Fully-Differential Isolation Amplifier for Energy Metering

Check for Samples: AMC1100

FEATURES

- **±250-mV Input Voltage Range Optimized for Shunt Resistors**
- **Very Low Nonlinearity: 0.075% max at 5 V**
- **Low Offset Error: 1.5 mV max**
- **Low Noise: 3.1 mV_{RMS} typ**
- **Low High-Side Supply Current: 8 mA max at 5 V**
- **Input Bandwidth: 60 kHz min**
- **Fixed Gain: 8 (0.5% Accuracy)**
- **High Common-Mode Rejection Ratio: 108 dB**
- **Low-Side Operation: 3.3 V**
- **Certified Galvanic Isolation:**
  - **UL1577 and IEC60747-5-2 Approved**
  - **Isolation Voltage: 4250 V_{PEAK}**
  - **Working Voltage: 1200 V_{PEAK}**
  - **Transient Immunity: 2.5 kV/µs min**
- **Typical 10-Year Lifespan at Rated Working Voltage (see Application Report SLLA197)**
- **Fully Specified Over the Extended Industrial Temperature Range**

APPLICATIONS

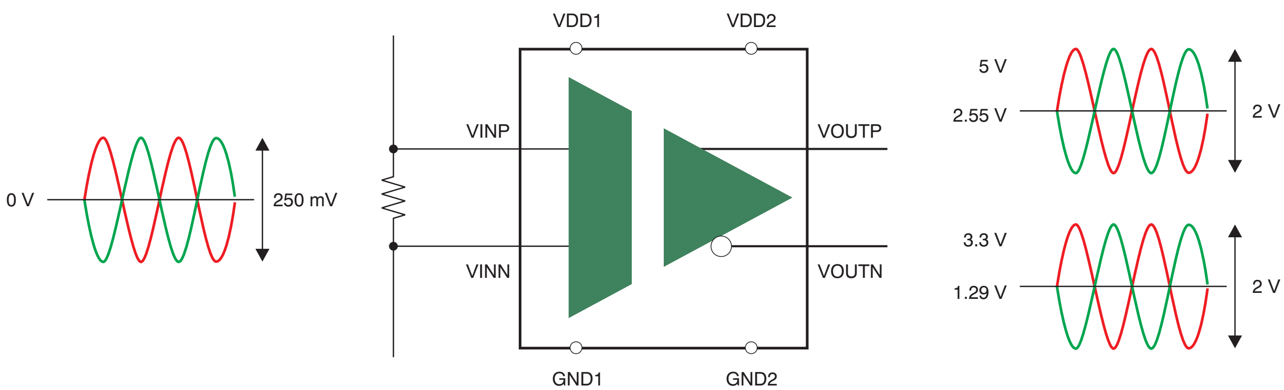
- **Shunt Resistor Based Current Sensing in:**
  - **Energy Meters**
  - **Green Energy**
  - **Power Measurement Applications**

DESCRIPTION

The AMC1100 is a precision isolation amplifier with an output separated from the input circuitry by a silicon dioxide (SiO_2) barrier that is highly resistant to magnetic interference. This barrier has been certified to provide galvanic isolation of up to 4250 V_{PEAK}, according to UL1577 and IEC60747-5-2. Used in conjunction with isolated power supplies, this device prevents noise currents on a high common-mode voltage line from entering the local ground and interfering with or damaging sensitive circuitry.

The AMC1100 input is optimized for direct connection to shunt resistors or other low voltage level signal sources. The excellent performance of the device enables accurate current and voltage measurement in energy-metering applications. The output signal common-mode voltage is automatically adjusted to either the 3-V or 5-V low-side supply.

The AMC1100 is fully specified over the extended industrial temperature range of –40°C to +105°C and is available in the SMD-type, gullwing-8 package.



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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.

PACKAGE AND ORDERING INFORMATION

For the most current package and ordering information see the Package Option Addendum at the end of this document, or visit the device product folder on www.ti.com.

ABSOLUTE MAXIMUM RATINGS(1)

Over the operating ambient temperature range, unless otherwise noted.

		VALUE	UNIT
Supply voltage, VDD1 to GND1 or VDD2 to GND2		–0.5 to 6	V
Analog input voltage at VINP, VINN		GND1 – 0.5 to VDD1 + 0.5	V
Input current to any pin except supply pins		±10	mA
Maximum junction temperature, T_J Max		+150	°C
Electrostatic discharge (ESD) ratings, all pins	Human body model (HBM) JEDEC standard 22, test method A114-C.01	±2500	V
	Charged device model (CDM) JEDEC standard 22, test method C101	±1000	V

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated is not implied. Exposure to absolute maximum rated conditions for extended periods may affect device reliability.

THERMAL INFORMATION

THERMAL METRIC(1)		AMC1100 DUB (SOP) 8 PINS	UNITS
θ_{JA}	Junction-to-ambient thermal resistance	75.1	°C/W
θ_{JCtop}	Junction-to-case (top) thermal resistance	61.6	
θ_{JB}	Junction-to-board thermal resistance	39.8	
ψ_{JT}	Junction-to-top characterization parameter	27.2	
ψ_{JB}	Junction-to-board characterization parameter	39.4	
θ_{JCbot}	Junction-to-case (bottom) thermal resistance	N/A	

(1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, SPRA953.

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REGULATORY INFORMATION

VDE AND IEC	UL
Certified according to IEC 60747-5-2	Recognized under 1577 component recognition program
File number: 40016131	File number: E181974

IEC 60747-5-2 INSULATION CHARACTERISTICS

Over operating free-air temperature range, unless otherwise noted.

PARAMETER		TEST CONDITIONS	VALUE	UNIT
V_{IORM}	Maximum working insulation voltage		1200	V_{PEAK}
V_{PR}	Input-to-output test voltage	Qualification test: after input/output safety test subgroup 2/3 $V_{PR} = V_{IORM} \times 1.2$, t = 10 s, partial discharge < 5 pC	1140	V_{PEAK}
		Qualification test: method A, after environmental tests subgroup 1, $V_{PR} = V_{IORM} \times 1.6$, t = 10 s, partial discharge < 5 pC	1920	V_{PEAK}
		100% production test: method B1, $V_{PR} = V_{IORM} \times 1.875$, t = 1 s, partial discharge < 5 pC	2250	V_{PEAK}
V_{IOTM}	Transient overvoltage	Qualification test: t = 60 s	4250	V_{PEAK}
V_{ISO}	Insulation voltage per UL	Qualification test: $V_{TEST} = V_{ISO}$, t = 60 s	4250	V_{PEAK}
		100% production test: $V_{TEST} = 1.2 \times V_{ISO}$, t = 1 s	5100	V_{PEAK}
R_S	Insulation resistance	V_{IO} = 500 V at T_S	$> 10^9$	Ω
PD	Pollution degree		2	°

IEC SAFETY LIMITING VALUES

Safety limiting intends to prevent potential damage to the isolation barrier upon failure of input or output (I/O) circuitry. I/O circuitry failure can allow low resistance to either ground or supply and, without current limiting, dissipate sufficient power to overheat the die and damage the isolation barrier, thus potentially leading to secondary system failures.

The safety-limiting constraint is the operating virtual junction temperature range specified in the Absolute Maximum Ratings table. The power dissipation and junction-to-air thermal impedance of the device installed in the application hardware determine the junction temperature. The assumed junction-to-air thermal resistance in the Thermal Information table is that of a device installed in the JESD51-3, *Low Effective Thermal Conductivity Test Board for Leaded Surface-Mount Packages* and is conservative. The power is the recommended maximum input voltage times the current. The junction temperature is then the ambient temperature plus the power times the junction-to-air thermal resistance.

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_S	Safety input, output, or supply current	θ_{JA} = 246°C/W, V_{IN} = 5.5 V, T_J = +150°C, T_A = +25°C			10	mA
T_C	Maximum-case temperature				+150	°C

IEC 61000-4-5 RATINGS

PARAMETER		TEST CONDITIONS	VALUE	UNIT
V_{IOSM}	Surge immunity	1.2-µs or 50-µs voltage surge and 8-µs or 20-µs current surge	±6000	V

IEC 60664-1 RATINGS

PARAMETER	TEST CONDITIONS	SPECIFICATION
Basic isolation group	Material group	II
Installation classification	Rated mains voltage ≤ 150 V_{RMS}	I-IV
	Rated mains voltage ≤ 300 V_{RMS}	I-IV
	Rated mains voltage ≤ 400 V_{RMS}	I-III
	Rated mains voltage < 600 V_{RMS}	I-III

PACKAGE CHARACTERISTICS[1]

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
L(I01)	Minimum air gap (clearance)	Shortest terminal-to-terminal distance through air	7			mm
L(I02)	Minimum external tracking (creepage)	Shortest terminal-to-terminal distance across package surface	7			mm
CTI	Tracking resistance (comparative tracking index)	DIN IEC 60112 and VDE 0303 part 1	> 400			V
	Minimum internal gap (internal clearance)	Distance through insulation	0.014			mm
R_{IO}	Isolation resistance	Input to output, V_{IO} = 500 V, all pins on each side of the barrier tied together to create a two-terminal device, T_A < +85°C		> 10^{12}		Ω
		Input to output, V_{IO} = 500 V, +85°C ≤ T_A < T_A max		> 10^{11}		Ω
C_{IO}	Barrier capacitance input to output	V_I = 0.5 V_{PP} at 1 MHz		1.2		pF
C_I	Input capacitance to ground	V_I = 0.5 V_{PP} at 1 MHz		3		pF

(1) Creepage and clearance requirements should be applied according to the specific equipment isolation standards of a specific application. Care should be taken to maintain the creepage and clearance distance of the board design to ensure that the mounting pads of the isolator on the printed circuit board (PCB) do not reduce this distance. Creepage and clearance on a PCB become equal according to the measurement techniques shown in the *Isolation Glossary* section. Techniques such as inserting grooves or ribs on the PCB are used to help increase these specifications.

ELECTRICAL CHARACTERISTICS

All minimum and maximum specifications are at T_A = –40°C to +105°C and are within the specified voltage range, unless otherwise noted. Typical values are at T_A = +25°C, VDD1 = 5 V, and VDD2 = 3.3 V.

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
INPUT						
	Maximum input voltage before clipping	VINP – VINN		±320		mV
	Differential input voltage	VINP – VINN	–250		+250	mV
V_{CM}	Common-mode operating range		-0.16		VDD1	V
V_{OS}	Input offset voltage		–1.5	±0.2	+1.5	mV
TCV_{OS}	Input offset thermal drift		–10	±1.5	+10	µV/K
CMRR	Common-mode rejection ratio	V_{IN} from 0 V to 5 V at 0 Hz		108		dB
		V_{IN} from 0 V to 5 V at 50 kHz		95		dB
C_{IN}	Input capacitance to GND1	VINP or VINN		3		pF
C_{IND}	Differential input capacitance			3.6		pF
R_{IN}	Differential input resistance			28		kΩ
	Small-signal bandwidth		60	100		kHz
OUTPUT						
	Nominal gain			8		
G_{ERR}	Gain error	Initial, at T_A = +25°C	–0.5	±0.05	+0.5	%
			–1	±0.05	+1	%
TCG_{ERR}	Gain error thermal drift			±56		ppm/K
	Nonlinearity	4.5 V ≤ VDD2 ≤ 5.5 V	–0.075	±0.015	+0.075	%
		2.7 V ≤ VDD2 ≤ 3.6 V	–0.1	±0.023	+0.1	%
	Nonlinearity thermal drift			2.4		ppm/K
	Output noise	VINP = VINN = 0 V		3.1		mV_{RMS}
PSRR	Power-supply rejection ratio	vs VDD1, 10-kHz ripple		80		dB
		vs VDD2, 10-kHz ripple		61		dB
	Rise-and-fall time	0.5-V step, 10% to 90%		3.66	6.6	µs

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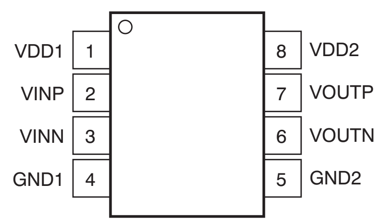
ELECTRICAL CHARACTERISTICS (continued)

All minimum and maximum specifications are at T_A = –40°C to +105°C and are within the specified voltage range, unless otherwise noted. Typical values are at T_A = +25°C, VDD1 = 5 V, and VDD2 = 3.3 V.

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
OUTPUT (continued)						
	V_{IN} to V_{OUT} signal delay	0.5-V step, 50% to 10%, unfiltered output		1.6	3.3	µs
		0.5-V step, 50% to 50%, unfiltered output		3.15	5.6	µs
		0.5-V step, 50% to 90%, unfiltered output		5.26	9.9	µs
CMTI	Common-mode transient immunity	V_{CM} = 1 kV	2.5	3.75		kV/µs
	Output common-mode voltage	2.7 V ≤ VDD2 ≤ 3.6 V	1.15	1.29	1.45	V
		4.5 V ≤ VDD2 ≤ 5.5 V	2.4	2.55	2.7	V
	Short-circuit current			20		mA
R_{OUT}	Output resistance			2.5		Ω
POWER SUPPLY						
VDD1	High-side supply voltage		4.5	5.0	5.5	V
VDD2	Low-side supply voltage		2.7	5.0	5.5	V
I_{DD1}	High-side supply current			5.4	8	mA
I_{DD2}	Low-side supply current	2.7 V < VDD2 < 3.6 V		3.8	6	mA
		4.5 V < VDD2 < 5.5 V		4.4	7	mA
P_{DD1}	High-side power dissipation			27.0	44.0	mW
P_{DD2}	Low-side power dissipation	2.7 V < VDD2 < 3.6 V		11.4	21.6	mW
		4.5 V < VDD2 < 5.5 V		22.0	38.5	mW

PIN CONFIGURATION

DUB PACKAGE
SOP-8
(TOP VIEW)



PIN DESCRIPTIONS

PIN NAME	PIN NO	FUNCTION	DESCRIPTION
GND1	4	Power	High-side analog ground
GND2	5	Power	Low-side analog ground
VDD1	1	Power	High-side power supply
VDD2	8	Power	Low-side power supply
VINN	3	Analog input	Inverting analog input
VINP	2	Analog input	Noninverting analog input
VOUTN	6	Analog output	Inverting analog output
VOUTP	7	Analog output	Noninverting analog output

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TYPICAL CHARACTERISTICS

At VDD1 = VDD2 = 5 V, VINP = –250 mV to +250 mV, and VINN = 0 V, unless otherwise noted.

INPUT OFFSET vs HIGH-SIDE SUPPLY VOLTAGE

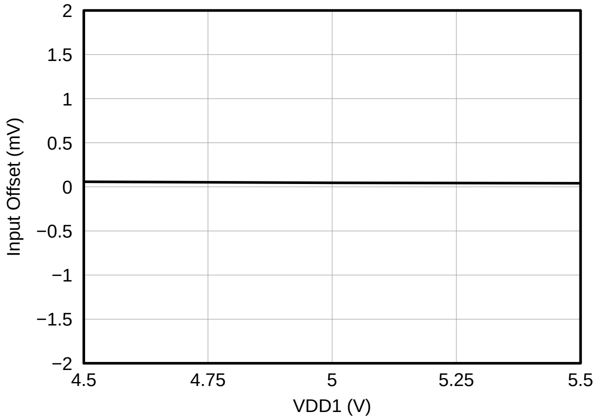

Figure 1.

INPUT OFFSET vs LOW-SIDE SUPPLY VOLTAGE

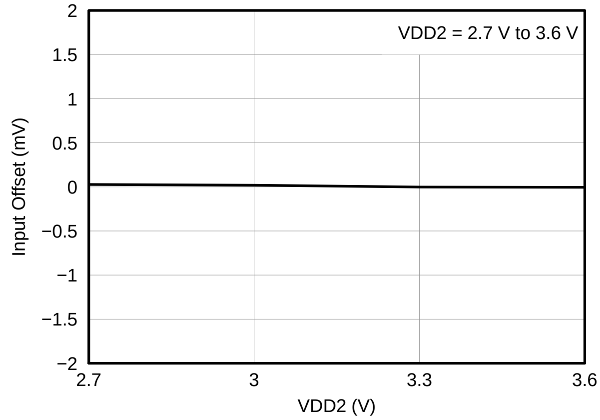

Figure 2.

INPUT OFFSET vs LOW-SIDE SUPPLY VOLTAGE

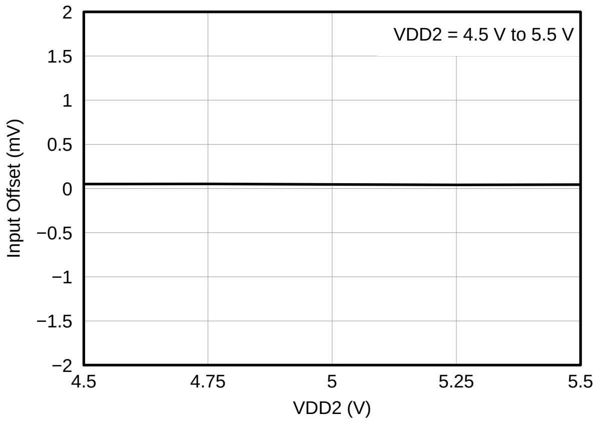

Figure 3.

INPUT OFFSET vs TEMPERATURE

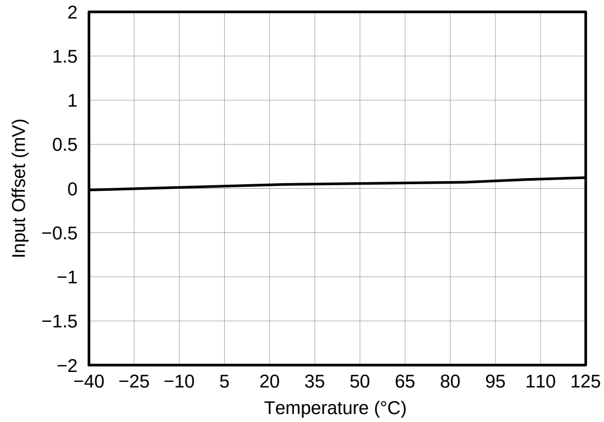

Figure 4.

COMMON-MODE REJECTION RATIO vs INPUT FREQUENCY

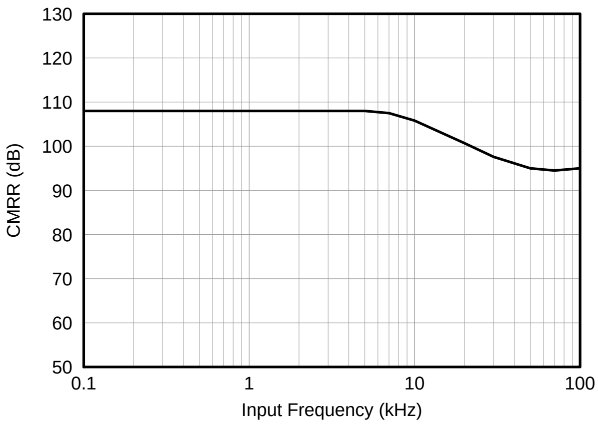

Figure 5.

INPUT CURRENT vs INPUT VOLTAGE

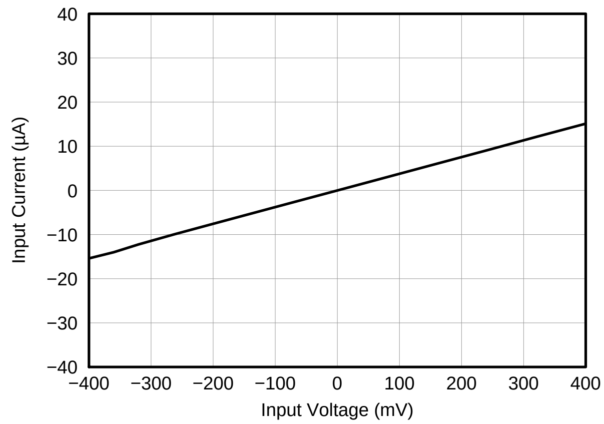

Figure 6.

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TYPICAL CHARACTERISTICS (continued)

At VDD1 = VDD2 = 5 V, VINP = –250 mV to +250 mV, and VINN = 0 V, unless otherwise noted.

INPUT BANDWIDTH vs TEMPERATURE

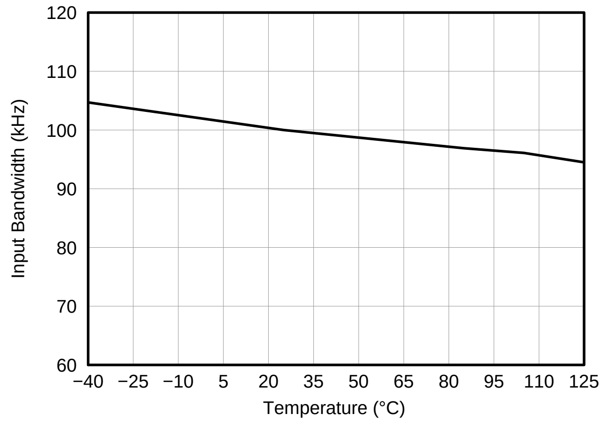

Figure 7.

GAIN ERROR vs HIGH-SIDE SUPPLY VOLTAGE

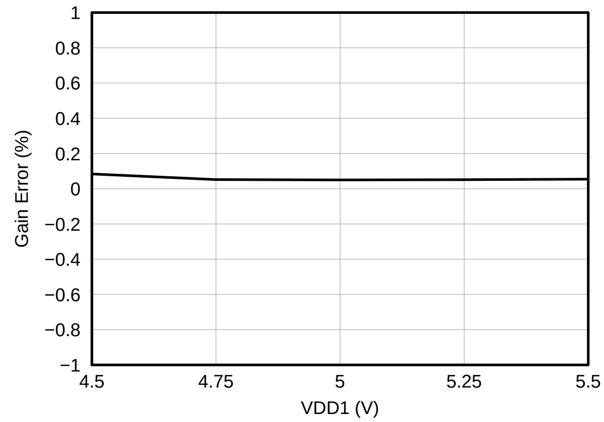

Figure 8.

GAIN ERROR vs LOW-SIDE SUPPLY VOLTAGE

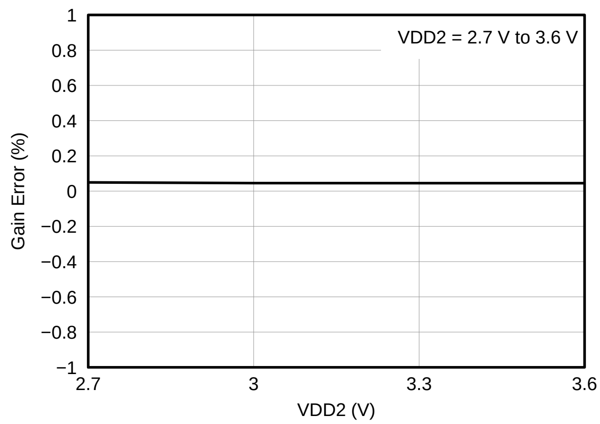

Figure 9.

GAIN ERROR vs LOW-SIDE SUPPLY VOLTAGE

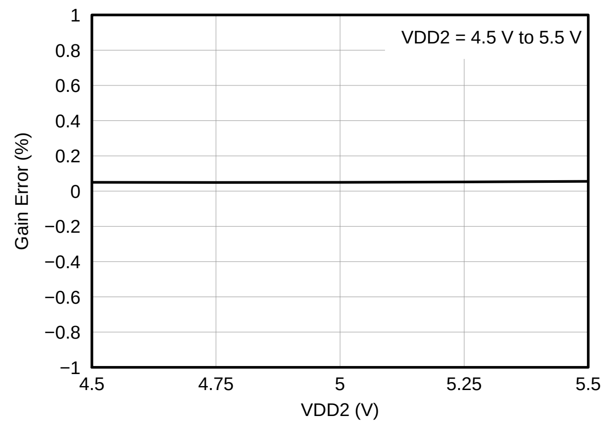

Figure 10.

GAIN ERROR vs TEMPERATURE

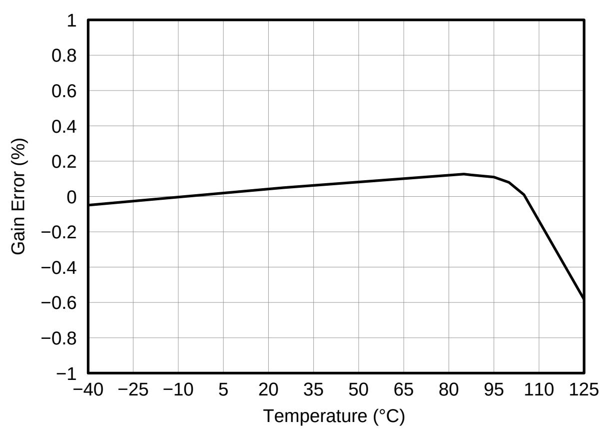

Figure 11.

NORMALIZED GAIN vs INPUT FREQUENCY

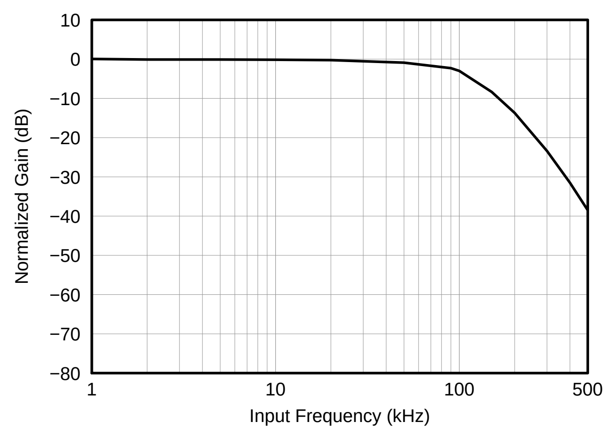

Figure 12.

TYPICAL CHARACTERISTICS (continued)

At VDD1 = VDD2 = 5 V, VINP = –250 mV to +250 mV, and VINN = 0 V, unless otherwise noted.

OUTPUT PHASE vs INPUT FREQUENCY

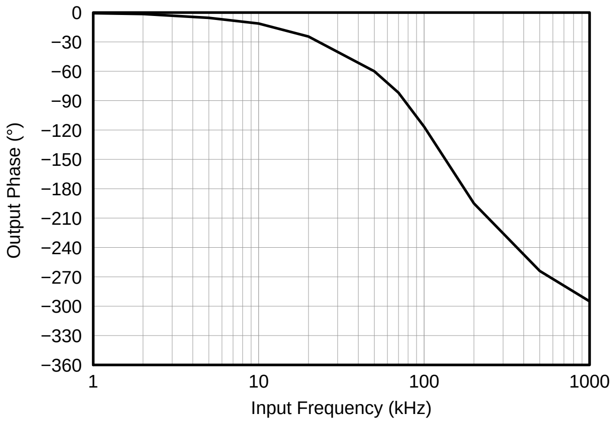

Figure 13.

OUTPUT VOLTAGE vs INPUT VOLTAGE

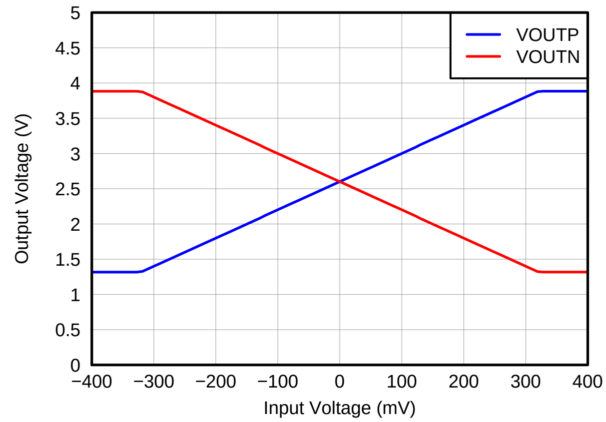

Figure 14.

OUTPUT VOLTAGE vs INPUT VOLTAGE

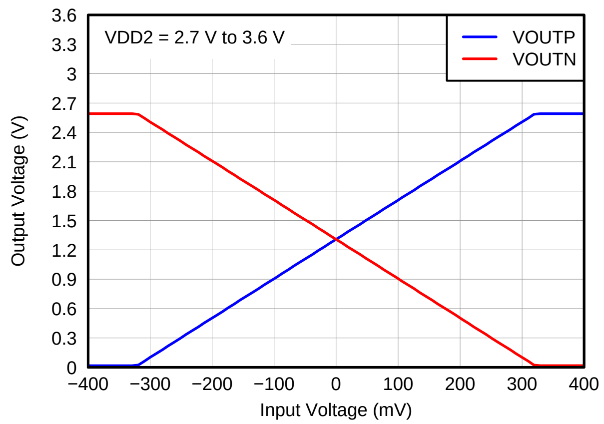

Figure 15.

NONLINEARITY vs HIGH-SIDE SUPPLY VOLTAGE

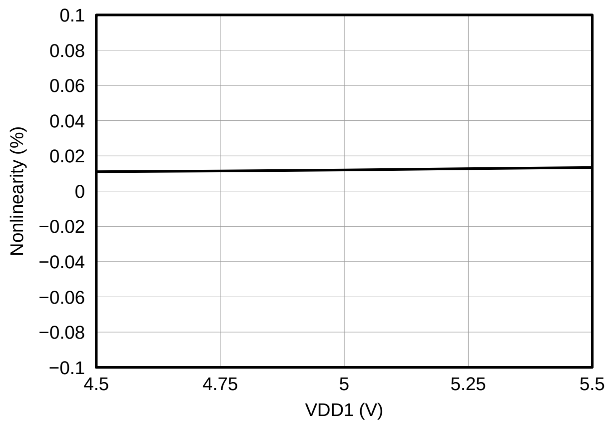

Figure 16.

NONLINEARITY vs LOW-SIDE SUPPLY VOLTAGE

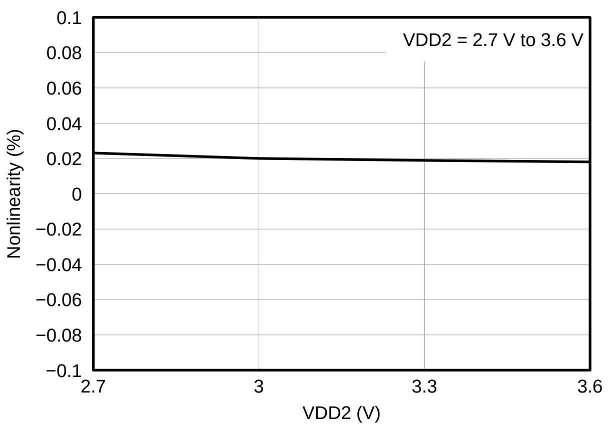

Figure 17.

NONLINEARITY vs LOW-SIDE SUPPLY VOLTAGE

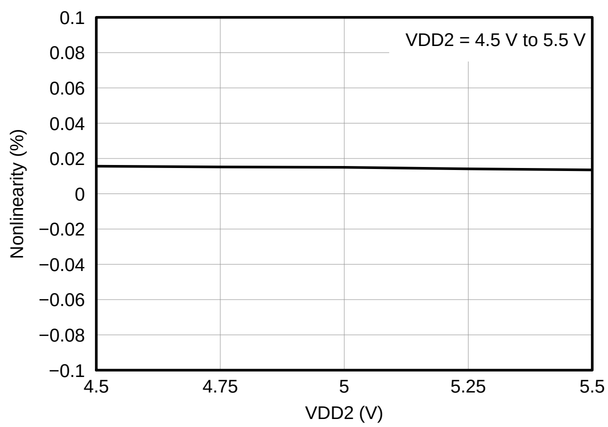

Figure 18.

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TYPICAL CHARACTERISTICS (continued)

At VDD1 = VDD2 = 5 V, VINP = –250 mV to +250 mV, and VINN = 0 V, unless otherwise noted.

NONLINEARITY
vs INPUT VOLTAGE

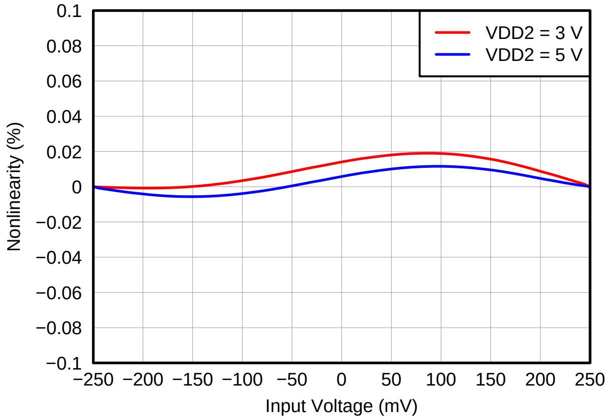

Figure 19.

NONLINEARITY
vs TEMPERATURE

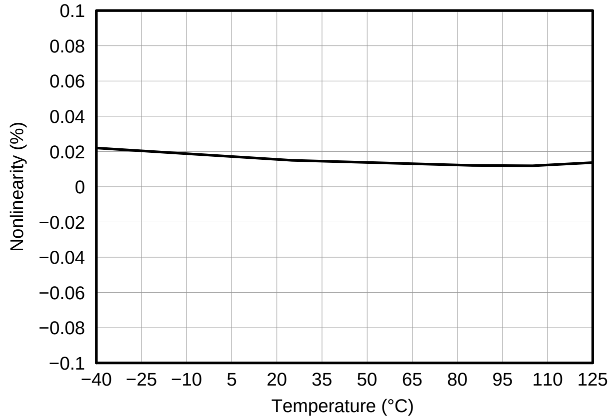

Figure 20.

OUTPUT NOISE DENSITY
vs FREQUENCY

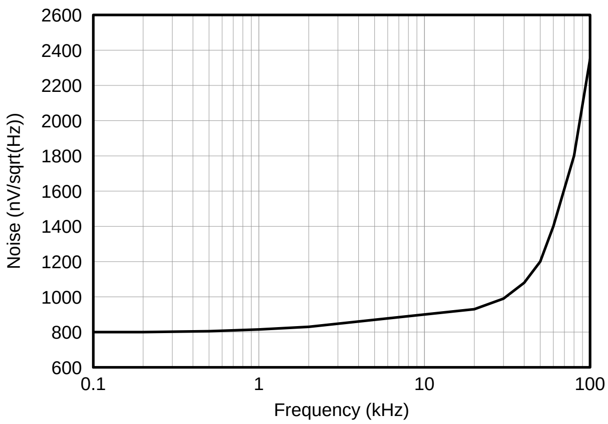

Figure 21.

POWER-SUPPLY REJECTION RATIO
vs RIPPLE FREQUENCY

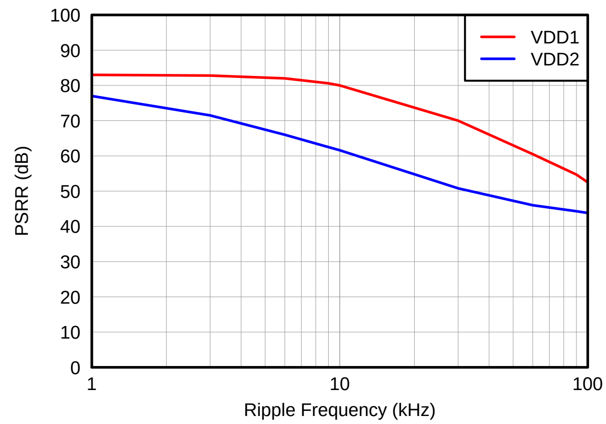

Figure 22.

OUTPUT RISE AND FALL TIME
vs TEMPERATURE

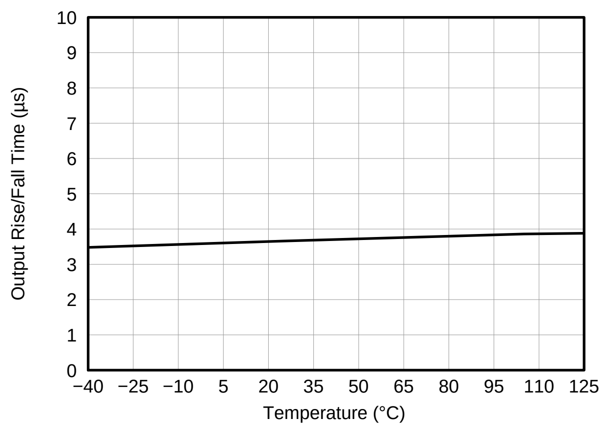

Figure 23.

FULL-SCALE
STEP RESPONSE

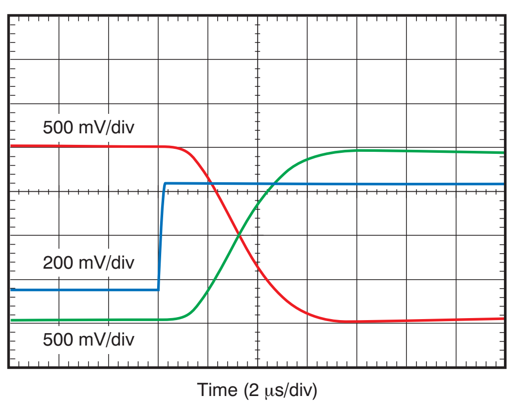

Figure 24.

TYPICAL CHARACTERISTICS (continued)

At VDD1 = VDD2 = 5 V, VINP = –250 mV to +250 mV, and VINN = 0 V, unless otherwise noted.

OUTPUT SIGNAL DELAY TIME vs TEMPERATURE

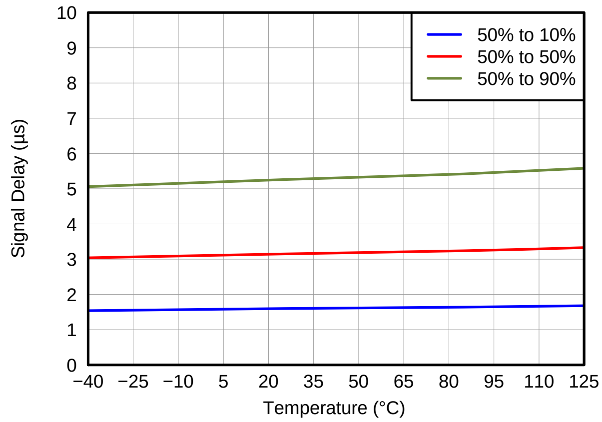

Figure 25.

OUTPUT COMMON-MODE VOLTAGE vs LOW-SIDE SUPPLY VOLTAGE

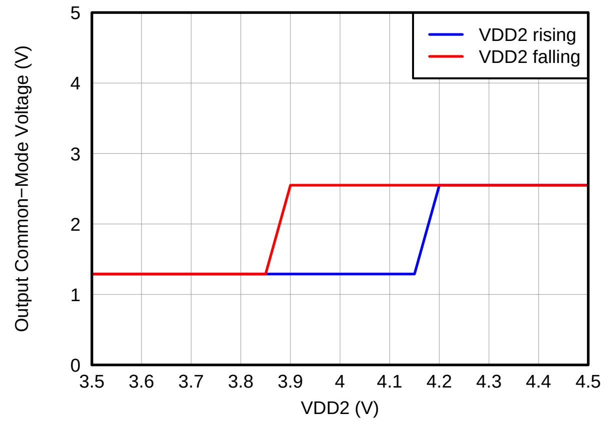

Figure 26.

OUTPUT COMMON-MODE VOLTAGE vs TEMPERATURE

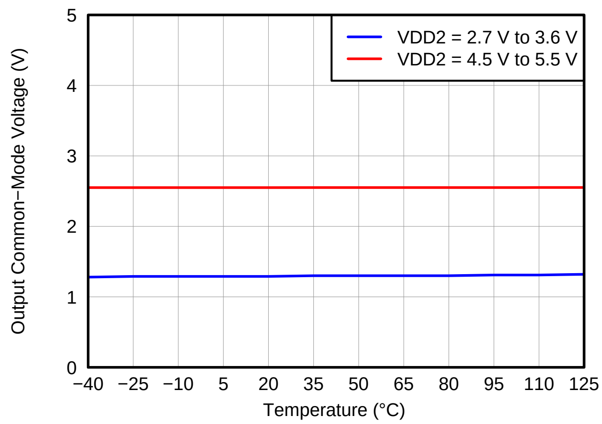

Figure 27.

SUPPLY CURRENT vs SUPPLY VOLTAGE

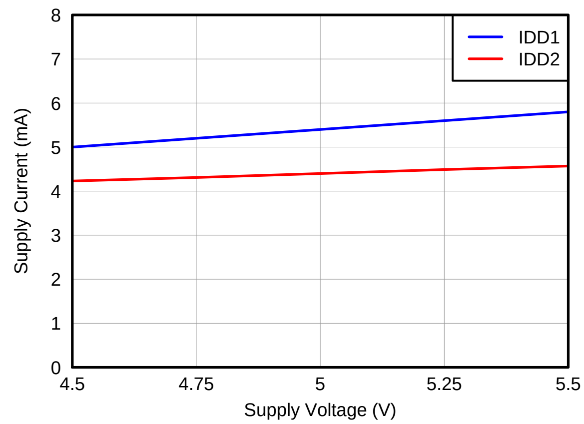

Figure 28.

LOW-SIDE SUPPLY CURRENT vs LOW-SIDE SUPPLY VOLTAGE

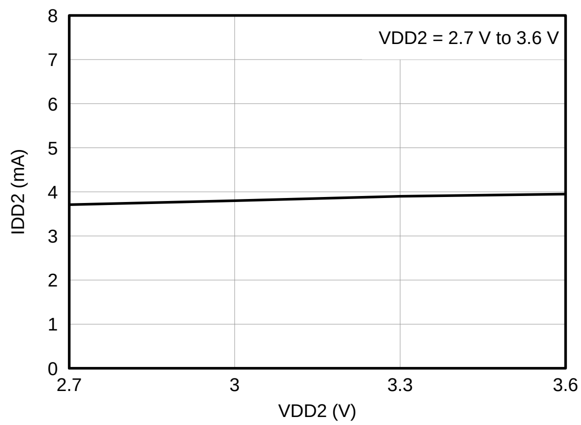

Figure 29.

SUPPLY CURRENT vs TEMPERATURE

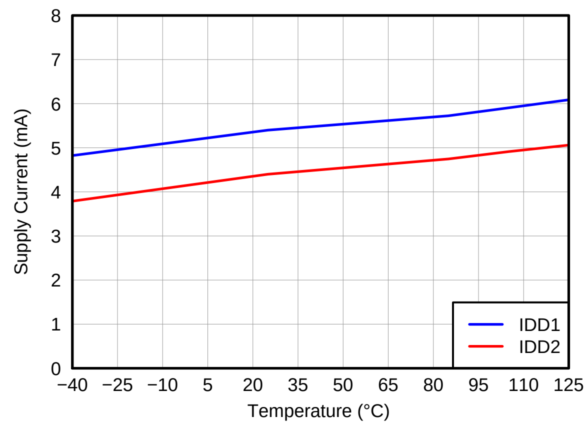

Figure 30.

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THEORY OF OPERATION

INTRODUCTION

The differential analog input of the AMC1100 is a switched-capacitor circuit based on a second-order modulator stage that digitizes the input signal into a 1-bit output stream. The device compares the differential input signal (V_{IN} = VINP – VINN) against the internal reference of 2.5 V using internal capacitors that are continuously charged and discharged with a typical frequency of 10 MHz. With the S1 switches closed, C_{IND} charges to the voltage difference across VINP and VINN. For the discharge phase, both S1 switches open first and then both S2 switches close. C_{IND} discharges to approximately AGND + 0.8 V during this phase. Figure 31 shows the simplified equivalent input circuitry.

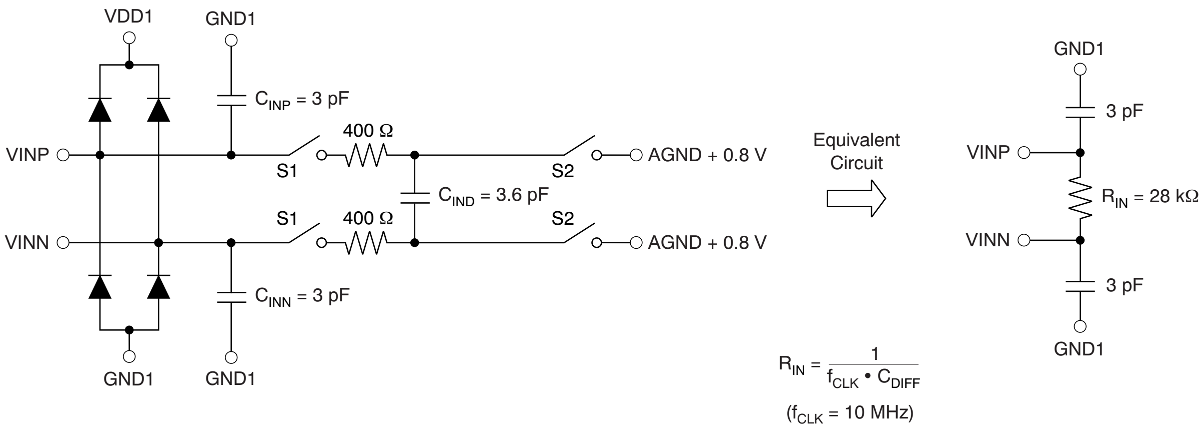


Figure 31. Equivalent Input Circuit

The analog input range is tailored to directly accommodate a voltage drop across a shunt resistor used for current sensing. However, there are two restrictions on the analog input signals, VINP and VINN. If the input voltage exceeds the range AGND – 0.5 V to AVDD + 0.5 V, the input current must be limited to 10 mA to prevent the implemented input protection diodes from damage. In addition, the device linearity and noise performance are ensured only when the differential analog input voltage remains within ±250 mV.

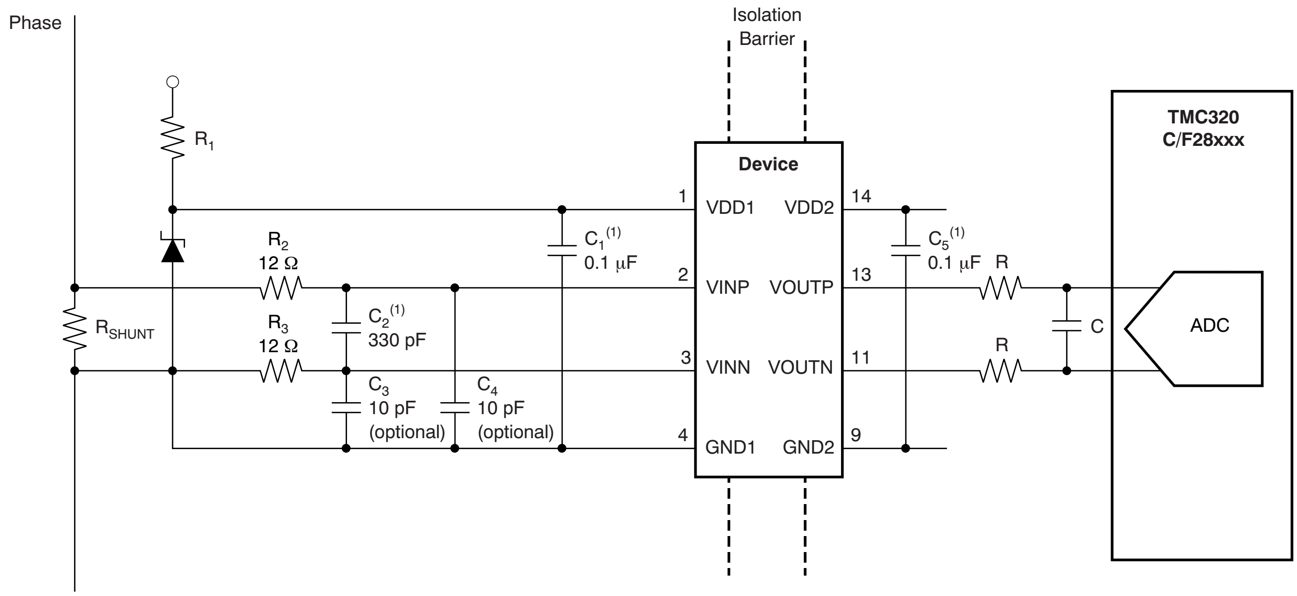
The isolated digital bit stream is processed by a third-order analog filter on the low-side and presented as a differential output of the device.

The SiO_2-based capacitive isolation barrier supports a high level of magnetic field immunity, as described in application report SLLA181, *ISO72x Digital Isolator Magnetic-Field Immunity* (available for download at www.ti.com).

APPLICATION INFORMATION

CURRENT MEASUREMENT

A typical operation of the AMC1100 is a current-measurement application, as shown in Figure 32. Measurement of the current through the phase of a power line is done via the shunt resistor R_{SHUNT} (in this case, a two-terminal shunt). For better performance, the differential signal is filtered using RC filters (components R_2, R_3, and C_2). Optionally, C_3 and C_4 can be used to reduce charge dumping from the inputs. In this case, care should be taken when choosing the quality of these capacitors; mismatch in values of these capacitors leads to a common-mode error at the modulator input.



(1) Place these capacitors as close as possible to the AMC1100.

Figure 32. Typical Application Diagram for the AMC1100

The high-side power supply for the AMC1100 (VDD1) is derived from the system supply. For lowest cost, a Zener diode can be used to limit the voltage to 5 V ± 10%. A 0.1-µF decoupling capacitor is recommended for filtering this power-supply path. This capacitor (C_1 in Figure 32) should be placed as close as possible to the VDD1 pin for best performance. If better filtering is required, an additional 1-µF to 10-µF capacitor can be used. For higher power efficiency, a step-down converter can be used (such as the TPS62120) to generate the AMC1100 supply voltage.

The floating ground reference (GND1) is derived from the end of the shunt resistor, which is connected to the negative input of the AMC1100 (VINN). If a four-terminal shunt is used, the inputs of the AMC1100 are connected to the inner leads while GND1 is connected to one of the outer shunt leads. The differential input of the AMC1100 ensures accurate operation even in noisy environments.

The differential output of the AMC1100 can either directly drive an analog-to-digital converter (ADC) input or can be further filtered before being processed by the ADC.

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As shown in Figure 33, it is recommended to place the bypass and filter capacitors as close as possible to the AMC1100 to ensure best performance.

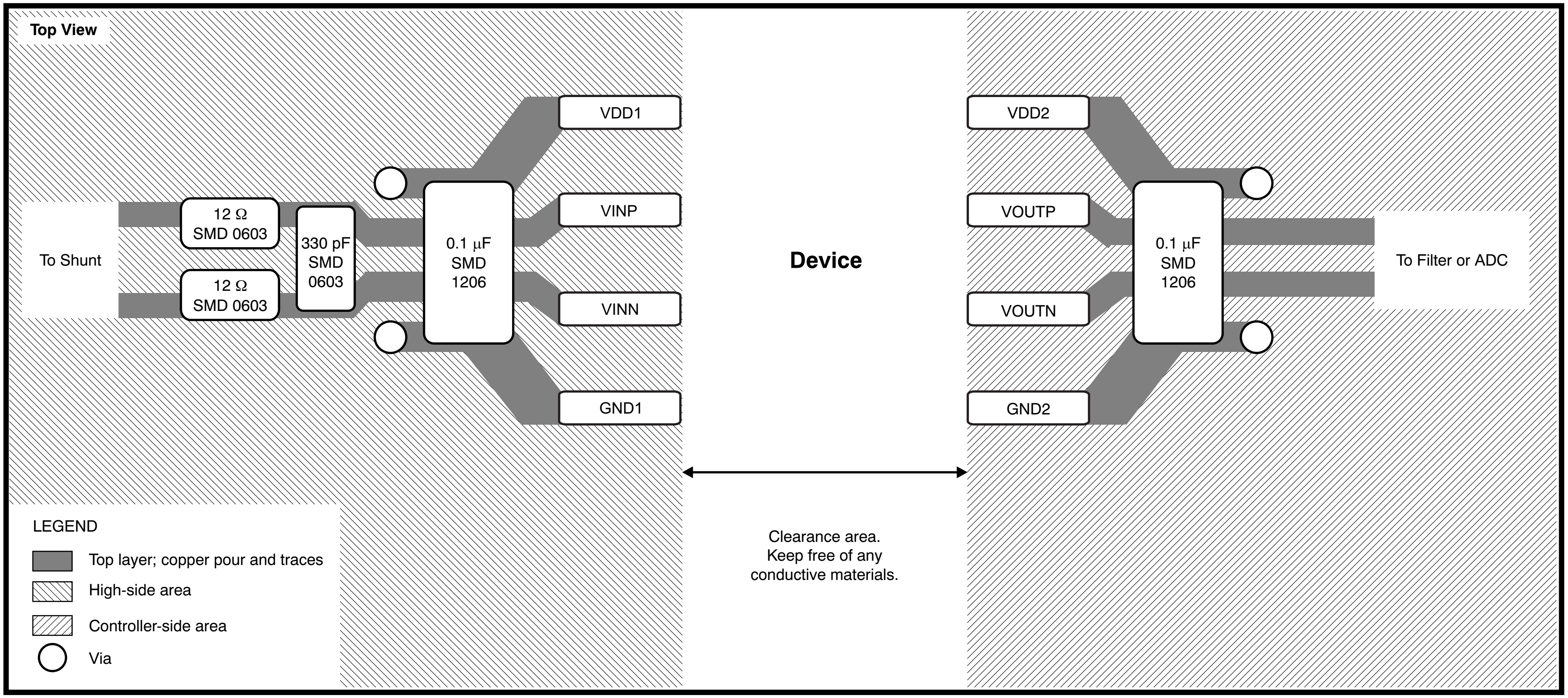

Figure 33. AMC1100 Layout Recommendation

To maintain the isolation barrier and the common-mode transient immunity (CMTI) of the device, the distance between the high-side ground (GND1) and the low-side ground (GND2) should be kept at maximum; that is the entire area underneath the device should be kept free of any conducting materials.

VOLTAGE MEASUREMENT

The AMC1100 can also be used for isolated voltage measurement applications, as shown in a simplified way in Figure 34. In such applications, usually a resistor divider (R_1 and R_2 in Figure 34) is used to match the relatively small input voltage range of the AMC1100. R_2 and the AMC1100 input resistance (R_{IN}) also create a resistance divider that results in additional gain error. With the assumption that R_1 and R_{IN} have a considerably higher value than R_2, the resulting total gain error can be estimated using Equation 1:

$$G_{ERRTOT} = G_{ERR} + \frac{R_2}{R_{IN}} \tag{1}$$

Where G_{ERR} = device gain error.

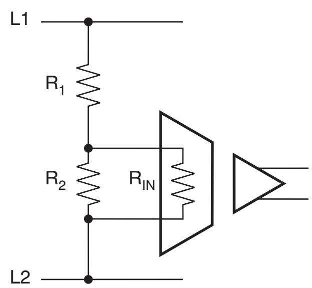

Figure 34. Voltage Measurement Application

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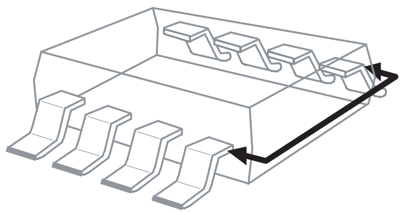
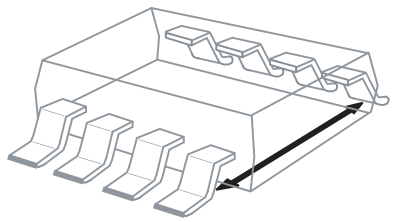
ISOLATION GLOSSARY

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 terminals connected together, and all output terminals connected together.

Input-to-Output Barrier Resistance: The total resistance between all input terminals connected together, and all output terminals 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 insulation surface degradation by small localized sparks. Such sparks result from a surface film of a conducting contaminant breaking 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*.

Insulation:

Operational insulation—Insulation needed for correct equipment operation.

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.

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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.

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.

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PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/ Ball Finish	MSL Peak Temp (3)	Samples (Requires Login)
AMC1100DUB	ACTIVE	SOP	DUB	8	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	
AMC1100DUBR	ACTIVE	SOP	DUB	8	350	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	

(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.

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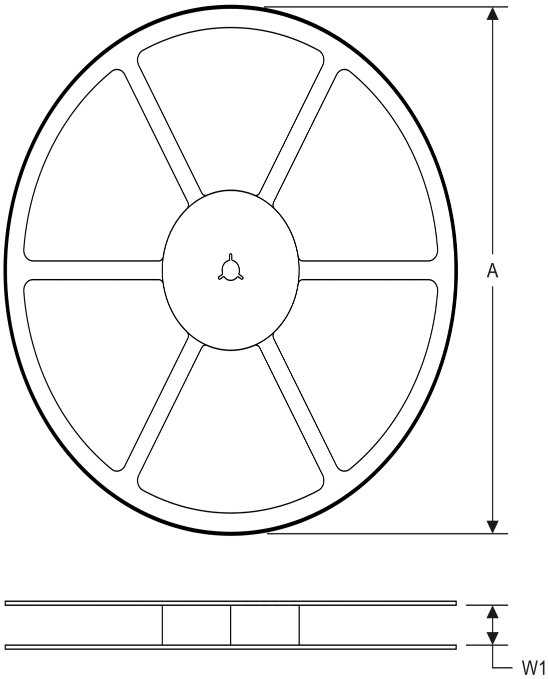
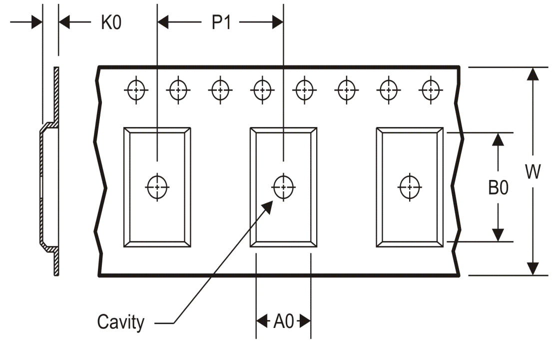
TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



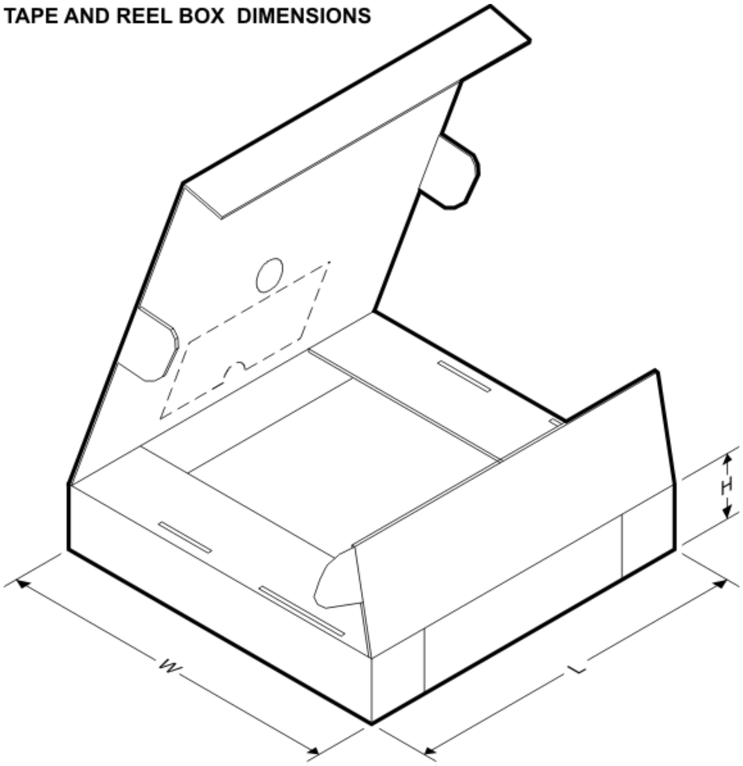
A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

TAPE AND REEL INFORMATION

*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
AMC1100DUBR	SOP	DUB	8	350	330.0	24.4	10.9	10.01	5.85	16.0	24.0	Q1

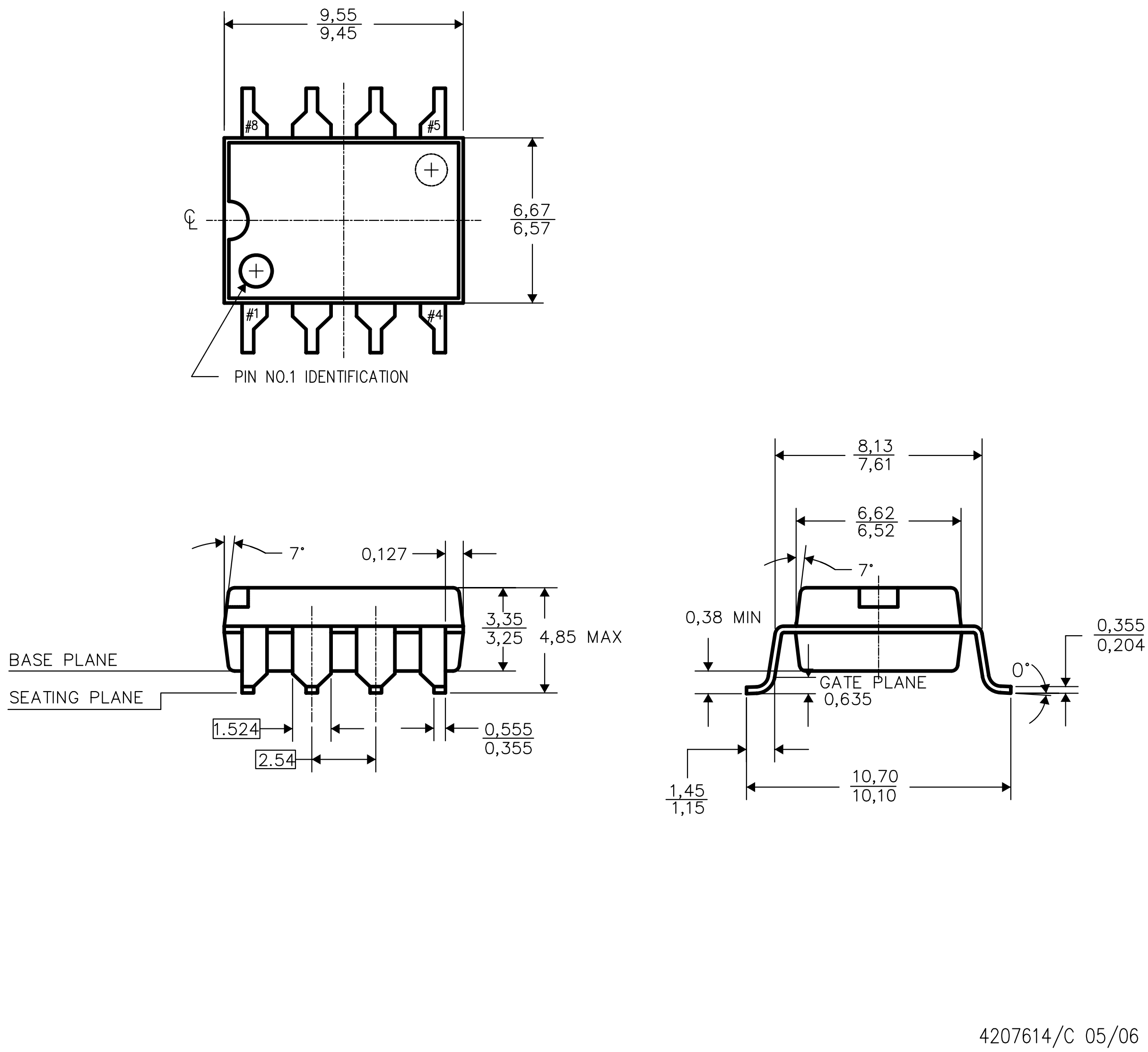
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

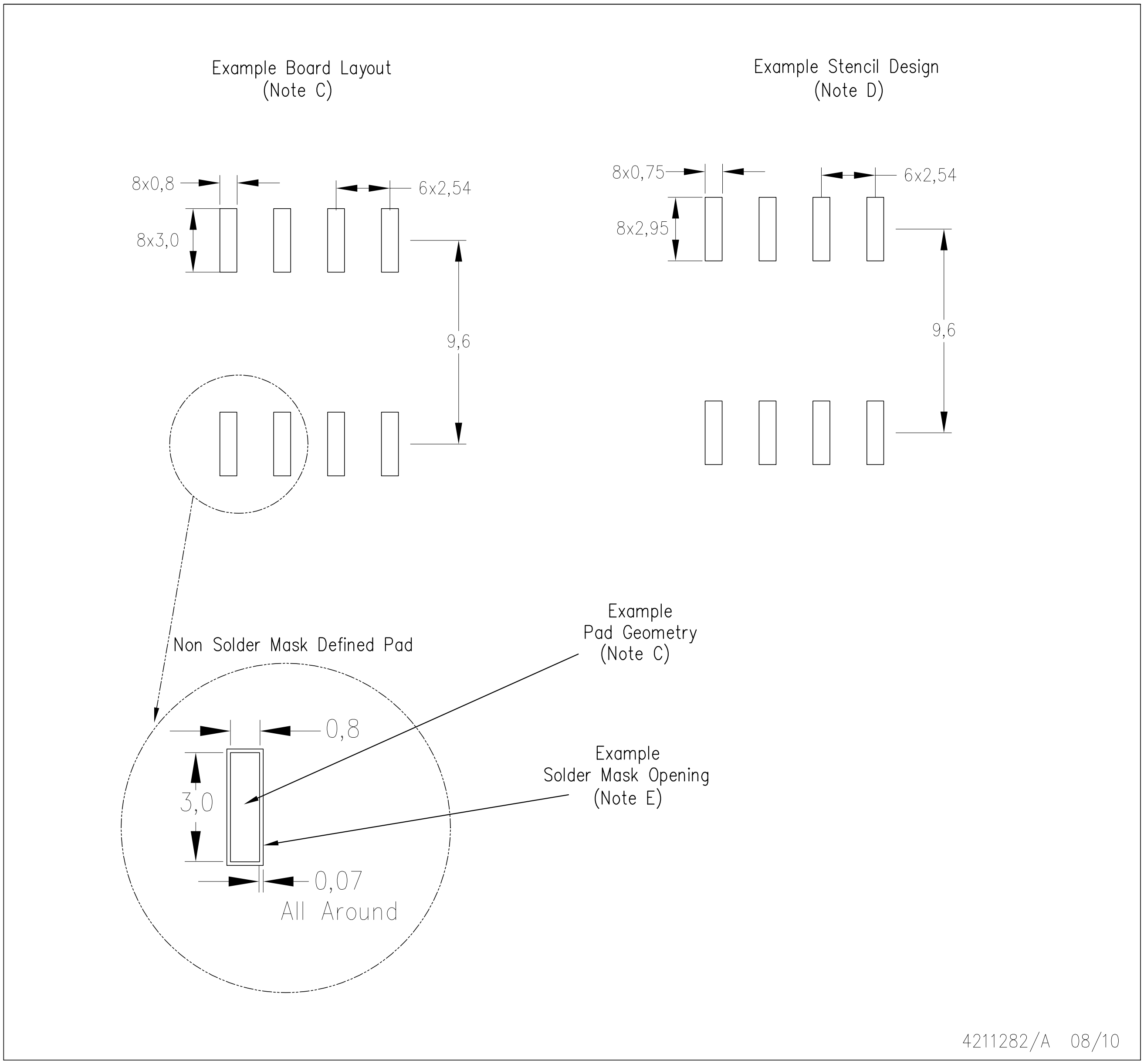
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
AMC1100DUBR	SOP	DUB	8	350	358.0	335.0	35.0

DUB (R–PDSO–G8) PLASTIC SMALL–OUTLINE



NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ANSI Y14.5 M–1982.
B. This drawing is subject to change without notice.
C. Dimensions do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.254mm.

DUB (R–PDSO–G8) PLASTIC SMALL OUTLINE



NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC–7525.
E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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