Excalibur™ LOW-NOISE HIGH-SPEED PRECISION OPERATIONAL AMPLIFIER

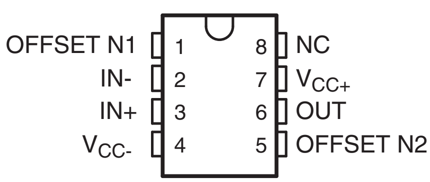
FEATURES

- **Controlled Baseline**
  - **One Assembly Site**
  - **One Test Site**
  - **One Fabrication Site**
- **Extended Temperature Performance of –55°C to 125°C**
- **Enhanced Diminishing Manufacturing Sources (DMS) Support**
- **Enhanced Product-Change Notification**
- **Qualification Pedigree[(1)]**

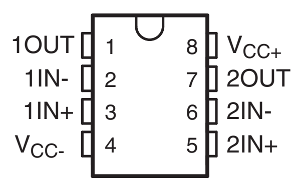
(1) Component qualification in accordance with JEDEC and industry standards to ensure reliable operation over an extended temperature range. This includes, but is not limited to, Highly Accelerated Stress Test (HAST) or biased 85/85, temperature cycle, autoclave or unbiased HAST, electromigration, bond intermetallic life, and mold compound life. Such qualification testing should not be viewed as justifying use of this component beyond specified performance and environmental limits.

- **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 Slew Rate (Min)**
- **High Gain-Bandwidth Product...5.9 MHz**
- **Low V_{IO}...900 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**

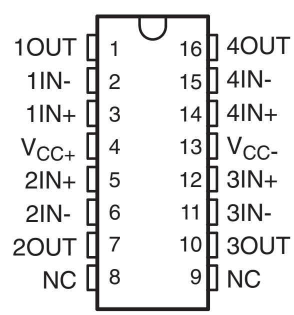
TLE2141
D PACKAGE
(TOP VIEW)



TLE2142
D PACKAGE
(TOP VIEW)



TLE2144
DW PACKAGE
(TOP VIEW)



NC – No internal connection

DESCRIPTION

The TLE214x devices are high-performance, internally compensated operational amplifiers built using the Texas Instruments complementary bipolar Excalibur™ process. They are pin-compatible upgrades to standard industry products.

The design incorporates an input stage that simultaneously achieves low audio-band noise of 10.5 nV/√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 TLE214x 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 900-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 V 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 V 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.

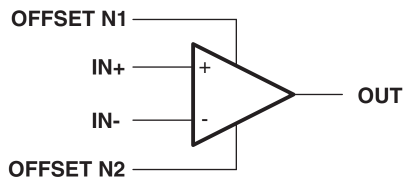
The TLE214x devices are available in industry-standard 8-pin and 16-pin small-outline packages. The devices are characterized for operation from –55°C to 125°C.

ORDERING INFORMATION(1)

T_A	PACKAGE(2)			ORDERABLE PART NUMBER	TOP-SIDE MARKING
–55°C to 125°C	Single	SOIC – D (8 pin)	Reel of 2500	TLE2141MDREP	2141EP
	Dual	SOIC – D (8 pin)	Reel of 2500	TLE2142MDREP(3)	TBD
	Quad	SOIC – DW (16 pin)	Reel of 2000	TLE2144MDWREP(3)	TBD

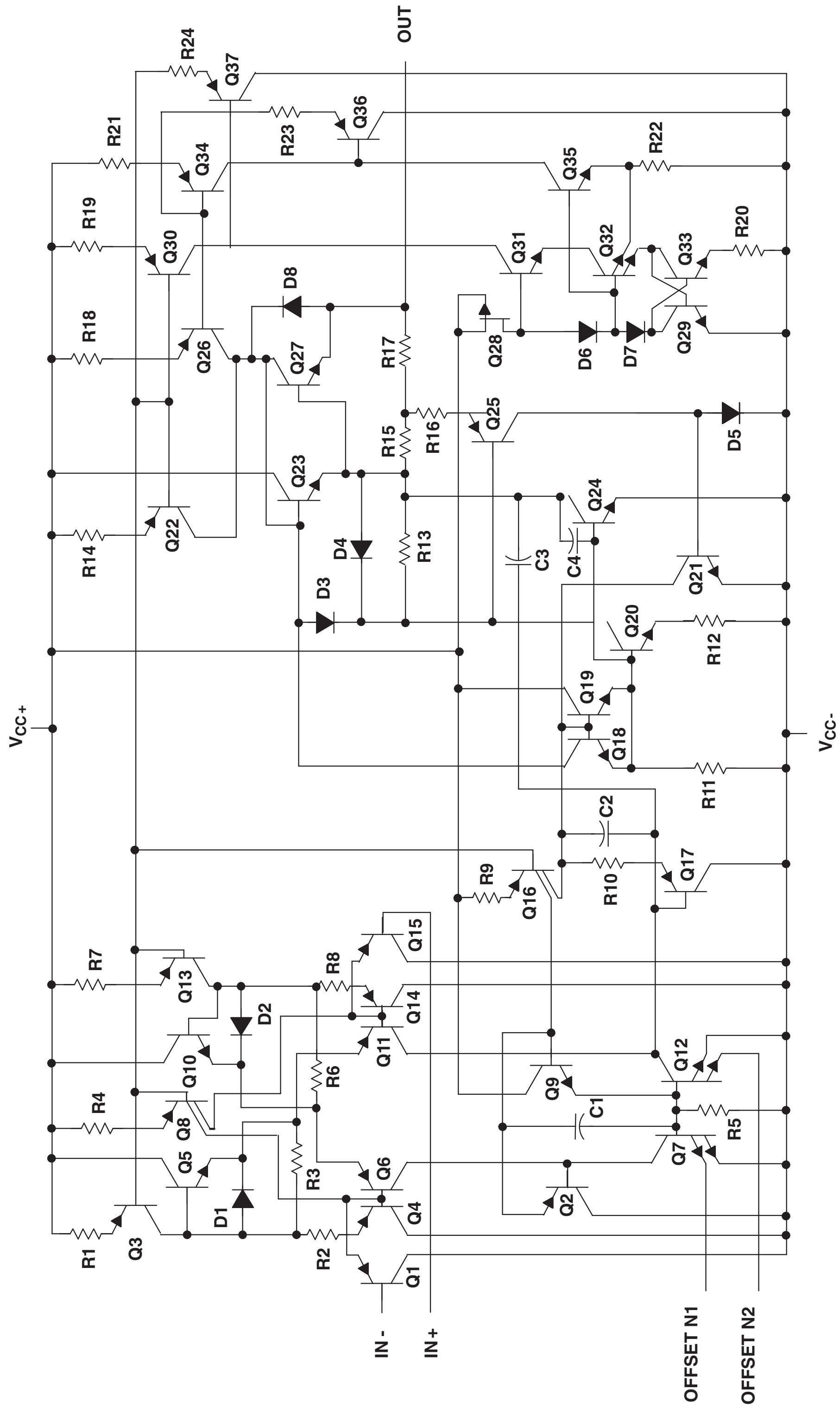
(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.
(2) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.
(3) Product Preview. Contact your TI sales representative for availability.

SYMBOL



A. OFFSET N1 and OFFSET N2 are available only on the TLE2141.

EQUIVALENT SCHEMATIC



DEVICE COMPONENT COUNT

COMPONENT	TLE2141	TLE2142	TLE2144
Transistors	46	65	130
Resistors	24	43	86
Diodes	8	14	28
Capacitors	4	8	16
Epi-FET	1	1	2

A. OFFSET N1 and OFFSET N2 are available only on the TLE2141.

ABSOLUTE MAXIMUM RATINGS[1]

over operating free-air temperature range (unless otherwise noted)

V_{CC+}	Supply voltage[2]		22 V
V_{CC-}	Supply voltage		–22 V
V_{ID}	Differential input voltage[3]		±44 V
V_I	Input voltage range (any input)		V_{CC+} V to (V_{CC-} – 0.3) V
I_I	Input current (each input)		±1 mA
I_O	Output current		±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[4]		Unlimited
θ_{JA}	Package thermal impedance[5][6]	D package	97.1°C/W
		DW package	57.3°C/W
T_A	Operating free-air temperature range		–55°C to 125 °C
T_{stg}	Storage temperature range[7]		–65°C to 150 °C
	Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds		260°C

(1) 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.
(2) All voltage values, except differential voltages, are with respect to the midpoint between V_{CC+} and V_{CC-}.
(3) Differential voltages are at IN+ with respect to IN–. Excessive current flows, if input, are brought below V_{CC-} – 0.3 V.
(4) 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.
(5) Maximum power dissipation is a function of T_J(max), θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) – T_A)/\theta_{JA}$. Operating at the absolute maximum T_J of 150°C can affect reliability.
(6) The package thermal impedance is calculated in accordance with JESD 51-7.
(7) Long-term high temperature storage and/or extended use at maximum recommended operating conditions may result in a reduction of overall device life. See http://www.ti.com/ep_quality for additional information on enhanced product packaging.

RECOMMENDED OPERATING CONDITIONS

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

TLE2141 ELECTRICAL CHARACTERISTICS

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

PARAMETER		TEST CONDITIONS	T_A (1)	TLE2141 MIN	TLE2141 TYP	TLE2141 MAX	UNIT
V_{IO}	Input offset voltage	V_O = 2.5 V, R_S = 50 Ω, V_{IC} = 2.5 V	25°C		225	1400	µV
			Full range			2100	
α_{VIO}	Temperature coefficient of input offset voltage	V_O = 2.5 V, R_S = 50 Ω, V_{IC} = 2.5 V	Full range		1.7		µV/°C
I_{IO}	Input offset current	V_O = 2.5 V, R_S = 50 Ω, V_{IC} = 2.5 V	25°C		8	100	nA
			Full range			250	
I_{IB}	Input bias current	V_O = 2.5 V, R_S = 50 Ω, V_{IC} = 2.5 V	25°C		–0.8	–2	µA
			Full range			–2.3	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω	25°C	0 to 3	–0.3 to 3.2		V
			Full range	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		V
		I_{OH} = –1.5 mA		3.8	4		
		I_{OH} = –15 mA		3.2	3.7		
		I_{OH} = –100 µA	Full range	3.75			
		I_{OH} = –1 mA		3.65			
		I_{OH} = –10 mA		3.25			
V_{OL}	Low-level output voltage	I_{OL} = 150 µA	25°C		75	125	mV
		I_{OL} = 1.5 mA			150	225	
		I_{OL} = 15 mA			1.2	1.6	V
		I_{OL} = 100 µA	Full range			200	mV
		I_{OL} = 1 mA				250	
		I_{OL} = 10 mA				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		V/mV
			Full range	5			
r_i	Input resistance		25°C		70		MΩ
c_i	Input capacitance		25°C		2.5		pF
z_o	Open-loop output impedance	f = 1 MHz	25°C		30		Ω
CMRR	Common-mode rejection ratio	V_{IC} = V_{ICR}(min), R_S = 50 Ω	25°C	85	118		dB
			Full range	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		dB
			Full range	85			
I_{CC}	Supply current	V_O = 2.5 V, No load, V_{IC} = 2.5 V	25°C		3.4	4.4	mA
			Full range			4.6	

(1) Full range is –55°C to 125°C.

TLE2141 OPERATING CHARACTERISTICS

V_{CC} = 5 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		TLE2141 MIN	TLE2141 TYP	TLE2141 MAX	UNIT
SR+	Positive slew rate	A_{VD} = –1, R_L = 2 kΩ(1), C_L = 500 pF			45		V/µs
SR–	Negative slew rate	A_{VD} = –1, R_L = 2 kΩ(1), C_L = 500 pF			42		V/µs
t_s	Settling time	A_{VD} = –1, 2.5-V step	To 0.1%		0.16		µs
			To 0.01%		0.22		
V_n	Equivalent input noise voltage	R_S = 20 Ω	f = 10 Hz		15		nV/√Hz
			f = 1 kHz		10.5		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz			0.48		µV
		f = 0.1 Hz to 10 Hz			0.51		
I_n	Equivalent input noise current	f = 10 Hz			1.92		pA/√Hz
		f = 1 kHz			0.5		
THD+N	Total harmonic distortion plus noise	V_O = 1 V to 3 V, R_L = 2 kΩ(1), A_{VD} = 2, f = 10 kHz			0.0052		%
B_1	Unity-gain bandwidth	R_L = 2 kΩ(1), C_L = 100 pF(1)			5.9		MHz
	Gain-bandwidth product	R_L = 2 kΩ(1), C_L = 100 pF(1), f = 100 kHz			5.8		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 2 V, R_L = 2 kΩ(1), A_{VD} = 1			660		kHz
ϕ_m	Phase margin at unity gain	R_L = 2 kΩ(1), C_L = 100 pF(1)			57		°

(1) R_L and C_L terminated to 2.5 V.

TLE2141 ELECTRICAL CHARACTERISTICS

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

PARAMETER		TEST CONDITIONS		T_A (1)	TLE2141 MIN	TLE2141 TYP	TLE2141 MAX	UNIT
V_{IO}	Input offset voltage	V_{IC} = 0, R_S = 50 Ω		25°C		200	900	µV
				Full range			1700	
α_{VIO}	Temperature coefficient of input offset voltage	V_{IC} = 0, R_S = 50 Ω		Full range		1.7		µV/°C
I_{IO}	Input offset current	V_{IC} = 0, R_S = 50 Ω		25°C		7	100	nA
				Full range			250	
I_{IB}	Input bias current	V_{IC} = 0, R_S = 50 Ω		25°C		–0.7	–1.5	µA
				Full range			–1.8	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω		25°C	–15 to 13	–15.3 to 13.2		V
				Full range	–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		V
		I_O = –1.5 mA			13.7	14		
		I_O = –15 mA			13.1	13.7		
		I_O = –100 µA		Full range	13.7			
		I_O = –1 mA			13.6			
		I_O = –10 mA			13.1			
V_{OM-}	Maximum negative peak output voltage swing	I_O = 150 µA		25°C	–14.7	–14.9		V
		I_O = 1.5 mA			–14.5	–14.8		
		I_O = 15 mA			–13.4	–13.8		
		I_O = 100 µA		Full range	–14.6			
		I_O = 1 mA			–14.5			
		I_O = 10 mA			–13.4			
A_{VD}	Large-signal differential voltage amplification	V_O = ±10 V, R_L = 2 kΩ		25°C	100	450		V/mV
				Full range	20			
r_i	Input resistance			25°C		65		MΩ
c_i	Input capacitance			25°C		2.5		pF
z_o	Open-loop output impedance	f = 1 MHz		25°C		30		Ω
CMRR	Common-mode rejection ratio	V_{IC} = V_{ICR}(min), R_S = 50 Ω		25°C	85	108		dB
				Full range	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		dB
				Full range	85			
I_{OS}	Short-circuit output current	V_O = 0	V_{ID} = 1 V	25°C	–25	–50		mA
			V_{ID} = –1 V		20	31		
I_{CC}	Supply current	V_O = 0, No load, V_{IC} = 2.5 V		25°C		3.5	4.5	mA
				Full range			4.7	

(1) Full range is –55°C to 125°C.

TLE2141 OPERATING CHARACTERISTICS

V_{CC} = ±15 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		TLE2141 MIN	TLE2141 TYP	TLE2141 MAX	UNIT
SR+	Positive slew rate	A_{VD} = –1, R_L = 2 kΩ, C_L = 100 pF		27	45		V/µs
SR–	Negative slew rate	A_{VD} = –1, R_L = 2 kΩ, C_L = 100 pF		27	42		V/µs
t_s	Settling time	A_{VD} = –1, 10-V step	To 0.1%		0.34		µs
			To 0.01%		0.4		
V_n	Equivalent input noise voltage	R_S = 20 Ω	f = 10 Hz		15		nV/√Hz
			f = 1 kHz		10.5		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz			0.48		µV
		f = 0.1 Hz to 10 Hz			0.51		
I_n	Equivalent input noise current	f = 10 Hz			1.89		pA/√Hz
		f = 1 kHz			0.47		
THD+N	Total harmonic distortion plus noise	$V_{O(PP)}$ = 20 V, R_L = 2 kΩ, A_{VD} = 10, f = 10 kHz			0.01		%
B_1	Unity-gain bandwidth	R_L = 2 kΩ, C_L = 100 pF			6		MHz
	Gain-bandwidth product	R_L = 2 kΩ, C_L = 100 pF, f = 100 kHz			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		kHz
ϕ_m	Phase margin at unity gain	R_L = 2 kΩ, C_L = 100 pF			58		°

TLE2142 ELECTRICAL CHARACTERISTICS

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

PARAMETER		TEST CONDITIONS	T_A (1)	TLE2142 MIN	TLE2142 TYP	TLE2142 MAX	UNIT
V_{IO}	Input offset voltage	V_O = 2.5 V, R_S = 50 Ω, V_{IC} = 2.5 V	25°C		220	1900	µV
			Full range			2600	
α_{VIO}	Temperature coefficient of input offset voltage	V_O = 2.5 V, R_S = 50 Ω, V_{IC} = 2.5 V	Full range		1.7		µV/°C
I_{IO}	Input offset current	V_O = 2.5 V, R_S = 50 Ω, V_{IC} = 2.5 V	25°C		8	100	nA
			Full range			200	
I_{IB}	Input bias current	V_O = 2.5 V, R_S = 50 Ω, V_{IC} = 2.5 V	25°C		–0.8	–2	µA
			Full range			–2.3	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω	25°C	0 to 3	–0.3 to 3.2		V
			Full range	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		V
		I_{OH} = –1.5 mA		3.8	4		
		I_{OH} = –15 mA		3.4	3.7		
		I_{OH} = –100 µA	Full range	3.75			
		I_{OH} = –1 mA		3.65			
		I_{OH} = –10 mA		3.45			
V_{OL}	Low-level output voltage	I_{OL} = 150 µA	25°C		75	125	mV
		I_{OL} = 1.5 mA			150	225	
		I_{OL} = 15 mA			1.2	1.4	V
		I_{OL} = 100 µA	Full range			200	mV
		I_{OL} = 1 mA				250	
		I_{OL} = 10 mA				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		V/mV
			Full range	5			
r_i	Input resistance		25°C		70		MΩ
c_i	Input capacitance		25°C		2.5		pF
z_o	Open-loop output impedance	f = 1 MHz	25°C		30		Ω
CMRR	Common-mode rejection ratio	V_{IC} = V_{ICR}(min), R_S = 50 Ω	25°C	85	118		dB
			Full range	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		dB
			Full range	85			
I_{CC}	Supply current	V_O = 2.5 V, No load, V_{IC} = 2.5 V	25°C		6.6	8.8	mA
			Full range			9.2	

(1) Full range is –55°C to 125°C.

TLE2142 OPERATING CHARACTERISTICS

V_{CC} = 5 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		TLE2142 MIN	TLE2142 TYP	TLE2142 MAX	UNIT
SR+	Positive slew rate	A_{VD} = –1, R_L = 2 kΩ(1), C_L = 500 pF			45		V/µs
SR–	Negative slew rate	A_{VD} = –1, R_L = 2 kΩ(1), C_L = 500 pF			42		V/µs
t_s	Settling time	A_{VD} = –1, 2.5-V step	To 0.1%		0.16		µs
			To 0.01%		0.22		
V_n	Equivalent input noise voltage	R_S = 20 Ω	f = 10 Hz		15		nV/√Hz
			f = 1 kHz		10.5		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz			0.48		µV
		f = 0.1 Hz to 10 Hz			0.51		
I_n	Equivalent input noise current	f = 10 Hz			1.92		pA/√Hz
		f = 1 kHz			0.5		
THD+N	Total harmonic distortion plus noise	V_O = 1 V to 3 V, R_L = 2 kΩ(1), A_{VD} = 2, f = 10 kHz			0.0052		%
B_1	Unity-gain bandwidth	R_L = 2 kΩ(1), C_L = 100 pF			5.9		MHz
	Gain-bandwidth product	R_L = 2 kΩ(1), C_L = 100 pF, f = 100 kHz			5.8		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 2 V, R_L = 2 kΩ(1), A_{VD} = 1, C_L = 100 pF			660		kHz
ϕ_m	Phase margin at unity gain	R_L = 2 kΩ(1), C_L = 100 pF			57		°

(1) R_L terminated at 2.5 V.

TLE2142 ELECTRICAL CHARACTERISTICS

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

PARAMETER		TEST CONDITIONS		T_A (1)	TLE2142			UNIT
					MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{IC} = 0, R_S = 50 Ω		25°C		290	1200	µV
				Full range			2000	
α_{VIO}	Temperature coefficient of input offset voltage	V_{IC} = 0, R_S = 50 Ω		Full range		1.7		µV/°C
I_{IO}	Input offset current	V_{IC} = 0, R_S = 50 Ω		25°C		7	100	nA
				Full range			250	
I_{IB}	Input bias current	V_{IC} = 0, R_S = 50 Ω		25°C		–0.7	–1.5	µA
				Full range			–1.8	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω		25°C	–15 to 13	–15.3 to 13.2		V
				Full range	–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		V
		I_O = –1.5 mA			13.7	14		
		I_O = –15 mA			13.3	13.7		
		I_O = –100 µA		Full range	13.7			
		I_O = –1 mA			13.6			
		I_O = –10 mA			13.3			
V_{OM-}	Maximum negative peak output voltage swing	I_O = 150 µA		25°C	–14.7	–14.9		V
		I_O = 1.5 mA			–14.5	–14.8		
		I_O = 15 mA			–13.4	–13.8		
		I_O = 100 µA		Full range	–14.6			
		I_O = 1 mA			–14.5			
		I_O = 10 mA			–13.4			
A_{VD}	Large-signal differential voltage amplification	V_O = ±10 V, R_L = 2 kΩ		25°C	100	450		V/mV
				Full range	20			
r_i	Input resistance			25°C		65		MΩ
c_i	Input capacitance			25°C		2.5		pF
z_o	Open-loop output impedance	f = 1 MHz		25°C		30		Ω
CMRR	Common-mode rejection ratio	V_{IC} = V_{ICR}(min), R_S = 50 Ω		25°C	85	108		dB
				Full range	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		dB
				Full range	85			
I_{OS}	Short-circuit output current	V_O = 0	V_{ID} = 1 V	25°C	–25	–50		mA
			V_{ID} = –1 V		20	31		
I_{CC}	Supply current	V_O = 0, No load, V_{IC} = 2.5 V		25°C		6.9	9	mA
				Full range			9.4	

(1) Full range is –55°C to 125°C.

TLE2142 OPERATING CHARACTERISTICS

V_{CC} = ±15 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		TLE2142 MIN	TLE2142 TYP	TLE2142 MAX	UNIT
SR+	Positive slew rate	A_{VD} = –1, R_L = 2 kΩ, C_L = 100 pF		27	45		V/µs
SR–	Negative slew rate	A_{VD} = –1, R_L = 2 kΩ, C_L = 100 pF		27	42		V/µs
t_s	Settling time	A_{VD} = –1, 10-V step	To 0.1%		0.34		µs
			To 0.01%		0.4		
V_n	Equivalent input noise voltage	R_S = 20 Ω	f = 10 Hz		15		nV/√Hz
			f = 1 kHz		10.5		
$V_{n(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz			0.48		µV
		f = 0.1 Hz to 10 Hz			0.51		
I_n	Equivalent input noise current	f = 10 Hz			1.89		pA/√Hz
		f = 1 kHz			0.47		
THD+N	Total harmonic distortion plus noise	$V_{O(PP)}$ = 20 V, R_L = 2 kΩ, A_{VD} = 10, f = 10 kHz			0.01		%
B_1	Unity-gain bandwidth	R_L = 2 kΩ, C_L = 100 pF			6		MHz
	Gain-bandwidth product	R_L = 2 kΩ, C_L = 100 pF, f = 100 kHz			5.9		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 20 V, A_{VD} = 1, R_L = 2 kΩ, A_{VD} = 1, C_L = 100 pF			668		kHz
ϕ_m	Phase margin at unity gain	R_L = 2 kΩ, C_L = 100 pF			58		°

TLE2144 ELECTRICAL CHARACTERISTICS

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

PARAMETER		TEST CONDITIONS	T_A (1)	TLE2144 MIN	TLE2144 TYP	TLE2144 MAX	UNIT
V_{IO}	Input offset voltage	V_O = 2.5 V, R_S = 50 Ω, V_{IC} = 2.5 V	25°C		0.5	3.8	mV
			Full range			5.2	
α_{VIO}	Temperature coefficient of input offset voltage	V_O = 2.5 V, R_S = 50 Ω, V_{IC} = 2.5 V	Full range		1.7		µV/°C
I_{IO}	Input offset current	V_O = 2.5 V, R_S = 50 Ω, V_{IC} = 2.5 V	25°C		8	100	nA
			Full range			250	
I_{IB}	Input bias current	V_O = 2.5 V, R_S = 50 Ω, V_{IC} = 2.5 V	25°C		–0.8	–2	µA
			Full range			–2.3	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω	25°C	0 to 3	–0.3 to 3.2		V
			Full range	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		V
		I_{OH} = –1.5 mA		3.8	4		
		I_{OH} = –15 mA		3.4	3.7		
		I_{OH} = –100 µA	Full range	3.75			
		I_{OH} = –1 mA		3.65			
		I_{OH} = –10 mA		3.45			
V_{OL}	Low-level output voltage	I_{OL} = 150 µA	25°C		75	125	mV
		I_{OL} = 1.5 mA			150	225	
		I_{OL} = 15 mA			1.2	1.6	V
		I_{OL} = 100 µA	Full range			200	mV
		I_{OL} = 1 mA				250	
		I_{OL} = 10 mA				1.45	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	95		V/mV
			Full range	5			
r_i	Input resistance		25°C		70		MΩ
c_i	Input capacitance		25°C		2.5		pF
z_o	Open-loop output impedance	f = 1 MHz	25°C		3.		Ω
CMRR	Common-mode rejection ratio	V_{IC} = V_{ICR}(min), R_S = 50 Ω	25°C	85	118		dB
			Full range	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		dB
			Full range	85			
I_{CC}	Supply current	V_O = 2.5 V, No load, V_{IC} = 2.5 V	25°C		13.2	17.6	mA
			Full range			18.4	

(1) Full range is –55°C to 125°C.

TLE2144 OPERATING CHARACTERISTICS

V_{CC} = 5 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		TLE2144 MIN	TLE2144 TYP	TLE2144 MAX	UNIT
SR+	Positive slew rate	A_{VD} = –1, R_L = 2 kΩ(1), C_L = 500 pF			45		V/µs
SR–	Negative slew rate	A_{VD} = –1, R_L = 2 kΩ(1), C_L = 500 pF			42		V/µs
t_s	Settling time	A_{VD} = –1, 2.5-V step	To 0.1%		0.16		µs
			To 0.01%		0.22		
V_n	Equivalent input noise voltage	R_S = 20 Ω	f = 10 Hz		15		nV/√Hz
			f = 1 kHz		10.5		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz			0.48		µV
		f = 0.1 Hz to 10 Hz			0.51		
I_n	Equivalent input noise current	f = 10 Hz			1.92		pA/√Hz
		f = 1 kHz			0.5		
THD+N	Total harmonic distortion plus noise	V_O = 1 V to 3 V, R_L = 2 kΩ(1), A_{VD} = 2, f = 10 kHz			0.0052		%
B_1	Unity-gain bandwidth	R_L = 2 kΩ(1), C_L = 100 pF			5.9		MHz
	Gain-bandwidth product	R_L = 2 kΩ(1), C_L = 100 pF, f = 100 kHz			5.8		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 2 V, R_L = 2 kΩ(1), A_{VD} = 1			660		kHz
ϕ_m	Phase margin at unity gain	R_L = 2 kΩ(1), C_L = 100 pF			57		°

(1) R_L terminated at 2.5 V.

TLE2144 ELECTRICAL CHARACTERISTICS

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

PARAMETER		TEST CONDITIONS	T_A (1)	TLE2144 MIN	TLE2144 TYP	TLE2144 MAX	UNIT
V_{IO}	Input offset voltage	V_{IC} = 0, R_S = 50 Ω	25°C		0.6	2.4	mV
			Full range			4	
α_{VIO}	Temperature coefficient of input offset voltage	V_{IC} = 0, R_S = 50 Ω	25°C		1.7		µV/°C
I_{IO}	Input offset current	V_{IC} = 0, R_S = 50 Ω	25°C		7	100	nA
			Full range			250	
I_{IB}	Input bias current	V_{IC} = 0, R_S = 50 Ω	25°C		–0.7	–1.5	µA
			Full range			–1.8	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω	25°C	–15 to 13	–15.3 to 13.2		V
			Full range	–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		V
		I_O = –1.5 mA		13.7	14		
		I_O = –15 mA		13.1	13.7		
		I_O = –100 µA	Full range	13.7			
		I_O = –1 mA		13.6			
		I_O = –10 mA		13.1			
V_{OM-}	Maximum negative peak output voltage swing	I_O = 150 µA	25°C	–14.7	–14.9		V
		I_O = 1.5 mA		–14.5	–14.8		
		I_O = 15 mA		–13.4	–13.8		
		I_O = 100 µA	Full range	–14.6			
		I_O = 1 mA		–14.5			
		I_O = 10 mA		–13.4			
A_{VD}	Large-signal differential voltage amplification	V_O = ±10 V, R_L = 2 kΩ	25°C	100	170		V/mV
			Full range	20			
r_i	Input resistance		25°C		65		MΩ
c_i	Input capacitance		25°C		2.5		pF
z_o	Open-loop output impedance	f = 1 MHz	25°C		30		Ω
CMRR	Common-mode rejection ratio	V_{IC} = V_{ICR}(min), R_S = 50 Ω	25°C	85	108		dB
			Full range	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		dB
			Full range	85			
I_{OS}	Short-circuit output current	V_O = 0, V_{ID} = 1 V	25°C	–25	–50		mA
		V_O = 0, V_{ID} = –1 V		20	31		
I_{CC}	Supply current	V_O = 0, No load, V_{IC} = 2.5 V	25°C		13.8	18	mA
			Full range			18.8	

(1) Full range is –55°C to 125°C.

TLE2144 OPERATING CHARACTERISTICS

V_{CC} = ±15 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		TLE2144 MIN	TLE2144 TYP	TLE2144 MAX	UNIT
SR+	Positive slew rate	A_{VD} = –1, R_L = 2 kΩ, C_L = 100 pF		27	45		V/µs
SR–	Negative slew rate	A_{VD} = –1, R_L = 2 kΩ, C_L = 100 pF		27	42		V/µs
t_s	Settling time	A_{VD} = –1, 10-V step	To 0.1%		0.34		µs
			To 0.01%		0.4		
V_n	Equivalent input noise voltage	R_S = 20 Ω	f = 10 Hz		15		nV/√Hz
			f = 1 kHz		10.5		
$V_{n(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz			0.48		µV
		f = 0.1 Hz to 10 Hz			0.51		
I_n	Equivalent input noise current	f = 10 Hz			1.89		pA/√Hz
		f = 10 kHz			0.47		
THD+N	Total harmonic distortion plus noise	$V_{O(PP)}$ = 20 V, R_L = 2 kΩ, A_{VD} = 10, f = 10 kHz			0.01		%
B_1	Unity-gain bandwidth	R_L = 2 kΩ, C_L = 100 pF			6		MHz
	Gain-bandwidth product	R_L = 2 kΩ, C_L = 100 pF, f = 100 kHz			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		kHz
ϕ_m	Phase margin at unity gain	R_L = 2 kΩ, C_L = 100 pF			58		°

TYPICAL CHARACTERISTICS

Table of Graphs

V_{IO}	Input offset voltage		Distribution	Figure 1, Figure 2, Figure 3
I_{IO}	Input offset current		vs Free-air temperature	Figure 4
I_{IB}	Input bias current		vs Common-mode input voltage	Figure 5
			vs Free-air temperature	Figure 6
V_{OM+}	Maximum positive peak output voltage		vs Supply voltage	Figure 7
			vs Free-air temperature	Figure 8
			vs Output current	Figure 9
			vs Settling time	Figure 11
V_{OM-}	Maximum negative peak output voltage		vs Supply voltage	Figure 7
			vs Free-air temperature	Figure 8
			vs Output current	Figure 10
			vs Settling time	Figure 11
$V_{O(PP)}$	Maximum peak-to-peak output voltage		vs Frequency	Figure 12
V_{OH}	High-level output voltage		vs Output current	Figure 13
V_{OL}	Low-level output voltage		vs Output current	Figure 14
	Phase shift		vs Frequency	Figure 15
A_{VD}	Large-signal differential voltage amplification		vs Frequency	Figure 15
			vs Free-air temperature	Figure 16
z_o	Closed-loop output impedance		vs Frequency	Figure 17
I_{OS}	Short-circuit output current		vs Free-air temperature	Figure 18
CMRR	Common-mode rejection ratio		vs Frequency	Figure 19
			vs Free-air temperature	Figure 20
k_{SVR}	Supply-voltage rejection ratio		vs Frequency	Figure 21
			vs Free-air temperature	Figure 22
I_{CC}	Supply current		vs Supply voltage	Figure 23
			vs Free-air temperature	Figure 24
V_n	Equivalent input noise voltage		vs Frequency	Figure 25
V_n	Input noise voltage		Over a 10-second period	Figure 26
I_n	Noise current		vs Frequency	Figure 27
THD+N	Total harmonic distortion plus noise		vs Frequency	Figure 28
SR	Slew rate		vs Free-air temperature	Figure 29
			vs Load capacitance	Figure 30
	Pulse response	Noninverting large signal	vs Time	Figure 31
		Inverting large signal	vs Time	Figure 32
		Small signal	vs Time	Figure 33
B_1	Unity-gain bandwidth		vs Load capacitance	Figure 34
	Gain margin		vs Load capacitance	Figure 35
ϕ_m	Phase margin		vs Load capacitance	Figure 36

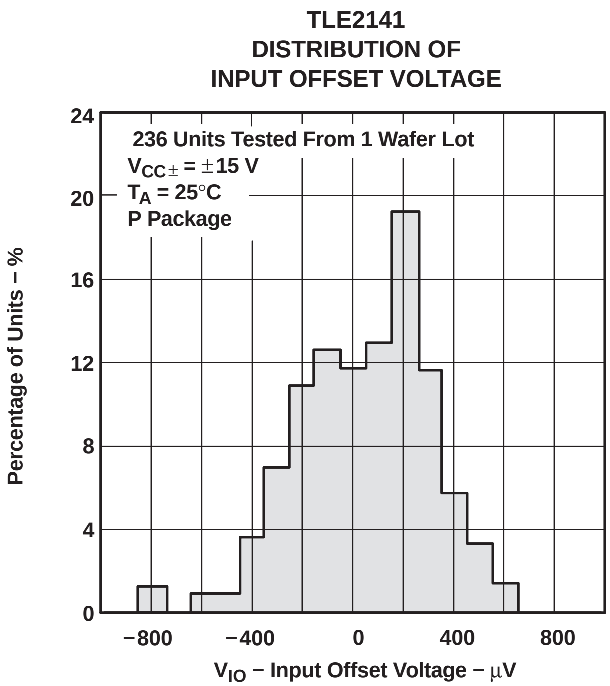


Figure 1.

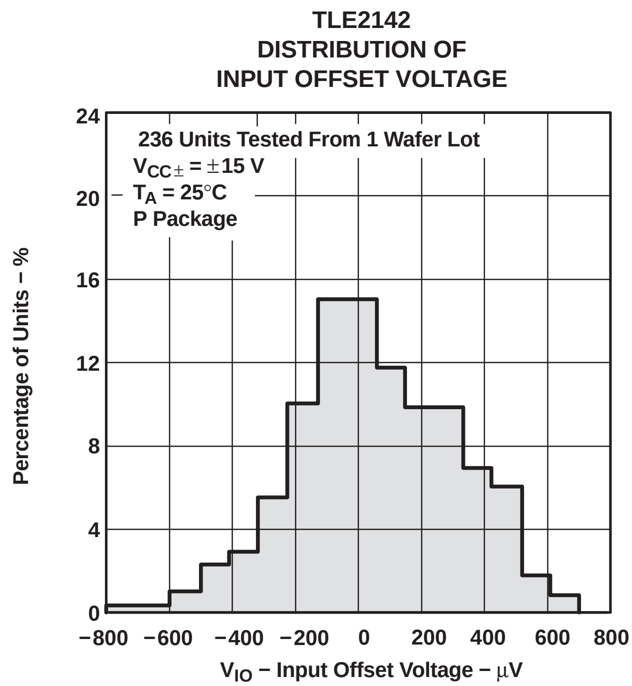


Figure 2.

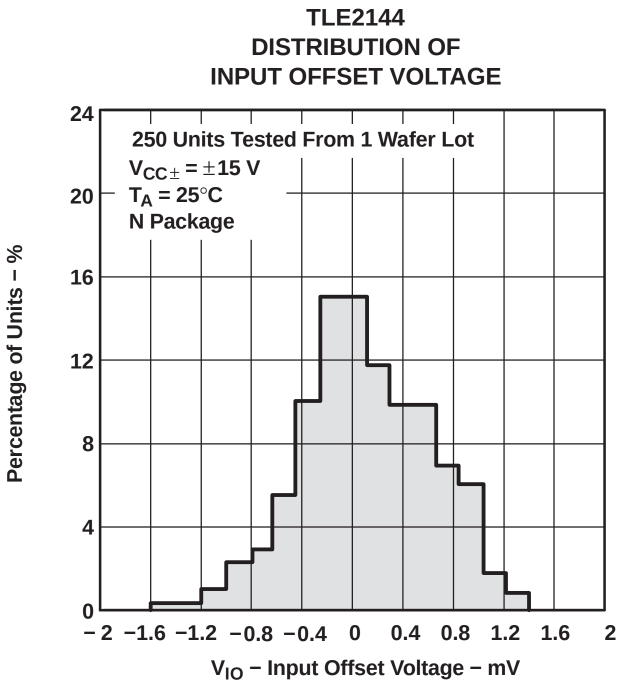


Figure 3.

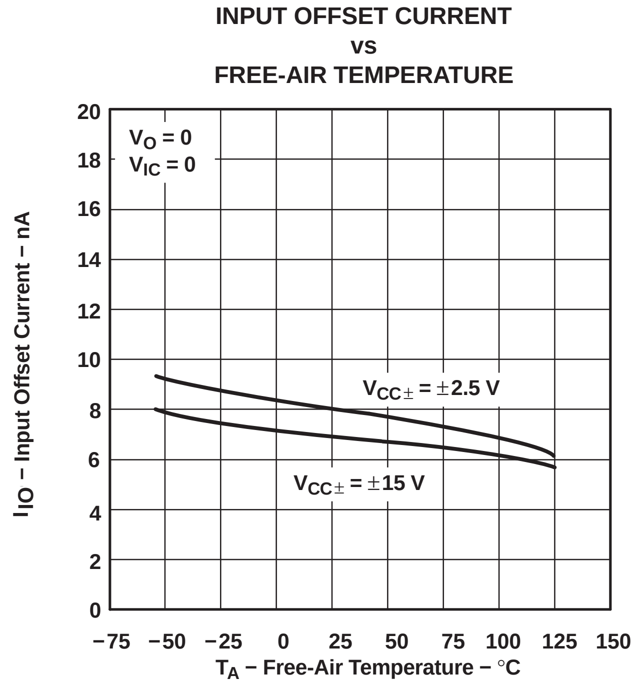


Figure 4.

INPUT BIAS CURRENT
vs
COMMON-MODE INPUT VOLTAGE

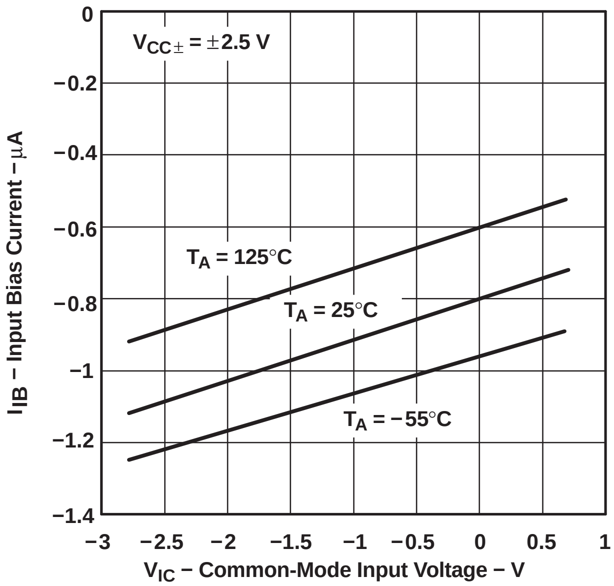


Figure 5.

INPUT BIAS CURRENT
vs
FREE-AIR TEMPERATURE

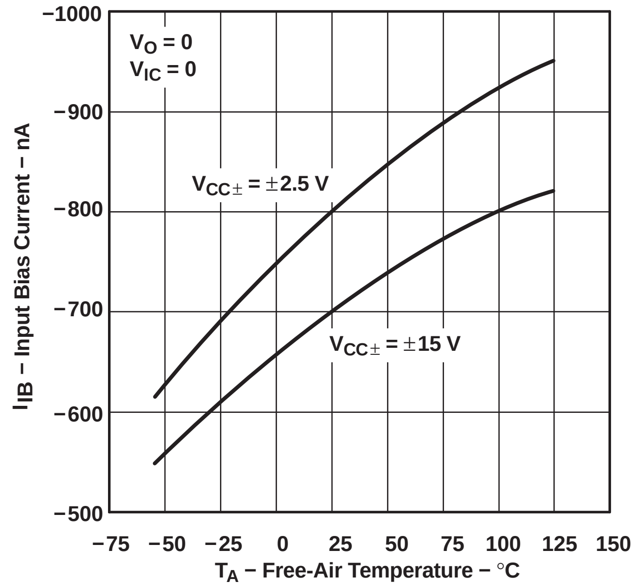


Figure 6.

MAXIMUM PEAK OUTPUT VOLTAGE
vs
SUPPLY VOLTAGE

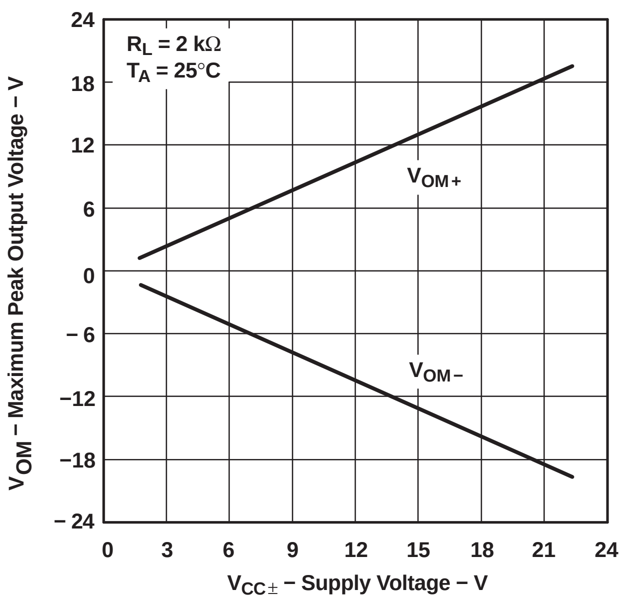


Figure 7.

MAXIMUM PEAK OUTPUT VOLTAGE
vs
FREE-AIR TEMPERATURE

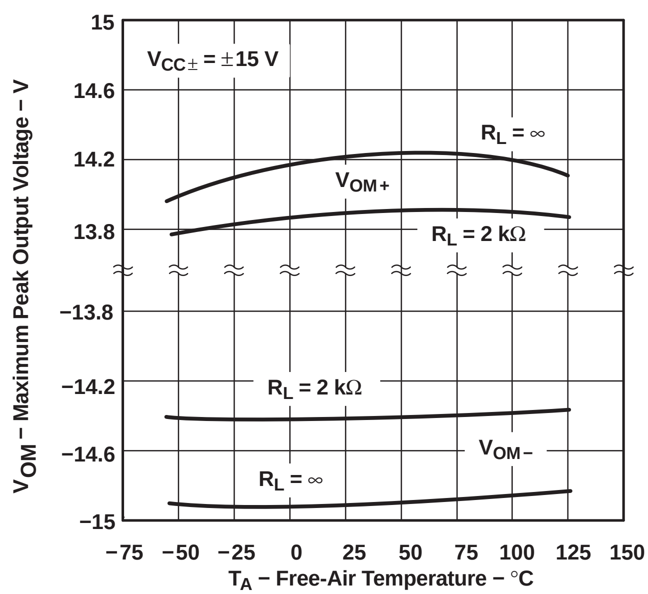


Figure 8.

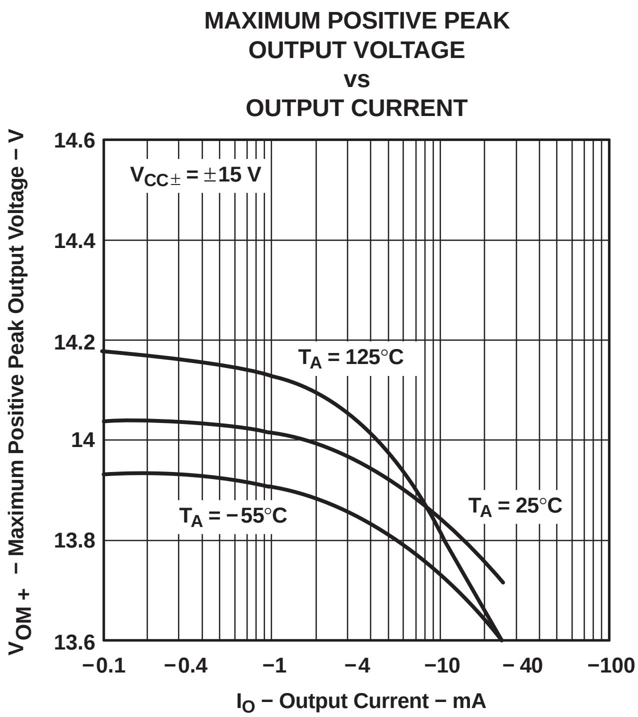


Figure 9.

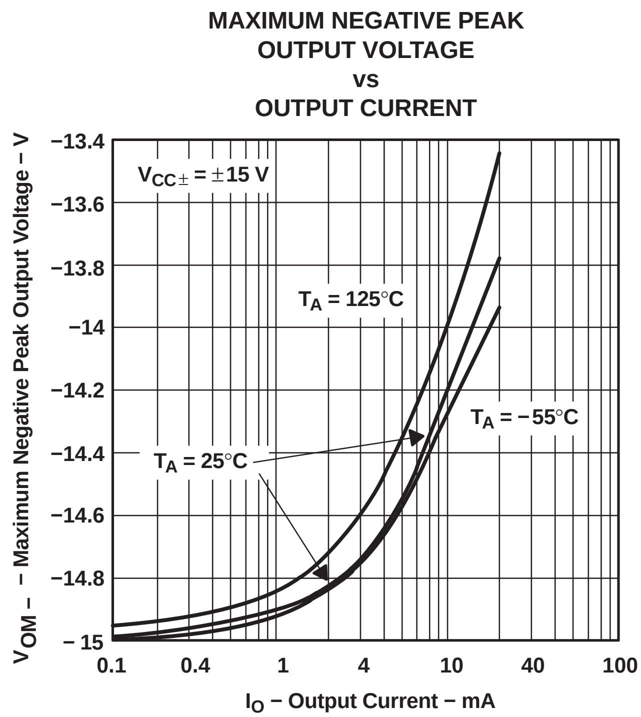


Figure 10.

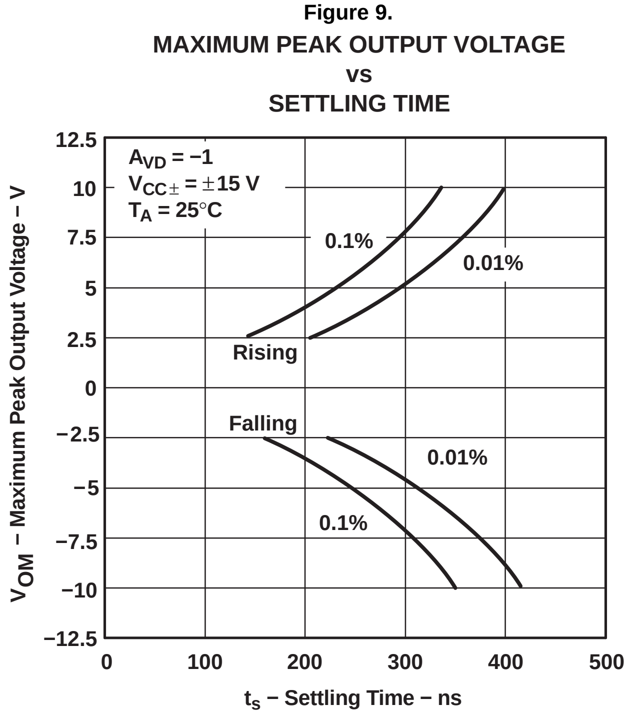


Figure 11.

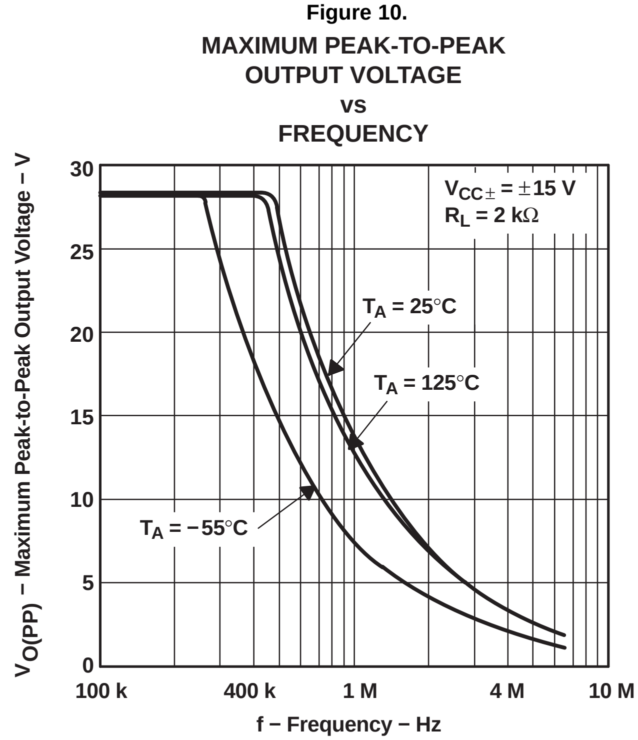


Figure 12.

HIGH-LEVEL OUTPUT VOLTAGE vs OUTPUT CURRENT

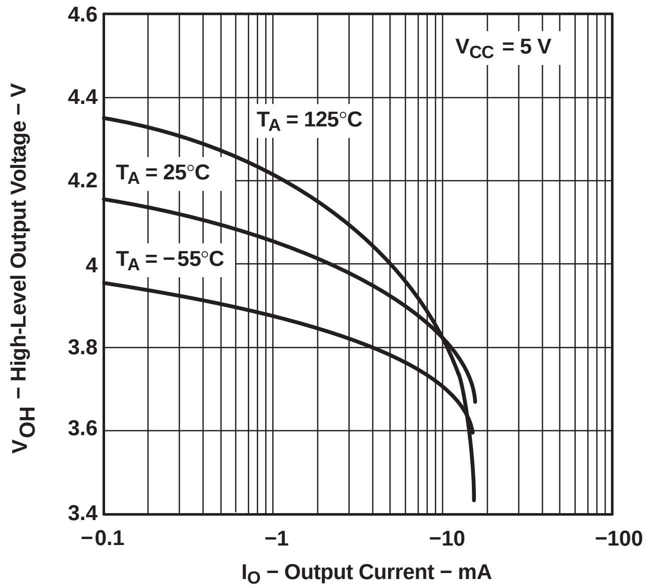


Figure 13.

LOW-LEVEL OUTPUT VOLTAGE vs OUTPUT CURRENT

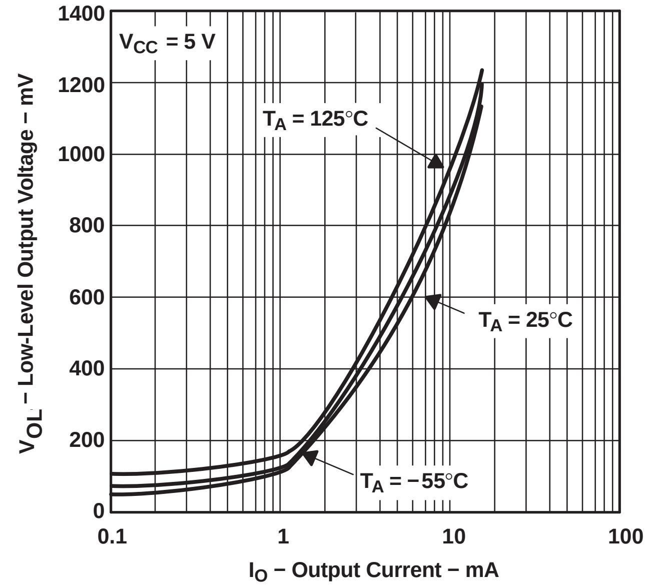


Figure 14.

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE SHIFT vs FREQUENCY

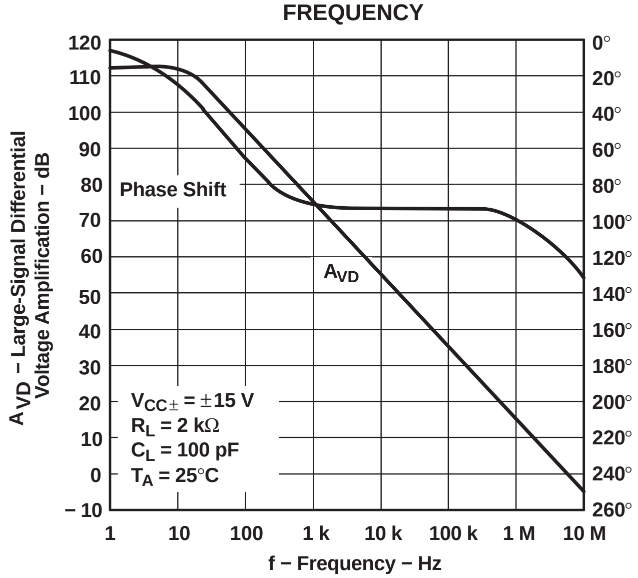


Figure 15.

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION vs FREE-AIR TEMPERATURE

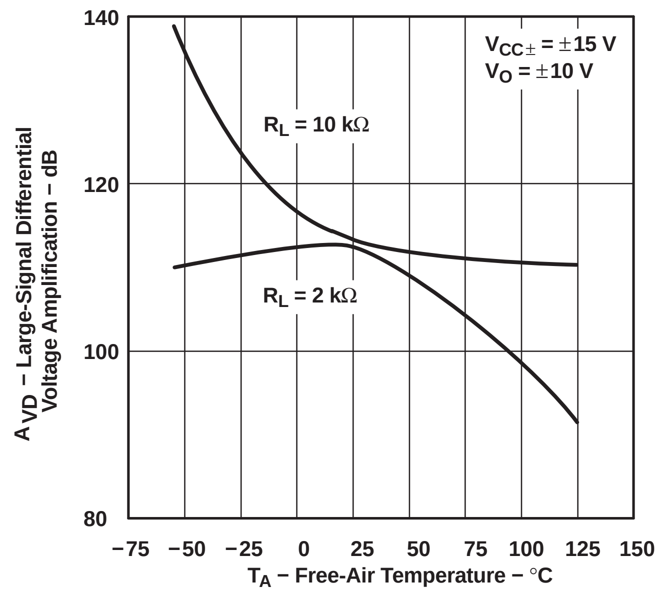


Figure 16.

**CLOSED-LOOP OUTPUT IMPEDANCE
vs
FREQUENCY**

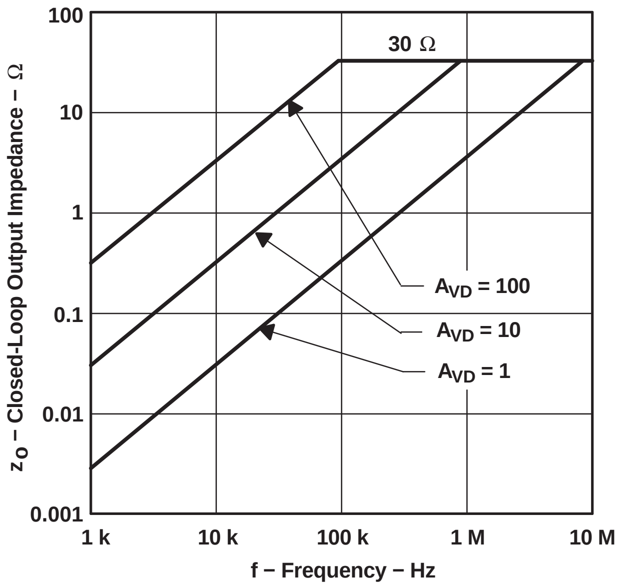


Figure 17.

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

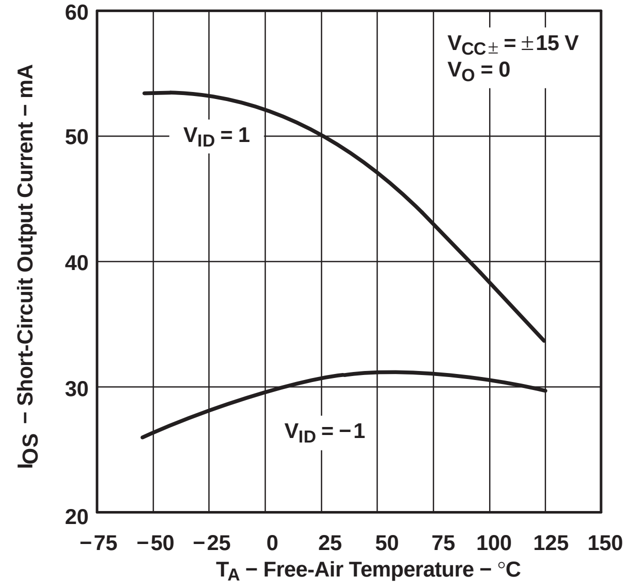


Figure 18.

**COMMON-MODE REJECTION RATIO
vs
FREQUENCY**

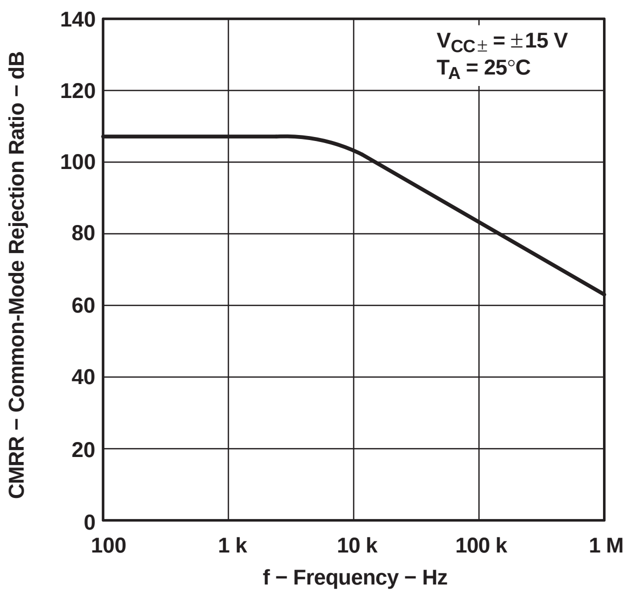


Figure 19.

**COMMON-MODE REJECTION RATIO
vs
FREE-AIR TEMPERATURE**

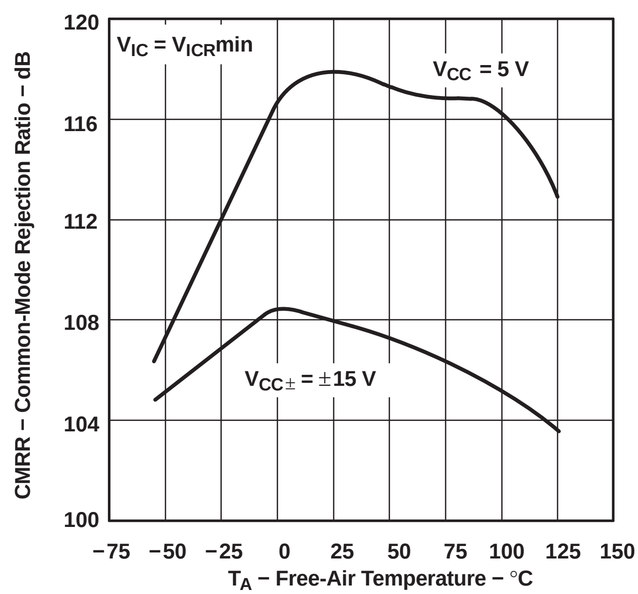


Figure 20.

SUPPLY-VOLTAGE REJECTION RATIO
vs
FREQUENCY

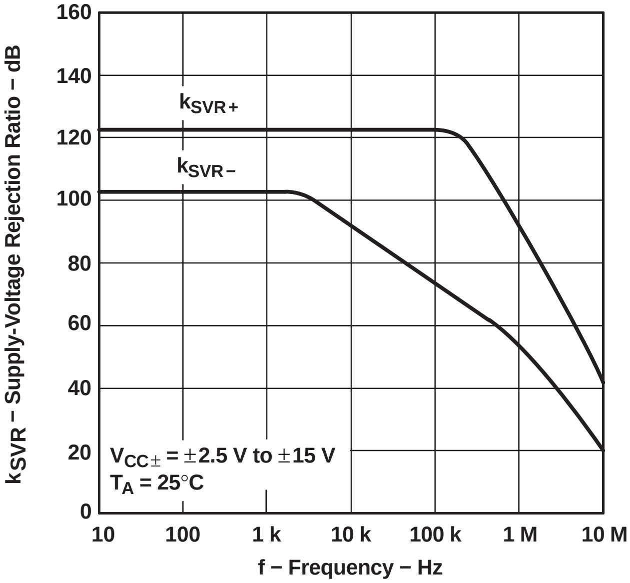


Figure 21.

SUPPLY-VOLTAGE REJECTION RATIO
vs
FREE-AIR TEMPERATURE

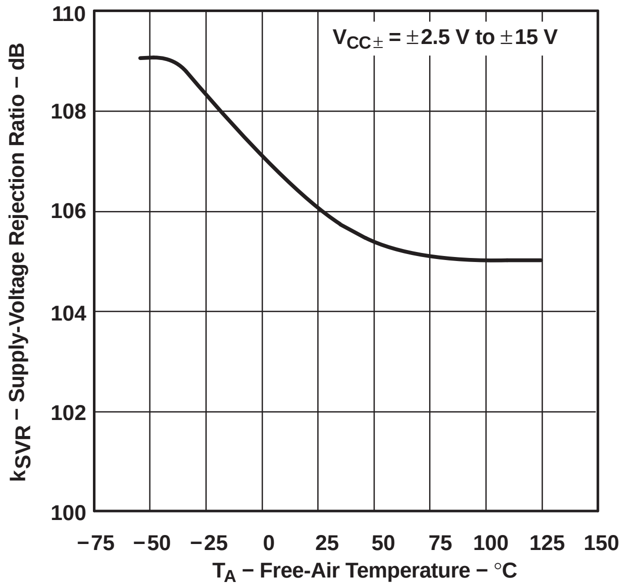


Figure 22.

SUPPLY CURRENT
vs
SUPPLY VOLTAGE

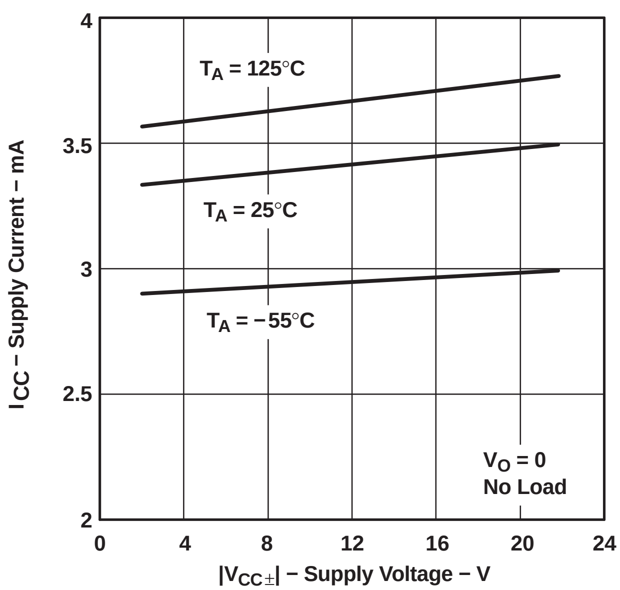


Figure 23.

SUPPLY CURRENT
vs
FREE-AIR TEMPERATURE

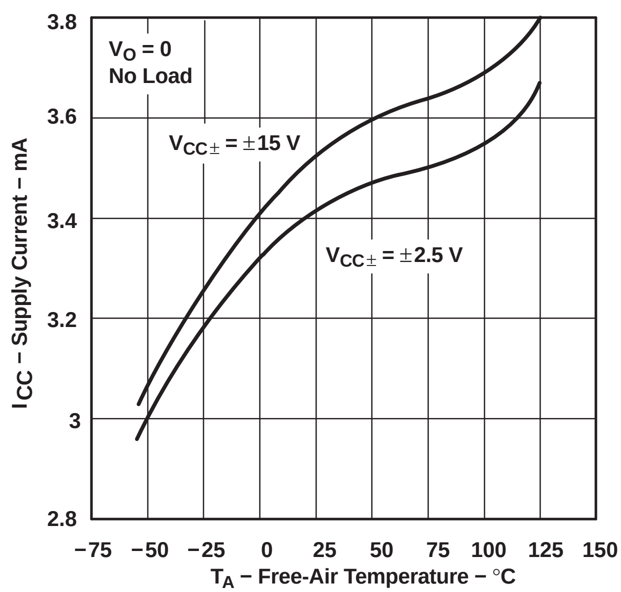


Figure 24.

EQUIVALENT INPUT NOISE VOLTAGE
vs
FREQUENCY

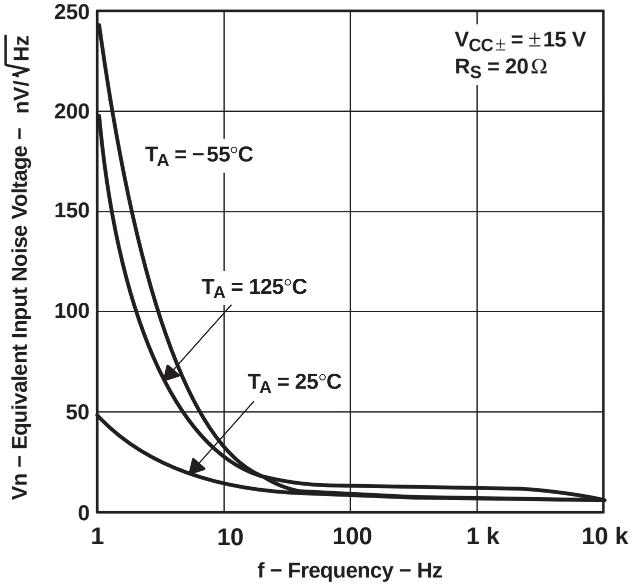


Figure 25.

INPUT NOISE VOLTAGE
OVER A 10-SECOND PERIOD

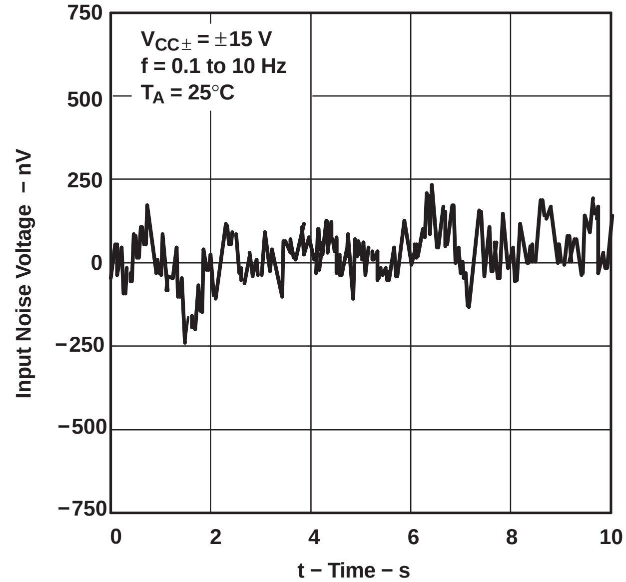


Figure 26.

NOISE CURRENT
vs
FREQUENCY

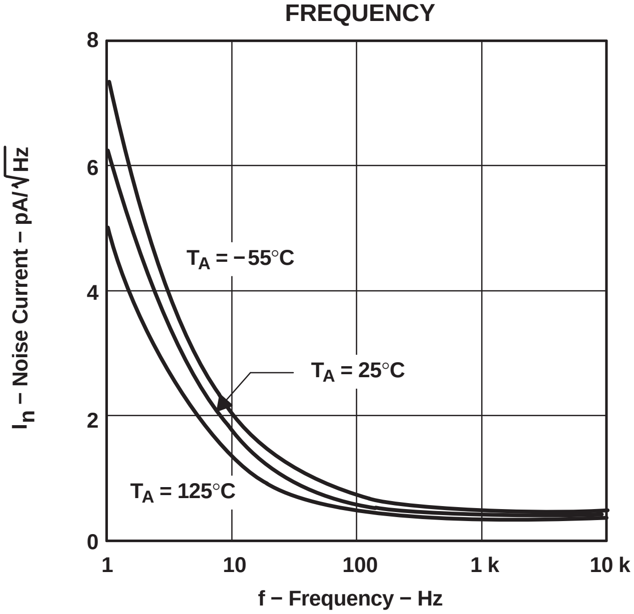


Figure 27.

TOTAL HARMONIC DISTORTION
PLUS NOISE
vs
FREQUENCY

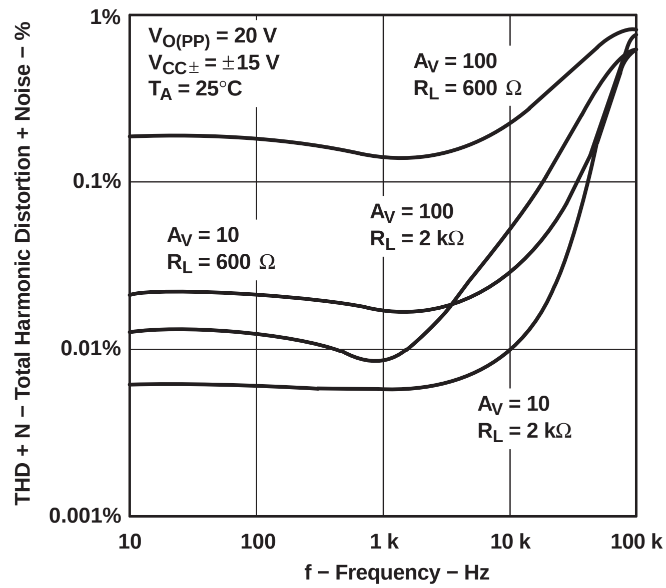


Figure 28.

SLEW RATE
vs
FREE-AIR TEMPERATURE

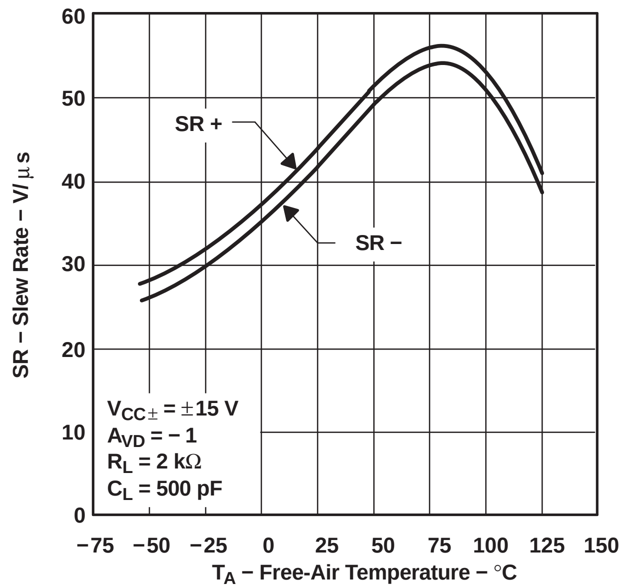


Figure 29.

SLEW RATE
vs
LOAD CAPACITANCE

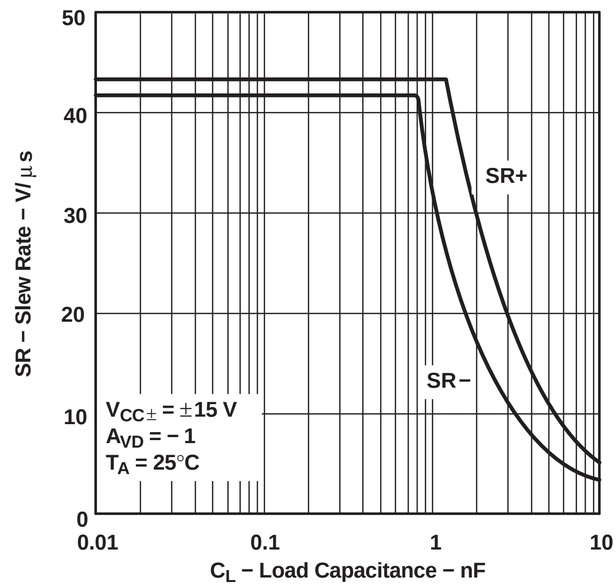


Figure 30.

NONINVERTING
LARGE-SIGNAL
PULSE RESPONSE

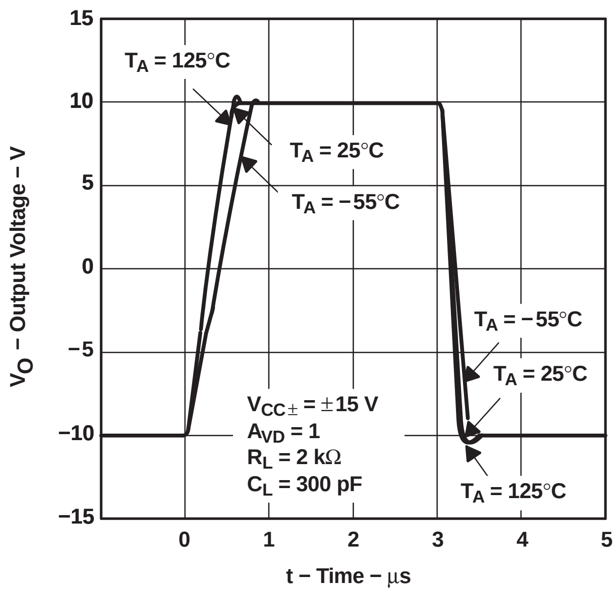


Figure 31.

INVERTING
LARGE-SIGNAL
PULSE RESPONSE

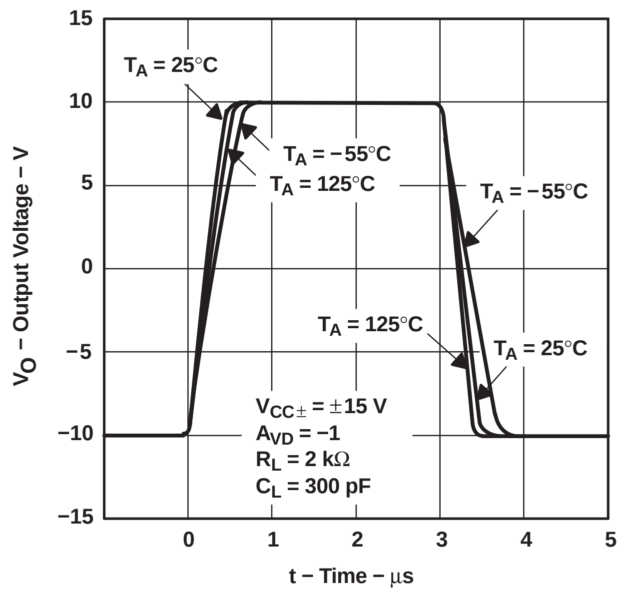


Figure 32.

SMALL-SIGNAL
PULSE RESPONSE

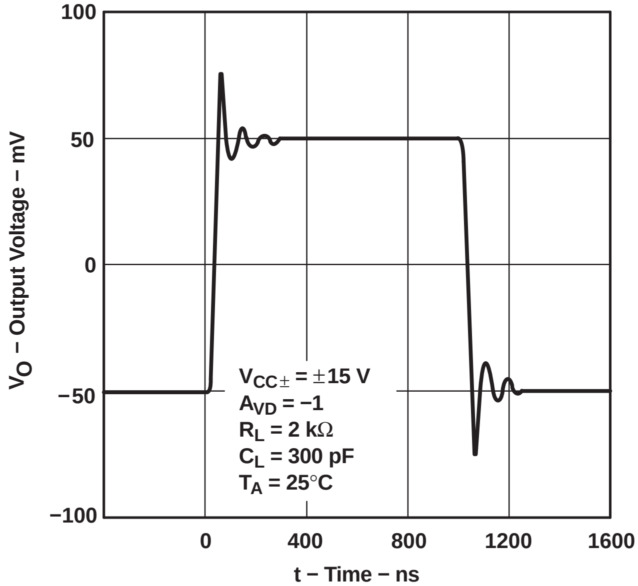


Figure 33.

UNITY-GAIN BANDWIDTH
vs
LOAD CAPACITANCE

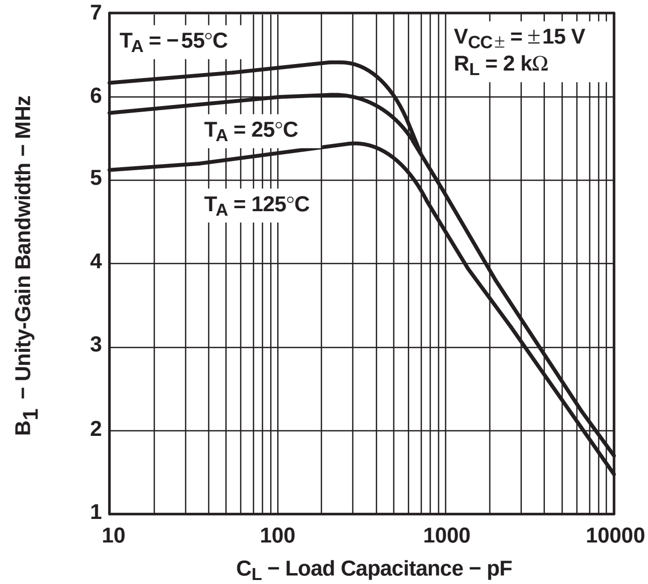


Figure 34.

GAIN MARGIN
vs
LOAD CAPACITANCE

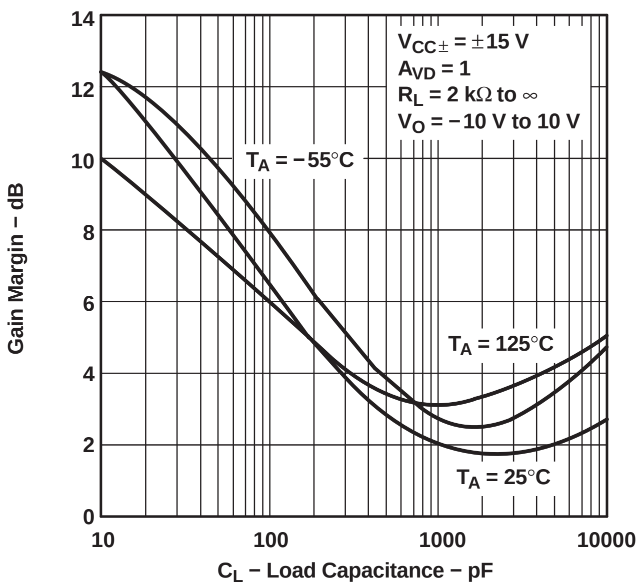


Figure 35.

PHASE MARGIN
vs
LOAD CAPACITANCE

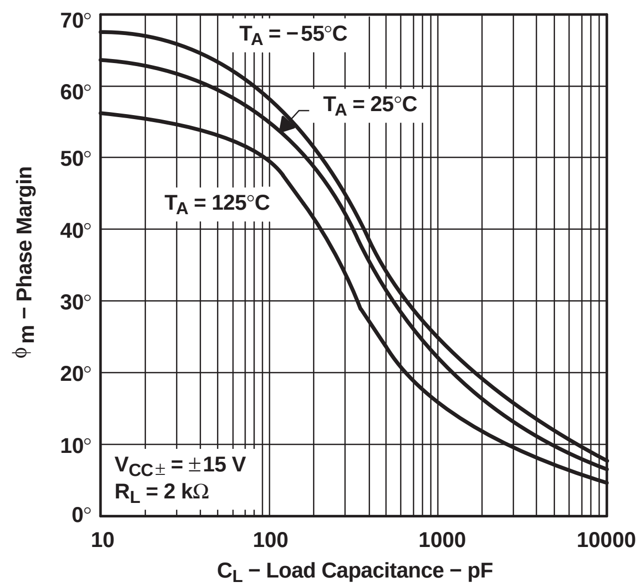


Figure 36.

APPLICATION INFORMATION

Input Offset Voltage Nulling

The TLE2141 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 37 as shown. If external nulling is not needed, the null pins may be left unconnected.

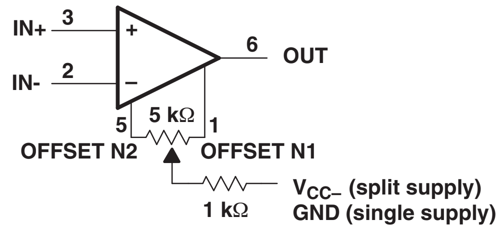
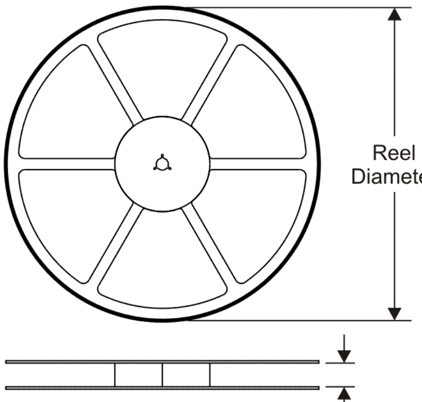
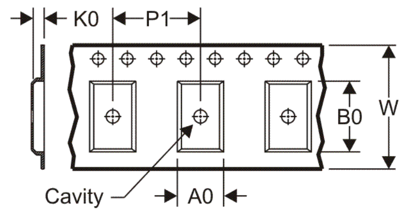


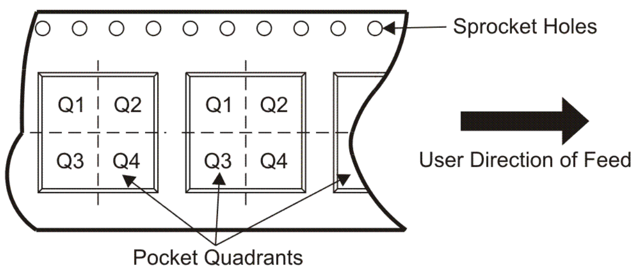
Figure 37. Input Offset Voltage Null Circuit

TAPE AND REEL INFORMATION





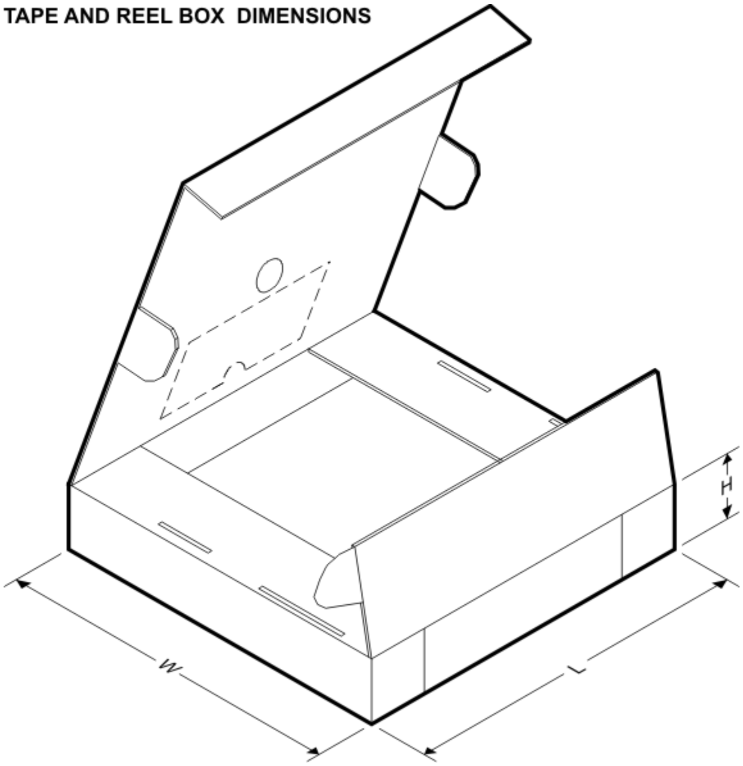
A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TLE2141MDREP	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TLE2144MDWREP	SOIC	DW	16	2000	330.0	16.4	10.75	10.7	2.7	12.0	16.0	Q1

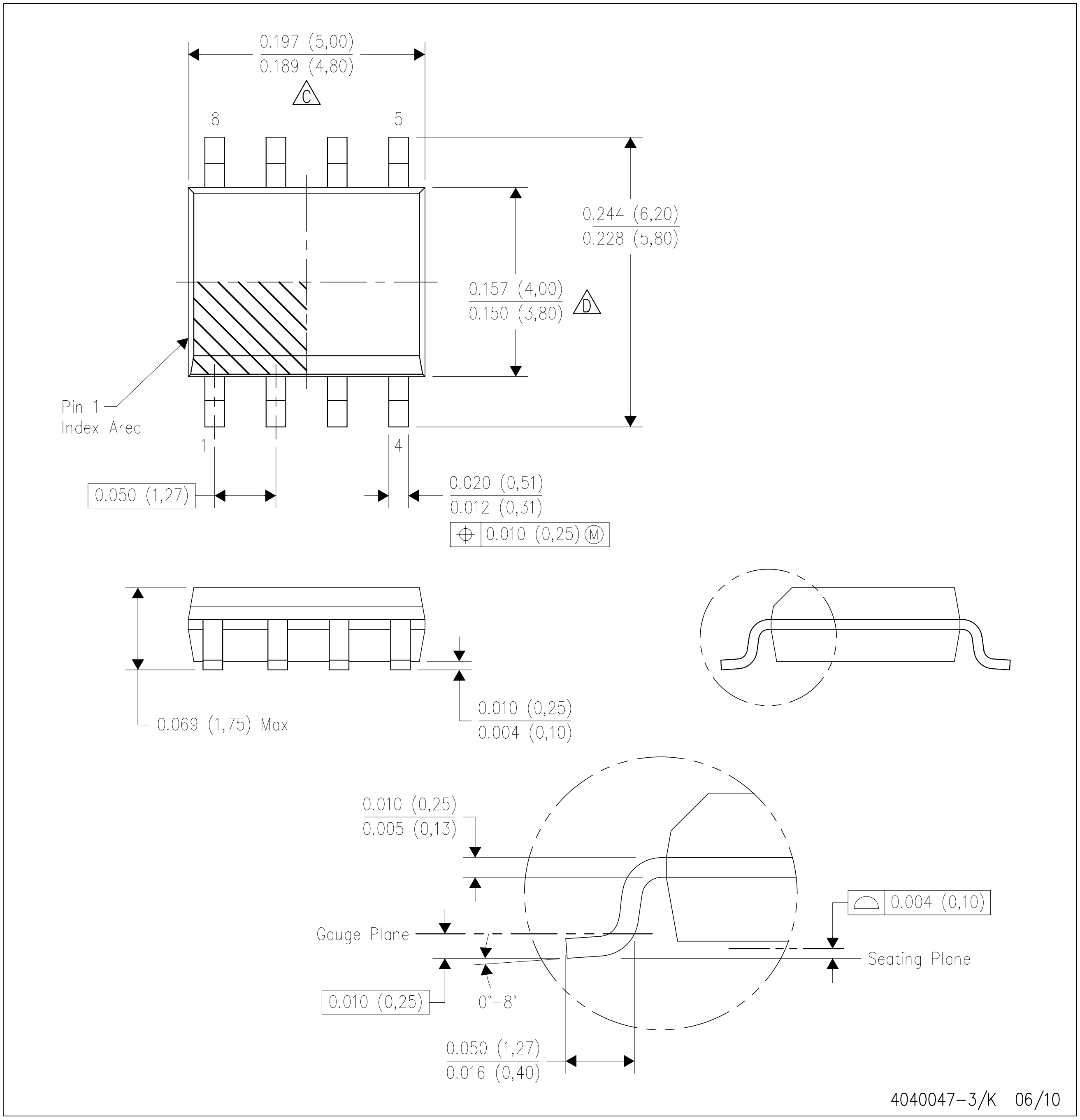
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TLE2141MDREP	SOIC	D	8	2500	340.5	338.1	20.6
TLE2144MDWREP	SOIC	DW	16	2000	346.0	346.0	33.0

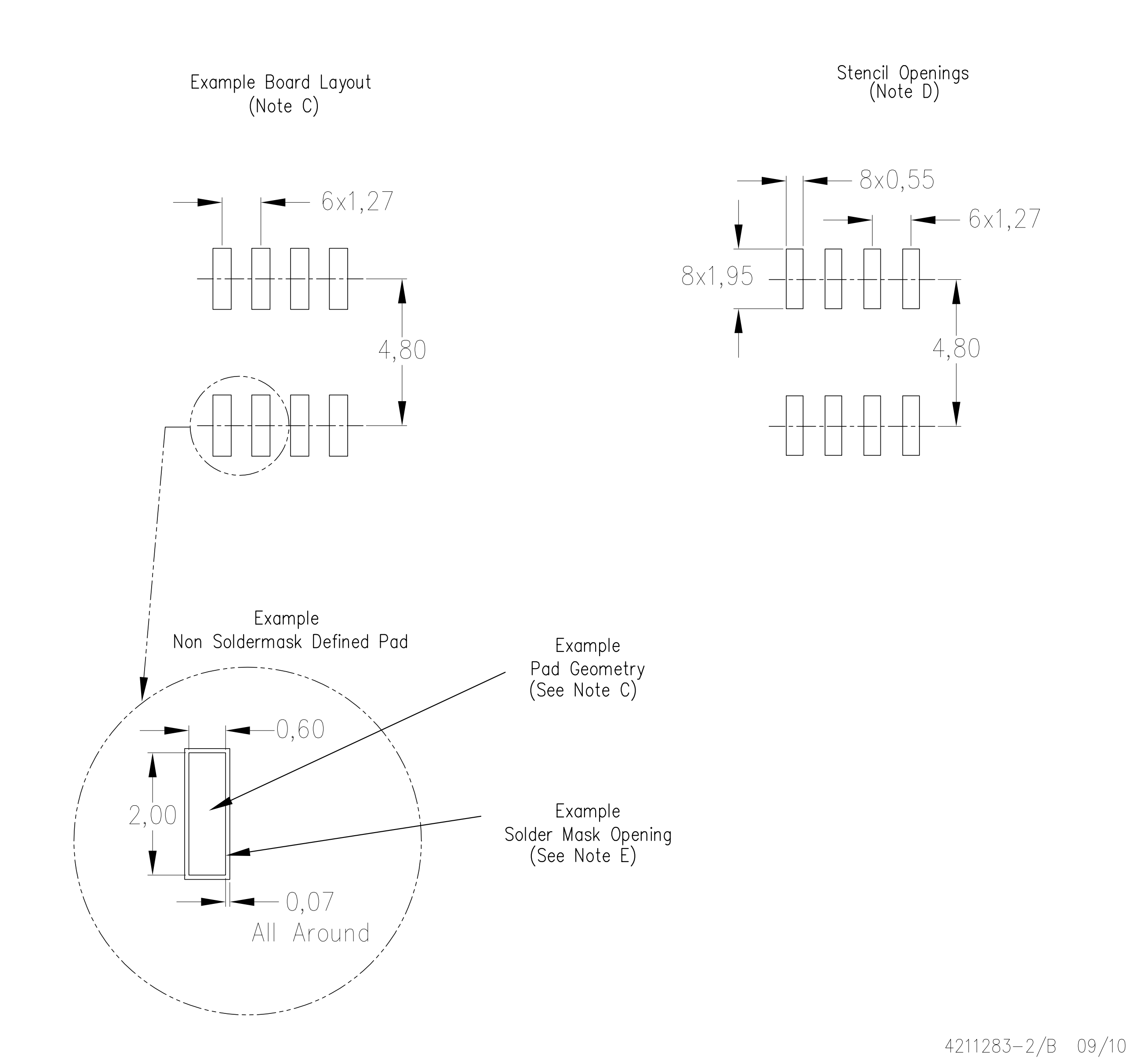
D (R-PDSO-G8) PLASTIC SMALL-OUTLINE PACKAGE



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

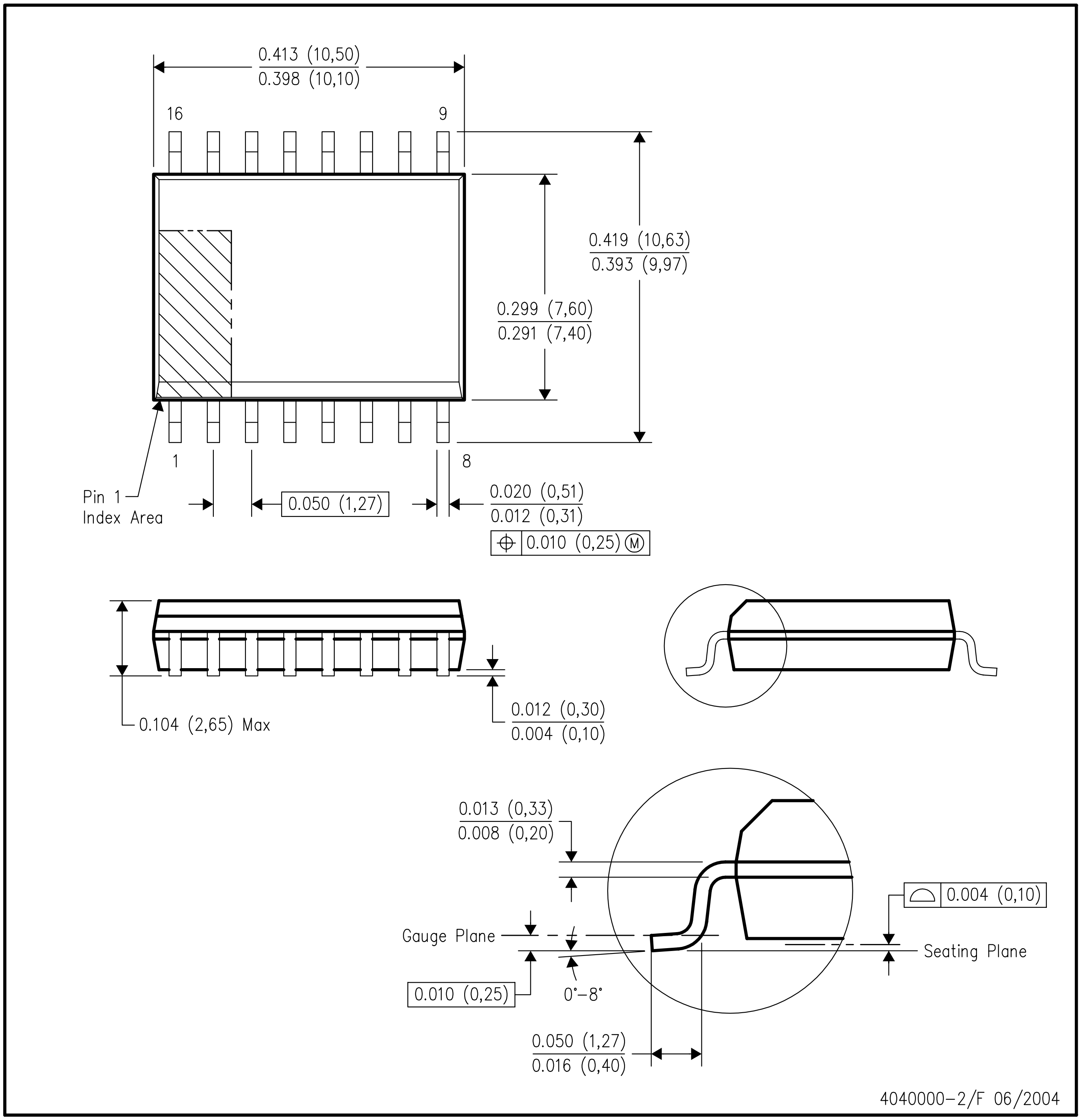
查询"TLE2141-EP"供应商

D (R-PDSO-G8) PLASTIC SMALL OUTLINE



NOTES:
- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. Publication IPC-7351 is recommended for alternate designs.
- D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
- E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

DW (R-PDSO-G16) PLASTIC SMALL-OUTLINE PACKAGE



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-013 variation AA.

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