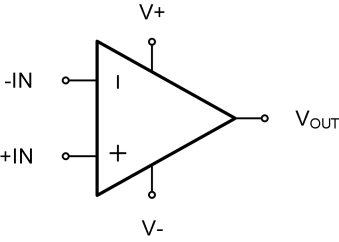


## GTV321 GTV358 GTV324

### Low-Voltage, Low-power, Rail-to-Rail I/O CMOS Op Amps

| 1 Features  | 2 Application   |
|---|---|
| <ul style="list-style-type: none"> <li>- High gain bandwidth: 1 MHz</li> <li>- Rail-to-rail input and output</li> <li>- Low supply current: 90 <math>\mu</math>A/amplifier at 5 V</li> <li>- Input voltage range: -0.1 V to +5.6 V with <math>V_S=5.5</math> V</li> <li>- Supply range: +2.5 V to +5.5 V</li> <li>- Operation temperature range: -40°C to +125°C</li> </ul> | <ul style="list-style-type: none"> <li>- Sensors</li> <li>- Photodiode amplification</li> <li>- Active filters</li> <li>- Test equipment</li> <li>- Driving A/D converters</li> </ul> |

| 3 Description   | Circuit Diagram  |
|---|--|
| <p>The GTV3XX families of products offer low voltage operation and rail-to-rail input and output, as well as excellent speed/power consumption ratio, providing an excellent bandwidth (1MHz) and slew rate of 0.7V/us. The op-amps are unity gain stable and feature an ultra-low input bias current.</p> <p>The devices are ideal for sensor interfaces, active filters and portable applications. The GTV3XX families of operational amplifiers are specified at the temperature range of -40°C to +125°C under single or dual power supplies of 2.5V to 5.5V.</p> |  |

**4 Revision History**

| <b>Revision</b> | <b>Date</b>  | <b>Note</b>  |
|-----------------|--------------|--|
| Rev. A1.0       | 2023. 06. 09 | Original Version   |
| Rev. A1.1       | 2023. 09. 01 | Added DFN  |
| Rev. A1.2       | 2023. 12. 15 | 1.Updated Package Qty<br>2.Added Tape and Reel Information |
| Rev. A1.3       | 2023. 12. 26 | 1.Added Marking<br>2.Added MSL                             |
| Rev. A1.4       | 2024. 01. 26 | Updated Part Name  |

The latest datasheet version should be checked on the GTIC official website, as the company does not actively inform customers about updates to the datasheet.

**5 Device Summary, Pin and Packages**
**Table. 5-1. Device Summary<sup>(1)</sup>**

| Serial Name | Part Name | Package   | Body Size (Nom)      | Marking <sup>(2)</sup> | MSL <sup>(3)</sup> | Package Qty        |
|-------------|-----------|-----------|----------------------|------------------------|--------------------|--------------------|
| GTV321      | GTV321C5  | SC70-5    | 2.10mm×1.25mm×1.00mm | GTV321<br>XXXXX        | 3                  | Tape and Reel,3000 |
|             | GTV321S5  | SOT23-5   | 2.90mm×1.60mm×1.10mm | GTV321<br>XXXXX        | 3                  | Tape and Reel,3000 |
|             | GTV321BC5 | SC70-5    | 2.10mm×1.25mm×1.00mm | GTV321<br>XXXXX        | 3                  | Tape and Reel,3000 |
|             | GTV321BS5 | SOT23-5   | 2.90mm×1.60mm×1.10mm | GTV321<br>XXXXX        | 3                  | Tape and Reel,3000 |
|             | GTV321M8  | MSOP8     | 3.00mm×3.00mm×1.10mm | GTV321<br>XXXXXXXX     | 3                  | Tape and Reel,4000 |
|             | GTV321P8  | SOP8      | 6.00mm×3.90mm×1.75mm | GTV321<br>XXXXXXXX     | 3                  | Tape and Reel,4000 |
| GTV358      | GTV358F8  | DFN2*2-8L | 2.00mm×2.00mm×0.75mm | GTV358<br>XXXX         | 3                  | Tape and Reel,3000 |
|             | GTV358A8  | DFN3*3-8L | 3.00mm×3.00mm×0.75mm | GTV358<br>XXXXX        | 3                  | Tape and Reel,5000 |
|             | GTV358M8  | MSOP8     | 3.00mm×3.00mm×1.10mm | GTV358<br>XXXXXXXX     | 3                  | Tape and Reel,4000 |
|             | GTV358T8  | TSSOP8    | 3.00mm×4.40mm×1.10mm | GTV358<br>XXXXXXXX     | 3                  | Tape and Reel,4000 |
|             | GTV358P8  | SOP8      | 6.00mm×3.90mm×1.75mm | GTV358<br>XXXXXXXX     | 3                  | Tape and Reel,4000 |
| GTV324      | GTV324TD  | TSSOP14   | 5.00mm×4.40mm×1.20mm | GTV324<br>XXXXXXXX     | 3                  | Tape and Reel,4000 |
|             | GTV324PD  | SOP14     | 8.65mm×3.90mm×1.75mm | GTV324<br>XXXXXXXX     | 3                  | Tape and Reel,4000 |

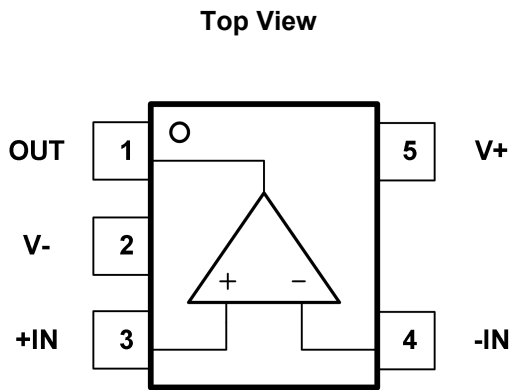
(1) For all available packages, please contact product sales.

(2) There may be additional marking, which relates to the lot trace code information (data code and vendor code), the logo or the environmental category on the device.

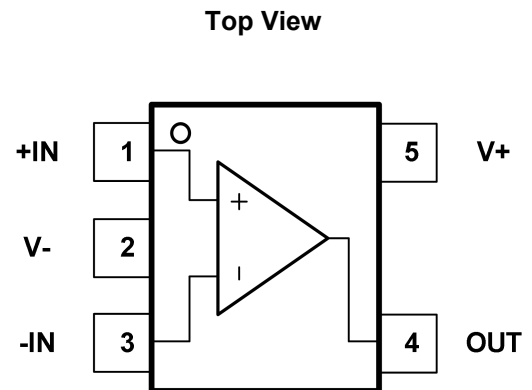
(3) MSL, The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications.

(4) "XXXXX" in Marking will be appeared as the batch code.

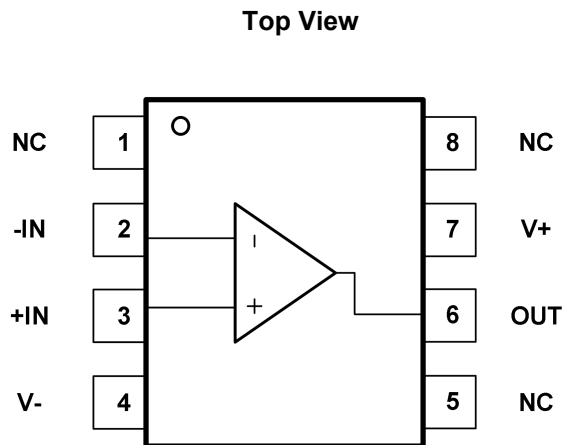
FAE: 13148878879

**5 Device Summary, Pin and Packages(continued)**


**Fig.5-1. GTV321: C5 (SC70-5) Package**  
**GTV321: S5 (SOT23-5) Package**



**Fig.5-2. GTV321: BC5 (SC70-5) Package**  
**GTV321: BS5 (SOT23-5) Package**



**Fig.5-3. GTV321: M8 (MSOP8) Package**  
**GTV321: P8 (SOP8) Package**

**Table. 5-2. Pin Definition**

| Name | Pin      |            |          | I/O | Description  |
|------|----------|------------|----------|-----|--|
|      | C5<br>S5 | BC5<br>BS5 | M8<br>P8 |     |  |
| -IN  | 4        | 3          | 2        | I   | Inverting input  |
| +IN  | 3        | 1          | 3        | I   | Noninverting input   |
| NC   | -        | -          | 1,5,8    | -   | No internal connection (can be left floating)                    |
| OUT  | 1        | 4          | 6        | O   | Output   |
| V-   | 2        | 2          | 4        | -   | Negative (lowest) supply or ground (for single-supply operation) |
| V+   | 5        | 5          | 7        | -   | Positive (highest) supply  |

\* It is suggested to leave the unconnected pins floating.

5 Device Summary, Pin and Packages(continued)

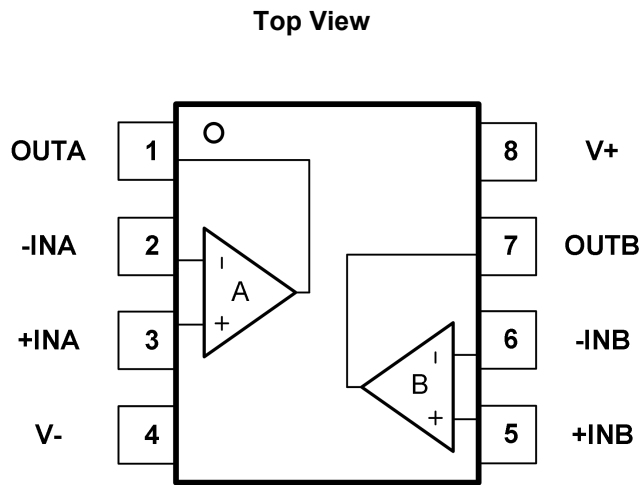


Fig.5-4.GTV358: M8(MSOP8) Package  
 GTV358: T8(TSSOP8) Package  
 GTV358: P8(SOP8) Package

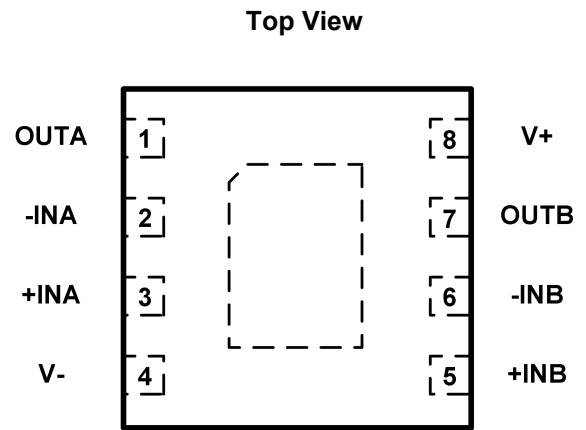
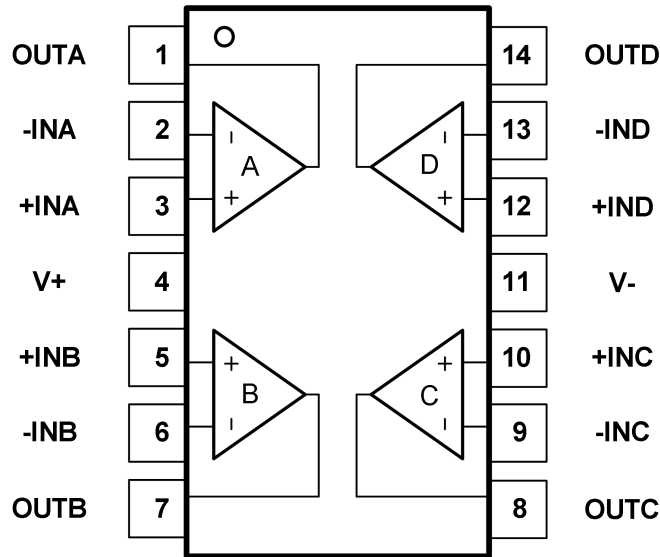


Fig.5-5. GTV358: F8(DFN2\*2-8) Package  
 GTV358: A8(DFN3\*3-8) Package

Table. 5-3. Pin Definition

| Name | Pin |    |    |       | I/O | Description  |
|------|-----|----|----|-------|-----|--|
|      | F8  | A8 | M8 | T8 P8 |     |  |
| -INA |     |    | 2  |       | I   | Inverting input, channel A                                       |
| +INA |     |    | 3  |       | I   | Noninverting input, channel A                                    |
| -INB |     |    | 6  |       | I   | Inverting input, channel B                                       |
| +INB |     |    | 5  |       | I   | Noninverting input, channel B                                    |
| OUTA |     |    | 1  |       | O   | Output, channel A  |
| OUTB |     |    | 7  |       | O   | Output, channel B  |
| V-   |     |    | 4  |       | -   | Negative (lowest) supply or ground (for single-supply operation) |
| V+   |     |    | 8  |       | -   | Positive (highest) supply  |

\* It is suggested to leave the unconnected pins floating.

**5 Device Summary, Pin and Packages(continued)**
**Top View**


**Fig.5-6. GTV324: TD (TSSOP14) Package**  
**GTV324: PD (SOP14) Package**

**Table. 5-4. Pin Definition**

| Pin  |       | I/O | Description  |
|------|-------|-----|--|
| Name | PD TD |     |  |
| -INA | 2     | I   | Inverting input, channel A                                       |
| +INA | 3     | I   | Noninverting input, channel A                                    |
| -INB | 6     | I   | Inverting input, channel B                                       |
| +INB | 5     | I   | Noninverting input, channel B                                    |
| -INC | 9     | I   | Inverting input, channel C                                       |
| +INC | 10    | I   | Noninverting input, channel C                                    |
| -IND | 13    | I   | Inverting input, channel D                                       |
| +IND | 12    | I   | Noninverting input, channel D                                    |
| OUTA | 1     | O   | Output, channel A  |
| OUTB | 7     | O   | Output, channel B  |
| OUTC | 8     | O   | Output, channel C  |
| OUTD | 14    | O   | Output, channel D  |
| V-   | 11    | -   | Negative (lowest) supply or ground (for single-supply operation) |
| V+   | 4     | -   | Positive (highest) supply  |

\* It is suggested to leave the unconnected pins floating.

## 6 Voltage, Temperature, ESD and Thermal ratings

### 6.1 Absolute Maximum Ratings

| Parameters                       | Min.                  | Max.                  | Unit |
|----------------------------------|-----------------------|-----------------------|------|
| Supply Voltage $V_s=(V^+)-(V^-)$ |                       | 6.5                   | V    |
| Select Input Voltage             | (V <sup>-</sup> )-0.5 | (V <sup>+</sup> )+0.5 | V    |
| Maximum Junction Temperature     | -55                   | 150                   | °C   |
| Storage Temperature Range        | -55                   | 150                   | °C   |

(1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not implied.

(2) Input terminals are diode-clamped to the power-supply rails. Input signals that can swing more than 0.3V beyond the supply rails should be current-limited to 10mA or less.

### 6.2 ESD Ratings

| ESD    |                         |                            | Value | Unit |
|--------|-------------------------|----------------------------|-------|------|
| V(ESD) | Electrostatic discharge | Human-body model (HBM)     | 3.5 K | V    |
|        |                         | Charged-device model (CDM) | 2 K   | V    |

(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.

### 6.3 Recommended Operating Conditions

Over operating free-air temperature range (unless otherwise noted)

| Symbol                           | Parameters            | Min.  | Max.  | Unit |
|----------------------------------|-----------------------|-------|-------|------|
| Supply Voltage $V_s=(V^+)-(V^-)$ | Single-supply         | 2.5   | 5.5   | V    |
|                                  | Dual-supply           | ±1.25 | ±2.75 |      |
| TA                               | Operating temperature | -40   | 125   | °C   |

### 6.4 Thermal Information

| Package Type   | $\theta_{JA}$ | $\theta_{JC}$ | Unit |
|----------------|---------------|---------------|------|
| SC70-5         | 400           | 150           | °C/W |
| SOT23-5        | 250           | 81            | °C/W |
| DFN2*2-8L      | 100           | 60            | °C/W |
| DFN3*3-8L      | NA            | NA            | °C/W |
| MSOP8          | 210           | 45            | °C/W |
| TSSOP8         | 191           | 44            | °C/W |
| SOP8(SOIC-8)   | 158           | 43            | °C/W |
| TSSOP14        | 180           | 35            | °C/W |
| SOP14(SOIC-14) | 120           | 36            | °C/W |

## 7 Electrical Specifications

$V_{CC}=5.0V$ ,  $V_{cm}=V_{CC}/2$ ,  $V_o=V_{CC}/2$ , and  $R_L=10k\Omega$ , FULL= $-40^{\circ}C$  to  $+125^{\circ}C$ , Typical values are at  $T_A=+25^{\circ}C$ . (unless otherwise noted)

| Parameters                         | Symbol       | Conditions  | $V_{CC}$ | $T_A$          | Min. | Typ.       | Max. | Unit              |
|------------------------------------|--------------|---|----------|----------------|------|------------|------|-------------------|
| <b>OFFSET VOLTAGE</b>              |              |   |          |                |      |            |      |                   |
| Input offset voltage               | $V_{os}$     |   | 5V       | $+25^{\circ}C$ | -4   | $\pm 1$    | 4    | mV                |
| Input offset voltage average drift | $V_{os\ TC}$ | $-40^{\circ}C$ to $+125^{\circ}C$                                 | 5V       |                |      | $\pm 0.22$ |      | $\mu V/^{\circ}C$ |
| Power-supply rejection ratio       | PSRR         | $-40^{\circ}C$ to $+125^{\circ}C$                                 | 5V       | FULL           | 74   | 120        |      | dB                |
| <b>INPUT VOLTAGE RANGE</b>         |              |   |          |                |      |            |      |                   |
| Common-mode voltage range          | $V_{cm}$     |   | 5.5V     | $+25^{\circ}C$ | -0.1 |            | 5.6  | V                 |
| Common-mode rejection ratio        | CMRR         | $V_{CM}=-0.1V$ to $5.1V$  | 5V       | FULL           | 85   | 130        |      | dB                |
| <b>INPUT BIAS CURRENT</b>          |              |   |          |                |      |            |      |                   |
| Input bias current                 | $I_B$        |   | 5V       | $+25^{\circ}C$ |      | 30         |      | pA                |
| Input offset current               | $I_{os}$     |   | 5V       | $+25^{\circ}C$ |      | 2          |      | pA                |
| <b>INPUT CAPACITOR</b>             |              |   |          |                |      |            |      |                   |
| Differential Input capacitor       | $C_{ID}$     |   | 5V       | $+25^{\circ}C$ |      | 7.7        |      | pF                |
| Common-Mode Input capacitor        | $C_{IC}$     |   | 5V       | $+25^{\circ}C$ |      | 9          |      | pF                |
| <b>NOISE</b>                       |              |   |          |                |      |            |      |                   |
| Total harmonic distortion + noise  | THD+N        | $A_v=1, f=1kHz, V_{out}=1V_{pp}$                                  | 5.5V     | $+25^{\circ}C$ |      | 0.003      |      | %                 |
| Input voltage noise(rms)           | $E_N$        | $f=0.1Hz$ to $10Hz$   | 5V       | $+25^{\circ}C$ |      | 2.2        |      | $\mu V_{rms}$     |
| Input voltage noise density        | $e_N$        | $f=1kHz$  | 5V       | $+25^{\circ}C$ |      | 35         |      | $nV/\sqrt{Hz}$    |
| Input current noise density        | $I_n$        | $f=1kHz$  | 5V       | $+25^{\circ}C$ |      | 23         |      | $fA/\sqrt{Hz}$    |
| <b>OPEN-LOOP GAIN</b>              |              |   |          |                |      |            |      |                   |
| Open-loop voltage gain             | AOL          |   | 5V       | $+25^{\circ}C$ | 85   | 120        |      | dB                |
| <b>FREQUENCY RESPONSE</b>          |              |   |          |                |      |            |      |                   |
| Gain bandwidth product             | GBP          |   | 5V       | $+25^{\circ}C$ |      | 1          |      | MHz               |
| Phase margin                       | PM           |   | 5V       | $+25^{\circ}C$ |      | 60         |      | $^{\circ}$        |
| Gain margin                        | GM           |   | 5V       | $+25^{\circ}C$ |      | 12         |      | dB                |
| Slew rate                          | SR           | $A_v=1, V_{out}=1.5V$ to $3.5V, C_{load}=60pF, R_{load}=2K\Omega$ | 5V       | $+25^{\circ}C$ |      | 0.7        |      | $V/\mu s$         |
| Settling time,0.1%                 | $t_s$        | $A_v=1, 2V$ step, $C_{load}=60pF, R_{load}=2K\Omega$              | 5V       | $+25^{\circ}C$ |      | 3.5        |      | $\mu s$           |
| <b>OUTPUT</b>                      |              |   |          |                |      |            |      |                   |
| Output swing from rail             | $V_o$        | $R_L=10k\Omega$   | 5V       | $+25^{\circ}C$ |      | 5          | 15   | mV                |
| Output current                     | $I_{out}$    |   | 5V       | $+25^{\circ}C$ |      | 70         |      | mA                |
| <b>POWER SUPPLY</b>                |              |   |          |                |      |            |      |                   |
| Quiescent current/amplifier        | $I_Q$        |   | 5V       | $+25^{\circ}C$ |      | 90         | 150  | $\mu A$           |



### 8 Typical Characteristics

$V_{cc}=5.0V$ ,  $V_{cm}=V_{cc}/2$ ,  $V_o=V_{cc}/2$ , and  $R_L=10k\Omega$ , FULL= $-40^{\circ}C$  to  $+125^{\circ}C$ , Typical values are at  $T_A=+25^{\circ}C$ . (unless otherwise noted)

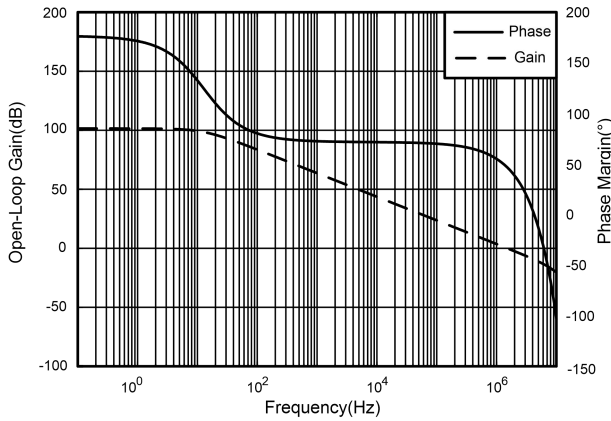


Fig.8-1. Open-Loop Gain and Phase vs Frequency

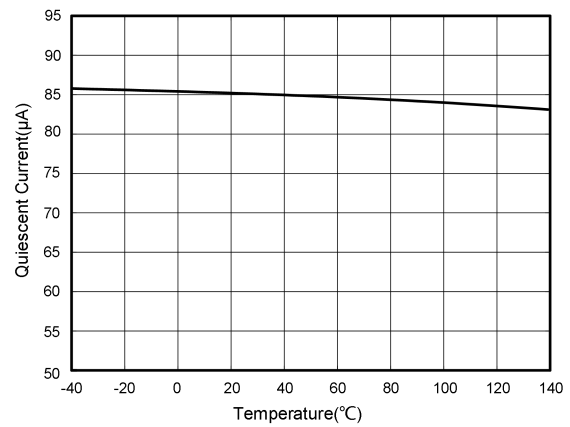


Fig.8-2. Quiescent Current vs Temperature

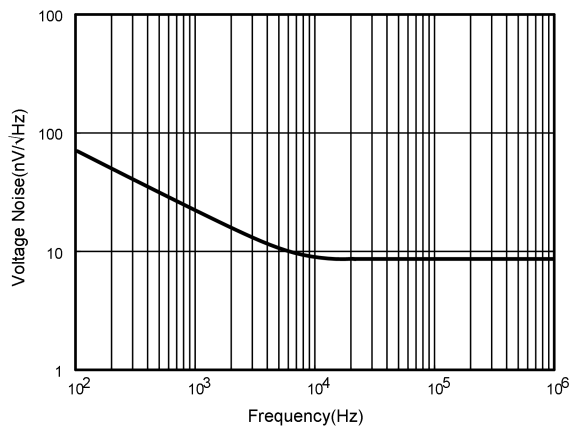


Fig.8-3. Voltage Noise vs Frequency

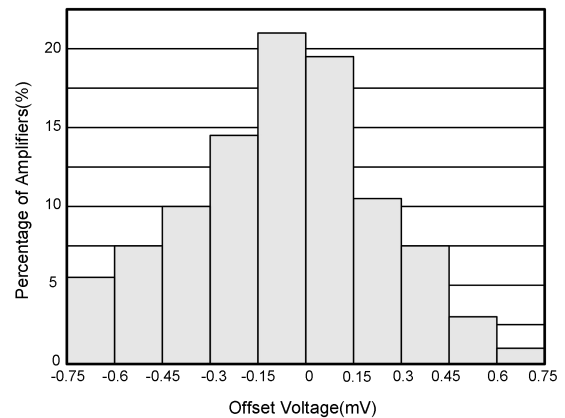


Fig.8-4. Offset Voltage Production Distribution

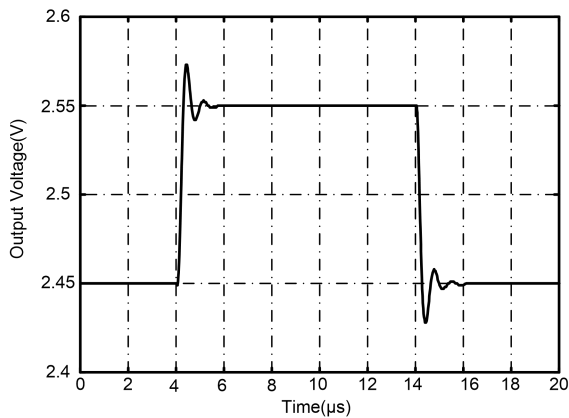


Fig.8-5. Small-Signal Step Response

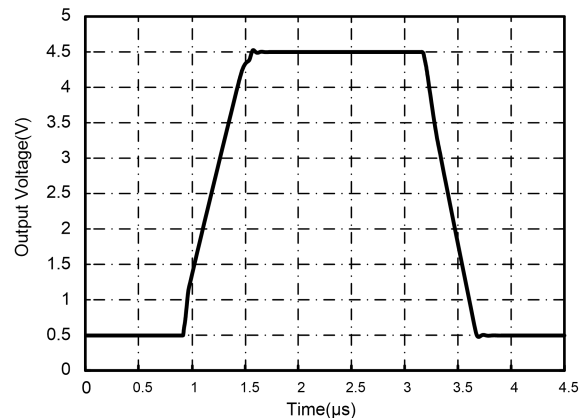


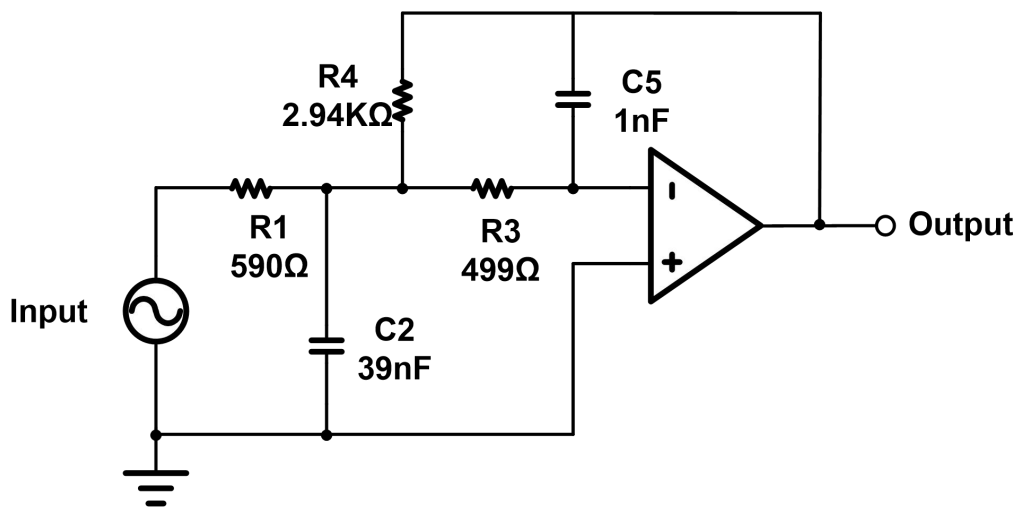
Fig.8-6. Large-Signal Step Response

## 9 Detailed Description

The GTV3XX families of products are rail-to-rail operational amplifiers that can be run from a single-supply voltage 2.5V to 5.5V ( $\pm 1.25V$  to  $\pm 2.75V$ ). Supply voltages higher than 6.5V (absolute maximum) can permanently damage the amplifier. Rail-to-rail input and output swing significantly increases dynamic range, especially in low-supply applications.

Attention to good layout practices is always recommended. Keep traces short. When possible, use a PCB ground plane with surface-mount components placed as close to the device pins as possible. Place a 0.1 $\mu F$  capacitor closely across the supply pins. These guidelines should be applied throughout the analog circuit to improve performance and provide benefits such as reducing the EMI susceptibility.

## 10 Application Note

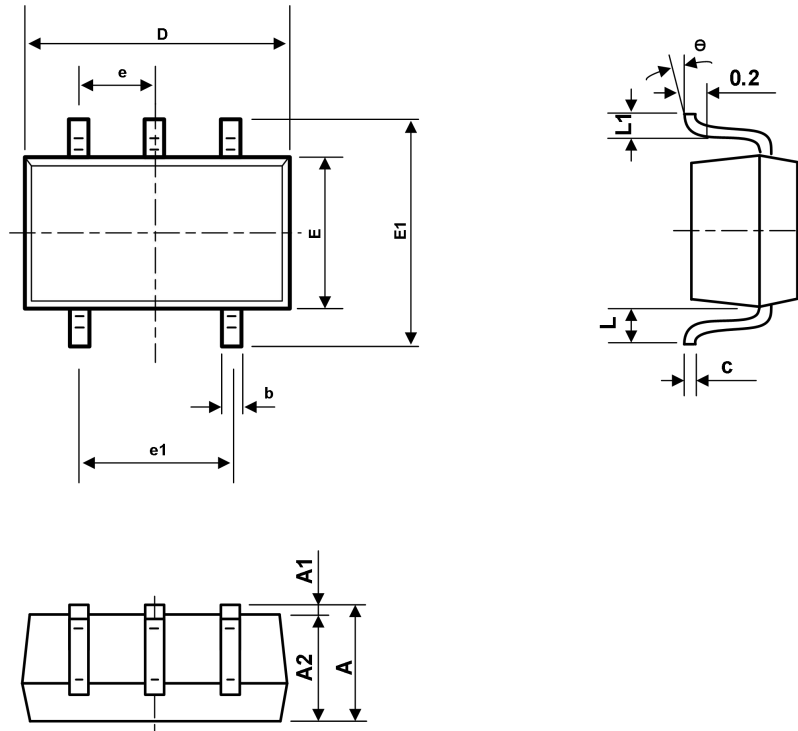


**Fig.10-1. 25-kHz Low-pass Filter**

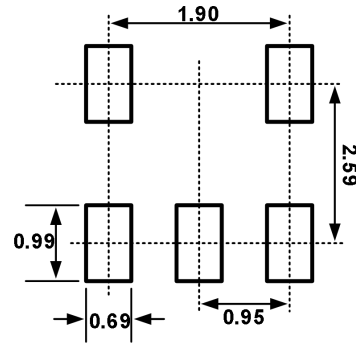
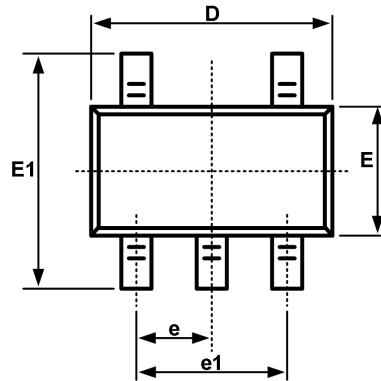
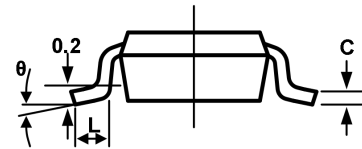
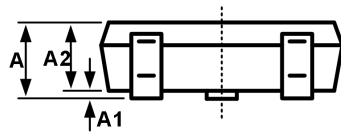
Low-pass filters are commonly employed in signal processing applications to reduce noise and prevent aliasing. The GTV3XX families of products devices are ideally suited to construct high-speed, high-precision active filters. Fig.10-1 shows a second-order, low-pass filter commonly encountered in signal processing applications.

Use the following parameters for this design example:

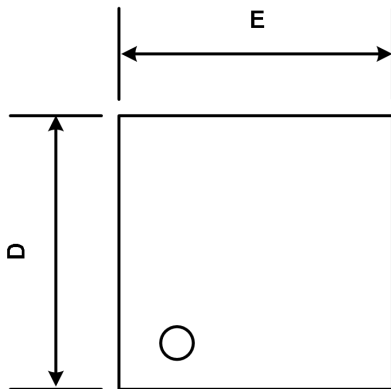
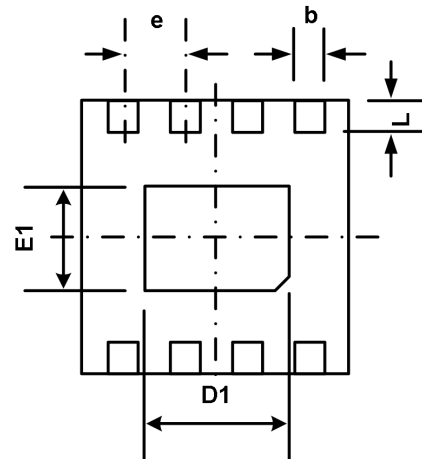
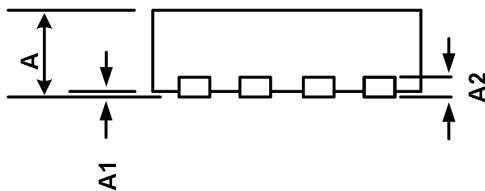
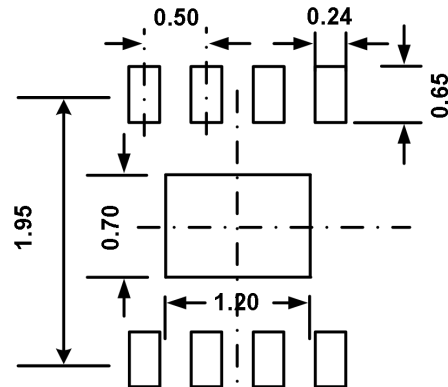
- Gain=5V/V (inverting gain)
- Low-pass cutoff frequency=25kHz
- Second-order Chebyshev filter response with 3-dB gain peaking in the passband.

**11 Package Outline Dimension**
**SC70-5**


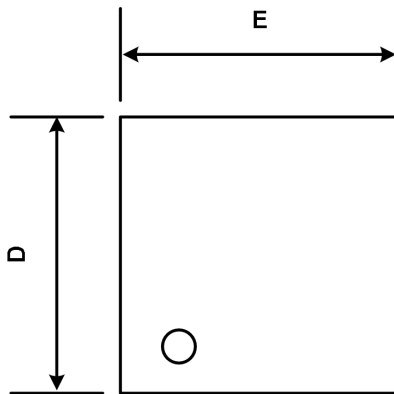
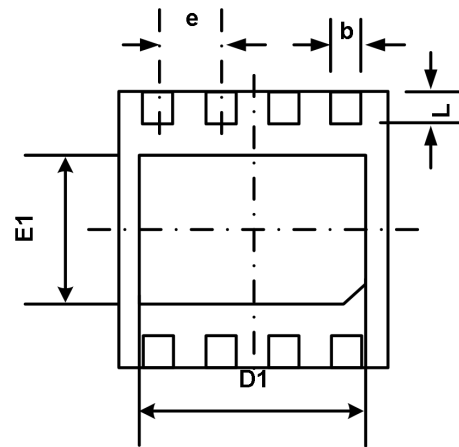
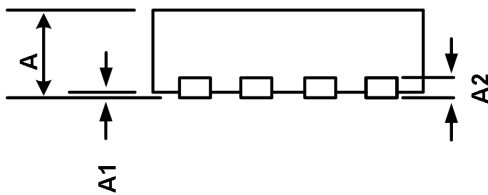
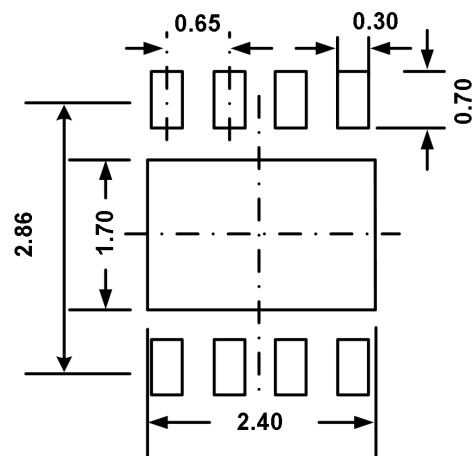
| Symbol   | Dimensions in Millimeters |       | Dimensions in Inches |       |
|----------|---------------------------|-------|----------------------|-------|
|          | Min.                      | Max.  | Min.                 | Max.  |
| A        | 0.900                     | 1.100 | 0.035                | 0.043 |
| A1       | 0.000                     | 0.100 | 0.000                | 0.004 |
| A2       | 0.900                     | 1.000 | 0.035                | 0.039 |
| b        | 0.150                     | 0.350 | 0.006                | 0.014 |
| c        | 0.110                     | 0.175 | 0.004                | 0.007 |
| D        | 2.000                     | 2.200 | 0.079                | 0.087 |
| E        | 1.150                     | 1.350 | 0.045                | 0.053 |
| E1       | 2.150                     | 2.450 | 0.085                | 0.096 |
| e        | 0.650TYP                  |       | 0.026TYP             |       |
| e1       | 1.200                     | 1.400 | 0.047                | 0.055 |
| L        | 0.525REF                  |       | 0.021REF             |       |
| L1       | 0.260                     | 0.460 | 0.010                | 0.018 |
| $\theta$ | 0°                        | 8°    | 0°                   | 8°    |

**11 Package Outline Dimension(continued)**
**SOT23-5**

**Recommended Land Pattern (Unit: mm)**


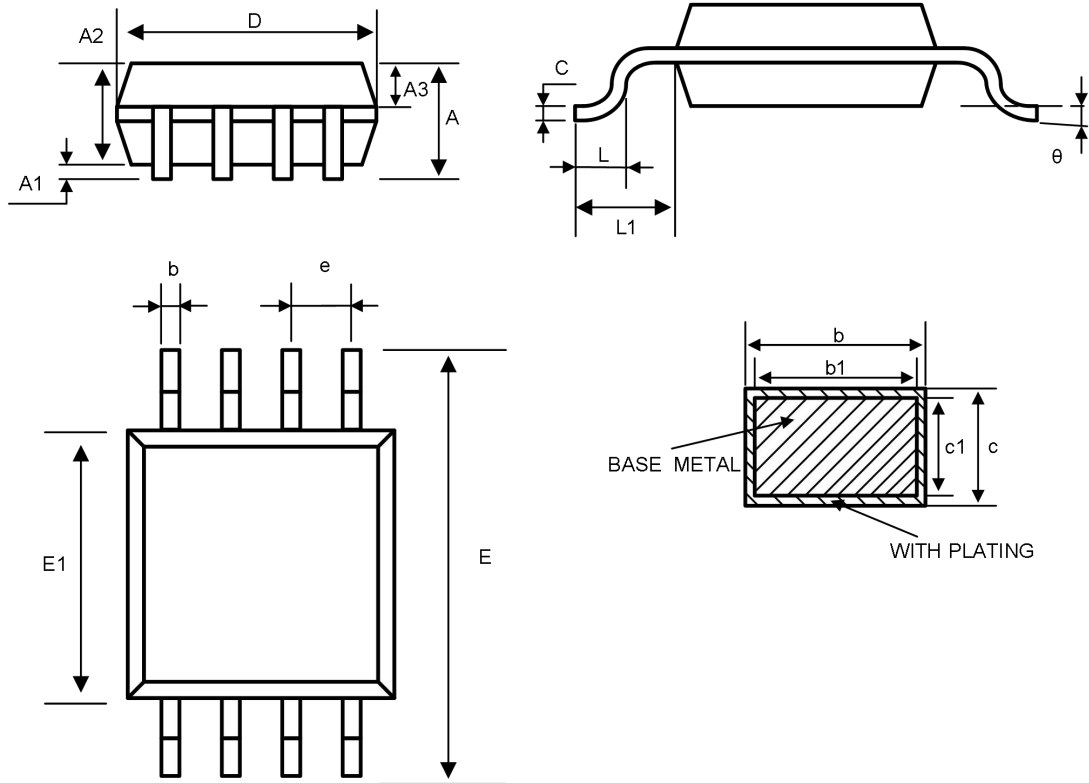
| Symbol | Dimensions in Millimeters |       | Dimensions in Inches |       |
|--------|---------------------------|-------|----------------------|-------|
|        | Min.                      | Max.  | Min.                 | Max.  |
| A      | 1.050                     | 1.250 | 0.041                | 0.049 |
| A1     | 0.000                     | 0.100 | 0.000                | 0.004 |
| A2     | 1.050                     | 1.150 | 0.041                | 0.045 |
| b      | 0.300                     | 0.500 | 0.012                | 0.020 |
| c      | 0.100                     | 0.200 | 0.004                | 0.008 |
| D      | 2.820                     | 3.020 | 0.111                | 0.119 |
| E      | 1.500                     | 1.700 | 0.059                | 0.067 |
| E1     | 2.650                     | 2.950 | 0.104                | 0.116 |
| e      | 0.950(BSC)                |       | 0.037(BSC)           |       |
| e1     | 1.800                     | 2.000 | 0.071                | 0.079 |
| L      | 0.300                     | 0.600 | 0.012                | 0.024 |
| L1     | 0.600REF                  |       | 0.024REF             |       |
| θ      | 0°                        | 8°    | 0°                   | 8°    |

**11 Package Outline Dimension(continued)**
**DFN2\*2-8L**

**TOP VIEW**

**BOTTOM VIEW**

**SIDE VIEW**

**RECOMMENDED LAND PATTERN(unit:mm)**

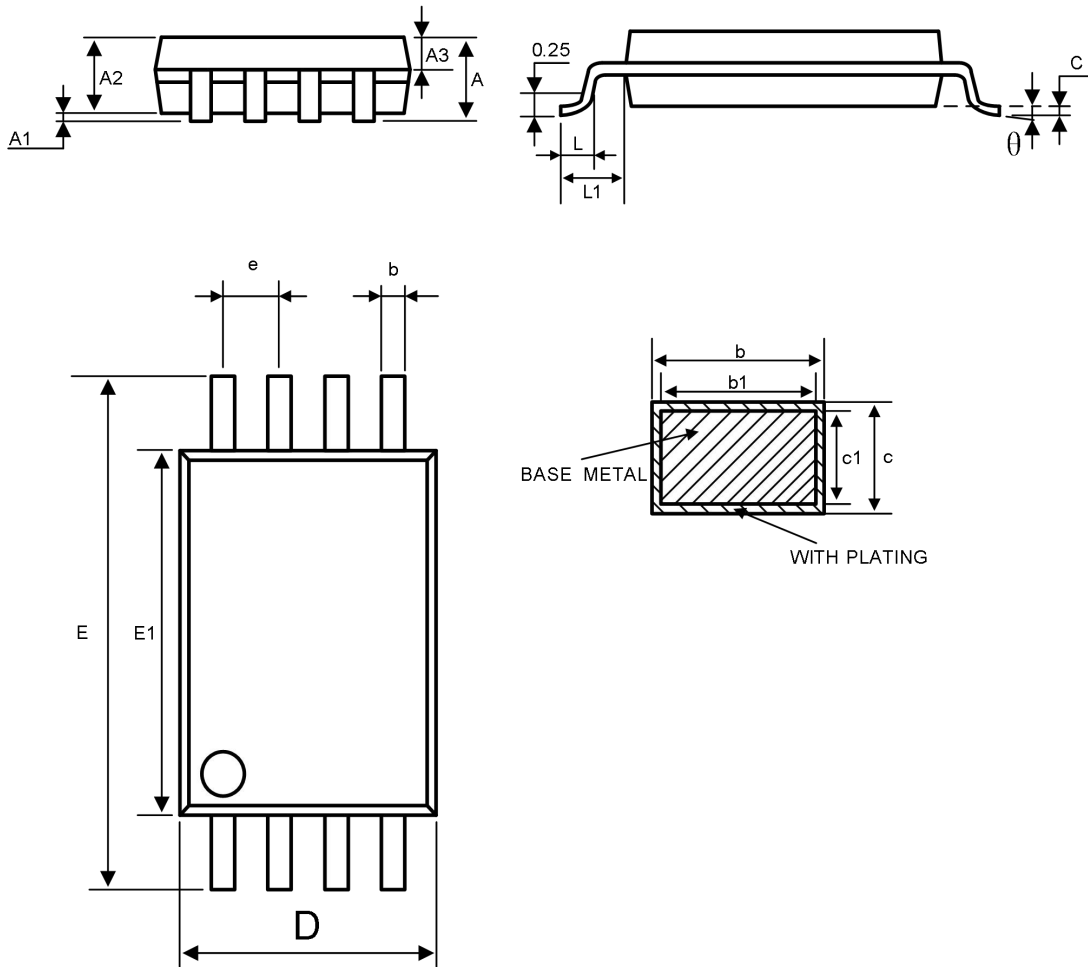
| Symbol | Dimensions in Millimeters |       | Dimensions in Inches |       |
|--------|---------------------------|-------|----------------------|-------|
|        | Min.                      | Max.  | Min.                 | Max.  |
| A      | 0.700                     | 0.800 | 0.028                | 0.031 |
| A1     | 0.000                     | 0.050 | 0.000                | 0.002 |
| A2     | 0.203(TYP)                |       | 0.035(TYP)           |       |
| b      | 0.180                     | 0.300 | 0.007                | 0.012 |
| D      | 1.900                     | 2.100 | 0.075                | 0.083 |
| D1     | 1.100                     | 1.300 | 0.043                | 0.051 |
| E      | 1.900                     | 2.100 | 0.075                | 0.083 |
| E1     | 0.600                     | 0.800 | 0.024                | 0.031 |
| e      | 0.500(TYP)                |       | 0.020TYP             |       |
| L      | 0.250                     | 0.450 | 0.010                | 0.018 |

**11 Package Outline Dimension(continued)**
**DFN3\*3-8L**

**TOP VIEW**

**BOTTOM VIEW**

**SIDE VIEW**

**RECOMMENDED LAND PATTERN(unit: mm)**

| Symbol | Dimensions in Millimeters |       | Dimensions in Inches |       |
|--------|---------------------------|-------|----------------------|-------|
|        | Min.                      | Max.  | Min.                 | Max.  |
| A      | 0.700                     | 0.800 | 0.028                | 0.031 |
| A1     | 0.000                     | 0.050 | 0.000                | 0.002 |
| A2     | 0.203                     |       | 0.008                |       |
| b      | 0.250                     | 0.350 | 0.010                | 0.014 |
| D      | 2.900                     | 3.100 | 0.114                | 0.122 |
| D1     | 2.350                     | 2.450 | 0.093                | 0.096 |
| E      | 2.900                     | 3.100 | 0.114                | 0.122 |
| E1     | 1.650                     | 1.750 | 0.065                | 0.069 |
| e      | 0.650(TYP)                |       | 0.026TYP             |       |
| L      | 0.370                     | 0.470 | 0.015                | 0.019 |

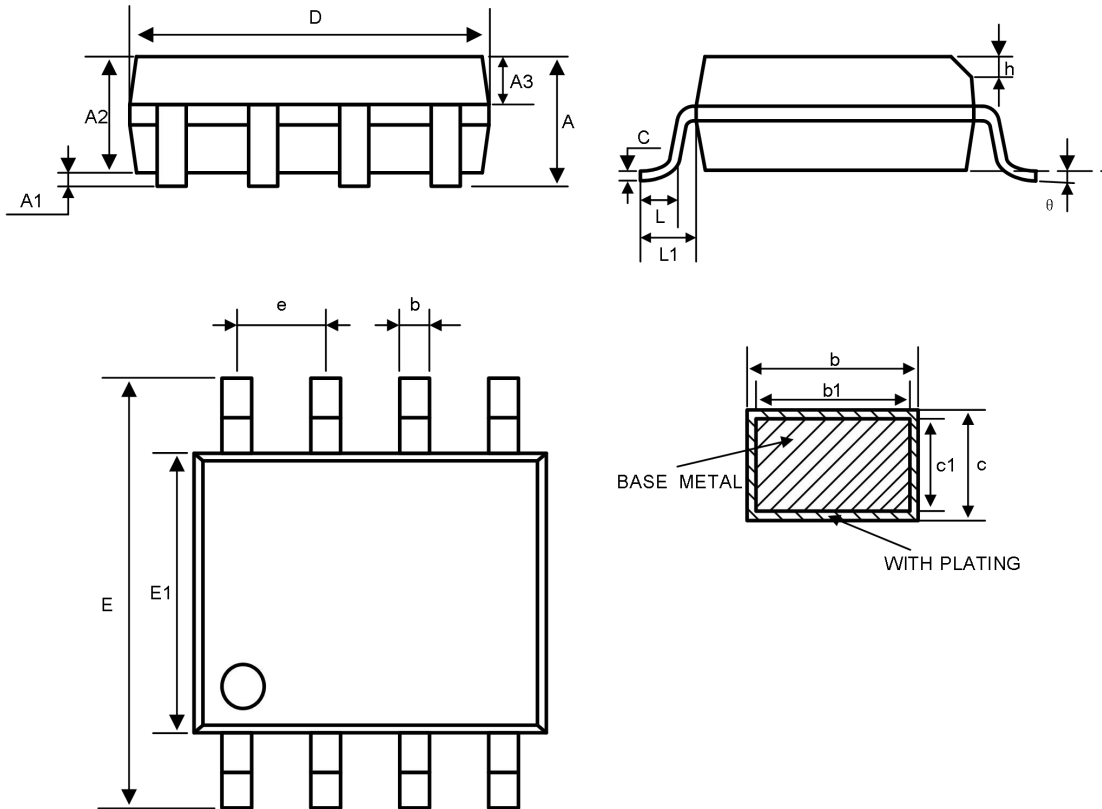
**11 Package Outline Dimension(continued)**
**MSOP8**


| Symbol   | Dimensions in Millimeters |      |      | Dimensions in Inches |       |       |
|----------|---------------------------|------|------|----------------------|-------|-------|
|          | Min.                      | Nom. | Max. | Min.                 | Nom.  | Max.  |
| A        | —                         | —    | 1.10 | —                    | —     | 0.043 |
| A1       | 0.05                      | —    | 0.15 | 0.002                | —     | 0.006 |
| A2       | 0.75                      | 0.85 | 0.95 | 0.030                | 0.033 | 0.037 |
| A3       | 0.30                      | 0.35 | 0.40 | 0.012                | 0.014 | 0.016 |
| b        | 0.28                      | —    | 0.36 | 0.011                | —     | 0.014 |
| b1       | 0.27                      | 0.30 | 0.33 | 0.011                | 0.012 | 0.013 |
| c        | 0.15                      | —    | 0.19 | 0.006                | —     | 0.007 |
| c1       | 0.14                      | 0.15 | 0.16 | 0.006                | 0.006 | 0.006 |
| D        | 2.90                      | 3.00 | 3.10 | 0.114                | 0.118 | 0.122 |
| E        | 4.70                      | 4.90 | 5.10 | 0.185                | 0.193 | 0.201 |
| E1       | 2.90                      | 3.00 | 3.10 | 0.114                | 0.118 | 0.122 |
| e        | 0.65BSC                   |      |      | 0.026BSC             |       |       |
| L        | 0.40                      | —    | 0.70 | 0.016                | —     | 0.028 |
| L1       | 0.95REF                   |      |      | 0.037REF             |       |       |
| $\theta$ | 0                         | —    | 8°   | 0                    | —     | 8°    |

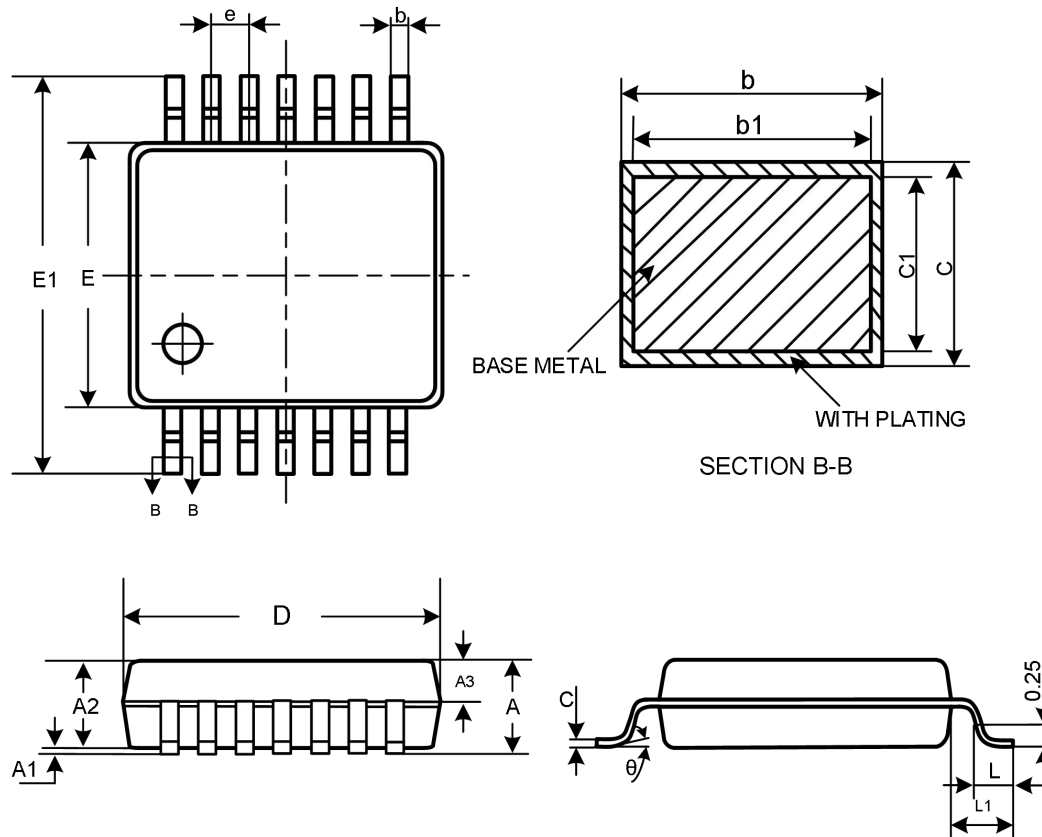
**11 Package Outline Dimension(continued)**
**TSSOP8**


| Symbol | Dimensions in Millimeters |      |      | Dimensions in Inches |       |       |
|--------|---------------------------|------|------|----------------------|-------|-------|
|        | Min.                      | Nom. | Max. | Min.                 | Nom.  | Max.  |
| A      | —                         | —    | 1.20 | —                    | —     | 0.047 |
| A1     | 0.05                      | —    | 0.15 | 0.002                | —     | 0.006 |
| A2     | 0.90                      | 1.00 | 1.05 | 0.035                | 0.039 | 0.041 |
| A3     | 0.39                      | 0.44 | 0.49 | 0.015                | 0.017 | 0.019 |
| b      | 0.20                      | —    | 0.28 | 0.008                | —     | 0.011 |
| b1     | 0.19                      | 0.22 | 0.25 | 0.007                | 0.009 | 0.010 |
| c      | 0.13                      | —    | 0.17 | 0.005                | —     | 0.007 |
| c1     | 0.12                      | 0.13 | 0.14 | 0.005                | 0.005 | 0.006 |
| D      | 2.90                      | 3.00 | 3.10 | 0.114                | 0.118 | 0.122 |
| E1     | 4.30                      | 4.40 | 4.50 | 0.169                | 0.173 | 0.177 |
| E      | 6.20                      | 6.40 | 6.60 | 0.244                | 0.251 | 0.260 |
| e      | 0.65BSC                   |      |      | 0.026BSC             |       |       |
| L      | 0.45                      | —    | 0.75 | 0.018                | —     | 0.030 |
| L1     | 1.00REF                   |      |      | 0.039REF             |       |       |
| θ      | 0                         | —    | 8°   | 0                    | —     | 8°    |

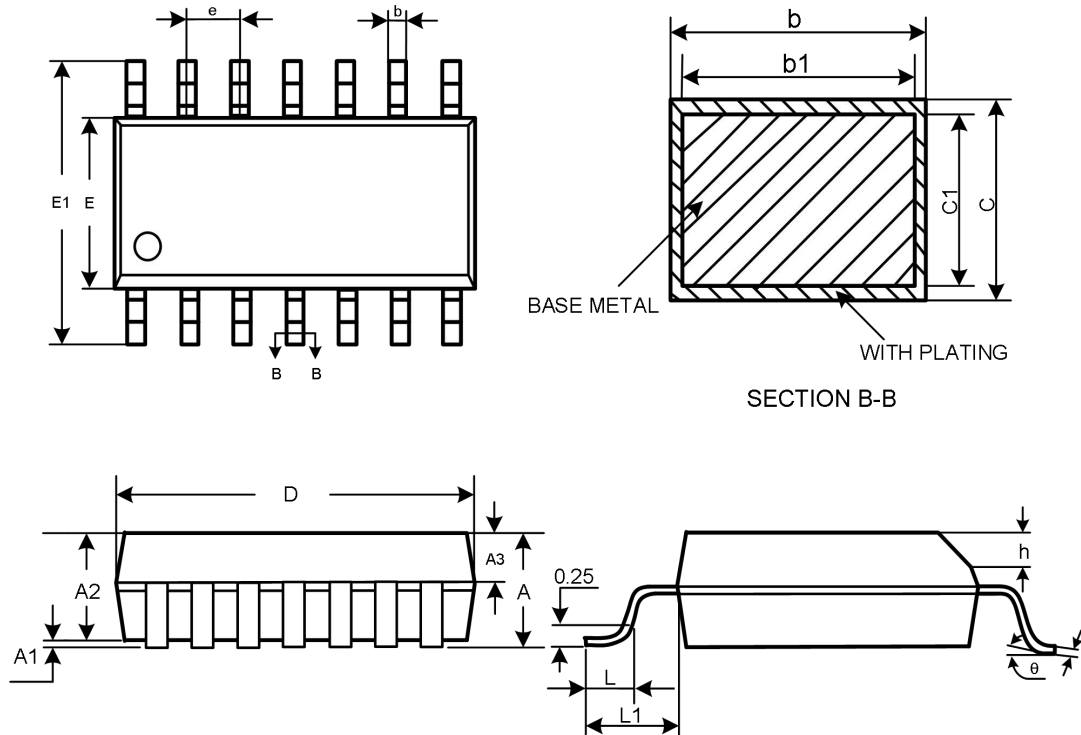


**11 Package Outline Dimension(continued)**
**SOP8**


| Symbol | Dimensions in Millimeters |      |       | Dimensions in Inches |       |       |
|--------|---------------------------|------|-------|----------------------|-------|-------|
|        | Min.                      | Nom. | Max.  | Min.                 | Nom.  | Max.  |
| A      | —                         | —    | 1.75  | —                    | —     | 0.069 |
| A1     | 0.10                      | —    | 0.225 | 0.004                | —     | 0.009 |
| A2     | 1.30                      | 1.40 | 1.50  | 0.051                | 0.055 | 0.059 |
| A3     | 0.60                      | 0.65 | 0.70  | 0.024                | 0.026 | 0.028 |
| b      | 0.39                      | —    | 0.47  | 0.015                | —     | 0.019 |
| b1     | 0.38                      | 0.41 | 0.44  | 0.015                | 0.016 | 0.017 |
| c      | 0.20                      | —    | 0.21  | 0.008                | —     | 0.008 |
| c1     | 4.80                      | 4.90 | 5.00  | 0.189                | 0.193 | 0.197 |
| D      | 5.80                      | 6.00 | 6.20  | 0.228                | 0.236 | 0.244 |
| E      | 5.80                      | 6.00 | 6.20  | 0.228                | 0.236 | 0.244 |
| E1     | 3.80                      | 3.90 | 4.00  | 0.150                | 0.154 | 0.157 |
| e      | 1.27BSC                   |      |       | 0.05BSC              |       |       |
| h      | 0.25                      | —    | 0.50  | 0.010                | —     | 0.020 |
| L      | 0.50                      | —    | 0.80  | 0.020                | —     | 0.031 |
| L1     | 1.05REF                   |      |       | 0.041REF             |       |       |
| theta  | 0                         | —    | 8°    | 0                    | —     | 8°    |

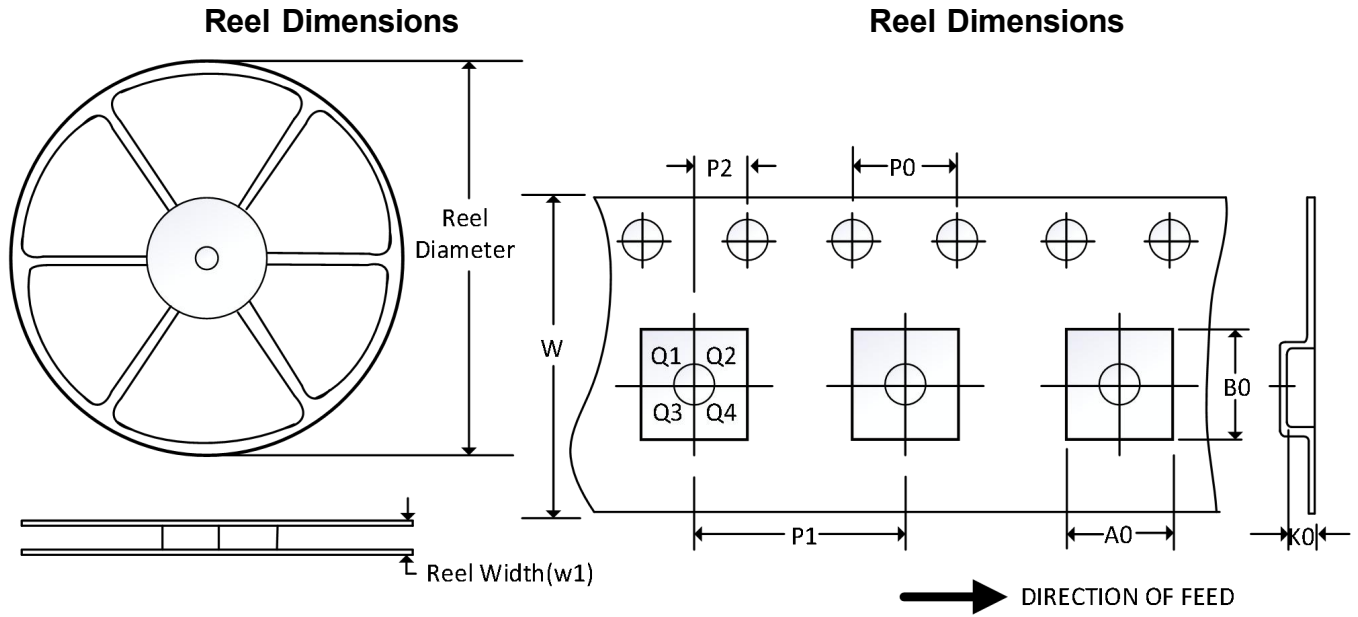
**11 Package Outline Dimension(continued)**
**TSSOP14**


| SYMBOL | Dimensions in Millimeters |      |      | Dimensions in Inches |       |       |
|--------|---------------------------|------|------|----------------------|-------|-------|
|        | Min.                      | Nom. | Max. | Min.                 | Nom.  | Max.  |
| A      | —                         | —    | 1.20 | —                    | —     | 0.047 |
| A1     | 0.05                      | —    | 0.15 | 0.002                | —     | 0.006 |
| A2     | 0.90                      | 1.00 | 1.05 | 0.035                | 0.039 | 0.041 |
| A3     | 0.39                      | 0.44 | 0.49 | 0.015                | 0.017 | 0.019 |
| b      | 0.20                      | —    | 0.28 | 0.008                | —     | 0.011 |
| b1     | 0.19                      | 0.22 | 0.25 | 0.007                | 0.009 | 0.010 |
| c      | 0.13                      | —    | 0.17 | 0.005                | —     | 0.007 |
| c1     | 0.12                      | 0.13 | 0.14 | 0.005                | 0.005 | 0.006 |
| D      | 4.90                      | 5.00 | 5.10 | 0.193                | 0.197 | 0.201 |
| E1     | 4.30                      | 4.40 | 4.50 | 0.169                | 0.173 | 0.177 |
| E      | 6.20                      | 6.40 | 6.60 | 0.244                | 0.252 | 0.260 |
| e      | 0.65BSC                   |      |      | 0.026BSC             |       |       |
| L      | 0.45                      | 0.60 | 0.75 | 0.018                | 0.024 | 0.030 |
| L1     | 1.00BCS                   |      |      | 0.039BSC             |       |       |
| θ      | 0                         | —    | 8°   | 0                    | —     | 8°    |

**11 Package Outline Dimension(continued)**
**SOP14**


| SYMBOL | Dimensions in Millimeters |      |       | Dimensions in Inches |       |       |
|--------|---------------------------|------|-------|----------------------|-------|-------|
|        | Min.                      | Nom. | Max.  | Min.                 | Nom.  | Max.  |
| A      | —                         | —    | 1.75  | —                    | —     | 0.069 |
| A1     | 0.10                      | —    | 0.225 | 0.004                | —     | 0.009 |
| A2     | 1.30                      | 1.40 | 1.50  | 0.051                | 0.055 | 0.059 |
| A3     | 0.60                      | 0.65 | 0.70  | 0.024                | 0.026 | 0.028 |
| b      | 0.39                      | —    | 0.47  | 0.015                | —     | 0.019 |
| b1     | 0.38                      | 0.41 | 0.44  | 0.015                | 0.016 | 0.017 |
| c      | 0.20                      | —    | 0.24  | 0.20                 | —     | 0.24  |
| c1     | 0.19                      | 0.20 | 0.21  | 0.007                | 0.008 | 0.008 |
| D      | 8.55                      | 8.65 | 8.75  | 0.337                | 0.341 | 0.344 |
| E      | 5.80                      | 6.00 | 6.20  | 0.228                | 0.236 | 0.244 |
| E1     | 3.80                      | 3.90 | 4.00  | 0.150                | 0.154 | 0.157 |
| e      | 1.27BSC                   |      |       | 0.05BSC              |       |       |
| h      | 0.25                      | —    | 0.50  | 0.010                | —     | 0.020 |
| L      | 0.50                      | —    | 0.80  | 0.020                | —     | 0.031 |
| L1     | 1.05REF                   |      |       | 0.041REF             |       |       |
| θ      | 0                         | —    | 8°    | 0                    | —     | 8°    |

## 12 Tape and Reel Information



NOTE: The picture is only for reference. Please make the object as the standard.

### Key Parameter List of Tape and Reel

| Package Type    | Reel Diameter | Reel Width (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P0 (mm) | P1 (mm) | P2 (mm) | W (mm) | Pin1 Quadrant |
|-----------------|---------------|-----------------|---------|---------|---------|---------|---------|---------|--------|---------------|
| SC70-5          | 7"            | 9.5             | 2.25    | 2.55    | 1.20    | 4.0     | 4.0     | 2.0     | 8.0    | Q3            |
| SOT23-5         | 7"            | 9.5             | 3.20    | 3.20    | 1.40    | 4.0     | 4.0     | 2.0     | 8.0    | Q3            |
| DFN2*2-8L       | 7"            | 9.5             | 2.30    | 2.30    | 1.10    | 4.0     | 4.0     | 2.0     | 8.0    | Q2            |
| DFN3*3-8L       | 13"           | 12.4            | 3.35    | 3.35    | 1.13    | 4.0     | 8.0     | 2.0     | 12.0   | Q1            |
| MSOP8           | 13"           | 12.4            | 5.20    | 3.30    | 1.50    | 4.0     | 8.0     | 2.0     | 12.0   | Q1            |
| TSSOP8          | 13"           | 12.4            | 6.90    | 3.45    | 1.65    | 4.0     | 8.0     | 2.0     | 12.0   | Q1            |
| SOIC-8 (SOP8)   | 13"           | 12.4            | 6.40    | 5.40    | 2.10    | 4.0     | 8.0     | 2.0     | 12.0   | Q1            |
| TSSOP-14        | 13"           | 12.4            | 6.95    | 5.60    | 1.20    | 4.0     | 8.0     | 2.0     | 12.0   | Q1            |
| SOIC-14 (SOP14) | 13"           | 16.4            | 6.60    | 9.30    | 2.10    | 4.0     | 8.0     | 2.0     | 16.0   | Q1            |

NOTE:

1. All dimensions are nominal.
2. Plastic or metal protrusions of 0.15mm maximum per side are not included.