- **Output Swing Includes Both Supply Rails**
- **Extended Common-Mode Input Voltage Range . . . 0 V to 4.5 V (Min) with 5-V Single Supply**
- **No Phase Inversion**
- **Low Noise . . . 18 nV/√Hz Typ at f = 1 kHz**
- **Low Input Offset Voltage**
  950 μV Max at T_A = 25°C (TLV2422A)
- **Low Input Bias Current . . . 1 pA Typ**
- **Micropower Operation . . . 50 μA Per Channel**
- **600-Ω Output Drive**
- **Available in Q-Temp Automotive**
  HighRel Automotive Applications
  Configuration Control / Print Support
  Qualification to Automotive Standards

description

The TLV2422 and TLV2422A are dual low-voltage operational amplifiers from Texas Instruments. The common-mode input voltage range for this device has been extended over the typical CMOS amplifiers making them suitable for a wide range of applications. In addition, the devices do not phase invert when the common-mode input is driven to the supply rails. This satisfies most design requirements without paying a premium for rail-to-rail input performance. They also exhibit rail-to-rail output performance for increased dynamic range in single- or split-supply applications. This family is fully characterized at 3-V and 5-V supplies and is optimized for low-voltage operation. The TLV2422 only requires 50 μA of supply current per channel, making it ideal for battery-powered applications. The TLV2422 also has increased output drive over previous rail-to-rail operational amplifiers and can drive 600-Ω loads for telecom applications.

Other members in the TLV2422 family are the high-power, TLV2442, and low-power, TLV2432, versions.

HIGH-LEVEL OUTPUT VOLTAGE
vs
HIGH-LEVEL OUTPUT CURRENT

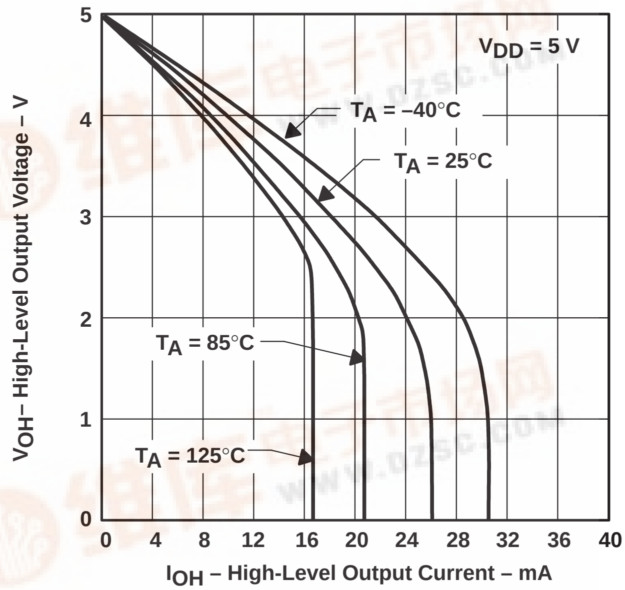


Figure 1

The TLV2422, exhibiting high input impedance and low noise, is excellent for small-signal conditioning for high-impedance sources, such as piezoelectric transducers. Because of the micropower dissipation levels and low-voltage 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 TLV2422A is available with a maximum input offset voltage of 950 μV.

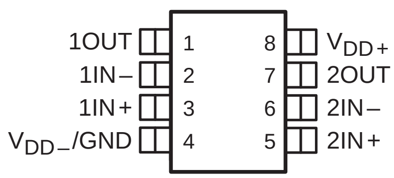
If the design requires single operational amplifiers, see the TI TLV2211/21/31. This is a family of rail-to-rail output operational amplifiers in the SOT-23 package. Their small size and low power consumption, make them ideal for high density, battery-powered equipment.

AVAILABLE OPTIONS

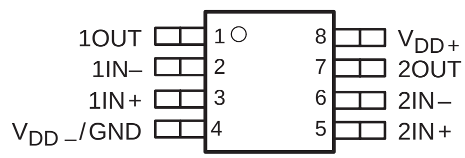
T_A	V_{IO}max AT 25°C	PACKAGED DEVICES					CHIP FORM (Y)
		SMALL OUTLINE (D)	CHIP CARRIER (FK)	CERAMIC DIP (JG)	TSSOP (PW)	CERAMIC FLAT PACK (U)	
0°C to 70°C	2.5 mV	TLV2422CD	—	—	TLV2422CPWLE	—	TLV2422Y
–40°C to 85°C	950 µV 2.5 mV	TLV2422AID TLV2422ID	— —	— —	TLV2422AIPWLE —	— —	
–40°C to 125°C	950 µV 2.5 mV	TLV2422AQD TLV2422QD	— —	— —	— —	— —	
–55°C to 125°C	950 µV 2 mV	— —	TLV2422AMFK TLV2422MFK	TLV2422AMJG TLV2422MJG	— —	TLV2422AMU TLV2422MU	

The D packages are available taped and reeled. Add R suffix to device type (e.g., TLV2422CDR). The PW package is available only left-end taped and reeled. Chips are tested at 25°C.

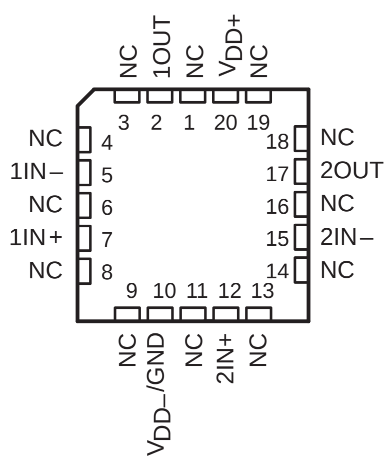
D OR JG PACKAGE
(TOP VIEW)



PW PACKAGE
(TOP VIEW)

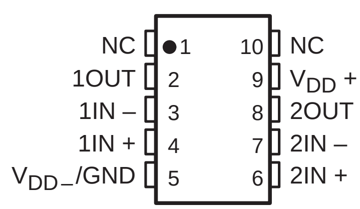


FK PACKAGE
(TOP VIEW)

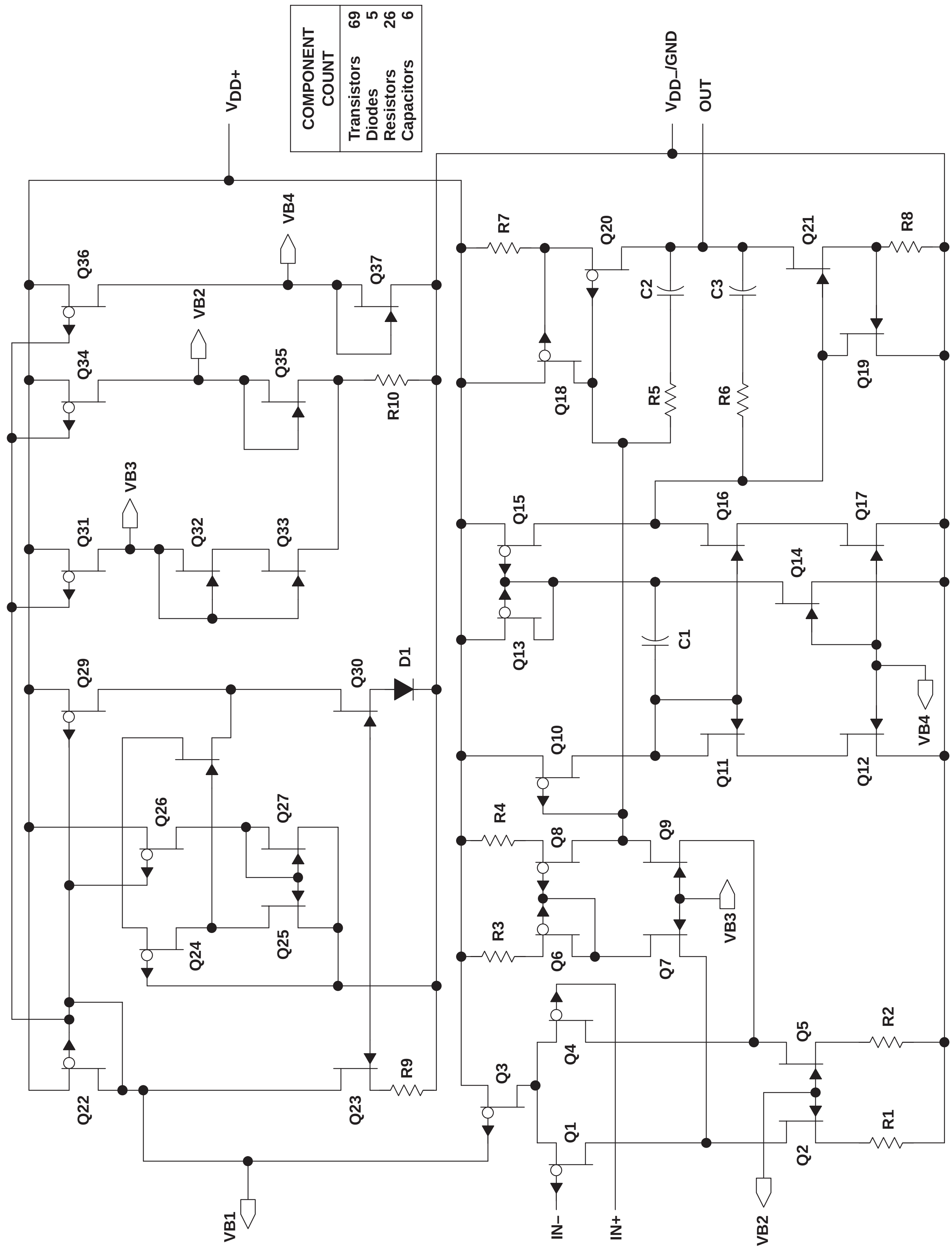


NC – No internal connection

U PACKAGE
(TOP VIEW)



equivalent schematic (each amplifier)



COMPONENT COUNT	
Transistors	69
Diodes	5
Resistors	26
Capacitors	6

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

Supply voltage, V_{DD} (see Note 1) . . . . 12 V
Differential input voltage, V_{ID} (see Note 2) . . . . $\pm V_{DD}$
Input voltage, V_I (any input, see Note 1): C and I suffix . . . . -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: C suffix . . . . 0°C to 70°C
I suffix . . . . –40°C to 85°C
Q suffix . . . . –40°C to 125°C
M suffix . . . . –55°C to 125°C
Storage temperature range, T_{stg} . . . . –65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds . . . . 260°C

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

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

DISSIPATION RATING TABLE

PACKAGE	$T_A \le 25°C$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25°C$	$T_A = 70°C$ POWER RATING	$T_A = 85°C$ POWER RATING	$T_A = 125°C$ POWER RATING
D	725 mW	5.8 mW/°C	464 mW	377 mW	145 mW
FK	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
PW	525 mW	4.2 mW/°C	336 mW	273 mW	105 mW
U	675 mW	5.4 mW/°C	432 mW	350 mW	135 mW

recommended operating conditions

	C SUFFIX		I SUFFIX		Q SUFFIX		M SUFFIX		UNIT
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
Supply voltage, $V_{DD\pm}$	2.7	10	2.7	10	2.7	10	2.7	10	V
Input voltage range, V_I	V_{DD-}	$V_{DD+} -0.8$	V_{DD-}	$V_{DD+} -0.8$	V_{DD-}	$V_{DD+} -0.8$	V_{DD-}	$V_{DD+} -0.8$	V
Common-mode input voltage, V_{IC}	V_{DD-}	$V_{DD+} -0.8$	V_{DD-}	$V_{DD+} -0.8$	V_{DD-}	$V_{DD+} -0.8$	V_{DD-}	$V_{DD+} -0.8$	V
Operating free-air temperature, T_A	0	70	–40	85	–40	125	–55	125	°C

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

PARAMETER		TEST CONDITIONS	T_A†	TLV2422C MIN	TLV2422C TYP	TLV2422C MAX	UNIT
V_{IO}	Input offset voltage	V_{IC} = 0, $V_{DD}\pm$ = ±2.5 V, V_O = 0, R_S = 50 Ω	25°C		300	2000	µV
			Full range			2500	
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			150	
I_{IB}	Input bias current		25°C		1		pA
			Full range			150	
V_{ICR}	Common-mode input voltage range	$\lvert V_{IO}\rvert \le$ 5 mV, R_S = 50 Ω	25°C	0 to 2.5	–0.25 to 2.75		V
			Full range	0 to 2.2			
V_{OH}	High-level output voltage	I_{OH} = –100 µA	25°C		2.97		V
		I_{OH} = –500 µA	25°C		2.75		
			Full range	2.5			
V_{OL}	Low-level output voltage	V_{IC} = 0, I_{OL} = 100 µA	25°C		0.05		V
		V_{IC} = 0, I_{OL} = 250 µA	25°C		0.2		
			Full range			0.5	
A_{VD}	Large-signal differential voltage amplification	V_{IC} = 2.5 V, V_O = 1 V to 2 V, R_L = 10 kΩ‡	25°C	6	10		V/mV
			Full range	3			
		V_{IC} = 2.5 V, V_O = 1 V to 2 V, R_L = 1 MΩ‡	25°C		700		
$r_{i(d)}$	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	25°C		8		pF
z_o	Closed-loop output impedance	f = 100 kHz, A_V = 10	25°C		130		Ω
CMRR	Common-mode rejection ratio	V_{IC} = 0 to 2.5 V, V_O = 1.5 V, R_S = 50 Ω	25°C	70	83		dB
			Full range	70			
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		dB
			Full range	80			
I_{DD}	Supply current	V_O = 1.5 V, No load	25°C		100	150	µA
			Full range			175	

† 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.

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

PARAMETER		TEST CONDITIONS	T_A†	TLV2422I MIN	TLV2422I TYP	TLV2422I MAX	TLV2422AI MIN	TLV2422AI TYP	TLV2422AI MAX	UNIT
V_{IO}	Input offset voltage	V_{IC} = 0, V_{DD}± = ±2.5 V, V_O = 0, R_S = 50 Ω	25°C		300	2000		300	950	µV
			Full range			2500			1500	
α_{VIO}	Temperature coefficient of input offset voltage		25°C to 70°C		2			2		µV/°C
	Input offset voltage long-term drift (see Note 4)		25°C		0.003			0.003		µV/mo
I_{IO}	Input offset current		25°C		0.5			0.5		pA
			Full range			150			150	
I_{IB}	Input bias current		25°C		1			1		pA
			Full range			150			150	
V_{ICR}	Common-mode input voltage range	$\lvert V_{IO} \rvert$ ≤ 5 mV, R_S = 50 Ω	25°C	0 to 2.5	–0.25 to 2.75		0 to 2.5	–0.25 to 2.75		V
			Full range	0 to 2.2			0 to 2.2			
V_{OH}	High-level output voltage	I_{OH} = –100 µA	25°C		2.97			2.97		V
		I_{OH} = –500 µA	25°C		2.75			2.75		
			Full range	2.5			2.5			
V_{OL}	Low-level output voltage	V_{IC} = 0, I_{OL} = 100 µA	25°C		0.05			0.05		V
		V_{IC} = 0, I_{OL} = 250 µA	25°C		0.2			0.2		
			Full range			0.5			0.5	
A_{VD}	Large-signal differential voltage amplification	V_{IC} = 2.5 V, V_O = 1 V to 2 V, R_L = 10 kΩ‡	25°C	6	10		6	10		V/mV
			Full range	3			3			
		V_{IC} = 2.5 V, V_O = 1 V to 2 V, R_L = 1 MΩ‡	25°C		700			700		
$r_{i(d)}$	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	25°C		8			8		pF
z_o	Closed-loop output impedance	f = 100 kHz, A_V = 10	25°C		130			130		Ω
CMRR	Common-mode rejection ratio	V_{IC} = 0 to 2.5 V, V_O = 1.5 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} = 2.7 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	V_O = 1.5 V, No load	25°C		100	150		100	150	µA
			Full range			175			175	

† Full range is – 40°C to 85°C.
‡ Referenced to 2.5 V
NOTE 4: Typical values are based on the input offset voltage shift observed through 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.

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

PARAMETER		TEST CONDITIONS		T_A†	TLV2422C, TLV2422I TLV2422AI MIN	TYP	MAX	UNIT
SR	Slew rate at unity gain	V_O = 1.5 V to 3.5 V, C_L = 100 pF‡	R_L = 10 kΩ‡,	25°C	0.01	0.02		V/μs
				Full range	0.008			
V_n	Equivalent input noise voltage	f = 10 Hz		25°C		100		nV/√Hz
		f = 1 kHz		25°C		23		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C		2.7		μV
		f = 0.1 Hz to 10 Hz		25°C		4		
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 = 1 kHz, R_L = 10 kΩ‡	A_V = 1	25°C		0.25%		
			A_V = 10			1.8%		
	Gain-bandwidth product	f = 10 kHz, C_L = 100 pF‡	R_L = 10 kΩ‡,	25°C		46		kHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 1 V, R_L = 10 kΩ‡,	A_V = 1, C_L = 100 pF‡	25°C		8.3		kHz
t_s	Settling time	A_V = –1, Step = 0.5 V to 2.5 V, R_L = 10 kΩ‡, C_L = 100 pF‡	To 0.1%	25°C		8.6		μs
			To 0.01%			16		
ϕ_m	Phase margin at unity gain	R_L = 10 kΩ‡,	C_L = 100 pF‡	25°C		62°		
	Gain margin			25°C		11		dB

† Full range for the C version is 0°C to 70°C. Full range for the I version is –40°C to 85°C.
‡ Referenced to 2.5 V

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

PARAMETER		TEST CONDITIONS	T_A†	TLV2422Q, TLV2422M			TLV2422AQ, TLV2422AM			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{IC} = 0, $V_{DD\pm}$ = ±1.5 V, V_O = 0, R_S = 50 Ω	25°C		300	2000		300	950	µV
			Full range			2500			1800	
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
			Full range			150			150	
I_{IB}	Input bias current		25°C		1			1		pA
			Full range			300			300	
V_{ICR}	Common-mode input voltage range	$\|V_{IO}\|$ ≤ 5 mV, R_S = 50 Ω	25°C	0 to 2.5	–0.25 to 2.75		0 to 2.5	–0.25 to 2.75		V
			Full range	0 to 2.2			0 to 2.2			
V_{OH}	High-level output voltage	I_{OH} = –100 µA	25°C		2.97			2.97		V
		I_{OH} = –500 µA	25°C		2.75			2.75		
			Full range	2.5			2.5			
V_{OL}	Low-level output voltage	V_{IC} = 0, I_{OL} = 100 µA	25°C		0.05			0.05		V
		V_{IC} = 0, I_{OL} = 250 µA	25°C		0.2			0.2		
			Full range			0.5			0.5	
A_{VD}	Large-signal differential voltage amplification	V_{IC} = 1.5 V, V_O = 1 V to 2 V, R_L = 10 kΩ‡	25°C	6	10		6	10		V/mV
			Full range	2			2			
		V_{IC} = 1.5 V, V_O = 1 V to 2 V, R_L = 1 MΩ‡	25°C		700			700		
$r_{i(d)}$	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	25°C		8			8		pF
z_o	Closed-loop output impedance	f = 100 kHz, A_V = 10	25°C		130			130		Ω
CMRR	Common-mode rejection ratio	V_{IC} = V_{ICR} min, V_O = 1.5 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} = 2.7 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	V_O = 1.5 V, No load	25°C		100	150		100	150	µA
			Full range			175			175	

† 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.

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

PARAMETER		TEST CONDITIONS		T_A†	TLV2422Q, TLV2422M, TLV2422AQ, TLV2422AM MIN	TYP	MAX	UNIT
SR	Slew rate at unity gain	V_O = 1.1 V to 1.9 V, C_L = 100 pF‡	R_L = 10 kΩ‡,	25°C	0.01	0.02		V/μs
				Full range	0.008			
V_n	Equivalent input noise voltage	f = 10 Hz		25°C		100		nV/√Hz
		f = 1 kHz		25°C		23		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C		2.7		μV
		f = 0.1 Hz to 10 Hz		25°C		4		
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 = 1 kHz, R_L = 10 kΩ‡	A_V = 1	25°C		0.25%		
			A_V = 10			1.8%		
	Gain-bandwidth product	f = 10 kHz, C_L = 100 pF‡	R_L = 10 kΩ‡,	25°C		46		kHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 1 V, R_L = 10 kΩ‡,	A_V = 1, C_L = 100 pF‡	25°C		8.3		kHz
t_s	Settling time	A_V = –1, Step = 0.5 V to 2.5 V, R_L = 10 kΩ‡, C_L = 100 pF‡	To 0.1%	25°C		8.6		μs
			To 0.01%			16		
ϕ_m	Phase margin at unity gain	R_L = 10 kΩ‡,	C_L = 100 pF‡	25°C		62°		
	Gain margin			25°C		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

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

PARAMETER		TEST CONDITIONS		T_A†	TLV2422C MIN	TLV2422C TYP	TLV2422C 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	2000	µV
				Full range			2500	
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			150	
I_{IB}	Input bias current			25°C		1		pA
				Full range			150	
V_{ICR}	Common-mode input voltage range	$\|V_{IO}\|$ ≤ 5 mV,	R_S = 50 Ω	25°C	0 to 4.5	–0.25 to 4.75		V
				Full range	0 to 4.2			
V_{OH}	High-level output voltage	I_{OH} = –100 µA		25°C		4.97		V
		I_{OH} = –1 mA		25°C	4.5	4.75		
				Full range	4.25			
V_{OL}	Low-level output voltage	V_{IC} = 2.5 V,	I_{OL} = 100 µA	25°C		0.04		V
		V_{IC} = 2.5 V,	I_{OL} = 500 µA	25°C		0.15		
				Full range			0.5	
A_{VD}	Large-signal differential voltage amplification	V_{IC} = 2.5 V, V_O = 1 V to 4 V	R_L = 10 kΩ‡	25°C	8	12		V/mV
				Full range	5			
			R_L = 1 MΩ‡	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		25°C		8		pF
z_o	Closed-loop output impedance	f = 100 kHz,	A_V = 10	25°C		130		Ω
CMRR	Common-mode rejection ratio	V_{IC} = 0 to 4.5 V, R_S = 50 Ω	V_O = 2.5 V,	25°C	70	90		dB
				Full range	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		dB
				Full range	80			
I_{DD}	Supply current	V_O = 2.5 V,	No load	25°C		100	150	µA
				Full range			175	

† 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.

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

PARAMETER		TEST CONDITIONS	T_A†	TLV2422I			TLV2422AI			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{IC} = 0, $V_{DD\pm}$ = ±2.5 V, V_O = 0, R_S = 50 Ω	25°C		300	2000		300	950	µV
			Full range			2500			1500	
α_{VIO}	Temperature coefficient of input offset voltage		25°C to 70°C		2			2		µV/°C
	Input offset voltage long-term drift (see Note 4)		25°C		0.003			0.003		µV/mo
I_{IO}	Input offset current		25°C		0.5			0.5		pA
			Full range			150			150	
I_{IB}	Input bias current		25°C		1			1		pA
			Full range			150			150	
V_{ICR}	Common-mode input voltage range	$\lvert V_{IO}\rvert \le$ 5 mV, R_S = 50 Ω	25°C	0 to 4.5	–0.25 to 4.75		0 to 4.5	–0.25 to 4.75		V
			Full range	0 to 4.2			0 to 4.2			
V_{OH}	High-level output voltage	I_{OH} = –100 µA	25°C		4.97			4.97		V
		I_{OH} = –1 mA	25°C	4.5	4.75		4.5	4.75		
			Full range	4.25			4.25			
V_{OL}	Low-level output voltage	V_{IC} = 2.5 V, I_{OL} = 100 µA	25°C		0.04			0.04		V
		V_{IC} = 2.5 V, I_{OL} = 500 µA	25°C		0.15			0.15		
			Full range			0.5			0.5	
A_{VD}	Large-signal differential voltage amplification	V_{IC} = 2.5 V, V_O = 1 V to 4 V, R_L = 10 kΩ‡	25°C	8	12		8	12		V/mV
			Full range	5			5			
		R_L = 1 MΩ‡	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	25°C		8			8		pF
z_o	Closed-loop output impedance	f = 100 kHz, A_V = 10	25°C		130			130		Ω
CMRR	Common-mode rejection ratio	V_{IC} = 0 to 4.5 V, V_O = 2.5 V, R_S = 50 Ω	25°C	70	90		70	90		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			
I_{DD}	Supply current	V_O = 2.5 V, No load	25°C		100	150		100	150	µA
			Full range			175			175	

† Full range is – 40°C to 85°C.
‡ Referenced to 2.5 V
NOTE 4: Typical values are based on the input offset voltage shift observed through 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.

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

PARAMETER		TEST CONDITIONS		T_A†	TLV2422C, TLV2422I TLV2422AI MIN	TYP	MAX	UNIT
SR	Slew rate at unity gain	V_O = 1.5 V to 3.5 V, C_L = 100 pF‡	R_L = 10 kΩ‡,	25°C	0.01	0.02		V/µs
				Full range	0.008			
V_n	Equivalent input noise voltage	f = 10 Hz		25°C		100		nV/√Hz
		f = 1 kHz		25°C		18		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C		1.9		µV
		f = 0.1 Hz to 10 Hz		25°C		2.8		
I_n	Equivalent input noise current			25°C		0.6		fA√Hz
THD + N	Total harmonic distortion plus noise	V_O = 1.5 V to 3.5 V, f = 1 kHz, R_L = 10 kΩ‡	A_V = 1	25°C		0.24%		
			A_V = 10			1.7%		
	Gain-bandwidth product	f = 10 kHz, C_L = 100 pF‡	R_L =10 kΩ‡,	25°C		52		kHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 2 V, R_L = 10 kΩ‡,	A_V = 1, C_L = 100 pF‡	25°C		5.3		kHz
t_s	Settling time	A_V = –1, Step = 1.5 V to 3.5 V, R_L = 10 kΩ‡, C_L = 100 pF‡	To 0.1%	25°C		8.5		µs
			To 0.01%			15.5		
ϕ_m	Phase margin at unity gain	R_L = 10 kΩ‡,	C_L = 100 pF‡	25°C		66°		
	Gain margin			25°C		11		dB

† Full range for the C version is 0°C to 70°C. Full range for the I version is –40°C to 85°C.
‡ Referenced to 2.5 V

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

PARAMETER		TEST CONDITIONS	T_A†	TLV2422Q, TLV2422M			TLV2422AQ, TLV2422AM			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{IC} = 0, V_{DD}± = ±2.5 V, V_O = 0, R_S = 50 Ω	25°C		300	2000		300	950	µV
			Full range			2500			1800	
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
			Full range			150			150	
I_{IB}	Input bias current		25°C		1			1		pA
			Full range			300			300	
V_{ICR}	Common-mode input voltage range	$\lvert V_{IO}\rvert$ ≤ 5 mV, R_S = 50 Ω	25°C	0 to 4.5	–0.25 to 4.75		0 to 4.5	–0.25 to 4.75		V
			Full range	0 to 4.2			0 to 4.2			
V_{OH}	High-level output voltage	I_{OH} = –100 µA	25°C		4.97			4.97		V
		I_{OH} = –1 mA	25°C		4.75			4.75		
			Full range	4.5			4.5			
V_{OL}	Low-level output voltage	V_{IC} = 2.5 V, I_{OL} = 100 µA	25°C		0.04			0.04		V
		V_{IC} = 2.5 V, I_{OL} = 500 µA	25°C		0.15			0.15		
			Full range			0.5			0.5	
A_{VD}	Large-signal differential voltage amplification	V_{IC} = 2.5 V, V_O = 1 V to 4 V, R_L = 10 kΩ‡	25°C	8	12		8	12		V/mV
			Full range	3			3			
		V_{IC} = 2.5 V, V_O = 1 V to 4 V, R_L = 1 MΩ‡	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	25°C		8			8		pF
z_o	Closed-loop output impedance	f = 100 kHz, A_V = 10	25°C		130			130		Ω
CMRR	Common-mode rejection ratio	V_{IC} = V_{ICR} min, V_O = 2.5 V, R_S = 50 Ω	25°C	70	90		70	90		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			
I_{DD}	Supply current	V_O = 2.5 V, No load	25°C		100	150		100	150	µA
			Full range			175			175	

† 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.

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

PARAMETER		TEST CONDITIONS		T_A†	TLV2422Q, TLV2422M, TLV2422AQ, TLV2422AM MIN	TYP	MAX	UNIT
SR	Slew rate at unity gain	V_O = 1.5 V to 3.5 V, C_L = 100 pF‡	R_L = 10 kΩ‡,	25°C	0.01	0.02		V/µs
				Full range	0.008			
V_n	Equivalent input noise voltage	f = 10 Hz		25°C		100		nV/√Hz
		f = 1 kHz		25°C		18		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C		1.9		µV
		f = 0.1 Hz to 10 Hz		25°C		2.8		
I_n	Equivalent input noise current			25°C		0.6		fA√Hz
THD + N	Total harmonic distortion plus noise	V_O = 1.5 V to 3.5 V, f = 1 kHz, R_L = 10 kΩ‡	A_V = 1	25°C		0.24%		
			A_V = 10			1.7%		
	Gain-bandwidth product	f = 10 kHz, C_L = 100 pF‡	R_L =10 kΩ‡,	25°C		52		kHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 2 V, R_L = 10 kΩ‡,	A_V = 1, C_L = 100 pF‡	25°C		5.3		kHz
t_s	Settling time	A_V = –1, Step = 1.5 V to 3.5 V, R_L = 10 kΩ‡, C_L = 100 pF‡	To 0.1%	25°C		8.5		µs
			To 0.01%			15.5		
ϕ_m	Phase margin at unity gain	R_L = 10 kΩ‡,	C_L = 100 pF‡	25°C		66°		
	Gain margin			25°C		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

Table of Graphs

			FIGURE
V_{IO}	Input offset voltage	Distribution vs Common-mode input voltage	2,3 4,5
α_{VIO}	Temperature coefficient	Distribution	6,7
I_{IB}/I_{IO}	Input bias and input offset currents	vs Free-air temperature	8
V_{OH}	High-level output voltage	vs High-level output current	9,11
V_{OL}	Low-level output voltage	vs Low-level output current	10,12
$V_{O(PP)}$	Maximum peak-to-peak output voltage	vs Frequency	13
I_{OS}	Short-circuit output current	vs Supply voltage vs Free-air temperature	14 15
V_{ID}	Differential input voltage	vs Output voltage	16,17
	Differential gain	vs Load resistance	18
A_{VD}	Large-signal differential voltage amplification	vs Frequency vs Free-air temperature	19,20 21,22
z_o	Output impedance	vs Frequency	23,24
CMRR	Common-mode rejection ratio	vs Frequency vs Free-air temperature	25 26
k_{SVR}	Supply-voltage rejection ratio	vs Frequency vs Free-air temperature	27,28 29
I_{DD}	Supply current	vs Supply voltage	30
SR	Slew rate	vs Load capacitance vs Free-air temperature	31 32
V_O	Inverting large-signal pulse response		33,34
V_O	Voltage-follower large-signal pulse response		35,36
V_O	Inverting small-signal pulse response		37,38
V_O	Voltage-follower small-signal pulse response		39,40
V_n	Equivalent input noise voltage	vs Frequency	41, 42
	Noise voltage (referred to input)	Over a 10-second period	43
THD + N	Total harmonic distortion plus noise	vs Frequency	44,45
	Gain-bandwidth product	vs Supply voltage vs Free-air temperature	46 47
ϕ_m	Phase margin	vs Frequency vs Load capacitance	19,20 48
	Gain margin	vs Load capacitance	49
B_1	Unity-gain bandwidth	vs Load capacitance	50

TYPICAL CHARACTERISTICS

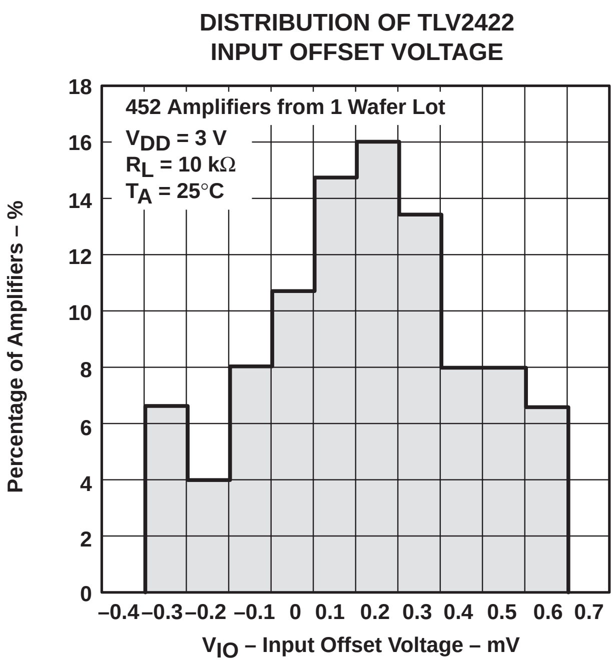


Figure 2

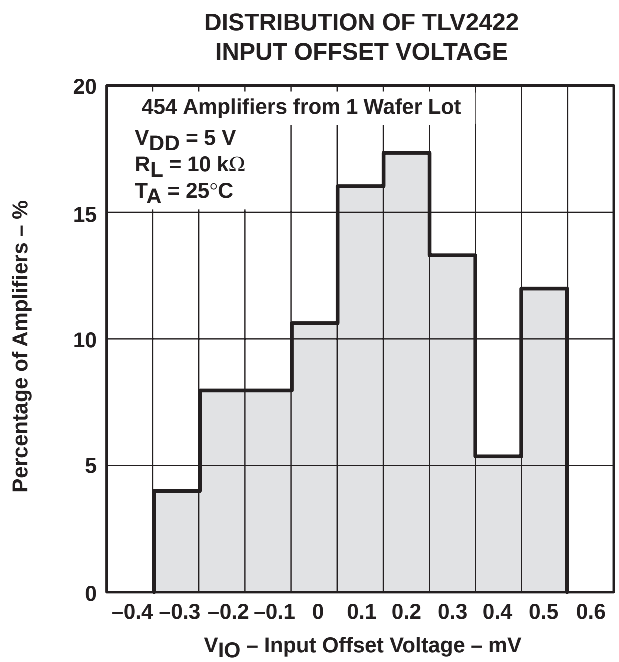


Figure 3

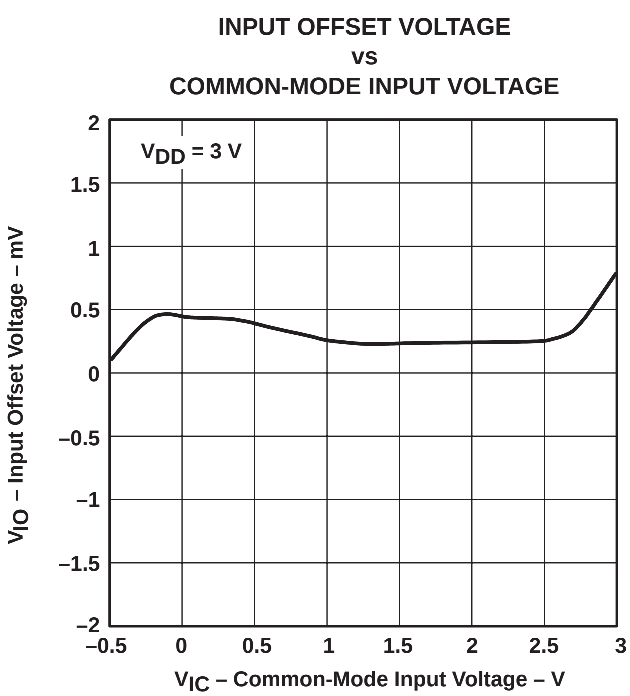


Figure 4

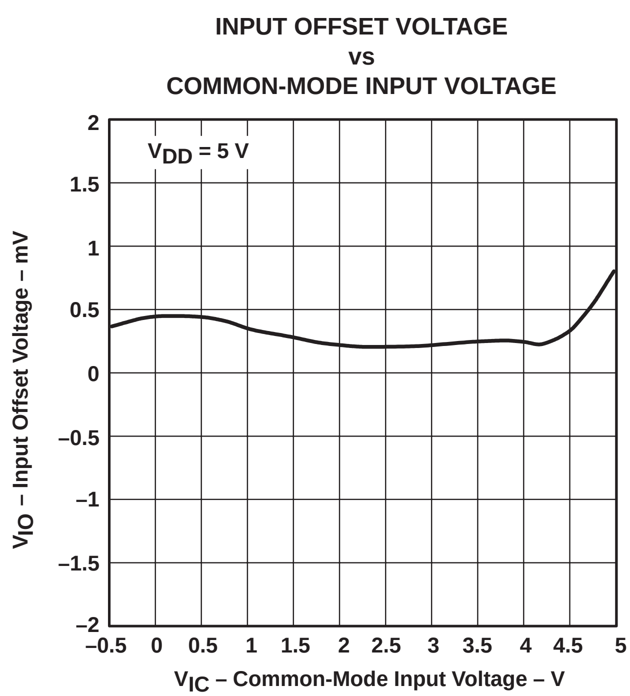


Figure 5

TYPICAL CHARACTERISTICS

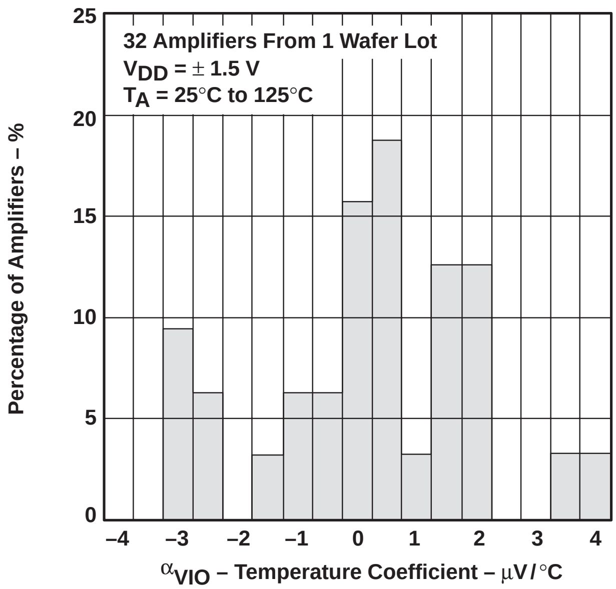


Figure 6

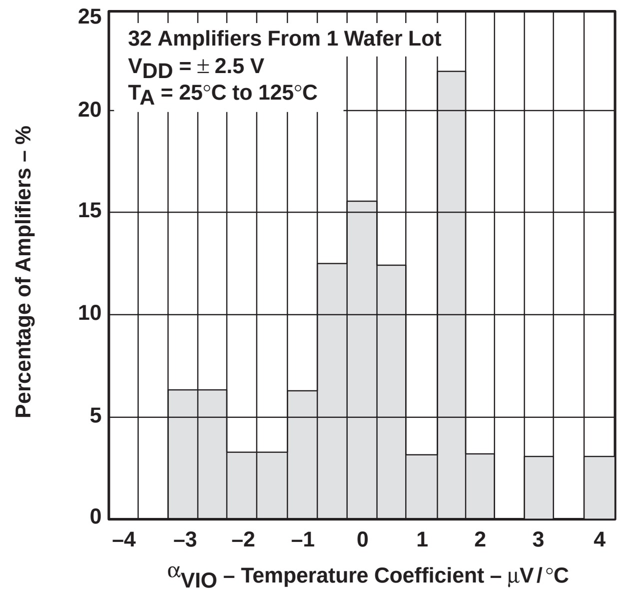


Figure 7

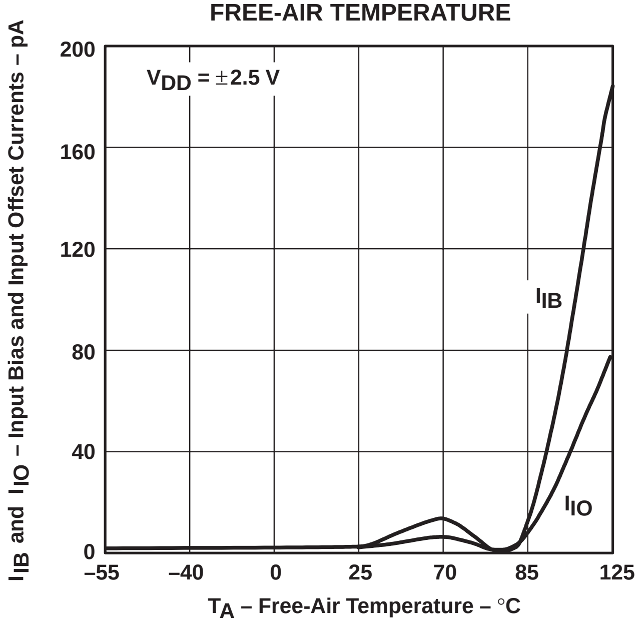


Figure 8

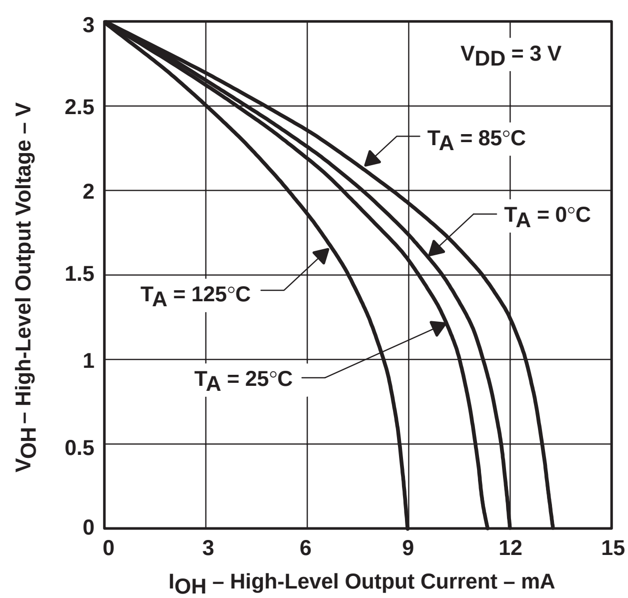


Figure 9

TYPICAL CHARACTERISTICS

LOW-LEVEL OUTPUT VOLTAGE vs LOW-LEVEL OUTPUT CURRENT

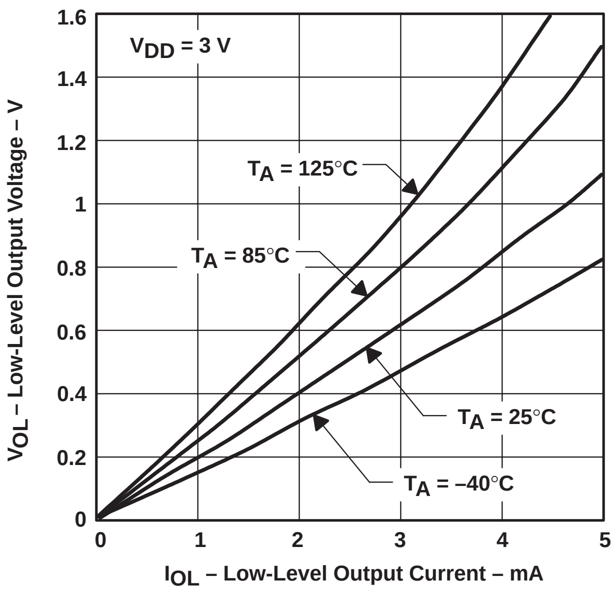


Figure 10

HIGH-LEVEL OUTPUT VOLTAGE vs HIGH-LEVEL OUTPUT CURRENT

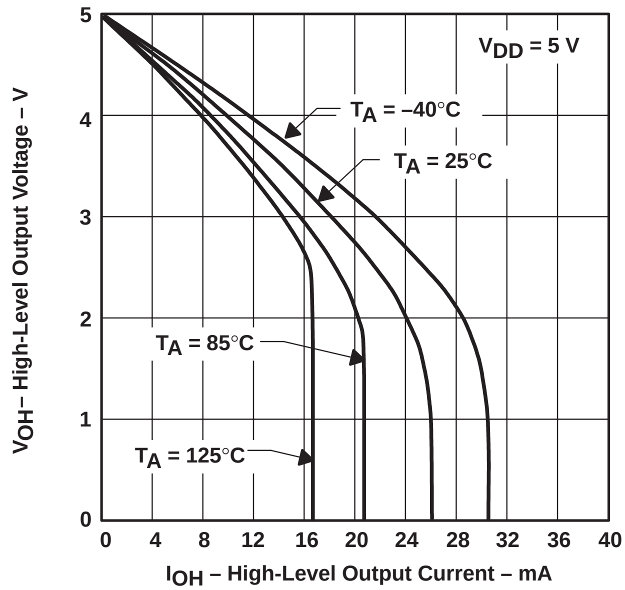


Figure 11

LOW-LEVEL OUTPUT VOLTAGE vs LOW-LEVEL OUTPUT CURRENT

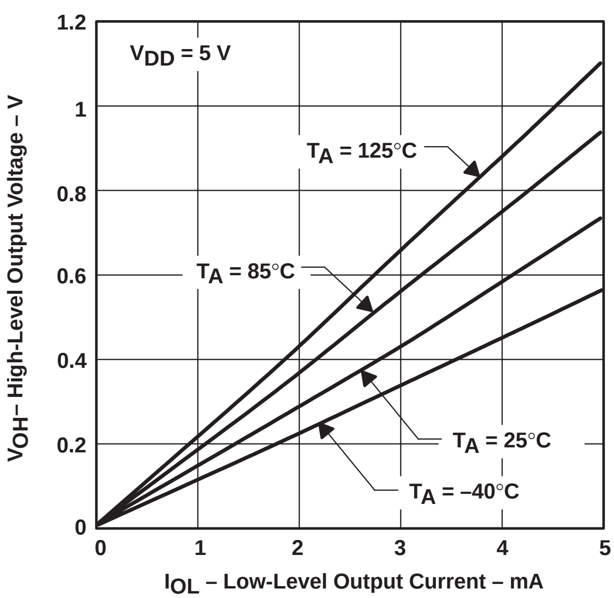


Figure 12

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE vs FREQUENCY

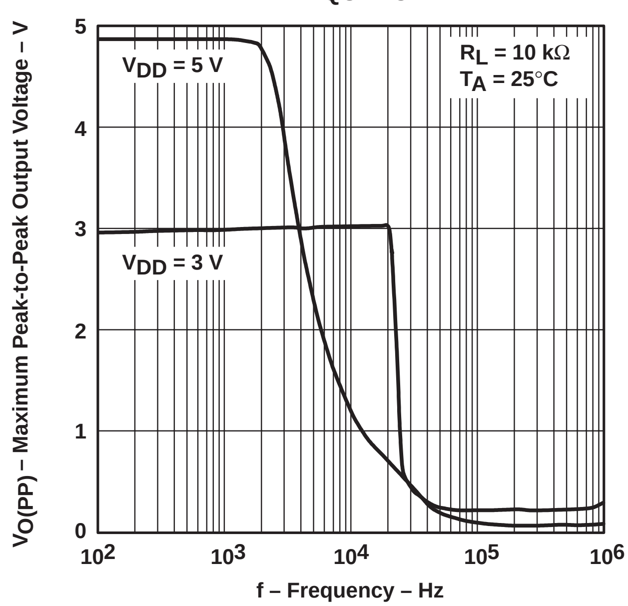


Figure 13

TYPICAL CHARACTERISTICS

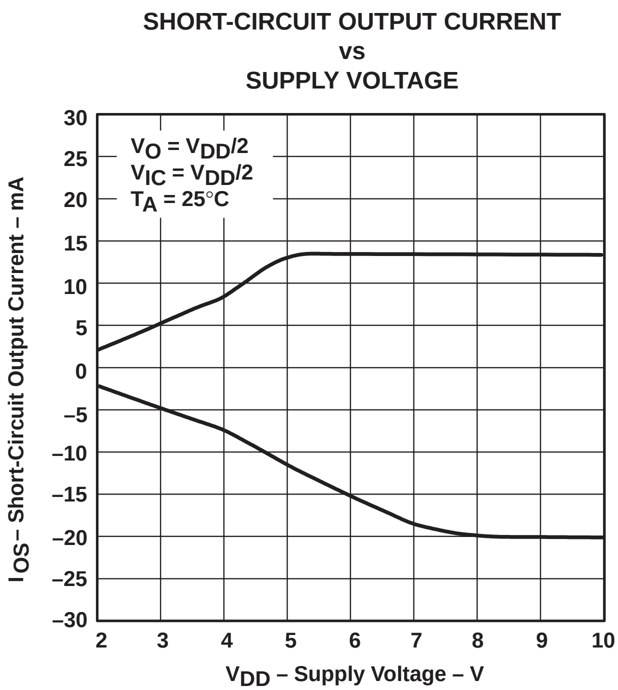


Figure 14

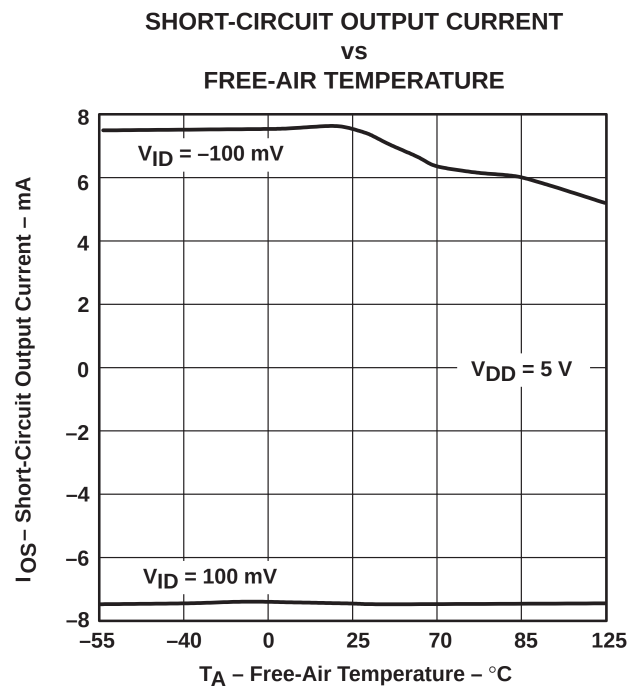


Figure 15

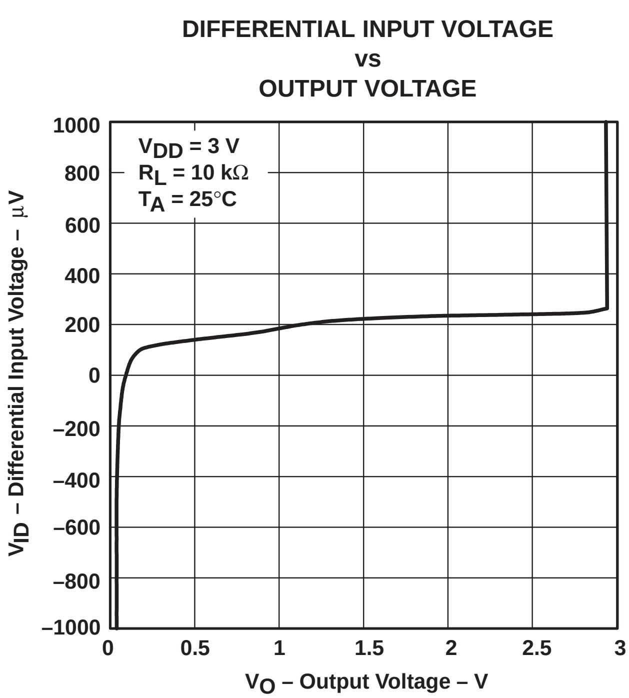


Figure 16

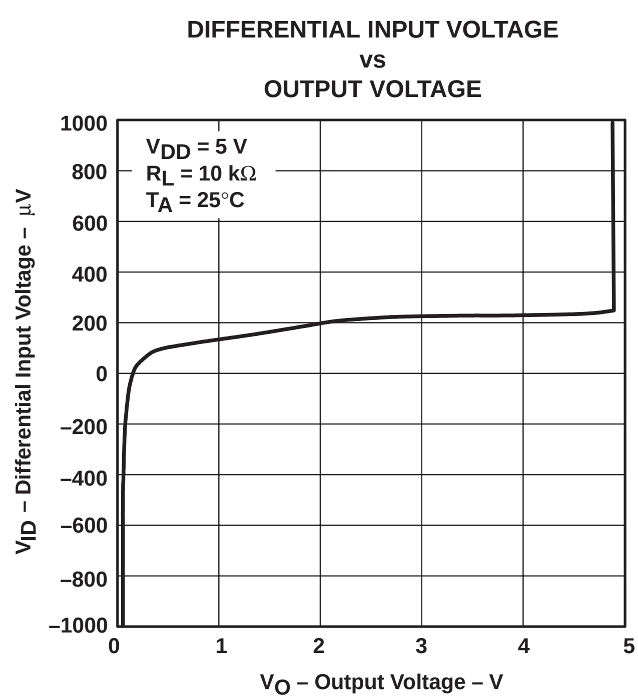


Figure 17

TYPICAL CHARACTERISTICS

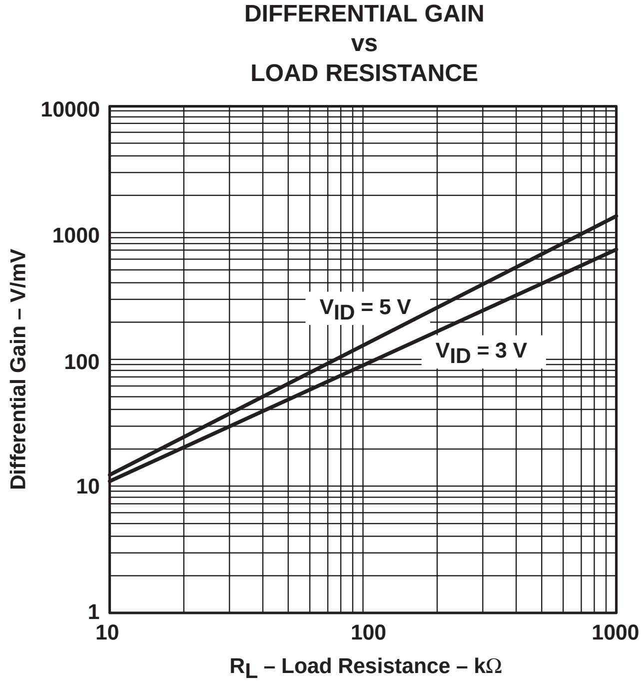


Figure 18

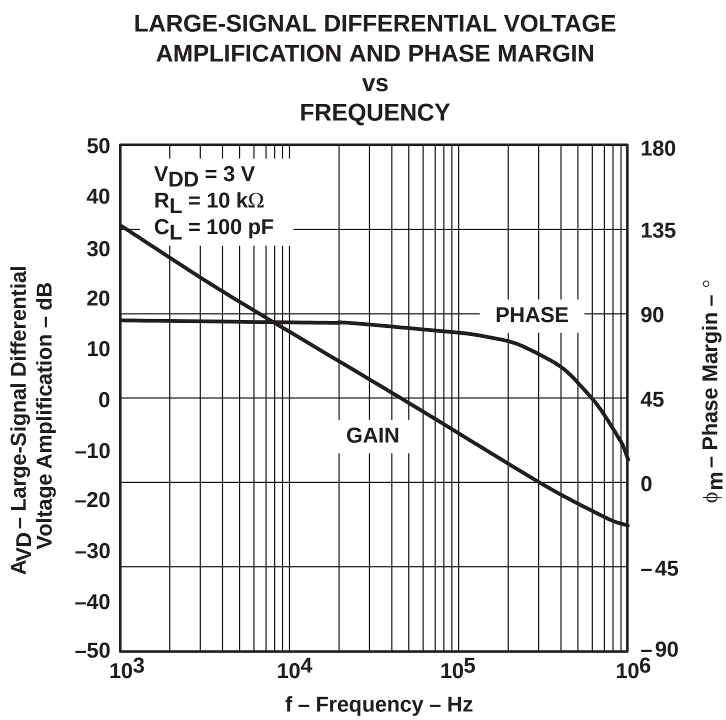


Figure 19

TYPICAL CHARACTERISTICS

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE MARGIN vs FREQUENCY

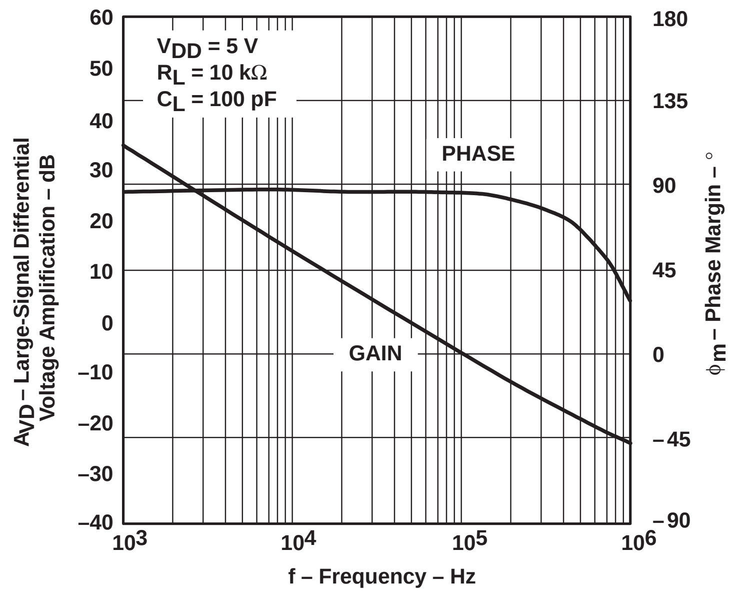


Figure 20

DIFFERENTIAL VOLTAGE AMPLIFICATION vs FREE-AIR TEMPERATURE

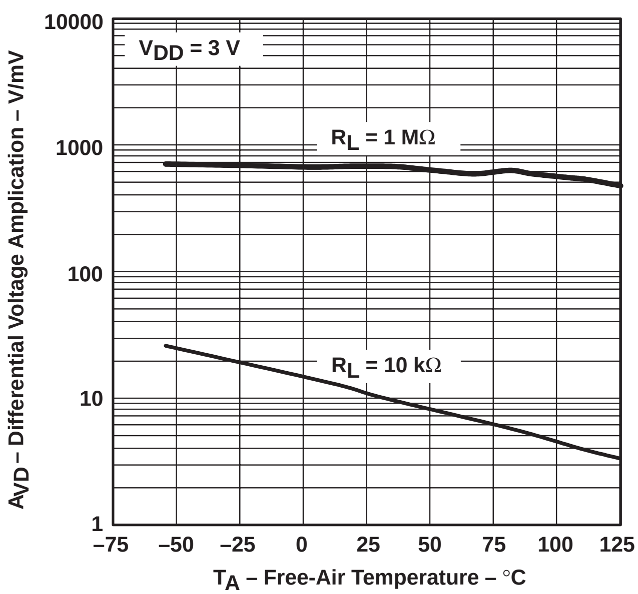


Figure 21

DIFFERENTIAL VOLTAGE AMPLIFICATION vs FREE-AIR TEMPERATURE

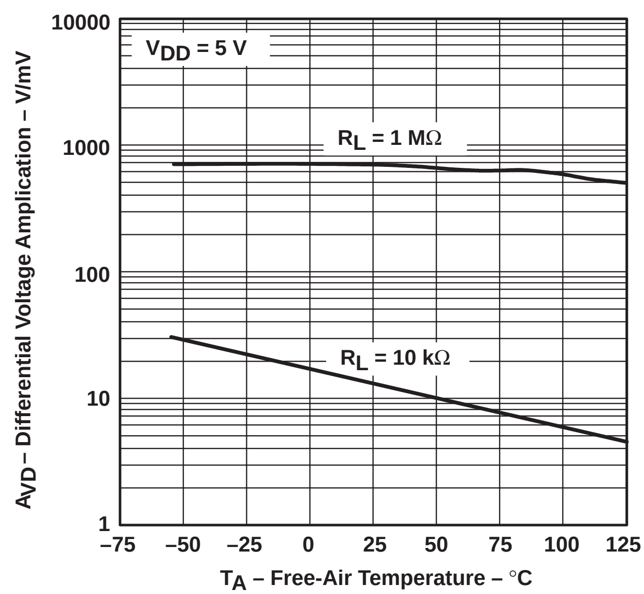


Figure 22

TYPICAL CHARACTERISTICS

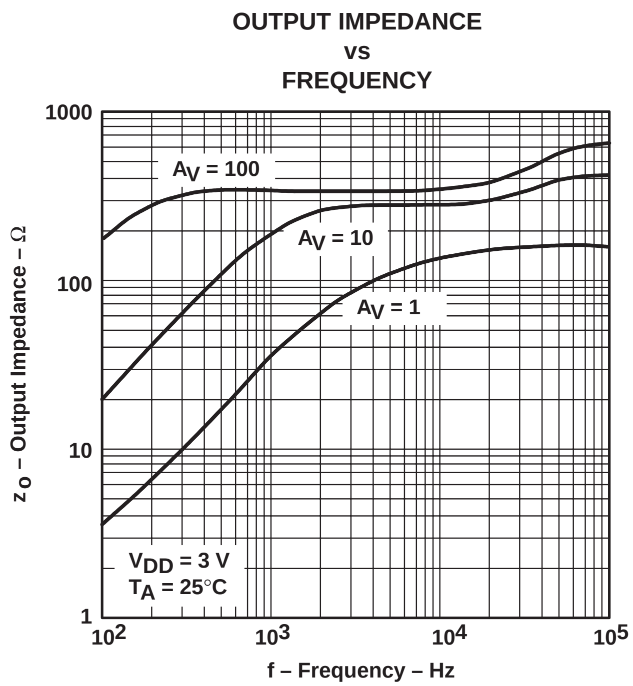


Figure 23

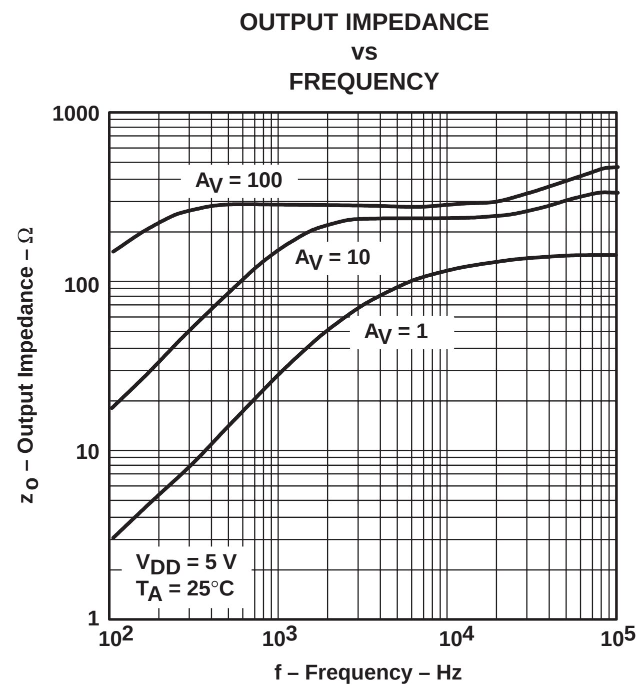


Figure 24

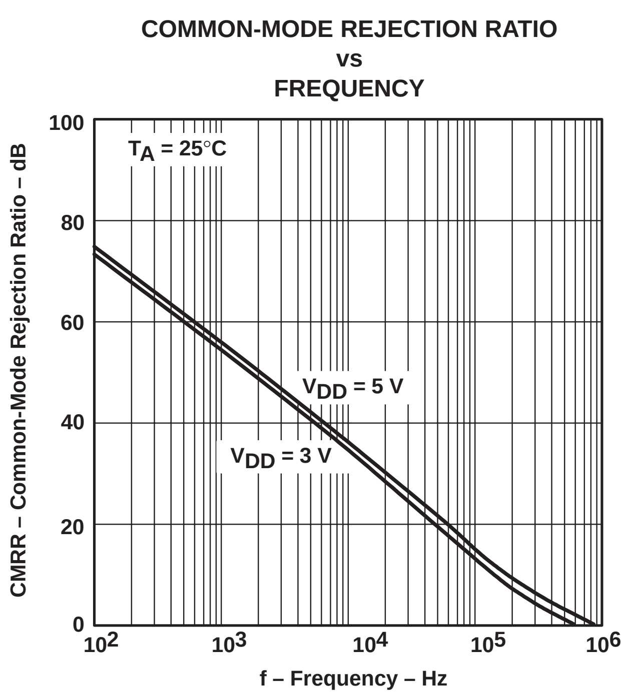


Figure 25

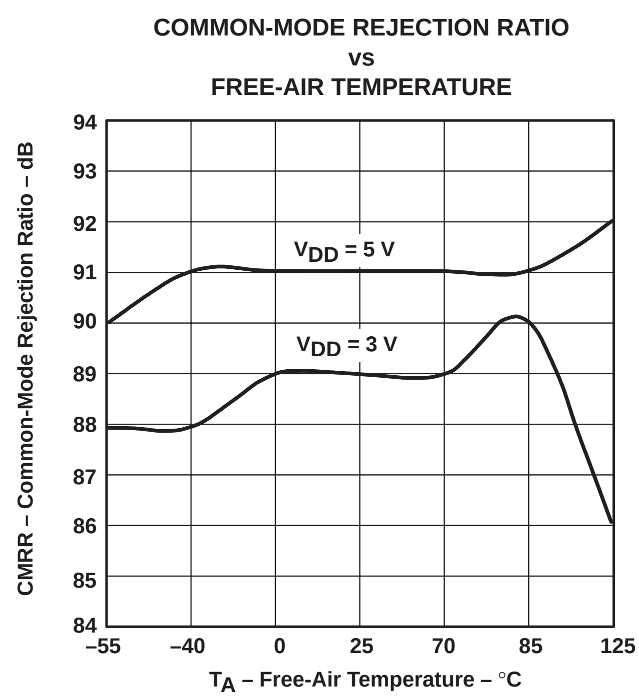


Figure 26

TYPICAL CHARACTERISTICS

SUPPLY-VOLTAGE REJECTION RATIO
vs
FREQUENCY

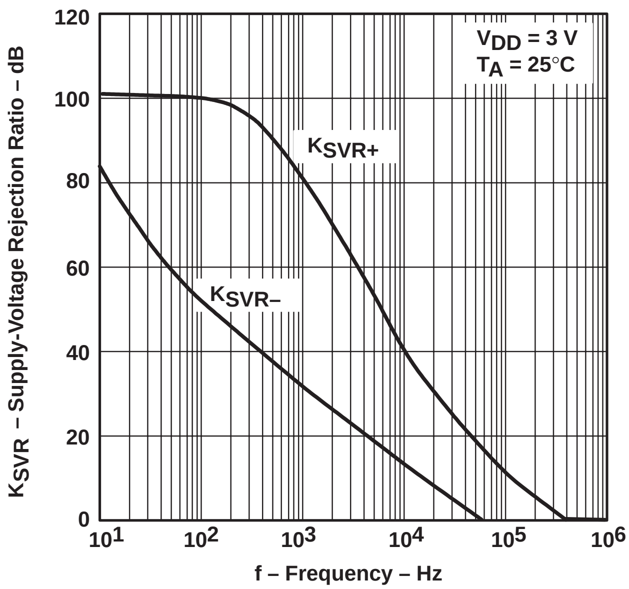


Figure 27

SUPPLY-VOLTAGE REJECTION RATIO
vs
FREQUENCY

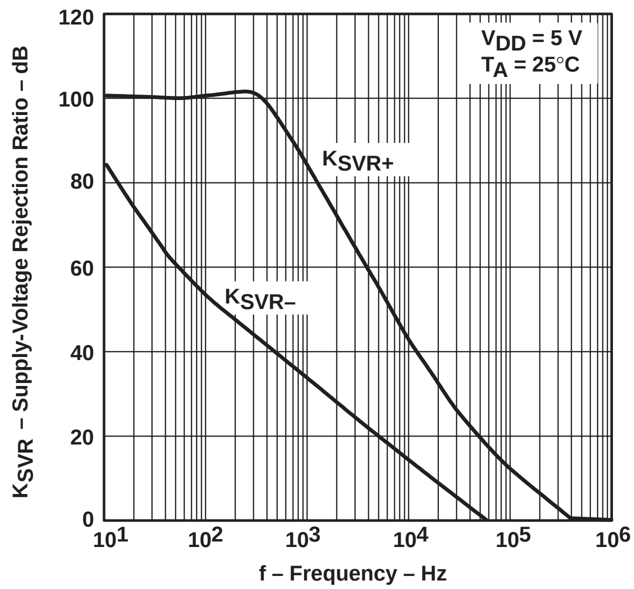


Figure 28

SUPPLY-VOLTAGE REJECTION RATIO
vs
FREE-AIR TEMPERATURE

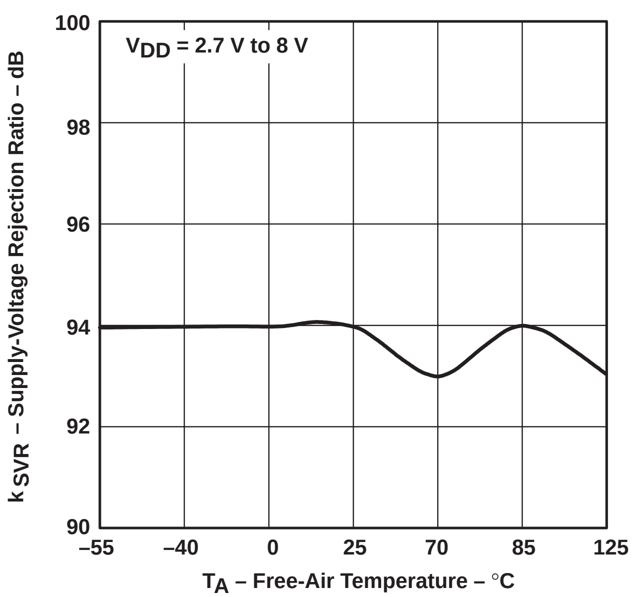


Figure 29

SUPPLY CURRENT
vs
SUPPLY VOLTAGE

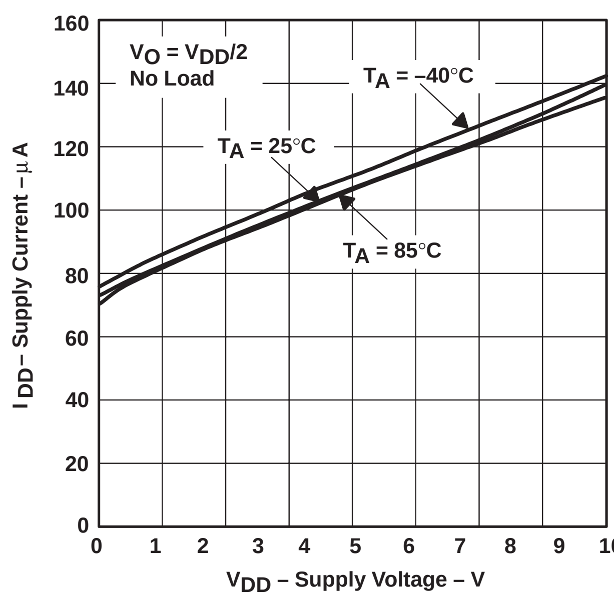


Figure 30

TYPICAL CHARACTERISTICS

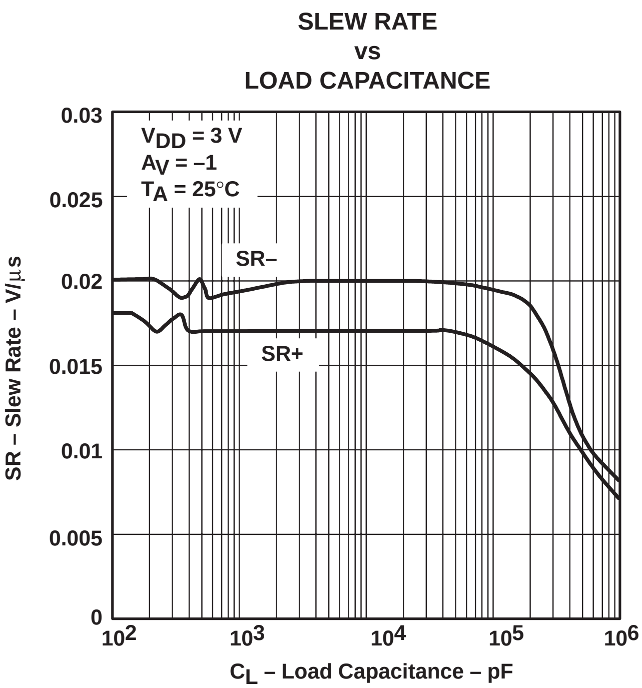


Figure 31

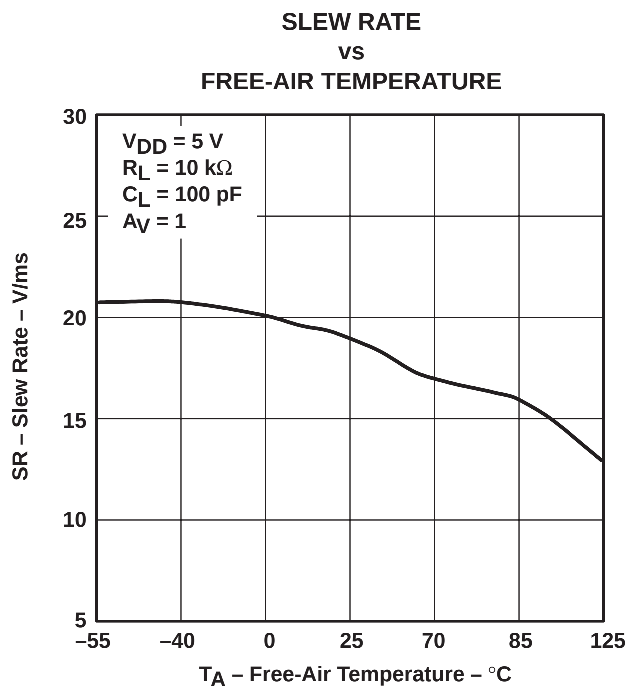


Figure 32

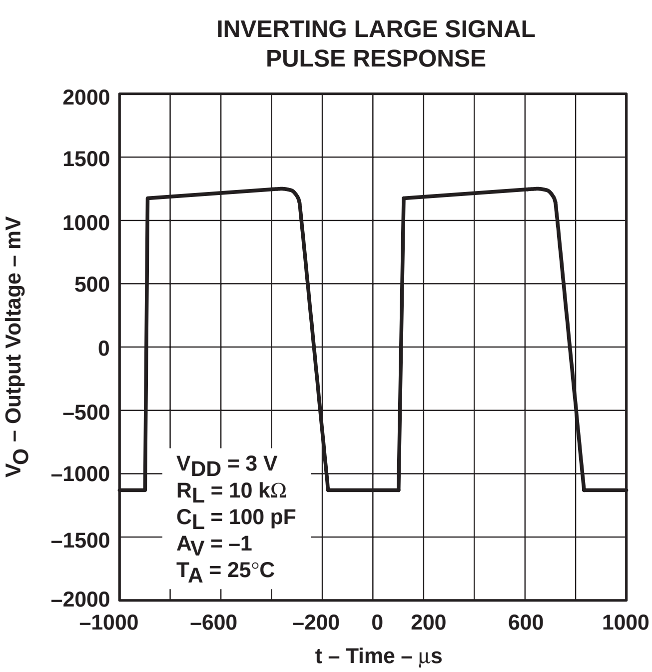


Figure 33

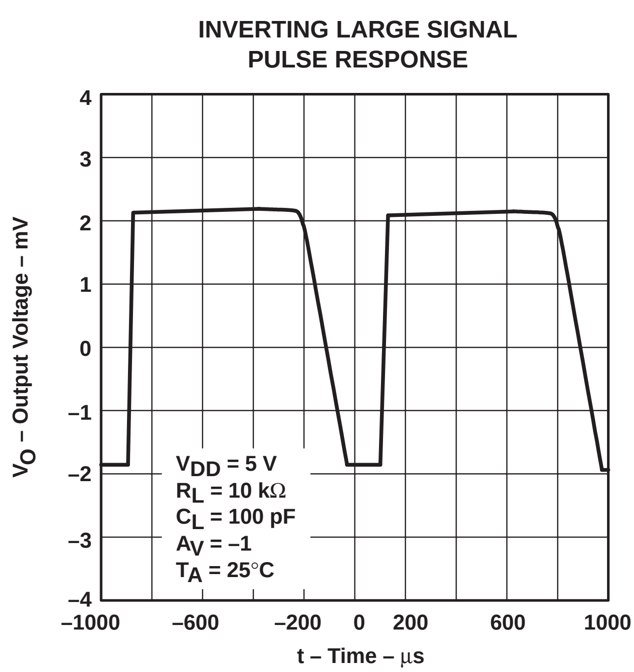


Figure 34

TYPICAL CHARACTERISTICS

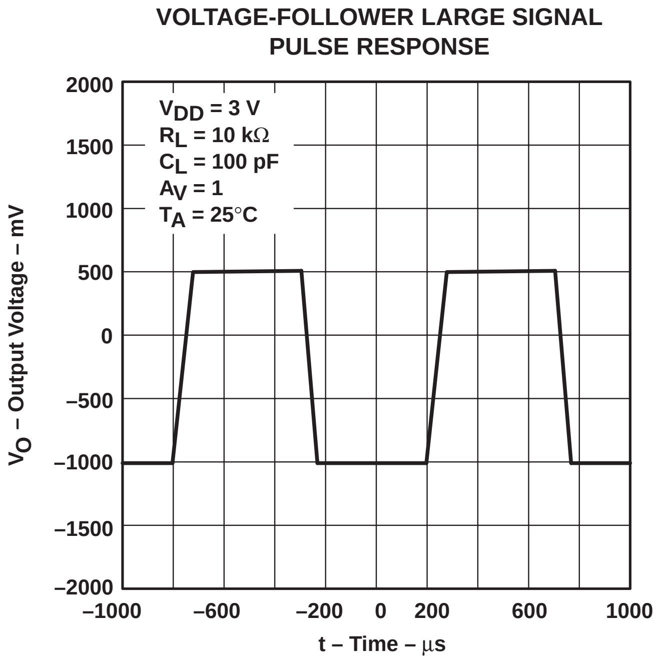


Figure 35

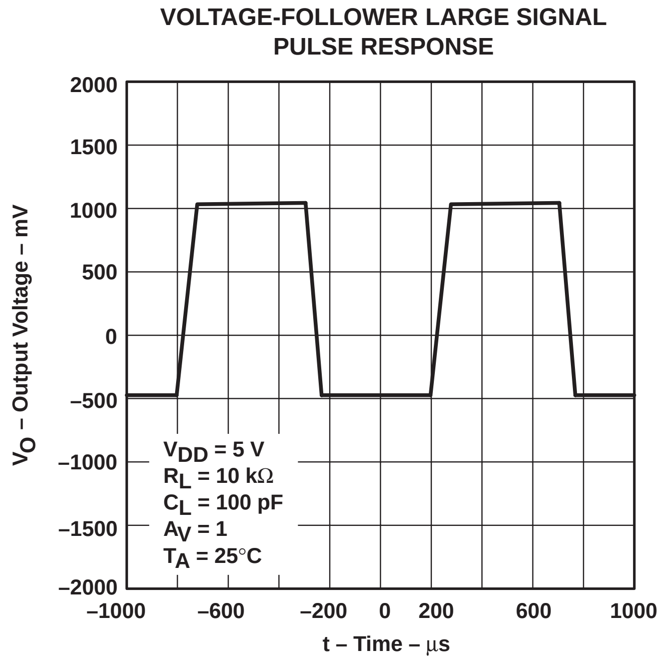


Figure 36

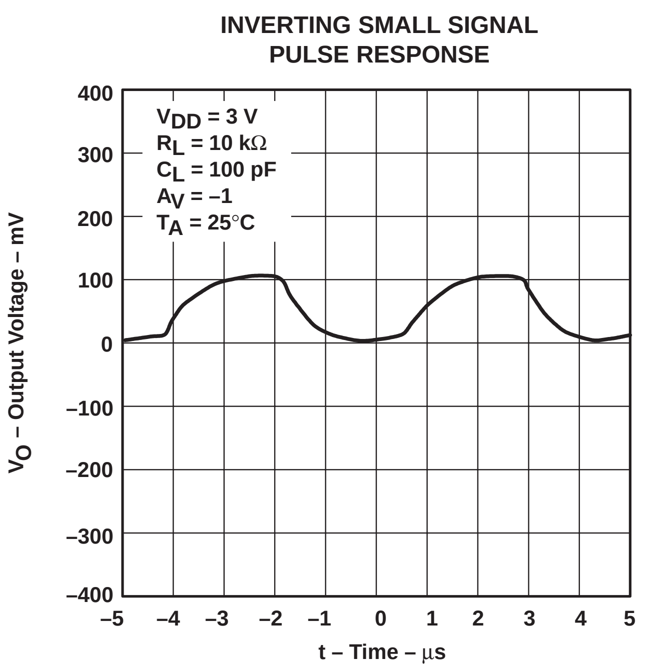


Figure 37

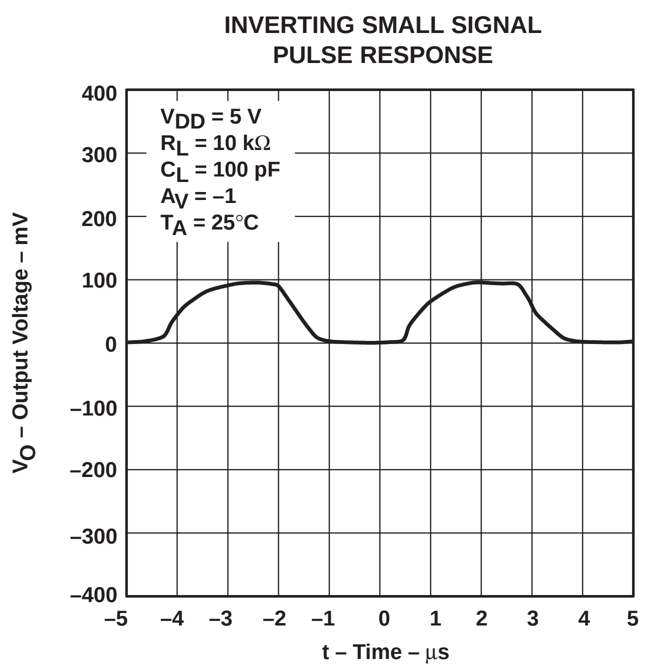


Figure 38

TYPICAL CHARACTERISTICS

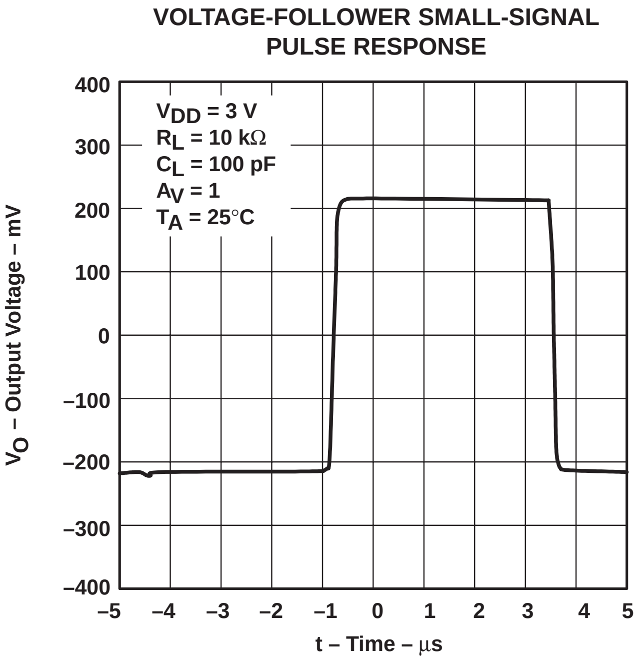


Figure 39

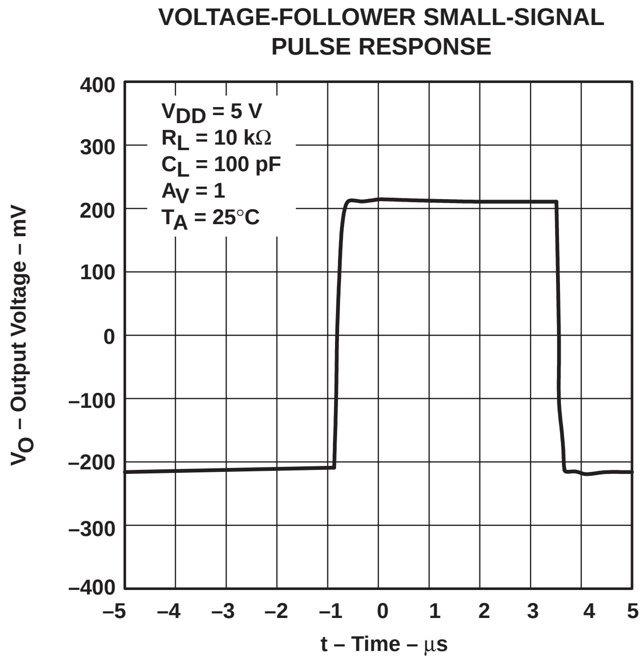


Figure 40

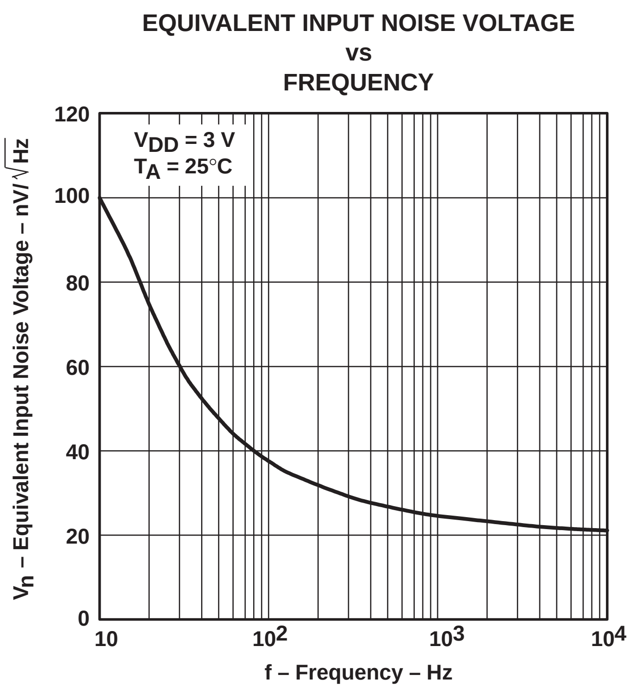


Figure 41

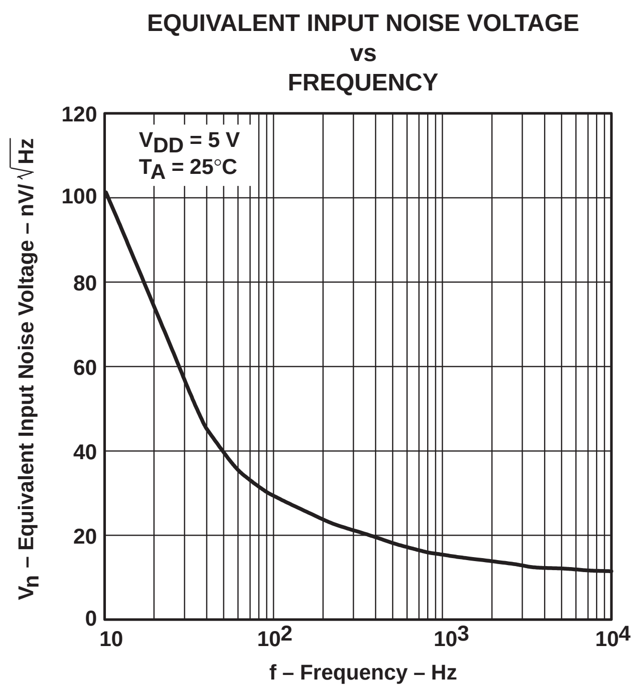


Figure 42

TYPICAL CHARACTERISTICS

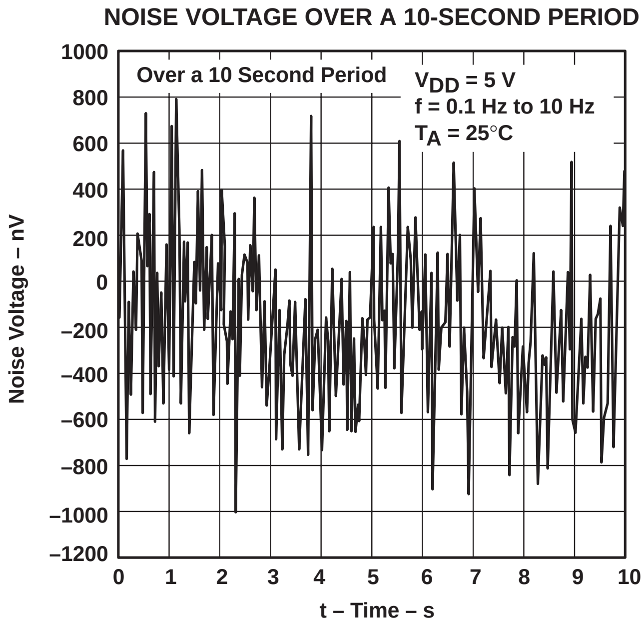


Figure 43

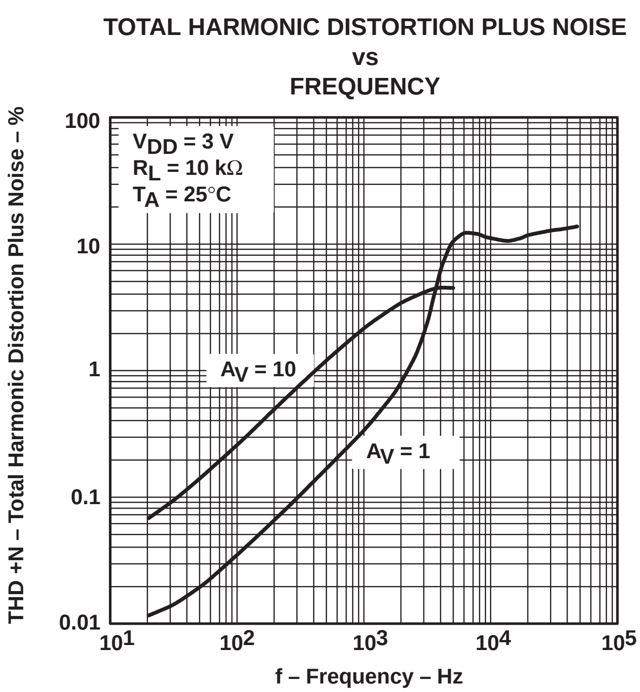


Figure 44

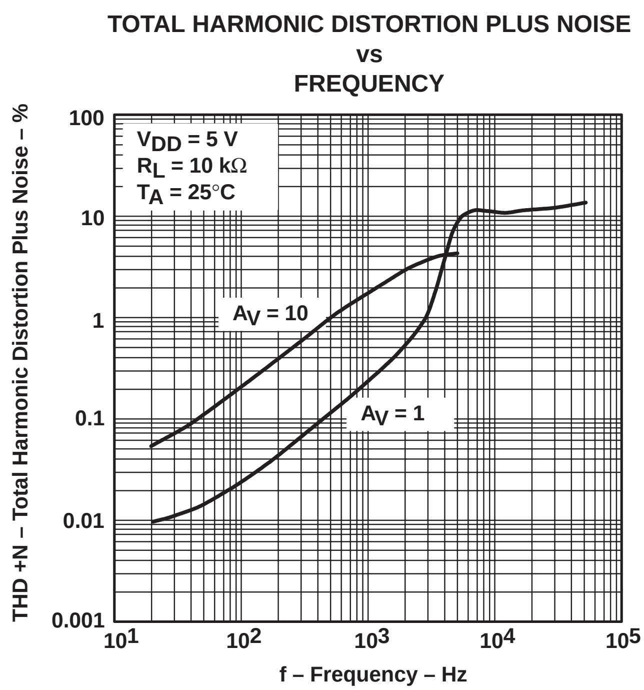


Figure 45

TYPICAL CHARACTERISTICS

GAIN-BANDWIDTH PRODUCT
vs
SUPPLY VOLTAGE

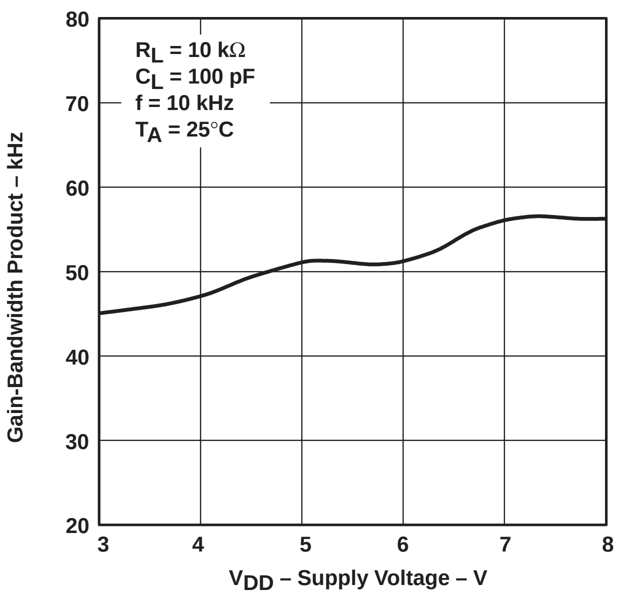


Figure 46

GAIN-BANDWIDTH PRODUCT
vs
FREE-AIR TEMPERATURE

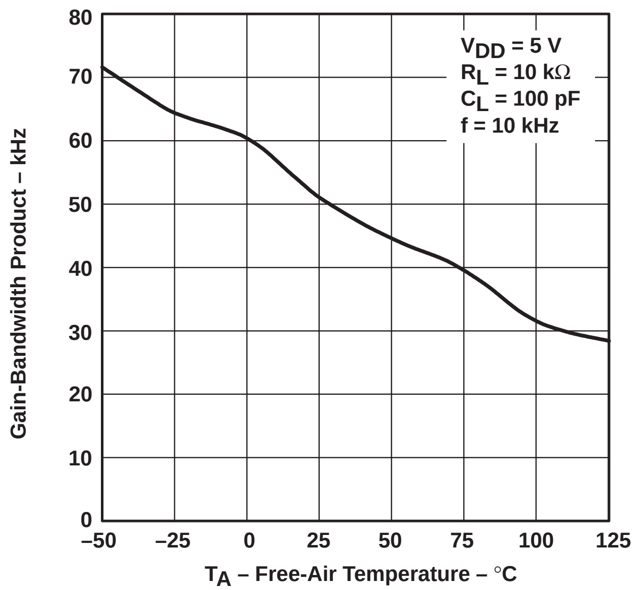


Figure 47

PHASE MARGIN
vs
LOAD CAPACITANCE

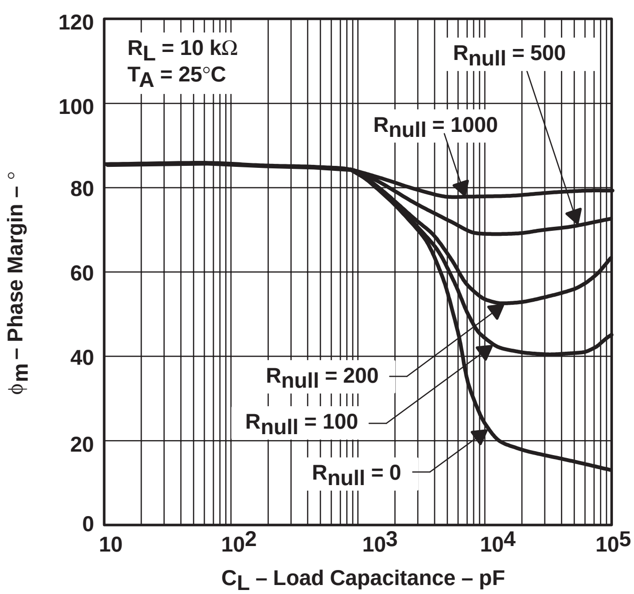


Figure 48

GAIN MARGIN
vs
LOAD CAPACITANCE

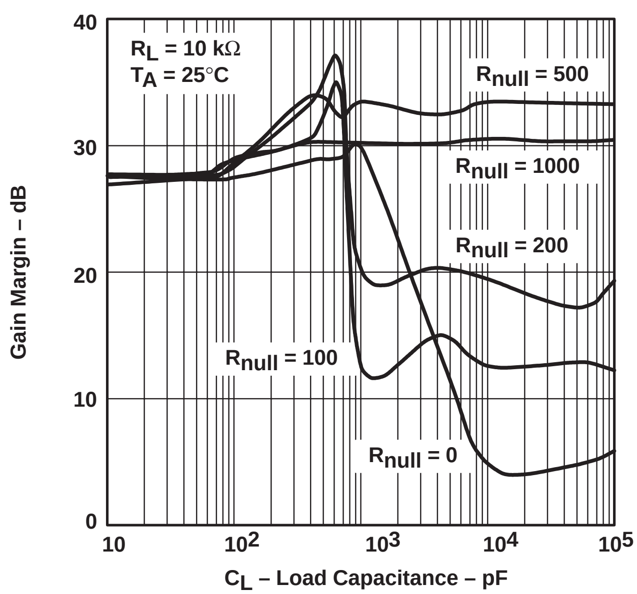


Figure 49

TYPICAL CHARACTERISTICS

UNITY-GAIN BANDWIDTH
vs
LOAD CAPACITANCE

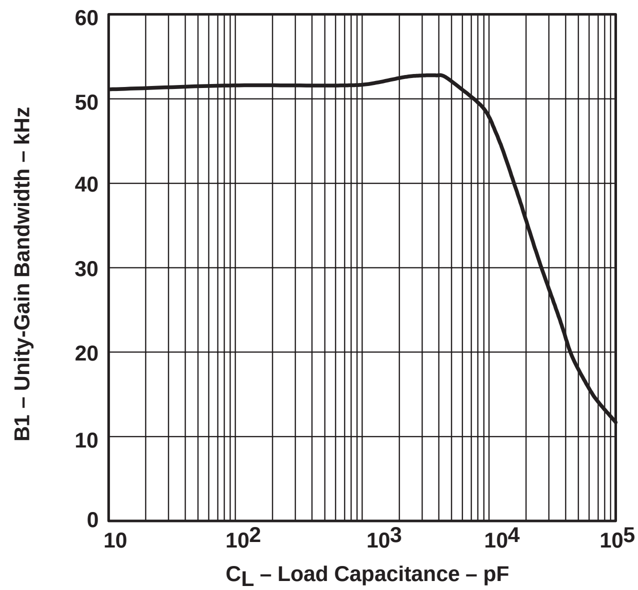
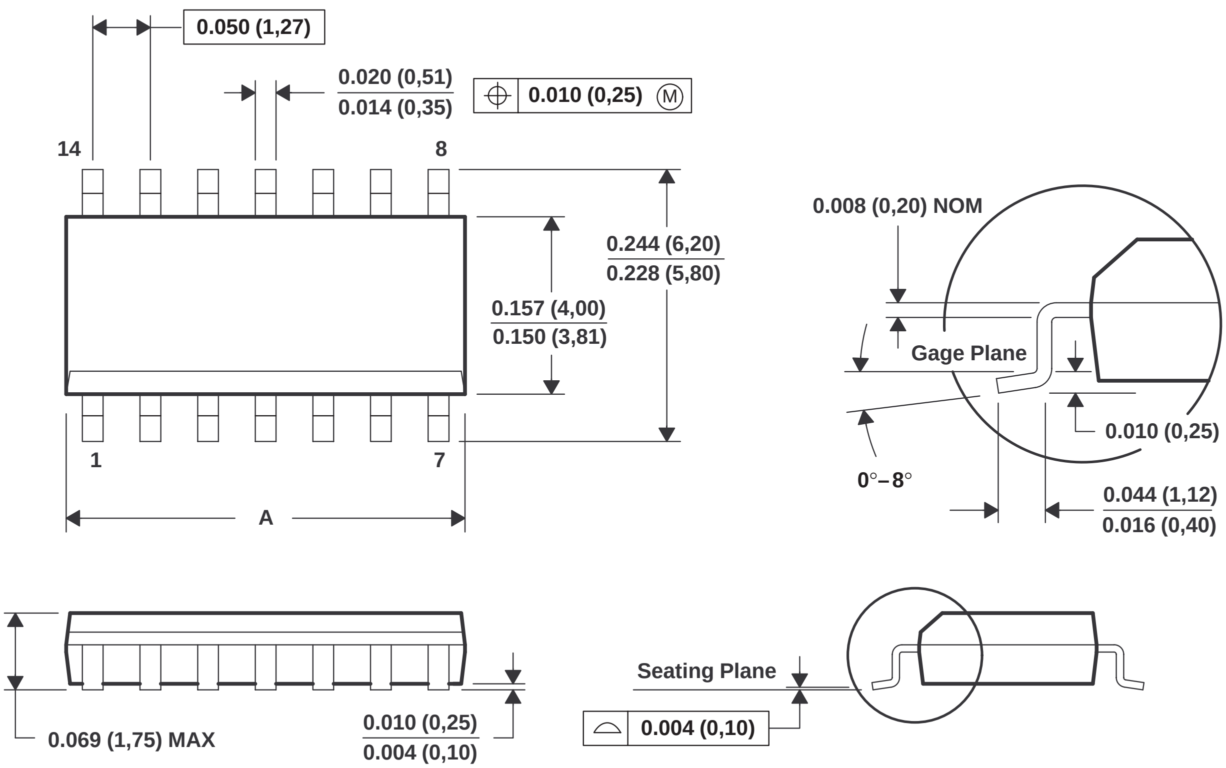


Figure 50

MECHANICAL DATA

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)

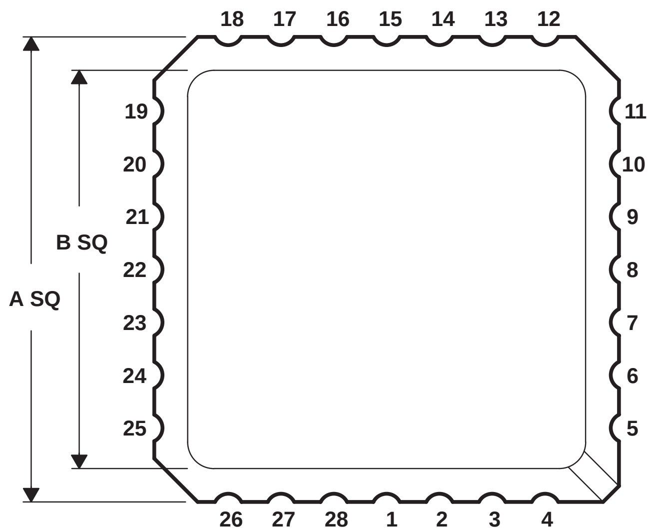
4040047/D 10/96

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. Falls within JEDEC MS-012

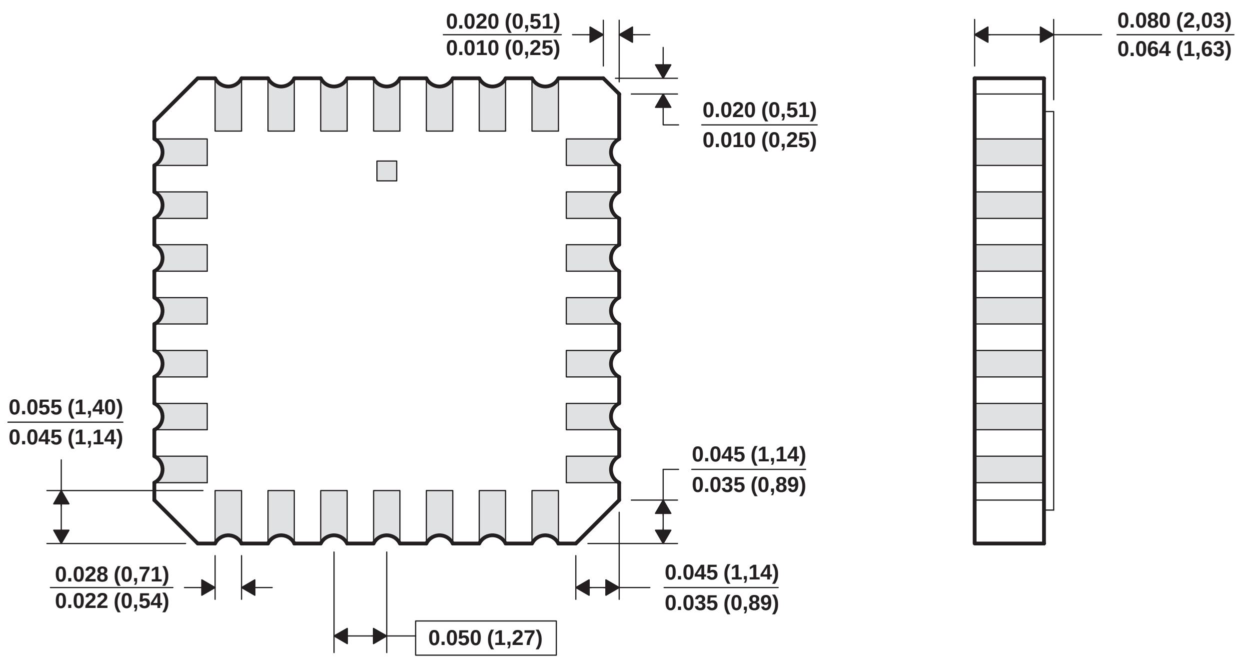
MECHANICAL DATA

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)

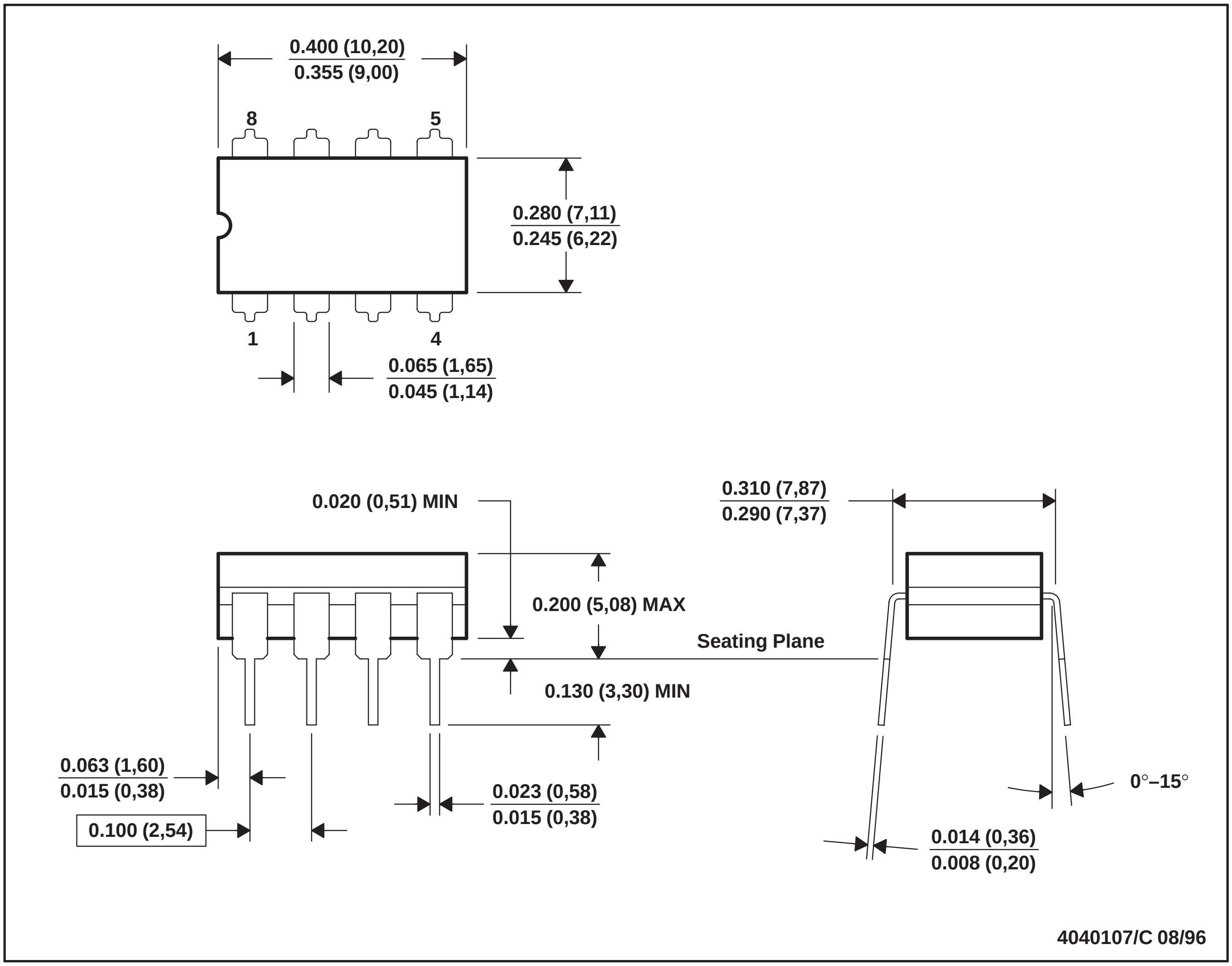


4040140 / D 10/96

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

MECHANICAL DATA

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

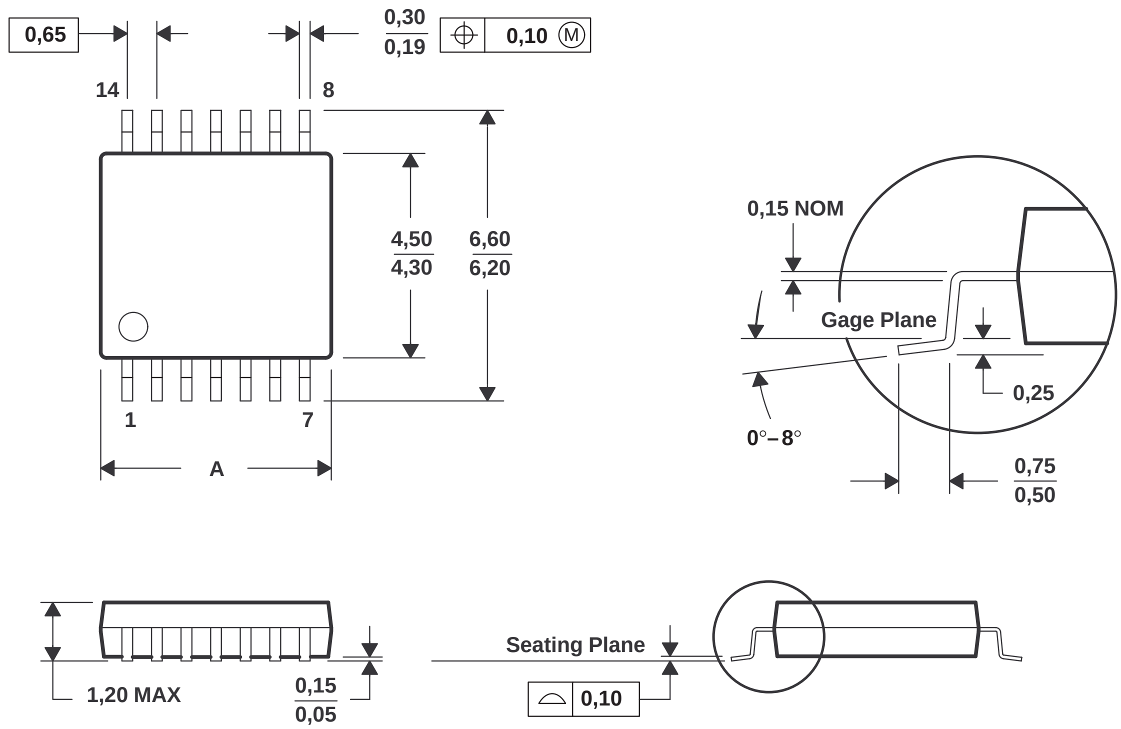


NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
E.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

MECHANICAL DATA

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

14 PIN SHOWN



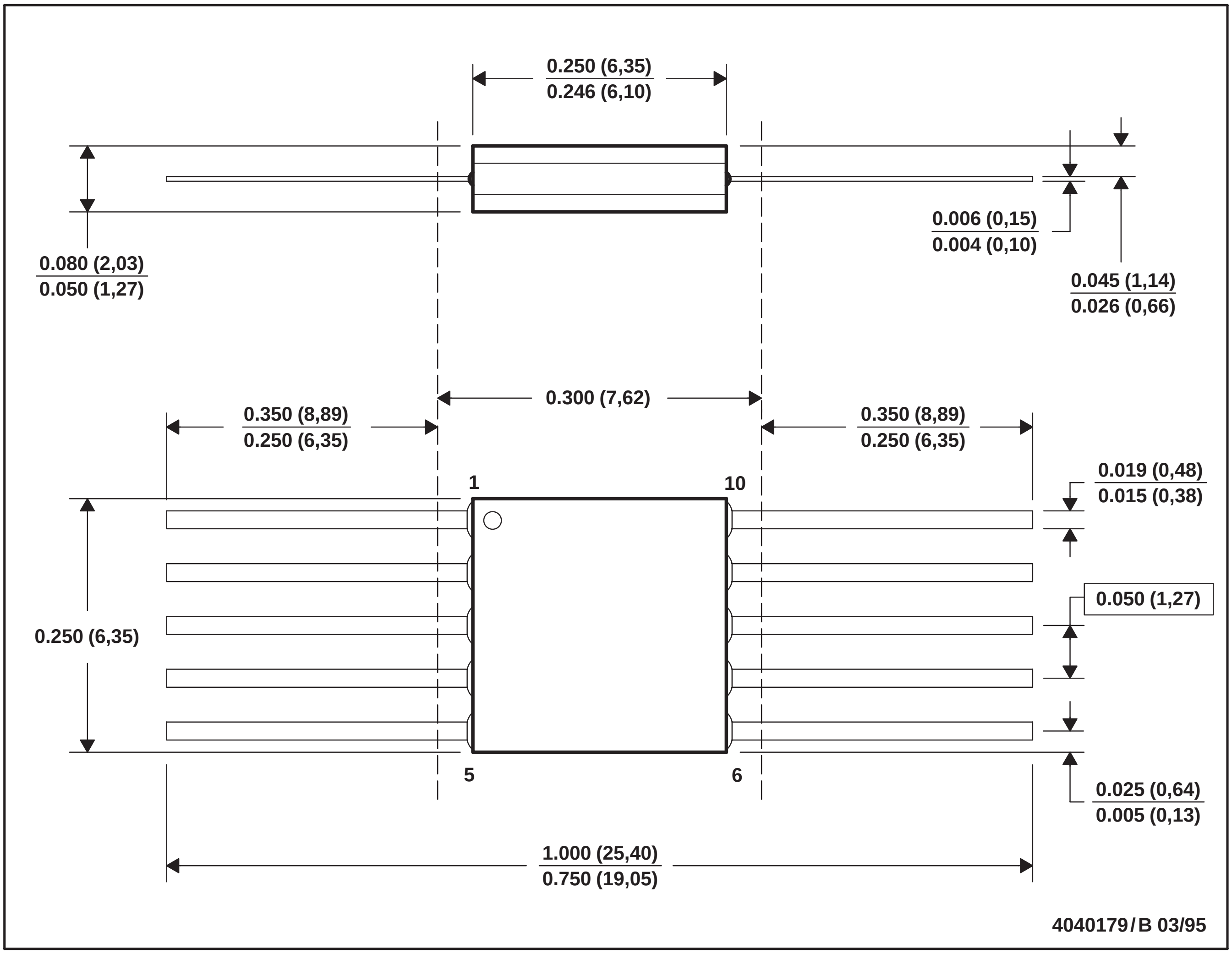
PINS ** / DIM	8	14	16	20	24	28
A MAX	3,10	5,10	5,10	6,60	7,90	9,80
A MIN	2,90	4,90	4,90	6,40	7,70	9,60

4040064/E 08/96

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

MECHANICAL DATA

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

IMPORTANT NOTICE

Texas Instruments and its subsidiaries (TI) reserve the right to make changes to their products or to discontinue any product or service without notice, and advise customers to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgement, including those pertaining to warranty, patent infringement, and limitation of liability.

TI warrants performance of its semiconductor products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are utilized to the extent TI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

CERTAIN APPLICATIONS USING SEMICONDUCTOR PRODUCTS MAY INVOLVE POTENTIAL RISKS OF DEATH, PERSONAL INJURY, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE ("CRITICAL APPLICATIONS"). TI SEMICONDUCTOR PRODUCTS ARE NOT DESIGNED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS. INCLUSION OF TI PRODUCTS IN SUCH APPLICATIONS IS UNDERSTOOD TO BE FULLY AT THE CUSTOMER'S RISK.

In order to minimize risks associated with the customer's applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance or customer product design. TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used. TI's publication of information regarding any third party's products or services does not constitute TI's approval, warranty or endorsement thereof.