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**

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.

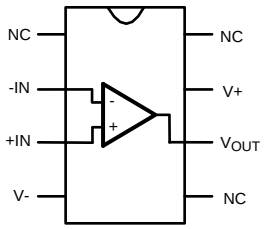
To ensure that the most challenging loads are driven without compromise, the LMP8671/2/4 has a high slew rate of ±20V/µs and an output current capability of ±26mA.

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

Table 1. Key Specifications

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

Connection Diagram

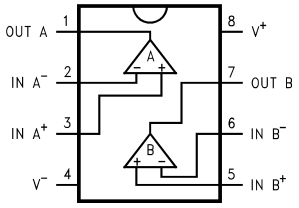


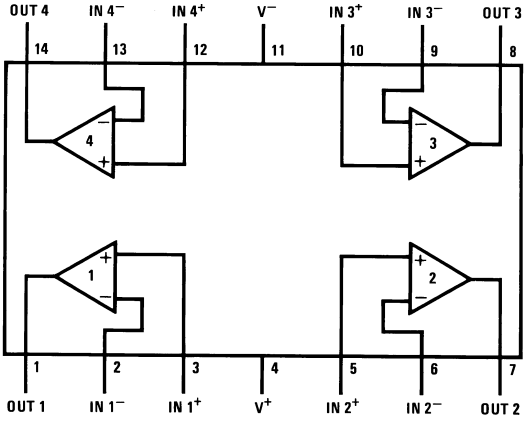
Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

All trademarks are the property of their respective owners.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of the Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

Copyright © 2011, Texas Instruments Incorporated





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)

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 (3)	Continuous
Power Dissipation	Internally Limited
ESD Rating (4)	2000V
ESD Rating (5)	
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,	
see product folder at www.national.com and	
www.national.com/ms/MS/MS-SOLDERING.pdf	

(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 guaranteed 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 guaranteed.

(3) 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.

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

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

Copyright © 2011, Texas Instruments Incorporated

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	$\pm 2.5V \le V_S \le \pm 22V$

Copyright © 2011, Texas Instruments Incorporated

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	$nV/\sqrt{Hz}$ (max)
i_n	Current Noise Density	f = 1kHz f = 10Hz	1.6 3.1		$pA/\sqrt{Hz}$
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	[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)

(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 guaranteed.

(3) Datasheet min/max specification limits are guaranteed 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 = $|20\log(\Delta V_{OS}/\Delta V_S)|$.

Copyright © 2011, Texas Instruments Incorporated

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

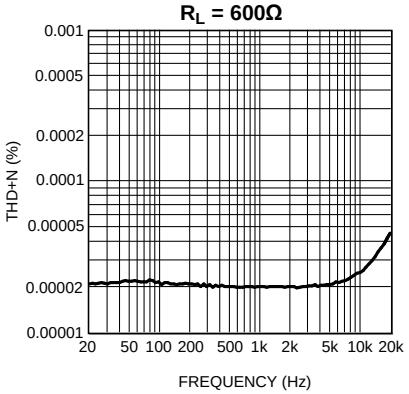
The following specifications apply for V_S = ±20V, R_L = 2kΩ, R_{SOURCE} = 10Ω, f_{IN} = 1kHz, T_A = 25°C, unless otherwise specified. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	LMP8671/2/4		Units (Limits)
			Typical [2]	Limit [3]	
I_{OUT-CC}	Instantaneous Short Circuit Current		+53 –42		mA
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)

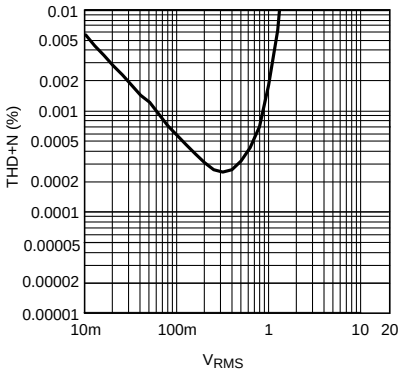
Copyright © 2011, Texas Instruments Incorporated

Typical Performance Characteristics

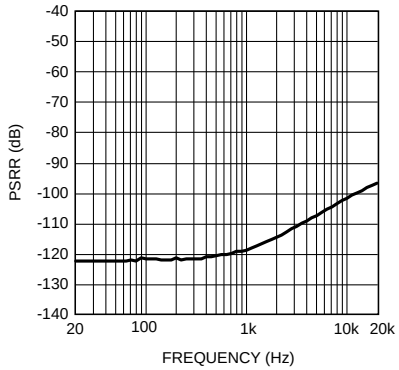
THD+N vs Frequency
$+V_{CC} = -V_{EE} = 15V$, $V_O = 3V_{RMS}$, $R_L = 600\Omega$



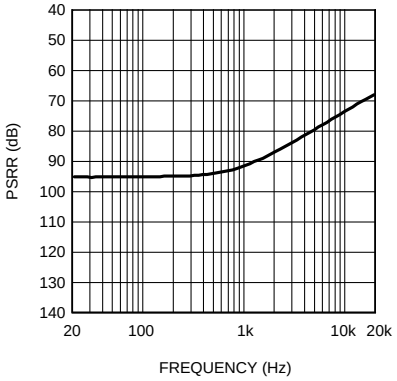
THD+N vs Output Voltage
$V_{CC} = 2.5V$, $V_{EE} = -2.5V$, $R_L = 600\ \Omega$



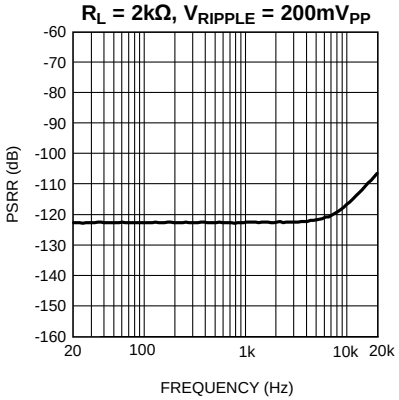
PSRR+ vs Frequency
$V_{CC} = 2.5V$, $V_{EE} = -2.5V$, $R_L = 2k\Omega$, $V_{RIPPLE} = 200mV_{PP}$



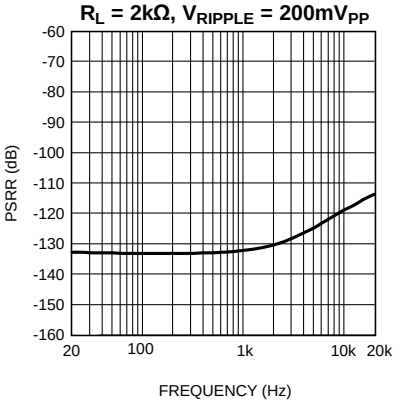
PSRR– vs Frequency
$V_{CC} = 2.5V$, $V_{EE} = -2.5V$, $R_L = 2k\Omega$, $V_{RIPPLE} = 200mV_{PP}$



PSRR+ vs Frequency
$V_{CC} = 15V$, $V_{EE} = -15V$, $R_L = 2k\Omega$, $V_{RIPPLE} = 200mV_{PP}$



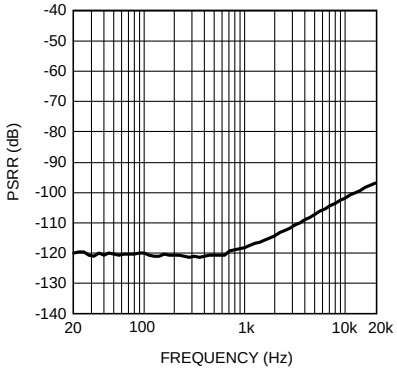
PSRR– vs Frequency
$V_{CC} = 15V$, $V_{EE} = -15V$, $R_L = 2k\Omega$, $V_{RIPPLE} = 200mV_{PP}$



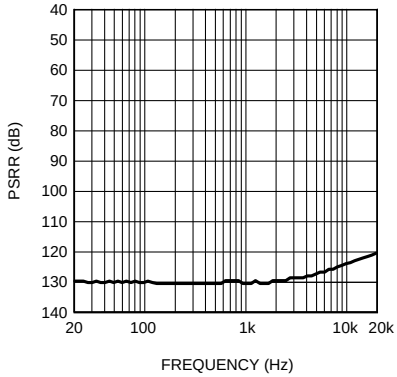
Copyright © 2011, Texas Instruments Incorporated

Typical Performance Characteristics (continued)

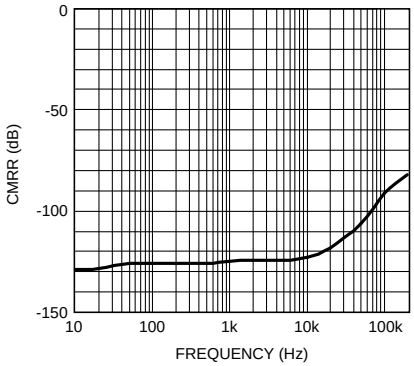
PSRR+ vs Frequency
V_{CC} = 15V, V_{EE} = –15V,
R_L = 600Ω, V_{RIPPLE} = 200mV_{PP}



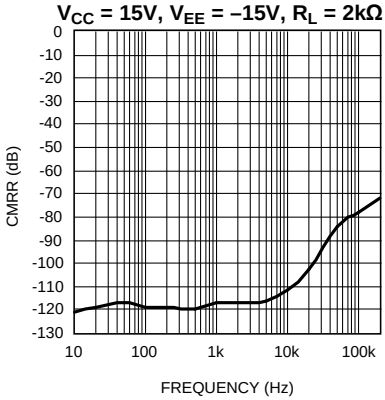
PSRR– vs Frequency
V_{CC} = 15V, V_{EE} = –15V,
R_L = 600Ω, V_{RIPPLE} = 200mV_{PP}



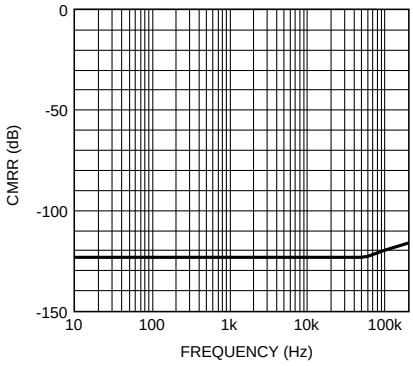
CMRR vs Frequency
V_{CC} = 15V, V_{EE} = –15V, R_L = 600Ω



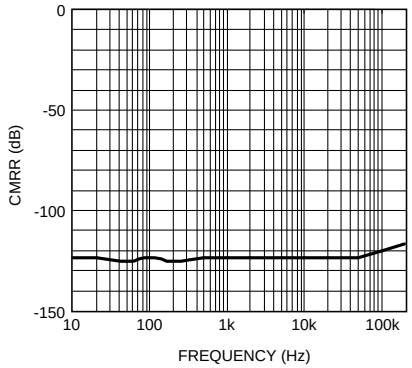
CMRR vs Frequency
V_{CC} = 15V, V_{EE} = –15V, R_L = 2kΩ



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



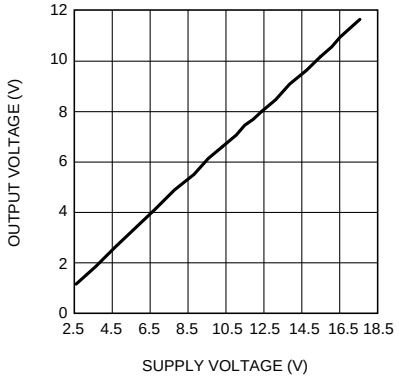
CMRR vs Frequency
V_{CC} = 2.5V, V_{EE} = –2.5V, R_L = 2kΩ



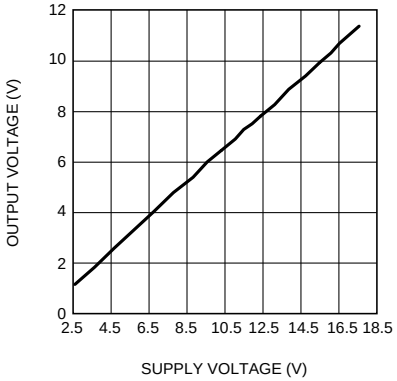
Copyright © 2011, Texas Instruments Incorporated

Typical Performance Characteristics (continued)

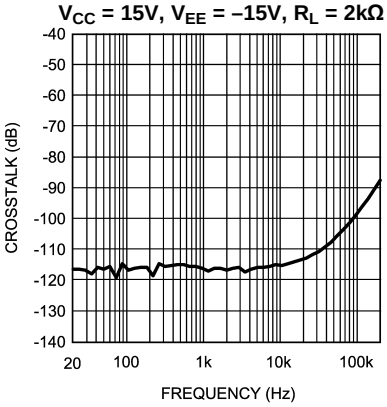
Output Voltage vs Supply Voltage THD+N = 1%, R_L = 2kΩ



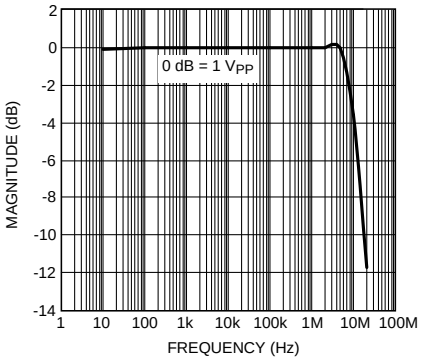
Output Voltage vs Supply Voltage THD+N = 1%, R_L = 600Ω



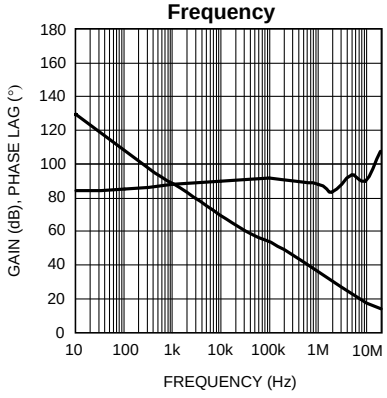
Crosstalk vs Frequency V_{CC} = 15V, V_{EE} = –15V, R_L = 2kΩ



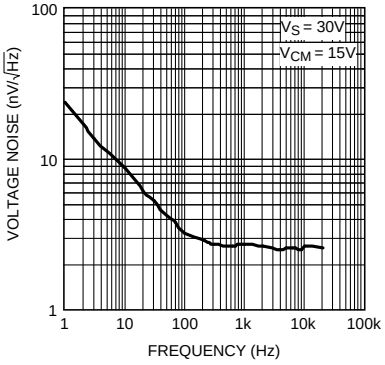
Full Power Bandwidth vs Frequency



Gain Phase vs Frequency



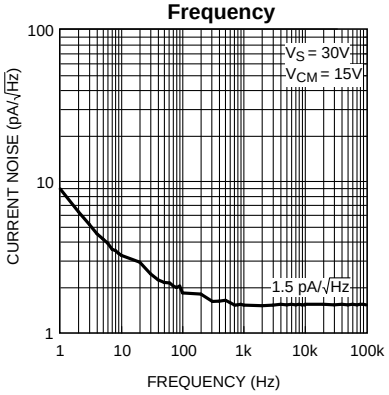
Voltage Noise Density vs Frequency



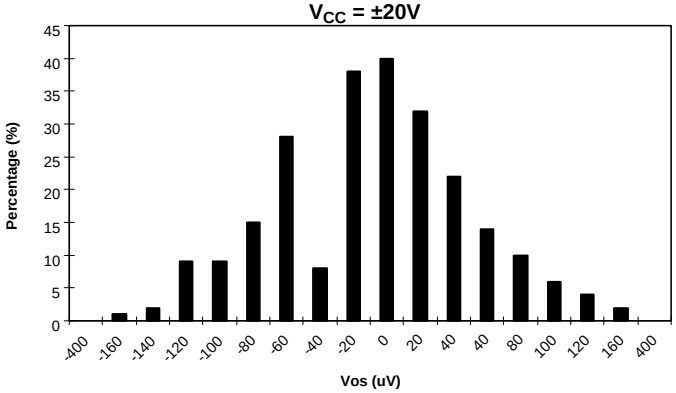
Copyright © 2011, Texas Instruments Incorporated

Typical Performance Characteristics (continued)

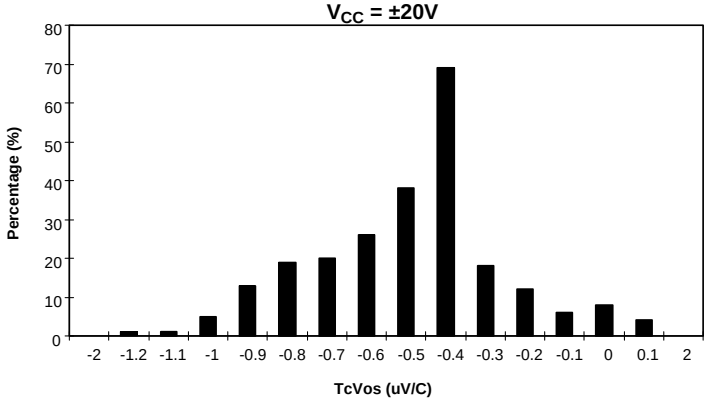
Current Noise Density vs Frequency



Offset Voltage Distribution
V_{CC} = ±20V



TcVos Distribution
V_{CC} = ±20V



Copyright © 2011, Texas Instruments Incorporated

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Samples (Requires Login)
LMP8671MA/NOPB	ACTIVE	SOIC	D	8	95	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	
LMP8671MAX/NOPB	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	
LMP8672MA/NOPB	ACTIVE	SOIC	D	8	95	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	
LMP8672MAX/NOPB	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	
LMP8674MA/NOPB	ACTIVE	SOIC	D	14	55	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	
LMP8674MAX/NOPB	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	

(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) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

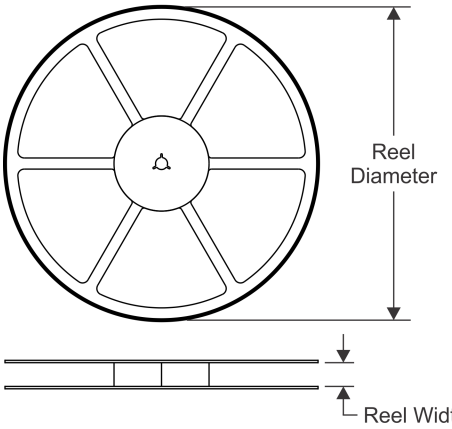
(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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

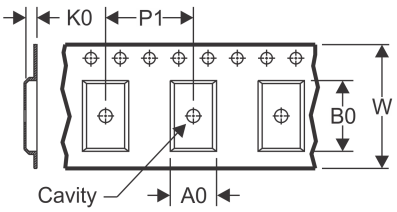
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

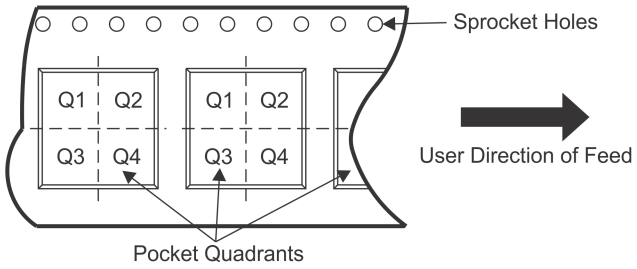


TAPE DIMENSIONS



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

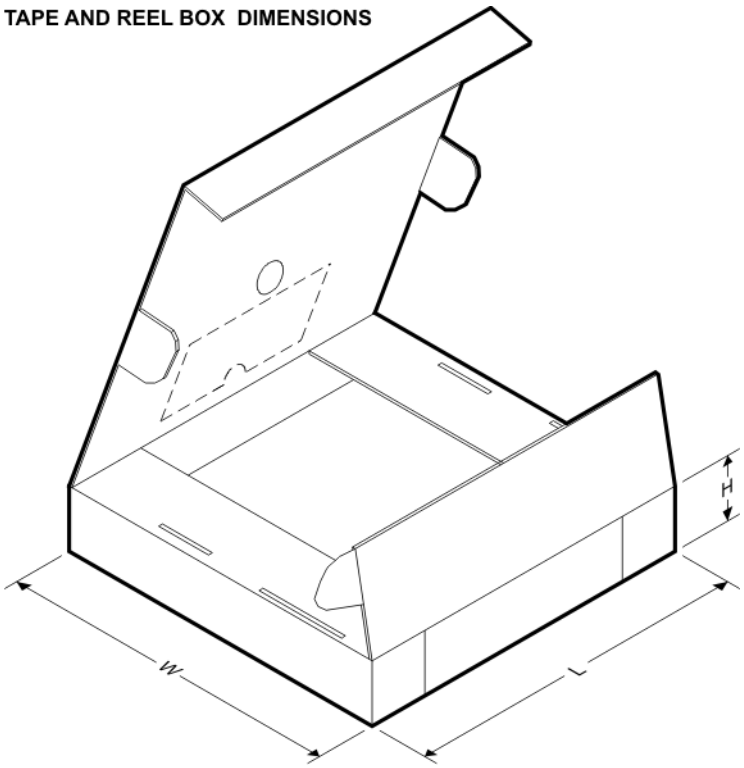
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
LMP8671MAX/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LMP8672MAX/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LMP8674MAX/NOPB	SOIC	D	14	2500	330.0	16.4	6.5	9.35	2.3	8.0	16.0	Q1

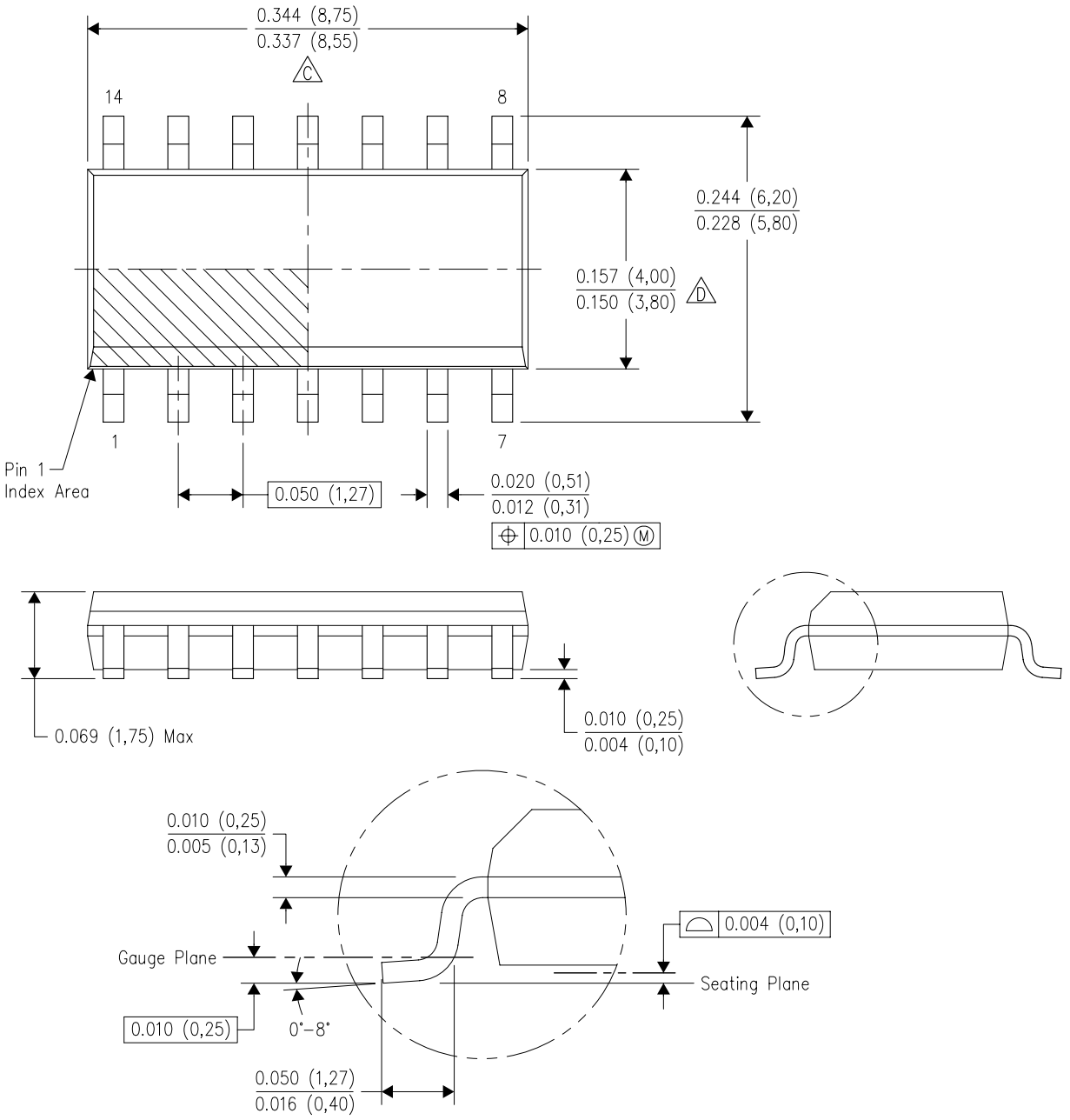
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LMP8671MAX/NOPB	SOIC	D	8	2500	349.0	337.0	45.0
LMP8672MAX/NOPB	SOIC	D	8	2500	349.0	337.0	45.0
LMP8674MAX/NOPB	SOIC	D	14	2500	349.0	337.0	45.0

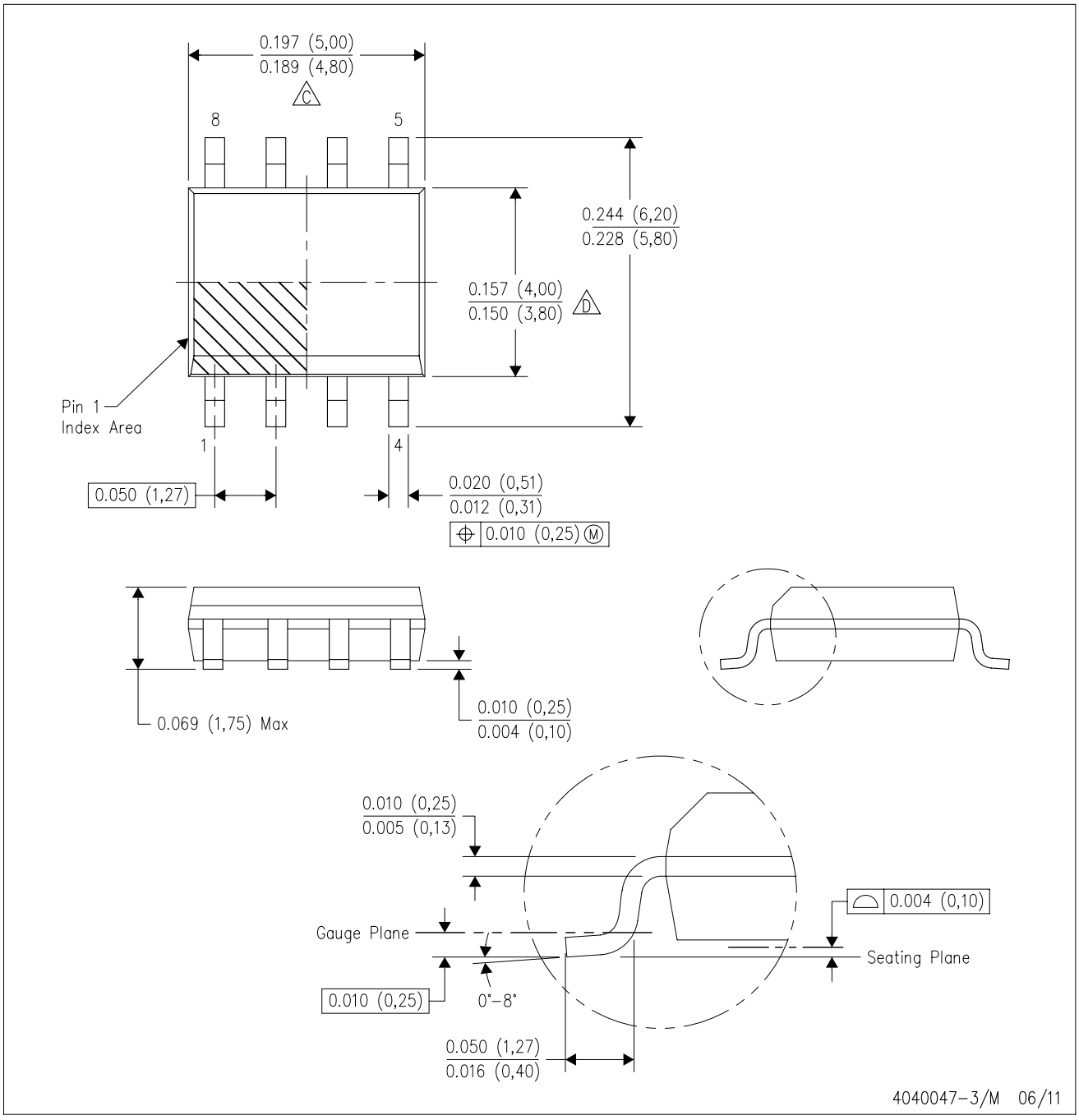
D (R–PDSO–G14) PLASTIC SMALL OUTLINE



4040047–5/M 06/11

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
E. Reference JEDEC MS–012 variation AB.

D (R–PDSO–G8) PLASTIC SMALL OUTLINE



NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
E. Reference JEDEC MS–012 variation AA.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as “components”) are sold subject to TI’s terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI’s terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers’ products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers’ products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI’s goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have ***not*** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products		**Applications**	
Audio	www.ti.com/audio	Automotive and Transportation	www.ti.com/automotive
Amplifiers	amplifier.ti.com	Communications and Telecom	www.ti.com/communications
Data Converters	dataconverter.ti.com	Computers and Peripherals	www.ti.com/computers
DLP® Products	www.dlp.com	Consumer Electronics	www.ti.com/consumer-apps
DSP	dsp.ti.com	Energy and Lighting	www.ti.com/energy
Clocks and Timers	www.ti.com/clocks	Industrial	www.ti.com/industrial
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Security	www.ti.com/security
Power Mgmt	power.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Applications Processors	www.ti.com/omap	**TI E2E Community**	e2e.ti.com
Wireless Connectivity	www.ti.com/wirelessconnectivity		

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2012, Texas Instruments Incorporated