



OPA512

Very-High Current—High Power OPERATIONAL AMPLIFIER

FEATURES

- WIDE SUPPLY RANGE: $\pm 10V$ to $\pm 50V$
- HIGH OUTPUT CURRENT: 15A Peak
- CLASS A/B OUTPUT STAGE:
Low Distortion
- VOLTAGE-CURRENT LIMIT PROTECTION
CIRCUIT
- SMALL TO-3 PACKAGE

APPLICATIONS

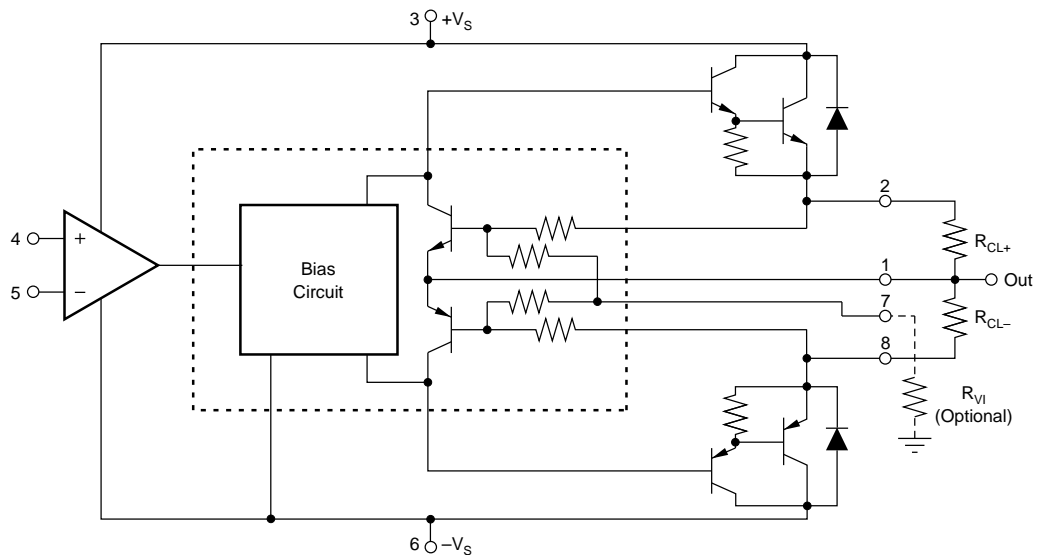
- SERVO AMPLIFIER
- MOTOR DRIVER
- SYNCRO EXCITATION
- AUDIO AMPLIFIER
- TEST PIN DRIVER

DESCRIPTION

The OPA512 is a high voltage, very-high current operational amplifier designed to drive a wide variety of resistive and reactive loads. Its complementary class A/B output stage provides superior performance in applications requiring freedom from cross-over distortion. User-set current limit circuitry provides protection to the amplifier and load in fault conditions. A resistor-programmable voltage-current limiter circuit may be used to further protect the amplifier from damaging conditions.

The OPA512 employs a laser-trimmed monolithic integrated circuit to bias the output transistors, providing excellent low-level signal fidelity and high output voltage swing. The reduced internal parts count made possible with this monolithic IC improves performance and reliability.

This hybrid integrated circuit is housed in a hermetic TO-3 package and all circuitry is electrically-isolated from the case. This allows direct mounting to a chassis or heat sink without cumbersome insulating hardware and provides optimum heat transfer.



International Airport Industrial Park • Mailing Address: PO Box 11400 • Tucson, AZ 85734 • Street Address: 6730 S. Tucson Blvd. • Tucson, AZ 85706
Tel: (520) 746-1111 • Twx: 910-952-1111 • Cable: BBRCORP • Telex: 066-6491 • FAX: (520) 889-1510 • Immediate Product Info: (800) 548-6132

SPECIFICATIONS

ELECTRICAL

At $T_C = +25^\circ\text{C}$, and $V_S = \pm 40\text{V}$, unless otherwise noted.

PARAMETER	CONDITIONS	OPA512BM			OPA512SM			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
INPUT OFFSET VOLTAGE Initial Offset vs Temperature vs Supply Voltage vs Power	Specified Temp. Range		± 2 ± 10 ± 30 ± 20	± 6 ± 65 ± 200		± 1 * * *	± 3 ± 40 *	mV $\mu\text{V}/^\circ\text{C}$ $\mu\text{V}/\text{V}$ $\mu\text{V}/\text{V}$
INPUT BIAS CURRENT Initial vs Temperature vs Supply Voltage	Specified Temp. Range		12 ± 50 ± 10	30 400		10 * *	20 *	nA $\text{pA}/^\circ\text{C}$ pA/V
INPUT OFFSET CURRENT Initial vs Temperature	Specified Temp. Range		± 12 ± 50	± 30		± 5 *	± 10	nA $\text{pA}/^\circ\text{C}$
INPUT IMPEDANCE, DC			200			*		M Ω
INPUT CAPACITANCE			3			*		pF
VOLTAGE RANGE Common-Mode Voltage Common-Mode Rejection	Specified Temp. Range Specified Temp. Range	$\pm(V_S - 5)$ 74	$\pm(V_S - 3)$ 100		*	*	*	V dB
GAIN Open-Loop Gain at 10Hz Gain-Bandwidth Product, 1MHz Power Bandwidth Phase Margin	1k Ω Load Specified Temp. Range 8 Ω Load 8 Ω Load 8 Ω Load Specified Temp. Range 8 Ω Load		110 96 108 4 20 20			*	*	dB dB MHz kHz Degrees
OUTPUT Voltage Swing ⁽¹⁾ Current, Peak Settling Time to 0.1% Slew Rate Capacitive Load	BM at 10A, SM at 15A Specified Temp. Range $I_O = 80\text{mA}$ $I_O = 5\text{A}$ 2V Step Specified Temp. Range G = 1 Specified Temp. Range G > 10	$\pm(V_S - 6)$ $\pm(V_S - 5)$ $\pm(V_S - 5)$ 10 2.5				$\pm(V_S - 7)$ * * 15 * *		V V V A μs V/ μs nF
POWER SUPPLY Voltage Current, Quiescent	Specified Temp. Range	± 10	± 40 25	± 45 50	*	*	± 50 35	V mA
THERMAL RESISTANCE AC Junction-to-Case ⁽³⁾ DC Junction-to-Case Junction to Air	$T_C = -55^\circ\text{C}$ to $+125^\circ\text{C}$, f > 60Hz $T_C = -55^\circ\text{C}$ to $+125^\circ\text{C}$ $T_C = -55^\circ\text{C}$ to $+125^\circ\text{C}$		0.8 1.25 30	0.9 1.4		*	*	$^\circ\text{C}/\text{W}$ $^\circ\text{C}/\text{W}$ $^\circ\text{C}/\text{W}$
TEMPERATURE RANGE Specified	T_C	-25		+85	-55		+125	$^\circ\text{C}$

*Specification same as OPA512BM.

NOTES: (1) $+V_S$ and $-V_S$ denote the positive and negative supply voltage, respectively. Total V_S is measured from $+V_S$ to $-V_S$. (2) SOA = Safe Operating Area.

(3) Rating applies if the output current alternates between both output transistors at a rate faster than 60Hz.

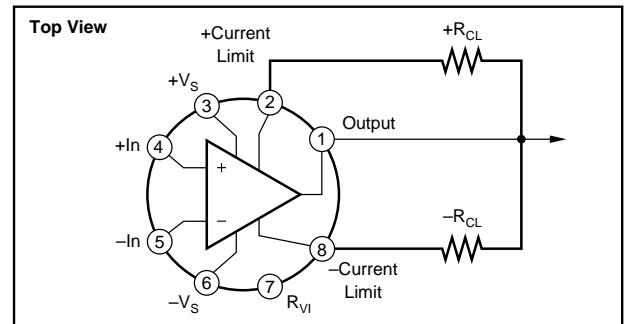
The information provided herein is believed to be reliable; however, BURR-BROWN assumes no responsibility for inaccuracies or omissions. BURR-BROWN assumes no responsibility for the use of this information, and all use of such information shall be entirely at the user's own risk. Prices and specifications are subject to change without notice. No patent rights or licenses to any of the circuits described herein are implied or granted to any third party. BURR-BROWN does not authorize or warrant any BURR-BROWN product for use in life support devices and/or systems.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage, $+V_S$ to $-V_S$	100V
Output Current: Source	15A
Sink	see SOA
Power Dissipation, Internal ⁽¹⁾	125W
Input Voltage: Differential	$\pm(V_S - 3V)$
Common-mode	$\pm V_S$
Temperature: Pins (soldering, 10s)	+300°C
Junction ⁽¹⁾	+200°C
Temperature Range: Storage ⁽²⁾	-65°C to +150°C
Operating (Case)	-55°C to +125°C

NOTES: (1) Long term operation at the maximum junction temperature will result in reduced product life. Derate internal power dissipation to achieve high MTTF. (2) OPA512BM, -55°C to +100°C.

CONNECTION DIAGRAM



ORDERING INFORMATION

MODEL	PACKAGE	TEMPERATURE RANGE
OPA512BM	8-pin TO-3	-25°C to +85°C
OPA512SM	8-pin TO-3	-55°C to +125°C

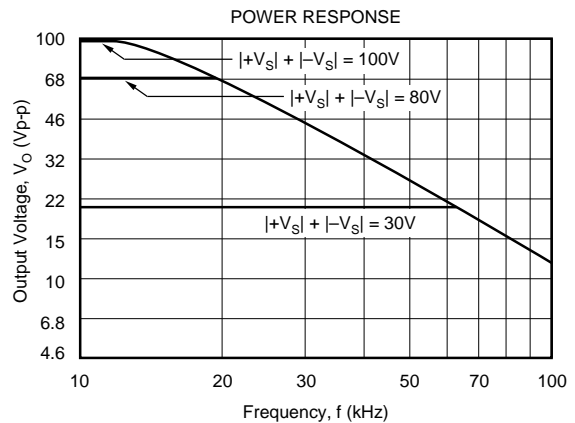
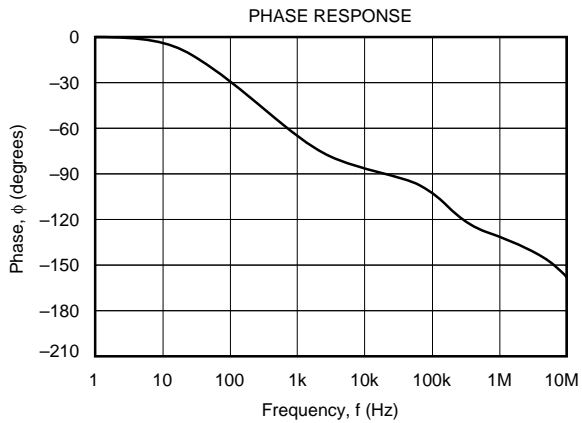
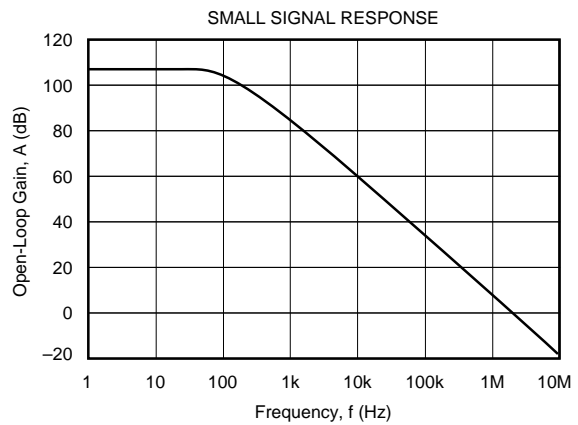
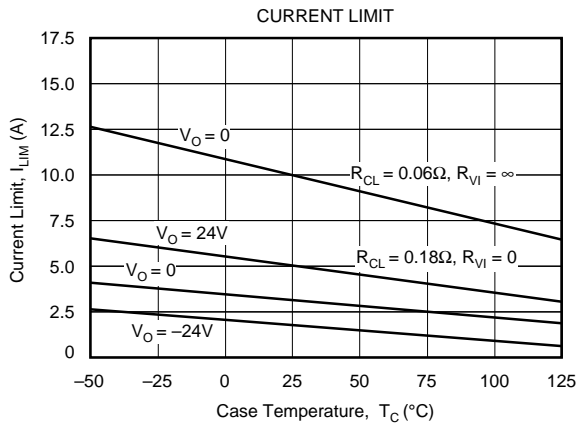
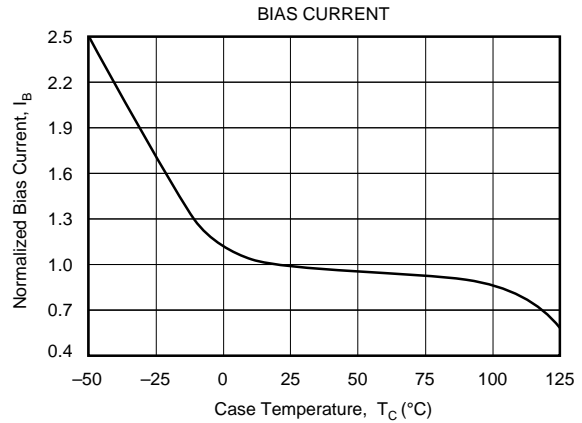
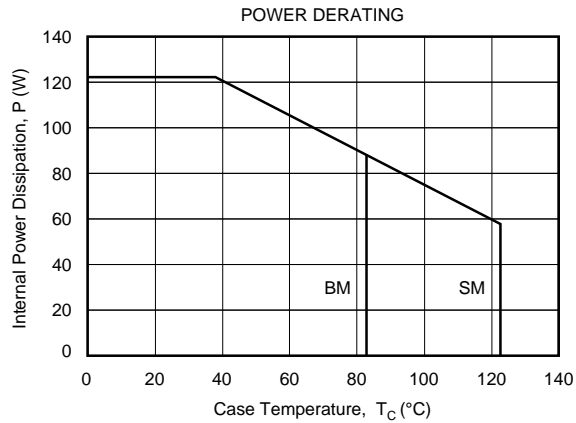
PACKAGE INFORMATION

MODEL	PACKAGE	PACKAGE DRAWING NUMBER ⁽¹⁾
OPA512BM	8-Pin TO-3	030
OPA512SM	8-Pin TO-3	030

NOTE: (1) For detailed drawing and dimension table, please see end of data sheet, or Appendix D of Burr-Brown IC Data Book.

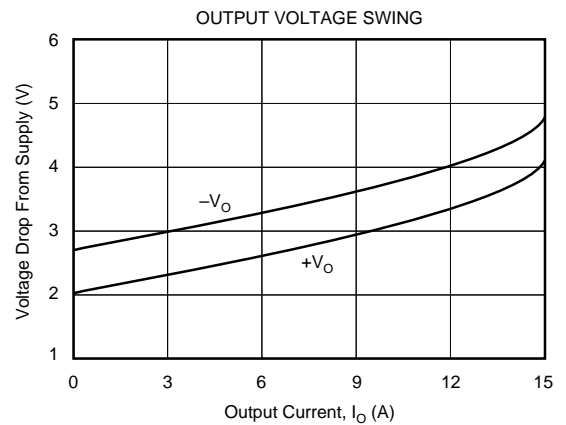
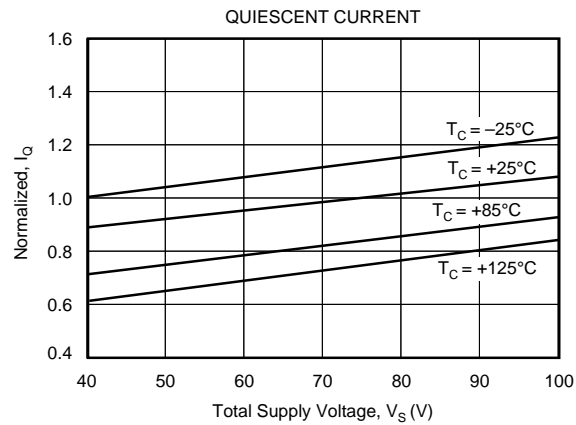
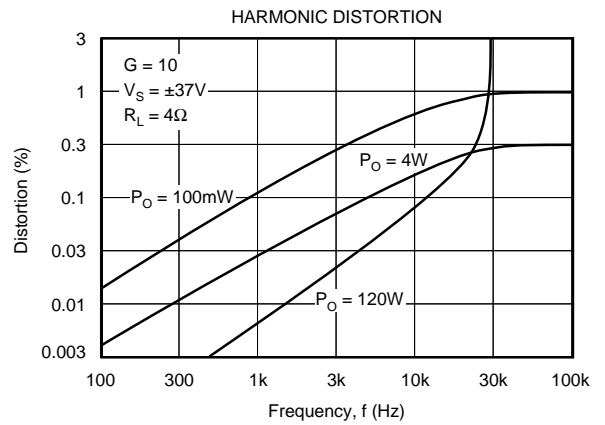
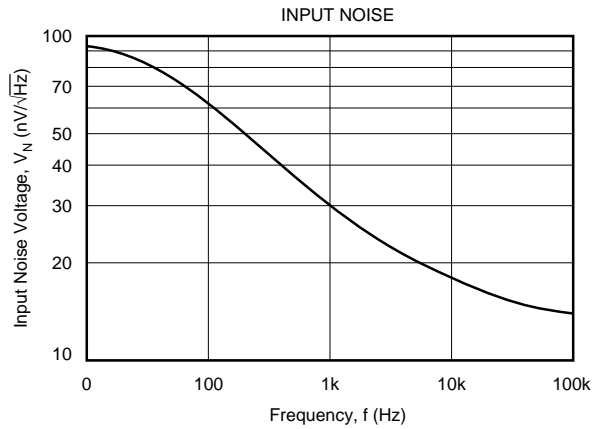
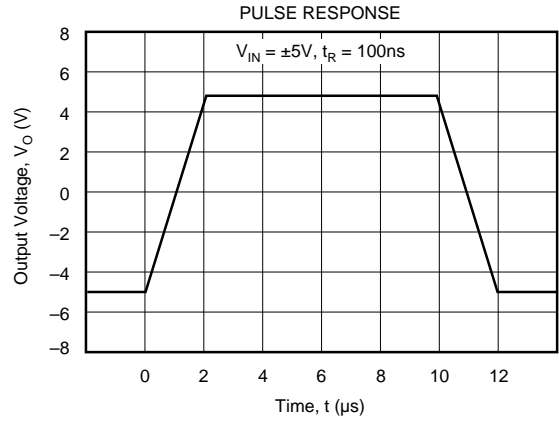
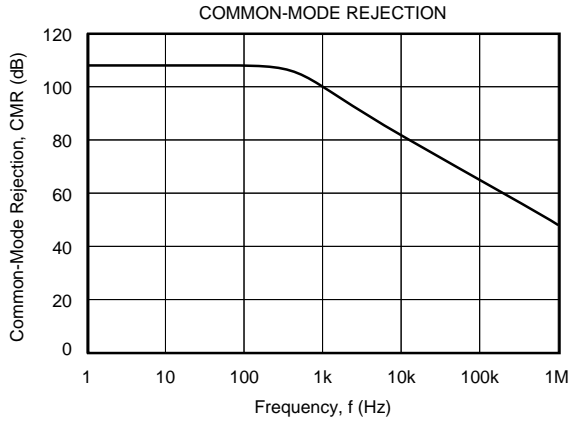
TYPICAL PERFORMANCE CURVES

$T_A = 25^\circ\text{C}$, $V_S = \pm 40\text{VDC}$, unless otherwise noted.



TYPICAL PERFORMANCE CURVES (CONT)

$T_A = 25^\circ\text{C}$, $V_S = \pm 40\text{VDC}$, unless otherwise noted.



APPLICATIONS INFORMATION

POWER SUPPLIES

Specifications for the OPA512 are based on a nominal operating voltage of $\pm 40\text{V}$. A single power supply or unbalanced supplies may be used as long as the maximum total operating voltage (total of $+V_S$ and $-V_S$) is not greater than 90V (100V for OPA512SM model.)

CURRENT LIMITS

Current limit resistors must be provided for proper operation. Independent positive and negative current limit values may be selected by choice of R_{CL+} and R_{CL-} , respectively. Resistor values are calculated by:

$$R_{CL} = 0.65/I_{LIM} \text{ (amps)} - 0.007$$

This is the nominal current limit value at room temperature. The maximum output current decreases at high temperature as shown in the typical performance curve. Most wire-wound resistors are satisfactory, but some highly inductive types may cause loop stability problems. Be sure to evaluate performance with the actual resistors to be used in production.

HEAT SINKING

Power amplifiers are rated by case temperature (not ambient temperature.) The maximum allowable power dissipation is a function of the case temperature as shown in the power derating curve. Load characteristics, signal conditions, and power supply voltage determine the power dissipated by the amplifier. The case temperature will be determined by the heat sinking conditions. Sufficient heat sinking must be provided to keep the case temperature within safe bounds given the power dissipated and ambient temperature. See Application Bulletin AB-038 for further details.

SAFE OPERATING AREA (SOA)

The safe area plot provides a comprehensive summary of the power handling limitations of a power amplifier, including maximum current, voltage and power as well as the secondary breakdown region (see Figure 1) It shows the allowable output current as a function of the power supply to output voltage differential (voltage across the conducting power device.) See Application Bulletin AB-039 for details on SOA.

VOLTAGE-CURRENT LIMITER CIRCUITRY

The voltage-current (V-I) limiter circuit provides a means to protect the amplifier from SOA damage such as a short circuit to ground, yet allows high output currents to flow

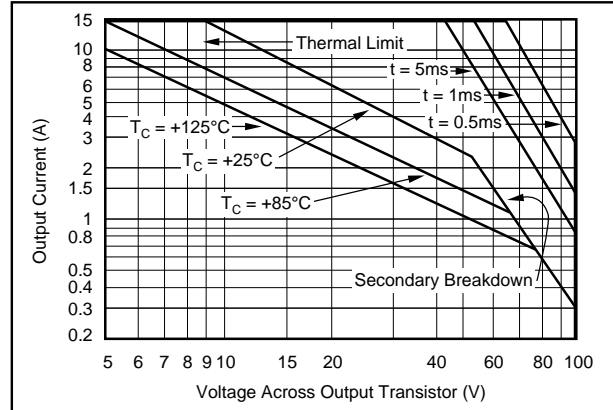


FIGURE 1. Safe Operating Area.

under normal load conditions. Sensing both the output current and the output voltage, this limiter circuit increases the current limit value as the output voltage approaches the power supply voltage (where power dissipation is low.) This type of limiting is achieved by connecting pin 7 through a programming resistor to ground. The V-I limiter circuit is governed by the equation:

$$I_{LIMIT} = \frac{0.65 + \frac{0.28 V_o}{20 + R_{VI}}}{R_{CL} + 0.007}$$

where:

I_{LIMIT} is the maximum current available at a given output voltage.

R_{VI} is the value (k Ω) of the resistor from pin 7 to ground.

R_{CL} is the current limit resistor in ohms.

V_o is the instantaneous output voltage in volts.

Reactive or EMF-generating loads may produce unusual (perhaps undesirable) waveforms with the V-I limit circuit driven into limit. Since current peaks in a reactive load do not align with the output voltage peaks, the output waveform will not appear as a simple voltage-limited waveform. Response of the load to the limiter, in fact, may produce a “backfire” reaction producing unusual output waveforms.

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
OPA512BM	NRND	TO-3	LMF	8	18	Pb-Free (RoHS Exempt)	Call TI	N / A for Pkg Type
OPA512SM	NRND	TO-3	LMF	8	18	Pb-Free (RoHS Exempt)	Call TI	N / A for Pkg Type

⁽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.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

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

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI 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 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. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

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

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		Applications	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DSP	dsp.ti.com	Broadband	www.ti.com/broadband
Interface	interface.ti.com	Digital Control	www.ti.com/digitalcontrol
Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
RFID	www.ti-rfid.com	Telephony	www.ti.com/telephony
Low Power Wireless	www.ti.com/lpw	Video & Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2007, Texas Instruments Incorporated