# AMC3301 具有集成式直流/直流转换器的 ±250mV 输入、增强型隔离式精密放大器

## 1 特性

- 3.3V 或 5V 单电源，具有集成直流/直流转换器
- ±250mV 输入电压范围，针对使用分流电阻器测量电流进行了优化
- 固定增益：8.2
- 低直流误差：
  - 失调电压：±150 µ V（最大值）
  - 温漂：±1µV/°C（最大值）
  - 增益误差：±0.2%（最大值）
  - 增益误差漂移：±40ppm/°C（最大值）
  - 非线性度：±0.04%（最大值）
- 高 CMTI：85kV/µs（最小值）
- 系统级诊断功能
- 符合 CISPR-11 和 CISPR-25 EMI 标准
- 安全相关认证：
  - 符合 DIN EN IEC 60747-17 (VDE 0884-17) 的 6000$V_{PK}$ 增强型隔离
  - 4250$V_{RMS}$ 隔离，符合 UL1577 标准且持续时长为 1 分钟
- 可在更大的工业级温度范围内正常工作：-40°C 至 +125°C

## 2 应用

- 基于分流器的隔离式电流检测，用于：
  - 保护继电器
  - 电机驱动器
  - 电源
  - 光电逆变器

## 3 说明

AMC3301 是一款精密的隔离放大器，针对基于分流器的电流测量进行了优化。完全集成的隔离式 DC/DC 转换器允许从器件的低侧进行单电源操作，从而使该器件成为空间受限应用的独特解决方案。增强型电容式隔离栅已通过 DIN EN IEC 60747-17 (VDE 0884-17) 和 UL1577 认证，可支持高达 1.2k$V_{RMS}$ 的工作电压。

该隔离栅可将系统中以不同共模电压电平运行的各器件隔开，并保护电压较低的器件免受高电压冲击。

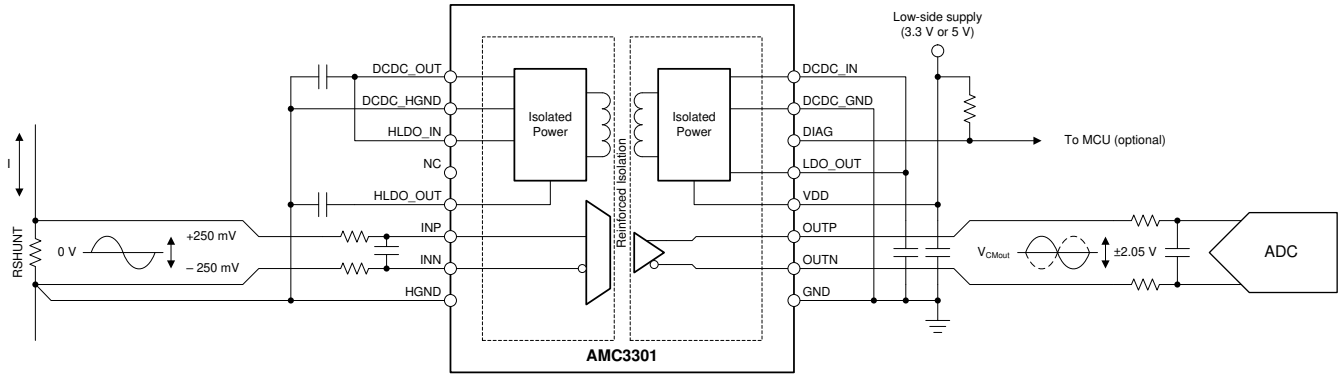
AMC3301 的输入经优化，可直接连接至低阻抗分流电阻器或其他具有低信号电平的低阻抗电压源。出色的直流精度和低温漂支持在 –40°C 至 +125°C 的扩展工业温度范围内进行精确的电流测量。

AMC3301 的集成直流/直流转换器故障检测和诊断输出引脚可简化系统级设计和诊断。

**封装信息**

| 器件型号 | 封装(1) | 封装尺寸(2) |
|---|---|---|
| AMC3301 | DWE（SOIC，16） | 10.3mm × 10.3mm |

(1) 如需更多信息，请参阅*机械、封装和可订购信息*。
(2) 封装尺寸（长 × 宽）为标称值，并包括引脚（如适用）。




**典型应用**

本资源的原文使用英文撰写。 为方便起见，TI 提供了译文；由于翻译过程中可能使用了自动化工具，TI 不保证译文的准确性。 为确认准确性，请务必访问 ti.com 参考最新的英文版本（控制文档）。

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# 4 Pin Configuration and Functions

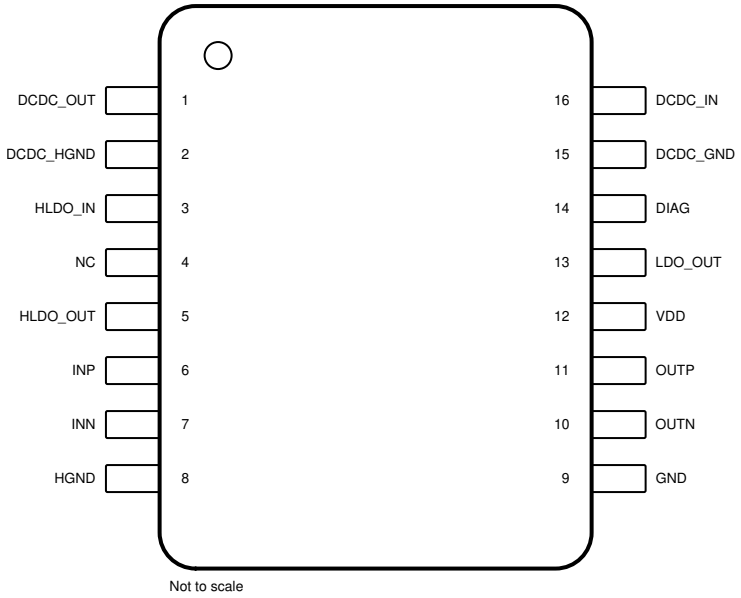



**图 4-1. DWE Package, 16-Pin SOIC, Top View**

**表 4-1. Pin Functions**

| PIN | | TYPE | DESCRIPTION |
|---|---|---|---|
| NO. | NAME | | |
| 1 | DCDC_OUT | Power | High-side output of the isolated DC/DC converter; connect this pin to the HLDO_IN pin.(1) |
| 2 | DCDC_HGND | High-side power ground | High-side ground reference for the isolated DC/DC converter; connect this pin to the HGND pin. |
| 3 | HLDO_IN | Power | Input of the high-side LDO; connect this pin to the DCDC_OUT pin.(1) |
| 4 | NC | — | No internal connection; connect this pin to HGND or leave this pin unconnected. |
| 5 | HLDO_OUT | Power | Output of the high-side LDO.(1) |
| 6 | INP | Analog input | Noninverting analog input. Either INP or INN must have a DC current path to HGND to define the common-mode input voltage.(2) |
| 7 | INN | Analog input | Inverting analog input. Either INP or INN must have a DC current path to HGND to define the common-mode input voltage.(2) |
| 8 | HGND | High-side signal ground | High-side analog ground; connect this pin to the DCDC_HGND pin. |
| 9 | GND | Low-side signal ground | Low-side analog ground; connect this pin to the DCDC_GND pin. |
| 10 | OUTN | Analog output | Inverting analog output. |
| 11 | OUTP | Analog output | Noninverting analog output. |
| 12 | VDD | Low-side power | Low-side power supply.(1) |
| 13 | LDO_OUT | Power | Output of the low-side LDO; connect this pin to the DCDC_IN pin. The output of the LDO must not be loaded by external circuitry.(1) |
| 14 | DIAG | Digital output | Active-low, open-drain status indicator output; connect this pin to the pullup supply (for example, VDD) using a resistor or leave this pin floating if not used. |
| 15 | DCDC_GND | Low-side power ground | Low-side ground reference for the isolated DC/DC converter; connect this pin to the GND pin. |
| 16 | DCDC_IN | Power | Low-side input of the isolated DC/DC converter; connect this pin to the LDO_OUT pin.(1) |

(1) See the *Power Supply Recommendations* section for power-supply decoupling recommendations.
(2) See the *Layout* section for details.

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# 5 Specifications

## 5.1 Absolute Maximum Ratings

see (1)

| | | MIN | MAX | UNIT |
|---|---|---|---|---|
| Power-supply voltage | VDD to GND | –0.3 | 6.5 | V |
| Analog input voltage | INP, INN | HGND – 6 | $V_{HLDO_OUT}$ + 0.5 | V |
| Analog output voltage | OUTP, OUTN | GND – 0.5 | VDD + 0.5 | V |
| Digital output voltage | DIAG | GND – 0.5 | 6.5 | V |
| Input current | Continuous, any pin except power-supply pins | –10 | 10 | mA |
| Temperature | Junction, $T_J$ | | 150 | °C |
| | Storage, $T_{stg}$ | –65 | 150 | |

(1) Operation outside the *Absolute Maximum Ratings* may cause permanent device damage. *Absolute Maximum Ratings* do not imply functional operation of the device at these or any other conditions beyond those listed under *Recommended Operating Conditions*. If used outside the Recommended Operating Conditions but within the Absolute Maximum Ratings, the device may not be fully functional, and this may affect device reliability, functionality, performance, and shorten the device lifetime

## 5.2 ESD Ratings

| | | | VALUE | UNIT |
|---|---|---|---|---|
| $V_{(ESD)}$ | Electrostatic discharge | Human body model (HBM), per ANSI/ESDA/JEDEC JS-001(1) | ±2000 | V |
| | | Charged-device model (CDM), per per ANSI/ESDA/JEDEC JS-002(2) | ±1000 | |

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

## 5.3 Recommended Operating Conditions

over operating ambient temperature range (unless otherwise noted)

| | | | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|---|
| **POWER SUPPLY** | | | | | | |
| VDD | Low-side power supply | VDD to GND | 3 | 3.3 | 5.5 | V |
| **ANALOG INPUT** | | | | | | |
| $V_{Clipping}$ | Differential input voltage before clipping output | $V_{IN} = V_{INP} – V_{INN}$ | | ±320 | | mV |
| $V_{FSR}$ | Specified linear differential full-scale voltage | $V_{IN} = V_{INP} – V_{INN}$ | –250 | | 250 | mV |
| | Absolute common-mode input voltage (1) | $(V_{INP} + V_{INN}) / 2$ to HGND | –2 | | $V_{HLDO_OUT}$ | V |
| $V_{CM}$ | Operating common-mode input voltage | $(V_{INP} + V_{INN}) / 2$ to HGND | –0.16 | | 1 | V |
| **ANALOG OUTPUT** | | | | | | |
| $C_{LOAD}$ | Capacitive load | On OUTP or OUTN to GND2, Without any series resistance | | | 500 | pF |
| $C_{LOAD}$ | Capacitive load | OUTP to OUTN, Without any series resistance | | | 250 | pF |
| $R_{LOAD}$ | Resistive load | On OUTP or OUTN to GND2 | | 10 | 1 | kΩ |
| **DIGITAL OUTPUT** | | | | | | |
| | Pull-up supply-voltage for DIAG pin | | 0 | | VDD | V |
| **TEMPERATURE RANGE** | | | | | | |
| $T_A$ | Specified ambient temperature | | –40 | | 125 | °C |

(1) Steady-state voltage supported by the device in case of a system failure. See specified common-mode input voltage $V_{CM}$ for normal operation. Observe analog input voltage range as specified in the *Absolute Maximum Ratings* table.


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## 5.4 Thermal Information

| THERMAL METRIC(1) | | AMC3301 DWE (SOIC) 16 PINS | UNIT |
|---|---|---|---|
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance | 73.5 | °C/W |
| $R_{\theta JC(top)}$ | Junction-to-case (top) thermal resistance | 31 | °C/W |
| $R_{\theta JB}$ | Junction-to-board thermal resistance | 44 | °C/W |
| $\psi_{JT}$ | Junction-to-top characterization parameter | 16.7 | °C/W |
| $\psi_{JB}$ | Junction-to-board characterization parameter | 42.8 | °C/W |
| $R_{\theta JC(bot)}$ | Junction-to-case (bottom) thermal resistance | n/a | °C/W |

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

## 5.5 Power Ratings

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $P_D$ | Maximum power dissipation | VDD = 5.5 V | | | 231 | mW |
| | | VDD = 3.6 V | | | 151 | |

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## 5.6 Insulation Specifications

over operating ambient temperature range (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | VALUE | UNIT |
|---|---|---|---|---|
| **GENERAL** | | | | |
| CLR | External clearance (1) | Shortest pin-to-pin distance through air | ⩾ 8 | mm |
| CPG | External creepage (1) | Shortest pin-to-pin distance across the package surface | ⩾ 8 | mm |
| DTI | Distance through the insulation | Minimum internal gap (internal clearance - capacitive signal isolation) | ⩾ 21 | µm |
| | | Minimum internal gap (internal clearance - transformer power isolation) | ⩾ 120 | |
| CTI | Comparative tracking index | DIN EN 60112 (VDE 0303-11); IEC 60112 | ⩾ 600 | V |
| | Material group | According to IEC 60664-1 | I | |
| | Overvoltage category per IEC 60664-1 | Rated mains voltage ⩽ 600 $V_{RMS}$ | I-III | |
| | | Rated mains voltage ⩽ 1000 $V_{RMS}$ | I-II | |
| **DIN EN IEC 60747-17 (VDE 0884-17)(2)** | | | | |
| $V_{IORM}$ | Maximum repetitive peak isolation voltage | At AC voltage | 1700 | $V_{PK}$ |
| $V_{IOWM}$ | Maximum-rated isolation working voltage | At AC voltage (sine wave) | 1200 | $V_{RMS}$ |
| | | At DC voltage | 1700 | $V_{DC}$ |
| $V_{IOTM}$ | Maximum transient isolation voltage | $V_{TEST} = V_{IOTM}$, t = 60s (qualification test),<br>$V_{TEST} = 1.2 \times V_{IOTM}$, t = 1s (100% production test) | 6000 | $V_{PK}$ |
| $V_{IMP}$ | Maximum impulse voltage(3) | Tested in air, 1.2/50µs waveform per IEC 62368-1 | 7700 | $V_{PK}$ |
| $V_{IOSM}$ | Maximum surge isolation voltage(4) | Tested in oil (qualification test),<br>1.2/50µs waveform per IEC 62368-1 | 10000 | $V_{PK}$ |
| $q_{pd}$ | Apparent charge(5) | Method a, after input/output safety test subgroups 2 and 3,<br>$V_{pd(ini)} = V_{IOTM}$, $t_{ini}$ = 60s, $V_{pd(m)} = 1.2 \times V_{IORM}$, $t_m$ = 10s | ⩽ 5 | pC |
| | | Method a, after environmental tests subgroup 1,<br>$V_{pd(ini)} = V_{IOTM}$, $t_{ini}$ = 60s, $V_{pd(m)} = 1.6 \times V_{IORM}$, $t_m$ = 10 s | ⩽ 5 | |
| | | Method b1, at preconditioning (type test) and routine test,<br>$V_{pd(ini)} = 1.2 \times V_{IOTM}$, $t_{ini}$ = 1s, $V_{pd(m)} = 1.875 \times V_{IORM}$, $t_m$ = 1s | ⩽ 5 | |
| | | Method b2, at routine test (100% production)(7),<br>$V_{pd(ini)} = V_{pd(m)} = 1.2 \times V_{IOTM}$, $t_{ini} = t_m$ = 1s | ⩽ 5 | pC |
| $C_{IO}$ | Barrier capacitance, input to output(6) | $V_{IO}$ = 0.5 $V_{PP}$ at 1MHz | ≅ 4.5 | pF |
| $R_{IO}$ | Insulation resistance, input to output(6) | $V_{IO}$ = 500 V at $T_A$ = 25°C | > $10^{12}$ | Ω |
| | | $V_{IO}$ = 500 V at 100°C ⩽ $T_A$ ⩽ 125°C | > $10^{11}$ | |
| | | $V_{IO}$ = 500 V at $T_S$ = 150°C | > $10^9$ | |
| | Pollution degree | | 2 | |
| | Climatic category | | 40/125/21 | |
| **UL1577** | | | | |
| $V_{ISO}$ | Withstand isolation voltage | $V_{TEST} = V_{ISO}$, t = 60 s (qualification test),<br>$V_{TEST} = 1.2 \times V_{ISO}$, t = 1 s (100% production test) | 4250 | $V_{RMS}$ |

(1) Apply creepage and clearance requirements according to the specific equipment isolation standards of an application. Care must be taken to maintain the creepage and clearance distance of a 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 in certain cases. Techniques such as inserting grooves, ribs, or both on a PCB are used to help increase these specifications.
(2) This coupler is suitable for *safe electrical insulation* only within the safety ratings. Compliance with the safety ratings must be ensured by means of suitable protective circuits.
(3) Testing is carried out in air to determine the surge immunity of the package.
(4) Testing is carried in oil to determine the intrinsic surge immunity of the isolation barrier.
(5) Apparent charge is electrical discharge caused by a partial discharge (pd).
(6) All pins on each side of the barrier are tied together, creating a two-pin device.
(7) Either method b1 or b2 is used in production.


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## 5.7 Safety-Related Certifications

| VDE | UL |
|---|---|
| DIN EN IEC 60747-17 (VDE 0884-17),<br>EN IEC 60747-17,<br>DIN EN IEC 62368-1 (VDE 0868-1),<br>EN IEC 62368-1,<br>IEC 62368-1 Clause : 5.4.3 ; 5.4.4.4 ; 5.4.9 | Recognized under 1577 component recognition and<br>CSA component acceptance NO 5 programs |
| Reinforced insulation | Single protection |
| Certificate number: 40040142 | File number: E181974 |

## 5.8 Safety Limiting Values

Safety limiting (1) intends to minimize potential damage to the isolation barrier upon failure of input or output circuitry. A failure ofthe I/O can allow low resistance to ground or the supply and, without current limiting, dissipate sufficient power to overheat the die and damage the isolation barrier potentially leading to secondary system failures.

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $I_S$ | Safety input, output, or supply current | $R_{\theta JA}$ = 73.5°C/W, VDD = 5.5 V,<br>$T_J$ = 150°C, $T_A$ = 25°C | | | 309 | mA |
| | | $R_{\theta JA}$ = 73.5°C/W, VDD = 3.6 V,<br>$T_J$ = 150°C, $T_A$ = 25°C | | | 472 | |
| $P_S$ | Safety input, output, or total power | $R_{\theta JA}$ = 73.5°C/W,<br>$T_J$ = 150°C, $T_A$ = 25°C | | | 1700 | mW |
| $T_S$ | Maximum safety temperature | | | | 150 | °C |

(1) The maximum safety temperature, $T_S$, has the same value as the maximum junction temperature, $T_J$, specified for the device. The $I_S$ and $P_S$ parameters represent the safety current and safety power, respectively. Do not exceed the maximum limits of $I_S$ and $P_S$. These limits vary with the ambient temperature, $T_A$.
The junction-to-air thermal resistance, $R_{\theta JA}$, in the *Thermal Information* table is that of a device installed on a high-K test board for leaded surface-mount packages. Use these equations to calculate the value for each parameter:
$T_J = T_A + R_{\theta JA} \times P$, where P is the power dissipated in the device.
$T_{J(max)} = T_S = T_A + R_{\theta JA} \times P_S$, where $T_{J(max)}$ is the maximum junction temperature.
$P_S = I_S \times VDD_{max}$, where $VDD_{max}$ is the maximum low-side voltage.

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## 5.9 Electrical Characteristics

minimum and maximum specifications apply from $T_A$ = –40°C to +125°C, VDD = 3.0 V to 5.5 V, INP = –250 mV to +250 mV, INN = HGND = 0 V, and the external components listed in the *Typical Application* section; typical specifications are at $T_A$ = 25°C, and VDD = 3.3 V (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **ANALOG INPUT** | | | | | | |
| $R_{IN}$ | Single-ended input resistance | INN = HGND | | 19 | | kΩ |
| $R_{IND}$ | Differential input resistance | | | 22 | | |
| $I_{IB}$ | Input bias current | INP = INN = HGND; $I_{IB} = (I_{IBP} + I_{IBN}) / 2$ | –41 | –30 | –24 | µA |
| $TCI_{IB}$ | Input bias current drift | | | 0.8 | | nA/°C |
| $I_{IO}$ | Input offset current | $I_{IO} = \lvert I_{IBP} - I_{IBN} \rvert$ | | 1.4 | | nA |
| $C_{IN}$ | Single-ended input capacitance | INN = HGND, $f_{IN}$ = 275 kHz | | 2 | | pF |
| $C_{IND}$ | Differential input capacitance | $f_{IN}$ = 275 kHz | | 1 | | |
| **ANALOG OUTPUT** | | | | | | |
| | Nominal gain | | | 8.2 | | V/V |
| $V_{CMout}$ | Common-mode output voltage | | 1.39 | 1.44 | 1.49 | V |
| $V_{CLIPout}$ | Clipping differential output voltage | $V_{OUT} = (V_{OUTP} - V_{OUTN})$; $\lvert V_{IN} \rvert = \lvert V_{INP} - V_{INN} \rvert > V_{Clipping}$ | | ±2.49 | | V |
| $V_{Failsafe}$ | Failsafe differential output voltage | $V_{OUT} = (V_{OUTP} - V_{OUTN})$; $V_{DCDC_OUT} \leq V_{DCDCUV}$, or $V_{HLDO_OUT} \leq V_{HLDOUV}$ | | –2.57 | -2.5 | V |
| BW | Output bandwidth | | 290 | 334 | | kHz |
| $R_{OUT}$ | Output resistance | On OUTP or OUTN | | 0.2 | | Ω |
| | Output short-circuit current | On OUTP or OUTN, sourcing or sinking, INP = INN = HGND, outputs shorted to either GND or VDD | | 14 | | mA |
| CMTI | Common-mode transient immunity | \|HGND – GND\| = 2 kV | 85 | 135 | | kV/µs |
| **ACCURACY** | | | | | | |
| $V_{OS}$ | Input offset voltage(1) (2) | $T_A$ = 25°C, INP = INN = HGND | –0.15 | ±0.02 | 0.15 | mV |
| $TCV_{OS}$ | Input offset drift(1) (2) (4) | | –1 | ±0.15 | 1 | uV/°C |
| $E_G$ | Gain error(1) | $T_A$ = 25°C | –0.2% | ±0.04% | 0.2% | |
| $TCE_G$ | Gain error drift(1) (5) | | –40 | ±6 | 40 | ppm/°C |
| | Nonlinearity(1) | | –0.04% | ±0.002% | 0.04% | |
| | Nonlinearity drift(1) | | | 0.9 | | ppm/°C |
| SNR | Signal-to-noise ratio | $V_{IN}$ = 0.5 $V_{PP}$, $f_{IN}$ = 1 kHz, BW = 10 kHz, 10 kHz filter | 80 | 85 | | dB |
| | | $V_{IN}$ = 0.5 $V_{PP}$, $f_{IN}$ = 10 kHz, BW = 100 kHz, 1 MHz filter | 67 | 71 | | |
| THD | Total harmonic distortion(3) | $V_{IN}$ = 0.5 Vpp, $f_{IN}$ = 10 kHz, BW = 100 kHz | | –85 | | dB |
| | Output noise | INP = INN = HGND, $f_{IN}$ = 0 Hz, BW = 100 kHz | | 300 | | $\mu V_{RMS}$ |
| CMRR | Common-mode rejection ratio | $f_{IN}$ = 0 Hz, $V_{CM\ min} \leq V_{CM} \leq V_{CM\ max}$ | | –97 | | dB |
| | | $f_{IN}$ = 10 kHz, $V_{CM\ min} \leq V_{CM} \leq V_{CM\ max}$ | | –98 | | |


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## 5.9 Electrical Characteristics（续）

minimum and maximum specifications apply from $T_A$ = –40°C to +125°C, VDD = 3.0 V to 5.5 V, INP = –250 mV to +250 mV, INN = HGND = 0 V, and the external components listed in the *Typical Application* section; typical specifications are at $T_A$ = 25°C, and VDD = 3.3 V (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| PSRR | Power-supply rejection ratio | VDD from 3.0 V to 5.5 V, at dc, input referred | | –109 | | dB |
| | | INP = INN = HGND, VDD from 3.0 V to 5.5 V, 10 kHz / 100 mV ripple, input referred | | –98 | | |
| **DIGITAL OUTPUT (DIAG)** | | | | | | |
| $V_{OL}$ | Low-level output voltage | $I_{SINK}$= 4 mA | | 80 | 250 | mV |
| $I_{LKG}$ | Open-drain output leakage current | VDD = 5V | | 5 | 100 | nA |
| **POWER SUPPLY** | | | | | | |
| IDD | Low-side supply current | no external load on HLDO | | 27.5 | 40 | mA |
| | | 1 mA external load on HLDO | | 29.5 | 42 | |
| $VDD_{UV}$ | VDD analog undervoltage detection threshold | VDD rising | | | 2.9 | V |
| | | VDD falling | | | 2.8 | |
| $VDD_{POR}$ | VDD digital reset threshold | VDD rising | | | 2.5 | V |
| | | VDD falling | | | 2.4 | |
| $V_{DCDC_OUT}$ | DCDC output voltage | DCDC_OUT to HGND | 3.1 | 3.5 | 4.65 | V |
| $V_{DCDCUV}$ | DCDC output undervoltage detection threshold voltage | DCDC output falling | 2.1 | 2.25 | | V |
| $V_{HLDO_OUT}$ | High-side LDO output voltage | HLDO to HGND, 4 mA external load, VDD > 3.6 V | 3 | 3.2 | 3.4 | V |
| $V_{HLDOUV}$ | High-side LDO output undervoltage detection threshold voltage | HLDO output falling | 2.4 | 2.6 | | V |
| $I_H$ | High-side supply current for auxiliary circuitry | 3 V ≤ VDD < 3.6 V, load connected from HLDO_OUT to HGND, non-switching | | | 1 | mA |
| | | 3.6 V ≤ VDD ≤ 5.5 V, load connected from HLDO_OUT to HGND, non-switching | | | 4.0 | mA |
| $t_{AS}$ | Analog settling time | VDD step to 3.0 V, to OUTP and OUTN valid, 0.1% settling | | 0.9 | 1.4 | ms |

(1) The typical value includes one standard deviation ("sigma") at nominal operating conditions.
(2) This parameter is input referred.
(3) THD is the ratio of the rms sum of the amplitues of first five higher harmonics to the amplitude of the fundamental.
(4) Offset error temperature drift is calculated using the box method, as described by the following equation: $TCV_{OS} = (V_{OS,MAX} - V_{OS,MIN}) / TempRange$ where $V_{OS,MAX}$ and $V_{OS,MIN}$ refer to the maximum and minimum $V_{OS}$ values measured within the temperature range (–40 to 125℃).
(5) Gain error temperature drift is calculated using the box method, as described by the following equation: $TCE_G\ (ppm) = ((E_{G,MAX} - E_{G,MIN}) / TempRange) \times 10^4$ where $E_{G,MAX}$ and $E_{G,MIN}$ refer to the maximum and minimum $E_G$ values (in %) measured within the temperature range (–40 to 125℃).

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## 5.10 Switching Characteristics

over operating ambient temperature range (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $t_r$ | Output signal rise time | | | 1.3 | | µs |
| $t_f$ | Output signal fall time | | | 1.3 | | µs |
| | $V_{INx}$ to $V_{OUTx}$ signal delay (50% – 10%) | Unfiltered output | | 1 | 1.5 | µs |
| | $V_{INx}$ to $V_{OUTx}$ signal delay (50% – 50%) | Unfiltered output | | 1.6 | 2.1 | µs |
| | $V_{INx}$ to $V_{OUTx}$ signal delay (50% – 90%) | Unfiltered output | | 2.5 | 3 | µs |

## 5.11 Timing Diagram

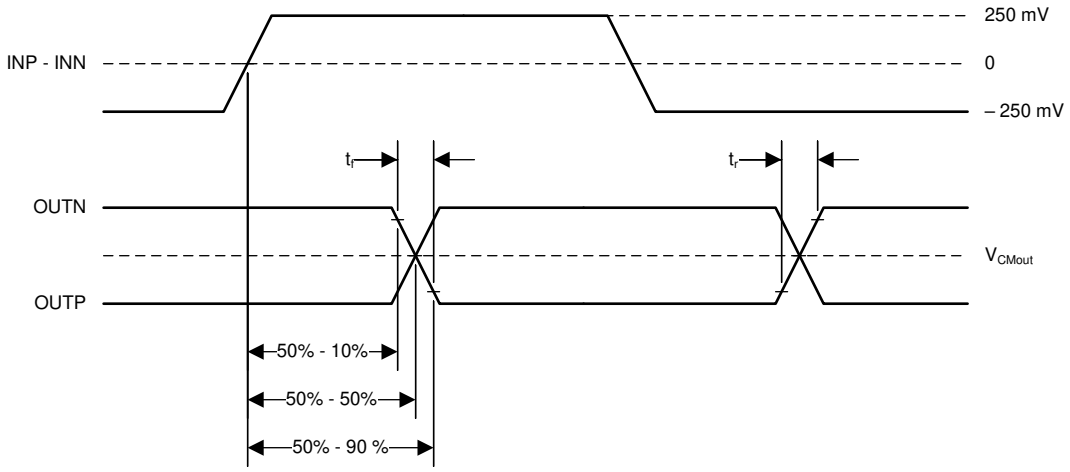



**图 5-1. Rise, Fall, and Delay Time Waveforms**


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## 5.12 Insulation Characteristics Curves

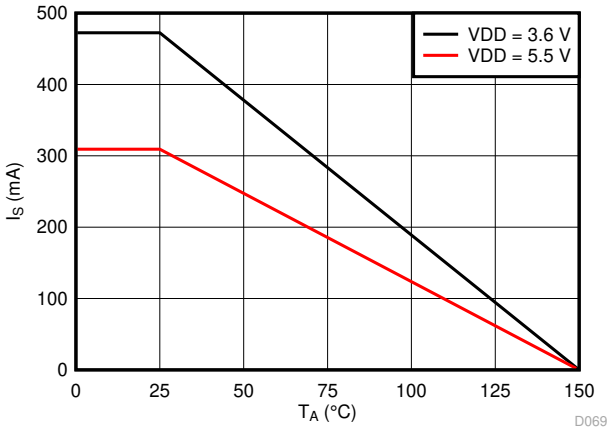



**图 5-2. Thermal Derating Curve for Safety-Limiting Current per VDE**

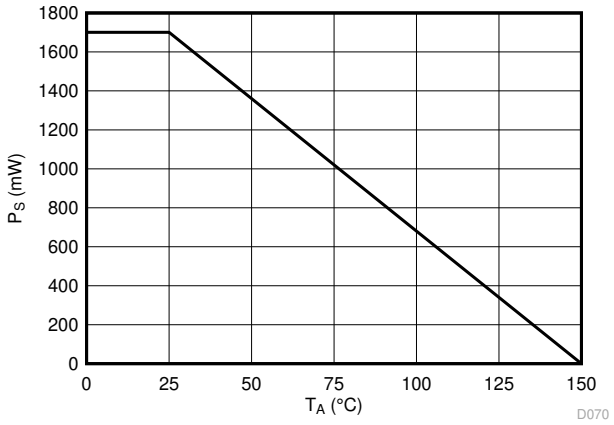
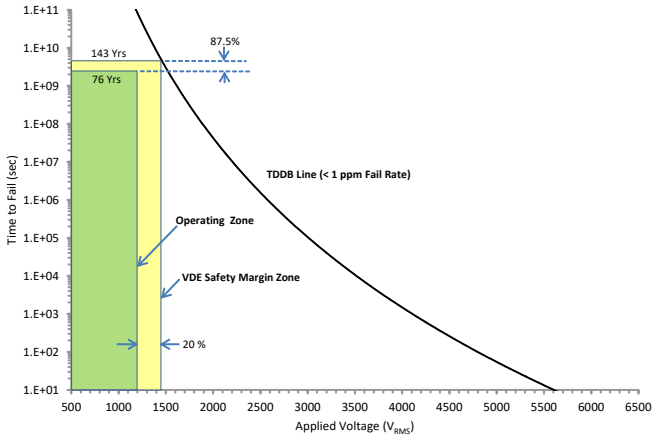



**图 5-3. Thermal Derating Curve for Safety-Limiting Power per VDE**




$T_A$ up to 150°C, stress-voltage frequency = 60 Hz,
isolation working voltage = 1200 $V_{RMS}$, operating lifetime = 76 years

**图 5-4. Reinforced Isolation Capacitor Lifetime Projection**

## 5.13 Typical Characteristics

at VDD = 3.3 V, INP = – 250 mV to +250 mV, INN = HGND = 0 V, and $f_{IN}$ = 10 kHz (unless otherwise noted)

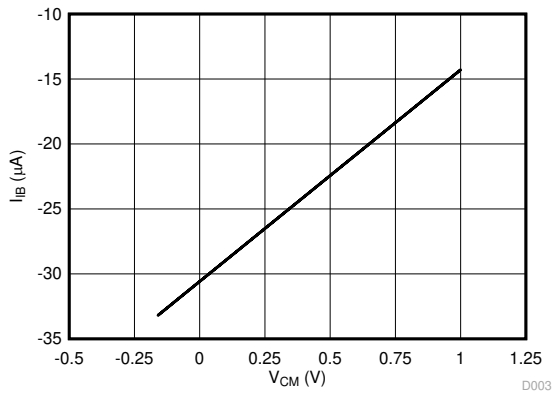



图 5-5. Input Bias Current vs Common-Mode Input Voltage

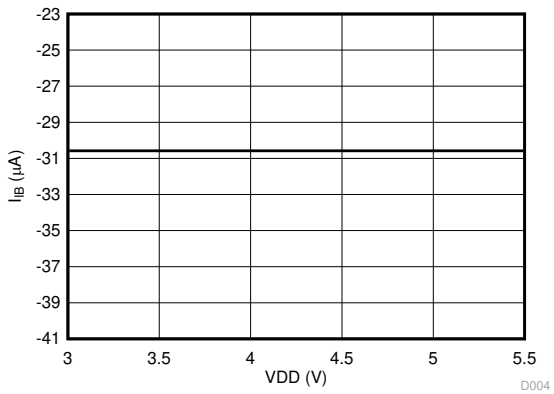



图 5-6. Input Bias Current vs Supply Voltage

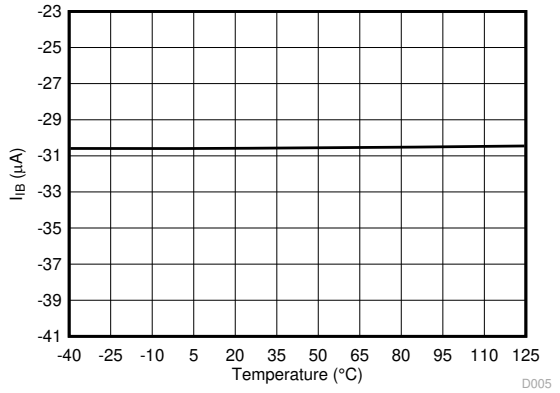



图 5-7. Input Bias Current vs Temperature

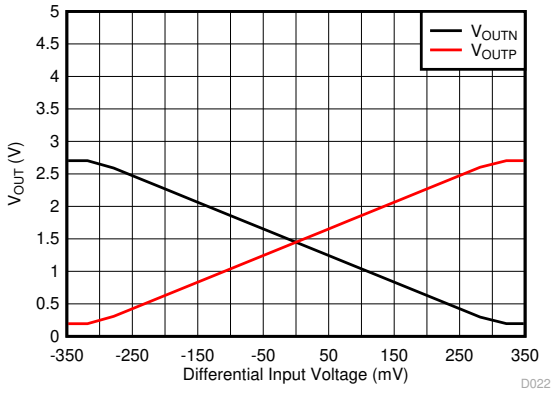



图 5-8. Output Voltage vs Input Voltage

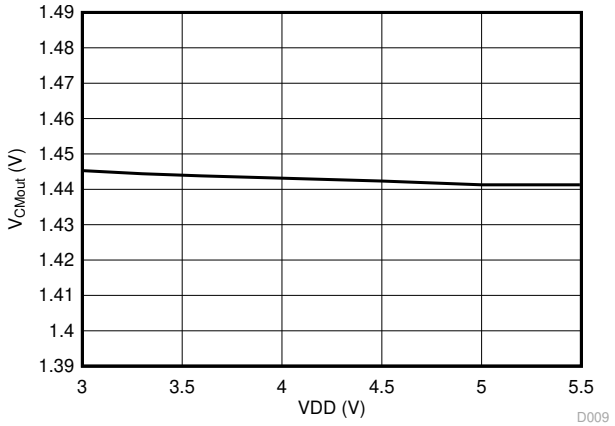



图 5-9. Output Common-Mode Voltage vs Supply Voltage

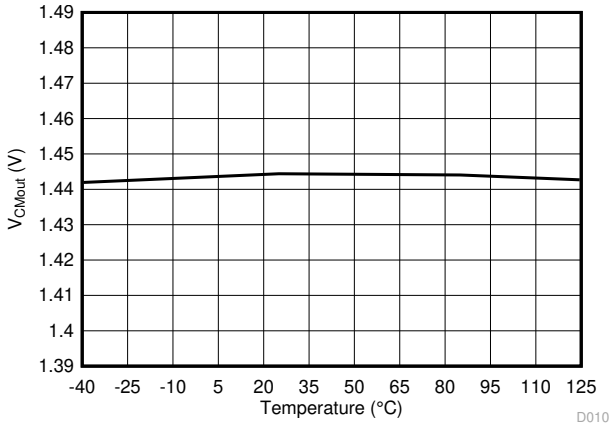



图 5-10. Output Common-Mode Voltage vs Temperature


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## 5.13 Typical Characteristics (continued)

at VDD = 3.3 V, INP = – 250 mV to +250 mV, INN = HGND = 0 V, and $f_{IN}$ = 10 kHz (unless otherwise noted)

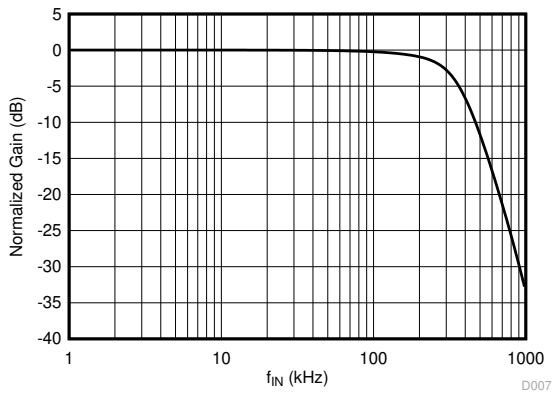



图 5-11. Normalized Gain vs Input Frequency

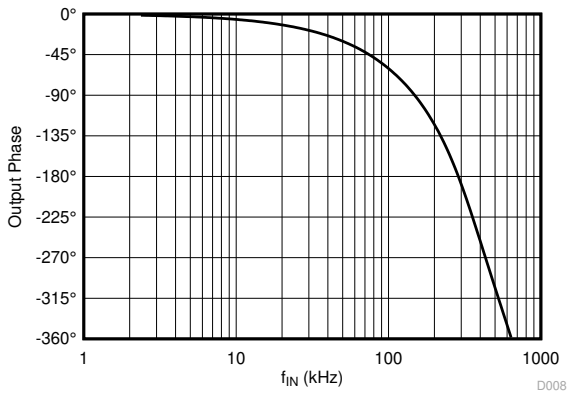



图 5-12. Output Phase vs Input Frequency

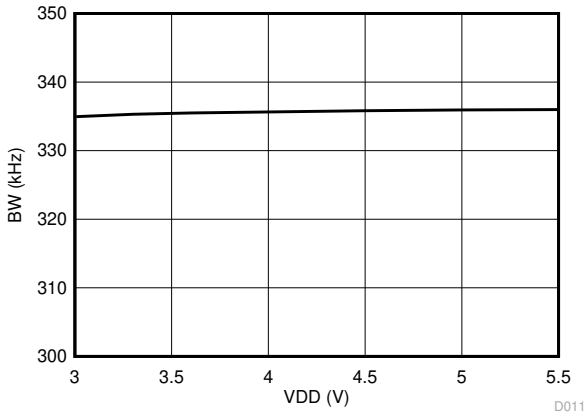



图 5-13. Output Bandwidth vs Supply Voltage

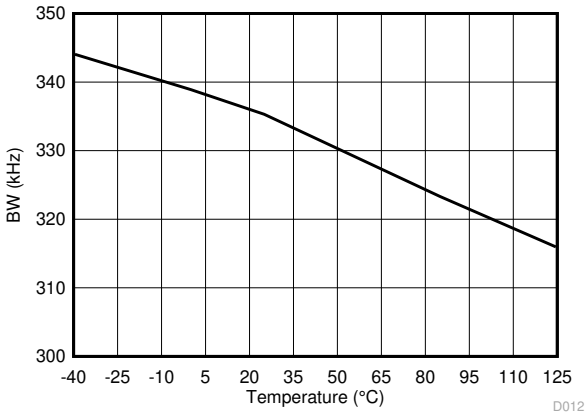



图 5-14. Output Bandwidth vs Temperature

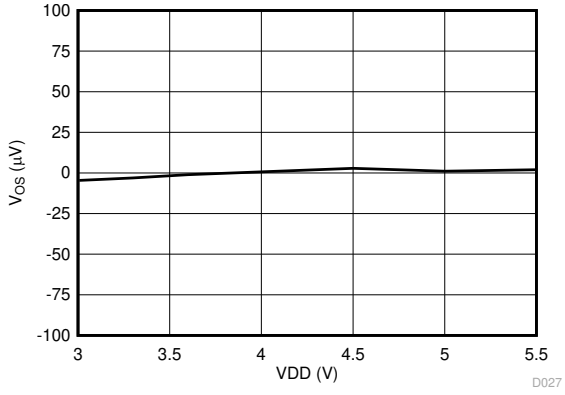



图 5-15. Input Offset Voltage vs Supply Voltage

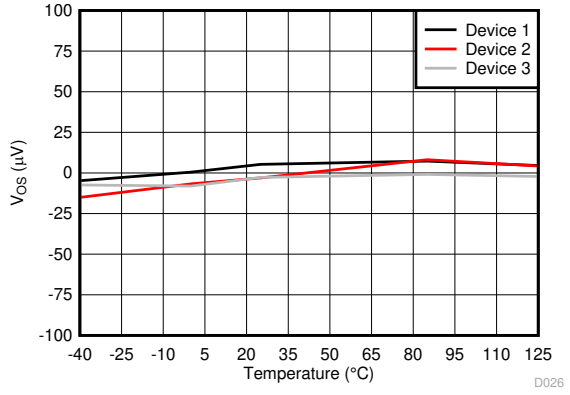



图 5-16. Input Offset Voltage vs Temperature

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## 5.13 Typical Characteristics (continued)

at VDD = 3.3 V, INP = – 250 mV to +250 mV, INN = HGND = 0 V, and $f_{IN}$ = 10 kHz (unless otherwise noted)

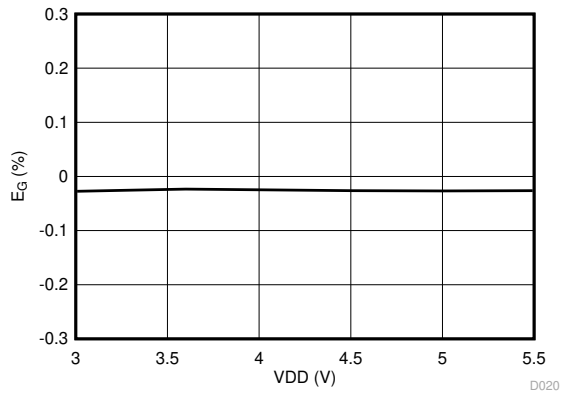



图 5-17. Gain Error vs Supply Voltage

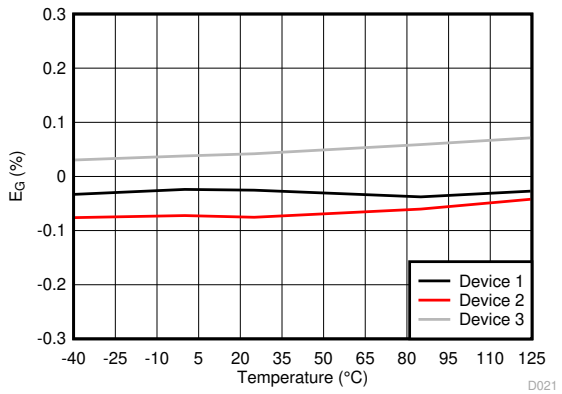



图 5-18. Gain Error vs Temperature

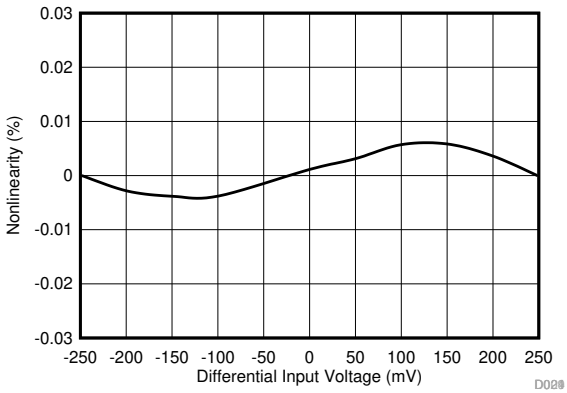



图 5-19. Nonlinearity vs Input Voltage

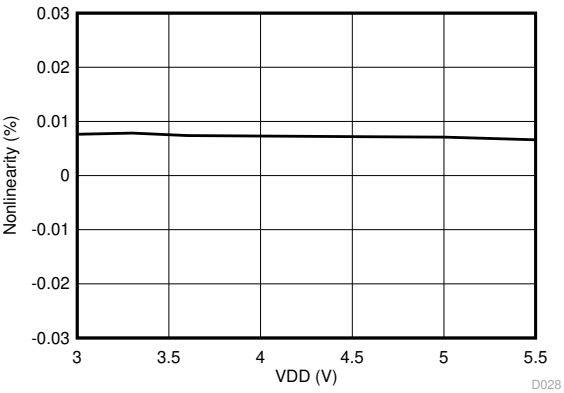



图 5-20. Nonlinearity vs Supply Voltage

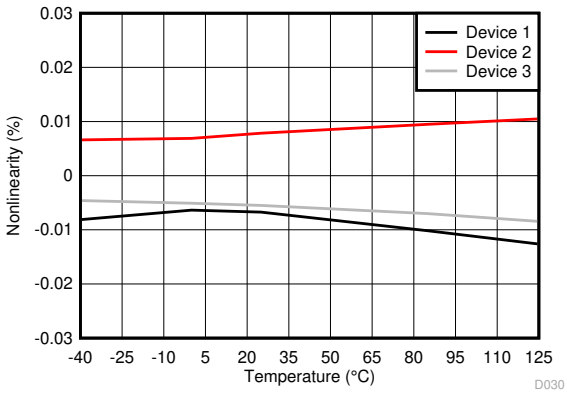
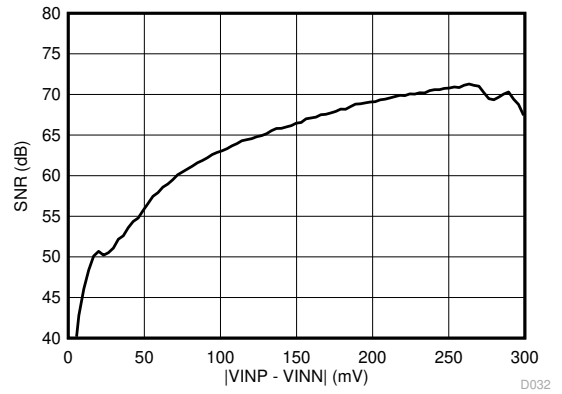



图 5-21. Nonlinearity vs Temperature



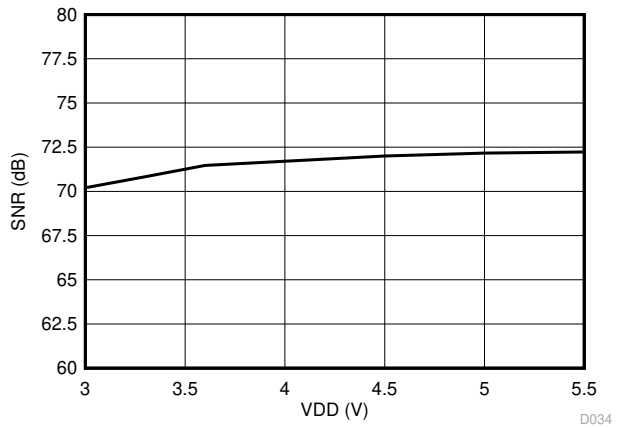

$V_{IN}$ = 0.5 $V_{pp}$, $f_{IN}$ = 10 kHz

图 5-22. Signal-to-Noise Ratio vs Input Voltage


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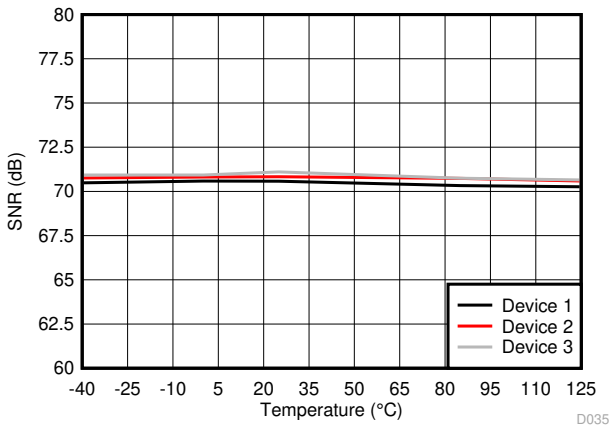
## 5.13 Typical Characteristics (continued)

at VDD = 3.3 V, INP = –250 mV to +250 mV, INN = HGND = 0 V, and $f_{IN}$ = 10 kHz (unless otherwise noted)




$V_{IN}$ = 0.5 $V_{pp}$, $f_{IN}$ = 10 kHz

**图 5-23. Signal-to-Noise Ratio vs Supply Voltage**




$V_{IN}$ = 0.5 $V_{pp}$, $f_{IN}$ = 10 kHz

**图 5-24. Signal-to-Noise Ratio vs Temperature**

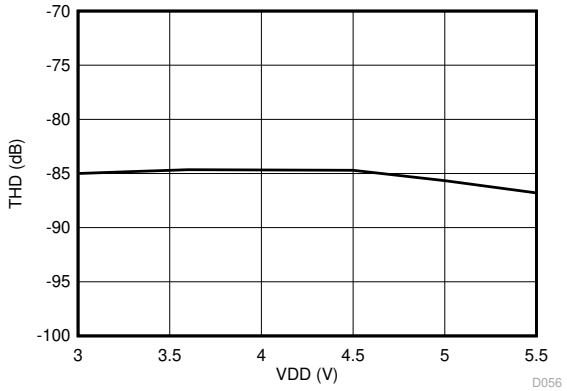



**图 5-25. Total Harmonic Distortion vs Supply Voltage**

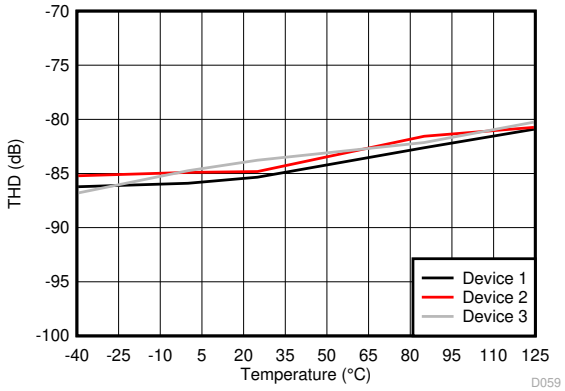



**图 5-26. Total Harmonic Distortion vs Temperature**

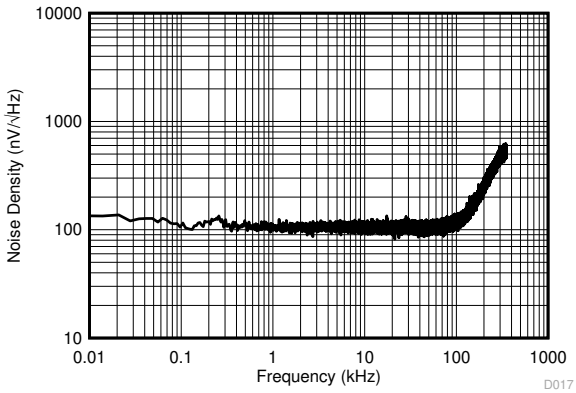



**图 5-27. Input-Referred Noise Density vs Frequency**

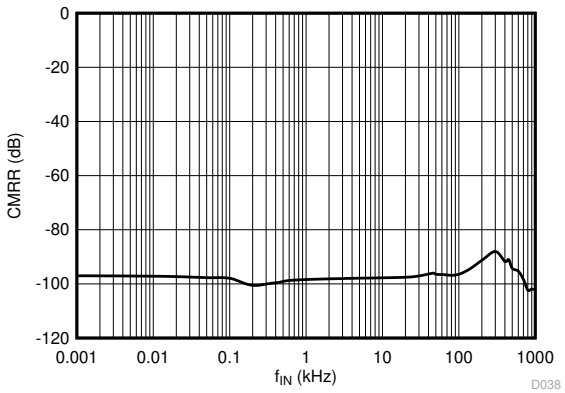



**图 5-28. Common-Mode Rejection Ratio vs Input Frequency**

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## 5.13 Typical Characteristics (continued)

at VDD = 3.3 V, INP = – 250 mV to +250 mV, INN = HGND = 0 V, and $f_{IN}$ = 10 kHz (unless otherwise noted)

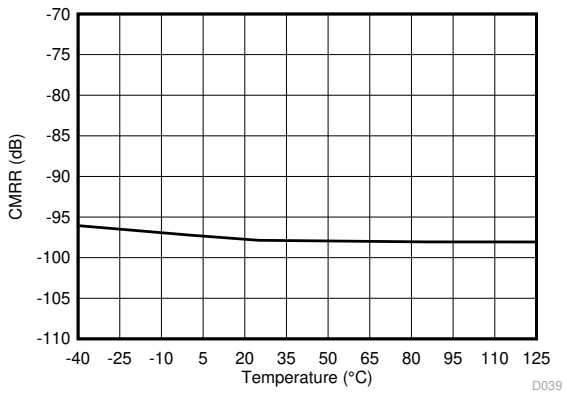



图 5-29. Common-Mode Rejection Ratio vs Temperature

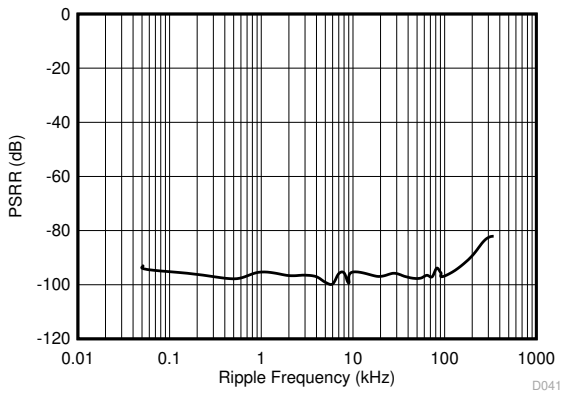



图 5-30. Power-Supply Rejection Ratio vs Ripple Frequency

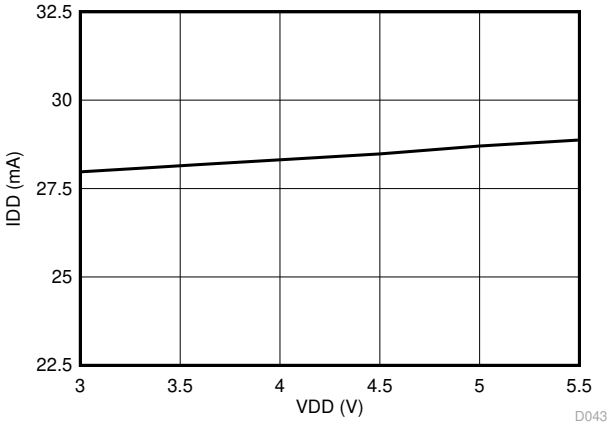



图 5-31. Supply Current vs Supply Voltage

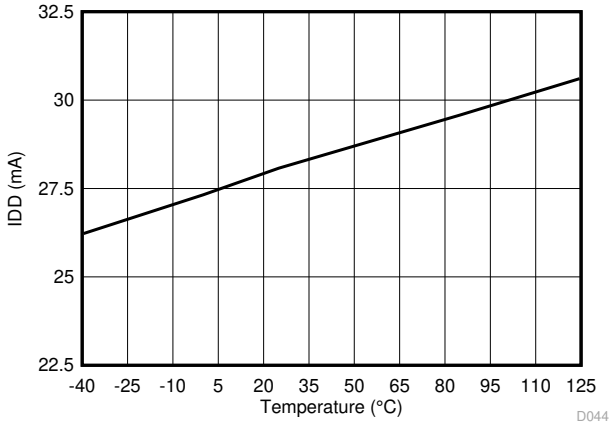



图 5-32. Supply Current vs Temperature

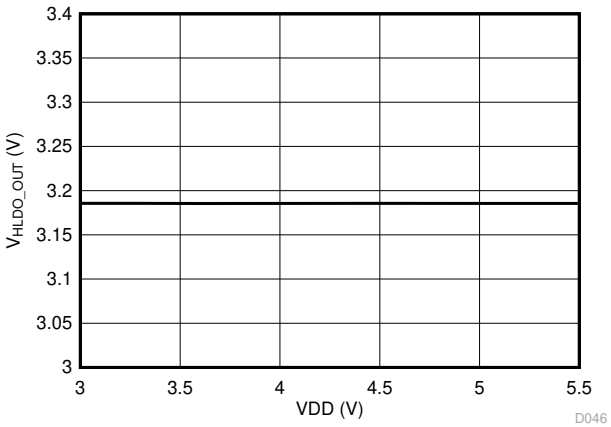



图 5-33. High-Side LDO Line Regulation

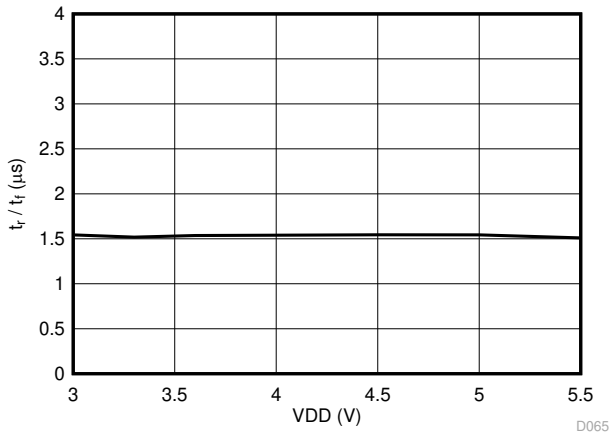



图 5-34. Output Rise and Fall time vs Supply Voltage


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## 5.13 Typical Characteristics (continued)

at VDD = 3.3 V, INP = – 250 mV to +250 mV, INN = HGND = 0 V, and $f_{IN}$ = 10 kHz (unless otherwise noted)

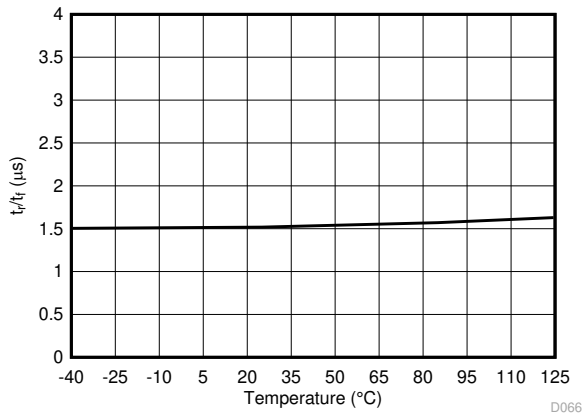



图 5-35. Output Rise and Fall Time vs Temperature

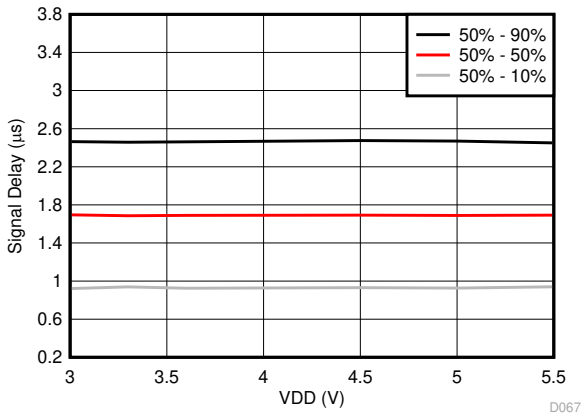



图 5-36. $V_{IN}$ to $V_{OUT}$ Signal Delay vs Supply Voltage

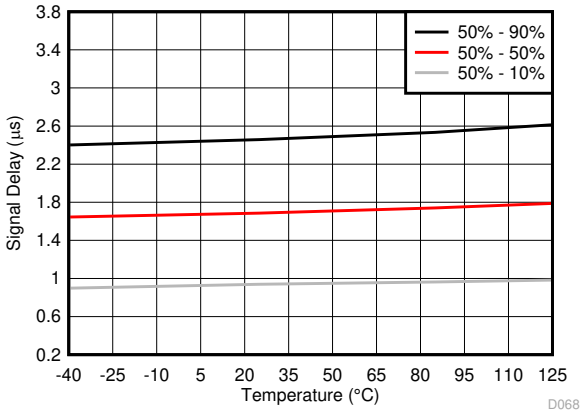



图 5-37. $V_{IN}$ to $V_{OUT}$ Signal Delay vs Temperature

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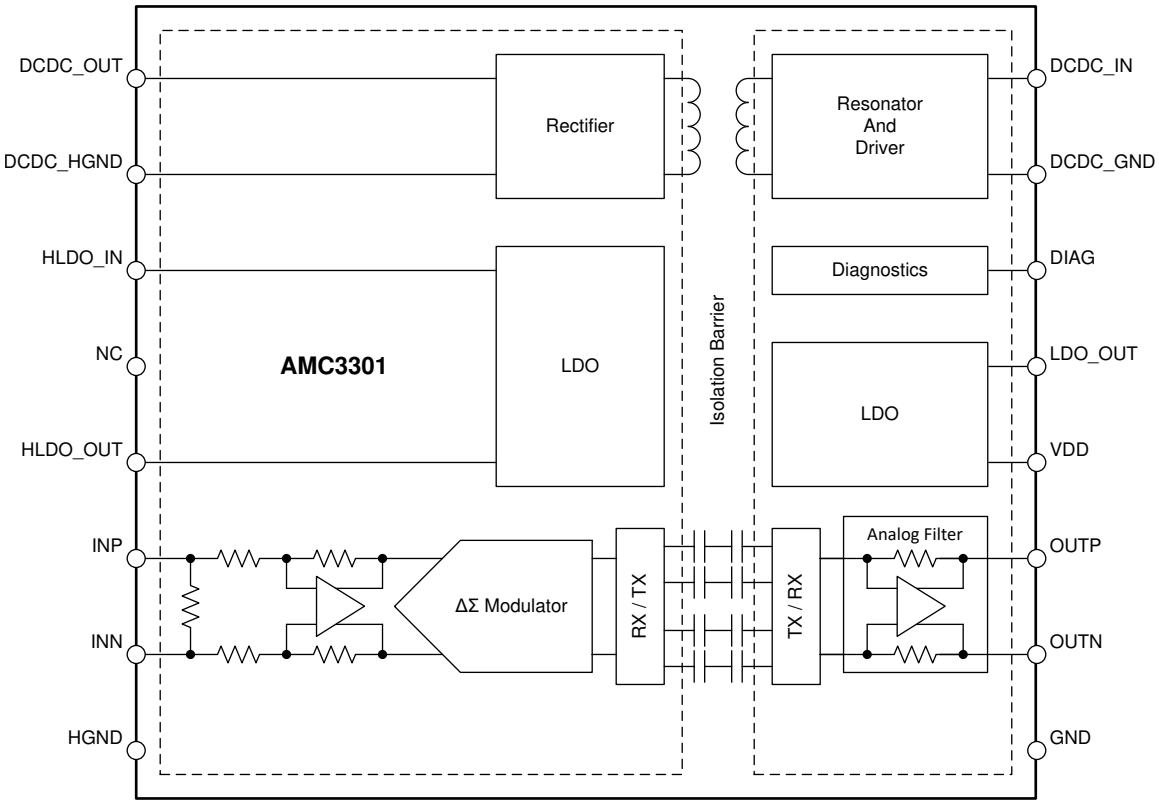
# 6 Detailed Description

## 6.1 Overview

The AMC3301 is a fully differential, precision, isolated amplifier with a fully integrated DC/DC converter that can supply the device from a single 3.3-V or 5-V voltage supply on the low-side. The input stage of the device consists of a fully differential amplifier that drives a second-order, delta-sigma ($\Delta\Sigma$) modulator. The modulator uses an internal voltage reference and clock generator to convert the analog input signal to a digital bitstream. The drivers (termed *TX* in the *Functional Block Diagram*) transfer the output of the modulator across the isolation barrier that separates the high-side and low-side voltage domains. As shown in the *Functional Block Diagram*, the received bitstream and clock are synchronized and processed by a fourth-order analog filter on the low-side and presented as a differential output of the device

The signal path is isolated by a double capacitive silicon dioxide ($SiO_2$) insuation barrier, whereas power isolation uses an on-chip transformer separated by a thin-film polymer as the insulating material.

## 6.2 Functional Block Diagram




## 6.3 Feature Description

### 6.3.1 Analog Input

The differential amplifier input stage of the AMC3301 feeds a second-order, switched-capacitor, feed-forward $\Delta\Sigma$ modulator. The gain of the differential amplifier is set by internal precision resistors with a differential input impedance of $R_{IND}$. The modulator converts the analog signal into a bitstream that is transferred across the isolation barrier, as described in the *Data Isolation Channel Signal Transmission* section.

There are two restrictions on the analog input signals (INP and INN). First, if the input voltages $V_{INP}$ or $V_{INN}$ exceed the range specified in the *Absolute Maximum Ratings* table, the input current must be limited to the absolute maximum value, because the device input electrostatic discharge (ESD) diodes turns on. In addition, the linearity and parametric performance of the device are ensured only when the analog input voltage remains


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within linear full-scale range ($V_{FSR}$) and within the common-mode input voltage range ($V_{CM}$) as specified in the *Recommended Operating Conditions* table.

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### 6.3.2 Data Isolation Channel Signal Transmission

The AMC3301 uses an on-off keying (OOK) modulation scheme, as shown in 图 6-1, to transmit the modulator output bitstream across the capacitive $SiO_2$-based isolation barrier. The transmit driver (TX) shown in the *Functional Block Diagram* transmits an internally generated, high-frequency carrier across the isolation barrier to represent a digital *one* and does not send a signal to represent a digital *zero*. The nominal frequency of the carrier used inside the AMC3301 is 480 MHz.

The receiver (RX) on the other side of the isolation barrier recovers and demodulates the signal and produces the output. The AMC3301 transmission channel is optimized to achieve the highest level of common-mode transient immunity (CMTI) and lowest level of radiated emissions caused by the high-frequency carrier and RX/TX buffer switching.

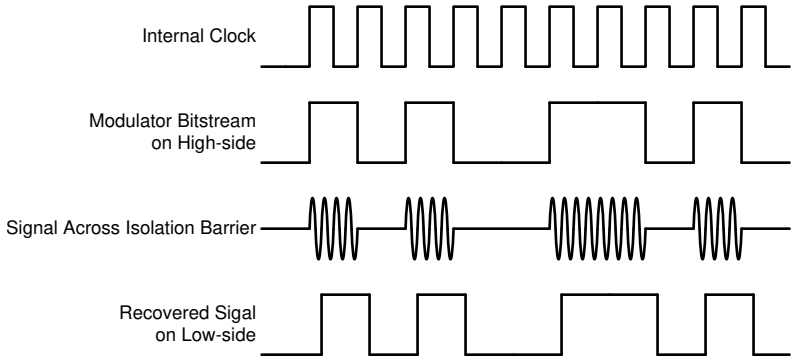



**图 6-1. OOK-Based Modulation Scheme**


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### 6.3.3 Analog Output

The AMC3301 offers a differential analog output comprised of the OUTP and OUTN pins. For differential input voltages ($V_{INP}$ – $V_{INN}$) in the range from –250 mV to +250 mV, the device provides a linear response with a nominal gain of 8.2. For example, for a differential input voltage of 250 mV, the differential output voltage ($V_{OUTP}$ – $V_{OUTN}$) is 2.05 V. At zero input (INP shorted to INN), both pins output the same common-mode output voltage $V_{CMout}$, as specified in the *Electrical Characteristics* table. For absolute differential input voltages greater than 250 mV but less than 320 mV, the differential output voltage continues to increase in magnitude but with reduced linearity performance. The outputs saturate at a differential output voltage of $V_{CLIPout}$ as shown in 图 6-2 if the differential input voltage exceeds the $V_{Clipping}$ value.

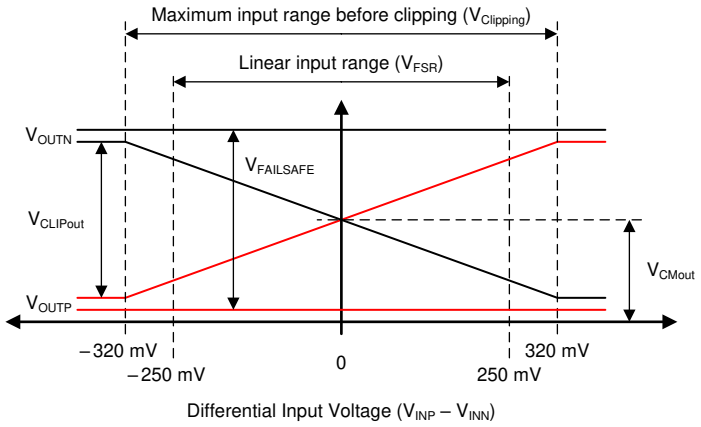



**图 6-2. Output Behavior of the AMC3301**

The AMC3301 provides a fail-safe output that simplifies diagnostics on system level. 图 6-2 shows the fail-safe mode, in which the AMC3301 outputs a negative differential output voltage that does not occur under normal operating conditions. The fail-safe output is active in two cases:

- The low-side does not receive data from the high-side (for example, because of a loss of power on the high side).
- The high-side DC/DC output voltage (DCDC_OUT) or the high-side LDO output voltage (HLDO_OUT) drop below their respective undervoltage detection thresholds (brown-out).

Use the maximum $V_{FAILSAFE}$ voltage specified in the *Electrical Characteristics* table as a reference value for the fail-safe detection on the system level.

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### 6.3.4 Isolated DC/DC Converter

The AMC3301 offers a fully integrated isolated DC/DC converter that includes the following components as illustrated in the *Functional Block Diagram*:

- Low-dropout regulator (LDO) on the low-side to stabilize the supply voltage VDD that drives the low-side of the converter. This circuit does not output a constant voltage and is not intended for driving any external load.
- Low-side full-bridge inverter and drivers
- Laminate-based, air-core transformer for high-immunity to magnetic fields
- High-side full-bridge rectifier
- High-side LDO to stabilize the output voltage of the DC/DC converter for high analog performance of the signal path. The high-side LDO outputs a constant voltage and can provide a limited amount of current to power external circuitry.

The DC/DC converter uses a spread-spectrum clock generation technique to reduce the spectral density of the electromagnetic radiation. The resonator frequency is synchronized to the operation of the $\Delta\Sigma$ modulator to minimize the interference with data transmission and support the high analog performance of the device.

The architecture of the DC/DC converter is optimized to drive the high-side circuitry of the AMC3301 and can source up to $I_H$ of additional DC current for an optional auxiliary circuit such as an active filter, preamplifier, or comparator. $I_H$ is specified in the *Electrical Characteristics* table as a DC, non-switching current.

### 6.3.5 Diagnostic Output

The open-drain DIAG pin can be monitored to confirm the device is operational and the output voltage is valid. As shown in 图 6-3, during power-up, the DIAG pin is actively held low until the high-side supply is in regulation and the device operates properly. During normal operation, the DIAG pin is in high-impedance (Hi-Z) state and is pulled high through an external pullup resistor. The DIAG pin is actively pulled low if:

- The low-side does not receive data from the high-side (for example, because of a loss of power on the high side). In this case, the amplifier outputs are driven to the $V_{FAILSAFE}$ value that is shown in 图 6-2.
- The high-side DC/DC output voltage (DCDC_OUT) or the high-side LDO output voltage (HLDO_OUT) drop below their respective undervoltage detection thresholds (brown-out). In this case, the low-side may still receive data from the high-side but the data may not be valid. The amplifier outputs are driven to the $V_{FAILSAFE}$ value that is shown in 图 6-2.

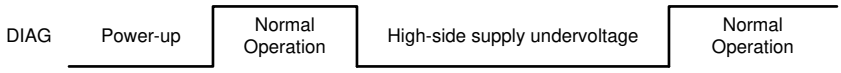



**图 6-3. DIAG Output Under Different Operating Conditions**

During normal operation, the DIAG pin is in a high-impedance state. Connect the DIAG pin to a pullup resistor or leave open if not used.

## 6.4 Device Functional Modes

The AMC3301 is operational when the power supply VDD is applied, as specified in the *Recommended Operating Conditions* table.


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# 7 Application and Implementation

备注

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI’s customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

## 7.1 Application Information

The low input voltage range, low nonlinearity, and low temperature drift make the AMC3301 a high-performance solution for industrial applications where shunt-based current sensing with high common-mode voltage levels is required.

## 7.2 Typical Application

The AMC3301 is ideally suited for shunt-based current sensing applications where accurate current monitoring is required in the presence of high common-mode voltages. The AMC3301 integrates an isolated power supply for the high-voltage side and therefore makes the device particularly easy to use in applications that do not have a high-side supply readily available or where a high-side supply is referenced to a different ground potential than the signal to be measured.

图 7-1 shows a simplified schematic of the AMC3301 in a solar inverter where the phase current is measured on the grid-side of an LCL filter. Although the system offers a supply for the high-side gate driver, there is a large common-mode voltage between the gate driver supply ground reference and the shunt resistor on the other side of the LCL filter. Therefore, the gate driver supply is not suitable for powering the high-side of an isolated amplifier that measures the voltage across the shunt. The integrated isolated power supply of the AMC3301 solves that problem and enables current sensing at locations that is optimal for the system.

The diagram also shows the AMC3330 being used for sensing the AC output voltage.

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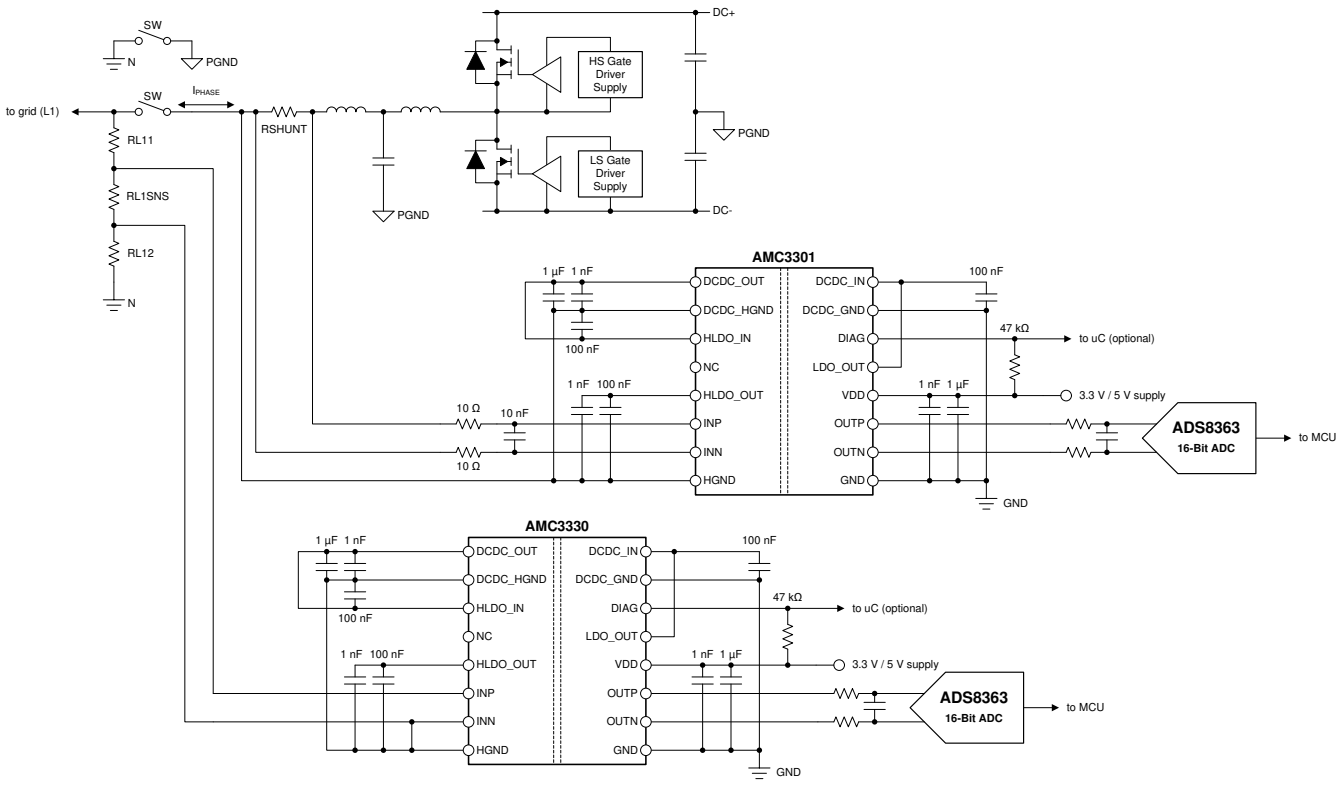



**图 7-1. The AMC3301 in a Solar Inverter Application**


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### 7.2.1 Design Requirements

表 7-1 lists the parameters for this typical application.

**表 7-1. Design Requirements**

| PARAMETER | VALUE |
|---|---|
| Supply voltage | 3.3 V or 5 V |
| Voltage drop across the shunt for a linear response ($V_{SHUNT}$) | ±250 mV (maximum) |

### 7.2.2 Detailed Design Procedure

The AMC3301 requires a single 3.3-V or 5-V supply on its low-side. The high-side supply is internally generated by an integrated DC/DC converter as explained in the *Isolated DC/DC Converter* section.

The ground reference (HGND) is derived from the terminal of the shunt resistor that is connected to the negative input of the AMC3301 (INN). If a four-pin shunt is used, the inputs of the AMC3301 are connected to the inner leads and HGND is connected to one of the outer shunt leads. To minimize offset and improve accuracy, set the ground connection to a separate trace that connects directly to the shunt resistor rather than shorting HGND to INN directly at the input to the device. See the *Layout* section for more details.

#### 7.2.2.1 Shunt Resistor Sizing

Use Ohm's Law to calculate the voltage drop across the shunt resistor ($V_{SHUNT}$) for the desired measured current: $V_{SHUNT} = I \times R_{SHUNT}$ .

Consider the following two restrictions to choose the proper value of the shunt resistor, $R_{SHUNT}$:

- The voltage drop caused by the nominal current range must not exceed the recommended differential input voltage range: $|V_{SHUNT}| \leqslant |V_{FSR}|$
- The voltage drop caused by the maximum allowed overcurrent must not exceed the input voltage that causes a clipping output: $|V_{SHUNT}| \leqslant |V_{Clipping}|$

#### 7.2.2.2 Input Filter Design

TI recommends placing an RC filter in front of the isolated amplifier to improve signal-to-noise performance of the signal path. Design the input filter such that:

- The cutoff frequency of the filter is at least one order of magnitude lower than the sampling frequency (20 MHz) of the $\Delta\Sigma$ modulator
- The input bias current does not generate significant voltage drop across the DC impedance of the input filter
- The impedances measured from the analog inputs are equal

For most applications, the structure shown in 图 7-2 achieves excellent performance.

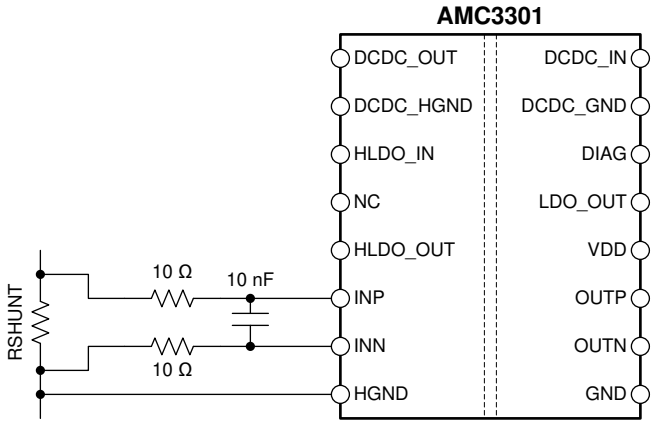



**图 7-2. Differential Input Filter**

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#### 7.2.2.3 Differential to Single-Ended Output Conversion

图 7-3 shows an example of a TLV6001 based signal conversion and filter circuit for systems using single-ended-input ADCs to convert the analog output voltage into digital. With R1 = R2 = R3 = R4, the output voltage equals ($V_{OUTP}$ – $V_{OUTN}$) + $V_{REF}$. Tailor the bandwidth of this filter stage to the bandwidth requirement of the system. For most applications, R1 = R2 = R3 = R4 = 3.3 kΩ and C1 = C2 = 330 pF yields good performance.

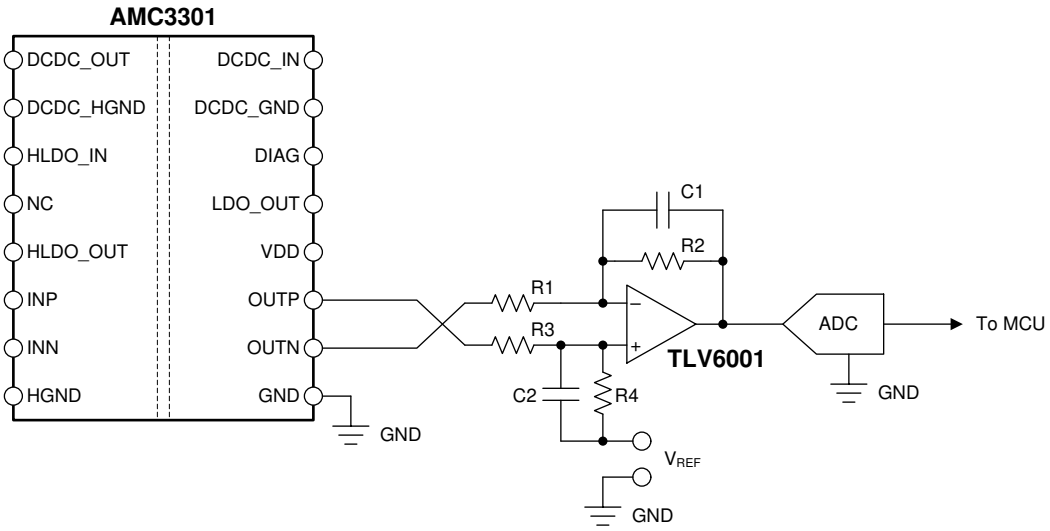



**图 7-3. Connecting the AMC3301 Output to a Single-Ended Input ADC**

For more information on the general procedure to design the filtering and driving stages of successive-approximation-register (SAR) ADCs, see the *18-Bit, 1MSPS Data Acquisition Block (DAQ) Optimized for Lowest Distortion and Noise* reference guide and *18-Bit Data Acquisition Block (DAQ) Optimized for Lowest Power* reference guide, available for download at www.ti.com.

### *7.2.3 Application Curve*

In frequency inverter applications, the power switches must be protected in case of an overcurrent condition. To allow for fast powering off of the system, a low delay caused by the isolated amplifier is required. 图 7-4 shows the typical full-scale step response of the AMC3301. Consider the delay of the required window comparator and the MCU to calculate the overall response time of the system.

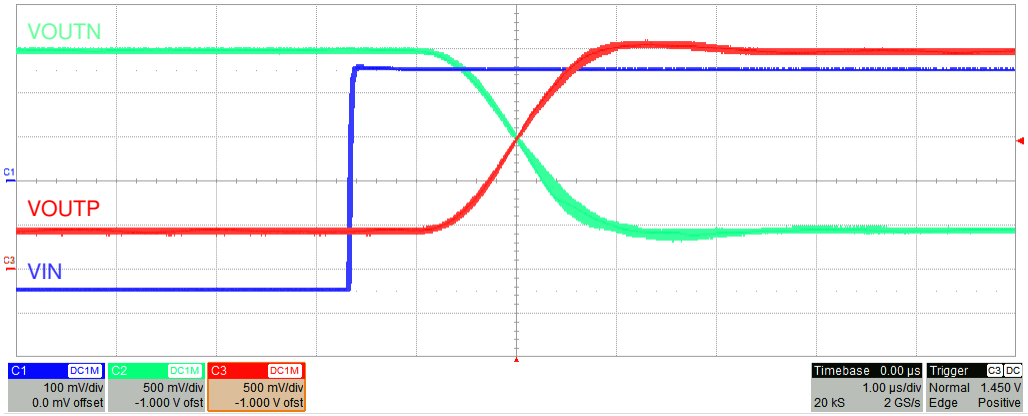



**图 7-4. Step Response of the AMC3301**


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## 7.3 Best Design Practices

Do not leave the analog inputs INP and INN of the AMC3301 unconnected (floating) when the device is powered up. If the device inputs are left floating, the input bias current may drive the inputs to a positive value that exceeds the operating common-mode input voltage and the output of the device is undetermined.

Connect the negative input (INN) to the high-side ground (HGND), either by a hard short or through a resistive path. A DC current path between INN and HGND is required to define the input common-mode voltage. Take care not to exceed the input common-mode range as specified in the *Recommended Operating Conditions* table. For best accuracy, route the ground connection as a separate trace that connects directly to the shunt resistor rather than shorting AGND to INN directly at the input to the device. See the *Layout* section for more details.

The high-side LDO can source a limited amount of current ($I_H$) to power external circuitry. Take care not to overload the high-side LDO.

The low-side LDO does not output a constant voltage and is not intended for powering any external circuitry. Do not connect any external load to the LDO_OUT pin.

## 7.4 Power Supply Recommendations

The AMC3301 is powered from the low-side power supply (VDD) with a nominal value of 3.3 V or 5 V. TI recommends a low-ESR decoupling capacitor of 1 nF (C8 in 图 7-5) placed as close as possible to the VDD pin, followed by a 1-µF capacitor (C9) to filter this power-supply path.

The low-side of the DC/DC converter is decoupled with a low-ESR 100-nF capacitor (C4) positioned close to the device between the DCDC_IN and DCDC_GND pins. Use a 1-µF capacitor (C2) to decouple the high side in addition to a low-ESR, 1-nF capacitor (C3) placed as close as possible to the device and connected to the DCDC_OUT and DCDC_HGND pins.

For the high-side LDO, use low-ESR capacitors of 1 nF (C6), placed as close as possible to the AMC3301, followed by a 100-nF decoupling capacitor (C5).

The ground reference for the high-side (HGND) is derived from the terminal of the shunt resistor which is connected to the negative input (INN) of the device. For best DC accuracy, use a separate trace to make this connection instead of shorting HGND to INN directly at the device input. The high-side DC/DC ground terminal (DCDC_HGND) is shorted to HGND directly at the device pins.

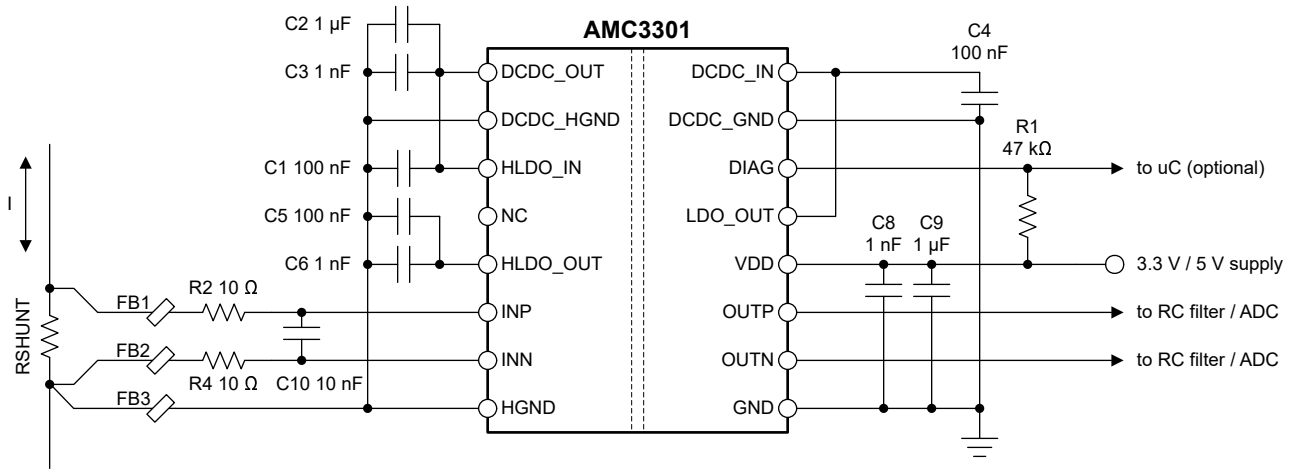



**图 7-5. Decoupling the AMC3301**

Capacitors must provide adequate *effective* capacitance under the applicable DC bias conditions they experience in the application. Multilayer ceramic capacitors (MLCC) typically exhibit only a fraction of their nominal capacitance under real-world conditions and this factor must be taken into consideration when selecting

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these capacitors. This problem is especially acute in low-profile capacitors, in which the dielectric field strength is higher than in taller components. Reputable capacitor manufacturers provide capacitance versus DC bias curves that greatly simplify component selection.

The *Best Practices to Attenuate AMC3301 Family Radiated Emissions EMI* application note is available for download at www.ti.com.

表 7-2 lists components suitable for use with the AMC3301. This list is not exhaustive. Other components may exist that are equally suitable (or better), however these listed components have been validated during the development of the AMC3301.

**表 7-2. Recommended External Components**

| DESCRIPTION | | PART NUMBER | MANUFACTURER | SIZE (EIA, L x W) |
|---|---|---|---|---|
| **VDD** | | | | |
| C8 | 1 nF ± 10%, X7R, 50 V | 12065C102KAT2A | AVX | 1206, 3.2 mm x 1.6 mm |
| C9 | 1 µF ± 10%, X7R, 25 V | 12063C105KAT2A | AVX | 1206, 3.2 mm x 1.6 mm |
| **DC/DC CONVERTER** | | | | |
| C4 | 100 nF ± 10%, X7R, 50 V | C0603C104K5RACAUTO | Kemet | 0603, 1.6 mm x 0.8 mm |
| C3 | 1 nF ± 10%, X7R, 50 V | C0603C102K5RACTU | Kemet | 0603, 1.6 mm x 0.8 mm |
| C2 | 1 µF ± 10%, X7R, 25 V | CGA3E1X7R1E105K080AC | TDK | 0603, 1.6 mm x 0.8 mm |
| **HLDO** | | | | |
| C1 | 100 nF ± 10%, X7R, 50 V | C0603C104K5RACAUTO | Kemet | 0603, 1.6 mm x 0.8 mm |
| C5 | 100 nF ± 5%, NP0, 50 V | C3216NP01H104J160AA | TDK | 1206, 3.2 mm x 1.6 mm |
| C6 | 1 nF ± 10%, X7R, 50 V | 12065C102KAT2A | AVX | 1206, 3.2 mm x 1.6 mm |
| **FERRITE BEADS** | | | | |
| FB1, FB2, FB3 | Ferrite bead(1) | 74269244182 | Wurth Elektronik | 0402, 1.0mm × 0.5mm |
| | | BLM15HD182SH1 | Murata | 0402, 1.0mm × 0.5mm |
| | | BKH1005LM182-T | Taiyo Yuden | 0402, 1.0mm × 0.5mm |

(1) No ferrite beads are used for parametric validation.


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## 7.5 Layout

### 7.5.1 Layout Guidelines

图 7-6 shows a layout recommendation with the critical placement of the decoupling capacitors. The same component reference designators are used as in the *Power Supply Recommendations* section. Decoupling capacitors are placed as close as possible to the AMC3301 supply pins. For best performance, place the shunt resistor close to the INP and INN inputs of the AMC3301 and keep the layout of both connections symmetrical.

To avoid causing errors in the measurement by the input bias currents of the AMC3301, connect the high-side ground pin (HGND) to the INN-side of the shunt resistor. Use a separate trace in the layout to make this connection to maintain equal currents in the INN and INP traces.

### 7.5.2 Layout Example

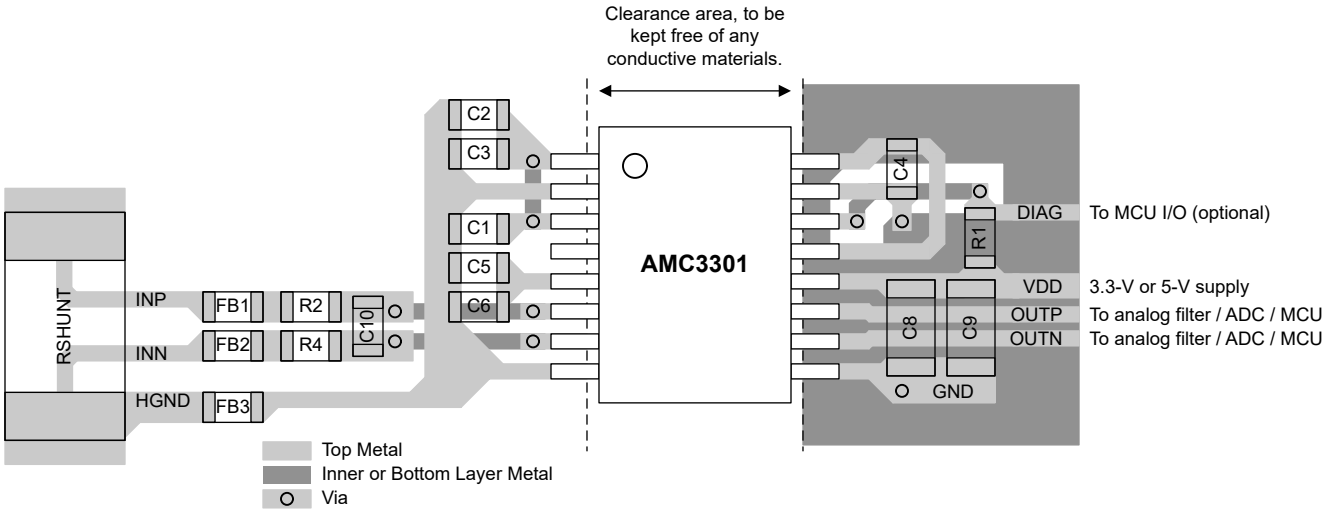



**图 7-6. Recommended Layout of the AMC3301**

# 8 Device and Documentation Support

## 8.1 Device Support

### 8.1.1 Device Nomenclature

Texas Instruments, *Isolation Glossary*

## 8.2 Documentation Support

### 8.2.1 Related Documentation

For related documentation, see the following:

- Texas Instruments, *ISO72x Digital Isolator Magnetic-Field Immunity* application report
- Texas Instruments, *AMC3330 Precision, ±1-V Input, Reinforced Isolated Amplifier* data sheet
- Texas Instruments, *TLV600x Low-Power, Rail-to-Rail In/Out, 1-MHz Operational Amplifier for Cost-Sensitive Systems* data sheet
- Texas Instruments, *18-Bit, 1-MSPS Data Acquisition Block (DAQ) Optimized for Lowest Distortion and Noise* reference guide
- Texas Instruments, *18-Bit, 1-MSPS Data Acquisition Block (DAQ) Optimized for Lowest Power* reference guide

## 8.3 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

## 8.4 支持资源

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ESD 的损坏小至导致微小的性能降级，大至整个器件故障。精密的集成电路可能更容易受到损坏，这是因为非常细微的参数更改都可能会导致器件与其发布的规格不相符。

## 8.7 术语表

| | |
|---|---|
| TI 术语表 | 本术语表列出并解释了术语、首字母缩略词和定义。 |


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# 9 Revision History

注：以前版本的页码可能与当前版本的页码不同

**Changes from Revision B (May 2021) to Revision C (May 2025)** **Page**

- 通篇将增强型隔离安全相关认证从 *VDE V 0884-11* 更改为 *DIN EN IEC 60747-17 (VDE 0884-17)* ....1
- Added analog output capacitive and resistive drive capability specification....4
- Added DIGITAL OUTPUT (DIAG) specification....4
- Updated Barrier capacitance specification from 3.5 pF to 4.5 pF....6
- Changed isolation standard from DIN VDE V 0884-11 (VDE V 0884-11) to DIN EN IEC 60747-17 (VDE 0884-17) and updated the Insulation Specifications and Safety-Related Certifications tables accordingly....7
- Added DIGITAL OUTPUT (DIAG) electrical specifications....8
- Added $VDD_{UV}$ and $VDD_{POR}$ specifications....8
- Added IH specification for 3.6 V ≤ VDD ≤ 5.5 V....8
- Changed *HLDO_OUT pin* to *LDO_OUT pin* in *Best Design Practices* section....27

**Changes from Revision A (July 2020) to Revision B (May 2021)** **Page**

- 更改了“特性”部分：更改了*低直流误差*要点中的*失调电压*和*温漂*子要点，重新排列了各要点，添加了最后一个要点....1
- 将*应用*部分的目标应用从*隔离式电压检测*更改为*基于分流器的隔离式电流检测*....1
- Changed *Pin Configuration and Functions* section....3
- Changed A*bsolute Maximum Ratings*: changed max for *DIAG* pin from 5.5 V to 6.5 V....4
- Changed overvoltage category for rated mains voltage ≤ 600 V from I-IV to I-III and for rated mains voltage ≤1000 V from I-III to I-II....6
- Changed *output bandwidth (BW) (min)* from 250 kHz to 290 kHz....8
- Changed *Typical Characteristics* section. Removed histograms, editorial changes....12
- Changed *Functional Block Diagram* figure....18
- Changed *Data Isolation Channel Signal Transmission* section....20
- Changed *Analog Output* section....21
- Changed *Diagnostic Output* section: added *DIAG Output Under Different Operating Conditions* figure....22
- Changed *Typical Application* section....23
- Changed *Input Filter Design* section: changed *Differential Input Filter* figure....25
- Added *Differential to Single-Ended Output Conversion* section....26
- Changed *Step Response of the AMC3301* figure....26
- Changed *Power Supply Recommendations* section: changed nominal value in the first sentence from *3.3 V (or 5 V) ± 10 V* to *3.3 V or 5 V*, changed *primary-side* to *low-side*, *secondary-side* to *high-side*, and *Decoupling the AMC3301* figure....27
- Changed *Recommended Layout of the AMC3301* figure....29

# 10 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.

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## PACKAGING INFORMATION

| Orderable part number | Status (1) | Material type (2) | Package \| Pins | Package qty \| Carrier | RoHS (3) | Lead finish/ Ball material (4) | MSL rating/ Peak reflow (5) | Op temp (°C) | Part marking (6) |
|---|---|---|---|---|---|---|---|---|---|
| AMC3301DWE | Active | Production | SOIC (DWE) \| 16 | 40 \| TUBE | Yes | NIPDAU | Level-3-260C-168 HR | -40 to 125 | AMC3301 |
| AMC3301DWE.A | Active | Production | SOIC (DWE) \| 16 | 40 \| TUBE | Yes | NIPDAU | Level-3-260C-168 HR | -40 to 125 | AMC3301 |
| AMC3301DWEG4 | Active | Production | SOIC (DWE) \| 16 | 40 \| TUBE | Yes | NIPDAU | Level-3-260C-168 HR | -40 to 125 | AMC3301 |
| AMC3301DWEG4.A | Active | Production | SOIC (DWE) \| 16 | 40 \| TUBE | Yes | NIPDAU | Level-3-260C-168 HR | -40 to 125 | AMC3301 |
| AMC3301DWER | Active | Production | SOIC (DWE) \| 16 | 2000 \| LARGE T&R | Yes | NIPDAU | Level-3-260C-168 HR | -40 to 125 | AMC3301 |
| AMC3301DWER.A | Active | Production | SOIC (DWE) \| 16 | 2000 \| LARGE T&R | Yes | NIPDAU | Level-3-260C-168 HR | -40 to 125 | AMC3301 |

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

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

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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**OTHER QUALIFIED VERSIONS OF AMC3301 :**

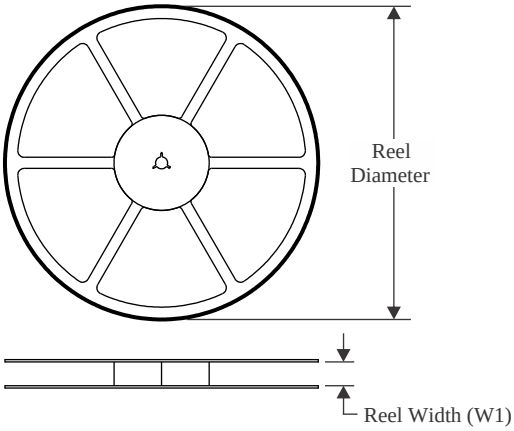
- Automotive : AMC3301-Q1

NOTE: Qualified Version Definitions:

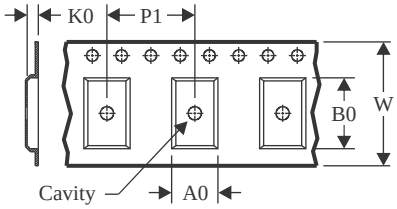
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**

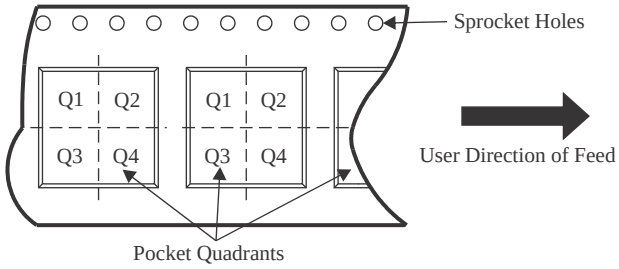



**TAPE DIMENSIONS**




| | |
|---|---|
| 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 |

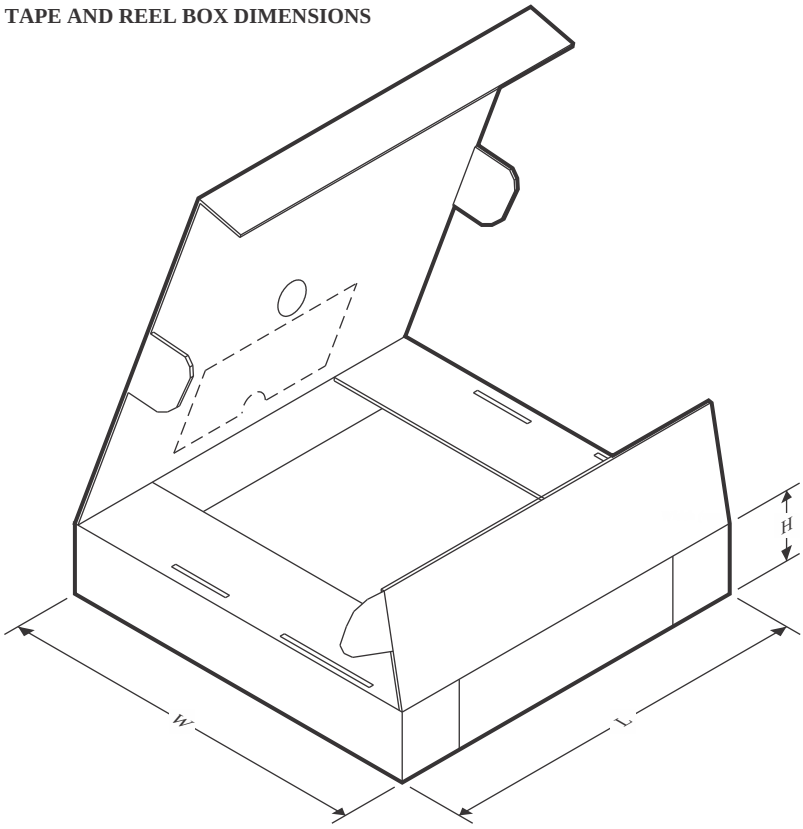
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**




*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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AMC3301DWER | SOIC | DWE | 16 | 2000 | 330.0 | 16.4 | 10.75 | 10.7 | 2.7 | 12.0 | 16.0 | Q1 |

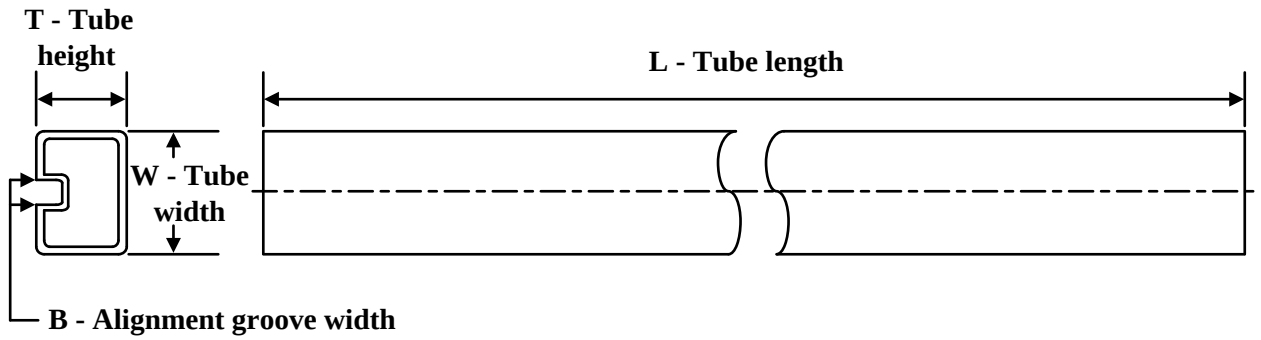
TAPE AND REEL BOX DIMENSIONS




*All dimensions are nominal

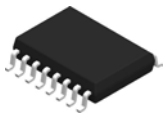
| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| AMC3301DWER | SOIC | DWE | 16 | 2000 | 350.0 | 350.0 | 43.0 |

## TUBE




*All dimensions are nominal

| Device | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (µm) | B (mm) |
|---|---|---|---|---|---|---|---|---|
| AMC3301DWE | DWE | SO-MOD | 16 | 40 | 506.98 | 12.7 | 4826 | 6.6 |
| AMC3301DWE.A | DWE | SO-MOD | 16 | 40 | 506.98 | 12.7 | 4826 | 6.6 |
| AMC3301DWEG4 | DWE | SO-MOD | 16 | 40 | 506.98 | 12.7 | 4826 | 6.6 |
| AMC3301DWEG4.A | DWE | SO-MOD | 16 | 40 | 506.98 | 12.7 | 4826 | 6.6 |

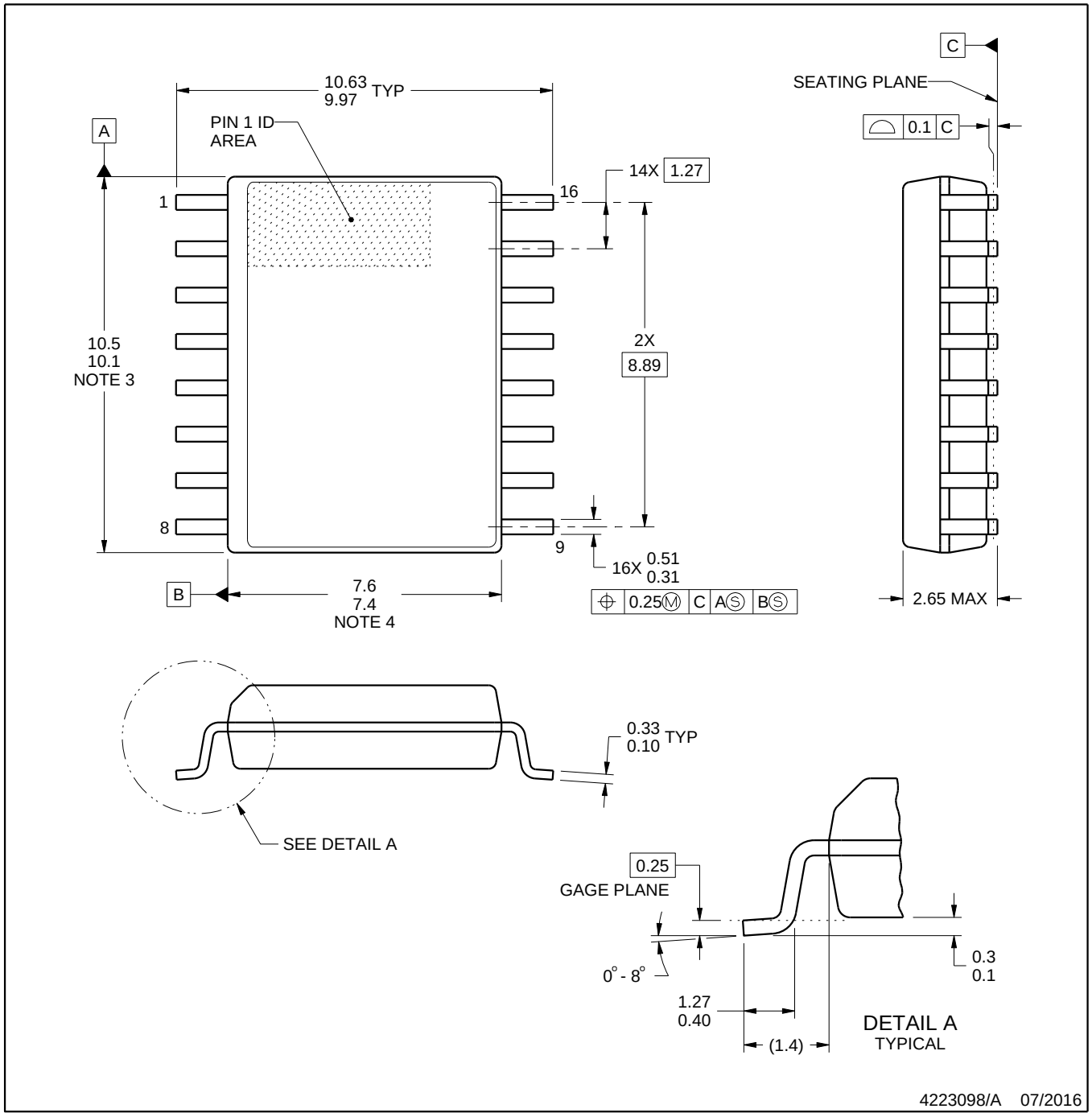


# PACKAGE OUTLINE

## DWE0016A

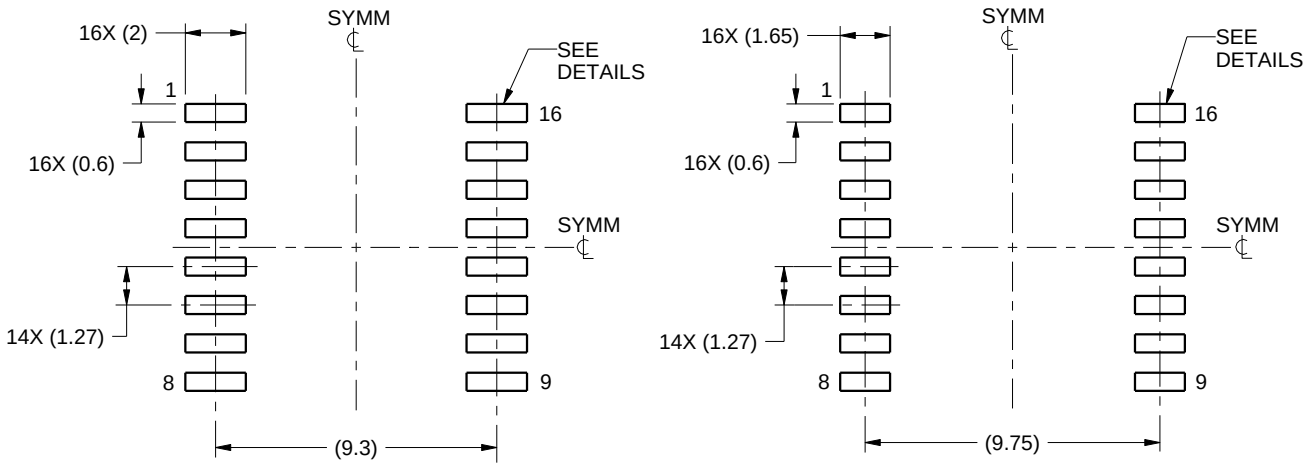
## SOIC - 2.65 mm max height

SOIC




NOTES:

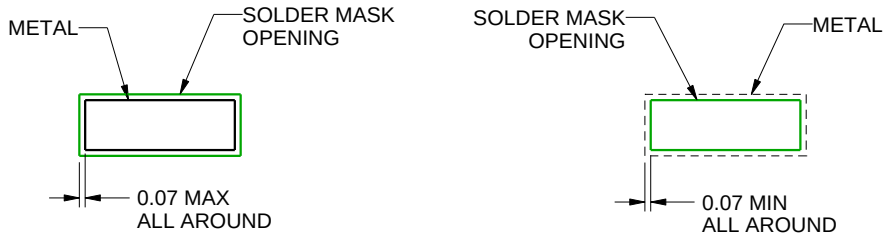
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm, per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm, per side.
5. Reference JEDEC registration MS-013.




IPC-7351 NOMINAL
7.3 mm CLEARANCE/CREEPAGE

HV / ISOLATION OPTION
8.1 mm CLEARANCE/CREEPAGE

LAND PATTERN EXAMPLE
SCALE:4X




NON SOLDER MASK DEFINED

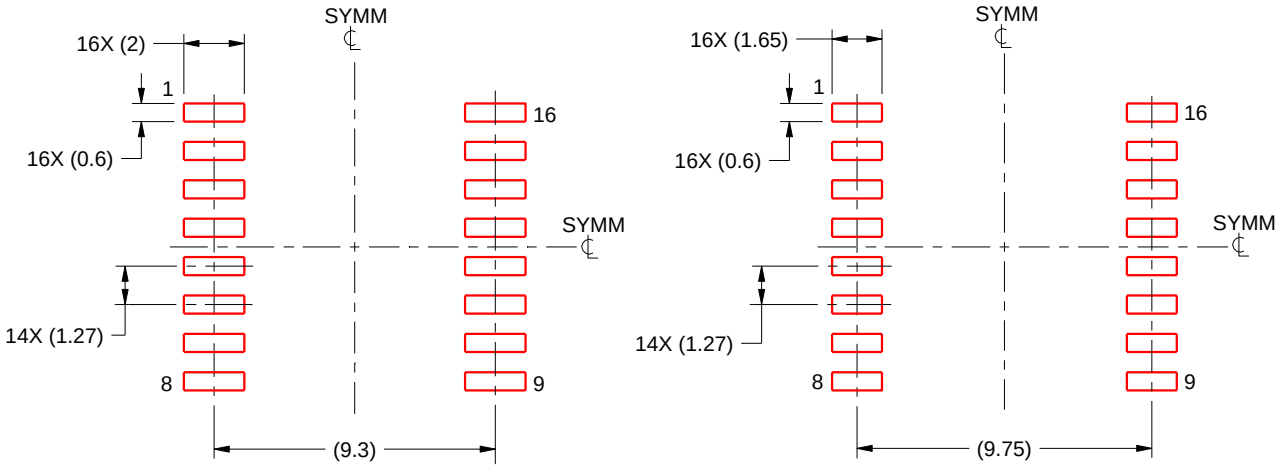
SOLDER MASK DEFINED

SOLDER MASK DETAILS

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NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.




IPC-7351 NOMINAL
7.3 mm CLEARANCE/CREEPAGE

HV / ISOLATION OPTION
8.1 mm CLEARANCE/CREEPAGE

SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:4X

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NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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