Single, Dual, and Quad 40V Low Noise Precision Amplifiers

Check for Samples: LMP8671, LMP8672, LMP8674

FEATURES

- **Output Short Circuit Protection**
- **PSRR and CMRR Exceed 110dB**
- **Best in Class Linearity (135dB)**

APPLICATIONS

- **Low Noise Industrial Applications Including Test, Measurement, and Ultrasound**
- **Precision Active Filters**
- **PLL Filters**
- **4-20mA Current Loops**
- **Motor Control**

KEY SPECIFICATIONS

- **Input Offset Voltage 0.4mV**
- **TC V_{OS} 2µV/°C (max)**
- **Power Supply Voltage Range ±2.5V to ±20V**
- **Voltage Noise Density 2.5nV/$\sqrt{Hz}$**
- **Slew Rate ±20V/µs**
- **Gain Bandwidth Product 55MHz**
- **Open Loop Gain 135dB**
- **Input Bias Current 10nA**

DESCRIPTION

The LMP8671/2/4 combines great precision, low noise and a large operating voltage range to provide a high SNR and a wide dynamic range. Its AC performance allows it to be used over a wide frequency without degradation. It is the ideal choice for applications requiring DC precision and low noise such as precision PLL filters, multi feedback and multi pole active filters, GPS receivers and precision control loop systems. The LMP8671/2/4 offers an extremely high open loop gain of 135dB, low voltage noise density (2.5nV/$\sqrt{Hz}$), and a superb linearity of 0.000009%. These characteristics drastically reduce gain error which is a challenge in accurate systems requiring higher gains such as data acquisition systems.

To ensure that the most challenging loads are driven without compromise, the LMP8671/2/4 has a high slew rate of ±20V/µs and an output current capability of ±26mA.

The LMP8671/2 family of high-voltage amplifiers are available in SOIC-8, the LMP8674 in SOIC-14.

Connection Diagrams

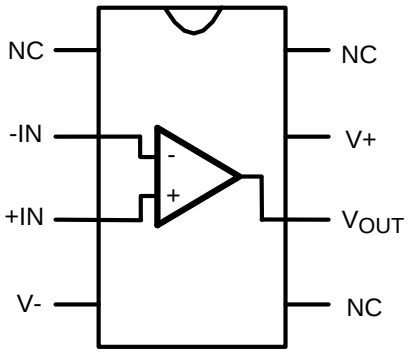


Figure 1. See Package Number — D0008A

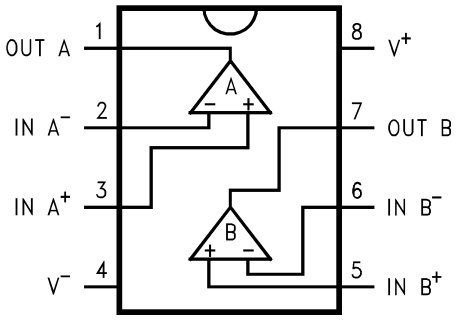


Figure 2. See Package Number — D0008A

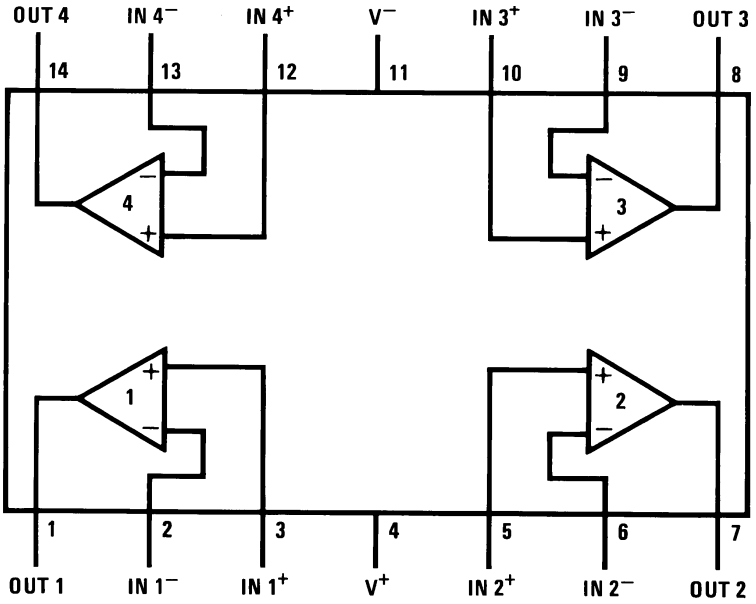


Figure 3. See Package Number — D0014A

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

Absolute Maximum Ratings[1][2][3]

Power Supply Voltage ($V_S = V^+ - V^-$)		46V
Storage Temperature		−65°C to 150°C
Input Voltage		(V-) - 0.7V to (V+) + 0.7V
Output Short Circuit[4]		Continuous
Power Dissipation		Internally Limited
ESD Rating[5]		2000V
ESD Rating[6]	Pins 1, 4, 7 and 8	200V
	Pins 2, 3, 5 and 6	100V
Junction Temperature		150°C
Thermal Resistance	θ_{JA} (SO)	145°C/W
For soldering specifications, http://www.ti.com/lit/SNOA549		

(1) "*Absolute Maximum Ratings*" indicate limits beyond which damage to the device may occur, including inoperability and degradation of device reliability and/or performance. Functional operation of the device and/or non-degradation at the *Absolute Maximum Ratings* or other conditions beyond those indicated in the *Recommended Operating Conditions* is not implied. The *Recommended Operating Conditions* indicate conditions at which the device is functional and the device should not be operated beyond such conditions. All voltages are measured with respect to the ground pin, unless otherwise specified.

(2) The *Electrical Characteristics* tables list ensured specifications under the listed *Recommended Operating Conditions* except as otherwise modified or specified by the *Electrical Characteristics Conditions* and/or Notes. Typical specifications are estimations only and are not ensured.

(3) If Military/Aerospace specified devices are required, please contact the TI Sales Office/ Distributors for availability and specifications.

(4) The maximum power dissipation must be derated at elevated temperatures and is dictated by T_{JMAX}, θ_{JA}, and the ambient temperature, T_A. The maximum allowable power dissipation is $P_{DMAX} = (T_{JMAX} - T_A) / \theta_{JA}$ or the number given in *Absolute Maximum Ratings*, whichever is lower.

(5) Human body model, applicable std. JESD22-A114C.

(6) Machine model, applicable std. JESD22-A115-A.

Operating Ratings

Temperature Range $T_{MIN} \le T_A \le T_{MAX}$	$-40°C \le T_A \le 125°C$
Supply Voltage Range LMP8671/2/4	$\pm 2.5V \le V_S \le \pm 22V$

Electrical Characteristics for the LMP8671/2/4[1]

The following specifications apply for V_S = ±20V, R_L = 2kΩ, R_{SOURCE} = 10Ω, f_{IN} = 1kHz, T_A = 25°C, unless otherwise specified. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	LMP8671/2/4		Units (Limits)
			Typical[2]	Limit[3]	
V_{OS}	Offset Voltage		±100	±400 **±750**	µV (max)
$\Delta V_{OS}/\Delta Temp$	Average Input Offset Voltage Drift vs Temperature	–40°C ≤ T_A ≤ 125°C	0.1	2	µV/°C (max)
I_B	Input Bias Current	V_{CM} = 0V			
		LMP8671/4	10	±75 **±95**	nA (max)
		V_{CM} = 0V			
		LMP8672	50	±200 **±250**	nA (max)
I_{OS}	Input Offset Current	V_{CM} = 0V			
		LMP8671/4	11	±50 **±95**	nA (max)
		V_{CM} = 0V			
		LMP8672	25	±100 **±125**	nA (max)
$\Delta I_{OS}/\Delta Temp$	Input Bias Current Drift vs Temperature	–40°C ≤ T_A ≤ 125°C	0.2		nA/°C
V_{IN-CM}	Common-Mode Input Voltage Range		+17.1 –16.9		V (min) V (min)
Z_{IN}	Differential Input Impedance		30		kΩ
	Common Mode Input Impedance	–10V<Vcm<10V	1000		MΩ
e_n	Equivalent Input Noise Voltage	20Hz to 20kHz	0.34	0.65	μV_{RMS} (max)
	Equivalent Input Noise Density	f = 1kHz	2.5	4.7	nV/√Hz (max)
i_n	Current Noise Density	f = 1kHz f = 10Hz	1.6 3.1		pA/√Hz
THD+N	Total Harmonic Distortion + Noise	A_V = 1, V_{OUT} = 3V_{rms}, R_L = 600Ω	0.00003	0.00009	% (max)
t_S	Settling time	A_V = –1, 10V step, C_L = 100pF 0.1% error range	1.2		µs
GBWP	Gain Bandwidth Product		55	45	MHz (min)
SR	Slew Rate		±20	±15	V/µs (min)
PSRR	Average Input Offset Voltage Shift vs Power Supply Voltage	See[4]	125	110 **100**	dB (min)
CMRR	Common-Mode Rejection	–15V≤Vcm≤15V	115	105 **100**	dB (min)
A_{VOL}	Open Loop Voltage Gain	–15V ≤ Vout ≤ 15V R_L = 2kΩ	135	125	dB (min)
V_{OUTMAX}	Maximum Output Voltage Swing	R_L = 2kΩ	±19.0	±18.8 ±18.6	V (min)
I_{OUT-CC}	Instantaneous Short Circuit Current		+53 –42		mA

(1) "*Absolute Maximum Ratings*" indicate limits beyond which damage to the device may occur, including inoperability and degradation of device reliability and/or performance. Functional operation of the device and/or non-degradation at the *Absolute Maximum Ratings* or other conditions beyond those indicated in the *Recommended Operating Conditions* is not implied. The *Recommended Operating Conditions* indicate conditions at which the device is functional and the device should not be operated beyond such conditions. All voltages are measured with respect to the ground pin, unless otherwise specified.
(2) Typical values represent most likely parametric norms at T_A = +25ºC, and at the *Recommended Operation Conditions* at the time of product characterization and are not ensured.
(3) Datasheet min/max specification limits are ensured by test or statistical analysis.
(4) PSRR is measured as follows: For V_S, V_{OS} is measured at two supply voltages, ±5V and ±20V, PSRR = |20log($\Delta V_{OS}/\Delta V_S$)|.

Electrical Characteristics for the LMP8671/2/4[1] (continued)

The following specifications apply for V_S = ±20V, R_L = 2kΩ, R_{SOURCE} = 10Ω, f_{IN} = 1kHz, T_A = 25°C, unless otherwise specified. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	LMP8671/2/4		Units (Limits)
			Typical[2]	Limit[3]	
R_{OUT}	Output Impedance	f_{IN} = 10kHz Closed-Loop Open-Loop	 0.01 13		Ω
I_{OUT}	Output Current	R_L = 2kΩ	9.5	9.3	mA (min)
I_S	Total Quiescent Current	I_{OUT} = 0mA			
		LMP8671	5	6 **8**	mA (max)
		LMP8672	12.5	16	mA (max)
		LMP8674	20	22	mA (max)

Typical Performance Characteristics

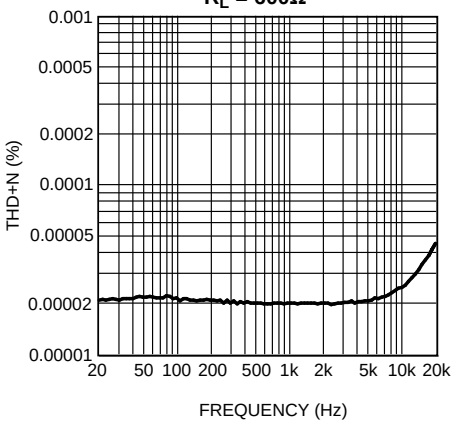


Figure 4.

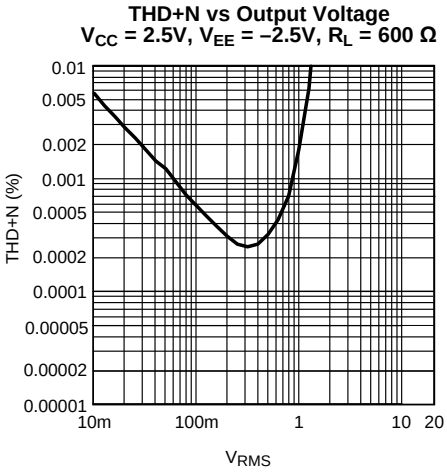


Figure 5.

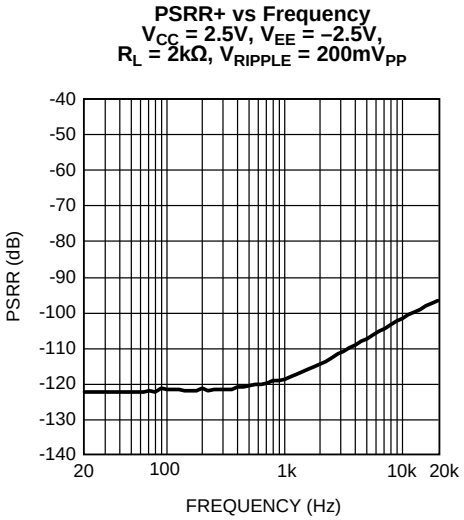


Figure 6.

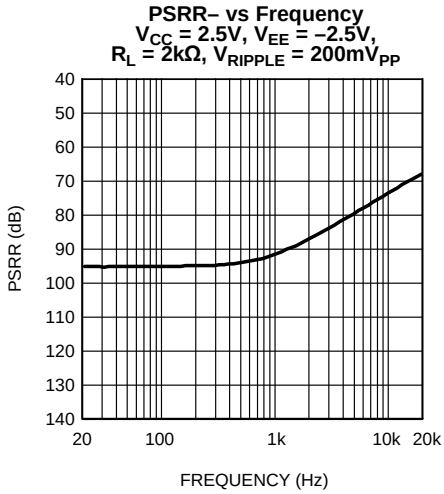


Figure 7.

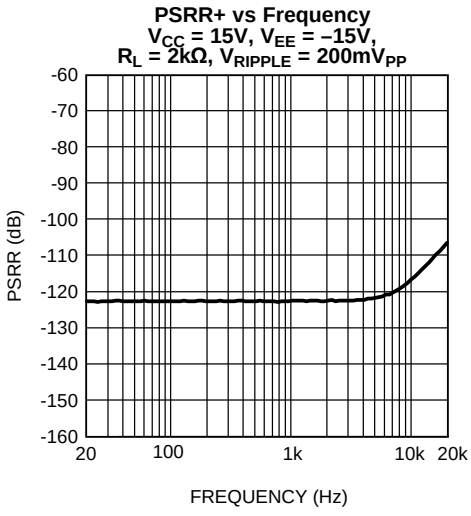


Figure 8.

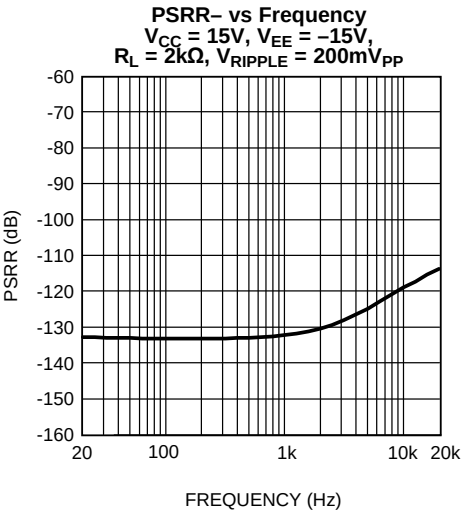


Figure 9.

Typical Performance Characteristics (continued)

PSRR+ vs Frequency
V_{CC} = 15V, V_{EE} = –15V,
R_L = 600Ω, V_{RIPPLE} = 200mV_{PP}

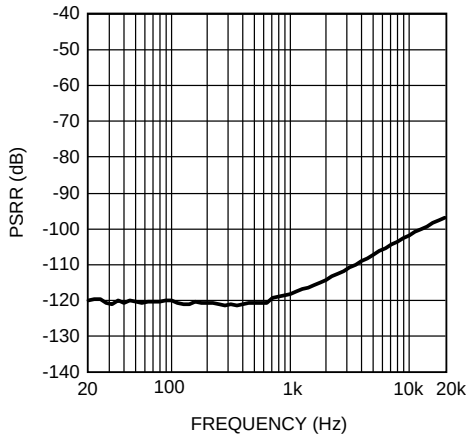


Figure 10.

PSRR– vs Frequency
V_{CC} = 15V, V_{EE} = –15V,
R_L = 600Ω, V_{RIPPLE} = 200mV_{PP}

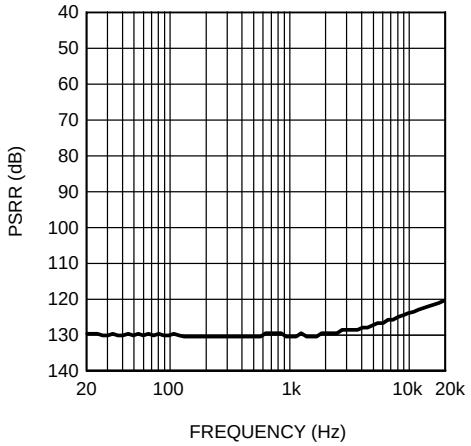


Figure 11.

CMRR vs Frequency
V_{CC} = 15V, V_{EE} = –15V, R_L = 600Ω

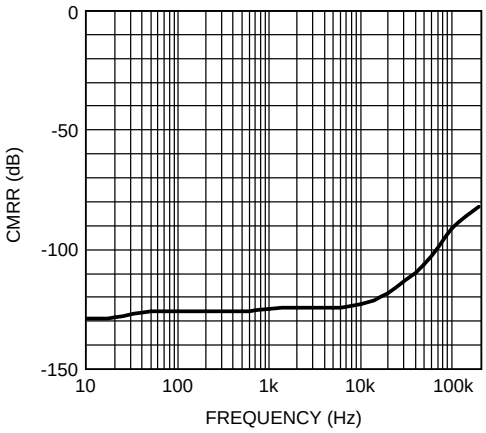


Figure 12.

CMRR vs Frequency
V_{CC} = 15V, V_{EE} = –15V, R_L = 2kΩ

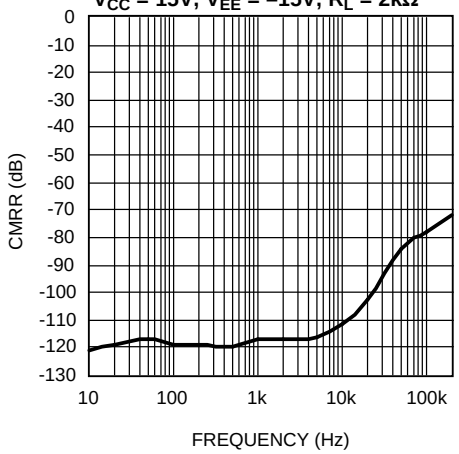


Figure 13.

CMRR vs Frequency
V_{CC} = 2.5V, V_{EE} = –2.5V, R_L = 600Ω

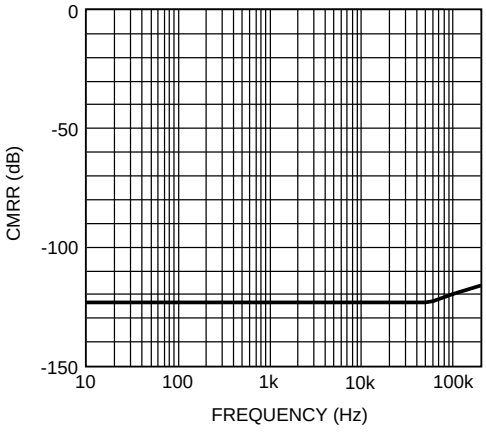


Figure 14.

CMRR vs Frequency
V_{CC} = 2.5V, V_{EE} = –2.5V, R_L = 2kΩ

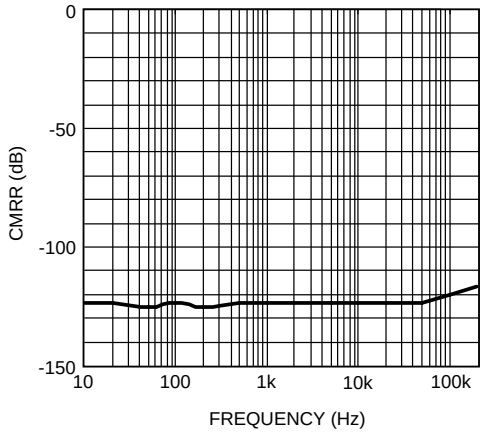


Figure 15.

Typical Performance Characteristics (continued)

Output Voltage vs Supply Voltage
THD+N = 1%, R_L = 2kΩ

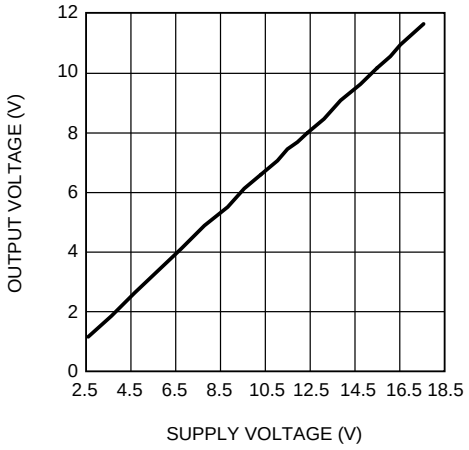


Figure 16.

Output Voltage vs Supply Voltage
THD+N = 1%, R_L = 600Ω

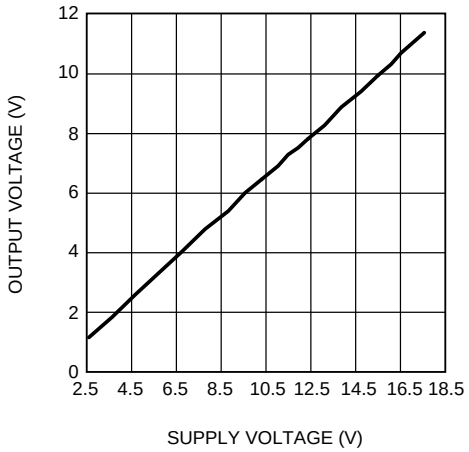


Figure 17.

Crosstalk vs Frequency
V_{CC} = 15V, V_{EE} = –15V, R_L = 2kΩ

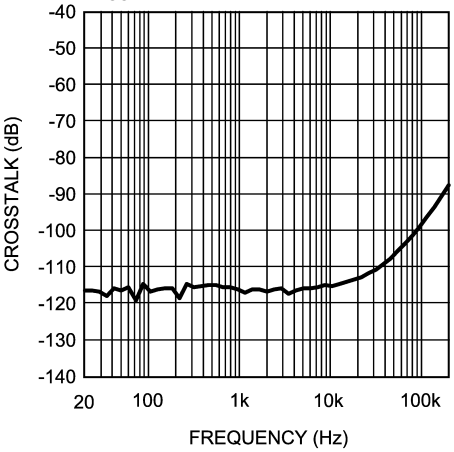


Figure 18.

Full Power Bandwidth vs Frequency

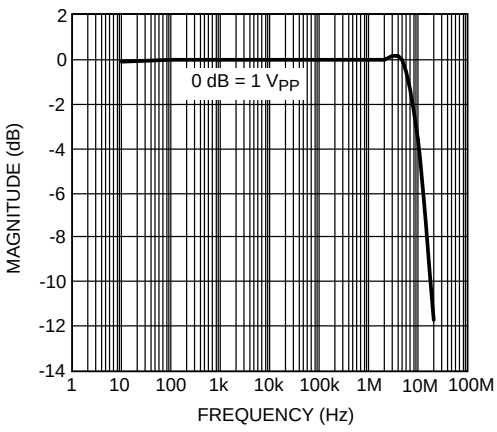


Figure 19.

Gain Phase vs Frequency

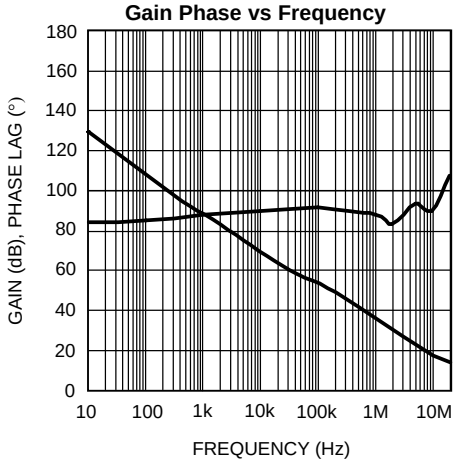


Figure 20.

Voltage Noise Density vs Frequency

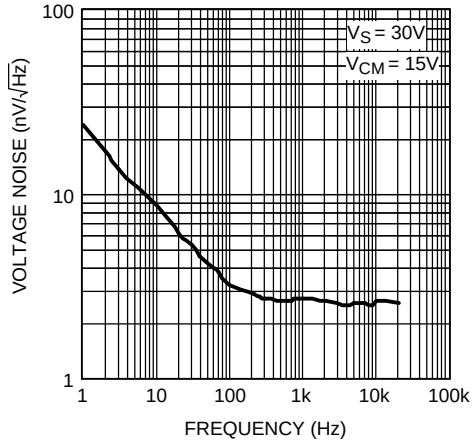


Figure 21.

Typical Performance Characteristics (continued)

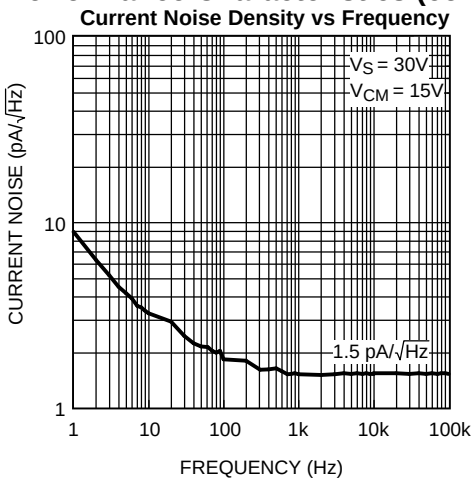


Figure 22.

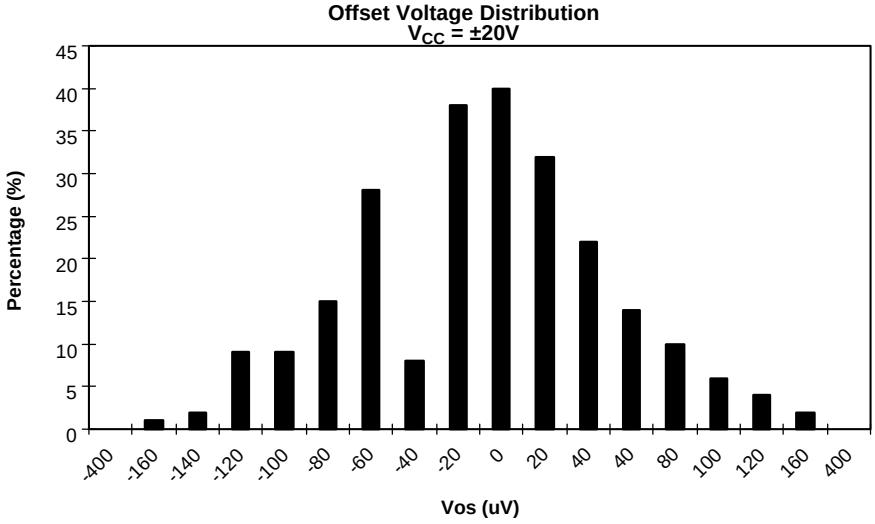


Figure 23.

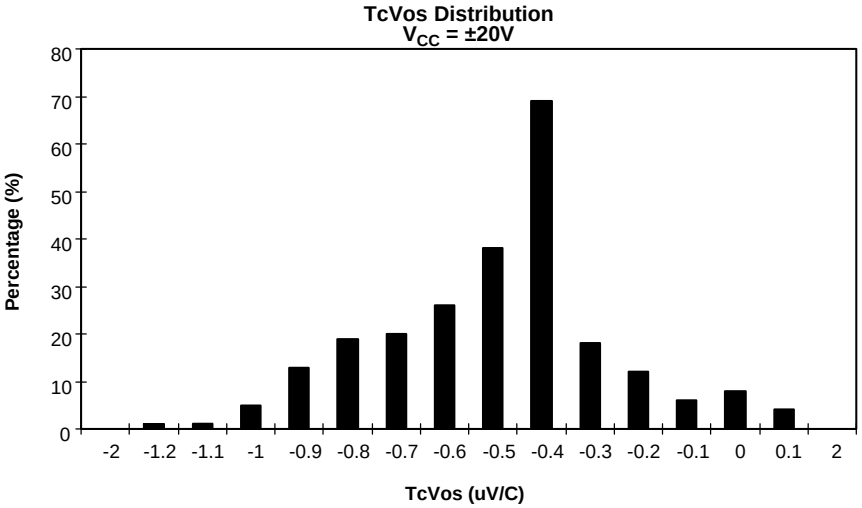


Figure 24.

REVISION HISTORY

Changes from Revision A (March 2013) to Revision B	Page
• Changed layout of National Data Sheet to TI format	8

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
LMP8672MA/NOPB	ACTIVE	SOIC	D	8	95	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	LMP86 72MA	Samples
LMP8672MAX/NOPB	ACTIVE	SOIC	D	8	2500	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	LMP86 72MA	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.

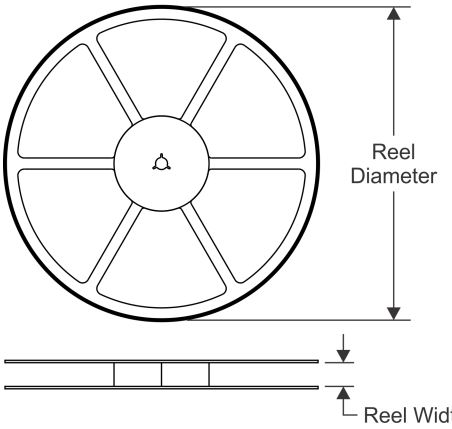
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(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.

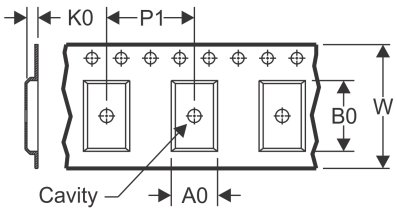
(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

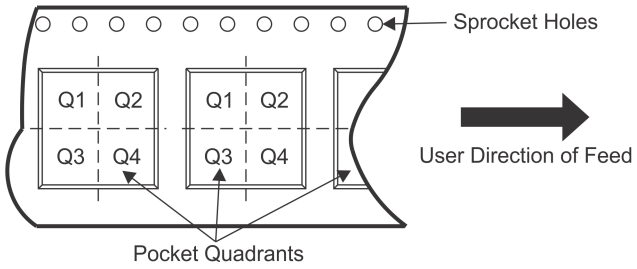


TAPE DIMENSIONS



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

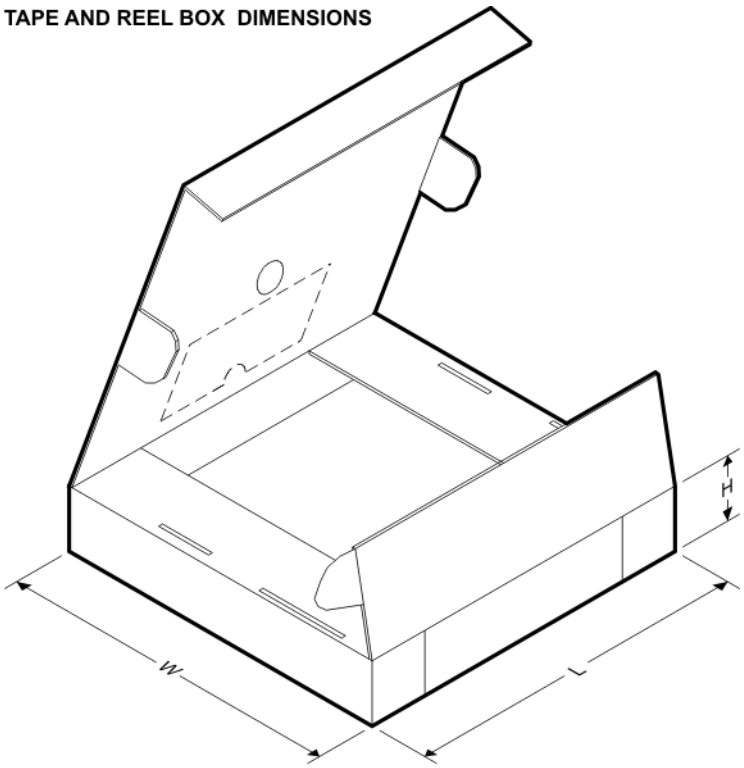
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
LMP8672MAX/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1

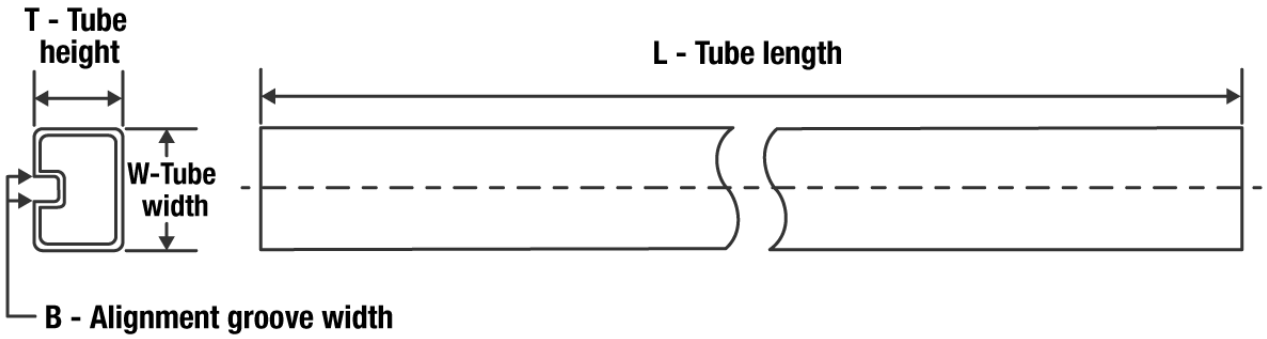
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

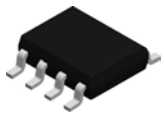
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LMP8672MAX/NOPB	SOIC	D	8	2500	356.0	356.0	35.0

TUBE



*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
LMP8672MA/NOPB	D	SOIC	8	95	495	8	4064	3.05

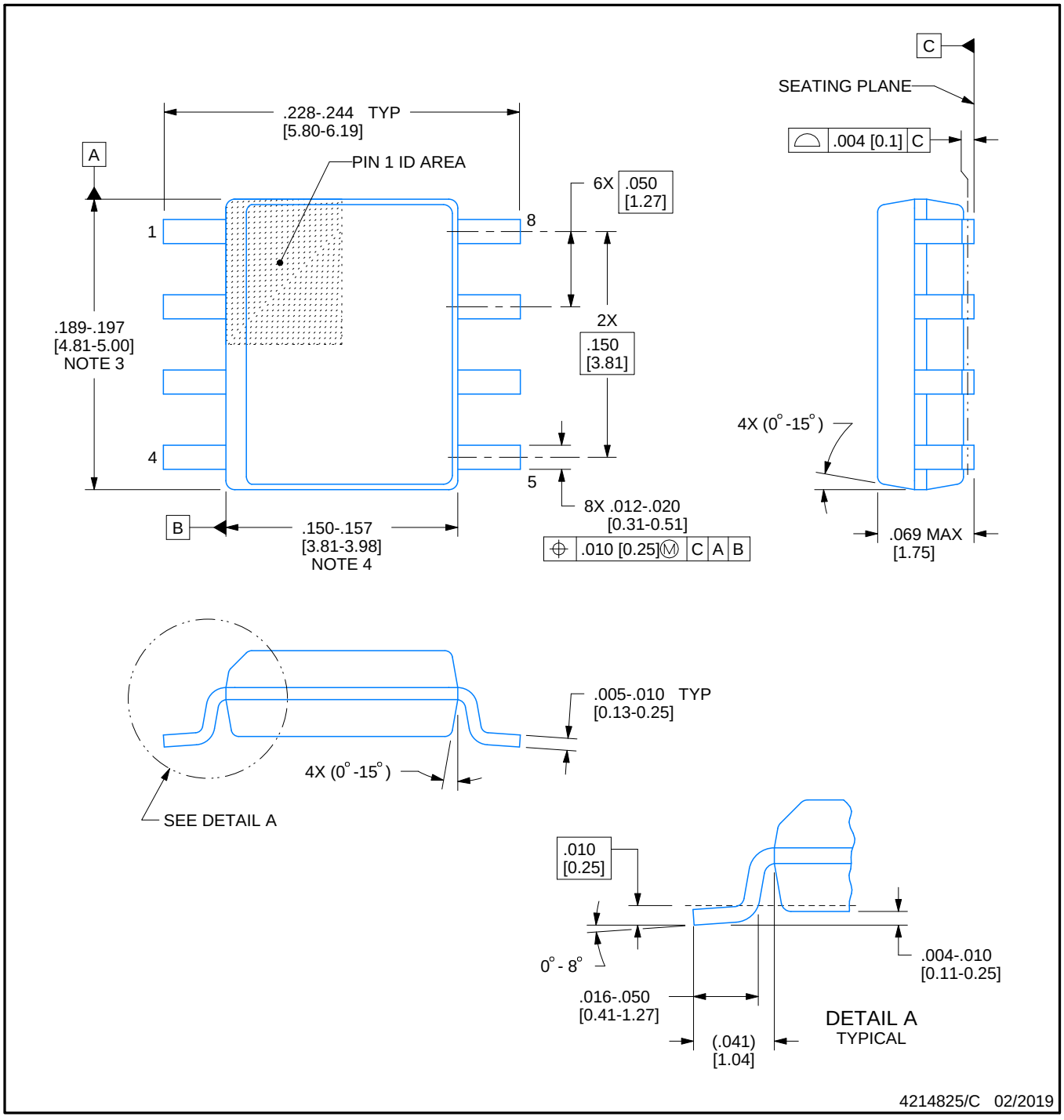


PACKAGE OUTLINE

D0008A

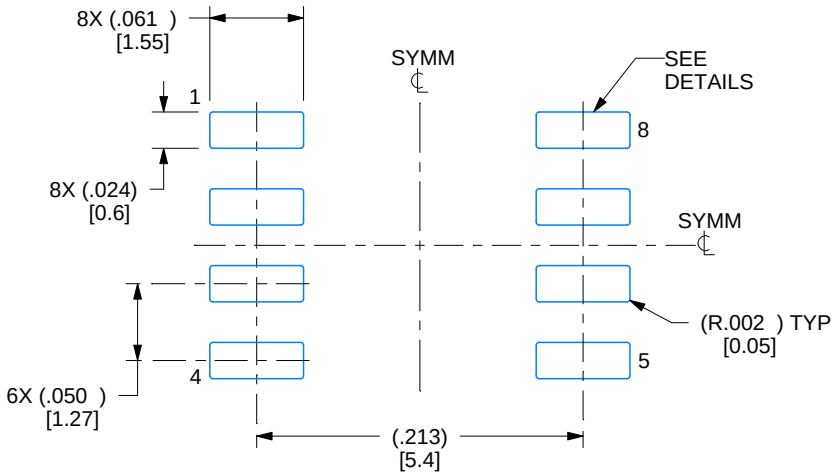
SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT

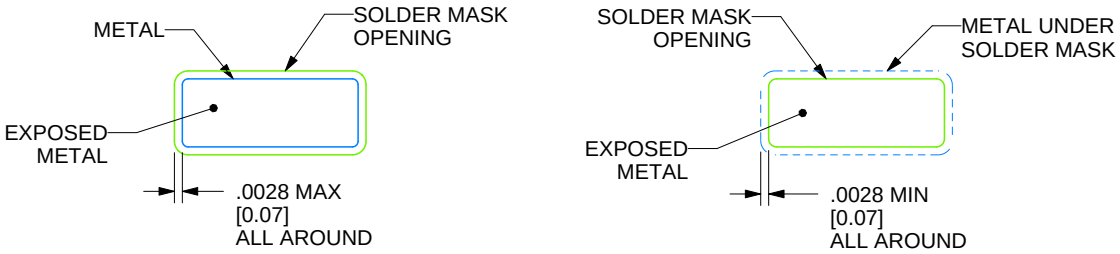


NOTES:

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



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:8X



SOLDER MASK DETAILS

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NOTES: (continued)

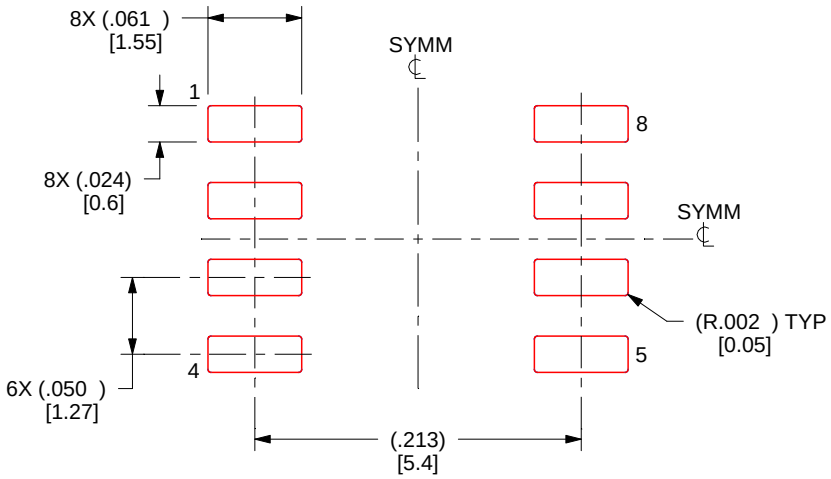
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



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

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NOTES: (continued)

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

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