- **Output Swing includes Both Supply Rails**
- **Low Noise . . . 12 nV/√Hz Typ at f = 1 kHz**
- **Low Input Bias Current . . . 1 pA Typ**
- **Fully Specified for Both Single-Supply and Split-Supply Operation**
- **Low Power . . . 500 μA Max**
- **Common-Mode Input Voltage Range Includes Negative Rail**
- **Low Input Offset Voltage**
  950 μV Max at T_A = 25°C (TLC2262A)
- **Macromodel Included**
- **Performance Upgrade for the TS27M2/M4 and TLC27M2/M4**
- **Available in Q-Temp Automotive**
  HighRel Automotive Applications
  Configuration Control / Print Support
  Qualification to Automotive Standards

description

The TLC2262 and TLC2264 are dual and quadruple operational amplifiers from Texas Instruments. Both devices exhibit rail-to-rail output performance for increased dynamic range in single- or split-supply applications. The TLC226x family offers a compromise between the micropower TLC225x and the ac performance of the TLC227x. It has low supply current for battery-powered applications, while still having adequate ac performance for applications that demand it. The noise performance has been dramatically improved over previous generations of CMOS amplifiers. Figure 1 depicts the low level of noise voltage for this CMOS amplifier, which has only 200 μA (typ) of supply current per amplifier.

EQUIVALENT INPUT NOISE VOLTAGE vs FREQUENCY

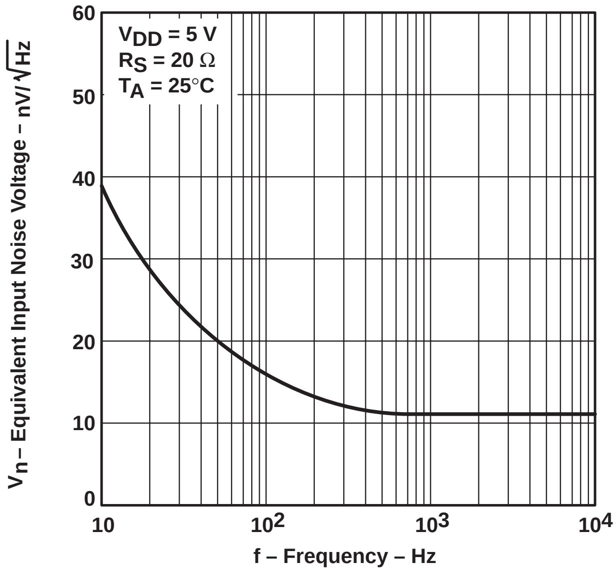


Figure 1

The TLC226x, exhibiting high input impedance and low noise, are excellent for small-signal conditioning for high-impedance sources, such as piezoelectric transducers. Because of the micro-power dissipation levels, these devices work well in hand-held monitoring and remote-sensing applications. In addition, the rail-to-rail output feature with single or split supplies makes this family a great choice when interfacing with analog-to-digital converters (ADCs). For precision applications, the TLC226xA family is available and has a maximum input offset voltage of 950 μV. This family is fully characterized at 5 V and ±5 V.

The TLC2262/4 also makes great upgrades to the TLC27M2/L4 or TS27M2/L4 in standard designs. They offer increased output dynamic range, lower noise voltage and lower input offset voltage. This enhanced feature set allows them to be used in a wider range of applications. For applications that require higher output drive and wider input voltage range, see the TLV2432 and TLV2442. If your design requires single amplifiers, please see the TLV2211/21/31 family. These devices are single rail-to-rail operational amplifiers in the SOT-23 package. Their small size and low power consumption, make them ideal for high density, battery-powered equipment.

TEXAS INSTRUMENTS
POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

TLC2262 AVAILABLE OPTIONS

T_A	V_{IO}max AT 25°C	PACKAGED DEVICES					
		SMALL OUTLINE (D)	CHIP CARRIER (FK)	CERAMIC DIP (JG)	PLASTIC DIP (P)	TSSOP (PW)	CERAMIC FLATPACK (U)
0°C to 70°C	2.5 mV	TLC2262CD	—	—	TLC2262CP	TLC2262CPWLE	—
–40°C to 125°C	950 µV 2.5 mV	TLC2262AID TLC2262ID	— —	— —	TLC2262AIP TLC2262IP	TLC2262AIPWLE —	— —
–40°C to 125°C	950 µV 2.5 mV	TLC2262AQD TLC2262QD	— —	— —	— —	— —	— —
–55°C to 125°C	950 µV 2.5 mV	— —	TLC2262AMFK TLC2262MFK	TLC2262AMJG TLC2262MJG	— —	— —	TLC2262AMU TLC2262MU

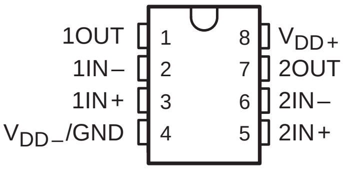
The D packages are available taped and reeled. Add R suffix to device type (e.g., TLC2262CDR). The PW package is available only left-end taped and reeled. Chips are tested at 25°C.

TLC2264 AVAILABLE OPTIONS

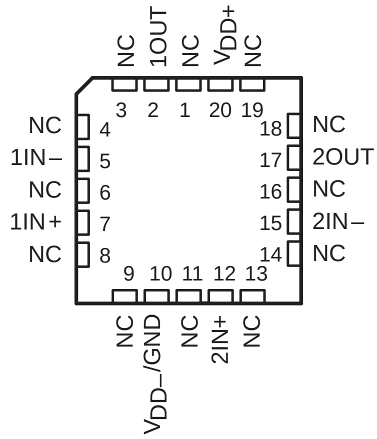
T_A	V_{IO}max AT 25°C	PACKAGED DEVICES					
		SMALL OUTLINE (D)	CHIP CARRIER (FK)	CERAMIC DIP (J)	PLASTIC DIP (N)	TSSOP (PW)	CERAMIC FLATPACK (W)
0°C to 70°C	2.5 mV	TLC2264CD	—	—	TLC2264CN	TLC2264CPWLE	—
–40°C to 125°C	950 µV 2.5 mV	TLC2264AID TLC2264ID	— —	— —	TLC2264AIN TLC2264IN	TLC2264AIPWLE —	— —
–40°C to 125°C	950 µV 2.5 mV	TLC2264AQD TLC2264QD	— —	— —	— —	— —	— —
–55°C to 125°C	950 µV 2.5 mV	— —	TLC2264AMFK TLC2264MFK	TLC2264AMJ TLC2264MJ	— —	— —	TLC2264AMW TLC2264MW

The D packages are available taped and reeled. Add R suffix to device type (e.g., TLC2264CDR). The PW package is available only left-end taped and reeled. Chips are tested at 25°C.

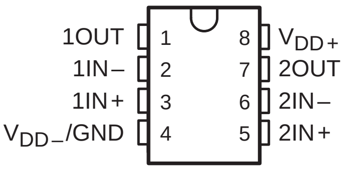
TLC2262C, TLC2262AC
TLC2262I, TLC2262AI
TLC2262Q, TLC2262AQ
D, P, OR PW PACKAGE
(TOP VIEW)



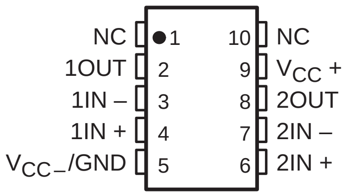
TLC2262M, TLC2262AM . . . FK PACKAGE
(TOP VIEW)



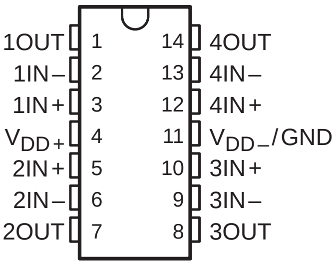
TLC2262M, TLC2262AM . . . JG PACKAGE
(TOP VIEW)



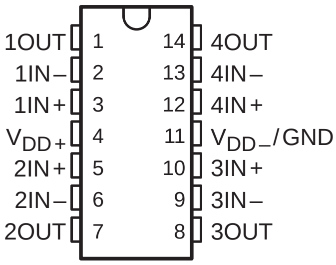
TLC2262M, TLC2262AM . . . U PACKAGE
(TOP VIEW)



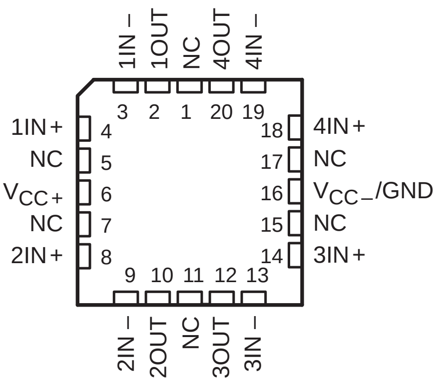
TLC2264C, TLC2264AC
TLC2264I, TLC2264AI
TLC2264Q, TLC2264AQ
D, N, OR PW PACKAGE
(TOP VIEW)



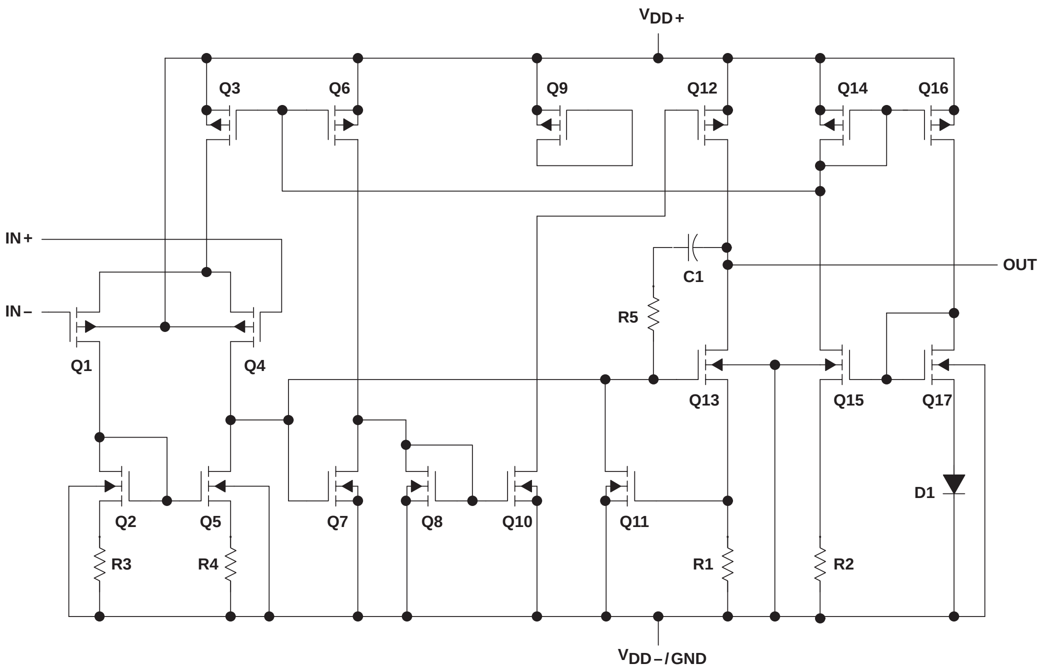
TLC2264M, TLC2264AM . . . J OR W PACKAGE
(TOP VIEW)



TLC2264M, TLC2264AM . . . FK PACKAGE
(TOP VIEW)



equivalent schematic (each amplifier)



ACTUAL DEVICE COMPONENT COUNT†		
COMPONENT	TLC2262	TLC2264
Transistors	38	76
Resistors	28	56
Diodes	9	18
Capacitors	3	6

† 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) . . . . V_{DD-} – 0.3 V to V_{DD+}
Input current, I_I (each input) . . . . ±5 mA
Output current, I_O . . . . ±50 mA
Total current into V_{DD+} . . . . ±50 mA
Total current out of V_{DD-} . . . . ±50 mA
Duration of short-circuit current at (or below) 25°C (see Note 3) . . . . unlimited
Continuous total dissipation . . . . See Dissipation Rating Table
Operating free-air temperature range, T_A: C suffix . . . . 0°C to 70°C
I suffix . . . . –40°C to 125°C
Q suffix . . . . –40°C to 125°C
M suffix . . . . –55°C to 125°C
Storage temperature range, T_{stg} . . . . –65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D, N, P, and PW packages . . . . 260°C
J, JG, U, and W packages . . . . 300°C

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

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

DISSIPATION RATING TABLE

PACKAGE	$T_A \le 25°C$ 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–8	725 mW	5.8 mW/°C	464 mW	377 mW	145 mW
D–14	950 mW	7.6 mW/°C	608 mW	494 mW	190 mW
FK	1375 mW	11.0 mW/°C	880 mW	715 mW	275 mW
J	1375 mW	11.0 mW/°C	880 mW	715 mW	275 mW
JG	1050 mW	8.4 mW/°C	672 mW	546 mW	210 mW
N	1150 mW	9.2 mW/°C	736 mW	598 mW	230 mW
P	1000 mW	8.0 mW/°C	640 mW	520 mW	200 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	140 mW
U	700 mW	5.5 mW/°C	452 mW	370 mW	150 mW
W	700 mW	5.5 mW/°C	452 mW	370 mW	150 mW

recommended operating conditions

	C SUFFIX		I SUFFIX		Q SUFFIX		M SUFFIX		UNIT
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
Supply voltage, $V_{DD\pm}$	±2.2	±8	±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_{DD-}	V_{DD+} –1.5	V
Common-mode input voltage, V_{IC}	V_{DD-}	V_{DD+} –1.5	V_{DD-}	V_{DD+} –1.5	V_{DD-}	V_{DD+} –1.5	V_{DD-}	V_{DD+} –1.5	V
Operating free-air temperature, T_A	0	70	–40	125	–40	125	–55	125	°C

TLC2262C electrical characteristics at specified free-air temperature, V_{DD} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLC2262C MIN	TLC2262C TYP	TLC2262C MAX	UNIT
V_{IO}	Input offset voltage	V_{IC} = 0, V_O = 0,	V_{DD}± = ±2.5 V, R_S = 50 Ω	25°C		300	2500	μV
				Full range			3000	
α_{VIO}	Temperature coefficient of input offset voltage			25°C to 70°C		2		μV/°C
	Input offset voltage long-term drift (see Note 4)			25°C		0.003		μV/mo
I_{IO}	Input offset current			25°C		0.5		pA
				Full range			100	
I_{IB}	Input bias current			25°C		1		pA
				Full range			100	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω,	$\|V_{IO}\|$ ≤ 5 mV	25°C	0 to 4	–0.3 to 4.2		V
				Full range	0 to 3.5			
V_{OH}	High-level output voltage	I_{OH} = –20 μA		25°C		4.99		V
		I_{OH} = –100 μA		25°C	4.85	4.94		
				Full range	4.82			
		I_{OH} = –400 μA		25°C	4.70	4.85		
				Full range	4.60			
V_{OL}	Low-level output voltage	V_{IC} = 2.5 V,	I_{OL} = 50 μA	25°C		0.01		V
		V_{IC} = 2.5 V,	I_{OL} = 500 μA	25°C		0.09	0.15	
				Full range			0.15	
		V_{IC} = 2.5 V,	I_{OL} = 1 mA	25°C		0.2	0.3	
				Full range			0.3	
		V_{IC} = 2.5 V,	I_{OL} = 4 mA	25°C		0.7	1	
				Full range			1.2	
A_{VD}	Large-signal differential voltage amplification	V_{IC} = 2.5 V, V_O = 1 V to 4 V	R_L = 50 kΩ‡	25°C	80	170		V/mV
				Full range	55			
			R_L = 1 MΩ‡	25°C		550		
$r_{i(d)}$	Differential input resistance			25°C		10^{12}		Ω
$r_{i(c)}$	Common-mode input resistance			25°C		10^{12}		Ω
$c_{i(c)}$	Common-mode input capacitance	f = 10 kHz,	P package	25°C		8		pF
z_o	Closed-loop output impedance	f = 100 kHz,	A_V = 10	25°C		240		Ω
CMRR	Common-mode rejection ratio	V_{IC} = 0 to 2.7 V, R_S = 50 Ω	V_O = 2.5 V,	25°C	70	83		dB
				Full range	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		dB
				Full range	80			
I_{DD}	Supply current	V_O = 2.5 V,	No load	25°C		400	500	μA
				Full range			500	

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

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

TLC2262C operating characteristics at specified free-air temperature, V_{DD} = 5 V

PARAMETER		TEST CONDITIONS		T_A†	TLC2262C MIN	TLC2262C TYP	TLC2262C MAX	UNIT
SR	Slew rate at unity gain	V_O = 1.5 V to 3.5 V, C_L = 100 pF‡	R_L = 50 kΩ‡,	25°C	0.35	0.55		V/μs
				Full range	0.3			
V_n	Equivalent input noise voltage	f = 10 Hz		25°C		40		nV/√Hz
		f = 1 kHz		25°C		12		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C		0.7		μV
		f = 0.1 Hz to 10 Hz		25°C		1.3		
I_n	Equivalent input noise current			25°C		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 = 50 kΩ‡	A_V = 1	25°C		0.017%		
			A_V = 10			0.03%		
	Gain-bandwidth product	f = 10 kHz, C_L = 100 pF‡	R_L = 50 kΩ‡,	25°C		0.71		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 2 V, R_L = 50 kΩ‡,	A_V = 1, C_L = 100 pF‡	25°C		185		kHz
t_s	Settling time	A_V = –1, Step = 0.5 V to 2.5 V, R_L = 50 kΩ‡, C_L = 100 pF‡	To 0.1%	25°C		6.4		μs
			To 0.01%			14.1		
ϕ_m	Phase margin at unity gain	R_L = 50 kΩ‡,	C_L = 100 pF‡	25°C		56°		
	Gain margin			25°C		11		dB

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

TLC2262C electrical characteristics at specified free-air temperature, $V_{DD\pm} = \pm5$ V (unless otherwise specified)

PARAMETER		TEST CONDITIONS		T_A†	TLC2262C MIN	TYP	MAX	UNIT
V_{IO}	Input offset voltage	$V_{IC} = 0$, $R_S = 50\ \Omega$	$V_O = 0$,	25°C		300	2500	μV
				Full range			3000	
α_{VIO}	Temperature coefficient of input offset voltage			25°C to 70°C		2		μV/°C
	Input offset voltage long-term drift (see Note 4)			25°C		0.003		μV/mo
I_{IO}	Input offset current			25°C		0.5		pA
				Full range			100	
I_{IB}	Input bias current			25°C		1		pA
				Full range			100	
V_{ICR}	Common-mode input voltage range	$\lvert V_{IO}\rvert \le 5$ mV,	$R_S = 50\ \Omega$	25°C	−5 to 4	−5.3 to 4.2		V
				Full range	−5 to 3.5			
V_{OM+}	Maximum positive peak output voltage	$I_O = -20\ \mu A$		25°C		4.99		V
		$I_O = -100\ \mu A$		25°C	4.85	4.94		
				Full range	4.82			
		$I_O = -400\ \mu A$		25°C	4.7	4.85		
				Full range	4.6			
V_{OM-}	Maximum negative peak output voltage	$V_{IC} = 0$,	$I_O = 50\ \mu A$	25°C		−4.99		V
		$V_{IC} = 0$,	$I_O = 500\ \mu A$	25°C	−4.85	−4.91		
				Full range	−4.85			
		$V_{IC} = 0$,	$I_O = 1$ mA	25°C	−4.7	−4.8		
				Full range	−4.7			
		$V_{IC} = 0$,	$I_O = 4$ mA	25°C	−4	−4.3		
				Full range	−3.8			
A_{VD}	Large-signal differential voltage amplification	$V_O = \pm4$ V	$R_L = 50\ k\Omega$	25°C	80	200		V/mV
				Full range	55			
			$R_L = 1\ M\Omega$	25°C		1000		
$r_{i(d)}$	Differential input resistance			25°C		10^{12}		Ω
$r_{i(c)}$	Common-mode input resistance			25°C		10^{12}		Ω
$c_{i(c)}$	Common-mode input capacitance	f = 10 kHz,	P package	25°C		8		pF
z_o	Closed-loop output impedance	f = 100 kHz,	$A_V = 10$	25°C		220		Ω
CMRR	Common-mode rejection ratio	$V_{IC} = -5$ V to 2.7 V, $V_O = 0$ V,	$R_S = 50\ \Omega$	25°C	75	88		dB
				Full range	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		dB
				Full range	80			
I_{DD}	Supply current	$V_O = 0$ V,	No load	25°C		425	500	μA
				Full range			500	

† Full range is 0°C to 70°C.

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

TLC2262C operating characteristics at specified free-air temperature, $V_{DD\pm} = \pm5$ V

PARAMETER		TEST CONDITIONS		T_A†	TLC2262C MIN	TLC2262C TYP	TLC2262C MAX	UNIT
SR	Slew rate at unity gain	$V_O = \pm1.9$ V, C_L = 100 pF	R_L = 50 kΩ,	25°C	0.35	0.55		V/µs
				Full range	0.3			
V_n	Equivalent input noise voltage	f = 10 Hz		25°C		43		nV/√Hz
		f = 1 kHz		25°C		12		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C		0.8		µV
		f = 0.1 Hz to 10 Hz		25°C		1.3		
I_n	Equivalent input noise current			25°C		0.6		fA√Hz
THD + N	Total harmonic distortion pulse duration	$V_O = \pm2.3$ V, f = 20 kHz, R_L = 50 kΩ	A_V = 1	25°C		0.014%		
			A_V = 10			0.024%		
	Gain-bandwidth product	f = 10 kHz, C_L = 100 pF	R_L = 50 kΩ,	25°C		0.73		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 4.6 V, R_L = 50 kΩ,	A_V = 1, C_L = 100 pF	25°C		85		kHz
t_s	Settling time	$A_V = -1$, Step = –2.3 V to 2.3 V, R_L = 50 kΩ, C_L = 100 pF	To 0.1%	25°C		7.1		µs
			To 0.01%			16.5		
ϕ_m	Phase margin at unity gain	R_L = 50 kΩ,	C_L = 100 pF	25°C		57°		
	Gain margin			25°C		11		dB

† Full range is 0°C to 70°C.

TLC2264C electrical characteristics at specified free-air temperature, V_{DD} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLC2264C			UNIT
					MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{IC} = 0, V_O = 0,	$V_{DD\pm}$ = ±2.5 V, R_S = 50 Ω	25°C		300	2500	µV
				Full range			3000	
α_{VIO}	Temperature coefficient of input offset voltage			25°C to 70°C		2		µV/°C
	Input offset voltage long-term drift (see Note 4)			25°C		0.003		µV/mo
I_{IO}	Input offset current			25°C		0.5		pA
				Full range			100	
I_{IB}	Input bias current			25°C		1		pA
				Full range			100	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω,	$\|V_{IO}\|$ ≤ 5 mV	25°C	0 to 4	−0.3 to 4.2		V
				Full range	0 to 3.5			
V_{OH}	High-level output voltage	I_{OH} = −20 µA		25°C		4.99		V
		I_{OH} = −100 µA		25°C	4.85	4.94		
				Full range	4.82			
		I_{OH} = −400 µA		25°C	4.70	4.85		
				Full range	4.60			
V_{OL}	Low-level output voltage	V_{IC} = 2.5 V,	I_{OL} = 50 µA	25°C		0.01		V
		V_{IC} = 2.5 V,	I_{OL} = 500 µA	25°C		0.09	0.15	
				Full range			0.15	
		V_{IC} = 2.5 V,	I_{OL} = 1 mA	25°C		0.2	0.3	
				Full range			0.3	
		V_{IC} = 2.5 V,	I_{OL} = 4 mA	25°C		0.7	1	
				Full range			1.2	
A_{VD}	Large-signal differential voltage amplification	V_{IC} = 2.5 V, V_O = 1 V to 4 V	R_L = 50 kΩ‡	25°C	80	170		V/mV
				Full range	55			
			R_L = 1 MΩ‡	25°C		550		
$r_{i(d)}$	Differential input resistance			25°C		10^{12}		Ω
$r_{i(c)}$	Common-mode input resistance			25°C		10^{12}		Ω
$c_{i(c)}$	Common-mode input capacitance	f = 10 kHz,	N package	25°C		8		pF
z_o	Closed-loop output impedance	f = 100 kHz,	A_V = 10	25°C		240		Ω
CMRR	Common-mode rejection ratio	V_{IC} = 0 to 2.7 V, R_S = 50 Ω	V_O = 2.5 V,	25°C	70	83		dB
				Full range	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		dB
				Full range	80			
I_{DD}	Supply current (four amplifiers)	V_O = 2.5 V,	No load	25°C		0.8	1	mA
				Full range			1	

† Full range is 0°C to 70°C.
‡ Referenced to 2.5 V
NOTE 4. Typical values are based on the input offset voltage shift observed through 500 hours of operating life test at T_A = 150°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLC2264C operating characteristics at specified free-air temperature, V_{DD} = 5 V

PARAMETER		TEST CONDITIONS		T_A†	TLC2264C MIN	TLC2264C TYP	TLC2264C MAX	UNIT
SR	Slew rate at unity gain	V_O = 1.4 V to 2.6 V, R_L = 50 kΩ‡, C_L = 100 pF‡		25°C	0.35	0.55		V/µs
				Full range	0.3			
V_n	Equivalent input noise voltage	f = 10 Hz		25°C		40		nV/√Hz
		f = 1 kHz		25°C		12		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C		0.7		µV
		f = 0.1 Hz to 10 Hz		25°C		1.3		
I_n	Equivalent input noise current			25°C		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 = 50 kΩ‡	A_V = 1	25°C		0.017%		
			A_V = 10			0.03%		
	Gain-bandwidth product	f = 10 kHz, R_L = 50 kΩ‡, C_L = 100 pF‡		25°C		0.71		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 2 V, A_V = 1, R_L = 50 kΩ‡, C_L = 100 pF‡		25°C		185		kHz
t_s	Settling time	A_V = –1, Step = 0.5 V to 2.5 V, R_L = 50 kΩ‡, C_L = 100 pF‡	To 0.1%	25°C		6.4		µs
			To 0.01%			14.1		
ϕ_m	Phase margin at unity gain	R_L = 50 kΩ‡, C_L = 100 pF‡		25°C		56°		
	Gain margin			25°C		11		dB

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

TLC2264C electrical characteristics at specified free-air temperature, $V_{DD\pm} = \pm5$ V (unless otherwise specified)

PARAMETER		TEST CONDITIONS		T_A†	TLC2264C MIN	TLC2264C TYP	TLC2264C MAX	UNIT
V_{IO}	Input offset voltage	$V_{IC} = 0$, $V_O = 0$, $R_S = 50\ \Omega$		25°C		300	2500	μV
				Full range			3000	
α_{VIO}	Temperature coefficient of input offset voltage			25°C to 70°C		2		μV/°C
	Input offset voltage long-term drift (see Note 4)			25°C		0.003		μV/mo
I_{IO}	Input offset current			25°C		0.5		pA
				Full range			100	
I_{IB}	Input bias current			25°C		1		pA
				Full range			100	
V_{ICR}	Common-mode input voltage range	$\lvert V_{IO}\rvert \le 5$ mV, $R_S = 50\ \Omega$		25°C	−5 to 4	−5.3 to 4.2		V
				Full range	−5 to 3.5			
V_{OM+}	Maximum positive peak output voltage	$I_O = -20\ \mu A$		25°C		4.99		V
		$I_O = -100\ \mu A$		25°C	4.85	4.94		
				Full range	4.82			
		$I_O = -400\ \mu A$		25°C	4.7	4.85		
				Full range	4.6			
V_{OM-}	Maximum negative peak output voltage	$V_{IC} = 0$, $I_O = 50\ \mu A$		25°C		−4.99		V
		$V_{IC} = 0$, $I_O = 500\ \mu A$		25°C	−4.85	−4.91		
				Full range	−4.85			
		$V_{IC} = 0$, $I_O = 1$ mA		25°C	−4.7	−4.8		
				Full range	−4.7			
		$V_{IC} = 0$, $I_O = 4$ mA		25°C	−4	−4.3		
				Full range	−3.8			
A_{VD}	Large-signal differential voltage amplification	$V_O = \pm4$ V	$R_L = 50\ k\Omega$	25°C	80	200		V/mV
				Full range	55			
			$R_L = 1\ M\Omega$	25°C		1000		
$r_{i(d)}$	Differential input resistance			25°C		10^{12}		Ω
$r_{i(c)}$	Common-mode input resistance			25°C		10^{12}		Ω
$c_{i(c)}$	Common-mode input capacitance	f = 10 kHz, N package		25°C		8		pF
z_o	Closed-loop output impedance	f = 100 kHz, $A_V = 10$		25°C		220		Ω
CMRR	Common-mode rejection ratio	$V_{IC} = -5$ V to 2.7 V, $V_O = 0$, $R_S = 50\ \Omega$		25°C	75	88		dB
				Full range	75			
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		25°C	80	95		dB
				Full range	80			
I_{DD}	Supply current (four amplifiers)	$V_O = 0$, No load		25°C		0.85	1	mA
				Full range			1	

† Full range is 0°C to 70°C.

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

TLC2264C operating characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5$ V

PARAMETER		TEST CONDITIONS		T_A†	TLC2264C MIN	TLC2264C TYP	TLC2264C MAX	UNIT
SR	Slew rate at unity gain	$V_O = \pm 1.9$ V, C_L = 100 pF	R_L = 50 kΩ,	25°C	0.35	0.55		V/µs
				Full range	0.3			
V_n	Equivalent input noise voltage	f = 10 Hz		25°C		43		nV/√Hz
		f = 1 kHz		25°C		12		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C		0.8		µV
		f = 0.1 Hz to 10 Hz		25°C		1.3		
I_n	Equivalent input noise current			25°C		0.6		fA/√Hz
THD + N	Total harmonic distortion plus noise	$V_O = \pm 2.3$ V, f = 20 kHz, R_L = 50 kΩ	A_V = 1	25°C		0.014%		
			A_V = 10			0.024%		
	Gain-bandwidth product	f = 10 kHz, C_L = 100 pF	R_L = 50 kΩ,	25°C		0.73		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 4.6 V, R_L = 50 kΩ,	A_V = 1, C_L = 100 pF	25°C		70		kHz
t_s	Settling time	$A_V = -1$, Step = –2.3 V to 2.3 V, R_L = 50 kΩ, C_L = 100 pF	To 0.1%	25°C		7.1		µs
			To 0.01%			16.5		
ϕ_m	Phase margin at unity gain	R_L = 50 kΩ,	C_L = 100 pF	25°C		57°		
	Gain margin			25°C		11		dB

† Full range is 0°C to 70°C.

TLC2262I electrical characteristics at specified free-air temperature, V_{DD} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLC2262I MIN	TLC2262I TYP	TLC2262I MAX	TLC2262AI MIN	TLC2262AI TYP	TLC2262AI MAX	UNIT
V_{IO}	Input offset voltage	$V_{DD\pm} = \pm 2.5$ V, $V_O = 0$,	$V_{IC} = 0$, $R_S = 50\ \Omega$	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		0.003			0.003		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	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	$I_{OH} = -20\ \mu A$		25°C		4.99			4.99		V
		$I_{OH} = -100\ \mu A$		25°C	4.85	4.94		4.85	4.94		
				Full range	4.82			4.82			
		$I_{OH} = -400\ \mu A$		25°C	4.7	4.85		4.7	4.85		
				Full range	4.5			4.5			
V_{OL}	Low-level output voltage	$V_{IC} = 2.5$ V,	$I_{OL} = 50\ \mu A$	25°C		0.01			0.01		V
		$V_{IC} = 2.5$ V,	$I_{OL} = 500\ \mu A$	25°C		0.09	0.15		0.09	0.15	
				Full range			0.15			0.15	
		$V_{IC} = 2.5$ V,	$I_{OL} = 4$ mA	25°C		0.8	1		0.7	1	
				Full range			1.2			1.2	
A_{VD}	Large-signal differential voltage amplification	$V_{IC} = 2.5$ V, $V_O = 1$ V to 4 V	$R_L = 50\ k\Omega$‡	25°C	80	100		80	170		V/mV
				Full range	50			50			
			$R_L = 1\ M\Omega$‡	25°C		550			550		
$r_{i(d)}$	Differential input resistance			25°C		10^{12}			10^{12}		Ω
$r_{i(c)}$	Common-mode input resistance			25°C		10^{12}			10^{12}		Ω
$c_{i(c)}$	Common-mode input capacitance	f = 10 kHz,	P package	25°C		8			8		pF
z_o	Closed-loop output impedance	f = 100 kHz,	$A_V = 10$	25°C		240			240		Ω
CMRR	Common-mode rejection ratio	$V_{IC} = 0$ to 2.7 V, $R_S = 50\ \Omega$	$V_O = 2.5$ V,	25°C	70	83		70	83		dB
				Full range	70			70			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$)	$V_{DD} = 4.4$ 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		400	500		400	500	µA
				Full range			500			500	

† Full range is – 40°C to 125°C.
‡ Referenced to 2.5 V
NOTE 4: Typical values are based on the input offset voltage shift observed through 500 hours of operating life test at T_A = 150°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLC2262I operating characteristics at specified free-air temperature, V_{DD} = 5 V

PARAMETER		TEST CONDITIONS		T_A†	TLC2262I			TLC2262AI			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	V_O = 1.5 V to 3.5 V, C_L = 100 pF‡	R_L = 50 kΩ‡,	25°C	0.35	0.55		0.35	0.55		V/µs
				Full range	0.25			0.25			
V_n	Equivalent input noise voltage	f = 10 Hz		25°C		40			40		nV/√Hz
		f = 1 kHz		25°C		12			12		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C		0.7			0.7		µV
		f = 0.1 Hz to 10 Hz		25°C		1.3			1.3		
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 = 50 kΩ‡	A_V = 1	25°C		0.017%			0.017%		
			A_V = 10			0.03%			0.03%		
	Gain-bandwidth product	f = 50 kHz, C_L = 100 pF‡	R_L = 50 kΩ‡,	25°C		0.82			0.82		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 2 V, R_L = 50 kΩ‡,	A_V = 1, C_L = 100 pF‡	25°C		185			185		kHz
t_s	Settling time	A_V = –1, Step = 0.5 V to 2.5 V, R_L = 50 kΩ‡, C_L = 100 pF‡	To 0.1%	25°C		6.4			6.4		µs
			To 0.01%			14.1			14.1		
ϕ_m	Phase margin at unity gain	R_L = 50 kΩ‡,	C_L = 100 pF‡	25°C		56°			56°		
	Gain margin			25°C		11			11		dB

† Full range is – 40°C to 125°C.
‡ Referenced to 2.5 V

TLC2262I electrical characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5$ V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A†	TLC2262I			TLC2262AI			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 85°C		2			2		μV/°C
	Input offset voltage long-term drift (see Note 4)		25°C		0.003			0.003		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
		$I_O = -100\ \mu A$	25°C	4.85	4.94		4.85	4.94		
			Full range	4.82			4.82			
		$I_O = -400\ \mu A$	25°C	4.7	4.85		4.7	4.85		
			Full range	4.5			4.5			
V_{OM-}	Maximum negative peak output voltage	$V_{IC} = 0$, $I_O = 50\ \mu A$	25°C		−4.99			−4.99		V
		$V_{IC} = 0$, $I_O = 500\ \mu A$	25°C	−4.85	−4.91		−4.85	−4.91		
			Full range	−4.85			−4.85			
		$V_{IC} = 0$, $I_O = 4$ mA	25°C	−4	−4.3		−4	−4.3		
			Full range	−3.8			−3.8			
A_{VD}	Large-signal differential voltage amplification	$V_O = \pm 4$ V, $R_L = 50\ k\Omega$	25°C	80	200		80	200		V/mV
			Full range	50			50			
		$V_O = \pm 4$ V, $R_L = 1\ M\Omega$	25°C		1000			1000		
$r_{i(d)}$	Differential input resistance		25°C		10^{12}			10^{12}		Ω
$r_{i(c)}$	Common-mode input resistance		25°C		10^{12}			10^{12}		Ω
$c_{i(c)}$	Common-mode input capacitance	f = 10 kHz, P package	25°C		8			8		pF
z_o	Closed-loop output impedance	f = 100 kHz, $A_V = 10$	25°C		220			220		Ω
CMRR	Common-mode rejection ratio	$V_{IC} = -5$ V to 2.7 V, $V_O = 0$, $R_S = 50\ \Omega$	25°C	75	88		75	88		dB
			Full range	75			75			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{DD\pm} / \Delta V_{IO}$)	$V_{DD} = 4.4$ 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		425	500		425	500	μA
			Full range			500			500	

† Full range is – 40°C to 125°C.

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

TLC2262I operating characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5$ V

PARAMETER		TEST CONDITIONS		T_A†	TLC2262I			TLC2262AI			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	$V_O = \pm 1.9$ V, $C_L = 100$ pF	$R_L = 50$ kΩ,	25°C	0.35	0.55		0.35	0.55		V/µs
				Full range	0.25			0.25			
V_n	Equivalent input noise voltage	f = 10 Hz		25°C		43			43		nV/√Hz
		f = 1 kHz		25°C		12			12		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C		0.8			0.8		µV
		f = 0.1 Hz to 10 Hz		25°C		1.3			1.3		
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, $R_L = 50$ kΩ, f = 20 kHz	$A_V = 1$	25°C		0.014%			0.014%		
			$A_V = 10$			0.024%			0.024%		
	Gain-bandwidth product	f =10 kHz, $C_L = 100$ pF	$R_L = 50$ kΩ,	25°C		0.73			0.73		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)} = 4.6$ V, $R_L = 50$ kΩ,	$A_V = 1$, $C_L = 100$ pF	25°C		85			85		kHz
t_s	Settling time	$A_V = -1$, Step = –2.3 V to 2.3 V, $R_L = 50$ kΩ, $C_L = 100$ pF	To 0.1%	25°C		7.1			7.1		µs
			To 0.01%			16.5			16.5		
ϕ_m	Phase margin at unity gain	$R_L = 50$ kΩ,	$C_L = 100$ pF	25°C		57°			57°		
	Gain margin			25°C		11			11		dB

† Full range is –40°C to 125°C.

TLC2264I electrical characteristics at specified free-air temperature, V_{DD} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A†	TLC2264I MIN	TLC2264I TYP	TLC2264I MAX	TLC2264AI MIN	TLC2264AI TYP	TLC2264AI MAX	UNIT
V_{IO}	Input offset voltage	$V_{DD\pm}$ = ±2.5 V, V_{IC} = 0, 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		0.003			0.003		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, $\|V_{IO}\|$ ≤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} = –100 µA	25°C	4.85	4.94		4.85	4.94		
			Full range	4.82			4.82			
		I_{OH} = –400 µA	25°C	4.7	4.85		4.7	4.85		
			Full range	4.5			4.5			
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} = 4 mA	25°C		0.8	1		0.7	1	
			Full range			1.2			1.2	
A_{VD}	Large-signal differential voltage amplification	V_{IC} = 2.5 V, V_O = 1 V to 4 V, R_L = 50 kΩ‡	25°C	80	100		80	170		V/mV
			Full range	50			50			
		V_{IC} = 2.5 V, V_O = 1 V to 4 V, R_L = 1 MΩ‡	25°C		550			550		
$r_{i(d)}$	Differential input resistance		25°C		10^{12}			10^{12}		Ω
$r_{i(c)}$	Common-mode input resistance		25°C		10^{12}			10^{12}		Ω
$c_{i(c)}$	Common-mode input capacitance	f = 10 kHz, N package	25°C		8			8		pF
z_o	Closed-loop output impedance	f = 100 kHz, A_V = 10	25°C		240			240		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	83		70	83		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 (four amplifiers)	V_O = 2.5 V, No load	25°C		0.8	1		0.8	1	mA
			Full range			1			1	

† Full range is – 40°C to 125°C.
‡ Referenced to 2.5 V
NOTE 4: Typical values are based on the input offset voltage shift observed through 500 hours of operating life test at T_A = 150°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLC2264I operating characteristics at specified free-air temperature, V_{DD} = 5 V

PARAMETER		TEST CONDITIONS		T_A†	TLC2264I MIN	TLC2264I TYP	TLC2264I MAX	TLC2264AI MIN	TLC2264AI TYP	TLC2264AI MAX	UNIT
SR	Slew rate at unity gain	V_O = 1.4 V to 2.6 V, C_L = 100 pF‡	R_L = 50 kΩ‡,	25°C	0.35	0.55		0.35	0.55		V/μs
				Full range	0.25			0.25			
V_n	Equivalent input noise voltage	f = 10 Hz		25°C		40			40		nV/√Hz
		f = 1 kHz		25°C		12			12		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C		0.7			0.7		μV
		f = 0.1 Hz to 10 Hz		25°C		1.3			1.3		
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 = 50 kΩ‡	A_V = 1	25°C		0.017%			0.017%		
			A_V = 10			0.03%			0.03%		
	Gain-bandwidth product	f = 50 kHz, C_L = 100 pF‡	R_L = 50 kΩ‡,	25°C		0.71			0.71		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 2 V, R_L = 50 kΩ‡,	A_V = 1, C_L = 100 pF‡	25°C		185			185		kHz
t_s	Settling time	A_V = –1, Step = 0.5 V to 2.5 V, R_L = 50 kΩ‡, C_L = 100 pF‡	To 0.1%	25°C		6.4			6.4		μs
			To 0.01%			14.1			14.1		
ϕ_m	Phase margin at unity gain	R_L = 50 kΩ‡,	C_L = 100 pF‡	25°C		56°			56°		
	Gain margin			25°C		11			11		dB

† Full range is – 40°C to 125°C.
‡ Referenced to 2.5 V

TLC2264I electrical characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5$ V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLC2264I			TLC2264AI			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	$V_{IC} = 0$, $R_S = 50\ \Omega$	$V_O = 0$,	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		0.003			0.003		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
		$I_O = -100\ \mu A$		25°C	4.85	4.94		4.85	4.94		
				Full range	4.82			4.82			
		$I_O = -400\ \mu A$		25°C	4.7	4.85		4.7	4.85		
				Full range	4.5			4.5			
V_{OM-}	Maximum negative peak output voltage	$V_{IC} = 0$,	$I_O = 50\ \mu A$	25°C		−4.99			−4.99		V
		$V_{IC} = 0$,	$I_O = 500\ \mu A$	25°C	−4.85	−4.91		−4.85	−4.91		
				Full range	−4.85			−4.85			
		$V_{IC} = 0$,	$I_O = 4$ mA	25°C	−4	−4.3		−4	−4.3		
				Full range	−3.8			−3.8			
A_{VD}	Large-signal differential voltage amplification	$V_O = \pm 4$ V	$R_L = 50\ k\Omega$	25°C	80	200		80	200		V/mV
				Full range	50			50			
			$R_L = 1\ M\Omega$	25°C		1000			1000		
$r_{i(d)}$	Differential input resistance			25°C		10^{12}			10^{12}		Ω
$r_{i(c)}$	Common-mode input resistance			25°C		10^{12}			10^{12}		Ω
$c_{i(c)}$	Common-mode input capacitance	f = 10 kHz,	N package	25°C		8			8		pF
z_o	Closed-loop output impedance	f = 100 kHz,	$A_V = 10$	25°C		220			220		Ω
CMRR	Common-mode rejection ratio	$V_{IC} = -5$ V to 2.7 V, $V_O = 0$,	$R_S = 50\ \Omega$	25°C	75	88		75	88		dB
				Full range	75			75			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{DD\pm}/\Delta V_{IO}$)	$V_{DD\pm} = \pm 2.2$ V to ± 8 V, $V_{IC} = V_{DD}/2$,	No load	25°C	80	95		80	95		dB
				Full range	80			80			
I_{DD}	Supply current (four amplifiers)	$V_O = 0$,	No load	25°C		0.85	1		0.85	1	mA
				Full range			1			1	

† Full range is – 40°C to 125°C.

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

TLC2264I operating characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5$ V

PARAMETER		TEST CONDITIONS		T_A†	TLC2264I			TLC2264AI			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	$V_O = \pm 1.9$ V, $C_L = 100$ pF	$R_L = 50$ kΩ,	25°C	0.35	0.55		0.35	0.55		V/μs
				Full range	0.25			0.25			
V_n	Equivalent input noise voltage	f = 10 Hz		25°C		43			43		nV/√Hz
		f = 1 kHz		25°C		12			12		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C		0.8			0.8		μV
		f = 0.1 Hz to 10 Hz		25°C		1.3			1.3		
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, $R_L = 50$ kΩ, f = 20 kHz	$A_V = 1$	25°C		0.014%			0.014%		
			$A_V = 10$			0.024%			0.024%		
	Gain-bandwidth product	f =10 kHz, $C_L = 100$ pF	$R_L = 50$ kΩ,	25°C		0.73			0.73		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)} = 4.6$ V, $R_L = 50$ kΩ,	$A_V = 1$, $C_L = 100$ pF	25°C		70			70		kHz
t_s	Settling time	$A_V = -1$, Step = –2.3 V to 2.3 V, $R_L = 50$ kΩ, $C_L = 100$ pF	To 0.1%	25°C		7.1			7.1		μs
			To 0.01%			16.5			16.5		
ϕ_m	Phase margin at unity gain	$R_L = 50$ kΩ,	$C_L = 100$ pF	25°C		57°			57°		
	Gain margin			25°C		11			11		dB

† Full range is –40°C to 125°C.

TLC2262Q/M electrical characteristics at specified free-air temperature, V_{DD} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A†	TLC2262Q, TLC2262M			TLC2262AQ, TLC2262AM			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	$V_{DD\pm} = \pm 2.5$ V, $V_{IC} = 0$, $V_O = 0$, $R_S = 50\ \Omega$	25°C		300	2500		300	950	µV
			Full range			3000			1500	
α_{VIO}	Temperature coefficient of input offset voltage		Full range		5			5		µV/°C
	Input offset voltage long-term drift (see Note 4)		25°C		0.003			0.003		µV/mo
I_{IO}	Input offset current		25°C		0.5			0.5		pA
			125°C			500			500	
I_{IB}	Input bias current		25°C		1			1		pA
			125°C			500			500	
V_{ICR}	Common-mode input voltage range	$R_S = 50\ \Omega$, $\lvert V_{IO} \rvert \le 5$ 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	$I_{OH} = -20\ \mu A$	25°C		4.99			4.99		V
		$I_{OH} = -100\ \mu A$	25°C	4.85	4.94		4.85	4.94		
			Full range	4.82			4.82			
		$I_{OH} = -400\ \mu A$	25°C	4.7	4.85		4.7	4.85		
			Full range	4.5			4.5			
V_{OL}	Low-level output voltage	$V_{IC} = 2.5$ V, $I_{OL} = 50\ \mu A$	25°C		0.01			0.01		V
		$V_{IC} = 2.5$ V, $I_{OL} = 500\ \mu A$	25°C		0.09	0.15		0.09	0.15	
			Full range			0.15			0.15	
		$V_{IC} = 2.5$ V, $I_{OL} = 4$ mA	25°C		0.8	1		0.7	1	
			Full range			1.2			1.2	
A_{VD}	Large-signal differential voltage amplification	$V_{IC} = 2.5$ V, $V_O = 1$ V to 4 V, $R_L = 50\ k\Omega$‡	25°C	80	100		80	170		V/mV
			Full range	50			50			
		$R_L = 1\ M\Omega$‡	25°C		550			550		
$r_{i(d)}$	Differential input resistance		25°C		10^{12}			10^{12}		Ω
$r_{i(c)}$	Common-mode input resistance		25°C		10^{12}			10^{12}		Ω
$c_{i(c)}$	Common-mode input capacitance	f = 10 kHz, P package	25°C		8			8		pF
z_o	Closed-loop output impedance	f = 100 kHz, $A_V = 10$	25°C		240			240		Ω
CMRR	Common-mode rejection ratio	$V_{IC} = 0$ to 2.7 V, $V_O = 2.5$ V, $R_S = 50\ \Omega$	25°C	70	83		70	83		dB
			Full range	70			70			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$)	$V_{DD} = 4.4$ V to 16 V, $V_{IC} = V_{DD}/2$, No load	25°C	80	95		80	95		dB
			Full range	80			80			

† Full range is –40°C to 125°C for Q suffix, – 55°C to 125°C for M suffix.
‡ Referenced to 2.5 V
NOTE 4: Typical values are based on the input offset voltage shift observed through 500 hours of operating life test at T_A = 150°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLC2262Q/M electrical characteristics at specified free-air temperature, V_{DD} = 5 V (unless otherwise noted) (continued)

PARAMETER		TEST CONDITIONS		T_A†	TLC2262Q, TLC2262M			TLC2262AQ, TLC2262AM			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
I_{DD}	Supply current	V_O = 2.5 V,	No load	25°C		400	500		400	500	µA
				Full range			500			500	

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

TLC2262Q/M operating characteristics at specified free-air temperature, V_{DD} = 5 V

PARAMETER		TEST CONDITIONS		T_A†	TLC2262Q, TLC2262M			TLC2262AQ, TLC2262AM			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	V_O = 0.5 V to 3.5 V, C_L = 100 pF‡	R_L = 50 kΩ‡,	25°C	0.35	0.55		0.35	0.55		V/µs
				Full range	0.25			0.25			
V_n	Equivalent input noise voltage	f = 10 Hz		25°C		40			40		nV/√Hz
		f = 1 kHz		25°C		12			12		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C		0.7			0.7		µV
		f = 0.1 Hz to 10 Hz		25°C		1.3			1.3		
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 = 50 kΩ‡	A_V = 1	25°C		0.017%			0.017%		
			A_V = 10			0.03%			0.03%		
	Gain-bandwidth product	f = 50 kHz, C_L = 100 pF‡	R_L = 50 kΩ‡,	25°C		0.82			0.82		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 2 V, R_L = 50 kΩ‡,	A_V = 1, C_L = 100 pF‡	25°C		185			185		kHz
t_s	Settling time	A_V = –1, Step = 0.5 V to 2.5 V, R_L = 50 kΩ‡, C_L = 100 pF‡	To 0.1%	25°C		6.4			6.4		µs
			To 0.01%			14.1			14.1		
ϕ_m	Phase margin at unity gain	R_L = 50 kΩ‡,	C_L = 100 pF‡	25°C		56°			56°		
	Gain margin			25°C		11			11		dB

† Full range is –40°C to 125°C for Q suffix, – 55°C to 125°C for M suffix.
‡ Referenced to 2.5 V

TLC2262Q/M electrical characteristics at specified free-air temperature, $V_{DD\pm} = \pm5$ V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLC2262Q, TLC2262M			TLC2262AQ, TLC2262AM			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			Full range		5			5		µV/°C
	Input offset voltage long-term drift (see Note 4)			25°C		0.003			0.003		µV/mo
I_{IO}	Input offset current			25°C		0.5			0.5		pA
				125°C			500			500	
I_{IB}	Input bias current			25°C		1			1		pA
				125°C			500			500	
V_{ICR}	Common-mode input voltage range	$R_S = 50\ \Omega$, $\lvert V_{IO}\rvert \le 5$ 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
		$I_O = –100\ \mu A$		25°C	4.85	4.94		4.85	4.94		
				Full range	4.82			4.82			
		$I_O = –400\ \mu A$		25°C	4.7	4.85		4.7	4.85		
				Full range	4.5			4.5			
V_{OM-}	Maximum negative peak output voltage	$V_{IC} = 0$, $I_O = 50\ \mu A$		25°C		–4.99			–4.99		V
		$V_{IC} = 0$, $I_O = 500\ \mu A$		25°C	–4.85	–4.91		–4.85	–4.91		
				Full range	–4.85			–4.85			
		$V_{IC} = 0$, $I_O = 4$ mA		25°C	–4	–4.3		–4	–4.3		
				Full range	–3.8			–3.8			
A_{VD}	Large-signal differential voltage amplification	$V_O = \pm4$ V	$R_L = 50\ k\Omega$	25°C	80	200		80	200		V/mV
				Full range	50			50			
			$R_L = 1\ M\Omega$	25°C		1000			1000		
$r_{i(d)}$	Differential input resistance			25°C		10^{12}			10^{12}		Ω
$r_{i(c)}$	Common-mode input resistance			25°C		10^{12}			10^{12}		Ω
$c_{i(c)}$	Common-mode input capacitance	f = 10 kHz, P package		25°C		8			8		pF
z_o	Closed-loop output impedance	f = 100 kHz, $A_V = 10$		25°C		220			220		Ω
CMRR	Common-mode rejection ratio	$V_{IC} = –5$ V to 2.7 V, $V_O = 0$, $R_S = 50\ \Omega$		25°C	75	88		75	88		dB
				Full range	75			75			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{DD\pm} / \Delta V_{IO}$)	$V_{DD} = 4.4$ V to 16 V, $V_{IC} = V_{DD}/2$, No load		25°C	80	95		80	95		dB
				Full range	80			80			

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

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

TLC2262Q/M electrical characteristics at specified free-air temperature, $V_{DD\pm} = \pm5$ V (unless otherwise noted) (continued)

PARAMETER		TEST CONDITIONS		T_A†	TLC2262Q, TLC2262M			TLC2262AQ, TLC2262AM			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
I_{DD}	Supply current	$V_O = 0$,	No load	25°C		425	500		425	500	μA
				Full range			500			500	

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

TLC2262Q/M operating characteristics at specified free-air temperature, $V_{DD\pm} = \pm5$ V

PARAMETER		TEST CONDITIONS		T_A†	TLC2262Q, TLC2262M			TLC2262AQ, TLC2262AM			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	$V_O = \pm2$ V, $C_L = 100$ pF	$R_L = 50$ kΩ,	25°C	0.35	0.55		0.35	0.55		V/μs
				Full range	0.25			0.25			
V_n	Equivalent input noise voltage	f = 10 Hz		25°C		43			43		nV/√Hz
		f = 1 kHz		25°C		12			12		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C		0.8			0.8		μV
		f = 0.1 Hz to 10 Hz		25°C		1.3			1.3		
I_n	Equivalent input noise current			25°C		0.6			0.6		fA√Hz
THD + N	Total harmonic distortion plus noise	$V_O = \pm2.3$ V, $R_L = 50$ kΩ, f = 20 kHz	$A_V = 1$	25°C		0.014%			0.014%		
			$A_V = 10$			0.024%			0.024%		
	Gain-bandwidth product	f =10 kHz, $C_L = 100$ pF	$R_L = 50$ kΩ,	25°C		0.73			0.73		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)} = 4.6$ V, $R_L = 50$ kΩ,	$A_V = 1$, $C_L = 100$ pF	25°C		85			85		kHz
t_s	Settling time	$A_V = -1$, Step = –2.3 V to 2.3 V, $R_L = 50$ kΩ, $C_L = 100$ pF	To 0.1%	25°C		7.1			7.1		μs
			To 0.01%			16.5			16.5		
ϕ_m	Phase margin at unity gain	$R_L = 50$ kΩ,	$C_L = 100$ pF	25°C		57°			57°		
	Gain margin			25°C		11			11		dB

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

TLC2264Q/M electrical characteristics at specified free-air temperature, V_{DD} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLC2264Q, TLC2264M MIN	TLC2264Q, TLC2264M TYP	TLC2264Q, TLC2264M MAX	TLC2264AQ, TLC2264AM MIN	TLC2264AQ, TLC2264AM TYP	TLC2264AQ, TLC2264AM MAX	UNIT
V_{IO}	Input offset voltage	$V_{DD\pm}$ = ±2.5 V, V_O = 0,	V_{IC} = 0, R_S = 50 Ω	25°C		300	2500		300	950	μV
				Full range			3000			1500	
α_{VIO}	Temperature coefficient of input offset voltage			Full range		2			2		μV/°C
	Input offset voltage long-term drift (see Note 4)			25°C		0.003			0.003		μV/mo
I_{IO}	Input offset current			25°C		0.5			0.5		pA
				125°C			500			500	
I_{IB}	Input bias current			25°C		1			1		pA
				125°C			500			500	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω,	$\|V_{IO}\| \le 5$ 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} = –100 μA		25°C	4.85	4.94		4.85	4.94		
				Full range	4.82			4.82			
		I_{OH} = –400 μA		25°C	4.7	4.85		4.7	4.85		
				Full range	4.5			4.5			
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} = 4 mA	25°C		0.8	1		0.7	1	
				Full range			1.2			1.2	
A_{VD}	Large-signal differential voltage amplification	V_{IC} = 2.5 V, V_O = 1 V to 4 V	R_L = 50 kΩ‡	25°C	80	100		80	170		V/mV
				Full range	50			50			
			R_L = 1 MΩ‡	25°C		550			550		
$r_{i(d)}$	Differential input resistance			25°C		10^{12}			10^{12}		Ω
$r_{i(c)}$	Common-mode input resistance			25°C		10^{12}			10^{12}		Ω
$c_{i(c)}$	Common-mode input capacitance	f = 10 kHz,	N package	25°C		8			8		pF
z_o	Closed-loop output impedance	f = 100 kHz,	A_V = 10	25°C		240			240		Ω
CMRR	Common-mode rejection ratio	V_{IC} = 0 to 2.7 V, R_S = 50 Ω	V_O = 2.5 V,	25°C	70	83		70	83		dB
				Full range	70			70			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$)	V_{DD} = 4.4 V to 16 V, $V_{IC} = V_{DD}/2$,	No load	25°C	80	95		80	95		dB
				Full range	80			80			

† Full range is –40°C to 125°C for Q suffix, – 55°C to 125°C for M suffix.
‡ Referenced to 2.5 V
NOTE 4: Typical values are based on the input offset voltage shift observed through 500 hours of operating life test at T_A = 150°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLC2264Q/M electrical characteristics at specified free-air temperature, V_{DD} = 5 V (unless otherwise noted) (continued)

PARAMETER		TEST CONDITIONS	T_A†	TLC2264Q, TLC2264M			TLC2264AQ, TLC2264AM			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
I_{DD}	Supply current (four amplifiers)	V_O = 2.5 V, No load	25°C		0.8	1		0.8	1	mA
			Full range			1			1	

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

TLC2264Q/M operating characteristics at specified free-air temperature, V_{DD} = 5 V

PARAMETER		TEST CONDITIONS		T_A†	TLC2264Q, TLC2264M			TLC2264AQ, TLC2264AM			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	V_O = 0.5 V to 3.5 V, C_L = 100 pF‡	R_L = 50 kΩ‡,	25°C	0.35	0.55		0.35	0.55		V/µs
				Full range	0.25			0.25			
V_n	Equivalent input noise voltage	f = 10 Hz		25°C		40			40		nV/√Hz
		f = 1 kHz		25°C		12			12		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C		0.7			0.7		µV
		f = 0.1 Hz to 10 Hz		25°C		1.3			1.3		
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 = 50 kΩ‡	A_V = 1	25°C		0.017%			0.017%		
			A_V = 10			0.03%			0.03%		
	Gain-bandwidth product	f = 50 kHz, C_L = 100 pF‡	R_L = 50 kΩ‡,	25°C		0.71			0.71		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 2 V, R_L = 50 kΩ‡,	A_V = 1, C_L = 100 pF‡	25°C		185			185		kHz
t_s	Settling time	A_V = –1, Step = 0.5 V to 2.5 V, R_L = 50 kΩ‡, C_L = 100 pF‡	To 0.1%	25°C		6.4			6.4		µs
			To 0.01%			14.1			14.1		
ϕ_m	Phase margin at unity gain	R_L = 50 kΩ‡,	C_L = 100 pF‡	25°C		56°			56°		
	Gain margin			25°C		11			11		dB

† Full range is –40°C to 125°C for Q suffix, – 55°C to 125°C for M suffix.
‡ Referenced to 2.5 V

TLC2264Q/M electrical characteristics at specified free-air temperature, $V_{DD\pm} = \pm5$ V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLC2264Q, TLC2264M MIN	TYP	MAX	TLC2264AQ, TLC2264AM MIN	TYP	MAX	UNIT
V_{IO}	Input offset voltage	$V_{IC} = 0$, $R_S = 50\ \Omega$	$V_O = 0$,	25°C		300	2500		300	950	µV
				Full range			3000			1500	
α_{VIO}	Temperature coefficient of input offset voltage			Full range		2			2		µV/°C
	Input offset voltage long-term drift (see Note 4)			25°C		0.003			0.003		µV/mo
I_{IO}	Input offset current			25°C		0.5			0.5		pA
				125°C			500			500	
I_{IB}	Input bias current			25°C		1			1		pA
				125°C			500			500	
V_{ICR}	Common-mode input voltage range	$R_S = 50\ \Omega$, $\lvert V_{IO}\rvert \le 5$ 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
		$I_O = -100\ \mu A$		25°C	4.85	4.94		4.85	4.94		
				Full range	4.82			4.82			
		$I_O = -400\ \mu A$		25°C	4.7	4.85		4.7	4.85		
				Full range	4.5			4.5			
V_{OM-}	Maximum negative peak output voltage	$V_{IC} = 0$,	$I_O = 50\ \mu A$	25°C		−4.99			−4.99		V
		$V_{IC} = 0$,	$I_O = 500\ \mu A$	25°C	−4.85	−4.91		−4.85	−4.91		
				Full range	−4.85			−4.85			
		$V_{IC} = 0$,	$I_O = 4$ mA	25°C	−4	−4.3		−4	−4.3		
				Full range	−3.8			−3.8			
A_{VD}	Large-signal differential voltage amplification	$V_O = \pm4$ V	$R_L = 50\ k\Omega$	25°C	80	200		80	200		V/mV
				Full range	50			50			
			$R_L = 1\ M\Omega$	25°C		1000			1000		
$r_{i(d)}$	Differential input resistance			25°C		10^{12}			10^{12}		Ω
$r_{i(c)}$	Common-mode input resistance			25°C		10^{12}			10^{12}		Ω
$c_{i(c)}$	Common-mode input capacitance	f = 10 kHz,	N package	25°C		8			8		pF
z_o	Closed-loop output impedance	f = 100 kHz,	$A_V = 10$	25°C		220			220		Ω
CMRR	Common-mode rejection ratio	$V_{IC} = -5$ V to 2.7 V, $V_O = 0$,	$R_S = 50\ \Omega$	25°C	75	88		75	88		dB
				Full range	75			75			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{DD\pm}/\Delta V_{IO}$)	$V_{DD\pm} = \pm2.2$ V to ±8 V, $V_{IC} = V_{DD}/2$,	No load	25°C	80	95		80	95		dB
				Full range	80			80			

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

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

TLC2264Q/M electrical characteristics at specified free-air temperature, $V_{DD\pm} = \pm5$ V (unless otherwise noted) (continued)

PARAMETER		TEST CONDITIONS		T_A†	TLC2264Q, TLC2264M			TLC2264AQ, TLC2264AM			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
I_{DD}	Supply current (four amplifiers)	$V_O = 0$,	No load	25°C		0.85	1		0.85	1	mA
				Full range			1			1	

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

TLC2264Q/M operating characteristics at specified free-air temperature, $V_{DD\pm} = \pm5$ V

PARAMETER		TEST CONDITIONS		T_A†	TLC2264Q, TLC2264M			TLC2264AQ, TLC2264AM			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	$V_O = \pm2$ V, $C_L = 100$ pF	$R_L = 50$ kΩ,	25°C	0.35	0.55		0.35	0.55		V/μs
				Full range	0.25			0.25			
V_n	Equivalent input noise voltage	f = 10 Hz		25°C		43			43		nV/√Hz
		f = 1 kHz		25°C		12			12		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C		0.8			0.8		μV
		f = 0.1 Hz to 10 Hz		25°C		1.3			1.3		
I_n	Equivalent input noise current			25°C		0.6			0.6		fA/√Hz
THD + N	Total harmonic distortion plus noise	$V_O = \pm2.3$ V, $R_L = 50$ kΩ, f = 20 kHz	$A_V = 1$	25°C		0.014%			0.014%		
			$A_V = 10$			0.024%			0.024%		
	Gain-bandwidth product	f =10 kHz, $C_L = 100$ pF	$R_L = 50$ kΩ,	25°C		0.73			0.73		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)} = 4.6$ V, $R_L = 50$ kΩ,	$A_V = 1$, $C_L = 100$ pF	25°C		70			70		kHz
t_s	Settling time	$A_V = -1$, Step = –2.3 V to 2.3 V, $R_L = 50$ kΩ, $C_L = 100$ pF	To 0.1%	25°C		7.1			7.1		μs
			To 0.01%			16.5			16.5		
ϕ_m	Phase margin at unity gain	$R_L = 50$ kΩ,	$C_L = 100$ pF	25°C		57°			57°		
	Gain margin			25°C		11			11		dB

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

TYPICAL CHARACTERISTICS

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TYPICAL CHARACTERISTICS

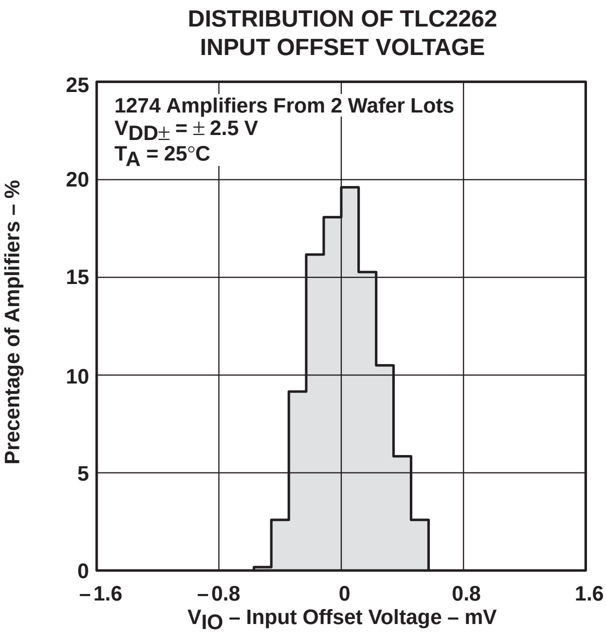


Figure 2

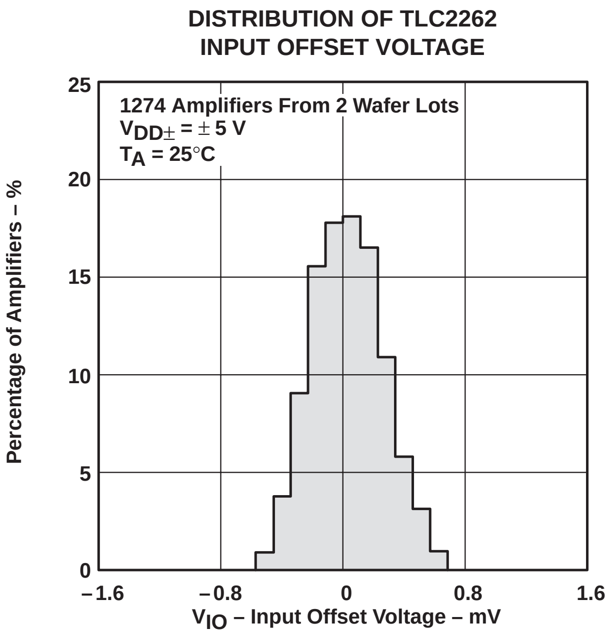


Figure 3

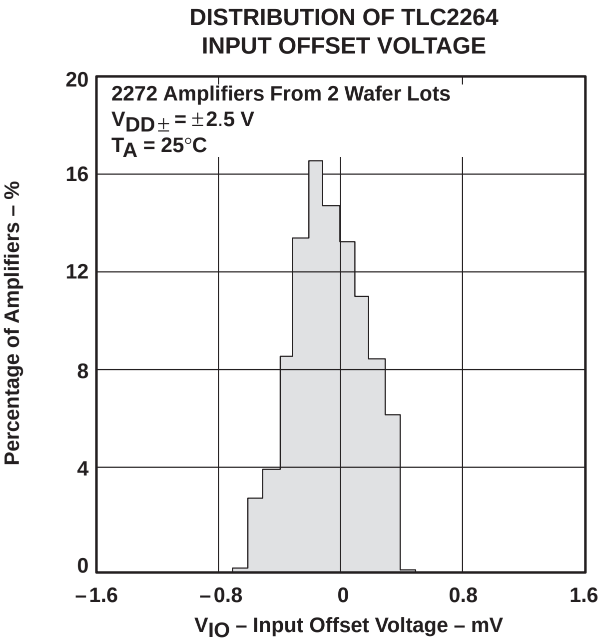


Figure 4

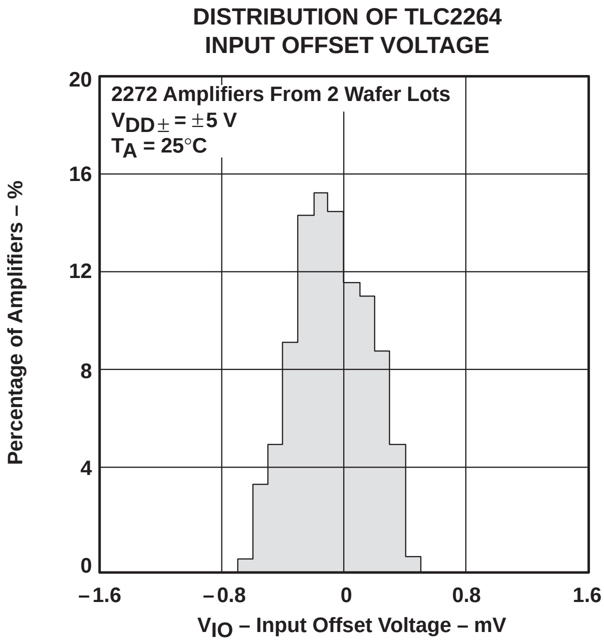
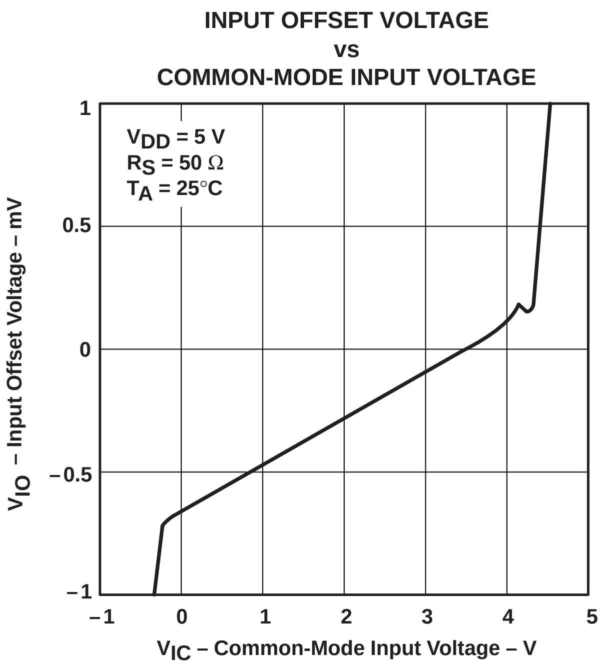


Figure 5

TYPICAL CHARACTERISTICS



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

Figure 6

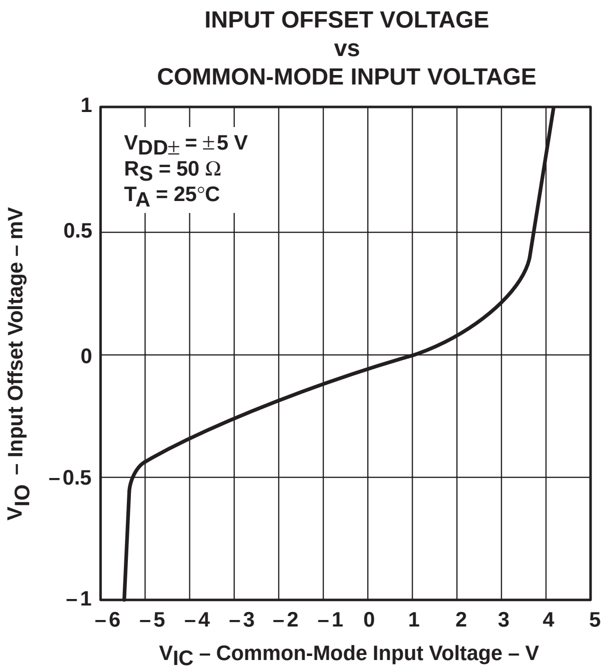


Figure 7

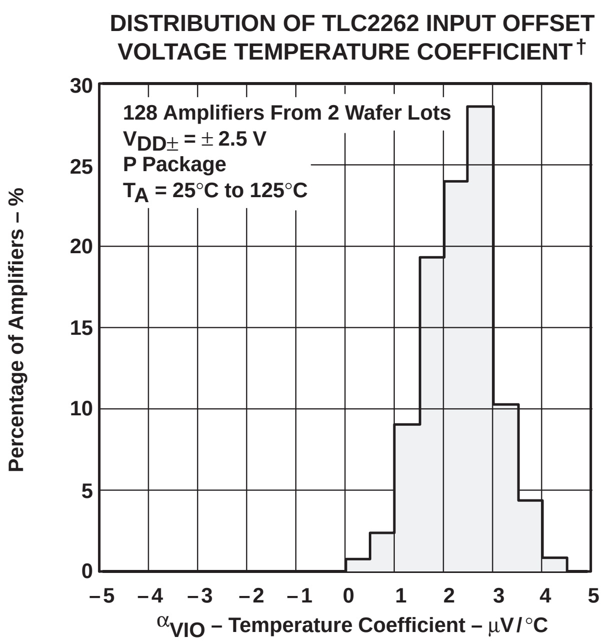


Figure 8

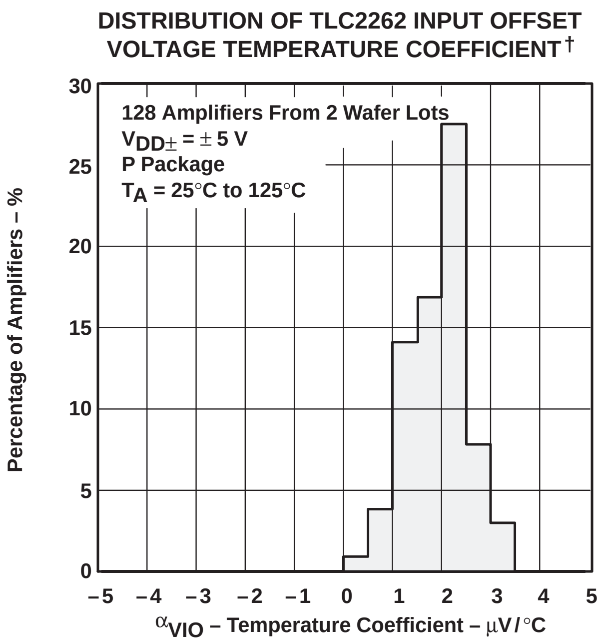


Figure 9

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

TYPICAL CHARACTERISTICS

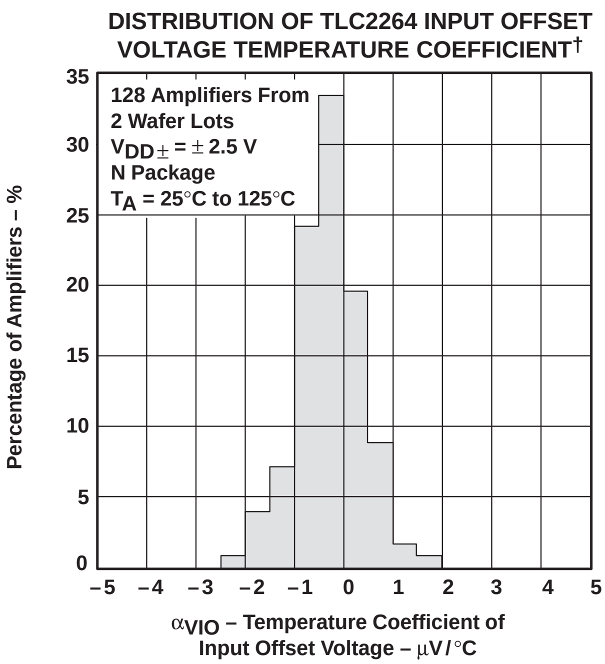


Figure 10

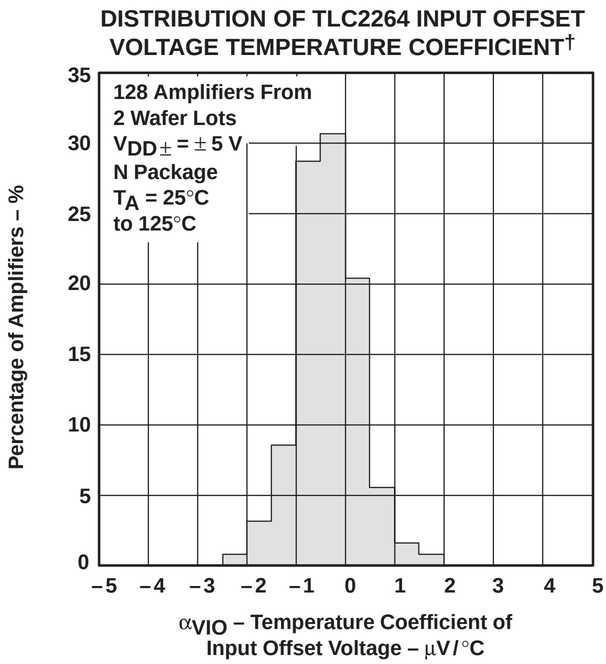


Figure 11

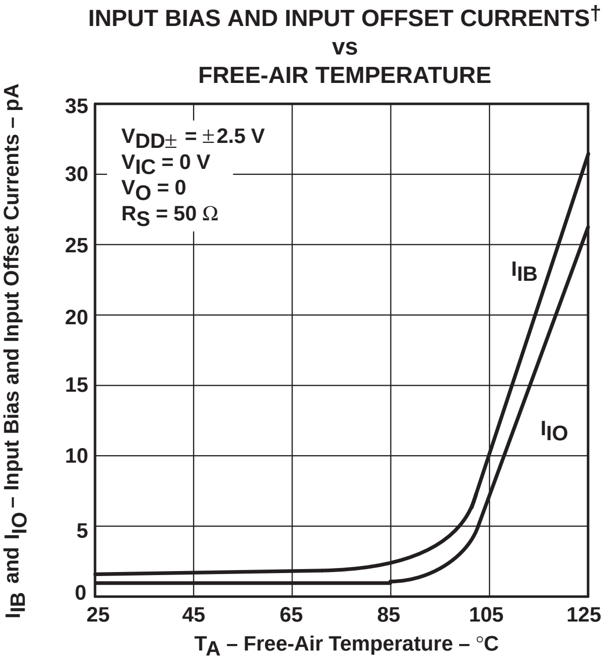


Figure 12

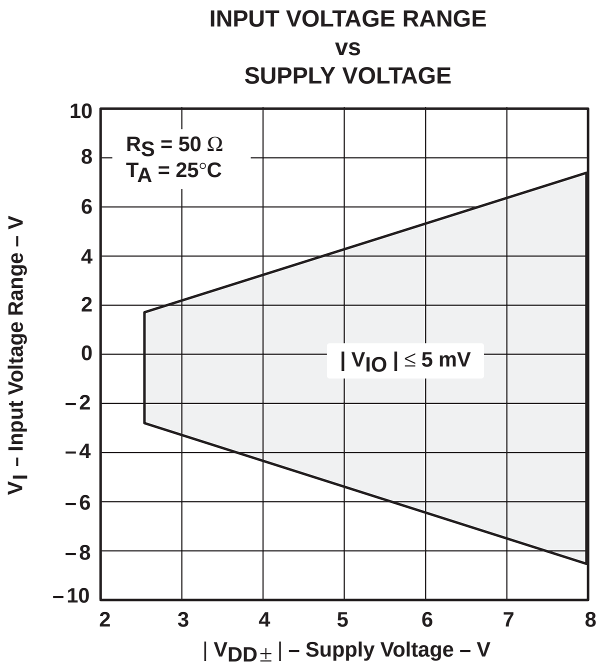


Figure 13

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

TYPICAL CHARACTERISTICS

INPUT VOLTAGE RANGE†‡ vs FREE-AIR TEMPERATURE

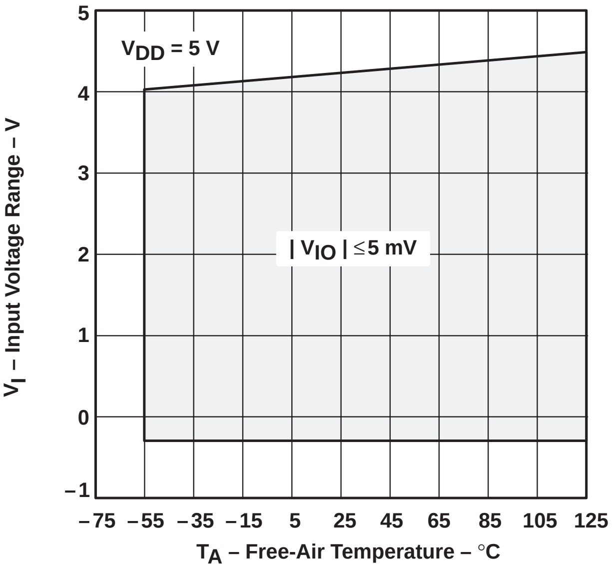


Figure 14

HIGH-LEVEL OUTPUT VOLTAGE†‡ vs HIGH-LEVEL OUTPUT CURRENT

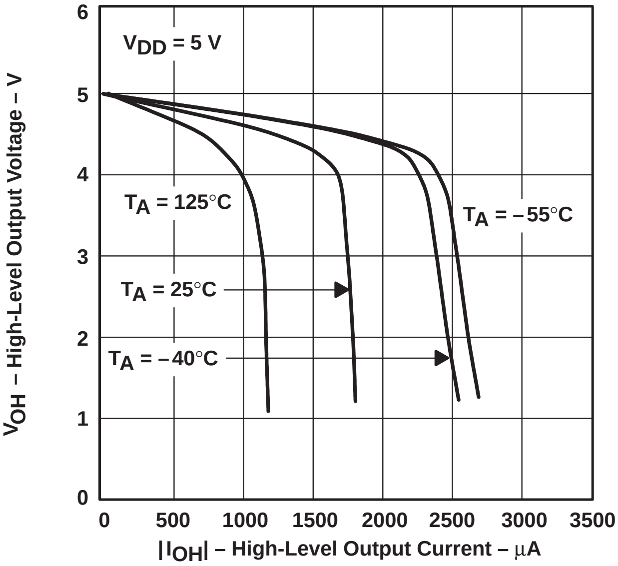


Figure 15

LOW-LEVEL OUTPUT VOLTAGE‡ vs LOW-LEVEL OUTPUT CURRENT

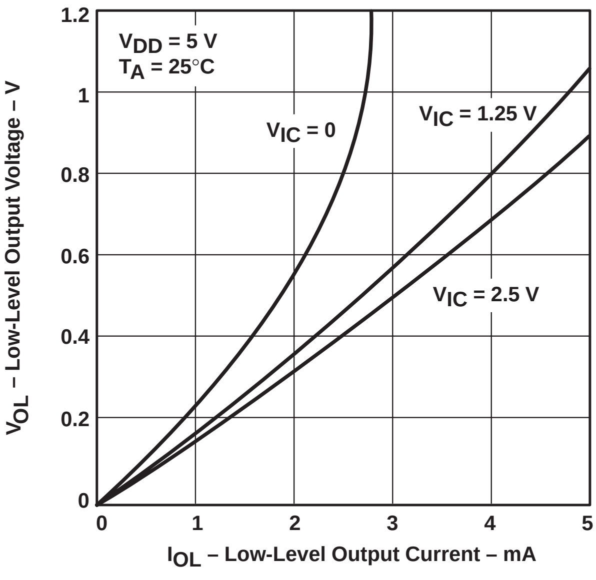


Figure 16

LOW-LEVEL OUTPUT VOLTAGE†‡ vs LOW-LEVEL OUTPUT CURRENT

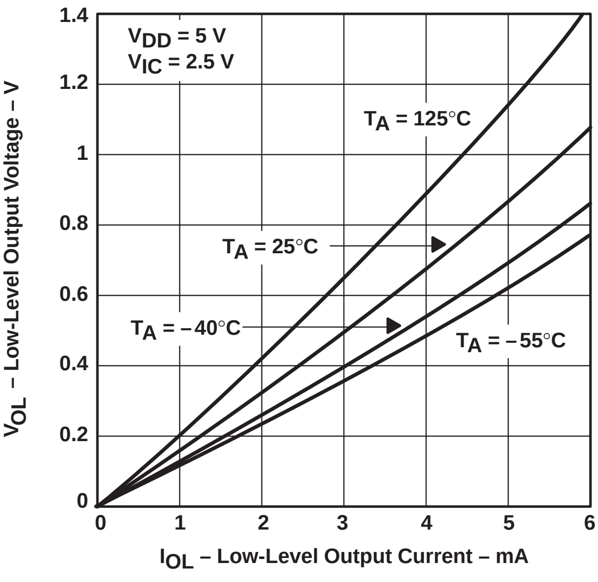


Figure 17

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

TYPICAL CHARACTERISTICS

MAXIMUM POSITIVE OUTPUT VOLTAGE† vs OUTPUT CURRENT

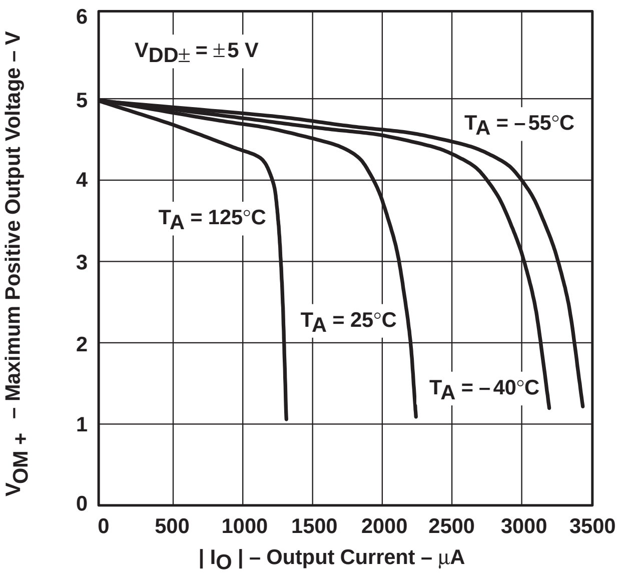


Figure 18

MAXIMUM NEGATIVE OUTPUT VOLTAGE† vs OUTPUT CURRENT

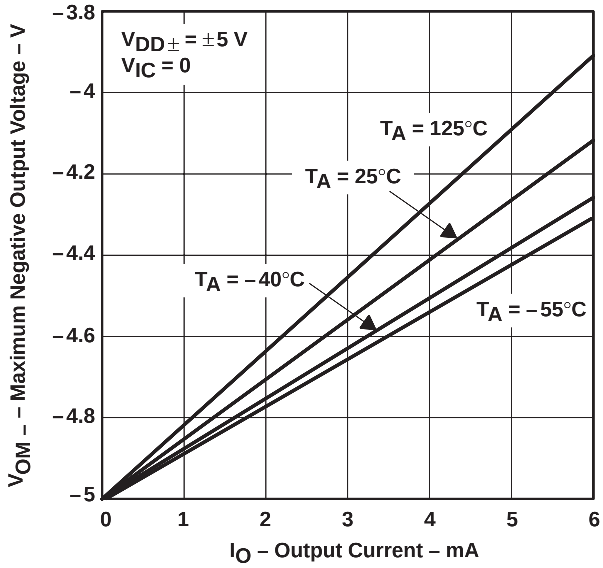
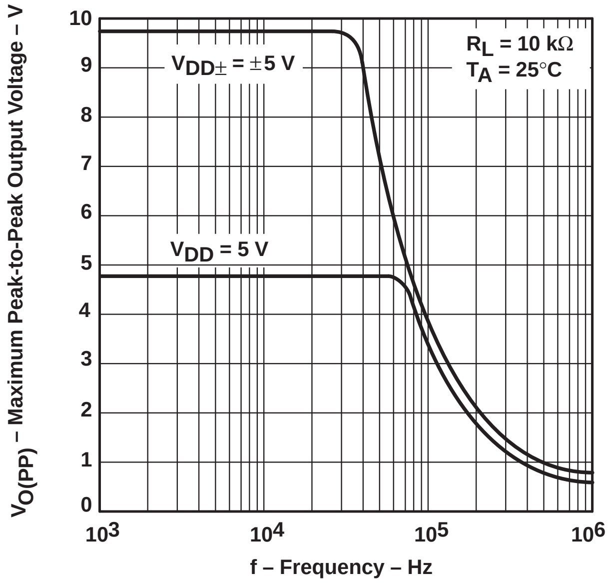


Figure 19

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE†‡ vs FREQUENCY



‡ For curves where V_{DD} = 5 V, all loads are referenced to 2.5 V.

Figure 20

SHORT-CIRCUIT OUTPUT CURRENT vs SUPPLY VOLTAGE

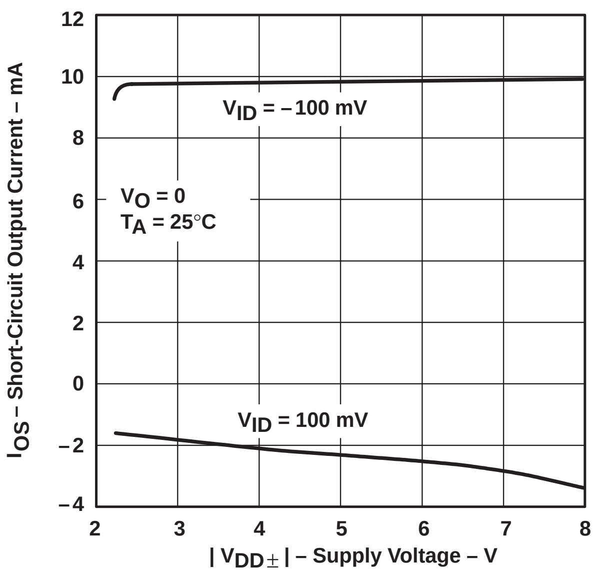


Figure 21

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

TYPICAL CHARACTERISTICS

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

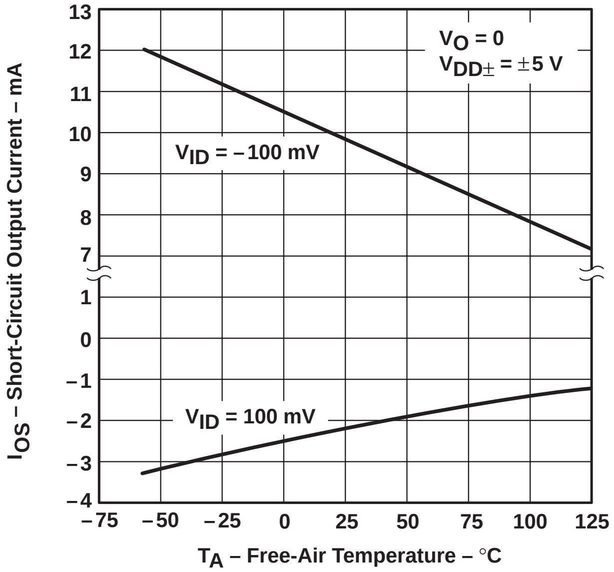


Figure 22

**OUTPUT VOLTAGE‡
vs
DIFFERENTIAL INPUT VOLTAGE**

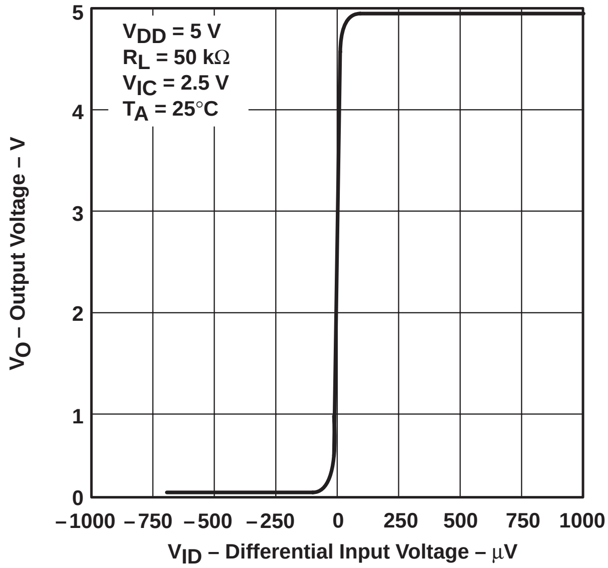


Figure 23

**OUTPUT VOLTAGE
vs
DIFFERENTIAL INPUT VOLTAGE**

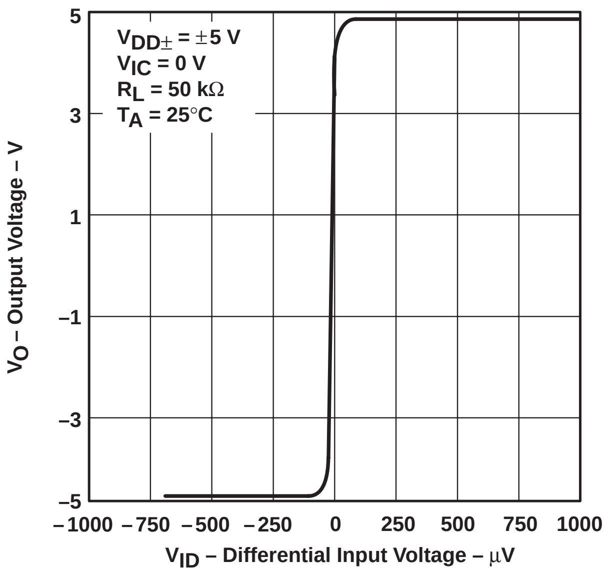


Figure 24

**DIFFERENTIAL GAIN‡
vs
LOAD RESISTANCE**

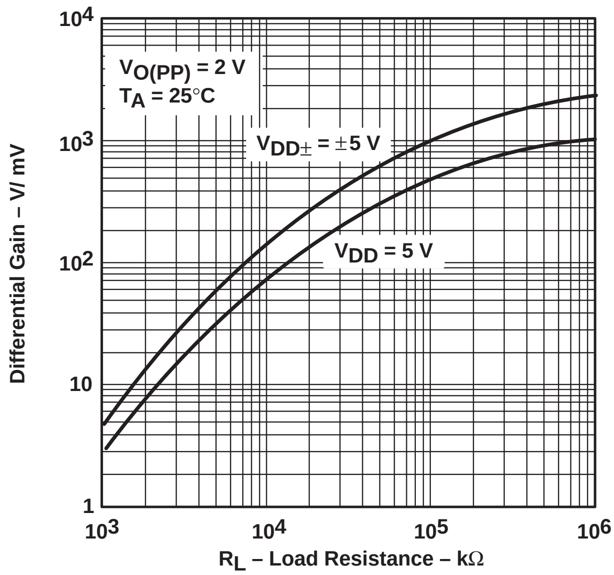
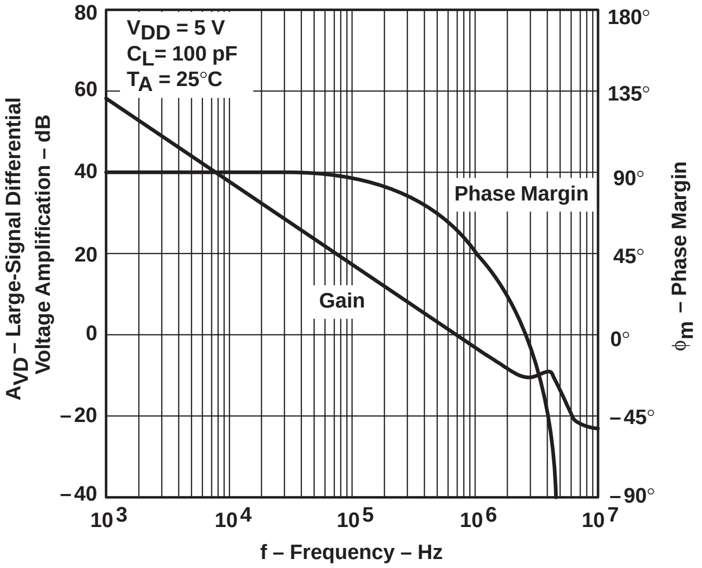


Figure 25

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

TYPICAL CHARACTERISTICS

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



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

Figure 26

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE MARGIN vs FREQUENCY

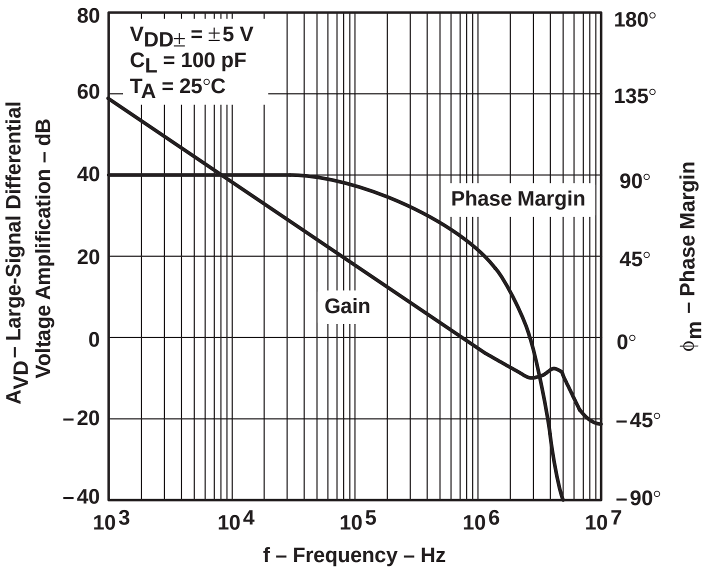


Figure 27

TYPICAL CHARACTERISTICS

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

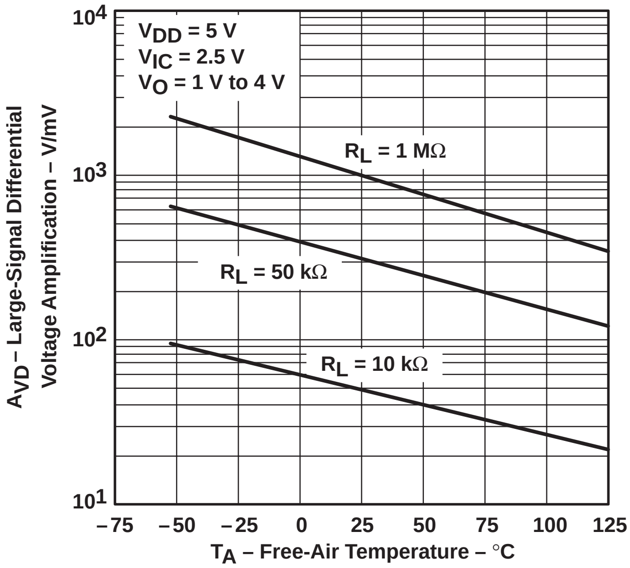


Figure 28

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

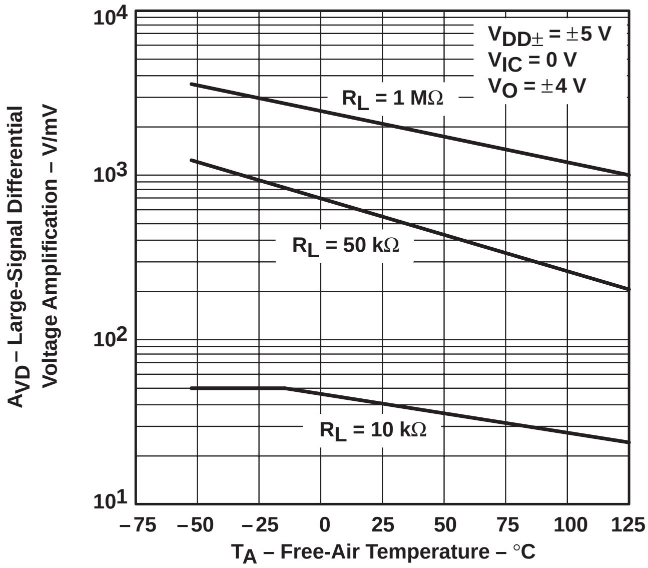


Figure 29

OUTPUT IMPEDANCE‡ vs FREQUENCY

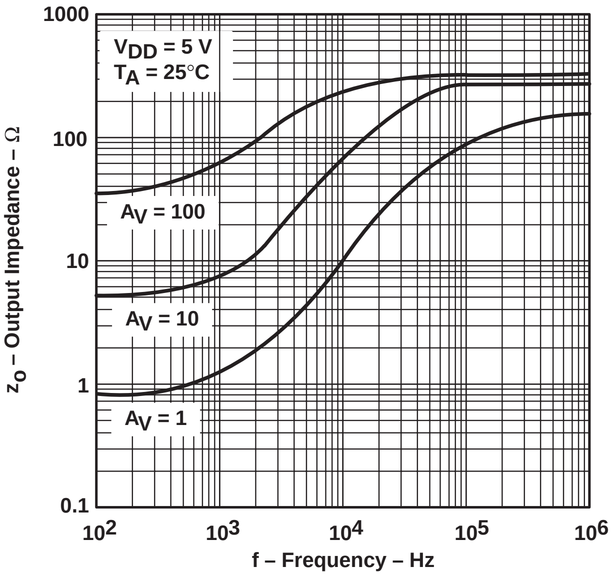


Figure 30

OUTPUT IMPEDANCE vs FREQUENCY

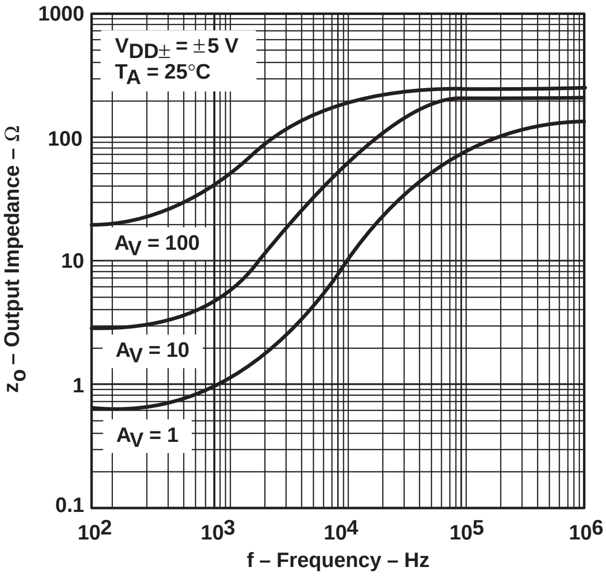


Figure 31

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

TYPICAL CHARACTERISTICS

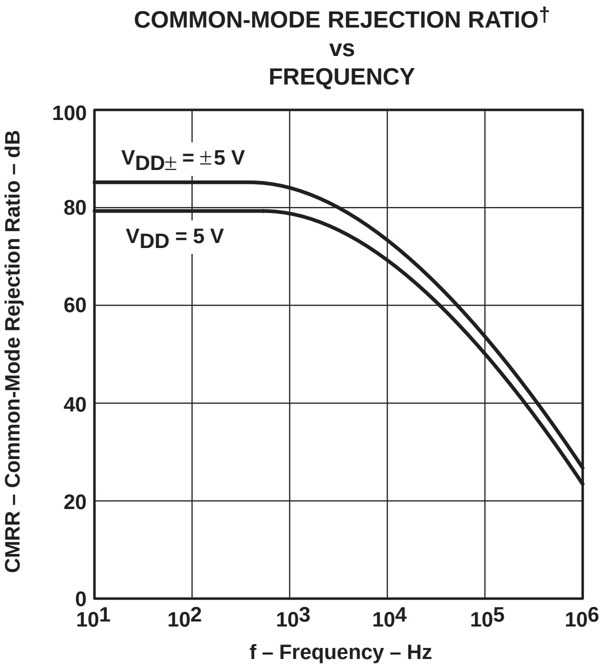


Figure 32

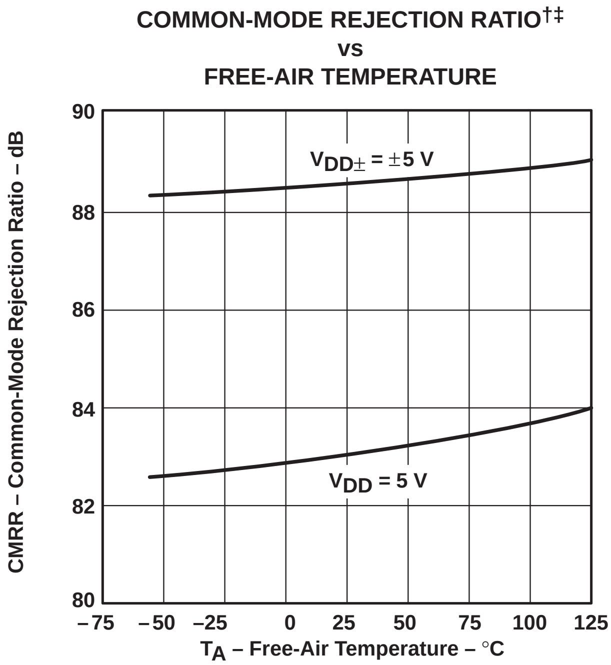


Figure 33

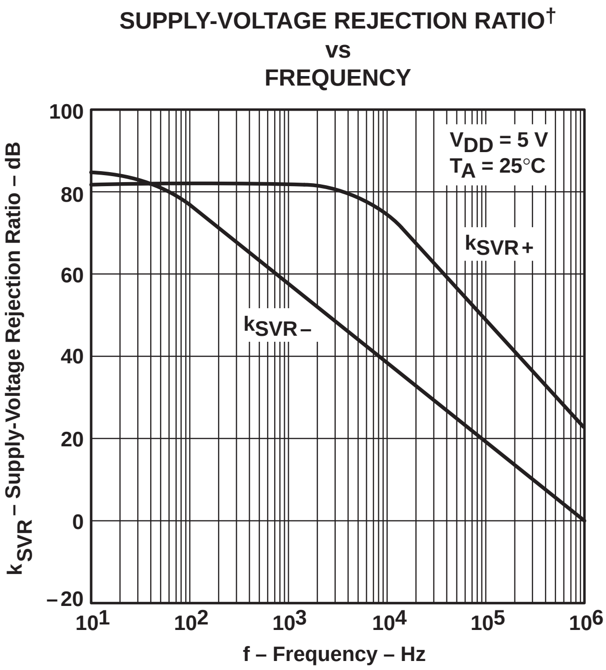


Figure 34

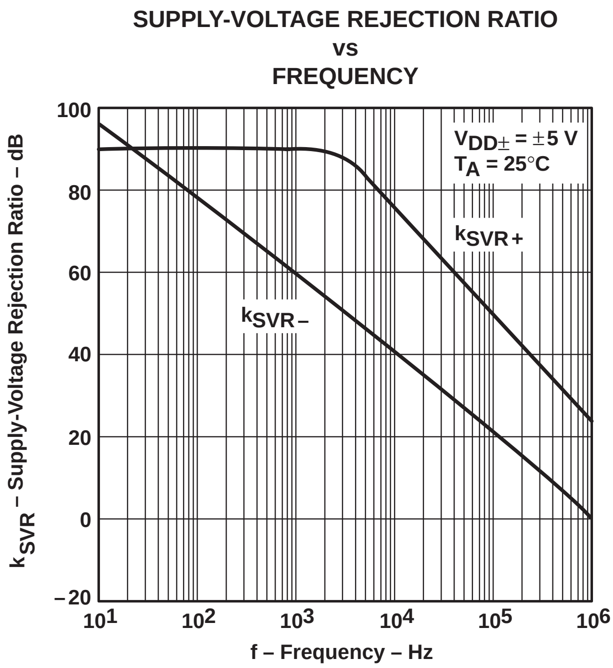


Figure 35

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

TYPICAL CHARACTERISTICS

SUPPLY-VOLTAGE REJECTION RATIO†
vs
FREE-AIR TEMPERATURE

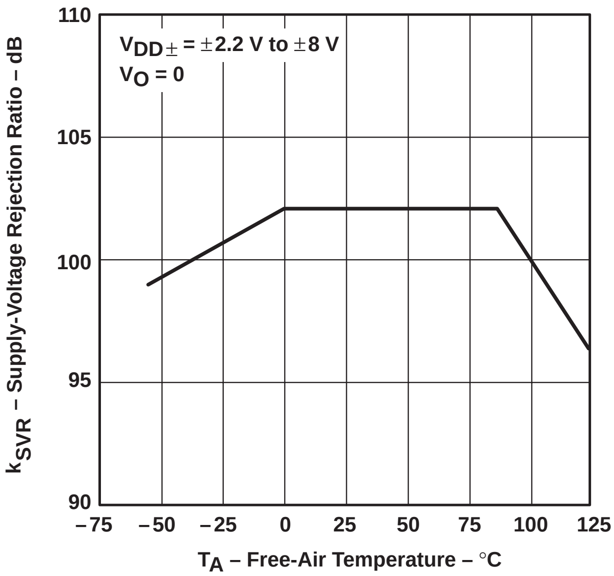


Figure 36

TLC2262
SUPPLY CURRENT†
vs
SUPPLY VOLTAGE

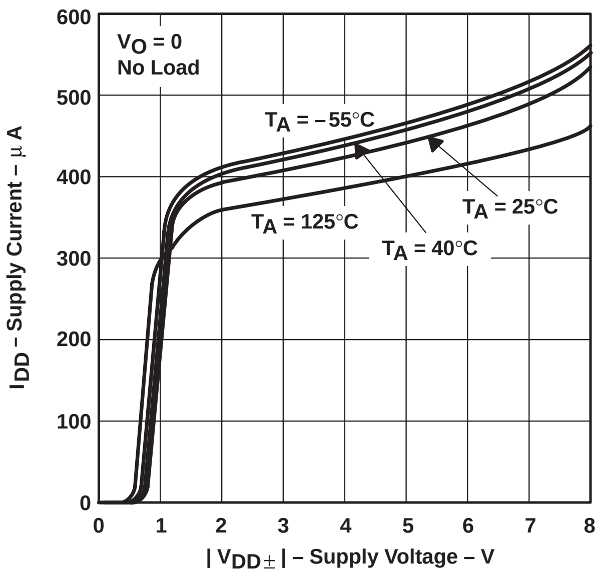


Figure 37

TLC2264
SUPPLY CURRENT†
vs
SUPPLY VOLTAGE

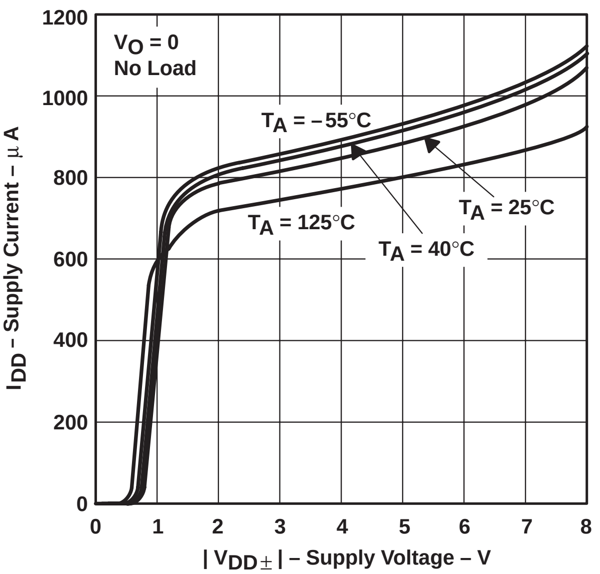


Figure 38

TLC2262
SUPPLY CURRENT†‡
vs
FREE-AIR TEMPERATURE

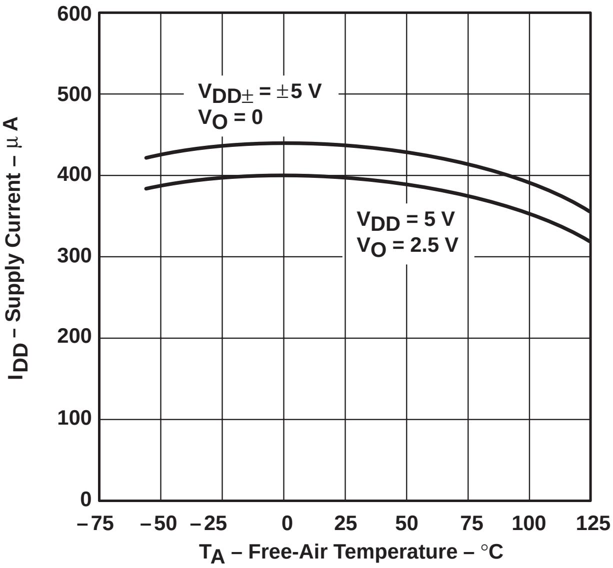


Figure 39

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

TYPICAL CHARACTERISTICS

**TLC2264
SUPPLY CURRENT†‡
vs
FREE-AIR TEMPERATURE**

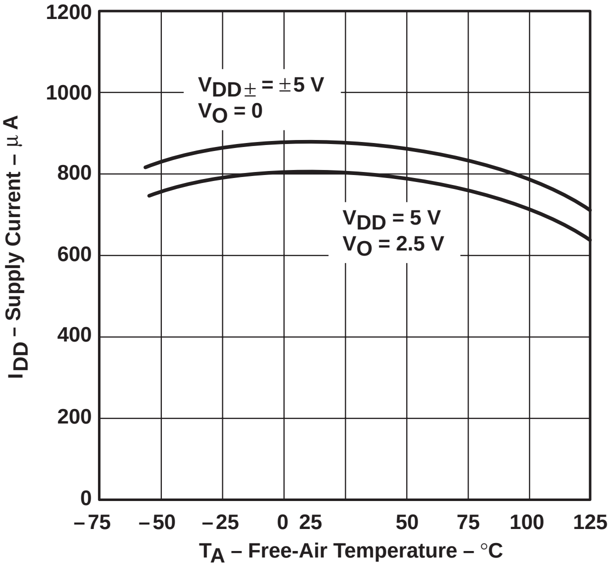


Figure 40

**SLEW RATE‡
vs
LOAD CAPACITANCE**

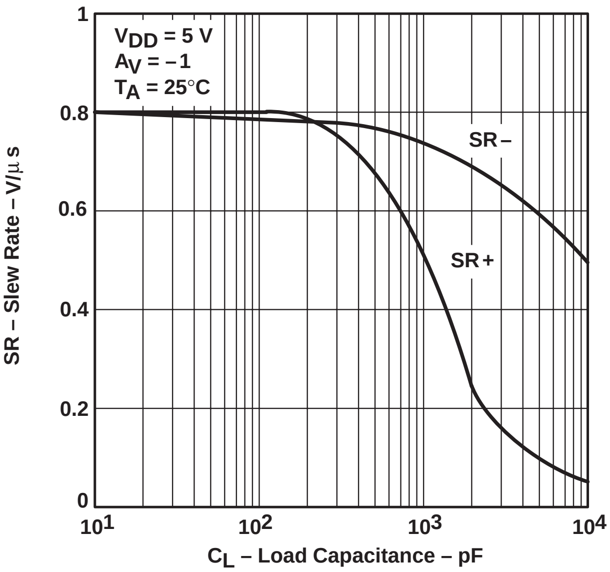


Figure 41

**SLEW RATE†‡
vs
FREE-AIR TEMPERATURE**

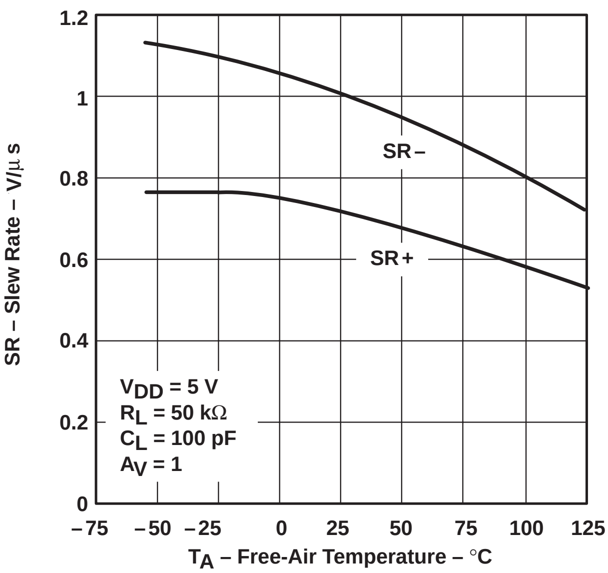


Figure 42

**INVERTING LARGE-SIGNAL PULSE
RESPONSE‡**

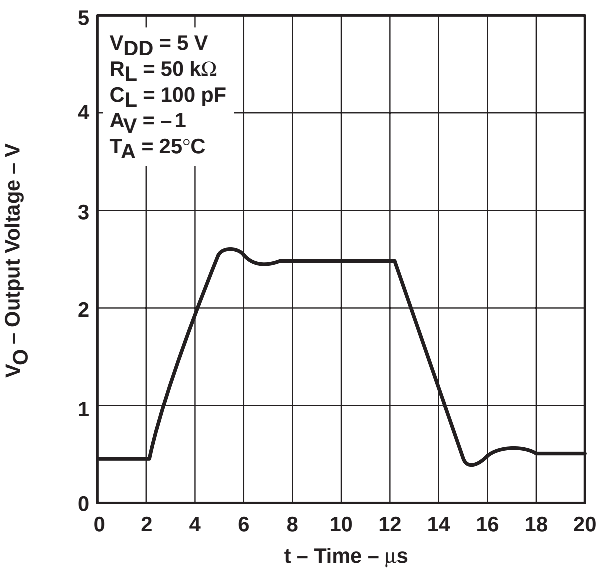


Figure 43

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

TYPICAL CHARACTERISTICS

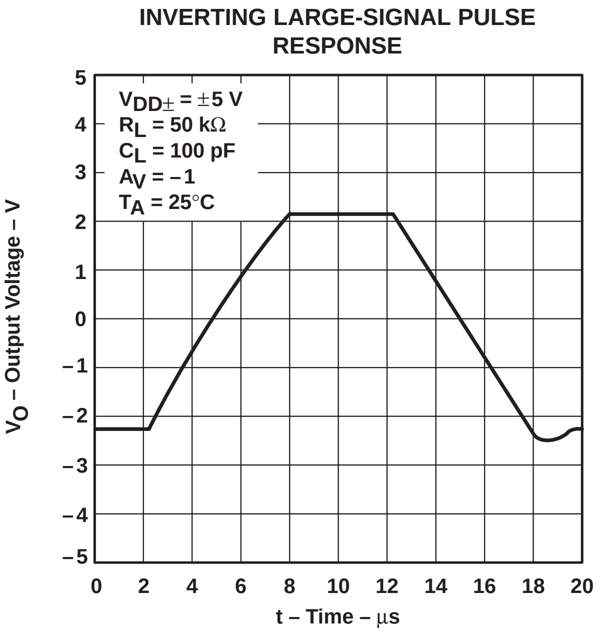


Figure 44

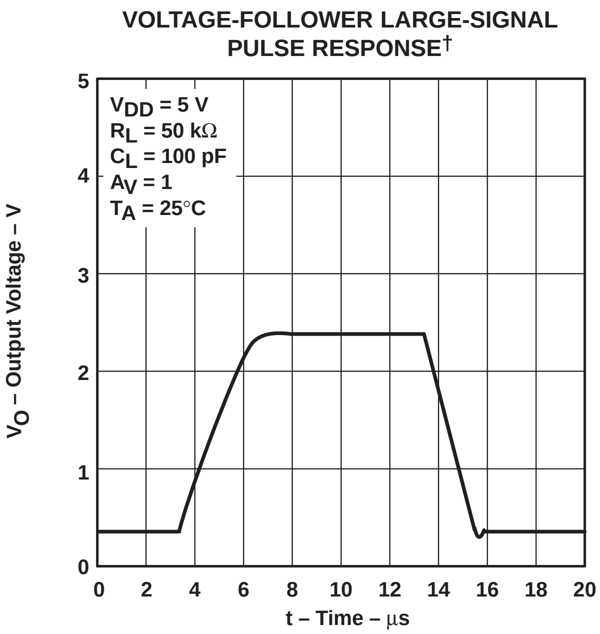


Figure 45

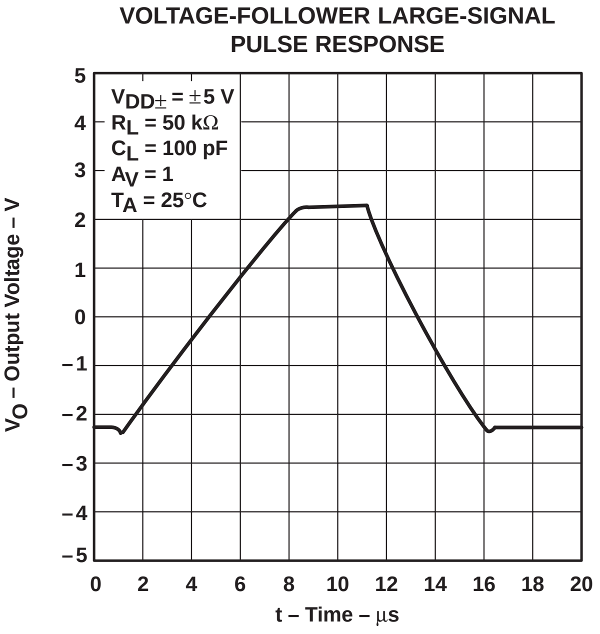


Figure 46

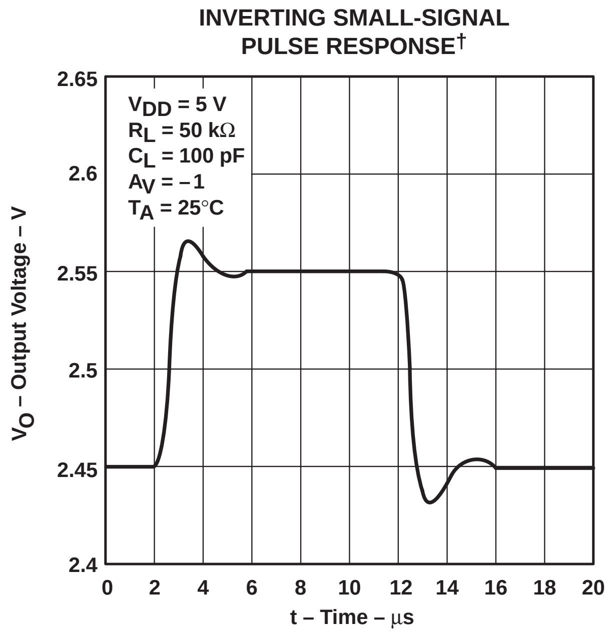


Figure 47

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

TYPICAL CHARACTERISTICS

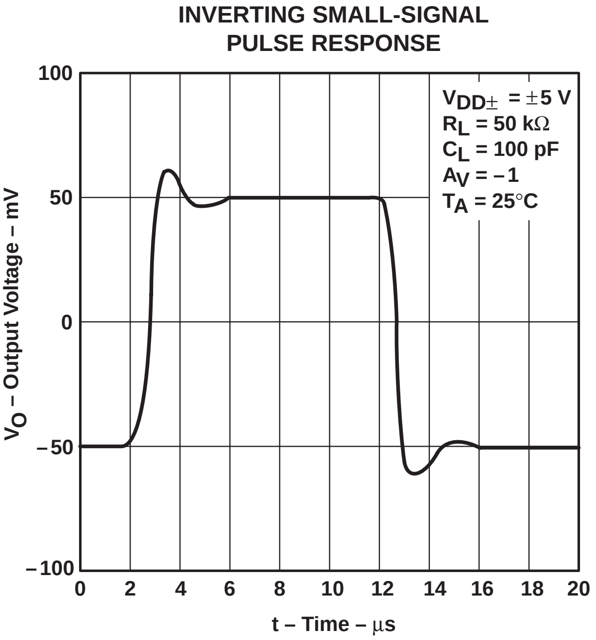


Figure 48

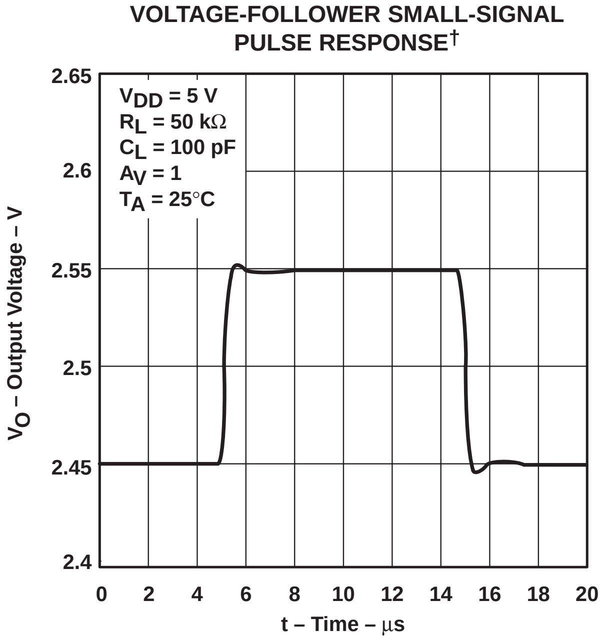


Figure 49

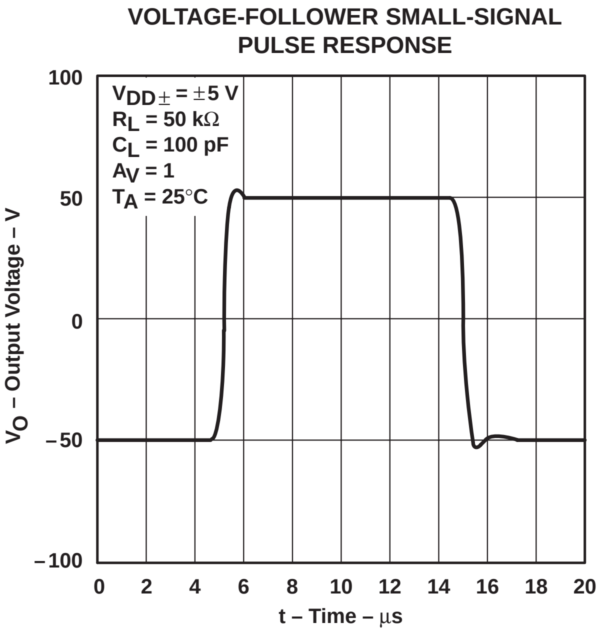


Figure 50

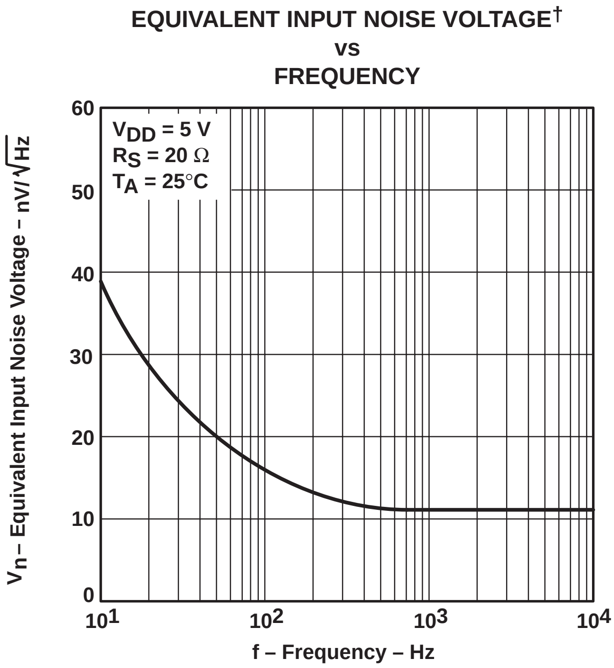


Figure 51

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

TYPICAL CHARACTERISTICS

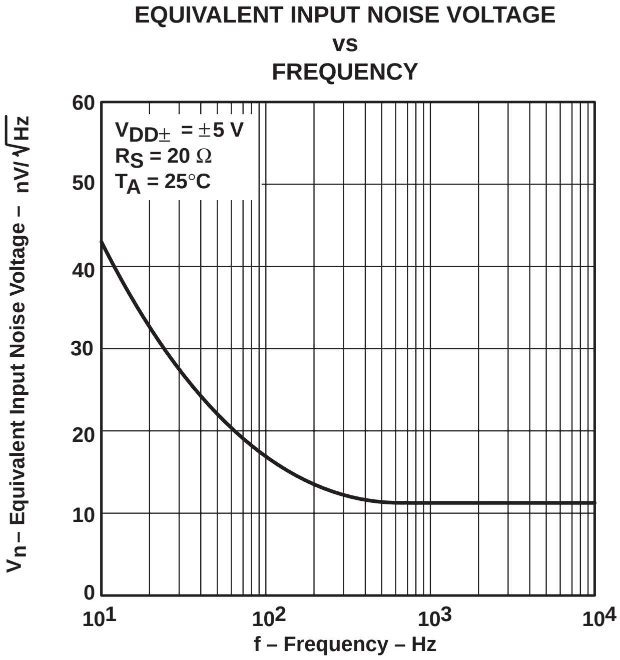


Figure 52

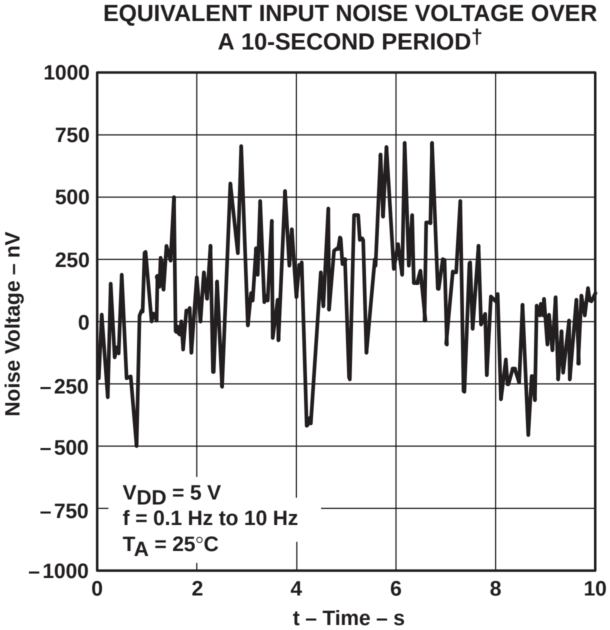


Figure 53

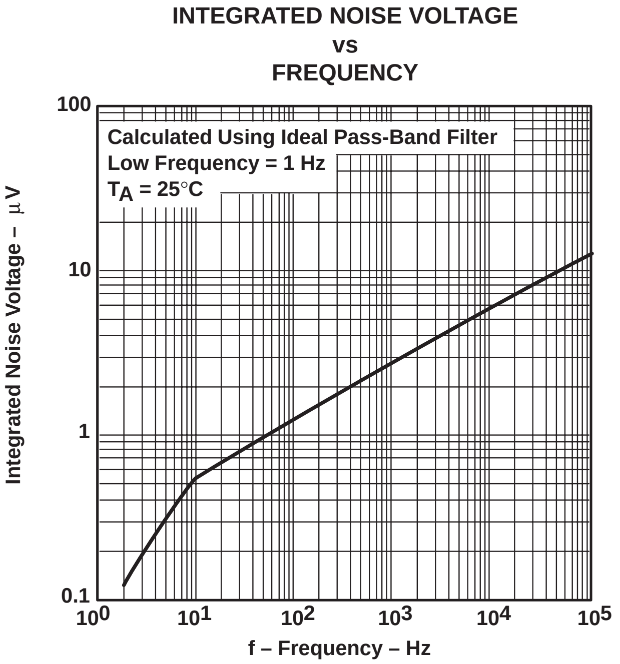


Figure 54

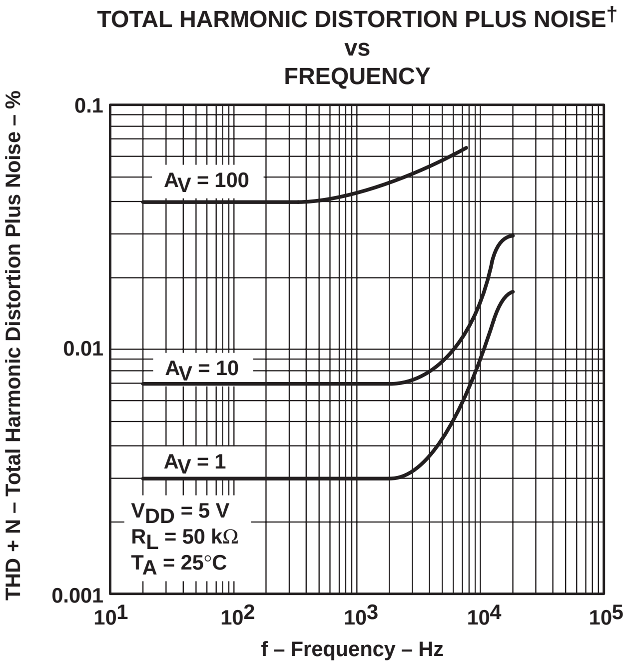


Figure 55

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

TYPICAL CHARACTERISTICS

GAIN-BANDWIDTH PRODUCT vs SUPPLY VOLTAGE

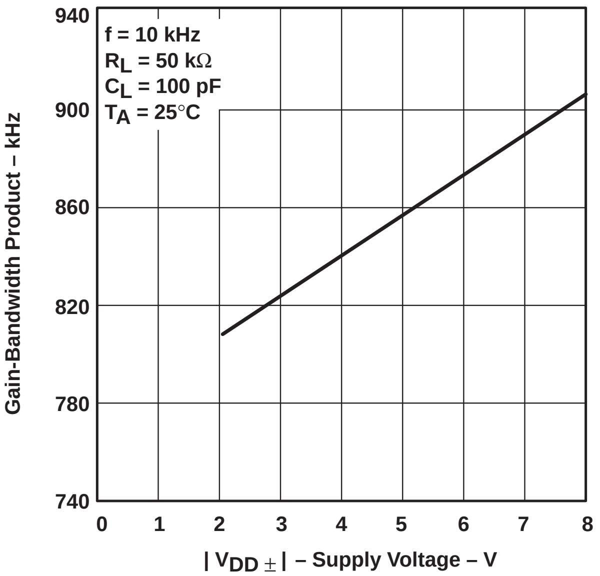


Figure 56

GAIN-BANDWIDTH PRODUCT†‡ vs FREE-AIR TEMPERATURE

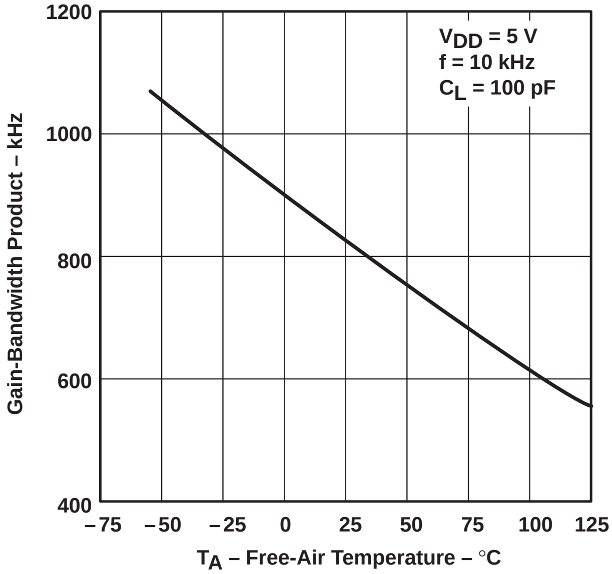


Figure 57

PHASE MARGIN vs LOAD CAPACITANCE

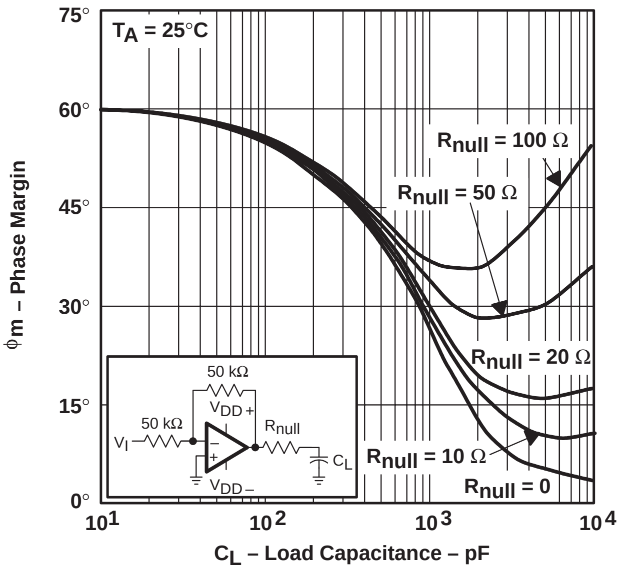


Figure 58

GAIN MARGIN vs LOAD CAPACITANCE

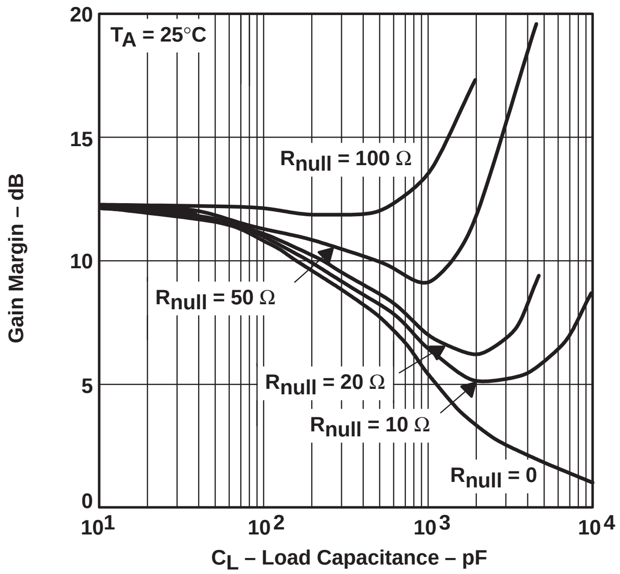


Figure 59

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

TYPICAL CHARACTERISTICS

UNITY-GAIN BANDWIDTH† vs LOAD CAPACITANCE

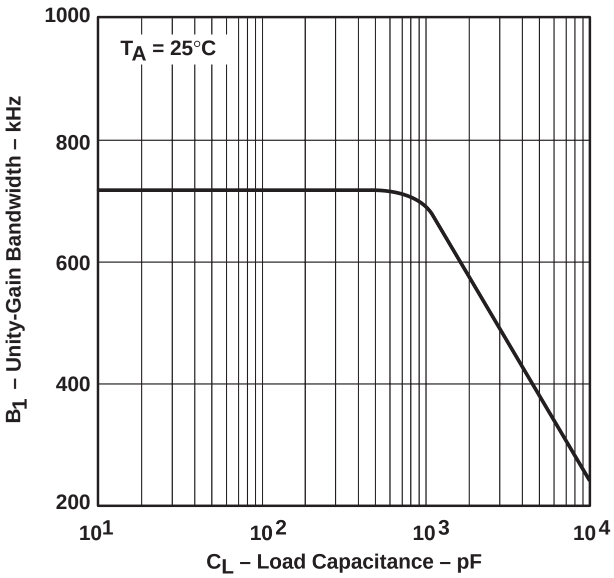


Figure 60

OVERESTIMATION OF PHASE MARGIN† vs LOAD CAPACITANCE

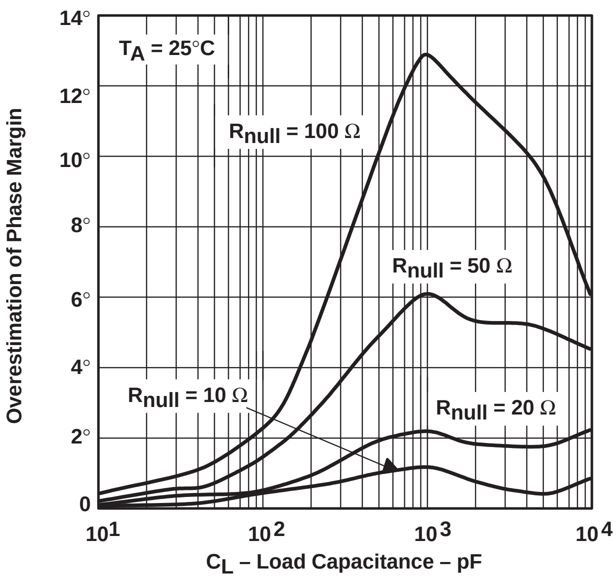


Figure 61

† See application information

APPLICATION INFORMATION

driving large capacitive loads

The TLC226x is designed to drive larger capacitive loads than most CMOS operational amplifiers. Figure 58 and Figure 59 illustrate its ability to drive loads greater than 400 pF while maintaining good gain and phase margins (R_{null} = 0).

A smaller series resistor (R_{null}) at the output of the device (see Figure 62) improves the gain and phase margins when driving large capacitive loads. Figure 58 and Figure 59 show the effects of adding series resistances of 10 Ω, 20 Ω, 50 Ω, and 100 Ω. The addition of this series resistor has two effects: the first is that it adds a zero to the transfer function and the second is that it reduces the frequency of the pole associated with the output load in the transfer function.

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

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

where :

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

The unity-gain bandwidth (UGBW) frequency decreases as the capacitive load increases (see Figure 60). To use equation 1, UGBW must be approximated from Figure 60.

Using equation 1 alone overestimates the improvement in phase margin, as illustrated in Figure 61. The overestimation is caused by the decrease in the frequency of the pole associated with the load, thus providing additional phase shift and reducing the overall improvement in phase margin. The pole associated with the load is reduced by the factor calculated in equation 2.

$$F = \frac{1}{1 + g_m \times R_{null}} \qquad (2)$$

Where :

F = factor reducing frequency of pole
g_m = small-signal output transconductance (typically 4.83×10^{-3} mhos)
R_{null} = output series resistance

For the TLC226x, the pole associated with the load is typically 7 MHz with 100-pF load capacitance. This value varies inversely with C_L: at C_L = 10 pF, use 70 MHz, at C_L = 1000 pF, use 700 kHz, and so on.

Reducing the pole associated with the load introduces phase shift, thereby reducing phase margin. This results in an error in the increase in phase margin expected by considering the zero alone (equation 1). Equation 3 approximates the reduction in phase margin due to the movement of the pole associated with the load. The result of this equation can be subtracted from the result of the equation in equation 1 to better approximate the improvement in phase margin.

APPLICATION INFORMATION

driving large capacitive loads (continued)

$$\Delta\Theta_{m2} = \tan^{-1}\left[\frac{UGBW}{\left(F \times P_2\right)}\right] - \tan^{-1}\left(\frac{UGBW}{P_2}\right) \tag{3}$$

Where :

$\Delta\Theta_{m2}$ = reduction in phase margin

UGBW = unity-gain bandwidth frequency

F = factor from equation 2

P_2 = unadjusted pole (70 MHz@10 pF, 7 MHz@100 pF, etc.)

Using these equations with Figure 60 and Figure 61 enables the designer to choose the appropriate output series resistance to optimize the design of circuits driving large capacitive loads.

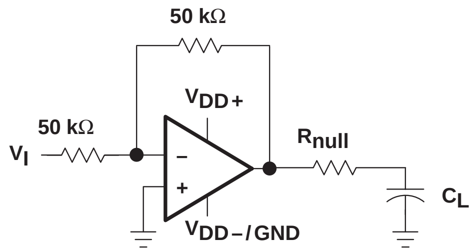


Figure 62. Series-Resistance Circuit

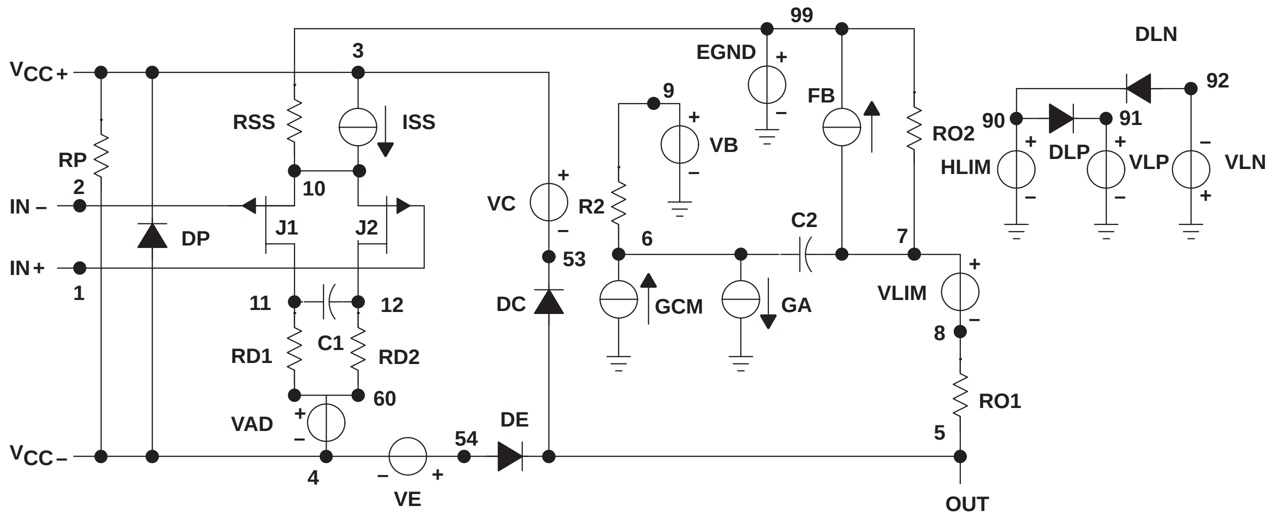
APPLICATION INFORMATION

macromodel information

Macromodel information provided was derived using Microsim *Parts*™, the model generation software used with Microsim *PSpice*™. The Boyle macromodel (see Note 5) and subcircuit in Figure 63 are generated using the TLC226x 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 TLC226x 1 2 3 4 5
      C1     11   12   3.560E–12
      C2     6    7    15.00E–12
      DC     5    53   DX
      DE     54   5    DX
      DLP    90   91   DX
      DLN    92   90   DX
      DP     4    3    DX
      EGND   99   0    POLY (2) (3,0) (4,0) 0 .5 .5
      FB     7    99   POLY (5) VB VC VE VLP
      + VLN 0 21.04E6 –30E6 30E6 30E6 –30E6
      GA     6    0    11    12 47.12E–6
      GCM    0    6    10    99 4.9E–9
      ISS    3    10   DC 8.250E–6
      HLIM   90   0    VLIM 1K
      J1     11   2    10 JX
      J2     12   1    10 JX
      R2     6    9    100.0E3
      RD1    60   11   21.22E3
      RD2    60   12   21.22E3
      R01    8    5    120
      R02    7    99   120
      RP     3    4    26.04E3
      RSS    10   99   24.24E6
      VAD    60   4    –.6
      VB     9    0    DC 0
      VC     3    53   DC .65
      VE     54   4    DC .65
      VLIM   7    8    DC 0
      VLP    91   0    DC 1.4
      VLN    0    92   DC 9.4
      .MODEL DX D (IS=800.0E–18)
      .MODEL JX PJF (IS=500.0E–15 BETA=281E–6
      + VTO=–.065)
      .ENDS
```

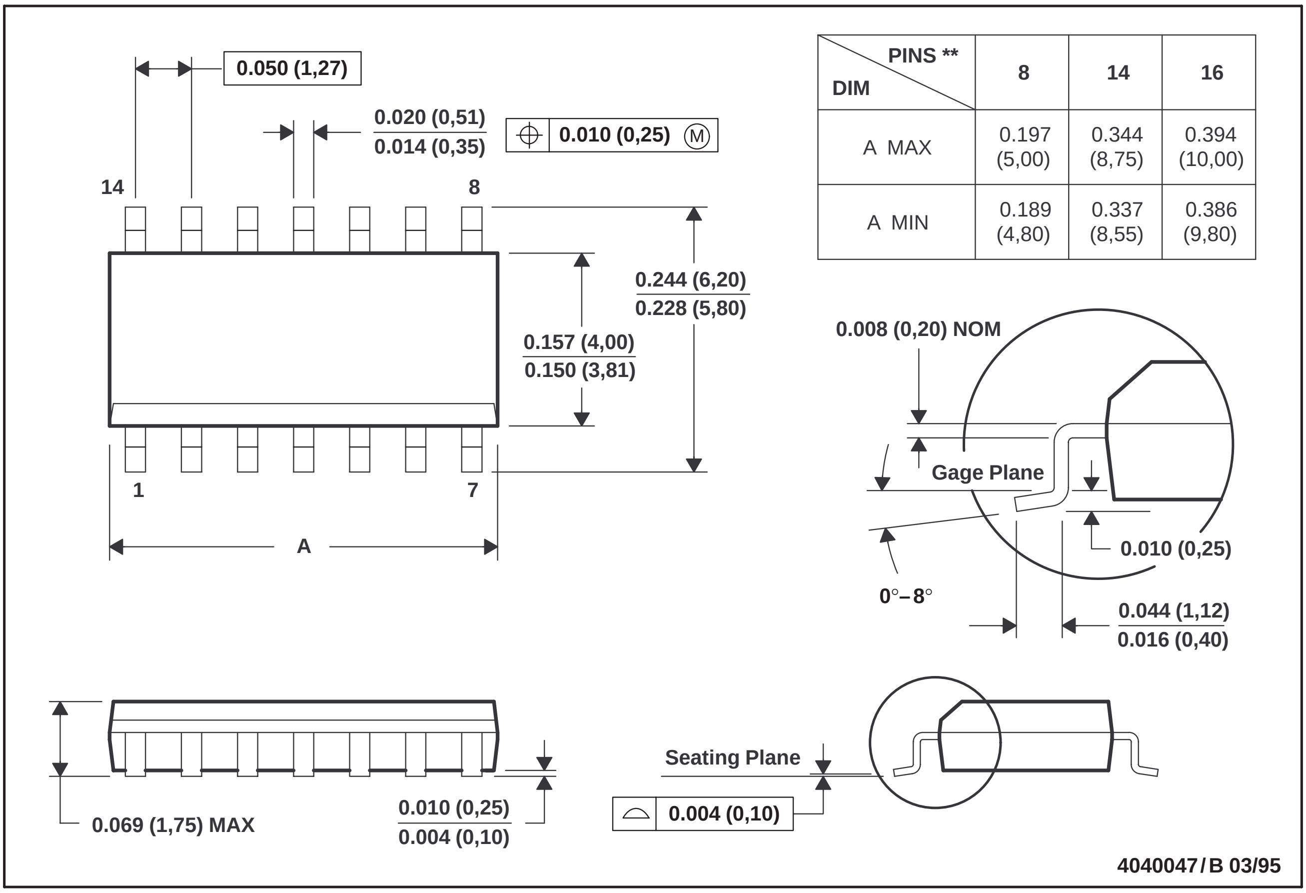
Figure 63. Boyle Macromodel and Subcircuit

PSpice and *Parts* are trademarks of MicroSim Corporation.

MECHANICAL INFORMATION

D (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14 PIN SHOWN



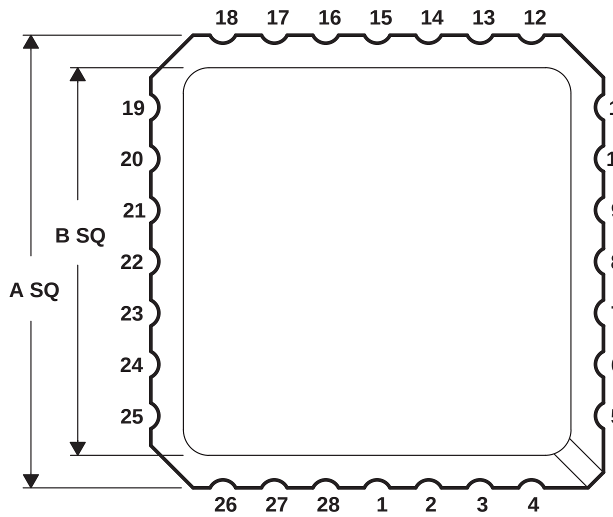
DIM \ PINS **	8	14	16
A MAX	0.197 (5,00)	0.344 (8,75)	0.394 (10,00)
A MIN	0.189 (4,80)	0.337 (8,55)	0.386 (9,80)

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

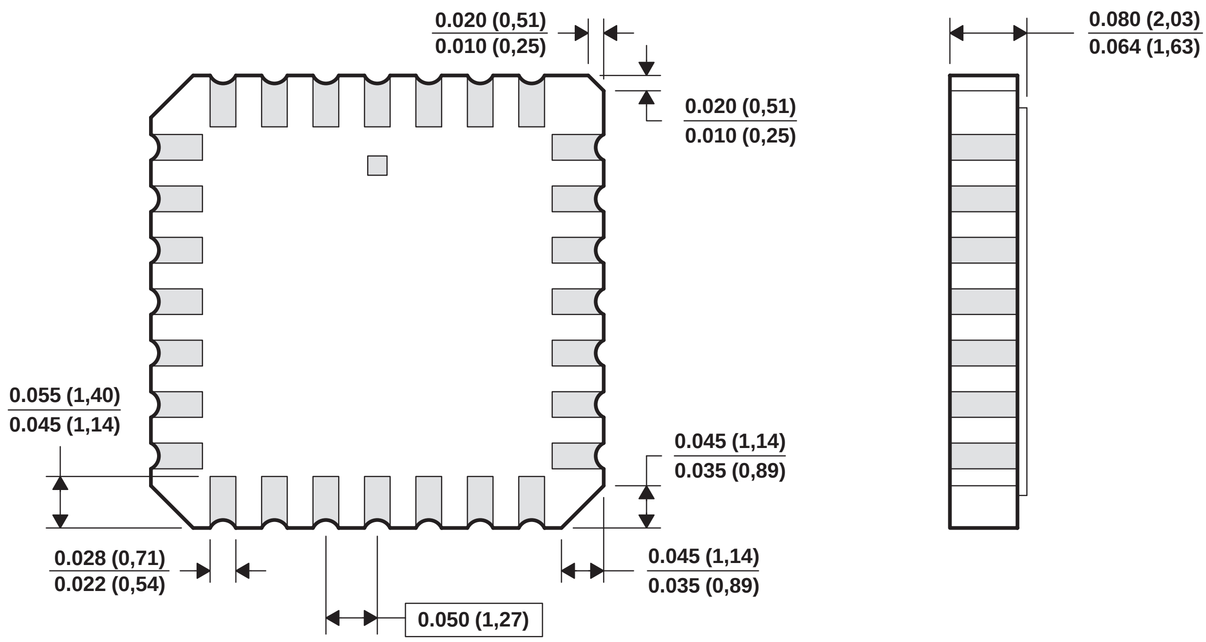
MECHANICAL INFORMATION

FK (S-CQCC-N)** **LEADLESS CERAMIC CHIP CARRIER**

28 TERMINAL SHOWN



NO. OF TERMINALS **	A		B	
	MIN	MAX	MIN	MAX
20	0.342 (8,69)	0.358 (9,09)	0.307 (7,80)	0.358 (9,09)
28	0.442 (11,23)	0.458 (11,63)	0.406 (10,31)	0.458 (11,63)
44	0.640 (16,26)	0.660 (16,76)	0.495 (12,58)	0.560 (14,22)
52	0.740 (18,78)	0.761 (19,32)	0.495 (12,58)	0.560 (14,22)
68	0.938 (23,83)	0.962 (24,43)	0.850 (21,6)	0.858 (21,8)
84	1.141 (28,99)	1.165 (29,59)	1.047 (26,6)	1.063 (27,0)



4040140/C 11/95

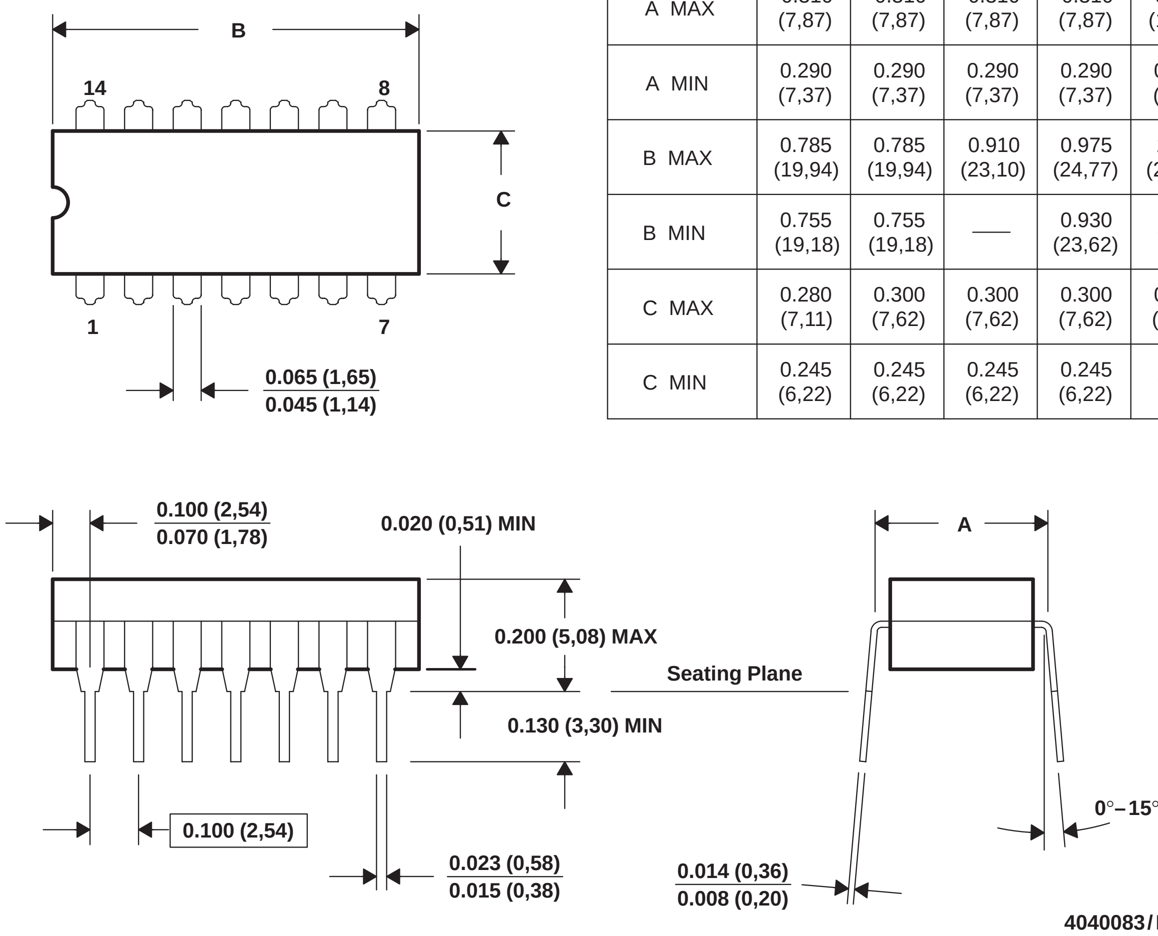
NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a metal lid.
D. The terminals are gold plated.
E. Falls within JEDEC MS-004

MECHANICAL INFORMATION

J (R-GDIP-T)** **CERAMIC DUAL-IN-LINE PACKAGE**

14 PIN SHOWN

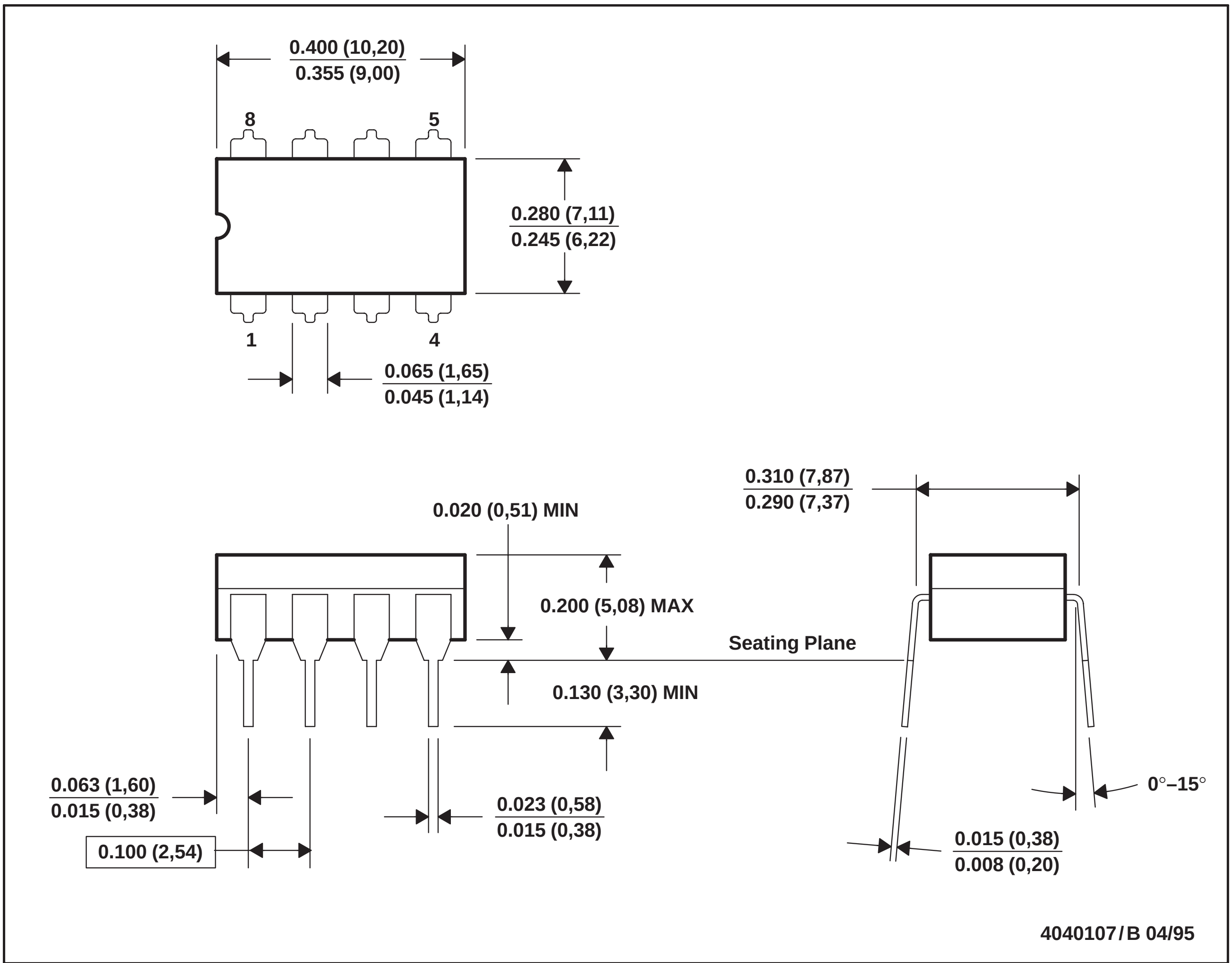
DIM \ PINS **	14	16	18	20	22
A MAX	0.310 (7,87)	0.310 (7,87)	0.310 (7,87)	0.310 (7,87)	0.410 (10,41)
A MIN	0.290 (7,37)	0.290 (7,37)	0.290 (7,37)	0.290 (7,37)	0.390 (9,91)
B MAX	0.785 (19,94)	0.785 (19,94)	0.910 (23,10)	0.975 (24,77)	1.100 (28,00)
B MIN	0.755 (19,18)	0.755 (19,18)	—	0.930 (23,62)	—
C MAX	0.280 (7,11)	0.300 (7,62)	0.300 (7,62)	0.300 (7,62)	0.388 (9,65)
C MIN	0.245 (6,22)	0.245 (6,22)	0.245 (6,22)	0.245 (6,22)	—



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

MECHANICAL INFORMATION

JG (R-GDIP-T8) **CERAMIC DUAL-IN-LINE PACKAGE**



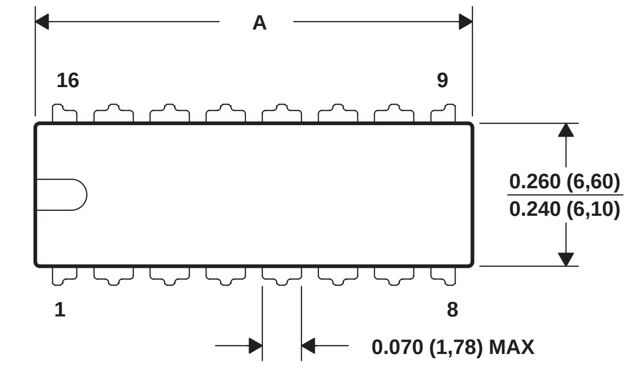
NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only
E.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

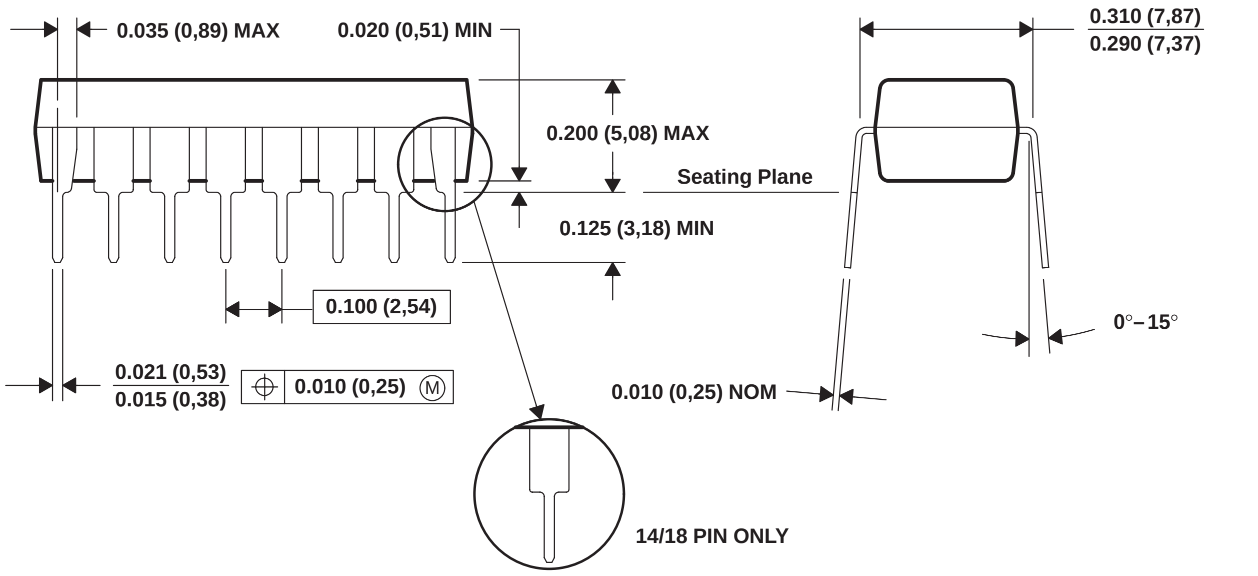
MECHANICAL INFORMATION

N (R-PDIP-T)** **PLASTIC DUAL-IN-LINE PACKAGE**

16 PIN SHOWN

DIM \ PINS **	14	16	18	20
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23.37)	0.975 (24,77)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21.59)	0.940 (23,88)



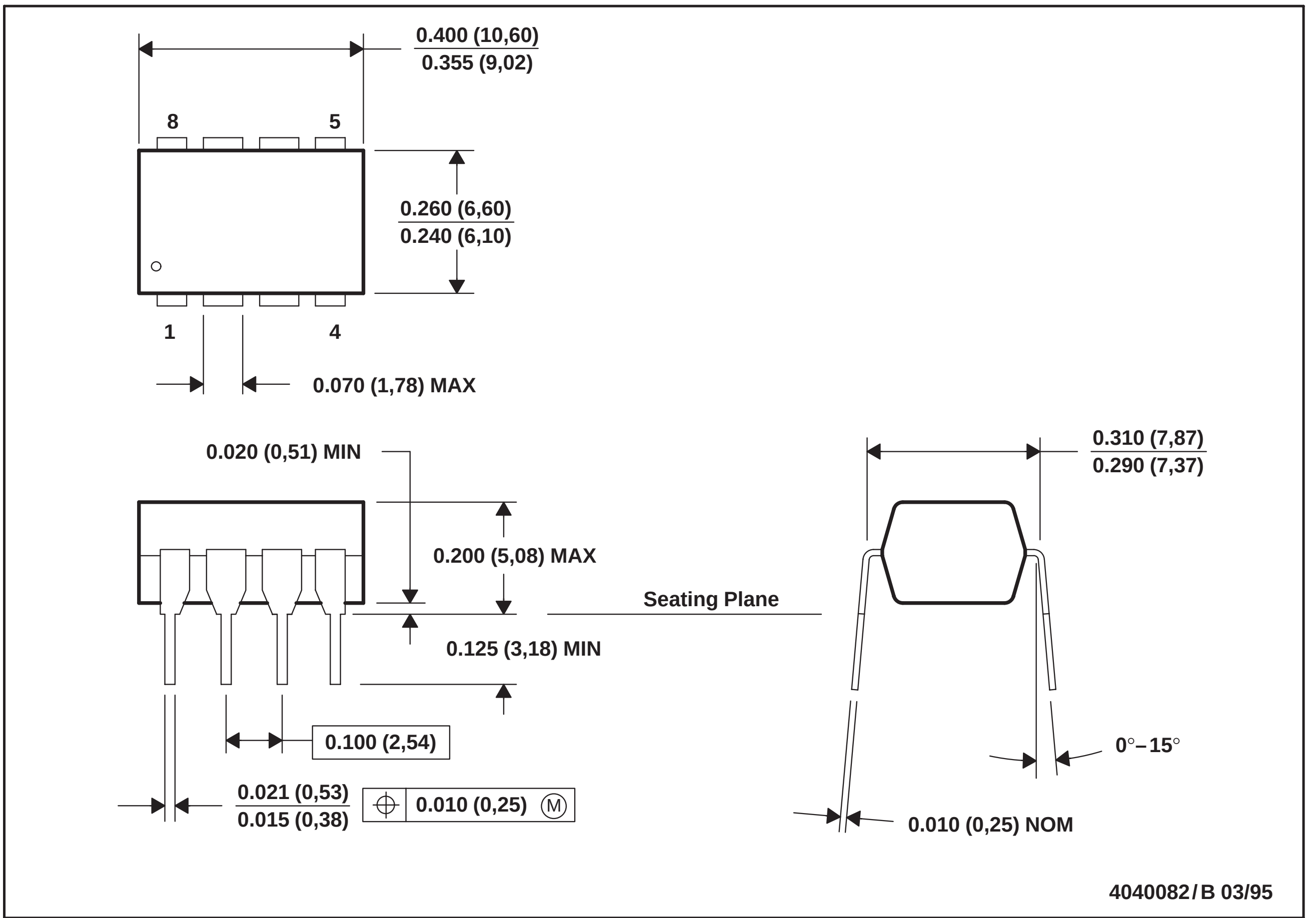


4040049/C 08/95

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

MECHANICAL INFORMATION

P (R-PDIP-T8) **PLASTIC DUAL-IN-LINE PACKAGE**

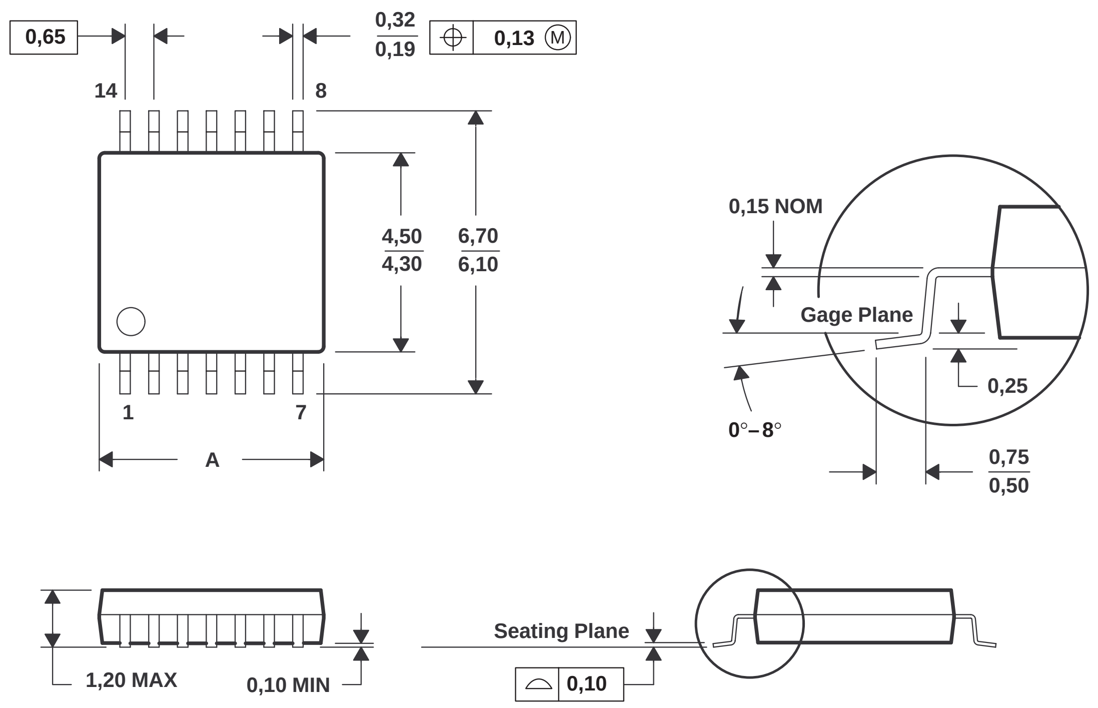


NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS-001

MECHANICAL INFORMATION

PW (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14 PIN SHOWN



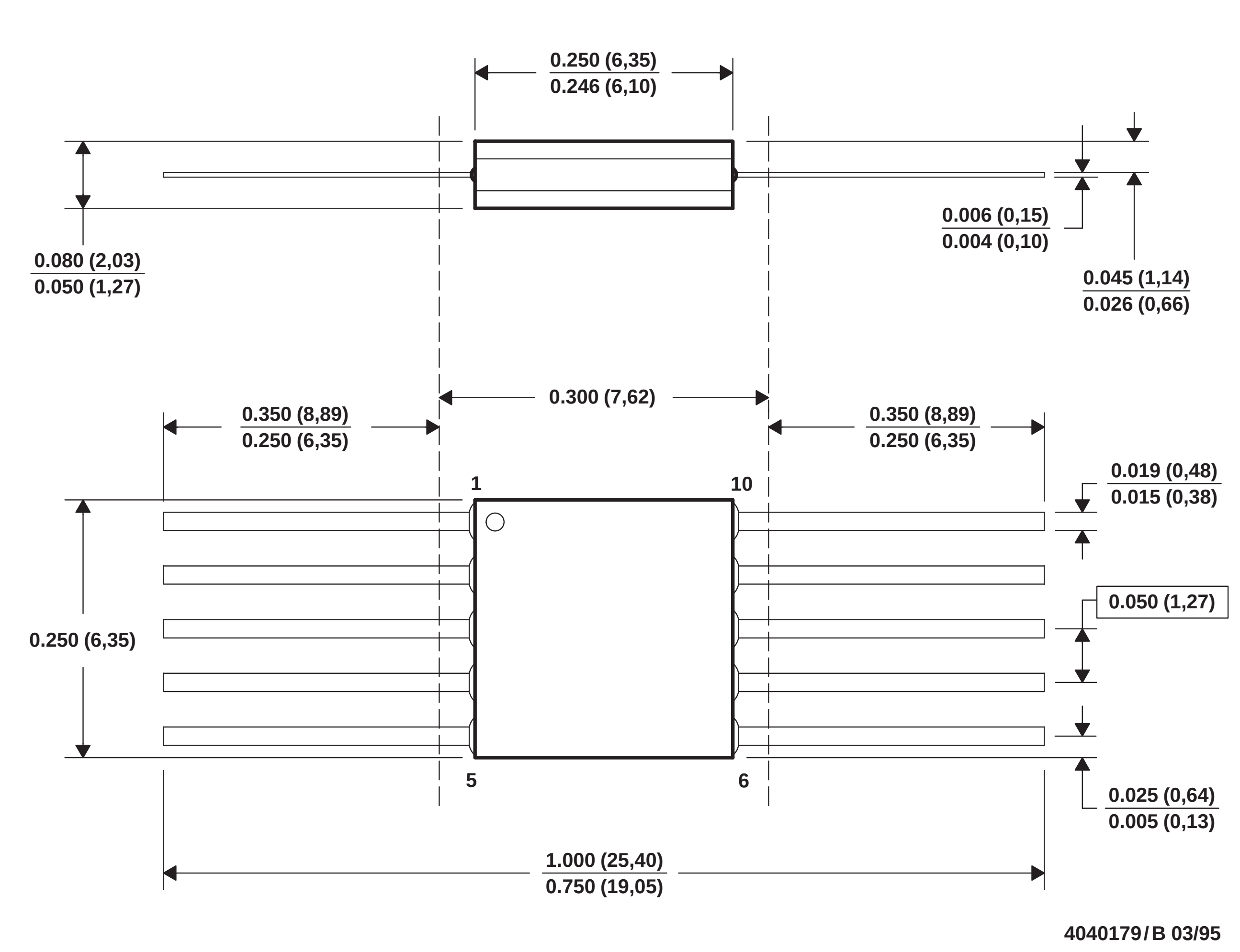
PINS ** / DIM	8	14	16	20	24	28
A MAX	3,10	5,10	5,10	6,60	7,90	9,80
A MIN	2,90	4,90	4,90	6,40	7,70	9,60

4040064/D 10/95

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

MECHANICAL INFORMATION

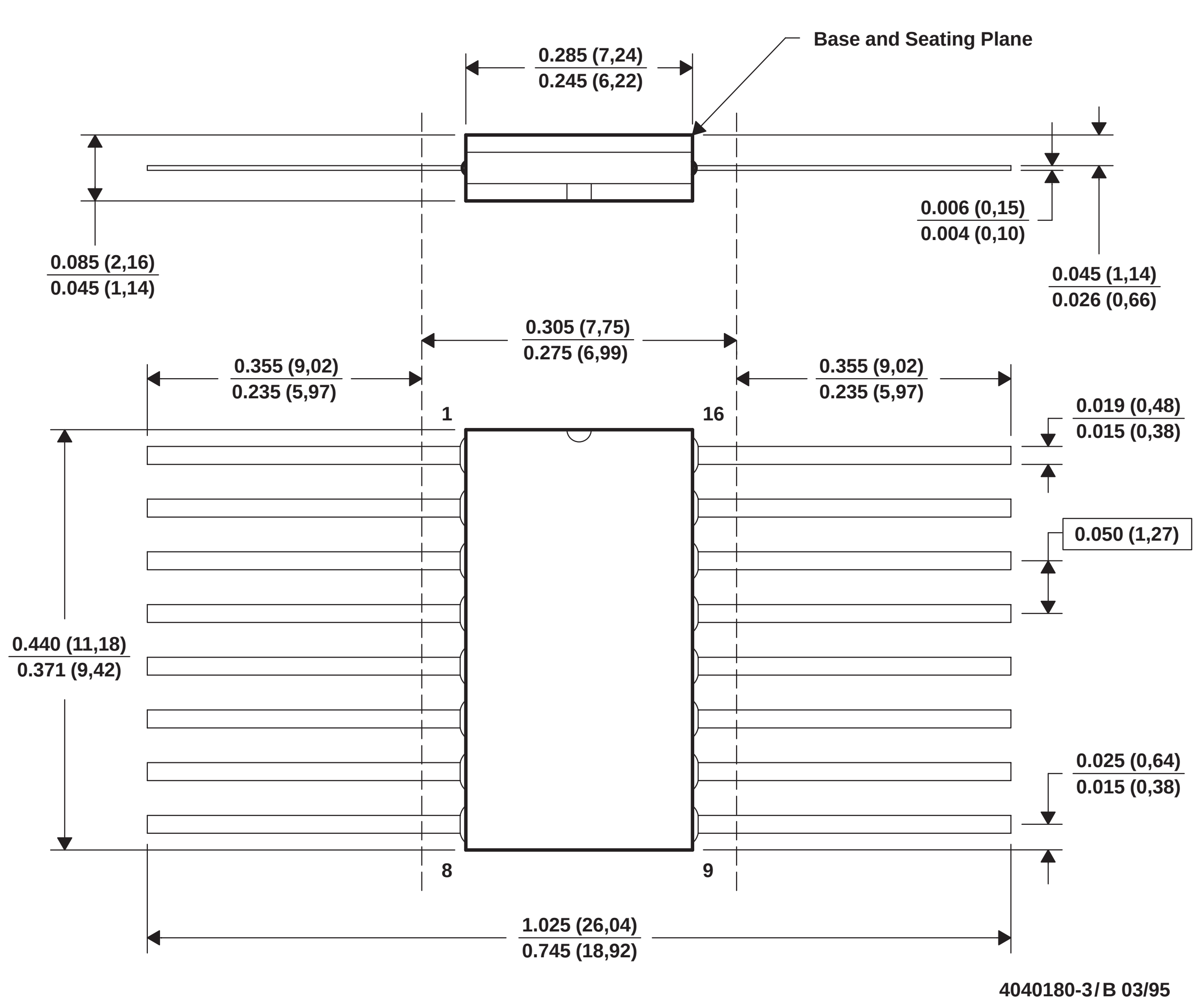
U (S-GDFP-F10) **CERAMIC DUAL FLATPACK**



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

MECHANICAL INFORMATION

W (R-GDFP-F16) **CERAMIC DUAL FLATPACK**



NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification only.
E. Falls within MIL-STD-1835 GDFP1-F16 and JEDEC MO-092AC

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