TEXAS INSTRUMENTS
THS7530
ZHCSEH6E – DECEMBER 2002 – REVISED AUGUST 2020

# THS7530 高速全差分连续 可变增益放大器

## 1 特性

- 低噪声：$V_n$ = 1.1nV/√Hz，噪声系数 = 9dB
- 低失真：
  - 频率为 32MHz 时：$HD_2$ = –65dBc，$HD_3$ = –61dBc
  - 频率为 70MHz 时：$IMD_3$ = –62dBc，$OIP_3$ = 21dBm
- 300MHz 带宽
- 连续可变增益范围：11.6dB 至 46.5dB
- 增益斜坡：38.8dB/V
- 全差分输入和输出
- 输出共模电压控制
- 输出电压限制

## 2 应用

- 超声波应用、声纳和雷达中的时间增益放大器
- 通信和视频中的自动增益控制
- 通信中的系统增益校准
- 仪表中的可变增益

## 3 说明

THS7530 器件采用德州仪器 (TI) 先进的 BiCom III SiGe 互补双极工艺制造。THS7530 是一款带有压控增益的直流耦合高带宽放大器。该放大器具有高阻抗差分输入和低阻抗差分输出，提供高带宽增益控制、输出共模控制和输出电压钳位功能。

带宽为 300MHz 时信号通道性能卓越，而带宽为 32MHz 且 $1V_{PP}$ 输出到 400Ω 时会出现 –61dBc 的三次谐波失真。

增益控制（单位：dB）呈线性变化。在 0V 至 0.9V 电压范围内，增益以 38.8dB/V 的斜率由 11.6dB 变化为 46.5dB。

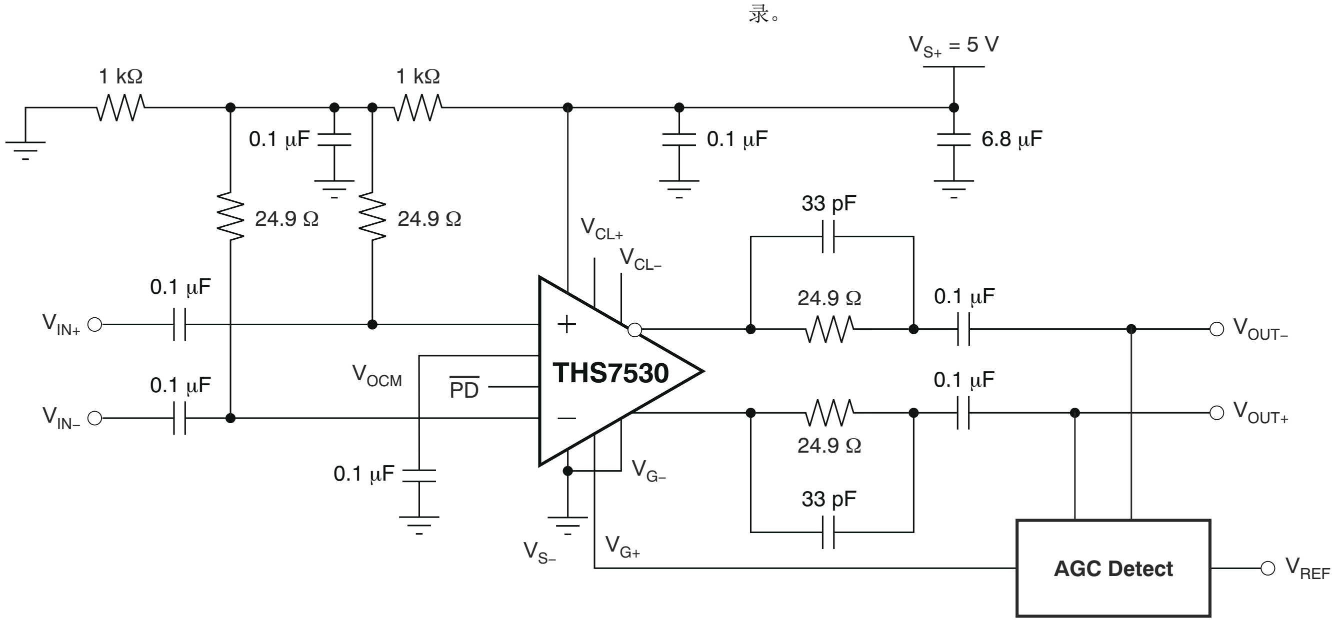
输出电压限制功能用于限制输出电压摆幅并避免后续级发生饱和。

该器件可在工业级温度范围内（–40°C 至 +85°C）额定运行。

器件信息(1)

| 器件型号 | 封装 | 封装尺寸（标称值） |
|---|---|---|
| THS7530 | HTSSOP (14) | 5.00mm × 4.40mm |

(1) 如需了解所有可用封装，请参阅数据表末尾的可订购产品附录。




典型应用电路

## Table of Contents

**1 特性** 1
**2 应用** 1
**3 说明** 1
**4 Revision History** 2
**5 Pin Configuration and Functions** 3
Pin Functions 3
**6 Specifications** 4
6.1 Absolute Maximum Ratings 4
6.2 ESD Ratings 4
6.3 Recommended Operating Conditions 4
6.4 Thermal Information 4
6.5 Electrical Characteristics: Main Amplifier 5
6.6 Package Thermal Data 7
6.7 Typical Characteristics 7
**7 Parameter Measurement Information** 10
7.1 Test Circuits 10
**8 Detailed Description** 12
8.1 Overview 12
8.2 Functional Block Diagram 12
8.3 Feature Description 12
8.4 Device Functional Modes 13
**9 Application and Implementation** 14
9.1 Application Information 14
9.2 Typical Application 16
**10 Power Supply Recommendations** 18
**11 Layout** 19
11.1 Layout Guidelines 19
11.2 Layout Examples 21
**12 Device and Documentation Support** 23
12.1 Device Support 23
12.2 Documentation Support 23
12.3 支持资源 23
12.4 Trademarks 23
12.5 静电放电警告 23
12.6 术语表 23
**13 Mechanical, Packaging, and Orderable Information** 23

## 4 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 D (July 2015) to Revision E (August 2020)** **Page**

- 更新了整个文档中的表格、图和交叉参考的编号格式 1

**Changes from Revision C (February 2010) to Revision D (July 2015)** **Page**

- 添加了 *ESD 等级* 表、*特性说明* 部分、*器件功能模式*、*应用和实施* 部分、*电源相关建议* 部分、*布局* 部分、*器件和文档支持* 部分以及 *机械、封装和可订购信息* 部分 1

**Changes from Revision B (February 2006) to Revision C (February 2010)** **Page**

- 更正了首页图片中的输入和输出极性指示 1
- Deleted *lead temperature* specification from Absolute Maximum Ratings table 4
- Corrected 图 7-2 10
- Changed 图 9-2 and 图 9-3 to correct problem with output polarity indication 14
- Changed 图 9-4 and 图 9-5 to correct problem with output polarity indication 14

## 5 Pin Configuration and Functions

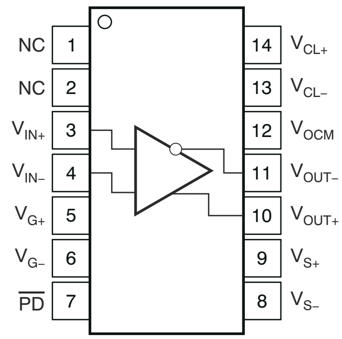



图 5-1. PWP Package 14-Pin HTSSOP With PowerPAD™ Top View

### Pin Functions

| PIN | | I/O | DESCRIPTION |
|---|---|---|---|
| NAME | NO. | | |
| NC | 1 | — | No internal connection |
| | 2 | | |
| PD | 7 | — | Power down, PD = logic low puts the device into low power mode; PD = logic high or open for normal operation |
| $V_{CL-}$ | 13 | I | Output negative clamp voltage input |
| $V_{CL+}$ | 14 | I | Output positive clamp voltage input |
| $V_{G-}$ | 6 | I | Gain setting negative input |
| $V_{G+}$ | 5 | I | Gain setting positive input |
| $V_{IN-}$ | 4 | I | Inverting amplifier input |
| $V_{IN+}$ | 3 | I | Noninverting amplifier input |
| $V_{OCM}$ | 12 | I | Output common-mode voltage input |
| $V_{OUT-}$ | 11 | O | Inverted amplifier output |
| $V_{OUT+}$ | 10 | O | Noninverted amplifier output |
| $V_{S-}$ | 8 | I | Negative amplifier power-supply input |
| $V_{S+}$ | 9 | I | Positive amplifier power-supply input |

# 6 Specifications

## 6.1 Absolute Maximum Ratings

Over operating free-air temperature range, unless otherwise noted.[(1)]

| | | MIN | MAX | UNIT |
|---|---|---|---|---|
| $V_{S+} - V_{S-}$ | Supply voltage | | 5.5 | V |
| $V_I$ | Input voltage | | $\pm V_S$ | V |
| $I_O$ | Output current | | 65 | mA |
| $V_{ID}$ | Differential input voltage | | ±4 | V |
| | Continuous power dissipation | See 节 6.4 | | |
| $T_J$ | Maximum junction temperature | | 150 | °C |
| | Maximum junction temperature for long term stability[(2)] | | 125 | °C |
| $T_{stg}$ | Storage temperature | –65 | 150 | °C |

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) The maximum junction temperature for continuous operation is limited by package constraints. Operation above this temperature may result in reduced reliability and/or lifetime of the device.

## 6.2 ESD Ratings

| | | | VALUE | UNIT |
|---|---|---|---|---|
| $V_{(ESD)}$ | Electrostatic discharge | Human body model (HBM), per ANSI/ESDA/JEDEC JS-001[(1)] | ±3000 | V |
| | | Charged device model (CDM), per JEDEC specification JESD22-C101[(2)] | ±1500 | |
| | | Machine model (MM) | ±200 | |

(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.

## 6.3 Recommended Operating Conditions

| | | | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|---|
| $[V_{S-}$ to $V_{S+}]$ | Supply voltage | | 4.5 | 5 | 5.5 | V |
| | Input common mode voltage | $[V_{S-}$ to $V_{S+}] = 5$ V | | 2.5 | | V |
| | Output common mode voltage | $[V_{S-}$ to $V_{S+}] = 5$ V | | 2.5 | | V |
| $T_A$ | Operating free-air temperature | | –40 | | 85 | °C |

## 6.4 Thermal Information

| THERMAL METRIC[(1)] | | THS7530 PWP (HTSSOP) 14 PINS | UNIT |
|---|---|---|---|
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance | 50.4 | °C/W |
| $R_{\theta JC(top)}$ | Junction-to-case (top) thermal resistance | 34.9 | °C/W |
| $R_{\theta JB}$ | Junction-to-board thermal resistance | 29 | °C/W |
| $\psi_{JT}$ | Junction-to-top characterization parameter | 1.6 | °C/W |
| $\psi_{JB}$ | Junction-to-board characterization parameter | 28.7 | °C/W |
| $R_{\theta JC(bot)}$ | Junction-to-case (bottom) thermal resistance | 3.2 | °C/W |

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

## 6.5 Electrical Characteristics: Main Amplifier

$V_{S+}$ = 5 V, $V_{S-}$ = 0 V, $V_{OCM}$ = 2.5 V, $V_{ICM}$ = 2.5 V, $V_{G-}$ = 0 V, $V_{G+}$ = 1 V (maximum gain), $T_A$ = 25°C, AC performance measured using the AC test circuit shown in 图 7-1 (unless otherwise noted). DC performance is measured using the DC test circuit shown in 图 7-2 (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|
| **AC PERFORMANCE** | | | | | |
| Small-signal bandwidth | All gains, $P_{IN}$ = –45 dBm | | 300 | | MHz |
| Slew rate[(1)] | 1-$V_{PP}$ Step, 25% to 75%, minimum gain | | 1250 | | V/μs |
| Settling time to 1%[(1)] | 1-$V_{PP}$ Step, minimum gain | | 11 | | ns |
| Harmonic distortion, 2nd harmonic | f = 32 MHz, $V_{O(PP)}$ = 1 V, $R_{L(diff)}$ = 400 Ω | | –65 | | dBc |
| Harmonic distortion, 3rd harmonic | f = 32 MHz, $V_{O(PP)}$ = 1 V, $R_{L(diff)}$ = 400 Ω | | –61 | | dBc |
| Third-order intermodulation distortion | $P_O$ = –10 dBm each tone, $f_C$ = 70 MHz, 200-kHz tone spacing | | –62 | | dBc |
| Third-order output intercept point | $f_C$ = 70 MHz, 200-kHz tone spacing | | 21 | | dBm |
| Noise figure (with input termination) | Source impedance: 50 Ω | | 9 | | dB |
| Total input voltage noise | f > 100 kHz | | 1.1 | | $nV/\sqrt{Hz}$ |
| **DC PERFORMANCE—INPUTS** | | | | | |
| Input bias current | $T_A$ = 25°C | | 20 | 39 | μA |
| | $T_A$ = –40°C to +85°C | | | 40 | |
| Input bias current offset | | | <150 | | pA |
| Minimum input voltage | Minimum gain, $T_A$ = 25°C | | 1.5 | 1.6 | V |
| | Minimum gain, $T_A$ = –40°C to +85°C | | | 1.7 | |
| Maximum input voltage | Minimum gain, $T_A$ = 25°C | 3.35 | 3.5 | | V |
| | Minimum gain, $T_A$ = –40°C to +85°C | 3.2 | | | |
| Common-mode rejection ratio | $T_A$ = 25°C | 56 | 114 | | dB |
| | $T_A$ = –40°C to +85°C | 44 | | | |
| Differential input impedance | | | 8.5 \|\| 3 | | kΩ \|\| pF |
| **DC PERFORMANCE—OUTPUTS** | | | | | |
| Output offset voltage | All gains, $T_A$ = 25°C | | ±100 | ±340 | mV |
| | All gains, $T_A$ = –40°C to +85°C | | | ±480 | |
| Maximum output voltage high | $T_A$ = 25°C | 3.275 | 3.5 | | V |
| | $T_A$ = –40°C to +85°C | 3.25 | | | |
| Minimum output voltage low | $T_A$ = 25°C | | 1.5 | 1.7 | V |
| | $T_A$ = –40°C to +85°C | | | 1.8 | |
| Output current | $T_A$ = 25°C | ±16 | ±37 | | mA |
| | $T_A$ = –40°C to +85°C | ±16 | | | |
| Output impedance | | | 15 | | Ω |
| **OUTPUT COMMON-MODE VOLTAGE CONTROL** | | | | | |
| Small-signal bandwidth | | | 32 | | MHz |
| Gain | | | 1 | | V/V |
| Common-mode offset voltage | $T_A$ = 25°C | | 4.5 | 12 | mV |
| | $T_A$ = –40°C to +85°C | | | 13.8 | |
| Minimum input voltage | | | 1.75 | | V |
| Maximum input voltage | | | 3.25 | | V |
| Input impedance | | | 25 \|\| 1 | | kΩ \|\| pF |
| Default voltage, with no connect | | | 2.5 | | V |
| Input bias current | | | <1 | | μA |
| **GAIN CONTROL** | | | | | |
| Gain control differential voltage range | $V_{G+}$ | | 0 to 1 | | V |
| Minus gain control voltage | $V_{G-}$ – $V_{S-}$ | | –0.6 to 0.8 | | V |

## 6.5 Electrical Characteristics: Main Amplifier (continued)

$V_{S+}$ = 5 V, $V_{S-}$ = 0 V, $V_{OCM}$ = 2.5 V, $V_{ICM}$ = 2.5 V, $V_{G-}$ = 0 V, $V_{G+}$ = 1 V (maximum gain), $T_A$ = 25°C, AC performance measured using the AC test circuit shown in 图 7-1 (unless otherwise noted). DC performance is measured using the DC test circuit shown in 图 7-2 (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|
| Minimum gain | $V_{G+}$ = 0 V | | 11.6 | | dB |
| Maximum gain | $V_{G+}$ = 0.9 V | | 46.5 | | dB |
| Gain slope | $V_{G+}$ = 0 V to 0.9 V | | 38.8 | | dB/V |
| Gain slope variation | $V_{G+}$ = 0 V to 0.9 V | | ±1.5 | | dB/V |
| Gain error | $V_{G+}$ = 0 V to 0.15 V | | ±4 | | dB |
| | $V_{G+}$ = 0.15 V to 0.9 V | | ±2.25 | | |
| Gain control input bias current | | | <1 | | µA |
| Gain control input resistance | | | 40 | | kΩ |
| Gain control bandwidth | Small signal –3 dB | | 15 | | MHz |
| **VOLTAGE CLAMPING** | | | | | |
| Output voltages ($V_{OUT\pm}$) relative to clamp voltages ($V_{CL\pm}$) | Device In voltage limiting mode, $T_A$ = 25°C | | ±25 | ±38 | mV |
| | Device In voltage limiting mode, $T_A$ = –40°C to +85°C | | | ±60 | |
| Clamp voltage ($V_{CL\pm}$) input resistance | Device in voltage limiting mode | | 3.3 | | kΩ |
| Clamp voltage ($V_{CL\pm}$) limits | | | $V_{S-}$ to $V_{S+}$ | | V |
| **POWER SUPPLY** | | | | | |
| Specified operating voltage | $T_A$ = 25°C | | 5 | 5.5 | V |
| | $T_A$ = –40°C to +85°C | | | 5.5 | |
| Maximum quiescent current | $T_A$ = 25°C | | 40 | 48 | mA |
| | $T_A$ = –40°C to +85°C | | | 49 | |
| Power supply rejection (±PSRR) | $T_A$ = 25°C | 70 | 77 | | dB |
| | $T_A$ = –40°C to +85°C | 45 | | | |
| **POWER DOWN** | | | | | |
| Enable voltage threshold | TTL low = shut down, $T_A$ = 25°C | | 1.4 | | V |
| | TTL low = shut down, $T_A$ = –40°C to +85°C | 1 | | | |
| Disable voltage threshold | TTL high = normal operation, $T_A$ = 25°C | | 1.4 | | V |
| | TTL high = normal operation, $T_A$ = –40°C to +85°C | | | 1.65 | |
| Power-down quiescent current | $T_A$ = 25°C | | 0.35 | 0.4 | mA |
| | $T_A$ = –40°C to +85°C | | | 0.45 | |
| Input current high | $T_A$ = 25°C | | ±9 | ±16 | µA |
| | $T_A$ = –40°C to +85°C | | | ±19 | |
| Input current low | $T_A$ = 25°C | | ±109 | ±116 | µA |
| | $T_A$ = –40°C to +85°C | | | ±119 | |
| Input impedance | | | 50 \|\| 1 | | kΩ \|\| pF |
| Turnon time delay | Measured to 50% quiescent current | | 820 | | ns |
| Turnoff time delay | Measured to 50% quiescent current | | 500 | | ns |
| Forward isolation in power down | | | 80 | | dB |
| Input resistance in power down | | | > 1 | | MΩ |
| Output resistance in power down | | | 16 | | kΩ |

(1) Slew rate and settling time measured at amplifier output.

## 6.6 Package Thermal Data

| PACKAGE | PCB | $T_A$ = 25°C POWER RATING(1) |
|---|---|---|
| PWP (14-pin)(2) | See 节 11. | 3 W |

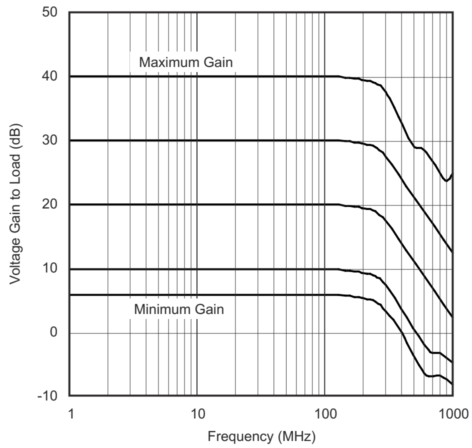
(1) This data was taken using 2 oz trace and copper pad that is soldered directly to a 3 in × 3 in PCB.
(2) The THS7530 incorporates a PowerPAD on the underside of the chip. The PowerpAD acts as a heatsink and must be connected to a thermally dissipative plane for proper power dissipation. Failure to do so may result in exceeding the maximum junction temperature which could permanently damage the device. See TI technical briefs SLMA002 and SLMA004 for more information about using the PowerPAD thermally enhanced package.

## 6.7 Typical Characteristics

Measured using the AC test circuit shown in 图 7-1 (unless otherwise noted).

**表 6-1. Table Of Graphs**

| | | FIGURE |
|---|---|---|
| Voltage Gain to Load | vs Frequency (Input at 45 dBm) | 图 6-1 |
| Gain and Gain Error | vs $V_{G+}$ | 图 6-2 |
| Noise Figure | vs Frequency | 图 6-3 |
| Output Intercept Point | vs Frequency | 图 6-4 |
| 1-dB Compression Point | vs Frequency | 图 6-5 |
| Total Input Voltage Noise | vs Frequency | 图 6-6 |
| Intermodulation Distortion | vs Frequency | 图 6-7 |
| Harmonic Distortion | vs Frequency | 图 6-8 |
| S-Parameters | vs Frequency | 图 9-7 |
| Differential Input Impedance of Main Amplifier | vs Frequency | 图 9-8 |
| Differential Output Impedance of Main Amplifier | vs Frequency | 图 6-9 |
| $V_{G+}$ Input Impedance | vs Frequency | 图 6-10 |
| $V_{OCM}$ Input Impedance | vs Frequency | 图 6-11 |
| Common-Mode Rejection Ratio | vs Frequency | 图 6-12 |
| Step Response: 2 $V_{PP}$ | vs Time | 图 6-13 |
| Step Response: Rising Edge | vs Time | 图 6-14 |
| Step Response: Falling Edge | vs Time | 图 6-15 |




Gain is taken at load. Add 6 dB to refer to amplifier output

$P_{IN}$ = –45 dBm

**图 6-1. Voltage Gain to Load vs Frequency**

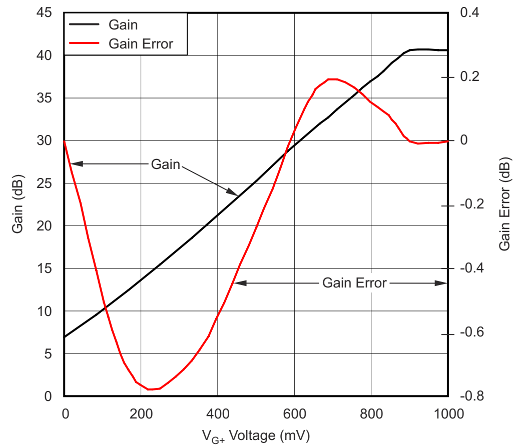
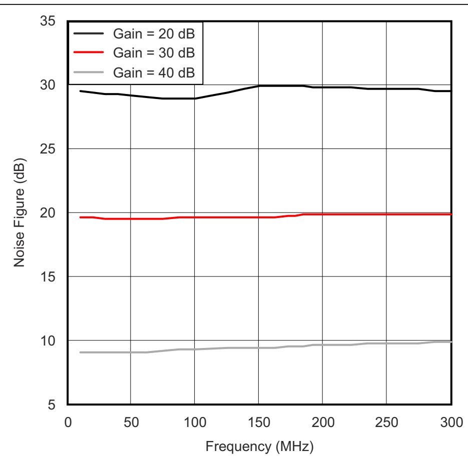
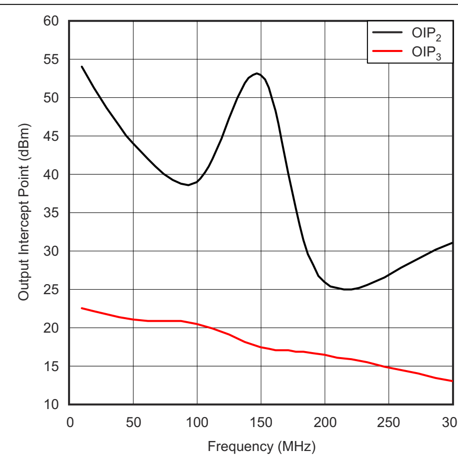



**图 6-2. Gain and Gain Error vs $V_{G+}$**



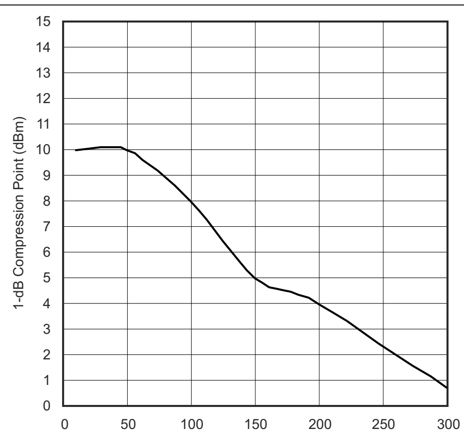

Terminated input

**图 6-3. Noise Figure vs Frequency**




Taken at load. Add 3 dB to refer to amplifier output.

**图 6-4. Output Intercept Point vs Frequency**




Taken at load. Add 3 dB to refer to amplifier output.

**图 6-5. 1-dB Compression Point vs Frequency**

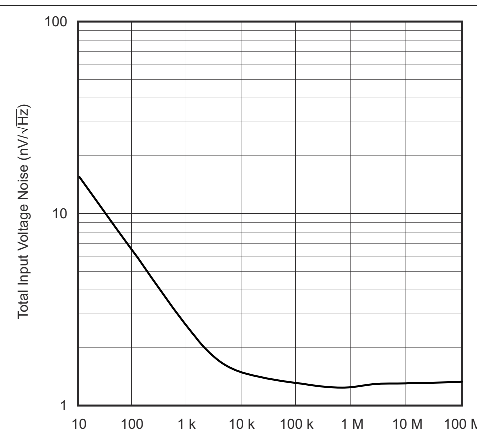
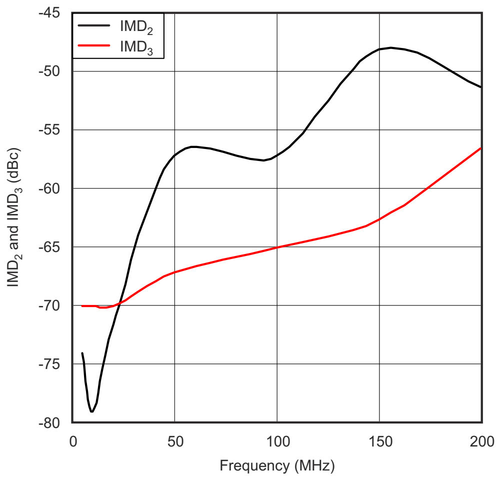
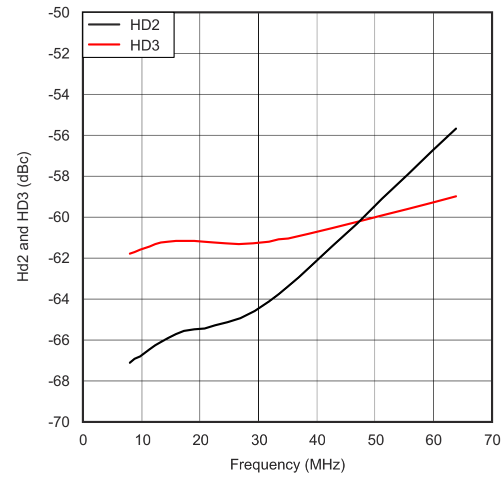



**图 6-6. Total Input Voltage Noise vs Frequency**




$V_{G+}$ = 1 V $V_O$ = 1 $V_{PP}$ (composite) $R_L$ = 400 Ω

**图 6-7. Intermodulation Distortion vs Frequency**




$V_{G+}$ = 1 V $V_O$ = 1 $V_{PP}$ $R_L$ = 400 Ω

**图 6-8. Harmonic Distortion vs Frequency**

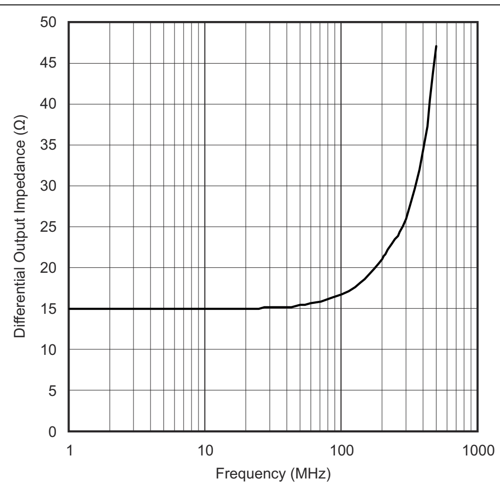



**图 6-9. Differential Output Impedance of Main Amplifier vs Frequency**

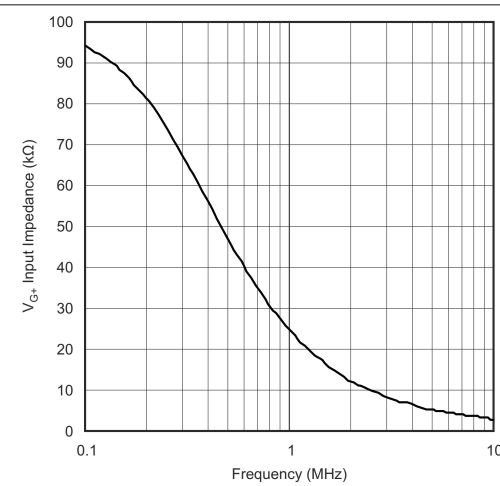



**图 6-10. $V_{G+}$ Input Impedance vs Frequency**

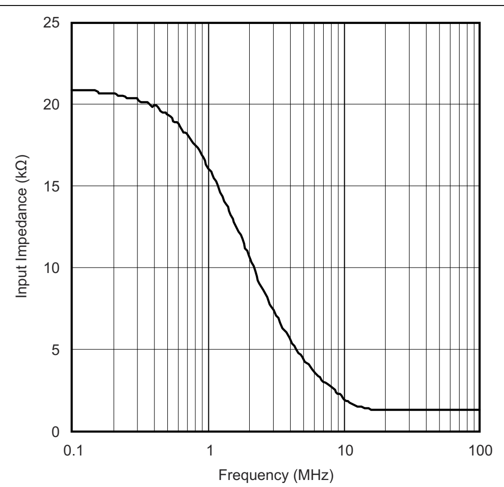



**图 6-11. $V_{OCM}$ Input Impedance vs Frequency**

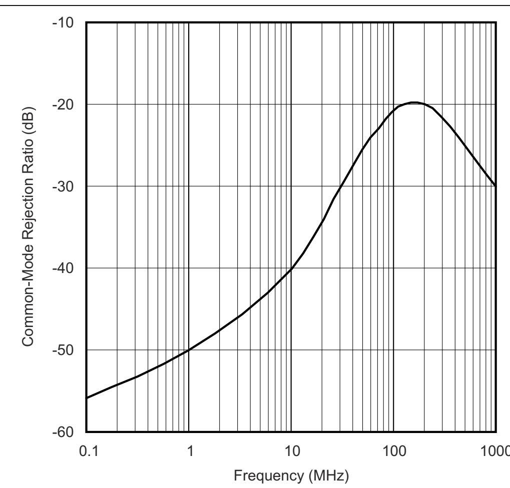
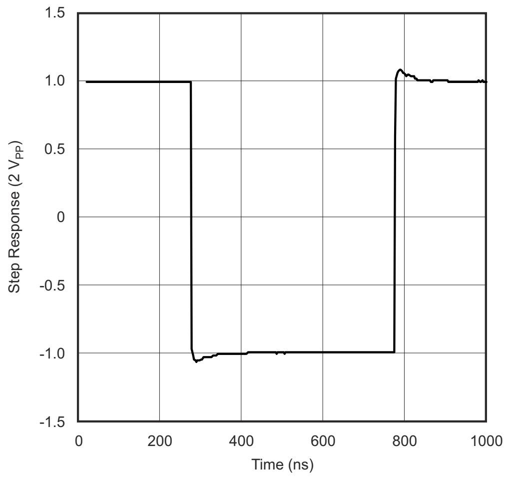
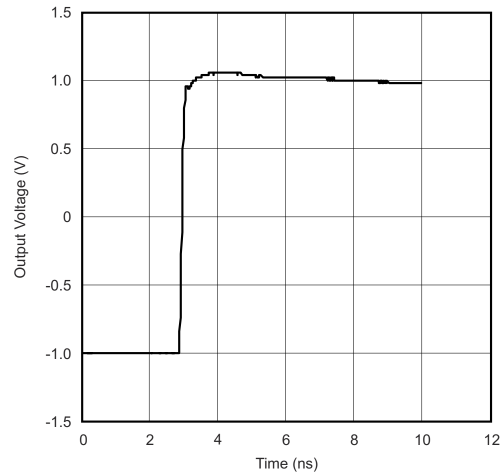



**图 6-12. Common-Mode Rejection Ratio vs Frequency**



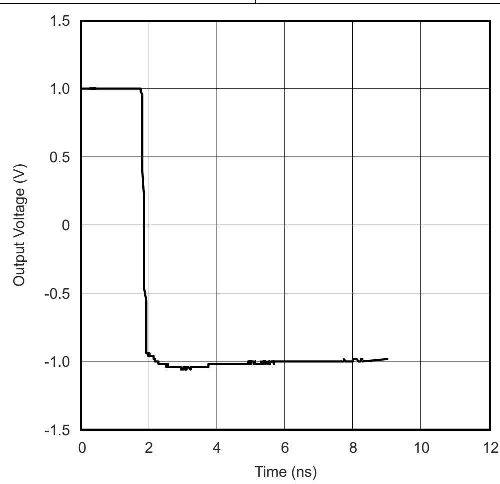

R$_L$ = 400 Ω At amplifier output and minimum gain

**图 6-13. Step Response**




R$_L$ = 400 Ω At amplifier output and minimum gain

**图 6-14. Step Response: Rising Edge**




R$_L$ = 400 Ω At amplifier output and minimum gain

**图 6-15. Step Response: Falling Edge**

# 7 Parameter Measurement Information

## 7.1 Test Circuits

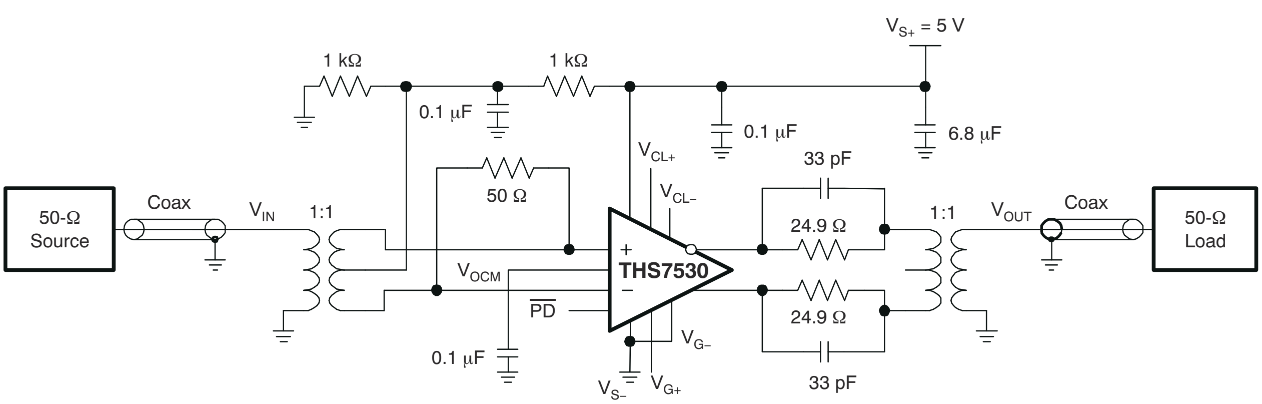



**图 7-1. AC Test Circuit**

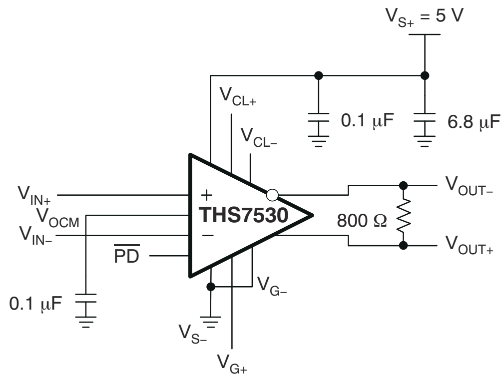



**图 7-2. DC Test Circuit**

# 8 Detailed Description

## 8.1 Overview

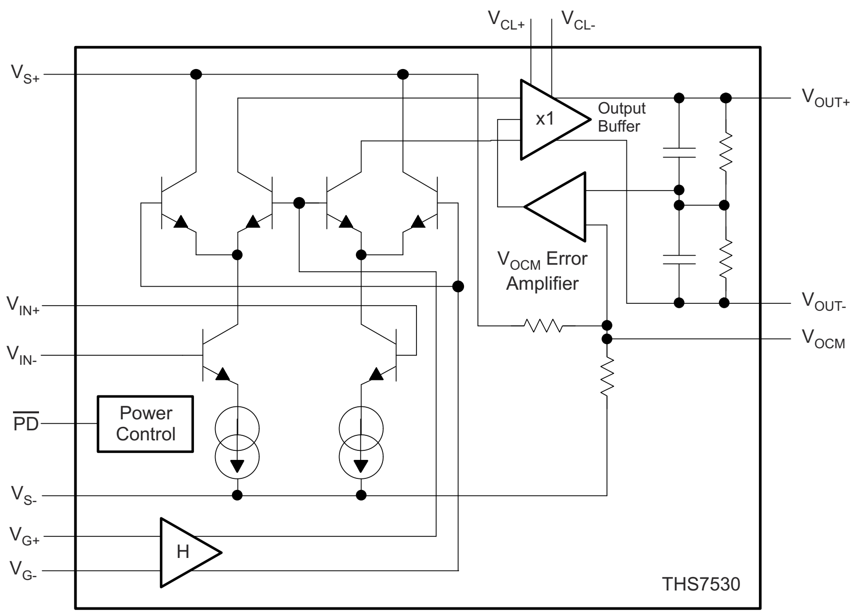
The THS7530 device is a fully-differential amplifier with 300-MHz bandwidth and with continually-variable gain from 11.6 dB to 46.5 dB. This amplifier together with an automatic gain control (AGC) circuit will precisely established a desired amplitude at its output.

The input architecture is a modified Gilbert cell. The output from the Gilbert cell is converted to a voltage and buffered to the output as a fully-differential signal. A summing node between the outputs is used to compare the output common-mode voltage to the $V_{OCM}$ input. The $V_{OCM}$ error amplifier then servos the output common-mode voltage to maintain it equal to the $V_{OCM}$ input. Left unterminated, $V_{OCM}$ is set to midsupply by internal resistors.

The gain control input is conditioned to give linear-in-dB gain control (block H). The gain control input is a differential signal from 0 V to 0.9 V which varies the gain from 11.6 dB to 46.5 dB.

$V_{CL+}$ and $V_{CL-}$ provide inputs that limit the output voltage swing of the amplifier.

## 8.2 Functional Block Diagram




## 8.3 Feature Description

The main features of the THS7530 device are continually-variable gain control, common-mode voltage control, output voltage clamps, and power-down mode.

### 8.3.1 Continually-Variable Gain Control

The amplifier gain in dB is a linear function of the gain control voltage, which has a range of 0 V to 0.9 V. The slope of the gain control input is 38.8 dB/V with a gain range of 11.6 dB to 46.5 dB, which is 3.8 to 211.3 V/V, respectively. The bandwidth of the gain control is 15 MHz, typically.

The gain control is a differential input to reduce noise due to ground bounce, coupling, and so forth. The negative gain-control input $V_{G-}$ can be below the negative supply by as much as 600 mV.

### 8.3.2 Common-Mode Voltage Control

The common-mode voltage control sets the common-mode voltage of the differential output. The gain of the control voltage is 1 V/V with a range of 1.75 V to 3.25 V above the negative supply. If unconnected, the common-mode voltage control is at mid-supply, typically 2.5 V above the negative supply. The bandwidth of the common-mode voltage control is an impressive 32 MHz.

#### 8.3.3 Output Voltage Clamps

Separate inputs, $V_{CL-}$ and $V_{CL+}$, establish the minimum and maximum output voltages, respectively. The typical error of the output voltage compared to the clamp voltage is only 25 mV. This feature can be used to avoid saturating the inputs of a receiving device, thereby precluding long recovery times in the signal path.

#### 8.3.4 Power-Down Mode

To minimize power consumption when idle, the THS7530 device has an active-low power-down control that reduces the quiescent current from 40 mA to 350 µA. The turnon delay is only 820 ns.

When in power-down mode, the THS7530 device has a 80-dB forward isolation to allow other devices to drive the same signal path with minimal interference from the idle THS7530 device.

### 8.4 Device Functional Modes

The THS7530 device has two functional modes: full-power mode and power-down mode. The power-down mode reduces the quiescent current of the device to 350 µA from a typical value of 40 mA.

With a turnon time of only 820 ns and a turnoff time of 500 ns, the power-down mode can be used to greatly reduce the average power consumption of the device without sacrificing system performance.

# 9 Application and Implementation

**备注**

以下应用部分的信息不属于 TI 组件规范，TI 不担保其准确性和完整性。客户应负责确定 TI 组件是否适用于其应用。客户应验证并测试其设计，以确保系统功能。

## 9.1 Application Information

The THS7530 device is designed to work in a wide variety of applications requiring continuously variable gain and a fully-differential signal path. The common-mode voltage control and the output voltage clamps enable the THS7530 device to drive a diverse array of receiving circuits.

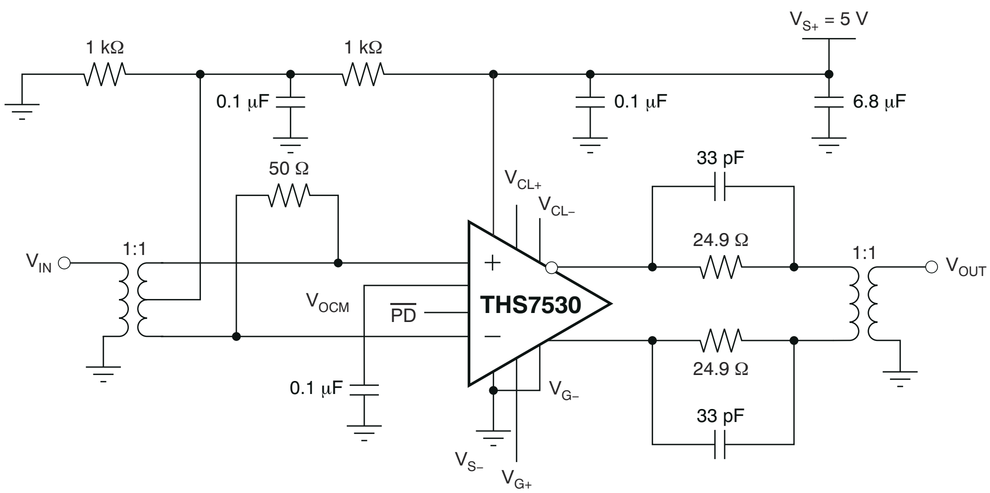



图 9-1. EVM Schematic: Designed for Use With Typical 50-Ω RF Test Equipment

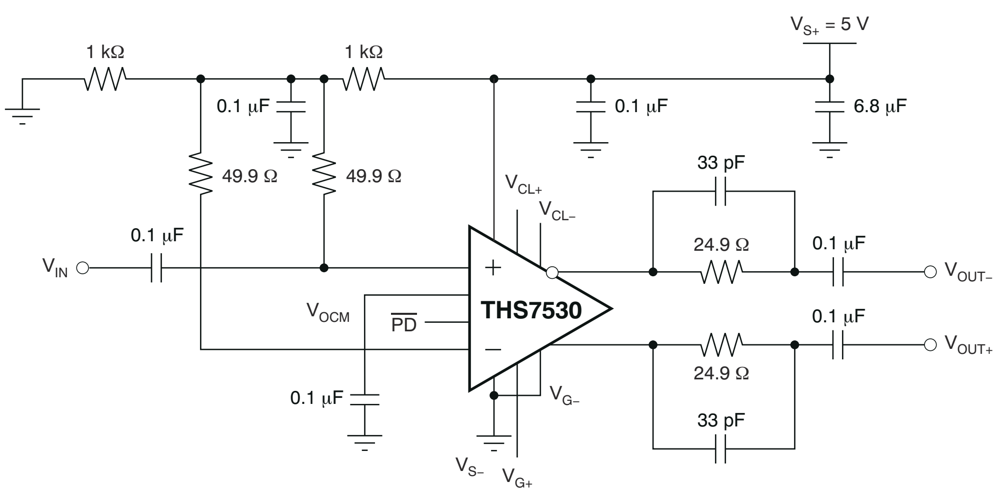



图 9-2. AC-Coupled Single-Ended Input With AC-Coupled Differential Output

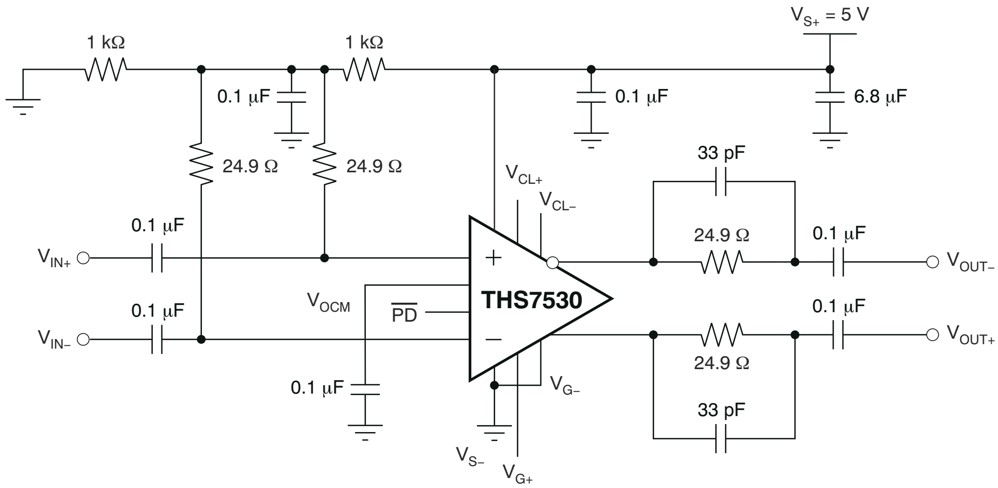



图 9-3. AC-Coupled Differential Input With AC-Coupled Differential Output

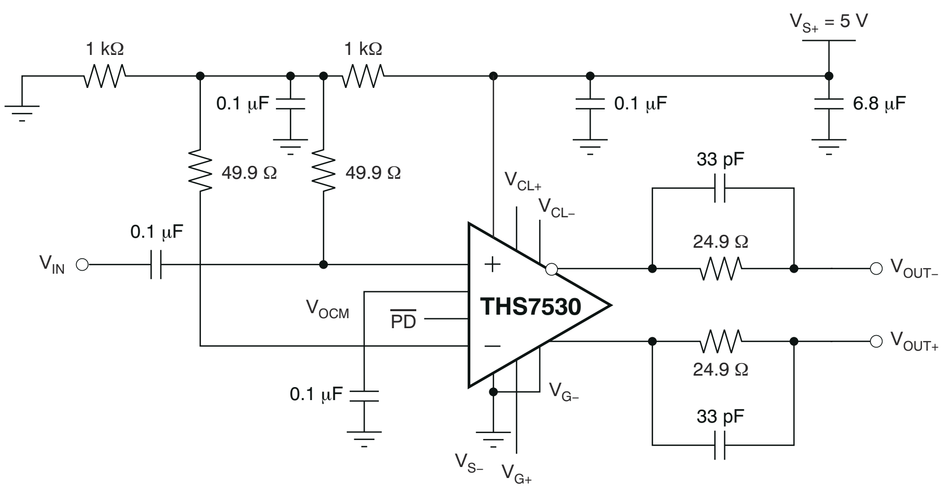



图 9-4. DC-Coupled Single-Ended Input With DC-Coupled Differential Output

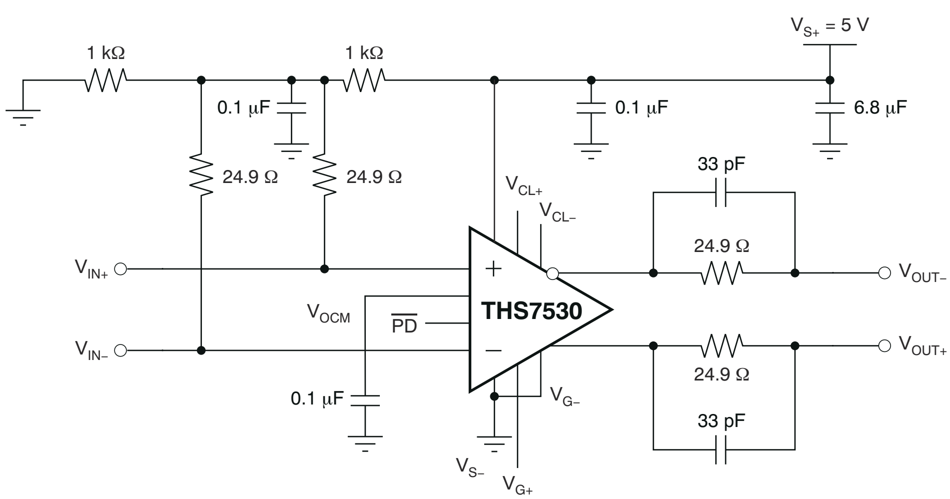



图 9-5. DC-Coupled Differential Input With DC-Coupled Differential Output

## 9.2 Typical Application

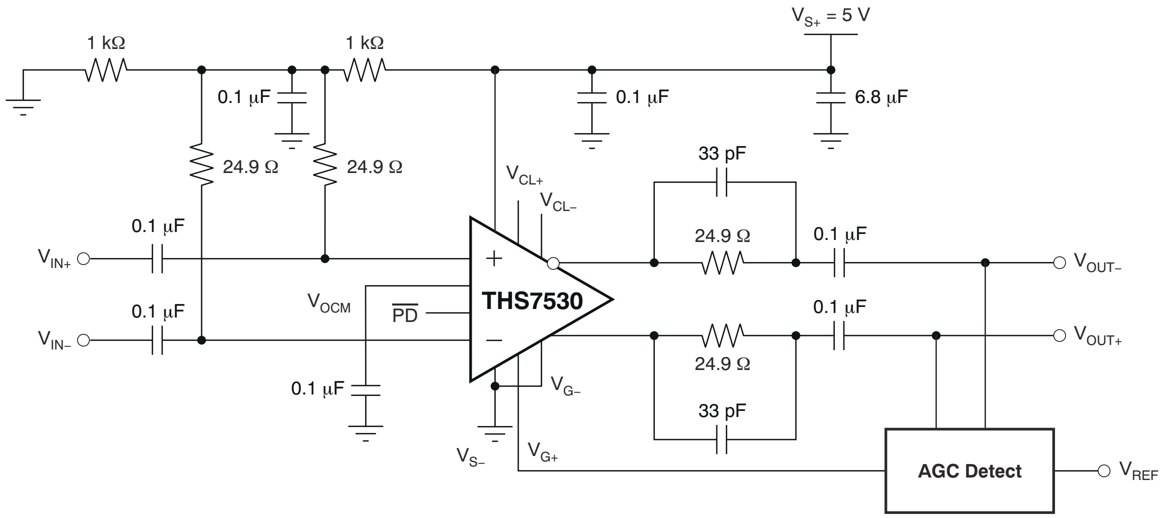



**图 9-6. Typical Application Circuit**

### 9.2.1 Design Requirements

A typical application circuit is shown in *图 9-6*. Two noteworthy aspects of this circuit are the customer' s automatic gain control (AGC) circuit and the THS7530 input bias circuit.

The proper design of the AGC circuit is essential for the THS7530 device to operate properly in the customer' s application. The method of detecting the amplitude of the differential output of the THS7530 device and creating the gain-control voltage, $V_{G+}$, from the detected amplitude and the reference amplitude, $V_{ref}$, are application-specific and beyond the scope of this document. The bandwidth of the amplitude of the THS7530 amplitude control is 15 MHz, which allows for rapid corrections of amplitude errors but which also allows noise from DC to 15 MHz to create an amplitude error. The trade-off between rapid amplitude correction and amplitude modulation due to noise is an important design consideration.

The input bias currents of the differential inputs of the THS7530 device are typically 20 µA. When the differential inputs are AC-coupled, the bias currents must be supplied as shown in *图 9-6*. In this circuit, the DC bias voltage is mid-supply and the AC differential input impedance is 50 Ω. The 0.1-µF capacitor between the two 24.9-Ω resistors creates an AC ground for the driving circuit.

### 9.2.2 Detailed Design Procedure

The THS7530 device is designed for nominal 5-V power supply from $V_{S+}$ to $V_{S-}$.

The amplifier has fully differential inputs, $V_{IN+}$ and $V_{IN-}$, and fully differential outputs, $V_{OUT+}$ and $V_{OUT-}$ The inputs are high impedance and outputs are low impedance. External resistors are recommended for impedance matching and termination purposes.

The inputs and outputs can be DC-coupled, but for best performance, the input and output common-mode voltage should be maintained at the midpoint between the two supply pins. The output common-mode voltage is controlled by the voltage applied to $V_{OCM}$. Left unterminated, $V_{OCM}$ is set to midsupply by internal resistors. A 0.1-µF bypass capacitor should be placed between $V_{OCM}$ and ground to reduce common-mode noise. The input common-mode voltage defaults to midrail when left unconnected. For voltages other than midrail, $V_{OCM}$must be biased by external means. $V_{IN+}$ and $V_{IN-}$ both require a nominal 30-µA bias current for proper operation. Therefore, ensure equal input impedance at each input to avoid generating an offset voltage that varies with gain.

Voltage applied from $V_{G-}$ to $V_{G+}$ controls the gain of the part with 38.8-dB/V gain slope. The input can be differential or single ended. $V_{G-}$ must be maintained within –0.6 V and 0.8 V of $V_{S-}$ for proper operation. The negative gain input should typically be tied directly to the negative power supply.

$V_{CL+}$ and $V_{CL-}$ are inputs that limit the output voltage swing of the amplifier. The voltages applied set an absolute limit on the voltages at the output. Input voltages at $V_{CL+}$ and $V_{CL-}$ clamp the output, ensuring that neither output exceeds those values.

The power-down input is a TTL compatible input, referenced to the negative supply voltage. A logic low puts the THS7530 device in power-saving mode. In power-down mode the part consumes less than 1-mA current, the output goes high impedance, and a high amount of isolation is maintained between the input and output.

Power-supply bypass capacitors are required for proper operation. A 6.8-μF tantalum bulk capacitor is recommended if the amplifier is located far from the power supply and may be shared among other devices. A ceramic 0.1-μF capacitor is recommended within 0.1-in of the device power pin. The ceramic capacitors should be located on the same layer as the amplifier to eliminate the use of vias between the capacitors and the power pin.

**表 9-1. THS7530EVM Bill of Materials**

| ITEM NO. | DESCRIPTION | SIZE | REFERENCE DESIGNATOR | QTY | PART NUMBER |
|---|---|---|---|---|---|
| 1 | Bead, ferrite, 3 A, 80 Ω | 1206 | FB1 | 1 | (Steward) HI1206N800R – 00 |
| 2 | Capacitor, tantalum, 6.8 mF, 35 V, 10% | D | C2 | 1 | (AVX) TAJD685K035R |
| 3 | Capacitor, ceramic, 0.1 mF, X7R, 16V | 508 | C1 | 1 | (AVX) 0508YC104KAT2A |
| 5 | Capacitor, ceramic, 0.1 mF, X7R, 50 V | 805 | C3, C7, C12, C13, C14, C15, C16, C17 | 8 | (AVX) 08055C104KAT2A |
| 6 | Diode, Schottky, 20 V, 0.5 A | SOD-123 | D1 | 1 | (Diodes Inc.) B0520LW – 7 |
| 7 | Resistor, 10 Ω, 1/8 W, 1% | 805 | R24, R25, R26 | 3 | (PHYCOMP) 9C08052A10R0FKHFT |
| 8 | Resistor, 24.9 Ω, 1/8 W, 1% | 805 | R9, R15 | 2 | (PHYCOMP) 9C08052A24R9FKHFT |
| 9 | Resistor, 1 kΩ, 1.8W, 1% | 805 | R7, R12 | 2 | (PHYCOMP) 9C08052A1001FKHFT |
| 10 | Resistor, 3.92 kΩ, 1/8 W, 1% | 805 | R1 | 1 | (PHYCOMP) 9C08052A3921FKHFT |
| 11 | Resistor, 0 Ω, 1/4 W | 1206 | C4, C5 | 2 | (PHYCOMP) 9C12063A0R00JLHFT |
| 12 | Resistor, 49.9 Ω, 1/4 W, 1% | 1206 | R4 | 1 | (PHYCOMP) 9C12063A49R9FKRFT |
| 13 | Pot., ceramic, 1/4 inch square, 1 kΩ | | R2 | 1 | (Bourns) 3362P – 1 – 102 |
| 14 | Pot., ceramic, 1/4 inch square, 10 kΩ | | R21, R22, R23 | 3 | (Bourns) 3362P – 1 – 103 |
| 15 | IC, TLV2371 | SOT-23 | U2, U3, U4 | 3 | (TI) TLV2371IDBVT |
| 16 | Transformer, 1:1 | CD542 | T1, T2 | 2 | (Mini-Circuits) ADT1-1WT |
| 17 | Connector, edge, SMA PCB Jack | | J3, J4 | 2 | (Johnson) 142 – 0701 – 801 |
| 18 | Jack, banana receptacle, 0.25-in diameter hole | | J1, J2 | 2 | (HH Smith) 101 |
| 19 | Header, 0.1-in Ctrs, 0.025-in square pins | 2 POS. | JP1 | 1 | (Sullins) PZC36SAAN |
| 20 | Shunts | | JP1 | 1 | (Sullins) SSC02SYAN |
| 21 | Test point, black | | TP2, TP3, TP4 | 3 | (Keystone) 5001 |
| 22 | Test points, red | | TP1, TP8, TP9, TP10 | 4 | (Keystone) 5000 |
| 23 | Standoff, 4 – 40 Hex, 0.625-in Length | | | 4 | (Keystone) 1804 |
| 24 | Screw, Phillips, 4 – 40, .250-in | | | 4 | SHR – 0440 – 016 – SN |
| 25 | IC, THS7530 | | U1 | 1 | (TI) THS7530PWP |
| 26 | Board, printed circuit | | | 1 | (TI) EDGE # 6441987 |

### 9.2.3 Application Curves

图 9-7 and 图 9-8 highlight the input characteristics of the THS7530 device that should be used to design the circuit driving the THS7530 device.

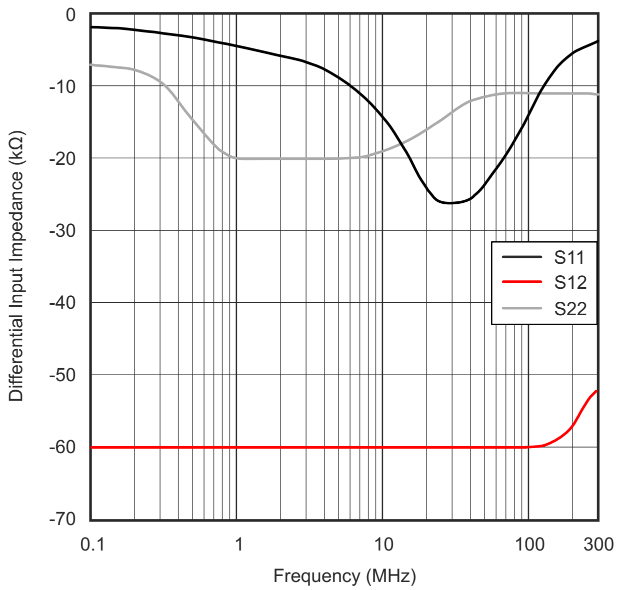



图 9-7. S-Parameters vs Frequency

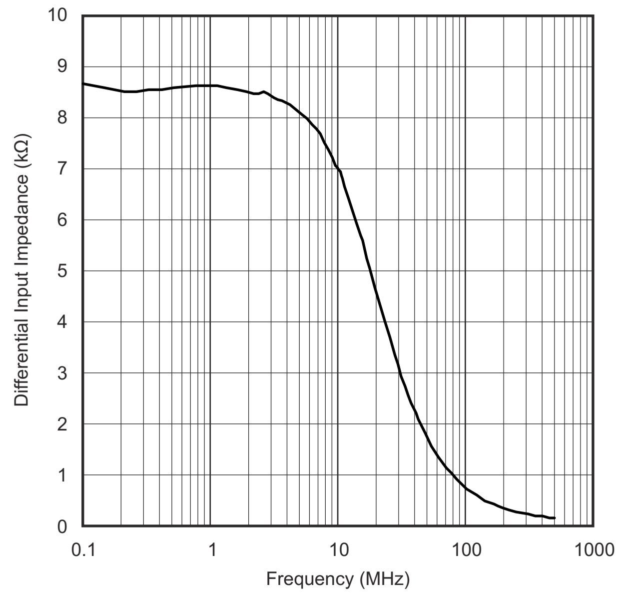



图 9-8. Differential Input Impedance of Main Amplifier vs Frequency

## 10 Power Supply Recommendations

The THS7530 device is principally intended to operate with a nominal single-supply voltage of 5 V. Supply voltage tolerances of ±10% are supported. The absolute maximum supply is 5.5 V.

Supply decoupling is required, as described in 节 9.

Split (or bipolar) supplies can be used with the THS7530 device, as long as the total value across the device remains less than 5.5 V (absolute maximum).

# 11 Layout

## 11.1 Layout Guidelines

The THS7530 device is available in a thermally-enhanced PowerPAD™ package. 图 11-1 shows the recommended number of vias and thermal land size recommended for best performance. Thermal vias connect the thermal land to internal or external copper planes and should have a drill diameter sufficiently small so that the via hole is effectively plugged when the barrel of the via is plated with copper. This plug is needed to prevent wicking the solder away from the interface between the package body and the thermal land on the surface of the board during solder reflow. The experiments conducted jointly with Solectron Texas indicate that a via drill diameter of 0.33 mm (13 mils, or .013 in) or smaller works well when 1-ounce copper is plated at the surface of the board and simultaneously plating the barrel of the via. If the thermal vias are not plugged when the copper plating is performed, then a solder mask material should be used to cap the vias with a dimension equal to the via diameter + 0.1 mm minimum. This prevents the solder from being wicked through the thermal via and potentially creating a solder void in the region between the package bottom and the thermal land on the surface of the PCB.

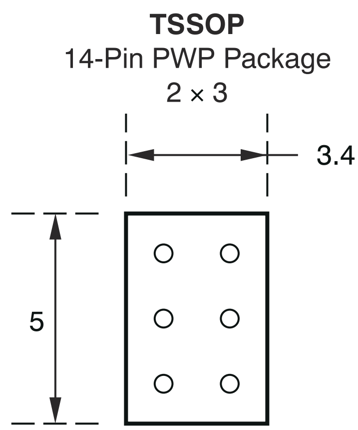



**图 11-1. Recommended Thermal Land Size and Thermal Via Patterns (Dimensions in mm)**

See TI's Technical Brief titled, *PowerPAD™ Thermally Enhanced Package* (SLMA002) for a detailed discussion of the PowerPAD™ package, its dimensions, and recommended use.

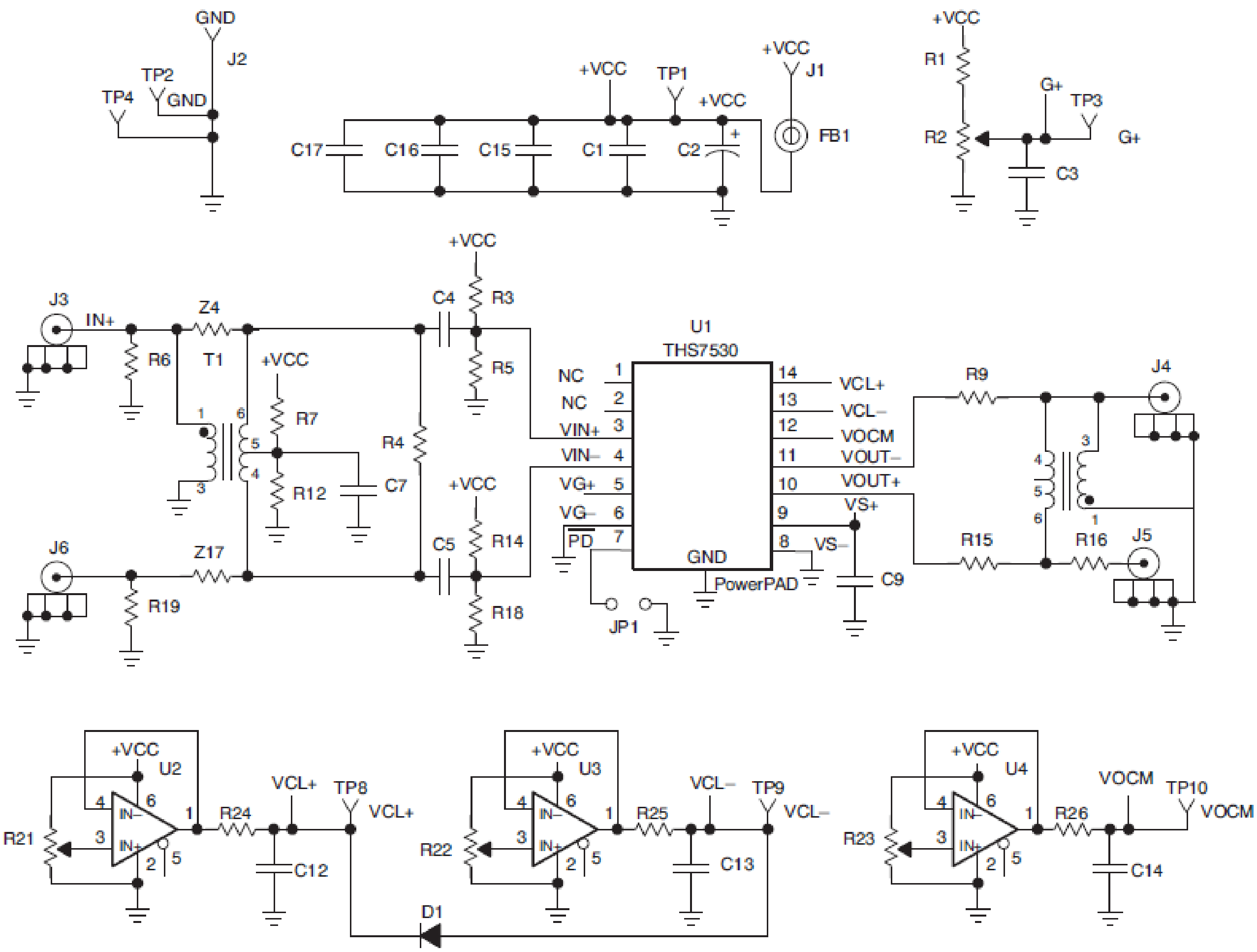



图 11-2. EVM Schematic

## 11.2 Layout Examples

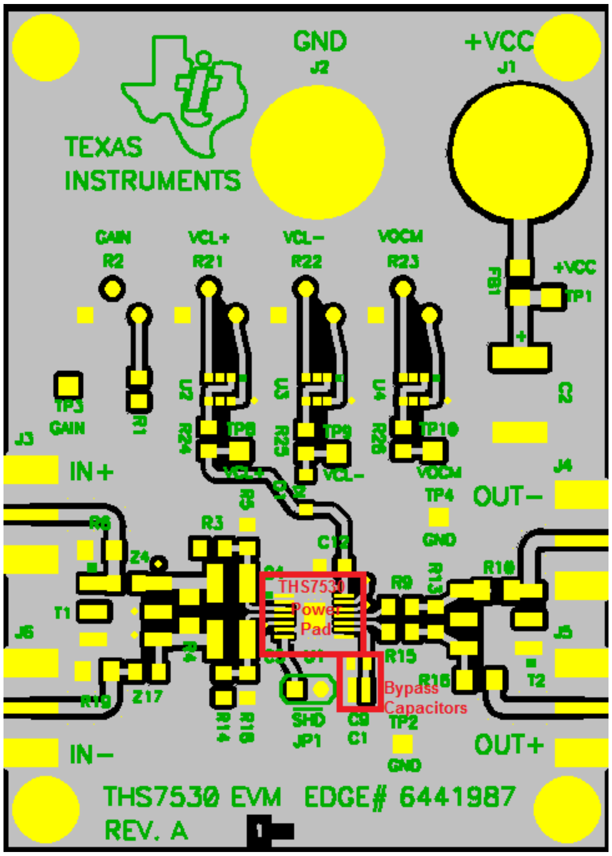



图 11-3. Layout Diagram (Top)

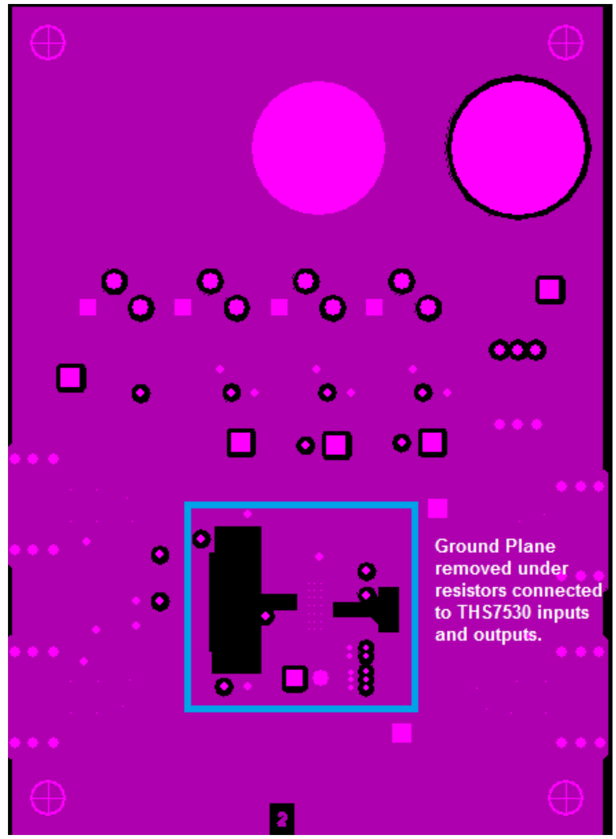



图 11-4. Layout Diagram (Ground)

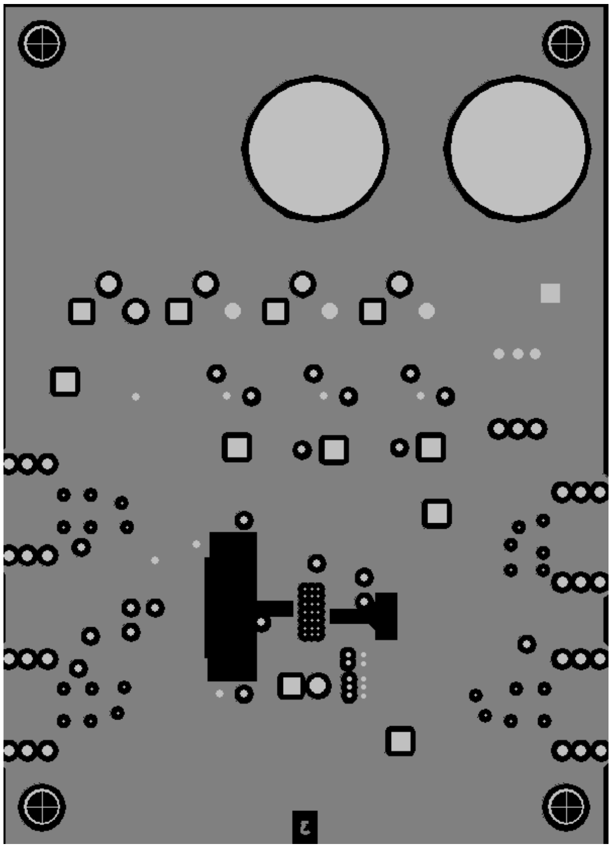


图 11-5. Layout Diagram (Power)

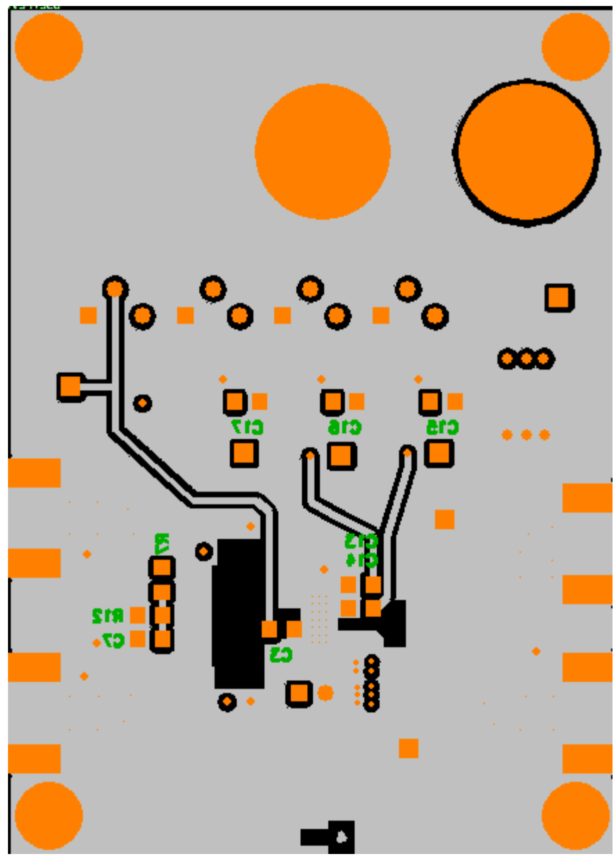


图 11-6. Layout Diagram (Bottom)

# 12 Device and Documentation Support

## 12.1 Device Support

### 12.1.1 第三方产品免责声明

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### 12.1.2 Development Support

For the THS7530 PSpice Model, see SLOJ139.

For the THS7530 TINA-TI Spice Model, see SLAM020.

For the THS7530 TINA-TI Reference Design, see SLAC091.

## 12.2 Documentation Support

### 12.2.1 Related Documentation

For related documentation, see the following:

- *THS7530 EVM Users Guide*, SLOU161
- *Noise Analysis for High-Speed Op Amps*, SBOA066
- *TI's Analog Signal Chain Guide*, SLYB174
- *PowerPAD™ Thermally Enhanced Package*, SLMA002
- *PowerPAD™ Made Easy*, SLMA004

## 12.3 支持资源

TI E2E™ 中文支持论坛是工程师的重要参考资料，可直接从专家处获得快速、经过验证的解答和设计帮助。搜索现有解答或提出自己的问题，获得所需的快速设计帮助。

链接的内容由各个贡献者“按原样”提供。这些内容并不构成 TI 技术规范，并且不一定反映 TI 的观点；请参阅 TI 的使用条款。

## 12.4 Trademarks

PowerPAD™ is a trademark of Texas Instruments.
TI E2E™ is a trademark of Texas Instruments.
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## 12.5 静电放电警告

静电放电 (ESD) 会损坏这个集成电路。德州仪器 (TI) 建议通过适当的预防措施处理所有集成电路。如果不遵守正确的处理和安装程序，可能会损坏集成电路。

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。

## 12.6 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。 |

# 13 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.

## 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| THS7530PWP | ACTIVE | HTSSOP | PWP | 14 | 90 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 85 | THS7530 | Samples |
| THS7530PWPR | ACTIVE | HTSSOP | PWP | 14 | 2000 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 85 | THS7530 | Samples |

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

[(2)] **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.

**Important Information and Disclaimer:**The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

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

**OTHER QUALIFIED VERSIONS OF THS7530 :**

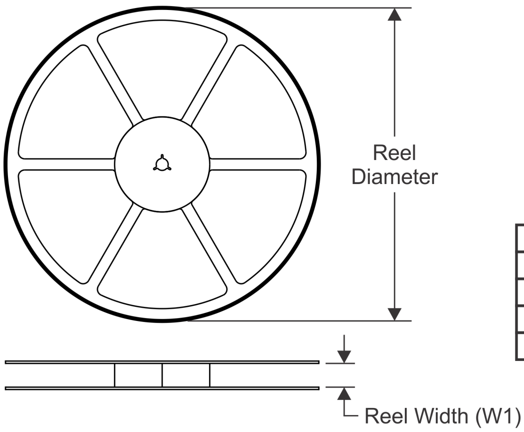
- Automotive : THS7530-Q1

NOTE: Qualified Version Definitions:

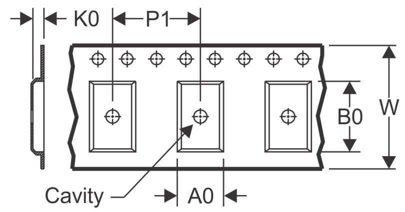
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

# TAPE AND REEL INFORMATION

**REEL DIMENSIONS**

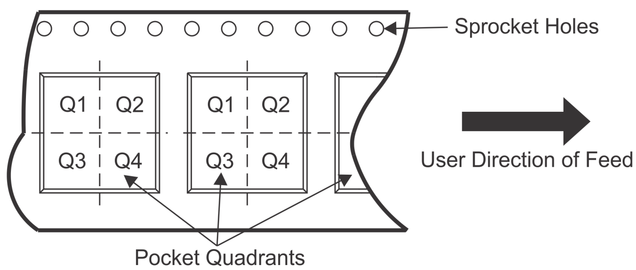



**TAPE DIMENSIONS**




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

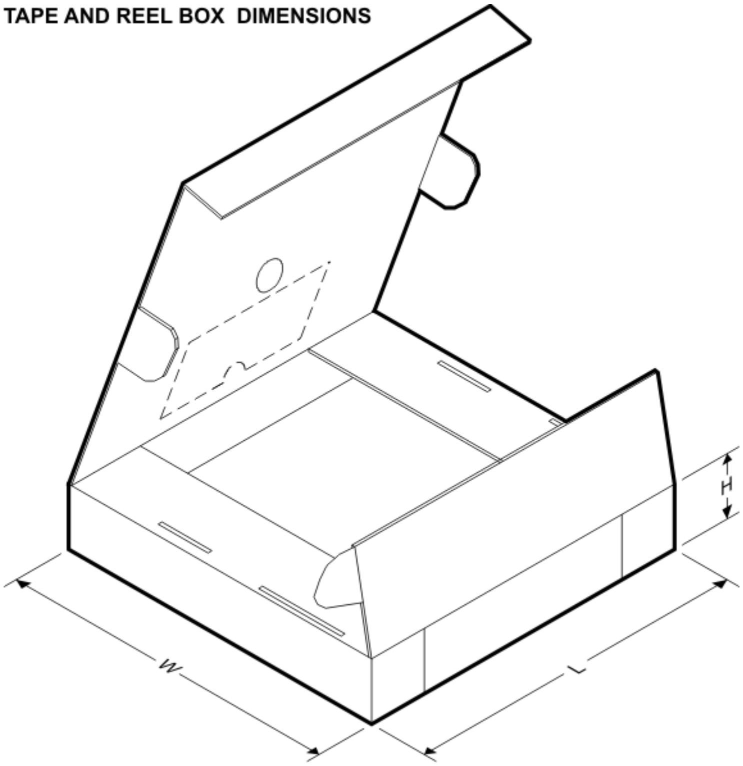
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**




*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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| THS7530PWPR | HTSSOP | PWP | 14 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |

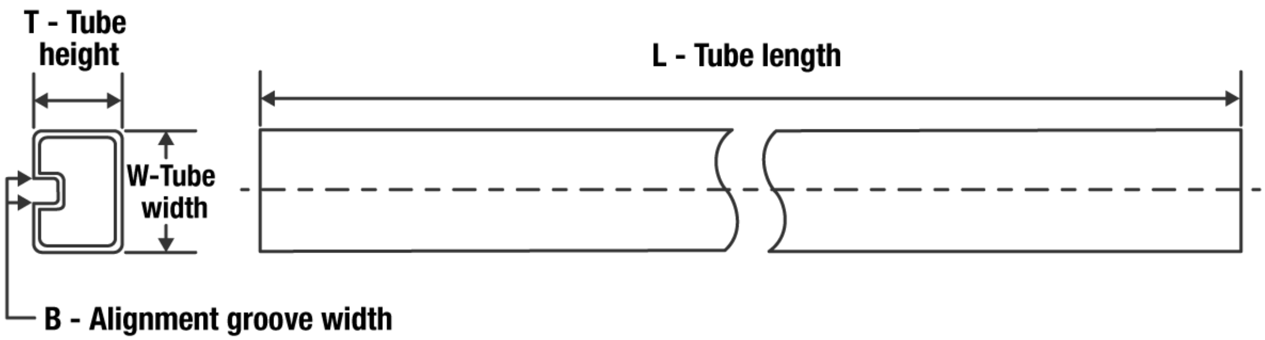
TAPE AND REEL BOX DIMENSIONS




*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| THS7530PWPR | HTSSOP | PWP | 14 | 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) |
|---|---|---|---|---|---|---|---|---|
| THS7530PWP | PWP | HTSSOP | 14 | 90 | 530 | 10.2 | 3600 | 3.5 |

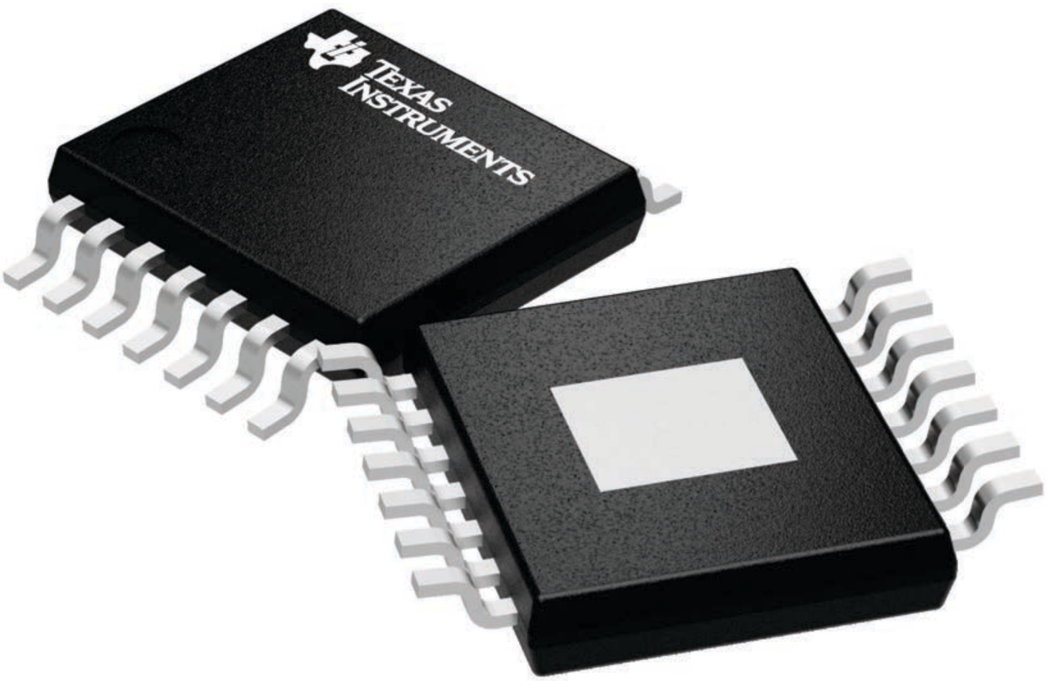
# PWP 14

**PowerPAD TSSOP - 1.2 mm max height**

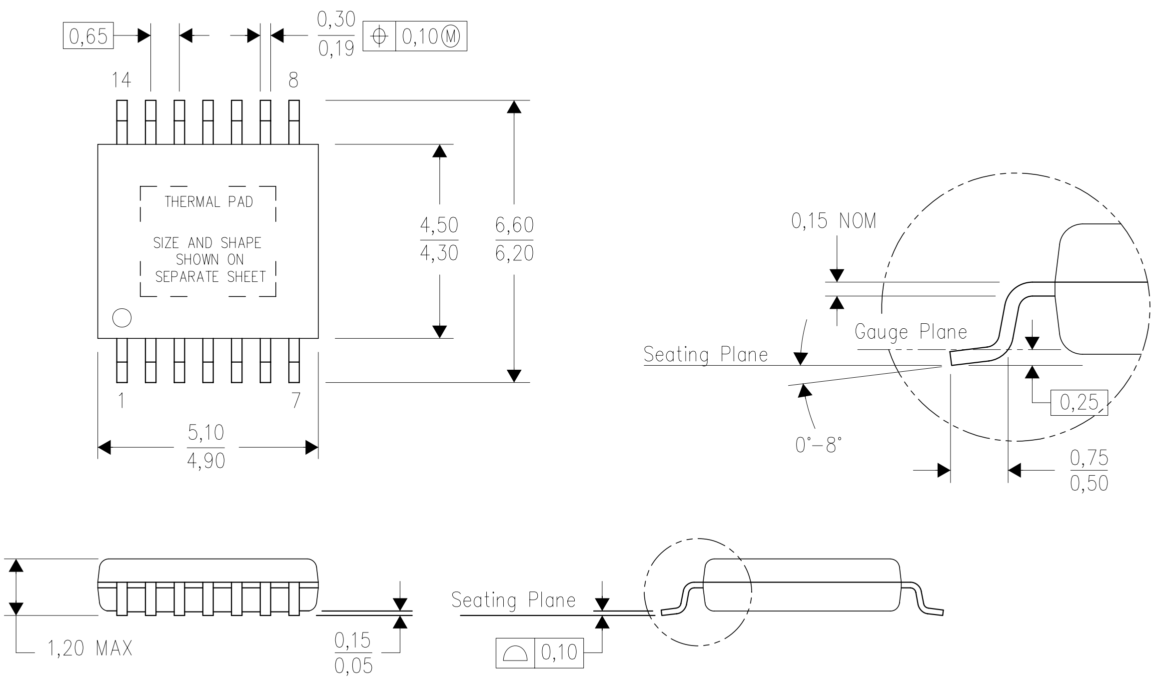
**4.4 x 5.0, 0.65 mm pitch**

PLASTIC SMALL OUTLINE

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



PWP (R-PDSO-G14) PowerPAD™ PLASTIC SMALL OUTLINE




4073225-2/I 05/11

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusions. Mold flash and protrusion shall not exceed 0.15 per side.
D. This package is designed to be soldered to a thermal pad on the board. Refer to Technical Brief, PowerPad Thermally Enhanced Package, Texas Instruments Literature No. SLMA002 for information regarding recommended board layout. This document is available at www.ti.com <http: //www.ti.com>.
E. See the additional figure in the Product Data Sheet for details regarding the exposed thermal pad features and dimensions.
E. Falls within JEDEC MO-153

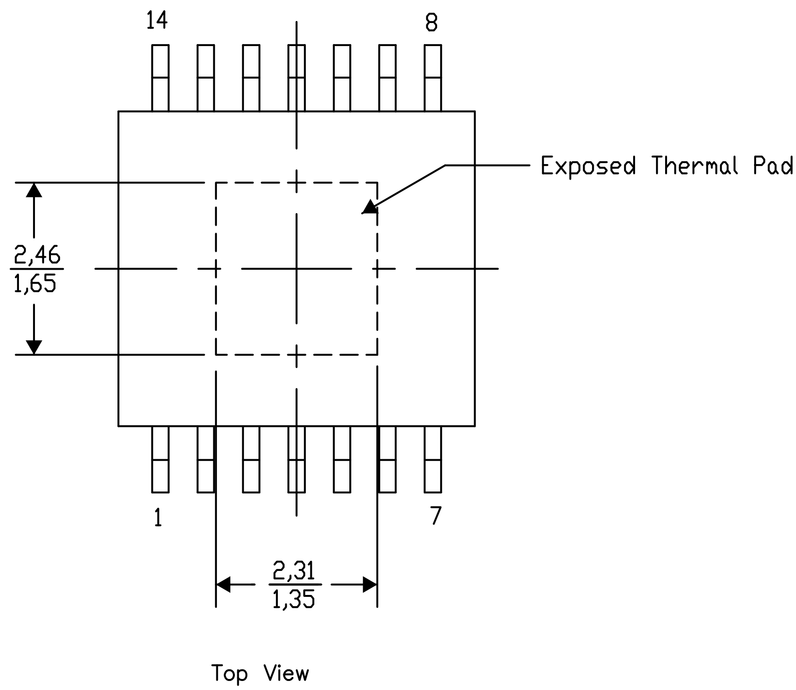
PWP (R-PDSO-G14) PowerPAD™ SMALL PLASTIC OUTLINE

THERMAL INFORMATION

This PowerPAD™ package incorporates an exposed thermal pad that is designed to be attached to a printed circuit board (PCB). The thermal pad must be soldered directly to the PCB. After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

For additional information on the PowerPAD package and how to take advantage of its heat dissipating abilities, refer to Technical Brief, PowerPAD Thermally Enhanced Package, Texas Instruments Literature No. SLMA002 and Application Brief, PowerPAD Made Easy, Texas Instruments Literature No. SLMA004. Both documents are available at www.ti.com.

The exposed thermal pad dimensions for this package are shown in the following illustration.



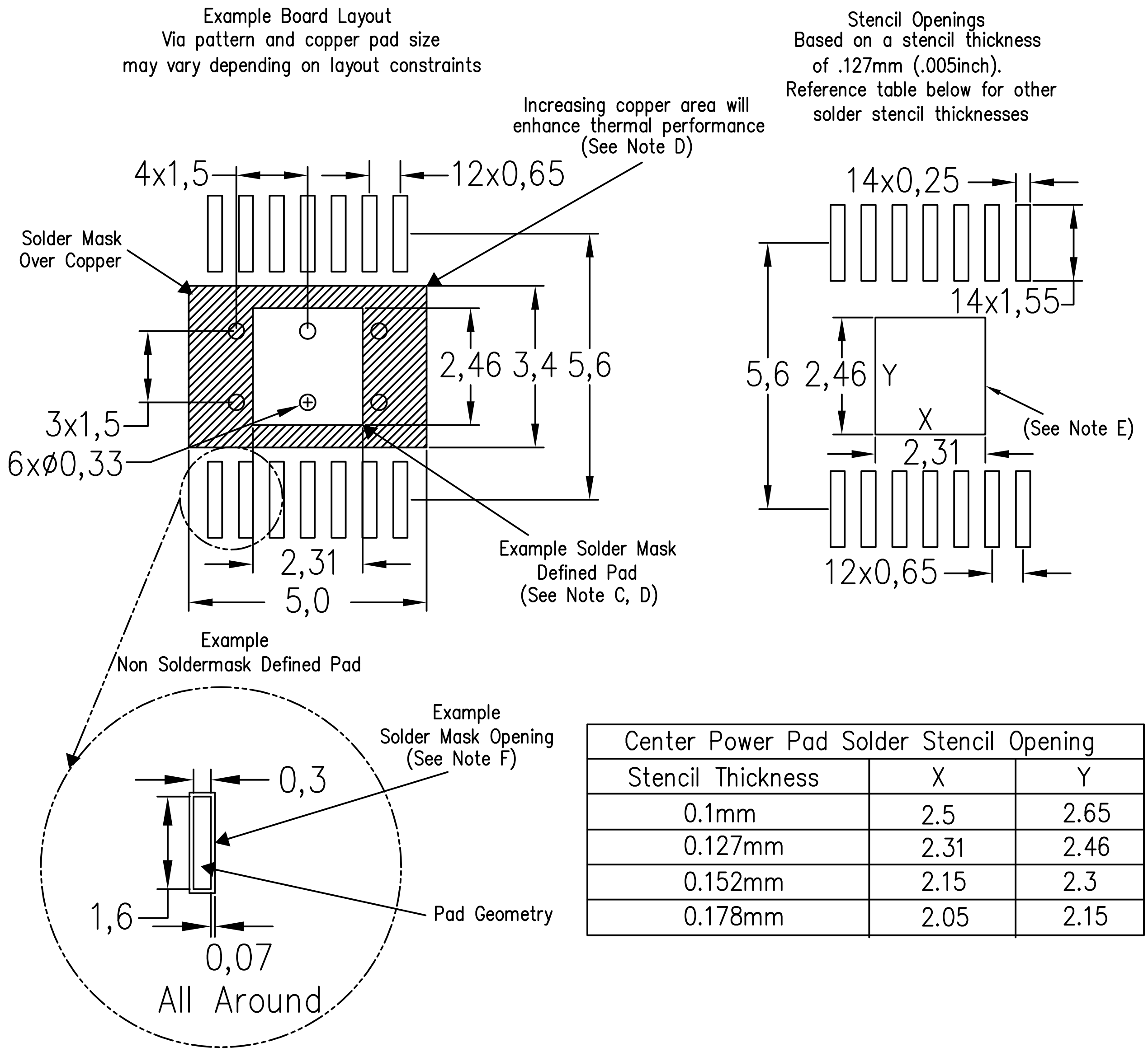

Exposed Thermal Pad Dimensions

4206332-2/AO 01/16

NOTE: A. All linear dimensions are in millimeters

PowerPAD is a trademark of Texas Instruments

PWP (R-PDSO-G14) PowerPAD™ PLASTIC SMALL OUTLINE

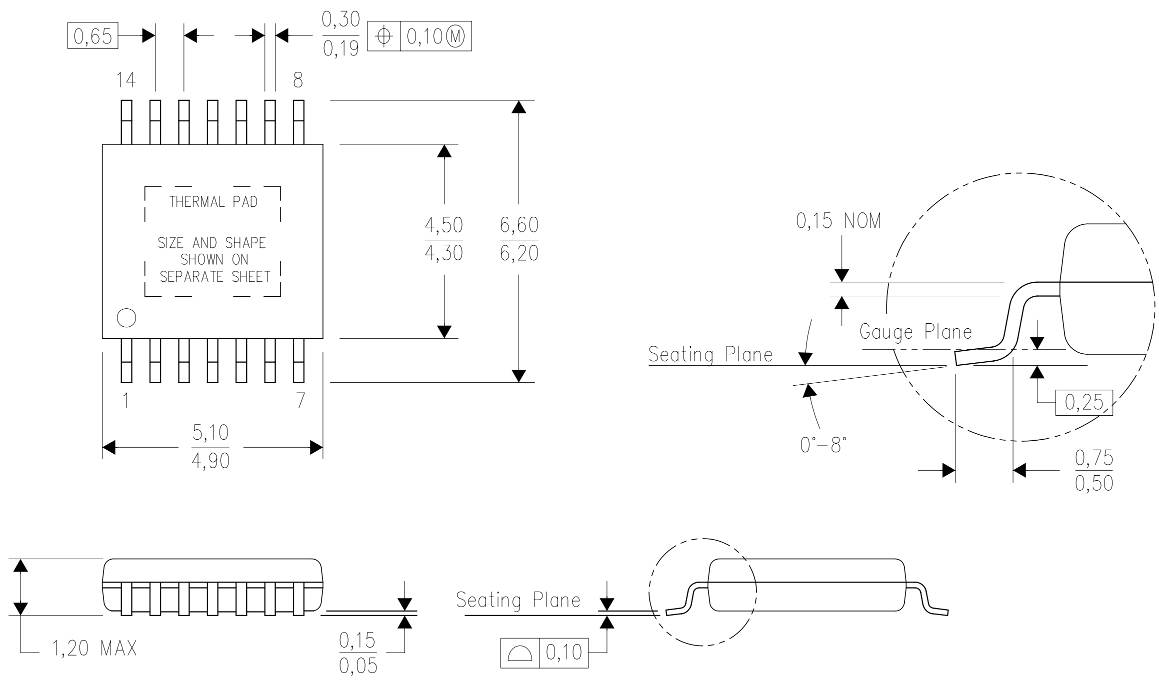



| Center Power Pad Solder Stencil Opening | | |
|---|---|---|
| Stencil Thickness | X | Y |
| 0.1mm | 2.5 | 2.65 |
| 0.127mm | 2.31 | 2.46 |
| 0.152mm | 2.15 | 2.3 |
| 0.178mm | 2.05 | 2.15 |

4207609-2/W 09/15

NOTES:
- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
- D. This package is designed to be soldered to a thermal pad on the board. Refer to Technical Brief, PowerPad Thermally Enhanced Package, Texas Instruments Literature No. SLMA002, SLMA004, and also the Product Data Sheets for specific thermal information, via requirements, and recommended board layout. These documents are available at www.ti.com <http://www.ti.com>. Publication IPC-7351 is recommended for alternate designs.
- E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC-7525 for other stencil recommendations.
- F. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

PWP (R-PDSO-G14) PowerPAD™ PLASTIC SMALL OUTLINE




4073225-2/I 05/11

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusions. Mold flash and protrusion shall not exceed 0.15 per side.
D. This package is designed to be soldered to a thermal pad on the board. Refer to Technical Brief, PowerPad Thermally Enhanced Package, Texas Instruments Literature No. SLMA002 for information regarding recommended board layout. This document is available at www.ti.com <http: //www.ti.com>.
E. See the additional figure in the Product Data Sheet for details regarding the exposed thermal pad features and dimensions.
E. Falls within JEDEC MO-153

PWP (R-PDSO-G14) PowerPAD™ SMALL PLASTIC OUTLINE

THERMAL INFORMATION

This PowerPAD™ package incorporates an exposed thermal pad that is designed to be attached to a printed circuit board (PCB). The thermal pad must be soldered directly to the PCB. After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

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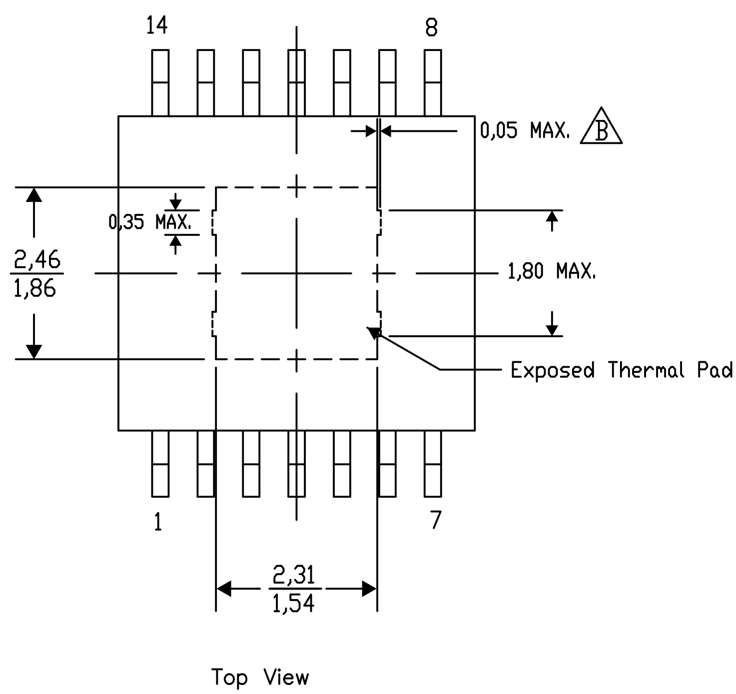
The exposed thermal pad dimensions for this package are shown in the following illustration.




Exposed Thermal Pad Dimensions

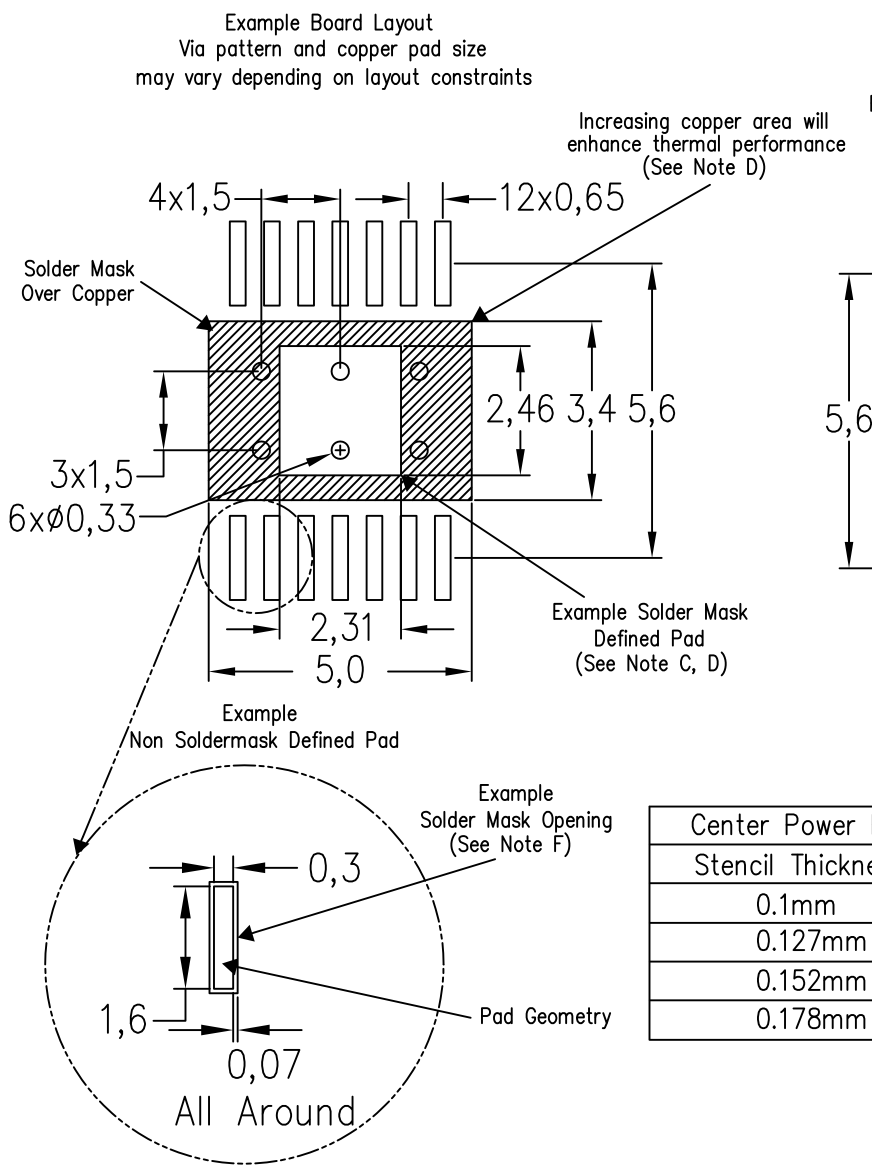
4206332-44/A0 01/16

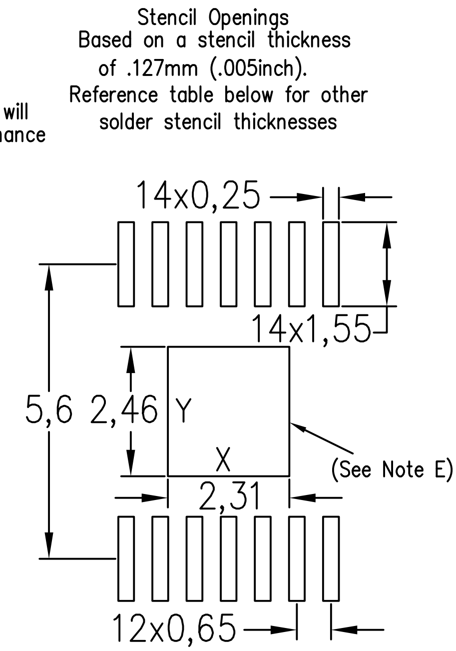
NOTE: A. All linear dimensions are in millimeters

B. Exposed tie strap features may not be present.

PowerPAD is a trademark of Texas Instruments

## PWP (R–PDSO–G14) PowerPAD™ PLASTIC SMALL OUTLINE




| Center Power Pad Solder Stencil Opening | | |
|---|---|---|
| Stencil Thickness | X | Y |
| 0.1mm | 2.5 | 2.65 |
| 0.127mm | 2.31 | 2.46 |
| 0.152mm | 2.15 | 2.3 |
| 0.178mm | 2.05 | 2.15 |

4207609–2/W 09/15

NOTES:
- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
- D. This package is designed to be soldered to a thermal pad on the board. Refer to Technical Brief, PowerPad Thermally Enhanced Package, Texas Instruments Literature No. SLMA002, SLMA004, and also the Product Data Sheets for specific thermal information, via requirements, and recommended board layout. These documents are available at www.ti.com <http://www.ti.com>. Publication IPC–7351 is recommended for alternate designs.
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- F. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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