

# LMV981, LMV982

## Single and Dual Low Voltage, Rail-to-Rail Input and Output, Operational Amplifiers with Shutdown

The LMV981 Single and LMV982 Dual are low-voltage operational amplifiers which can operate on single-sided power supplies (1.8 V to 5.0 V) with rail-to-rail input and output swing. Both devices come in small state-of-the-art packages and require very low quiescent current making them ideal for battery-operated, portable applications such as notebook computers and hand-held instruments. Rail-to-Rail operation allows for optimal signal-to-noise applications plus the small packages allow for closer placement to signal sources further enhancing overall signal chain performance.

The LMV981 Single and LMV982 Dual both have a shutdown pin that can be used to disable the device and further reduce power consumption. Shutdown is implemented by driving the  $\overline{\text{SHDN}}$  Pin LOW.

### Features

- Specified at Single-Sided Power Supply: 1.8 V, 2.7 V, and 5 V
- Small Packages:
  - LMV981 in a SC-70\* and uLLGA (1.5mm x 1.5mm x 0.4mm)
  - LMV982 in a Micro10\* and uQFN (1.4mm x 1.8mm x 0.6 mm)
- No Output Crossover Distortion
- Extended Industrial Temperature Range:  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$
- Low Quiescent Current 210  $\mu\text{A}$ , max per channel
- No Output Phase-Reversal from Overdriven Input
- These are Pb-Free Devices

### Typical Applications

- Notebook Computers, Portable Battery-Operated Instruments, PDA's
- Active Filters, Supply-Current Monitoring

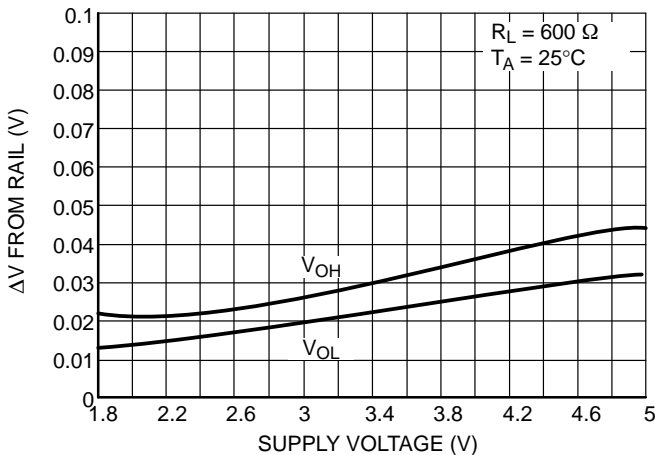


Figure 1. Output Voltage Swing vs. Supply Voltage

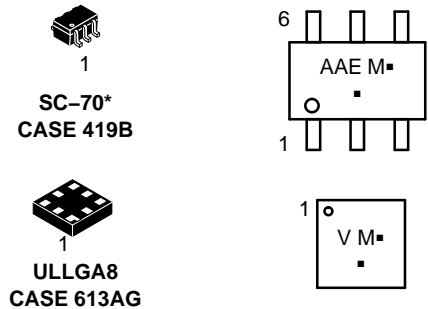


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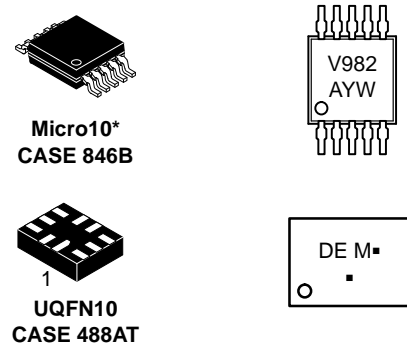
### MARKING DIAGRAMS

#### LMV981 (Single)



M = Date Code  
 ■ = Pb-Free Package  
 (Note: Microdot may be in either location)

#### LMV982 (Dual)



A = Assembly Location  
 Y = Year  
 W = Work Week  
 ■ = Pb-Free Package  
 (Note: Microdot may be in either location)

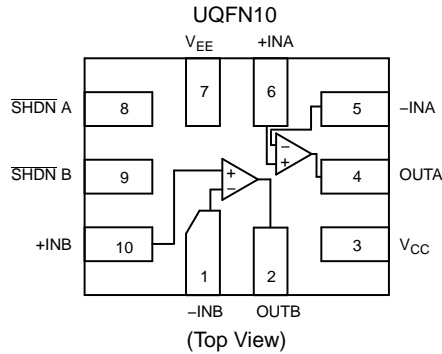
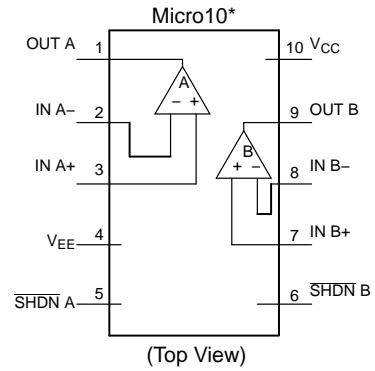
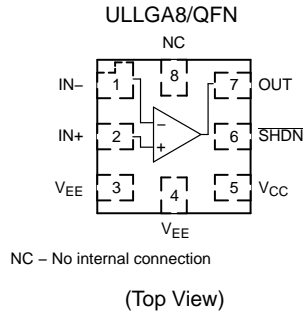
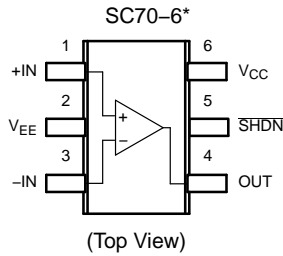
### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 17 of this data sheet.

\*Consult sales for package availability

# LMV981, LMV982

## PIN CONNECTIONS



\*Consult sales for package availability

## MAXIMUM RATINGS

| Symbol        | Rating  | Value                                | Unit               |
|---------------|---|--------------------------------------|--------------------|
| $V_S$         | Supply Voltage (Operating Range $V_S = 2.7\text{ V to }5.5\text{ V}$ )                  | 5.5                                  | V                  |
| $V_{IDR}$     | Input Differential Voltage  | $\pm$ Supply Voltage                 | V                  |
| $V_{ICR}$     | Input Common Mode Voltage Range   | $-0.5\text{ to }(V+) + 0.5$          | V                  |
|               | Maximum Input Current   | 10                                   | mA                 |
| $t_{So}$      | Output Short Circuit (Note 1)   | Continuous                           |                    |
| $T_J$         | Maximum Junction Temperature (Operating Range $-40^\circ\text{C to }85^\circ\text{C}$ ) | 150                                  | $^\circ\text{C}$   |
| $\theta_{JA}$ | Thermal Resistance  | SC-70<br>ULLGA8<br>Micro10<br>UQFN10 | $^\circ\text{C/W}$ |
| $T_{stg}$     | Storage Temperature (SOT23-6)   | $-65\text{ to }150$                  | $^\circ\text{C}$   |
|               | Mounting Temperature (Infrared or Convection -30 sec)                                   | 260                                  | $^\circ\text{C}$   |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

ESD data available upon request.

1. Continuous short-circuit operation to ground at elevated ambient temperature can result in exceeding the maximum allowed junction temperature of  $150^\circ\text{C}$ . Output currents in excess of 45 mA over long term may adversely affect reliability. Shorting output to either  $V+$  or  $V-$  will adversely affect reliability.

# LMV981, LMV982

**1.8 V DC ELECTRICAL CHARACTERISTICS** Unless otherwise noted, all min/max limits are guaranteed for  $T_A = 25^\circ\text{C}$ ,  $V^+ = 1.8\text{ V}$ ,  $V^- = 0\text{ V}$ ,  $V_{CM} = V^+/2$ ,  $V_O = V^+/2$  and  $R_L > 1\text{ M}\Omega$ . Typical specifications represent the most likely parametric norm.

| Parameter  | Symbol  | Condition   | Min             | Typ                | Max             | Unit                         |
|--|---|---|-----------------|--------------------|-----------------|------------------------------|
| Input Offset Voltage                               | $V_{IO}$  | LMV981 (Single) ( $-40^\circ\text{C}$ to $+125^\circ\text{C}$ )   |                 | 1                  | 6               | mV                           |
|  |   | LMV982 (Dual) ( $-40^\circ\text{C}$ to $+125^\circ\text{C}$ )   |                 | 1                  | 7.5             |                              |
| Input Offset Voltage Average Drift                 | $TCV_{IO}$  |   |                 | 5.5                |                 | $\mu\text{V}/^\circ\text{C}$ |
| Input Bias Current (Note 2)                        | $I_B$   | $-40^\circ\text{C}$ to $+125^\circ\text{C}$   |                 | < 1                |                 | nA                           |
| Input Offset Current (Note 2)                      | $I_{IO}$  | $-40^\circ\text{C}$ to $+125^\circ\text{C}$   |                 | < 1                |                 | nA                           |
| Supply Current (per Channel)                       | $I_{CC}$  | In Active Mode  |                 | 75                 | 185             | $\mu\text{A}$                |
|  |   | $-40^\circ\text{C}$ to $+125^\circ\text{C}$   |                 |                    | 205             |                              |
|  |   | In Shutdown: LMV981 (Single)  |                 |                    | 1.0             |                              |
|  |   | $-40^\circ\text{C}$ to $+125^\circ\text{C}$   |                 |                    | 2.0             |                              |
|  |   | In Shutdown: LMV982 (Dual)  |                 |                    | 3.5             |                              |
|  |   | $-40^\circ\text{C}$ to $+125^\circ\text{C}$   |                 |                    | 5.0             |                              |
| Common Mode Rejection Ratio                        | CMRR  | $0\text{ V} \leq V_{CM} \leq 0.6\text{ V}$ , $1.4\text{ V} \leq V_{CM} \leq 1.8\text{ V}$                     |                 | 40                 |                 | dB                           |
|  |   | $-40^\circ\text{C}$ to $+125^\circ\text{C}$   |                 | 40                 |                 |                              |
|  |   | $-0.2\text{ V} \leq V_{CM} \leq 0\text{ V}$ , $1.8\text{ V} \leq V_{CM} \leq 2\text{ V}$                      |                 | 40                 |                 |                              |
| Power Supply Rejection Ratio                       | PSRR  | $1.8\text{ V} \leq V^+ \leq 5\text{ V}$ , $V_{CM} = 0.5\text{ V}$   | 50              | 70                 |                 | dB                           |
|  |   | $-40^\circ\text{C}$ to $+125^\circ\text{C}$   | 50              |                    |                 |                              |
| Input Common-Mode Voltage Range                    | VCM   | For CMRR $\geq 50\text{ dB}$ and $T_A = 25^\circ\text{C}$   | $V^-$<br>$-0.2$ | $-0.2$<br>to $2.1$ | $V^+$<br>$+0.2$ | V                            |
|  |   | For CMRR $\geq 50\text{ dB}$ and $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$                             | $V^-$           |                    | $V^+$           |                              |
|  |   | For CMRR $\geq 50\text{ dB}$ and $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$                            | $V^-$<br>$+0.2$ |                    | $V^+$<br>$-0.2$ |                              |
| Large Signal Voltage Gain LMV981 (Single) (Note 2) | $A_V$   | $R_L = 600\ \Omega$ to $0.9\text{ V}$ , $V_O = 0.2\text{ V}$ to $1.6\text{ V}$ , $V_{CM} = 0.5\text{ V}$      | 77              | 101                |                 | dB                           |
|  |   | $-40^\circ\text{C}$ to $+125^\circ\text{C}$   | 73              |                    |                 |                              |
| Large Signal Voltage Gain LMV982 (Dual) (Note 2)   | $A_V$   | $R_L = 2\text{ k}\Omega$ to $0.9\text{ V}$ , $V_O = 0.2\text{ V}$ to $1.6\text{ V}$ , $V_{CM} = 0.5\text{ V}$ | 80              | 105                |                 | dB                           |
|  |   | $-40^\circ\text{C}$ to $+125^\circ\text{C}$   | 75              |                    |                 |                              |
|  |   | $R_L = 600\ \Omega$ to $0.9\text{ V}$ , $V_O = 0.2\text{ V}$ to $1.6\text{ V}$ , $V_{CM} = 0.5\text{ V}$      | 75              | 90                 |                 |                              |
|  |   | $-40^\circ\text{C}$ to $+125^\circ\text{C}$   | 72              |                    |                 |                              |
| Output Swing                                       | $V_{OH}$  | $R_L = 600\ \Omega$ to $0.9\text{ V}$ , $V_{IN} = \pm 100\text{ mV}$  | 1.65            | 1.72               |                 | V                            |
|  |   | $-40^\circ\text{C}$ to $+125^\circ\text{C}$   | 1.63            |                    |                 |                              |
|  | $V_{OL}$  | $R_L = 600\ \Omega$ to $0.9\text{ V}$ , $V_{IN} = \pm 100\text{ mV}$  |                 | 0.077              | 0.105           |                              |
|  |   | $-40^\circ\text{C}$ to $+125^\circ\text{C}$   |                 |                    | 0.12            |                              |
|  | $V_{OH}$  | $R_L = 2\text{ k}\Omega$ to $0.9\text{ V}$ , $V_{IN} = \pm 100\text{ mV}$                                     | 1.75            | 1.77               |                 |                              |
|  |   | $-40^\circ\text{C}$ to $+125^\circ\text{C}$   | 1.74            |                    |                 |                              |
| $V_{OL}$   | $R_L = 2\text{ k}\Omega$ to $0.9\text{ V}$ , $V_{IN} = \pm 100\text{ mV}$ |   | 0.24            | 0.035              |                 |                              |
|  | $-40^\circ\text{C}$ to $+125^\circ\text{C}$                               |   |                 | 0.04               |                 |                              |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

2. Guaranteed by design and/or characterization.

## LMV981, LMV982

**1.8 V DC ELECTRICAL CHARACTERISTICS** Unless otherwise noted, all min/max limits are guaranteed for  $T_A = 25^\circ\text{C}$ ,  $V^+ = 1.8\text{ V}$ ,  $V^- = 0\text{ V}$ ,  $V_{CM} = V^+/2$ ,  $V_O = V^+/2$  and  $R_L > 1\text{ M}\Omega$ . Typical specifications represent the most likely parametric norm.

| Parameter                    | Symbol     | Condition   | Min | Typ  | Max | Unit |
|------------------------------|------------|---|-----|------|-----|------|
| Output Short Circuit Current | $I_O$      | Sourcing, $V_O = 0\text{ V}$ , $V_{IN} = +100\text{ mV}$  | 4.0 | 30   |     | mA   |
|                              |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$               | 3.3 |      |     |      |
|                              |            | Sinking, $V_O = 1.8\text{ V}$ , $V_{IN} = -100\text{ mV}$ | 7.0 | 60   |     |      |
|                              |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$               | 5.0 |      |     |      |
| Shutdown Enable Control      | $V_{SHDN}$ | Turn-on Voltage to Enable Device                          |     | 1.0  |     | V    |
|                              |            | Turn-off Voltage to Shutdown Device                       |     | 0.55 |     |      |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

2. Guaranteed by design and/or characterization.

**1.8V AC ELECTRICAL CHARACTERISTICS** Unless otherwise specified, all limits are guaranteed for  $T_A = 25^\circ\text{C}$ ,  $V^+ = 1.8\text{ V}$ ,  $V^- = 0\text{ V}$ ,  $V_{CM} = 2.0\text{ V}$ ,  $V_O = V^+/2$  and  $R_L > 1\text{ M}\Omega$ . Typical specifications represent the most likely parametric norm. Min/Max specifications are guaranteed by testing, characterization, or statistical analysis.

| Parameter                        | Symbol     | Condition   | Min | Typ   | Max | Unit                   |
|----------------------------------|------------|---|-----|-------|-----|------------------------|
| Slew Rate                        | SR         | (Note 3)  |     | 0.35  |     | V/ $\mu\text{S}$       |
| Gain Bandwidth Product           | GBWP       |   |     | 1.4   |     | MHz                    |
| Phase Margin                     | $\Theta_m$ |   |     | 67    |     | $^\circ$               |
| Gain Margin                      | Gm         |   |     | 7     |     | dB                     |
| Input-Referred Voltage Noise     | $e_n$      | $f = 50\text{ kHz}$ , $V_{CM} = 0.5\text{ V}$                                   |     | 60    |     | nV/ $\sqrt{\text{Hz}}$ |
| Total Harmonic Distortion        | THD        | $f = 1\text{ kHz}$ , $A_V = +1$ , $R_L = 600\ \Omega$ , $V_O = 1\text{ V}_{PP}$ |     | 0.023 |     | %                      |
| Amplifier-to-Amplifier Isolation |            | (Note 4)  |     | 123   |     | dB                     |

3. Connected as voltage follower with input step from  $V^-$  to  $V^+$ . Number specified is the slower of the positive and negative slew rates.

4. Input referred,  $R_L = 100\text{ k}\Omega$  connected to  $V^+/2$ . Each amp excited in turn with  $1\text{ kHz}$  to produce  $V_O = 3\text{ V}_{PP}$ . (For Supply Voltages  $< 3\text{ V}$ ,  $V_O = V^+$ ).

## LMV981, LMV982

**2.7V DC ELECTRICAL CHARACTERISTICS** Unless otherwise noted, all min/max limits are guaranteed for  $T_A = 25^\circ\text{C}$ ,  $V^+ = 2.7\text{ V}$ ,  $V^- = 0\text{ V}$ ,  $V_{CM} = V^+/2$ ,  $V_O = V^+/2$  and  $R_L > 1\text{ M}\Omega$ . Typical specifications represent the most likely parametric norm.

| Parameter  | Symbol     | Condition  | Min             | Typ                | Max             | Unit                         |
|--|------------|--|-----------------|--------------------|-----------------|------------------------------|
| Input Offset Voltage                               | $V_{IO}$   | LMV981 (Single) ( $-40^\circ\text{C}$ to $+125^\circ\text{C}$ )                            |                 | 1                  | 6               | mV                           |
|  |            | LMV982 (Dual) ( $-40^\circ\text{C}$ to $+125^\circ\text{C}$ )                              |                 | 1                  | 7.5             |                              |
| Input Offset Voltage Average Drift                 | $TCV_{IO}$ |  |                 | 5.5                |                 | $\mu\text{V}/^\circ\text{C}$ |
| Input Bias Current (Note 5)                        | $I_B$      | $-40^\circ\text{C}$ to $+125^\circ\text{C}$  |                 | < 1                |                 | nA                           |
| Input Offset Current (Note 5)                      | $I_{IO}$   | $-40^\circ\text{C}$ to $+125^\circ\text{C}$  |                 | < 1                |                 | nA                           |
| Supply Current (per Channel)                       | $I_{CC}$   | In Active Mode   |                 | 80                 | 190             | $\mu\text{A}$                |
|  |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$  |                 |                    | 210             |                              |
|  |            | In Shutdown: LMV981 (Single)   |                 |                    | 1.0             |                              |
|  |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$  |                 |                    | 2.0             |                              |
|  |            | In Shutdown: LMV982 (Dual)   |                 |                    | 3.5             |                              |
|  |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$  |                 |                    | 5.0             |                              |
| Common Mode Rejection Ratio                        | CMRR       | $0\text{ V} \leq V_{CM} \leq 1.5\text{ V}$ , $2.3\text{ V} \leq V_{CM} \leq 2.7\text{ V}$  | 50              | 70                 |                 | dB                           |
|  |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$  | 50              |                    |                 |                              |
|  |            | $-0.2\text{ V} \leq V_{CM} \leq 0\text{ V}$ , $2.7\text{ V} \leq V_{CM} \leq 2.9\text{ V}$ | 50              | 70                 |                 |                              |
| Power Supply Rejection Ratio                       | PSRR       | $1.8\text{ V} \leq V^+ \leq 5\text{ V}$ , $V_{CM} = 0.5\text{ V}$                          | 50              | 70                 |                 | dB                           |
|  |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$  | 50              |                    |                 |                              |
| Input Common-Mode Voltage Range                    | VCM        | For CMRR $\geq 50\text{ dB}$ and $T_A = 25^\circ\text{C}$                                  | $V^-$<br>$-0.2$ | $-0.2$<br>to $3.0$ | $V^+$<br>$+0.2$ | V                            |
|  |            | For CMRR $\geq 50\text{ dB}$ and $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$          | $V^-$           |                    | $V^+$           |                              |
|  |            | For CMRR $\geq 50\text{ dB}$ and $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$         | $V^-$<br>$+0.2$ |                    | $V^+$<br>$-0.2$ |                              |
| Large Signal Voltage Gain LMV981 (Single) (Note 5) | $A_V$      | $R_L = 600\ \Omega$ to $1.35\text{ V}$ , $V_O = 0.2\text{ V}$ to $2.5\text{ V}$            | 87              | 104                |                 | dB                           |
|  |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$  | 86              |                    |                 |                              |
|  |            | $R_L = 2\text{ k}\Omega$ to $1.35\text{ V}$ , $V_O = 0.2\text{ V}$ to $2.5\text{ V}$       | 92              | 110                |                 |                              |
|  |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$  | 91              |                    |                 |                              |
| Large Signal Voltage Gain LMV982 (Dual) (Note 5)   | $A_V$      | $R_L = 600\ \Omega$ to $1.35\text{ V}$ , $V_O = 0.2\text{ V}$ to $2.5\text{ V}$            | 78              | 90                 |                 | dB                           |
|  |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$  | 75              |                    |                 |                              |
|  |            | $R_L = 2\text{ k}\Omega$ to $1.35\text{ V}$ , $V_O = 0.2\text{ V}$ to $2.5\text{ V}$       | 81              | 100                |                 |                              |
|  |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$  | 78              |                    |                 |                              |
| Output Swing                                       | $V_{OH}$   | $R_L = 600\ \Omega$ to $1.35\text{ V}$ , $V_{IN} = \pm 100\text{ mV}$                      | 2.55            | 2.62               |                 | V                            |
|  |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$  | 2.53            |                    |                 |                              |
|  | $V_{OL}$   | $R_L = 600\ \Omega$ to $1.35\text{ V}$ , $V_{IN} = \pm 100\text{ mV}$                      |                 | 0.083              | 0.11            |                              |
|  |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$  |                 |                    | 0.13            |                              |
|  | $V_{OH}$   | $R_L = 2\text{ k}\Omega$ to $1.35\text{ V}$ , $V_{IN} = \pm 100\text{ mV}$                 | 2.65            | 2.675              |                 |                              |
|  |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$  | 2.64            |                    |                 |                              |
|  | $V_{OL}$   | $R_L = 2\text{ k}\Omega$ to $1.35\text{ V}$ , $V_{IN} = \pm 100\text{ mV}$                 |                 | 0.025              | 0.04            |                              |
|  |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$  |                 |                    | 0.045           |                              |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

5. Guaranteed by design and/or characterization.

## LMV981, LMV982

**2.7V DC ELECTRICAL CHARACTERISTICS** Unless otherwise noted, all min/max limits are guaranteed for  $T_A = 25^\circ\text{C}$ ,  $V^+ = 2.7\text{ V}$ ,  $V^- = 0\text{ V}$ ,  $V_{CM} = V^+/2$ ,  $V_O = V^+/2$  and  $R_L > 1\text{ M}\Omega$ . Typical specifications represent the most likely parametric norm.

| Parameter                    | Symbol     | Condition   | Min | Typ  | Max | Unit |
|------------------------------|------------|---|-----|------|-----|------|
| Output Short Circuit Current | $I_O$      | Sourcing, $V_O = 0\text{ V}$ , $V_{IN} = \pm 100\text{ mV}$ | 20  | 65   |     | mA   |
|                              |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$                 | 15  |      |     |      |
|                              |            | Sinking, $V_O = 0\text{ V}$ , $V_{IN} = -100\text{ mV}$     | 18  | 75   |     |      |
|                              |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$                 | 12  |      |     |      |
| Shutdown Enable Control      | $V_{SHDN}$ | Turn-on Voltage to Enable Device                            |     | 1.9  |     | V    |
|                              |            | Turn-off Voltage to Shutdown Device                         |     | 0.55 |     |      |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

5. Guaranteed by design and/or characterization.

**2.7V AC ELECTRICAL CHARACTERISTICS** Unless otherwise specified, all limits are guaranteed for  $T_A = 25^\circ\text{C}$ ,  $V^+ = 2.7\text{ V}$ ,  $V^- = 0\text{ V}$ ,  $V_{CM} = 2.0\text{ V}$ ,  $V_O = V^+/2$  and  $R_L > 1\text{ M}\Omega$ . Typical specifications represent the most likely parametric norm. Min/Max specifications are guaranteed by testing, characterization, or statistical analysis.

| Parameter                        | Symbol     | Condition   | Min | Typ   | Max | Unit                   |
|----------------------------------|------------|---|-----|-------|-----|------------------------|
| Slew Rate                        | SR         | (Note 6)  |     | 0.4   |     | V/ $\mu\text{S}$       |
| Gain Bandwidth Product           | GBWP       |   |     | 1.4   |     | MHz                    |
| Phase Margin                     | $\Theta_m$ |   |     | 70    |     | $^\circ$               |
| Gain Margin                      | Gm         |   |     | 7.5   |     | dB                     |
| Input-Referred Voltage Noise     | $e_n$      | $f = 50\text{ kHz}$ , $V_{CM} = 1.0\text{ V}$                                   |     | 57    |     | nV/ $\sqrt{\text{Hz}}$ |
| Total Harmonic Distortion        | THD        | $f = 1\text{ kHz}$ , $A_V = +1$ , $R_L = 600\ \Omega$ , $V_O = 1\text{ V}_{PP}$ |     | 0.022 |     | %                      |
| Amplifier-to-Amplifier Isolation |            | (Note 7)  |     | 123   |     | dB                     |

6. Connected as voltage follower with input step from  $V^-$  to  $V^+$ . Number specified is the slower of the positive and negative slew rates.

7. Input referred,  $R_L = 100\text{ k}\Omega$  connected to  $V^+/2$ . Each amp excited in turn with 1 kHz to produce  $V_O = 3\text{ V}_{PP}$ . (For Supply Voltages  $< 3\text{ V}$ ,  $V_O = V^+$ ).

## LMV981, LMV982

**5V DC ELECTRICAL CHARACTERISTICS** Unless otherwise noted, all min/max limits are guaranteed for  $T_A = 25^\circ\text{C}$ ,  $V^+ = 5\text{ V}$ ,  $V^- = 0\text{ V}$ ,  $V_{CM} = V^+/2$ ,  $V_O = V^+/2$  and  $R_L > 1\text{ M}\Omega$ . Typical specifications represent the most likely parametric norm.

| Parameter  | Symbol     | Condition  | Min             | Typ                | Max             | Unit                         |
|--|------------|--|-----------------|--------------------|-----------------|------------------------------|
| Input Offset Voltage                               | $V_{IO}$   | LMV981 (Single) ( $-40^\circ\text{C}$ to $+125^\circ\text{C}$ )                            |                 | 1                  | 6               | mV                           |
|  |            | LMV982 (Dual) ( $-40^\circ\text{C}$ to $+125^\circ\text{C}$ )                              |                 | 1                  | 7.5             |                              |
| Input Offset Voltage Average Drift                 | $TCV_{IO}$ |  |                 | 5.5                |                 | $\mu\text{V}/^\circ\text{C}$ |
| Input Bias Current (Note 8)                        | $I_B$      | $-40^\circ\text{C}$ to $+125^\circ\text{C}$  |                 | < 1                |                 | nA                           |
| Input Offset Current (Note 8)                      | $I_{IO}$   | $-40^\circ\text{C}$ to $+125^\circ\text{C}$  |                 | < 1                |                 | nA                           |
| Supply Current (per Channel)                       | $I_{CC}$   | In Active Mode   |                 | 95                 | 210             | $\mu\text{A}$                |
|  |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$  |                 |                    | 230             |                              |
|  |            | In Shutdown: LMV981 (Single)   |                 |                    | 1.0             |                              |
|  |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$  |                 |                    | 2.0             |                              |
|  |            | In Shutdown: LMV982 (Dual)   |                 |                    | 3.5             |                              |
|  |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$  |                 |                    | 5.0             |                              |
| Common-Mode Rejection Ratio                        | CMRR       | $0\text{ V} \leq V_{CM} \leq 3.8\text{ V}$ , $4.6\text{ V} \leq V_{CM} \leq 5.0\text{ V}$  | 50              | 70                 |                 | dB                           |
|  |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$  | 50              |                    |                 |                              |
|  |            | $-0.2\text{ V} \leq V_{CM} \leq 0\text{ V}$ , $5.0\text{ V} \leq V_{CM} \leq 5.2\text{ V}$ | 50              | 70                 |                 |                              |
| Power Supply Rejection Ratio                       | PSRR       | $1.8\text{ V} \leq V^+ \leq 5\text{ V}$ , $V_{CM} = 0.5\text{ V}$                          | 50              | 70                 |                 | dB                           |
|  |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$  | 50              |                    |                 |                              |
| Input Common-Mode Voltage Range                    | VCM        | For CMRR $\geq 50\text{ dB}$ and $T_A = 25^\circ\text{C}$                                  | $V^-$<br>$-0.2$ | $-0.2$<br>to $5.3$ | $V^+$<br>$+0.2$ | V                            |
|  |            | For CMRR $\geq 50\text{ dB}$ and $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$          | $V^-$           |                    | $V^+$           |                              |
|  |            | For CMRR $\geq 50\text{ dB}$ and $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$         | $V^-$<br>$+0.3$ |                    | $V^+$<br>$-0.3$ |                              |
| Large Signal Voltage Gain LMV981 (Single) (Note 8) | $A_V$      | $R_L = 600\ \Omega$ to $2.5\text{ V}$ , $V_O = 0.2\text{ V}$ to $4.8\text{ V}$             | 88              | 102                |                 | dB                           |
|  |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$  | 87              |                    |                 |                              |
|  |            | $R_L = 2\text{ k}\Omega$ to $2.5\text{ V}$ , $V_O = 0.2\text{ V}$ to $4.8\text{ V}$        | 94              | 113                |                 |                              |
|  |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$  | 93              |                    |                 |                              |
| Large Signal Voltage Gain LMV982 (Dual) (Note 8)   | $A_V$      | $R_L = 600\ \Omega$ to $2.5\text{ V}$ , $V_O = 0.2\text{ V}$ to $4.8\text{ V}$             | 81              | 90                 |                 | dB                           |
|  |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$  | 78              |                    |                 |                              |
|  |            | $R_L = 2\text{ k}\Omega$ to $2.5\text{ V}$ , $V_O = 0.2\text{ V}$ to $4.8\text{ V}$        | 85              | 100                |                 |                              |
|  |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$  | 82              |                    |                 |                              |
| Output Swing                                       | $V_{OH}$   | $R_L = 600\ \Omega$ to $2.5\text{ V}$ , $V_{IN} = \pm 100\text{ mV}$                       | 4.855           | 4.89               |                 | V                            |
|  |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$  | 4.835           |                    |                 |                              |
|  | $V_{OL}$   | $R_L = 600\ \Omega$ to $2.5\text{ V}$ , $V_{IN} = \pm 100\text{ mV}$                       |                 | 0.12               | 0.16            |                              |
|  |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$  |                 |                    | 0.18            |                              |
|  | $V_{OH}$   | $R_L = 2\text{ k}\Omega$ to $2.5\text{ V}$ , $V_{IN} = \pm 100\text{ mV}$                  | 4.945           | 4.967              |                 |                              |
|  |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$  | 4.935           |                    |                 |                              |
|  | $V_{OL}$   | $R_L = 2\text{ k}\Omega$ to $2.5\text{ V}$ , $V_{IN} = \pm 100\text{ mV}$                  |                 | 0.037              | 0.065           |                              |
|  |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$  |                 |                    | 0.075           |                              |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

8. Guaranteed by design and/or characterization.

## LMV981, LMV982

**5V DC ELECTRICAL CHARACTERISTICS** Unless otherwise noted, all min/max limits are guaranteed for  $T_A = 25^\circ\text{C}$ ,  $V^+ = 5\text{ V}$ ,  $V^- = 0\text{ V}$ ,  $V_{CM} = V^+/2$ ,  $V_O = V^+/2$  and  $R_L > 1\text{ M}\Omega$ . Typical specifications represent the most likely parametric norm.

| Parameter                    | Symbol     | Condition  | Min | Typ  | Max | Unit |
|------------------------------|------------|--|-----|------|-----|------|
| Output Short-Circuit Current | $I_O$      | Sourcing, $V_O = 0\text{ V}$ , $V_{IN} = +100\text{ mV}$ | 40  | 60   |     | mA   |
|                              |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$              | 40  |      |     |      |
|                              |            | Sinking, $V_O = 5\text{ V}$ , $V_{IN} = -100\text{ mV}$  | 45  | 65   |     |      |
|                              |            | $-40^\circ\text{C}$ to $+125^\circ\text{C}$              | 45  |      |     |      |
| Shutdown Enable Control      | $V_{SHDN}$ | Turn-on Voltage to Enable Device                         |     | 4.2  |     | V    |
|                              |            | Turn-off Voltage to Shutdown Device                      |     | 0.55 |     |      |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

8. Guaranteed by design and/or characterization.

**5V AC ELECTRICAL CHARACTERISTICS** Unless otherwise specified, all limits are guaranteed for  $T_A = 25^\circ\text{C}$ ,  $V^+ = 5\text{ V}$ ,  $V^- = 0\text{ V}$ ,  $V_{CM} = 2.0\text{ V}$ ,  $V_O = V^+/2$  and  $R_L > 1\text{ M}\Omega$ . Typical specifications represent the most likely parametric norm.

| Parameter                        | Symbol     | Condition   | Min | Typ   | Max | Unit                         |
|----------------------------------|------------|---|-----|-------|-----|------------------------------|
| Slew Rate                        | SR         | (Note 9)  |     | 0.48  |     | V/ $\mu\text{S}$             |
| Gain Bandwidth Product           | GBWP       |   |     | 1.5   |     | MHz                          |
| Phase Margin                     | $\Theta_m$ |   |     | 65    |     | $^\circ$                     |
| Gain Margin                      | Gm         |   |     | 8     |     | dB                           |
| Input-Referred Voltage Noise     | $e_n$      | $f = 50\text{ kHz}$ , $V_{CM} = 2\text{ V}$                                     |     | 50    |     | $\text{nV}/\sqrt{\text{Hz}}$ |
| Total Harmonic Distortion        | THD        | $f = 1\text{ kHz}$ , $A_V = +1$ , $R_L = 600\ \Omega$ , $V_O = 1\text{ V}_{PP}$ |     | 0.022 |     | %                            |
| Amplifier-to-Amplifier Isolation |            | (Note 10)   |     | 123   |     | dB                           |

9. Connected as voltage follower with input step from  $V^-$  to  $V^+$ . Number specified is the slower of the positive and negative slew rates.

10. Input referred,  $R_L = 100\text{ k}\Omega$  connected to  $V^+/2$ . Each amp excited in turn with  $1\text{ kHz}$  to produce  $V_O = 3\text{ V}_{PP}$ . (For Supply Voltages  $< 3\text{ V}$ ,  $V_O = V^+$ ).



# LMV981, LMV982

## TYPICAL CHARACTERISTICS

( $T_A = 25^\circ\text{C}$  and  $V_S = 5\text{ V}$  unless otherwise specified)

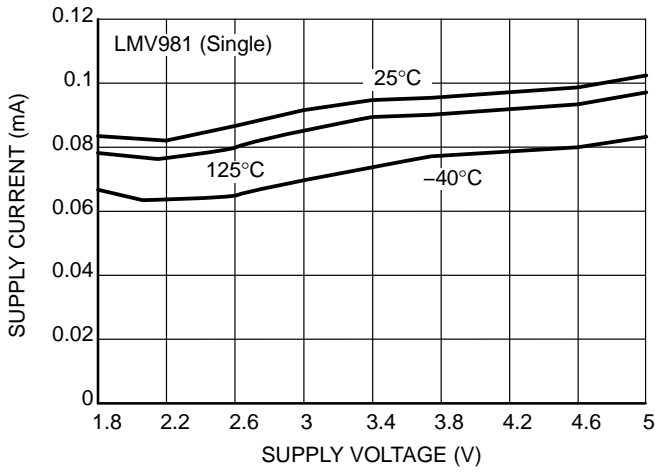


Figure 2. Supply Current vs. Supply Voltage

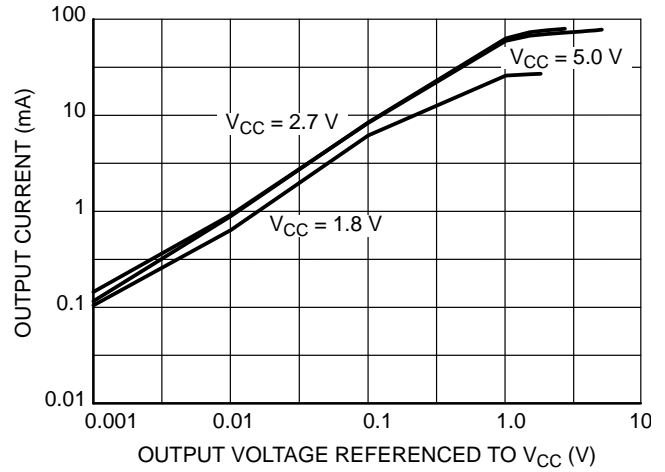


Figure 3. Sourcing Current vs. Output Voltage ( $T_A = 25^\circ\text{C}$ )

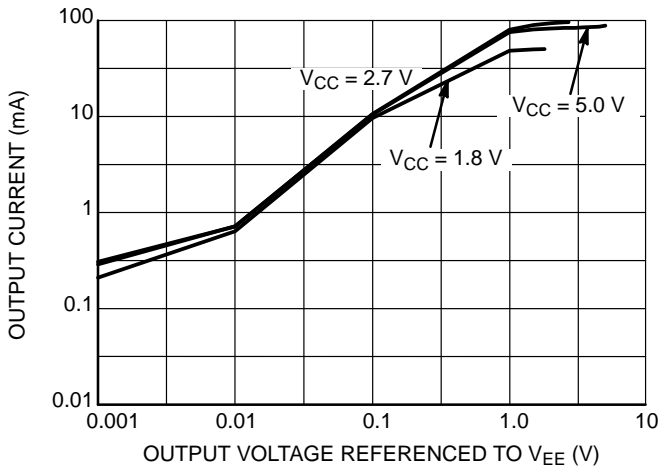


Figure 4. Sinking Current vs. Output Voltage ( $T_A = 25^\circ\text{C}$ )

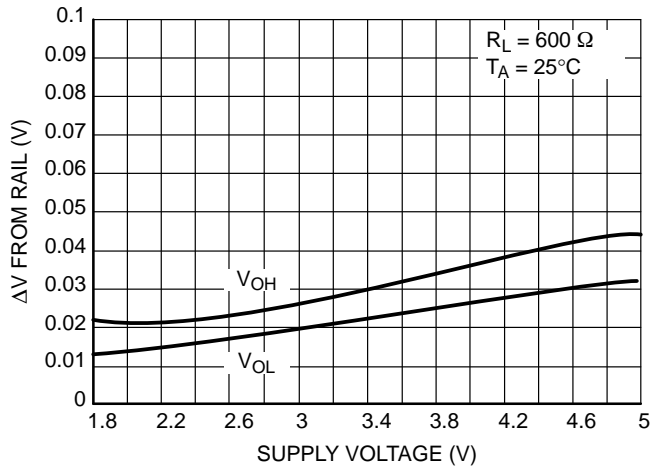


Figure 5. Output Voltage Swing vs. Supply Voltage

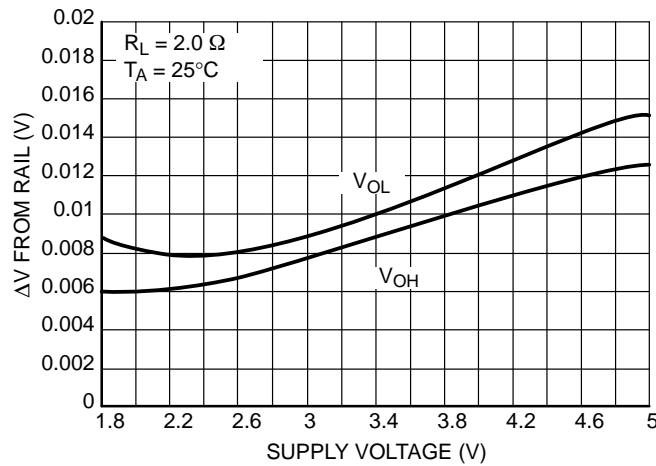


Figure 6. Output Voltage vs. Supply Voltage

# LMV981, LMV982

## TYPICAL CHARACTERISTICS

( $T_A = 25^\circ\text{C}$  and  $V_S = 5\text{ V}$  unless otherwise specified)

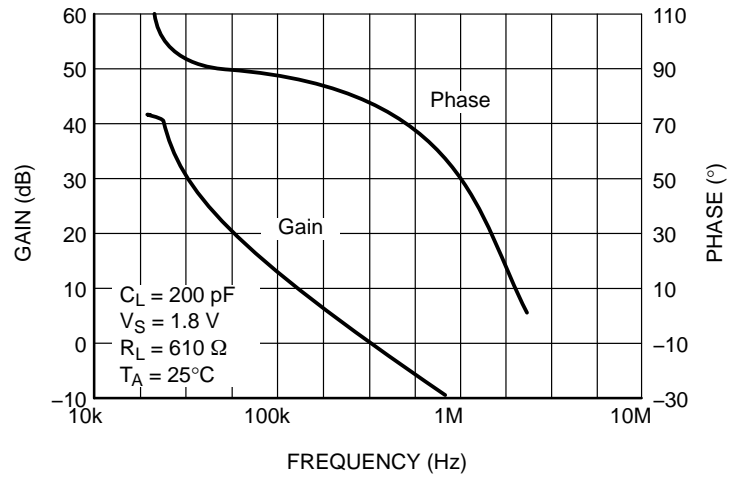


Figure 7. Gain and Phase vs. Frequency

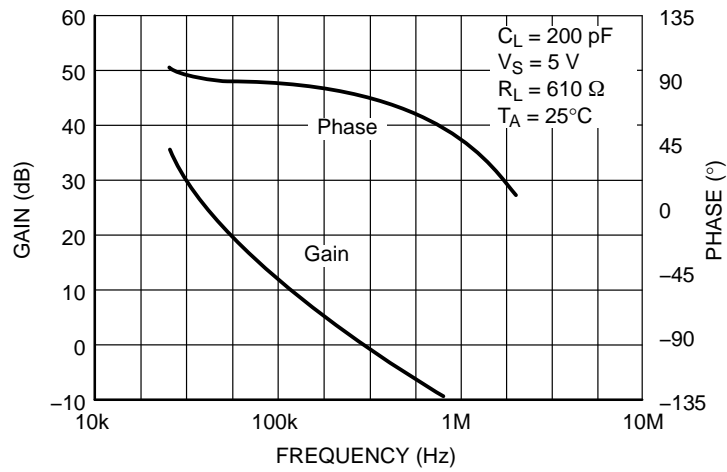


Figure 8. Gain and Phase vs. Frequency

# LMV981, LMV982

## TYPICAL CHARACTERISTICS

( $T_A = 25^\circ\text{C}$  and  $V_S = 5\text{ V}$  unless otherwise specified)

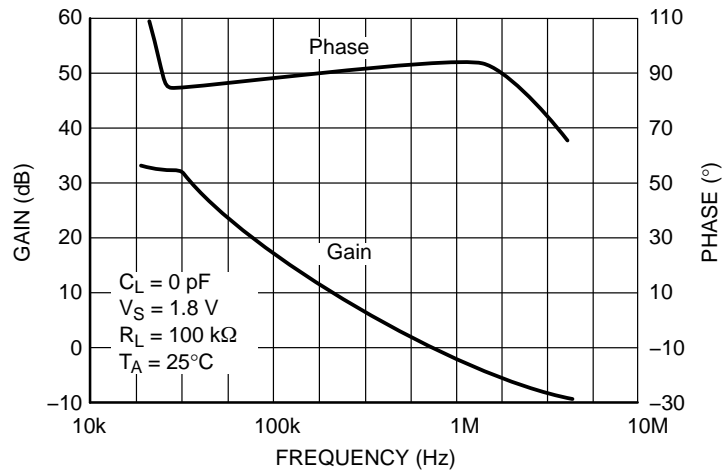


Figure 9. Gain and Phase vs. Frequency

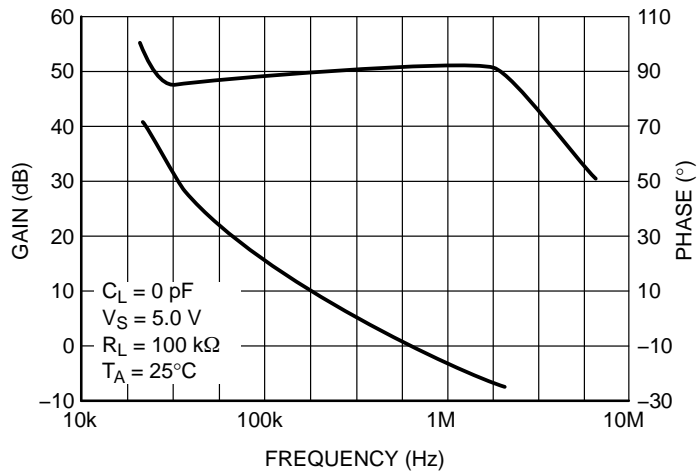


Figure 10. Gain and Phase vs. Frequency

# LMV981, LMV982

## TYPICAL CHARACTERISTICS

( $T_A = 25^\circ\text{C}$  and  $V_S = 5\text{ V}$  unless otherwise specified)

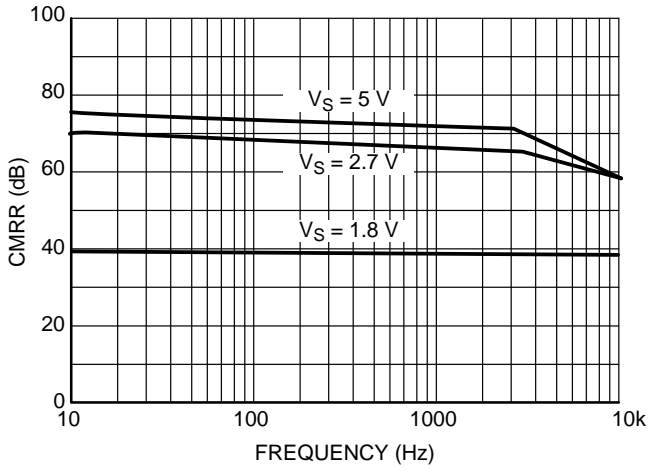


Figure 11. CMRR vs. Frequency

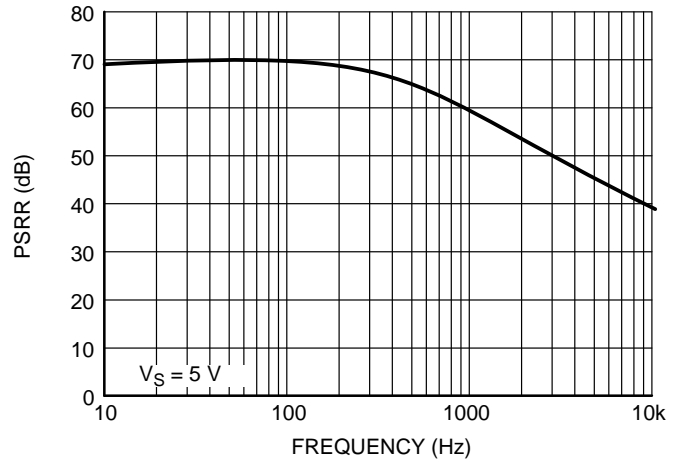


Figure 12. PSRR vs. Frequency

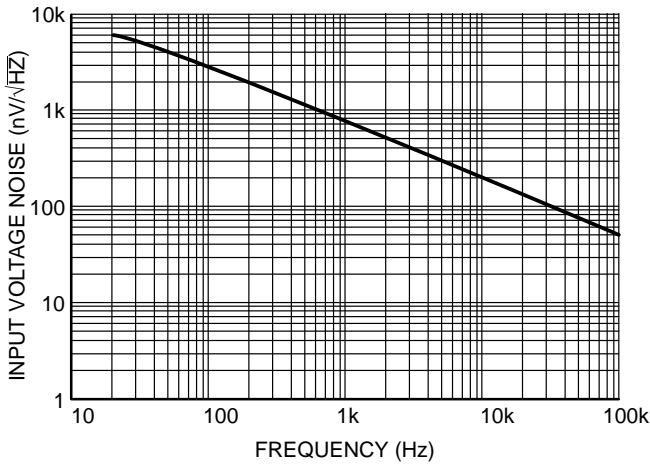


Figure 13. Input Voltage Noise vs. Frequency

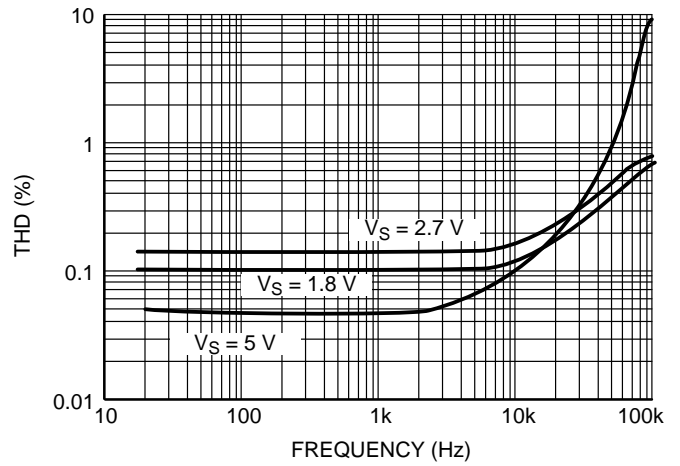


Figure 14. THD vs. Frequency

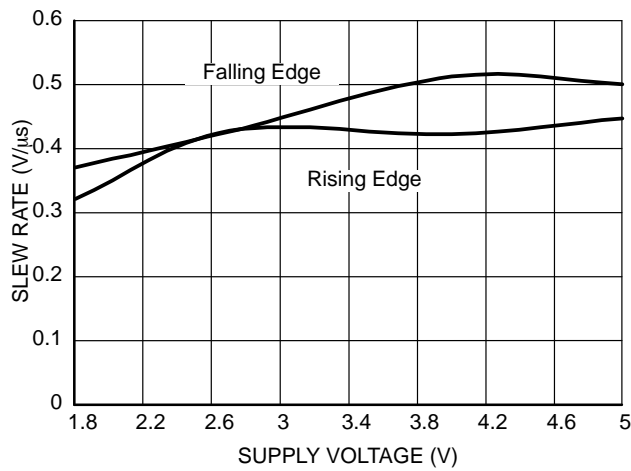
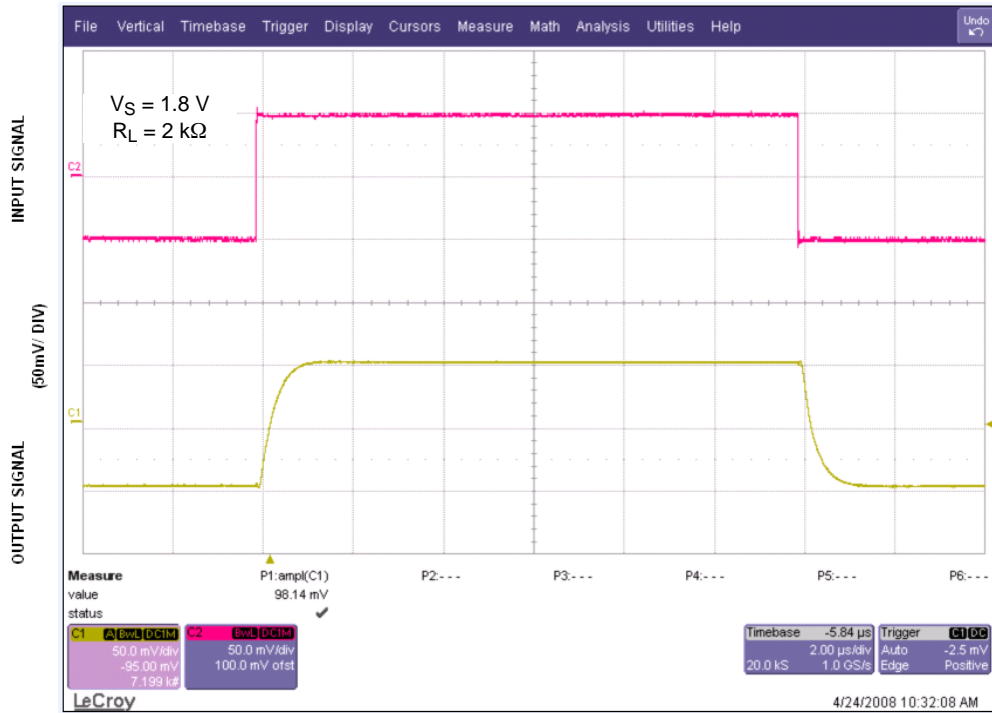


Figure 15. Slew Rate vs. Supply Voltage

# LMV981, LMV982

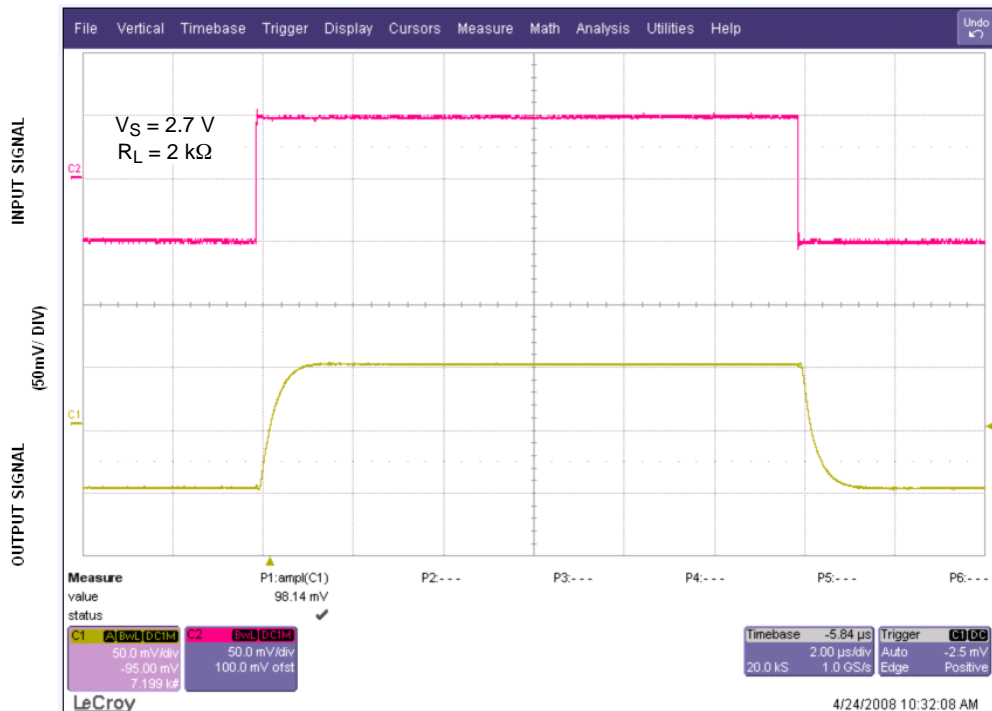
## TYPICAL CHARACTERISTICS

( $T_A = 25^\circ\text{C}$  and  $V_S = 5\text{ V}$  unless otherwise specified)



TIME (2 $\mu\text{s}/\text{div}$ )

Figure 16. Small Signal Noninverting Response



TIME (2 $\mu\text{s}/\text{div}$ )

Figure 17. Small Signal Noninverting Response

# LMV981, LMV982

## TYPICAL CHARACTERISTICS

( $T_A = 25^\circ\text{C}$  and  $V_S = 5\text{ V}$  unless otherwise specified)



TIME (2 $\mu\text{s}/\text{div}$ )

Figure 18. Small Signal Noninverting Response



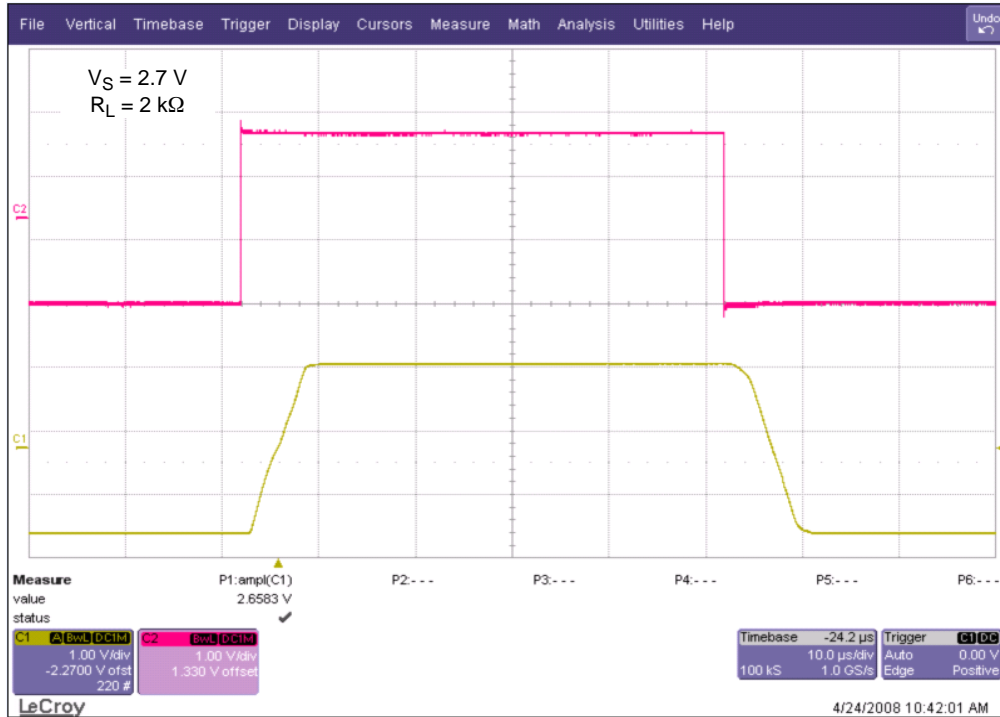
TIME (2 $\mu\text{s}/\text{div}$ )

Figure 19. Large Signal Noninverting Response

# LMV981, LMV982

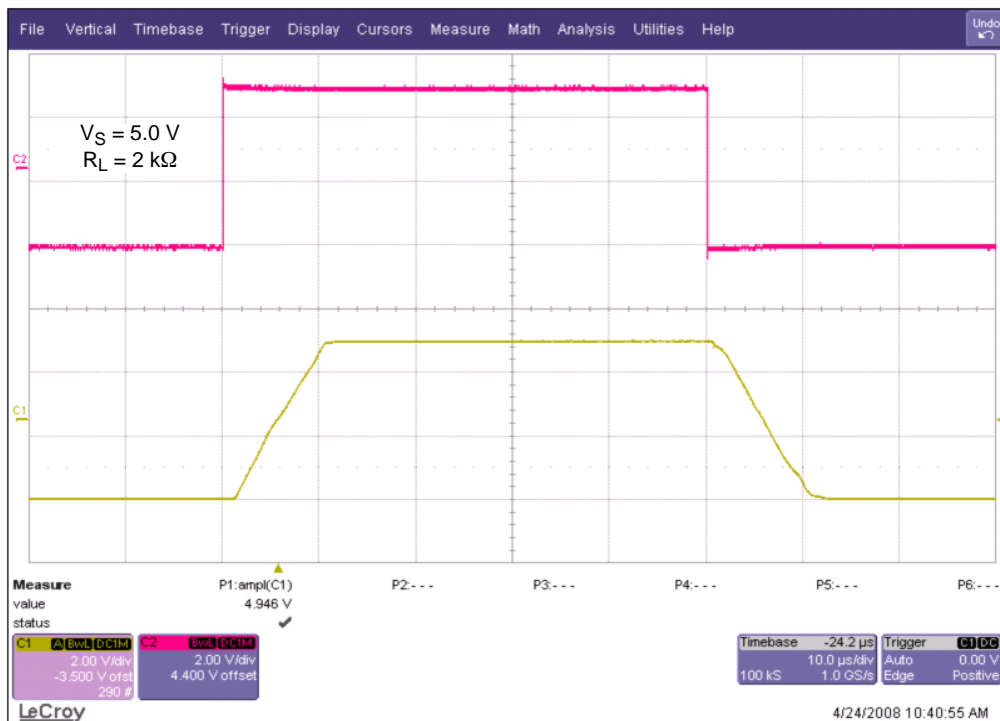
## TYPICAL CHARACTERISTICS

( $T_A = 25^\circ\text{C}$  and  $V_S = 5\text{ V}$  unless otherwise specified)



TIME (2 $\mu\text{s}/\text{div}$ )

Figure 20. Large Signal Noninverting Response



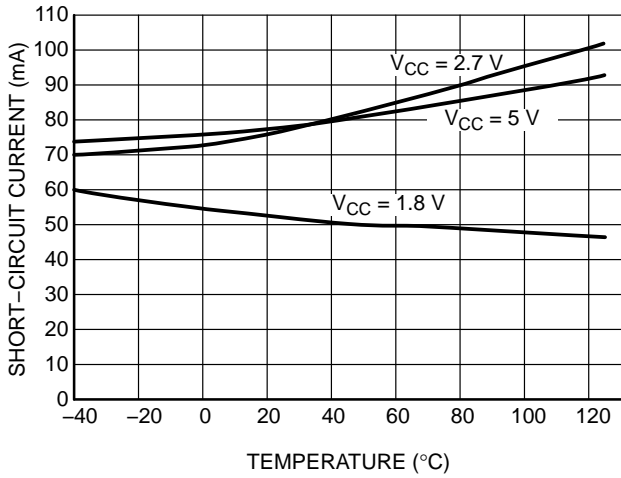
TIME (2 $\mu\text{s}/\text{div}$ )

Figure 21. Large Signal Noninverting Response

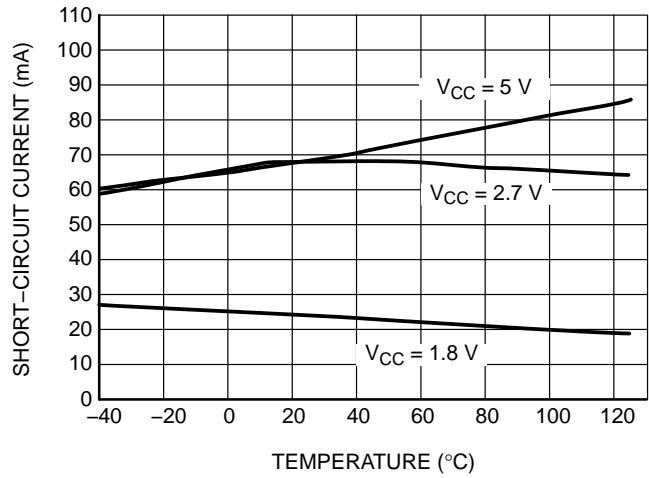
# LMV981, LMV982

## TYPICAL CHARACTERISTICS

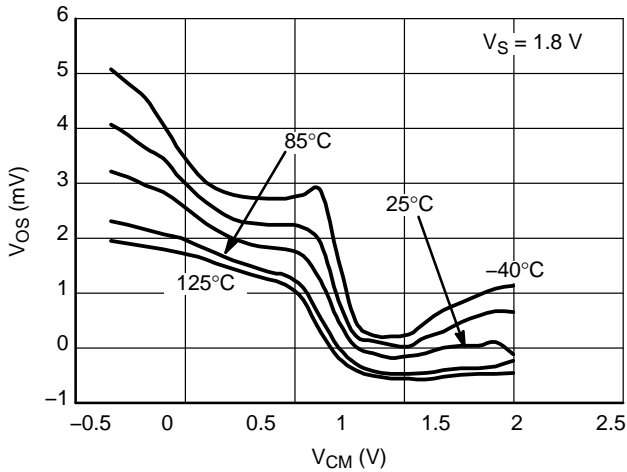
( $T_A = 25^\circ\text{C}$  and  $V_S = 5\text{ V}$  unless otherwise specified)



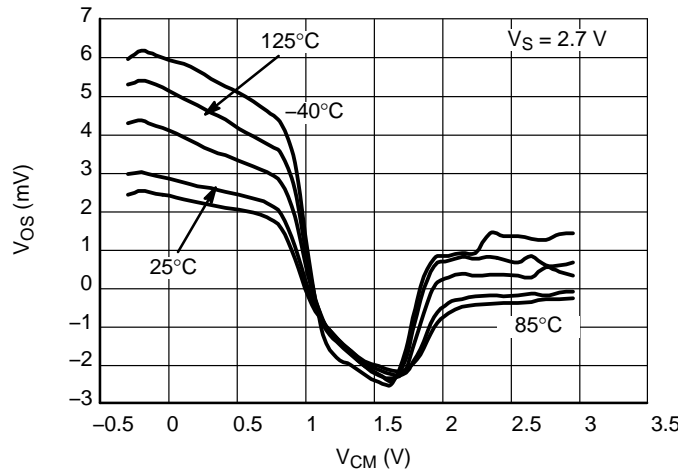
**Figure 22. Short-Circuit vs. Supply Voltage (Sinking)**



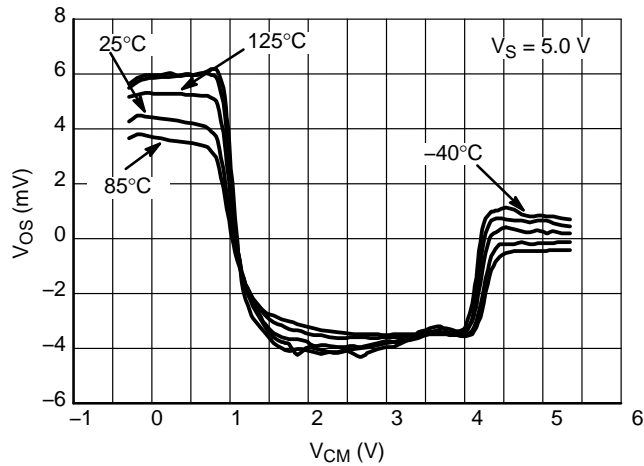
**Figure 23. Short-Circuit vs. Supply Voltage (Sourcing)**



**Figure 24. Offset Voltage vs. Common Mode Range  $V_{DD} 1.8\text{ V}$**



**Figure 25. Offset Voltage vs. Common Mode Range  $V_{DD} 2.7\text{ V}$**



**Figure 26. Offset Voltage vs. Common Mode Range  $V_{DD} 5.0\text{ V}$**



# LMV981, LMV982

## APPLICATION INFORMATION

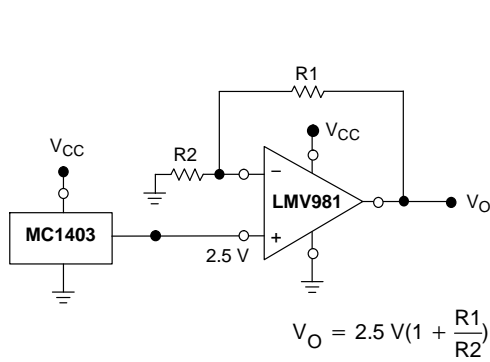


Figure 27. Voltage Reference

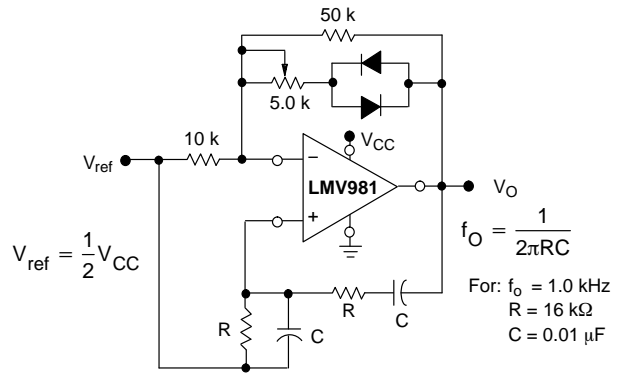


Figure 28. Wien Bridge Oscillator

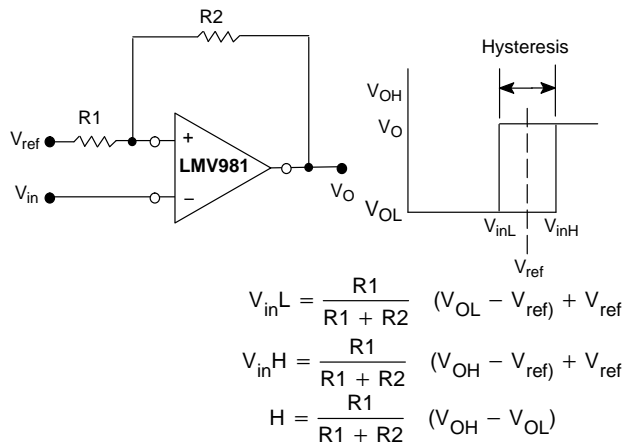
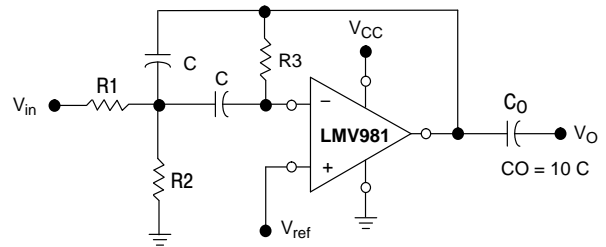


Figure 29. Comparator with Hysteresis

$$V_{inL} = \frac{R1}{R1 + R2} (V_{OL} - V_{ref}) + V_{ref}$$

$$V_{inH} = \frac{R1}{R1 + R2} (V_{OH} - V_{ref}) + V_{ref}$$

$$H = \frac{R1}{R1 + R2} (V_{OH} - V_{OL})$$



Given:  $f_o$  = center frequency  
 $A(f_o)$  = gain at center frequency

Choose value  $f_o, C$   
 Then:  $R3 = \frac{Q}{\pi f_o C}$   
 $R1 = \frac{R3}{2 A(f_o)}$   
 $R2 = \frac{R1 R3}{4Q^2 R1 - R3}$

For less than 10% error from operational amplifier,  
 $((Q_o f_o)/BW) < 0.1$  where  $f_o$  and  $BW$  are expressed in Hz.  
 If source impedance varies, filter may be preceded with  
 voltage follower buffer to stabilize filter parameters.

Figure 30. Multiple Feedback Bandpass Filter

## ORDERING INFORMATION

| Order Number  | # of Channels | Specific Device Marking | Package Type          | Shipping†          |
|---------------|---------------|-------------------------|-----------------------|--------------------|
| LMV981SQ3T2G* | Single        | AAE                     | SC70-6*<br>(Pb-Free)  | 3000 / Tape & Reel |
| LMV981MU3TBG  | Single        | V                       | ULLGA8<br>(Pb-Free)   | 3000 / Tape & Reel |
| LMV982DMR2G*  | Dual          | V982                    | Micro10*<br>(Pb-Free) | 4000 / Tape & Reel |
| LMV982MUTAG   | Dual          | DE                      | UQFN10<br>(Pb-Free)   | 3000 / Tape & Reel |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

\*Consult sales for package availability.

# MECHANICAL CASE OUTLINE

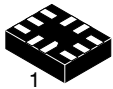
## PACKAGE DIMENSIONS

ON Semiconductor®

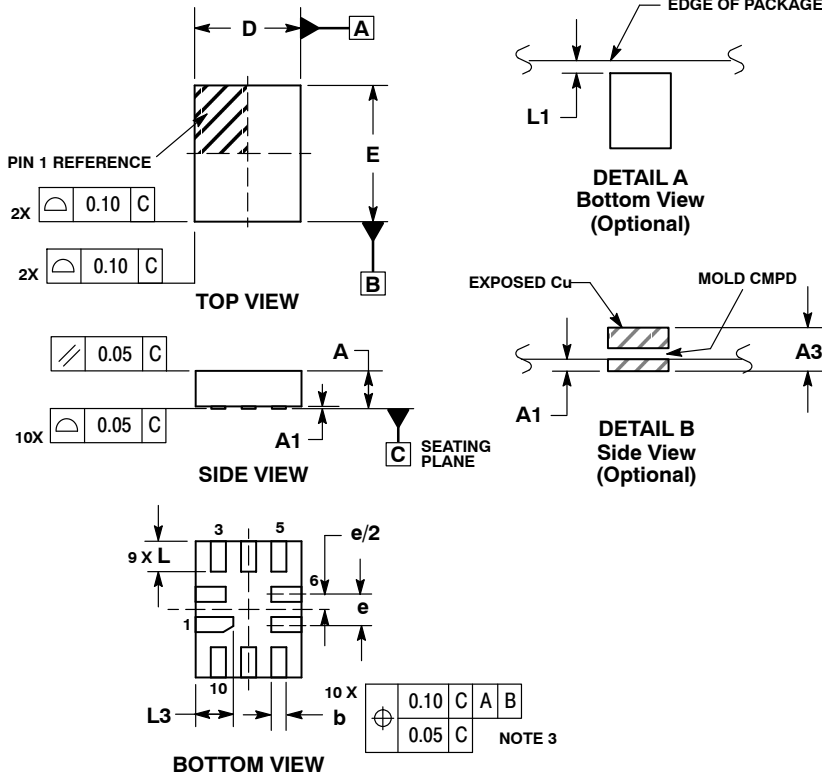


### UQFN10 1.4x1.8, 0.4P CASE 488AT-01 ISSUE A

DATE 01 AUG 2007



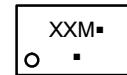
SCALE 5:1



NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.25 AND 0.30 MM FROM TERMINAL.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

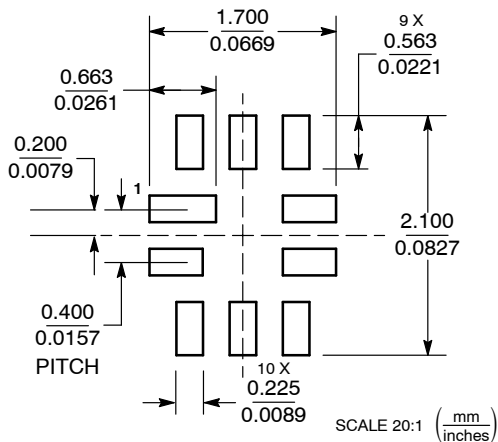
### GENERIC MARKING DIAGRAM\*



- XX = Specific Device Code
  - M = Date Code
  - = Pb-Free Package
- (Note: Microdot may be in either location)

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present.

### MOUNTING FOOTPRINT



|                         |                                     |  |
|-------------------------|-------------------------------------|--|
| <b>DOCUMENT NUMBER:</b> | <b>98AON22493D</b>                  | Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red. |
| <b>DESCRIPTION:</b>     | <b>10 PIN UQFN, 1.4 X 1.8, 0.4P</b> | <b>PAGE 1 OF 1</b>   |

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