

Features

- Supply Voltage: 3 V to 36 V
- Offset Voltage: ± 3.5 mV Maximum at 25°C
- Rail-to-Rail Input and Output
- Bandwidth: 4.6 MHz
- Slew Rate: 3.5 V/ μ s
- Low Noise: 53 nV/ $\sqrt{\text{Hz}}$ at 1 kHz
- Zero-Crossover Input:
 - Excellent THD+N: 0.0008 %

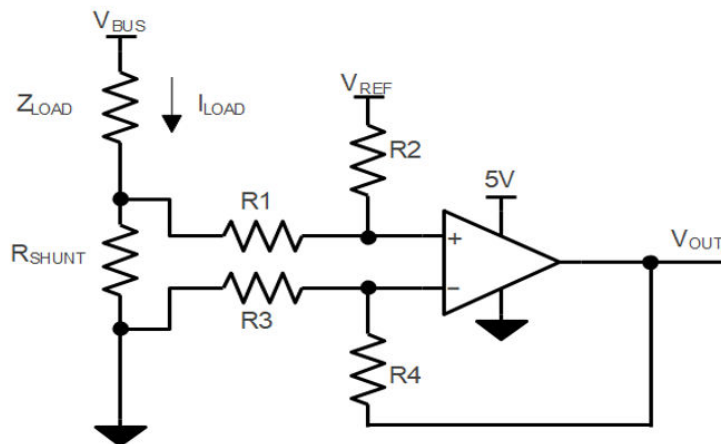
Applications

- Industrial Control
- Power Supply
- Audio Equipment

Description

The TPA277x is a series of the newest high-supply-voltage amplifiers with 3.5-mV low-offset voltage, low noise, and stable high-frequency response. The series incorporates proprietary and patented design techniques to achieve excellent AC performance with a 4-MHz bandwidth, a 3.5-V/ μ s slew rate, and low distortion while drawing a quiescent current of 1 mA per amplifier. The input common-mode voltage extends to $-V_S$ and $+V_S$, and the output swings rail-to-rail. The amplifier can be used as a plug-in replacement for commercially available op amps to improve performance.

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

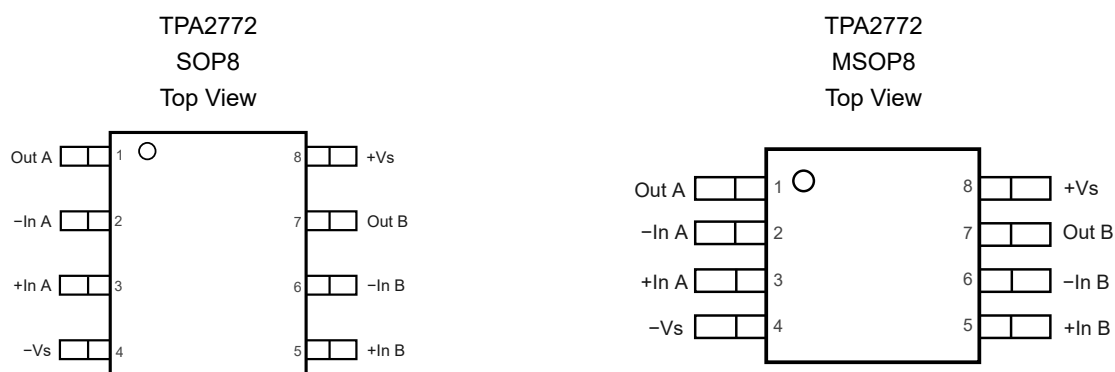
Date	Revision	Notes
2025-01-26	Rev.A.0	Initial version.
2025-05-09	Rev.A.1	Updated the Electrical Characteristics: • V_{OS}, $V_S = 5\text{ V}$, $V_{CM} = 0\text{ V}$ to 5.1 V: from Min -2.5, Max 2.5 to Min -3, Max 3. • V_{OS}, $V_S = 5\text{ V}$, $V_{CM} = 0\text{ V}$ to 5.1 V, $T_A = -40^\circ\text{C}$ to 125°C: from Min -3.5, Max 3.5 to Min -4, Max 4.

Pin Configuration and Functions

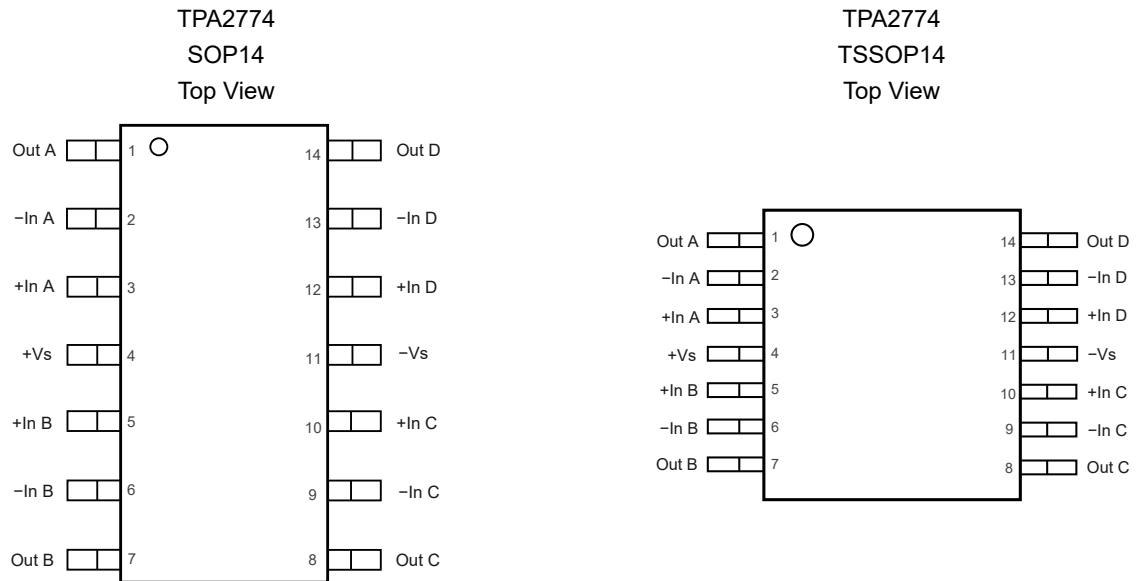


Table 1. Pin Functions: TPA2771/TPA2771U

Pin No.		Name	I/O	Description
TPA2771	TPA2771U			
1	4	Out	O	Output
2	2	-Vs	-	Negative power supply
3	1	+In	I	Non-inverting input
4	3	-In	I	Inverting input
5	5	+Vs	-	Positive power supply


Table 2. Pin Functions: TPA2772

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


Table 3. Pin Functions: TPA2774

Pin No.		Name	I/O	Description
SOP14	TSSOP14			
1	1	Out A	O	Output
2	2	-In A	I	Inverting input
3	3	+In A	I	Non-inverting input
4	4	+Vs		Positive power supply
5	5	+In B	I	Non-inverting input
6	6	-In B	I	Inverting input
7	7	Out B	O	Output
8	8	Out C	O	Output
9	9	-In C	I	Inverting input
10	10	+In C	I	Non-inverting input
11	11	-Vs		Negative power supply
12	12	+In D	I	Non-inverting input
13	13	-In D	I	Inverting input
14	14	Out D	O	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
	Input Current: +IN, –IN ⁽²⁾	–10	10	mA
	Output Short-Circuit Duration ⁽³⁾		Infinite	
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 the 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 rating. This depends on the power dissipation of the application. The thermal resistance varies with the amount of PC board metal connected to the package.

ESD, Electrostatic Discharge Protection

Symbol	Parameter	Condition	Minimum Level	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⁾	1.5	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)	3		36	V

Thermal Information

Package Type	θ _{JA}	θ _{Jc}	Unit
SOT23-5	250	81	°C/W
SOP8	158	43	°C/W
MSOP8	210	45	°C/W
SOP14	120	36	°C/W

Package Type	θ_{JA}	θ_{JC}	Unit
TSSOP14	180	35	°C/W

Electrical Characteristics

All test conditions: $V_S = 36\text{ V}$, $T_A = 25^\circ\text{C}$, $R_L = 10\text{ k}\Omega$, unless otherwise noted.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Power Supply						
V _S	Supply Voltage Range	(+V _S) – (–V _S)	3		36	V
I _Q	Quiescent Current per Amplifier			1.25	1.7	mA
		T _A = –40°C to 125°C			2	mA
		V _S = 5 V		1	1.4	mA
		V _S = 5 V, T _A = –40°C to 125°C			1.7	mA
PSRR	Power Supply Rejection Ratio	V _S = 3 V to 36 V	82	105		dB
		V _S = 3 V to 36 V, T _A = –40°C to 125°C	78			dB
Input Characteristics						
V _{OS}	Input Offset Voltage	V _{CM} = 0 V to 36.1 V	–3.5	±0.8	3.5	mV
		V _{CM} = 0 V to 36.1 V, T _A = –40°C to 125°C	–5		5	mV
		V _S = 5 V, V _{CM} = 0 V to 5.1 V	–3	±0.5	3	mV
		V _S = 5 V, V _{CM} = 0 V to 5.1 V, T _A = –40°C to 125°C	–4		4	mV
V _{OS} TC	Input Offset Voltage Drift	T _A = –40°C to 125°C		1		μV/°C
I _B	Input Bias Current	V _{CM} = 18 V	–40	–20	40	nA
		V _{CM} = 18 V, T _A = –40°C to 125°C	–100		100	nA
I _{OS}	Input Offset Current	V _{CM} = 18 V	–10	1	10	nA
		V _{CM} = 18 V, T _A = –40°C to 125°C	–40		40	nA
R _{IN}	Input Resistance	Differential mode		3.5		MΩ
		Common mode		30		GΩ
C _{IN}	Input Capacitance	Differential mode		3		pF
		Common mode		2		pF
A _V	Open-Loop Voltage Gain	V _{OUT} = 0.5 V to 35.5 V	105	115		dB
		V _{OUT} = 0.5 V to 35.5 V, T _A = –40°C to 125°C	100			dB
V _{CMR}	Common-Mode Input Voltage Range		–V _S		(+V _S) + 0.1	V
CMRR	Common-Mode Rejection Ratio	V _{CM} = 0 V to 36.1 V	90	110		dB
		V _{CM} = 0 V to 36.1 V, T _A = –40°C to 125°C	85			dB

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
	Differential-Mode Input Voltage Range		(−V _S) − (+V _S)		(+V _S) − (−V _S)	
Output Characteristics						
	Output Swing from Rail	No load		5	20	mV
		No load, T _A = −40°C to 125°C			25	mV
		R _L = 10 kΩ to V _S / 2		60	100	mV
		R _L = 10 kΩ to V _S / 2, T _A = −40°C to 125°C			150	mV
		R _L = 2 kΩ to V _S / 2		300	500	mV
		R _L = 2 kΩ to V _S / 2, T _A = −40°C to 125°C			800	mV
	Output Swing from Negative Rail	V _S = 5 V, no load		3	10	mV
		V _S = 5 V, no load, T _A = −40°C to 125°C			15	mV
		V _S = 5 V, R _L = 10 kΩ to V _S / 2		10	30	mV
		V _S = 5 V, R _L = 10 kΩ to V _S / 2, T _A = −40°C to 125°C			50	mV
		V _S = 5 V, R _L = 2 kΩ to V _S / 2		50	100	mV
		V _S = 5 V, R _L = 2 kΩ to V _S / 2, T _A = −40°C to 125°C			150	mV
I _{SC}	Output Short-Circuit Current	V _S = 36 V		100		mA
		V _S = 5 V		50		mA
AC Specifications						
GBW	Gain-Bandwidth Product			4.6		MHz
SR	Slew Rate	G = 1, 10-V step	2.5	3.5		V/μs
		G = 1, 10-V step, T _A = −40°C to 125°C	1.7			V/μs
t _{OR}	Overload Recovery			1.5		μs
t _S	Settling Time, 0.1%	V _S = 36 V, 9-V step, R _L = 10 kΩ, C _L = 100 pF, G = 1		6		μs
	Capacitive Load Drive			0.1		nF
PM	Phase Margin	R _L = 10 kΩ, C _L = 50 pF		50		°
GM	Gain Margin	R _L = 10 kΩ, C _L = 50 pF		7.4		dB
	Crosstalk	V _{OUT} = 5 V _{pp} , f = 10 kHz, G = +11, R _L = 10 kΩ		115		dB
Noise Performance						
E _N	Input Voltage Noise	f = 0.1 Hz to 10 Hz		5.5		μV _{PP}
e _N	Input Voltage Noise Density	f = 10 Hz		274		nV/√Hz

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
		$f = 1 \text{ kHz}$		53		$\text{nV}/\sqrt{\text{Hz}}$
i_{IN}	Input Current Noise	$f = 1 \text{ kHz}$		0.2		$\text{pA}/\sqrt{\text{Hz}}$
THD+N	Total Harmonic Distortion and Noise	$V_{\text{S}} = 36 \text{ V}$, $V_{\text{IN}} = 1 \text{ V}_{\text{rms}}$, $R_{\text{L}} = 10 \text{ k}\Omega$, $A_{\text{V}} = +1$, $f = 1 \text{ kHz}$, $\text{BW} = 22 \text{ kHz}$		0.0008		%

Typical Performance Characteristics

All test conditions: $V_S = 30\text{ V}$, $T_A = +25^\circ\text{C}$, unless otherwise noted.

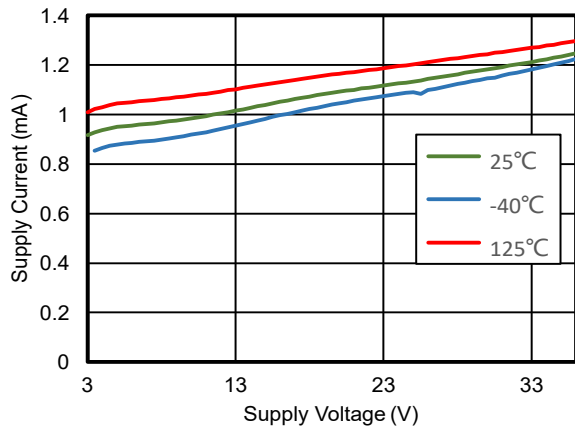


Figure 1. Supply Current vs. Supply Voltage, 1ch

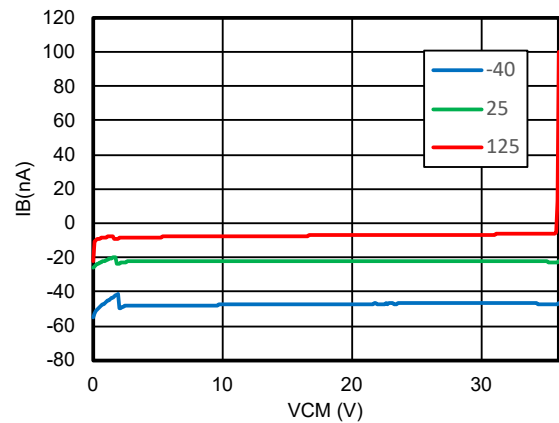


Figure 2. I_B vs. Common-Mode Voltage

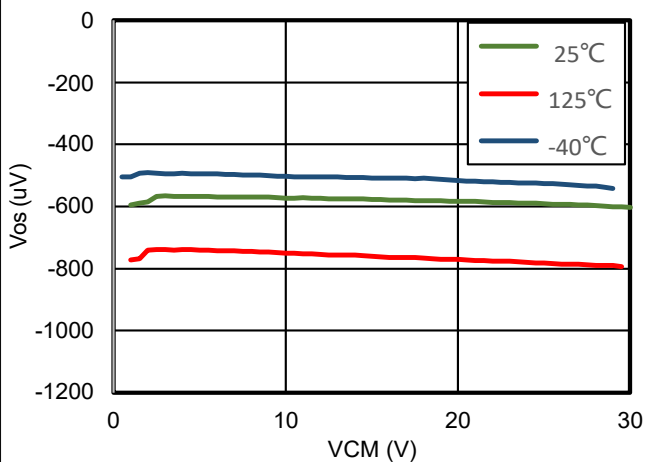


Figure 3. V_{OS} vs. Common-Mode Voltage

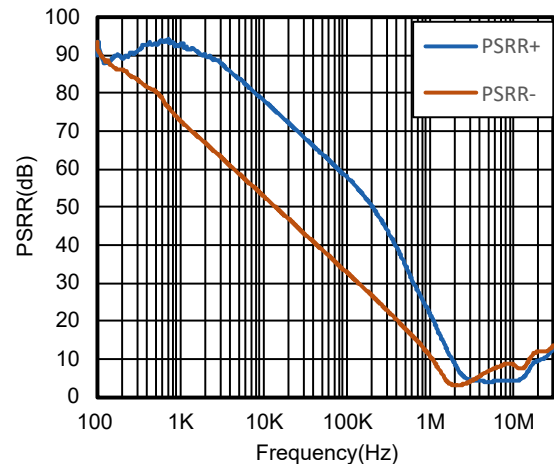


Figure 4. PSRR vs. Frequency

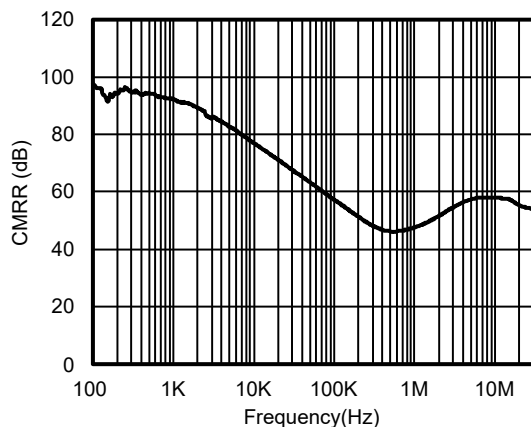


Figure 5. CMRR vs. Frequency

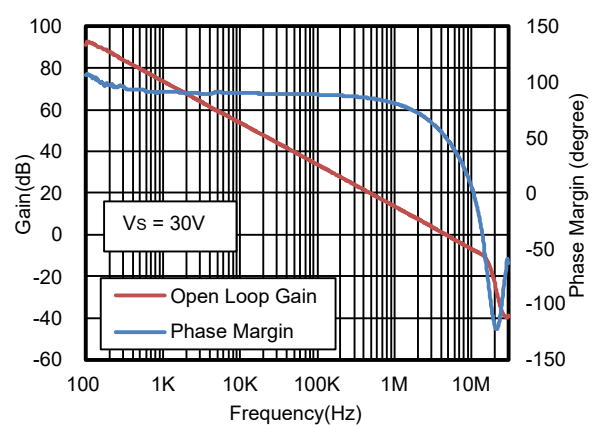
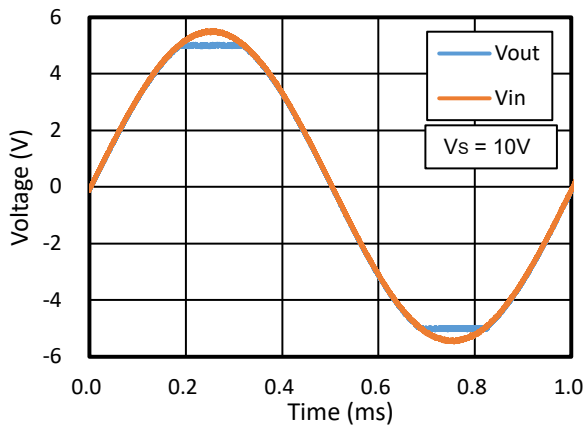
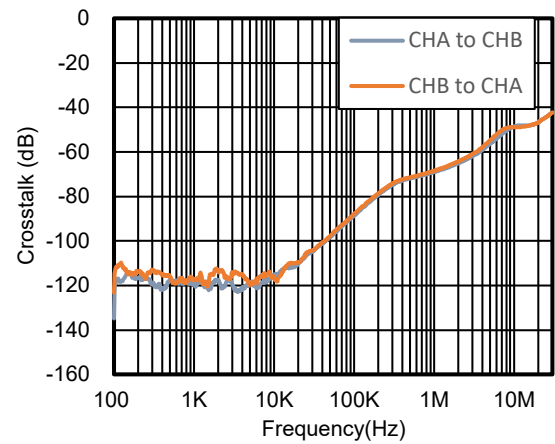
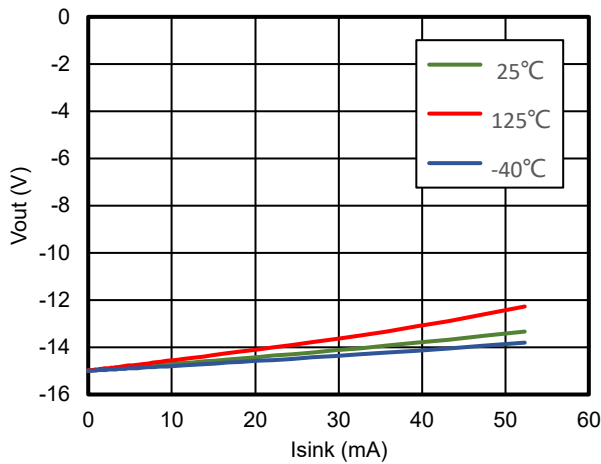
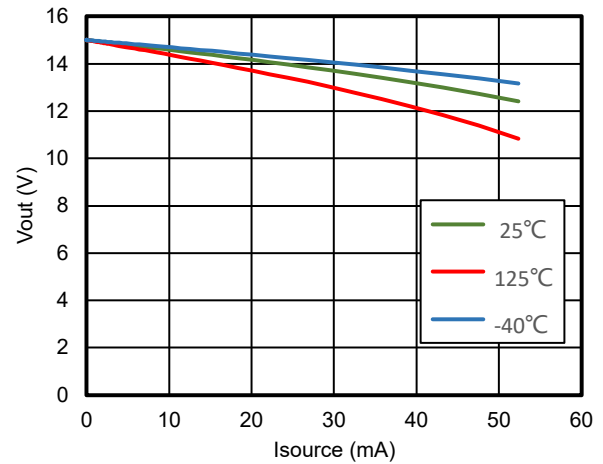
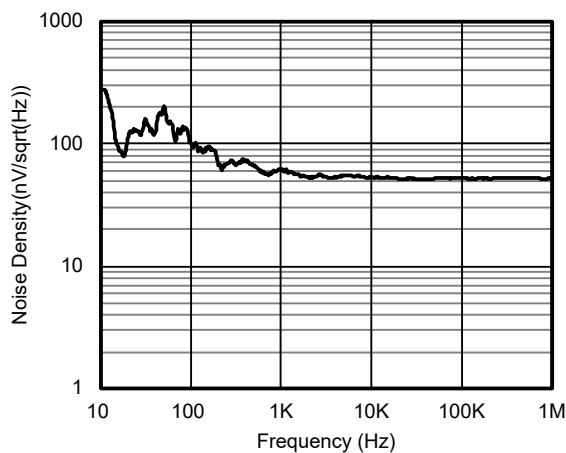
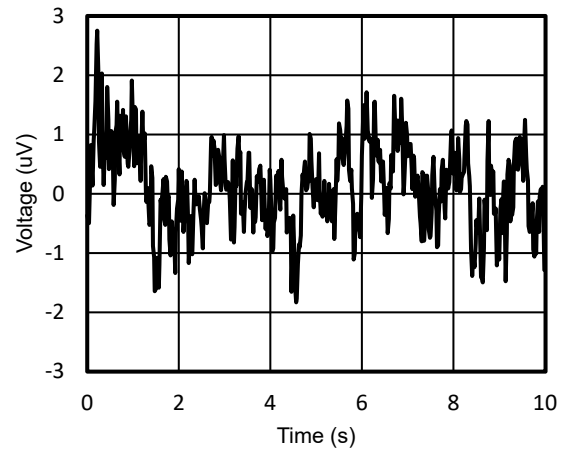
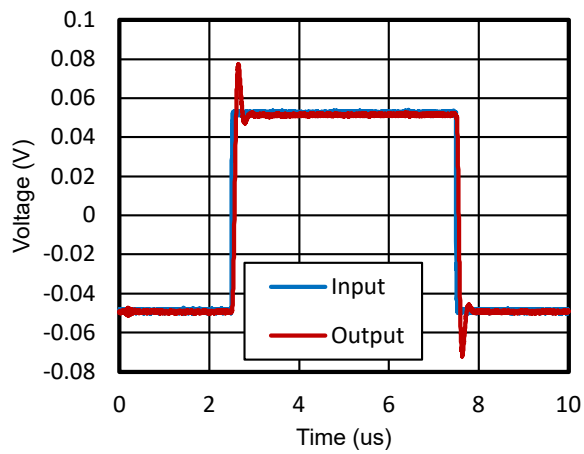
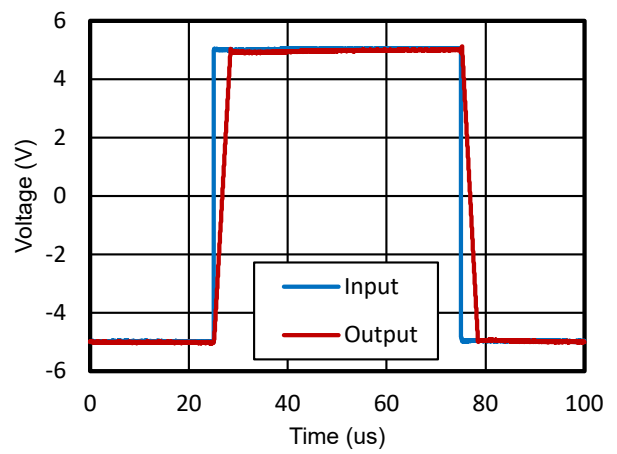
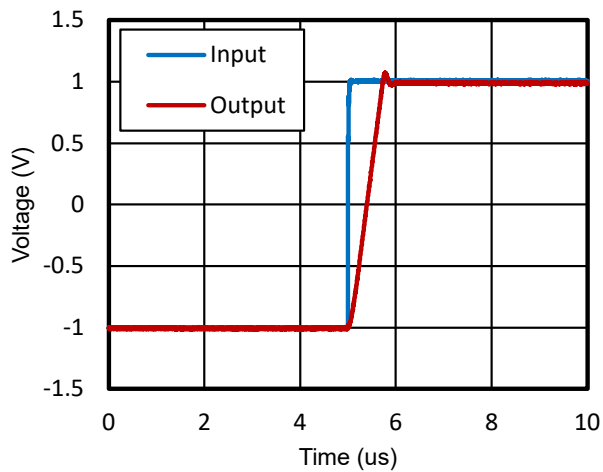
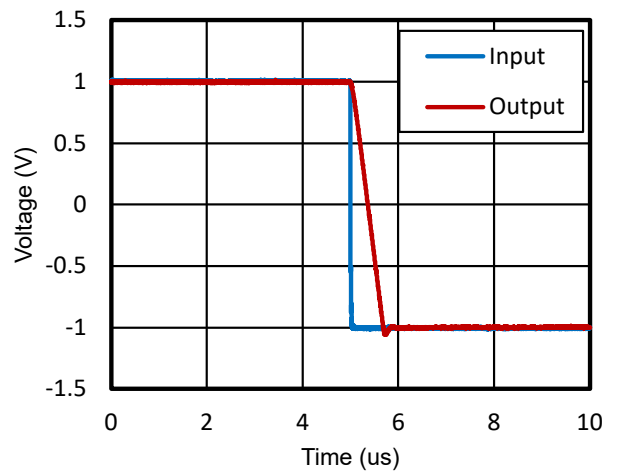
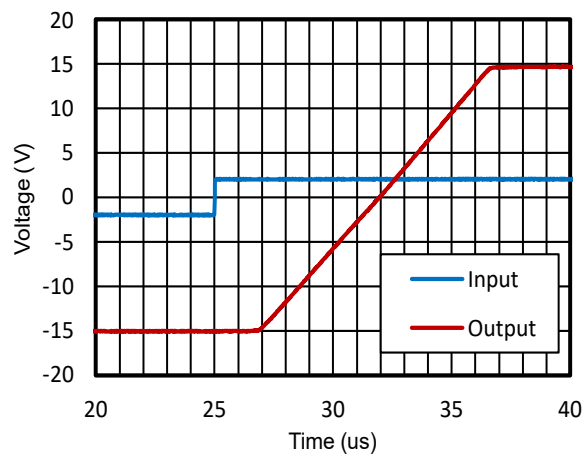
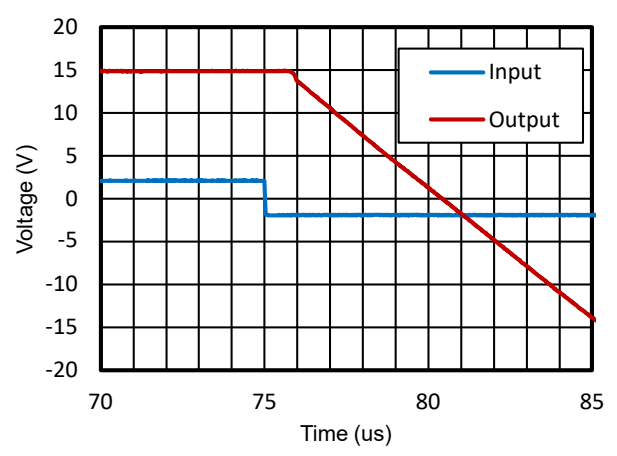


Figure 6. Open-Loop Gain and Phase vs. Frequency


Figure 7. No Phase Reversal

Figure 8. Channel Crosstalk vs Frequency

Figure 9. I_{sink} vs. V_{OUT}

Figure 10. I_{source} vs. V_{OUT}

Figure 11. Input Voltage Noise Spectral Density vs. Frequency

Figure 12. 0.1-Hz to 10-Hz Voltage Noise


Figure 13. 100-mV Small-Signal Step Response

Figure 14. 10-V Large-Signal Step Response

Figure 15. Positive Slew Rate

Figure 16. Negative Slew Rate

Figure 17. Overload Recovery

Figure 18. Overload Recovery

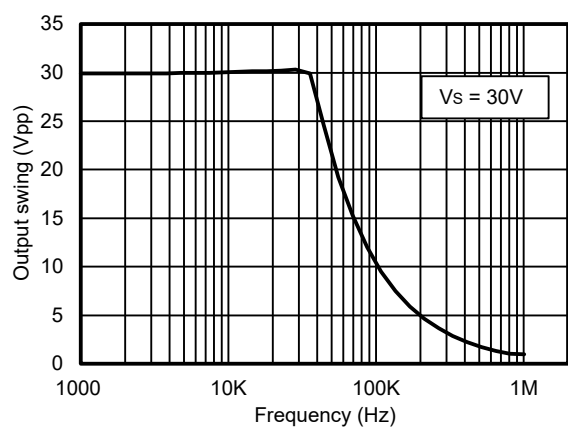


Figure 19. Maximum Output Voltage vs. Frequency

Detailed Description

Overview

The TPA277x is a series of op amps that operate on a single-supply voltage (3 V to 36 V), or a split-supply voltage (± 1.5 V to ± 18 V), making the series highly versatile and easy to use. The power-supply pins should have local bypass ceramic capacitors (typically 0.01 μ F to 0.1 μ F). These amplifiers are fully specified from 3 V to 36 V and over the extended temperature range from -40°C to $+125^{\circ}\text{C}$. Parameters that exhibit variance with regard to operating voltage or temperature are presented in [Typical Performance Characteristics](#).

Functional Block Diagram

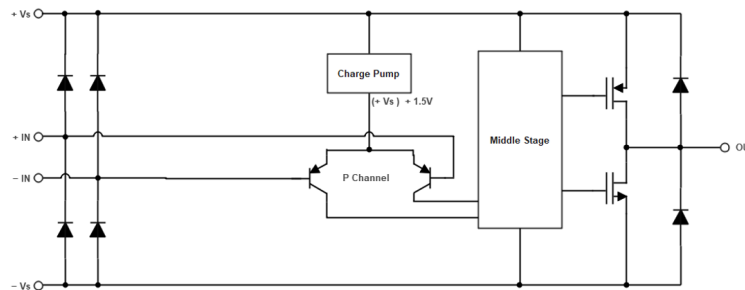


Figure 20. Functional Block Diagram

Feature Description

Operating Voltage

The series is designed for single supply operation from 3 V to 36 V or dual supply operation from ± 1.5 V to ± 18 V.

The recommended operating voltage conditions are as follows:

Power supply voltage ($+V_S$) – ($-V_S$): 3 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 3 V to 36 V.

For example, if operating with a single supply, ($-V_S$) = 0 V, ($+V_S$) can support 3 V to 36 V. If using dual supplies with equal absolute values, the minimum voltage is ± 1.5 V, and the maximum voltage is ± 18 V. It can even 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.

Rail-to-Rail Input

The series has a unique zero-crossover input topology to eliminate the input offset transition region, which is brought by the complementary input stage of rail-to-rail input operational amplifiers. The input common-mode range includes negative and positive supplies. CMRR is excellent in all common-mode range and no input stage crossover distortion. When driving ADCs, the highly linear common-mode range of the series assures that the signal conditional system linearity performance is not compromised.

Rail-to-Rail Output

The series delivers rail-to-rail output swing capability with a novel PSRR-enhanced class-AB output stage. Different load conditions change the ability of the amplifier to swing close to the rails.

Application and Implementation

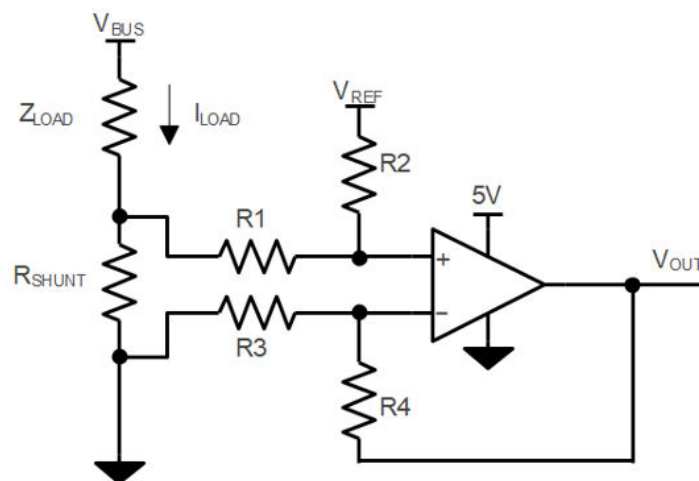
Note

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 21 shows the devices configured in a low-side current-sensing application. The low-side current-sensing method is to place a sense resistor between the load and the circuit ground. The voltage dropping across the resistor is amplified by different amplifier circuits with the devices. The V_{REF} can be used to add a 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.



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

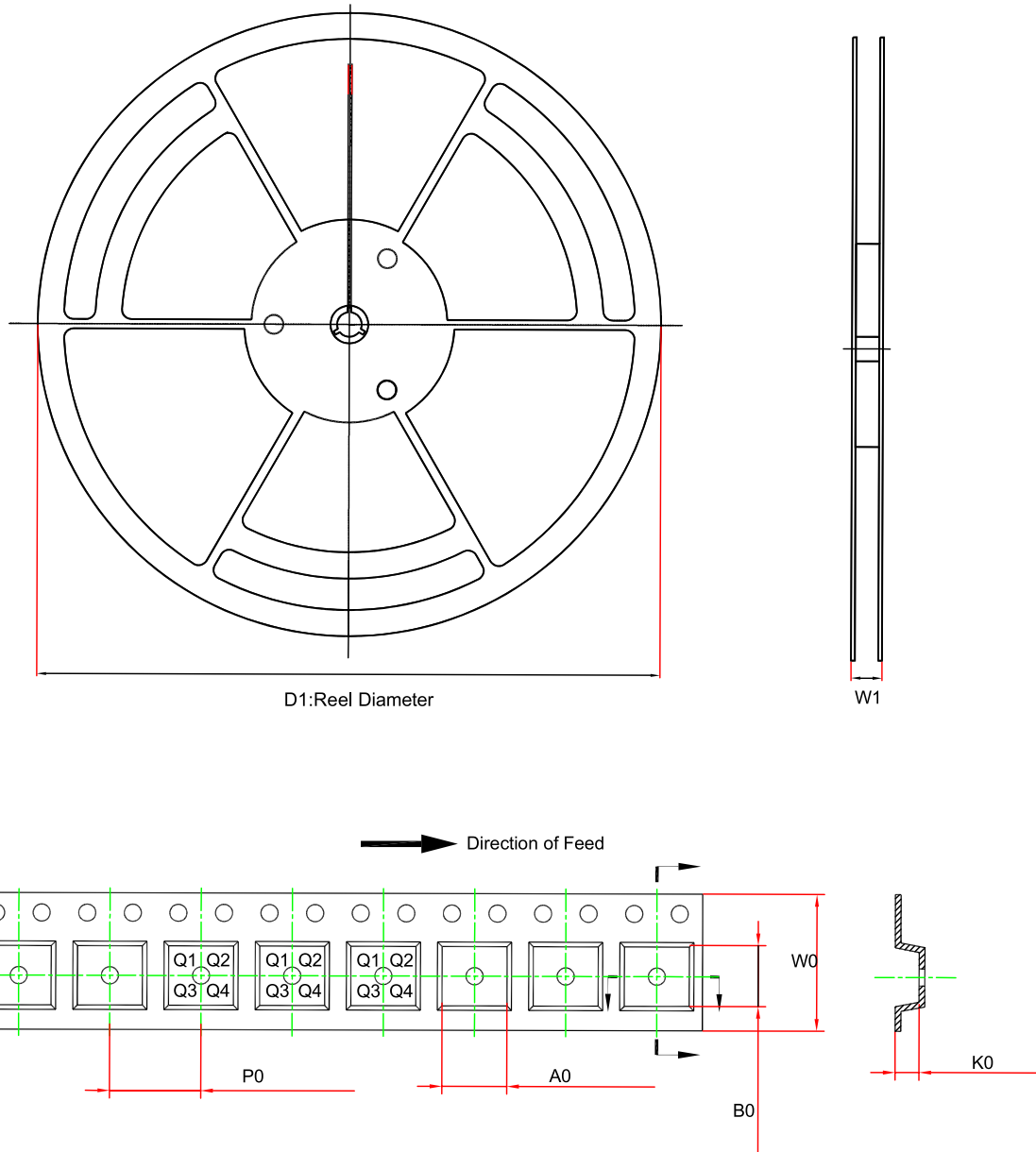
$$\text{When } R3 = R1, R2 = R4, R_{SHUNT} \ll R1$$

Figure 21. 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
TPA2771-S5TR	SOT23-5	180	12	3.3	3.25	1.4	4	8	Q3
TPA2771U-S5TR	SOT23-5	180	12	3.3	3.25	1.4	4	8	Q3
TPA2772-SO1R	SOP8	330	17.6	6.5	5.4	2	8	12	Q1
TPA2772-VS1R	MSOP8	330	17.6	5.3	3.4	1.3	8	12	Q1
TPA2774-SO2R	SOP14	330	21.6	6.5	9.3	2.1	8	16	Q1
TPA2774-TS2R	TSSOP14	330	17.6	6.8	5.5	1.5	8	12	Q1

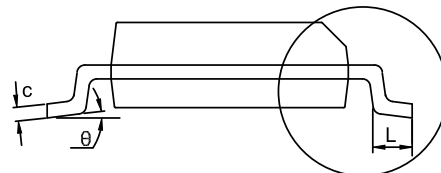
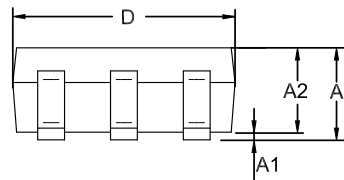
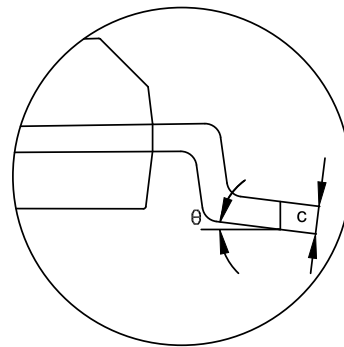
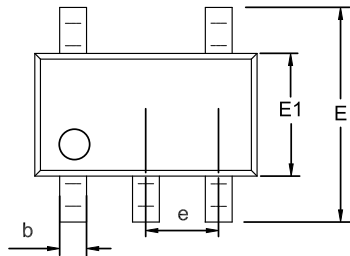
(1) The value is for reference only. Contact the 3PEAK factory for more information.

Package Outline Dimensions

SOT23-5

Package Outline Dimensions

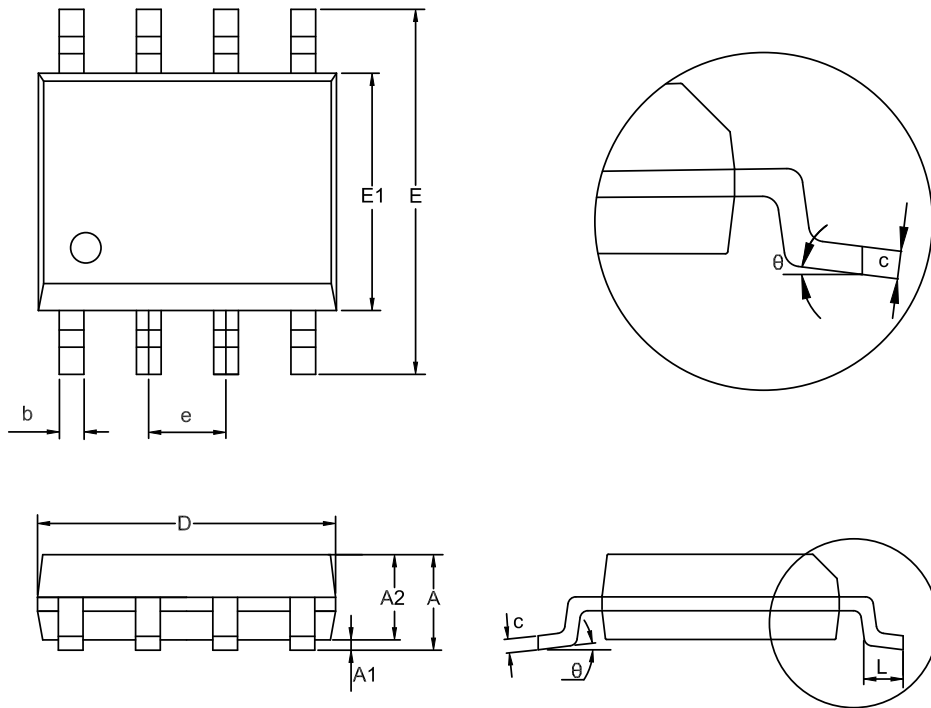
S5T(SOT23-5-A)



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

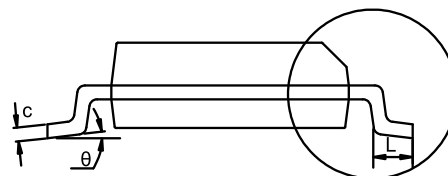
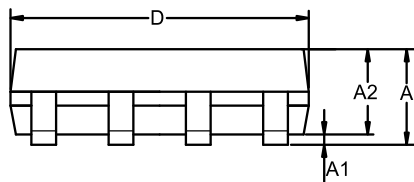
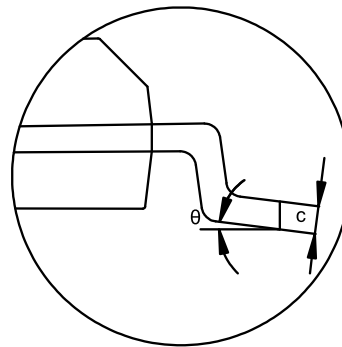
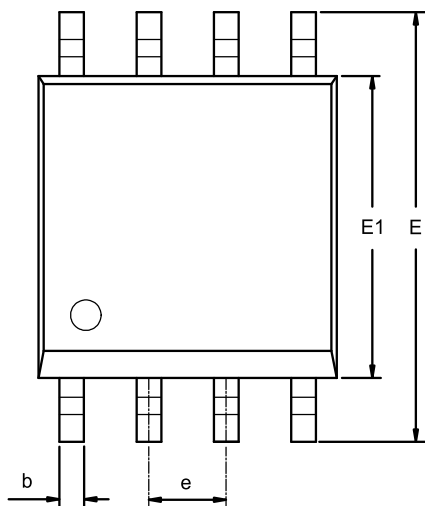
1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

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

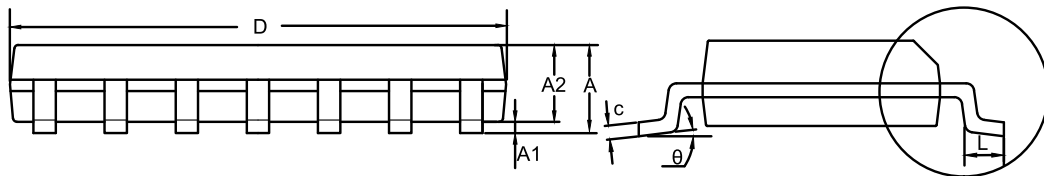
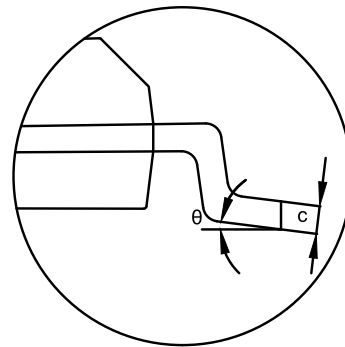
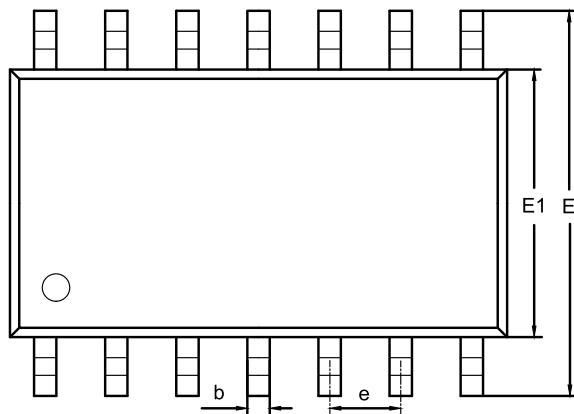
1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

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

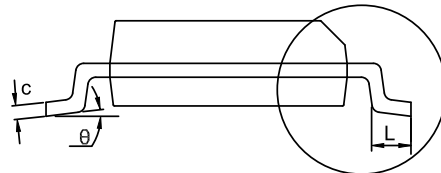
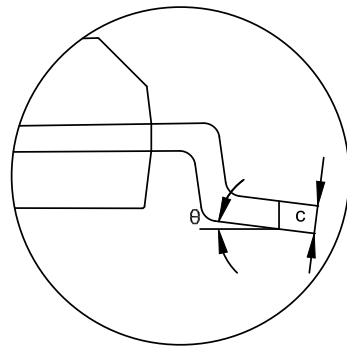
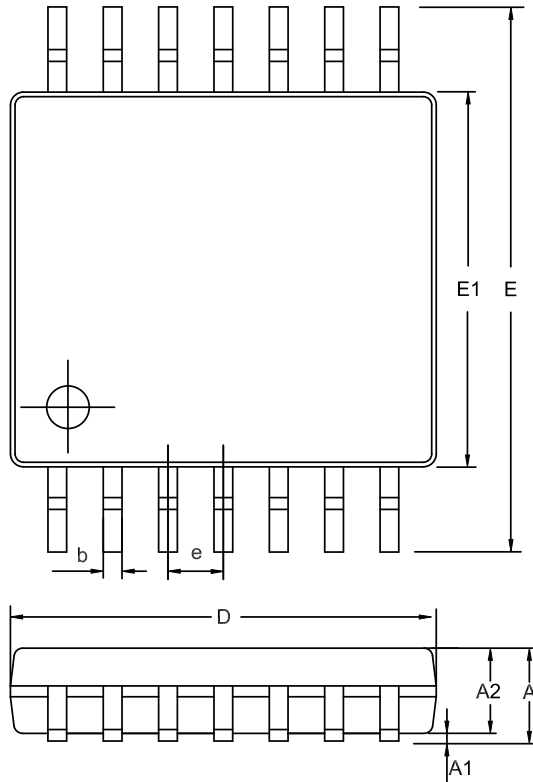
1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

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
TPA2771-S5TR ⁽¹⁾	–40 to 125°C	SOT23-5	A36	1	Tape and Reel, 3000	Green
TPA2771U-S5TR-S ⁽¹⁾	–40 to 125°C	SOT23-5	A37	1	Tape and Reel, 3000	Green
TPA2772-SO1R	–40 to 125°C	SOP8	A2772	1	Tape and Reel, 4000	Green
TPA2772-VS1R ⁽¹⁾	–40 to 125°C	MSOP8	A2772	1	Tape and Reel, 3000	Green
TPA2774-SO2R	–40 to 125°C	SOP14	A2774	1	Tape and Reel, 2500	Green
TPA2774-TS2R ⁽¹⁾	–40 to 125°C	TSSOP14	A2774	1	Tape and Reel, 3000	Green

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

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

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