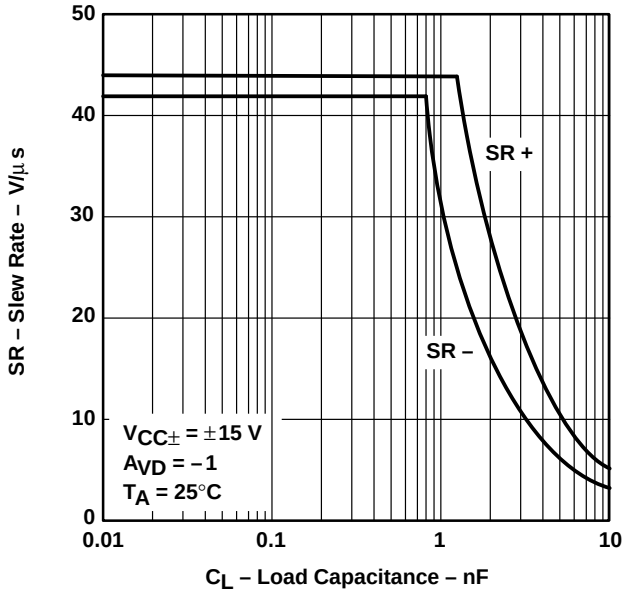
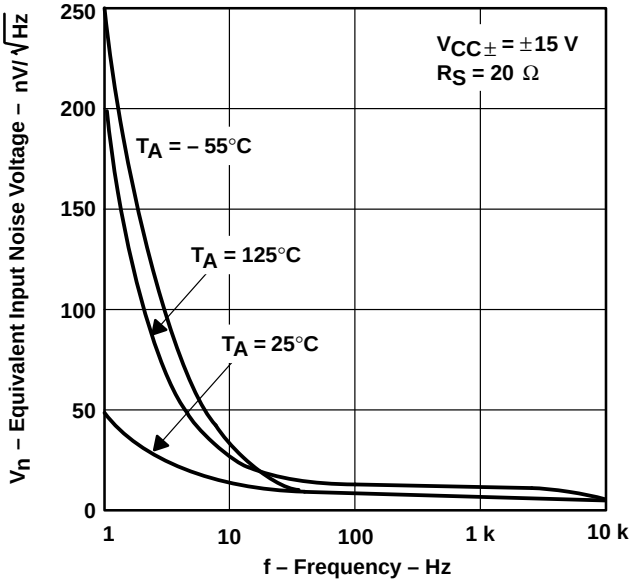
- **Low Noise**
  10 Hz . . . 15 nV/$\sqrt{\text{Hz}}$
  1 kHz . . . 10.5 nV/$\sqrt{\text{Hz}}$
- **10 000-pF Load Capability**
- **20-mA Min Short-Circuit Output Current**
- **27-V/μs Min Slew Rate**
- **High Gain-Bandwidth Product . . . 5.9 MHz**
- **Low V_{IO} . . . 500 μV Max at 25°C**
- **Single or Split Supply . . . 4 V to 44 V**
- **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 TLE2141 and TLE2141A devices are high-performance, internally compensated operational amplifiers built using Texas Instruments complementary bipolar Excalibur process. The TLE2141A is a tighter offset voltage grade of the TLE2141. Both are pin-compatible upgrades to standard industry products.

AVAILABLE OPTIONS

T_A	V_{IO}max AT 25°C	PACKAGED DEVICES				CHIP FORM (Y)
		SMALL OUTLINE (D)	CHIP CARRIER (FK)	CERAMIC DIP (JG)	PLASTIC DIP (P)	
0°C to 70°C	500 μV 900 μV	TLE2141ACD TLE2141CD	—	—	TLE2141ACP TLE2141CP	—
–40°C to 105°C	500 μV 900 μV	TLE2141AID TLE2141ID	—	—	TLE2141AIP TLE2141IP	TLE2141Y
–55°C to 125°C	500 μV 900 μV	TLE2141AMD TLE2141MD	TLE2141AMFK TLE2141MFK	TLE2141AMJG TLE2141MJB	TLE2141AMP TLE2141MP	—

The D packages are available taped and reeled. Add R suffix to device type (e.g., TLE2141ACDR).

description (continued)

The design incorporates an input stage that simultaneously achieves low audio-band noise of 10.5 nV/$\sqrt{\text{Hz}}$ with a 10-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 TLE2141 and TLE2141A are useful for low-droop sample-and-holds and direct buffering of long cables, including 4-mA to 20-mA current loops.

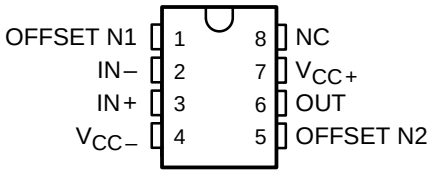
The special design also exhibits an improved insensitivity to inherent integrated circuit component mismatches as is evidenced by a 500-μV maximum offset voltage and 1.7-μV/°C typical drift. Minimum common-mode rejection ratio and supply-voltage rejection ratio are 85 dB and 90 dB, respectively.

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.

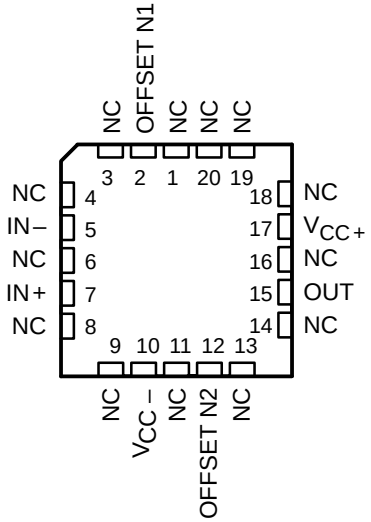
Both versions can also be used as comparators. Differential inputs of $V_{CC\pm}$ can be maintained without damage to the device. Open-loop propagation delay with TTL supply levels is typically 200 ns. This gives a good indication as to output stage saturation recovery when the device is driven beyond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

Both the TLE2141 and TLE2141A 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)

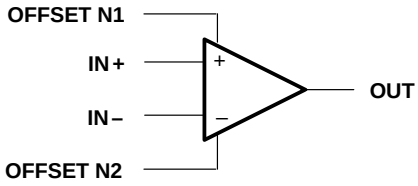


FK PACKAGE
(TOP VIEW)



NC – No internal connection

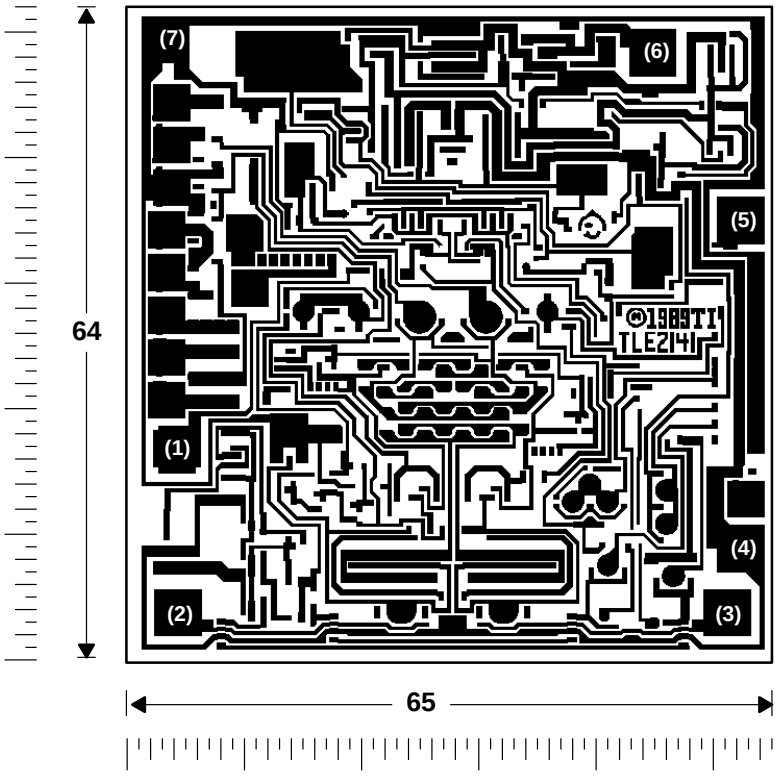
symbol

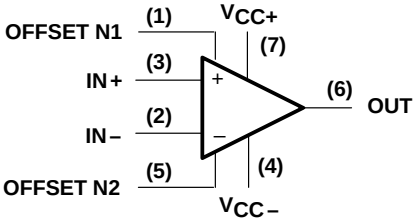


TLE2141Y chip information

This chip, when properly assembled, displays characteristics similar to the TLE2141. 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

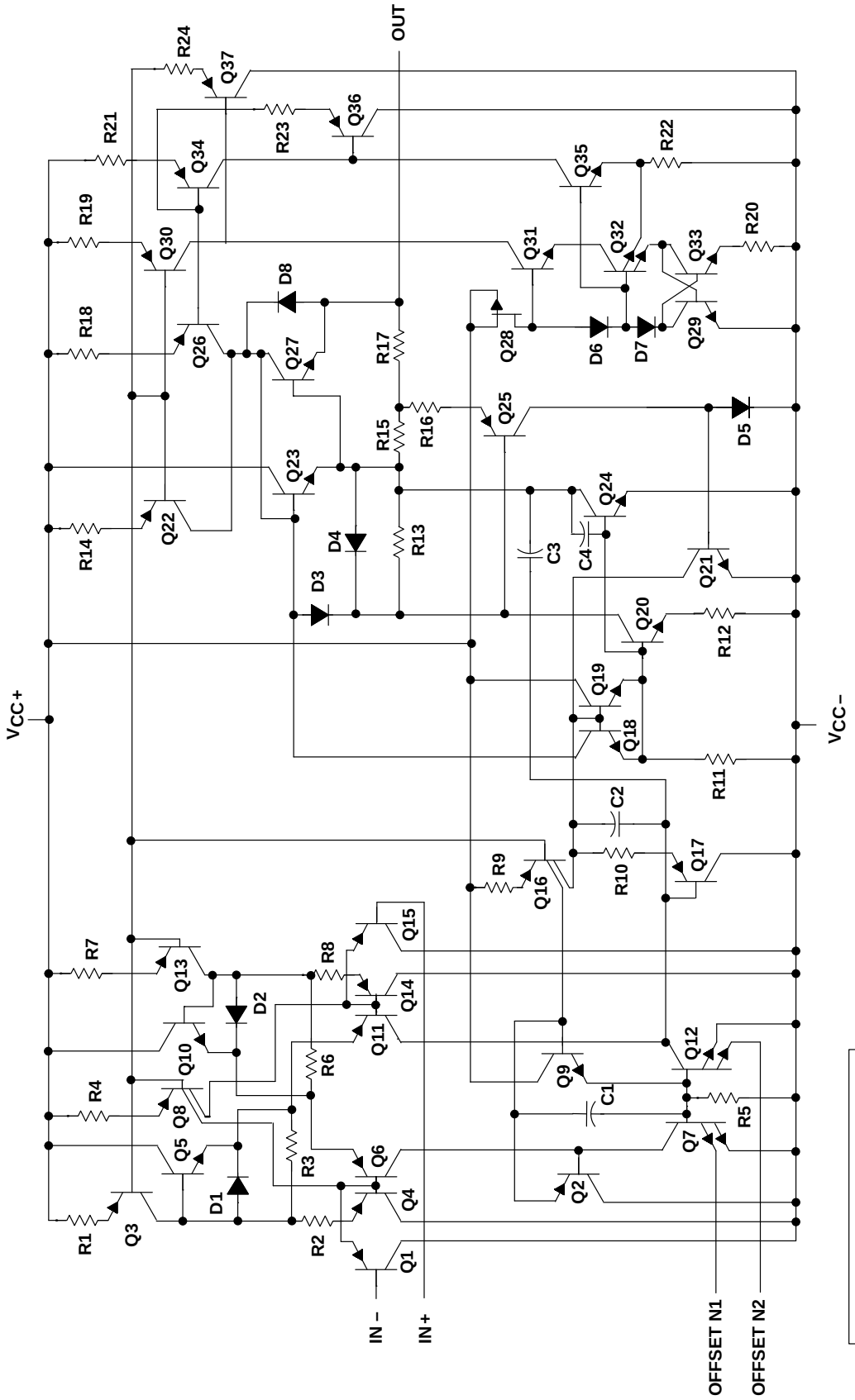
BONDING PADS: 4 × 4 MINIMUM

$T_J$max = 150°C

TOLERANCES ARE ±10%.

ALL DIMENSIONS ARE IN MILS.

equivalent schematic



COMPONENT COUNT (total device)	
Transistors	36
Epi-FET	1
Diodes	8
Resistors	24
Capacitors	4

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) . . . . . ±44 V
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+} . . . . . 80 mA
Total current out of V_{CC-} . . . . . 80 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 flows 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 mW	5.8 mW/°C	464 mW	261 mW	145 mW
FK	1375 mW	11.0 mW/°C	880 mW	495 mW	275 mW
JG	1050 mW	8.4 mW/°C	672 mW	378 mW	210 mW
P	1000 mW	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†	TLE2141C			TLE2141AC			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		225	1400		200	1000	μV
			Full range			1700			1300	
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	3.2	3.7		3.2	3.7		
			Full range	3.2			3.2			
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	1.6		1.2	1.6	V
			Full range			1.7			1.7	
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		3.4	4.4		3.4	4.4	mA
			Full range			4.6			4.6	

† Full range is 0°C to 70°C.

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

PARAMETER		TEST CONDITIONS†		TLE2141C			TLE2141AC			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 and C_L terminated to 2.5 V.

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

PARAMETER		TEST CONDITIONS		T_A†	TLE2141C			TLE2141AC			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{IC} = 0, V_O = 0	R_S = 50 Ω,	25°C		200	900		175	500	μV
				Full range			1300			800	
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	13.1	13.7		13.1	13.7		
				Full range	13			13			
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		3.5	4.5		3.5	4.5	mA
				Full range			4.7			4.7	

† Full range is 0°C to 70°C.

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

PARAMETER		TEST CONDITIONS		TLE2141C			TLE2141AC			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†	TLE2141I			TLE2141AI			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		225	1400		200	1000	μV
			Full range			1900			1500	
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		3.2	3.7		3.2	3.7		
		I_{OH} = −100 μA	Full range	3.8			3.8			
		I_{OH} = −1 mA		3.7			3.7			
		I_{OH} = −10 mA		3.3			3.3			
V_{OL}	Low-level output voltage	I_{OL} = 150 μA	25°C		75	125		75	125	mV
		I_{OL} = 1.5 μA			150	225		150	225	
		I_{OL} = 15 mA			1.2	1.6		1.2	1.6	V
		I_{OL} = 100 μA	Full range			175			175	mV
		I_{OL} = 1 mA				225			225	
		I_{OL} = 10 mA				1.4			1.4	V
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	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		3.4	4.4		3.4	4.4	mA
			Full range			4.6			4.6	

† Full range is −40°C to 105°C.

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

PARAMETER		TEST CONDITIONS†		TLE2141I			TLE2141AI			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 and C_L terminated to 2.5 V.

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

PARAMETER		TEST CONDITIONS		T_A†	TLE2141I			TLE2141AI			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{IC} = 0, V_O = 0	R_S = 50 Ω,	25°C		200	900		175	500	μV
				Full range			1500			1000	
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			13.1	13.7		13.1	13.7		
		I_O = −100 μA		Full range	13.7			13.7			
		I_O = −1 mA			13.6			13.6			
		I_O = −10 mA			13.1			13.1			
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,	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		3.5	4.5		3.5	4.5	mA
				Full range			4.7			4.7	

† Full range is −40°C to 105°C.

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

PARAMETER		TEST CONDITIONS		TLE2141I			TLE2141AI			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†	TLE2141M			TLE2141AM			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		225	1400		200	1000	μV
			Full range			2100			1700	
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			250			250	
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		3.2	3.7		3.2	3.7		
		I_{OH} = −100 μA	Full range	3.75			3.75			
		I_{OH} = −1 mA		3.65			3.65			
		I_{OH} = −10 mA		3.25			3.25			
V_{OL}	Low-level output voltage	I_{OL} = 150 μA	25°C		75	125		75	125	mV
		I_{OL} = 1.5 μA			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			225	
		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		3.4	4.4		3.4	4.4	mA
			Full range			4.6			4.6	

† Full range is −55°C to 125°C.

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

PARAMETER		TEST CONDITIONS†		TLE2141M			TLE2141AM			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,		660			660		kHz
ϕ_m	Phase margin at unity gain	R_L = 2 kΩ,	C_L = 100 pF		57°			57°		

† R_L and C_L terminated to 2.5 V.

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

PARAMETER		TEST CONDITIONS		T_A†	TLE2141M			TLE2141AM			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{IC} = 0,	R_S = 50 Ω	25°C		200	900		175	500	μV
				Full range			1700			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			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			13.1	13.7		13.1	13.7		
		I_O = −100 μA		Full range	13.7			13.7			
		I_O = −1 mA			13.6			13.6			
		I_O = −10 mA			13.1			13.1			
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		3.5	4.5		3.5	4.5	mA
				Full range			4.7			4.7	

† Full range is −55°C to 125°C.

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

PARAMETER		TEST CONDITIONS		TLE2141M			TLE2141AM			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
SR+	Positive slew rate	A_{VD} = –1, C_L = 100 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, $V_{CC\pm}$ = ±15 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		TLE2141Y			UNIT
				MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{IC} = 0, V_O = 0	R_S = 50 Ω,		200	1000	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_0	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		3.5	4.5	mA

TYPICAL CHARACTERISTICS

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TYPICAL CHARACTERISTICS†

**TLE2141
DISTRIBUTION OF
INPUT OFFSET VOLTAGE**

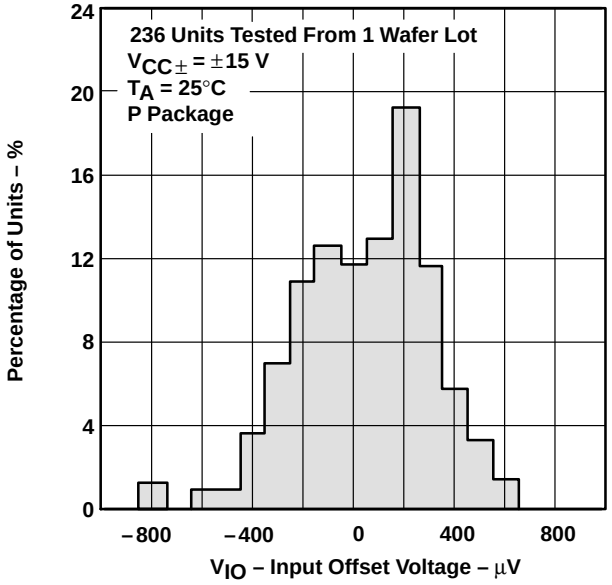

Figure 1

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

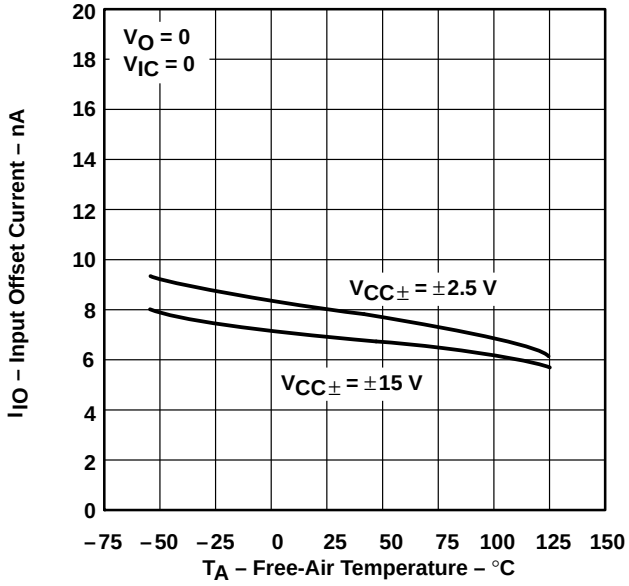

Figure 2

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

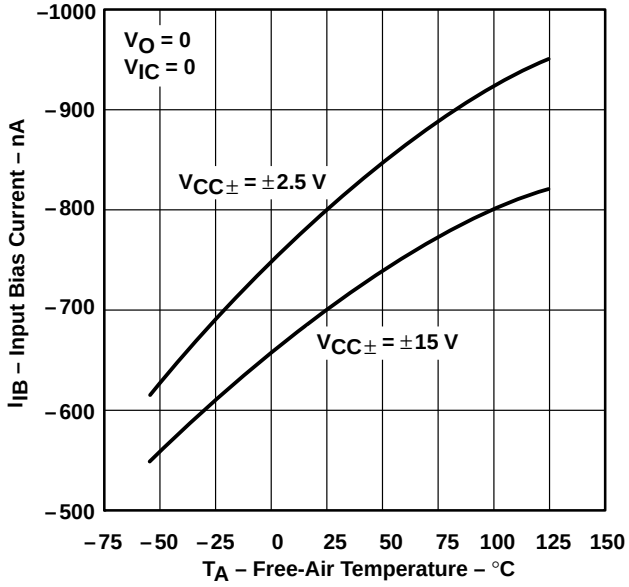

Figure 3

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

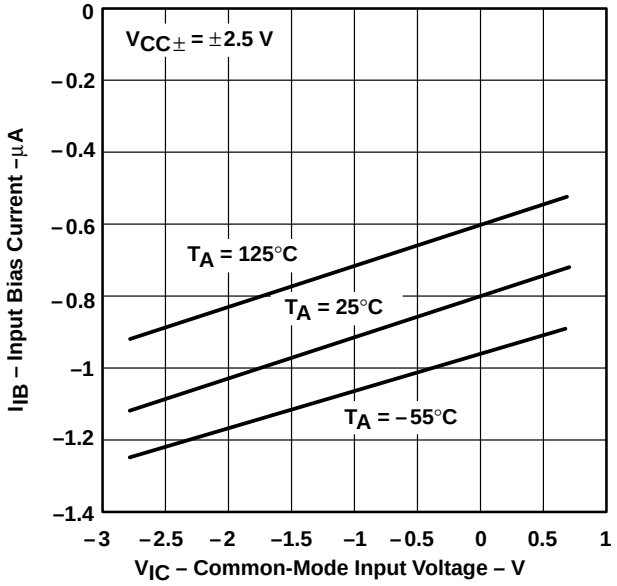

Figure 4

† 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

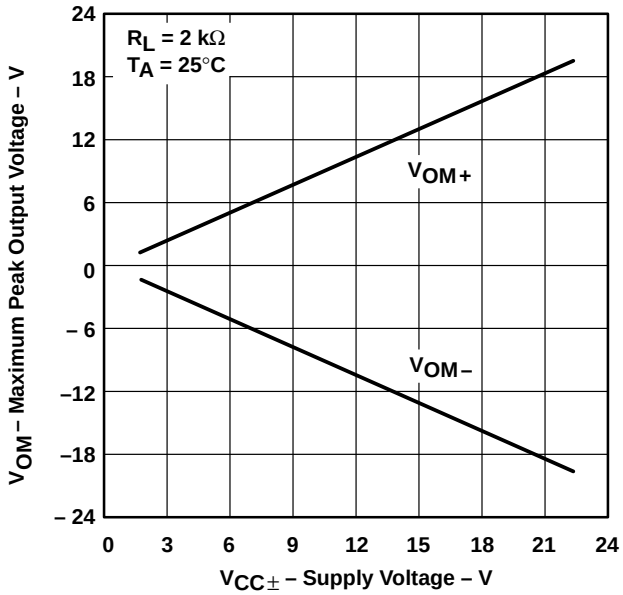

Figure 5

MAXIMUM PEAK OUTPUT VOLTAGE vs FREE-AIR TEMPERATURE

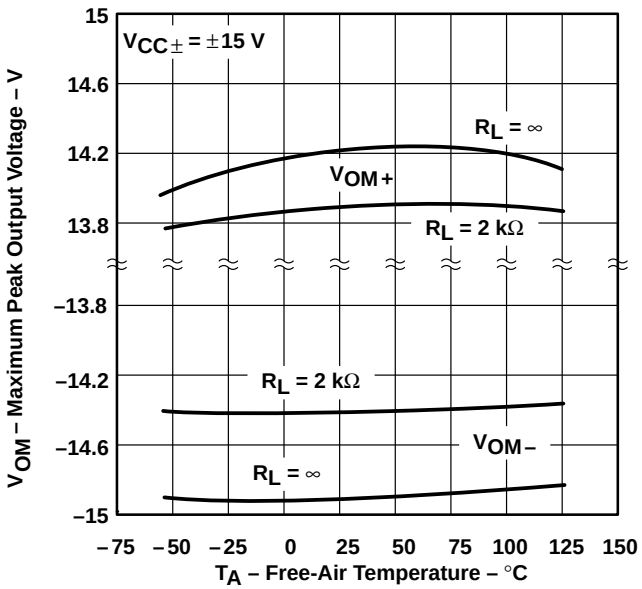

Figure 6

MAXIMUM POSITIVE PEAK OUTPUT VOLTAGE vs OUTPUT CURRENT

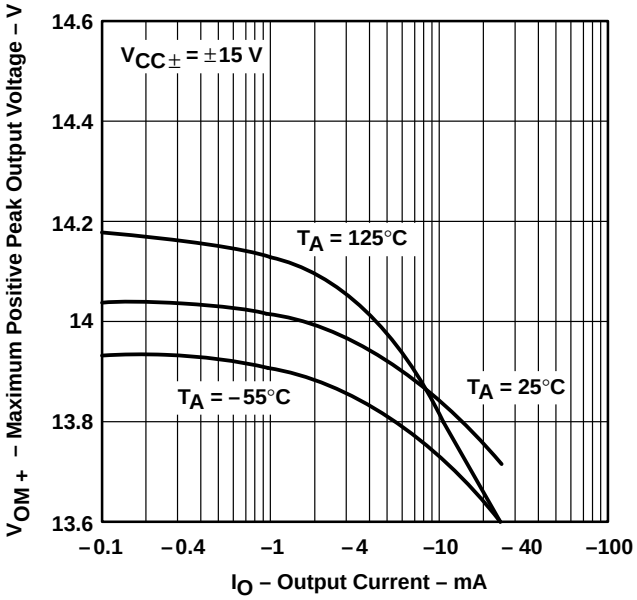

Figure 7

MAXIMUM NEGATIVE PEAK OUTPUT VOLTAGE vs OUTPUT CURRENT

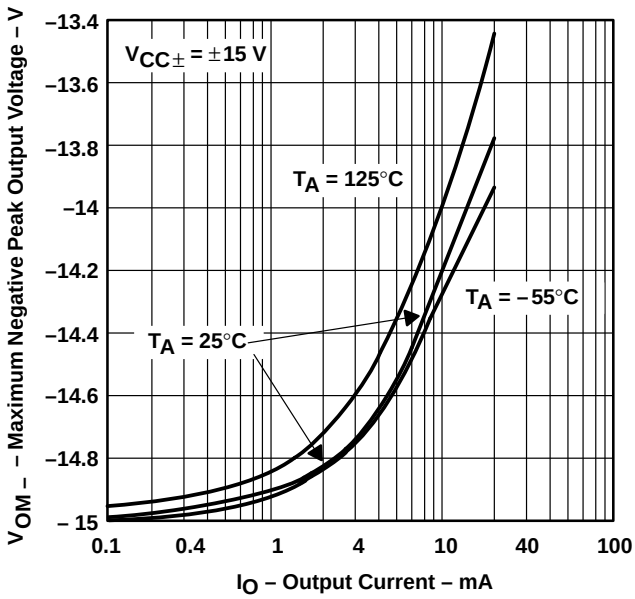

Figure 8

† 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

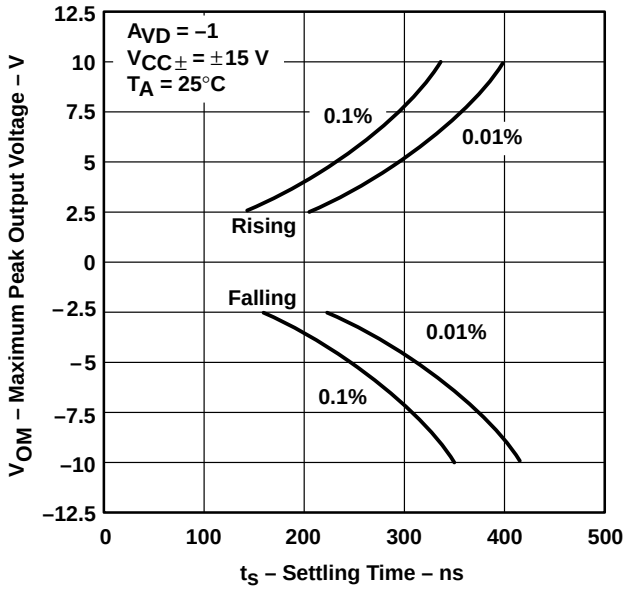

Figure 9

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE vs FREQUENCY

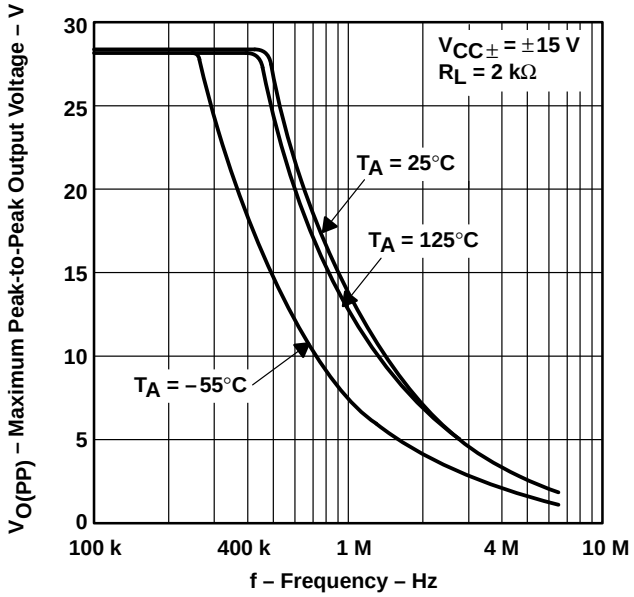

Figure 10

HIGH-LEVEL OUTPUT VOLTAGE vs OUTPUT CURRENT

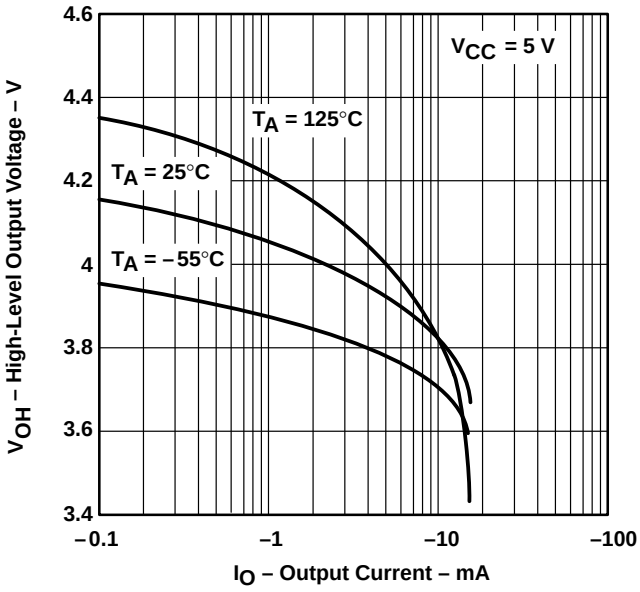

Figure 11

LOW-LEVEL OUTPUT VOLTAGE vs OUTPUT CURRENT

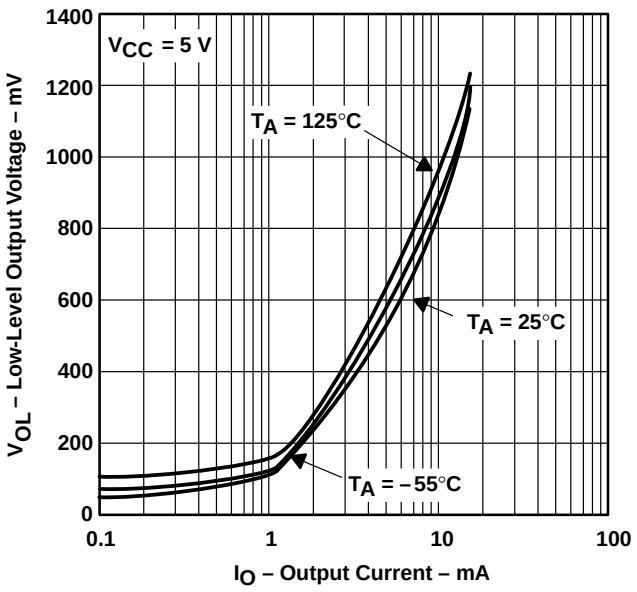

Figure 12

† 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

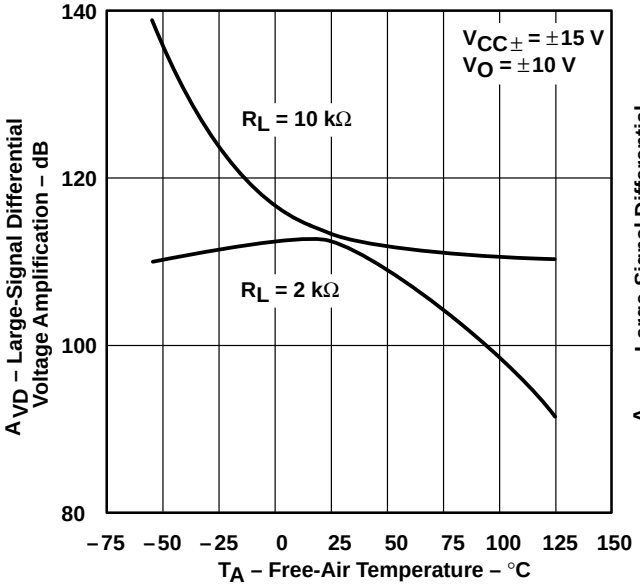

Figure 13

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE SHIFT vs FREQUENCY

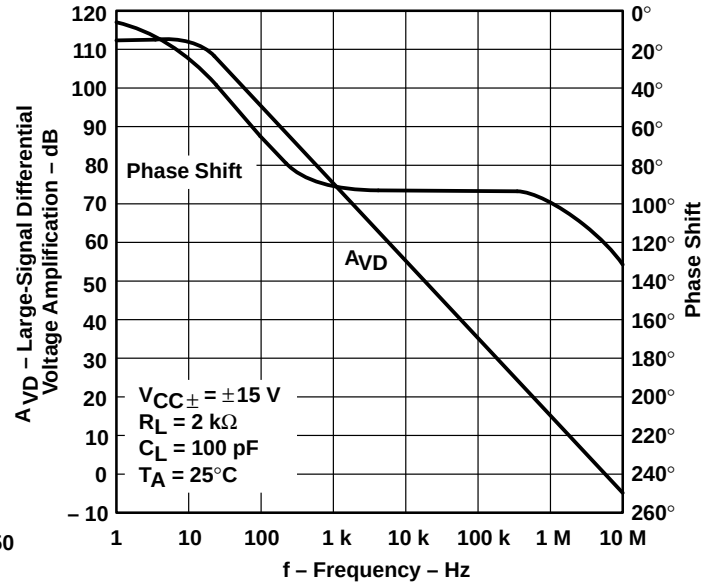

Figure 14

CLOSED-LOOP OUTPUT IMPEDANCE vs FREQUENCY

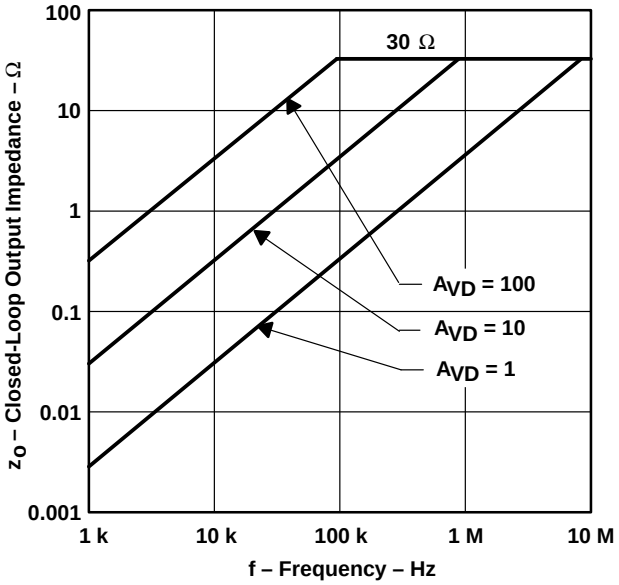

Figure 15

SHORT-CIRCUIT OUTPUT CURRENT vs FREE-AIR TEMPERATURE

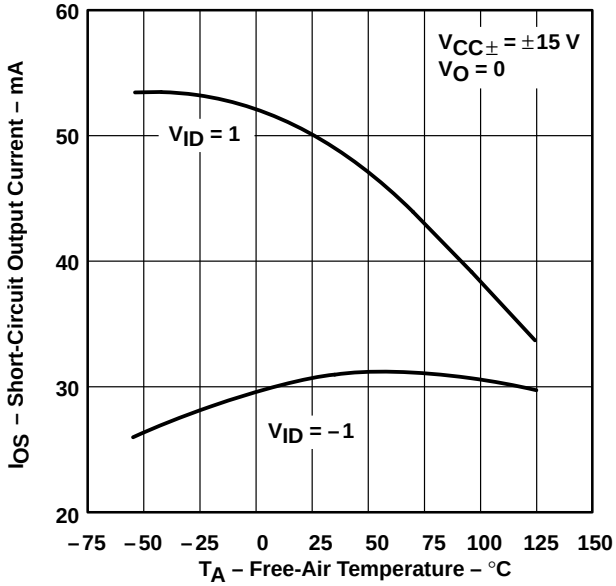

Figure 16

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

TYPICAL CHARACTERISTICS†

COMMON-MODE REJECTION RATIO vs FREQUENCY

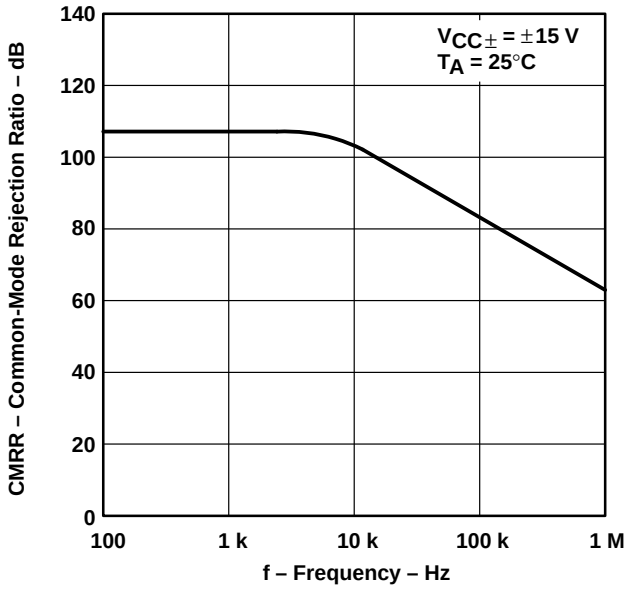

Figure 17

COMMON-MODE REJECTION RATIO vs FREE-AIR TEMPERATURE

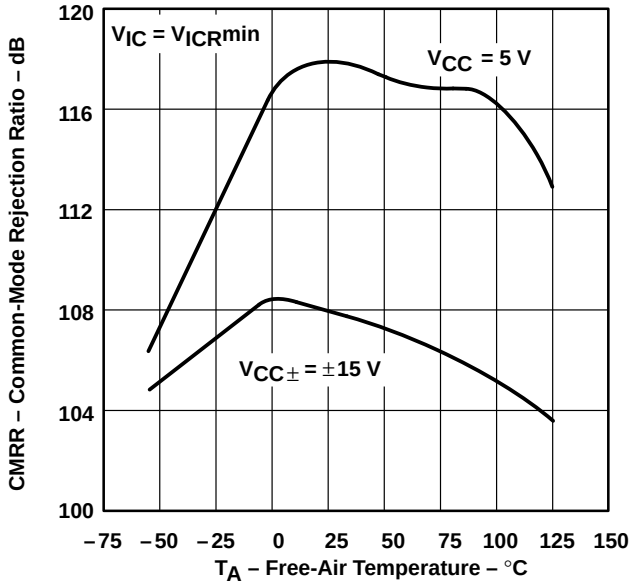

Figure 18

SUPPLY-VOLTAGE REJECTION RATIO vs FREQUENCY

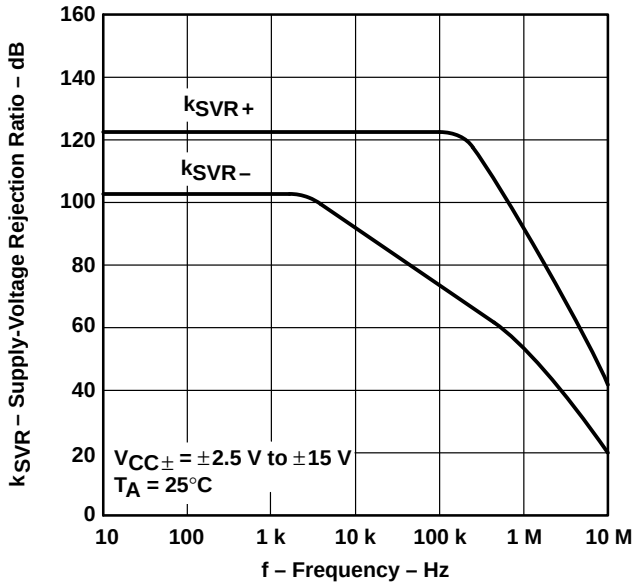

Figure 19

SUPPLY-VOLTAGE REJECTION RATIO vs FREE-AIR TEMPERATURE

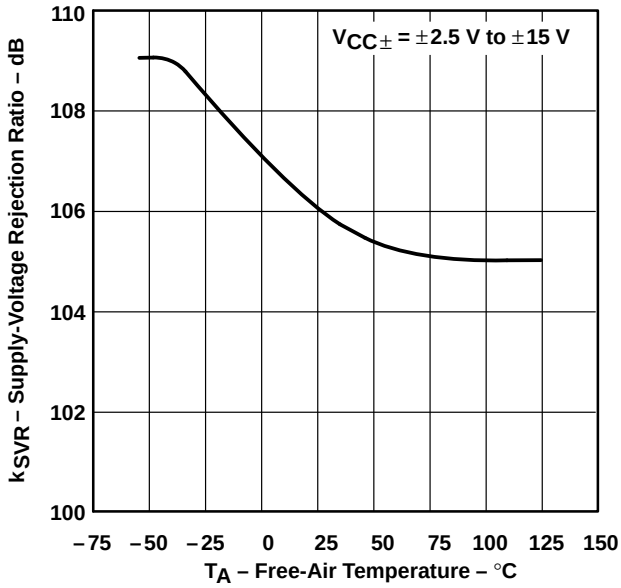

Figure 20

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

TYPICAL CHARACTERISTICS†

SUPPLY CURRENT vs FREE-AIR TEMPERATURE

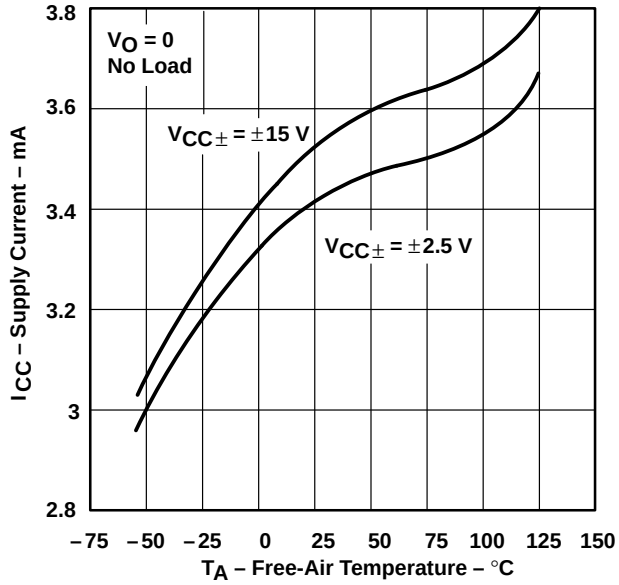

Figure 21

SUPPLY CURRENT vs SUPPLY VOLTAGE

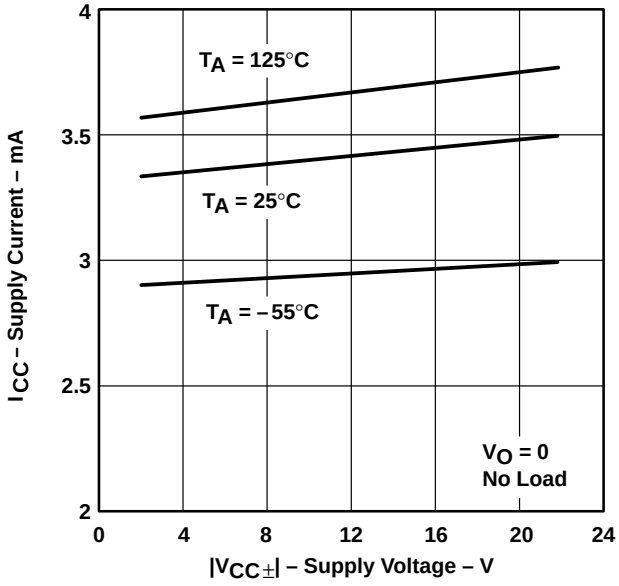

Figure 22

EQUIVALENT INPUT NOISE VOLTAGE vs FREQUENCY

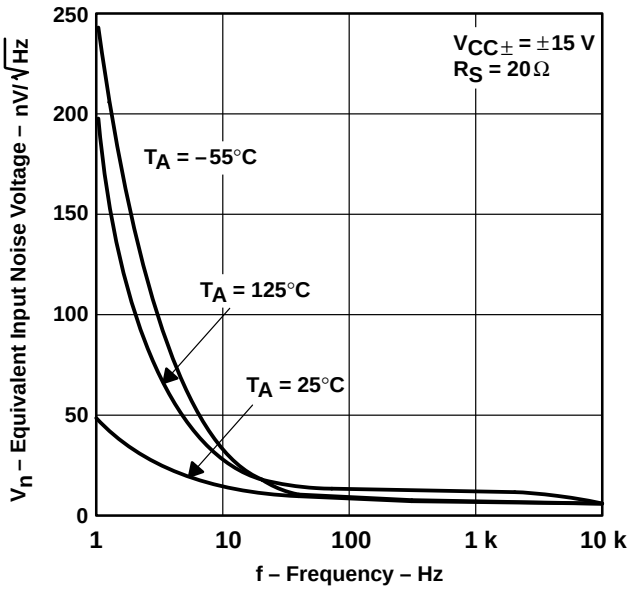

Figure 23

INPUT NOISE VOLTAGE OVER A 10-SECOND PERIOD

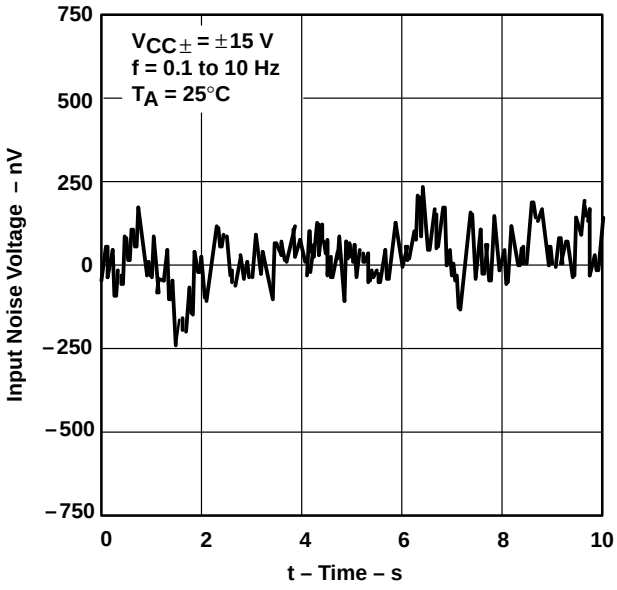

Figure 24

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

TYPICAL CHARACTERISTICS†

NOISE CURRENT vs FREQUENCY

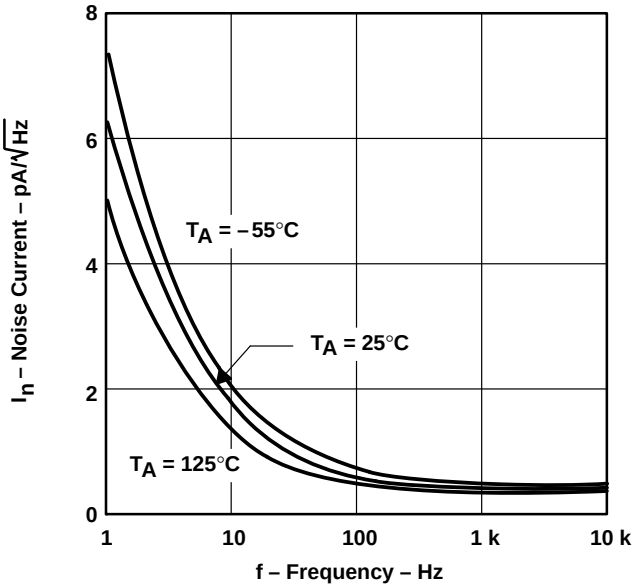

Figure 25

TOTAL HARMONIC DISTORTION PLUS NOISE vs FREQUENCY

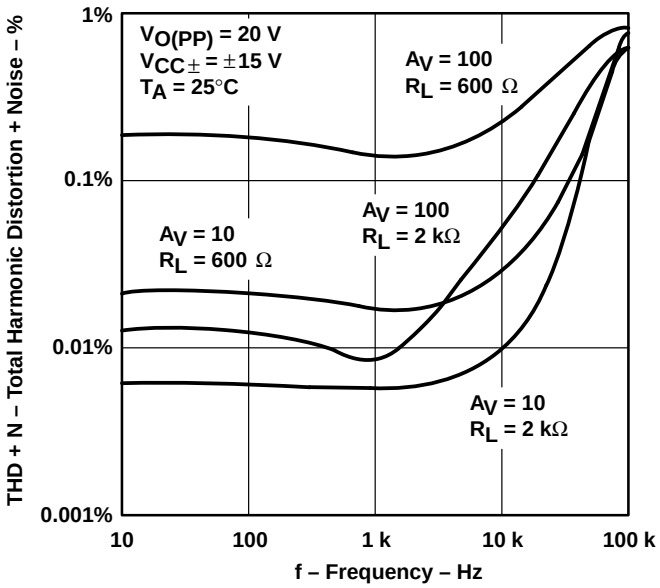

Figure 26

SLEW RATE vs FREE-AIR TEMPERATURE

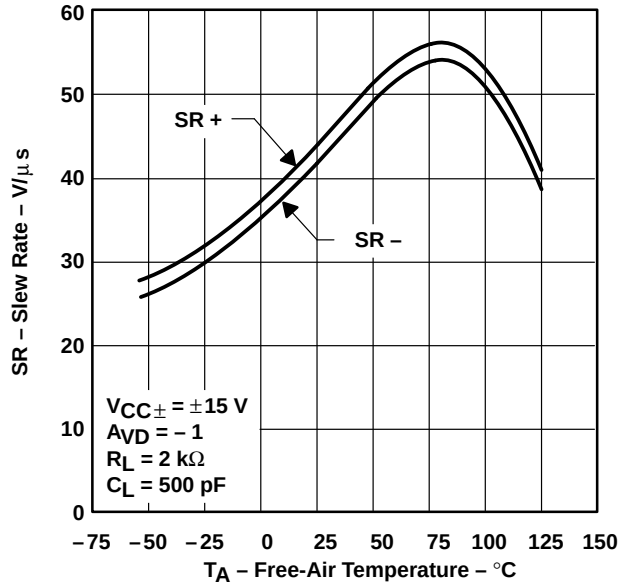

Figure 27

SLEW RATE vs LOAD CAPACITANCE

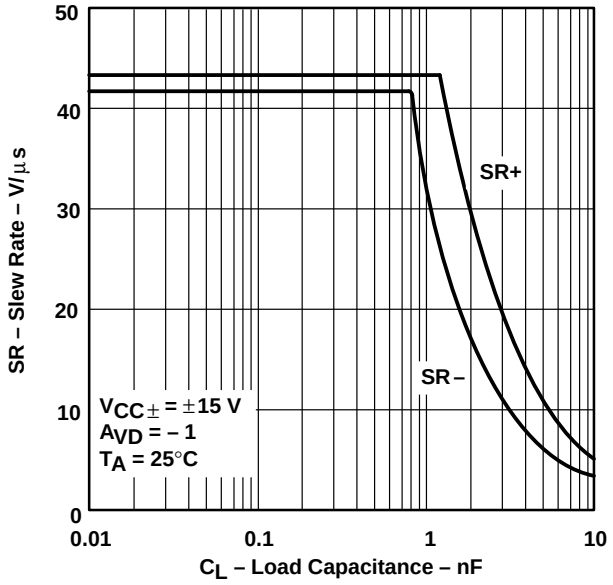

Figure 28

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

TYPICAL CHARACTERISTICS†

**NONINVERTING
LARGE-SIGNAL
PULSE RESPONSE**

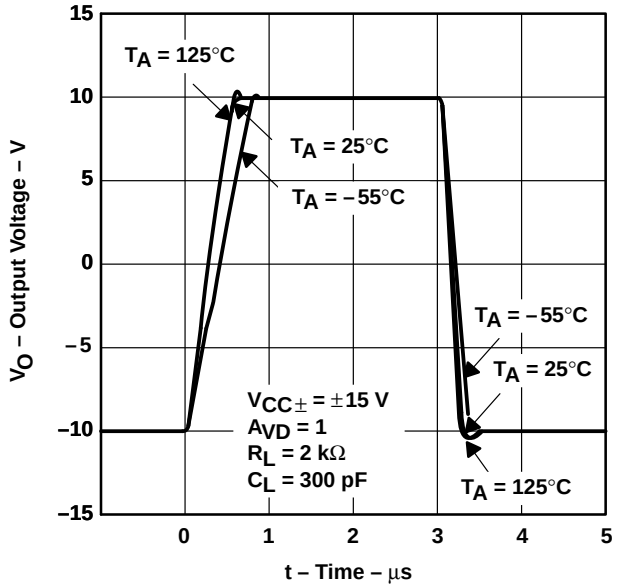

Figure 29

**INVERTING
LARGE-SIGNAL
PULSE RESPONSE**

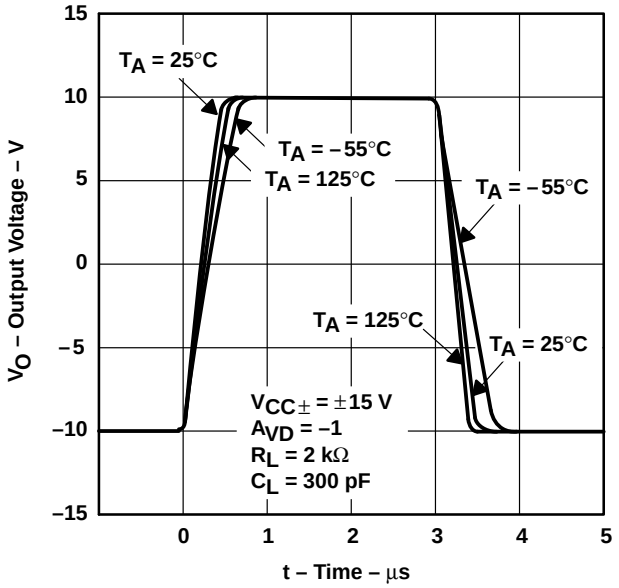

Figure 30

**SMALL-SIGNAL
PULSE RESPONSE**

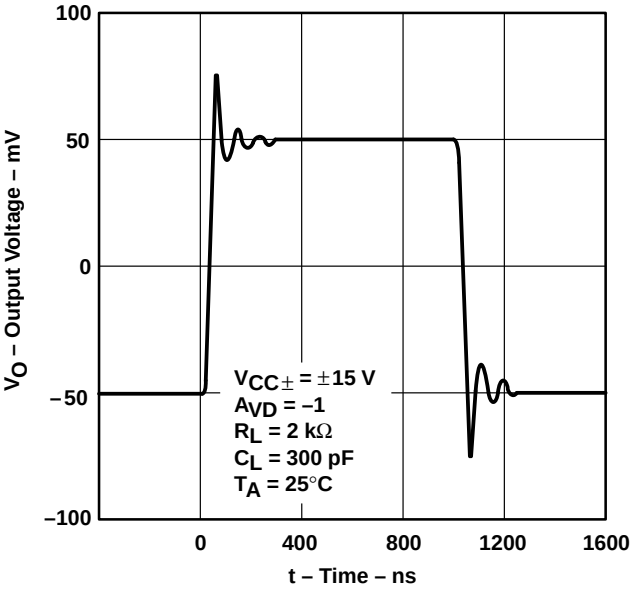

Figure 31

**UNITY-GAIN BANDWIDTH
vs
LOAD CAPACITANCE**

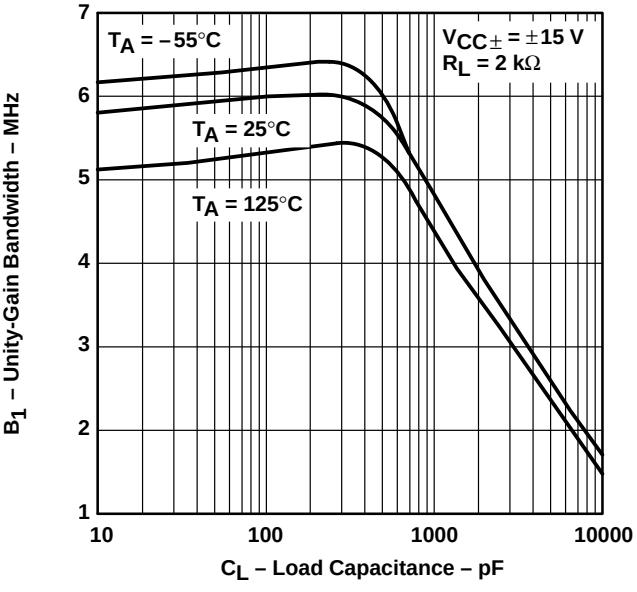

Figure 32

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

TYPICAL CHARACTERISTICS†

GAIN MARGIN vs LOAD CAPACITANCE

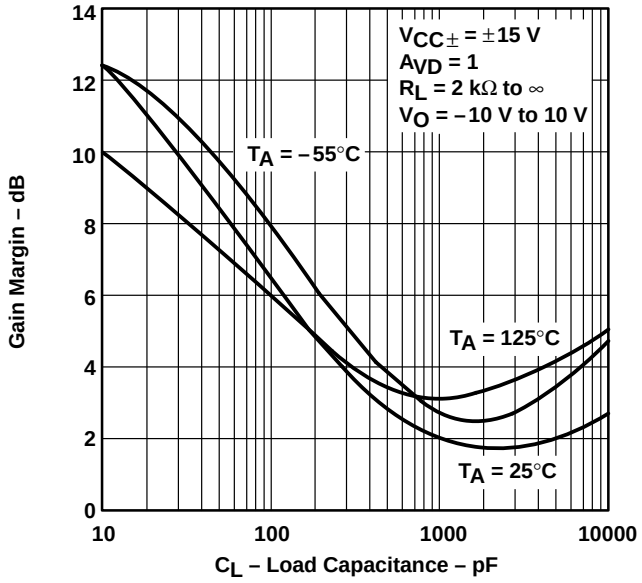

Figure 33

PHASE MARGIN vs LOAD CAPACITANCE

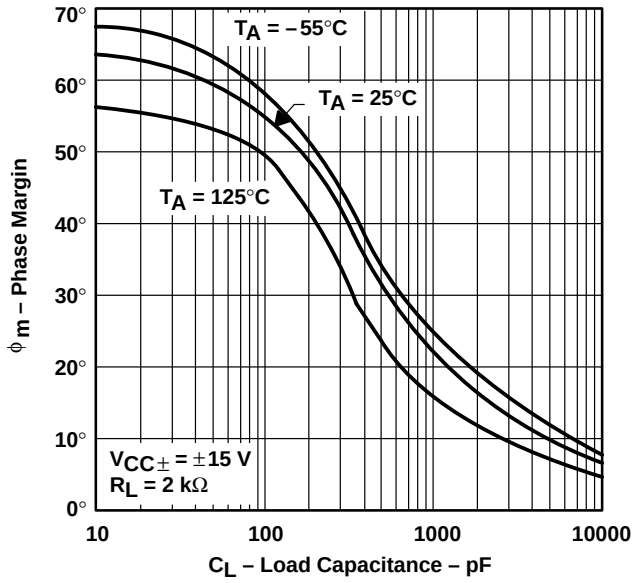

Figure 34

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

APPLICATION INFORMATION

input offset voltage nulling

The TLE2141 series offers external null pins that can be used to further reduce the input offset voltage. If this feature is desired, connect the circuit of Figure 35 as shown. If external nulling is not needed, the null pins may be left unconnected.

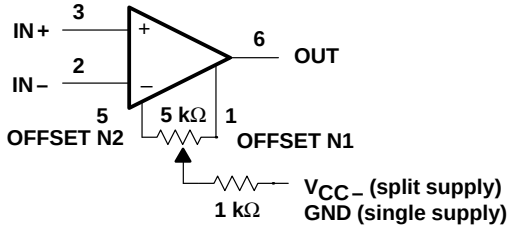

Figure 35. Input Offset Voltage Null Circuit

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