

**TLC225x**  
**Advanced LinCMOS™ RAIL-TO-RAIL**  
**VERY LOW-POWER OPERATIONAL AMPLIFIERS**  
 SLOS176A – FEBRUARY 1997 – REVISED JULY 1999

- **Output Swing Includes Both Supply Rails**
- **Low Noise . . . 19 nV/√Hz Typ at f = 1 kHz**
- **Low Input Bias Current . . . 1 pA Typ**
- **Fully Specified for Both Single-Supply and Split-Supply Operation**
- **Very Low Power . . . 35 μA Per Channel Typ**
- **Common-Mode Input Voltage Range Includes Negative Rail**
- **Low Input Offset Voltage**  
850 μV Max at T<sub>A</sub> = 25°C (TLC225xA)
- **Macromodel Included**
- **Performance Upgrades for the TS27L2/L4 and TLC27L2/L4**
- **Available in Q-Temp Automotive HighRel Automotive Applications Configuration Control / Print Support Qualification to Automotive Standards**

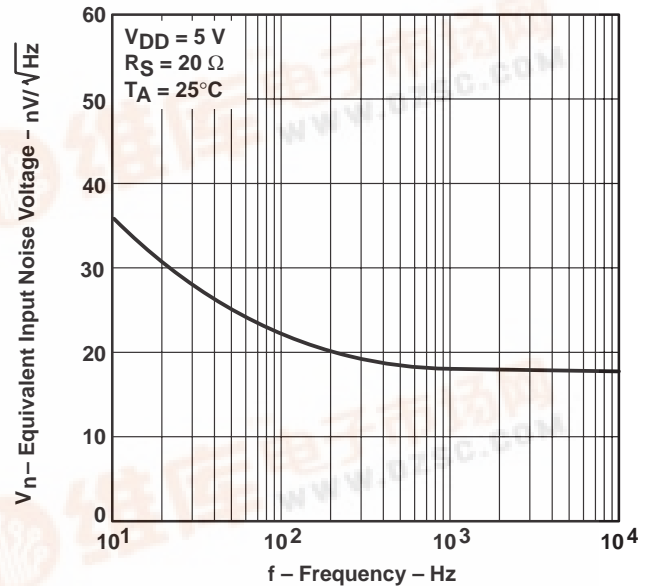
**description**

The TLC2252 and TLC2254 are dual and quadruple operational amplifiers from Texas Instruments. Both devices exhibit rail-to-rail output performance for increased dynamic range in single- or split-supply applications. The TLC225x family consumes only 35 μA of supply current per channel. This micropower operation makes them good choices for battery-powered applications. The noise performance has been dramatically improved over previous generations of CMOS amplifiers. Looking at Figure 1, the TLC225x has a noise level of 19 nV/√Hz at 1kHz; four times lower than competitive micropower solutions.

The TLC225x amplifiers, exhibiting high input impedance and low noise, are excellent for small-signal conditioning for high-impedance sources, such as piezoelectric transducers. Because of the micropower dissipation levels, 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 TLC225xA family is available and has a maximum input offset voltage of 850 μV. This family is fully characterized at 5 V and ±5 V.

The TLC2252/4 also makes great upgrades to the TLC27L2/L4 or TS27L2/L4 in standard designs. They offer increased output dynamic range, lower noise voltage, and lower input offset voltage. This enhanced feature set allows them to be used in a wider range of applications. For applications that require higher output drive and wider input voltage ranges, see the TLV2432 and TLV2442 devices. If the design requires single amplifiers, please see the TLV2211/21/31 family. These devices are single rail-to-rail operational amplifiers in the SOT-23 package. Their small size and low power consumption, make them ideal for high density, battery-powered equipment.

**EQUIVALENT INPUT NOISE VOLTAGE  
 VS  
 FREQUENCY**



**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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**TLC2252 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)	PLASTIC DIP (P)	TSSOP‡ (PW)	CERAMIC FLATPACK (U)
0°C to 70°C	1500 μV	TLC2252CD	—	—	TLC2252CP	TLC2252CPWLE	—
-40°C to 85°C	850 μV	TLC2252AID	—	—	TLC2252AIP	TLC2252AIPWLE	—
	1500 μV	TLC2252ID	—	—	TLC2252IP	—	—
-40°C to 125°C	850 μV	TLC2252AQD	—	—	—	—	—
	1500 μV	TLC2252QD	—	—	—	—	—
-55°C to 125°C	850 μV	—	TLC2252AMFK	TLC2252AMJG	—	—	TLC2252AMU
	1500 μV	—	TLC2252MFK	TLC2252MJG	—	—	TLC2252MU

† The D packages are available taped and reeled. Add R suffix to device type (e.g., TLC2262CDR).

‡ The PW package is available only left-ended taped and reeled.

§ Chip forms are tested at 25°C only.

**TLC2254 AVAILABLE OPTIONS**

T <sub>A</sub>	V <sub>IO</sub> max AT 25°C	PACKAGED DEVICES					
		SMALL OUTLINE† (D)	CHIP CARRIER (FK)	CERAMIC DIP (J)	PLASTIC DIP (N)	TSSOP‡ (PW)	CERAMIC FLATPACK (W)
0°C to 70°C	1500 μV	TLC2254CD	—	—	TLC2254CN	TLC2254CPWLE	—
-40°C to 85°C	850 μV	TLC2254AID	—	—	TLC2254AIN	TLC2254AIPWLE	—
	1500 μV	TLC2254ID	—	—	TLC2254IN	—	—
-40°C to 125°C	850 μV	TLC2254AQD	—	—	—	—	—
	1500 μV	TLC2254QD	—	—	—	—	—
-55°C to 125°C	850 μV	—	TLC2254AMFK	TLC2254AMJ	—	—	TLC2254AMW
	1500 μV	—	TLC2254MFK	TLC2254MJ	—	—	TLC2254MW

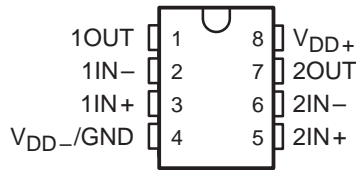
† The D packages are available taped and reeled. Add R suffix to the device type (e.g., TLC2254CDR).

‡ The PW package is available only left-end taped and reeled. Chips are tested at 25°C.

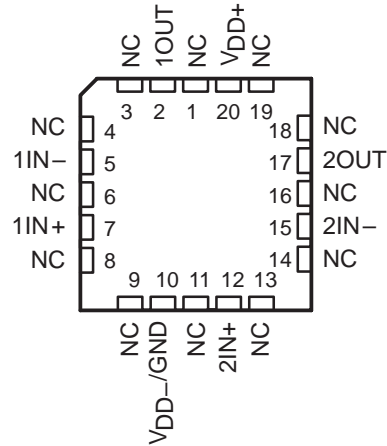
§ Chip forms are tested at 25°C only.

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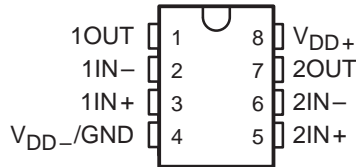
**TLC2252C, TLC2252AC**  
**TLC2252I, TLC2252AI**  
**TLC2252Q, TLC2252AQ**  
**D, P, OR PW PACKAGE**  
**(TOP VIEW)**



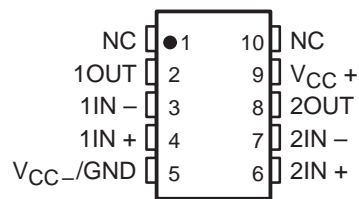
**TLC2252M, TLC2252AM . . . FK PACKAGE**  
**(TOP VIEW)**



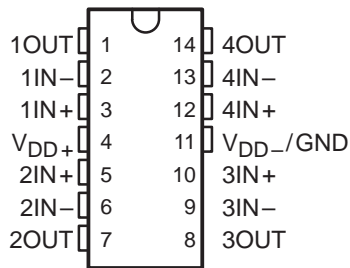
**TLC2252M, TLC2252AM . . . JG PACKAGE**  
**(TOP VIEW)**



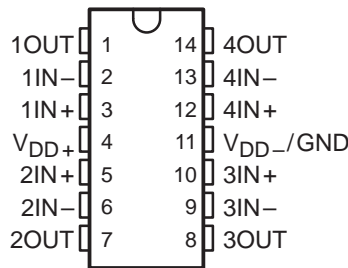
**TLC2262M, TLC2252AM . . . U PACKAGE**  
**(TOP VIEW)**



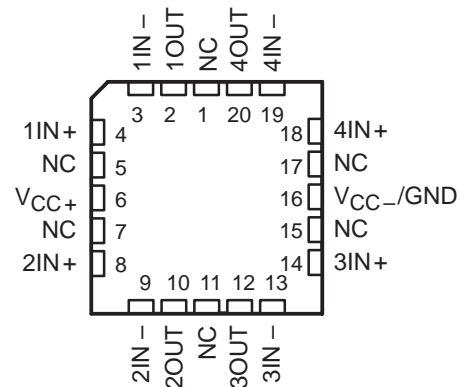
**TLC2254C, TLC2254AC**  
**TLC2254I, TLC2254AI**  
**TLC2254Q, TLC2254AQ**  
**D, N, OR PW PACKAGE**  
**(TOP VIEW)**



**TLC2254M, TLC2254AM**  
**J OR W PACKAGE**  
**(TOP VIEW)**

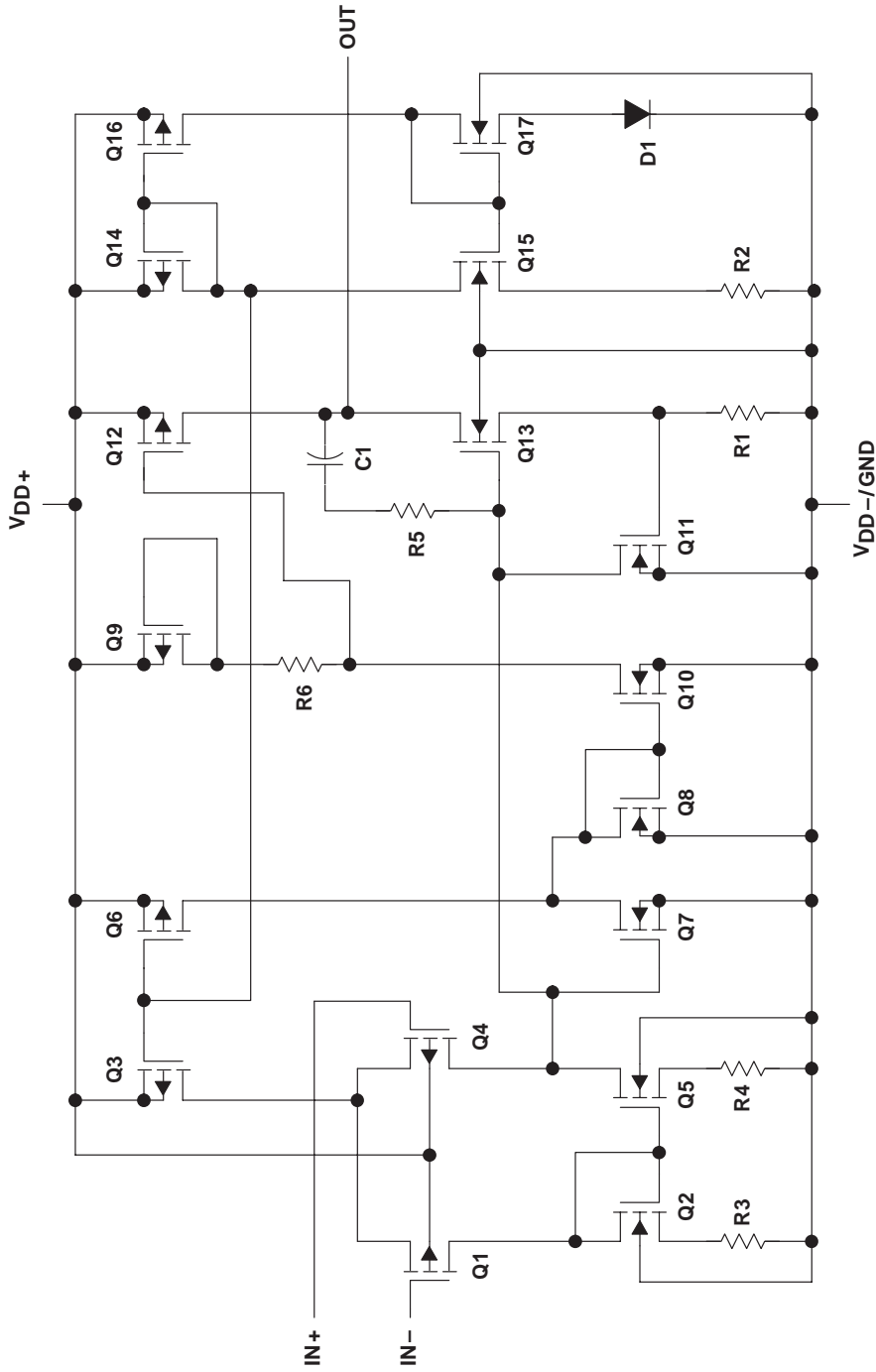


**TLC2254M, TLC2254AM**  
**FK PACKAGE**  
**(TOP VIEW)**



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equivalent schematic (each amplifier)



ACTUAL DEVICE COMPONENT COUNT†		
COMPONENT	TLC2252	TLC2254
Transistors	38	76
Resistors	30	56
Diodes	9	18
Capacitors	3	6

† Includes both amplifiers and all ESD, bias, and trim circuitry

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

Supply voltage, $V_{DD+}$ (see Note 1)	8 V
Supply voltage, $V_{DD-}$ (see Note 1)	–8 V
Differential input voltage, $V_{ID}$ (see Note 2)	$\pm 16$ V
Input voltage, $V_I$ (any input, see Note 1)	$\pm 8$ V
Input current, $I_I$ (each 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	–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 when 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	$T_A \leq 25^\circ\text{C}$	DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$	$T_A = 70^\circ\text{C}$	$T_A = 85^\circ\text{C}$	$T_A = 125^\circ\text{C}$
	POWER RATING		POWER RATING	POWER RATING	POWER RATING
D–8	724 mW	5.8 mW/°C	464 mW	377 mW	144 mW
D–14	950 mW	7.6 mW/°C	608 mW	450 mW	190 mW
FK	1375 mW	11.0 mW/°C	880 mW	715 mW	275 mW
J	1375 mW	11.0 mW/°C	880 mW	715 mW	275 mW
JG	1050 mW	8.4 mW/°C	672 mW	546 mW	275 mW
N	1150 mW	9.2 mW/°C	736 mW	736 mW	—
P	1000 mW	8.0 mW/°C	640 mW	520 mW	—
PW–8	525 mW	4.2 mW/°C	336 mW	273 mW	—
PW–14	700 mW	5.6 mW/°C	448 mW	448 mW	—
U	700 mW	5.5 mW/°C	246 mW	330 mW	150 mW
W	700 mW	5.5 mW/°C	246 mW	330 mW	150 mW

**recommended operating conditions**

	C SUFFIX		I SUFFIX		Q SUFFIX		M SUFFIX		UNIT
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
Supply voltage, $V_{DD\pm}$	$\pm 2.2$	$\pm 8$	$\pm 2.2$	$\pm 8$	$\pm 2.2$	$\pm 8$	$\pm 2.2$	$\pm 8$	V
Input voltage range, $V_I$	$V_{DD-}$	$V_{DD+} - 1.5$	$V_{DD-}$	$V_{DD+} - 1.5$	$V_{DD-}$	$V_{DD+} - 1.5$	$V_{DD-}$	$V_{DD+} - 1.5$	V
Common-mode input voltage, $V_{IC}$	$V_{DD-}$	$V_{DD+} - 1.5$	$V_{DD-}$	$V_{DD+} - 1.5$	$V_{DD-}$	$V_{DD+} - 1.5$	$V_{DD-}$	$V_{DD+} - 1.5$	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,  $V_{DD} = 5\text{ V}$  (unless otherwise noted)**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLC2252C			UNIT
			MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_{IC} = 0,$ $V_O = 0,$ $V_{DD} = \pm 2.5\text{ V},$ $R_S = 50\ \Omega$	25°C	200 1500		$\mu\text{V}$	
		Full range	1750			
$\alpha_{V_{IO}}$ Temperature coefficient of input offset voltage		25°C to 70°C	0.5		$\mu\text{V}/^\circ\text{C}$	
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		$\text{pA}$	
		Full range	100			
$I_{IB}$ Input bias current	25°C	1		$\text{pA}$		
	Full range	100				
$V_{ICR}$ Common-mode input voltage range	$R_S = 50\ \Omega,$ $ V_{IO}  \leq 5\text{ mV}$	25°C	0 to 4	-0.3 to 4.2	$\text{V}$	
		Full range	0 to 3.5			
$V_{OH}$ High-level output voltage	$I_{OH} = -20\ \mu\text{A}$	25°C	4.98		$\text{V}$	
	$I_{OH} = -75\ \mu\text{A}$	25°C	4.9	4.94		
	Full range	4.8				
$V_{OL}$ Low-level output voltage	$I_{OH} = -150\ \mu\text{A}$	25°C	4.8	4.88	$\text{V}$	
	$V_{IC} = 2.5\text{ V},$ $I_{OL} = 50\ \mu\text{A}$	25°C	0.01			
		Full range	0.09 0.15			
	$V_{IC} = 2.5\text{ V},$ $I_{OL} = 500\ \mu\text{A}$	25°C	0.01			
		Full range	0.15			
	$V_{IC} = 2.5\text{ V},$ $I_{OL} = 1\text{ mA}$	25°C	0.2	0.3		
Full range		0.3				
$V_{IC} = 2.5\text{ V},$ $I_{OL} = 4\text{ mA}$	25°C	0.7	1			
	Full range	1.2				
$A_{VD}$ Large-signal differential voltage amplification	$V_{IC} = 2.5\text{ V},$ $V_O = 1\text{ V to }4\text{ V}$	$R_L = 100\text{ k}\Omega^\ddagger$	25°C	100 350	$\text{V}/\text{mV}$	
		$R_L = 1\text{ M}\Omega^\ddagger$	Full range	10		
			25°C	1700		
$r_{id}$ Differential input resistance		25°C	$10^{12}$		$\Omega$	
$r_{ic}$ Common-mode input resistance		25°C	$10^{12}$		$\Omega$	
$c_{ic}$ Common-mode input capacitance	$f = 10\text{ kHz},$ P package	25°C	8		$\text{pF}$	
$z_o$ Closed-loop output impedance	$f = 25\text{ kHz},$ $A_V = 10$	25°C	200		$\Omega$	
CMRR Common-mode rejection ratio	$V_{IC} = 0\text{ to }2.7\text{ V},$ $V_O = 2.5\text{ V},$ $R_S = 50\ \Omega$	25°C	70	83	$\text{dB}$	
		Full range	70			
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{DD}/\Delta V_{IO}$ )	$V_{DD} = 4.4\text{ V to }16\text{ V},$ $V_{IC} = V_{DD}/2,$ No load	25°C	80	95	$\text{dB}$	
		Full range	80			
$I_{DD}$ Supply current	$V_O = 2.5\text{ V},$ No load	25°C	70	125	$\mu\text{A}$	
		Full range	150			

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

PARAMETER		TEST CONDITIONS		$T_A$ †	TLC2252C			UNIT
					MIN	TYP	MAX	
SR	Slew rate at unity gain	$V_O = 1.5\text{ V to }3.5\text{ V}$ , $R_L = 100\text{ k}\Omega$ ‡, $C_L = 100\text{ pF}$ ‡		25°C	0.07	0.12	V/ $\mu$ s	
				Full range	0.05			
$V_n$	Equivalent input noise voltage	$f = 10\text{ Hz}$		25°C	36		nV/ $\sqrt{\text{Hz}}$	
		$f = 1\text{ kHz}$		25°C	19			
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ Hz to }1\text{ Hz}$		25°C	0.7		$\mu$ V	
		$f = 0.1\text{ Hz to }10\text{ Hz}$		25°C	1.1			
$I_n$	Equivalent input noise current			25°C	0.6		fA/ $\sqrt{\text{Hz}}$	
THD + N	Total harmonic distortion plus noise	$V_O = 0.5\text{ V to }2.5\text{ V}$ , $f = 10\text{ kHz}$ , $R_L = 50\text{ k}\Omega$ ‡		25°C	$A_V = 1$			
					$A_V = 10$			1%
Gain-bandwidth product		$f = 10\text{ kHz}$ , $C_L = 100\text{ pF}$ ‡	$R_L = 50\text{ k}\Omega$ ‡	25°C	0.2		MHz	
$B_{OM}$	Maximum output-swing bandwidth	$V_{O(PP)} = 2\text{ V}$ , $R_L = 50\text{ k}\Omega$ ‡	$A_V = 1$ , $C_L = 100\text{ pF}$ ‡	25°C	30		kHz	
$\phi_m$	Phase margin at unity gain	$R_L = 50\text{ k}\Omega$ ‡, $C_L = 100\text{ pF}$ ‡		25°C	63°			
Gain margin				25°C	15		dB	

† Full range is 0°C to 70°C.

‡ Referenced to 2.5 V

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

PARAMETER	TEST CONDITIONS	$T_A$ †	TLC2252C			UNIT
			MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_{IC} = 0, V_O = 0, R_S = 50\ \Omega$	25°C	200	1500	$\mu\text{V}$	
		Full range	1750			
$\alpha_{VIO}$ Temperature coefficient of input offset voltage		25°C to 70°C	0.5		$\mu\text{V}/^\circ\text{C}$	
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		$\text{pA}$	
		Full range	100			
$I_{IB}$ Input bias current	25°C	1		$\text{pA}$		
	Full range	100				
$V_{ICR}$ Common-mode input voltage range	$ V_{IO}  \leq 5\text{ mV}, R_S = 50\ \Omega$	25°C	-5 to 4	-5.3 to 4.2	$\text{V}$	
		Full range	-5 to 3.5			
$V_{OM+}$ Maximum positive peak output voltage	$I_O = -20\ \mu\text{A}$ $I_O = -100\ \mu\text{A}$ $I_O = -200\ \mu\text{A}$	25°C	4.98		$\text{V}$	
		25°C	4.9	4.93		
		Full range	4.7			
		25°C	4.8	4.86		
$V_{OM-}$ Maximum negative peak output voltage	$V_{IC} = 0, I_O = 50\ \mu\text{A}$	25°C	-4.99		$\text{V}$	
		25°C	-4.85	-4.91		
	Full range	-4.85				
	$V_{IC} = 0, I_O = 1\ \text{mA}$	25°C	-4.7	-4.8		
		Full range	-4.7			
	$V_{IC} = 0, I_O = 4\ \text{mA}$	25°C	-4	-4.3		
Full range		-3.8				
$A_{VD}$ Large-signal differential voltage amplification	$V_O = \pm 4\ \text{V}$	$R_L = 100\ \text{k}\Omega$	25°C	45	650	$\text{V}/\text{mV}$
			Full range	10		
		$R_L = 1\ \text{M}\Omega$	25°C	3000		
$r_{id}$ Differential input resistance		25°C	$10^{12}$		$\Omega$	
$r_{ic}$ Common-mode input resistance		25°C	$10^{12}$		$\Omega$	
$c_{ic}$ Common-mode input capacitance	$f = 10\ \text{kHz}, \text{ P package}$	25°C	8		$\text{pF}$	
$z_o$ Closed-loop output impedance	$f = 25\ \text{kHz}, A_V = 10$	25°C	190		$\Omega$	
CMRR Common-mode rejection ratio	$V_{IC} = -5\ \text{V to } 2.7\ \text{V}, V_O = 0, R_S = 50\ \Omega$	25°C	75	88	$\text{dB}$	
		Full range	75			
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{DD\pm} / \Delta V_{IO}$ )	$V_{DD\pm} = 2.2\ \text{V to } \pm 8\ \text{V}, V_{IC} = 0, \text{ No load}$	25°C	80	95	$\text{dB}$	
		Full range	80			
$I_{DD}$ Supply current	$V_O = 0, \text{ No load}$	25°C	80	125	$\mu\text{A}$	
		Full range	150			

† Full range is 0°C to 70°C.

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,  $V_{DD\pm} = \pm 5\text{ V}$**

PARAMETER		TEST CONDITIONS		$T_A$ †	TLC2252C			UNIT
					MIN	TYP	MAX	
SR	Slew rate at unity gain	$V_O = \pm 1.9\text{ V}$ , $C_L = 100\text{ pF}$	$R_L = 100\text{ k}\Omega$	25°C	0.07	0.12	$\text{V}/\mu\text{s}$	
				Full range	0.05			
$V_n$	Equivalent input noise voltage			25°C	38		$\text{nV}/\sqrt{\text{Hz}}$	
				25°C	19			
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage			25°C	0.8		$\mu\text{V}$	
				25°C	1.1			
$I_n$	Equivalent input noise current			25°C	0.6		$\text{fA}/\sqrt{\text{Hz}}$	
THD + N	Total harmonic distortion pulse duration	$V_O = \pm 2.3\text{ V}$ , $f = 10\text{ kHz}$ , $R_L = 50\text{ k}\Omega$	$A_V = 1$	25°C	0.2%			
			$A_V = 10$		1%			
Gain-bandwidth product		$f = 10\text{ kHz}$ , $C_L = 100\text{ pF}$	$R_L = 50\text{ k}\Omega$	25°C	0.21		MHz	
$B_{OM}$	Maximum output-swing bandwidth	$V_{O(PP)} = 4.6\text{ V}$ , $R_L = 50\text{ k}\Omega$	$A_V = 1$ , $C_L = 100\text{ pF}$	25°C	14		kHz	
$\phi_m$	Phase margin at unity gain	$R_L = 50\text{ k}\Omega$ , $C_L = 100\text{ pF}$		25°C	63°			
	Gain margin			25°C	15		dB	

† Full range is 0°C to 70°C.

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

PARAMETER	TEST CONDITIONS	$T_A$ †	TLC2254C			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	200 1500		$\mu\text{V}$	
		Full range	1750			
$\alpha_{VIO}$ Temperature coefficient of input offset voltage		25°C to 70°C	0.5		$\mu\text{V}/^\circ\text{C}$	
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		$\text{pA}$	
		Full range	100			
$I_{IB}$ Input bias current	25°C	1		$\text{pA}$		
	Full range	100				
$V_{ICR}$ Common-mode input voltage range	$R_S = 50\ \Omega,$ $ V_{IO}  \leq 5\text{ mV}$	25°C	0 to 4	-0.3 to 4.2	$\text{V}$	
		Full range	0 to 3.5			
$V_{OH}$ High-level output voltage	$I_{OH} = -20\ \mu\text{A}$	25°C	4.98		$\text{V}$	
	$I_{OH} = -75\ \mu\text{A}$	25°C	4.9	4.94		
	$I_{OH} = -150\ \mu\text{A}$	Full range	4.8			
		25°C	4.8	4.88		
$V_{OL}$ Low-level output voltage	$V_{IC} = 2.5\text{ V},$ $I_{OL} = 50\ \mu\text{A}$	25°C	0.01		$\text{V}$	
	$V_{IC} = 2.5\text{ V},$ $I_{OL} = 500\ \mu\text{A}$	25°C	0.09	0.15		
		Full range	0.15			
	$V_{IC} = 2.5\text{ V},$ $I_{OL} = 1\text{ mA}$	25°C	0.2	0.3		
		Full range	0.3			
	$V_{IC} = 2.5\text{ V},$ $I_{OL} = 4\text{ mA}$	25°C	0.7	1		
		Full range	1.2			
	$A_{VD}$ Large-signal differential voltage amplification	$V_{IC} = 2.5\text{ V},$ $V_O = 1\text{ V to }4\text{ V}$	$R_L = 100\ \text{k}\Omega^\ddagger$	25°C		100 350
$R_L = 1\ \text{M}\Omega^\ddagger$			Full range	10		
			25°C	1700		
$r_{i(d)}$ Differential input resistance		25°C	10 <sup>12</sup>		$\Omega$	
$r_{i(c)}$ Common-mode input resistance		25°C	10 <sup>12</sup>		$\Omega$	
$c_{i(c)}$ Common-mode input capacitance	$f = 10\ \text{kHz},$ N package	25°C	8		$\text{pF}$	
$z_o$ Closed-loop output impedance	$f = 25\ \text{kHz},$ $A_V = 10$	25°C	200		$\Omega$	
CMRR Common-mode rejection ratio	$V_{IC} = 0\text{ to }2.7\text{ V},$ $V_O = 2.5\text{ V},$ $R_S = 50\ \Omega$	25°C	70	83	$\text{dB}$	
		Full range	70			
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{DD}/\Delta V_{IO}$ )	$V_{DD} = 4.4\text{ V to }16\text{ V},$ $V_{IC} = V_{DD}/2,$ No load	25°C	80	95	$\text{dB}$	
		Full range	80			
$I_{DD}$ Supply current (four amplifiers)	$V_O = 2.5\text{ V},$ No load	25°C	140	250	$\mu\text{A}$	
		Full range	300			

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

PARAMETER		TEST CONDITIONS		$T_A$ †	TLC2254C			UNIT
					MIN	TYP	MAX	
SR	Slew rate at unity gain	$V_O = 1.4\text{ V to }2.6\text{ V}$ $R_L = 100\text{ k}\Omega$ ‡, $C_L = 100\text{ pF}$ ‡		25°C	0.07	0.12	$\text{V}/\mu\text{s}$	
				Full range	0.05			
$V_n$	Equivalent input noise voltage			25°C	36		$\text{nV}/\sqrt{\text{Hz}}$	
				25°C	19			
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage			25°C	0.7		$\mu\text{V}$	
				25°C	1.1			
$I_n$	Equivalent input noise current			25°C	0.6		$\text{fA}/\sqrt{\text{Hz}}$	
THD + N	Total harmonic distortion plus noise	$V_O = 0.5\text{ V to }2.5\text{ V}$ , $f = 10\text{ kHz}$ , $R_L = 50\text{ k}\Omega$ ‡		25°C	$A_V = 1$			
					$A_V = 10$			
	Gain-bandwidth product	$f = 10\text{ kHz}$ , $C_L = 100\text{ pF}$ ‡	$R_L = 50\text{ k}\Omega$ ‡,	25°C	0.2		MHz	
$B_{OM}$	Maximum output-swing bandwidth	$V_{O(PP)} = 2\text{ V}$ , $R_L = 50\text{ k}\Omega$ ‡,	$A_V = 1$ , $C_L = 100\text{ pF}$ ‡	25°C	30		kHz	
$\phi_m$	Phase margin at unity gain	$R_L = 50\text{ k}\Omega$ ‡,	$C_L = 100\text{ pF}$ ‡	25°C	63°			
	Gain margin			25°C	15		dB	

† Full range is 0°C to 70°C.

‡ Referenced to 2.5 V

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

PARAMETER	TEST CONDITIONS	$T_A$ †	TLC2254C			UNIT
			MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_{IC} = 0, V_O = 0, R_S = 50\ \Omega$	25°C	200	1500	$\mu\text{V}$	
		Full range	1750			
$\alpha_{VIO}$ Temperature coefficient of input offset voltage		25°C to 70°C	0.5		$\mu\text{V}/^\circ\text{C}$	
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		$\text{pA}$	
		Full range	100			
$I_{IB}$ Input bias current		25°C	1		$\text{pA}$	
		Full range	100			
$V_{ICR}$ Common-mode input voltage range	$ V_{IO}  \leq 5\ \text{mV}, R_S = 50\ \Omega$	25°C	-5 to 4	-5.3 to 4.2	$\text{V}$	
		Full range	-5 to 3.5			
$V_{OM+}$ Maximum positive peak output voltage	$I_O = -20\ \mu\text{A}$	25°C	4.98		$\text{V}$	
	$I_O = -100\ \mu\text{A}$	25°C	4.9	4.93		
		Full range	4.7			
	$I_O = -200\ \mu\text{A}$	25°C	4.8	4.86		
$V_{OM-}$ Maximum negative peak output voltage	$V_{IC} = 0, I_O = 50\ \mu\text{A}$	25°C	-4.99		$\text{V}$	
	$V_{IC} = 0, I_O = 500\ \mu\text{A}$	25°C	-4.85	-4.91		
		Full range	-4.85			
	$V_{IC} = 0, I_O = 1\ \text{mA}$	25°C	-4.7	-4.8		
		Full range	-4.7			
	$V_{IC} = 0, I_O = 4\ \text{mA}$	25°C	-4	-4.3		
$A_{VD}$ Large-signal differential voltage amplification	$V_O = \pm 4\ \text{V}$	$R_L = 100\ \text{k}\Omega$	25°C	40	150	$\text{V}/\text{mV}$
		$R_L = 1\ \text{M}\Omega$	Full range	10		
			25°C	3000		
$r_{i(d)}$ Differential input resistance		25°C	10 <sup>12</sup>		$\Omega$	
$r_{i(c)}$ Common-mode input resistance		25°C	10 <sup>12</sup>		$\Omega$	
$c_{i(c)}$ Common-mode input capacitance	$f = 10\ \text{kHz}, N$ package	25°C	8		$\text{pF}$	
$z_o$ Closed-loop output impedance	$f = 25\ \text{kHz}, A_V = 10$	25°C	190		$\Omega$	
CMRR Common-mode rejection ratio	$V_{IC} = -5\ \text{V to } 2.7\ \text{V}, V_O = 0, R_S = 50\ \Omega$	25°C	75	88	$\text{dB}$	
		Full range	75			
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{DD\pm} / \Delta V_{IO}$ )	$V_{DD\pm} = \pm 2.2\ \text{V to } \pm 8\ \text{V}, V_{IC} = 0, \text{No load}$	25°C	80	95	$\text{dB}$	
		Full range	80			
$I_{DD}$ Supply current (four amplifiers)	$V_O = 0, \text{No load}$	25°C	160	250	$\mu\text{A}$	
		Full range	300			

† Full range is 0°C to 70°C.

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,  $V_{DD\pm} = \pm 5\text{ V}$**

PARAMETER		TEST CONDITIONS		T <sub>A</sub> †	TLC2254C			UNIT
					MIN	TYP	MAX	
SR	Slew rate at unity gain	V <sub>O</sub> = ±1.9 V, C <sub>L</sub> = 100 pF	R <sub>L</sub> = 100 kΩ,	25°C	0.07	0.12	V/μs	
				Full range	0.05			
V <sub>n</sub>	Equivalent input noise voltage	f = 10 Hz	f = 1 kHz	25°C	38		nV/√Hz	
				25°C	19			
V <sub>N(PP)</sub>	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz	f = 0.1 Hz to 10 Hz	25°C	0.8		μV	
				25°C	1.1			
I <sub>n</sub>	Equivalent input noise current			25°C	0.6		fA/√Hz	
THD + N	Total harmonic distortion plus noise	V <sub>O</sub> = ±2.3 V, f = 20 kHz, R <sub>L</sub> = 50 kΩ	A <sub>V</sub> = 1	25°C	0.2%			
					A <sub>V</sub> = 10	1%		
	Gain-bandwidth product	f = 10 kHz, C <sub>L</sub> = 100 pF	R <sub>L</sub> = 50 kΩ,	25°C	0.21		MHz	
BOM	Maximum output-swing bandwidth	V <sub>O(PP)</sub> = 4.6 V, R <sub>L</sub> = 50 kΩ,	A <sub>V</sub> = 1, C <sub>L</sub> = 100 pF	25°C	14		kHz	
φ <sub>m</sub>	Phase margin at unity gain	R <sub>L</sub> = 50 kΩ,	C <sub>L</sub> = 100 pF	25°C	63°			
	Gain margin			25°C	15		dB	

† Full range is 0°C to 70°C.

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

PARAMETER	TEST CONDITIONS	$T_A$ †	TLC2252I			TLC2252AI			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_{DD} \pm = \pm 2.5\text{ V}, V_O = 0, V_{IC} = 0, R_S = 50\ \Omega$	25°C	200 1500		200 850		$\mu\text{V}$		
		Full range	1750		1000				
$\alpha_{VIO}$ Temperature coefficient of input offset voltage		25°C to 85°C	0.5		0.5		$\mu\text{V}/^\circ\text{C}$		
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		$\text{pA}$		
		Full range	1000		1000				
$I_{IB}$ Input bias current	25°C	1		1		$\text{pA}$			
	Full range	1000		1000					
$V_{ICR}$ Common-mode input voltage range	$R_S = 50\ \Omega,  V_{IO}  \leq 5\text{ mV}$	25°C	0 to 4	-0.3 to 4.2	0 to 4	-0.3 to 4.2	$\text{V}$		
		Full range	0 to 3.5		0 to 3.5				
$V_{OH}$ High-level output voltage	$I_{OH} = -20\ \mu\text{A}$	25°C	4.98		4.98		$\text{V}$		
		25°C	4.9	4.94	4.9	4.94			
		Full range	4.8		4.8				
		25°C	4.8	4.88	4.8	4.88			
$V_{OL}$ Low-level output voltage	$V_{IC} = 2.5\text{ V}, I_{OL} = 50\ \mu\text{A}$	25°C	0.01		0.01		$\text{V}$		
		25°C	0.09	0.15	0.09	0.15			
	$V_{IC} = 2.5\text{ V}, I_{OL} = 500\ \mu\text{A}$	Full range	0.15		0.15				
		25°C	0.8	1	0.7	1			
	$V_{IC} = 2.5\text{ V}, I_{OL} = 4\text{ mA}$	Full range	1.2		1.2				
		25°C	100	350	100	350			
$AVD$ Large-signal differential voltage amplification	$V_{IC} = 2.5\text{ V}, V_O = 1\text{ V to }4\text{ V}$	$R_L = 100\text{ k}\Omega \ddagger$	25°C	100	350	100	350	$\text{V}/\text{mV}$	
			Full range	10		10			
		$R_L = 1\text{ M}\Omega \ddagger$	25°C	1700		1700			
$r_{id}$ Differential input resistance		25°C	$10^{12}$		$10^{12}$		$\Omega$		
$r_{ic}$ Common-mode input resistance		25°C	$10^{12}$		$10^{12}$		$\Omega$		
$C_{ic}$ Common-mode input capacitance	$f = 10\text{ kHz}, \text{ P package}$	25°C	8		8		$\text{pF}$		
$z_o$ Closed-loop output impedance	$f = 25\text{ kHz}, A_V = 10$	25°C	200		200		$\Omega$		
CMRR Common-mode rejection ratio	$V_{IC} = 0\text{ to }2.7\text{ V}, V_O = 2.5\text{ V}, R_S = 50\ \Omega$	25°C	70	83	70	83	$\text{dB}$		
		Full range	70		70				
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{DD}/\Delta V_{IO}$ )	$V_{DD} = 4.4\text{ V to }16\text{ V}, V_{IC} = V_{DD}/2, \text{ No load}$	25°C	80	95	80	95	$\text{dB}$		
		Full range	80		80				
$I_{DD}$ Supply current	$V_O = 2.5\text{ V}, \text{ No load}$	25°C	70	125	70	125	$\mu\text{A}$		
		Full range	150		150				

† Full range is  $-40^\circ\text{C}$  to  $125^\circ\text{C}$ .

‡ 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,  $V_{DD} = 5\text{ V}$

PARAMETER	TEST CONDITIONS		$T_A$ †	TLC2252I			TLC2252AI			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	$V_O = 1.5\text{ V to }3.5\text{ V},$ $R_L = 100\text{ k}\Omega$ ‡, $C_L = 100\text{ pF}$ ‡	25°C	0.07	0.12		0.07	0.12		V/ $\mu\text{s}$
			Full range	0.05			0.05			
$V_n$	Equivalent input noise voltage	$f = 10\text{ Hz}$ $f = 1\text{ kHz}$	25°C	36			36			nV/ $\sqrt{\text{Hz}}$
			25°C	19			19			
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ Hz to }1\text{ Hz}$ $f = 0.1\text{ Hz to }10\text{ Hz}$	25°C	0.7			0.7			$\mu\text{V}$
			25°C	1.1			1.1			
$I_n$	Equivalent input noise current		25°C	0.6			0.6			fA/ $\sqrt{\text{Hz}}$
THD + N	Total harmonic distortion plus noise	$V_O = 0.5\text{ V to }2.5\text{ V},$ $f = 10\text{ kHz},$ $R_L = 50\text{ k}\Omega$ ‡	$A_V = 1$	0.2%			0.2%			
			$A_V = 10$	1%			1%			
	Gain-bandwidth product	$f = 50\text{ kHz},$ $C_L = 100\text{ pF}$ ‡	$R_L = 50\text{ k}\Omega$ ‡, 25°C	0.2			0.2			MHz
$B_{OM}$	Maximum output-swing bandwidth	$V_{O(PP)} = 2\text{ V},$ $R_L = 50\text{ k}\Omega$ ‡,	$A_V = 1,$ $R_L = 50\text{ k}\Omega$ ‡, 25°C	30			30			kHz
$\phi_m$	Phase margin at unity gain	$R_L = 50\text{ k}\Omega$ ‡,	$C_L = 100\text{ pF}$ ‡ 25°C	63°			63°			
	Gain margin			25°C	15			15		

† Full range is  $-40^\circ\text{C}$  to  $125^\circ\text{C}$ .

‡ Referenced to 2.5 V

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

PARAMETER	TEST CONDITIONS	$T_A$ †	TLC2252I			TLC2252AI			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_{IC} = 0, V_O = 0, R_S = 50\ \Omega$	25°C	200		1500	200		850	$\mu\text{V}$
		Full range	1750			1000			
$\alpha_{VIO}$ Temperature coefficient of input offset voltage		25°C to 85°C	0.5			0.5			$\mu\text{V}/^\circ\text{C}$
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			$\text{pA}$
		Full range	1000			1000			
$I_{IB}$ Input bias current	25°C	1			1			$\text{pA}$	
	Full range	1000			1000				
$V_{ICR}$ Common-mode input voltage range	$R_S = 50\ \Omega,  V_{IO}  \leq 5\ \text{mV}$	25°C	-5 to 4	-5.3 to 4.2		-5 to 4	-5.3 to 4.2	V	
		Full range	-5 to 3.5			-5 to 3.5			
$V_{OM+}$ Maximum positive peak output voltage	$I_O = -20\ \mu\text{A}$	25°C	4.98		4.98		V		
	$I_O = -100\ \mu\text{A}$	25°C	4.9	4.93	4.9	4.93			
		Full range	4.7		4.7				
	$I_O = -200\ \mu\text{A}$	25°C	4.8	4.86	4.8	4.86			
$V_{OM-}$ Maximum negative peak output voltage	$V_{IC} = 0, I_O = 50\ \mu\text{A}$	25°C	-4.99		-4.99		V		
	$V_{IC} = 0, I_O = 500\ \mu\text{A}$	25°C	-4.85	-4.91	-4.85	-4.91			
		Full range	-4.85		-4.85				
	$V_{IC} = 0, I_O = 4\ \text{mA}$	25°C	-4	-4.3	-4	-4.3			
		Full range	-3.8		-3.8				
	$A_{VD}$ Large-signal differential voltage amplification	$V_O = \pm 4\ \text{V}$	$R_L = 50\ \text{k}\Omega$	25°C	40	150		40	150
Full range				10		10			
$R_L = 1\ \text{M}\Omega$			25°C	3000			3000		
$r_{id}$ Differential input resistance		25°C	$10^{12}$			$10^{12}$			$\Omega$
$r_{ic}$ Common-mode input resistance		25°C	$10^{12}$			$10^{12}$			$\Omega$
$c_{ic}$ Common-mode input capacitance	$f = 10\ \text{kHz}, \text{P package}$	25°C	8			8			pF
$z_o$ Closed-loop output impedance	$f = 25\ \text{kHz}, A_V = 10$	25°C	190			190			$\Omega$
CMRR Common-mode rejection ratio	$V_{IC} = -5\ \text{V to } 2.7\ \text{V}, V_O = 0, R_S = 50\ \Omega$	25°C	75	88		75	88	dB	
		Full range	75		75				
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{DD\pm} / \Delta V_{IO}$ )	$V_{DD} = 4.4\ \text{V to } 16\ \text{V}, V_{IC} = V_{DD}/2, \text{No load}$	25°C	80	95		80	95	dB	
		Full range	80		80				
$I_{DD}$ Supply current	$V_O = 2.5\ \text{V}, \text{No load}$	25°C	80	125		80	125	$\mu\text{A}$	
		Full range	150		150				

† Full range is -40°C to 125°C.

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,  $V_{DD\pm} = \pm 5\text{ V}$

PARAMETER	TEST CONDITIONS	$T_A$ †	TLC2252I			TLC2252AI			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain $V_O = \pm 1.9\text{ V}$ , $R_L = 100\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	0.07	0.12		0.07	0.12		$\text{V}/\mu\text{s}$
		Full range	0.05			0.05			
$V_n$	Equivalent input noise voltage	$f = 10\text{ Hz}$	25°C		38		38		$\text{nV}/\sqrt{\text{Hz}}$
		$f = 1\text{ kHz}$	25°C		19		19		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ Hz to }1\text{ Hz}$	25°C		0.8		0.8		$\mu\text{V}$
		$f = 0.1\text{ Hz to }10\text{ Hz}$	25°C		1.1		1.1		
$I_n$	Equivalent input noise current		25°C		0.6		0.6		$\text{fA}/\sqrt{\text{Hz}}$
THD + N	Total harmonic distortion plus noise	$V_O = \pm 2.3\text{ V}$ , $R_L = 50\text{ k}\Omega$ , $f = 10\text{ kHz}$	$A_V = 1$	25°C		0.2%		0.2%	
			$A_V = 10$			1%		1%	
	Gain-bandwidth product	$f = 10\text{ kHz}$ , $R_L = 50\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C		0.21		0.21		MHz
$B_{OM}$	Maximum output-swing bandwidth	$V_{O(PP)} = 4.6\text{ V}$ , $A_V = 1$ , $R_L = 50\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C		14		14		kHz
$\phi_m$	Phase margin at unity gain	$R_L = 50\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C		63°		63°		
			25°C		15		15		dB
	Gain margin		25°C		15		15		dB

† Full range is  $-40^\circ\text{C}$  to  $125^\circ\text{C}$ .

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

PARAMETER	TEST CONDITIONS	$T_A$ †	TLC2254I			TLC2254AI			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_{DD} \pm \pm 2.5\text{ V}$ , $V_{IC} = 0$ , $V_O = 0$ , $R_S = 50\ \Omega$	25°C	200 1500		200 850		$\mu\text{V}$		
		Full range	1750		1000				
$\alpha V_{IO}$ Temperature coefficient of input offset voltage		25°C to 125°C	0.5		0.5		$\mu\text{V}/^\circ\text{C}$		
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	1000		1000				
$I_{IB}$ Input bias current	25°C	1		1		pA			
	Full range	1000		1000					
$V_{ICR}$ Common-mode input voltage range	$R_S = 50\ \Omega$ , $ V_{IO}  \leq 5\text{ mV}$	25°C	0 to 4	-0.3 to 4.2	0 to 4	-0.3 to 4.2	V		
		Full range	0 to 3.5		0 to 3.5				
$V_{OH}$ High-level output voltage	$I_{OH} = -20\ \mu\text{A}$ $I_{OH} = -75\ \mu\text{A}$ $I_{OH} = -150\ \mu\text{A}$	25°C	4.98		4.98		V		
		25°C	4.9	4.94	4.9	4.94			
		Full range	4.8		4.8				
		25°C	4.8	4.88	4.8	4.88			
$V_{OL}$ Low-level output voltage	$V_{IC} = 2.5\text{ V}$ , $I_{OL} = 50\ \mu\text{A}$ $V_{IC} = 2.5\text{ V}$ , $I_{OL} = 500\ \mu\text{A}$ $V_{IC} = 2.5\text{ V}$ , $I_{OL} = 4\text{ mA}$	25°C	0.01		0.01		V		
		25°C	0.09	0.15	0.09	0.15			
		Full range	0.15		0.15				
		25°C	0.8	1	0.7	1			
		Full range	1.2		1.2				
$A_{VD}$ Large-signal differential voltage amplification	$V_{IC} = 2.5\text{ V}$ , $V_O = 1\text{ V to }4\text{ V}$	25°C	$R_L = 100\text{ k}\Omega$ ‡	100	350	100	350	V/mV	
			Full range	10		10			
		25°C	$R_L = 1\text{ M}\Omega$ ‡	1700		1700			
$r_{i(d)}$ Differential input resistance		25°C	1012		1012		$\Omega$		
$r_{i(c)}$ Common-mode input resistance		25°C	1012		1012		$\Omega$		
$C_{i(c)}$ Common-mode input capacitance	$f = 10\text{ kHz}$ , N package	25°C	8		8		pF		
$z_o$ Closed-loop output impedance	$f = 25\text{ kHz}$ , $A_V = 10$	25°C	200		200		$\Omega$		
CMRR Common-mode rejection ratio	$V_{IC} = 0\text{ to }2.7\text{ V}$ , $V_O = 2.5\text{ V}$ , $R_S = 50\ \Omega$	25°C	70	83	70	83	dB		
		Full range	70		70				
kSVR Supply-voltage rejection ratio ( $\Delta V_{DD}/\Delta V_{IO}$ )	$V_{DD} = 4.4\text{ V to }16\text{ V}$ , $V_{IC} = V_{DD}/2$ , No load	25°C	80	95	80	95	dB		
		Full range	80		80				
$I_{DD}$ Supply current (four amplifiers)	$V_O = 2.5\text{ V}$ , No load	25°C	140	250	140	250	$\mu\text{A}$		
		Full range	300		300				

† Full range is  $-40^\circ\text{C}$  to  $125^\circ\text{C}$ .

‡ 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,  $V_{DD} = 5\text{ V}$

PARAMETER	TEST CONDITIONS	$T_A$ †	TLC2254I			TLC2254AI			UNIT	
			MIN	TYP	MAX	MIN	TYP	MAX		
SR	Slew rate at unity gain $V_O = 1.4\text{ V to }2.6\text{ V}$ , $R_L = 100\text{ k}\Omega$ ‡, $C_L = 100\text{ pF}$ ‡	25°C	0.07	0.12		0.07	0.12		$\text{V}/\mu\text{s}$	
		Full range	0.05			0.05				
$V_n$	Equivalent input noise voltage	$f = 10\text{ Hz}$	25°C		36		36		$\text{nV}/\sqrt{\text{Hz}}$	
		$f = 1\text{ kHz}$	25°C		19		19			
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ Hz to }1\text{ Hz}$	25°C		0.7		0.7		$\mu\text{V}$	
		$f = 0.1\text{ Hz to }10\text{ Hz}$	25°C		1.1		1.1			
$I_n$	Equivalent input noise current		25°C		0.6		0.6	$\text{fA}/\sqrt{\text{Hz}}$		
THD + N	Total harmonic distortion plus noise $V_O = 0.5\text{ V to }2.5\text{ V}$ , $f = 20\text{ kHz}$ , $R_L = 50\text{ k}\Omega$ ‡	$A_V = 1$	25°C	0.2%			0.2%			
		$A_V = 10$		1%			1%			
	Gain-bandwidth product $f = 50\text{ kHz}$ , $C_L = 100\text{ pF}$ ‡	$R_L = 50\text{ k}\Omega$ ‡	25°C	0.2			0.2			MHz
BOM	Maximum output-swing bandwidth $V_{O(PP)} = 2\text{ V}$ , $R_L = 50\text{ k}\Omega$ ‡	$A_V = 1$ , $C_L = 100\text{ pF}$ ‡	25°C	30			30			kHz
$\phi_m$	Phase margin at unity gain	$R_L = 50\text{ k}\Omega$ ‡, $C_L = 100\text{ pF}$ ‡	25°C	63°			63°			
			25°C	15			15			dB
	Gain margin		25°C	15			15			dB

† Full range is  $-40^\circ\text{C}$  to  $125^\circ\text{C}$ .

‡ Referenced to 2.5 V

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

PARAMETER	TEST CONDITIONS	$T_A$ †	TLC2254I			TLC2254AI			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
$V_{IO}$ Input offset voltage		25°C	200		1500	200		850	$\mu\text{V}$
		Full range	1750			1000			
$\alpha_{VIO}$ Temperature coefficient of input offset voltage		25°C to 125°C	0.5			0.5			$\mu\text{V}/^\circ\text{C}$
Input offset voltage long-term drift (see Note 4)	$V_{IC} = 0, V_O = 0, R_S = 50\ \Omega$	25°C	0.003			0.003			$\mu\text{V}/\text{mo}$
$I_{IO}$ Input offset current		25°C	0.5			0.5			$\text{pA}$
		Full range	1000			1000			
$I_{IB}$ Input bias current		25°C	1			1			$\text{pA}$
		Full range	1000			1000			
$V_{ICR}$ Common-mode input voltage range	$R_S = 50\ \Omega,  V_{IO}  \leq 5\ \text{mV}$	25°C	-5 to 4	-5.3 to 4.2		-5 to 4	-5.3 to 4.2		V
		Full range	-5 to 3.5			-5 to 3.5			
$V_{OM+}$ Maximum positive peak output voltage	$I_O = -20\ \mu\text{A}$	25°C	4.98		4.98				V
		25°C	4.9	4.93	4.9	4.93			
		Full range	4.7		4.7				
		25°C	4.8	4.86	4.8	4.86			
$V_{OM-}$ Maximum negative peak output voltage	$V_{IC} = 0, I_O = 50\ \mu\text{A}$	25°C	-4.99		-4.99				V
		25°C	-4.85	-4.91	-4.85	-4.91			
	Full range	-4.85		-4.85					
	25°C	-4	-4.3	-4	-4.3				
	Full range	-3.8		-3.8					
	$A_{VD}$ Large-signal differential voltage amplification	$V_O = \pm 4\ \text{V}$	$R_L = 100\ \text{k}\Omega$	25°C	40	150	40	150	
Full range				10		10			
$R_L = 1\ \text{M}\Omega$			25°C	3000			3000		
$r_{i(d)}$ Differential input resistance		25°C	$10^{12}$			$10^{12}$			$\Omega$
$r_{i(c)}$ Common-mode input resistance		25°C	$10^{12}$			$10^{12}$			$\Omega$
$c_{i(c)}$ Common-mode input capacitance	$f = 10\ \text{kHz}, \text{ N package}$	25°C	8			8			$\text{pF}$
$z_o$ Closed-loop output impedance	$f = 25\ \text{kHz}, A_V = 10$	25°C	190			190			$\Omega$
CMRR Common-mode rejection ratio	$V_{IC} = -5\ \text{V to } 2.7\ \text{V}, V_O = 0, R_S = 50\ \Omega$	25°C	75	88	75	88			dB
		Full range	75		75				
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{DD\pm}/\Delta V_{IO}$ )	$V_{DD\pm} = \pm 2.2\ \text{V to } \pm 8\ \text{V}, V_{IC} = V_{DD}/2, \text{ No load}$	25°C	80	95	80	95			dB
		Full range	80		80				
$I_{DD}$ Supply current (four amplifiers)	$V_O = 0, \text{ No load}$	25°C	160	250	160	250			$\mu\text{A}$
		Full range	300			300			

† Full range is  $-40^\circ\text{C}$  to  $125^\circ\text{C}$ .

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,  $V_{DD\pm} = \pm 5\text{ V}$

PARAMETER	TEST CONDITIONS	$T_A$ †	TLC2254I			TLC2254AI			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain $V_O = \pm 1.9\text{ V}$ , $C_L = 100\text{ pF}$ , $R_L = 100\text{ k}\Omega$	25°C	0.07	0.12		0.07	0.12		$\text{V}/\mu\text{s}$
		Full range	0.05			0.05			
$V_n$	Equivalent input noise voltage	$f = 10\text{ Hz}$	25°C		38		38		$\text{nV}/\sqrt{\text{Hz}}$
		$f = 1\text{ kHz}$	25°C		19		19		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ Hz to }1\text{ Hz}$	25°C		0.8		0.8		$\mu\text{V}$
		$f = 0.1\text{ Hz to }10\text{ Hz}$	25°C		1.1		1.1		
$I_n$	Equivalent input noise current		25°C		0.6		0.6	$\text{fA}/\sqrt{\text{Hz}}$	
THD + N	Total harmonic distortion plus noise	$V_O = \pm 2.3\text{ V}$ , $R_L = 50\text{ k}\Omega$ , $f = 20\text{ kHz}$	$A_V = 1$	25°C	0.2%			0.2%	
			$A_V = 10$		1%				
	Gain-bandwidth product	$f = 10\text{ kHz}$ , $C_L = 100\text{ pF}$	$R_L = 50\text{ k}\Omega$	25°C	0.21			MHz	
BOM	Maximum output-swing bandwidth	$V_{O(PP)} = 4.6\text{ V}$ , $R_L = 50\text{ k}\Omega$	$A_V = 1$ , $C_L = 100\text{ pF}$	25°C	14			kHz	
$\phi_m$	Phase margin at unity gain	$R_L = 50\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	63°					
			25°C	15			15	dB	

† Full range is  $-40^\circ\text{C}$  to  $125^\circ\text{C}$ .

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

PARAMETER	TEST CONDITIONS	$T_A$ †	TLC2252Q TLC2252M			TLC2252AQ TLC2252AM			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_{DD\pm} = \pm 2.5\text{ V}$ , $V_O = 0$ , $V_{IC} = 0$ , $R_S = 50\ \Omega$	25°C	200 1500		200 850		$\mu\text{V}$		
		Full range	1750		1000				
$\alpha_{VIO}$ Temperature coefficient of input offset voltage		25°C to 125°C	0.5		0.5		$\mu\text{V}/^\circ\text{C}$		
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		$\text{pA}$		
		Full range	500		500				
$I_{IB}$ Input bias current	25°C	1		1		$\text{pA}$			
	Full range	500		500					
$V_{ICR}$ Common-mode input voltage range	$R_S = 50\ \Omega$ , $ V_{IO}  \leq 5\text{ mV}$	25°C	0 to 4	-0.3 to 4.2	0 to 4	-0.3 to 4.2	$\text{V}$		
		Full range	0 to 3.5		0 to 3.5				
$V_{OH}$ High-level output voltage	$I_{OH} = -20\ \mu\text{A}$	25°C	4.98		4.98		$\text{V}$		
	$I_{OH} = -75\ \mu\text{A}$	25°C	4.9	4.94	4.9	4.94			
	Full range	4.8		4.8					
$V_{OL}$ Low-level output voltage	$I_{OH} = -150\ \mu\text{A}$	25°C	4.8	4.88	4.8	4.88	$\text{V}$		
	$V_{IC} = 2.5\text{ V}$ , $I_{OL} = 50\ \mu\text{A}$	25°C	0.01		0.01				
		Full range	0.09 0.15		0.09 0.15				
	$V_{IC} = 2.5\text{ V}$ , $I_{OL} = 500\ \mu\text{A}$	25°C	0.01		0.01				
Full range		0.09 0.15		0.09 0.15					
AVD Large-signal differential voltage amplification	$V_{IC} = 2.5\text{ V}$ , $V_O = 1\text{ V to }4\text{ V}$	$R_L = 100\ \text{k}\Omega$ ‡	25°C	100	350	100	350	$\text{V}/\text{mV}$	
			Full range	10		10			
		$R_L = 1\ \text{M}\Omega$ ‡	25°C	1700		1700			
			Full range	1.2		1.2			
$r_{id}$ Differential input resistance		25°C	$10^{12}$		$10^{12}$		$\Omega$		
$r_{ic}$ Common-mode input resistance		25°C	$10^{12}$		$10^{12}$		$\Omega$		
$C_{ic}$ Common-mode input capacitance	$f = 10\ \text{kHz}$ , $f = 10\ \text{kHz}$	25°C	8		8		$\text{pF}$		
$Z_o$ Closed-loop output impedance	$f = 25\ \text{kHz}$ , $A_V = 10$	25°C	200		200		$\Omega$		
CMRR Common-mode rejection ratio	$V_{IC} = 0\text{ to }2.7\text{ V}$ , $V_O = 2.5\text{ V}$ , $R_S = 50\ \Omega$	25°C	70	83	70	83	$\text{dB}$		
		Full range	70		70				
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{DD}/\Delta V_{IO}$ )	$V_{DD} = 4.4\text{ V to }16\text{ V}$ , $V_{IC} = V_{DD}/2$ , No load	25°C	80	95	80	95	$\text{dB}$		
		Full range	80		80				
$I_{DD}$ Supply current	$V_O = 2.5\text{ V}$ , No load	25°C	70	125	70	125	$\mu\text{A}$		
		Full range	150		150				

† Full range is  $-40^\circ\text{C}$  to  $125^\circ\text{C}$  for Q suffix,  $-55^\circ\text{C}$  to  $125^\circ\text{C}$  for M suffix.

‡ 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	$T_A$ †	TLC2252Q TLC2252M			TLC2252AQ TLC2252AM			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain $V_O = 0.5\text{ V to }3.5\text{ V}$ , $R_L = 100\text{ k}\Omega$ ‡, $C_L = 100\text{ pF}$ ‡	25°C	0.07	0.12		0.07	0.12		V/ $\mu\text{s}$
		Full range	0.05			0.05			
$V_n$	Equivalent input noise voltage	f = 10 Hz		36			36		nV/ $\sqrt{\text{Hz}}$
		f = 1 kHz		19			19		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		0.7			0.7		$\mu\text{V}$
		f = 0.1 Hz to 10 Hz		1.1			1.1		
$I_n$	Equivalent input noise current	25°C		0.6			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 = 10 kHz, $R_L = 50\text{ k}\Omega$ ‡	$A_V = 1$		0.2%			0.2%		
		$A_V = 10$		1%			1%		
	Gain-bandwidth product	f = 50 kHz, $C_L = 100\text{ pF}$ ‡			$R_L = 50\text{ k}\Omega$ ‡,	25°C	0.2	0.2	MHz
BOM	Maximum output-swing bandwidth	$V_{O(PP)} = 2\text{ V}$ , $R_L = 50\text{ k}\Omega$ ‡,			$A_V = 1$ , $C_L = 100\text{ pF}$ ‡	25°C	30	30	kHz
$\phi_m$	Phase margin at unity gain	$R_L = 50\text{ k}\Omega$ ‡, $C_L = 100\text{ pF}$ ‡	25°C		63°			63°	
			25°C		15			15	dB

† Full range is – 40°C to 125°C for Q suffix, – 55°C to 125°C for M suffix.

‡ Referenced to 2.5 V

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

PARAMETER	TEST CONDITIONS	$T_A$ †	TLC2252Q TLC2252M			TLC2252AQ TLC2252AM			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_{IC} = 0, V_O = 0,$ $R_S = 50 \Omega$	25°C	200 1500		200 850		$\mu V$		
		Full range	1750		1000				
$\alpha_{VIO}$ Temperature coefficient of input offset voltage		25°C to 125°C	0.5		0.5		$\mu V/^\circ C$		
Input offset voltage long-term drift (see Note 4)		25°C	0.003		0.003		$\mu V/mo$		
$I_{IO}$ Input offset current		25°C	0.5		0.5		$pA$		
		Full range	500		500				
$I_{IB}$ Input bias current	25°C	1		1		$pA$			
	Full range	500		500					
$V_{ICR}$ Common-mode input voltage range	$R_S = 50 \Omega,  V_{IO}  \leq 5 mV$	25°C	-5 to 4	-5.3 to 4.2	-5 to 4	-5.3 to 4.2	V		
		Full range	-5 to 3.5		-5 to 3.5				
$V_{OM+}$ Maximum positive peak output voltage	$I_O = -20 \mu A$	25°C	4.98		4.98		V		
	$I_O = -100 \mu A$	25°C	4.9	4.93	4.9	4.93			
		Full range	4.7		4.7				
	$I_O = -200 \mu A$	25°C	4.8	4.86	4.8	4.86			
$V_{OM-}$ Maximum negative peak output voltage	$V_{IC} = 0, I_O = 50 \mu A$	25°C	-4.99		-4.99		V		
		25°C	-4.85	-4.91	-4.85	-4.91			
	Full range	-4.85		-4.85					
	$V_{IC} = 0, I_O = 500 \mu A$	25°C	-4	-4.3	-4	-4.3			
		Full range	-3.8		-3.8				
	$A_{VD}$ Large-signal differential voltage amplification	$V_O = \pm 4 V$	$R_L = 100 k\Omega$	25°C	40	150		40	150
Full range				10		10			
$R_L = 1 M\Omega$			25°C	3000		3000			
$r_{id}$ Differential input resistance		25°C	1012		1012		$\Omega$		
$r_{ic}$ Common-mode input resistance		25°C	1012		1012		$\Omega$		
$c_{ic}$ Common-mode input capacitance	f = 10 kHz, P package	25°C	8		8		pF		
$z_o$ Closed-loop output impedance	f = 25 kHz, $A_V = 10$	25°C	190		190		$\Omega$		
CMRR Common-mode rejection ratio	$V_{IC} = -5 V$ to 2.7 V, $V_O = 0, R_S = 50 \Omega$	25°C	75	88	75	88	dB		
		Full range	75		75				
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{DD\pm} / \Delta V_{IO}$ )	$V_{DD} = \pm 2.2 V$ to $\pm 8 V,$ $V_{IC} = 0,$ No load	25°C	80	95	80	95	dB		
		Full range	80		80				
$I_{DD}$ Supply current	$V_O = 2.5 V,$ No load	25°C	80	125	80	125	$\mu A$		
		Full range	150		150				

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

NOTE 4: Typical values are based on the input offset voltage shift observed through 500 hours of operating life test at  $T_A = 150^\circ C$  extrapolated to  $T_A = 25^\circ C$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.



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

PARAMETER	TEST CONDITIONS	$T_A$ †	TLC2252Q TLC2252M			TLC2252AQ TLC2252AM			UNIT	
			MIN	TYP	MAX	MIN	TYP	MAX		
SR	Slew rate at unity gain $V_O = \pm 2\text{ V}$ , $C_L = 100\text{ pF}$ , $R_L = 100\text{ k}\Omega$	25°C	0.07	0.12		0.07	0.12		V/ $\mu\text{s}$	
		Full range	0.05			0.05				
$V_n$	Equivalent input noise voltage	f = 10 Hz		38			38		nV/ $\sqrt{\text{Hz}}$	
		f = 1 kHz	25°C		19		19			
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz	25°C		0.8		0.8		$\mu\text{V}$	
		f = 0.1 Hz to 10 Hz	25°C		1.1		1.1			
$I_n$	Equivalent input noise current	25°C		0.6		0.6		fA/ $\sqrt{\text{Hz}}$		
THD + N	Total harmonic distortion plus noise $V_O = \pm 2.3\text{ V}$ , $R_L = 50\text{ k}\Omega$ , f = 10 kHz	$A_V = 1$	25°C	0.2%			0.2%			
		$A_V = 10$		1%			1%			
	Gain-bandwidth product	f = 10 kHz, $C_L = 100\text{ pF}$ , $R_L = 50\text{ k}\Omega$	25°C	0.21			0.21			MHz
BOM	Maximum output-swing bandwidth	$V_{O(PP)} = 4.6\text{ V}$ , $R_L = 50\text{ k}\Omega$ , $A_V = 1$ , $C_L = 100\text{ pF}$	25°C	14			14			kHz
$\phi_m$	Phase margin at unity gain	$R_L = 50\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	63°			63°			
	Gain margin		25°C	15			15			dB

† Full range is – 40°C to 125°C for Q suffix, – 55°C to 125°C for M suffix.

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

PARAMETER	TEST CONDITIONS	$T_A$ †	TLC2254Q TLC2254M			TLC2254AQ TLC2254AM			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_{DD\pm} = \pm 2.5\text{ V}$ , $V_{IC} = 0$ , $V_O = 0$ , $R_S = 50\ \Omega$	25°C	200		1500	200		850	$\mu\text{V}$
		Full range	1750			1000			
$\alpha_{V_{IO}}$ Temperature coefficient of input offset voltage		25°C to 125°C	0.5			0.5			$\mu\text{V}/^\circ\text{C}$
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			$\text{pA}$
		125°C	500			500			
$I_{IB}$ Input bias current	25°C	1			1			$\text{pA}$	
	125°C	500			500				
$V_{ICR}$ Common-mode input voltage range	$R_S = 50\ \Omega$ , $ V_{IO}  \leq 5\text{ mV}$	25°C	0 to 4	-0.3 to 4.2		0 to 4	-0.3 to 4.2	$\text{V}$	
		Full range	0 to 3.5		0 to 3.5				
$V_{OH}$ High-level output voltage	$I_{OH} = -20\ \mu\text{A}$	25°C	4.98		4.98		$\text{V}$		
		25°C	4.9	4.94	4.9	4.94			
		Full range	4.8		4.8				
$V_{OL}$ Low-level output voltage	$V_{IC} = 2.5\text{ V}$ , $I_{OL} = 50\ \mu\text{A}$	25°C	0.01		0.01		$\text{V}$		
		25°C	0.09	0.15	0.09	0.15			
		Full range	0.15		0.15				
		25°C	0.8	1	0.7	1			
		Full range	1.2		1.2				
$A_{VD}$ Large-signal differential voltage amplification	$V_{IC} = 2.5\text{ V}$ , $V_O = 1\text{ V to }4\text{ V}$	25°C	$R_L = 100\ \text{k}\Omega$ ‡		100		350	$\text{V}/\text{mV}$	
			$R_L = 1\ \text{M}\Omega$ ‡		10		10		
		Full range	1700		1700				
$r_{i(d)}$ Differential input resistance		25°C	10 <sup>12</sup>		10 <sup>12</sup>		$\Omega$		
$r_{i(c)}$ Common-mode input resistance		25°C	10 <sup>12</sup>		10 <sup>12</sup>		$\Omega$		
$C_{i(c)}$ Common-mode input capacitance	$f = 10\text{ kHz}$ , N package	25°C	8		8		$\text{pF}$		
$z_o$ Closed-loop output impedance	$f = 25\text{ kHz}$ , $A_V = 10$	25°C	200		200		$\Omega$		
CMRR Common-mode rejection ratio	$V_{IC} = 0\text{ to }2.7\text{ V}$ , $V_O = 2.5\text{ V}$ , $R_S = 50\ \Omega$	25°C	70	83	70	83	$\text{dB}$		
		Full range	70		70				
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{DD}/\Delta V_{IO}$ )	$V_{DD} = 4.4\text{ V to }16\text{ V}$ , $V_{IC} = V_{DD}/2$ , No load	25°C	80	95	80	95	$\text{dB}$		
		Full range	80		80				
$I_{DD}$ Supply current (four amplifiers)	$V_O = 2.5\text{ V}$ , No load	25°C	140	250	140	250	$\mu\text{A}$		
		Full range	300		300				

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

‡ 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	$T_A$ †	TLC2254Q TLC2254M			TLC2254AQ TLC2254AM			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain $V_O = 0.5\text{ V to }3.5\text{ V}$ , $R_L = 100\text{ k}\Omega^\ddagger$ , $C_L = 100\text{ pF}^\ddagger$	25°C	0.07	0.12		0.07	0.12		V/ $\mu\text{s}$
		Full range	0.05			0.05			
$V_n$	Equivalent input noise voltage $f = 10\text{ Hz}$	25°C		36			36		nV/ $\sqrt{\text{Hz}}$
		25°C		19			19		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage $f = 0.1\text{ Hz to }1\text{ Hz}$	25°C		0.7			0.7		$\mu\text{V}$
		25°C		1.1			1.1		
$I_n$	Equivalent input noise current	25°C		0.6			0.6		fA/ $\sqrt{\text{Hz}}$
THD + N	Total harmonic distortion plus noise $V_O = 0.5\text{ V to }2.5\text{ V}$ , $f = 20\text{ kHz}$ , $R_L = 50\text{ k}\Omega^\ddagger$	$A_V = 1$	25°C		0.2%			0.2%	
		$A_V = 10$			1%			1%	
	Gain-bandwidth product $f = 50\text{ kHz}$ , $C_L = 100\text{ pF}^\ddagger$	$R_L = 50\text{ k}\Omega^\ddagger$	25°C		0.2			0.2	MHz
BOM	Maximum output-swing bandwidth $V_{O(PP)} = 2\text{ V}$ , $R_L = 50\text{ k}\Omega^\ddagger$	$A_V = 1$ , $C_L = 100\text{ pF}^\ddagger$	25°C		30			30	kHz
$\phi_m$	Phase margin at unity gain $R_L = 50\text{ k}\Omega^\ddagger$	$C_L = 100\text{ pF}^\ddagger$	25°C		63°			63°	
	Gain margin		25°C		15			15	dB

† Full range is – 40°C to 125°C for Q suffix, – 55°C to 125°C for M suffix.

‡ Referenced to 2.5 V

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

PARAMETER	TEST CONDITIONS	$T_A$ †	TLC2254Q TLC2254M			TLC2254AQ TLC2254AM			UNIT	
			MIN	TYP	MAX	MIN	TYP	MAX		
$V_{IO}$ Input offset voltage		25°C	200	1500		200	850	$\mu$ V		
		Full range		1750		1000				
$\alpha_{VIO}$ Temperature coefficient of input offset voltage		25°C to 125°C	0.5			0.5			$\mu$ V/°C	
Input offset voltage long-term drift (see Note 4)	$V_{IC} = 0, V_O = 0, R_S = 50 \Omega$	25°C	0.003			0.003			$\mu$ V/mo	
$I_{IO}$ Input offset current		25°C	0.5			0.5			pA	
		125°C		500		500				
$I_{IB}$ Input bias current		25°C	1			1			pA	
		125°C		500		500				
$V_{ICR}$ Common-mode input voltage range	$R_S = 50 \Omega,  V_{IO}  \leq 5$ mV	25°C	-5 to 4	-5.3 to 4.2		-5 to 4	-5.3 to 4.2	V		
		Full range	-5 to 3.5			-5 to 3.5				
$V_{OM+}$ Maximum positive peak output voltage	$I_O = -20 \mu$ A	25°C	4.98			4.98			V	
	$I_O = -100 \mu$ A	25°C	4.9	4.93		4.9	4.93			
		Full range	4.7			4.7				
	$I_O = -200 \mu$ A	25°C	4.8	4.86		4.8	4.86			
$V_{OM-}$ Maximum negative peak output voltage	$V_{IC} = 0, I_O = 50 \mu$ A	25°C	-4.99			-4.99			V	
	$V_{IC} = 0, I_O = 500 \mu$ A	25°C	-4.85	-4.91		-4.85	-4.91			
		Full range	-4.85			-4.85				
	$V_{IC} = 0, I_O = 4$ mA	25°C	-4	-4.3		-4	-4.3			
$A_{VD}$ Large-signal differential voltage amplification	$V_O = \pm 4$ V	$R_L = 100$ k $\Omega$	25°C	40	150		40	150	V/mV	
			Full range	10			10			
		$R_L = 1$ M $\Omega$	25°C	3000			3000			
$r_{i(d)}$ Differential input resistance		25°C	$10^{12}$			$10^{12}$			$\Omega$	
$r_{i(c)}$ Common-mode input resistance		25°C	$10^{12}$			$10^{12}$			$\Omega$	
$c_{i(c)}$ Common-mode input capacitance	f = 10 kHz, N package	25°C	8			8			pF	
$z_o$ Closed-loop output impedance	f = 25 kHz, $A_V = 10$	25°C	190			190			$\Omega$	
CMRR Common-mode rejection ratio	$V_{IC} = -5$ V to 2.7 V, $V_O = 0, R_S = 50 \Omega$	25°C	75	88		75	88	dB		
		Full range	75			75				
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{DD\pm}/\Delta V_{IO}$ )	$V_{DD\pm} = \pm 2.2$ V to $\pm 8$ V, $V_{IC} = V_{DD}/2$ , No load	25°C	80	95		80	95	dB		
		Full range	80			80				
$I_{DD}$ Supply current (four amplifiers)	$V_O = 0, \text{ No load}$	25°C	160	250		160	250	$\mu$ A		
		Full range	300			300				

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

NOTE 4: Typical values are based on the input offset voltage shift observed through 500 hours of operating life test at  $T_A = 150^\circ$ C extrapolated to  $T_A = 25^\circ$ 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,  $V_{DD\pm} = \pm 5\text{ V}$

PARAMETER	TEST CONDITIONS		$T_A$ †	TLC2254Q TLC2254M			TLC2254AQ TLC2254AM			UNIT	
				MIN	TYP	MAX	MIN	TYP	MAX		
SR	Slew rate at unity gain	$V_O = \pm 2\text{ V}$ , $C_L = 100\text{ pF}$	$R_L = 100\text{ k}\Omega$	25°C	0.07	0.12		0.07	0.12	V/ $\mu\text{s}$	
				Full range	0.05			0.05			
$V_n$	Equivalent input noise voltage			25°C	38			38			nV/ $\sqrt{\text{Hz}}$
				25°C	19			19			
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage			25°C	0.8			0.8			$\mu\text{V}$
				25°C	1.1			1.1			
$I_n$	Equivalent input noise current			25°C	0.6			0.6			fA/ $\sqrt{\text{Hz}}$
THD + N	Total harmonic distortion plus noise	$V_O = \pm 2.3\text{ V}$ , $R_L = 50\text{ k}\Omega$ , $f = 20\text{ kHz}$	$A_V = 1$	25°C	0.2%			0.2%			
					$A_V = 10$	1%			1%		
	Gain-bandwidth product	$f = 10\text{ kHz}$ , $C_L = 100\text{ pF}$	$R_L = 50\text{ k}\Omega$	25°C	0.21			0.21			MHz
BOM	Maximum output-swing bandwidth	$V_{O(PP)} = 4.6\text{ V}$ , $R_L = 50\text{ k}\Omega$	$A_V = 1$ , $C_L = 100\text{ pF}$	25°C	14			14			kHz
$\phi_m$	Phase margin at unity gain	$R_L = 50\text{ k}\Omega$	$C_L = 100\text{ pF}$	25°C	63°			63°			
	Gain margin			25°C	15			15			

† Full range is – 40°C to 125°C for Q suffix, – 55°C to 125°C for M suffix.

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**TYPICAL CHARACTERISTICS**

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CMRR	Common-mode rejection ratio	vs Frequency	32
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TYPICAL CHARACTERISTICS

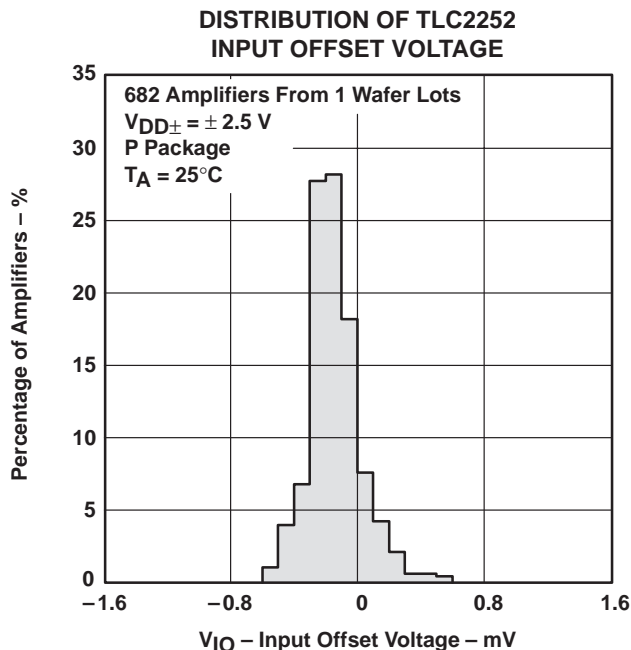


Figure 2

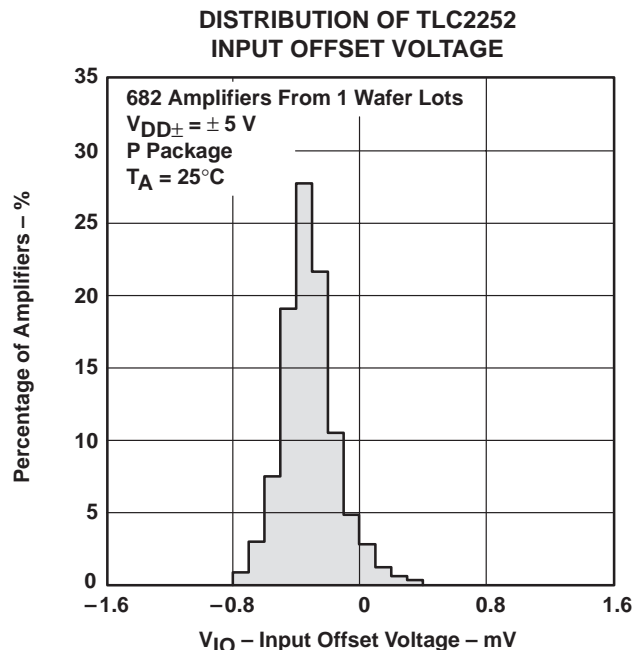


Figure 3

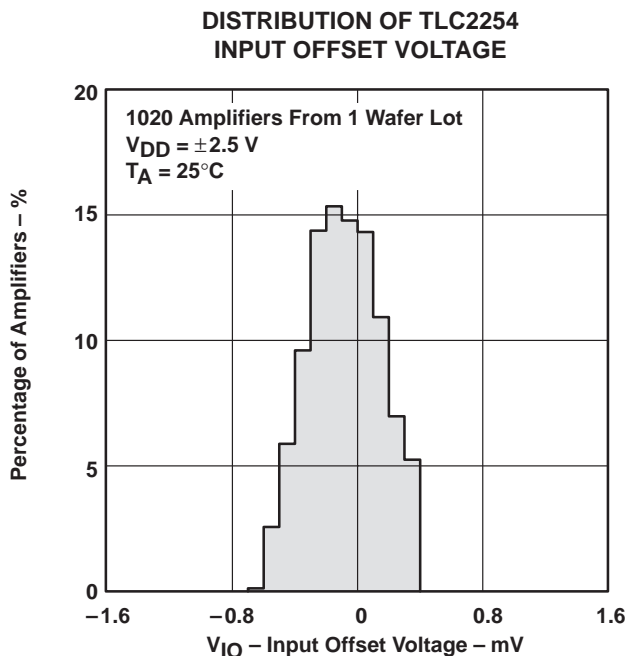


Figure 4

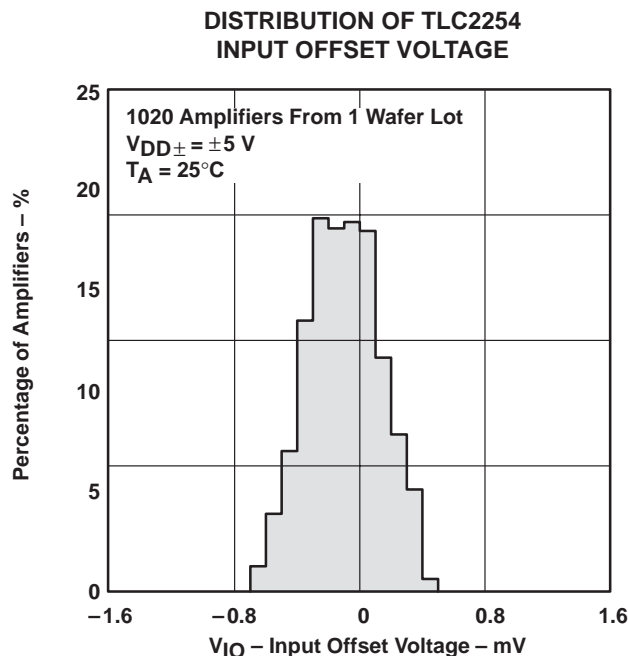


Figure 5

TYPICAL CHARACTERISTICS

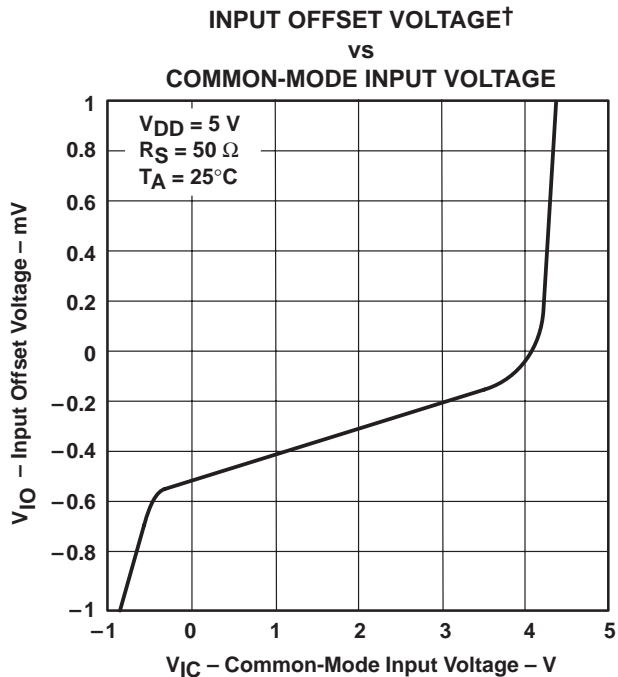


Figure 6

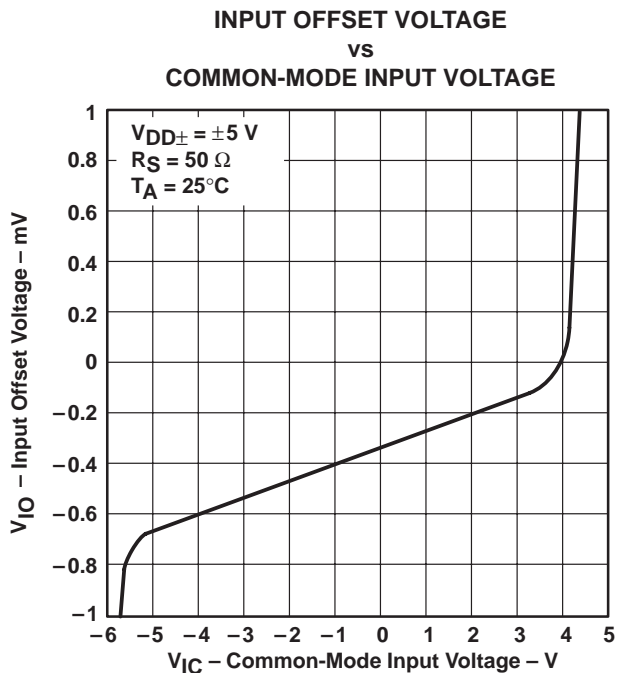


Figure 7

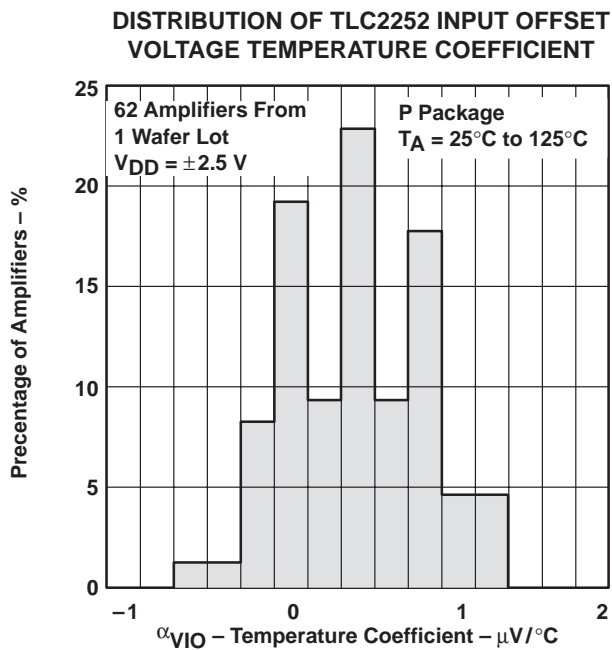


Figure 8

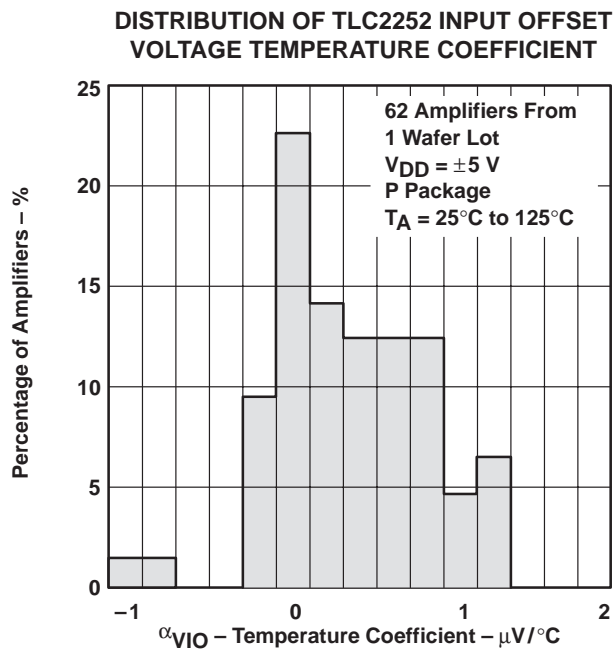


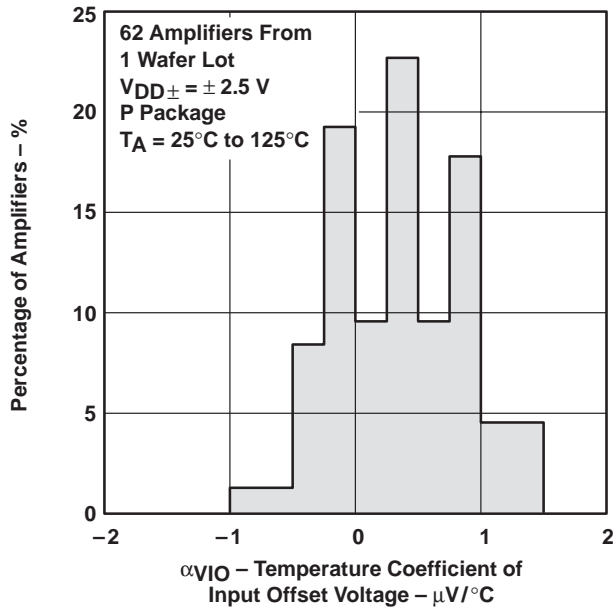
Figure 9

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



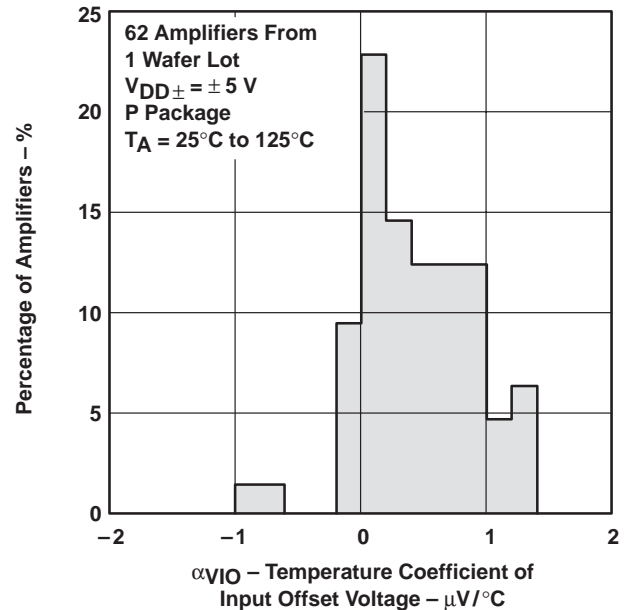
**TYPICAL CHARACTERISTICS**

**DISTRIBUTION OF TLC2254 INPUT OFFSET VOLTAGE TEMPERATURE COEFFICIENT**



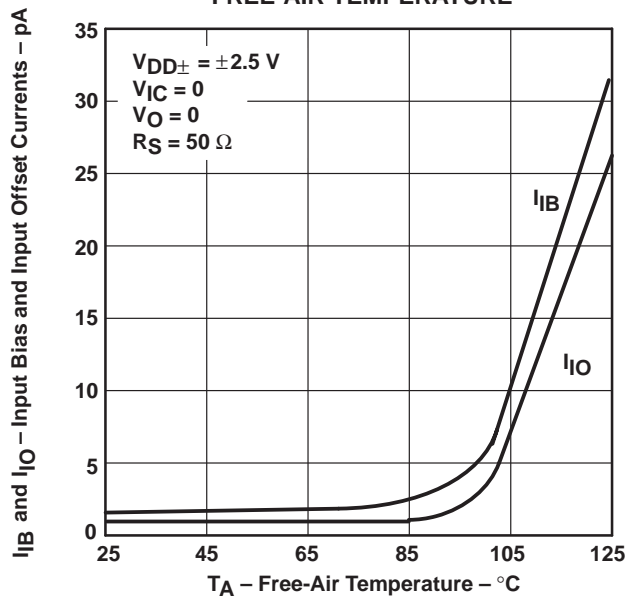
**Figure 10**

**DISTRIBUTION OF TLC2254 INPUT OFFSET VOLTAGE TEMPERATURE COEFFICIENT**



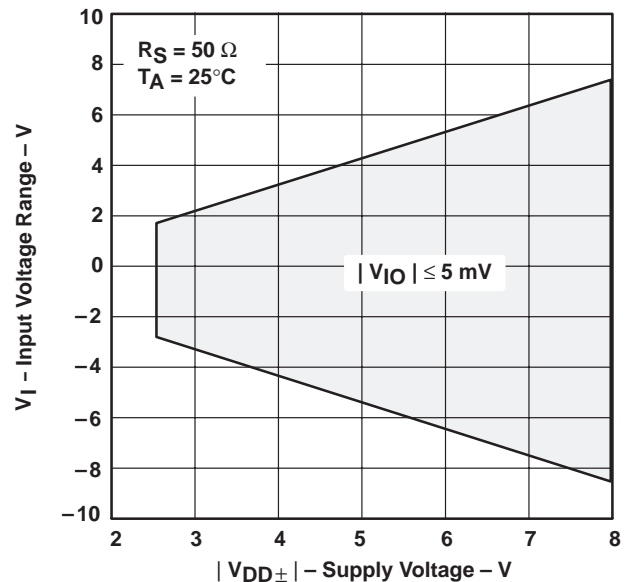
**Figure 11**

**INPUT BIAS AND INPUT OFFSET CURRENTS†  
vs  
FREE-AIR TEMPERATURE**



**Figure 12**

**INPUT VOLTAGE RANGE  
vs  
SUPPLY VOLTAGE**



**Figure 13**

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS

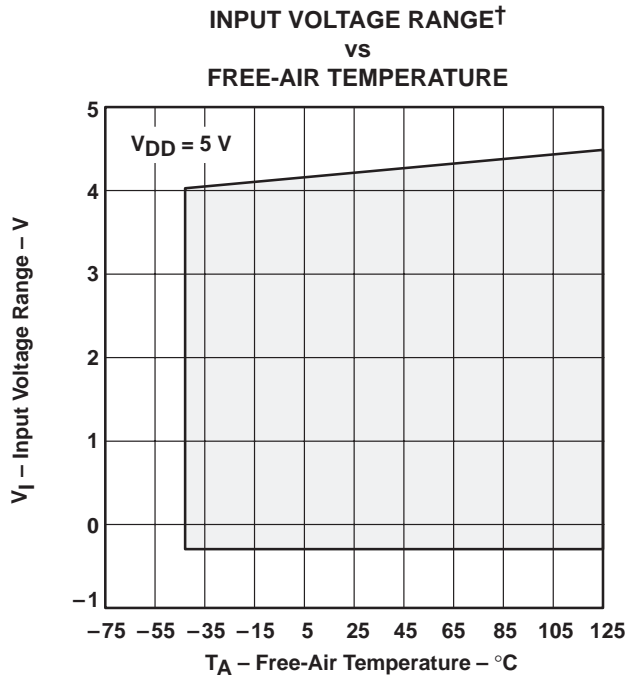


Figure 14

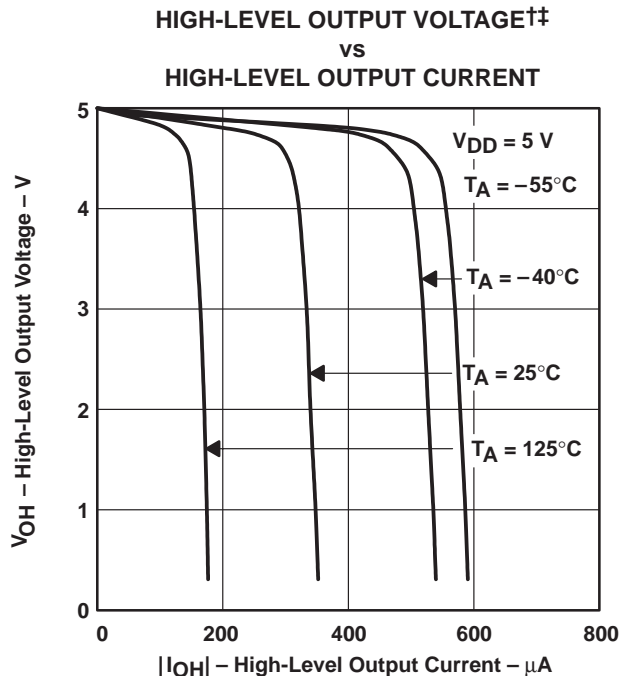


Figure 15

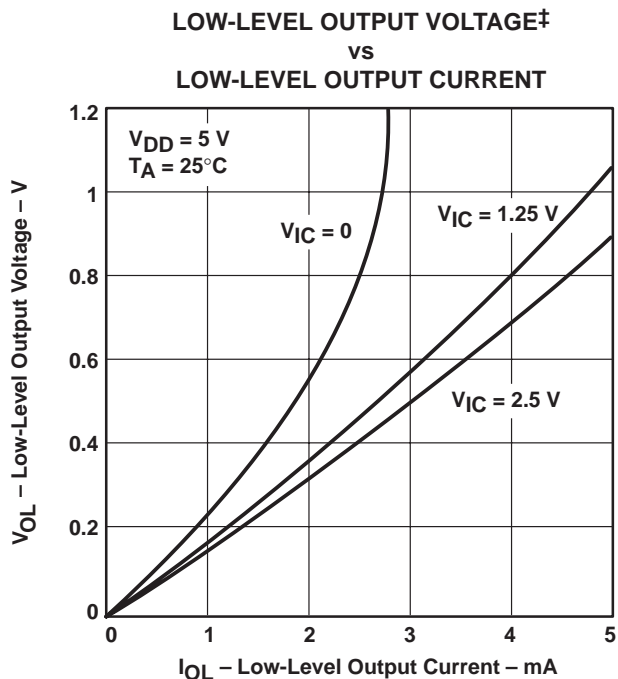


Figure 16

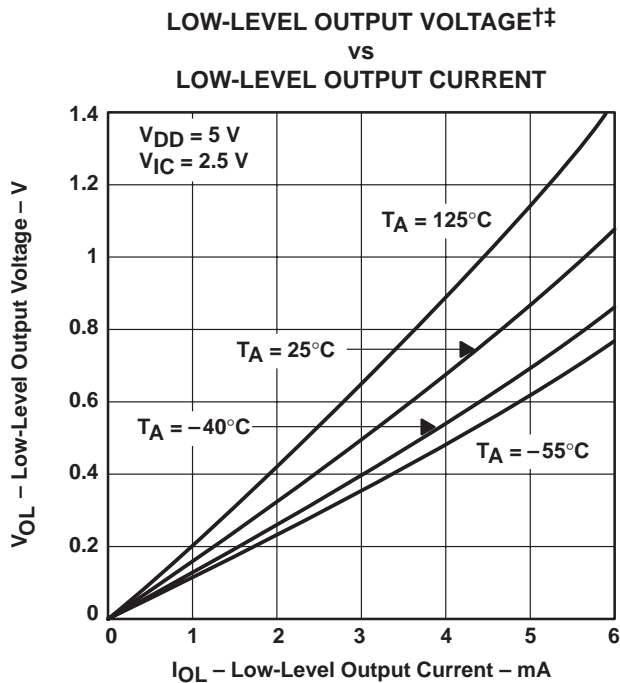
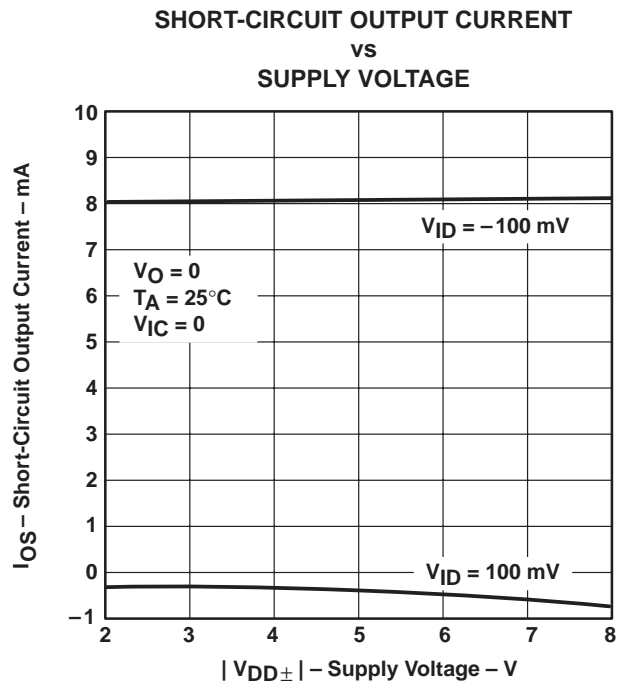
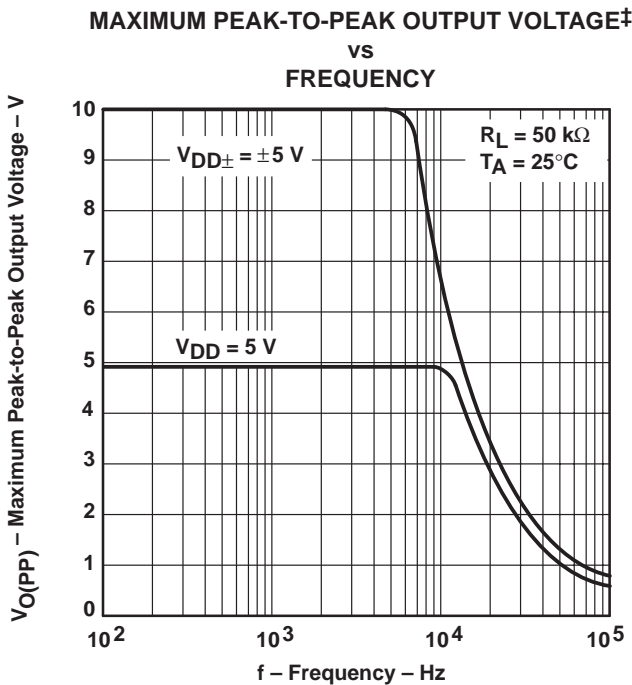
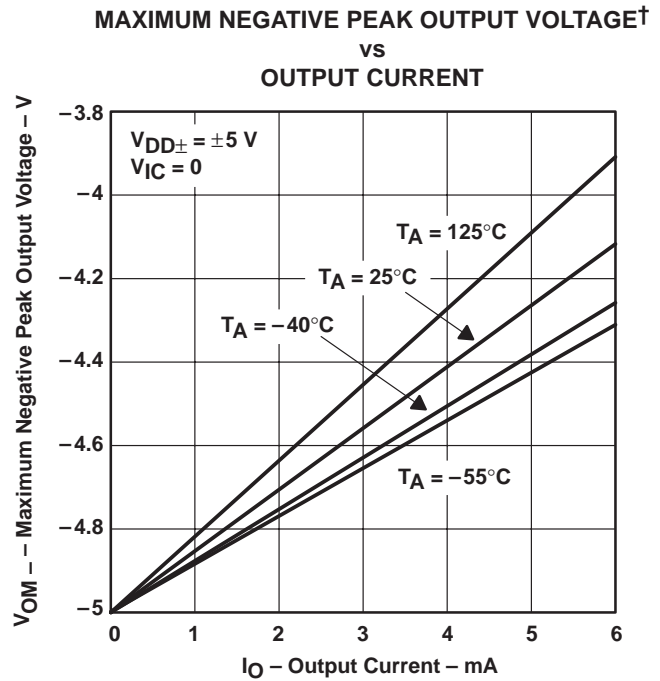
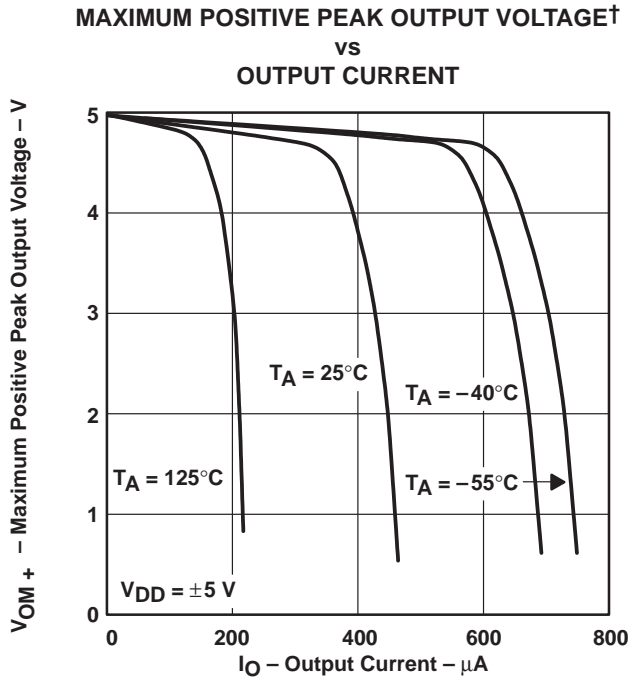


Figure 17

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.  
 ‡ For curves where  $V_{DD} = 5\text{ V}$ , all loads are referenced to 2.5 V.

**TYPICAL CHARACTERISTICS**



† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.  
 ‡ For curves where  $V_{DD} = 5\text{ V}$ , all loads are referenced to 2.5 V.

TYPICAL CHARACTERISTICS

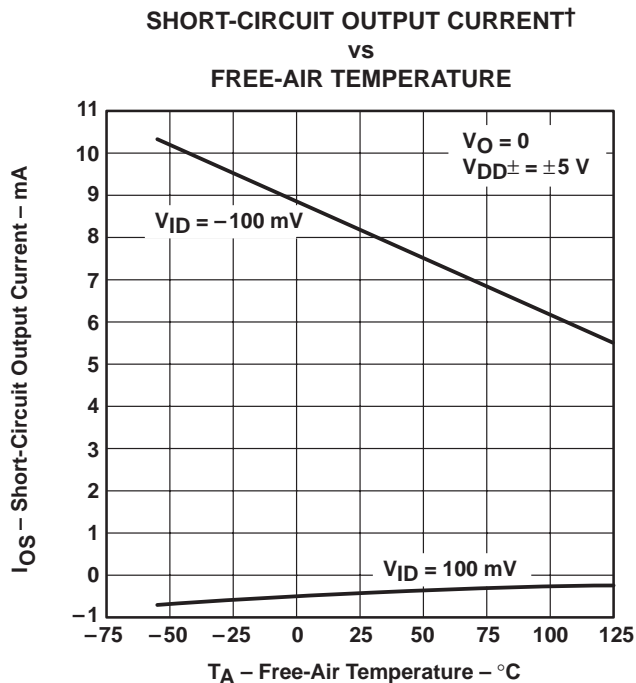


Figure 22

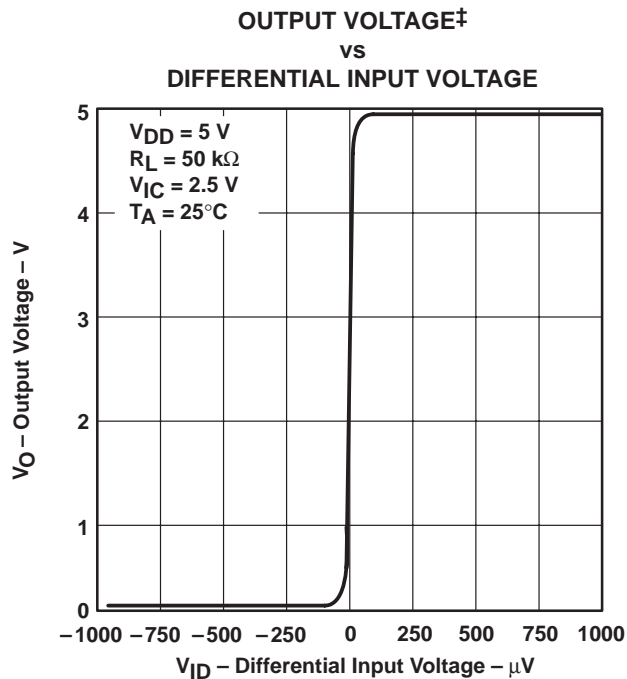


Figure 23

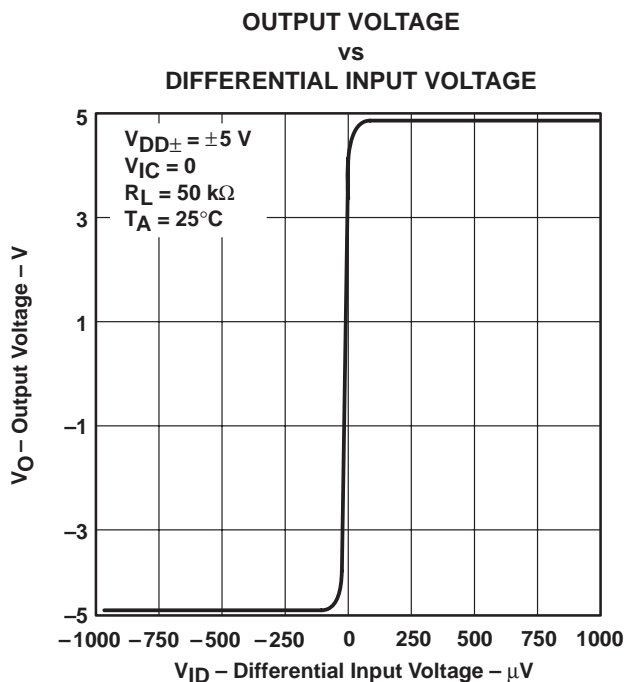


Figure 24

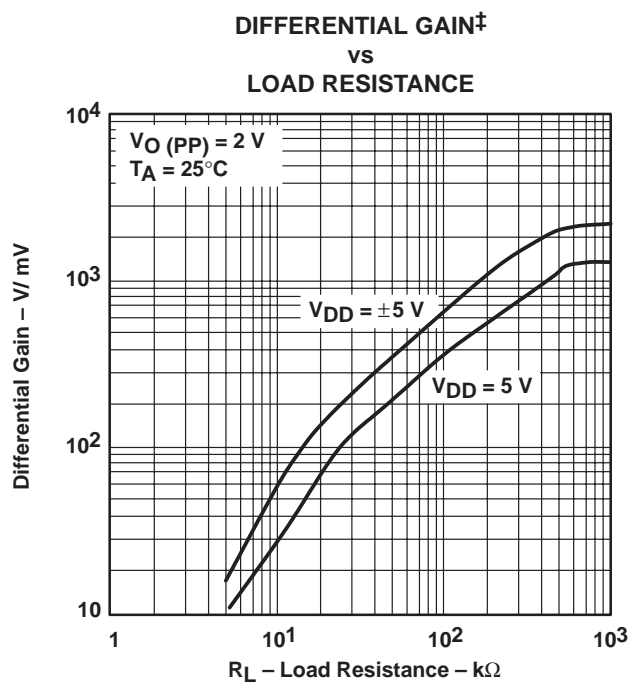
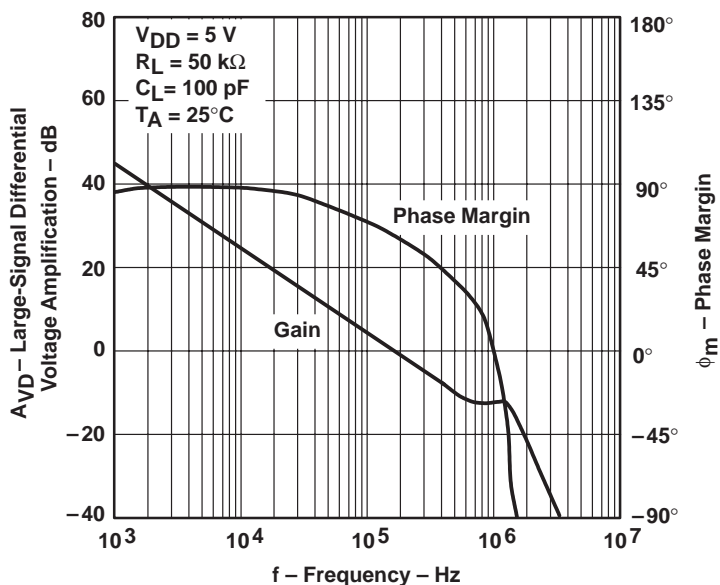


Figure 25

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.  
 ‡ For curves where  $V_{DD} = 5 \text{ V}$ , all loads are referenced to 2.5 V.

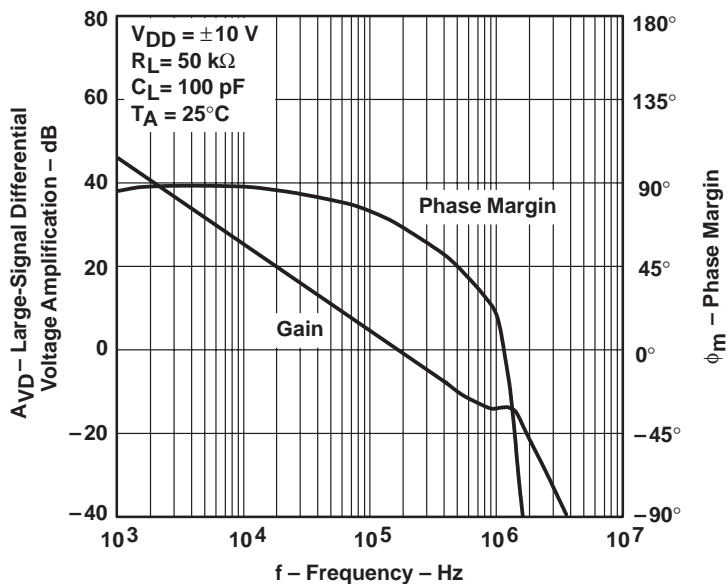
**TYPICAL CHARACTERISTICS**

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



**Figure 26**

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

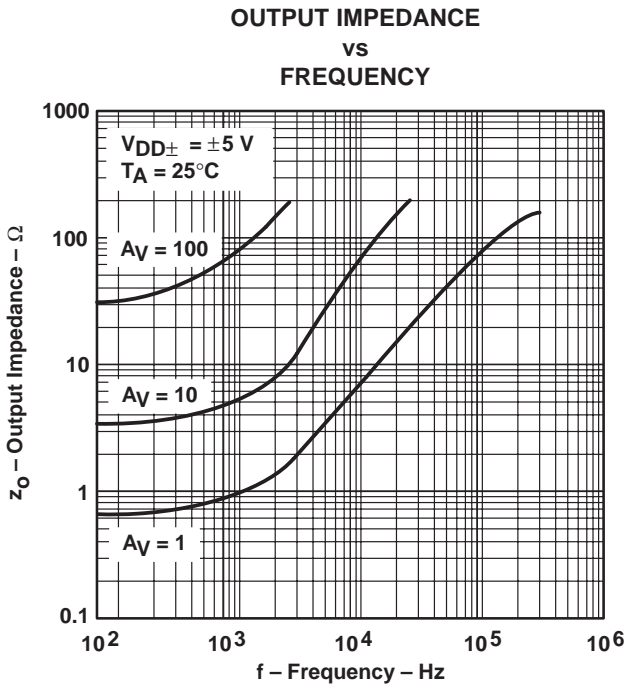
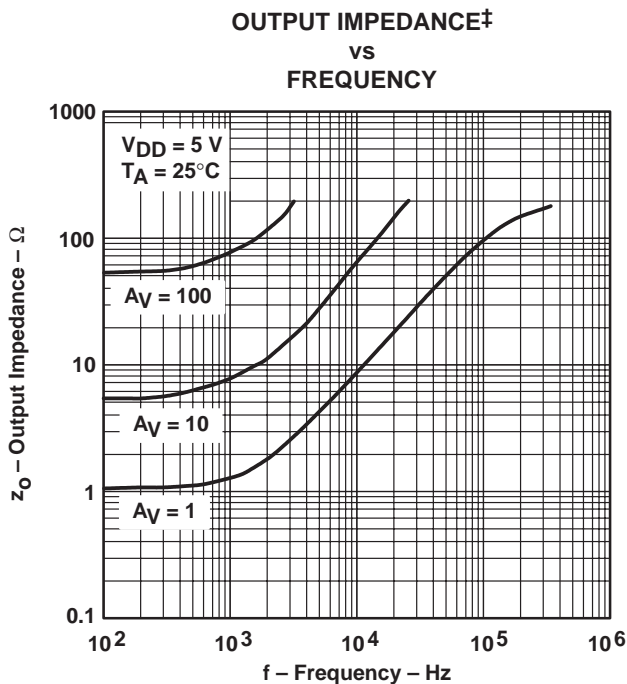
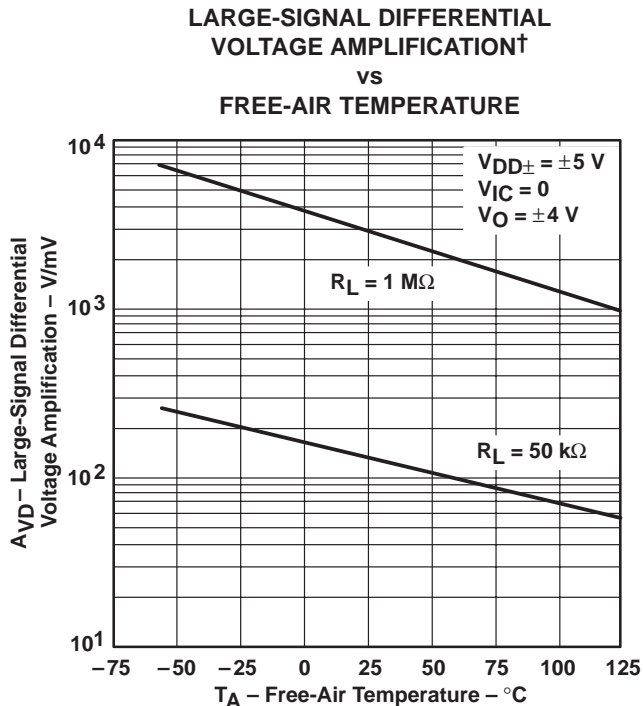
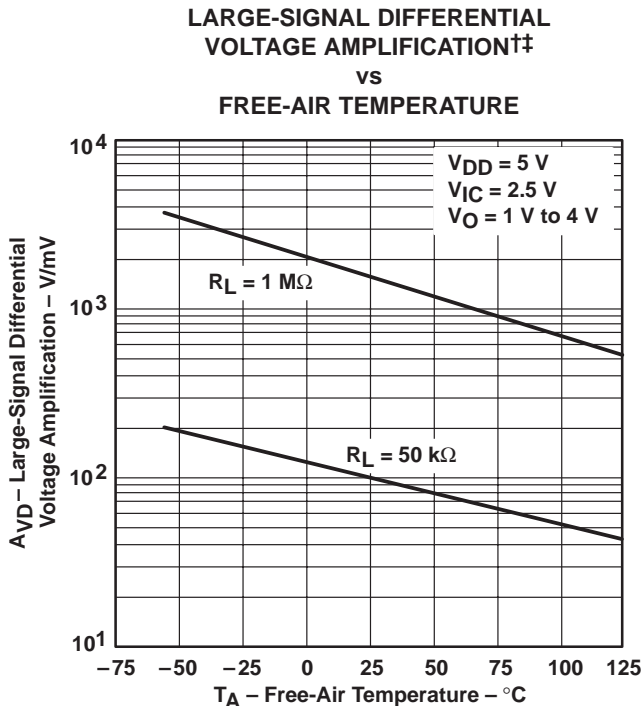


**Figure 27**

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

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TYPICAL CHARACTERISTICS



† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.  
 ‡ For curves where  $V_{DD} = 5\text{ V}$ , all loads are referenced to 2.5 V.

**TYPICAL CHARACTERISTICS**

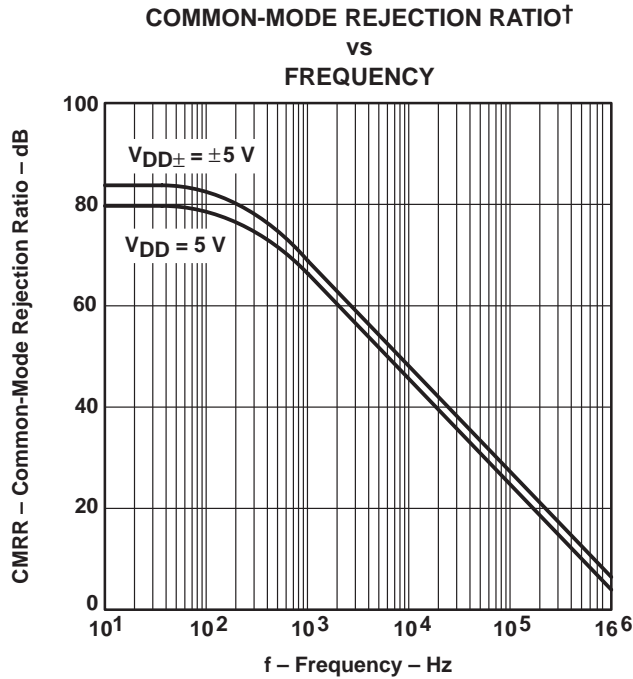


Figure 32

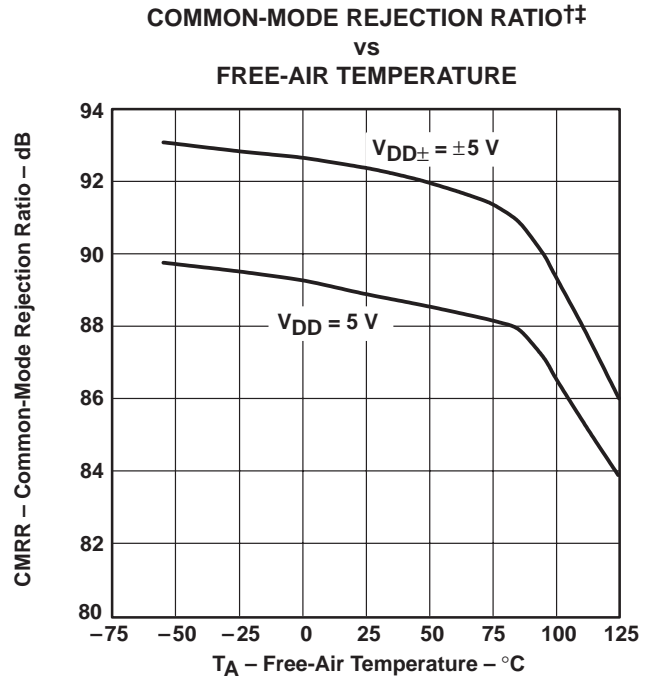


Figure 33

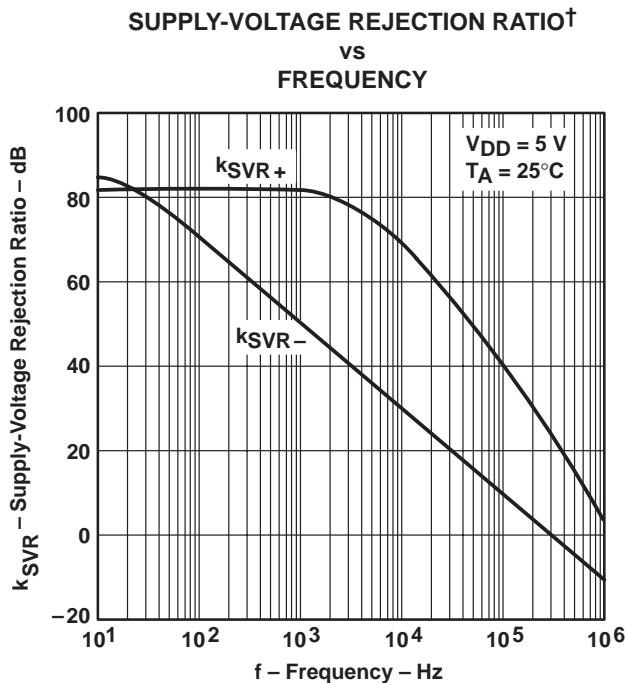


Figure 34

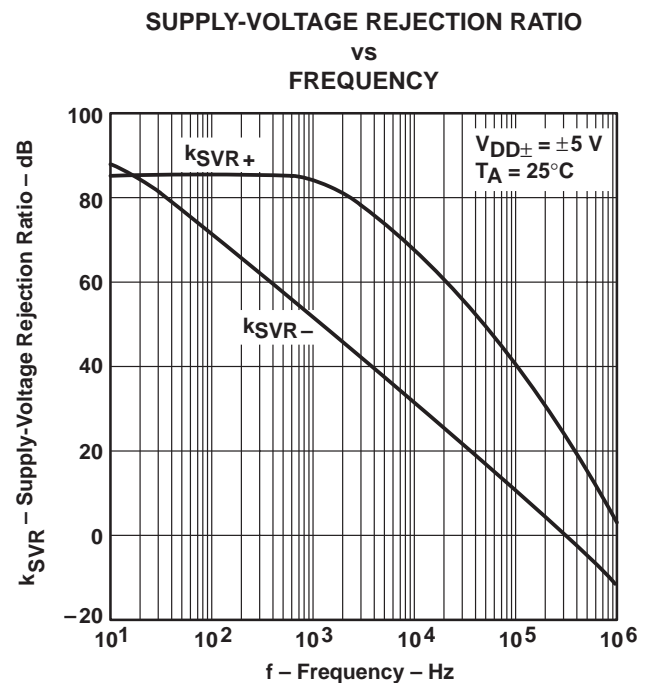


Figure 35

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

†† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

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TYPICAL CHARACTERISTICS

SUPPLY-VOLTAGE REJECTION RATIO†  
 vs  
 FREE-AIR TEMPERATURE

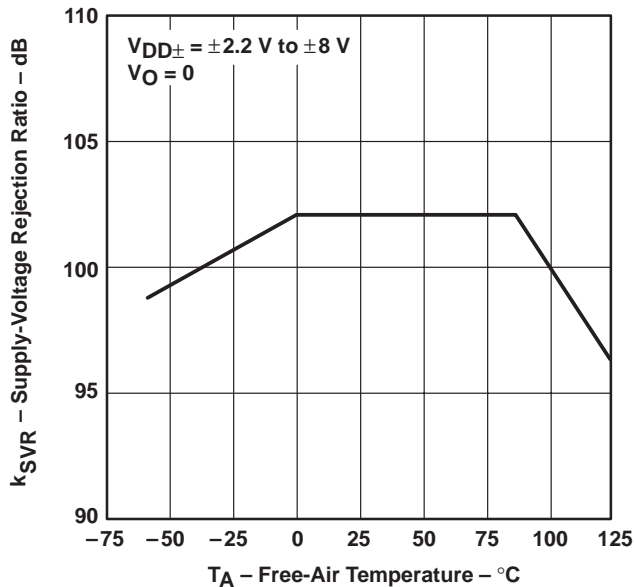


Figure 36

SUPPLY CURRENT†  
 vs  
 SUPPLY VOLTAGE

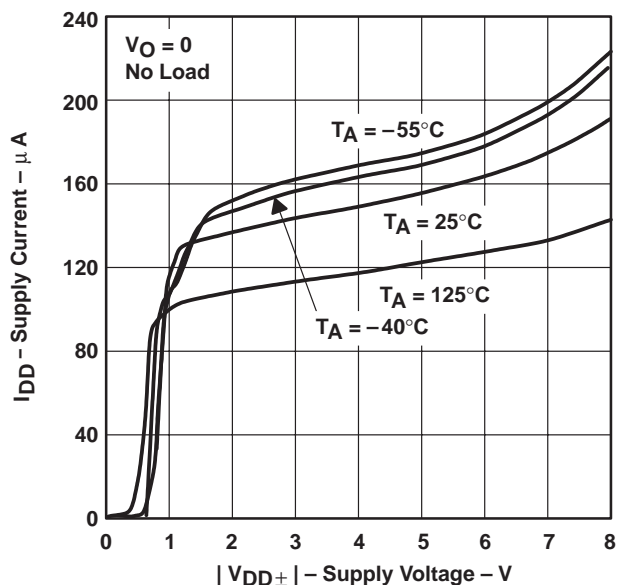


Figure 37

SUPPLY CURRENT†‡  
 vs  
 FREE-AIR TEMPERATURE

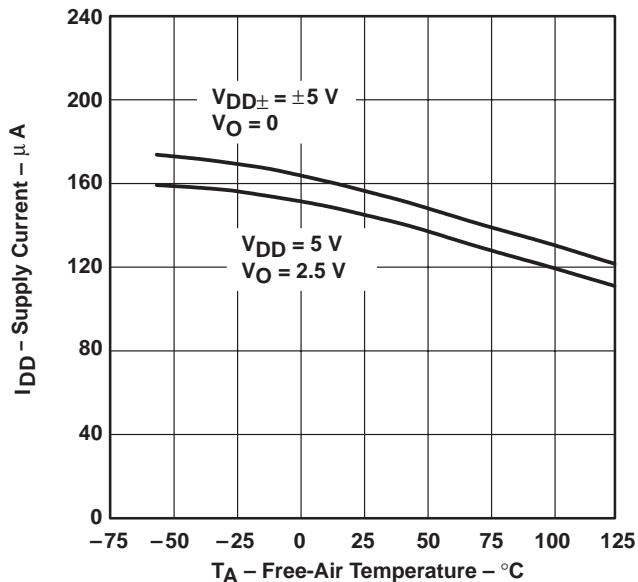


Figure 38

SLEW RATE‡  
 vs  
 LOAD CAPACITANCE

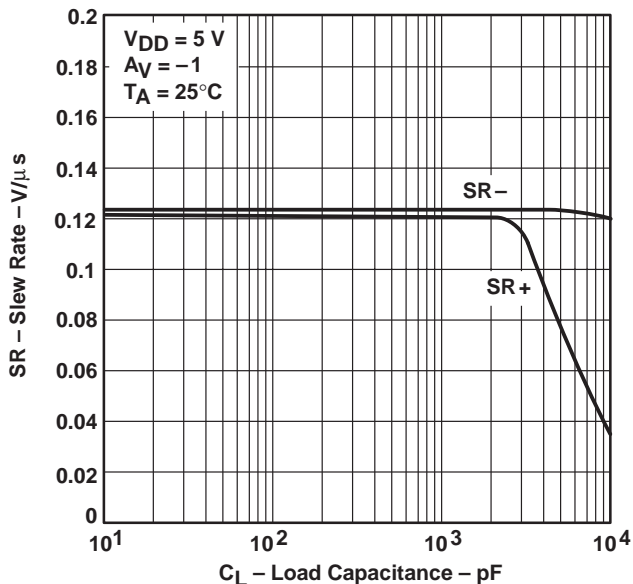
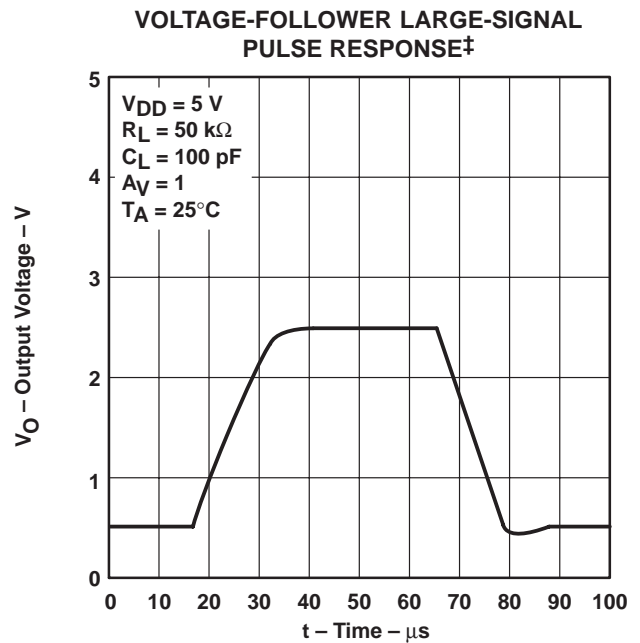
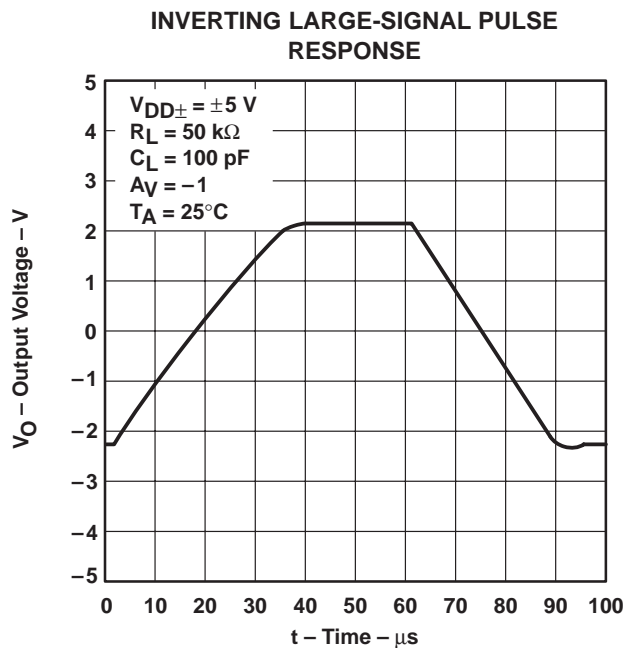
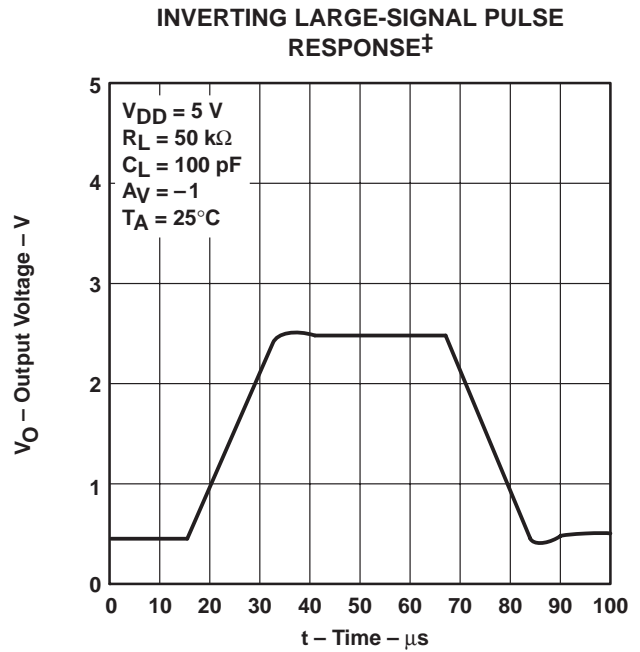
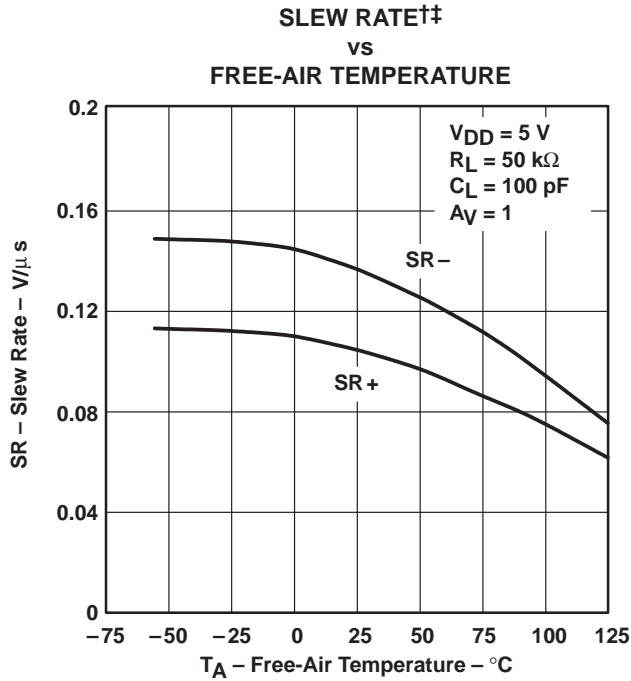


Figure 39

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.  
 ‡ For curves where  $V_{DD} = 5\text{ V}$ , all loads are referenced to 2.5 V.



**TYPICAL CHARACTERISTICS**



† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.  
 ‡ For curves where  $V_{DD} = 5\text{ V}$ , all loads are referenced to 2.5 V.

TYPICAL CHARACTERISTICS

VOLTAGE-FOLLOWER LARGE-SIGNAL PULSE RESPONSE

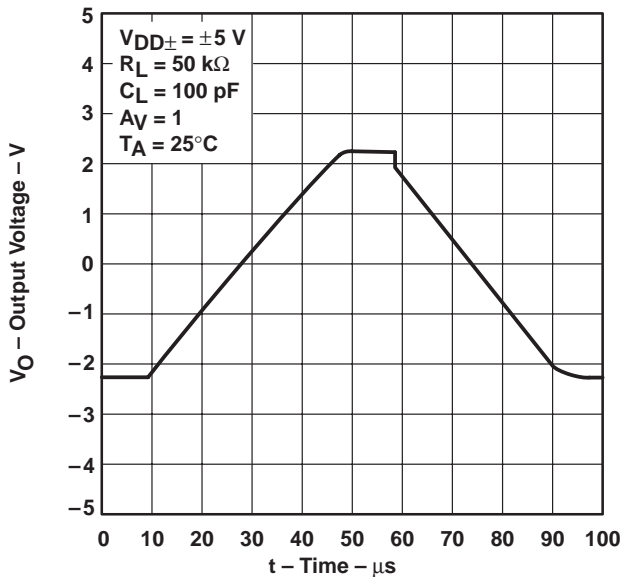


Figure 44

INVERTING SMALL-SIGNAL PULSE RESPONSE†

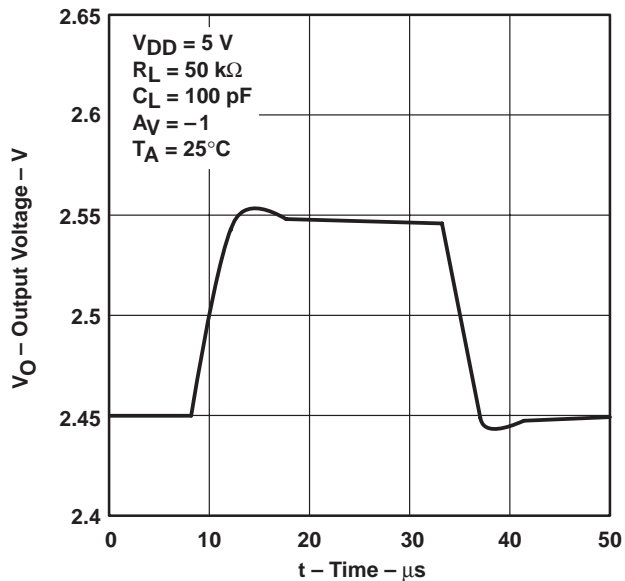


Figure 45

INVERTING SMALL-SIGNAL PULSE RESPONSE

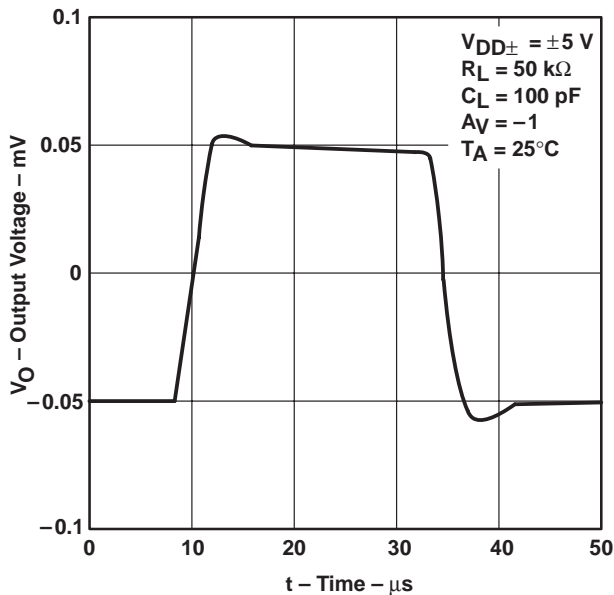


Figure 46

VOLTAGE-FOLLOWER SMALL-SIGNAL PULSE RESPONSE†

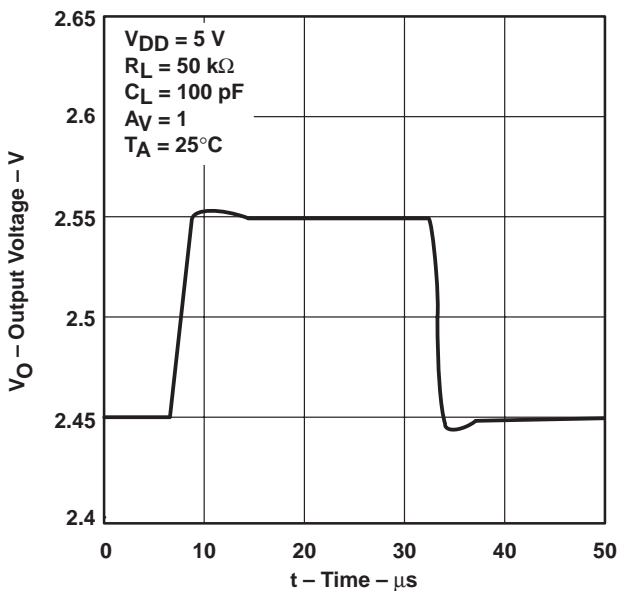


Figure 47

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

TYPICAL CHARACTERISTICS

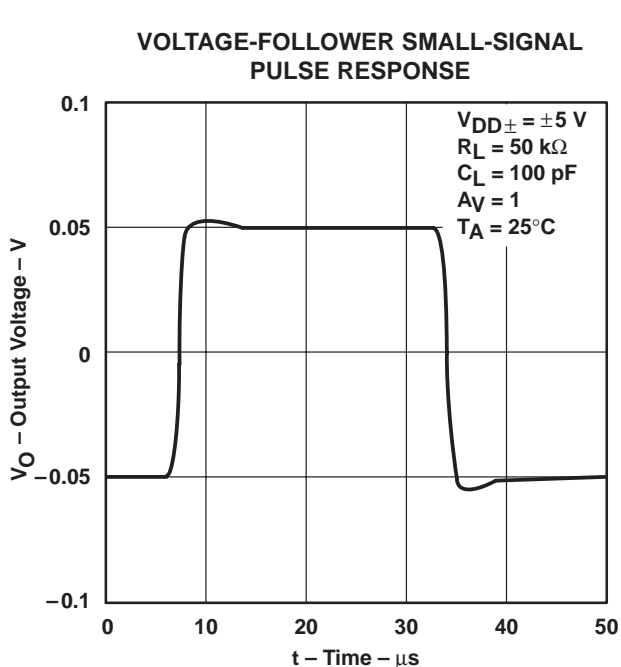


Figure 48

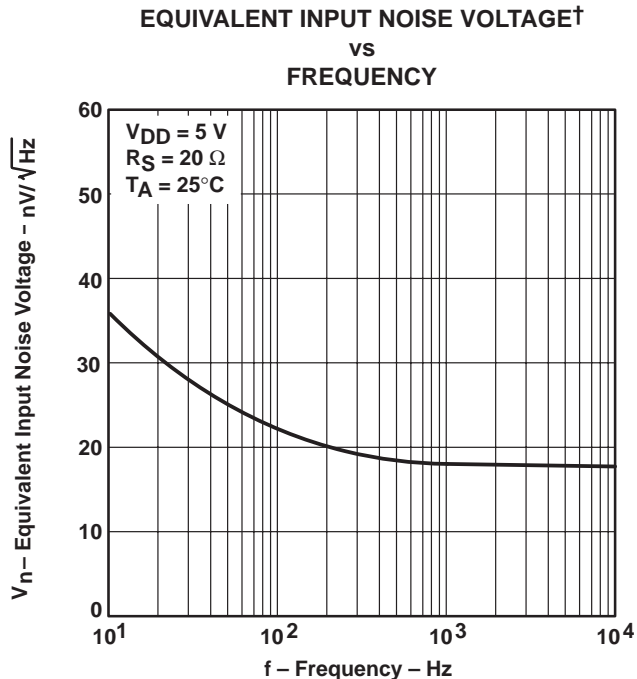


Figure 49

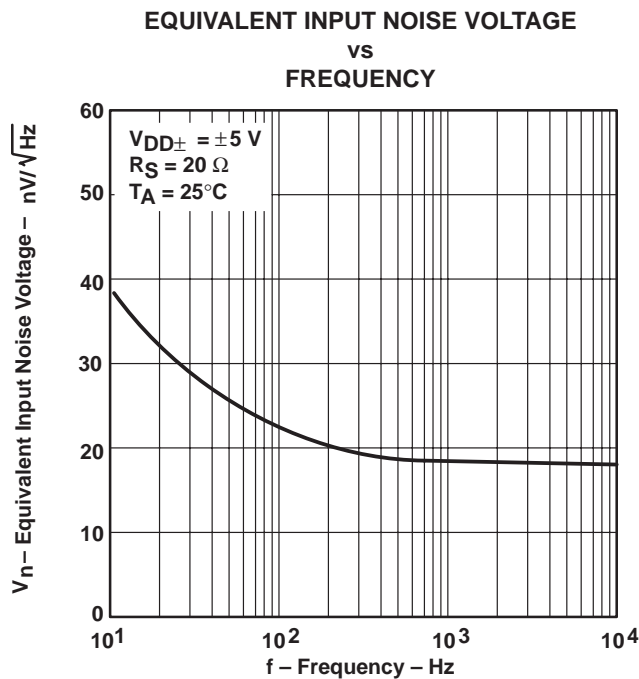


Figure 50

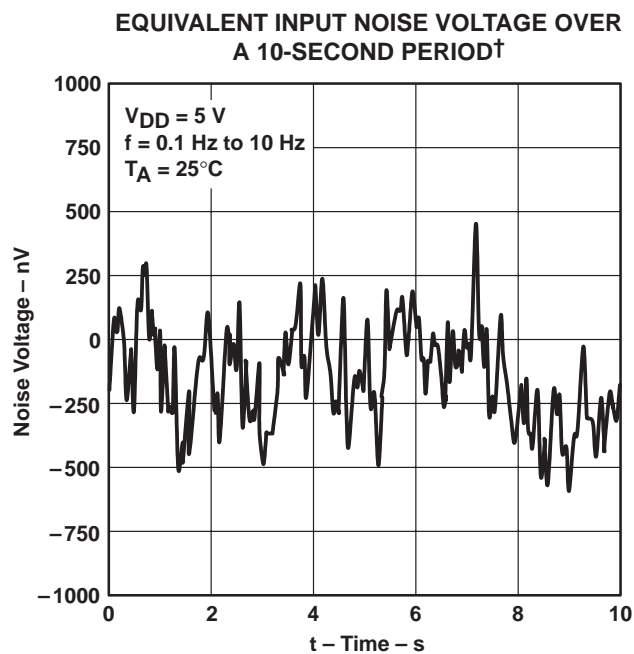


Figure 51

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

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TYPICAL CHARACTERISTICS

INTEGRATED NOISE VOLTAGE  
 vs  
 FREQUENCY

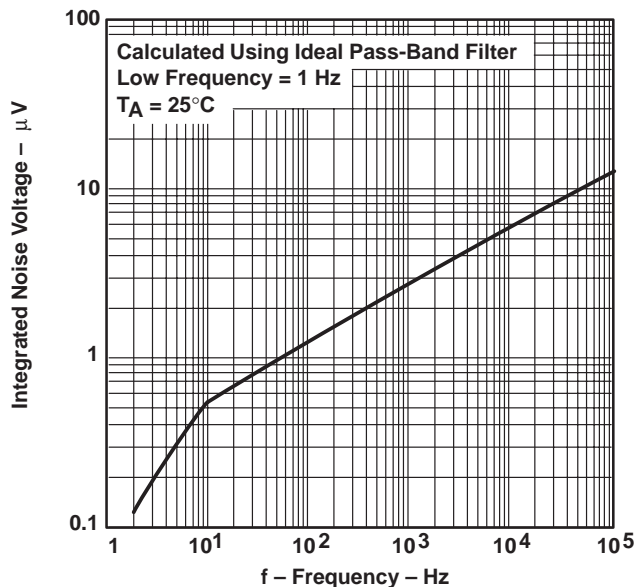


Figure 52

TOTAL HARMONIC DISTORTION PLUS NOISE†  
 vs  
 FREQUENCY

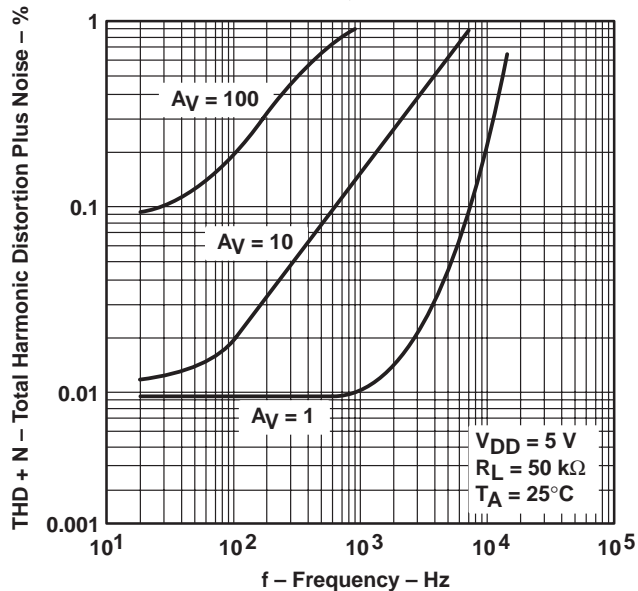


Figure 53

GAIN-BANDWIDTH PRODUCT†‡  
 vs  
 FREE-AIR TEMPERATURE

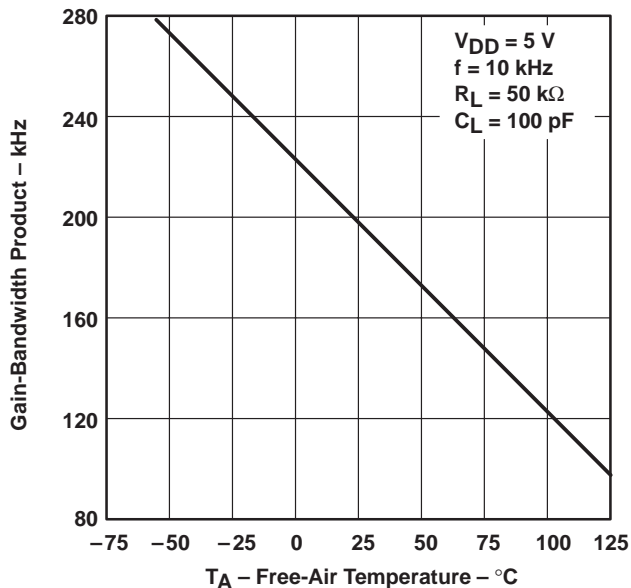


Figure 54

GAIN-BANDWIDTH PRODUCT  
 vs  
 SUPPLY VOLTAGE

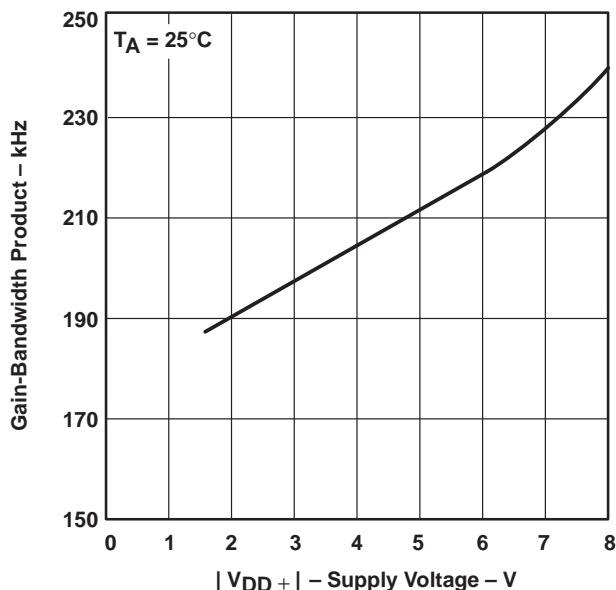


Figure 55

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

‡ Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS

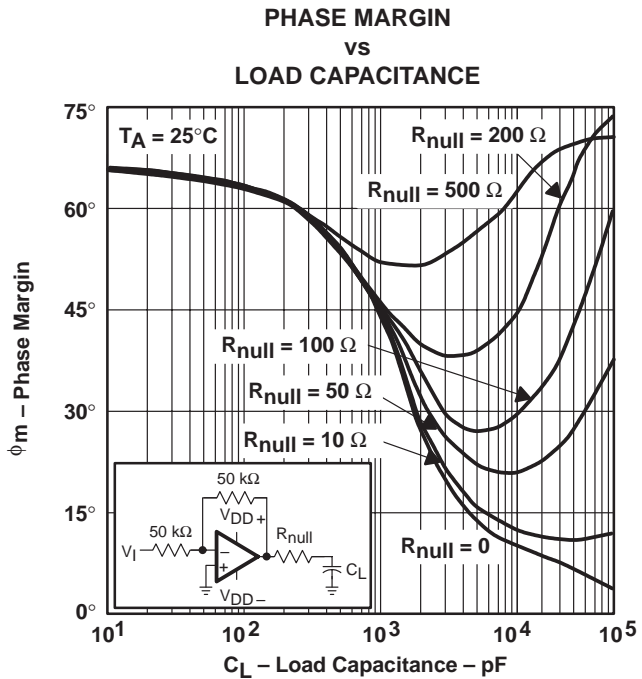


Figure 56

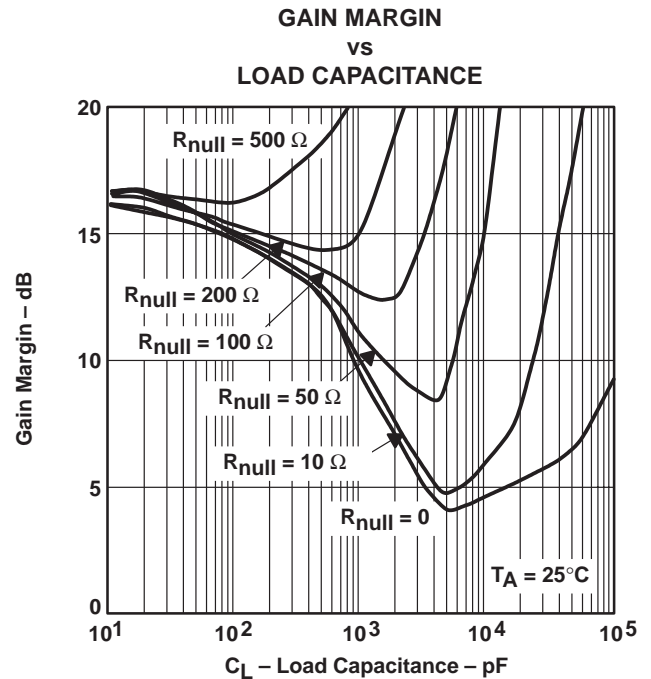


Figure 57

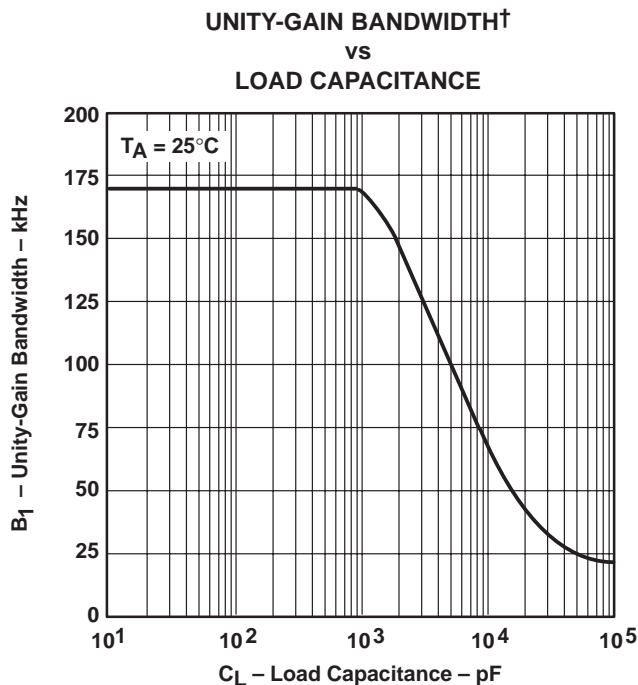


Figure 58

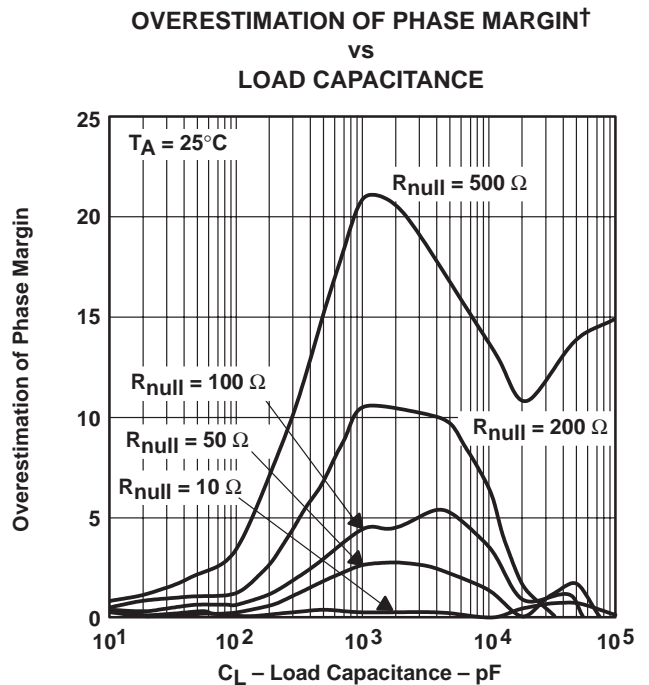


Figure 59

† See application information

**APPLICATION INFORMATION**

**driving large capacitive loads**

The TLC225x is designed to drive larger capacitive loads than most CMOS operational amplifiers. Figure 56 and Figure 57 illustrate its ability to drive loads up to 1000 pF while maintaining good gain and phase margins ( $R_{null} = 0$ ).

A smaller series resistor ( $R_{null}$ ) at the output of the device (see Figure 60) improves the gain and phase margins when driving large capacitive loads. Figure 56 and Figure 57 show the effects of adding series resistances of 10  $\Omega$ , 50  $\Omega$ , 100  $\Omega$ , 200  $\Omega$ , and 500  $\Omega$ . The addition of this series resistor has two effects: the first is that it adds a zero to the transfer function and the second is that it reduces the frequency of the pole associated with the output load in the transfer function.

The zero introduced to the transfer function is equal to the series resistance times the load capacitance. To calculate the improvement in phase margin, equation 1 can be used.

$$\Delta\phi_{m1} = \tan^{-1} \left( 2 \times \pi \times \text{UGBW} \times R_{null} \times C_L \right) \tag{1}$$

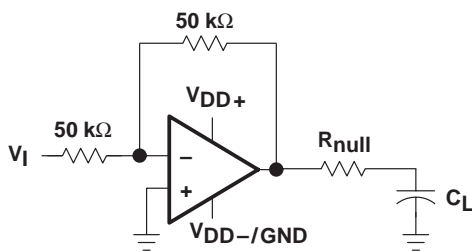
where :

- $\Delta\phi_{m1}$  = improvement in phase margin
- UGBW = unity-gain bandwidth frequency
- $R_{null}$  = output series resistance
- $C_L$  = load capacitance

The unity-gain bandwidth (UGBW) frequency decreases as the capacitive load increases (see Figure 58). To use equation 1, UGBW must be approximated from Figure 58.

Using equation 1 alone overestimates the improvement in phase margin, as illustrated in Figure 59. The overestimation is caused by the decrease in the frequency of the pole associated with the load, thus providing additional phase shift and reducing the overall improvement in phase margin.

Using Figure 60, with equation 1 enables the designer to choose the appropriate output series resistance to optimize the design of circuits driving large capacitance loads.



**Figure 60. Series-Resistance Circuit**

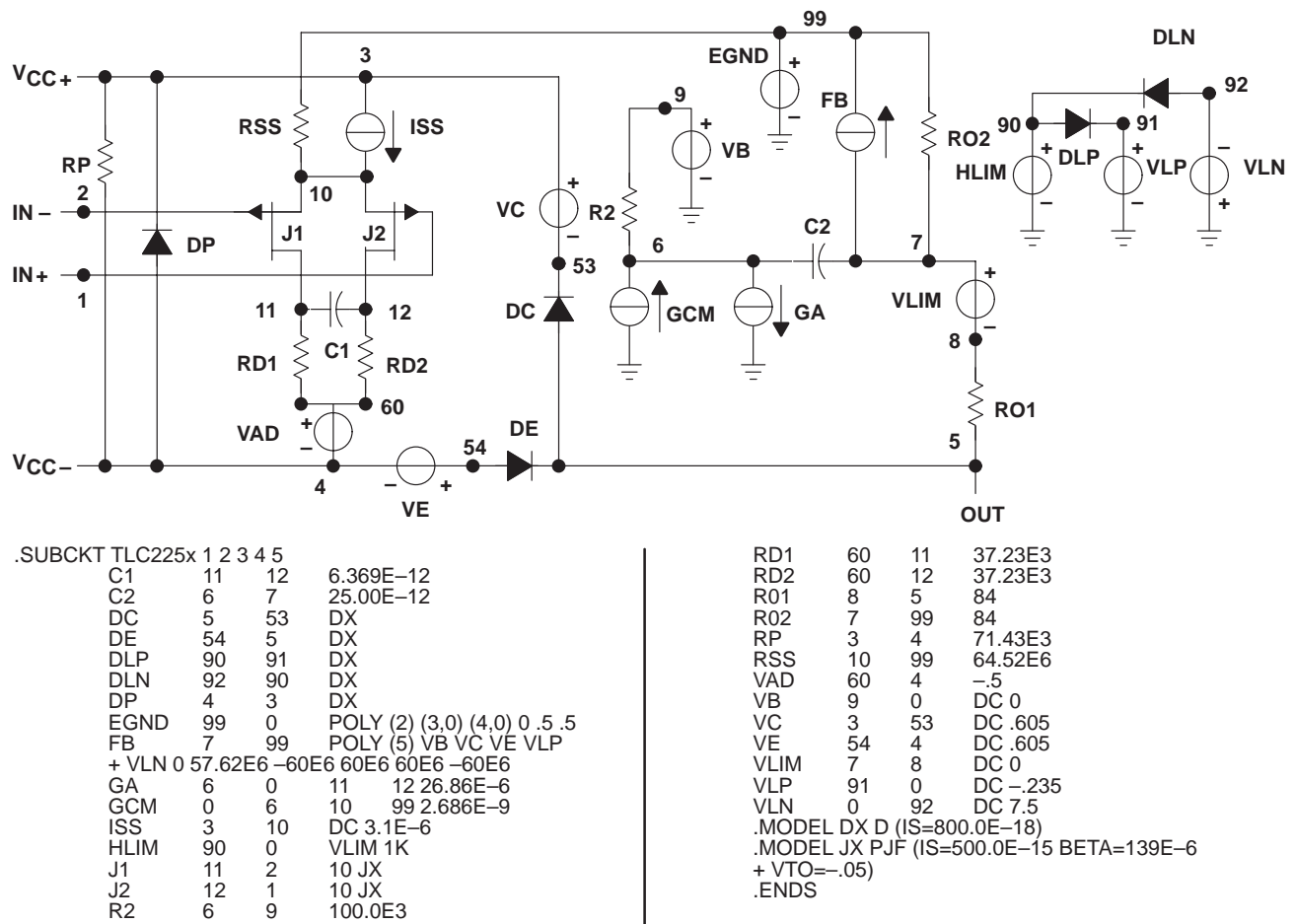
## APPLICATION INFORMATION

### macromodel information

Macromodel information provided was derived using Microsim *Parts*™, the model generation software used with Microsim *PSpice*™. The Boyle macromodel (see Note 5) and subcircuit in Figure 61 are generated using the TLC225x 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 61. Boyle Macromodel and Subcircuit**

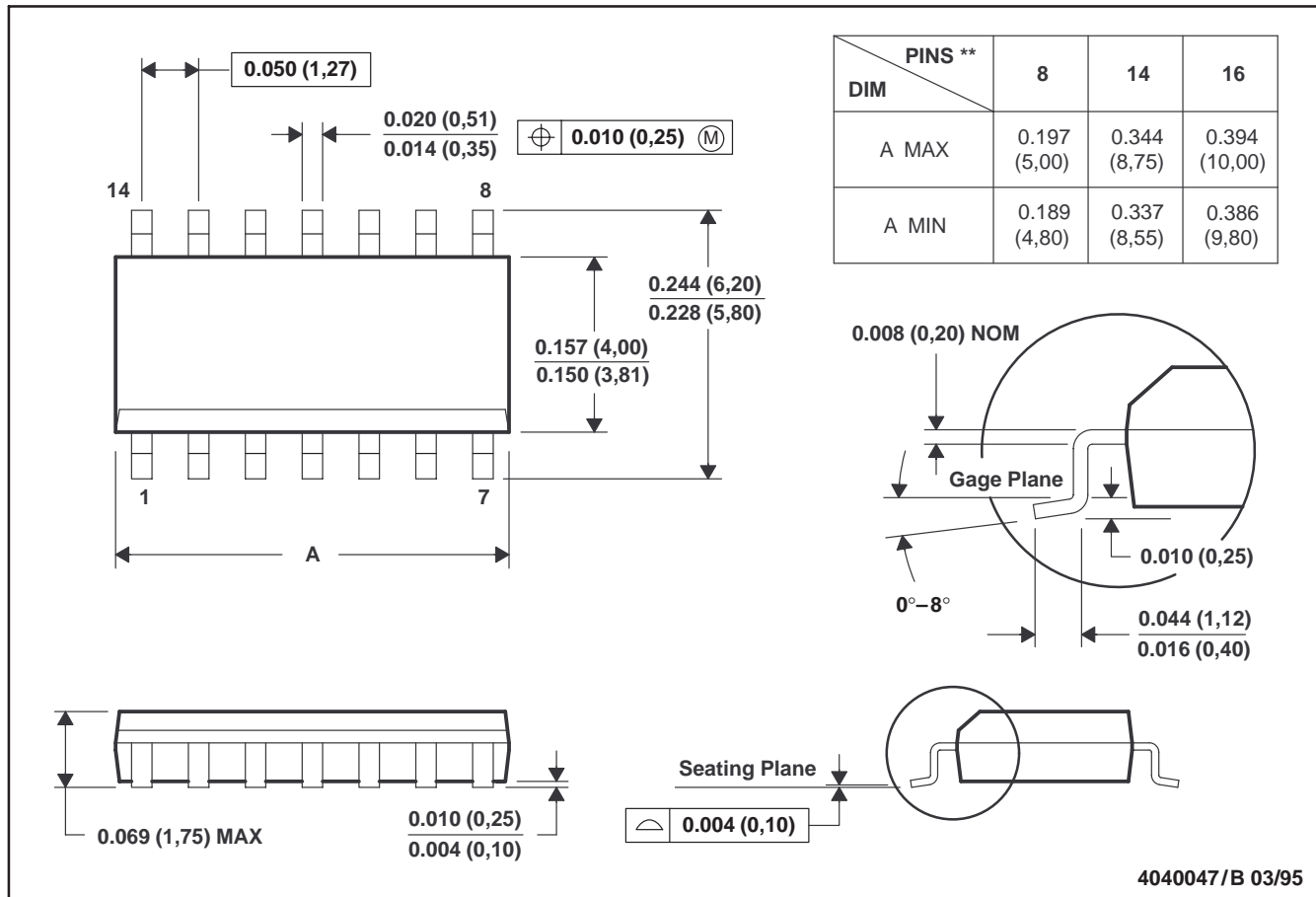
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**MECHANICAL INFORMATION**

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

**PLASTIC SMALL-OUTLINE PACKAGE**

14 PIN SHOWN



4040047/B 03/95

- 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. Four center pins are connected to die mount pad.  
 E. Falls within JEDEC MS-012



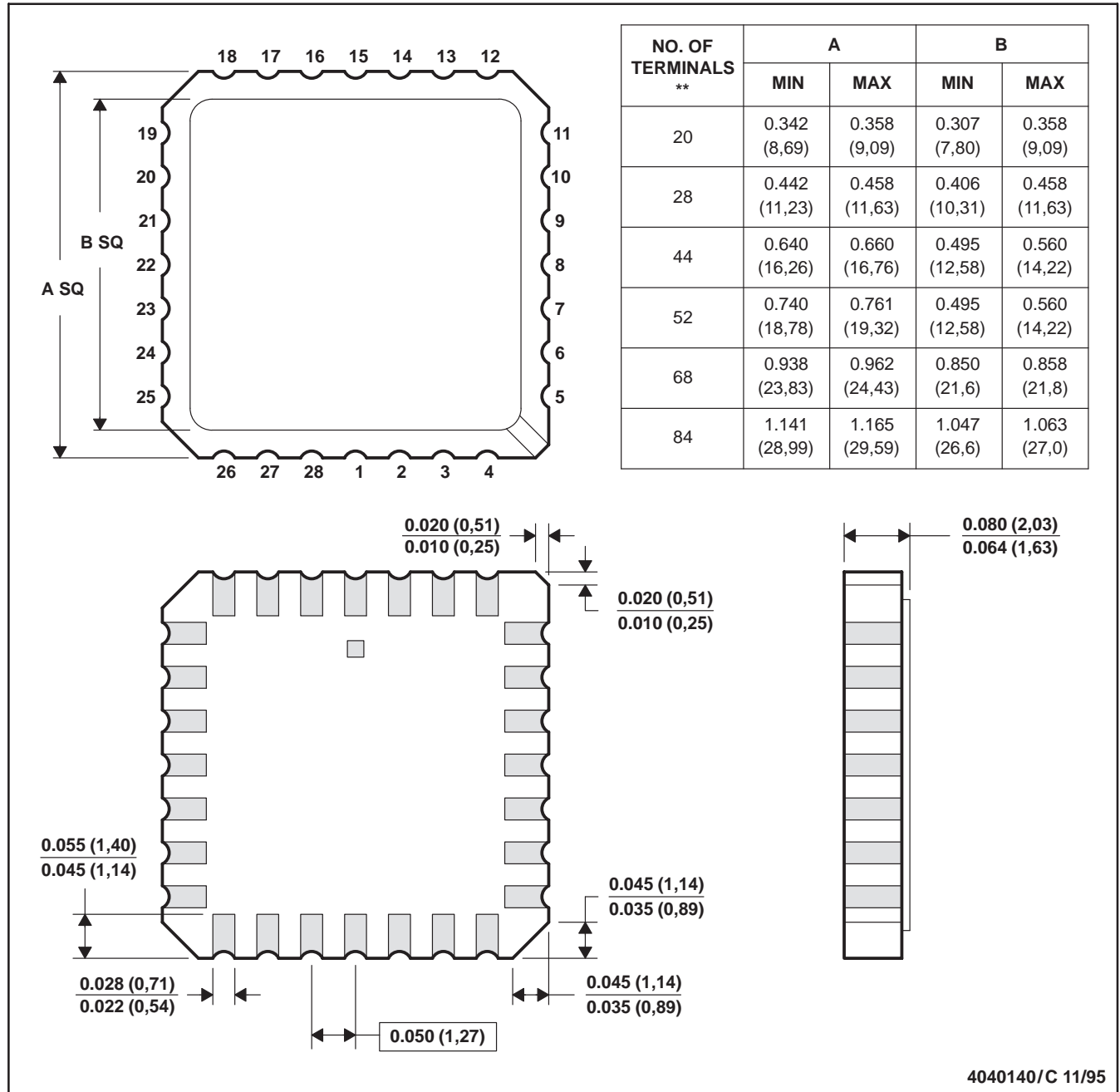
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**MECHANICAL INFORMATION**

**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

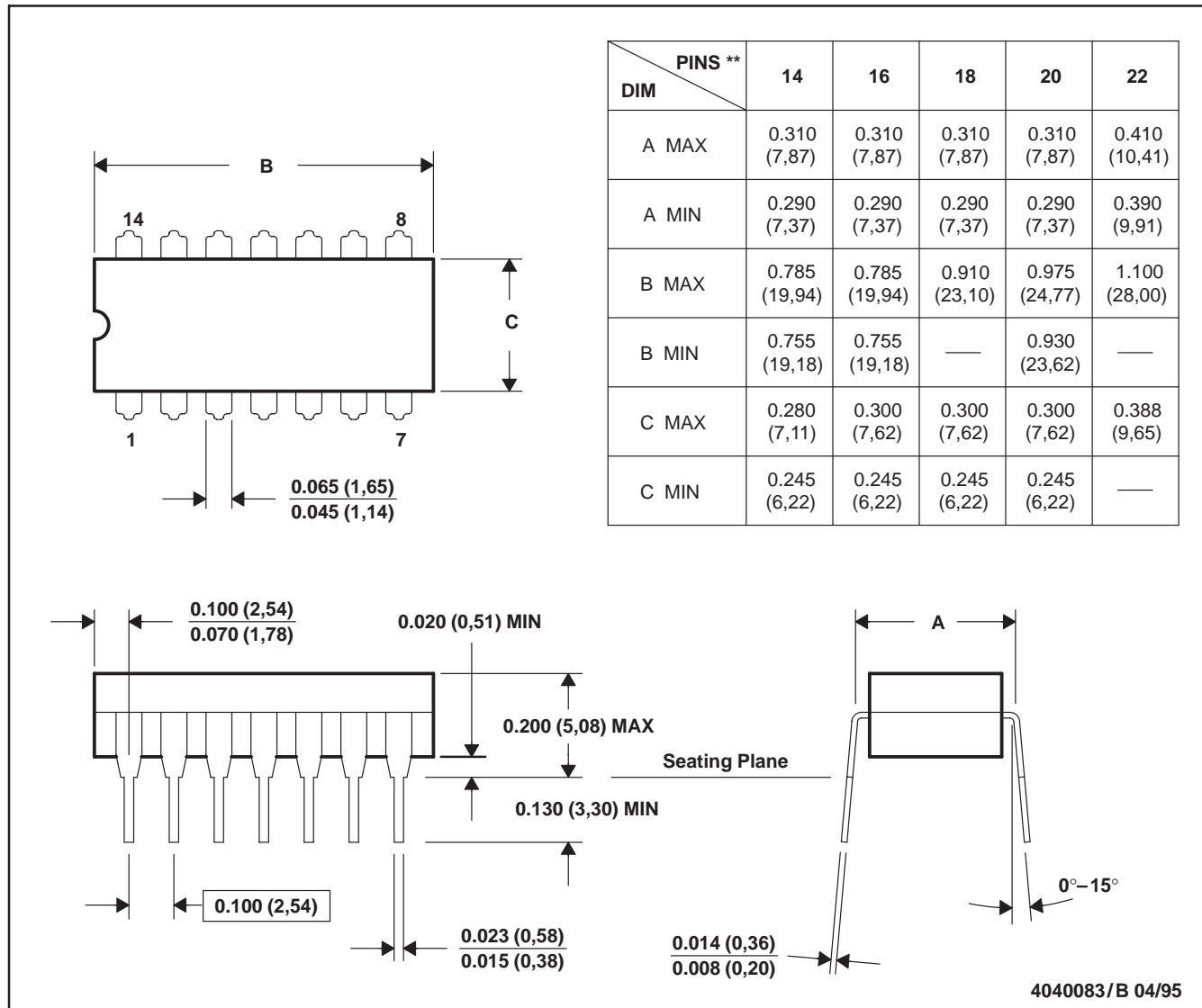
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**MECHANICAL INFORMATION**

**J (R-GDIP-T\*\*)**

**CERAMIC DUAL-IN-LINE PACKAGE**

14 PIN SHOWN



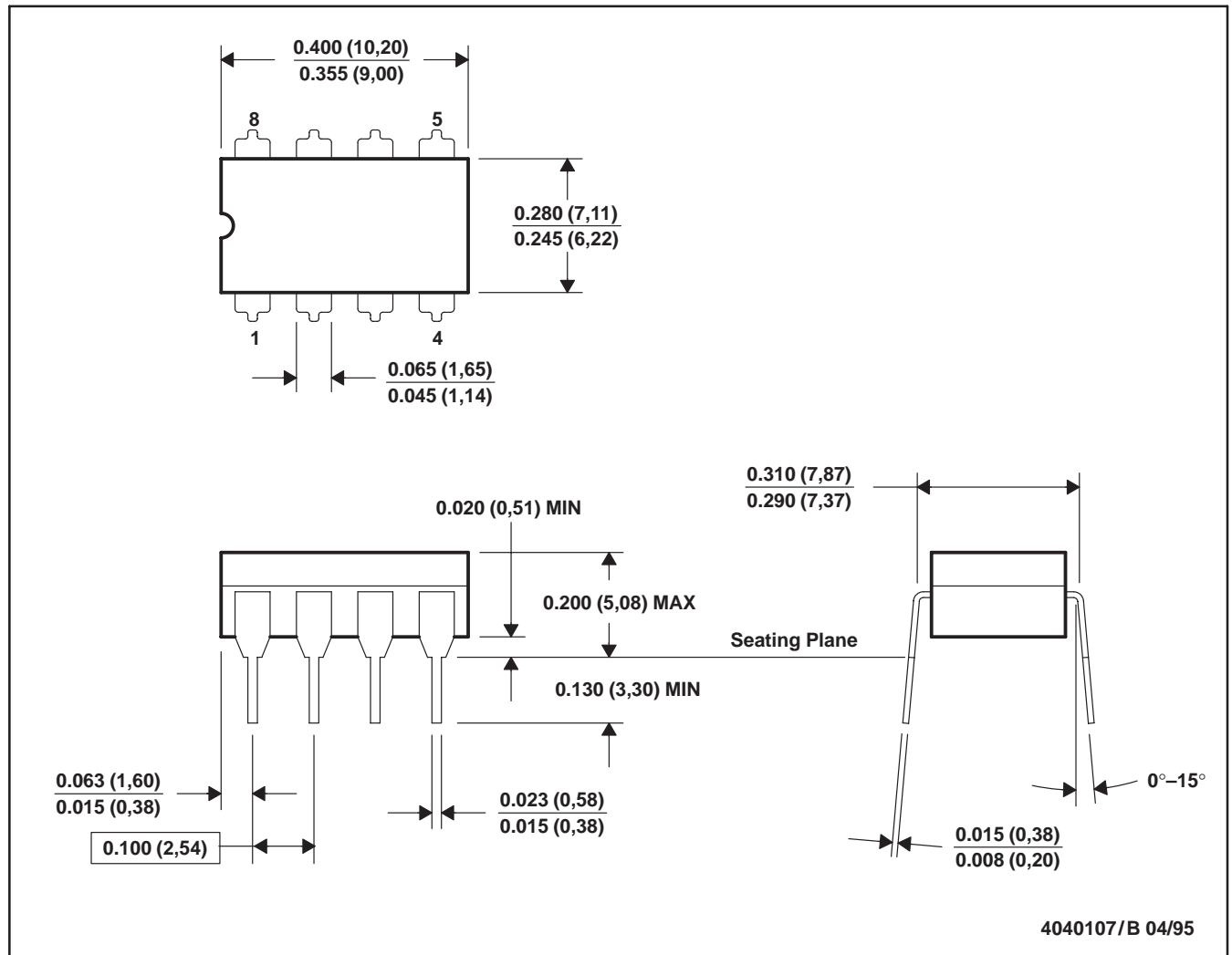
- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. This package can be hermetically sealed with a ceramic lid using glass frit.  
 D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.  
 E. Falls within MIL-STD-1835 GDIP1-T14, GDIP1-T16, GDIP1-T18, GDIP1-T20, and GDIP1-T22

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**MECHANICAL INFORMATION**

**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

**TLC225x, TLC225xA**  
**Advanced LinCMOS™ RAIL-TO-RAIL**  
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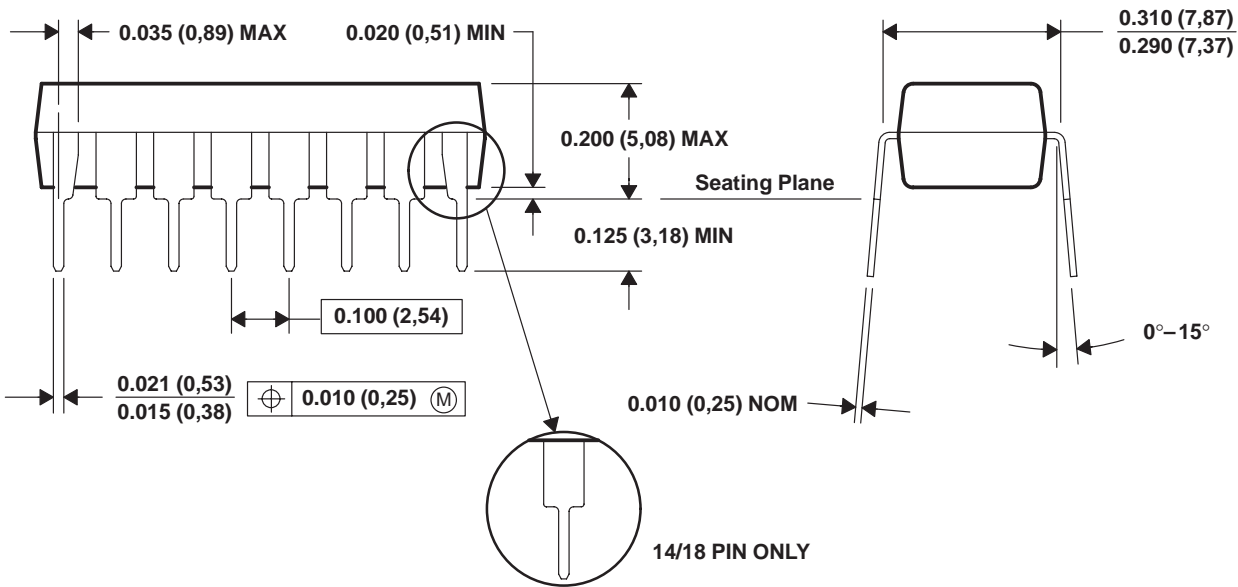
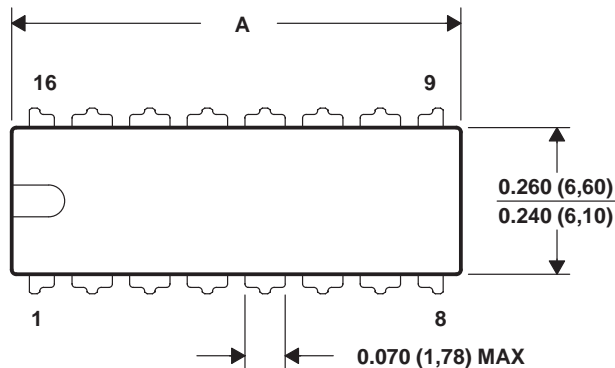
**MECHANICAL INFORMATION**

**N (R-PDIP-T\*\*)**

**PLASTIC DUAL-IN-LINE PACKAGE**

16 PIN SHOWN

DIM \ PINS **	14	16	18	20
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23,37)	0.975 (24,77)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)



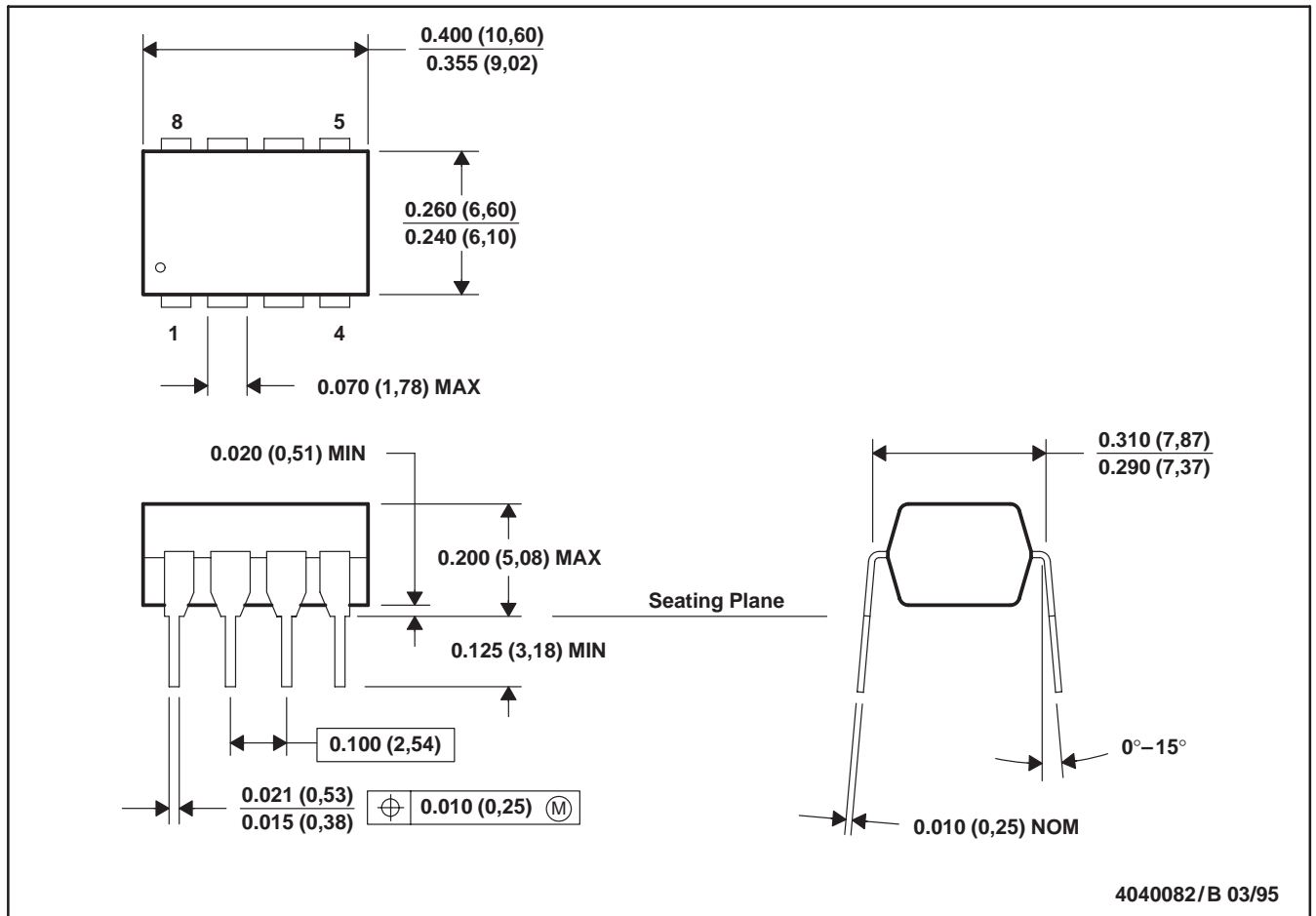
4040049/C 08/95

- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Falls within JEDEC MS-001 (20 pin package is shorter than MS-001.)

**MECHANICAL INFORMATION**

**P (R-PDIP-T8)**

**PLASTIC DUAL-IN-LINE PACKAGE**



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Falls within JEDEC MS-001

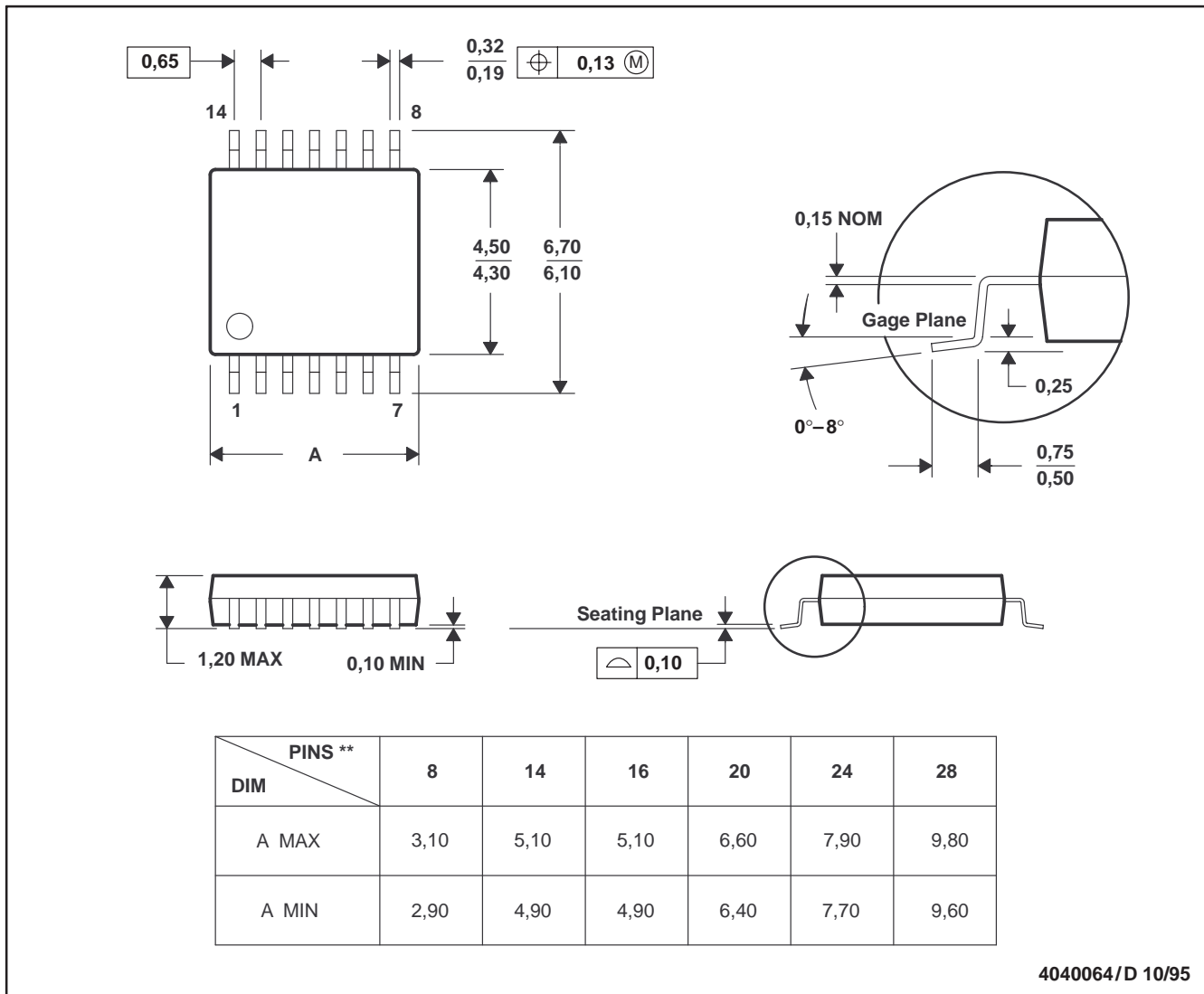
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**MECHANICAL INFORMATION**

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

**PLASTIC SMALL-OUTLINE PACKAGE**

14 PIN SHOWN



4040064/D 10/95

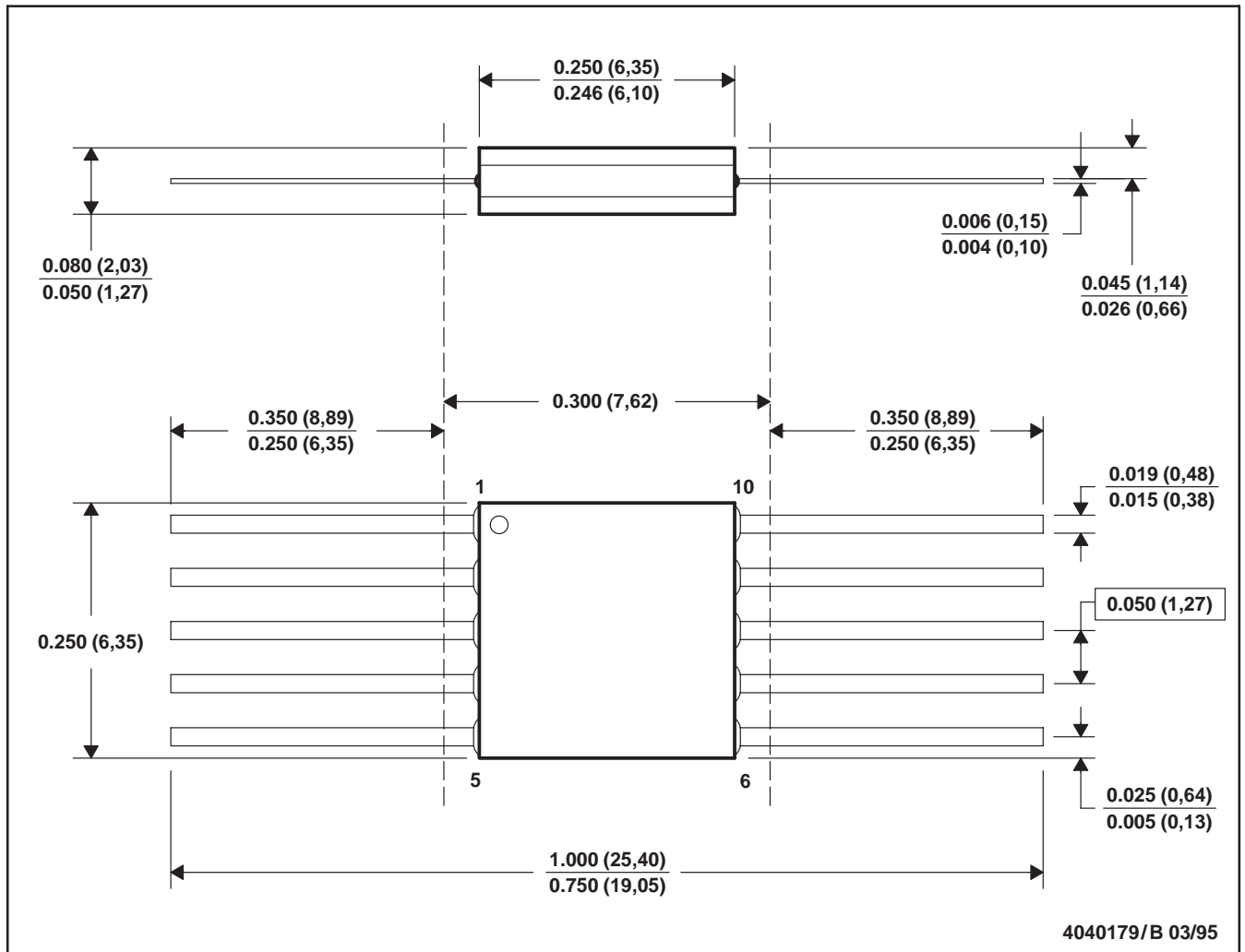
- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-153

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**MECHANICAL INFORMATION**

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

**CERAMIC DUAL FLATPACK**



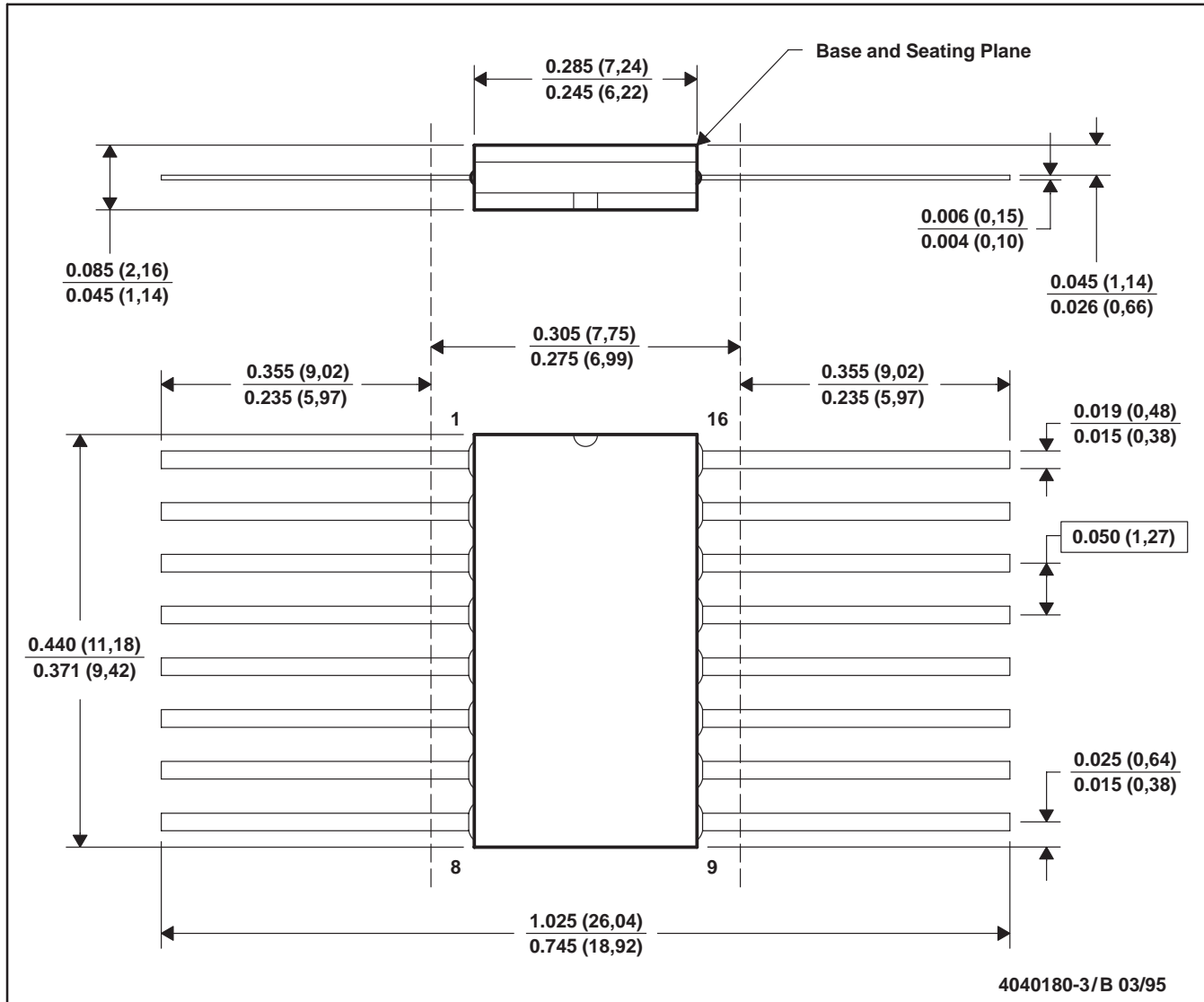
- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. This package can be hermetically sealed with a ceramic lid using glass frit.  
 D. Index point is provided on cap for terminal identification only.  
 E. Falls within MIL STD 1835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

**TLC225x, TLC225xA**  
**Advanced LinCMOS™ RAIL-TO-RAIL**  
**VERY LOW-POWER OPERATIONAL AMPLIFIERS**  
 SLOS176A – FEBRUARY 1997 – REVISED JULY 1999

**MECHANICAL INFORMATION**

**W (R-GDFP-F16)**

**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-F16 and JEDEC MO-092AC



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