- **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 (TLV226xA)
- **Wide Supply Voltage Range**
  2.7 V to 8 V
- **Macromodel Included**
- **Available in Q-Temp Automotive**
  HighRel Automotive Applications
  Configuration Control / Print Support
  Qualification to Automotive Standards

description

The TLV2262 and TLV2264 are dual and quad low voltage operational amplifiers from Texas Instruments. Both devices exhibit rail-to-rail output performance for increased dynamic range in single or split supply applications. The TLV226x family offers a compromise between the micropower TLV225x 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. This family is fully characterized at 3 V and 5 V and is optimized for low-voltage applications. 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.

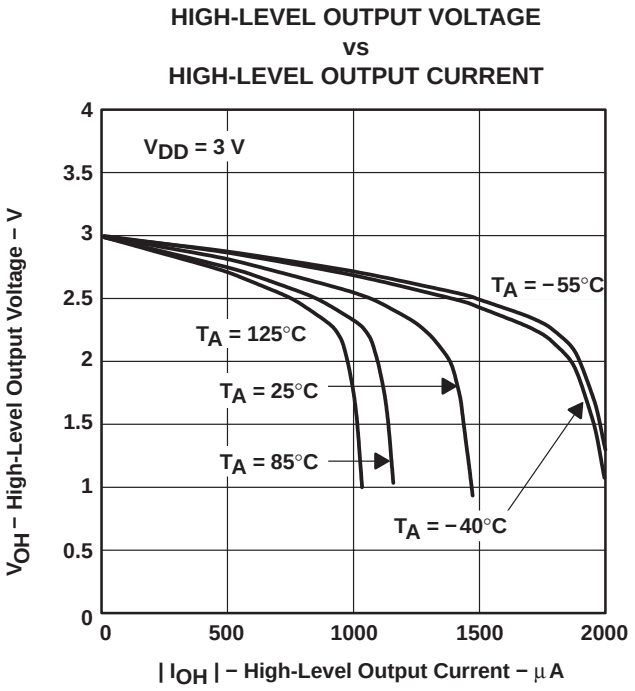


Figure 1

The TLV226x, exhibiting high input impedance and low noise, are excellent for small-signal conditioning for high-impedance sources, such as piezoelectric transducers. Because of the micropower dissipation levels combined with 3-V operation, these devices work well in hand-held monitoring and remote-sensing applications. In addition, the rail-to-rail output feature with single or split supplies makes this family a great choice when interfacing with analog-to-digital converters (ADCs). For precision applications, the TLV226xA family is available and has a maximum input offset voltage of 950 μV.

The TLV2262/4 also makes great upgrades to the TLV2332/4 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 devices. 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.

Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

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TLV2262 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	TLV2262CD	—	—	TLV2262CP	TLV2262CPWLE	—
−40°C to 125°C	950 µV 2.5 mV	TLV2262AID TLV2262ID	— —	— —	TLV2262AIP TLV2262IP	TLV2262AIPWLE —	— —
−40°C to 125°C	950 µV 2.5 mV	TLV2262AQD TLV2262QD	— —	— —	— —	— —	— —
−55°C to 125°C	950 µV 2.5 mV	— —	TLV2262AMFK TLV2262MFK	TLV2262AMJG TLV2262MJG	— —	— —	TLV2262AMU TLV2262MU

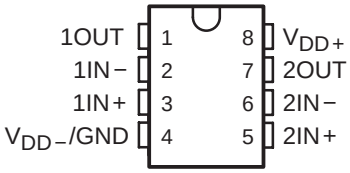
† The D packages are available taped and reeled. Add R suffix to device type (e.g., TLV2262CDR).
‡ The PW package is available only left-end taped and reeled.
§ Chips are tested at 25°C.
¶ For the most current package and ordering information see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.

TLV2264 AVAILABLE OPTIONS

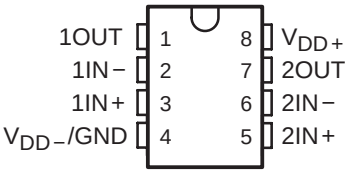
T_A	V_{IO}max AT 25°C	PACKAGED DEVICES					
		SMALL OUTLINE (D)	CHIP CARRIER (FK)	CERAMIC DIP (J)	PLASTIC DIP (N)	TSSOP (PW)	CERAMIC FLATPACK (W)
−40°C to 125°C	950 µV 2.5 mV	TLV2264AID TLV2264ID	— —	— —	TLV2264AIN TLV2264IN	TLV2264AIPWLE —	— —
−40°C to 125°C	950 µV 2.5 mV	TLV2264AQD TLV2264QD	— —	— —	— —	— —	— —
−55°C to 125°C	950 µV 2.5 mV	— —	TLV2264AMFK TLV2264MFK	TLV2264AMJ TLV2264MJ	— —	— —	TLV2264AMW TLV2264MW

† The D packages are available taped and reeled. Add R suffix to device type (e.g., TLV2262IDR).
‡ The PW package is available only left-end taped and reeled.
§ Chips are tested at 25°C.
¶ For the most current package and ordering information see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.

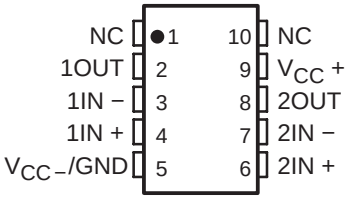
**TLV2262C, TLV2262AC
TLV2262I, TLV2262AI
TLV2262Q, TLV2262AQ
D, P, OR PW PACKAGE
(TOP VIEW)**



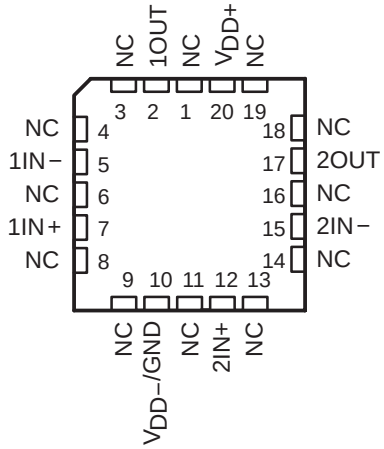
**TLV2262M, TLV2262AM
JG PACKAGE
(TOP VIEW)**



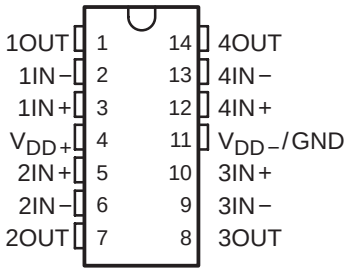
**TLV2662M, TLV2262AM
U PACKAGE
(TOP VIEW)**



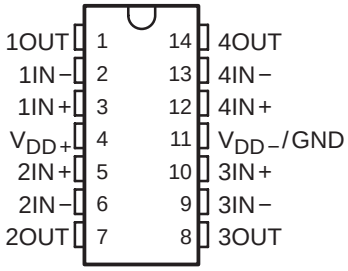
**TLV2262M, TLV2262AM
FK PACKAGE
(TOP VIEW)**



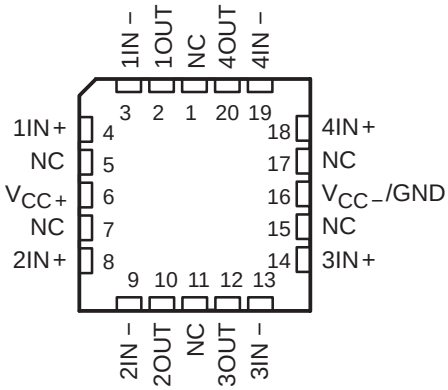
**TLV2264I, TLV2264AI
TLV2264Q, TLV2264AQ
D, N, OR PW PACKAGE
(TOP VIEW)**



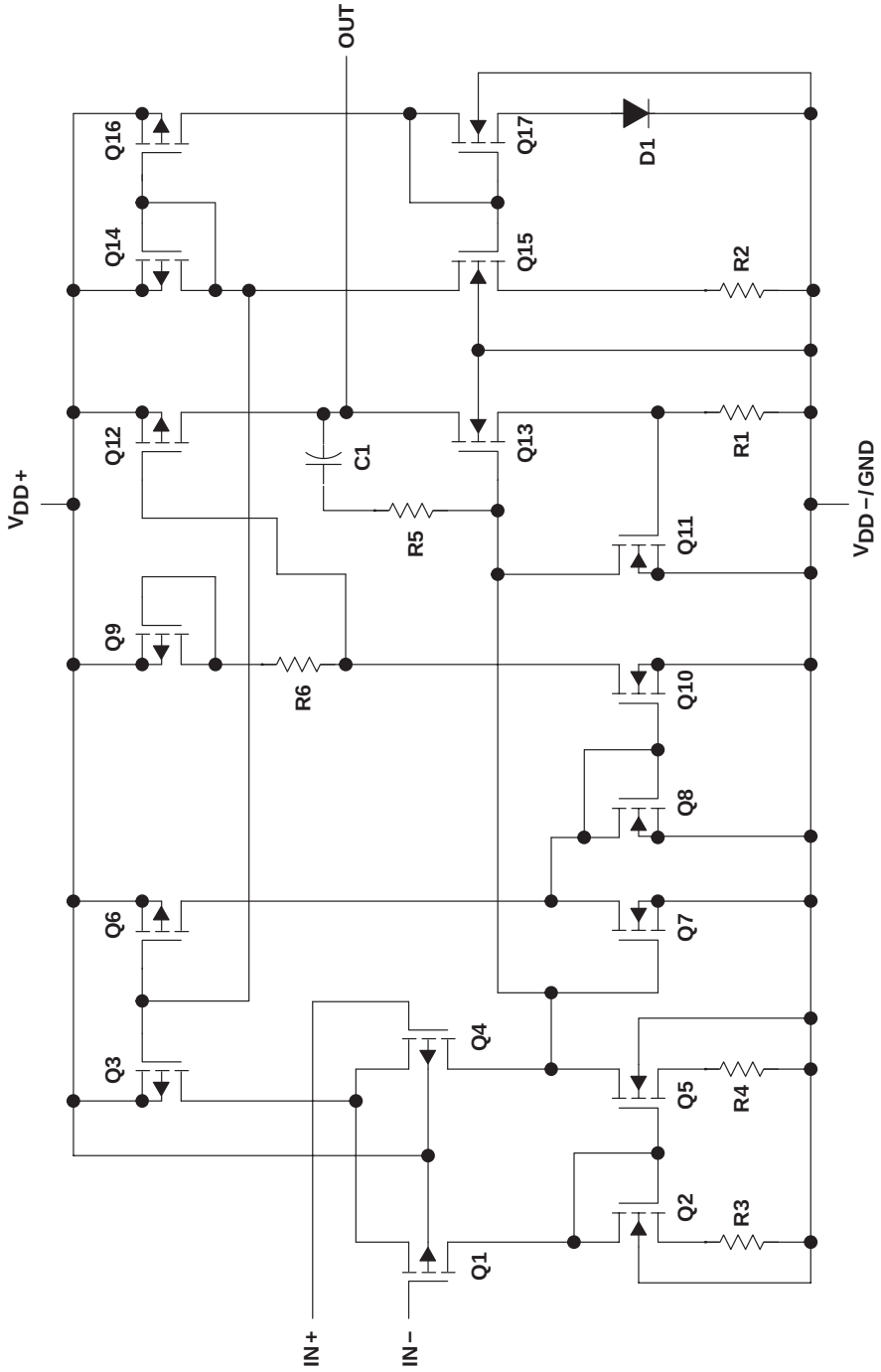
**TLV2264M, TLV2264AM
J OR W PACKAGE
(TOP VIEW)**



**TLV2264M, TLV2264AM
FK PACKAGE
(TOP VIEW)**



equivalent schematic (each amplifier)



ACTUAL DEVICE COMPONENT COUNT†		
COMPONENT	TLV2252	TLV2254
Transistors	38	76
Resistors	28	54
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) . . . . . 16 V
Differential input voltage, V_{ID} (see Note 2) . . . . . $\pm V_{DD}$
Input voltage range, 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 power dissipation . . . . . See Dissipation Rating Table
Operating free-air temperature range, T_A: 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

† 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 V_{DD-}.
2. Differential voltages are at the noninverting input with respect to the inverting input. Excessive current flows when input is brought below V_{DD-} − 0.3 V.
3. The output may be shorted to either supply. Temperature and/or supply voltages must be limited to ensure that the maximum dissipation rating is not exceeded.

DISSIPATION RATING TABLE

PACKAGE	$T_A \le 25°C$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25°C$	$T_A = 85°C$ POWER RATING	$T_A = 125°C$ POWER RATING
D−8	725 mW	5.8 mW/°C	377 mW	145 mW
D−14	950 mW	7.6 mW/°C	494 mW	190 mW
FK	1375 mW	11.0 mW/°C	715 mW	275 mW
J	1375 mW	11.0 mW/°C	715 mW	275 mW
JG	1050 mW	8.4 mW/°C	—	210 mW
N	1150 mW	9.2 mW/°C	598 mW	—
P	1000 mW	8.0 mW/°C	520 mW	200 mW
PW−8	525 mW	4.2 mW/°C	273 mW	105 mW
PW−14	700 mW	5.6 mW/°C	364 mW	—
U	700 mW	5.5 mW/°C	—	150 mW
W	700 mW	5.5 mW/°C	370 mW	150 mW

recommended operating conditions

	I SUFFIX		Q SUFFIX		M SUFFIX		UNIT
	MIN	MAX	MIN	MAX	MIN	MAX	
Supply voltage, $V_{DD\pm}$ (see Note 1)	2.7	8	2.7	8	2.7	8	V
Input voltage range, V_I	V_{DD-}	V_{DD+} −1.3	V_{DD-}	V_{DD+} −1.3	V_{DD-}	V_{DD+} −1.3	V
Common-mode input voltage, V_{IC}	V_{DD-}	V_{DD+} −1.3	V_{DD-}	V_{DD+} −1.3	V_{DD-}	V_{DD+} −1.3	V
Operating free-air temperature, T_A	−40	125	−40	125	−55	125	°C

NOTE 1: All voltage values, except differential voltages, are with respect to V_{DD-}.

TLV2262I electrical characteristics at specified free-air temperature, V_{DD} = 3 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLV2262I			TLV2262AI			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	$V_{DD\pm}$ = ±1.5 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			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	60		0.5	60	pA
				85°C			150			150	
				Full range			800			800	
I_{IB}	Input bias current			25°C		1	60		1	60	pA
				85°C			150			150	
				Full range			800			800	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω,	$\lvert V_{IO}\rvert \le$ 5 mV	25°C	0 to 2	−0.3 to 2.2		0 to 2	−0.3 to 2.2		V
				Full range	0 to 1.7			0 to 1.7			
V_{OH}	High-level output voltage	I_{OH} = −20 μA		25°C		2.99			2.99		V
		I_{OH} = −100 μA		25°C	2.85			2.85			
				Full range	2.825			2.825			
		I_{OH} = −400 μA		25°C	2.7			2.7			
				Full range	2.65			2.65			
V_{OL}	Low-level output voltage	V_{IC} = 1.5 V,	I_{OL} = 50 μA	25°C		10			10		mV
		V_{IC} = 1.5 V,	I_{OL} = 500 μA	25°C		100			100		
				Full range			150			150	
		V_{IC} = 1.5 V,	I_{OL} = 1 mA	25°C		200			200		
				Full range			300			300	
A_{VD}	Large-signal differential voltage amplification	V_{IC} = 1.5 V, V_O = 1 V to 2 V	R_L = 50 kΩ‡	25°C	60	100		60	100		V/mV
				Full range	30			30			
			R_L = 1 MΩ‡	25°C		100			100		
$r_{i(d)}$	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		270			270		Ω
CMRR	Common-mode rejection ratio	V_{IC} = 0 to 1.7 V, V_O = 1.5 V,	R_S = 50 Ω	25°C	65	75		65	77		dB
				Full range	60			60			
k_{SVR}	Supply voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$)	V_{DD} = 2.7 V to 8 V, V_{IC} = V_{DD}/2,	No load	25°C	80	95		80	100		dB
				Full range	80			80			

† Full range is − 40°C to 125°C.
‡ Referenced to 1.5 V
NOTE 4: Typical values are based on the input offset voltage shift observed through 500 hours of operating life test at T_A = 150°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLV2262I electrical characteristics at specified free-air temperature, V_{DD} = 3 V (unless otherwise noted) (continued)

PARAMETER		TEST CONDITIONS	T_A†	TLV2262I			TLV2262AI			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
I_{DD}	Supply current	V_O = 1.5 V, No load	25°C		400	500		400	500	µA
			Full range			500			500	

† Full range is − 40°C to 125°C.

TLV2262I operating characteristics at specified free-air temperature, V_{DD} = 3 V

PARAMETER		TEST CONDITIONS		T_A†	TLV2262I			TLV2262AI			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	V_O = 1.1 V to 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	0.3			0.3			
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		0.6			0.6		µV
		f = 0.1 Hz to 10 Hz		25°C		1			1		
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		0.03%			0.03%		
			A_V = 10			0.05%			0.05%		
	Gain-bandwidth product	f = 1 kHz, C_L = 100 pF‡	R_L = 50 kΩ‡,	25°C		0.67			0.67		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 1 V, R_L = 50 kΩ‡,	A_V = 1, C_L = 100 pF‡	25°C		395			395		kHz
t_s	Settling time	A_V = −1, Step = 1 V to 2 V, R_L = 50 kΩ‡, C_L = 100 pF‡	To 0.1%	25°C		5.6			5.6		µs
			To 0.01%			12.5			12.5		
ϕ_m	Phase margin at unity gain	R_L = 50 kΩ‡,	C_L = 100 pF‡	25°C		55°			55°		
	Gain margin			25°C		11			11		dB

† Full range is − 40°C to 125°C.
‡ Referenced to 1.5 V

TLV2262I electrical characteristics at specified free-air temperature, V_{DD} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLV2262I			TLV2262AI			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
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			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	60		0.5	60	pA
				85°C			150			150	
				Full range			800			800	
I_{IB}	Input bias current			25°C		1	60		1	60	pA
				85°C			150			150	
				Full range			800			800	
V_{ICR}	Common-mode input voltage range	$\|V_{IO}\|$ ≤5 mV,	R_S = 50 Ω	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	4.6			4.6			
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} = 1 mA	25°C		0.2	0.3		0.2	0.3	
				Full range			0.3			0.3	
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		80	170		V/mV
				Full range	55			55			
			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,	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 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 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.
‡ 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.

TLV2262I electrical characteristics at specified free-air temperature, V_{DD} = 5 V (unless otherwise noted) (continued)

PARAMETER		TEST CONDITIONS	T_A†	TLV2262I			TLV2262AI			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.

TLV2262I operating characteristics at specified free-air temperature, V_{DD} = 5 V

PARAMETER		TEST CONDITIONS		T_A†	TLV2262I			TLV2262AI			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	0.3			0.3			
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

TLV2264I electrical characteristics at specified free-air temperature, V_{DD} = 3 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLV2264I			TLV2264AI			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	$V_{DD\pm}$ = ±1.5 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 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	60		0.5	60	pA
				85°C			150			150	
				Full range			800			800	
I_{IB}	Input bias current			25°C		1	60		1	60	pA
				85°C			150			150	
				Full range			800			800	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω,	$\lvert V_{IO}\rvert \le$5 mV	25°C	0 to 2	−0.3 to 2.2		0 to 2	−0.3 to 2.2		V
				Full range	0 to 1.7			0 to 1.7			
V_{OH}	High-level output voltage	I_{OH} = −20 µA		25°C		2.99			2.99		V
		I_{OH} = −100 µA		25°C	2.85			2.85			
				Full range	2.825			2.825			
		I_{OH} = −400 µA		25°C	2.7			2.7			
				Full range	2.65			2.65			
V_{OL}	Low-level output voltage	V_{IC} = 1.5 V,	I_{OL} = 50 µA	25°C		10			10		mV
		V_{IC} = 1.5 V,	I_{OL} = 500 µA	25°C		100			100		
				Full range			150			150	
		V_{IC} = 1.5 V,	I_{OL} = 1 mA	25°C		200			200		
				Full range			300			300	
A_{VD}	Large-signal differential voltage amplification	V_{IC} = 1.5 V, V_O = 1 to 2 V	R_L = 50 kΩ‡	25°C	60	100		60	100		V/mV
				Full range	30			30			
			R_L = 1 MΩ‡	25°C		100			100		
$r_{i(d)}$	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		270			270		Ω
CMRR	Common-mode rejection ratio	V_{IC} = 0 to 1.7 V, V_O = 1.5 V,	R_S = 50 Ω	25°C	65	75		65	77		dB
				Full range	60			60			
k_{SVR}	Supply voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$)	V_{DD} = 2.7 V to 8 V, V_{IC} = V_{DD}/2,	No load	25°C	80	95		80	100		dB
				Full range	80			80			

† Full range is − 40°C to 125°C.
‡ Referenced to 1.5 V
NOTE 4: Typical values are based on the input offset voltage shift observed through 500 hours of operating life test at T_A = 150°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLV2264I electrical characteristics at specified free-air temperature, V_{DD} = 3 V (unless otherwise noted) (continued)

PARAMETER		TEST CONDITIONS	T_A†	TLV2264I			TLV2264AI			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
I_{DD}	Supply current (four amplifiers)	V_O = 1.5 V, No load	25°C		0.8	1		0.8	1	mA
			Full range			1			1	

† Full range is − 40°C to 125°C.

TLV2264I operating characteristics at specified free-air temperature, V_{DD} = 3 V

PARAMETER		TEST CONDITIONS		T_A†	TLV2264I			TLV2264AI			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	V_O = 0.7 V to 1.7 V, C_L = 100 pF‡	R_L = 50 kΩ‡,	25°C	0.35	0.55		0.35	0.55		V/μs
				Full range	0.3			0.3			
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		0.6			0.6		μV
		f = 0.1 Hz to 10 Hz		25°C		1			1		
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		0.03%			0.03%		
			A_V = 10			0.05%			0.05%		
	Gain-bandwidth product	f = 1 kHz, C_L = 100 pF‡	R_L = 50 kΩ‡,	25°C		0.67			0.67		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 1 V, R_L = 50 kΩ‡,	A_V = 1, C_L = 100 pF‡	25°C		395			395		kHz
t_s	Settling time	A_V = −1, Step = 1 V to 2 V, R_L = 50 kΩ‡, C_L = 100 pF‡	To 0.1%	25°C		5.6			5.6		μs
			To 0.01%			12.5			12.5		
ϕ_m	Phase margin at unity gain	R_L = 50 kΩ‡,	C_L = 100 pF‡	25°C		55°			55°		
	Gain margin			25°C		11			11		dB

† Full range is − 40°C to 125°C.
‡ Referenced to 1.5 V

TLV2264I electrical characteristics at specified free-air temperature, V_{DD} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLV2264I			TLV2264AI			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
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 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	60		0.5	60	pA
				85°C			150			150	
				Full range			800			800	
I_{IB}	Input bias current			25°C		1	60		1	60	pA
				85°C			150			150	
				Full range			800			800	
V_{ICR}	Common-mode input voltage range	$\|V_{IO}\|$ ≤5 mV, R_S = 50 Ω		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	4.6			4.6			
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} = 1 mA	25°C		0.2	0.3		0.2	0.3	
				Full range			0.3			0.3	
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		80	170		V/mV
				Full range	55			55			
			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 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.
‡ 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.

TLV2264I electrical characteristics at specified free-air temperature, V_{DD} = 5 V (unless otherwise noted) (continued)

PARAMETER		TEST CONDITIONS		T_A†	TLV2264I			TLV2264AI			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.

TLV2264I operating characteristics at specified free-air temperature, V_{DD} = 5 V

PARAMETER		TEST CONDITIONS		T_A†	TLV2264I			TLV2264AI			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
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	0.3			0.3			
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

TLV2262Q and TLV2262M electrical characteristics at specified free-air temperature, V_{DD} = 3 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLV2262Q, TLV2262M			TLV2262AQ, TLV2262AM			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	$V_{DD\pm}$ = ±1.5 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			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	60		0.5	60	pA
				125°C			800			800	
I_{IB}	Input bias current			25°C		1	60		1	60	pA
				125°C			800			800	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω,	$\lvert V_{IO}\rvert$ ≤5 mV	25°C	0 to 2	−0.3 to 2.2		0 to 2	−0.3 to 2.2		V
				Full range	0 to 1.7			0 to 1.7			
V_{OH}	High-level output voltage	I_{OH} = −20 µA		25°C		2.99			2.99		V
		I_{OH} = −100 µA		25°C	2.85			2.85			
				Full range	2.82			2.82			
		I_{OH} = −400 µA		25°C	2.7			2.7			
				Full range	2.55			2.55			
V_{OL}	Low-level output voltage	V_{IC} = 1.5 V,	I_{OL} = 50 µA	25°C		10			10		mV
		V_{IC} = 1.5 V,	I_{OL} = 500 µA	25°C		100	150		100	150	
				Full range			165			165	
		V_{IC} = 1.5 V,	I_{OL} = 1 mA	25°C		200	300		200	300	
				Full range			300			300	
A_{VD}	Large-signal differential voltage amplification	V_{IC} = 1.5 V, V_O = 1 V to 2 V	R_L = 50 kΩ‡	25°C	60	100		60	100		V/mV
				Full range	25			25			
			R_L = 1 MΩ‡	25°C		100			100		
$r_{i(d)}$	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		270			270		Ω
CMRR	Common-mode rejection ratio	V_{IC} = 0 to 1.7 V, V_O = 1.5 V,	R_S = 50 Ω	25°C	65	75		65	77		dB
				Full range	60			60			
k_{SVR}	Supply voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$)	V_{DD} = 2.7 V to 8 V, V_{IC} = V_{DD}/2,	No load	25°C	80	95		80	100		dB
				Full range	80			80			

† Full range is −40°C to 125°C for Q level part, −55°C to 125°C for M level part.
‡ Referenced to 1.5 V

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

TLV2262Q and TLV2262M electrical characteristics at specified free-air temperature, V_{DD} = 3 V (unless otherwise noted) (continued)

PARAMETER		TEST CONDITIONS	T_A†	TLV2262Q, TLV2262M			TLV2262AQ, TLV2262AM			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
I_{DD}	Supply current	V_O = 1.5 V, No load	25°C		400	500		400	500	µA
			Full range			500			500	

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

TLV2262Q and TLV2262M operating characteristics at specified free-air temperature, V_{DD} = 3 V

PARAMETER		TEST CONDITIONS		T_A†	TLV2262Q, TLV2262M			TLV2262AQ, TLV2262AM			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	V_O = 0.5 V to 1.7 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		0.6			0.6		µV
		f = 0.1 Hz to 10 Hz		25°C		1			1		
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		0.03%			0.03%		
			A_V = 10			0.05%			0.05%		
	Gain-bandwidth product	f = 1 kHz, C_L = 100 pF‡	R_L = 50 kΩ‡,	25°C		0.67			0.67		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 1 V, R_L = 50 kΩ‡,	A_V = 1, C_L = 100 pF‡	25°C		395			395		kHz
t_s	Settling time	A_V = −1, Step = 1 V to 2 V, R_L = 50 kΩ‡, C_L = 100 pF‡	To 0.1%	25°C		5.6			5.6		µs
			To 0.01%			12.5			12.5		
ϕ_m	Phase margin at unity gain	R_L = 50 kΩ‡,	C_L = 100 pF‡	25°C		55°			55°		
	Gain margin			25°C		11			11		dB

† Full range is −40°C to 125°C for Q level part, −55°C to 125°C for M level part.
‡ Referenced to 1.5 V

TLV2262Q and TLV2262M electrical characteristics at specified free-air temperature, V_{DD} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLV2262Q, TLV2262M			TLV2262AQ, TLV2262AM			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
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	60		0.5	60	pA
				125°C			800			800	
I_{IB}	Input bias current			25°C		1	60		1	60	pA
				125°C			800			800	
V_{ICR}	Common-mode input voltage range	$|V_{IO}| \le$5 mV, R_S = 50 Ω		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} = 1 mA	25°C		0.2	0.3		0.2	0.3	
				Full range			0.3			0.3	
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		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,	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 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 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 level part, −55°C to 125°C for M level part.
‡ Referenced to 2.5 V
NOTE 4: Typical values are based on the input offset voltage shift observed through 500 hours of operating life test at T_A = 150°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLV2262Q and TLV2262M electrical characteristics at specified free-air temperature, V_{DD} = 5 V (unless otherwise noted) (continued)

PARAMETER		TEST CONDITIONS	T_A†	TLV2262Q, TLV2262M			TLV2262AQ, TLV2262AM			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 level part, −55°C to 125°C for M level part.

TLV2262Q and TLV2262M operating characteristics at specified free-air temperature, V_{DD} = 5 V

PARAMETER		TEST CONDITIONS		T_A†	TLV2262Q, TLV2262M			TLV2262AQ, TLV2262AM			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 level part, −55°C to 125°C for M level part.
‡ Referenced to 2.5 V

TLV2264Q and TLV2264M electrical characteristics at specified free-air temperature, V_{DD} = 3 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLV2264Q, TLV2264M			TLV2264AQ, TLV2264AM			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	$V_{DD\pm}$ = ±1.5 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	60		0.5	60	pA
				125°C			800			800	
I_{IB}	Input bias current			25°C		1	60		1	60	pA
				125°C			800			800	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω,	$\lvert V_{IO}\rvert \le$ 5 mV	25°C	0 to 2	−0.3 to 2.2		0 to 2	−0.3 to 2.2		V
				Full range	0 to 1.7			0 to 1.7			
V_{OH}	High-level output voltage	I_{OH} = −20 µA		25°C		2.99			2.99		V
		I_{OH} = −100 µA		25°C	2.85			2.85			
				Full range	2.82			2.82			
		I_{OH} = −400 µA		25°C	2.7			2.7			
				Full range	2.6			2.6			
V_{OL}	Low-level output voltage	V_{IC} = 1.5 V,	I_{OL} = 50 µA	25°C		10			10		mV
		V_{IC} = 1.5 V,	I_{OL} = 500 µA	25°C		100	150		100	150	
				Full range			150			150	
		V_{IC} = 1.5 V,	I_{OL} = 1 mA	25°C		200	300		200	300	
				Full range			300			300	
A_{VD}	Large-signal differential voltage amplification	V_{IC} = 1.5 V, V_O = 1 V to 2 V	R_L = 50 kΩ‡	25°C	60	100		60	100		V/mV
				Full range	25			25			
			R_L = 1 MΩ‡	25°C		100			100		
$r_{i(d)}$	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		270			270		Ω
CMRR	Common-mode rejection ratio	V_{IC} = 0 to 1.7 V, V_O = 1.5 V, R_S = 50 Ω		25°C	65	75		65	77		dB
				Full range	60			60			
k_{SVR}	Supply voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$)	V_{DD} = 2.7 V to 8 V, V_{IC} = V_{DD}/2,	No load	25°C	80	95		80	100		dB
				Full range	80			80			

† Full range is −40°C to 125°C for Q level part, −55°C to 125°C for M level part.
‡ Referenced to 1.5 V
NOTE 4: Typical values are based on the input offset voltage shift observed through 500 hours of operating life test at T_A = 150°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLV2264Q and TLV2264M electrical characteristics at specified free-air temperature, V_{DD} = 3 V (unless otherwise noted) (continued)

PARAMETER		TEST CONDITIONS	T_A†	TLV2264Q, TLV2264M			TLV2264AQ, TLV2264AM			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
I_{DD}	Supply current (four amplifiers)	V_O = 1.5 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 level part, −55°C to 125°C for M level part.

TLV2264Q and TLV2264M operating characteristics at specified free-air temperature, V_{DD} = 3 V

PARAMETER		TEST CONDITIONS		T_A†	TLV2264Q, TLV2264M			TLV2264AQ, TLV2264AM			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	V_O = 0.5 V to 1.7 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		0.6			0.6		μV
		f = 0.1 Hz to 10 Hz		25°C		1			1		
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		0.03%			0.03%		
			A_V = 10			0.05%			0.05%		
	Gain-bandwidth product	f = 1 kHz, C_L = 100 pF‡	R_L = 50 kΩ‡,	25°C		0.67			0.67		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 1 V, R_L = 50 kΩ‡,	A_V = 1, C_L = 100 pF‡	25°C		395			395		kHz
t_s	Settling time	A_V = −1, Step = 1 V to 2 V, R_L = 50 kΩ‡, C_L = 100 pF‡	To 0.1%	25°C		5.6			5.6		μs
			To 0.01%			12.5			12.5		
ϕ_m	Phase margin at unity gain	R_L = 50 kΩ‡,	C_L = 100 pF‡	25°C		55°			55°		
	Gain margin			25°C		11			11		dB

† Full range is −40°C to 125°C for Q level part, −55°C to 125°C for M level part.
‡ Referenced to 1.5 V

TLV2264Q and TLV2264M electrical characteristics at specified free-air temperature, V_{DD} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLV2264Q, TLV2264M			TLV2264AQ, TLV2264AM			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
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	60		0.5	60	pA
				125°C			800			800	
I_{IB}	Input bias current			25°C		1	60		1	60	pA
				125°C			800			800	
V_{ICR}	Common-mode input voltage range	$|V_{IO}| \le$5 mV,	R_S = 50 Ω	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} = 1 mA	25°C		0.2	0.3		0.2	0.3	
				Full range			0.3			0.3	
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		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, 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 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 level part, −55°C to 125°C for M level part.
‡ Referenced to 2.5 V
NOTE 4: Typical values are based on the input offset voltage shift observed through 500 hours of operating life test at T_A = 150°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLV2264Q and TLV2264M electrical characteristics at specified free-air temperature, V_{DD} = 5 V (unless otherwise noted) (continued)

PARAMETER		TEST CONDITIONS		T_A†	TLV2264Q, TLV2264M			TLV2264AQ, TLV2264AM			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 level part, −55°C to 125°C for M level part.

TLV2264Q and TLV2264M operating characteristics at specified free-air temperature, V_{DD} = 5 V

PARAMETER		TEST CONDITIONS		T_A†	TLV2264Q, TLV2264M			TLV2264AQ, TLV2264AM			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 level part, −55°C to 125°C for M level part.
‡ Referenced to 2.5 V

TYPICAL CHARACTERISTICS

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THD + N	Total harmonic distortion plus noise	vs Frequency	54
	Gain-bandwidth product	vs Supply voltage vs Free-air temperature	55 56
ϕ_m	Phase margin	vs Frequency vs Load capacitance	26, 27 57
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TYPICAL CHARACTERISTICS

DISTRIBUTION OF TLV2262
INPUT OFFSET VOLTAGE

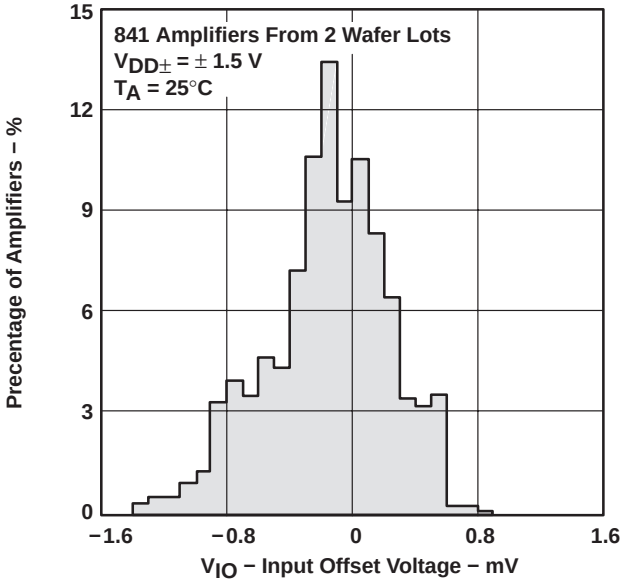


Figure 2

DISTRIBUTION OF TLV2262
INPUT OFFSET VOLTAGE

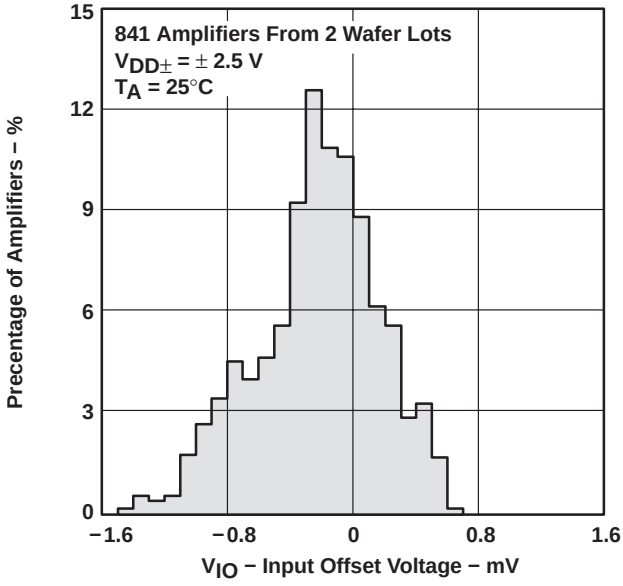


Figure 3

DISTRIBUTION OF TLV2264
INPUT OFFSET VOLTAGE

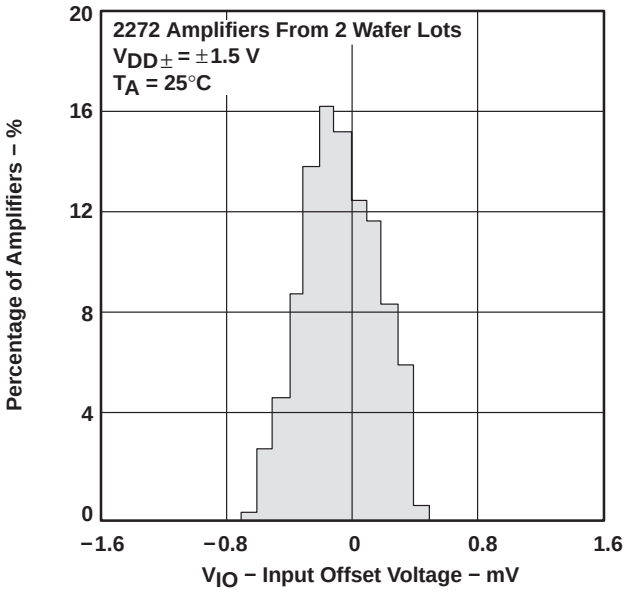


Figure 4

DISTRIBUTION OF TLV2264
INPUT OFFSET VOLTAGE

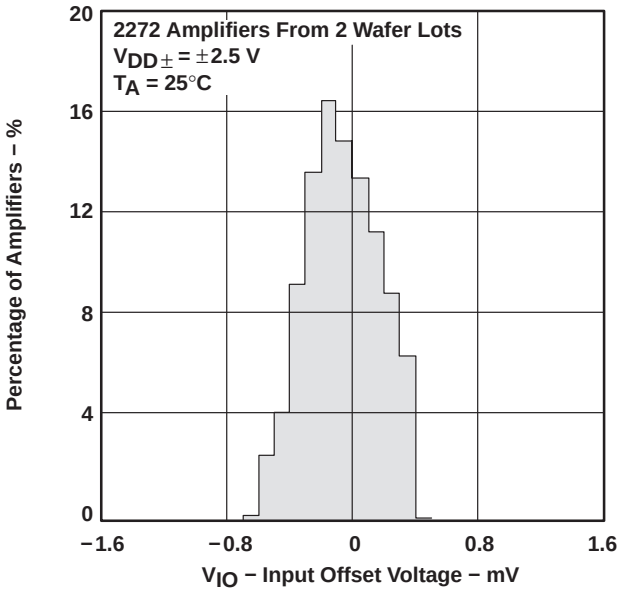


Figure 5

TYPICAL CHARACTERISTICS

INPUT OFFSET VOLTAGE† vs COMMON-MODE INPUT VOLTAGE

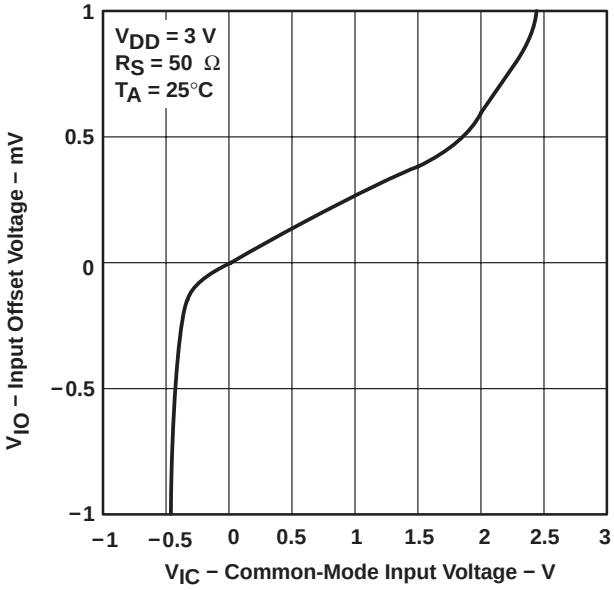


Figure 6

INPUT OFFSET VOLTAGE† vs COMMON-MODE INPUT VOLTAGE

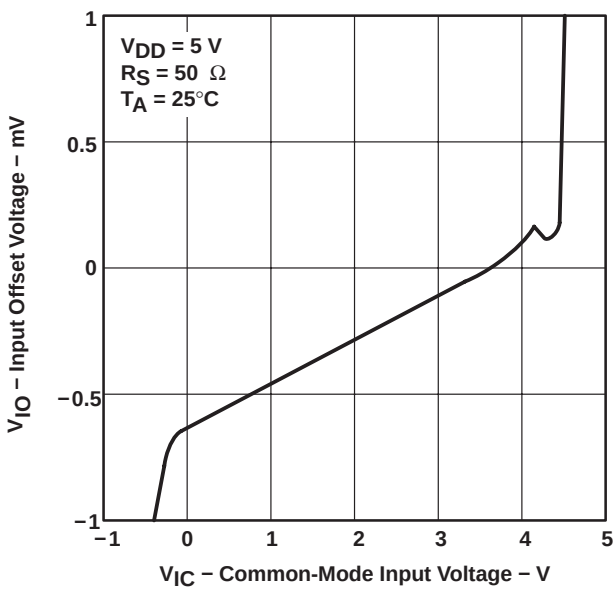


Figure 7

DISTRIBUTION OF TLV2262 INPUT OFFSET VOLTAGE TEMPERATURE COEFFICIENT

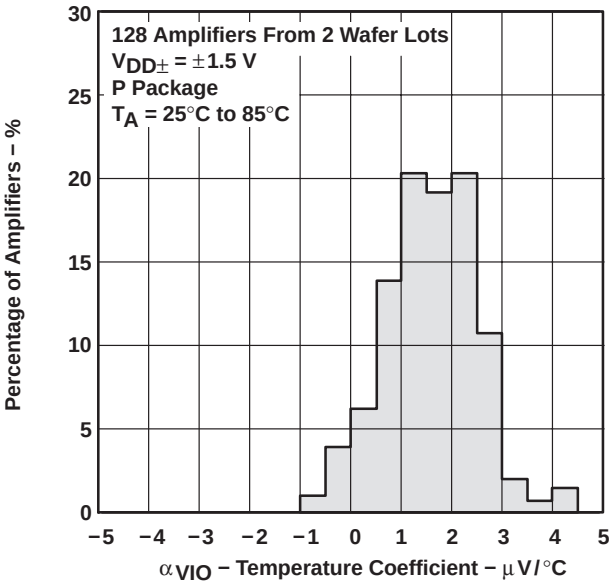


Figure 8

DISTRIBUTION OF TLV2262 INPUT OFFSET VOLTAGE TEMPERATURE COEFFICIENT

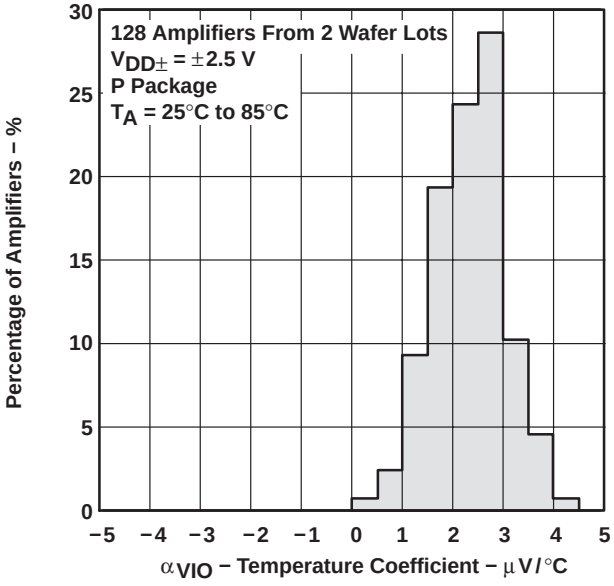


Figure 9

† For all curves where V_{DD} = 5 V, all loads are referenced to 2.5 V. For all curves where V_{DD} = 3 V, all loads are referenced to 1.5 V.

TYPICAL CHARACTERISTICS

DISTRIBUTION OF TLV2264 INPUT OFFSET VOLTAGE TEMPERATURE COEFFICIENT

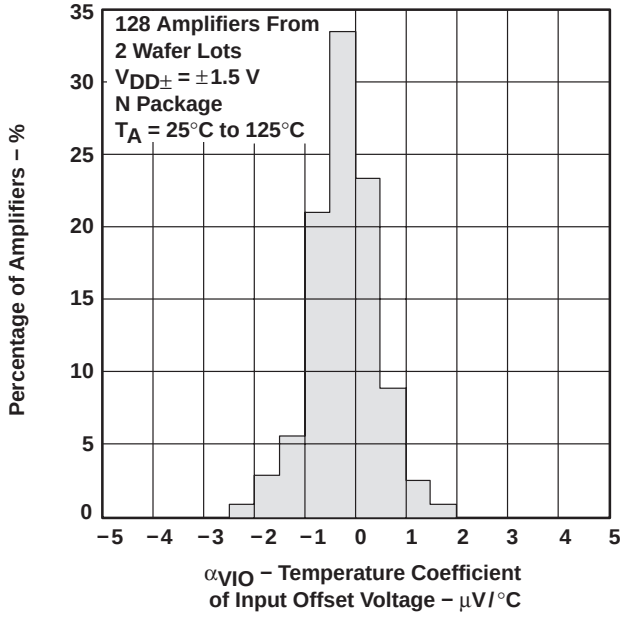


Figure 10

DISTRIBUTION OF TLV2264 INPUT OFFSET VOLTAGE TEMPERATURE COEFFICIENT

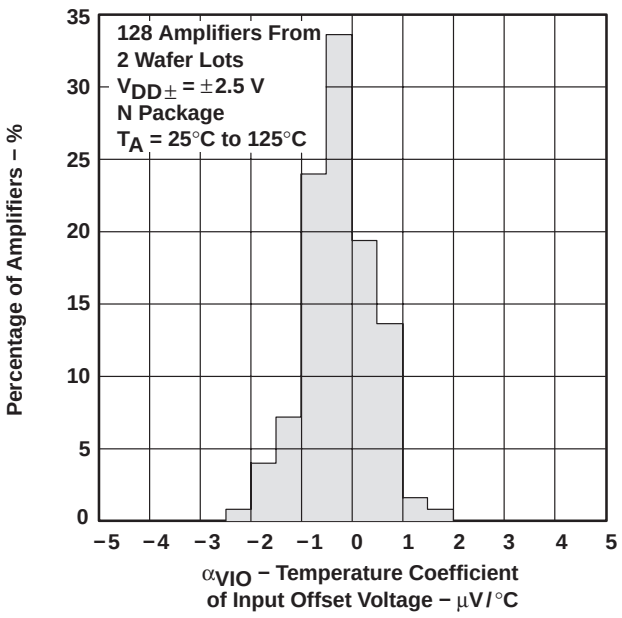


Figure 11

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

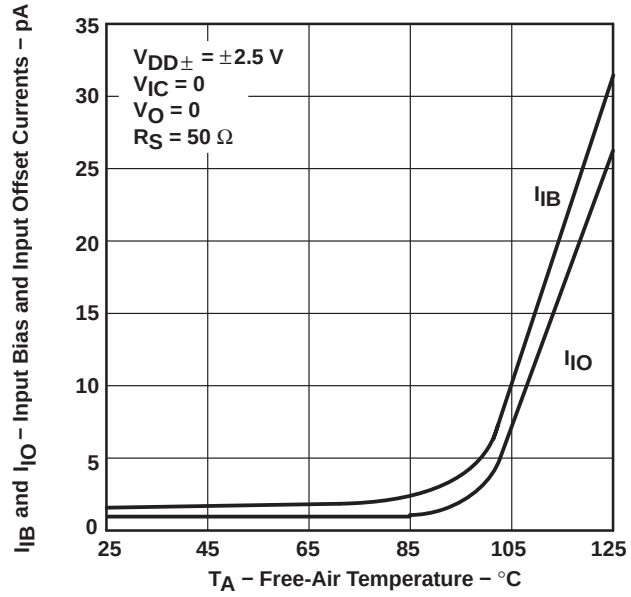


Figure 12

INPUT VOLTAGE vs SUPPLY VOLTAGE

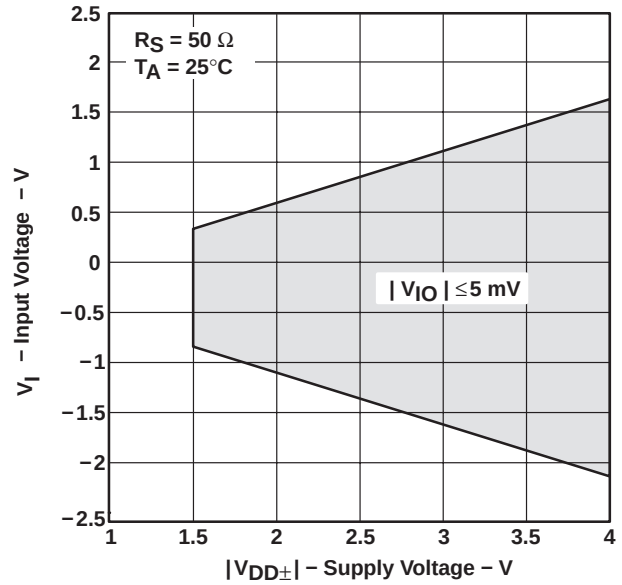


Figure 13

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

TYPICAL CHARACTERISTICS

INPUT VOLTAGE†‡ vs FREE-AIR TEMPERATURE

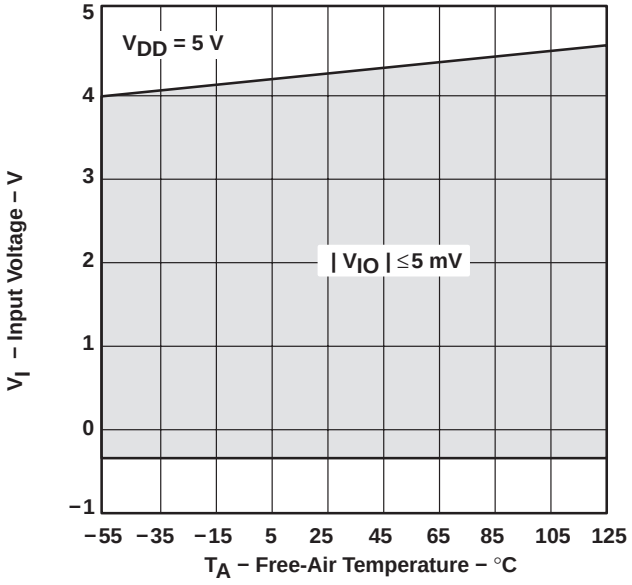


Figure 14

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

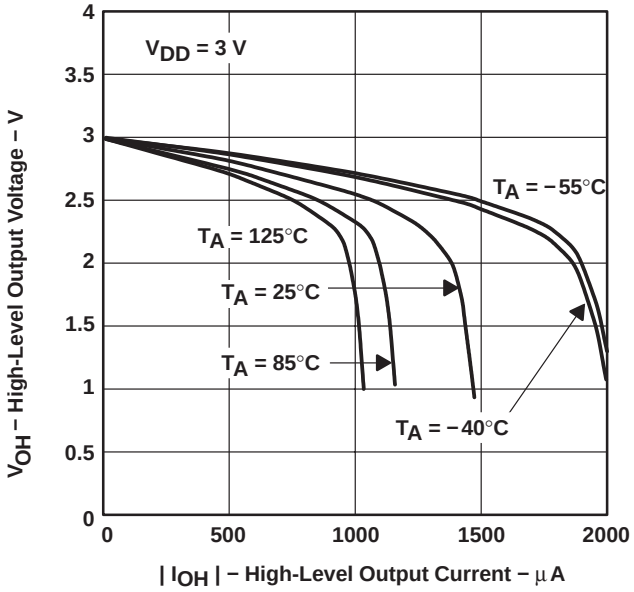


Figure 15

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

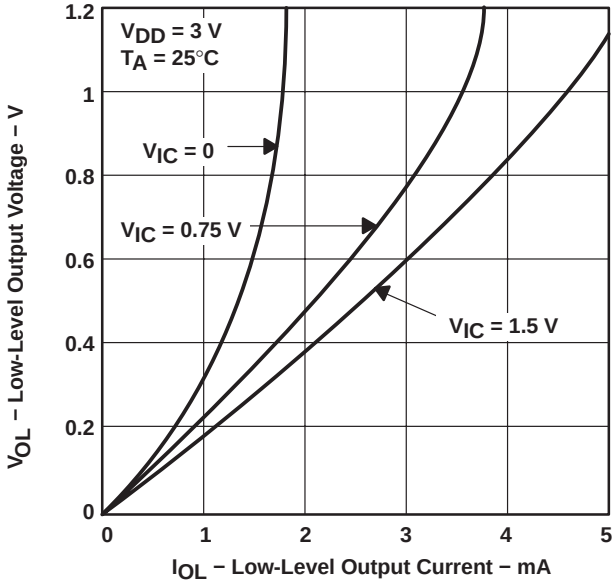


Figure 16

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

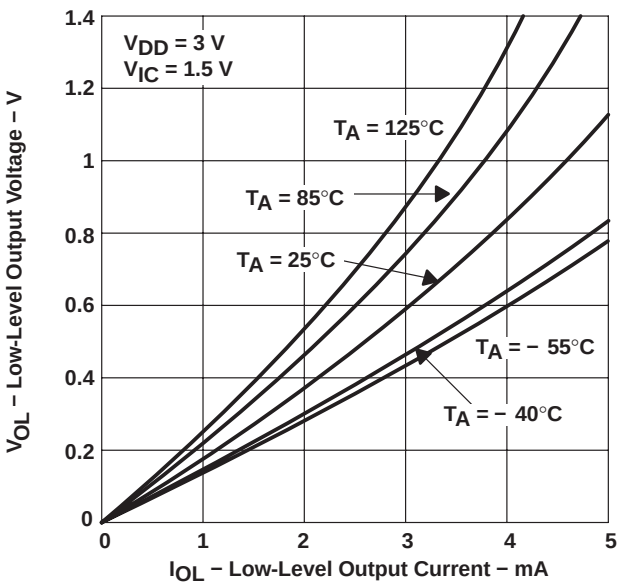


Figure 17

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.
‡ For all curves where V_{DD} = 5 V, all loads are referenced to 2.5 V. For all curves where V_{DD} = 3 V, all loads are referenced to 1.5 V.

TYPICAL CHARACTERISTICS

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

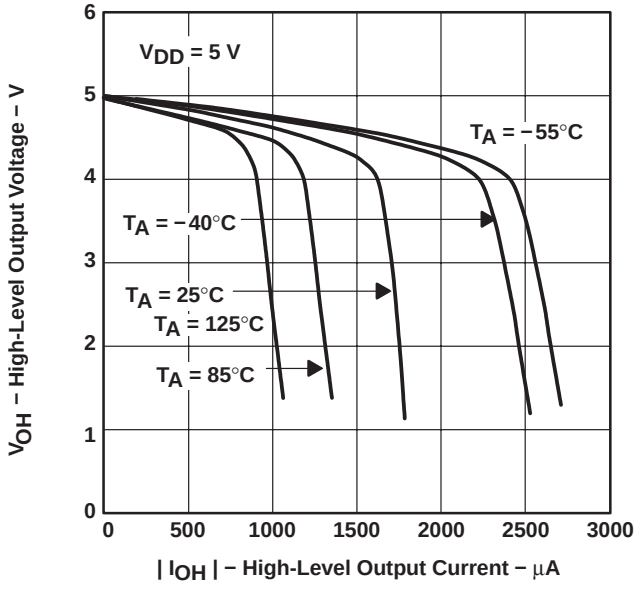


Figure 18

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

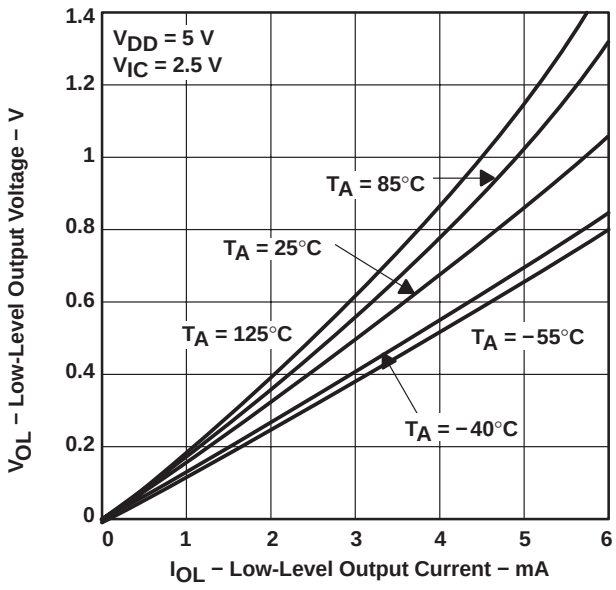


Figure 19

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE‡ vs FREQUENCY

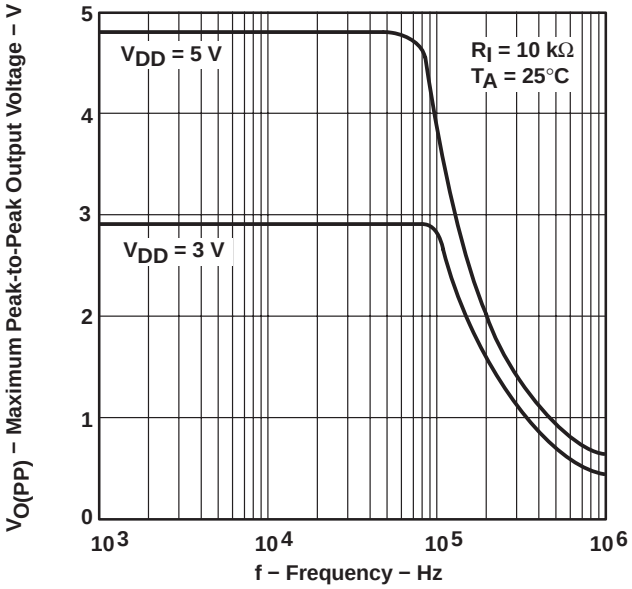


Figure 20

SHORT-CIRCUIT OUTPUT CURRENT vs SUPPLY VOLTAGE

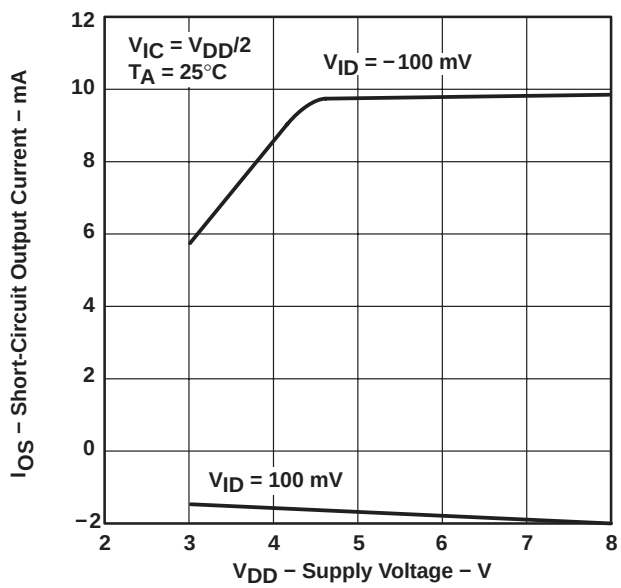


Figure 21

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.
‡ For all curves where V_{DD} = 5 V, all loads are referenced to 2.5 V. For all curves where V_{DD} = 3 V, all loads are referenced to 1.5 V.

TYPICAL CHARACTERISTICS

SHORT-CIRCUIT OUTPUT CURRENT† vs FREE-AIR TEMPERATURE

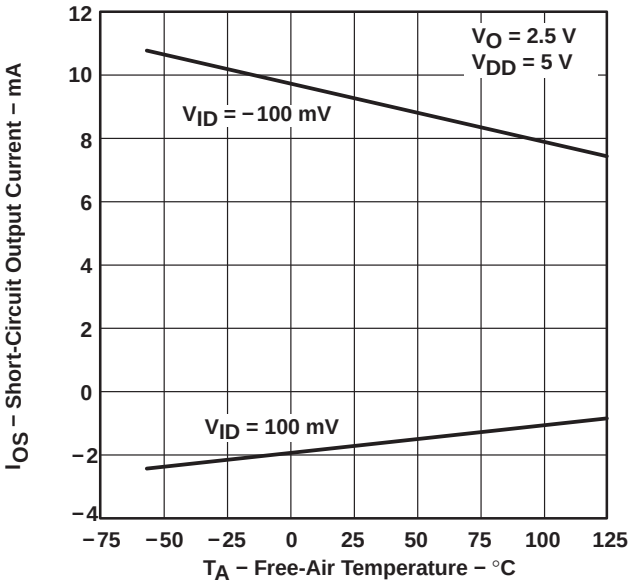


Figure 22

DIFFERENTIAL INPUT VOLTAGE‡ vs OUTPUT VOLTAGE

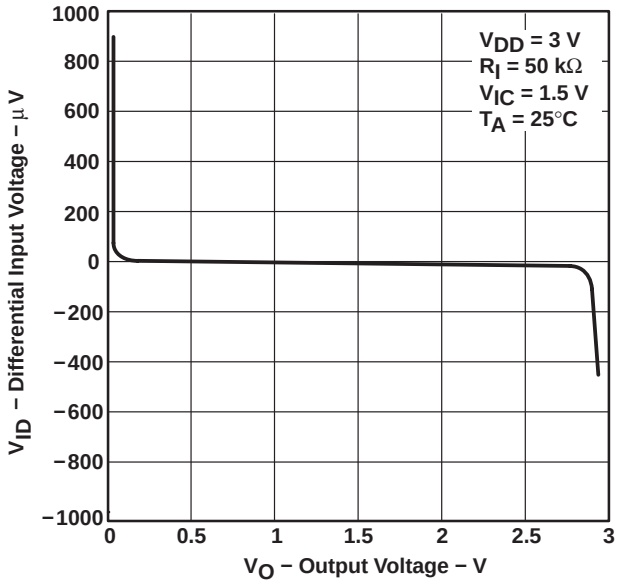


Figure 23

DIFFERENTIAL INPUT VOLTAGE‡ vs OUTPUT VOLTAGE

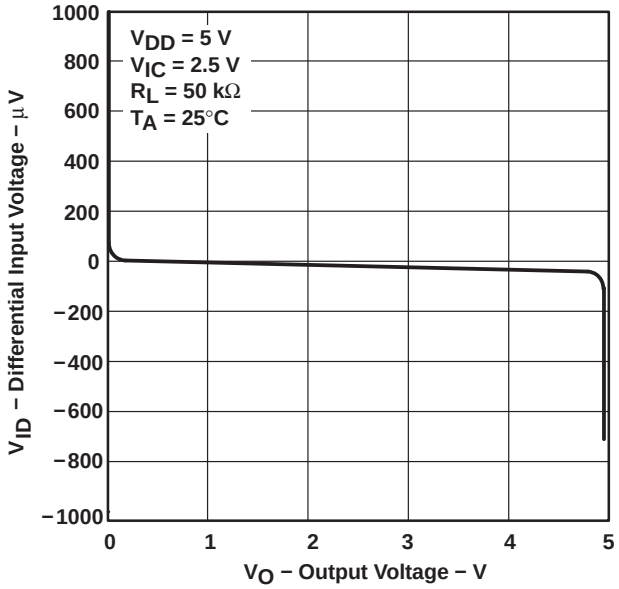


Figure 24

DIFFERENTIAL VOLTAGE AMPLIFICATION‡ vs LOAD RESISTANCE

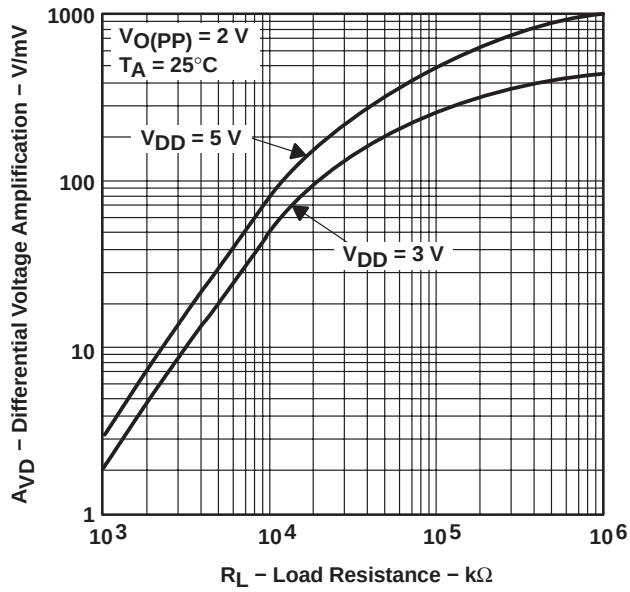


Figure 25

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.
‡ For all curves where V_{DD} = 5 V, all loads are referenced to 2.5 V. For all curves where V_{DD} = 3 V, all loads are referenced to 1.5 V.

TYPICAL CHARACTERISTICS

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

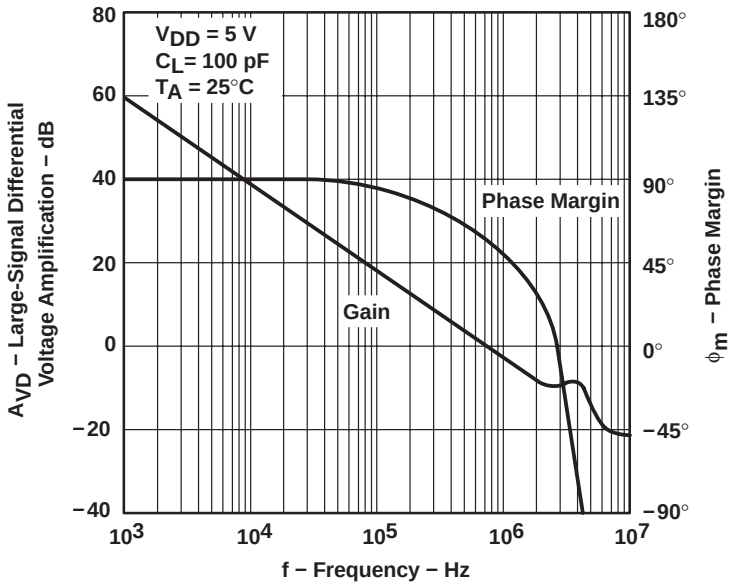


Figure 26

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

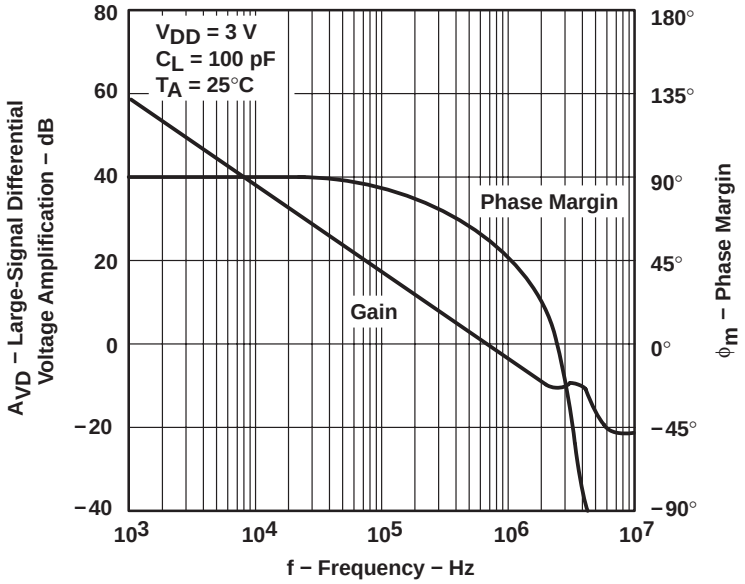


Figure 27

† For all curves where V_{DD} = 5 V, all loads are referenced to 2.5 V. For all curves where V_{DD} = 3 V, all loads are referenced to 1.5 V.

TYPICAL CHARACTERISTICS

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

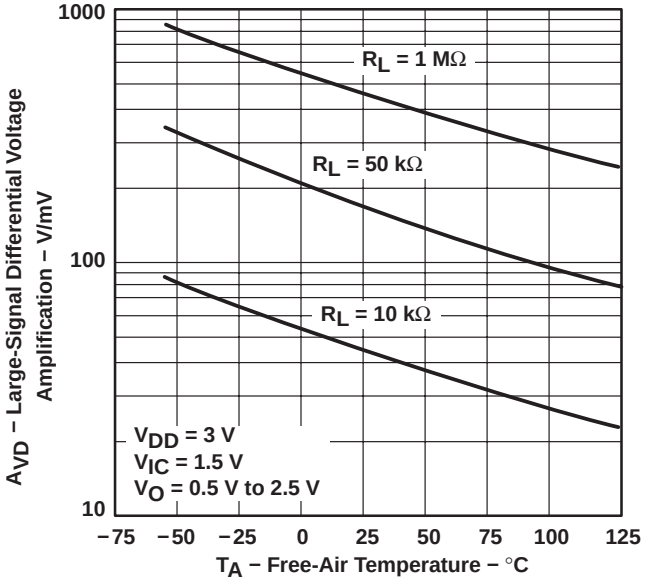


Figure 28

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

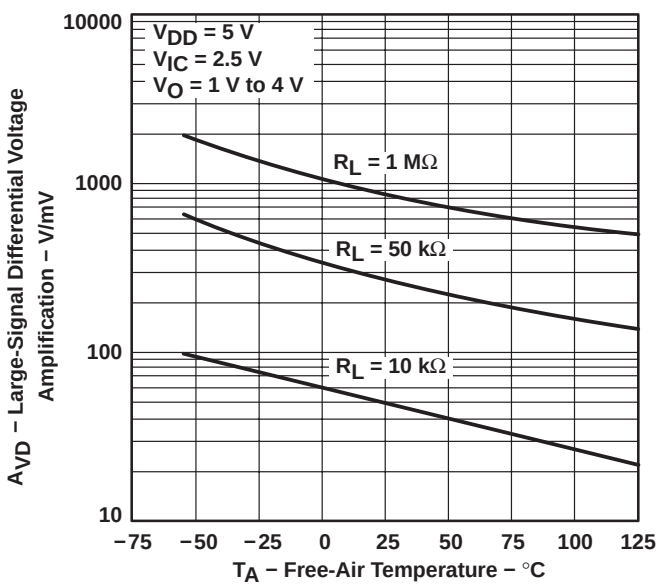


Figure 29

OUTPUT IMPEDANCE‡ vs FREQUENCY

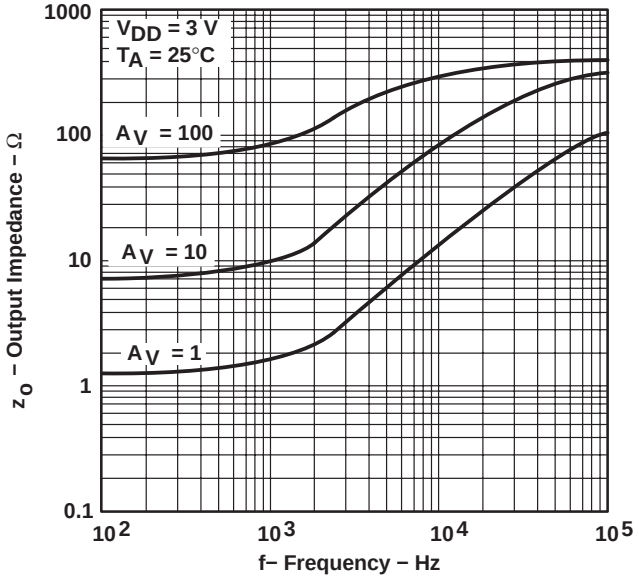


Figure 30

OUTPUT IMPEDANCE‡ vs FREQUENCY

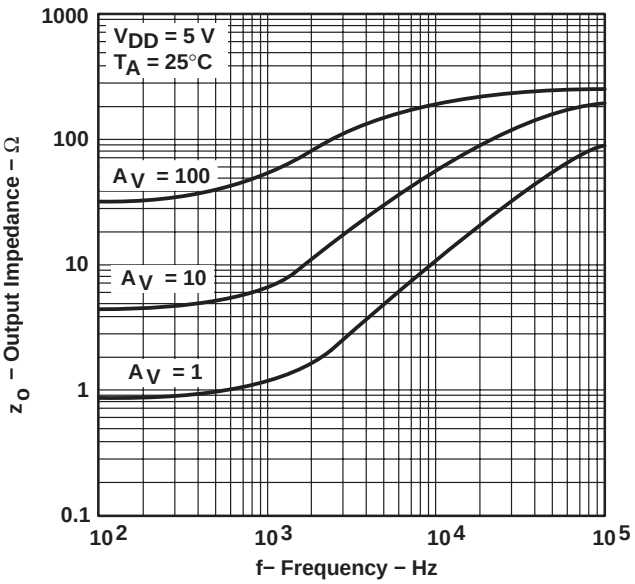


Figure 31

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.
‡ For all curves where V_{DD} = 5 V, all loads are referenced to 2.5 V. For all curves where V_{DD} = 3 V, all loads are referenced to 1.5 V.

TYPICAL CHARACTERISTICS

COMMON-MODE REJECTION RATIO† vs FREQUENCY

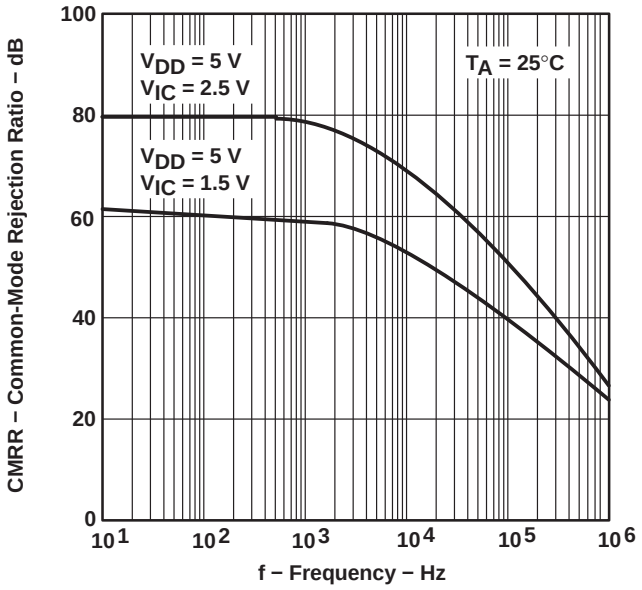


Figure 32

COMMON-MODE REJECTION RATIO†‡ vs FREE-AIR TEMPERATURE

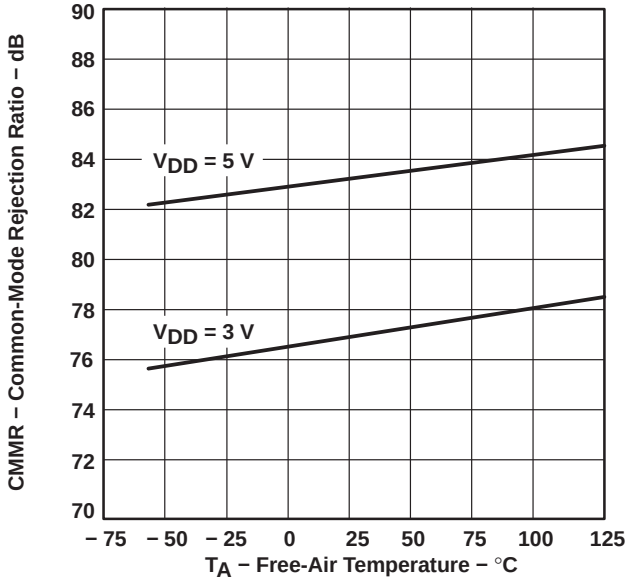


Figure 33

SUPPLY-VOLTAGE REJECTION RATIO† vs FREQUENCY

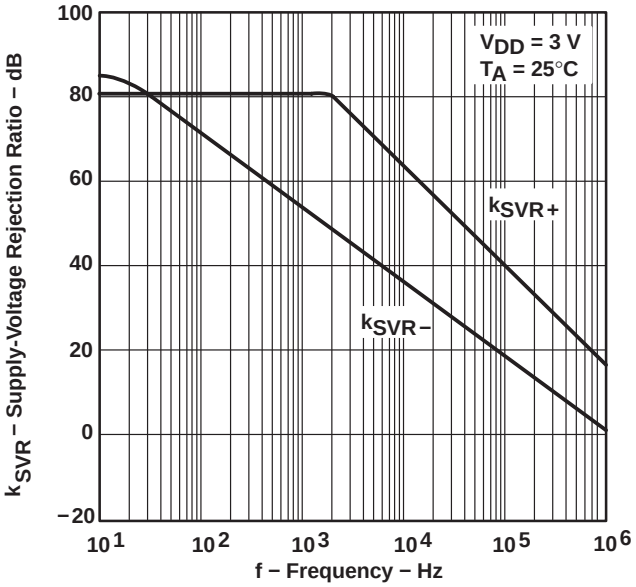


Figure 34

SUPPLY-VOLTAGE REJECTION RATIO† vs FREQUENCY

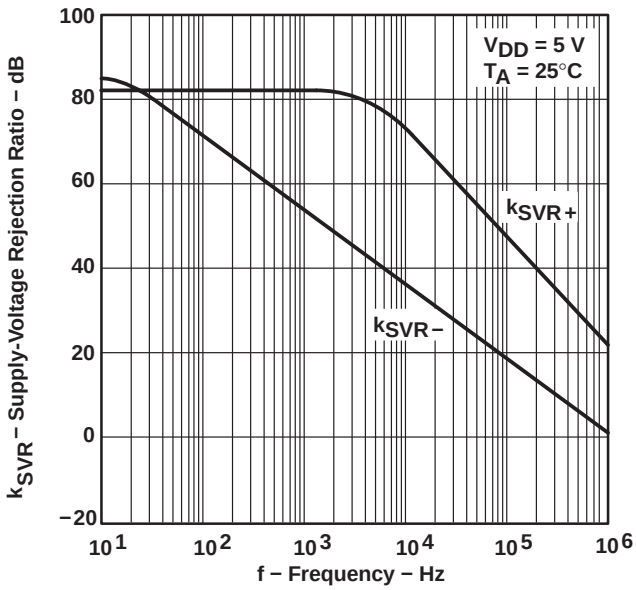


Figure 35

† For all curves where V_{DD} = 5 V, all loads are referenced to 2.5 V. For all curves where V_{DD} = 3 V, all loads are referenced to 1.5 V.
‡ Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS

TLV2262
SUPPLY-VOLTAGE REJECTION RATIO† vs FREE-AIR TEMPERATURE

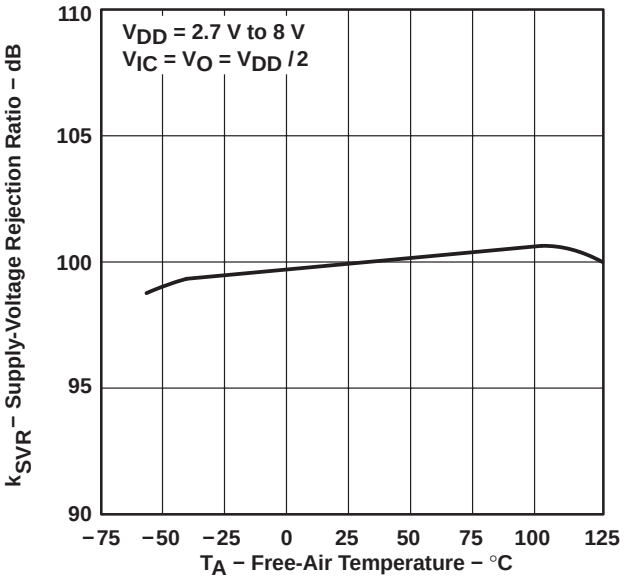


Figure 36

TLV2264
SUPPLY-VOLTAGE REJECTION RATIO† vs FREE-AIR TEMPERATURE

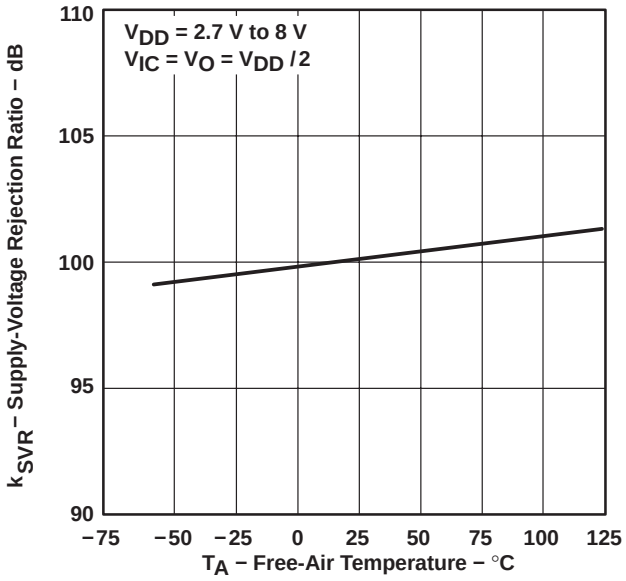


Figure 37

TLV2262
SUPPLY CURRENT†‡ vs FREE-AIR TEMPERATURE

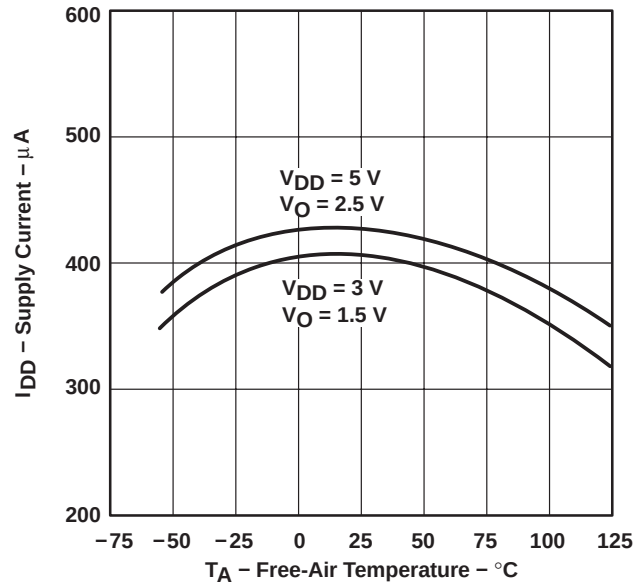


Figure 38

TLV2264
SUPPLY CURRENT†‡ vs FREE-AIR TEMPERATURE

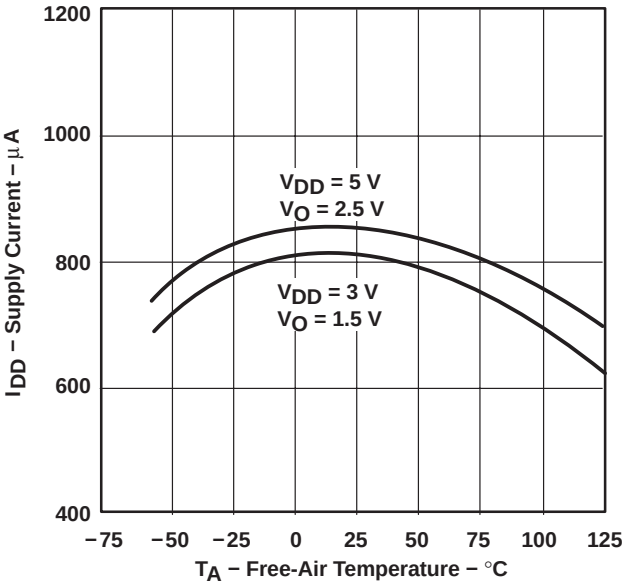


Figure 39

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.
‡ For all curves where V_{DD} = 5 V, all loads are referenced to 2.5 V. For all curves where V_{DD} = 3 V, all loads are referenced to 1.5 V.

TYPICAL CHARACTERISTICS

SLEW RATE† vs LOAD CAPACITANCE

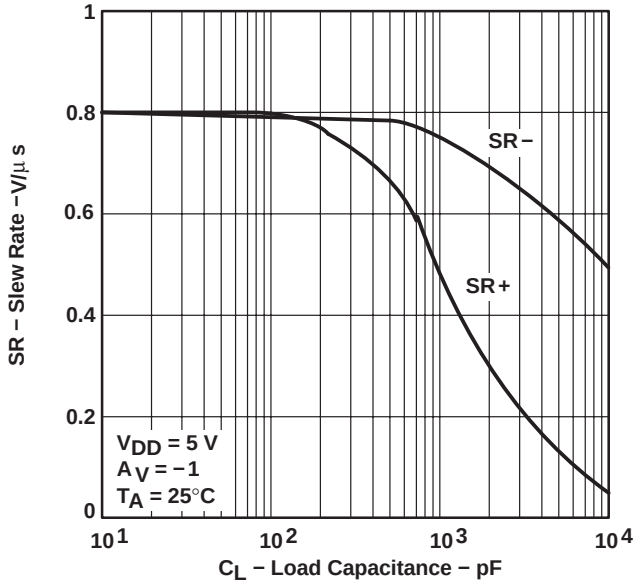


Figure 40

SLEW RATE†‡ vs FREE-AIR TEMPERATURE

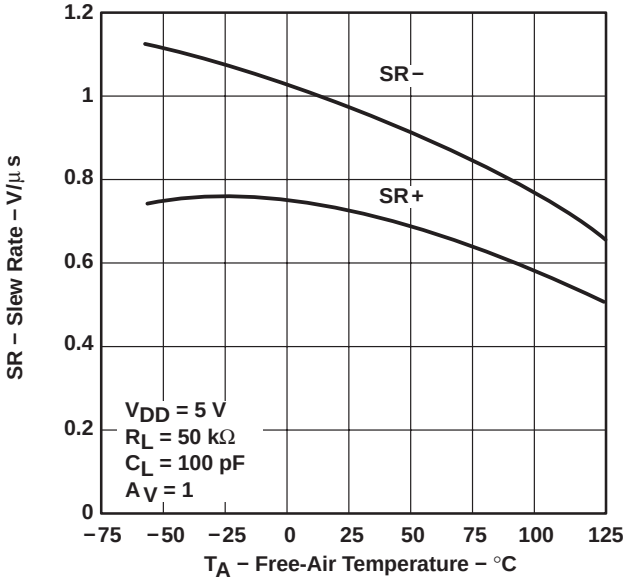


Figure 41

INVERTING LARGE-SIGNAL PULSE RESPONSE†

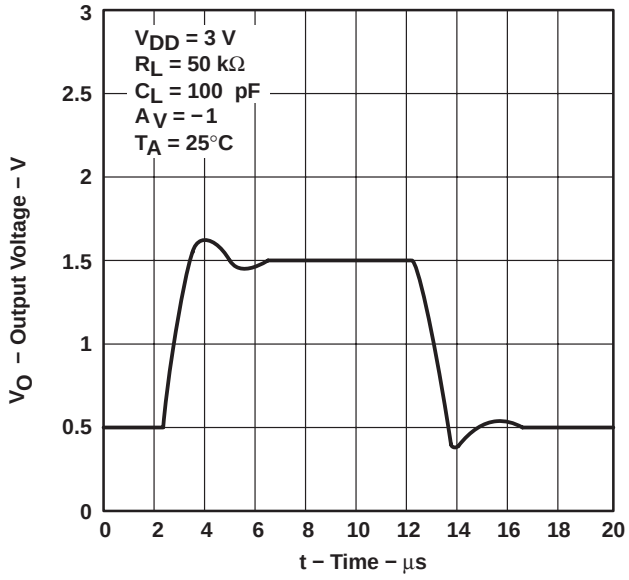


Figure 42

INVERTING LARGE-SIGNAL PULSE RESPONSE†

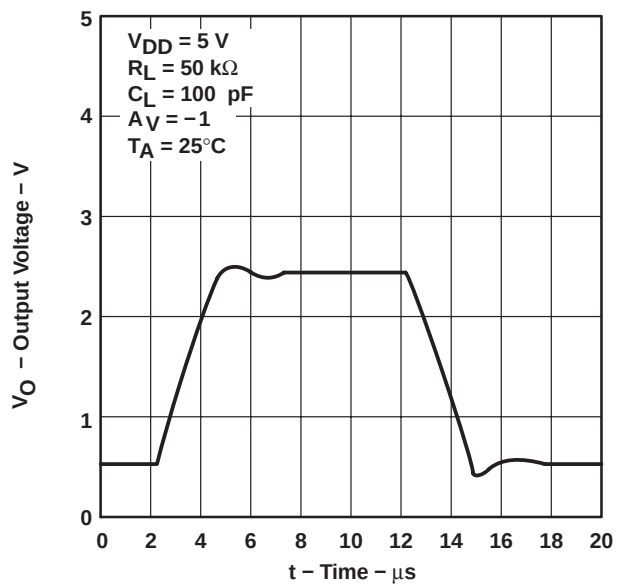


Figure 43

† For all curves where V_{DD} = 5 V, all loads are referenced to 2.5 V. For all curves where V_{DD} = 3 V, all loads are referenced to 1.5 V.
‡ Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS

VOLTAGE-FOLLOWER LARGE-SIGNAL
PULSE RESPONSE†

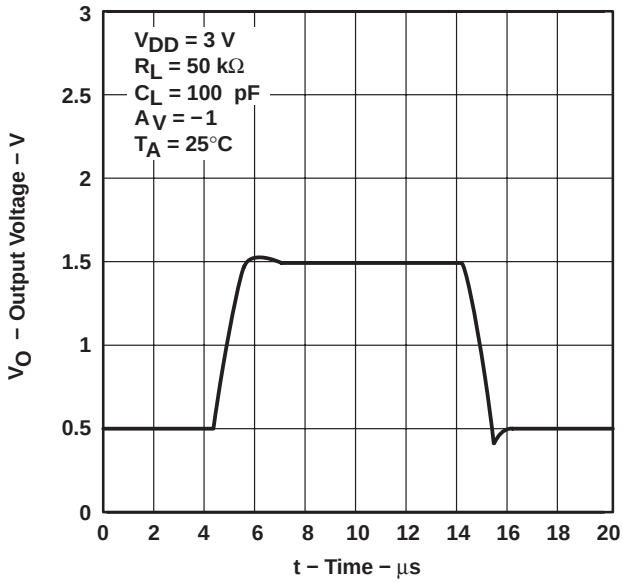


Figure 44

VOLTAGE-FOLLOWER LARGE-SIGNAL
PULSE RESPONSE†

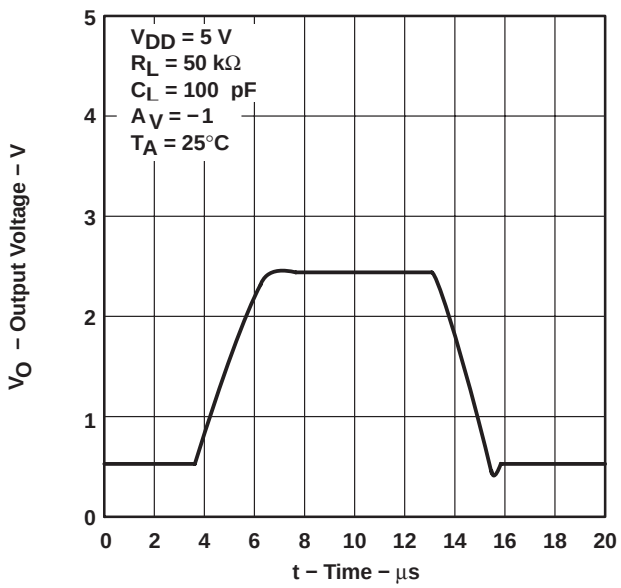


Figure 45

INVERTING SMALL-SIGNAL
PULSE RESPONSE†

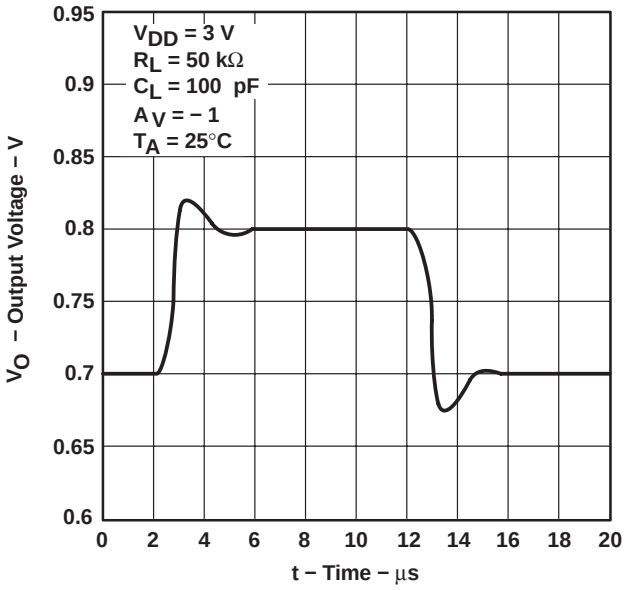


Figure 46

INVERTING SMALL-SIGNAL
PULSE RESPONSE†

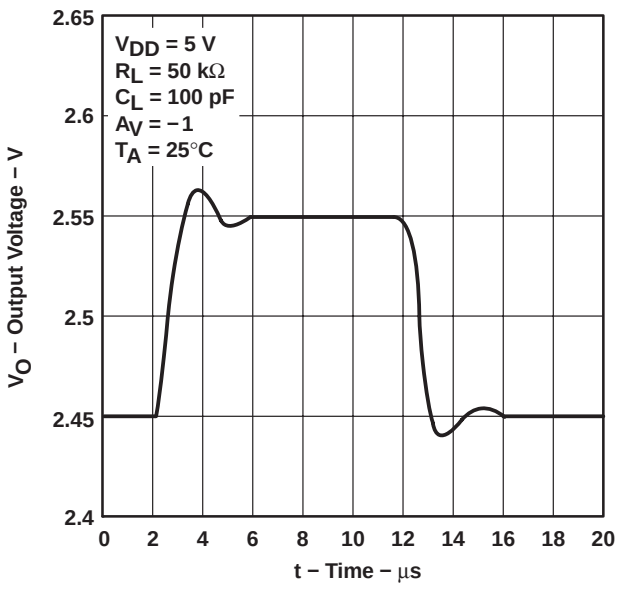


Figure 47

† For all curves where V_{DD} = 5 V, all loads are referenced to 2.5 V. For all curves where V_{DD} = 3 V, all loads are referenced to 1.5 V.

TYPICAL CHARACTERISTICS

VOLTAGE-FOLLOWER SMALL-SIGNAL
PULSE RESPONSE†

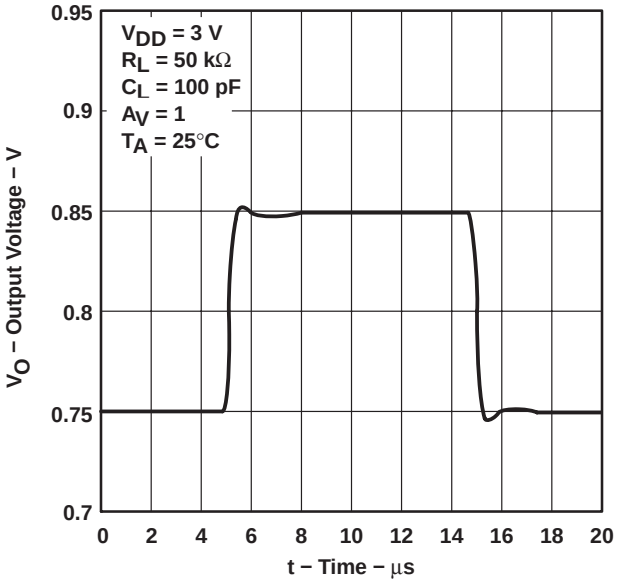


Figure 48

VOLTAGE-FOLLOWER SMALL-SIGNAL
PULSE RESPONSE†

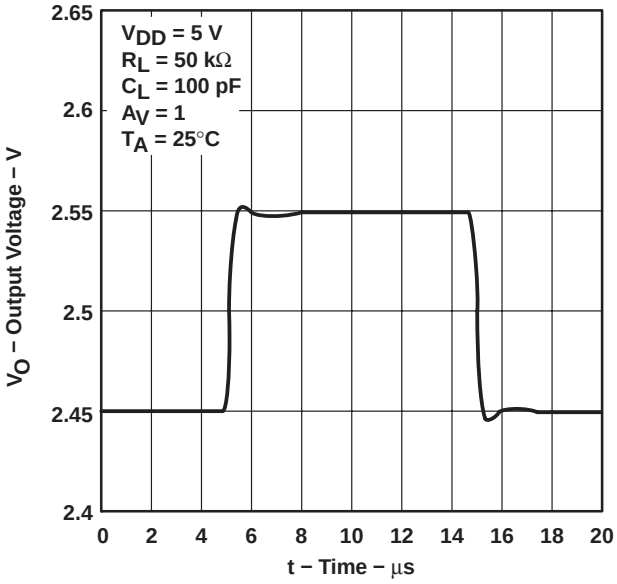


Figure 49

EQUIVALENT INPUT NOISE VOLTAGE†
vs
FREQUENCY

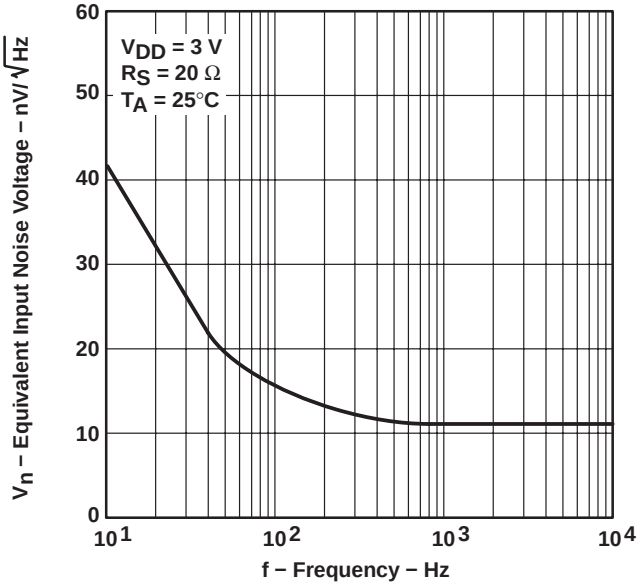


Figure 50

EQUIVALENT INPUT NOISE VOLTAGE†
vs
FREQUENCY

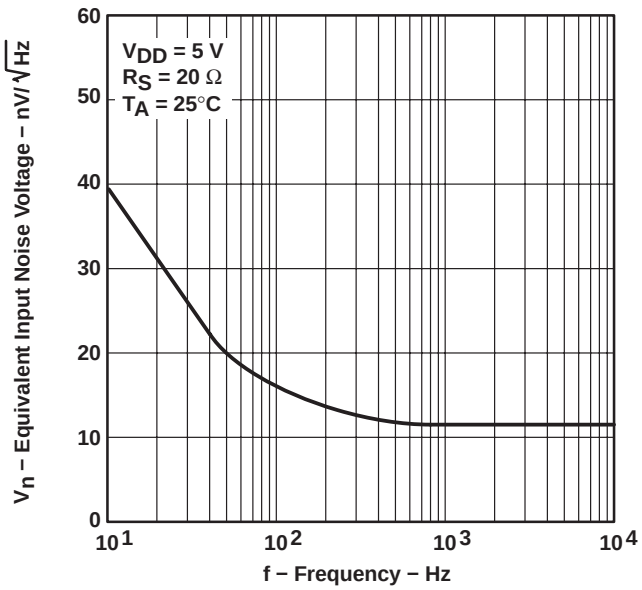


Figure 51

† For all curves where V_{DD} = 5 V, all loads are referenced to 2.5 V. For all curves where V_{DD} = 3 V, all loads are referenced to 1.5 V.

TYPICAL CHARACTERISTICS

INPUT NOISE VOLTAGE OVER A 10-SECOND PERIOD†

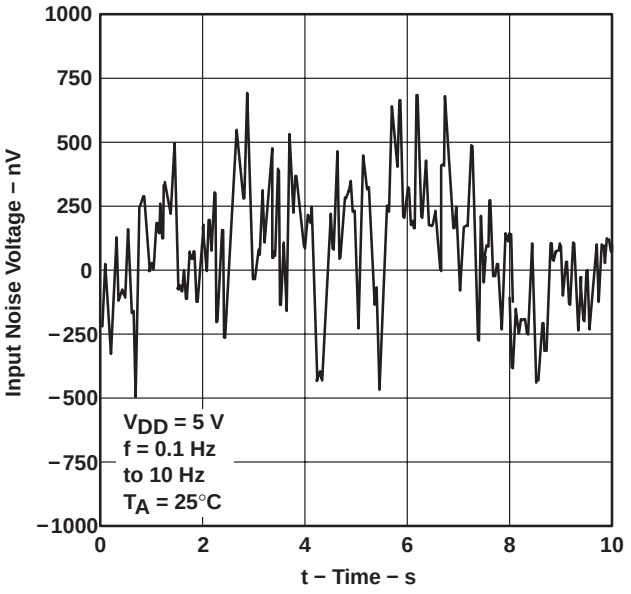


Figure 52

INTEGRATED NOISE VOLTAGE vs FREQUENCY

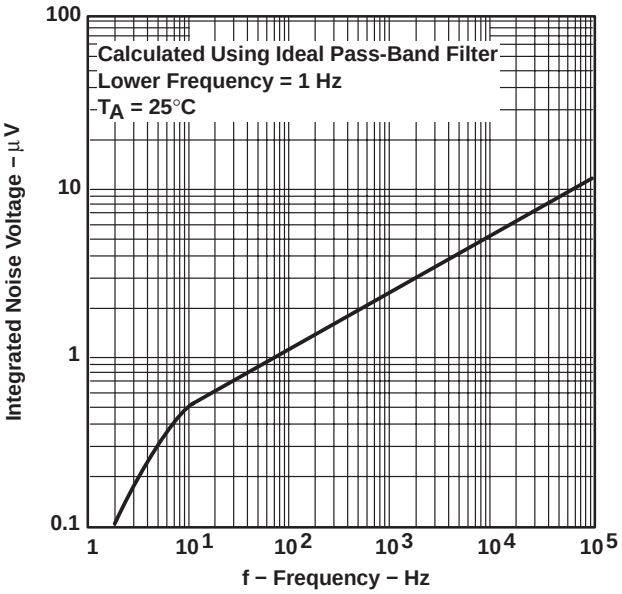


Figure 53

TOTAL HARMONIC DISTORTION PLUS NOISE† vs FREQUENCY

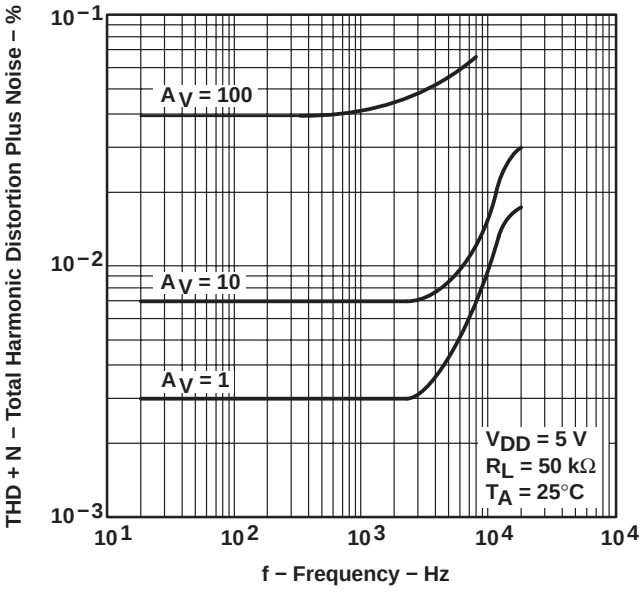


Figure 54

GAIN-BANDWIDTH PRODUCT vs SUPPLY VOLTAGE

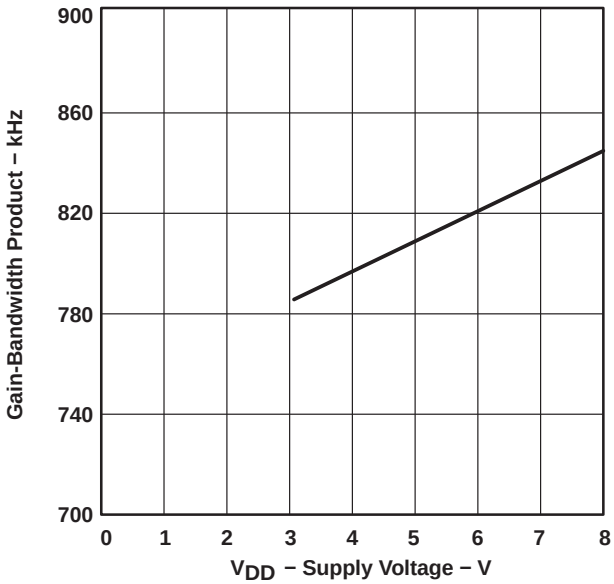


Figure 55

† For all curves where V_{DD} = 5 V, all loads are referenced to 2.5 V. For all curves where V_{DD} = 3 V, all loads are referenced to 1.5 V.

TYPICAL CHARACTERISTICS

GAIN-BANDWIDTH PRODUCT† ‡ vs FREE-AIR TEMPERATURE

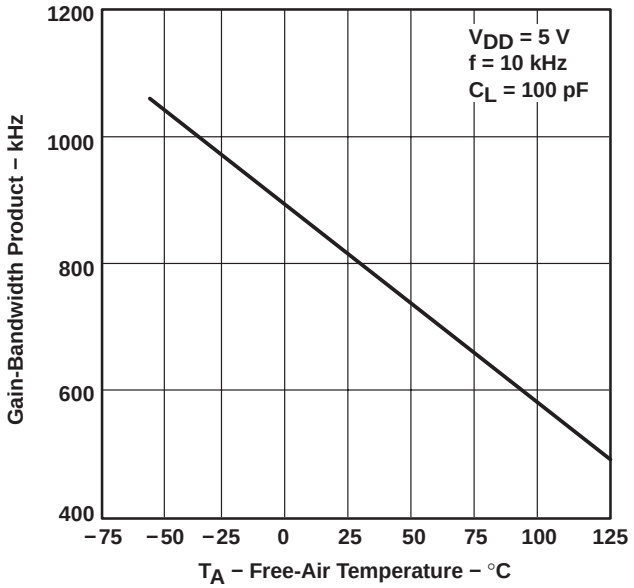


Figure 56

PHASE MARGIN vs LOAD CAPACITANCE

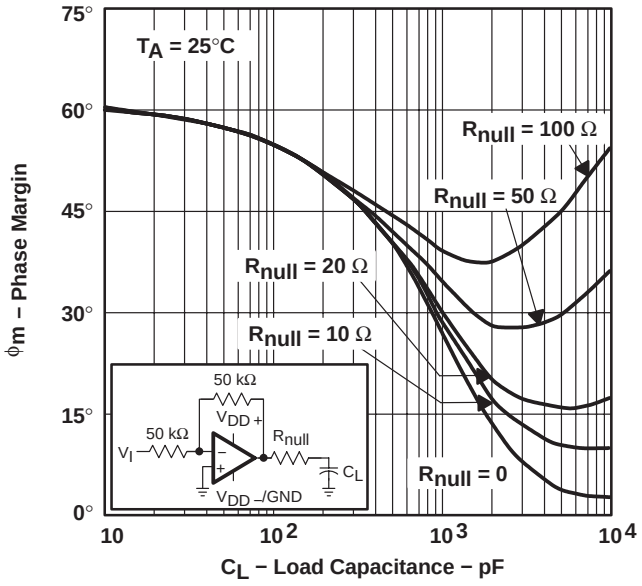


Figure 57

GAIN MARGIN vs LOAD CAPACITANCE

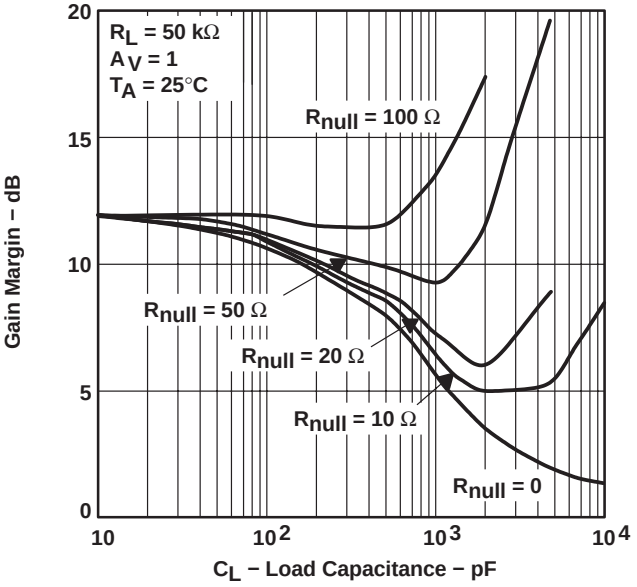


Figure 58

UNITY-GAIN BANDWIDTH vs LOAD CAPACITANCE

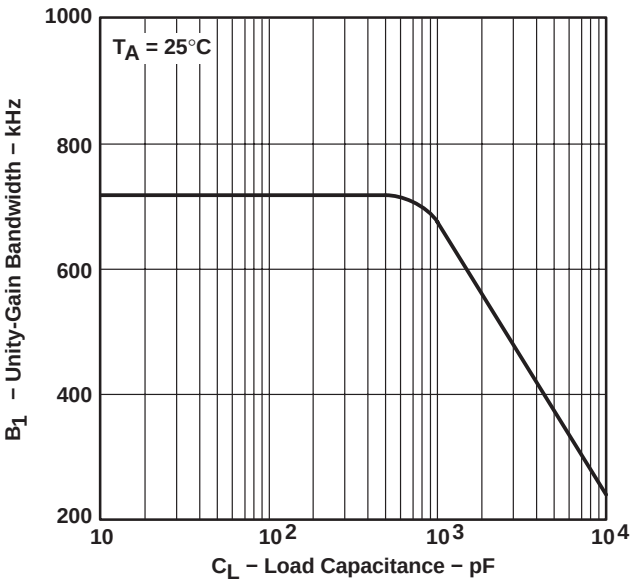
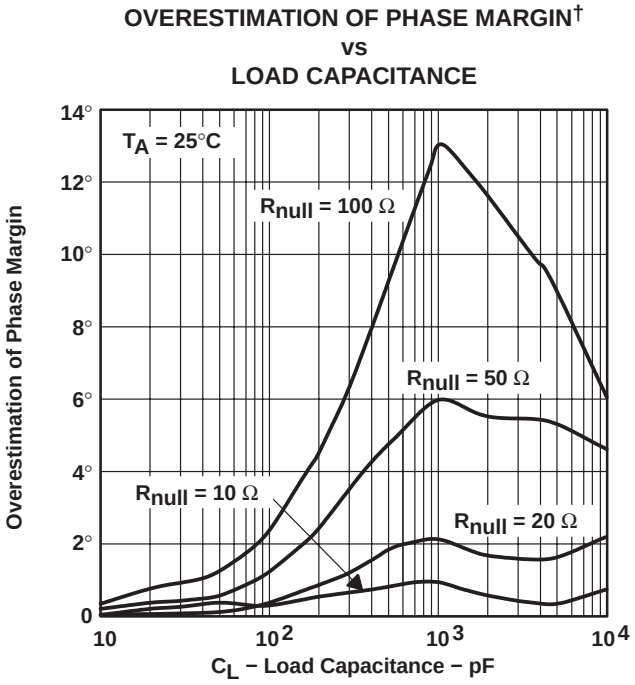


Figure 59

† For all curves where V_{DD} = 5 V, all loads are referenced to 2.5 V. For all curves where V_{DD} = 3 V, all loads are referenced to 1.5 V.
‡ Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS



† See application information

Figure 60

APPLICATION INFORMATION

driving large capacitive loads

The TLV226x is designed to drive larger capacitive loads than most CMOS operational amplifiers. Figure 51 and Figure 52 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 61) improves the gain and phase margins when driving large capacitive loads. Figure 51 and Figure 52 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.

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

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 53). To use equation 1, UGBW must be approximated from Figure 53.

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

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

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 TLV226x, 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 1 to better approximate the improvement in phase margin.

APPLICATION INFORMATION

driving large capacitive loads (continued)

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

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.

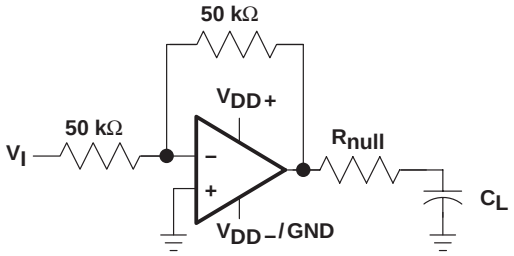


Figure 61. Series-Resistance Circuit

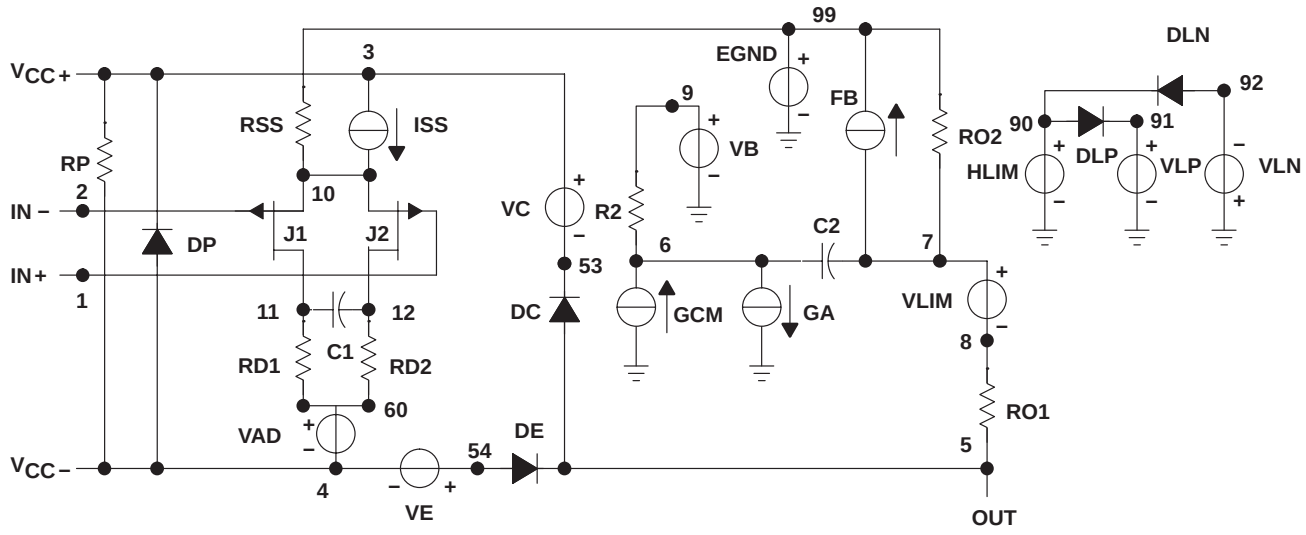
APPLICATION INFORMATION

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 62 are generated using the TLV226x 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 TLV226x 1 2 3 4 5
C1      11      12      5.5E−12
C2      6       7       20.00E−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 8.84E6 −10E6 10E6 10E6 −10E6
GA      6       0       11      12 62.83E−6
GCM     0       6       10      99 12.34E−9
ISS     3       10      DC 11.05E−6
HLIM    90      0       VLIM 1K
J1      11      2       10 JX
J2      12      1       10 JX
R2      6       9       100.0E3
RD1     60      11      15.92E3
RD2     60      12      15.92E3
R01     8       5       135
R02     7       99      135
RP      3       4       15.87E3
RSS     10      99      18.18E6
VAD     60      4       −.5
VB      9       0       DC 0
VC      3       53      DC .615
VE      54      4       DC .615
VLIM    7       8       DC 0
VLP     91      0       DC 1
VLN     0       92      DC 5.1
.MODEL DX D (IS=800.0E−18)
.MODEL JX PJF (IS=500.0E−15 BETA=325E−6
+ VTO=−.08)
.ENDS
```

Figure 62. Boyle Macromodel and Subcircuit

PSpice and *Parts* are trademarks of MicroSim Corporation.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
5962-9550401Q2A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type
5962-9550401QHA	ACTIVE	CFP	U	10	1	TBD	A42 SNPB	N / A for Pkg Type
5962-9550401QPA	ACTIVE	CDIP	JG	8	1	TBD	A42 SNPB	N / A for Pkg Type
5962-9550402Q2A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type
5962-9550402QCA	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	N / A for Pkg Type
5962-9550402QDA	ACTIVE	CFP	W	14	1	TBD	A42 SNPB	N / A for Pkg Type
5962-9550403Q2A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type
5962-9550403QHA	ACTIVE	CFP	U	10	1	TBD	A42 SNPB	N / A for Pkg Type
5962-9550403QPA	ACTIVE	CDIP	JG	8	1	TBD	A42 SNPB	N / A for Pkg Type
5962-9550404Q2A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type
5962-9550404QCA	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	N / A for Pkg Type
5962-9550404QDA	ACTIVE	CFP	W	14	1	TBD	A42 SNPB	N / A for Pkg Type
TLV2262AID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2262AIDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2262AIDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2262AIDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2262AIP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TLV2262AIPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TLV2262AIPW	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2262AIPWG4	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2262AIPWLE	OBSOLETE	TSSOP	PW	8		TBD	Call TI	Call TI
TLV2262AIPWR	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2262AIPWRG4	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2262AMFKB	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type
TLV2262AMJGB	ACTIVE	CDIP	JG	8	1	TBD	A42 SNPB	N / A for Pkg Type
TLV2262AMUB	ACTIVE	CFP	U	10	1	TBD	A42 SNPB	N / A for Pkg Type
TLV2262AQD	NRND	SOIC	D	8	75	TBD	CU NIPDAU	Level-1-220C-UNLIM
TLV2262AQDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2262AQDR	NRND	SOIC	D	8	2500	TBD	CU NIPDAU	Level-1-220C-UNLIM
TLV2262AQDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2262ID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2262IDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
TLV2262IDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2262IDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2262IP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TLV2262IPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TLV2262IPW	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2262IPWG4	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2262IPWR	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2262IPWRG4	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2262MFKB	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type
TLV2262MJGB	ACTIVE	CDIP	JG	8	1	TBD	A42 SNPB	N / A for Pkg Type
TLV2262MUB	ACTIVE	CFP	U	10	1	TBD	A42 SNPB	N / A for Pkg Type
TLV2262QD	NRND	SOIC	D	8	75	TBD	CU NIPDAU	Level-1-220C-UNLIM
TLV2262QDG4	ACTIVE	SOIC	D	8	1500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2262QDR	NRND	SOIC	D	8	2500	TBD	CU NIPDAU	Level-1-220C-UNLIM
TLV2262QDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2264AID	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2264AIDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2264AIDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2264AIDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2264AIN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TLV2264AINE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TLV2264AIPW	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2264AIPWG4	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2264AIPWLE	OBSOLETE	TSSOP	PW	14		TBD	Call TI	Call TI
TLV2264AIPWR	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2264AIPWRG4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2264AMFKB	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type
TLV2264AMJB	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	N / A for Pkg Type
TLV2264AMWB	ACTIVE	CFP	W	14	1	TBD	A42 SNPB	N / A for Pkg Type
TLV2264AQD	ACTIVE	SOIC	D	14	50	TBD	CU NIPDAU	Level-1-220C-UNLIM

Orderable Device	Status [1]	Package Type	Package Drawing	Pins	Package Qty	Eco Plan [2]	Lead/Ball Finish	MSL Peak Temp [3]
TLV2264AQDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2264AQDR	ACTIVE	SOIC	D	14	2500	TBD	CU NIPDAU	Level-1-220C-UNLIM
TLV2264AQDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2264ID	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2264IDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2264IDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2264IDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2264IN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TLV2264INE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TLV2264IPWR	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2264IPWRG4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2264MFKB	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type
TLV2264MJ	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	N / A for Pkg Type
TLV2264MJB	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	N / A for Pkg Type
TLV2264MWB	ACTIVE	CFP	W	14	1	TBD	A42 SNPB	N / A for Pkg Type
TLV2264QD	ACTIVE	SOIC	D	14	50	TBD	CU NIPDAU	Level-1-220C-UNLIM
TLV2264QDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2264QDR	ACTIVE	SOIC	D	14	2500	TBD	CU NIPDAU	Level-1-220C-UNLIM
TLV2264QDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

[1] The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

[2] Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

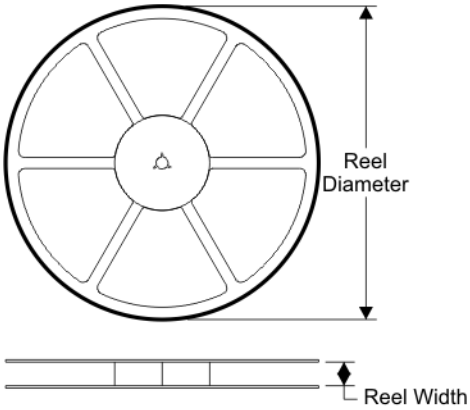
[3] MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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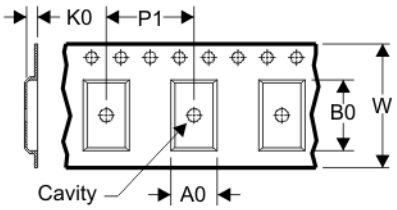
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TAPE AND REEL BOX INFORMATION

REEL DIMENSIONS

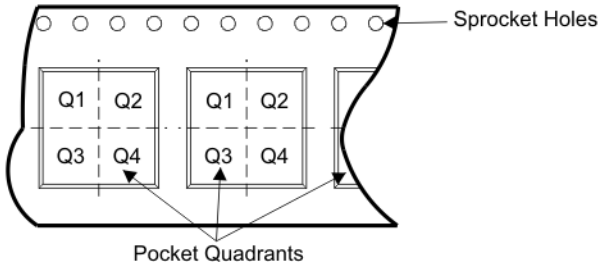


TAPE DIMENSIONS



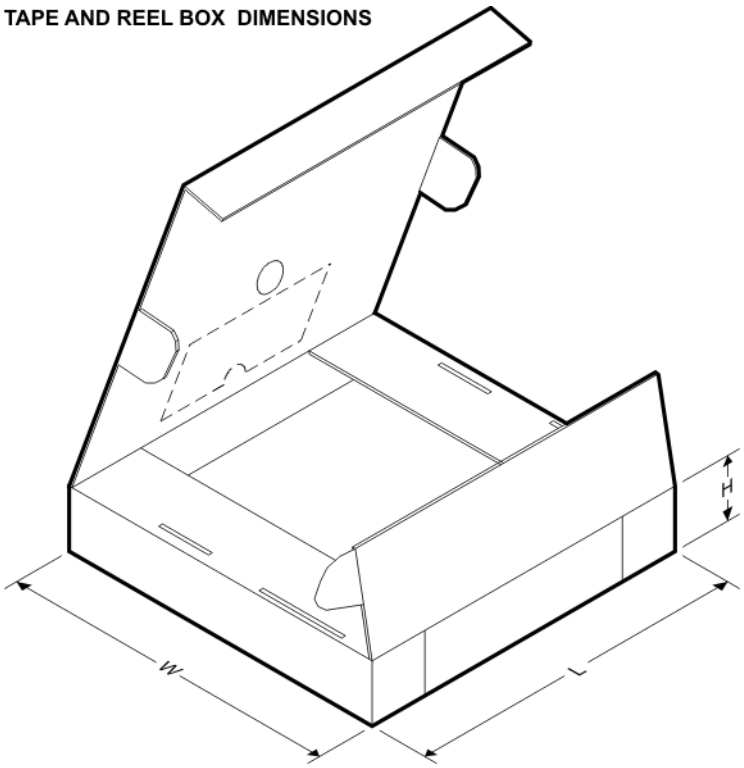
A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



Device	Package	Pins	Site	Reel Diameter (mm)	Reel Width (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TLV2262AIDR	D	8	SITE 27	330	12	6.4	5.2	2.1	8	12	Q1
TLV2262AIDR	D	8	SITE 60	330	12	6.4	5.2	2.1	8	12	Q1
TLV2262AIPWR	PW	8	SITE 41	330	12	7.0	3.6	1.6	8	12	Q1
TLV2262IDR	D	8	SITE 27	330	12	6.4	5.2	2.1	8	12	Q1
TLV2262IDR	D	8	SITE 60	330	12	6.4	5.2	2.1	8	12	Q1
TLV2262IPWR	PW	8	SITE 41	330	12	7.0	3.6	1.6	8	12	Q1
TLV2264AIDR	D	14	SITE 60	330	16	6.5	9.0	2.1	8	16	Q1
TLV2264AIPWR	PW	14	SITE 41	330	12	7.0	5.6	1.6	8	12	Q1
TLV2264IDR	D	14	SITE 60	330	16	6.5	9.0	2.1	8	16	Q1
TLV2264IPWR	PW	14	SITE 41	330	12	7.0	5.6	1.6	8	12	Q1

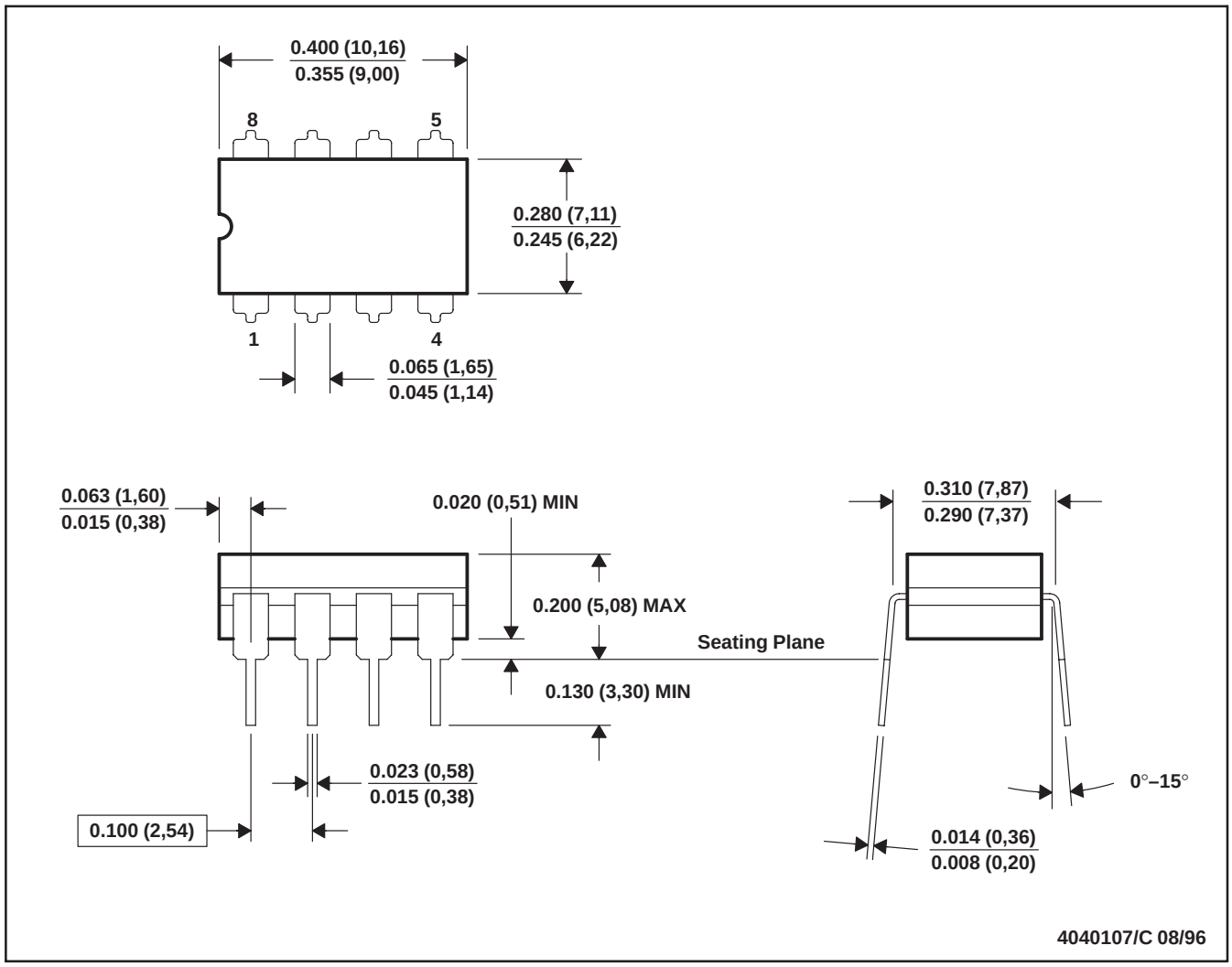
TAPE AND REEL BOX DIMENSIONS



Device	Package	Pins	Site	Length (mm)	Width (mm)	Height (mm)
TLV2262AIDR	D	8	SITE 27	342.9	338.1	20.64
TLV2262AIDR	D	8	SITE 60	346.0	346.0	29.0
TLV2262AIPWR	PW	8	SITE 41	346.0	346.0	29.0
TLV2262IDR	D	8	SITE 27	342.9	338.1	20.64
TLV2262IDR	D	8	SITE 60	346.0	346.0	29.0
TLV2262IPWR	PW	8	SITE 41	346.0	346.0	29.0
TLV2264AIDR	D	14	SITE 60	346.0	346.0	33.0
TLV2264AIPWR	PW	14	SITE 41	346.0	346.0	29.0
TLV2264IDR	D	14	SITE 60	346.0	346.0	33.0
TLV2264IPWR	PW	14	SITE 41	346.0	346.0	29.0

MCER001A – JANUARY 1995 – REVISED JANUARY 1997

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

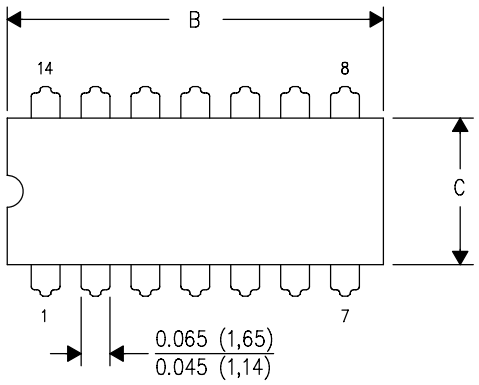


NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification.
E. Falls within MIL STD 1835 GDIP1-T8

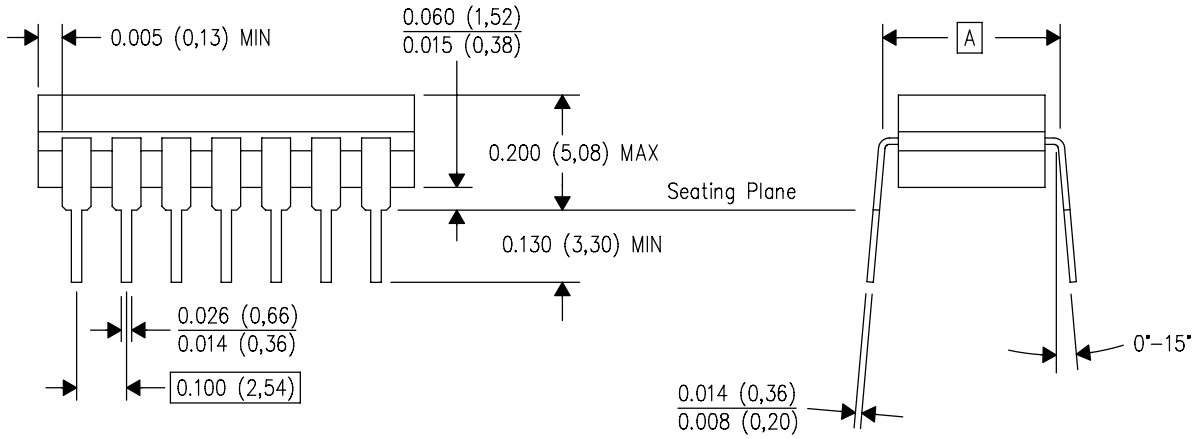
J (R–GDIP–T**)

14 LEADS SHOWN

CERAMIC DUAL IN–LINE PACKAGE



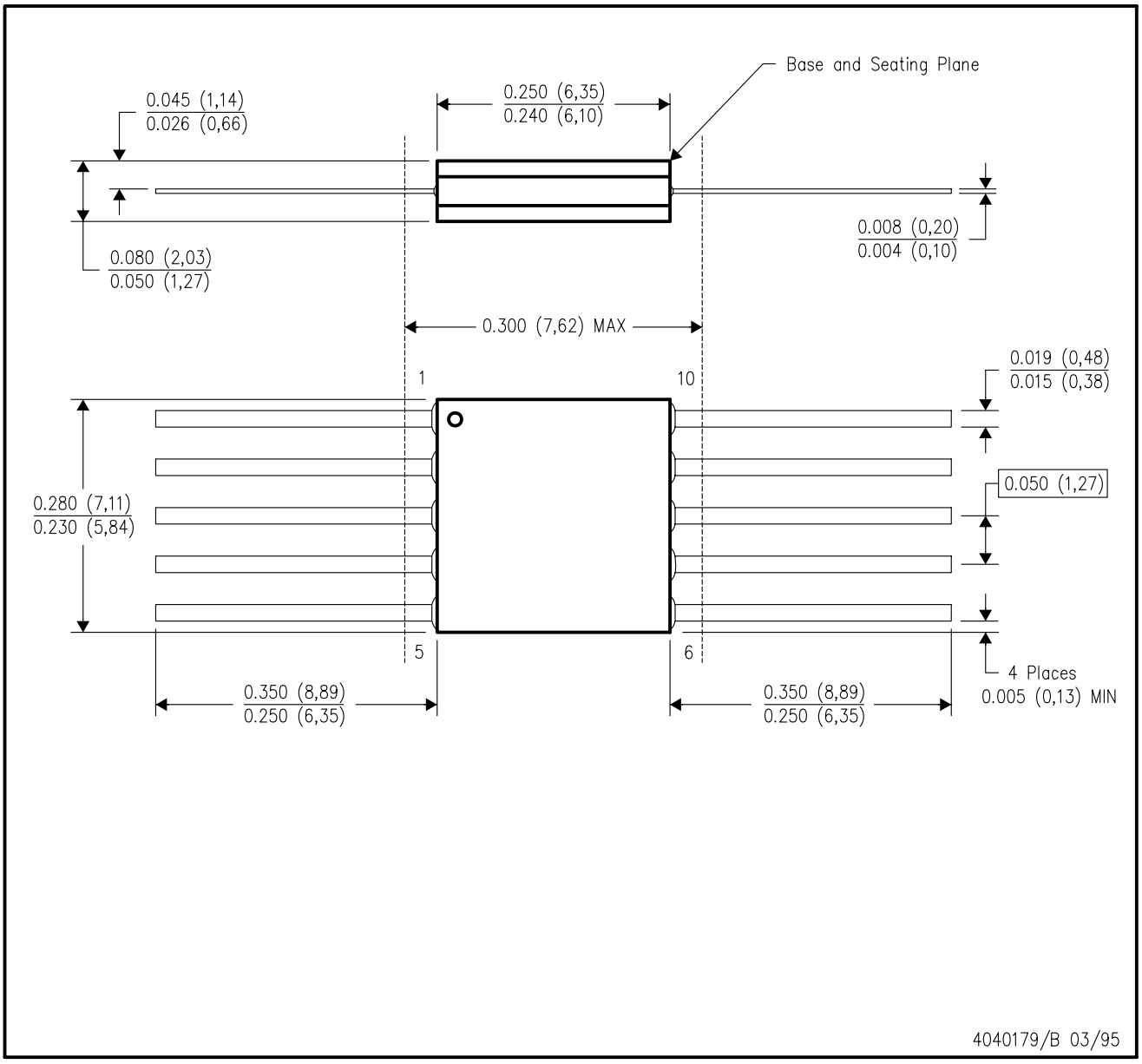
DIM \ PINS **	14	16	18	20
A	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC
B MAX	0.785 (19,94)	.840 (21,34)	0.960 (24,38)	1.060 (26,92)
B MIN	—	—	—	—
C MAX	0.300 (7,62)	0.300 (7,62)	0.310 (7,87)	0.300 (7,62)
C MIN	0.245 (6,22)	0.245 (6,22)	0.220 (5,59)	0.245 (6,22)



4040083/F 03/03

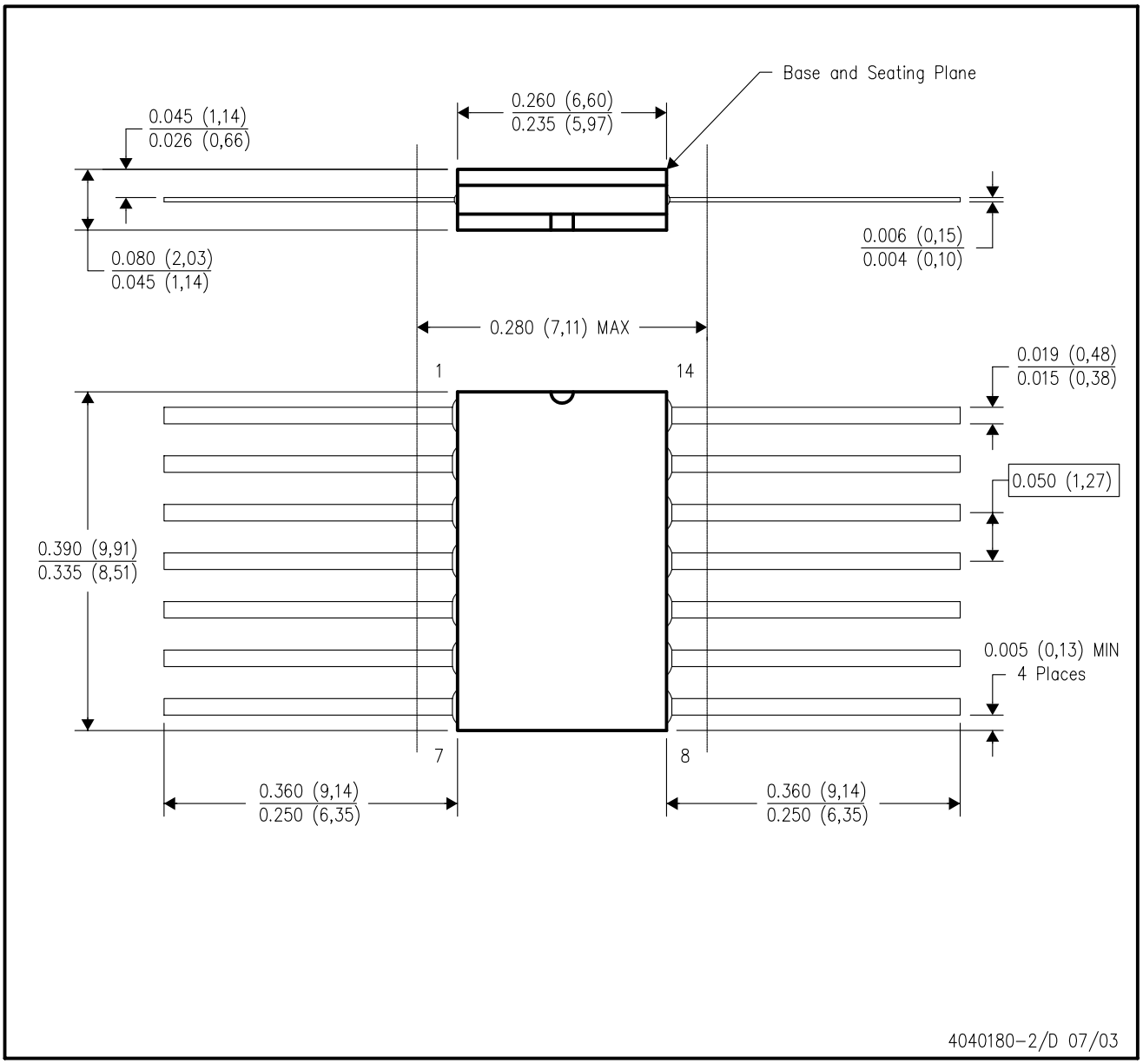
NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package is hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
E. Falls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

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

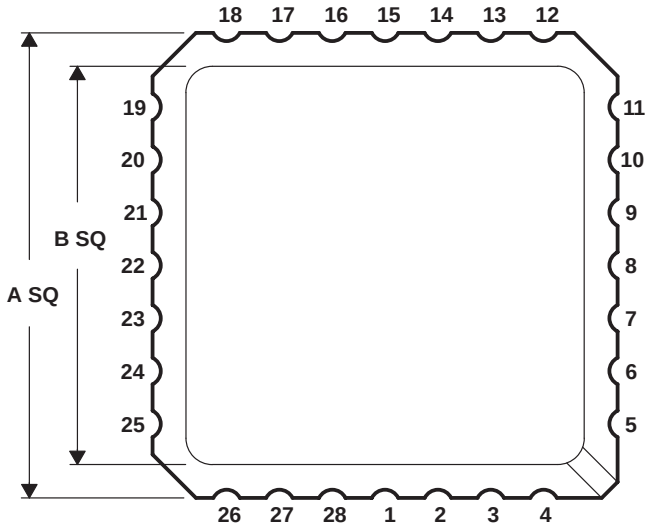
W (R–GDFP–F14) CERAMIC DUAL FLATPACK



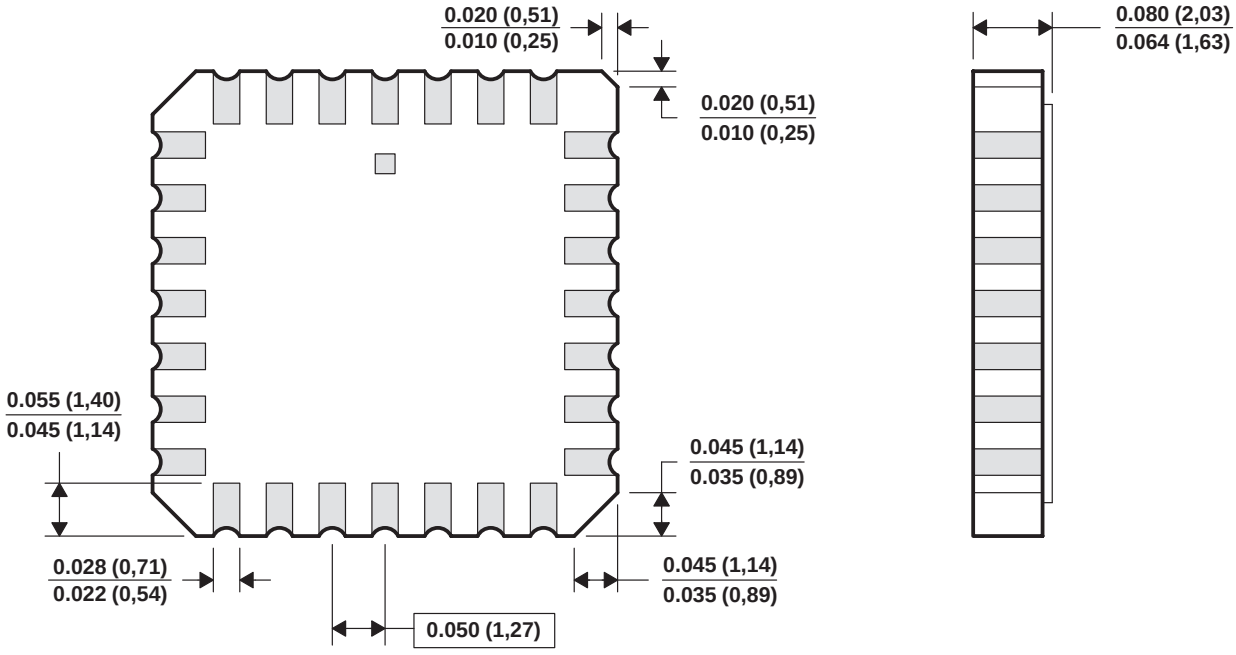
NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification only.
E. Falls within MIL STD 1835 GDFP1–F14 and JEDEC MO–092AB

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	0.739 (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)

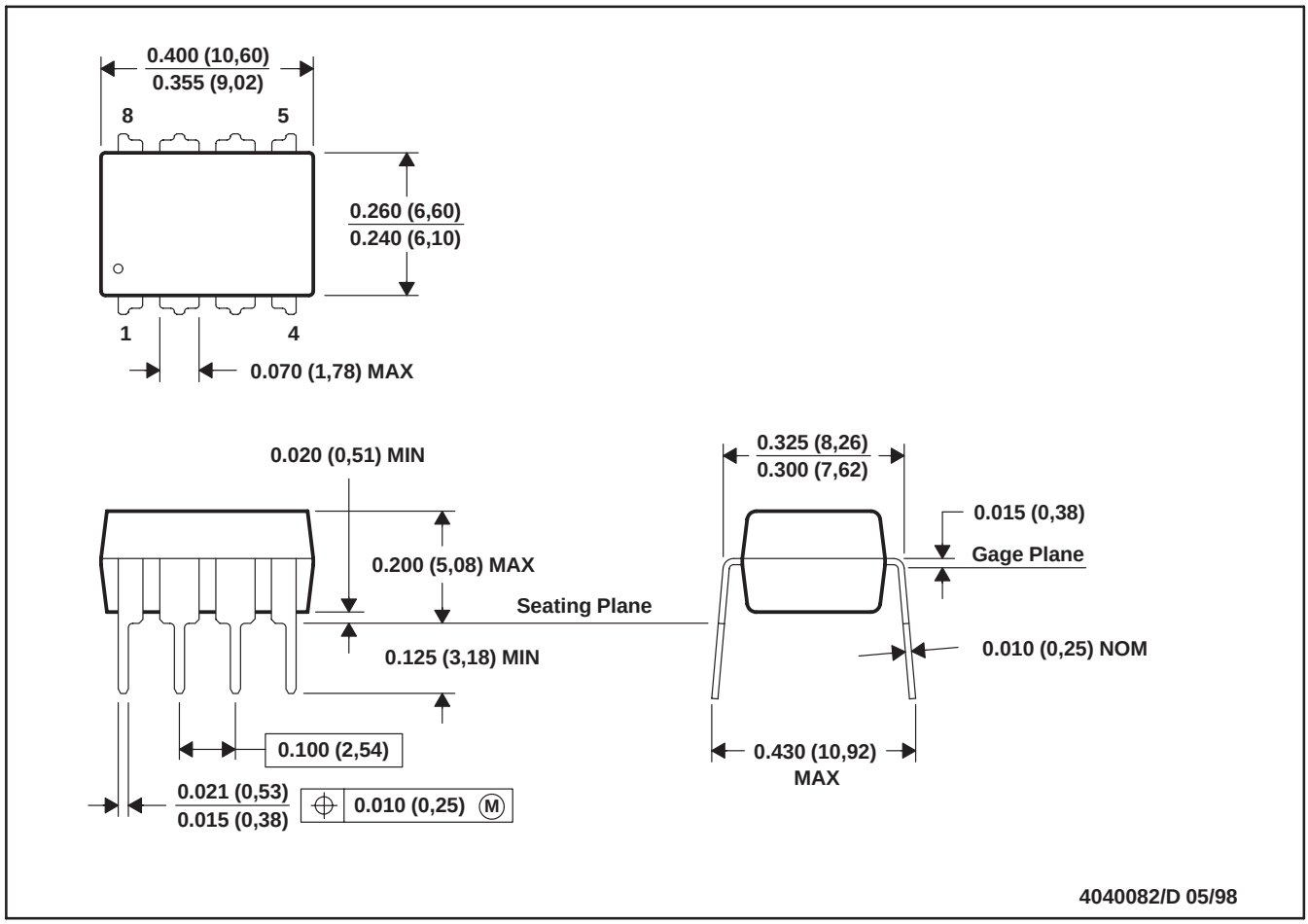


4040140/D 10/96

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

MPDI001A – JANUARY 1995 – REVISED JUNE 1999

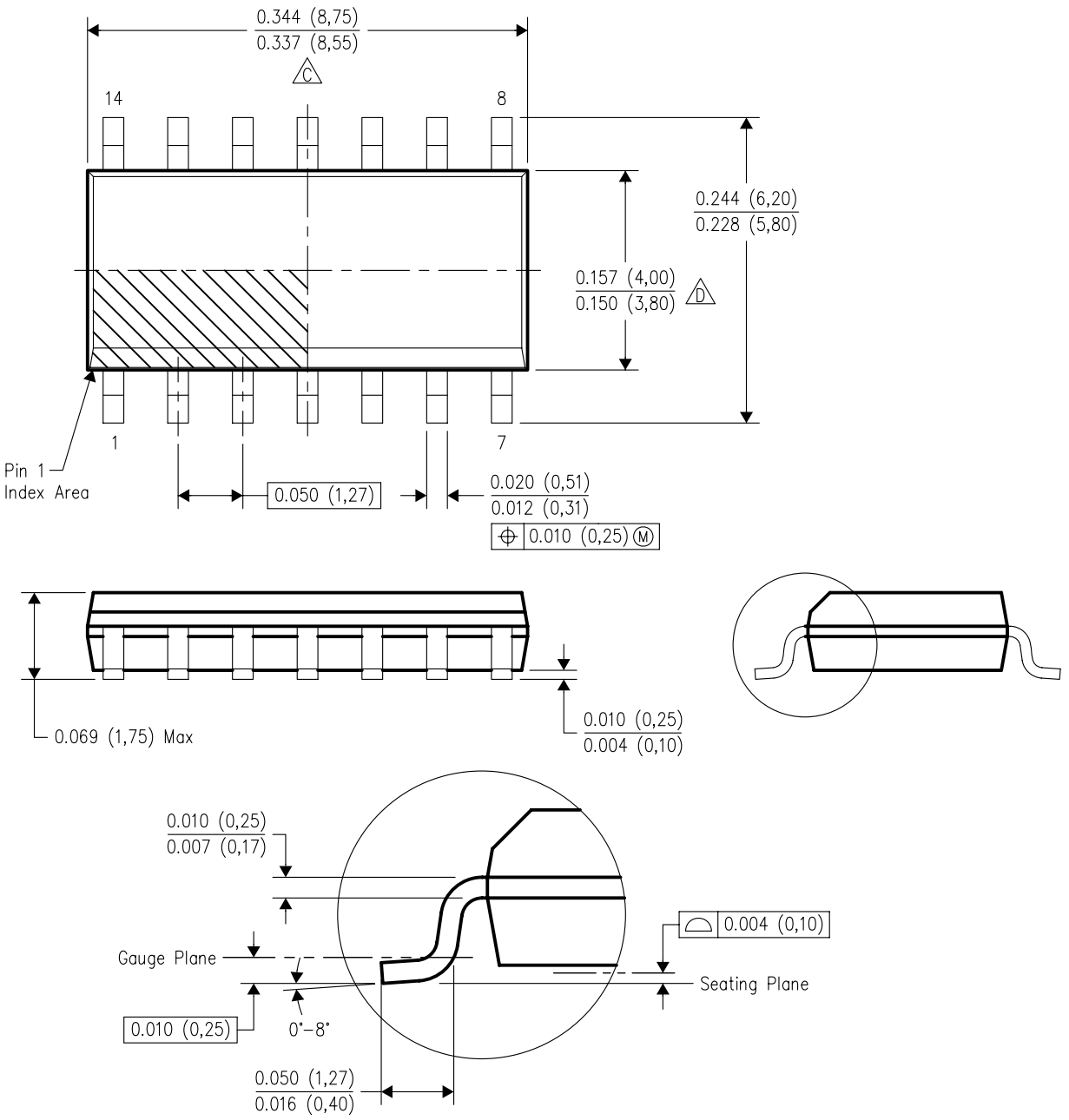
P (R-PDIP-T8) **PLASTIC DUAL-IN-LINE**



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

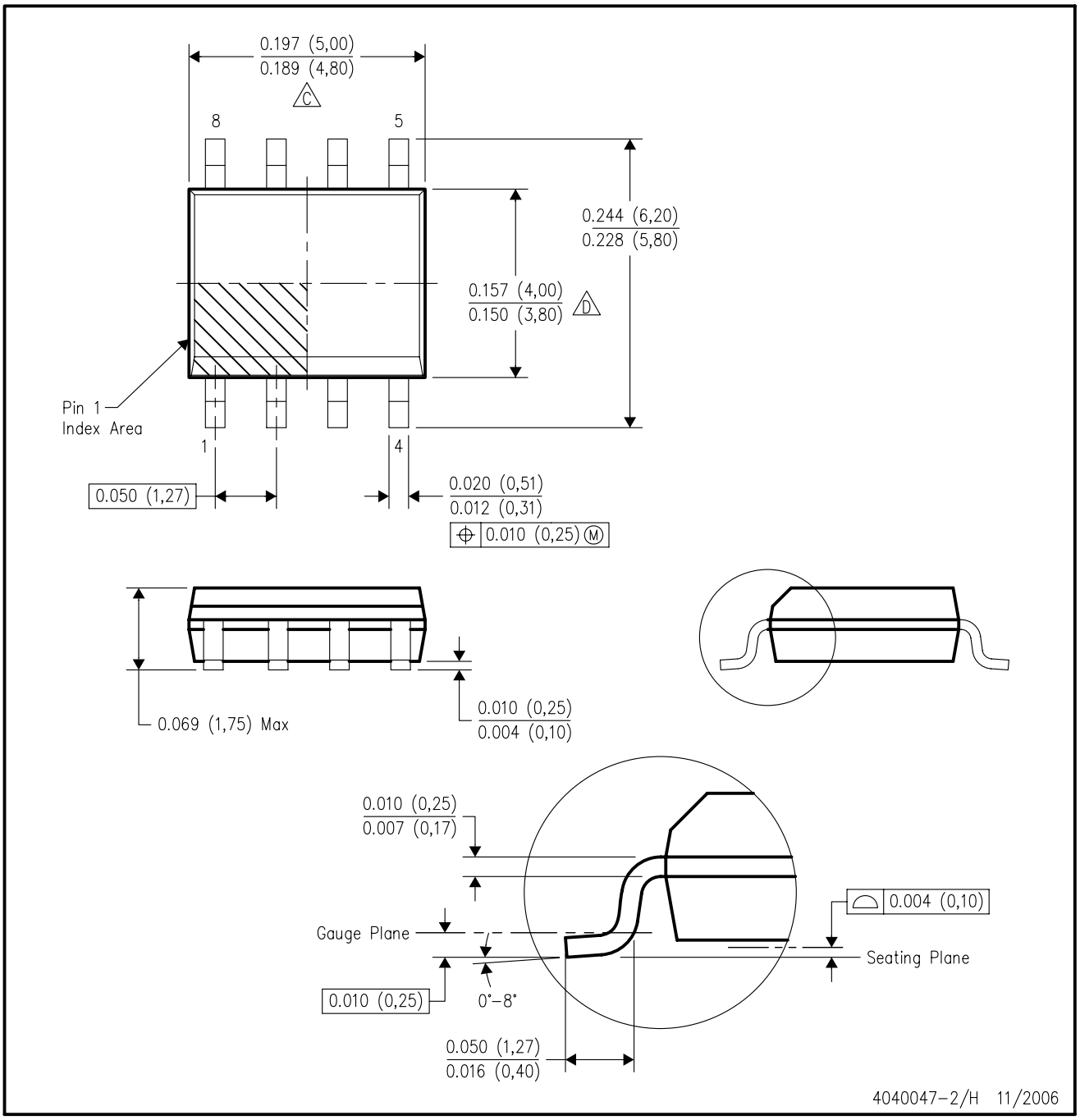
For the latest package information, go to http://www.ti.com/sc/docs/package/pkg_info.htm

D (R–PDSO–G14) PLASTIC SMALL–OUTLINE PACKAGE



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

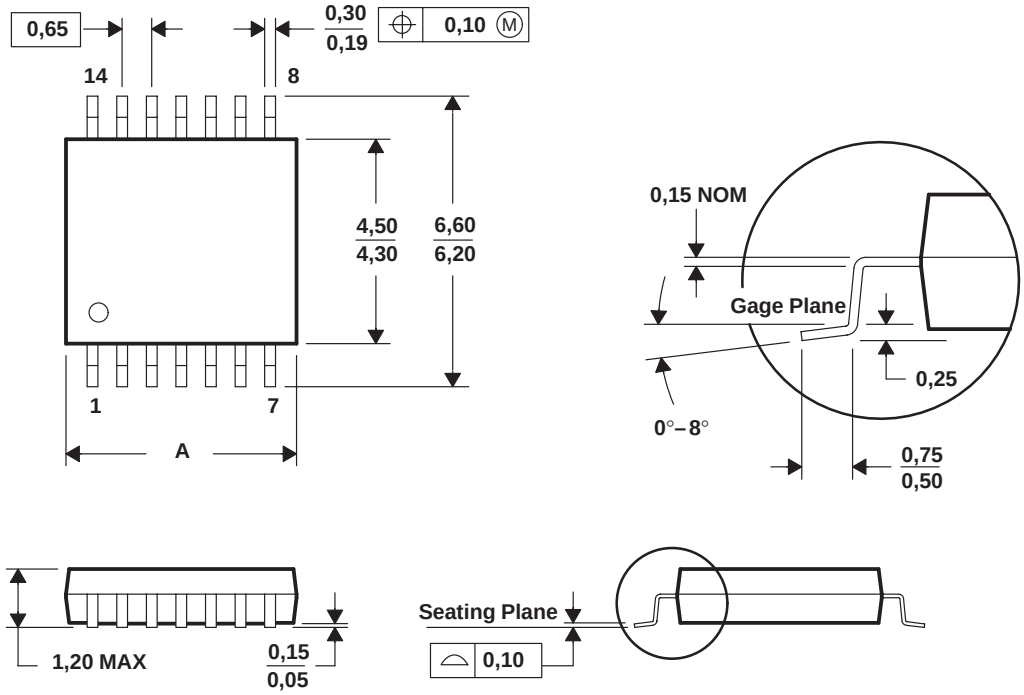
D (R–PDSO–G8) PLASTIC SMALL–OUTLINE PACKAGE



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

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

14 PINS SHOWN



DIM \ PINS **	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

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

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