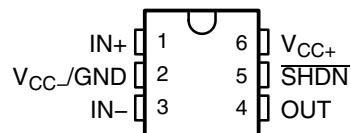


# LMV981 SINGLE, LMV982 DUAL 1.8-V OPERATIONAL AMPLIFIERS WITH RAIL-TO-RAIL INPUT AND OUTPUT AND SHUTDOWN

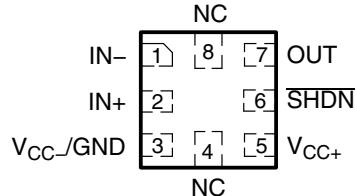
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- **1.8-V, 2.7-V, and 5-V Specifications**
- **Rail-to-Rail Output Swing**
  - 600- $\Omega$  Load . . . 80 mV From Rail
  - 2-k $\Omega$  Load . . . 30 mV From Rail
- $V_{ICR}$  . . . 200 mV Beyond Rails
- **Gain Bandwidth . . . 1.4 MHz**
- **Supply Current . . . 100  $\mu$ A/Amplifier**
- **Max  $V_{IO}$  . . . 4 mV**
- **Turn-On Time From Shutdown . . . 8.4  $\mu$ s**
- **Space-Saving Packages**
  - LMV981: SOT-23-6, SC-70, and QFN
  - LMV982: MSOP and VSSOP
- **Applications**
  - Industrial (Utility/Energy Metering)
  - Automotive
  - Communications (Optical Telecom, Data/Voice Cable Modems)
  - Consumer Electronics (PDAs, PCs, CDR/W, Portable Audio)
  - Supply-Current Monitoring
  - Battery Monitoring

## LMV981 . . . DBV (SOT23-6) OR DCK (SC-70) PACKAGE (TOP VIEW)

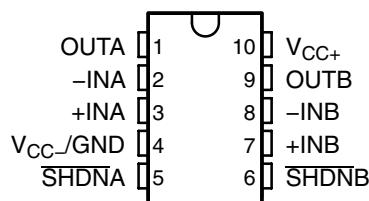


## LMV981 . . . RUG (QFN) PACKAGE (TOP VIEW)



NC – No internal connection

## LMV982 . . . DGS (VSSOP/MSOP) PACKAGE (TOP VIEW)



## description/ordering information

The LMV981 and LMV982 devices are low-voltage, low-power operational amplifiers that are well suited for today's low-voltage and/or portable applications. Specified for operation of 1.8 V to 5 V, they can be used in portable applications that are powered from a single-cell Li-ion or two-cell batteries. They have rail-to-rail input and output capability for maximum signal swings in low-voltage applications. The LMV98x input common-mode voltage extends 200 mV beyond the rails for increased flexibility. The output can swing rail-to-rail unloaded and typically can reach 80 mV from the rails, while driving a 600- $\Omega$  load (at 1.8-V operation).

## ORDERING INFORMATION<sup>†</sup>

$T_A$	PACKAGE <sup>‡</sup>			ORDERABLE PART NUMBER	TOP-SIDE MARKING <sup>§</sup>
-40°C to 125°C	Single	QFN (RUG)	Reel of 3000	LMV981IRUGR	R7
		SOT-23 (DBV)	Reel of 3000	LMV981IDBVR	RBA_
			Reel of 250	LMV981IDBVT	PREVIEW
		SC-70 (DCK)	Reel of 3000	LMV981IDCKR	R7_
	Dual		Reel of 250	LMV981IDCKT	PREVIEW
		MSOP/VSSOP (DGS)	Reel of 2500	LMV982IDGSR	RCB
			Reel of 250	LMV982IDGST	

<sup>†</sup> 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).

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

<sup>§</sup> DBV/DCK: The actual top-side marking has one additional character that designates the wafer fab/assembly site.



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# LMV981 SINGLE, LMOV982 DUAL 1.8-V OPERATIONAL AMPLIFIERS WITH RAIL-TO-RAIL INPUT AND OUTPUT AND SHUTDOWN

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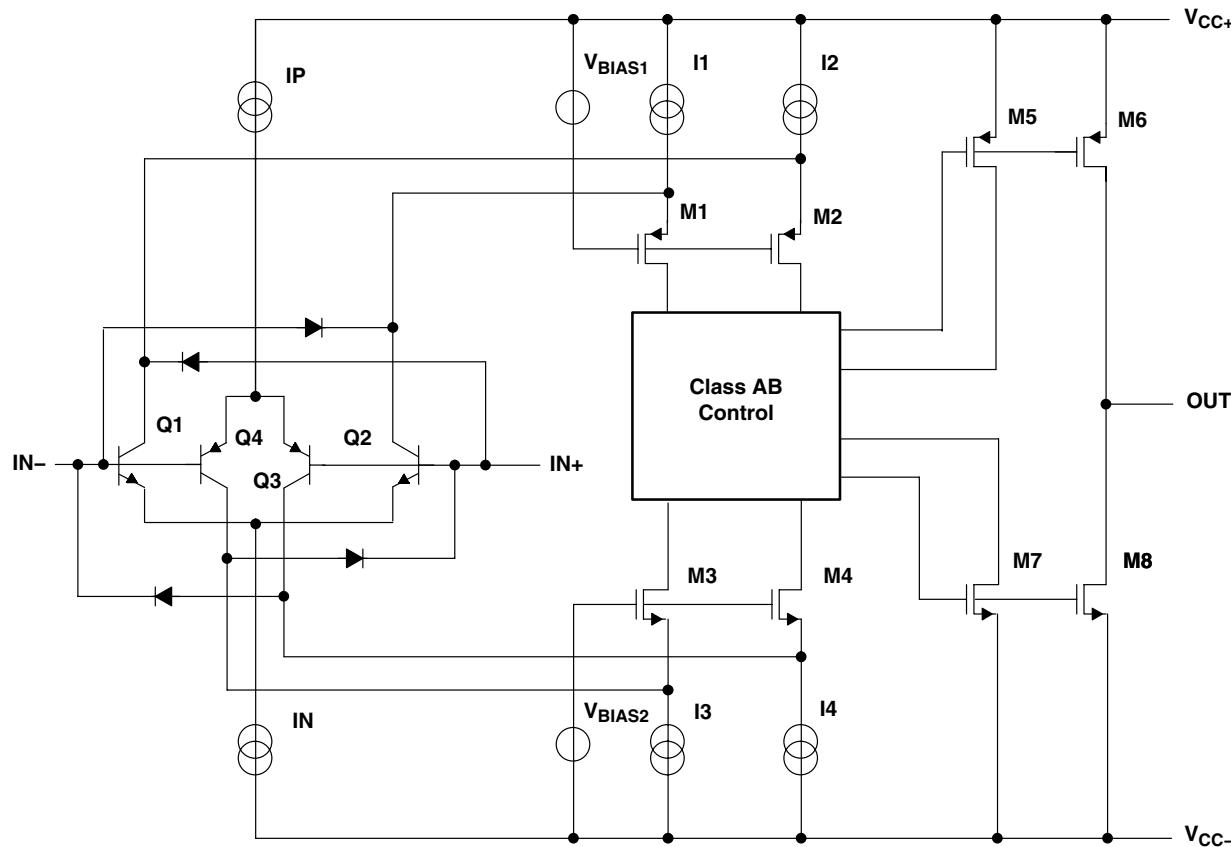
## description/ordering information (continued)

The LMOV981 and LMOV982 devices offer shutdown capability for additional power savings. Pulling the SHDN pin low puts the amplifiers in shutdown, where only  $0.156\ \mu\text{A}$  typically is consumed from a 1.8-V supply. In normal operation with the same 1.8-V supply, the devices typically consume a quiescent current of  $103\ \mu\text{A}$  per channel, and yet they are able to achieve excellent electrical specifications, such as 101-dB open-loop DC gain and 1.4-MHz-gain bandwidth. Furthermore, the amplifiers offer good output drive characteristics, with the ability to drive a  $600\text{-}\Omega$  load and  $1000\text{-}\text{pF}$  capacitance, with minimal ringing.

The LMOV981 and LMOV982 devices are offered in the latest packaging technology to meet the most demanding space-constraint applications. The LMOV981 is offered in standard SOT-23 and SC-70 packages. The LMOV982 is available in the 10-pin MSOP package.

The LMOV98x devices are characterized for operation from  $-40^\circ\text{C}$  to  $125^\circ\text{C}$ , making them universally suited for commercial, industrial, and automotive applications.

## simplified schematic



**LMV981 SINGLE, LMV982 DUAL  
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**absolute maximum ratings over free-air temperature range (unless otherwise noted)**

Supply voltage, $V_{CC+} - V_{CC-}$ (see Note 1)	.....	5.5 V
Differential input voltage, $V_{ID}$ (see Note 2)	.....	Supply voltage
Input voltage range, $V_I$ (either input)	.....	$V_{CC-} - 0.2$ V to $V_{CC+} + 0.2$ V
Duration of output short circuit (one amplifier) to $V_{CC\pm}$ (see Notes 3 and 4)	.....	Unlimited
Package thermal impedance, $\theta_{JA}$ (see Notes 4 and 5):	DBV package	165°C/W
	DCK package	259°C/W
	DGS package	165°C/W
	RUG package	253°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. Applies to both single-supply and split-supply operation. Continuous short-circuit operation at elevated ambient temperature can result in exceeding the maximum-allowed junction temperature of 150°C. Output currents in excess of 45 mA over long term may adversely affect reliability.
4. Maximum power dissipation is a function of  $T_J(max)$ ,  $\theta_{JA}$ , 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
$V_{CC}$	Supply voltage ( $V_{CC+} - V_{CC-}$ )	1.8	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

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**electrical characteristics at  $T_A = 25^\circ\text{C}$ ,  $V_{CC+} = 1.8 \text{ V}$ ,  $V_{CC-} = 0 \text{ V}$ ,  $V_{IC} = V_{CC}/2$ ,  $V_O = V_{CC}/2$ ,  $R_L > 1 \text{ M}\Omega$ , and SHDN tied to  $V_{CC+}$  (unless otherwise noted)**

PARAMETER		TEST CONDITIONS	$T_A$	MIN	TYP	MAX	UNIT
$V_{IO}$	Input offset voltage LMV981 (single)	25°C		1	4		mV
		Full range			6		
	LMV982 (dual)	25°C		1	5.5		
		Full range			7.5		
$\alpha_{V_{IO}}$	Average temperature coefficient of input offset voltage		25°C		5.5		$\mu\text{V}/^\circ\text{C}$
$I_{IB}$	Input bias current $V_{IC} = V_{CC+} - 0.8 \text{ V}$	25°C		15	35		nA
		25°C			65		
		Full range			75		
$I_{IO}$	Input offset current	25°C		13	25		nA
		Full range			40		
$I_{CC}$	Supply current (per channel)	25°C		103	185		$\mu\text{A}$
		Full range			205		
		LMV981	25°C	0.156	1		
			Full range		2		
		LM982	25°C	0.178	3.5		
			Full range		5		
CMRR	Common-mode rejection ratio	$0 \leq V_{IC} \leq 0.6 \text{ V}$ , $1.4 \text{ V} \leq V_{IC} \leq 1.8 \text{ V}$	25°C	60	78		dB
			$-40^\circ\text{C}$ to $85^\circ\text{C}$	55			
		$0.2 \text{ V} \leq V_{IC} \leq 0.6 \text{ V}$ , $1.4 \text{ V} \leq V_{IC} \leq 1.6 \text{ V}$	$-40^\circ\text{C}$ to $125^\circ\text{C}$	55			
			25°C	50	72		
$k_{SVR}$	Supply-voltage rejection ratio	$1.8 \text{ V} \leq V_{CC+} \leq 5 \text{ V}$ , $V_{IC} = 0.5 \text{ V}$	25°C	75	100		dB
			Full range	70			
$V_{ICR}$	Common-mode input voltage range	CMRR $\geq 50 \text{ dB}$	25°C	$V_{CC-} - 0.2$	$-0.2$ to $2.1$	$V_{CC+} + 0.2$	V
			$-40^\circ\text{C}$ to $85^\circ\text{C}$	$V_{CC-}$		$V_{CC+}$	
			$-40^\circ\text{C}$ to $125^\circ\text{C}$	$V_{CC-} + 0.2$		$V_{CC+} - 0.2$	
$A_V$	Large-signal voltage gain	LMV981	$R_L = 600 \Omega$ to $0.9 \text{ V}$ , $V_O = 0.2 \text{ V}$ to $1.6 \text{ V}$ , $V_{IC} = 0.5 \text{ V}$	25°C	77	101	dB
				Full range	73		
			$R_L = 2 \text{ k}\Omega$ to $0.9 \text{ V}$ , $V_O = 0.2 \text{ V}$ to $1.6 \text{ V}$ , $V_{IC} = 0.5 \text{ V}$	25°C	80	105	
				Full range	75		
		LMV982	$R_L = 600 \Omega$ to $0.9 \text{ V}$ , $V_O = 0.2 \text{ V}$ to $1.6 \text{ V}$ , $V_{IC} = 0.5 \text{ V}$	25°C	75	90	
				Full range	72		
			$R_L = 2 \text{ k}\Omega$ to $0.9 \text{ V}$ , $V_O = 0.2 \text{ V}$ to $1.6 \text{ V}$ , $V_{IC} = 0.5 \text{ V}$	25°C	78	100	
				Full range	75		



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**electrical characteristics at  $T_A = 25^\circ\text{C}$ ,  $V_{CC+} = 1.8 \text{ V}$ ,  $V_{CC-} = 0 \text{ V}$ ,  $V_{IC} = V_{CC+}/2$ ,  $V_O = V_{CC+}/2$ ,  $R_L > 1 \text{ M}\Omega$ , and SHDN tied to  $V_{CC+}$  (unless otherwise noted) (continued)**

PARAMETER		TEST CONDITIONS		$T_A$	MIN	TYP	MAX	UNIT
$V_O$	Output swing	$R_L = 600 \Omega$ to $0.9 \text{ V}$ , $V_{ID} = \pm 100 \text{ mV}$	High level	$25^\circ\text{C}$	1.65	1.72		V
				Full range	1.63			
		$R_L = 2 \text{ k}\Omega$ to $0.9 \text{ V}$ , $V_{ID} = \pm 100 \text{ mV}$	Low level	$25^\circ\text{C}$	0.077	0.105		
				Full range		0.12		
		$R_L = 600 \Omega$ to $0.9 \text{ V}$ , $V_{ID} = \pm 100 \text{ mV}$	High level	$25^\circ\text{C}$	1.75	1.77		
				Full range	1.74			
			Low level	$25^\circ\text{C}$	0.024	0.035		
				Full range		0.04		
$I_{OS}$	Output short-circuit current	$V_O = 0 \text{ V}$ , $V_{ID} = 100 \text{ mV}$	Sourcing	$25^\circ\text{C}$	4	8		mA
				Full range	3.3			
		$V_O = 1.8 \text{ V}$ , $V_{ID} = -100 \text{ mV}$	Sinking	$25^\circ\text{C}$	7	9		
				Full range	5			
$T_{ON}$	Turn-on time from shutdown			$25^\circ\text{C}$		19		$\mu\text{s}$
$V_{SHDN}$	Turn-on voltage to enable part			$25^\circ\text{C}$	1.0			V
	Turn-off voltage				0.55			
GBW	Gain bandwidth product			$25^\circ\text{C}$	1.4			MHz
SR	Slew rate	See Note 6		$25^\circ\text{C}$	0.35			$\text{V}/\mu\text{s}$
$\Phi_m$	Phase margin			$25^\circ\text{C}$	67			deg
	Gain margin			$25^\circ\text{C}$	7			dB
$V_n$	Equivalent input noise voltage	$f = 1 \text{ kHz}$ , $V_{IC} = 0.5 \text{ V}$		$25^\circ\text{C}$	60			$\text{nV}/\sqrt{\text{Hz}}$
$I_n$	Equivalent input noise current	$f = 1 \text{ kHz}$		$25^\circ\text{C}$	0.06			$\text{pA}/\sqrt{\text{Hz}}$
THD	Total harmonic distortion	$f = 1 \text{ kHz}$ , $A_V = 1$ , $R_L = 600 \Omega$ , $V_{ID} = 1 \text{ V}_{PP}$		$25^\circ\text{C}$	0.023			%
	Amp-to-amp isolation	See Note 7		$25^\circ\text{C}$	123			dB

NOTES: 6. Number specified is the slower of the positive and negative slew rates.

7. Input referred,  $V_{CC+} = 5 \text{ V}$  and  $R_L = 100 \text{ k}\Omega$  connected to  $2.5 \text{ V}$ . Each amp is excited in turn with a  $1\text{-kHz}$  signal to produce  $V_O = 3 \text{ V}_{PP}$ .

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**electrical characteristics at  $T_A = 25^\circ\text{C}$ ,  $V_{CC+} = 2.7\text{ V}$ ,  $V_{CC-} = 0\text{ V}$ ,  $V_{IC} = V_{CC+}/2$ ,  $V_O = V_{CC+}/2$ ,  $R_L > 1\text{ M}\Omega$ , and SHDN tied to  $V_{CC+}$  (unless otherwise noted)**

PARAMETER	TEST CONDITIONS	$T_A$	MIN	TYP	MAX	UNIT
$V_{IO}$ Input offset voltage	LMV981 (single)	25°C		1	4	mV
		Full range			6	
	LMV982 (dual)	25°C		1	5.5	
		Full range			7.5	
$\alpha_{V_{IO}}$ Average temperature coefficient of input offset voltage		25°C		5.5		$\mu\text{V}/^\circ\text{C}$
$I_{IB}$ Input bias current	$V_{IC} = V_{CC+} - 0.8\text{ V}$	25°C		15	35	nA
		25°C			65	
		Full range			75	
$I_{IO}$ Input offset current		25°C		8	25	nA
		Full range			40	
$I_{CC}$ Supply current (per channel)		25°C		105	190	$\mu\text{A}$
		Full range			210	
	In shutdown	25°C		0.61	1	
		Full range			2	
	LMV981	25°C		0.101	3.5	
		Full range			5	
CMRR Common-mode rejection ratio	$0 \leq V_{IC} \leq 1.5\text{ V}$ , $2.3\text{ V} \leq V_{IC} \leq 2.7\text{ V}$	25°C		60	81	dB
		$-40^\circ\text{C} \text{ to } 85^\circ\text{C}$		55		
	$0.2 \leq V_{IC} \leq 1.5\text{ V}$ , $2.3\text{ V} \leq V_{IC} \leq 2.5\text{ V}$	$-40^\circ\text{C} \text{ to } 125^\circ\text{C}$		55		
		$-0.2\text{ V} \leq V_{IC} \leq 0\text{ V}$ , $2.7\text{ V} \leq V_{IC} \leq 2.9\text{ V}$	25°C	50	74	
$k_{SVR}$ Supply-voltage rejection ratio	$1.8\text{ V} \leq V_{CC+} \leq 5\text{ V}$ , $V_{IC} = 0.5\text{ V}$	25°C		75	100	dB
		Full range		70		
$V_{ICR}$ Common-mode input voltage range	CMRR $\geq 50\text{ dB}$	25°C	$V_{CC-} - 0.2$	$-0.2 \text{ to } 3.0$	$V_{CC+} + 0.2$	V
		$-40^\circ\text{C} \text{ to } 85^\circ\text{C}$	$V_{CC-}$		$V_{CC+}$	
		$-40^\circ\text{C} \text{ to } 125^\circ\text{C}$	$V_{CC-} + 0.2$		$V_{CC+} - 0.2$	
$A_V$ Large-signal voltage gain	LMV981	$R_L = 600\text{ }\Omega$ to $1.35\text{ V}$ , $V_O = 0.2\text{ V}$ to $2.5\text{ V}$	25°C	87	104	dB
			Full range	86		
		$R_L = 2\text{ k}\Omega$ to $1.35\text{ V}$ , $V_O = 0.2\text{ V}$ to $2.5\text{ V}$	25°C	92	110	
			Full range	91		
	LMV982	$R_L = 600\text{ }\Omega$ to $1.35\text{ V}$ , $V_O = 0.2\text{ V}$ to $2.5\text{ V}$	25°C	78	90	
			Full range	75		
		$R_L = 2\text{ k}\Omega$ to $1.35\text{ V}$ , $V_O = 0.2\text{ V}$ to $2.5\text{ V}$	25°C	81	100	
			Full range	78		

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**characteristics at  $T_A = 25^\circ\text{C}$ ,  $V_{CC+} = 2.7\text{ V}$ ,  $V_{CC-} = 0\text{ V}$ ,  $V_{IC} = V_{CC+}/2$ ,  $V_O = V_{CC+}/2$ ,  $R_L > 1\text{ M}\Omega$ , and SHDN tied to  $V_{CC+}$  (unless otherwise noted) (continued)**

PARAMETER		TEST CONDITIONS		$T_A$	MIN	TYP	MAX	UNIT
$V_O$	Output swing	$R_L = 600\text{ }\Omega$ to $1.35\text{ V}$ , $V_{ID} = \pm 100\text{ mV}$	High level	$25^\circ\text{C}$	2.55	2.62		V
				Full range	2.53			
			Low level	$25^\circ\text{C}$	0.083	0.11		
				Full range		0.13		
	Output short-circuit current	$R_L = 2\text{ k}\Omega$ to $1.35\text{ V}$ , $V_{ID} = \pm 100\text{ mV}$	High level	$25^\circ\text{C}$	2.65	2.675		
				Full range	2.64			
			Low level	$25^\circ\text{C}$	0.025	0.04		
				Full range		0.045		
$I_{OS}$	Output short-circuit current	$V_O = 0\text{ V}$ , $V_{ID} = 100\text{ mV}$	Sourcing	$25^\circ\text{C}$	20	30		mA
				Full range	15			
		$V_O = 2.7\text{ V}$ , $V_{ID} = -100\text{ mV}$	Sinking	$25^\circ\text{C}$	18	25		
				Full range	12			
$T_{on}$	Turn-on time from shutdown			$25^\circ\text{C}$		12.5		$\mu\text{s}$
$V_{SHDN}$	Turn-on voltage to enable part			$25^\circ\text{C}$		1.9		V
	Turn-off voltage					0.8		
GBW	Gain bandwidth product			$25^\circ\text{C}$		1.4		MHz
SR	Slew rate	See Note 6		$25^\circ\text{C}$		0.4		$\text{V}/\mu\text{s}$
$\Phi_m$	Phase margin			$25^\circ\text{C}$		70		deg
	Gain margin			$25^\circ\text{C}$		7.5		dB
$V_n$	Equivalent input noise voltage	$f = 1\text{ kHz}$ , $V_{IC} = 0.5\text{ V}$		$25^\circ\text{C}$		57		$\text{nV}/\sqrt{\text{Hz}}$
$I_n$	Equivalent input noise current	$f = 1\text{ kHz}$		$25^\circ\text{C}$		0.082		$\text{pA}/\sqrt{\text{Hz}}$
THD	Total harmonic distortion	$f = 1\text{ kHz}$ , $A_V = 1$ , $R_L = 600\text{ }\Omega$ , $V_{ID} = 1\text{ V}_{PP}$		$25^\circ\text{C}$		0.022		%
	Amp-to-amp isolation	See Note 7		$25^\circ\text{C}$		123		dB

NOTES: 6. Number specified is the slower of the positive and negative slew rates.

7. Input referred,  $V_{CC+} = 5\text{ V}$  and  $R_L = 100\text{ k}\Omega$  connected to  $2.5\text{ V}$ . Each amp is excited in turn with a  $1\text{-kHz}$  signal to produce  $V_O = 3\text{ V}_{PP}$ .

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**electrical characteristics at  $T_A = 25^\circ\text{C}$ ,  $V_{CC+} = 5\text{ V}$ ,  $V_{CC-} = 0\text{ V}$ ,  $V_{IC} = V_{CC+}/2$ ,  $V_O = V_{CC+}/2$ ,  $R_L > 1\text{ M}\Omega$ , and SHDN tied to  $V_{CC+}$  (unless otherwise noted)**

PARAMETER		TEST CONDITIONS	$T_A$	MIN	TYP	MAX	UNIT
$V_{IO}$	Input offset voltage LMV981 (single)	25°C		1	4		mV
		Full range			6		
	LMV982 (dual)	25°C		1	5.5		
		Full range			7.5		
$\alpha_{V_{IO}}$	Average temperature coefficient of input offset voltage		25°C		5.5		$\mu\text{V}/^\circ\text{C}$
$I_{IB}$	Input bias current $V_{IC} = V_{CC+} - 0.8\text{ V}$	25°C		15	35		nA
		25°C			65		
		Full range			75		
$I_{IO}$	Input offset current	25°C		9	25		nA
		Full range			40		
$I_{CC}$	Supply current (per channel)	25°C		116	210		$\mu\text{A}$
		Full range			230		
		LMV981 In shutdown	25°C		0.201	1	
			Full range			2	
		LM982	25°C		0.302	3.5	
			Full range			5	
CMRR	Common-mode rejection ratio	$0 \leq V_{IC} \leq 3.8\text{ V}$ , $4.6\text{ V} \leq V_{IC} \leq 5\text{ V}$	25°C	60	86		dB
			$-40^\circ\text{C} \text{ to } 85^\circ\text{C}$	55			
		$0.3 \leq V_{IC} \leq 3.8\text{ V}$ , $4.6\text{ V} \leq V_{IC} \leq 4.7\text{ V}$	$-40^\circ\text{C} \text{ to } 125^\circ\text{C}$	55			
			$-0.2\text{ V} \leq V_{IC} \leq 0\text{ V}$ , $5\text{ V} \leq V_{IC} \leq 5.2\text{ V}$	25°C	50	78	
$k_{SVR}$	Supply-voltage rejection ratio	$1.8\text{ V} \leq V_{CC+} \leq 5\text{ V}$ , $V_{IC} = 0.5\text{ V}$	25°C	75	100		dB
			Full range	70			
$V_{ICR}$	Common-mode input voltage range	CMRR $\geq 50\text{ dB}$	25°C	$V_{CC-} - 0.2$	$-0.2 \text{ to } 5.3$	$V_{CC+} + 0.2$	V
			$-40^\circ\text{C} \text{ to } 85^\circ\text{C}$	$V_{CC-}$		$V_{CC+}$	
			$-40^\circ\text{C} \text{ to } 125^\circ\text{C}$	$V_{CC-} + 0.3$		$V_{CC+} - 0.3$	
$A_V$	Large-signal voltage gain	LMV981	$R_L = 600\text{ }\Omega$ to 2.5 V, $V_O = 0.2\text{ V}$ to 4.8 V	25°C	88	102	dB
			Full range		87		
			$R_L = 2\text{ k}\Omega$ to 2.5 V, $V_O = 0.2\text{ V}$ to 4.8 V	25°C	94	113	
			Full range		93		
		LMV982	$R_L = 600\text{ }\Omega$ to 2.5 V, $V_O = 0.2\text{ V}$ to 4.8 V	25°C	81	90	
			Full range		78		
			$R_L = 2\text{ k}\Omega$ to 2.5 V, $V_O = 0.2\text{ V}$ to 4.8 V	25°C	85	100	
			Full range		82		

**LMV981 SINGLE, LMV982 DUAL  
1.8-V OPERATIONAL AMPLIFIERS  
WITH RAIL-TO-RAIL INPUT AND OUTPUT AND SHUTDOWN**

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**electrical characteristics at  $T_A = 25^\circ\text{C}$ ,  $V_{CC+} = 5 \text{ V}$ ,  $V_{CC-} = 0 \text{ V}$ ,  $V_{IC} = V_{CC+}/2$ ,  $V_O = V_{CC+}/2$ ,  $R_L > 1 \text{ M}\Omega$ , and SHDN tied to  $V_{CC+}$  (unless otherwise noted) (continued)**

PARAMETER		TEST CONDITIONS		$T_A$	MIN	TYP	MAX	UNIT
$V_O$	Output swing	$R_L = 600 \Omega$ to 2.5 V, $V_{ID} = \pm 100 \text{ mV}$	High level	25°C	4.855	4.89		V
				Full range	4.835			
			Low level	25°C		0.12	0.16	
				Full range		0.18		
		$R_L = 2 \text{ k}\Omega$ to 2.5 V, $V_{ID} = \pm 100 \text{ mV}$	High level	25°C	4.945	4.967		
				Full range	4.935			
			Low level	25°C		0.037	0.065	
				Full range		0.075		
$I_{OS}$	Output short-circuit current	LMV981: $V_O = 0 \text{ V}$ , $V_{ID} = 100 \text{ mV}$	Sourcing	25°C	80	100		mA
				Full range	68			
		$V_O = 5 \text{ V}$ , $V_{ID} = -100 \text{ mV}$	Sinking	25°C	58	65		
				Full range	45			
$T_{on}$	Turn-on time from shutdown			25°C		8.4		μs
$V_{SHDN}$	Turn-on voltage to enable part			25°C		4.2		V
	Turn-off voltage					0.8		
GBW	Gain bandwidth product			25°C		1.5		MHz
SR	Slew rate	See Note 6		25°C		0.42		V/μs
$\Phi_m$	Phase margin			25°C		71		deg
	Gain margin			25°C		8		dB
$V_n$	Equivalent input noise voltage	$f = 1 \text{ kHz}$ , $V_{IC} = 1 \text{ V}$		25°C		50		nV/√Hz
$I_n$	Equivalent input noise current	$f = 1 \text{ kHz}$		25°C		0.07		pA/√Hz
THD	Total harmonic distortion	$f = 1 \text{ kHz}$ , $A_V = 1$ , $R_L = 600 \Omega$ , $V_{ID} = 1 \text{ V}_{PP}$		25°C		0.022		%
	Amp-to-amp isolation	See Note 7		25°C		123		dB

NOTES: 6. Number specified is the slower of the positive and negative slew rates.

7. Input referred,  $V_{CC+} = 5 \text{ V}$  and  $R_L = 100 \text{ k}\Omega$  connected to 2.5 V. Each amp is excited in turn with a 1-kHz signal to produce  $V_O = 3 \text{ V}_{PP}$ .

**LMV981 SINGLE, LMOV982 DUAL  
1.8-V OPERATIONAL AMPLIFIERS  
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**TYPICAL PERFORMANCE CHARACTERISTICS**  
Unless Otherwise Specified,  $V_{CC+} = 5$  V, Single Supply,  $T_A = 25^\circ\text{C}$

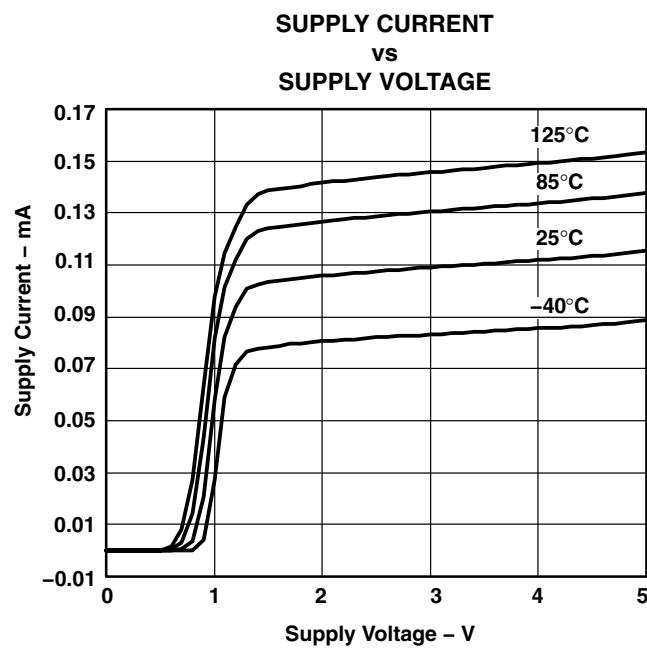


Figure 1

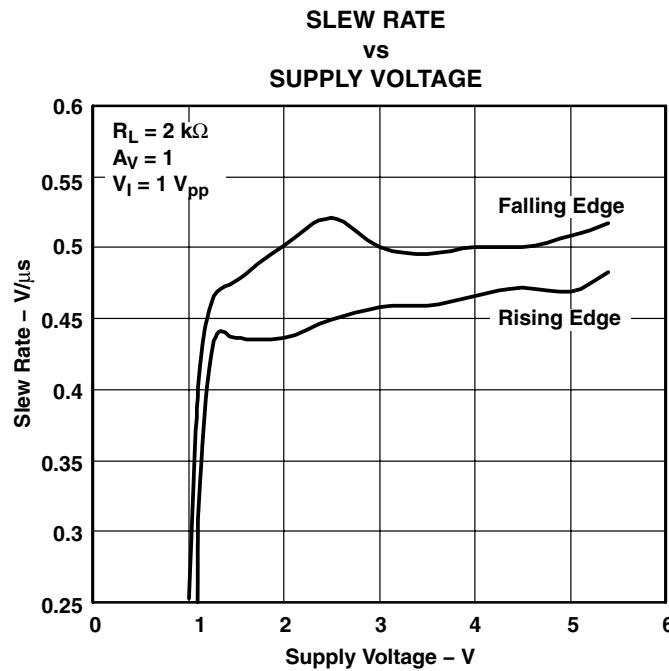


Figure 2

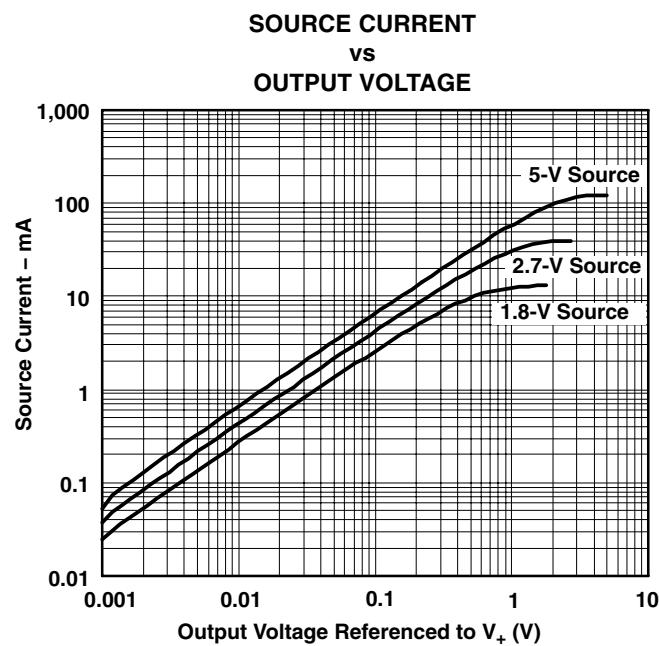


Figure 3

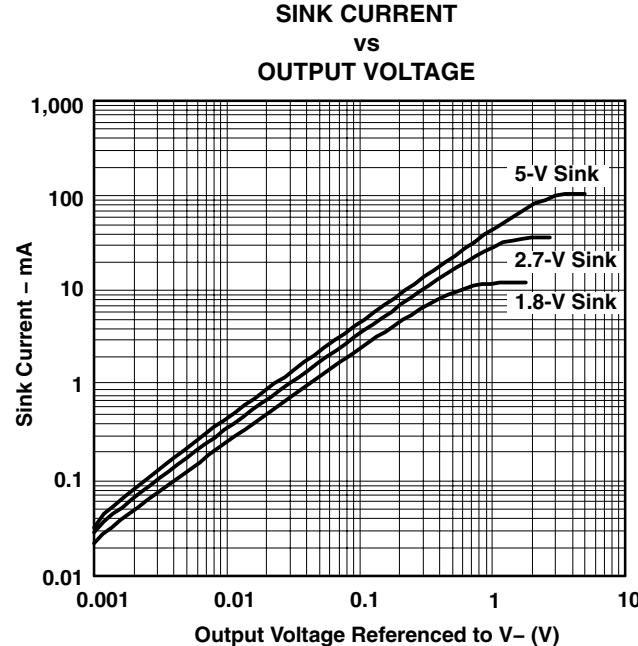


Figure 4

**TYPICAL PERFORMANCE CHARACTERISTICS**  
Unless Otherwise Specified,  $V_{CC+} = 5$  V, Single Supply,  $T_A = 25^\circ\text{C}$

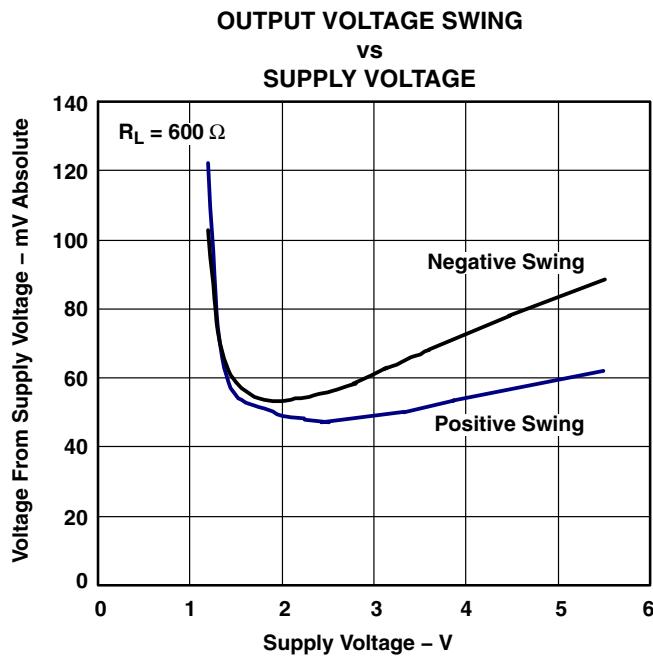


Figure 5

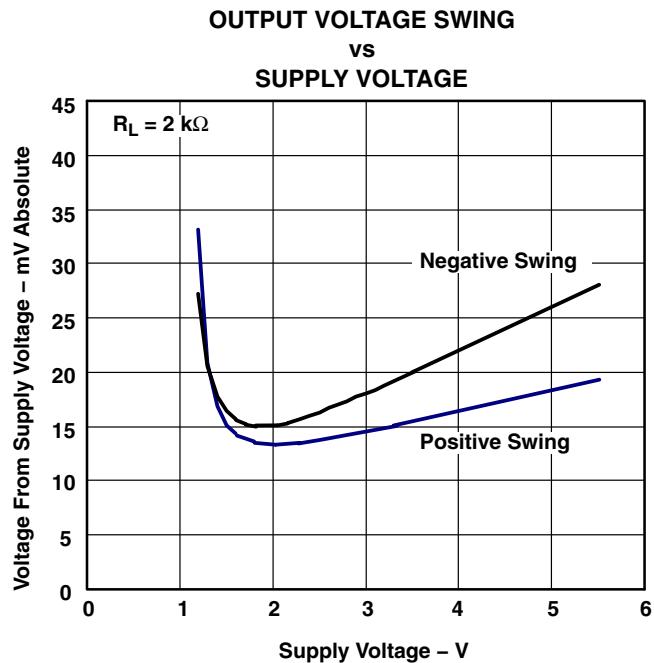


Figure 6

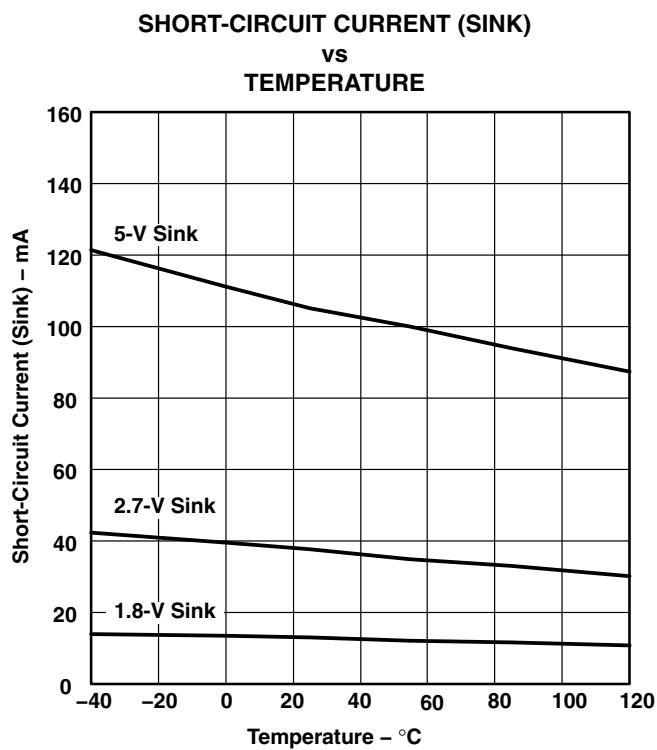


Figure 7

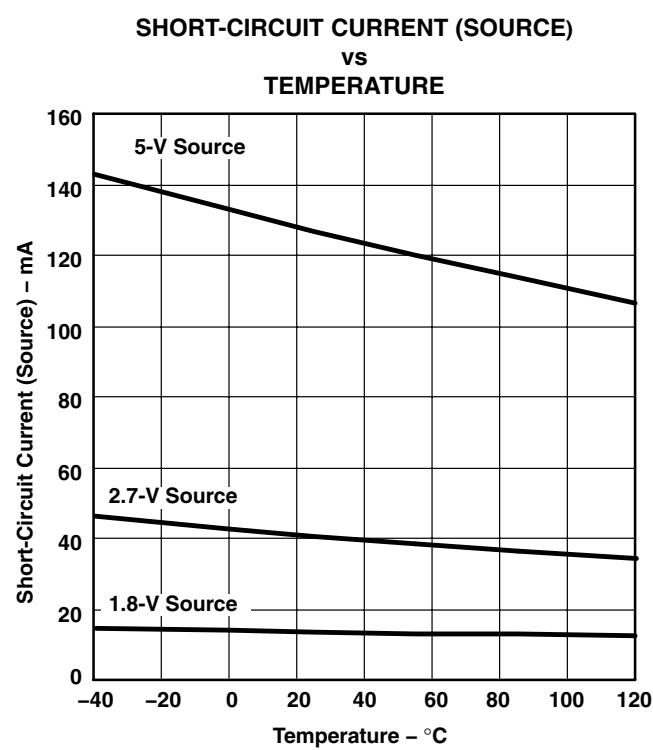


Figure 8

**LMV981 SINGLE, LMV982 DUAL  
1.8-V OPERATIONAL AMPLIFIERS  
WITH RAIL-TO-RAIL INPUT AND OUTPUT AND SHUTDOWN**

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**TYPICAL PERFORMANCE CHARACTERISTICS**  
Unless Otherwise Specified,  $V_{CC+} = 5$  V, Single Supply,  $T_A = 25^\circ\text{C}$

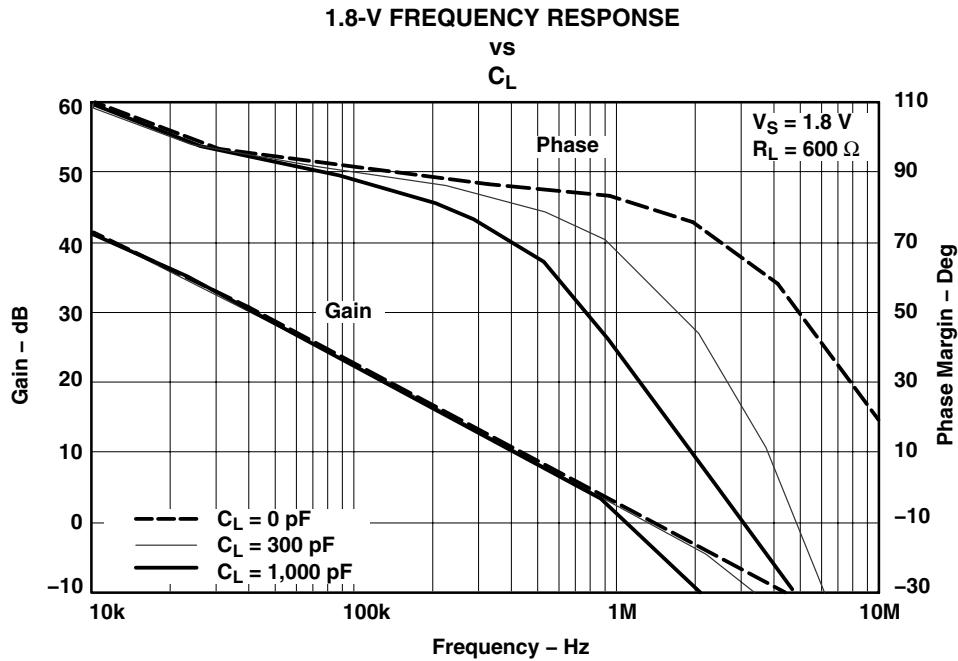


Figure 9

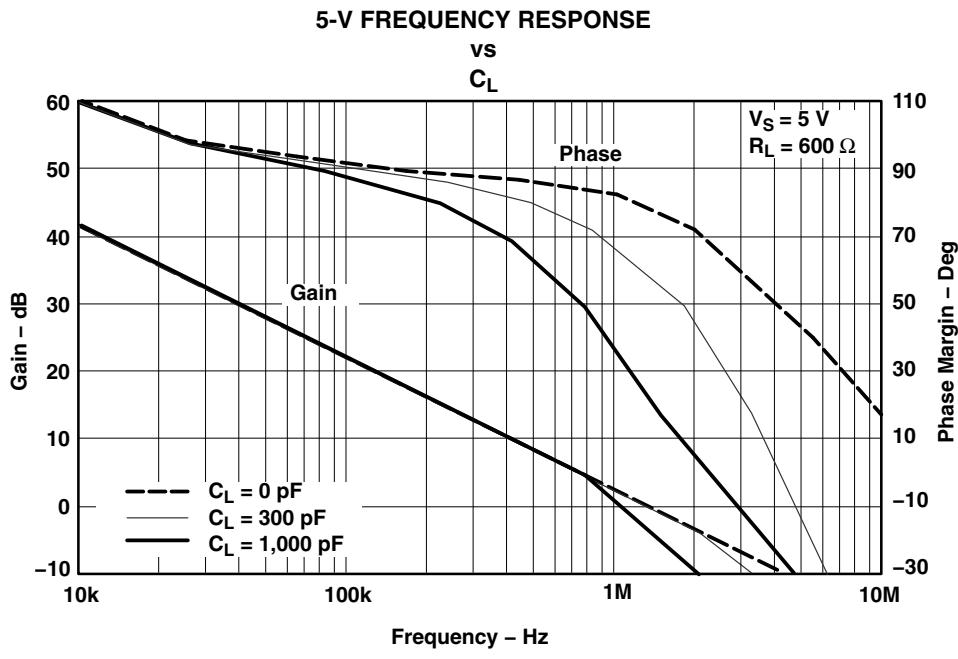


Figure 10

**LMV981 SINGLE, LMV982 DUAL  
1.8-V OPERATIONAL AMPLIFIERS  
WITH RAIL-TO-RAIL INPUT AND OUTPUT AND SHUTDOWN**

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**TYPICAL PERFORMANCE CHARACTERISTICS**  
Unless Otherwise Specified,  $V_{CC+} = 5$  V, Single Supply,  $T_A = 25^\circ\text{C}$

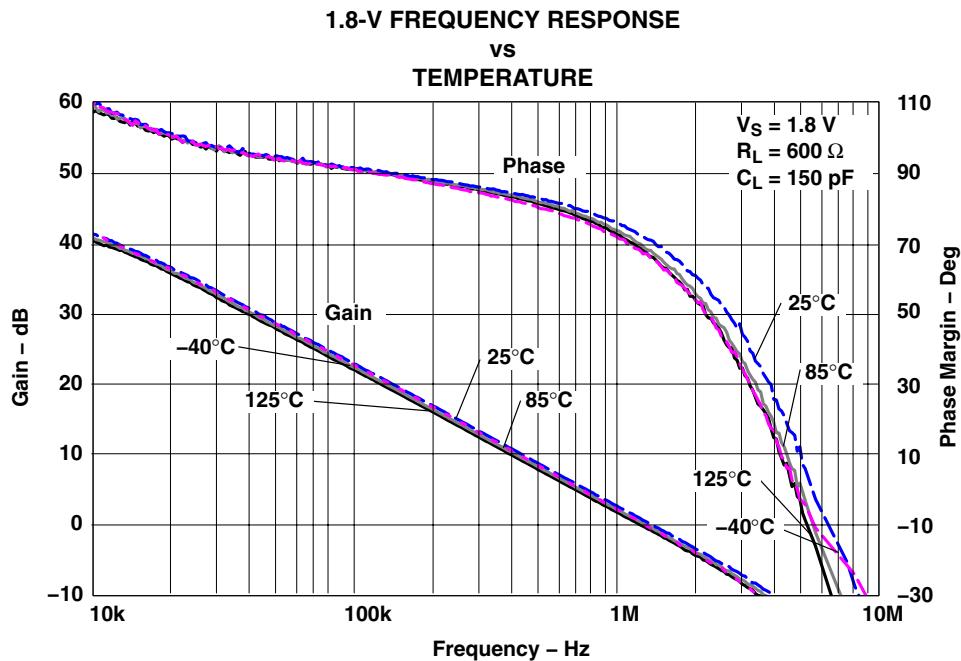


Figure 11

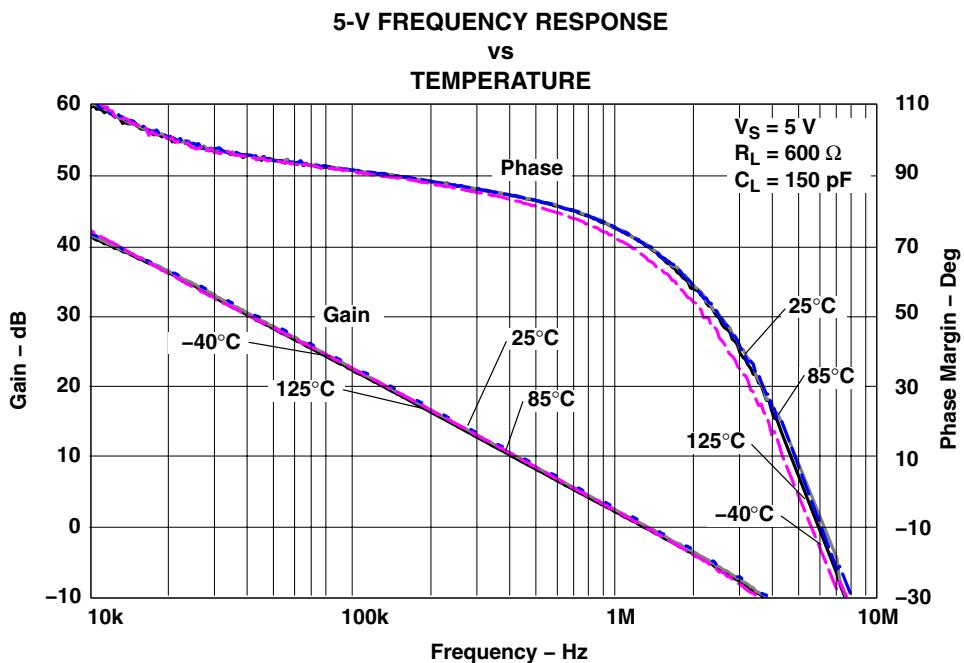


Figure 12

**LMV981 SINGLE, LMV982 DUAL  
1.8-V OPERATIONAL AMPLIFIERS  
WITH RAIL-TO-RAIL INPUT AND OUTPUT AND SHUTDOWN**

SLOS440H – AUGUST 2004 – REVISED JULY 2007

**TYPICAL PERFORMANCE CHARACTERISTICS**  
Unless Otherwise Specified,  $V_{CC+} = 5$  V, Single Supply,  $T_A = 25^\circ\text{C}$

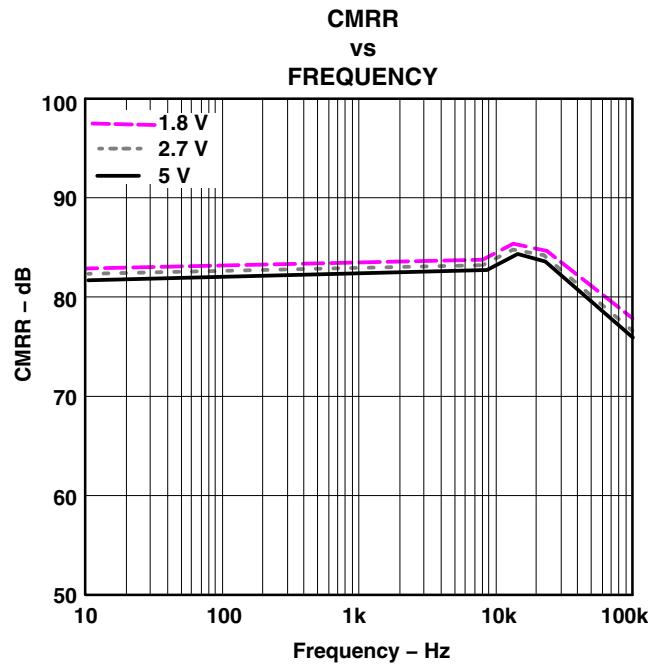


Figure 13

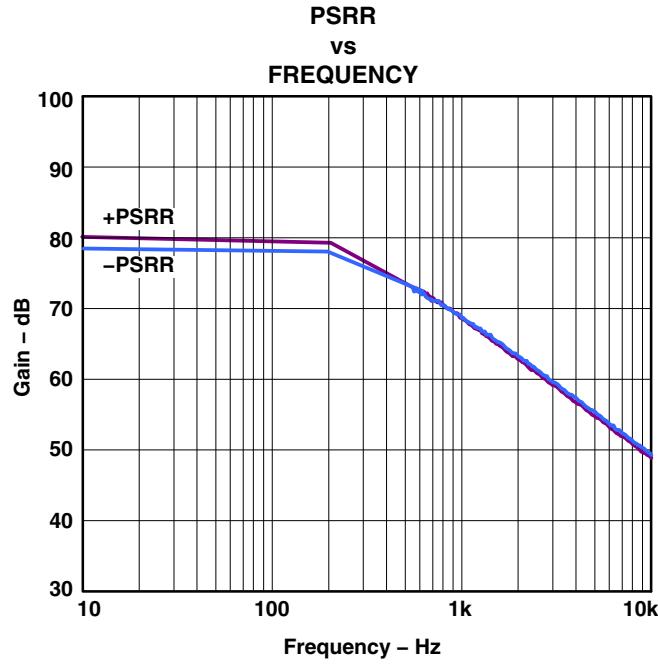


Figure 14

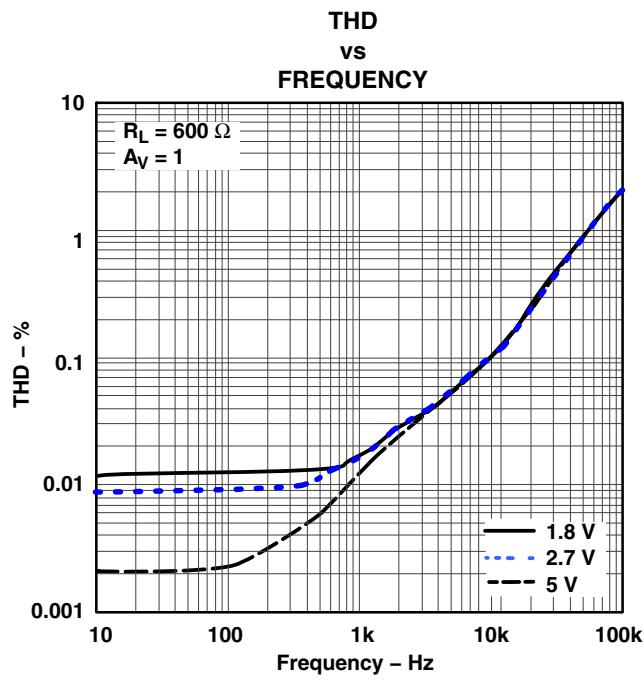


Figure 15

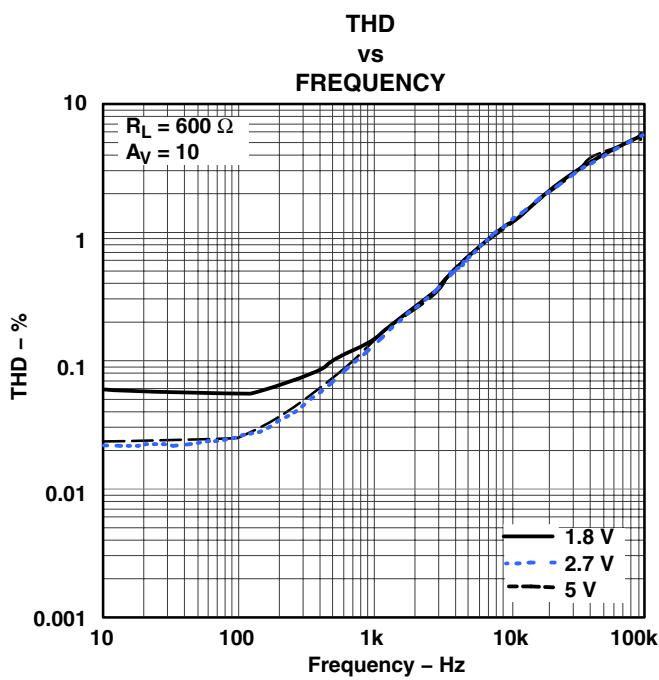


Figure 16

**TYPICAL PERFORMANCE CHARACTERISTICS**  
Unless Otherwise Specified,  $V_{CC+} = 5$  V, Single Supply,  $T_A = 25^\circ\text{C}$

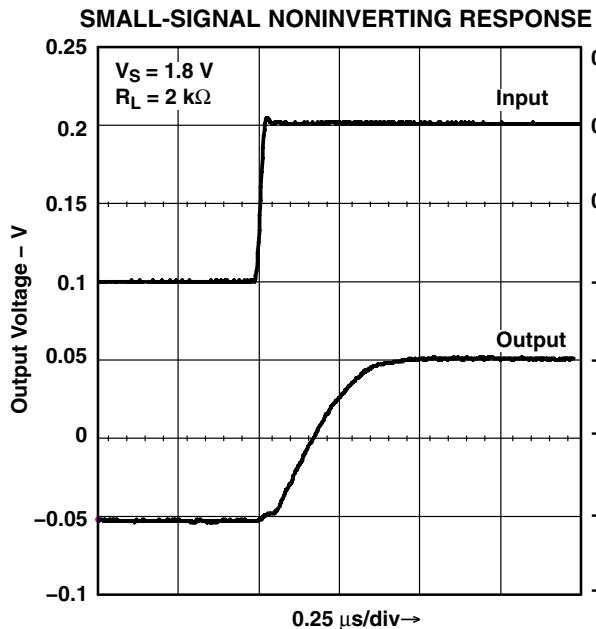


Figure 17

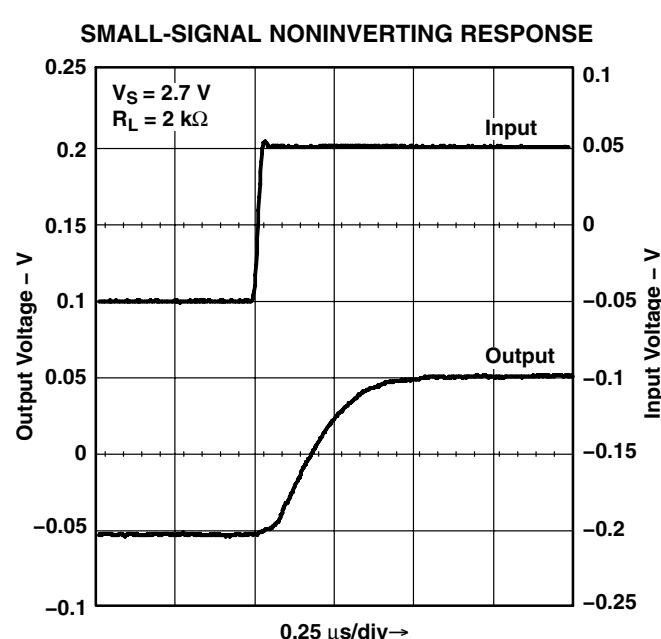


Figure 18

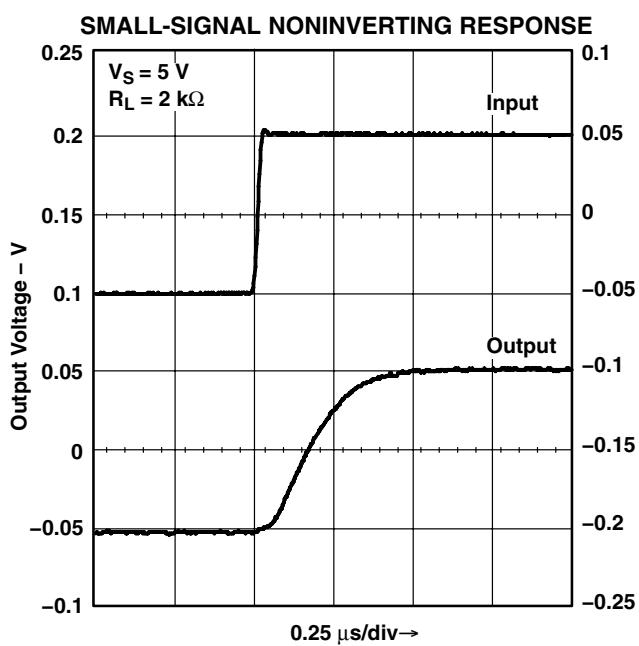


Figure 19

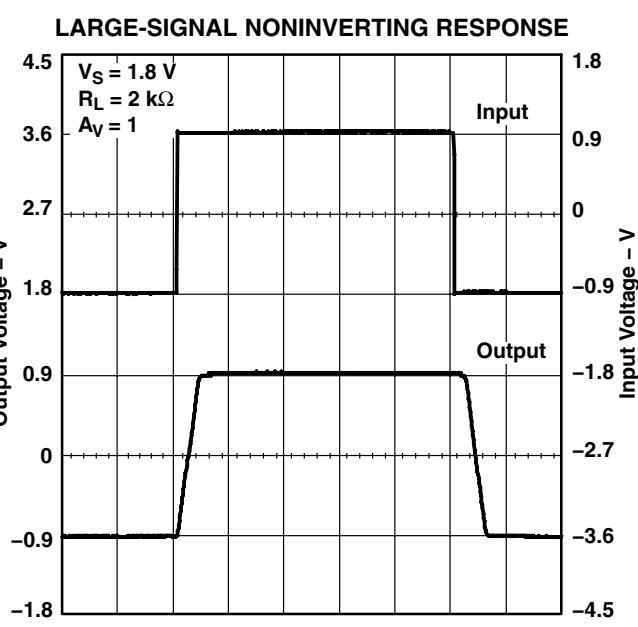
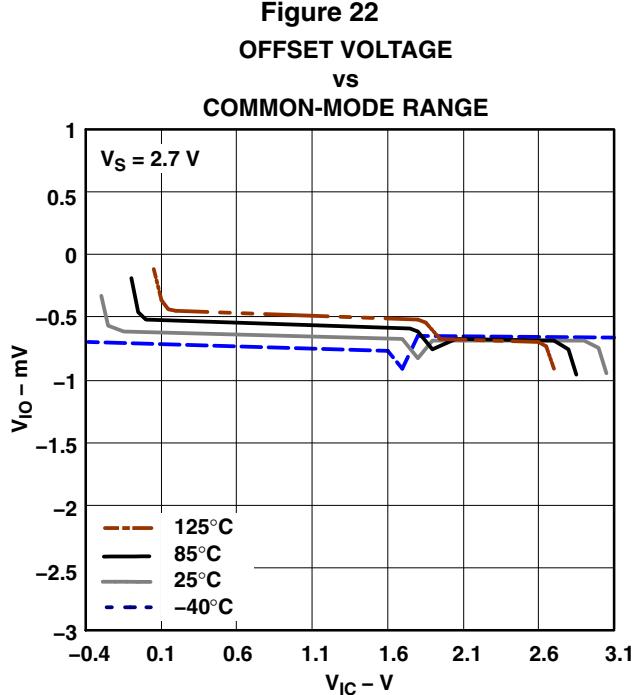
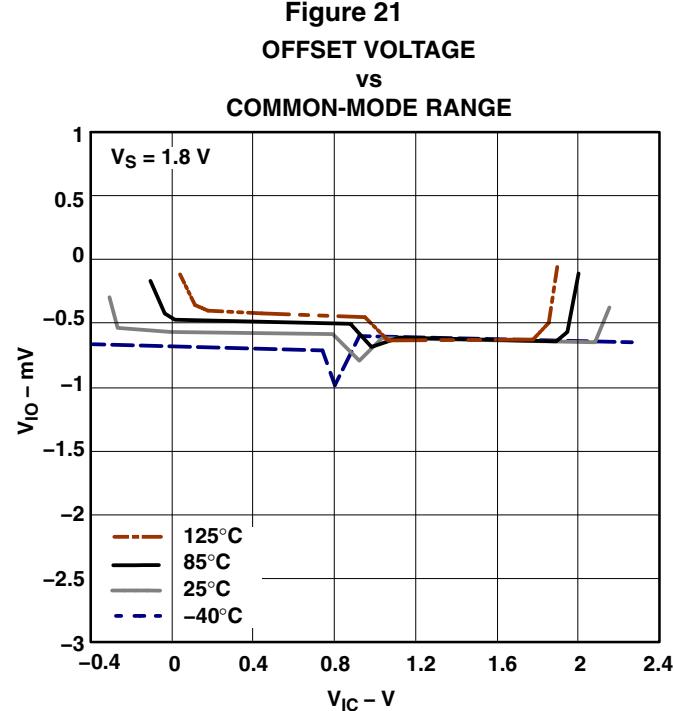
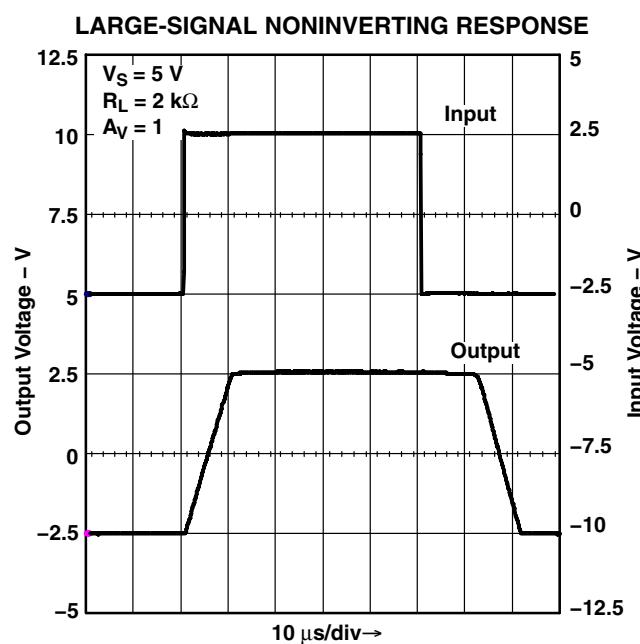
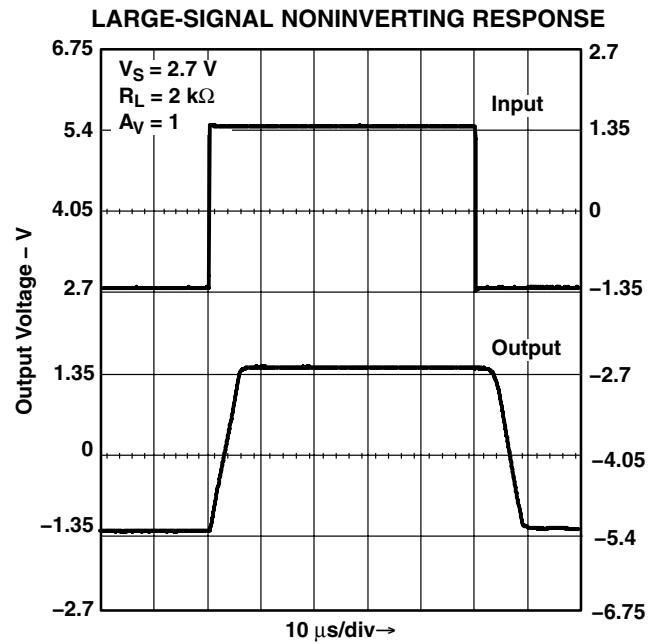


Figure 20

**LMV981 SINGLE, LMOV982 DUAL  
1.8-V OPERATIONAL AMPLIFIERS  
WITH RAIL-TO-RAIL INPUT AND OUTPUT AND SHUTDOWN**

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**TYPICAL PERFORMANCE CHARACTERISTICS**  
Unless Otherwise Specified,  $V_{CC+} = 5$  V, Single Supply,  $T_A = 25^\circ\text{C}$



TYPICAL PERFORMANCE CHARACTERISTICS  
Unless Otherwise Specified,  $V_{CC+} = 5$  V, Single Supply,  $T_A = 25^\circ\text{C}$

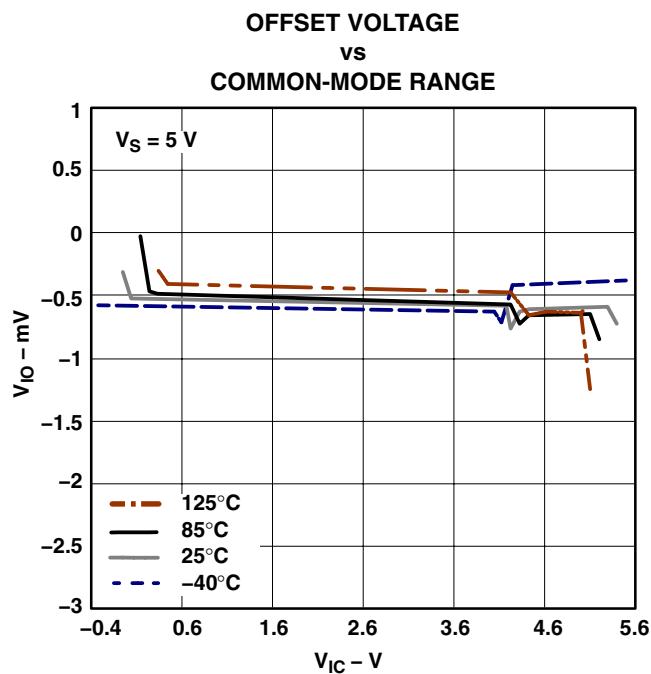


Figure 25

**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>	Samples (Requires Login)
LMV981IDBVR	ACTIVE	SOT-23	DBV	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
LMV981IDBVRE4	ACTIVE	SOT-23	DBV	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
LMV981IDBVRG4	ACTIVE	SOT-23	DBV	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
LMV981IDCKR	ACTIVE	SC70	DCK	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
LMV981IDCKRE4	ACTIVE	SC70	DCK	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
LMV981IDCKRG4	ACTIVE	SC70	DCK	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
LMV981IRUGR	ACTIVE	X2QFN	RUG	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
LMV981IRUGRG4	ACTIVE	X2QFN	RUG	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
LMV982IDGSR	ACTIVE	MSOP	DGS	10	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
LMV982IDGSRE4	ACTIVE	MSOP	DGS	10	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
LMV982IDGSRG4	ACTIVE	MSOP	DGS	10	2500	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.

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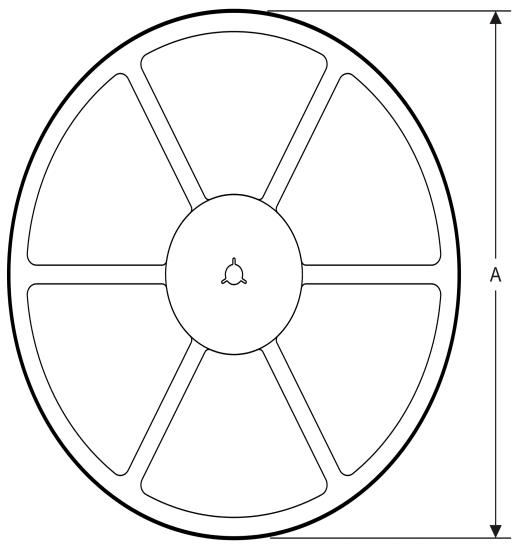
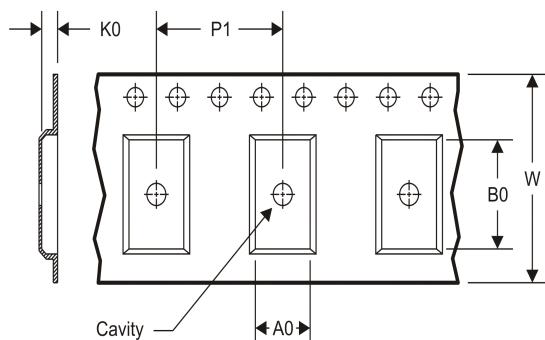
**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**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)

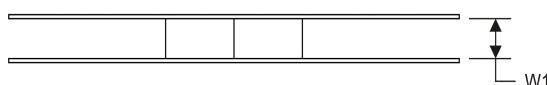
(<sup>3</sup>) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**TAPE AND REEL INFORMATION**
**REEL DIMENSIONS**

**TAPE DIMENSIONS**


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


**TAPE AND REEL INFORMATION**

\*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
LMV981IDBVR	SOT-23	DBV	6	3000	180.0	8.4	3.23	3.17	1.37	4.0	8.0	Q3
LMV981IDCKR	SC70	DCK	6	3000	180.0	8.4	2.25	2.4	1.22	4.0	8.0	Q3
LMV981IRUGR	X2QFN	RUG	8	3000	179.0	8.4	1.7	1.7	0.6	4.0	8.0	Q2
LMV982IDGSR	MSOP	DGS	10	2500	330.0	12.4	5.3	3.3	1.3	8.0	12.0	Q1

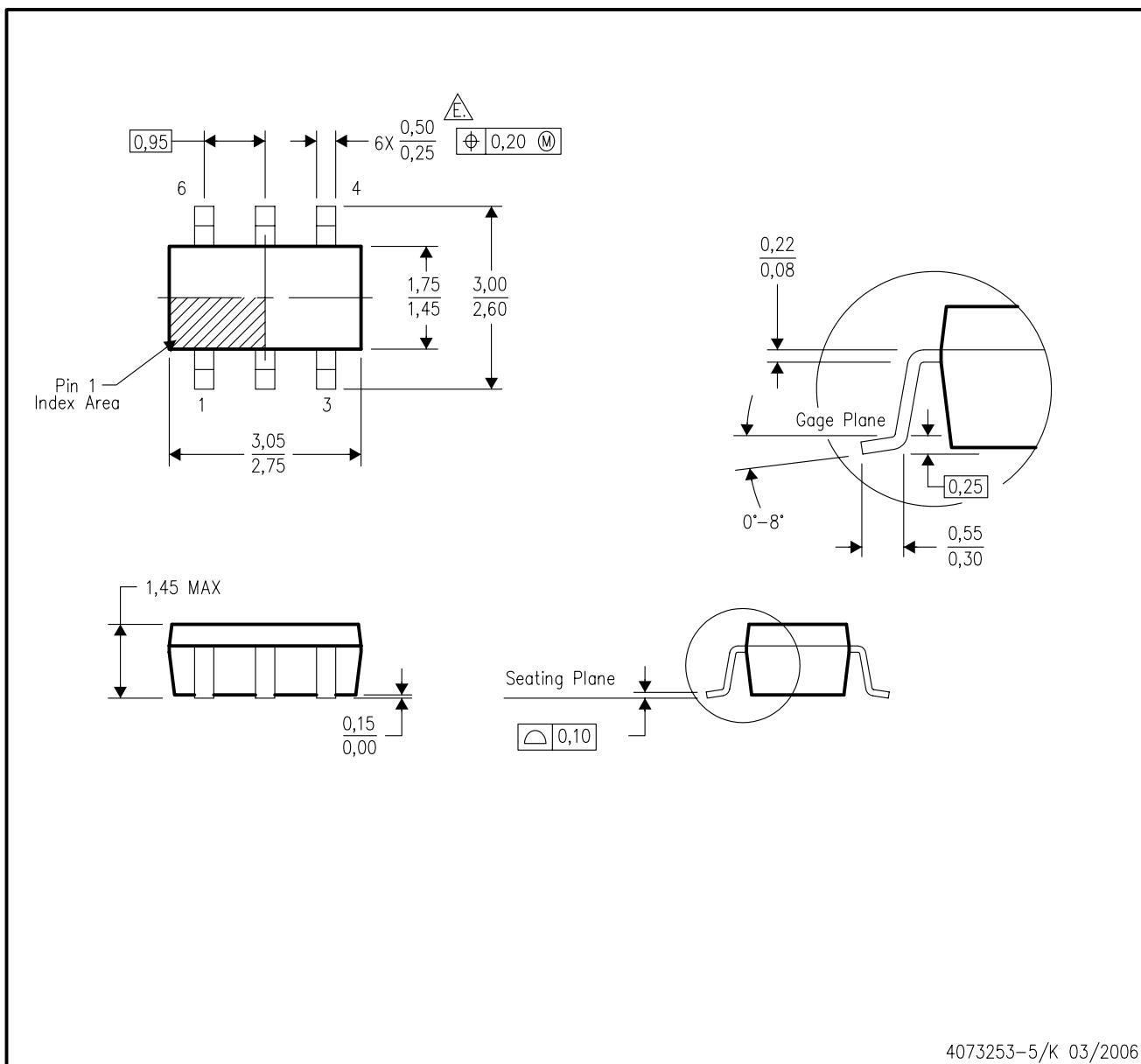
**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LMV981IDBVR	SOT-23	DBV	6	3000	202.0	201.0	28.0
LMV981IDCKR	SC70	DCK	6	3000	202.0	201.0	28.0
LMV981IRUGR	X2QFN	RUG	8	3000	203.0	203.0	35.0
LMV982IDGSR	MSOP	DGS	10	2500	370.0	355.0	55.0

## DBV (R-PDSO-G6)

## PLASTIC SMALL-OUTLINE PACKAGE



4073253-5/K 03/2006

NOTES:

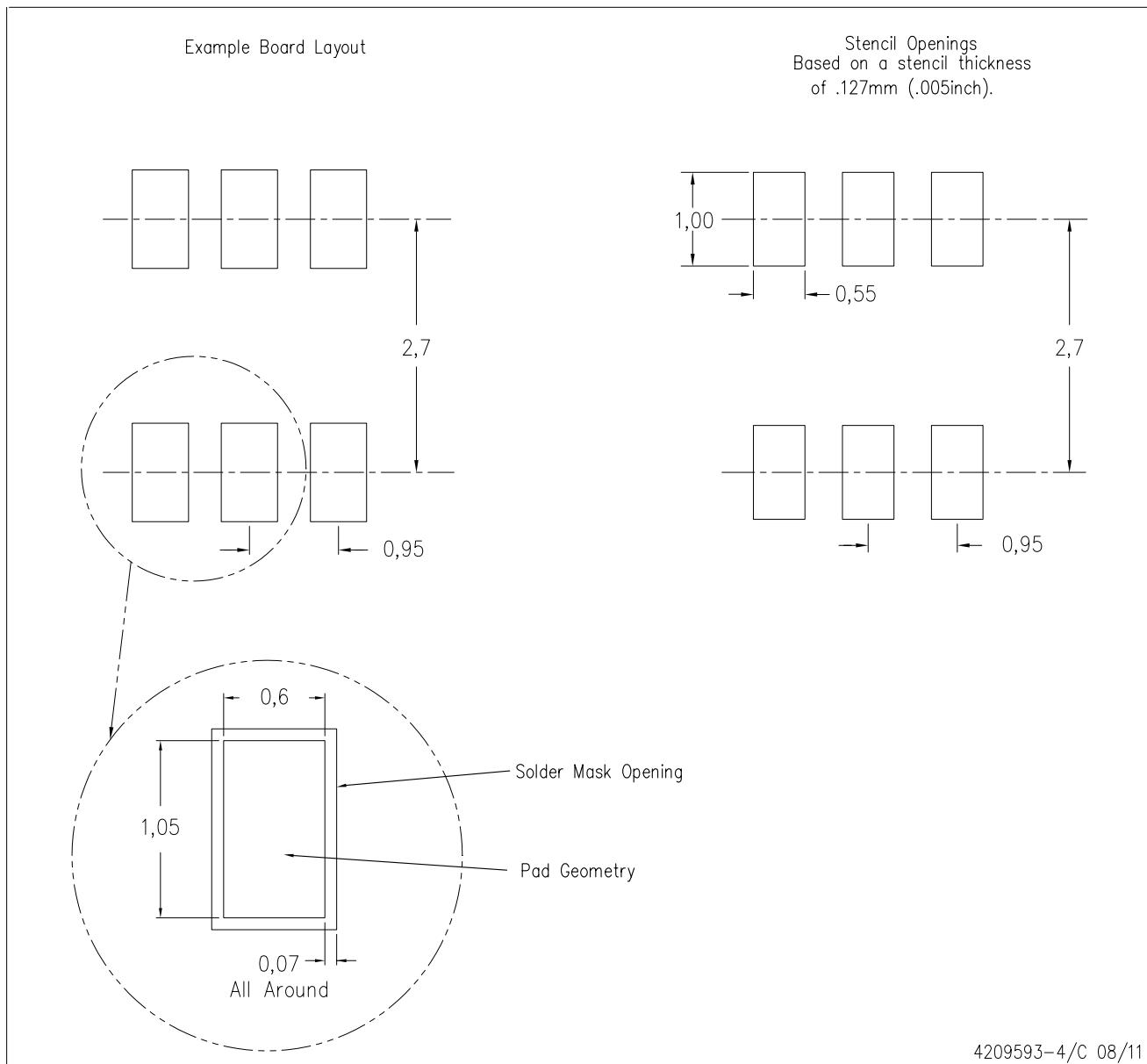
- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
- D. Leads 1,2,3 may be wider than leads 4,5,6 for package orientation.

 Falls within JEDEC MO-178 Variation AB, except minimum lead width.

# LAND PATTERN DATA

DBV (R-PDSO-G6)

PLASTIC SMALL OUTLINE

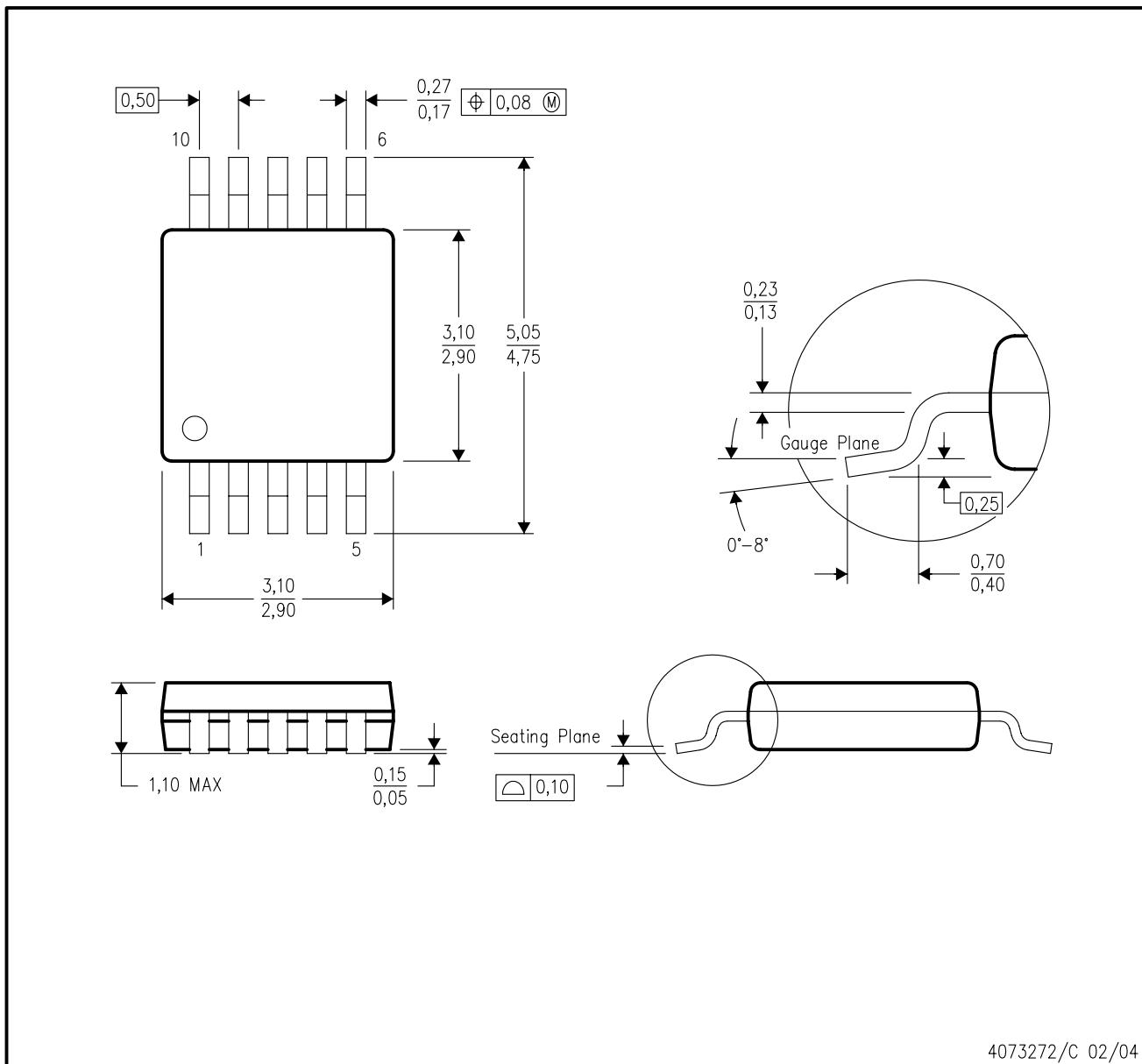


NOTES:

- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
- D. Publication IPC-7351 is recommended for alternate designs.
- E. 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. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC-7525 for other stencil recommendations.

## DGS (S-PDSO-G10)

## PLASTIC SMALL-OUTLINE PACKAGE



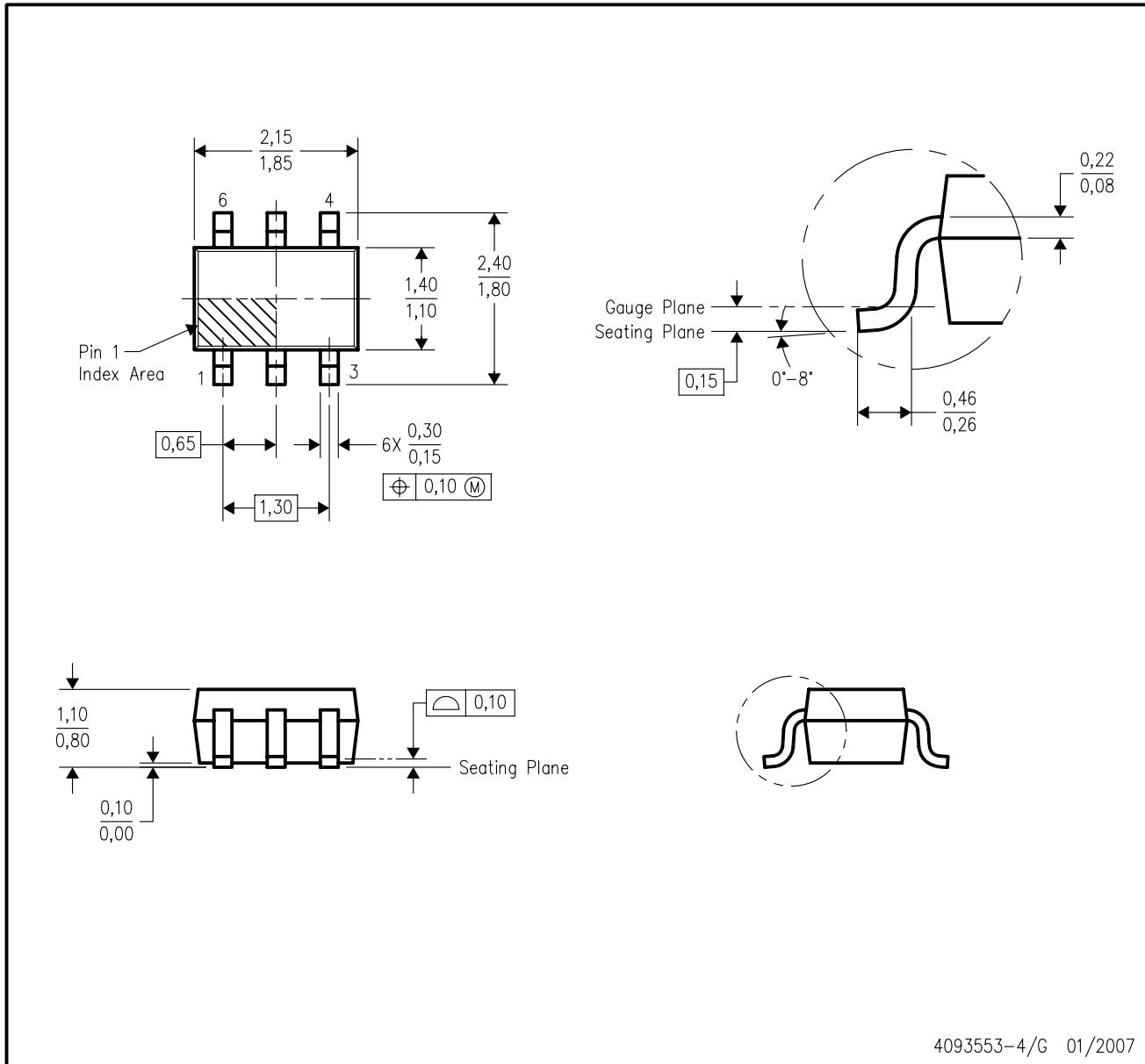
NOTES:

- 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 BA.

4073272/C 02/04

## DCK (R-PDSO-G6)

## PLASTIC SMALL-OUTLINE PACKAGE



4093553-4/G 01/2007

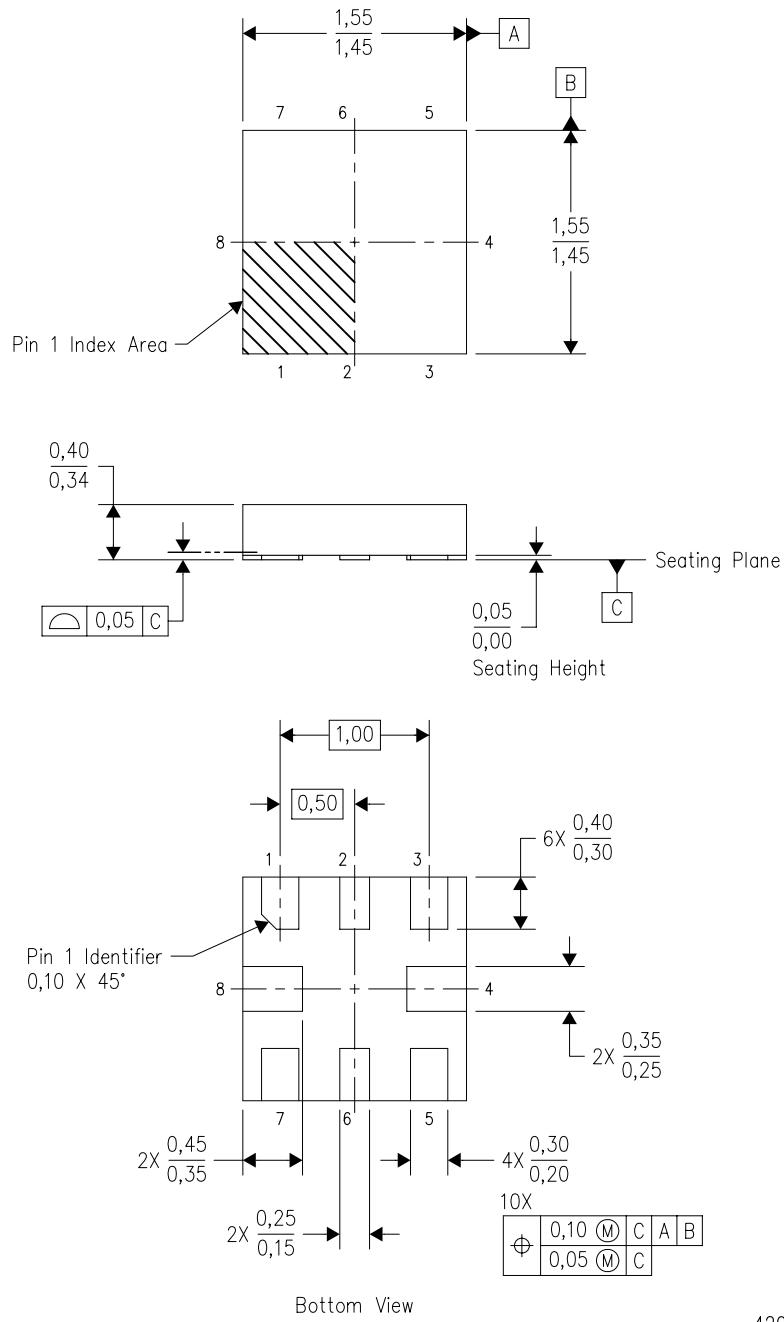
NOTES:

- All linear dimensions are in millimeters.
- This drawing is subject to change without notice.
- Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
- Falls within JEDEC MO-203 variation AB.

## MECHANICAL DATA

RUG (S-PQFP-N8)

PLASTIC QUAD FLATPACK



Bottom View

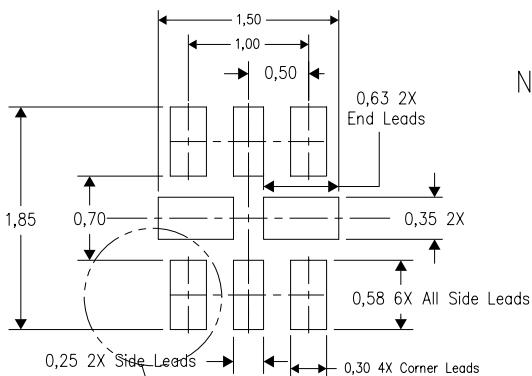
4208528-2/B 04/2008

NOTES:

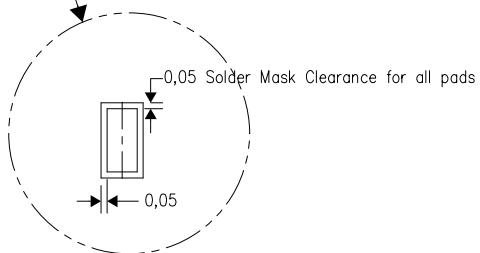
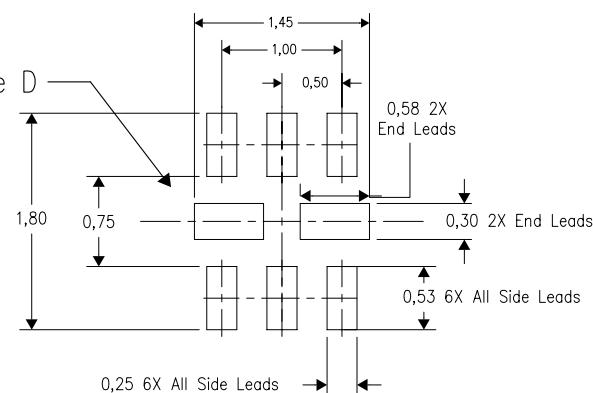
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
- B. This drawing is subject to change without notice.
- C. QFN (Quad Flatpack No-Lead) package configuration.
- D. This package complies to JEDEC MO-288 variation X2ECD.

RUG (R-PQFP-N8)

## Example Board Layout



## Example Stencil Design (Note E)



4210299-2/A 06/09

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. Customers should contact their board fabrication site for minimum solder mask web tolerances between signal pads.
- E. Maximum stencil thickness 0,127 mm (5 mils). All linear dimensions are in millimeters.
- F. 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 stencil design considerations.
- G. Side aperture dimensions over-print land for acceptable area ratio  $> 0.66$ . Customer may reduce side aperture dimensions if stencil manufacturing process allows for sufficient release at smaller opening.

## IMPORTANT NOTICE

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