

Features

- Supply Voltage: 2.7 V to 5.5 V or Dual Supply: ± 1.35 V to ± 2.75 V
- Low Offset Voltage: ± 45 μ V Maximum
- Zero Drift: ± 0.01 μ V/ $^{\circ}$ C
- Rail-to-Rail Input and Output
- Gain Bandwidth Product: 15 MHz
- Slew Rate: 5 V/ μ s
- Low Noise: 10 nV/ $\sqrt{\text{Hz}}$ at 1 kHz
- AEC-Q100 Qualified for Automotive Applications, Grade 1: -40°C to 125°C

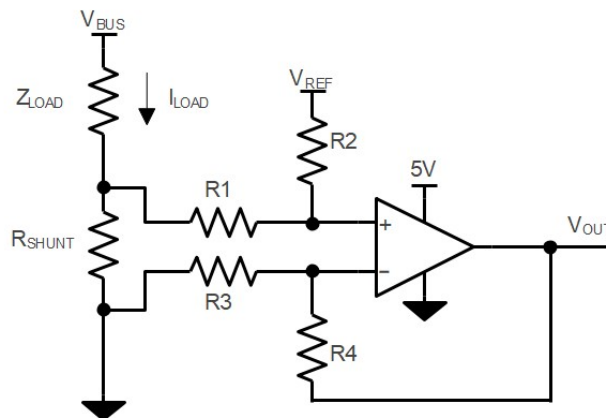
Applications

- On-Board Charger
- Motor Control
- Automotive Current Measurement

Description

The TPA5571Q and TPA5572Q are the newest zero-drift amplifiers with a maximum 45- μ V low-offset voltage, low noise, and stable high-frequency response. It incorporates proprietary and patented design techniques to achieve excellent AC performance with 15-MHz bandwidth, 5-V/ μ s slew rate, and low distortion while drawing 1-mA quiescent current per amplifier. The input common-mode voltage extends to the power rail, 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. Considering the requirements of the low standby power, there is a shutdown function which is in TPA5571NQ with only 7.5- μ A shutdown current.

Typical Application Circuit



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

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

Table of Contents

Features	1
Applications	1
Description	1
Typical Application Circuit	1
Revision History	3
Pin Configuration and Functions	4
Specifications	7
Absolute Maximum Ratings ⁽¹⁾	7
ESD, Electrostatic Discharge Protection.....	7
Recommended Operating Conditions.....	8
Thermal Information.....	8
Electrical Characteristics	9
Typical Performance Characteristics.....	11
Detailed Description	15
Overview.....	15
Functional Block Diagram.....	15
Feature Description.....	15
Application and Implementation	17
Application Information	17
Tape and Reel Information	18
Package Outline Dimensions	19
SOT23-5.....	19
SOT23-6.....	20
MSOP8.....	21
SOP8.....	22
Order Information	23
IMPORTANT NOTICE AND DISCLAIMER	24

Revision History

Date	Revision	Notes
2024-05-10	Rev.A.0	Initial version.
2024-07-05	Rev.A.1	The following updates are all about the typo, and the actual product remains unchanged. Updated the conditions of V_{OS} : from " $V_S = 3.3\text{ V}$, $V_{CM} = 2.5\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C " to " $V_S = 3.3\text{ V}$, $V_{CM} = 1.65\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C ".
2024-11-05	Rev.A.2	The following updates in Electrical Characteristics are about adding items, and the physical object remains unchanged. - Added Input Bias Current in $V_S = 3.3\text{ V}$, $V_{CM} = 1.65\text{ V}$ - Added Input Offset Current in $V_S = 3.3\text{ V}$, $V_{CM} = 1.65\text{ V}$
2024-12-18	Rev.A.3	Corrected handwriting errors. The physical object has not changed.
2025-09-19	Rev.A.4	Updated the Electrical Characteristics: V_{OS}, $V_S = 5\text{ V}$, $V_{CM} = 2.5\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C: from Min -150, Max 150 to Min -45, Max 45. V_{OS}, $V_S = 3.3\text{ V}$, $V_{CM} = 1.65\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C: from Min -150, Max 150 to Min -45, Max 45.

Pin Configuration and Functions

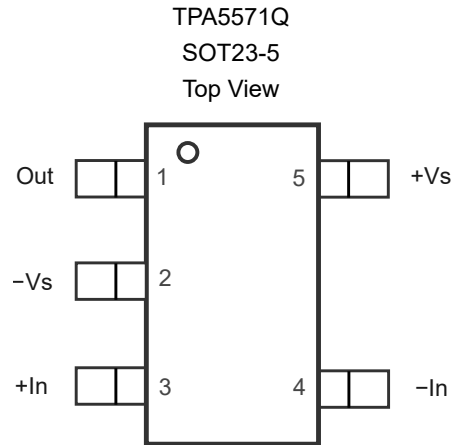
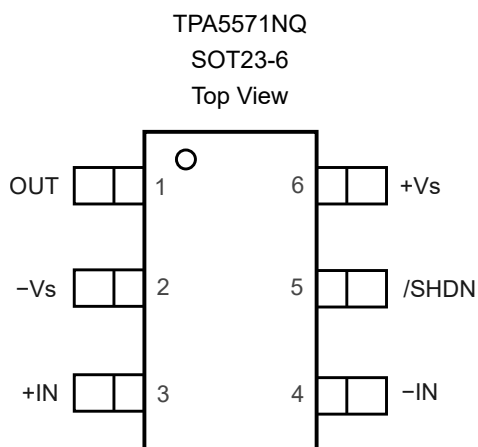
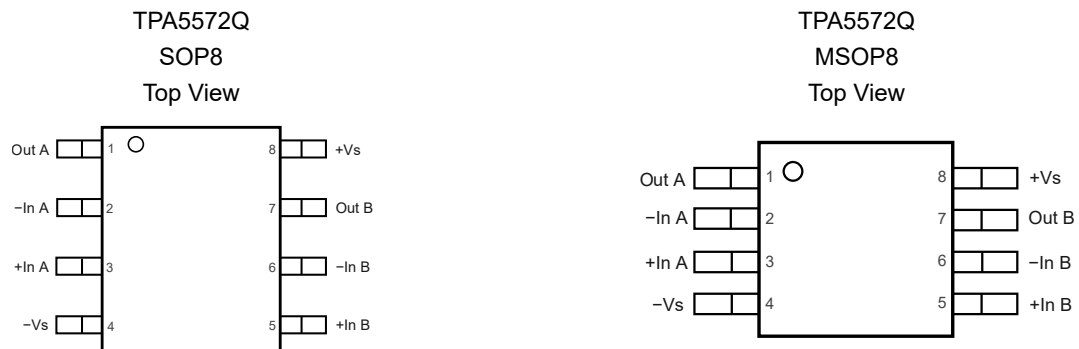


Table 1. Pin Functions: TPA5571Q

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

5-V, Zero-Drift, RRIO, 15-MHz, Precision Operational Amplifier

Table 2. Pin Functions: TPA5571NQ

Pin No.	Name	I/O	Description
1	Out	O	Output
2	-V _S		Negative power supply
3	+In	I	Noninverting input
4	-In	I	Inverting input
5	/SHDN	I	Shut down input. The device is shut down when the low-level input voltage is on the input; the device is active when the high-level input voltage is on the input. The device is active by default with a 10-MΩ internal pull-up resistor.
6	+V _S		Positive power supply

5-V, Zero-Drift, RRIO, 15-MHz, Precision Operational Amplifier

Table 3. Pin Functions: TPA5572Q

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

Specifications

Absolute Maximum Ratings ⁽¹⁾

All test conditions: over operating ambient temperature, unless otherwise noted.

Symbol	Parameter	Min	Max	Unit
	Supply Voltage, $(+V_S) - (-V_S)$		6.5	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: $+I_N, -I_N$ ⁽²⁾	-10	10	mA
	Output Voltage	$(-V_S) - 0.3$	$(+V_S) + 0.3$	V
	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 negative power supply. If the input extends more than 300 mV beyond the negative 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

Parameter		Condition	Minimum Level	Unit
HBM	Human Body Model ESD	AEC-Q100-002	3	kV
CDM	Charged Device Model ESD	AEC-Q100-011	1.5	kV

Recommended Operating Conditions

Parameter		Min	Typ	Max	Unit
V _S	Supply Voltage, (+V _S) – (–V _S)	2.7		5.5	V
T _A	Operating Temperature Range	–40		125	°C

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

5-V, Zero-Drift, RRIO, 15-MHz, Precision Operational Amplifier
Electrical Characteristics

All test conditions: $V_S = 5\text{ V}$, $T_A = 25^\circ\text{C}$, $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$, unless otherwise noted.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Power Supply						
V _S	Supply Voltage Range	Supply Voltage, (+V _S) – (–V _S), T _A = –40°C to 125°C	2.7		5.5	V
I _Q	Quiescent Current per Amplifier	V _S = 2.7 V to 5.5 V, T _A = –40°C to 125°C		1	1.8	mA
	Shutdown Current	V _S = 2.7 to 5.5 V, /SHDN = 0 V, T _A = –40°C to 125°C		7.5	21	μA
	Input Logic High of Shutdown ⁽¹⁾	T _A = –40°C to 125°C	0.7 × V _S			V
	Input Logic Low of Shutdown ⁽¹⁾	T _A = –40°C to 125°C			0.3 × V _S	V
PSRR	Power Supply Rejection Ratio	V _S = 2.7 V to 5.5 V	114	124		dB
		V _S = 2.7 V to 5.5 V, T _A = –40°C to 125°C	110			dB
Input Characteristics						
V _{OS}	Input Offset Voltage	V _S = 5 V, V _{CM} = 2.5 V, T _A = –40°C to 125°C	–45	10	45	μV
		V _S = 3.3 V, V _{CM} = 1.65 V, T _A = –40°C to 125°C	–45	10	45	μV
V _{OS} TC	Input Offset Voltage Drift	T _A = –40°C to 125°C		0.01		μV/°C
I _B	Input Bias Current	V _S = 5 V, V _{CM} = 2.5 V		200	1000	pA
		V _S = 5 V, V _{CM} = 2.5 V, T _A = –40°C to 125°C			1500	pA
I _{OS}	Input Offset Current	V _S = 5 V, V _{CM} = 2.5 V		100	600	pA
		V _S = 5 V, V _{CM} = 2.5 V, T _A = –40°C to 125°C			1000	pA
I _B	Input Bias Current ⁽¹⁾	V _S = 3.3 V, V _{CM} = 1.65V		200	1000	pA
		V _S = 3.3 V, V _{CM} = 1.65V, T _A = –40°C to 125°C			1500	pA
I _{OS}	Input Offset Current ⁽¹⁾	V _S = 3.3 V, V _{CM} = 1.65V		100	600	pA
		V _S = 3.3 V, V _{CM} = 1.65V, T _A = –40°C to 125°C			1000	pA
R _{IN}		Common Mode		5		GΩ
C _{IN}	Input Capacitance	Differential Mode		2		pF
		Common Mode		5		pF
A _V	Open-Loop Voltage Gain	V _O = 0.5 V to 4.5 V	120	150		dB
		V _O = 0.5 V to 4.5 V, T _A = –40°C to 125°C	115			dB

5-V, Zero-Drift, RRIO, 15-MHz, Precision Operational Amplifier

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V _{CMR}	Common-Mode Input Voltage Range	T _A = −40°C to 125°C	(−V _S) − 0.1		(+V _S) + 0.1	V
CMRR	Common-Mode Rejection Ratio	V _{CM} = 0 V to 5 V	115	144		dB
		V _{CM} = 0 V to 5 V, T _A = −40°C to 125°C	110			dB
Output Characteristics						
	Output Voltage Swing from Positive Rail or Negative Rail	R _{LOAD} = 10 kΩ to V _S / 2, T _A = −40°C to 125°C		5	10	mV
		R _{LOAD} = 2 kΩ to V _S / 2, T _A = −40°C to 125°C		22	35	mV
I _{SC}	Output Short-Circuit Current	Sink or Source	128	160		mA
		Sink or Source, T _A = −40°C to 125°C	100			mA
AC Specifications						
GBW	Gain-Bandwidth Product			15		MHz
SR	Slew Rate	G = 1, 2-V step		5		V/μs
t _{OR}	Overload Recovery			5		μs
t _S	Settling Time, 0.1%	G = 1, 2-V step		3		us
	Settling Time, 0.01%			4		μs
PM	Phase Margin	R _L = 10 kΩ, C _L = 100 pF		45		°
GM	Gain Margin	R _L = 10 kΩ, C _L = 100 pF		10		dB
	Channel Separation	f = 100 kHz		120		dB
Noise Performance						
E _N	Input Voltage Noise	f = 0.1 Hz to 10 Hz		0.2		μV _{PP}
e _N	Input Voltage Noise Density	f = 1 kHz		10		nV/√Hz
i _N	Input Current Noise	f = 1 kHz		200		fA/√Hz
THD+N	Total Harmonic Distortion and Noise	G = 1, f = 1 kHz, V _O = 1 V _{RMS} , R _L = 2 kΩ		0.0007		%

(1) Provided by bench tests and design simulation.

Typical Performance Characteristics

All test conditions: $V_S = 5\text{ V}$, $T_A = +25^\circ\text{C}$, the test device is TPA5571QN-S6TR, unless otherwise noted.

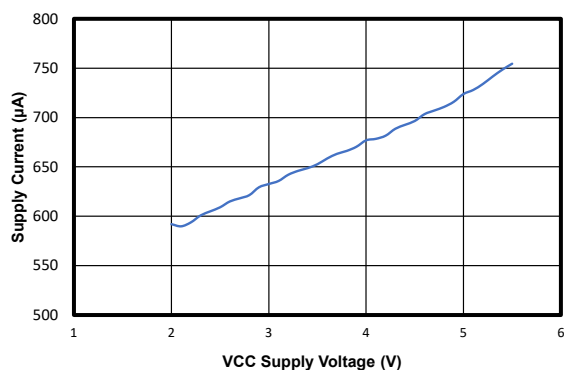


Figure 1. Supply Current vs. Supply Voltage

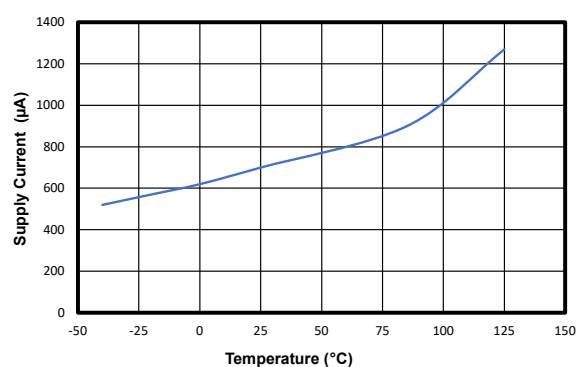


Figure 2. Supply Current vs. Temperature

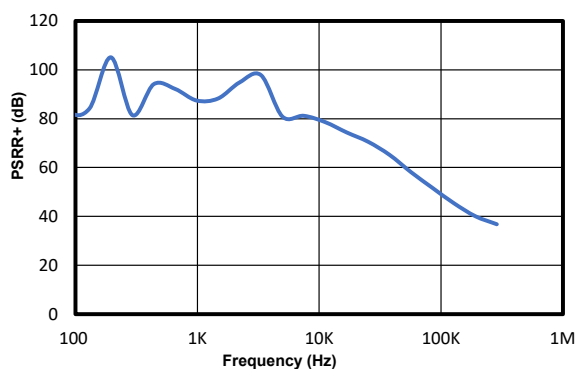


Figure 3. PSRR+ vs. Frequency

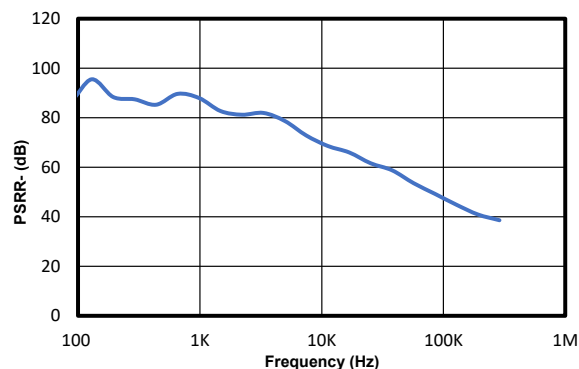


Figure 4. PSRR- vs. Frequency

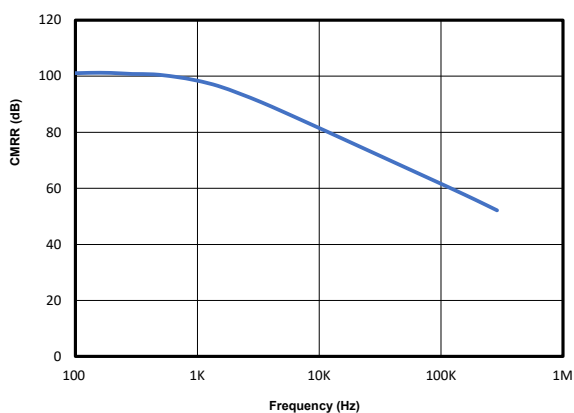


Figure 5. CMRR vs. Frequency

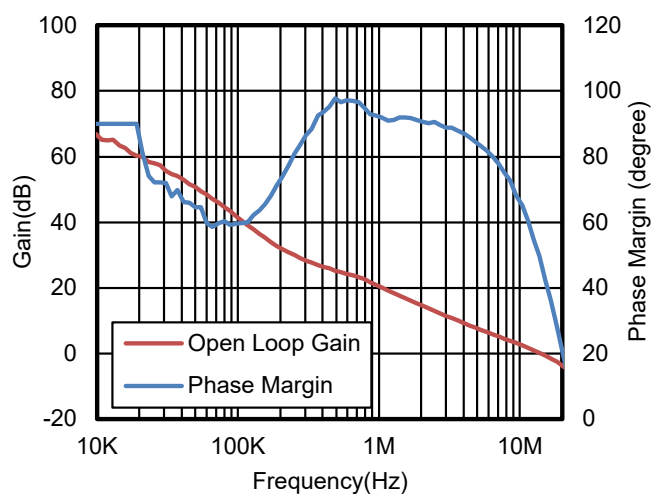
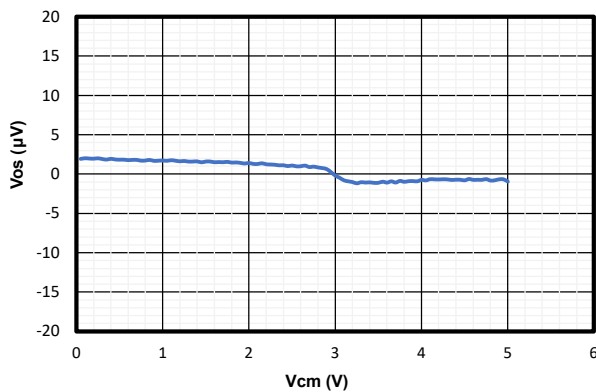
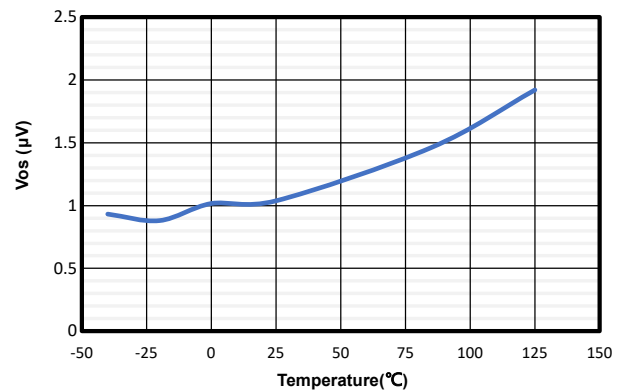
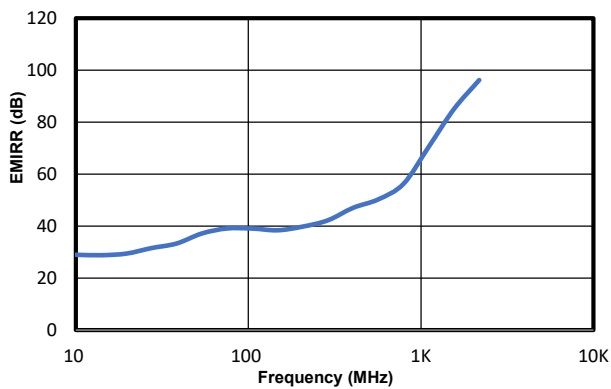
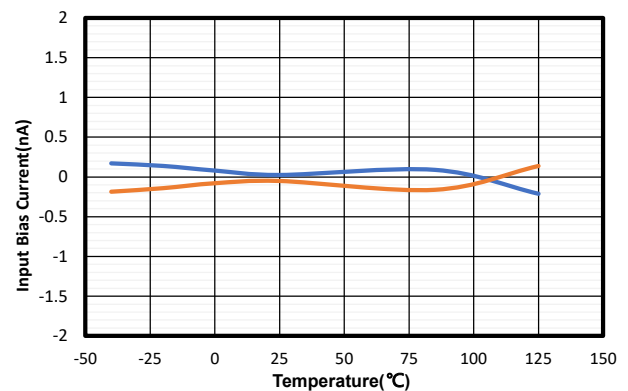
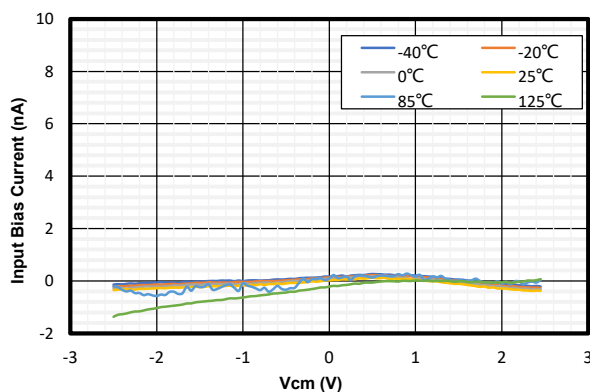
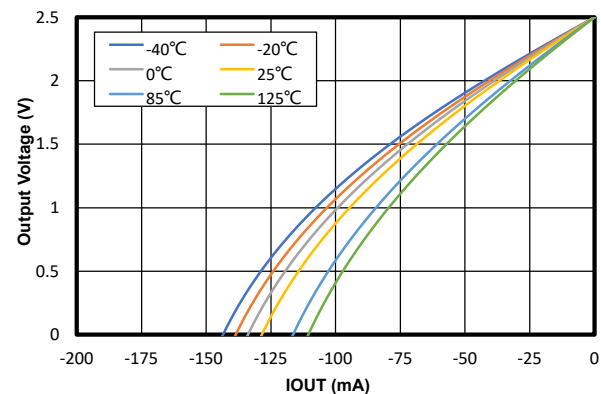


Figure 6. Open Loop Gain and Phase Margin vs. Frequency, $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$


Figure 7. V_{OS} vs. V_{CM} , $V_S = 5\text{ V}$

Figure 8. V_{OS} vs. Temperature

Figure 9. EMIRR vs. Frequency

Figure 10. I_B vs. Temperature

Figure 11. I_B vs. Common Voltage, $(-V_S) = -2.5\text{ V}$, $(+V_S) = 2.5\text{ V}$

Figure 12. Output Voltage vs. Output Current, $(-V_S) = -2.5\text{ V}$, $(+V_S) = 2.5\text{ V}$

5-V, Zero-Drift, RRIO, 15-MHz, Precision Operational Amplifier

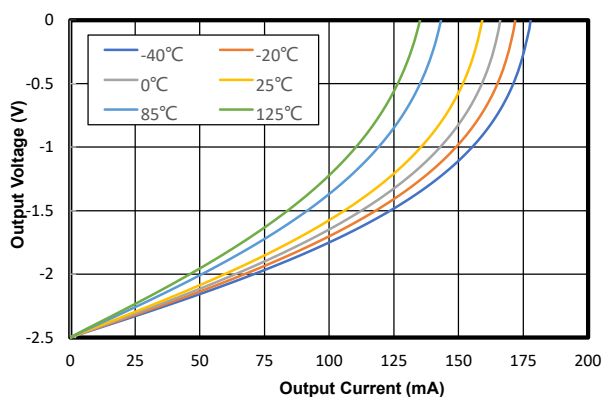


Figure 13. Output Voltage vs. Output Current, ($-V_S$) = -2.5 V, ($+V_S$) = 2.5 V

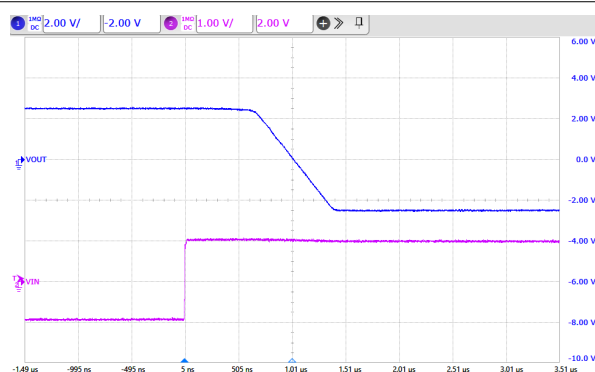


Figure 14. Overload Recovery at Negative Rail

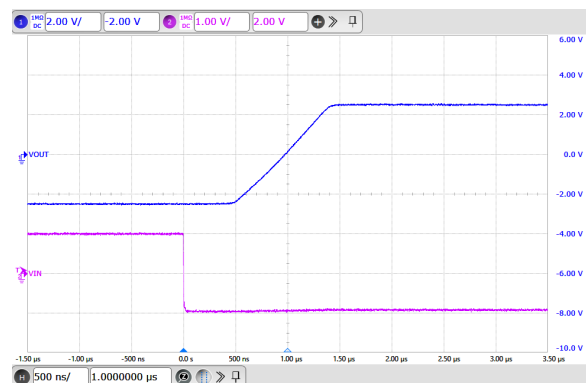


Figure 15. Overload Recovery at Positive Rail

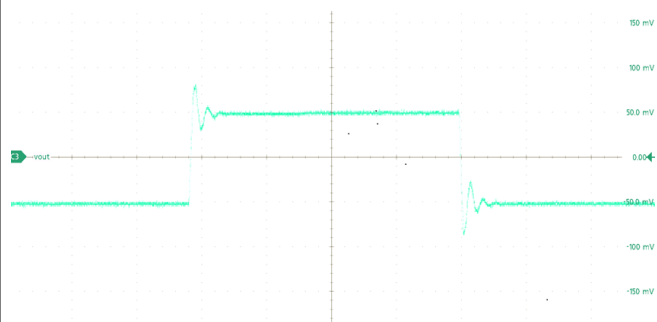


Figure 16. Small-Signal Step Response: 50 mV/div, Time: 400 ns/div

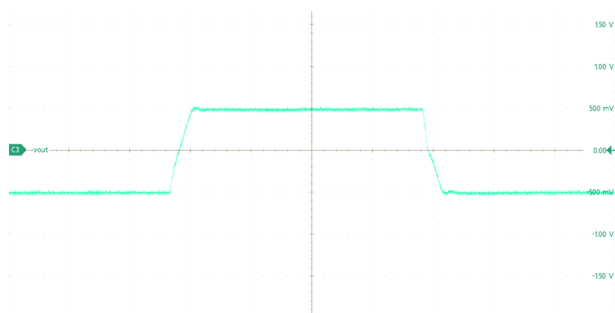


Figure 17. Large Signal Step Response: 500 mV/div, Time: 400 ns/div

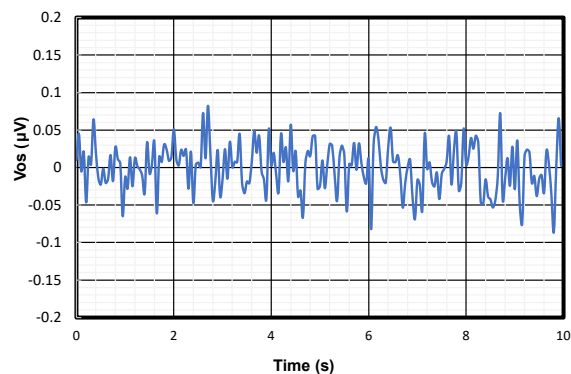
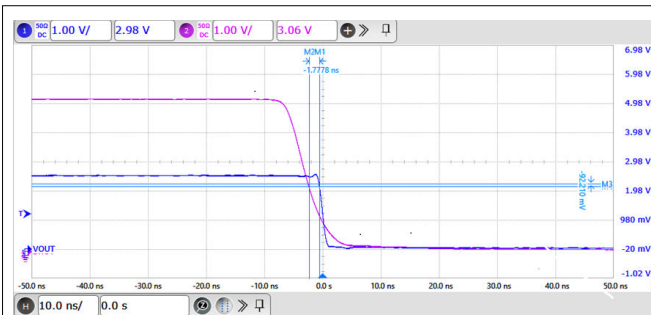
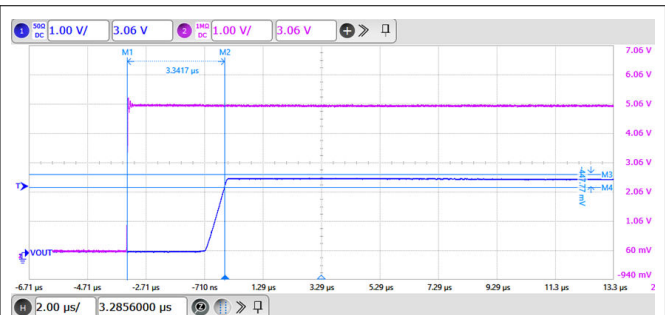
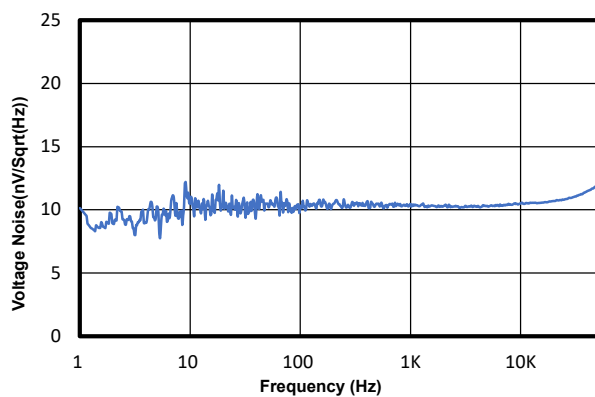
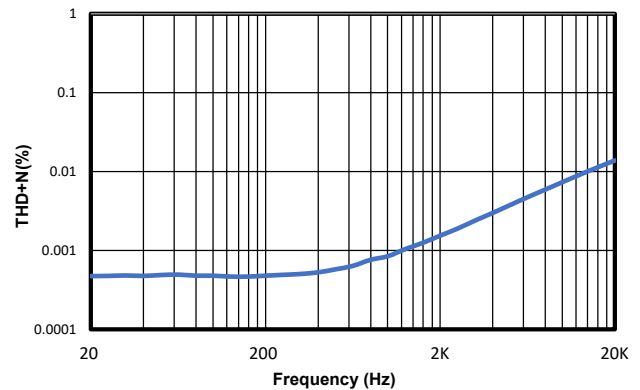


Figure 18. 0.1-Hz to 10-Hz Voltage Noise, $V_{CM} = 0$ V

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Figure 19. Turnoff Transient

Figure 20. Turnon Transient

**Figure 21. Voltage Noise Spectral Density vs. Frequency,
 $V_{CM} = 1\text{ V}$**

Figure 22. THD vs. Frequency, $G = 1$, $V_{IN} = 1\text{ V}_{RMS}$

Detailed Description

Overview

The TPA557xQ is a series of zero-drift amplifiers that can operate on a single-supply voltage (2.7 V to 5.5 V), or a split-supply voltage (± 1.35 V to ± 2.75 V).

Functional Block Diagram

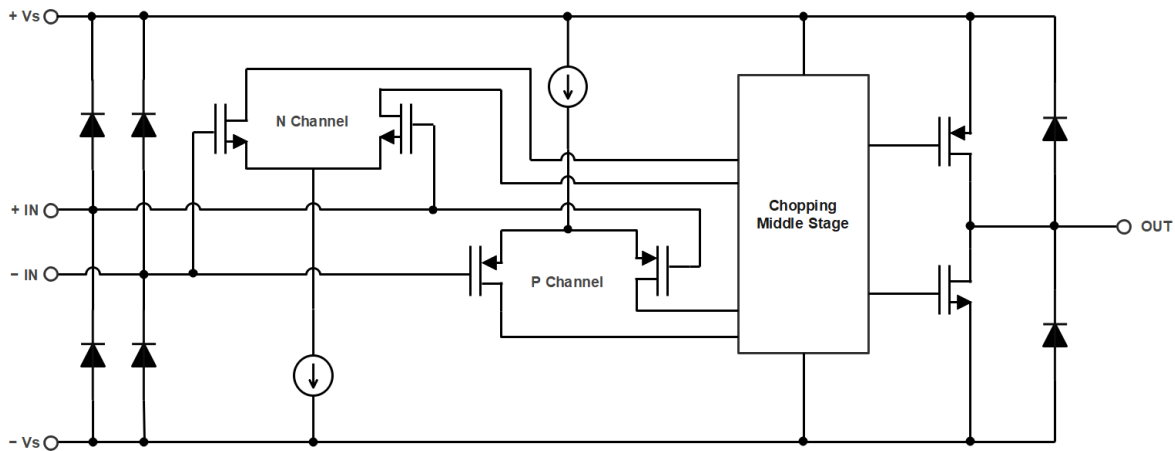


Figure 23. Functional Block Diagram

Feature Description

Operating Voltage

The TPA557xQ series is designed for single-supply operation from 2.7 V to 5.5 V, or dual-supply operation from ± 1.35 V to ± 2.75 V.

Residual Voltage Ripple

The chopping technique can be used in amplifier design due to the internal notch filter. Although the chopping-related voltage ripple is suppressed, a higher noise spectrum exists at the chopping frequency and its harmonics due to the residual ripple.

The devices set the chopping frequency to 400 kHz. If the frequency of the input signal is close to the chopping frequency, the signal may be interfered with by the residue ripple. To suppress the noise at the chopping frequency, it is recommended that a post filter be placed at the output of the amplifier.

Rail-to-Rail Input

The input common-mode voltage range of the TPA557xQ family extends 100 mV beyond the supply rails. This performance is achieved with a complementary input stage: a P-channel input differential pair in parallel with an N-channel differential pair. The P-channel pair is active for inputs from 100 mV below the negative supply to approximately $(+V_S) - 1.5$ V, whereas the N-channel pair is active for input voltages close to the positive rail, typically $(+V_S) - 1.5$ V to 100 mV above the positive supply. There is around 200-mV transition region at $(+V_S) - 1.5$ V where both pairs are on. Within this transition region, PSRR, CMRR, offset voltage, offset drift, and THD can degrade compared to those operating outside this region.

Rail-to-Rail Output

The TPA557x family delivers rail-to-rail output swing capability with a class-AB output stage. Different load conditions change the ability of the amplifier to swing close to the rails.

Shutdown Function

The shutdown function is available in the TPA557xNQ. The operational amplifier is enabled with a valid high voltage and shut down by a valid low voltage. A valid high level is defined as $0.7 \times V_S$ and a valid low level is defined as $0.3 \times V_S$, the valid voltage level refers to the voltage on ($-V_S$) . The pin of SHDN is internally pulled up to a valid high level when this pin is left floating, so the amplifier is enabled initially if the shutdown pin is floated. The output state of the amplifier is the high-impedance state when it is shut down.

Application and Implementation

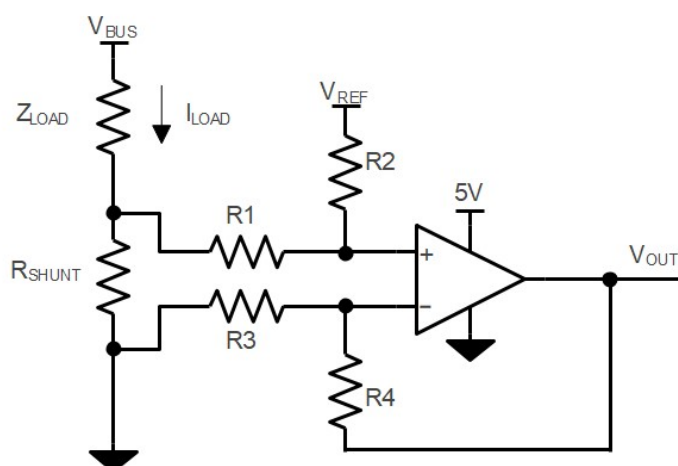
Note

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 24 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. 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.



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

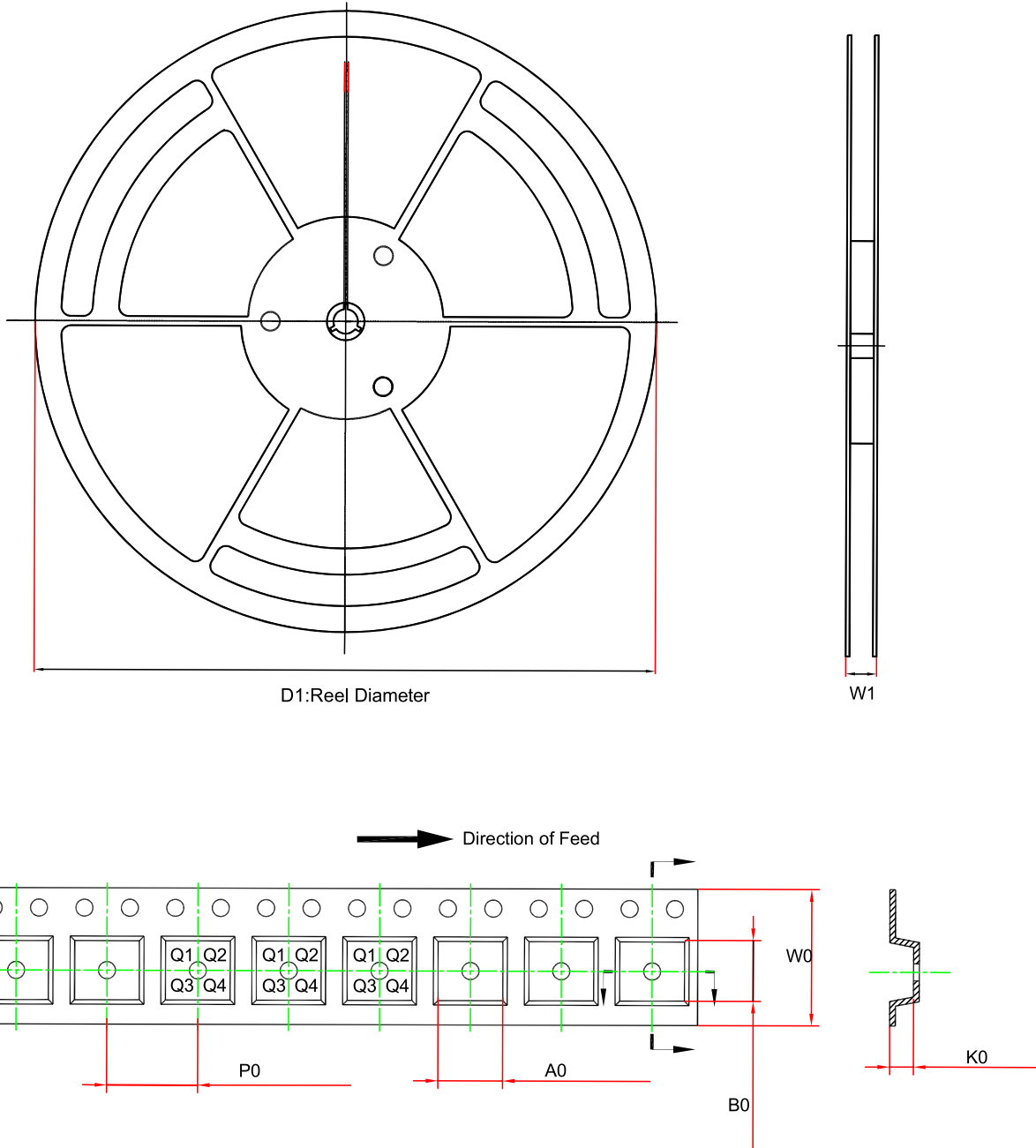
$$\text{When } R3 = R1, R2 = R4, R_{SHUNT} \ll R1$$

Figure 24. 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
TPA5571NQ-S6TR-S	SOT23-6	180.0	12	3.3	3.25	1.4	4.0	8.0	Q3
TPA5571Q-S5TR-S	SOT23-5	180.0	12	3.3	3.25	1.4	4.0	8.0	Q3
TPA5572Q-SO1R-S	SOP8	330.0	17.6	6.5	5.4	2.0	8.0	12.0	Q1
TPA5572Q-VS1R-S	MSOP8	330.0	17.6	5.3	3.4	1.3	8.0	12.0	Q1

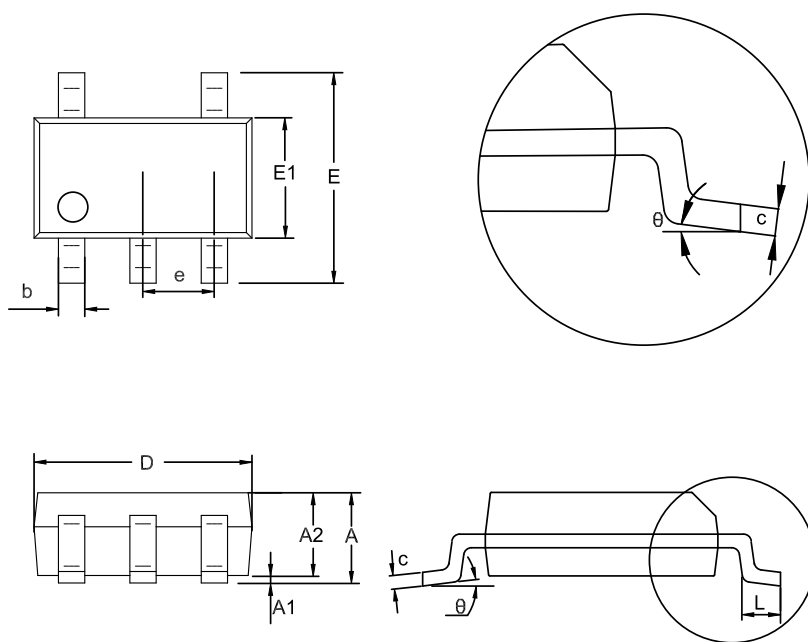
(1) The value is for reference only. Contact the 3PEAK factory for more information.

Package Outline Dimensions

SOT23-5

Package Outline Dimensions

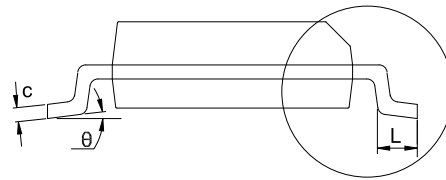
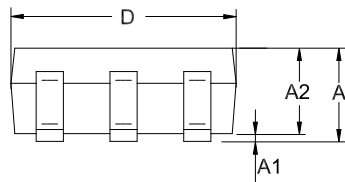
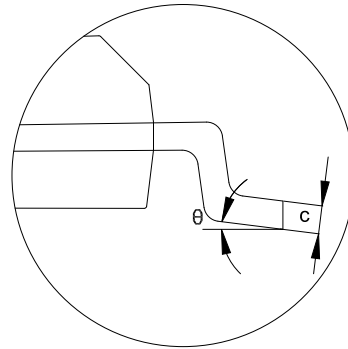
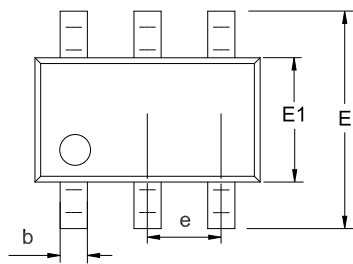
S5T(SOT23-5-A)



NOTES

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

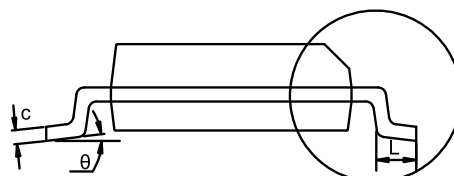
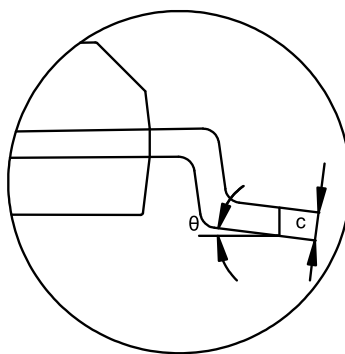
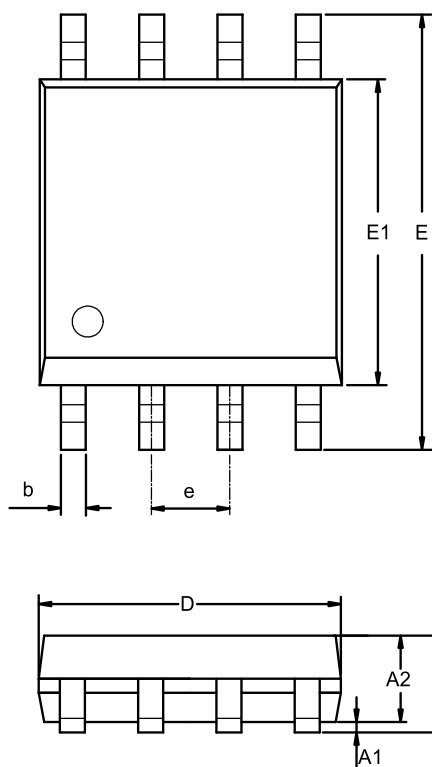
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.150	0.000	0.006
A2	1.000	1.200	0.039	0.047
b	0.280	0.500	0.011	0.020
c	0.100	0.230	0.004	0.009
D	2.820	3.020	0.111	0.119
E	2.600	3.000	0.102	0.118
E1	1.500	1.720	0.059	0.068
e	0.950 BSC		0.037 BSC	
L	0.300	0.600	0.012	0.024
θ	0	8°	0	8°

SOT23-6
Package Outline Dimensions
S6T(SOT23-6-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

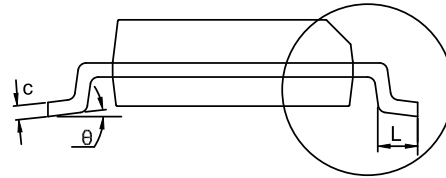
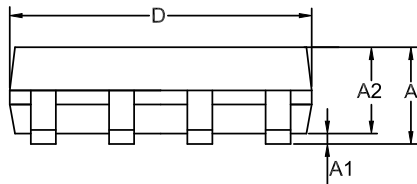
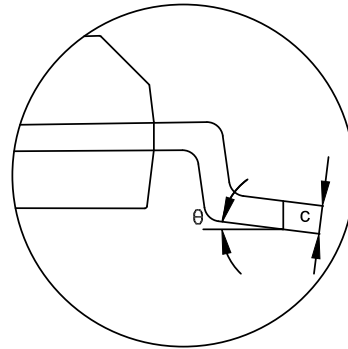
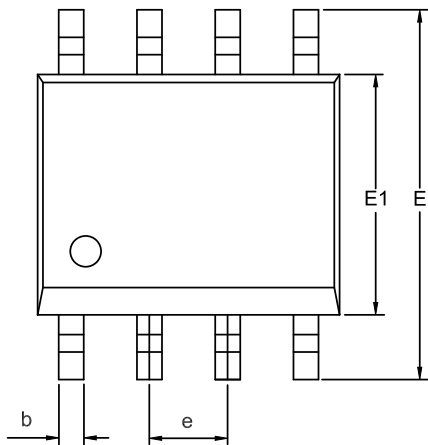
1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

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.

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.

Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
TPA5571NQ-S6TR-S	-40 to 125°C	SOT23-6	A51	1	Tape and Reel, 3000	Green
TPA5571Q-S5TR-S	-40 to 125°C	SOT23-5	A50	1	Tape and Reel, 3000	Green
TPA5572Q-SO1R-S	-40 to 125°C	SOP8	5572Q	1	Tape and Reel, 4000	Green
TPA5572Q-VS1R-S	-40 to 125°C	MSOP8	5572Q	1	Tape and Reel, 3000	Green

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

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