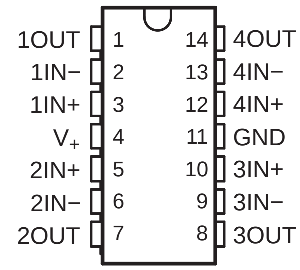
FEATURES

- **Qualified for Automotive Applications**
- **2.7-V and 5-V Performance**
- **Rail-to-Rail Output Swing**
- **Input Bias Current…1 pA Typ**
- **Input Offset Voltage…0.25 mV Typ**
- **Low Supply Current…100 μA Typ**
- **Gain Bandwidth of 1 MHz Typ**
- **Slew Rate…1 V/μs Typ**
- **Turn-On Time From Shutdown…5 μs Typ**
- **Input Referred Voltage Noise (at 10 kHz)… 20 nV/√Hz**

PW (TSSOP) PACKAGE
(TOP VIEW)



DESCRIPTION/ORDERING INFORMATION

The LMV344 device is a quad CMOS operational amplifier with low voltage, low power, and rail-to-rail output swing capabilities. The PMOS input stage offers an ultra-low input bias current of 1 pA (typ) and an offset voltage of 0.25 mV (typ). The single supply amplifier is designed specifically for low-voltage (2.7 V to 5 V) operation, with a wide common-mode input voltage range that typically extends from –0.2 V to 0.8 V from the positive supply rail. Additional features are a 20-nV/√Hz voltage noise at 10 kHz, 1-MHz unity-gain bandwidth, 1-V/μs slew rate, and 100-μA current consumption per channel.

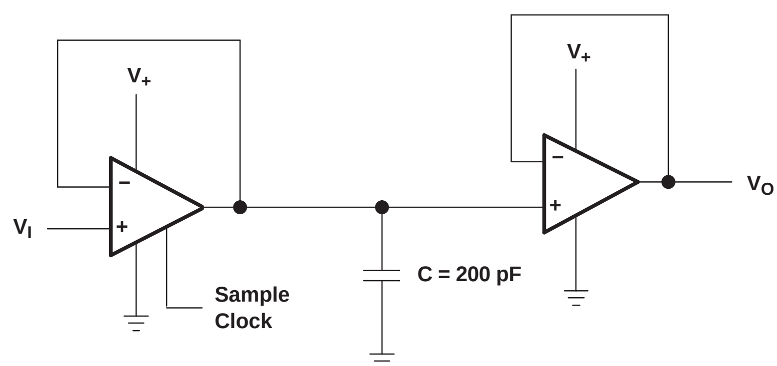
An extended industrial temperature range from –40°C to 125°C makes this device suitable for automotive applications.

ORDERING INFORMATION

T_A	PACKAGE(1)		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 125°C	TSSOP – PW	Reel of 2000	LMV344IPWRQ1	LMV344Q

(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

APPLICATION CIRCUIT: SAMPLE-AND-HOLD CIRCUIT



Absolute Maximum Ratings[1]

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

		MIN	MAX	UNIT
V_+	Supply voltage[2]		5.5	V
V_{ID}	Differential input voltage[3]		±5.5	V
V_I	Input voltage range (either input)	0	5.5	V
θ_{JA}	Package thermal impedance[4][5]		113	°C/W
T_J	Operating virtual junction temperature		150	°C
T_{stg}	Storage temperature range	–65	150	°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 and V_+ specified for the measurement of I_{OS}) are with respect to the network GND.
(3) Differential voltages are at IN+ with respect to IN–.
(4) 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.
(5) The package thermal impedance is calculated in accordance with JESD 51-7.

Recommended Operating Conditions

		MIN	MAX	UNIT
V_+	Supply voltage (single-supply operation)	2.5	5.5	V
T_A	Operating free-air temperature	–40	125	°C

ESD Protection

TEST CONDITIONS	TYP	UNIT
Human-Body Model	2000	V
Machine Model	200	V

Electrical Characteristics

V_+ = 2.7 V, GND = 0 V, V_{IC} = V_O = V_+/2, R_L > 1 MΩ (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A	MIN	TYP[(1)]	MAX	UNIT
V_{IO}	Input offset voltage			25°C		0.25	4	mV
				Full range			4.5	
α_{VIO}	Average temperature coefficient of input offset voltage			Full range		1.7		μV/°C
I_{IB}	Input bias current			25°C		1	120	pA
				–40°C to 85°C			250	
				–40°C to 125°C			3	nA
I_{IO}	Input offset current			25°C		6.6		fA
CMRR	Common-mode rejection ratio	0 ≤ V_{ICR} ≤ 1.7 V		25°C	56	80		dB
		0 ≤ V_{ICR} ≤ 1.6 V		Full range	50			
k_{SVR}	Supply-voltage rejection ratio	2.7 V ≤ V_+ ≤ 5 V		25°C	65	82		dB
				Full range	60			
V_{ICR}	Common-mode input voltage range	CMRR ≥ 50 dB		25°C	0	–0.2 to 1.9	1.7	V
A_V	Large-signal voltage gain[(2)]	R_L = 10 kΩ to 1.35 V		25°C	78	113		dB
				Full range	70			
		R_L = 2 kΩ to 1.35 V		25°C	72	103		
				Full range	64			
V_O	Output swing (delta from supply rails)	R_L = 2 kΩ to 1.35 V	Low level	25°C		24	60	mV
				Full range			95	
			High level	25°C		26	60	
				Full range			95	
		R_L = 10 kΩ to 1.35 V	Low level	25°C		5	30	
				Full range			40	
			High level	25°C		5.3	30	
				Full range			40	
I_{CC}	Supply current (per channel)			25°C		100	170	μA
				Full range			230	
I_{OS}	Output short-circuit current	Sourcing		25°C	18	24		mA
		Sinking			15	24		
SR	Slew rate	R_L = 10 kΩ[(3)]		25°C		1		V/μs
GBM	Unity-gain bandwidth	R_L = 10 kΩ, C_L = 200 pF		25°C		1		MHz
Φ_m	Phase margin	R_L = 100 kΩ		25°C		72		deg
G_m	Gain margin	R_L = 100 kΩ		25°C		20		dB
V_n	Equivalent input noise voltage	f = 1 kHz		25°C		40		$nV/\sqrt{Hz}$
I_n	Equivalent input noise current	f = 1 kHz		25°C		0.001		$pA/\sqrt{Hz}$
THD	Total harmonic distortion	f = 1 kHz, A_V = 1, R_L = 600 Ω, V_I = 1 V_{PP}		25°C		0.017		%

(1) Typical values represent the most likely parametric norm.
(2) GND + 0.2 V ≤ V_O ≤ V_+ – 0.2 V
(3) Connected as voltage follower with 2-V_{PP} step input. Number specified is the slower of the positive and negative slew rates.

Electrical Characteristics

V_+ = 5 V, GND = 0 V, V_{IC} = V_O = V_+/2, R_L > 1 MΩ (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A	MIN	TYP[(1)]	MAX	UNIT
V_{IO}	Input offset voltage			25°C		0.25	4	mV
				Full range			4.5	
α_{VIO}	Average temperature coefficient of input offset voltage			Full range		1.9		µV/°C
I_{IB}	Input bias current			25°C		1	200	pA
				–40°C to 85°C			375	
				–40°C to 125°C			5	nA
I_{IO}	Input offset current			25°C		6.6		fA
CMRR	Common-mode rejection ratio	0 ≤ V_{ICR} ≤ 4 V		25°C	56	86		dB
		0 ≤ V_{ICR} ≤ 3.9 V		Full range	50			
k_{SVR}	Supply-voltage rejection ratio	2.7 V ≤ V_+ ≤ 5 V		25°C	65	82		dB
				Full range	60			
V_{ICR}	Common-mode input voltage range	CMRR ≥ 50 dB		25°C	0	–0.2 to 4.2	4	V
A_V	Large-signal voltage gain[(2)]	R_L = 10 kΩ to 2.5 V		25°C	78	116		dB
				Full range	70			
		R_L = 2 kΩ to 2.5 V		25°C	72	107		
				Full range	64			
V_O	Output swing (delta from supply rails)	R_L = 2 kΩ to 2.5 V	Low level	25°C		32	60	mV
				Full range			95	
			High level	25°C		34	60	
				Full range			95	
		R_L = 10 kΩ to 2.5 V	Low level	25°C		7	30	
				Full range			40	
			High level	25°C		7	30	
				Full range			40	
I_{CC}	Supply current (per channel)			25°C		107	200	µA
				Full range			260	
I_{OS}	Output short-circuit current	Sourcing		25°C	70	90		mA
		Sinking			50	75		
SR	Slew rate	R_L = 10 kΩ[(3)]		25°C		1		V/µs
GBM	Unity-gain bandwidth	R_L = 10 kΩ, C_L = 200 pF		25°C		1		MHz
Φ_m	Phase margin	R_L = 100 kΩ		25°C		70		deg
G_m	Gain margin	R_L = 100 kΩ		25°C		20		dB
V_n	Equivalent input noise voltage	f = 1 kHz		25°C		39		$nV/\sqrt{Hz}$
I_n	Equivalent input noise current	f = 1 kHz		25°C		0.001		$pA/\sqrt{Hz}$
THD	Total harmonic distortion	f = 1 kHz, A_V = 1, R_L = 600 Ω, V_I = 1 V_{PP}		25°C		0.012		%

(1) Typical values represent the most likely parametric norm.
(2) GND + 0.2 V ≤ V_O ≤ V_+ – 0.2 V
(3) Connected as voltage follower with 2-V_{PP} step input. Number specified is the slower of the positive and negative slew rates.

TYPICAL CHARACTERISTICS

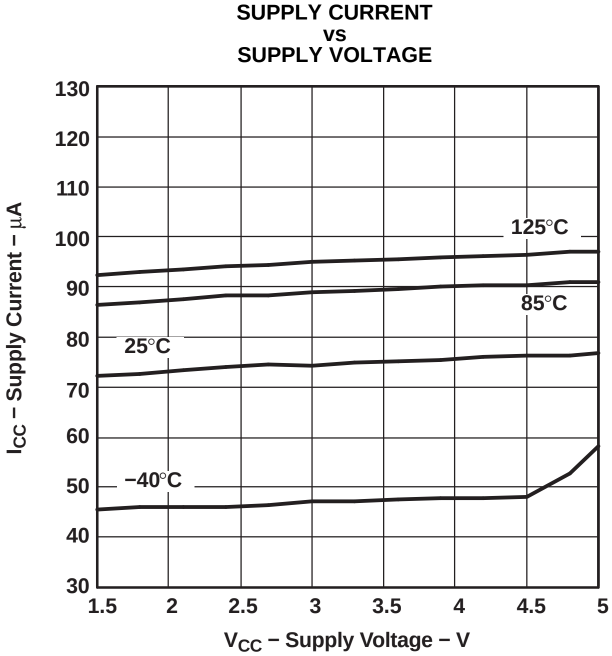


Figure 1.

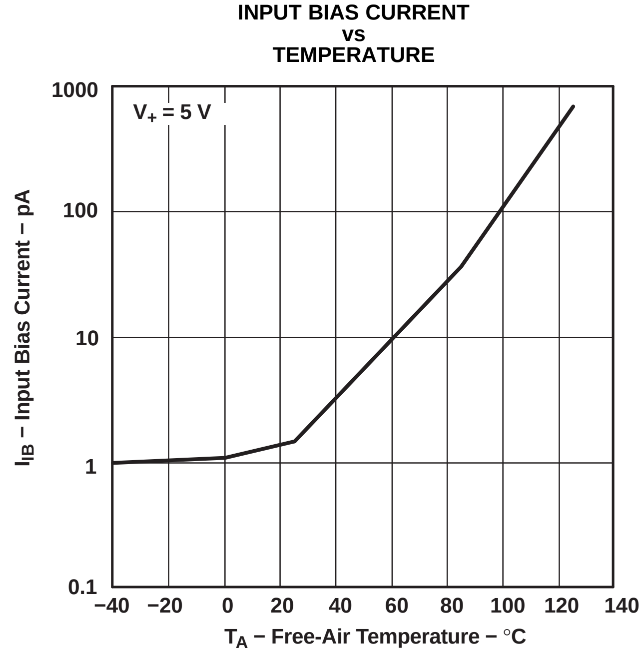


Figure 2.

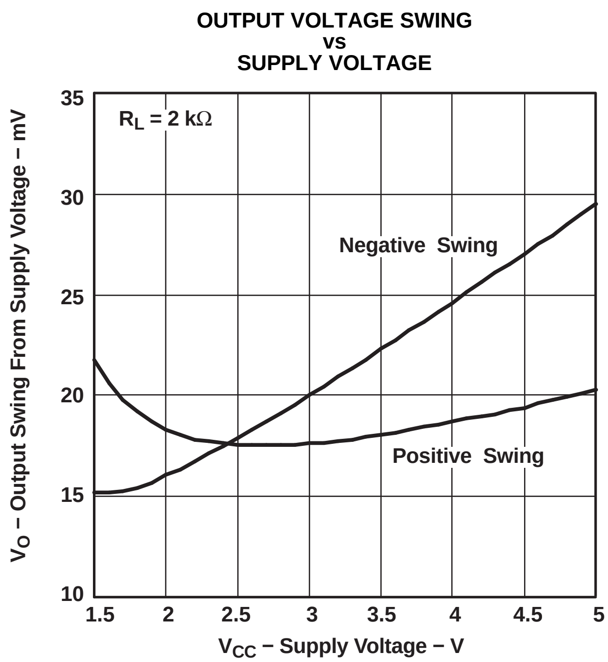


Figure 3.

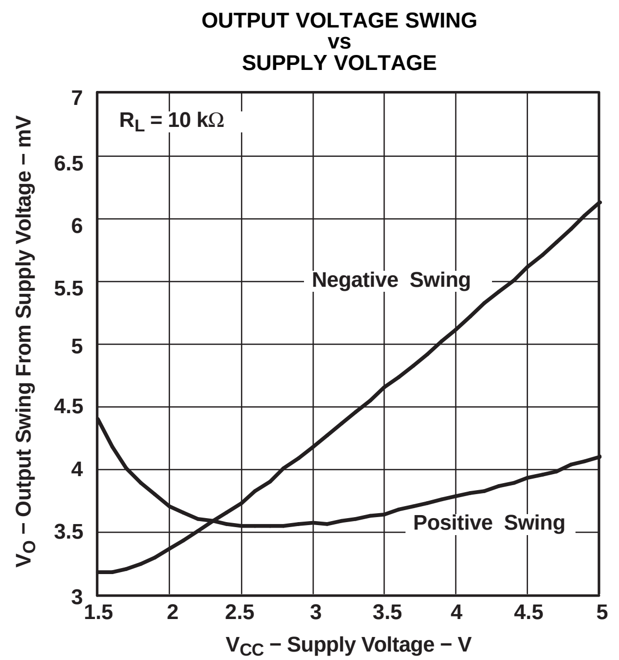


Figure 4.

TYPICAL CHARACTERISTICS (continued)

SOURCE CURRENT vs OUTPUT VOLTAGE

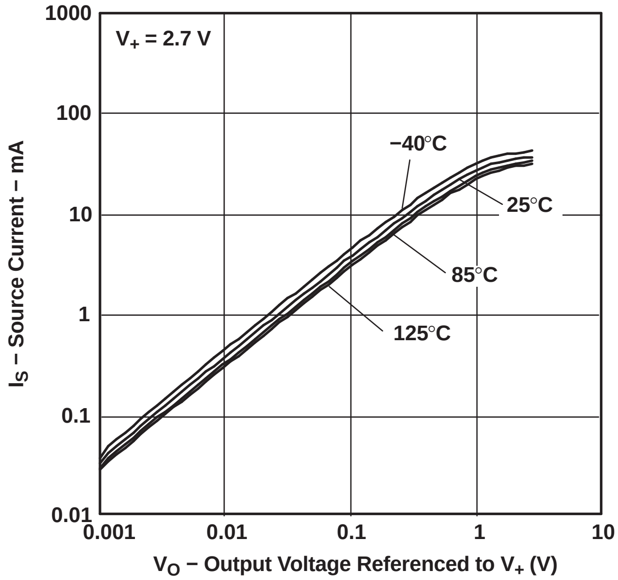


Figure 5.

SOURCE CURRENT vs OUTPUT VOLTAGE

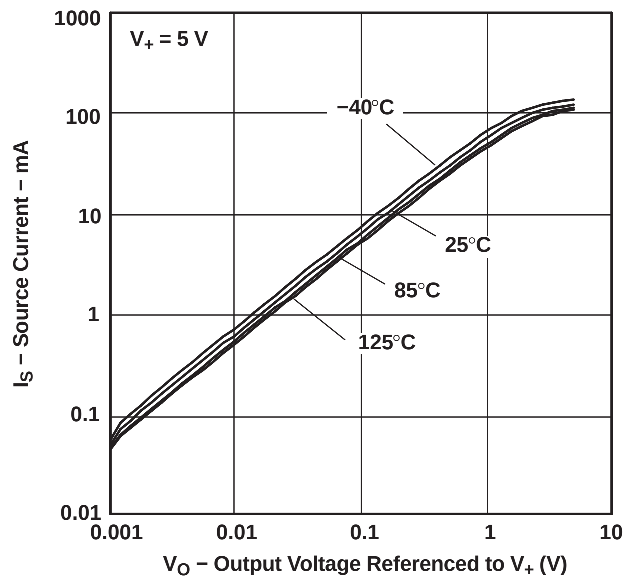


Figure 6.

SINK CURRENT vs OUTPUT VOLTAGE

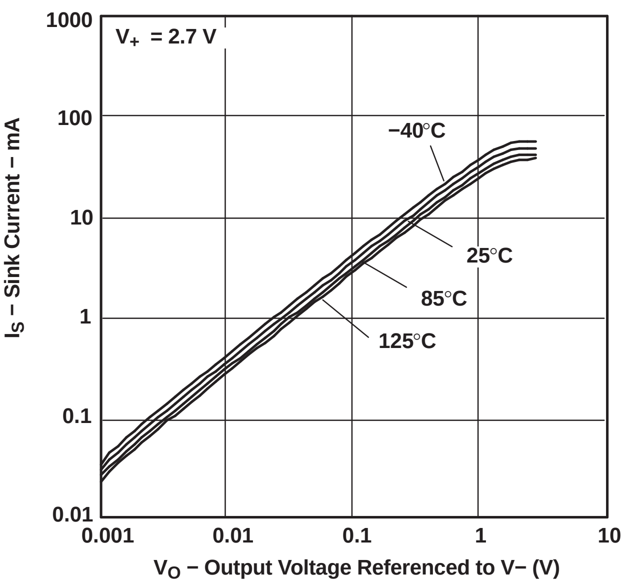


Figure 7.

SINK CURRENT vs OUTPUT VOLTAGE

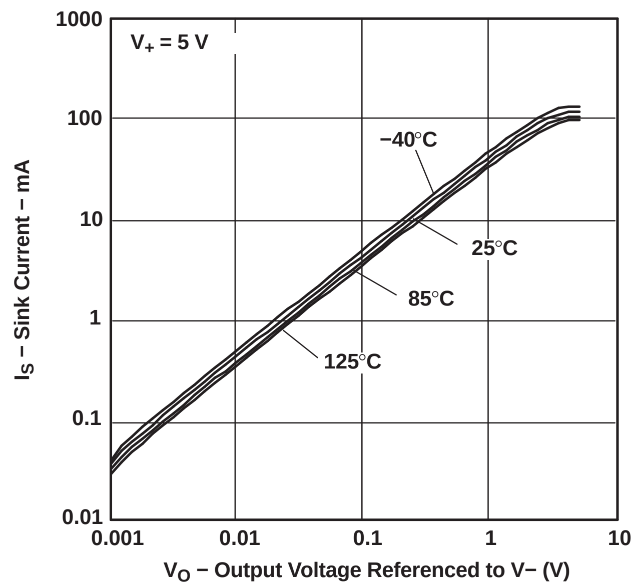


Figure 8.

TYPICAL CHARACTERISTICS (continued)

OFFSET VOLTAGE
vs
COMMON-MODE VOLTAGE

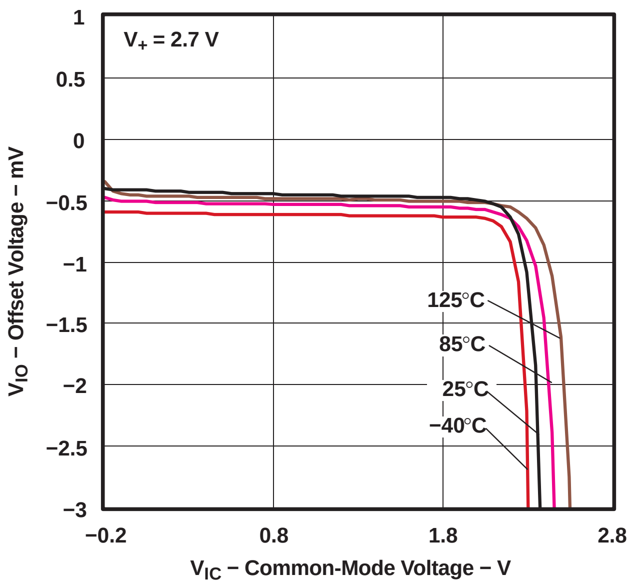


Figure 9.

OFFSET VOLTAGE
vs
COMMON-MODE VOLTAGE

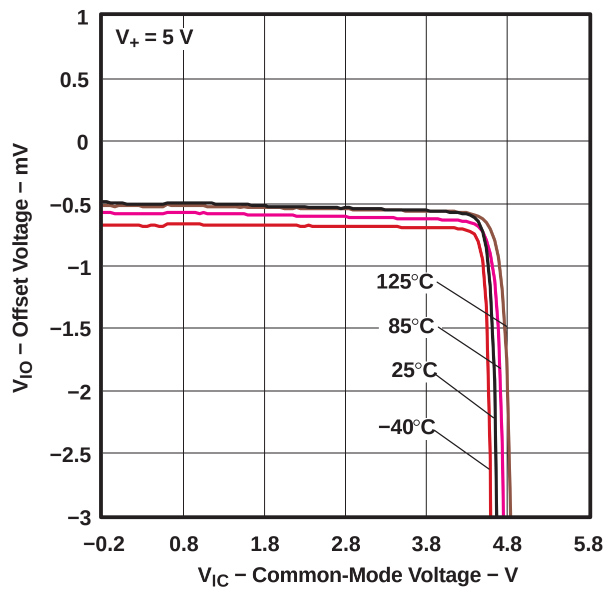


Figure 10.

INPUT VOLTAGE
vs
OUTPUT VOLTAGE

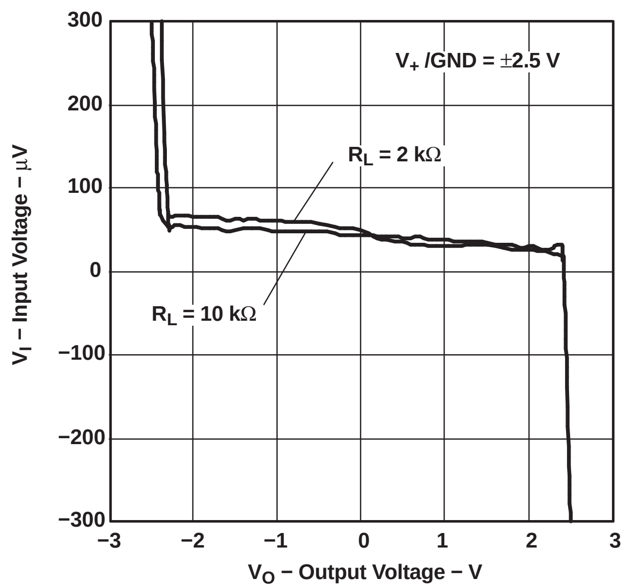


Figure 11.

INPUT VOLTAGE
vs
OUTPUT VOLTAGE

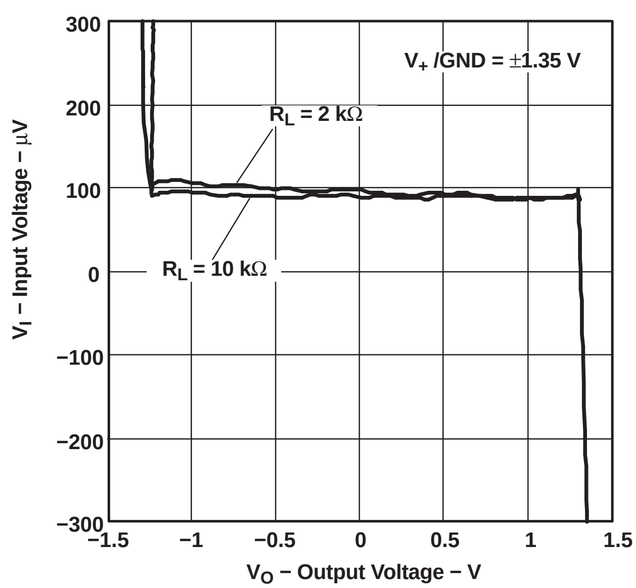


Figure 12.

TYPICAL CHARACTERISTICS (continued)

SLEW RATE
vs
SUPPLY VOLTAGE

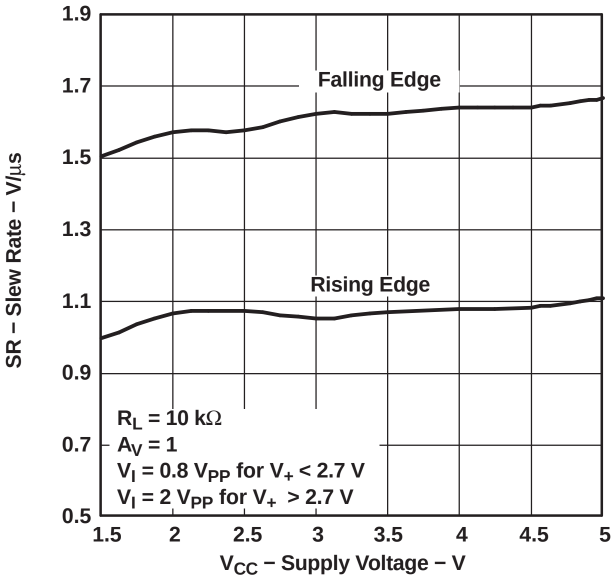


Figure 13.

SLEW RATE
vs
TEMPERATURE

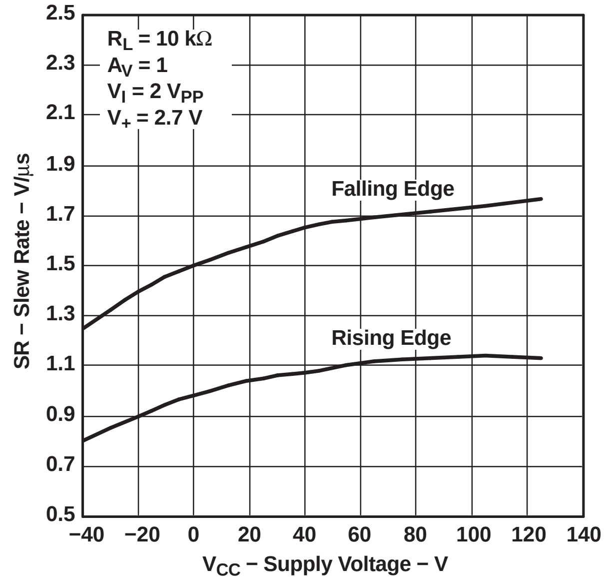


Figure 14.

SLEW RATE
vs
TEMPERATURE

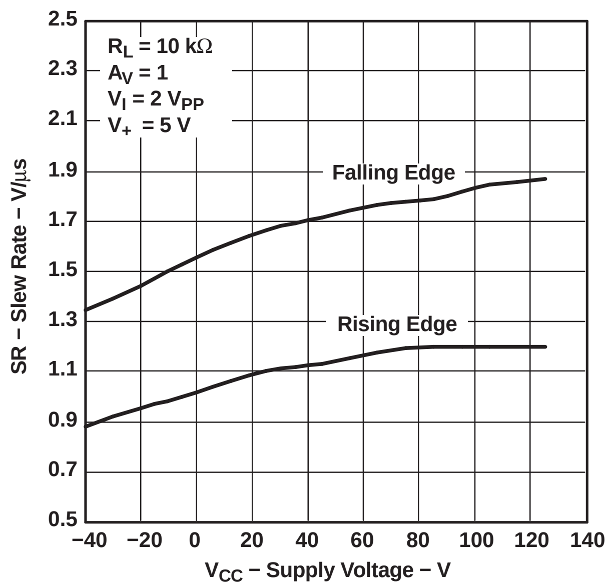


Figure 15.

CMRR
vs
FREQUENCY

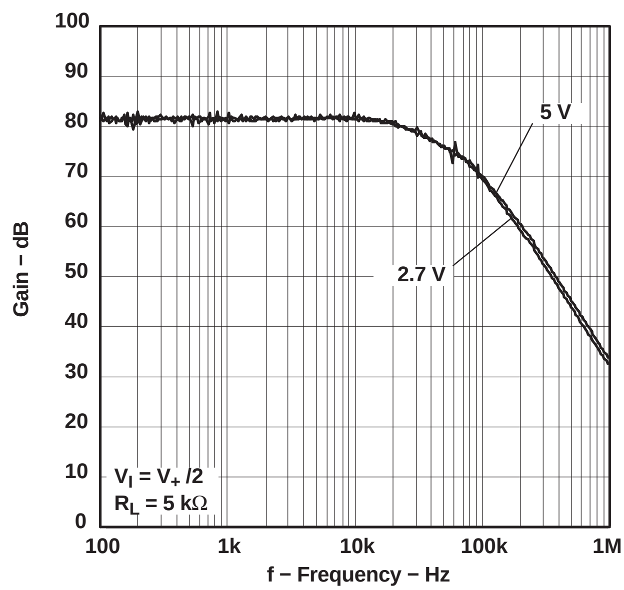


Figure 16.

TYPICAL CHARACTERISTICS (continued)

PSRR
vs
FREQUENCY

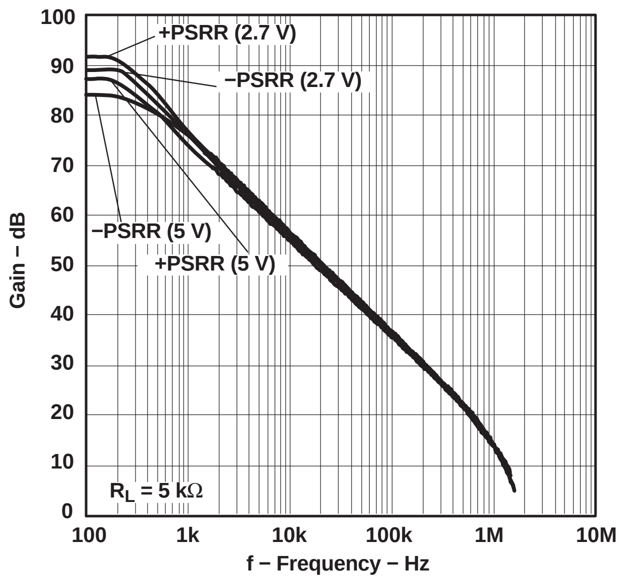


Figure 17.

INPUT VOLTAGE NOISE
vs
FREQUENCY

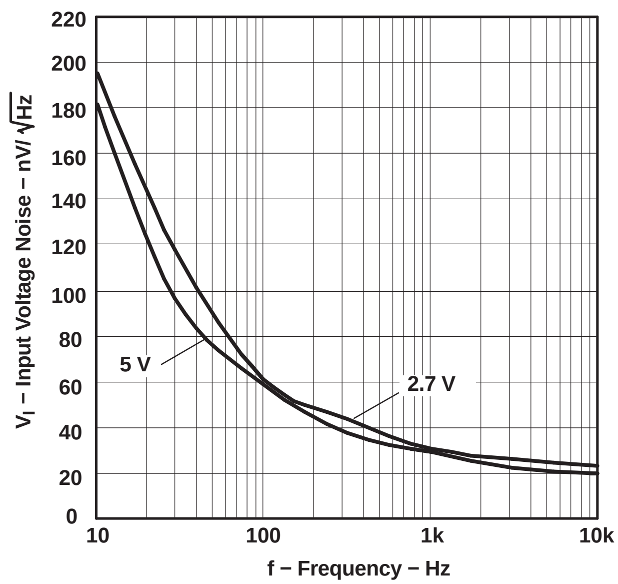


Figure 18.

TOTAL HARMONIC DISTORTION + NOISE
vs
FREQUENCY

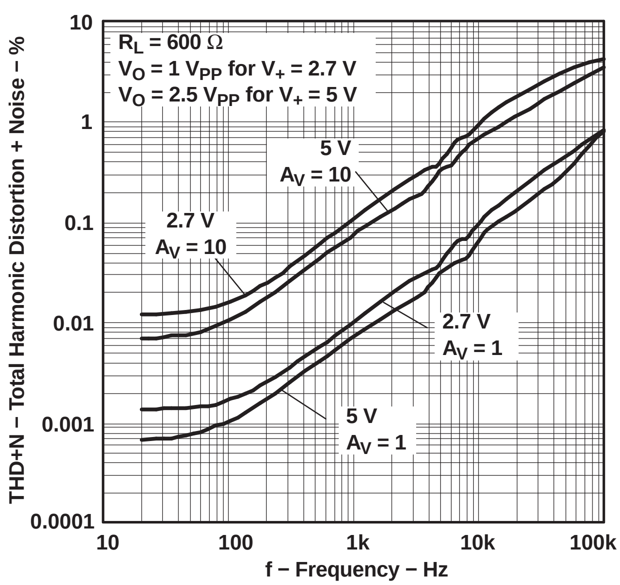


Figure 19.

TOTAL HARMONIC DISTORTION + NOISE
vs
OUTPUT VOLTAGE

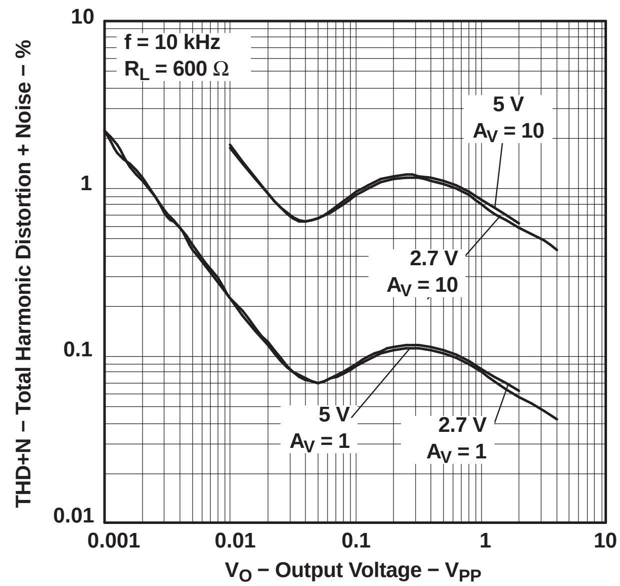


Figure 20.

TYPICAL CHARACTERISTICS (continued)

GAIN AND PHASE MARGIN vs FREQUENCY (T_A = –40°C, 25°C, 125°C)

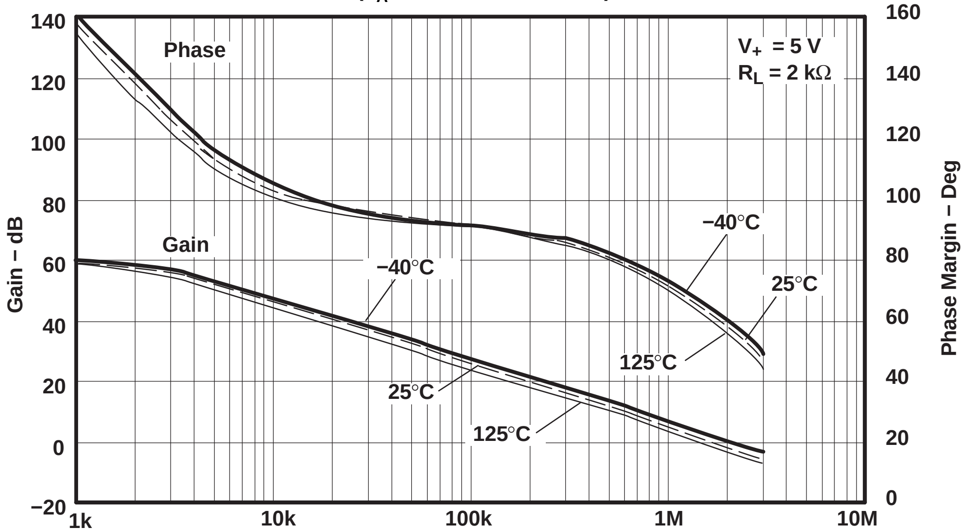


Figure 21.

GAIN AND PHASE MARGIN vs FREQUENCY (R_L = 600 Ω, 2 kΩ, 100 kΩ)

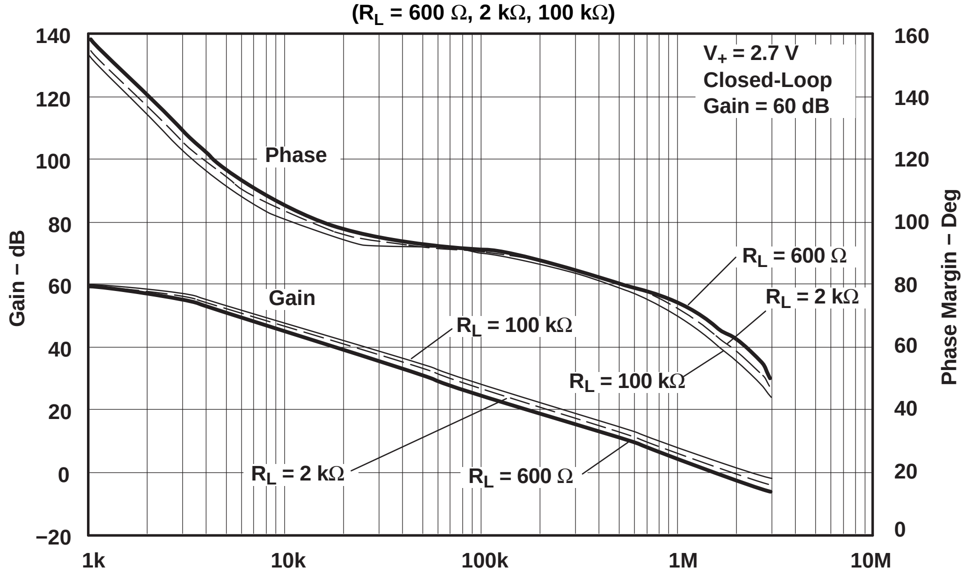


Figure 22.

TYPICAL CHARACTERISTICS (continued)

GAIN AND PHASE MARGIN vs FREQUENCY (R_L = 600 Ω, 2 kΩ, 100 kΩ)

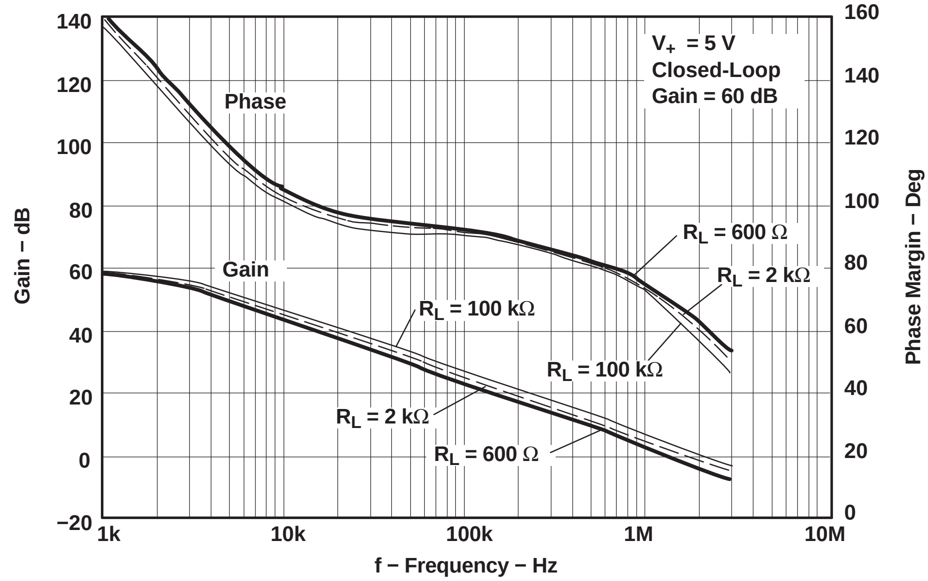


Figure 23.

GAIN AND PHASE MARGIN vs FREQUENCY (C_L = 0 pF, 100 pF, 500 pF, 1000 pF)

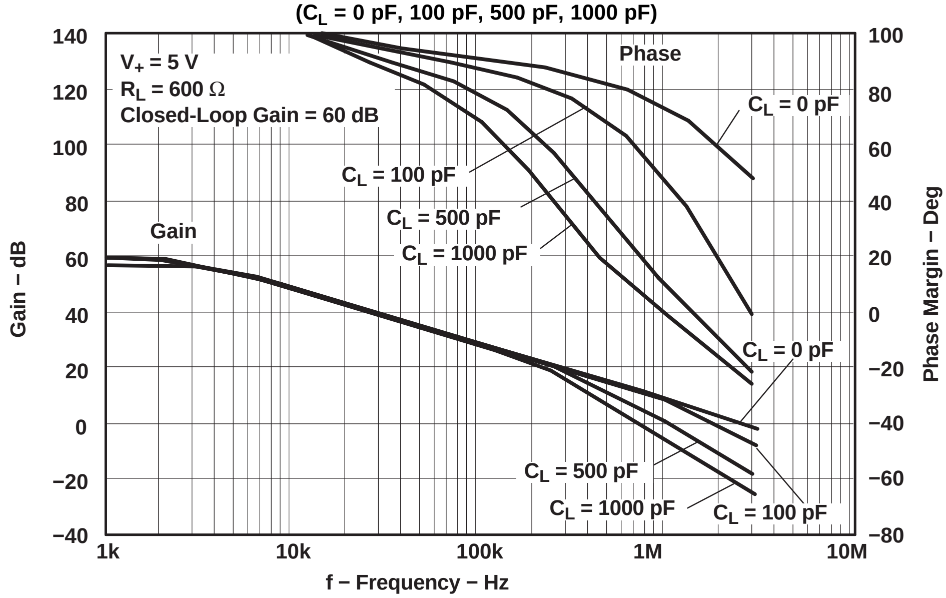


Figure 24.

TYPICAL CHARACTERISTICS (continued)

SMALL-SIGNAL NONINVERTING RESPONSE

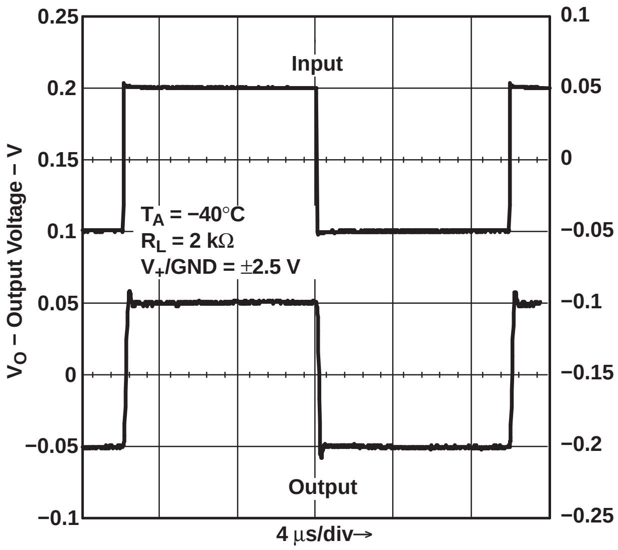


Figure 25.

LARGE-SIGNAL NONINVERTING RESPONSE

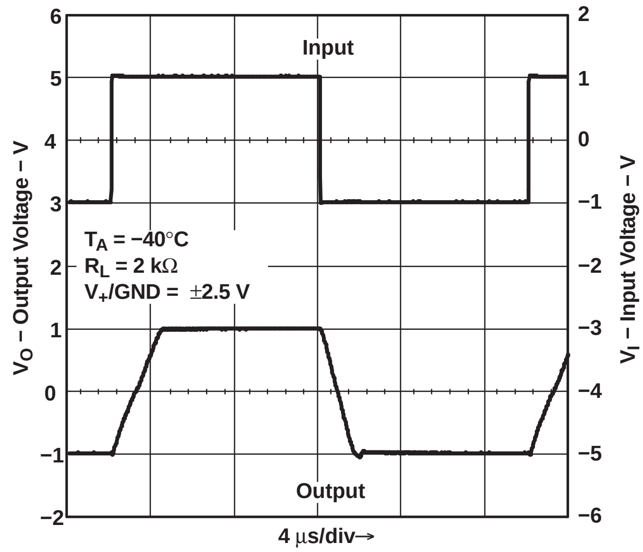


Figure 26.

SMALL-SIGNAL NONINVERTING RESPONSE

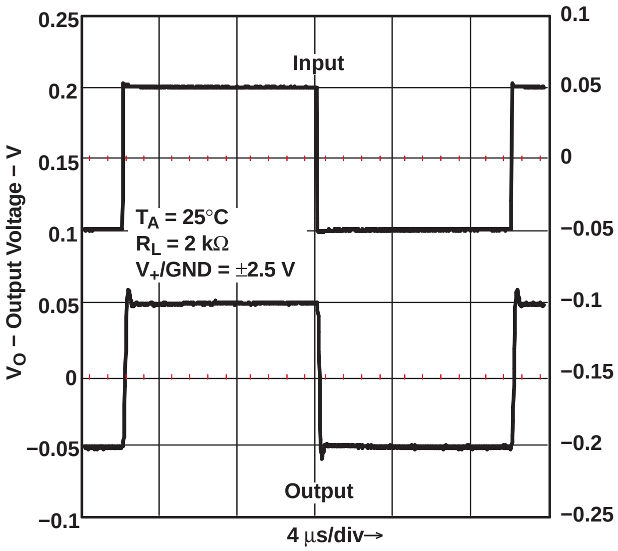


Figure 27.

LARGE-SIGNAL NONINVERTING RESPONSE

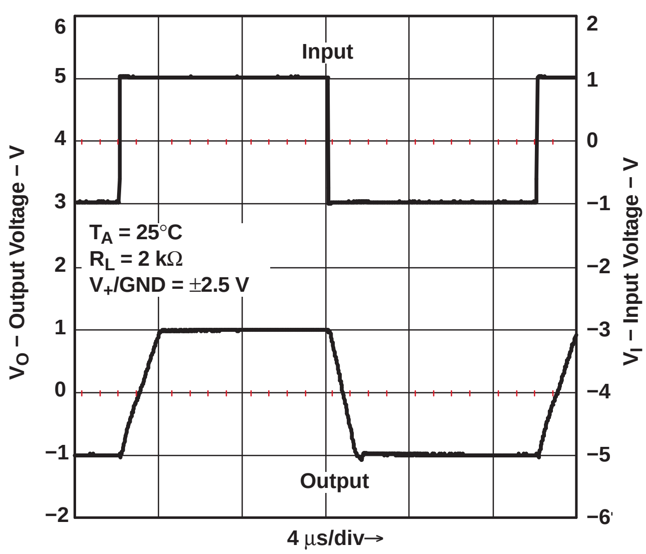


Figure 28.

TYPICAL CHARACTERISTICS (continued)

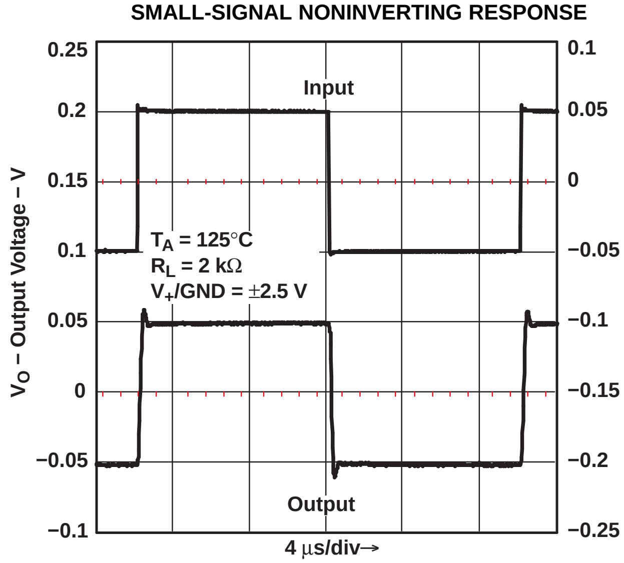


Figure 29.

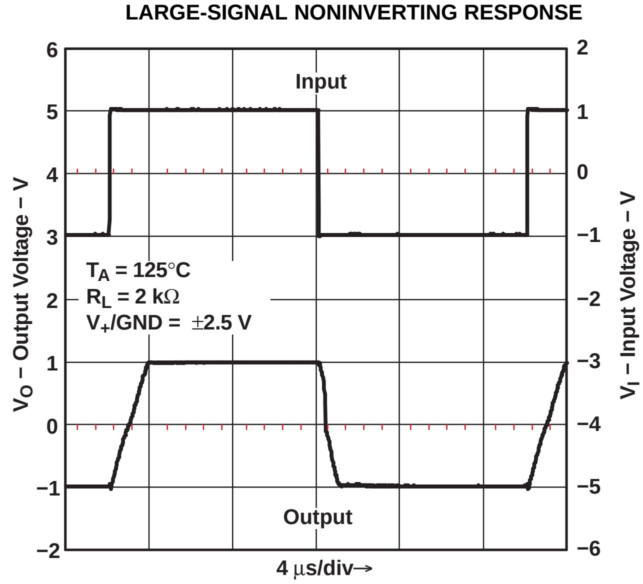


Figure 30.

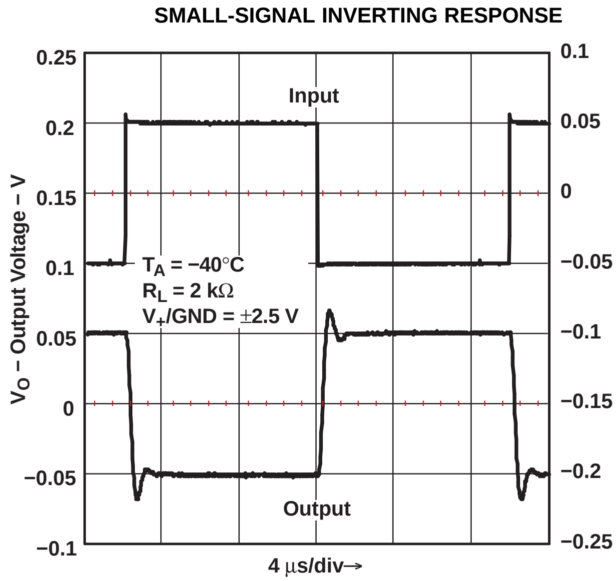


Figure 31.

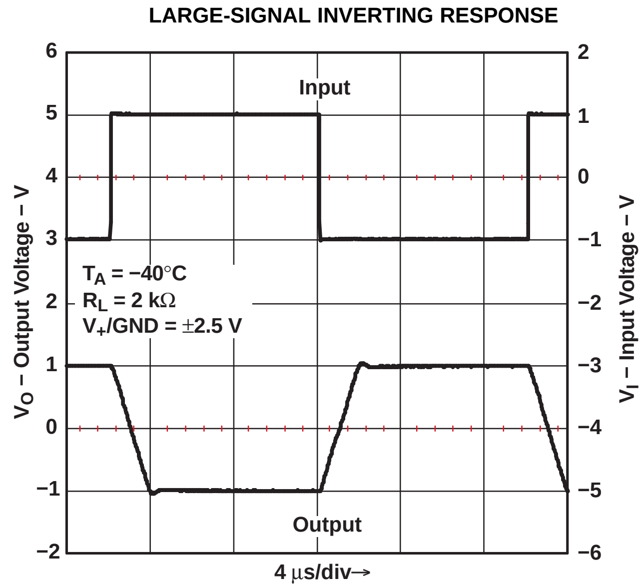


Figure 32.

TYPICAL CHARACTERISTICS (continued)

SMALL-SIGNAL INVERTING RESPONSE

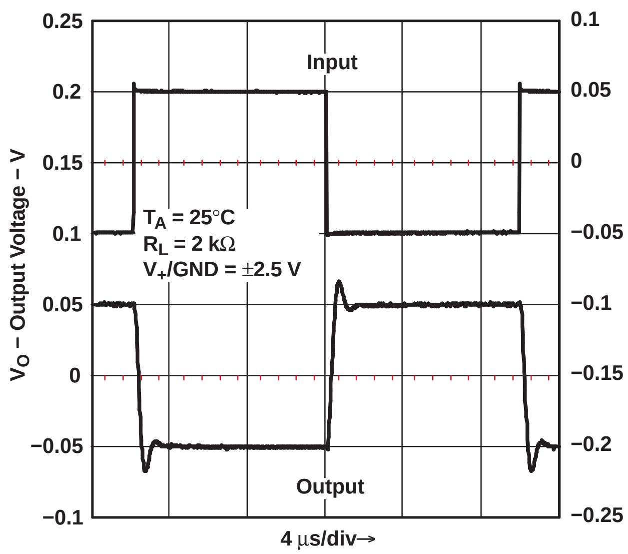


Figure 33.

LARGE-SIGNAL INVERTING RESPONSE

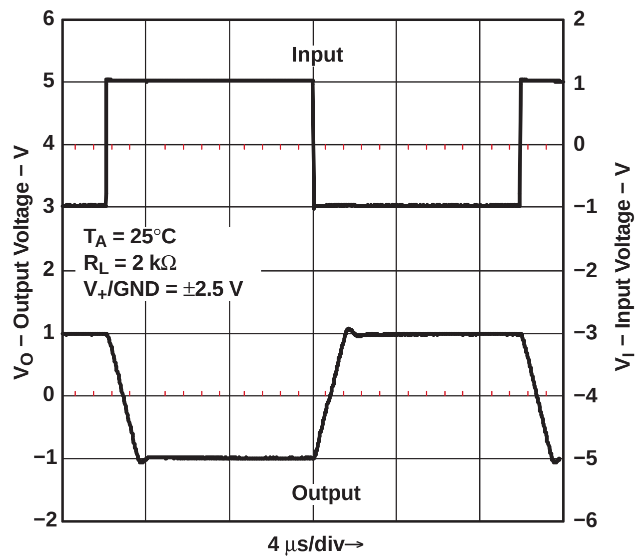


Figure 34.

SMALL-SIGNAL INVERTING RESPONSE

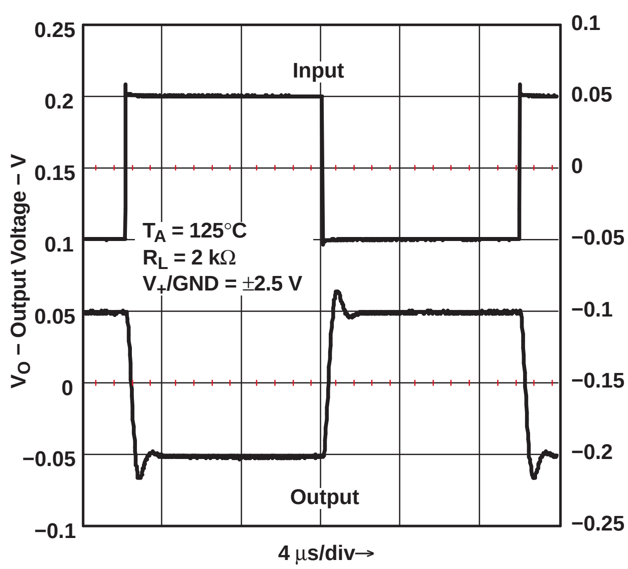


Figure 35.

LARGE-SIGNAL INVERTING RESPONSE

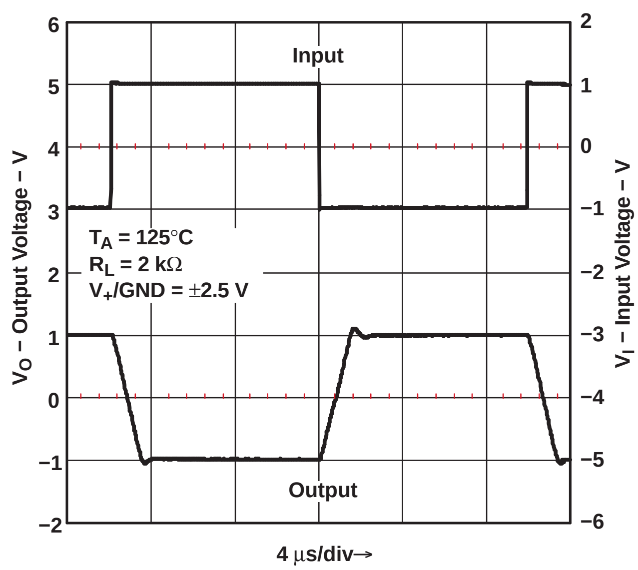


Figure 36.

PACKAGING INFORMATION

Orderable Device	Status [1]	Package Type	Package Drawing	Pins	Package Qty	Eco Plan [2]	Lead/Ball Finish	MSL Peak Temp [3]
LMV344IPWRQ1	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

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

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

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

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OTHER QUALIFIED VERSIONS OF LMV344-Q1 :

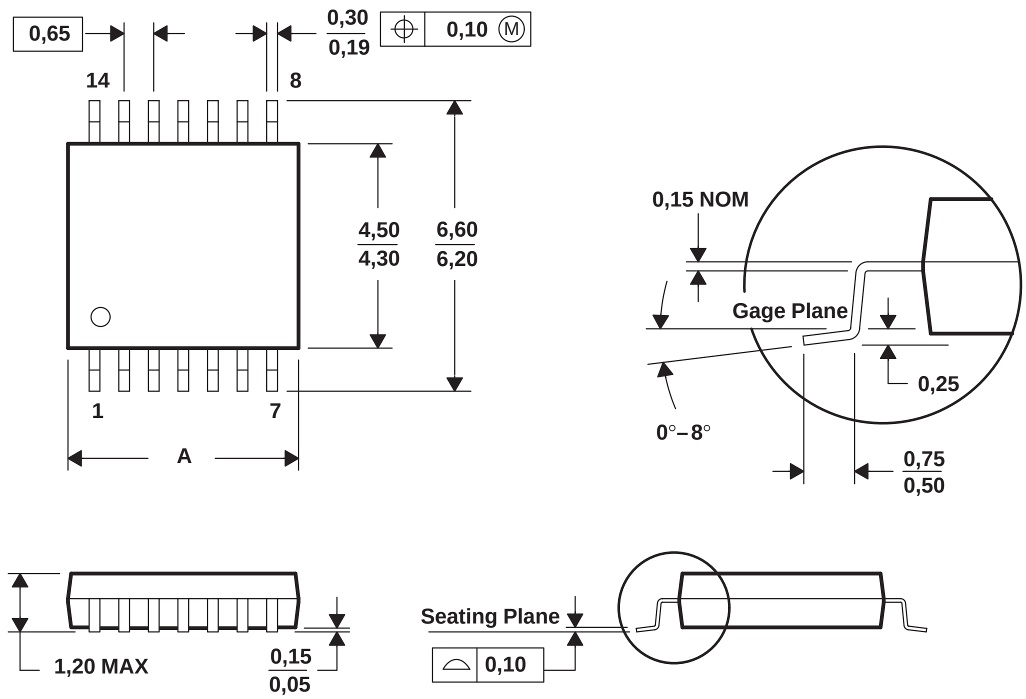
- Catalog: LMV344

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

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

14 PINS SHOWN



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

4040064/F 01/97

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

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