36-V, 10-MHz, High PSRR, Op Amps

Features

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

Applications

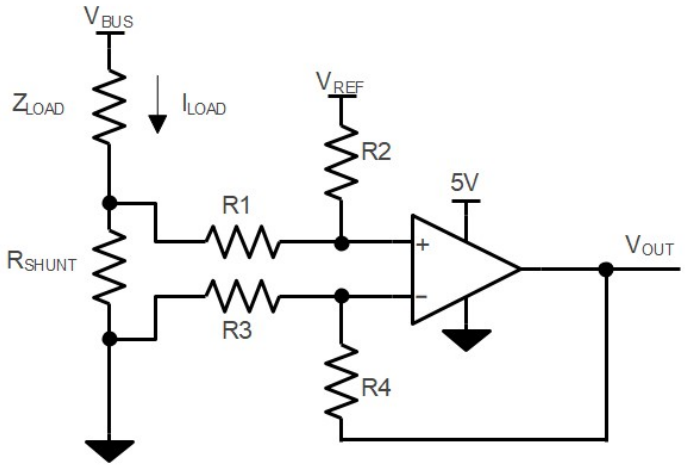
- Sensor Interface
- Motor Control
- Industrial Control
- Audio

Description

The TPA267x series amplifiers are the newest high-supply voltage amplifiers with low offset, low power, and stable high-frequency response. They incorporate proprietary and patented design techniques to achieve very good AC performance with 10-MHz bandwidth, 15-V/μs slew rate. The high PSRR performance increases the immunity to high-frequency noise from power supply. The input common-mode voltage range extends to V–, and the outputs swing rail-to-rail. The 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 devices an ideal choice for industrial control, motor control, and other applications that need the amplifer to be robust and high immunity to noise from the power supply.

Typical Application Circuit OPA



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

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

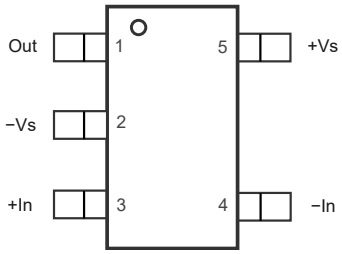
Table of Contents

Revision History

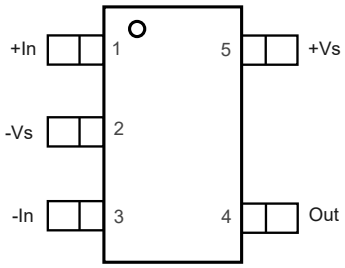
Date	Revision	Notes
2023-11-27	Rev.A.0	Initial version.
2024-1-3	Rev.A.1	Removed the minimum Isc value.
2024-2-6	Rev.A.2	Modified the pin configuration of SOP8. The physical object has not changed, just a correction of hand writing errors.

Pin Configuration and Functions

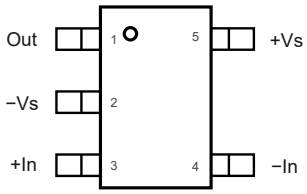
TPA2671
SOT23-5 Package
Top View



TPA2671U
SOT23-5 Package
Top View



TPA2671
SOT353-5(SC70) Package
Top View



TPA2671U
SOT353-5(SC70) Package
Top View

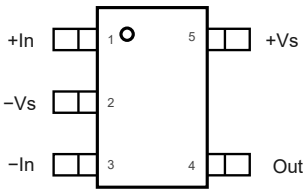
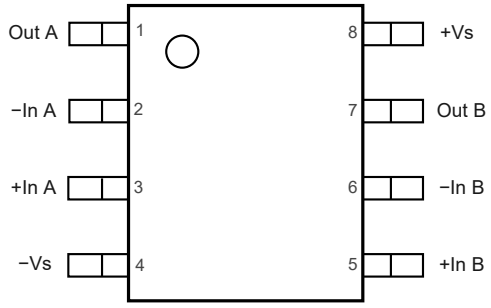


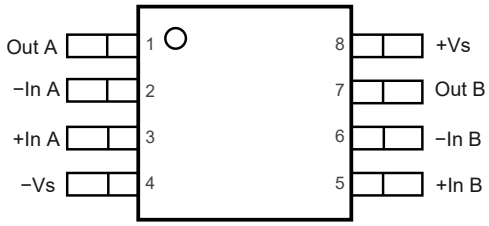
Table 1. Pin Functions: TPA2671, TPA2671U

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

TPA2672
SOP8 Package
Top View



TPA2672
MSOP8 Package
Top View



TPA2672
TSSOP8 Package
Top View

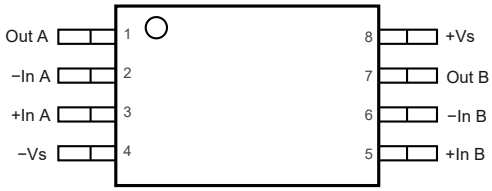
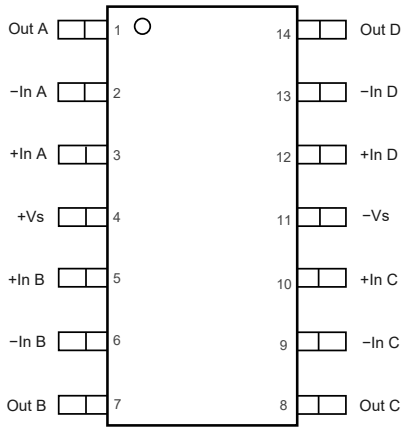


Table 2. Pin Functions: TPA2672

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

TPA2674
SOP14 Package
Top View



TPA2674
TSSOP14 Package
Top View

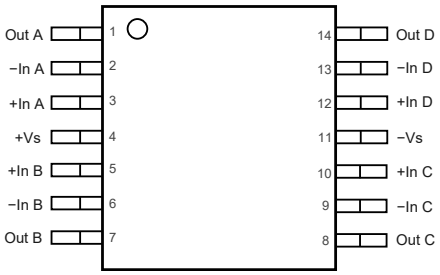


Table 3. Pin Functions: TPA2674

Pin		Name	I/O	Description
SOP14	TSSOP14			
1		Out A	Output	Output
2		−In A	Input	Inverting input
3		+In A	Input	Noninverting input
4		$+V_S$		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		$-V_S$		Negative power supply
12		+In D	Input	Noninverting input
13		−In D	Input	Inverting input
14		Out D	Output	Output

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

Package Type	θ_{JA}	θ_{JC}	Unit
TSSOP8	191	50	°C/W
MSOP8	210	45	°C/W
SOP14	120	36	°C/W
TSSOP14	180	35	°C/W

Electrical Characteristics

Test condition is at V_S = 36 V, T_A = 25°C, R_L = 10 kΩ, unless otherwise noted

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
Av	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-)		(V+)-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 = −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

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
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 = 1kHz		38		nV/√Hz
THD+N	Total Harmonic Distortion and Noise	f = 1 kHz, G =1, No road, V_{OUT} = 2 V_{pp}		0.0001		%

(1) Provided by bench test and design simulation.
(2) Provided by design simulation.

Typical Performance Characteristics

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

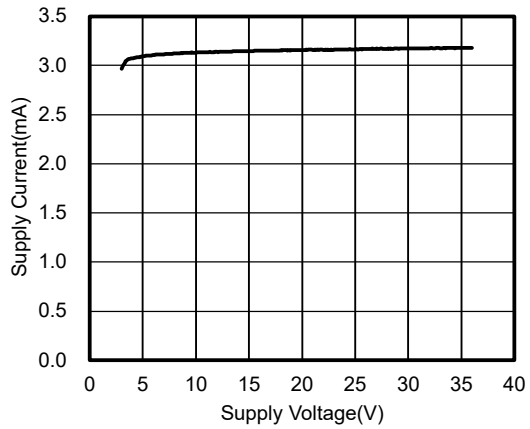


Figure 1. Supply Current vs Supply Voltage, dual channel

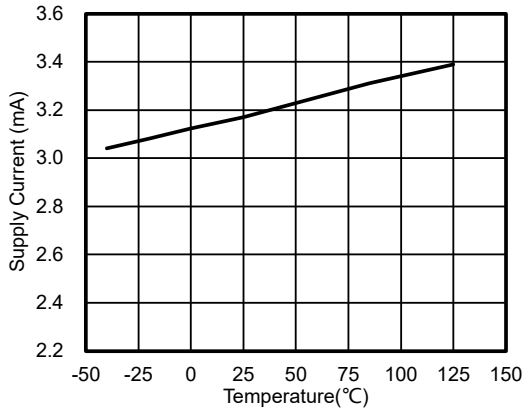


Figure 2. Supply Current vs Temperature, dual channel

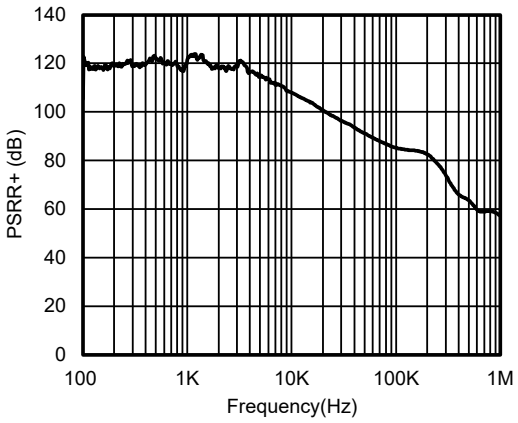


Figure 3. PSRR+ vs Frequency

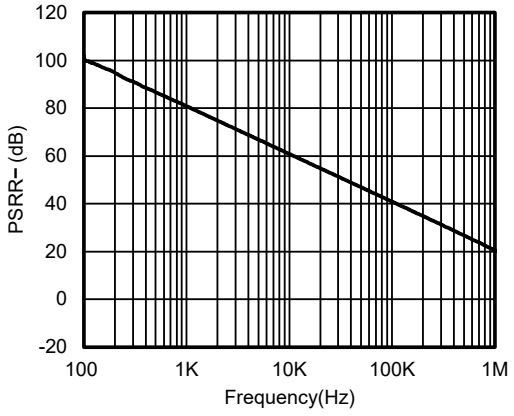


Figure 4. PSRR− vs Frequency

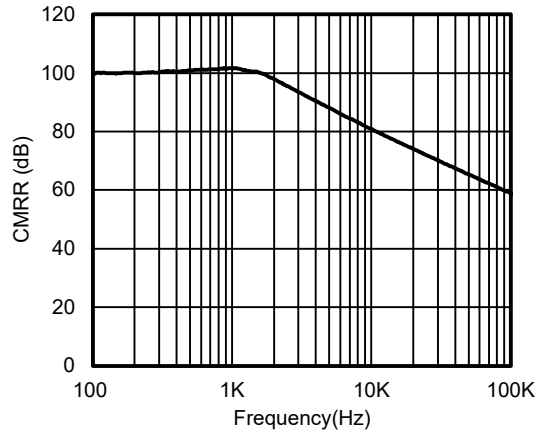


Figure 5. CMRR vs Frequency

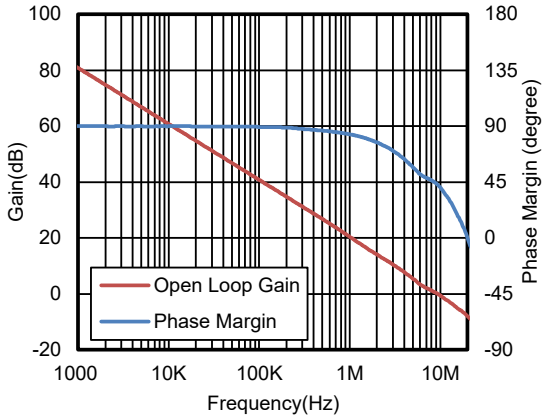


Figure 6. Open Loop Gain and Phase Margin vs Frequency, RL = 10 kΩ

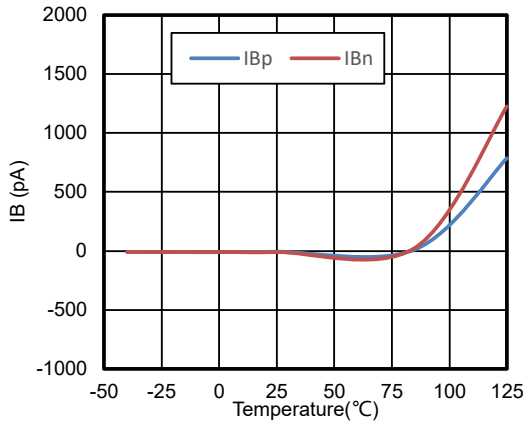


Figure 7. I_B vs Temperature

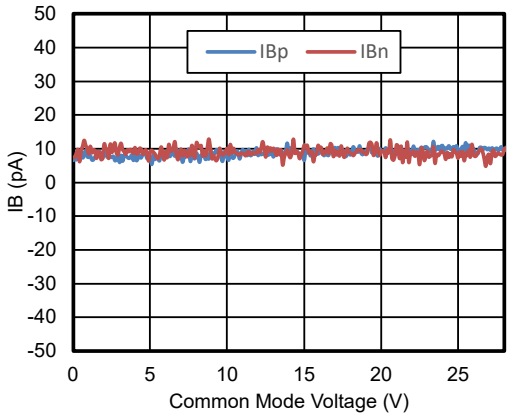


Figure 8. I_B vs V_{CM}

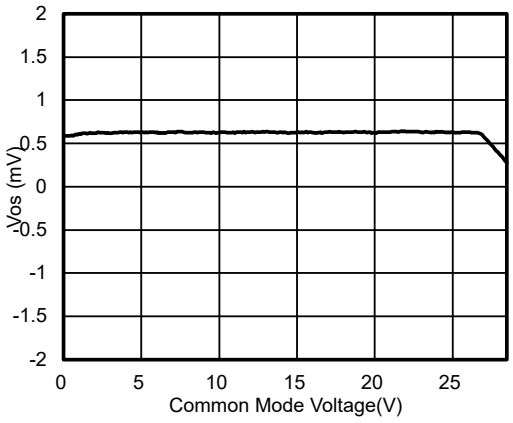


Figure 9. V_{OS} vs V_{CM}, V_S = 30 V

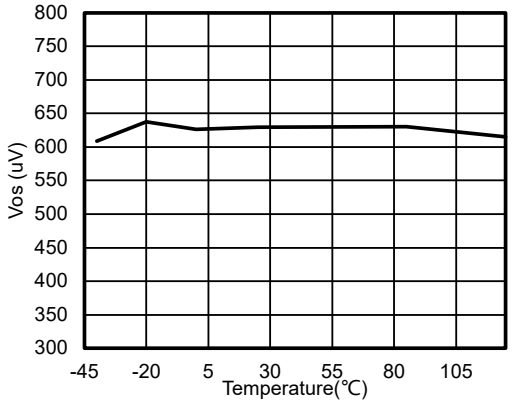


Figure 10. V_{OS} vs Temperature

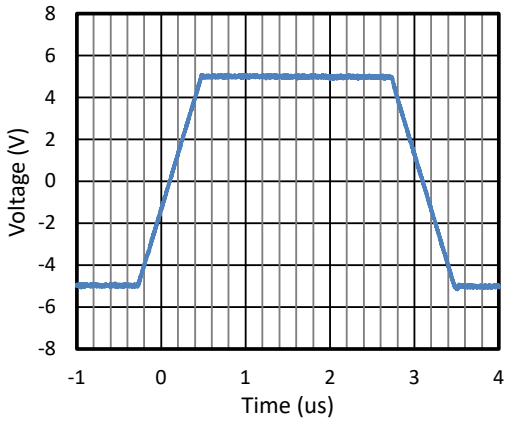


Figure 11. Large Signal Step Response

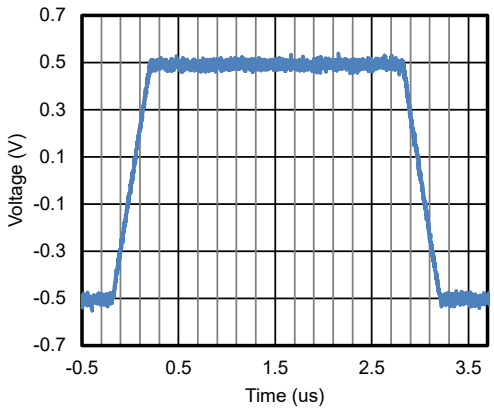


Figure 12. Small Signal Step Response

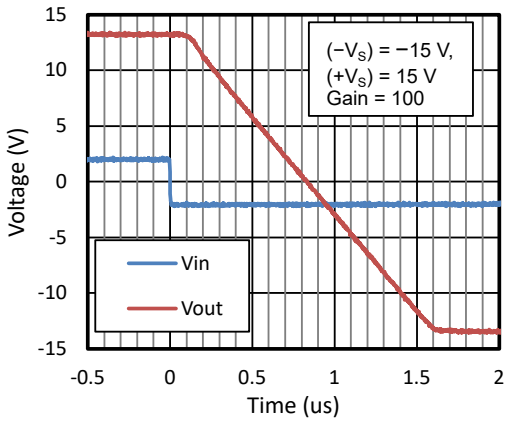


Figure 13. Overload Recovery at Negative Rail

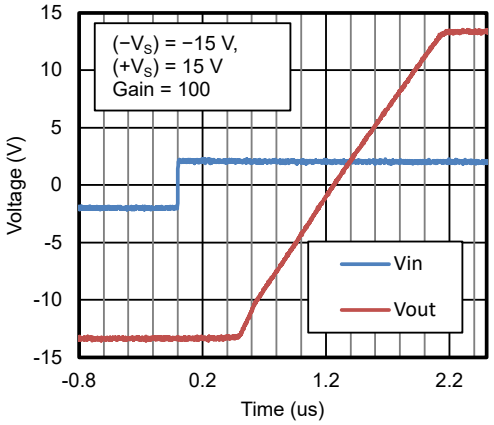


Figure 14. Overload Recovery at Positive Rail

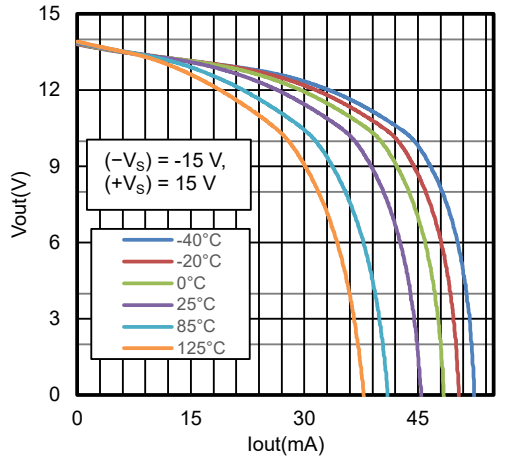


Figure 15. V_{OUT} vs. I_{OUT}, Source

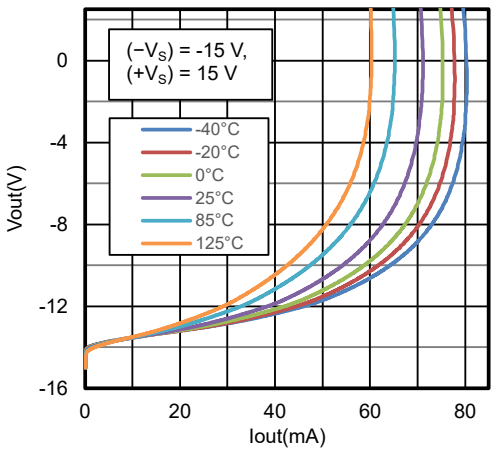


Figure 16. V_{OUT} vs. I_{OUT}, Sink

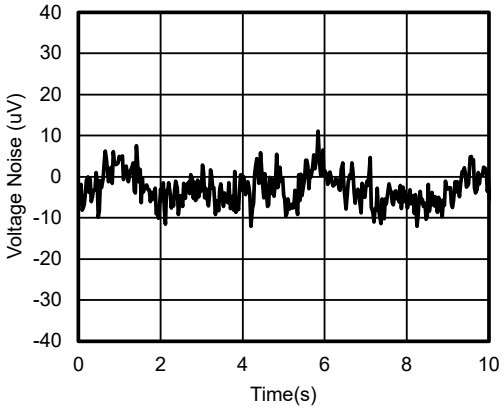


Figure 17. 0.1 to 10 Hz Voltage Noise

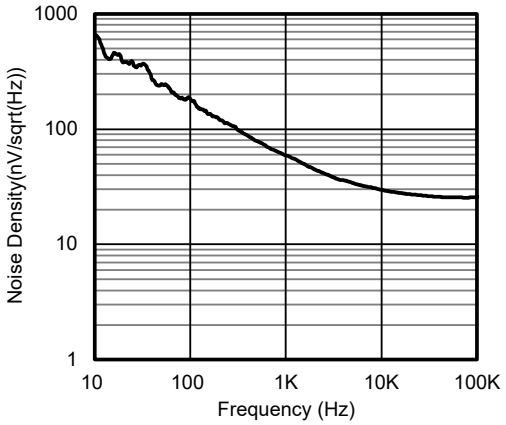


Figure 18. Voltage Noise Spectral Density vs Frequency

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

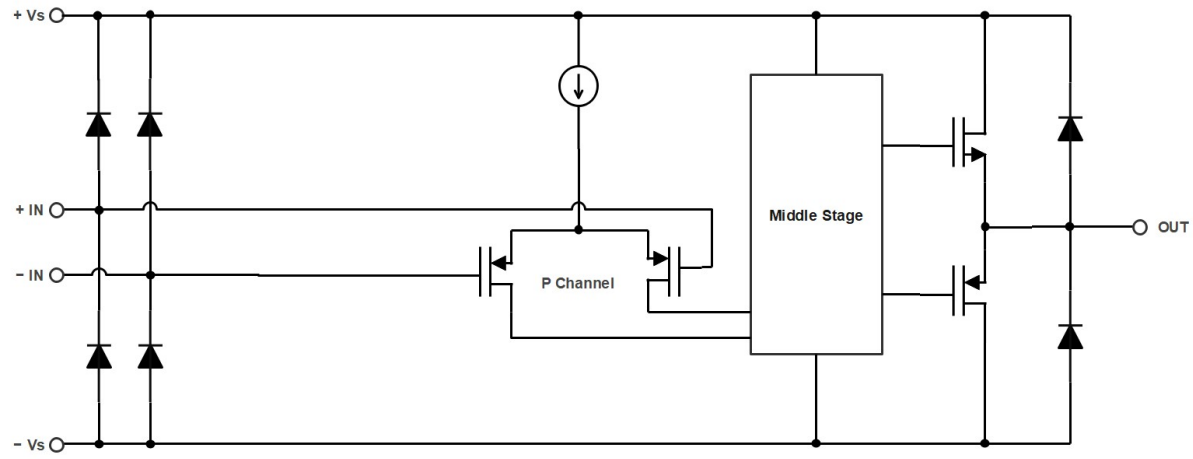


Figure 19. Functional Block Diagram

Feature Description

Operating Voltage

The device is designed for single supply operation from 4 V to 36 V or dual supply operation from ±2 V to ±18 V.

High AC PSRR

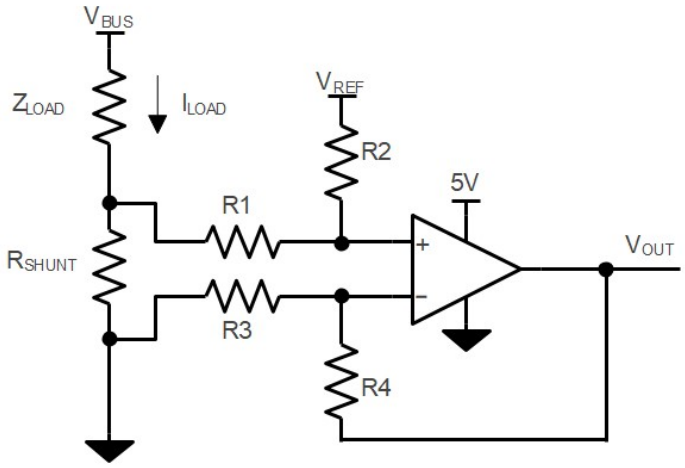
Any ac signal, which includes noise, riding on the dc supply lines will exercise the op amp's PSRR capabilities. PSRR is highest at dc and low ac frequencies and then rolls off with increased frequency. However, the PSRR of TPA267x is not only ultra high at dc but also maintain 80dB at about 100K frequency, which can increase the immunity to the high frequency noise from switching power supply。

Application and Implementation

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 consists of placing a sense resistor between the load and the circuit ground. The voltage dropping across the resistor is amplified by different amplifier circuits with the device. The V_{REF} can be used to add bias voltage to 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

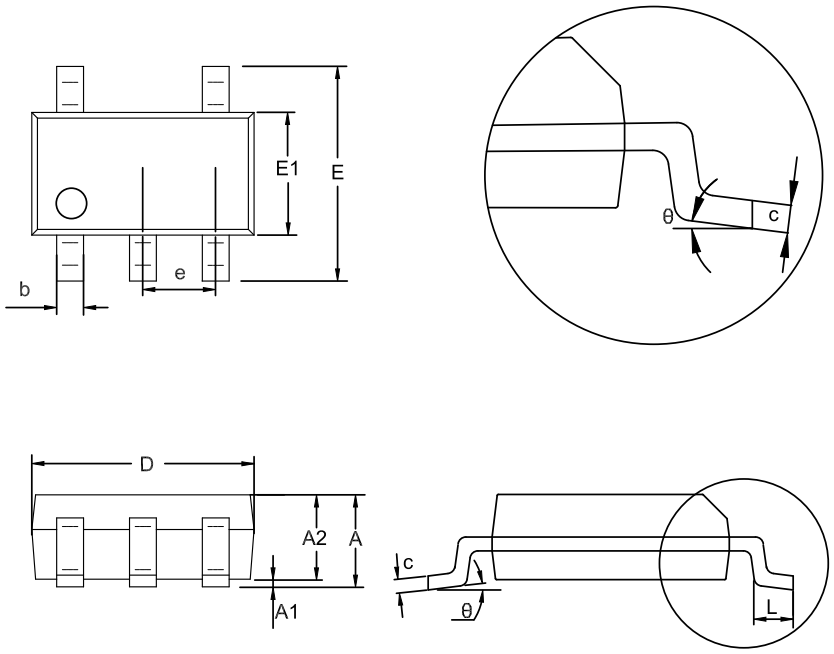
Power Supply Recommendations

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

Package Outline Dimensions

SOT23-5

Package Outline Dimensions S5T(SOT23-5-A)



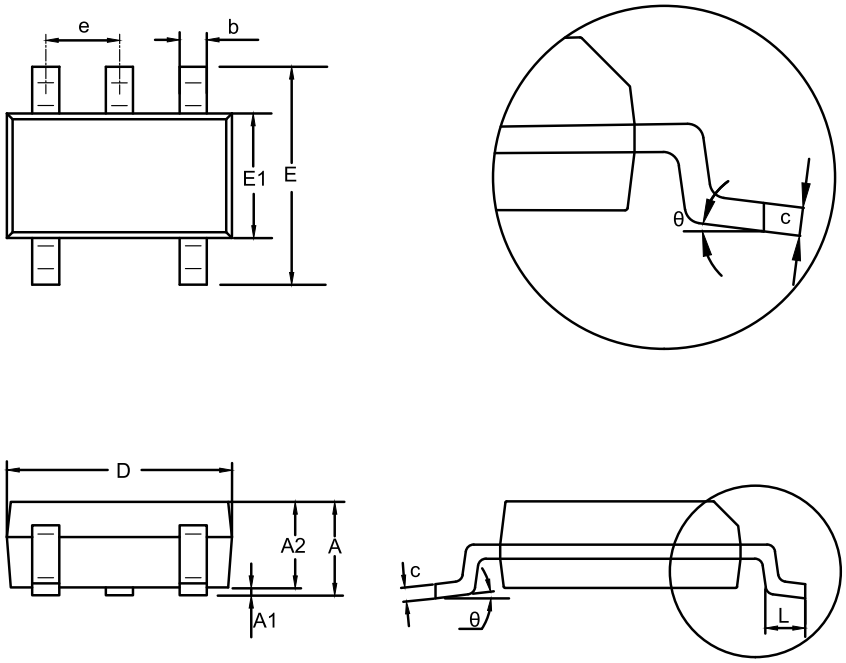
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.150	0.000	0.006
A2	1.000	1.200	0.039	0.047
b	0.280	0.500	0.011	0.020
c	0.100	0.230	0.004	0.009
D	2.820	3.020	0.111	0.119
E	2.600	3.000	0.102	0.118
E1	1.500	1.720	0.059	0.068
e	0.950 BSC		0.037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

SOT353-5(SC70-5)

Package Outline Dimensions SC5(SOT353-5-A)



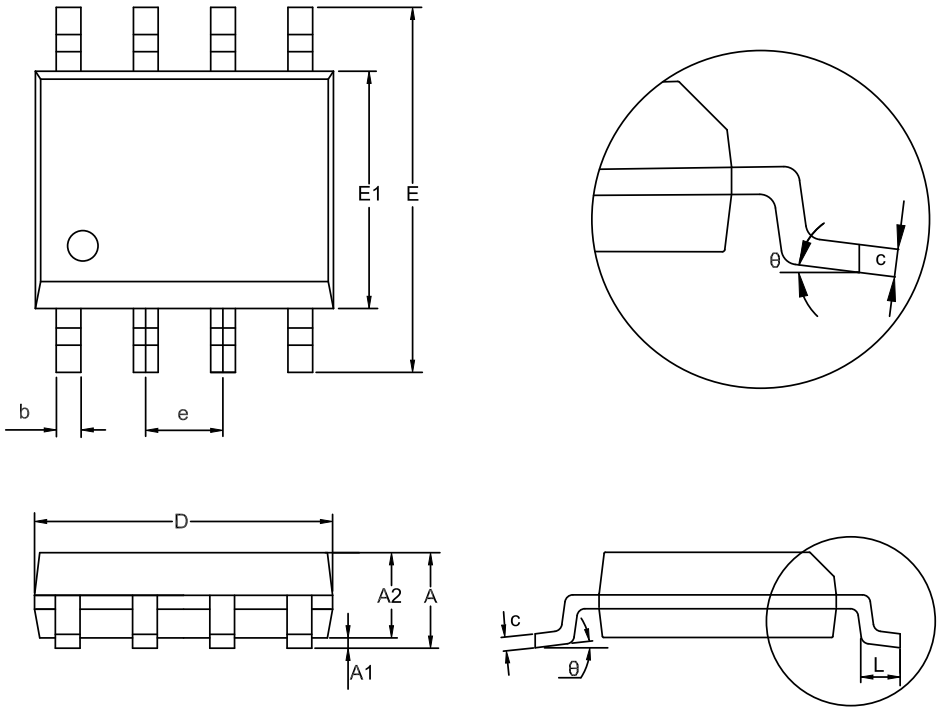
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.850	1.100	0.033	0.043
A1	0.000	0.100	0.000	0.004
A2	0.800	1.000	0.031	0.039
b	0.150	0.350	0.006	0.014
c	0.110	0.230	0.004	0.009
D	2.000	2.200	0.079	0.087
E	2.150	2.450	0.085	0.096
E1	1.150	1.350	0.045	0.053
e	0.650 BSC		0.026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



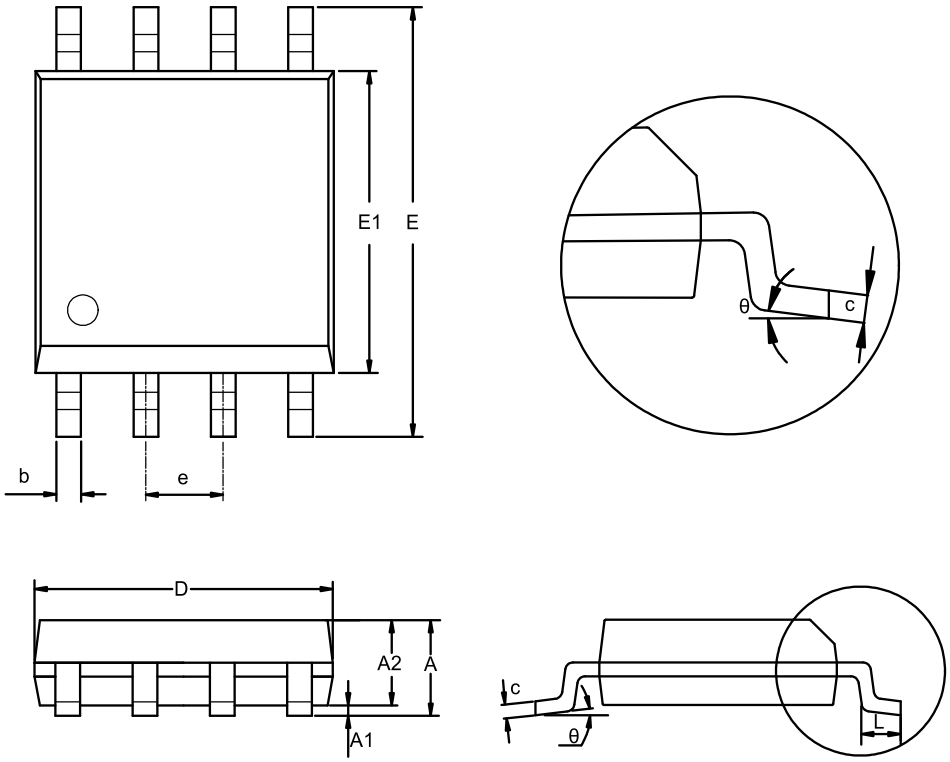
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.250	1.550	0.049	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	1.270 BSC		0.050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



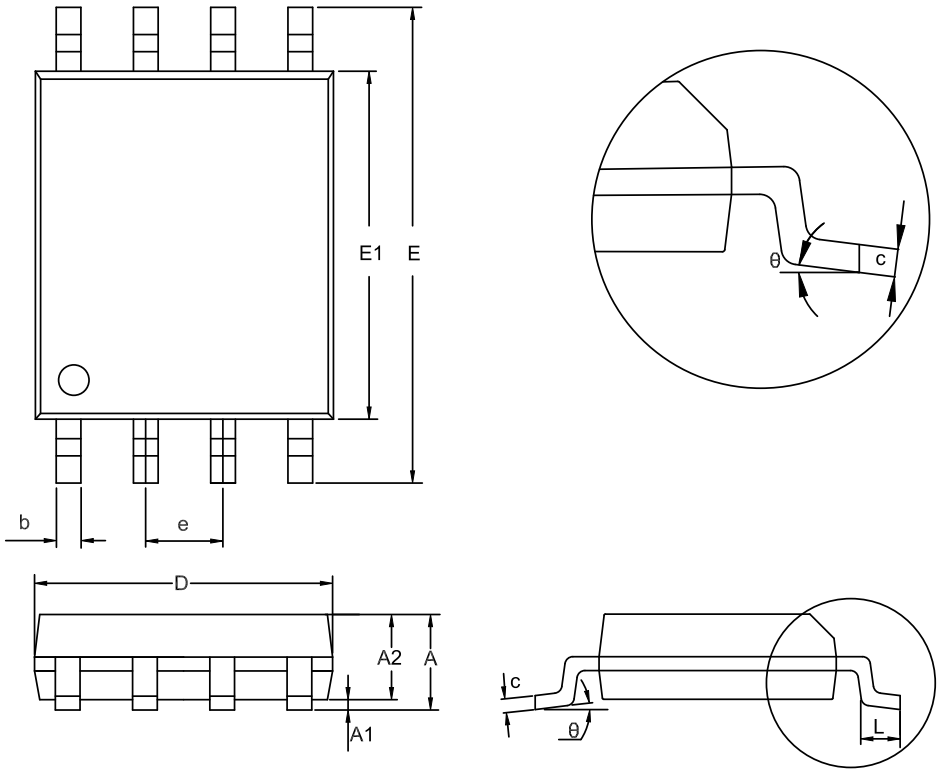
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.800	1.100	0.031	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	4.700	5.100	0.185	0.201
E1	2.900	3.100	0.114	0.122
e	0.650 BSC		0.026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



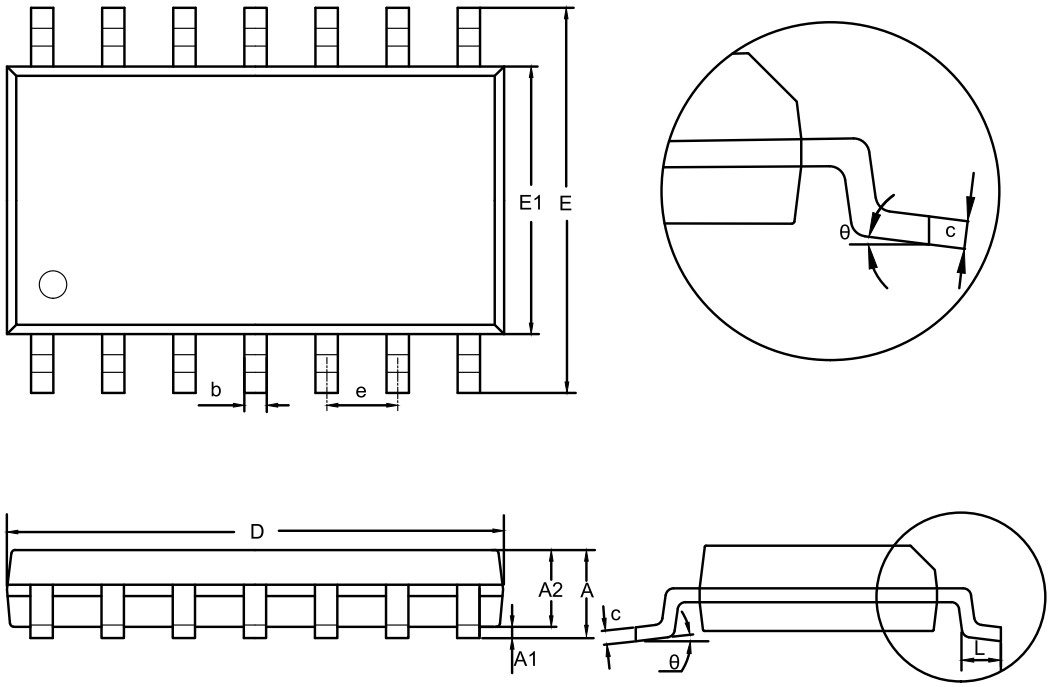
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.900	1.200	0.035	0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	2.900	3.100	0.114	0.122
E	6.200	6.600	0.244	0.260
E1	4.300	4.500	0.169	0.177
e	0.650 BSC		0.026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



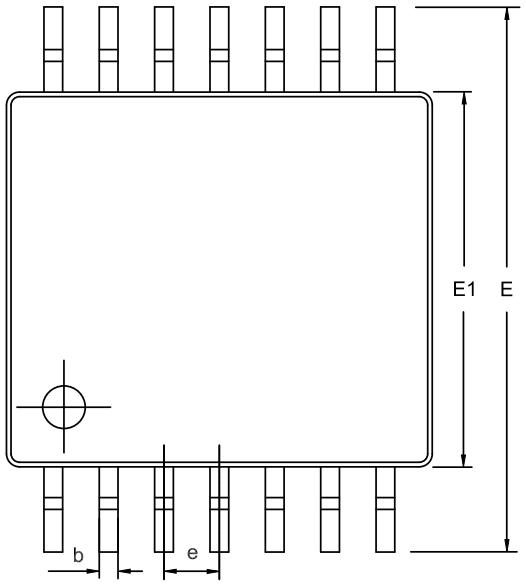
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.250	1.650	0.049	0.065
b	0.310	0.510	0.012	0.020
c	0.100	0.250	0.004	0.010
D	8.450	8.850	0.333	0.348
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	1.270 BSC		0.050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

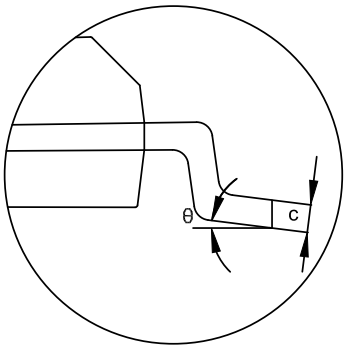
NOTES

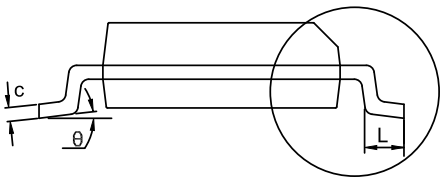
1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

TSSOP14

Package Outline Dimensions TS2(TSSOP-14-A)





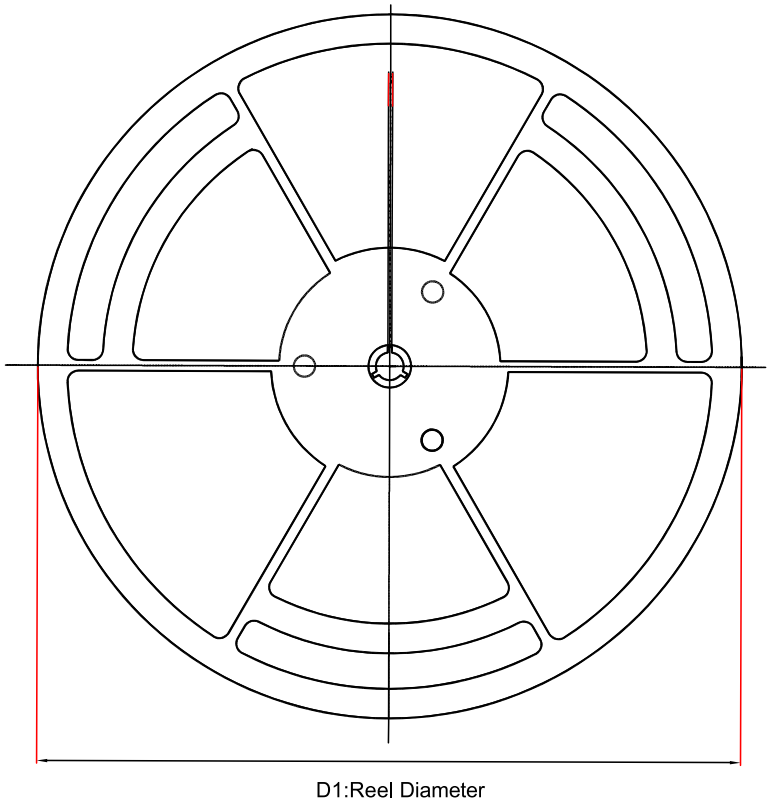


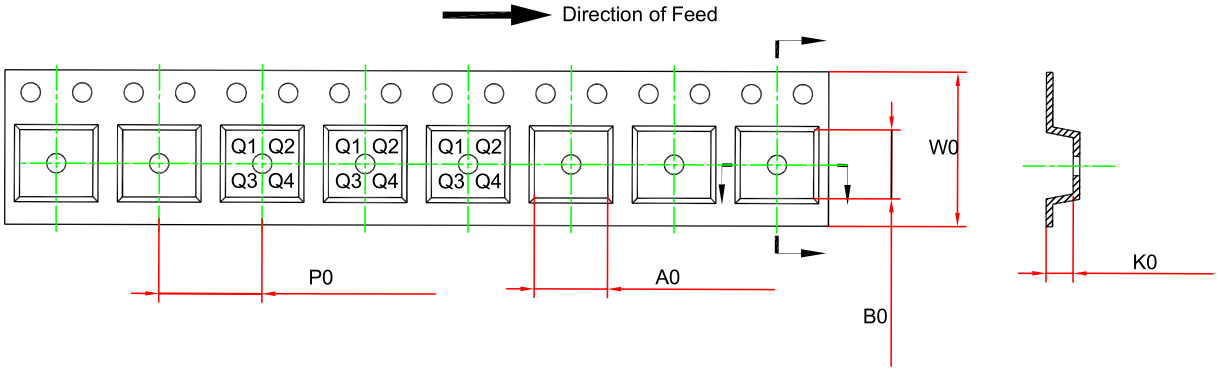
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.900	1.200	0.035	0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.900	5.100	0.193	0.201
E	6.200	6.600	0.244	0.260
E1	4.300	4.500	0.169	0.177
e	0.650 BSC		0.026 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.

Tape and Reel Information





Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	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	SOT353-5	178	12.1	2.4	2.5	1.2	4	8	Q3
TPA2671U-SC5R	SOT353-5	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)	B0 (mm)	K0 (mm)	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

Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
TPA2674-SO2R	-40 to 125°C	SOP14	A2674	MSL3	Tape and Reel,2500	Green
TPA2674-TS2R	-40 to 125°C	TSSOP14	A2674	MSL3	Tape and Reel,3000	Green
TPA2671-SC5R(1)	-40 to 125°C	SOT353-5	671	MSL3	Tape and Reel,3000	Green
TPA2671U-SC5R(1)	-40 to 125°C	SOT353-5	67U	MSL3	Tape and Reel,3000	Green
TPA2671-S5TR	-40 to 125°C	SOT23-5	671	MSL3	Tape and Reel,3000	Green
TPA2671U-S5TR(1)	-40 to 125°C	SOT23-5	67U	MSL3	Tape and Reel,3000	Green
TPA2672-SO1R	-40 to 125°C	SOP8	A2672	MSL3	Tape and Reel,4000	Green
TPA2672-TS1R(1)	-40 to 125°C	TSSOP-8	A2672	MSL3	Tape and Reel,3000	Green
TPA2672-VS1R	-40 to 125°C	MSOP8	A2672	MSL3	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.

IMPORTANT NOTICE AND DISCLAIMER

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

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

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

This page intentionally left blank