

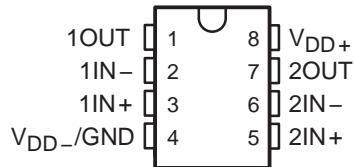
TLC227x-Q1, TLC227xA-Q1
Advanced LinCMOS™ RAIL-TO-RAIL
OPERATIONAL AMPLIFIERS

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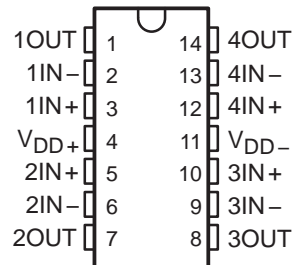
AVAILABLE OPTIONS

T _A	V _{IO} max At 25°C	PACKAGED DEVICES	
		SMALL OUTLINE (D)	TSSOP (PW)
-40°C to 125°C	950 μV 2.5 mV	TLC2272AQDRQ1 TLC2272QDRQ1	TLC2272AQPWRQ1 TLC2272QPWRQ1
-40°C to 125°C	950 μV 2.5 mV	TLC2274AQDRQ1 TLC2274QDRQ1	TLC2274AQPWRQ1 TLC2274QPWRQ1

TLC2272
D OR PW PACKAGE
(TOP VIEW)



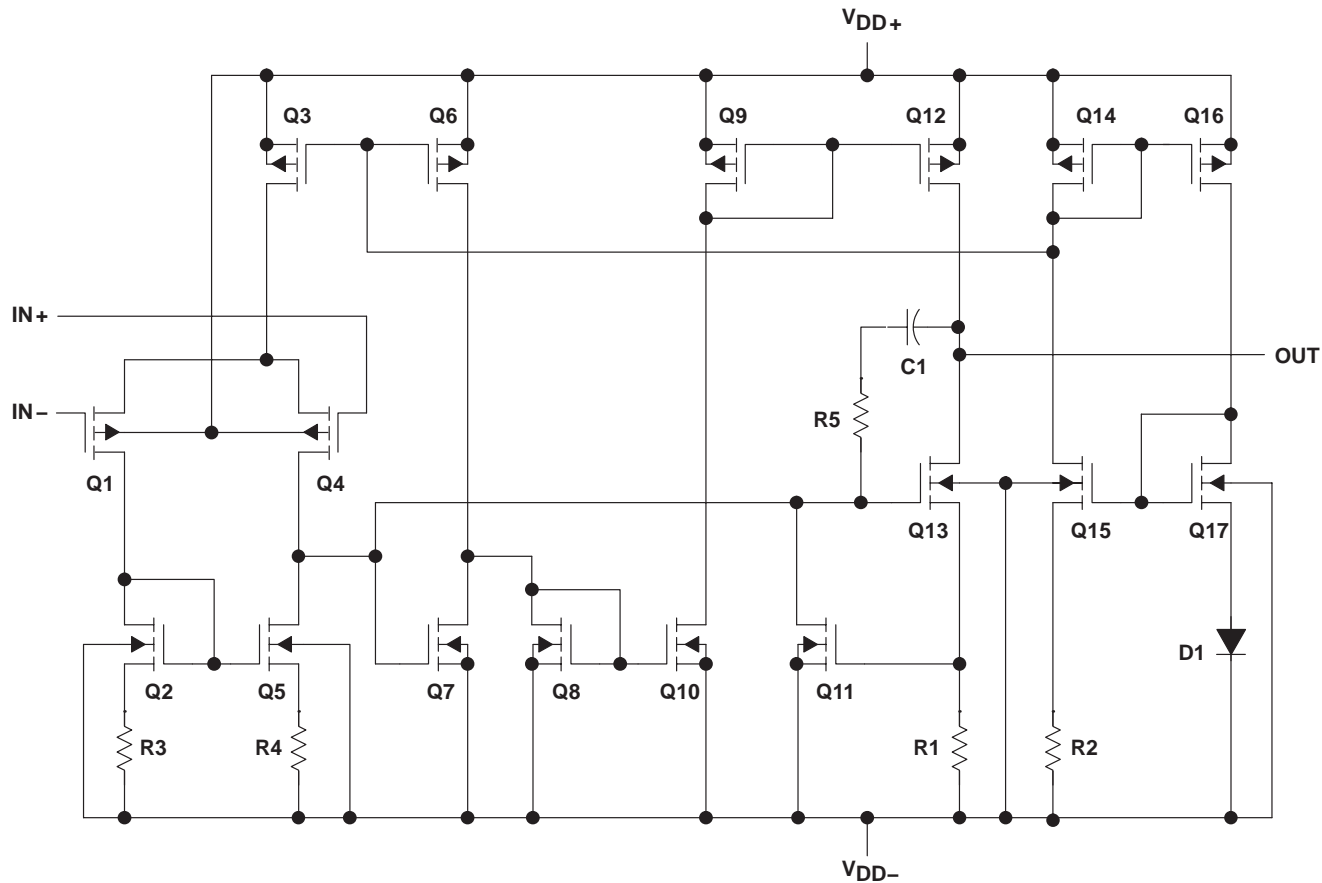
TLC2274
D OR PW PACKAGE
(TOP VIEW)



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equivalent schematic (each amplifier)



ACTUAL DEVICE COMPONENT COUNT†		
COMPONENT	TLC2272	TLC2274
Transistors	38	76
Resistors	26	52
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)	±16 V
Input voltage range, V_I (any input, see Note 1)	$V_{DD-} - 0.3$ V to V_{DD+}
Input current, I_I (any 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 dissipation	See Dissipation Rating Table
Operating free-air temperature range, T_A	-40°C to 125°C
Storage temperature range	-65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D or PW package	260°C

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

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

DISSIPATION RATING TABLE

PACKAGE	$T_A \leq 25^\circ\text{C}$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$	$T_A = 70^\circ\text{C}$ POWER RATING	$T_A = 85^\circ\text{C}$ POWER RATING	$T_A = 125^\circ\text{C}$ POWER RATING
D-8	725 mW	5.8 mW/°C	464 mW	337 mW	145 mW
D-14	950 mW	7.6 mW/°C	608 mW	494 mW	190 mW
PW-8	525 mW	4.2 mW/°C	336 mW	273 mW	105 mW
PW-14	700 mW	5.6 mW/°C	448 mW	364 mW	—

recommended operating conditions

	MIN	MAX	UNIT
Supply voltage, $V_{DD\pm}$	±2.2	±8	V
Input voltage, V_I	V_{DD-}	$V_{DD+} - 1.5$	V
Common-mode input voltage, V_{IC}	V_{DD-}	$V_{DD+} - 1.5$	V
Operating free-air temperature, T_A	-40	125	°C

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TLC2272Q electrical characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_A †	TLC2272Q			TLC2272AQ			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{IC} = 0\text{ V},$ $V_O = 0\text{ V},$ $V_{DD\pm} = \pm 2.5\text{ V},$ $R_S = 50\ \Omega$	25°C	300 2500		300 950		μV		
		Full range	3000			1500			
α_{VIO} Temperature coefficient of input offset voltage		25°C to 125°C	2		2		$\mu\text{V}/^\circ\text{C}$		
Input offset voltage long-term drift (see Note 4)		25°C	0.002		0.002		$\mu\text{V}/\text{mo}$		
I_{IO} Input offset current		25°C	0.5 60		0.5 60		pA		
		Full range	800			800			
I_{IB} Input bias current	25°C	1 60		1 60		pA			
	Full range	800			800				
V_{ICR} Common-mode input voltage	$R_S = 50\ \Omega,$ $ 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	$I_{OH} = -20\ \mu\text{A}$	25°C	4.99		4.99		V		
	$I_{OH} = -200\ \mu\text{A}$	25°C	4.85	4.93	4.85	4.93			
	$I_{OH} = -1\text{ mA}$	25°C	4.25	4.65	4.25	4.65			
		Full range	4.25			4.25			
V_{OL} Low-level output voltage	$V_{IC} = 2.5\text{ V},$ $I_{OL} = 50\ \mu\text{A}$	25°C	0.01		0.01		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			
		$V_{IC} = 2.5\text{ V},$ $I_{OL} = 5\text{ mA}$	25°C	0.9	1.5	0.9		1.5	
Full range	1.5			1.5					
A_{VD} Large-signal differential voltage amplification	$V_{IC} = 2.5\text{ V},$ $V_O = 1\text{ V to }4\text{ V}$	$R_L = 10\text{ k}\Omega$ ‡	25°C	10	35	10	35	V/mV	
			Full range	10			10		
		$R_L = 1\text{ m}\Omega$ ‡	25°C	175		175			
r_{id} Differential input resistance		25°C	10^{12}		10^{12}		Ω		
r_i Common-mode input resistance		25°C	10^{12}		10^{12}		Ω		
c_i Common-mode input capacitance	$f = 10\text{ kHz},$ P package	25°C	8		8		pF		
z_o Closed-loop output impedance	$f = 1\text{ MHz},$ $A_V = 10$	25°C	140		140		Ω		
CMRR Common-mode rejection ratio	$V_{IC} = 0\text{ V to }2.7\text{ V},$ $V_O = 2.5\text{ V},$ $R_S = 50\ \Omega$	25°C	70	75	70	75	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	dB		
		Full range	80			80			
I_{DD} Supply current	$V_O = 2.5\text{ V},$ No load	25°C	2.2	3	2.2	3	mA		
		Full range	3			3			

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

‡ Referenced to 2.5 V

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

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TLC2272Q operating characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$

PARAMETER	TEST CONDITIONS	T_A †	TLC2272Q			TLC2272AQ			UNIT	
			MIN	TYP	MAX	MIN	TYP	MAX		
SR	Slew rate at unity gain $V_O = 1.25\text{ V to }2.75\text{ V}$, $R_L = 10\text{ k}\Omega$ ‡, $C_L = 100\text{ pF}$ ‡	25°C	2.3	3.6		2.3	3.6	$\text{V}/\mu\text{s}$		
		Full range	1.7			1.7				
V_n	Equivalent input noise voltage $f = 10\text{ Hz}$ $f = 1\text{ kHz}$	25°C	50			50			$\text{nV}/\sqrt{\text{Hz}}$	
		25°C	9			9				
V_{NPP}	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	1			1			μV	
		25°C	1.4			1.4				
I_n	Equivalent input noise current	25°C	0.6			0.6			$\text{fA}/\sqrt{\text{Hz}}$	
THD + N	Total harmonic distortion plus noise $V_O = 0.5\text{ V to }2.5\text{ V}$, $f = 20\text{ kHz}$, $R_L = 10\text{ k}\Omega$ ‡	25°C	$A_V = 1$	0.0013%			0.0013%			
			$A_V = 10$	0.004%			0.004%			
			$A_V = 100$	0.03%			0.03%			
	Gain-bandwidth product $f = 10\text{ kHz}$, $C_L = 100\text{ pF}$ ‡	25°C	2.18			2.18			MHz	
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	1			1			MHz	
t_s	Settling time $A_V = -1$, Step = $0.5\text{ V to }2.5\text{ V}$, $R_L = 10\text{ k}\Omega$ ‡, $C_L = 100\text{ pF}$ ‡	25°C	To 0.1%	1.5			1.5			μs
			To 0.01%	2.6			2.6			
ϕ_m	Phase margin at unity gain $R_L = 10\text{ k}\Omega$ ‡, $C_L = 100\text{ pF}$ ‡	25°C	50°			50°				
		25°C	10			10				dB
	Gain margin	25°C	10			10			dB	

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

‡ Referenced to 2.5 V

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TLC2272Q electrical characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5\text{ V}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_A †	TLC2272Q			TLC2272AQ			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO} Input offset voltage		25°C	300	2500		300	950	μV	
		Full range			3000		1500		
α_{VIO} Temperature coefficient of input offset voltage		25°C to 125°C	2			2			$\mu\text{V}/^\circ\text{C}$
Input offset voltage long-term drift (see Note 4)	$V_{IC} = 0\text{ V}$, $R_S = 50\ \Omega$	$V_O = 0\text{ V}$, 25°C	0.002			0.002			$\mu\text{V}/\text{mo}$
I_{IO} Input offset current		25°C	0.5	60		0.5	60	pA	
		Full range			800		800		
I_{IB} Input bias current		25°C	1	60		1	60	pA	
		Full range			800		800		
V_{ICR} Common-mode input voltage	$R_S = 50\ \Omega$, $ 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	4.99			4.99			V
	$I_O = -200\ \mu\text{A}$	25°C	4.85	4.93		4.85	4.93		
		Full range	4.85			4.85			
	$I_O = -1\text{ mA}$	25°C	4.25	4.65		4.25	4.65		
Full range		4.25			4.25				
V_{OM-} Maximum negative peak output voltage	$V_{IC} = 0\text{ V}$, $I_O = 50\ \mu\text{A}$	25°C	-4.99			-4.99			V
	$V_{IC} = 0\text{ V}$, $I_O = 500\ \mu\text{A}$	25°C	-4.85	-4.91		-4.85	-4.91		
		Full range	-4.85			-4.85			
	$V_{IC} = 0\text{ V}$, $I_O = 5\text{ mA}$	25°C	-3.5	-4.1		-3.5	-4.1		
Full range		-3.5			-3.5				
A_{VD} Large-signal differential voltage amplification	$V_O = \pm 4\text{ V}$	$R_L = 10\ \text{k}\Omega$	25°C	20	50		20	50	V/mV
			Full range	20			20		
		$R_L = 1\ \text{m}\Omega$	25°C	300			300		
r_{id} Differential input resistance		25°C	10^{12}			10^{12}			Ω
r_i Common-mode input resistance		25°C	10^{12}			10^{12}			Ω
c_i Common-mode input capacitance	$f = 10\ \text{kHz}$, P package	25°C	8			8			pF
z_o Closed-loop output impedance	$f = 1\ \text{MHz}$, $A_V = 10$	25°C	130			130			Ω
CMRR Common-mode rejection ratio	$V_{IC} = -5\text{ V}$ to 2.7 V , $V_O = 0\text{ V}$, $R_S = 50\ \Omega$	25°C	75	80		75	80	dB	
		Full range	75			75			
k_{SVR} Supply-voltage rejection ratio ($\Delta V_{DD\pm}/\Delta V_{IO}$)	$V_{DD} = \pm 2.2\text{ V}$ to $\pm 8\text{ V}$, $V_{IC} = 0\text{ V}$, 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	2.4	3		2.4	3	mA	
		Full range	3			3			

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

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

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TLC2272Q operating characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5\text{ V}$

PARAMETER	TEST CONDITIONS	T_A †	TLC2272Q			TLC2272AQ			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain $V_O = \pm 1\text{ V}$, $C_L = 100\text{ pF}$ $R_L = 10\text{ k}\Omega$	25°C	2.3	3.6		2.3	3.6	$\text{V}/\mu\text{s}$	
		Full range	1.7			1.7			
V_n	Equivalent input noise voltage $f = 10\text{ Hz}$ $f = 1\text{ kHz}$	25°C	50			50			$\text{nV}/\sqrt{\text{Hz}}$
		25°C	9			9			
V_{NPP}	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	1			1			μV
		25°C	1.4			1.4			
I_n	Equivalent input noise current	25°C	0.6			0.6			$\text{fA}/\sqrt{\text{Hz}}$
THD + N	Total harmonic distortion plus noise $V_O = \pm 2.3\text{ V}$ $R_L = 10\text{ k}\Omega$, $f = 20\text{ kHz}$	25°C		$A_V = 1$	0.0011%			0.0011%	
				$A_V = 10$	0.004%			0.004%	
				$A_V = 100$	0.03%			0.03%	
	Gain-bandwidth product $f = 10\text{ kHz}$, $C_L = 100\text{ pF}$ $R_L = 10\text{ k}\Omega$	25°C	2.25			2.25			MHz
B_{OM}	Maximum output-swing bandwidth $V_{O(PP)} = 4.6\text{ V}$, $R_L = 10\text{ k}\Omega$, $A_V = 1$, $C_L = 100\text{ pF}$	25°C	0.54			0.54			MHz
t_s	Settling time $A_V = -1$, Step = $-2.3\text{ V to }2.3\text{ V}$, $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$	25°C		To 0.1%	1.5			1.5	μs
				To 0.01%	3.2			3.2	
ϕ_m	Phase margin at unity gain $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$	25°C	52°			52°			
		25°C	10			10			dB

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

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TLC2274Q electrical characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_A †	TLC2274Q			TLC2274AQ			UNIT	
			MIN	TYP	MAX	MIN	TYP	MAX		
V_{IO} Input offset voltage		25°C		300	2500		300	950	μV	
		Full range			3000			1500		
α_{VIO} Temperature coefficient of input offset voltage		25°C to 125°C		2			2	$\mu\text{V}/^\circ\text{C}$		
Input offset voltage long-term drift (see Note 4)	$V_{DD\pm} = \pm 2.5\text{ V}$, $V_{IC} = 0\text{ V}$, $V_O = 0\text{ V}$, $R_S = 50\ \Omega$	25°C		0.002			0.002	$\mu\text{V}/\text{mo}$		
I_{IO} Input offset current		25°C		0.5	60		0.5	60	pA	
		Full range			800			800		
I_{IB} Input bias current		25°C		1	60		1	60	pA	
		Full range			800			800		
V_{ICR} Common-mode input voltage	$R_S = 50\ \Omega$, $ 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	$I_{OH} = -20\ \mu\text{A}$	25°C		4.99			4.99	V		
		25°C		4.85	4.93		4.85		4.93	
		Full range		4.85			4.85			
		25°C		4.25	4.65		4.25		4.65	
V_{OL} Low-level output voltage	$I_{OH} = -1\text{ mA}$	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		0.9	1.5		0.9		1.5	
A_{VD} Large-signal differential voltage amplification	$V_{IC} = 2.5\text{ V}$, $V_O = 1\text{ V to }4\text{ V}$	$R_L = 10\text{ k}\Omega$ ‡	25°C	10	35		10	35	V/mV	
			Full range		10			10		
		$R_L = 1\text{ M}\Omega$ ‡	25°C		175			175		
			Full range							
r_{id} Differential input resistance		25°C		10^{12}			10^{12}	Ω		
r_i Common-mode input resistance		25°C		10^{12}			10^{12}	Ω		
c_i Common-mode input capacitance	$f = 10\text{ kHz}$, N package	25°C		8			8	pF		
z_o Closed-loop output impedance	$f = 1\text{ MHz}$, $A_V = 10$	25°C		140			140	Ω		
CMRR Common-mode rejection ratio	$V_{IC} = 0\text{ V to }2.7\text{ V}$, $V_O = 2.5\text{ V}$, $R_S = 50\ \Omega$	25°C	70	75		70	75	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	dB		
		Full range		80			80			
I_{DD} Supply current	$V_O = 2.5\text{ V}$, No load	25°C		4.4	6		4.4	6	mA	
		Full range			6			6		

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

‡ Referenced to 2.5 V

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

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TLC2274Q operating characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$

PARAMETER	TEST CONDITIONS	T_A †	TLC2274Q			TLC2274AQ			UNIT	
			MIN	TYP	MAX	MIN	TYP	MAX		
SR	Slew rate at unity gain $V_O = 0.5\text{ V to }2.5\text{ V},$ $R_L = 10\text{ k}\Omega\ddagger,$ $C_L = 100\text{ pF}\ddagger$	25°C	2.3	3.6		2.3	3.6	$\text{V}/\mu\text{s}$		
		Full range	1.7			1.7				
V_n	Equivalent input noise voltage $f = 10\text{ Hz}$ $f = 1\text{ kHz}$	25°C	50			50			$\text{nV}/\sqrt{\text{Hz}}$	
		25°C	9			9				
$V_{N(PP)}$	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	1			1			μV	
		25°C	1.4			1.4				
I_n	Equivalent input noise current	25°C	0.6			0.6			$\text{fA}/\sqrt{\text{Hz}}$	
THD + N	Total harmonic distortion plus noise $V_O = 0.5\text{ V to }2.5\text{ V},$ $f = 20\text{ kHz},$ $R_L = 10\text{ k}\Omega\ddagger$	25°C	$A_V = 1$	0.0013%			0.0013%			
			$A_V = 10$	0.004%			0.004%			
			$A_V = 100$	0.03%			0.03%			
	Gain-bandwidth product $f = 10\text{ kHz},$ $C_L = 100\text{ pF}\ddagger$	25°C	2.18			2.18			MHz	
B_{OM}	Maximum output-swing bandwidth $V_{O(PP)} = 2\text{ V},$ $R_L = 10\text{ k}\Omega\ddagger,$ $A_V = 1,$ $C_L = 100\text{ pF}\ddagger$	25°C	1			1			MHz	
t_s	Settling time $A_V = -1,$ Step = 0.5 V to 2.5 V, $R_L = 10\text{ k}\Omega\ddagger,$ $C_L = 100\text{ pF}\ddagger$	25°C	$T_o = 0.1\%$	1.5			1.5			μs
			$T_o = 0.01\%$	2.6			2.6			
ϕ_m	Phase margin at unity gain $R_L = 10\text{ k}\Omega\ddagger,$ $C_L = 100\text{ pF}\ddagger$	25°C	50°			50°				
		25°C	10			10				
	Gain margin	25°C	10			10			dB	

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

‡ Referenced to 2.5 V

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TLC2274Q electrical characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5\text{ V}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_A †	TLC2274Q			TLC2274AQ			UNIT	
			MIN	TYP	MAX	MIN	TYP	MAX		
V_{IO} Input offset voltage		25°C		300	2500		300	950	μV	
		Full range			3000			1500		
α_{VIO} Temperature coefficient of input offset voltage		25°C to 125°C		2			2	$\mu\text{V}/^\circ\text{C}$		
Input offset voltage long-term drift (see Note 4)	$V_{IC} = 0\text{ V}, V_O = 0\text{ V}, R_S = 50\ \Omega$	25°C		0.002			0.002	$\mu\text{V}/\text{mo}$		
I_{IO} Input offset current		25°C		0.5	60		0.5	60	pA	
I_{IB} Input bias current		Full range			800			800		
		25°C		1	60		1	60	pA	
V_{ICR} Common-mode input voltage	$R_S = 50\ \Omega, V_{IO} \leq 5\text{ mV}$	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		4.99			4.99	V		
	$I_O = -200\ \mu\text{A}$	25°C		4.85	4.93		4.85		4.93	
		Full range		4.85			4.85			
	$I_O = -1\text{ mA}$	25°C		4.25	4.65		4.25		4.65	
V_{OM-} Maximum negative peak output voltage	$V_{IC} = 0\text{ V}, I_O = 50\ \mu\text{A}$	25°C		-4.99			-4.99	V		
	$V_{IC} = 0\text{ V}, I_O = 500\ \mu\text{A}$	25°C		-4.85	-4.91		-4.85		-4.91	
		Full range		-4.85			-4.85			
	$V_{IC} = 0\text{ V}, I_O = 5\text{ mA}$	25°C		-3.5	-4.1		-3.5		-4.1	
A_{VD} Large-signal differential voltage amplification	$V_O = \pm 4\text{ V}$	$R_L = 10\text{ k}\Omega$	25°C		20	50		20	50	V/mV
			Full range		20			20		
		$R_L = 1\text{ M}\Omega$	25°C		300			300		
r_{id} Differential input resistance		25°C		10^{12}			10^{12}	Ω		
r_i Common-mode input resistance		25°C		10^{12}			10^{12}	Ω		
c_i Common-mode input capacitance	$f = 10\text{ kHz}, \text{ N package}$	25°C		8			8	pF		
z_o Closed-loop output impedance	$f = 1\text{ MHz}, A_V = 10$	25°C		130			130	Ω		
CMRR Common-mode rejection ratio	$V_{IC} = -5\text{ V to } 2.7\text{ V}, V_O = 0\text{ V}, R_S = 50\ \Omega$	25°C		75	80		75	80	dB	
		Full range		75			75			
k_{SVR} Supply-voltage rejection ratio ($\Delta V_{DD\pm}/\Delta V_{IO}$)	$V_{DD\pm} = \pm 2.2\text{ V to } \pm 8\text{ V}, V_{IC} = 0\text{ V}, \text{ No load}$	25°C		80	95		80	95	dB	
		Full range		80			80			
I_{DD} Supply current	$V_O = 0\text{ V}, \text{ No load}$	25°C		4.8	6		4.8	6	mA	
		Full range			6			6		

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

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

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TLC2274Q operating characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5\text{ V}$

PARAMETER	TEST CONDITIONS	T_A †	TLC2274Q			TLC2274AQ			UNIT	
			MIN	TYP	MAX	MIN	TYP	MAX		
SR	Slew rate at unity gain $V_O = \pm 2.3\text{ V}$, $C_L = 100\text{ pF}$, $R_L = 10\text{ k}\Omega$,	25°C	2.3	3.6		2.3	3.6		V/ μs	
		Full range	1.7			1.7				
V_n	Equivalent input noise voltage $f = 10\text{ Hz}$ $f = 1\text{ kHz}$	25°C	50			50			nV/ $\sqrt{\text{Hz}}$	
		25°C	9			9				
$V_{N(PP)}$	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	1			1			μV	
		25°C	1.4			1.4				
I_n	Equivalent input noise current	25°C	0.6			0.6			fA/ $\sqrt{\text{Hz}}$	
THD + N	Total harmonic distortion plus noise $V_O = \pm 2.3\text{ V}$, $R_L = 10\text{ k}\Omega$, $f = 20\text{ kHz}$	25°C	$A_V = 1$	0.0011%			0.0011%			
			$A_V = 10$	0.004%			0.004%			
			$A_V = 100$	0.03%			0.03%			
	Gain-bandwidth product $f = 10\text{ kHz}$, $C_L = 100\text{ pF}$, $R_L = 10\text{ k}\Omega$,	25°C	2.25			2.25			MHz	
B_{OM}	Maximum output-swing bandwidth $V_{O(PP)} = 4.6\text{ V}$, $R_L = 10\text{ k}\Omega$, $A_V = 1$, $C_L = 100\text{ pF}$	25°C	0.54			0.54			MHz	
t_s	Settling time $A_V = -1$, Step = $-2.3\text{ V to }2.3\text{ V}$, $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$	25°C	To 0.1%	1.5			1.5			μs
			To 0.01%	3.2			3.2			
ϕ_m	Phase margin at unit gain $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$	25°C	52°			52°				
		25°C	10			10				
	Gain margin	25°C	10			10			dB	

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

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TYPICAL CHARACTERISTICS

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

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TYPICAL CHARACTERISTICS

**DISTRIBUTION OF TLC2272
INPUT OFFSET VOLTAGE**

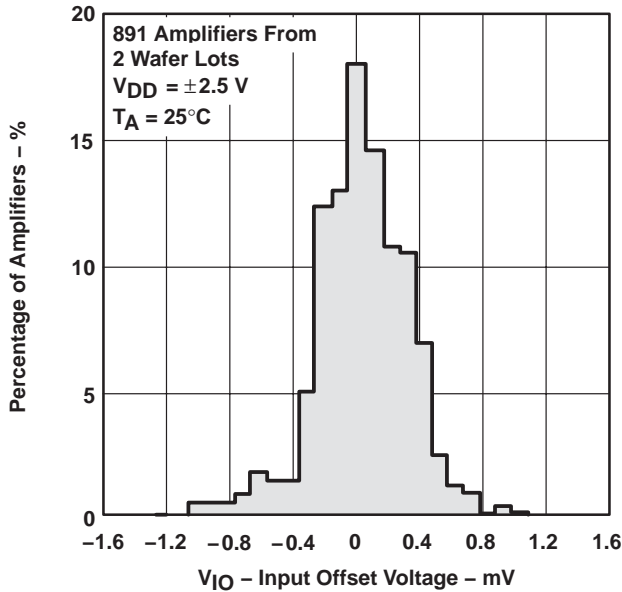


Figure 1

**DISTRIBUTION OF TLC2272
INPUT OFFSET VOLTAGE**

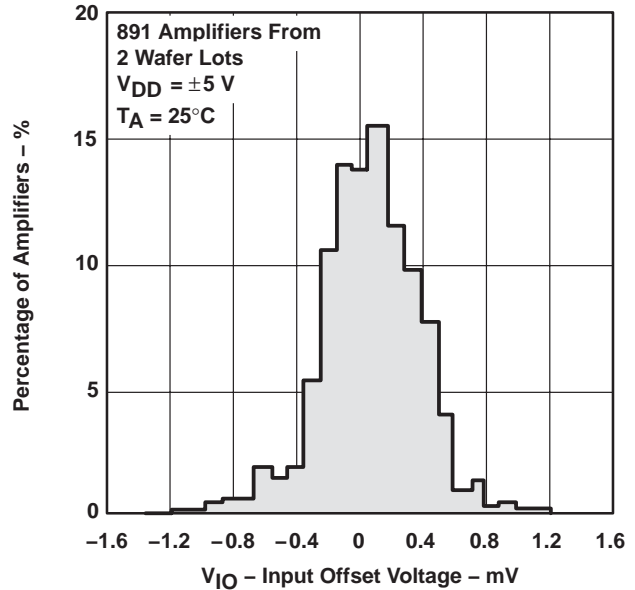


Figure 2

**DISTRIBUTION OF TLC2274
INPUT OFFSET VOLTAGE**

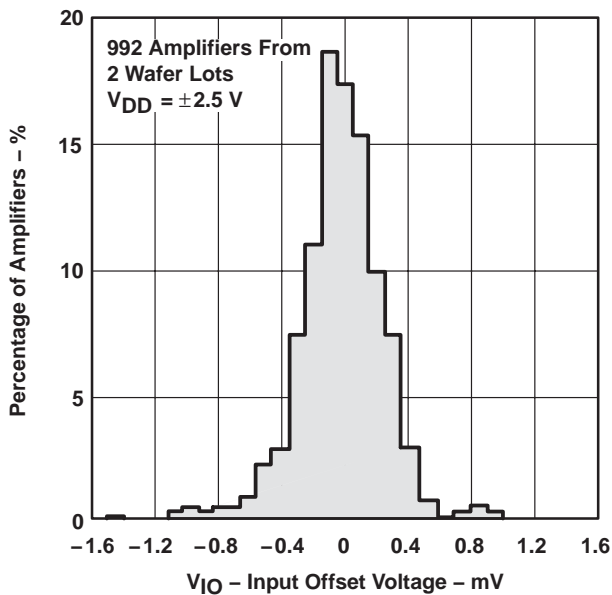


Figure 3

**DISTRIBUTION OF TLC2274
INPUT OFFSET VOLTAGE**

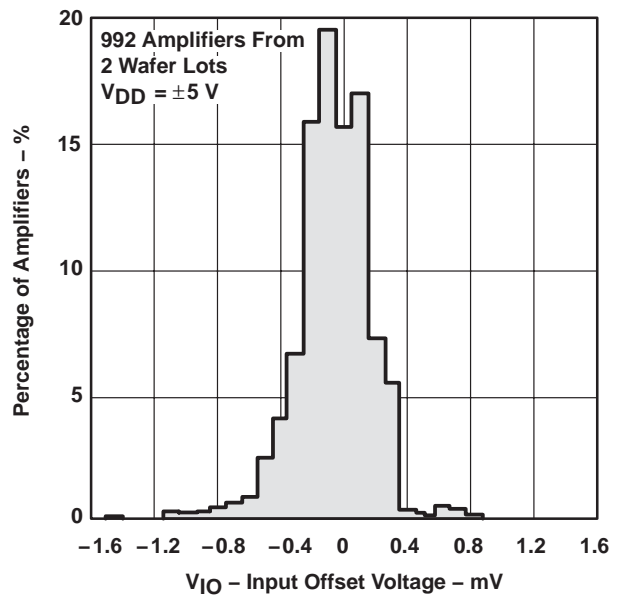


Figure 4

TYPICAL CHARACTERISTICS

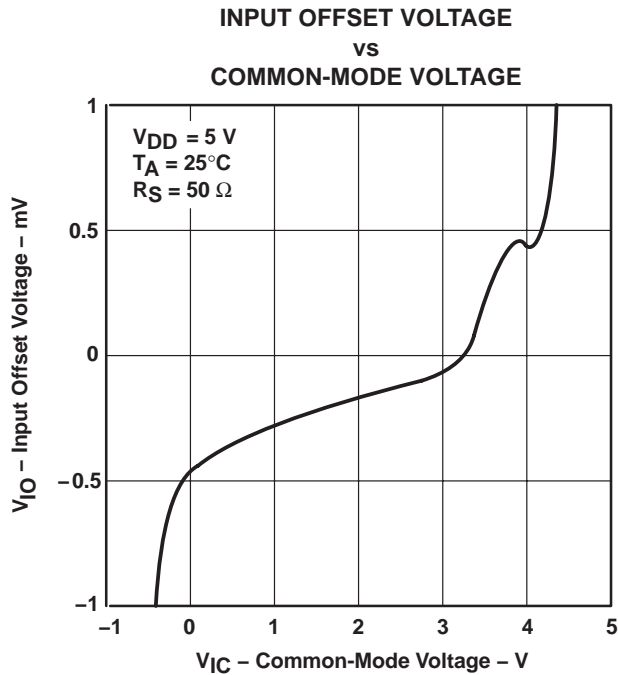


Figure 5

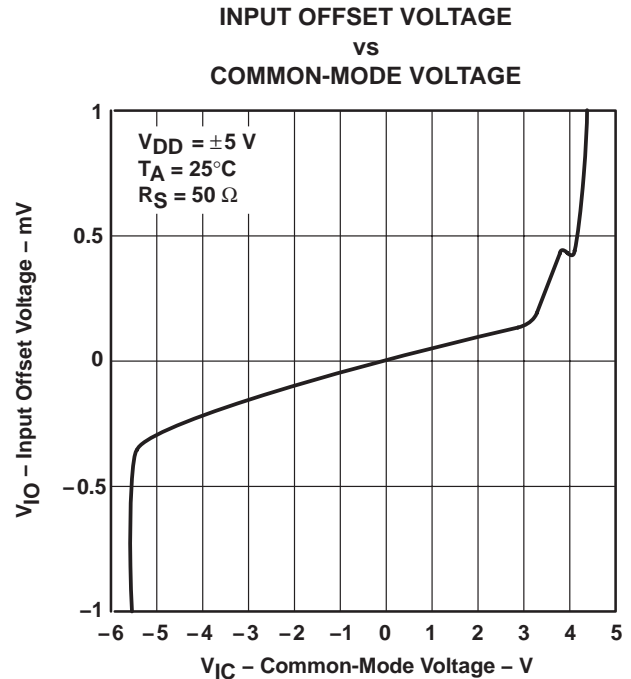


Figure 6

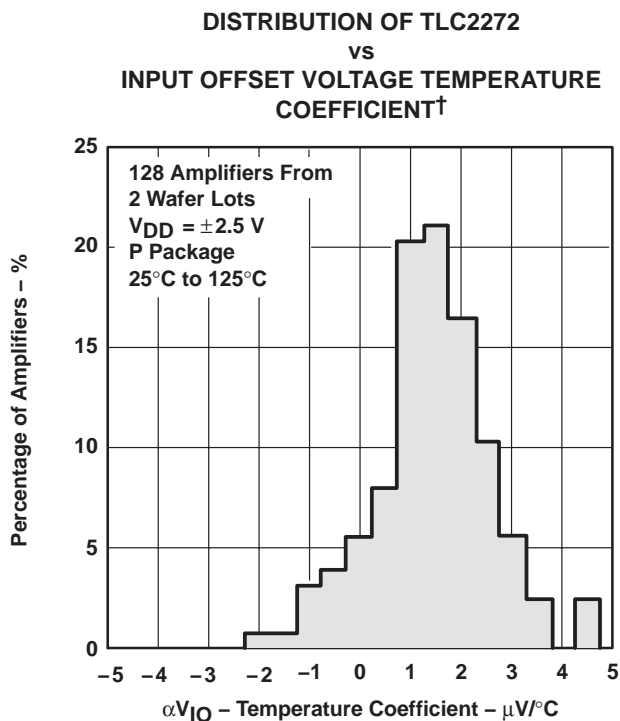


Figure 7

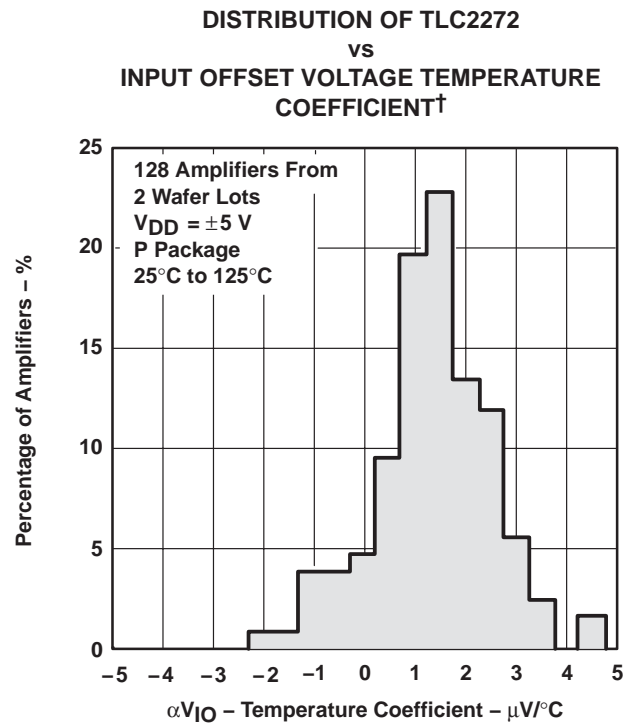


Figure 8

† 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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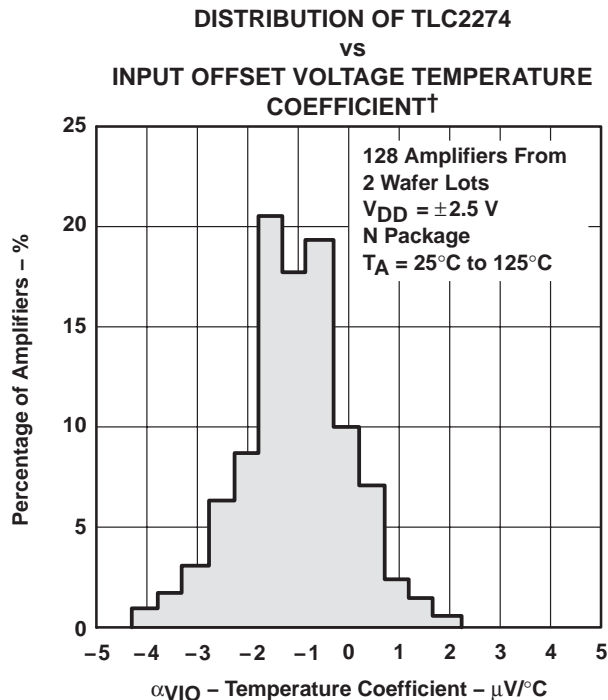


Figure 9

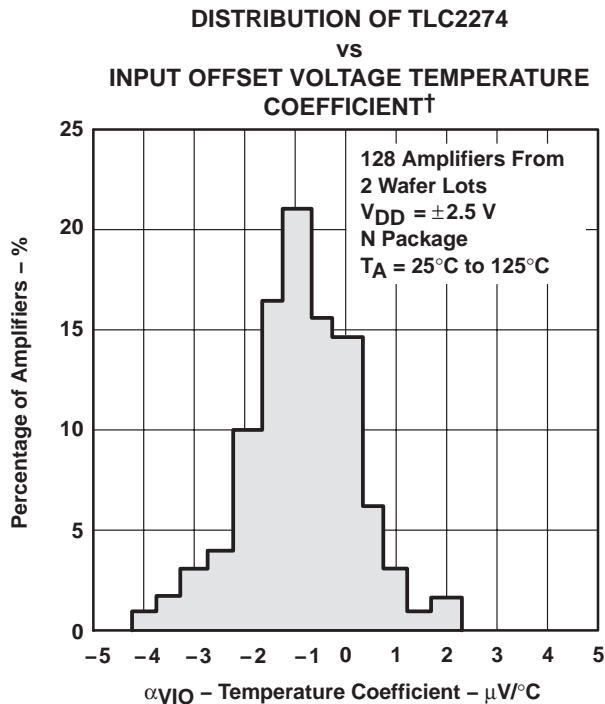


Figure 10

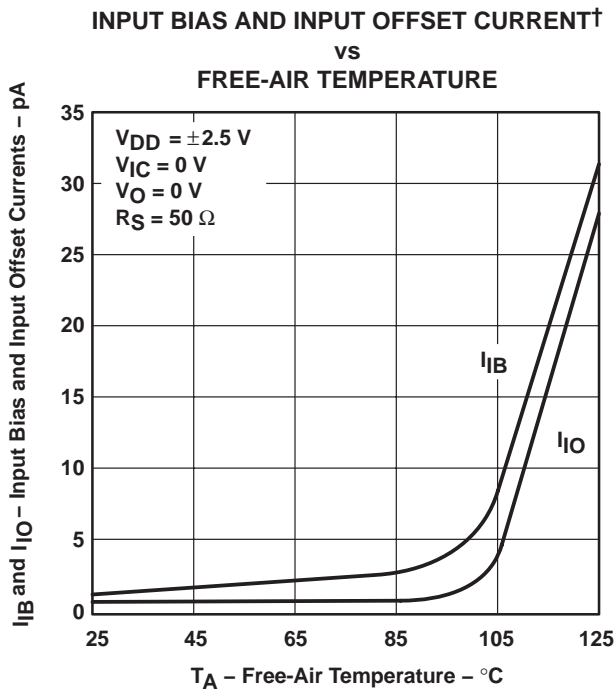


Figure 11

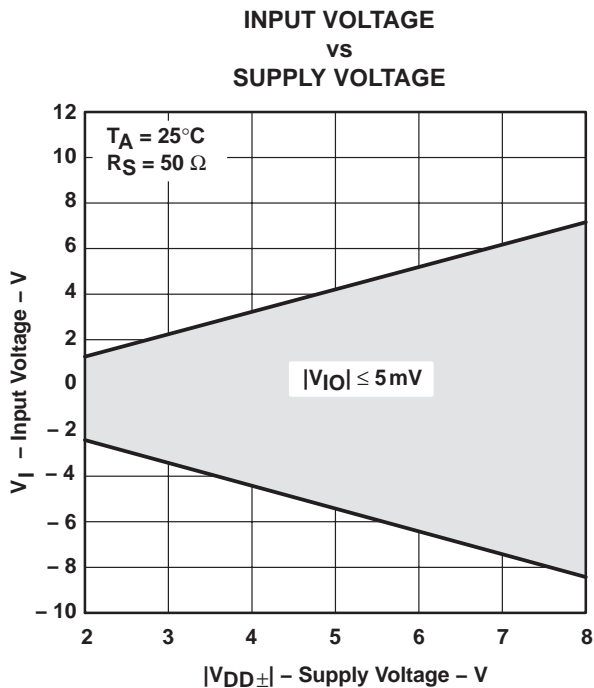


Figure 12

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

TYPICAL CHARACTERISTICS

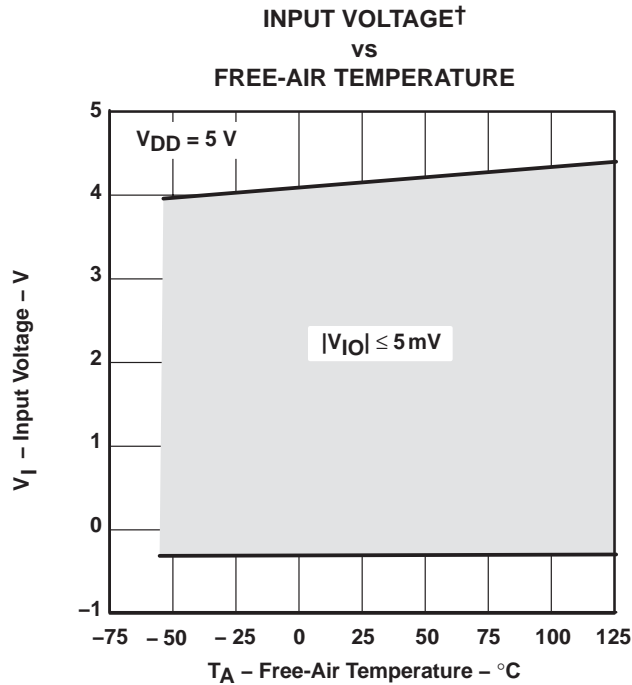


Figure 13

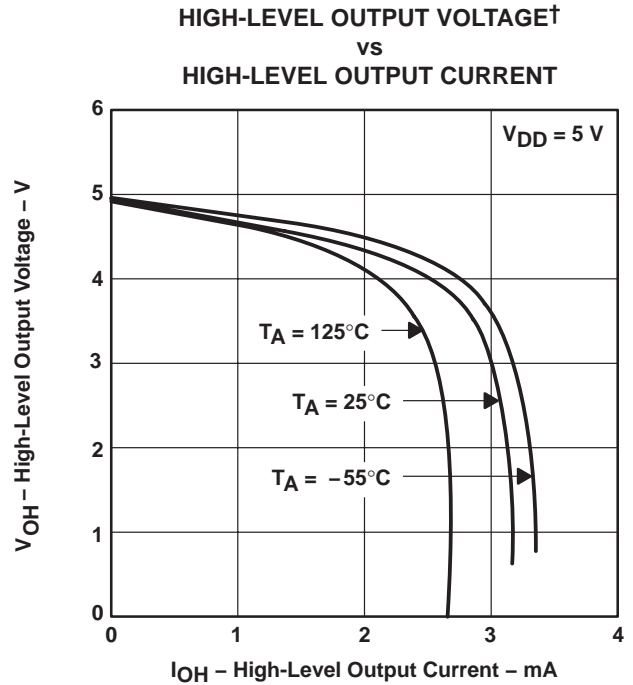


Figure 14

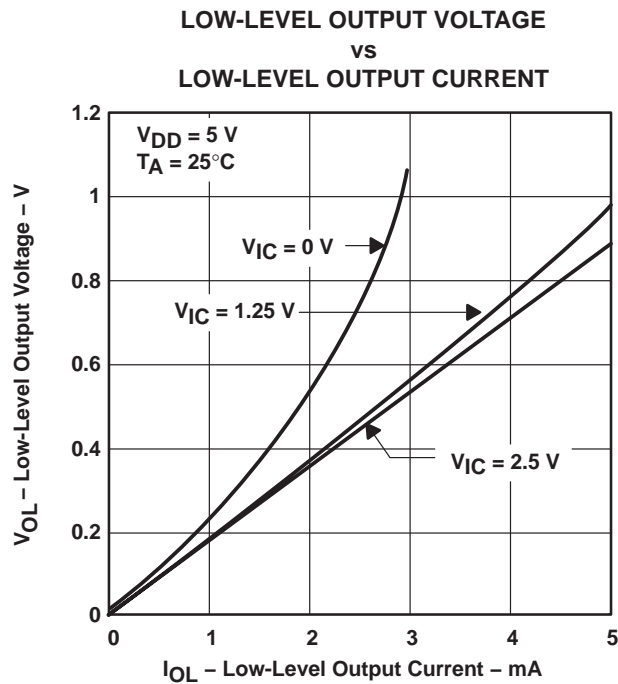


Figure 15

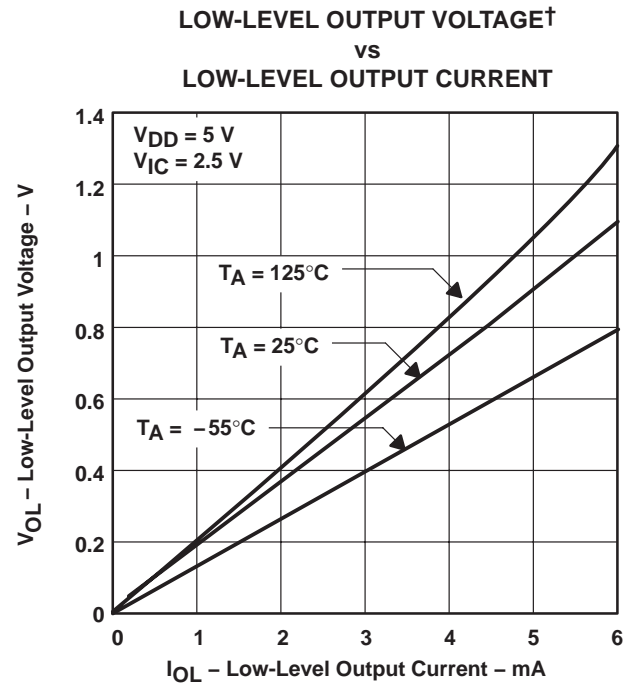


Figure 16

† 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

MAXIMUM POSITIVE PEAK OUTPUT VOLTAGE†
vs
OUTPUT CURRENT

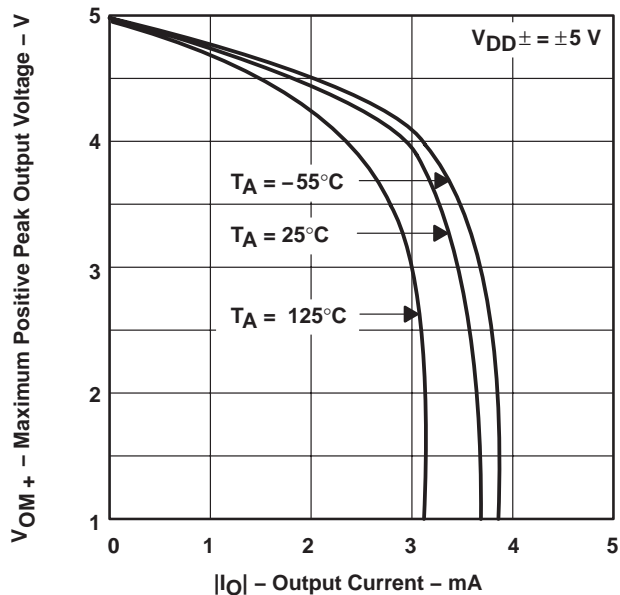


Figure 17

MAXIMUM NEGATIVE PEAK OUTPUT VOLTAGE†
vs
OUTPUT CURRENT

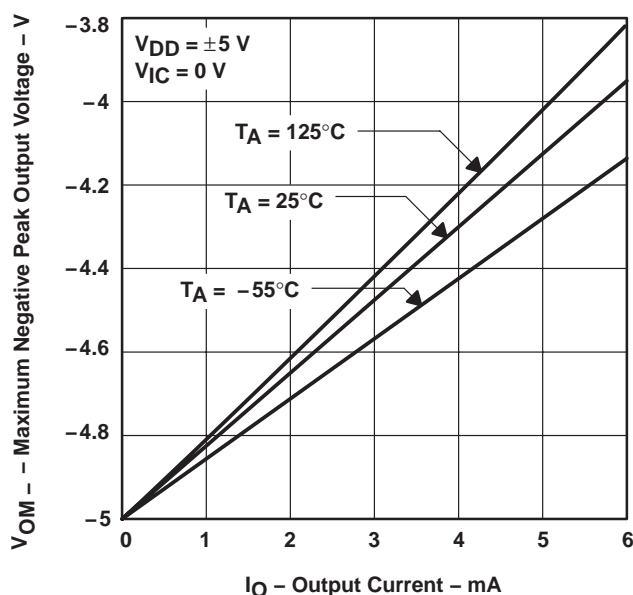


Figure 18

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE
vs
FREQUENCY

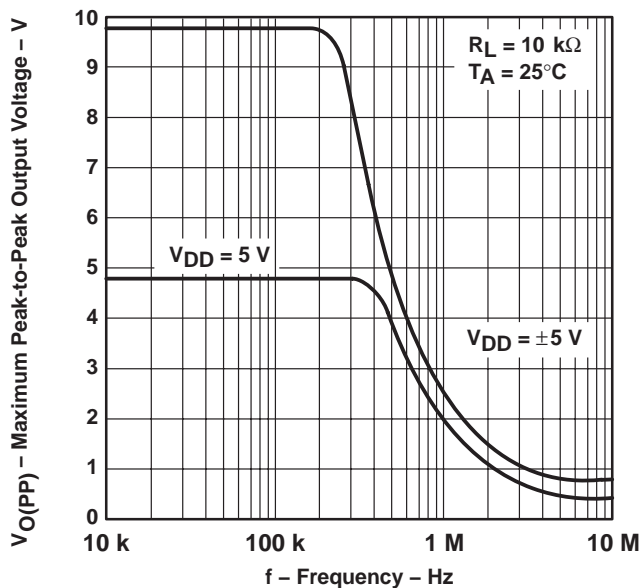


Figure 19

SHORT-CIRCUIT OUTPUT CURRENT
vs
SUPPLY VOLTAGE

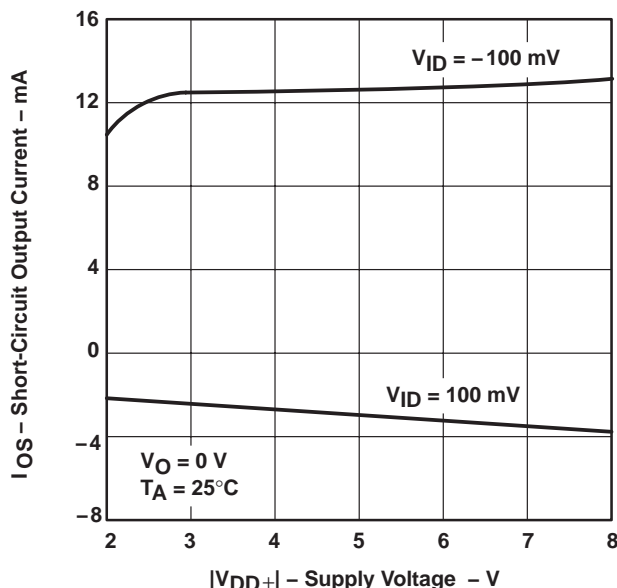


Figure 20

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

TYPICAL CHARACTERISTICS

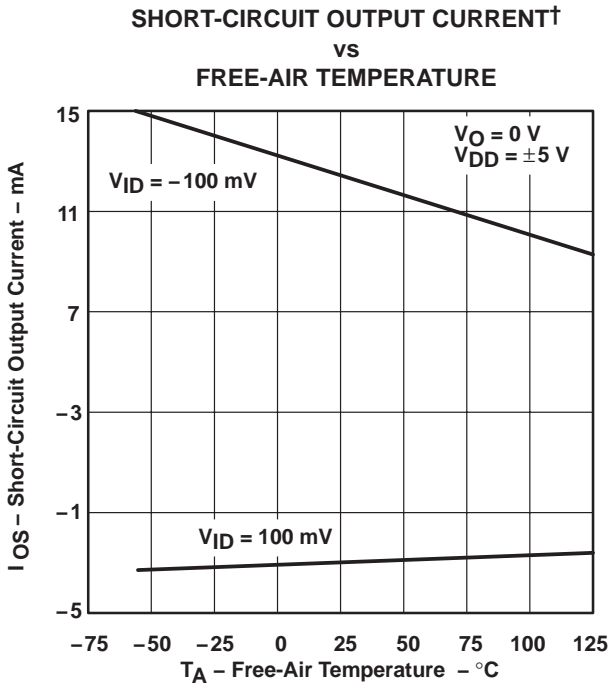


Figure 21

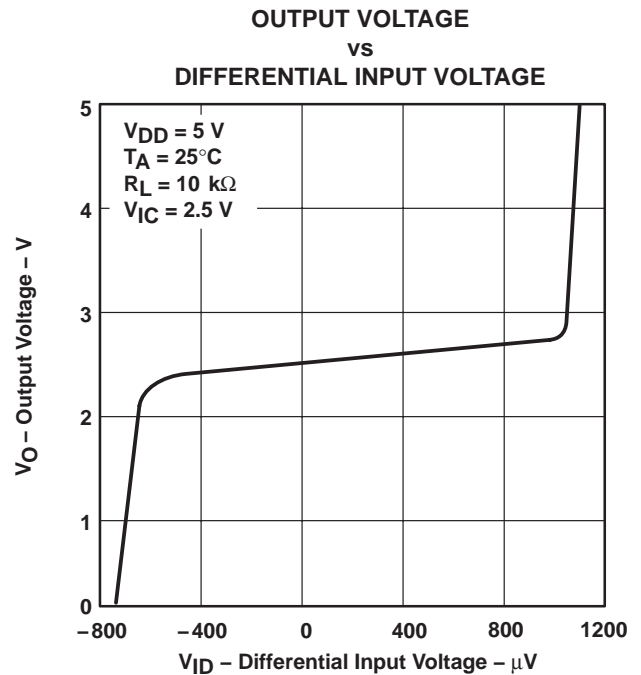


Figure 22

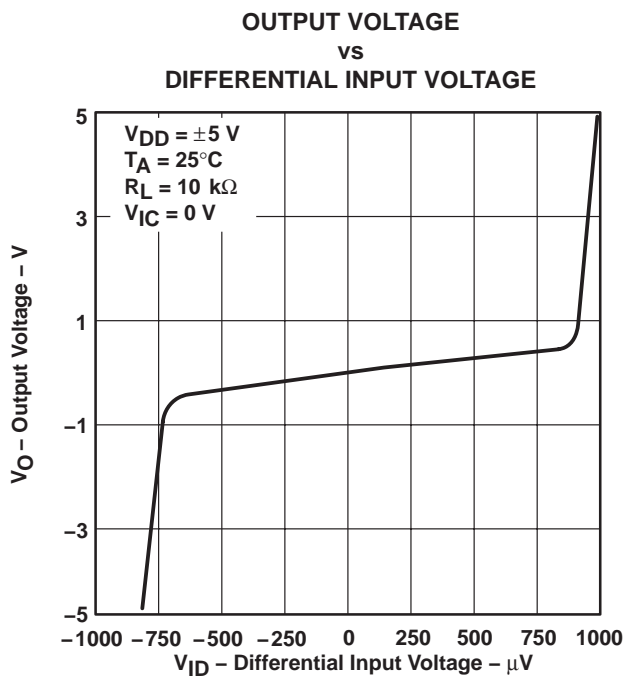


Figure 23

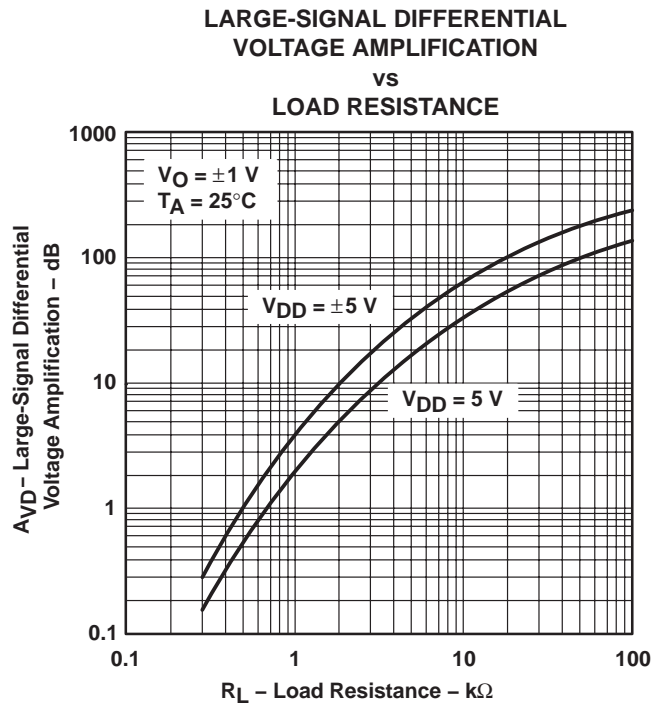


Figure 24

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

TYPICAL CHARACTERISTICS

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE MARGIN
vs
FREQUENCY

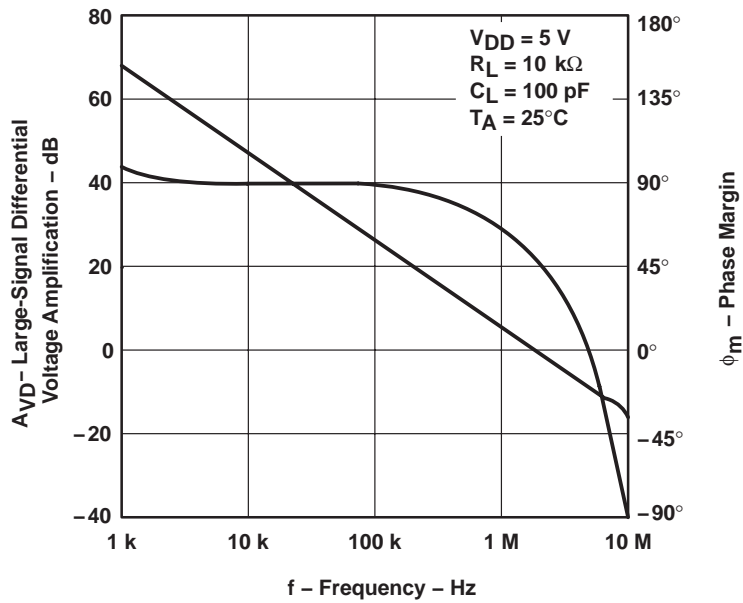


Figure 25

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE MARGIN
vs
FREQUENCY

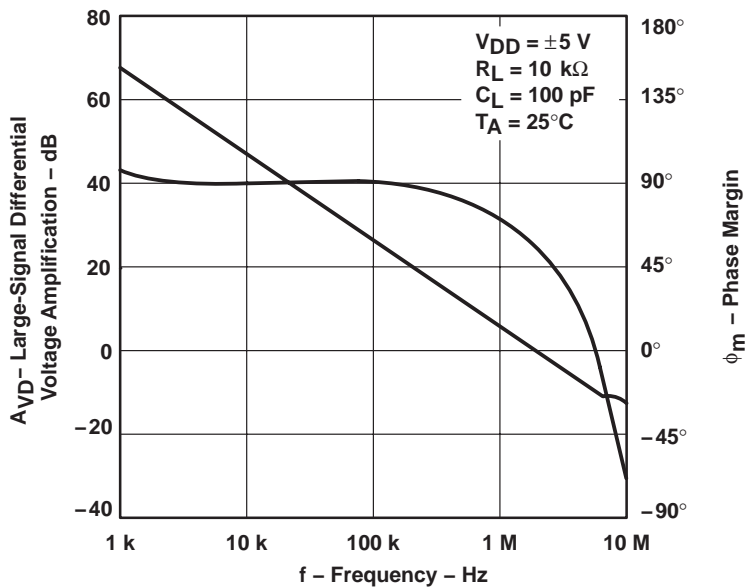


Figure 26

TYPICAL CHARACTERISTICS

LARGE-SIGNAL DIFFERENTIAL
 VOLTAGE AMPLIFICATION†
 vs
 FREE-AIR TEMPERATURE

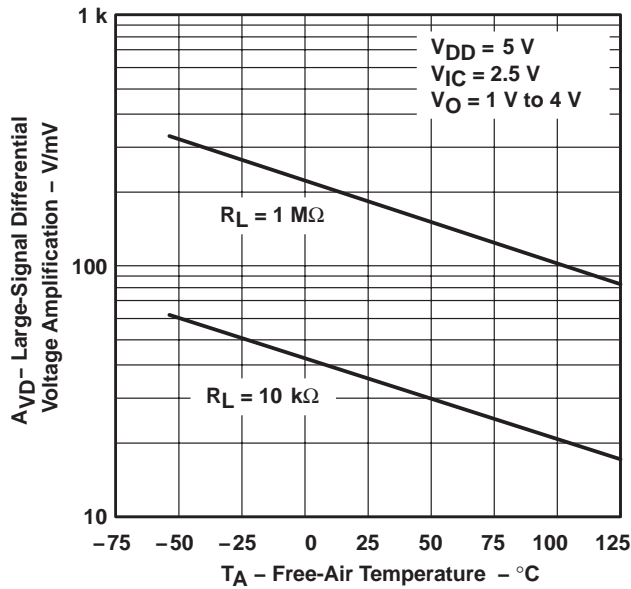


Figure 27

LARGE-SIGNAL DIFFERENTIAL
 VOLTAGE AMPLIFICATION†
 vs
 FREE-AIR TEMPERATURE

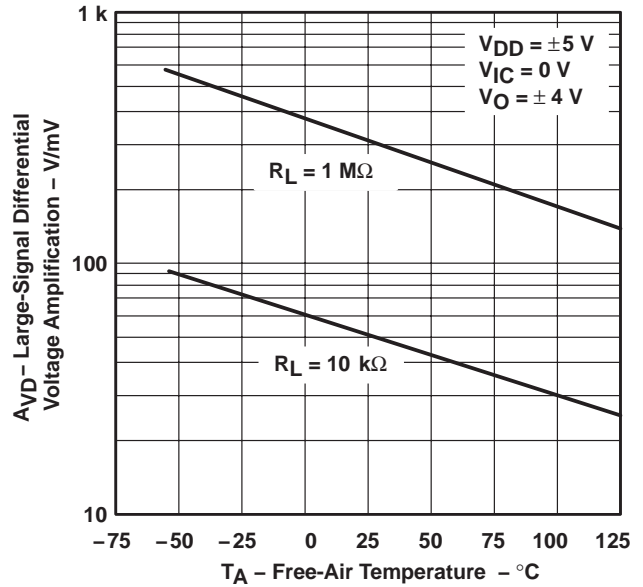


Figure 28

OUTPUT IMPEDANCE
 vs
 FREQUENCY

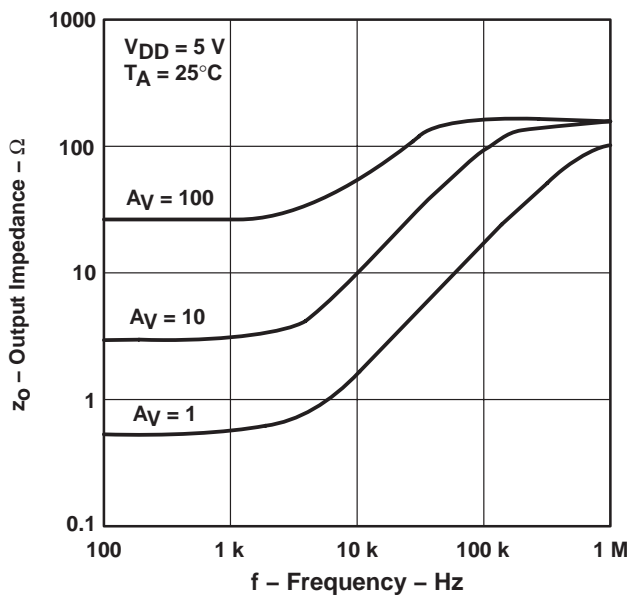


Figure 29

OUTPUT IMPEDANCE
 vs
 FREQUENCY

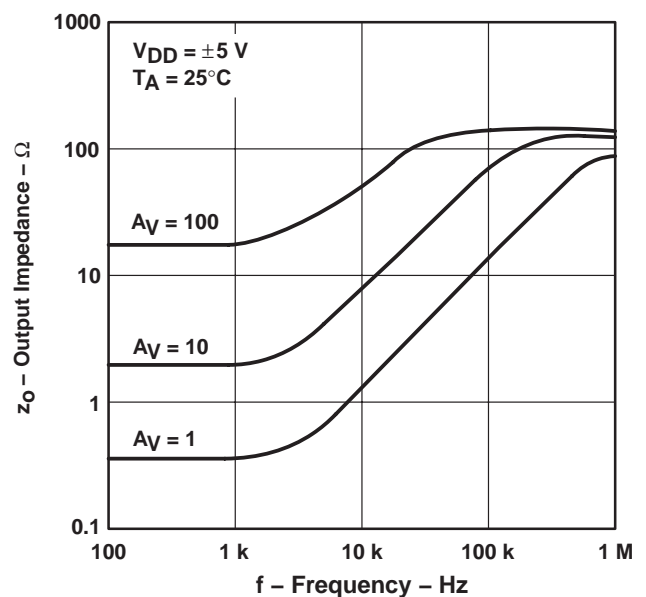


Figure 30

† 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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COMMON-MODE REJECTION RATIO
 vs
FREQUENCY

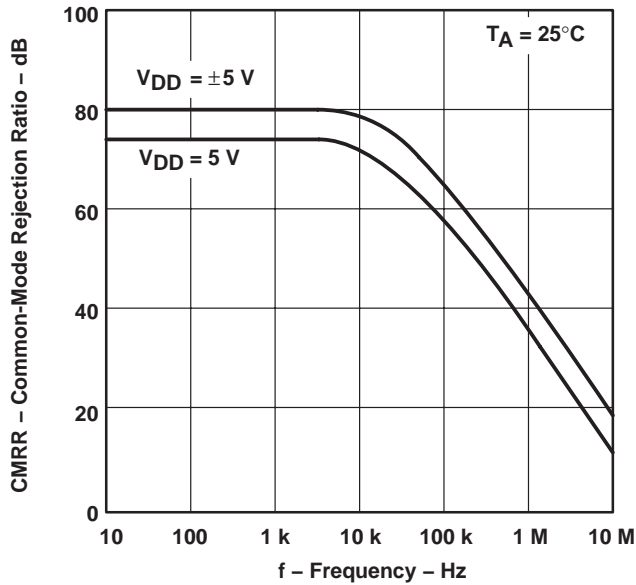


Figure 31

COMMON-MODE REJECTION RATIO
 vs
FREE-AIR TEMPERATURE

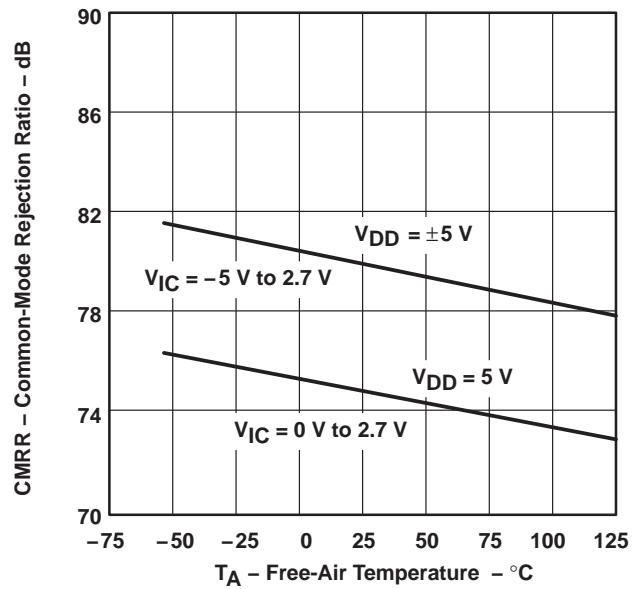


Figure 32

SUPPLY-VOLTAGE REJECTION RATIO
 vs
FREQUENCY

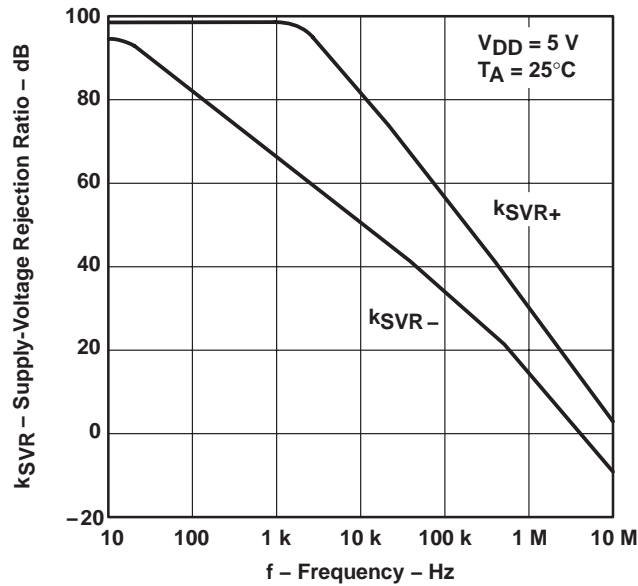


Figure 33

SUPPLY-VOLTAGE REJECTION RATIO
 vs
FREQUENCY

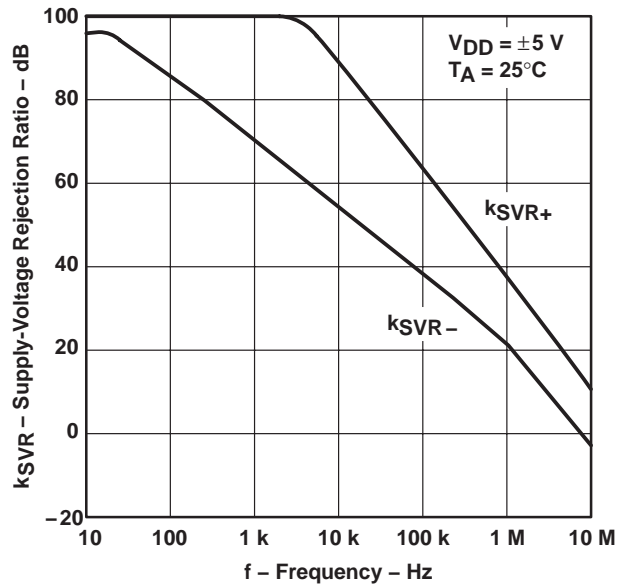


Figure 34

TYPICAL CHARACTERISTICS

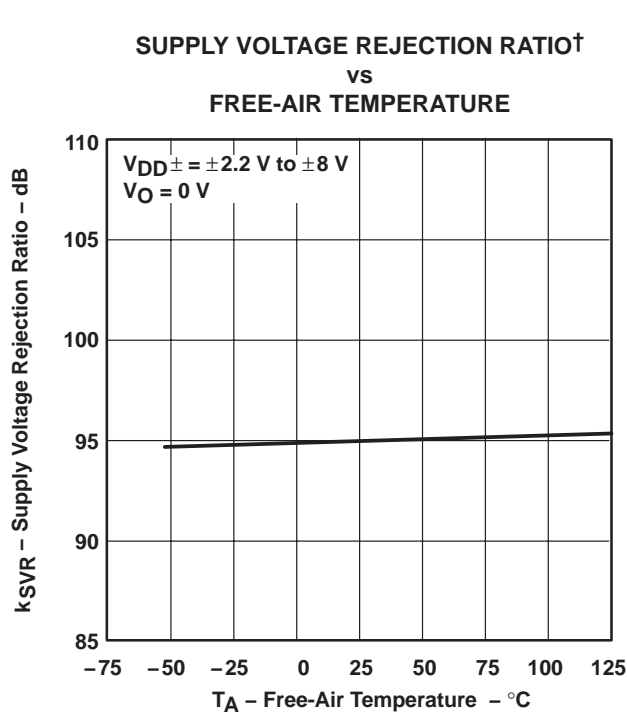


Figure 35

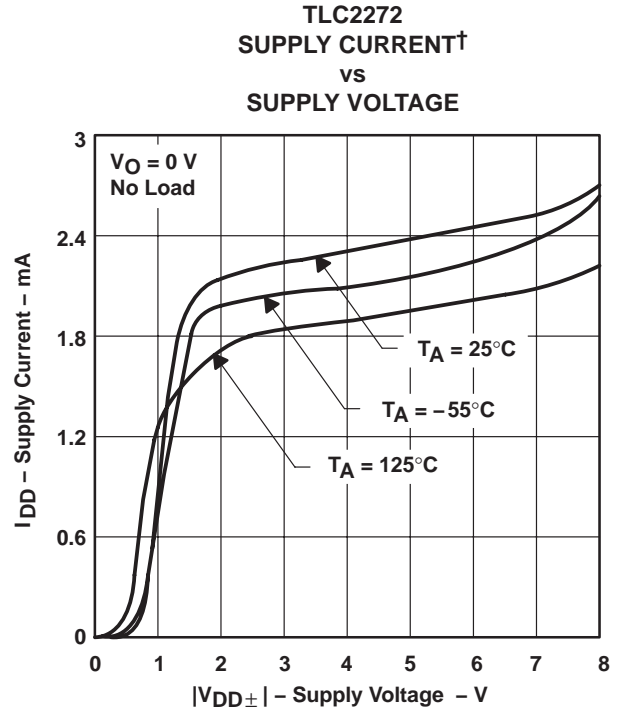


Figure 36

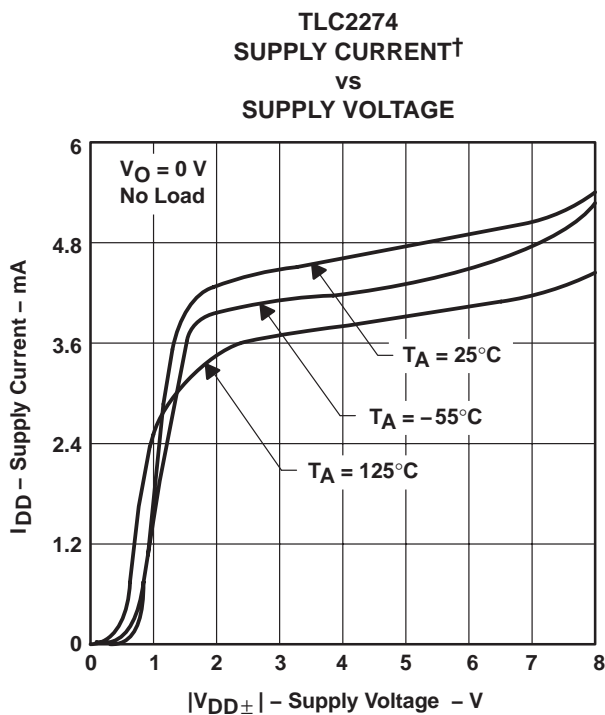


Figure 37

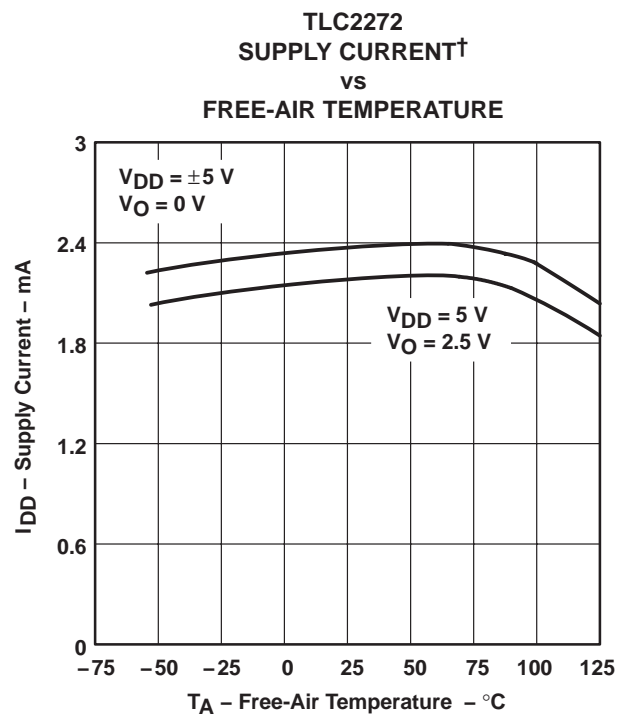


Figure 38

† 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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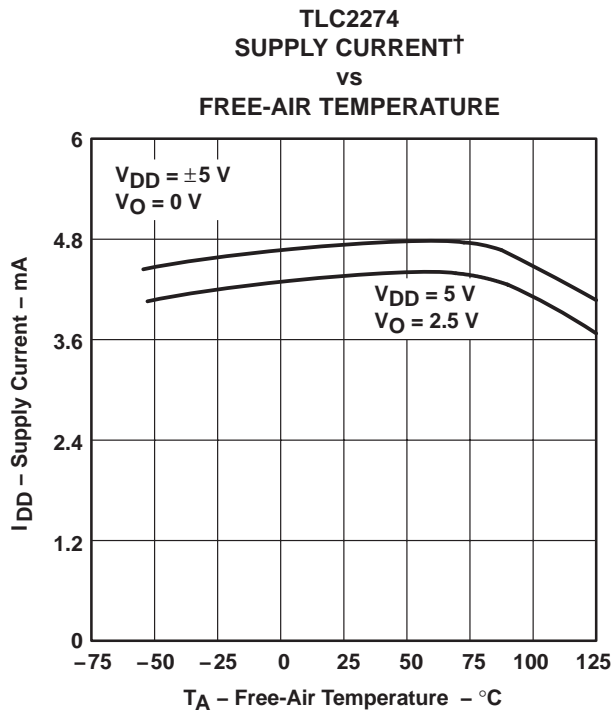


Figure 39

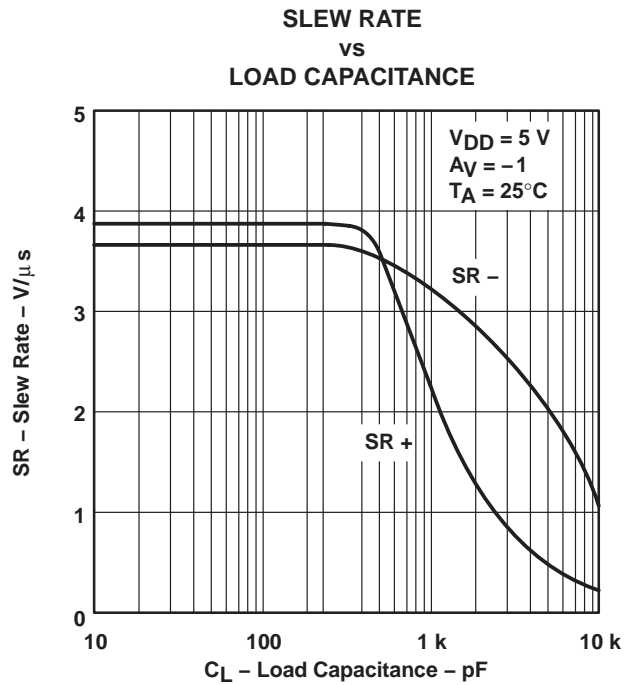


Figure 40

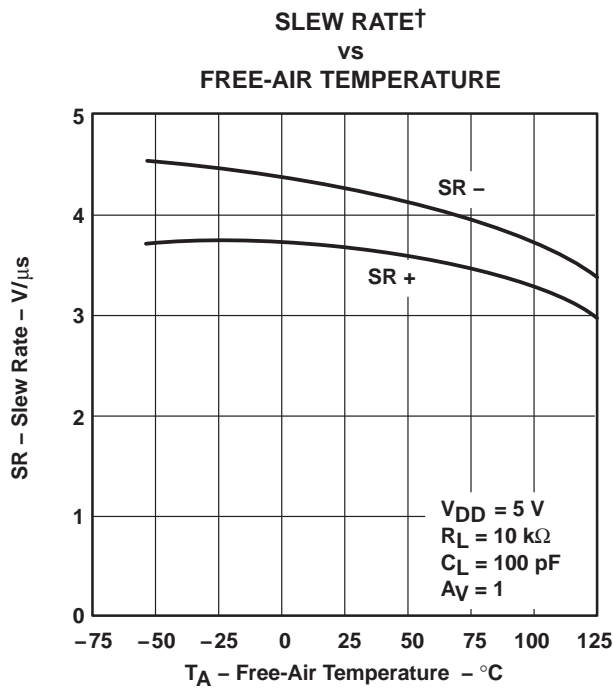


Figure 41

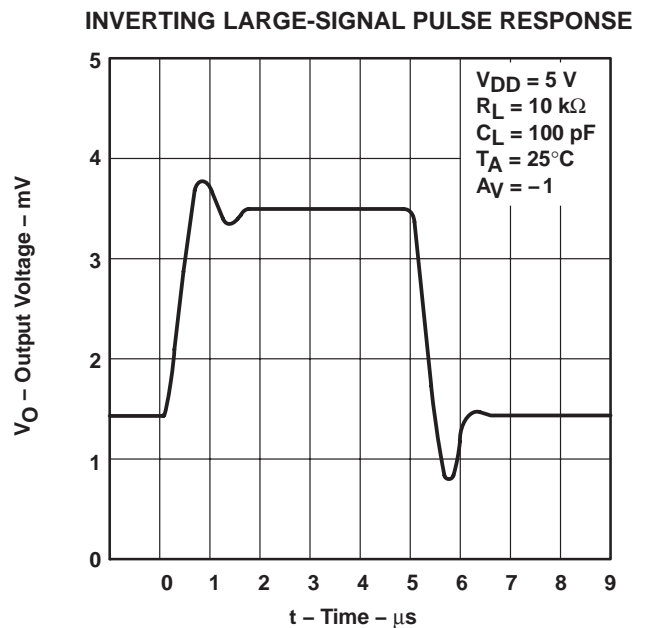


Figure 42

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

TYPICAL CHARACTERISTICS

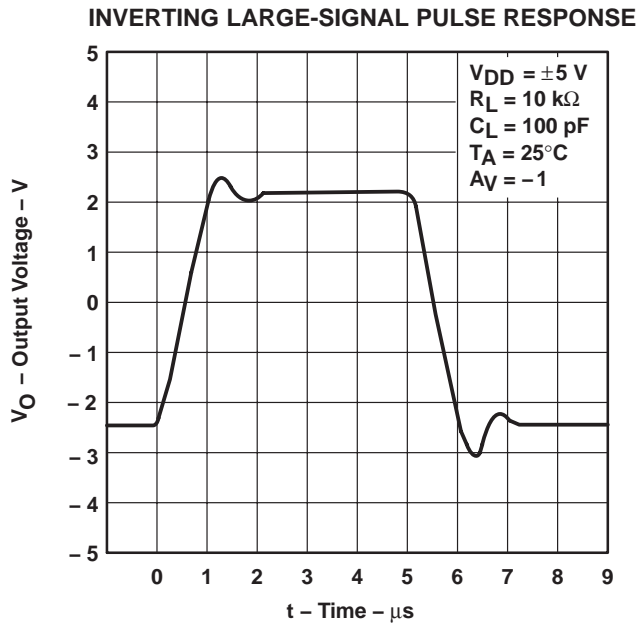


Figure 43

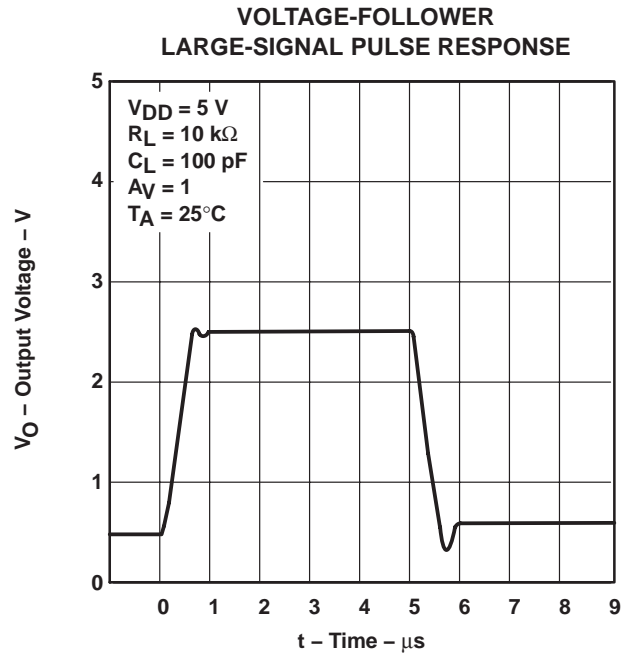


Figure 44

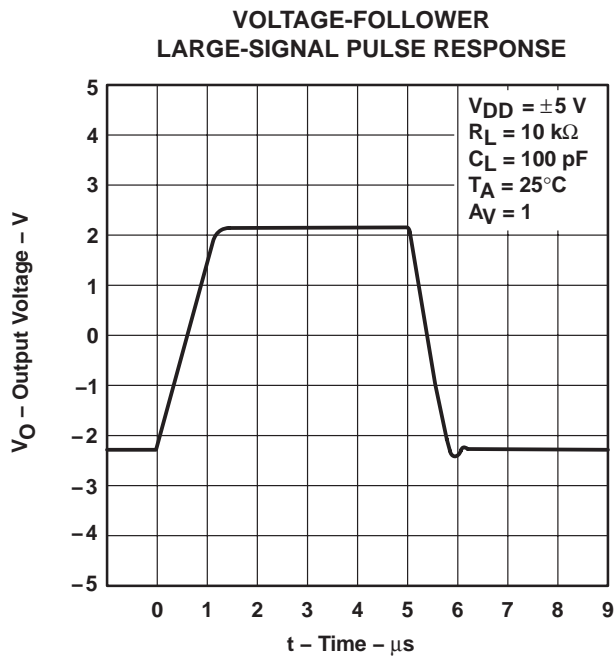


Figure 45

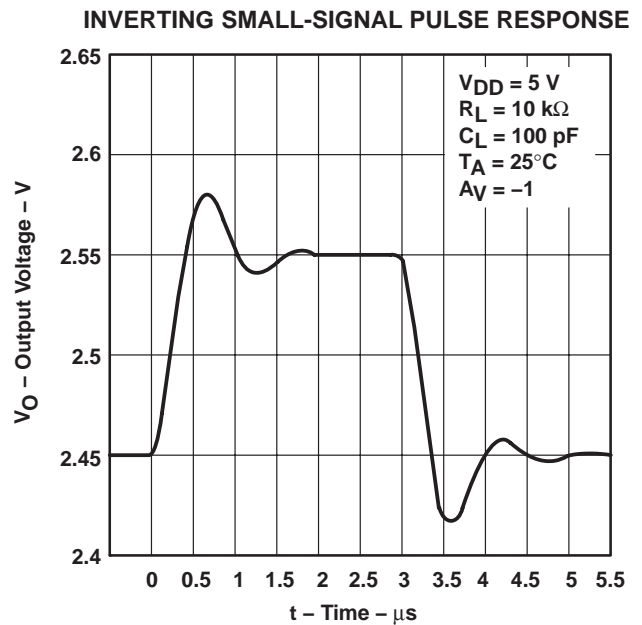


Figure 46

TYPICAL CHARACTERISTICS

INVERTING SMALL-SIGNAL PULSE RESPONSE

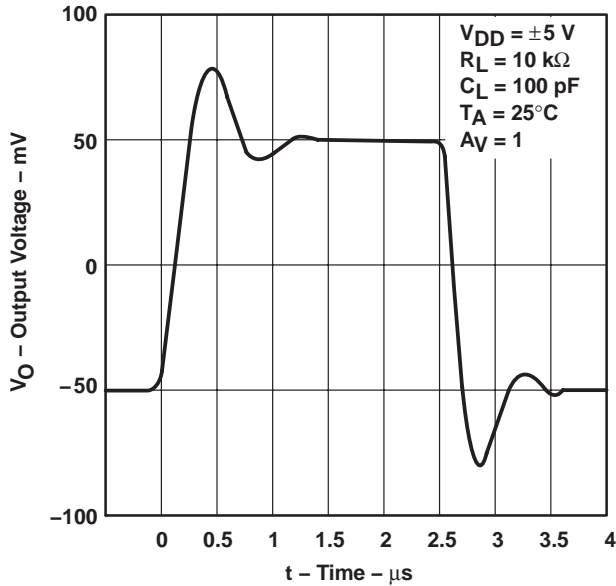


Figure 47

VOLTAGE-FOLLOWER SMALL-SIGNAL PULSE RESPONSE

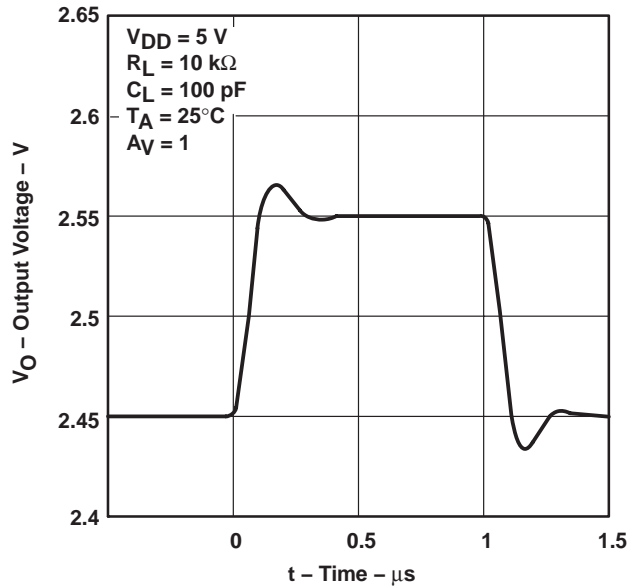


Figure 48

VOLTAGE-FOLLOWER SMALL-SIGNAL PULSE RESPONSE

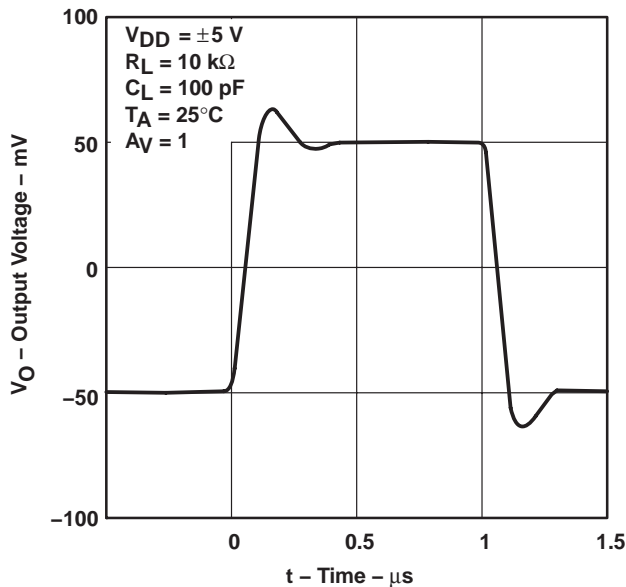


Figure 49

EQUIVALENT INPUT NOISE VOLTAGE vs FREQUENCY

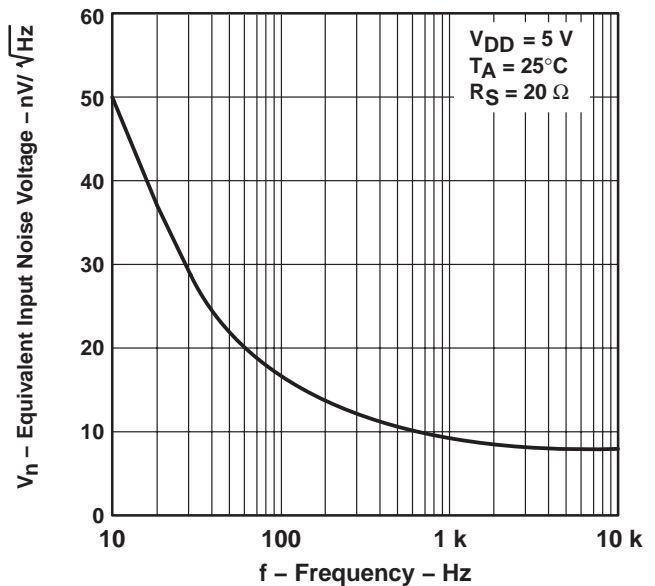


Figure 50

TYPICAL CHARACTERISTICS

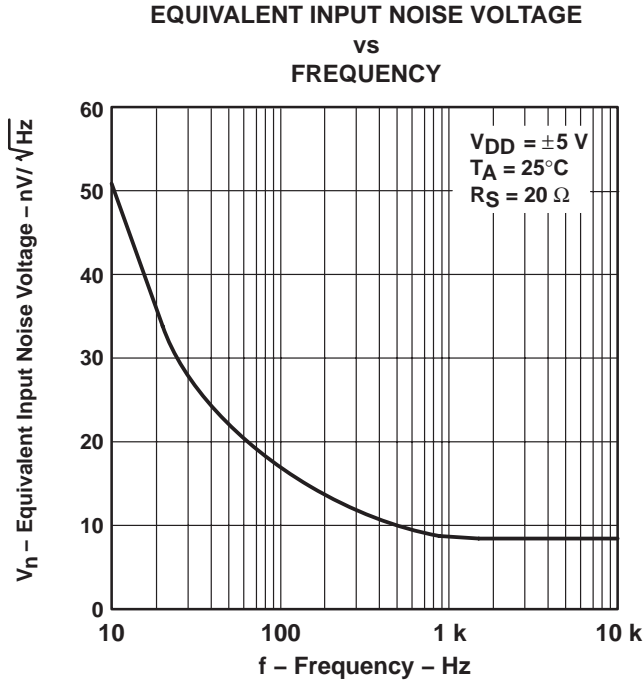


Figure 51

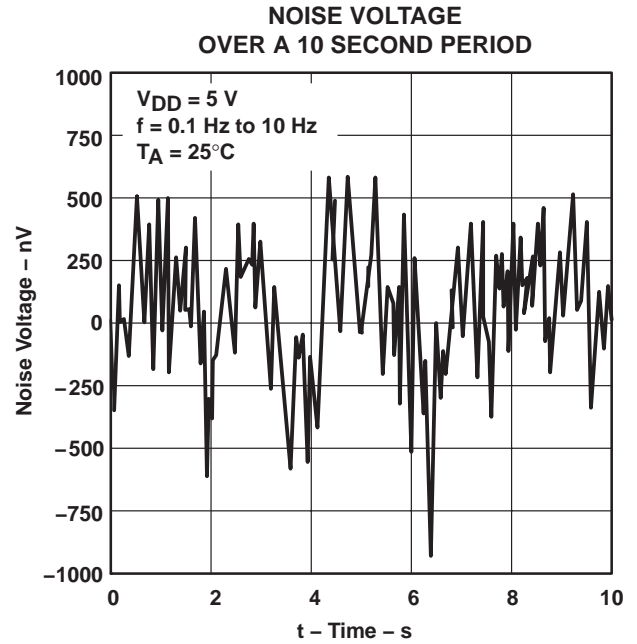


Figure 52

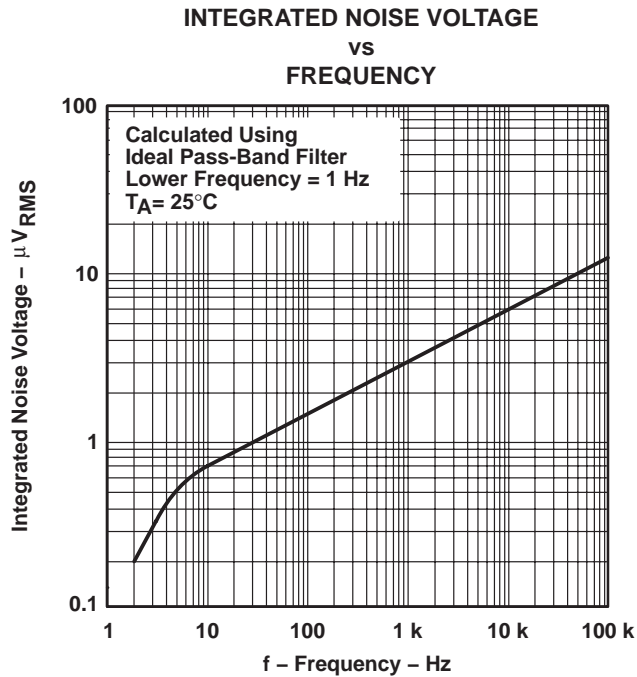


Figure 53

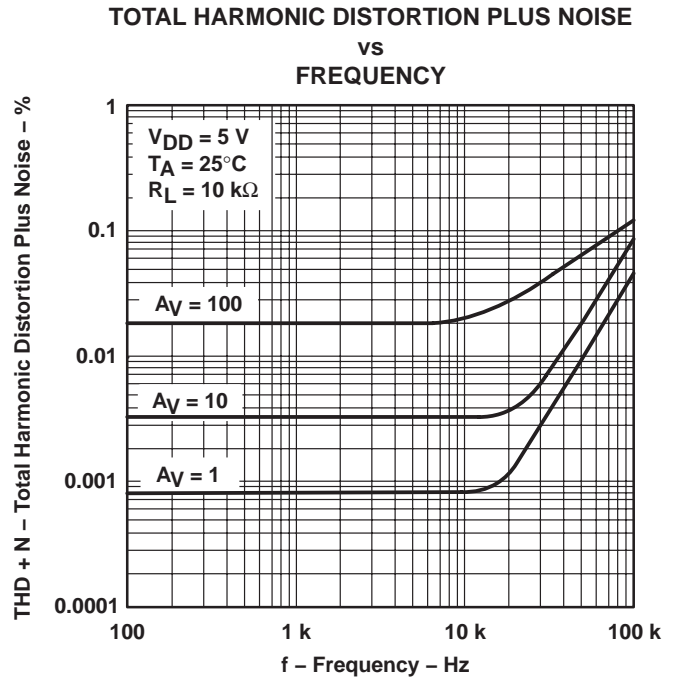


Figure 54

TLC227x-Q1, TLC227xA-Q1
Advanced LinCMOS™ RAIL-TO-RAIL
OPERATIONAL AMPLIFIERS
 SGLS007B – FEBRUARY 2003 – REVISED OCTOBER 2003

TYPICAL CHARACTERISTICS

GAIN-BANDWIDTH PRODUCT
vs
SUPPLY VOLTAGE

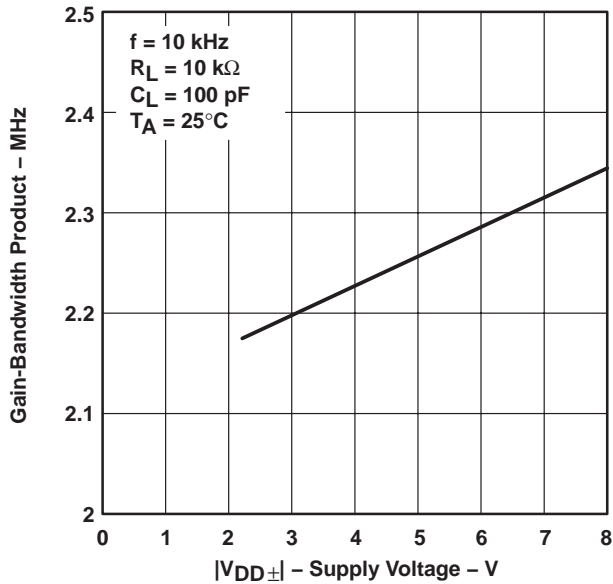


Figure 55

GAIN-BANDWIDTH PRODUCT†
vs
FREE-AIR TEMPERATURE

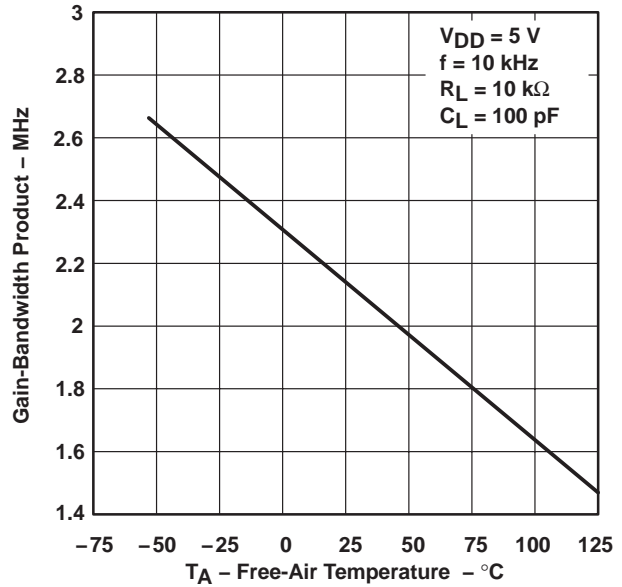


Figure 56

PHASE MARGIN
vs
LOAD CAPACITANCE

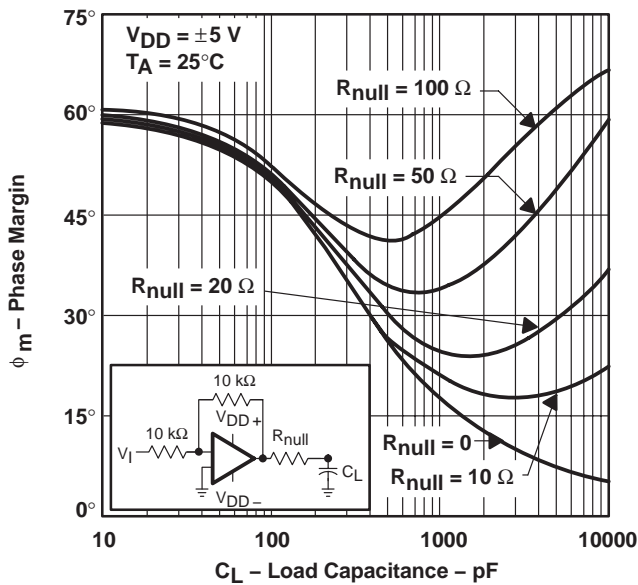


Figure 57

GAIN MARGIN
vs
LOAD CAPACITANCE

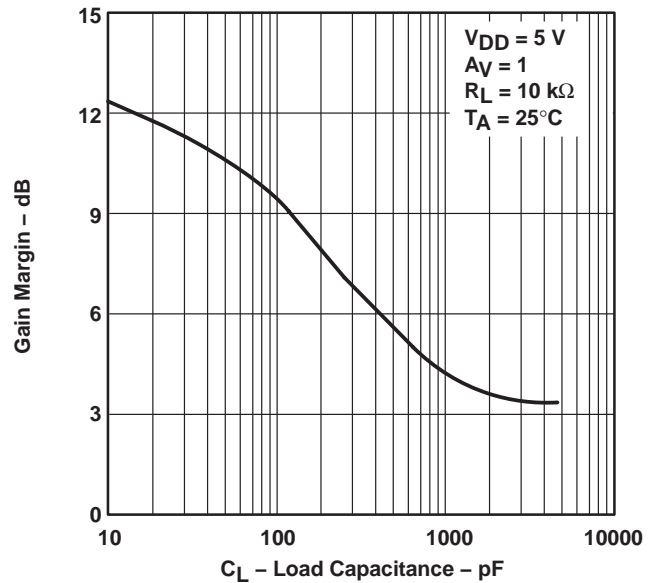


Figure 58

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

TLC227x-Q1, TLC227xA-Q1 Advanced LinCMOS™ RAIL-TO-RAIL OPERATIONAL AMPLIFIERS

SGLS007B – FEBRUARY 2003 – REVISED OCTOBER 2003

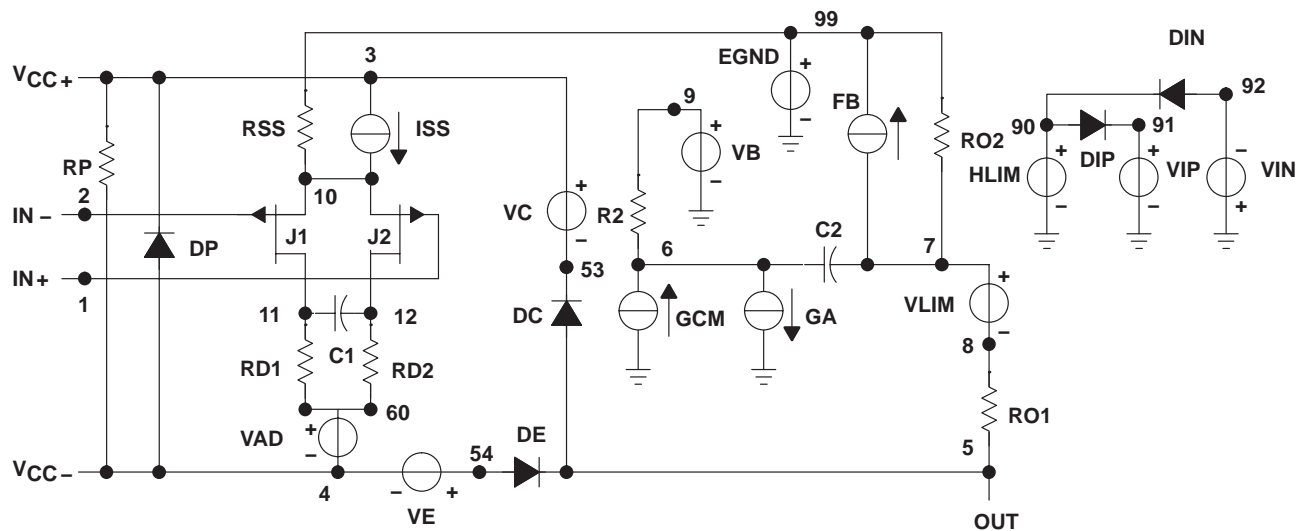
APPLICATION INFORMATION

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 59 were generated using the TLC227x 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).



```
.SUBCKT TLC227x 1 2 3 4 5
C1      11      1214E-12
C2      6       760.00E-12
DC      5       53DX
DE      54      5DX
DLP     90      91DX
DLN     92      90DX
DP      4       3DX
EGND    99      0POLY (2) (3,0) (4,) 0 .5 .5
FB      99      0POLY (5) VB VC VE VLP VLN 0
+ 984.9E3 -1E6 1E6 1E6 -1E6
GA      6       011 12 377.0E-6
GCM 0 6 10 99 134E-9
ISS     3       10DC 216.OE-6
HLIM    90      0VLIM 1K
J1      11      210 JX
J2      12      110 JX
R2      6       9100.OE3
RD1     60      112.653E3
RD2     60      122.653E3
R01     8       550
R02     7       9950
RP      3       44.310E3
RSS     10      99925.9E3
VAD     60      4-.5
VB      9       0DC 0
VC 3 53 DC .78
VE      54      4DC .78
VLIM    7       8DC 0
VLP     91      0DC 1.9
VLN     0       92DC 9.4
.MODEL DX D (IS=800.0E-18)
.MODEL JX PJF (IS=1.500E-12BETA=1.316E-3
+ VTO=-.270)
.ENDS
```

Figure 59. Boyle Macromodel and Subcircuit

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Macromodels, simulation models, or other models provided by TI, directly or indirectly, are not warranted by TI as fully representing all of the specification and operating characteristics of the semiconductor product to which the model relates.

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
TLC2272AQDRG4Q1	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2272AQDRQ1	ACTIVE	SOIC	D	8	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-250C-1 YEAR/ Level-1-235C-UNLIM
TLC2272AQPWRG4Q1	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2272AQPWRQ1	ACTIVE	TSSOP	PW	8	2000	TBD	CU NIPDAU	Level-1-250C-UNLIM
TLC2272QDRG4Q1	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2272QDRQ1	ACTIVE	SOIC	D	8	2500	TBD	CU NIPDAU	Level-1-220C-UNLIM
TLC2272QPWRG4Q1	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2272QPWRQ1	ACTIVE	TSSOP	PW	8	2000	TBD	CU NIPDAU	Level-1-250C-UNLIM
TLC2274AQDRG4Q1	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274AQDRQ1	ACTIVE	SOIC	D	14	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-250C-1 YEAR/ Level-1-235C-UNLIM
TLC2274AQPWRG4Q1	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274AQPWRQ1	ACTIVE	TSSOP	PW	14	2000	TBD	CU NIPDAU	Level-1-250C-UNLIM
TLC2274QDRG4Q1	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274QDRQ1	ACTIVE	SOIC	D	14	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-250C-1 YEAR/ Level-1-235C-UNLIM
TLC2274QPWRG4Q1	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274QPWRQ1	ACTIVE	TSSOP	PW	14	2000	TBD	CU NIPDAU	Level-1-250C-UNLIM

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

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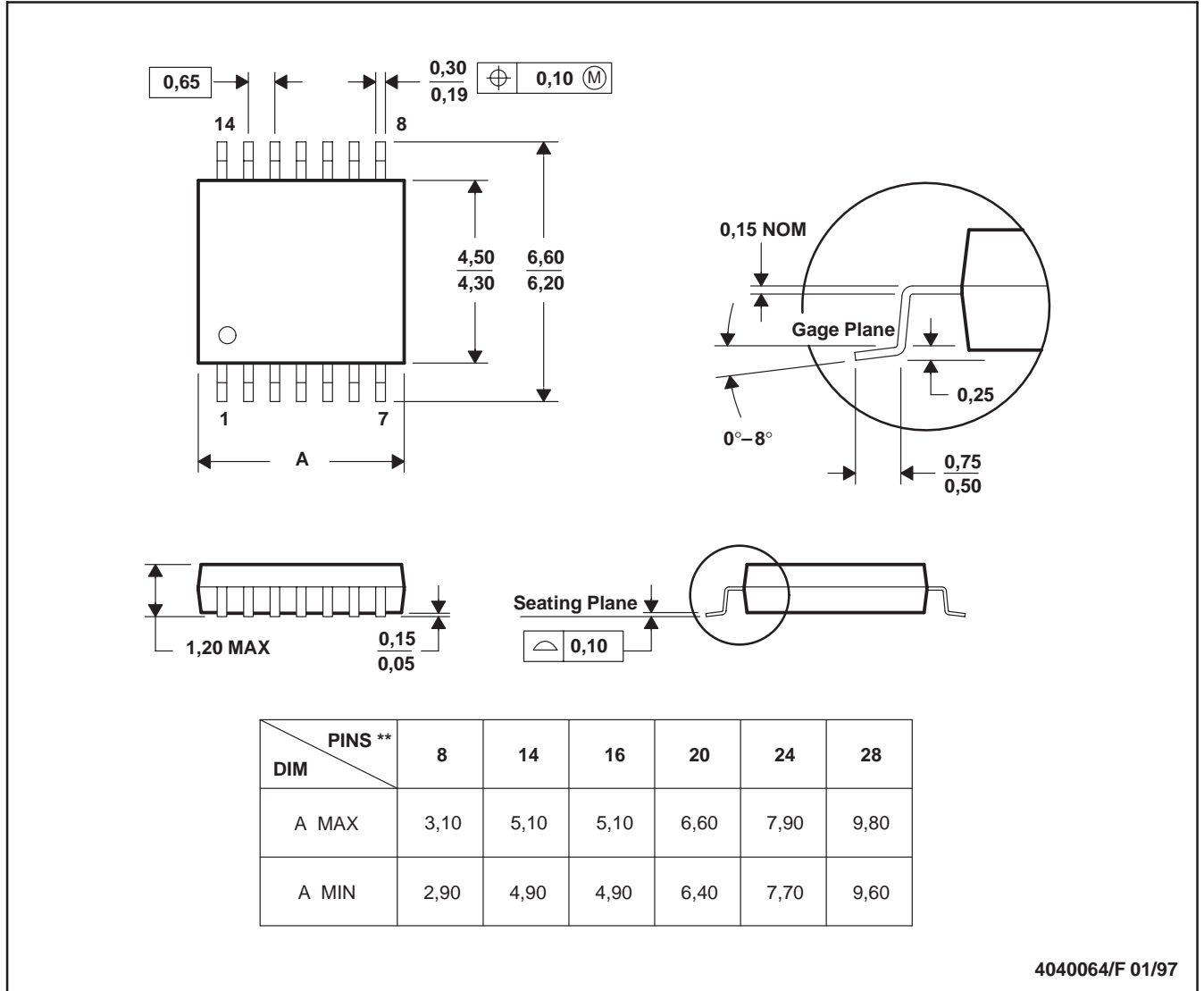
MECHANICAL DATA

MTSS001C – JANUARY 1995 – REVISED FEBRUARY 1999

PW (R-PDSO-G)**

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN

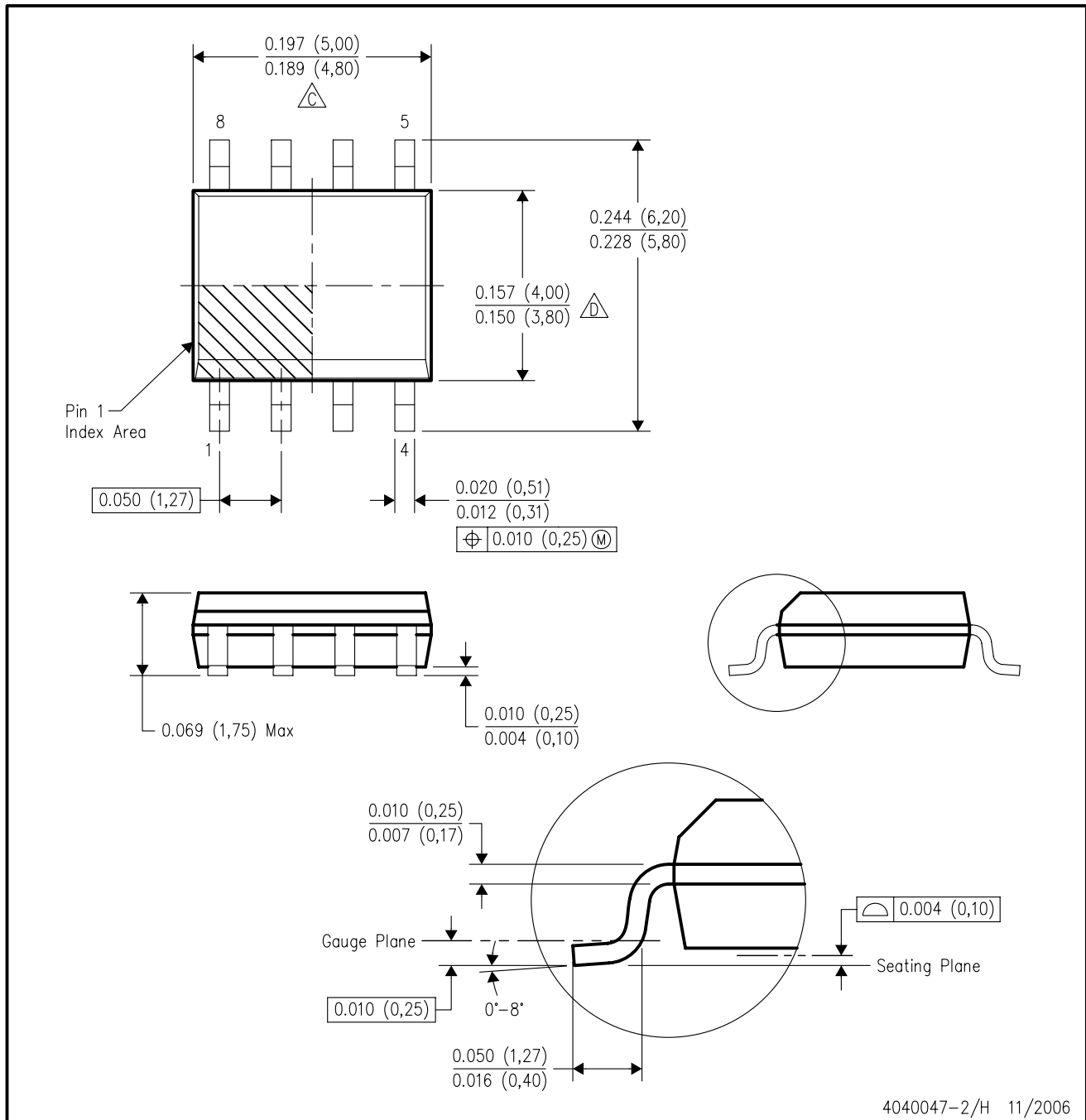


- NOTES: A. All linear dimensions are in millimeters.
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
 D. Falls within JEDEC MO-153

MECHANICAL DATA

D (R-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE



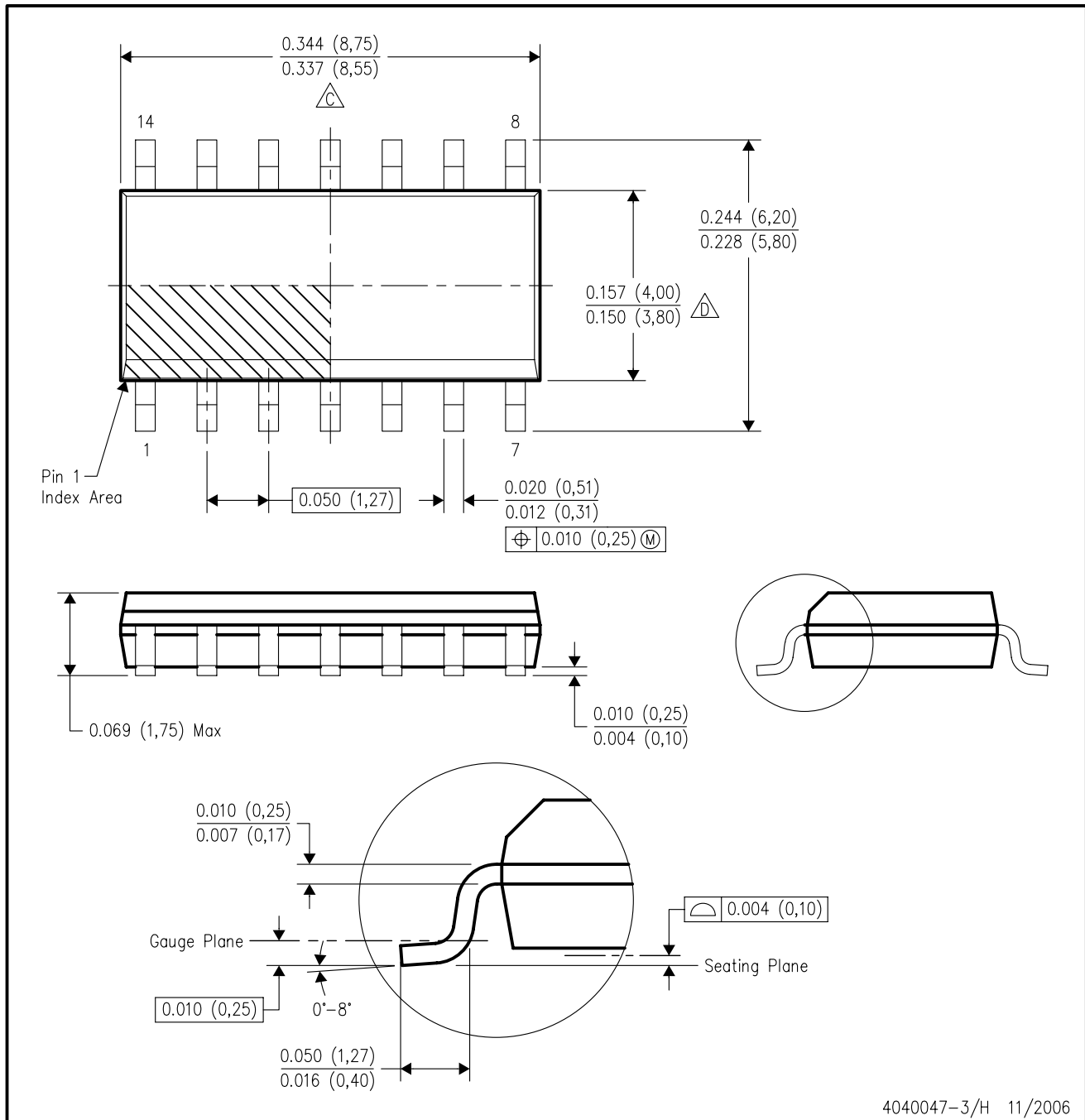
4040047-2/H 11/2006

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



MECHANICAL DATA

D (R-PDSO-G14)

PLASTIC SMALL-OUTLINE PACKAGE



4040047-3/H 11/2006

- NOTES:
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 - B. This drawing is subject to change without notice.
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 -  Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
 - E. Reference JEDEC MS-012 variation AB.

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