configurations:

```
//Set the configuration to AIN0/AIN1, FS=+/-0.256mV, SS, DR=128sps, PULLUP on DOUT

#define ADSCON_CH0     (0x8B8A)

//Set the configuration to AIN2/AIN3, FS=+/-0.256mV, SS, DR=128sps, PULLUP on DOUT

#define ADSCON_CH1     (0xBB8A)
```

6.1 Main Function Flow Chart

Figure 11 shows the main function flow chart.

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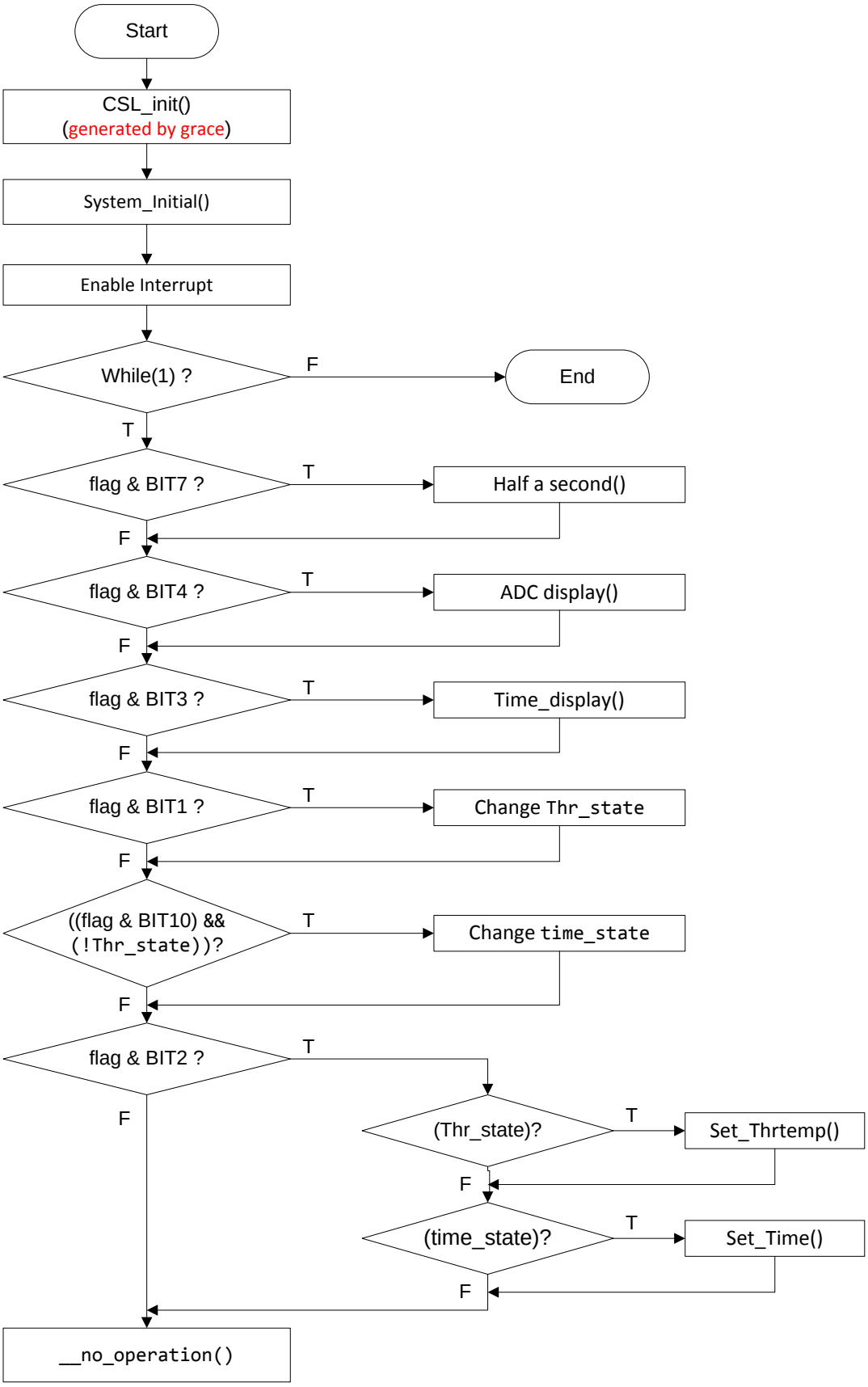

Figure 11. Flow Chart of the Main Function

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6.2 Grace

The CSL_Init( ) is generated by the Grace™ graphical configuration tool. For more information about Grace refer to http://www.ti.com/tool/grace. Figure 12 shows the MSP430G2553 device overview. Configure the peripheral of MSP430G2553 by using the Grace tool.

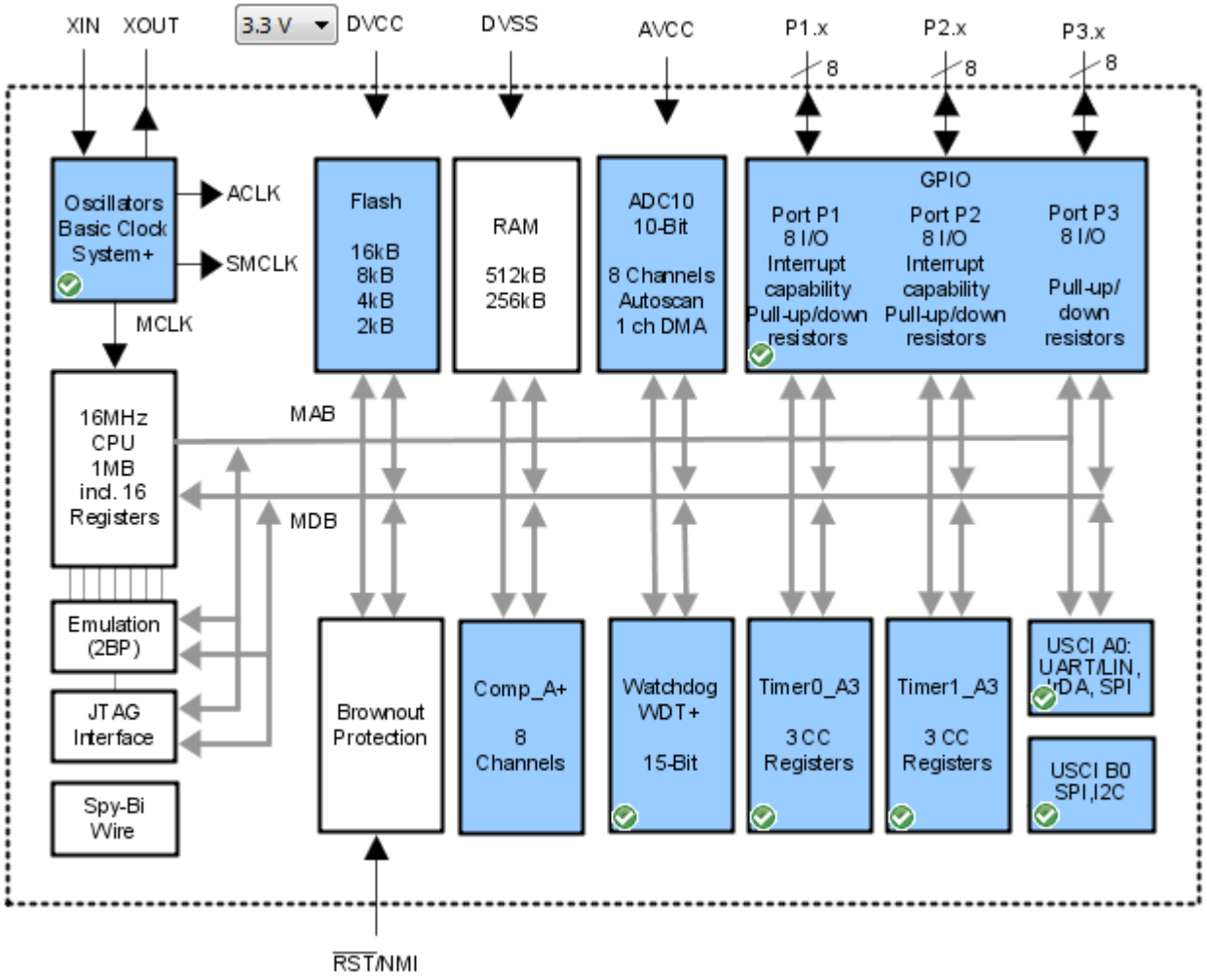

Figure 12. Overview of Grace

6.3 UART Communication

UART communication functions are defined in the software project but are not called in the demo project. Use the UART to transmit data from the Launchpad to the PC. There are two files (*UART_TxRx.h* and *UART_TxRx.c*) that are relative to UART communication. Two functions can be used to transmit character and string data from the LauchPad to the PC. These two functions are defined in *UART_TxRx.h.*

```
void uart_txc(char c);  // transmit a character by LauchPad UART

void uart_txstr(char *c);     // transmit a sring by LauchPad UART
```

These functions can be added in the project, and then rebuilt.

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7 Schematic, PCB Layout, and Bill of Materials

This section contains the block diagram, schematic diagram, PCB layout, and complete bill of materials for the 430BOOST-ADS1118 Booster Pack.

7.1 Schematic

Figure 13 shows the schematic of 430BOOST-ADS1118 Booster Pack.

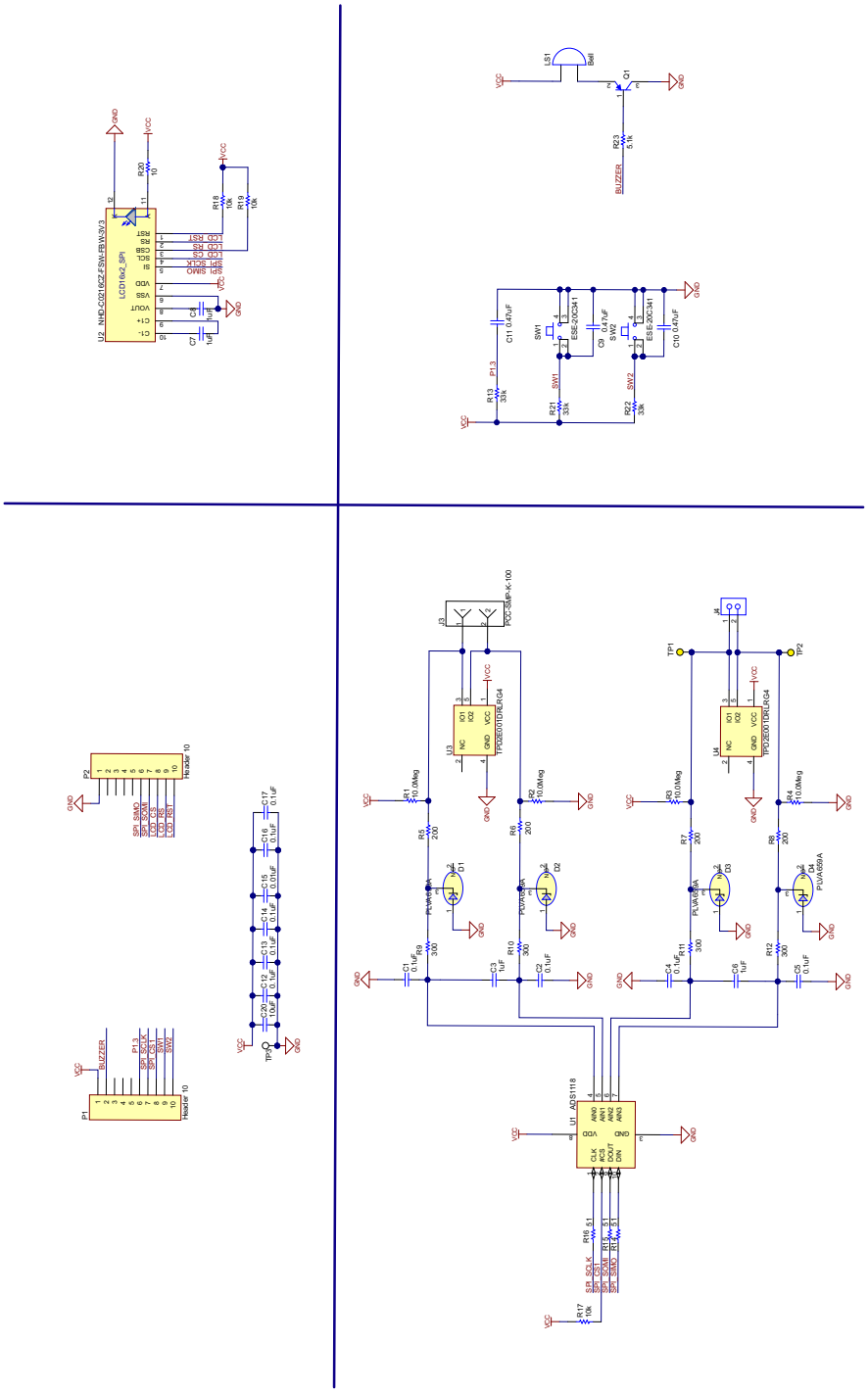

Figure 13. Schematic

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7.2 PCB Layout

Figure 14 shows the 430BOOST-ADS1118 Booster Pack top-layer silkscreen.

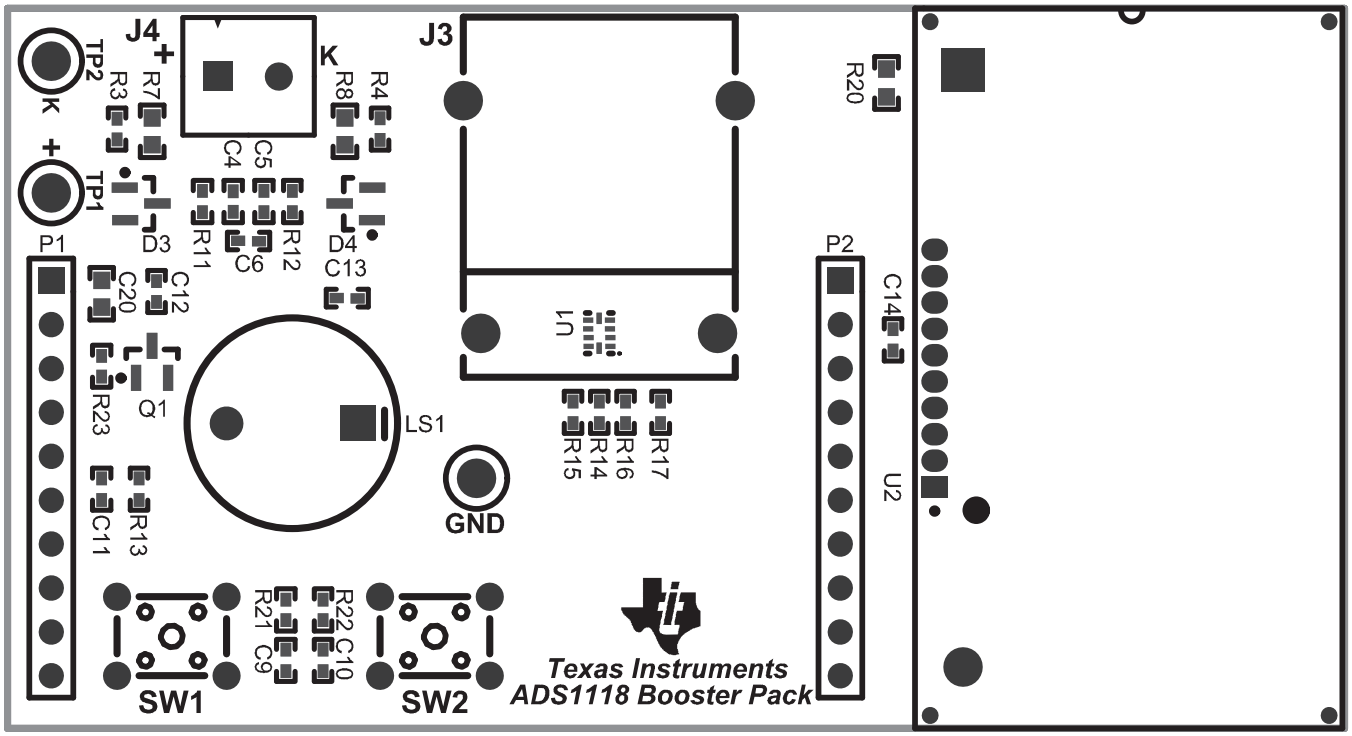

Figure 14. Top-Layer Silkscreen

Figure 15 and Figure 16 show the PCB layout of 430BOOST-ADS1118 Booster Pack.

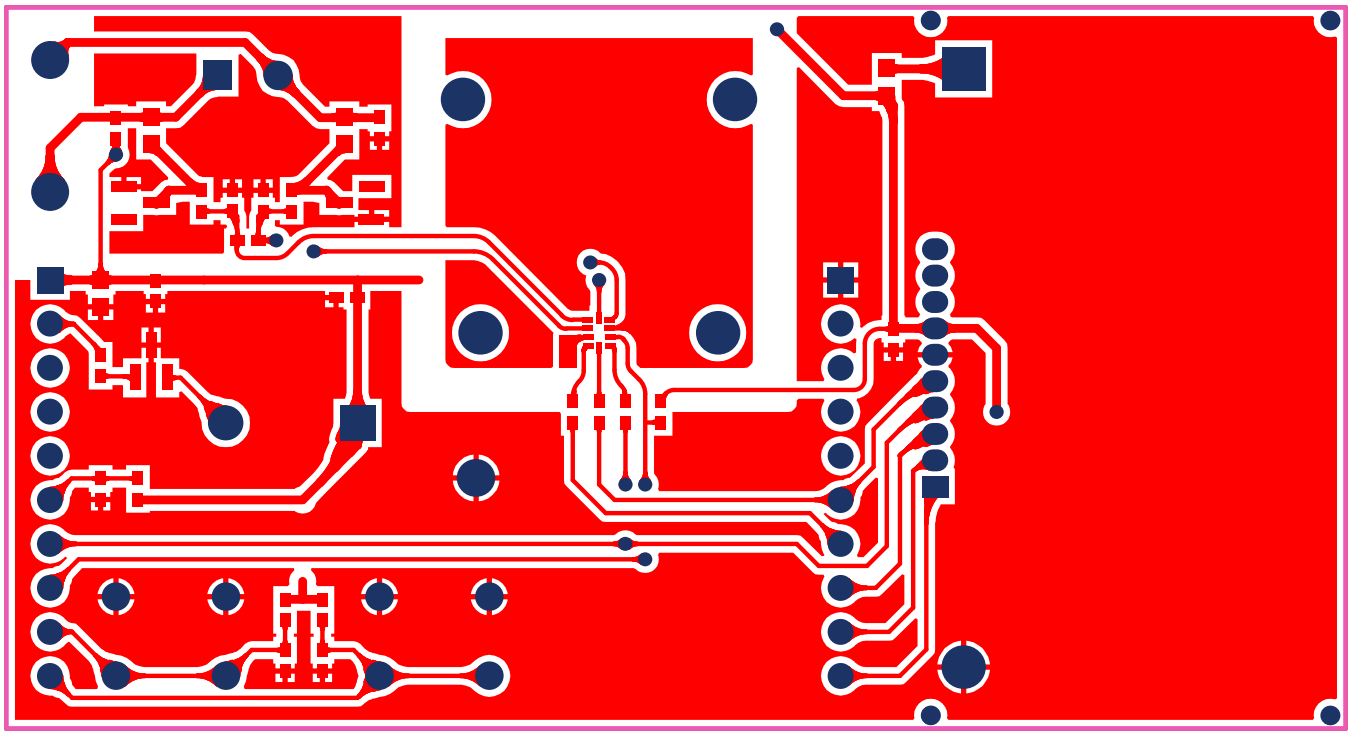

Figure 15. PCB Top Layer

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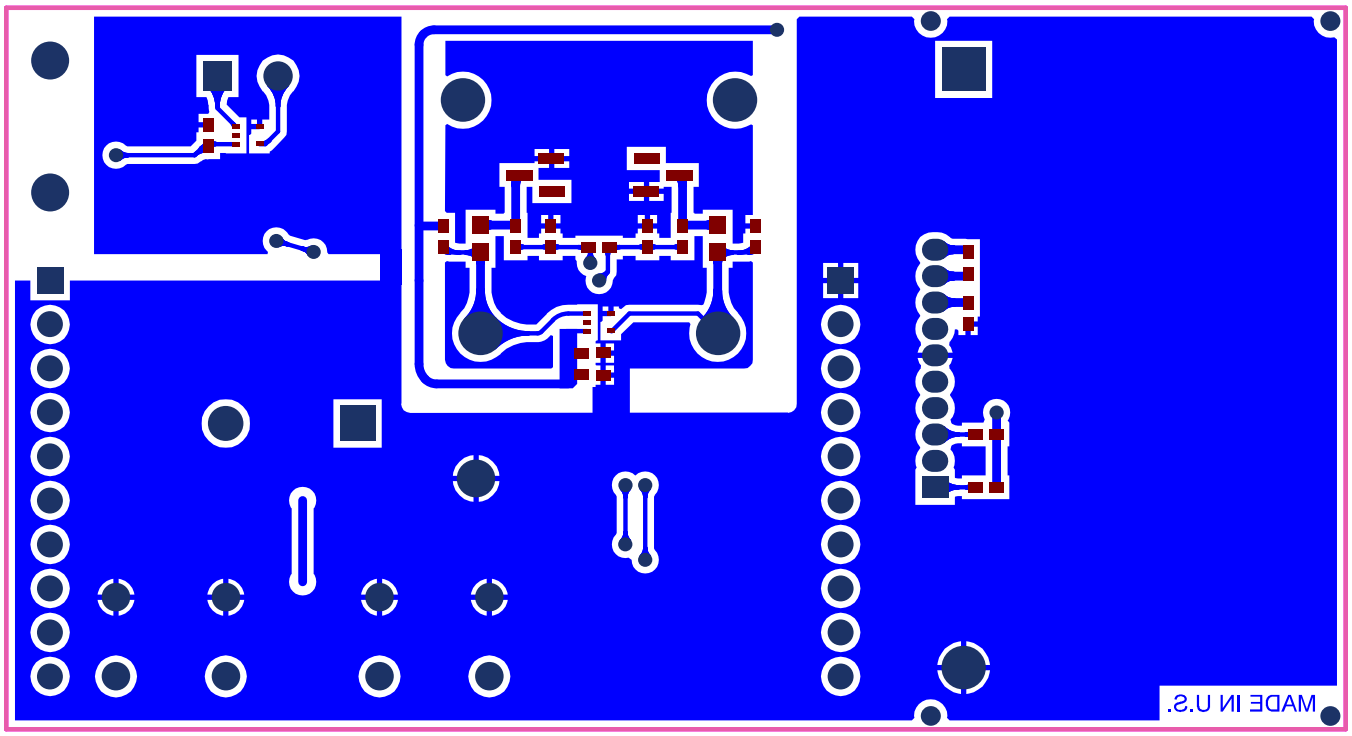

Figure 16. PCB Bottom Layer

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7.3 Bill of Materials

Table 1 lists the bill of materials.

Table 1. Bill of Materials

Item No.	Ref Des	Description	Vendor/Mfr	Part Number
1	U1	ADS1118, RUG Package	Texas Instruments	ADS1118
2	U2	LCD1602, Serial Interface	Newhaven Display	NHD-C0216CZ-FSW-FBW-3V3
3	U3,U4	+/- 15 kV ESD-Protection Array 2 Channels	Texas Instruments	TPD2E001DRLRG4
4	Q1	Transistor, PNP, 65V, 0.1A, SOT-23	Diodes Inc	BC856B-7-F
5	D1,D2,D3,D4	DIODE ZENER 5.9V 250MW SOT23	NXP Semiconductors	PLVA659A,215
6	LS1	BUZZER 2.30KHZ 2-5VDC 82DB PCB	Soberton Inc	WST-1203UX
7	T1	type K thermocouple	Omega Engineering inc.	5SRTC-TT-K-24-36
8	C1, C2, C4, C5, C12, C13, C14, C16, C17	CAP, CERM, 0.1uF, 6.3V, +/-10%, X5R, 0402	TDK Corporation	C1005X5R0J104K
9	C3, C6, C7, C8	CAP, CERM, 1uF, 6.3V, +/-20%, X5R, 0402	TDK Corporation	C1005X5R0J105M
10	C9, C10, C11	CAP, CERM, 0.47uF, 6.3V, +/-10%, X5R, 0402	TDK Corporation	C1005X5R0J474K
11	C15	CAP, CERM, 0.01uF, 16V, +/-10%, X7R, 0402	TDK Corporation	C1005X7R1C103K
12	C20	CAP, CERM, 10uF, 6.3V, +/-20%, X5R, 0603	TDK Corporation	C1608X5R0J106M080AB
13	R1, R2, R3, R4	RES, 10Meg ohm, 1%, 0.063W, 0402	Yageo	RC0402FR-0710ML
14	R5, R6, R7, R8	RES, 200 ohm, 1%, 0.1W, 0603	Yageo	RC0603FR-07200RL
15	R9, R10, R11, R12	RES, 300 ohm, 1%, 0.063W, 0402	Yageo	RC0402FR-07300RL
16	R23	RES, 5.1k ohm, 5%, 0.063W, 0402	Yageo	RC0402JR-075K1L
17	R13, R21, R22	RES, 33k ohm, 5%, 0.063W, 0402	Yageo	RC0402JR-0733KL
18	R20	RES, 10 ohm, 5%, 0.1W, 0603	Yageo	RC0603JR-0710RL
19	R17, R18, R19	RES, 10k ohm, 5%, 0.063W, 0402	Yageo	RC0402JR-0710KL
20	R14, R15, R16	RES, 51 ohm, 5%, 0.063W, 0402	Yageo	RC0402JR-0751RL
21	S1, S2	SWITCH TACTILE SPST-NO 0.05A 12V	TE Connectivity	FSM4JH
22	J4	TERM BLOCK 2POS SIDE ENT 3.5MM	TE Connectivity	1776275-2
23	P1, P2	Header, 10-Pin	Wurth Electronics Inc	61301011821
24	TP1, TP2	Test Point, TH, Compact, Yellow	Keystone Electronics	5009
25	TP3	Test Point, TH, Multipurpose, White	Keystone Electronics	5012
26	J3	omega type K connector	OMEGA	PCC-SMP-K

8 References

1. ADS1118 EVM User Guide and Software Tutorial (SBAU184).
2. Precision Thermocouple Measurement with the ADS1118 (SBAA189).

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As noted in the EVM User's Guide and/or EVM itself, this EVM and/or accompanying hardware may or may not be subject to the Federal Communications Commission (FCC) and Industry Canada (IC) rules.

For EVMs **not** subject to the above rules, this evaluation board/kit/module is intended for use for ENGINEERING DEVELOPMENT, DEMONSTRATION OR EVALUATION PURPOSES ONLY and is not considered by TI to be a finished end product fit for general consumer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC or ICES-003 rules, which are designed to provide reasonable protection against radio frequency interference. Operation of the equipment may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

General Statement for EVMs including a radio

User Power/Frequency Use Obligations: This radio is intended for development/professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability of this EVM and its development application(s) must comply with local laws governing radio spectrum allocation and power limits for this evaluation module. It is the user's sole responsibility to only operate this radio in legally acceptable frequency space and within legally mandated power limitations. Any exceptions to this are strictly prohibited and unauthorized by Texas Instruments unless user has obtained appropriate experimental/development licenses from local regulatory authorities, which is responsibility of user including its acceptable authorization.

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

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

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.

For EVMs annotated as IC – INDUSTRY CANADA Compliant

This Class A or B digital apparatus complies with Canadian ICES-003.

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

Concerning EVMs including radio transmitters

This device complies with Industry Canada licence-exempt RSS standard(s). 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.

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.

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada.

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

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.

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.

【Important Notice for Users of EVMs for RF Products in Japan】

This development kit is NOT certified as Confirming to Technical Regulations of Radio Law of Japan

If you use this product in Japan, you are required by Radio Law of Japan to follow the instructions below with respect to this product:

1. Use this product 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 this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or
3. Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product. Also, please do not transfer this product, unless you give the same notice above to the transferee. Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

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EVALUATION BOARD/KIT/MODULE (EVM)
WARNINGS, RESTRICTIONS AND DISCLAIMERS

For Feasibility Evaluation Only, in Laboratory/Development Environments. Unless otherwise indicated, this EVM is not a finished electrical equipment and not intended for consumer use. It is intended solely for use for preliminary feasibility evaluation in laboratory/development environments by technically qualified electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems and subsystems. It should not be used as all or part of a finished end product.

Your Sole Responsibility and Risk. You acknowledge, represent and agree that:

1. You have unique knowledge concerning Federal, State and local regulatory requirements (including but not limited to Food and Drug Administration regulations, if applicable) which relate to your products and which relate to your use (and/or that of your employees, affiliates, contractors or designees) of the EVM for evaluation, testing and other purposes.
2. You have full and exclusive responsibility to assure the safety and compliance of your products with all such laws and other applicable regulatory requirements, and also to assure the safety of any activities to be conducted by you and/or your employees, affiliates, contractors or designees, using the EVM. Further, you are responsible to assure 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.
3. Since the EVM is not a completed product, it may not meet all applicable regulatory and safety compliance standards (such as UL, CSA, VDE, CE, RoHS and WEEE) which may normally be associated with similar items. You assume full responsibility to determine and/or assure compliance with any such standards and related certifications as may be applicable. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.
4. You will take care of proper disposal and recycling of the EVM's electronic components and packing materials.

Certain Instructions. It is important to operate this EVM within TI's recommended specifications and environmental considerations per the user guidelines. Exceeding the specified EVM ratings (including but not limited to input and output voltage, current, power, and environmental ranges) may cause property damage, personal injury or death. If there are questions concerning these ratings please 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 result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM User's 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, some circuit components may have case temperatures greater than 60°C as long as the input and output are maintained at a normal ambient operating temperature. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors which can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during normal operation, please be aware that these devices may be very warm to the touch. As with all electronic evaluation tools, only qualified personnel knowledgeable in electronic measurement and diagnostics normally found in development environments should use these EVMs.

Agreement to Defend, Indemnify and Hold Harmless. You agree to 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 use of the EVM that is not in accordance with the terms of the agreement. This obligation shall apply whether Claims arise under law of tort or contract or any other legal theory, and even if the EVM fails to perform as described or expected.

Safety-Critical or Life-Critical Applications. If you intend to evaluate the components for possible use in safety critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, such as devices which are classified as FDA Class III or similar classification, then you must specifically notify TI of such intent and enter into a separate Assurance and Indemnity Agreement.

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