

FEATURES

- 2.5-V, 2.7-V, and 5-V Performance
- -40°C to 125°C Operation
- No Crossover Distortion
- Low Supply Current at $V_{\text{CC}+} = 5\text{ V}$:
 - LMV821...0.3 mA Typ
 - LMV822...0.5 mA Typ
 - LMV824...1 mA Typ
- Rail-to-Rail Output Swing
- Gain Bandwidth of 5.5 MHz Typ at 5 V
- Slew Rate of 1.9 V/ μs Typ at 5 V

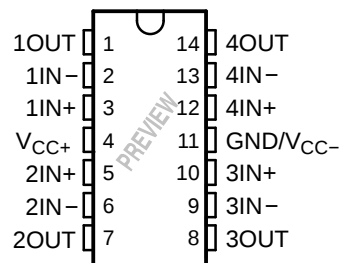
DESCRIPTION/ORDERING INFORMATION

The LMV821 single, LMV822 dual, and LMV824 quad devices are low-voltage (2.5 V to 5.5 V), low-power commodity operational amplifiers. Electrical characteristics are very similar to the LMV3xx operational amplifiers (low supply current, rail-to-rail outputs, input common-mode range that includes ground). However, the LMV8xx devices offer a higher bandwidth (5.5 MHz typical) and faster slew rate (1.9 V/ μs typical).

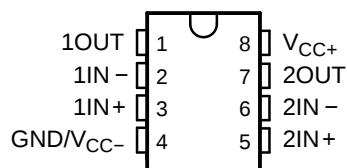
The LMV8xx devices are cost-effective solutions for applications requiring low-voltage/low-power operation and space-saving considerations. The LMV821 is available in the ultra-small DCK package, which is approximately half the size of SOT-23-5. The DCK package saves space on printed circuit boards and enables the design of small portable electronic devices (cordless and cellular phones, laptops, PDAs, PCMIA). It also allows the designer to place the device closer to the signal source to reduce noise pickup and increase signal integrity.

The LMV8xx devices are characterized for operation from -40°C to 85°C . The LMV8xxl devices are characterized for operation from -40°C to 125°C .

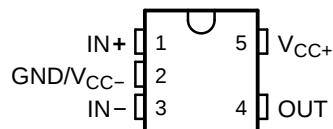
LMV824... D, DGV, OR PW PACKAGE
(TOP VIEW)



LMV822... D OR DGK PACKAGE
(TOP VIEW)



LMV821... DBV OR DCK 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.

LMV821 SINGLE, LMV822 DUAL, LMV824 QUAD LOW-VOLTAGE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS

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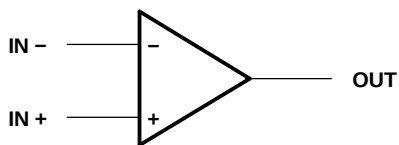
ORDERING INFORMATION

T _A	PACKAGE ⁽¹⁾			ORDERABLE PART NUMBER	TOP-SIDE MARKING ⁽²⁾
–40°C to 85°C	Single	SC-70 – DCK	Reel of 3000	LMV821DCKR	RY_
			Reel of 250	LMV821DCKT	
		SOT-23 – DBV	Reel of 3000	LMV821DBVR	RB8_
			Reel of 250	LMV821DBVT	
	Dual	SOIC – D	Tube of 75	LMV822D	MV822
			Reel of 2500	LMV822DR	
		MSOP/VSSOP – DGK	Tube of 100	LMV822DGK	RA_
			Reel of 2500	LMV822DGKR	
	Quad	SOIC – D	Tube of 50	LMV824D	LMV824
			Reel of 2500	LMV824DR	
		TSSOP – PW	Tube of 90	LMV824PW	MV824
			Reel of 2000	LMV824PWR	
		TVSOP – DGV	Reel of 2000	LMV824DGV	MV824
–40°C to 125°C	Single	SC-70 – DCK	Reel of 3000	LMV821IDCKR	RZ_
			Reel of 250	LMV821IDCKT	
		SOT-23 – DBV	Reel of 3000	LMV821IDBVR	RB1_
			Reel of 250	LMV821IDBVT	
	Dual	SOIC – D	Tube of 75	LMV822ID	MV822I
			Reel of 2500	LMV822IDR	
		MSOP/VSSOP – DGK	Tube of 100	LMV822IDGK	R8_
			Reel of 2500	LMV822IDGKR	
	Quad	SOIC – D	Tube of 50	LMV824ID	LMV824I
			Reel of 2500	LMV824IDR	
		TSSOP – PW	Tube of 90	LMV824IPW	MV824I
			Reel of 2000	LMV824IPWR	
		TVSOP – DGV	Reel of 2000	LMV824IDGVR	MV824I

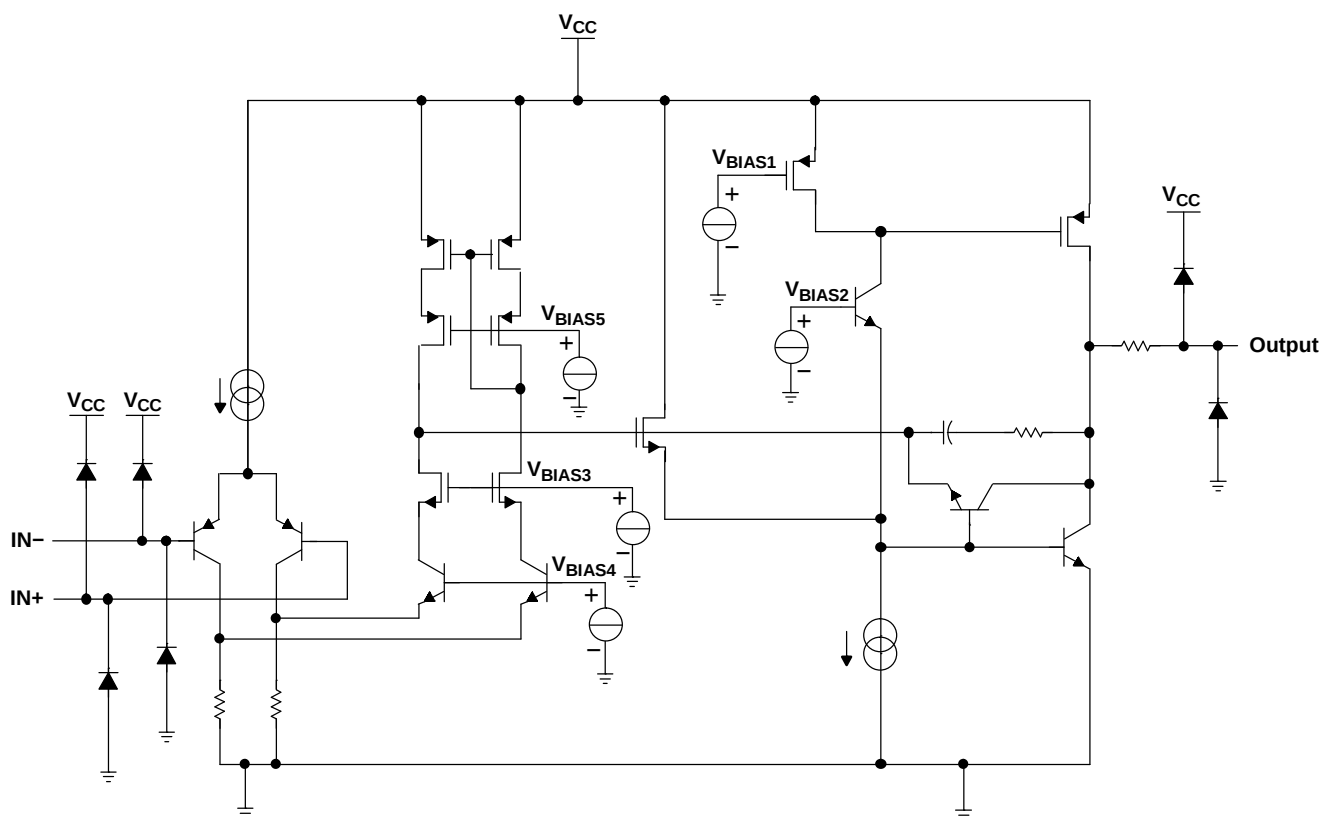
(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

(2) DBV/DCK/DGK: The actual top-side marking has one additional character that designates the assembly/test site.

SYMBOL (EACH AMPLIFIER)



LMV824 SIMPLIFIED SCHEMATIC



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Absolute Maximum Ratings⁽¹⁾

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

			MIN	MAX	UNIT
V_{CC}	Supply voltage ⁽²⁾			5.5	V
V_{ID}	Differential input voltage ⁽³⁾			$\pm V_{CC}$	V
V_I	Input voltage range (either input)		V_{CC-}	V_{CC+}	V
	Duration of output short circuit (one amplifier) to ground ⁽⁴⁾	At or below $T_A = 25^\circ\text{C}$, $V_{CC} \leq 5.5\text{ V}$		Unlimited	
θ_{JA}	Package thermal impedance ⁽⁵⁾⁽⁶⁾	D package		97	$^\circ\text{C/W}$
		8 pin			
		14 pin		86	
		DBV package		206	
		DCK package		252	
		DGK package		172	
		DGV package		127	
		PW package		113	
T_J	Operating virtual junction temperature			150	$^\circ\text{C}$
T_{stg}	Storage temperature range		-65	150	$^\circ\text{C}$

- (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_{CC} specified for the measurement of I_{OS}) are with respect to the network GND.
- (3) Differential voltages are at $IN+$ with respect to $IN-$.
- (4) Short circuits from outputs to V_{CC} can cause excessive heating and eventual destruction.
- (5) Maximum power dissipation is a function of $T_J(\text{max})$, θ_{JA} , and T_A . The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(\text{max}) - T_A)/\theta_{JA}$. Operating at the absolute maximum T_J of 150°C can affect reliability.
- (6) The package thermal impedance is calculated in accordance with JESD 51-7.

Recommended Operating Conditions

			MIN	MAX	UNIT
V_{CC}	Supply voltage (single-supply operation)		2.5	5	V
T_A	Operating free-air temperature	LMV8xxI	-40	125	$^\circ\text{C}$
		LMV8xx	-40	85	

LMV8xx 2.5-V Electrical Characteristics

$V_{CC+} = 2.5\text{ V}$, $V_{CC-} = 0\text{ V}$, $V_{IC} = 1\text{ V}$, $V_O = 1.25\text{ V}$, and $R_L > 1\text{ M}\Omega$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS		T_A	LMV8xx			UNIT
				MIN	TYP	MAX	
V_{IO} Input offset voltage			25°C		1	3.5	mV
			–40°C to 85°C			4	
V_O Output swing	$V_{CC+} = 2.5\text{ V}$, $R_L = 600\text{ }\Omega$ to 1.25 V	High level	25°C	2.3	2.37		V
			–40°C to 85°C	2.2			
		Low level	25°C		0.13	0.2	
			–40°C to 85°C			0.3	
	$V_{CC+} = 2.5\text{ V}$, $R_L = 2\text{ k}\Omega$ to 1.25 V	High level	25°C	2.4	2.46		
			–40°C to 85°C	2.3			
		Low level	25°C		0.08	0.12	
			–40°C to 85°C			0.2	

LMV8xxI 2.5-V Electrical Characteristics

$V_{CC+} = 2.5\text{ V}$, $V_{CC-} = 0\text{ V}$, $V_{IC} = 1\text{ V}$, $V_O = 1.25\text{ V}$, and $R_L > 1\text{ M}\Omega$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS		T_A	LMV8xxI			UNIT
				MIN	TYP	MAX	
V_{IO} Input offset voltage			25°C		1	3.5	mV
			–40°C to 125°C			5.5	
V_O Output swing	$V_{CC+} = 2.5\text{ V}$, $R_L = 600\text{ }\Omega$ to 1.25 V	High level	25°C	2.28	2.37		V
			–40°C to 125°C	2.18			
		Low level	25°C		0.13	0.22	
			–40°C to 125°C			0.32	
	$V_{CC+} = 2.5\text{ V}$, $R_L = 2\text{ k}\Omega$ to 1.25 V	High level	25°C	2.38	2.46		
			–40°C to 125°C	2.28			
		Low level	25°C		0.08	0.14	
			–40°C to 125°C			0.22	

LMV821 SINGLE, LMV822 DUAL, LMV824 QUAD LOW-VOLTAGE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS

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LMV8xx 2.7-V Electrical Characteristics

$V_{CC+} = 2.7\text{ V}$, $V_{CC-} = 0\text{ V}$, $V_{IC} = 1\text{ V}$, $V_O = 1.35\text{ V}$, and $R_L > 1\text{ M}\Omega$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_A	LMV8xx			UNIT
			MIN	TYP	MAX	
V_{IO} Input offset voltage		25°C		1	3.5	mV
		–40°C to 85°C			4	
α_{VIO} Average temperature coefficient of input offset voltage		25°C		1		$\mu\text{V}/^\circ\text{C}$
I_{IB} Input bias current		25°C		30	90	nA
		–40°C to 85°C			140	
I_{IO} Input offset current		25°C		0.5	30	nA
		–40°C to 85°C			50	
CMRR Common-mode rejection ratio	$V_{IC} = 0\text{ to }1.7\text{ V}$	25°C	70	85		dB
		–40°C to 85°C	68			
$+k_{SVR}$ Positive supply-voltage rejection ratio	$V_{CC+} = 1.7\text{ V to }4\text{ V}$, $V_{CC-} = -1\text{ V}$, $V_O = 0$, $V_{IC} = 0$	25°C	75	85		dB
		–40°C to 85°C	70			
$-k_{SVR}$ Negative supply-voltage rejection ratio	$V_{CC+} = 1.7\text{ V}$, $V_{CC-} = -1\text{ V to }-3.3\text{ V}$, $V_O = 0$, $V_{IC} = 0$	25°C	73	85		dB
		–40°C to 85°C	70			
V_{ICR} Common-mode input voltage range	CMRR $\geq 50\text{ dB}$	25°C	–0.2 to 1.9	–0.3 to 2		V
A_V Large-signal voltage amplification	$R_L = 600\text{ }\Omega\text{ to }1.35\text{ V}$, $V_O = 1.35\text{ V to }2.2\text{ V}$	Sourcing	25°C	90	100	dB
			–40°C to 85°C	85		
	$R_L = 600\text{ }\Omega\text{ to }1.35\text{ V}$, $V_O = 1.35\text{ V to }0.5\text{ V}$	Sinking	25°C	85	90	
			–40°C to 85°C	80		
	$R_L = 2\text{ k}\Omega\text{ to }1.35\text{ V}$, $V_O = 1.35\text{ V to }2.2\text{ V}$	Sourcing	25°C	95	100	
			–40°C to 85°C	90		
	$R_L = 2\text{ k}\Omega\text{ to }1.35\text{ V}$, $V_O = 1.35\text{ V to }0.5\text{ V}$	Sinking	25°C	90	95	
			–40°C to 85°C	85		
V_O Output swing	$V_{CC+} = 2.7\text{ V}$, $R_L = 600\text{ }\Omega\text{ to }1.35\text{ V}$	High level	25°C	2.5	2.58	V
			–40°C to 85°C	2.4		
		Low level	25°C	0.13	0.2	
			–40°C to 85°C		0.3	
	$V_{CC+} = 2.7\text{ V}$, $R_L = 2\text{ k}\Omega\text{ to }1.35\text{ V}$	High level	25°C	2.6	2.66	
			–40°C to 85°C	2.5		
		Low level	25°C	0.08	0.12	
			–40°C to 85°C		0.2	
I_O Output current	$V_O = 0\text{ V}$	Sourcing	25°C	12	16	mA
	$V_O = 2.7\text{ V}$	Sinking	25°C	12	26	
I_{CC} Supply current	LMV821		25°C	0.22	0.3	mA
			–40°C to 85°C		0.5	
	LMV822 (both amplifiers)		25°C	0.45	0.6	
			–40°C to 85°C		0.8	
	LMV824 (all four amplifiers)		25°C	0.72	1	
			–40°C to 85°C		1.2	

LMV8xx 2.7-V Electrical Characteristics (continued)

$V_{CC+} = 2.7\text{ V}$, $V_{CC-} = 0\text{ V}$, $V_{IC} = 1\text{ V}$, $V_O = 1.35\text{ V}$, and $R_L > 1\text{ M}\Omega$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A	LMV8xx			UNIT
				MIN	TYP	MAX	
SR	Slew rate ⁽¹⁾		25°C		1.7		V/ μ s
GBW	Gain bandwidth product	⁽²⁾	25°C		5		MHz
Φ_m	Phase margin	⁽²⁾	25°C		60		deg
	Gain margin	⁽²⁾	25°C		8.6		dB
	Amplifier-to-amplifier isolation	$V_{CC+} = 5\text{ V}$, $R_L = 100\text{ k}\Omega$ to 2.5 V ⁽³⁾	25°C		135		dB
V_n	Equivalent input noise voltage	$f = 1\text{ kHz}$, $V_{IC} = 1\text{ V}$	25°C		45		nV/ $\sqrt{\text{Hz}}$
I_n	Equivalent input noise current	$f = 1\text{ kHz}$	25°C		0.18		pA/ $\sqrt{\text{Hz}}$
THD	Total harmonic distortion	$f = 1\text{ kHz}$, $A_V = -2$, $R_L = 10\text{ k}\Omega$, $V_O = 4.1\text{ V}_{p-p}$	25°C		0.01		%

(1) Connected as voltage follower with 1-V step input. Value specified is the slower of the positive and negative slew rates.

(2) 40-dB closed-loop dc gain, $C_L = 22\text{ pF}$

(3) Each amplifier excited in turn with 1 kHz to produce $V_O = 3\text{ V}_{p-p}$

LMV821 SINGLE, LMV822 DUAL, LMV824 QUAD LOW-VOLTAGE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS

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LMV8xxI 2.7-V Electrical Characteristics

$V_{CC+} = 2.7\text{ V}$, $V_{CC-} = 0\text{ V}$, $V_{IC} = 1\text{ V}$, $V_O = 1.35\text{ V}$, and $R_L > 1\text{ M}\Omega$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_A	LMV8xxI			UNIT
			MIN	TYP	MAX	
V_{IO} Input offset voltage		25°C		1	3.5	mV
		–40°C to 125°C			5.5	
α_{VIO} Average temperature coefficient of input offset voltage		25°C		1		$\mu\text{V}/^\circ\text{C}$
I_{IB} Input bias current		25°C		30	90	nA
		–40°C to 125°C			140	
I_{IO} Input offset current		25°C		0.5	30	nA
		–40°C to 125°C			50	
CMRR Common-mode rejection ratio	$V_{IC} = 0\text{ to }1.7\text{ V}$	25°C	70	85		dB
		–40°C to 125°C	68			
$+k_{SVR}$ Positive supply-voltage rejection ratio	$V_{CC+} = 1.7\text{ V to }4\text{ V}$, $V_{CC-} = -1\text{ V}$, $V_O = 0$, $V_{IC} = 0$	25°C	75	85		dB
		–40°C to 125°C	70			
$-k_{SVR}$ Negative supply-voltage rejection ratio	$V_{CC+} = 1.7\text{ V}$, $V_{CC-} = -1\text{ V to }-3.3\text{ V}$, $V_O = 0$, $V_{IC} = 0$	25°C	73	85		dB
		–40°C to 125°C	70			
V_{ICR} Common-mode input voltage range	CMRR $\geq 50\text{ dB}$	25°C	–0.2 to 1.9	–0.3 to 2		V
A_V Large-signal voltage amplification	$R_L = 600\text{ }\Omega\text{ to }1.35\text{ V}$, $V_O = 1.35\text{ V to }2.2\text{ V}$	Sourcing	25°C	90	100	dB
			–40°C to 125°C	85		
	$R_L = 600\text{ }\Omega\text{ to }1.35\text{ V}$, $V_O = 1.35\text{ V to }0.5\text{ V}$	Sinking	25°C	85	90	
			–40°C to 125°C	80		
	$R_L = 2\text{ k}\Omega\text{ to }1.35\text{ V}$, $V_O = 1.35\text{ V to }2.2\text{ V}$	Sourcing	25°C	95	100	
			–40°C to 125°C	90		
	$R_L = 2\text{ k}\Omega\text{ to }1.35\text{ V}$, $V_O = 1.35\text{ V to }0.5\text{ V}$	Sinking	25°C	90	95	
			–40°C to 125°C	85		
V_O Output swing	$V_{CC+} = 2.7\text{ V}$, $R_L = 600\text{ }\Omega\text{ to }1.35\text{ V}$	High level	25°C	2.5	2.58	V
			–40°C to 125°C	2.4		
		Low level	25°C	0.13	0.2	
			–40°C to 125°C		0.3	
	$V_{CC+} = 2.7\text{ V}$, $R_L = 2\text{ k}\Omega\text{ to }1.35\text{ V}$	High level	25°C	2.6	2.66	
			–40°C to 125°C	2.5		
		Low level	25°C	0.08	0.12	
			–40°C to 125°C		0.2	
I_O Output current	$V_O = 0\text{ V}$	Sourcing	25°C	12	16	mA
	$V_O = 2.7\text{ V}$	Sinking	25°C	12	26	
I_{CC} Supply current	LMV821		25°C	0.22	0.3	mA
			–40°C to 125°C		0.5	
	LMV822 (both amplifiers)		25°C	0.45	0.6	
			–40°C to 125°C		0.8	
	LMV824 (all four amplifiers)		25°C	0.72	1	
			–40°C to 125°C		1.2	

LMV8xxI 2.7-V Electrical Characteristics (continued)

$V_{CC+} = 2.7\text{ V}$, $V_{CC-} = 0\text{ V}$, $V_{IC} = 1\text{ V}$, $V_O = 1.35\text{ V}$, and $R_L > 1\text{ M}\Omega$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A	LMV8xxI			UNIT
				MIN	TYP	MAX	
SR	Slew rate ⁽¹⁾		25°C		1.7		V/ μ s
GBW	Gain bandwidth product	⁽²⁾	25°C		5		MHz
Φ_m	Phase margin	⁽²⁾	25°C		60		deg
	Gain margin	⁽²⁾	25°C		8.6		dB
	Amplifier-to-amplifier isolation	$V_{CC+} = 5\text{ V}$, $R_L = 100\text{ k}\Omega$ to 2.5 V ⁽³⁾	25°C		135		dB
V_n	Equivalent input noise voltage	$f = 1\text{ kHz}$, $V_{IC} = 1\text{ V}$	25°C		45		nV/ $\sqrt{\text{Hz}}$
I_n	Equivalent input noise current	$f = 1\text{ kHz}$	25°C		0.18		pA/ $\sqrt{\text{Hz}}$
THD	Total harmonic distortion	$f = 1\text{ kHz}$, $A_V = -2$, $R_L = 10\text{ k}\Omega$, $V_O = 4.1\text{ V}_{p-p}$	25°C		0.01		%

(1) Connected as voltage follower with 1-V step input. Value specified is the slower of the positive and negative slew rates.

(2) 40-dB closed-loop dc gain, $C_L = 22\text{ pF}$

(3) Each amplifier excited in turn with 1 kHz to produce $V_O = 3\text{ V}_{p-p}$

LMV821 SINGLE, LMV822 DUAL, LMV824 QUAD LOW-VOLTAGE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS

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LMV8xx 5-V Electrical Characteristics

$V_{CC+} = 5\text{ V}$, $V_{CC-} = 0\text{ V}$, $V_{IC} = 2\text{ V}$, $V_O = 2.5\text{ V}$, and $R_L > 1\text{ M}\Omega$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T _A	LMV8xx			UNIT
					MIN	TYP	MAX	
V _{IO}	Input offset voltage			25°C	1	3.5	mV	
				–40°C to 85°C	4			
α _{VIO}	Average temperature coefficient of input offset voltage			25°C	1		μV/°C	
I _{IB}	Input bias current			25°C	40	100	nA	
				–40°C to 85°C	150			
I _{IO}	Input offset current			25°C	0.5	30	nA	
				–40°C to 85°C	50			
CMRR	Common-mode rejection ratio	V _{IC} = 0 to 4 V		25°C	72	90	dB	
				–40°C to 85°C	70			
+k _{SVR}	Positive supply-voltage rejection ratio	V _{CC+} = 1.7 V to 4 V, V _{CC–} = –1 V, V _O = 0, V _{IC} = 0		25°C	75	85	dB	
				–40°C to 85°C	70			
–k _{SVR}	Negative supply-voltage rejection ratio	V _{CC+} = 1.7 V, V _{CC–} = –1 V to –3.3 V, V _O = 0, V _{IC} = 0		25°C	73	85	dB	
				–40°C to 85°C	70			
V _{ICR}	Common-mode input voltage range	CMRR ≥ 50 dB		25°C	–0.2 to 4.2	–0.3 to 4.3	V	
A _V	Large-signal voltage amplification	R _L = 600 Ω to 2.5 V, V _O = 2.5 V to 4.5 V	Sourcing	25°C	95	105	dB	
				–40°C to 85°C	90			
		R _L = 600 Ω to 2.5 V, V _O = 2.5 V to 0.5 V	Sinking	25°C	95	105		
				–40°C to 85°C	90			
		R _L = 2 kΩ to 2.5 V, V _O = 2.5 V to 4.5 V	Sourcing	25°C	95	105		
				–40°C to 85°C	90			
		R _L = 2 kΩ to 2.5 V, V _O = 2.5 V to 0.5 V	Sinking	25°C	95	105		
				–40°C to 85°C	90			
V _O	Output swing	V _{CC+} = 5 V, R _L = 600 Ω to 2.5 V	High level	25°C	4.75	4.84	V	
				–40°C to 85°C	4.7			
			Low level	25°C	0.17	0.25		
				–40°C to 85°C		0.3		
		V _{CC+} = 5 V, R _L = 2 kΩ to 2.5 V	High level	25°C	4.85	4.9		
				–40°C to 85°C	4.8			
	Low level		25°C	0.1	0.15			
			–40°C to 85°C		0.2			
I _O	Output current	V _O = 0 V	Sourcing	25°C	20	45	mA	
				–40°C to 85°C	15			
		V _O = 5 V	Sinking	25°C	20	40		
				–40°C to 85°C	15			
I _{CC}	Supply current	LMV821		25°C	0.3	0.4	mA	
				–40°C to 85°C		0.6		
		LMV822 (both amplifiers)		25°C	0.5	0.7		
				–40°C to 85°C		0.9		
		LMV824 (all four amplifiers)		25°C	1	0.3		
				–40°C to 85°C		1.5		

LMV8xx 5-V Electrical Characteristics (continued)

$V_{CC+} = 5\text{ V}$, $V_{CC-} = 0\text{ V}$, $V_{IC} = 2\text{ V}$, $V_O = 2.5\text{ V}$, and $R_L > 1\text{ M}\Omega$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A	LMV8xx			UNIT
				MIN	TYP	MAX	
SR	Slew rate	$V_{CC+} = 5\text{ V}^{(1)}$	25°C	1.4	1.9		V/ μ s
GBW	Gain bandwidth product	⁽²⁾	25°C		5.5		MHz
Φ_m	Phase margin	⁽²⁾	25°C		64.2		deg
	Gain margin	⁽²⁾	25°C		8.7		dB
	Amplifier-to-amplifier isolation	$V_{CC+} = 5\text{ V}$, $R_L = 100\text{ k}\Omega$ to $2.5\text{ V}^{(3)}$	25°C		135		dB
V_n	Equivalent input noise voltage	$f = 1\text{ kHz}$, $V_{IC} = 1\text{ V}$	25°C		42		nV/ $\sqrt{\text{Hz}}$
I_n	Equivalent input noise current	$f = 1\text{ kHz}$	25°C		0.2		pA/ $\sqrt{\text{Hz}}$
THD	Total harmonic distortion	$f = 1\text{ kHz}$, $A_V = -2$, $R_L = 10\text{ k}\Omega$, $V_O = 4.1\text{ V}_{p-p}$	25°C		0.01		%

(1) Connected as voltage follower with 3-V step input. Value specified is the slower of the positive and negative slew rates.

(2) 40-dB closed-loop dc gain, $C_L = 22\text{ pF}$

(3) Each amplifier excited in turn with 1 kHz to produce $V_O = 3\text{ V}_{p-p}$

LMV821 SINGLE, LMV822 DUAL, LMV824 QUAD LOW-VOLTAGE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS

SLOS434G—FEBRUARY 2004—REVISED AUGUST 2005

LMV8xxI 5-V Electrical Characteristics

$V_{CC+} = 5\text{ V}$, $V_{CC-} = 0\text{ V}$, $V_{IC} = 2\text{ V}$, $V_O = 2.5\text{ V}$, and $R_L > 1\text{ M}\Omega$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_A	LMV8xxI			UNIT
			MIN	TYP	MAX	
V_{IO} Input offset voltage		25°C		1	3.5	mV
		–40°C to 125°C			5.5	
α_{VIO} Average temperature coefficient of input offset voltage		25°C		1		$\mu\text{V}/^\circ\text{C}$
I_{IB} Input bias current		25°C		40	100	nA
		–40°C to 125°C			150	
I_{IO} Input offset current		25°C		0.5	30	nA
		–40°C to 125°C			50	
CMRR Common-mode rejection ratio	$V_{IC} = 0\text{ to }4\text{ V}$	25°C	72	90		dB
		–40°C to 125°C	70			
$+k_{SVR}$ Positive supply-voltage rejection ratio	$V_{CC+} = 1.7\text{ V to }4\text{ V}$, $V_{CC-} = -1\text{ V}$, $V_O = 0$, $V_{IC} = 0$	25°C	75	85		dB
		–40°C to 125°C	70			
$-k_{SVR}$ Negative supply-voltage rejection ratio	$V_{CC+} = 1.7\text{ V}$, $V_{CC-} = -1\text{ V to }-3.3\text{ V}$, $V_O = 0$, $V_{IC} = 0$	25°C	73	85		dB
		–40°C to 125°C	70			
V_{ICR} Common-mode input voltage range	CMRR $\geq 50\text{ dB}$	25°C	–0.2 to 4.2	–0.3 to 4.3		V
A_V Large-signal voltage amplification	$R_L = 600\text{ }\Omega\text{ to }2.5\text{ V}$, $V_O = 2.5\text{ V to }4.5\text{ V}$	Sourcing	25°C	95	105	dB
			–40°C to 125°C	90		
	$R_L = 600\text{ }\Omega\text{ to }2.5\text{ V}$, $V_O = 2.5\text{ V to }0.5\text{ V}$	Sinking	25°C	95	105	
			–40°C to 125°C	90		
	$R_L = 2\text{ k}\Omega\text{ to }2.5\text{ V}$, $V_O = 2.5\text{ V to }4.5\text{ V}$	Sourcing	25°C	95	105	
			–40°C to 125°C	90		
	$R_L = 2\text{ k}\Omega\text{ to }2.5\text{ V}$, $V_O = 2.5\text{ V to }0.5\text{ V}$	Sinking	25°C	95	105	
			–40°C to 125°C	90		
V_O Output swing	$V_{CC+} = 5\text{ V}$, $R_L = 600\text{ }\Omega\text{ to }2.5\text{ V}$	High level	25°C	4.75	4.84	V
			–40°C to 125°C	4.6		
		Low level	25°C	0.17	0.25	
			–40°C to 125°C		0.3	
	$V_{CC+} = 5\text{ V}$, $R_L = 2\text{ k}\Omega\text{ to }2.5\text{ V}$	High level	25°C	4.85	4.9	
			–40°C to 125°C	4.8		
		Low level	25°C	0.1	0.15	
			–40°C to 125°C		0.2	
I_O Output current	$V_O = 0\text{ V}$	Sourcing	25°C	20	45	mA
			–40°C to 125°C	15		
	$V_O = 5\text{ V}$	Sinking	25°C	20	40	
			–40°C to 125°C	15		
I_{CC} Supply current	LMV821		25°C	0.3	0.4	mA
			–40°C to 125°C		0.6	
	LMV822 (both amplifiers)		25°C	0.5	0.7	
			–40°C to 125°C		0.9	
	LMV824 (all four amplifiers)		25°C	1	1.3	
			–40°C to 125°C		1.5	

LMV8xxI 5-V Electrical Characteristics (continued)

$V_{CC+} = 5\text{ V}$, $V_{CC-} = 0\text{ V}$, $V_{IC} = 2\text{ V}$, $V_O = 2.5\text{ V}$, and $R_L > 1\text{ M}\Omega$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A	LMV8xxI			UNIT
				MIN	TYP	MAX	
SR	Slew rate	$V_{CC+} = 5\text{ V}^{(1)}$	25°C	1.4	1.9		V/ μ s
GBW	Gain bandwidth product	⁽²⁾	25°C		5.5		MHz
Φ_m	Phase margin	⁽²⁾	25°C		64.2		deg
	Gain margin	⁽²⁾	25°C		8.7		dB
	Amplifier-to-amplifier isolation	$V_{CC+} = 5\text{ V}$, $R_L = 100\text{ k}\Omega$ to $2.5\text{ V}^{(3)}$	25°C		135		dB
V_n	Equivalent input noise voltage	$f = 1\text{ kHz}$, $V_{IC} = 1\text{ V}$	25°C		42		nV/ $\sqrt{\text{Hz}}$
I_n	Equivalent input noise current	$f = 1\text{ kHz}$	25°C		0.2		pA/ $\sqrt{\text{Hz}}$
THD	Total harmonic distortion	$f = 1\text{ kHz}$, $A_V = -2$, $R_L = 10\text{ k}\Omega$, $V_O = 4.1\text{ V}_{p-p}$	25°C		0.01		%

(1) Connected as voltage follower with 3-V step input. Value specified is the slower of the positive and negative slew rates.

(2) 40-dB closed-loop dc gain, $C_L = 22\text{ pF}$

(3) Each amplifier excited in turn with 1 kHz to produce $V_O = 3\text{ V}_{p-p}$

TYPICAL CHARACTERISTICS

$T_A = 25^\circ\text{C}$, $V_{CC+} = 5\text{-V}$ Single Supply (Unless Otherwise Noted)

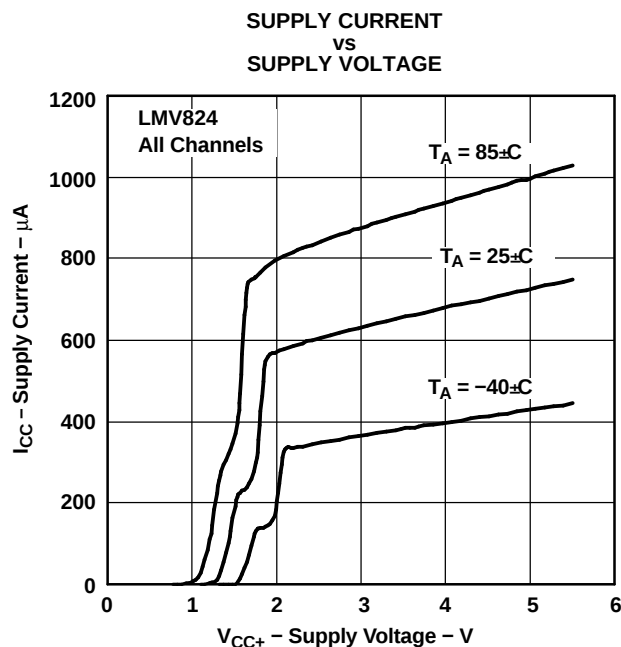


Figure 1.

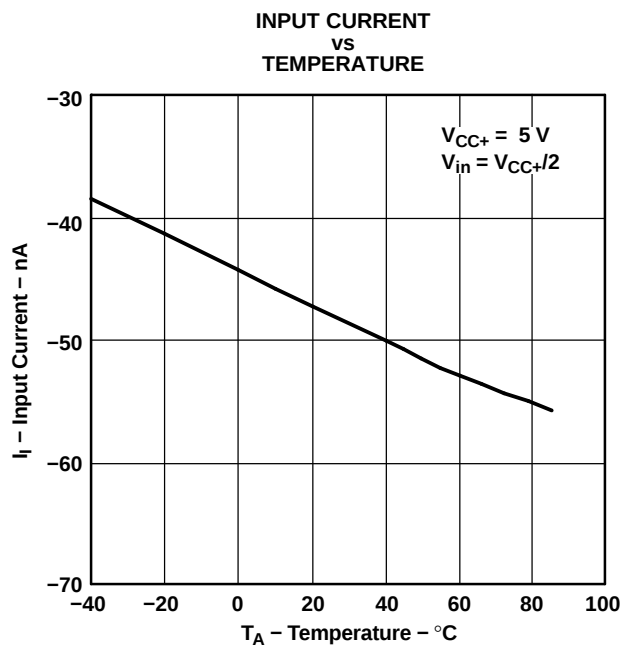


Figure 2.

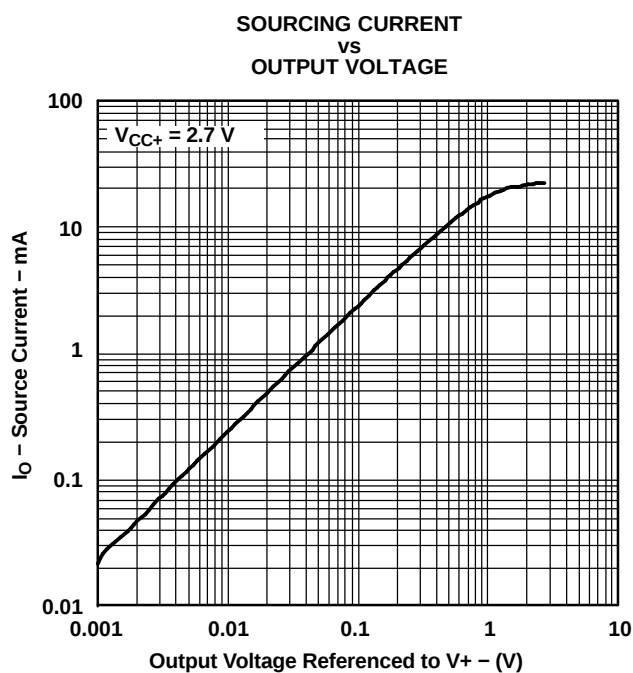


Figure 3.

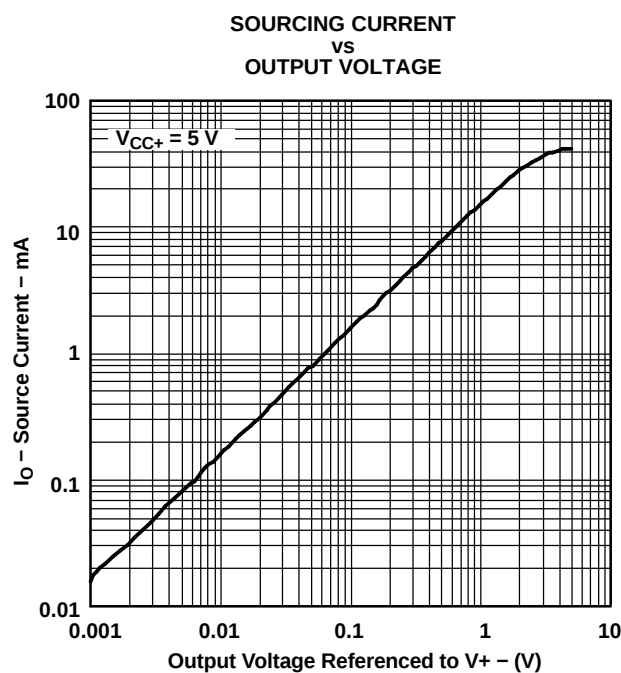


Figure 4.

TYPICAL CHARACTERISTICS (continued)

$T_A = 25^\circ\text{C}$, $V_{CC+} = 5\text{-V}$ Single Supply (Unless Otherwise Noted)

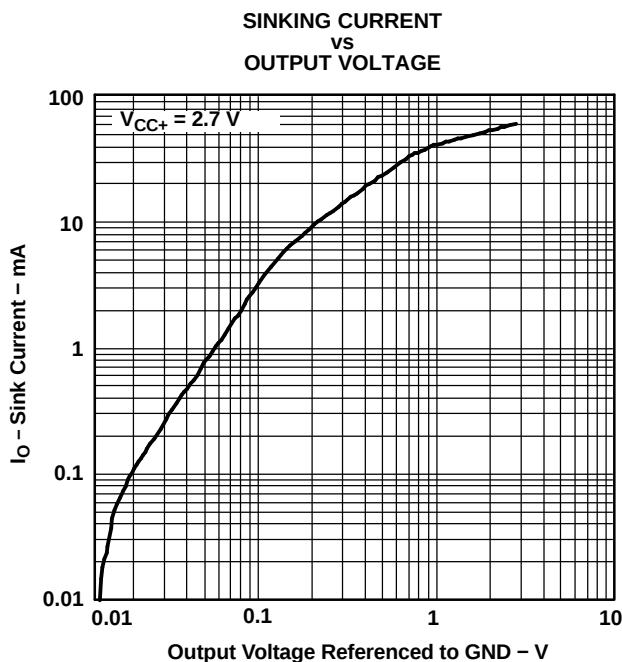


Figure 5.

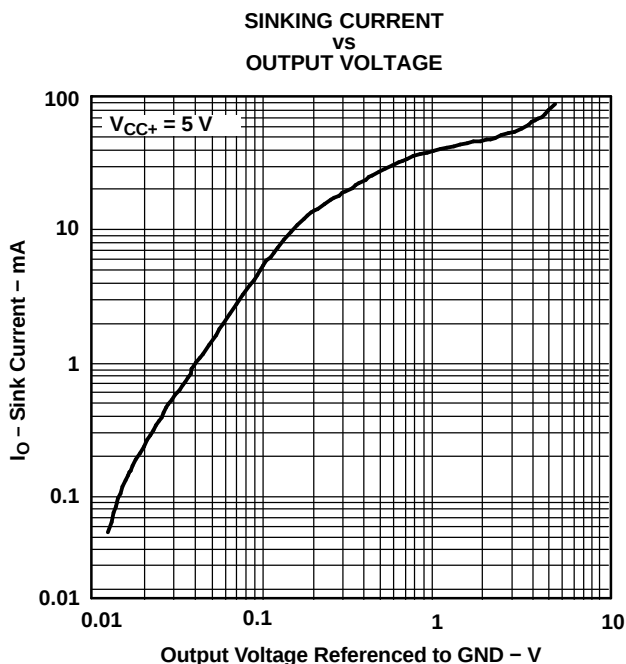


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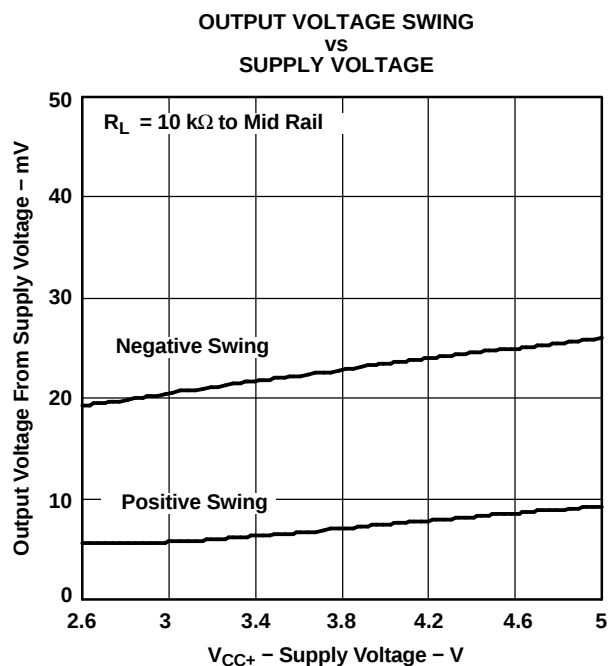


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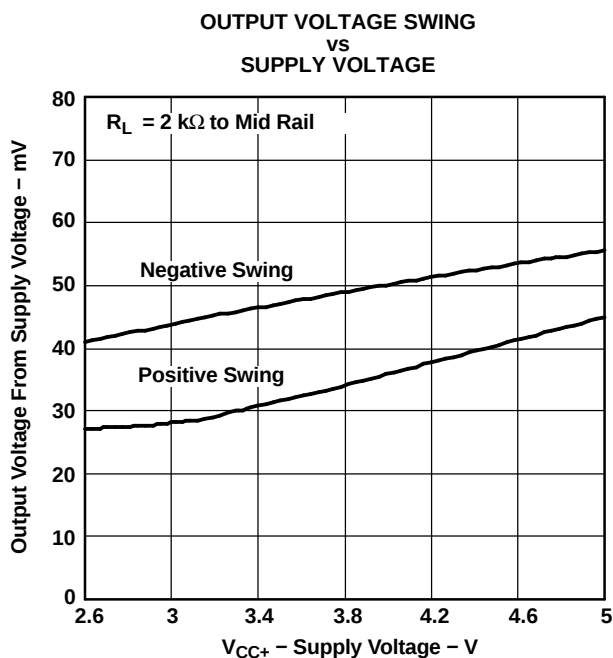


Figure 8.

TYPICAL CHARACTERISTICS (continued)

$T_A = 25^\circ\text{C}$, $V_{CC+} = 5\text{-V}$ Single Supply (Unless Otherwise Noted)

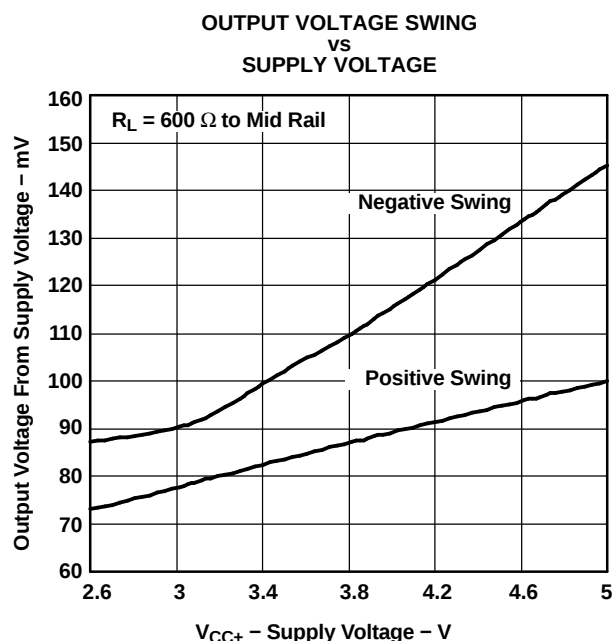


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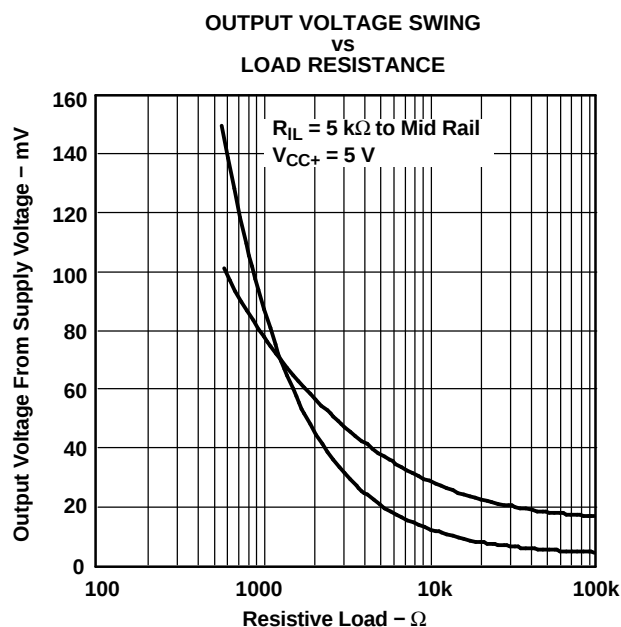


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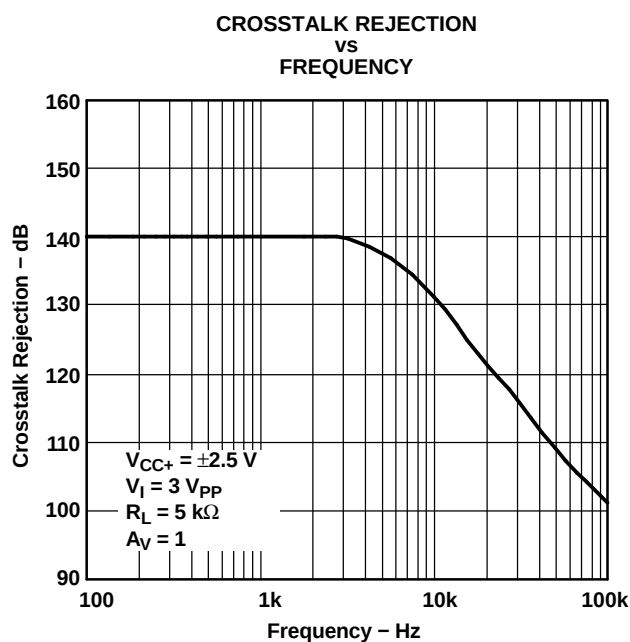


Figure 11.

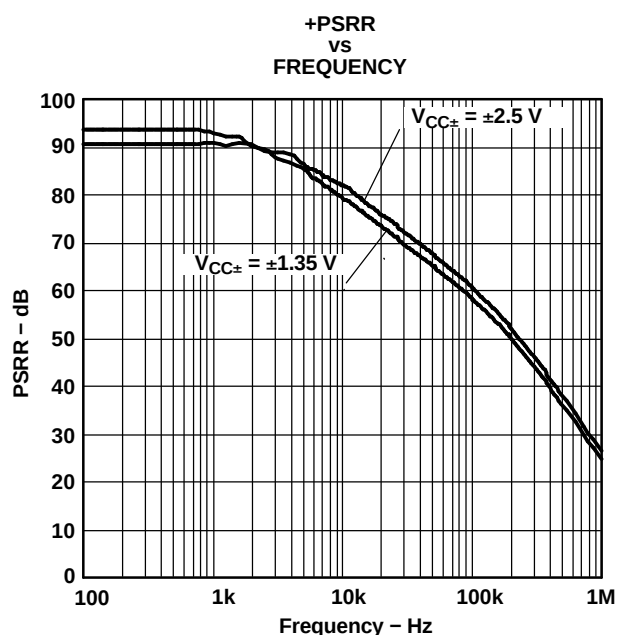
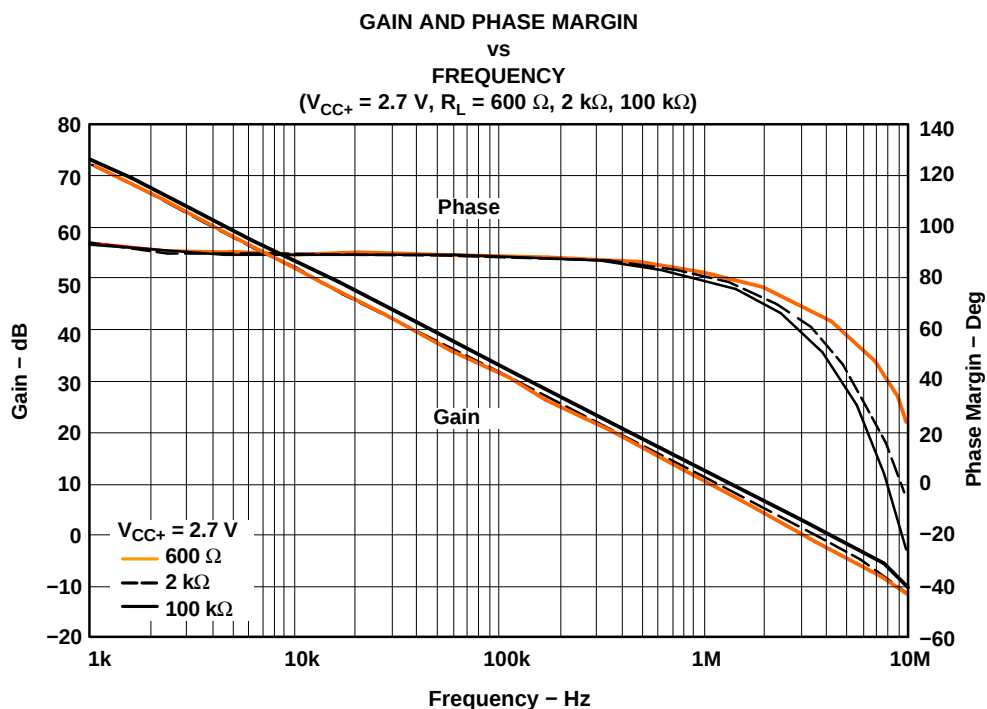
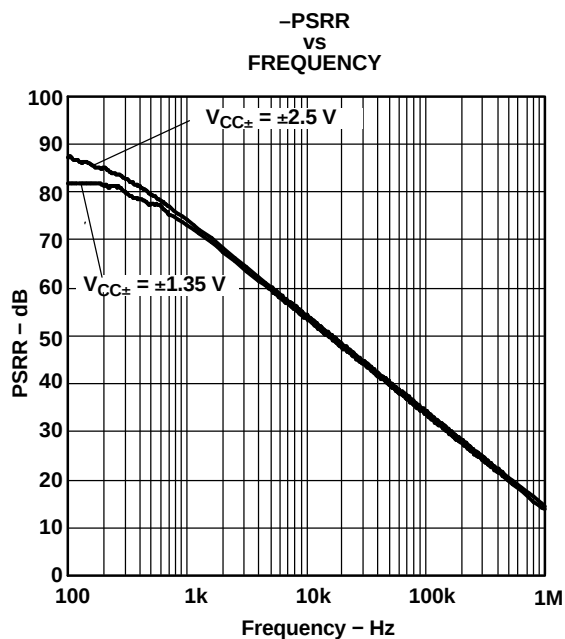


Figure 12.

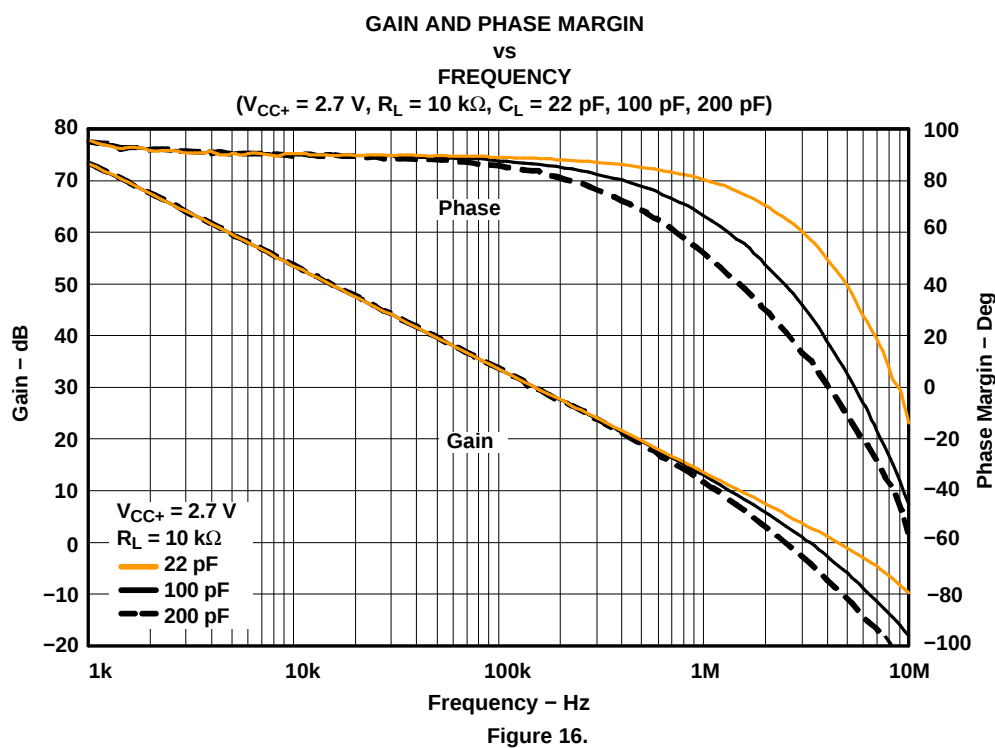
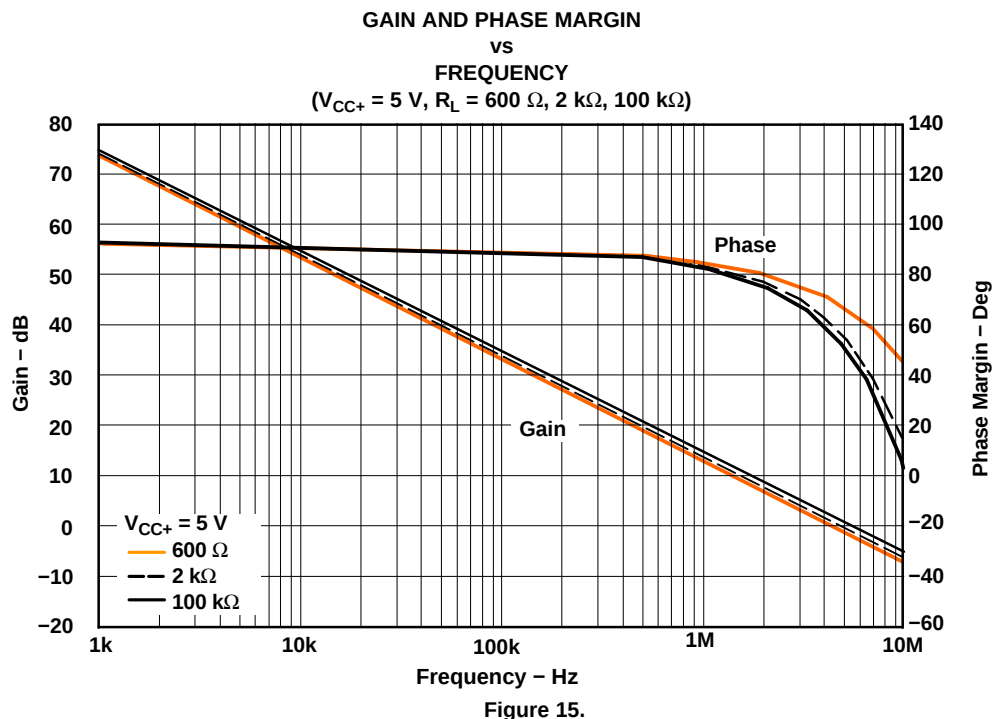
TYPICAL CHARACTERISTICS (continued)

$T_A = 25^\circ\text{C}$, $V_{CC+} = 5\text{-V}$ Single Supply (Unless Otherwise Noted)



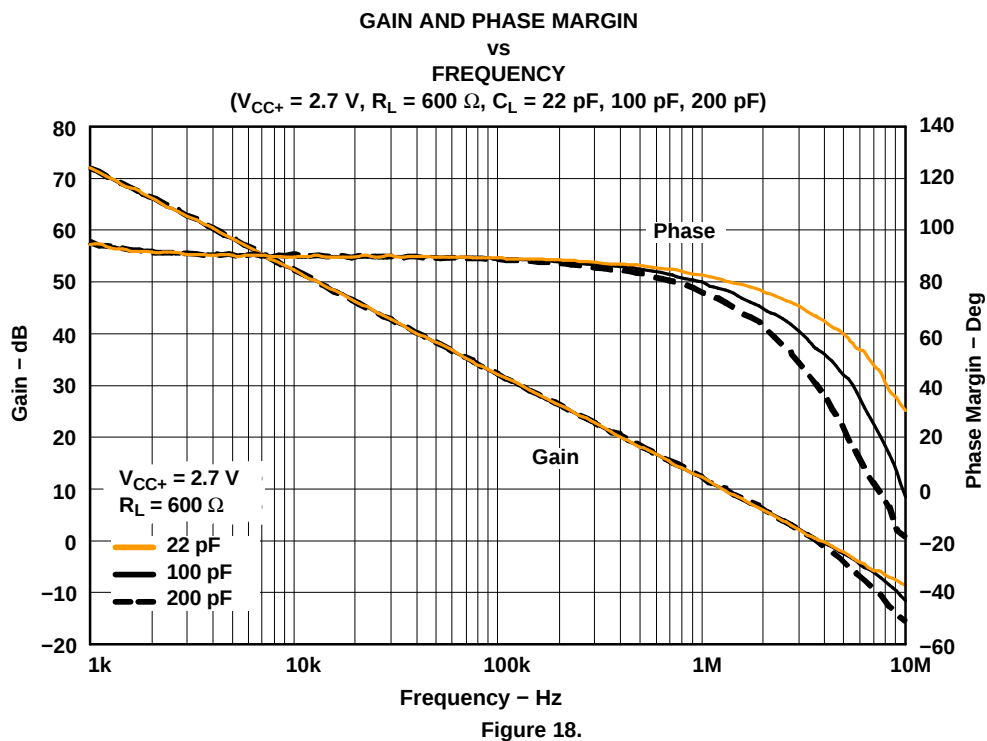
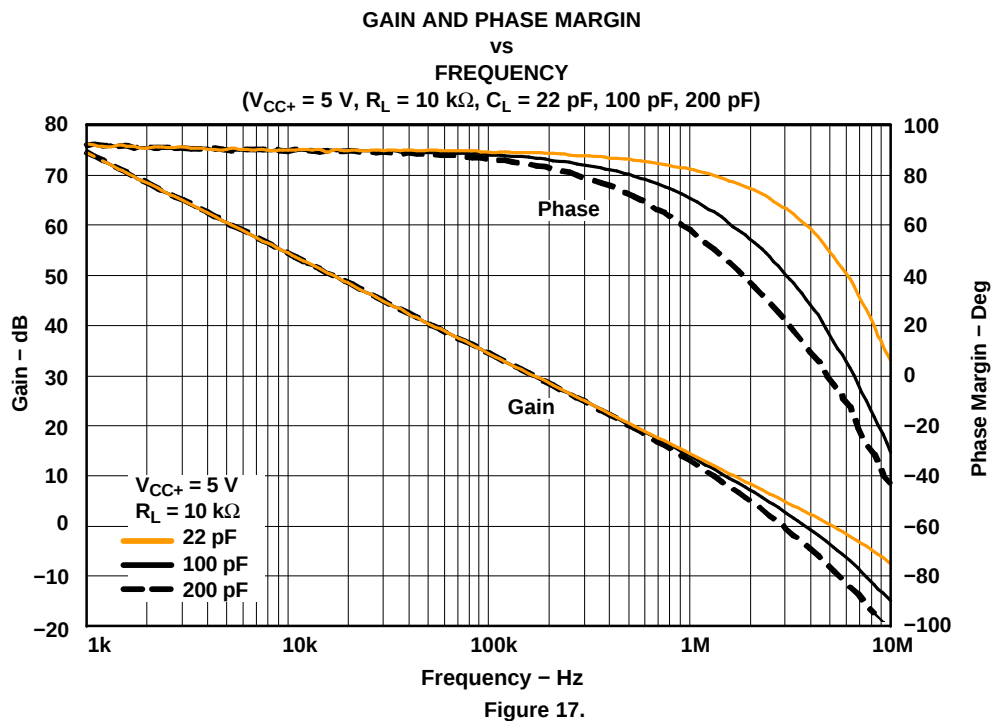
TYPICAL CHARACTERISTICS (continued)

$T_A = 25^\circ\text{C}$, $V_{CC+} = 5\text{-V}$ Single Supply (Unless Otherwise Noted)



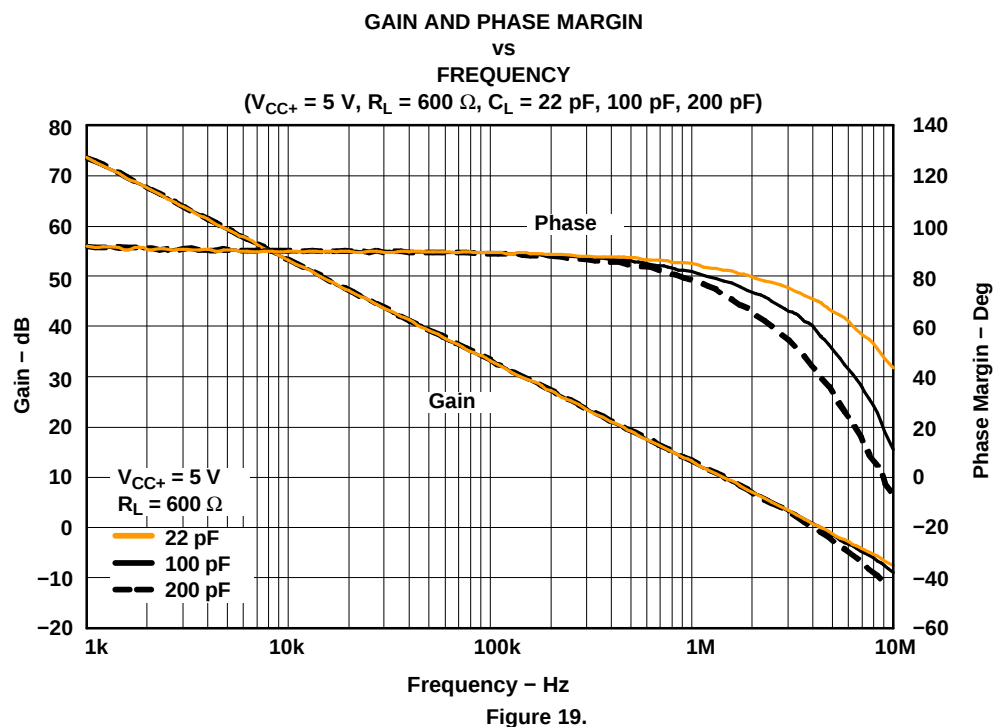
TYPICAL CHARACTERISTICS (continued)

$T_A = 25^\circ\text{C}$, $V_{CC+} = 5\text{-V}$ Single Supply (Unless Otherwise Noted)



TYPICAL CHARACTERISTICS (continued)

$T_A = 25^\circ\text{C}$, $V_{CC+} = 5\text{-V}$ Single Supply (Unless Otherwise Noted)



PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
LMV821DBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV821DBVRE4	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV821DBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV821DBVTE4	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV821DCKR	ACTIVE	SC70	DCK	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV821DCKRE4	ACTIVE	SC70	DCK	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV821DCKT	ACTIVE	SC70	DCK	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV821DCKTE4	ACTIVE	SC70	DCK	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV821IDBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV821IDBVRE4	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV821IDBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV821IDBVTE4	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV821IDCKR	ACTIVE	SC70	DCK	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV821IDCKRE4	ACTIVE	SC70	DCK	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV821IDCKT	ACTIVE	SC70	DCK	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV821IDCKTE4	ACTIVE	SC70	DCK	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV822D	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV822DE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV822DGKR	ACTIVE	MSOP	DGK	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV822DR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV822DRE4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV822ID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV822IDE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV822IDGKR	ACTIVE	MSOP	DGK	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV822IDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
LMV822IDRE4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV824D	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV824DE4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV824DGVR	ACTIVE	TVSOP	DGV	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV824DGVRE4	ACTIVE	TVSOP	DGV	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV824DR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV824DRE4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV824ID	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV824IDE4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV824IDGVR	ACTIVE	TVSOP	DGV	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV824IDGVRE4	ACTIVE	TVSOP	DGV	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV824IDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV824IDRE4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV824IPW	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV824IPWE4	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV824IPWR	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV824IPWRE4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV824PW	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV824PWE4	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV824PWR	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LMV824PWRE4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS) 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.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

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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.

DGV (R-PDSO-G**)

PLASTIC SMALL-OUTLINE

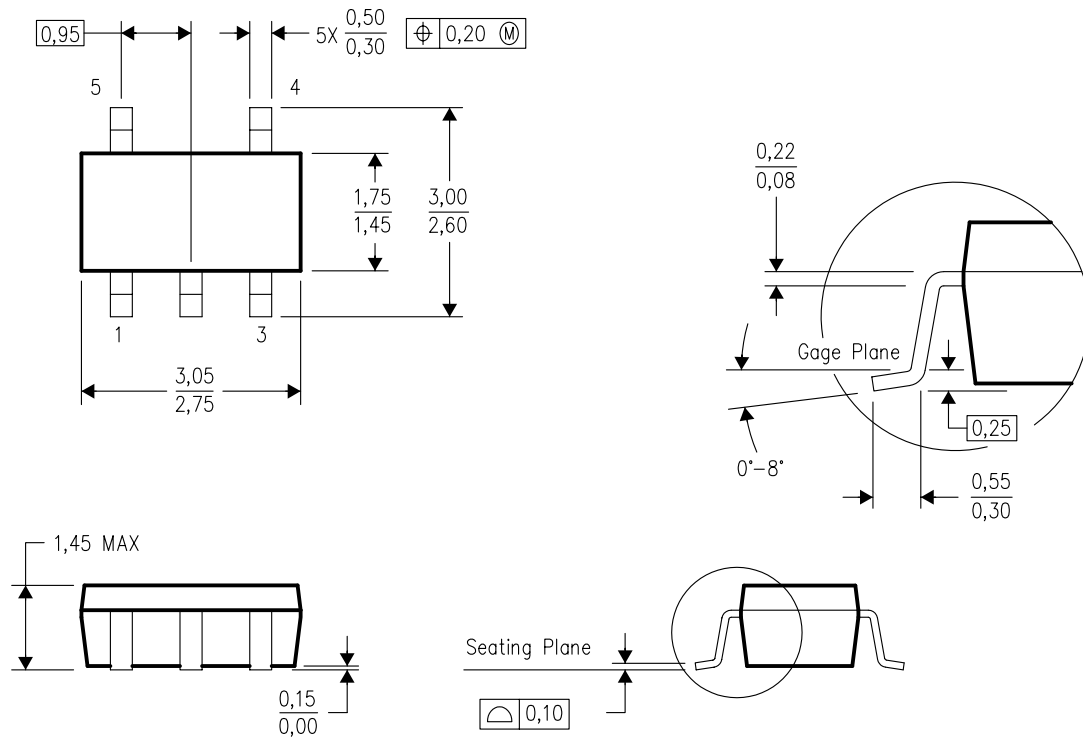
24 PINS SHOWN



- 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 per side.
 D. Falls within JEDEC: 24/48 Pins – MO-153
 14/16/20/56 Pins – MO-194

DBV (R-PDSO-G5)

PLASTIC SMALL-OUTLINE PACKAGE

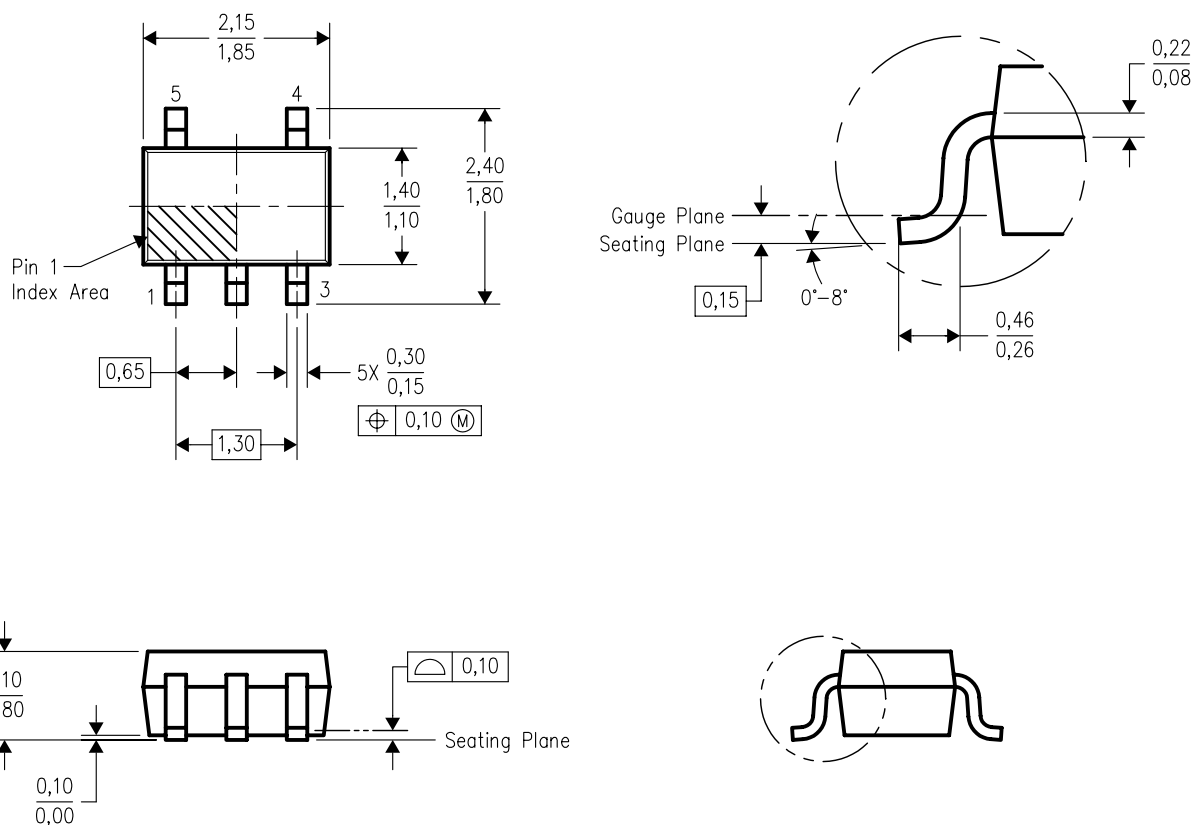


4073253-4/J 10/2005

- 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

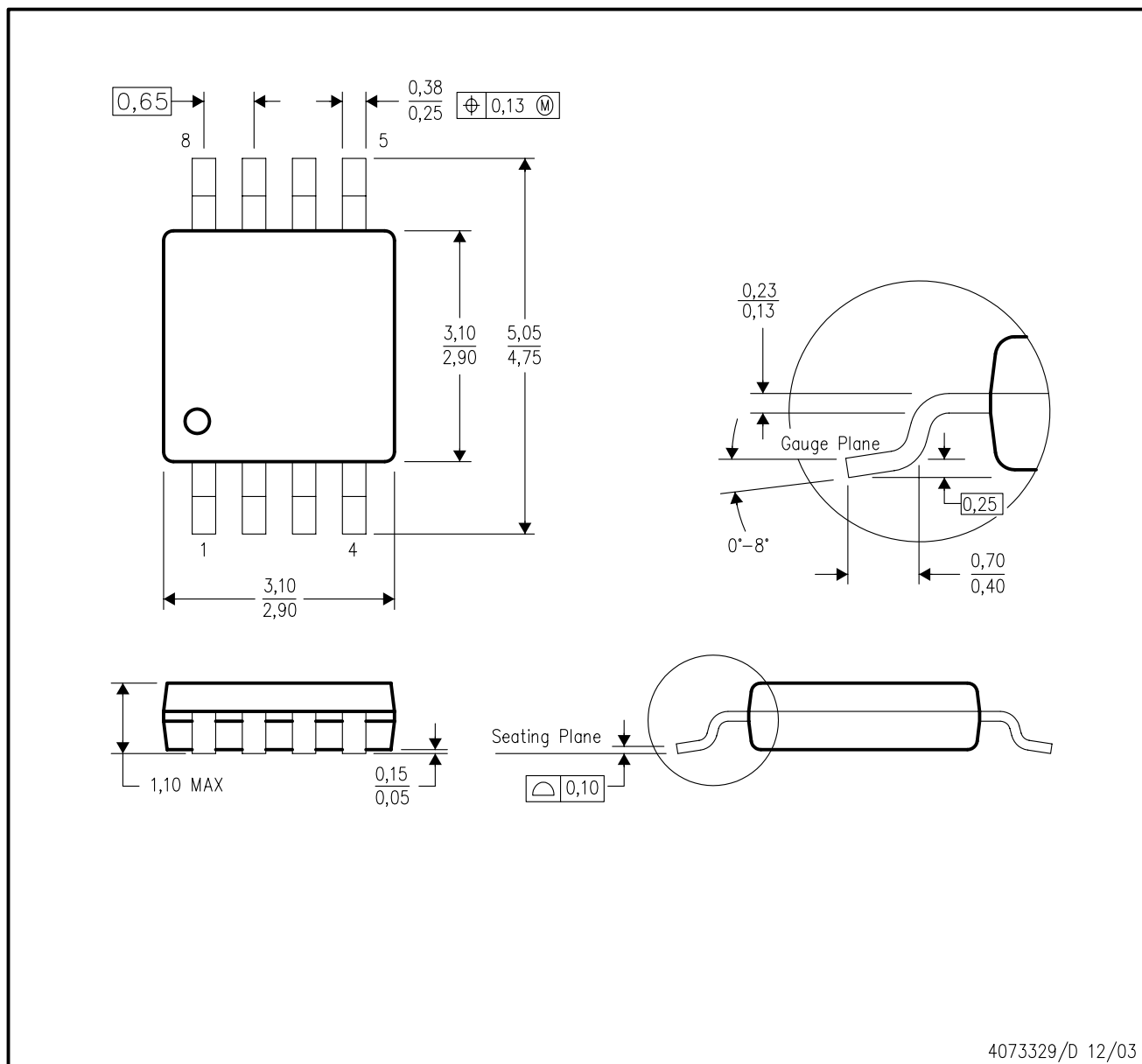


4093553-2/E 10/2005

- 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 AA.

DGK (S-PDSO-G8)

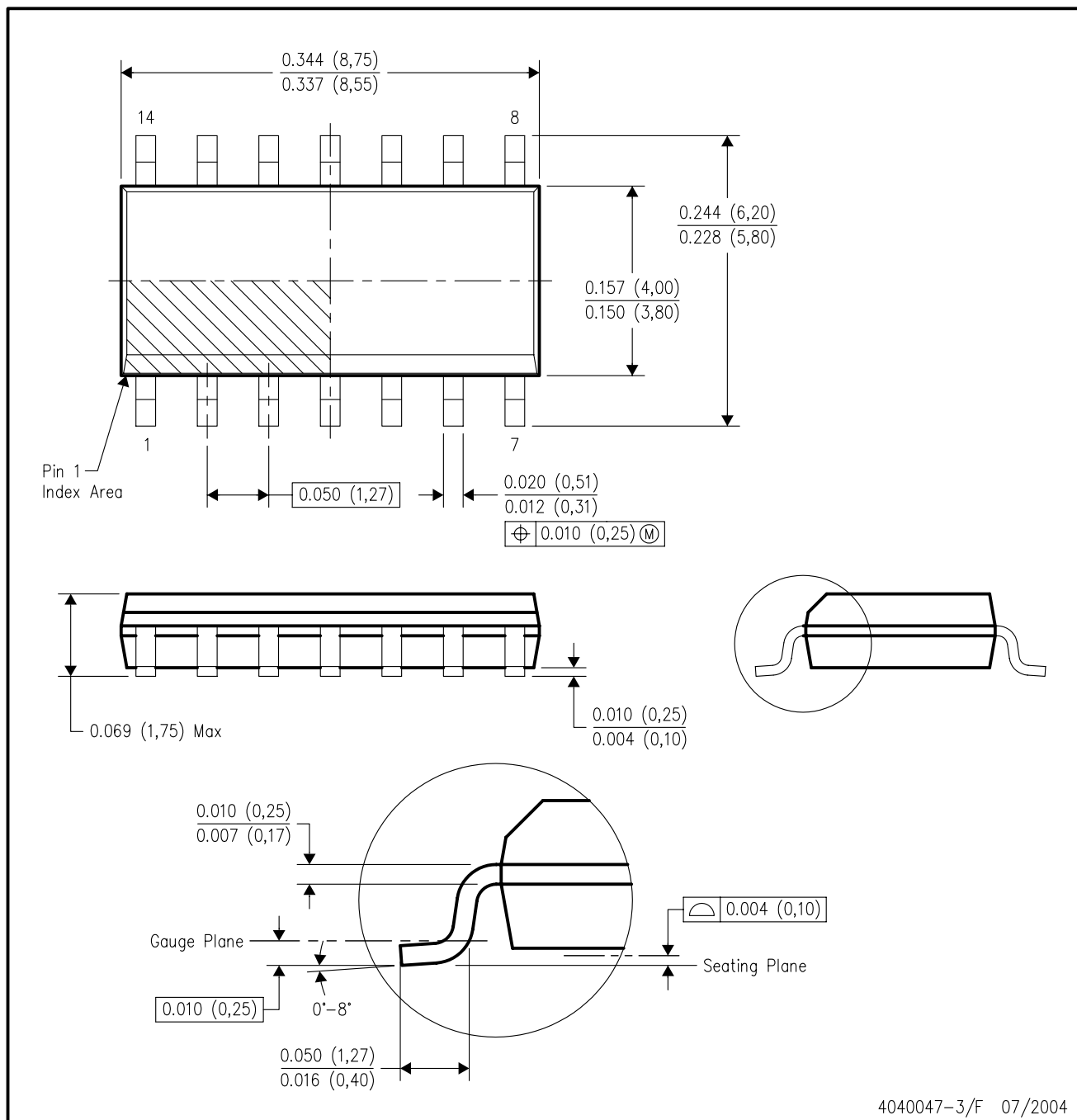
PLASTIC SMALL-OUTLINE PACKAGE



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

D (R-PDSO-G14)

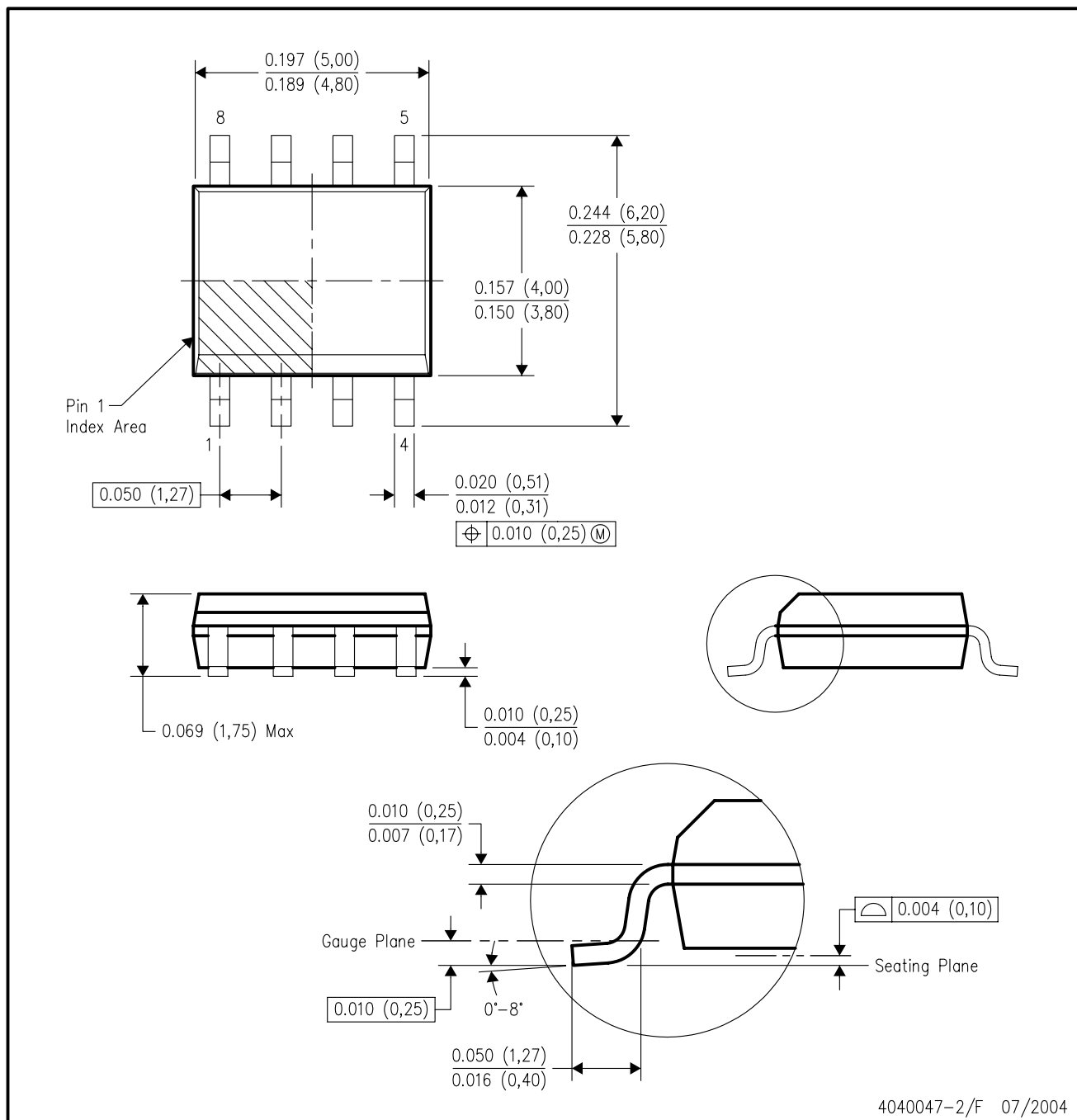
PLASTIC SMALL-OUTLINE PACKAGE



4040047-3/F 07/2004

D (R-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE

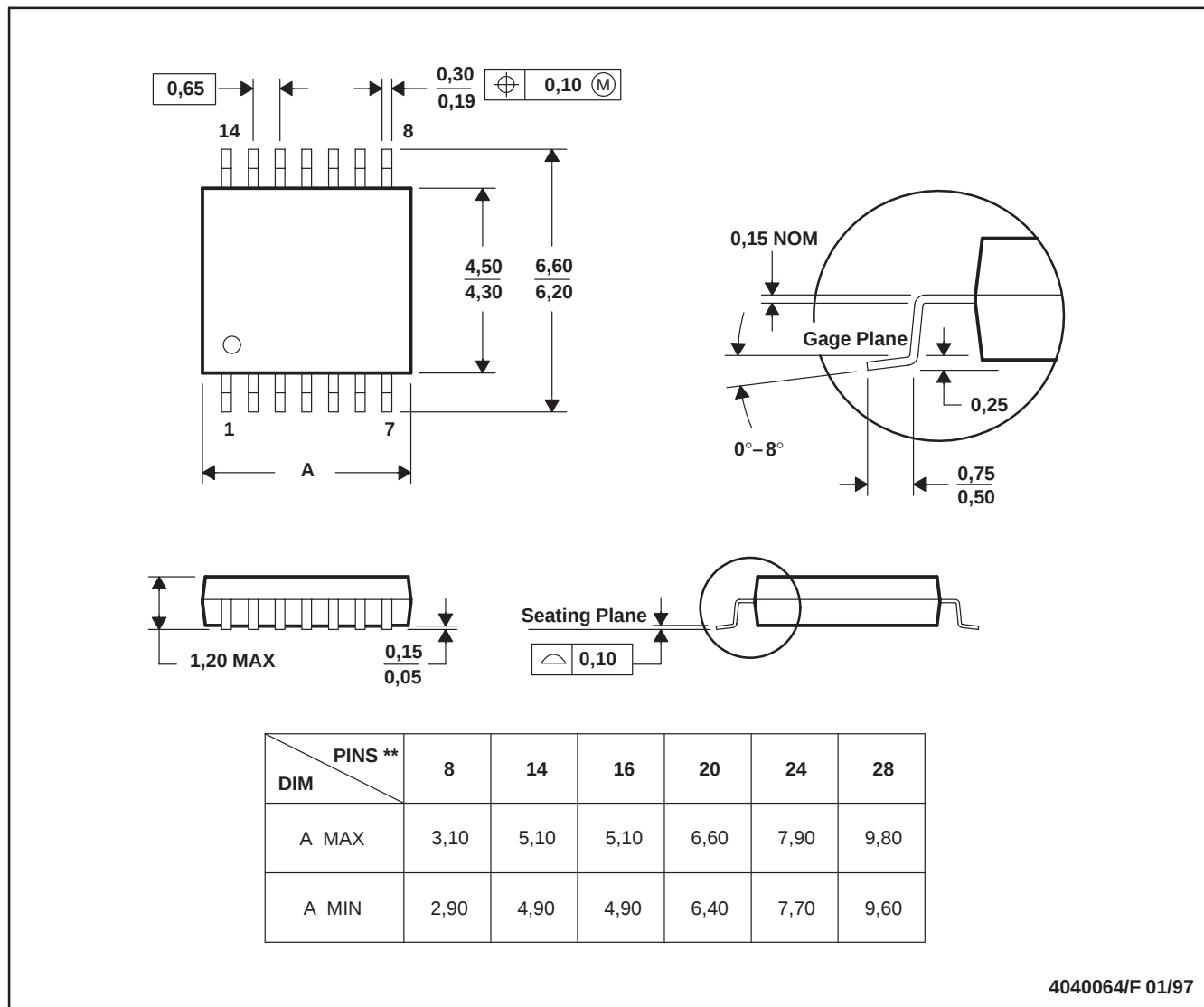


- NOTES:
- All linear dimensions are in inches (millimeters).
 - This drawing is subject to change without notice.
 - Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
 - Falls within JEDEC MS-012 variation AA.

PW (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



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

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