LM7301

Low Power, 4 MHz GBW, Rail-to-Rail Input-Output Operational Amplifier

The LM7301 series of operational amplifiers provide high performance in a wide range of applications. The benefits include greater than rail−to−rail input range, full rail−to−rail output swing, large capacitive load driving ability and low distortion.

With only 0.6 mA supply current, the 4 MHz gain−bandwidth of this device supports new portable applications where higher power devices unacceptably drain battery life.

The LM7301 series can be driven by voltages that exceed both power supply rails, thus eliminating concerns over exceeding the common−mode voltage range. The rail−to−rail output swing capability provides the maximum possible dynamic range at the output. This is particularly important when operating on low supply voltages.

Operating on supplies of 1.8 V to 32 V, the LM7301 is excellent for a very wide range of applications in low power systems.

Placing the amplifier right at the signal source reduces board size and simplifies signal routing. The LM7301 fits easily on low profile PCMCIA cards.

Features

- At V_S = 5 V (Typical unless otherwise noted)
- Tiny 5−pin SOT23 Package Saves Space
- Greater than Rail−to−Rail Input CMVR −0.25 V to 5.25 V
- Rail−to−Rail Output Swing 0.07 V to 4.93 V
- Wide Gain−Bandwidth 4 MHz
- Low Supply Current 0.60 mA
- Wide Supply Range 1.8 V to 32 V
- High PSRR 104 dB
- High CMRR 93 dB
- Excellent Gain 97 dB
- Capable of Driving a 1 nF Capacitive Load
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant

Typical Applications

- Portable Instrumentation
- Signal Conditioning Amplifiers/ADC Buffers
- Active Filters
- Modems
- PCMCIA Cards

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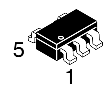
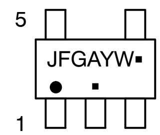


TSOP−5
(SOT23−5)
SN SUFFIX
CASE 483

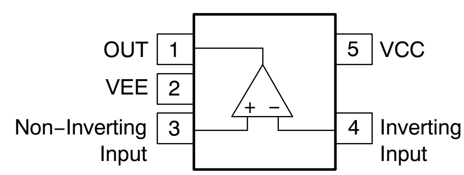
MARKING DIAGRAM



A = Assembly Location
Y = Year
W = Work Week
▪ = Pb−Free Package

(Note: Microdot may be in either location)

PIN CONNECTIONS



(Top View)

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 12 of this data sheet.

PIN FUNCTION DESCRIPTION

Pin No.	Pin Name	Description
1	Output	Amplifier Output
2	VEE	Negative Power Supply
3	Non−inverting Input	Non−inverting Amplifier Input
4	Inverting Input	Inverting Amplifier Input
5	VCC	Positive Power Supply

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input voltage common mode range	V_{icr}	(V+) + 0.3 V, (V−) − 0.3 V	V
Differential input voltage range	V_{diff}	15	V
Supply Voltage (V+ − V−)	V_{CC}	35	V
Current at Input Pin	I_{in}	±10	mA
Current at Output Pin (Note 1)	I_{out}	±20	mA
Current at Power Supply Pin	I_{CC}	25	mA
Maximum Junction Temperature (Note 2)	$T_{J(max)}$	150	°C
Storage Temperature Range	T_{STG}	−65 to 150	°C
ESD Capability, Human Body Model (Note 3)	ESD_{HBM}	2.5	kV

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. Applies to both single supply and split supply operation. Continuous short circuit operation at elevated ambient temperature can result in exceeding the maximum allowed junction temperature of 150°C.
2. The maximum power dissipation is a function of $T_{J(max)}$, T_{JA}, and T_A. The maximum allowable dissipation at any ambient temperature is $P_D = (T_{J(max)} - T_A)/T_{JA}$. All numbers apply for packages soldered directly to a PC board.
3. Human Body Model, applicable std. MIL−STD−883, method 3015.7.

THERMAL CHARACTERISTICS

Rating	Symbol	Value	Unit
Thermal Characteristics, SOT−5, 3 x 3.3 mm (Note 4)	$R_{\theta JA}$	333	°C/W

4. Values based on copper area of 645 mm^2 (or 1 in^2) of 1 oz copper thickness and FR4 PCB substrate.

OPERATING RANGES

Rating	Symbol	Min	Max	Unit
Supply Voltage	V_{CC}	1.8	32	V
Operating Temperature Range	T_A	−40	85	°C

5.0 V DC ELECTRICAL CHARACTERISTICS Unless otherwise specified, all limits guaranteed for T_A = 25°C, V+ = 5 V, V− = 0 V, Vcm = V+/2, and RL > 1M to V+/2. **Boldface** limits apply at the temperature extremes

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{os}	Input Offset Voltage			0.03	6	mV
					8	
TCVos	Input Offset Voltage Average Drift			**2**		μV/C
Ib	Input Bias Current	V_{cm} = 0 V		65	200	nA
					250	
		V_{cm} = 5 V		−55	−75	
					−85	
Ios	Input Offset Current	V_{cm} = 0 V		0.7	70	nA
					80	
		V_{cm} = 5 V		0.7	55	
					65	
Rin	Input Resistance, CM	0 V ≤ V_{cm} ≤ 5 V		39		MΩ
CMRR	Common Mode Rejection Ratio	0 V ≤ V_{cm} ≤ 5 V	70	88		dB
			67			
		0 V ≤ V_{cm} ≤ 3.5 V		93		
PSRR	Power Supply Rejection Ratio	2.2 V ≤ V+ ≤ 30 V	87	104		dB
			84			
V_{cm}	Input Common−Mode Voltage Range	CMRR ≥ 65 dB		5.1		V
				−0.1		
A_V	Large Signal Voltage Gain	R_L = 10k Vo = 4.0 V_{pp}	82	97		dB
			80			
V_{OH}	High Output Voltage Swing	R_L = 10k	4.88	4.93		V
			4.85			
		R_L = 2k	4.8	4.87		
			4.78			
V_{OL}	Low Output Voltage Swing	R_L = 10k		0.07	0.12	
					0.15	
		R_L = 2k		0.14	0.2	
					0.22	
I_{sc}	Output Short Circuit Current	Sourcing	8	10.5		mA
			5.5			
		Sinking	6	9.8		
			5			
Is	Supply Current	R_L = open		0.6	1.1	mA
					1.24	

AC ELECTRICAL CHARACTERISTICS T_A = 25°C, V+ = 2.2 V to 30 V, V− = 0 V, Vcm = V+/2, and R_L > 1 M to V+/2

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
SR	Slew Rate	±4 V Step @ Vs = ±6 V		1.25		V/μs
GBW	Gain−Bandwidth Product	f = 100 kHz, R_L = 10k		4		MHz
eN	Input−Referred Voltage Noise	f = 1 kHz		30		nV/rtHz
iN	Input−Referred Current Noise	f = 1 kHz		0.24		pA/rtHz
THD	Total Harmonic Distortion	f = 10 kHz		0.004		%

2.2 V DC ELECTRICAL CHARACTERISTICS Unless otherwise specified, all limits guaranteed for T_A = 25°C, V+ = 2.2 V, V− = 0 V, Vcm =Vo = V+/2, and RL > 1 M to V+/2. **Boldface** limits apply at the temperature extremes

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Vos	Input Offset Voltage			0.04	6	mV
					8	
TCVos	Input Offset Voltage Average Drift			**2**		μV/C
Ib	Input Bias Current	V_{cm} = 0 V		65	200	nA
					250	
		V_{cm} = 2.2 V		−55	−75	
					−85	
Ios	Input Offset Current	V_{cm} = 0 V		0.8	70	nA
					80	
		V_{cm} = 2.2 V		0.4	55	
					65	
Rin	Input Resistance, CM	0 V ≤ V_{cm} ≤ 2.2 V		18		MΩ
CMRR	Common Mode Rejection Ratio	0 V ≤ V_{cm} ≤ 2.2 V	60	82		dB
			56			
PSRR	Power Supply Rejection Ratio	2.2 V ≤ V+ ≤ 30 V	87	104		dB
			84			
Vcm	Input Common−Mode Voltage Range	CMRR ≥ 60 dB		2.3		V
				−0.1		
AV	Large Signal Voltage Gain	R_L = 10k Vo = 1.6 V_{pp}	76	93		dB
			74			
V_{OH}	High Output Voltage Swing	R_L = 10k	2.1	2.15		V
			2			
		R_L = 2k	2.07	2.1		
			2			
V_{OL}	Low Output Voltage Swing	R_L = 10k		0.05	0.08	
					0.1	
		R_L = 2k		0.09	0.13	
					0.14	
Isc	Output Short Circuit Current	Sourcing	8	8.7		mA
			5.5			
		Sinking	6	8.7		
			5			

2.2 V DC ELECTRICAL CHARACTERISTICS Unless otherwise specified, all limits guaranteed for T_A = 25°C, V+ = 2.2 V, V− = 0 V, Vcm =Vo = V+/2, and RL > 1 M to V+/2. **Boldface** limits apply at the temperature extremes

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Is	Supply Current	R_L = open		0.57	0.97	mA
					1.24	

30V DC ELECTRICAL CHARACTERISTICS Unless otherwise specified, all limits guaranteed for T_A = 25°C, V+ = 30 V, V− = 0 V, V_{cm} =Vo = V+/2, and R_L > 1 M to V+/2. **Boldface** limits apply at the temperature extremes

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Vos	Input Offset Voltage			0.04	6	mV
					8	
TCVos	Input Offset Voltage Average Drift			**2**		uV/C
Ib	Input Bias Current	V_{cm} = 0 V		70	300	nA
					500	
		V_{cm} = 30 V		−60	−100	
					−200	
Ios	Input Offset Current	V_{cm} = 0 V		1.2	90	nA
					190	
		V_{cm} = 30 V		0.5	65	
					135	
Rin	Input Resistance, CM	0 V ≤ V_{cm} ≤ 30 V		200		MΩ
CMRR	Common Mode Rejection Ratio	0 V ≤ V_{cm} ≤ 30 V	80	104		dB
			78			
		0 V ≤ V_{cm} ≤ 27 V	90	115		
			88			
PSRR	Power Supply Rejection Ratio	2.2 V ≤ V+ ≤ 30 V	87	104		dB
			84			
Vcm	Input Common−Mode Voltage Range	CMRR ≥ 80 dB		30.1		V
				−0.1		
AV	Large Signal Voltage Gain	R_L = 10k Vo = 28 V_{pp}	89	100		dB
			86			
V_{OH}	High Output Voltage Swing	R_L = 10k	29.75	29.8		V
			28.65			
V_{OL}	Low Output Voltage Swing	R_L = 10k		0.16	0.275	
					0.375	
I_{sc}	Output Short Circuit Current	Sourcing (Note 5)	8.8	17		mA
			6.5			
		Sinking (Note 5)	8.2	14		
			6			
I_s	Supply Current	R_L = open		0.7	1.3	mA
					1.35	

5. The maximum power dissipation is a function of $T_{J(max)}$, T_{JA}, and T_A. The maximum allowable dissipation at any ambient temperature is $P_D = (T_{J(max)} - T_A)/T_{JA}$. All numbers apply for packages soldered directly to a PC board.

TYPICAL CHARACTERISTICS

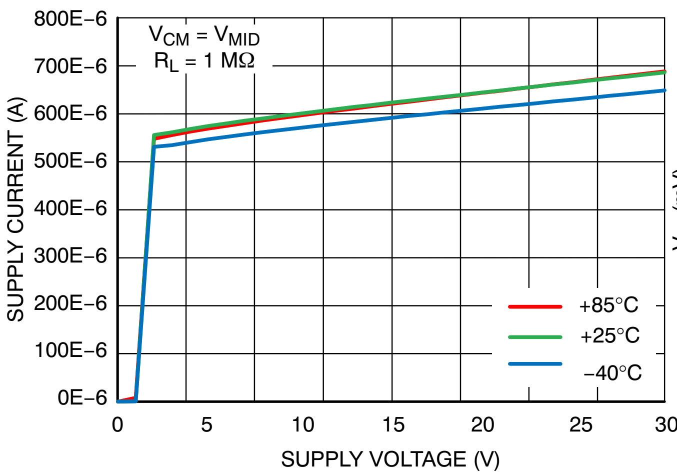


Figure 1. Supply Current vs. Supply Voltage

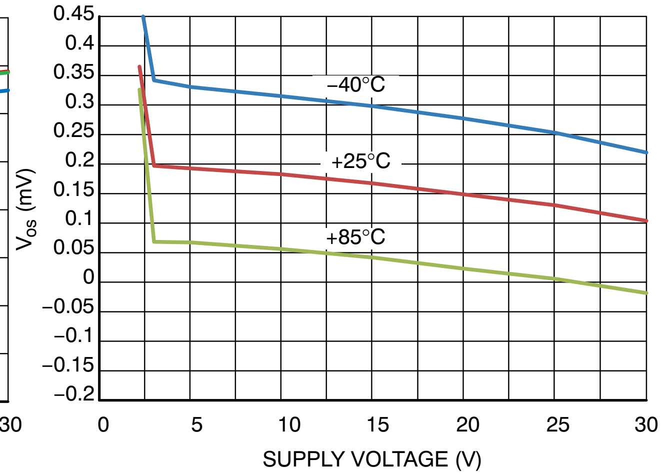


Figure 2. V_{os} vs. Supply Voltage

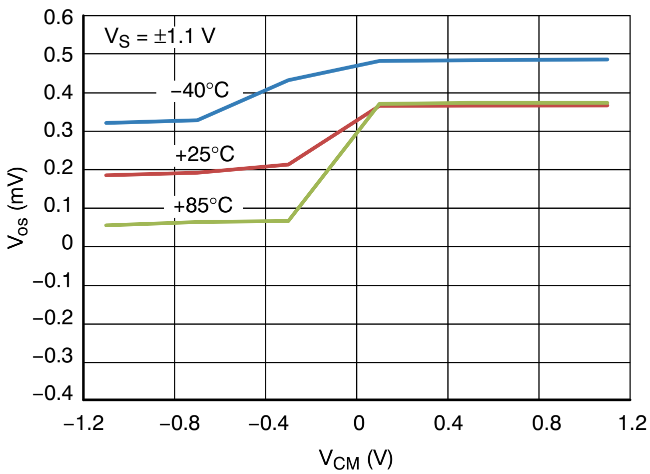


Figure 3. V_{os} vs. V_{CM}

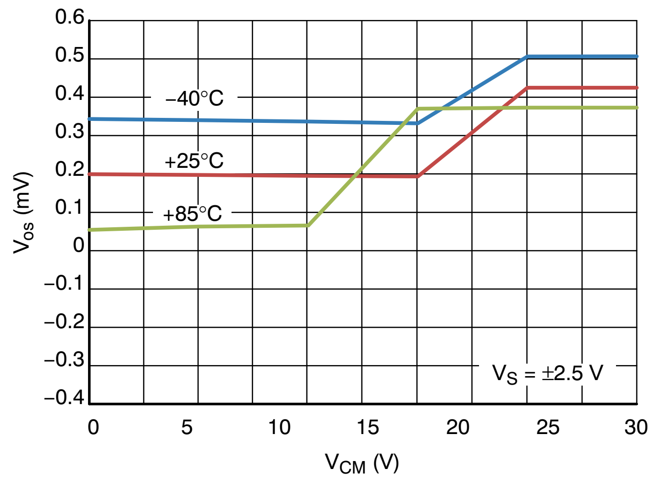


Figure 4. V_{os} vs. V_{CM}

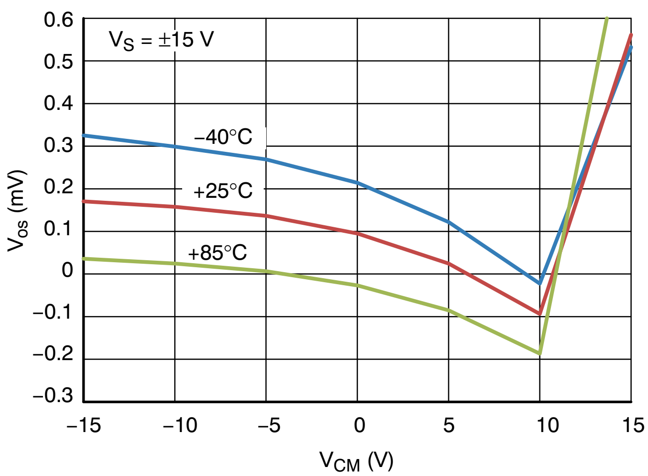


Figure 5. V_{os} vs. V_{CM}

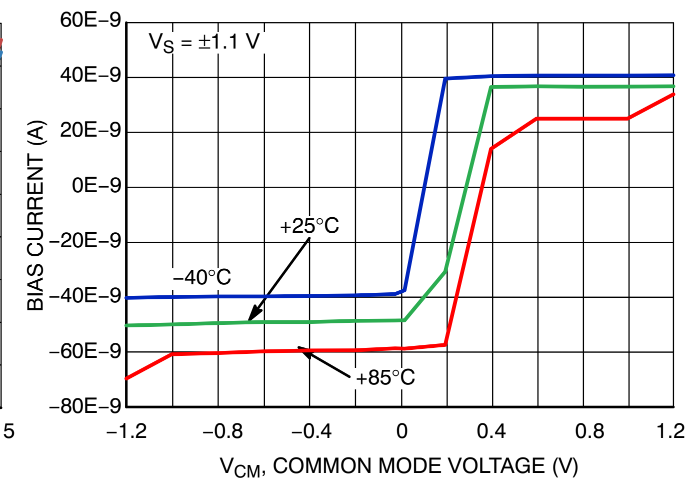


Figure 6. Inverting Input Bias Current vs. Common Mode

TYPICAL CHARACTERISTICS

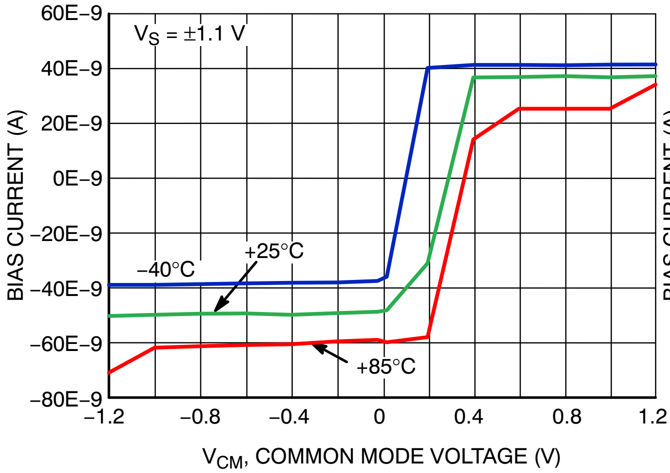


Figure 7. Non−Inverting Input Bias Current vs. Common Mode

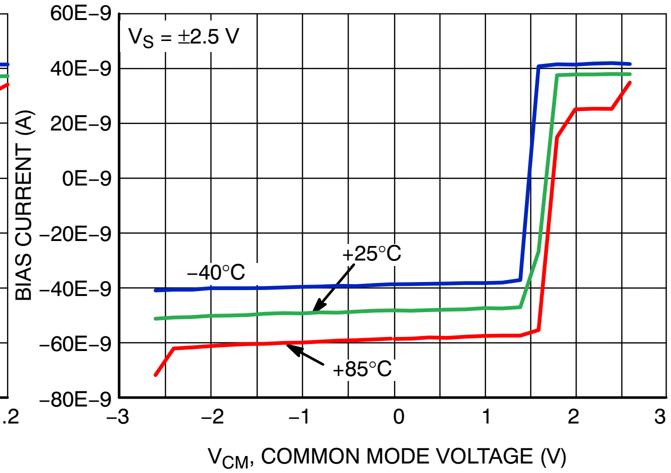


Figure 8. Inverting Input Bias Current vs. Common Mode

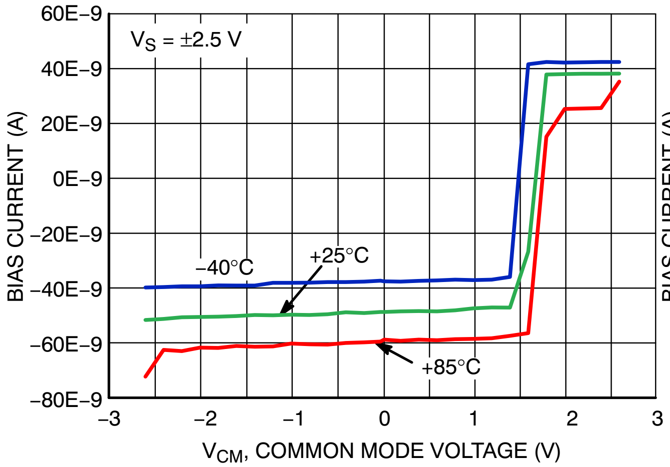


Figure 9. Non−Inverting Input Bias Current vs. Common Mode

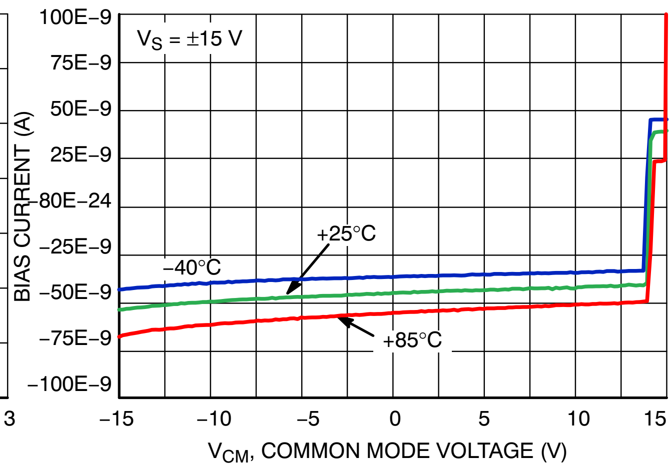


Figure 10. Inverting Input Bias Current vs. Common Mode

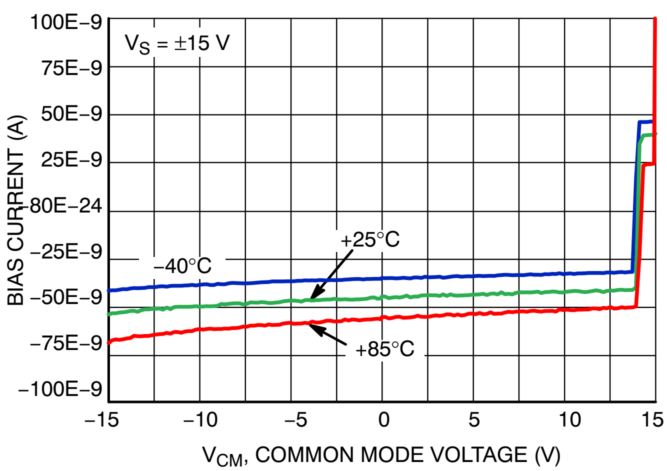


Figure 11. Non−Inverting Input Bias Current vs. Common Mode

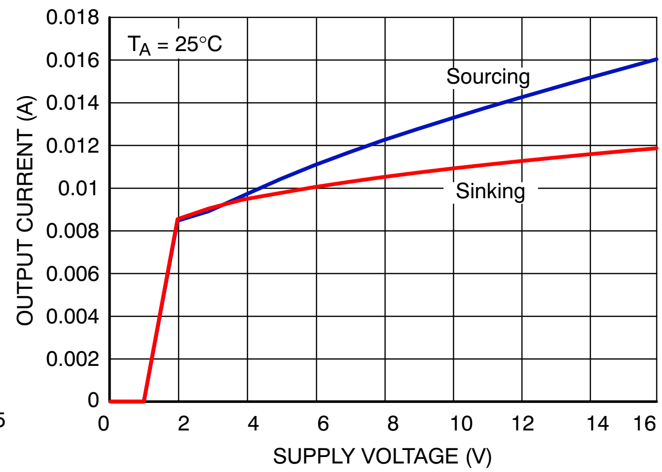


Figure 12. Short−Circuit Current vs. Supply Voltage

TYPICAL CHARACTERISTICS

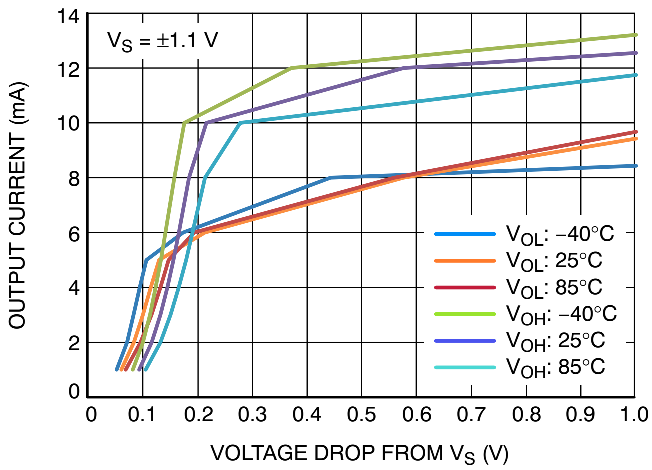


Figure 13. I_O vs. V_O

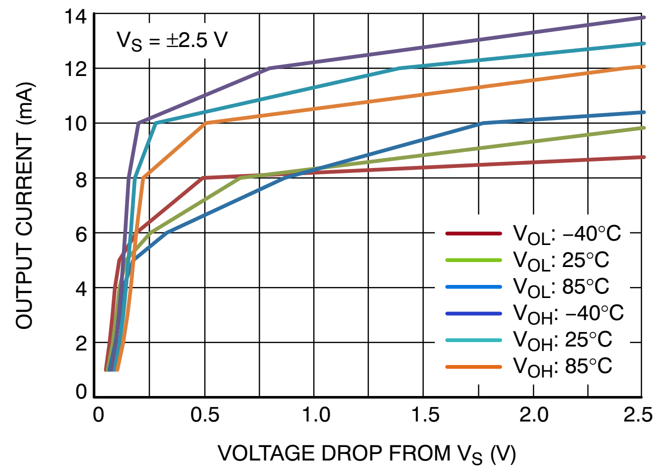


Figure 14. I_O vs. V_O

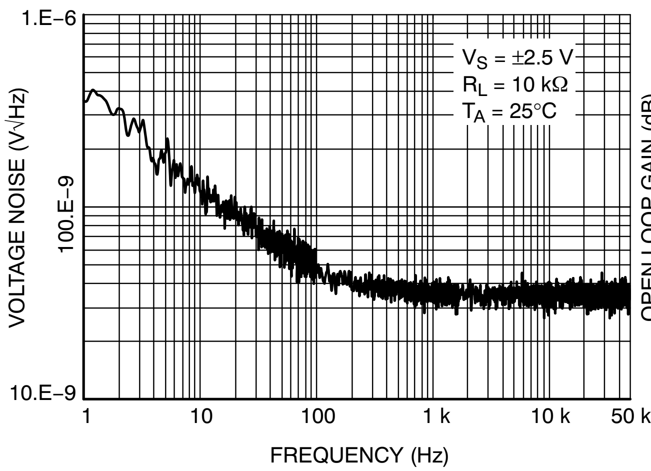


Figure 15. Voltage Noise vs. Frequency

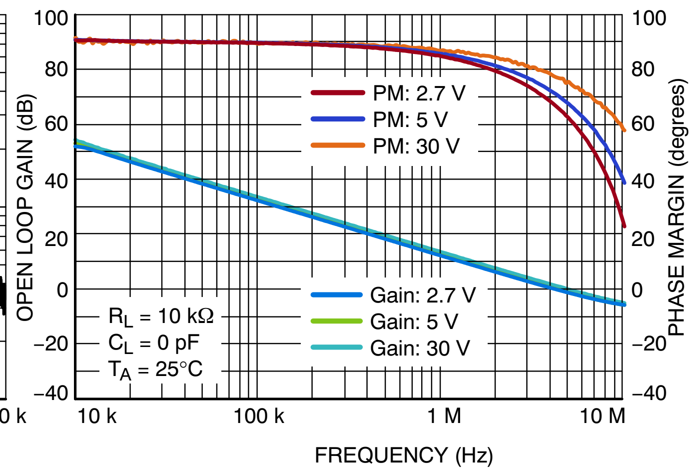


Figure 16. Gain and Phase Margin

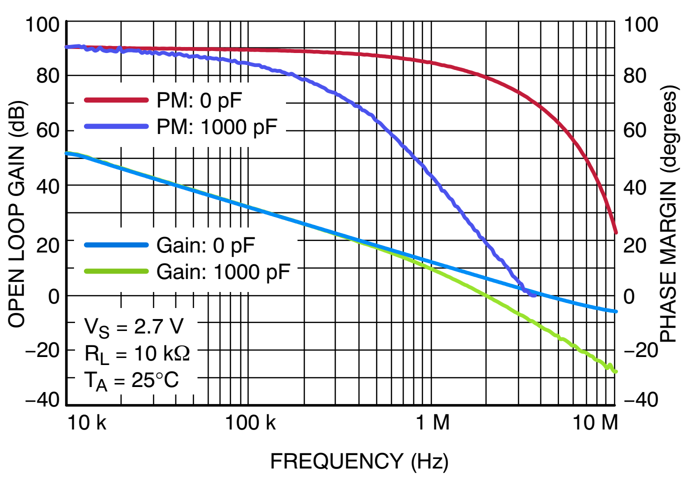


Figure 17. Gain/Phase vs. Capacitive Load

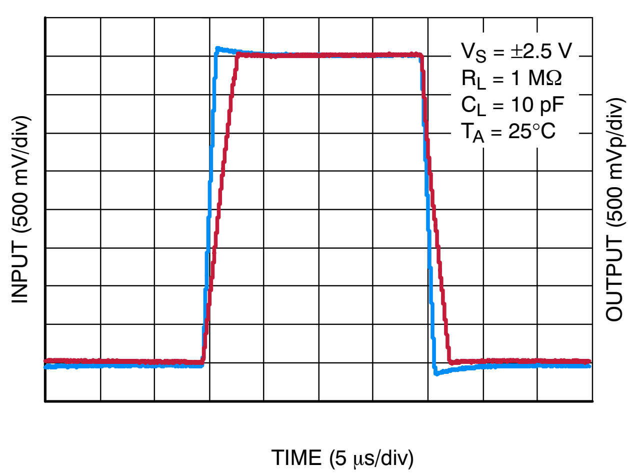


Figure 18. Large Signal Step Response

TYPICAL CHARACTERISTICS

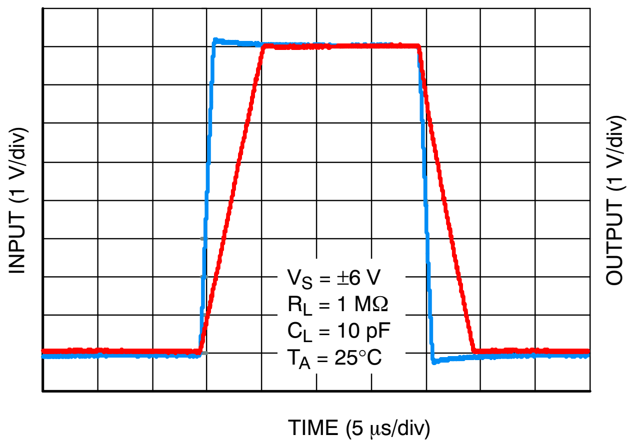


Figure 19. Large Signal Step Response

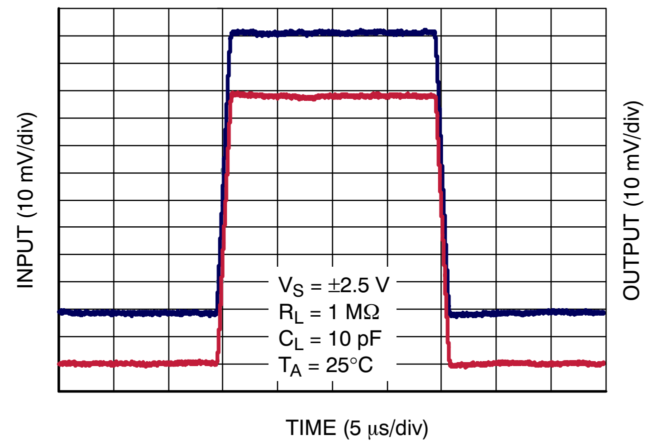


Figure 20. Small Signal Step Response

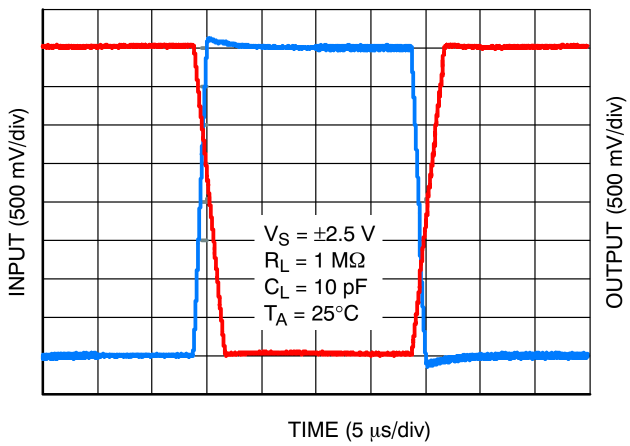


Figure 21. Inverting Large Signal Step Response

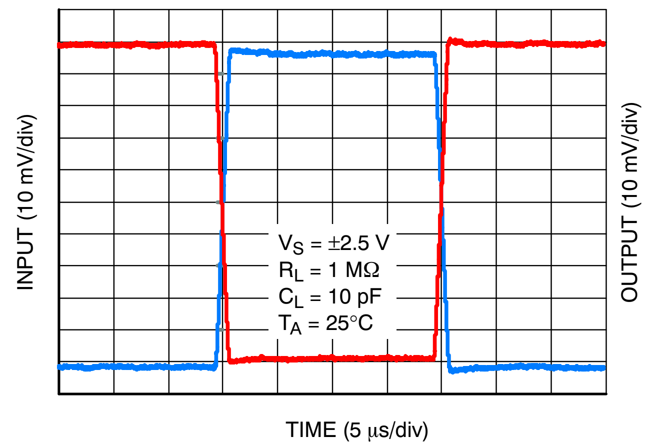


Figure 22. Inverting Small Signal Step Response

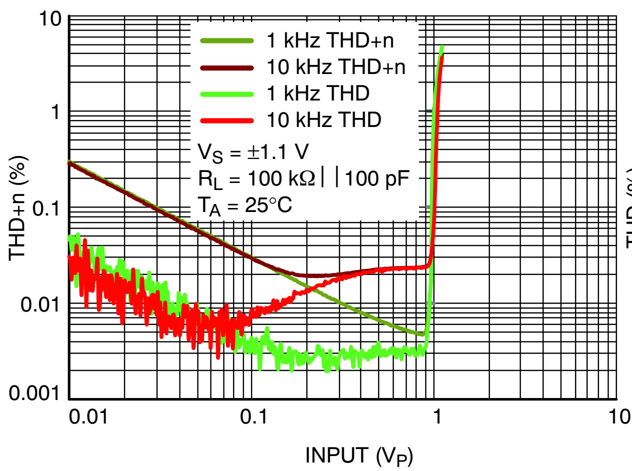


Figure 23. Harmonic Distortion

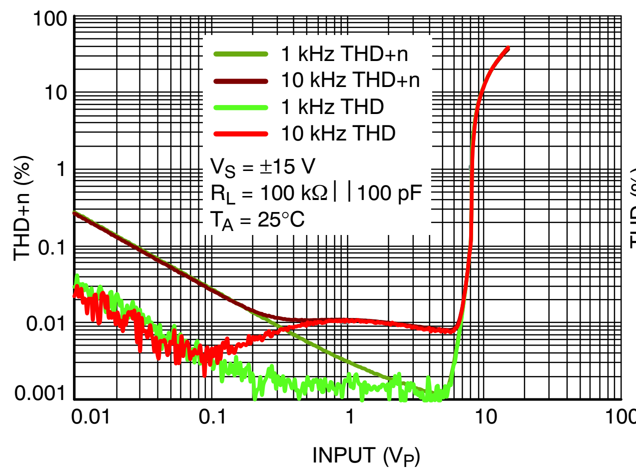


Figure 24. Harmonic Distortion

TYPICAL CHARACTERISTICS

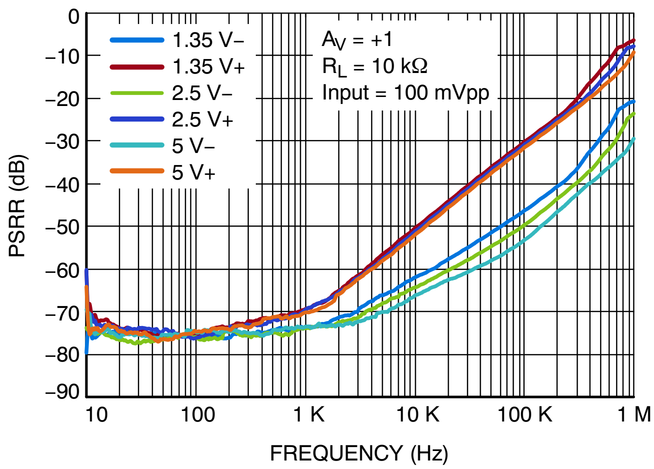


Figure 25. PSRR vs. Frequency

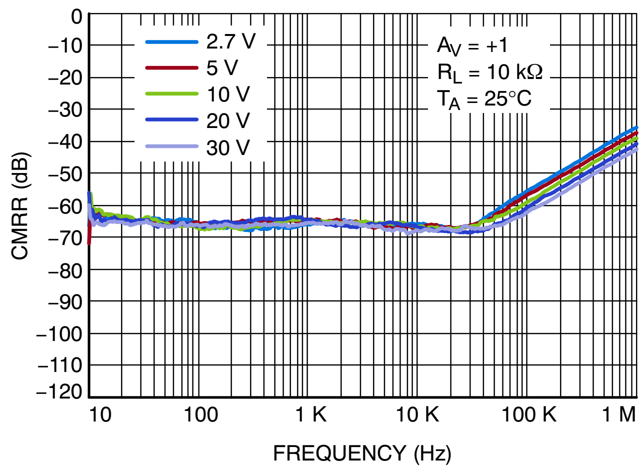


Figure 26. CMRR vs. Frequency

APPLICATIONS INFORMATION

GENERAL INFORMATION

Low supply current, wide bandwidth, wide input common mode range, "rail−to−rail" output, good capacitive load driving ability, wide supply voltage (1.8 V to 32 V) and low distortion all make the LM7301 ideal for many diverse applications.

The high common−mode rejection ratio and full rail−to−rail input range provides precision performance when operated in non−inverting applications where the common−mode error is added directly to the other system errors.

CAPACITIVE LOAD DRIVING

The LM7301 has the ability to drive large capacitive loads. For example, 1000 pF only reduces the phase margin to about 25°.

WIDE SUPPLY RANGE

The high power−supply rejection ratio (PSRR) and common mode rejection ratio (CMRR) provide precision performance when operated on battery or other unregulated supplies. This advantage is further enhanced by the very wide supply range (2.2 V – 30 V, guaranteed) offered by the LM7301. In situations where highly variable or unregulated supplies are present, the excellent PSRR and wide supply range of the LM7301 benefit the system designer with continued precision performance, even in such adverse supply conditions.

SPECIFIC ADVANTAGES OF 5−Pin TSOP

The obvious advantage of the 5−pin TSOP is that it can save board space, a critical aspect of any portable or miniaturized system design. The need to decrease overall system size is inherent in any handheld, portable, or lightweight system application.

Furthermore, the low profile can help in height limited designs, such as consumer hand−held remote controls, sub−notebook computers, and PCMCIA cards.

An additional advantage of the tiny package is that it allows better system performance due to ease of package placement. Because the tiny package is so small, it can fit on the board right where the op amp needs to be placed for optimal performance, unconstrained by the usual space limitations.

This optimal placement of the tiny package allows for many system enhancements, not easily achieved with the constraints of a larger package. For example, problems such as system noise due to undesired pickup of digital signals can be easily reduced or mitigated. This pick−up problem is often caused by long wires in the board layout going to or from an op amp. By placing the tiny package closer to the signal source and allowing the LM7301 output to drive the long wire, the signal becomes less sensitive to such pick−up. An overall reduction of system noise results.

Often times system designers try to save space by using dual or quad op amps in their board layouts. This causes a complicated board layout due to the requirement of routing several signals to and from the same place on the board. Using the tiny op amp eliminates this problem.

LOW DISTORTION, HIGH OUTPUT DRIVE CAPABILITY

The LM7301 offers superior low−distortion performance, with a total−harmonic−distortion−plus−noise of 0.02% at f = 10 kHz. The advantage offered by the LM7301 is its low distortion levels, even at high output current and low load resistance.

TYPICAL APPLICATIONS

HANDHELD REMOTE CONTROLS

The LM7301 offers outstanding specifications for applications requiring good speed/power trade−off. In applications such as remote control operation, where high bandwidth and low power consumption are needed. The LM7301 performance can easily meet these requirements.

OPTICAL LINE ISOLATION FOR MODEMS

The combination of the low distortion and good load driving capabilities of the LM7301 make it an excellent choice for driving opto−coupler circuits to achieve line isolation for modems. This technique prevents telephone line noise from coupling onto the modem signal. Superior isolation is achieved by coupling the signal optically from the computer modem to the telephone lines; however, this also requires a low distortion at relatively high currents. Due to its low distortion at high output drive currents, the LM7301 fulfills this need, in this and in other telecom applications.

REMOTE MICROPHONE IN PERSONAL COMPUTERS

Remote microphones in Personal Computers often utilize a microphone at the top of the monitor which must drive a long cable in a high noise environment. One method often used to reduce the noise is to lower the signal impedance, which reduces the noise pickup. In this configuration, the amplifier usually requires 30 db − 40 db of gain, at bandwidths higher than most low−power CMOS parts can achieve. The LM7301 offers the tiny package, higher bandwidths, and greater output drive capability than other rail−to−rail input/output parts can provide for this application.

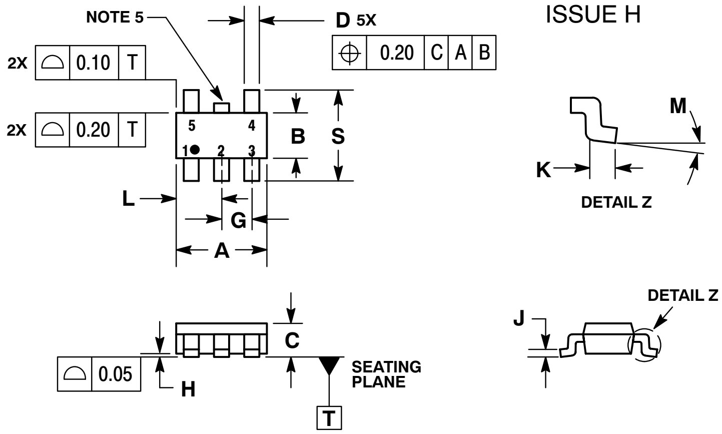
ORDERING INFORMATION

Device	Marking	Package	Shipping†
LM7301SN1T1G	JFG	SOT23−5 (Pb−Free)	3000 / Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

PACKAGE DIMENSIONS

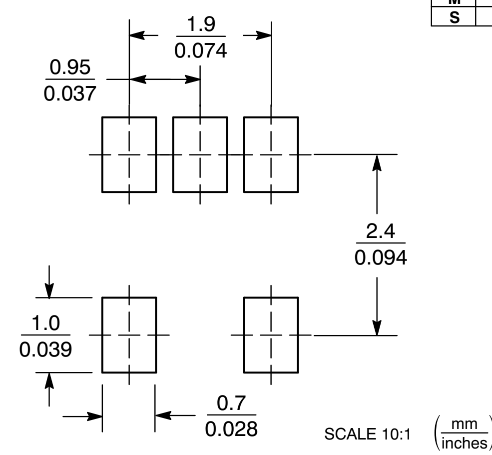
TSOP−5
CASE 483−02
ISSUE H



NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.
5. OPTIONAL CONSTRUCTION: AN ADDITIONAL TRIMMED LEAD IS ALLOWED IN THIS LOCATION. TRIMMED LEAD NOT TO EXTEND MORE THAN 0.2 FROM BODY.

	MILLIMETERS	
DIM	**MIN**	**MAX**
A	3.00 BSC	
B	1.50 BSC	
C	0.90	1.10
D	0.25	0.50
G	0.95 BSC	
H	0.01	0.10
J	0.10	0.26
K	0.20	0.60
L	1.25	1.55
M	0 °	10 °
S	2.50	3.00

SOLDERING FOOTPRINT*



*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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