

## Features

- Supply Voltage: 2.5 V to 5.5 V
- Offset Voltage: 5 mV Maximum
- Bandwidth: 1.5 MHz, Slew Rate: 0.7 V/ $\mu$ s
- Low Power: 100  $\mu$ A per channel
- Rail-to-Rail Input and Output
- Low 1/f Noise: 22 nV/ $\sqrt{\text{Hz}}$  at 1 kHz
- $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$  Operation Temperature Range

## Applications

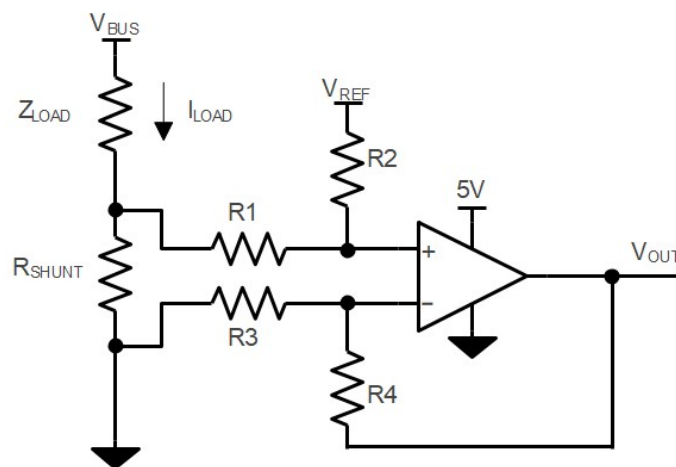
- Instrumentation
- Motor Control
- Industrial Control

## Description

The devices are CMOS single, dual, and quad RRIO op-amps with low power and stable high-frequency response. They incorporate 3PEAK's proprietary and patented design techniques to achieve excellent AC performance with 1.5-MHz bandwidth, 0.7-V/ $\mu$ s slew rate, and low distortion while drawing only 100  $\mu$ A of quiescent current per amplifier. The input common-mode voltage range extends 100 mV beyond power rail and the outputs swing rail-to-rail.

These devices can be used as plug-in replacements for many commercially available op-amps to improve performance.

## Typical Application Circuit



$$V_{\text{OUT}} = (I_{\text{LOAD}} \times R_{\text{SHUNT}}) \times (R_2 / R_1) + V_{\text{REF}}$$

$$\text{When } R_3 = R_1, R_2 = R_4, R_{\text{SHUNT}} \ll R_1$$

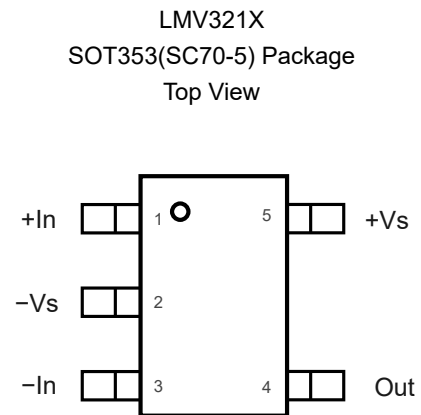
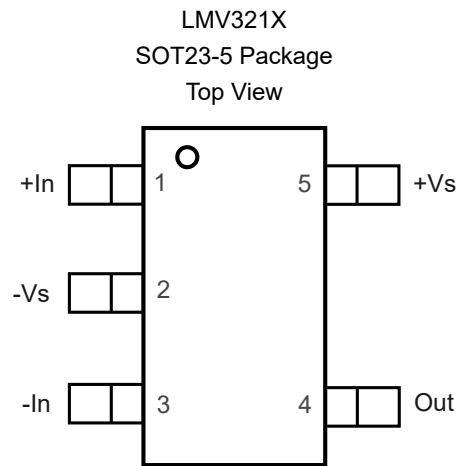
## Table of Contents

|                                              |           |
|----------------------------------------------|-----------|
| <b>Features</b> .....                        | <b>1</b>  |
| <b>Applications</b> .....                    | <b>1</b>  |
| <b>Description</b> .....                     | <b>1</b>  |
| <b>Typical Application Circuit</b> .....     | <b>1</b>  |
| <b>Revision History</b> .....                | <b>3</b>  |
| <b>Pin Configuration and Functions</b> ..... | <b>4</b>  |
| <b>Specifications</b> .....                  | <b>7</b>  |
| Absolute Maximum Ratings .....               | 7         |
| ESD, Electrostatic Discharge Protection..... | 7         |
| Recommended Operating Conditions.....        | 7         |
| Thermal Information.....                     | 7         |
| Electrical Characteristics.....              | 9         |
| Electrical Characteristics (Continued).....  | 10        |
| Typical Performance Characteristics.....     | 11        |
| <b>Detailed Description</b> .....            | <b>14</b> |
| Functional Block Diagram.....                | 14        |
| <b>Application and Implementation</b> .....  | <b>15</b> |
| Application Information .....                | 15        |
| <b>Tape and Reel Information</b> .....       | <b>16</b> |
| <b>Package Outline Dimensions</b> .....      | <b>17</b> |
| SOT353.....                                  | 17        |
| SOT23-5.....                                 | 18        |
| SOP8.....                                    | 19        |
| MSOP8.....                                   | 20        |
| SOP14.....                                   | 21        |
| TSSOP14.....                                 | 22        |
| <b>Order Information</b> .....               | <b>23</b> |
| <b>IMPORTANT NOTICE AND DISCLAIMER</b> ..... | <b>24</b> |

## Revision History

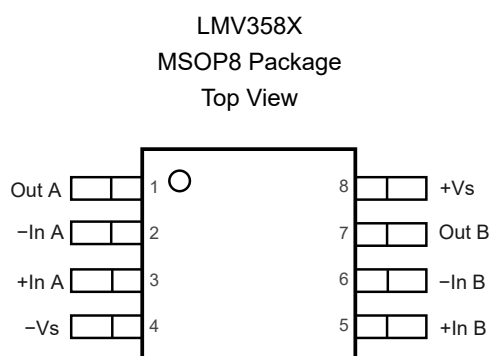
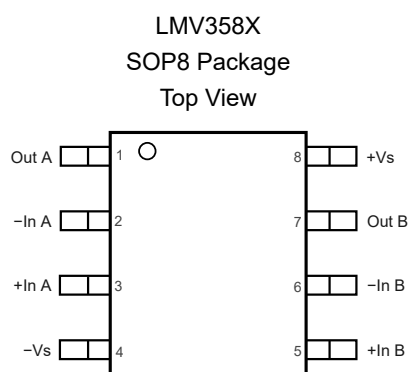
| Date       | Revision | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2023-09-04 | Rev.A.0  | Initial release.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 2023-09-13 | Rev.A.1  | Adjusted the Vos, Isc, and CMRR.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 2024-09-12 | Rev.A.2  | <p>Added product: LMV321X-S5TR, LMV324X-SO2R, LMV324-TS2R.<br/>Tightened Vos specification for LMV358X and LMV324X.<br/>The following updates in Electrical Characteristics are about typos, the physical object remains unchanged.</p> <ul style="list-style-type: none"><li>• <math>V_{OS}</math>, <math>V_{CM} = 3\text{ V to } 5\text{ V}</math>: from Min -5, Typ 1.2, Max 5 to Min -3, Typ 3, Max 7.4.</li><li>• <math>V_{CM} = 3\text{ V to } 5\text{ V}</math>, <math>T_A = -40^{\circ}\text{C to } 125^{\circ}\text{C}</math>: from Min -7.5, Max 7.5 to Min -5.6, Max 11.</li></ul> |

## Pin Configuration and Functions



**Table 1. Pin Functions: LMV321X**

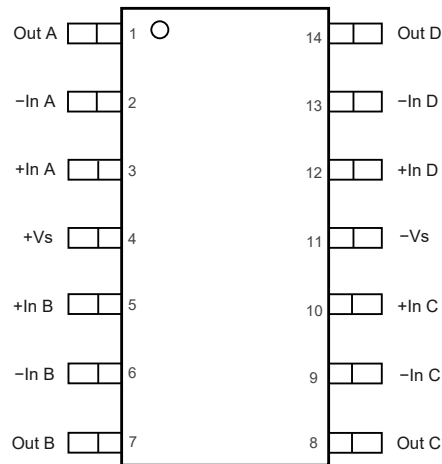
| Pin No. | Name | I/O | Description           |
|---------|------|-----|-----------------------|
| 1       | +In  | I   | Noninverting input    |
| 2       | -Vs  | -   | Negative power supply |
| 3       | -In  | I   | Inverting input       |
| 4       | Out  | O   | Output                |
| 5       | +Vs  | -   | Positive power supply |



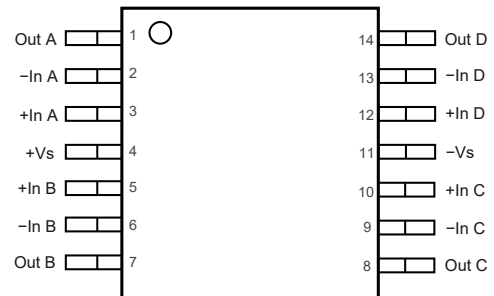
**Table 2. Pin Functions: LMV358X**

| Pin No. | Name  | I/O | Description           |
|---------|-------|-----|-----------------------|
| 1       | Out A | O   | Output                |
| 2       | -In A | I   | Inverting input       |
| 3       | +In A | I   | Noninverting input    |
| 4       | -Vs   | -   | Negative power supply |
| 5       | +In B | I   | Noninverting input    |
| 6       | -In B | I   | Inverting input       |
| 7       | Out B | O   | Output                |
| 8       | +Vs   | -   | Positive power supply |

LMV324X  
SOP14 Package  
Top View



LMV324X  
TSSOP14 Package  
Top View



**Table 3. Pin Functions: LMV324X**

| Pin No. | Name  | I/O | Description           |
|---------|-------|-----|-----------------------|
| 1       | Out A | O   | Output                |
| 2       | -In A | I   | Inverting input       |
| 3       | +In A | I   | Noninverting input    |
| 4       | +Vs   | -   | Positive power supply |
| 5       | +In B | I   | Noninverting input    |
| 6       | -In B | I   | Inverting input       |
| 7       | Out B | O   | Output power supply   |
| 8       | Out C | O   | Output power supply   |
| 9       | -In C | I   | Inverting input       |
| 10      | +In C | I   | Noninverting input    |
| 11      | -Vs   | -   | Negative power supply |
| 12      | +In D | I   | Noninverting input    |
| 13      | -In D | I   | Inverting input       |
| 14      | Out D | O   | Output                |

## Specifications

### Absolute Maximum Ratings

Over operating ambient temperature (unless otherwise noted) <sup>(1)</sup>

| Parameter        |                                                         | Min                                     | Max                                     | Unit |
|------------------|---------------------------------------------------------|-----------------------------------------|-----------------------------------------|------|
|                  | Supply Voltage, (+V <sub>S</sub> ) – (–V <sub>S</sub> ) |                                         | 6.5                                     | V    |
|                  | Input Voltage                                           | (–V <sub>S</sub> ) – 0.3                | (+V <sub>S</sub> ) + 0.5                | V    |
|                  | Differential Input Voltage                              | (–V <sub>S</sub> ) – (+V <sub>S</sub> ) | (+V <sub>S</sub> ) – (–V <sub>S</sub> ) | V    |
|                  | Input Current: +IN, –IN <sup>(2)</sup>                  | –10                                     | 10                                      | mA   |
|                  | Output Voltage                                          | (–V <sub>S</sub> ) – 0.3                | (+V <sub>S</sub> ) + 0.3                | V    |
|                  | Output Short-Circuit Duration <sup>(3)</sup>            |                                         | Infinite                                |      |
| T <sub>J</sub>   | Maximum Junction Temperature                            |                                         | 150                                     | °C   |
| T <sub>A</sub>   | Operating Temperature Range                             | –40                                     | 125                                     | °C   |
| T <sub>STG</sub> | Storage Temperature Range                               | –65                                     | 150                                     | °C   |
| T <sub>L</sub>   | Lead Temperature (Soldering 10 sec)                     |                                         | 260                                     | °C   |

- (1) Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.
- (2) The inputs are protected by ESD protection diodes to each power supply. If the input extends more than 300 mV beyond the power supply, the input current should be limited to less than 10 mA.
- (3) A heat sink may be required to keep the junction temperature below the absolute maximum. This depends on the power supply voltage and how many amplifiers are shorted. Thermal resistance varies with the amount of PC board metal connected to the package. The specified values are for short traces connected to the leads.

### ESD, Electrostatic Discharge Protection

| Parameter |                          | Condition                             | Minimum Level | Unit |
|-----------|--------------------------|---------------------------------------|---------------|------|
| HBM       | Human Body Model ESD     | ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup> | 6             | kV   |
| CDM       | Charged Device Model ESD | ANSI/ESDA/JEDEC JS-002 <sup>(2)</sup> | 1.5           | kV   |

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
- (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

### Recommended Operating Conditions

| Parameter      |                                                         | Min | Typ | Max | Unit |
|----------------|---------------------------------------------------------|-----|-----|-----|------|
| V <sub>S</sub> | Supply Voltage, (+V <sub>S</sub> ) – (–V <sub>S</sub> ) | 2.5 |     | 5.5 | V    |
| T <sub>A</sub> | Operating Temperature Range                             | –40 |     | 125 | °C   |

### Thermal Information

| Package Type    | θ <sub>JA</sub> | θ <sub>JC</sub> | Unit |
|-----------------|-----------------|-----------------|------|
| SOT353 (SC70-5) | 400             | 150             | °C/W |

| Package Type | $\theta_{JA}$ | $\theta_{JC}$ | Unit |
|--------------|---------------|---------------|------|
| SOT23-5      | 250           | 81            | °C/W |
| SOP8         | 158           | 43            | °C/W |
| MSOP8        | 210           | 45            | °C/W |
| SOP14        | 120           | 36            | °C/W |
| TSSOP14      | 180           | 35            | °C/W |

## Electrical Characteristics

All test conditions:  $V_S = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ ,  $R_L = 10\text{ k}\Omega$ , unless otherwise noted.

| Parameter              |                                           | Conditions                                                                      | Min                      | Typ  | Max                      | Unit  |
|------------------------|-------------------------------------------|---------------------------------------------------------------------------------|--------------------------|------|--------------------------|-------|
| Power Supply           |                                           |                                                                                 |                          |      |                          |       |
| V <sub>S</sub>         | Supply Voltage Range                      |                                                                                 | 2.5                      |      | 5.5                      | V     |
| I <sub>Q</sub>         | Quiescent Current per Amplifier           |                                                                                 |                          | 100  | 160                      | μA    |
|                        |                                           | T <sub>A</sub> = −40°C to 125°C                                                 |                          |      | 190                      | μA    |
| PSRR                   | Power Supply Rejection Ratio              | V <sub>S</sub> = 2.5 V to 5.5 V                                                 | 80                       | 110  |                          | dB    |
|                        |                                           | V <sub>S</sub> = 2.5 V to 5.5 V, T <sub>A</sub> = −40°C to 125°C                | 75                       |      |                          | dB    |
| Input Characteristics  |                                           |                                                                                 |                          |      |                          |       |
| V <sub>OS</sub>        | Input Offset Voltage                      | V <sub>CM</sub> = 0 V to 3 V, LMV321X                                           | −5                       | ±1.2 | 5                        | mV    |
|                        |                                           | V <sub>CM</sub> = 0 V to 3 V, LMV321X, T <sub>A</sub> = −40°C to 125°C          | −7.5                     |      | 7.5                      | mV    |
|                        |                                           | V <sub>CM</sub> = 0 V to 3 V, LMV358X, LMV324X                                  | 1                        | 3    | 5                        | mV    |
|                        |                                           | V <sub>CM</sub> = 0 V to 3 V, LMV358X, LMV324X, T <sub>A</sub> = −40°C to 125°C | 0.15                     |      | 5.6                      | mV    |
|                        |                                           | V <sub>CM</sub> = 3 V to 5 V                                                    | −3                       | 3    | 7.4                      | mV    |
|                        |                                           | V <sub>CM</sub> = 3 V to 5 V, T <sub>A</sub> = −40°C to 125°C                   | −5.6                     |      | 11                       | mV    |
| V <sub>OS</sub> TC     | Input Offset Voltage Drift <sup>(1)</sup> |                                                                                 |                          | 1    |                          | μV/°C |
| I <sub>B</sub>         | Input Bias Current <sup>(1)</sup>         | V <sub>CM</sub> = 2.5 V                                                         | −300                     | 10   | 300                      | pA    |
|                        |                                           | V <sub>CM</sub> = 2.5 V, T <sub>A</sub> = −40°C to 125°C                        | −5                       |      | 5                        | nA    |
| I <sub>OS</sub>        | Input Offset Current <sup>(1)</sup>       | V <sub>CM</sub> = 2.5 V                                                         | −300                     | 10   | 300                      | pA    |
|                        |                                           | V <sub>CM</sub> = 2.5 V, T <sub>A</sub> = −40°C to 125°C                        | −5                       |      | 5                        | nA    |
| C <sub>IN</sub>        | Input Capacitance <sup>(2)</sup>          | Differential Mode                                                               |                          | 6    |                          | pF    |
|                        |                                           | Common Mode                                                                     |                          | 8    |                          | pF    |
| A <sub>V</sub>         | Open-loop Voltage Gain                    | V <sub>O</sub> = 0.1 V to 4.9 V                                                 | 80                       | 100  |                          | dB    |
|                        |                                           | V <sub>O</sub> = 0.1 V to 4.9 V, T <sub>A</sub> = −40°C to 125°C                | 75                       |      |                          | dB    |
| V <sub>CMR</sub>       | Common-mode Input Voltage Range           | T <sub>A</sub> = −40°C to 125°C                                                 | (−V <sub>S</sub> ) − 0.1 |      | (+V <sub>S</sub> ) + 0.1 | V     |
| CMRR                   | Common Mode Rejection Ratio               | V <sub>CM</sub> = 0 V to 5 V <sup>(2)</sup>                                     |                          | 80   |                          | dB    |
|                        |                                           | V <sub>CM</sub> = 0 V to 3 V                                                    | 85                       | 110  |                          | dB    |
|                        |                                           | V <sub>CM</sub> = 0 V to 3 V, T <sub>A</sub> = −40°C to 125°C                   | 80                       |      |                          | dB    |
| Output Characteristics |                                           |                                                                                 |                          |      |                          |       |
|                        | Output Voltage Swing from Positive Rail   | R <sub>L</sub> = 10 kΩ to V <sub>S</sub> /2                                     |                          | 10   | 15                       | mV    |
|                        |                                           | R <sub>L</sub> = 10 kΩ to V <sub>S</sub> /2, T <sub>A</sub> = −40°C to 125°C    |                          |      | 20                       | mV    |
|                        | Output Voltage Swing from Negative Rail   | R <sub>L</sub> = 10 kΩ to V <sub>S</sub> /2                                     |                          | 10   | 15                       | mV    |
|                        |                                           | R <sub>L</sub> = 10 kΩ to V <sub>S</sub> /2, T <sub>A</sub> = −40°C to 125°C    |                          |      | 20                       | mV    |

**Electrical Characteristics (Continued)**

All test conditions:  $V_S = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ ,  $R_L = 10\text{ k}\Omega$ , unless otherwise noted.

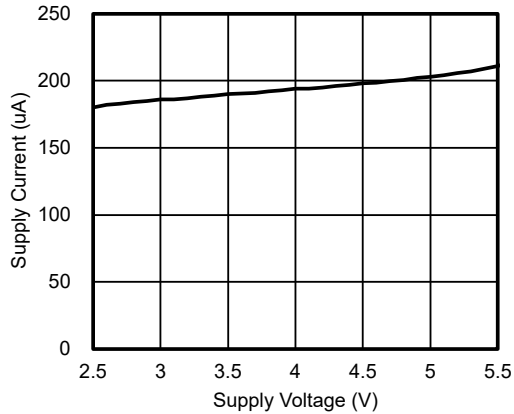
| Parameter         |                                                    | Conditions                                  | Min | Typ   | Max | Unit   |
|-------------------|----------------------------------------------------|---------------------------------------------|-----|-------|-----|--------|
| Isc               | Output Short-Circuit Current                       | Sink or Source                              |     | 90    |     | mA     |
|                   |                                                    | Sink or Source, TA = -40°C to 125°C         | 50  |       |     | mA     |
| AC Specifications |                                                    |                                             |     |       |     |        |
| GBW               | Gain-Bandwidth Product <sup>(1)</sup>              |                                             |     | 1.5   |     | MHz    |
| SR                | Slew Rate <sup>(1)</sup>                           | G = 1, 2 V step, TA = -40°C to 125°C        |     | 0.7   |     | V/μs   |
| ts                | Settling Time, 0.1% <sup>(1)</sup>                 | G = 1, 2 V step                             |     | 4.3   |     | ns     |
|                   | Settling Time, 0.01% <sup>(2)</sup>                | G = 1, 2 V step                             |     | 5.4   |     | ns     |
| PM                | Phase Margin <sup>(1)</sup>                        | RL= 10 kΩ, CL= 100 pF                       |     | 80    |     | °      |
| GM                | Gain Margin <sup>(1)</sup>                         | RL= 10 kΩ, CL= 100 pF                       |     | 15    |     | dB     |
|                   | Channel Separation <sup>(1)</sup>                  | f = 100 kHz                                 |     |       |     | dB     |
| Noise Performance |                                                    |                                             |     |       |     |        |
| EN                | Input Voltage Noise <sup>(1)</sup>                 | f = 0.1 Hz to 10 Hz,                        |     | 2.1   |     | μVRMS  |
| eN                | Input Voltage Noise Density <sup>(1)</sup>         | f = 1 kHz                                   |     | 22    |     | nV/√Hz |
| iN                | Input Current Noise <sup>(1)</sup>                 | f = 1 kHz                                   |     | 2     |     | fA/√Hz |
| THD+N             | Total Harmonic Distortion and Noise <sup>(2)</sup> | f = 1 kHz, G = 1, RL = 10 kΩ, VOUT = 1 VRMS |     | 0.002 |     | %      |

(1) Provided by bench test and design simulation.

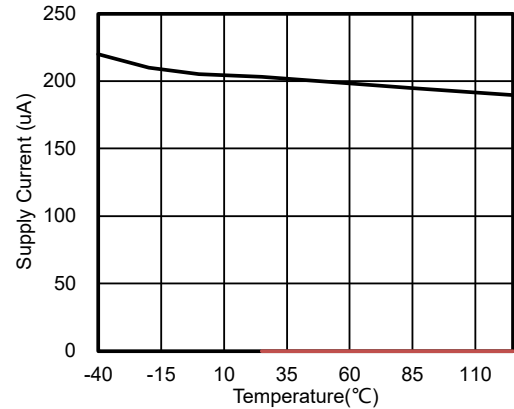
(2) Provided by design simulation.

## Typical Performance Characteristics

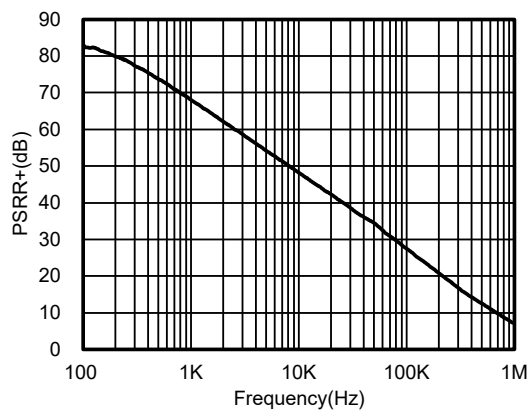
All test conditions:  $V_S = 5\text{ V}$ ,  $V_{CM} = 2.5\text{ V}$ , unless otherwise noted.



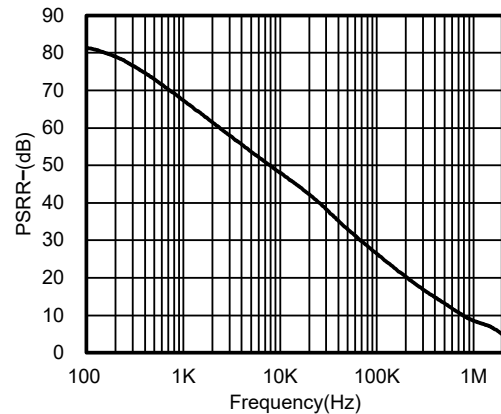
**Figure 1. Supply Current vs Supply Voltage**



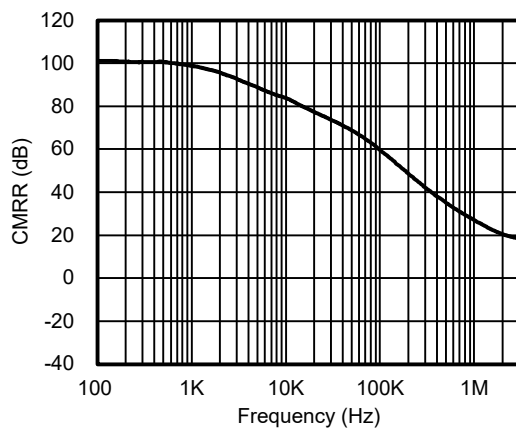
**Figure 2. Supply Current vs Temperature**



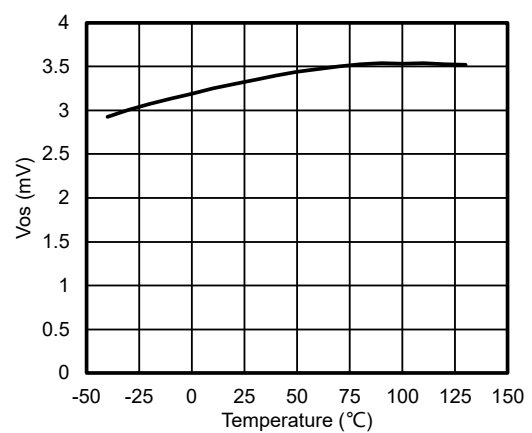
**Figure 3. PSRR+ vs Frequency**



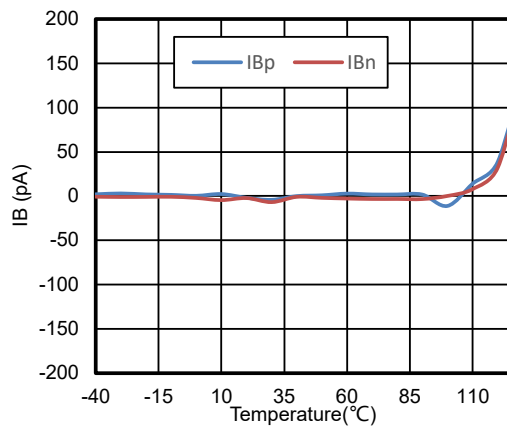
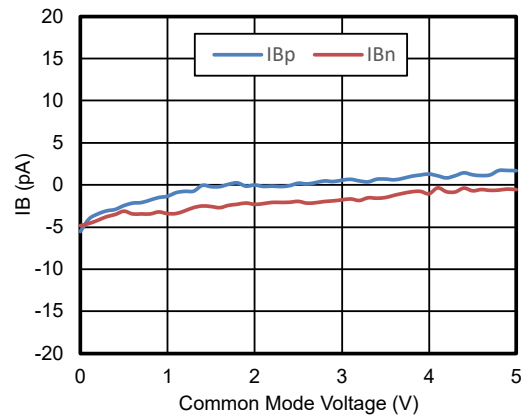
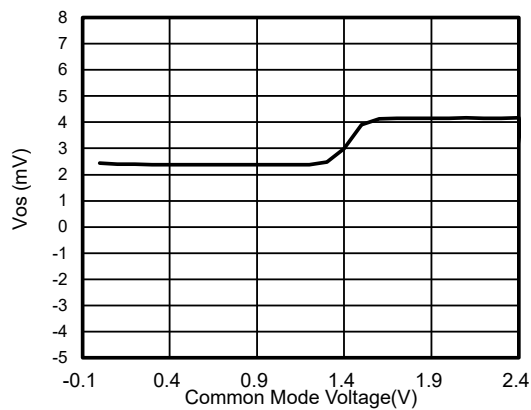
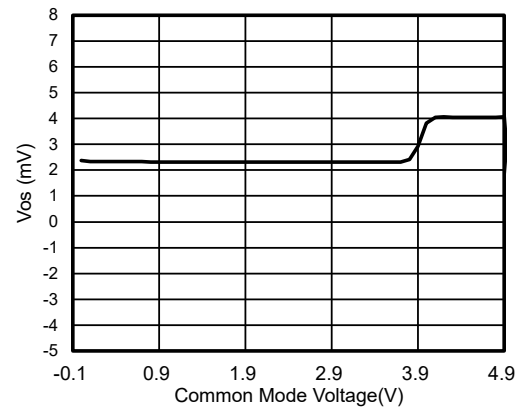
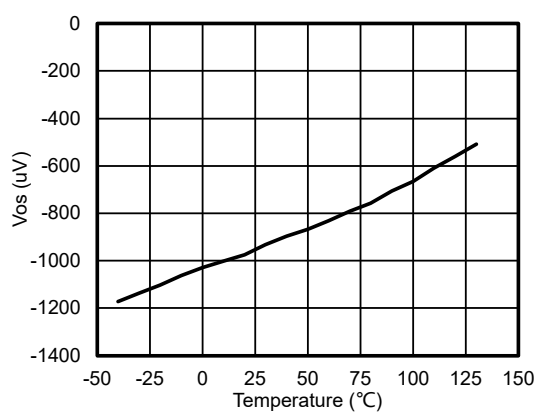
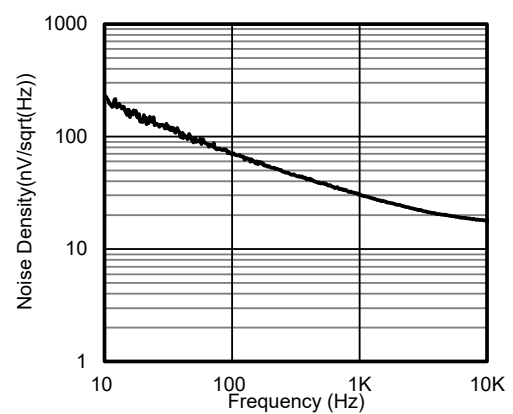
**Figure 4. PSRR- vs Frequency**

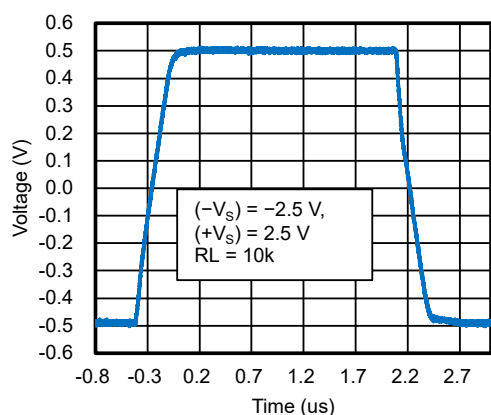
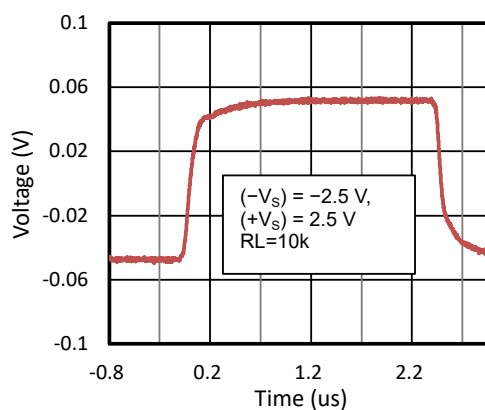
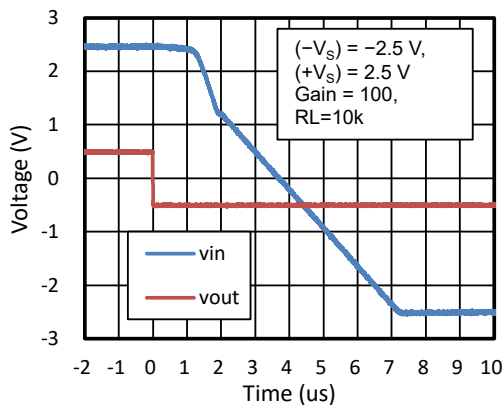
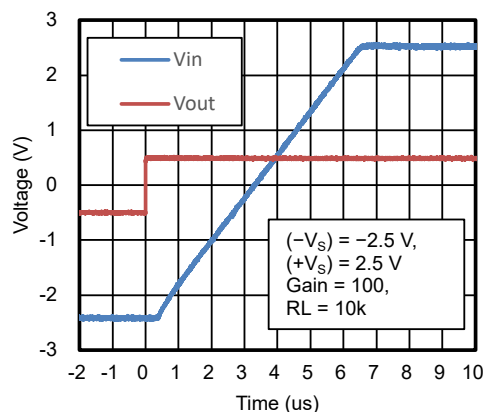
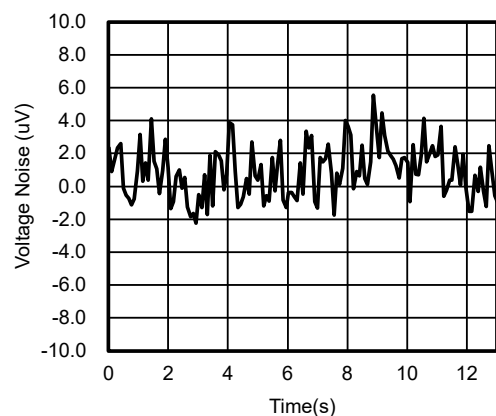


**Figure 5. CMRR vs Frequency**



**Figure 6. Open Loop Gain and Phase Margin vs Frequency,  $R_L = 10\text{ k}\Omega$**


**Figure 7.  $I_B$  vs Temperature**

**Figure 8.  $I_B$  vs  $V_{CM}$ ,  $V_S = 5\text{ V}$** 

**Figure 9.  $V_{OS}$  vs  $V_{CM}$ ,  $V_S = 2.5\text{ V}$** 

**Figure 10.  $V_{OS}$  vs  $V_{CM}$ ,  $V_S = 5\text{ V}$** 

**Figure 11.  $V_{OS}$  vs Temperature**

**Figure 12. Voltage Noise Spectral Density vs Frequency,  
 $V_{CM} = 2.5\text{ V}$**


**Figure 13. Large Signal Step Response**

**Figure 14. Small Signal Step Response**

**Figure 15. Overload Recovery at Negative Rail**

**Figure 16. Overload Recovery at Positive Rail**

**Figure 17. 0.1 to 10 Hz Voltage Noise,  $V_{CM} = 2.5\text{ V}$**

## Detailed Description

### Functional Block Diagram

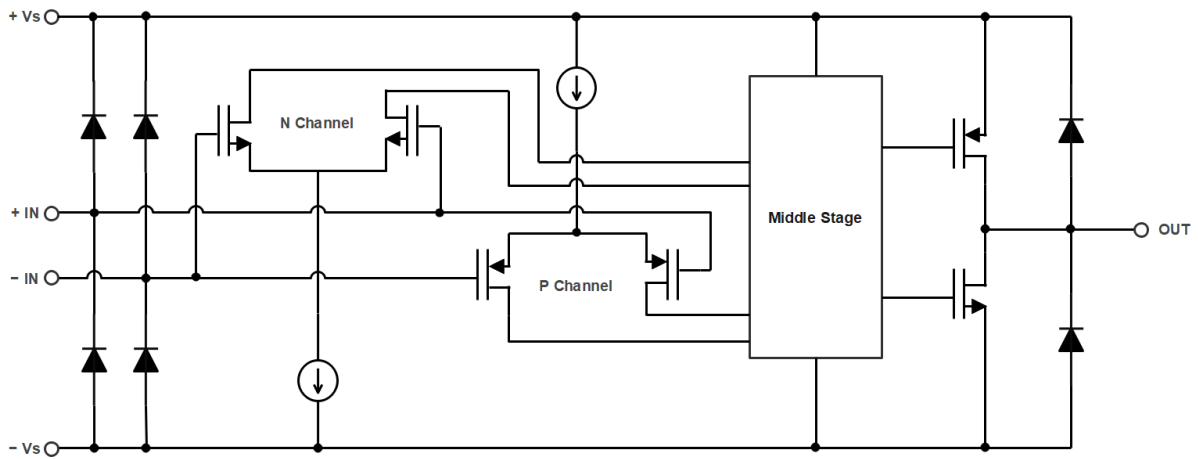


Figure 18. Functional Block Diagram

## Application and Implementation

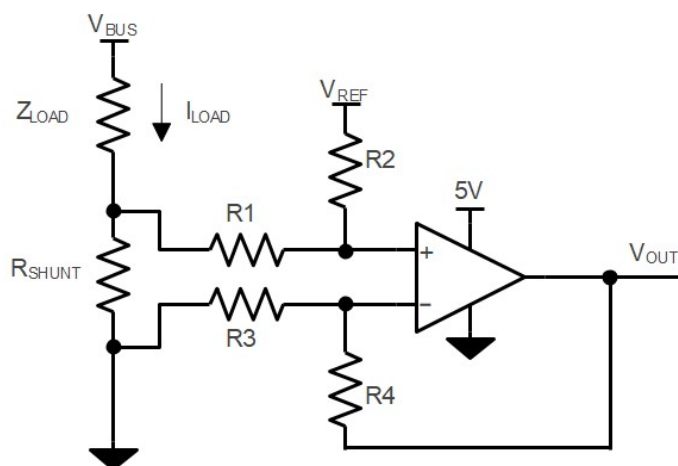
### Note

Information in the following application sections is not part of the 3PEAK's component specification and 3PEAK does not warrant its accuracy or completeness. 3PEAK's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

## Application Information

### Low-Side Current Sensing Application

The following figure shows the device configured in a low-side current sensing application. The low-side current sensing method places a sense resistor between the load and the circuit ground. The voltage dropping across the resistor is amplified by different amplifier circuits with the device. The  $V_{REF}$  can be used to add bias voltage to output voltage. Particular attention must be paid to the matching and precision of R1, R2, R3, and R4, to maximize the accuracy of the measurement.



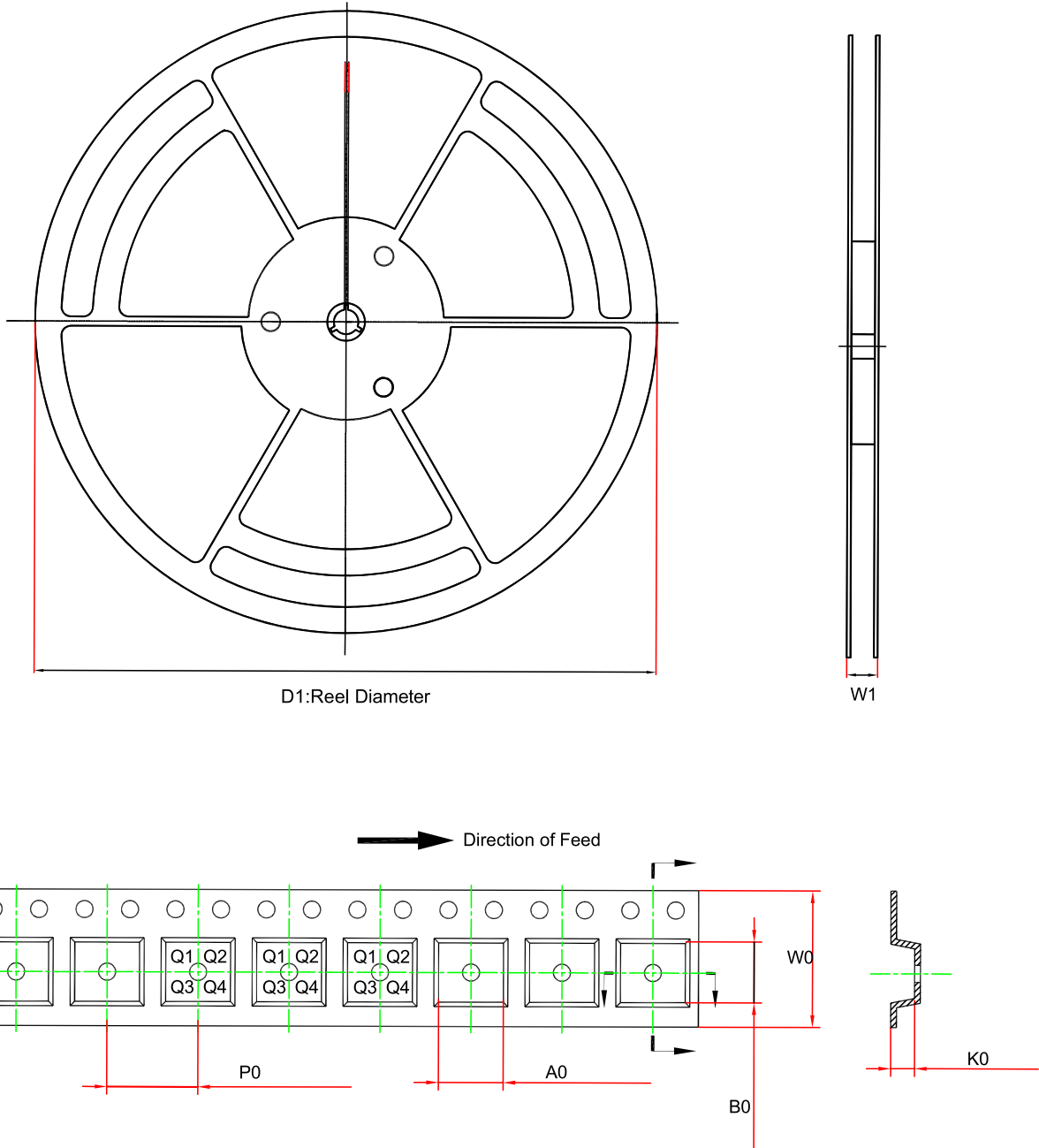
$$V_{OUT} = (I_{LOAD} \times R_{SHUNT}) \times (R2 / R1) + V_{REF}$$

$$\text{When } R3 = R1, R2 = R4, R_{SHUNT} \ll R1$$

### Power Supply Recommendations

Place 0.1-μF bypass capacitors close to the power-supply pins to reduce coupling errors from the noisy or high-impedance power supplies.

## Tape and Reel Information



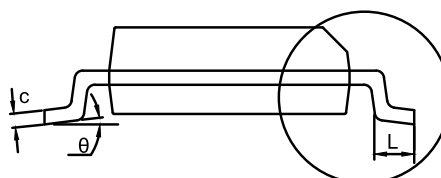
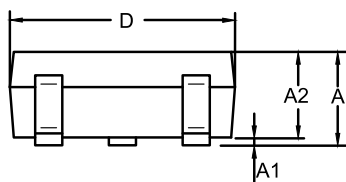
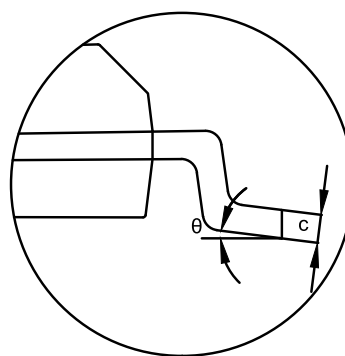
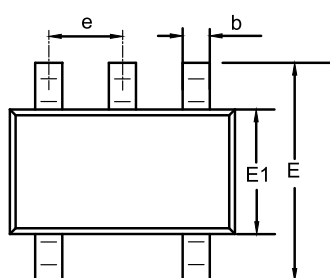
| Order Number | Package | D1<br>(mm) | W1<br>(mm) | A0<br>(mm) | B0<br>(mm) | K0<br>(mm) | P0<br>(mm) | W0<br>(mm) | Pin1<br>Quadrant |
|--------------|---------|------------|------------|------------|------------|------------|------------|------------|------------------|
| LMV321X-SC5R | SOT353  | 178.0      | 12.1       | 2.4        | 2.5        | 1.2        | 4.0        | 8.0        | Q3               |
| LMV321X-S5TR | SOT23-5 | 180.0      | 12.0       | 3.3        | 3.3        | 1.4        | 4.0        | 8.0        | Q3               |
| LMV358X-SO1R | SOP8    | 330.0      | 17.6       | 6.5        | 5.4        | 2.0        | 8.0        | 12.0       | Q1               |
| LMV358X-VS1R | MSOP8   | 330.0      | 17.6       | 5.3        | 3.4        | 1.3        | 8.0        | 12.0       | Q1               |
| LMV324X-SO2R | SOP14   | 330.0      | 21.6       | 6.5        | 9.2        | 1.8        | 8.0        | 16.0       | Q1               |
| LMV324X-TS2R | TSSOP14 | 330.0      | 17.6       | 6.8        | 5.5        | 1.3        | 8.0        | 12.0       | Q1               |

## Package Outline Dimensions

### SOT353

#### Package Outline Dimensions

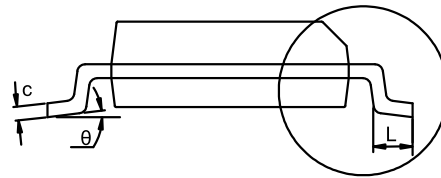
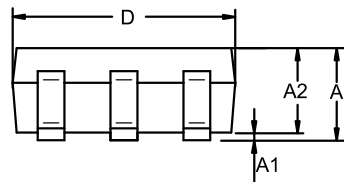
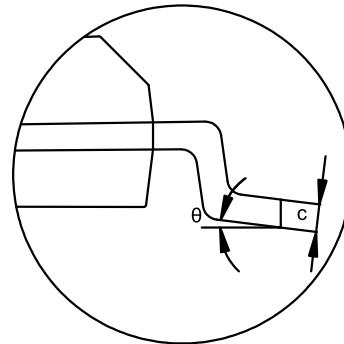
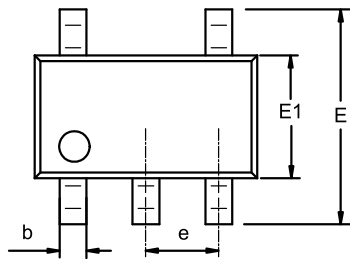
#### SC5(SOT353-5-A)



| Symbol | Dimensions<br>In Millimeters |       | Dimensions<br>In Inches |       |
|--------|------------------------------|-------|-------------------------|-------|
|        | MIN                          | MAX   | MIN                     | MAX   |
| A      | 0.850                        | 1.100 | 0.033                   | 0.043 |
| A1     | 0.000                        | 0.100 | 0.000                   | 0.004 |
| A2     | 0.800                        | 1.000 | 0.031                   | 0.039 |
| b      | 0.150                        | 0.350 | 0.006                   | 0.014 |
| c      | 0.110                        | 0.230 | 0.004                   | 0.009 |
| D      | 2.000                        | 2.200 | 0.079                   | 0.087 |
| E      | 2.150                        | 2.450 | 0.085                   | 0.096 |
| E1     | 1.150                        | 1.350 | 0.045                   | 0.053 |
| e      | 0.650 BSC                    |       | 0.026 BSC               |       |
| L      | 0.260                        | 0.460 | 0.010                   | 0.018 |
| theta  | 0                            | 8°    | 0                       | 8°    |

#### NOTES

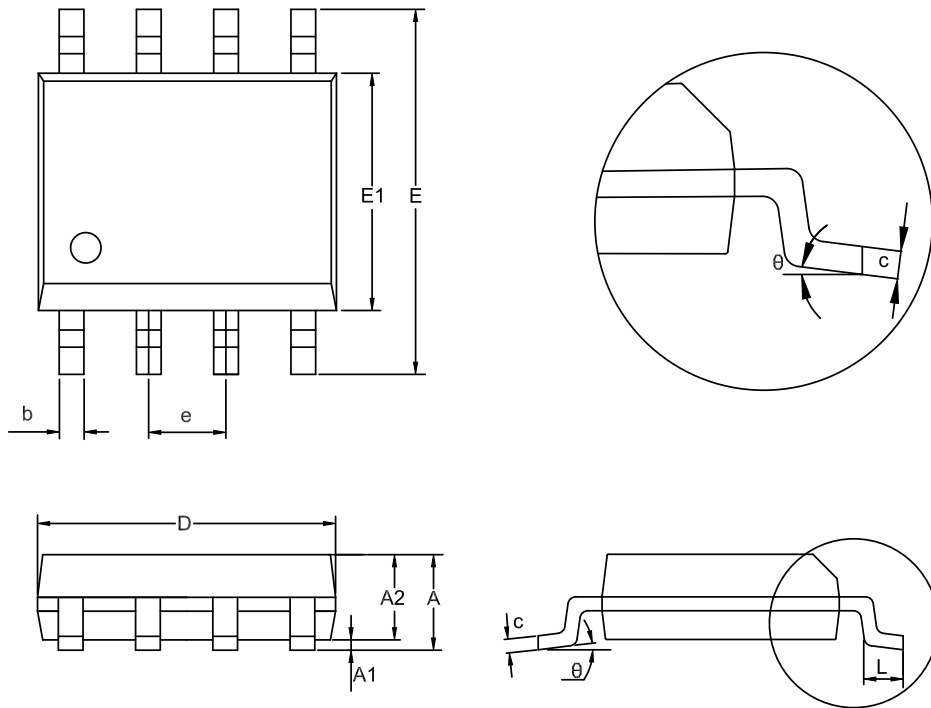
1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

**SOT23-5**
**Package Outline Dimensions**
**S5T(SOT23-5-B)**


| Symbol   | Dimensions<br>In Millimeters |       | Dimensions<br>In Inches |       |
|----------|------------------------------|-------|-------------------------|-------|
|          | MIN                          | MAX   | MIN                     | MAX   |
| A        | 1.050                        | 1.250 | 0.041                   | 0.049 |
| A1       | 0.000                        | 0.150 | 0.000                   | 0.006 |
| A2       | 1.000                        | 1.200 | 0.039                   | 0.047 |
| b        | 0.330                        | 0.410 | 0.013                   | 0.016 |
| c        | 0.100                        | 0.230 | 0.004                   | 0.009 |
| D        | 2.820                        | 3.020 | 0.111                   | 0.119 |
| E        | 2.600                        | 3.000 | 0.102                   | 0.118 |
| E1       | 1.500                        | 1.720 | 0.059                   | 0.068 |
| e        | 0.950 BSC                    |       | 0.037 BSC               |       |
| L        | 0.300                        | 0.600 | 0.012                   | 0.024 |
| $\theta$ | 0                            | 8°    | 0                       | 8°    |

**NOTES**

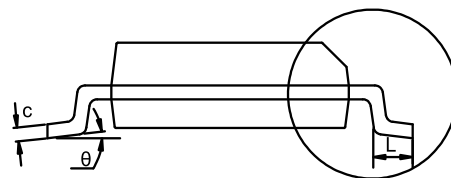
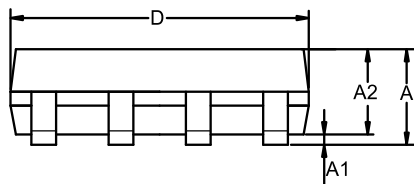
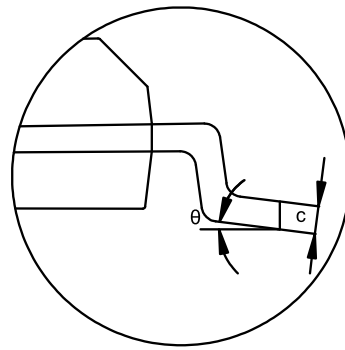
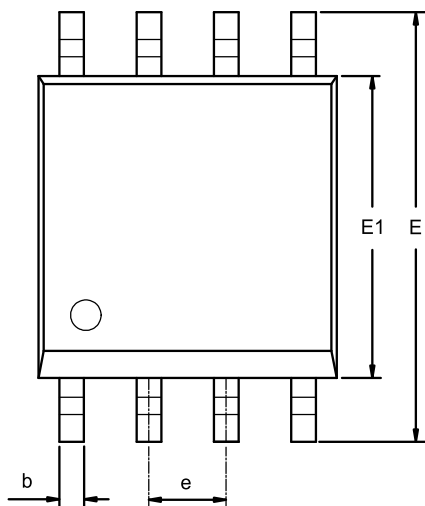
1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

**SOP8**
**Package Outline Dimensions**
**SO1(SOP-8-A)**


| Symbol | Dimensions<br>In Millimeters |       | Dimensions<br>In Inches |       |
|--------|------------------------------|-------|-------------------------|-------|
|        | MIN                          | MAX   | MIN                     | MAX   |
| A      | 1.350                        | 1.750 | 0.053                   | 0.069 |
| A1     | 0.050                        | 0.250 | 0.002                   | 0.010 |
| A2     | 1.250                        | 1.550 | 0.049                   | 0.061 |
| b      | 0.330                        | 0.510 | 0.013                   | 0.020 |
| c      | 0.170                        | 0.250 | 0.007                   | 0.010 |
| D      | 4.700                        | 5.100 | 0.185                   | 0.201 |
| E      | 5.800                        | 6.200 | 0.228                   | 0.244 |
| E1     | 3.800                        | 4.000 | 0.150                   | 0.157 |
| e      | 1.270 BSC                    |       | 0.050 BSC               |       |
| L      | 0.400                        | 1.000 | 0.016                   | 0.039 |
| θ      | 0                            | 8°    | 0                       | 8°    |

**NOTES**

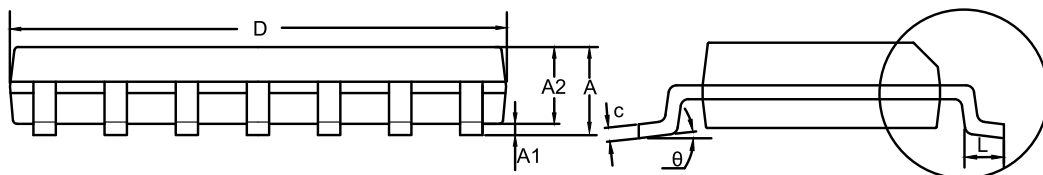
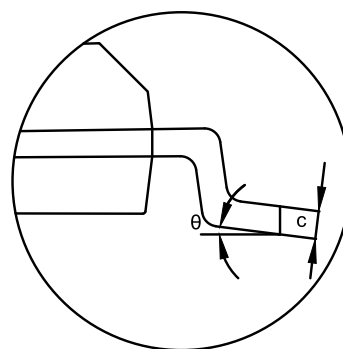
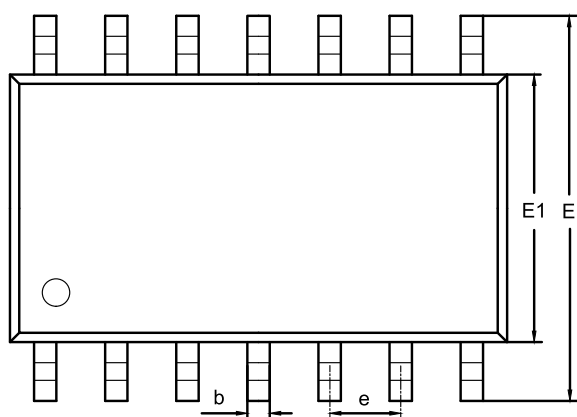
1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

**MSOP8**
**Package Outline Dimensions**
**VS1(MSOP-8-A)**


| Symbol   | Dimensions<br>In Millimeters |       | Dimensions<br>In Inches |       |
|----------|------------------------------|-------|-------------------------|-------|
|          | MIN                          | MAX   | MIN                     | MAX   |
| A        | 0.800                        | 1.100 | 0.031                   | 0.043 |
| A1       | 0.020                        | 0.150 | 0.001                   | 0.006 |
| A2       | 0.750                        | 0.950 | 0.030                   | 0.037 |
| b        | 0.250                        | 0.380 | 0.010                   | 0.015 |
| c        | 0.090                        | 0.230 | 0.004                   | 0.009 |
| D        | 2.900                        | 3.100 | 0.114                   | 0.122 |
| E        | 4.700                        | 5.100 | 0.185                   | 0.201 |
| E1       | 2.900                        | 3.100 | 0.114                   | 0.122 |
| e        | 0.650 BSC                    |       | 0.026 BSC               |       |
| L        | 0.400                        | 0.800 | 0.016                   | 0.031 |
| $\theta$ | 0                            | 8°    | 0                       | 8°    |

**NOTES**

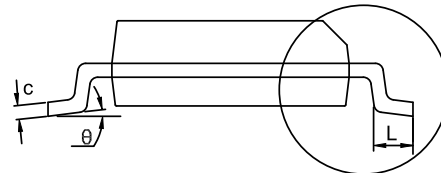
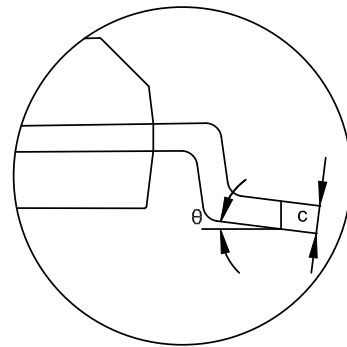
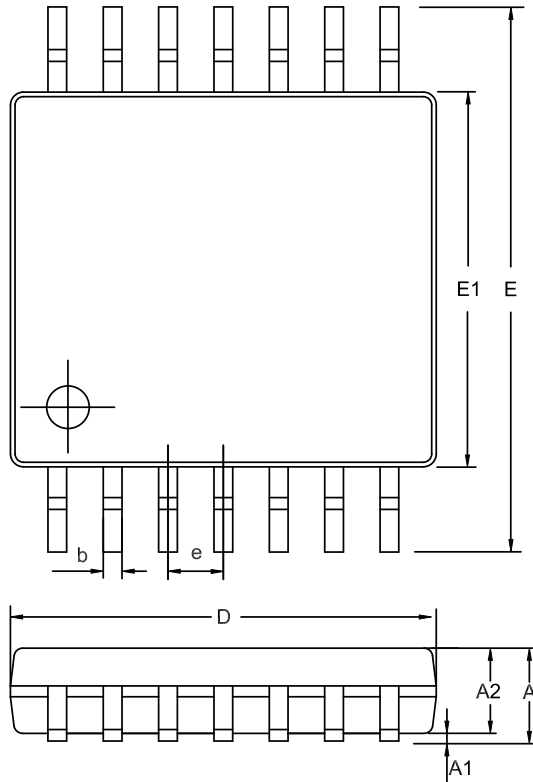
1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

**SOP14**
**Package Outline Dimensions**
**SO2(SOP-14-A)**


| Symbol   | Dimensions<br>In Millimeters |       | Dimensions<br>In Inches |       |
|----------|------------------------------|-------|-------------------------|-------|
|          | MIN                          | MAX   | MIN                     | MAX   |
| A        | 1.350                        | 1.750 | 0.053                   | 0.069 |
| A1       | 0.050                        | 0.250 | 0.002                   | 0.010 |
| A2       | 1.250                        | 1.650 | 0.049                   | 0.065 |
| b        | 0.310                        | 0.510 | 0.012                   | 0.020 |
| c        | 0.100                        | 0.250 | 0.004                   | 0.010 |
| D        | 8.450                        | 8.850 | 0.333                   | 0.348 |
| E        | 5.800                        | 6.200 | 0.228                   | 0.244 |
| E1       | 3.800                        | 4.000 | 0.150                   | 0.157 |
| e        | 1.270 BSC                    |       | 0.050 BSC               |       |
| L        | 0.400                        | 1.270 | 0.016                   | 0.050 |
| $\theta$ | 0                            | 8°    | 0                       | 8°    |

**NOTES**

1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

**TSSOP14**
**Package Outline Dimensions**
**TS2(TSSOP-14-A)**


| Symbol | Dimensions<br>In Millimeters |       | Dimensions<br>In Inches |       |
|--------|------------------------------|-------|-------------------------|-------|
|        | MIN                          | MAX   | MIN                     | MAX   |
| A      | 0.900                        | 1.200 | 0.035                   | 0.047 |
| A1     | 0.050                        | 0.150 | 0.002                   | 0.006 |
| A2     | 0.800                        | 1.050 | 0.031                   | 0.041 |
| b      | 0.190                        | 0.300 | 0.007                   | 0.012 |
| c      | 0.090                        | 0.200 | 0.004                   | 0.008 |
| D      | 4.900                        | 5.100 | 0.193                   | 0.201 |
| E      | 6.200                        | 6.600 | 0.244                   | 0.260 |
| E1     | 4.300                        | 4.500 | 0.169                   | 0.177 |
| e      | 0.650 BSC                    |       | 0.026 BSC               |       |
| L      | 0.450                        | 0.750 | 0.018                   | 0.030 |
| θ      | 0                            | 8°    | 0                       | 8°    |

**NOTES**

1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

## Order Information

| Order Number                | Operating Temperature Range | Package         | Marking Information | MSL  | Transport Media, Quantity | Eco Plan |
|-----------------------------|-----------------------------|-----------------|---------------------|------|---------------------------|----------|
| LMV321X-SC5R <sup>(1)</sup> | –40 to 125°C                | SOT353 (SC70-5) | A08                 | MSL1 | Tape and Reel, 3000       | Green    |
| LMV321X-S5TR                | –40 to 125°C                | SOT23-5         | A08                 | MSL1 | Tape and Reel, 3000       | Green    |
| LMV358X-SO1R                | –40 to 125°C                | SOP8            | V358X               | MSL3 | Tape and Reel, 4000       | Green    |
| LMV358X-VS1R                | –40 to 125°C                | MSOP8           | V358X               | MSL3 | Tape and Reel, 3000       | Green    |
| LMV324X-SO2R                | –40 to 125°C                | SOP14           | V324X               | MSL3 | Tape and Reel, 2500       | Green    |
| LMV324X-TS2R                | –40 to 125°C                | TSSOP14         | V324X               | MSL3 | Tape and Reel, 3000       | Green    |

(1) For future products, contact the 3PEAK factory for more information and sample.

**Green:** 3PEAK defines "Green" to mean RoHS compatible and free of halogen substances.

## **IMPORTANT NOTICE AND DISCLAIMER**

**Copyright**© 3PEAK 2012-2024. All rights reserved.

**Trademarks.** Any of the 思瑞浦 or 3PEAK trade names, trademarks, graphic marks, and domain names contained in this document /material are the property of 3PEAK. You may NOT reproduce, modify, publish, transmit or distribute any Trademark without the prior written consent of 3PEAK.

**Performance Information.** Performance tests or performance range contained in this document/material are either results of design simulation or actual tests conducted under designated testing environment. Any variation in testing environment or simulation environment, including but not limited to testing method, testing process or testing temperature, may affect actual performance of the product.

**Disclaimer.** 3PEAK provides technical and reliability data (including data sheets), design resources (including reference designs), application or other design recommendations, networking tools, security information and other resources "As Is". 3PEAK makes no warranty as to the absence of defects, and makes no warranties of any kind, express or implied, including without limitation, implied warranties as to merchantability, fitness for a particular purpose or non-infringement of any third-party's intellectual property rights. Unless otherwise specified in writing, products supplied by 3PEAK are not designed to be used in any life-threatening scenarios, including critical medical applications, automotive safety-critical systems, aviation, aerospace, or any situations where failure could result in bodily harm, loss of life, or significant property damage. 3PEAK disclaims all liability for any such unauthorized use.