

## FEATURES

- 2.7-V and 5-V Performance
- $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$  Operation
- Low-Power Shutdown Mode (LMV324S)
- No Crossover Distortion
- Low Supply Current
  - LMV321 ... 130  $\mu\text{A}$  Typ
  - LMV358 ... 210  $\mu\text{A}$  Typ
  - LMV324 ... 410  $\mu\text{A}$  Typ
  - LMV324S ... 410  $\mu\text{A}$  Typ
- Rail-to-Rail Output Swing
- ESD Protection Exceeds JESD 22
  - 2000-V Human-Body Model (A114-A)
  - 1000-V Charged-Device Model (C101)

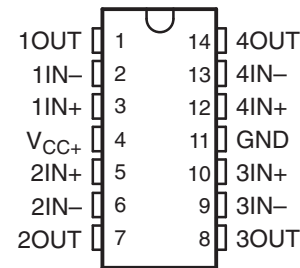
## DESCRIPTION/ ORDERING INFORMATION

The LMV321, LMV358, and LMV324/LMV324S are single, dual, and quad low-voltage (2.7 V to 5.5 V) operational amplifiers with rail-to-rail output swing. The LMV324S, which is a variation of the standard LMV324, includes a power-saving shutdown feature that reduces supply current to a maximum of 5  $\mu\text{A}$  per channel when the amplifiers are not needed. Channels 1 and 2 together are put in shutdown, as are channels 3 and 4. While in shutdown, the outputs actively are pulled low.

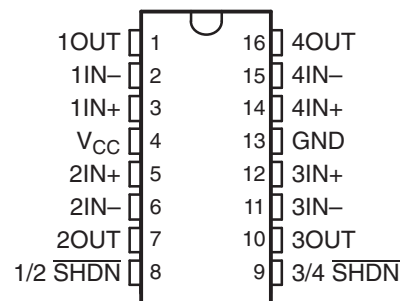
The LMV321, LMV358, LMV324, and LMV324S are the most cost-effective solutions for applications where low-voltage operation, space saving, and low cost are needed. These amplifiers are designed specifically for low-voltage (2.7 V to 5 V) operation, with performance specifications meeting or exceeding the 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/ $\mu\text{s}$  slew rate.

The LMV321 is available in the ultra-small DCK (SC-70) package, which is approximately one-half the size of the DBV (SOT-23) package. This package saves space on printed circuit boards and enables the design of small portable electronic devices. It also allows the designer to place the device closer to the signal source to reduce noise pickup and increase signal integrity.

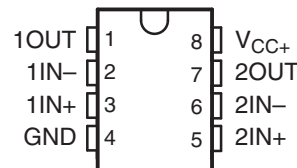
LMV324 ... D (SOIC) OR PW (TSSOP) PACKAGE  
(TOP VIEW)



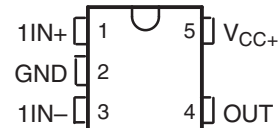
LMV324S ... D (SOIC) OR PW (TSSOP) PACKAGE  
(TOP VIEW)



LMV358 ... D (SOIC), DDU (VSSOP),  
DGK (MSOP), OR PW (TSSOP) PACKAGE  
(TOP VIEW)



LMV321 ... DBV (SOT-23) OR DCK (SC-70) PACKAGE  
(TOP VIEW)



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

**LMV321 SINGLE, LMV358 DUAL  
LMV324 QUAD, LMV324S QUAD WITH SHUTDOWN  
LOW-VOLTAGE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS**

SLOS263T–AUGUST 1999–REVISED SEPTEMBER 2007

**ORDERING INFORMATION<sup>(1)</sup>**

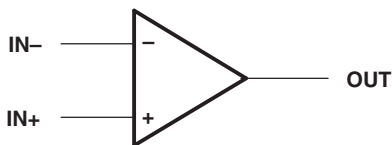
T <sub>A</sub>	PACKAGE <sup>(2)</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING <sup>(3)</sup>	
–40°C to 85°C	Single	SC-70 – DCK	Reel of 3000	LMV321IDCKR	R3_
			Reel of 250	LMV321IDCKT	
		SOT-23 – DBV	Reel of 3000	LMV321IDBVR	RC1_
			Reel of 250	LMV321IDBVT	
	Dual	MSOP/VSSOP – DGK	Reel of 2500	LMV358IDGKR	R5_
			Reel of 250	LMV358IDGKT	PREVIEW
		SOIC – D	Tube of 75	LMV358ID	MV358I
			Reel of 2500	LMV358IDR	
		TSSOP – PW	Tube of 150	LMV358IPW	MV358I
			Reel of 2000	LMV358IPWR	
	VSSOP – DDU	Reel of 3000	LMV358IDDU	RA5_	
	Quad	SOIC – D	Tube of 50	LMV324ID	LMV324I
			Reel of 2500	LMV324IDR	
			Tube of 50	LMV324SID	LMV324SI
Reel of 2500			LMV324SIDR		
TSSOP – PW		Reel of 2000	LMV324IPWR	MV324I	
		Reel of 2000	LMV324SIPWR	MV324SI	
–40°C to 125°C	Dual	MSOP/VSSOP – DGK	Reel of 2500	LMV358QDGKR	RH_
			Reel of 250	LMV358QDGKT	
		SOIC – D	Tube of 75	LMV358QD	MV358Q
			Reel of 2500	LMV358QDR	
	TSSOP – PW	Tube of 150	LMV358QPW	MV358Q	
		Reel of 2000	LMV358QPWR		
	VSSOP – DDU	Reel of 3000	LMV358QDDUR	RAH_	
	Quad	SOIC – D	Tube of 50	LMV324QD	LMV324Q
			Reel of 2500	LMV324QDR	
		TSSOP – PW	Tube of 90	LMV324QPW	MV324Q
Reel of 2000			LMV324QPWR		

(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](http://www.ti.com).

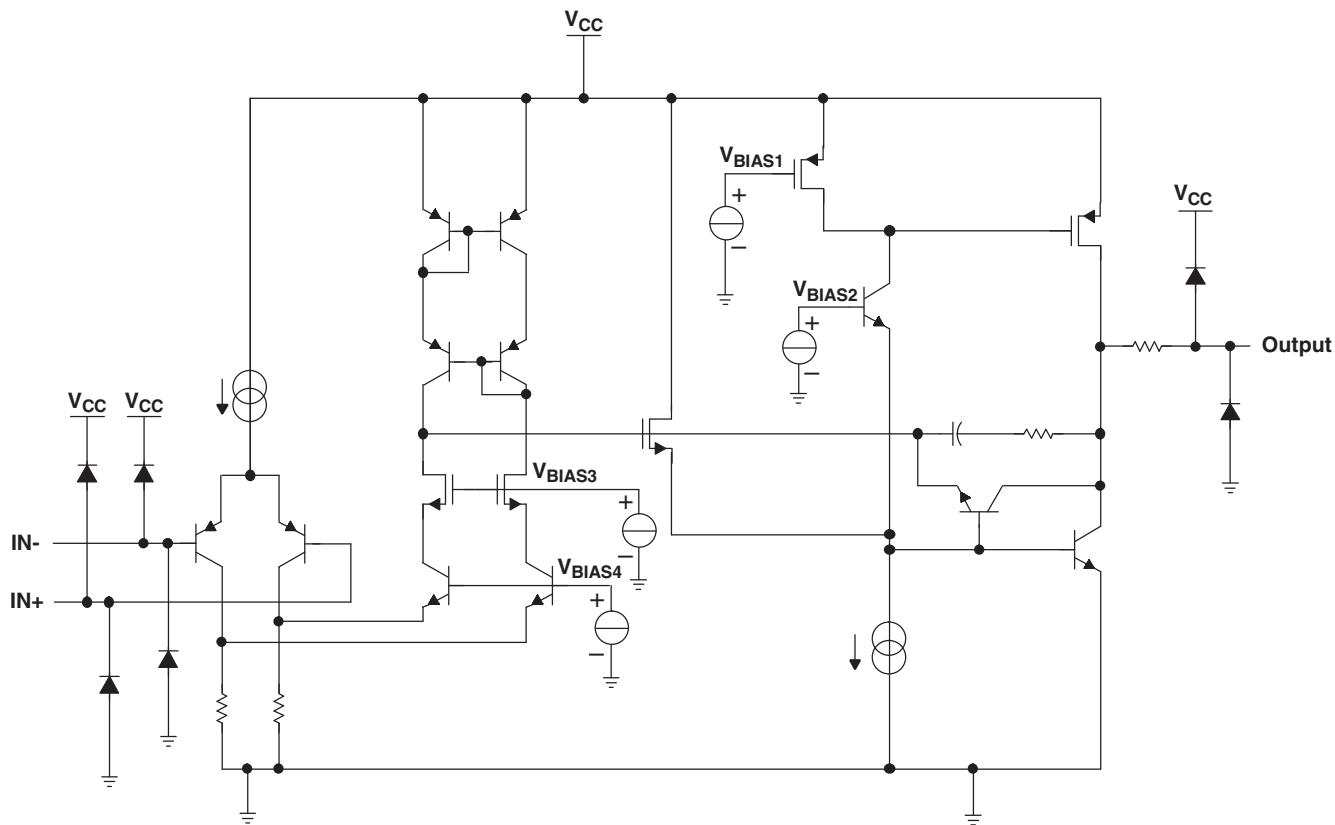
(2) Package drawings, thermal data, and symbolization are available at [www.ti.com/packaging](http://www.ti.com/packaging).

(3) DBV/DCK/DDU/DGK: The actual top-side marking has one additional character that designates the wafer fab/assembly site.

**SYMBOL (EACH AMPLIFIER)**



**LMV324 SIMPLIFIED SCHEMATIC**



# LMV321 SINGLE, LMV358 DUAL LMV324 QUAD, LMV324S QUAD WITH SHUTDOWN LOW-VOLTAGE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS

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## Absolute Maximum Ratings<sup>(1)</sup>

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

		MIN	MAX	UNIT	
V <sub>CC</sub>	Supply voltage <sup>(2)</sup>		5.5	V	
V <sub>ID</sub>	Differential input voltage <sup>(3)</sup>		±5.5	V	
V <sub>I</sub>	Input voltage range (either input)	–0.2	5.5	V	
Duration of output short circuit (one amplifier) to ground <sup>(4)</sup>		At or below T <sub>A</sub> = 25°C, V <sub>CC</sub> ≤ 5.5 V		Unlimited	
θ <sub>JA</sub>	Package thermal impedance <sup>(5)(6)</sup>	D package	8 pin	97	°C/W
			14 pin	86	
			16 pin	73	
		DBV package	5 pin	206	
		DCK package	5 pin	252	
		DDU package	8 pin	TBD	
		DGK package	8 pin	172	
		PW package	8 pin	149	
		14 pin	113		
		16 pin	108		
T <sub>J</sub>	Operating virtual junction temperature		150	°C	
T <sub>stg</sub>	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<sub>CC</sub> specified for the measurement of I<sub>OS</sub>) are with respect to the network GND.
- (3) Differential voltages are at IN+ with respect to IN–.
- (4) Short circuits from outputs to V<sub>CC</sub> can cause excessive heating and eventual destruction.
- (5) Maximum power dissipation is a function of T<sub>J(max)</sub>, θ<sub>JA</sub>, and T<sub>A</sub>. The maximum allowable power dissipation at any allowable ambient temperature is P<sub>D</sub> = (T<sub>J(max)</sub> – T<sub>A</sub>)/θ<sub>JA</sub>. Operating at the absolute maximum T<sub>J</sub> of 150°C can affect reliability.
- (6) The package thermal impedance is calculated in accordance with JESD 51-7.

## Recommended Operating Conditions<sup>(1)</sup>

		MIN	MAX	UNIT
V <sub>CC</sub>	Supply voltage (single-supply operation)	2.7	5.5	V
V <sub>IH</sub>	Amplifier turn-on voltage level (LMV324S) <sup>(2)</sup>	V <sub>CC</sub> = 2.7 V	1.7	V
		V <sub>CC</sub> = 5 V	3.5	
V <sub>IL</sub>	Amplifier turn-off voltage level (LMV324S)	V <sub>CC</sub> = 2.7 V	0.7	V
		V <sub>CC</sub> = 5 V	1.5	
T <sub>A</sub>	Operating free-air temperature	I temperature	–40	°C
		Q temperature	–40	

- (1) All unused control inputs of the device must be held at V<sub>CC</sub> or GND to ensure proper device operation. See the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number [SCBA004](#).
- (2) V<sub>IH</sub> should not be allowed to exceed V<sub>CC</sub>.

## Electrical Characteristics

 $V_{CC+} = 2.7\text{ V}$ ,  $T_A = 25^\circ\text{C}$  (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP <sup>(1)</sup>	MAX	UNIT
$V_{IO}$	Input offset voltage				1.7	7	mV
$\alpha_{VIO}$	Average temperature coefficient of input offset voltage				5		$\mu\text{V}/^\circ\text{C}$
$I_{IB}$	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	$V_{CC} = 2.7\text{ V}$ to 5 V, $V_O = 1\text{ V}$		50	60		dB
$V_{ICR}$	Common-mode input voltage range	CMRR $\geq 50$ dB		0	-0.2		V
					1.9	1.7	
$V_O$	Output swing	$R_L = 10\text{ k}\Omega$ to 1.35 V	High level	$V_{CC} - 100$	$V_{CC} - 10$		mV
			Low level		60	180	
$I_{CC}$	Supply current	LMV321I			80	170	$\mu\text{A}$
		LMV358I (both amplifiers)			140	340	
		LMV324I/LMV324SI (all four amplifiers)			260	680	
$B_1$	Unity-gain bandwidth	$C_L = 200\text{ pF}$			1		MHz
$\Phi_m$	Phase margin				60		deg
$G_m$	Gain margin				10		dB
$V_n$	Equivalent input noise voltage	$f = 1\text{ kHz}$			46		$\text{nV}/\sqrt{\text{Hz}}$
$I_n$	Equivalent input noise current	$f = 1\text{ kHz}$			0.17		$\text{pA}/\sqrt{\text{Hz}}$

(1) Typical values represent the likely parametric nominal values determined at the time of characterization. Typical values depend on the application and configuration and may vary over time. Typical values are not ensured on production material.

## Shutdown Characteristics (LMV324S)

 $V_{CC+} = 2.7\text{ V}$ ,  $T_A = 25^\circ\text{C}$  (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP <sup>(1)</sup>	MAX	UNIT
$I_{CC(\text{SHDN})}$	Supply current in shutdown mode (per channel)	$\overline{\text{SHDN}} \leq 0.6\text{ V}$				5	$\mu\text{A}$
$t_{(\text{on})}$	Amplifier turn-on time	$A_V = 1$ , $R_L = \text{Open}$ (measured at 50% point)			2		$\mu\text{s}$
$t_{(\text{off})}$	Amplifier turn-off time	$A_V = 1$ , $R_L = \text{Open}$ (measured at 50% point)			40		ns

(1) Typical values represent the likely parametric nominal values determined at the time of characterization. Typical values depend on the application and configuration and may vary over time. Typical values are not ensured on production material.

# LMV321 SINGLE, LMV358 DUAL LMV324 QUAD, LMV324S QUAD WITH SHUTDOWN LOW-VOLTAGE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS

SLOS263T–AUGUST 1999–REVISED SEPTEMBER 2007

## Electrical Characteristics

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

PARAMETER		TEST CONDITIONS		$T_A$ (1)	MIN	TYP(2)	MAX	UNIT	
$V_{IO}$	Input offset voltage			25°C		1.7	7	mV	
				Full range			9		
$\alpha_{VIO}$	Average temperature coefficient of input offset voltage			25°C		5		$\mu\text{V}/^\circ\text{C}$	
$I_{IB}$	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	$V_{CC} = 2.7\text{ V}$ to 5 V, $V_O = 1\text{ V}$ , $V_{CM} = 1\text{ V}$		25°C	50	60		dB	
$V_{ICR}$	Common-mode input voltage range	CMRR $\geq 50\text{ dB}$		25°C	0	-0.2		V	
						4.2	4		
$V_O$	Output swing	$R_L = 2\text{ k}\Omega$ 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		
		$R_L = 10\text{ k}\Omega$ to 2.5 V	High level	High level	25°C	$V_{CC} - 100$	$V_{CC} - 10$		
					Full range		$V_{CC} - 200$		
			Low level	Low level	25°C		65		180
					Full range				280
$A_{VD}$	Large-signal differential voltage gain	$R_L = 2\text{ k}\Omega$		25°C	15	100		V/mV	
				Full range		10			
$I_{OS}$	Output short-circuit current	Sourcing, $V_O = 0\text{ V}$		25°C	5	60		mA	
		Sinking, $V_O = 5\text{ V}$			10	160			
$I_{CC}$	Supply current	LMV321I		25°C		130	250	$\mu\text{A}$	
				Full range			350		
		LMV358I (both amplifiers)		25°C		210	440		
				Full range			615		
		LMV324I/LMV324SI (all four amplifiers)		25°C		410	830		
				Full range			1160		
$B_1$	Unity-gain bandwidth	$C_L = 200\text{ pF}$		25°C		1		MHz	
$\Phi_m$	Phase margin			25°C		60		deg	
$G_m$	Gain margin			25°C		10		dB	
$V_n$	Equivalent input noise voltage	$f = 1\text{ kHz}$		25°C		39		$\text{nV}/\sqrt{\text{Hz}}$	
$I_n$	Equivalent input noise current	$f = 1\text{ kHz}$		25°C		0.21		$\text{pA}/\sqrt{\text{Hz}}$	
SR	Slew rate			25°C		1		V/ $\mu\text{s}$	

(1) Full range  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$  for I temperature and  $-40^\circ\text{C}$  to  $125^\circ\text{C}$  for Q temperature.

(2) Typical values represent the likely parametric nominal values determined at the time of characterization. Typical values depend on the application and configuration and may vary over time. Typical values are not ensured on production material.

### Shutdown Characteristics (LMV324S)

$V_{CC+} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$  (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP <sup>(1)</sup>	MAX	UNIT
$I_{CC(SHDN)}$	Supply current in shutdown mode (per channel)	$\overline{SHDN} \leq 0.6\text{ V}$ , $T_A = -40^\circ\text{C}$ to $85^\circ\text{C}$			5	$\mu\text{A}$
$t_{(on)}$	Amplifier turn-on time	$A_V = 1$ , $R_L = \text{Open}$ (measured at 50% point)		2		$\mu\text{s}$
$t_{(off)}$	Amplifier turn-off time	$A_V = 1$ , $R_L = \text{Open}$ (measured at 50% point)		40		ns

- (1) Typical values represent the likely parametric nominal values determined at the time of characterization. Typical values depend on the application and configuration and may vary over time. Typical values are not ensured on production material.

TYPICAL CHARACTERISTICS

LMV321 FREQUENCY RESPONSE  
 VS  
 RESISTIVE LOAD

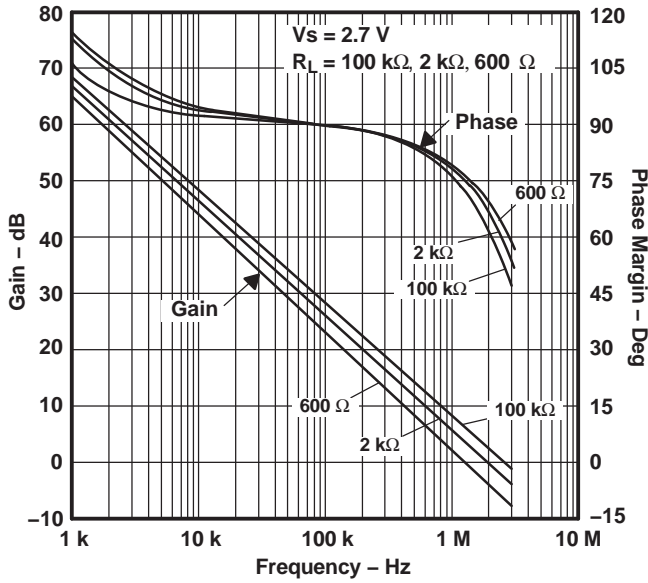


Figure 1.

LMV321 FREQUENCY RESPONSE  
 VS  
 RESISTIVE LOAD

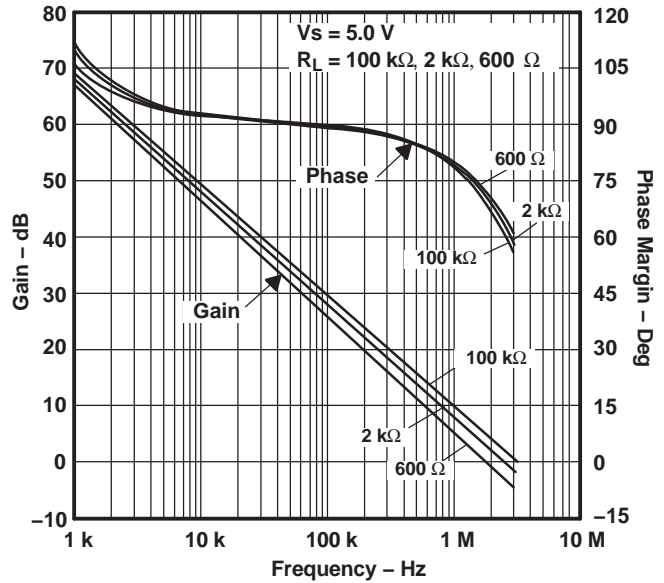


Figure 2.

LMV321 FREQUENCY RESPONSE  
 VS  
 CAPACITIVE LOAD

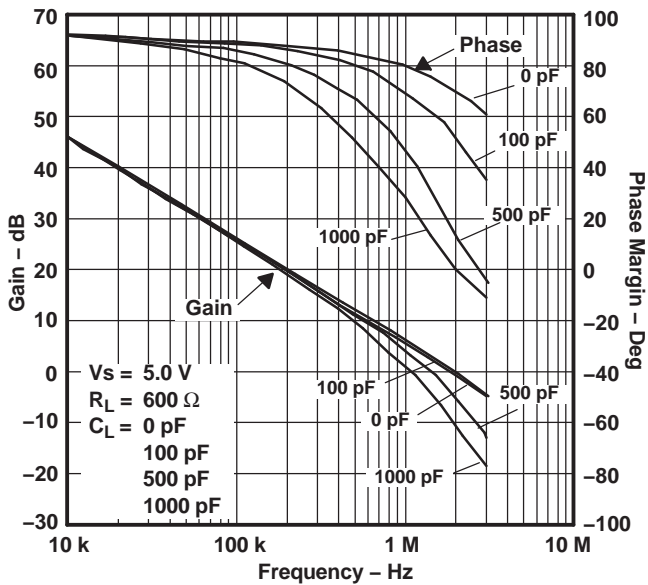


Figure 3.

LMV321 FREQUENCY RESPONSE  
 VS  
 CAPACITIVE LOAD

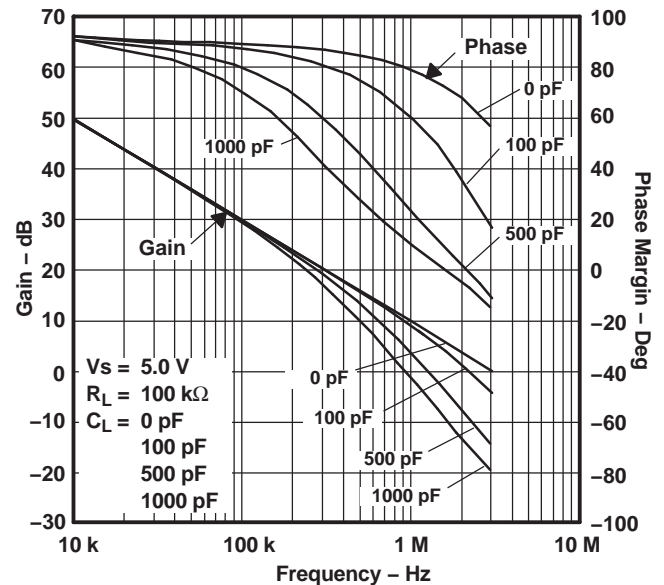


Figure 4.



TYPICAL CHARACTERISTICS (continued)

LMV321 FREQUENCY RESPONSE  
VS  
TEMPERATURE

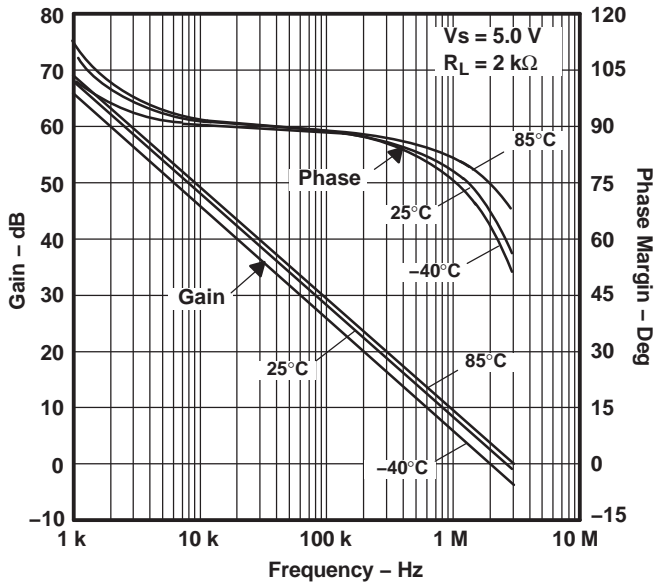


Figure 5.

STABILITY

VS  
CAPACITIVE LOAD

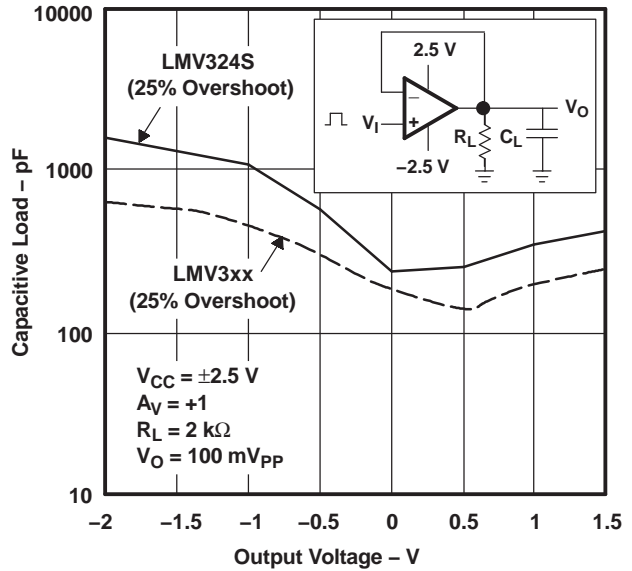


Figure 6.

STABILITY  
VS  
CAPACITIVE LOAD

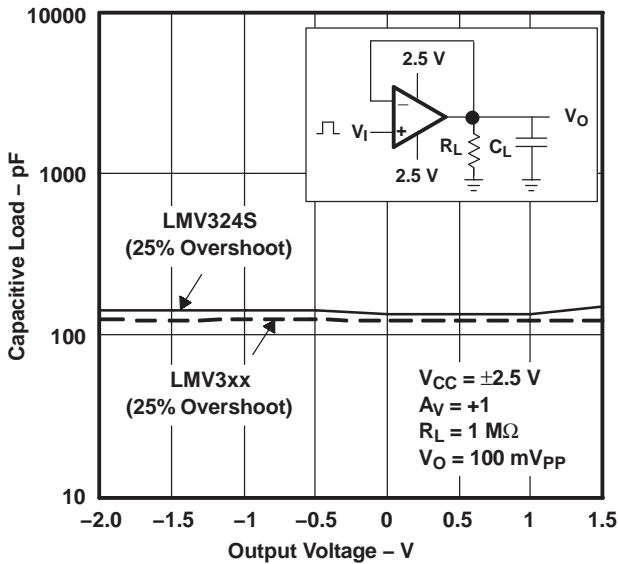


Figure 7.

STABILITY  
VS  
CAPACITIVE LOAD

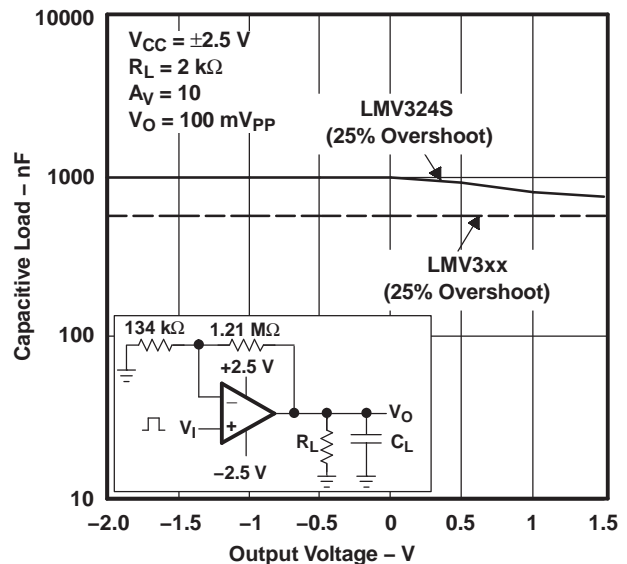
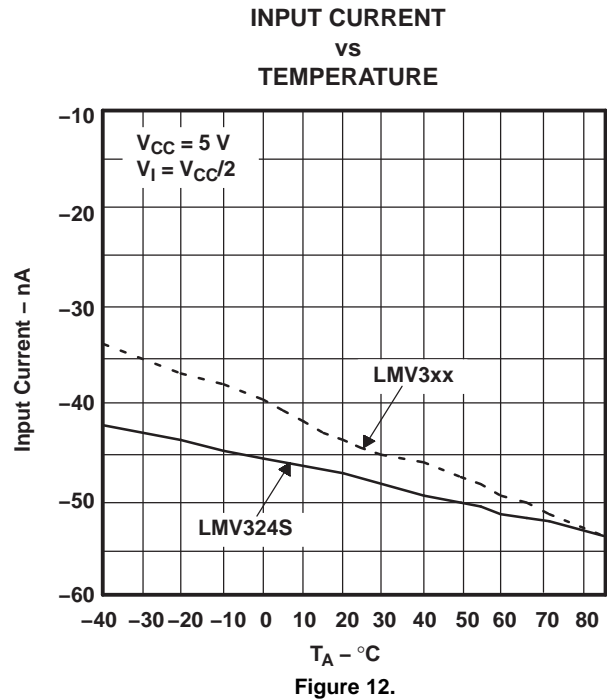
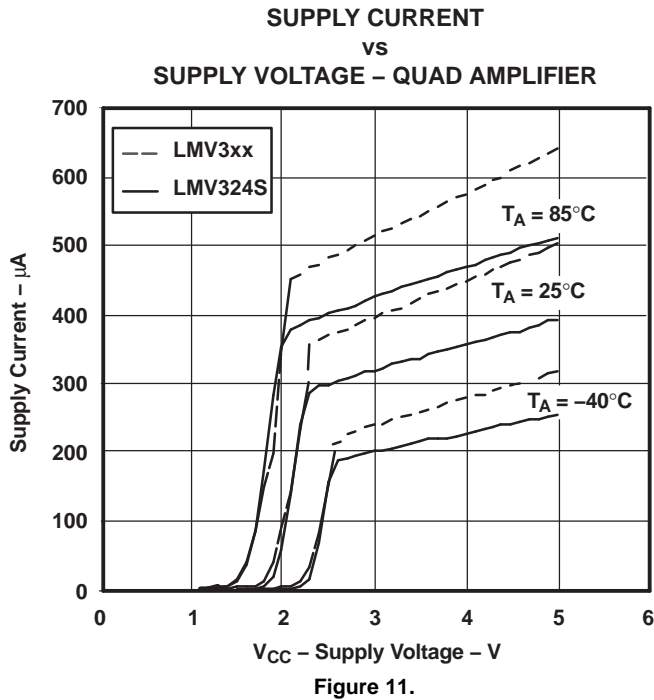
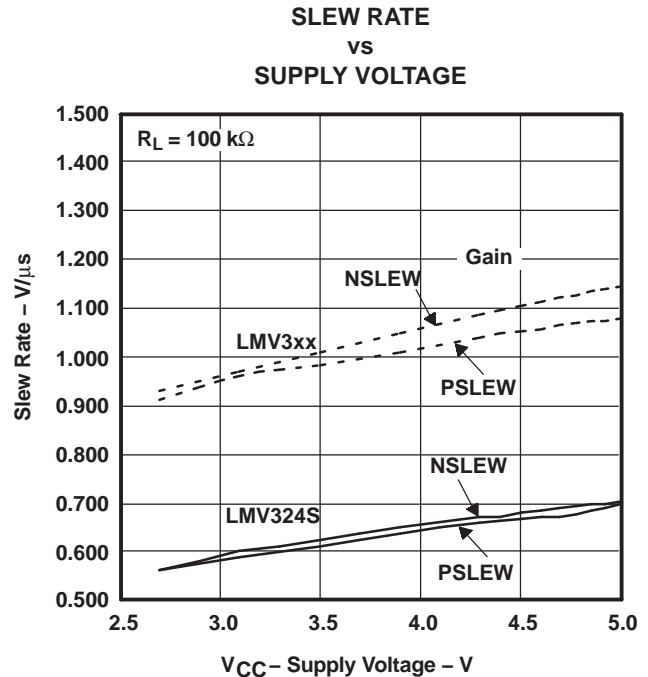
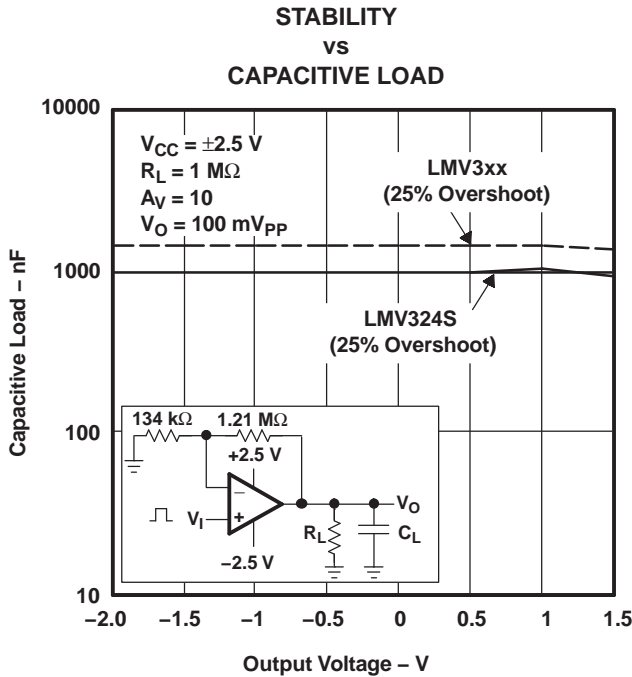
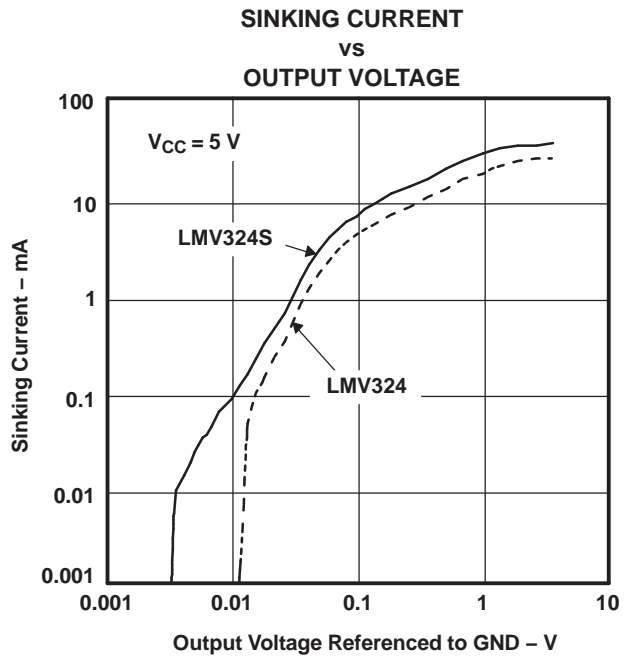
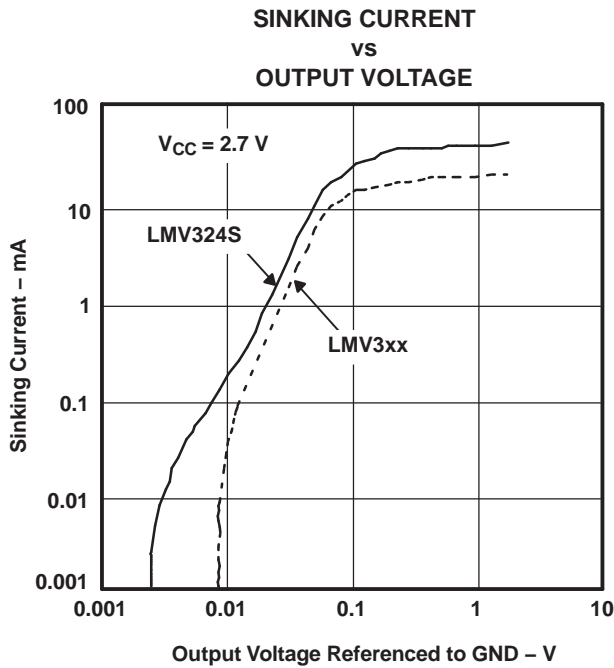
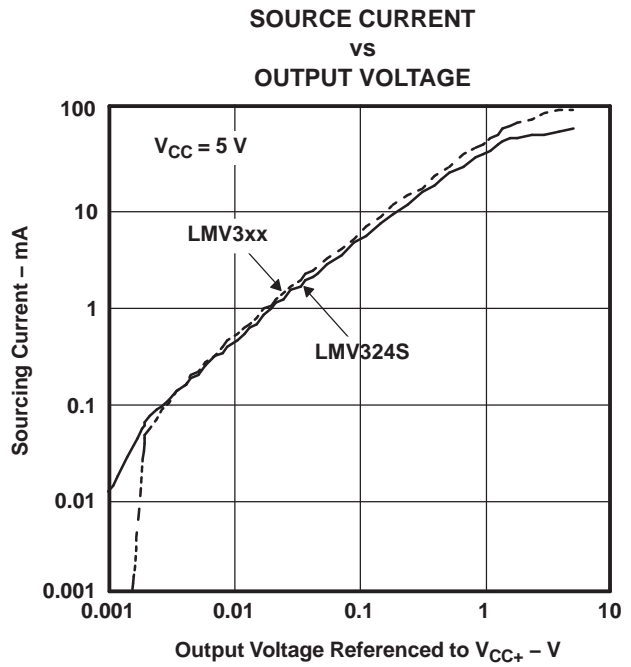
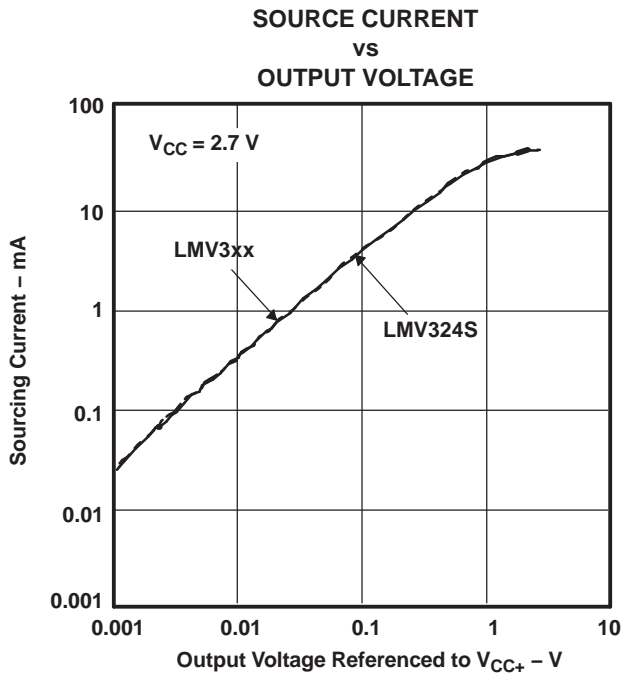


Figure 8.

TYPICAL CHARACTERISTICS (continued)



**TYPICAL CHARACTERISTICS (continued)**



TYPICAL CHARACTERISTICS (continued)

SHORT-CIRCUIT CURRENT  
 vs  
 TEMPERATURE

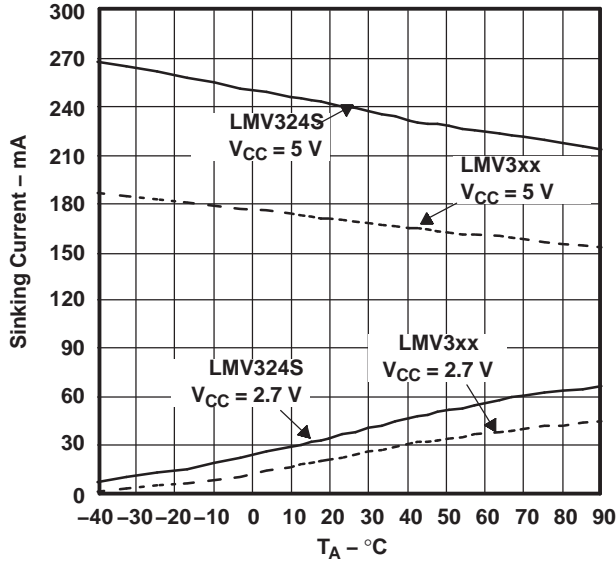


Figure 17.

SHORT-CIRCUIT CURRENT  
 vs  
 TEMPERATURE

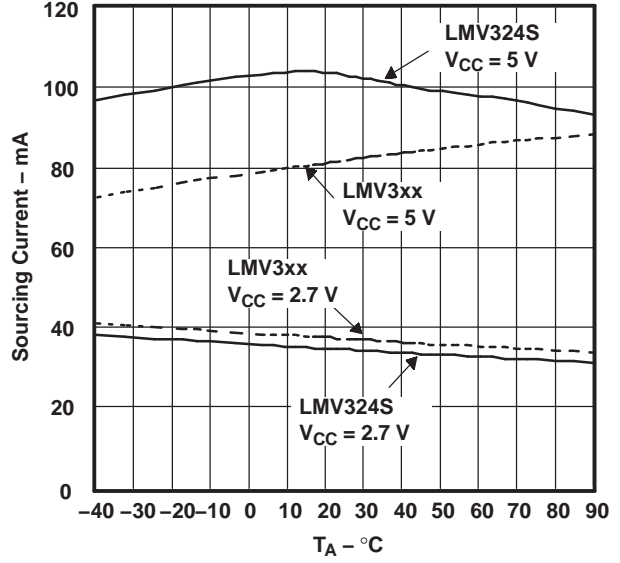


Figure 18.

-k<sub>SVR</sub>  
 vs  
 FREQUENCY

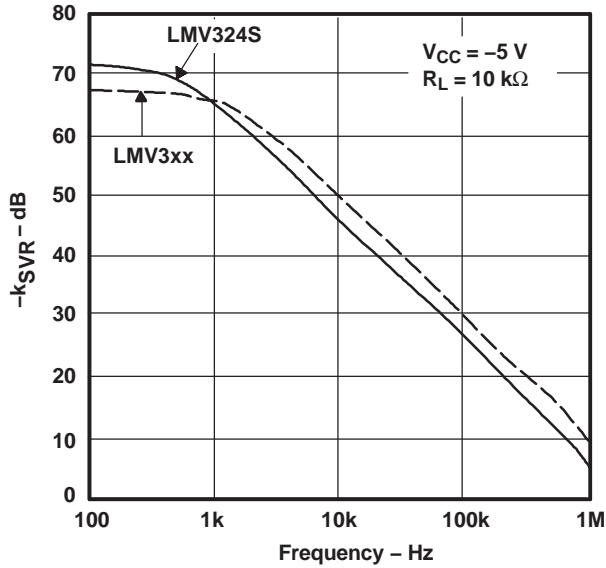


Figure 19.

+k<sub>SVR</sub>  
 vs  
 FREQUENCY

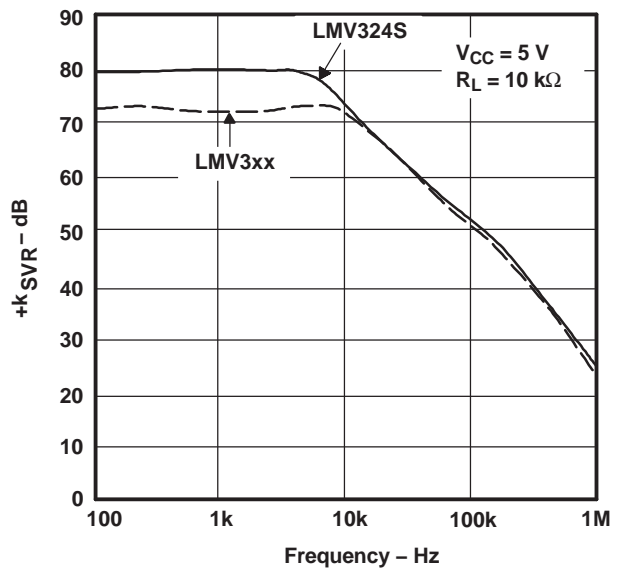
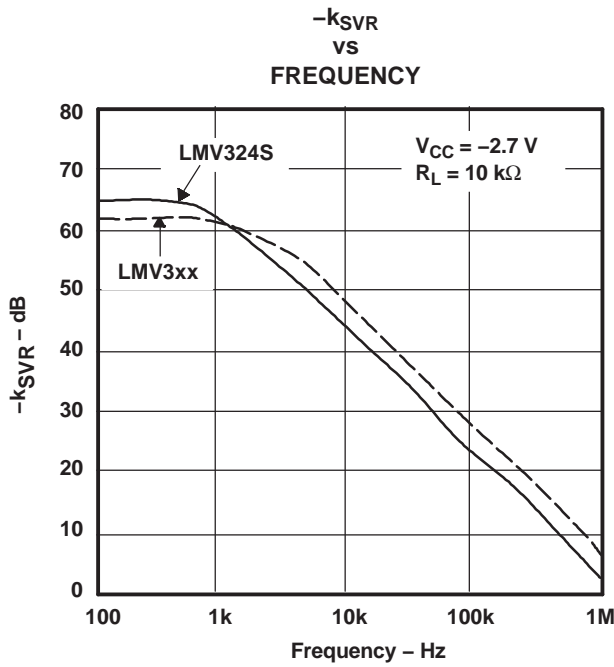
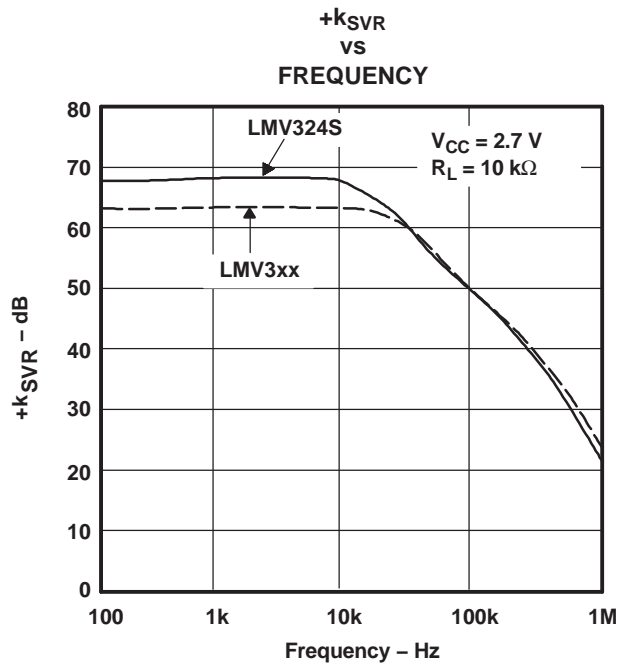
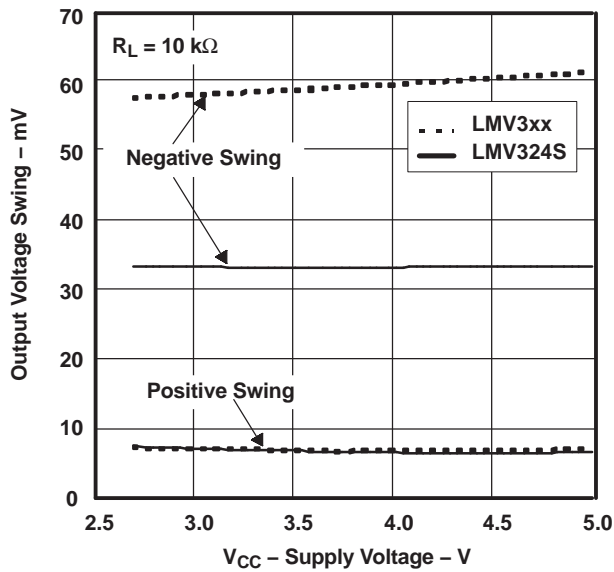


Figure 20.

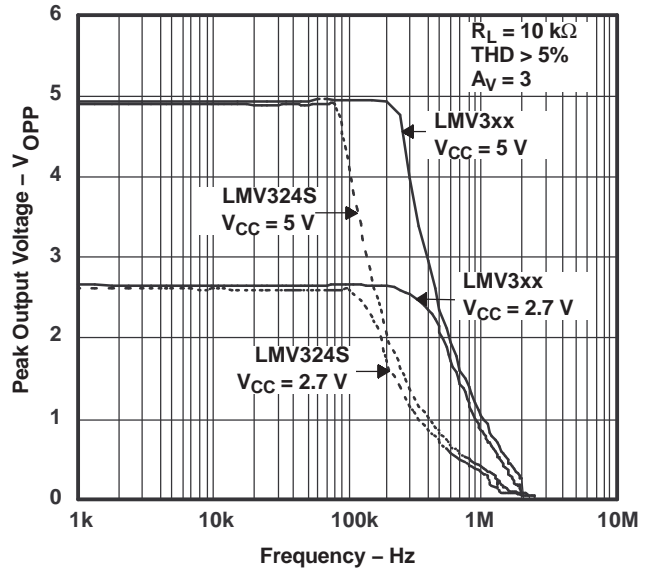
**TYPICAL CHARACTERISTICS (continued)**



**OUTPUT VOLTAGE SWING FROM RAILS**  
 VS  
**SUPPLY VOLTAGE**



**OUTPUT VOLTAGE**  
 VS  
**FREQUENCY**



TYPICAL CHARACTERISTICS (continued)

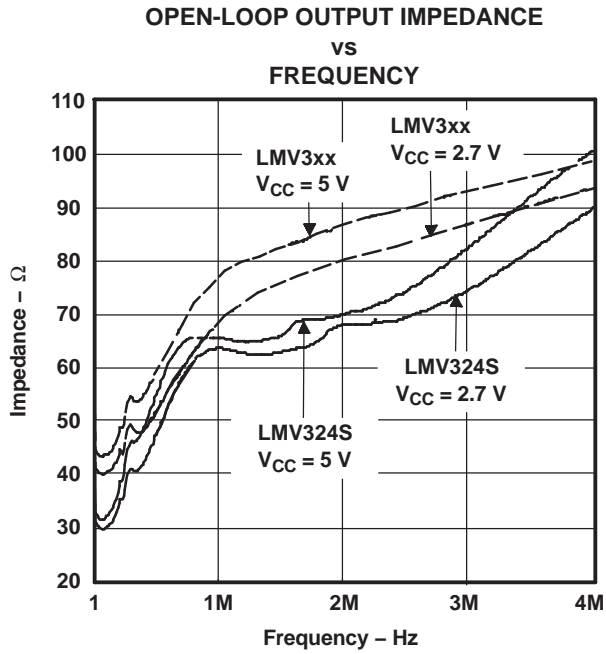


Figure 25.

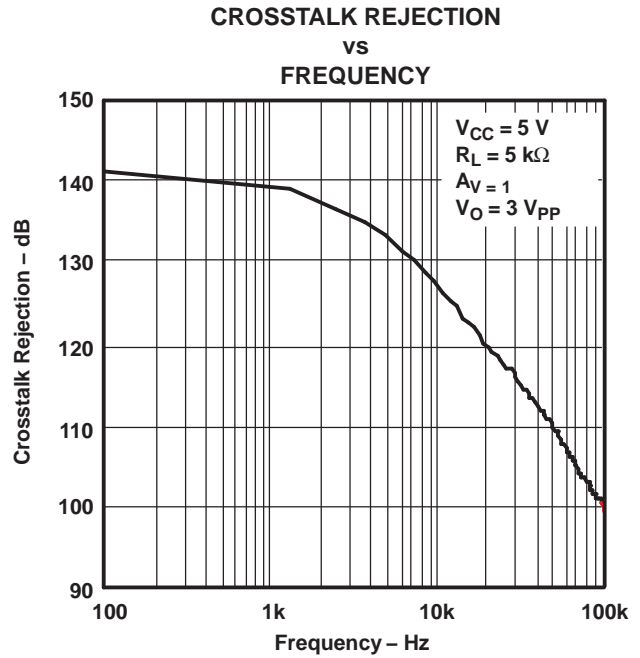


Figure 26.

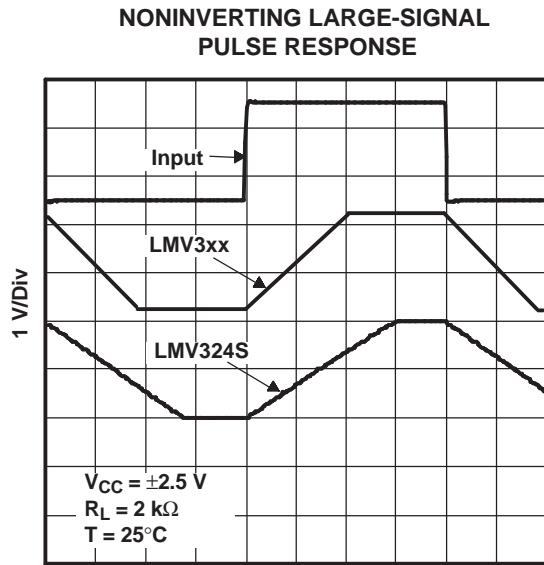


Figure 27.

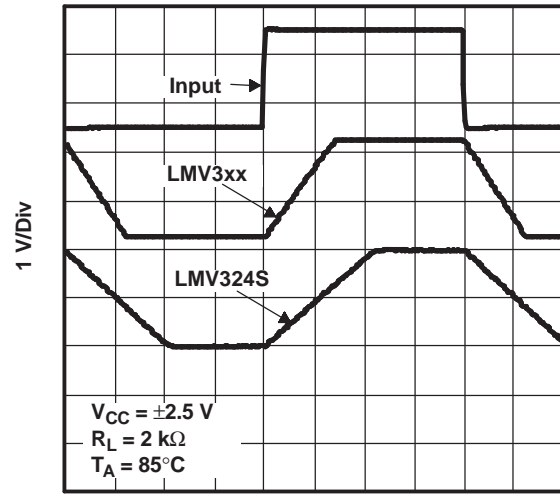
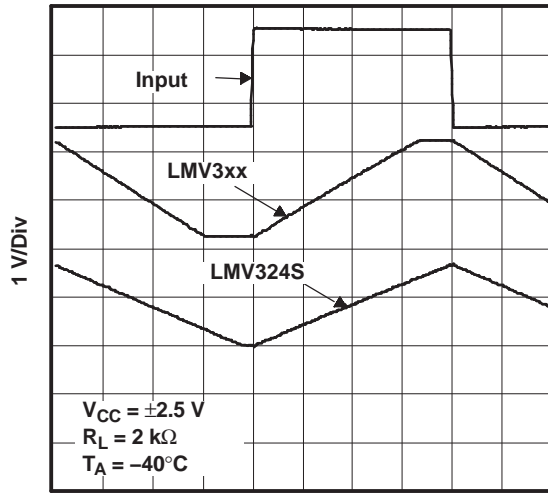


Figure 28.

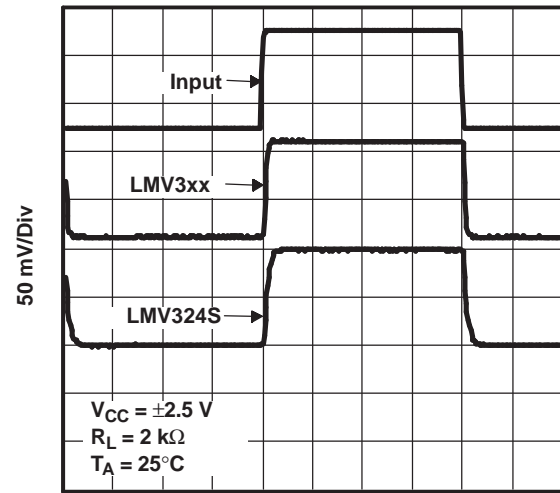
**TYPICAL CHARACTERISTICS (continued)**

**NONINVERTING LARGE-SIGNAL PULSE RESPONSE**



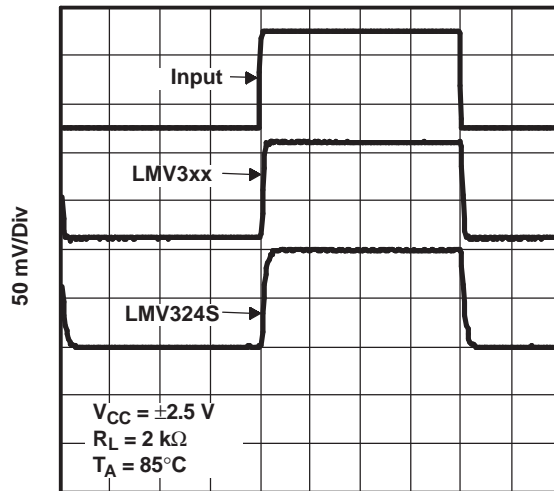
1  $\mu\text{s}/\text{Div}$   
Figure 29.

**NONINVERTING SMALL-SIGNAL PULSE RESPONSE**



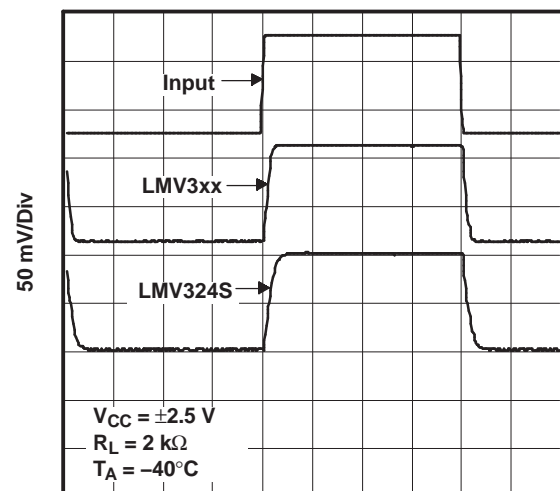
1  $\mu\text{s}/\text{Div}$   
Figure 30.

**NONINVERTING SMALL-SIGNAL PULSE RESPONSE**



1  $\mu\text{s}/\text{Div}$   
Figure 31.

**NONINVERTING SMALL-SIGNAL PULSE RESPONSE**



1  $\mu\text{s}/\text{Div}$   
Figure 32.

TYPICAL CHARACTERISTICS (continued)

INVERTING LARGE-SIGNAL  
 PULSE RESPONSE

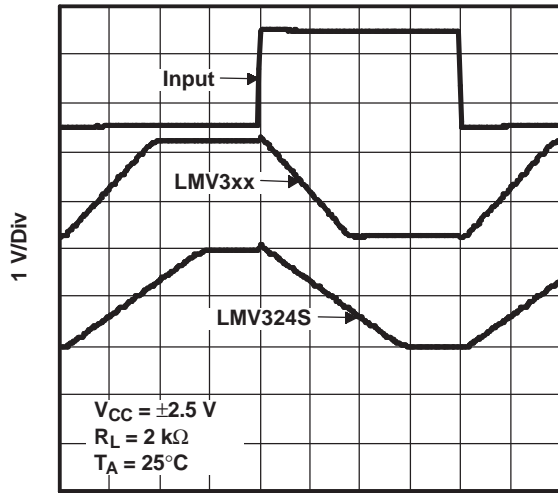


Figure 33.

INVERTING LARGE-SIGNAL  
 PULSE RESPONSE

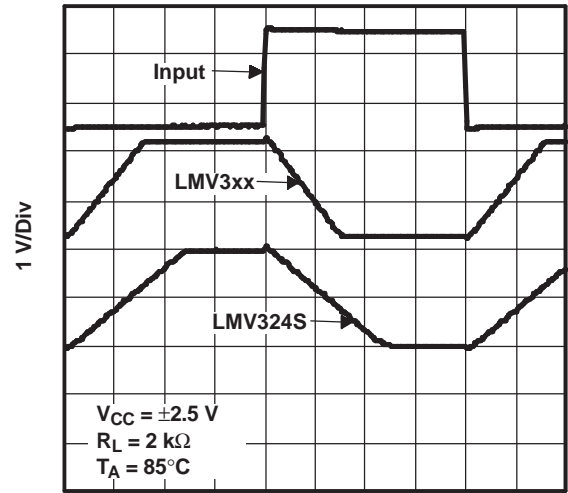


Figure 34.

INVERTING LARGE-SIGNAL  
 PULSE RESPONSE

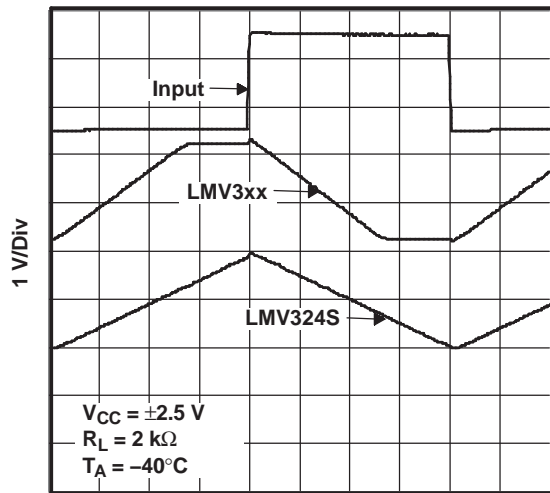


Figure 35.

INVERTING SMALL-SIGNAL  
 PULSE RESPONSE

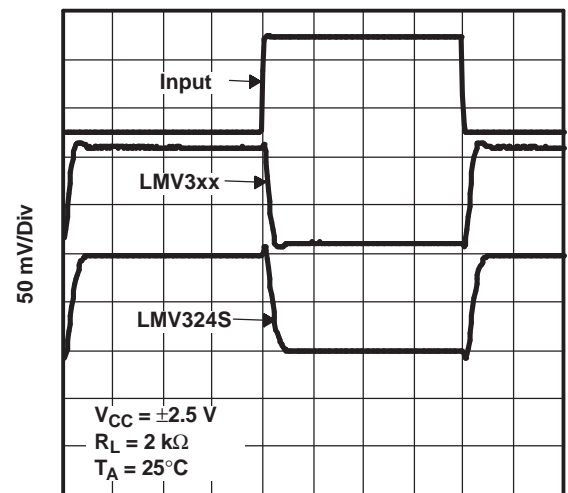
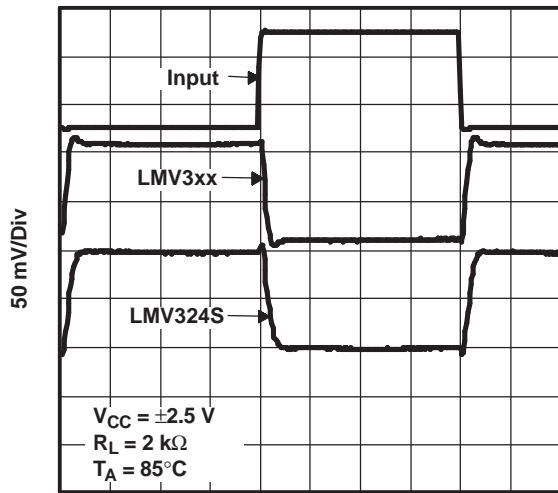


Figure 36.



**TYPICAL CHARACTERISTICS (continued)**

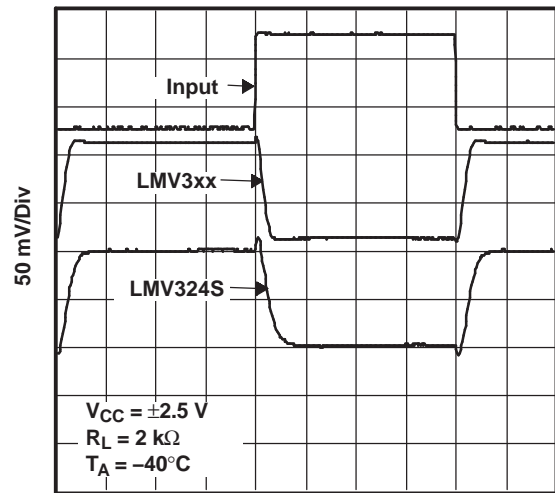
**INVERTING SMALL-SIGNAL PULSE RESPONSE**



1 μs/Div

Figure 37.

**INVERTING SMALL-SIGNAL PULSE RESPONSE**



1 μs/Div

Figure 38.

**INPUT CURRENT NOISE vs FREQUENCY**

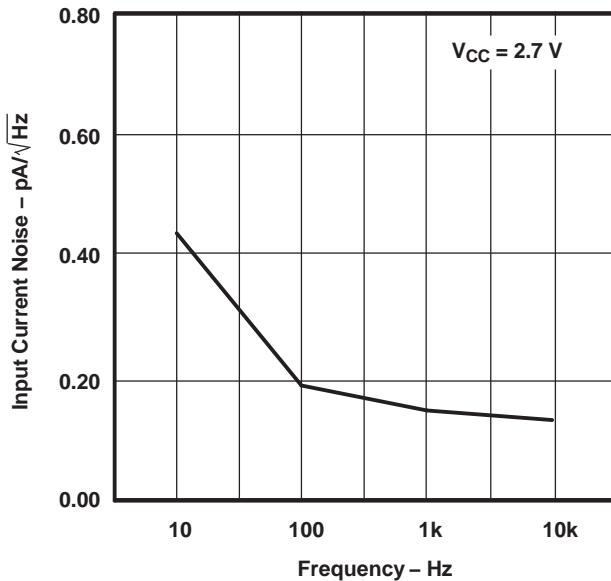


Figure 39.

**INPUT CURRENT NOISE vs FREQUENCY**

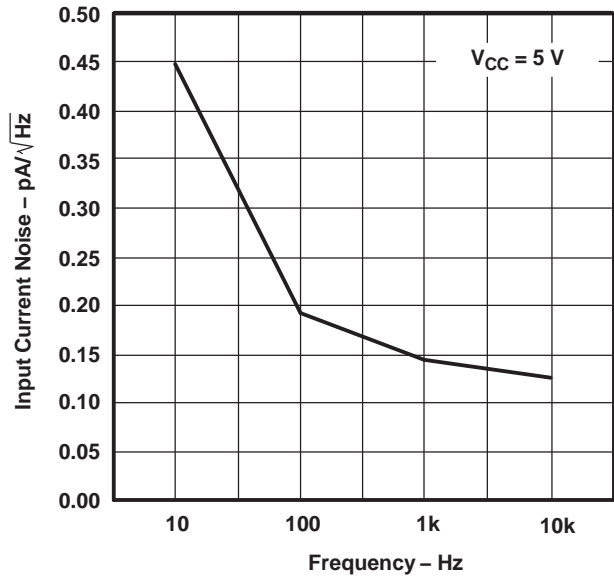
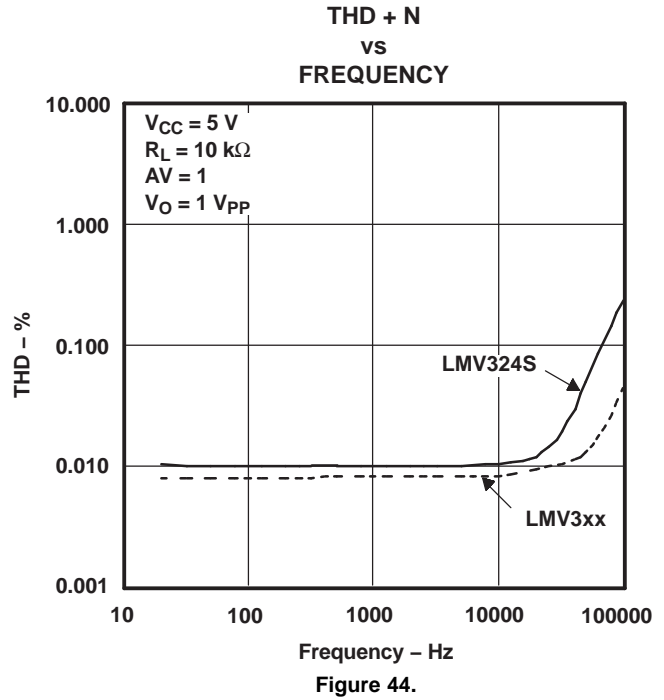
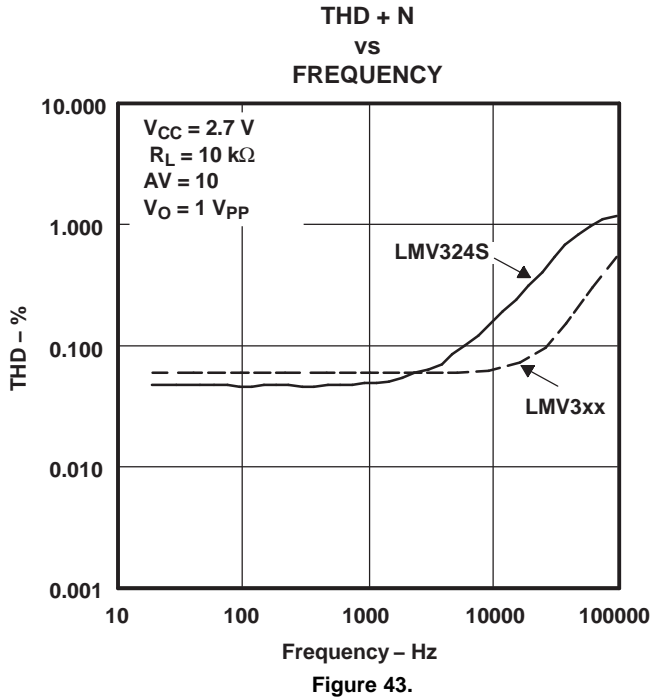
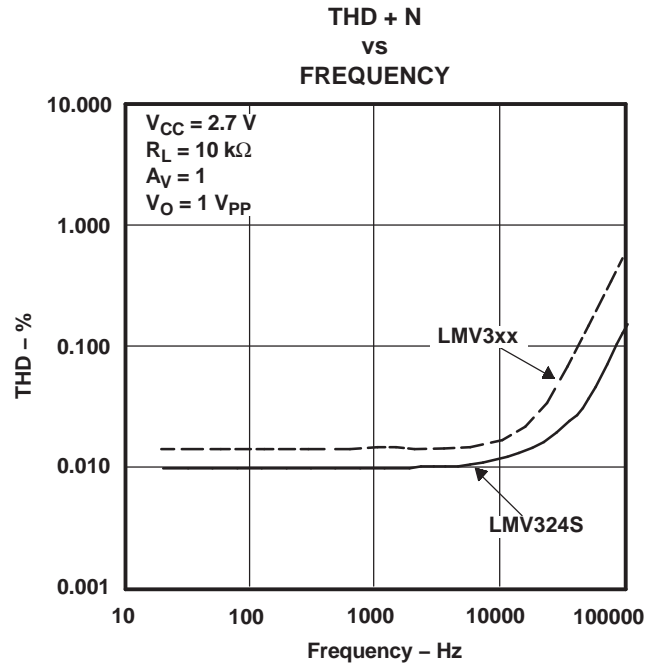
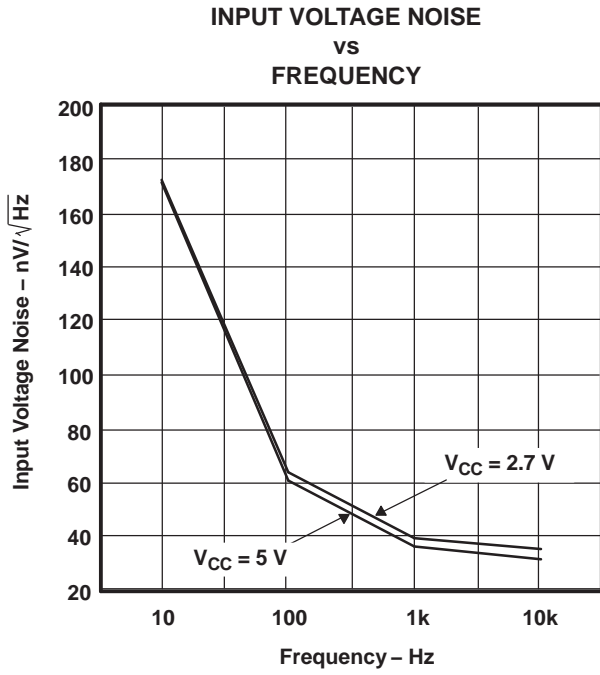
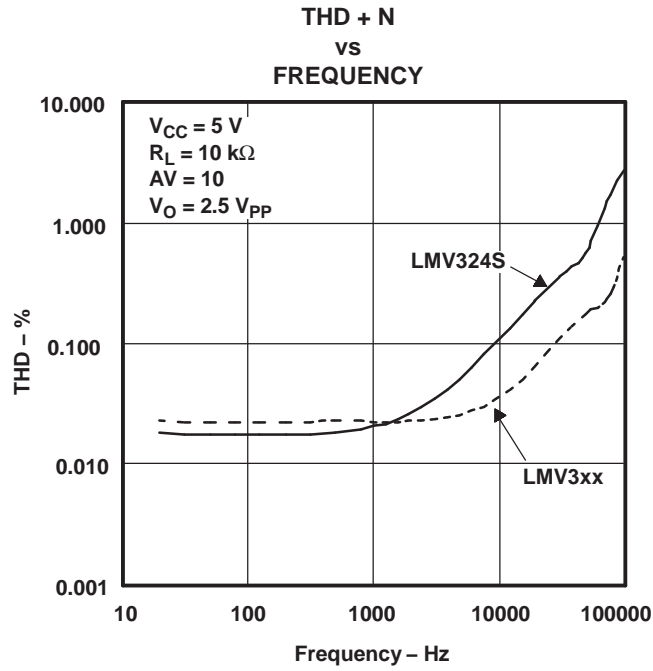


Figure 40.

TYPICAL CHARACTERISTICS (continued)



**TYPICAL CHARACTERISTICS (continued)**



**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
LMV321IDBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV321IDBVRG4	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV321IDBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV321IDBVTE4	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV321IDBVTG4	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV321IDCKR	ACTIVE	SC70	DCK	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV321IDCKRG4	ACTIVE	SC70	DCK	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV321IDCKT	ACTIVE	SC70	DCK	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV321IDCKTE4	ACTIVE	SC70	DCK	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV321IDCKTG4	ACTIVE	SC70	DCK	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV324ID	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV324IDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV324IDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV324IDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV324IPWR	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV324IPWRG4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV324QD	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV324QDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV324QDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV324QDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV324QPW	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV324QPWE4	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV324QPWG4	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV324QPWR	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV324QPWRG4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
LMV324SID	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV324SIDE4	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV324SIDG4	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV324SIDR	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV324SIDRE4	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV324SIDRG4	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV324SIPWR	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV324SIPWRE4	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV324SIPWRG4	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358ID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358IDDUR	ACTIVE	VSSOP	DDU	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358IDDURE4	ACTIVE	VSSOP	DDU	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358IDDURG4	ACTIVE	VSSOP	DDU	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358IDE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358IDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358IDGKR	ACTIVE	MSOP	DGK	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358IDGKRG4	ACTIVE	MSOP	DGK	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358IDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358IDRE4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358IDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358IPW	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358IPWE4	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358IPWG4	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358IPWR	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358IPWRE4	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358IPWRG4	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
LMV358QD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358QDDUR	ACTIVE	VSSOP	DDU	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358QDDURE4	ACTIVE	VSSOP	DDU	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358QDDURG4	ACTIVE	VSSOP	DDU	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358QDE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358QDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358QDGKR	ACTIVE	MSOP	DGK	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358QDGKRG4	ACTIVE	MSOP	DGK	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358QDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358QDRE4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358QDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358QPW	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358QPWE4	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358QPWG4	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358QPWR	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358QPWRE4	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV358QPWRG4	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

<sup>(1)</sup> 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.

<sup>(2)</sup> 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)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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**TAPE AND REEL INFORMATION**



**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**



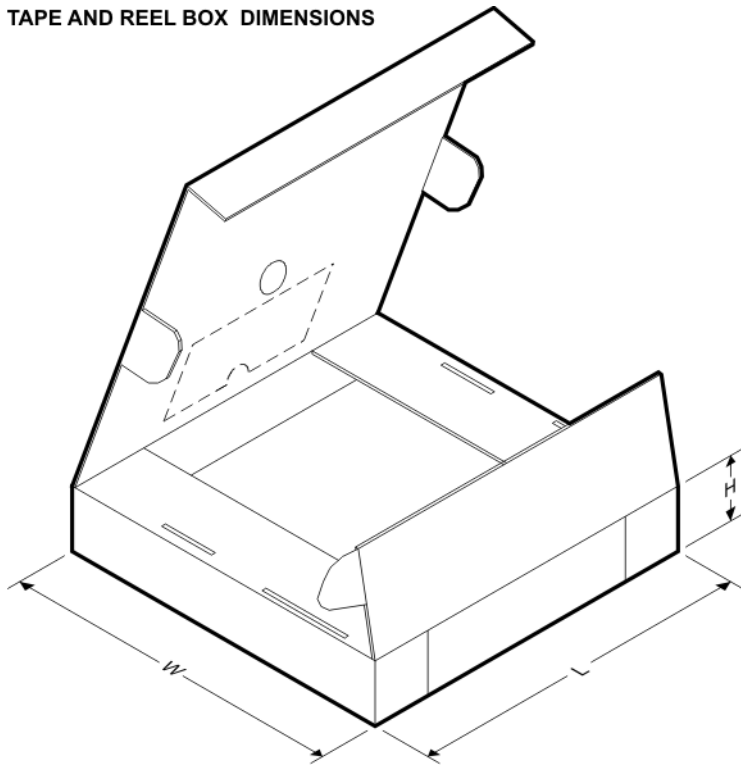
\*All dimensions are nominal

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
LMV321IDBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
LMV321IDBVR	SOT-23	DBV	5	3000	180.0	9.2	3.23	3.17	1.37	4.0	8.0	Q3
LMV321IDBVT	SOT-23	DBV	5	250	180.0	9.2	3.23	3.17	1.37	4.0	8.0	Q3
LMV321IDCKR	SC70	DCK	5	3000	178.0	9.0	2.4	2.5	1.2	4.0	8.0	Q3
LMV321IDCKR	SC70	DCK	5	3000	180.0	9.2	2.24	2.34	1.22	4.0	8.0	Q3
LMV321IDCKR	SC70	DCK	5	3000	180.0	9.2	2.24	2.34	1.22	4.0	8.0	Q3
LMV321IDCKT	SC70	DCK	5	250	180.0	9.2	2.24	2.34	1.22	4.0	8.0	Q3
LMV321IDCKT	SC70	DCK	5	250	180.0	9.2	2.24	2.34	1.22	4.0	8.0	Q3
LMV321IDCKT	SC70	DCK	5	250	178.0	9.0	2.4	2.5	1.2	4.0	8.0	Q3
LMV324IDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
LMV324IPWR	TSSOP	PW	14	2000	330.0	12.4	7.0	5.6	1.6	8.0	12.0	Q1
LMV324QDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
LMV324QPWR	TSSOP	PW	14	2000	330.0	12.4	7.0	5.6	1.6	8.0	12.0	Q1
LMV324SIDR	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1
LMV324SIPWR	TSSOP	PW	16	2000	330.0	12.4	7.0	5.6	1.6	8.0	12.0	Q1
LMV358IDDUR	VSSOP	DDU	8	3000	180.0	9.2	2.25	3.35	1.05	4.0	8.0	Q3
LMV358IDGKR	MSOP	DGK	8	2500	330.0	12.4	5.3	3.3	1.3	8.0	12.0	Q1
LMV358IDGKR	MSOP	DGK	8	2500	330.0	13.0	5.3	3.4	1.4	8.0	12.0	Q1



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
LMV358IDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
LMV358IDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
LMV358IPWR	TSSOP	PW	8	2000	330.0	12.4	7.0	3.6	1.6	8.0	12.0	Q1
LMV358QDDUR	VSSOP	DDU	8	3000	180.0	9.2	2.25	3.35	1.05	4.0	8.0	Q3
LMV358QDGKR	MSOP	DGK	8	2500	330.0	13.0	5.3	3.4	1.4	8.0	12.0	Q1
LMV358QDGKR	MSOP	DGK	8	2500	330.0	12.4	5.3	3.3	1.3	8.0	12.0	Q1
LMV358QDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
LMV358QPWR	TSSOP	PW	8	2000	330.0	12.4	7.0	3.6	1.6	8.0	12.0	Q1

**TAPE AND REEL BOX DIMENSIONS**



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LMV321IDBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
LMV321IDBVR	SOT-23	DBV	5	3000	205.0	200.0	33.0
LMV321IDBVT	SOT-23	DBV	5	250	205.0	200.0	33.0
LMV321IDCKR	SC70	DCK	5	3000	180.0	180.0	18.0
LMV321IDCKR	SC70	DCK	5	3000	202.0	201.0	28.0
LMV321IDCKR	SC70	DCK	5	3000	205.0	200.0	33.0
LMV321IDCKT	SC70	DCK	5	250	202.0	201.0	28.0
LMV321IDCKT	SC70	DCK	5	250	205.0	200.0	33.0
LMV321IDCKT	SC70	DCK	5	250	180.0	180.0	18.0

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LMV324IDR	SOIC	D	14	2500	346.0	346.0	33.0
LMV324IPWR	TSSOP	PW	14	2000	346.0	346.0	29.0
LMV324QDR	SOIC	D	14	2500	346.0	346.0	33.0
LMV324QPWR	TSSOP	PW	14	2000	346.0	346.0	29.0
LMV324SIDR	SOIC	D	16	2500	333.2	345.9	28.6
LMV324SIPWR	TSSOP	PW	16	2000	346.0	346.0	29.0
LMV358IDDUR	VSSOP	DDU	8	3000	202.0	201.0	28.0
LMV358IDGKR	MSOP	DGK	8	2500	370.0	355.0	55.0
LMV358IDGKR	MSOP	DGK	8	2500	358.0	335.0	35.0
LMV358IDR	SOIC	D	8	2500	340.5	338.1	20.6
LMV358IDR	SOIC	D	8	2500	346.0	346.0	29.0
LMV358IPWR	TSSOP	PW	8	2000	346.0	346.0	29.0
LMV358QDDUR	VSSOP	DDU	8	3000	202.0	201.0	28.0
LMV358QDGKR	MSOP	DGK	8	2500	358.0	335.0	35.0
LMV358QDGKR	MSOP	DGK	8	2500	370.0	355.0	55.0
LMV358QDR	SOIC	D	8	2500	340.5	338.1	20.6
LMV358QPWR	TSSOP	PW	8	2000	346.0	346.0	29.0

DBV (R-PDSO-G5)

PLASTIC SMALL-OUTLINE PACKAGE



- 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. Mold flash and protrusion shall not exceed 0.15 per side.
  - D. Falls within JEDEC MO-178 Variation AA.

DCK (R-PDSO-G5)

PLASTIC SMALL-OUTLINE PACKAGE



- 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. Mold flash and protrusion shall not exceed 0.15 per side.
  - D. Falls within JEDEC MO-203 variation AA.

PW (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



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

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.
  - $\triangle C$  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.
  - $\triangle D$  Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
  - E. Reference JEDEC MS-012 variation AA.

D (R-PDSO-G14)

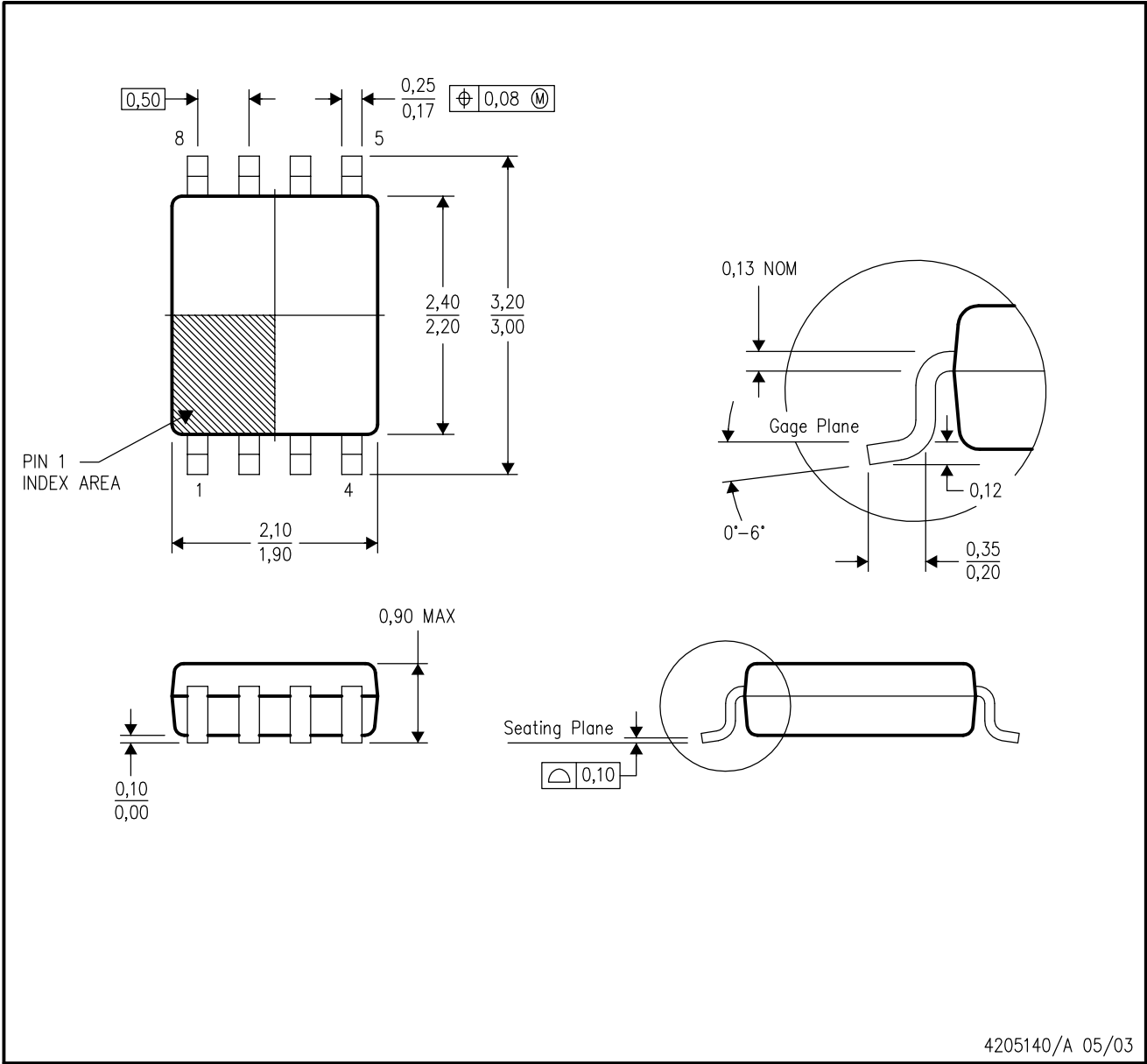
PLASTIC SMALL-OUTLINE PACKAGE



4040047-3/H 11/2006

DDU (R-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE

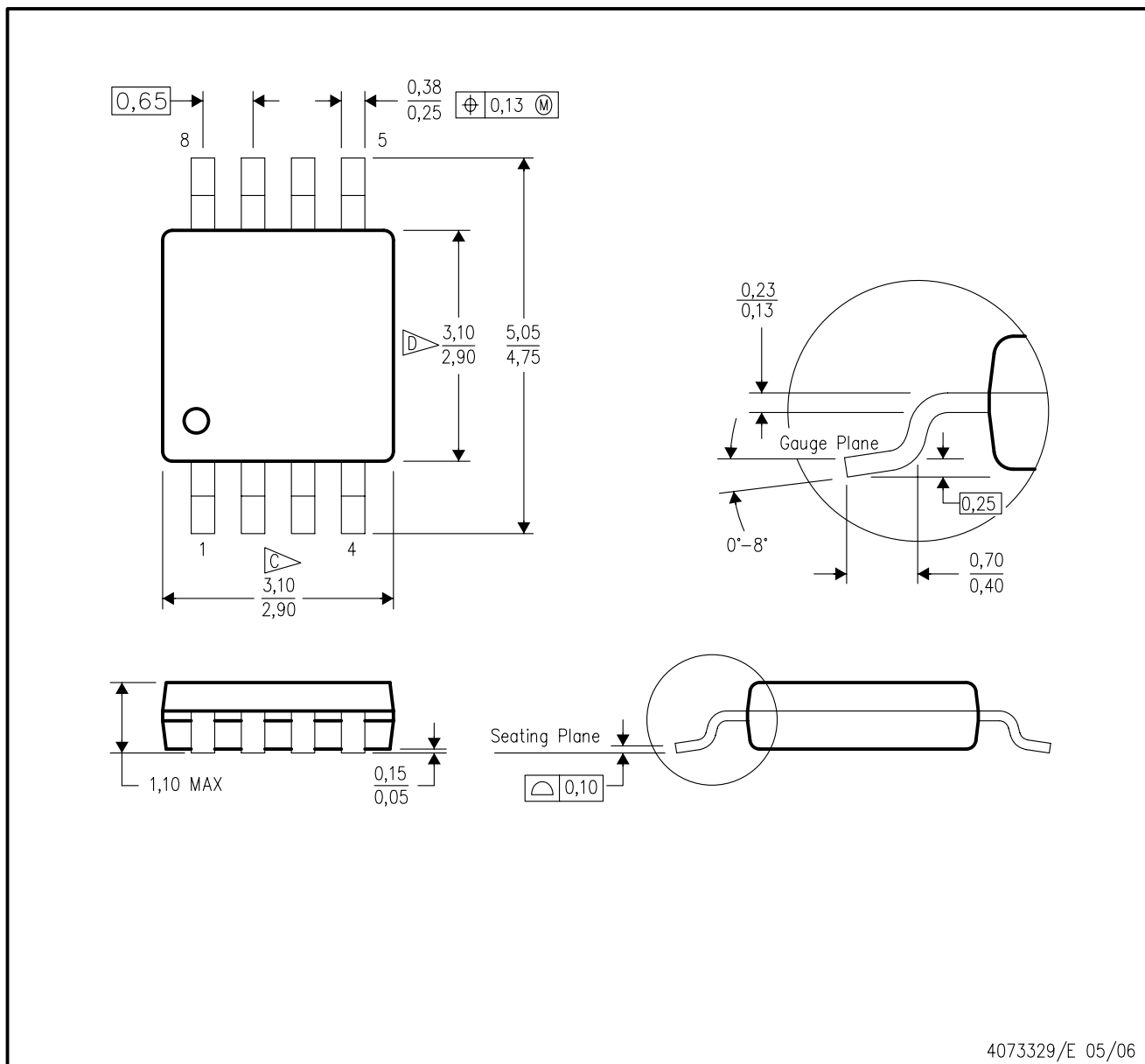


- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion.
  - D. Falls within JEDEC MO-187 variation CA.



DGK (S-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in 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 0.15 per end.
  - D. Body width does not include interlead flash. Interlead flash shall not exceed 0.50 per side.
  - E. Falls within JEDEC MO-187 variation AA, except interlead flash.

D (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 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 AC.

D(R-PDSO-G16)



4209373/A 03/08

- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Refer to IPC7351 for alternate board design.
  - 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
  - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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