

LMV321/LMV358/LMV324 Single/Dual/Quad General Purpose, Low Voltage, Rail-to-Rail Output Operational Amplifiers

General Description

The LMV358/LMV324 are low voltage (2.7–5.5V) versions of the dual and quad commodity op amps, LM358/LMV324, which currently operate at 5–30V. The LMV321 is the single version.

The LMV321/LMV358/LMV324 are the most cost effective solutions for the applications where low voltage operation, space saving and low price are needed. They offer specifications that meet or exceed the familiar LM358/LMV324. The LMV321/LMV358/LMV324 have rail-to-rail output swing capability and the input common-mode voltage range includes ground. They all exhibit excellent speed to power ratio, achieving 1 MHz of bandwidth and 1 V/ μ s of slew rate with low supply current.

The LMV321 is available in the space saving 5-Pin SC70, which is approximately half the size of the 5-Pin SOT23. The small package saves space on PC boards, and enables the design of small portable electronic devices. It also allows the designer to place the device closer to the signal source to reduce noise pickup and increase signal integrity.

The chips are built with National's advanced submicron silicon-gate BiCMOS process. The LMV321/LMV358/LMV324 have bipolar input and output stages for improved noise performance and higher output current drive.

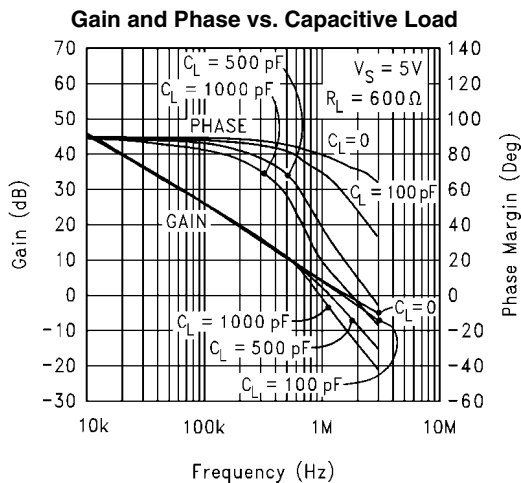
Features

(For $V^+ = 5V$ and $V^- = 0V$, unless otherwise specified)

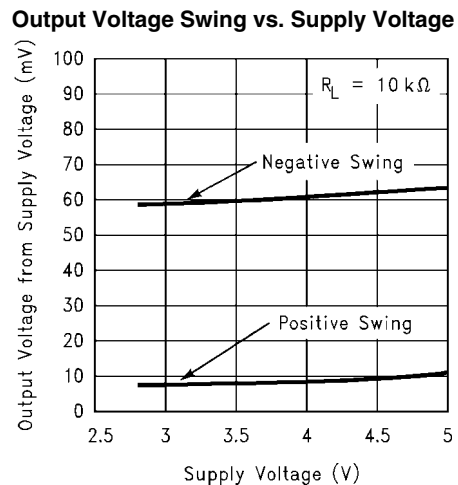
- Guaranteed 2.7V and 5V performance
- No crossover distortion
- Industrial temperature range –40°C to +85°C
- Gain-bandwidth product 1 MHz
- Low supply current
 - LMV321 130 μ A
 - LMV358 210 μ A
 - LMV324 410 μ A
- Rail-to-rail output swing @ 10 k Ω
 - $V^+ - 10$ mV
 - $V^- + 65$ mV
- V_{CM} –0.2V to $V^+ - 0.8V$

Applications

- Active filters
- General purpose low voltage applications
- General purpose portable devices



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Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

| | |
|--|-----------------|
| ESD Tolerance (Note 2) | |
| Human Body Model | |
| LMV358/LMV324 | 2000V |
| LMV321 | 900V |
| Machine Model | 100V |
| Differential Input Voltage | ±Supply Voltage |
| Supply Voltage (V ⁺ -V ⁻) | 5.5V |
| Output Short Circuit to V ⁺ | (Note 3) |
| Output Short Circuit to V ⁻ | (Note 4) |
| Soldering Information | |
| Infrared or Convection (20 sec) | 235°C |

| | |
|-------------------------------|----------------|
| Storage Temp. Range | -65°C to 150°C |
| Junction Temperature (Note 5) | 150°C |

Operating Ratings (Note 1)

| | |
|--|----------------|
| Supply Voltage | 2.7V to 5.5V |
| Temperature Range (Note 5) | |
| LMV321/LMV358/LMV324 | -40°C to +85°C |
| Thermal Resistance (θ_{JA}) (Note 10) | |
| 5-pin SC70 | 478°C/W |
| 5-pin SOT23 | 265°C/W |
| 8-Pin SOIC | 190°C/W |
| 8-Pin MSOP | 235°C/W |
| 14-Pin SOIC | 145°C/W |
| 14-Pin TSSOP | 155°C/W |

2.7V DC Electrical Characteristics

Unless otherwise specified, all limits guaranteed for T_J = 25°C, V⁺ = 2.7V, V⁻ = 0V, V_{CM} = 1.0V, V_O = V⁺/2 and R_L > 1 M Ω .

| Symbol | Parameter | Conditions | Min (Note 7) | Typ (Note 6) | Max (Note 7) | Units |
|-------------------|------------------------------------|---|---------------------|--------------------|-----------------|------------|
| V _{OS} | Input Offset Voltage | | | 1.7 | 7 | mV |
| TCV _{OS} | Input Offset Voltage Average Drift | | | 5 | | μ V/°C |
| I _B | Input Bias Current | | | 11 | 250 | nA |
| I _{OS} | Input Offset Current | | | 5 | 50 | nA |
| CMRR | Common Mode Rejection Ratio | 0V ≤ V _{CM} ≤ 1.7V | 50 | 63 | | dB |
| PSRR | Power Supply Rejection Ratio | 2.7V ≤ V ⁺ ≤ 5V V _O = 1V | 50 | 60 | | dB |
| V _{CM} | Input Common-Mode Voltage Range | For CMRR ≥ 50 dB | 0 | -0.2 | | V |
| | | | | 1.9 | 1.7 | V |
| V _O | Output Swing | R _L = 10 k Ω to 1.35V | V ⁺ -100 | V ⁺ -10 | | mV |
| | | | | 60 | 180 | mV |
| I _S | Supply Current | LMV321 | | 80 | 170 | μ A |
| | | LMV358 Both amplifiers | | 140 | 340 | μ A |
| | | LMV324 All four amplifiers | | 260 | 680 | μ A |

2.7V AC Electrical Characteristics

Unless otherwise specified, all limits guaranteed for T_J = 25°C, V⁺ = 2.7V, V⁻ = 0V, V_{CM} = 1.0V, V_O = V⁺/2 and R_L > 1 M Ω .

| Symbol | Parameter | Conditions | Min (Note 7) | Typ (Note 6) | Max (Note 7) | Units |
|----------------|------------------------------|-------------------------|-----------------|-----------------|-----------------|------------------------|
| GBWP | Gain-Bandwidth Product | C _L = 200 pF | | 1 | | MHz |
| Φ_m | Phase Margin | | | 60 | | Deg |
| G _m | Gain Margin | | | 10 | | dB |
| e _n | Input-Referred Voltage Noise | f = 1 kHz | | 46 | | $\frac{nV}{\sqrt{Hz}}$ |
| i _n | Input-Referred Current Noise | f = 1 kHz | | 0.17 | | $\frac{pA}{\sqrt{Hz}}$ |

5V DC Electrical Characteristics

Unless otherwise specified, all limits guaranteed for $T_J = 25^\circ\text{C}$, $V^+ = 5\text{V}$, $V^- = 0\text{V}$, $V_{\text{CM}} = 2.0\text{V}$, $V_O = V^+/2$ and $R_L > 1\text{M}\Omega$.

Boldface limits apply at the temperature extremes.

| Symbol | Parameter | Conditions | Min (Note 7) | Typ (Note 6) | Max (Note 7) | Units |
|--------------------------|---------------------------------------|--|--|-----------------|----------------------|------------------------------|
| V_{OS} | Input Offset Voltage | | | 1.7 | 7 9 | mV |
| TCV_{OS} | Input Offset Voltage Average Drift | | | 5 | | $\mu\text{V}/^\circ\text{C}$ |
| I_{B} | Input Bias Current | | | 15 | 250 500 | nA |
| I_{OS} | Input Offset Current | | | 5 | 50 150 | nA |
| CMRR | Common Mode Rejection Ratio | $0\text{V} \leq V_{\text{CM}} \leq 4\text{V}$ | 50 | 65 | | dB |
| PSRR | Power Supply Rejection Ratio | $2.7\text{V} \leq V^+ \leq 5\text{V}$ $V_O = 1\text{V}$, $V_{\text{CM}} = 1\text{V}$ | 50 | 60 | | dB |
| V_{CM} | Input Common-Mode Voltage Range | For CMRR ≥ 50 dB | 0 | -0.2 | | V |
| | | | | 4.2 | 4 | V |
| A_V | Large Signal Voltage Gain (Note 8) | $R_L = 2\text{k}\Omega$ | 15 10 | 100 | | V/mV |
| V_O | Output Swing | $R_L = 2\text{k}\Omega$ to 2.5V | $V^+ - 300$ $V^+ - 400$ | $V^+ - 40$ | | mV |
| | | | | 120 | 300 400 | mV |
| | | $R_L = 10\text{k}\Omega$ to 2.5V | $V^+ - 100$ $V^+ - 200$ | $V^+ - 10$ | | mV |
| | | | | 65 | 180 280 | mV |
| I_O | Output Short Circuit Current | Sourcing, $V_O = 0\text{V}$ | 5 | 60 | | mA |
| | | Sinking, $V_O = 5\text{V}$ | 10 | 160 | | |
| I_S | Supply Current | LMV321 | | 130 | 250 350 | μA |
| | | LMV358 Both amplifiers | | 210 | 440 615 | μA |
| | | LMV324 All four amplifiers | | 410 | 830 1160 | μA |

5V AC Electrical Characteristics

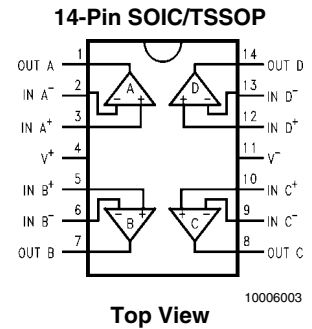
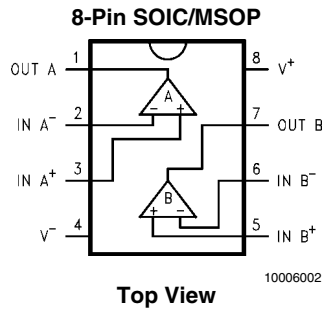
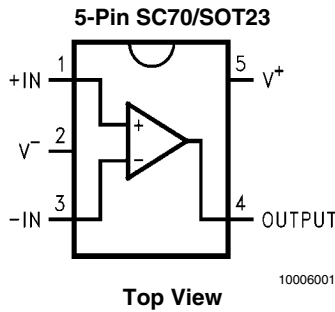
Unless otherwise specified, all limits guaranteed for $T_J = 25^\circ\text{C}$, $V^+ = 5\text{V}$, $V^- = 0\text{V}$, $V_{\text{CM}} = 2.0\text{V}$, $V_O = V^+/2$ and $R_L > 1\text{M}\Omega$.

Boldface limits apply at the temperature extremes.

| Symbol | Parameter | Conditions | Min (Note 7) | Typ (Note 6) | Max (Note 7) | Units |
|----------|------------------------------|----------------------|-----------------|-----------------|-----------------|--------------------------------------|
| SR | Slew Rate | (Note 9) | | 1 | | V/ μs |
| GBWP | Gain-Bandwidth Product | $C_L = 200\text{pF}$ | | 1 | | MHz |
| Φ_m | Phase Margin | | | 60 | | Deg |
| G_m | Gain Margin | | | 10 | | dB |
| e_n | Input-Referred Voltage Noise | $f = 1\text{kHz}$ | | 39 | | $\frac{\text{nV}}{\sqrt{\text{Hz}}}$ |
| i_n | Input-Referred Current Noise | $f = 1\text{kHz}$ | | 0.21 | | $\frac{\text{pA}}{\sqrt{\text{Hz}}}$ |

- Note 1:** Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not guaranteed. For guaranteed specifications and the test conditions, see the Electrical Characteristics.
- Note 2:** Human Body Model, applicable std. MIL-STD-883, Method 3015.7. Machine Model, applicable std. JESD22-A115-A (ESD MM std. of JEDEC) Field-Induced Charge-Device Model, applicable std. JESD22-C101-C (ESD FICDM std. of JEDEC)
- Note 3:** Shorting output to V+ will adversely affect reliability.
- Note 4:** Shorting output to V- will adversely affect reliability.
- Note 5:** The maximum power dissipation is a function of $T_{J(MAX)}$, θ_{JA} . The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(MAX)} - T_A) / \theta_{JA}$. All numbers apply for packages soldered directly onto a PC Board.
- Note 6:** Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration. The typical values are not tested and are not guaranteed on shipped production material.
- Note 7:** All limits are guaranteed by testing or statistical analysis.
- Note 8:** R_L is connected to V-. The output voltage is $0.5V \leq V_O \leq 4.5V$.
- Note 9:** Connected as voltage follower with 3V step input. Number specified is the slower of the positive and negative slew rates.
- Note 10:** All numbers are typical, and apply for packages soldered directly onto a PC board in still air.

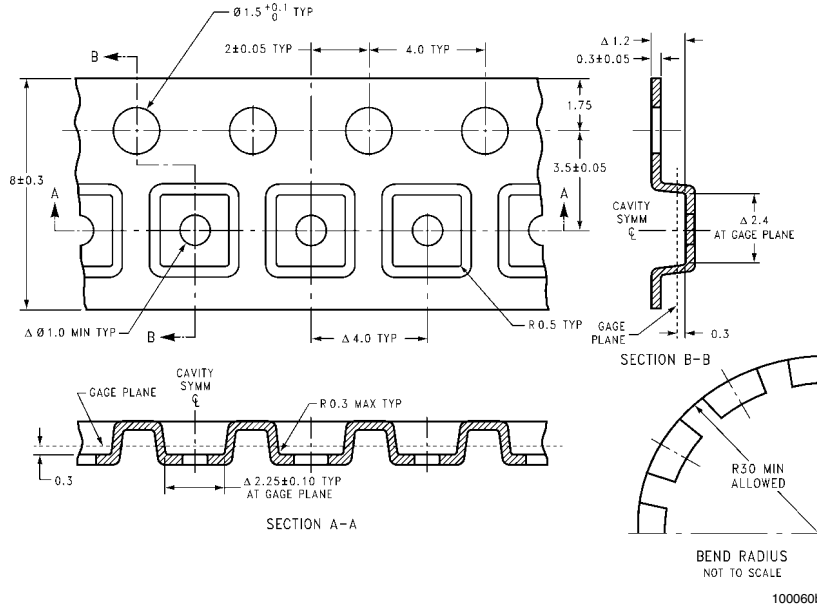
Connection Diagrams



Ordering Information

| Package | Temperature Range | Packaging Marking | Transport Media | NSC Drawing |
|--------------|------------------------------|-------------------|--------------------------|-------------|
| | Industrial -40°C to +85°C | | | |
| 5-Pin SC70 | LMV321M7 | A12 | 1k Units Tape and Reel | MAA05A |
| | LMV321M7X | | 3k Units Tape and Reel | |
| 5-Pin SOT23 | LMV321M5 | A13 | 1k Units Tape and Reel | MF05A |
| | LMV321M5X | | 3k Units Tape and Reel | |
| 8-Pin SOIC | LMV358M | LMV358M | Rails | M08A |
| | LMV358MX | | 2.5k Units Tape and Reel | |
| 8-Pin MSOP | LMV358MM | LMV358 | 1k Units Tape and Reel | MUA08A |
| | LMV358MMX | | 3.5k Units Tape and Reel | |
| 14-Pin SOIC | LMV324M | LMV324M | Rails | M14A |
| | LMV324MX | | 2.5k Units Tape and Reel | |
| 14-Pin TSSOP | LMV324MT | LMV324MT | Rails | MTC14 |
| | LMV324MTX | | 2.5k Units Tape and Reel | |

SC70-5 Tape and Reel Specification

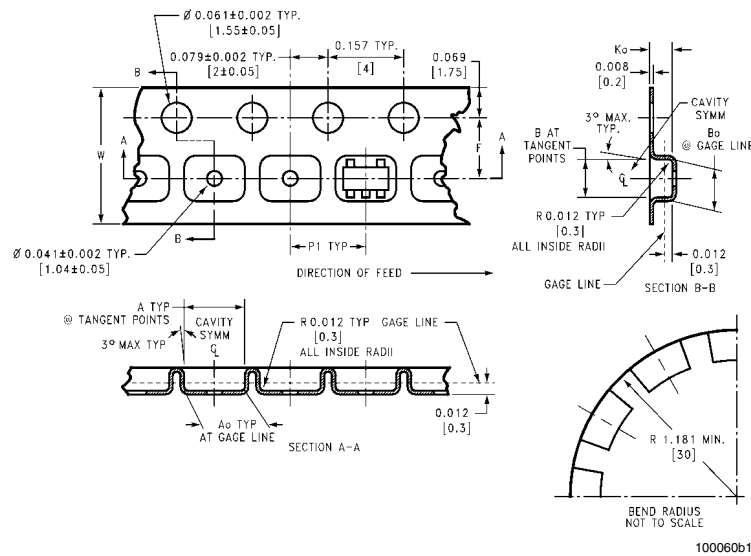


SOT-23-5 Tape and Reel Specification

TAPE FORMAT

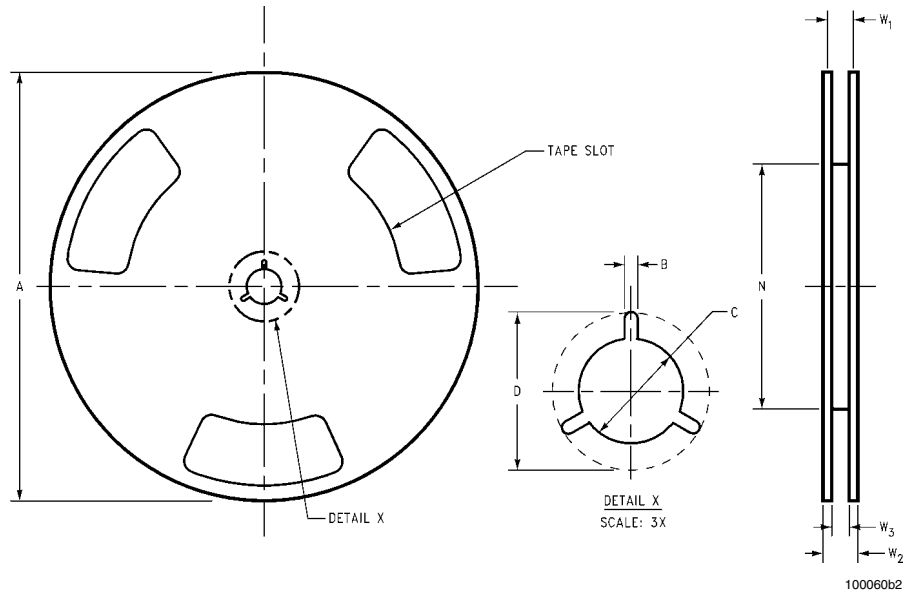
| Tape Section | # Cavities | Cavity Status | Cover Tape Status |
|-----------------------|------------|---------------|-------------------|
| Leader (Start End) | 0 (min) | Empty | Sealed |
| | 75 (min) | Empty | Sealed |
| Carrier | 3000 | Filled | Sealed |
| | 250 | Filled | Sealed |
| Trailer (Hub End) | 125 (min) | Empty | Sealed |
| | 0 (min) | Empty | Sealed |

TAPE DIMENSIONS

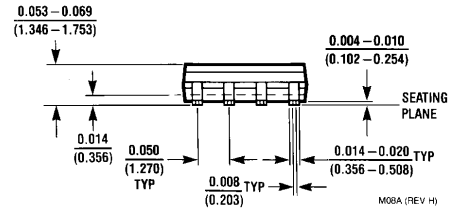
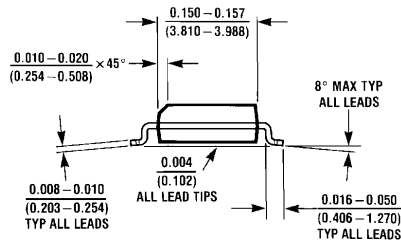
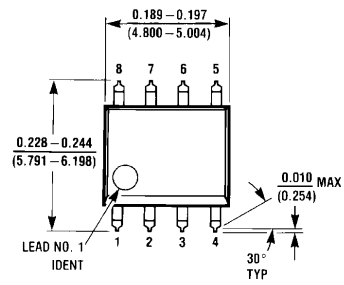


| | | | | | | | | |
|-------------|------------------------------|-------------------------------|------------------------------|------------------------------|---|---|----------------------------|--|
| 8 mm | 0.130 (3.3) | 0.124 (3.15) | 0.130 (3.3) | 0.126 (3.2) | 0.138 ±0.002 (3.5 ±0.05) | 0.055 ±0.004 (1.4 ±0.11) | 0.157 (4) | 0.315 ±0.012 (8 ±0.3) |
| Tape Size | DIM A | DIM A _o | DIM B | DIM B _o | DIM F | DIM K _o | DIM P1 | DIM W |

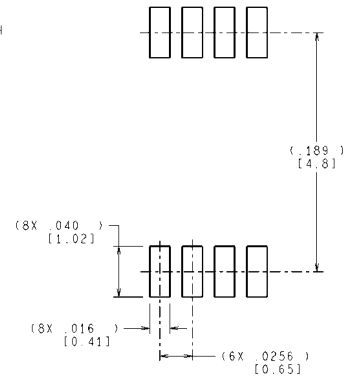
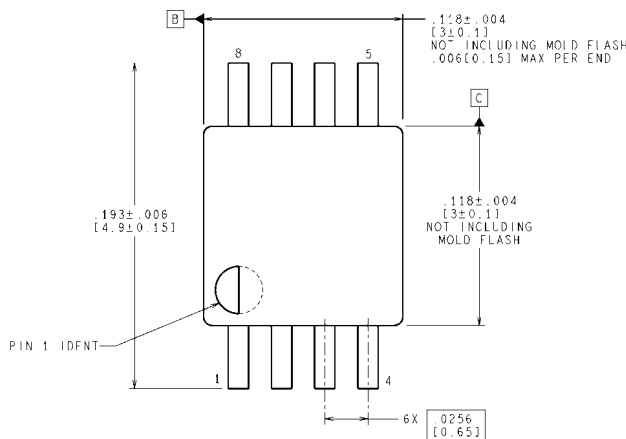
REEL DIMENSIONS



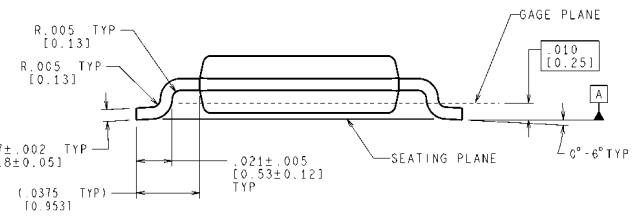
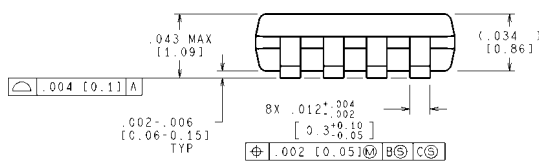
| | | | | | | | | |
|-------------|---------------|--------------|--------------|--------------|--------------|-----------------------------|--------------|--------------------------|
| 8 mm | 7.00 | 0.059 | 0.512 | 0.795 | 2.165 | 0.331 + 0.059/-0.000 | 0.567 | W1 + 0.078/-0.039 |
| | 330.00 | 1.50 | 13.00 | 20.20 | 55.00 | 8.40 + 1.50/-0.00 | 14.40 | W1 + 2.00/-1.00 |
| Tape Size | A | B | C | D | N | W1 | W2 | W3 |



8-Pin SOIC
NS Package Number M08A



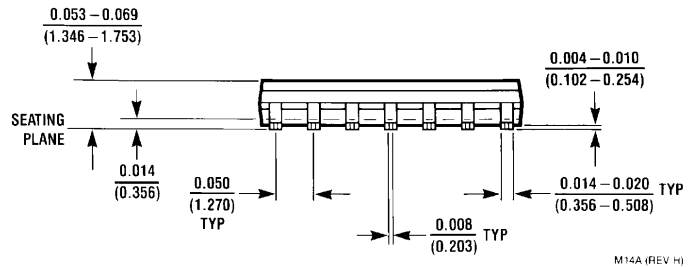
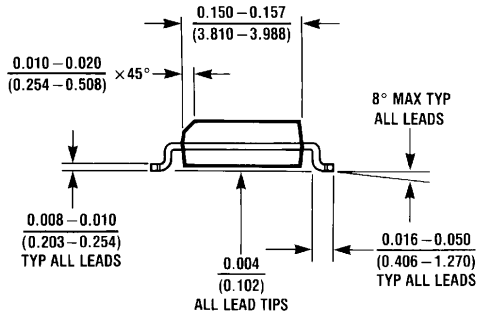
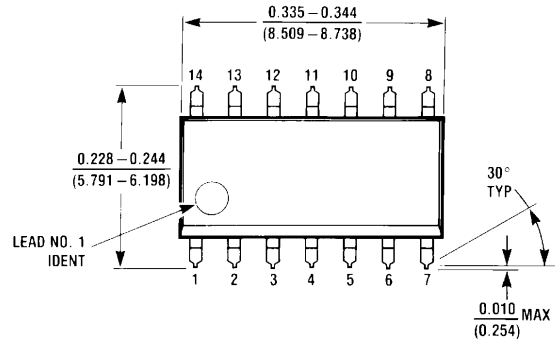
RECOMMENDED LAND PATTERN



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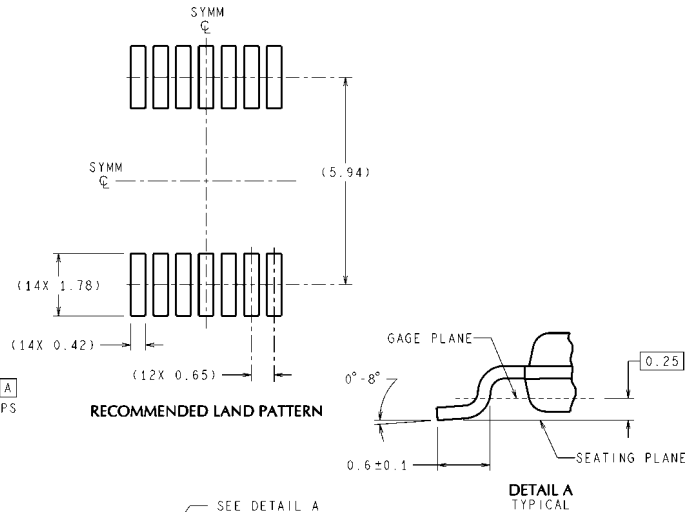
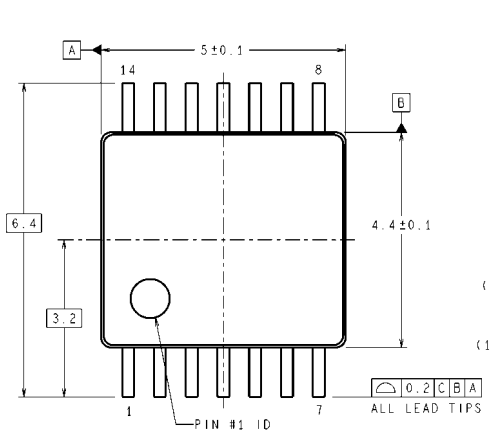
8-Pin MSOP
NS Package Number MUA08A

MUA08A (Rev F)



M14A (REV H)

14-Pin SOIC
NS Package Number M14A



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MTC14 (Rev D)

14-Pin TSSOP
NS Package Number MTC14