# LMV931 SINGLE, LMV932 DUAL, LMV934 QUAD 1.8-V OPERATIONAL AMPLIFIERS WITH RAIL-TO-RAIL INPUT AND OUTPUT

SLOS441G – AUGUST 2004 – REVISED FEBRUARY 2006

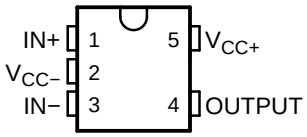
## FEATURES

- 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: MSOP and SOIC
  - LMV934: SOIC and TSSOP

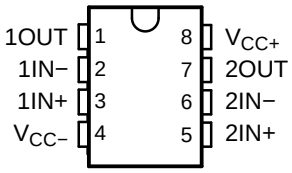
## APPLICATIONS

- 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

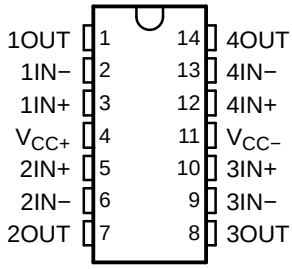
**LMV931 . . . DBV (SOT-23-5) OR DCK (SC-70) PACKAGE**
**(TOP VIEW)**




**LMV932 . . . D (SOIC) OR**
**DGK (VSSOP/MSOP) PACKAGE**
**(TOP VIEW)**




**LMV934 . . . D (SOIC) OR PW (TSSOP) PACKAGE**
**(TOP VIEW)**




## DESCRIPTION/ORDERING INFORMATION

### ORDERING INFORMATION

| $T_A$ | PACKAGE(1) | | | ORDERABLE PART NUMBER | TOP-SIDE MARKING(2) |
|---|---|---|---|---|---|
| –40°C to 125°C | Single | SOT-23 – DBV | Reel of 3000 | LMV931IDBVR | RBB_ |
| | | | Reel of 250 | LMV931IDBVT | PREVIEW |
| | | SC-70 – DCK | Reel of 3000 | LMV931IDCKR | RB_ |
| | | | Reel of 250 | LMV931IDCKT | PREVIEW |
| | Dual | MSOP/VSSOP – DGK | Reel of 2500 | LMV932IDGKR | RD_ |
| | | | Reel of 250 | LMV932IDGKT | PREVIEW |
| | | SOIC – D | Tube of 75 | LMV932ID | MV932I |
| | | | Reel of 2500 | LMV932IDR | |
| | Quad | SOIC – D | Tube of 50 | LMV934ID | LMV934I |
| | | | Reel of 2500 | LMV934IDR | |
| | | TSSOP – PW | Tube of 90 | LMV934IPW | MV934I |
| | | | Reel of 2000 | LMV934IPWR | |

(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.

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.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of the Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

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## DESCRIPTION/ORDERING INFORMATION (CONTINUED)

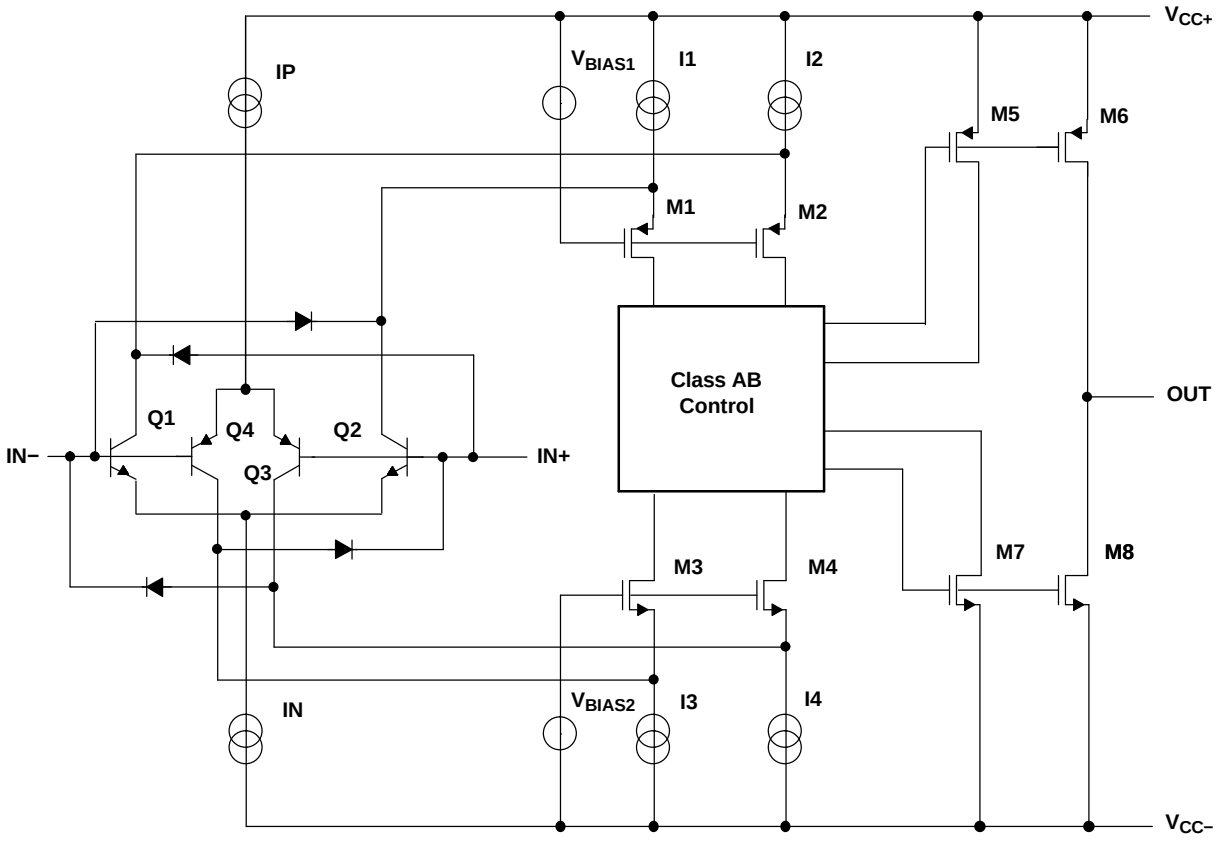
The LMV93x devices are low-voltage low-power operational amplifiers that are well suited for today's low-voltage and/or portable applications. Specified for operation of 1.8 V to 5 V, they can be used in portable applications that are powered from a single-cell Li-ion or two-cell batteries. They have 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 MSOP and SOIC packages. The LMV934 is available in the traditional SOIC and TSSOP packages.

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

**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 $V_{CC\pm}$(4)(5) | | Unlimited | | |
| $\theta_{JA}$ | Package thermal impedance(5)(6) | D package (8 pin) | | 97 | °C/W |
| | | D package (14 pin) | | 86 | |
| | | DBV package | | 206 | |
| | | DCK package | | 252 | |
| | | DGK package | | 172 | |
| | | PW package | | 113 | |
| $T_J$ | 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 $T_J(max)$, $\theta_{JA}$, 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.
(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, 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 | |
| $\alpha_{V_{IO}}$ | 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 | 75 | 100 | | dB |
| | | | | | Full range | 70 | | | |
| $V_{ICR}$ | 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 | | | |
| | | 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 | | | |

## Electrical Characteristics (continued)

$V_{CC+}$ = 1.8 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 |
|---|---|---|---|---|---|---|---|
| GBW | Gain bandwidth product | | 25°C | | 1.4 | | MHz |
| SR | Slew rate(1) | | 25°C | | 0.35 | | V/µS |
| $\Phi_m$ | 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 | |
| $\alpha_{V_{IO}}$ | 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 | 75 | 100 | | dB |
| | | | | | Full range | 70 | | | |
| $V_{ICR}$ | 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 | | | |
| | | 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 |
| $\Phi_m$ | 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 | |
| $\alpha_{V_{IO}}$ | 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) | | | | 25°C | | 116 | 210 | µA |
| | | | | | Full range | | | 230 | |
| 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 | 75 | 100 | | dB |
| | | | | | Full range | 70 | | | |
| $V_{ICR}$ | 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 | |
| $I_{OS}$ | Output short-circuit current | | $V_O$ = 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 | | | |

## 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 |
|---|---|---|---|---|---|---|---|
| GBW | Gain bandwidth product | | 25°C | | 1.5 | | MHz |
| SR | Slew rate(1) | | 25°C | | 0.42 | | V/µS |
| $\Phi_m$ | 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/√Hz |
| $I_n$ | Equivalent input noise current | f = 1 kHz | 25°C | | 0.07 | | 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 $V_{p-p}$.

## TYPICAL CHARACTERISTICS

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

**SUPPLY CURRENT vs SUPPLY VOLTAGE**

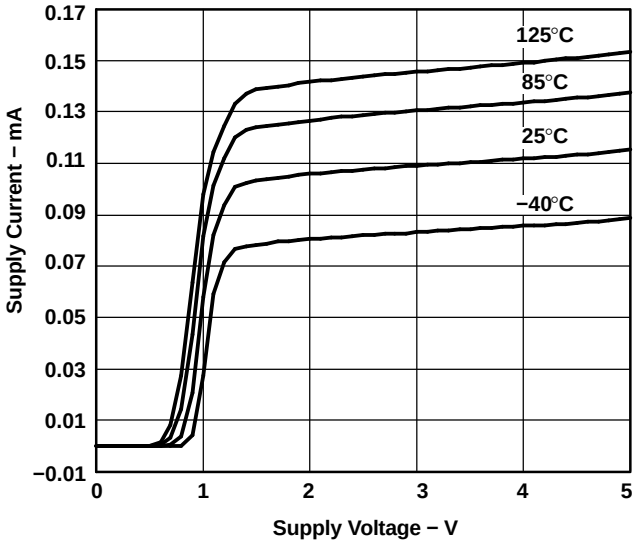



Figure 1.

**SLEW RATE vs SUPPLY VOLTAGE**

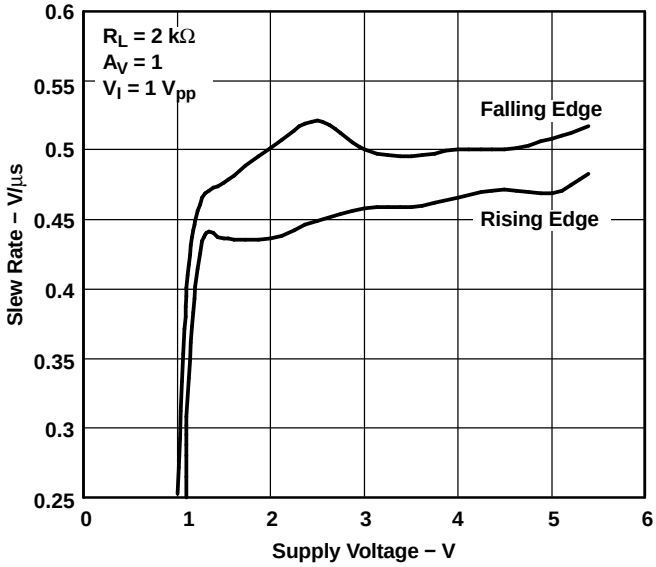



Figure 2.

**SOURCE CURRENT vs OUTPUT VOLTAGE**

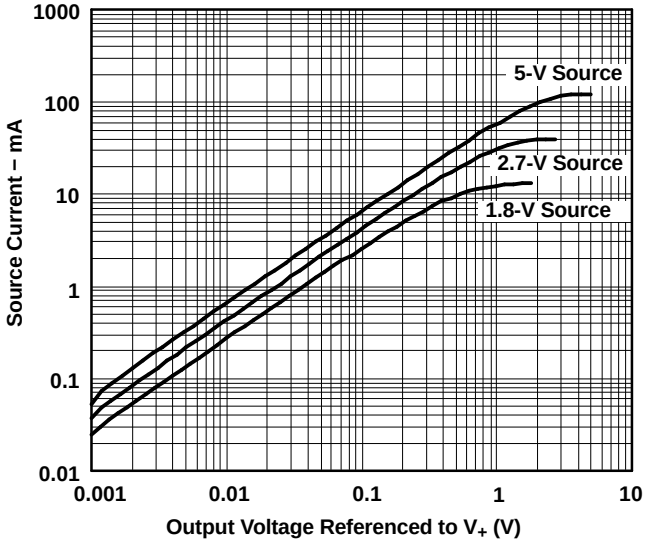



Figure 3.

**SINK CURRENT vs OUTPUT VOLTAGE**

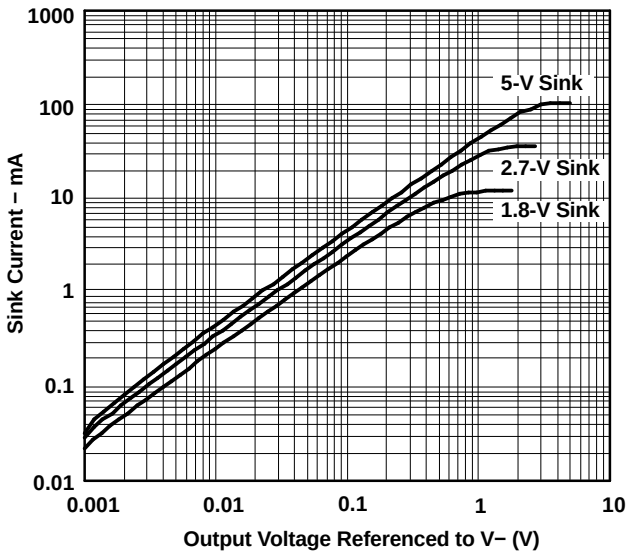



Figure 4.

## TYPICAL CHARACTERISTICS (continued)

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

**OUTPUT VOLTAGE SWING vs SUPPLY VOLTAGE**

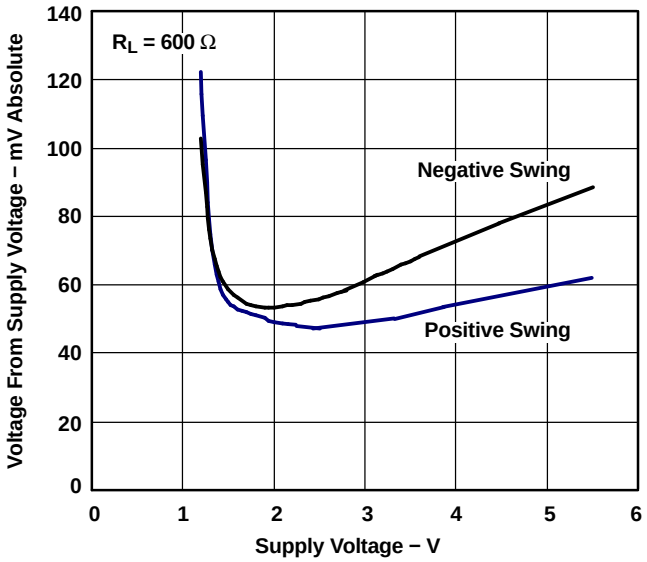



Figure 5.

**OUTPUT VOLTAGE SWING vs SUPPLY VOLTAGE**

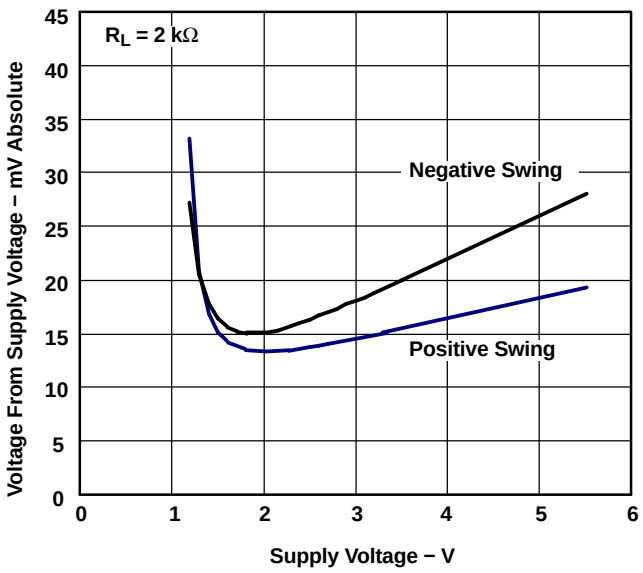



Figure 6.

**SHORT-CIRCUIT CURRENT (SINK) vs TEMPERATURE**

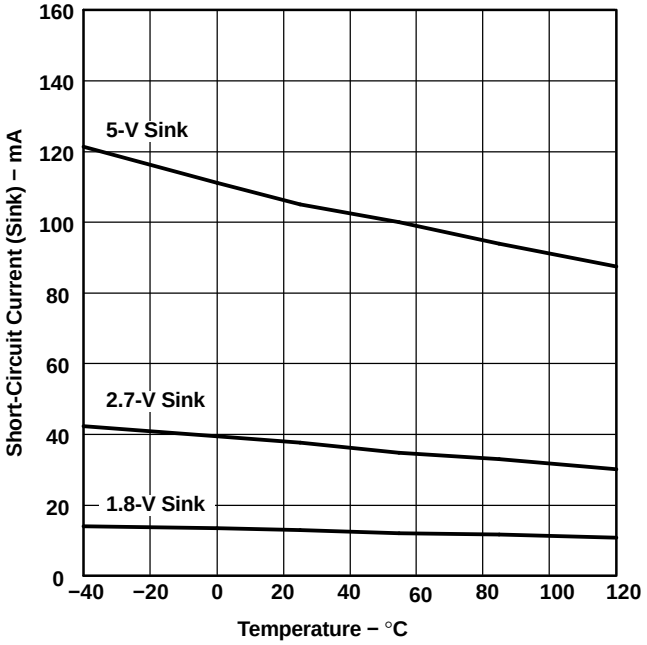



Figure 7.

**SHORT-CIRCUIT CURRENT (SOURCE) vs TEMPERATURE**

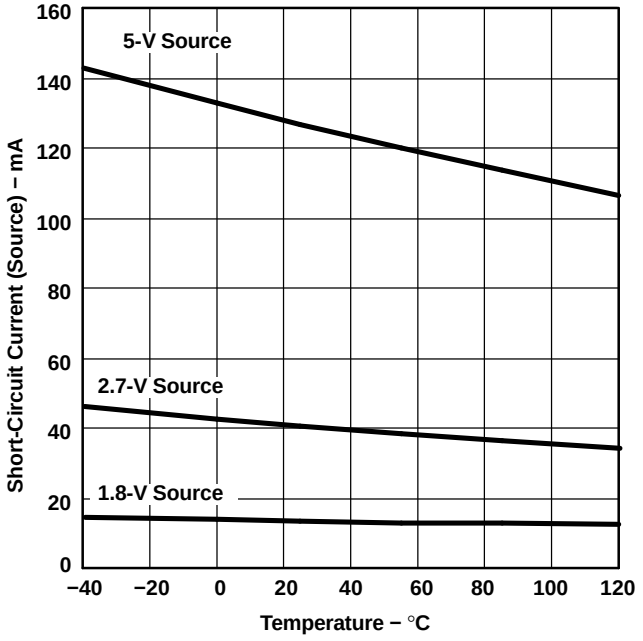



Figure 8.

## TYPICAL CHARACTERISTICS (continued)

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

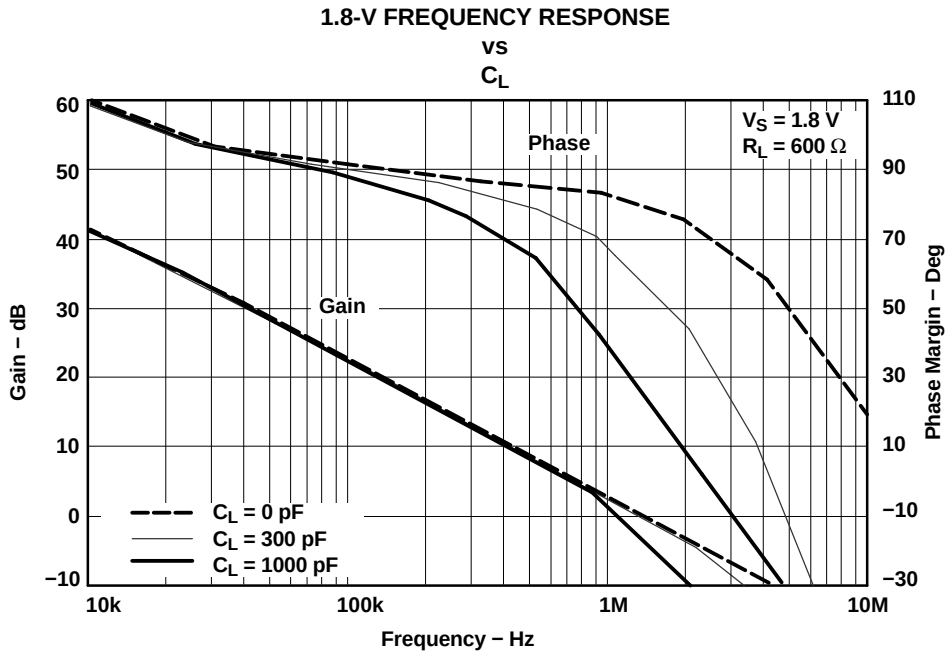



**Figure 9.**

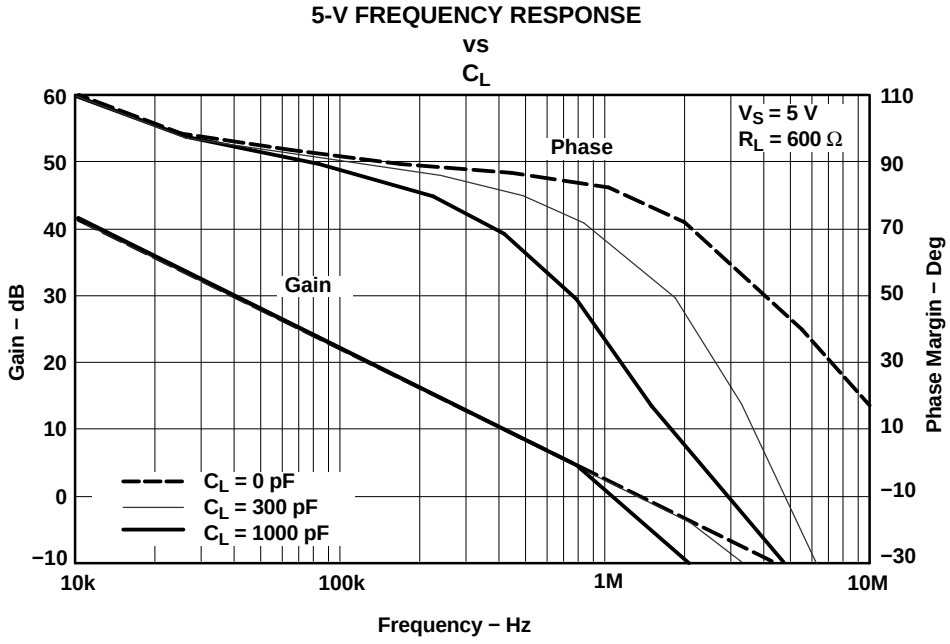



**Figure 10.**

## TYPICAL CHARACTERISTICS (continued)

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

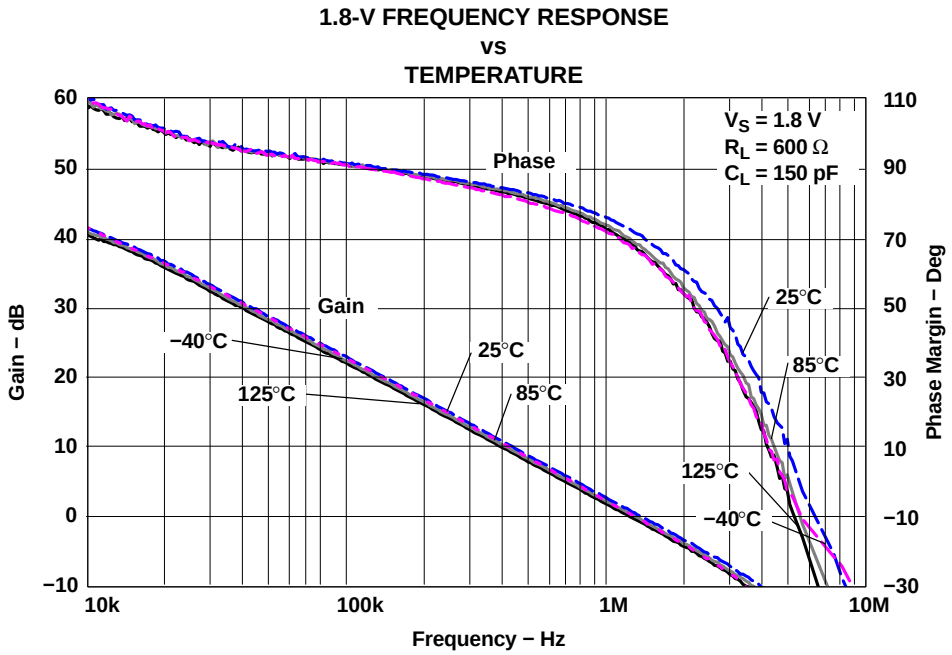



**Figure 11.**

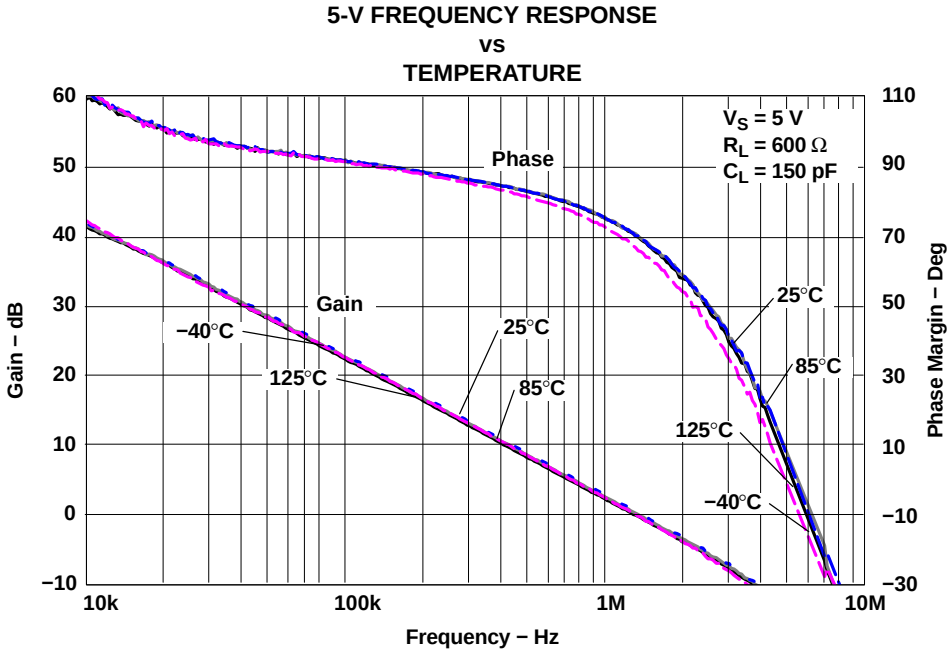



**Figure 12.**

## TYPICAL CHARACTERISTICS (continued)

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

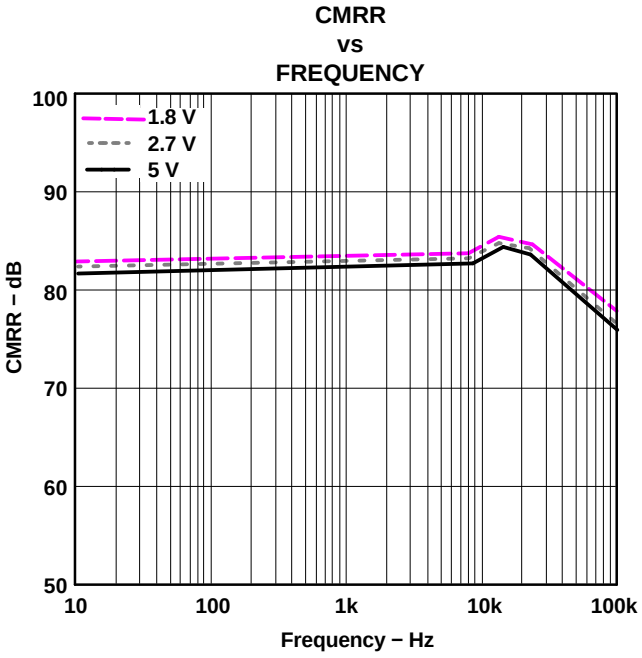



Figure 13.

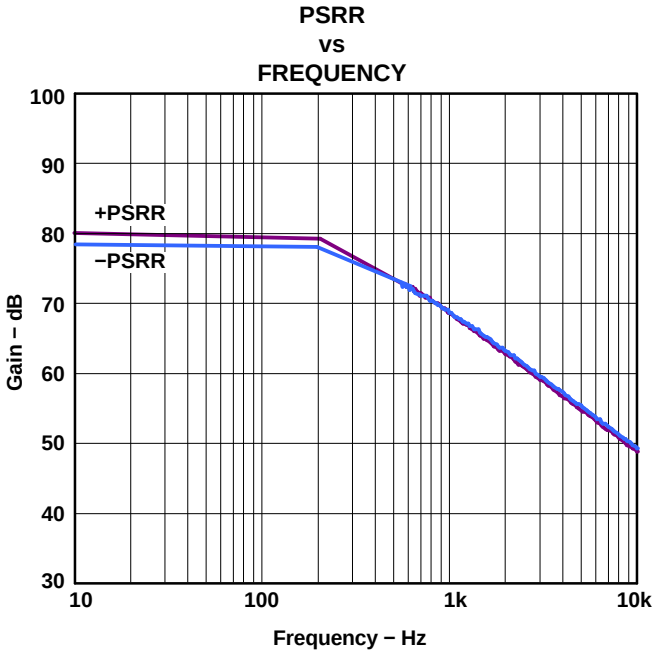



Figure 14.

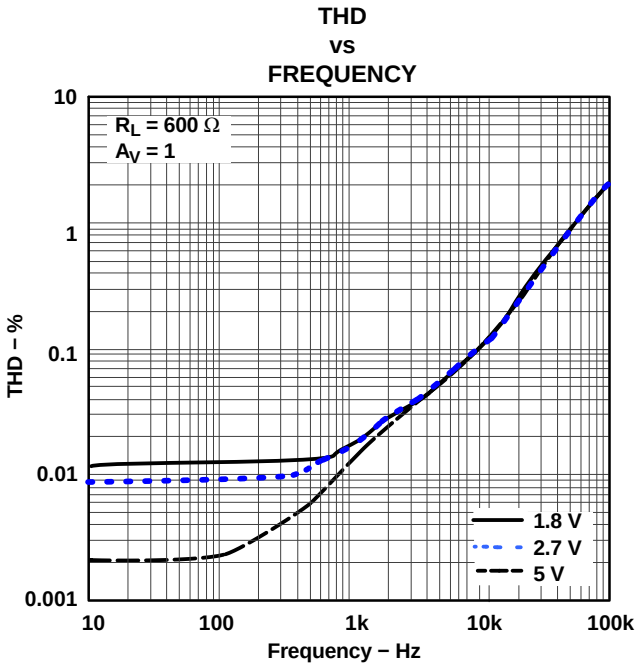



Figure 15.

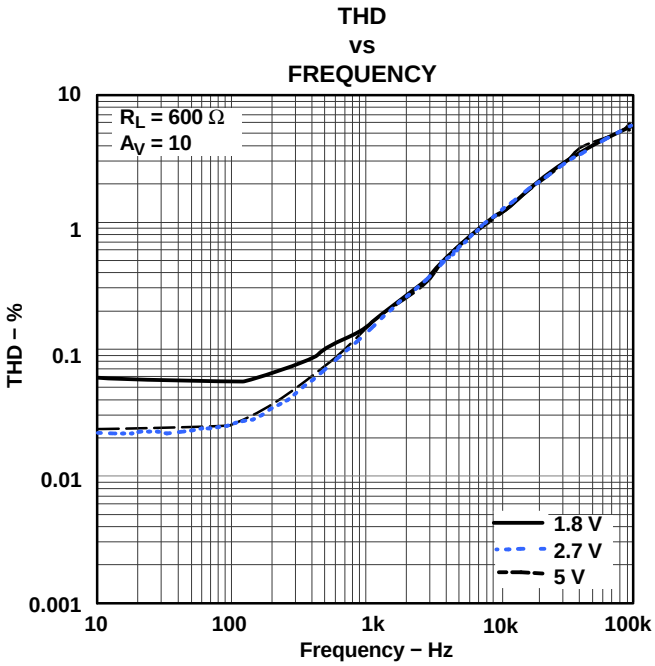



Figure 16.

## TYPICAL CHARACTERISTICS (continued)

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

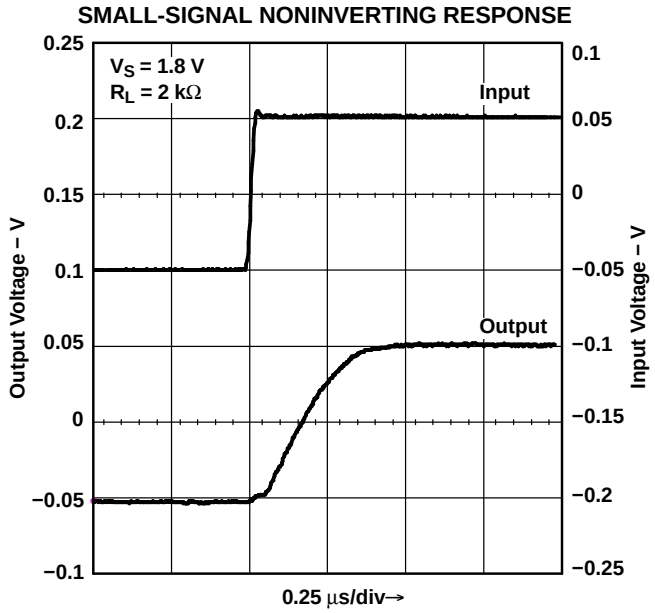



Figure 17.

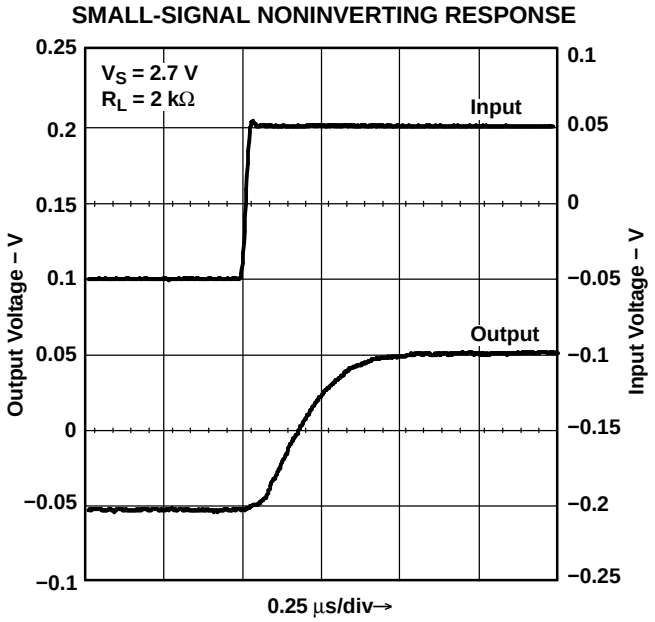



Figure 18.

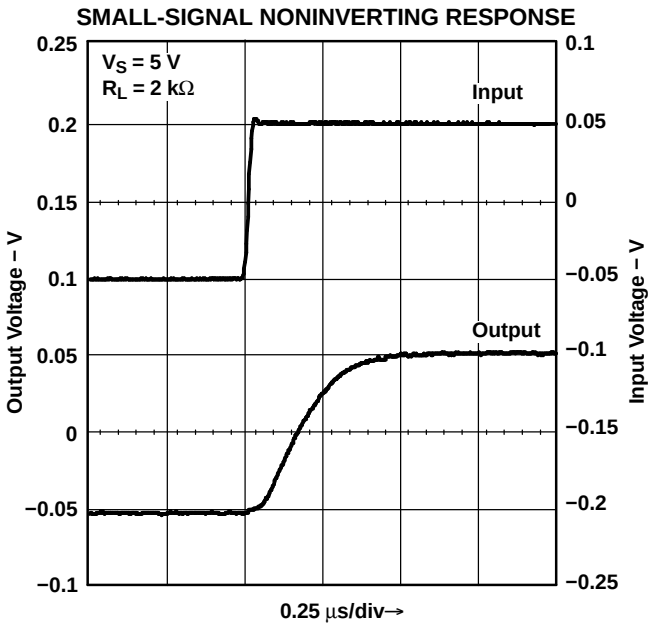



Figure 19.

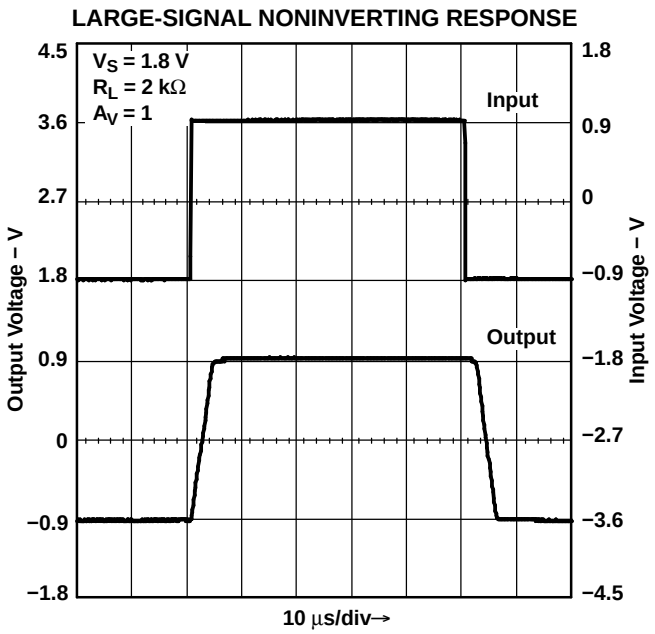



Figure 20.

## TYPICAL CHARACTERISTICS (continued)

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

**LARGE-SIGNAL NONINVERTING RESPONSE**

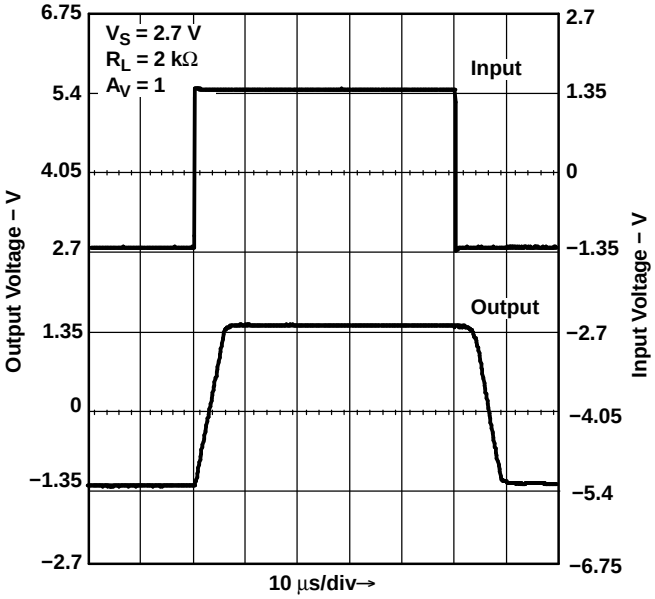



Figure 21.

**LARGE-SIGNAL NONINVERTING RESPONSE**

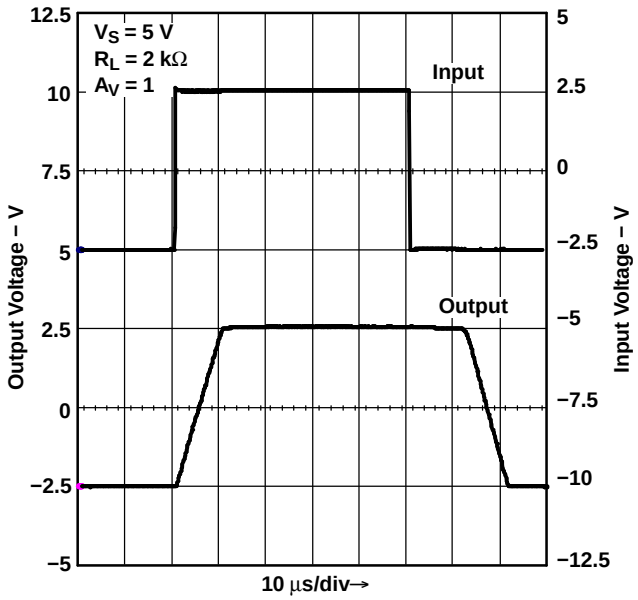



Figure 22.

**OFFSET VOLTAGE vs COMMON-MODE RANGE**

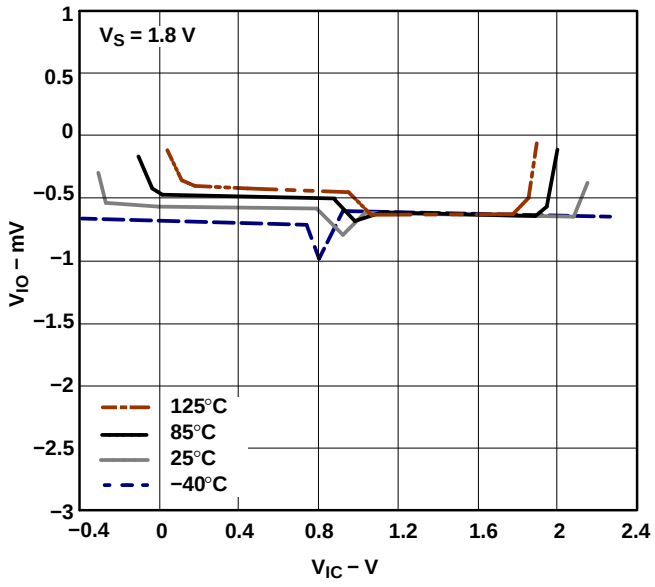



Figure 23.

**OFFSET VOLTAGE vs COMMON-MODE RANGE**

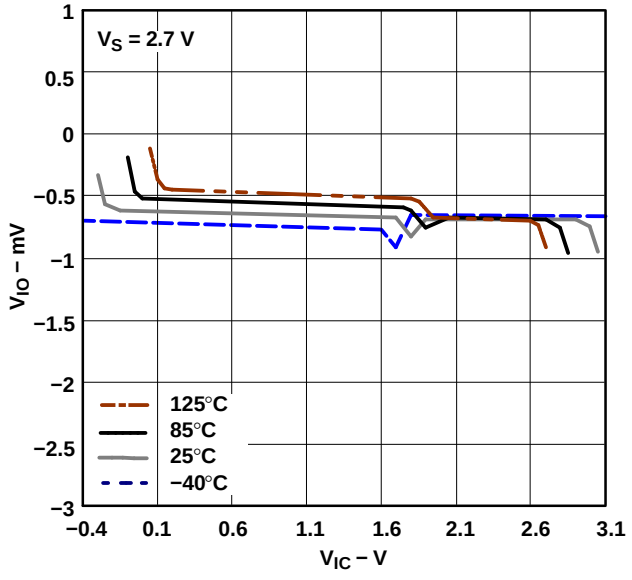



Figure 24.

## TYPICAL CHARACTERISTICS (continued)

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

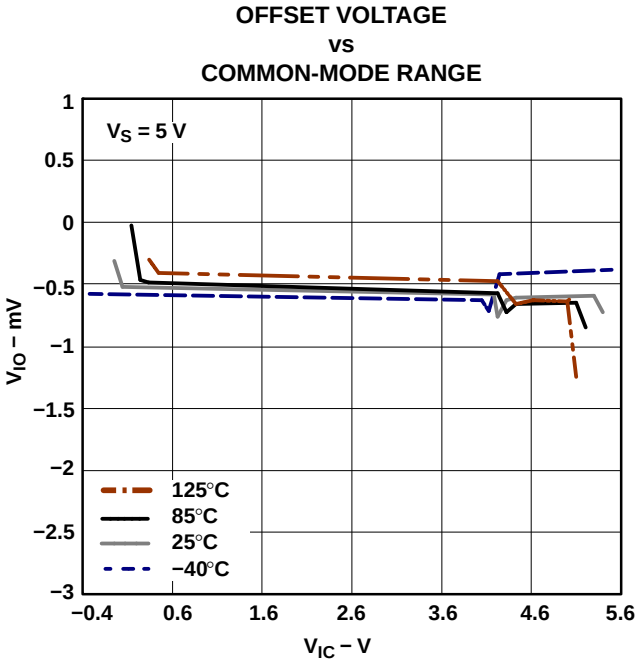



**Figure 25.**

## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish | MSL Peak Temp (3) |
|---|---|---|---|---|---|---|---|---|
| LMV931IDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| LMV931IDBVRE4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| LMV931IDCKR | ACTIVE | SC70 | DCK | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| LMV931IDCKRE4 | ACTIVE | SC70 | DCK | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| LMV931IDCKRG4 | ACTIVE | SC70 | DCK | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| LMV932ID | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| LMV932IDE4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| LMV932IDG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| LMV932IDGKR | ACTIVE | MSOP | DGK | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| LMV932IDGKRG4 | ACTIVE | MSOP | DGK | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| LMV932IDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| LMV932IDRE4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| LMV932IDRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| LMV934ID | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| LMV934IDE4 | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| LMV934IDR | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| LMV934IDRE4 | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| LMV934IPW | ACTIVE | TSSOP | PW | 14 | 90 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| LMV934IPWE4 | ACTIVE | TSSOP | PW | 14 | 90 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| LMV934IPWR | ACTIVE | TSSOP | PW | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| LMV934IPWRE4 | 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), 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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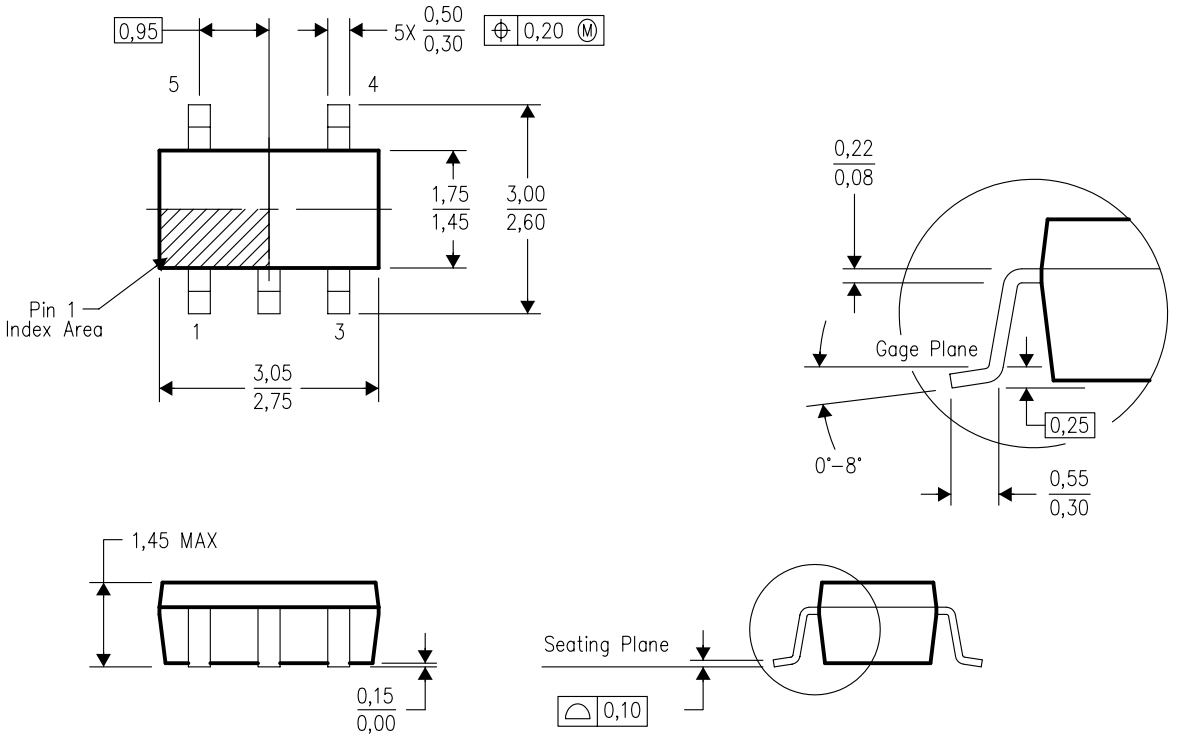
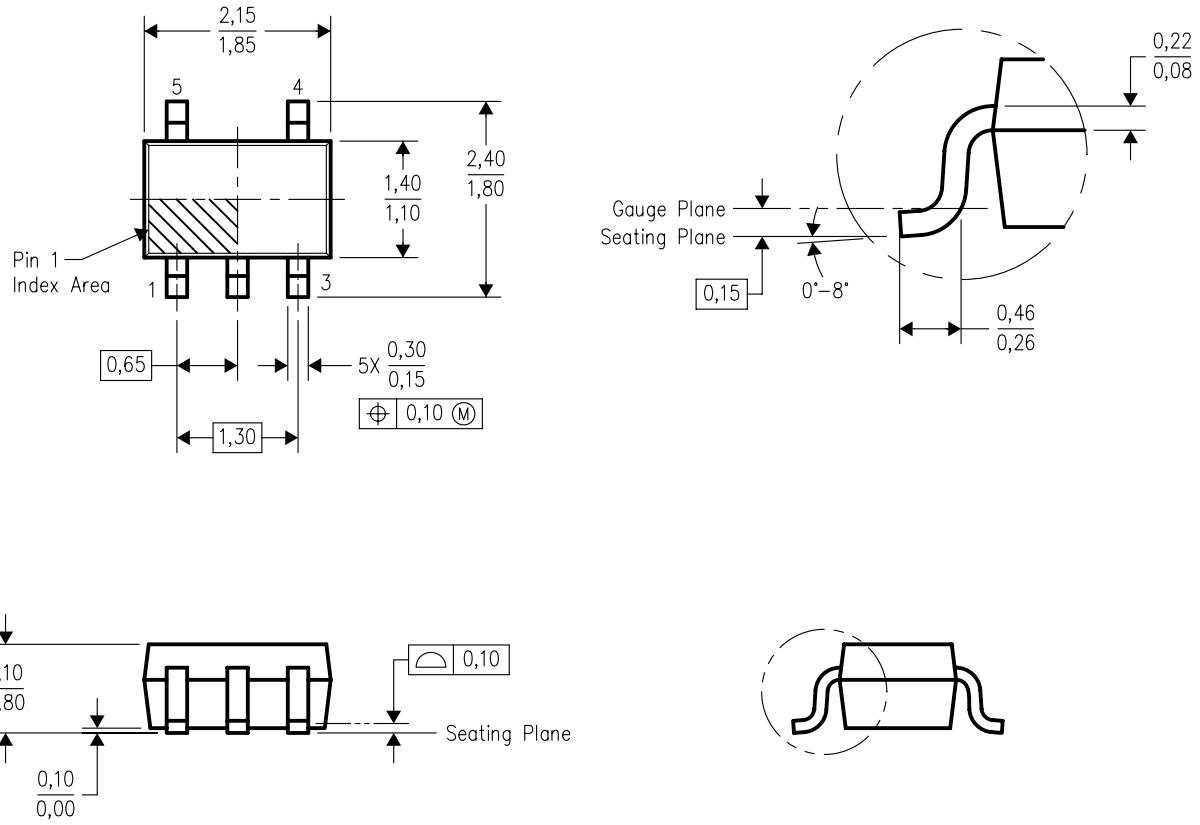
## DBV (R–PDSO–G5) PLASTIC SMALL–OUTLINE PACKAGE




4073253–4/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. Falls within JEDEC MO–178 Variation AA.

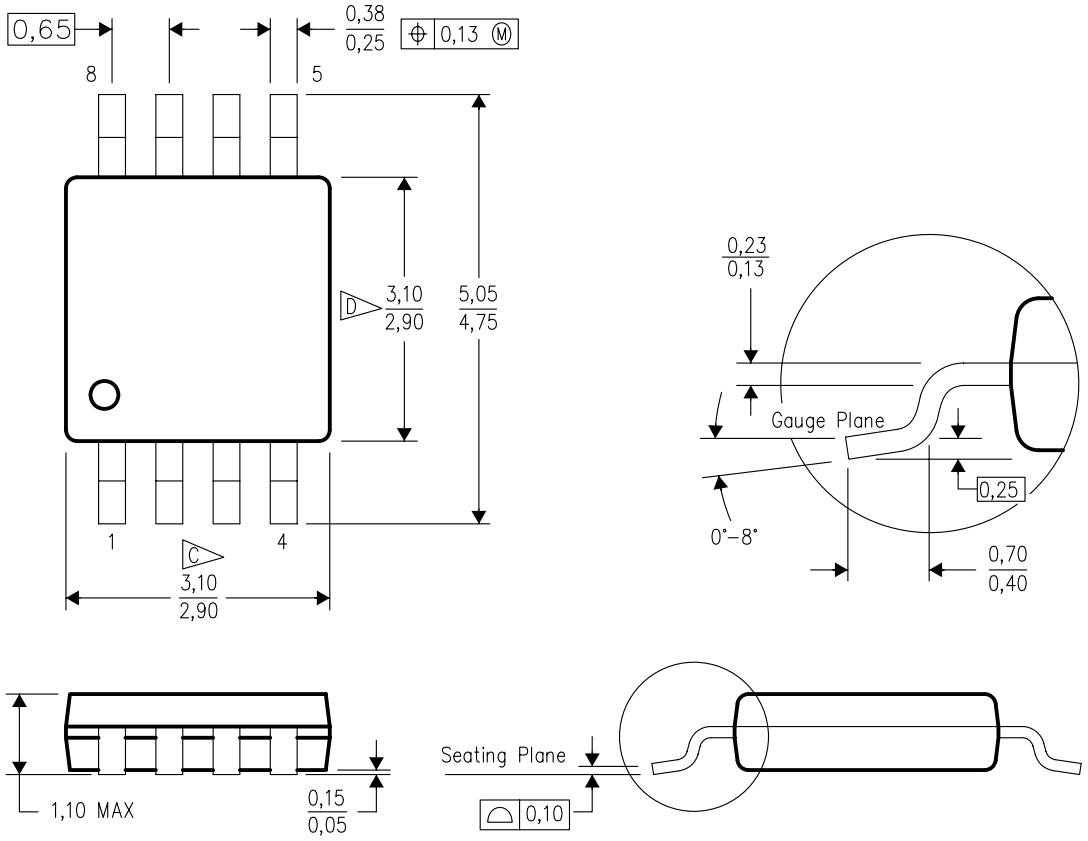
## DCK (R–PDSO–G5) PLASTIC SMALL–OUTLINE PACKAGE




4093553–3/G 01/2007

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.

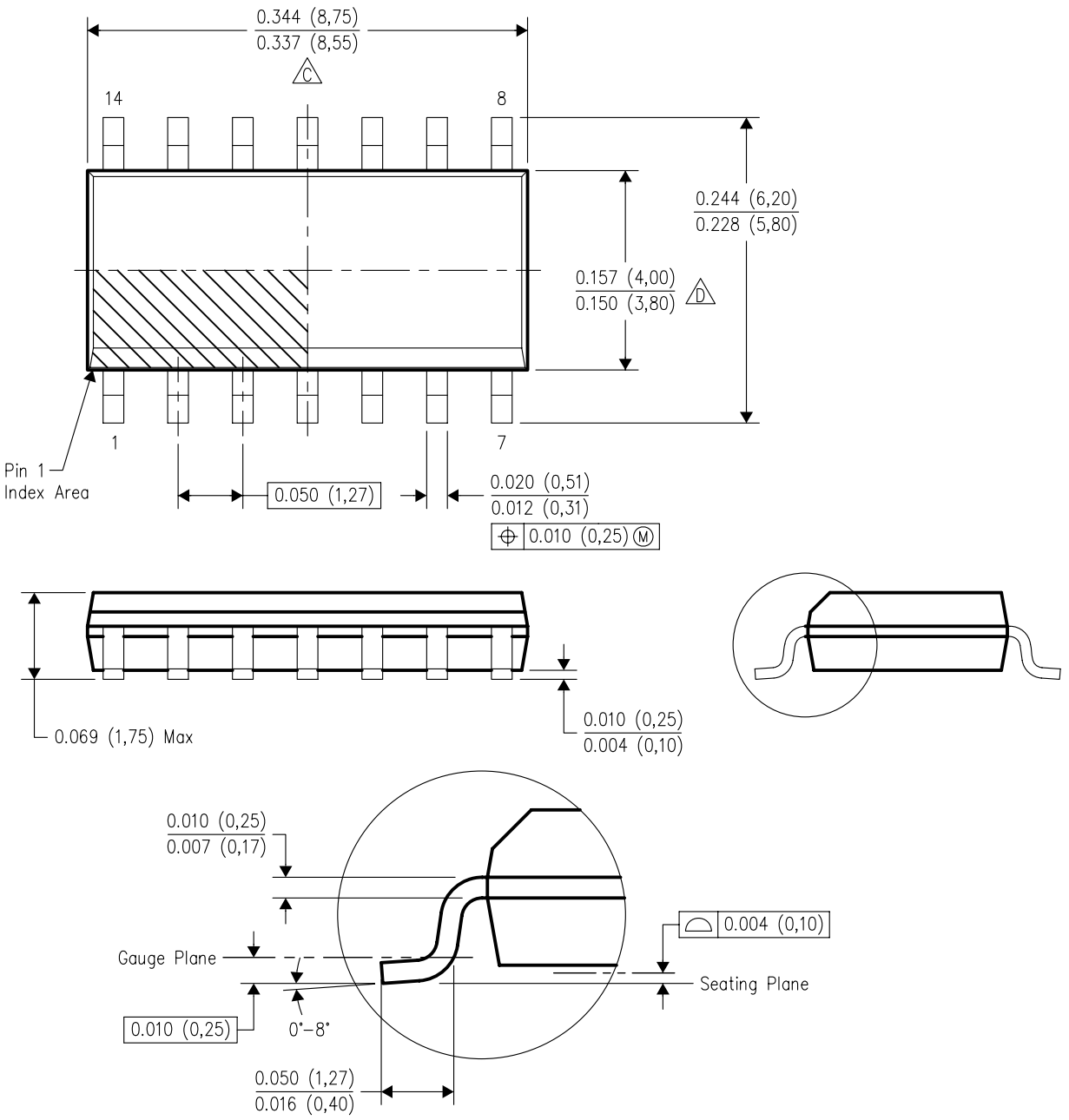
## DGK (S–PDSO–G8) PLASTIC SMALL–OUTLINE PACKAGE




4073329/E 05/06

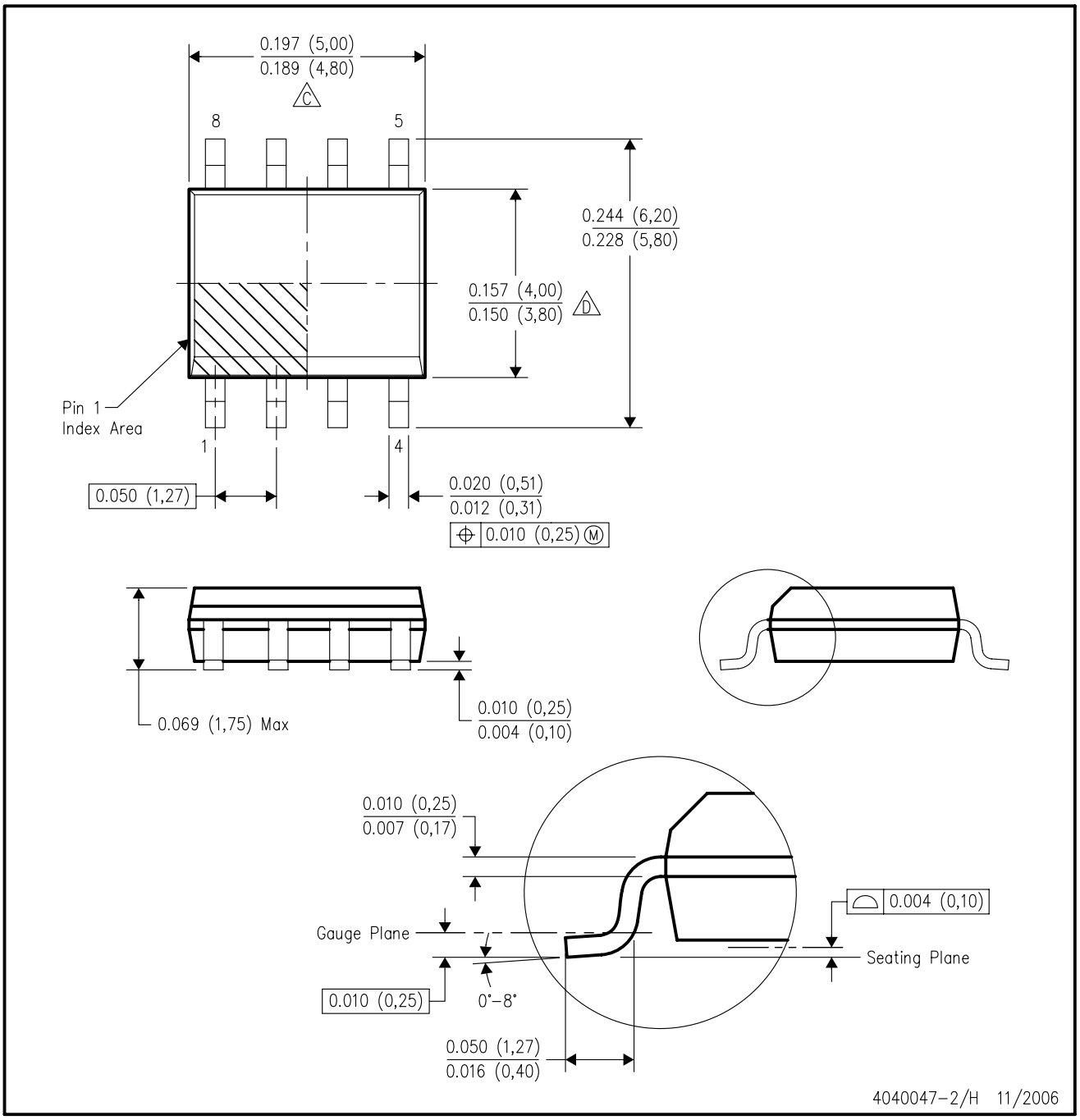
NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 per end.
D. Body width does not include interlead flash. Interlead flash shall not exceed 0.50 per side.
E. Falls within JEDEC MO–187 variation AA, except interlead flash.

## D (R–PDSO–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.

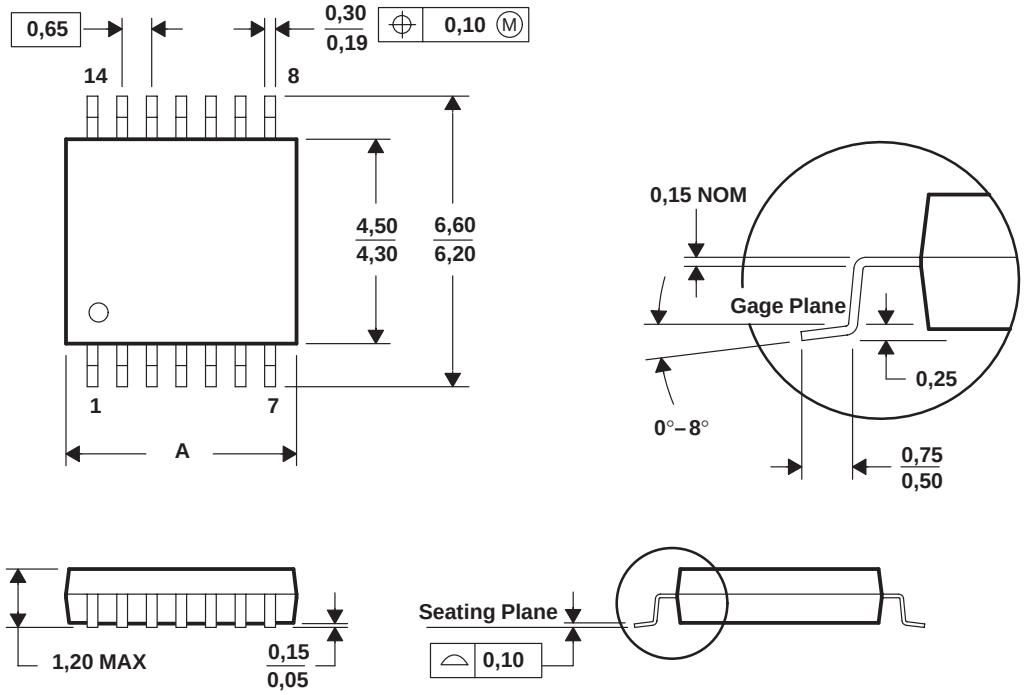
## D (R–PDSO–G8) PLASTIC SMALL–OUTLINE PACKAGE




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.

**PW (R-PDSO-G**)** **PLASTIC SMALL-OUTLINE PACKAGE**

**14 PINS SHOWN**




| DIM \ PINS ** | 8 | 14 | 16 | 20 | 24 | 28 |
|---|---|---|---|---|---|---|
| A MAX | 3,10 | 5,10 | 5,10 | 6,60 | 7,90 | 9,80 |
| A MIN | 2,90 | 4,90 | 4,90 | 6,40 | 7,70 | 9,60 |

**4040064/F 01/97**

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

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