

# TLV2442, TLV2442A, TLV2444, TLV2444A Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT WIDE-INPUT-VOLTAGE OPERATIONAL AMPLIFIERS

SLOS169H – NOVEMBER 1996 – REVISED MARCH 2001

- Output Swing Includes Both Supply Rails
- Extended Common-Mode Input Voltage Range . . . 0 V to 4.25 V (Min) at 5-V Single Supply
- No Phase Inversion
- Low Noise . . . 16 nV/√Hz Typ at f = 1 kHz
- Low Input Offset Voltage  
950 μV Max at T<sub>A</sub> = 25°C (TLV244xA)
- Low Input Bias Current . . . 1 pA Typ
- 600-Ω Output Drive
- High-Gain Bandwidth . . . 1.8 MHz Typ
- Low Supply Current . . . 750 μA Per Channel Typ
- Macromodel Included
- Available in Q-Temp Automotive  
HighRel Automotive Applications  
Configuration Control/Print Support  
Qualification to Automotive Standards

## description

The TLV244x and TLV244xA are low-voltage operational amplifiers from Texas Instruments. The common-mode input voltage range of these devices has been extended over typical standard CMOS amplifiers, making them suitable for a wide range of applications. In addition, these devices do not phase invert when the common-mode input is driven to the supply rails. This satisfies most design requirements without paying a premium for rail-to-rail input performance. They also exhibit rail-to-rail output performance for increased dynamic range in single- or split-supply applications. This family is fully characterized at 3-V and 5-V supplies and is optimized for low-voltage operation. Both devices offer comparable ac performance while having lower noise, input offset voltage, and power dissipation than existing CMOS operational amplifiers. The TLV244x has increased output drive over previous rail-to-rail operational amplifiers and can drive 600-Ω loads for telecommunications applications.

The other members in the TLV244x family are the low-power, TLV243x, and micro-power, TLV2422, versions.

The TLV244x, exhibiting high input impedance and low noise, is excellent for small-signal conditioning for high-impedance sources, such as piezoelectric transducers. Because of the micropower dissipation levels and low-voltage operation, these devices work well in hand-held monitoring and remote-sensing applications. In addition, the rail-to-rail output feature with single- or split-supplies makes this family a great choice when interfacing with analog-to-digital converters (ADCs). For precision applications, the TLV244xA is available with a maximum input offset voltage of 950 μV.

If the design requires single operational amplifiers, see the TI TLV2211/21/31. This is a family of rail-to-rail output operational amplifiers in the SOT-23 package. Their small size and low power consumption make them ideal for high density, battery-powered equipment.

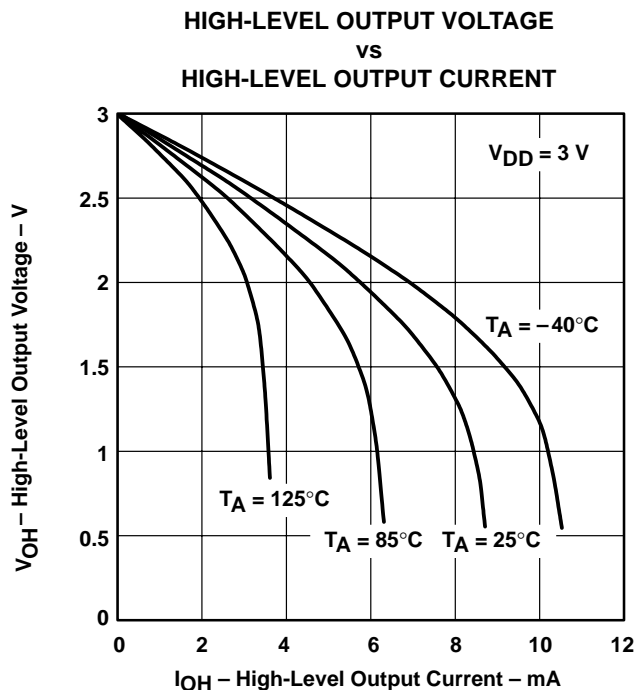


Figure 1



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.

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

**TEXAS  
INSTRUMENTS**

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On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

# TLV2442, TLV2442A, TLV2444, TLV2444A

## Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT

### WIDE-INPUT-VOLTAGE OPERATIONAL AMPLIFIERS

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#### TLV2442 AVAILABLE OPTIONS

T <sub>A</sub>	V <sub>IO</sub> max AT 25°C	PACKAGED DEVICES				
		SMALL OUTLINE (D)	CHIP CARRIER (FK)	CERAMIC DIP (JG)	TSSOP (PW)	CERAMIC FLAT PACK (U)
0°C to 70°C	2.5 mV	TLV2442CD	—	—	TLV2442CPW	—
–40°C to 85°C	950 μV 2.5 mV	TLV2442AID TLV2442ID	—	—	TLV2442AIPW —	—
–40°C to 125°C	950 μV 2.5 mV	TLV2442AQD TLV2442QD	—	—	TLV2442AQPW TLV2442QPW	—
–55°C to 125°C	950 μV 2.5 mV	—	TLV2442AMFK TLV2442MFK	TLV2442AMJG TLV2442MJG	—	TLV2442AMU TLV2442MU

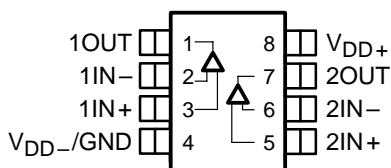
The D and PW packages are available taped and reeled. Add R suffix to device type (e.g., TLV2442CDR).

#### TLV2444 AVAILABLE OPTIONS

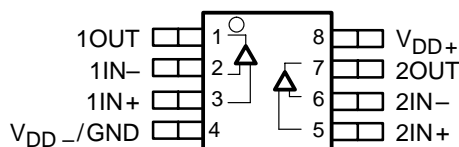
T <sub>A</sub>	V <sub>IO</sub> max AT 25°C	PACKAGED DEVICES	
		SMALL OUTLINE (D)	TSSOP (PW)
0°C to 70°C	2.5 mV	TLV2444CD	TLV2444CPW
–40°C to 125°C	950 μV 2.5 mV	TLV2444AID TLV2444ID	TLV2444AIPW TLV2444IPW

The D and PW packages are available taped and reeled. Add R suffix to device type (e.g., TLV2444CDR).

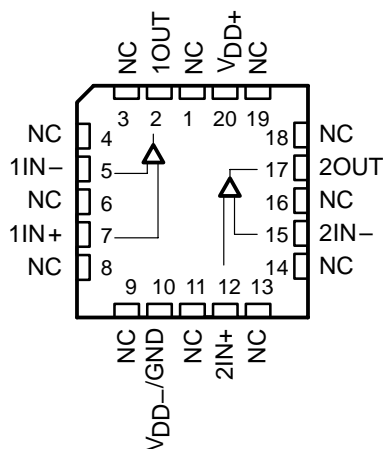
**TLV2442  
D OR JG PACKAGE  
(TOP VIEW)**



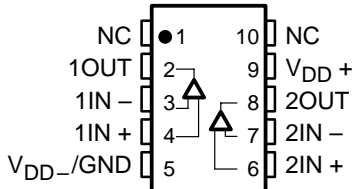
**TLV2442  
PW PACKAGE  
(TOP VIEW)**



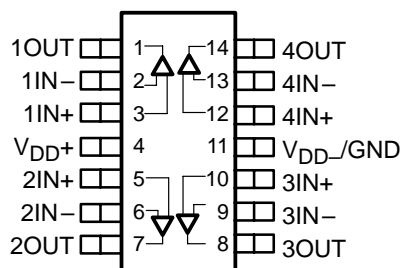
**TLV2442  
FK PACKAGE  
(TOP VIEW)**



**TLV2442  
U PACKAGE  
(TOP VIEW)**



**TLV2444  
D OR PW PACKAGE  
(TOP VIEW)**



NC – No internal connection

**equivalent schematic (each amplifier)**



COMPONENT COUNT	
Transistors	69
Diodes	5
Resistors	26
Capacitors	6

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**absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†**

Supply voltage, $V_{DD}$ (see Note 1)	12 V
Differential input voltage, $V_{ID}$ (see Note 2)	$\pm V_{DD}$
Input voltage, $V_I$ (any input, see Note 1)	-0.3 V to $V_{DD}$
Input current, $I_I$ (any input)	$\pm 5$ mA
Output current, $I_O$	$\pm 50$ mA
Total current into $V_{DD+}$	$\pm 50$ mA
Total current out of $V_{DD-}$	$\pm 50$ mA
Duration of short-circuit current at (or below) 25°C (see Note 3)	unlimited
Continuous total dissipation	See Dissipation Rating Table
Operating free-air temperature range, $T_A$ : C suffix	0°C to 70°C
I suffix (dual)	-40°C to 85°C
I suffix (quad)	-40°C to 125°C
Q suffix	-40°C to 125°C
M suffix	-55°C to 125°C
Storage temperature range, $T_{stg}$	-65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	260°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

- NOTES: 1. All voltage values, except differential voltages, are with respect to the midpoint between  $V_{DD+}$  and  $V_{DD-}$ .  
 2. Differential voltages are at  $IN+$  with respect to  $IN-$ . Excessive current will flow if input is brought below  $V_{DD-} - 0.3$  V.  
 3. The output may be shorted to either supply. Temperature and/or supply voltages must be limited to ensure that the maximum dissipation rating is not exceeded.

**DISSIPATION RATING TABLE**

PACKAGE	$T_A \leq 25^\circ\text{C}$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$	$T_A = 70^\circ\text{C}$ POWER RATING	$T_A = 85^\circ\text{C}$ POWER RATING	$T_A = 125^\circ\text{C}$ POWER RATING
D (8)	725 mW	5.8 mW/°C	464 mW	377 mW	145 mW
D (14)	1022 mW	7.6 mW/°C	900 mW	777 mW	450 mW
FK	1375 mW	11.0 mW/°C	880 mW	715 mW	275 mW
JG	1050 mW	8.4 mW/°C	672 mW	546 mW	210 mW
PW (8)	525 mW	4.2 mW/°C	336 mW	273 mW	105 mW
PW (14)	720 mW	5.6 mW/°C	634 mW	547 mW	317 mW
U	675 mW	5.4 mW/°C	432 mW	350 mW	135 mW

**recommended operating conditions**

	C SUFFIX		I SUFFIX		Q SUFFIX		M SUFFIX		UNIT
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
Supply voltage, $V_{DD}$	2.7	10	2.7	10	2.7	10	2.7	10	V
Input voltage range, $V_I$	$V_{DD-}$	$V_{DD+} - 1$	$V_{DD-}$	$V_{DD+} - 1$	$V_{DD-}$	$V_{DD+} - 1.3$	$V_{DD-}$	$V_{DD+} - 1.3$	V
Common-mode input voltage, $V_{IC}$	$V_{DD-}$	$V_{DD+} - 1$	$V_{DD-}$	$V_{DD+} - 1$	$V_{DD-} + 2$	$V_{DD+} - 1.3$	$V_{DD-} + 2$	$V_{DD+} - 1.3$	V
Operating free-air temperature, $T_A$	0	70	-40	125	-40	125	-55	125	°C



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**electrical characteristics at specified free-air temperature,  $V_{DD} = 3\text{ V}$  (unless otherwise noted)**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLV2442			UNIT
			MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_{IC} = 1.5\text{ V}$ , $V_O = 1.5\text{ V}$ , $R_S = 50\ \Omega$	TLV244xC TLV244xI	25°C	300	2000	$\mu\text{V}$
			Full range	2500		
		TLV244xAI	25°C	300	950	
			Full range	1500		
		TLV2442AQ TLV2442AM	25°C	300	950	
			Full range	1600		
$\alpha_{VIO}$ Temperature coefficient of input offset voltage		25°C to 85°C	2		$\mu\text{V}/^\circ\text{C}$	
Input offset voltage long-term drift (see Note 4)		25°C	0.002		$\mu\text{V}/\text{mo}$	
$I_{IO}$ Input offset current		25°C	0.5	60	$\text{pA}$	
		Full range	150			
$I_{IB}$ Input bias current		25°C	1	60	$\text{pA}$	
		-40°C to 85°C	150			
		125°C	350			
		TLV2442Q/AQ TLV2442M/AM	Full range	260		
$V_{ICR}$ Common-mode input voltage range	$ V_{IO}  \leq 5\text{ mV}$ , $R_S = 50\ \Omega$	25°C	0 to 2.25	-0.25 to 2.5	$\text{V}$	
		Full range	0 to 2			
		25°C to -55°C	0 to 2.25	-0.25 to 2.5		
		125°C	0 to 2			
$V_{OH}$ High-level output voltage	$I_O = -100\ \mu\text{A}$	25°C	2.98		$\text{V}$	
		25°C	2.5			
		Full range	2.25			
$V_{OL}$ Low-level output voltage	$V_{IC} = 1.5\text{ V}$ , $I_O = 100\ \mu\text{A}$	25°C	0.02		$\text{V}$	
		25°C	0.63			
		Full range	1			
$A_{VD}$ Large-signal differential voltage amplification	$V_O = 1\text{ V to }2\text{ V}$	$R_L = 600\ \Omega$	25°C	0.7	1	$\text{V/mV}$
			Full range	0.4		
		$R_L = 1\ \text{M}\Omega$	25°C	750		
$r_{id}$ Differential input resistance		25°C	1000		$\text{G}\Omega$	
$r_i$ Common-mode input resistance		25°C	1000		$\text{G}\Omega$	
$c_i$ Common-mode input capacitance	$f = 10\ \text{kHz}$	25°C	8		$\text{pF}$	
$z_o$ Closed-loop output impedance	$f = 1\ \text{MHz}$ , $A_V = 10$	25°C	130		$\Omega$	

† Full range for the C suffix is 0°C to 70°C. Full range for the dual I suffix is -40°C to 85°C. Full range for the quad I suffix is -40°C to 125°C. Full range for the Q suffix is -40°C to 125°C. Full range for the M suffix is -55°C to 125°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at  $T_A = 150^\circ\text{C}$  extrapolated to  $T_A = 25^\circ\text{C}$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.



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**electrical characteristics at specified free-air temperature,  $V_{DD} = 3\text{ V}$  (unless otherwise noted) (continued)**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLV2442			UNIT
			MIN	TYP	MAX	
CMRR Common-mode rejection ratio	$V_{IC} = 0\text{ to }2.25\text{ V}$ , $V_O = 1.5\text{ V}$ , $R_S = 50\ \Omega$	25°C	65	75		dB
		Full range	55			
		TLV2442Q/AQ TLV2442M/AM	Full range	50		
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{DD\pm}/\Delta V_{IO}$ )	$V_{DD} = 2.7\text{ V to }8\text{ V}$ , No load $V_{IC} = V_{DD}/2$ ,	25°C	80	95		dB
		Full range	80			
$I_{DD}$ Supply current (per channel)	$V_O = 1.5\text{ V}$ , No load	25°C		725	1100	$\mu\text{A}$
		Full range			1100	

† Full range for the C suffix is 0°C to 70°C. Full range for the dual I suffix is –40°C to 85°C. Full range for the quad I suffix is –40°C to 125°C. Full range for the Q suffix is –40°C to 125°C. Full range for the M suffix is –55°C to 125°C.

**operating characteristics at specified free-air temperature,  $V_{DD} = 3\text{ V}$**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLV244x			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain	$V_O = 1\text{ V to }2\text{ V}$ , $R_L = 600\ \Omega$ , $C_L = 100\text{ pF}$	25°C	0.65	1.3		$\text{V}/\mu\text{s}$
		Full range	0.65			
		TLV2442Q/AQ TLV2442M/AM	Full range	0.4		
$V_n$ Equivalent input noise voltage	$f = 10\text{ Hz}$	25°C		170		$\text{nV}/\sqrt{\text{Hz}}$
	$f = 1\text{ kHz}$	25°C		18		
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ Hz to }1\text{ Hz}$	25°C		2.6		$\mu\text{V}$
	$f = 0.1\text{ Hz to }10\text{ Hz}$	25°C		5.1		
$I_n$ Equivalent input noise current		25°C		0.6		$\text{fA}/\sqrt{\text{Hz}}$
THD + N Total harmonic distortion plus noise	$V_O = 0.5\text{ V to }2.5\text{ V}$ , $R_L = 600\ \Omega$ , $f = 1\text{ kHz}$	25°C	$A_V = 1$	0.08%		
			$A_V = 10$	0.3%		
			$A_V = 100$	2%		
Gain-bandwidth product	$f = 10\text{ kHz}$ , $C_L = 100\text{ pF}$	$R_L = 600\ \Omega$ , 25°C		1.75		MHz
BOM Maximum output-swing bandwidth	$V_{O(PP)} = 1\text{ V}$ , $A_V = 1$ ,	$R_L = 600\ \Omega$ , $C_L = 100\text{ pF}$ , 25°C		0.9		MHz
$t_s$ Settling time	$A_V = -1$ , Step = –2.3 V to 2.3 V, $R_L = 600\ \Omega$ , $C_L = 100\text{ pF}$	25°C	To 0.1%	1.5		$\mu\text{s}$
			To 0.01%	3.2		
$\phi_m$ Phase margin at unity gain	$R_L = 600\ \Omega$ , $C_L = 100\text{ pF}$	25°C		65°		
Gain margin		25°C		9		dB

† Full range for the C suffix is 0°C to 70°C. Full range for the dual I suffix is –40°C to 85°C. Full range for the quad I suffix is –40°C to 125°C. Full range for the Q suffix is –40°C to 125°C. Full range for the M suffix is –55°C to 125°C.



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**electrical characteristics at specified free-air temperature,  $V_{DD} = 5\text{ V}$  (unless otherwise noted)**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLV244x			UNIT
			MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_{DD\pm} = \pm 2.5\text{ V}$ , $V_O = 0$ , $V_{IC} = 0$ , $R_S = 50\ \Omega$	TLV244xC TLV244xI	25°C	300	2000	$\mu\text{V}$
			Full range		2500	
		TLV244xA	25°C	300	950	
			Full range		1500	
		TLV2442AQ TLV2442AM	25°C	300	950	
			Full range		1600	
$\alpha_{VIO}$ Temperature coefficient of input offset voltage		25°C to 85°C	2		$\mu\text{V}/^\circ\text{C}$	
Input offset voltage long-term drift (see Note 4)		25°C	0.002		$\mu\text{V}/\text{mo}$	
$I_{IO}$ Input offset current		25°C	0.5	60	$\text{pA}$	
		Full range		150		
$I_{IB}$ Input bias current		25°C	1	60	$\text{pA}$	
		-40°C to 85°C		150		
		125°C		350		
		TLV2442Q/AQ TLV2442M/AM	Full range			260
$V_{ICR}$ Common-mode input voltage range	$ V_{IO}  \leq 5\text{ mV}$ , $R_S = 50\ \Omega$	25°C	0 to 4.25	-0.25 to 4.5	V	
		Full range	0 to 4			
$V_{OH}$ High-level output voltage	$I_{OH} = -100\ \mu\text{A}$	25°C	4.97		V	
	$I_{OH} = -5\text{ mA}$	25°C	4	4.35		
		Full range	4			
$V_{OL}$ Low-level output voltage	$V_{IC} = 2.5\text{ V}$ , $I_{OL} = 100\ \mu\text{A}$	25°C	0.01		V	
	$V_{IC} = 2.5\text{ V}$ , $I_{OL} = 5\text{ mA}$	25°C	0.8			
		Full range	1.25			
$A_{VD}$ Large-signal differential voltage amplification	$V_{IC} = 2.5\text{ V}$ , $V_O = 1\text{ V to }4\text{ V}$	$R_L = 600\ \Omega$ ‡	25°C	0.9	1.3	V/mV
			Full range	0.5		
		$R_L = 1\text{ M}\Omega$ ‡	25°C	950		
$r_{id}$ Differential input resistance		25°C	1000		$\text{G}\Omega$	
$r_i$ Common-mode input resistance		25°C	1000		$\text{G}\Omega$	
$c_i$ Common-mode input capacitance	$f = 10\text{ kHz}$	25°C	8		$\text{pF}$	
$z_o$ Closed-loop output impedance	$f = 1\text{ MHz}$ , $A_V = 10$	25°C	140		$\Omega$	
CMRR Common-mode rejection ratio	$V_{IC} = 0\text{ to }4.25\text{ V}$ , $V_O = 2.5\text{ V}$ , $R_S = 50\ \Omega$	25°C	70	75	dB	
		Full range	70			

† Full range for the C suffix is 0°C to 70°C. Full range for the dual I suffix is -40°C to 85°C. Full range for the quad I suffix is -40°C to 125°C. Full range for the Q suffix is -40°C to 125°C. Full range for the M suffix is -55°C to 125°C.

‡ Referenced to 2.5 V

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at  $T_A = 150^\circ\text{C}$  extrapolated to  $T_A = 25^\circ\text{C}$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.

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**electrical characteristics at specified free-air temperature,  $V_{DD} = 5\text{ V}$  (unless otherwise noted) (continued)**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLV244x			UNIT
			MIN	TYP	MAX	
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{DD}/\Delta V_{IO}$ )	$V_{DD} = 4.4\text{ V to }8\text{ V}$ , $V_{IC} = V_{DD}/2$ , No load	25°C	80	95		dB
		Full range	80			
$I_{DD}$ Supply current (per channel)	$V_O = 2.5\text{ V}$ , No load	25°C	750	1100		$\mu\text{A}$
		Full range	1100			

† Full range for the C suffix is 0°C to 70°C. Full range for the dual I suffix is –40°C to 85°C. Full range for the quad I suffix is –40°C to 125°C. Full range for the Q suffix is –40°C to 125°C. Full range for the M suffix is –55°C to 125°C.

**operating characteristics at specified free-air temperature,  $V_{DD} = 5\text{ V}$**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLV244x			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain	$V_O = 0.5\text{ V to }2.5\text{ V}$ , $R_L = 600\ \Omega$ ‡, $C_L = 100\text{ pF}$ ‡	25°C	0.75	1.4		$\text{V}/\mu\text{s}$
		Full range	0.75			
		Full range	0.5			
$V_n$ Equivalent input noise voltage	$f = 10\text{ Hz}$	25°C	130			$\text{nV}/\sqrt{\text{Hz}}$
		25°C	16			
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ Hz to }1\text{ Hz}$	25°C	1.8			$\mu\text{V}$
	$f = 0.1\text{ Hz to }10\text{ Hz}$	25°C	3.6			
$I_n$ Equivalent input noise current		25°C	0.6			$\text{fA}/\sqrt{\text{Hz}}$
THD + N Total harmonic distortion plus noise	$V_O = 1.5\text{ V to }3.5\text{ V}$ , $f = 1\text{ kHz}$ , $R_L = 600\ \Omega$ ‡	25°C	$A_V = 1$			
			$A_V = 10$			
			$A_V = 100$			
Gain-bandwidth product	$f = 10\text{ kHz}$ , $R_L = 600\ \Omega$ ‡, $C_L = 100\text{ pF}$ ‡	25°C	1.81			MHz
BOM Maximum output-swing bandwidth	$V_{O(PP)} = 2\text{ V}$ , $R_L = 600\ \Omega$ ‡, $A_V = 1$ , $C_L = 100\text{ pF}$ ‡	25°C	0.5			MHz
$t_s$ Settling time	$A_V = -1$ , Step = 0.5 V to 2.5 V, $R_L = 600\ \Omega$ ‡, $C_L = 100\text{ pF}$ ‡	25°C	To 0.1%			$\mu\text{s}$
			To 0.01%			
$\phi_m$ Phase margin at unity gain	$R_L = 600\ \Omega$ ‡, $C_L = 100\text{ pF}$ ‡	25°C	68°			
Gain margin		25°C	8			dB

† Full range for the C suffix is 0°C to 70°C. Full range for the dual I suffix is –40°C to 85°C. Full range for the quad I suffix is –40°C to 125°C. Full range for the Q suffix is –40°C to 125°C. Full range for the M suffix is –55°C to 125°C.

‡ Referenced to 2.5 V





**TLV2442, TLV2442A, TLV2444, TLV2444A**  
**Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT**  
**WIDE-INPUT-VOLTAGE OPERATIONAL AMPLIFIERS**

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**TYPICAL CHARACTERISTICS**

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$V_{OL}$	Low-level output voltage	vs Low-level output current	11, 12
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$I_{OS}$	Short-circuit output current	vs Supply voltage vs Free-air temperature	14 15
$V_O$	Output voltage	vs Differential Input voltage	16, 17
$A_{VD}$	Differential voltage amplification	vs Load resistance	18
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	Large-signal differential voltage amplification	vs Free-air temperature	21, 22
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CMRR	Common-mode rejection ratio	vs Frequency	25
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	Gain margin	vs Load capacitance	49
$B_1$	Unity-gain bandwidth	vs Load capacitance	50

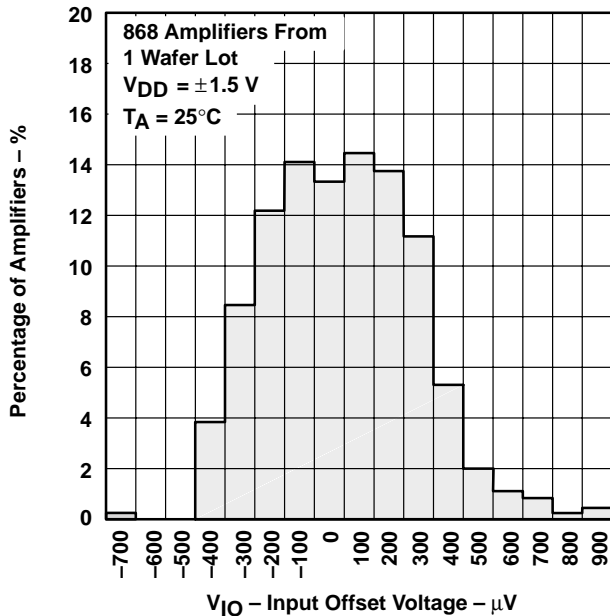
† For all graphs where  $V_{DD} = 5$  V, all loads are referenced to 2.5 V.

**TLV2442, TLV2442A, TLV2444, TLV2444A**  
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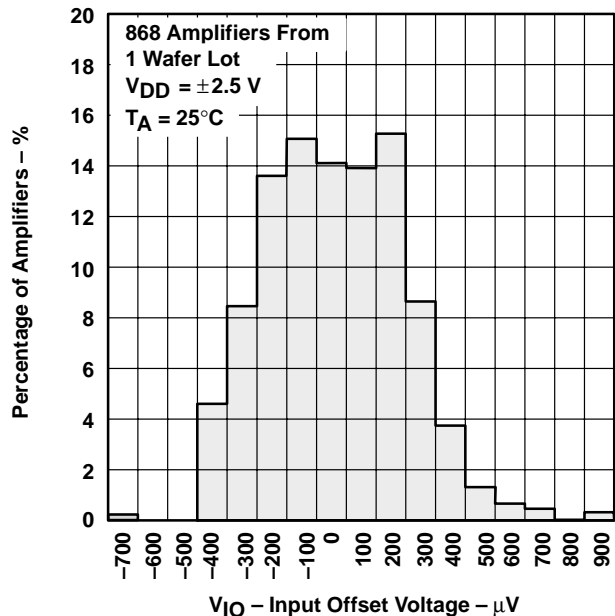
**TYPICAL CHARACTERISTICS**

**DISTRIBUTION OF TLV2442  
 INPUT OFFSET VOLTAGE**



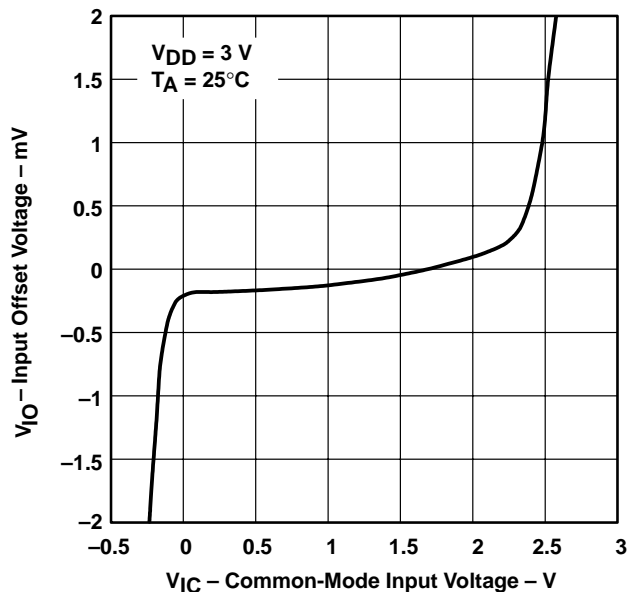
**Figure 2**

**DISTRIBUTION OF TLV2442  
 INPUT OFFSET VOLTAGE**



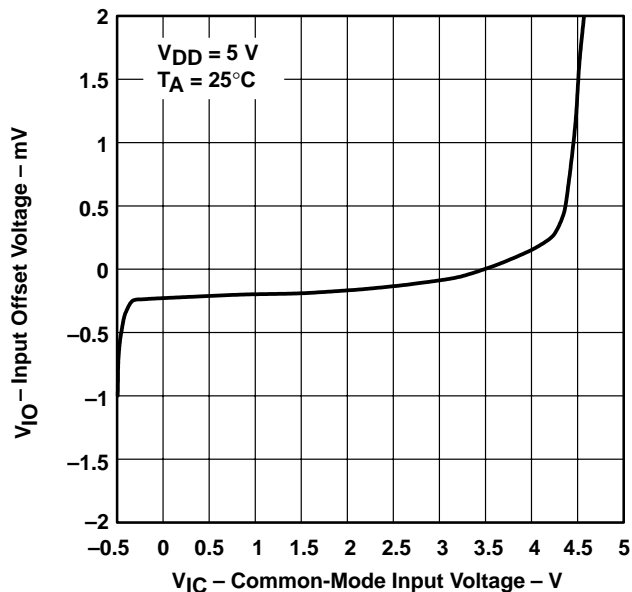
**Figure 3**

**INPUT OFFSET VOLTAGE  
 vs  
 COMMON-MODE INPUT VOLTAGE**



**Figure 4**

**INPUT OFFSET VOLTAGE  
 vs  
 COMMON-MODE INPUT VOLTAGE**



**Figure 5**



TYPICAL CHARACTERISTICS

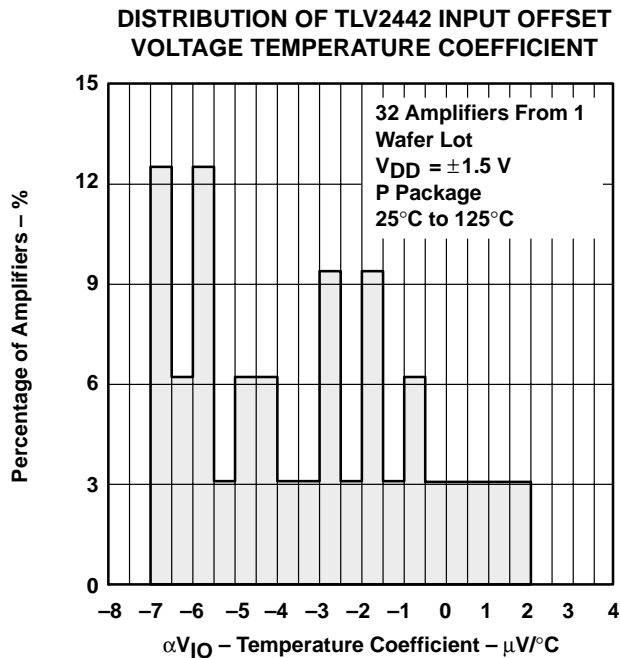


Figure 6

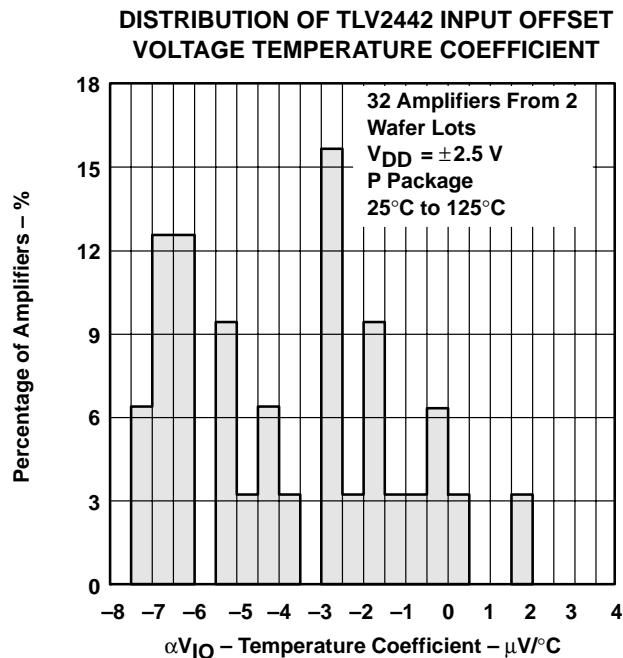


Figure 7

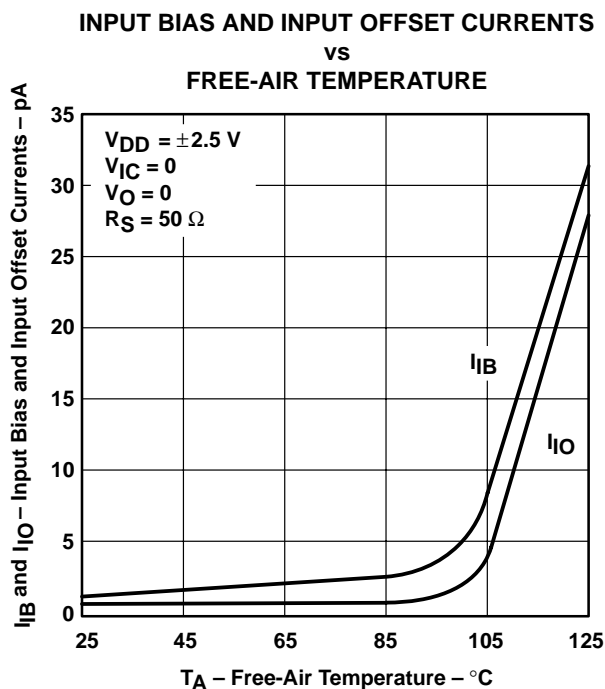


Figure 8

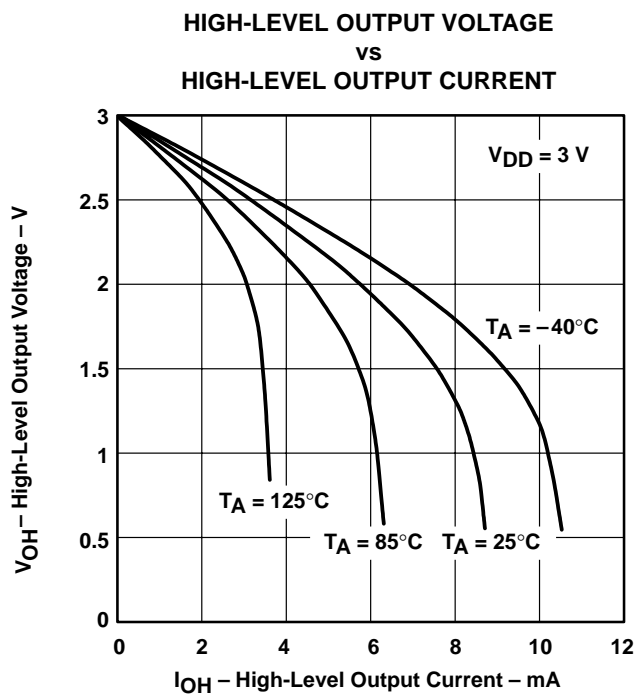


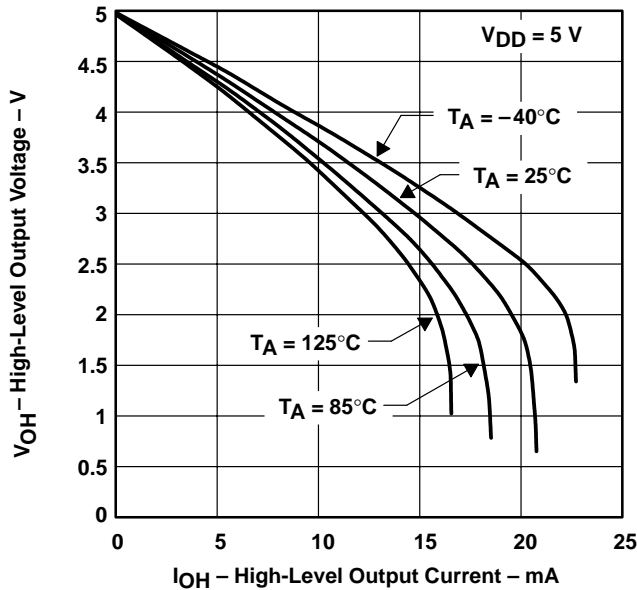
Figure 9

**TLV2442, TLV2442A, TLV2444, TLV2444A**  
**Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT**  
**WIDE-INPUT-VOLTAGE OPERATIONAL AMPLIFIERS**

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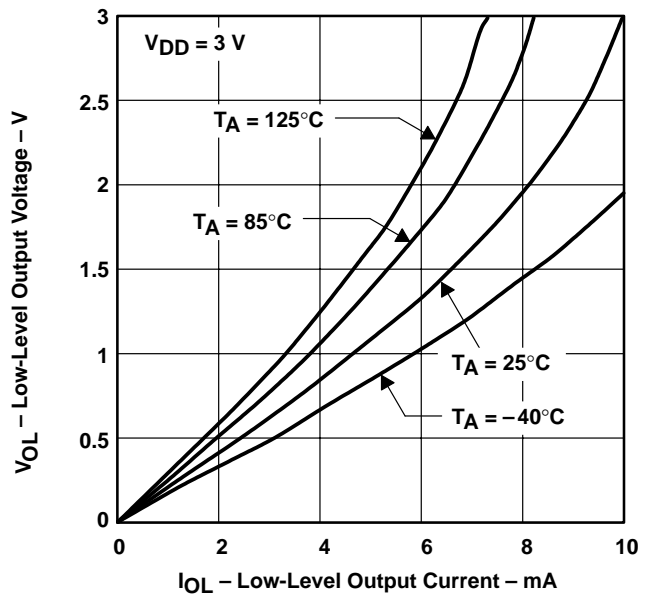
**TYPICAL CHARACTERISTICS**

**HIGH-LEVEL OUTPUT VOLTAGE  
vs  
HIGH-LEVEL OUTPUT CURRENT**



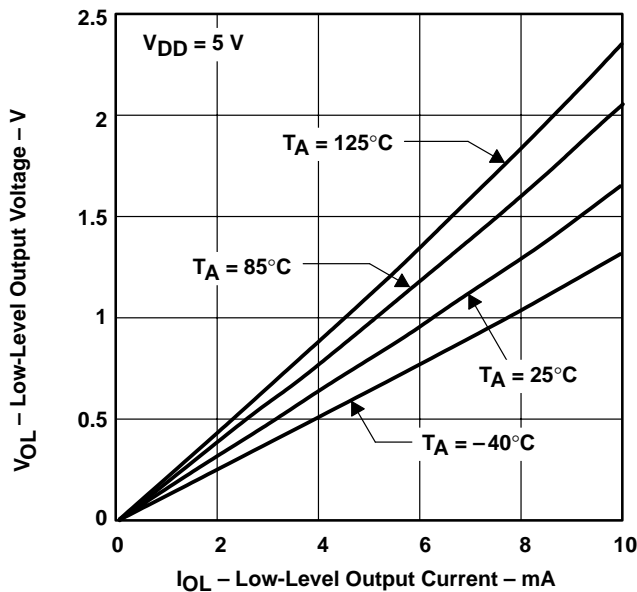
**Figure 10**

**LOW-LEVEL OUTPUT VOLTAGE  
vs  
LOW-LEVEL OUTPUT CURRENT**



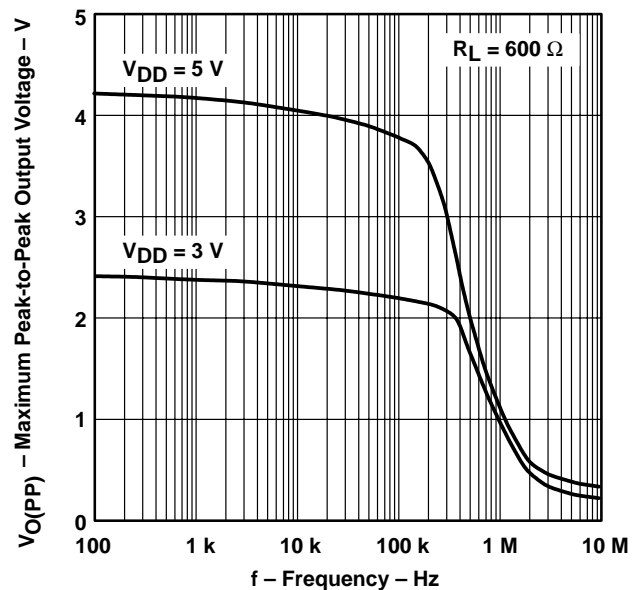
**Figure 11**

**LOW-LEVEL OUTPUT VOLTAGE  
vs  
LOW-LEVEL OUTPUT CURRENT**



**Figure 12**

**MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE  
vs  
FREQUENCY**



**Figure 13**



TYPICAL CHARACTERISTICS

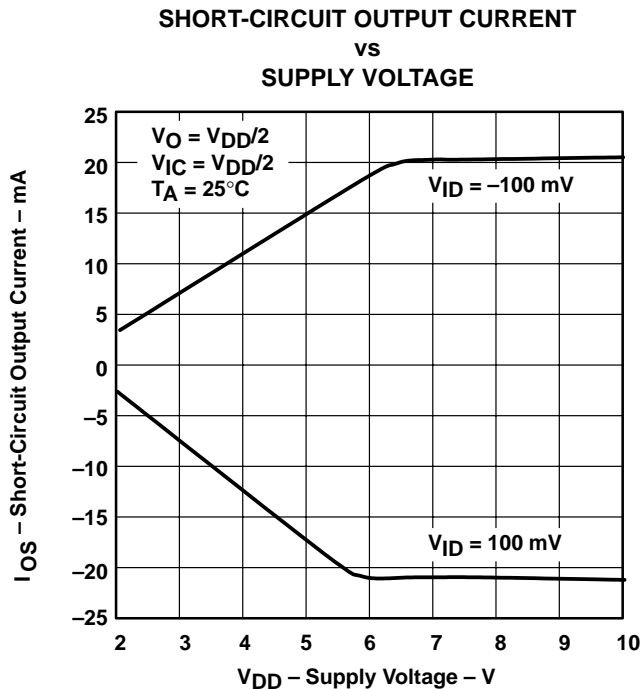


Figure 14

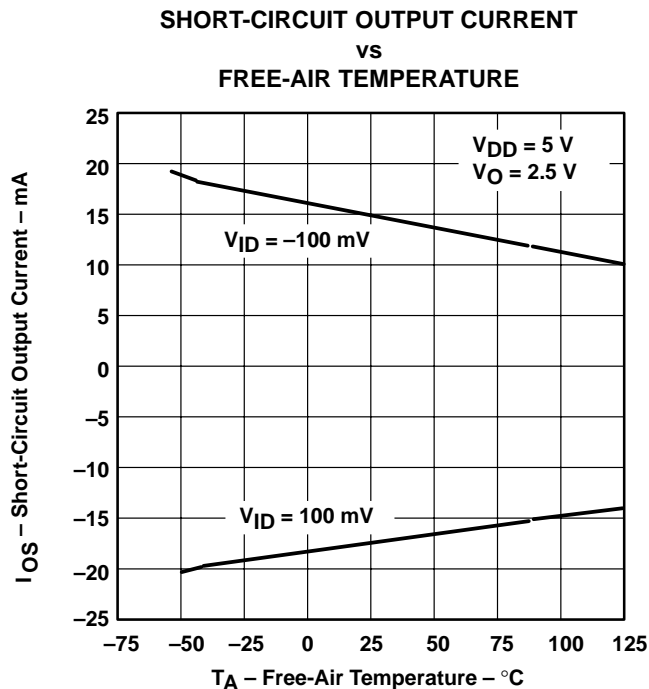


Figure 15

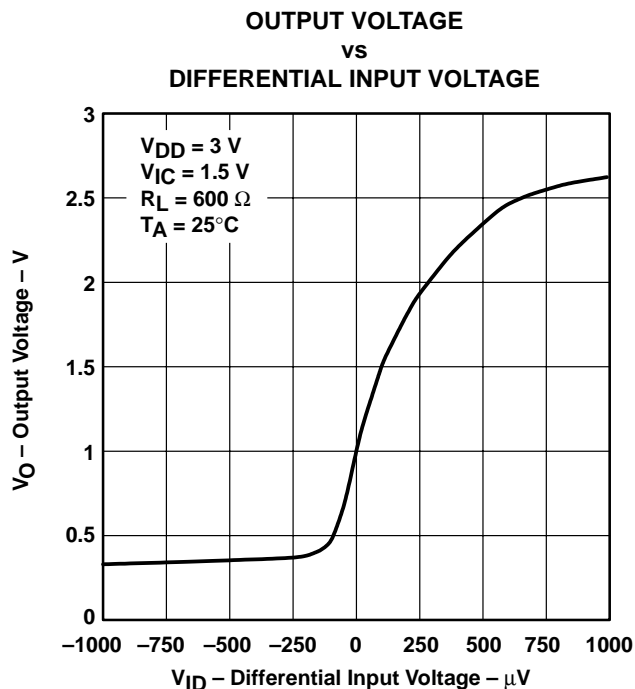


Figure 16

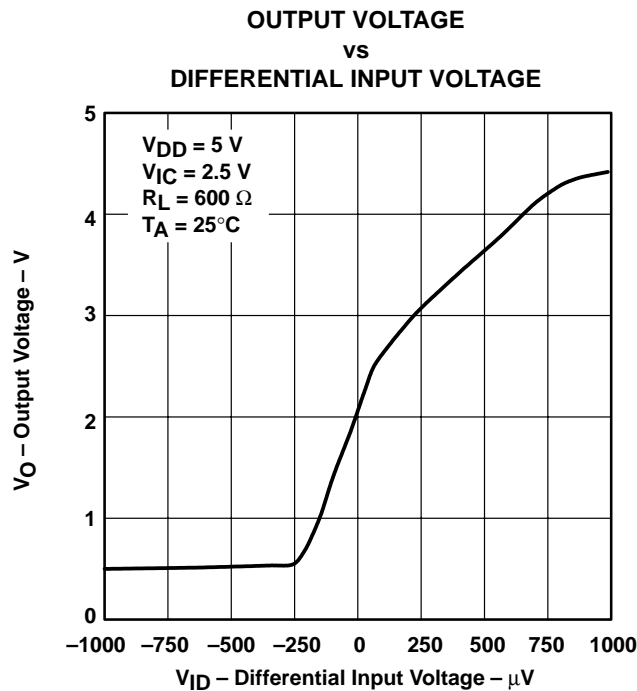


Figure 17

**TLV2442, TLV2442A, TLV2444, TLV2444A**  
**Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT**  
**WIDE-INPUT-VOLTAGE OPERATIONAL AMPLIFIERS**

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**TYPICAL CHARACTERISTICS**

**DIFFERENTIAL VOLTAGE AMPLIFICATION**  
**vs**  
**LOAD RESISTANCE**

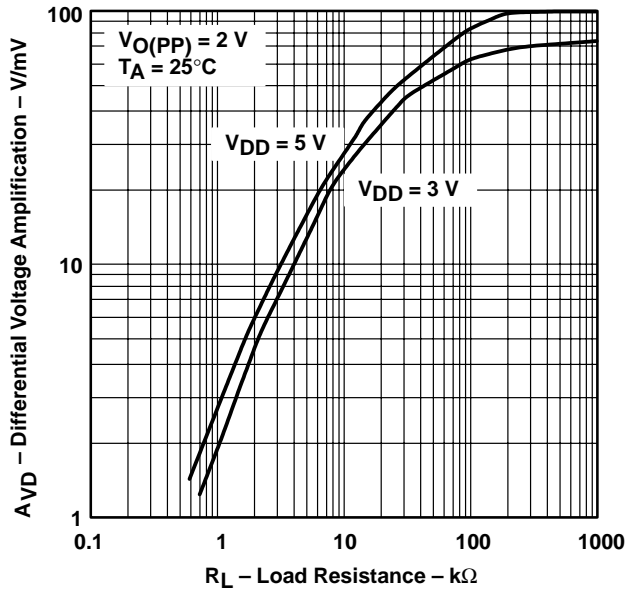


Figure 18

**LARGE-SIGNAL DIFFERENTIAL VOLTAGE**  
**AMPLIFICATION AND PHASE MARGIN**  
**vs**  
**FREQUENCY**

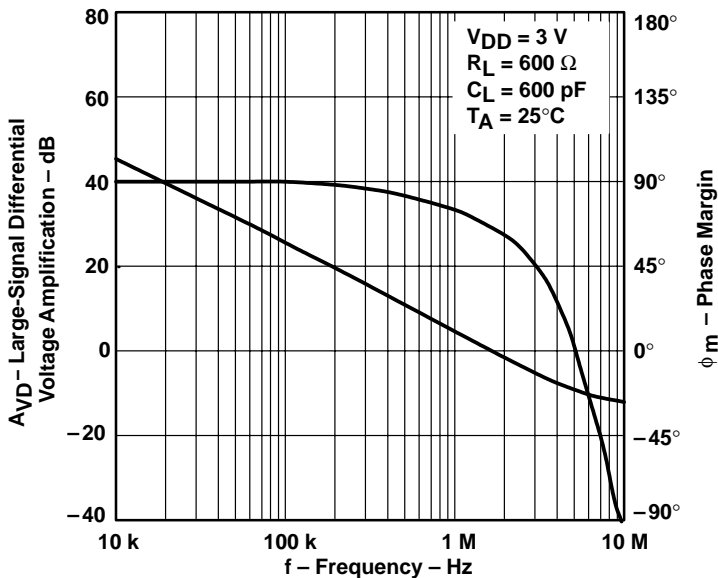


Figure 19



TYPICAL CHARACTERISTICS

LARGE-SIGNAL DIFFERENTIAL VOLTAGE  
 AMPLIFICATION AND PHASE MARGIN  
 vs  
 FREQUENCY



Figure 20

LARGE-SIGNAL DIFFERENTIAL  
 VOLTAGE AMPLIFICATION  
 vs  
 FREE-AIR TEMPERATURE



Figure 21

LARGE-SIGNAL DIFFERENTIAL  
 VOLTAGE AMPLIFICATION  
 vs  
 FREE-AIR TEMPERATURE

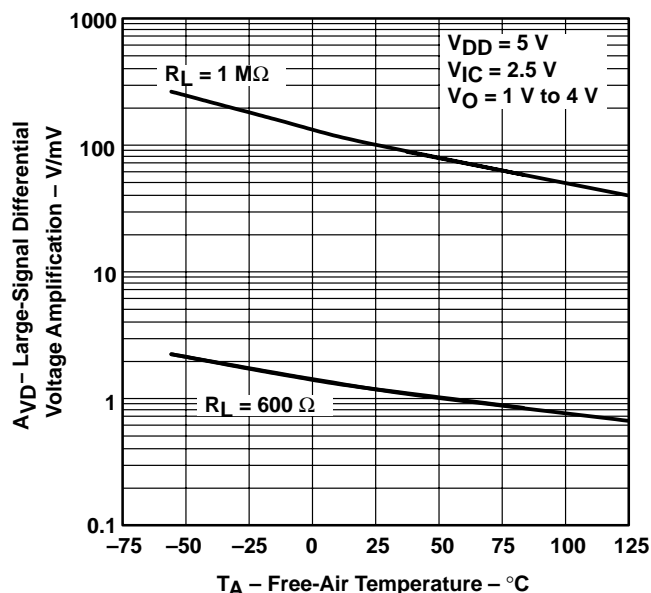


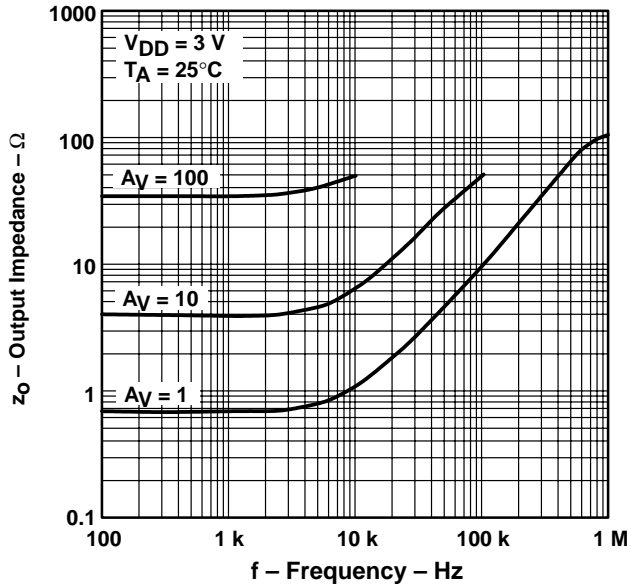
Figure 22

**TLV2442, TLV2442A, TLV2444, TLV2444A**  
**Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT**  
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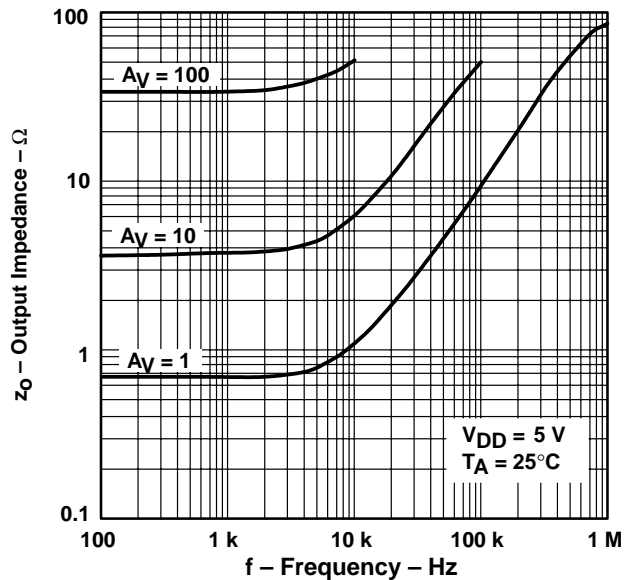
**TYPICAL CHARACTERISTICS**

**OUTPUT IMPEDANCE  
vs  
FREQUENCY**



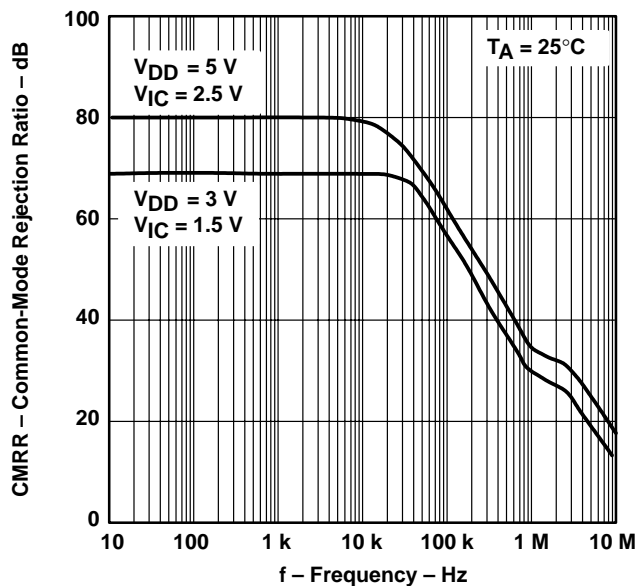
**Figure 23**

**OUTPUT IMPEDANCE  
vs  
FREQUENCY**



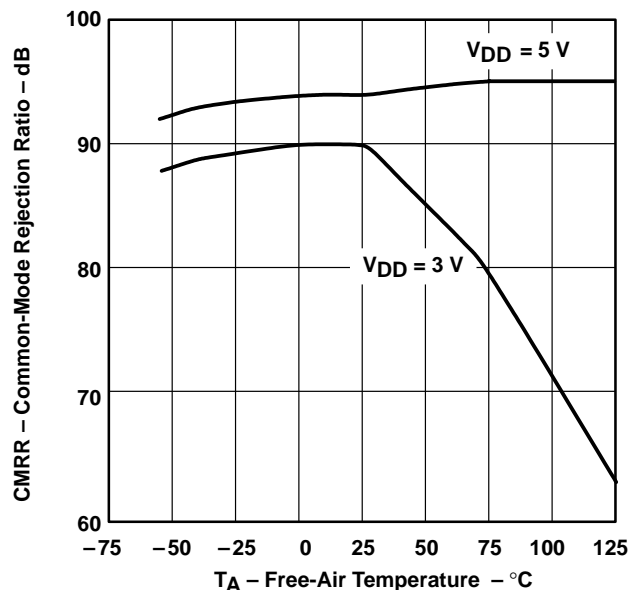
**Figure 24**

**COMMON-MODE REJECTION RATIO  
vs  
FREQUENCY**



**Figure 25**

**COMMON-MODE REJECTION RATIO  
vs  
FREE-AIR TEMPERATURE**



**Figure 26**





TYPICAL CHARACTERISTICS



Figure 27



Figure 28

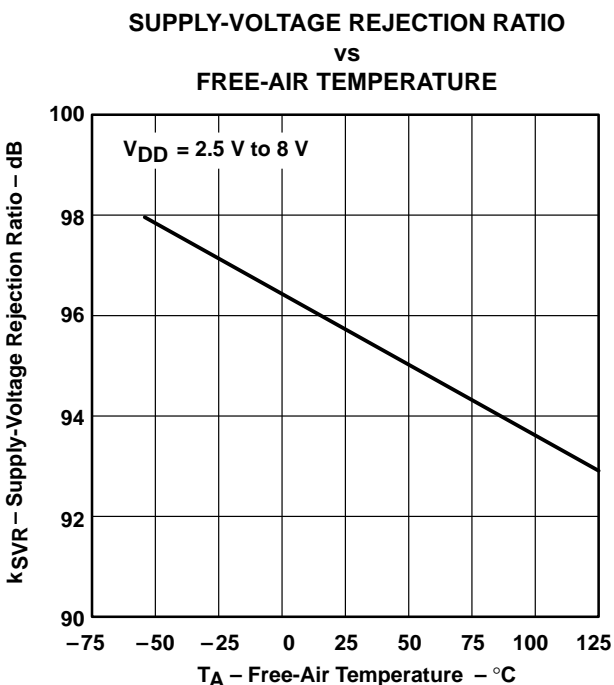


Figure 29

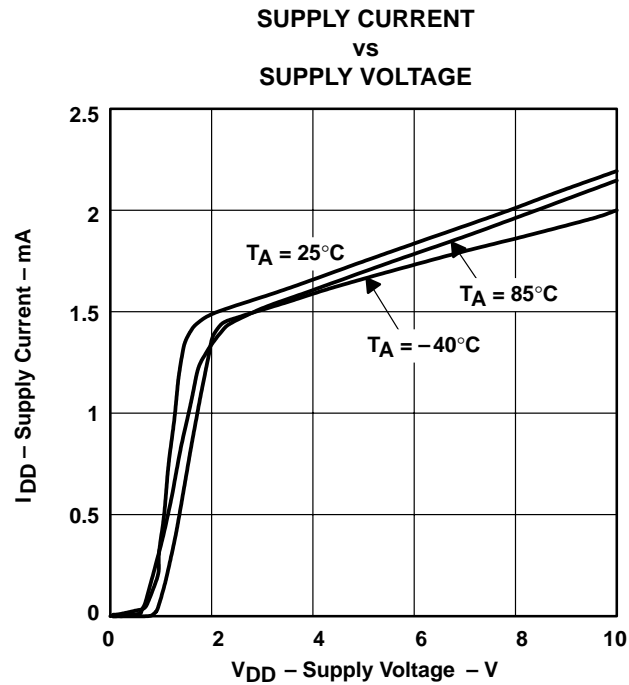


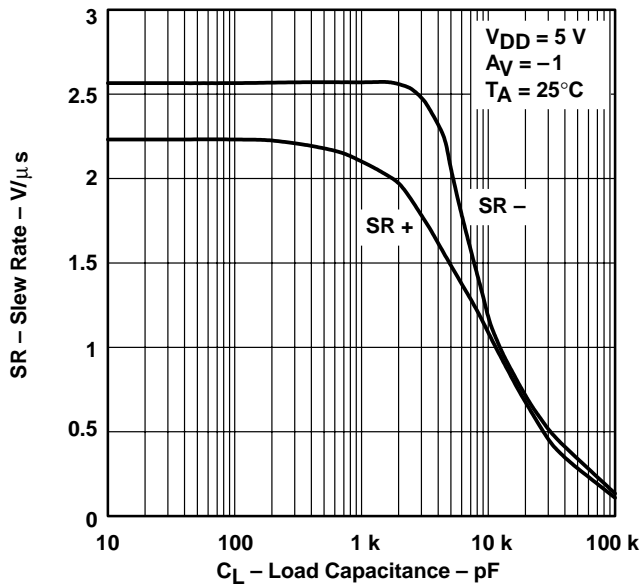
Figure 30

**TLV2442, TLV2442A, TLV2444, TLV2444A**  
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**WIDE-INPUT-VOLTAGE OPERATIONAL AMPLIFIERS**

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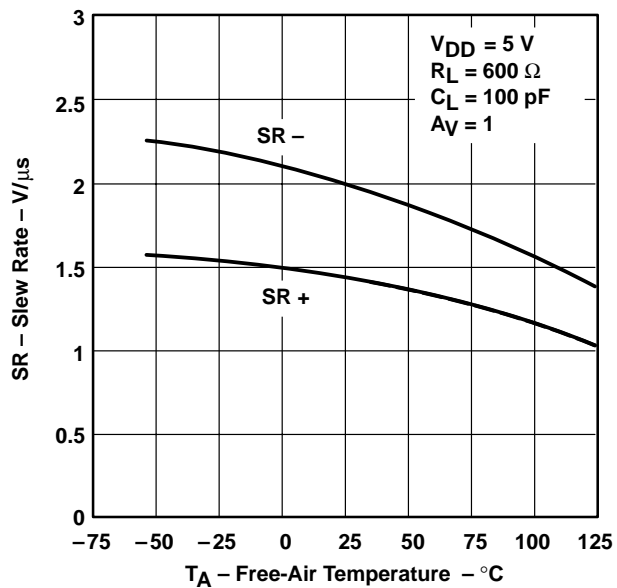
**TYPICAL CHARACTERISTICS**

**SLEW RATE  
vs  
LOAD CAPACITANCE**



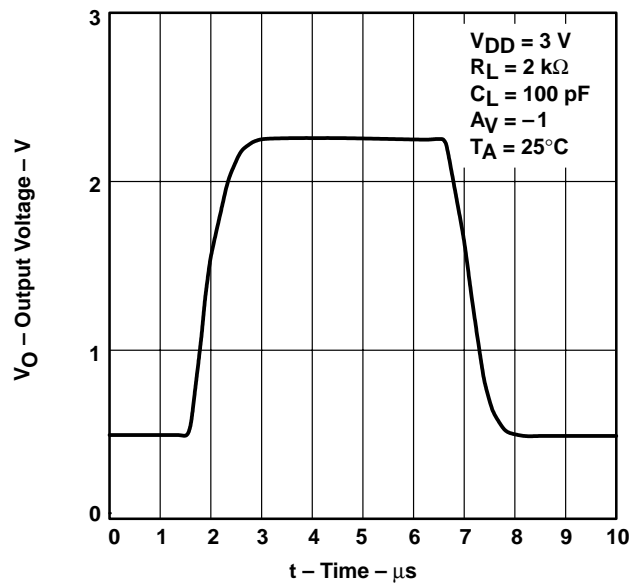
**Figure 31**

**SLEW RATE  
vs  
FREE-AIR TEMPERATURE**



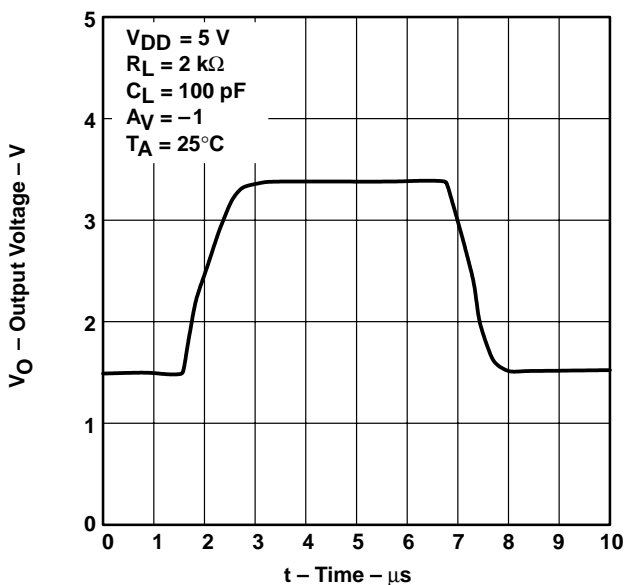
**Figure 32**

**INVERTING LARGE-SIGNAL PULSE RESPONSE**



**Figure 33**

**INVERTING LARGE-SIGNAL PULSE RESPONSE**



**Figure 34**



TYPICAL CHARACTERISTICS

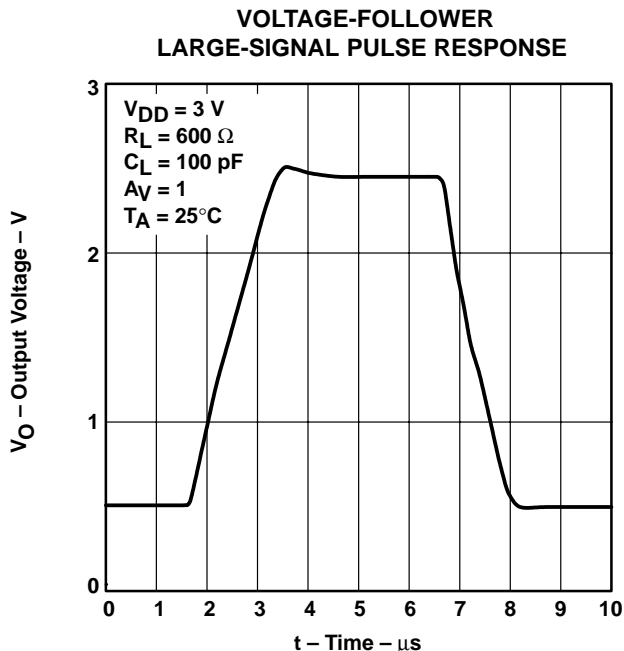


Figure 35



Figure 36

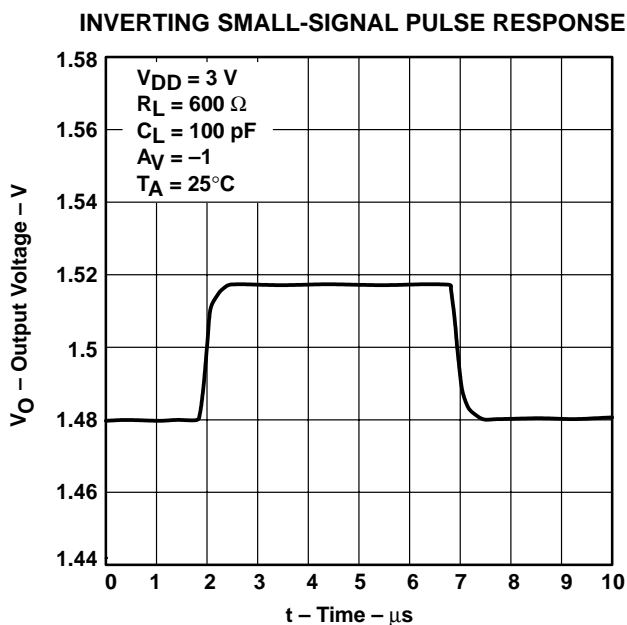


Figure 37

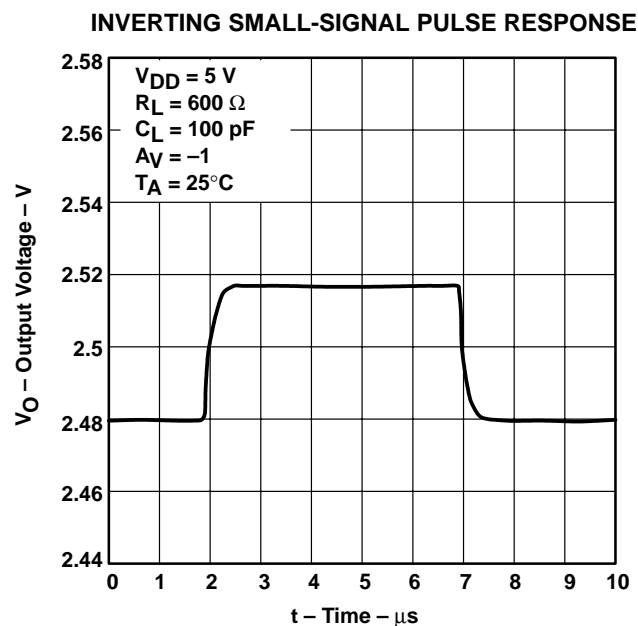


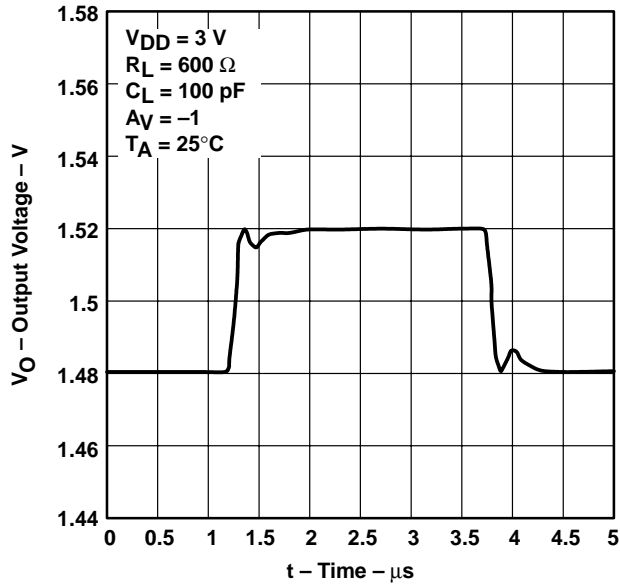
Figure 38

**TLV2442, TLV2442A, TLV2444, TLV2444A**  
**Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT**  
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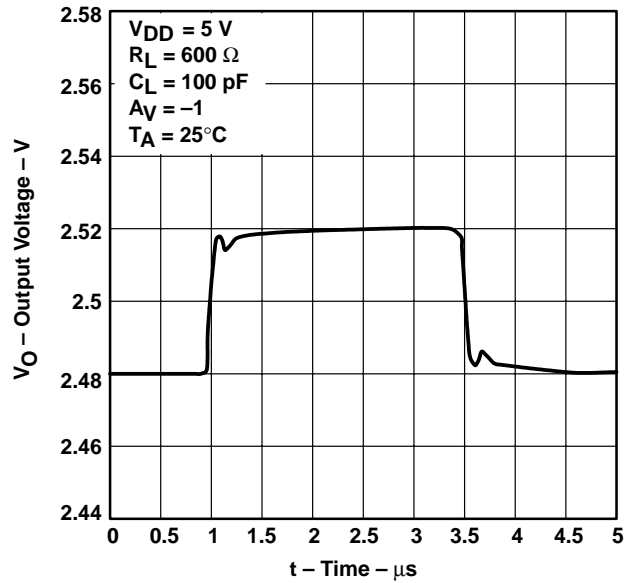
**TYPICAL CHARACTERISTICS**

**VOLTAGE-FOLLOWER  
 SMALL-SIGNAL PULSE RESPONSE**



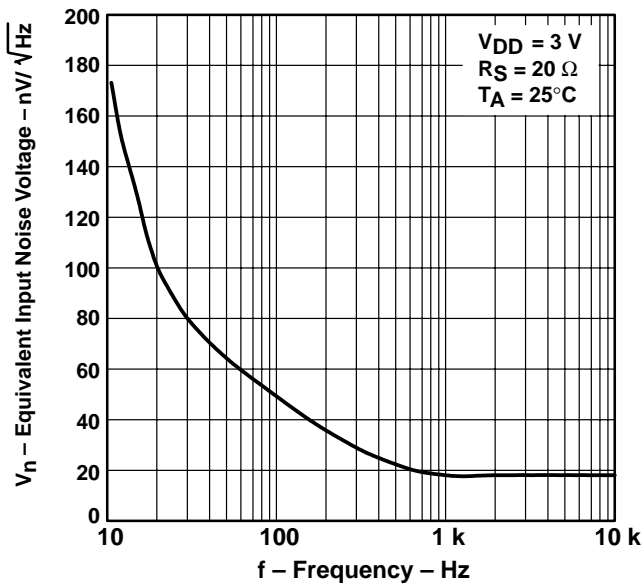
**Figure 39**

**VOLTAGE-FOLLOWER  
 SMALL-SIGNAL PULSE RESPONSE**



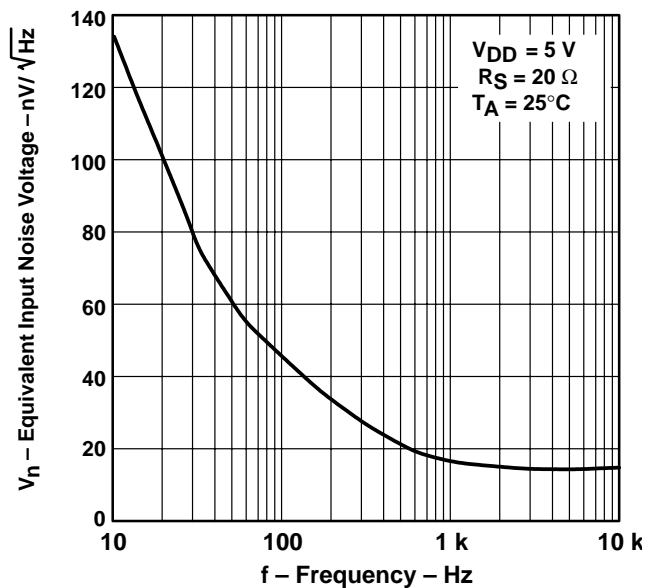
**Figure 40**

**EQUIVALENT INPUT NOISE VOLTAGE  
 VS  
 FREQUENCY**



**Figure 41**

**EQUIVALENT INPUT NOISE VOLTAGE  
 VS  
 FREQUENCY**



**Figure 42**



TYPICAL CHARACTERISTICS

NOISE VOLTAGE  
 OVER A 10-SECOND PERIOD



Figure 43

TOTAL HARMONIC DISTORTION PLUS NOISE  
 VS  
 FREQUENCY



Figure 44

TOTAL HARMONIC DISTORTION PLUS NOISE  
 VS  
 FREQUENCY



Figure 45

GAIN-BANDWIDTH PRODUCT  
 VS  
 FREE-AIR TEMPERATURE

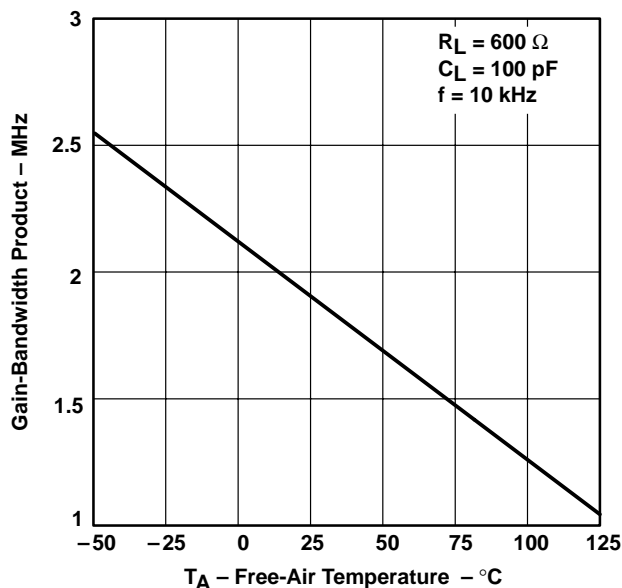


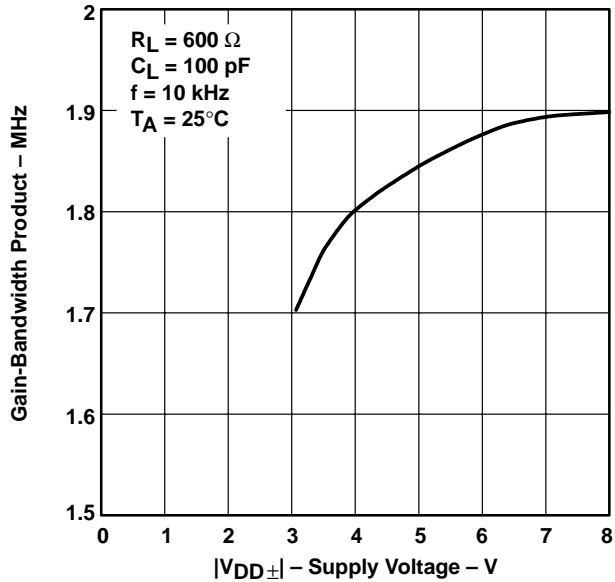
Figure 46

**TLV2442, TLV2442A, TLV2444, TLV2444A**  
**Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT**  
**WIDE-INPUT-VOLTAGE OPERATIONAL AMPLIFIERS**

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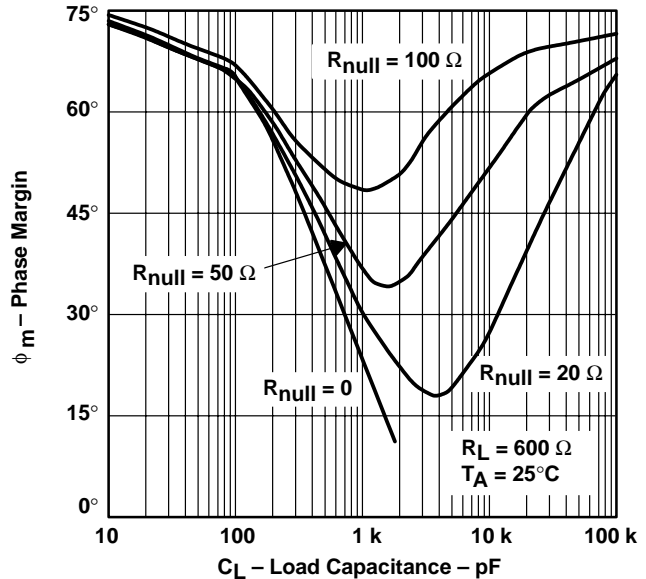
**TYPICAL CHARACTERISTICS**

**GAIN-BANDWIDTH PRODUCT**  
**vs**  
**SUPPLY VOLTAGE**



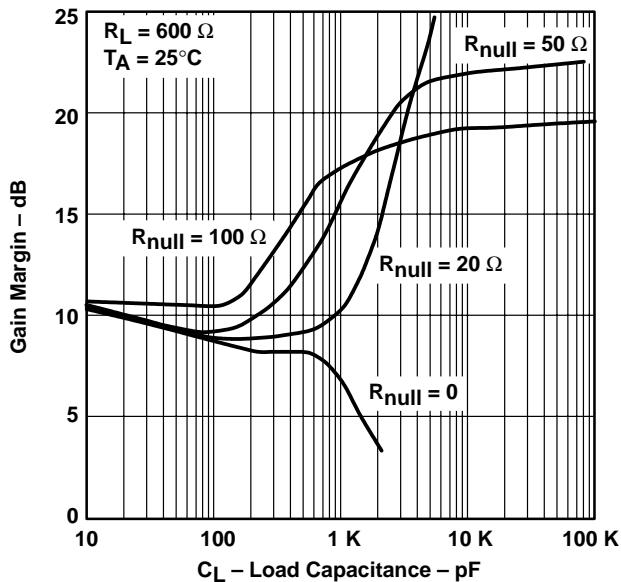
**Figure 47**

**PHASE MARGIN**  
**vs**  
**LOAD CAPACITANCE**



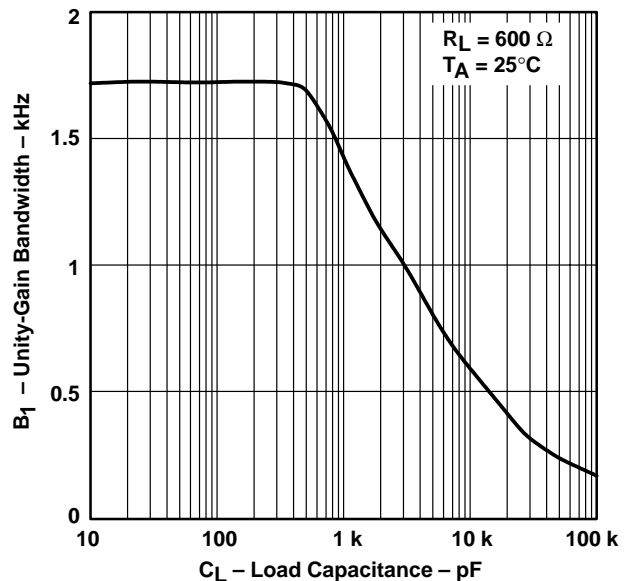
**Figure 48**

**GAIN MARGIN**  
**vs**  
**LOAD CAPACITANCE**



**Figure 49**

**UNITY-GAIN BANDWIDTH**  
**vs**  
**LOAD CAPACITANCE**



**Figure 50**



# TLV2442, TLV2442A, TLV2444, TLV2444A Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT WIDE-INPUT-VOLTAGE OPERATIONAL AMPLIFIERS

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## APPLICATION INFORMATION

### macromodel information

Macromodel information provided was derived using *PSpice™ Parts™* model generation software. The Boyle macromodel (see Note 5) and subcircuit in Figure 51 were generated using the TLV244x typical electrical and operating characteristics at  $T_A = 25^\circ\text{C}$ . Using this information, output simulations of the following key parameters can be generated to a tolerance of 20% (in most cases):

- Maximum positive output voltage swing
- Maximum negative output voltage swing
- Slew rate
- Quiescent power dissipation
- Input bias current
- Open-loop voltage amplification
- Unity gain frequency
- Common-mode rejection ratio
- Phase margin
- DC output resistance
- AC output resistance
- Short-circuit output current limit

NOTE 5: G. R. Boyle, B. M. Cohn, D. O. Pederson, and J. E. Solomon, "Macromodeling of Integrated Circuit Operational Amplifiers," *IEEE Journal of Solid-State Circuits*, SC-9, 353 (1974).

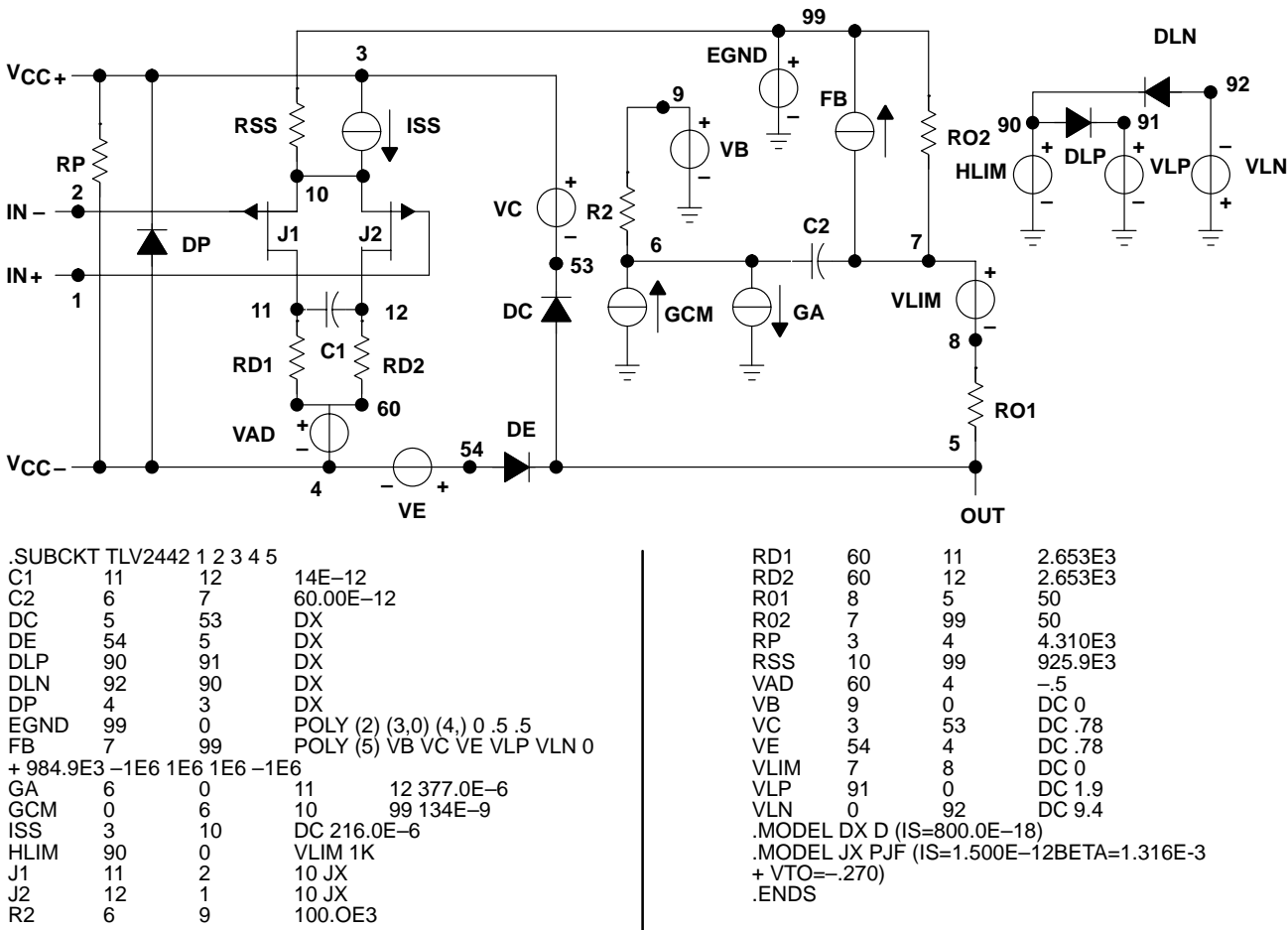


Figure 51. Boyle Macromodel and Subcircuit

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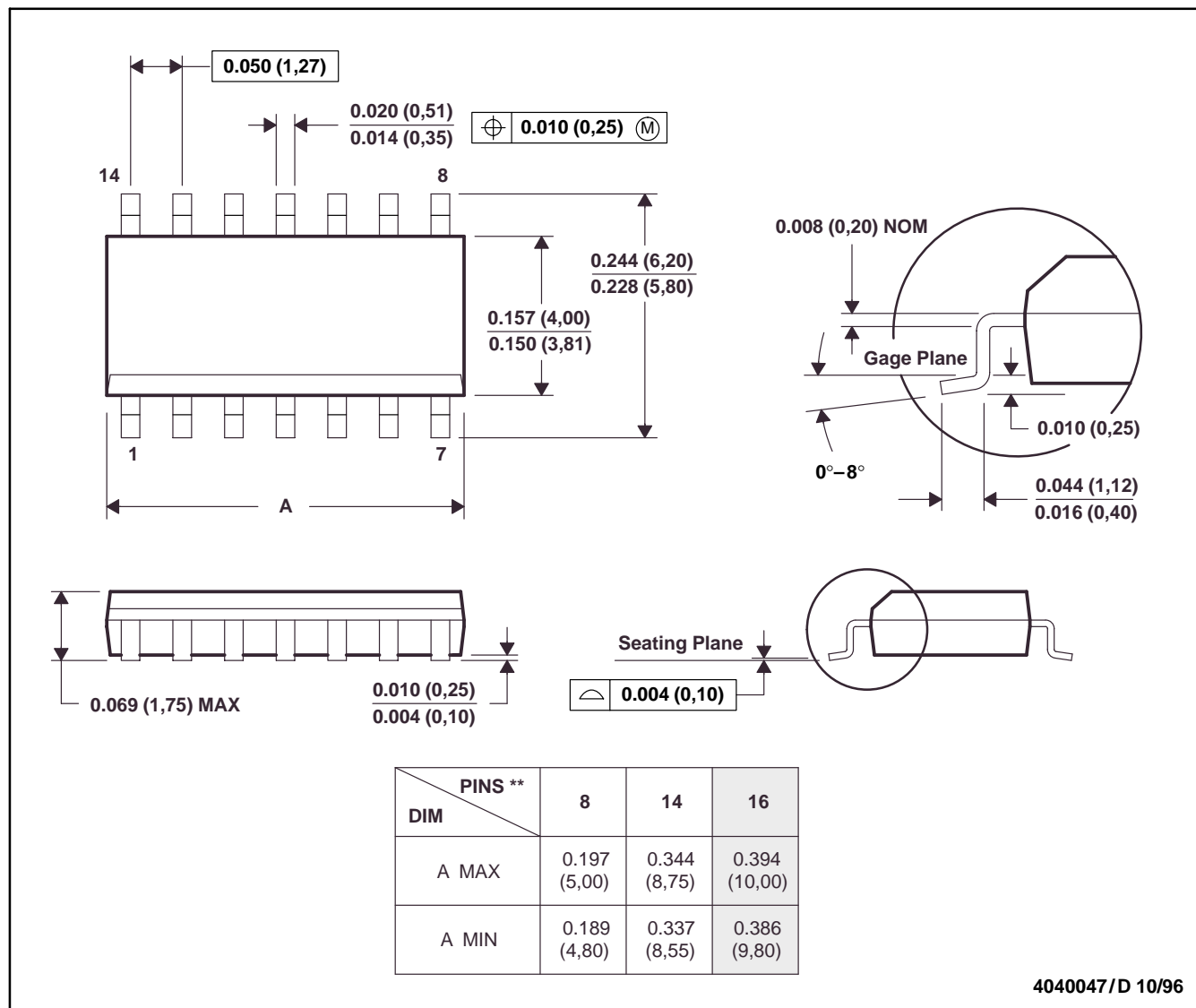
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**MECHANICAL DATA**

**D (R-PDSO-G\*\*)**

**PLASTIC SMALL-OUTLINE PACKAGE**

14 PIN SHOWN



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion, not to exceed 0.006 (0,15).  
 D. Falls within JEDEC MS-012



**TLV2442, TLV2442A, TLV2444, TLV2444A**  
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**MECHANICAL DATA**

**FK (S-CQCC-N\*\*)**

**LEADLESS CERAMIC CHIP CARRIER**

28 TERMINAL SHOWN



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. This package can be hermetically sealed with a metal lid.  
 D. The terminals are gold plated.  
 E. Falls within JEDEC MS-004

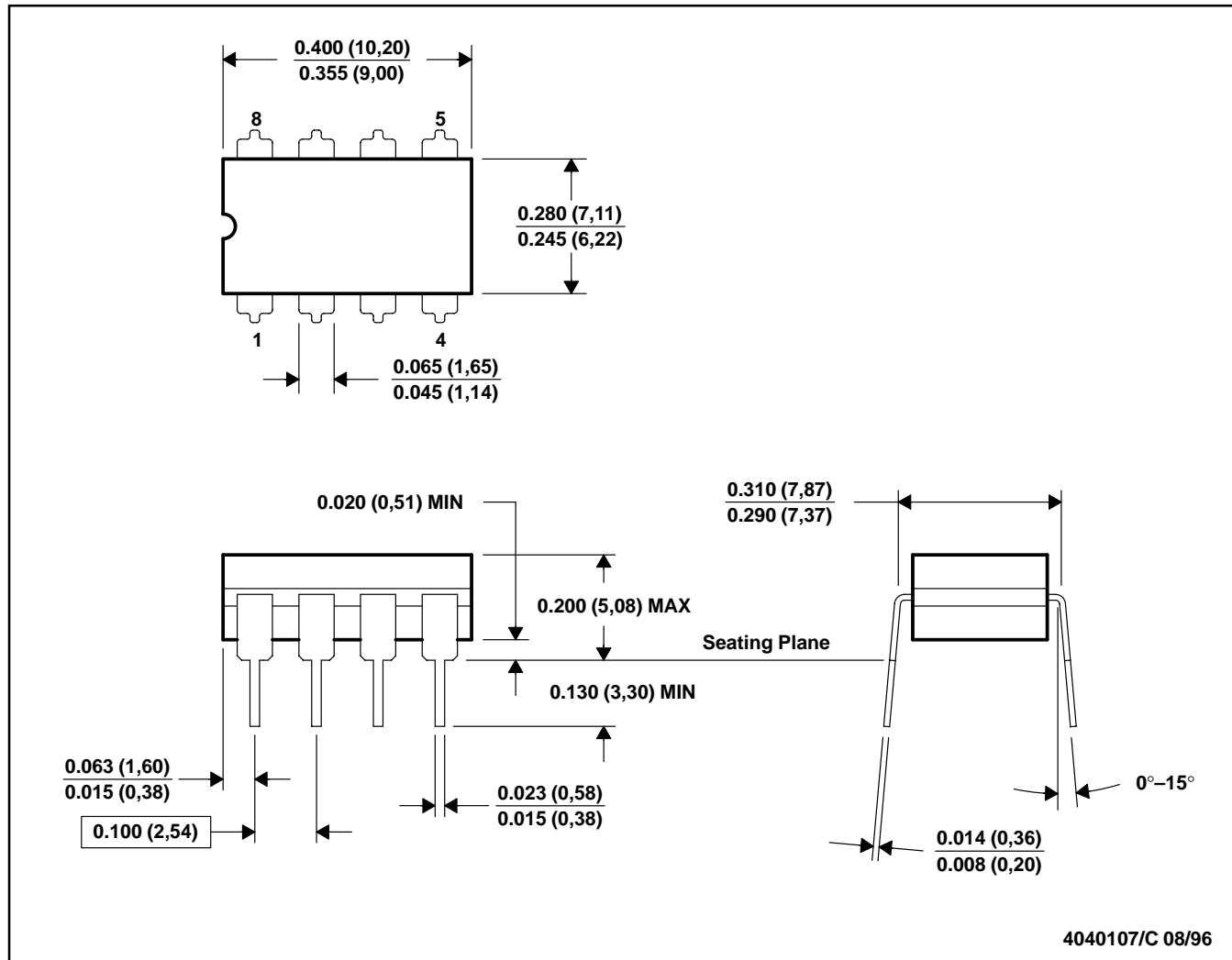
**TLV2442, TLV2442A, TLV2444, TLV2444A**  
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**MECHANICAL DATA**

**JG (R-GDIP-T8)**

**CERAMIC DUAL-IN-LINE PACKAGE**



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. This package can be hermetically sealed with a ceramic lid using glass frit.  
 D. Index point is provided on cap for terminal identification on press ceramic glass frit seal only.  
 E. Falls within MIL-STD-1835 GDIP1-T8

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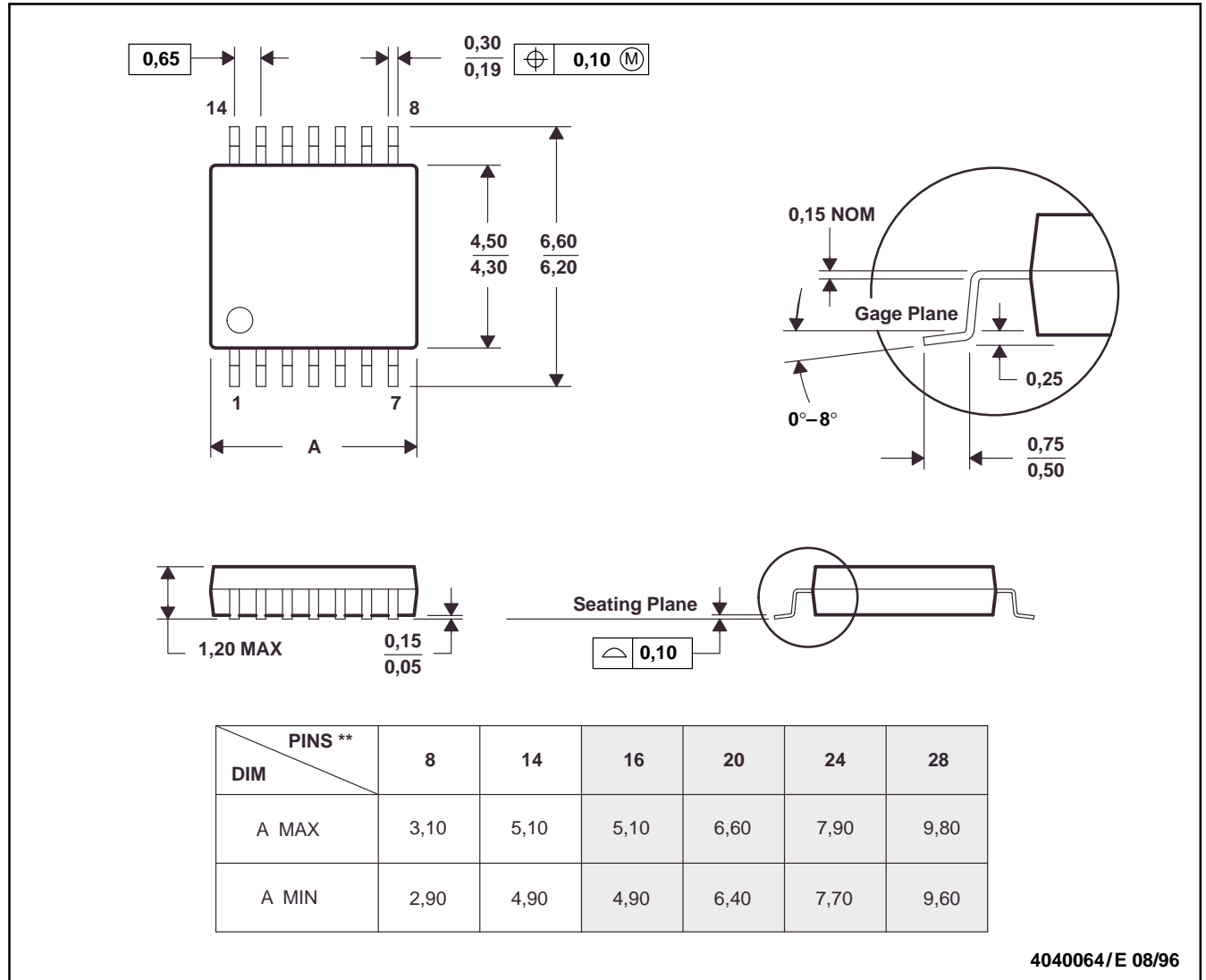
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MECHANICAL DATA

PW (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14 PIN SHOWN



4040064/E 08/96

- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-153

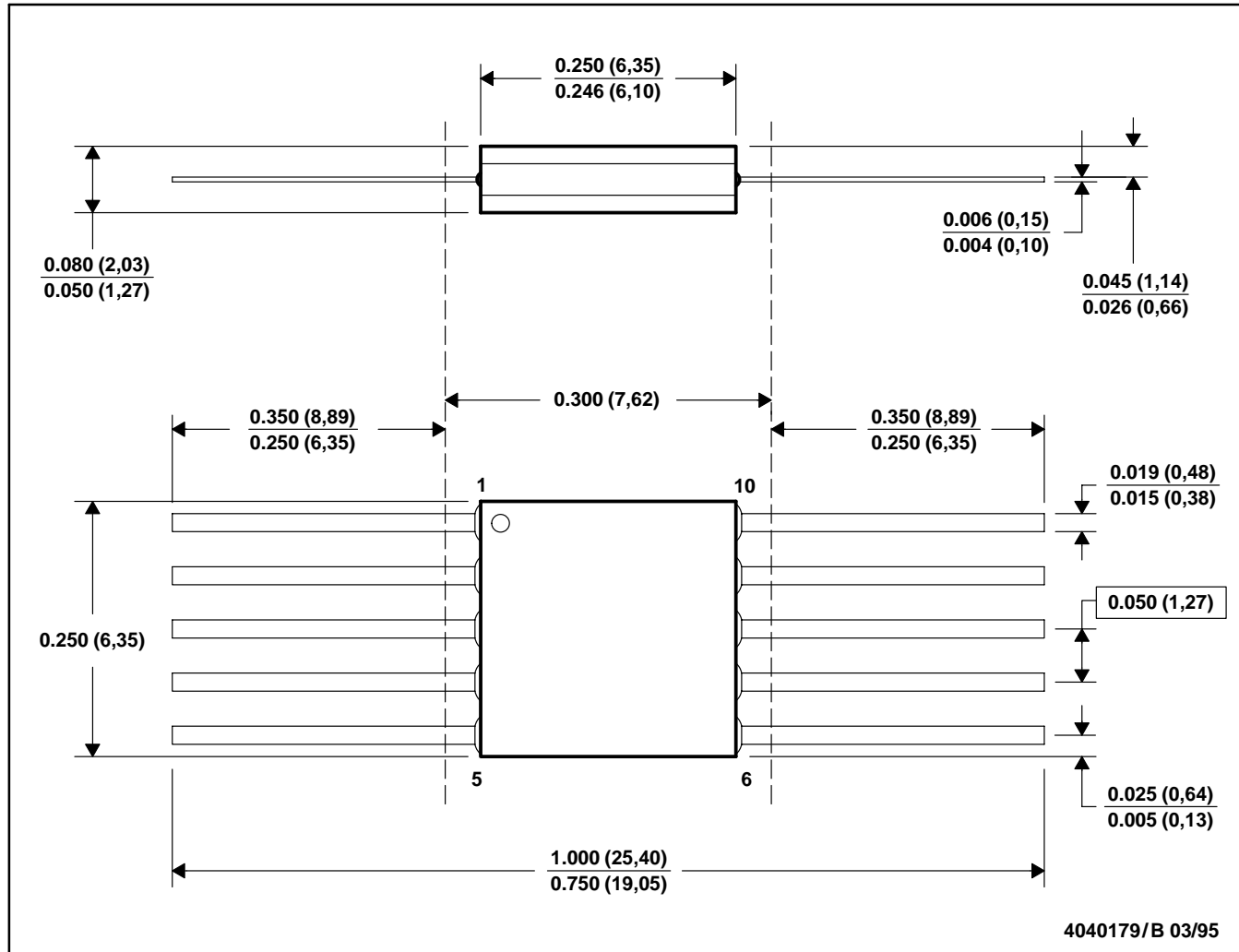
**TLV2442, TLV2442A, TLV2444, TLV2444A**  
**Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT**  
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**MECHANICAL DATA**

**U (S-GDFP-F10)**

**CERAMIC DUAL FLATPACK**



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. This package can be hermetically sealed with a ceramic lid using glass frit.  
 D. Index point is provided on cap for terminal identification only.  
 E. Falls within MIL STD 1835 GDFP1-F10 and JEDEC MO-092AA



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**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
5962-9751101Q2A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type
5962-9751101QHA	ACTIVE	CFP	U	10	1	TBD	A42 SNPB	N / A for Pkg Type
5962-9751101QPA	ACTIVE	CDIP	JG	8	1	TBD	A42 SNPB	N / A for Pkg Type
5962-9751102Q2A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type
5962-9751102QHA	ACTIVE	CFP	U	10	1	TBD	A42 SNPB	N / A for Pkg Type
5962-9751102QPA	ACTIVE	CDIP	JG	8	1	TBD	A42 SNPB	N / A for Pkg Type
TLV2442AID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2442AIDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2442AIDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2442AIDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2442AIPW	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2442AIPWG4	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2442AIPWLE	OBSOLETE	TSSOP	PW	8		TBD	Call TI	Call TI
TLV2442AIPWR	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2442AIPWRG4	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2442AMFKB	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type
TLV2442AMJGB	ACTIVE	CDIP	JG	8	1	TBD	A42 SNPB	N / A for Pkg Type
TLV2442AMUB	ACTIVE	CFP	U	10	1	TBD	A42 SNPB	N / A for Pkg Type
TLV2442AQD	NRND	SOIC	D	8	75	TBD	CU NIPDAU	Level-1-220C-UNLIM
TLV2442AQDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2442AQDR	NRND	SOIC	D	8	2500	TBD	Call TI	Call TI
TLV2442AQDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2442AQPW	ACTIVE	TSSOP	PW	8	150	TBD	CU NIPDAU	Level-1-220C-UNLIM
TLV2442AQPWG4	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2442AQPWR	ACTIVE	TSSOP	PW	8	2000	TBD	CU NIPDAU	Level-1-220C-UNLIM
TLV2442AQPWRG4	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2442CD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2442CDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2442CDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2442CDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2442CPW	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
						no Sb/Br)		
TLV2442CPWG4	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2442CPWLE	OBSOLETE	TSSOP	PW	8		TBD	Call TI	Call TI
TLV2442CPWR	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2442CPWRG4	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2442ID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2442IDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2442IDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2442IDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2442IPWRG4	ACTIVE	TSSOP	PW	8		TBD	Call TI	Call TI
TLV2442MFKB	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type
TLV2442MJGB	ACTIVE	CDIP	JG	8	1	TBD	A42 SNPB	N / A for Pkg Type
TLV2442MUB	ACTIVE	CFP	U	10	1	TBD	A42 SNPB	N / A for Pkg Type
TLV2442QD	NRND	SOIC	D	8	75	TBD	CU NIPDAU	Level-1-220C-UNLIM
TLV2442QDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2442QDR	NRND	SOIC	D	8	2500	TBD	Call TI	Call TI
TLV2442QDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2442QPW	ACTIVE	TSSOP	PW	8	150	TBD	CU NIPDAU	Level-1-220C-UNLIM
TLV2442QPWG4	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2442QPWR	ACTIVE	TSSOP	PW	8	2000	TBD	CU NIPDAU	Level-1-220C-UNLIM
TLV2442QPWRG4	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2444AID	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2444AIDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2444AIDRG4	ACTIVE	SOIC	D	14		TBD	Call TI	Call TI
TLV2444AIPW	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2444AIPWG4	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2444AIPWR	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2444AIPWRG4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2444AQPWRQ1	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2444CD	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
TLV2444CDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2444CDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2444CDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2444CPW	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2444CPWG4	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2444CPWR	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2444CPWRG4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2444ID	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2444IDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2444IDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2444IDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2444IPWR	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2444IPWRG4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

<sup>(1)</sup> 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.

<sup>(2)</sup> 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)

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

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JG (R-GDIP-T8)

CERAMIC DUAL-IN-LINE



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. This package can be hermetically sealed with a ceramic lid using glass frit.  
 D. Index point is provided on cap for terminal identification.  
 E. Falls within MIL STD 1835 GDIP1-T8



FK (S-CQCC-N\*\*)

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. This package can be hermetically sealed with a metal lid.
  - D. The terminals are gold plated.
  - E. Falls within JEDEC MS-004

D (R-PDSO-G14)

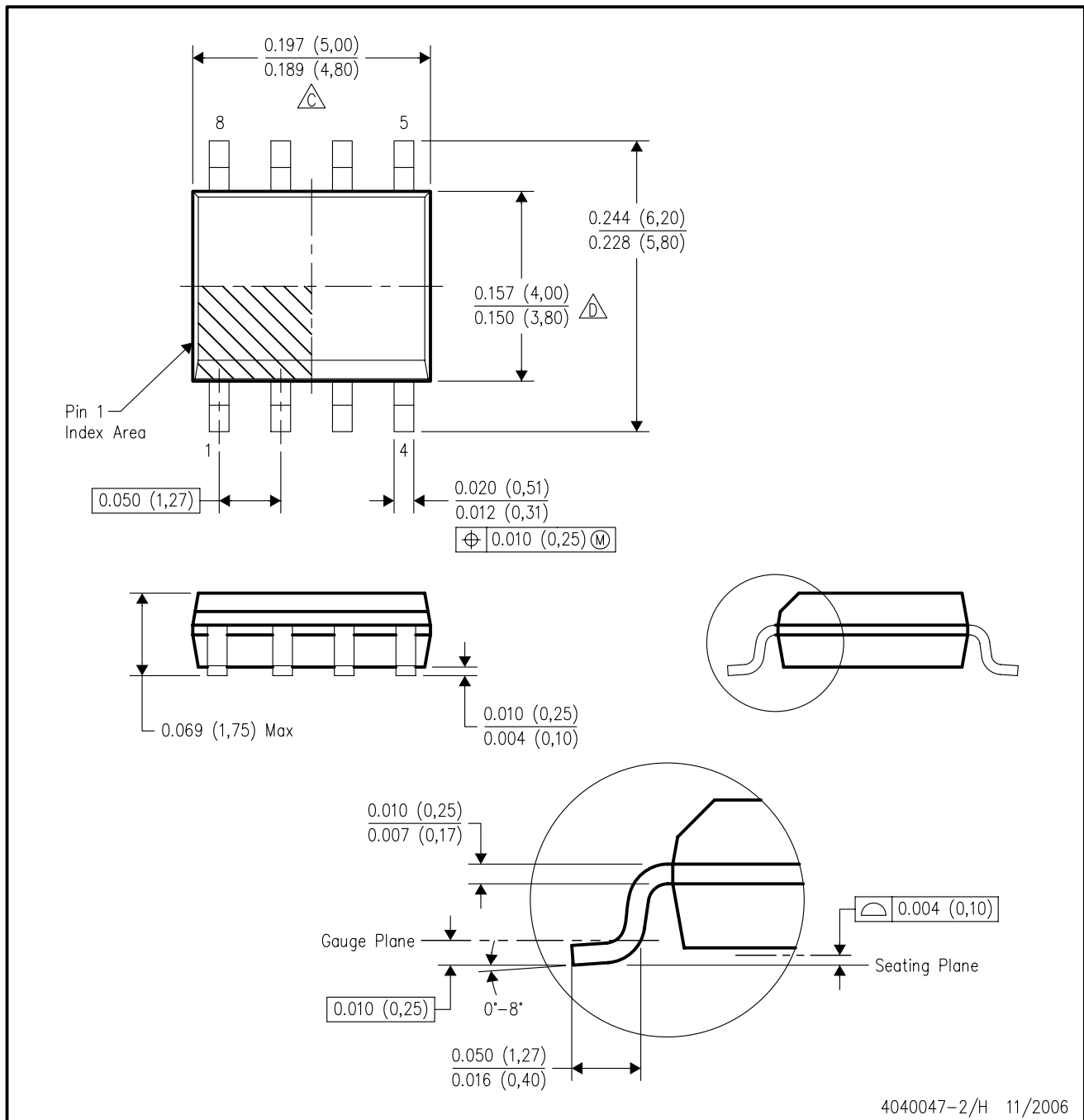
PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - $\triangle C$  Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 (0,15) per end.
  - $\triangle D$  Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
  - E. Reference JEDEC MS-012 variation AB.

D (R-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE



- 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 .006 (0,15) per end.
  - D. Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
  - E. Reference JEDEC MS-012 variation AA.

PW (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



4040064/F 01/97

- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-153

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DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>	Broadband	<a href="http://www.ti.com/broadband">www.ti.com/broadband</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>	Digital Control	<a href="http://www.ti.com/digitalcontrol">www.ti.com/digitalcontrol</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>	Military	<a href="http://www.ti.com/military">www.ti.com/military</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>	Optical Networking	<a href="http://www.ti.com/opticalnetwork">www.ti.com/opticalnetwork</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>	Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>	Telephony	<a href="http://www.ti.com/telephony">www.ti.com/telephony</a>
Low Power Wireless	<a href="http://www.ti.com/lpw">www.ti.com/lpw</a>	Video & Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>
		Wireless	<a href="http://www.ti.com/wireless">www.ti.com/wireless</a>

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