AMC1304EVM User's Guide

This user's guide describes the characteristics, operation, and use of the AMC1304EVM. The AMC1304EVM 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 AMC1304EVM.

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

Table 1. Related Documentation

Device	Literature Number
AMC1304	SBAS655
AMC1210	SBAS372
SN6501	SLLSEA0
TMS320F28377D	SPRS880

Contents

List of Figures

List of Tables

1 Overview

1.1 Features

- Full-featured evaluation module for the AMC1304 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 AMC1304 low-dropout regulator (LDO) input derived from the controller-side power supply

1.2 Introduction

The AMC1304 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 AMC1304 can be used to achieve 16 bits of resolution 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 AMC1304 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 AMC1304 device installed at U1.

2.1 Analog Inputs

The analog input to the AMC1304EVM printed circuit board (PCB) consists of a simple RC filter circuit. The input circuitry for the AMC1304 is shown in Figure 1.

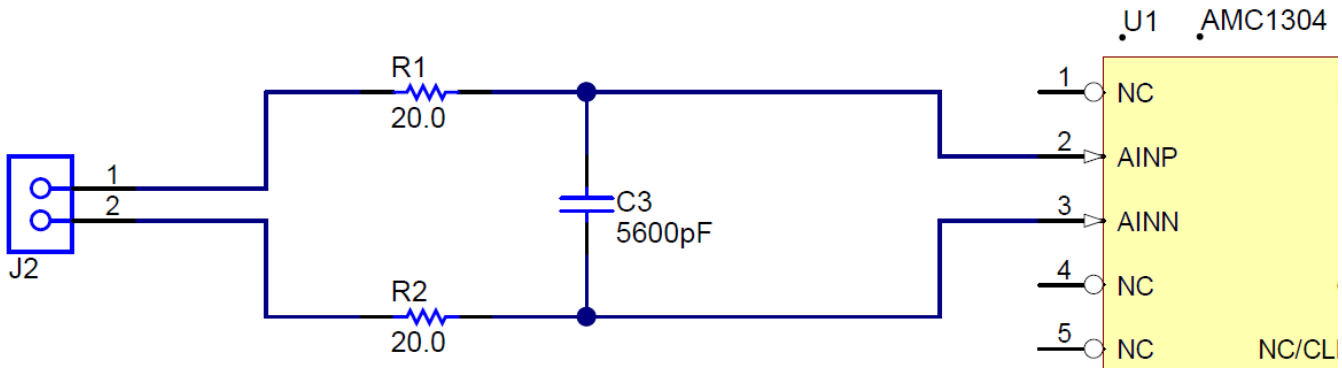


Figure 1. AMC1304EVM Schematic: Analog Input Section

Note that the RC filter circuit is not required in every application; the input amplifier of the AMC1304 already provides a limited input bandwidth. See Table 2 for additional details about the analog input bandwidth for each component in the AMC1304 family.

Note that the RC filter circuit is not required in every application; the input amplifier of the AMC1305 already provides a limited input bandwidth. Refer to Table 2 for additional details about the analog input bandwidth for each component in the AMC1305 family.

3 Digital Interface

The AMC1304EVM 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 AMC1304 device are routed to the two-wire screw terminals at J1, J3, and J4, as Figure 2 shows.

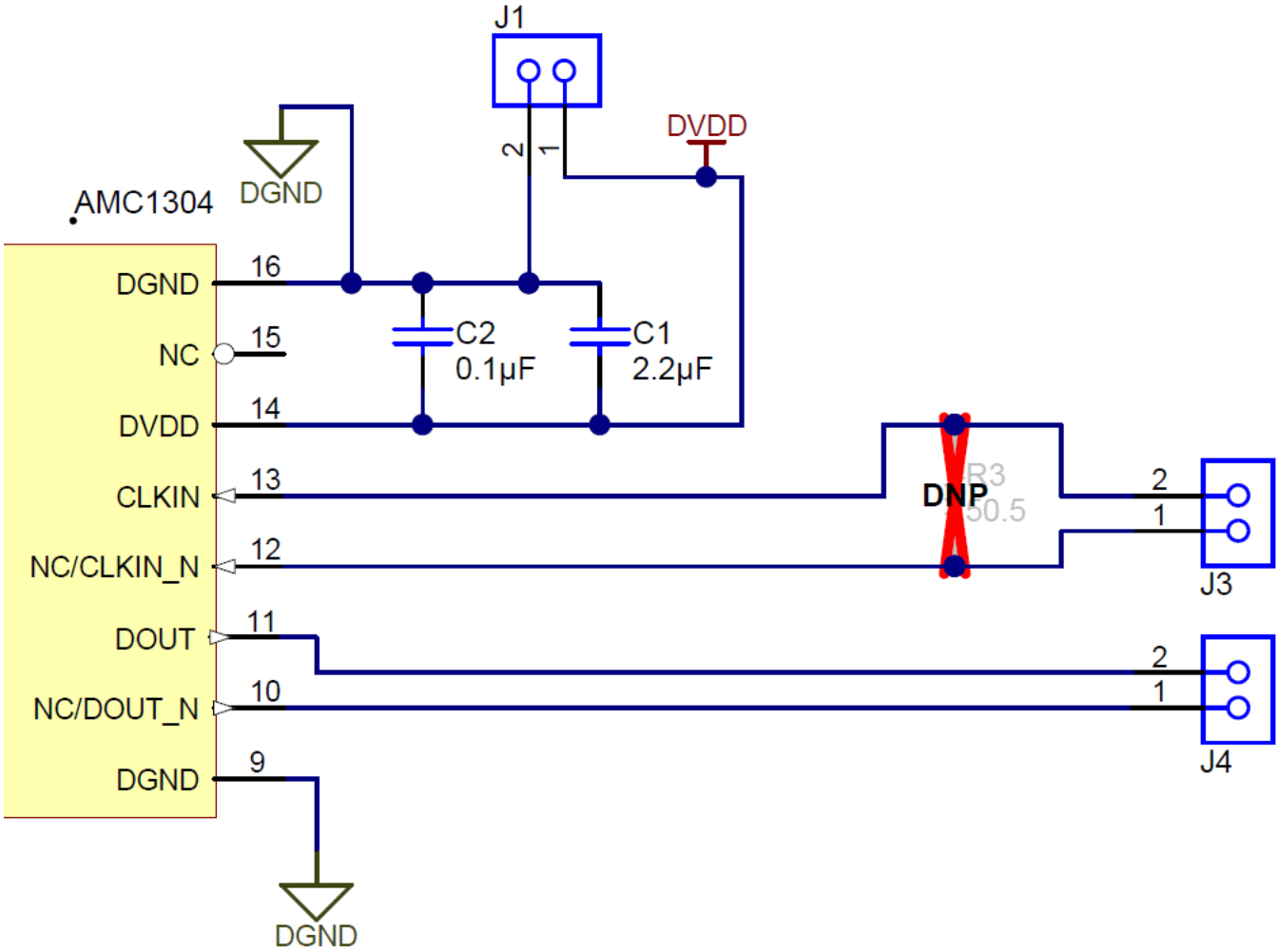


Figure 2. Power, Clock Input, and Digital Data Output

Note that component R3 in Figure 2 is marked as DNP (do not populate) because Figure 2 corresponds to an AMC1304EVM populated with a CMOS variant of the AMC1304. Refer to Table 2 for additional details about the analog input ranges and interfaces available in the AMC1304 family.

4 Power Supplies

Power for the controller side of the AMC1304 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 AMC1304 device (note that in both options, power is provided to the LDO input on pin 6 of the AMC1304). One option is to supply the high side of the AMC1304 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.

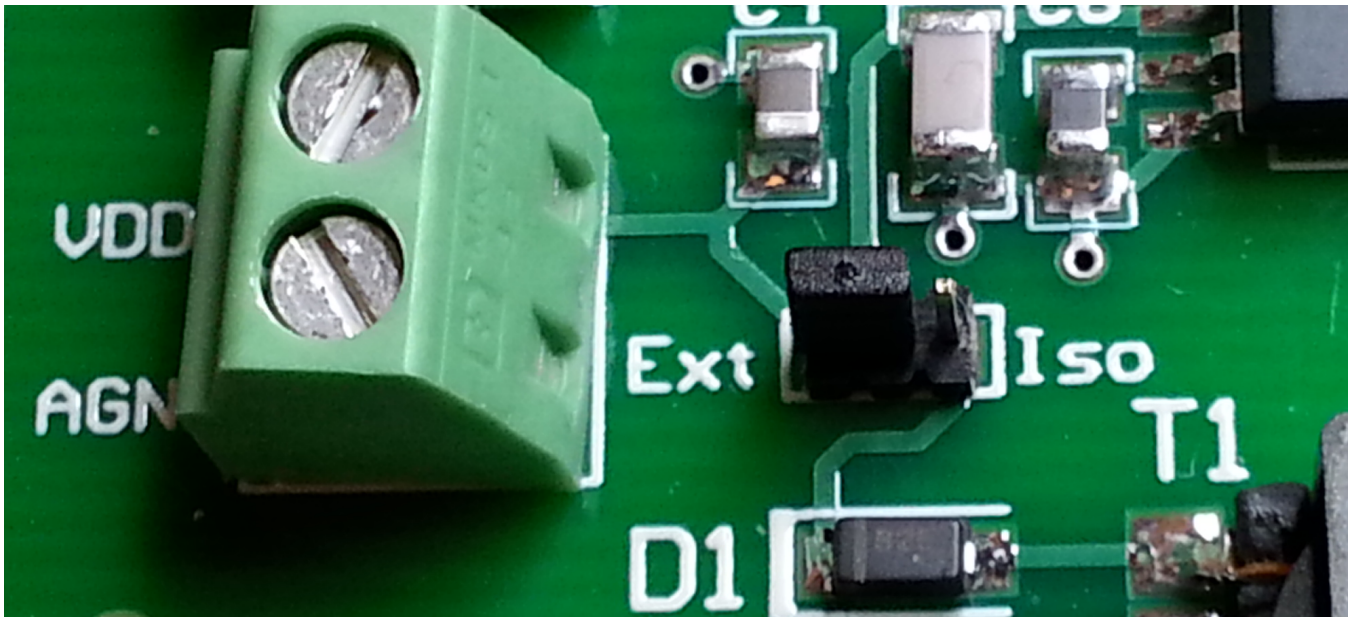


Figure 3. JP1 in *Ext* Position

The second option is to supply the high side of the AMC1304 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 AMC1304 device by using the SN6501 transformer driver located at U2. To take advantage of this isolated, onboard supply, the user must set jumper JP1 to the position labeled *Iso*, as shown in Figure 4.

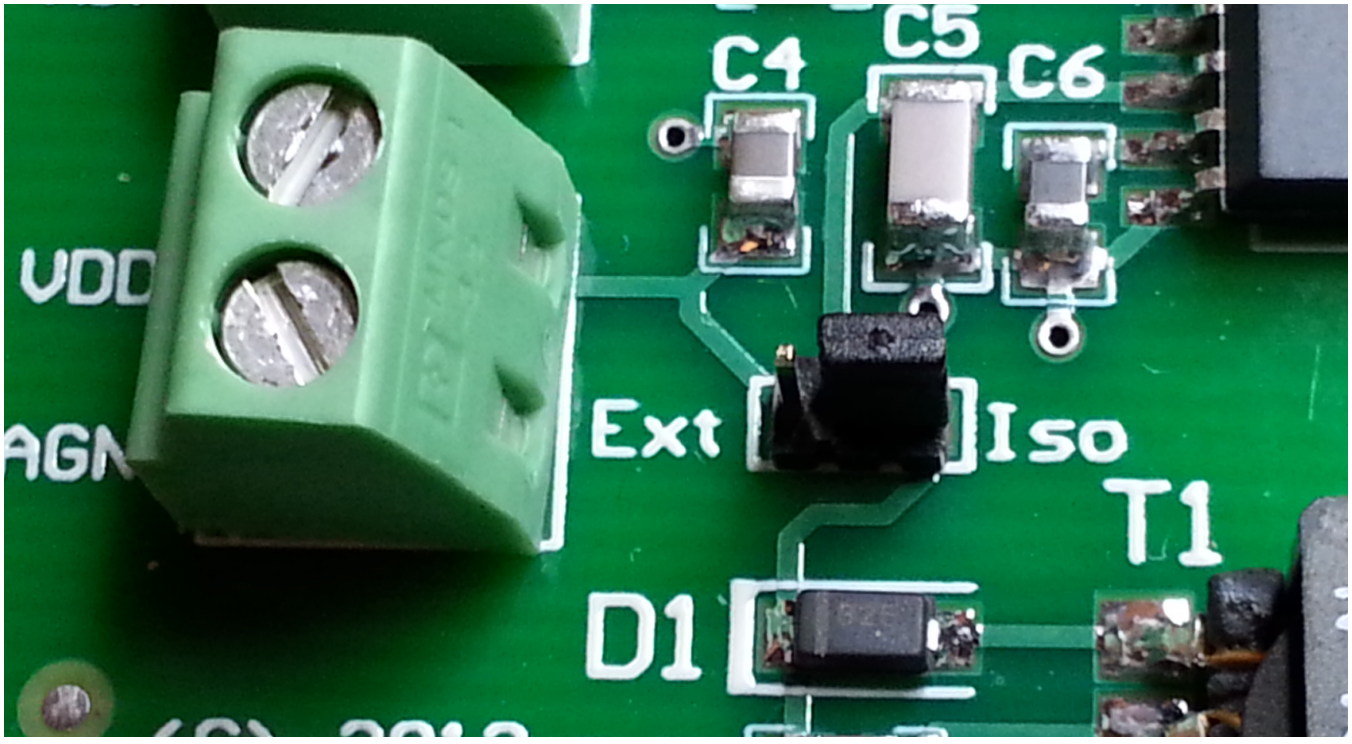


Figure 4. JP1 in *Iso* Position

The design of the isolated, unregulated power source to the AMC1304 LDO 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 range fits well within the AMC1304 controller-side supply range. Two important components in the dc-dc converter are the isolation transformer and the rectifier diode.

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 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 AMC1304 low-dropout regulator input range.

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 100 mV at 8-mA forward current is used in this low-voltage design. Figure 5 illustrates the forward voltage versus forward current characteristics of the MBR0520L diode.

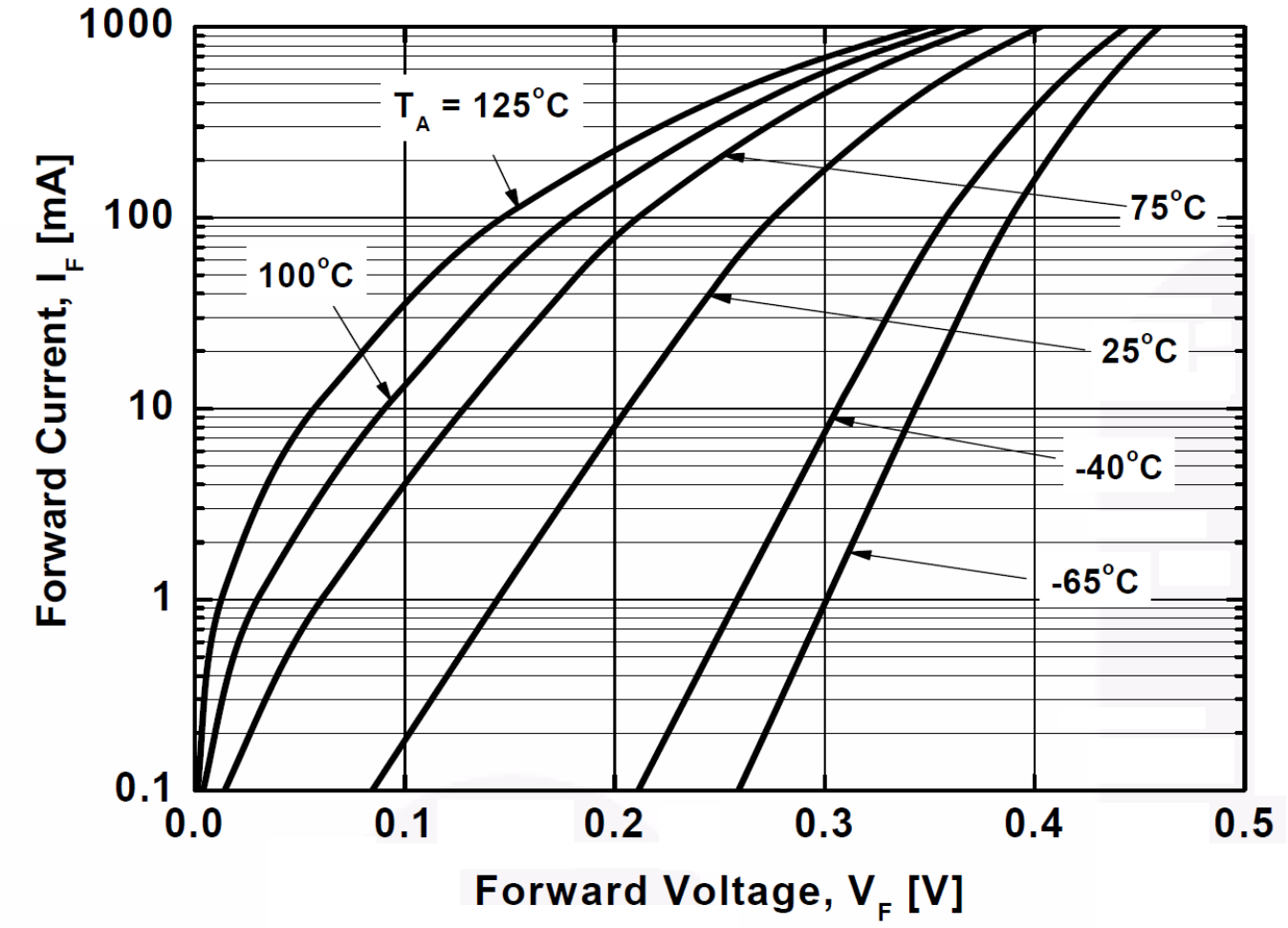


Figure 5. Forward Voltage of the Rectifier Diode

5 EVM Set-Up and Operation

This section describes the general operation of the AMC1304EVM.

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 6 of the AMC1304 is provided from the supply connected to J1 by means of an isolation transformer and the SN6501 transformer driver. This configuration provides an isolated, unregulated source to the AMC1304 low-dropout regulator input. The isolated, unregulated, open-circuit voltage generated is between 7.85 V and 12.8 V when the voltage applied to J1 is between 2.7 V and 5.5 V, respectively. 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 (see Figure 3) so that the two-wire screw terminal at J5 can be used.

Use a voltage between 2.7 V dc and 5.5 V dc for the supply provided to J1 and a voltage between 4 V dc and 18 V dc for the supply provided to J5.

The analog inputs to the AMC1304EVM PCB can be applied directly to the two-wire screw terminal at J2.

CAUTION

Carefully review the AMC1304 product data sheet for the limitations of the analog input range, and ensure that the appropriate analog and digital voltages are applied before connecting any analog input to the EVM.

Note that the AMC1304EVM is designed for evaluation of the electrical characteristics of the AMC1304 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 AMC1304 LDO input has isolation ratings different from those of the AMC1304. 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 AMC1304EVM, the digital output activates when an external modulator clock source is applied. The internal reference of the AMC1304 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. There are four products in the AMC1304 family; Table 2 lists additional details about the analog input ranges and interfaces available in the family.

Table 2. AMC1304 Family Information

Product	Input Voltage Range	Interface	Input Bandwidth
AMC1304M05	±50 mV	CMOS	1 MHz
AMC1304M25	±250 mV	CMOS	1.8 MHz
AMC1304L05	±50 mV	LVDS	1 MHz
AMC1304L25	±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 AMC1304 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 AMC1304 device type), the ones density of the modulator output approaches 10%.

6 BOM, Schematic, and Layout

This section contains the complete bill of materials (BOM), schematic diagram, and PCB layout for the AMC1304EVM.

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 AMC1304EVM PCBs.

6.1 Printed Circuit Board Layout

Figure 6 shows the PCB layout.

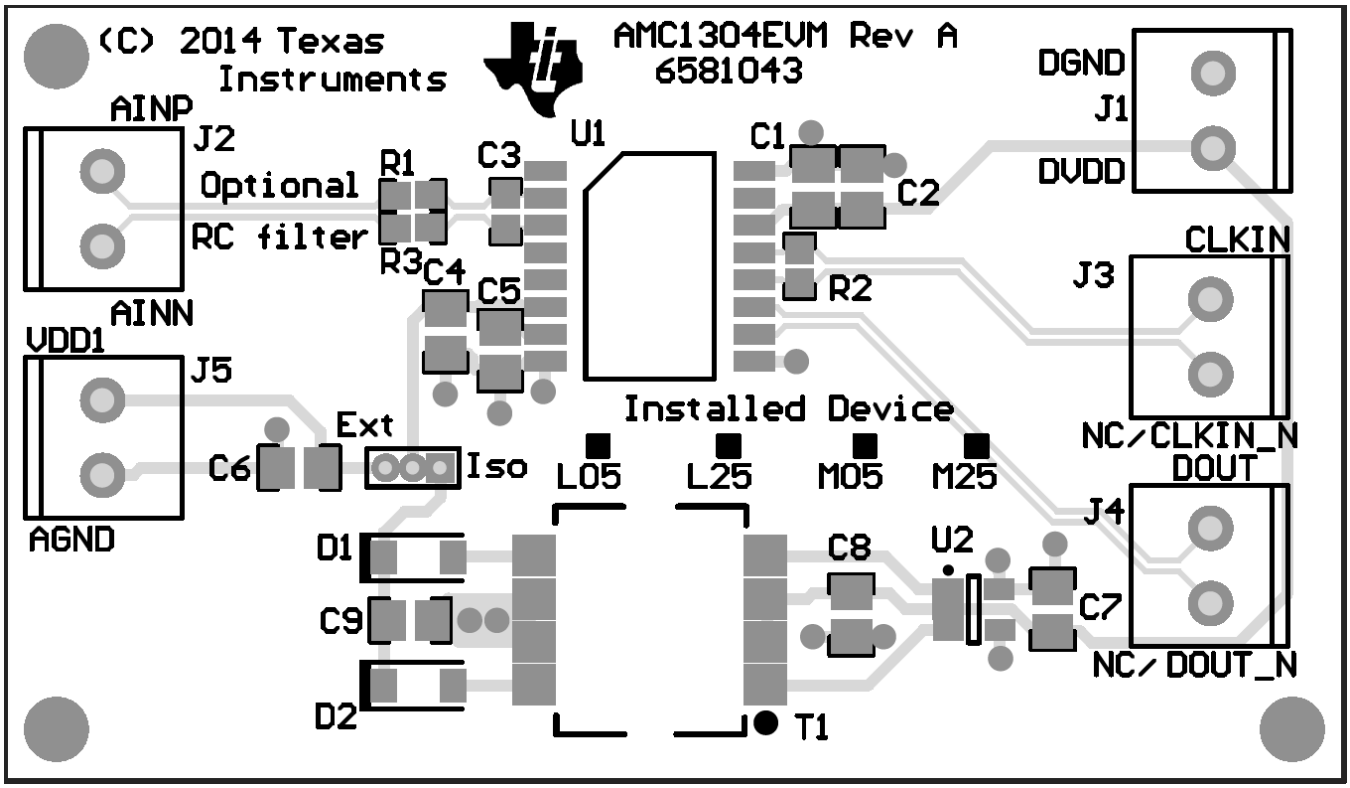


Figure 6. AMC1304EVM Silk Screen Drawing

6.2 Schematic

The AMC1304EVM schematic is appended to the end of this document.

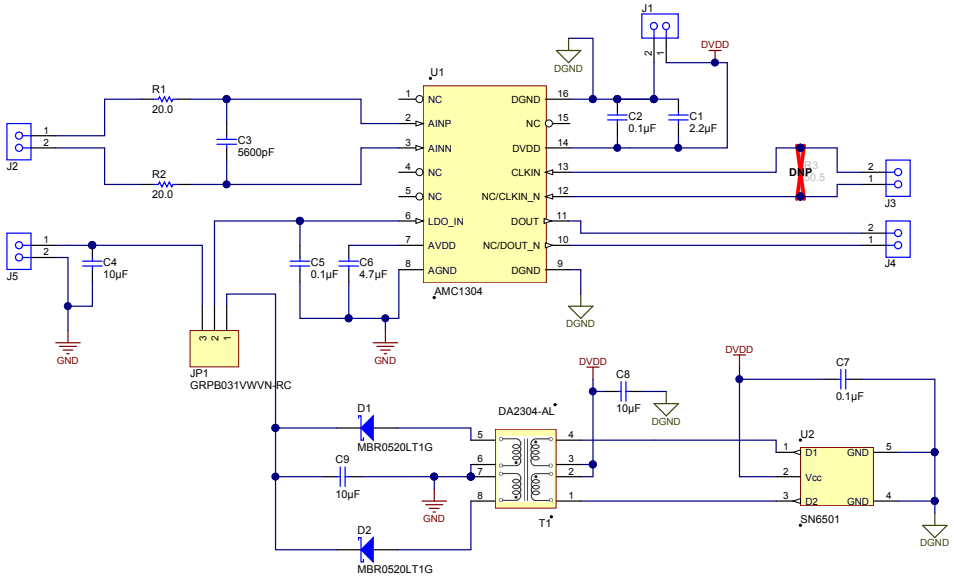
6.3 Bill of Materials

Note that items 14 and 16 of the bill of materials depend on the type of AMC1304 used in the EVM. Resistor R3 is populated only when the AMC1304 used is the AMC1304L05 or the AMC1304L25. R3 is not populated for EVMs that use the AMC1304M05 or AMC1304M25.

Table 3. AMC1304EVM Bill of Materials

Item	Qty	Reference Designator	Description	Manufacturer	Mfr Part Number
1	1	—	Printed circuit board	Any	N/A
2	1	C1	CAP, CERM, 2.2uF, 16V, +/-10%, X7R, 0805	Taiyo Yuden	EMK212B7225KG-T
3	3	C2, C5, C7	CAP, CERM, 0.1uF, 25V, +/-5%, C0G/NP0, 1206	TDK	C3216C0G1E104J
4	1	C3	CAP, CERM, 5600pF, 25V, +/-5%, C0G/NP0, 0805	TDK	C2012C0G1E562J
5	3	C4, C8, C9	CAP, CERM, 10uF, 16V, +/-10%, X5R, 0805	Taiyo Yuden	EMK212BJ106KG-T
6	1	C6	CAP, CERM, 4.7uF, 10V, +/-10%, X5R, 0805	Kemet	C0805C475K8PACTU
7	2	D1, D2	Diode, Schottky, 20V, 0.5A, SOD-123	ON Semiconductor	MBR0520LT1G
8	3	FID1, FID2, FID3	Fiducial mark. There is nothing to buy or mount.	N/A	N/A
9	5	J1, J2, J3, J4, J5	Conn Term Block, 2POS, 3.5mm, TH	Phoenix Contact	1751248
10	1	JP1	Header, 3-Pin	Sullins Connector Solutions	GRPB031VWVN-RC
11	2	R1, R2	RES, 20.0 ohm, 0.1%, 0.1W, 0603	Yageo America	RT0603BRD0720RL
12	1	SH-J1	Shunt, 1.27 mm	Harwin Inc	M50-2000005
13	1	T1	1:2.2 Isolation Transformer	Coilcraft	DA2304-AL
14	1	U1	AMC1304 isolated delta-sigma modulator, 16-pin DW (SOIC)	Texas Instruments	AMC1304
15	1	U2	SN6501 transformer driver	Texas Instruments	SN6501
16	1	R3	RES, 50.5 ohm, 0.1%, 0.1W, 0603. Populated only on EVMs with LVDS interface.	Yageo America	RT0603BRD0750R5L

Revision History	
Revision	Notes



Number: AMC1304EVM	Rev: E1	Designed for: Public Release	Mod. Date: 7/1/2014
SVN Rev: Not in version control		Project Title: AMC1304 Evaluation Module	
Drawn By: Jose Duenas		Sheet Title: Main Schematic	
Engineer: Jose Duenas		Assembly Variant: CMOS_output	Sheet: 2 of 3
		File: AMC1304_Main.SchDoc	Size: B
		Contact: http://www.ti.com/support	

Texas Instruments
http://www.ti.com

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as “components”) are sold subject to TI’s terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI’s terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers’ products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers’ products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI’s goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have ***not*** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products		**Applications**	
Audio	www.ti.com/audio	Automotive and Transportation	www.ti.com/automotive
Amplifiers	amplifier.ti.com	Communications and Telecom	www.ti.com/communications
Data Converters	dataconverter.ti.com	Computers and Peripherals	www.ti.com/computers
DLP® Products	www.dlp.com	Consumer Electronics	www.ti.com/consumer-apps
DSP	dsp.ti.com	Energy and Lighting	www.ti.com/energy
Clocks and Timers	www.ti.com/clocks	Industrial	www.ti.com/industrial
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Security	www.ti.com/security
Power Mgmt	power.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Applications Processors	www.ti.com/omap	**TI E2E Community**	e2e.ti.com
Wireless Connectivity	www.ti.com/wirelessconnectivity		

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265