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

LM7301

ON Semiconductor®

www.onsemi.com

The LM7301 operational amplifier provides high performance in a wide range of applications. It features common mode input range beyond the rails, full rail-to-rail output swing, large capacitive load driving capability, and low signal distortion.

The LM7301 operates on supplies of 1.8 V to 32 V and is excellent for a wide range of applications in low power systems. With a gain-bandwidth of 4 MHz while consuming only 0.6 mA supply current, it supports portable applications where higher power devices would reduce battery life.

The wide input common mode voltage range allows the LM7301 to be driver by signals 100 mV beyond both rails, eliminating concerns associated with exceeding the common−mode voltage range. The capability for rail−to−rail output swing provides the maximum possible dynamic range at the output, which is particularly important when operating on low supply voltages.

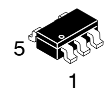
The LM7301 is available in a space-saving TSOP-5 package.

Features

- Wide Supply Range: 1.8 V to 32 V
- Input Common Mode Voltage Range Extends Beyond Rails: V_{EE} − 0.1 V to V_{CC} + 0.1 V
- Rail−to−Rail Output Swing: 0.07 V to 4.93 V at V_S = 5 V
- Wide Gain−Bandwidth: 4 MHz
- Low Supply Current: 0.60 mA at V_S = 5 V
- High PSRR: 104 dB at V_S = 5 V
- High CMRR: 93 dB at V_S = 5 V
- Excellent Gain: 97 dB at V_S = 5 V
- Capable of Driving a 1 nF Capacitive Load
- Tiny 5−pin SOT23 Package Saves Space
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant

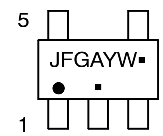
Typical Applications

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



TSOP−5
(SOT23−5)
SN SUFFIX
CASE 483

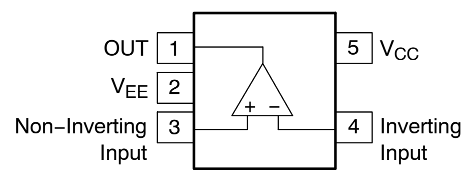
MARKING DIAGRAM



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 11 of this data sheet.

PIN FUNCTION DESCRIPTION

Pin No.	Pin Name	Description
1	Output	Amplifier Output
2	V_{EE}	Negative Power Supply
3	Non−inverting Input	Non−inverting Amplifier Input
4	Inverting Input	Inverting Amplifier Input
5	V_{CC}	Positive Power Supply

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input Voltage Common Mode Range	V_{CM}	V_{CC} + 0.3 V, V_{EE} − 0.3 V	V
Differential Input Voltage Range	V_{diff}	15	V
Supply Voltage (V_{CC} − V_{EE})	V_S	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 those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

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 $T_{J(max)}$, θ_{JA}, and T_A. The maximum allowable dissipation at any ambient temperature is $P_D = (T_{J(max)} - T_A)/\theta_{JA}$. All numbers apply for packages soldered directly to a printed circuit 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)	θ_{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_S	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_{CC} = 5 V, V_{EE} = 0 V, V_{CM} = mid−supply, and R_L > 1 MΩ to mid−supply. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{OS}	Input Offset Voltage			0.03	6	mV
					8	
$\Delta V_{OS}/\Delta T$	Input Offset Voltage Average Drift			**2**		μV/°C
I_{IB}	Input Bias Current	V_{CM} = 0 V		65	200	nA
					250	
		V_{CM} = 5 V		−55	−75	
					−85	
I_{OS}	Input Offset Current	V_{CM} = 0 V		0.7	70	nA
					80	
		V_{CM} = 5 V		0.7	55	
					65	
R_{IN}	Input Resistance, Common Mode	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_S ≤ 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 = 10 kΩ Vo = 4.0 V_{pp}	82	97		dB
			80			
V_{OH}	High Output Voltage Swing	R_L = 10 kΩ	4.88	4.93		V
			4.85			
		R_L = 2 kΩ	4.8	4.87		
			4.78			
V_{OL}	Low Output Voltage Swing	R_L = 10 kΩ		0.07	0.12	
					0.15	
		R_L = 2 kΩ		0.14	0.2	
					0.22	
I_{SC}	Output Short Circuit Current	Sourcing	8	10.5		mA
			5.5			
		Sinking	6	9.8		
			5			
I_S	Supply Current	R_L = open		0.6	1.1	mA
					1.24	

AC ELECTRICAL CHARACTERISTICS T_A = 25°C, V_{CC} = 2.2 V to 30 V, V_{EE} = 0 V, V_{CM} = mid−supply, and R_L > 1 MΩ to mid−supply

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
e_N	Input−Referred Voltage Noise	f = 1 kHz		30		nV/√Hz
i_N	Input−Referred Current Noise	f = 1 kHz		0.24		pA/√Hz
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_{CC} = 2.2 V, V_{EE} = 0 V, V_{CM} = mid−supply, and R_L > 1 MΩ to mid−supply. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{OS}	Input Offset Voltage			0.04	6	mV
					8	
$\Delta V_{OS}/\Delta T$	Input Offset Voltage Average Drift			**2**		μV/°C
I_{IB}	Input Bias Current	V_{CM} = 0 V		65	200	nA
					250	
		V_{CM} = 2.2 V		−55	−75	
					−85	
I_{OS}	Input Offset Current	V_{CM} = 0 V		0.8	70	nA
					80	
		V_{CM} = 2.2 V		0.4	55	
					65	
R_{IN}	Input Resistance, Common Mode	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_S ≤ 30 V	87	104		dB
			84			
V_{CM}	Input Common−Mode Voltage Range	CMRR ≥ 60 dB		2.3		V
				−0.1		
A_V	Large Signal Voltage Gain	R_L = 10 kΩ Vo = 1.6 V_{pp}	76	93		dB
			74			
V_{OH}	High Output Voltage Swing	R_L = 10 kΩ	2.1	2.15		V
			2			
		R_L = 2 kΩ	2.07	2.1		
			2			
V_{OL}	Low Output Voltage Swing	R_L = 10 kΩ		0.05	0.08	
					0.1	
		R_L = 2 kΩ		0.09	0.13	
					0.14	
I_{SC}	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_{CC} = 2.2 V, V_{EE} = 0 V, V_{CM} = mid−supply, and R_L > 1 MΩ to mid−supply. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
I_S	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_{CC} = 30 V, V_{EE} = 0 V, V_{CM} = mid−supply, and R_L > 1 MΩ to mid−supply. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{OS}	Input Offset Voltage			0.04	6	mV
					8	
$\Delta V_{OS}/\Delta T$	Input Offset Voltage Average Drift			**2**		μV/°C
I_{IB}	Input Bias Current	V_{CM} = 0 V		70	300	nA
					500	
		V_{CM} = 30 V		−60	−100	
					−200	
I_{OS}	Input Offset Current	V_{CM} = 0 V		1.2	90	nA
					190	
		V_{CM} = 30 V		0.5	65	
					135	
R_{IN}	Input Resistance, Common Mode	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_S ≤ 30 V	87	104		dB
			84			
V_{CM}	Input Common−Mode Voltage Range	CMRR ≥ 80 dB		30.1		V
				−0.1		
A_V	Large Signal Voltage Gain	R_L = 10 kΩ Vo = 28 V_{pp}	89	100		dB
			86			
V_{OH}	High Output Voltage Swing	R_L = 10 kΩ	29.75	29.8		V
			28.65			
V_{OL}	Low Output Voltage Swing	R_L = 10 kΩ		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 $T_{J(max)}$, θ_{JA}, and T_A. The maximum allowable dissipation at any ambient temperature is $P_D = (T_{J(max)} - T_A)/\theta_{JA}$. All numbers apply for packages soldered directly to a printed circuit board.

TYPICAL CHARACTERISTICS

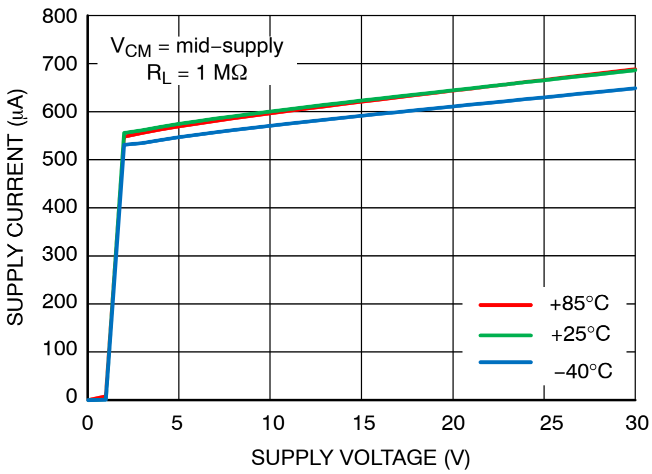


Figure 1. Supply Current vs. Supply Voltage

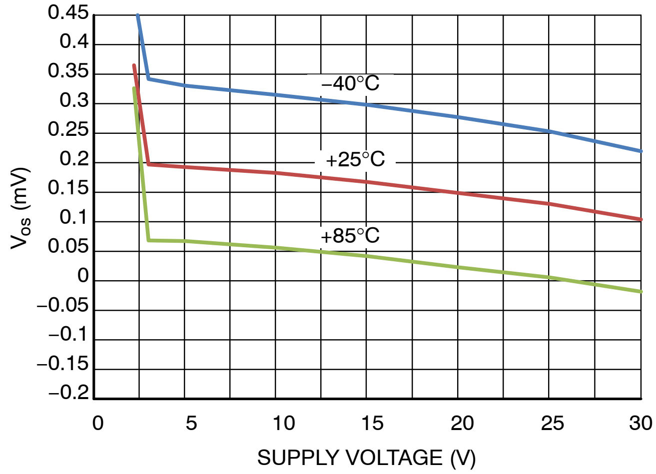


Figure 2. V_{OS} vs. Supply Voltage

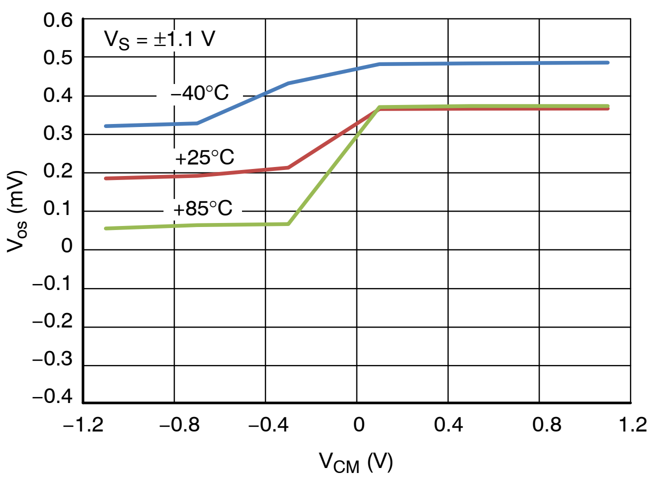


Figure 3. V_{OS} vs. V_{CM}

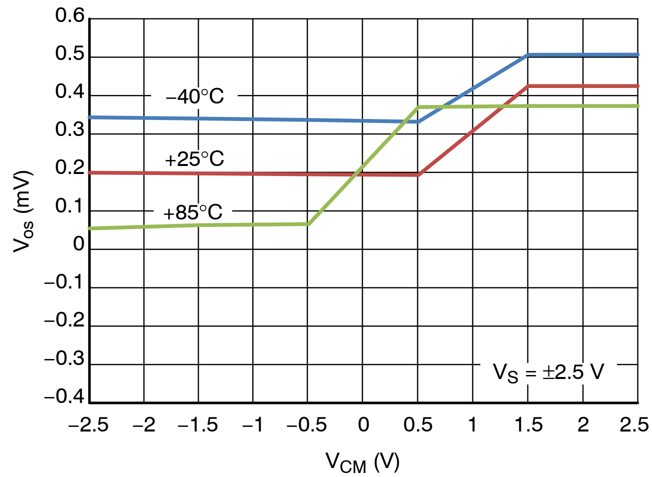


Figure 4. V_{OS} vs. V_{CM}

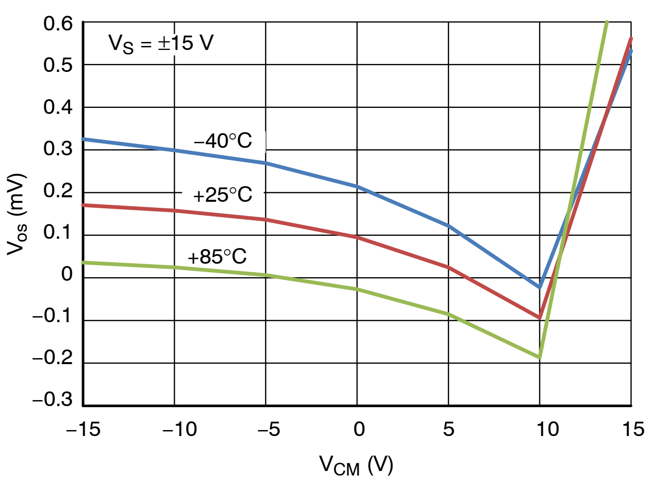


Figure 5. V_{OS} vs. V_{CM}

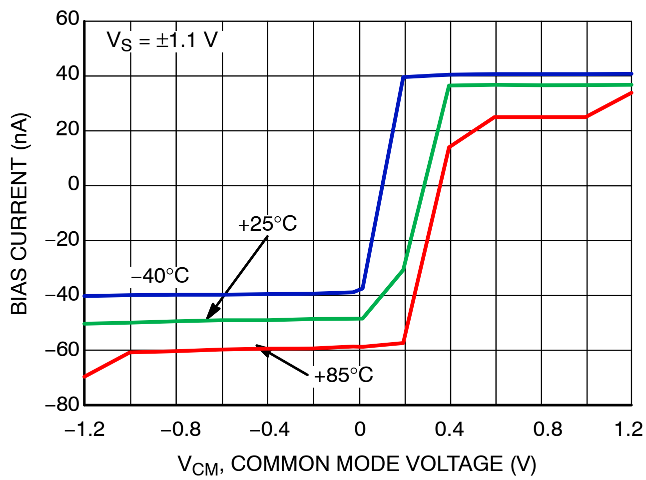


Figure 6. Inverting Input Bias Current vs. Common Mode

TYPICAL CHARACTERISTICS

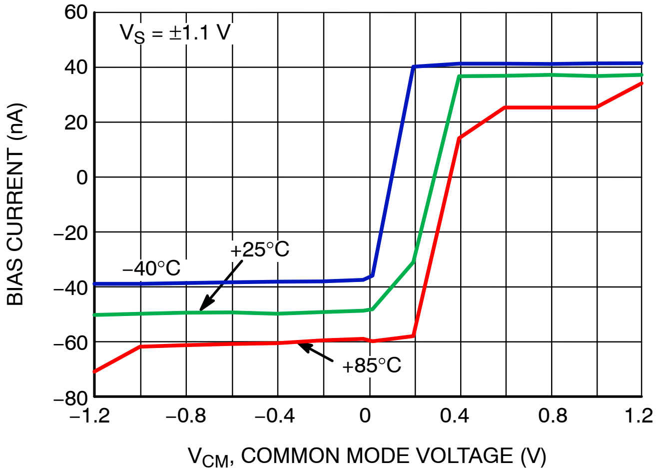


Figure 7. Non−Inverting Input Bias Current vs. Common Mode

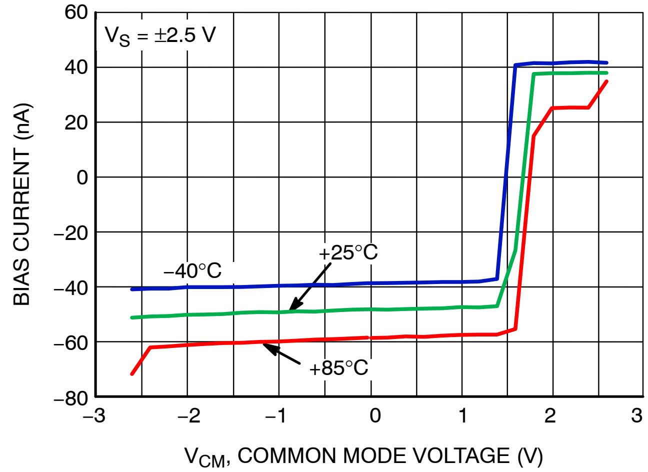


Figure 8. Inverting Input Bias Current vs. Common Mode

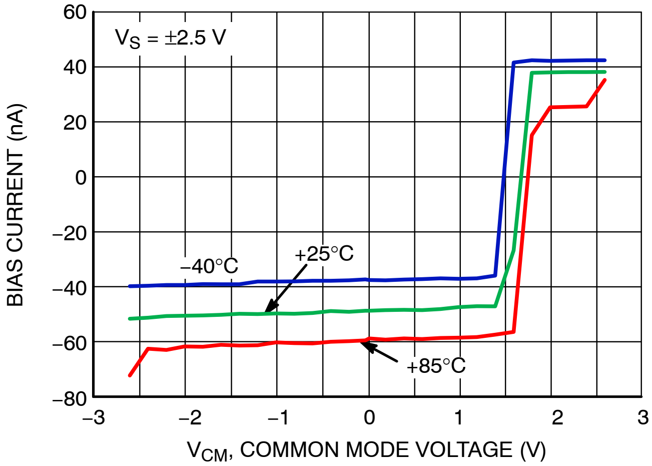


Figure 9. Non−Inverting Input Bias Current vs. Common Mode

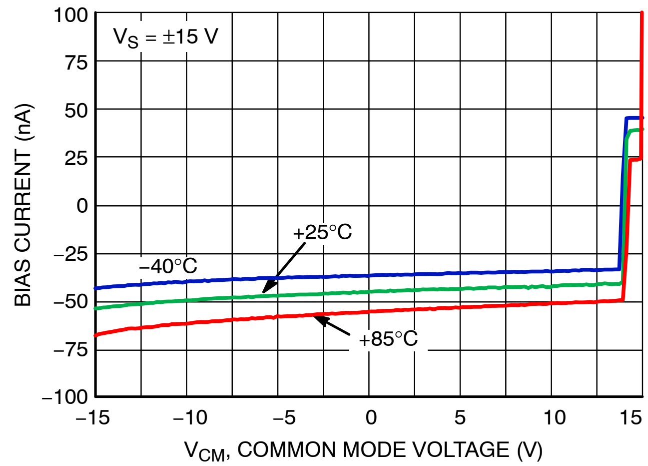


Figure 10. Inverting Input Bias Current vs. Common Mode

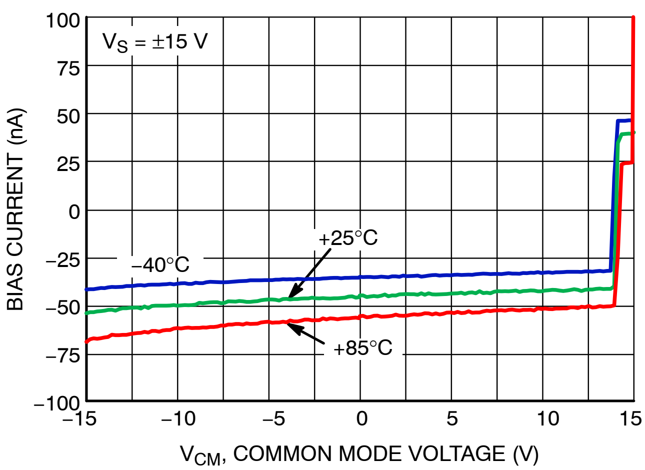


Figure 11. Non−Inverting Input Bias Current vs. Common Mode

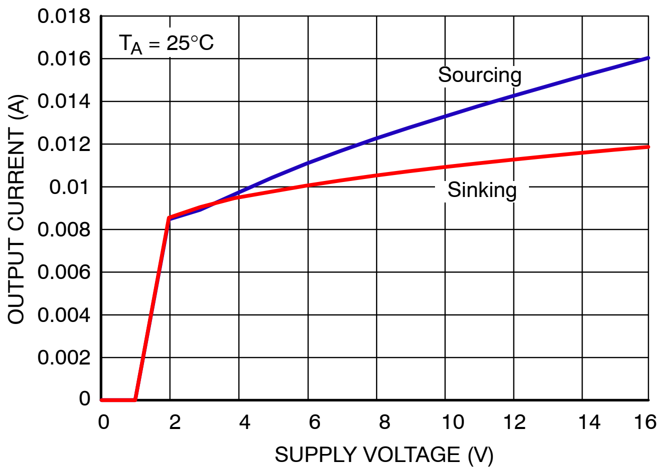


Figure 12. Short−Circuit Current vs. Supply Voltage

TYPICAL CHARACTERISTICS

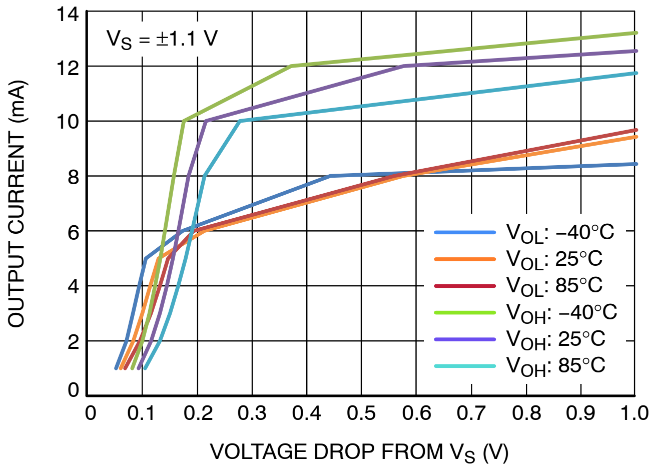


Figure 13. I_O vs. V_O

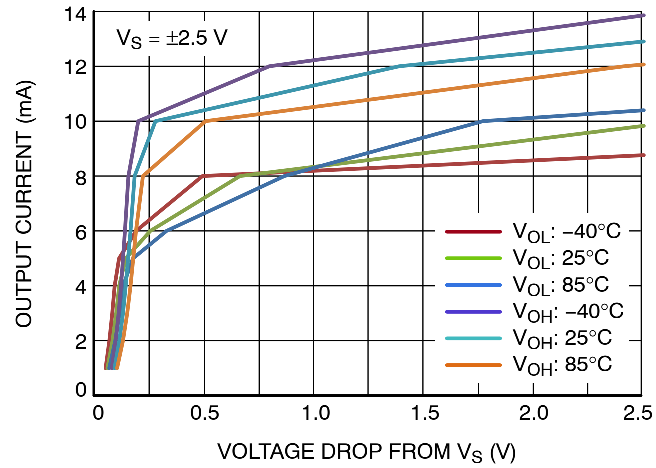


Figure 14. I_O vs. V_O

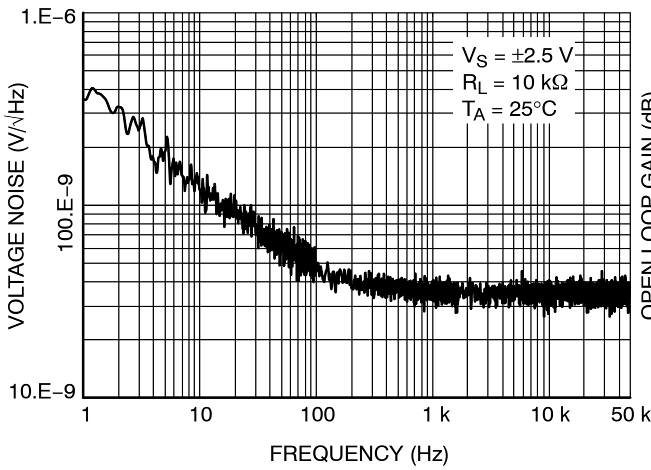


Figure 15. Voltage Noise vs. Frequency

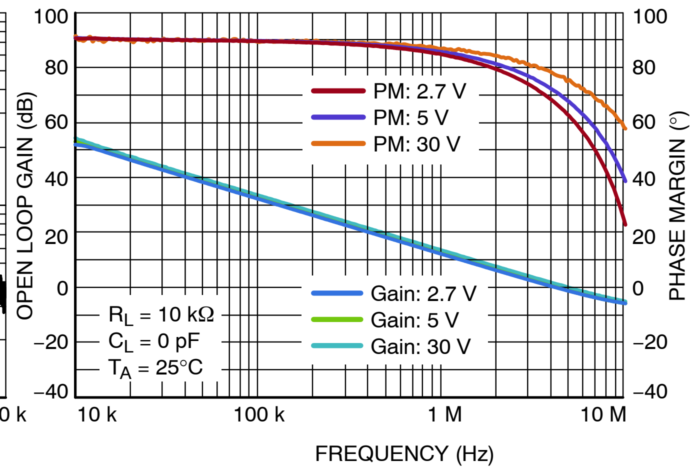


Figure 16. Gain and Phase Margin

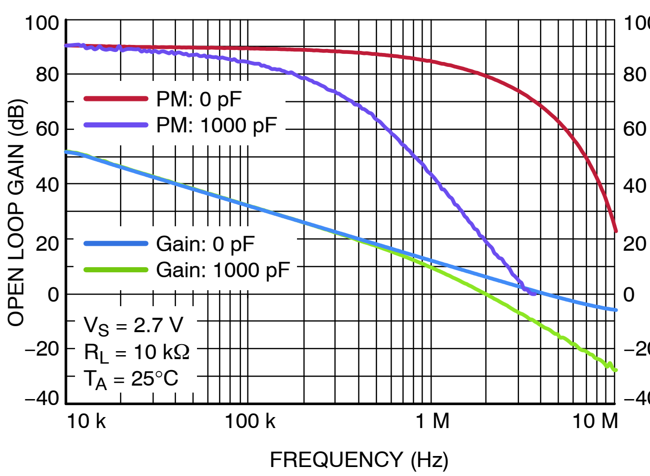


Figure 17. Gain/Phase vs. Capacitive Load

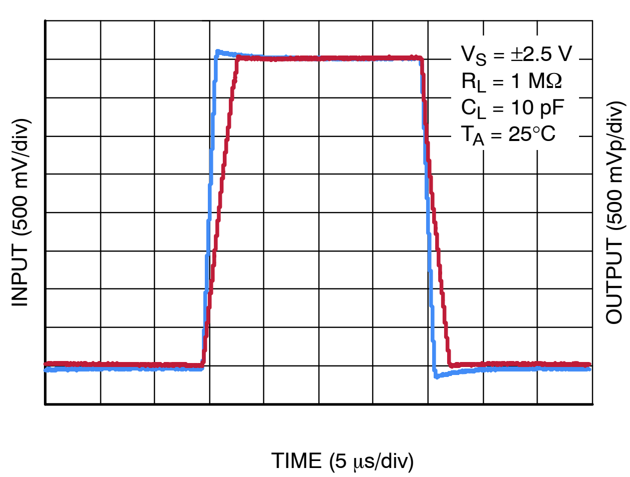


Figure 18. Large Signal Step Response

TYPICAL CHARACTERISTICS

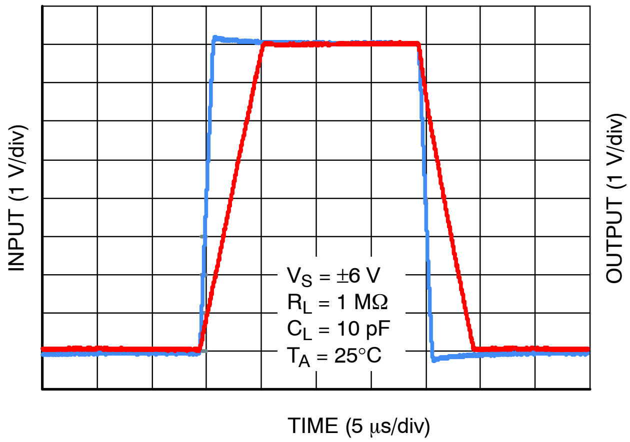


Figure 19. Large Signal Step Response

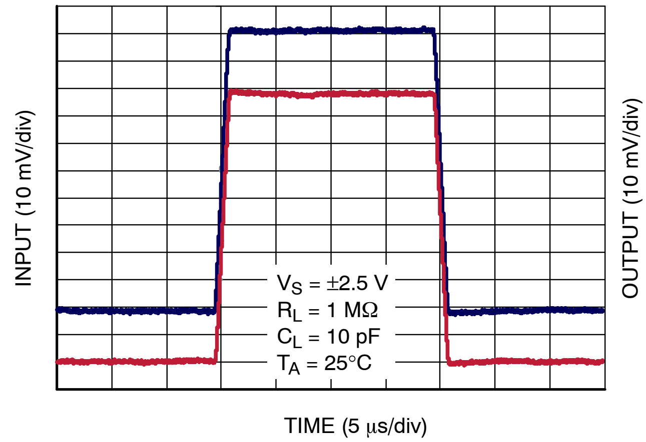


Figure 20. Small Signal Step Response

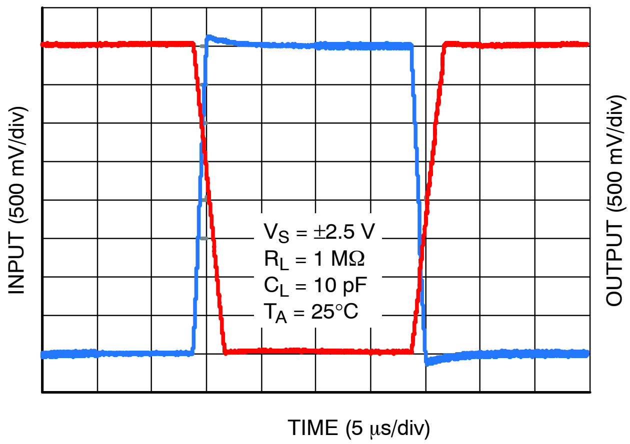


Figure 21. Inverting Large Signal Step Response

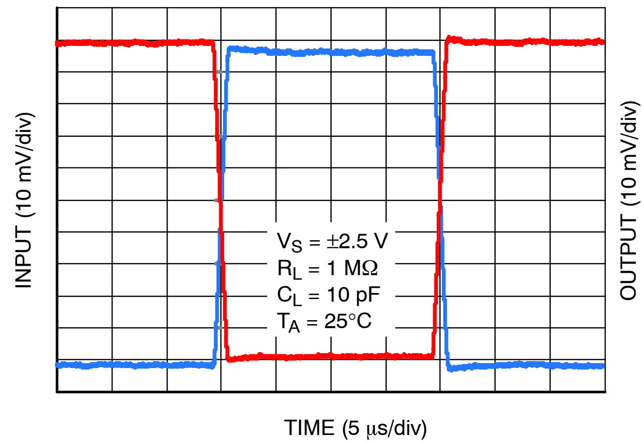


Figure 22. Inverting Small Signal Step Response

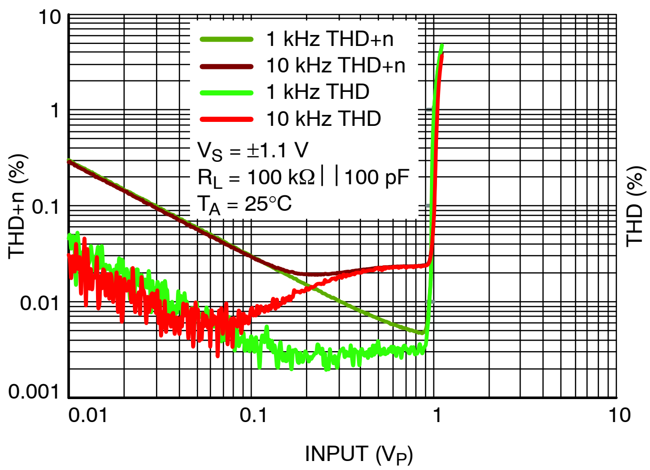


Figure 23. Harmonic Distortion

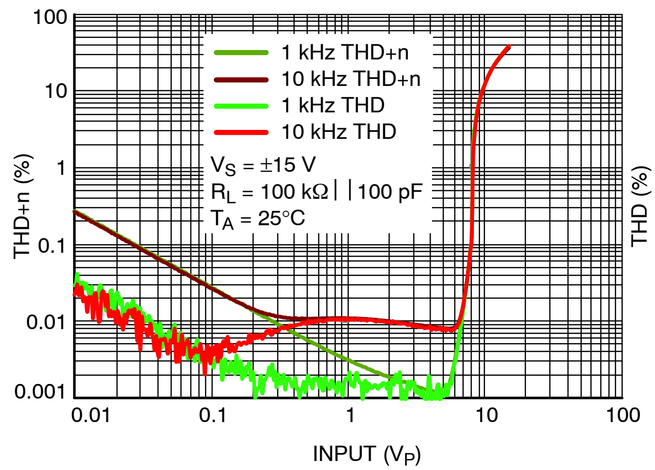


Figure 24. Harmonic Distortion

TYPICAL CHARACTERISTICS

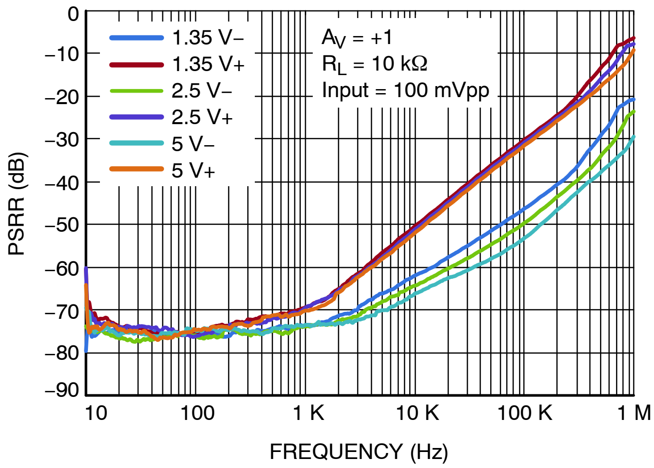


Figure 25. PSRR vs. Frequency

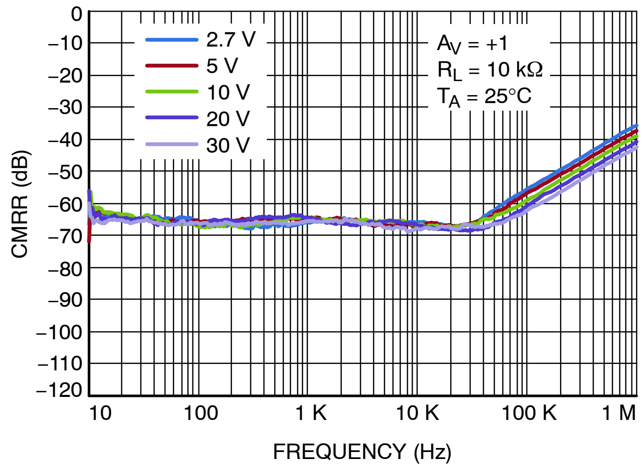


Figure 26. CMRR vs. Frequency

APPLICATIONS INFORMATION

GENERAL INFORMATION

The LM7301 is ideal in a variety of situations due to low supply current, wide bandwidth, wide input common mode range extending 100 mV beyond the rails, full rail-to-rail output, high capacitive load driving ability, wide supply voltage (1.8 V to 32 V), and low distortion. The high common mode rejection ratio and full rail-to-rail input range provides precision performance, particularly in non−inverting applications where the common mode error is added directly to the other system errors.

CAPACITIVE LOAD DRIVING

The LM7301 is capable of driving large capacitive loads. A 1000 pF load only reduces the phase margin to about 25°.

WIDE SUPPLY RANGE

High PSRR and CMRR provide precision performance when the LM7301 is operating on a battery or other unregulated supplies. This advantage is further enhanced by the very wide supply range of 1.8 V to 32 V. In situations where highly variable or unregulated supplies are present, the excellent PSRR and wide supply range will maintain this precision performance, even in such adverse supply conditions.

SPECIFIC ADVANTAGES OF 5−Pin TSOP

The most apparent 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 the overall system size is inherent in any 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 TSOP-5 package is that it allows better system performance due to ease of package placement. Because the 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 allows for many system enhancements, which cannot be easily achieved with the constraints of a larger package. For example, problems such as system noise due picking up undesired digital signal 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 noise. An overall reduction of system noise results.

Often, trying to save space by using dual or quad op amps causes complicated board layouts 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 excellent low distortion performance, with a THD+N of 0.02% at f = 10 kHz. Low distortion levels are offered even at in scenarios with high output current and low load resistance.

TYPICAL APPLICATIONS

HANDHELD REMOTE CONTROLS

The LM7301 offers outstanding specifications for applications requiring balance between speed and power. 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 low distortion and high load driving capabilities of the LM7301 make it an excellent choice in modems for driving opto-isolator circuits to achieve line isolation. 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 as well as other telecom applications.

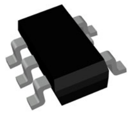
REMOTE MICROPHONE IN PERSONAL COMPUTERS

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

ORDERING INFORMATION

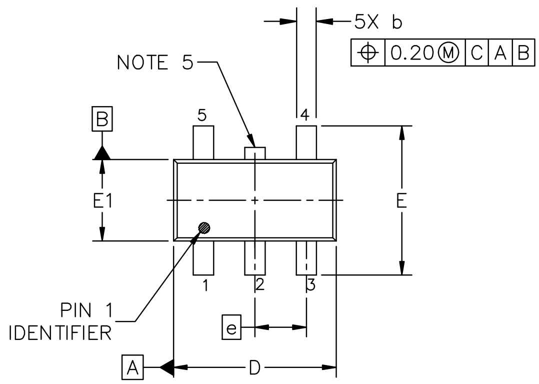
Device	Marking	Package	Shipping†
LM7301SN1T1G	JFG	SOT23−5 (Pb−Free)	3000 / Tape & Reel

†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.

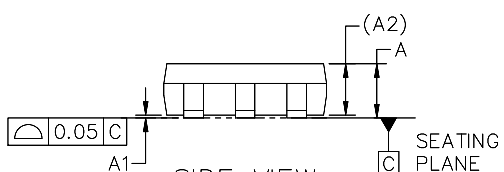


TSOP−5 3.00x1.50x0.95, 0.95P
CASE 483
ISSUE P

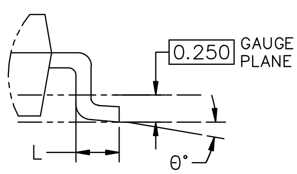
DATE 01 APR 2024



TOP VIEW



SIDE VIEW

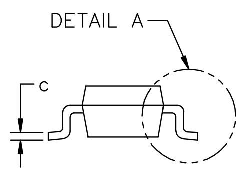


DETAIL "A"
SCALE 2:1

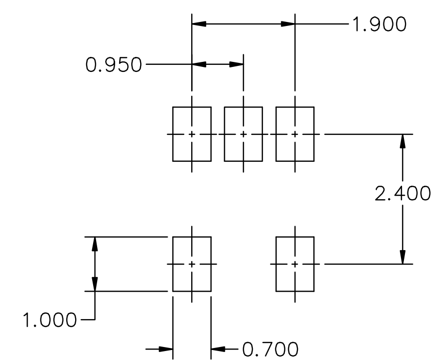
NOTES:

1. DIMENSIONING AND TOLERANCING CONFORM TO ASME Y14.5−2018.
2. ALL DIMENSION ARE IN MILLIMETERS (ANGLES IN DEGREES).
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. DIMENSIONS D AND E1 DO NOT INCLUDE MOLD FLASH, PROTRUSIONS OF GATE BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.15 PER SIDE. DIMENSION D.
5. OPTIONAL CONSTRUCTION: AN ADDITIONAL TRIMMED LEAD IS ALLOWED IN THIS LOCATION. TRIMMED LEAD NOT TO EXTEND MORE THAN 0.2 FROM BODY.

DIM	MILLIMETERS		
	MIN.	NOM.	MAX.
A	0.900	1.000	1.100
A1	0.010	0.055	0.100
A2	0.950 REF.		
b	0.250	0.375	0.500
c	0.100	0.180	0.260
D	2.850	3.000	3.150
E	2.500	2.750	3.000
E1	1.350	1.500	1.650
e	0.950 BSC		
L	0.200	0.400	0.600
θ	0°	5°	10°



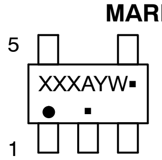
END VIEW



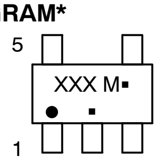
RECOMMENDED MOUNTING FOOTPRINT*

* FOR ADDITIONAL INFORMATION ON OUR Pb−FREE STRATEGY AND SOLDERING DETAILS, PLEASE DOWNLOAD THE ON SEMICONDUCTOR SOLDERING AND MOUNTING TECHNIQUES REFERENCE MANUAL, SOLDERRM/D.

GENERIC MARKING DIAGRAM*



Analog



Discrete/Logic

Analog:

XXX = Specific Device Code
A = Assembly Location
Y = Year
W = Work Week
▪ = Pb−Free Package
(Note: Microdot may be in either location)

Discrete/Logic:

XXX = Specific Device Code
M = Date Code
▪ = Pb−Free Package

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

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DESCRIPTION:	TSOP−5 3.00x1.50x0.95, 0.95P	PAGE 1 OF 1

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