AMC-MOD-50A-EVM Evaluation Module

Description

The AMC-MOD-50A-EVM is an isolated current-sensing evaluation module designed for ±50A shunt-based current sensing. This EVM allows sensing up to ±50A peak current through an external shunt resistor while measuring the isolated output through the isolation barrier of the AMC1306M05. The AMC1306M05 is a high-precision, isolated modulator optimized for shunt-based current measurements and is paired with the Isabellenhütte™ BVN-M-R001 shunt resistor. This EVM features via stitching to facilitate heat dissipation at large currents and performs within ±1% (typical) accuracy.

Get Started

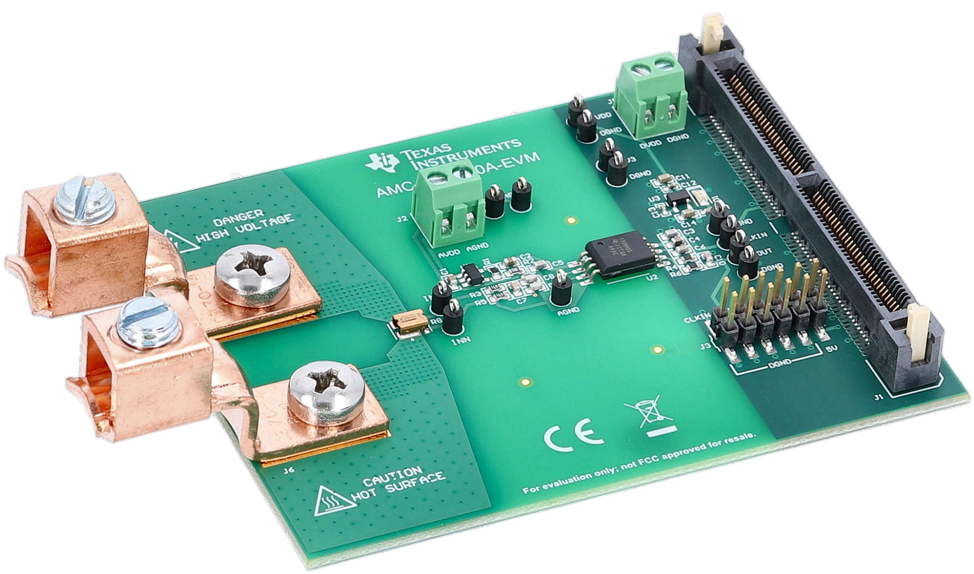
1. Order the AMC-MOD-50A-EVM on ti.com.
2. Download the comprehensive reference design files.
3. Evaluate performance on the bench.

Features

- ±50A isolated current sensing
- C2000 control card connector for digital evaluation
- Heat dissipation design up to 180°C at 2 minutes
- Lugs to connect the EVM to current carrying leads
- Test points for easy evaluation
- Additional shunt resistor footprint for flexible design

Applications

- Motor drives
- Power delivery
- Onboard chargers (OBCs)
- Traction inverters
- DC/DC converters
- Energy storage systems (ESS)
- EV charging
- Solar inverters



1 Evaluation Module Overview

1.1 Introduction

Throughout this document, the abbreviation *EVM* and the term *evaluation module* are synonymous with the AMC-MOD-50A-EVM. This document includes how to set up and evaluate the EVM, the printed circuit board (PCB) layout, schematics, and bill of materials (BOM).

1.2 Kit Contents

Table 1-1 details the contents included in the AMC-MOD-50A-EVM kit.

Table 1-1. AMC-MOD-50A-EVM Kit Contents

Item	Description	Quantity
AMC-MOD-50A-EVM	PCB	1
CB70-14-CY	Terminal 90A Lug	2
McMaster-Carr Hexnut	Hexnut	2
McMaster-Carr Phillips Screw	Screw	2

1.3 Specification

The AMC-MOD-50A-EVM provides the ability to evaluate high currents up to ±50A. See the AMC1306M05, TLV709A01DBVR, TPS73633DBVR, and BVN-M-R001 data sheets for detailed device specifications.

1.4 Device Information

The AMC-MOD-50A-EVM is designed to provide ease-of-use and high accuracy in large-current applications. The current-sensing device, AMC1306M05, is an isolated, reinforced delta-sigma modulator intended for shunt-based current sensing with an external clock and digital output. The AMC1306M05 senses current across the BVN-M-R001 shunt resistor. Overcurrent detection is configurable using a microcontroller through the C2000 control card connector. The EVM features an additional unpopulated shunt resistor footprint in parallel to extend the current-sensing range flexibility. See Section 2.7 for details. Included in the EVM kit are high-current lug connectors used for supplying primary current to be sensed by the EVM.

2 Hardware

This section summarizes the AMC-MOD-50A-EVM components, assembly instructions, interfaces, power requirements, test point information, and lug information.

2.1 Hardware Overview

Figure 2-1 shows the hardware labels for this EVM.

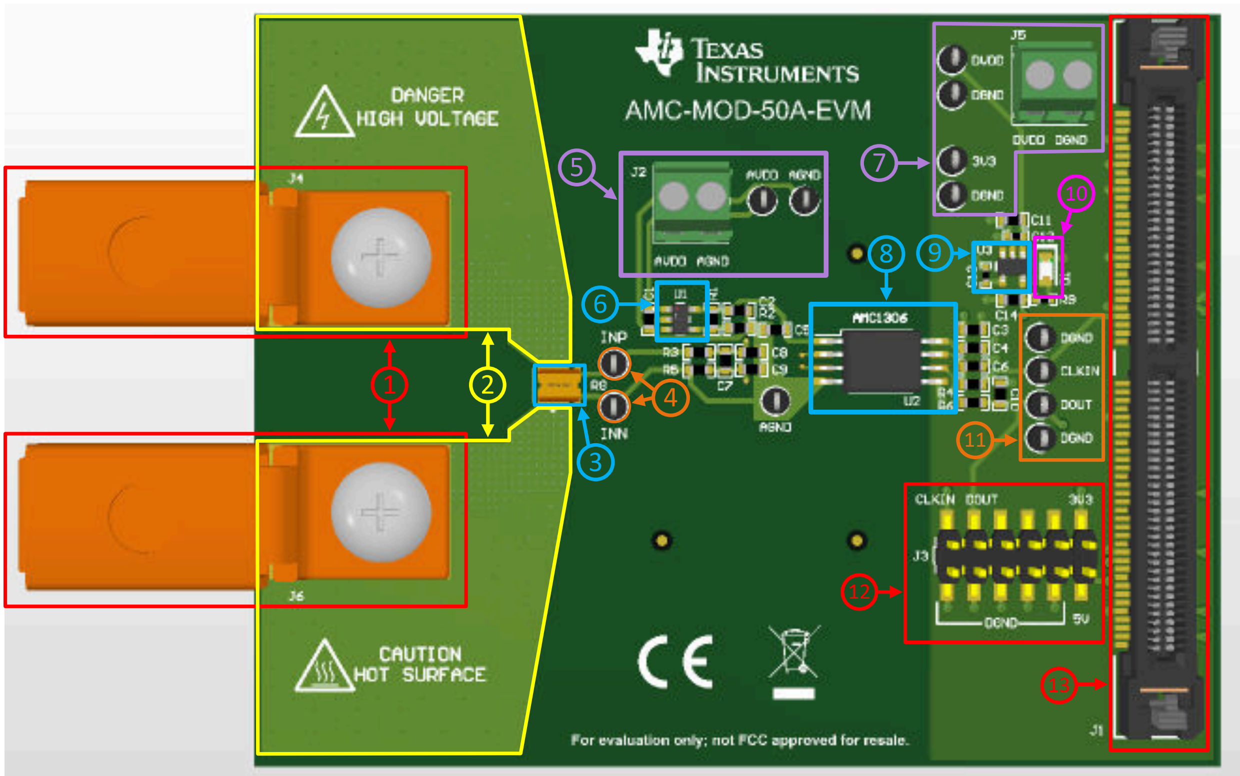


Figure 2-1. AMC-MOD-50A-EVM Hardware Labels

The AMC-MOD-50A-EVM has many hardware features, allowing the user to access and assess the EVM from many points in the signal chain. The default configuration is one 1mΩ shunt populated at R8 to sense ±50A applications.

Note

This EVM is an example high current-sensing design. Further designs are modified per system requirements. Considerations are listed below.

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1. Lugs	Current-carrying cable board connectors. Copper planes under the lugs help dissipate heat.
2. Via Stitch	Via stitching provides aeration to dissipate heat further.
3. Isabellenhütte BVN-M-R001	1mΩ, ±1% tolerance shunt resistor for accurate current sensing. The PCB is not designed for more than ±70A. *If an alternate current-sensing range is desired, consider alternate shunt resistor values.* • Design Considerations for Isolated Current Sensing • Shunt Resistor Selection for Isolated Data Converters
4. AMC1306M05 Input Test Points	AMC1306M05 differential analog input test points.
5. High-Side Power Supply	High-side power-supply connectors: terminal block J2 or test point connections.
6. TLV709A01DBVR	Low-dropout (LDO) for stable and constant high-side power supply.

7. Low-Side Power Supply	Low-side power-supply connectors: terminal block J5 or test point connections.
8. AMC1306M05	Isolated, reinforced delta-sigma current-sensing modulator with external clock and ±50mV input. *If an integrated DC/DC converter is desired, consider the AMC3306M05, isolated current-sensing modulator.*
9. TPS73633DBVR	Low-dropout (LDO) for stable and constant high-side power supply.
10. LED	LED on to indicate device powered.
11. AMC1306M05 Digital Output and Clock Input Test Points	AMC1306M05 digital output (DOUT) and external clock input (CLKIN) test points.
12. AMC1306M05 Low-Side Header Connectors	Header connections for the AMC1306M05 low-side pins.
13. C2000 Control Card Connector	C2000 microcontroller control card connector for digital output analysis and clock generation.

2.2 Assembly Instructions

This section includes step-by-step instructions on how to assemble the AMC-MOD-50A-EVM. Lugs come secured by default, but if the user needs to reattach the lugs during evaluation, follow these steps:

1. Connect the high-current input lugs to the J2 (IN+) and J5(IN-) pads with the supplied screw and hex nut.
   a. Make sure the lugs do not touch when secured.
   b. Make sure that the lugs are positioned such that the lugs make contact with the maximum amount of surface area of the PCB pad.
   c. Make sure the connectors are tightly fastened to the current carrying cables such that the connectors cannot be moved by hand. A torque wrench is recommended to provide symmetrical connection. A torque of approximately 40in-lbs is recommended.
2. Solder an additional shunt resistor if desired. See Section 2.7 for more information on shunt limitations.
3. Implement overcurrent protection through the external microcontroller if desired.

2.3 Interfaces

The AMC-MOD-50A-EVM features analog input and digital interface circuitry.

2.3.1 Analog Input

Figure 2-2 shows the analog input circuit for the AMC-MOD-50A-EVM.

The input is supplied through the high current input lugs at J2 (IN+) and J5 (IN−). The input current is sensed through shunt resistor R8 and carried into the analog inputs of the AMC1306M05. R7 is unpopulated by default configuration. The AMC1306M05 input is accessible to the user through test points INP and INN.

For the AMC3302 input, the passive components R3, R5, and C7 make a differential antialiasing filter with a cutoff frequency of 497kHz. Capacitors C8 and C9 help attenuate common-mode signals. C2 and C5 serve as decoupling capacitors for noise reduction and high-side power supply (AVDD) stability.

The adjustable output LDO, TLV709A01DBVR, circuitry includes resistors R1 and R2 to set the output voltage at 3.3V. Capacitors C1 and C2 counteract reactive input sources and improve transient responses.

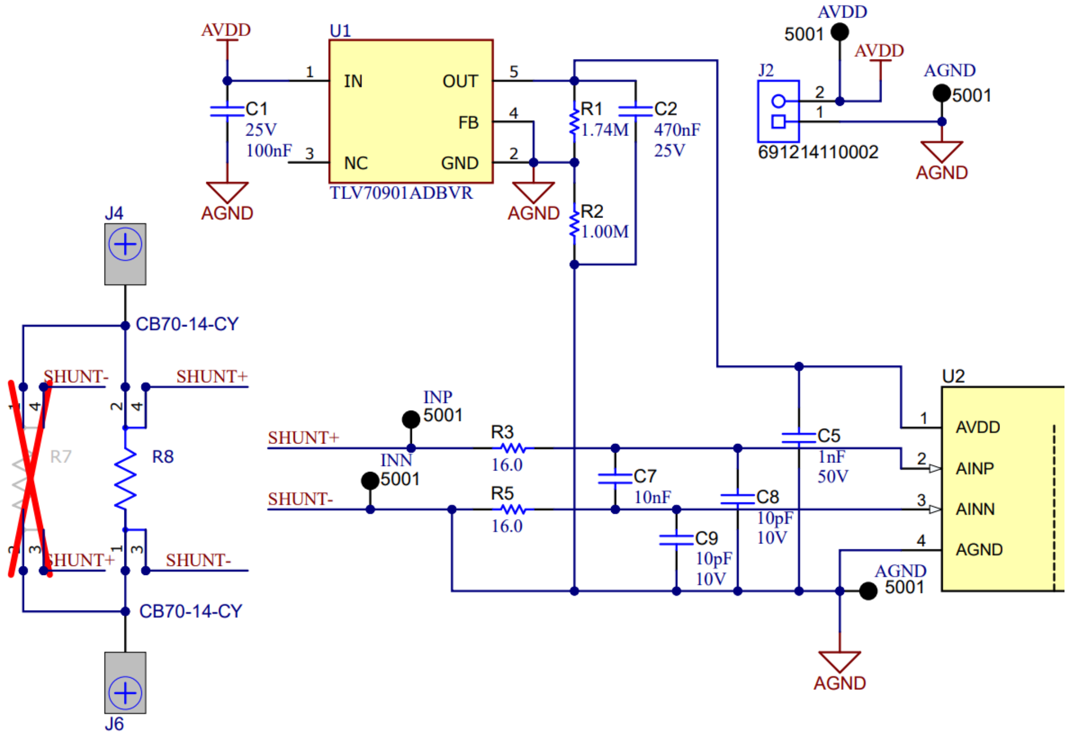

Figure 2-2. AMC-MOD-50A-EVM Analog Input

2.3.2 Digital Interface

Figure 2-3 shows the digital interface circuit for the AMC-MOD-50A-EVM.

The AMC1306M05 digital output and external clock input are accessible to the user through test points DOUT and CLKIN, respectively. DOUT is referenced to DGND and CLKIN is referenced to DGND. The passive components of the digital interface include R4, R6, C6, and C10 to form two RC filters for the data and clock lines. Each RC filter has a cutoff frequency of 53MHz. C3 and C4 serve as decoupling capacitors for noise reduction and low-side power supply (DVDD) stability.

The fixed output LDO, TPS73633DBVR, circuitry includes C11, C12. C13, and C14. These components serve as decoupling capacitors for noise reduction and high-side power supply (DVDD) stability.

Connectors J1 and J3 enable C2000 microcontroller connection for further digital output analysis.

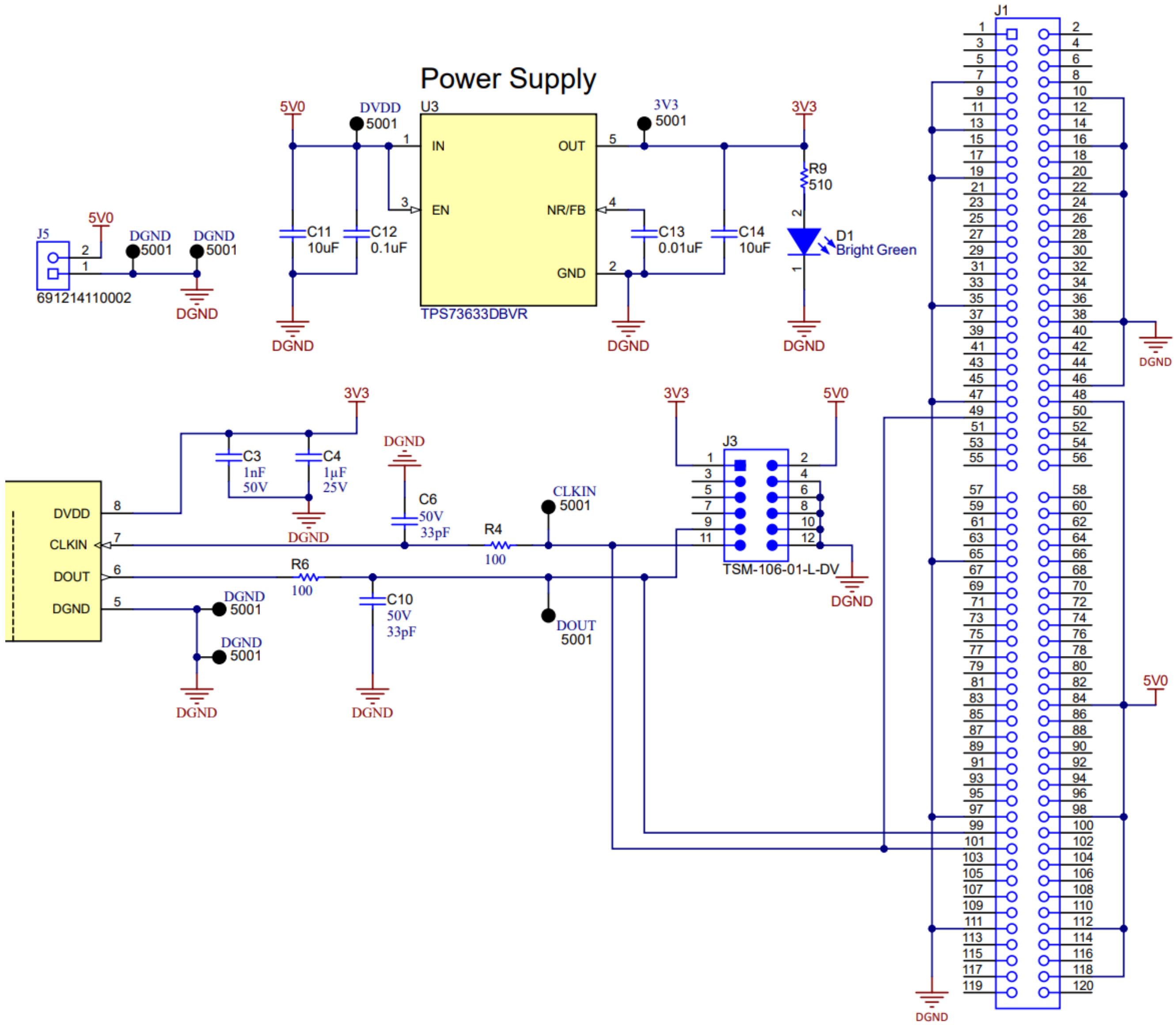

Figure 2-3. AMC-MOD-50A-EVM Digital Interface

2.4 Power Requirements

The EVM requires two external power rails for AVDD and DVDD. AVDD is the analog, high-side power supply and DVDD is the digital, low-side power supply.

2.4.1 AVDD Input

The EVM provides access to AVDD by terminal block J2 and test points AVDD and AGND. The LDO linear voltage regulator, U1, stabilizes the power supply to an adjustable voltage, set to 3.3V by default. Make sure the power supply is between the LDO recommended input voltage and operating conditions with respect to AGND (2.5V−5V).

2.4.2 DVDD Input

The EVM provides access to DVDD by terminal block J5 and test points DVDD and DGND. The LDO linear voltage regulator, U3, stabilizes the power supply to a fixed voltage, 3.3V. Make sure the power supply is set to the LDO recommended input voltage and operating conditions with respect to DGND (5V). The LED, D1, lights up when powered. Alternatively, power the AMC1306M05 with the 3V3 and DGND test points if C2000 connection is not required or the C2000 is powered by the PC.

2.5 Test Points

The AMC-MOD-50A-EVM includes 13 test points throughout the EVM signal chain. These connections allow full evaluation of the current-sensing circuitry. Attach external equipments, such as power supplies and digital multimeters (DMMs) with hook clips, to the surface-mounted test points for easy evaluation.

2.6 Lug Information

The input connectors labeled J2 (IN+) and J5 (IN−) correspond to the high-current rated load connector lugs supplied with the EVM kit. Make sure these components are securely screwed to the board to make contact. The acceptable continuous load input maximum for the included connectors is ±70A for DC and AC measurements. Continuous allowable current is also limited by the maximum operating conditions of the shunt resistor.

2.7 Best Design Practices

Do not apply more than ±70A continuous load to this EVM. The AMC-MOD-50A-EVM is defined to measure the ±50A range. Populating a second 1mΩ shunt on the additional shunt resistor footprint, R7, can doubles the current-sensing range while using the same ±50mV input of the AMC1306M05; however, this PCB is only designed to withstand continuous currents up to ±70A because of heat dissipation restrictions. For best reliability with a standard FR4-based PCB, make sure the temperature does not exceed 180°C.

3 Implementation Results

3.1 Evaluation Procedure

To evaluate the function of the board, run a test procedure. Section 3.1.2 provides further information. For more in depth signal chain evaluation, see Section 3.1.3.

3.1.1 Equipment Setup

The following list outlines the required equipment setup. Figure 3-1 and Figure 3-2 illustrate the positive and negative current equipment setup, respectively.

1. Two DC voltage sources capable of providing 2.5V−5V limited to 50mA.
2. High current electronic load (for example, Agilent™ N3300A).
3. DC current source.
4. High current carrying cables.
5. One *(or more)* oscilloscope or digital mulitmeters (DMMs) with at least 6.5 digits of resolution. *Optional:* Use the C2000 control card and Code Composer Studio for full signal chain evaluation.
6. One signal generator set for a 3.3V square wave at 20MHz. *Optional:* High current supply control shunt for full signal chain evaluation.

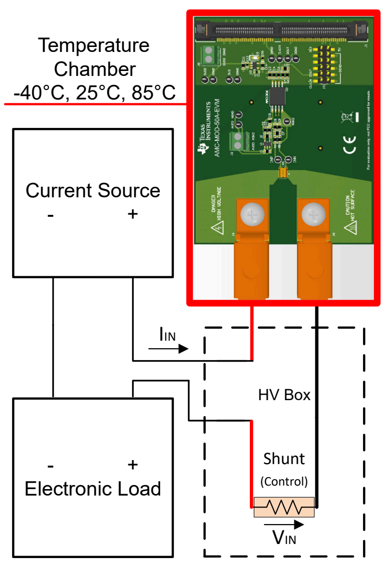

Figure 3-1. Positive Current Equipment Setup

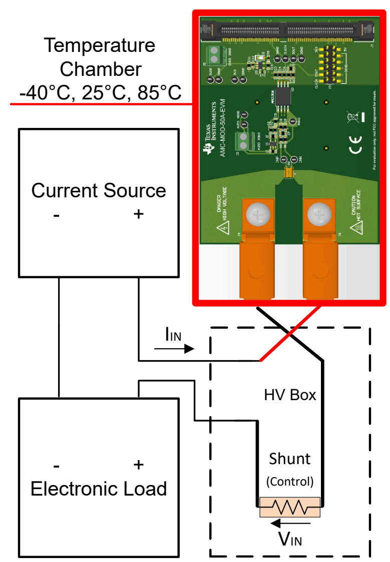

Figure 3-2. Negative Current Equipment Setup

3.1.2 Test Procedure

Note

Verify that the outputs of the connected supplies are disabled before connecting or disconnecting equipment.

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1. Set the first 5V (±10%) source and limit the current to 50mA, as noted in Section 3.1.1. Connect the EVM voltage source to one of the DVDD connections, referenced to DGND. Turn on the power source and make sure there is no more current limit drawn than what is specified in the device data sheets. See Section 2.4.2 for more information. Leave unpowered for now.
2. Set the second 2.5V−5V (±10%) source and limit the current to 50mA, as noted in Section 3.1.1. Connect the EVM voltage source to one of the AVDD connections, referenced to AGND. Turn on the power source and make sure there is no more current limit drawn than what is specified in the device data sheets. See Section 2.4.1 for more information. Leave unpowered for now.
3. Set the signal generator to a 3.3V square wave at 20MHz frequency, as noted in Section 3.1.1. Connect the signal generator to test point CLKIN, referenced to DGND. Leave unpowered for now.

4. Tie inputs INP and INN together and to AGND. Turn on both power supplies and signal generator. Use the oscilloscope or the DMM to verify that isolated power is present on both supplies.
5. Measure test point DOUT, referenced to DGND, using either an oscilloscope or DMM. Make sure the output is 50% high or average to 1.65V. This setting confirms device functionality. Turn off power sources.
6. Untie the inputs and connect the high current carrying cables to the positive and negative lugs, J2 (IN+) and J5 (IN−). For high-side measurement of the positive current, IN– sources to the electronic load. For the negative current, IN+ sources to the load. Set current bounds if supplies allow. Turn on all connected supplies.
7. Apply the appropriate full-scale linear input signal: ±50A.
8. Measure the AMC1306M05 digital output with the oscilloscope or the DMM.

   Verify that the digital output is at the value specified by the device data sheet.

   a. For a 50A input set the output to 90% high, or approximately 2.97V. Use test-point 3V3 referenced to test-point DGND and verify using the following equation:

$$3V3 \times 0.9 \tag{1}$$

   b. For a -50A input set the output 10% high, or approximately 0.33V. Use test-point 3V3 referenced to test-point DGND and verify using the following equation:

$$3V3 \times 0.1 \tag{2}$$

3.1.3 Full Signal Chain Evaluation Procedure

Note

Verify that the outputs of the connected supplies are disabled before connecting or disconnecting equipment. These are general instructions for EVM evaluation. For more information on getting started with the Code Composer Studio, visit Code Composer Studio Academy for additional resources and training modules.

1. Set the first 5V (±10%) source and limit the current to 50mA, as noted in Section 3.1.1. Connect the EVM voltage source to one of the DVDD connections, referenced to DGND. Turn on the power source and make sure there is no more current limit drawn than what is specified in the device data sheets. See Section 2.4.2 for more information. Leave unpowered for now.
2. Set the second 2.5V−5V (±10%) source and limit the current to 50mA, as noted in Section 3.1.1. Connect the EVM voltage source to one of the AVDD connections, referenced to AGND. Turn on the power source and make sure there is no more current limit drawn than what is specified in the device data sheets. See Section 2.4.1 for more information. Leave unpowered for now.
3. Connect a C2000 control card, such as the TMDSCNCD280039C, to connector J1.
4. Install Code Composer Studio (CCS). Open or create the project by selecting the connected control card in the board settings. Configure the following settings in *ProjectName*.syscfg:
   a. Enable EPWM for CLKIN with the following settings:
      i. Name: *Mod_Clk*
      ii. Use Hardware: EPWM1
      iii. Time Base Clock Divider: Divide clock by 1
      iv. Time Base Period: 5
      v. Counter Mode: Up - count mode

   b. Enable SDFM for data collection with the following settings:
      i. Name: *SDFM_1*
      ii. Use Filter Channel 1: ■
      iii. Chanel 1 SDCLK source: SD1 channel clock
      iv. SD Modulator Frequency (MHz): 20
      v. Differential clipping voltage (V): 0.064
      vi. DC input to SD-modulator (V): 0

   c. To evaluate the current-sensing performance of the EVM, capture the SDFM output for each current value by averaging as many samples as memory allows. Roughly 300 samples per current value works well for evaluation. A time delay of 5 seconds between collected samples with 15 second input current increments is a good starting point. Follow the main pseudo code example (Figure 3-3) for getting started:

```
n =  100 ; // number of samples averaged
result = 0; // averaged SDFM output
ResultsArray; // array of stored samples
sample_num = 0; // number of samples obtained

for(;;){
    for(i = 0; i < n; i++){
        result += SDFM_Output[0]; // where SDFM_Output is updated from an interrupt function
    }

    result = result/n;
    ResultsArray[sample_num] = result;
    result = 0; // reset result value
    sample_num++; // increment number of samples
    DEVICE_DELAY(t); // delay between collected samples
}
```

Figure 3-3. Main Pseudo Code Example

5. Connect the high current carrying cables to the positive and negative lugs, J2 (IN+) and J5 (IN−). For high-side measurement of the positive current, IN– sources to the electronic load; for the negative current, IN+ sources to the load. Set current bounds if supplies allow. Turn on all connected supplies.
6. Turn on the power sources and begin the CCS program to begin data collection.
7. Apply the appropriate full-scale linear input sweep ±50A range (*or ±70A*). Incrementing 1A every 15 seconds for data collection works well for evaluation. Record input current, input voltage at INP referenced to INN, and optionally voltage across a control shunt.

   Visit the C2000 E2E Microcontrollers Forum for additional support on data collection.
8. Convert SDFM output to millivolts (mV) using the following formula:

$$V_{OUT} = \frac{Output_{SDFM} \times 0.128}{2^{31}} \quad (3)$$

9. Calculate the total error results across the entire current sweep:
   a. Default Values:

$$R_{IND} = 4.9k\Omega \quad (4)$$

$$I_B = 36\mu A \quad (5)$$

   b. Error Equations:

$$V_{IDEAL} = V_{IN} \times \frac{R_{IND}}{R_{IND} + R_3 + R_5} + I_B \times R_8 \quad (6)$$

$$V_{ERROR} = V_{OUT} - V_{IDEAL} \quad (7)$$

$$E_{\%FSR} = \frac{V_{ERROR}}{V_{ERROR}(I_{IN} = -200A) - V_{ERROR}(I_{IN} = 200A)} \times 100 \quad (8)$$

10. Plot the calculated results against input current, I_{IN}. Figure 3-4 shows an example results plot.

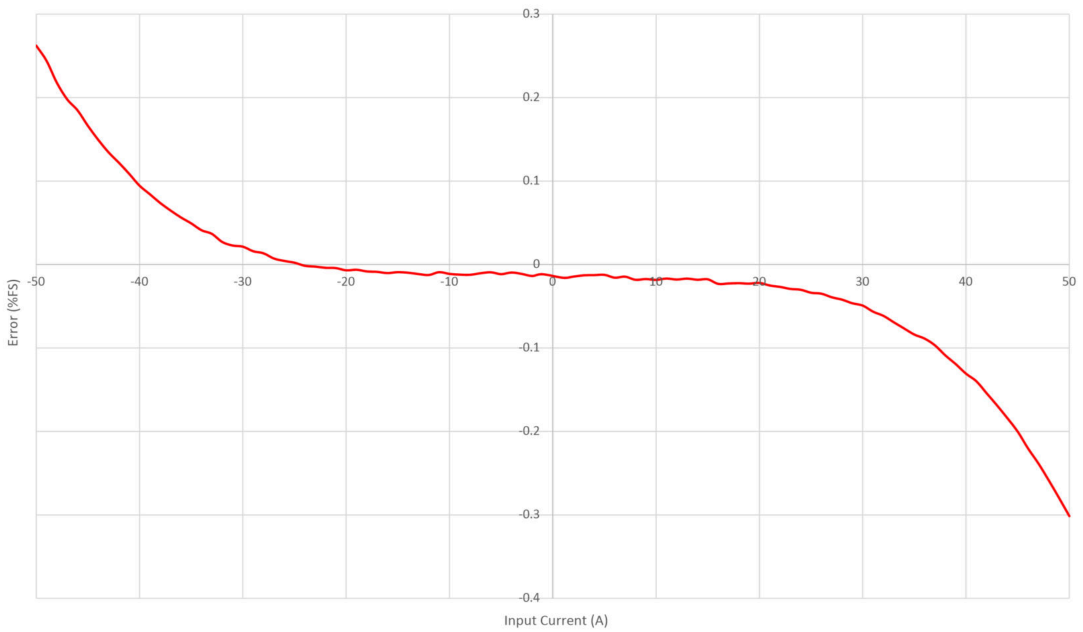

Figure 3-4. AMC-MOD-50A-EVM Total Error %FS Results

11. To evaluate the overcurrent detection performance, configure the C2000 settings in the Code Composer Studio.
12. Repeat these steps at hot and cold temperatures if desired. Calibrate if necessary.

3.2 Performance Data and Results

3.2.1 Shunt Selection Calculations

Consider desired input range and power dissipated when selecting a shunt resistor for high current applications.

The following equation calculates the ideal shunt resistance:

$$R_{SHUNT} = \frac{V}{I} = \frac{50mV(Input\ \ Range\ \ of\ \ AMC3302)}{50A(Current\ \ Range)} = 1m\Omega \quad (9)$$

The following equation calculates the amount of power dissipated.

$$P = I^2R = 50A^2 \times 1m\Omega = 2.5W \quad (10)$$

Make sure power dissipated is ⅔ of the shunt resistor power rating for heat dissipation at high currents. See the *Shunt Resistor Selection for Isolated Data Converters* application note for more information.

3.2.2 Filter Selection

Figure 3-5 shows a diagram identifying three filters. Use these three circuit filters to adjust the AMC-MOD-50A-EVM performance. With each filter, there is a tradeoff between noise and propagation delay. The weaker the filter, the shorter the propagation delay.

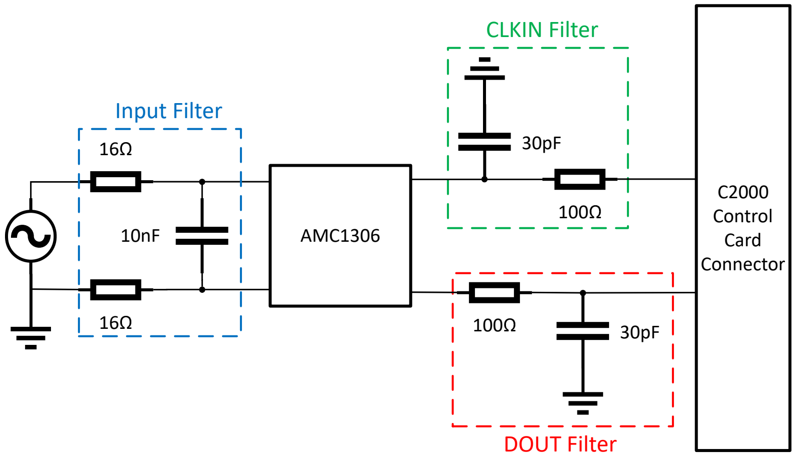

Figure 3-5. AMC-MOD-50A-EVM Filter Diagram

The following equation calculates the cutoff frequency for the input filter.

$$F_C = \frac{1}{2\pi RC} = \frac{1}{2\pi \times 32\Omega \times 10nF} = 497kHz \quad (11)$$

Selecting a shunt resistor with high inductance when measuring a high frequency signal potentially causes overshoot in AC measurements. Overshoot caused by parasitic inductance is compensated for with proper design of the differential RC filter. Best input filter design is dependent on the inductance of the resistor and PCB design. Figure 3-6 shows an example simulation for TINA-TI.

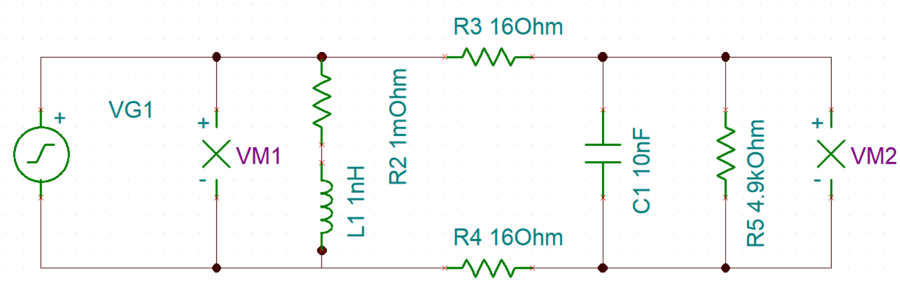

Figure 3-6. Input Filter TINA-TI

The following equation calculates the cutoff frequency for the DOUT and CLKIN filters. Modify as needed for bandwidth limitations.

$$F_C = \frac{1}{2\pi RC} = \frac{1}{2\pi \times 100\Omega \times 30pF} = 53MHz \quad (12)$$

3.2.3 Thermal Results

The AMC-MOD-50A-EVM is rated for ±50A peak current and ±35A RMS. The temperature rating of the FR4-based PCB used is 180°C. Figure 3-7 and Figure 3-8 demonstrate EVM thermal performance at 35A and 50A, respectively. As demonstrated in Figure 3-9, if a system requires lower temperatures, consider adding forced air cooling. As demonstrated in Figure 3-10, if lower temperatures are required, consider a larger shunt size for greater heat dissipation. Thermal performance additionally depends on final system design and environment.

Results are captured at 25°C ambient temperature and after applying the specified current for two minutes.

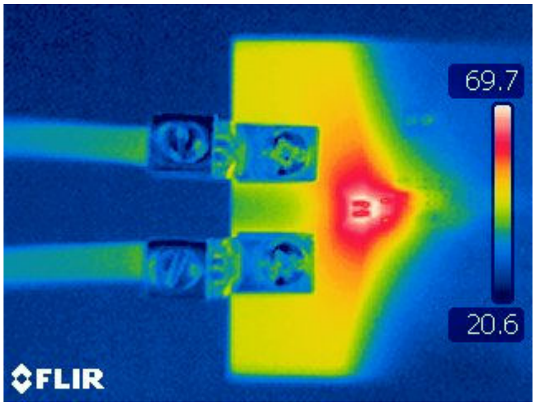

Figure 3-7. Typical Thermal Results: AMC-MOD-50A-EVM at 35A

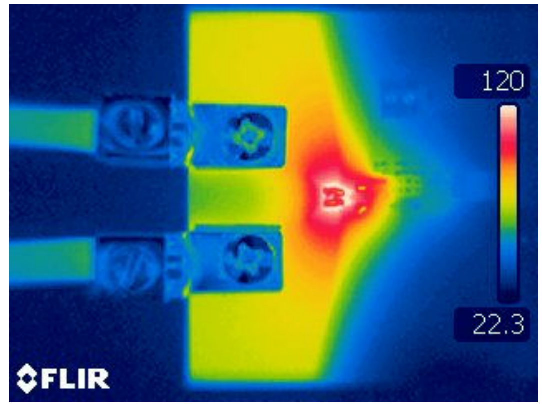

Figure 3-8. Worst-Case Thermal Results: AMC-MOD-50A-EVM at 50A

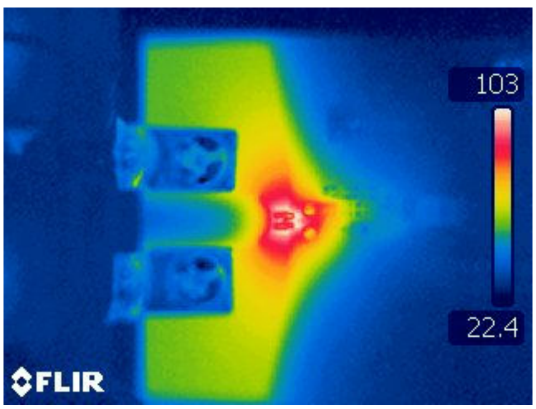

Figure 3-9. Worst-Case Thermal Results With Forced Air Cooling: AMC-MOD-50A-EVM at 50A

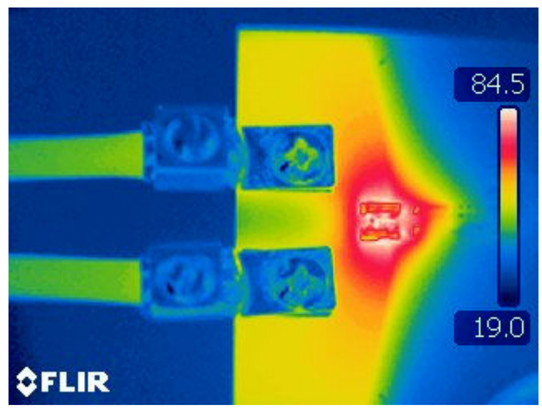

Figure 3-10. Worst-Case Thermal Results With Larger Shunt Resistor Package (Size 2725): AMC-MOD-50A-EVM at 50A

4 Hardware Design Files

4.1 Schematic

Figure 4-1 shows the schematic for the AMC-MOD-50A-EVM.

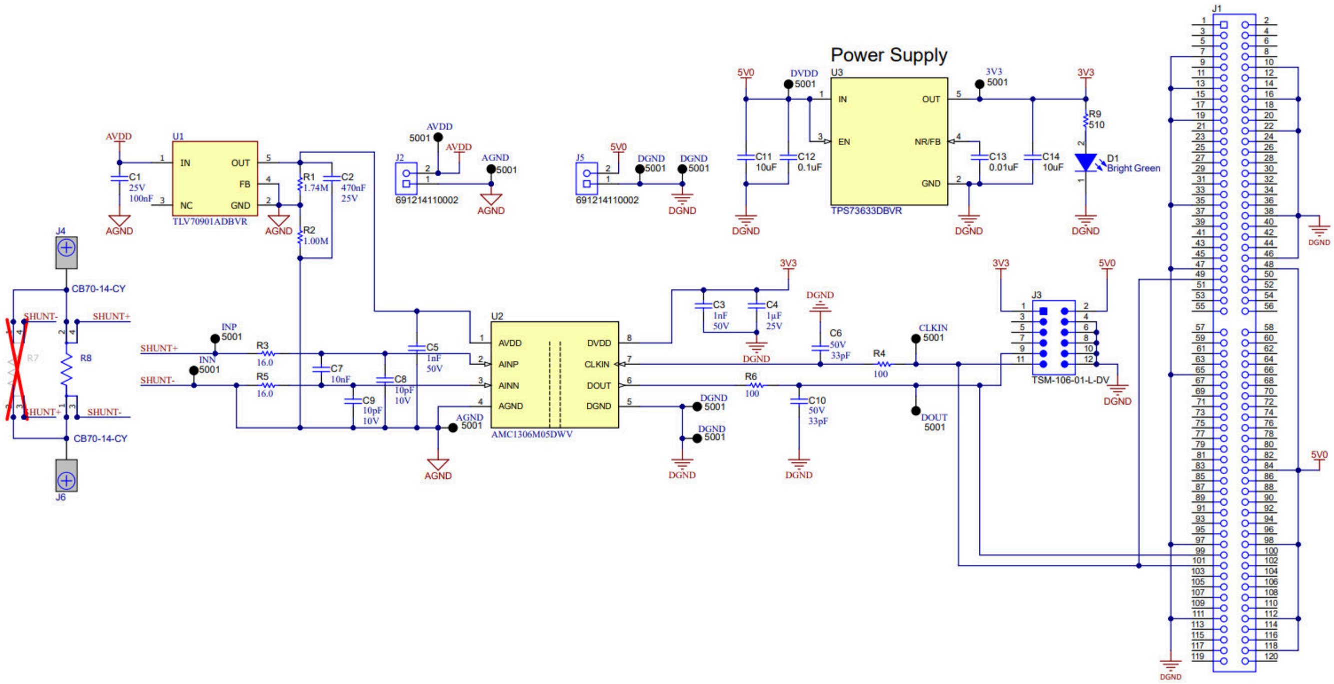

Figure 4-1. AMC-MOD-50A-EVM Schematic

4.2 PCB Layouts

Figure 4-2 shows the top printed circuit board (PCB) drawing of the AMC-MOD-50A-EVM. Figure 4-3 shows the bottom PCB drawing of the AMC-MOD-50A-EVM.

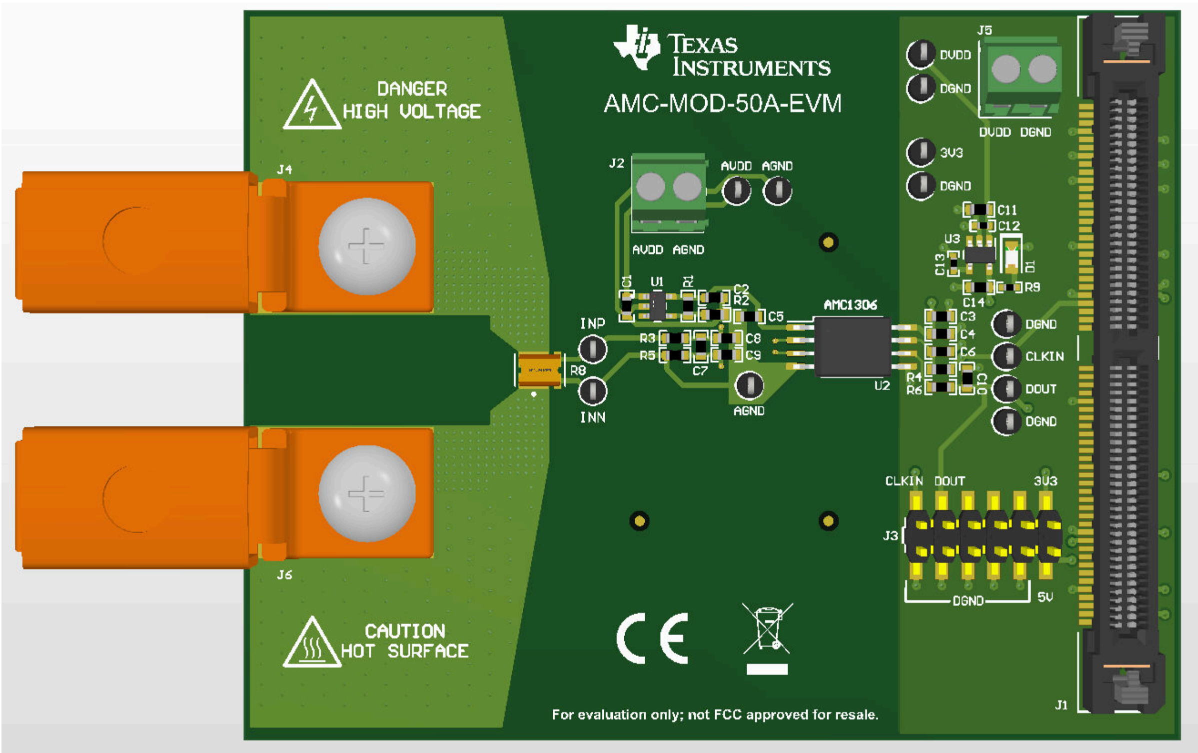

Figure 4-2. AMC-MOD-50A-EVM Top PCB Drawing

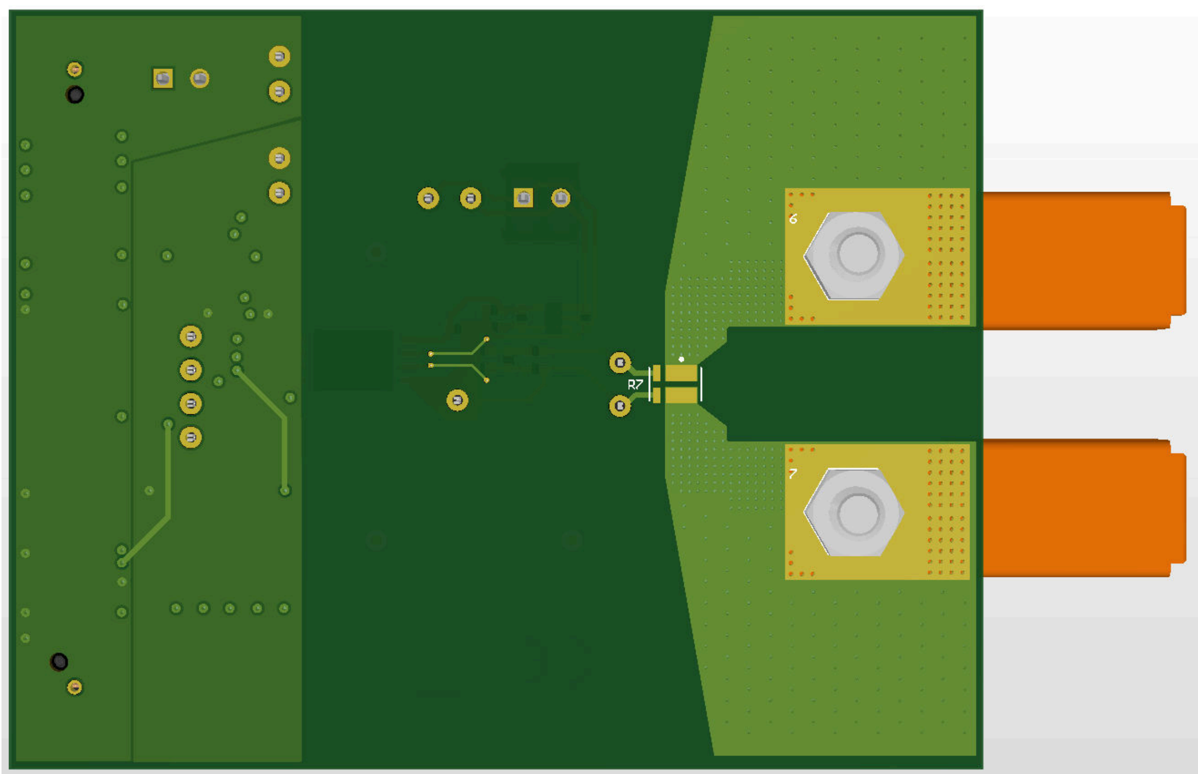

Figure 4-3. AMC-AMP-50A-EVM Bottom PCB Drawing

4.3 Bill of Materials (BOM)

Table 4-1 lists the BOM for the AMC-MOD-50A-EVM.

Table 4-1. AMC-MOD-50A-EVM BOM

Designator	Description	Manufacturer	Part Number
C1	CAP, CERM, 0.1µF, 25V, ±10%, X7R, AEC-Q200 Grade 1, 0603	MuRata	GCM188R71E104KA57D
C2	CAP, CERM, 0.47µF, 25V, ±10%, X7R, 0603	TDK	C1608X7R1E474K080AE
C3, C5	CAP, CERM, 1000pF, 50V, ±10%, X7R, 0603	Kemet	C0603C102K5RACTU
C4	CAP, CERM, 1µF, 25V, ±10%, X7R, AEC-Q200 Grade 1, 0603	TDK	CGA3E1X7R1E105K080AC
C6, C10	CAP, CERM, 33pF, 50V, ±5%, C0G/NP0, AEC-Q200 Grade 0, 0603	TDK	CGA3E2NP01H330J080AA
C7	CAP, CERM, 0.01µF, 25V, ±10%, X7R, 0603	Presidio Components	SR0603X7R103K1NT95(F)#M123A
C8, C9	CAP, CERM, 10pF, 10V, ±10%, X7R, 0603	AVX	0603ZC100KAT2A
C11, C14	CAP, CERM, 10uF, 10V, ±20%, X5R, 0603	MuRata	GRM188R61A106ME69D
C12	CAP, CERM, 0.1uF, 10V, ±20%, X5R, 0402	Wurth Elektronik	885012105010
C13	CAP, CERM, 0.01uF, 10V, ±10%, X7R, 0402	AVX	0402ZC103KAT2A
D1	LED, Bright Green, SMD	Wurth Elektronik	150080VS75000
J1	C2000 controlCARD-120HSEC connector, SMT	Samtec	HSEC8-160-01-L-DV-A-BL
J2, J5	Terminal Block, 3.5mm, 2x1, Tin, TH	Wurth Elektronik	691214110002
J3	Header, 2.54mm, 6x2, Gold, SMT	Samtec	TSM-106-01-L-DV
J4, J6	Terminal 90A Lug	Panduit	CB70-14-CY
R1	RES, 1.74M, 1%, 0.1W, AEC-Q200 Grade 0, 0603	Vishay-Dale	CRCW06031M74FKEA
R2	RES, 1.00 M, 1%, 0.125W, 0603	Vishay/Beyschlag	MCT06030C1004FP500
R3, R5	RES, 16.0, 0.5%, 0.1W, 0603	Yageo America	RT0603DRE0716RL
R4, R6	RES, 100, 5%, 0.1W, AEC-Q200 Grade 0, 0603	Vishay-Dale	CRCW0603100RJNEA
R8	1 mOhms ±1% 7W Chip Resistor Wide 1612 (3831 Metric), 1216 Current Sense, Moisture Resistant	Isabellenhuette	BVN-M-R001-1.0
R9	RES, 510, 5%, 0.063W, AEC-Q200 Grade 0, 0402	Vishay-Dale	CRCW0402510RJNED
U1	150-mA, 30-V, 3.2-µA Quiescent Current, Low-Dropout Linear Regulator	Texas Instruments	TLV709A01DBVR

Table 4-1. AMC-MOD-50A-EVM BOM (continued)

Designator	Description	Manufacturer	Part Number
U2	Small Reinforced Isolated Modulator With ±50mV Input and CMOS Interface, DWV0008A (SOIC-8)	Texas Instruments	AMC1306M05DWV
U3	Single Output Low Noise LDO, 400mA, Fixed 3.3V Output, 1.7 to 5.5V Input, with Reverse Current Protection, 5-pin SOT-23 (DBV), -40 to 85 degC, Green (RoHS & no Sb/Br)	Texas Instruments	TPS73633DBVR
3V3, AGND, AVDD, CLKIN, DGND, DOUT, DVDD, INN, INP	Test Point, Miniature, Black, TH	Keystone Electronics	5001
N/A	Passivated 18-8 Stainless Steel Pan Head Phillips Screws M5 x 0.8mm Thread, 10mm Long	McMaster-Carr	92000A320
N/A	JIS Hex Nut Medium-Strength Zinc-Plated Steel, Class 8, M5 x 0.8mm Thread	McMaster-Carr	91028A415

5 Additional Information

5.1 Trademarks

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6 Related Documentation

- Texas Instruments, *AMC1306M05, High-Precision, ±50mV Input, Reinforced Isolated Modulator with External Clock* data sheet
- Texas Instruments, *TLV709 150mA, 30V, 3.2µA Quiescent Current, Low-Dropout Linear Regulator* data sheet
- Texas Instruments, *TPS736 Capacitor-Free, NMOS, 400mA, Low-Dropout Regulator With Reverse Current Protection* data sheet
- Texas Instruments, *Shunt Resistor Selection for Isolated Data Converters* application brief
- Texas Instruments, *Design Considerations for Isolated Current Sensing* analog design journal
- Isabellenhütte USA, *BVN (1216) ISA-WELD™Precision Resistor* data sheet