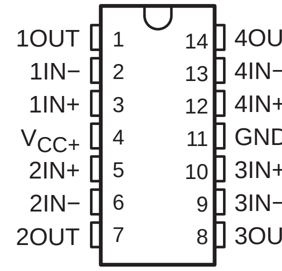
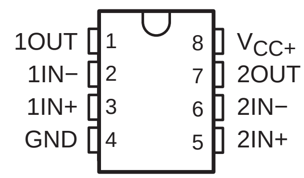
- **Qualification in Accordance With AEC-Q100†**
- **Qualified for Automotive Applications**
- **Customer-Specific Configuration Control Can Be Supported Along With Major-Change Approval**
- **2.7-V and 5-V Performance**
- **No Crossover Distortion**
- **Low Supply Current:**
  LMV358 . . . 210 μA Typ
  LMV324 . . . 410 μA Typ
- **Rail-to-Rail Output Swing**

†Contact factory for details. Q100 qualification data available on request.

LMV324 . . . D OR PW PACKAGE
(TOP VIEW)



LMV358 . . . D OR PW PACKAGE
(TOP VIEW)



description/ordering information

The LMV358 and LMV324 are dual and quad low-voltage (2.7 V to 5.5 V) operational amplifiers with rail-to-rail output swing.

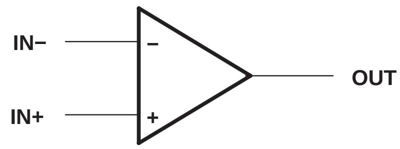
The LMV358 and LMV324 are the most cost-effective solution for applications where low-voltage operation, space saving, and low price are needed. These amplifiers were designed specifically for low-voltage (2.7 V to 5 V) operation, with performance specifications meeting or exceeding the venerable LM358 and LM324 devices that operate from 5 V to 30 V. Additional features of the LMV3xx devices are a common-mode input voltage range that includes ground, 1-MHz unity-gain bandwidth, and 1-V/μs slew rate.

ORDERING INFORMATION

T_A		PACKAGE‡		ORDERABLE PART NUMBER	TOP-SIDE MARKING
−40°C to 85°C	Dual	SOIC (D)	Tube of 75	LMV358IDQ1	358IQ1
			Reel of 2500	LMV358IDRQ1	
		TSSOP (PW)	Reel of 2000	LMV358IPWRQ1	358IQ1
−40°C to 85°C	Quad	SOIC (D)	Tube of 50	LMV324IDQ1	LMV324IQ1
			Reel of 2500	LMV324IDRQ1	
		TSSOP (PW)	Reel of 2000	LMV324IPWRQ1	V324IQ1
−40°C to 125°C	Dual	SOIC (D)	Tube of 75	LMV358QDQ1	V358Q1
			Reel of 2500	LMV358QDRQ1	
		TSSOP (PW)	Reel of 2000	LMV358QPWRQ1	V358Q1
−40°C to 125°C	Quad	SOIC (D)	Tube of 50	LMV324QDQ1	LMV324Q1
			Reel of 2500	LMV324QDRQ1	
		TSSOP (PW)	Reel of 2000	LMV324QPWRQ1	MV324Q1

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

symbol (each amplifier)



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

Supply voltage, V_{CC} (see Note 1) . . . . 5.5 V
Differential input voltage, V_{ID} (see Note 2) . . . . ±5.5 V
Input voltage, V_I (either input) . . . . 0 to 5.5 V
Duration of output short circuit (one amplifier) to ground at (or below) T_A = 25°C,
V_{CC} ≤ 5.5 V (see Note 3) . . . . Unlimited
Package thermal impedance, θ_{JA} (see Notes 4 and 5): D (8-pin) package . . . . 97°C/W
D (14-pin) package . . . . 86°C/W
PW (8-pin) package . . . . 149°C/W
PW (14-pin) package . . . . 113°C/W
Operating virtual junction temperature, T_J . . . . 150°C
Storage temperature range, T_{stg} . . . . −65 to 150°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 and V_{CC} specified for the measurement of I_{OS}) are with respect to the network GND.
2. Differential voltages are at IN+ with respect to IN−.
3. Short circuits from outputs to V_{CC} can cause excessive heating and eventual destruction.
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 $P_D = (T_J(max) - T_A)/\theta_{JA}$. Selecting the maximum of 150°C can affect reliability.
5. The package thermal impedance is calculated in accordance with JESD 51-7.

recommended operating conditions (see Note 6)

			MIN	MAX	UNIT
V_{CC}	Supply voltage (single-supply operation)		2.7	5.5	V
V_{IH}	Amplifier turn-on voltage level	V_{CC} = 2.7 V	1.7		V
		V_{CC} = 5 V	3.5		
V_{IL}	Amplifier turn-off voltage level	V_{CC} = 2.7 V		0.7	V
		V_{CC} = 5 V		1.5	
T_A	Operating free-air temperature	I suffix	−40	85	°C
		Q suffix	−40	125	

NOTE 6: All unused control inputs of the device must be held at V_{CC} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

electrical characteristics at T_A = 25°C and V_{CC+} = 2.7 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
V_{IO}	Input offset voltage				1.7	7	mV
$\alpha_{V_{IO}}$	Average temperature coefficient of input offset voltage				5		μV/°C
I_{IB}	Input bias current				11	250	nA
I_{IO}	Input offset current				5	50	nA
CMRR	Common-mode rejection ratio	V_{CM} = 0 to 1.7 V		50	63		dB
k_{SVR}	Supply-voltage rejection ratio	V_{CC} = 2.7 V to 5 V, V_O = 1 V		50	60		dB
V_{ICR}	Common-mode input voltage range	CMRR ≥ 50 dB		0 to 1.7	−0.2 to 1.9		V
	Output swing	R_L = 10 kΩ to 1.35 V	High level	V_{CC}−100	V_{CC}−10		mV
			Low level		60	180	
I_{CC}	Supply current	LMV358 (both amplifiers)			140	340	μA
		LMV324 (all four amplifiers)			260	680	
B_1	Unity-gain bandwidth	C_L = 200 pF			1		MHz
ϕ_m	Phase margin				60		deg
G_m	Gain margin				10		dB
V_n	Equivalent input noise voltage	f = 1 kHz			46		$nV/\sqrt{Hz}$
I_n	Equivalent input noise current	f = 1 kHz			0.17		$pA/\sqrt{Hz}$

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

PARAMETER		TEST CONDITIONS		T_A†	MIN	TYP	MAX	UNIT
V_{IO}	Input offset voltage			25°C		1.7	7	mV
				Full range			9	
$\alpha_{V_{IO}}$	Average temperature coefficient of input offset voltage			25°C		5		μV/°C
I_{IB}	Input bias current			25°C		15	250	nA
				Full range			500	
I_{IO}	Input offset current			25°C		5	50	nA
				Full range			150	
CMRR	Common-mode rejection ratio	V_{CM} = 0 to 4 V		25°C	50	65		dB
k_{SVR}	Supply-voltage rejection ratio	V_{CC}= 2.7 V to 5 V, V_O = 1 V, V_{CM} = 1 V		25°C	50	60		dB
V_{ICR}	Common-mode input voltage range	CMMR ≥ 50 dB		25°C	0 to 4	−0.2 to 4.2		V
	Output swing	R_L = 2 kΩ to 2.5 V	High level	25°C	V_{CC}−300	V_{CC}−40		mV
				Full range	V_{CC}−400			
			Low level	25°C		120	300	
				Full range			400	
		R_L = 10 kΩ to 2.5 V	High level	25°C	V_{CC}−100	V_{CC}−10		
				Full range	V_{CC}−200			
			Low level	25°C		65	180	
				Full range			280	
A_{VD}	Large-signal differential voltage gain	R_L = 2 kΩ		25°C	15	100		V/mV
				Full range	10			
I_{OS}	Output short-circuit current	Sourcing, V_O = 0 V		25°C	5	60		mA
		Sinking, V_O = 5 V			10	160		
I_{CC}	Supply current	LMV358 (both amplifiers)		25°C		210	440	μA
				Full range			615	
		LMV324 (all four amplifiers)		25°C		410	830	
				Full range			1160	
B_1	Unity-gain bandwidth	C_L = 200 pF		25°C		1		MHz
ϕ_m	Phase margin			25°C		60		deg
G_m	Gain margin			25°C		10		dB
V_n	Equivalent input noise voltage	f = 1 kHz		25°C		39		nV/√Hz
I_n	Equivalent input noise current	f = 1 kHz		25°C		0.21		pA/√Hz
SR	Slew rate			25°C		1		V/μs

† Full range is −40°C to 85°C for I level part, −40°C to 125°C for Q level part.

TYPICAL CHARACTERISTICS

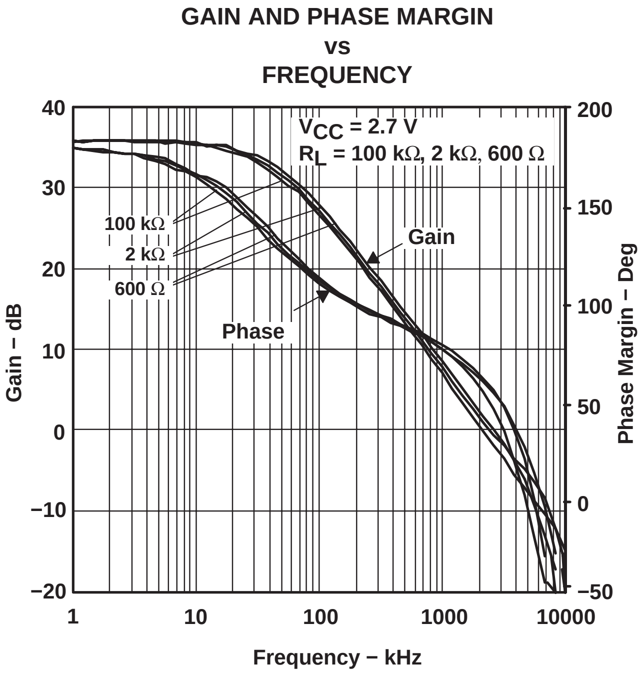


Figure 1

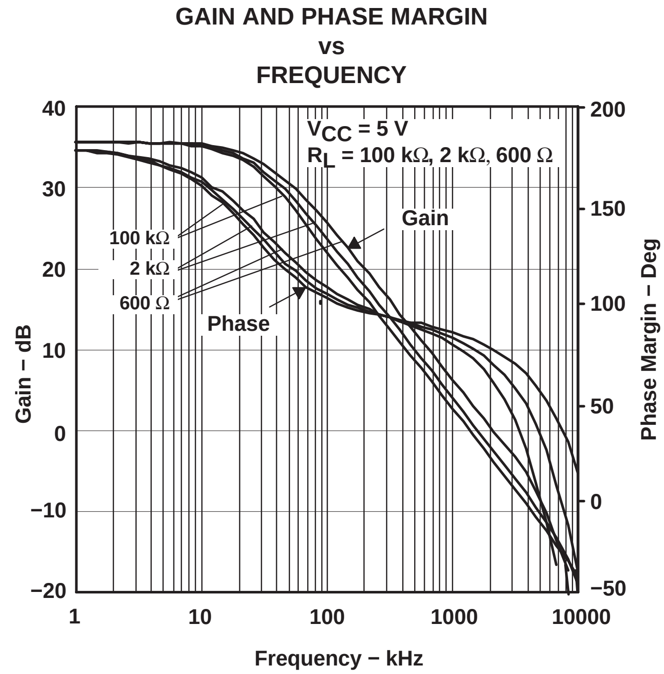


Figure 2

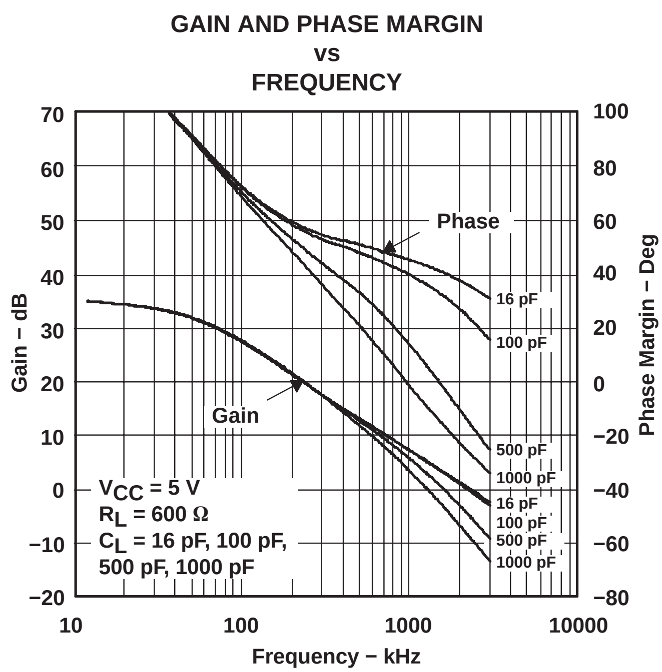


Figure 3

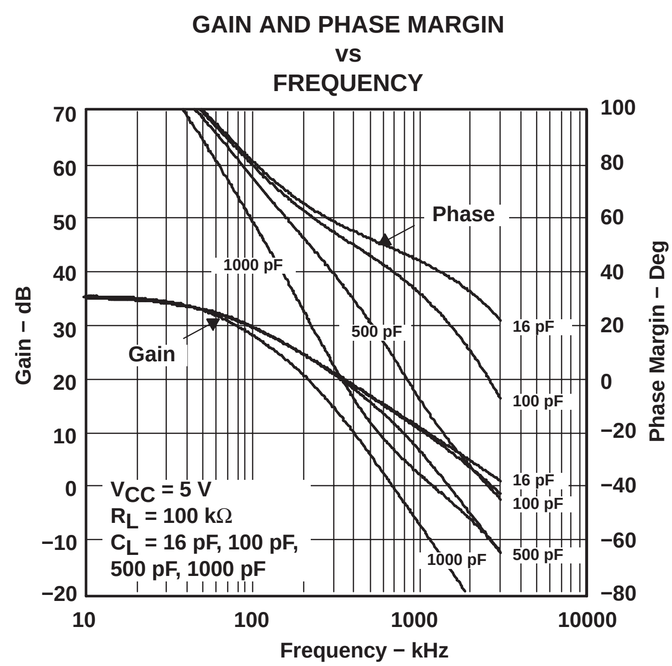


Figure 4

TYPICAL CHARACTERISTICS

GAIN AND PHASE MARGIN vs FREQUENCY

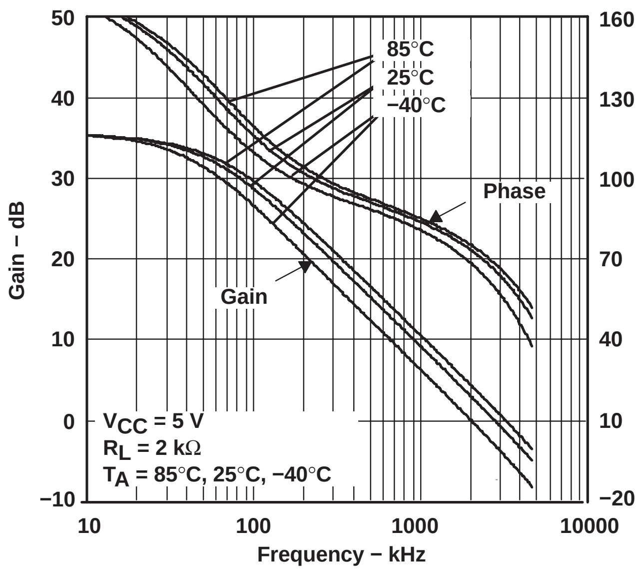


Figure 5

STABILITY vs CAPACITIVE LOAD

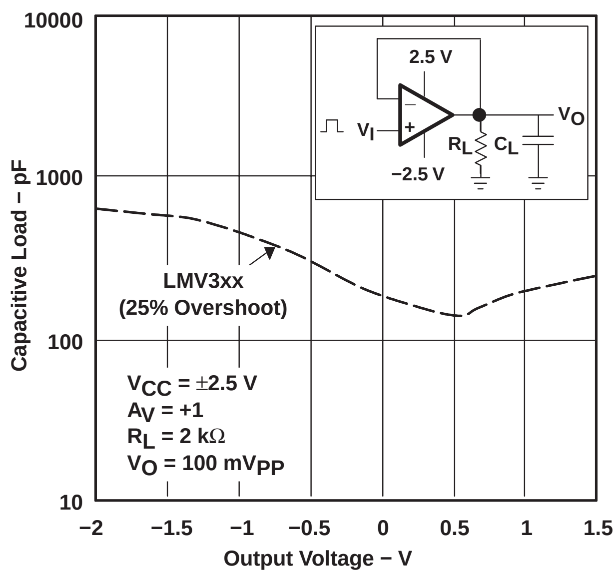


Figure 6

STABILITY vs CAPACITIVE LOAD

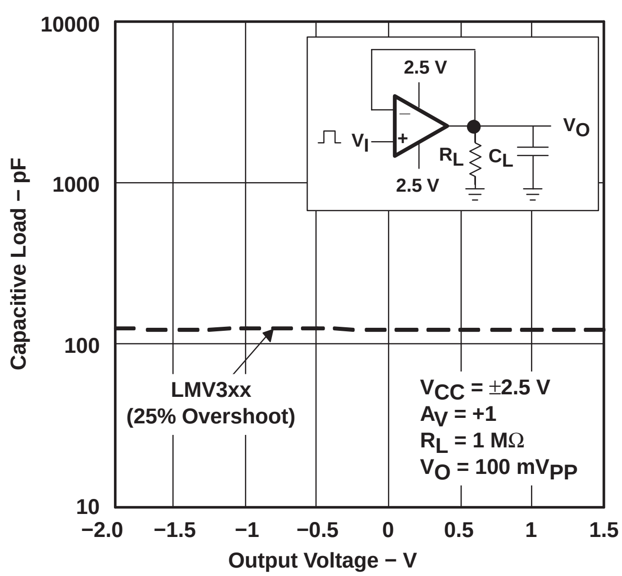


Figure 7

STABILITY vs CAPACITIVE LOAD

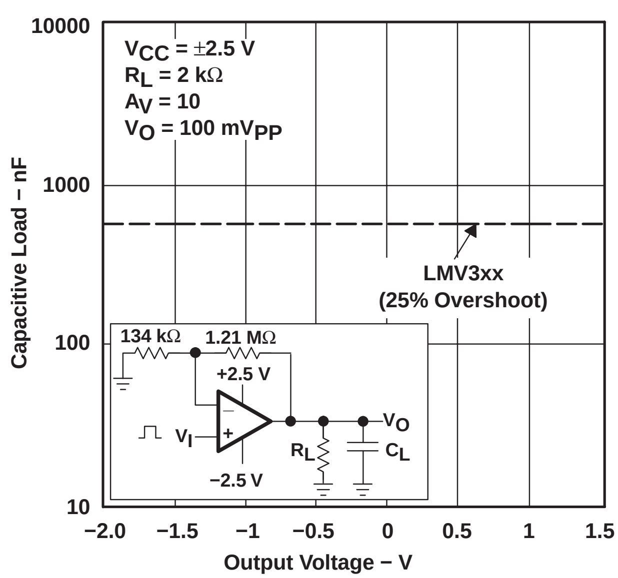


Figure 8

TYPICAL CHARACTERISTICS

STABILITY vs CAPACITIVE LOAD

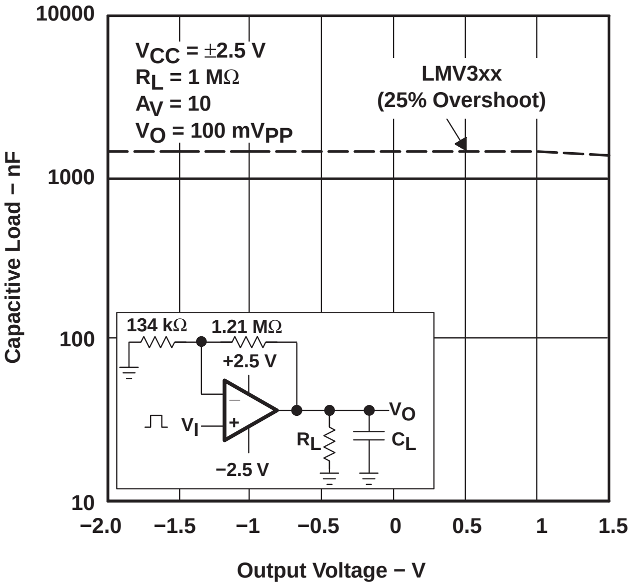


Figure 9

SLEW RATE vs SUPPLY VOLTAGE

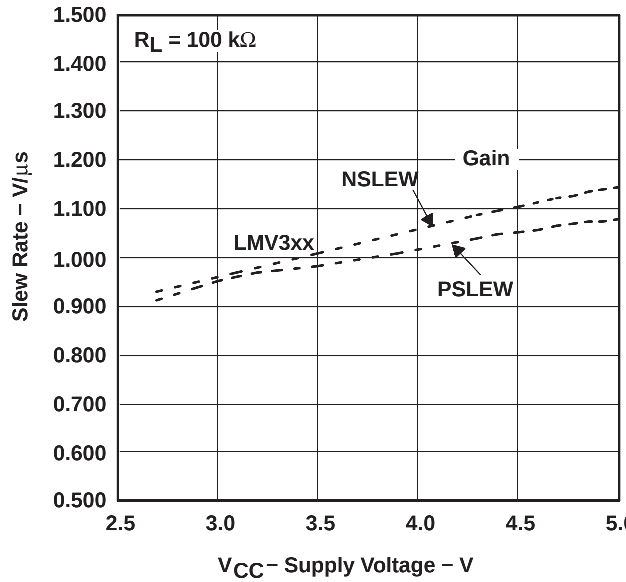


Figure 10

SUPPLY CURRENT vs SUPPLY VOLTAGE − QUAD AMPLIFIER

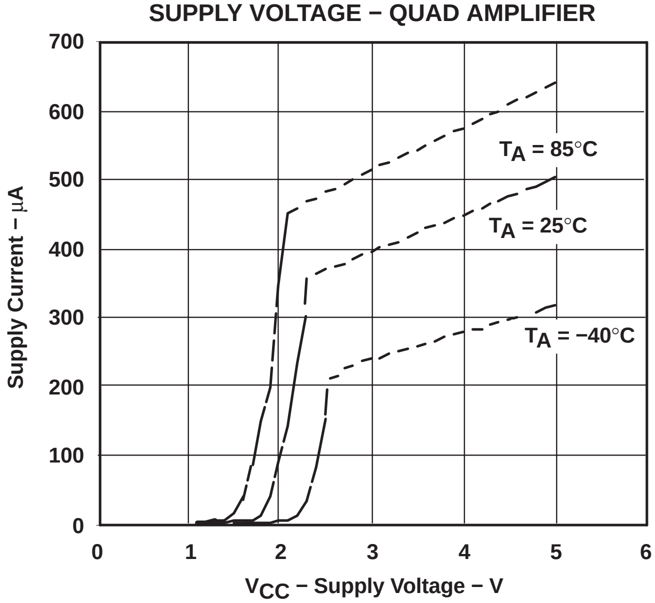


Figure 11

INPUT CURRENT vs TEMPERATURE

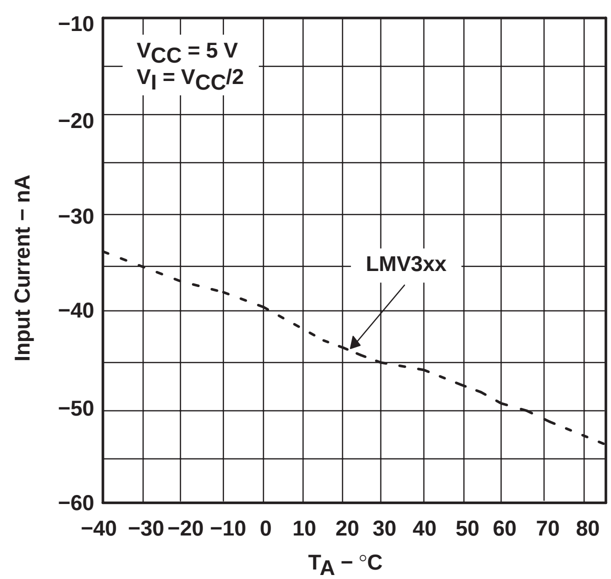


Figure 12

TYPICAL CHARACTERISTICS

SOURCE CURRENT vs OUTPUT VOLTAGE

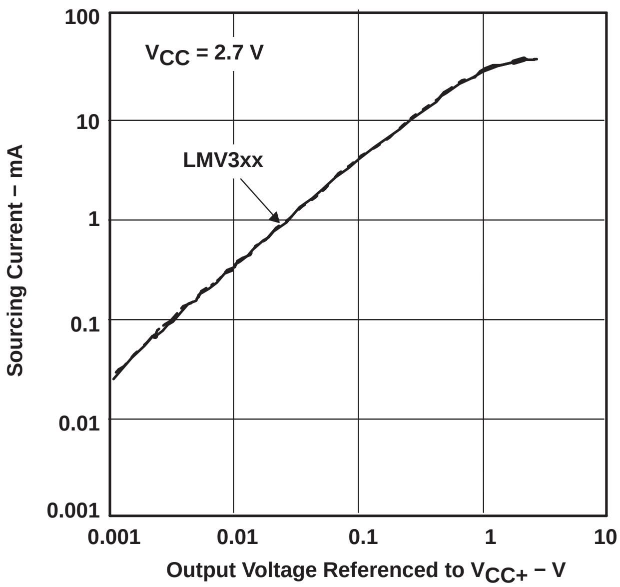


Figure 13

SOURCE CURRENT vs OUTPUT VOLTAGE

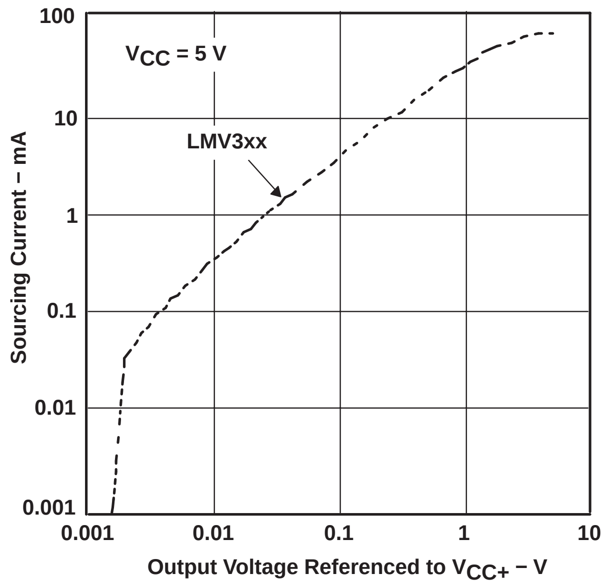


Figure 14

SINKING CURRENT vs OUTPUT VOLTAGE

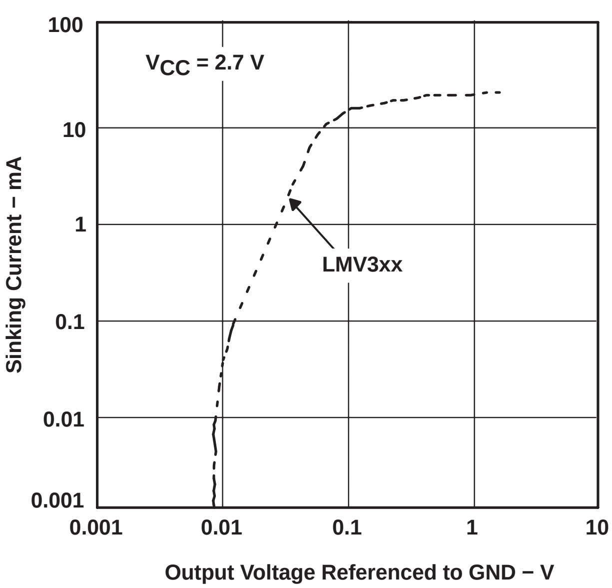


Figure 15

SINKING CURRENT vs OUTPUT VOLTAGE

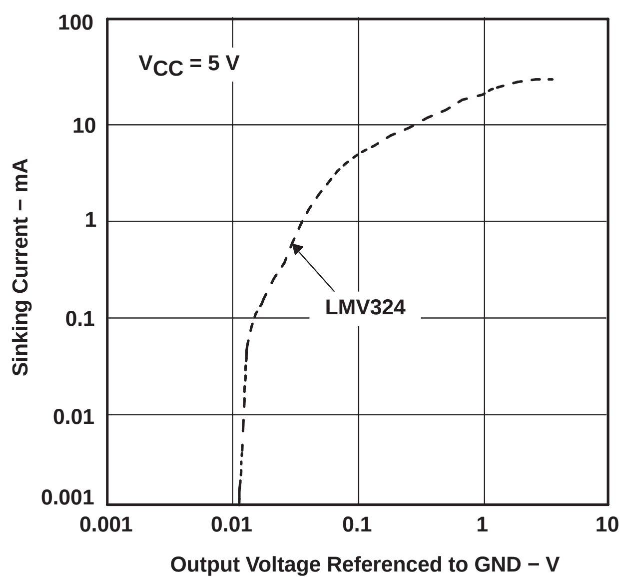


Figure 16

TYPICAL CHARACTERISTICS

SHORT-CIRCUIT CURRENT
vs
TEMPERATURE

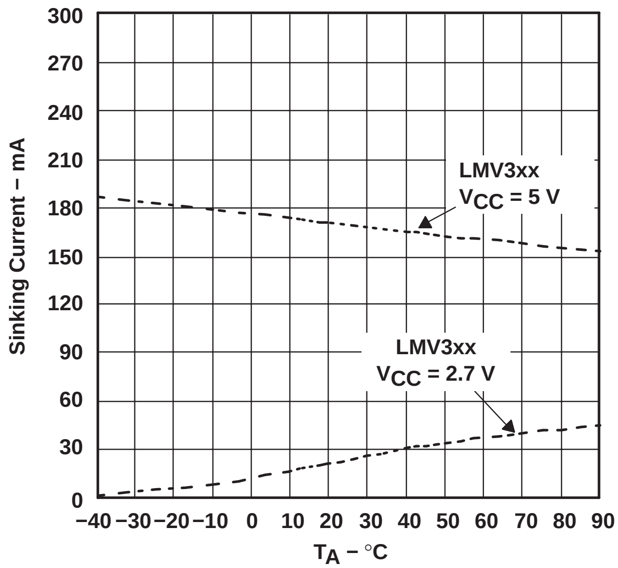


Figure 17

SHORT-CIRCUIT CURRENT
vs
TEMPERATURE

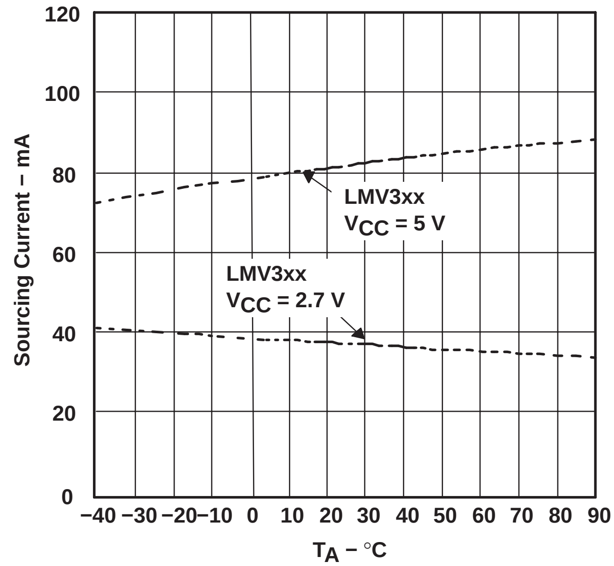


Figure 18

$-k_{SVR}$
vs
FREQUENCY

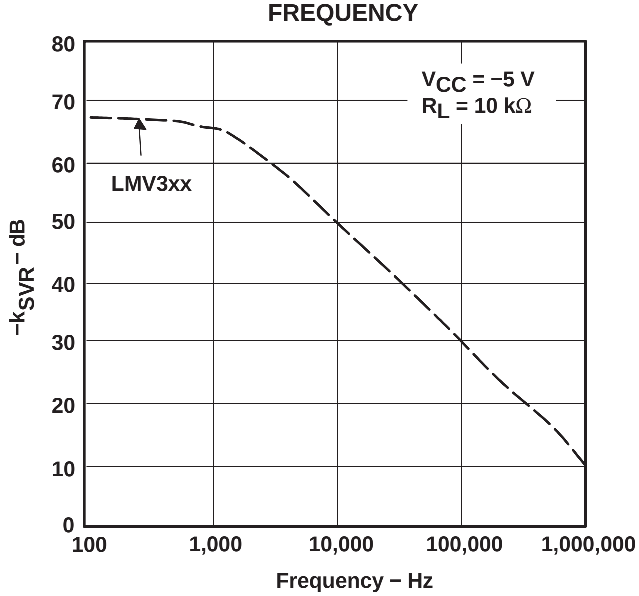


Figure 19

$+k_{SVR}$
vs
FREQUENCY

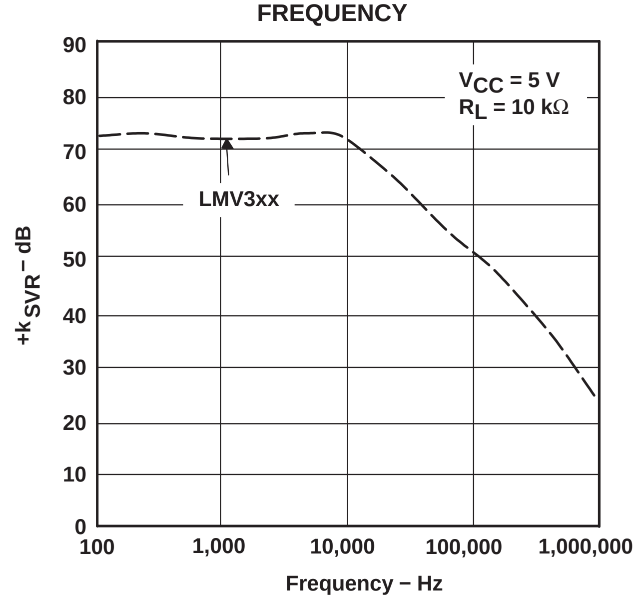


Figure 20

TYPICAL CHARACTERISTICS

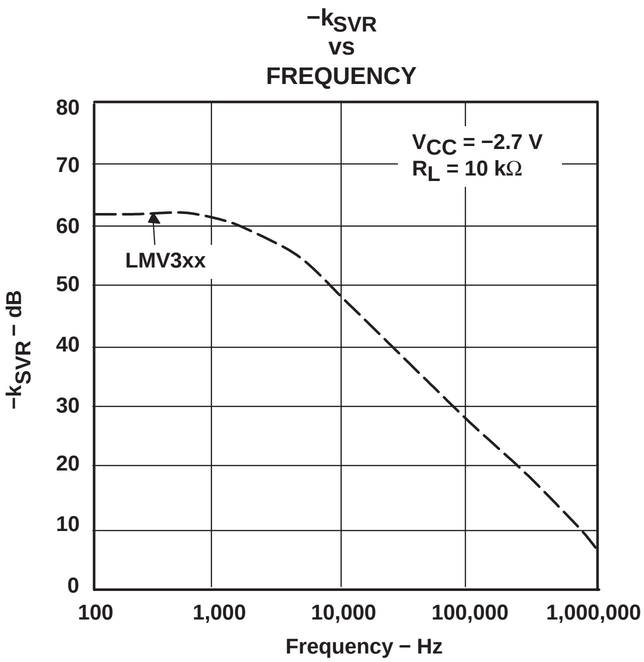


Figure 21

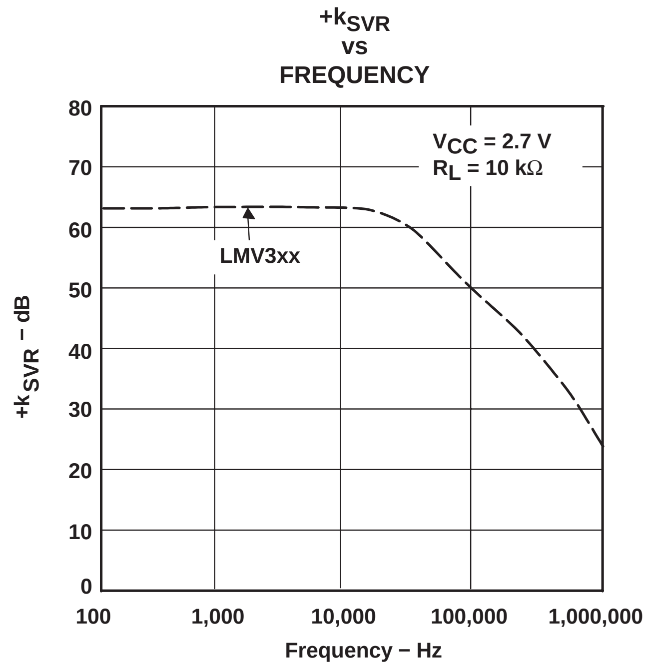


Figure 22

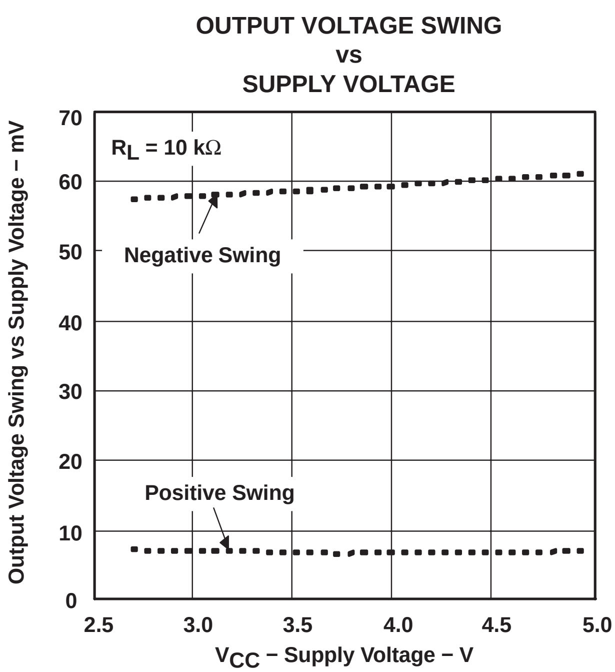


Figure 23

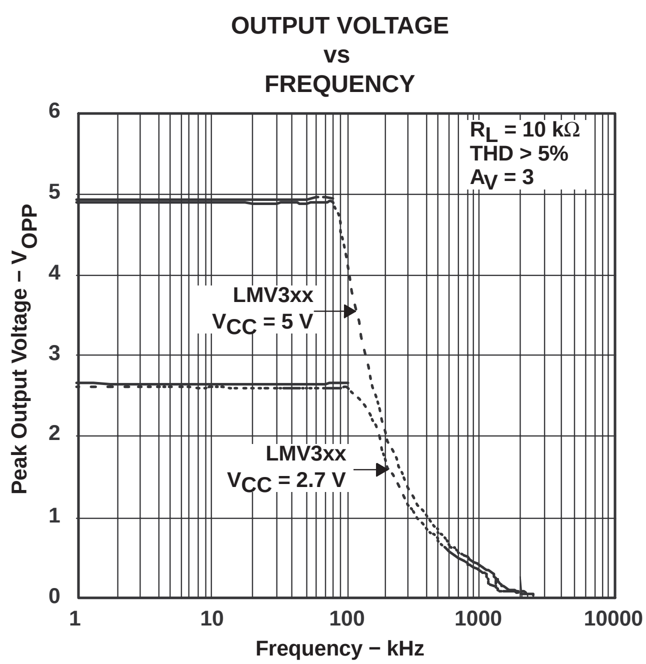


Figure 24

TYPICAL CHARACTERISTICS

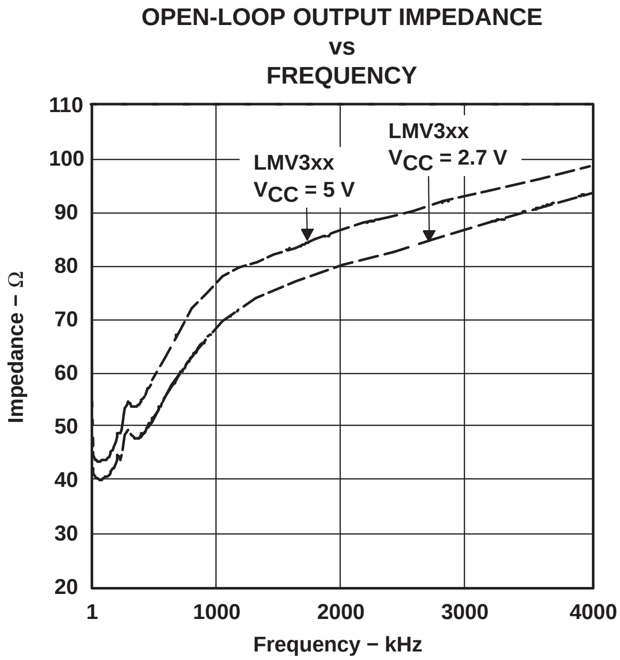


Figure 25

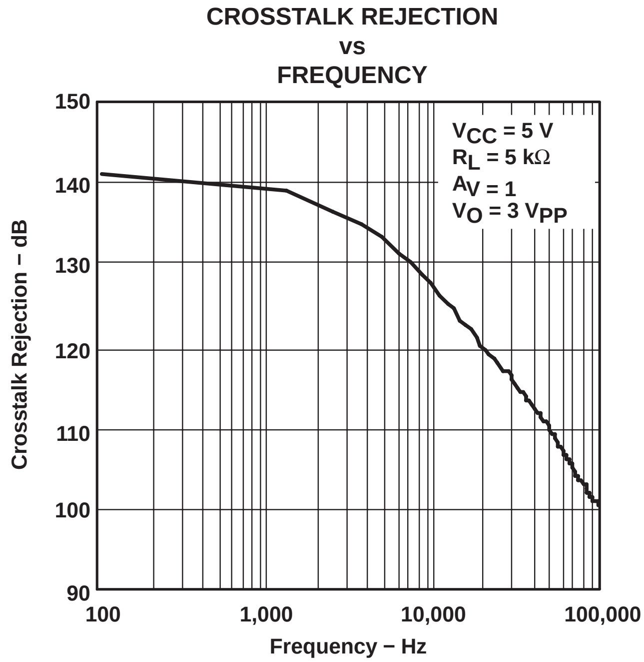


Figure 26

TYPICAL CHARACTERISTICS

NONINVERTING LARGE-SIGNAL PULSE RESPONSE

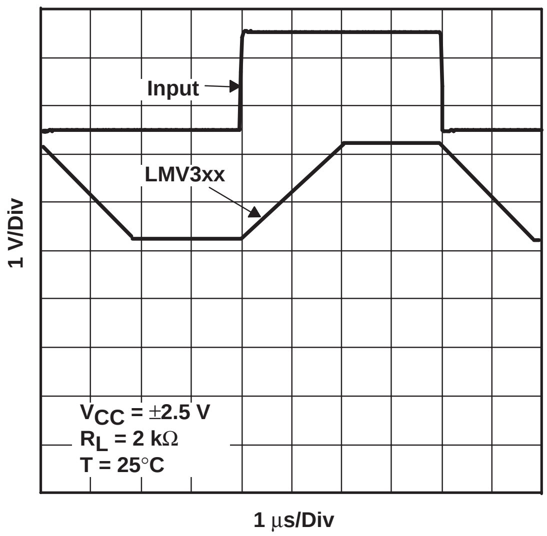


Figure 27

NONINVERTING LARGE-SIGNAL PULSE RESPONSE

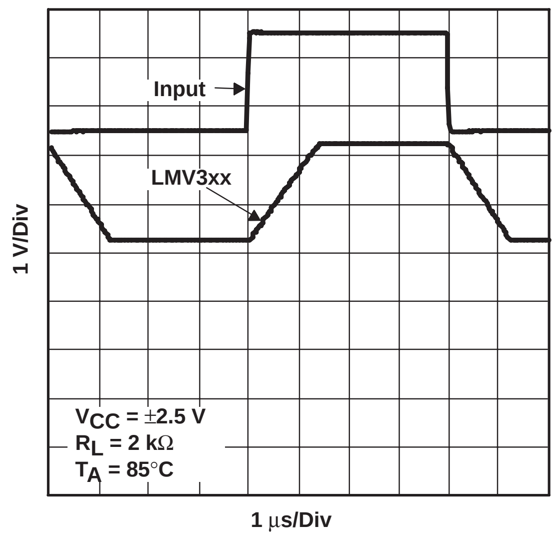


Figure 28

NONINVERTING LARGE-SIGNAL PULSE RESPONSE

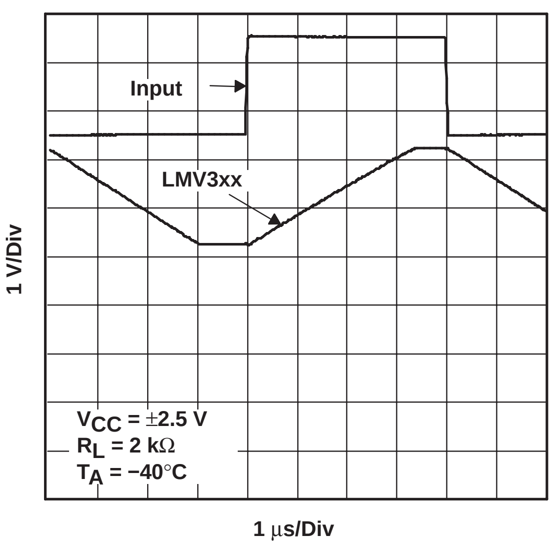


Figure 29

TYPICAL CHARACTERISTICS

NONINVERTING SMALL-SIGNAL PULSE RESPONSE

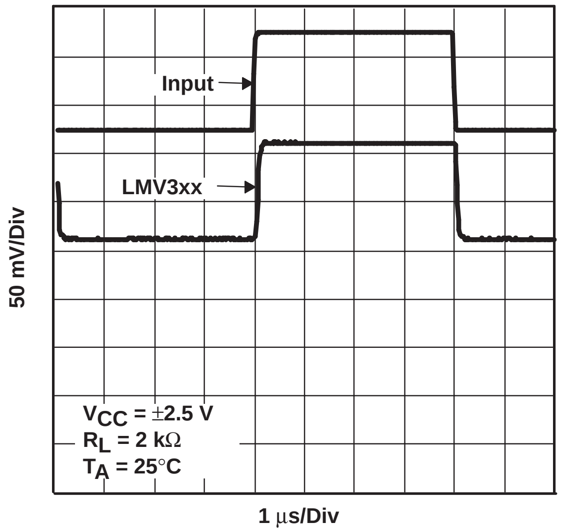


Figure 30

NONINVERTING SMALL-SIGNAL PULSE RESPONSE

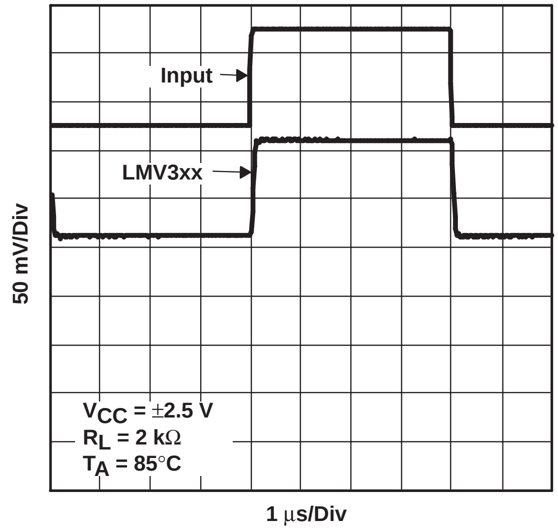


Figure 31

NONINVERTING SMALL-SIGNAL PULSE RESPONSE

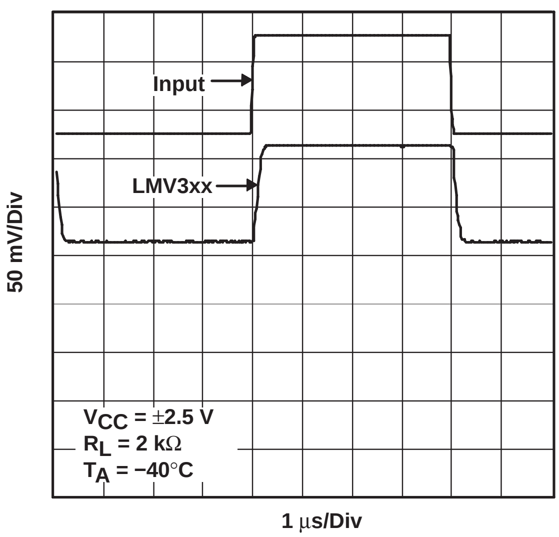


Figure 32

TYPICAL CHARACTERISTICS

INVERTING LARGE-SIGNAL PULSE RESPONSE

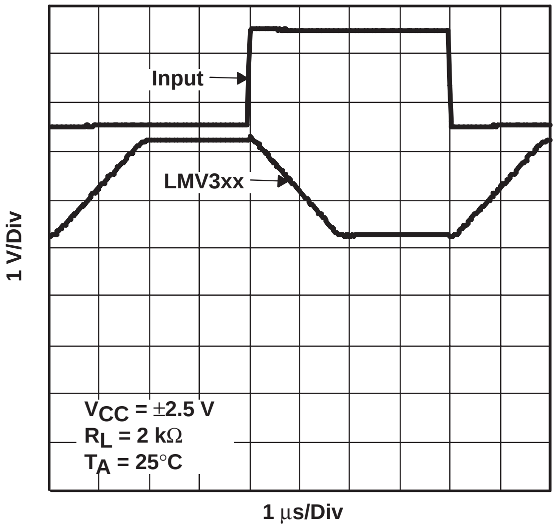


Figure 33

INVERTING LARGE-SIGNAL PULSE RESPONSE

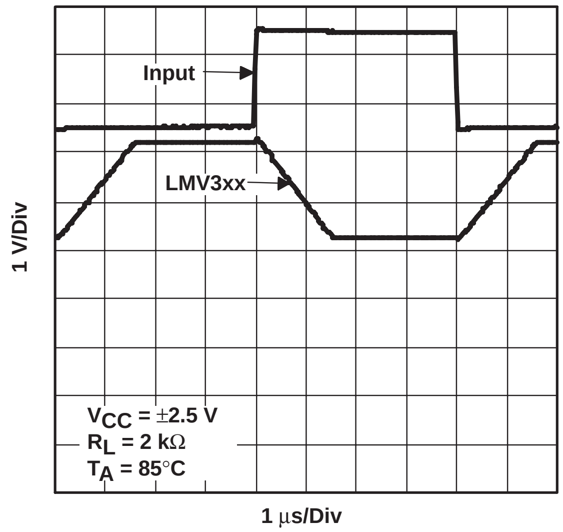


Figure 34

INVERTING LARGE-SIGNAL PULSE RESPONSE

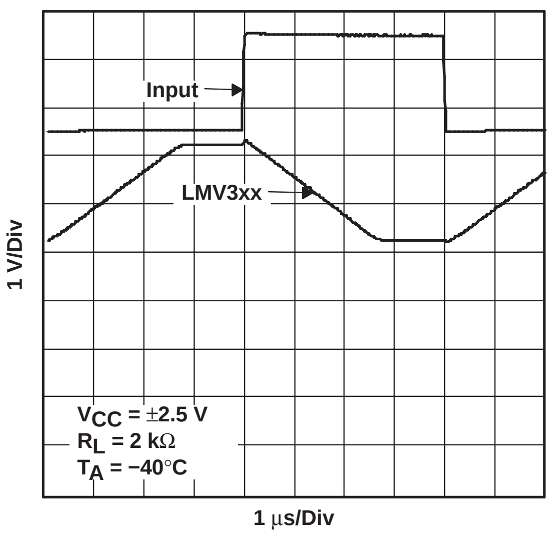


Figure 35

TYPICAL CHARACTERISTICS

INVERTING SMALL-SIGNAL PULSE RESPONSE

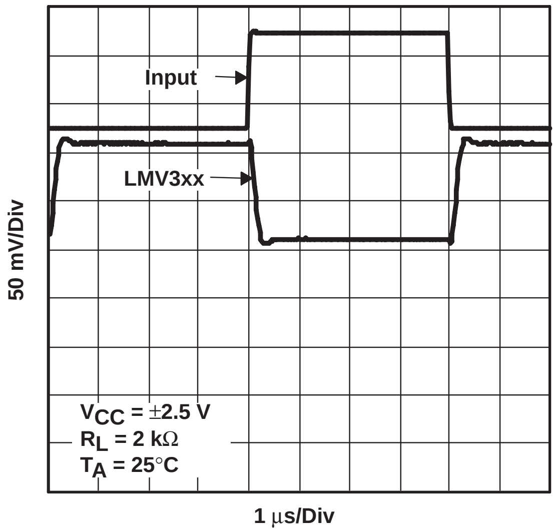


Figure 36

INVERTING SMALL-SIGNAL PULSE RESPONSE

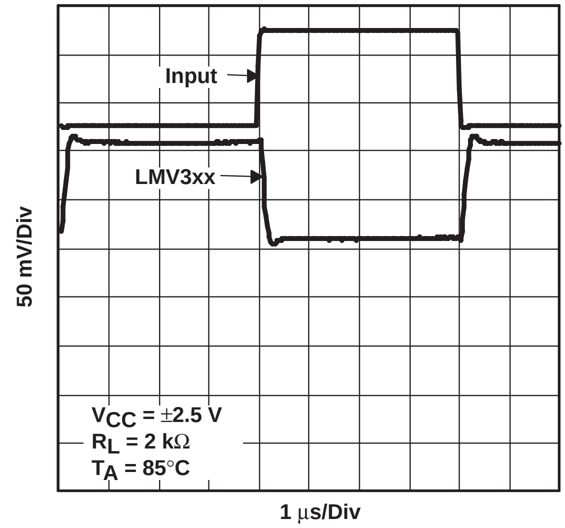


Figure 37

INVERTING SMALL-SIGNAL PULSE RESPONSE

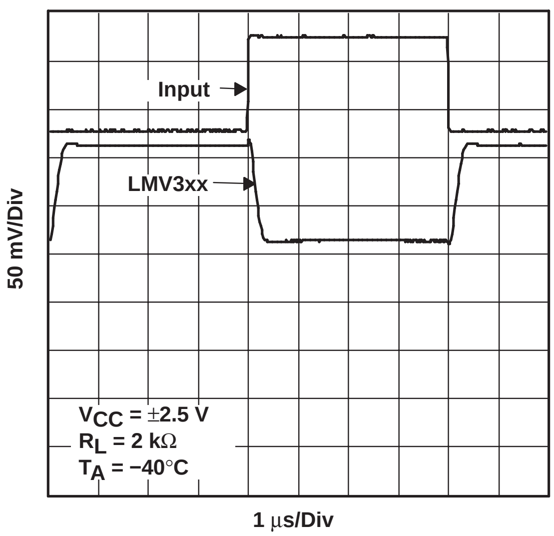


Figure 38

TYPICAL CHARACTERISTICS

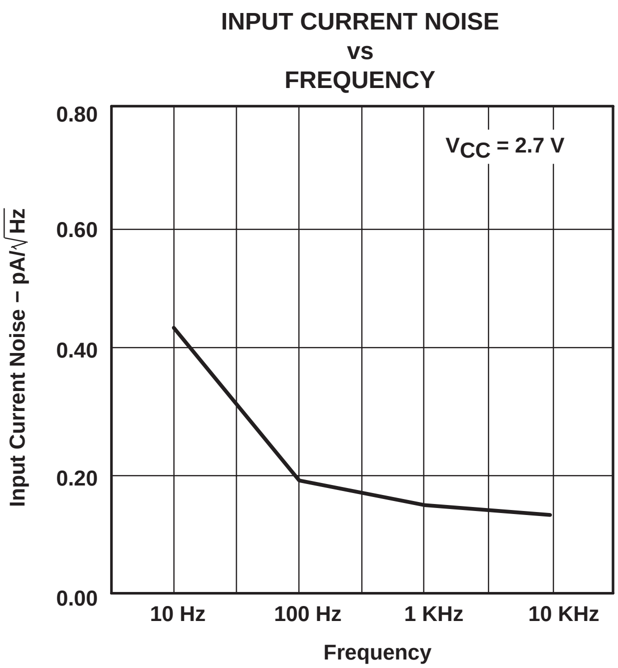


Figure 39

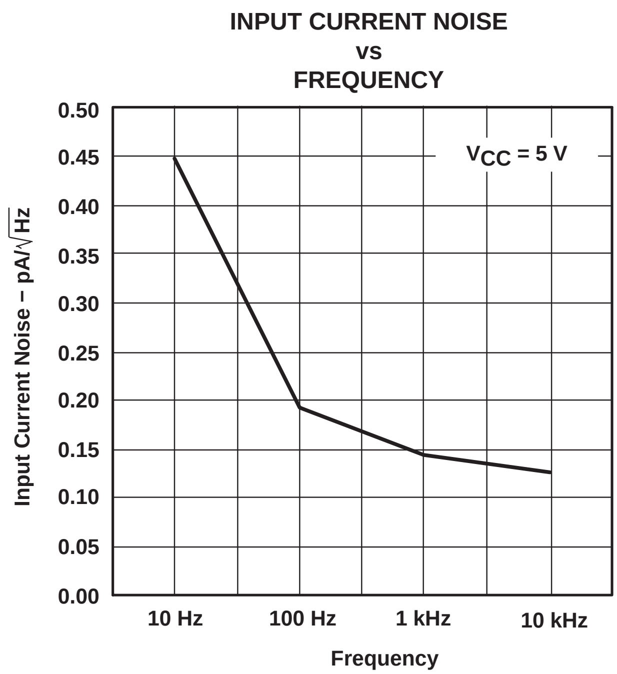


Figure 40

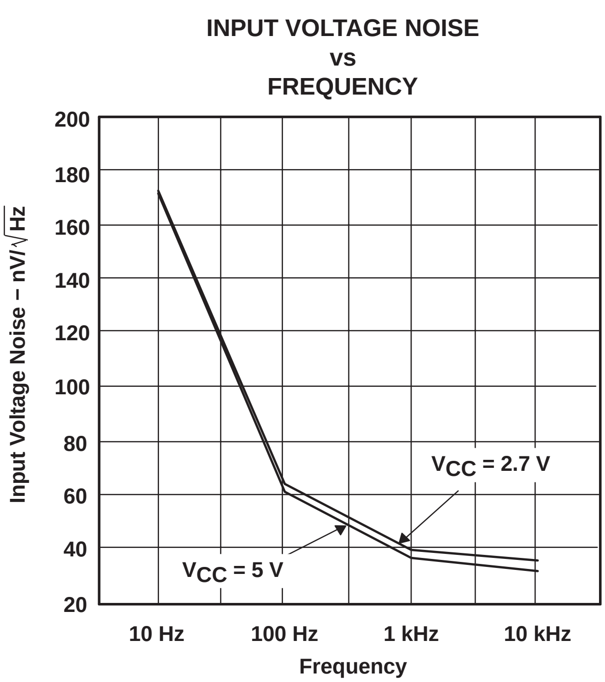


Figure 41

TYPICAL CHARACTERISTICS

THD + N
vs
FREQUENCY

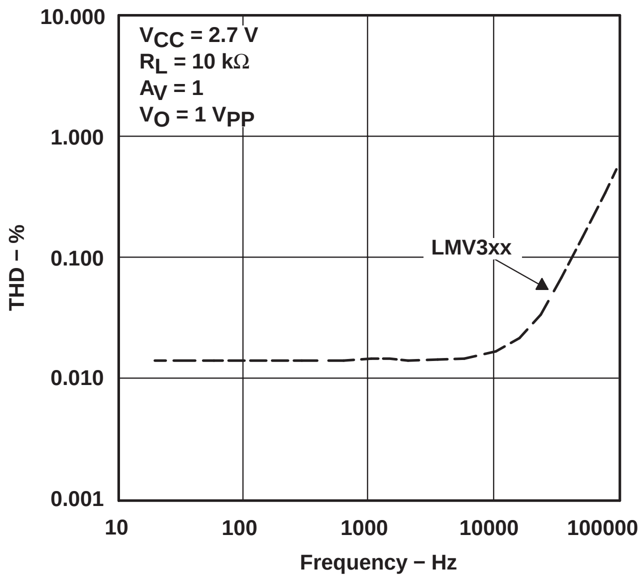


Figure 42

THD + N
vs
FREQUENCY

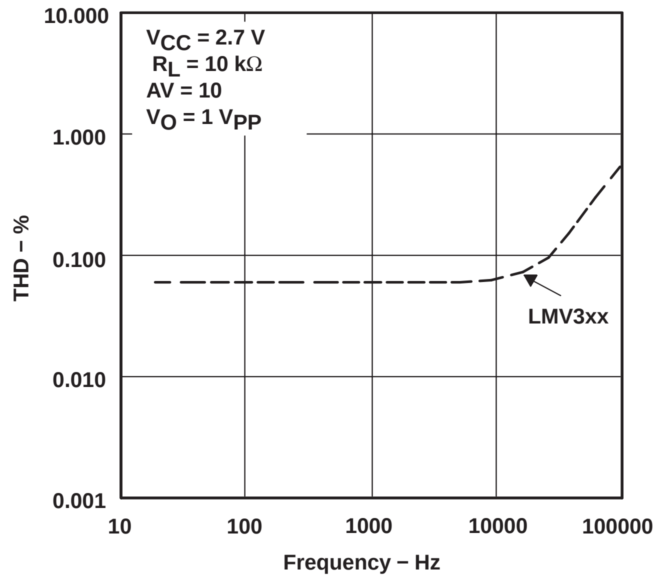


Figure 43

THD + N
vs
FREQUENCY

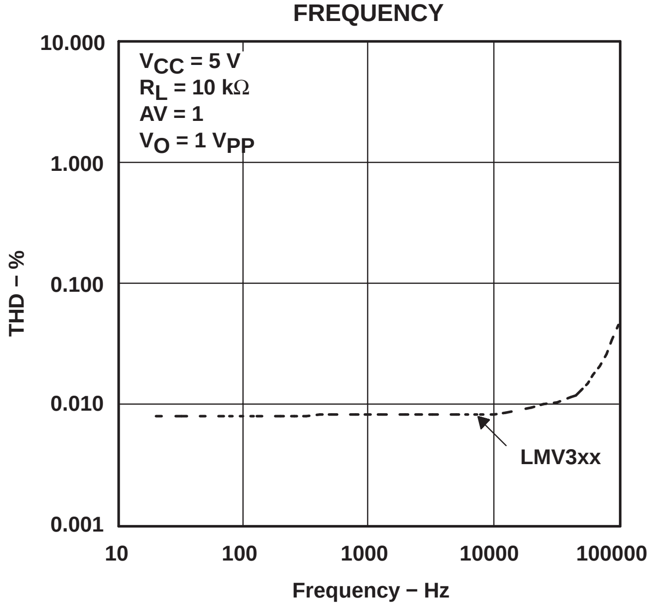


Figure 44

THD + N
vs
FREQUENCY

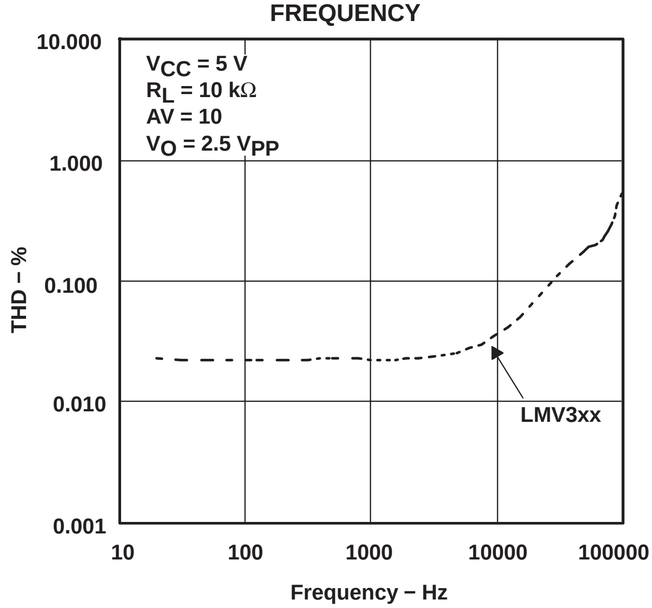
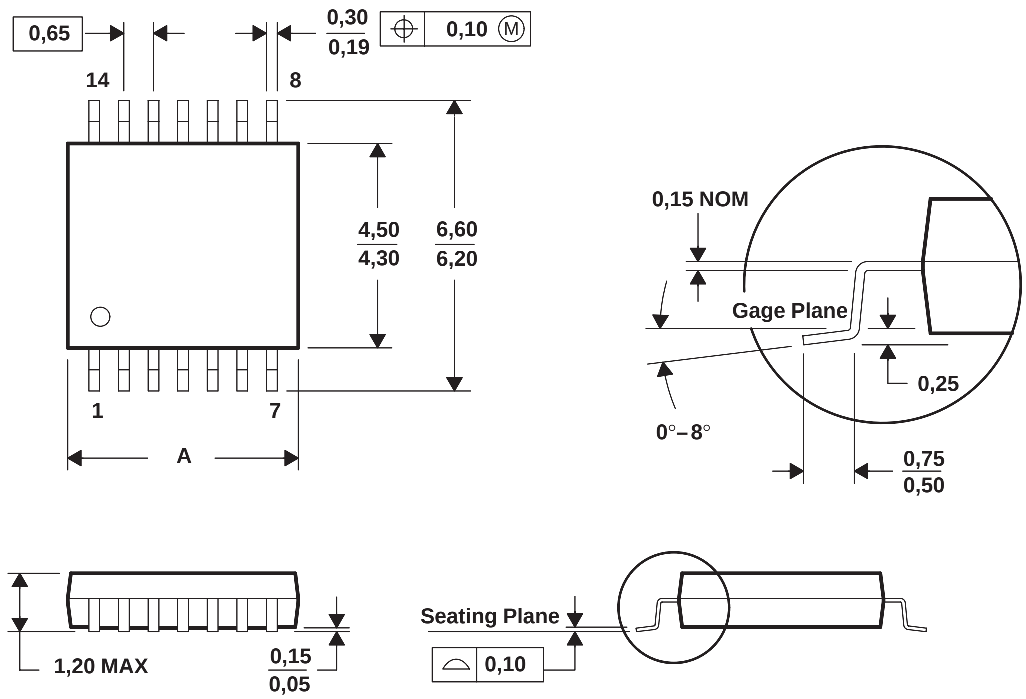


Figure 45

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