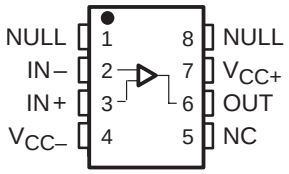
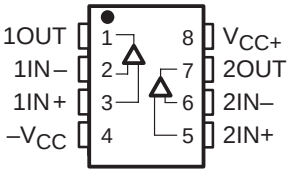
- **High Speed**
  - **180 MHz Bandwidth (G = 1, –3 dB)**
  - **400 V/μs Slew Rate**
  - **40-ns Settling Time (0.1%)**
- **High Output Drive, I_O = 115 mA (typ)**
- **Excellent Video Performance**
  - **75 MHz 0.1 dB Bandwidth (G = 1)**
  - **0.02% Differential Gain**
  - **0.02° Differential Phase**
- **Very Low Distortion**
  - **THD = –72 dBc at f = 1 MHz**
- **Wide Range of Power Supplies**
  - **V_{CC} = ±5 V to ±15 V**
- **Available in Standard SOIC or MSOP PowerPAD™ Package**
- **Evaluation Module Available**

THS4061
D AND DGN† PACKAGE
(TOP VIEW)



NC – No internal connection

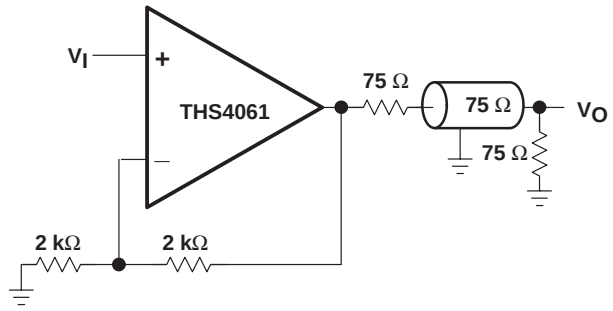
THS4062
D AND DGN PACKAGE
(TOP VIEW)



† This product is in the product preview stage of development. For information on availability, contact the local TI sales office.

description

The THS4061 and THS4062 are general-purpose, single/dual, high-speed voltage feedback amplifiers ideal for a wide range of applications including video, communication, and imaging. The devices offer very good ac performance with 180-MHz bandwidth, 400-V/μs slew rate, and 40-ns settling time (0.1%). The THS4061/2 are stable at all gains for both inverting and noninverting configurations. These amplifiers have a high output drive capability of 115 mA and draw only 7.8 mA supply current per channel. Excellent professional video results can be obtained with the low differential gain/phase errors of 0.02%/0.02° and wide 0.1 db flatness to 75 MHz. For applications requiring low distortion, the THS4061/2 is ideally suited with total harmonic distortion of –72 dBc at f = 1 MHz.



LINE DRIVER (G = 2)

HIGH-SPEED AMPLIFIER FAMILY

DEVICE	ARCH.		SUPPLY VOLTAGE			BW (MHz)	SR (V/μs)	THD f = 1 MHz (dB)	t_S 0.1% (ns)	DIFF. GAIN	DIFF. PHASE	V_n (nV/√Hz)
	VFB	CFB	5 V	±5 V	±15 V							
THS3001		•		•	•	420	6500	–96	40	0.01%	0.02°	1.6
THS4001	•		•	•	•	270	400	–72	40	0.04%	0.15°	12.5
THS4031/32	•			•	•	100	100	–72	60	0.02%	0.03°	1.6
THS4061/62	•			•	•	180	400	–72	40	0.02%	0.02°	14.5

AVAILABLE OPTIONS

T_A	NUMBER OF CHANNELS	PACKAGED DEVICES		MSOP SYMBOL	EVALUATION MODULES
		PLASTIC SMALL OUTLINE† (D)	PLASTIC MSOP† (DGN)		
0°C to 70°C	1	THS4061CD	THS4061CDGN‡	TIABS	THS4061EVM
	2	THS4062CD	THS4062CDGN	TIABM	THS4062EVM
–40°C to 85°C	1	THS4061ID	THS4061IDGN‡	TIABT	—
	2	THS4062ID	THS4062IDGN	TIABN	—

† The D and DGN packages are available taped and reeled. Add an R suffix to the device type (i.e., THS4061CDGNR).
‡ This product is in the product preview stage of development. For information on availability, contact the local TI sales office.

functional block diagram

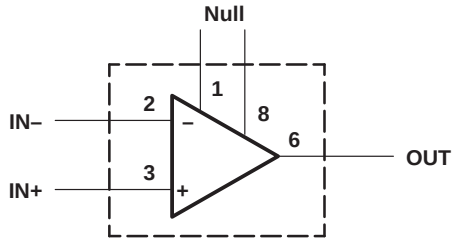


Figure 1. THS4061 – Single Channel

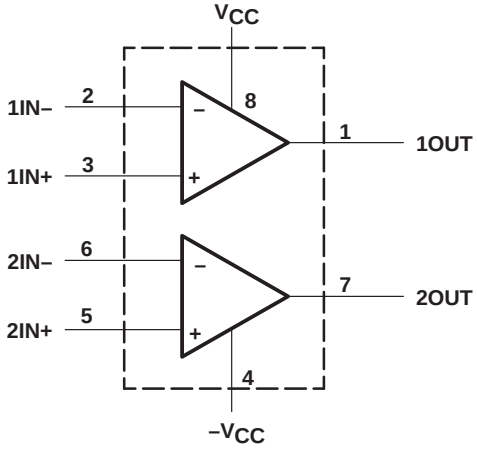


Figure 2. THS4062 – Dual Channel

CAUTION: The THS4061 and THS4062 provide ESD protection circuitry. However, permanent damage can still occur if this device is subjected to high-energy electrostatic discharges. Proper ESD precautions are recommended to avoid any performance degradation or loss of functionality

absolute maximum ratings over operating free-air temperature (unless otherwise noted)†

Supply voltage, $V_{CC}+$ to $V_{CC}-$ . . . . . 33 V
Input voltage, V_I . . . . . $\pm V_{CC}$
Output current, I_O . . . . . 150 mA
Differential input voltage, V_{IO} . . . . . ±4 V
Continuous total power dissipation . . . . . See Dissipation Rating Table
Maximum junction temperature, T_J . . . . . 150°C
Operating free-air temperature, T_A: C-suffix . . . . . 0°C to 70°C
I-suffix . . . . . –40°C to 85°C
Storage temperature, T_{stg} . . . . . –65°C to 150°C
Lead temperature, 1,6 mm (1/16 inch) from case for 10 seconds . . . . . 300°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

DISSIPATION RATING TABLE

PACKAGE	$T_A \le 25°C$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25°C$	$T_A = 70°C$ POWER RATING	$T_A = 85°C$ POWER RATING
D	740 mW	6 mW/°C	475 mW	385 mW
DGN‡	2.14 W	17.1 mW/°C	1.37 W	1.11 W

‡ The DGN package incorporates a PowerPAD on the underside of the device. This acts as a heatsink and must be connected to a thermal dissipation plane for proper power dissipation. Failure to do so can result in exceeding the maximum specified junction temperature, which could permanently damage the device.

recommended operating conditions

		MIN	NOM	MAX	UNIT
Supply voltage, $V_{CC}+$ and $V_{CC}-$	Dual supply	±4.5		±16	V
	Single supply	9		32	
Operating free-air temperature, T_A	C-suffix	0		70	°C
	I-suffix	–40		85	

electrical characteristics at T_A = 25°C, V_{CC} = ±15 V, R_L = 150 Ω (unless otherwise noted)

PARAMETER		TEST CONDITIONS†		MIN	TYP	MAX	UNIT
V_{CC}	Supply voltage operating range	Dual supply		±4.5		±16.5	V
		Single supply		9		33	
I_{CC}	Quiescent current (per amplifier)	V_{CC} = ±15 V	T_A = full range		7.8	10.5	mA
		V_{CC} = ±5 V			7.3	10	
V_O	Output voltage swing	V_{CC} = ±15 V	R_L = 250 Ω	±11.5	±12.5		V
		V_{CC} = ±5 V	R_L = 150 Ω	±3.2	±3.5		
		V_{CC} = ±15 V	R_L = 1 kΩ	±13	±13.5		V
		V_{CC} = ±5 V		±3.5	±3.7		
I_O	Output current	V_{CC} = ±15 V	R_L = 20 Ω	80	115		mA
		V_{CC} = ±5 V		50	75		
I_{SC}	Short-circuit current	V_{CC} = ±15 V			150		mA
BW	Dynamic performance small-signal bandwidth (–3 dB)	V_{CC} = ±15 V	Gain = 1		180		MHz
		V_{CC} = ±5 V			180		
		V_{CC} = ±15 V	Gain = –1		50		MHz
		V_{CC} = ±5 V			50		
	Bandwidth for 0.1 dB flatness	V_{CC} = ±15 V	Gain = 1		75		MHz
		V_{CC} = ±5 V			20		
V_{OS}	Input offset voltage	V_{CC} = ±5 V or ±15 V	T_A = full range		2.5	8	mV
	Offset drift	V_{CC} = ±5 V or ±15 V			15		µV/°C
I_{IB}	Input bias current	V_{CC} = ±5 V or ±15 V	T_A = full range		3	6	µA
I_{OS}	Input offset current	V_{CC} = ±5 V or ±15 V	T_A = full range		75	250	nA
	Offset current drift	T_A = full range			0.3		nA/°C
CMRR	Common mode rejection ratio	V_{CC} = ±15 V, V_{ICR} = ±12 V	T_A = full range	70	110		dB
		V_{CC} = ±5 V, V_{ICR} = ±2.5 V		70	95		
PSRR	Power supply rejection ratio	V_{CC} = ±5 V or ±15 V	T_A = 25°C	70	78		dB
			T_A = full range	68			
V_{ICR}	Common-mode input voltage range	V_{CC} = ±15 V		±13.8	±14.1		V
		V_{CC} = ±5 V		±3.8	±4.3		
R_I	Input resistance				1		MΩ
C_i	Input capacitance				2		pF
R_O	Output resistance	Open loop			12		Ω
	Channel-to-channel crosstalk (THS4062 only)	V_{CC} = ±5 V or ±15 V, f = 1 MHz			65		dB

† Full range = 0°C to 70°C for C suffix and –40°C to 85°C for I suffix

operating characteristics at T_A = 25°C, V_{CC} = ±15 V, R_L = 150 Ω (unless otherwise noted)

PARAMETER		TEST CONDITIONS†			MIN	TYP	MAX	UNIT
SR	Slew rate	V_{CC} = ±15 V		Gain = –1		400		V/µs
		V_{CC} = ±5 V				350		
t_s	Settling time to 0.1%	V_{CC} = ±15 V,	5-V step (0 V to 5 V)	Gain = –1		40		ns
		V_{CC} = ±5 V,	V_O = –2.5 V to 2.5 V,			40		
	Settling time to 0.01%	V_{CC} = ±15 V,	5-V step (0 V to 5 V)	Gain = –1		140		ns
		V_{CC} = ±5 V,	V_O = –2.5 V to 2.5 V,			150		
THD	Total harmonic distortion	f = 1 MHz				–72		dBc
	Differential gain error	Gain = 2,	NTSC, 40 IRE Modulation	V_{CC} = ±15 V		0.02%		
				V_{CC} = ±5 V		0.02%		
	Differential phase error	Gain = 2,	NTSC, 40 IRE Modulation	V_{CC} = ±15 V		0.02°		
				V_{CC} = ±5 V		0.06°		
	Open loop gain	V_{CC} = ±15 V,	V_O = ±10 V, R_L = 1 kΩ	T_A = 25°C	5	15		V/mV
				T_A = full range	4			
		V_{CC} = ±5 V,	V_O = ±2.5 V, R_L = 1 kΩ	T_A = 25°C	2.5	8		V/mV
				T_A = full range	2			
V_n	Input voltage noise	f = 10 kHz,	V_{CC} = ±5 V or ±15 V			14.5		nV/√Hz
I_n	Input current noise	f = 10 kHz,	V_{CC} = ±5 V or ±15 V			1.6		pA/√Hz

† Full range = 0°C to 70°C for C suffix and –40°C to 85°C for I suffix

TYPICAL CHARACTERISTICS

Table of Graphs

			FIGURE
I_{IB}	Input bias current	vs Free-air temperature	3
V_{IO}	Input offset voltage	vs Free-air temperature	4
	Open-loop gain	vs Frequency	5
	Phase	vs Frequency	5
	Differential gain	vs Number of loads	6, 8
	Differential phase	vs Number of loads	7, 9
	Closed-loop gain	vs Frequency	10, 11
	Output Amplitude	vs Frequency	12, 13
CMRR	Common-mode rejection ratio	vs Frequency	14
PSRR	Power-supply rejection ratio	vs Frequency	15
		vs Free-air temperature	16
$V_{O(PP)}$	Output voltage swing	vs Supply voltage	17
I_{CC}	Supply current	vs Free-air temperature	18
E_{nv}	Noise spectral density	vs Frequency	19
THD	Total harmonic distortion	vs Frequency	20, 21

TYPICAL CHARACTERISTICS

INPUT BIAS CURRENT vs FREE-AIR TEMPERATURE

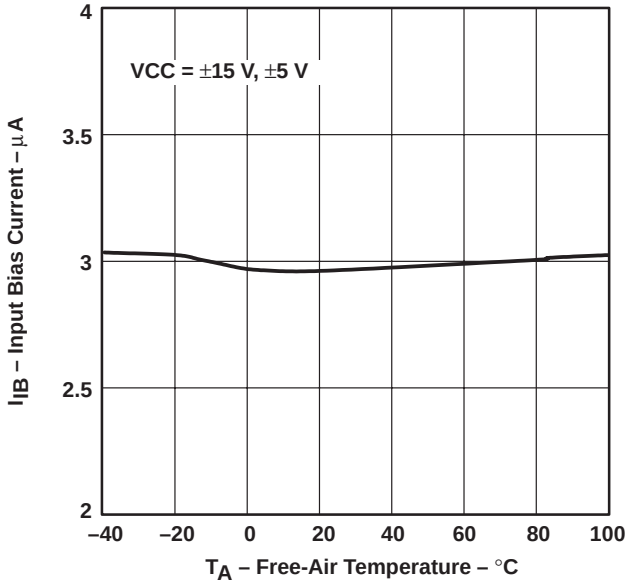


Figure 3

INPUT OFFSET VOLTAGE vs FREE-AIR TEMPERATURE

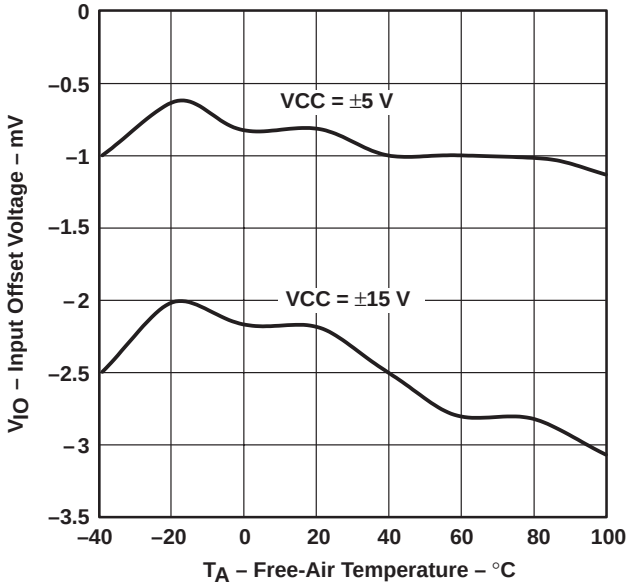


Figure 4

OPEN-LOOP GAIN AND PHASE vs FREQUENCY

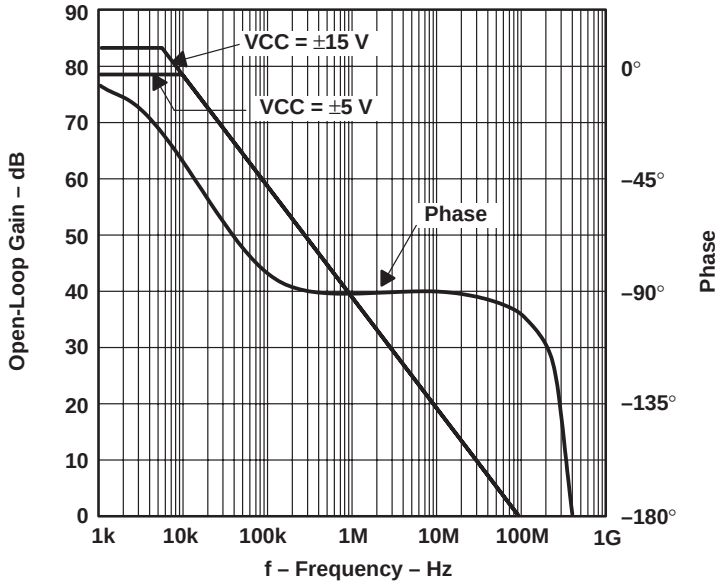


Figure 5

TYPICAL CHARACTERISTICS

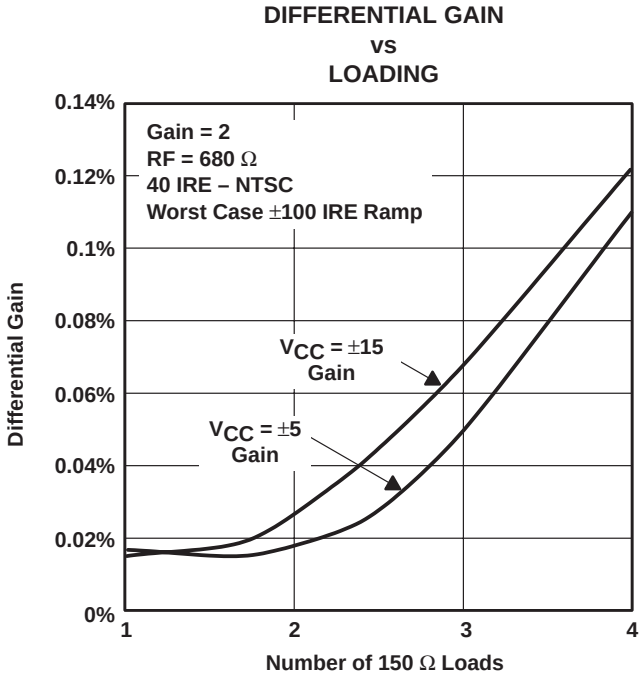


Figure 6

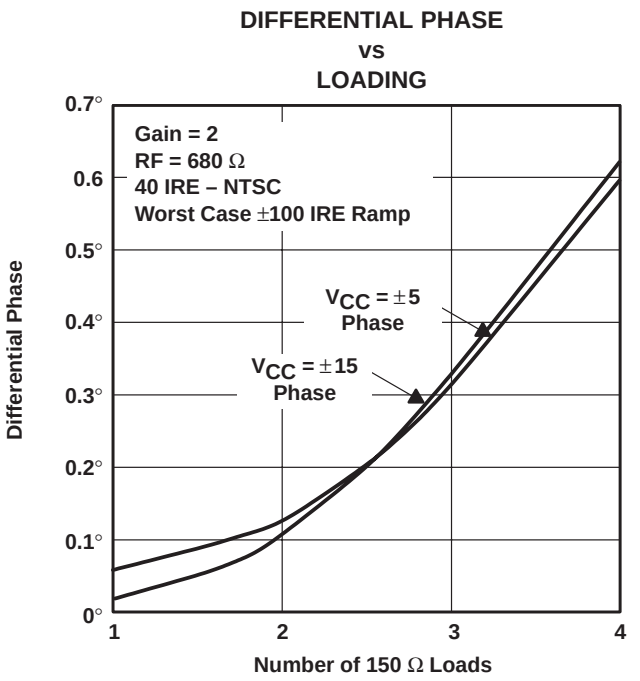


Figure 7

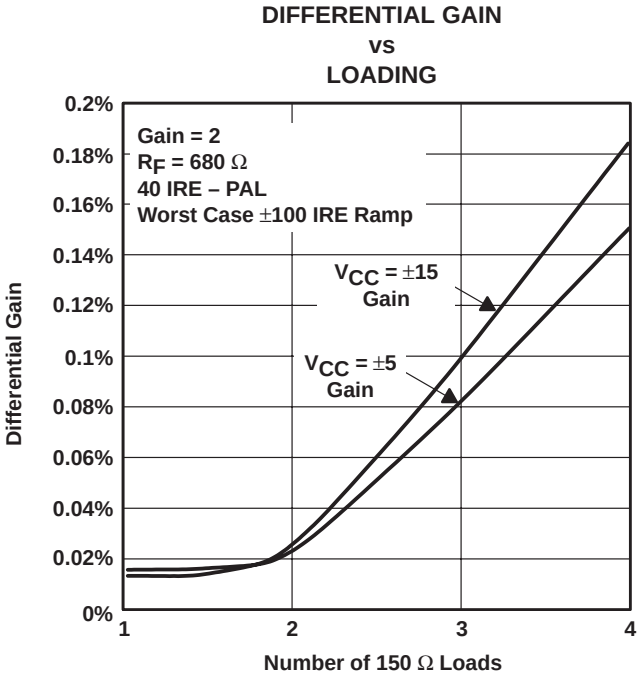


Figure 8

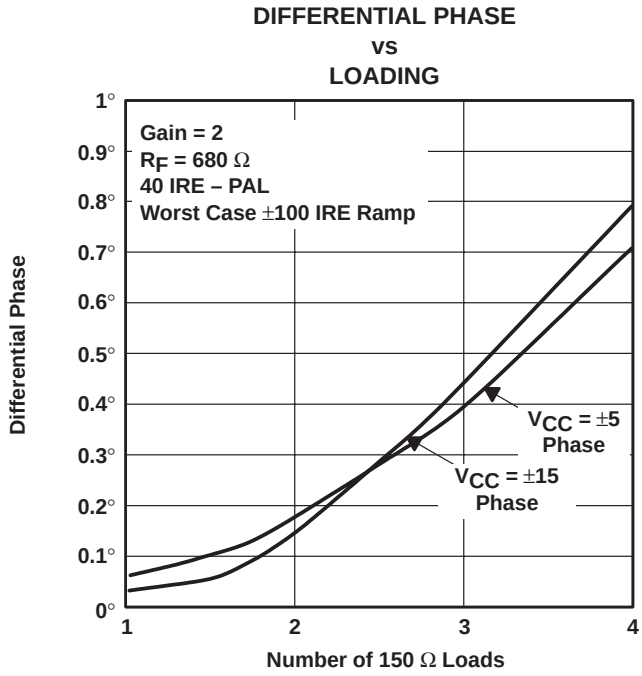


Figure 9

TYPICAL CHARACTERISTICS

CLOSED-LOOP GAIN
vs
FREQUENCY

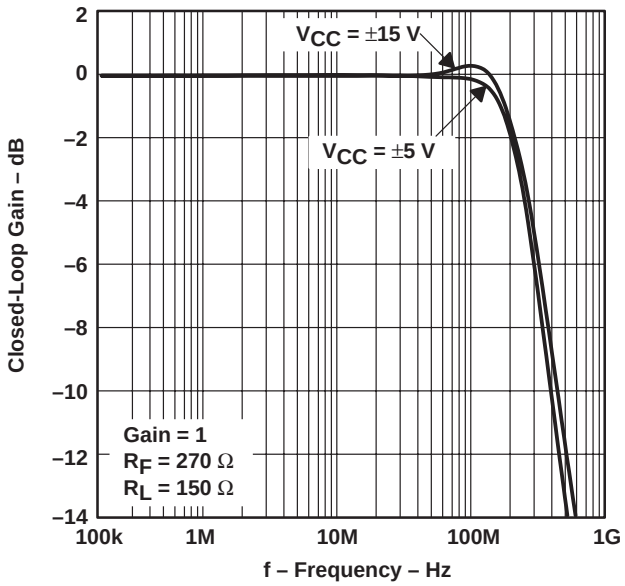


Figure 10

CLOSED-LOOP GAIN
vs
FREQUENCY

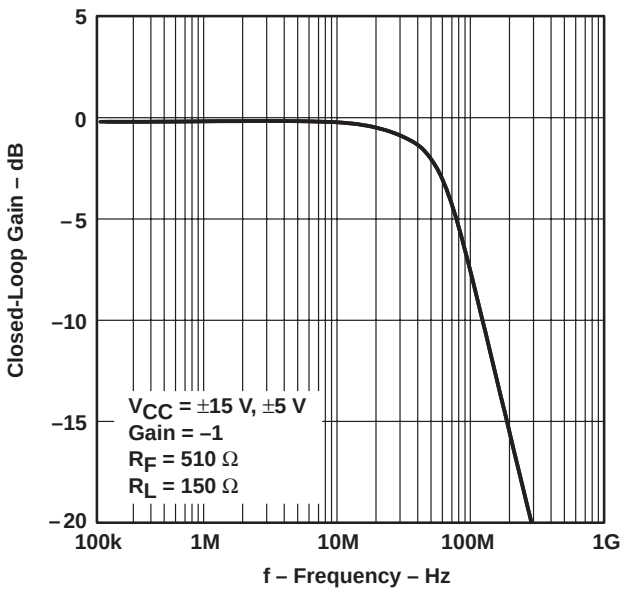


Figure 11

OUTPUT AMPLITUDE
vs
FREQUENCY

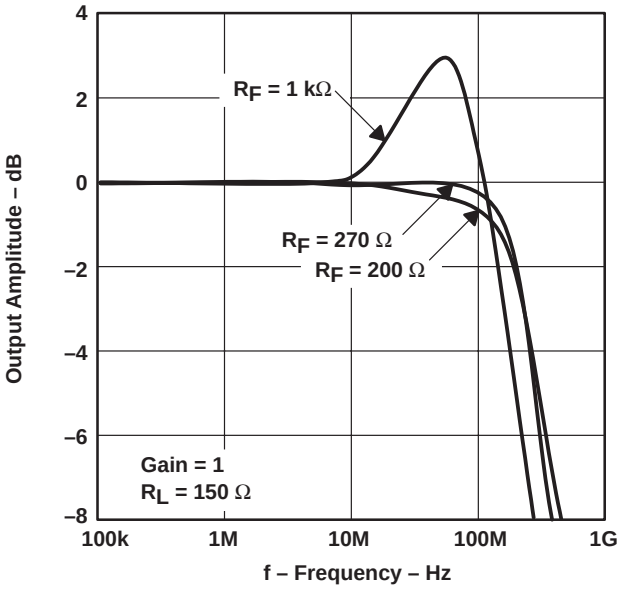


Figure 12

OUTPUT AMPLITUDE
vs
FREQUENCY

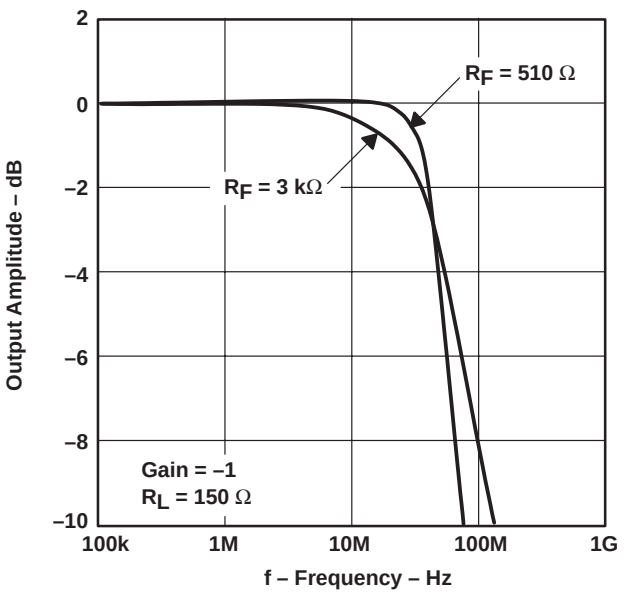


Figure 13

TYPICAL CHARACTERISTICS

COMMON-MODE REJECTION RATIO vs FREQUENCY

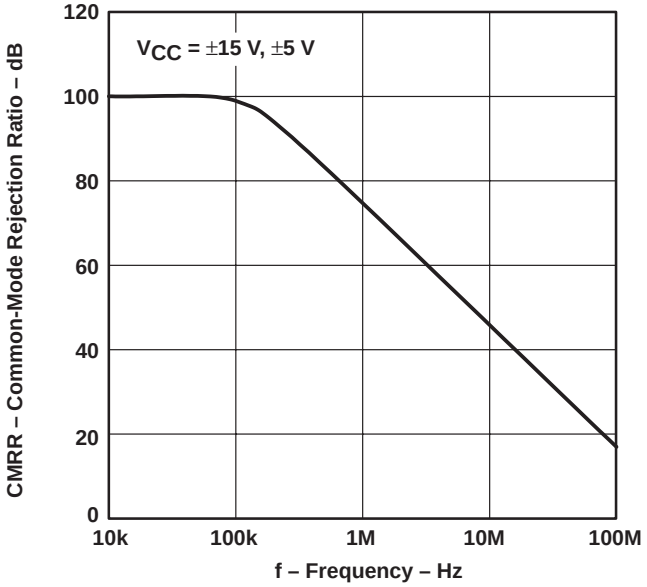


Figure 14

POWER SUPPLY REJECTION RATIO vs FREQUENCY

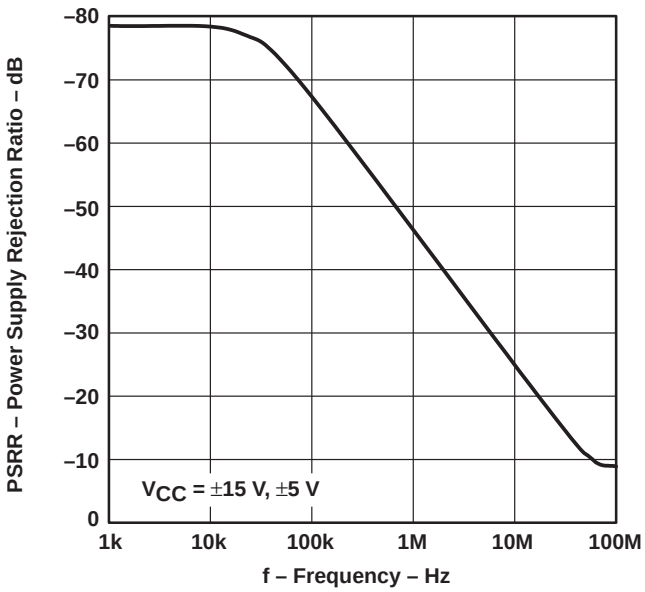


Figure 15

POWER SUPPLY REJECTION RATIO vs FREE-AIR TEMPERATURE

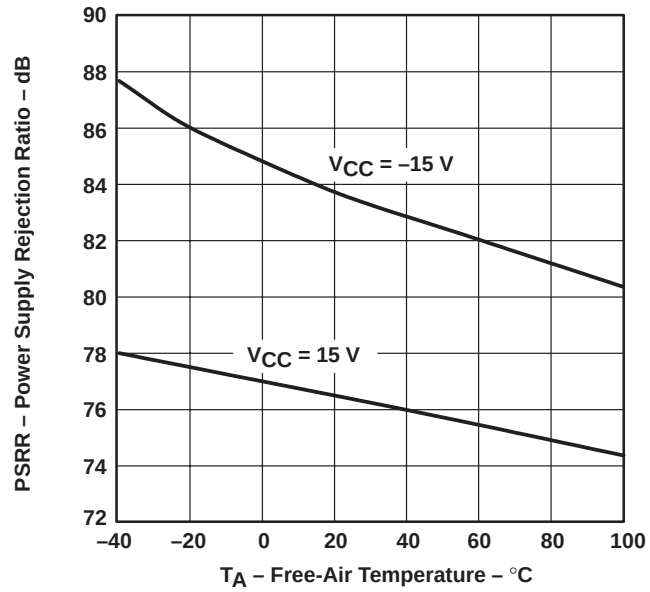


Figure 16

OUTPUT VOLTAGE SWING vs SUPPLY VOLTAGE

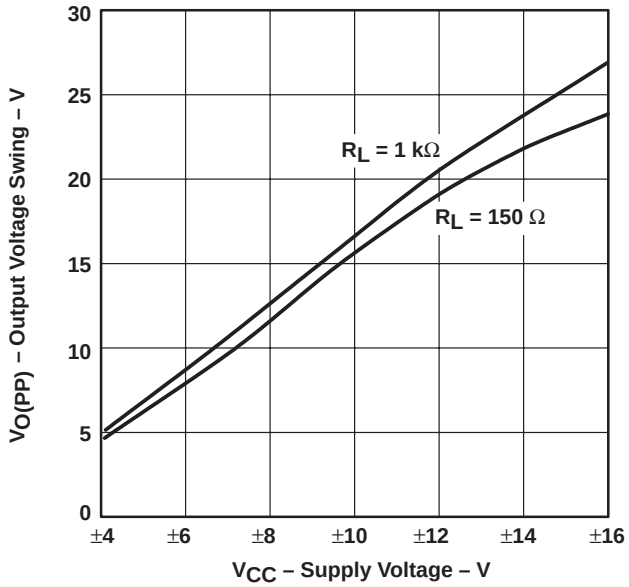


Figure 17

TYPICAL CHARACTERISTICS

SUPPLY CURRENT vs FREE-AIR TEMPERATURE

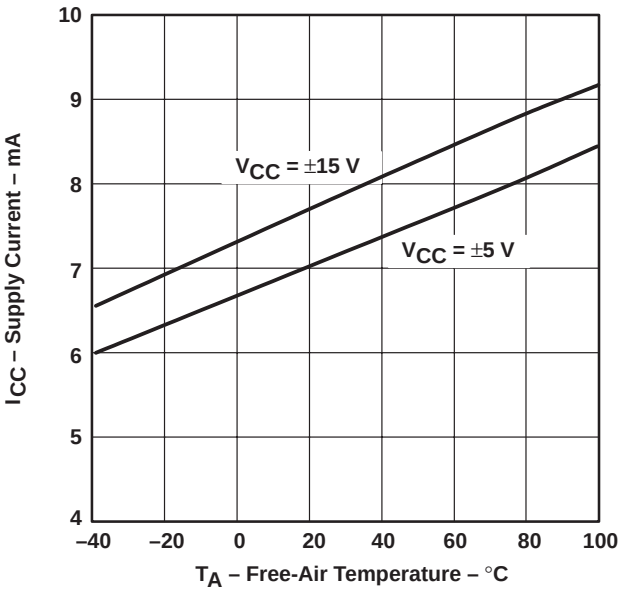


Figure 18

NOISE SPECTRAL DENSITY vs FREQUENCY

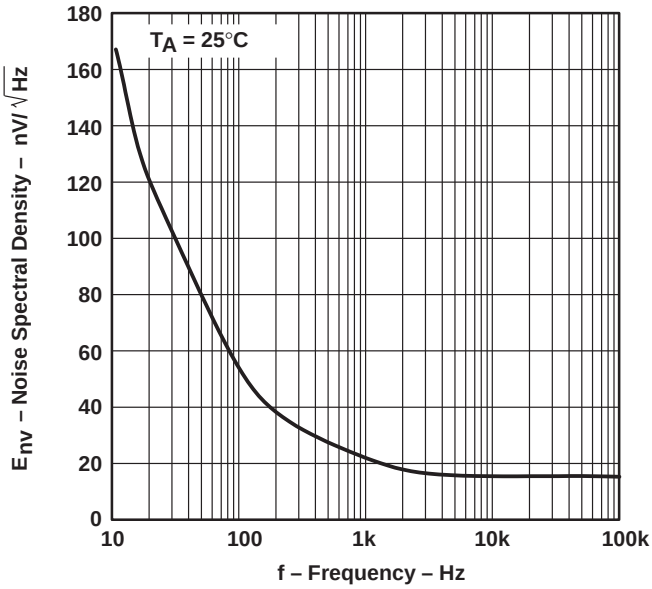


Figure 19

TOTAL HARMONIC DISTORTION vs FREQUENCY

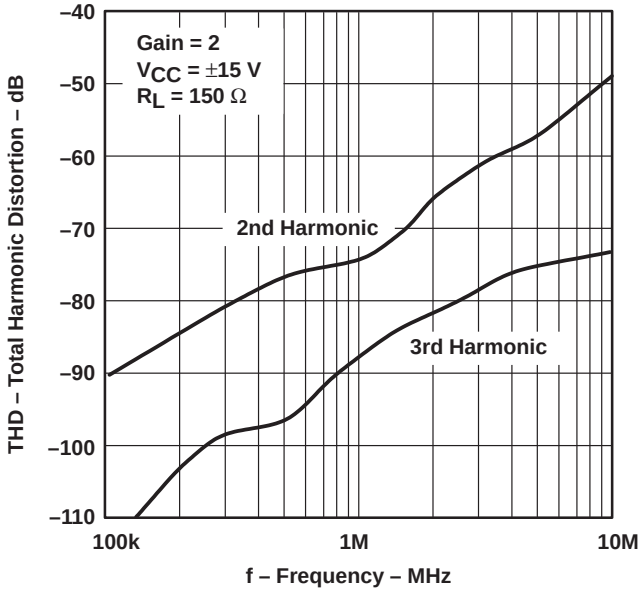


Figure 20

TOTAL HARMONIC DISTORTION vs FREQUENCY

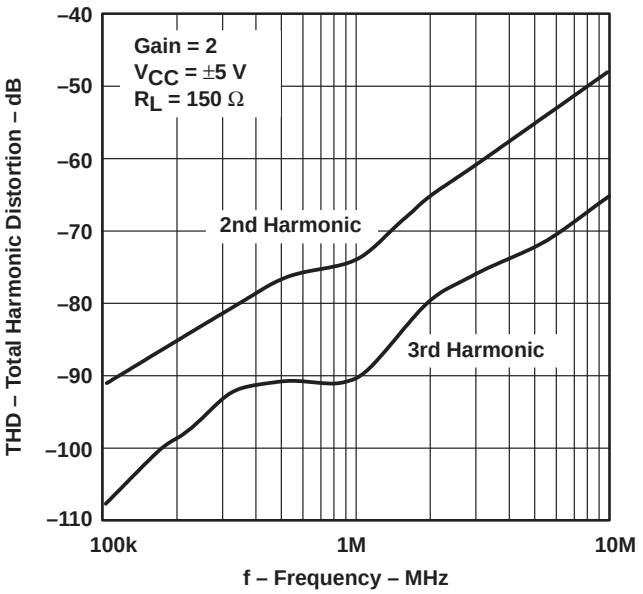


Figure 21

APPLICATION INFORMATION

theory of operation

The THS406x is a high speed, operational amplifier configured in a voltage feedback architecture. It is built using a 30-V, dielectrically isolated, complementary bipolar process with NPN and PNP transistors possessing f_Ts of several GHz. This results in an exceptionally high performance amplifier that has a wide bandwidth, high slew rate, fast settling time, and low distortion. A simplified schematic is shown in Figure 22.

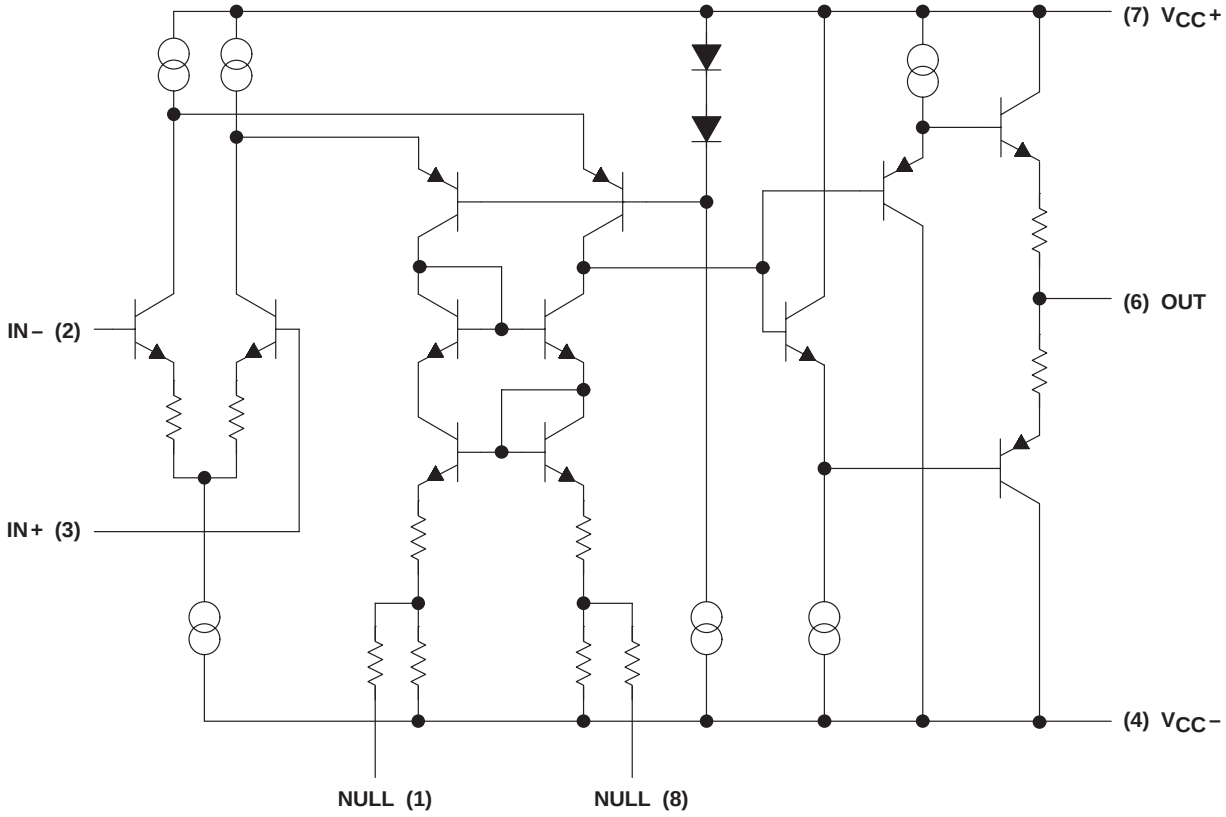


Figure 22. THS4061 Simplified Schematic

APPLICATION INFORMATION

offset nulling

The THS4061 has very low input offset voltage for a high-speed amplifier. However, if additional correction is required, an offset nulling function has been provided. By placing a potentiometer between terminals 1 and 8 and tying the wiper to the negative supply, the input offset can be adjusted. This is shown in Figure 23.

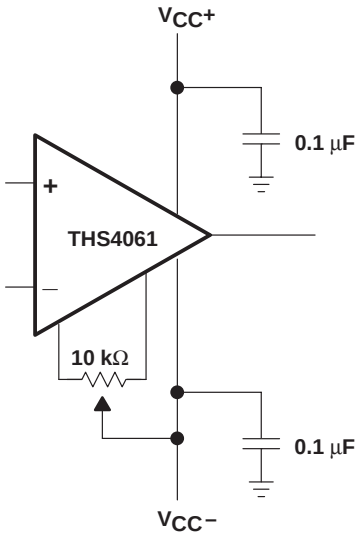


Figure 23. Offset Nulling Schematic

optimizing unity gain response

Internal frequency compensation of the THS406x was selected to provide very wideband performance yet still maintain stability when operated in a noninverting unity gain configuration. When amplifiers are compensated in this manner there is usually peaking in the closed loop response and some ringing in the step response for very fast input edges, depending upon the application. This is because a minimum phase margin is maintained for the G=+1 configuration. For optimum settling time and minimum ringing, a feedback resistor of 270 Ω should be used as shown in Figure 24. Additional capacitance can also be used in parallel with the feedback resistance if even finer optimization is required.

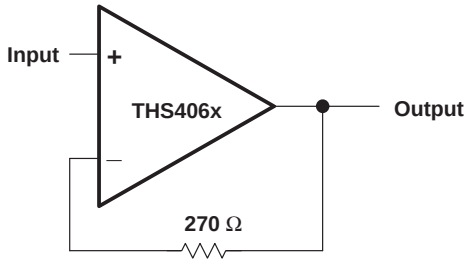


Figure 24. Noninverting, Unity Gain Schematic

APPLICATION INFORMATION

driving a capacitive load

Driving capacitive loads with high performance amplifiers is not a problem as long as certain precautions are taken. The first is to realize that the THS406x has been internally compensated to maximize its bandwidth and slew rate performance. When the amplifier is compensated in this manner, capacitive loading directly on the output will decrease the device's phase margin leading to high frequency ringing or oscillations. Therefore, for capacitive loads of greater than 10 pF, it is recommended that a resistor be placed in series with the output of the amplifier, as shown in Figure 25. A minimum value of 20 Ω should work well for most applications. For example, in 75-Ω transmission systems, setting the series resistor value to 75 Ω both isolates any capacitance loading and provides the proper line impedance matching at the source end.

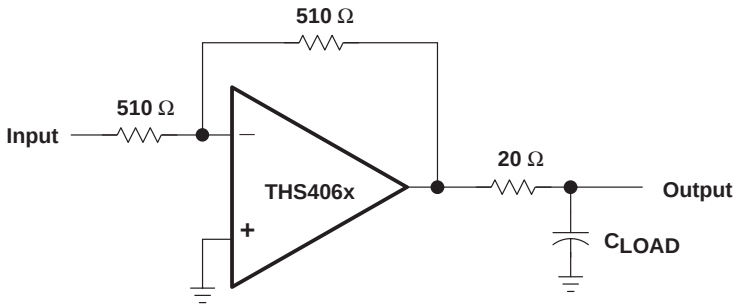


Figure 25. Driving a Capacitive Load

circuit layout considerations

In order to achieve the levels of high frequency performance of the THS406x, it is essential that proper printed-circuit board high frequency design techniques be followed. A general set of guidelines is given below. In addition, a THS406x evaluation board is available to use as a guide for layout or for evaluating the device performance.

- Ground planes – It is highly recommended that a ground plane be used on the board to provide all components with a low inductive ground connection. However, in the areas of the amplifier inputs and output, the ground plane can be removed to minimize the stray capacitance.
- Proper power supply decoupling – Use a 6.8-μF tantalum capacitor in parallel with a 0.1-μF ceramic capacitor on each supply terminal. It may be possible to share the tantalum among several amplifiers depending on the application, but a 0.1-μF ceramic capacitor should always be used on the supply terminal of every amplifier. In addition, the 0.1-μF capacitor should be placed as close as possible to the supply terminal. As this distances increases, the inductance in the connecting trace makes the capacitor less effective. The designer should strive for distances of less than 0.1 inches between the device power terminals and the ceramic capacitors.
- Sockets – Sockets are not recommended for high-speed operational amplifiers. The additional lead inductance in the socket pins will often lead to stability problems. Surface-mount packages soldered directly to the printed-circuit board is the best implementation.
- Short trace runs/compact part placements – Optimum high frequency performance is achieved when stray series inductance has been minimized. To realize this, the circuit layout should be made as compact as possible thereby minimizing the length of all trace runs. Particular attention should be paid to the inverting input of the amplifier. Its length should be kept as short as possible. This will help to minimize stray capacitance at the input of the amplifier.

APPLICATION INFORMATION

circuit layout considerations (continued)

- Surface-mount passive components – Using surface-mount passive components is recommended for high-frequency amplifier circuits for several reasons. First, because of the extremely low lead inductance of surface-mount components, the problem with stray series inductance is greatly reduced. Second, the small size of surface-mount components naturally leads to a more compact, layout thereby minimizing both stray inductance and capacitance. If leaded components are used, it is recommended that the lead lengths be kept as short as possible.

evaluation board

An evaluation board is available for the THS4061 (literature number SLOP226) and THS4062 (literaure number SLOP235). This board has been configured for very low parasitic capacitance in order to realize the full performance of the amplifier. A schematic of the evaluation board is shown in Figure 26. The circuitry has been designed so that the amplifier may be used in either an inverting or noninverting configuration. To order the evaluation board contact your local TI sales office or distributor. For more detailed information, refer to the *THS4061 EVM User's Manual* (literature number SLOU038) or the *THS4062 EVM User's Manual* (literature number SLOU040)

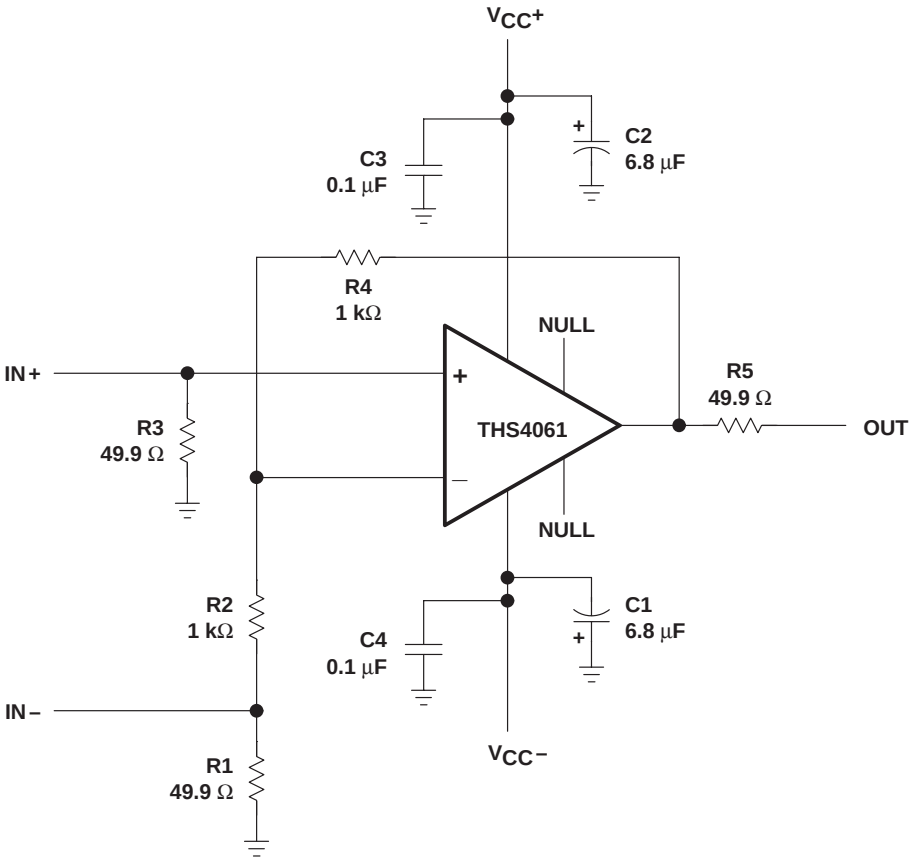
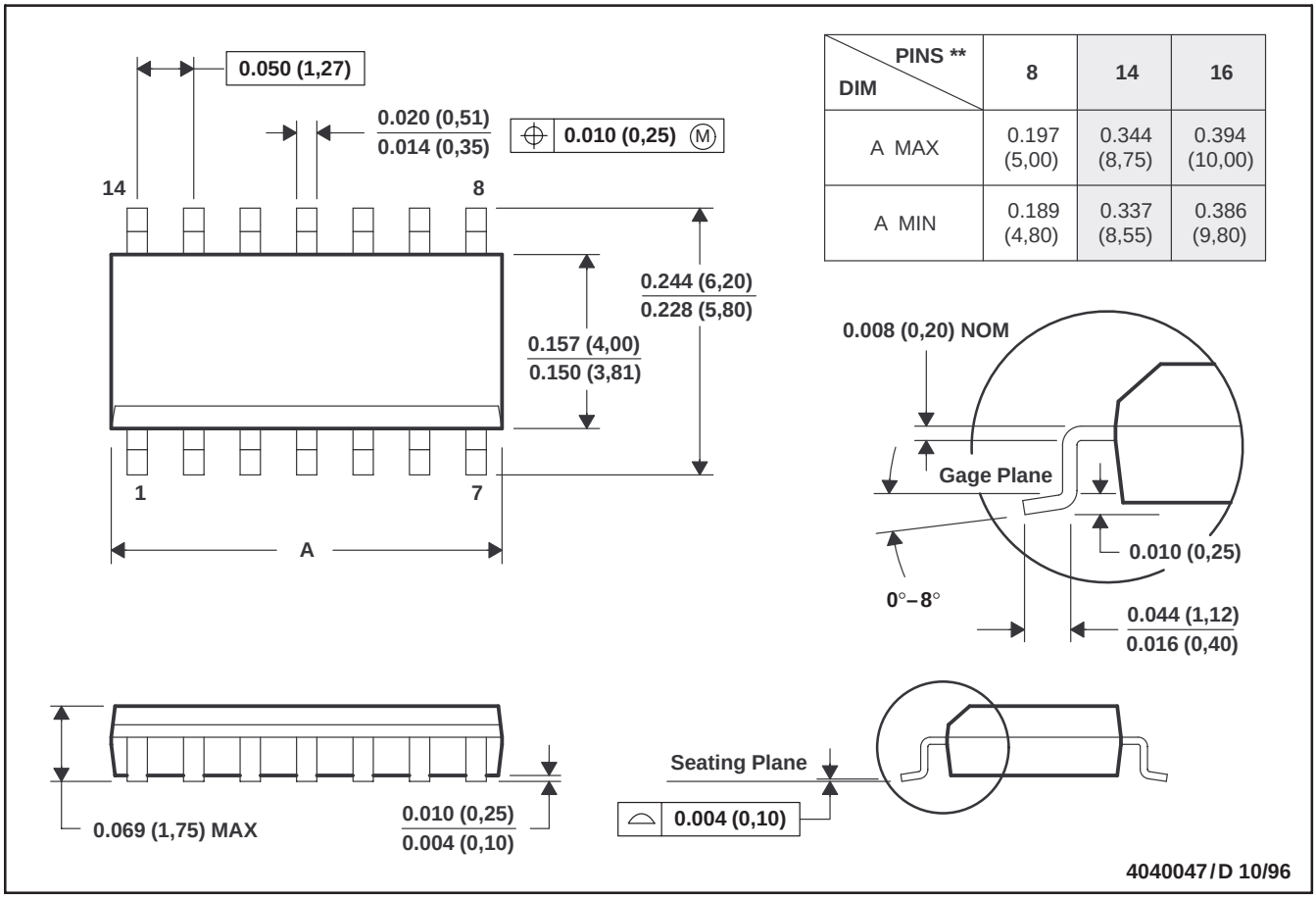


Figure 26. THS4061 Evaluation Board Schematic

MECHANICAL INFORMATION

D (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14 PIN SHOWN

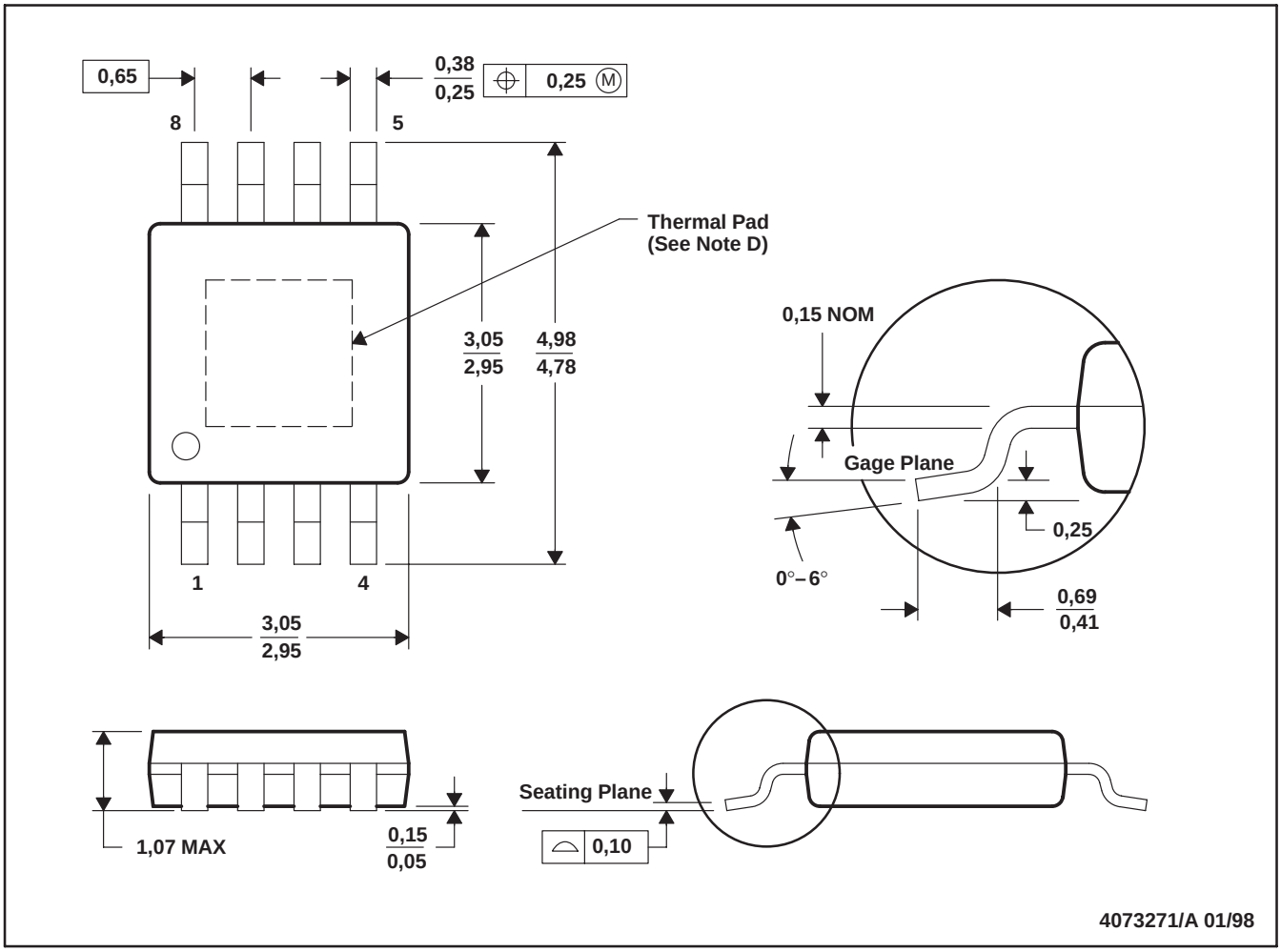


DIM \ PINS **	8	14	16
A MAX	0.197 (5,00)	0.344 (8,75)	0.394 (10,00)
A MIN	0.189 (4,80)	0.337 (8,55)	0.386 (9,80)

NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion, not to exceed 0.006 (0,15).
D. Falls within JEDEC MS-012

MECHANICAL INFORMATION

DGN (S-PDSO-G8) **PowerPAD™ PLASTIC SMALL-OUTLINE PACKAGE**



NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions include mold flash or protrusions.
D. The package thermal performance may be enhanced by attaching an external heat sink to the thermal pad. This pad is electrically and thermally connected to the backside of the die and possibly selected leads.
E. Falls within JEDEC MO-187

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