

TLV2422, TLV2422A, TLV2422Y
Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT
WIDE-INPUT-VOLTAGE MICROPOWER DUAL OPERATIONAL AMPLIFIERS

SLOS199B – SEPTEMBER 1997 – REVISED SEPTEMBER 1999

- Output Swing Includes Both Supply Rails
- Extended Common-Mode Input Voltage Range . . . 0 V to 4.5 V (Min) with 5-V Single Supply
- No Phase Inversion
- Low Noise . . . 18 nV/√Hz Typ at f = 1 kHz
- Low Input Offset Voltage
950 μV Max at T_A = 25°C (TLV2422A)
- Low Input Bias Current . . . 1 pA Typ
- Micropower Operation . . . 50 μA Per Channel
- 600-Ω Output Drive
- Available in Q-Temp Automotive
HighRel Automotive Applications
Configuration Control / Print Support
Qualification to Automotive Standards

description

The TLV2422 and TLV2422A are dual low-voltage operational amplifiers from Texas Instruments. The common-mode input voltage range for this device has been extended over the typical CMOS amplifiers making them suitable for a wide range of applications. In addition, the 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. The TLV2422 only requires 50 μA of supply current per channel, making it ideal for battery-powered applications. The TLV2422 also has increased output drive over previous rail-to-rail operational amplifiers and can drive 600-Ω loads for telecom applications.

Other members in the TLV2422 family are the high-power, TLV2442, and low-power, TLV2432, versions.

The TLV2422, 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 TLV2422A 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.

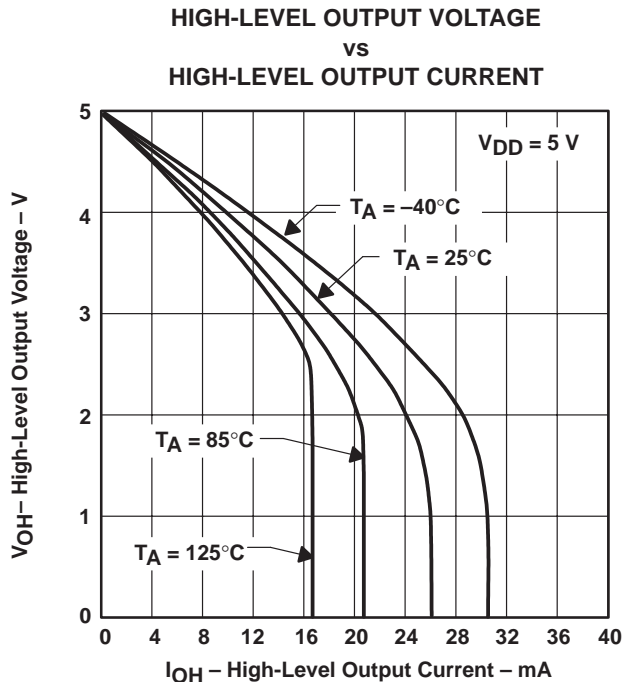


Figure 1



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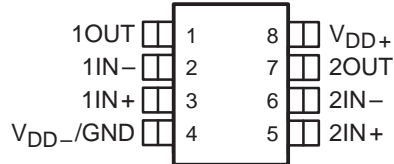
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AVAILABLE OPTIONS

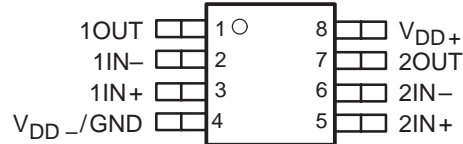
T _A	V _{IO} max AT 25°C	PACKAGED DEVICES					CHIP FORM (Y)
		SMALL OUTLINE (D)	CHIP CARRIER (FK)	CERAMIC DIP (JG)	TSSOP (PW)	CERAMIC FLAT PACK (U)	
0°C to 70°C	2.5 mV	TLV2422CD	—	—	TLV2422CPWLE	—	TLV2422Y
–40°C to 85°C	950 μV 2.5 mV	TLV2422AID TLV2422ID	— —	— —	TLV2422AIPWLE —	— —	
–40°C to 125°C	950 μV 2.5 mV	TLV2422AQD TLV2422QD	— —	— —	— —	— —	
–55°C to 125°C	950 μV 2 mV	— —	TLV2422AMFK TLV2422MFK	TLV2422AMJG TLV2422MJG	— —	TLV2422AMU TLV2422MU	

The D packages are available taped and reeled. Add R suffix to device type (e.g., TLV2422CDR). The PW package is available only left-end taped and reeled. Chips are tested at 25°C.

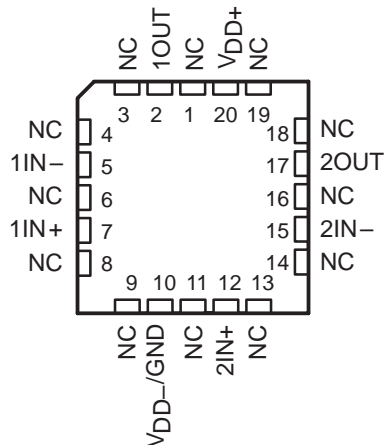
**D OR JG PACKAGE
(TOP VIEW)**



**PW PACKAGE
(TOP VIEW)**

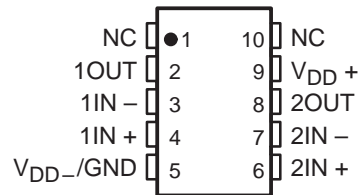


**FK PACKAGE
(TOP VIEW)**

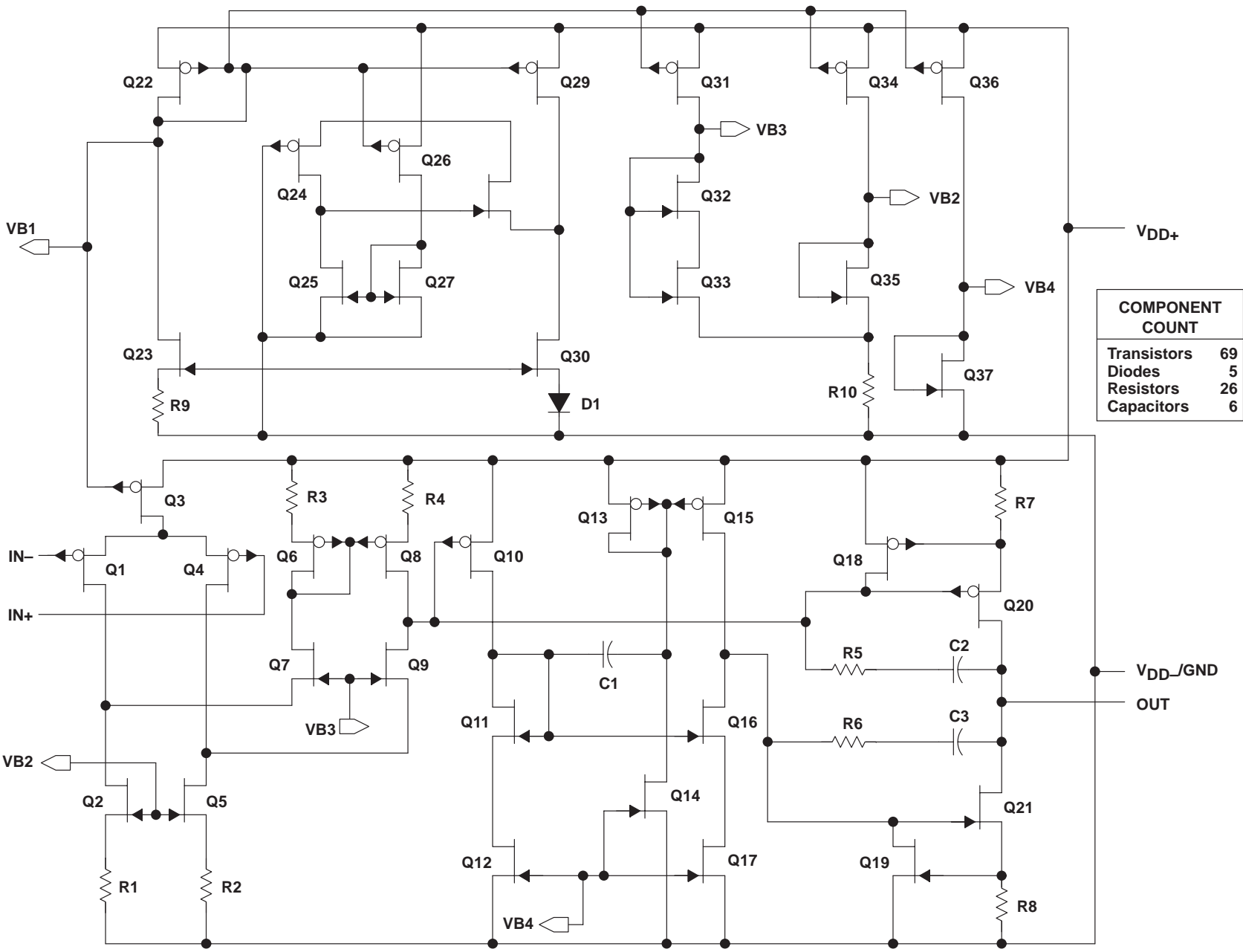


NC – No internal connection

**U PACKAGE
(TOP VIEW)**



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): C and I suffix	-0.3 V to V_{DD}
Input current, I_I (each input)	± 5 mA
Output current, I_O	± 50 mA
Total current into V_{DD+}	± 50 mA
Total current out of V_{DD-}	± 50 mA
Duration of short-circuit current at (or below) 25°C (see Note 3)	unlimited
Continuous total power dissipation	See Dissipation Rating Table
Operating free-air temperature range, T_A : C suffix	0°C to 70°C
I suffix	-40°C to 85°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 flows 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	725 mW	5.8 mW/°C	464 mW	377 mW	145 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	525 mW	4.2 mW/°C	336 mW	273 mW	105 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, $V_{DD\pm}$	2.7	10	2.7	10	2.7	10	2.7	10	V
Input voltage range, V_I	V_{DD-}	$V_{DD+} - 0.8$	V_{DD-}	$V_{DD+} - 0.8$	V_{DD-}	$V_{DD+} - 0.8$	V_{DD-}	$V_{DD+} - 0.8$	V
Common-mode input voltage, V_{IC}	V_{DD-}	$V_{DD+} - 0.8$	V_{DD-}	$V_{DD+} - 0.8$	V_{DD-}	$V_{DD+} - 0.8$	V_{DD-}	$V_{DD+} - 0.8$	V
Operating free-air temperature, T_A	0	70	-40	85	-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 †	TLV2422C			UNIT
			MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{IC} = 0,$ $V_O = 0,$ $V_{DD} \pm = \pm 2.5\text{ V},$ $R_S = 50\ \Omega$	25°C	300	2000	μV	
		Full range	2500			
α_{VIO} Temperature coefficient of input offset voltage		25°C to 70°C	2		$\mu\text{V}/^\circ\text{C}$	
Input offset voltage long-term drift (see Note 4)		25°C	0.003		$\mu\text{V}/\text{mo}$	
I_{IO} Input offset current		25°C	0.5		pA	
		Full range	150			
I_{IB} Input bias current		25°C	1		pA	
	Full range	150				
V_{ICR} Common-mode input voltage range	$ V_{IO} \leq 5\text{ mV},$ $R_S = 50\ \Omega$	25°C	0 to 2.5	-0.25 to 2.75	V	
		Full range	0 to 2.2			
V_{OH} High-level output voltage	$I_{OH} = -100\ \mu\text{A}$	25°C	2.97		V	
		25°C	2.75			
		Full range	2.5			
V_{OL} Low-level output voltage	$V_{IC} = 0,$ $I_{OL} = 100\ \mu\text{A}$	25°C	0.05		V	
		25°C	0.2			
		Full range	0.5			
A_{VD} Large-signal differential voltage amplification	$V_{IC} = 2.5\text{ V},$ $V_O = 1\text{ V to }2\text{ V}$	25°C	$R_L = 10\ \text{k}\Omega^\ddagger$		V/mV	
			6 10			
		Full range	3			
$r_{i(d)}$ Differential input resistance		25°C	$R_L = 1\ \text{M}\Omega^\ddagger$		Ω	
			700			
$r_{i(c)}$ Common-mode input resistance		25°C	10^{12}		Ω	
$c_{i(c)}$ Common-mode input capacitance	$f = 10\ \text{kHz}$	25°C	8		pF	
z_o Closed-loop output impedance	$f = 100\ \text{kHz},$ $A_V = 10$	25°C	130		Ω	
CMRR Common-mode rejection ratio	$V_{IC} = 0\text{ to }2.5\text{ V},$ $V_O = 1.5\text{ V},$ $R_S = 50\ \Omega$	25°C	70	83	dB	
		Full range	70			
k_{SVR} Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$)	$V_{DD} = 2.7\text{ V to }8\text{ V},$ $V_{IC} = V_{DD}/2,$ No load	25°C	80	95	dB	
		Full range	80			
I_{DD} Supply current	$V_O = 1.5\text{ V},$ No load	25°C	100	150	μA	
		Full range	175			

† Full range is 0°C to 70°C.

‡ Referenced to 2.5 V

NOTE 4: Typical values are based on the input offset voltage shift observed through 500 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)

PARAMETER	TEST CONDITIONS	T_A †	TLV2422I			TLV2422AI			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{IC} = 0, V_O = 0, V_{DD} \pm = \pm 2.5\text{ V}, R_S = 50\ \Omega$	25°C	300	2000		300	950	μV	
		Full range			2500		1500		
$\alpha_{V_{IO}}$ Temperature coefficient of input offset voltage		25°C to 70°C	2			2			$\mu\text{V}/^\circ\text{C}$
Input offset voltage long-term drift (see Note 4)		25°C	0.003			0.003			$\mu\text{V}/\text{mo}$
I_{IO} Input offset current		25°C	0.5			0.5			pA
		Full range			150			150	
I_{IB} Input bias current	25°C	1			1			pA	
	Full range			150			150		
V_{ICR} Common-mode input voltage range	$ V_{IO} \leq 5\text{ mV}, R_S = 50\ \Omega$	25°C	0 to 2.5	-0.25 to 2.75		0 to 2.5	-0.25 to 2.75	V	
		Full range	0 to 2.2			0 to 2.2			
V_{OH} High-level output voltage	$I_{OH} = -100\ \mu\text{A}$ $I_{OH} = -500\ \mu\text{A}$	25°C	2.97			2.97			V
		25°C	2.75			2.75			
		Full range	2.5			2.5			
V_{OL} Low-level output voltage	$V_{IC} = 0, I_{OL} = 100\ \mu\text{A}$ $V_{IC} = 0, I_{OL} = 250\ \mu\text{A}$	25°C	0.05			0.05			V
		25°C	0.2			0.2			
		Full range			0.5			0.5	
A_{VD} Large-signal differential voltage amplification	$V_{IC} = 2.5\text{ V}, V_O = 1\text{ V to } 2\text{ V}$	25°C	$R_L = 10\text{ k}\Omega$ ‡		6	10	6	10	V/mV
			Full range		3		3		
		25°C	$R_L = 1\text{ M}\Omega$ ‡		700		700		
$r_{i(d)}$ Differential input resistance		25°C	10^{12}			10^{12}			Ω
$r_{i(c)}$ Common-mode input resistance		25°C	10^{12}			10^{12}			Ω
$C_{i(c)}$ Common-mode input capacitance	$f = 10\text{ kHz}$	25°C	8			8			pF
z_o Closed-loop output impedance	$f = 100\text{ kHz}, A_V = 10$	25°C	130			130			Ω
CMRR Common-mode rejection ratio	$V_{IC} = 0\text{ to } 2.5\text{ V}, V_O = 1.5\text{ V}, R_S = 50\ \Omega$	25°C	70	83		70	83	dB	
		Full range	70			70			
k_{SVR} Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$)	$V_{DD} = 2.7\text{ V to } 8\text{ V}, V_{IC} = V_{DD}/2, \text{ No load}$	25°C	80	95		80	95	dB	
		Full range	80			80			
I_{DD} Supply current	$V_O = 1.5\text{ V}, \text{ No load}$	25°C	100	150		100	150	μA	
		Full range			175				175

† Full range is -40°C to 85°C.

‡ Referenced to 2.5 V

NOTE 4: Typical values are based on the input offset voltage shift observed through 500 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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operating characteristics at specified free-air temperature, $V_{DD} = 3\text{ V}$

PARAMETER		TEST CONDITIONS		T_A †	TLV2422C, TLV2422I TLV2422AI			UNIT
					MIN	TYP	MAX	
SR	Slew rate at unity gain	$V_O = 1.5\text{ V to }3.5\text{ V}, R_L = 10\text{ k}\Omega\ddagger, C_L = 100\text{ pF}\ddagger$		25°C	0.01	0.02	$\text{V}/\mu\text{s}$	
				Full range	0.008			
V_n	Equivalent input noise voltage	f = 10 Hz		25°C	100		$\text{nV}/\sqrt{\text{Hz}}$	
		f = 1 kHz		25°C	23			
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C	2.7		μV	
		f = 0.1 Hz to 10 Hz		25°C	4			
I_n	Equivalent input noise current			25°C	0.6		$\text{fA}/\sqrt{\text{Hz}}$	
THD + N	Total harmonic distortion plus noise	$V_O = 0.5\text{ V to }2.5\text{ V}, f = 1\text{ kHz}, R_L = 10\text{ k}\Omega\ddagger$		$A_V = 1$	0.25%			
				$A_V = 10$	1.8%			
	Gain-bandwidth product	f = 10 kHz, $C_L = 100\text{ pF}\ddagger$	$R_L = 10\text{ k}\Omega\ddagger,$	25°C	46		kHz	
BOM	Maximum output-swing bandwidth	$V_{O(PP)} = 1\text{ V}, R_L = 10\text{ k}\Omega\ddagger,$	$A_V = 1, C_L = 100\text{ pF}\ddagger$	25°C	8.3		kHz	
t_s	Settling time	$A_V = -1, \text{ Step} = 0.5\text{ V to }2.5\text{ V}, R_L = 10\text{ k}\Omega\ddagger, C_L = 100\text{ pF}\ddagger$		To 0.1%	8.6		μs	
				To 0.01%	16			
ϕ_m	Phase margin at unity gain	$R_L = 10\text{ k}\Omega\ddagger, C_L = 100\text{ pF}\ddagger$		25°C	62°			
	Gain margin			25°C	11			dB

† Full range for the C version is 0°C to 70°C. Full range for the I version is -40°C to 85°C.

‡ Referenced to 2.5 V

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

PARAMETER	TEST CONDITIONS	T_A †	TLV2422Q, TLV2422M			TLV2422AQ, TLV2422AM			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{IC} = 0,$ $V_O = 0,$ $V_{DD} \pm = \pm 1.5\text{ V},$ $R_S = 50\ \Omega$	25°C	300	2000		300	950	μV	
		Full range			2500		1800		
$\alpha_{V_{IO}}$ Temperature coefficient of input offset voltage		Full range		2			2	$\mu\text{V}/^\circ\text{C}$	
Input offset voltage long-term drift (see Note 4)		25°C		0.003			0.003	$\mu\text{V}/\text{mo}$	
I_{IO} Input offset current		25°C		0.5			0.5	pA	
		Full range			150		150		
I_{IB} Input bias current	25°C		1			1	pA		
	Full range			300		300			
V_{ICR} Common-mode input voltage range	$ V_{IO} \leq 5\text{ mV},$ $R_S = 50\ \Omega$	25°C	0 to 2.5	-0.25 to 2.75		0 to 2.5	-0.25 to 2.75	V	
		Full range	0 to 2.2			0 to 2.2			
V_{OH} High-level output voltage	$I_{OH} = -100\ \mu\text{A}$ $I_{OH} = -500\ \mu\text{A}$	25°C		2.97			2.97	V	
		25°C		2.75			2.75		
		Full range		2.5			2.5		
V_{OL} Low-level output voltage	$V_{IC} = 0,$ $I_{OL} = 100\ \mu\text{A}$ $V_{IC} = 0,$ $I_{OL} = 250\ \mu\text{A}$	25°C		0.05			0.05	V	
		25°C		0.2			0.2		
		Full range			0.5		0.5		
A_{VD} Large-signal differential voltage amplification	$V_{IC} = 1.5\text{ V},$ $V_O = 1\text{ V to }2\text{ V}$	25°C	$R_L = 10\ \text{k}\Omega$ ‡		6	10	6	10	V/mV
			Full range		2		2		
		25°C	$R_L = 1\ \text{M}\Omega$ ‡		700		700		
$r_{i(d)}$ Differential input resistance		25°C		10^{12}			10^{12}	Ω	
$r_{i(c)}$ Common-mode input resistance		25°C		10^{12}			10^{12}	Ω	
$C_{i(c)}$ Common-mode input capacitance	$f = 10\ \text{kHz}$	25°C		8			8	pF	
z_o Closed-loop output impedance	$f = 100\ \text{kHz},$ $A_V = 10$	25°C		130			130	Ω	
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICR}\ \text{min},$ $V_O = 1.5\text{ V},$ $R_S = 50\ \Omega$	25°C	70	83		70	83	dB	
		Full range		70			70		
kSVR Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$)	$V_{DD} = 2.7\text{ V to }8\text{ V},$ $V_{IC} = V_{DD}/2,$ No load	25°C	80	95		80	95	dB	
		Full range		80			80		
I_{DD} Supply current	$V_O = 1.5\text{ V},$ No load	25°C	100	150		100	150	μA	
		Full range			175		175		

† Full range is -40°C to 125°C for Q level part, -55°C to 125°C for M level part.

‡ Referenced to 1.5 V

NOTE 4: Typical values are based on the input offset voltage shift observed through 500 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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operating characteristics at specified free-air temperature, $V_{DD} = 3\text{ V}$

PARAMETER	TEST CONDITIONS	T_A †	TLV2422Q, TLV2422M, TLV2422AQ, TLV2422AM			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain	$V_O = 1.1\text{ V to }1.9\text{ V},$ $R_L = 10\text{ k}\Omega$ ‡, $C_L = 100\text{ pF}$ ‡	25°C	0.01	0.02		V/ μs
		Full range	0.008			
V_n Equivalent input noise voltage	$f = 10\text{ Hz}$	25°C	100		nV/ $\sqrt{\text{Hz}}$	
	$f = 1\text{ kHz}$	25°C	23			
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ Hz to }1\text{ Hz}$	25°C	2.7		μV	
	$f = 0.1\text{ Hz to }10\text{ Hz}$	25°C	4			
I_n Equivalent input noise current		25°C	0.6		fA/ $\sqrt{\text{Hz}}$	
THD + N Total harmonic distortion plus noise	$V_O = 0.5\text{ V to }2.5\text{ V},$ $f = 1\text{ kHz},$ $R_L = 10\text{ k}\Omega$ ‡	$A_V = 1$	0.25%			
		$A_V = 10$	1.8%			
Gain-bandwidth product	$f = 10\text{ kHz},$ $C_L = 100\text{ pF}$ ‡	$R_L = 10\text{ k}\Omega$ ‡, 25°C	46		kHz	
BOM Maximum output-swing bandwidth	$V_{O(PP)} = 1\text{ V},$ $R_L = 10\text{ k}\Omega$ ‡,	$A_V = 1,$ $C_L = 100\text{ pF}$ ‡	25°C	8.3		kHz
t_s Settling time	$A_V = -1,$ Step = 0.5 V to 2.5 V, $R_L = 10\text{ k}\Omega$ ‡, $C_L = 100\text{ pF}$ ‡	To 0.1%	8.6		μs	
		To 0.01%	16			
ϕ_m Phase margin at unity gain	$R_L = 10\text{ k}\Omega$ ‡,	$C_L = 100\text{ pF}$ ‡	25°C	62°		
			25°C	11		

† Full range is -40°C to 125°C for Q level part, -55°C to 125°C for M level part.

‡ Referenced to 1.5 V

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

PARAMETER	TEST CONDITIONS	T_A †	TLV2422C			UNIT
			MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{IC} = 0,$ $V_O = 0,$ $V_{DD} \pm = \pm 2.5\text{ V},$ $R_S = 50\ \Omega$	25°C		300	2000	μV
		Full range			2500	
αV_{IO} Temperature coefficient of input offset voltage		25°C to 70°C		2		$\mu\text{V}/^\circ\text{C}$
Input offset voltage long-term drift (see Note 4)		25°C		0.003		$\mu\text{V}/\text{mo}$
I_{IO} Input offset current		25°C		0.5		pA
		Full range			150	
I_{IB} Input bias current		25°C		1		pA
		Full range			150	
V_{ICR} Common-mode input voltage range	$ V_{IO} \leq 5\text{ mV},$ $R_S = 50\ \Omega$	25°C	0 to 4.5	-0.25 to 4.75	V	
		Full range	0 to 4.2			
V_{OH} High-level output voltage	$I_{OH} = -100\ \mu\text{A}$ $I_{OH} = -1\text{ mA}$	25°C		4.97	V	
		25°C		4.5 to 4.75		
		Full range		4.25		
V_{OL} Low-level output voltage	$V_{IC} = 2.5\text{ V},$ $I_{OL} = 100\ \mu\text{A}$ $V_{IC} = 2.5\text{ V},$ $I_{OL} = 500\ \mu\text{A}$	25°C		0.04	V	
		25°C		0.15		
		Full range		0.5		
A_{VD} Large-signal differential voltage amplification	$V_{IC} = 2.5\text{ V},$ $V_O = 1\text{ V to }4\text{ V}$ $R_L = 10\text{ k}\Omega^\ddagger$ $R_L = 1\text{ M}\Omega^\ddagger$	25°C	8	12	V/mV	
		Full range	5			
		25°C		1000		
$r_{i(d)}$ Differential input resistance		25°C		10^{12}	Ω	
$r_{i(c)}$ Common-mode input resistance		25°C		10^{12}	Ω	
$C_{i(c)}$ Common-mode input capacitance	$f = 10\text{ kHz}$	25°C		8	pF	
Z_O Closed-loop output impedance	$f = 100\text{ kHz},$ $A_V = 10$	25°C		130	Ω	
CMRR Common-mode rejection ratio	$V_{IC} = 0\text{ to }4.5\text{ V},$ $V_O = 2.5\text{ V},$ $R_S = 50\ \Omega$	25°C	70	90	dB	
		Full range	70			
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	$V_O = 2.5\text{ V},$ No load	25°C	100	150	μA	
		Full range		175		

† Full range is 0°C to 70°C.

‡ Referenced to 2.5 V

NOTE 4: Typical values are based on the input offset voltage shift observed through 500 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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PARAMETER	TEST CONDITIONS	T_A †	TLV2422I			TLV2422AI			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO} Input offset voltage		25°C	300	2000		300	950	μV	
		Full range		2500		1500			
α_{VIO} Temperature coefficient of input offset voltage		25°C to 70°C	2			2		$\mu\text{V}/^\circ\text{C}$	
Input offset voltage long-term drift (see Note 4)	$V_{IC} = 0,$ $V_O = 0,$	$V_{DD} \pm \pm 2.5\text{ V},$ $R_S = 50\ \Omega$	25°C	0.003		0.003		$\mu\text{V}/\text{mo}$	
I_{IO} Input offset current		25°C	0.5			0.5		pA	
		Full range		150		150			
I_{IB} Input bias current		25°C	1			1		pA	
		Full range		150		150			
V_{ICR} Common-mode input voltage range	$ V_{IO} \leq 5\text{ mV},$ $R_S = 50\ \Omega$	25°C	0 to 4.5	-0.25 to 4.75		0 to 4.5	-0.25 to 4.75	V	
		Full range	0 to 4.2			0 to 4.2			
V_{OH} High-level output voltage	$I_{OH} = -100\ \mu\text{A}$ $I_{OH} = -1\text{ mA}$	25°C	4.97			4.97		V	
		25°C	4.5	4.75		4.5	4.75		
		Full range	4.25			4.25			
V_{OL} Low-level output voltage	$V_{IC} = 2.5\text{ V},$ $I_{OL} = 100\ \mu\text{A}$ $V_{IC} = 2.5\text{ V},$ $I_{OL} = 500\ \mu\text{A}$	25°C	0.04			0.04		V	
		25°C	0.15			0.15			
		Full range		0.5			0.5		
A_{VD} Large-signal differential voltage amplification	$V_{IC} = 2.5\text{ V},$ $V_O = 1\text{ V to }4\text{ V}$	$R_L = 10\text{ k}\Omega^\ddagger$	25°C	8	12		8	12	V/mV
			Full range	5			5		
		$R_L = 1\text{ M}\Omega^\ddagger$	25°C	1000			1000		
$r_{i(d)}$ Differential input resistance		25°C	10^{12}			10^{12}		Ω	
$r_{i(c)}$ Common-mode input resistance		25°C	10^{12}			10^{12}		Ω	
$c_{i(c)}$ Common-mode input capacitance	$f = 10\text{ kHz}$	25°C	8			8		pF	
z_o Closed-loop output impedance	$f = 100\text{ kHz},$ $A_V = 10$	25°C	130			130		Ω	
CMRR Common-mode rejection ratio	$V_{IC} = 0\text{ to }4.5\text{ V},$ $V_O = 2.5\text{ V},$ $R_S = 50\ \Omega$	25°C	70	90		70	90	dB	
		Full range	70			70			
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		80	95	dB	
		Full range	80			80			
I_{DD} Supply current	$V_O = 2.5\text{ V},$ No load	25°C	100	150		100	150	μA	
		Full range		175			175		

† Full range is -40°C to 85°C .

‡ Referenced to 2.5 V

NOTE 4: Typical values are based on the input offset voltage shift observed through 500 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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PARAMETER	TEST CONDITIONS	T_A †	TLV2422C, TLV2422I TLV2422AI			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain	$V_O = 1.5\text{ V to }3.5\text{ V},$ $C_L = 100\text{ pF}‡$	25°C	0.01	0.02		V/ μs
			Full range 0.008			
V_n Equivalent input noise voltage	$f = 10\text{ Hz}$	25°C	100			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	1.9			μV
	$f = 0.1\text{ Hz to }10\text{ Hz}$	25°C	2.8			
I_n Equivalent input noise current		25°C	0.6			fA/ $\sqrt{\text{Hz}}$
THD + N Total harmonic distortion plus noise	$V_O = 1.5\text{ V to }3.5\text{ V},$ $f = 1\text{ kHz},$ $R_L = 10\text{ k}\Omega‡$	25°C	$A_V = 1$	0.24%		
			$A_V = 10$	1.7%		
Gain-bandwidth product	$f = 10\text{ kHz},$ $C_L = 100\text{ pF}‡$	$R_L = 10\text{ k}\Omega‡,$ 25°C	52			kHz
B_{OM} Maximum output-swing bandwidth	$V_{O(PP)} = 2\text{ V},$ $R_L = 10\text{ k}\Omega‡,$	$A_V = 1,$ $C_L = 100\text{ pF}‡$ 25°C	5.3			kHz
t_s Settling time	$A_V = -1,$ Step = 1.5 V to 3.5 V, $R_L = 10\text{ k}\Omega‡,$ $C_L = 100\text{ pF}‡$	25°C	To 0.1%	8.5		μs
			To 0.01%	15.5		
ϕ_m Phase margin at unity gain	$R_L = 10\text{ k}\Omega‡,$ $C_L = 100\text{ pF}‡$	25°C	66°			
Gain margin		25°C	11		dB	

† Full range for the C version is 0°C to 70°C. Full range for the I version is -40°C to 85°C.

‡ Referenced to 2.5 V



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

PARAMETER	TEST CONDITIONS	T_A †	TLV2422Q, TLV2422M			TLV2422AQ, TLV2422AM			UNIT	
			MIN	TYP	MAX	MIN	TYP	MAX		
V_{IO} Input offset voltage		25°C	300	2000		300	950	μV		
		Full range		2500		1800				
$\alpha_{V_{IO}}$ Temperature coefficient of input offset voltage		Full range	2			2			$\mu\text{V}/^\circ\text{C}$	
Input offset voltage long-term drift (see Note 4)	$V_{IC} = 0,$ $V_O = 0,$	$V_{DD} \pm \pm 2.5\text{ V},$ $R_S = 50\ \Omega$	25°C	0.003			0.003			$\mu\text{V}/\text{mo}$
I_{IO} Input offset current		25°C	0.5			0.5			pA	
		Full range	150			150				
I_{IB} Input bias current		25°C	1			1			pA	
		Full range	300			300				
V_{ICR} Common-mode input voltage range	$ V_{IO} \leq 5\text{ mV},$ $R_S = 50\ \Omega$	25°C	0 to 4.5	-0.25 to 4.75		0 to 4.5	-0.25 to 4.75	V		
		Full range	0 to 4.2			0 to 4.2				
V_{OH} High-level output voltage	$I_{OH} = -100\ \mu\text{A}$ $I_{OH} = -1\text{ mA}$	25°C	4.97			4.97			V	
		25°C	4.75			4.75				
		Full range	4.5			4.5				
V_{OL} Low-level output voltage	$V_{IC} = 2.5\text{ V},$ $I_{OL} = 100\ \mu\text{A}$ $V_{IC} = 2.5\text{ V},$ $I_{OL} = 500\ \mu\text{A}$	25°C	0.04			0.04			V	
		25°C	0.15			0.15				
		Full range	0.5			0.5				
A_{VD} Large-signal differential voltage amplification	$V_{IC} = 2.5\text{ V},$ $V_O = 1\text{ V to }4\text{ V}$	$R_L = 10\text{ k}\Omega^\ddagger$	25°C	8	12		8	12	V/mV	
			Full range	3			3			
		$R_L = 1\text{ M}\Omega^\ddagger$	25°C	1000			1000			
$r_{i(d)}$ Differential input resistance		25°C	10^{12}			10^{12}			Ω	
$r_{i(c)}$ Common-mode input resistance		25°C	10^{12}			10^{12}			Ω	
$c_{i(c)}$ Common-mode input capacitance	$f = 10\text{ kHz}$	25°C	8			8			pF	
z_o Closed-loop output impedance	$f = 100\text{ kHz},$ $A_V = 10$	25°C	130			130			Ω	
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICR}\text{ min},$ $V_O = 2.5\text{ V},$ $R_S = 50\ \Omega$	25°C	70	90		70	90	dB		
		Full range	70			70				
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		80	95	dB		
		Full range	80			80				
I_{DD} Supply current	$V_O = 2.5\text{ V},$ No load	25°C	100	150		100	150	μA		
		Full range	175			175				

† Full range is -40°C to 125°C for Q level part, -55°C to 125°C for M level part.

‡ Referenced to 2.5 V

NOTE 4: Typical values are based on the input offset voltage shift observed through 500 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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operating characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$

PARAMETER	TEST CONDITIONS	T_A †	TLV2422Q, TLV2422M, TLV2422AQ, TLV2422AM			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain	$V_O = 1.5\text{ V to }3.5\text{ V},$ $R_L = 10\text{ k}\Omega$ ‡, $C_L = 100\text{ pF}$ ‡	25°C	0.01	0.02		V/ μ s
		Full range	0.008			
V_n Equivalent input noise voltage	$f = 10\text{ Hz}$	25°C	100		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	1.9		μ V	
	$f = 0.1\text{ Hz to }10\text{ Hz}$	25°C	2.8			
I_n Equivalent input noise current		25°C	0.6		fA/ $\sqrt{\text{Hz}}$	
THD + N Total harmonic distortion plus noise	$V_O = 1.5\text{ V to }3.5\text{ V},$ $f = 1\text{ kHz},$ $R_L = 10\text{ k}\Omega$ ‡	$A_V = 1$	0.24%			
		$A_V = 10$	1.7%			
Gain-bandwidth product	$f = 10\text{ kHz},$ $C_L = 100\text{ pF}$ ‡	$R_L = 10\text{ k}\Omega$ ‡, 25°C	52		kHz	
BOM Maximum output-swing bandwidth	$V_{O(PP)} = 2\text{ V},$ $R_L = 10\text{ k}\Omega$ ‡,	$A_V = 1,$ $C_L = 100\text{ pF}$ ‡	25°C	5.3		kHz
t_s Settling time	$A_V = -1,$ Step = 1.5 V to 3.5 V, $R_L = 10\text{ k}\Omega$ ‡, $C_L = 100\text{ pF}$ ‡	To 0.1%	25°C	8.5		μ s
		To 0.01%		15.5		
ϕ_m Phase margin at unity gain	$R_L = 10\text{ k}\Omega$ ‡,	$C_L = 100\text{ pF}$ ‡	25°C	66°		
Gain margin			25°C	11		dB

† Full range is -40°C to 125°C for Q level part, -55°C to 125°C for M level part.

‡ Referenced to 2.5 V



TYPICAL CHARACTERISTICS

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	Noise voltage (referred to input)	Over a 10-second period	43
THD + N	Total harmonic distortion plus noise	vs Frequency	44,45
	Gain-bandwidth product	vs Supply voltage vs Free-air temperature	46 47
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	Gain margin	vs Load capacitance	49
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TYPICAL CHARACTERISTICS

DISTRIBUTION OF TLV2422
 INPUT OFFSET VOLTAGE

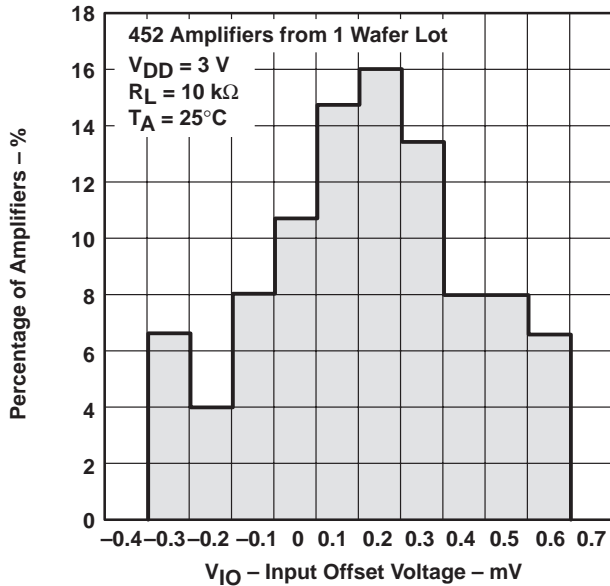


Figure 2

DISTRIBUTION OF TLV2422
 INPUT OFFSET VOLTAGE

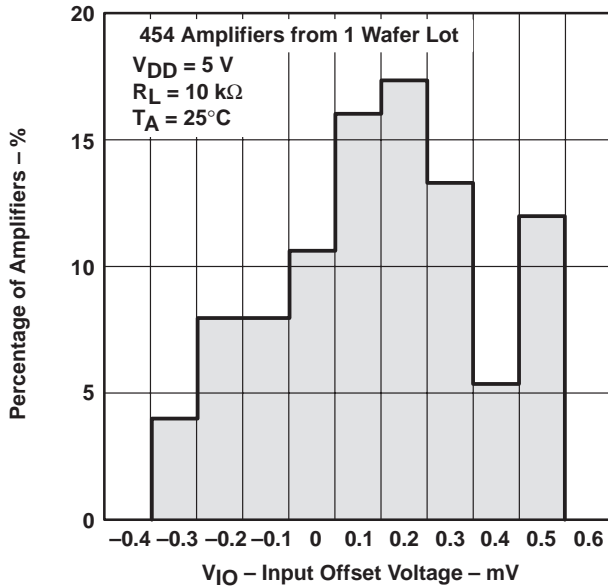


Figure 3

INPUT OFFSET VOLTAGE
 vs
 COMMON-MODE INPUT VOLTAGE

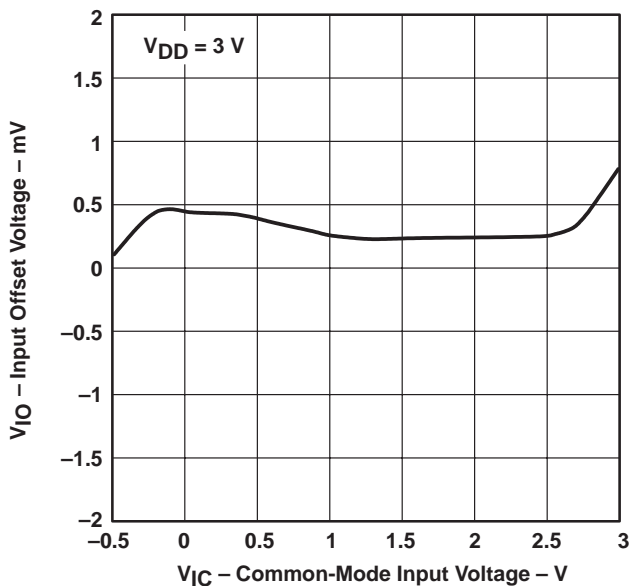


Figure 4

INPUT OFFSET VOLTAGE
 vs
 COMMON-MODE INPUT VOLTAGE

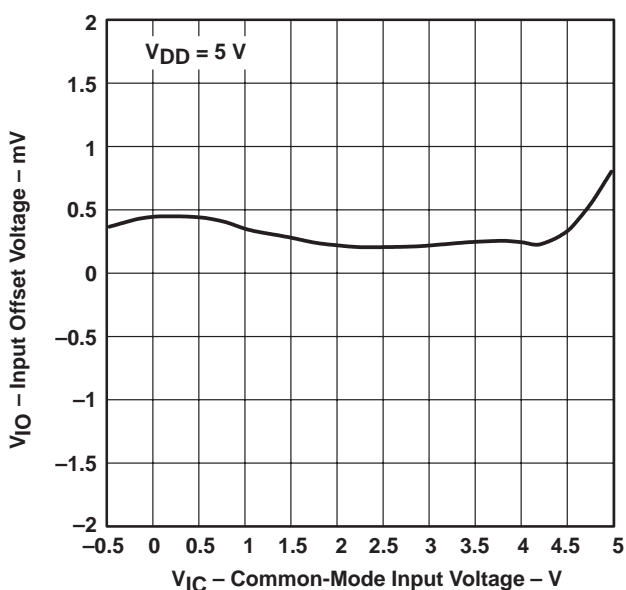


Figure 5

TYPICAL CHARACTERISTICS

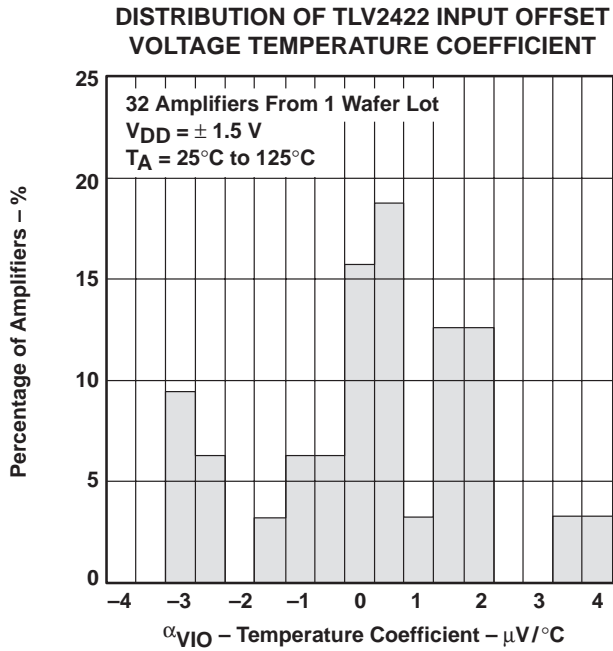


Figure 6

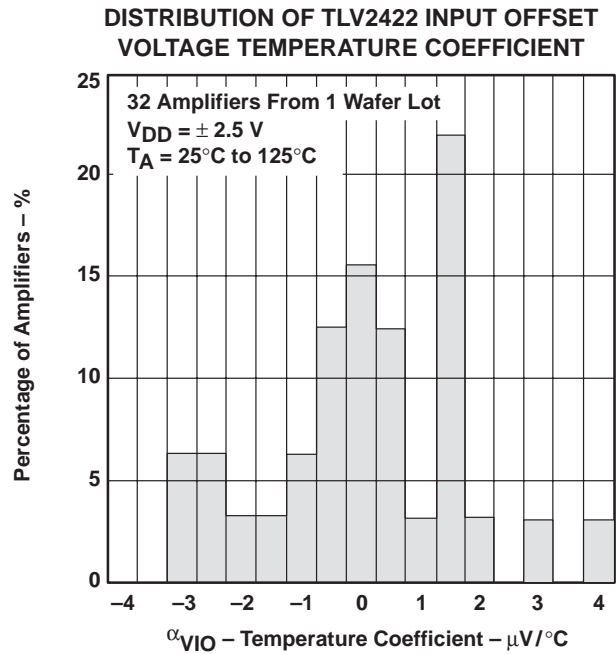


Figure 7

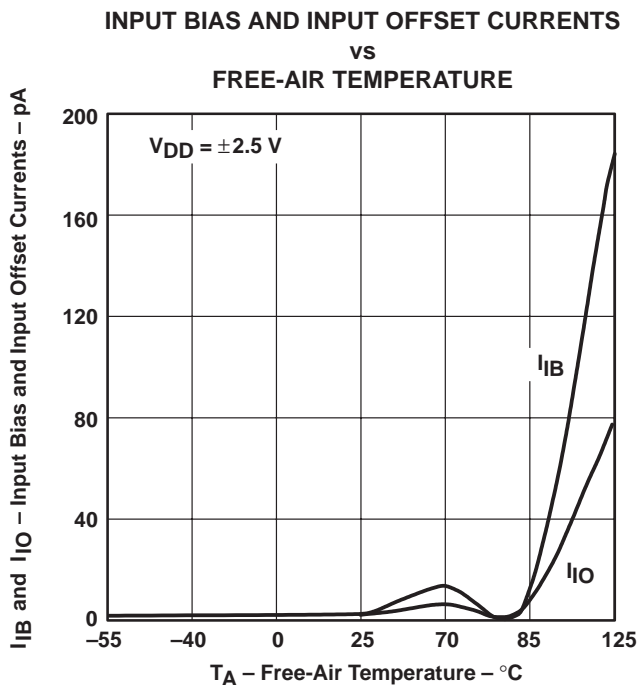


Figure 8

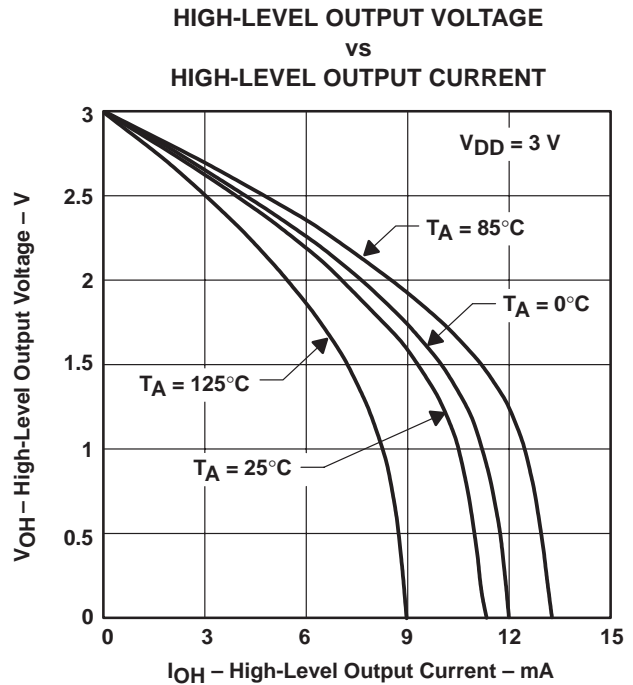


Figure 9

TYPICAL CHARACTERISTICS

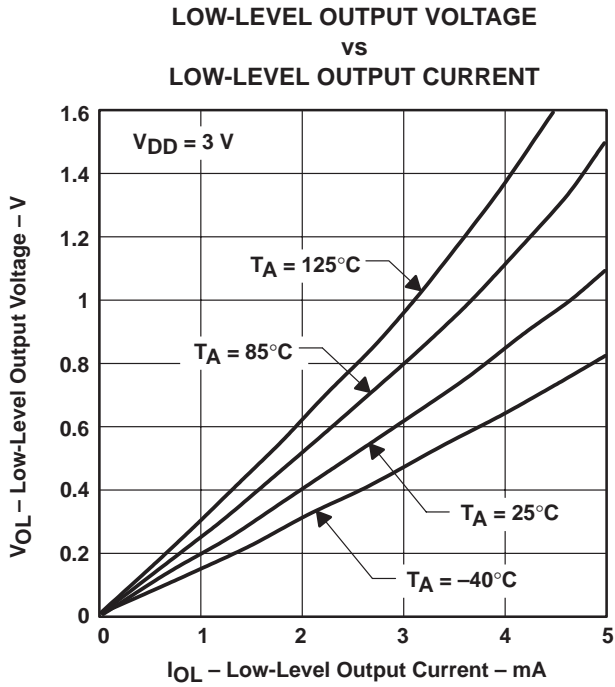


Figure 10

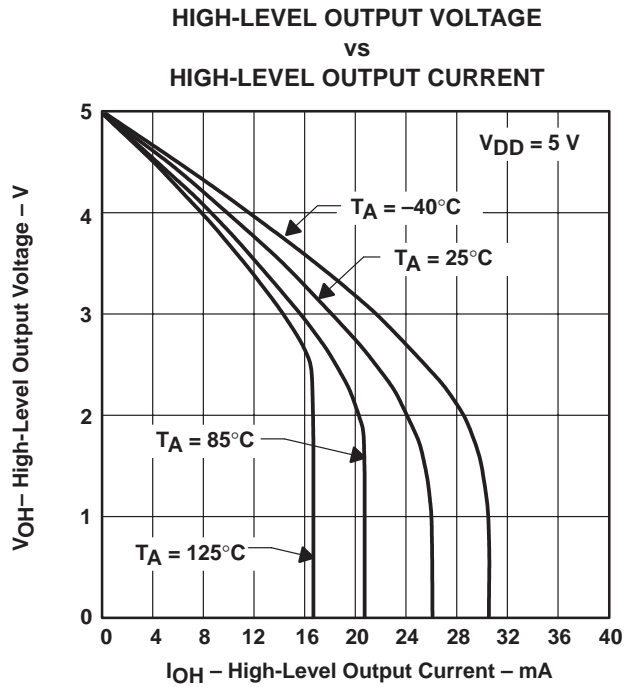


Figure 11

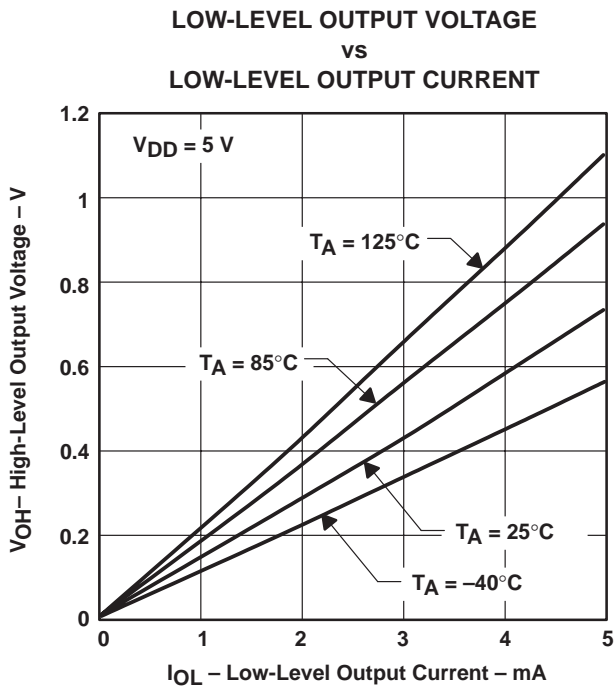


Figure 12

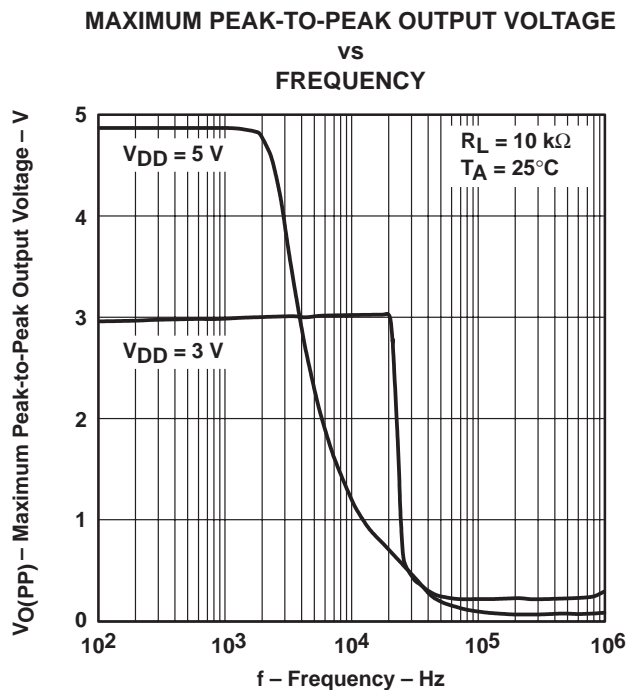


Figure 13

TYPICAL CHARACTERISTICS

**SHORT-CIRCUIT OUTPUT CURRENT
vs
SUPPLY VOLTAGE**

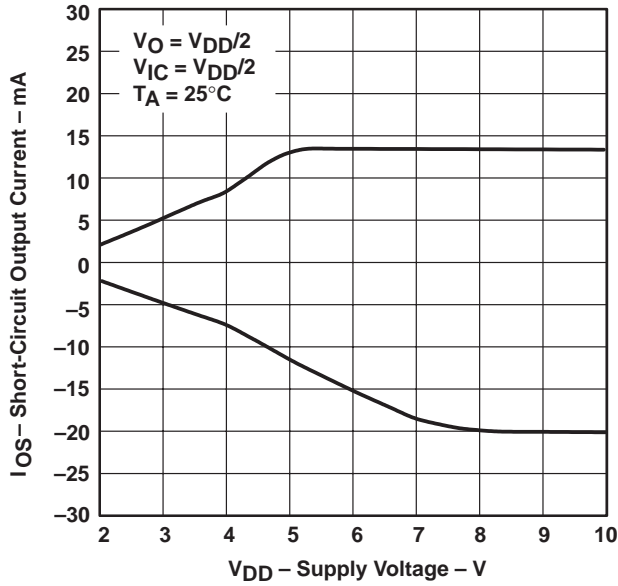


Figure 14

**SHORT-CIRCUIT OUTPUT CURRENT
vs
FREE-AIR TEMPERATURE**

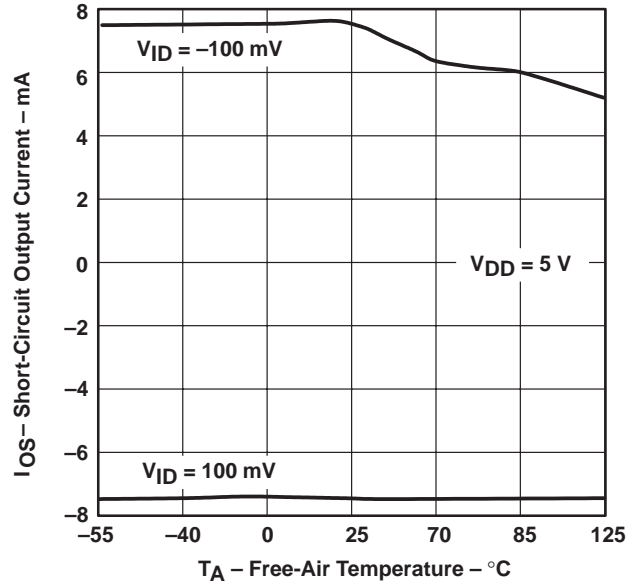


Figure 15

**DIFFERENTIAL INPUT VOLTAGE
vs
OUTPUT VOLTAGE**

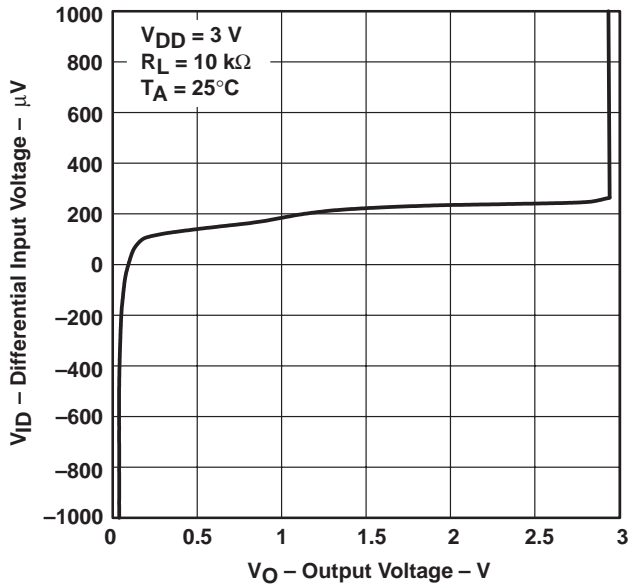


Figure 16

**DIFFERENTIAL INPUT VOLTAGE
vs
OUTPUT VOLTAGE**

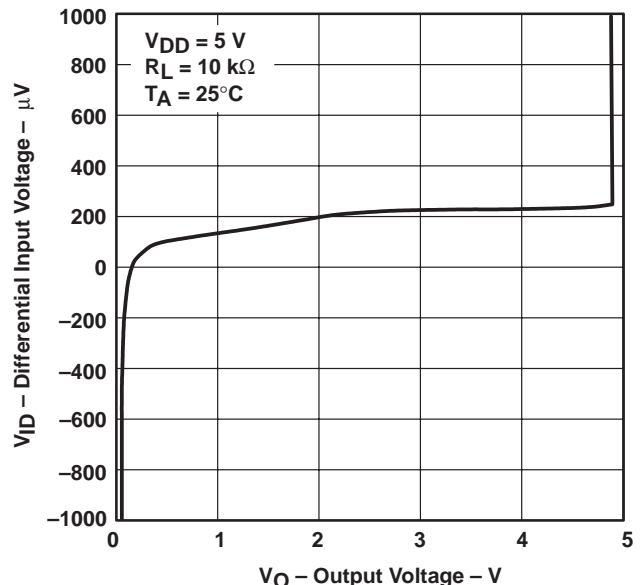


Figure 17

TYPICAL CHARACTERISTICS

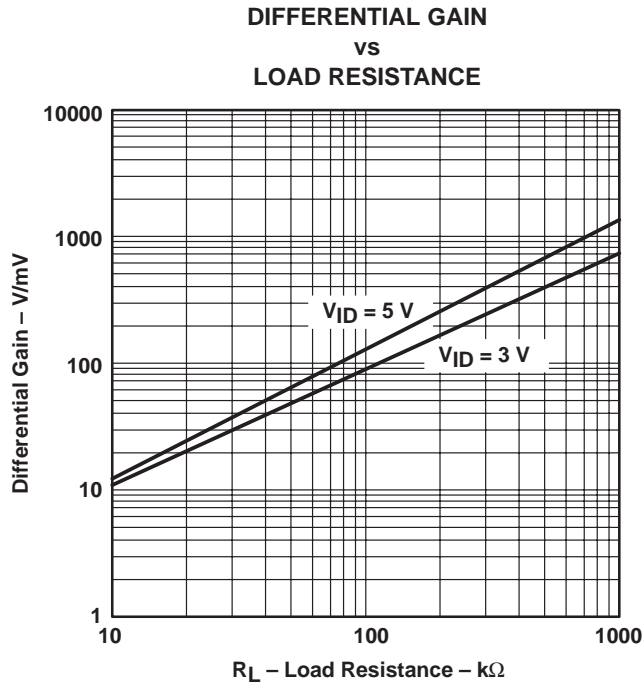


Figure 18

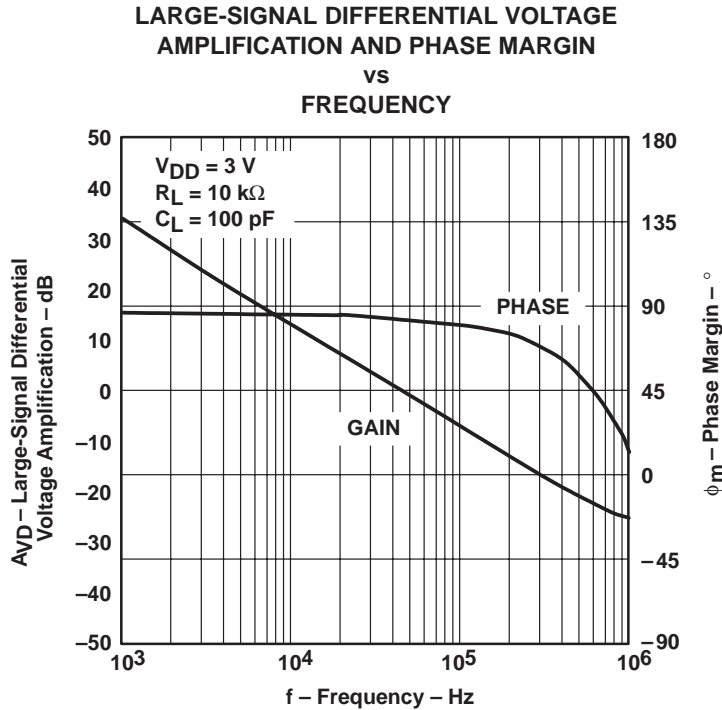


Figure 19

TYPICAL CHARACTERISTICS

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

vs
FREQUENCY

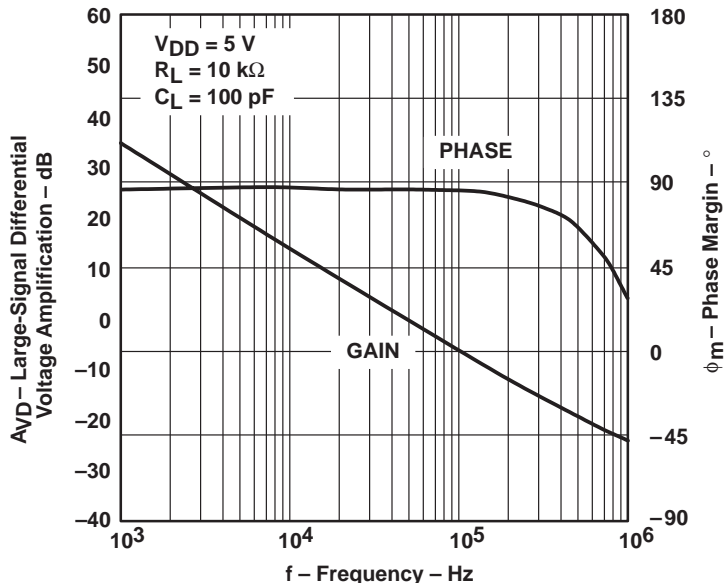


Figure 20

DIFFERENTIAL VOLTAGE AMPLIFICATION
vs
FREE-AIR TEMPERATURE

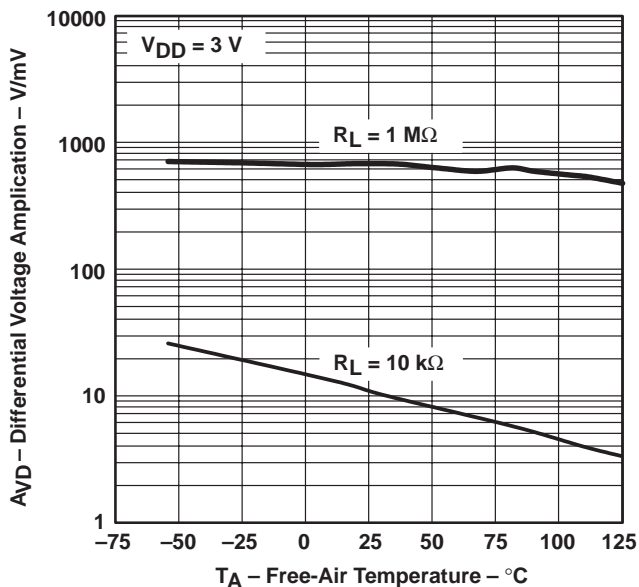


Figure 21

DIFFERENTIAL VOLTAGE AMPLIFICATION
vs
FREE-AIR TEMPERATURE

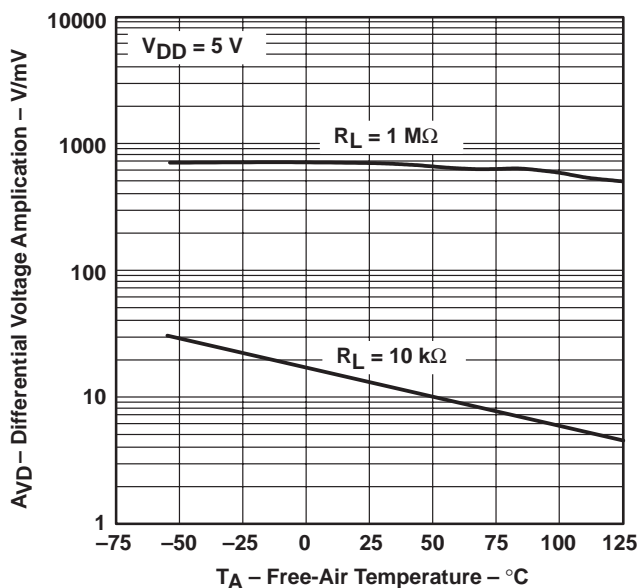


Figure 22

TYPICAL CHARACTERISTICS

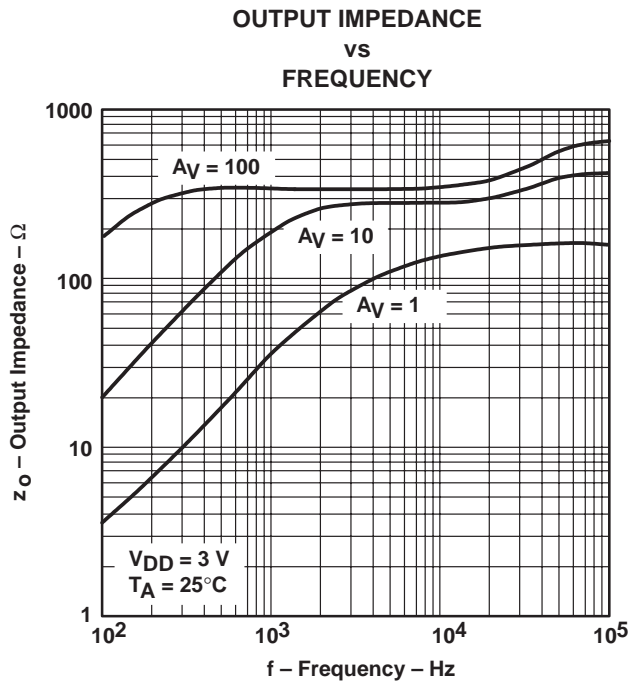


Figure 23

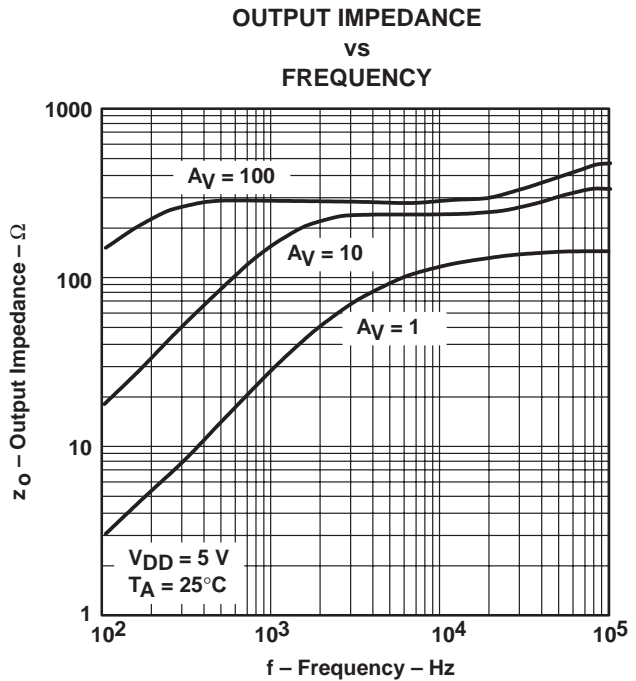


Figure 24

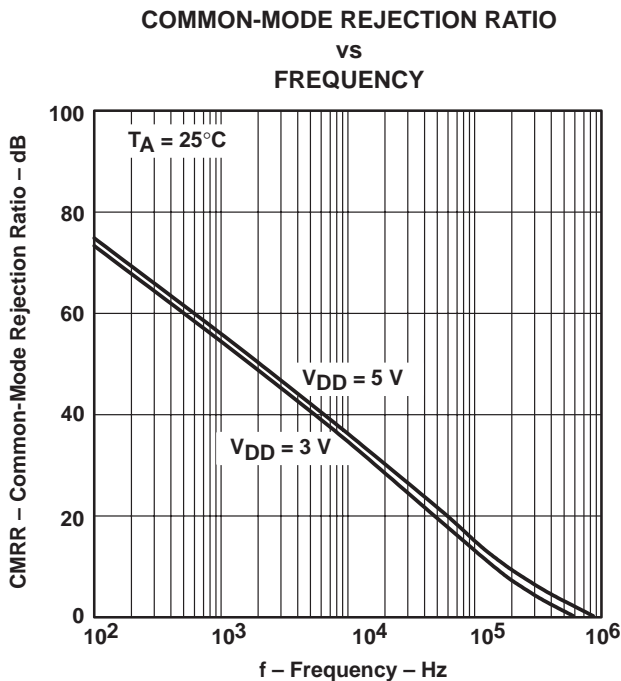


Figure 25

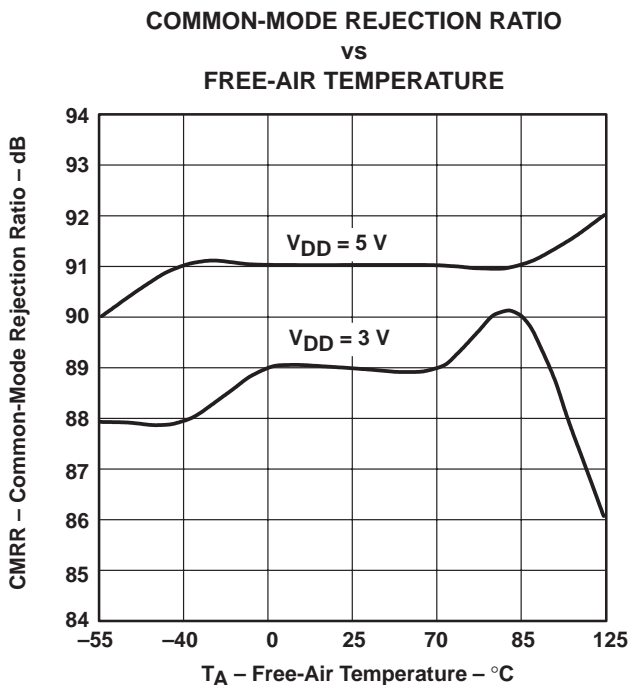


Figure 26

TYPICAL CHARACTERISTICS

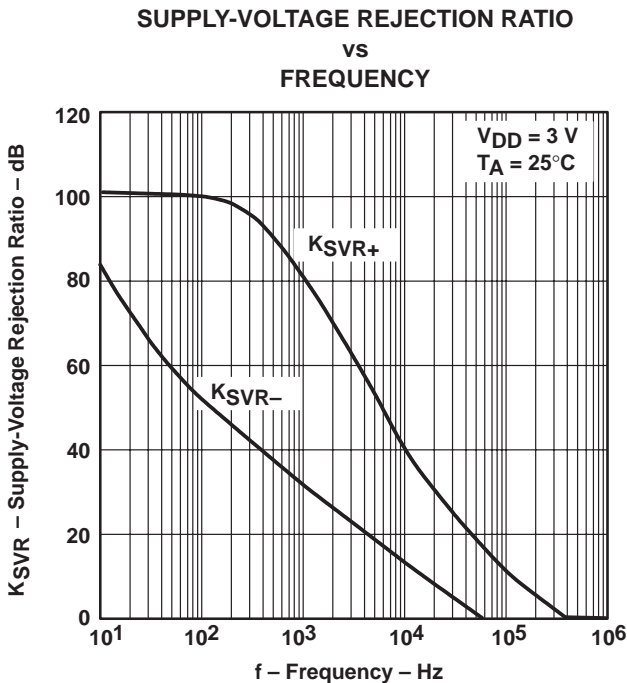


Figure 27

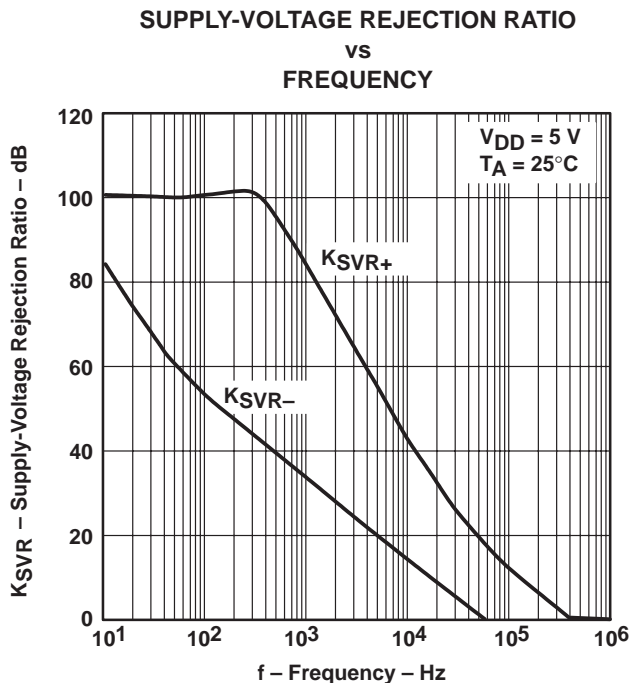


Figure 28

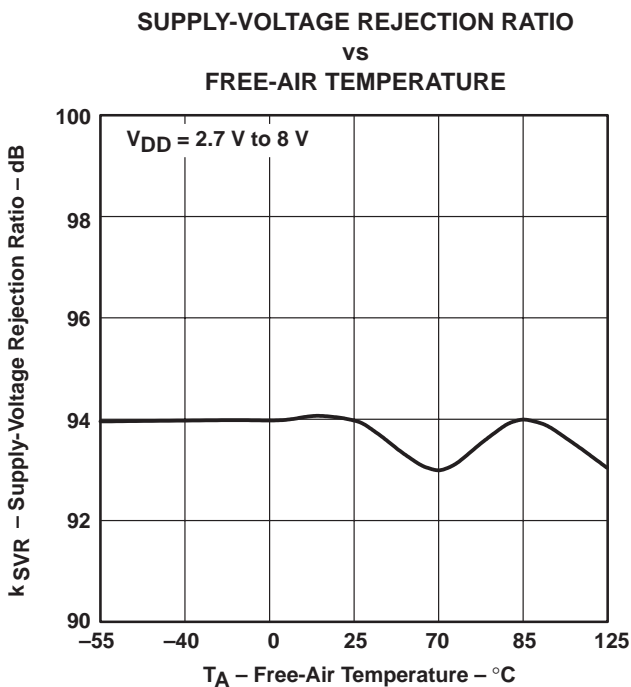


Figure 29

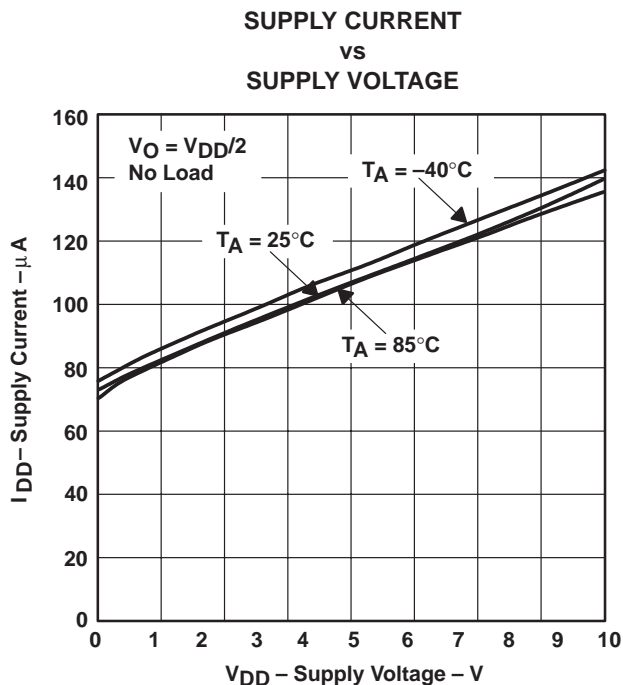


Figure 30

TYPICAL CHARACTERISTICS

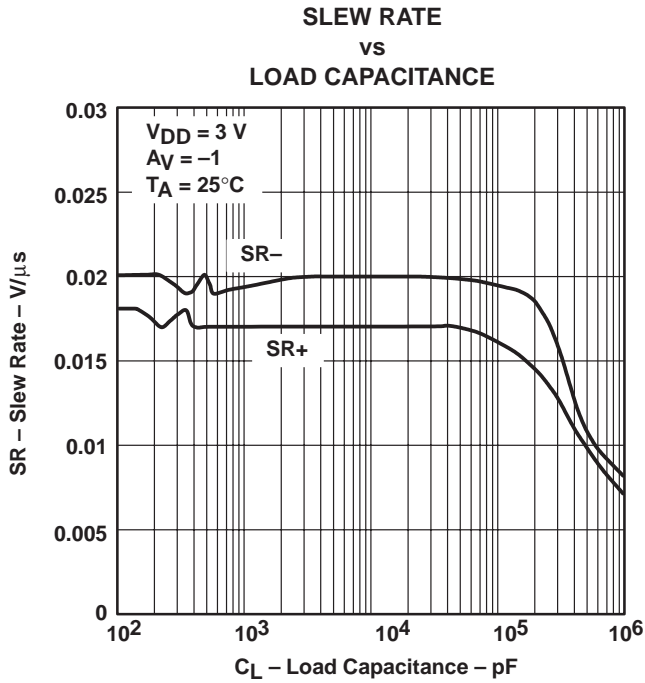


Figure 31

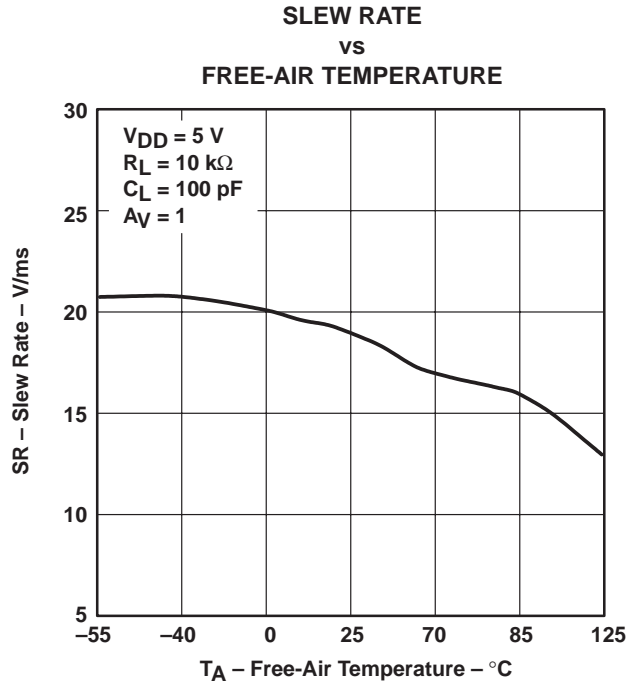


Figure 32

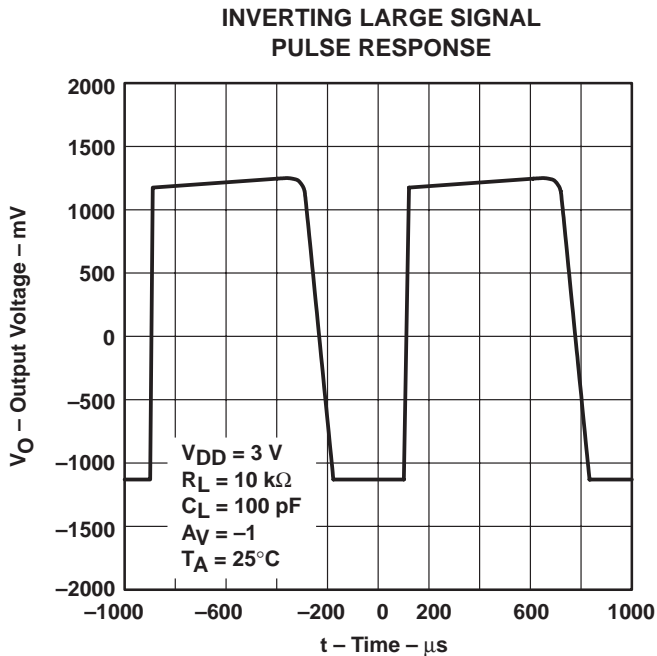


Figure 33

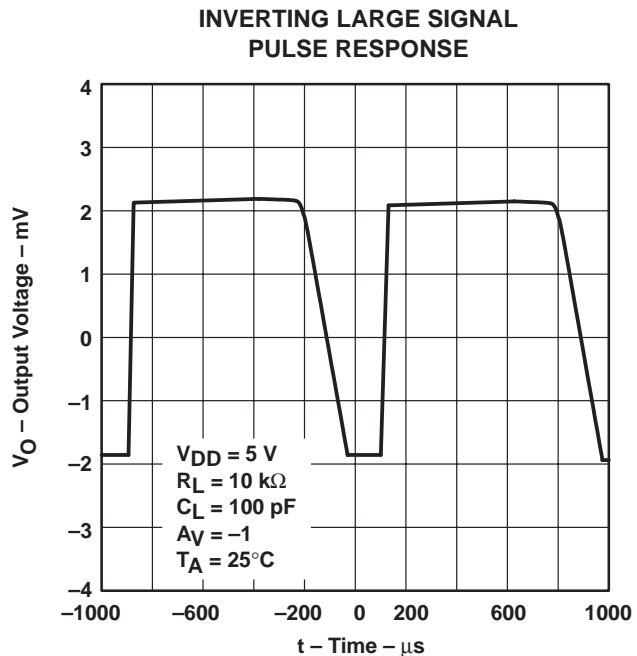


Figure 34

TYPICAL CHARACTERISTICS

**VOLTAGE-FOLLOWER LARGE SIGNAL
PULSE RESPONSE**

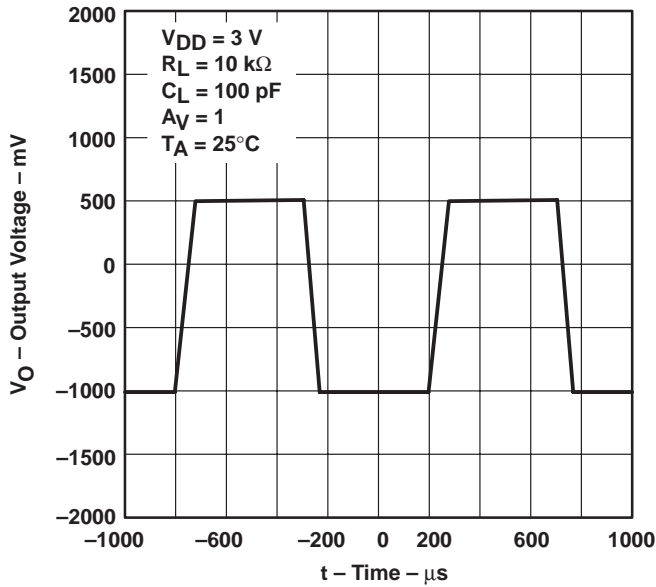


Figure 35

**VOLTAGE-FOLLOWER LARGE SIGNAL
PULSE RESPONSE**

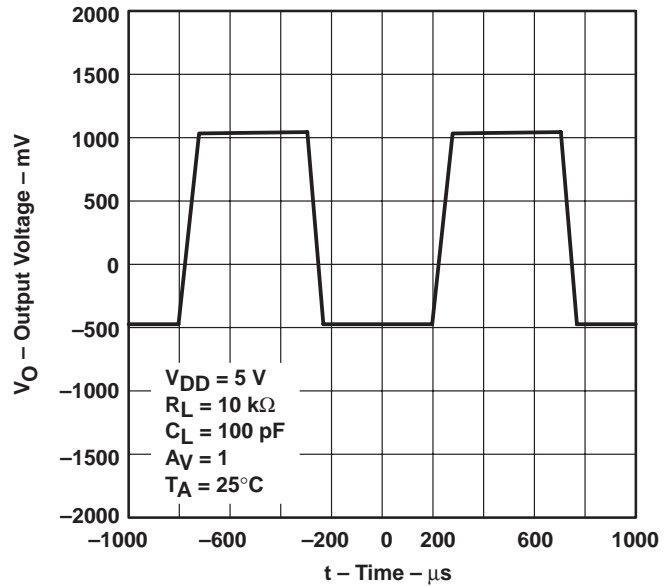


Figure 36

**INVERTING SMALL SIGNAL
PULSE RESPONSE**

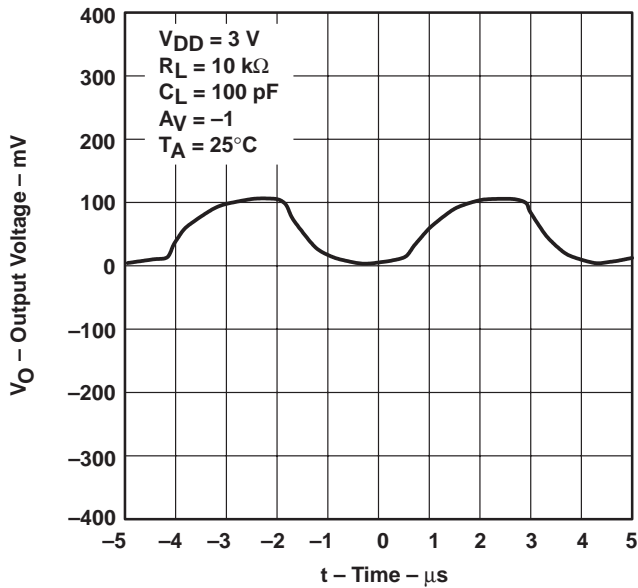


Figure 37

**INVERTING SMALL SIGNAL
PULSE RESPONSE**

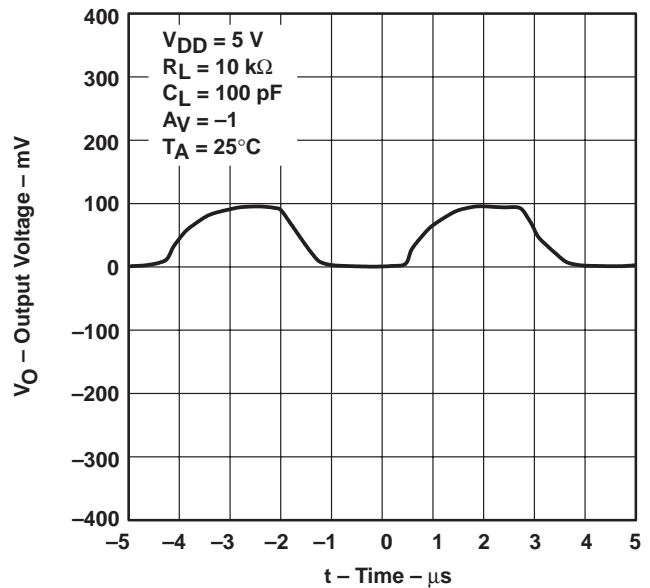


Figure 38

TYPICAL CHARACTERISTICS

VOLTAGE-FOLLOWER SMALL-SIGNAL PULSE RESPONSE

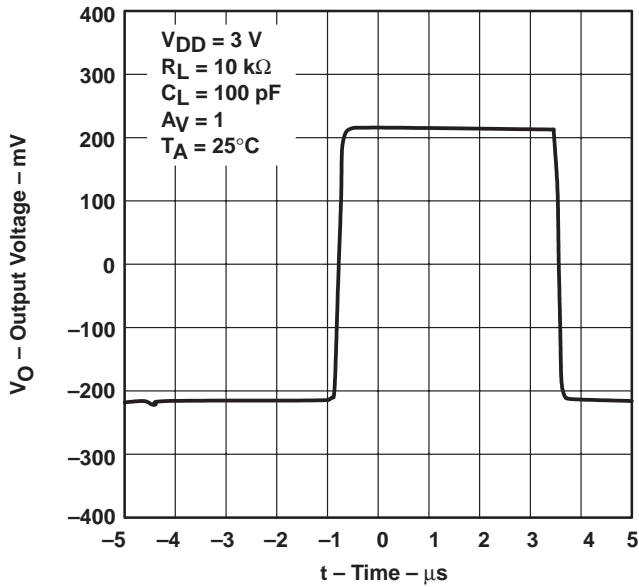


Figure 39

VOLTAGE-FOLLOWER SMALL-SIGNAL PULSE RESPONSE

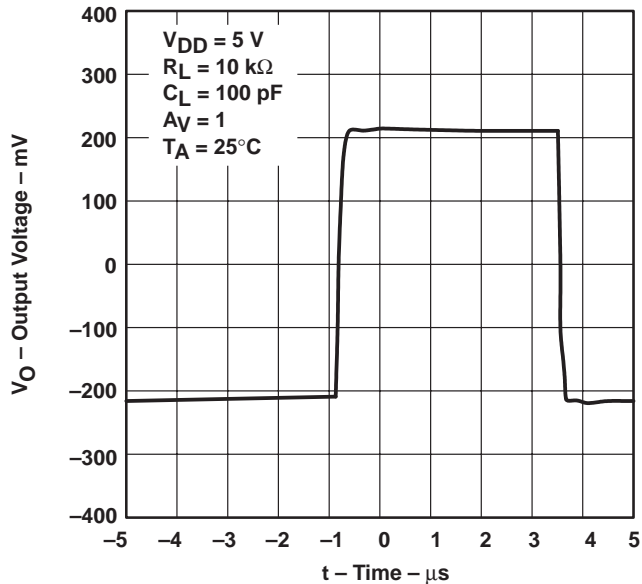


Figure 40

EQUIVALENT INPUT NOISE VOLTAGE VS FREQUENCY

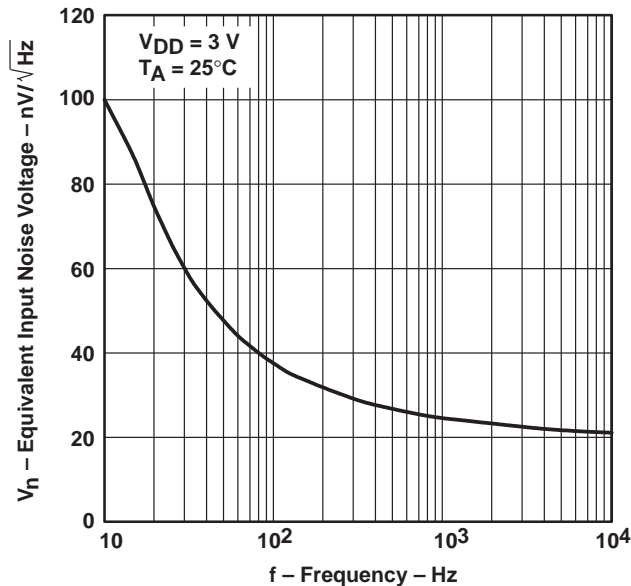


Figure 41

EQUIVALENT INPUT NOISE VOLTAGE VS FREQUENCY

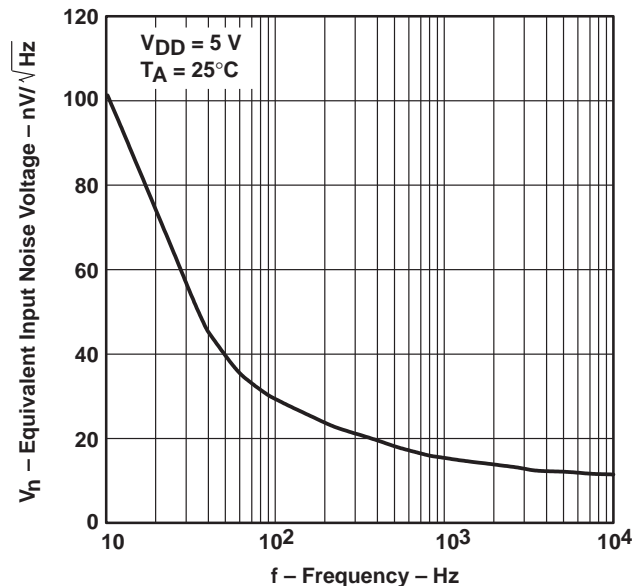


Figure 42

TYPICAL CHARACTERISTICS

NOISE VOLTAGE OVER A 10-SECOND PERIOD

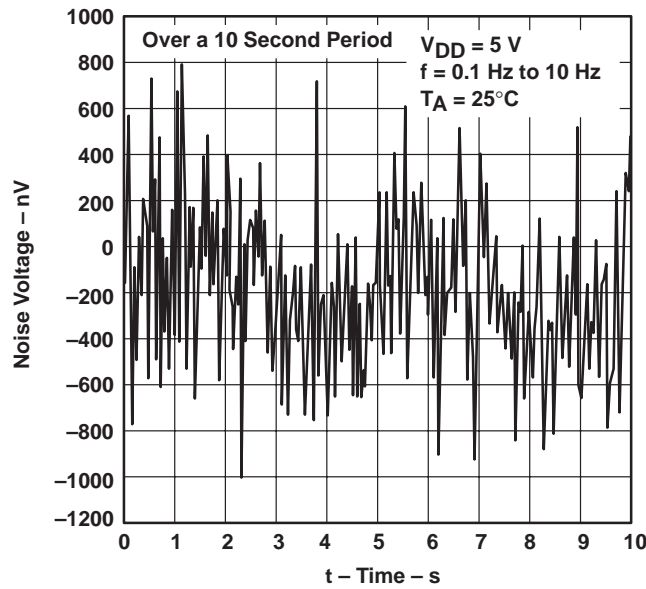


Figure 43

**TOTAL HARMONIC DISTORTION PLUS NOISE
vs
FREQUENCY**

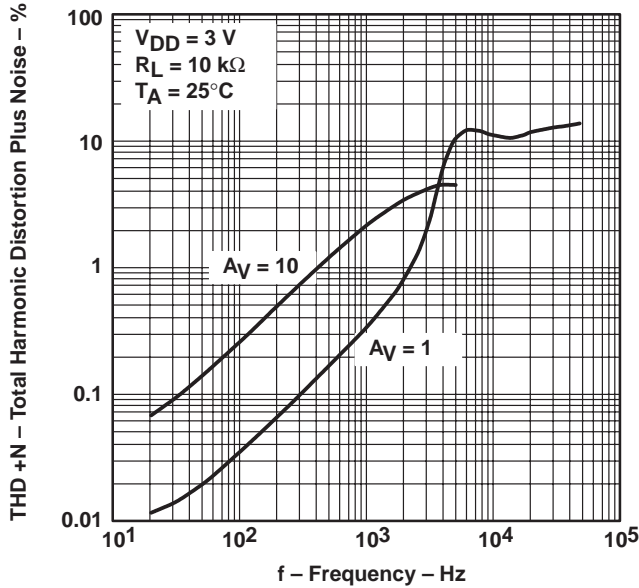


Figure 44

**TOTAL HARMONIC DISTORTION PLUS NOISE
vs
FREQUENCY**

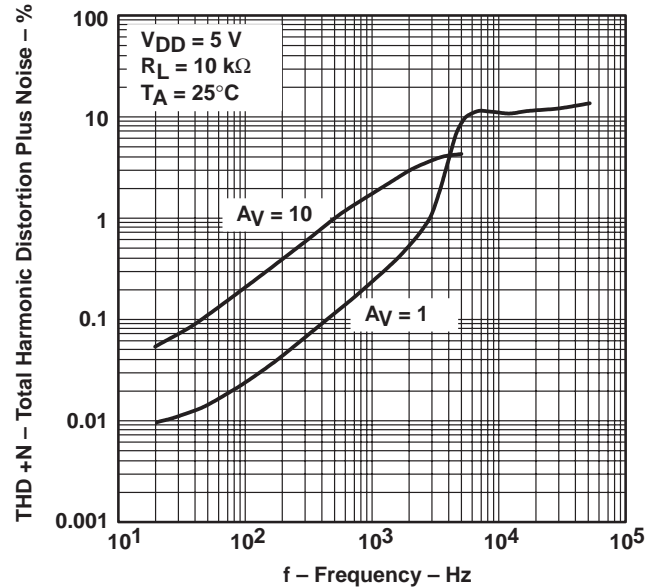


Figure 45

TYPICAL CHARACTERISTICS

GAIN-BANDWIDTH PRODUCT
 vs
 SUPPLY VOLTAGE

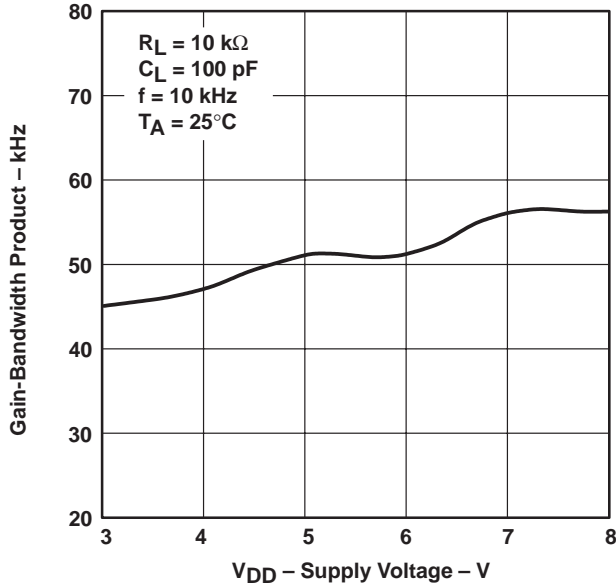


Figure 46

GAIN-BANDWIDTH PRODUCT
 vs
 FREE-AIR TEMPERATURE

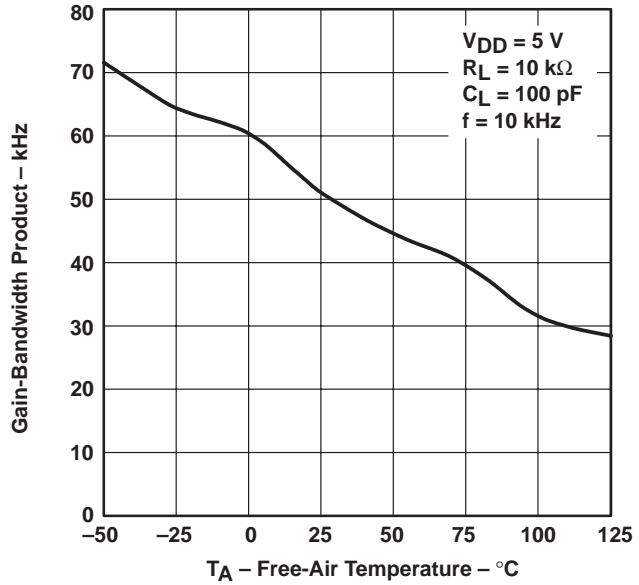


Figure 47

PHASE MARGIN
 vs
 LOAD CAPACITANCE

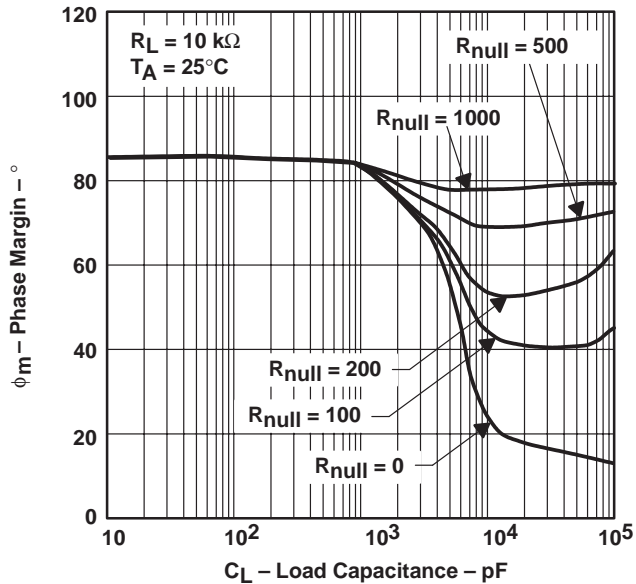


Figure 48

GAIN MARGIN
 vs
 LOAD CAPACITANCE

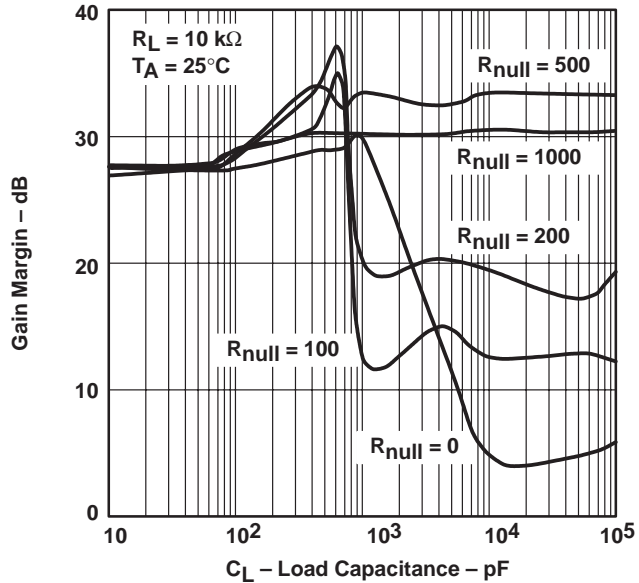


Figure 49

TYPICAL CHARACTERISTICS

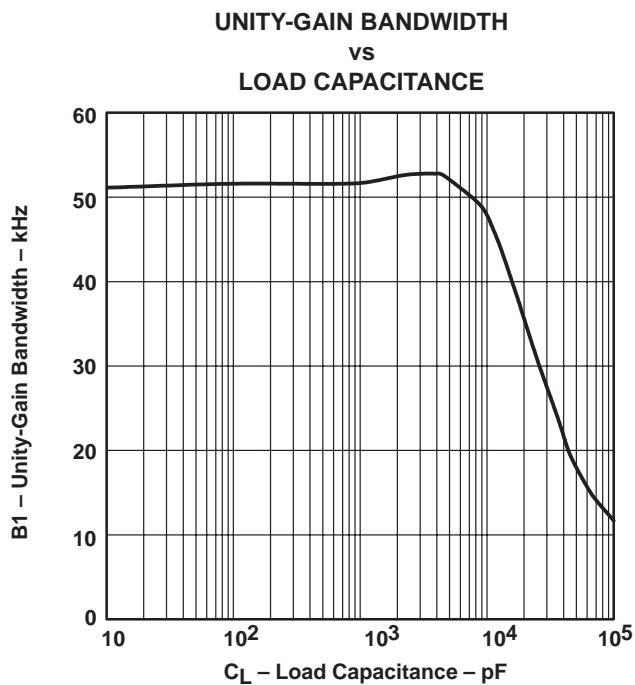


Figure 50

TLV2422, TLV2422A
Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT
WIDE-INPUT-VOLTAGE MICROPOWER DUAL OPERATIONAL AMPLIFIERS

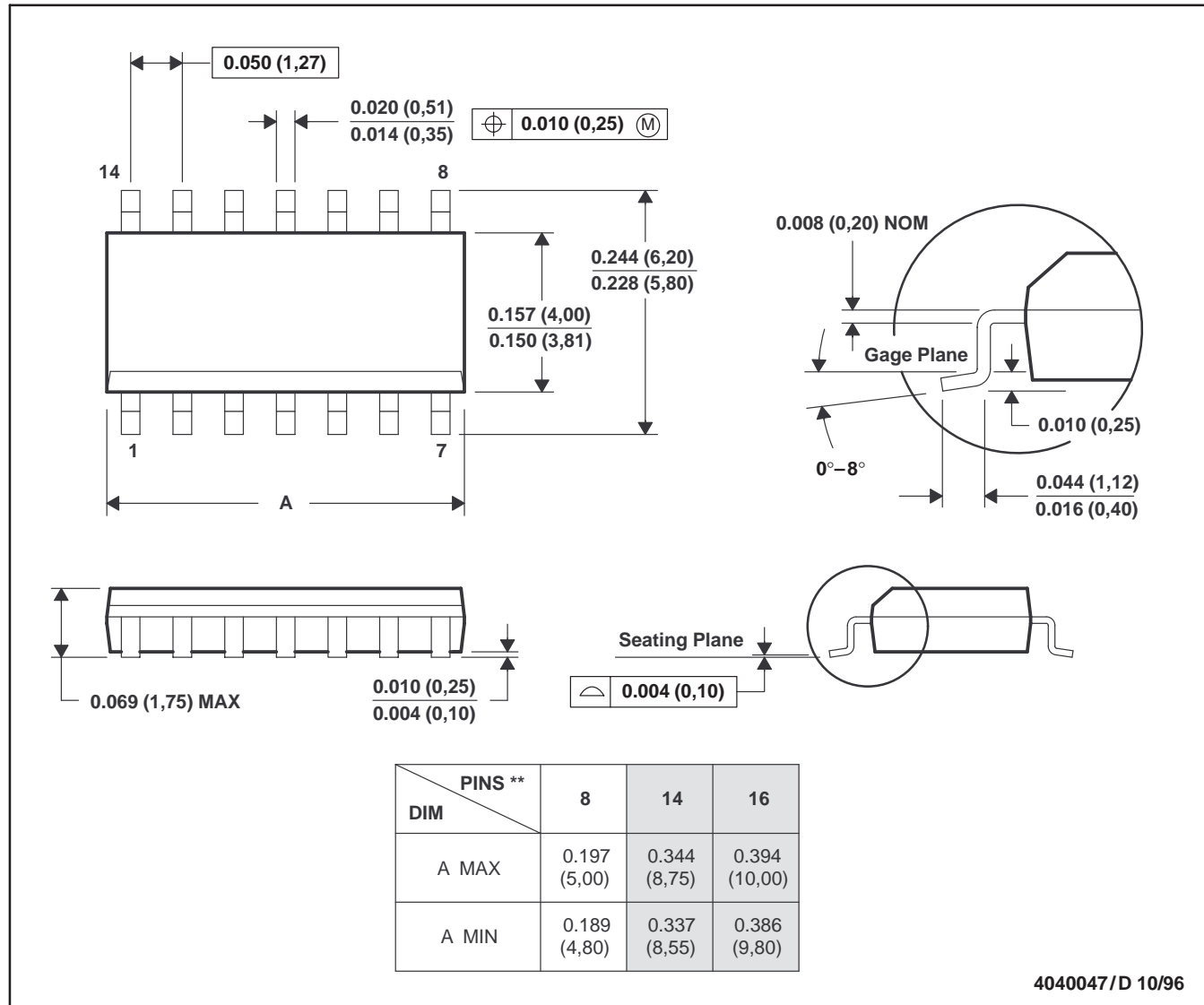
SLOS199B – SEPTEMBER 1997 – REVISED SEPTEMBER 1999

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

TLV2422, TLV2422A
Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT
WIDE-INPUT-VOLTAGE MICROPOWER DUAL OPERATIONAL AMPLIFIERS

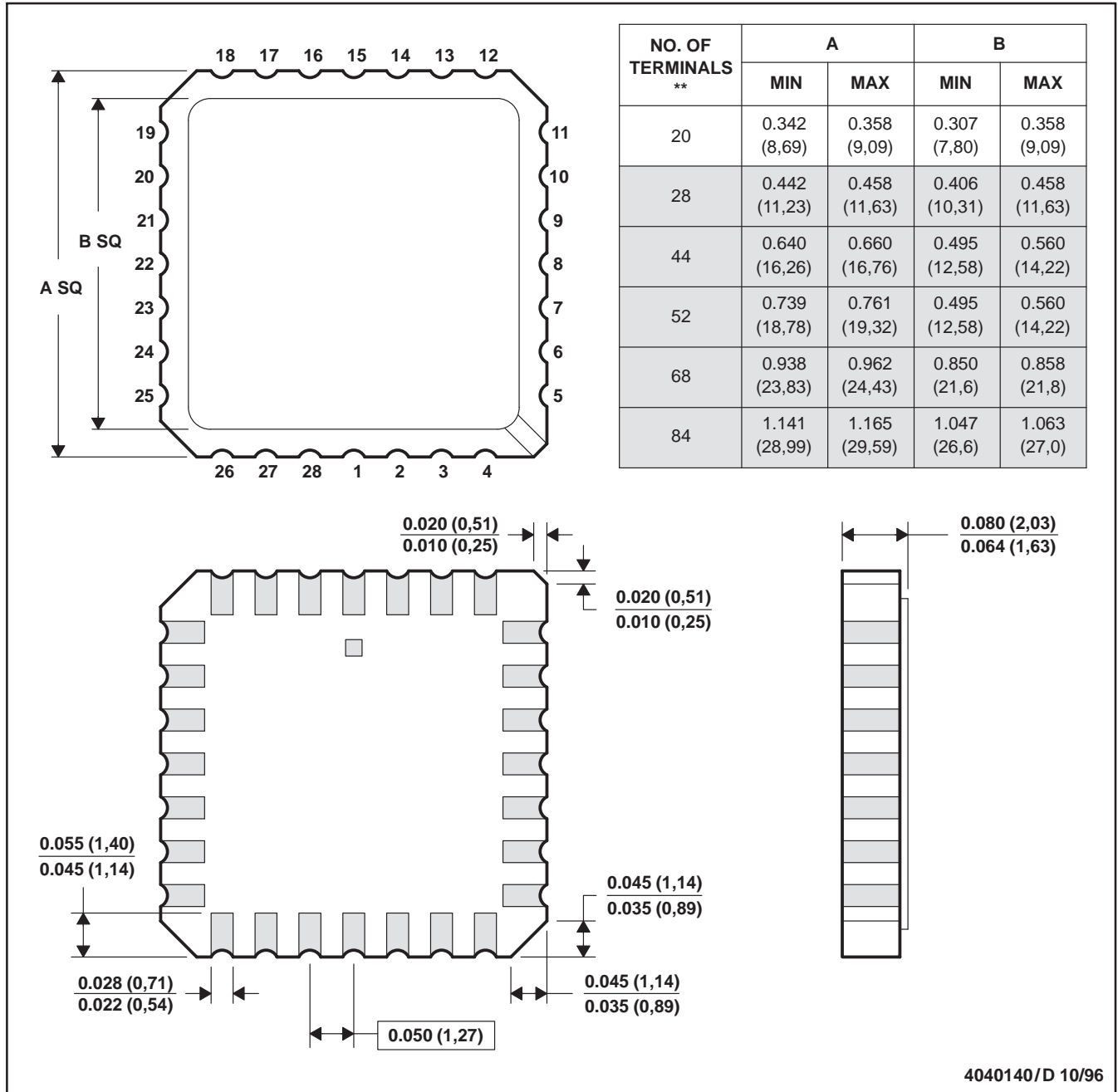
SLOS199B – SEPTEMBER 1997 – REVISED SEPTEMBER 1999

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

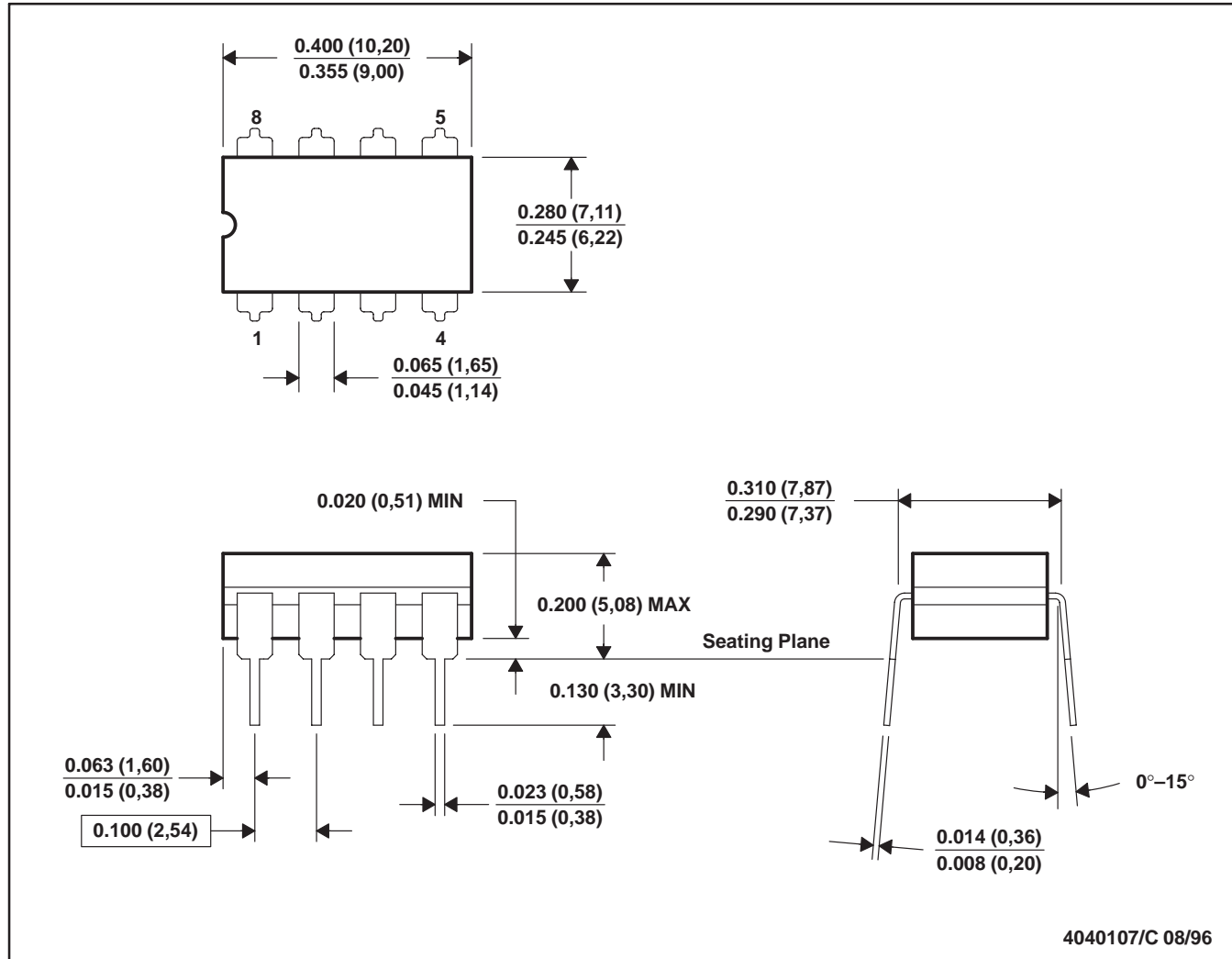
TLV2422, TLV2422A
Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT
WIDE-INPUT-VOLTAGE MICROPOWER DUAL OPERATIONAL AMPLIFIERS

SLOS199B – SEPTEMBER 1997 – REVISED SEPTEMBER 1999

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 only on press ceramic glass frit seal only.
 E. Falls within MIL-STD-1835 GDIP1-T8



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TLV2422, TLV2422A
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WIDE-INPUT-VOLTAGE MICROPOWER DUAL OPERATIONAL AMPLIFIERS

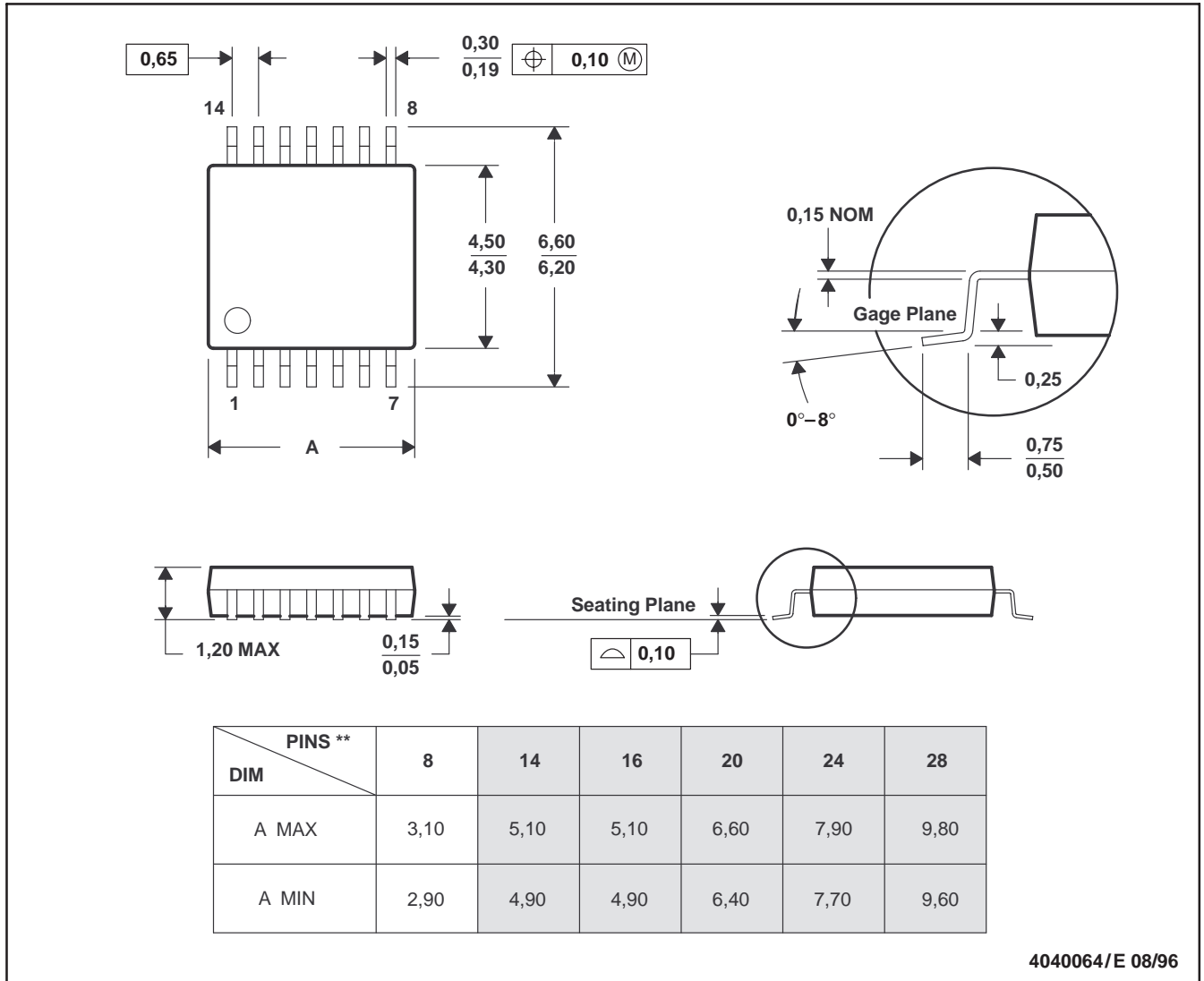
SLOS199B – SEPTEMBER 1997 – REVISED SEPTEMBER 1999

MECHANICAL DATA

PW (R-PDSO-G)**

PLASTIC SMALL-OUTLINE PACKAGE

14 PIN SHOWN



- 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

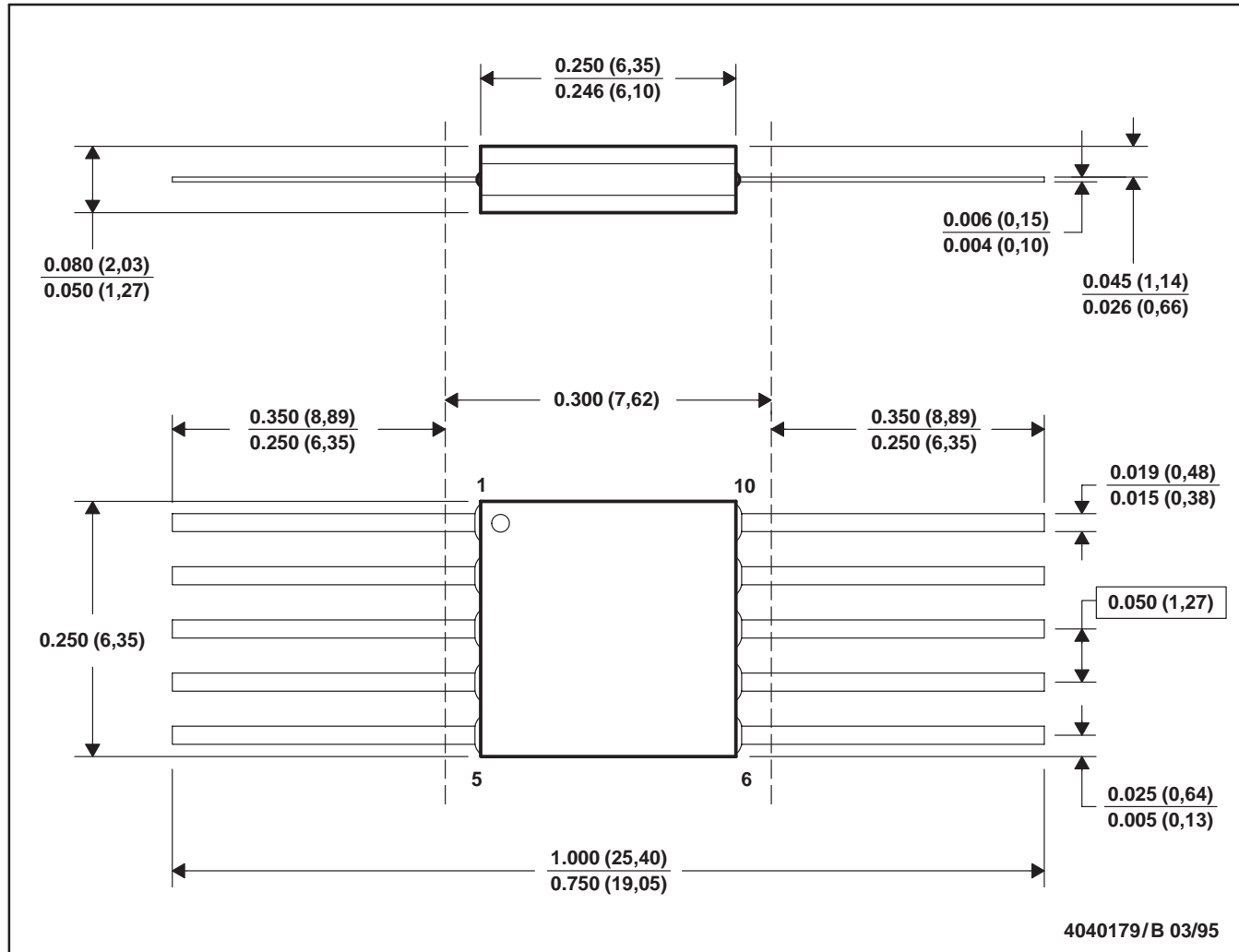
TLV2422, TLV2422A
Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT
WIDE-INPUT-VOLTAGE MICROPOWER DUAL OPERATIONAL AMPLIFIERS

SLOS199B – SEPTEMBER 1997 – REVISED SEPTEMBER 1999

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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