

## Features

- Supply Voltage: 4.5 V to 36 V
- Offset Voltage: ±150 μV Maximum
- Differential Input Voltage Range to Supply Rail, can Work as Comparator
- Input Rail to –V<sub>S</sub>, Rail to Rail Output
- Bandwidth: 7 MHz
- Slew Rate: 20 V/μs
- Excellent EMI Suppress Performance: 45 dB at 1 GHz
- Over-Temperature Protection
- Low Noise: 25 nV/√Hz at 1kHz
- 4 kV HBM, 2 kV CDM, 400 mA Latch Up
- –40°C to 125°C Operation Temperature Range

## Applications

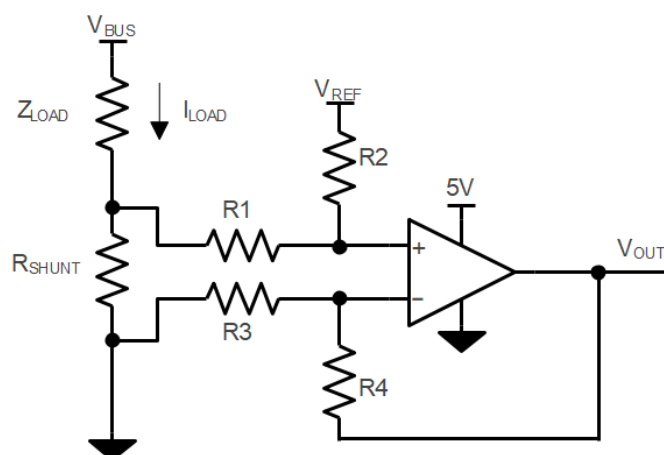
- Instrumentation
- Active Filters, ASIC Input or Output Amplifier
- Sensor Interface
- Motor Control
- Industrial Control

## Description

The TP128X family amplifiers are the newest high supply voltage amplifiers 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 7MHz bandwidth, 20 V/μs slew rate, and low distortion while drawing only 1600 μA of quiescent current per amplifier. The input common-mode voltage range extends to V<sub>–</sub>, and the outputs swing rail-to-rail. The TP128X 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 TP128X has an over-temperature protection feature to guarantee chip safety. The output of TP128X will enter high impedance when the die temperature reaches around 170°C and will recover the function when the die temperature is down to around 150°C.

## Typical Application Circuit



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

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

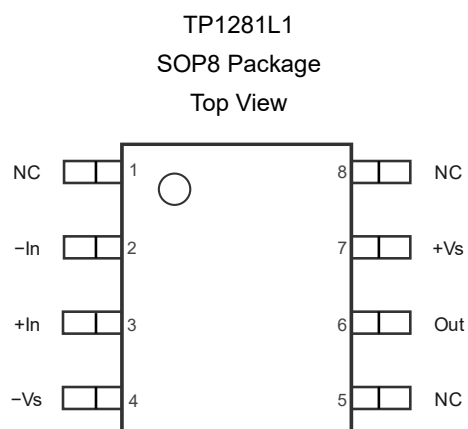
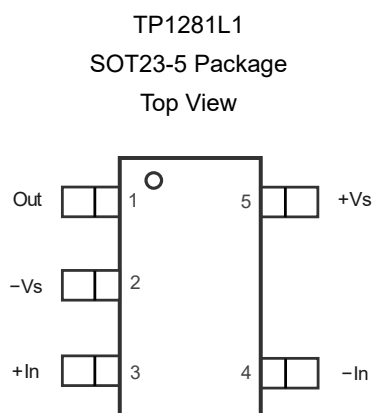
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## Revision History

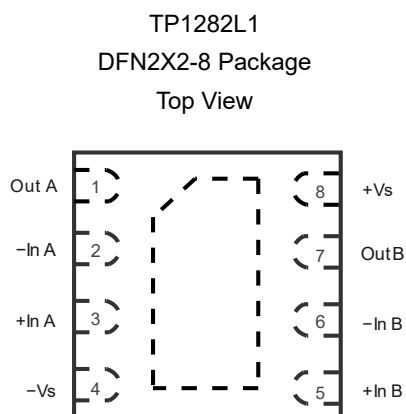
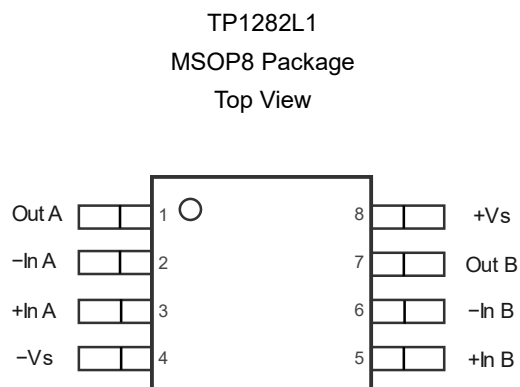
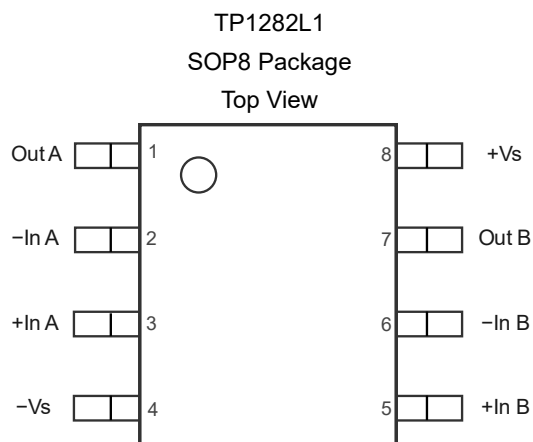
| Date       | Revision | Notes                              |
|------------|----------|------------------------------------|
| 2018/10/20 | Rev.0    | Initial Version                    |
| 2021/3/10  | Rev.A.0  | Added New Part Number: TP1284-TR   |
| 2022/4/29  | Rev.A.1  | Updated order information          |
| 2022/7/17  | Rev.A.2  | Removed TP1284L1-SR, Add TP1284-SR |

## Pin Configuration and Functions

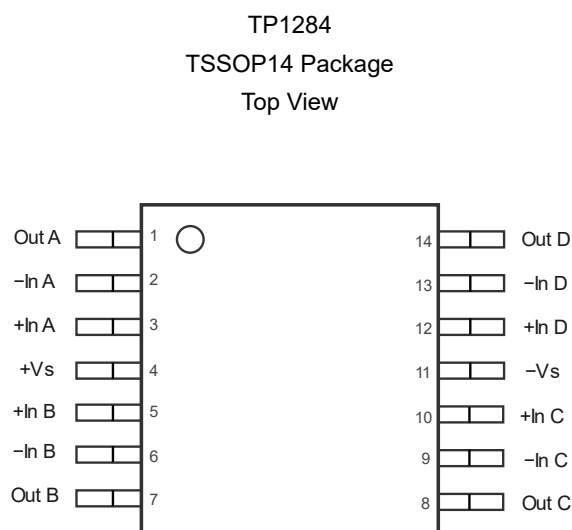
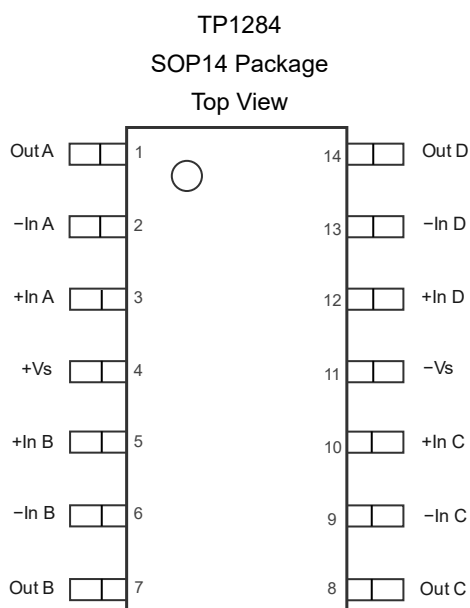


**Table 6-1. Pin Functions: TP1281L1**

| Pin     |      | Name | I/O    | Description           |
|---------|------|------|--------|-----------------------|
| SOT23-5 | SOP8 |      |        |                       |
| 1       | 6    | Out  | Output | Output                |
| 2       | 4    | -Vs  |        | Negative power supply |
| 3       | 3    | +In  | Input  | Noninverting input    |
| 4       | 2    | -In  | Input  | Inverting input       |
| 5       | 7    | +Vs  |        | Positive power supply |
|         | 1    | NC   |        | Not connected         |
|         | 5    | NC   |        | Not connected         |
|         | 8    | NC   |        | Not connected         |


**Table 6-2. Pin Functions: TP1281L1/TP1282L1**

| Pin | Name  | I/O    | Description           |
|-----|-------|--------|-----------------------|
| 1   | Out A | Output | Output                |
| 2   | -In A | Input  | Inverting input       |
| 3   | +In A | Input  | Noninverting input    |
| 4   | -Vs   |        | Negative power supply |
| 5   | +In B | Input  | Noninverting input    |
| 6   | -In B | Input  | Inverting input       |
| 7   | Out B | Output | Output                |
| 8   | +Vs   |        | Positive power supply |


**Table 6-3. Pin Functions: TP1284**

| Pin | Name  | I/O    | Description           |
|-----|-------|--------|-----------------------|
| 1   | Out A | Output | Output                |
| 2   | -In A | Input  | Inverting input       |
| 3   | +In A | Input  | Noninverting input    |
| 4   | +Vs   |        | Positive power supply |
| 5   | +In B | Input  | Noninverting input    |
| 6   | -In B | Input  | Inverting input       |
| 7   | Out B | Output | Output                |
| 8   | Out C | Output | Output                |
| 9   | -In C | Input  | Inverting input       |
| 10  | +In C | Input  | Noninverting input    |
| 11  | -Vs   |        | Negative power supply |
| 12  | +In D | Input  | Noninverting input    |
| 13  | -In D | Input  | Inverting input       |
| 14  | Out D | Output | Output                |

## Specifications

### Absolute Maximum Ratings<sup>(1)</sup>

|                  | Parameter                                                       | Min                                     | Max                                     | Unit |
|------------------|-----------------------------------------------------------------|-----------------------------------------|-----------------------------------------|------|
|                  | Supply Voltage: (+V <sub>S</sub> ) – (–V <sub>S</sub> )         |                                         | 40                                      | V    |
|                  | Input Voltage                                                   | (–V <sub>S</sub> ) – 0.3                | (+V <sub>S</sub> ) + 0.3                | V    |
|                  | Differential Input Voltage                                      | (–V <sub>S</sub> ) – (+V <sub>S</sub> ) | (+V <sub>S</sub> ) – (–V <sub>S</sub> ) | V    |
|                  | Input Current: +I <sub>N</sub> , –I <sub>N</sub> <sup>(2)</sup> | –10                                     | +10                                     | mA   |
|                  | 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 and outputs are protected by ESD protection diodes to negative power supply. If the input or output extends more than 500 mV beyond the negative power supply, the 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 comparators 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

| Symbol | Parameter                | Condition                             | Minimum Level | Unit |
|--------|--------------------------|---------------------------------------|---------------|------|
| HBM    | Human Body Model ESD     | ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup> | 4             | kV   |
| CDM    | Charged Device Model ESD | ANSI/ESDA/JEDEC JS-002 <sup>(2)</sup> | 2             | kV   |
| LU     | Latch Up                 | JESD 78, 25°C                         | 400           | mA   |
|        |                          | JESD 78, 125°C                        | 300           | mA   |

(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.

### Thermal Information

| Package Type | $\theta_{JA}$ | $\theta_{JC}$ | Unit |
|--------------|---------------|---------------|------|
| SOT23-5      | 250           | 81            | °C/W |
| SOP8         | 158           | 43            | °C/W |
| MSOP8        | 210           | 45            | °C/W |
| DFN2X2-8     | 100           | 60            | °C/W |
| SOP14        | 120           | 36            | °C/W |
| TSSOP14      | 180           | 35            | °C/W |

## Electrical Characteristics

All test condition is  $V_S = 30\text{ V}$ ,  $T_A = 25^\circ\text{C}$ ,  $R_L = 10\text{ k}\Omega$ , unless otherwise noted.

| Symbol                | Parameter                       | Conditions                                                     | T <sub>A</sub> | Min  | Typ  | Max | Unit  |
|-----------------------|---------------------------------|----------------------------------------------------------------|----------------|------|------|-----|-------|
| Power Supply          |                                 |                                                                |                |      |      |     |       |
| V <sub>S</sub>        | Supply Voltage Range            |                                                                |                | 4.5  |      | 36  | V     |
| I <sub>Q</sub>        | Quiescent Current per Amplifier | V <sub>S</sub> = 30 V, TP1281                                  |                |      | 1.5  | 2   | mA    |
|                       |                                 |                                                                | -40°C to 125°C |      |      | 3   | mA    |
|                       |                                 | V <sub>S</sub> = 30 V, TP1282/TP1284                           |                |      | 1    | 1.6 | mA    |
|                       |                                 |                                                                | -40°C to 125°C |      |      | 2.5 | mA    |
| PSRR                  | Power Supply Rejection Ratio    | V <sub>S</sub> = 4.5 V to 36 V                                 |                | 105  | 130  |     | dB    |
|                       |                                 |                                                                | -40°C to 125°C | 100  |      |     | dB    |
| Input Characteristics |                                 |                                                                |                |      |      |     |       |
| V <sub>OS</sub>       | Input Offset Voltage            | V <sub>S</sub> = 30 V, V <sub>CM</sub> = 15 V, TP1281/TP1282   |                | -100 | 50   | 100 | μV    |
|                       |                                 |                                                                | -40°C to 85°C  | -400 |      | 400 | μV    |
|                       |                                 |                                                                | -40°C to 125°C | -600 |      | 600 | μV    |
|                       |                                 | V <sub>S</sub> = 25 V, V <sub>CM</sub> = 12.5 V, TP1281/TP1282 |                | -100 | 50   | 100 | μV    |
|                       |                                 |                                                                | -40°C to 85°C  | -400 |      | 400 | μV    |
|                       |                                 |                                                                | -40°C to 125°C | -600 |      | 600 | μV    |
|                       |                                 | V <sub>S</sub> = 5 V, V <sub>CM</sub> = 2.5 V, TP1281/TP1282   |                | -150 | 50   | 150 | μV    |
|                       |                                 |                                                                | -40°C to 85°C  | -500 |      | 500 | μV    |
|                       |                                 |                                                                | -40°C to 125°C | -600 |      | 600 | μV    |
| V <sub>OS</sub>       | Input Offset Voltage            | V <sub>S</sub> = 30 V, V <sub>CM</sub> = 15 V, TP1284          |                | -150 | 50   | 150 | μV    |
|                       |                                 |                                                                | -40°C to 85°C  | -450 |      | 450 | μV    |
|                       |                                 |                                                                | -40°C to 125°C | -650 |      | 650 | μV    |
|                       |                                 | V <sub>S</sub> = 25 V, V <sub>CM</sub> = 12.5 V, TP1284        |                | -150 | 50   | 150 | μV    |
|                       |                                 |                                                                | -40°C to 85°C  | -450 |      | 450 | μV    |
|                       |                                 |                                                                | -40°C to 125°C | -650 |      | 650 | μV    |
|                       |                                 | V <sub>S</sub> = 5 V, V <sub>CM</sub> = 2.5 V, TP1284          |                | -200 | 50   | 200 | μV    |
|                       |                                 |                                                                | -40°C to 85°C  | -550 |      | 550 | μV    |
|                       |                                 |                                                                | -40°C to 125°C | -650 |      | 650 | μV    |
| V <sub>OS</sub> TC    | Input Offset Voltage Drift      |                                                                | -40°C to 125°C |      | 1    |     | μV/°C |
| I <sub>B</sub>        | Input Bias Current              |                                                                |                |      | 25   |     | pA    |
|                       |                                 | -40°C to 85°C                                                  |                |      | 80   |     | pA    |
|                       |                                 | -40°C to 125°C                                                 |                |      | 1000 |     | pA    |
| I <sub>OS</sub>       | Input Offset Current            |                                                                |                |      | 25   |     | pA    |
| I <sub>IN</sub>       | Different Input Current         | V <sub>S</sub> = 36 V, V <sub>ID</sub> = 36 V                  |                |      | 10   | 100 | nA    |
|                       |                                 |                                                                | -40°C to 125°C |      |      | 100 | 300   |

**Electrical Characteristics (Continued)**

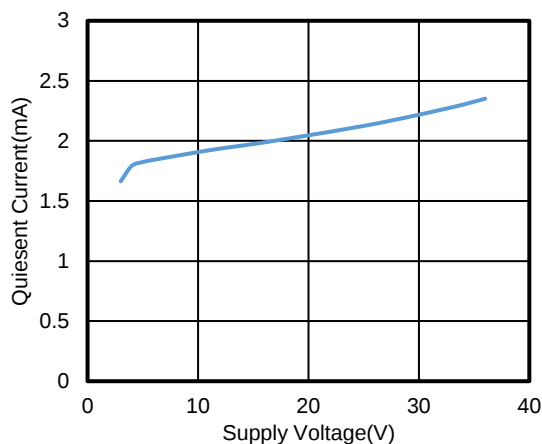
| Symbol                 | Parameter                       | Conditions                                                          | T <sub>A</sub> | Min  | Typ | Max        | Unit |
|------------------------|---------------------------------|---------------------------------------------------------------------|----------------|------|-----|------------|------|
| C <sub>IN</sub>        | Input Capacitance               | Differential Mode                                                   |                |      | 5   |            | pF   |
|                        |                                 | Common Mode                                                         |                |      | 2.5 |            | pF   |
| A <sub>V</sub>         | Open-loop Voltage Gain          | V <sub>S</sub> = 30 V, V <sub>OUT</sub> = 0.5 V to 29.5 V           |                | 120  | 130 |            | dB   |
|                        |                                 |                                                                     | -40°C to 125°C | 105  |     |            | dB   |
| V <sub>CMR</sub>       | Common-mode Input Voltage Range |                                                                     |                | (V-) |     | (V+) – 1.5 | V    |
| CMRR                   | Common Mode Rejection Ratio     | V <sub>CM</sub> = 0.5 V to 28.5 V                                   |                | 100  | 125 |            | dB   |
|                        |                                 |                                                                     | -40°C to 125°C | 95   |     |            | dB   |
| Output Characteristics |                                 |                                                                     |                |      |     |            |      |
| V <sub>OH</sub>        | Output Swing from Positive Rail | R <sub>LOAD</sub> = 100 kΩ to V <sub>S</sub> /2                     |                |      | 5   | 15         | mV   |
|                        |                                 |                                                                     | -40°C to 85°C  |      |     | 30         | mV   |
|                        |                                 |                                                                     | -40°C to 125°C |      |     | 40         | mV   |
|                        |                                 | R <sub>LOAD</sub> = 10 kΩ to V <sub>S</sub> /2                      |                |      | 50  | 80         | mV   |
|                        |                                 |                                                                     | -40°C to 85°C  |      |     | 120        | mV   |
|                        |                                 |                                                                     | -40°C to 125°C |      |     | 130        | mV   |
| V <sub>OL</sub>        | Output Swing from Negative Rail | R <sub>LOAD</sub> = 100 kΩ to V <sub>S</sub> /2                     |                |      | 5   | 10         | mV   |
|                        |                                 |                                                                     | -40°C to 85°C  |      |     | 20         | mV   |
|                        |                                 |                                                                     | -40°C to 125°C |      |     | 25         | mV   |
|                        |                                 | R <sub>LOAD</sub> = 10 kΩ to V <sub>S</sub> /2                      |                |      | 40  | 50         | mV   |
|                        |                                 |                                                                     | -40°C to 85°C  |      |     | 80         | mV   |
|                        |                                 |                                                                     | -40°C to 125°C |      |     | 100        | mV   |
| I <sub>SC</sub>        | Output Short-Circuit Current    | Source Current                                                      |                | 20   | 32  |            | mA   |
|                        |                                 | Sink Current                                                        |                | 15   | 25  |            | mA   |
| AC Specifications      |                                 |                                                                     |                |      |     |            |      |
| GBW                    | Gain-Bandwidth Product          |                                                                     |                |      | 7   |            | MHz  |
| SR                     | Slew Rate                       | G = 1, 10 V step                                                    |                | 13   | 20  |            | V/μs |
|                        |                                 |                                                                     | -40°C to 125°C | 10   |     |            | V/μs |
| t <sub>OR</sub>        | Overload Recovery               |                                                                     |                |      | 100 |            | ns   |
| t <sub>S</sub>         | Settling Time, 0.1%             | G = -1, 10 V step                                                   |                |      | 0.5 |            | μs   |
|                        | Settling Time, 0.01%            |                                                                     |                |      | 0.8 |            | μs   |
| PM                     | Phase Margin                    | V <sub>S</sub> = 36 V, R <sub>L</sub> =10 K, C <sub>L</sub> =100pF  |                |      | 60  |            | °    |
| GM                     | Gain Margin                     | V <sub>S</sub> = 36 V, R <sub>L</sub> =10 K, C <sub>L</sub> =100 pF |                |      | 10  |            | dB   |

**Electrical Characteristics (Continued)**

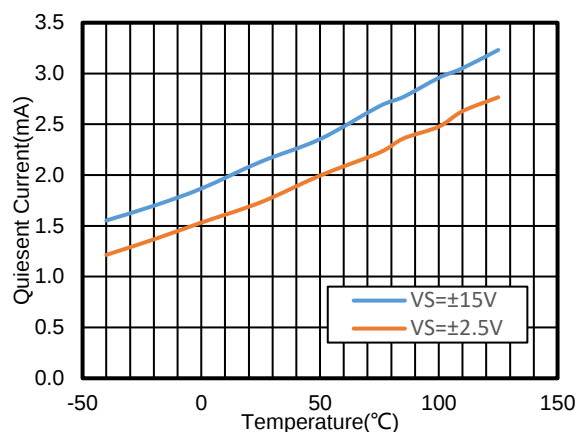
| Symbol            | Parameter                           | Conditions                                                                         | T <sub>A</sub> | Min | Typ    | Max | Unit              |
|-------------------|-------------------------------------|------------------------------------------------------------------------------------|----------------|-----|--------|-----|-------------------|
| Noise Performance |                                     |                                                                                    |                |     |        |     |                   |
| E <sub>N</sub>    | Input Voltage Noise                 | f = 0.1 Hz to 10 Hz                                                                |                |     | 2      |     | μV <sub>RMS</sub> |
| e <sub>N</sub>    | Input Voltage Noise Density         | f = 1 kHz                                                                          |                |     | 25     |     | nV/√Hz            |
| i <sub>N</sub>    | Input Current Noise                 | f = 1 kHz                                                                          |                |     | 2      |     | fA/√Hz            |
| THD+N             | Total Harmonic Distortion and Noise | f = 1 kHz, G = 1, R <sub>L</sub> = 10 kΩ,<br>V <sub>OUT</sub> = 6 V <sub>RMS</sub> |                |     | 0.0005 |     | %                 |
| Thermal Shutdown  |                                     |                                                                                    |                |     |        |     |                   |
|                   | Thermal Shutdown Temperature        |                                                                                    |                |     | 170    |     | °C                |
|                   | Recover Temperature                 |                                                                                    |                |     | 150    |     | °C                |

## Typical Performance Characteristics

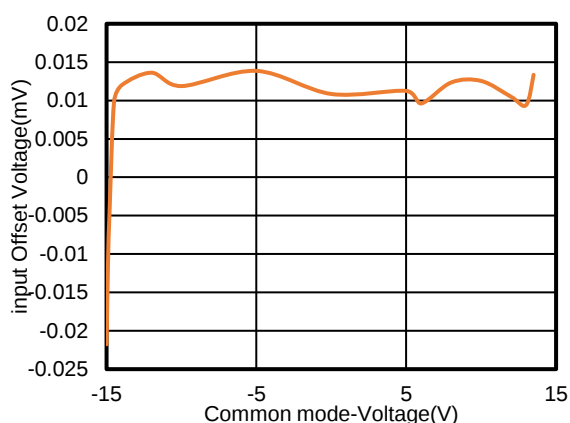
$V_S = \pm 15\text{ V}$ ,  $V_{CM} = 0\text{ V}$ ,  $R_L = 10\text{ k}\Omega$ , unless otherwise specified.



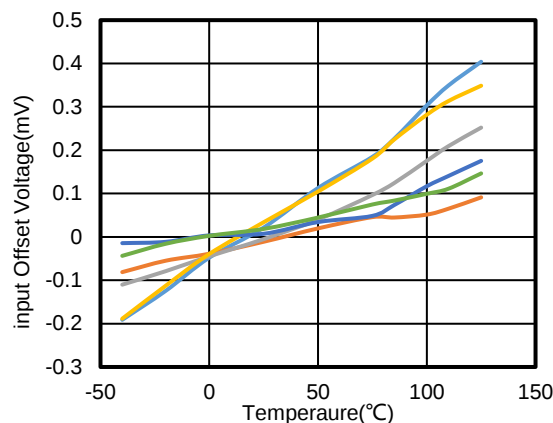
**Figure 1. Quiescent Current vs. Supply Voltage, TP1282**



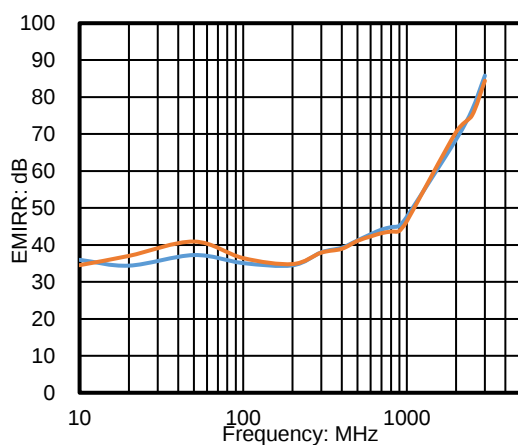
**Figure 2. Quiescent Current vs. Temperature, TP1282**



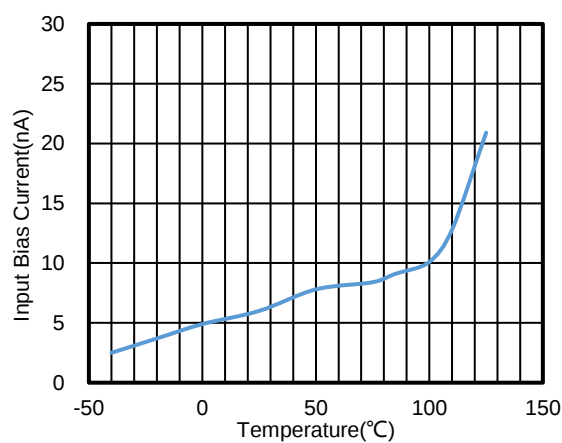
**Figure 3. Offset Voltage vs. Common-Mode Voltage**



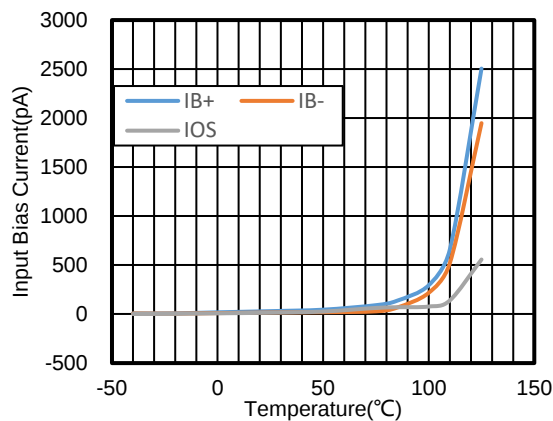
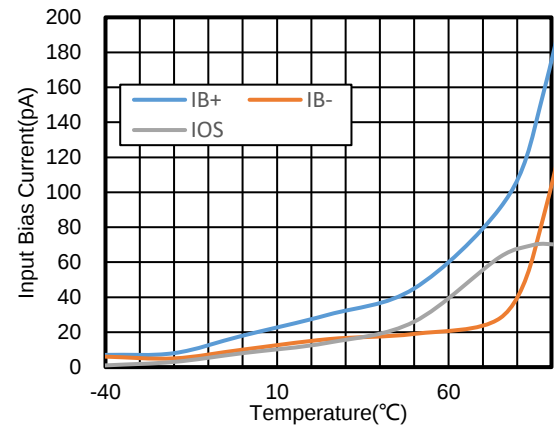
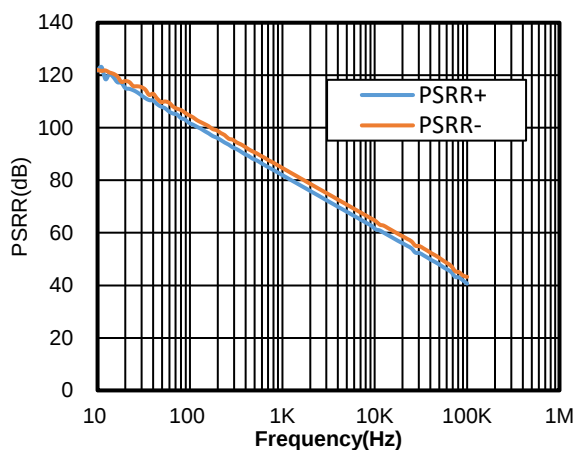
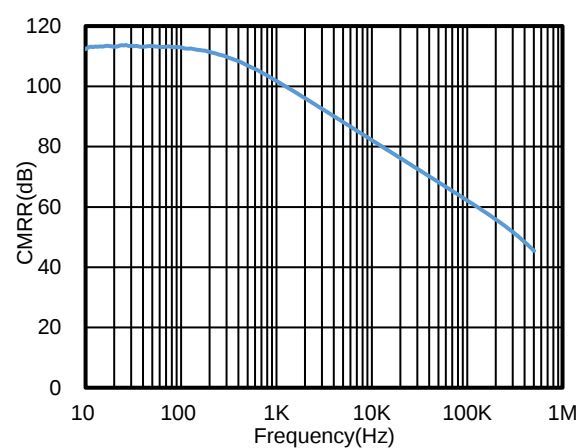
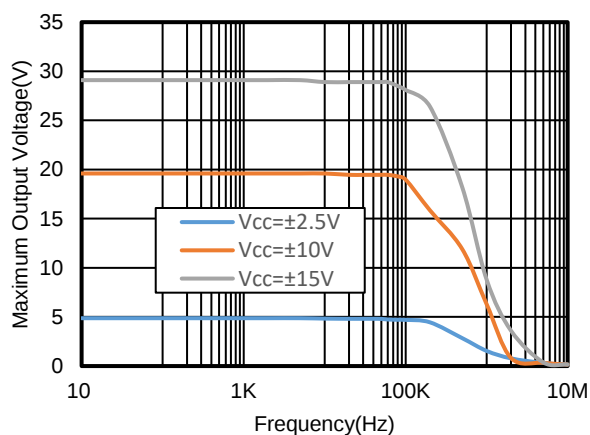
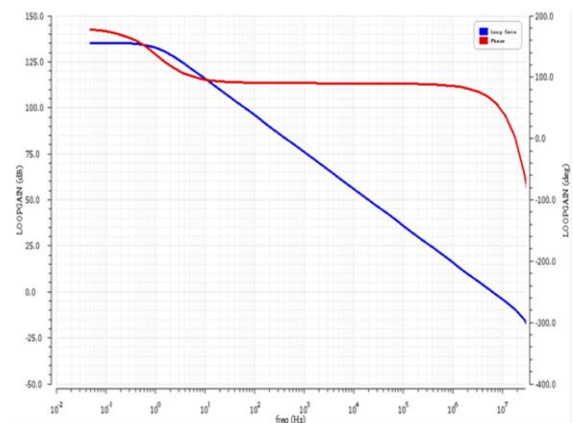
**Figure 4.  $V_{OS}$  vs. Temperature**



**Figure 5. EMIRR vs. Frequency**



**Figure 6. Input Current in Large  $V_{dm}$  vs. Temperature**


**Figure 7.  $I_B$  vs. Temperature, -40 to 125°C**

**Figure 8.  $I_B$  vs. Temperature, -40 to 90°C**

**Figure 9. PSRR vs. Frequency**

**Figure 10. CMRR vs. Frequency**

**Figure 11. Maximum Output Voltage vs. Frequency**

**Figure 12. Open Loop Gain and Phase vs. Frequency**
 $R_{LOAD} = 10\text{ K}, C_{LOAD} = 100\text{ pF}$

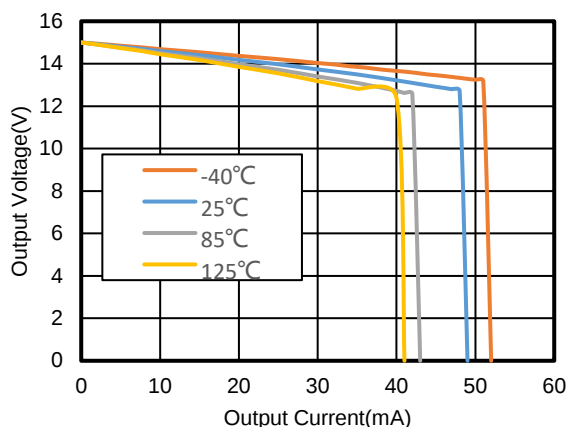


Figure 13. Positive Output Voltage vs. Output Current

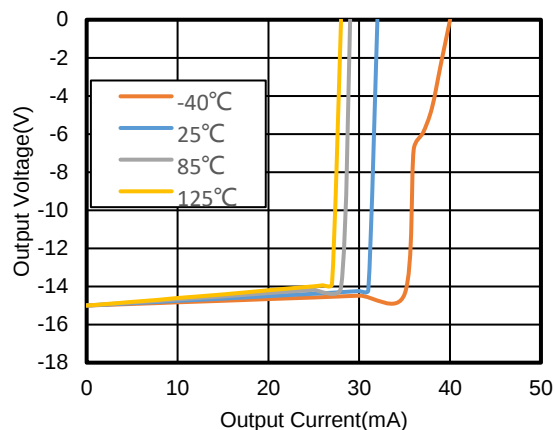


Figure 14. Negative Output Voltage vs. Output Current

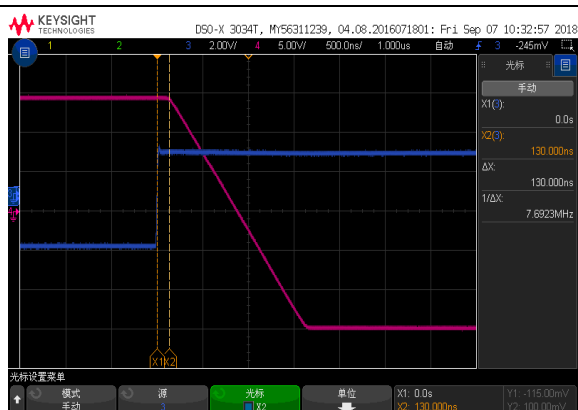


Figure 15. Positive Overload Recovery

Voltage: 5 V/div for Output, Time: 500 ns/div

$G = -10$ ,  $V_{REF} = GND$ ;  $V_{IN} = 5 V_{PP}$ ,  $R = 2 K$ ,  $C = 100 pF$

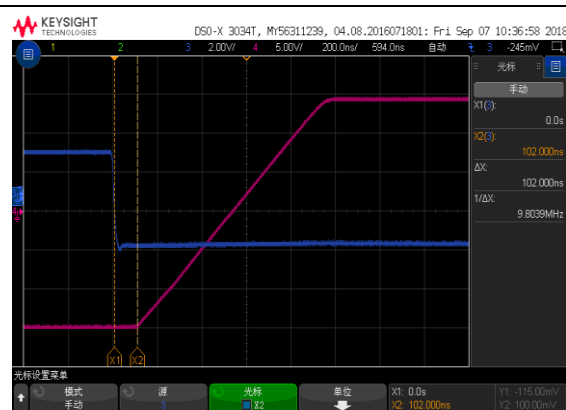


Figure 16. Negative Overload Recovery

Voltage: 5V/div for Output, Time: 500 ns/div

$G = -10$ ,  $V_{REF} = GND$ ;  $V_{IN} = 5 V_{PP}$ ,  $R = 2 K$ ,  $C = 100 pF$



Figure 17. 100mV Signal Step Response

Voltage: 50 mV/div, Time: 1  $\mu$ s/div

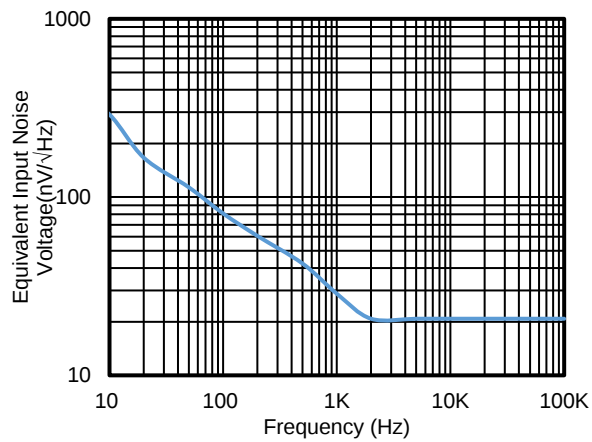
$R_L = 2 K$ ,  $C_L = 100 pF$ ,  $G = 1$



Figure 18. 10V Signal Step Response

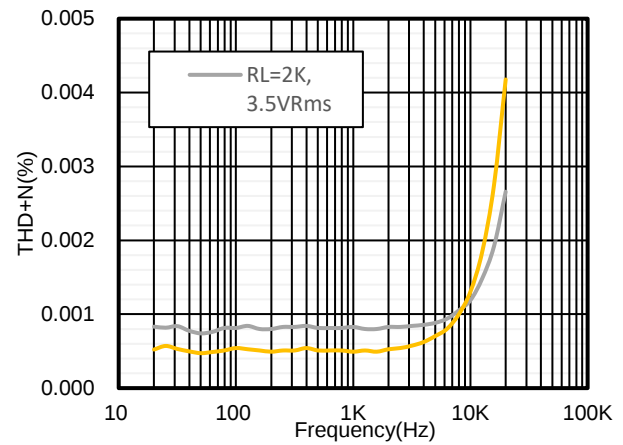
Voltage: 5 V/div, Time: 1  $\mu$ s/div

$R_L = 2 K$ ,  $C_L = 100 pF$ ,  $G = 1$



**Figure 19. Voltage Noise Spectral Density vs. Frequency**

$V_S = \pm 15\text{ V}$ ,  $V_{CM} = 0\text{ V}$



**Figure 20. THD+N vs. Frequency**

$V_S = \pm 15\text{ V}$ ,  $V_{CM} = 0\text{ V}$

## Detailed Description

### Overview

The TP128X series is a new family of low-power, rail-to-rail output op amplifiers. These devices operate from 4.5 V to 36 V, are unity-gain stable and designed for a wide range of general-purpose applications.

### Functional Block Diagram

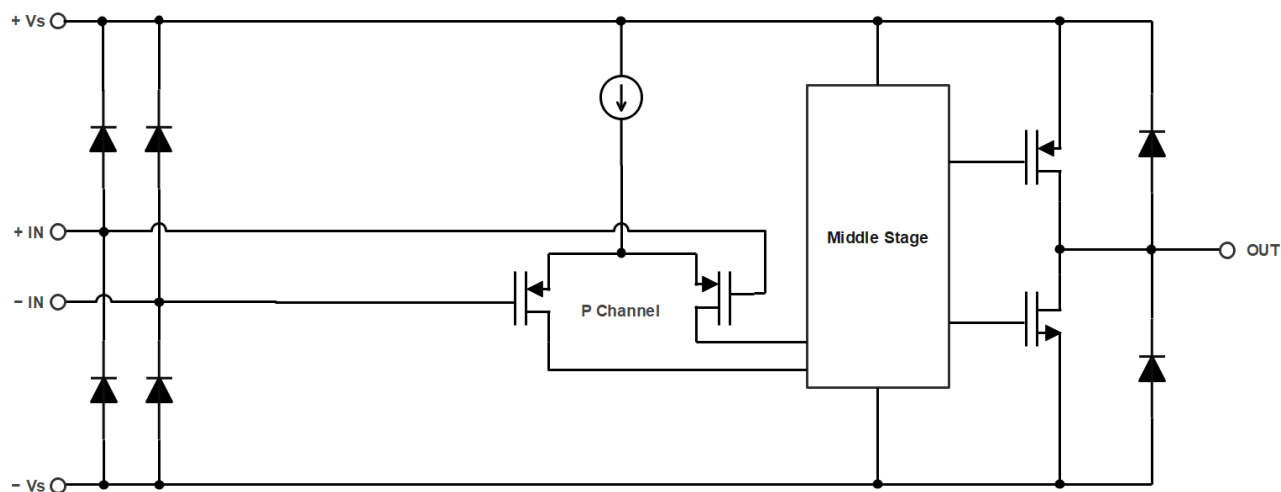
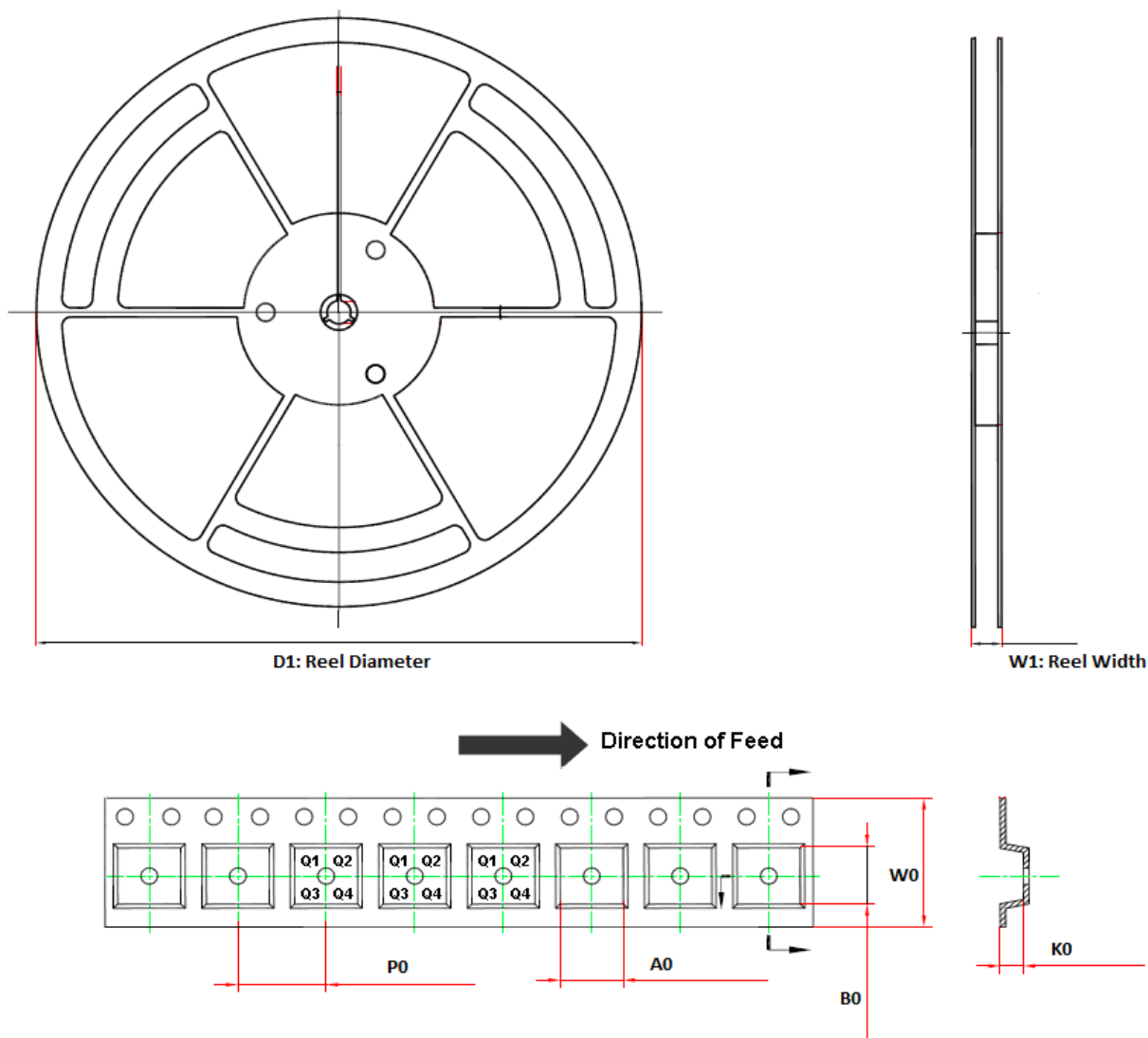


Figure 21. Functional Block Diagram

## Tape and Reel Information



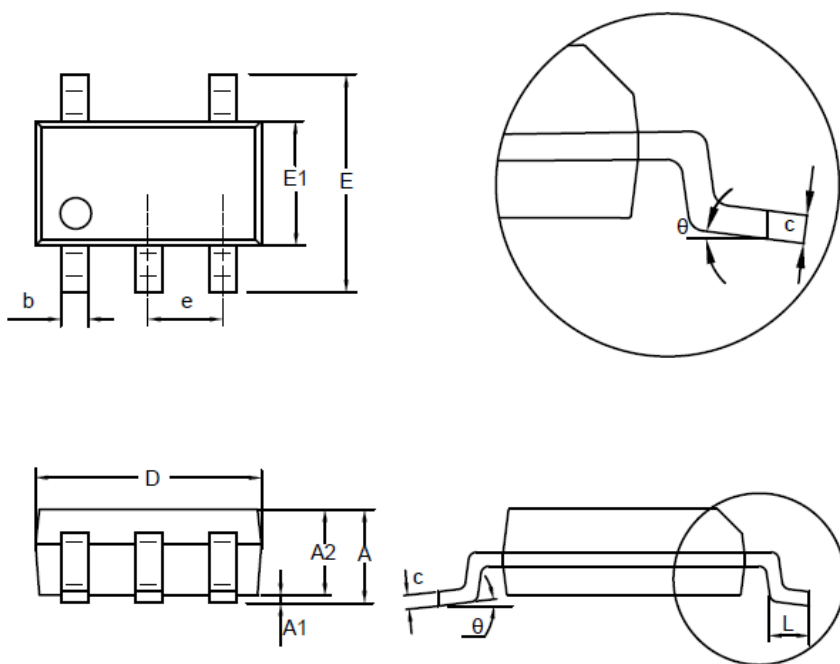
| Order Number | Package  | D1 (mm) | W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P0 (mm) | W0 (mm) | Pin1 Quadrant |
|--------------|----------|---------|---------|---------|---------|---------|---------|---------|---------------|
| TP1281L1-TR  | SOT23-5  | 180.0   | 13.1    | 3.2     | 3.2     | 1.4     | 4.0     | 8.0     | Q3            |
| TP1282L1-SR  | SOP8     | 330.0   | 17.6    | 6.4     | 5.4     | 2.1     | 8.0     | 12.0    | Q1            |
| TP1282L1-VR  | MSOP8    | 330.0   | 17.6    | 5.2     | 3.3     | 1.5     | 8.0     | 12.0    | Q1            |
| TP1282L1-FR  | DFN2X2-8 | 180.0   | 13.1    | 2.3     | 2.3     | 1.1     | 4.0     | 8.0     | Q1            |
| TP1284-SR    | SOP14    | 330.0   | 21.6    | 6.5     | 9.0     | 2.1     | 8.0     | 16.0    | Q1            |
| TP1284-TR    | TSSOP14  | 330.0   | 17.6    | 6.8     | 5.4     | 1.2     | 8.0     | 12.0    | Q1            |

## Package Outline Dimensions

### SOT23-5

#### Package Outline Dimensions

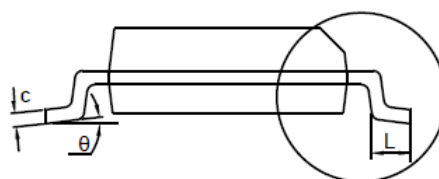
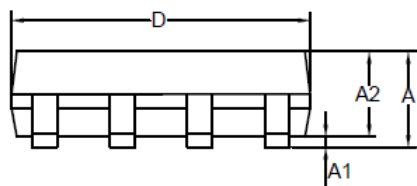
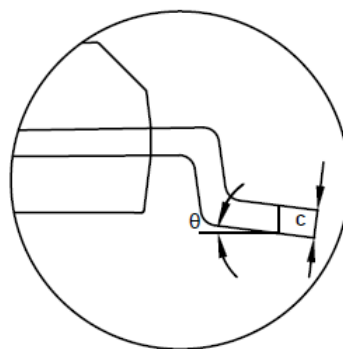
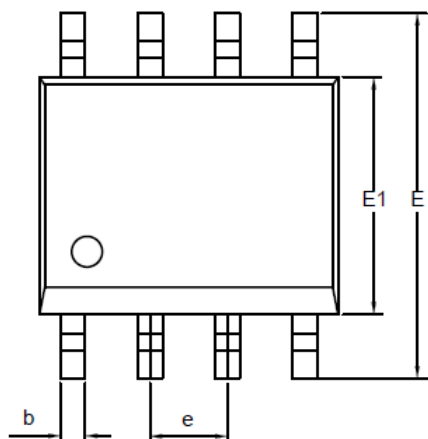
#### S5T(SOT23-5-A)



| 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      | 0.280                        | 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

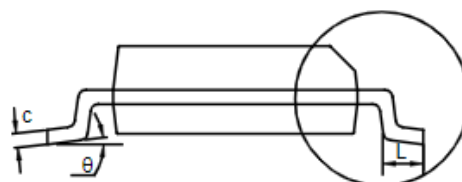
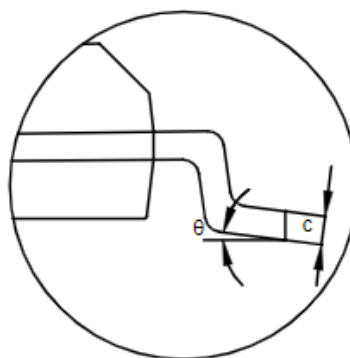
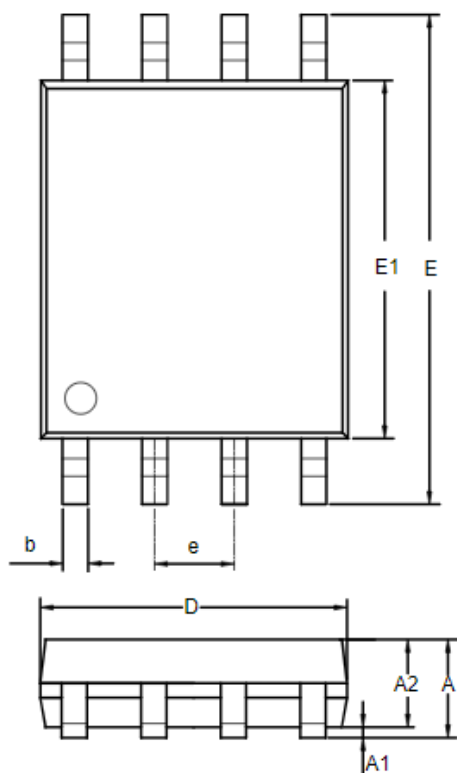
1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

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


| Symbol   | Dimensions<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 |
| $\theta$ | 0                            | 8     | 0                       | 8     |

**NOTES**

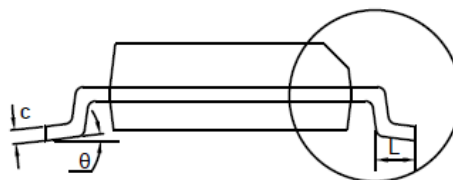
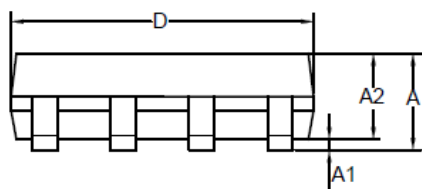
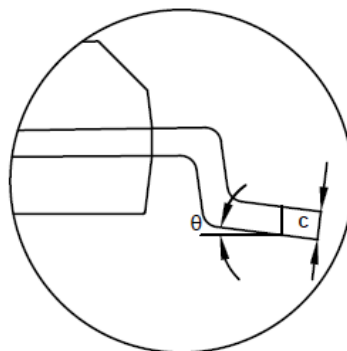
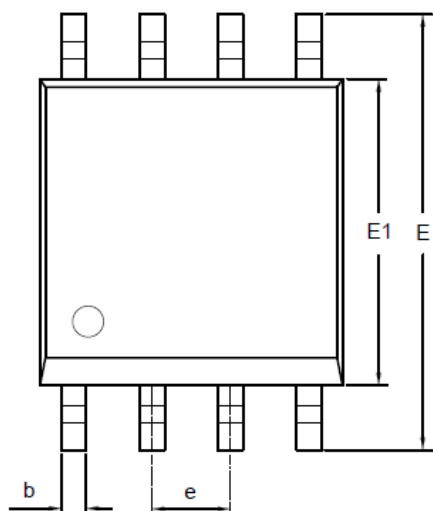
1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

**TSSOP8**
**Package Outline Dimensions**
**TS1(TSSOP-8-A)**


| Symbol | Dimensions<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      | 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**

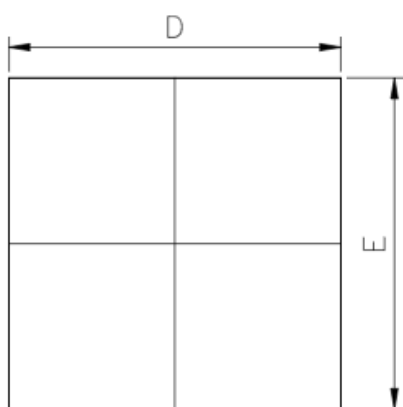
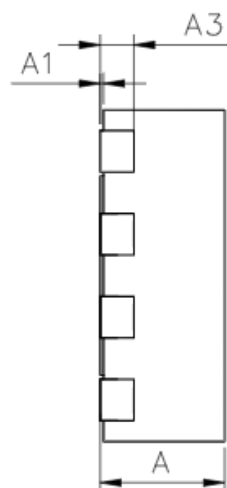
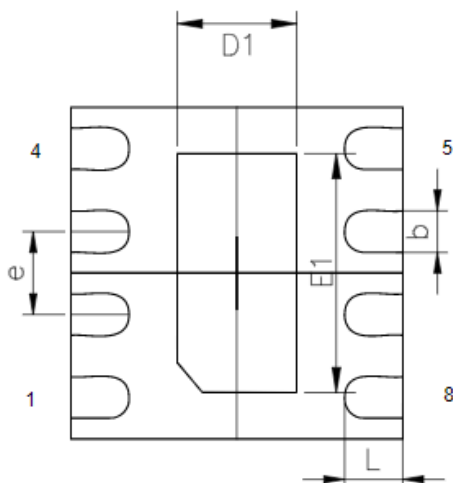
1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

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


| Symbol   | Dimensions<br>In Millimeters |       | Dimensions<br>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 |
| $\theta$ | 0                            | 8°    | 0                       | 8°    |

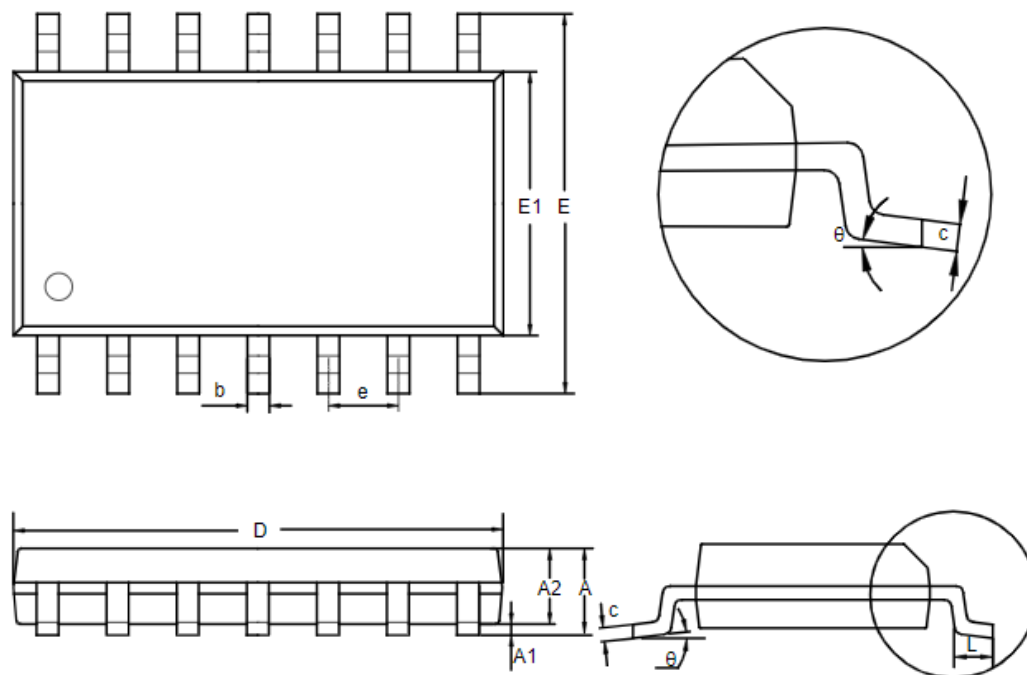
**NOTES**

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

**DFN2X2-8**
**Package Outline Dimensions**
**DFJ(DFN2X2-8-G)**

**Top View**

**Side View**

**Bottom View**
**NOTES**

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

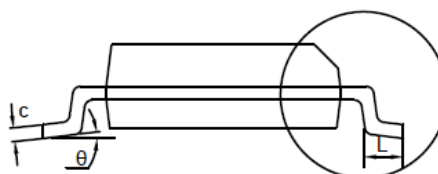
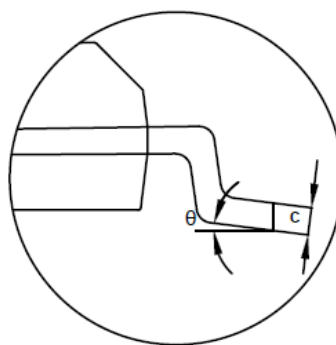
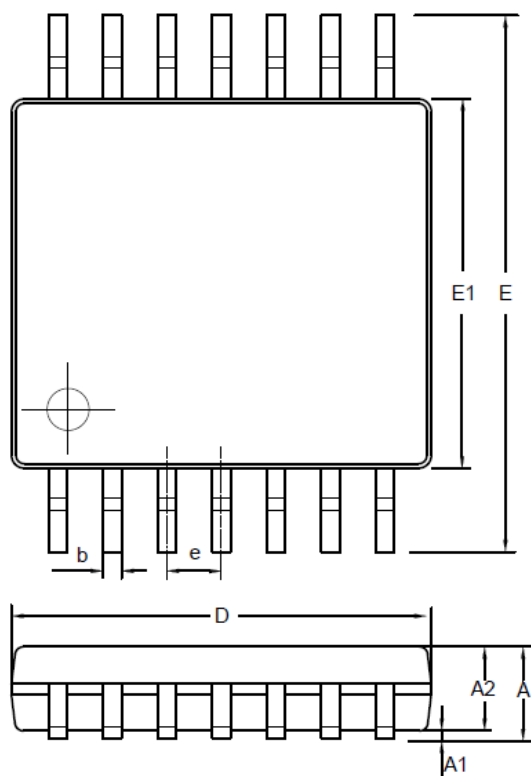
| Symbol | Dimensions<br>In Millimeters |       | Dimensions<br>In Inches |       |
|--------|------------------------------|-------|-------------------------|-------|
|        | MIN                          | MAX   | MIN                     | MAX   |
| A      | 0.800                        | 0.900 | 0.031                   | 0.035 |
| A1     | 0.000                        | 0.050 | 0.000                   | 0.002 |
| b      | 0.180                        | 0.300 | 0.007                   | 0.012 |
| A3     | 0.150                        | 0.250 | 0.006                   | 0.010 |
| D      | 1.900                        | 2.100 | 0.075                   | 0.083 |
| D1     | 0.750                        | 0.850 | 0.030                   | 0.033 |
| E      | 1.900                        | 2.100 | 0.075                   | 0.083 |
| E1     | 1.550                        | 1.650 | 0.061                   | 0.065 |
| 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<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 |
| 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<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 |
|-------------------------------|-----------------------------|----------|---------------------|-----|---------------------------|----------|
| TP1281L1-SR                   | -40 to 125°C                | SOP8     | 1281                | 1   | Tape and Reel, 4000       | Green    |
| TP1281L1-TR                   | -40 to 125°C                | SOT23-5  | 128                 | 1   | Tape and Reel, 3000       | Green    |
| TP1282L1-SR                   | -40 to 125°C                | SOP8     | 1282                | 1   | Tape and Reel, 4000       | Green    |
| TP1282L1-VR                   | -40 to 125°C                | MSOP8    | 1282                | 1   | Tape and Reel, 3000       | Green    |
| TP1282L1-FR <sup>Note 1</sup> | -40 to 125°C                | DFN2X2-8 | 128                 | 1   | Tape and Reel, 3000       | Green    |
| TP1284-SR                     | -40 to 125°C                | SOP14    | 1284                | 3   | Tape and Reel, 2500       | Green    |
| TP1284-TR                     | -40 to 125°C                | TSSOP14  | 1284                | 3   | Tape and Reel, 3000       | Green    |

(1) For Future product, contact 3PEAK factory for more information and sample.

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

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