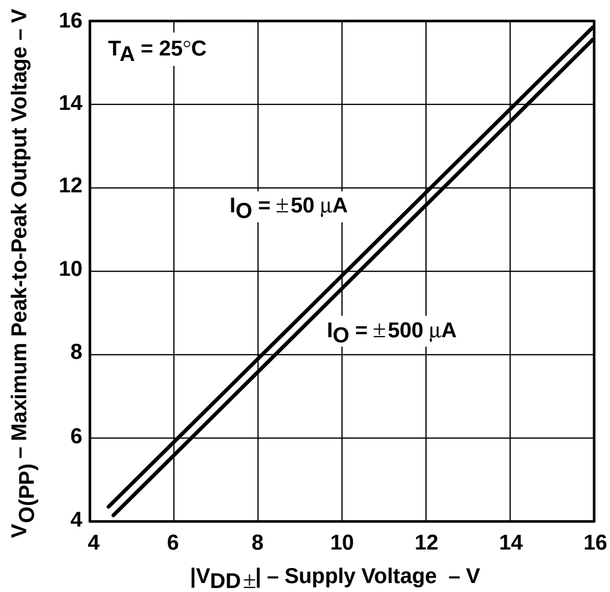
- **Output Swing Includes Both Supply Rails**
- **Low Noise . . . 9 nV/√Hz Typ at f = 1 kHz**
- **Low Input Bias Current . . . 1 pA Typ**
- **Fully Specified for Both Single-Supply and Split-Supply Operation**
- **Common-Mode Input Voltage Range Includes Negative Rail**
- **High-Gain Bandwidth . . . 2 MHz Typ**
- **High Slew Rate . . . 3 V/μs Typ**
- **Low Input Offset Voltage 950 μV Max at T_A = 25°C**
- **Macromodel Included**

description

The TLC2272 and TLC2272A are dual rail-to-rail operational amplifiers manufactured using Texas Instruments Advanced LinCMOS™ process. These devices offer comparable ac performance while having better noise, input offset voltage, and power dissipation than existing CMOS operational amplifiers. In addition, the common-mode input voltage range is wider than typical standard CMOS type amplifiers. To take advantage of this improvement in performance, making this device available for a wider range of applications, V_{ICR} is specified with a larger maximum input offset voltage test limit of ±5 mV. The Advanced LinCMOS™ process uses a silicon-gate technology to obtain input offset voltage stability with temperature and time that far exceeds that obtainable using metal-gate technology. Also, this technology makes possible input impedance levels that meet or exceed levels offered by topgate JFET and expensive dielectric-isolated devices.

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE vs SUPPLY VOLTAGE



The TLC2272 and TLC2272A, exhibiting high input impedance and low noise, are excellent for small-signal conditioning for high-impedance sources, such as piezoelectric transducers. In addition, the rail-to-rail output feature with single or split supplies makes these devices great choices for inputs to ADCs in either the unipolar or bipolar mode of operation. This feature, combined with its temperature performance, makes the TLC2272 family ideal for sonobuoys, pressure sensors, temperature control, active VR sensors, accelerometers, and many other applications.

AVAILABLE OPTIONS

T_A	V_{IO}max At 25°C	PACKAGED DEVICES			CHIP FORM (Y)
		SMALL OUTLINE (D)	PLASTIC DIP (P)	TSSOP (PW)	
0°C to 70°C	950 μV 2.5 mV	TLC2272ACD TLC2272CD	TLC2272ACP TLC2272CP	TLC2272CPWLE	TLC2272Y
–40°C to 85°C	950 μV 2.5 mV	TLC2272AID TLC2272ID	TLC2272AIP TLC2272IP	—	—
–55°C to 125°C	950 μV 2.5 mV	TLC2272AMD TLC2272MD	TLC2272AMP TLC2272MP	—	—

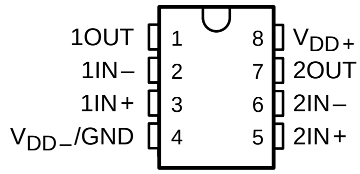
The D packages are available taped and reeled. Add R suffix to the device type (e.g., TLE2272CDR).
The PW package is available only left-end taped and reeled. Chips are tested at 25°C.

Advanced LinCMOS™ is a trademark of Texas Instruments Incorporated.

description (continued)

The device inputs and outputs are designed to withstand a 100-mA surge current without sustaining latch-up. In addition, internal ESD-protection circuits prevent functional failures up to 2000 V as tested under MIL-STD-883C, Method 3015.2; however, care should be exercised in handling these devices as exposure to ESD may result in degradation of the device parametric performance.

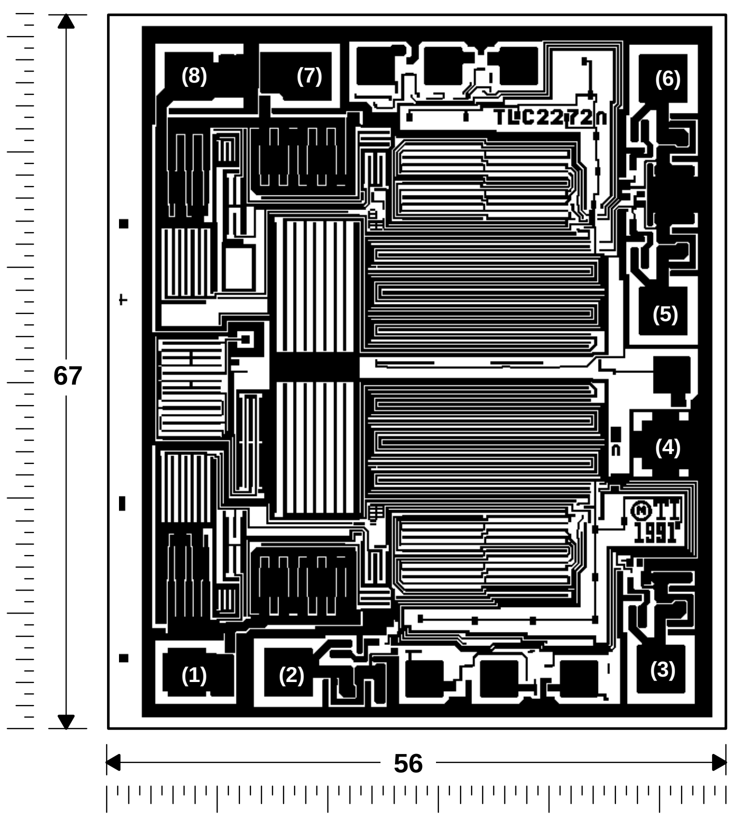
D, P, OR PW PACKAGE
(TOP VIEW)

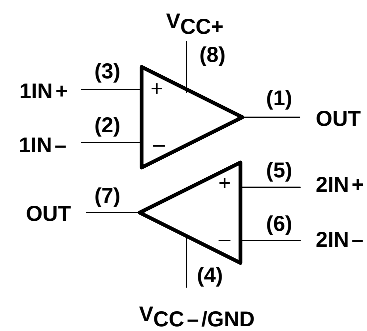


TLC2272Y chip information

These chips, when properly assembled, display characteristics similar to the TLC2272C. Thermal compression or ultrasonic bonding may be used on the doped-aluminum bonding pads. Chips may be mounted with conductive epoxy or a gold-silicon preform.

BONDING PAD ASSIGNMENTS





CHIP THICKNESS: 15 TYPICAL

BONDING PADS: 4 × 4 MINIMUM

$T_J$max = 150°C

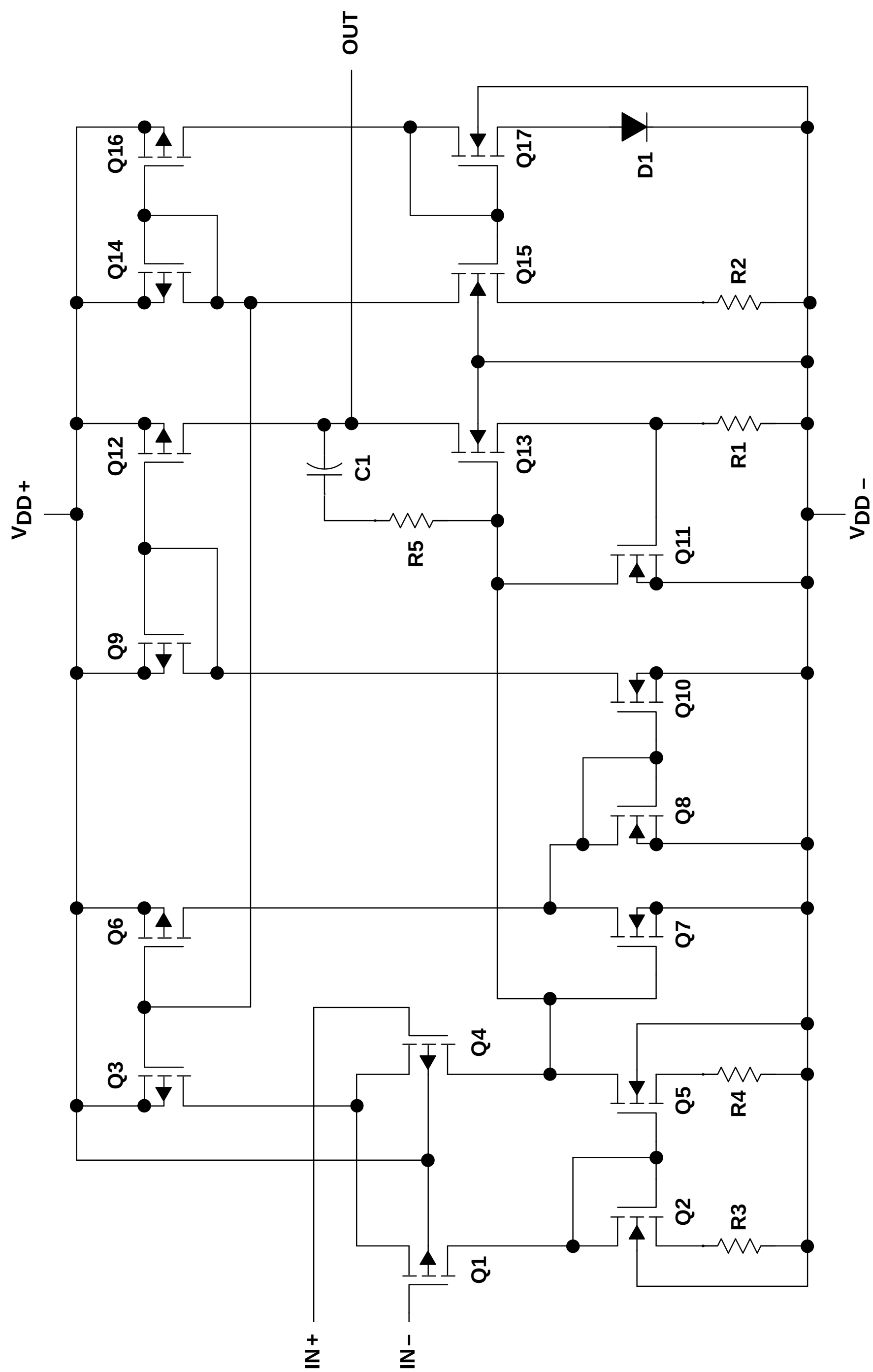
TOLERANCES ARE ±10%.

ALL DIMENSIONS ARE IN MILS.

PIN (4) IS INTERNALLY CONNECTED TO BACKSIDE OF CHIP.

TEXAS INSTRUMENTS
POST OFFICE BOX 655303 • DALLAS, TEXAS 75265
POST OFFICE BOX 1443 • HOUSTON, TEXAS 77251–1443

equivalent schematic (each amplifier)



COMPONENT COUNT†	
Transistors	38
Diodes	9
Resistors	26
Capacitors	3

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

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, V_I (any input, see Note 1) . . . ±8 V
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: C suffix . . . 0°C to 70°C
I suffix . . . –40°C to 85°C
M suffix . . . –55°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 . . . 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	$T_A \le 25°C$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25°C$	$T_A = 70°C$ POWER RATING	$T_A = 85°C$ POWER RATING	$T_A = 125°C$ POWER RATING
D	725 mW	5.8 mW/°C	464 mW	337 mW	145 mW
P	1000 mW	8.0 mW/°C	640 mW	520 mW	200 mW
PW	525 mW	4.2 mW/°C	336 mW	—	—

recommended operating conditions

	C SUFFIX		I SUFFIX		M SUFFIX		UNIT
	MIN	MAX	MIN	MAX	MIN	MAX	
Supply voltage, $V_{DD\pm}$	±2.2	±8	±2.2	±8	±2.2	±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
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
Operating free-air temperature, T_A	0	70	–40	85	–55	125	°C

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

PARAMETER		TEST CONDITIONS	T_A†	TLC2272C			TLC2272AC			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{IC} = 0, $V_{DD\pm}$ = ±2.5 V, V_O = 0, R_S = 50 Ω	25°C		300	2500		300	950	µV
			Full range			3000			1500	
α_{VIO}	Temperature coefficient of input offset voltage		25°C to 70°C		2			2		µV/°C
	Input offset voltage long-term drift (see Note 4)		25°C		0.002			0.002		µV/mo
I_{IO}	Input offset current		25°C		0.5			0.5		pA
			Full range			100			100	
I_{IB}	Input bias current		25°C		1			1		pA
			Full range			100			100	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω, $\lvert V_{IO} \rvert$ ≤ 5 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 µA	25°C		4.99			4.99		V
		I_{OH} = –200 µA	25°C	4.85	4.93		4.85	4.93		
			Full range	4.85			4.85			
		I_{OH} = –1 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 V, I_{OL} = 50 µA	25°C		0.01			0.01		V
		V_{IC} = 2.5 V, I_{OL} = 500 µA	25°C		0.09	0.15		0.09	0.15	
			Full range			0.15			0.15	
		V_{IC} = 2.5 V, I_{OL} = 5 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 V, V_O = 1 V to 4 V, R_L = 10 kΩ‡	25°C	15	35		15	35		V/mV
			Full range	15			15			
		R_L = 1 mΩ‡	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 kHz, P package	25°C		8			8		pF
z_o	Closed-loop output impedance	f = 1 MHz, A_V = 10	25°C		140			140		Ω
CMRR	Common-mode rejection ratio	V_{IC} = 0 to 2.7 V, V_O = 2.5 V, R_S = 50 Ω	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 V to 16 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 V, No load	25°C		2.2	3		2.2	3	mA
			Full range			3			3	

† 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 168 hours of operating life test at T_A = 150°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

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

PARAMETER		TEST CONDITIONS		T_A†	TLC2272C			TLC2272AC			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	V_O = 0.5 V to 2.5 V, R_L = 10 kΩ‡, C_L = 100 pF‡		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 Hz		25°C		50			50		nV/√Hz
		f = 1 kHz		25°C		9			9		
V_{NPP}	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C		1			1		µV
		f = 0.1 Hz to 10 Hz		25°C		1.4			1.4		
I_n	Equivalent input noise current			25°C		0.6			0.6		fA/√Hz
THD + N	Total harmonic distortion plus noise	V_O = 0.5 V to 2.5 V, f = 20 kHz, R_L = 10 kΩ‡,	A_V = 1	25°C		0.0013%			0.0013%		
			A_V = 10			0.004%			0.004%		
			A_V = 100			0.03%			0.03%		
	Gain-bandwidth product	f = 10 kHz, R_L = 10 kΩ‡, C_L = 100 pF‡		25°C		2.18			2.18		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 2 V, A_V = 1, R_L = 10 kΩ‡, C_L = 100 pF‡		25°C		1			1		MHz
t_s	Settling time	A_V = –1, Step = 0.5 V to 2.5 V, R_L = 10 kΩ‡, C_L = 100 pF‡	To 0.1%	25°C		1.5			1.5		µs
			To 0.01%			2.6			2.6		
ϕ_m	Phase margin at unity gain	R_L = 10 kΩ‡, C_L = 100 pF‡		25°C		50°			50°		
	Gain margin			25°C		10			10		dB

† Full range is 0°C to 70°C.
‡ Referenced to 2.5 V

electrical characteristics at specified free-air temperature, $V_{DD\pm} = \pm5$ V (unless otherwise specified)

PARAMETER		TEST CONDITIONS		T_A†	TLC2272C MIN	TLC2272C TYP	TLC2272C MAX	TLC2272AC MIN	TLC2272AC TYP	TLC2272AC MAX	UNIT
V_{IO}	Input offset voltage	$V_{IC} = 0$, $V_O = 0$, $R_S = 50\ \Omega$		25°C		300	2500		300	950	µV
				Full range			3000			1500	
α_{VIO}	Temperature coefficient of input offset voltage			25°C to 70°C		2			2		µV/°C
	Input offset voltage long-term drift (see Note 4)			25°C		0.002			0.002		µV/mo
I_{IO}	Input offset current			25°C		0.5			0.5		pA
				Full range			100			100	
I_{IB}	Input bias current			25°C		1			1		pA
				Full range			100			100	
V_{ICR}	Common-mode input voltage range	$R_S = 50\ \Omega$, $\lvert V_{IO}\rvert \le 5$ 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		4.99			4.99		V
		$I_O = -200\ \mu A$		25°C	4.85	4.93		4.85	4.93		
				Full range	4.85			4.85			
		$I_O = -1$ mA		25°C	4.25	4.65		4.25	4.65		
				Full range	4.25			4.25			
V_{OM-}	Maximum negative peak output voltage	$V_{IC} = 0$, $I_O = 50\ \mu A$		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			
		$V_{IC} = 0$, $I_O = 5$ mA		25°C	−3.5	−4.1		−3.5	−4.1		
				Full range	−3.5			−3.5			
A_{VD}	Large-signal differential voltage amplification	$V_O = \pm4$ V	$R_L = 10\ k\Omega$	25°C	25	50		25	50		V/mV
				Full range	25			25			
			$R_L = 1\ m\Omega$	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 kHz, P package		25°C		8			8		pF
z_o	Closed-loop output impedance	f = 1 MHz, $A_V = 10$		25°C		130			130		Ω
CMRR	Common-mode rejection ratio	$V_{IC} = -5$ to 2.7 V, $V_O = 0$ V, $R_S = 50\ \Omega$		25°C	75	80		75	80		dB
				Full range	75			75			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{DD\pm}/\Delta V_{IO}$)	$V_{DD\pm} = 2.2$ V to ±8 V, $V_{IC} = 0$, No load		25°C	80	95		80	95		dB
				Full range	80			80			
I_{DD}	Supply current	$V_O = 0$ V No load		25°C		2.4	3		2.4	3	mA
				Full range			3			3	

† Full range is 0°C to 70°C.

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

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

PARAMETER		TEST CONDITIONS		T_A†	TLC2272C			TLC2272AC			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	$V_O = \pm 2.3$ V, $R_L = 10$ kΩ, $C_L = 100$ pF		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 Hz		25°C		50			50		nV/√Hz
		f = 1 kHz		25°C		9			9		
V_{NPP}	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C		1			1		µV
		f = 0.1 Hz to 10 Hz		25°C		1.4			1.4		
I_n	Equivalent input noise current			25°C		0.6			0.6		fA/√Hz
THD + N	Total harmonic distortion pulse duration	$V_O = \pm 2.3$ V, f = 20 kHz, $R_L = 10$ kΩ	$A_V = 1$	25°C		0.0011%			0.0011%		
			$A_V = 10$			0.004%			0.004%		
			$A_V = 100$			0.03%			0.03%		
	Gain-bandwidth product	f = 10 kHz, $R_L = 10$ kΩ, $C_L = 100$ pF		25°C		2.25			2.25		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)} = 4.6$ V, $A_V = 1$, $R_L = 10$ kΩ, $C_L = 100$ pF		25°C		0.54			0.54		MHz
t_s	Settling time	$A_V = -1$, Step = −2.3 V to 2.3 V, $R_L = 10$ kΩ, $C_L = 100$ pF	To 0.1%	25°C		1.5			1.5		µs
			To 0.01%			3.2			3.2		
ϕ_m	Phase margin at unity gain	$R_L = 10$ kΩ, $C_L = 100$ pF		25°C		52°			52°		
	Gain margin			25°C		10			10		dB

† Full range is 0°C to 70°C.

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

PARAMETER		TEST CONDITIONS	T_A†	TLC2272I			TLC2272AI			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{IC} = 0, $V_{DD\pm}$ = ±2.5 V, V_O = 0, R_S = 50 Ω	25°C		300	2500		300	950	µV
			Full range			3000			1500	
α_{VIO}	Temperature coefficient of input offset voltage		25°C to 85°C		2			2		µV/°C
	Input offset voltage long-term drift (see Note 4)		25°C		0.002			0.002		µV/mo
I_{IO}	Input offset current		25°C		0.5			0.5		pA
			Full range			150			150	
I_{IB}	Input bias current		25°C		1			1		pA
			Full range			150			150	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω, $\lvert V_{IO} \rvert$ ≤5 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 µA	25°C		4.99			4.99		V
		I_{OH} = –200 µA	25°C	4.85	4.93		4.85	4.93		
			Full range	4.85			4.85			
		I_{OH} = –1 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 V, I_{OL} = 50 µA	25°C		0.01			0.01		V
		V_{IC} = 2.5 V, I_{OL} = 500 µA	25°C		0.09	0.15		0.09	0.15	
			Full range			0.15			0.15	
		V_{IC} = 2.5 V, I_{OL} = 5 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 V, V_O = 1 V to 4 V, R_L = 10 kΩ‡	25°C	15	35		15	35		V/mV
			Full range	15			15			
		V_{IC} = 2.5 V, V_O = 1 V to 4 V, R_L = 1 mΩ‡	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 kHz, P package	25°C		8			8		pF
z_o	Closed-loop output impedance	f = 1 MHz, A_V = 10	25°C		140			140		Ω
CMRR	Common-mode rejection ratio	V_{IC} = 0 to 2.7 V, V_O = 2.5 V, R_S = 50 Ω	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 V to 16 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 V, No load	25°C		2.2	3		2.2	3	mA
			Full range			3			3	

† Full range is – 40°C to 85°C.
‡ Referenced to 2.5 V

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

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

PARAMETER		TEST CONDITIONS		T_A†	TLC2272I MIN	TLC2272I TYP	TLC2272I MAX	TLC2272AI MIN	TLC2272AI TYP	TLC2272AI MAX	UNIT
SR	Slew rate at unity gain	V_O = 0.5 V to 2.5 V, R_L = 10 kΩ‡, C_L = 100 pF‡		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 Hz		25°C		50			50		nV/√Hz
		f = 1 kHz		25°C		9			9		
V_{NPP}	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C		1			1		µV
		f = 0.1 Hz to 10 Hz		25°C		1.4			1.4		
I_n	Equivalent input noise current			25°C		0.6			0.6		fA/√Hz
THD + N	Total harmonic distortion plus noise	V_O = 0.5 V to 2.5 V, f = 20 kHz, R_L = 10 kΩ‡	A_V = 1	25°C		0.0013%			0.0013%		
			A_V = 10			0.004%			0.004%		
			A_V = 100			0.03%			0.03%		
	Gain-bandwidth product	f = 10 kHz, R_L = 10 kΩ‡, C_L = 100 pF‡		25°C		2.18			2.18		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 2 V, A_V = 1, R_L = 10 kΩ‡, C_L = 100 pF‡		25°C		1			1		MHz
t_s	Settling time	A_V = –1, Step = 0.5 V to 2.5 V, R_L = 10 kΩ‡, C_L = 100 pF‡	To 0.1%	25°C		1.5			1.5		µs
			To 0.01%			2.6			2.6		
ϕ_m	Phase margin at unity gain	R_L = 10 kΩ‡, C_L = 100 pF‡		25°C		50°			50°		
	Gain margin			25°C		10			10		dB

† Full range is – 40°C to 85°C.
‡ Referenced to 2.5 V

electrical characteristics at specified free-air temperature, $V_{DD\pm} = \pm5$ V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A†	TLC2272I MIN	TLC2272I TYP	TLC2272I MAX	TLC2272AI MIN	TLC2272AI TYP	TLC2272AI MAX	UNIT
V_{IO}	Input offset voltage	$V_{IC} = 0$, $V_O = 0$, $R_S = 50\ \Omega$	25°C		300	2500		300	950	µV
			Full range			3000			1500	
α_{VIO}	Temperature coefficient of input offset voltage		25°C to 85°C		2			2		µV/°C
	Input offset voltage long-term drift (see Note 4)		25°C		0.002			0.002		µV/mo
I_{IO}	Input offset current		25°C		0.5			0.5		pA
			Full range			150			150	
I_{IB}	Input bias current		25°C		1			1		pA
			Full range			150			150	
V_{ICR}	Common-mode input voltage range	$R_S = 50\ \Omega$, $\|V_{IO}\| \le 5$ 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		4.99			4.99		V
		$I_O = -200\ \mu A$	25°C	4.85	4.93		4.85	4.93		
			Full range	4.85			4.85			
		$I_O = -1$ mA	25°C	4.25	4.65		4.25	4.65		
			Full range	4.25			4.25			
V_{OM-}	Maximum negative peak output voltage	$V_{IC} = 0$, $I_O = 50\ \mu A$	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			
		$V_{IC} = 0$, $I_O = 5$ mA	25°C	−3.5	−4.1		−3.5	−4.1		
			Full range	−3.5			−3.5			
A_{VD}	Large-signal differential voltage amplification	$V_O = \pm4$ V, $R_L = 10\ k\Omega$	25°C	25	50		25	50		V/mV
			Full range	25			25			
		$V_O = \pm4$ V, $R_L = 1\ m\Omega$	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 kHz, P package	25°C		8			8		pF
z_o	Closed-loop output impedance	f = 1 MHz, $A_V = 10$	25°C		130			130		Ω
CMRR	Common-mode rejection ratio	$V_{IC} = 0$ to 2.7 V, $V_O = 2.5$ V, $R_S = 50\ \Omega$	25°C	75	80		75	80		dB
			Full range	75			75			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{DD\pm}/\Delta V_{IO}$)	$V_{DD} = 4.4$ V to 16 V, $V_{IC} = V_{DD}/2$, No load	25°C	80	95		80	95		dB
			Full range	80			80			
I_{DD}	Supply current	$V_O = 2.5$ V, No load	25°C		2.4	3		2.4	3	mA
			Full range			3			3	

† Full range is – 40°C to 85°C.

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

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

PARAMETER		TEST CONDITIONS		T_A†	TLC2272I MIN	TLC2272I TYP	TLC2272I MAX	TLC2272AI MIN	TLC2272AI TYP	TLC2272AI MAX	UNIT
SR	Slew rate at unity gain	$V_O = \pm 2.3$ V, $R_L = 10$ kΩ, $C_L = 100$ pF		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 Hz		25°C		50			50		nV/√Hz
		f = 1 kHz		25°C		9			9		
V_{NPP}	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C		1			1		µV
		f = 0.1 Hz to 10 Hz		25°C		1.4			1.4		
I_n	Equivalent input noise current			25°C		0.6			0.6		fA/√Hz
THD + N	Total harmonic distortion plus noise	$V_O = \pm 2.3$ V, $R_L = 10$ kΩ, f = 20 kHz	$A_V = 1$	25°C		0.0011%			0.0011%		
			$A_V = 10$			0.004%			0.004%		
			$A_V = 100$			0.03%			0.03%		
	Gain-bandwidth product	f =10 kHz, $R_L = 10$ kΩ, $C_L = 100$ pF		25°C		2.25			2.25		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)} = 4.6$ V, $A_V = 1$, $R_L = 10$ kΩ, $C_L = 100$ pF		25°C		0.54			0.54		MHz
t_s	Settling time	$A_V = -1$, Step = −2.3 V to 2.3 V, $R_L = 10$ kΩ, $C_L = 100$ pF	To 0.1%	25°C		1.5			1.5		µs
			To 0.01%			3.2			3.2		
ϕ_m	Phase margin at unity gain	$R_L = 10$ kΩ, $C_L = 100$ pF		25°C		52°			52°		
	Gain margin			25°C		10			10		dB

† Full range is −40°C to 85°C.

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

PARAMETER		TEST CONDITIONS	T_A†	TLC2272M MIN	TLC2272M TYP	TLC2272M MAX	TLC2272AM MIN	TLC2272AM TYP	TLC2272AM MAX	UNIT
V_{IO}	Input offset voltage	V_{IC} = 0, $V_{DD\pm}$ = ±2.5 V, V_O = 0, R_S = 50 Ω	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		μV/°C
	Input offset voltage long-term drift (see Note 4)		25°C		0.002			0.002		μV/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 Ω, $\lvert V_{IO} \rvert$ ≤5 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 μA	25°C		4.99			4.99		V
		I_{OH} = –200 μA	25°C	4.85	4.93		4.85	4.93		
			Full range	4.85			4.85			
		I_{OH} = –1 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 V, I_{OL} = 50 μA	25°C		0.01			0.01		V
		V_{IC} = 2.5 V, I_{OL} = 500 μA	25°C		0.09	0.15		0.09	0.15	
			Full range			0.15			0.15	
		V_{IC} = 2.5 V, I_{OL} = 5 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 V, V_O = 1 V to 4 V, R_L = 10 kΩ‡	25°C	10	35		10	35		V/mV
			Full range	10			10			
		V_{IC} = 2.5 V, V_O = 1 V to 4 V, R_L = 1 mΩ‡	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 kHz, P package	25°C		8			8		pF
z_o	Closed-loop output impedance	f = 1 MHz, A_V = 10	25°C		140			140		Ω
CMRR	Common-mode rejection ratio	V_{IC} = 0 to 2.7 V, V_O = 2.5 V, R_S = 50 Ω	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 V to 16 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 V, No load	25°C		2.2	3		2.2	3	mA
			Full range			3			3	

† Full range is – 55°C to 125°C.
‡ Referenced to 2.5 V
NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at T_A = 150°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

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

PARAMETER		TEST CONDITIONS		T_A†	TLC2272M			TLC2272AM			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	V_O = 0.5 V to 2.5 V, R_L = 10 kΩ‡, C_L = 100 pF‡		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 Hz		25°C		50			50		nV/√Hz
		f = 1 kHz		25°C		9			9		
V_{NPP}	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C		1			1		μV
		f = 0.1 Hz to 10 Hz		25°C		1.4			1.4		
I_n	Equivalent input noise current			25°C		0.6			0.6		fA/√Hz
THD + N	Total harmonic distortion plus noise	V_O = 0.5 V to 2.5 V, f = 20 kHz, R_L = 10 kΩ‡,	A_V = 1	25°C		0.0013%			0.0013%		
			A_V = 10			0.004%			0.004%		
			A_V = 100			0.03%			0.03%		
	Gain-bandwidth product	f =10 kHz, R_L = 10 kΩ‡, C_L = 100 pF‡		25°C		2.18			2.18		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 2 V, A_V = 1, R_L = 10 kΩ‡, C_L = 100 pF‡		25°C		1			1		MHz
t_s	Settling time	A_V = –1, Step = 0.5 V to 2.5 V, R_L = 10 kΩ‡, C_L = 100 pF‡	To 0.1%	25°C		1.5			1.5		μs
			To 0.01%			2.6			2.6		
ϕ_m	Phase margin at unity gain	R_L = 10 kΩ‡, C_L = 100 pF‡		25°C		50°			50°		
	Gain margin			25°C		10			10		dB

† Full range is – 55°C to 125°C.
‡ Referenced to 2.5 V

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electrical characteristics at specified free-air temperature, $V_{DD\pm} = \pm5$ V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A†	TLC2272M			TLC2272AM			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	$V_{IC} = 0$, $V_O = 0$, $R_S = 50\ \Omega$	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		µV/°C
	Input offset voltage long-term drift (see Note 4)		25°C		0.002			0.002		µV/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	$R_S = 50\ \Omega$, $\lvert V_{IO}\rvert \le 5$ 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		4.99			4.99		V
		$I_O = -200\ \mu A$	25°C	4.85	4.93		4.85	4.93		
			Full range	4.85			4.85			
		$I_O = -1$ mA	25°C	4.25	4.65		4.25	4.65		
			Full range	4.25			4.25			
V_{OM-}	Maximum negative peak output voltage	$V_{IC} = 0$, $I_O = 50\ \mu A$	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			
		$V_{IC} = 0$, $I_O = 5$ mA	25°C	−3.5	−4.1		−3.5	−4.1		
			Full range	−3.5			−3.5			
A_{VD}	Large-signal differential voltage amplification	$V_O = \pm4$ V, $R_L = 10\ k\Omega$	25°C	20	50		20	50		V/mV
			Full range	20			20			
		$V_O = \pm4$ V, $R_L = 1\ m\Omega$	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 kHz, P package	25°C		8			8		pF
z_o	Closed-loop output impedance	f = 1 MHz, $A_V = 10$	25°C		130			130		Ω
CMRR	Common-mode rejection ratio	$V_{IC} = 0$ to 2.7 V, $V_O = 2.5$ V, $R_S = 50\ \Omega$	25°C	75	80		75	80		dB
			Full range	75			75			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{DD\pm}/\Delta V_{IO}$)	$V_{DD} = 4.4$ V to 16 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		2.4	3		2.4	3	mA
			Full range			3			3	

† Full range is – 55°C to 125°C.

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

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

PARAMETER		TEST CONDITIONS		T_A†	TLC2272M			TLC2272AM			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	$V_O = \pm 2.3$ V, $R_L = 10$ kΩ, $C_L = 100$ pF		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 Hz		25°C		50			50		nV/√Hz
		f = 1 kHz		25°C		9			9		
V_{NPP}	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C		1			1		μV
		f = 0.1 Hz to 10 Hz		25°C		1.4			1.4		
I_n	Equivalent input noise current			25°C		0.6			0.6		fA/√Hz
THD + N	Total harmonic distortion plus noise	$V_O = \pm 2.3$ V, $R_L = 10$ kΩ, f = 20 kHz	$A_V = 1$	25°C		0.0011%			0.0011%		
			$A_V = 10$			0.004%			0.004%		
			$A_V = 100$			0.03%			0.03%		
	Gain-bandwidth product	f =10 kHz, $R_L = 10$ kΩ, $C_L = 100$ pF		25°C		2.25			2.25		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)} = 4.6$ V, $A_V = 1$, $R_L = 10$ kΩ, $C_L = 100$ pF		25°C		0.54			0.54		MHz
t_s	Settling time	$A_V = -1$, Step = –2.3 V to 2.3 V, $R_L = 10$ kΩ, $C_L = 100$ pF	To 0.1%	25°C		1.5			1.5		μs
			To 0.01%			3.2			3.2		
ϕ_m	Phase margin at unity gain	$R_L = 10$ kΩ, $C_L = 100$ pF		25°C		52°			52°		
	Gain margin			25°C		10			10		dB

† Full range is –55°C to 125°C.

electrical characteristics at V_{DD} = 5 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS			TLC2272Y MIN	TLC2272Y TYP	TLC2272Y MAX	UNIT
V_{IO}	Input offset voltage	V_{IC} = 0, V_O = 0,	$V_{DD\pm}$ = ±2.5 V, R_S = 50 Ω			300	2500	µV
I_{IO}	Input offset current	V_{IC} = 0, V_O = 0,	$V_{DD\pm}$ = ±2.5 V, R_S = 50 Ω			0.5	100	pA
I_{IB}	Input bias current	V_{IC} = 0, V_O = 0,	$V_{DD\pm}$ = ±2.5 V, R_S = 50 Ω			1	100	pA
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω,	$\|V_{IO}\| \le 5$ mV		0 to 4	−0.3 to 4.2		V
V_{OH}	High-level output voltage	I_{OH} = −20 µA				4.99		V
		I_{OH} = −200 µA			4.85	4.93		
		I_{OH} = −1 mA			4.25	4.65		
V_{OL}	Low-level output voltage	V_{IC} = 2.5 V,	I_{OL} = 50 µA			0.01		V
		V_{IC} = 2.5 V,	I_{OL} = 500 µA			0.09	0.15	
		V_{IC} = 2.5 V,	I_{OL} = 5 mA			0.9	1.5	
A_{VD}	Large-signal differential voltage amplification	V_{IC} = 2.5 V, V_O = 1 V to 4 V	R_L = 10 kΩ†		15	35		V/mV
			R_L = 1 MΩ†			175		
r_{id}	Differential input resistance					10^{12}		Ω
r_i	Common-mode input resistance					10^{12}		Ω
c_i	Common-mode input capacitance	f = 10 kHz				8		pF
z_o	Closed-loop output impedance	f = 1 MHz,	A_V = 10			140		Ω
CMRR	Common-mode rejection ratio	V_{IC} = 0 to 2.7 V,	V_O = 2.5 V,	R_S = 50 Ω	70	75		dB
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$)	V_{DD} = 4.4 V to 16 V,	$V_{IC} = V_{DD}/2$,	No load	80	95		dB
I_{DD}	Supply current	V_O = 2.5 V,	No load			2.2	3	mA

† Referenced to 2.5 V

electrical characteristics at $V_{DD\pm} = \pm5$ V, $T_A = 25°C$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS			TLC2272Y MIN	TLC2272Y TYP	TLC2272Y MAX	UNIT
V_{IO}	Input offset voltage	$V_{IC} = 0$,	$R_S = 50\ \Omega$,	$V_O = 0$		300	2500	µV
I_{IO}	Input offset current	$V_{IC} = 0$,	$R_S = 50\ \Omega$,	$V_O = 0$		0.5	100	pA
I_{IB}	Input bias current	$V_{IC} = 0$,	$R_S = 50\ \Omega$,	$V_O = 0$		1	100	pA
V_{ICR}	Common-mode input voltage range	$R_S = 50\ \Omega$,	$\lvert V_{IO} \rvert \le 5$ mV		–5 to 4	–5.3 to 4.2		V
V_{OM+}	Maximum positive peak output voltage	$I_O = -20\ \mu A$				4.99		V
		$I_O = -200\ \mu A$			4.85	4.93		
		$I_O = -1$ mA			4.25	4.65		
V_{OM-}	Maximum negative peak output voltage	$V_{IC} = 0$,	$I_{OL} = 50\ \mu A$			–4.99		V
		$V_{IC} = 0$,	$I_{OL} = 500\ \mu A$		–4.85	–4.91		
		$V_{IC} = 0$,	$I_{OL} = 5$ mA		–3.5	–4.1		
A_{VD}	Large-signal differential voltage amplification	$V_O = \pm4$ V	$R_L = 10\ k\Omega$		25	50		V/mV
			$R_L = 1\ M\Omega$			300		
r_{id}	Differential input resistance					10^{12}		Ω
r_i	Common-mode input resistance					10^{12}		Ω
c_i	Common-mode input capacitance	f = 10 kHz				8		pF
z_o	Closed-loop output impedance	f = 1 MHz,	$A_V = 10$			130		Ω
CMRR	Common-mode rejection ratio	$V_{IC} = -5$ V to 2.7 V,	$V_O = 0$,	$R_S = 50\ \Omega$	75	80		dB
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{DD\pm}/\Delta V_{IO}$)	$V_{DD\pm} = \pm2.2$ V to ±8 V,	$V_{IC} = 0$,	No load	80	95		dB
I_{DD}	Supply current	$V_O = 0$,	No load			2.4	3	mA

TYPICAL CHARACTERISTICS

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V_{OM-}	Maximum negative peak output voltage	vs Output current	14
$V_{O(PP)}$	Maximum peak-to-peak output voltage	vs Frequency	15
I_{OS}	Short-circuit output current	vs Supply voltage vs Free-air temperature	16 17
V_O	Output voltage	vs Differential Input voltage	18,19
A_{VD}	Differential voltage amplification	vs Load resistance vs Frequency vs Free-air temperature	20 21, 22 23, 24
z_o	Output impedance	vs Frequency	25, 26
CMRR	Common-mode rejection ratio	vs Frequency vs Free-air temperature	27 28
k_{SVR}	Supply-voltage rejection ratio	vs Frequency vs Free-air temperature	29, 30 31
I_{DD}	Supply current	vs Supply voltage vs Free-air temperature	32 33
SR	Slew rate	vs Load capacitance vs Free-air temperature	34 35
V_O	Large-signal pulse response	vs Time	36, 37, 38, 39
V_O	Small-signal pulse response	vs Time	40, 41, 42, 43
V_n	Equivalent input noise voltage	vs Frequency	44, 45
	Noise voltage (referred to input)	Over a 10-second period	46
	Integrated noise voltage	vs Frequency	47
THD + N	Total harmonic distortion plus noise	vs Frequency	48
	Gain-bandwidth product	vs Free-air temperature vs Supply voltage	49 50
ϕ_m	Phase margin	vs Load capacitance vs Frequency	51 21, 22
	Gain margin	vs Load capacitance	52

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

TYPICAL CHARACTERISTICS

DISTRIBUTION OF TLC2272
INPUT OFFSET VOLTAGE

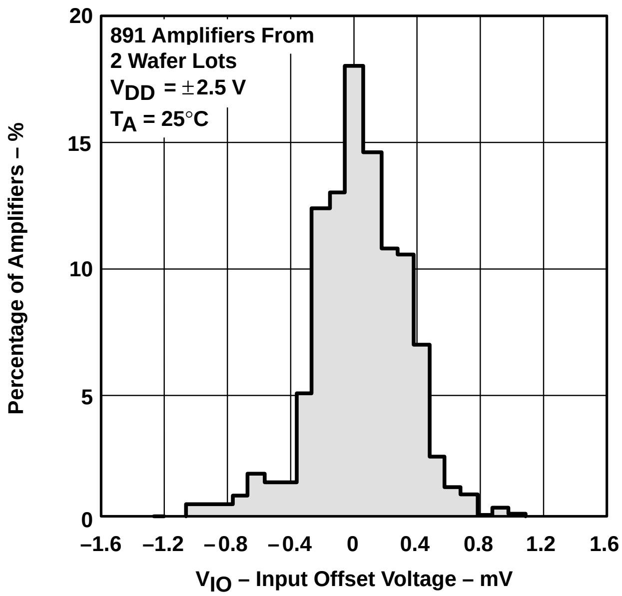

Figure 1

DISTRIBUTION OF TLC2272
INPUT OFFSET VOLTAGE

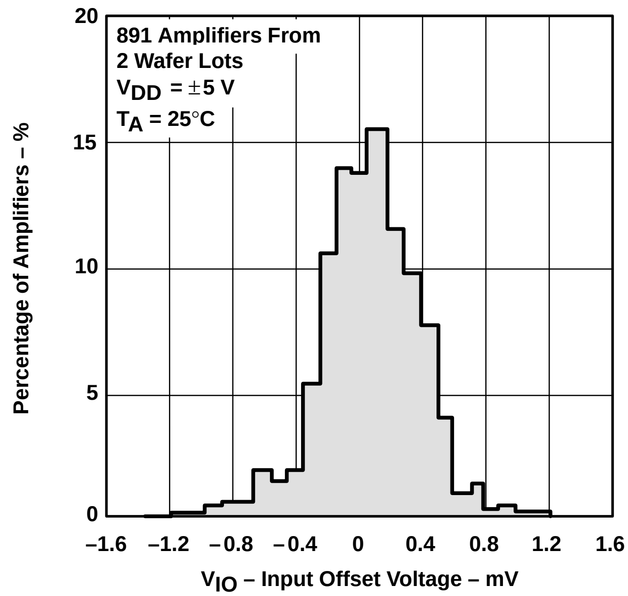

Figure 2

INPUT OFFSET VOLTAGE
vs
COMMON-MODE VOLTAGE

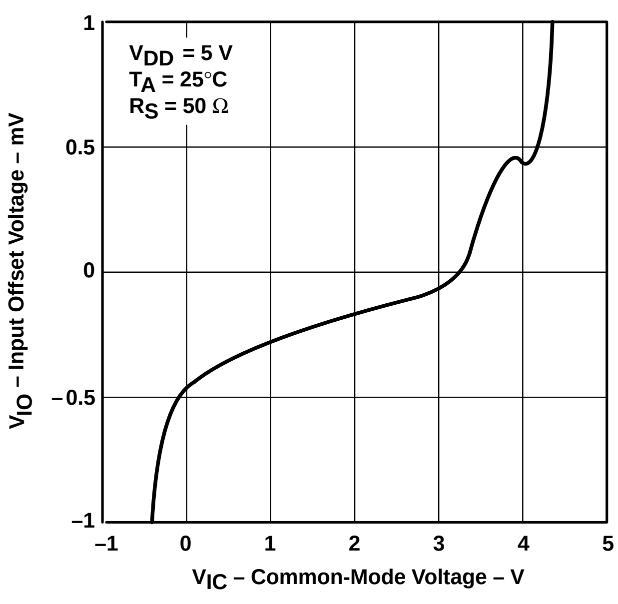

Figure 3

INPUT OFFSET VOLTAGE
vs
COMMON-MODE VOLTAGE

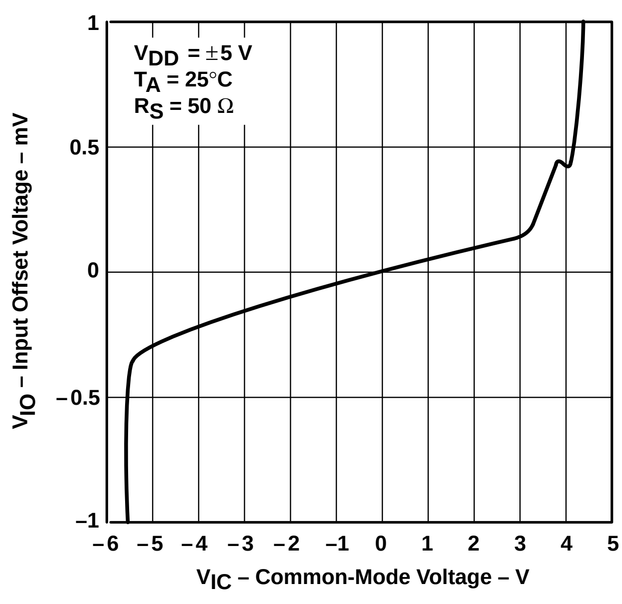

Figure 4

TYPICAL CHARACTERISTICS†

DISTRIBUTION OF TLC2272 INPUT OFFSET VOLTAGE TEMPERATURE COEFFICIENT

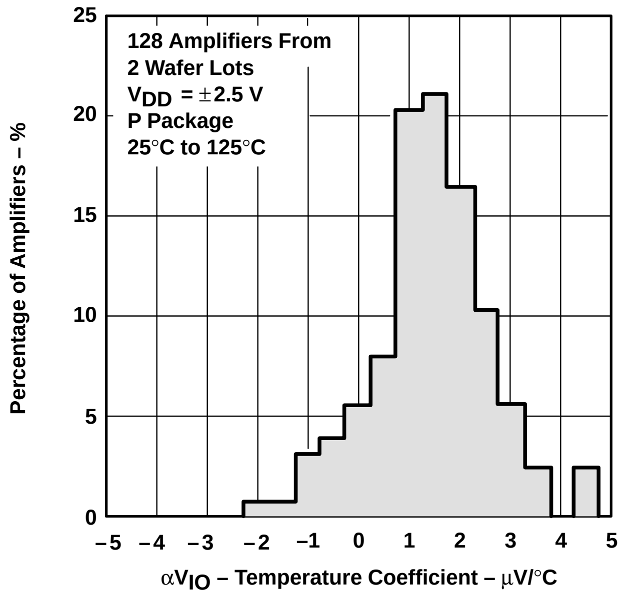

Figure 5

DISTRIBUTION OF TLC2272 INPUT OFFSET VOLTAGE TEMPERATURE COEFFICIENT

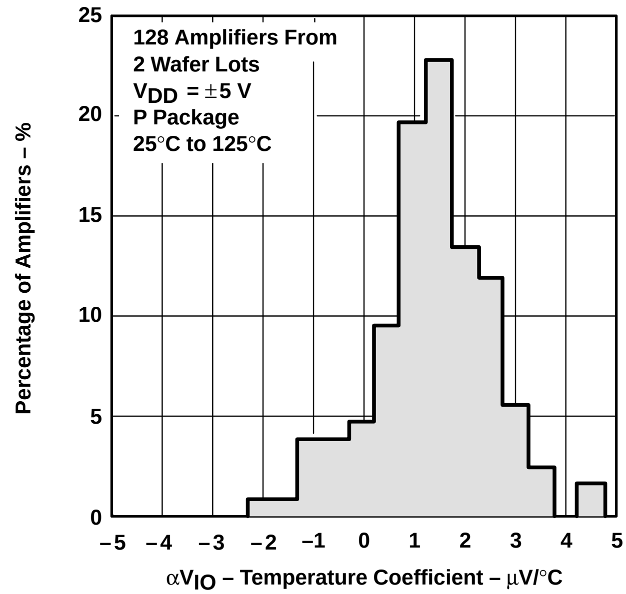

Figure 6

INPUT BIAS AND OFFSET CURRENT vs FREE-AIR TEMPERATURE

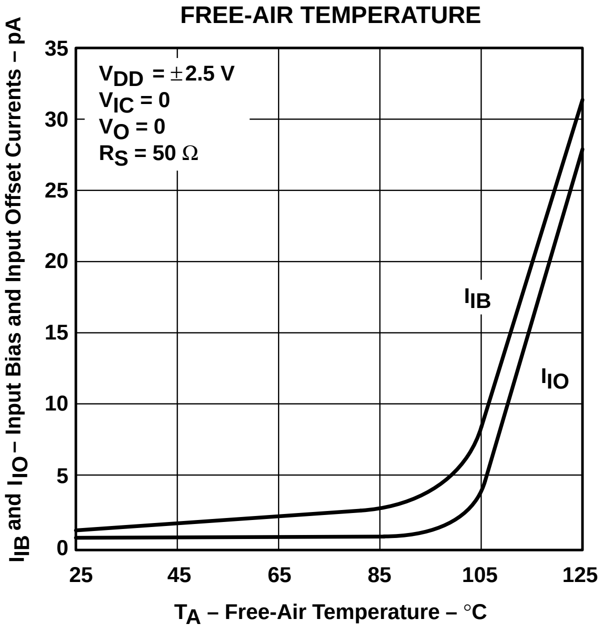

Figure 7

INPUT VOLTAGE RANGE vs SUPPLY VOLTAGE

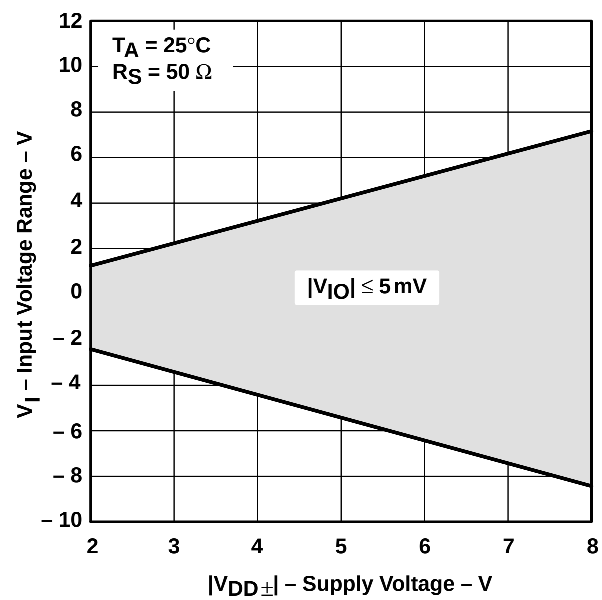

Figure 8

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

TYPICAL CHARACTERISTICS†

INPUT VOLTAGE RANGE
vs
FREE-AIR TEMPERATURE

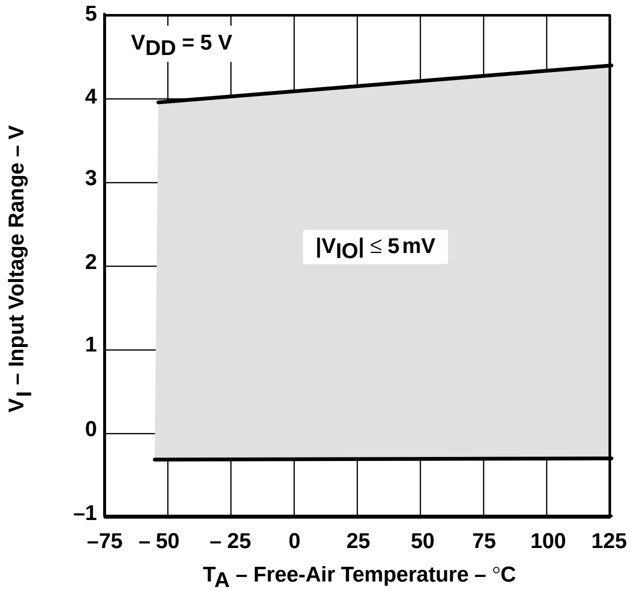

Figure 9

HIGH-LEVEL OUTPUT VOLTAGE
vs
HIGH-LEVEL OUTPUT CURRENT

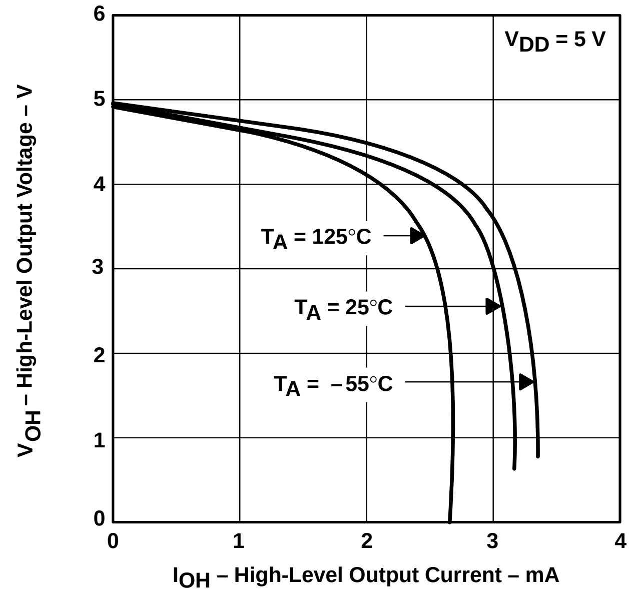

Figure 10

LOW-LEVEL OUTPUT VOLTAGE
vs
LOW-LEVEL OUTPUT CURRENT

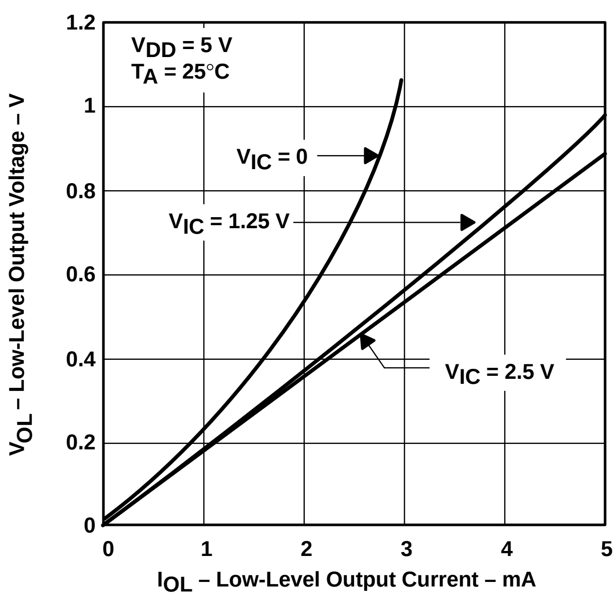

Figure 11

LOW-LEVEL OUTPUT VOLTAGE
vs
LOW-LEVEL OUTPUT CURRENT

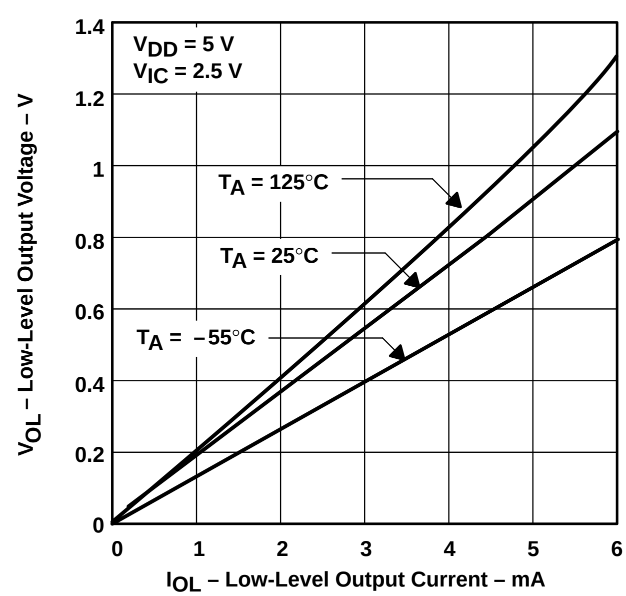

Figure 12

† 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

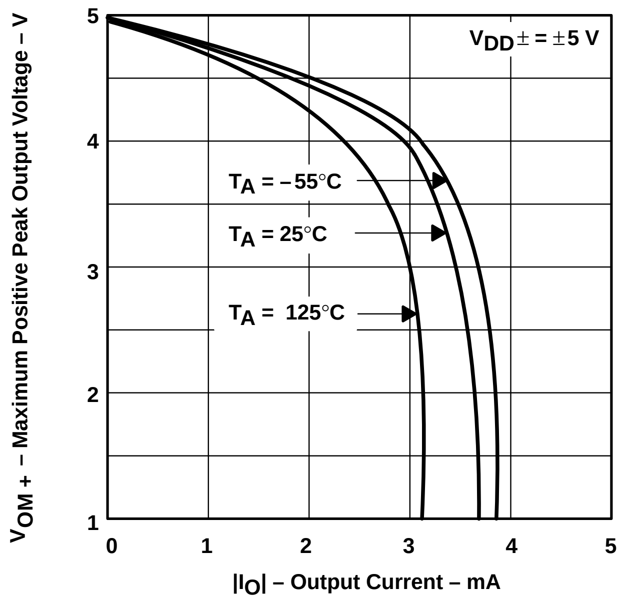

Figure 13

MAXIMUM NEGATIVE PEAK OUTPUT VOLTAGE vs OUTPUT CURRENT

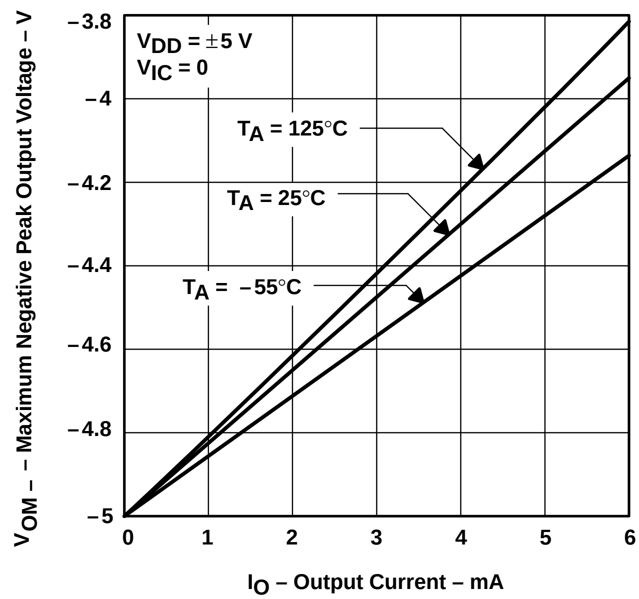

Figure 14

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE vs FREQUENCY

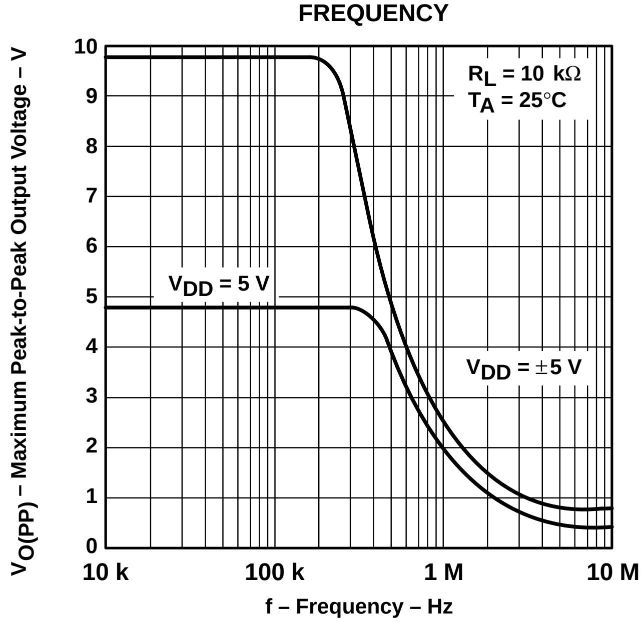

Figure 15

SHORT-CIRCUIT OUTPUT CURRENT vs SUPPLY VOLTAGE

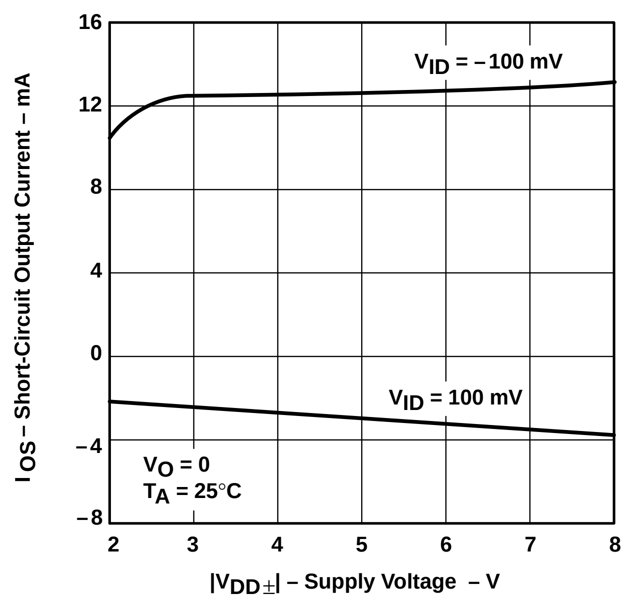

Figure 16

TYPICAL CHARACTERISTICS†

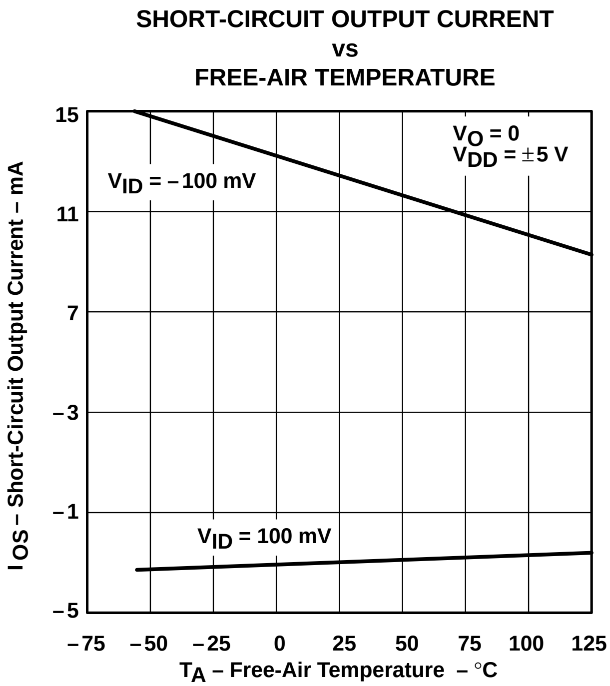

Figure 17

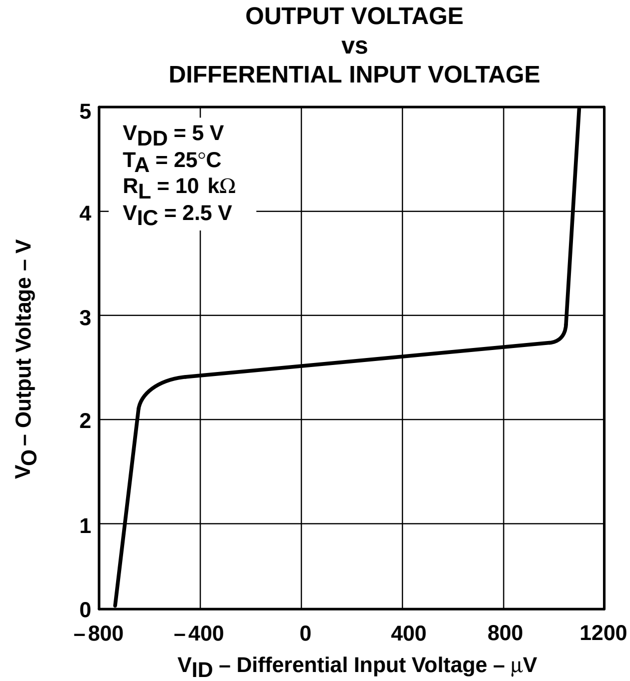

Figure 18

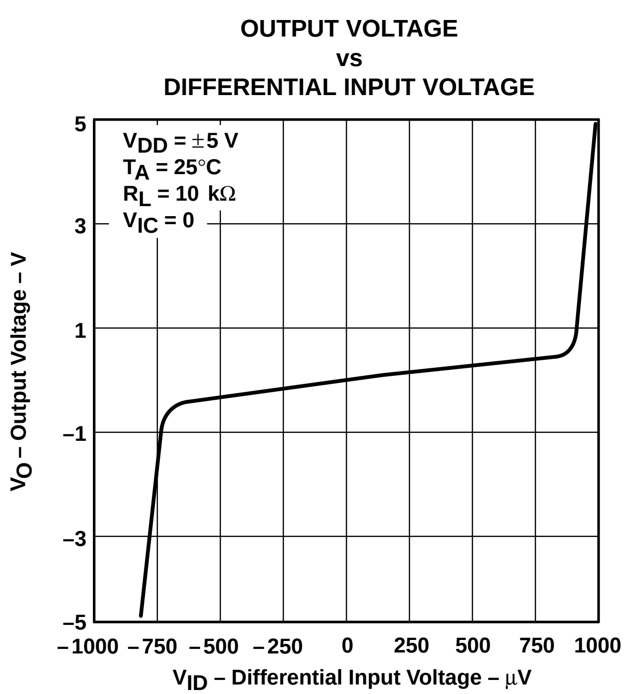

Figure 19

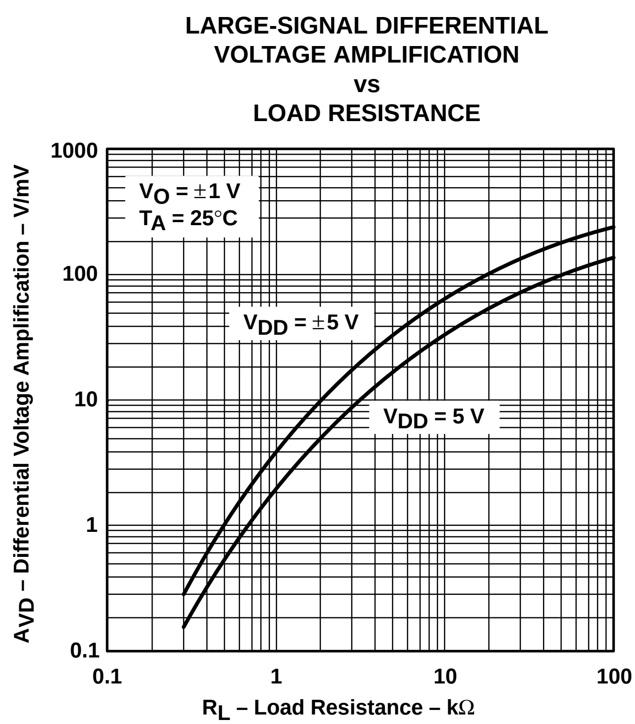

Figure 20

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

TYPICAL CHARACTERISTICS

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE MARGIN vs FREQUENCY

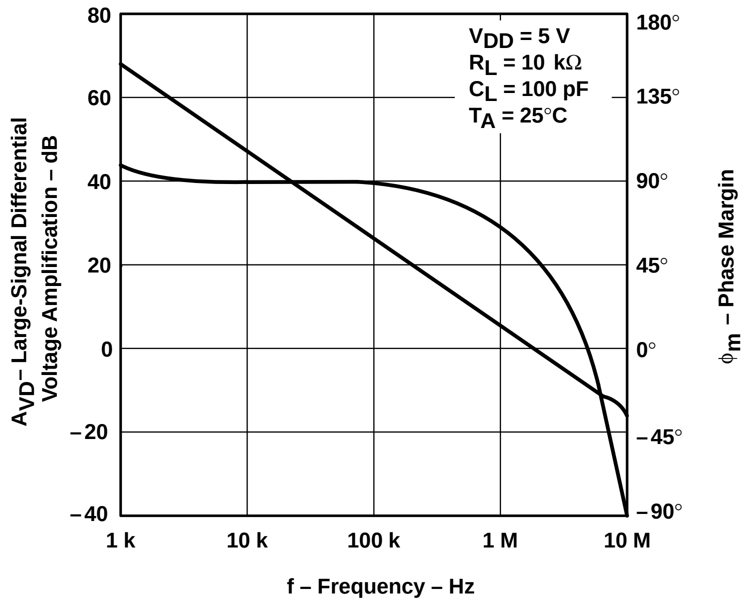

Figure 21

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE MARGIN vs FREQUENCY

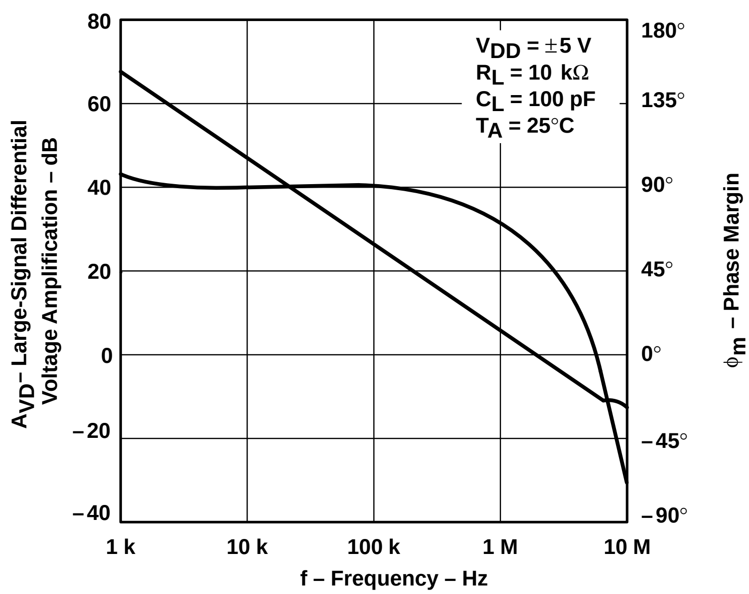

Figure 22

TYPICAL CHARACTERISTICS†

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION vs FREE-AIR TEMPERATURE

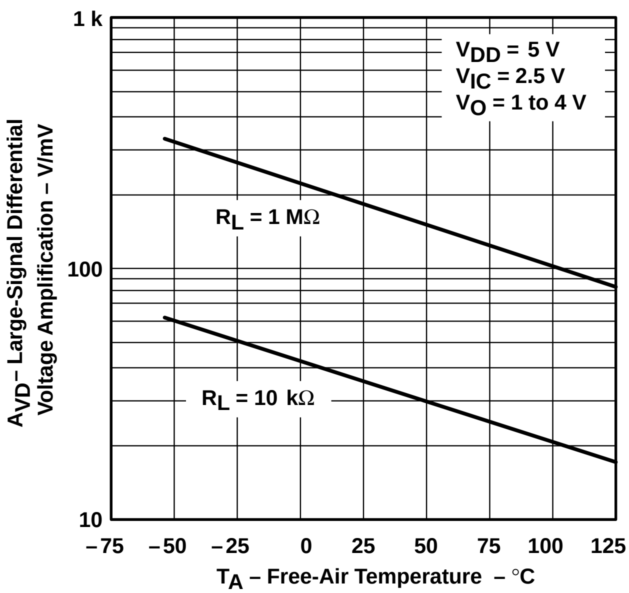

Figure 23

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION vs FREE-AIR TEMPERATURE

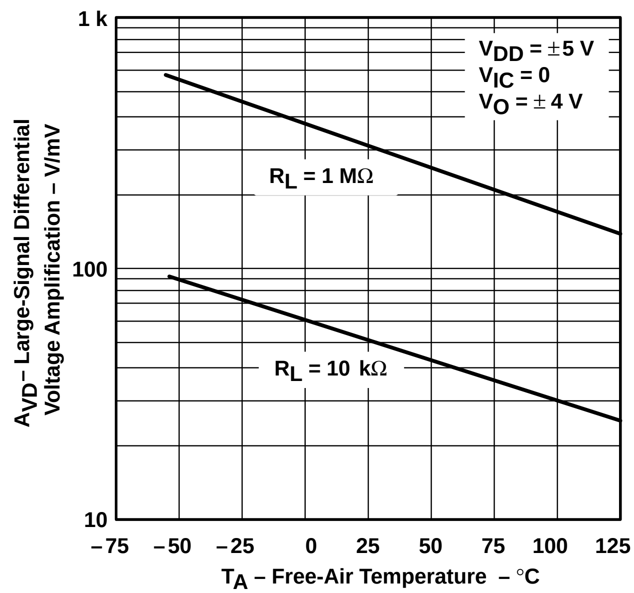

Figure 24

OUTPUT IMPEDANCE vs FREQUENCY

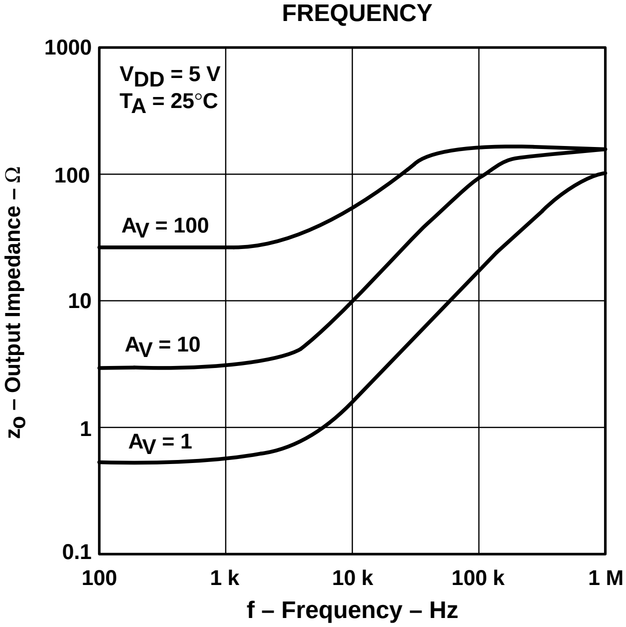

Figure 25

OUTPUT IMPEDANCE vs FREQUENCY

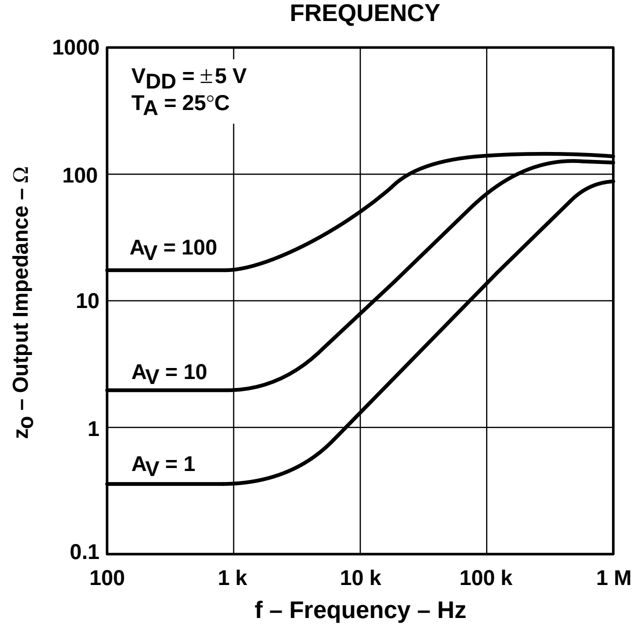

Figure 26

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

TYPICAL CHARACTERISTICS†

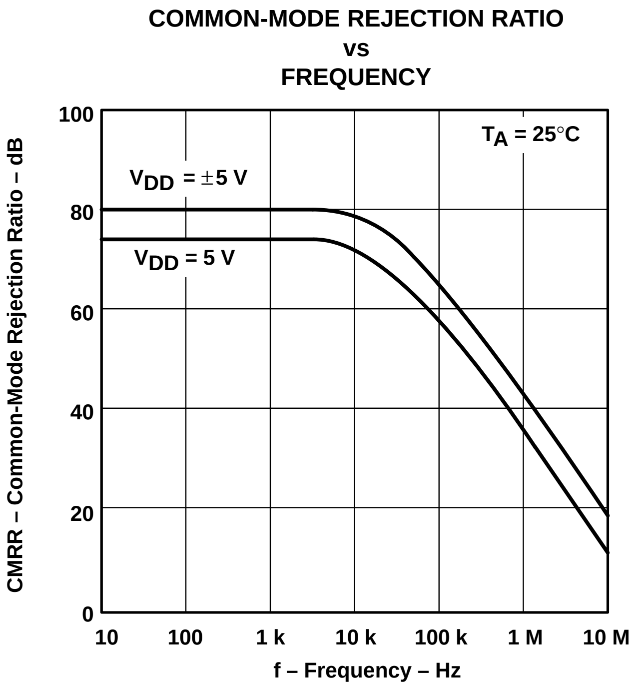

Figure 27

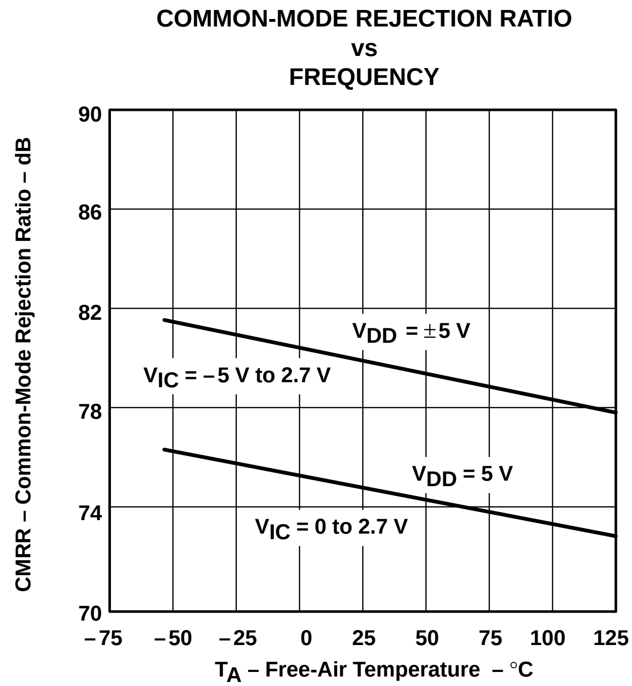

Figure 28

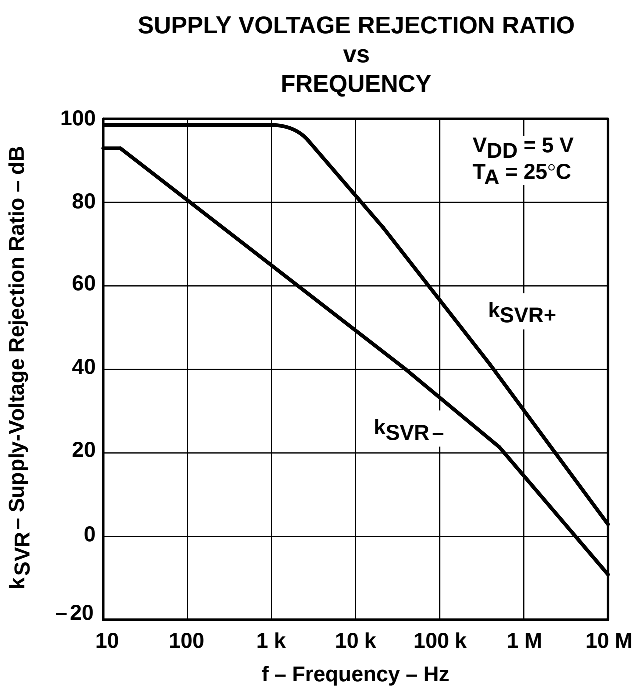

Figure 29

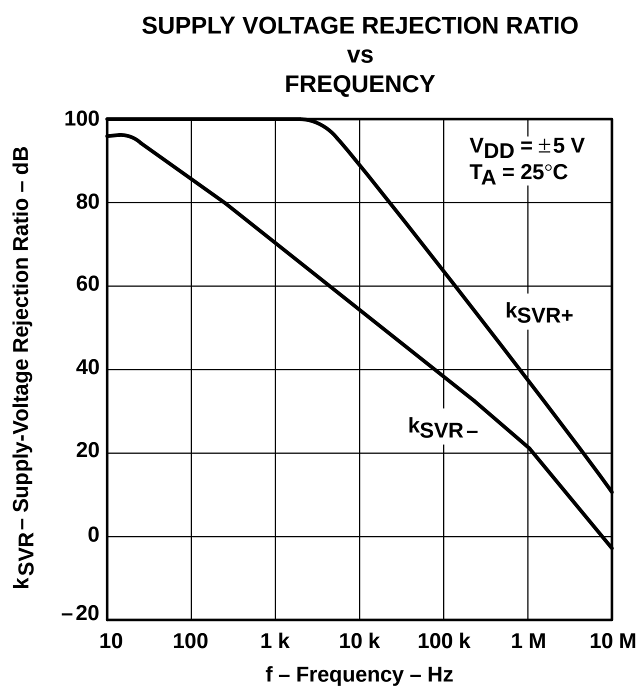

Figure 30

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

TYPICAL CHARACTERISTICS†

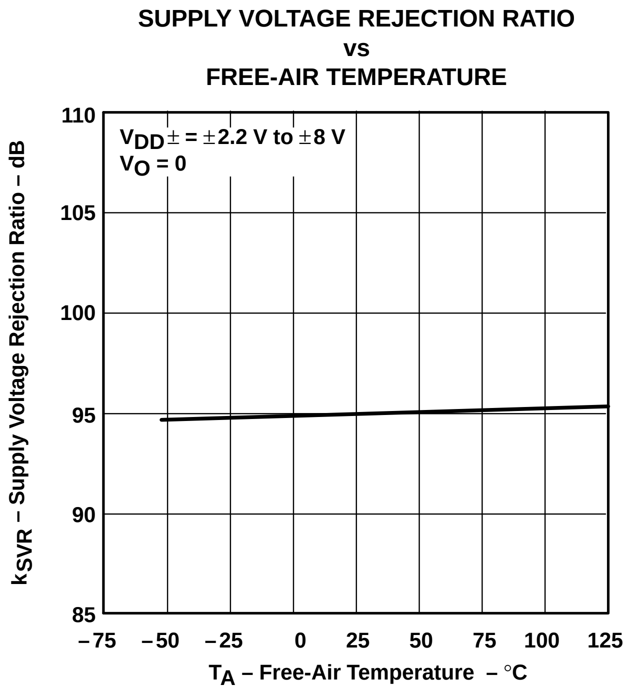

Figure 31

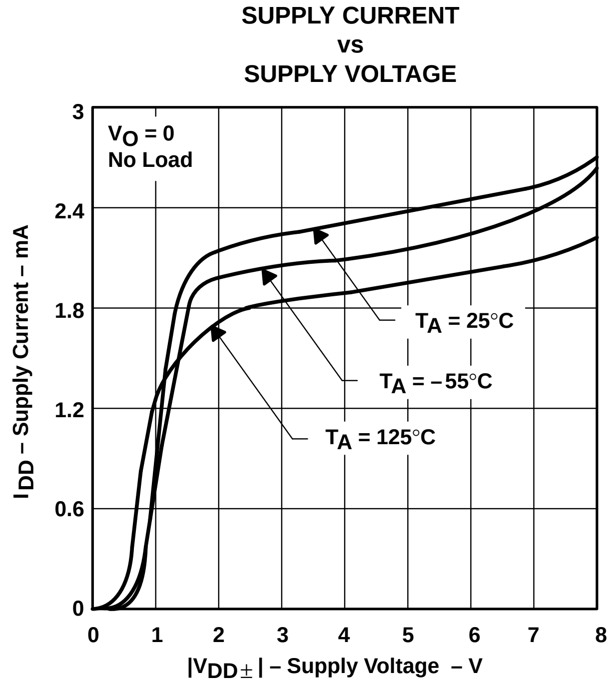

Figure 32

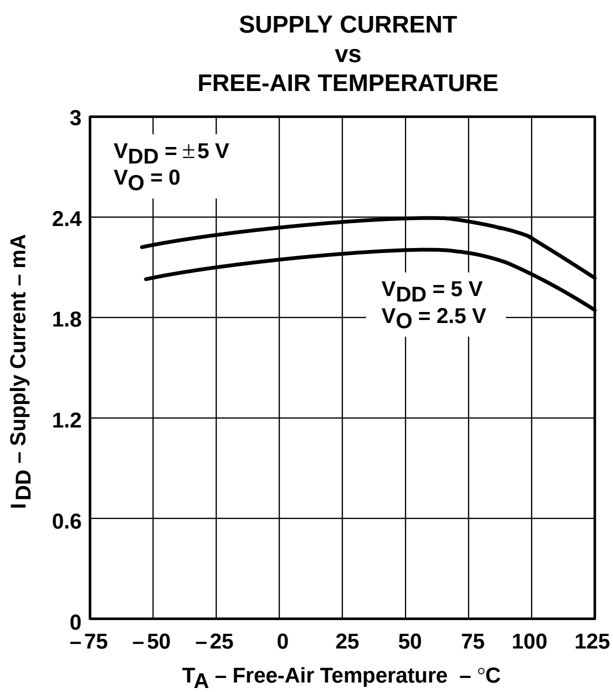

Figure 33

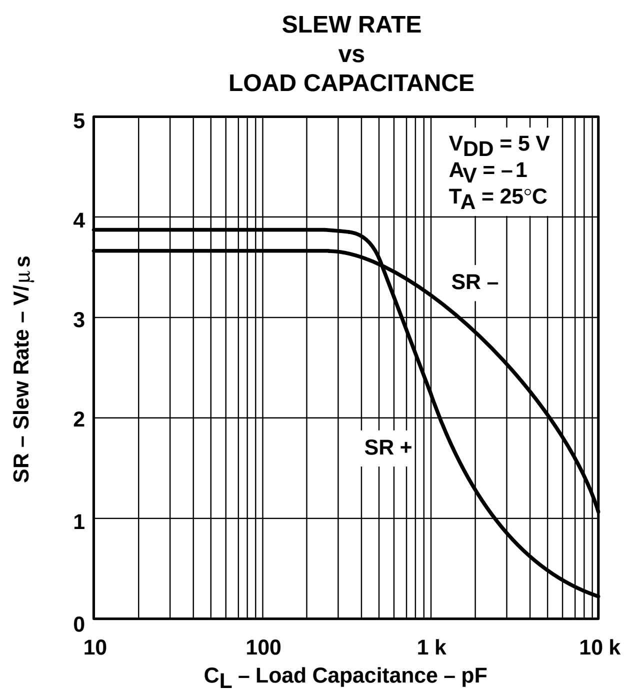

Figure 34

† 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†

SLEW RATE
vs
FREE-AIR TEMPERATURE

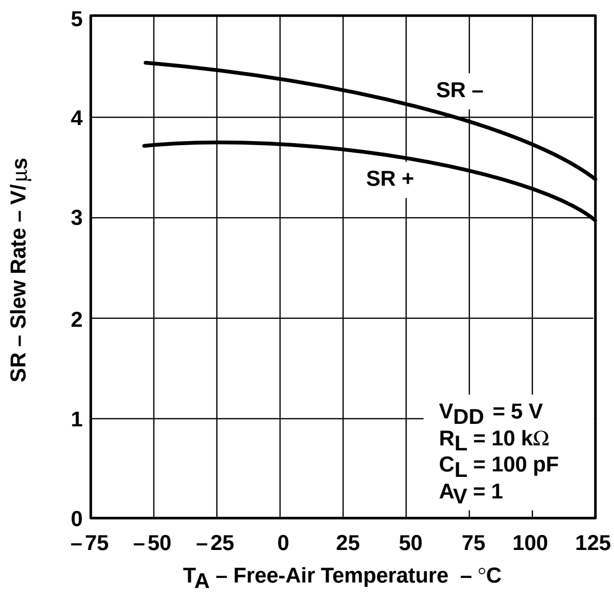


Figure 35

INVERTING LARGE-SIGNAL PULSE RESPONSE

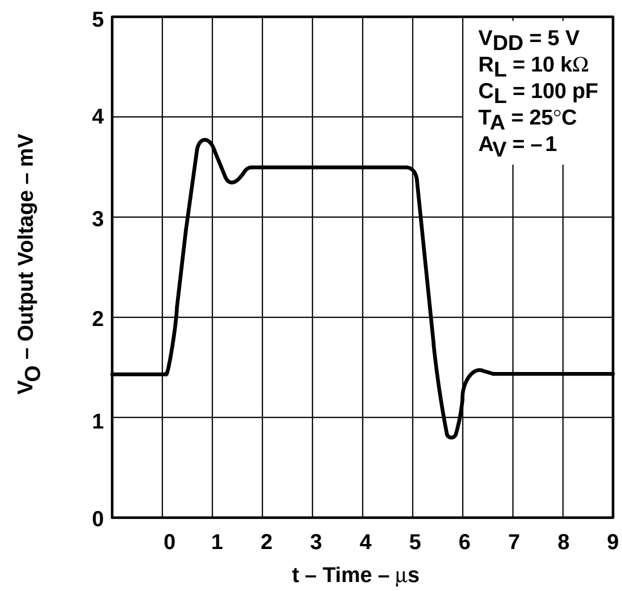


Figure 36

INVERTING LARGE-SIGNAL PULSE RESPONSE

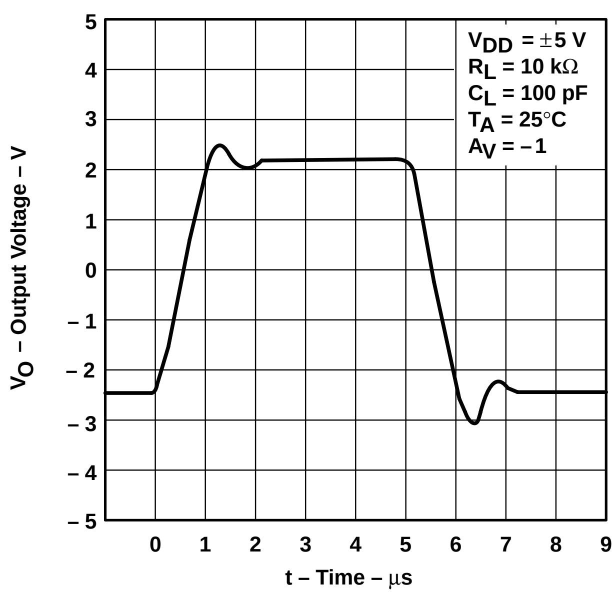


Figure 37

VOLTAGE-FOLLOWER
LARGE-SIGNAL PULSE RESPONSE

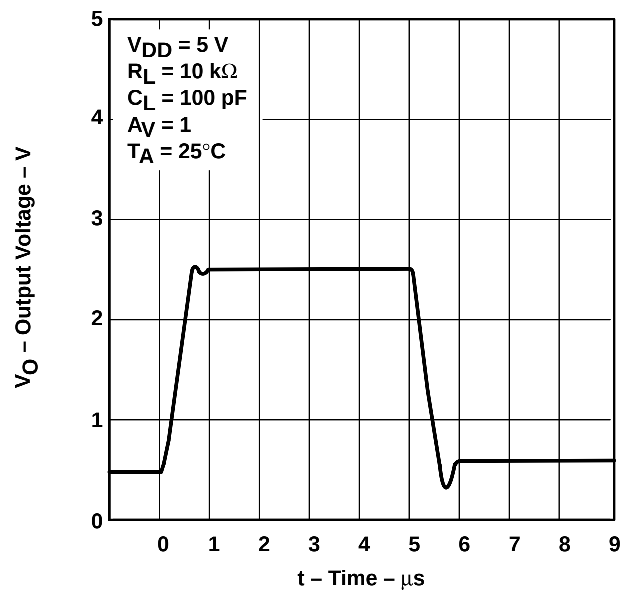


Figure 38

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

TYPICAL CHARACTERISTICS

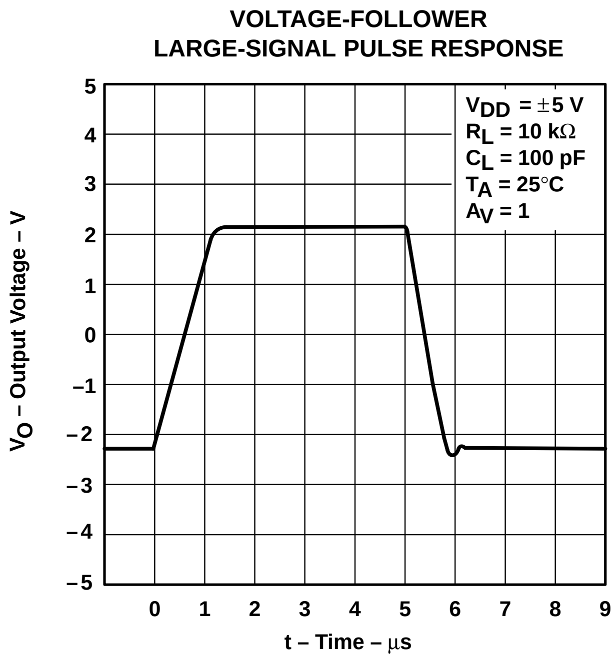


Figure 39

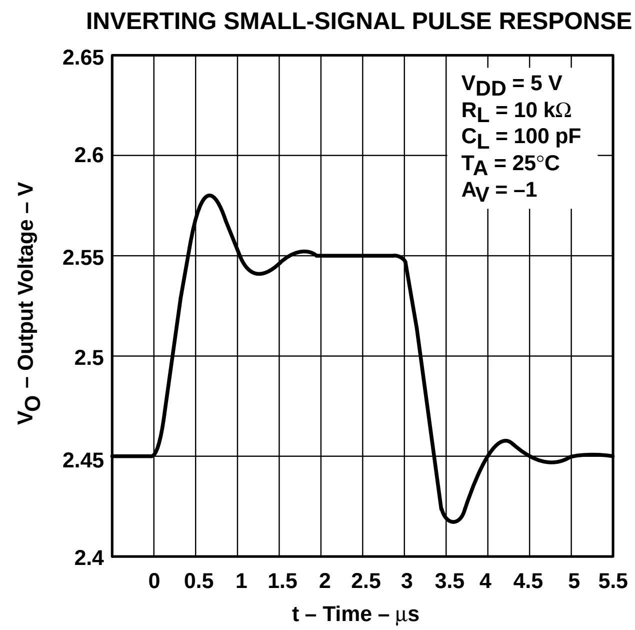


Figure 40

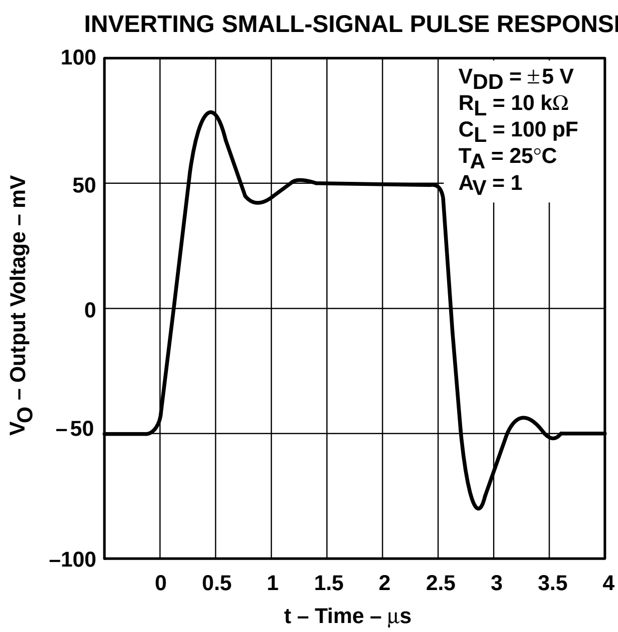


Figure 41

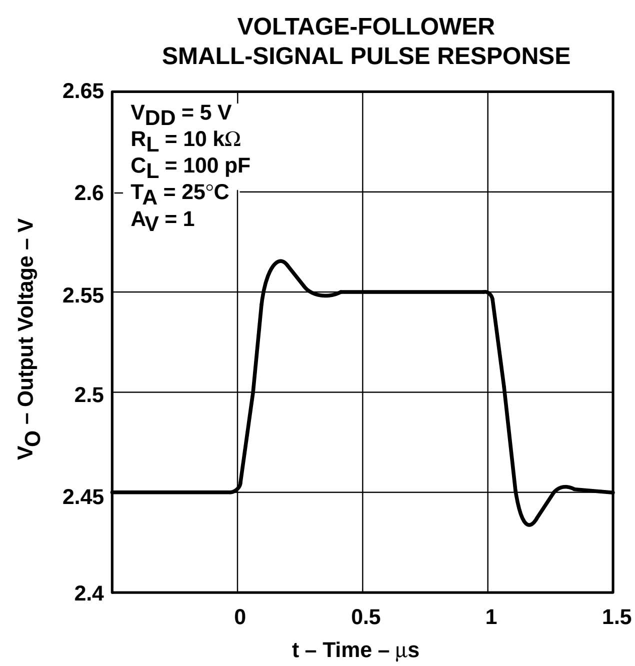


Figure 42

TYPICAL CHARACTERISTICS

VOLTAGE-FOLLOWER
SMALL-SIGNAL PULSE RESPONSE

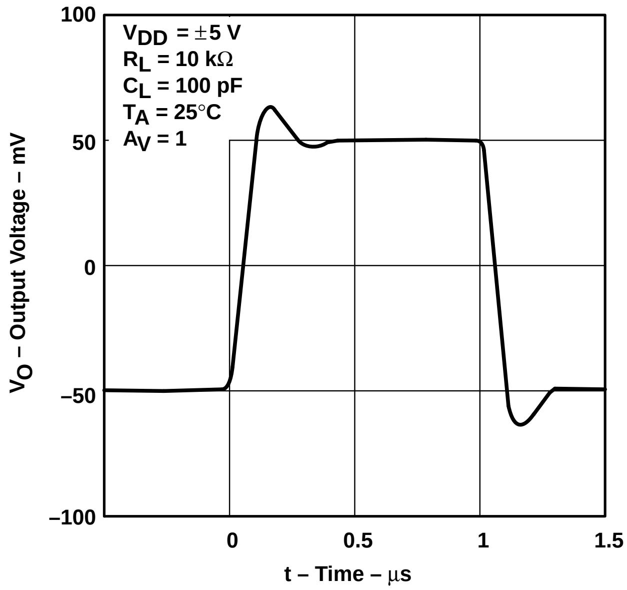


Figure 43

EQUIVALENT INPUT NOISE VOLTAGE
vs
FREQUENCY

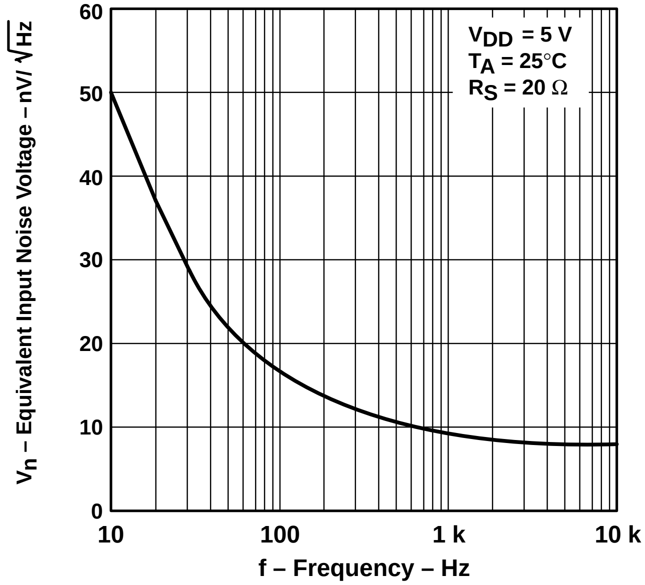


Figure 44

EQUIVALENT INPUT NOISE VOLTAGE
vs
FREQUENCY

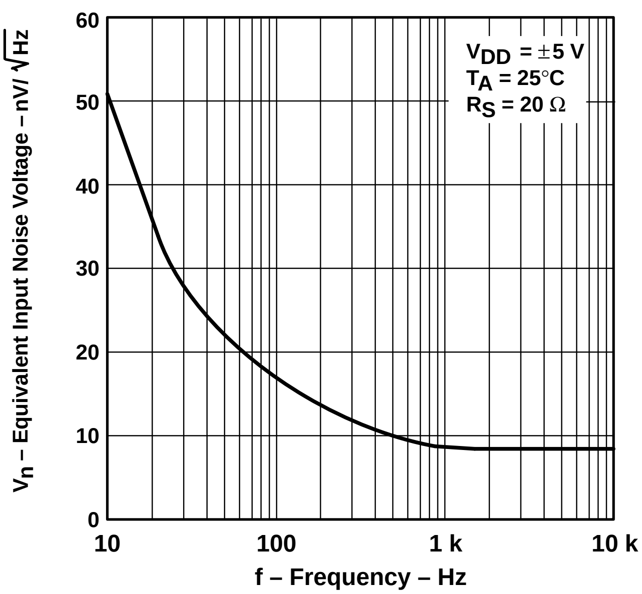


Figure 45

NOISE VOLTAGE
OVER A 10 SECOND PERIOD

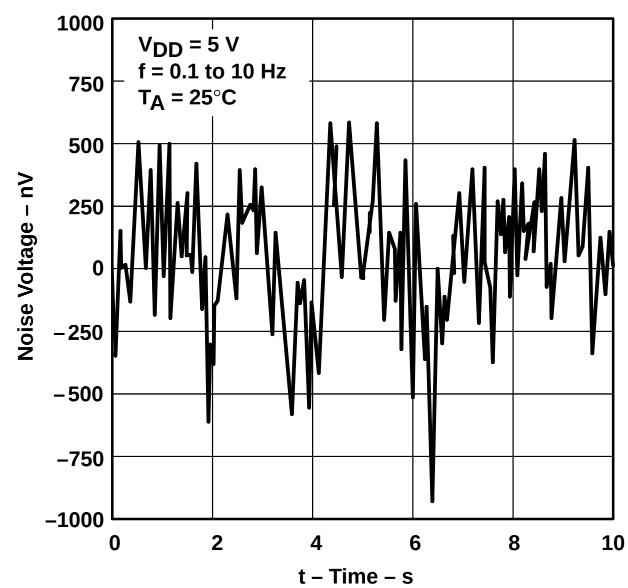


Figure 46

TYPICAL CHARACTERISTICS†

INTEGRATED NOISE VOLTAGE vs FREQUENCY

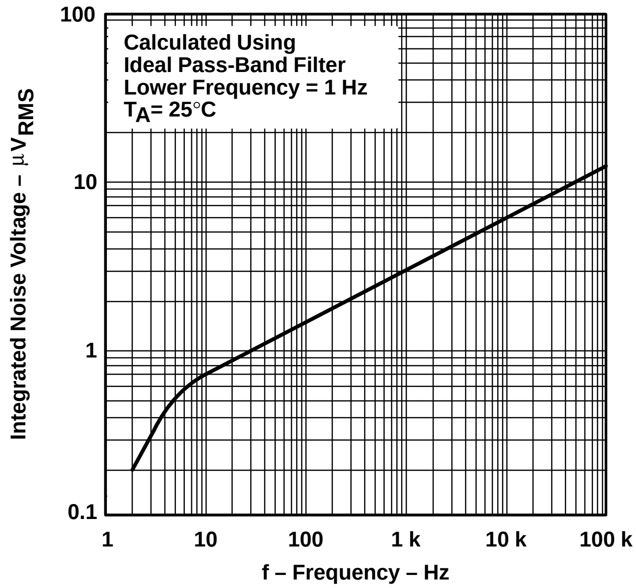


Figure 47

TOTAL HARMONIC DISTORTION PLUS NOISE vs FREQUENCY

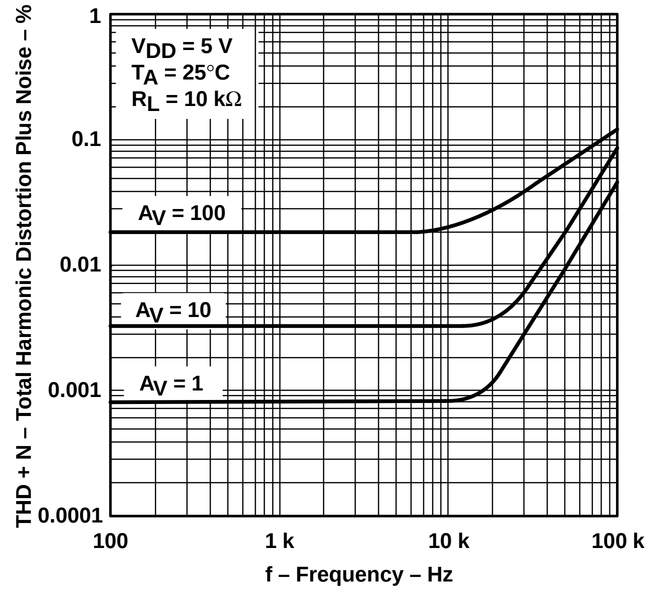


Figure 48

GAIN-BANDWIDTH PRODUCT vs FREE-AIR TEMPERATURE

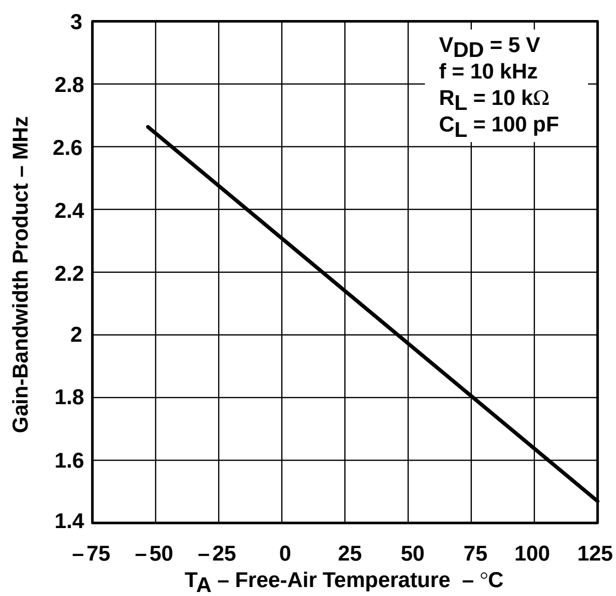


Figure 49

GAIN-BANDWIDTH PRODUCT vs FREE-AIR TEMPERATURE

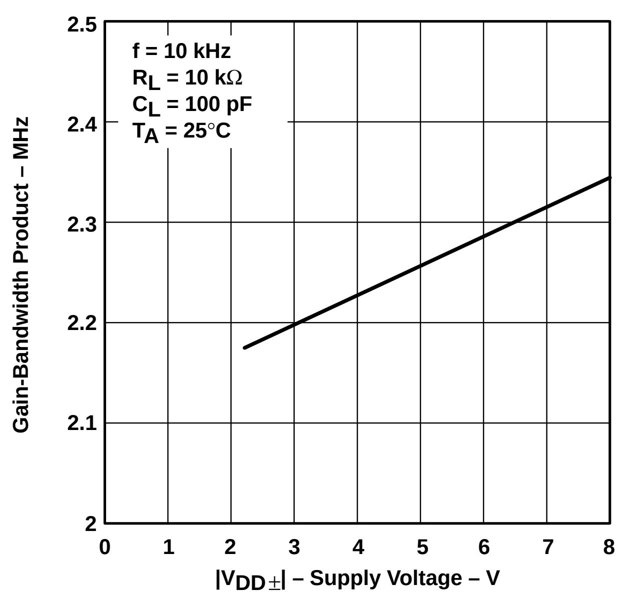


Figure 50

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

TYPICAL CHARACTERISTICS

**PHASE MARGIN
vs
LOAD CAPACITANCE**

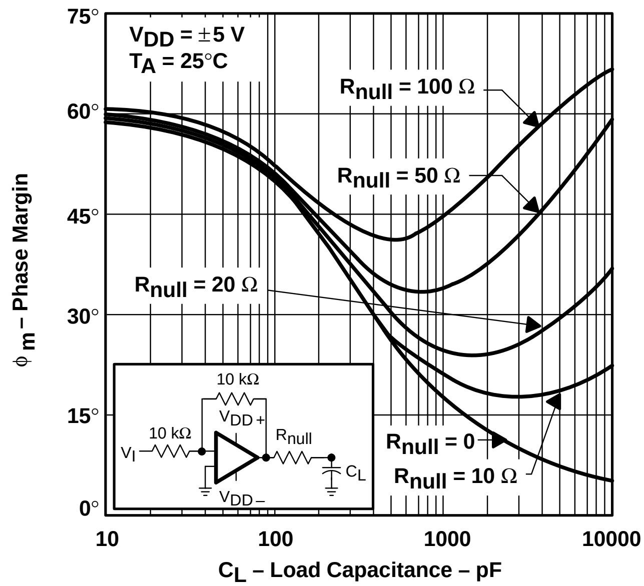


Figure 51

**GAIN MARGIN
vs
LOAD CAPACITANCE**

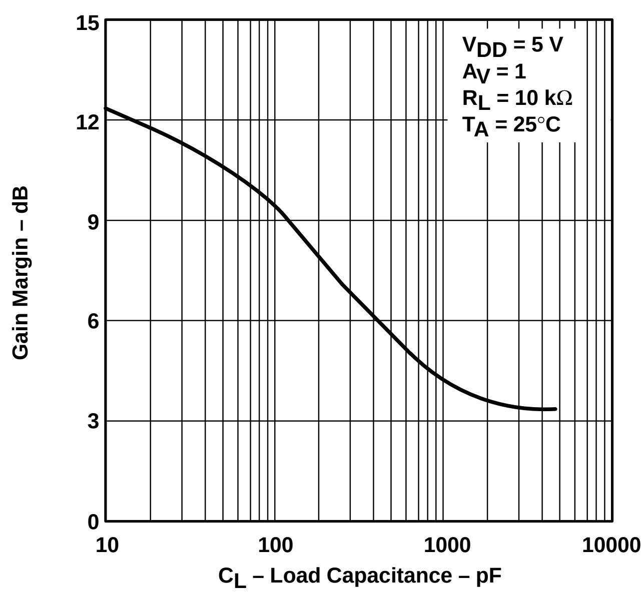


Figure 52

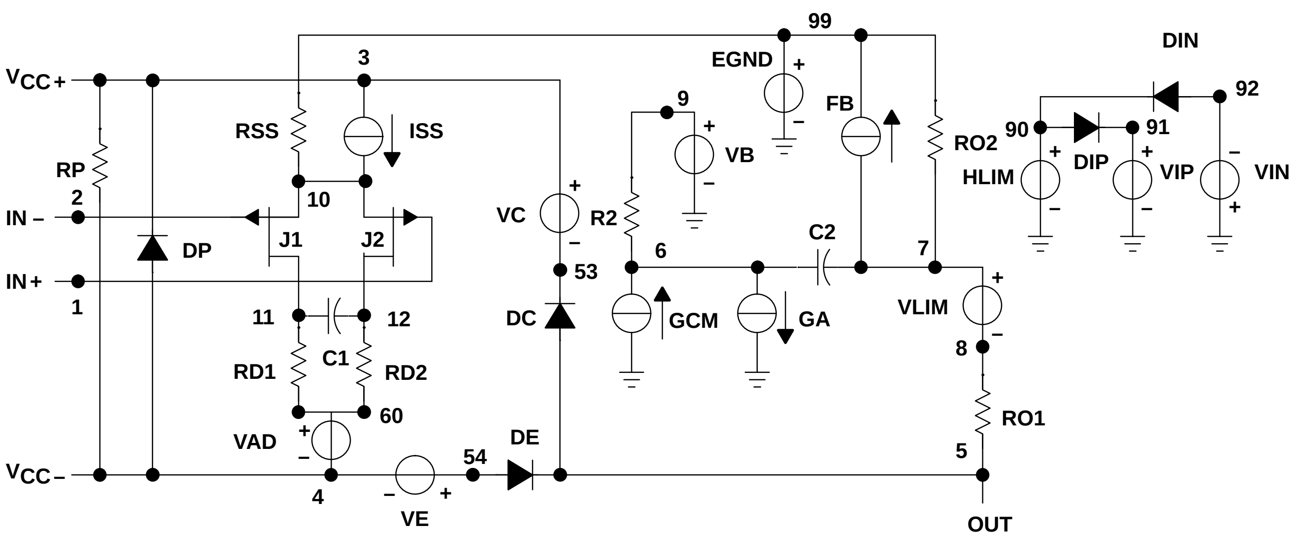
APPLICATION INFORMATION

macromodel information

Macromodel information provided was derived using *PSpice*™ *Parts*™ model generation software. The Boyle macromodel (see Note 5) and subcircuit in Figure 53 were generated using the TLC2272 typical electrical and operating characteristics at $T_A = 25°C$. 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 Intergrated Circuit Operational Amplifiers”, *IEEE Journal of Solid-State Circuits,* SC-9, 353 (1974).




```
.SUBCKT TLC2272 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 53. Boyle Macromodel and Subcircuit

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