## Features

- Supply Voltage: 2.5V to 6.0V
- Low Supply Current: typical 600μA per channel
- Rail to Rail Input and Output
- Bandwidth: typical 6 MHz
- Slew Rate: typical 4.5V/μs
- Excellent EMI Suppress Performance
- Offset Voltage: maximum ±3mV
- Offset Voltage Temperature Drift: typical 1 μV/°C
- Low Noise: typical 19 nV/√Hz at 1kHz
- High Output Capability: typical 100mA
- –40°C to 125°C Operation Temperature Range
- Green, Popular Type Package

## Applications

- White Goods
- Motor Control

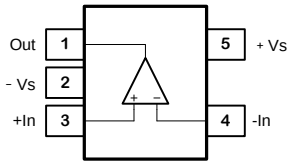
## Description

The TP156XAL1 series are CMOS dual, and quad RRIO op-amps with low offset, low power and stable high frequency response. They incorporate 3PEAK's proprietary and patented design techniques to achieve very good AC performance with 6MHz bandwidth, 4.5V/μs slew rate and low distortion while drawing only 600μA of quiescent current per amplifier. The input common-mode voltage range extends 300mV beyond V– and V+, and the outputs swing rail-to-rail. The TP156XAL1 family can be used as plug-in replacements for many commercially available op-amps to reduce power and improve input/output range and performance.

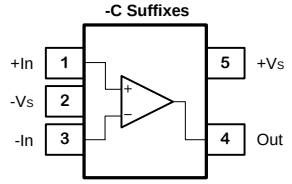
The combination of features makes the TP156XAL1 ideal choices for motor control and portable audio amplification, sound ports, and other consumer Audio. The TP156XAL1 Op-amp is very stable, and it is capable of driving heavy capacitive loads such as those found in LCDs. The ability to swing rail-to-rail at the inputs and outputs enables designers to buffer CMOS DACs, ASICs, or other wide output swing devices in single-supply systems.

## Pin Configuration

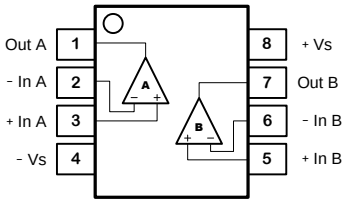
**TP1561AL1**
**5-Pin SOT23/SC70**
**-T and -C Suffixes**



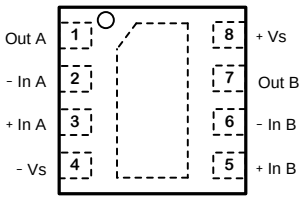

**TP1561AUL1**
**5-Pin SC70**
**-C Suffixes**



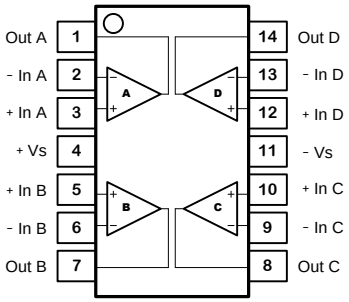

**TP1562AL1**
**8-Pin SOIC/TSSOP/MSOP**
**-S, -T and -V Suffixes**




**TP1562AL1**
**8-Pin DFN 2*2**
**(-F Suffix)**




**TP1564AL1**
**14-Pin SOIC/TSSOP**
**-S and -T Suffixes**




The thermal pad of DFN package is recommended to be left float or connected to -Vs

# Table of Contents

## Revision History

| Date | Revision | Notes |
|---|---|---|
| 2017/3/1 | Rev.Pre | Pre-Release Version |
| 2017/7/5 | Rev.0 | Release Version, confirm spec limit |
| 2017/10/28 | Rev.0.01 | TP1564AL1-TR sample is ready. TP1562AL1-VR(MSL1) sample is ready.<br>Correct the max of Common-mode Input Voltage Range in Electrical Characteristics from (V+) - 0.1 to (V+) + 0.1.<br>Correct Operating Temperature Range in Maximum Ratings from –45 to 125°C to –40 to 125°C. |
| 2017/12/26 | Rev.0.02 | Correct mark information of TP1562AL1-VR: XXXX change to XXXXL |
| 2018/5/30 | Rev.0.03 | Updated ESD condition to JS001/002 |
| 2018/8/30 | Rev.A | Updated full temperature spec, update Vos spec at 5V Vcm |
| 2019/2/25 | Rev.A01 | Added New Part: TP1562AL1-FR<br>Added Spec: Ib: min and max at 25°C and 125°C; open loop SR: min at 25°C, 85°C and 125°C<br>Updated Package Outline Dimensions to newest factory data. |
| 2020/5/26 | Rev.A.2 | Updated MSL of TP1564AL1-TR: MSL1 -> MSL 3 |
| 2021/11/15 | Rev.A.3 | Added New Part: TP1561AUL1-CR |
| 2021/11/18 | Rev.A.4 | Update MSL Level of TP1561AUL1-CR: “Pending” -> “3” |
| 2022/4/21 | Rev.A.5 | Updated Package Outline Dimensions of DFN-8 2*2. |
| 2023/5/23 | Rev.A.6 | The following updates are all about the new datasheet formats or typo, the actual product remains unchanged.<br>Updated to new format of package dimensions and tape and reel information.<br>Added typical value of Vos.<br>Updated address of web site. |

## Order Information

| Order Number | Operating Temperature Range | Package | Marking Information | MSL | Transport Media, Quantity |
|---|---|---|---|---|---|
| TP1561AL1-TR | -40 to 125°C | SOT23-5 | 61LXX | 1 | Tape and Reel, 3000 |
| TP1561AL1-CR Note 1 | -40 to 125°C | SOT353 (SC70-5) | 61LXX | 1 | Tape and Reel, 3000 |
| TP1561AUL1-CR | -40 to 125°C | SOT353 (SC70-5) | 61UXX | 3 | Tape and Reel, 3000 |
| TP1562AL1-SR | -40 to 125°C | SOP8 | 1562A<br>XXXXL | 1 | Tape and Reel, 4000 |
| TP1562AL1-TSR | -40 to 125°C | TSSOP8 | 1562A<br>XXXXL | 1 | Tape and Reel, 3000 |
| TP1562AL1-VR | -40 to 125°C | MSOP8 | 1562A<br>XXXXL | 1 | Tape and Reel, 3000 |
| TP1562AL1-FR | -40 to 125°C | DFN2X2-8 | 562<br>XXXXL | 1 | Tape and Reel, 3000 |
| TP1564AL1-SR | -40 to 125°C | SOP14 | 1564A<br>XXXXL | 1 | Tape and Reel, 2500 |
| TP1564AL1-TR | -40 to 125°C | TSSOP14 | 1564A<br>XXXXL | 3 | Tape and Reel, 3000 |

Note 1: The part will be in mass production in 3 months after manufacture start.

## Absolute Maximum Ratings Note 1

| Parameters | Rating |
|---|---|
| Supply Voltage, $(+V_S)$– $(-V_S)$ | 7 V |
| Voltage on Input/ Output Pin | $(-V_S)$ – 0.3 to $(+V_S)$ + 0.3 |
| Differential Input Voltage | $(-V_S)$ – $(+V_S)$ to $(+V_S)$ – $(-V_S)$ |
| Input Current: +IN, –IN Note 2 | ±10mA |
| Output Short-Circuit Duration Note 3 | Infinite |
| Maximum Junction Temperature | 150°C |
| Operating Temperature Range | –40 to 125°C |
| Storage Temperature Range | –65 to 150°C |
| Lead Temperature (Soldering, 10 sec) | 260°C |

Note 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.

Note 2: The inputs are protected by ESD protection diodes to each power supply. If the input extends more than 300mV beyond the power supply, the input current should be limited to less than 10mA.

Note 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 Rating

| Symbol | Parameter | Condition | Minimum Level | Unit |
|---|---|---|---|---|
| HBM | Human Body Model ESD | ANSI/ESDA/JEDEC JS-001, TP1561AUL1-CR | 6 | kV |
| | | ANSI/ESDA/JEDEC JS-001, All product except TP1561AUL1-CR | 8 | kV |
| CDM | Charged Device Model ESD | ANSI/ESDA/JEDEC JS-002 | 2 | kV |

## Thermal Information

| Package Type | $\theta_{JA}$ | $\theta_{JC}$ | Unit |
|---|---|---|---|
| 5-Pin SC70 | 400 | 210 | °C/W |
| 5-Pin SOT23 | 250 | 81 | °C/W |
| 8-Pin SOIC | 158 | 43 | °C/W |
| 8-Pin TSSOP | 191 | 44 | °C/W |
| 8-Pin MSOP | 210 | 45 | °C/W |
| 8-Pin DFN 2*2 | 100 | 60 | °C/W |
| 14-Pin SOIC | 120 | 36 | °C/W |
| 14-Pin TSSOP | 180 | 35 | °C/W |

## Electrical Characteristics

**All test condition is $V_S$ = 5V, $T_A$ = 25°C, $R_L$ = 2kΩ, $C_L$ =100pF, unless otherwise noted.**

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Power Supply | | | | | | |
| $V_S$ | Supply Voltage Range | | 2.5 | | 6 | V |
| $I_Q$ | Quiescent Current per Amplifier | | | 600 | 900 | μA |
| | | $T_A$ = -40 to 125°C | | | 1000 | μA |
| PSRR | Power Supply Rejection Ratio | | 75 | 90 | | dB |
| Input Characteristics | | | | | | |
| $V_{OS}$ | Input Offset Voltage | $V_{CM}$ = 0V to 3V | -3 | ±1 | 3 | mV |
| $V_{OS}$ | Input Offset Voltage | $V_{CM}$ = 0V to 3V, $T_A$ = -40 to 125°C | -4 | | 4 | mV |
| $V_{OS}$ TC | Input Offset Voltage Drift | $T_A$ = -40 to 125°C | | 1 | | μV/°C |
| $I_B$ | Input Bias Current | $T_A$ = 25 °C | -200 | 1 | 200 | pA |
| | | $T_A$ = 125 °C | -500 | 25 | 500 | pA |
| $I_{OS}$ | Input Offset Current | | | 1 | | pA |
| $R_{IN}$ | Input Impendence | | | $10^{12}$ | | Ω |
| $C_{IN}$ | Input Capacitance | Differential Mode | | 8 | | pF |
| | | Common Mode | | 7 | | pF |
| Av | Open-loop Voltage Gain | $R_{LOAD}$ = 10kΩ | 80 | 100 | | dB |
| $V_{CMR}$ | Common-mode Input Voltage Range | | (V-) - 0.1 | | (V+) + 0.1 | V |
| CMRR | Common Mode Rejection Ratio | $V_{CM}$ = 0V to 2.5V | 70 | 100 | | dB |
| Xtalk | Channel Separation | f = 1kHz, RL = 2kΩ | | 110 | | dB |
| Output Characteristics | | | | | | |
| $V_{OH}$, $V_{OL}$ | Maximum Output Voltage Swing | $R_{LOAD}$ = 10kΩ | | 3 | 15 | mV |
| | | $R_{LOAD}$ = 10kΩ, $T_A$ = -40 to 125°C | | | 20 | mV |
| $I_{SC}$ | Output Short-Circuit Current | | 90 | 100 | | mA |
| | | $T_A$ = -40 to 85°C | 75 | | | mA |
| | | $T_A$ = -40 to 125°C | 65 | | | mA |
| AC Specifications | | | | | | |
| GBW | Gain-Bandwidth Product | | | 6 | | MHz |
| SR | Slew Rate | $A_V$ = 1, $V_{OUT}$ = 1.5V to 3.5V, $C_{LOAD}$ = 60pF, $R_{LOAD}$ = 1kΩ | | 4.5 | | V/μs |
| SR | Slew Rate, Open Loop | Open Loop | 3 | 4.5 | | V/μs |
| | | Open Loop, $T_A$ = -40 to 85°C | 2.3 | | | V/μs |
| | | Open Loop, $T_A$ = -40 to 125°C | 2 | | | V/μs |
| $t_S$ | Settling Time, 0.1% | AV = 1, 2V Step, $C_{LOAD}$ = 60pF, $R_{LOAD}$ = 1kΩ | | 0.8 | | μs |
| | Settling Time, 0.01% | | | 1 | | μs |
| PM | Phase Margin | $R_{LOAD}$ = 1kΩ, $C_{LOAD}$ = 60pF | | 60 | | ° |
| GM | Gain Margin | $R_{LOAD}$ = 1kΩ, $C_{LOAD}$ = 60pF | | 15 | | dB |

| Noise Performance | | | | | | |
|---|---|---|---|---|---|---|
| $E_N$ | Input Voltage Noise | f = 0.1Hz to 10Hz | | 8 | | $\mu V_{PP}$ |
| $e_N$ | Input Voltage Noise Density | f = 1kHz | | 19 | | nV/√Hz |
| $i_N$ | Input Current Noise | f = 1kHz | | 2 | | fA/√Hz |
| THD+N | Total Harmonic Distortion and Noise | f = 1kHz, AV =1, RL = 2kΩ, VOUT = 1Vp-p | | 0.003 | | % |

## Typical Performance Characteristics

**$V_S$ = 5V, $V_{CM}$ = 2.5V, RL = Open, unless otherwise specified.**

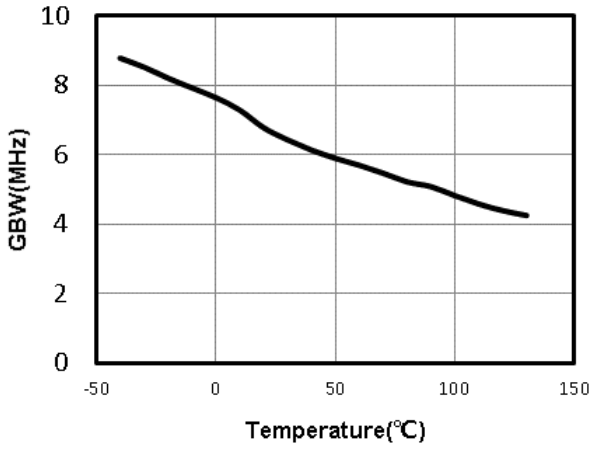



Figure 1. Unity Gain Bandwidth vs. Temperature

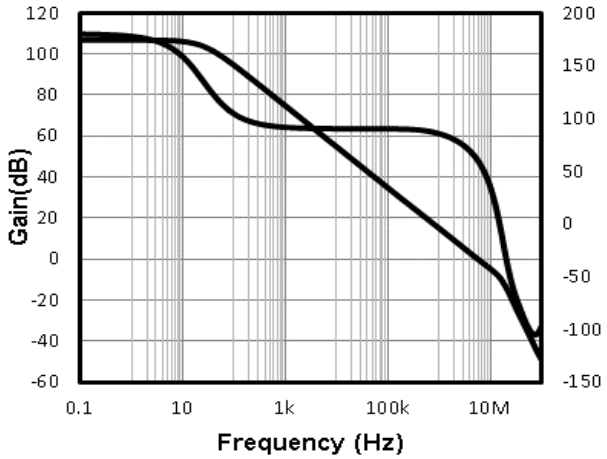



Figure 2. Open-Loop Gain and Phase

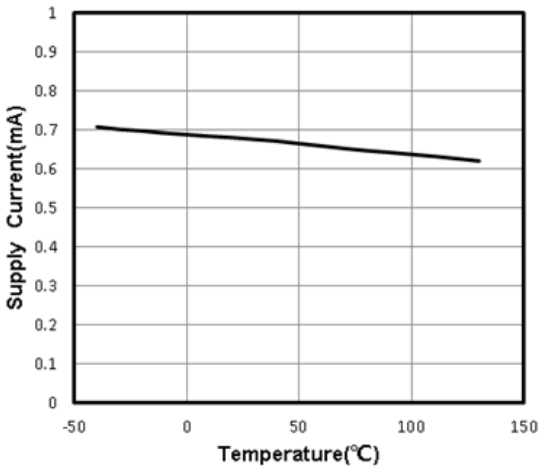



Figure 3. Supply Current vs. Temperature

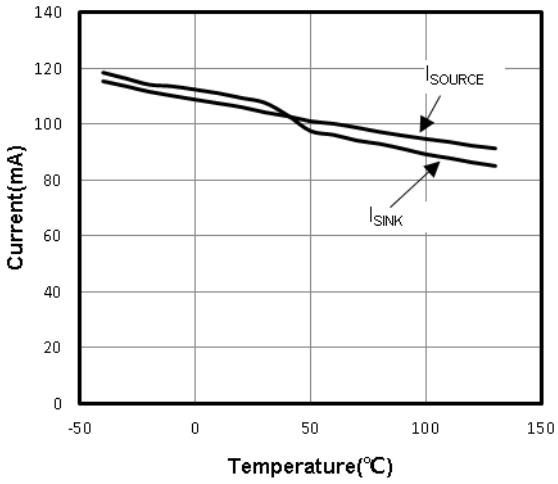



Figure 4. Short Circuit Current vs. Temperature

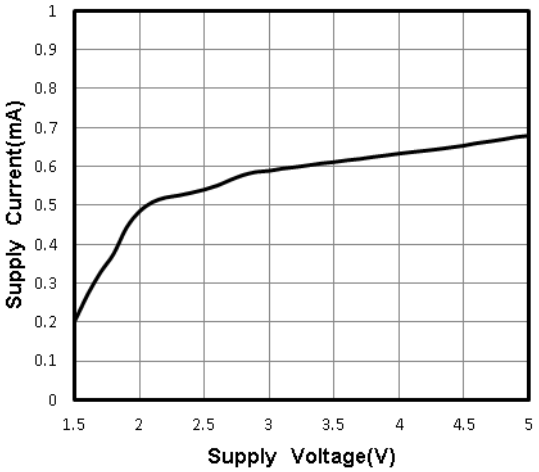



Figure 5. Quiescent Current vs. Supply Voltage

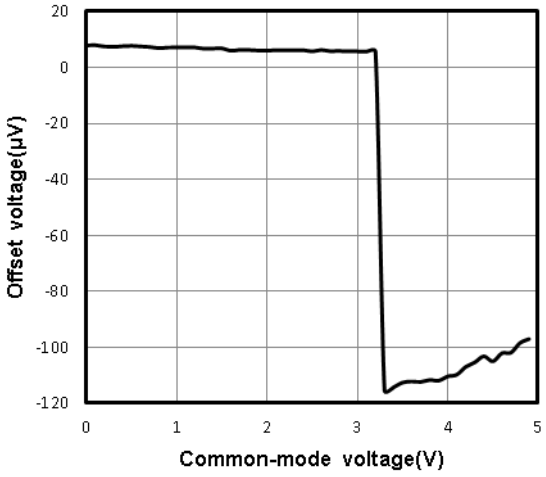



Figure 6. Offset Voltage vs. Common-Mode Voltage

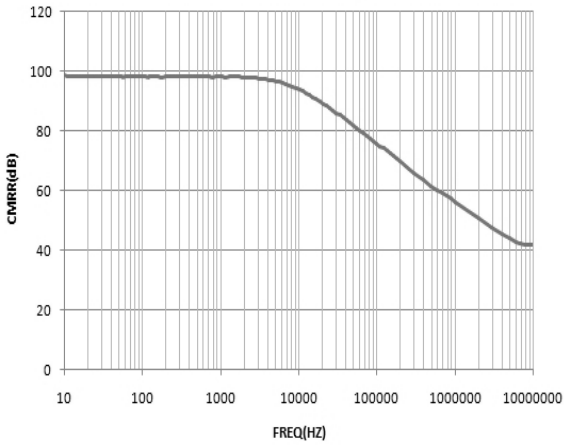



Figure 7. CMRR vs. Frequency

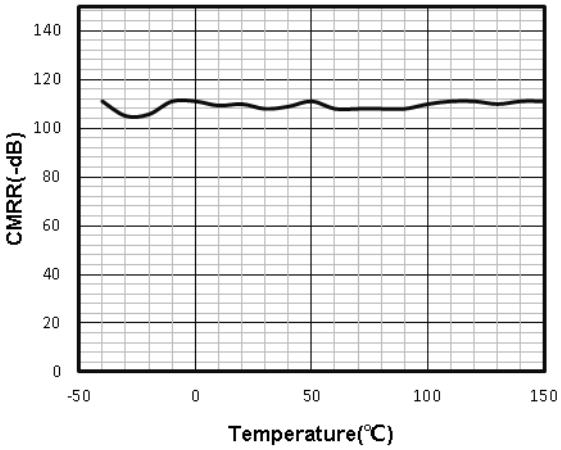



Figure 8. CMRR vs. Temperature

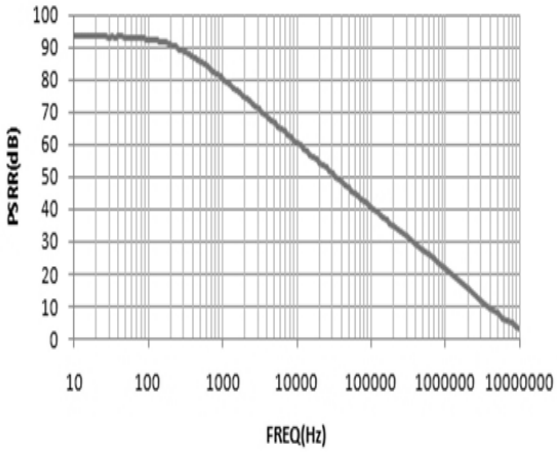



Figure 9. PSRR vs. Frequency

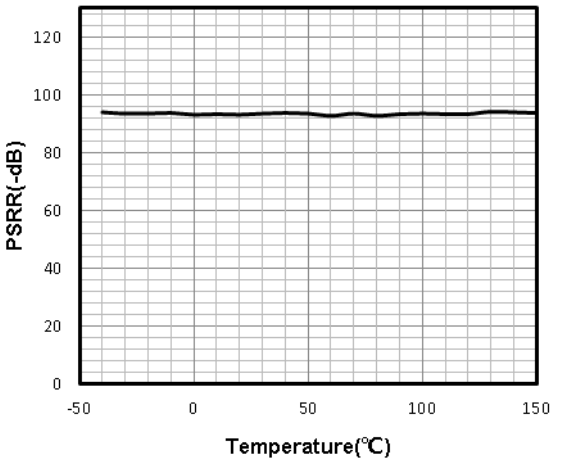



Figure 10. PSRR vs. Temperature

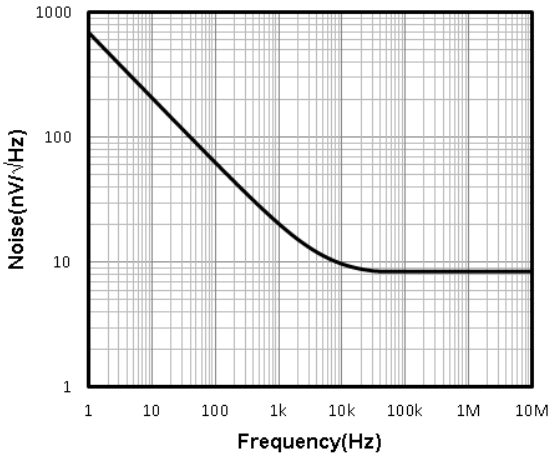



Figure 11. Input Voltage Noise Spectral Density

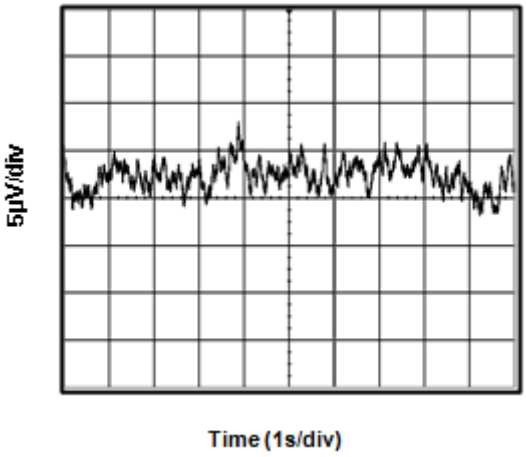



Figure 12. 0.1 Hz to 10 Hz Input Voltage Noise

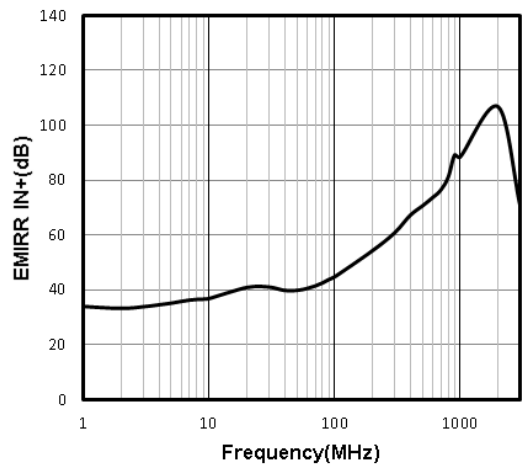



Figure 13. EMIRR IN+ vs. Frequency

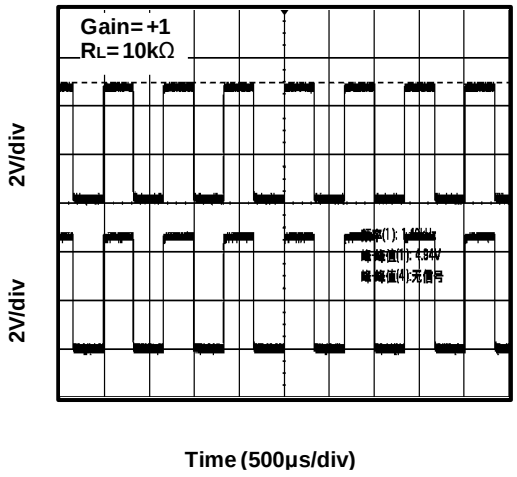



Figure 14. Large-Scale Step Response

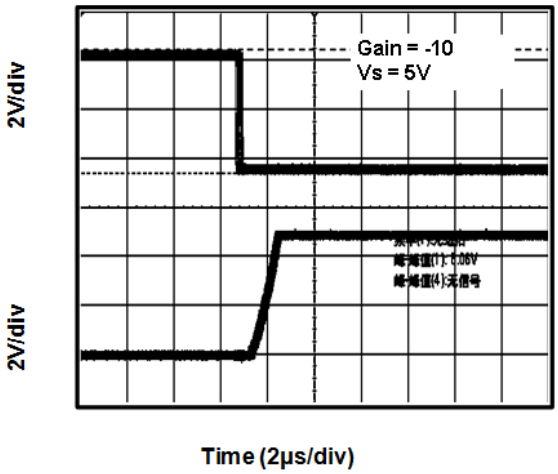



Figure 15. Negative Over-Voltage Recovery

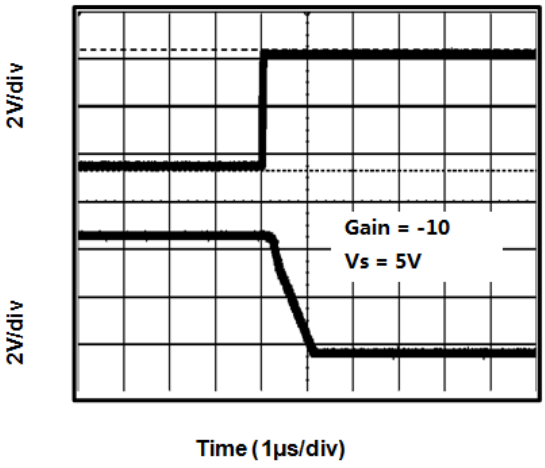



Figure 16. Positive Over-Voltage Recovery

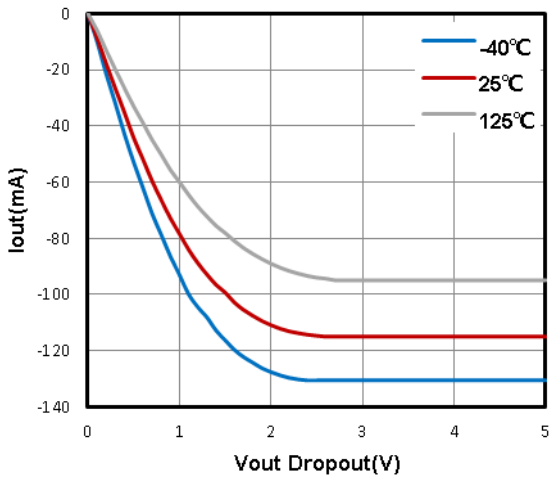



Figure 17. Negative Output Swing vs. Load Current

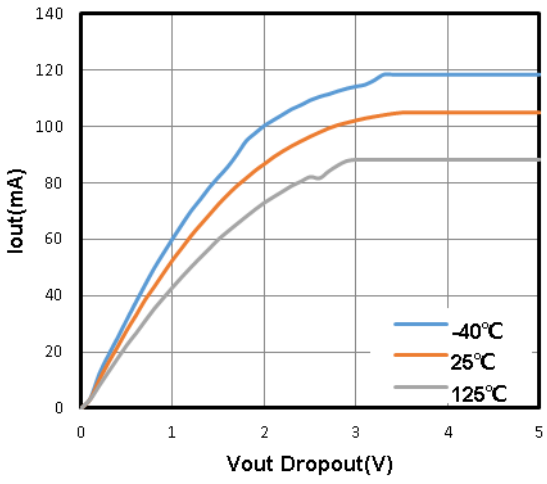



Figure 18. Positive Output Swing vs. Load Current

# Application Information

## Low Supply Voltage and Low Power Consumption

The TP156XAL1 family of operational amplifiers can operate with power supply voltages from 2.5 V to 6.0 V. Each amplifier draws only 600 μA quiescent current. The low supply voltage capability and low supply current are ideal for portable applications demanding high capacitive load driving capability and stable wide bandwidth. The TP156XAL1 family is optimized for wide bandwidth low power applications. They have an industry leading high GBWP to power ratio and are unity gain stable for any capacitive load. When the load capacitance increases, the increased capacitance at the output pushed the non-dominant pole to lower frequency in the open loop frequency response, lowering the phase and gain margin. Higher gain configurations tend to have better capacitive drive capability than lower gain configurations due to lower closed loop bandwidth and hence higher phase margin.

## Ground Sensing and Rail to Rail Output

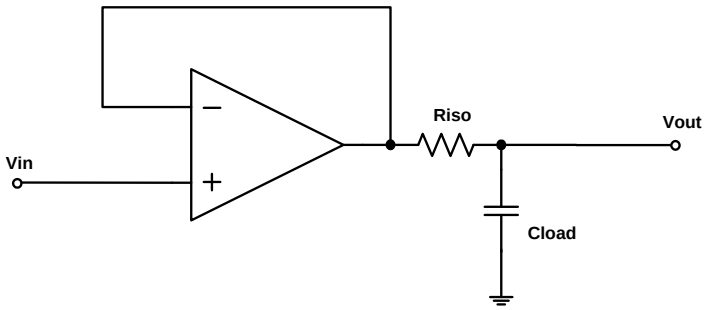
The TP156XAL1 family has excellent output drive capability, delivering over 100 mA of output drive current. The output stage is a rail-to-rail topology that is capable of swinging to within 10mV of either rail. Since the inputs can go 300 mV beyond either rail, the op-amp can easily perform ‘true ground’ sensing.

The maximum output current is a function of total supply voltage. As the supply voltage to the amplifier increases, the output current capability also increases. Attention must be paid to keep the junction temperature of the IC below 150°C when the output is in continuous short-circuit. The output of the amplifier has reverse-biased ESD diodes connected to each supply. The output should not be forced more than 0.5V beyond either supply, otherwise current will flow through these diodes.

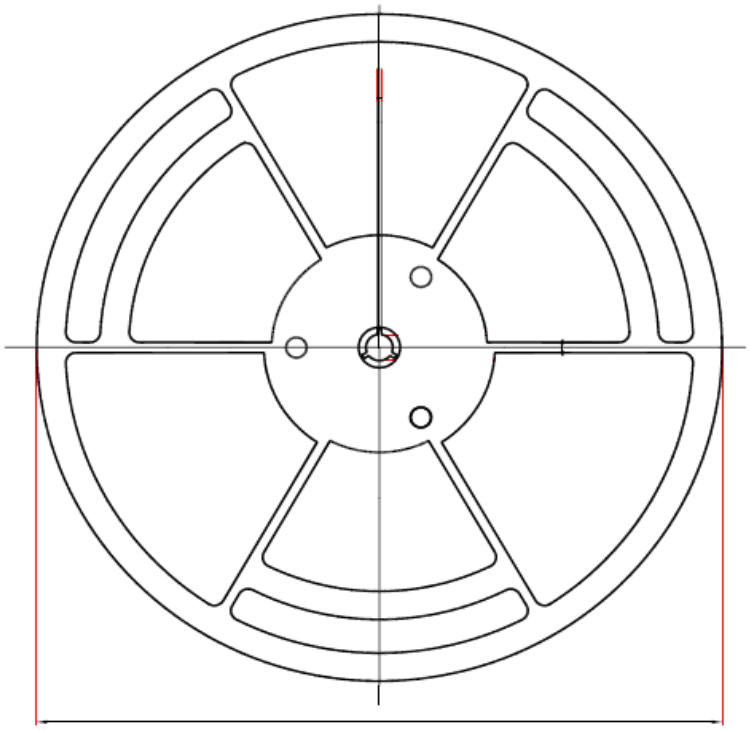
## Driving Large Capacitive Load

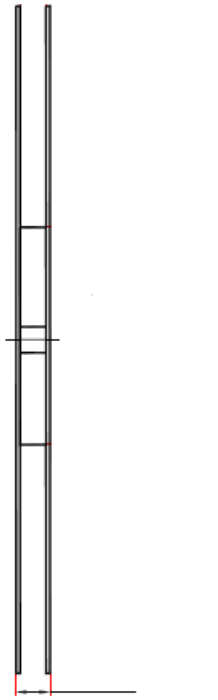
The TP156XAL1 family of OPA is designed to drive large capacitive loads. Refer to Typical Performance Characteristics for “Phase Margin vs. Load Capacitance”. As always, larger load capacitance decreases overall phase margin in a feedback system where internal frequency compensation is utilized. As the load capacitance increases, the feedback loop’s phase margin decreases, and the closed-loop bandwidth is reduced. This produces gain peaking in the frequency response, with overshoot and ringing in output step response. The unity-gain buffer (G = +1V/V) is the most sensitive to large capacitive loads.

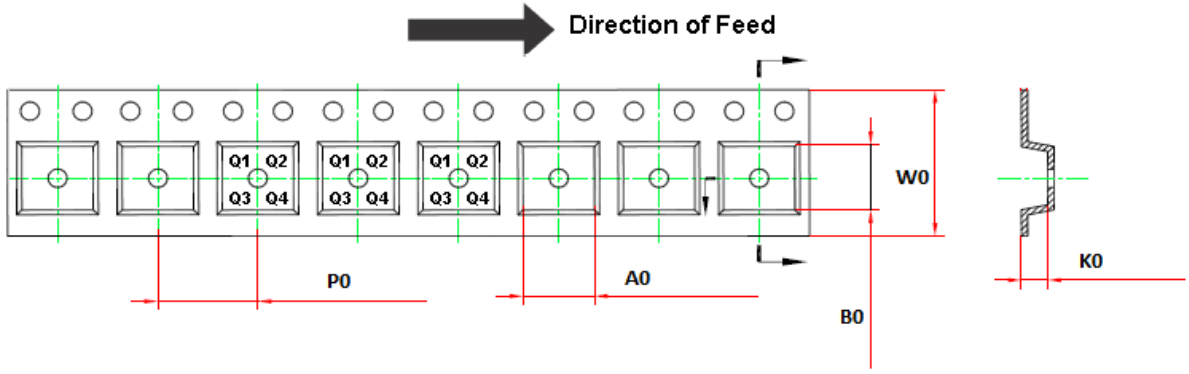
When driving large capacitive loads with the TP156XAL1 OPA family (e.g., > 200 pF when G = +1V/V), a small series resistor at the output (RISO in Figure 3) improves the feedback loop’s phase margin and stability by making the output load resistive at higher frequencies.



## Tape and Reel Information



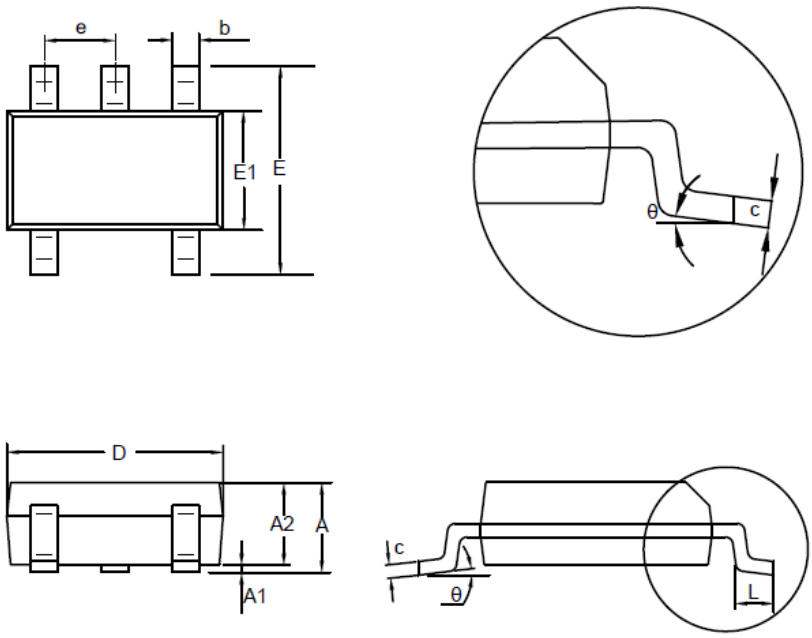




| Order Number | Package | D1 | W1 | A0 | B0 | K0 | P0 | W0 | Pin1 Quadrant |
|---|---|---|---|---|---|---|---|---|---|
| TP1561AL1-CR | SOT353 (SC70-5) | 178.0 | 12.3 | 2.4 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| TP1561AUL1-CR | SOT353 (SC70-5) | 178.0 | 12.3 | 2.4 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| TP1561AL1-TR | SOT23-5 | 179.0 | 12.1 | 3.3 | 3.25 | 1.4 | 4.0 | 8.0 | Q3 |
| TP1562AL1-SR | SOP8 | 330.0 | 17.6 | 6.5 | 5.4 | 2.0 | 8.0 | 12.0 | Q1 |
| TP1562AL1-VR | MSOP8 | 330.0 | 17.6 | 5.2 | 3.3 | 1.5 | 8.0 | 12.0 | Q1 |
| TP1562AL1-TSR | TSSOP8 | 330.0 | 17.6 | 6.8 | 3.3 | 1.7 | 8.0 | 12.0 | Q1 |
| TP1562AL1-FR | DFN2X2-8 | 180.0 | 13.1 | 2.3 | 2.3 | 1.1 | 4.0 | 8.0 | Q1 |
| TP1564AL1-SR | SOP14 | 330.0 | 21.6 | 6.5 | 9.1 | 1.8 | 8.0 | 16.0 | Q1 |
| TP1564AL1-TR | TSSOP14 | 330.0 | 17.6 | 6.8 | 5.5 | 1.6 | 8.0 | 12.0 | Q1 |

## Package Outline Dimensions

### SOT353 (SC70-5)

Package Outline Dimensions SC5(SOT353-5-A)



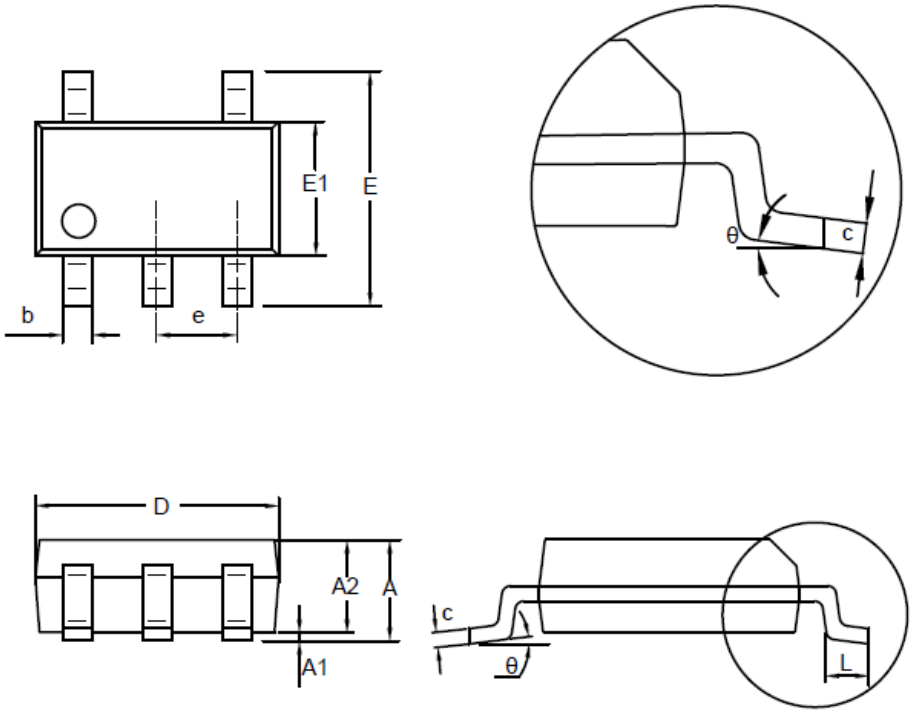

| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 0.850 | 1.100 | 0.033 | 0.043 |
| A1 | 0.000 | 0.100 | 0.000 | 0.004 |
| A2 | 0.800 | 1.000 | 0.031 | 0.039 |
| b | 0.150 | 0.350 | 0.006 | 0.014 |
| c | 0.110 | 0.230 | 0.004 | 0.009 |
| 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 |
| θ | 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-A)



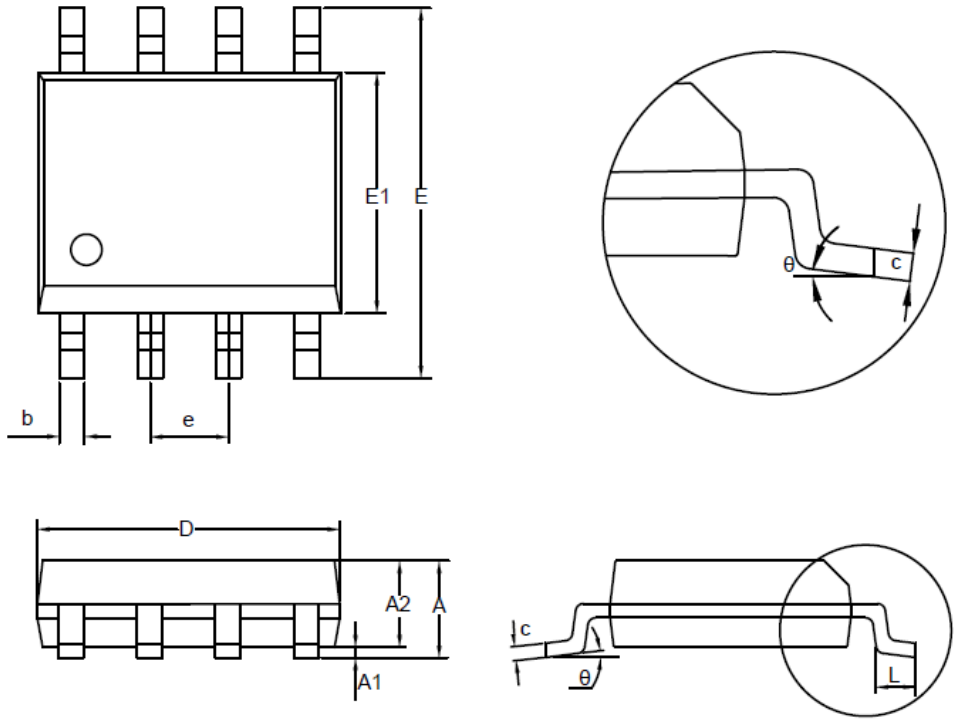

| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 1.050 | 1.250 | 0.041 | 0.049 |
| A1 | 0.000 | 0.150 | 0.000 | 0.006 |
| A2 | 1.000 | 1.200 | 0.039 | 0.047 |
| b | 0.280 | 0.500 | 0.011 | 0.020 |
| c | 0.100 | 0.230 | 0.004 | 0.009 |
| 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 |
| θ | 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)



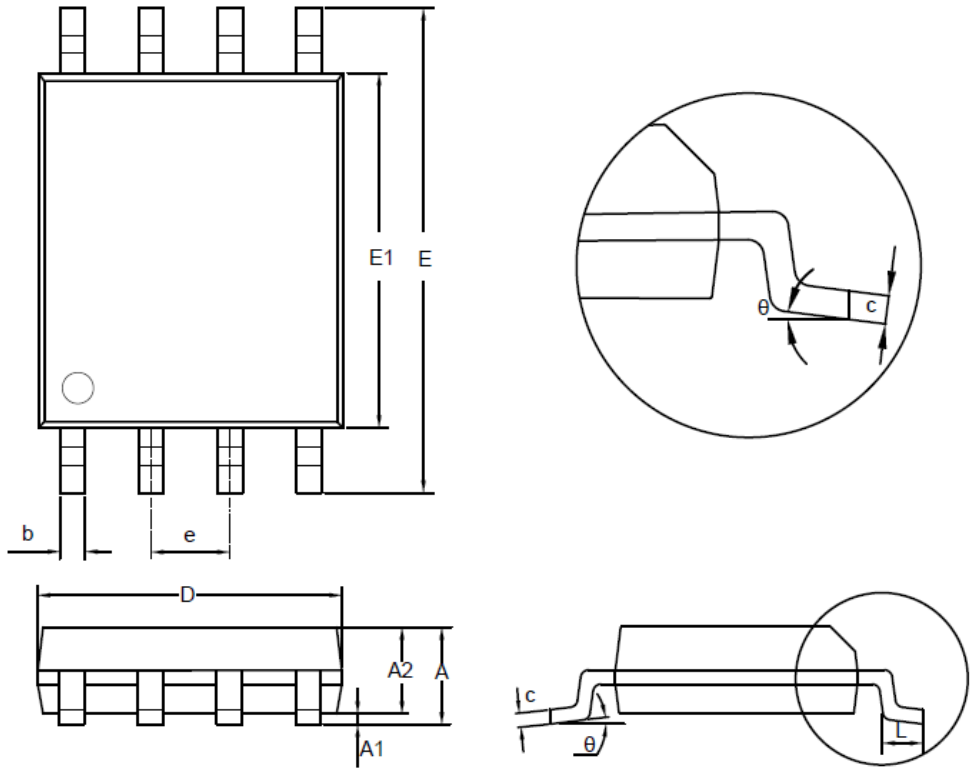

| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 1.350 | 1.750 | 0.053 | 0.069 |
| A1 | 0.050 | 0.250 | 0.002 | 0.010 |
| A2 | 1.250 | 1.550 | 0.049 | 0.061 |
| b | 0.330 | 0.510 | 0.013 | 0.020 |
| c | 0.170 | 0.250 | 0.007 | 0.010 |
| 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.

## TSSOP8

### Package Outline Dimensions TS1(TSSOP-8-A)



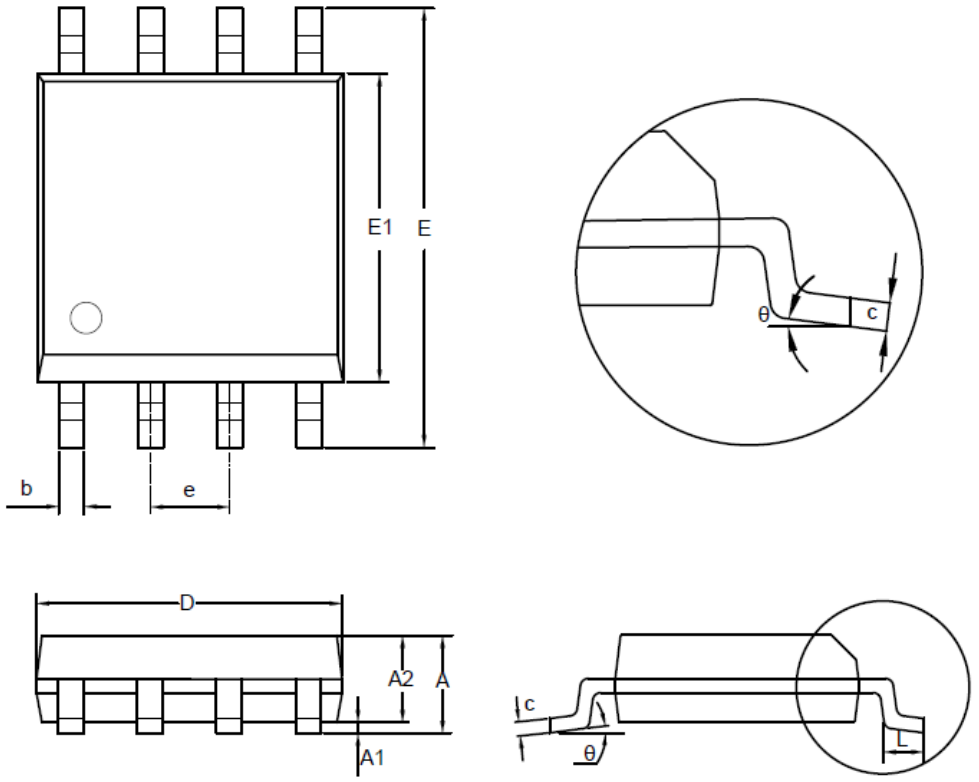

| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 0.900 | 1.200 | 0.035 | 0.047 |
| A1 | 0.050 | 0.150 | 0.002 | 0.006 |
| A2 | 0.800 | 1.050 | 0.031 | 0.041 |
| b | 0.190 | 0.300 | 0.007 | 0.012 |
| c | 0.090 | 0.200 | 0.004 | 0.008 |
| D | 2.900 | 3.100 | 0.114 | 0.122 |
| 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.

**MSOP8**

## Package Outline Dimensions VS1(MSOP-8-A)



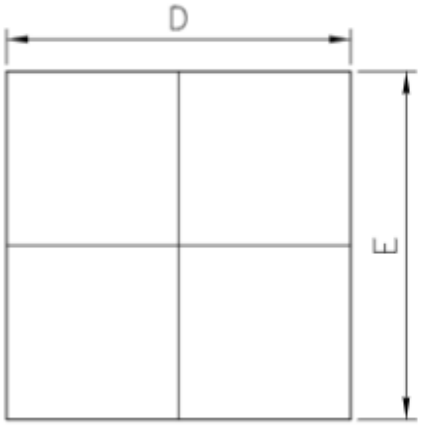

| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 0.800 | 1.100 | 0.031 | 0.043 |
| A1 | 0.050 | 0.150 | 0.002 | 0.006 |
| A2 | 0.750 | 0.950 | 0.030 | 0.037 |
| b | 0.250 | 0.380 | 0.010 | 0.015 |
| c | 0.090 | 0.230 | 0.004 | 0.009 |
| 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 |
| θ | 0 | 8° | 0 | 8° |

NOTES

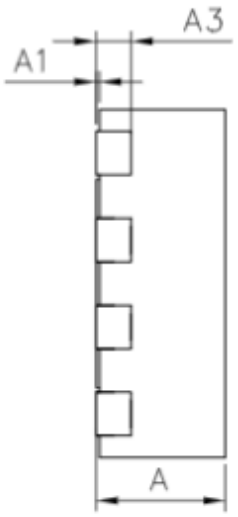
1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

**DFN2X2-8**

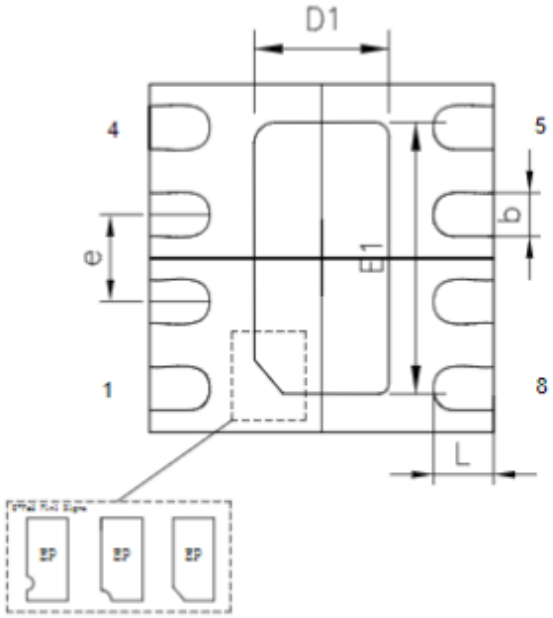
## Package Outline Dimensions DFG(DFN2X2-8-E)




Top View




Side View




Bottom View

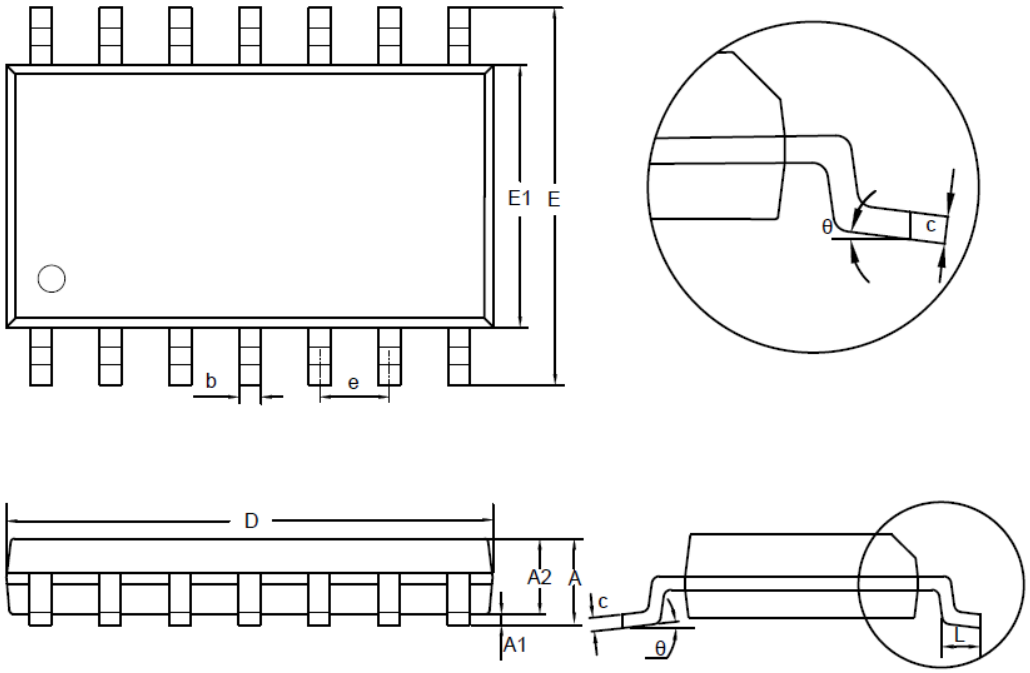
NOTES

1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.
3. The many types of E-pad Pin1 signs may appear in the product.

| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 0.500 | 0.600 | 0.020 | 0.024 |
| A1 | 0.000 | 0.050 | 0.000 | 0.002 |
| b | 0.150 | 0.300 | 0.006 | 0.012 |
| A3 | 0.100 | 0.200 | 0.004 | 0.008 |
| D | 1.900 | 2.100 | 0.075 | 0.083 |
| D1 | 0.800 | 1.000 | 0.031 | 0.039 |
| E | 1.900 | 2.100 | 0.075 | 0.083 |
| E1 | 1.600 | 1.800 | 0.063 | 0.071 |
| e | 0.500 BSC | | 0.020BSC | |
| L | 0.250 | 0.350 | 0.010 | 0.014 |

## SOP14

### Package Outline Dimensions SO2(SOP-14-A)



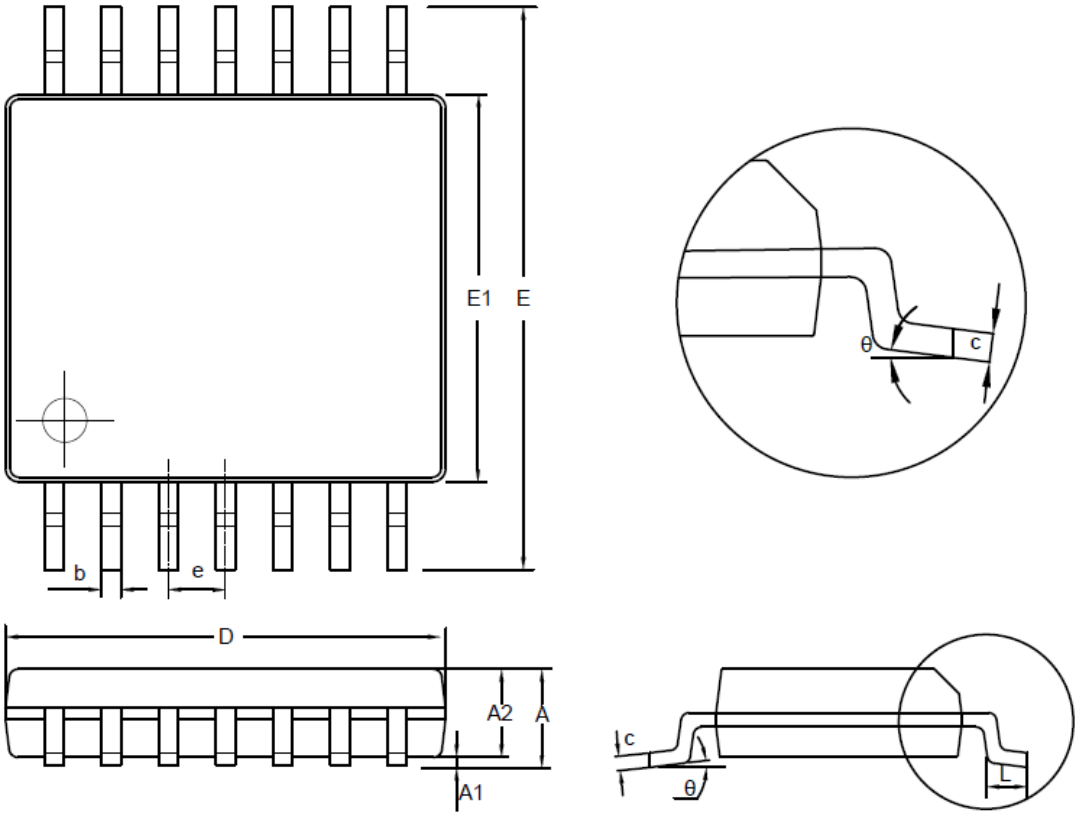

| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 1.350 | 1.750 | 0.053 | 0.069 |
| A1 | 0.050 | 0.250 | 0.002 | 0.010 |
| A2 | 1.250 | 1.650 | 0.049 | 0.065 |
| b | 0.310 | 0.510 | 0.012 | 0.020 |
| c | 0.100 | 0.250 | 0.004 | 0.010 |
| 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 |
| θ | 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 In Millimeters | | Dimensions 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.

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