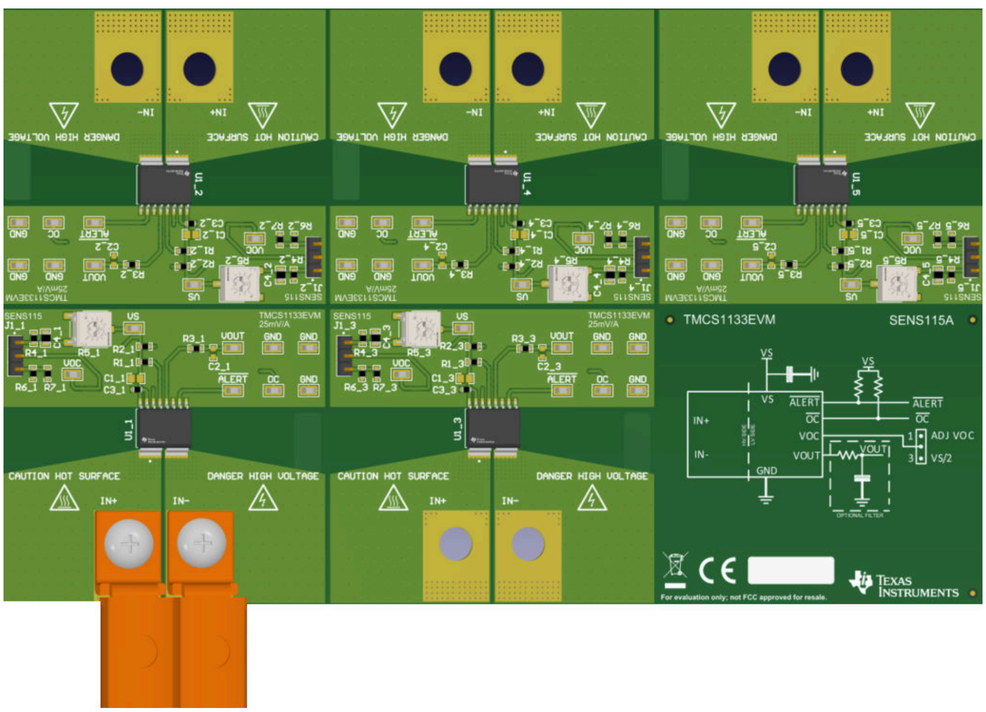
EVM User's Guide: TMCS1133AEVM TMCS1133BEVM TMCS1133CEVM
TMCS1133x Evaluation Module

Description

The TMCS1133EVM evaluation module (EVM) is intended to facilitate rapid, convenient use of the TMCS1133, an isolated hall-effect precision current sense monitor using an internal reference. This EVM allows the user push the maximum operating current through the hall-input side while measuring the isolated output through a reinforced isolation barrier. The fixture layout is not intended as a model for the target circuit, nor is the fixture layout laid out for electromagnetic (EMI) testing. The TMCS1133EVM consists of a single PCB, breakable into 5 individual pieces. allowing the user to test all sensitivity variations of a single quiescent point (A = 2.5 V, B = 1.65 V, or C = 0.33 V).

Features

- Evaluation of the TMCS1133 in all gain options
- Test points to allow ease of access to device pins
- Large copper planes to help with heat dissipation
- Large lug connectors to connect the EVM to large current carrying leads



1 Evaluation Module Overview

1.1 Introduction

This user's guide describes the characteristics, operation, and use of the TMCS1133 evaluation module (EVM). This EVM is designed to evaluate the performance of the TMCS1133 voltage output isolated Hall-effect current sense amplifiers in a variety of configurations. Throughout this document, the terms evaluation board, evaluation module, and EVM are synonymous with the TMCS1133xEVM. This document includes a schematic, reference printed-circuit board (PCB) layouts, and a complete bill of materials (BOM).

The TMCS1133 Hall-effect current sense amplifier (also called an isolated current-sense amplifier) senses magnetic flux generated from current passing through the lead frame at common-mode voltages from 0 V_{DC} to ±1100 V_{DC}, independent of the supply voltage. The device is available with zero-input reference point configurations of 2.5 V (A), 1.65 V (B), and 0.33 V (C), with fixed sensitivities available: 25 mV/A, 33 mV/A, 50 mV/A, 75 mV/A, 100 mV/A, and 150 mV/A. These devices operate from a single 3-V to 5.5-V power supply, drawing a maximum of 9.2 mA of supply current. The TMCS1133 is currently available in a 10-pin, SOIC, fused lead, surface-mount package. Table 1-1 lists the available sensitivity options.

Table 1-1. TMCS1133 Device Summary

Product	Zero Current Output Voltage	Sensitivity
TMCS1133A1A	2.5 V	25 mV/A
TMCS1133A2A	2.5 V	50 mV/A
TMCS1133A3A	2.5 V	75 mV/A
TMCS1133A4A	2.5 V	100 mV/A
TMCS1133A5A	2.5 V	150 mV/A
TMCS1133B1A	1.65 V	25 mV/A
TMCS1133B8A	1.65 V	33 mV/A
TMCS1133B2A	1.65 V	50 mV/A
TMCS1133B3A	1.65 V	75 mV/A
TMCS1133B4A	1.65 V	100 mV/A
TMCS1133B5A	1.65 V	150 mV/A
TMCS1133C1A	0.33 V	25 mV/A
TMCS1133C2A	0.33 V	50 mV/A
TMCS1133C3A	0.33 V	75 mV/A
TMCS1133C4A	0.33 V	100 mV/A
TMCS1133C5A	0.33 V	150 mV/A

1.2 Kit Contents

Table 1-2 lists the contents of the TMCS1133xEVM kit. Contact the nearest Texas Instruments Customer Support Center if any component is missing. TI highly recommends checking the TMCS1133 family product folder on the TI website at www.ti.com for further information regarding this product.

Table 1-2. TMCS1133xEVM Kit Contents

Item	Quantity
TMCS1133xEVM Test Board	1

1.3 Specification

The following are instructions to set up and use the TMCS1133xEVM. Figure 1-1 shows an example of a simple, low-side setup on the A1 (25 mV/A) sensitivity variant. This device has isolation, and external supplies are distinguished by *high voltage* (HV) for load and *low voltage* (LV) for DUT supply. The HV supply can be isolated and at a different potential than the LV supply.

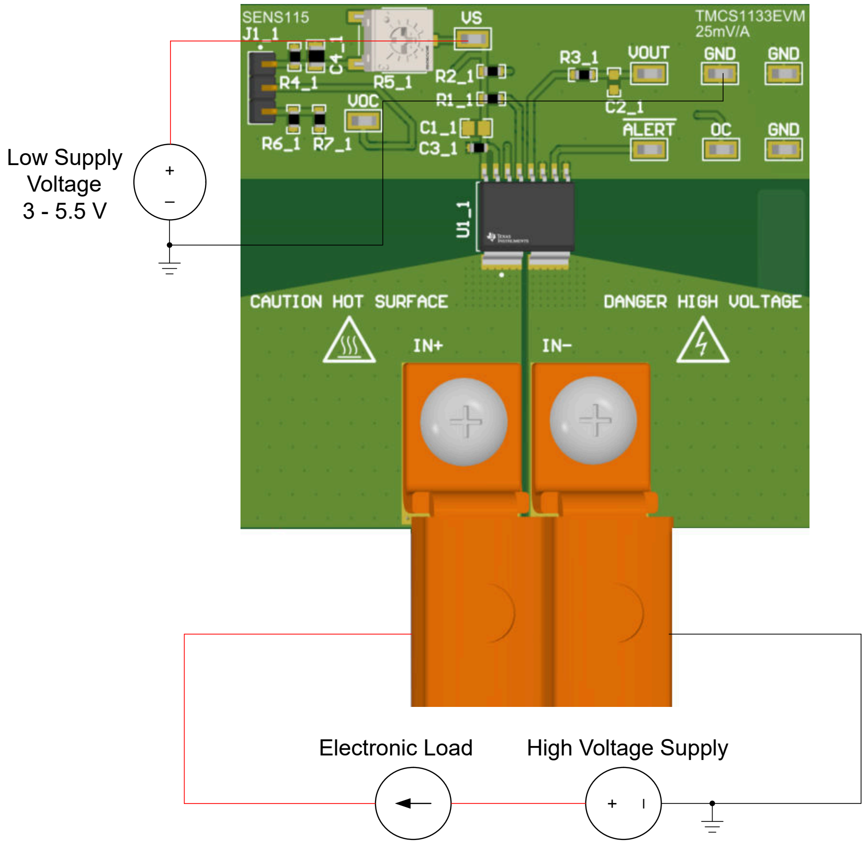


Figure 1-1. Low-Side Forward Current Setup for Reinforced Isolation

1. For greater maneuverable flexibility, break apart the EVM sub boards along the score lines. Otherwise, the board can be left intact.
2. Attach the high-current lug connectors to IN+ and IN– of the sensitivity version to be tested.
3. Connect the terminals of an external LV supply to the GND and VCC test points on the EVM sensitivity variant of choice. Be sure to connect GND first and make sure that the external LV supply is between 3 V and 5.5 V.
4. Connect the input per Section 2.6.

WARNING

When measuring current, first make sure that equipment (wires, connectors, etc.) can support the amperage and power dissipation. Secondly, make sure that current flowing through the inputs of the device is kept within the safe operating area limits of the device found in the TMCS1133 data sheet. Failure to do so can result in damage to the EVM, or personal injury.

Do not touch the HV terminals

Hot surface. Contact can cause burns. Do not touch!

1.4 Device Information

The TMCS1133 is an isolated, hall-effect based current-sense amplifier that provides ease-of-use and high performance. The TMCS1133xEVM is a family of EVMs intended to provide basic, functional evaluation of all TMCS1133 sensitivity variants. The TMCS1133xEVMs are not laid out for electromagnetic compatibility (EMC) testing. The TMCS1133xEVM family consists of three separate orderable PCBs that can be snapped apart into five individual segments, with each segment populated with a separate sensitivity. Each PCB allows testability of all sensitivity variants across one of the three orderable reference points of 2.5 V (TMCS1133AEVM), 1.65 V (TMCS1133BEVM), or 0.33 V (TMCS1133CEVM). Across all EVM variants, the parts that can be examined with the EVM consist of:

- TMCS1133A1A
- TMCS1133A2A
- TMCS1133A3A
- TMCS1133A4A
- TMCS1133A5A
- TMCS1133B1A
- TMCS1133B8A
- TMCS1133B2A
- TMCS1133B3A
- TMCS1133B4A
- TMCS1133B5A
- TMCS1133C1A
- TMCS1133C2A
- TMCS1133C3A
- TMCS1133C4A
- TMCS1133C5A

1.5 General Texas Instruments High Voltage Evaluation (TI HV EVM) User Safety Guidelines

WARNING

Always follow TI’s setup and application instructions, including use of all interface components within their recommended electrical rated voltage and power limits. Always use electrical safety precautions to help make sure of your personal safety and those working around you. Contact TI's Product Information Center http://support/ti./com for further information.

Save all warnings and instructions for future reference.

> **WARNING**
>
> Failure to follow warnings and instructions can result in personal injury, property damage or death due to electrical shock and burn hazards.

The term TI HV EVM refers to an electronic device typically provided as an open framed, unenclosed printed circuit board assembly. It is *intended strictly for use in development laboratory environments, solely for qualified professional users having training, expertise and knowledge of electrical safety risks in development and application of high voltage electrical circuits. Any other use and/or application are strictly prohibited by Texas Instruments.* If you are not suitably qualified, then immediately stop from further use of the HV EVM.

1. Work Area Safety
   a. Keep work area clean and orderly.
   b. Qualified observers must be present anytime circuits are energized.
   c. Effective barriers and signage must be present in the area where the TI HV EVM and the interface electronics are energized, indicating operation of accessible high voltages can be present, for the purpose of protecting inadvertent access.
   d. All interface circuits, power supplies, evaluation modules, instruments, meters, scopes and other related apparatus used in a development environment exceeding 50Vrms/75VDC must be electrically located within a protected Emergency Power Off EPO protected power strip.
   e. Use stable and nonconductive work surface.
   f. Use adequately insulated clamps and wires to attach measurement probes and instruments. No freehand testing whenever possible.
2. Electrical Safety
   As a precautionary measure, a good engineering practice is to assume that the entire EVM can have fully accessible and active high voltages.
   a. De-energize the TI HV EVM and all the inputs, outputs and electrical loads before performing any electrical or other diagnostic measurements. Revalidate that TI HV EVM power has been safely de-energized.
   b. With the EVM confirmed de-energized, proceed with required electrical circuit configurations, wiring, measurement equipment connection, and other application needs, while still assuming the EVM circuit and measuring instruments are electrically live.
   c. After EVM readiness is complete, energize the EVM as intended.

> **WARNING**
>
> While the EVM is energized, never touch the EVM or the electrical circuits, as the EVM or the electrical circuits can be at high voltages capable of causing electrical shock hazard.

3. Personal Safety
   a. Wear personal protective equipment (for example, latex gloves or safety glasses with side shields) or protect EVM in an adequate lucent plastic box with interlocks to protect from accidental touch.

Limitation for safe use:

EVMs are not to be used as all or part of a production unit.

2 Hardware

2.1 Bypass Capacitors

C1_x and C3_x are 10-µF and 0.1-µF supply bypass capacitors, respectively, for the TMCS1133. These devices are present to help smooth the supply voltage of the TMCS1133. By default, the 10-µF is depopulated, but can be populated for evaluating potentially extremely noisy supplies.

2.2 Output Filter

C2_x and R2_x are footprints for the optional output filter. Default values are 10 pF and 0 Ω, but no capacitors are installed.

2.3 Overcurrent Set Point and Overcurrent Circuitry

J1_x is a 1x3 header that allows the user to customize the input voltage reference of the overcurrent set point in a number of ways. Configuration options available include:

1. *Short J1_x pins 1 and 2 with the supplied shorting plug:* This provides the reference point with a voltage set via the potentiometer R5_x. R4_x is a 5.6kΩ resistor that forms a voltage divider with potentiometer that provides an output voltage by the following equations:

$$V_{OC} = \frac{R_4}{R_{POT} + R_4} \times V_S \tag{1}$$

$$\text{for } R_{POT,\ max},\ V_S = 5.5V,\ \ V_{OC} = \frac{R_4}{R_{POT} + R_4} \times V_S = \frac{5.60k\Omega}{100k\Omega + 5.60k\Omega} \times 5.5V = 0.291V \approx 0.3V \tag{2}$$

$$\text{for } R_{POT,\ min},\ V_S = 5.5V,\ \ V_{OC} = \frac{5.60k\Omega}{1k\Omega + 5.60k\Omega} \times V_S = 0.85 \times V_S \tag{3}$$

   The presence of the 5.6kΩ resistor keeps the minimum output voltage available at ≅0.3 V for the maximum device supply voltage of 5.5V. This provides a quick method on board for analyzing nearly the entire voltage range of VOC. Check VOC with a digital multimeter (DMM) for the desired voltage, adjusting R_{POT} higher or lower until the desired voltage is achieved.
2. *Short J1_x pins 2 and 3 with the supplied shorting plug:* This provides the reference point with the voltage produced by a resistor divider formed between R6_x and R7_x. This resistor divider is set to approx. 90% of V_S by default by the following equation, but can be customized for evaluation between any resistor pair in 0805 package within data sheet specifications.

$$V_{OC} = \frac{R_6}{R_6 + R_7} \times V_S = \frac{88.7k\Omega}{98.7k\Omega} \times V_S = 0.9 \times V_S \tag{4}$$

3. *Do not populate the shorting plug:* By not populating the shorting plug, the reference input VOC remains floating from any hardwired PCB input. This node can then be driven directly by the *VOC* test point on the board to directly drive specific external voltage the user can consider in their application.

The point set by any of the above methods is presented to an internal comparator, which is constantly monitored against the output voltage VOUT. In the event that VOUT > VOC, the active low nOC pin activates, pulling low to indicate that the system has reached the overcurrent point. Resistor R1_x acts as the pull up resistor for the active low nOC node.

2.4 Load Connectors

The input connectors labeled IN+_x and IN-_x correspond to the high-current rated load connectors supplied with the EVM. By default, the EVM is only populated with two of these connectors on the lowest sensitivity variant (A1, B1, or C1). These components are screwed to the board to make contact, and can be easily moved to the desired sensitivity option for test purposes. The fused lead frame inputs (pins 1 and 2 of the unit under test) accept a load that is converted to a magnetic field sensed by a Hall element that produces a voltage. This voltage is amplified by the selected device sensitivity and is presented at the VOUT test point. The acceptable load input maximum for the included connectors is 90 A for DC measurements. However, the continuous allowable load is bounded by the safe operating area (SOA) described in the TMCS1133 data sheet.

2.5 TMCS1133 Isolated Current-Sense Amplifier

U1_x is the TMCS1133 isolated current-sense amplifier. The TMCS1133xEVM board is divided into five detachable segments. Each segment is populated with one of the available device sensitivities for the chosen operating point A, B, or C. This configuration enables users to test all possible variants of the devices to determine the best sensitivity setting for a given application.

- A magnetic field is generated based on the load current that is connected across the inputs IN+_x and IN-_x, and flows through the TMCS1133 leadframe.
- The output voltage swing limitation and required load current sensing range are the key factors when determining device selection.
- The selected device must allow the output voltage to remain within the acceptable range after the load current is transduced and amplified by the respective device sensitivity. The max output voltage must remain within the range of 10 mV above ground to 100 mV below the supply voltage.
- Choose an appropriate sensitivity to create the largest appropriate output swing, and to minimize error.

2.6 Measurements

The following procedures are used to configure a measurement evaluation with an electronic load.

2.6.1

1. As illustrated in Figure 1-1, for a low-side measurement, connect the electronic load positive input terminal to the positive terminal of a supply capable of sourcing the desired amount of maximum load current. For a high-side measurement, connect the electronic load positive input terminal to the load sourcing terminal (IN+ or IN–) of the EVM. For high-side measurement of forward current, IN– sources to the electronic load; for reverse current, IN+ sources to the load.
2. Connect the electronic load negative output terminal to the external supply GND terminal for high-side measurements, or to the load sinking terminal of the EVM for low-side measurements.
3. For high-side measurements, connect the external supply to the load sinking terminal of the EVM. Otherwise, for low-side measurements, connect the load sourcing terminal of the EVM (IN+ or IN–) to the external supply GND.
4. Turn on all the connected supplies.
5. Apply load with electronic load or actual system load.
6. Measure the output voltage at the VOUT test point.

Note

The output voltage is equal to the sensitivity of the device multiplied by the load current passing through the leadframe of the DUT.

2.6.2 Advanced Measurement Tips

To assess whether the expected load matches the measured load, use a precision shunt resistor rated for the maximum intended current in series with the DUT. The precision shunt has a kelvin connection where the generated sense voltage can be measured by a precision multimeter, such as the 3458a multimeter. Sensing an external shunt voltage is preferred, as a typical multimeter can have a current limit far below the needed current measurement limits in question. Additionally, some meters have better voltage measurement precision than current measurement precision.

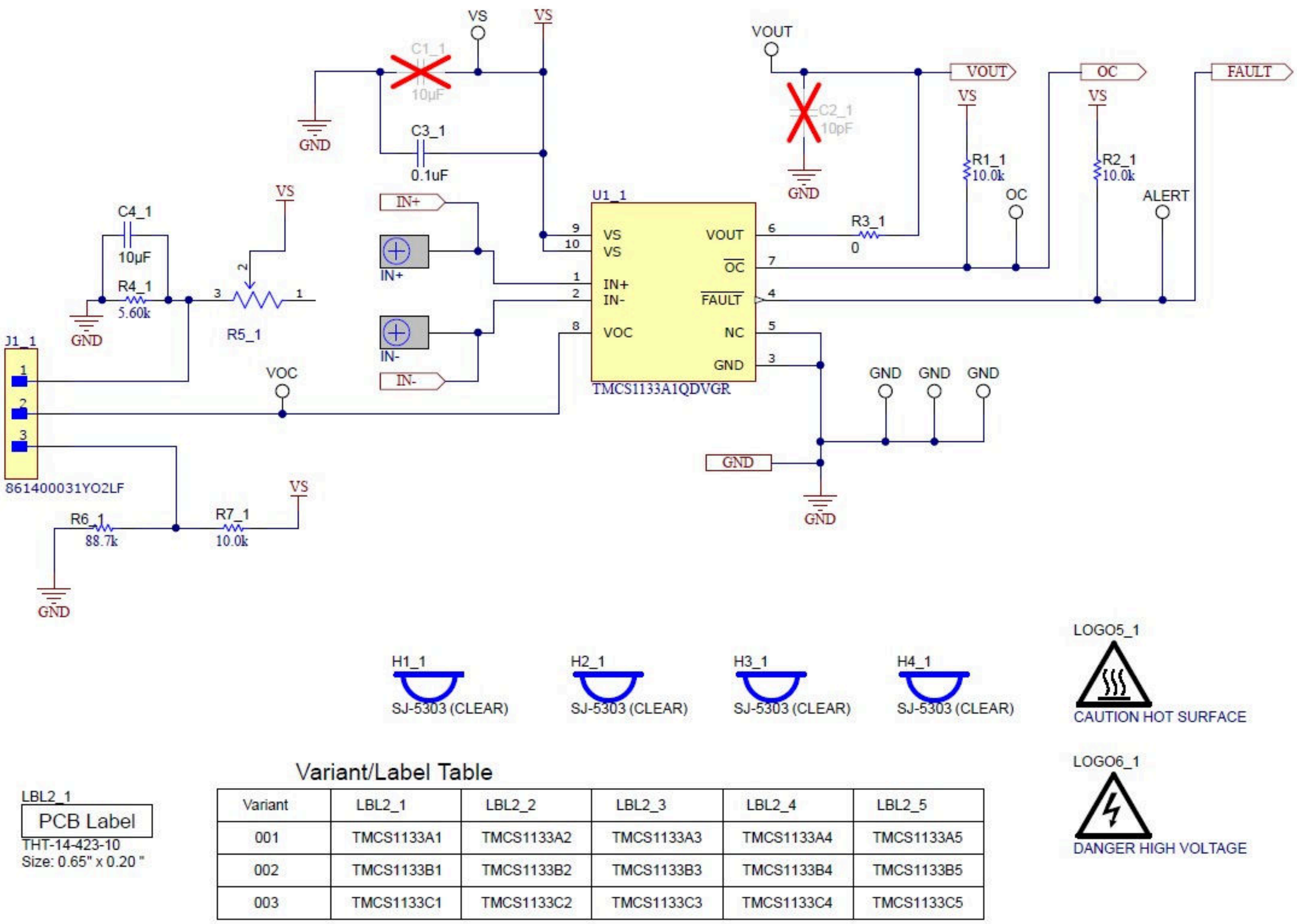
For evaluating performance when the DUT is subjected to quick current pulses, use short, large-gauge wire, or short bus bars, to reduce the inductance and resistance between the HV-supply, load, and EVM. By minimizing the inductance, the rate of load slew can be increased. If assessing the performance over large transient current spikes (>20 A) is desired, then be sure to use a supply with sufficient voltage headroom to accommodate the series resistance of the wires/bus bars, board planes, and DUT lead frame resistance. A large capacitor bank between the supply terminals must be used to make sure there is an adequate charge reservoir available to prevent the supply from drooping and helping supply the large current inrush through the device.

If assessing temperature performance is desired, then use wide, thin bus bars to reduce the thermal sinking ability of the system and minimize the inductance of the system. Board temperature is not an exact indicator of DUT temperature. More precise measurements can be obtained by placing a layer of thermally conductive grease on top of the DUT package and placing a thermal sensor directly on the thermal grease. See Thermal Implementation Guide for In-Package Magnetic Current Sensors for additional information and for details regarding thermal best practices.

3 Hardware Design Files

3.1 Schematics

Figure 3-1 shows the schematic of the A1 sub board on the TMCS1133AEVM PCB. Only the schematic for the A1 (25 mV/A) sensitivity variant is demonstrated in this document, as all variants use the same circuit and same PCB layout. Only U1 changes from board to board. All components associated with the 25-mV/A sensitivity variants have the nomenclature "_1" appended at the end. The 50-mV/A sensitivity variants have "_2" appended, the 75-mV/A sensitivity variants have "_3" appended, the 100-mV/A sensitivity variants have "_4" appended, and the 150-mV/A sensitivity variants have "_5" appended.



Variant	LBL2_1	LBL2_2	LBL2_3	LBL2_4	LBL2_5
001	TMCS1133A1	TMCS1133A2	TMCS1133A3	TMCS1133A4	TMCS1133A5
002	TMCS1133B1	TMCS1133B2	TMCS1133B3	TMCS1133B4	TMCS1133B5
003	TMCS1133C1	TMCS1133C2	TMCS1133C3	TMCS1133C4	TMCS1133C5

Figure 3-1. Schematic for A1 Device

3.2 PCB Layout

Figure 3-2 through Figure 3-5 illustrate the PCB layers of the TMCS1133xEVM.

Note

Board layouts are not to scale. These figures are intended to show how the board is laid out. The figures are not intended to be used for manufacturing TMCS1133xEVM PCBs.

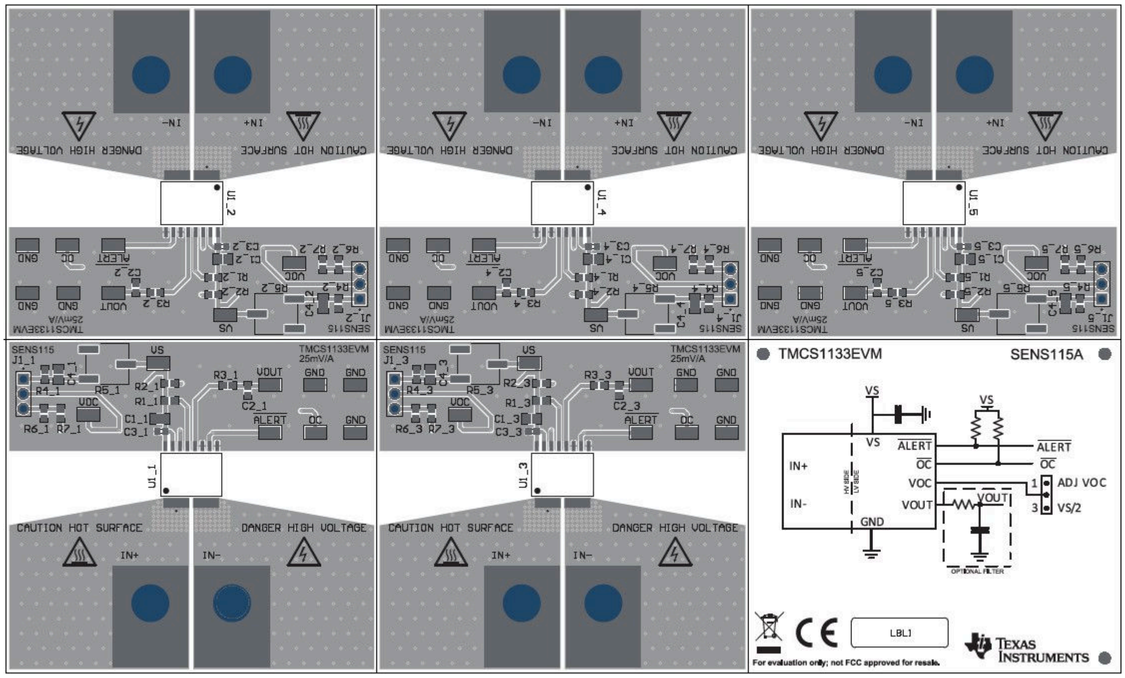


Figure 3-2. Top Overlay

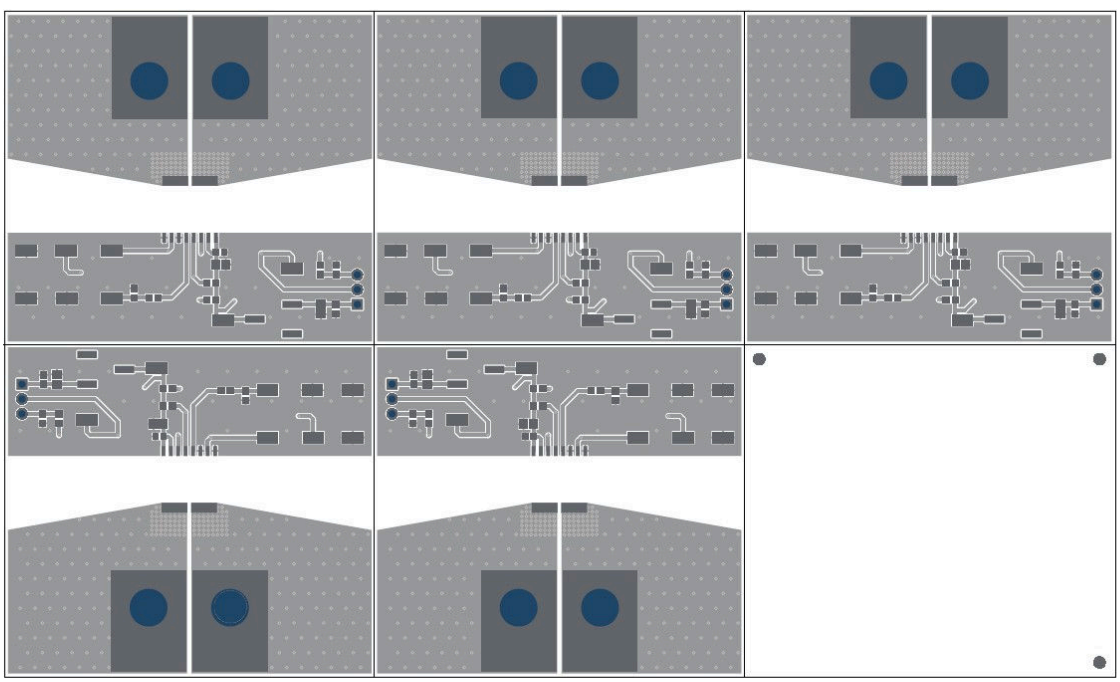


Figure 3-3. Top Layer

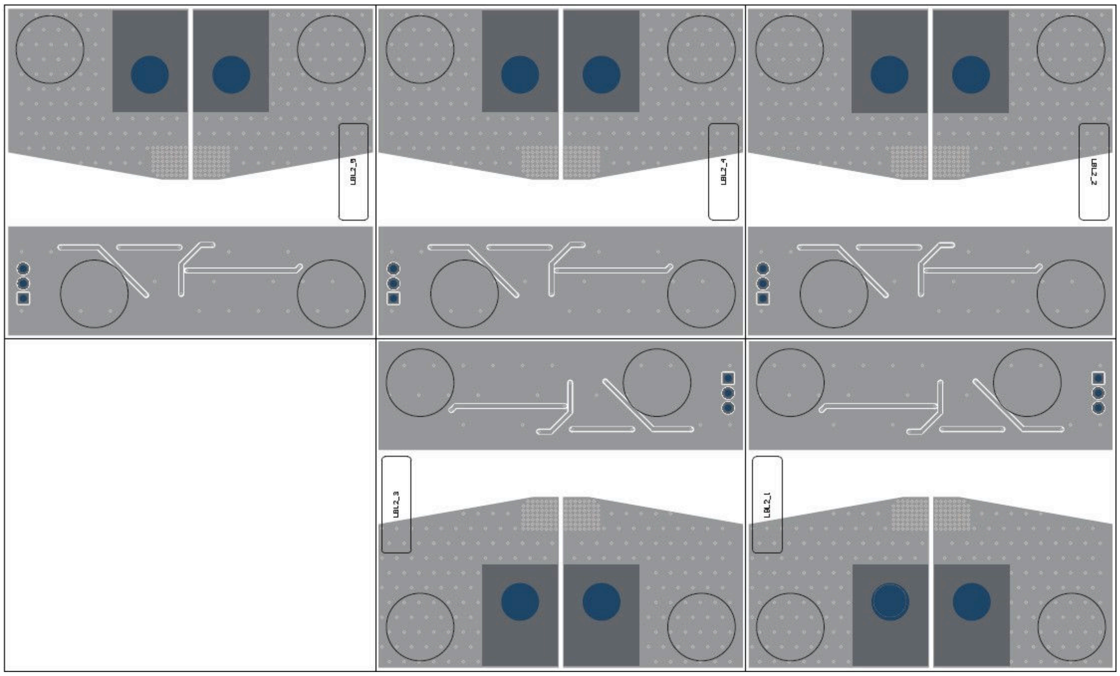


Figure 3-4. Bottom Overlay

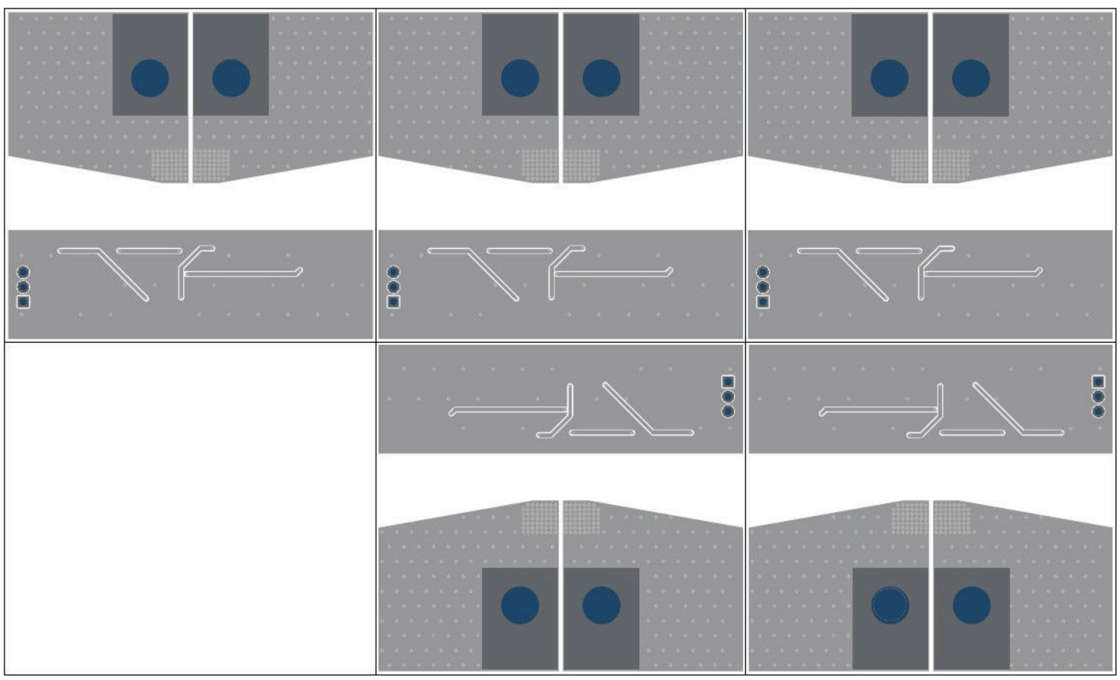


Figure 3-5. Bottom Layer

3.3 Bill of Materials

Table 3-1. Bill of Materials for TMCS1133AEVM

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
C3_1, C3_2, C3_3, C3_4, C3_5	5	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0603	0603	06035C104KAT2A	AVX
C4_1, C4_2, C4_3, C4_4, C4_5	5	10uF	CAP, CERM, 10 uF, 10 V, +/- 10%, X7R, 0805	0805	C2012X7R1A106K125AC	TDK
TP1_1, TP1_2, TP1_3, TP1_4, TP1_5, TP2_1, TP2_2, TP2_3, TP2_4, TP2_5, TP3_1, TP3_2, TP3_3, TP3_4, TP3_5, TP4_1, TP4_2, TP4_3, TP4_4, TP4_5, TP5_1, TP5_2, TP5_3, TP5_4, TP5_5, TP6_1, TP6_2, TP6_3, TP6_4, TP6_5, TP7_1, TP7_2, TP7_3, TP7_4, TP7_5, TP8_1, TP8_2, TP8_3, TP8_4, TP8_5	4		Test Point, Miniature, SMT	Testpoint_Keystone_Miniature	5015	Keystone, Keystone Electronics
H1_1, H1_2, H1_3, H1_4, H1_5, H2_1, H2_2, H2_3, H2_4, H2_5, H3_1, H3_2, H3_3, H3_4, H3_5, H4_1, H4_2, H4_3, H4_4, H4_5	2		Bumpon, Hemisphere, 0.44 X 0.20, Clear	Transparent Bumpon	SJ-5303 (CLEAR)	3M
H5, H6, H7, H8, H9	5		JUMPER W/TEST PNT 1X2PINS 2.54MM		60900213421	Würth Elektronik
T1_1, T2_1	2		Terminal 90 A Lug	CB70-14-CY	CB70-14-CY	Panduit
J1_1, J1_2, J1_3, J1_4, J1_5	5		Connector Header Through Hole 3 position 0.100" (2.54mm)	HDR3	861400031YO2LF	Amphenol ICC
LBL1, LBL2_1, LBL2_2, LBL2_3, LBL2_4, LBL2_5	6		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch	THT-14-423-10	Brady
R1_1, R1_2, R1_3, R1_4, R1_5, R2_1, R2_2, R2_3, R2_4, R2_5, R7_1, R7_2, R7_3, R7_4, R7_5	15	10.0k	RES, 10.0 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	CRCW080510K0FKEA	Vishay-Dale
R3_1, R3_2, R3_3, R3_4, R3_5	5	0	RES, 0, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	RMCF0603ZT0R00	Stackpole Electronics Inc

Table 3-1. Bill of Materials for TMCS1133AEVM (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
R4_1, R4_2, R4_3, R4_4, R4_5	5	5.60k	RES, 5.60 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	ERJ3EKF5601V	Panasonic
R5_1, R5_2, R5_3, R5_4, R5_5	5	100k	100 kOhms 0.5W, 1/2W Gull Wing Surface Mount Trimmer Potentiometer Cermet 1.0 Turn Top Adjustment	SMT3_6MM71_7MM04	3361P-1-104GLF	Bourns
R6_1, R6_2, R6_3, R6_4, R6_5	5	88.7 k	RES, 88.7 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060388K7FKEA	Vishay-Dale
U1_1	1		TMCS1133A1QDVGR	SOIC10	TMCS1133A1QDVGR	Texas Instruments
U1_2	1		TMCS1133A2QDVGR	SOIC10	TMCS1133A2QDVGR	Texas Instruments
U1_3	1		TMCS1133A3QDVGR	SOIC10	TMCS1133A3QDVGR	Texas Instruments
U1_4	1		TMCS1133A4QDVGR	SOIC10	TMCS1133A4QDVGR	Texas Instruments
U1_5	1		TMCS1133A5QDVGR	SOIC10	TMCS1133A5QDVGR	Texas Instruments
C1_1, C1_2, C1_3, C1_4, C1_5	0	10uF	CAP, CERM, 10 uF, 10 V, +/- 10%, X7R, 0805	0805	C2012X7R1A106K125AC	TDK
C2_1, C2_2, C2_3, C2_4, C2_5	0	10 pF	CAP, CERM, 10 pF, 10 V, +/- 10%, X7R, 0603	0603	0603ZC100KAT2A	AVX
T1_2, T1_3, T1_4, T1_5, T2_2, T2_3, T2_4, T2_5	0		Terminal 90 A Lug	CB70-14-CY	CB70-14-CY	Panduit

Table 3-2. Bill of Materials for TMCS1133BEVM

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
C3_1, C3_2, C3_3, C3_4, C3_5	5	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0603	0603	06035C104KAT2A	AVX
C4_1, C4_2, C4_3, C4_4, C4_5	5	10uF	CAP, CERM, 10 uF, 10 V, +/- 10%, X7R, 0805	0805	C2012X7R1A106K125AC	TDK
TP1_1, TP1_2, TP1_3, TP1_4, TP1_5, TP2_1, TP2_2, TP2_3, TP2_4, TP2_5, TP3_1, TP3_2, TP3_3, TP3_4, TP3_5, TP4_1, TP4_2, TP4_3, TP4_4, TP4_5, TP5_1, TP5_2, TP5_3, TP5_4, TP5_5, TP6_1, TP6_2, TP6_3, TP6_4, TP6_5, TP7_1, TP7_2, TP7_3, TP7_4, TP7_5, TP8_1, TP8_2, TP8_3, TP8_4, TP8_5	40		Test Point, Miniature, SMT	Testpoint_Keystone_Miniature	5015	Keystone, Keystone Electronics
H1_1, H1_2, H1_3, H1_4, H1_5, H2_1, H2_2, H2_3, H2_4, H2_5, H3_1, H3_2, H3_3, H3_4, H3_5, H4_1, H4_2, H4_3, H4_4, H4_5	20		Bumpon, Hemisphere, 0.44 X 0.20, Clear	Transparent Bumpon	SJ-5303 (CLEAR)	3M
H5, H6, H7, H8, H9	5		JUMPER W/TEST PNT 1X2PINS 2.54MM		60900213421	Würth Elektronik
T1_1, T2_1	2		Terminal 90 A Lug	CB70-14-CY	CB70-14-CY	Panduit
J1_1, J1_2, J1_3, J1_4, J1_5	5		Connector Header Through Hole 3 position 0.100" (2.54mm)	HDR3	861400031YO2LF	Amphenol ICC
LBL1, LBL2_1, LBL2_2, LBL2_3, LBL2_4, LBL2_5	6		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch	THT-14-423-10	Brady
R1_1, R1_2, R1_3, R1_4, R1_5, R2_1, R2_2, R2_3, R2_4, R2_5, R7_1, R7_2, R7_3, R7_4, R7_5	15	10.0k	RES, 10.0 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	CRCW080510K0FKEA	Vishay-Dale
R3_1, R3_2, R3_3, R3_4, R3_5	5	0	RES, 0, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	RMCF0603ZT0R00	Stackpole Electronics Inc

Table 3-2. Bill of Materials for TMCS1133BEVM (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
R4_1, R4_2, R4_3, R4_4, R4_5	5	5.60k	RES, 5.60 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	ERJ3EKF5601V	Panasonic
R5_1, R5_2, R5_3, R5_4, R5_5	5	100k	100 kOhms 0.5W, 1/2W Gull Wing Surface Mount Trimmer Potentiometer Cermet 1.0 Turn Top Adjustment	SMT3_6MM71_7MM04	3361P-1-104GLF	Bourns
R6_1, R6_2, R6_3, R6_4, R6_5	5	88.7 k	RES, 88.7 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060388K7FKEA	Vishay-Dale
U1_1	1		TMCS1133B1QDVGR	SOIC10	TMCS1133B1QDVGR	Texas Instruments
U1_2	1		TMCS1133B2QDVGR	SOIC10	TMCS1133B2QDVGR	Texas Instruments
U1_3	1		TMCS1133B3QDVGR	SOIC10	TMCS1133B3QDVGR	Texas Instruments
U1_4	1		TMCS1133B4QDVGR	SOIC10	TMCS1133B4QDVGR	Texas Instruments
U1_5	1		TMCS1133B5QDVGR	SOIC10	TMCS1133B5QDVGR	Texas Instruments
C1_1, C1_2, C1_3, C1_4, C1_5	0	10uF	CAP, CERM, 10 uF, 10 V, +/- 10%, X7R, 0805	0805	C2012X7R1A106K125AC	TDK
C2_1, C2_2, C2_3, C2_4, C2_5	0	10 pF	CAP, CERM, 10 pF, 10 V, +/- 10%, X7R, 0603	0603	0603ZC100KAT2A	AVX
T1_2, T1_3, T1_4, T1_5, T2_2, T2_3, T2_4, T2_5	0		Terminal 90 A Lug	CB70-14-CY	CB70-14-CY	Panduit

Table 3-3. Bill of Materials for TMCS1133CEVM

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
C3_1, C3_2, C3_3, C3_4, C3_5	5	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0603	0603	06035C104KAT2A	AVX
C4_1, C4_2, C4_3, C4_4, C4_5	5	10uF	CAP, CERM, 10 uF, 10 V, +/- 10%, X7R, 0805	0805	C2012X7R1A106K125AC	TDK
TP1_1, TP1_2, TP1_3, TP1_4, TP1_5, TP2_1, TP2_2, TP2_3, TP2_4, TP2_5, TP3_1, TP3_2, TP3_3, TP3_4, TP3_5, TP4_1, TP4_2, TP4_3, TP4_4, TP4_5, TP5_1, TP5_2, TP5_3, TP5_4, TP5_5, TP6_1, TP6_2, TP6_3, TP6_4, TP6_5, TP7_1, TP7_2, TP7_3, TP7_4, TP7_5, TP8_1, TP8_2, TP8_3, TP8_4, TP8_5	40		Test Point, Miniature, SMT	Testpoint_Keystone_Miniature	5015	Keystone, Keystone Electronics
H1_1, H1_2, H1_3, H1_4, H1_5, H2_1, H2_2, H2_3, H2_4, H2_5, H3_1, H3_2, H3_3, H3_4, H3_5, H4_1, H4_2, H4_3, H4_4, H4_5	20		Bumpon, Hemisphere, 0.44 X 0.20, Clear	Transparent Bumpon	SJ-5303 (CLEAR)	3M
H5, H6, H7, H8, H9	5		JUMPER W/TEST PNT 1X2PINS 2.54MM		60900213421	Würth Elektronik
IN-1_1, IN+1_1	2		Terminal 90 A Lug	CB70-14-CY	CB70-14-CY	Panduit
J1_1, J1_2, J1_3, J1_4, J1_5	5		Connector Header Through Hole 3 position 0.100" (2.54mm)	HDR3	861400031YO2LF	Amphenol ICC
LBL1, LBL2_1, LBL2_2, LBL2_3, LBL2_4, LBL2_5	6		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch	THT-14-423-10	Brady
R1_1, R1_2, R1_3, R1_4, R1_5, R2_1, R2_2, R2_3, R2_4, R2_5	10	10.0k	RES, 10.0 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	CRCW080510K0FKEA	Vishay-Dale
R3_1, R3_2, R3_3, R3_4, R3_5	5	0	RES, 0, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	RMCF0603ZT0R00	Stackpole Electronics Inc

Table 3-3. Bill of Materials for TMCS1133CEVM (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
R4_1, R4_2, R4_3, R4_4, R4_5	5	5.60k	RES, 5.60 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	ERJ3EKF5601V	Panasonic
R5_1, R5_2, R5_3, R5_4, R5_5	5	100k	100 kOhms 0.5W, 1/2W Gull Wing Surface Mount Trimmer Potentiometer Cermet 1.0 Turn Top Adjustment	SMT3_6MM71_7MM04	3361P-1-104GLF	Bourns
R6_1, R6_2, R6_3, R6_4, R6_5	5	88.7 k	RES, 88.7 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060388K7FKEA	Vishay-Dale
U1_1	1		TMCS1133C1QDVGR	SOIC10	TMCS1133C1QDVGR	Texas Instruments
U1_2	1		TMCS1133C2QDVGR	SOIC10	TMCS1133C2QDVGR	Texas Instruments
U1_3	1		TMCS1133C3QDVGR	SOIC10	TMCS1133C3QDVGR	Texas Instruments
U1_4	1		TMCS1133C4QDVGR	SOIC10	TMCS1133C4QDVGR	Texas Instruments
U1_5	1		TMCS1133C5QDVGR	SOIC10	TMCS1133C5QDVGR	Texas Instruments
C1_1, C1_2, C1_3, C1_4, C1_5	0	10uF	CAP, CERM, 10 uF, 10 V, +/- 10%, X7R, 0805	0805	C2012X7R1A106K125AC	TDK
C2_1, C2_2, C2_3, C2_4, C2_5	0	10 pF	CAP, CERM, 10 pF, 10 V, +/- 10%, X7R, 0603	0603	0603ZC100KAT2A	AVX
T1_2, T1_3, T1_4, T1_5, T2_2, T2_3, T2_4, T2_5	0		Terminal 90 A Lug	CB70-14-CY	CB70-14-CY	Panduit

4 Additional Information

Trademarks

All trademarks are the property of their respective owners.

5 Related Documentation

Table 5-1 provides literature references for TI's integrated circuits used in the assembly of the TMCS1133xEVM. This user's guide is available from the TI website under literature number SBAU423. Any letter appended to the literature number corresponds to the document revision that is current at the time of the writing of this document. Newer revisions are available from www.ti.com or the Texas Instruments' Literature Response Center at (800) 477-8924 or the Product Information Center at (972) 644-5580. When ordering, identify the document by both title and literature number.

Table 5-1. Related Documentation

document	Literature Number
TMCS1133 product data sheet	SBOSAG0