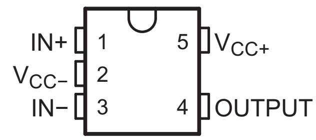
1.8-V OPERATIONAL AMPLIFIERS WITH RAIL-TO-RAIL INPUT AND OUTPUT

Check for Samples: LMV931-Q1, LMV932-Q1, LMV934-Q1

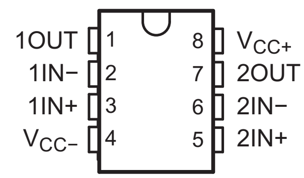
FEATURES

- **Qualified for Automotive Applications**
- **1.8-V, 2.7-V, and 5-V Specifications**
- **Rail-to-Rail Output Swing**
  - **600-Ω Load: 80 mV From Rail**
  - **2-kΩ Load: 30 mV From Rail**
- **V_{ICR}: 200 mV Beyond Rails**
- **Gain Bandwidth: 1.4 MHz**
- **Supply Current: 100 µA/Amplifier**
- **Max V_{IO}: 4 mV**
- **Space-Saving Packages**
  - **LMV931: SOT-23 and SC-70**
  - **LMV932: SOIC**
  - **LMV934: SOIC**

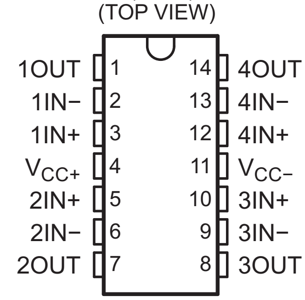
LMV931...DBV (SOT-23-5) OR DCK (SC-70) PACKAGE
(TOP VIEW)



LMV932...D (SOIC) PACKAGE
(TOP VIEW)



LMV934...D (SOIC) PACKAGE
(TOP VIEW)



APPLICATIONS

- **Industrial (Utility/Energy Metering)**
- **Automotive**
- **Communications (Optical Telecom, Data/Voice Cable Modems)**
- **Consumer Electronics (PDAs, PCs, CD-R/W, Portable Audio)**
- **Supply-Current Monitoring**
- **Battery Monitoring**

DESCRIPTION

The LMV93x 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 LMV93x 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-Ω load (at 1.8-V operation).

During 1.8-V operation, the devices typically consume a quiescent current of 103 µA 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-Ω load and 1000-pF capacitance with minimal ringing.

The LMV93x devices are offered in the latest packaging technology to meet the most demanding space-constraint applications. The LMV931 is offered in standard SOT-23 and SC-70 packages. The LMV932 is available in the traditional SOIC package. The LMV934 is available in the traditional SOIC package.

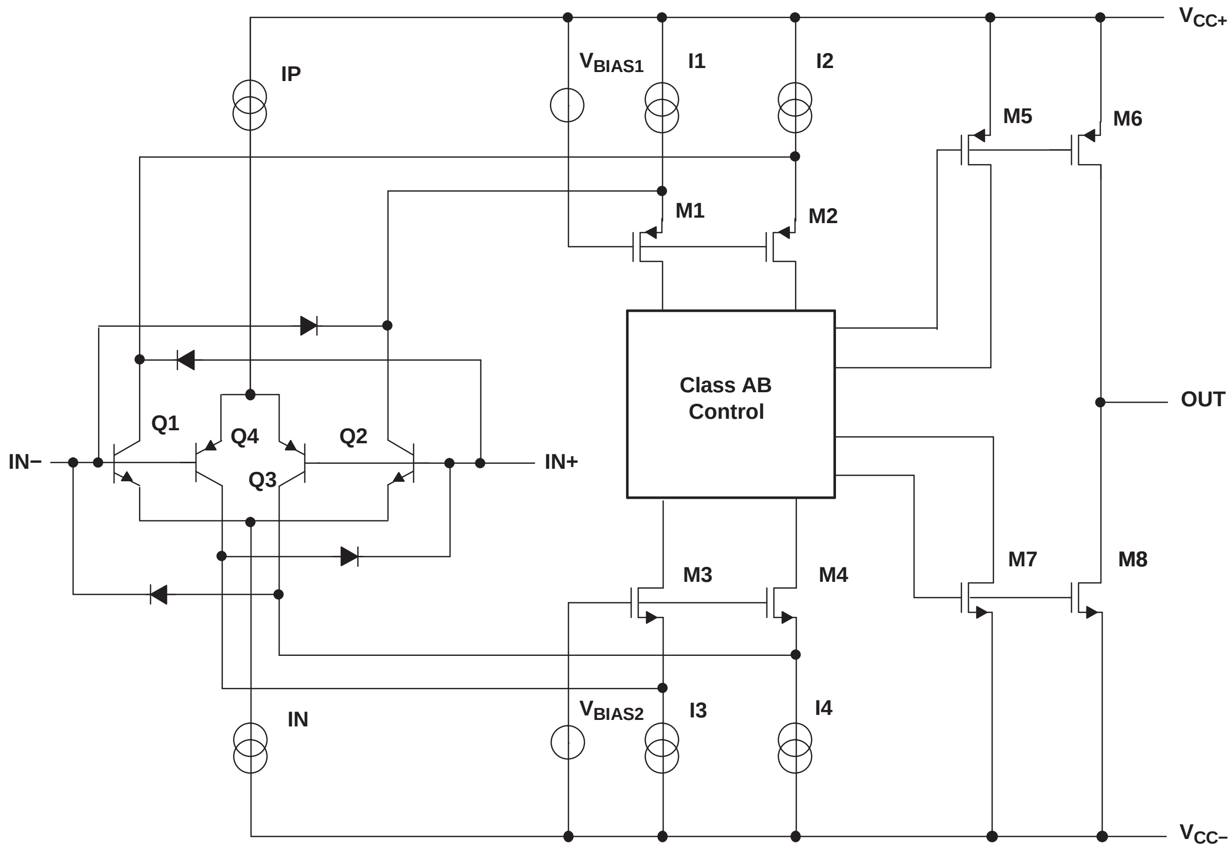
The LMV93x devices are characterized for operation from –40°C to 125°C, making the part universally suited for commercial, industrial, and automotive applications.

ORDERING INFORMATION(1)

T_A	PACKAGE(2)			ORDERABLE PART NUMBER	TOP-SIDE MARKING(3)
–40°C to 125°C	Single	SOT-23 – DBV	Reel of 3000	LMV931QDBVRQ1	RBB_
		SC-70 – DCK	Reel of 3000	LMV931QDCKRQ1	RB_
	Dual	SOIC – D	Reel of 2500	LMV932QDRQ1	MV932Q
	Quad	SOIC – D	Reel of 2500	LMV934QDRQ1	LMV934Q

(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.
(2) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.
(3) DBV/DCK: The actual top-side marking has one additional character that designates the wafer fab/assembly site.

SIMPLIFIED SCHEMATIC



ABSOLUTE MAXIMUM RATINGS[1]

over free-air temperature range (unless otherwise noted)

			MIN	MAX	UNIT
$V_{CC+} – V_{CC–}$	Supply voltage[2]			5.5	V
V_{ID}	Differential input voltage[3]		Supply voltage		
V_I	Input voltage range, either input		$V_{CC–}$ – 0.2	V_{CC+} + 0.2	V
	Duration of output short circuit (one amplifier) to $V_{CC±}$ [4] [5]		Unlimited		
θ_{JA}	Package thermal impedance[5] [6]	D package (8 pin)		97	°C/W
		D package (14 pin)		86	
		DBV package		206	
		DCK package		252	
T_J	Operating virtual junction temperature			150	°C
T_{stg}	Storage temperature range		–65	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) All voltage values (except differential voltages and V_{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) 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.
(5) Maximum power dissipation is a function of T_J(max), θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) – T_A)/\theta_{JA}$. Operating at the absolute maximum T_J of 150°C can affect reliability.
(6) 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

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

ELECTRICAL CHARACTERISTICS

V_{CC+} = 1.8 V, V_{CC-} = 0 V, V_{IC} = V_{CC+}/2, V_O = V_{CC+}/2, R_L > 1 MΩ (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A	MIN	TYP	MAX	UNIT
V_{IO}	Input offset voltage	LMV931 (single)		25°C		1	4	mV
				Full range			6	
		LMV932 (dual), LMV934 (quad)		25°C		1	5.5	
				Full range			7.5	
α_{VIO}	Average temperature coefficient of input offset voltage			25°C		5.5		μV/°C
I_{IB}	Input bias current	V_{IC} = V_{CC+} – 0.8 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	μA
				Full range			205	
CMRR	Common-mode rejection ratio	0 ≤ V_{IC} ≤ 0.6 V, 1.4 V ≤ V_{IC} ≤ 1.8 V		25°C	60	78		dB
				–40°C to 85°C	55			
		0.2 ≤ V_{IC} ≤ 0.6 V, 1.4 V ≤ V_{IC} ≤ 1.6 V		–40°C to 125°C	55			
		–0.2 ≤ V_{IC} ≤ 0 V, 1.8 V ≤ V_{IC} ≤ 2 V		25°C	50	72		
k_{SVR}	Supply-voltage rejection ratio	1.8 V ≤ V_{CC+} ≤ 5 V, V_{IC} = 0.5 V		25°C	72	100		dB
				Full range	65			
V_{ICR}	Common-mode input voltage range	CMRR ≥ 50 dB		25°C	V_{CC-} – 0.2	–0.2 to 2.1	V_{CC+} + 0.2	V
				–40°C to 85°C	V_{CC-}		V_{CC+}	
				–40°C to 125°C	V_{CC-} + 0.2		V_{CC+} – 0.2	
A_V	Large-signal voltage gain, LMV931	V_O = 0.2 V to 1.6 V, V_{IC} = 0.5 V	R_L = 600 Ω to 0.9 V	25°C	77	101		dB
				Full range	73			
			R_L = 2 kΩ to 0.9 V	25°C	80	105		
				Full range	75			
	Large-signal voltage gain, LMV932, LMV934		R_L = 600 Ω to 0.9 V	25°C	75	90		
				Full range	72			
			R_L = 2 kΩ to 0.9 V	25°C	78	100		
				Full range	75			
V_O	Output swing	R_L = 600 Ω to 0.9 V, V_{ID} = ±100 mV	High level	25°C	1.65	1.72		V
				Full range	1.63			
			Low level	25°C		0.077	0.105	
				Full range			0.120	
		R_L = 2 kΩ to 0.9 V, V_{ID} = ±100 mV	High level	25°C	1.75	1.77		
				Full range	1.74			
			Low level	25°C		0.024	0.035	
				Full range			0.040	
I_{OS}	Output short-circuit current	V_O = 0 V, V_{ID} = 100 mV	Sourcing	25°C	4	8		mA
				Full range	3.3			
		V_O = 1.8 V, V_{ID} = –100 mV	Sinking	25°C	7	9		
				Full range	5			
GBW	Gain bandwidth product			25°C		1.4		MHz

ELECTRICAL CHARACTERISTICS (continued)

V_{CC+} = 1.8 V, V_{CC-} = 0 V, V_{IC} = V_{CC+}/2, V_O = V_{CC+}/2, R_L > 1 MΩ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A	MIN	TYP	MAX	UNIT
SR	Slew rate[1]		25°C		0.35		V/µs
Φ_m	Phase margin		25°C		67		°
	Gain margin		25°C		7		dB
V_n	Equivalent input noise voltage	f = 1 kHz, V_{IC} = 0.5 V	25°C		60		nV/√Hz
I_n	Equivalent input noise current	f = 1 kHz	25°C		0.06		pA/√Hz
THD	Total harmonic distortion	f = 1 kHz, A_V = 1, R_L = 600 Ω, V_{ID} = 1 V_{p-p}	25°C		0.023		%
	Amplifier-to-amplifier isolation[2]		25°C		123		dB

(1) Number specified is the slower of the positive and negative slew rates.
(2) Input referred, V_{CC+} = 5 V and R_L = 100 kΩ connected to 2.5 V. Each amplifier is excited, in turn, with a 1-kHz signal to produce V_O = 3 V_{p-p}.

ELECTRICAL CHARACTERISTICS

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

PARAMETER		TEST CONDITIONS	T_A	MIN	TYP	MAX	UNIT
V_{IO}	Input offset voltage	LMV931 (single)	25°C		1	4	mV
			Full range			6	
		LMV932 (dual), LMV934 (quad)	25°C		1	5.5	
			Full range			7.5	
α_{VIO}	Average temperature coefficient of input offset voltage		25°C		5.5		μV/°C
I_{IB}	Input bias current	V_{IC} = V_{CC+} – 0.8 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	μA
			Full range			210	
CMRR	Common-mode rejection ratio	0 ≤ V_{IC} ≤ 1.5 V, 2.3 V ≤ V_{IC} ≤ 2.7 V	25°C	60	81		dB
			–40°C to 85°C	55			
		0.2 ≤ V_{IC} ≤ 1.5 V, 2.3 V ≤ V_{IC} ≤ 2.5 V	–40°C to 125°C	55			
		–0.2 ≤ V_{IC} ≤ 0 V, 2.7 V ≤ V_{IC} ≤ 2.9 V	25°C	50	74		
k_{SVR}	Supply-voltage rejection ratio	1.8 V ≤ V_{CC+} ≤ 5 V, V_{IC} = 0.5 V	25°C	72	100		dB
			Full range	65			
V_{ICR}	Common-mode input voltage range	CMRR ≥ 50 dB	25°C	V_{CC-} – 0.2	–0.2 to 3	V_{CC+} + 0.2	V
			–40°C to 85°C	V_{CC-}		V_{CC+}	
			–40°C to 125°C	V_{CC-} + 0.2		V_{CC+} – 0.2	
A_V	Large-signal voltage gain, LMV931	V_O = 0.2 V to 2.5 V; R_L = 600 Ω to 1.35 V	25°C	87	104		dB
			Full range	86			
		R_L = 2 kΩ to 1.35 V	25°C	92	110		
			Full range	91			
	Large-signal voltage gain, LMV932, LMV934	R_L = 600 Ω to 1.35 V	25°C	78	90		
			Full range	75			
		R_L = 2 kΩ to 1.35 V	25°C	81	100		
			Full range	78			
V_O	Output swing	R_L = 600 Ω to 1.35 V, V_{ID} = ±100 mV; High level	25°C	2.55	2.62		V
			Full range	2.53			
		Low level	25°C		0.083	0.11	
			Full range			0.13	
		R_L = 2 kΩ to 1.35 V, V_{ID} = ±100 mV; High level	25°C	2.65	2.675		
			Full range	2.64			
		Low level	25°C		0.025	0.04	
			Full range			0.045	
I_{OS}	Output short-circuit current	V_O = 0 V, V_{ID} = 100 mV; Sourcing	25°C	20	30		mA
			Full range	15			
		V_O = 2.7 V, V_{ID} = –100 mV; Sinking	25°C	18	25		
			Full range	12			
GBW	Gain bandwidth product		25°C		1.4		MHz

ELECTRICAL CHARACTERISTICS (continued)

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

PARAMETER		TEST CONDITIONS	T_A	MIN	TYP	MAX	UNIT
SR	Slew rate[(1)]		25°C		0.4		V/μs
Φ_m	Phase margin		25°C		70		°
	Gain margin		25°C		7.5		dB
V_n	Equivalent input noise voltage	f = 1 kHz, V_{IC} = 0.5 V	25°C		57		nV/√Hz
I_n	Equivalent input noise current	f = 1 kHz	25°C		0.082		pA/√Hz
THD	Total harmonic distortion	f = 1 kHz, A_V = 1, R_L = 600 Ω, V_{ID} = 1 V_{p-p}	25°C		0.022		%
	Amplifier-to-amplifier isolation[(2)]		25°C		123		dB

(1) Number specified is the slower of the positive and negative slew rates.
(2) Input referred, V_{CC+} = 5 V and R_L = 100 kΩ connected to 2.5 V. Each amplifier is excited, in turn, with a 1-kHz signal to produce V_O = 3 V_{p-p}.

ELECTRICAL CHARACTERISTICS

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

PARAMETER			TEST CONDITIONS		T_A	MIN	TYP	MAX	UNIT
V_{IO}	Input offset voltage		LMV931 (single)		25°C		1	4	mV
					Full range			6	
			LMV932 (dual), LMV934 (quad)		25°C		1	5.5	
					Full range			7.5	
α_{VIO}	Average temperature coefficient of input offset voltage				25°C		5.5		µV/°C
I_{IB}	Input bias current		V_{IC} = V_{CC+} – 0.8 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)		LMV931		25°C		116	210	µA
					Full range			230	
			LMV932, LMV934		25°C		116	225	
					Full range			275	
CMRR	Common-mode rejection ratio		0 ≤ V_{IC} ≤ 3.8 V, 4.6 V ≤ V_{IC} ≤ 5 V		25°C	60	86		dB
					–40°C to 85°C	55			
			0.3 ≤ V_{IC} ≤ 3.8 V, 4.6 V ≤ V_{IC} ≤ 4.7 V		–40°C to 125°C	55			
			–0.2 ≤ V_{IC} ≤ 0 V, 5 V ≤ V_{IC} ≤ 5.2 V		25°C	50	78		
k_{SVR}	Supply-voltage rejection ratio		1.8 V ≤ V_{CC+} ≤ 5 V, V_{IC} = 0.5 V		25°C	72	100		dB
					Full range	65			
V_{ICR}	Common-mode input voltage range		CMRR ≥ 50 dB		25°C	V_{CC-} – 0.2	–0.2 to 5.3	V_{CC+} + 0.2	V
					–40°C to 85°C	V_{CC-}		V_{CC+}	
					–40°C to 125°C	V_{CC-} + 0.3		V_{CC+} – 0.3	
A_V	Large-signal voltage gain	LMV931	V_O = 0.2 V to 4.8 V	R_L = 600 Ω to 2.5 V	25°C	88	102		dB
					Full range	87			
				R_L = 2 kΩ to 2.5 V	25°C	94	113		
					Full range	93			
		LMV932, LMV934		R_L = 600 Ω to 2.5 V	25°C	81	90		
					Full range	78			
				R_L = 2 kΩ to 2.5 V	25°C	85	100		
					Full range	82			
V_O	Output swing		R_L = 600 Ω to 2.5 V, V_{ID} = ±100 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 kΩ to 2.5 V, V_{ID} = ±100 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	

ELECTRICAL CHARACTERISTICS (continued)

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

PARAMETER			TEST CONDITIONS		T_A	MIN	TYP	MAX	UNIT
I_{OS}	Output short-circuit current	LMV931	V_O = 0 V, V_{ID} = 100 mV	Sourcing	25°C	80	100		mA
					Full range	68			
			V_O = 5 V, V_{ID} = –100 mV	Sinking	25°C	58	65		
					Full range	45			
		LMV932, LMV934	V_O = 0 V, V_{ID} = 100 mV	Sourcing	25°C	75	100		
					Full range	68			
			V_O = 5 V, V_{ID} = –100 mV	Sinking	25°C	50	65		
					Full range		60		
GBW	Gain bandwidth product				25°C		1.5		MHz
SR	Slew rate (1)				25°C		0.42		V/µs
Φ_m	Phase margin				25°C		71		°
	Gain margin				25°C		8		dB
V_n	Equivalent input noise voltage		f = 1 kHz, V_{IC} = 0.5 V		25°C		50		$nV/\sqrt{Hz}$
I_n	Equivalent input noise current		f = 1 kHz		25°C		0.07		$pA/\sqrt{Hz}$
THD	Total harmonic distortion		f = 1 kHz, A_V = 1, R_L = 600 Ω, V_{ID} = 1 V_{p-p}		25°C		0.022		%
	Amplifier-to-amplifier isolation (2)				25°C		123		dB

(1) Number specified is the slower of the positive and negative slew rates.
(2) Input referred, V_{CC+} = 5 V and R_L = 100 kΩ connected to 2.5 V. Each amplifier is excited, in turn, with a 1-kHz signal to produce V_O = 3 V_{p-p}.

TYPICAL CHARACTERISTICS

V_{CC+} = 5 V, Single Supply, T_A = 25°C (unless otherwise specified)

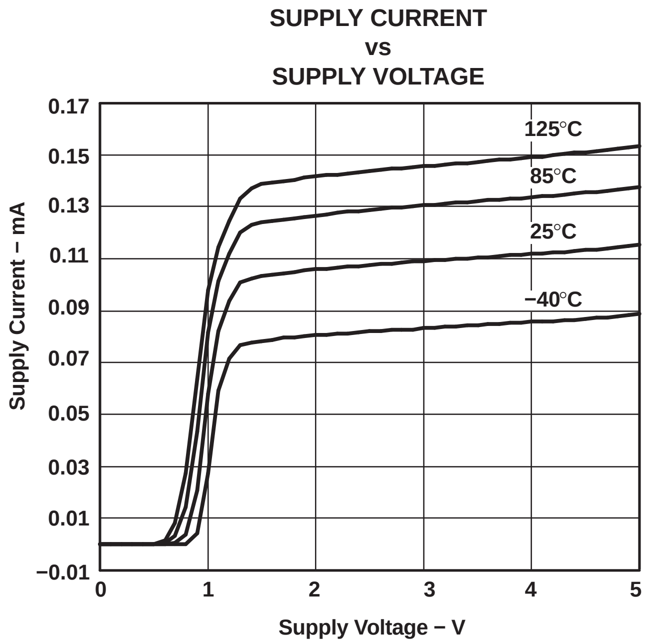


Figure 1.

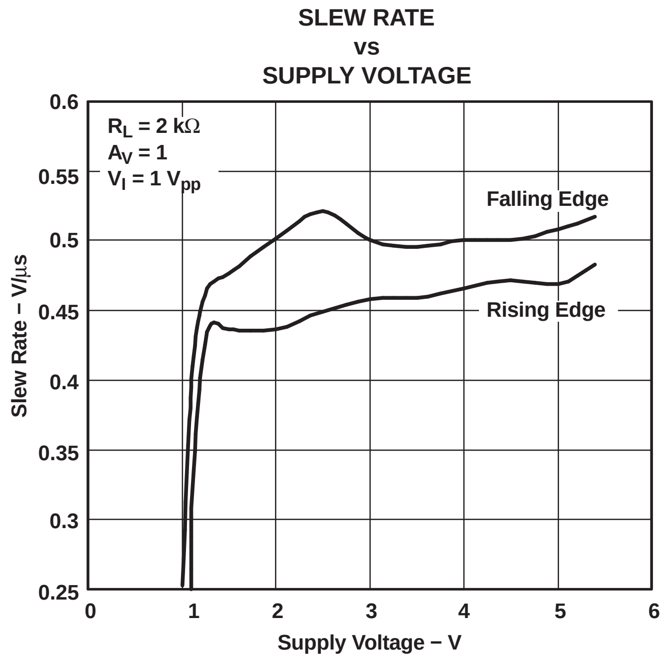


Figure 2.

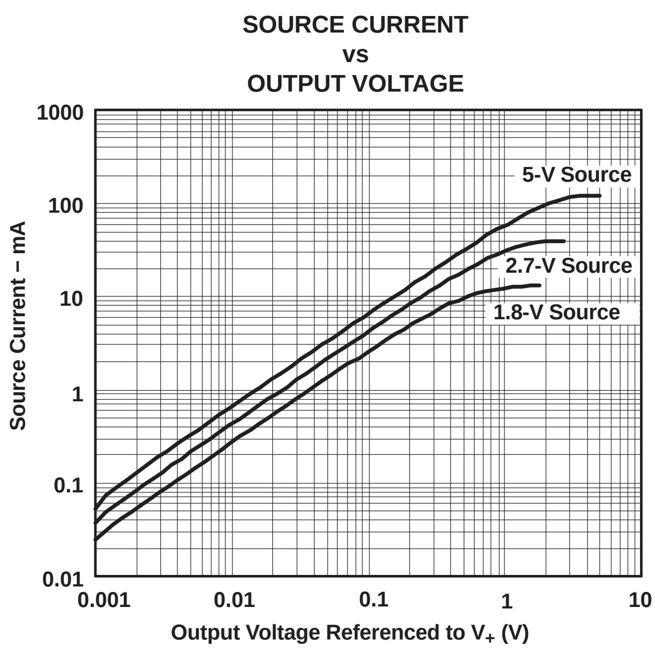


Figure 3.

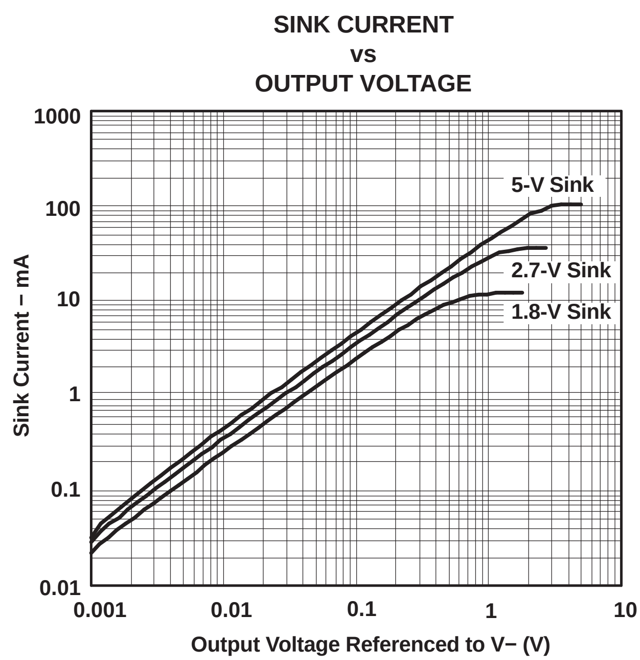


Figure 4.

TYPICAL CHARACTERISTICS (continued)

V_{CC+} = 5 V, Single Supply, T_A = 25°C (unless otherwise specified)

OUTPUT VOLTAGE SWING vs SUPPLY VOLTAGE

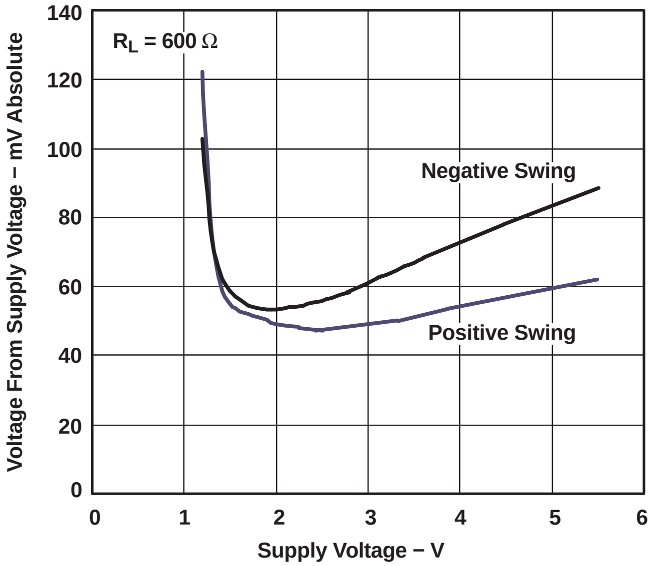


Figure 5.

OUTPUT VOLTAGE SWING vs SUPPLY VOLTAGE

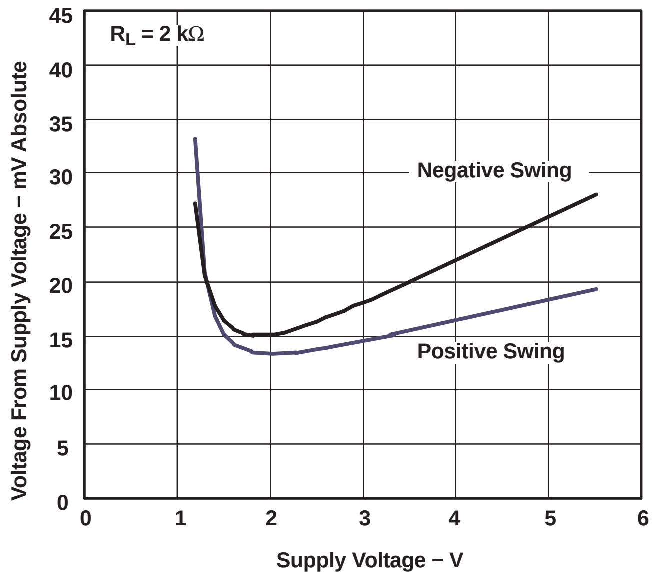


Figure 6.

SHORT-CIRCUIT CURRENT (SINK) vs TEMPERATURE

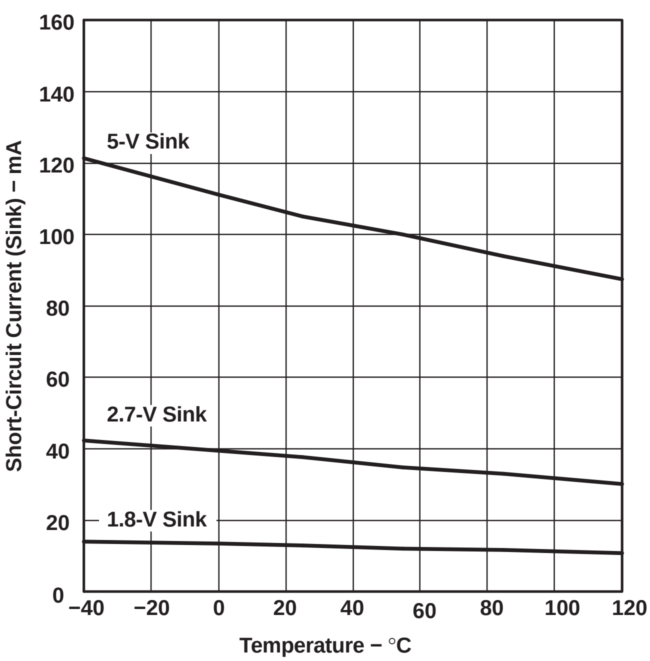


Figure 7.

SHORT-CIRCUIT CURRENT (SOURCE) vs TEMPERATURE

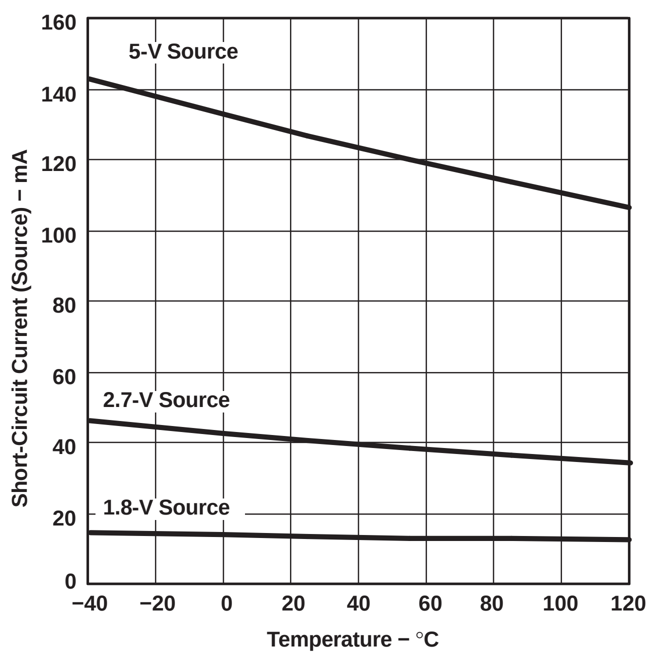


Figure 8.

TYPICAL CHARACTERISTICS (continued)

V_{CC+} = 5 V, Single Supply, T_A = 25°C (unless otherwise specified)

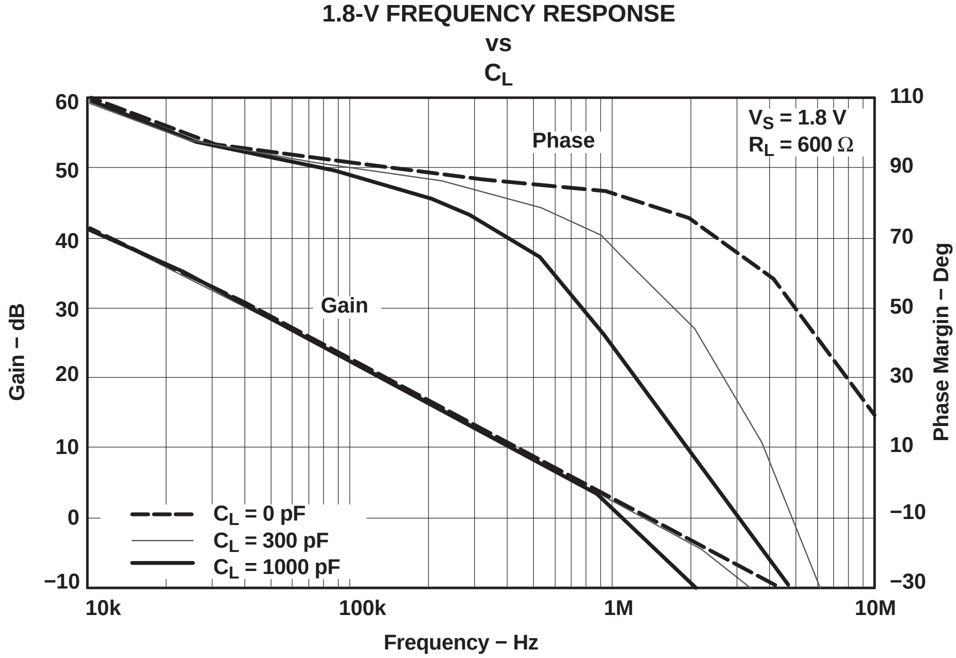


Figure 9.

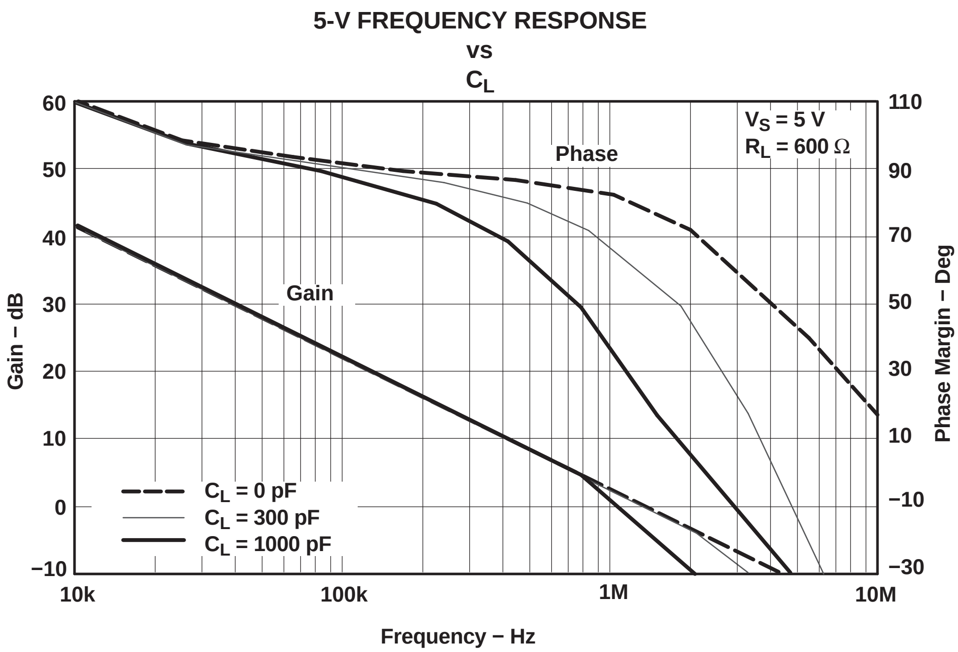


Figure 10.

TYPICAL CHARACTERISTICS (continued)

V_{CC+} = 5 V, Single Supply, T_A = 25°C (unless otherwise specified)

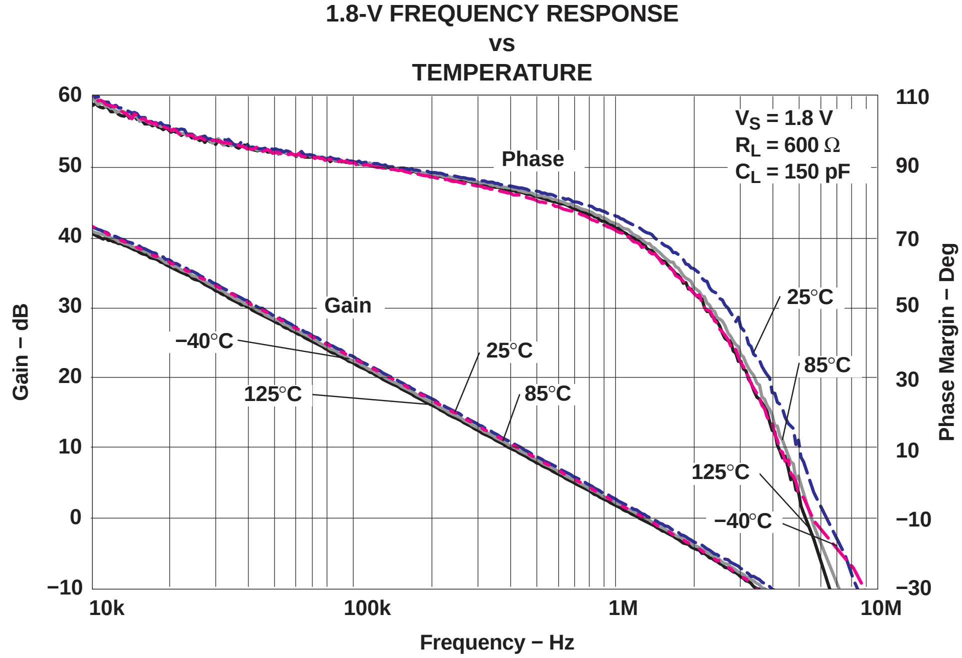


Figure 11.

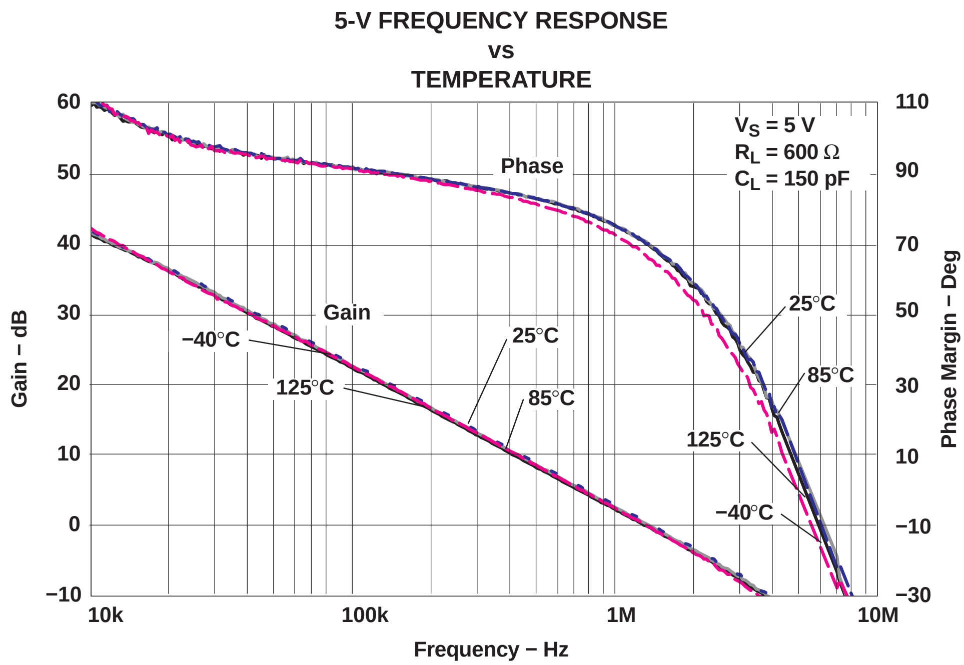


Figure 12.

TYPICAL CHARACTERISTICS (continued)

V_{CC+} = 5 V, Single Supply, T_A = 25°C (unless otherwise specified)

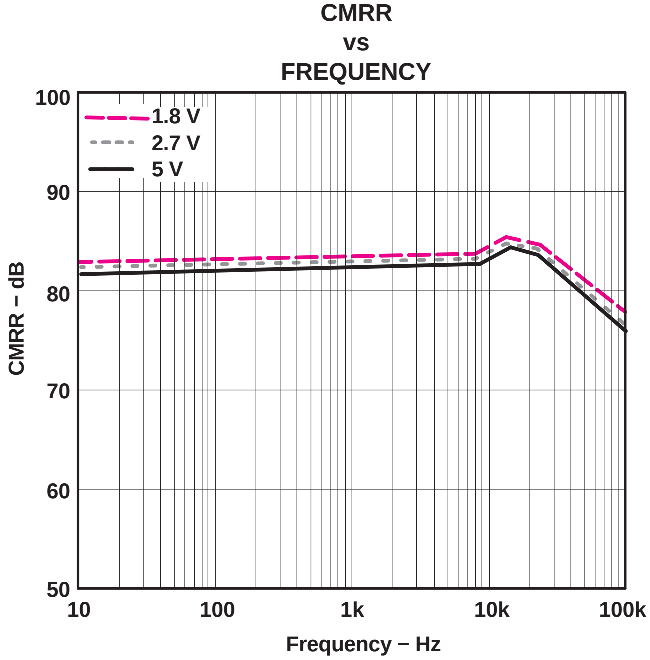
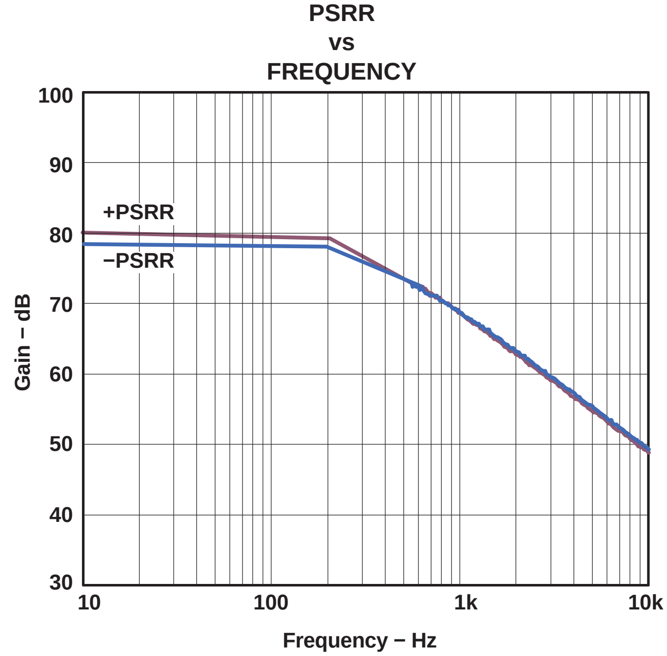


Figure 13.



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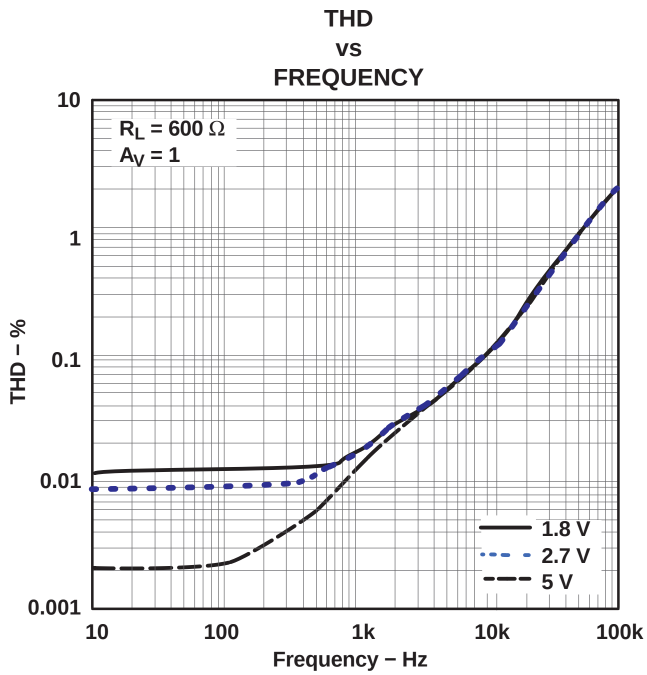

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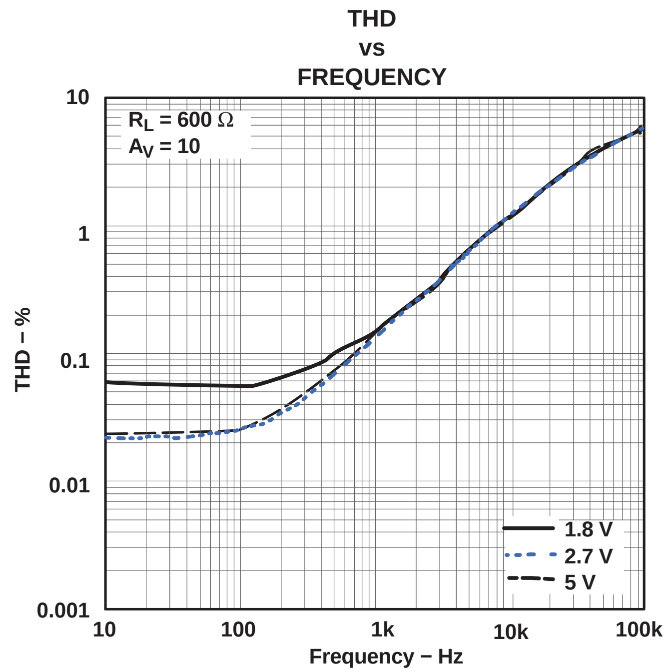


Figure 16.

TYPICAL CHARACTERISTICS (continued)

V_{CC+} = 5 V, Single Supply, T_A = 25°C (unless otherwise specified)

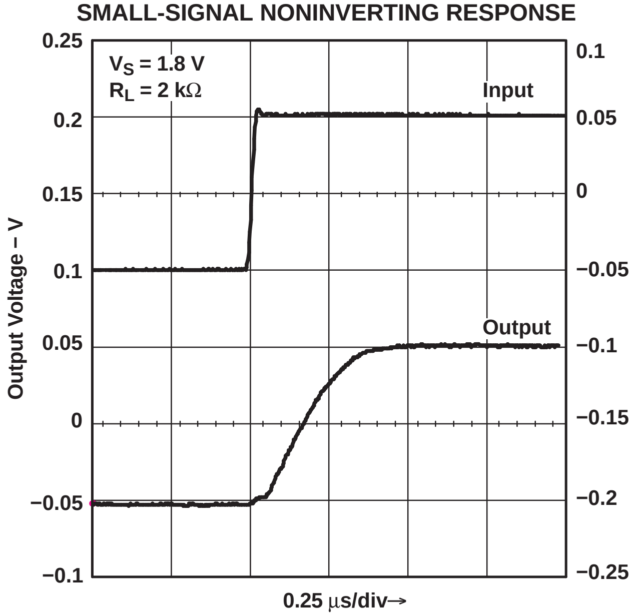
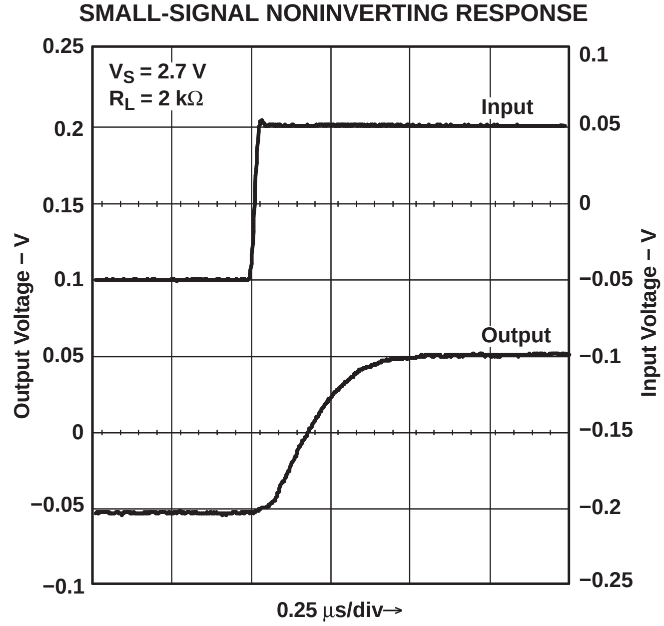


Figure 17.



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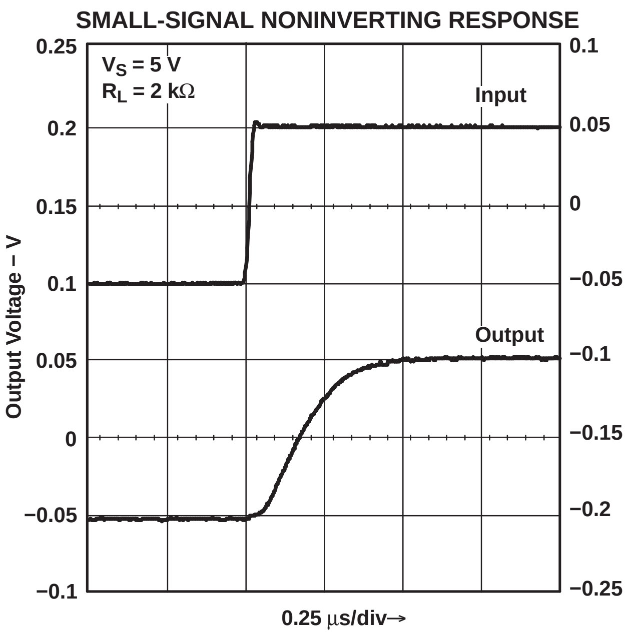

Figure 19.

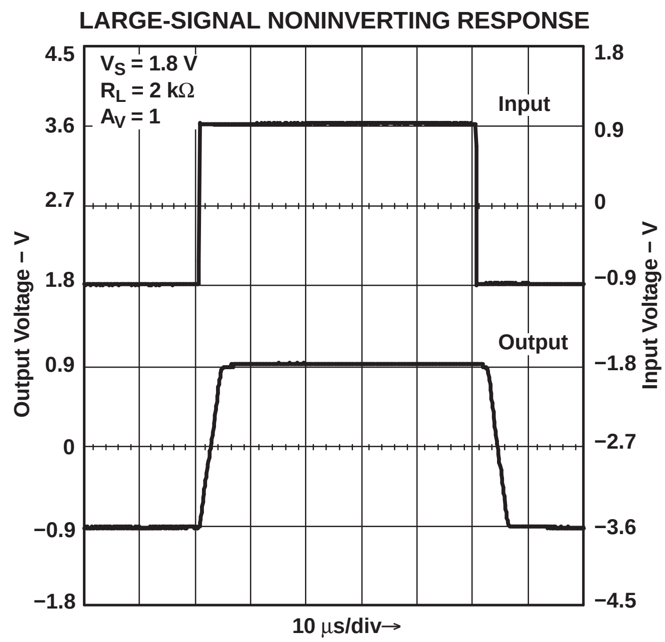

Figure 20.

TYPICAL CHARACTERISTICS (continued)

V_{CC+} = 5 V, Single Supply, T_A = 25°C (unless otherwise specified)

LARGE-SIGNAL NONINVERTING RESPONSE

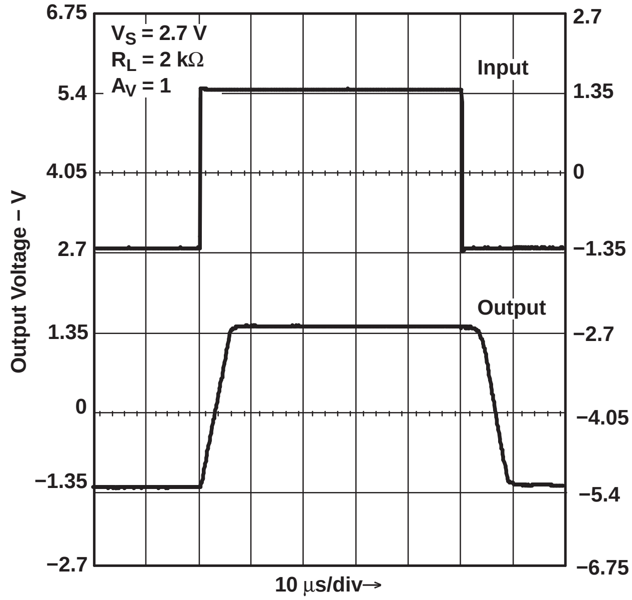

Figure 21.

LARGE-SIGNAL NONINVERTING RESPONSE

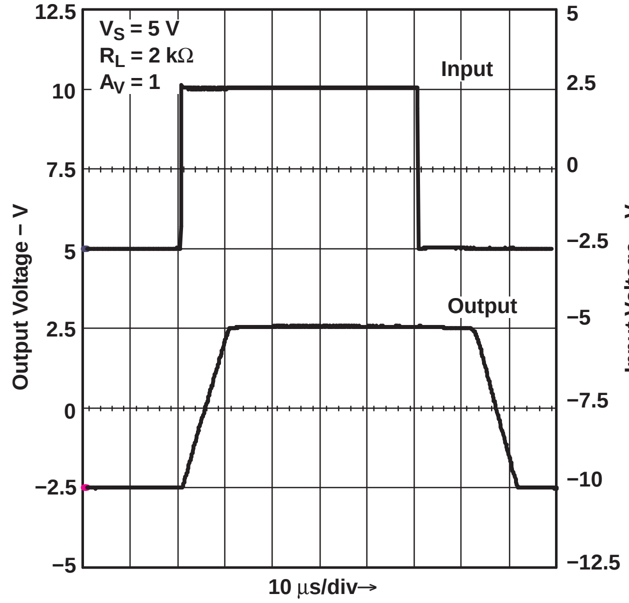

Figure 22.

OFFSET VOLTAGE vs COMMON-MODE RANGE

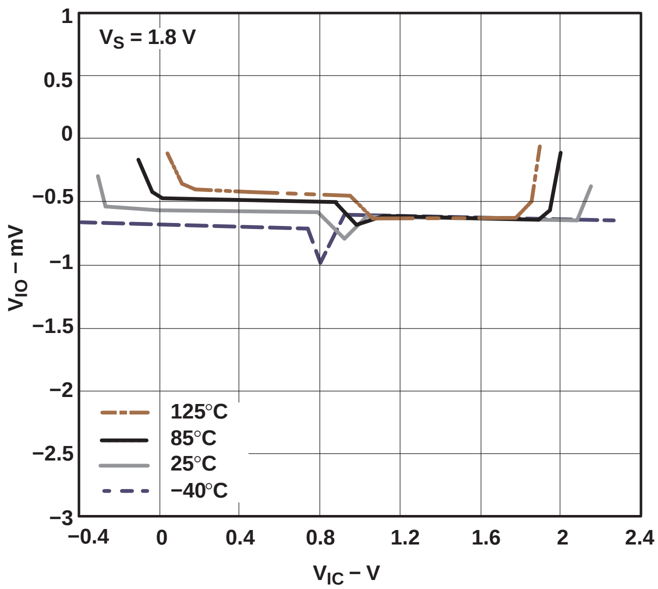

Figure 23.

OFFSET VOLTAGE vs COMMON-MODE RANGE

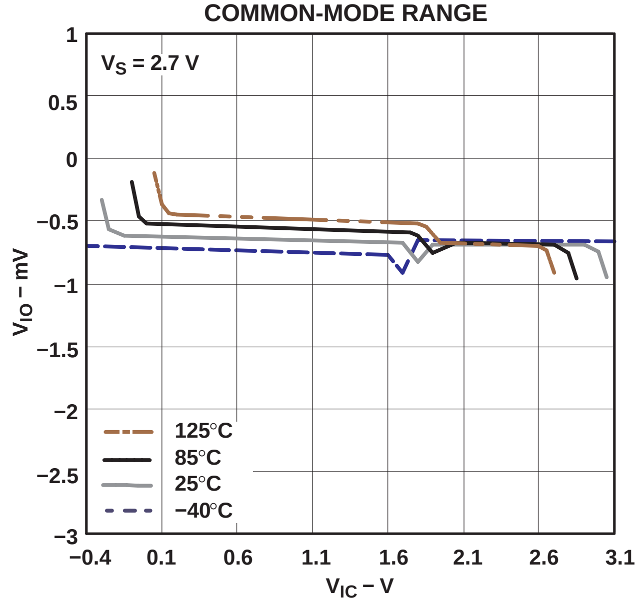

Figure 24.

TYPICAL CHARACTERISTICS (continued)

V_{CC+} = 5 V, Single Supply, T_A = 25°C (unless otherwise specified)

OFFSET VOLTAGE
vs
COMMON-MODE RANGE

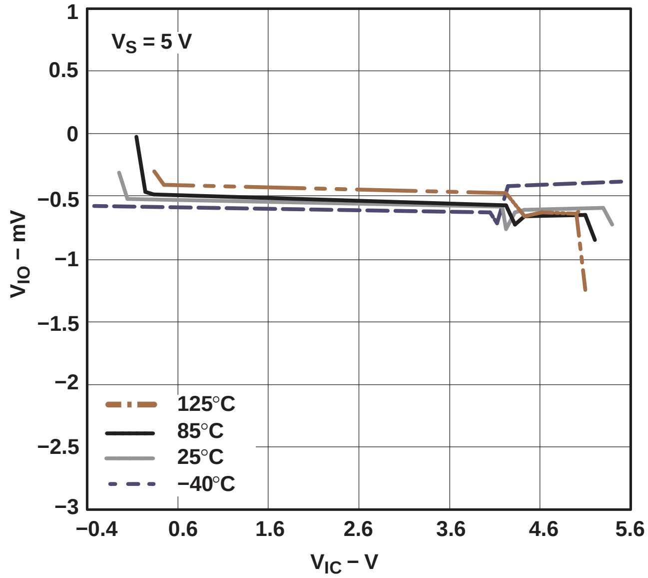

Figure 25.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/ Ball Finish	MSL Peak Temp (3)	Samples (Requires Login)
LMV931QDBVRQ1	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	Request Free Samples
LMV931QDCKRQ1	ACTIVE	SC70	DCK	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	Request Free Samples
LMV932QDRQ1	PREVIEW	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	Samples Not Available
LMV934QDRQ1	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	Purchase Samples

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

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

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

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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.

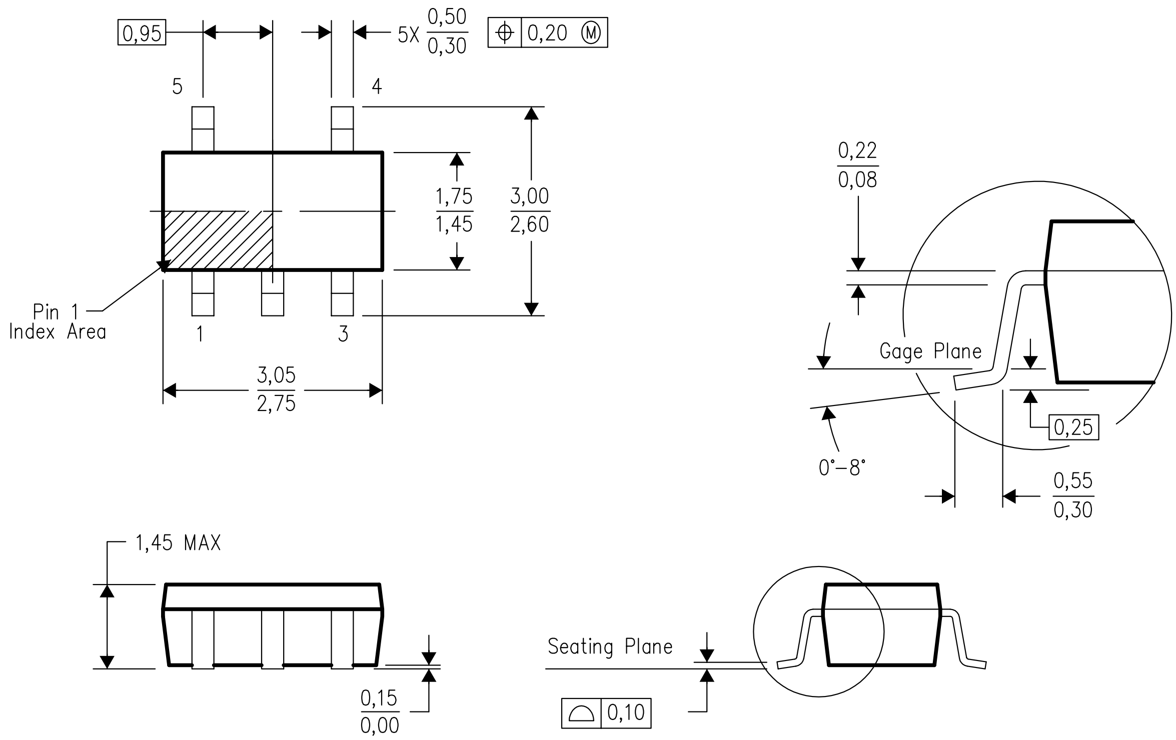
OTHER QUALIFIED VERSIONS OF LMV931-Q1, LMV932-Q1, LMV934-Q1 :

- Catalog: LMV931, LMV932, LMV934

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

DBV (R–PDSO–G5) PLASTIC SMALL–OUTLINE PACKAGE



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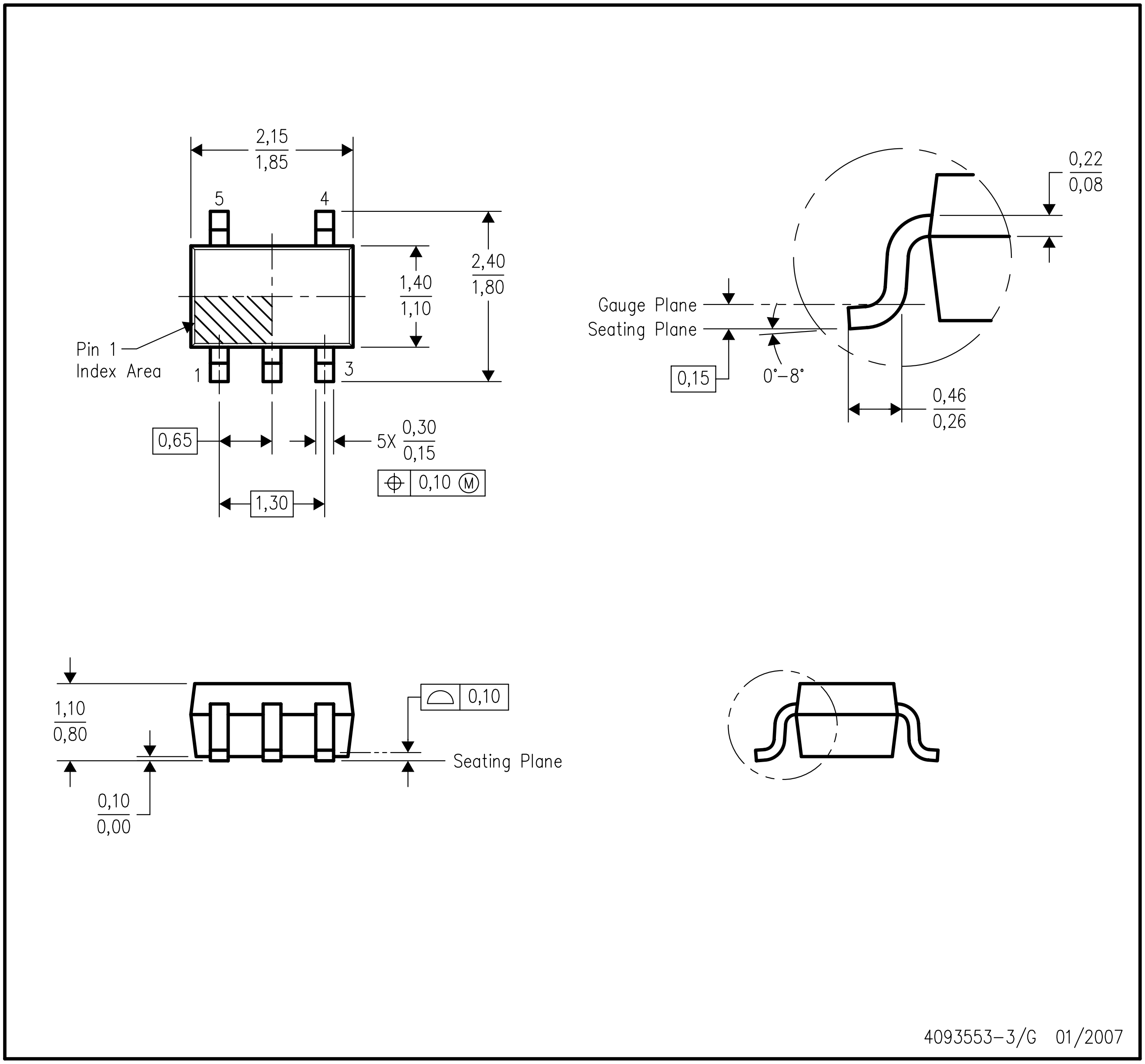
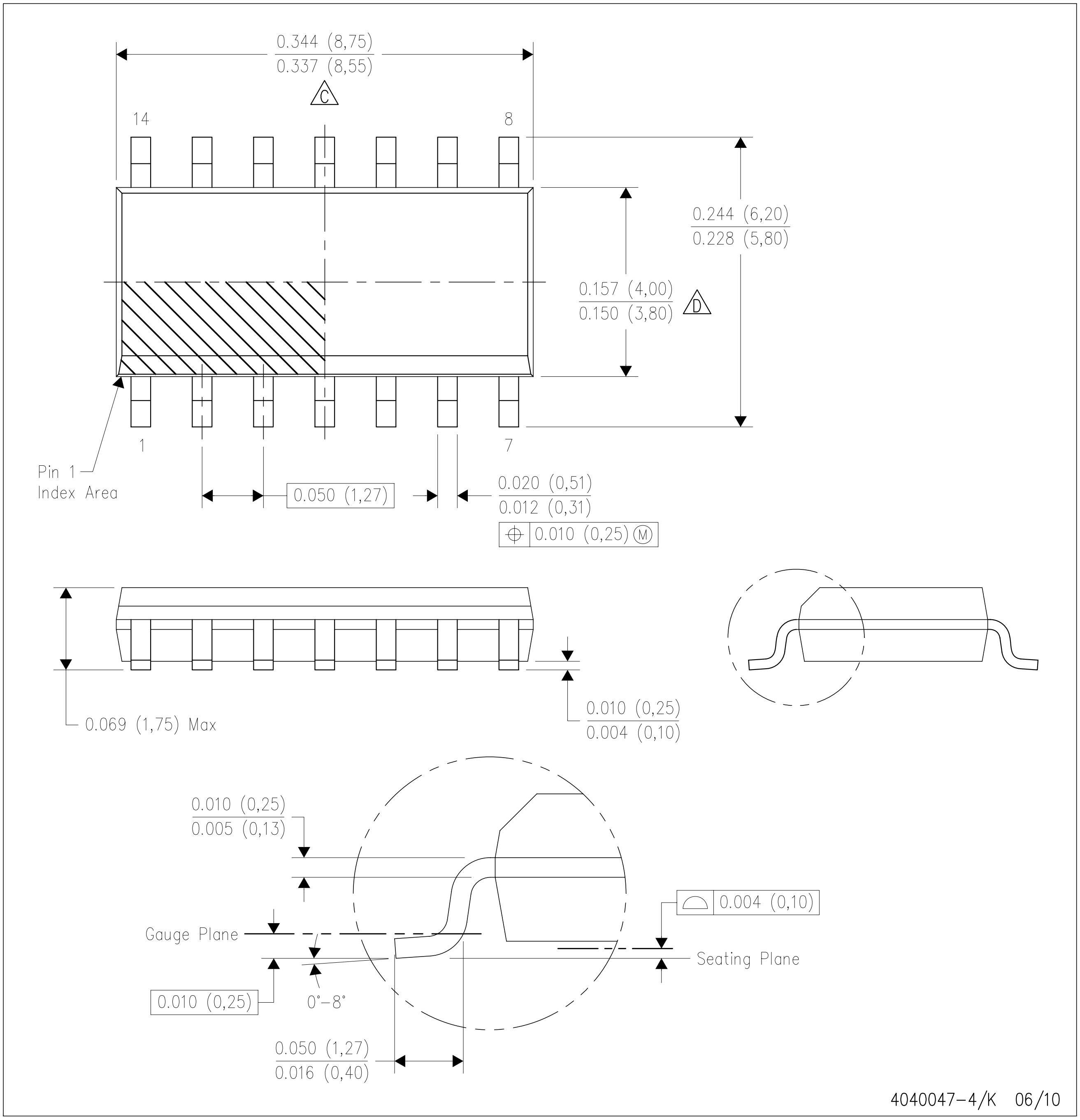
NOTES:
- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
- D. Falls within JEDEC MO–178 Variation AA.

DCK (R-PDSO-G5) PLASTIC SMALL-OUTLINE PACKAGE



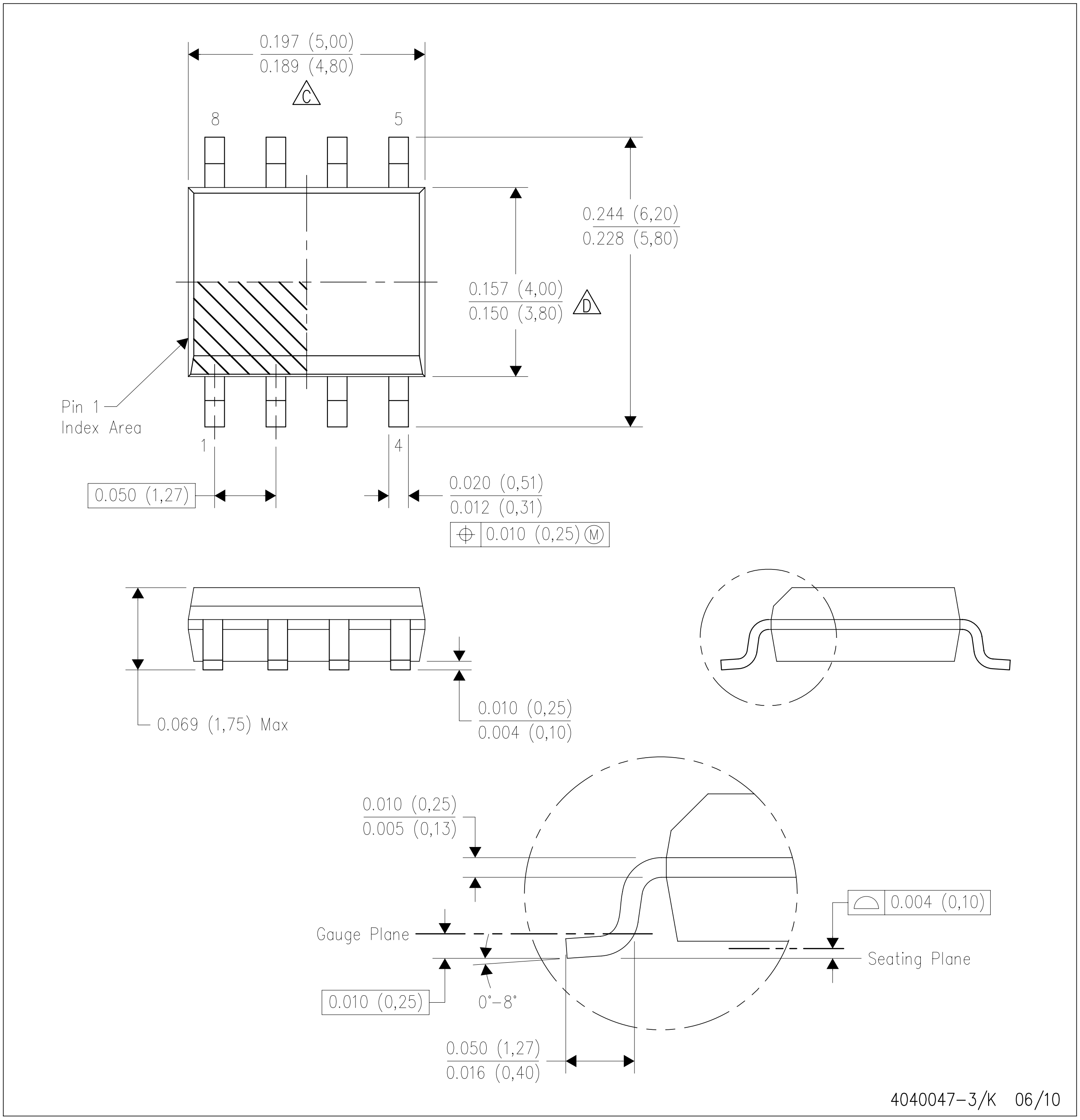
NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
D. Falls within JEDEC MO-203 variation AA.

D (R–PDSO–G14) 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 AB.

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.
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 AA.