AMC1305xxEVM User's Guide

This user's guide describes the characteristics, operation, and use of the AMC1305EVM populated with either the AMC1305L25, AMC1305M05 or AMC1305M25. See Table 1 for additional details about the analog input range and bandwidth for each component in the AMC1305 family. The AMC1305EVM is designed for prototyping and evaluation. A complete circuit description, schematic diagram, and bill of materials are included.

Throughout this document, the abbreviation *EVM* and the term *evaluation module* are synonymous with the AMC1305EVM.

The following related documents are available through the Texas Instruments web site at www.ti.com.

Related Documentation

Device	Literature Number
AMC1305	SBAS654
AMC1210	SBAS372
SN6501	SLLSEA0
TMS320F28377D	SPRS880A
TLV70450	SBVS148C

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1 Overview

1.1 Features

- Full-featured evaluation module for the AMC1305 single-channel, isolated, delta-sigma (ΔΣ) modulator
- Screw terminals for easy access to analog inputs, clock input, and modulator data output
- Optional isolated power to the AMC1305 analog voltage supply input derived from the controller-side power supply

1.2 Introduction

The AMC1305 is a single-channel, second-order, switched-capacitor, ΔΣ modulator with an output separated from the input interface circuitry by a capacitive isolation barrier. The isolation barrier provides galvanic isolation of up to 7000 V_{PEAK}. The AMC1305 can be used to achieve 16 bits of resolution with a dynamic range of 80 dB (13 ENOB) at a data rate of 78 kSPS when paired with a digital filter (such as the ΔΣ filter module in the TMS320F28377D or the AMC1210).

2 Analog Interface

The analog input to the AMC1305 is routed from the two-wire screw terminal at J2. This screw terminal gives the user access to the inverting and noninverting inputs of the AMC1305 device installed at U1.

2.1 Analog Inputs

The analog input to the AMC1305EVM printed circuit board (PCB) consists of a simple RC filter circuit. The input circuitry to the AMC1305 is shown in Figure 1.

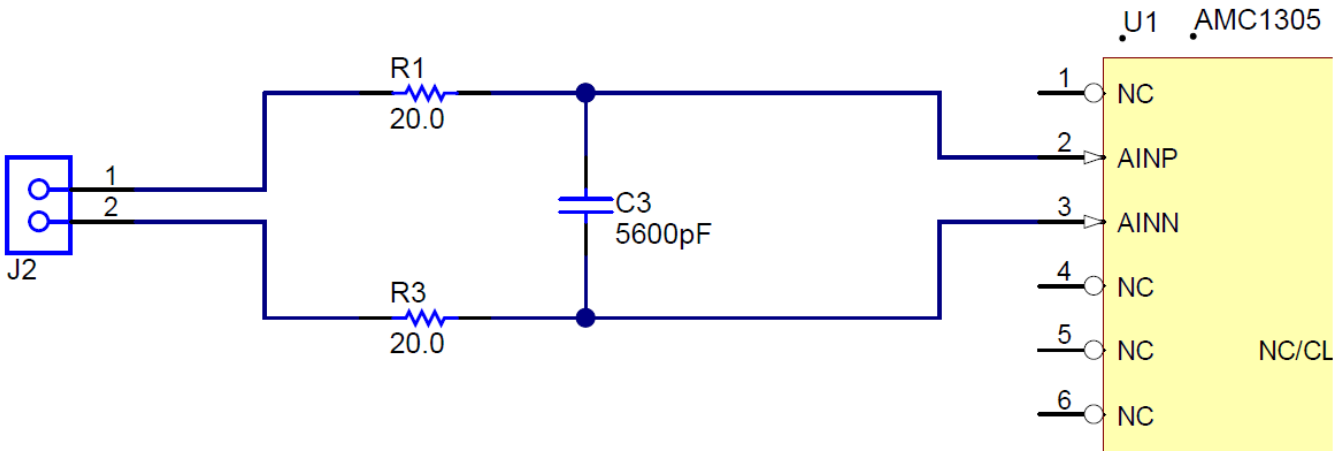


Figure 1. AMC1305EVM Schematic: Analog Input Section

Note that the RC filter circuit is not required in every application; the input amplifier of the AMC1305 already provides a limited input bandwidth. See Table 1 for additional details about the analog input bandwidth for each component in the AMC1305 family.

3 Digital Interface

The AMC1305EVM is designed for use with digital filters (such as the ΔΣ filter module in the TMS320F28377D or the AMC1210). The power, clock input, and modulator data output of the AMC1305 device are routed to the two-wire screw terminals at J1, J3, and J4, as Figure 2 shows.

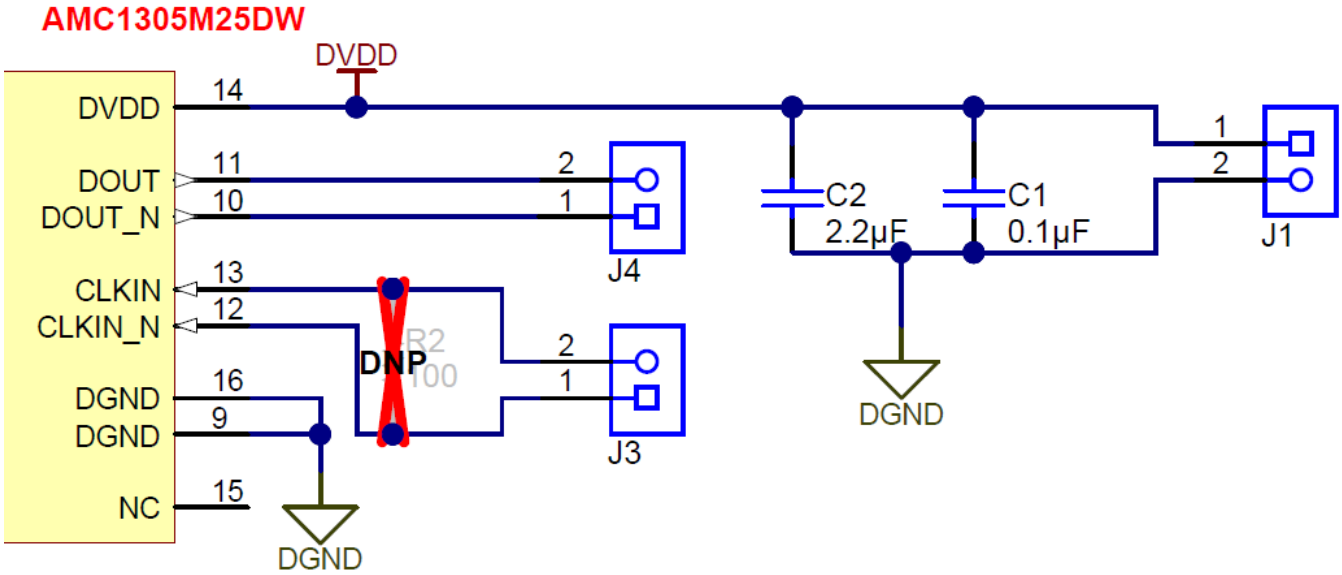


Figure 2. Power, Clock Input, and Digital Data Output

Note that component R2 in Figure 2 is marked as DNP (do not populate) because Figure 2 corresponds to an AMC1305EVM populated with a CMOS variant of the AMC1305. Refer to Table 1 for additional details about the analog input ranges and interfaces available in the AMC1305 family.

4 Power Supplies

Power for the controller side of the AMC1305 device is supplied through the two-wire screw terminal at J1.

The user has two options to provide power for the high side of the AMC1305 device. One option is to supply the high side of the AMC1305 through the two-wire screw terminal at J5; to accomplish that, the user must set jumper JP1 to the position labeled *Ext*; see Figure 3.

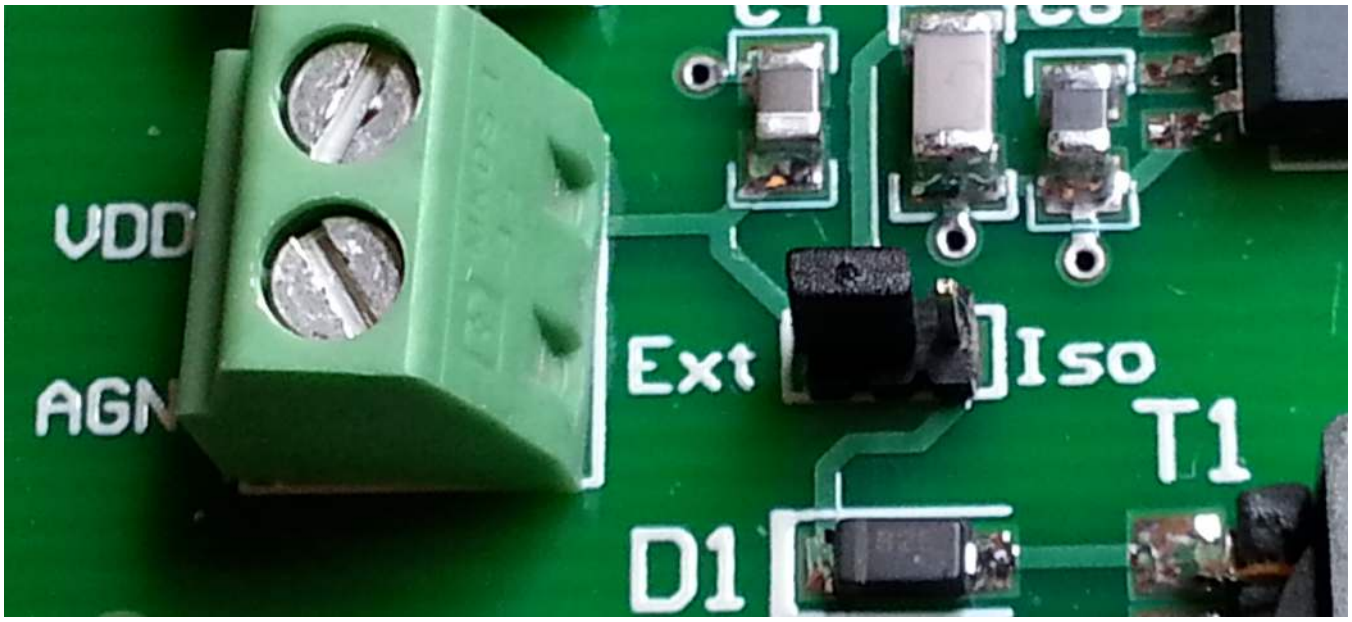


Figure 3. JP1 in *Ext* Position

The second option is to supply the high side of the AMC1305 with the filtered signal coming from the isolated side of the onboard transformer T1. Note that the filtered signal on the isolated side of T1 is generated from the power supplied to the controller side of the AMC1305 device by using the SN6501 transformer driver located at U3. To take advantage of this isolated, onboard supply, the user must set jumper JP1 to the position labeled *Iso*, as shown in Figure 4.

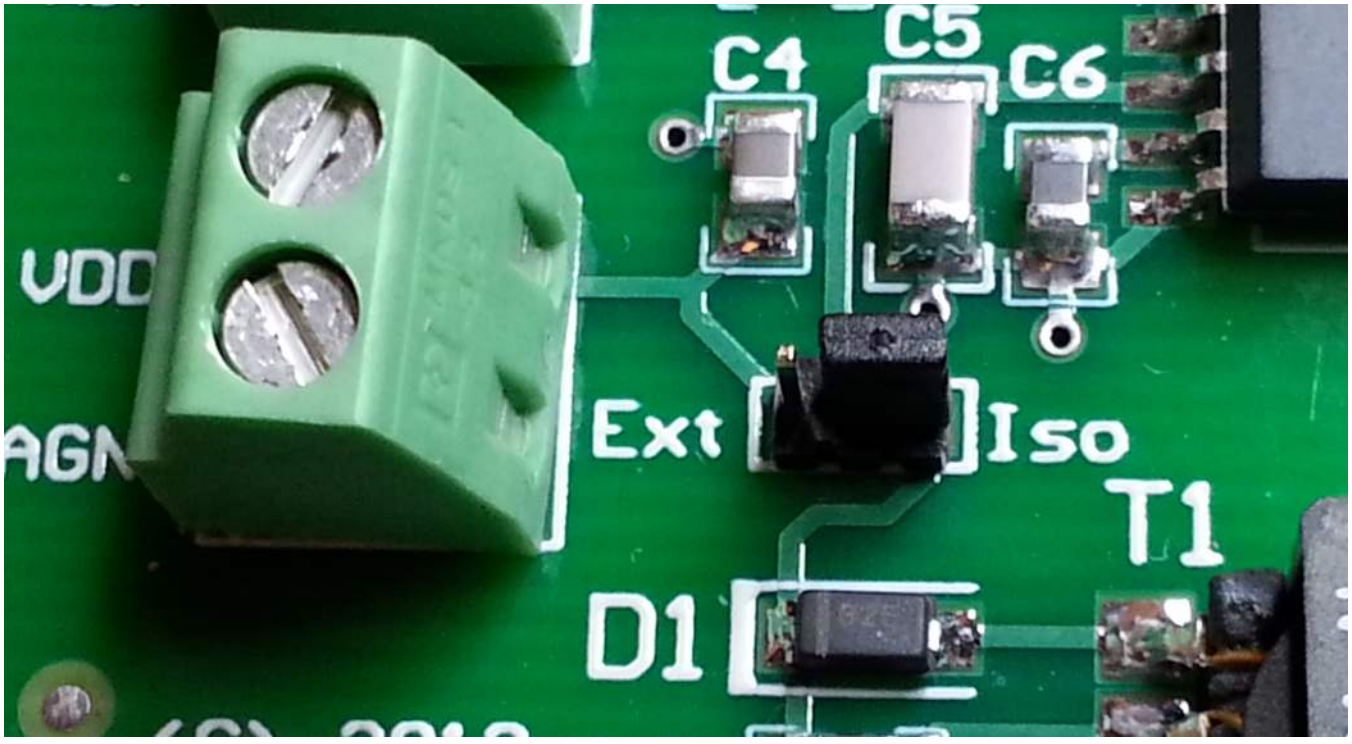


Figure 4. JP1 in *Iso* Position

The design of the isolated, unregulated power source to the AMC1305 analog supply input closely follows the TIPD121 Design Reference Guide, *0-5 A, Single-Supply, 2 kV Isolated Current Sensing Solution (SLAU521)*.

The SN6501 transformer driver is used because it is designed for low-power, push-pull converters with input voltages in the range of 3 V to 5.5 V; such voltage ranges fit well within the AMC1305 controller-side supply range. Three important components in the dc-dc converter are the isolation transformer, the rectifier diode, and the linear regulator.

4.1 Transformer Selection

To prevent the isolation transformer from saturating, its volt-seconds (V-t) product must be greater than the maximum volt-seconds product applied by the SN6501. The maximum voltage delivered by the SN6501 is the nominal converter input plus a 10% margin. The maximum time this voltage is applied to the primary is half the period of the lowest frequency at the specified input voltage. The minimum switching frequency of the SN6501 at 5-V operation is 300 kHz. Therefore, the transformer minimum V-t product under these conditions, as determined by equations (1) and (2) in the SN6501 data sheet, is 9.1 Vμs. The specified V-t product of the isolation transformer selected (DA2304) is well above this 9.1-Vμs requirement.

When searching for a suitable transformer, the minimum turns ratio required must be determined; such a ratio allows the push-pull converter to operate over the specified current and temperature range. The minimum turns ratio required can be expressed through the ratio of secondary to primary voltage multiplied by a correction factor that takes into account the transformer typical efficiency. Equations (3) through (8) in the SN6501 data sheet show the specific requirements for determining the minimum turns ratio for a given application. The DA2304 has a 1:2.2 turns ratio; such a ratio produces an unregulated, open-circuit voltage output well within the input range of the low-dropout regulator used in this design.

4.2 Rectifier Diode Selection

The chosen rectifier diode must possess low forward voltage to provide as much voltage to the converter output as possible. When used in high-frequency switching applications, the rectifier must also possess a short recovery time. Schottky diodes meet both of these requirements. The MBR0520L with a typical forward voltage of approximately 200 mV at 8-mA forward current is used in this design. Figure 5 illustrates the forward voltage versus forward current characteristics of the MBR0520L diode.

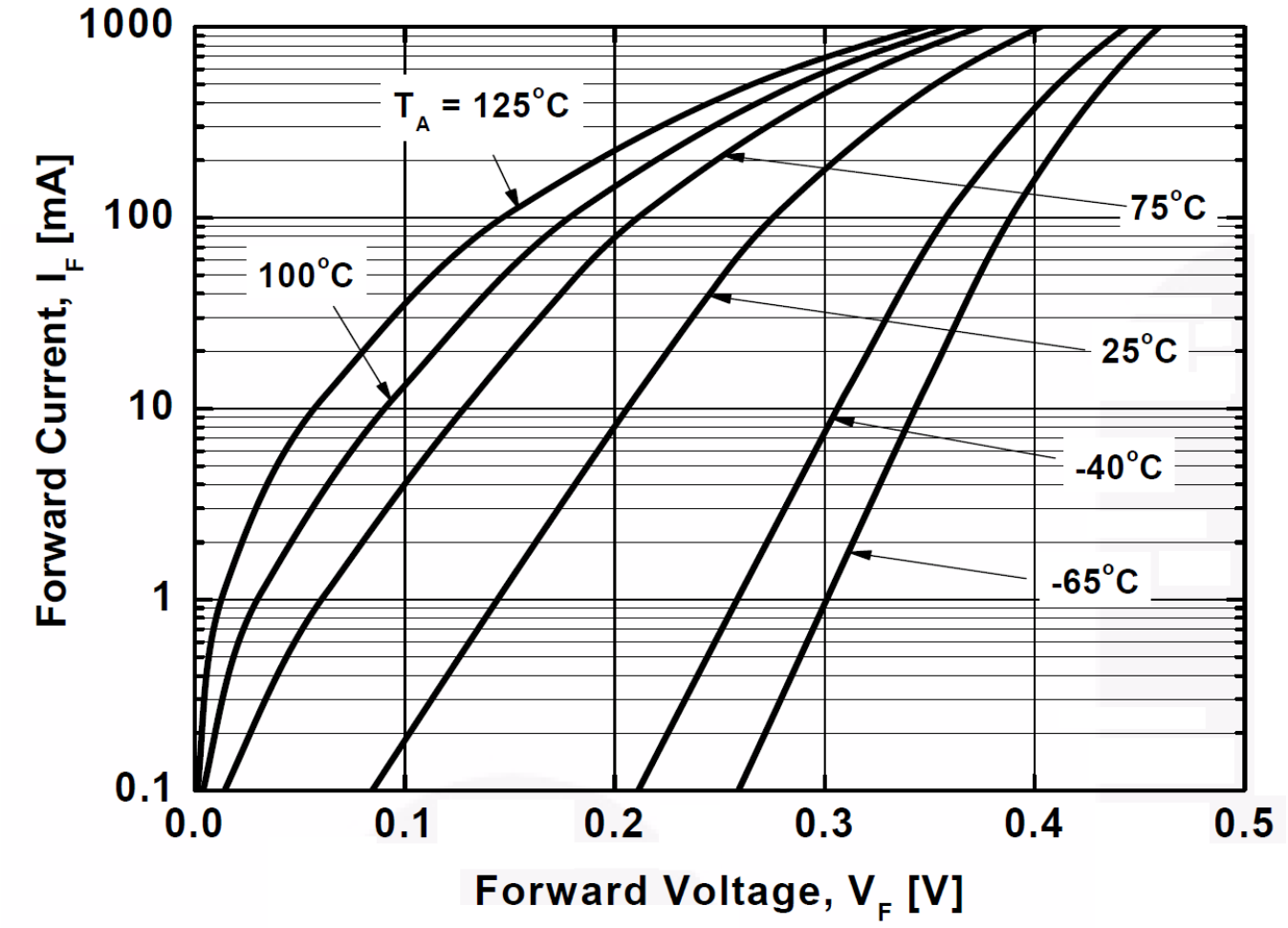


Figure 5. Forward Voltage of the Rectifier Diode

4.3 Linear Regulator Selection

A linear voltage regulator is included to ensure that a stable supply voltage is delivered to the AMC1305 high side (AVDD pin). The TLV70450 fits this application well because of its low quiescent current and regulation capabilities.

5 EVM Set-Up and Operation

This section describes the general operation of the AMC1305EVM.

5.1 Power and Analog Inputs: J1, J2, and J5

In the EVM default configuration, the isolated onboard supply is used. In other words, power to pin 7 of the AMC1305 is provided from the supply connected to J1 by means of an isolation transformer and the SN6501 transformer driver. This configuration provides an isolated, regulated source to the AMC1305. For power provided from high-side isolated rails (such as from a gate drive supply), move the shunt on jumper JP1 to the *Ext* position (as shown in Figure 3) so that the two-wire screw terminal at J5 can be used.

Use a voltage between 3 V dc and 5.5 V dc for the supply provided to J1 and a voltage between 4.4 V dc and 5.5 V dc for the supply provided to J5.

The analog inputs to the AMC1305EVM PCB can be applied directly to the two-wire screw terminal at J2.

CAUTION

Carefully review the AMC1305 product data sheet for the limitations of the analog input range, and ensure that the appropriate analog and digital supply voltages are applied before connecting any analog input to the EVM.

Note that the AMC1305EVM is designed for evaluation of the electrical characteristics of the AMC1305 only. The EVM is not meant for isolation tests and is not designed to be used in a high-voltage environment.

The transformer used to derive the isolated, unregulated power source to the LDO input has isolation ratings different from those of the AMC1305. Consult the transformer manufacturer for more information on the isolation capabilities of the transformer.

5.2 Device Operation

When the analog and digital power sources are applied to the AMC1305EVM, the digital output activates when an external modulator clock source is applied. The internal reference of the AMC1305 is used as the conversion reference.

Additionally, an analog input signal can be applied directly at screw terminal J2. See Figure 1 for more details. Table 1 lists additional details about the analog input ranges and interfaces available in the device family.

Table 1. AMC1305 Family Information

Product	Input Voltage Range	Interface	Input Bandwidth
AMC1305M05	±50 mV	CMOS	1 MHz
AMC1305M25	±250 mV	CMOS	1.8 MHz
AMC1305L25	±250 mV	LVDS	1.8 MHz

When the input voltage approaches the upper end of the specified full-scale range (50 mV or 250 mV, depending on the AMC1305 device type), the ones density of the modulator output approaches 90%.

When the input voltage approaches the lower end of the specified full-scale range (–50 mV or –250 mV, depending on the AMC1305 device type), the ones density of the modulator output approaches 10%.

6 Bill of Materials, Schematic, and Layout

This section contains the complete bill of materials (BOM), schematic diagram, and PCB layout for the AMC1305EVM.

NOTE: Board layouts are not to scale. These layouts are intended to show how the board is laid out and are not intended to be used for manufacturing AMC1305EVM PCBs.

6.1 Printed Circuit Board Layout

Figure 6 shows the PCB layout.

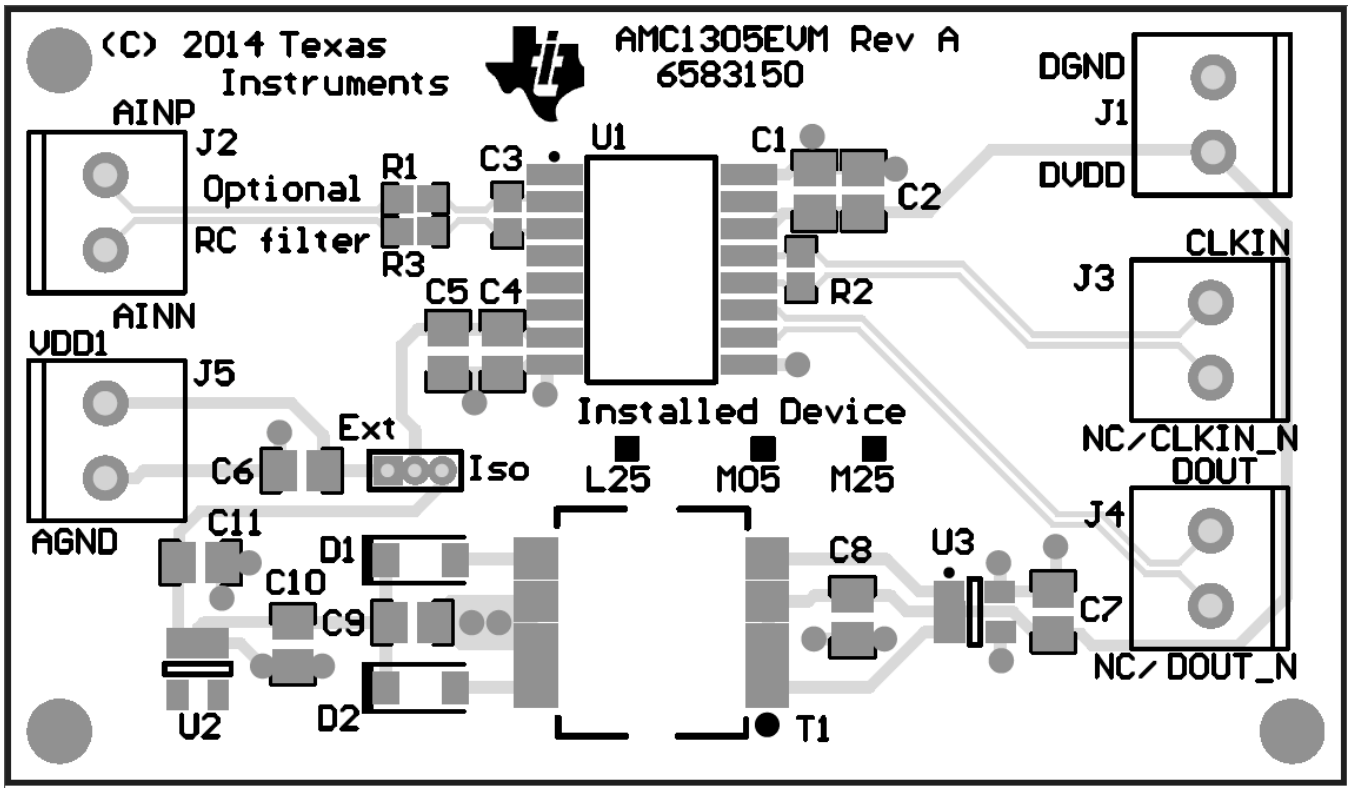


Figure 6. AMC1305EVM Silk Screen Drawing

6.2 Schematic

The AMC1305EVM schematic is appended to the end of this document.

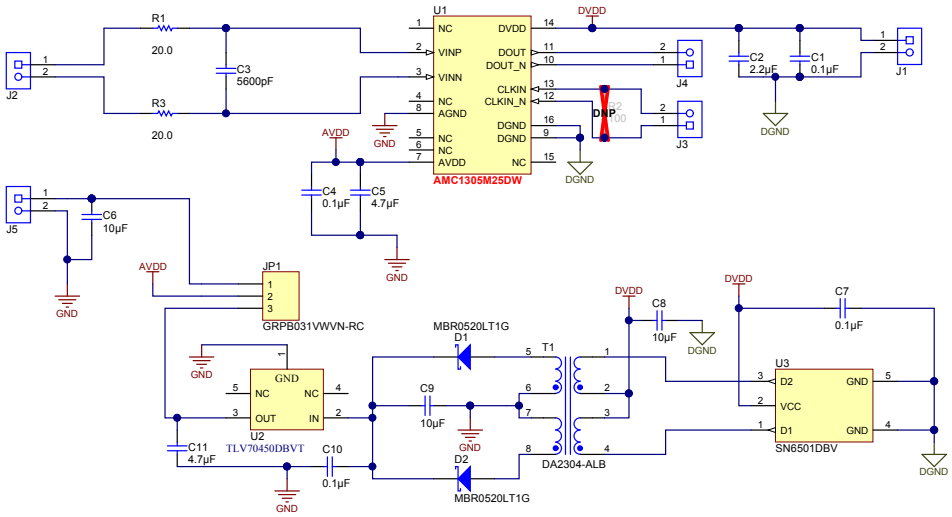
6.3 Bill of Materials

Note that items 14 and 16 of the bill of materials depend on the type of AMC1305 used in the EVM. Resistor R2 is populated only when the AMC1305 used is the AMC1305L25. R2 is not populated for EVMs that use the AMC1305M05 or AMC1305M25.

Table 2. AMC1305EVM Bill of Materials

Item	Qty			Reference Designator	Description	Manufacturer	Mfr Part Number
	L25	M05	M25				
1	1	1	1	—	Printed circuit board	Any	N/A
2	1	1	1	C2	CAP, CERM, 2.2uF, 16V, +/-10%, X7R, 0805	Taiyo Yuden	EMK212B7225KG-T
3	4	4	4	C1, C4, C7, C10	CAP, CERM, 0.1uF, 25V, +/-10%, X7R, 0805	Kemet	C0805C104K3RACTU
4	1	1	1	C3	CAP, CERM, 5600pF, 25V, +/-5%, C0G/NP0, 0603	TDK	C1608C0G1E562J
5	3	3	3	C6, C8, C9	CAP, CERM, 10uF, 16V, +/-10%, X5R, 0805	Taiyo Yuden	EMK212BJ106KG-T
6	2	2	2	C5, C11	CAP, CERM, 4.7uF, 10V, +/-10%, X5R, 0805	Taiyo Yuden	LMK212BJ475KD-T
7	2	2	2	D1, D2	Diode, Schottky, 20V, 0.5A, SOD-123	ON Semiconductor	MBR0520LT1G
8	3	3	3	FID1, FID2, FID3	Fiducial mark. There is nothing to buy or mount.	N/A	N/A
9	5	5	5	J1, J2, J3, J4, J5	Conn Term Block, 2POS, 3.5mm, TH	Phoenix Contact	1751248
10	1	1	1	JP1	Header, 3-Pin	Sullins Connector Solutions	GRPB031VWVN-RC
11	2	2	2	R1, R3	RES, 20.0 ohm, 0.1%, 0.1W, 0603	Yageo America	RT0603BRD0720RL
12	1	1	1	SH-J1	Shunt, 1.27 mm	Harwin Inc	M50-2000005
13	1	1	1	T1	1:2.2 Isolation Transformer	Coilcraft	DA2304-AL
14	1	0	0	U1	Isolated delta-sigma modulator, 16-pin DW (SOIC)	Texas Instruments	AMC1305L25
	0	1	0		Isolated delta-sigma modulator, 16-pin DW (SOIC)	Texas Instruments	AMC1305M05
	0	0	1		Isolated delta-sigma modulator, 16-pin DW (SOIC)	Texas Instruments	AMC1305M25
15	1	1	1	U3	SN6501 transformer driver	Texas Instruments	SN6501
16	1	0	0	R2	RES, 100, 1%, 0.1 W, 0603. Populated only on EVMs with LVDS interface.	Yageo America	RC0603FR-07100RL
17	1	1	1	U2	LOW-POWER 150-mA LOW-DROPOUT LINEAR REGULATOR, DBV0005A	Texas Instruments	TLV70450

Revision History	
Revision	Notes



Number: 6583150	Rev: A	Designed for: Public Release	Mod. Date: 8/13/2014
SVN Rev: Not in version control		Project Title: AMC1305 Evaluation Module	
Drawn By: Jose Duenas		Sheet Title: Main Schematic	
Engineer: Jose Duenas		Assembly Variant: AMC1305EVM_M25	Sheet: 2 of 3
		File: AMC1305_Main.SchDoc	Size: B
		Contact: http://www.ti.com/support	

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      CAUTION

      This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

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

      FCC Interference Statement for Class A EVM devices

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- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210*

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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

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2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
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4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

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4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure 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. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

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