36-V, 10-MHz, High-PSRR, Operational Amplifiers

Features

- Supply Voltage: 4 V to 36 V
- Differential Input Voltage Range to Supply Rail, can Work as Comparator
- Input Rail to $-V_S$
- Fast Response:
  - Bandwidth: 10 MHz
  - Slew Rate: 15 V/µs
- High PSRR+: 80 dB at 100 KHz
- Offset Voltage: ±3 mV Maximum at 25°C
- Operating Temperature Range: −40°C to 125°C

Applications

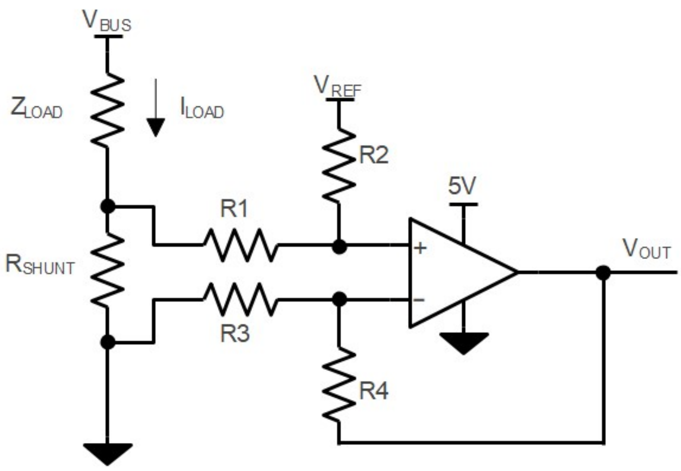
- Sensor Interface
- Motor Control
- Industrial Control
- Audio

Description

The TPA267x is a series of the newest high-supply voltage amplifiers with low offset, low power, and stable high-frequency response. The TPA267x incorporates proprietary and patented design techniques to achieve excellent AC performance with 10-MHz bandwidth and 15-V/µs slew rate. The high PSRR performance increases the immunity to high-frequency noise from the power supply. The series can be used as plug-in replacements for commercially available op amps.

The combination of features makes these devices optimal for industrial control, motor control, and other applications requiring robust amplifiers with high immunity to power supply noise.

Typical Application Circuit



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

When R3 = R1, R2 = R4, $R_{SHUNT} << R1$

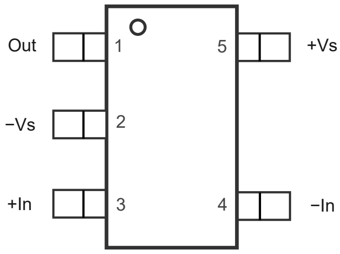
Table of Contents

Revision History

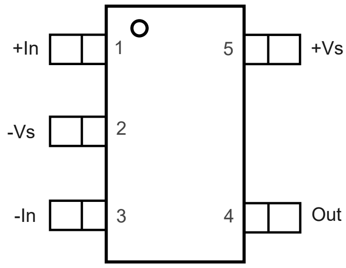
Date	Revision	Notes
2023-11-27	Rev.A.0	Initial version.
2024-01-03	Rev.A.1	Removed the minimum I_{SC} value.
2024-02-06	Rev.A.2	Modified the pin configuration of SOP8. Corrected the handwriting errors. The physical object remains unchanged.
2024-04-17	Rev.A.3	The following updates are all about the typos, and the actual product remains unchanged. • Added more description about the operating voltage in the Feature Description. • Removed the "Rail-to-Rail Output" in Features and Description. • Added the spec of Output Voltage Swing from Negative Rail under the condition when R_{LOAD} = 10 kΩ is connected to $-V_S$.
2024-12-07	Rev.A.4	Changed the status of TPA2672-TS1R to production in Order Information. Adjusted some descriptions, the actual product remains unchanged.

Pin Configuration and Functions

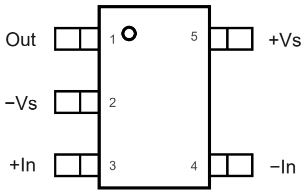
TPA2671
SOT23-5
Top View



TPA2671U
SOT23-5
Top View



TPA2671
SOT353 (SC70-5)
Top View



TPA2671U
SOT353 (SC70-5)
Top View

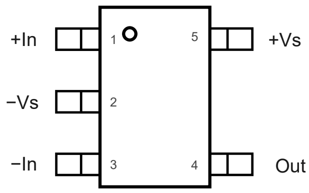
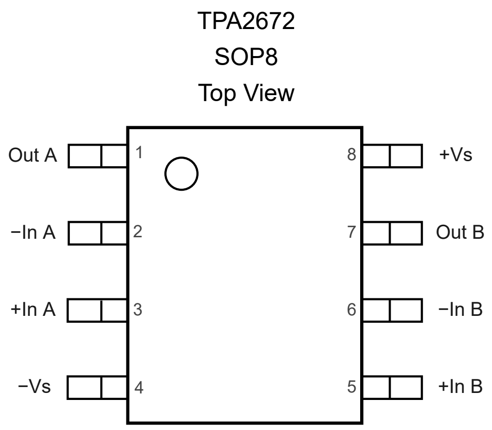
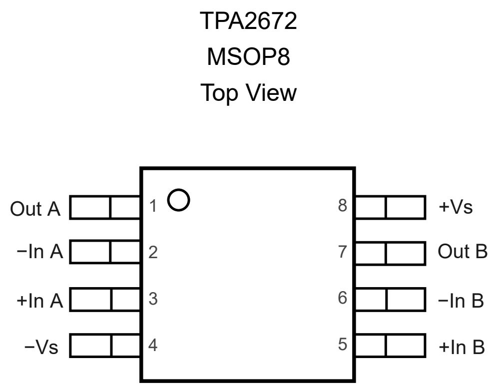


Table 1. Pin Functions: TPA2671, TPA2671U

Pin No.		Name	I/O	Description
TPA2671	TPA2671U			
1	4	Out	O	Output
2	2	$-V_S$	-	Negative power supply
3	1	+In	I	Non-inverting input
4	3	−In	I	Inverting input
5	5	$+V_S$	-	Positive power supply





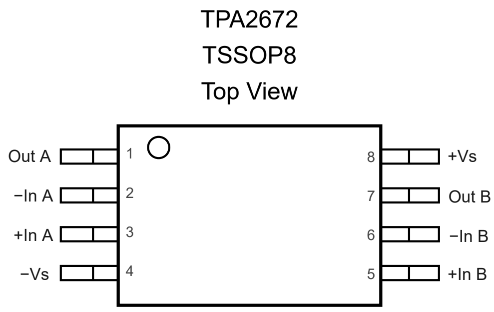
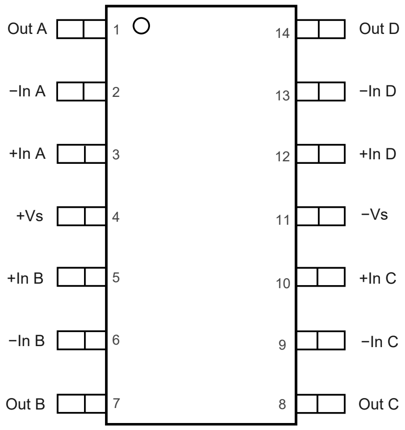


Table 2. Pin Functions: TPA2672

Pin No.			Name	I/O	Description
SOP8	MSOP8	TSSOP8			
1			Out A	O	Output
2			−In A	I	Inverting input
3			+In A	I	Non-inverting input
4			$-V_S$	-	Negative power supply
5			+In B	I	Non-inverting input
6			−In B	I	Inverting input
7			Out B	O	Output
8			$+V_S$	-	Positive power supply

TPA2674
SOP14
Top View



TPA2674
TSSOP14
Top View

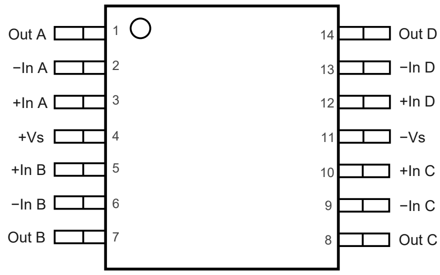


Table 3. Pin Functions: TPA2674

<table>
<tr><th colspan="2">Pin</th><th rowspan="2">Name</th><th rowspan="2">I/O</th><th rowspan="2">Description</th></tr>
<tr><th>SOP14</th><th>TSSOP14</th></tr>
<tr><td colspan="2">1</td><td>Out A</td><td>O</td><td>Output</td></tr>
<tr><td colspan="2">2</td><td>−In A</td><td>I</td><td>Inverting input</td></tr>
<tr><td colspan="2">3</td><td>+In A</td><td>I</td><td>Non-inverting input</td></tr>
<tr><td colspan="2">4</td><td>+V_S</td><td></td><td>Positive power supply</td></tr>
<tr><td colspan="2">5</td><td>+In B</td><td>I</td><td>Non-inverting input</td></tr>
<tr><td colspan="2">6</td><td>−In B</td><td>I</td><td>Inverting input</td></tr>
<tr><td colspan="2">7</td><td>Out B</td><td>O</td><td>Output</td></tr>
<tr><td colspan="2">8</td><td>Out C</td><td>O</td><td>Output</td></tr>
<tr><td colspan="2">9</td><td>−In C</td><td>I</td><td>Inverting input</td></tr>
<tr><td colspan="2">10</td><td>+In C</td><td>I</td><td>Non-inverting input</td></tr>
<tr><td colspan="2">11</td><td>−V_S</td><td></td><td>Negative power supply</td></tr>
<tr><td colspan="2">12</td><td>+In D</td><td>I</td><td>Non-inverting input</td></tr>
<tr><td colspan="2">13</td><td>−In D</td><td>I</td><td>Inverting input</td></tr>
<tr><td colspan="2">14</td><td>Out D</td><td>O</td><td>Output</td></tr>
</table>

Specifications

Absolute Maximum Ratings (1)

Parameter		Min	Max	Unit
Supply Voltage, $(+V_S) - (-V_S)$			40	V
Input Voltage		$(-V_S) - 0.3$	$(+V_S) + 0.3$	V
Differential Input Voltage		$(-V_S) - (+V_S)$	$(+V_S) - (-V_S)$	V
Input Current: +IN, −IN (2)		−10	10	mA
Output Short-Circuit Duration (3)		Continuous		
T_J	Maximum Junction Temperature		150	°C
T_A	Operating Temperature Range	−40	125	°C
T_{STG}	Storage Temperature Range	−65	150	°C
T_L	Lead Temperature (Soldering 10 sec)		260	°C

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

ESD, Electrostatic Discharge Protection

Symbol	Parameter	Condition	Value	Unit
HBM	Human Body Model ESD	ANSI/ESDA/JEDEC JS-001 (1)	2	kV
CDM	Charged Device Model ESD	ANSI/ESDA/JEDEC JS-002 (2)	1	kV

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

Recommended Operating Conditions

Parameter		Min	Typ	Max	Unit
V_S	Supply Voltage, $(+V_S) - (-V_S)$	4 (± 2)		36 (±18)	V
T_A	Operating Temperature Range	−40		125	°C

Thermal Information

Package Type	θ_{JA}	θ_{JC}	Unit
SOT353 (SC70-5)	400	150	°C/W
SOT23-5	250	81	°C/W
SOP8	158	43	°C/W
TSSOP8	191	50	°C/W
MSOP8	210	45	°C/W
SOP14	120	36	°C/W
TSSOP14	180	35	°C/W

Electrical Characteristics

All test conditions: V_S = 36 V, T_A = 25°C, R_L = 10 kΩ, unless otherwise noted.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Power Supply						
V_S	Supply Voltage Range		4		36	V
I_Q	Quiescent Current per Amplifier	V_S = 36 V		1.65	2.4	mA
		V_S = 36 V, T_A = −40°C to 125°C			2.5	mA
PSRR	Power Supply Rejection Ratio	V_S = 8 V to 36 V	90	113		dB
		V_S = 8 V to 36 V , T_A = −40°C to 125°C	85			dB
Input Characteristics						
V_{OS}	Input Offset Voltage	V_S = 36 V, V_{CM} = 18 V	−3	0.5	3	mV
		V_S = 36 V, V_{CM} = 18 V, T_A = −40°C to 125°C	−5		5	mV
		V_S = 4 V, V_{CM} = 2 V	−3	0.5	3	mV
		V_S = 4 V, V_{CM} = 2 V, T_A = −40°C to 125°C	−5		5	mV
V_{OS} TC	Input Offset Voltage Drift	T_A = −40°C to 125°C		2		μV/°C
I_B	Input Bias Current	V_S = 30 V, V_{CM} = 15 V	−800	50	800	pA
		V_S = 30 V, V_{CM} = 15 V, T_A = −40°C to 125°C	−5000		5000	pA
I_{OS}	Input Offset Current	V_S = 30 V, V_{CM} = 15 V	−800	50	800	pA
		V_S = 30 V, V_{CM} = 15 V, T_A = −40°C to 125°C	−5000		5000	pA
R_{IN}	Input Resistance			10^{10}		Ω
C_{IN}	Input Capacitance	Differential mode		2		pF
		Common mode		5		pF
A_V	Open-Loop Voltage Gain	V_O = 4 V to 32 V	120	135		dB
		V_O = 4 V to 32 V, T_A = −40°C to 125°C	95			dB
V_{CMR}	Common-Mode Input Voltage Range	T_A = −40°C to 125°C	($-V_S$)		($+V_S$) − 1.5	V
CMRR	Common-Mode Rejection Ratio	V_{CM} = 2 V to 34 V	90	110		dB
		V_{CM} = 2 V to 34 V, T_A = −40°C to 125°C	80			dB
Output Characteristics						
	Output Voltage Swing from Positive Rail	R_{LOAD} = 10kΩ to V_S / 2		1.2	1.47	V
		R_{LOAD} = 10 kΩ to V_S / 2, T_A = −40°C to 125°C			1.6	V
		R_{LOAD} = 2 kΩ to V_S / 2		1.4	1.86	V

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
		R_{LOAD} = 2 kΩ to V_S / 2, T_A = −40°C to 125°C			2.0	V
	Output Voltage Swing from Negative Rail	R_{LOAD} = 10kΩ to V_S / 2		1.0	1.46	V
		R_{LOAD} = 10 kΩ to V_S / 2, T_A = −40°C to 125°C			1.5	V
		R_{LOAD} = 2 kΩ to V_S / 2		1.3	1.88	V
		R_{LOAD} = 2 kΩ to V_S / 2, T_A = −40°C to 125°C			1.9	V
		R_{LOAD} = 10 kΩ to $-V_S$		0.01		V
I_{SC}	Output Short-Circuit Current	Sink current		75		mA
		Source current		50		mA
AC Specifications						
GBW	Gain-Bandwidth Product			10		MHz
SR	Slew Rate	G = 1, 2-V step		15		V/µs
t_{OR}	Overload Recovery			0.1		µs
t_S	Settling Time, 0.1%	G = 1, 10-V step		0.11		µs
	Settling Time, 0.01%	G = 1, 10-V step		0.14		µs
PM	Phase Margin	R_L = 10 kΩ, C_L = 100 pF		52		°
GM	Gain Margin	R_L = 10 kΩ, C_L = 100 pF		8.6		dB
Noise Performance						
E_N	Input Voltage Noise	f = 0.1 Hz to 10 Hz		20		$µV_{PP}$
e_N	Input Voltage Noise Density	f = 1 kHz		38		nV/√Hz
THD+N	Total Harmonic Distortion and Noise	f = 1 kHz, G =1, no load, V_{OUT} = 2 V_{pp}		0.0001		%

Typical Performance Characteristics

All test conditions: V_S = 30 V, R_L = 10 kΩ, unless otherwise noted.

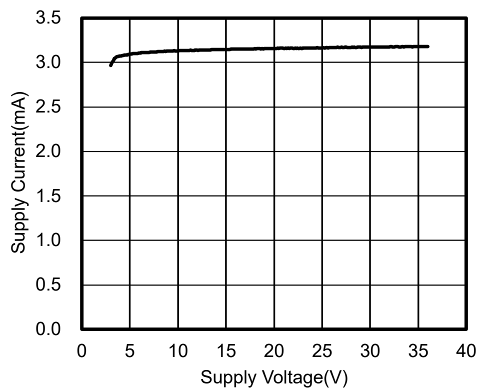


Figure 1. Supply Current vs. Supply Voltage, Dual Channel

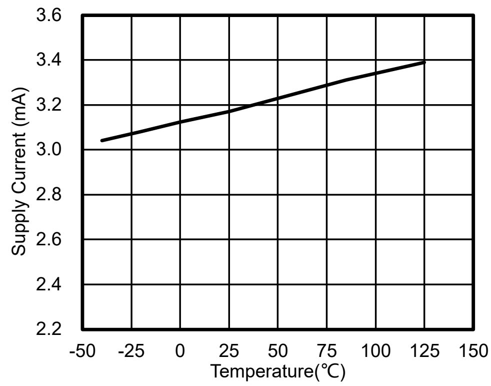


Figure 2. Supply Current vs. Temperature, Dual Channel

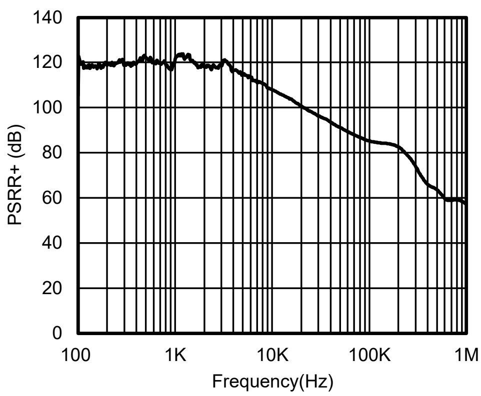


Figure 3. PSRR+ vs. Frequency

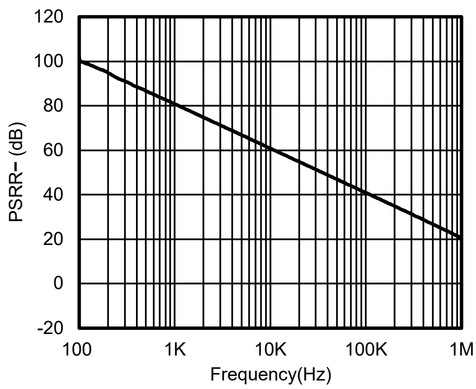


Figure 4. PSRR− vs. Frequency

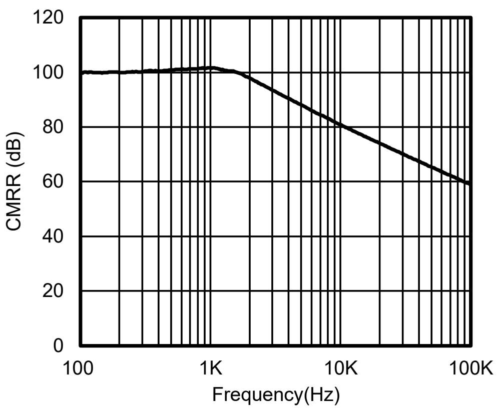


Figure 5. CMRR vs. Frequency

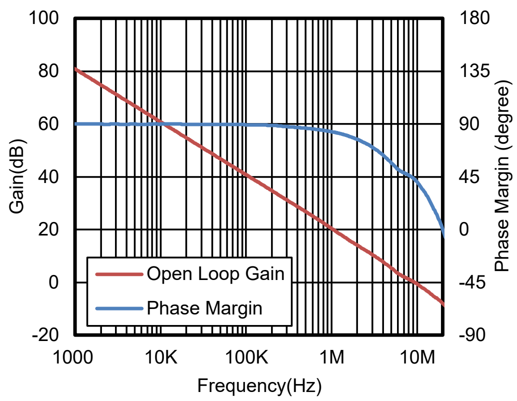


Figure 6. Open-Loop Gain and Phase Margin vs. Frequency, R_L = 10 kΩ

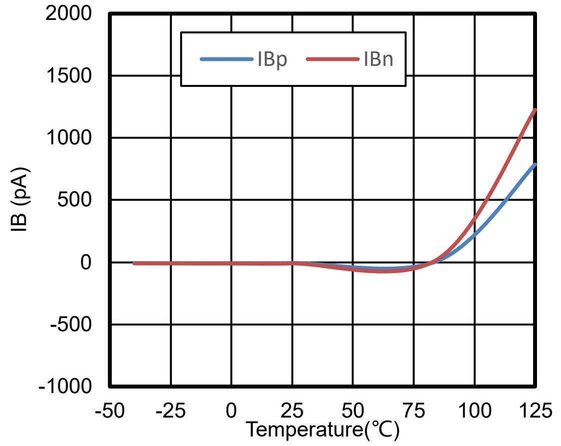


Figure 7. I_B vs. Temperature

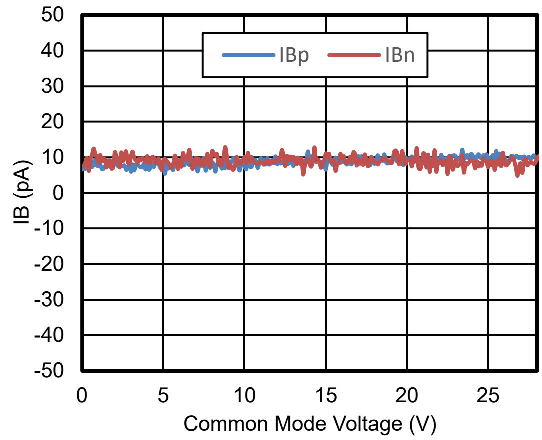


Figure 8. I_B vs. V_{CM}

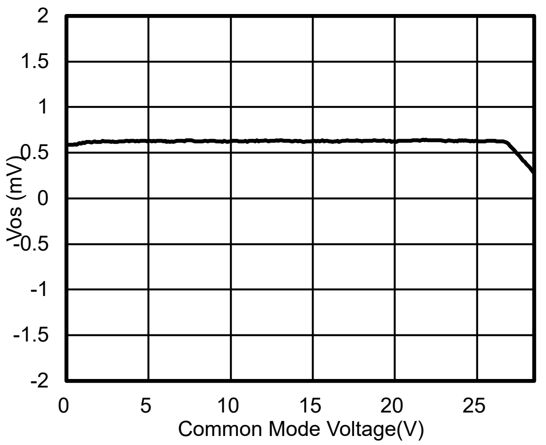


Figure 9. V_{OS} vs. V_{CM}, V_S = 30 V

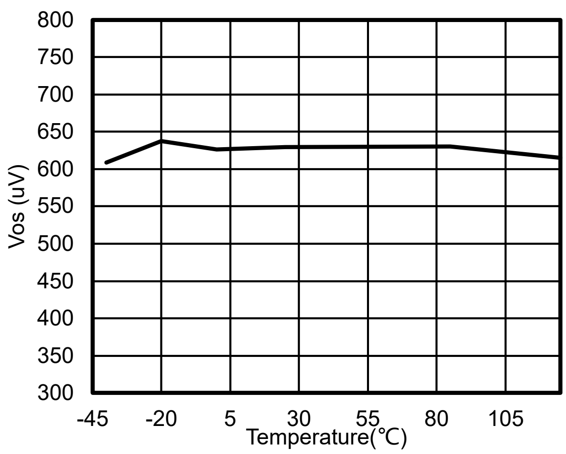


Figure 10. V_{OS} vs. Temperature

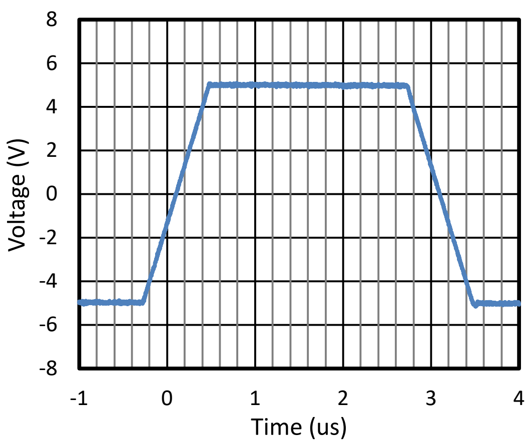


Figure 11. Large-Signal Step Response

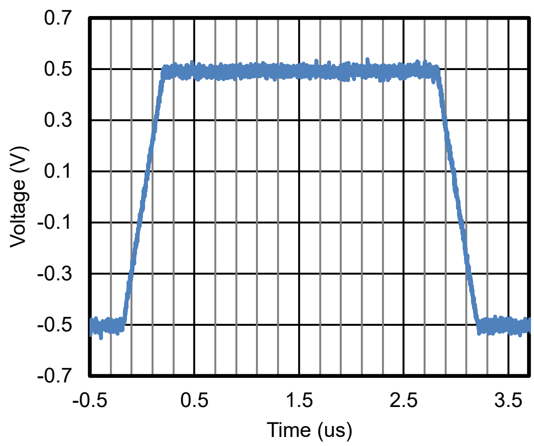


Figure 12. Small-Signal Step Response

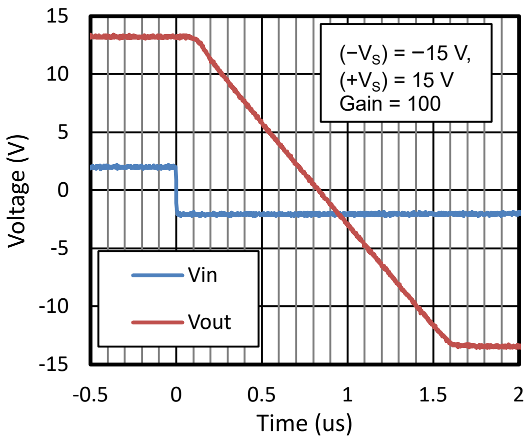


Figure 13. Overload Recovery at Negative Rail

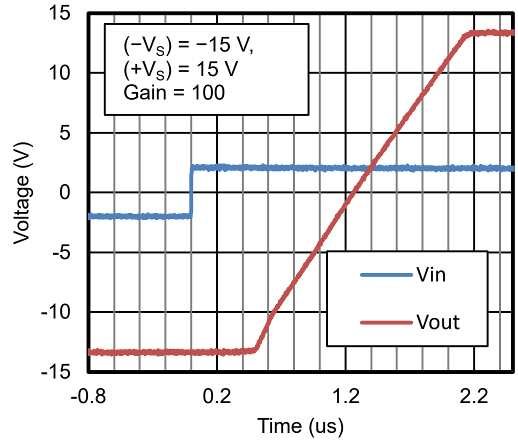


Figure 14. Overload Recovery at Positive Rail

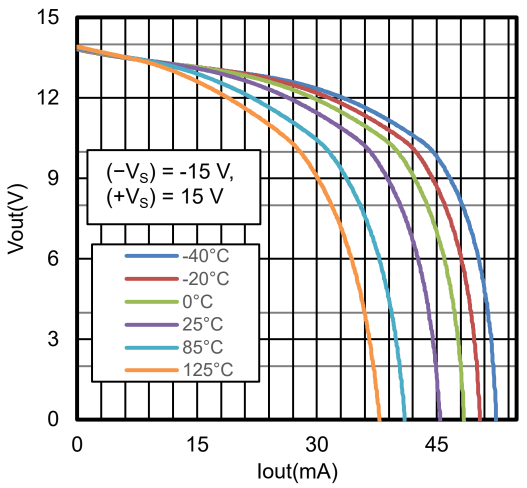


Figure 15. V_{OUT} vs. I_{OUT}, Source

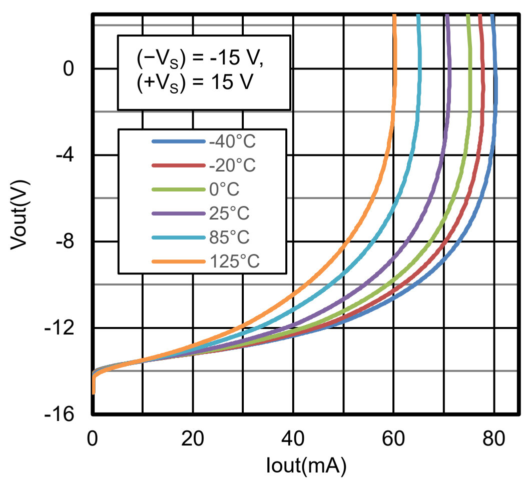


Figure 16. V_{OUT} vs. I_{OUT}, Sink

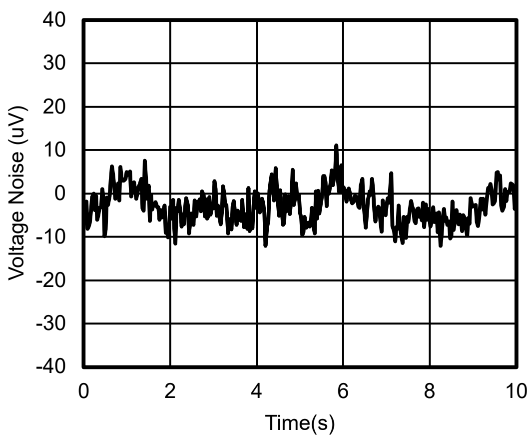


Figure 17. 0.1-Hz to 10-Hz Voltage Noise

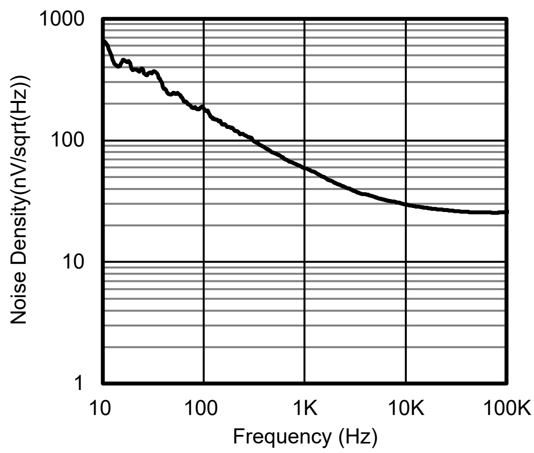


Figure 18. Voltage Noise Spectral Density vs. Frequency

Detailed Description

Overview

The series of op amps can operate on a single-supply voltage (4 V to 36 V), or a split-supply voltage (±2 V to ±18 V), making them highly versatile and easy to use. The power-supply pins should have local bypass ceramic capacitors (typically 0.01 μF to 0.1 μF).

Functional Block Diagram

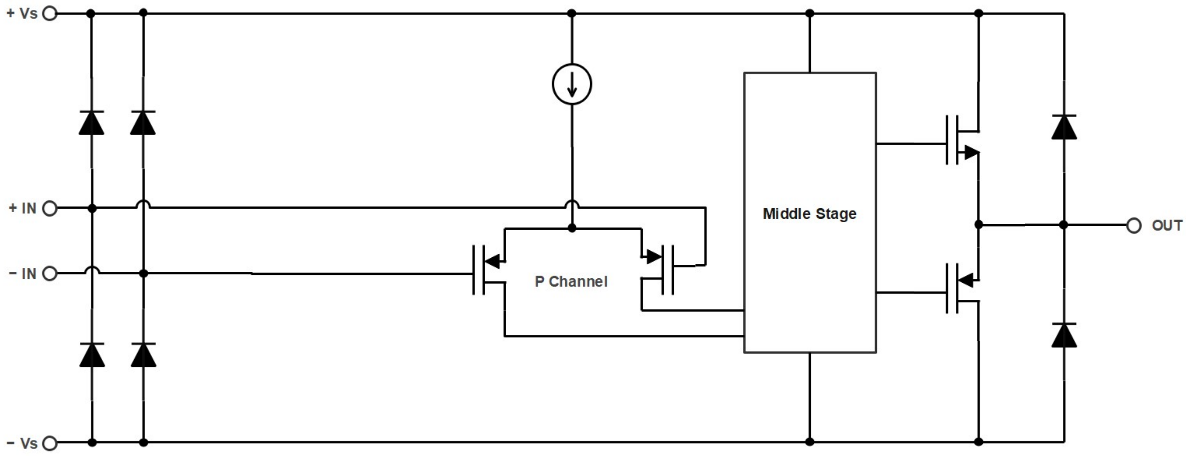


Figure 19. Functional Block Diagram

Feature Description

Operating Voltage

The devices are designed for single-supply operation from 4 V to 36 V, or dual-supply operation from ±2 V to ±18 V.

The recommended operating voltage conditions are as follows:

Power supply voltage ($+V_S$) − ($-V_S$): 4 V to 36 V. The power supply voltage can support the following three scenarios:

- Single supply;

- Dual supplies with equal voltage values;

- Various voltage configurations, as long as the voltage range of ($+V_S$) − ($-V_S$) is within 4 V to 36 V.

For example, if operating with a single supply, ($-V_S$) = 0 V, ($+V_S$) can support 4 V to 36 V. If using dual supplies with equal absolute values, the minimum voltage is ±2 V, and the maximum voltage is ±18 V. It can also support other voltage configurations, such as ($-V_S$) = 100 V, ($+V_S$) = 136 V, or ($-V_S$) = −6 V, ($+V_S$) = 30 V, and so on.

High AC PSRR

In some scenarios where this device is used, the power supply may have noise or interference at different amplitudes and frequencies. This amplifier exhibits excellent high-frequency signal suppression capability for the positive power supply, with a PSRR+ reaching 80 dB at 100 kHz, effectively suppressing the impact of noise or interference on the output signal from the power supply.

Application and Implementation

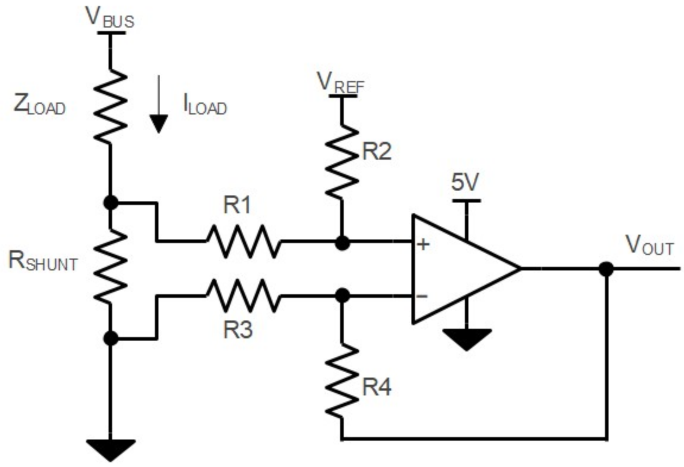
Note

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

Application Information

Low-Side Current-Sensing Application

Figure 20 shows the device configured in a low-side current sensing application. The low-side current sensing method places a sense resistor between the load and the circuit ground. The voltage dropping across the resistor is amplified by different amplifier circuits with the device. V_{REF} can be used to add bias voltage to the output voltage. Particular attention must be paid to the matching and precision of R1, R2, R3, and R4, to maximize the accuracy of the measurement.



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

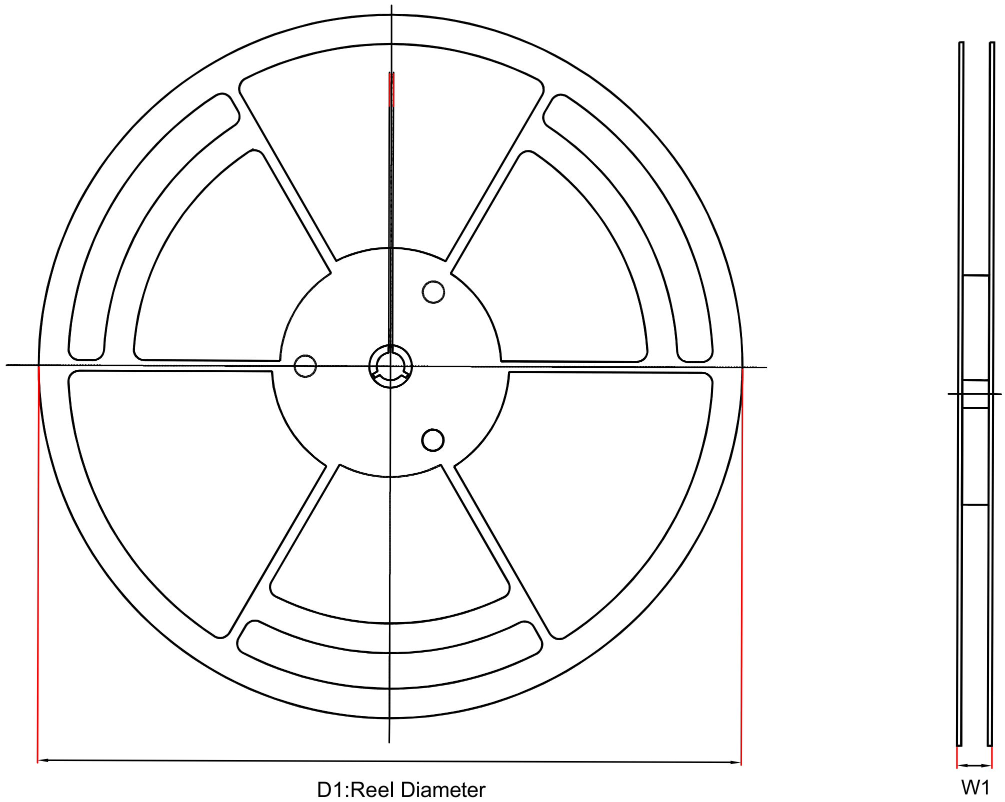
When R3 = R1, R2 = R4, $R_{SHUNT} << R1$

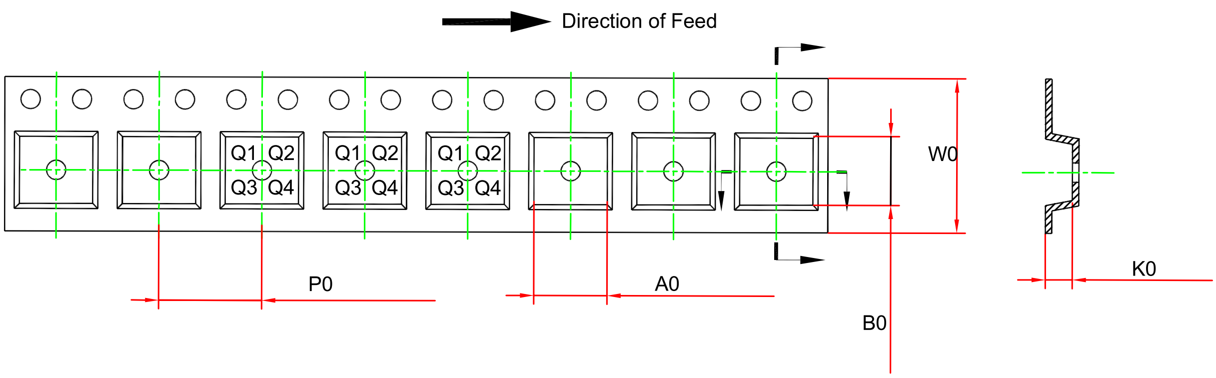
Figure 20. Low-Side Current-Sensing Application

Power Supply Recommendations

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

Tape and Reel Information





Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm) (1)	B0 (mm) (1)	K0 (mm) (1)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPA2674-SO2R	SOP14	330	21.6	6.5	9.15	1.8	8	16	Q1
TPA2674-TS2R	TSSOP14	330	17.6	6.8	5.5	1.7	8	12	Q1
TPA2671-SC5R	SOT353	178	12.1	2.4	2.5	1.2	4	8	Q3
TPA2671U-SC5R	SOT353	178	12.1	2.4	2.5	1.2	4	8	Q3
TPA2671-S5TR	SOT23-5	179	12	3.3	3.25	1.4	4	8	Q3
TPA2671U-S5TR	SOT23-5	179	12	3.3	3.25	1.4	4	8	Q3

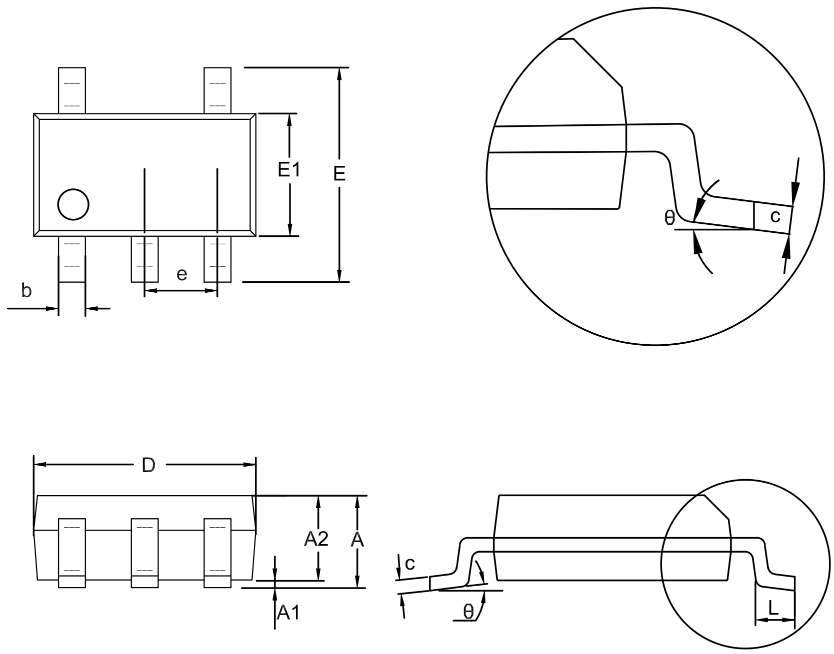
Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm) (1)	B0 (mm) (1)	K0 (mm) (1)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPA2672-SO1R	SOP8	330	17.6	6.5	5.4	2	8	12	Q1
TPA2672-TS1R	TSSOP8	330	17.6	6.8	3.4	1.7	8	12	Q1
TPA2672-VS1R	MSOP8	330	17.6	5.4	3.3	1.3	8	12	Q1

(1) The value is for reference only. Contact the 3PEAK factory for more information.

Package Outline Dimensions

SOT23-5

Package Outline Dimensions S5T(SOT23-5-A)



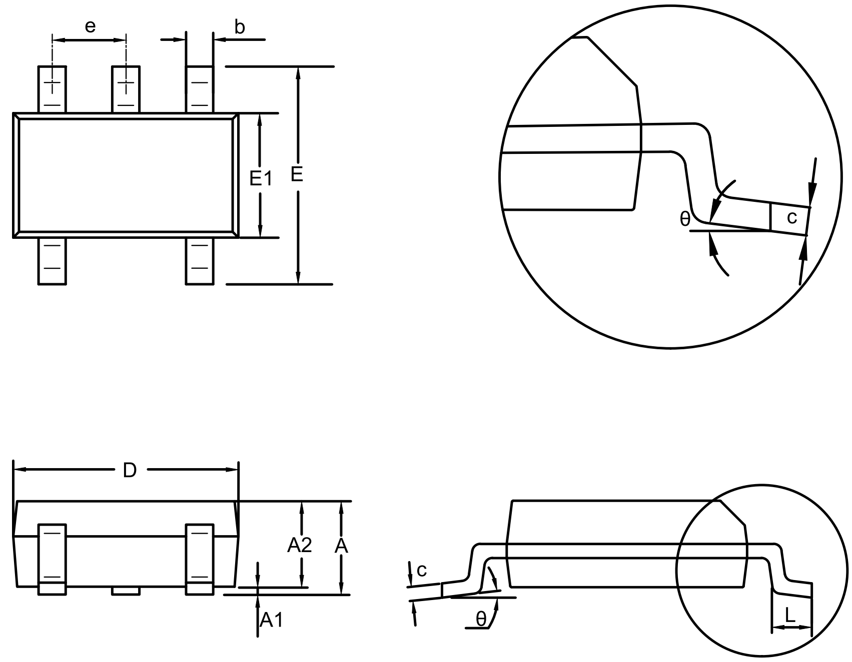
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.150	0.000	0.006
A2	1.000	1.200	0.039	0.047
b	0.280	0.500	0.011	0.020
c	0.100	0.230	0.004	0.009
D	2.820	3.020	0.111	0.119
E	2.600	3.000	0.102	0.118
E1	1.500	1.720	0.059	0.068
e	0.950 BSC		0.037 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.

SOT353 (SC70-5)

Package Outline Dimensions SC5(SOT353-5-A)



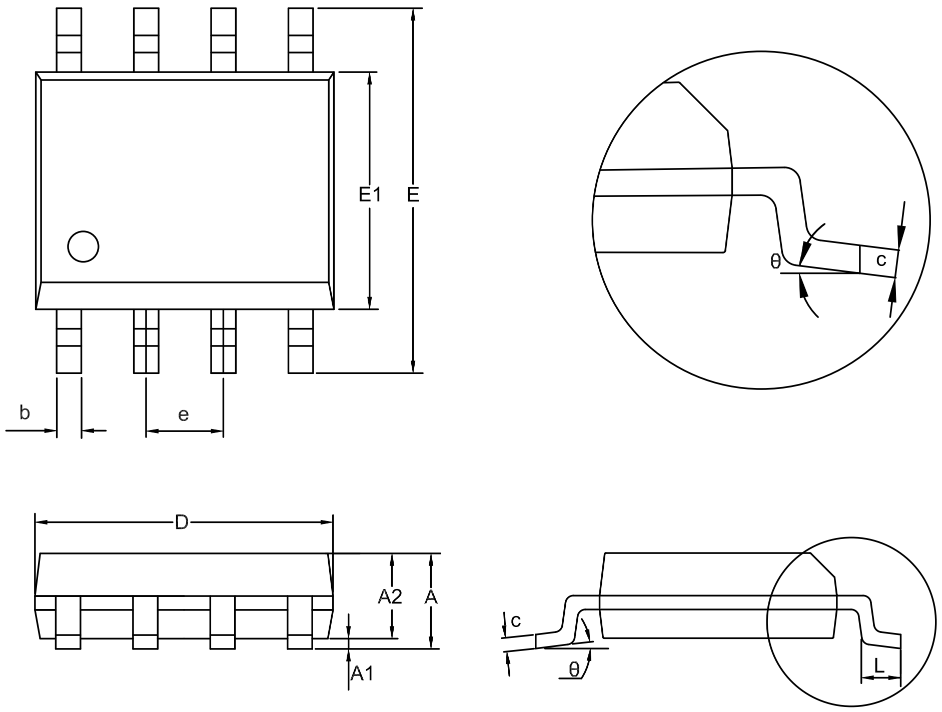
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.850	1.100	0.033	0.043
A1	0.000	0.100	0.000	0.004
A2	0.800	1.000	0.031	0.039
b	0.150	0.350	0.006	0.014
c	0.110	0.230	0.004	0.009
D	2.000	2.200	0.079	0.087
E	2.150	2.450	0.085	0.096
E1	1.150	1.350	0.045	0.053
e	0.650 BSC		0.026 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.

SOP8

Package Outline Dimensions SO1(SOP-8-A)



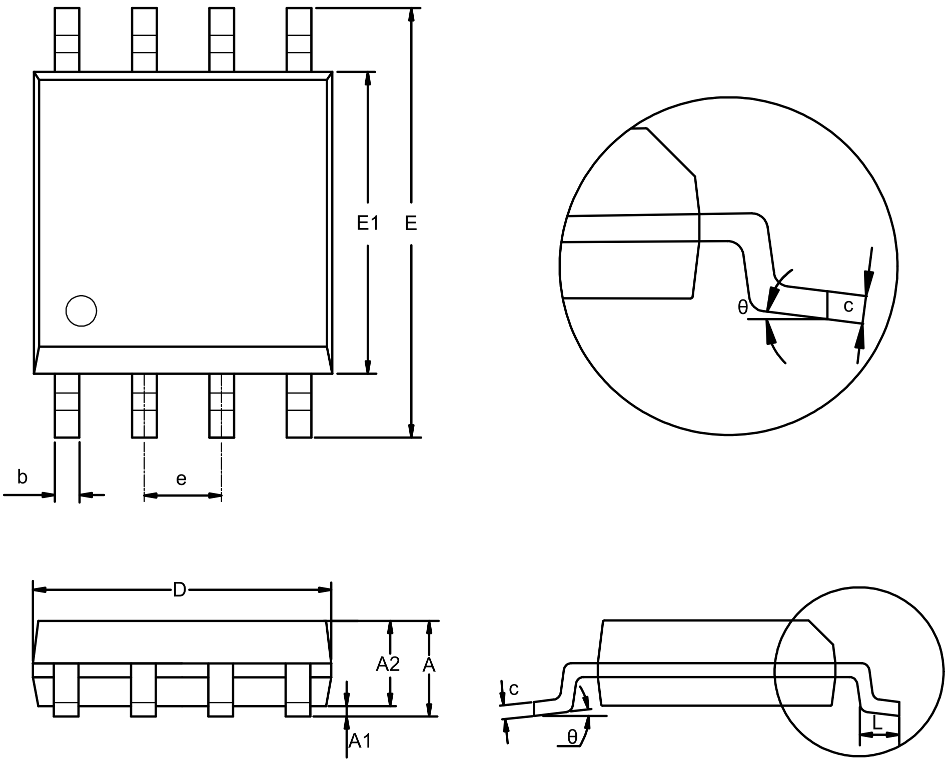
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.250	1.550	0.049	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	1.270 BSC		0.050 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.

MSOP8

Package Outline Dimensions VS1(MSOP-8-A)



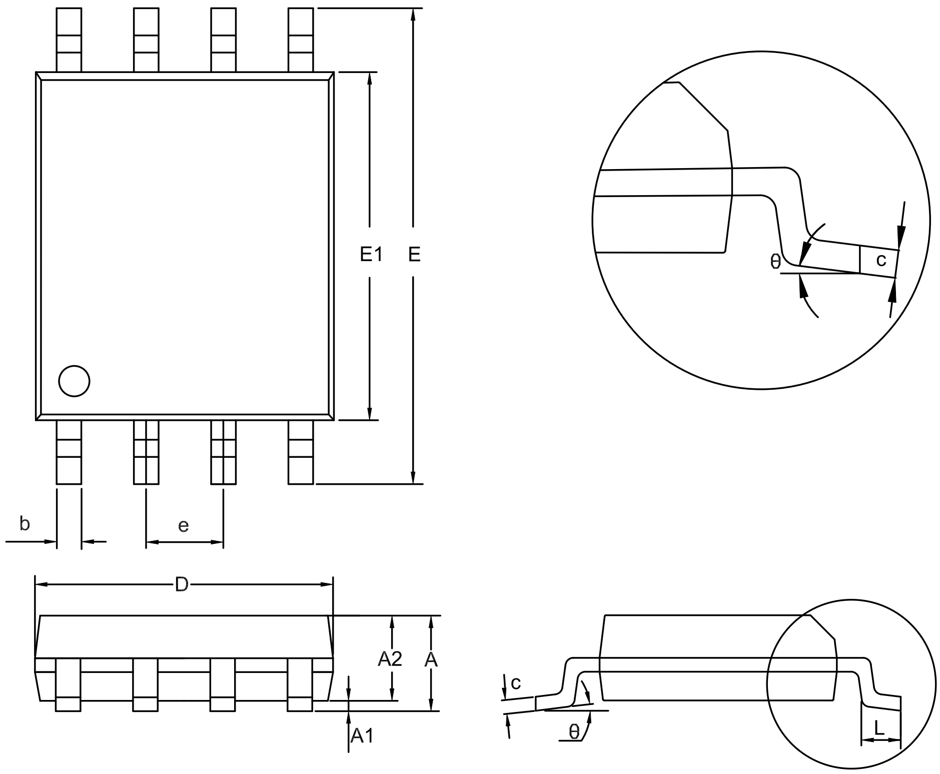
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.800	1.100	0.031	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	4.700	5.100	0.185	0.201
E1	2.900	3.100	0.114	0.122
e	0.650 BSC		0.026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



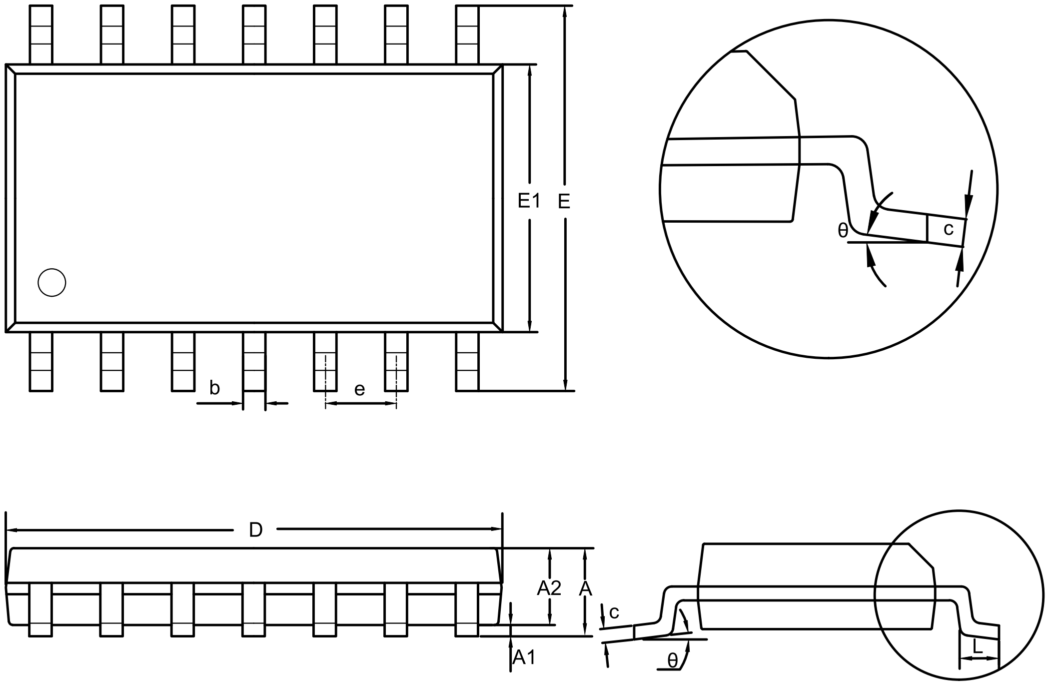
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.900	1.200	0.035	0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	2.900	3.100	0.114	0.122
E	6.200	6.600	0.244	0.260
E1	4.300	4.500	0.169	0.177
e	0.650 BSC		0.026 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.

SOP14

Package Outline Dimensions SO2(SOP-14-A)



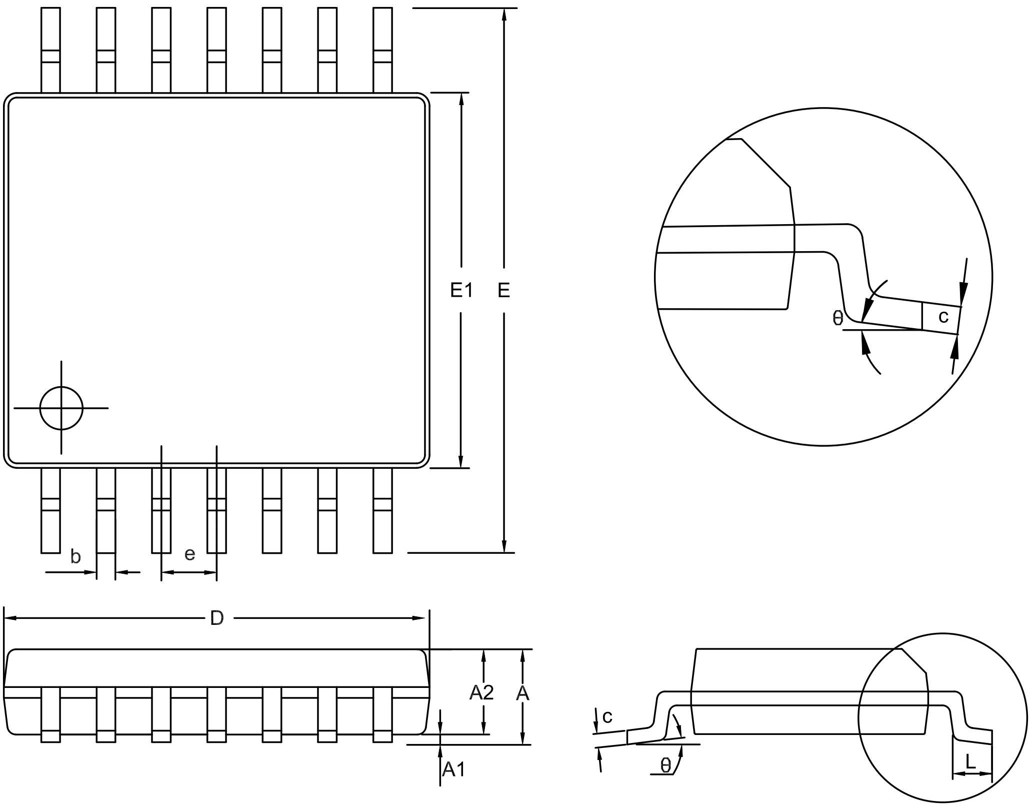
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.250	1.650	0.049	0.065
b	0.310	0.510	0.012	0.020
c	0.100	0.250	0.004	0.010
D	8.450	8.850	0.333	0.348
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	1.270 BSC		0.050 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.

Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
TPA2671-SC5R (1)	−40 to 125°C	SOT353 (SC70-5)	671	3	Tape and Reel, 3000	Green
TPA2671U-SC5R (1)	−40 to 125°C	SOT353 (SC70-5)	67U	3	Tape and Reel, 3000	Green
TPA2671-S5TR	−40 to 125°C	SOT23-5	671	3	Tape and Reel, 3000	Green
TPA2671U-S5TR (1)	−40 to 125°C	SOT23-5	67U	3	Tape and Reel, 3000	Green
TPA2672-SO1R	−40 to 125°C	SOP8	A2672	3	Tape and Reel, 4000	Green
TPA2672-TS1R	−40 to 125°C	TSSOP-8	A2672	3	Tape and Reel, 3000	Green
TPA2672-VS1R	−40 to 125°C	MSOP8	A2672	3	Tape and Reel, 3000	Green
TPA2674-SO2R	−40 to 125°C	SOP14	A2674	3	Tape and Reel, 2500	Green
TPA2674-TS2R	−40 to 125°C	TSSOP14	A2674	3	Tape and Reel, 3000	Green

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

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

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