AMC1304 Family of 20-MHz, Isolated Delta-Sigma Modulators for Shunt-Based Current Measurement

1 Features

- Pin-Compatible Family Optimized for Shunt Resistor Based Current Measurements:
  - ±50-mV or ±250-mV Input Voltage Ranges
  - CMOS or LVDS Digital Interface Options
- Excellent DC Performance Supporting High-Precision Sensing on System Level:
  - Offset Error: ±40 µV or ±150 µV (max)
  - Offset Drift: 1.3 µV/°C (max)
  - Gain Error: ±0.5% (max)
  - Gain Error Drift: ±40 ppm/°C (max)
- Certified Isolation Barrier:
  - Reinforced Isolation Rating
  - VDE V-0884-10, UL1577, and cUL Approved
  - Isolation Voltages: 7000 V_{PEAK}, 10 kV_{SURGE}
  - Working Voltages: 1.5 kV_{DC}, 1.0 $kV_{AC, rms}$
  - Transient Immunity: 15 kV/µs (min)
- High Electromagnetic Field Immunity (see Application Note SLLA181A)
- External 5-MHz to 20-MHz Clock Input for Easier System-Level Synchronization
- LDO Regulator with up to 18-V Input Voltage Range
- Fully Specified Over the Extended Industrial Temperature Range

2 Applications

- Shunt Resistor Based Current Sensing in:
  - Industrial Motor Drives
  - Photovoltaic Inverters
  - Energy Metering

3 Description

The AMC1304 family are precision, delta-sigma (ΔΣ) modulators with the output separated from the input circuitry by a capacitive isolation barrier that is highly resistant to magnetic interference. This barrier is certified to provide reinforced isolation of up to 7000 V_{PEAK} according to the UL1577 and VDE V-0884-10 standards. Used in conjunction with isolated power supplies, the device prevents noise currents on a high common-mode voltage line from entering the local ground and interfering with or damaging sensitive circuitry.

The input of the AMC1304 is optimized for direct connection to shunt resistors or other low voltage level signal sources. The unique low input voltage range of the device allows significant reduction of the power dissipation through the shunt while supporting excellent ac and dc performance. When used with an appropriate external digital filter, the device can be used to achieve 16 bits of resolution with a dynamic range of 76 dB (AMC1304x05) at 78 kSPS.

On the high-side, the modulator is supplied with an integrated LDO regulator that allows an unregulated voltage to be applied between 4 V and 18 V. The isolated digital interface operates from a 3.0-V to 5.5-V supply (DVDD).

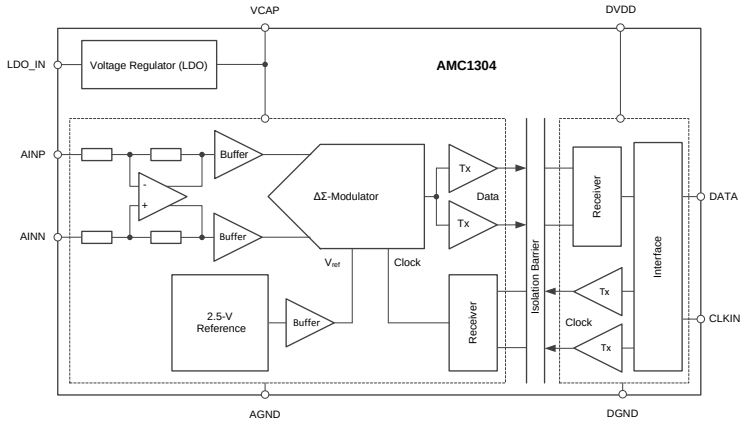
The AMC1304 is available in a wide-body SOIC-16 (DW) package and is specified from –40°C to 125°C.

Device Information(1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
AMC1304	SOIC (16)	10.30 mm × 7.50 mm

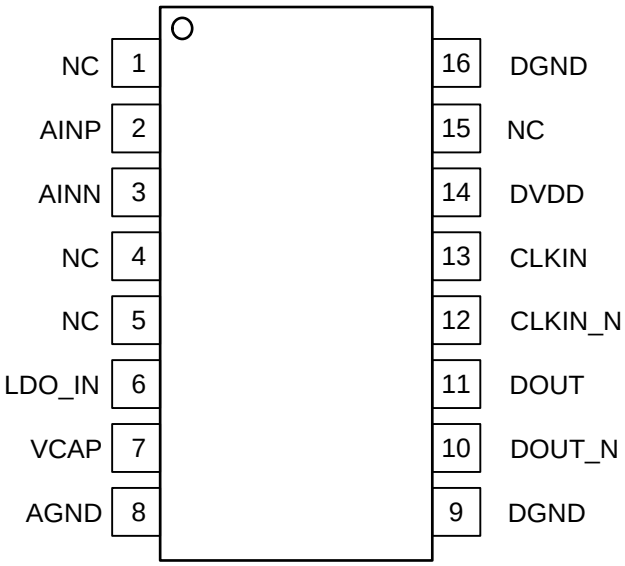
(1) For all available packages, see the orderable addendum at the end of the datasheet.

Simplified Schematic



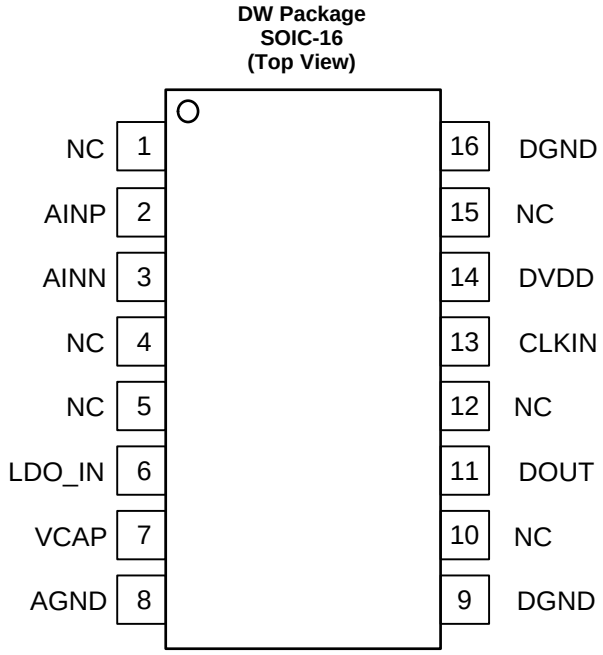
4 Pin Configurations and Functions

DW Package
SOIC-16
(Top View)



NOTE: LVDS interface versions (AMC1304Lx).

DW Package
SOIC-16
(Top View)



NOTE: CMOS interface versions (AMC1304Mx).

Pin Functions

PIN			FUNCTION	DESCRIPTION
NAME	NO.			
	AMC1304Lx (LVDS)	AMC1304Mx (CMOS)		
AINN	3	3	Analog input	Inverting analog signal input
AINP	2	2	Analog input	Noninverting analog signal input
AGND	8	8	Power	High-side ground reference
CLKIN	13	13	Digital input	Modulator clock input
CLKIN_N	12	—	Digital input	Inverted modulator clock input (LVDS interface)
DGND	9, 16	9, 16	Power	Controller-side ground reference
DOUT	11	11	Digital output	Modulator data output
DOUT_N	10	—	Digital output	Inverted modulator data output (LVDS interface)
DVDD	14	14	Power	Controller-side power supply
LDO_IN	6	6	Power	Low dropout regulator input
NC	1	1	—	No connect. Leave floating or connect to VCAP (pin 7).
NC	4, 5	4, 5	—	No connect. For best performance, leave these pins floating. Can be connected to AGND if necessary.
NC	—	10, 12	—	No connect; leave floating (CMOS interface)
NC	15	15	—	No connect. Leave floating or connect to DGND.
VCAP	7	7	Power	High-side power supply output (output of the LDO); connect decoupling capacitor to AGND

PRODUCT PREVIEW

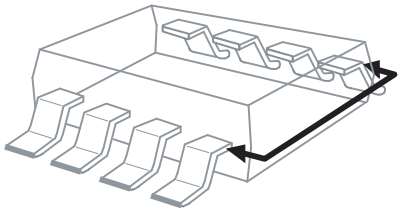
5 Device and Documentation Support

5.1 Device Support

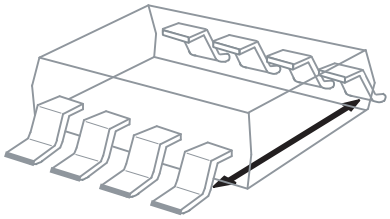
5.1.1 Device Nomenclature

5.1.1.1 Isolation Glossary

Creepage Distance: The shortest path between two conductive input to output leads measured along the surface of the insulation. The shortest distance path is found around the end of the package body.



Clearance: The shortest distance between two conductive input to output leads measured through air (line of sight).



Input-to-Output Barrier Capacitance: The total capacitance between all input pins connected together, and all output pins connected together.

Input-to-Output Barrier Resistance: The total resistance between all input pins connected together, and all output pins connected together.

Primary Circuit: An internal circuit directly connected to an external supply mains or other equivalent source that supplies the primary circuit electric power.

Secondary Circuit: A circuit with no direct connection to primary power that derives its power from a separate isolated source.

Comparative Tracking Index (CTI): CTI is an index used for electrical insulating materials. It is defined as the numerical value of the voltage that causes failure by tracking during standard testing. Tracking is the process that produces a partially conducting path of localized deterioration on or through the surface of an insulating material as a result of the action of electric discharges on or close to an insulation surface. The higher CTI value of the insulating material, the smaller the minimum creepage distance.

Generally, insulation breakdown occurs either through the material, over its surface, or both. Surface failure may arise from flashover or from the progressive degradation of the insulation surface by small localized sparks. Such sparks are the result of the breaking of a surface film of conducting contaminant on the insulation. The resulting break in the leakage current produces an overvoltage at the site of the discontinuity, and an electric spark is generated. These sparks often cause carbonization on insulation material and lead to a carbon track between points of different potential. This process is known as tracking.

Device Support (continued)

5.1.1.1.1 Insulation:

Operational insulation—Insulation needed for the correct operation of the equipment.

Basic insulation—Insulation to provide basic protection against electric shock.

Supplementary insulation—Independent insulation applied in addition to basic insulation in order to ensure protection against electric shock in the event of a failure of the basic insulation.

Double insulation—Insulation comprising both basic and supplementary insulation.

Reinforced insulation—A single insulation system that provides a degree of protection against electric shock equivalent to double insulation.

5.1.1.1.2 Pollution Degree:

Pollution Degree 1—No pollution, or only dry, nonconductive pollution occurs. The pollution has no influence on device performance.

Pollution Degree 2—Normally, only nonconductive pollution occurs. However, a temporary conductivity caused by condensation is to be expected.

Pollution Degree 3—Conductive pollution, or dry nonconductive pollution that becomes conductive because of condensation, occurs. Condensation is to be expected.

Pollution Degree 4—Continuous conductivity occurs as a result of conductive dust, rain, or other wet conditions.

5.1.1.1.3 Installation Category:

Overvoltage Category—This section is directed at insulation coordination by identifying the transient overvoltages that may occur, and by assigning four different levels as indicated in IEC 60664.

1. Signal Level: Special equipment or parts of equipment.
2. Local Level: Portable equipment, etc.
3. Distribution Level: Fixed installation.
4. Primary Supply Level: Overhead lines, cable systems.

Each category should be subject to smaller transients than the previous category.

5.2 Documentation Support

5.2.1 Related Documentation

- Application Report *ISO72x Digital Isolator Magnetic-Field Immunity*, SLLA181
- Application Note *Combining ADS1202 with FPGA Digital Filter for Current Measurement in Motor Control Applications*, SBAA094

5.2.2 Related Links

The table below lists quick access links. Categories include technical documents, support and community resources, tools and software, and quick access to sample or buy.

Table 1. Related Links

PARTS	PRODUCT FOLDER	SAMPLE & BUY	TECHNICAL DOCUMENTS	TOOLS & SOFTWARE	SUPPORT & COMMUNITY
AMC1304L05	Click here	Click here	Click here	Click here	Click here
AMC1304L25	Click here	Click here	Click here	Click here	Click here
AMC1304M05	Click here	Click here	Click here	Click here	Click here
AMC1304M25	Click here	Click here	Click here	Click here	Click here

5.3 Trademarks

All trademarks are the property of their respective owners.

5.4 Electrostatic Discharge Caution

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

5.5 Glossary

SLYZ022 — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

6 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

PRODUCT PREVIEW

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
AMC1304M05DW	PREVIEW	SOIC	DW	16	40	TBD	Call TI	Call TI	-40 to 125		
AMC1304M05DWR	PREVIEW	SOIC	DW	16	2000	TBD	Call TI	Call TI	-40 to 125		
AMC1304M25DW	PREVIEW	SOIC	DW	16	40	TBD	Call TI	Call TI	-40 to 125		
AMC1304M25DWR	PREVIEW	SOIC	DW	16	2000	TBD	Call TI	Call TI	-40 to 125		

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

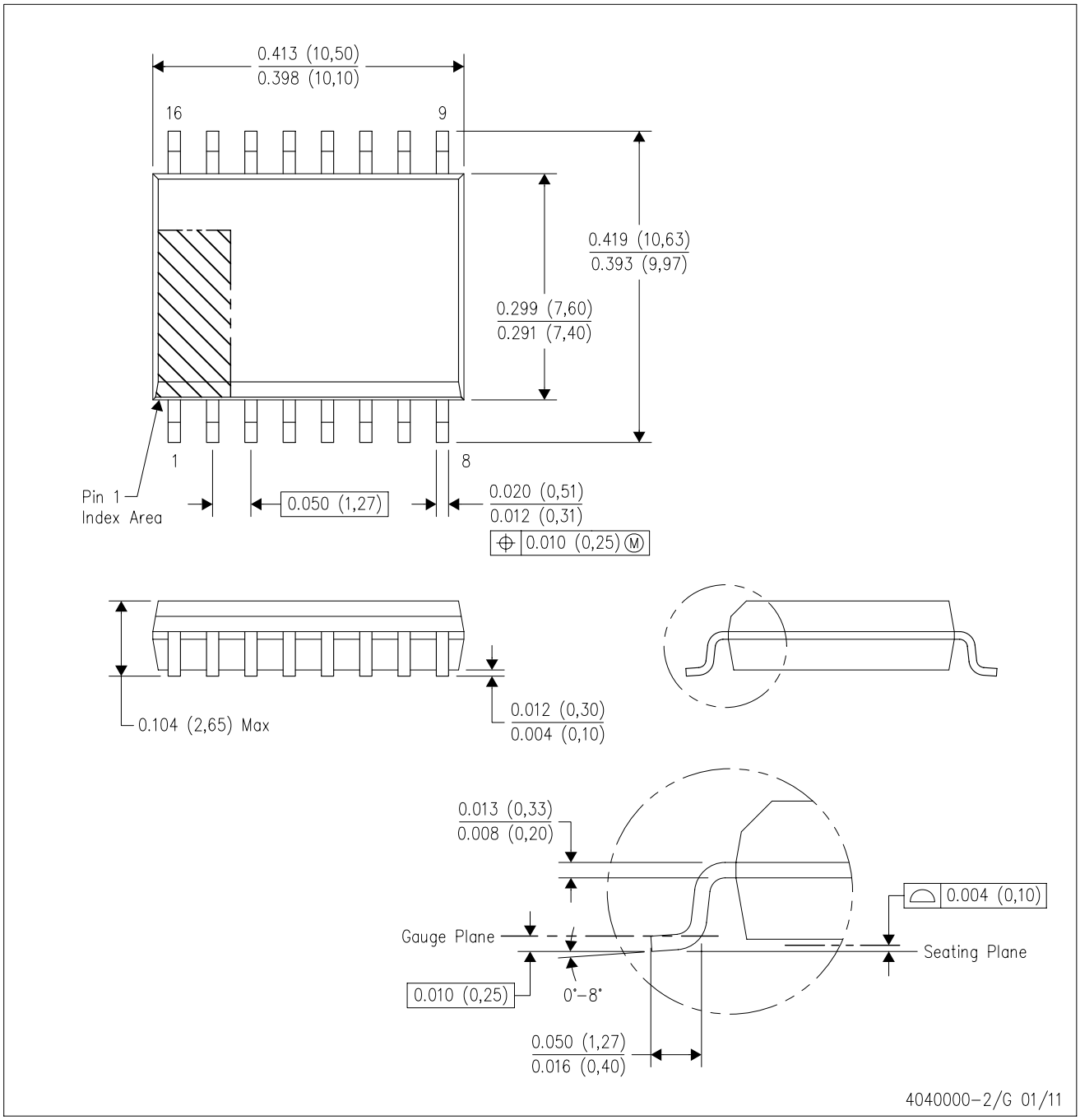
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

DW (R–PDSO–G16) PLASTIC SMALL OUTLINE



NOTES:
A. All linear dimensions are in inches (millimeters). Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
D. Falls within JEDEC MS–013 variation AA.

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