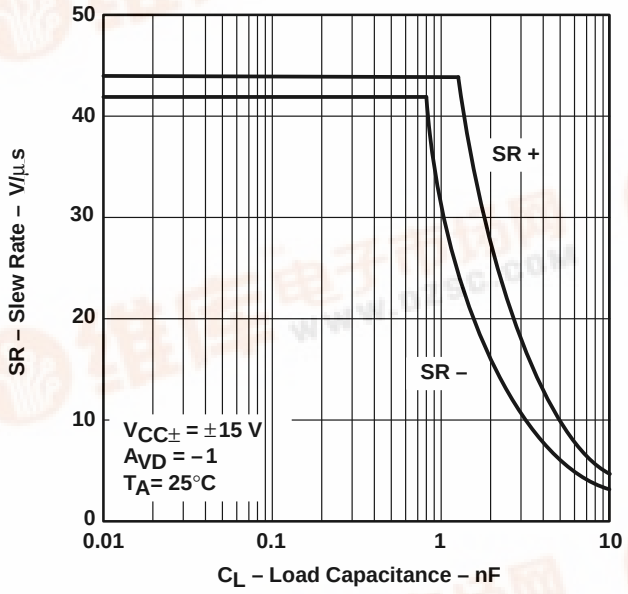
EXCALIBUR LOW-NOISE HIGH-SPEED PRECISION DUAL OPERATIONAL AMPLIFIERS

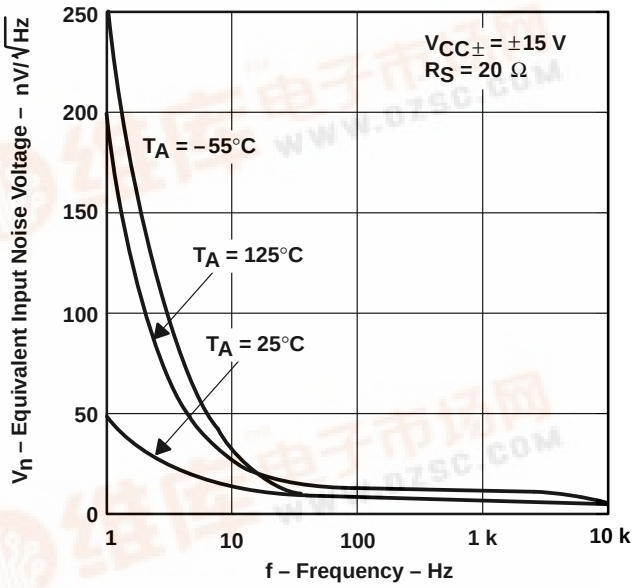
SLOS064B – DECEMBER 1990 – REVISED AUGUST 1994

- **Low Noise**
  10 Hz . . . 15 nV/√Hz
  1 kHz . . . 10.5 nV/√Hz
- **10 000-pF Load Capability**
- **20-mA Min Short-Circuit Output Current**
- **27-V/μs Min Slew Rate**
- **High Gain-Bandwidth Product . . . 5.9 MHz**
- **Low V_{IO} . . . 750 μV Max at 25°C**
- **Single or Split Supply**
- **Fast Settling Time**
  340 ns to 0.1%
  400 ns to 0.01%
- **Saturation Recovery . . . 150 ns**
- **Large Output Swing**
  V_{CC-} +0.1 V to V_{CC+} – 1 V

SLEW RATE vs LOAD CAPACITANCE



EQUIVALENT INPUT NOISE VOLTAGE vs FREQUENCY



description

The TLE2142 and TLE2142A devices are high-performance internally-compensated operational amplifiers built using Texas Instruments complementary bipolar Excalibur process. The TLE2142A is a tighter offset voltage grade of the TLE2142. Both are pin-compatible upgrades to standard industry products.

AVAILABLE OPTIONS

PACKAGED DEVICES						CHIP FORM (Y)
T_A	V_{IO}max AT 25°C	SMALL OUTLINE (D)	CHIP CARRIER (FK)	CERAMIC DIP (JG)	PLASTIC DIP (P)	
0°C to 70°C	750 μV	TLE2142ACD	—	—	TLE2142ACP	—
	1200 μV	TLE2142CD	—	—	TLE2142CP	
–40°C to 105°C	750 μV	TLE2142AID	—	—	TLC2142AIP	TLE2142Y
	1200 μV	TLE2142ID	—	—	TLC2142IP	
–55°C to 125°C	750 μV	TLE2142AMD	TLE2142AMFK	TLE2142AMJG	TLC2142AMP	—
	1200 μV	TLE2142MD	TLE2142MFK	TLE2142MJG	TLC2142MP	

The D packages are available taped and reeled. Add R suffix to device type (e.g., TLC2142ACDR).

description (continued)

The design incorporates a patent-pending input stage that simultaneously achieves low audio-band noise of 10.5 nV/$\sqrt{\text{Hz}}$, with a 6-Hz 1/f corner and symmetrical 40-V/μs slew rate typically with loads up to 800 pF. The resulting low distortion and high power bandwidth are important in high-fidelity audio applications. A fast settling time of 340 ns to 0.1% of a 10-V step with a 2-kΩ/100-pF load is useful in fast actuator/positioning drivers. Under similar test conditions, settling time to 0.01% is 400 ns.

The devices are stable with capacitive loads up to 10 nF, although the 6-MHz bandwidth decreases to 1.8 MHz at this high loading level. As such, the TLE2142 and TLE2142A are useful for low-droop sample-and-holds and direct buffering of long cables, including 4-mA to 20-mA current loops.

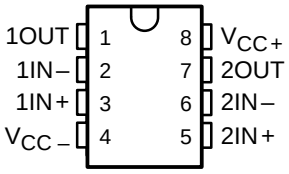
The special design also exhibits an improved insensitivity to inherit integrated circuit component mismatches as is evidenced by a 750-μV maximum offset voltage and 1.7-μV/°C typical drift. Minimum common-mode rejection ratio and supply voltage rejection ratio are 85 dB and 90 dB, respectively.

Device performance is relatively independent of supply voltage over the ±2-V to ±22-V range. Inputs can operate between V_{CC-} −0.3 to V_{CC+} −1.8 V without inducing phase reversal, although excessive input current may flow out of each input exceeding the lower common-mode input range. The all-npn output stage provides a nearly rail-to-rail output swing of V_{CC-} +0.1 to V_{CC+} −1 V under light current-loading conditions. The device can sustain shorts to either supply since output current is internally limited, but care must be taken to ensure that maximum package power dissipation is not exceeded.

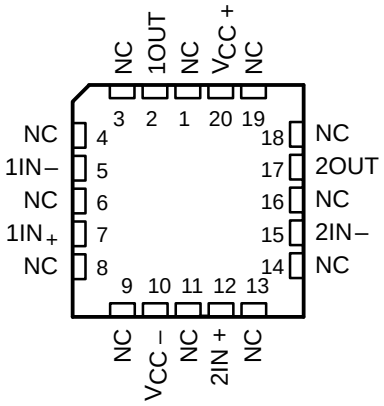
Both versions can also be used as comparators. Differential inputs of $V_{CC\pm}$ can be maintained without damage to the device. Open-loop propagation delay with TTL supply levels is typically 200 ns. This gives a good indication as to output stage saturation recovery when the device is driven beyond the limits of recommended output swing.

Both the TLE2142 and TLE2142A are available in a wide variety of packages, including both the industry-standard 8-pin small-outline version and chip form for high-density system applications. The C-suffix devices are characterized for operation from 0°C to 70°C, I-suffix devices from –40°C to 105°C, and M-suffix devices over the full military temperature range of –55°C to 125°C.

D, JG, OR P PACKAGE
(TOP VIEW)

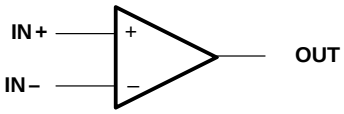


FK PACKAGE
(TOP VIEW)



NC – No internal connection

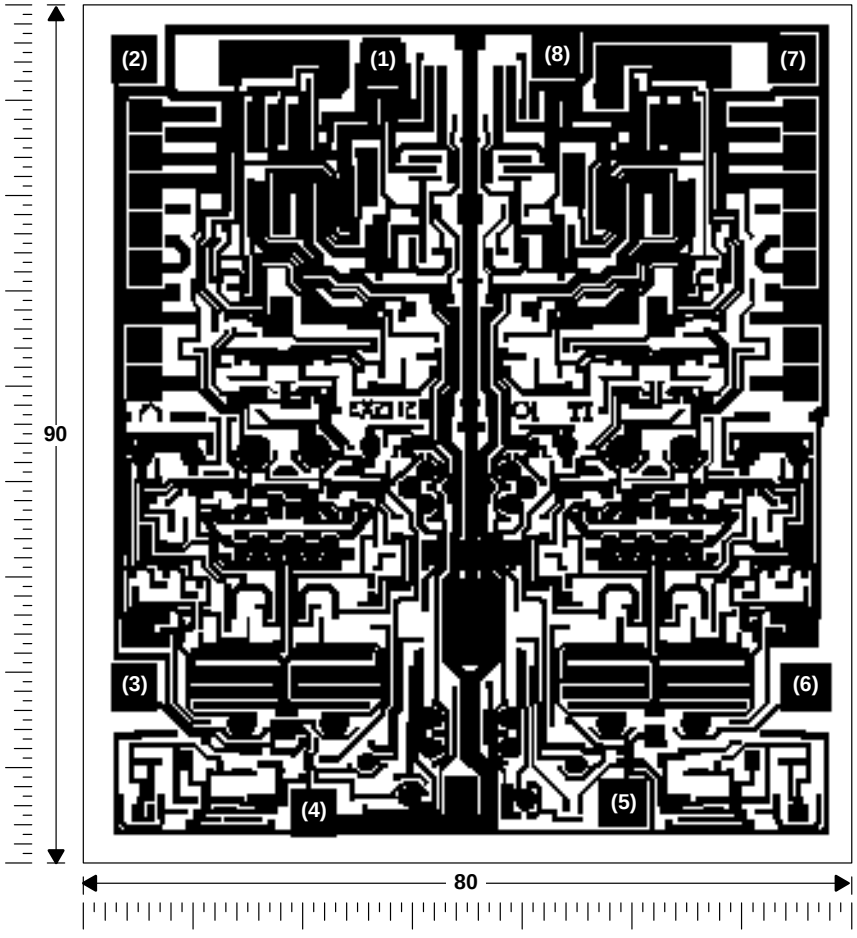
symbol (each amplifier)

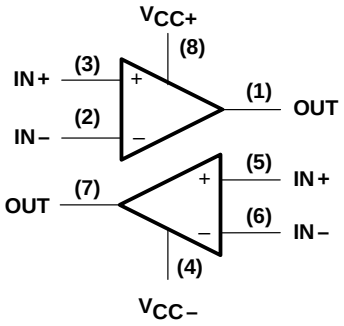


TLE2142Y chip information

This chip, when properly assembled, displays characteristics similar to the TLE2142. Thermal compression or ultrasonic bonding may be used on the doped-aluminum bonding pads. Chips may be mounted with conductive epoxy or a gold-silicon preform.

BONDING PAD ASSIGNMENTS





CHIP THICKNESS: 15 TYPICAL

BONDING PADS: 4 × 4 MINIMUM

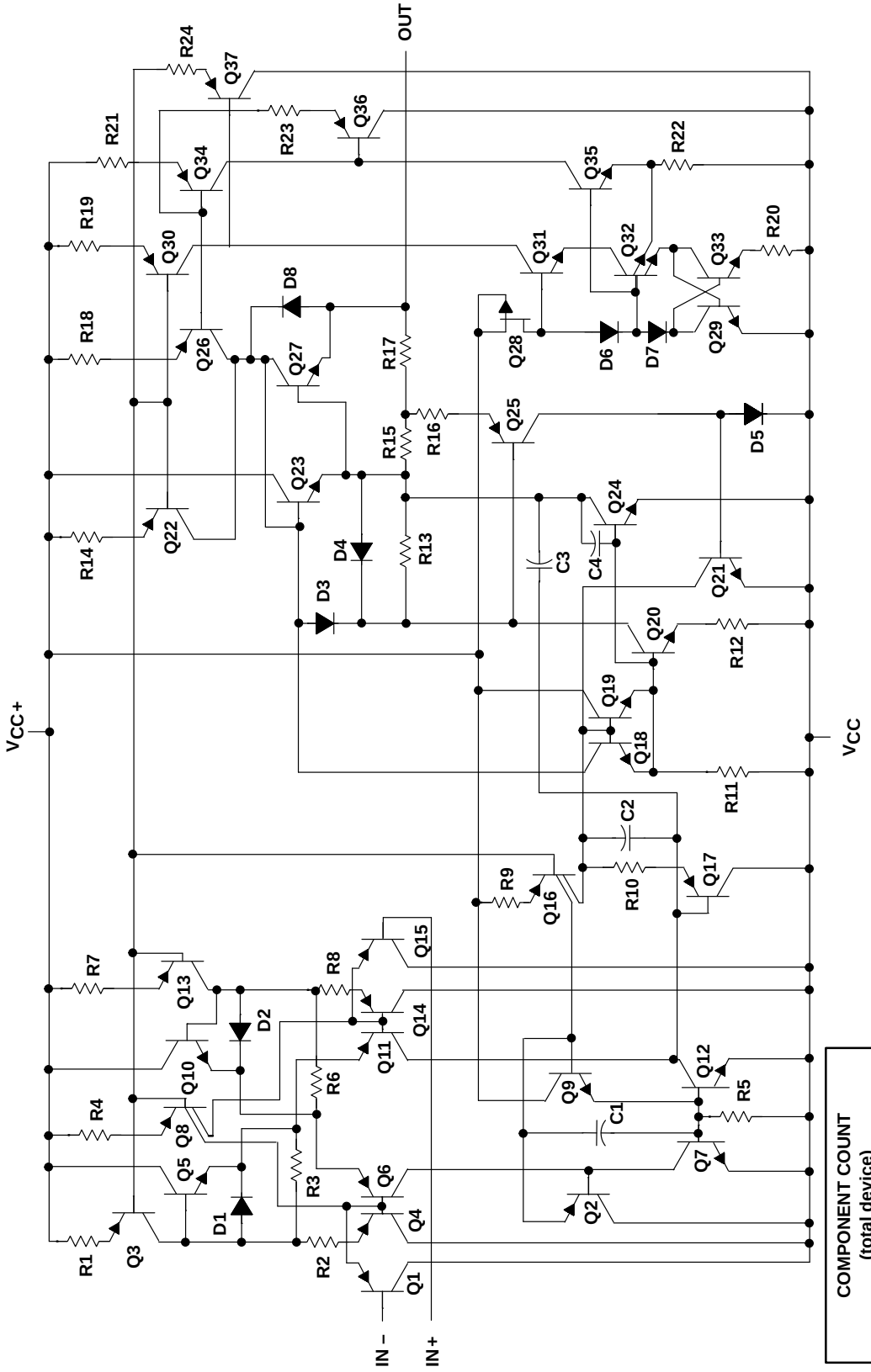
$T_J$max = 150°C

TOLERANCES ARE ±10%.

ALL DIMENSIONS ARE IN MILS.

PIN 4 IS INTERNALLY CONNECTED TO BACKSIDE OF CHIP.

equivalent schematic (per amplifier)



COMPONENT COUNT (total device)	
Transistors	65
Epi-FET	1
Diodes	14
Resistors	43
Capacitors	8

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

Supply voltage, V_{CC+} (see Note 1) . . . . . 22 V
Supply voltage, V_{CC-} . . . . . –22 V
Differential input voltage, V_{ID} (see Note 2) . . . . . V_{CC+} to V_{CC-}
Input voltage range, V_I (any input) . . . . . V_{CC+} to V_{CC-} –0.3 V
Input current, I_I (each input) . . . . . ±1 mA
Output current, I_O . . . . . ±80 mA
Total current into V_{CC+} . . . . . 160 mA
Total current out of V_{CC-} . . . . . 160 mA
Duration of short-circuit current at (or below) 25°C (see Note 3) . . . . . unlimited
Continuous total dissipation . . . . . See Dissipation Rating Table
Operating free-air temperature range, T_A: C suffix . . . . . 0°C to 70°C
I suffix . . . . . –40°C to 105°C
M suffix . . . . . –55°C to 125°C
Storage temperature range . . . . . –65°C to 150°C
Case temperature for 60 seconds: FK package . . . . . 260°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D or P package . . . . . 260°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: JG package . . . . . 300°C

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

NOTES: 1. All voltage values, except differential voltages, are with respect to the midpoint between V_{CC+} and V_{CC-}.
2. Differential voltages are at IN+ with respect to IN–. Excessive current will flow if input is brought below V_{CC-} –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	$T_A = 105°C$ POWER RATING	$T_A = 125°C$ POWER RATING
D	725 mV	5.8 mW/°C	464 mW	261 mW	145 mW
FK	1375 mV	11.0 mW/°C	880 mW	495 mW	275 mW
JG	1050 mV	8.4 mW/°C	672 mW	378 mW	210 mW
P	1000 mV	8.0 mW/°C	640 mW	360 mW	200 mW

recommended operating conditions

		C SUFFIX		I SUFFIX		M SUFFIX		UNIT
		MIN	MAX	MIN	MAX	MIN	MAX	
Supply voltage, $V_{CC\pm}$		±2	±22	±2	±22	±2	±22	V
Common-mode input voltage, V_{IC}	V_{CC} = 5 V	0	2.9	0	2.7	0	2.7	V
	$V_{CC\pm}$ = ±15 V	–15	12.9	–15	12.7	–15	12.7	
Operating free-air temperature, T_A		0	70	–40	105	–55	125	°C

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

PARAMETER		TEST CONDITIONS	T_A†	TLE2142C			TLE2142AC			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_O = 2.5 V, R_S = 50 Ω, V_{IC} = 2.5 V	25°C		220	1900		200	1500	µV
			Full range			2200			1800	
α_{VIO}	Temperature coefficient of input offset voltage		Full range		1.7			1.7		µV/°C
I_{IO}	Input offset current		25°C		8	100		8	100	nA
			Full range			150			150	
I_{IB}	Input bias current		25°C		−0.8	−2		−0.8	−2	µA
			Full range			−2.1			−2.1	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω	25°C	0 to 3	−0.3 to 3.2		0 to 3	−0.3 to 3.2		V
			Full range	0 to 2.9			0 to 2.9			
V_{OH}	High-level output voltage	I_{OH} = −150 µA	25°C	3.9	4.1		3.9	4.1		V
			Full range	3.8			3.8			
		I_{OH} = −1.5 mA	25°C	3.8	4		3.8	4		
			Full range	3.7			3.7			
		I_{OH} = −15 mA	25°C	3.4	3.7		3.4	3.7		
			Full range	3.4			3.4			
V_{OL}	Low-level output voltage	I_{OL} = 150 µA	25°C		75	125		75	125	mV
			Full range			150			150	
		I_{OL} = 1.5 mA	25°C		150	225		150	225	
			Full range			250			250	
		I_{OL} = 15 mA	25°C		1.2	1.4		1.2	1.4	V
			Full range			1.5			1.5	
A_{VD}	Large-signal differential voltage amplification	V_{CC} = ±2.5 V, R_L = 2 kΩ, V_O = 1 V to −1.5 V	25°C	50	220		50	220		V/mV
			Full range	25			25			
r_i	Input resistance		25°C		70			70		MΩ
c_i	Input capacitance		25°C		2.5			2.5		pF
z_o	Open-loop output impedance	f = 1 MHz	25°C		30			30		Ω
CMRR	Common-mode rejection ratio	V_{IC} = V_{ICR}min, R_S = 50 Ω	25°C	85	118		85	118		dB
			Full range	80			80			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$V_{CC\pm}$ = ±2.5 V to ±15 V, R_S = 50 Ω	25°C	90	106		90	106		dB
			Full range	85			85			
I_{CC}	Supply current	V_O = 2.5 V, No load, V_{IC} = 2.5 V	25°C		6.6	8.8		6.6	8.8	mA
			Full range			9.2			9.2	

† Full range is 0°C to 70°C.

operating characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS		TLE2142C			TLE2142AC			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
SR+	Positive slew rate	A_{VD} = –1, C_L = 500 pF	R_L = 2 kΩ†,		45			45		V/µs
SR–	Negative slew rate				42			42		
t_s	Settling time	A_{VD} = –1, 2.5-V step	To 0.1%		0.16			0.16		µs
			To 0.01%		0.22			0.22		
V_n	Equivalent input noise voltage	R_S = 20 Ω,	f = 10 Hz		15			15		nV/√Hz
		R_S = 20 Ω,	f = 1 kHz		10.5			10.5		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz			0.48			0.48		µV
		f = 0.1 Hz to 10 Hz			0.51			0.51		
I_n	Equivalent input noise current	f = 10 Hz			1.92			1.92		pA/√Hz
		f = 1 kHz			0.5			0.5		
THD + N	Total harmonic distortion plus noise	V_O = 1 V to 3 V, A_{VD} = 2,	R_L = 2 kΩ†, f = 10 kHz		0.0052%			0.0052%		
B1	Unity-gain bandwidth	R_L = 2 kΩ†,	C_L = 100 pF		5.9			5.9		MHz
	Gain-bandwidth product	R_L = 2 kΩ†, f = 100 kHz	C_L = 100 pF,		5.8			5.8		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 2 V, A_{VD} = 1,	R_L = 2 kΩ†, C_L = 100 pF		660			660		kHz
ϕ_m	Phase margin at unity gain	R_L = 2 kΩ†,	C_L = 100 pF		57°			57°		

† R_L terminates at 2.5 V.

electrical characteristics at specified free-air temperature, $V_{CC\pm}$ = ±15 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLE2142C			TLE2142AC			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{IC} = 0, V_O = 0	R_S = 50 Ω,	25°C		290	1200		275	750	μV
				Full range			1600			1200	
α_{VIO}	Temperature coefficient of input offset voltage			Full range		1.7			1.7		μV/°C
I_{IO}	Input offset current			25°C		7	100		7	100	nA
				Full range			150			150	
I_{IB}	Input bias current			25°C		−0.7	−1.5		−0.7	−1.5	μA
				Full range			−1.6			−1.6	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω		25°C	−15 to 13	−15.3 to 13.2		−15 to 13	−15.3 to 13.2		V
				Full range	−15 to 12.9	−15.3 to 13.1		−15 to 12.9	−15.3 to 13.1		
V_{OM+}	Maximum positive peak output voltage swing	I_O = −150 μA		25°C	13.8	14.1		13.8	14.1		V
				Full range	13.7			13.7			
		I_O = −1.5 mA		25°C	13.7	14		13.7	14		
				Full range	13.6			13.6			
		I_O = −15 mA		25°C	13.3	13.7		13.3	13.7		
				Full range	13.2			13.2			
V_{OM-}	Maximum negative peak output voltage swing	I_O = 150 μA		25°C	−14.7	−14.9		−14.7	−14.9		V
				Full range	−14.6			−14.6			
		I_O = 1.5 mA		25°C	−14.5	−14.8		−14.5	−14.8		
				Full range	−14.4			−14.4			
		I_O = 15 mA		25°C	−13.4	−13.8		−13.4	−13.8		
				Full range	−13.3			−13.3			
A_{VD}	Large-signal differential voltage amplification	V_O = ±10 V		25°C	100	450		100	450		V/mV
				Full range	75			75			
r_i	Input resistance	R_L = 2 kΩ		25°C		65			65		MΩ
c_i	Input capacitance			25°C		2.5			2.5		pF
z_o	Open-loop output impedance	f = 1 MHz		25°C		30			30		Ω
CMRR	Common-mode rejection ratio	V_{IC} = V_{ICR}min, R_S = 50 Ω		25°C	85	108		85	108		dB
				Full range	80			80			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$V_{CC\pm}$ = ± 2.5 V to ±15 V, R_S = 50 Ω		25°C	90	106		90	106		dB
				Full range	85			85			
I_{OS}	Short-circuit output current	V_O = 0	V_{ID} = 1 V	25°C	−25	−50		−25	−50		mA
			V_{ID} = −1 V		20	31		20	31		
I_{CC}	Supply current	V_O = 0,	No load	25°C		6.9	9		6.9	9	mA
				Full range			9.4			9.4	

† Full range is 0°C to 70°C.

operating characteristics, $V_{CC\pm}$ = ±15 V, T_A = 25°C

PARAMETER		TEST CONDITIONS		TLE2142C			TLE2142AC			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
SR+	Positive slew rate	A_{VD} = –1, C_L = 500 pF	R_L = 2 kΩ,	27	45		27	45		V/μs
SR–	Negative slew rate			27	42		27	42		
t_s	Settling time	A_{VD} = –1, 10-V step	To 0.1%		0.34			0.34		μs
			To 0.01%		0.4			0.4		
V_n	Equivalent input noise voltage	R_S = 20 Ω,	f = 10 Hz		15			15		nV/√Hz
		R_S = 20 Ω,	f = 1 kHz		10.5			10.5		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz			0.48			0.48		μV
		f = 0.1 Hz to 10 Hz			0.51			0.51		
I_n	Equivalent input noise current	f = 10 Hz			1.89			1.89		pA/√Hz
		f = 1 kHz			0.47			0.47		
THD + N	Total harmonic distortion plus noise	$V_{O(PP)}$ = 20 V, A_{VD} = 10,	R_L = 2 kΩ, f = 10 kHz		0.01%			0.01%		
B_1	Unity-gain bandwidth	R_L = 2 kΩ,	C_L = 100 pF		6			6		MHz
	Gain-bandwidth product	R_L = 2 kΩ, f =100 kHz	C_L = 100 pF,		5.9			5.9		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 20 V, A_{VD} = 1,	R_L = 2 kΩ, C_L = 100 pF		668			668		kHz
ϕ_m	Phase margin at unity gain	R_L = 2 kΩ,	C_L = 100 pF		58°			58°		

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

PARAMETER		TEST CONDITIONS	T_A†	TLE2142I			TLE2142AI			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_O = 2.5 V, R_S = 50 Ω, V_{IC} = 2.5 V	25°C		220	1900		220	1500	μV
			Full range			2400			2000	
α_{VIO}	Temperature coefficient of input offset voltage		Full range		1.7			1.7		μV/°C
I_{IO}	Input offset current		25°C		8	100		8	100	nA
			Full range			200			200	
I_{IB}	Input bias current		25°C		−0.8	−2		−0.8	−2	μA
			Full range			−2.2			−2.2	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω	25°C	0 to 3	−0.3 to 3.2		0 to 3	−0.3 to 3.2		V
			Full range	0 to 2.7	−0.3 to 2.9		0 to 2.7	−0.3 to 2.9		
V_{OH}	High-level output voltage	I_{OH} = −150 μA	25°C	3.9	4.1		3.9	4.1		V
		I_{OH} = −1.5 mA		3.8	4		3.8	4		
		I_{OH} = −15 mA		3.4	3.7		3.4	3.7		
		I_{OH} = 100 μA	Full range	3.8			3.8			
		I_{OH} = 1 mA		3.7			3.7			
		I_{OH} = 10 mA		3.5			3.5			
V_{OL}	Low-level output voltage	I_{OI} = 150 μA	25°C		75	125		75	125	mV
		I_{OL} = 1.5 mA			150	225		150	225	
		I_{OL} = 15 mA			1.2	1.4		1.2	1.4	V
		I_{OL} = 100 μA	Full range			175			175	mV
		I_{OL} = 1 mA				225			225	
		I_{OL} = 10 mA				1.2			1.2	V
A_{VD}	Large-signal differential voltage amplification	V_{IC} = ±2.5 V, R_L = 2 kΩ, V_O = 1 V to −1.5 V	25°C	50	220		50	220		V/mV
			Full range	10			10			
r_i	Input resistance		25°C		70			70		MΩ
c_i	Input capacitance		25°C		2.5			2.5		pF
z_o	Open-loop output impedance	f = 1 MHz	25°C		30			30		Ω
CMRR	Common-mode rejection ratio	V_{IC} = V_{ICR}min, R_S = 50 Ω	25°C	85	118		85	118		dB
			Full range	80			80			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$V_{CC\pm}$ = ±2.5 V to ±15 V, R_S = 50 Ω	25°C	90	106		90	106		dB
			Full range	85			85			
I_{CC}	Supply current	V_O = 2.5 V, No load, V_{IC} = 2.5 V	25°C		6.6	8.8		6.6	8.8	mA
			Full range			9.2			9.2	

† Full range is – 40°C to 105°C.

operating characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS		TLE2142I			TLE2142AI			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
SR+	Positive slew rate	A_{VD} = –1, C_L = 500 pF	R_L = 2 kΩ†,		45			45		V/μs
SR–	Negative slew rate				42			42		
t_s	Settling time	A_{VD} = –1, 2.5-V step	To 0.1%		0.16			0.16		μs
			To 0.01%		0.22			0.22		
V_n	Equivalent input noise voltage	R_S = 20 Ω,	f = 10 Hz		15			15		nV/√Hz
		R_S = 20 Ω,	f = 1 kHz		10.5			10.5		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz			0.48			0.48		μV
		f = 0.1 Hz to 10 Hz			0.51			0.51		
I_n	Equivalent input noise current	f = 10 Hz			1.92			1.92		pA/√Hz
		f = 1 kHz			0.5			0.5		
THD + N	Total harmonic distortion plus noise	V_O = 1 V to 3 V, A_{VD} = 2,	R_L = 2 kΩ†, f = 10 kHz		0.0052%			0.0052%		
B_1	Unity-gain bandwidth	R_L = 2 kΩ†,	C_L = 100 pF		5.9			5.9		MHz
	Gain-bandwidth product	R_L = 2 kΩ†, f = 100 kHz	C_L = 100 pF,		5.8			5.8		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 2 V, A_{VD} = 1,	R_L = 2 kΩ†, C_L = 100 pF		660			660		kHz
ϕ_m	Phase margin at unity gain	R_L = 2 kΩ†,	C_L = 100 pF		57°			57°		

† R_L terminates at 2.5 V.

electrical characteristics at specified free-air temperature, $V_{CC\pm}$ = ±15 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLE2142I			TLE2142I			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{IC} = 0, V_O = 0	R_S = 50 Ω,	25°C		290	1200		275	750	μV
				Full range			1800			1400	
α_{VIO}	Temperature coefficient of input offset voltage			Full range		1.7			1.7		μV/°C
I_{IO}	Input offset current			25°C		7	100		7	100	nA
				Full range			200			200	
I_{IB}	Input bias current			25°C		−0.7	−1.5		−0.7	−1.5	μA
				Full range			−1.7			−1.7	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω		25°C	−15 to 13	−15.3 to 13.2		−15 to 13	−15.3 to 13.2		V
				Full range	−15 to 12.7	−15.3 to 12.9		−15 to 12.7	−15.3 to 12.9		
V_{OM+}	Maximum positive peak output voltage swing	I_O = −150 μA		25°C	13.8	14.1		13.8	14.1		V
		I_O = −1.5 mA			13.7	14		13.7	14		
		I_O = −15 mA			13.3	13.7		13.3	13.7		
		I_O = −100 μA		Full range	13.7			13.7			
		I_O = −1 mA			13.6			13.6			
		I_O = −10 mA			13.3			13.3			
V_{OM-}	Maximum negative peak output voltage swing	I_O = 150 μA		25°C	−14.7	−14.9		−14.7	−14.9		V
		I_O = 1.5 mA			−14.5	−14.8		−14.5	−14.8		
		I_O = 15 mA			−13.4	−13.8		−13.4	−13.8		
		I_O = 100 μA		Full range	−14.6			−14.6			
		I_O = 1 mA			−14.5			−14.5			
		I_O = 10 mA			−13.4			−13.4			
A_{VD}	Large-signal differential voltage amplification	V_O = ±10 V, R_L = 2 kΩ		25°C	100	450		100	450		V/mV
				Full range	40			40			
r_i	Input resistance			25°C		65			65		MΩ
c_i	Input capacitance			25°C		2.5			2.5		pF
z_o	Open-loop output impedance	f = 1 MHz		25°C		30			30		Ω
CMRR	Common-mode rejection ratio	V_{IC} = V_{ICR}min		25°C	85	108		85	108		dB
		R_S = 50 Ω		Full range	80			80			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$V_{CC\pm}$ = ±2.5 V to ±15 V, R_S = 50 Ω		25°C	90	106		90	106		dB
				Full range	85			85			
I_{OS}	Short-circuit output current	V_O = 0	V_{ID} = 1 V	25°C	−25	−50		−25	−50		mA
			V_{ID} = −1 V		20	31		20	31		
I_{CC}	Supply current	V_O = 0,	No load	25°C		6.9	9		6.9	9	mA
				Full range			9.4			9.4	

† Full range is −40°C to 105°C.

operating characteristics, $V_{CC\pm}$ = ±15 V, T_A = 25°C

PARAMETER		TEST CONDITIONS		TLE2142I			TLE2142AI			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
SR+	Positive slew rate	A_{VD} = –1, C_L = 500 pF	R_L = 2 kΩ,	30	45		30	45		V/μs
SR–	Negative slew rate			30	42		30	42		
t_s	Settling time	A_{VD} = –1, 10-V step	To 0.1%		0.34			0.34		μs
			To 0.01%		0.4			0.4		
V_n	Equivalent input noise voltage	R_S = 20 Ω,	f = 10 Hz		15			15		nV/√Hz
		R_S = 20 Ω,	f = 1 kHz		10.5			10.5		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz			0.48			0.48		μV
		f = 0.1 Hz to 10 Hz			0.51			0.51		
I_n	Equivalent input noise current	f = 10 Hz			1.89			1.89		pA/√Hz
		f = 1 kHz			0.47			0.47		
THD + N	Total harmonic distortion plus noise	$V_{O(PP)}$ = 20 V, A_{VD} = 10,	R_L = 2 kΩ, f = 10 kHz		0.01%			0.01%		
B_1	Unity-gain bandwidth	R_L = 2 kΩ,	C_L = 100 pF		6			6		MHz
	Gain-bandwidth product	R_L = 2 kΩ, f =100 kHz	C_L = 100 pF,		5.9			5.9		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 20 V, A_{VD} = 1,	R_L = 2 kΩ, C_L = 100 pF		668			668		kHz
ϕ_m	Phase margin at unity gain	R_L = 2 kΩ,	C_L = 100 pF		58°			58°		

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

PARAMETER		TEST CONDITIONS	T_A†	TLE2142M			TLE2142AM			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_O = 2.5 V, R_S = 50 Ω, V_{IC} = 2.5 V	25°C		220	1900		200	1500	μV
			Full range			2600			2200	
α_{VIO}	Temperature coefficient of input offset voltage		Full range		1.7			1.7		μV/°C
I_{IO}	Input offset current		25°C		8	100		8	100	nA
			Full range			200			200	
I_{IB}	Input bias current		25°C		−0.8	−2		−0.8	−2	μA
			Full range			−2.3			−2.3	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω	25°C	0 to 3	−0.3 to 3.2		0 to 3	−0.3 to 3.2		V
			Full range	0 to 2.7	−0.3 to 2.9		0 to 2.7	−0.3 to 2.9		
V_{OH}	High-level output voltage	I_{OH} = −150 μA	25°C	3.9	4.1		3.9	4.1		V
		I_{OH} = −1.5 mA		3.8	4		3.8	4		
		I_{OH} = −15 mA		3.4	3.7		3.4	3.7		
		I_{OH} = 100 μA	Full range	3.75			3.75			
		I_{OH} = 1 mA		3.65			3.65			
		I_{OH} = 10 mA		3.45			3.45			
V_{OL}	Low-level output voltage	I_{OL} = 150 μA	25°C		75	125		75	125	mV
		I_{OL} = 1.5 mA			150	225		150	225	
		I_{OL} = 15 mA			1.2	1.4		1.2	1.4	V
		I_{OL} = 100 μA	Full range			200			200	mV
		I_{OL} = 1 mA				250			250	
		I_{OL} = 10 mA				1.25			1.25	V
A_{VD}	Large-signal differential voltage amplification	V_{IC} = ±2.5 V, R_L = 2 kΩ, V_O = 1 V to −1.5 V	25°C	50	220		50	220		V/mV
			Full range	5			5			
r_i	Input resistance		25°C		70			70		MΩ
c_i	Input capacitance		25°C		2.5			2.5		pF
z_o	Open-loop output impedance	f = 1 MHz	25°C		30			30		Ω
CMRR	Common-mode rejection ratio	V_{IC} = V_{ICR}min, R_S = 50 Ω	25°C	85	118		85	118		dB
			Full range	80			80			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$V_{CC\pm}$ = ±2.5 V to ±15 V, R_S = 50 Ω	25°C	90	106		90	106		dB
			Full range	85			85			
I_{CC}	Supply current	V_O = 2.5 V, No load, V_{IC} = 2.5 V	25°C		6.6	8.8		6.6	8.8	mA
			Full range			9.2			9.2	

† Full range is – 55°C to 125°C.

operating characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS		TLE2142M			TLE2142AM			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
SR+	Positive slew rate	A_{VD} = –1, C_L = 500 pF	R_L = 2 kΩ†,		45			45		V/μs
SR–	Negative slew rate				42			42		
t_s	Settling time	A_{VD} = –1, 2.5-V step	To 0.1%		0.16			0.16		μs
			To 0.01%		0.22			0.22		
V_n	Equivalent input noise voltage	R_S = 20 Ω,	f = 10 Hz		15			15		nV/√Hz
		R_S = 20 Ω,	f = 1 kHz		10.5			10.5		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz			0.48			0.48		μV
		f = 0.1 Hz to 10 Hz			0.51			0.51		
I_n	Equivalent input noise current	f = 10 Hz			1.92			1.92		pA/√Hz
		f = 1 kHz			0.5			0.5		
THD + N	Total harmonic distortion plus noise	V_O = 1 V to 3 V, A_{VD} = 2,	R_L = 2 kΩ†, f = 10 kHz		0.0052%			0.0052%		
B_1	Unity-gain bandwidth	R_L = 2 kΩ†,	C_L = 100 pF		5.9			5.9		MHz
	Gain-bandwidth product	R_L = 2 kΩ†, f = 100 kHz	C_L = 100 pF		5.8			5.8		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 2 V, A_{VD} = 1,	R_L = 2 kΩ†, C_L = 100 pF		660			660		kHz
ϕ_m	Phase margin	R_L = 2 kΩ†,	C_L = 100 pF		57°			57°		

† R_L terminates at 2.5 V.

electrical characteristics at specified free-air temperature, $V_{CC\pm}$ = ±15 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLE2142M			TLE2142AM			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{IC} = 0,	R_S = 50 Ω	25°C		290	1200		275	750	μV
				Full range			2000			1600	
α_{VIO}	Temperature coefficient of input offset voltage			Full range		1.7			1.7		μV/°C
I_{IO}	Input offset current			25°C		7	100		7	100	nA
				Full range			250			250	
I_{IB}	Input bias current			25°C		−0.7	−1.5		−0.7	−1.5	μA
				Full range			−1.8			−1.8	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω		25°C	−15 to 13	−15.3 to 13.2		−15 to 13	−15.3 to 13.2		V
				Full range	−15 to 12.7	−15.3 to 12.9		−15 to 12.7	−15.3 to 12.9		
V_{OM+}	Maximum positive peak output voltage swing	I_O = −150 μA		25°C	13.8	14.1		13.8	14.1		V
		I_O = −1.5 mA			13.7	14		13.7	14		
		I_O = −15 mA			13.3	13.7		13.3	13.7		
		I_O = −100 μA		Full range	13.7			13.7			
		I_O = −1 mA			13.6			13.6			
		I_O = −10 mA			13.3			13.3			
V_{OM-}	Maximum negative peak output voltage swing	I_O = 150 μA		25°C	−14.7	−14.9		−14.7	−14.9		V
		I_O = 1.5 mA			−14.5	−14.8		−14.5	−14.8		
		I_O = 15 mA			−13.4	−13.8		−13.4	−13.8		
		I_O = 100 μA		Full range	−14.6			−14.6			
		I_O = 1 mA			−14.5			−14.5			
		I_O = 10 mA			−13.4			−13.4			
A_{VD}	Large-signal differential voltage amplification	V_O = ±10 V,	R_L = 2 kΩ	25°C	100	450		100	450		V/mV
				Full range	20			20			
r_i	Input resistance			25°C		65			65		MΩ
c_i	Input capacitance			25°C		2.5			2.5		pF
z_o	Open-loop output impedance	f = 1 MHz		25°C		30			30		Ω
CMRR	Common-mode rejection ratio	V_{IC} = V_{ICR}min, R_S = 50 Ω		25°C	85	108		85	108		dB
				Full range	80			80			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$V_{CC\pm}$ = ±2.5 V to ±15 V, R_S = 50 Ω		25°C	90	106		90	106		dB
				Full range	85			85			
I_{OS}	Short-circuit output current	V_O = 0	V_{ID} = 1 V	25°C	−25	−50		−25	−50		mA
			V_{ID} = −1 V		20	31		20	31		
I_{CC}	Supply current	V_O = 0, V_{IC} = 2.5 V	No load,	25°C		6.9	9		6.9	9	mA
				Full range			9.4			9.4	

† Full range is −55°C to 125°C.

operating characteristics, $V_{CC\pm}$ = ±15 V, T_A = 25°C

PARAMETER		TEST CONDITIONS		TLE2142M			TLE2142AM			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
SR+	Positive slew rate	R_L = 2 kΩ, C_L = 100 pF	A_{VD} = –1,	27	45		27	45		V/μs
SR–	Negative slew rate			27	42		27	42		
t_s	Settling time	A_{VD} = –1, 10-V step	To 0.1%		0.34			0.34		μs
			To 0.01%		0.4			0.4		
V_n	Equivalent input noise voltage	R_S = 20 Ω,	f = 10 Hz		15			15		nV/√Hz
		R_S = 20 Ω,	f = 1 kHz		10.5			10.5		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz			0.48			0.48		μV
		f = 0.1 Hz to 10 Hz			0.51			0.51		
I_n	Equivalent input noise current	f = 10 Hz			1.89			1.89		pA/√Hz
		f = 1 kHz			0.47			0.47		
THD + N	Total harmonic distortion plus noise	$V_{O(PP)}$ = 20 V, A_{VD} = 10,	R_L = 2 kΩ, f = 10 kHz		0.01%			0.01%		
B_1	Unity-gain bandwidth	R_L = 2 kΩ,	C_L = 100 pF		6			6		MHz
	Gain-bandwidth product	R_L = 2 kΩ, f = 100 kHz	C_L = 100 pF,		5.9			5.9		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 20 V, A_{VD} = 1,	R_L = 2 kΩ, C_L = 100 pF		668			668		kHz
ϕ_m	Phase margin at unity gain	R_L = 2 kΩ,	C_L = 100 pF		58°			58°		

electrical characteristics at specified free-air temperature, $V_{CC\pm}$ = ±15 V, T_A = 25°C

PARAMETER		TEST CONDITIONS		TLE2142Y			UNIT
				MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{IC} = 0, V_O = 0, R_S = 50 Ω,			150	875	μV
I_{IO}	Input offset current				7	100	nA
I_{IB}	Input bias current				–0.7	–1.5	μA
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω		–15 to 13	–15.3 to 13.2		V
V_{OM+}	Maximum positive peak output voltage swing	I_O = –150 μA		13.8	14.1		V
		I_O = –1.5 mA		13.7	14		
		I_O = –15 mA		13.3	13.7		
V_{OM-}	Maximum negative peak output voltage swing	I_O = 150 μA		–14.7	–14.9		V
		I_O = 1.5 mA		–14.5	–14.8		
		I_O = 15 mA		–13.4	–13.8		
A_{VD}	Large-signal differential voltage amplification	V_O = ±10 V, R_L = 2 kΩ		100	450		V/mV
r_i	Input resistance				65		MΩ
c_i	Input capacitance				2.5		pF
z_o	Open-loop output impedance	f = 1 MHz			30		Ω
CMRR	Common-mode rejection ratio	V_{IC} = V_{ICR}min, R_S = 50 Ω		80	108		dB
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$V_{CC\pm}$ = ±2.5 V to ±15 V, R_S = 50 Ω		85	106		dB
I_{OS}	Short-circuit output current	V_O = 0	V_{ID} = 1 V	–25	–50		mA
			V_{ID} = –1 V	20	31		
I_{CC}	Supply current	V_O = 0, No load			6.9	9	mA

TYPICAL CHARACTERISTICS

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TYPICAL CHARACTERISTICS†

**TLE2142
DISTRIBUTION OF
INPUT OFFSET VOLTAGE**

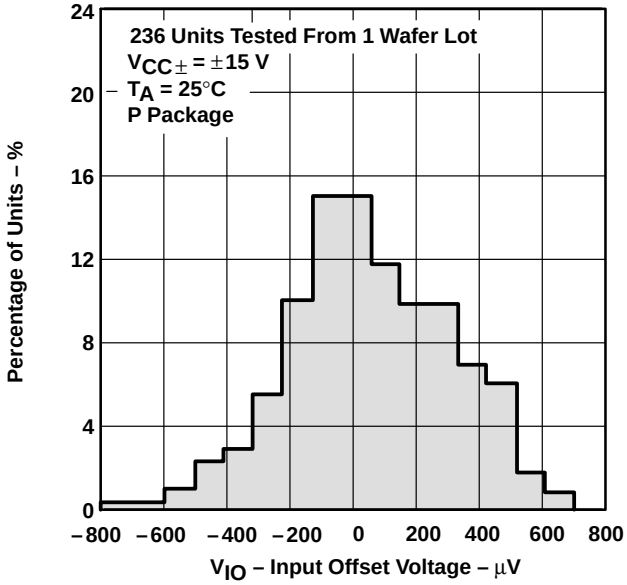

Figure 1

**INPUT OFFSET CURRENT
vs
FREE-AIR TEMPERATURE**

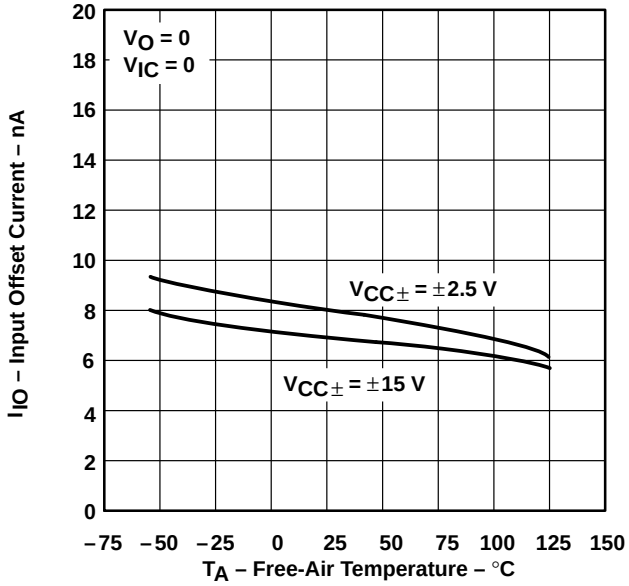

Figure 2

**INPUT BIAS CURRENT
vs
FREE-AIR TEMPERATURE**

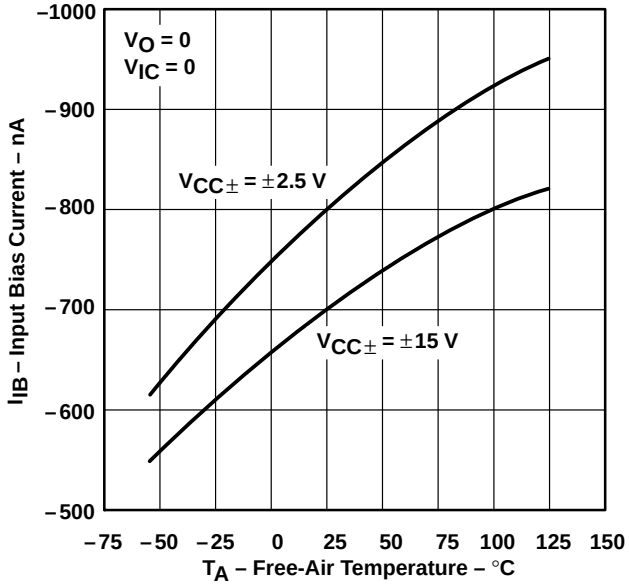

Figure 3

**INPUT BIAS CURRENT
vs
COMMON-MODE INPUT VOLTAGE**

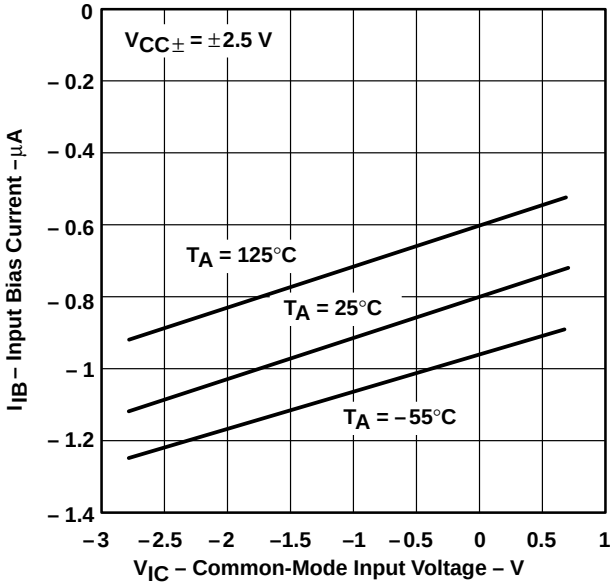

Figure 4

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

TYPICAL CHARACTERISTICS†

MAXIMUM PEAK OUTPUT VOLTAGE vs SUPPLY VOLTAGE

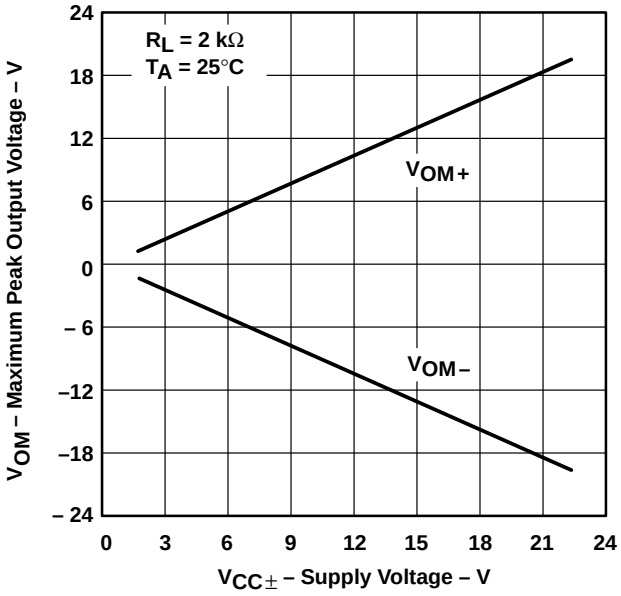

Figure 5

MAXIMUM PEAK OUTPUT VOLTAGE vs FREE-AIR TEMPERATURE

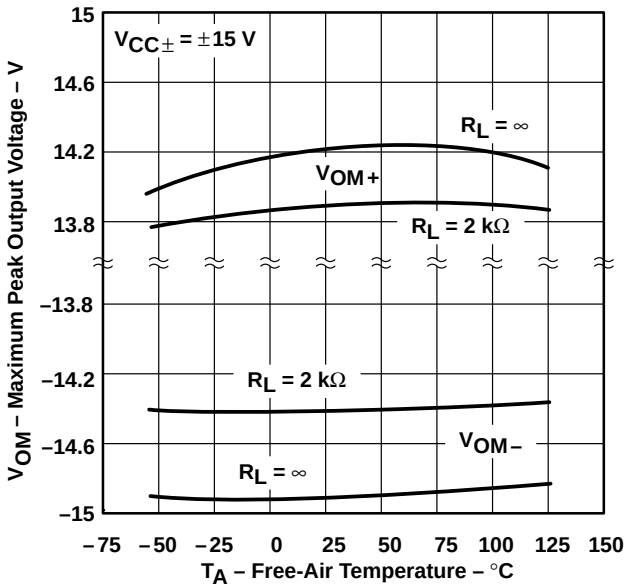

Figure 6

MAXIMUM POSITIVE PEAK OUTPUT VOLTAGE vs OUTPUT CURRENT

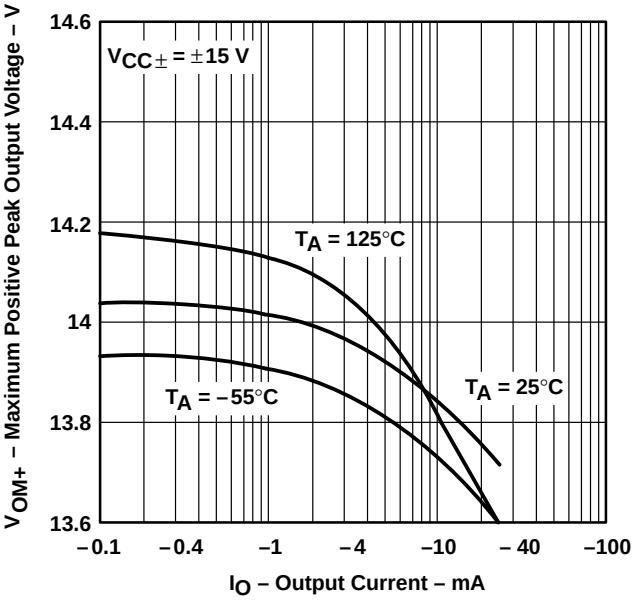

Figure 7

MAXIMUM NEGATIVE PEAK OUTPUT VOLTAGE vs OUTPUT CURRENT

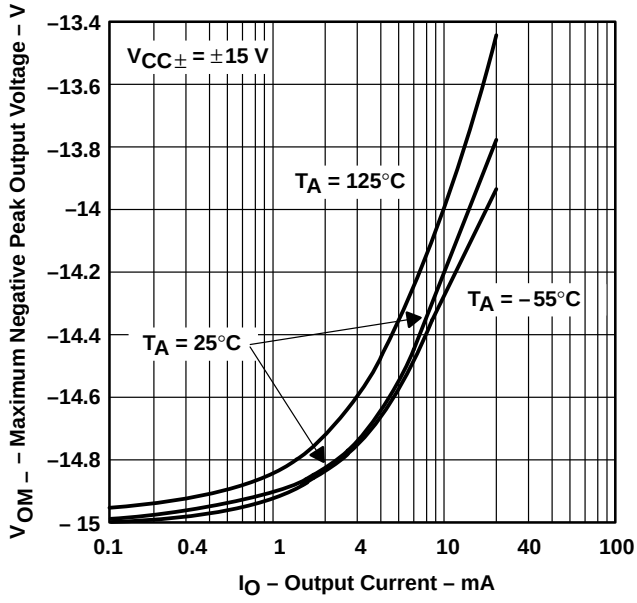

Figure 8

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

TYPICAL CHARACTERISTICS†

MAXIMUM PEAK OUTPUT VOLTAGE
vs
SETTLING TIME

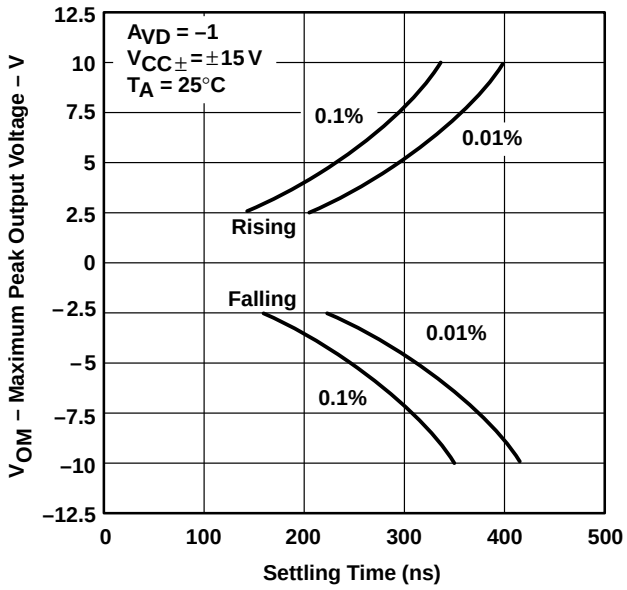

Figure 9

MAXIMUM PEAK-TO-PEAK
OUTPUT VOLTAGE
vs
FREQUENCY

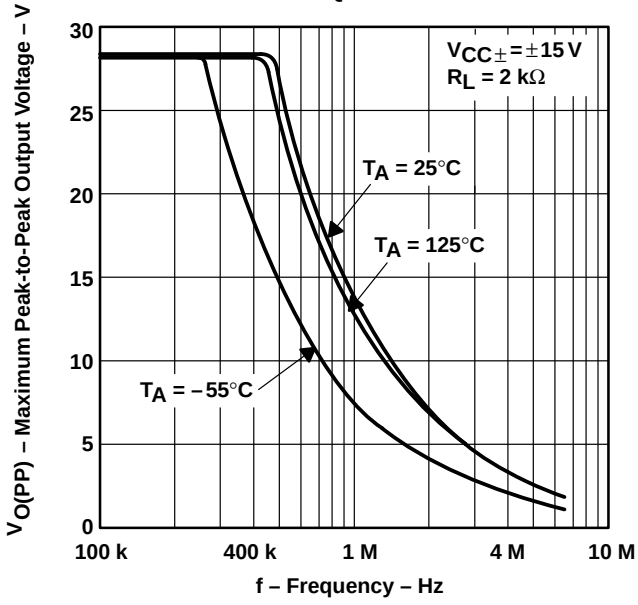

Figure 10

HIGH-LEVEL OUTPUT VOLTAGE
vs
OUTPUT CURRENT

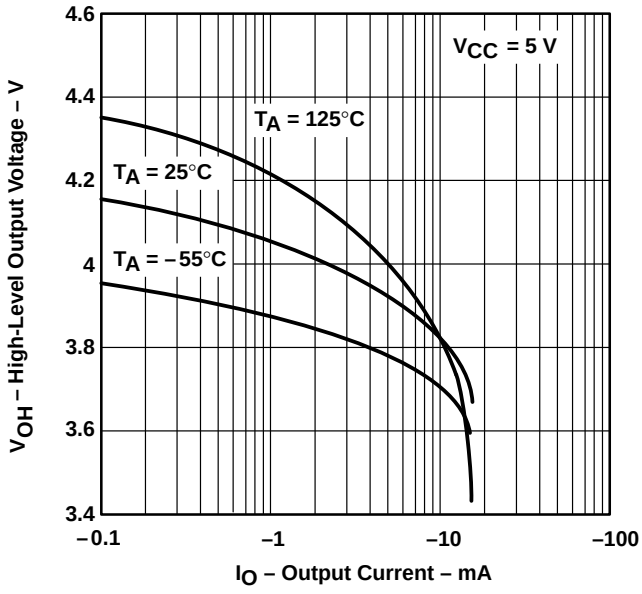

Figure 11

LOW-LEVEL OUTPUT VOLTAGE
vs
OUTPUT CURRENT

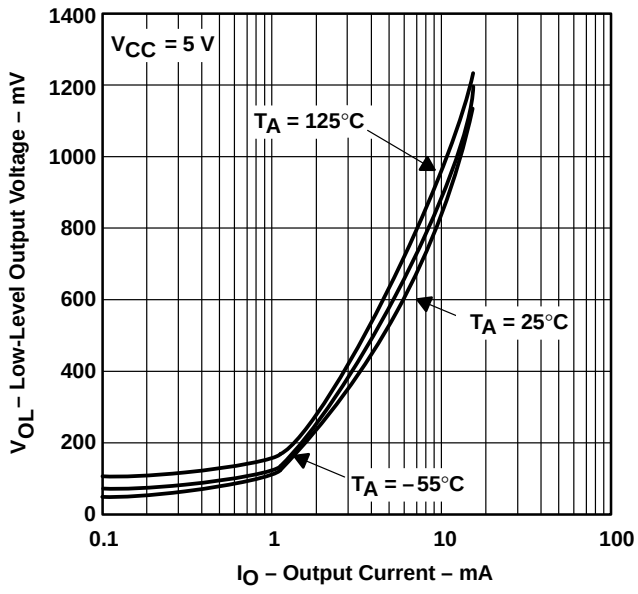

Figure 12

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

TYPICAL CHARACTERISTICS†

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION vs FREE-AIR TEMPERATURE

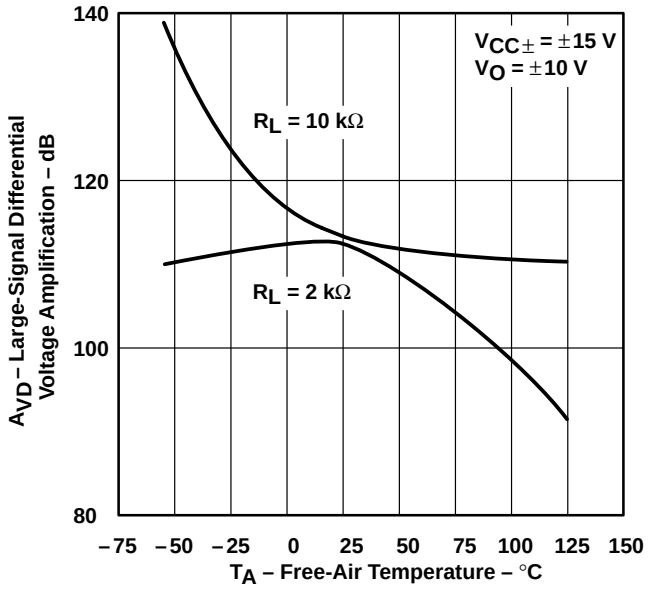

Figure 13

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE SHIFT vs FREQUENCY

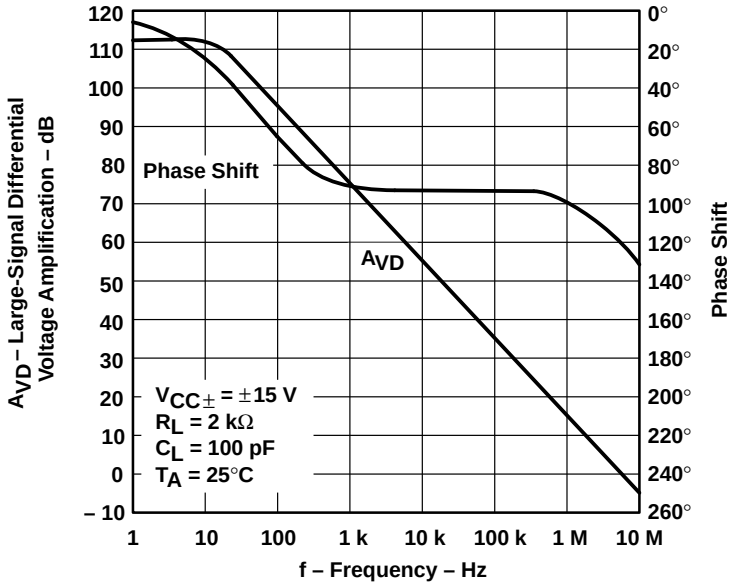

Figure 14

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

TYPICAL CHARACTERISTICS†

CLOSED-LOOP OUTPUT IMPEDANCE vs FREQUENCY

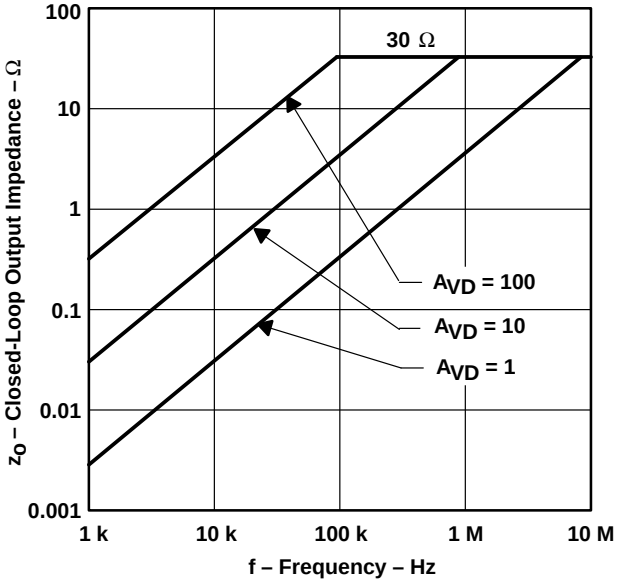

Figure 15

SHORT-CIRCUIT OUTPUT CURRENT vs FREE-AIR TEMPERATURE

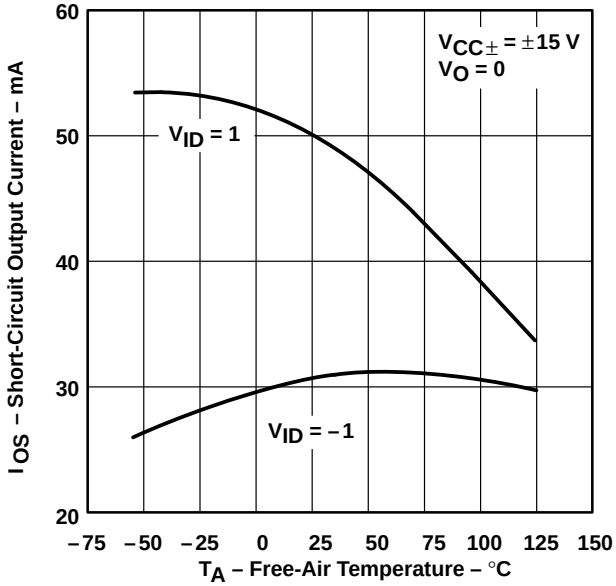

Figure 16

COMMON-MODE REJECTION RATIO vs FREQUENCY

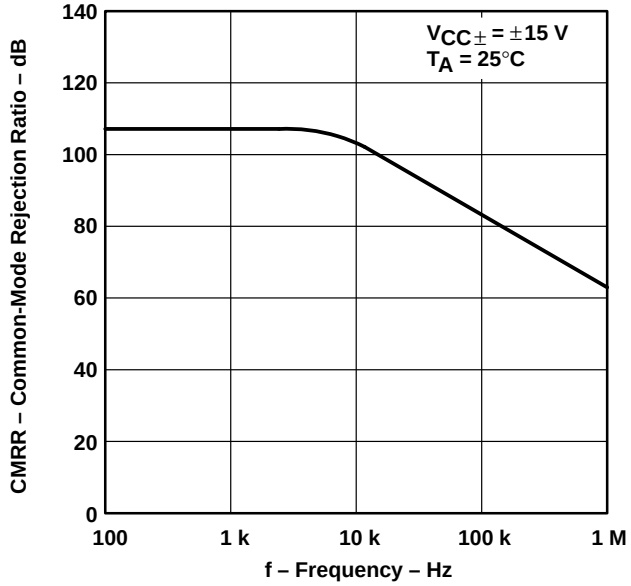

Figure 17

COMMON-MODE REJECTION RATIO vs FREE-AIR TEMPERATURE

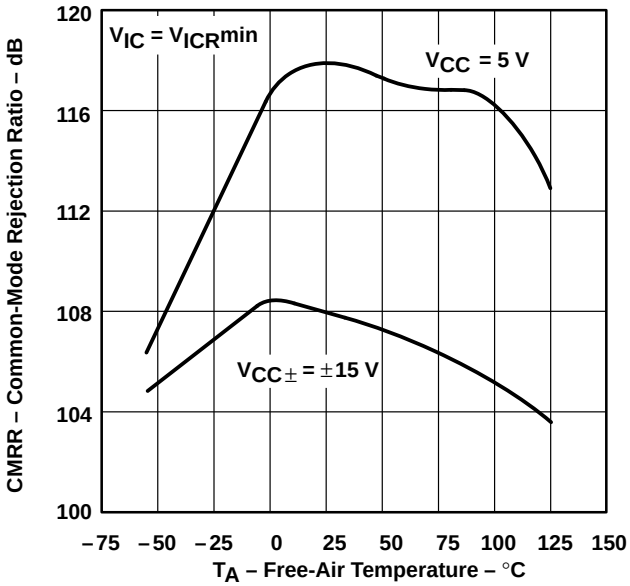

Figure 18

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

TYPICAL CHARACTERISTICS†

SUPPLY-VOLTAGE REJECTION RATIO vs FREQUENCY

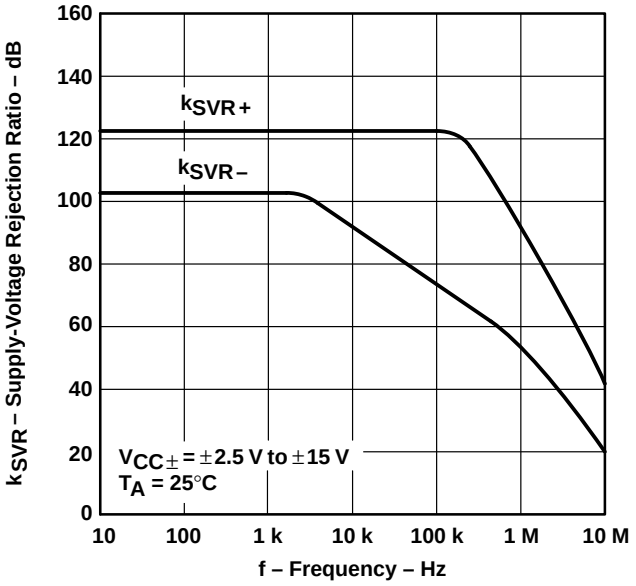

Figure 19

SUPPLY-VOLTAGE REJECTION RATIO vs FREE-AIR TEMPERATURE

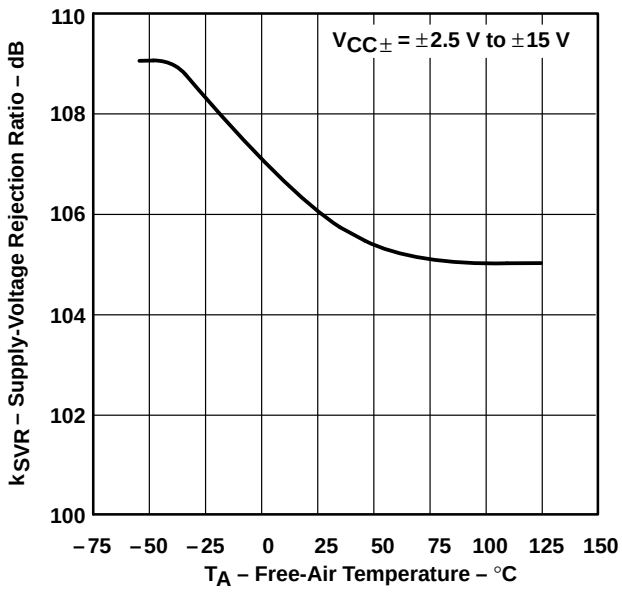

Figure 20

SUPPLY CURRENT vs FREE-AIR TEMPERATURE

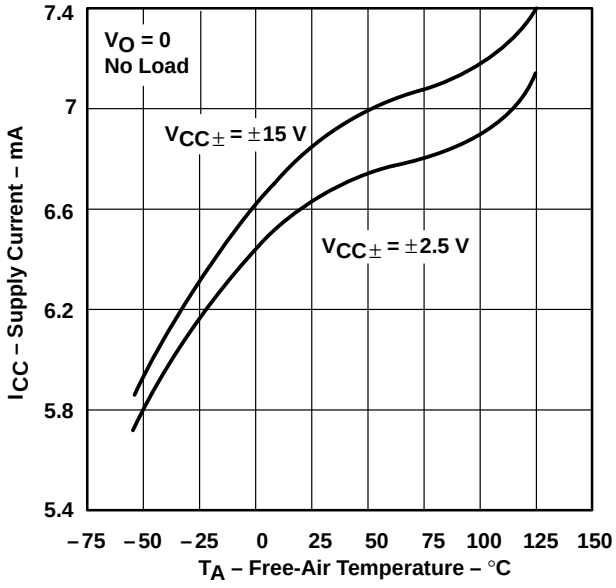

Figure 21

SUPPLY CURRENT vs SUPPLY VOLTAGE

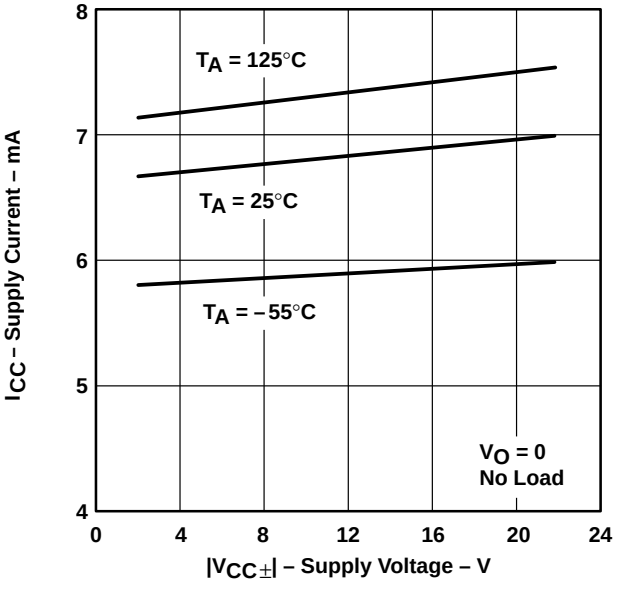

Figure 22

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

TYPICAL CHARACTERISTICS†

EQUIVALENT INPUT NOISE VOLTAGE vs FREQUENCY

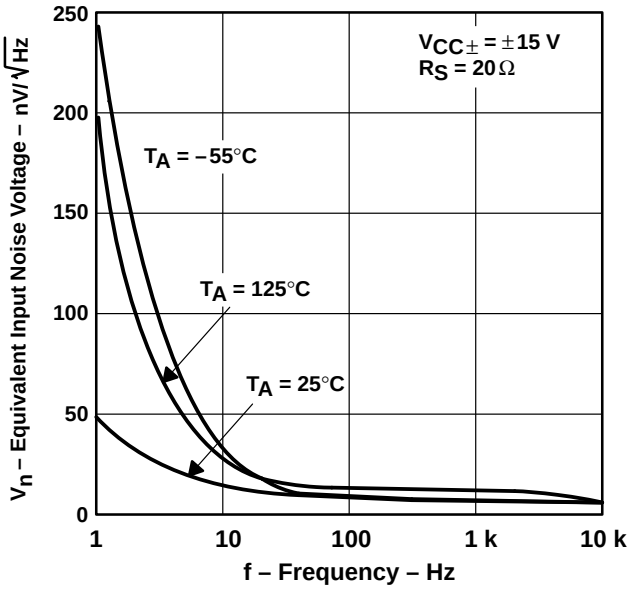

Figure 23

INPUT NOISE VOLTAGE OVER A 10-SECOND PERIOD

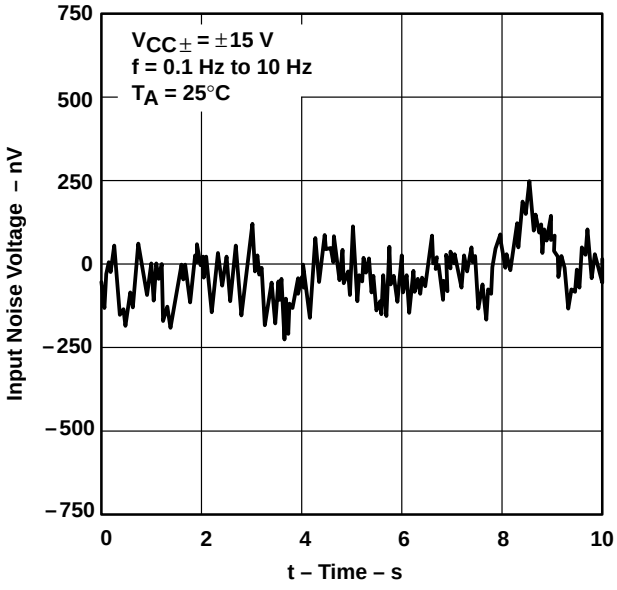

Figure 24

EQUIVALENT INPUT NOISE CURRENT vs FREQUENCY

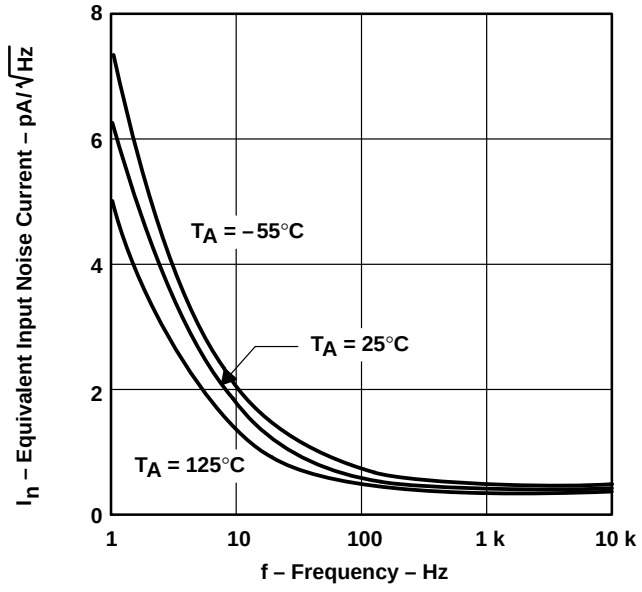

Figure 25

TOTAL HARMONIC DISTORTION + NOISE vs FREQUENCY

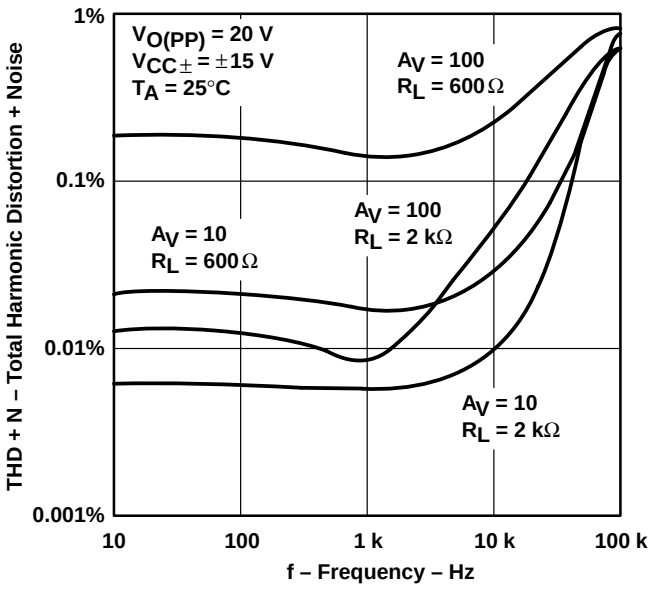

Figure 26

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

TYPICAL CHARACTERISTICS†

SLEW RATE vs FREE-AIR TEMPERATURE

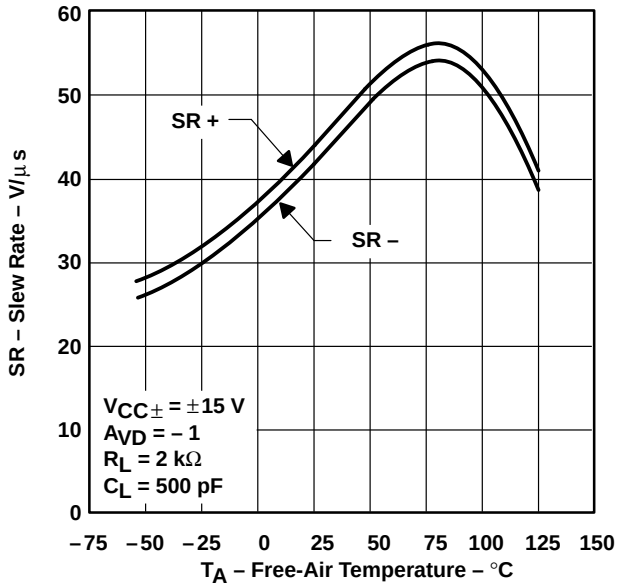

Figure 27

SLEW RATE vs LOAD CAPACITANCE

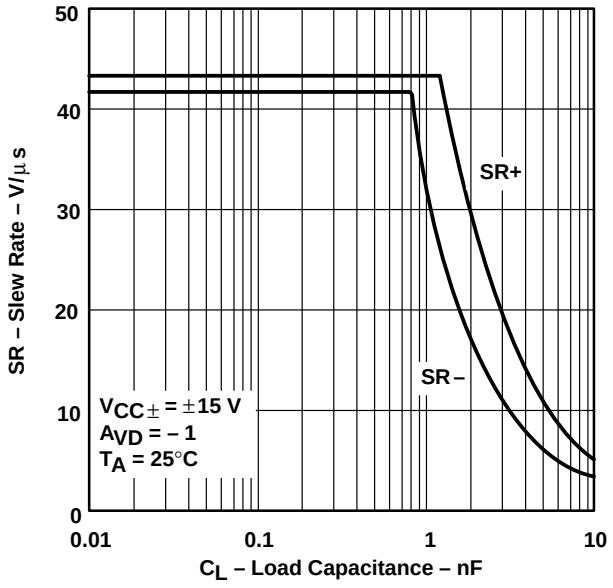

Figure 28

NONINVERTING LARGE-SIGNAL PULSE RESPONSE

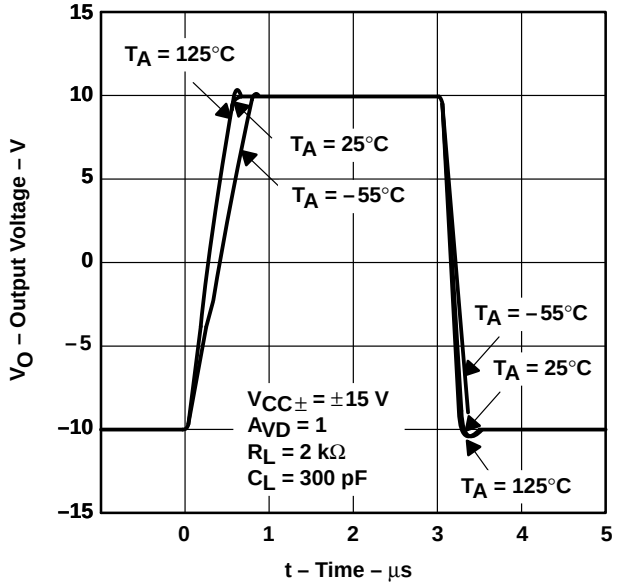

Figure 29

INVERTING LARGE-SIGNAL PULSE RESPONSE

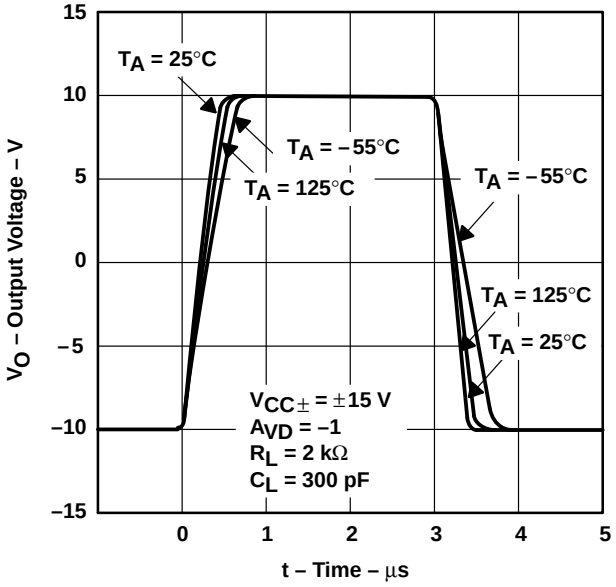

Figure 30

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

TYPICAL CHARACTERISTICS†

SMALL-SIGNAL PULSE RESPONSE

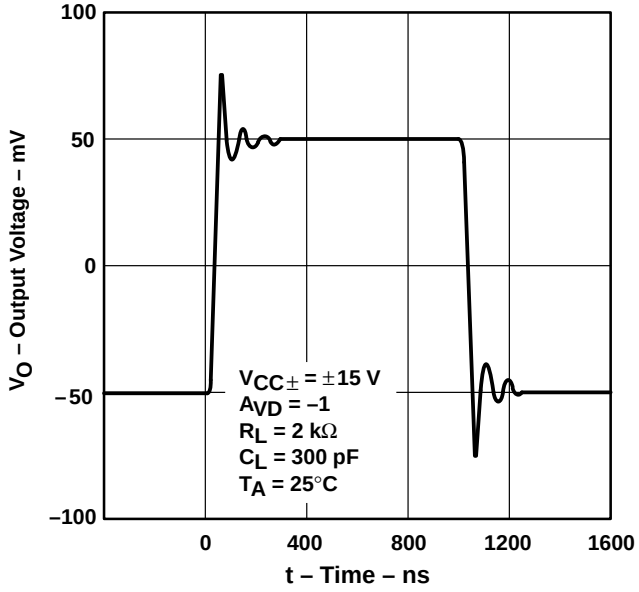

Figure 31

UNITY-GAIN BANDWIDTH vs LOAD CAPACITANCE

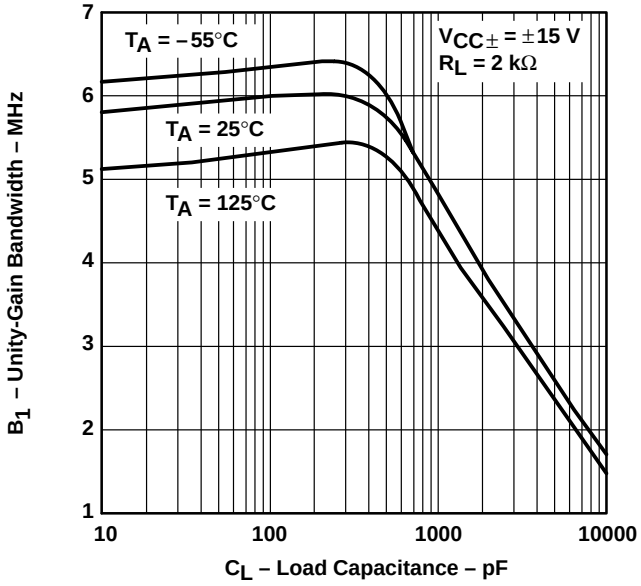

Figure 32

GAIN MARGIN vs LOAD CAPACITANCE

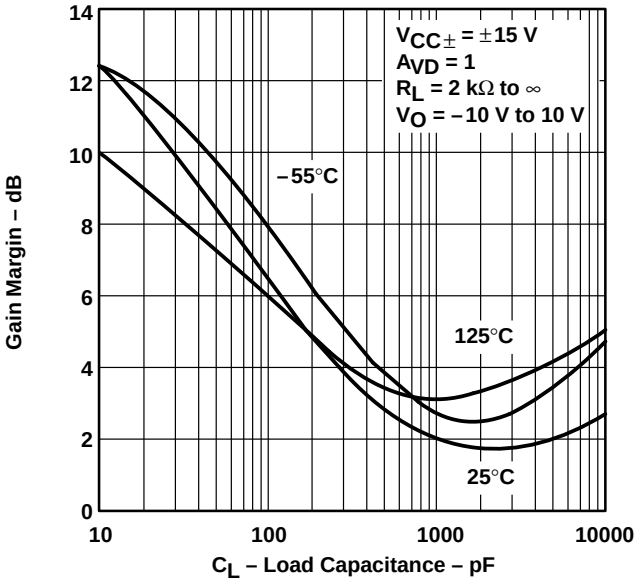

Figure 33

PHASE MARGIN vs LOAD CAPACITANCE

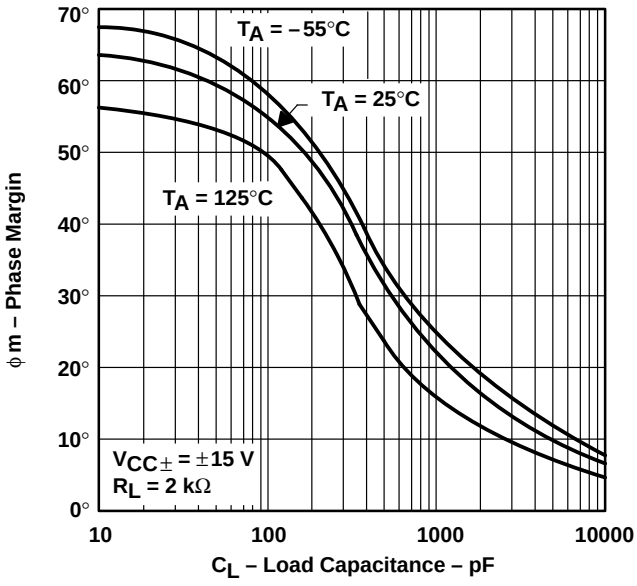

Figure 34

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

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