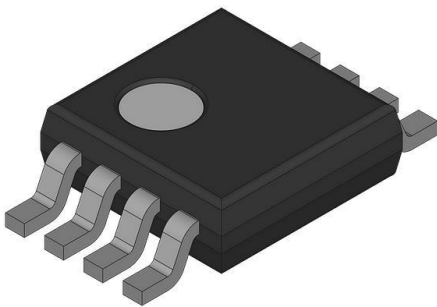


THS3201DGN Datasheet

www.digi-electronics.com



<https://www.DiGi-Electronics.com>

| | |
|------------------------------|---------------------------------|
| DiGi Electronics Part Number | THS3201DGN-DG |
| Manufacturer | Benchmarq |
| Manufacturer Product Number | THS3201DGN |
| Description | THS3201 1.8GHZ CURRENT FEEDBACK |
| Detailed Description | Amplifier IC |

This model THS3201DGN is available at DiGi Electronics.

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Purchase and inquiry

Manufacturer Product Number:

THS3201DGN

Series:

*

Manufacturer:

Benchmark

Product Status:

Active

Environmental & Export classification

ECCN:

EAR99

HTSUS:

8542.33.0001



1.8-GHz, LOW DISTORTION, CURRENT-FEEDBACK AMPLIFIER

FEATURES

- **Unity-Gain Bandwidth: 1.8 GHz**
- **High Slew Rate: 6700 V/ μ s ($G = 2$ V/V, $R_L = 100 \Omega$, 10-V Step)**
- **IMD₃: -78 dBc at 20 MHz: ($G = 10$ V/V, $R_L = 100 \Omega$, 2-V_{PP} Envelope)**
- **Noise Figure: 11 dB ($G = 10$ V/V, $R_G = 28 \Omega$, $R_F = 255 \Omega$)**
- **Input-Referred Noise ($f > 10$ MHz)**
 - Voltage Noise: 1.65 nV/ $\sqrt{\text{Hz}}$
 - Noninverting Current Noise: 13.4 pA/ $\sqrt{\text{Hz}}$
 - Inverting Current Noise: 20 pA/ $\sqrt{\text{Hz}}$
- **Output Drive: 100 mA**
- **Power-Supply Voltage Range: ± 3.3 V to ± 7.5 V**

APPLICATIONS

- Test and Measurement
- ATE
- High-Resolution, High-Sampling Rate ADC Drivers
- High-Resolution, High-Sampling Rate DAC Output Buffers

DESCRIPTION

The THS3201 is a wideband, high-speed current-feedback amplifier, designed to operate over a wide supply range of ± 3.3 V to ± 7.5 V for today's high performance applications.

The wide supply range, combined with low distortion and high slew rate, makes the THS3201 ideally suited for arbitrary waveform driver applications. The distortion performance also enables driving high-resolution and high-sampling rate analog-to-digital converters (ADCs).

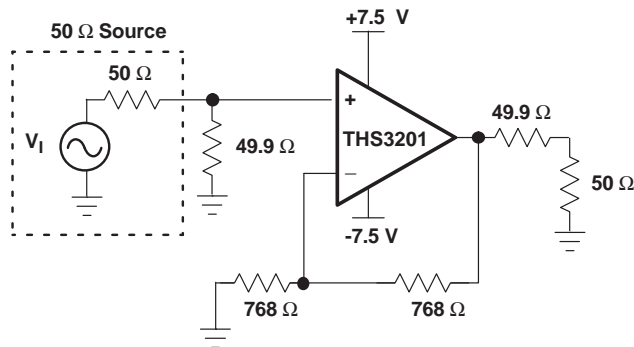
Its high voltage operation capabilities make the THS3201 especially suitable for many test, measurement, and ATE applications where lower voltage devices do not offer enough voltage swing capability. Output rise and fall times are nearly independent of step size (to first-order approximation), making the THS3201 ideal for buffering small to large step pulses with excellent linearity in high dynamic systems.

The THS3201 is offered in a 5-pin SOT-23, 8-pin SOIC, and an 8-pin MSOP with PowerPAD™ packages.

RELATED DEVICES AND DESCRIPTIONS

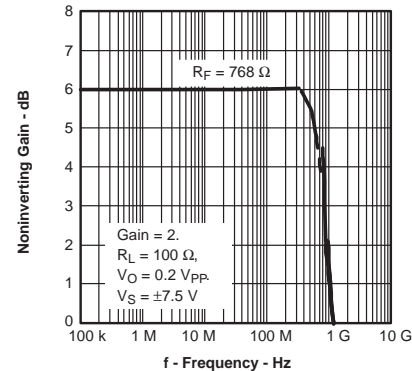
| DEVICE | DESCRIPTION |
|-----------|---|
| THS3202 | ± 7.5 -V, 2-GHz Dual Low Distortion CFB Amplifier |
| THS3001 | ± 15 -V, 420-MHz Low Distortion CFB Amplifier |
| THS3061/2 | ± 15 -V, 300-MHz Low Distortion CFB Amplifier |
| THS3122 | ± 15 -V, Dual CFB Amplifier With 350 mA Drive |
| OPA695 | ± 5 -V, 1.7-GHz Low Distortion CFB Amplifier |

Low-Noise, Low-Distortion, Wideband Application Circuit



NOTE: Power supply decoupling capacitors not shown

NONINVERTING SMALL SIGNAL FREQUENCY RESPONSE



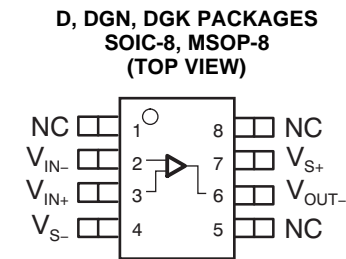
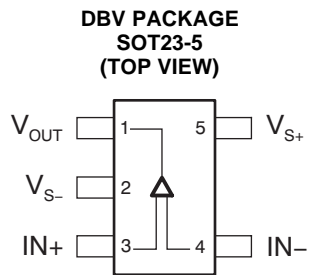
Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

PowerPAD is a trademark of Texas Instruments. All other trademarks are the property of their respective owners.

PACKAGE/ORDERING INFORMATION⁽¹⁾

| PART NUMBER | PACKAGE TYPE | PACKAGE MARKING | TRANSPORT MEDIA, QUANTITY |
|-------------|--------------|-----------------|---------------------------|
| THS3201D | SOIC-8 | — | Rails, 75 |
| THS3201DR | | | Tape and Reel, 2500 |
| THS3201DBVT | SOT-23 | BEO | Tape and Reel, 250 |
| THS3201DBVR | | | Tape and Reel, 3000 |
| THS3201DGN | MSOP-8-PP | BEN | Rails, 80 |
| THS3201DGNR | | | Tape and Reel, 2500 |
| THS3201DGK | MSOP-8 | BGP | Rails, 80 |
| THS3201DGKR | | | Tape and Reel, 2500 |

(1) For the most current package and ordering information see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.

PIN ASSIGNMENTS


NC = No internal connection.

See Note A.

- A. If a PowerPAD is used, it is electrically isolated from the active circuitry.

THS3201

SLOS416C–JUNE 2003–REVISED JUNE 2009

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ELECTRICAL CHARACTERISTICS: $V_S = \pm 7.5\text{ V}$

At $R_F = 768\ \Omega$, $R_L = 100\ \Omega$, and $G = +2$, unless otherwise noted.

| PARAMETER | TEST CONDITIONS | THS3201 | | | | | | |
|---|---|---------------------|------------------|-----------------|-------------------|------------|------------------------------|-----|
| | | TYP | OVER TEMPERATURE | | | | MIN/ TYP/ MAX | |
| | | +25°C | +25°C | 0°C to +70°C | –40°C to +85°C | UNITS | | |
| AC PERFORMANCE | | | | | | | | |
| Small-signal bandwidth, –3 dB ($V_O = 200\text{ mV}_{pp}$) | $G = +1$, $R_F = 1.2\text{ k}\Omega$ | 1.8 | | | | GHz | Typ | |
| | $G = +2$, $R_F = 768\ \Omega$ | 850 | | | | MHz | | |
| | $G = +5$, $R_F = 619\ \Omega$ | 565 | | | | | | |
| | $G = +10$, $R_F = 487\ \Omega$ | 520 | | | | | | |
| Bandwidth for 0.1 dB flatness | $G = +2$, $V_O = 200\text{ mV}_{pp}$ | 380 | | | | MHz | Typ | |
| Large-signal bandwidth | $G = +2$, $V_O = 2\text{ V}_{pp}$ | 880 | | | | MHz | Typ | |
| Slew rate | $G = +2$, $V_O = 5\text{-V step}$, Rise/Fall | 5400/4000 | | | | V/ μ s | Typ | |
| | $G = +2$, $V_O = 10\text{-V step}$, Rise/Fall | 9800/6700 | | | | | | |
| Rise and fall time | $G = +2$, $V_O = 4\text{-V step}$, Rise/Fall | 0.7/0.9 | | | | ns | Typ | |
| Settling time to 0.1% | $G = -2$, $V_O = 2\text{-V step}$ | 20 | | | | ns | Typ | |
| Settling time to 0.01% | | 60 | | | | | | |
| Harmonic distortion | | | | | | | | |
| 2 nd -order harmonic | $G = +5$, $f = 10\text{ MHz}$, $V_O = 2\text{ V}_{pp}$ | $R_L = 100\ \Omega$ | –64 | | | | dBc | Typ |
| 3 rd -order harmonic | | $R_L = 100\ \Omega$ | –73 | | | | | dBc |
| Third-order intermodulation distortion (IMD ₃) | $G = +10$, $f_c = 20\text{ MHz}$, $\Delta f = 1\text{ MHz}$, $V_{O(\text{envelope})} = 2\text{ V}_{pp}$ | | –78 | | | | dBc | Typ |
| Noise figure | $G = +10$, $f_c = 100\text{ MHz}$, $R_F = 255\ \Omega$, $R_G = 28$ | | 11 | | | | dB | Typ |
| Input voltage noise | $f > 10\text{ MHz}$ | | 1.65 | | | | nV/ $\sqrt{\text{Hz}}$ | Typ |
| Input current noise (noninverting) | $f > 10\text{ MHz}$ | | 13.4 | | | | pA/ $\sqrt{\text{Hz}}$ | Typ |
| Input current noise (inverting) | | | 20 | | | | pA/ $\sqrt{\text{Hz}}$ | Typ |
| Differential gain | $G = +2$, $R_L = 150\ \Omega$, $R_F = 768\ \Omega$ | NTSC | 0.008% | | | | | Typ |
| | | PAL | 0.004% | | | | | Typ |
| Differential phase | | NTSC | 0.007° | | | | | Typ |
| | | PAL | 0.011° | | | | | Typ |
| DC PERFORMANCE | | | | | | | | |
| Open-loop transimpedance gain | $V_O = \pm 1\text{ V}$, $R_L = 1\text{ k}\Omega$ | | 300 | 200 | 140 | 120 | k Ω | Min |
| Input offset voltage | $V_{CM} = 0\text{ V}$ | | ± 0.7 | ± 3 | ± 3.8 | ± 4 | mV | Max |
| Average offset voltage drift | | | | | ± 10 | ± 13 | $\mu\text{V}/^\circ\text{C}$ | Typ |
| Input bias current (inverting) | | | ± 13 | ± 60 | ± 80 | ± 85 | μA | Max |
| Average bias current drift (–) | | | | | ± 300 | ± 400 | nA/ $^\circ\text{C}$ | Typ |
| Input bias current (noninverting) | | | ± 14 | ± 35 | ± 45 | ± 50 | μA | Max |
| Average bias current drift (+) | | | | | ± 300 | ± 400 | nA/ $^\circ\text{C}$ | Typ |

ELECTRICAL CHARACTERISTICS: $V_S = \pm 7.5\text{ V}$ (continued)

At $R_F = 768\ \Omega$, $R_L = 100\ \Omega$, and $G = +2$, unless otherwise noted.

| PARAMETER | TEST CONDITIONS | THS3201 | | | | | |
|-------------------------------------|--|---------|------------------|-----------------|-------------------|------------|---------------------|
| | | TYP | OVER TEMPERATURE | | | | MIN/ TYP/ MAX |
| | | +25°C | +25°C | 0°C to +70°C | –40°C to +85°C | UNITS | |
| INPUT | | | | | | | |
| Common-mode input range | | ±5.1 | ±5 | ±5 | ±5 | V | Min |
| Common-mode rejection ratio | $V_{CM} = \pm 3.75\text{ V}$ | 71 | 60 | 58 | 58 | dB | Min |
| Inverting input impedance, Z_{in} | Open loop | 16 | | | | Ω | Typ |
| Input resistance | Noninverting | 780 | | | | k Ω | Typ |
| | Inverting | 11 | | | | Ω | Typ |
| Input capacitance | Noninverting | 1 | | | | pF | Typ |
| OUTPUT | | | | | | | |
| Voltage output swing | $R_L = 1\text{ k}\Omega$ | ±6 | ±5.9 | ±5.8 | ±5.8 | V | Min |
| | $R_L = 100\ \Omega$ | ±5.8 | ±5.7 | ±5.5 | ±5.5 | V | Min |
| Current output, sourcing | $R_L = 20\ \Omega$ | 115 | 105 | 100 | 100 | mA | Min |
| Current output, sinking | | 100 | 85 | 80 | 80 | mA | Min |
| Closed-loop output impedance | $G = +1$, $f = 1\text{ MHz}$ | 0.01 | | | | Ω | Typ |
| POWER SUPPLY | | | | | | | |
| Minimum operating voltage | Absolute minimum | | ±3.3 | ±3.3 | ±3.3 | V | Min |
| Maximum operating voltage | Absolute maximum | | ±8.25 | ±8.25 | ±8.25 | V | Max |
| Maximum quiescent current | | 14 | 18 | 21 | 21 | mA | Max |
| Power-supply rejection (+PSRR) | $V_{S+} = 7\text{ V to } 8\text{ V}$ | 69 | 63 | 60 | 60 | dB | Min |
| Power-supply rejection (–PSRR) | $V_{S-} = -7\text{ V to } -8\text{ V}$ | 65 | 58 | 55 | 55 | dB | Min |

THS3201

SLOS416C–JUNE 2003–REVISED JUNE 2009

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ELECTRICAL CHARACTERISTICS: $V_S = \pm 5\text{ V}$

At $R_F = 715\ \Omega$, $R_L = 100\ \Omega$, and $G = +2$, unless otherwise noted.

| PARAMETER | TEST CONDITIONS | THS3201 | | | | | | |
|--|---|---------------------|------------------|-----------------|-------------------|------------------|-------------------------------|-----|
| | | TYP | OVER TEMPERATURE | | | | MIN/ TYP/ MAX | |
| | | +25°C | +25°C | 0°C to +70°C | –40°C to +85°C | UNITS | | |
| AC PERFORMANCE | | | | | | | | |
| Small-signal bandwidth, –3dB ($V_O = 200\text{ mV}_{PP}$) | $G = +1, R_F = 1.2\text{ k}\Omega$ | 1.3 | | | | GHz | Typ | |
| | $G = +2, R_F = 715\ \Omega$ | 725 | | | | MHz | | |
| | $G = +5, R_F = 576\ \Omega$ | 540 | | | | | | |
| | $G = +10, R_F = 464\ \Omega$ | 480 | | | | | | |
| Bandwidth for 0.1 dB flatness | $G = +2, V_O = 200\text{ mV}_{PP}$ | 170 | | | | MHz | Typ | |
| Large-signal bandwidth | $G = +2, V_O = 2\text{ V}_{PP}$ | 900 | | | | MHz | Typ | |
| Slew rate | $G = +2, V_O = 5\text{-V step, Rise/Fall}$ | 5200/4000 | | | | V/ μs | Typ | |
| Rise and fall time | $G = +2, V_O = 4\text{-V step, Rise/Fall}$ | 0.7/0.9 | | | | ns | Typ | |
| Settling time to 0.1% | $G = -2, V_O = 2\text{-V step}$ | 20 | | | | ns | Typ | |
| Settling time to 0.01% | | 60 | | | | ns | Typ | |
| Harmonic distortion | | | | | | | | |
| 2 nd -order harmonic | $G = +5, f = 10\text{ MHz,}$ $V_O = 2\text{ V}_{PP}$ | $R_L = 100\ \Omega$ | –69 | | | | dBc | Typ |
| 3 rd -order harmonic | | $R_L = 100\ \Omega$ | –75 | | | | | dBc |
| Third-order intermodulation distortion (IMD ₃) | $G = +10, f_c = 20\text{ MHz, } \Delta f = 1\text{ MHz,}$ $V_{O(\text{envelope})} = 2\text{ V}_{PP}$ | | –81 | | | | dBc | Typ |
| Noise figure | $G = +10, f_c = 100\text{ MHz, } R_F = 255\ \Omega,$ $R_G = 28$ | | 11 | | | | dB | Typ |
| Input voltage noise | $f > 10\text{ MHz}$ | | 1.65 | | | | nV/ $\sqrt{\text{Hz}}$ | Typ |
| Input current noise (noninverting) | $f > 10\text{ MHz}$ | | 13.4 | | | | pA/ $\sqrt{\text{Hz}}$ | Typ |
| Input current noise (inverting) | | | 20 | | | | pA/ $\sqrt{\text{Hz}}$ | Typ |
| Differential gain | $G = +2, R_L = 150\ \Omega,$ $R_F = 768\ \Omega$ | NTSC | 0.006% | | | | | Typ |
| | | PAL | 0.004% | | | | | Typ |
| Differential phase | | NTSC | 0.03° | | | | | Typ |
| | | PAL | 0.04° | | | | | Typ |
| DC PERFORMANCE | | | | | | | | |
| Open-loop transimpedance gain | $V_O = +1\text{ V, } R_L = 1\text{ k}\Omega$ | | 300 | 200 | 140 | 120 | k Ω | Min |
| Input offset voltage | $V_{CM} = 0\text{ V}$ | | ± 0.7 | ± 3 | ± 3.8 | ± 4 | mV | Max |
| Average offset voltage drift | | | | | ± 10 | ± 13 | $\pm \text{V}/^\circ\text{C}$ | Typ |
| Input bias current (inverting) | | | ± 13 | ± 60 | ± 80 | ± 85 | μA | Max |
| Average bias current drift (–) | | | | | ± 300 | ± 400 | nA/ $^\circ\text{C}$ | Typ |
| Input bias current (noninverting) | | | ± 14 | ± 35 | ± 45 | ± 50 | μA | Max |
| Average bias current drift (+) | | | | | ± 300 | ± 400 | nA/ $^\circ\text{C}$ | Typ |

ELECTRICAL CHARACTERISTICS: $V_S = \pm 5\text{ V}$ (continued)

 At $R_F = 715\ \Omega$, $R_L = 100\ \Omega$, and $G = +2$, unless otherwise noted.

| PARAMETER | TEST CONDITIONS | THS3201 | | | | | |
|-------------------------------------|--|---------|------------------|-----------------|-------------------|------------|---------------------|
| | | TYP | OVER TEMPERATURE | | | | MIN/ TYP/ MAX |
| | | +25°C | +25°C | 0°C to +70°C | –40°C to +85°C | UNITS | |
| INPUT | | | | | | | |
| Common-mode input range | | ±2.6 | ±2.5 | ±2.5 | ±2.5 | V | Min |
| Common-mode rejection ratio | $V_{CM} = \pm 2.5\text{ V}$ | 71 | 60 | 58 | 58 | dB | Min |
| Inverting input impedance, Z_{IN} | Open loop | 17.5 | | | | Ω | Typ |
| Input resistance | Noninverting | 780 | | | | k Ω | Typ |
| | Inverting | 11 | | | | Ω | Typ |
| Input capacitance | Noninverting | 1 | | | | pF | Typ |
| OUTPUT | | | | | | | |
| Voltage output swing | $R_L = 1\text{ k}\Omega$ | ±3.65 | ±3.5 | ±3.45 | ±3.4 | V | Min |
| | $R_L = 100\ \Omega$ | ±3.45 | ±3.33 | ±3.25 | ±3.2 | | |
| Current output, sourcing | $R_L = 20\ \Omega$ | 115 | 105 | 100 | 100 | mA | Min |
| Current output, sinking | | 100 | 85 | 80 | 80 | mA | Min |
| Closed-loop output impedance | $G = +1$, $f = 1\text{ MHz}$ | 0.01 | | | | Ω | Typ |
| POWER SUPPLY | | | | | | | |
| Minimum operating voltage | Absolute minimum | | ±3.3 | ±3.3 | ±3.3 | V | Min |
| Maximum operating voltage | Absolute maximum | | ±8.25 | ±8.25 | ±8.25 | V | Max |
| Maximum quiescent current | | 14 | 16.8 | 19 | 20 | mA | Max |
| Power-supply rejection (+PSRR) | $V_{S+} = 4.5\text{ V to } 5.5\text{ V}$ | 69 | 63 | 60 | 60 | dB | Min |
| Power-supply rejection (–PSRR) | $V_{S-} = -4.5\text{ V to } -5.5\text{ V}$ | 65 | 58 | 55 | 55 | dB | Min |

TYPICAL CHARACTERISTICS

Table of Graphs ($V_S = \pm 7.5\text{ V}$)

| | | FIGURE |
|--|------------------------|---------------|
| Noninverting small-signal frequency response | | 1, 2 |
| Inverting small-signal frequency response | | 3 |
| Noninverting large-signal frequency response | | 4 |
| Inverting large-signal frequency response | | 5 |
| 0.1 dB gain flatness frequency response | | 6 |
| Capacitive load frequency response | | 7 |
| Recommended switching resistance | vs Capacitive Load | 8 |
| 2nd harmonic distortion | vs Frequency | 9 |
| 3rd harmonic distortion | vs Frequency | 10 |
| 2nd harmonic distortion, G = 2 | vs Output voltage | 11 |
| 3rd harmonic distortion, G = 2 | vs Output voltage | 12 |
| 2nd harmonic distortion, G = 5 | vs Output voltage | 13 |
| 3rd harmonic distortion, G = 5 | vs Output voltage | 14 |
| 2nd harmonic distortion, G = 10 | vs Output voltage | 15 |
| 3rd harmonic distortion, G = 10 | vs Output voltage | 16 |
| Third-order intermodulation distortion (IMD ₃) | vs Frequency | 17 |
| S-Parameter | vs Frequency | 18, 19 |
| Input voltage and current noise | vs Frequency | 20 |
| Noise figure | vs Frequency | 21 |
| Transimpedance | vs Frequency | 22 |
| Input offset voltage | vs Case Temperature | 23 |
| Input bias and offset current | vs Case Temperature | 24 |
| Slew rate | vs Output voltage step | 25 |
| Settling time | | 26, 27 |
| Quiescent current | vs Supply voltage | 28 |
| Output voltage | vs Load resistance | 29 |
| Rejection ratio | vs Frequency | 30 |
| Noninverting small-signal transient response | | 31 |
| Inverting large-signal transient response | | 32 |
| Overdrive recovery time | | 33 |
| Differential gain | vs Number of loads | 34 |
| Differential phase | vs Number of loads | 35 |
| Closed-loop output impedance | vs Frequency | 36 |

$V_S = \pm 7.5\text{ V}$ Graphs

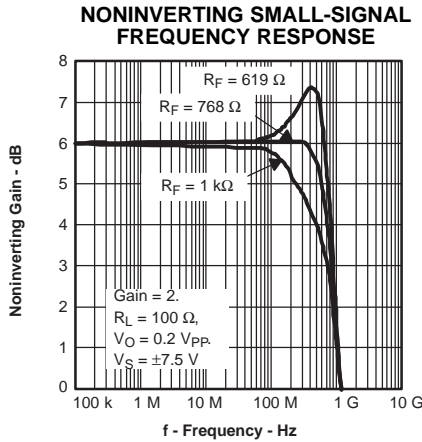


Figure 1.

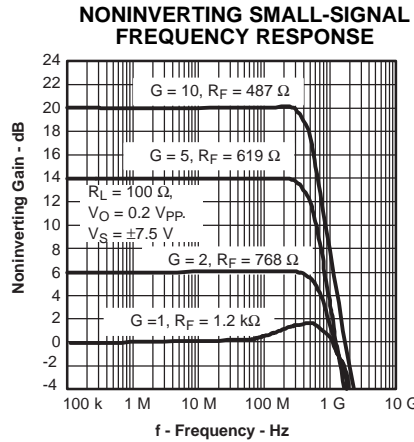


Figure 2.

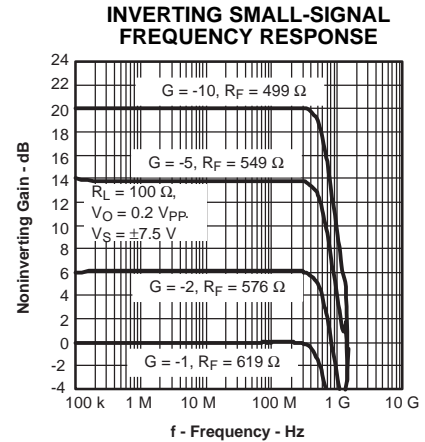


Figure 3.

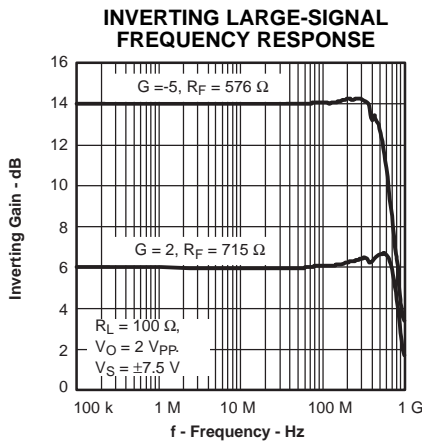


Figure 4.

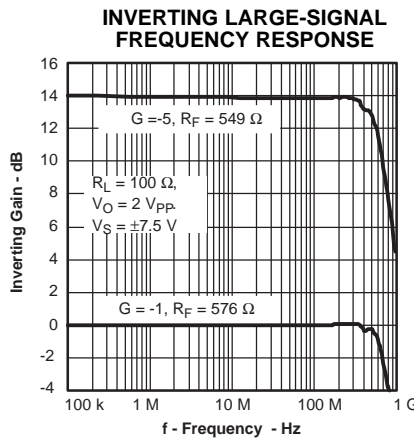


Figure 5.

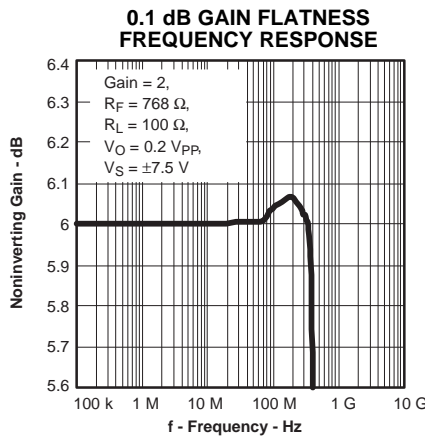


Figure 6.

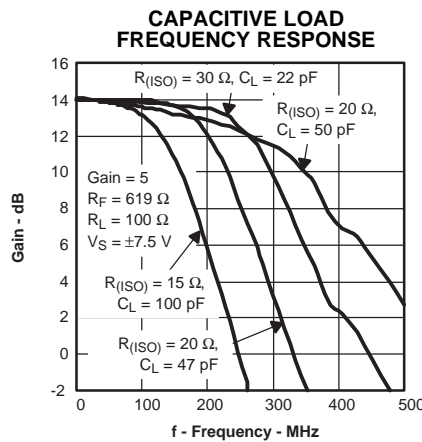


Figure 7.

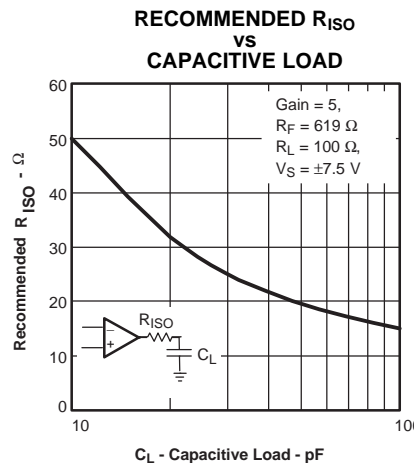


Figure 8.

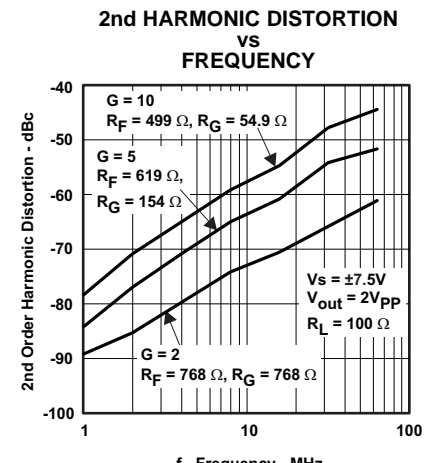


Figure 9.

$V_S = \pm 7.5$ V Graphs (continued)

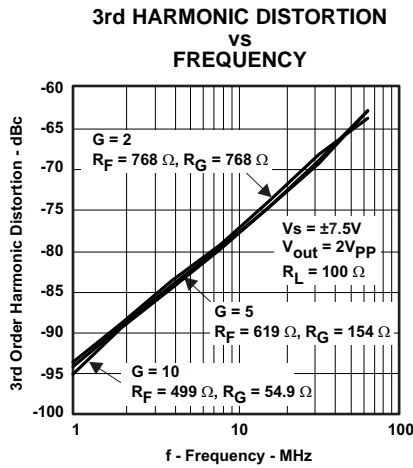


Figure 10.

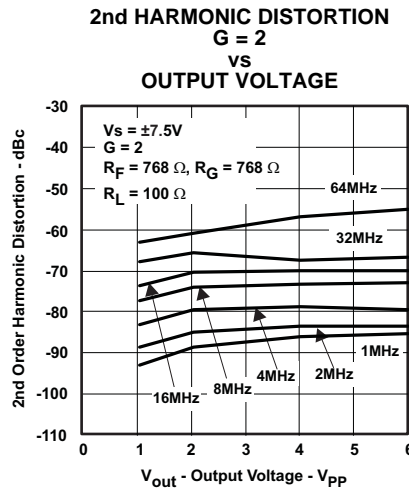


Figure 11.

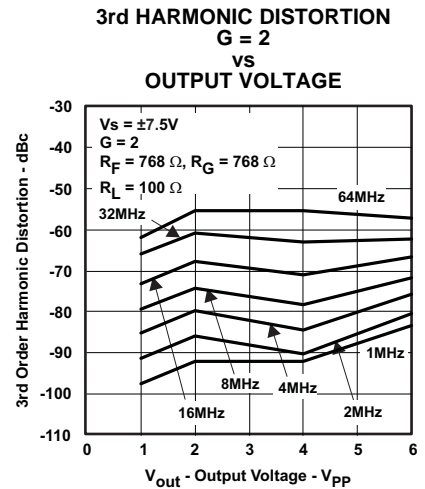


Figure 12.

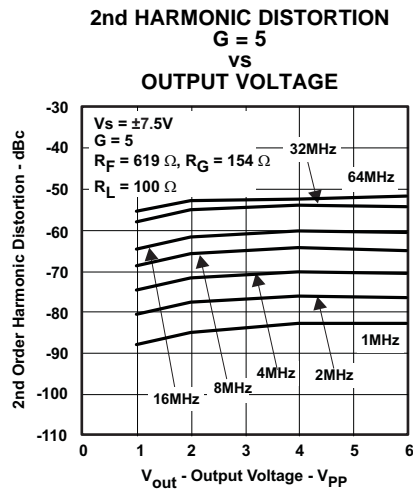


Figure 13.

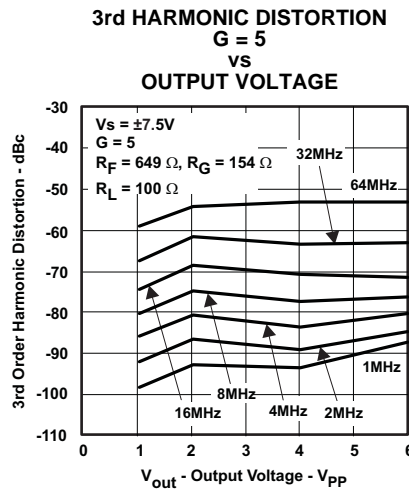


Figure 14.

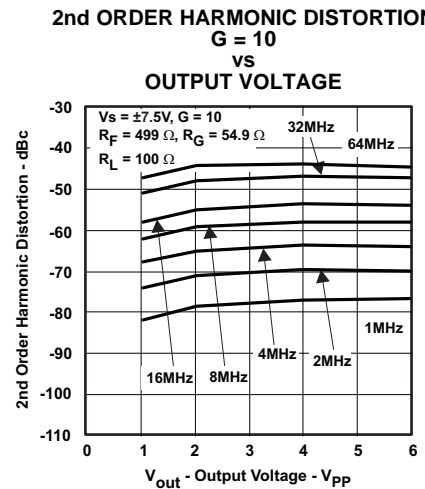


Figure 15.

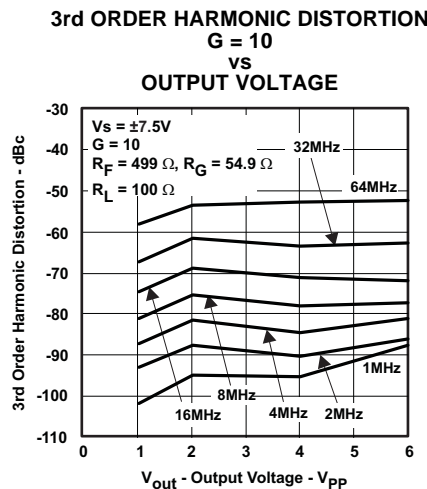


Figure 16.

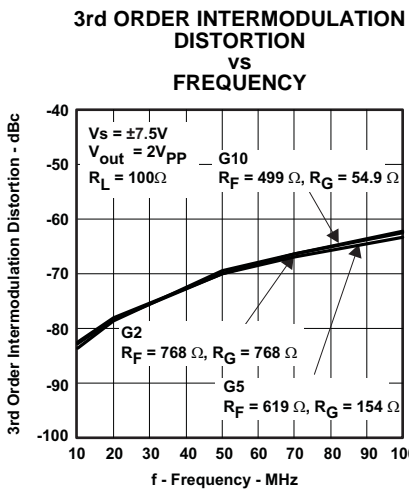


Figure 17.

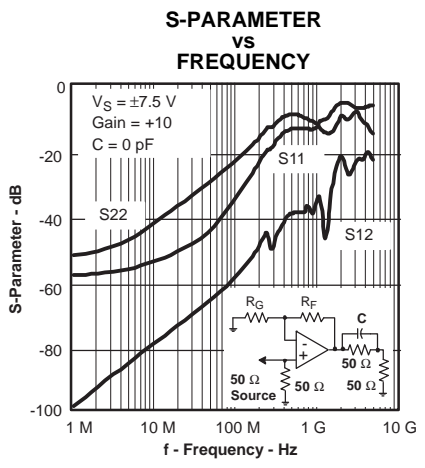


Figure 18.

$V_S = \pm 7.5$ V Graphs (continued)

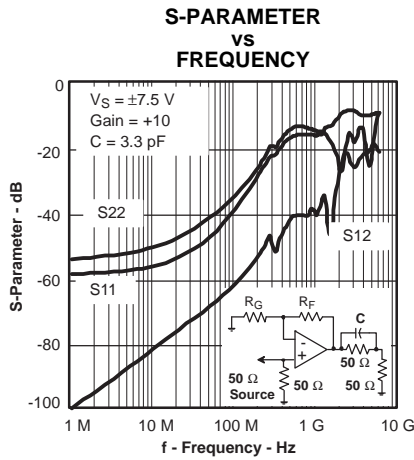


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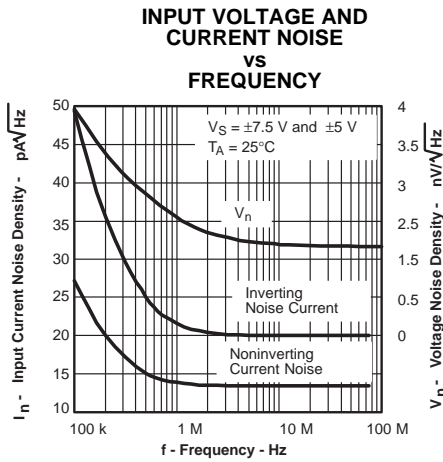


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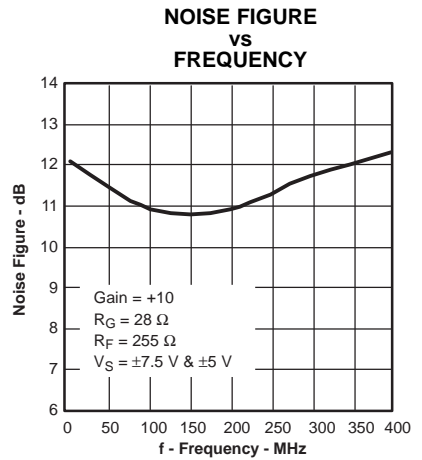


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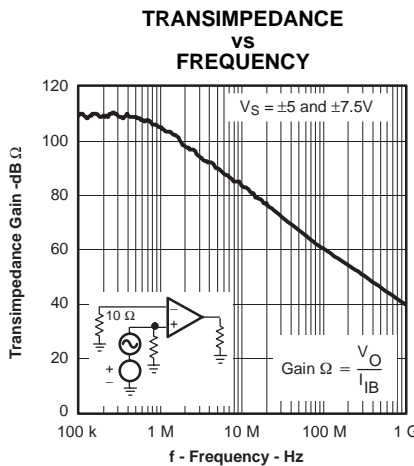


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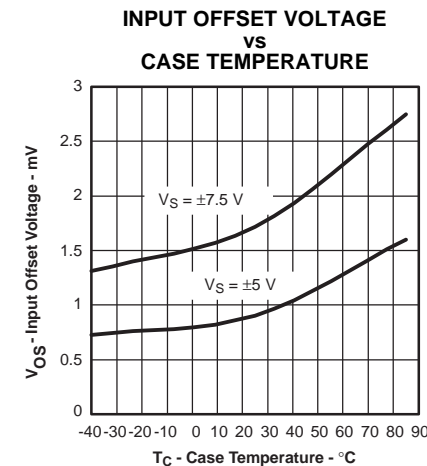


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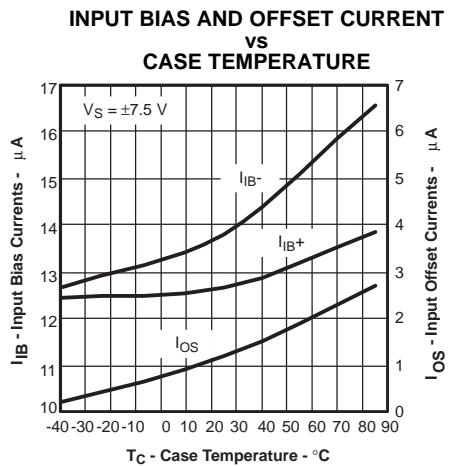


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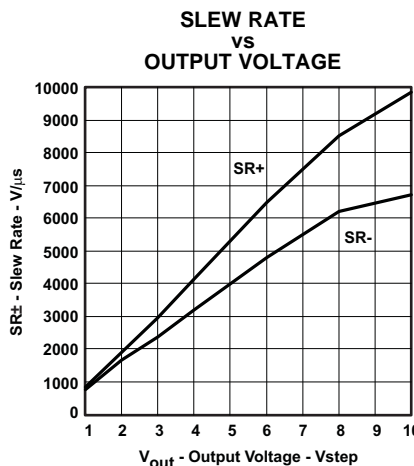


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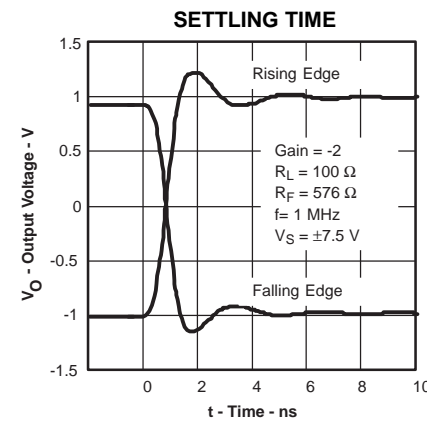


Figure 26.

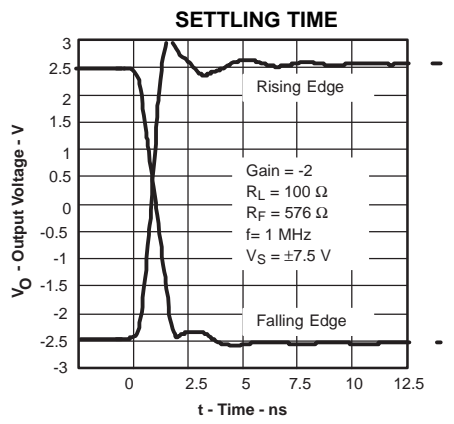


Figure 27.

$V_S = \pm 7.5$ V Graphs (continued)

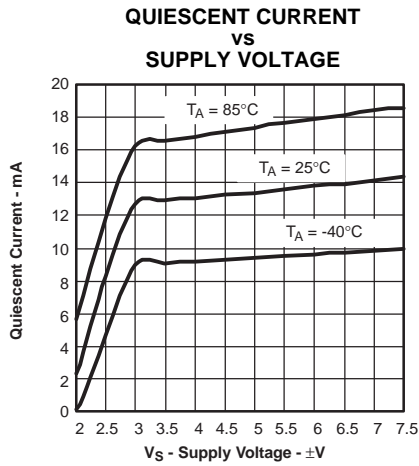


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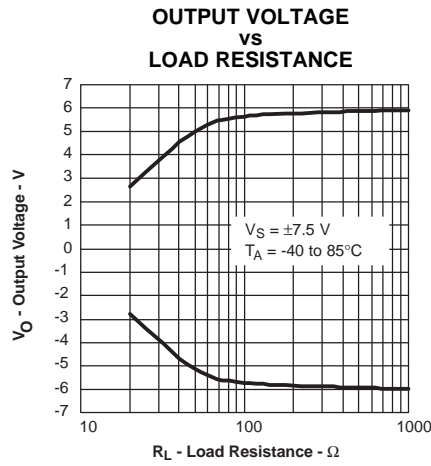


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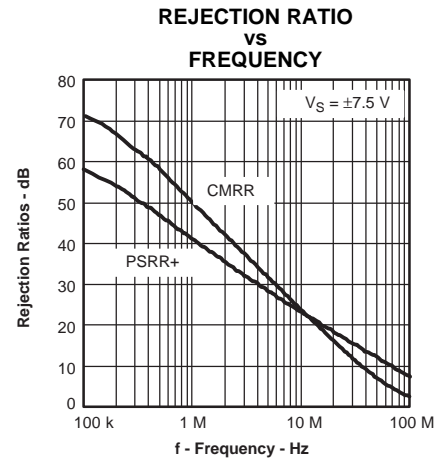


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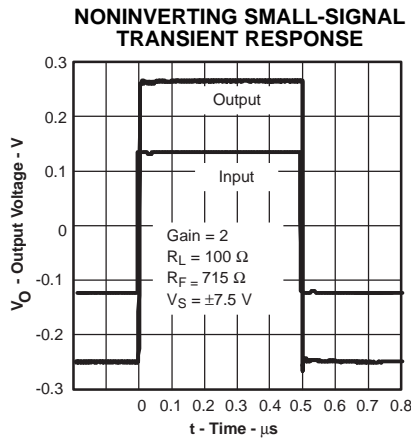


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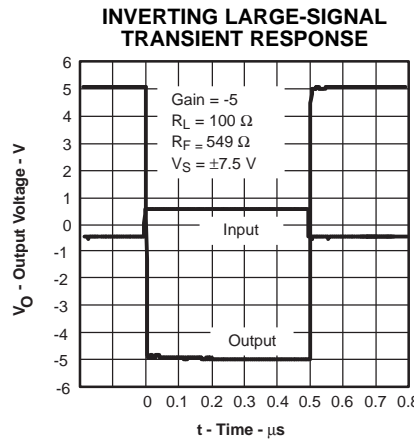


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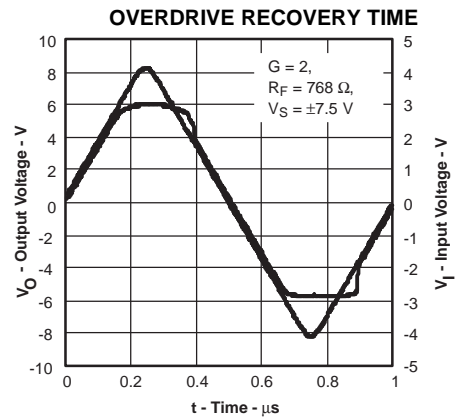


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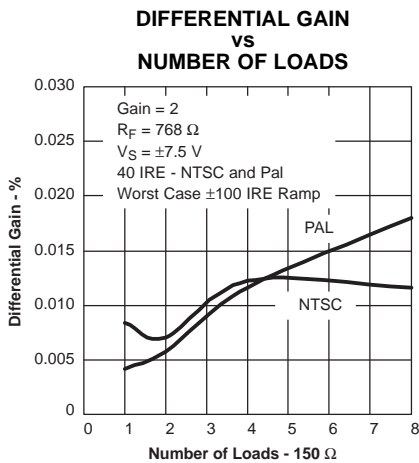


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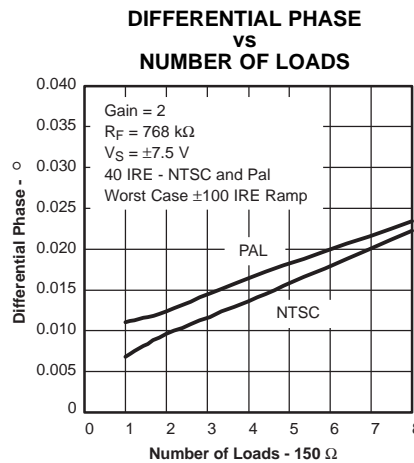


Figure 35.

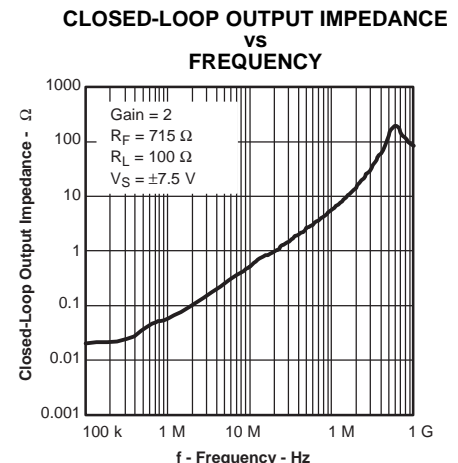


Figure 36.

V_S = ±5 V Graphs

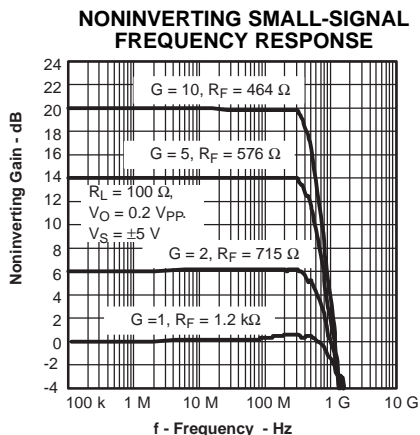


Figure 37.

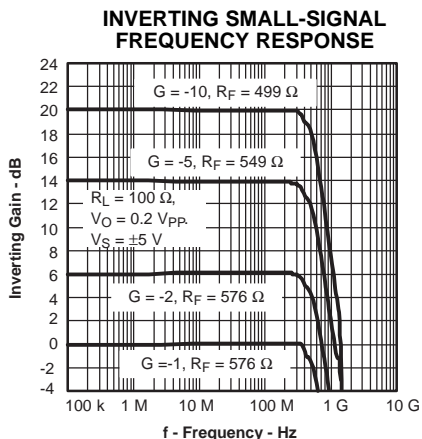


Figure 38.

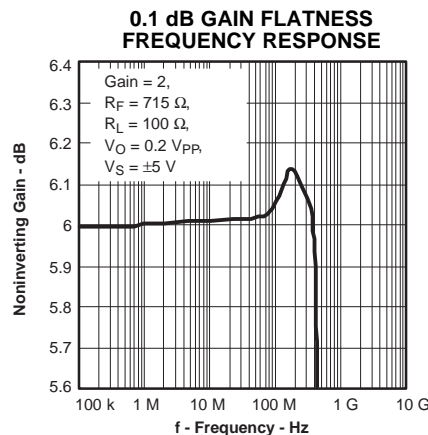


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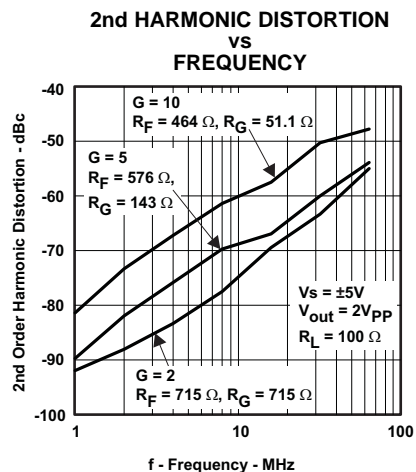


Figure 40.

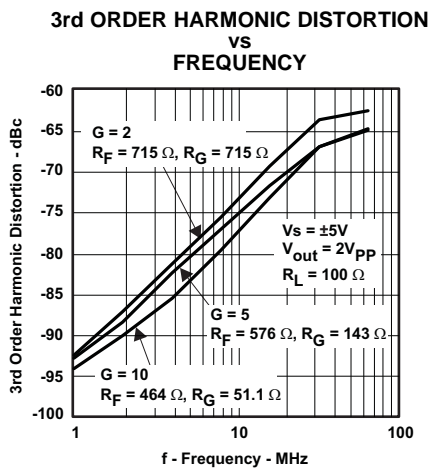


Figure 41.

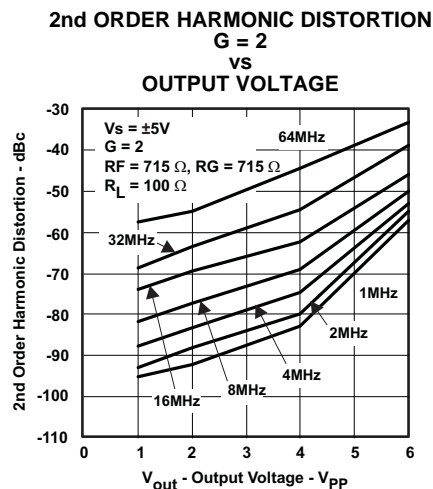


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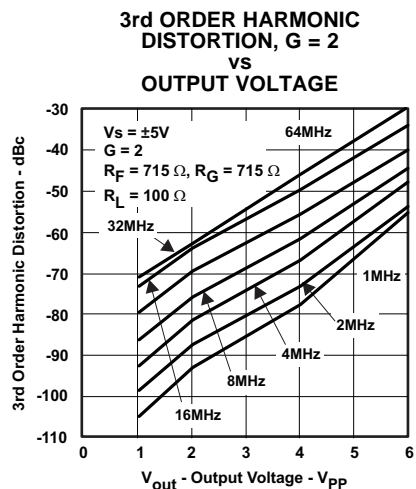


Figure 43.

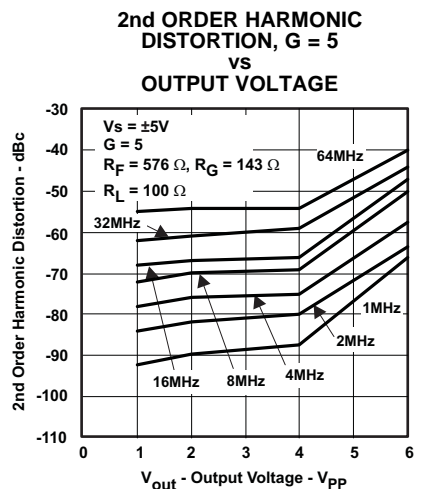


Figure 44.

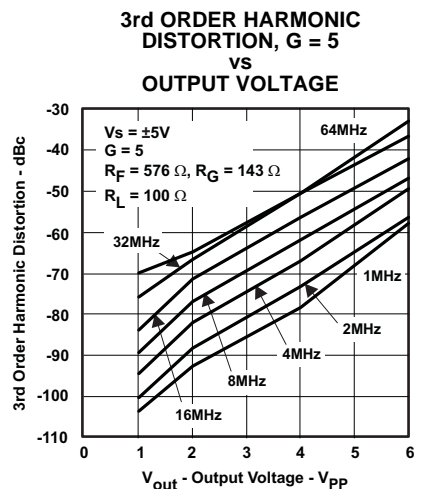
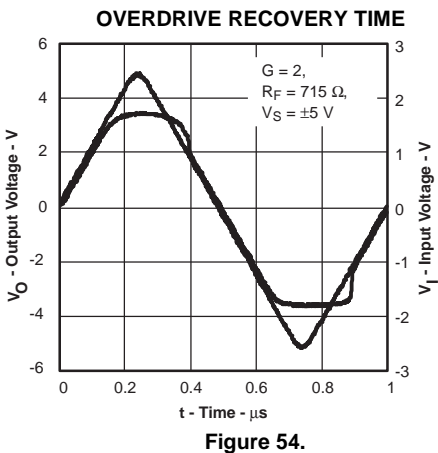
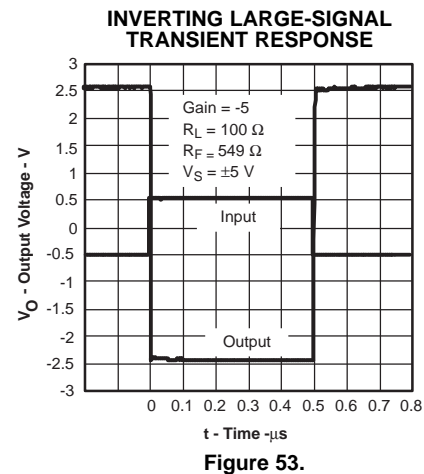
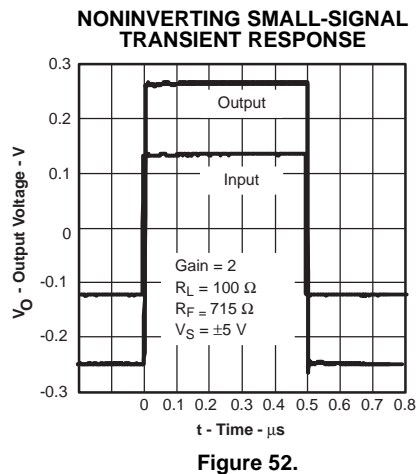
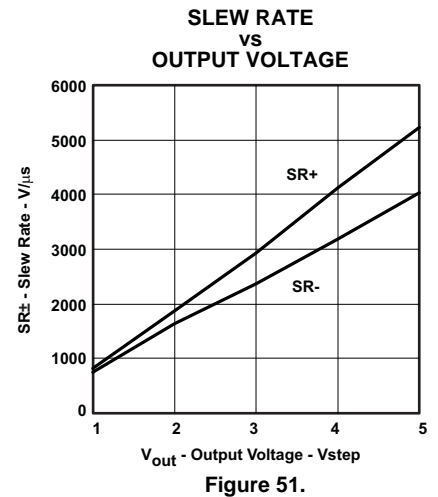
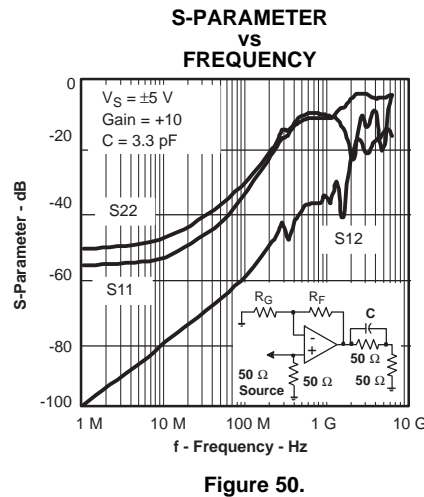
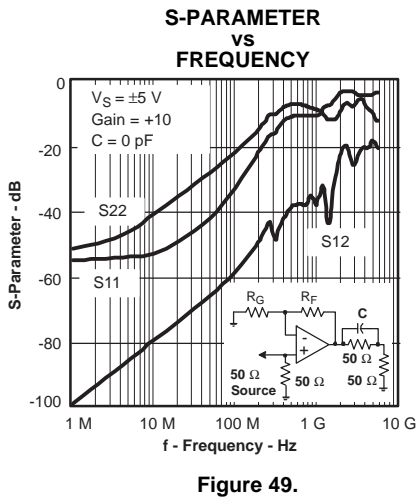
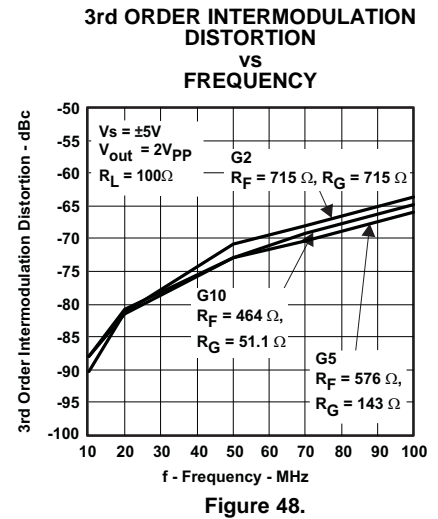
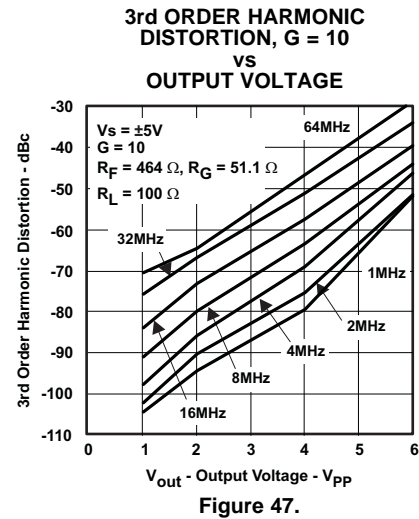
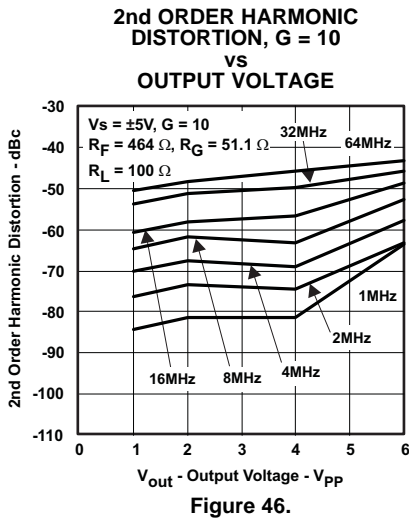


Figure 45.

$V_S = \pm 5\text{ V}$ Graphs (continued)



APPLICATION INFORMATION

WIDEBAND, NONINVERTING OPERATION

The THS3201 is a unity-gain stable, 1.8-GHz current-feedback operational amplifier, designed to operate from a ± 3.3 -V to ± 7.5 -V power supply.

Figure 55 shows the THS3201 in a noninverting gain of 2-V/V configuration typically used to generate the performance curves. Most of the curves were characterized using signal sources with 50- Ω source impedance, and with measurement equipment presenting a 50- Ω load impedance. The 49.9- Ω shunt resistor at the V_I terminal in Figure 55 matches the source impedance of the test generator.

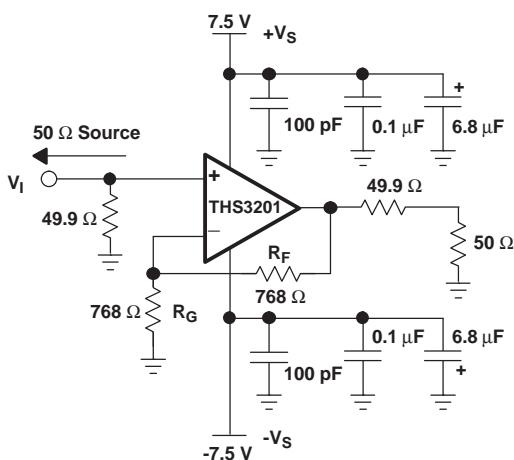


Figure 55. Wideband, Noninverting Gain Configuration

Unlike voltage-feedback amplifiers, current-feedback amplifiers are highly dependent on the feedback resistor R_F for maximum performance and stability. Table 1 shows the optimal gain setting resistors R_F and R_G at different gains to give maximum bandwidth with minimal peaking in the frequency response. Higher bandwidths can be achieved, at the expense of added peaking in the frequency response, by using even lower values for R_F . Conversely, increasing R_F decreases the bandwidth, but stability is improved.

Table 1. Recommended Resistor Values for Optimum Frequency Response

| THS3201 R_F for AC When $R_{LOAD} = 100 \Omega$ | | | |
|---|-----------------------|--------------------|--------------------|
| Gain (V/V) | Supply Voltage (V) | R_G (Ω) | R_F (Ω) |
| 1 | ± 7.5 | — | 1.2 k |
| | ± 5 | — | 1.2 k |
| 2 | ± 7.5 | 768 | 768 |
| | ± 5 | 715 | 715 |
| 5 | ± 7.5 | 154.9 | 619 |
| | ± 5 | 143 | 576 |
| 10 | ± 7.5 | 54.9 | 487 |
| | ± 5 | 51.1 | 464 |
| -1 | ± 7.5 | 619 | 619 |
| | ± 5 | 576 | 576 |
| -2 | ± 7.5 and ± 5 | 287 | 576 |
| -5 | ± 7.5 and ± 5 | 110 | 549 |
| -10 | ± 7.5 and ± 5 | 49.9 | 499 |

WIDEBAND, INVERTING GAIN OPERATION

Figure 56 shows the THS3201 in a typical inverting gain configuration where the input and output impedances and signal gain from Figure 55 are retained in an inverting circuit configuration.

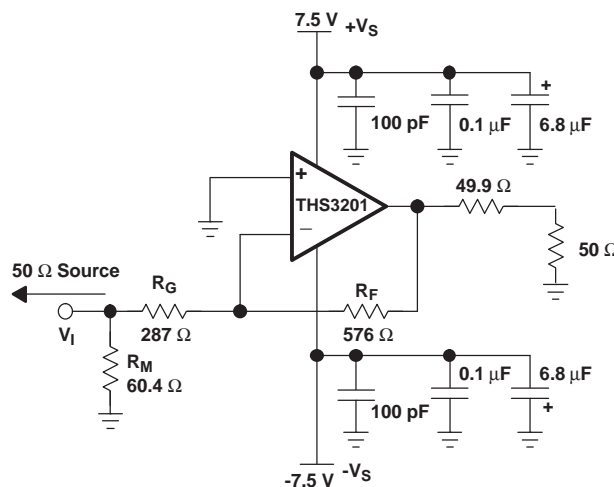


Figure 56. Wideband, Inverting Gain Configuration

SINGLE-SUPPLY OPERATION

The THS3201 has the capability to operate from a single supply voltage ranging from 6.6 V to 15 V. When operating from a single power supply, care must be taken to ensure the input signal and amplifier are biased appropriately to allow for the maximum output voltage swing. The circuits shown in [Figure 57](#) demonstrate methods to configure an amplifier in a manner conducive for single-supply operation.

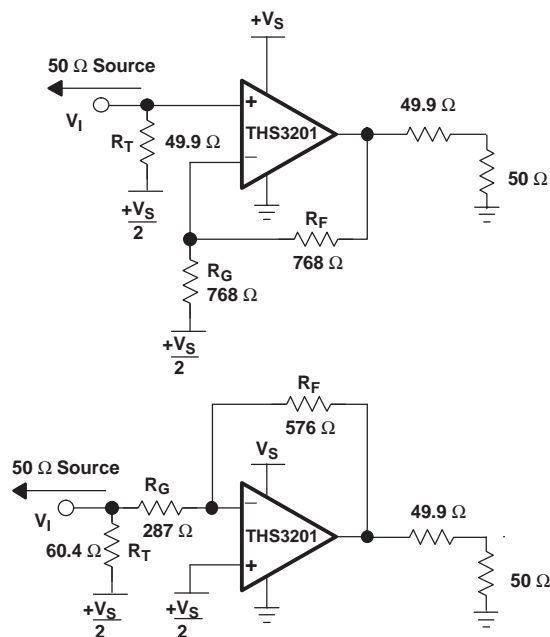


Figure 57. DC-Coupled Single-Supply Operation

VIDEO HDTV DRIVERS

The exceptional bandwidth and slew rate of the THS3201 matches the demands for professional video and HDTV. Most commercial HDTV standards requires a video passband of 30-MHz. To ensure high signal quality with minimal degradation of performance, a 0.1-dB gain flatness should be at least 7x the passband frequency to minimize group delay variations—requiring 210-MHz 0.1-dB frequency flatness from the amplifier. High slew rates ensure there is minimal distortion of the video signal. Component video and RGB video signals require fast transition times and fast settling times to keep a high signal quality. The [THS8135](#), for example, is a 240-MSPS video digital-to-analog converter (DAC) and has a transition time approaching 4 ns. The THS3201 is a perfect candidate for interfacing the output of such high-performance video components.

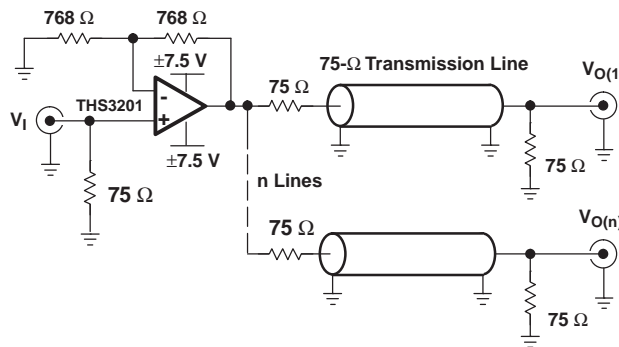


Figure 58. Video Distribution Amplifier Application

ADC DRIVER APPLICATION

The THS3201 can be used as a high-performance ADC driver in applications like radio receiver IF stages, and test and measurement devices. All high-performance ADCs have differential inputs. The THS3201 can be used in conjunction with a transformer as a drive amplifier in these applications. [Figure 59](#) and [Figure 60](#) show two different approaches.

In [Figure 59](#), a transformer is used after the amplifier to convert the signal to differential. The advantage of this approach is fewer components are required. R_{OUT} and R_T are required for impedance matching the transformer.

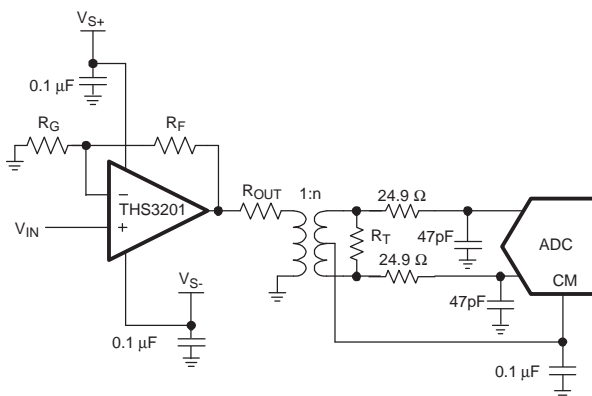


Figure 59. Differential ADC Driver Circuit 1

In [Figure 60](#), a transformer is used before two amplifiers to convert the signal to differential. The two amplifiers then amplify the differential signal. The advantage to this approach is each amplifier is required to drive half the voltage as before. R_T is used to impedance match the transformer.

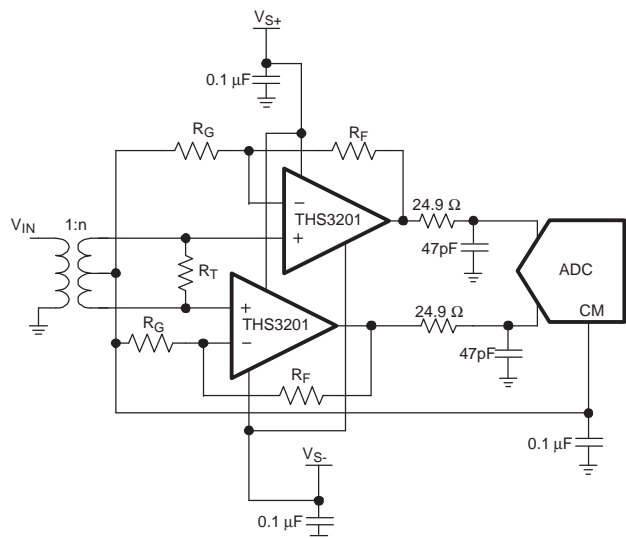


Figure 60. Differential ADC Driver Circuit 2

It is almost universally recommended to use a resistor and capacitor between the op amp output and the ADC input as shown in both figures.

This resistor-capacitor (RC) combination has multiple functions:

- The capacitor is a local charge reservoir for ADC
- The resistor isolates the amplifier from the ADC
- In conjunction, they form a low-pass noise filter

During the sampling phase, current is required to charge the ADC input sampling capacitors. By placing external capacitors directly at the input pins, most of the current is drawn from them. They are seen as a very low impedance source. They can be thought of as serving much the same purpose as a power-supply bypass capacitor to supply transient current, with the amplifier then providing the bulk charge.

Typically, a low-value capacitor in the range of 10 pF to 100 pF provides the required transient charge reservoir.

The capacitance and the switching action of the ADC is one of the worst loading scenarios that a high-speed amplifier encounters. The resistor provides a simple means of isolating the associated phase shift from the feedback network and maintaining the phase margin of the amplifier.

Typically, a low value resistor in the range of 10 Ω to 100 Ω provides the required isolation. Together, the R and C form a real pole in the s-plane located at the frequency:

$$f_p = \frac{1}{2\pi RC}$$

Placing this pole at about 10x the highest frequency of interest ensures it has no impact on the signal. Since the resistor is typically a small value, it is very bad practice to place the pole at (or very near) frequencies of interest. At the pole frequency, the amplifiers sees a load with a magnitude of:

$$\sqrt{2} \times R$$

If R is only 10 Ω, the amplifier is very heavily loaded above the pole frequency, and generates excessive distortion.

DAC DRIVER APPLICATION

The THS3201 can be used as a high-performance DAC output driver in applications like radio transmitter stages and arbitrary waveform generators. All high-performance DACs have differential current outputs. Two THS3201s can be used as a differential drive amplifier in these applications, as shown in Figure 61.

R_{PU} on the DAC output is used to convert the output current to voltage. The 24.9-Ω resistor and 47-pF capacitor between each DAC output and the op amp input is used to reduce the images generated at multiples of the sampling rate. The values shown form a pole at 136 MHz. R_{OUT} sets the output impedance of each amplifier.

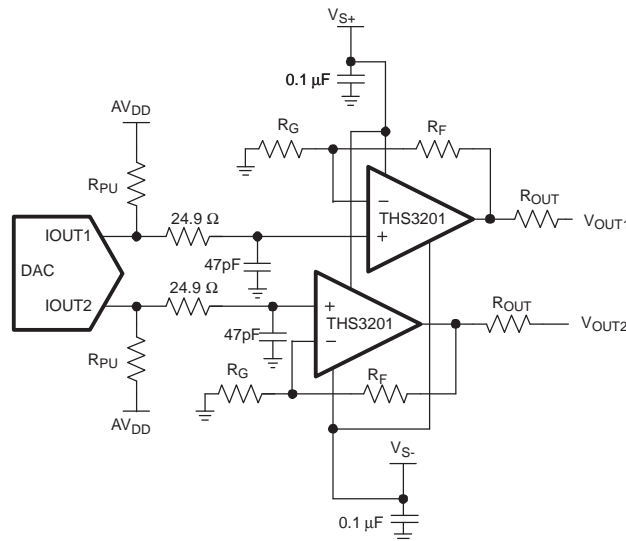


Figure 61. Differential DAC Driver Circuit

PRINTED CIRCUIT BOARD LAYOUT TECHNIQUES FOR OPTIMAL PERFORMANCE

Achieving optimum performance with high frequency amplifier-like devices in the THS3201 requires careful attention to board layout parasitic and external component types.

Recommendations that optimize performance include:

- Minimize parasitic capacitance to any power or ground plane for the negative input and output pins by voiding the area directly below these pins and connecting traces and the feedback path. Parasitic capacitance on the output and negative input pins can cause instability. To reduce unwanted capacitance, a window around the signal I/O pins should be opened in all of the ground and power planes around those pins and the feedback path. Otherwise, ground and power planes should be unbroken elsewhere on the board.
 - Minimize the distance (<0.25") from the power-supply pins to high frequency 0.1- μ F and 100 pF decoupling capacitors. At the device pins, the ground and power-plane layout should not be in close proximity to the signal I/O pins. Avoid narrow power and ground traces to minimize inductance between the pins and the decoupling capacitors. The power-supply connections should always be decoupled with these capacitors. Larger (6.8 μ F or more) tantalum decoupling capacitors, effective at lower frequency, should also be used on the main supply pins. These may be placed somewhat farther from the device and may be shared among several devices in the same area of the printed circuit board (PCB). The primary goal is to minimize the impedance seen in the differential-current return paths. For driving differential loads with the THS3201, adding a capacitor between the power-supply pins improves 2nd order harmonic distortion performance. This also minimizes the current loop formed by the differential drive.
 - Careful selection and placement of external components preserve the high-frequency performance of the THS3201. Resistors should be a very low reactance type. Surface-mount resistors work best and allow a tighter overall layout. Again, keep their leads and PCB trace length as short as possible. Never use wirebound type resistors in a high frequency application. Since the output pin and inverting input pins are the most sensitive to parasitic capacitance, always position the feedback and series output resistors, if any, as close as possible to the inverting input pins and output pins. Other network components, such as input termination resistors, should be placed close to the gain-setting resistors. Even with a low parasitic capacitance shunting the external resistors, excessively high resistor values can create significant time constants that can degrade performance. Good axial metal-film or surface-mount resistors have approximately 0.2 pF in shunt with the resistor. For resistor values >2.0 k Ω this parasitic capacitance can add a pole and/or a zero that can affect circuit operation. Keep resistor values as low as possible, consistent with load driving considerations.
 - Connections to other wideband devices on the board may be made with short direct traces or through onboard transmission lines. For short connections, consider the trace and the input to the next device as a lumped capacitive load. Relatively wide traces (50 mils to 100 mils) should be used, preferably with ground and power planes opened up around them. Estimate the total capacitive load and determine if isolation resistors on the outputs are necessary. Low parasitic capacitive loads (< 4 pF) may not need an R_S since the THS3201 is nominally compensated to operate with a 2-pF parasitic load. Higher parasitic capacitive loads without an R_S are allowed as the signal gain increases (increasing the unloaded phase margin). If a long trace is required, and the 6-dB signal loss intrinsic to a doubly-terminated transmission line is acceptable, implement a matched impedance transmission line using microstrip or stripline techniques (consult an ECL design handbook for microstrip and stripline layout techniques).
 - A 50- Ω environment is not necessary onboard, and in fact, a higher impedance environment improves distortion as shown in the distortion versus load plots. With a characteristic board trace impedance based on board material and trace dimensions, a matching series resistor into the trace from the output of the THS3201 is used as well as a terminating shunt resistor at the input of the destination device.
- Remember also that the terminating impedance is the parallel combination of the shunt resistor and the input impedance of the destination device: this total effective impedance should be set to match the trace impedance. If the 6-dB attenuation of a doubly-terminated transmission line is un-acceptable, a long trace can be series-terminated at the source end only. Treat the trace as a capacitive load in this case. This does not preserve signal integrity as well as a doubly-terminated line. If the input impedance of the destination device is low, there is some signal attenuation due to the voltage divider formed by the series output into the terminating impedance.

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- Socketing a high-speed part like the THS3201 is not recommended. The additional lead length and pin-to-pin capacitance introduced by the socket can create an extremely troublesome parasitic network which can make it almost impossible to achieve a smooth, stable frequency response. Best results are obtained by soldering the THS3201 parts directly onto the board.

PowerPAD DESIGN CONSIDERATIONS

The THS3201 is available in a thermally-enhanced PowerPAD family of packages. These packages are constructed using a downset leadframe upon which the die is mounted [see Figure 62(a) and Figure 62(b)]. This arrangement results in the lead frame being exposed as a thermal pad on the underside of the package [see Figure 62(c)]. Because this thermal pad has direct thermal contact with the die, excellent thermal performance can be achieved by providing a good thermal path away from the thermal pad.

The PowerPAD package allows for both assembly and thermal management in one manufacturing operation. During the surface-mount solder operation (when the leads are being soldered), the thermal pad can also be soldered to a copper area underneath the package. Through the use of thermal paths within this copper area, heat can be conducted away from the package into either a ground plane or other heat dissipating device.

The PowerPAD package represents a breakthrough in combining the small area and ease of assembly of surface-mount with the, heretofore, awkward mechanical methods of heatsinking.

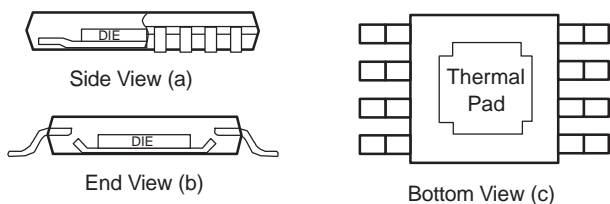


Figure 62. Views of Thermally-Enhanced Package

Although there are many ways to properly heatsink the PowerPAD package, the following steps illustrate the recommended approach.

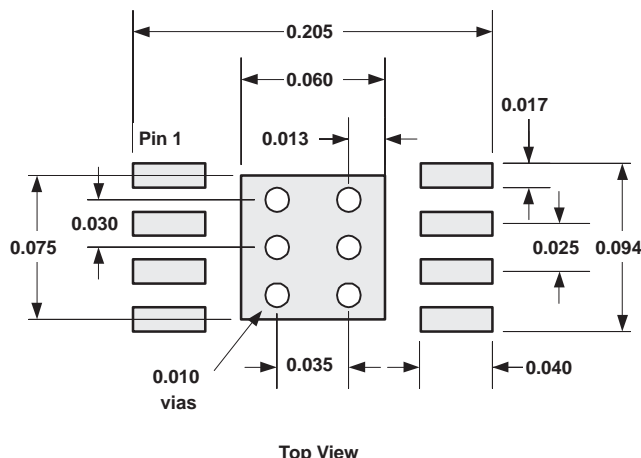


Figure 63. DGN PowerPAD PCB Etch and Via Pattern

PowerPAD PCB LAYOUT CONSIDERATIONS

1. Prepare the PCB with a top side etch pattern as shown in Figure 63. There should be etch for the leads as well as etch for the thermal pad.
2. Place five holes in the area of the thermal pad. These holes should be 10 mils in diameter. Keep them small so that solder wicking through the holes is not a problem during reflow.
3. Additional vias may be placed anywhere along the thermal plane outside of the thermal pad area. This helps dissipate the heat generated by the THS3201 IC. These additional vias may be larger than the 10-mil diameter vias directly under the thermal pad. They can be larger because they are not in the thermal pad area to be soldered so that wicking is not a problem.
4. Connect all holes to the internal ground plane.
5. When connecting these holes to the ground plane, **do not** use the typical web or spoke via connection methodology. Web connections have a high thermal resistance connection that is useful for slowing the heat transfer during soldering operations. This makes the soldering of vias that have plane connections easier. In this application, however, low thermal resistance is desired for the most efficient heat transfer. Therefore, the holes under the THS3201 PowerPAD package should make their connection to the internal ground plane with a complete connection around the entire circumference of the plated-through hole.
6. The top-side solder mask should leave the terminals of the package and the thermal pad area with its five holes exposed. The bottom-side solder mask should cover the five holes of the thermal pad area. This prevents solder from

THS3201

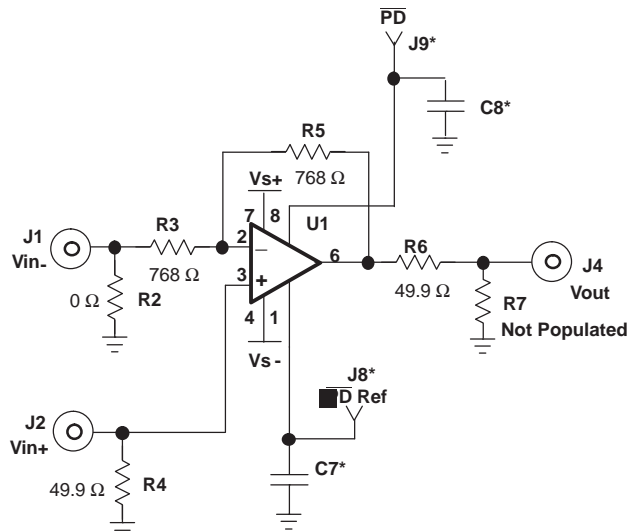
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DESIGN TOOLS

Evaluation Fixture, Spice Models, and Applications Support

Texas Instruments is committed to providing its customers with the highest quality of applications support. To support this goal an evaluation board has been developed for the THS3201 operational amplifier. The board is easy to use, allowing for straightforward evaluation of the device. The evaluation board can be ordered through the Texas Instruments web site at www.ti.com, or through your local Texas Instruments sales representative. The schematic diagram, board layers, and bill of materials of the evaluation boards are provided below.



*Does Not Apply to the THS3201

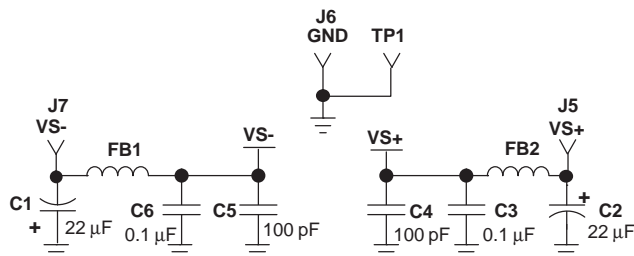


Figure 65. THS3201 EVM Circuit Configuration

Table 2. Bill of Materials⁽¹⁾

| THS3201DGN EVM | | | | | |
|----------------|--|----------|------------|--------------|-----------------------------|
| ITEM | DESCRIPTION | SMD SIZE | REF DES | PCB QUANTITY | MANUFACTURER'S PART NUMBER |
| 1 | Bead, ferrite, 3 A, 80 Ω | 1206 | FB1, FB2 | 2 | (Steward) HI1206N800R-00 |
| 2 | Cap, 22 μF, tantalum, 25 V, 10% | D | C1, C2 | 2 | (AVX) TAJD226K025R |
| 3 | Cap, 100 pF, ceramic, 5%, 150 V | AQ12 | C4, C5 | 2 | (AVX) AQ12EM101JAJME |
| 4 | Cap, 0.1 μF, ceramic, X7R, 50 V | 0805 | C3, C6 | 2 | (AVX) 08055C104KAT2A |
| 6 | Open | 0805 | R7 | 1 | |
| 7 | Resistor, 49.9 Ω, 1/8 W, 1% | 0805 | R6 | 1 | (Phycomp) 9C08052A49R9FKHFT |
| 9 | Resistor, 768 Ω, 1/8 W, 1% | 0805 | R3, R5 | 2 | (Phycomp) 9C08052A7680FKHFT |
| 10 | Open | 1206 | C7, C8 | 2 | |
| 11 | Resistor, 0 Ω, 1/4 W, 1% | 1206 | R2 | 1 | (KOA) RK73Z2BLTD |
| 12 | Resistor, 49.9 Ω, 1/4 W, 1% | 1206 | R4 | 1 | (Phycomp) 9C12063A49R9FKRFT |
| 13 | Test point, black | | TP1 | 1 | (Keystone) 5001 |
| 14 | Open | | J8, J9 | 2 | |
| 15 | Jack, Banana Receptance, 0.25" dia. hole | | J5, J6, J7 | 3 | (HH Smith) 101 |
| 16 | Connector, edge, SMA PCB jack | | J1, J2, J4 | 3 | (Johnson) 142-0701-801 |
| 17 | Standoff, 4-40 hex, 0.625" length | | | 4 | (Keystone) 1804 |
| 18 | Screw, Phillips, 4-40, .250" | | | 4 | SHR-0440-016-SN |
| 19 | IC, THS3201 | | U1 | 1 | (TI) THS3201DGN |
| 20 | Board, printed circuit | | | 1 | (TI) Edge # 6447972 Rev.A |

(1) The components shown in the BOM were used in test by TI.

Computer simulation of circuit performance using SPICE is often useful when analyzing the performance of analog circuits and systems. This is particularly true for video and R_F -amplifier circuits where parasitic capacitance and inductance can have a major effect on circuit performance. A SPICE model for the THS3201 family of devices is available through the Texas Instruments web site (www.ti.com). The Product Information Center (PIC) is available for design assistance and detailed product information. These models do a good job of predicting small-signal ac and transient performance under a wide variety of operating conditions. They are not intended to model the distortion characteristics of the amplifier, nor do they attempt to distinguish between the package types in their small-signal ac performance. Detailed information about what is and is not modeled is contained in the model file itself.

ADDITIONAL REFERENCE MATERIAL

- PowerPAD Made Easy, application brief ([SLMA004](#))
- PowerPAD Thermally Enhanced Package, technical brief ([SLMA002](#))
- Voltage Feedback vs Current-Feedback Amplifiers ([SLVA051](#))
- Current-Feedback Analysis and Compensation ([SLOA021](#))
- Current-Feedback Amplifiers: Review, Stability, and Application ([SBOA081](#))
- Effect of Parasitic Capacitance in Op Amp Circuits ([SLOA013](#))

EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage and the output voltage ranges as specified in the table below.

| | |
|---------------------|---|
| Input Range, V_S | 6.6 V ($\pm 3.3V$) to 16.5V ($\pm 8.25V$) |
| Input Range, V_I | NOT TO EXCEED: Power-Supply Voltage Applied |
| Output Range, V_O | NOT TO EXCEED: Power-Supply Voltage Applied |

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative.

During normal operation, some circuit components may have case temperatures greater than +125°C. The EVM is designed to operate properly with certain components above +125°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

| Changes from Revision B (March 2008) to Revision C | Page |
|---|------|
| • Changed 5-V Step to 10-V Step in second bullet of <i>Features</i> list | 1 |
| • Deleted lead temperature row from <i>Absolute Maximum Ratings</i> table | 2 |

| Changes from Revision A (January, 2004) to Revision B | Page |
|--|------|
| • Updated document format | 1 |
| • Updated <i>Features</i> , <i>Applications</i> , and <i>Description</i> sections | 1 |
| • Updated Package/Ordering Information | 3 |
| • Changed ± 7.5 -V slew rate typical values..... | 4 |
| • Changed ± 7.5 -V rise and fall time typical values..... | 4 |
| • Changed ± 7.5 -V 2nd-order harmonic typical values..... | 4 |
| • Changed ± 7.5 -V 3rd-order harmonic typical values | 4 |
| • Deleted ± 7.5 -V 3rd-order intermodulation distortion specifications | 4 |
| • Changed ± 5 -V slew rate typical values..... | 6 |
| • Changed ± 5 -V rise and fall time typical values..... | 6 |
| • Changed ± 5 -V 2nd-order harmonic typical values..... | 6 |
| • Changed ± 5 -V 3rd-order harmonic typical values | 6 |
| • Deleted ± 5 -V 3rd-order intermodulation distortion specifications | 6 |
| • Added Figure 9 through Figure 17 ; updated Figure 25 | 8 |
| • Added Figure 40 through Figure 48 ; added Figure 51 | 9 |
| • Deleted <i>Power Supply</i> section..... | 19 |
| • Updated first paragraph in <i>Printed Circuit Board Layout</i> section..... | 19 |

PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead finish/ Ball material (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|------------------|---------------|--------------|-----------------|------|-------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|---------|
| THS3201D | NRND | SOIC | D | 8 | 75 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | 3201 | |
| THS3201DBVT | NRND | SOT-23 | DBV | 5 | 250 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | BEO | |
| THS3201DBVTG4 | NRND | SOT-23 | DBV | 5 | 250 | TBD | Call TI | Call TI | -40 to 85 | | |
| THS3201DGN | NRND | HVSSOP | DGN | 8 | 80 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | BEN | |
| THS3201DGNR | NRND | HVSSOP | DGN | 8 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | BEN | |
| THS3201DR | NRND | SOIC | D | 8 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | 3201 | |

(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.

OBSELETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

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

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

(6) Lead finish/Ball material - Orderable Devices 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.

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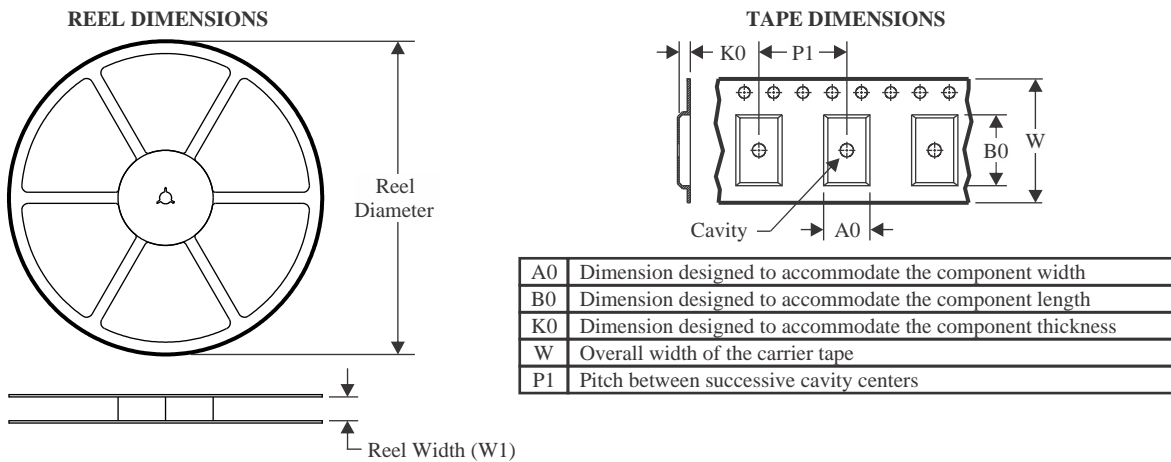
OTHER QUALIFIED VERSIONS OF THS3201 :

- Enhanced Product : [THS3201-EP](#)

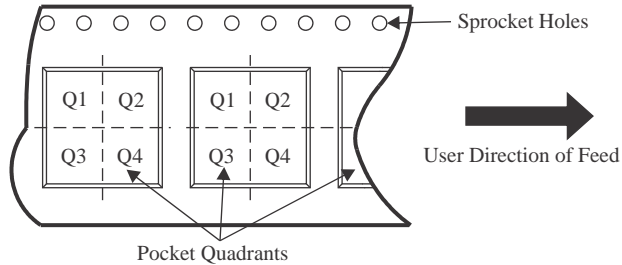
NOTE: Qualified Version Definitions:

- Enhanced Product - Supports Defense, Aerospace and Medical Applications

TAPE AND REEL INFORMATION



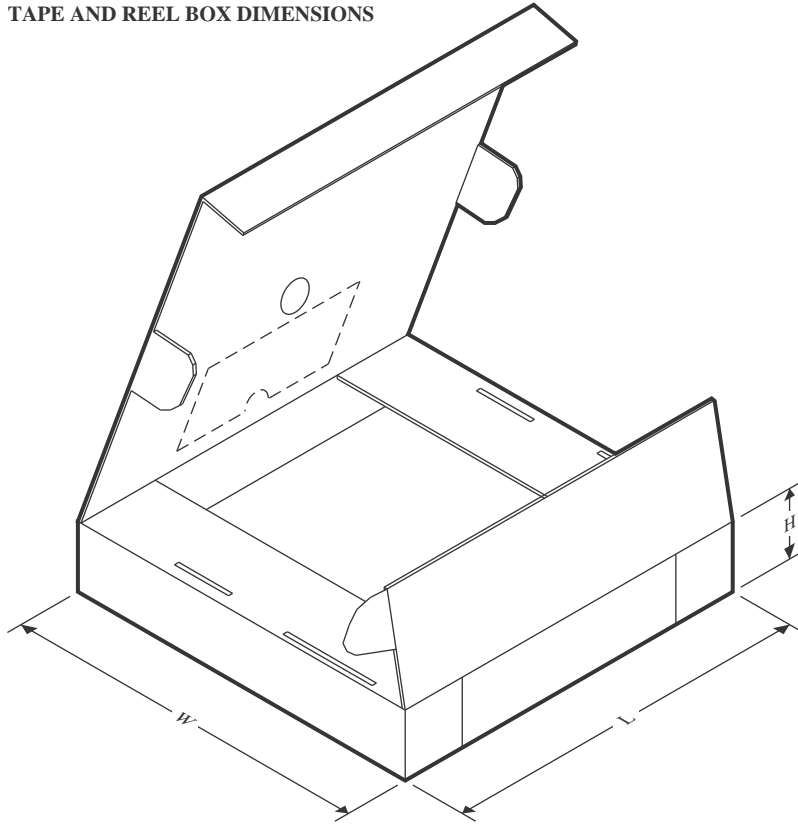
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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 |
|-------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| THS3201DBVT | SOT-23 | DBV | 5 | 250 | 180.0 | 9.0 | 3.15 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| THS3201DGNR | HVSSOP | DGN | 8 | 2500 | 330.0 | 12.4 | 5.3 | 3.4 | 1.4 | 8.0 | 12.0 | Q1 |
| THS3201DR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |

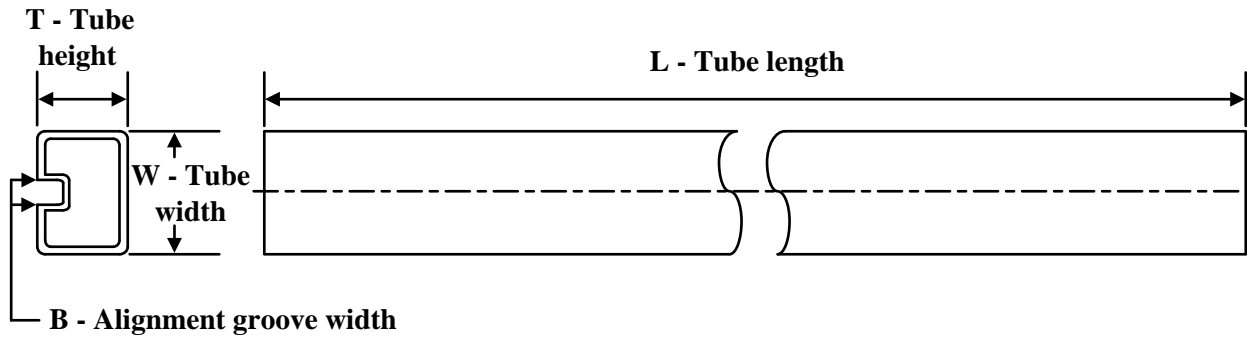
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|-------------|--------------|-----------------|------|------|-------------|------------|-------------|
| THS3201DBVT | SOT-23 | DBV | 5 | 250 | 182.0 | 182.0 | 20.0 |
| THS3201DGNR | HVSSOP | DGN | 8 | 2500 | 358.0 | 335.0 | 35.0 |
| THS3201DR | SOIC | D | 8 | 2500 | 350.0 | 350.0 | 43.0 |

TUBE



*All dimensions are nominal

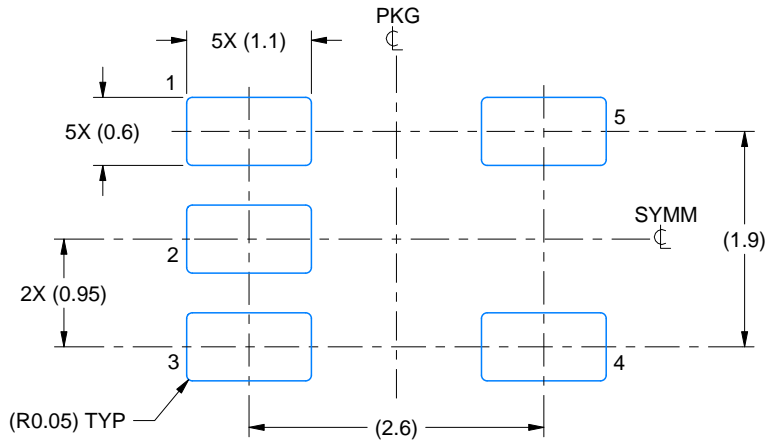
| Device | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (μm) | B (mm) |
|----------|--------------|--------------|------|-----|--------|--------|--------|--------|
| THS3201D | D | SOIC | 8 | 75 | 505.46 | 6.76 | 3810 | 4 |

EXAMPLE BOARD LAYOUT

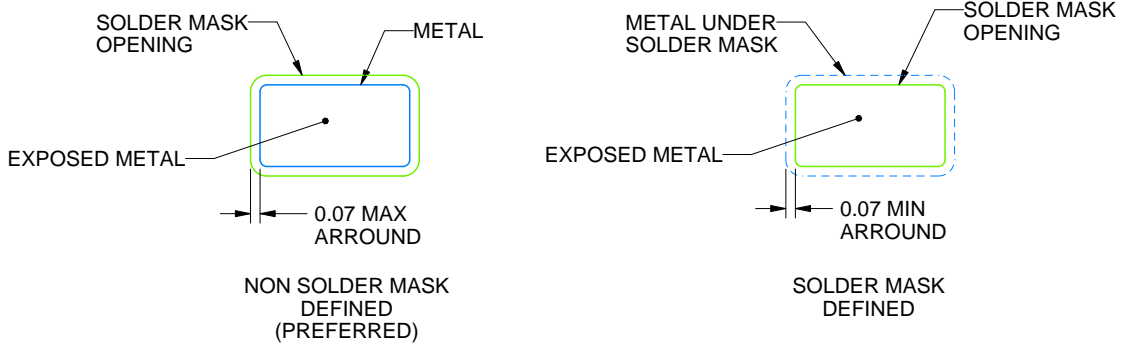
DBV0005A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:15X



SOLDER MASK DETAILS

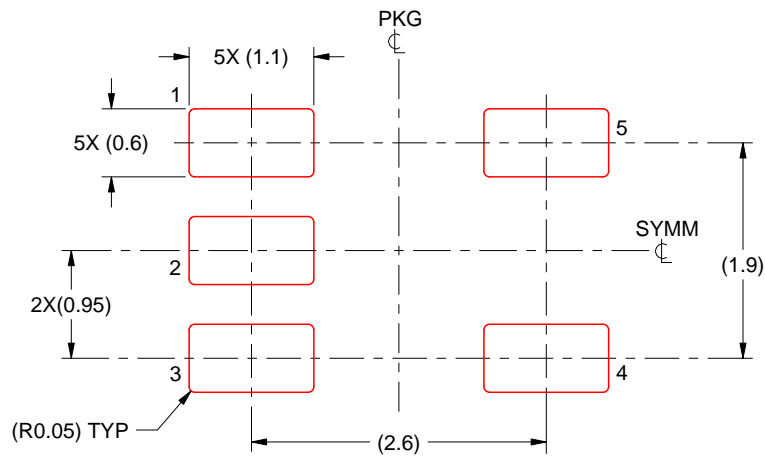
4214839/K 08/2024

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.

EXAMPLE STENCIL DESIGN**DBV0005A****SOT-23 - 1.45 mm max height**

SMALL OUTLINE TRANSISTOR



SOLDER PASTE EXAMPLE
 BASED ON 0.125 mm THICK STENCIL
 SCALE:15X

4214839/K 08/2024

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.

GENERIC PACKAGE VIEW

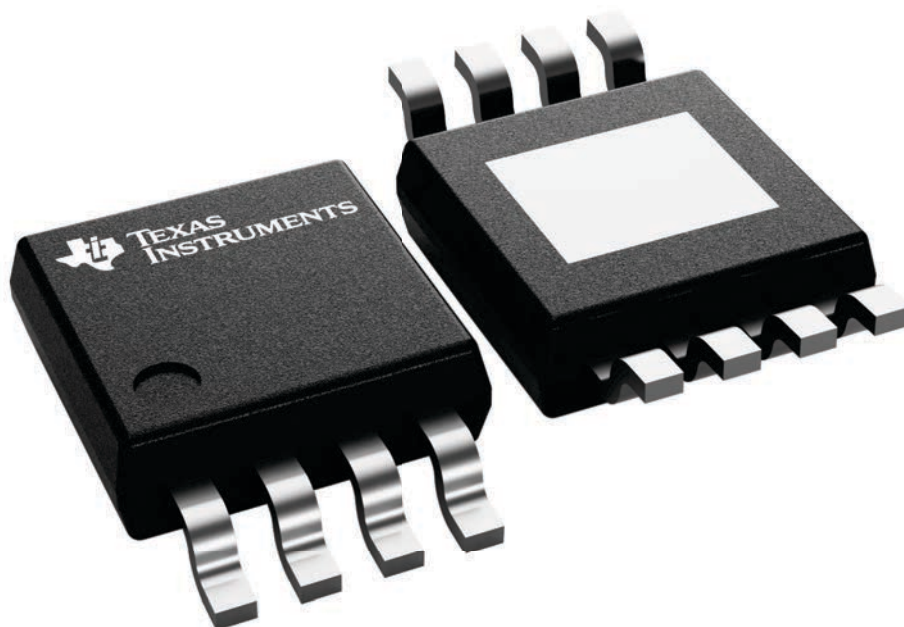
DGN 8

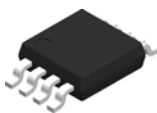
PowerPAD™ HVSSOP - 1.1 mm max height

3 x 3, 0.65 mm pitch

SMALL OUTLINE PACKAGE

This image is a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.



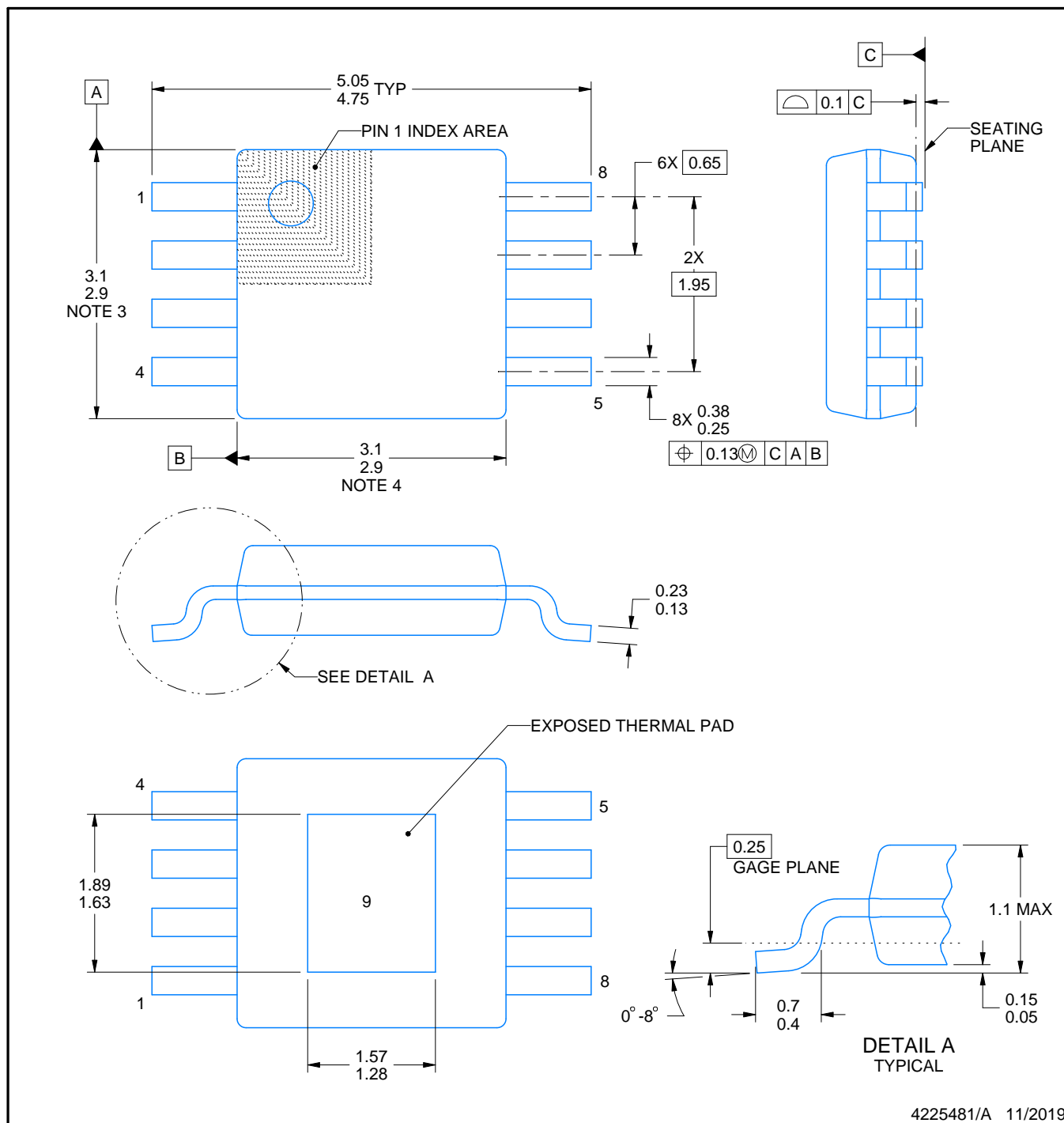


PACKAGE OUTLINE

DGN0008D

PowerPAD™ VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



4225481/A 11/2019

NOTES:

PowerPAD is a trademark of Texas Instruments.

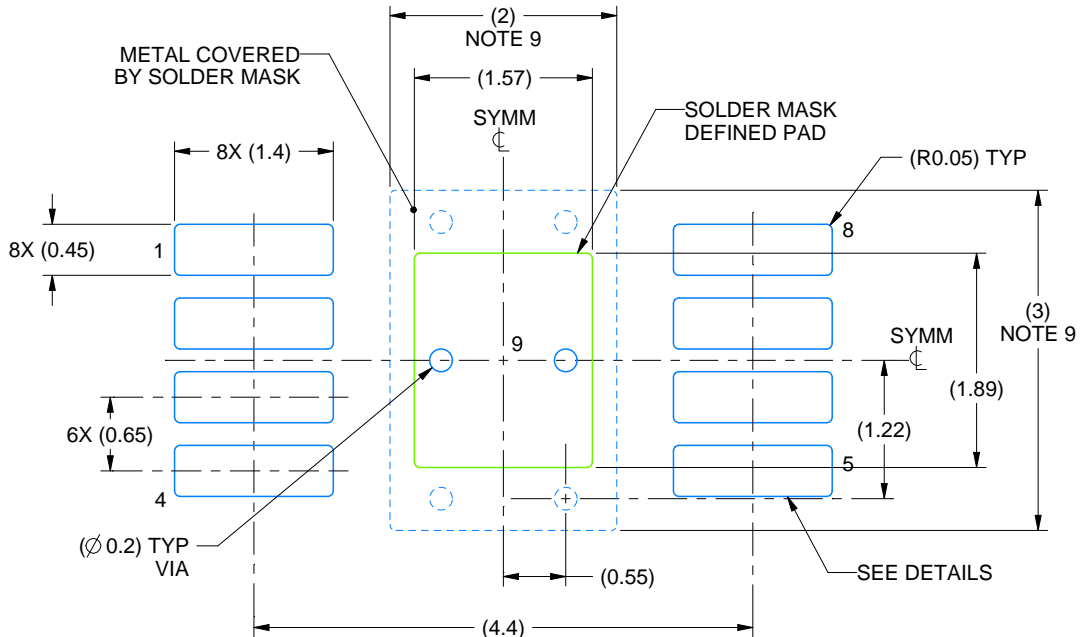
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or 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 MO-187.

EXAMPLE BOARD LAYOUT

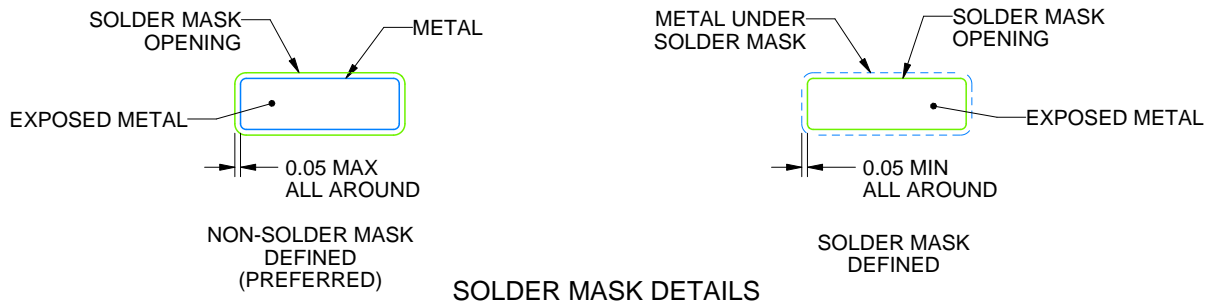
DGN0008D

PowerPAD™ VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 15X



4225481/A 11/2019

NOTES: (continued)

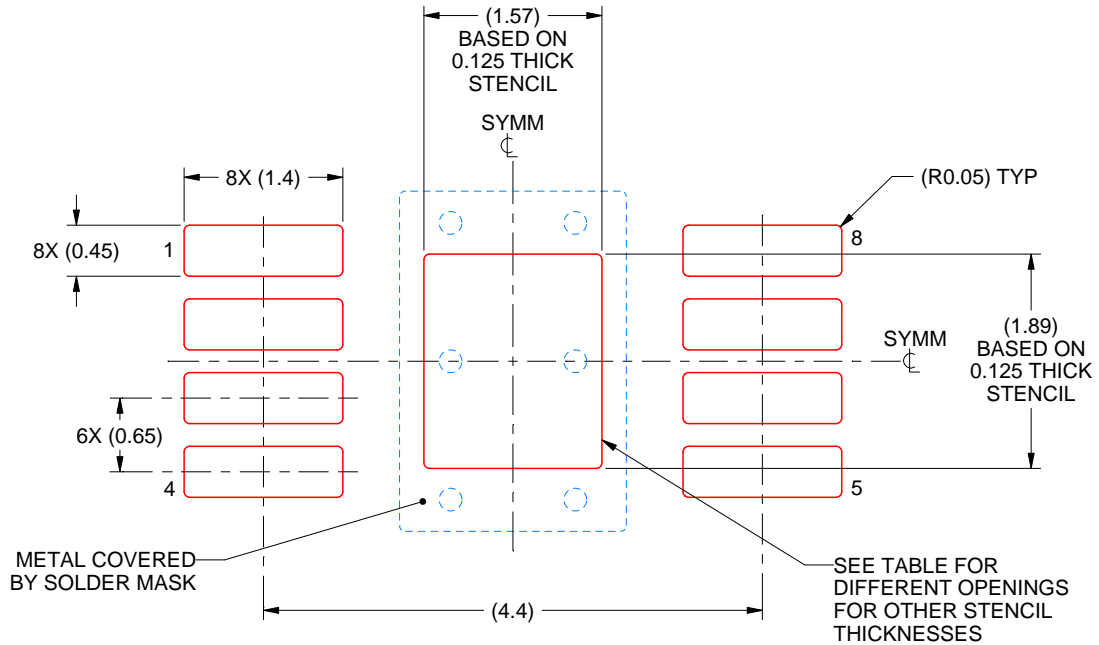
- 6. Publication IPC-7351 may have alternate designs.
- 7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.
- 8. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.
- 9. Size of metal pad may vary due to creepage requirement.

EXAMPLE STENCIL DESIGN

DGN0008D

PowerPAD™ VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



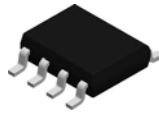
SOLDER PASTE EXAMPLE
 EXPOSED PAD 9:
 100% PRINTED SOLDER COVERAGE BY AREA
 SCALE: 15X

| STENCIL THICKNESS | SOLDER STENCIL OPENING |
|-------------------|------------------------|
| 0.1 | 1.76 X 2.11 |
| 0.125 | 1.57 X 1.89 (SHOWN) |
| 0.15 | 1.43 X 1.73 |
| 0.175 | 1.33 X 1.60 |

4225481/A 11/2019

NOTES: (continued)

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

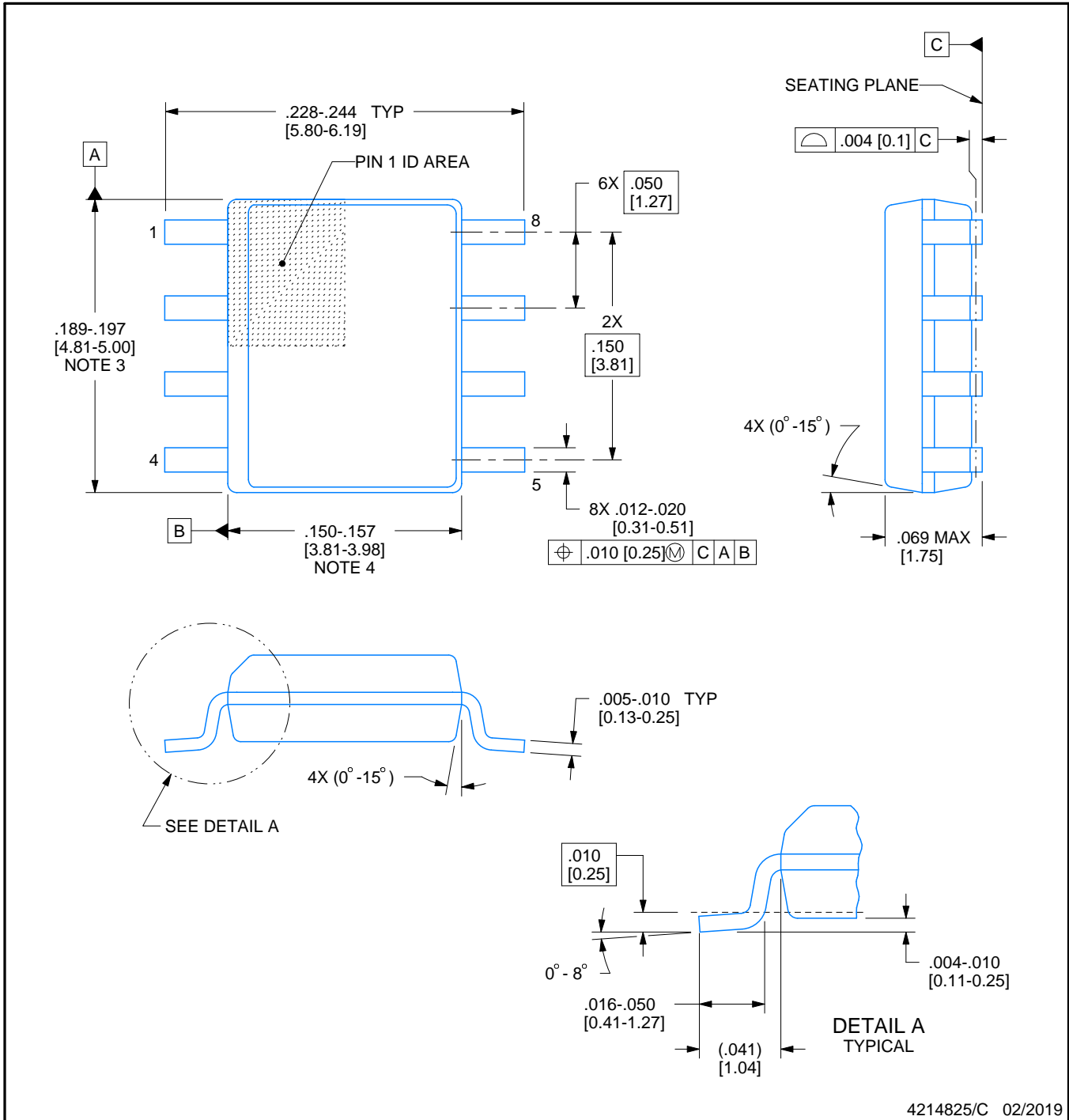


PACKAGE OUTLINE

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



4214825/C 02/2019

NOTES:

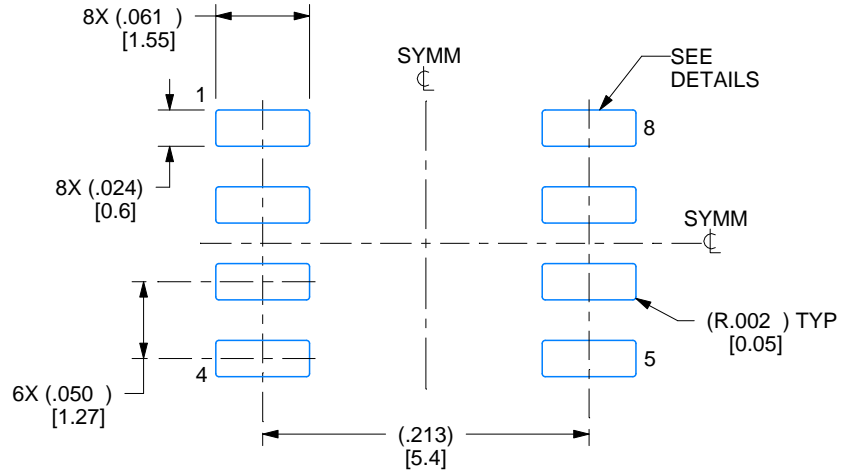
1. Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed $.006$ [0.15] per side.
4. This dimension does not include interlead flash.
5. Reference JEDEC registration MS-012, variation AA.

EXAMPLE BOARD LAYOUT

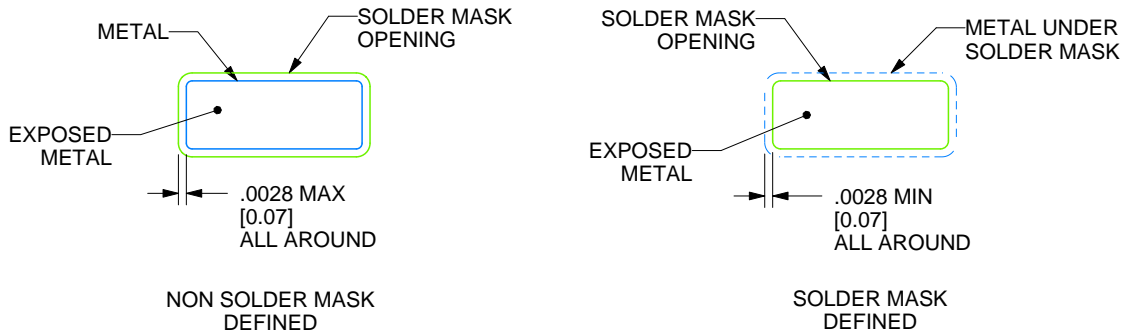
D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:8X



SOLDER MASK DETAILS

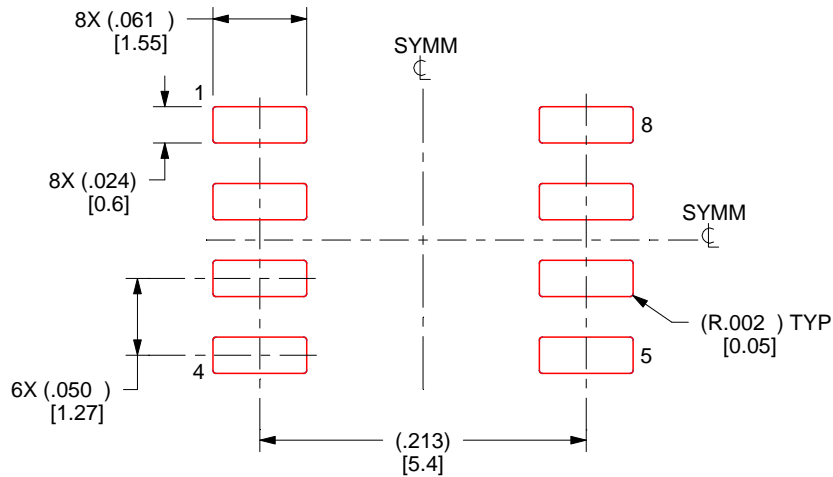
4214825/C 02/2019

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.

EXAMPLE STENCIL DESIGN**D0008A****SOIC - 1.75 mm max height**

SMALL OUTLINE INTEGRATED CIRCUIT



SOLDER PASTE EXAMPLE
 BASED ON .005 INCH [0.125 MM] THICK STENCIL
 SCALE:8X

4214825/C 02/2019

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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