

Features

- Supply Voltage: 4.5 V to 36 V or ± 2.25 V to ± 18 V
- Offset Voltage: ± 40 μ V Maximum at 25°C
- Differential Input Voltage Range to Supply Rail, can Work as a Comparator
- Input Rail to $-V_S$, Rail-to-Rail Output
- Bandwidth: 6 MHz, Slew Rate: 5 V/ μ s
- Excellent EMI Suppress Performance: 85 dB at 1 GHz
- Over-Temperature Protection
- Low Noise: 8 nV/ $\sqrt{\text{Hz}}$ at 1 kHz
- AEC-Q100 Qualification
- -40°C to 125°C Operating Temperature Range

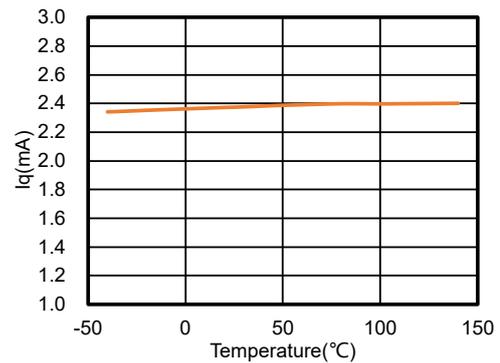
Applications

- Instrumentation
- Active Filters, ASIC Inputs, or Output Amplifiers
- Sensor Interface
- Motor Control
- Industrial Control

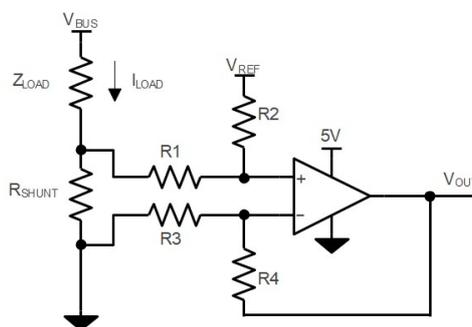
Description

The TPA186xQ is a series of the newest high-supply-voltage amplifiers with 40- μ V low offset, low noise, and stable high-frequency response. The TPA186xQ series incorporates 3PEAK's proprietary and patented design techniques to achieve excellent AC performance with 6-MHz bandwidth, 5-V/ μ s slew rate, and low distortion, while drawing only 1.4-mA quiescent current per amplifier. The common-mode input voltage range extends to V_- , and the outputs swing rail-to-rail.

The TPA186xQ series has an over-temperature protection feature to guarantee chip safety. The output of the TPA186xQ enters high impedance when the die temperature reaches around 170°C , and recovers the function when the die temperature is down to around 150°C . The TPA186xQ series has a very small power temperature coefficient, which is beneficial for temperature-sensitive applications.



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	6
Absolute Maximum Ratings ⁽¹⁾	6
ESD, Electrostatic Discharge Protection.....	6
Recommended Operating Conditions.....	6
Thermal Information.....	6
Electrical Characteristics.....	8
Typical Performance Characteristics.....	10
Detailed Description	13
Overview.....	13
Functional Block Diagram.....	13
Feature Description.....	13
Application and Implementation	15
Application Information	15
Tape and Reel Information	16
Package Outline Dimensions	17
SOT23-5.....	17
SOP8.....	18
Order Information	19
IMPORTANT NOTICE AND DISCLAIMER	20

Revision History

Date	Revision	Notes
2024-02-15	Rev.A.0	Initial version
2024-12-19	Rev.A.1	The following updates are all about the new datasheet formats or typos, and the actual product remains unchanged. <ul style="list-style-type: none">• Updated the Tape and Reel Information.

Pin Configuration and Functions

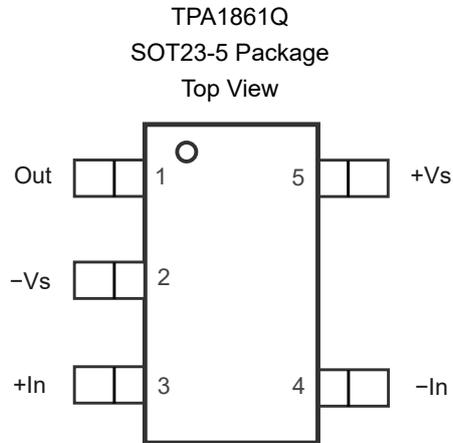
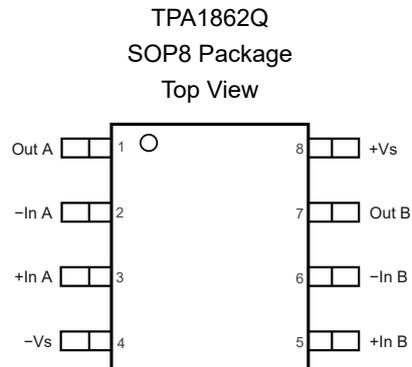


Table 1. Pin Functions: TPA1861Q

Pin No.	Name	I/O	Description
SOT23-5			
1	Out	O	Output
2	-Vs		Negative power supply
3	+In	I	Non-inverting input
4	-In	I	Inverting input
5	+Vs		Positive power supply


Table 2. Pin Functions: TPA1862Q

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

Parameter		Min	Max	Unit
	Supply Voltage, (+V _S) - (-V _S)		40	V
	Input Voltage	(-V _S) - 0.3	40	V
	Differential Input Voltage	(-V _S) - (+V _S)	(+V _S) - (-V _S)	V
	Input Current: +IN, -IN ⁽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 to 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	2	kV
CDM	Charged Device Model ESD	AEC-Q100-011	1	kV

Recommended Operating Conditions

Parameter		Min	Typ	Max	Unit
V _S	Supply Voltage	Single Supply	4.5	36	V
		Dual Supply	±2.25	±18	V
T _A	Operating Temperature Range	-40		125	°C

Thermal Information

Package Type	θ _{JA}	θ _{JC}	Unit
SOT23-5	250	81	°C/W

Package Type	θ_{JA}	θ_{JC}	Unit
SOP8	158	43	°C/W

Electrical Characteristics

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

Parameter		Conditions	T_A	Min	Typ	Max	Unit
Power Supply							
V_S	Supply Voltage Range	$(+V_S) - (-V_S)$		4.5		36	V
I_Q	Quiescent Current per Amplifier	$V_S = 30\text{ V}$			1.4	1.6	mA
			$-40^\circ\text{C to } 125^\circ\text{C}$			2	mA
		$V_S = 5\text{ V}$			1.2	1.5	mA
			$-40^\circ\text{C to } 125^\circ\text{C}$			1.8	mA
PSRR	Power Supply Rejection Ratio	$V_S = 4.5\text{ V to } 36\text{ V}$		115	140		dB
			$-40^\circ\text{C to } 125^\circ\text{C}$	110			dB
Input Characteristics							
V_{OS}	Input Offset Voltage	$V_S = 30\text{ V}, V_{CM} = 15\text{ V}$		-40		40	μV
			$-40^\circ\text{C to } 125^\circ\text{C}$	-80		80	μV
		$V_S = 5\text{ V}, V_{CM} = 2.5\text{ V}$		-40		40	μV
			$-40^\circ\text{C to } 125^\circ\text{C}$	-80		80	μV
V_{OSTC}	Input Offset Voltage Drift		$-40^\circ\text{C to } 125^\circ\text{C}$		0.01		$\mu\text{V}/^\circ\text{C}$
I_B	Input Bias Current				100	1000	pA
		$-40^\circ\text{C to } 125^\circ\text{C}$			100	5000	pA
I_{OS}	Input Offset Current				100	1000	pA
		$-40^\circ\text{C to } 125^\circ\text{C}$			100	5000	pA
I_{IN}	Different Input Current	$V_S = 36\text{ V}, V_{ID} = 36\text{ V}$			10	100	μA
			$-40^\circ\text{C to } 125^\circ\text{C}$				120
C_{IN}	Input Capacitance	Differential mode			5		pF
		Common mode			2.5		pF
A_v	Open-Loop Voltage Gain	$R_{LOAD} = 10\text{ k}\Omega,$ $V_{OUT} = 0.5\text{ V to } 29.5\text{ V}$		120	140		dB
			$-40^\circ\text{C to } 125^\circ\text{C}$	115			dB
V_{CMR}	Common-Mode Input Voltage Range			(V-)		(V+) - 1.5	V
CMRR	Common-Mode Rejection Ratio	$V_{CM} = 0\text{ V to } 28.5\text{ V}$		115	140		dB
			$-40^\circ\text{C to } 125^\circ\text{C}$	110			dB
Output Characteristics							
	Output Swing from Positive Rail	$R_{LOAD} = 100\text{ k}\Omega\text{ to } V_S / 2$			12	25	mV
			$-40^\circ\text{C to } 125^\circ\text{C}$				40
		$R_{LOAD} = 10\text{ k}\Omega\text{ to } V_S / 2$			80	120	mV
			$-40^\circ\text{C to } 125^\circ\text{C}$				200
		$R_{LOAD} = 2\text{ k}\Omega\text{ to } V_S / 2$			370	500	mV

Parameter		Conditions	T _A	Min	Typ	Max	Unit	
			-40°C to 125°C			750	mV	
	Output Swing from Negative Rail	R _{LOAD} = 100 kΩ to V _S / 2			5	25	mV	
			-40°C to 125°C			30		mV
		R _{LOAD} = 10 kΩ to V _S / 2			30	80		mV
			-40°C to 125°C				200	
		R _{LOAD} = 2 kΩ to V _S / 2			140	300		mV
			-40°C to 125°C				500	
I _{SC}	Output Short-Circuit Current	Source		60	95		mA	
			-40°C to 125°C	35			mA	
		Sink		120	150		mA	
			-40°C to 125°C	70			mA	
	Capacitive Load Drive				1		nF	
AC Specifications								
GBW	Gain-Bandwidth Product				6		MHz	
SR	Slew Rate	G = 1, 10-V step		3	5		V/μs	
			-40°C to 125°C	2.2			V/μs	
t _{OR}	Overload Recovery				500		ns	
t _s	Settling Time, 0.1%	G = 1, 10-V step			7		μs	
	Settling Time, 0.01%				12		μs	
PM	Phase Margin	R _L = 10 K, C _L = 100 pF			70		°	
GM	Gain Margin	R _L = 10 K, C _L = 100 pF			15		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 = 0.1 Hz			8		nV/√Hz	
		f = 1 kHz			8		nV/√Hz	
		f = 10 kHz			10		nV/√Hz	
		f = 100 kHz			20		nV/√Hz	
i _N	Input Current Noise	f = 10 kHz			200		fA/√Hz	
THD+N	Total Harmonic Distortion and Noise	f = 1 kHz, G = 1, R _L = 10 kΩ, V _{OUT} = 6 V _{RMS}			0.0005		%	

Typical Performance Characteristics

All test conditions: $V_S = \pm 15\text{ V}$, $V_{CM} = 0\text{ V}$, $R_L = 10\text{ k}\Omega$, unless otherwise noted.

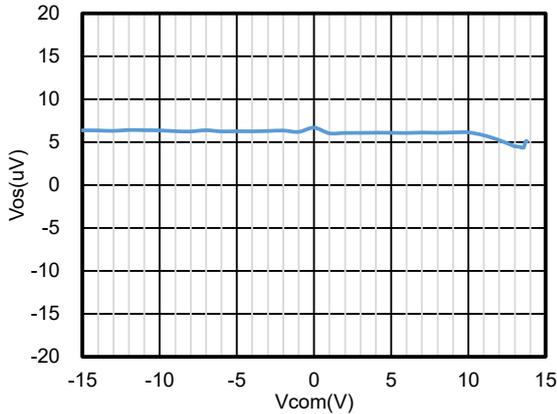


Figure 1. Offset Voltage vs. Common-Mode Voltage

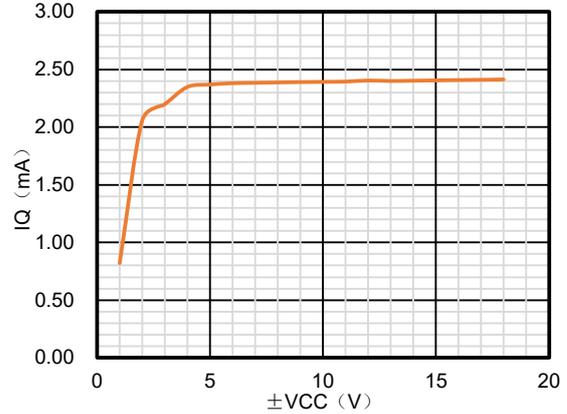


Figure 2. I_Q vs. Supply Voltage

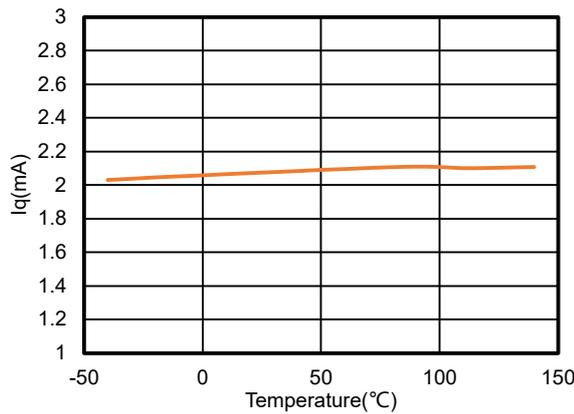


Figure 3. I_Q vs. Temperature, $\pm 2.5\text{-V}$ Supply, TPA1862Q

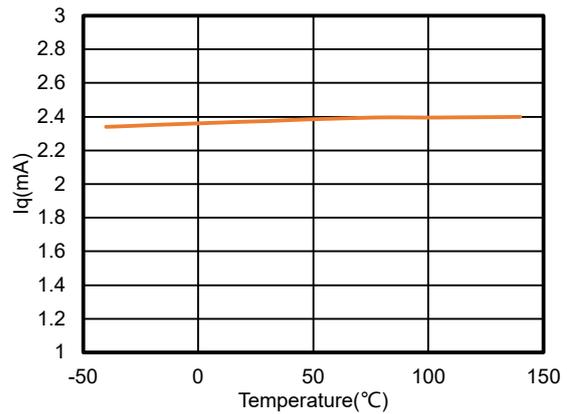


Figure 4. I_Q vs. Temperature, $\pm 15\text{-V}$ Supply, TPA1862Q

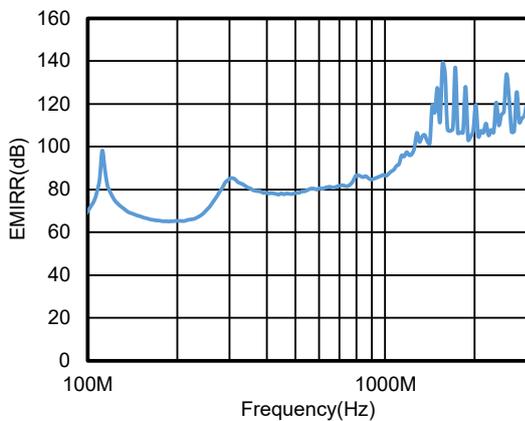


Figure 5. EMIRR vs. Frequency

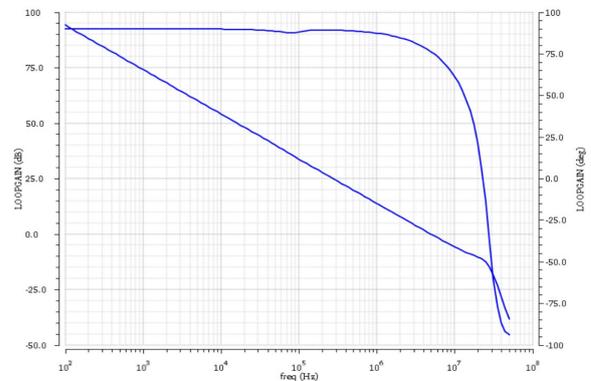


Figure 6. Open-Loop Gain and Phase vs. Frequency, $R_L = 10\text{ k}\Omega$, $C_L = 50\text{ pF}$

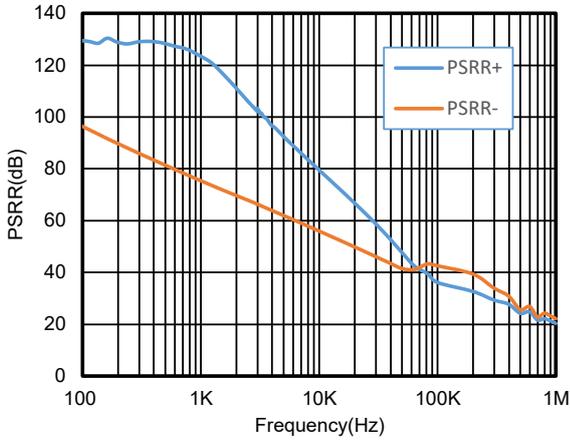


Figure 7. PSRR vs. Frequency

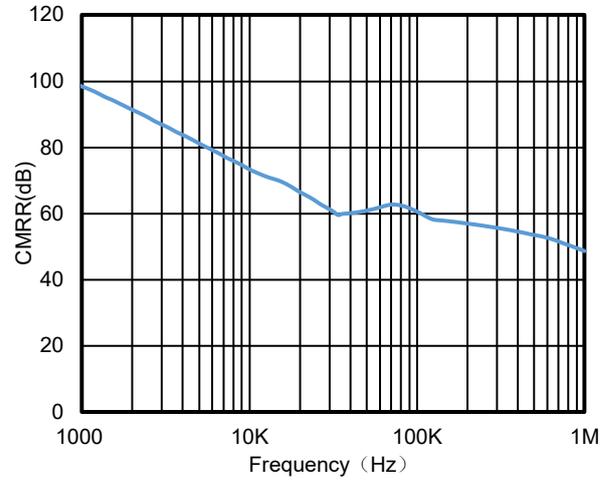
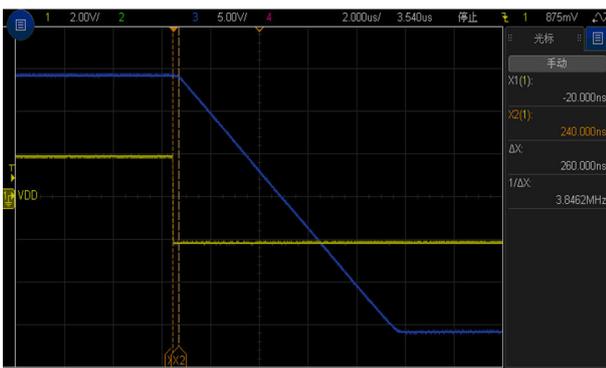


Figure 8. CMRR vs. Frequency



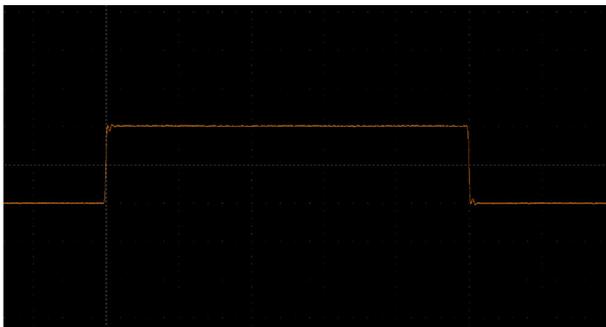
Time: 2 μ s/div, Measure Time: 260 ns
 $R_L = 2\text{ K}$, $C_L = 100\text{ pF}$, $G = 10$

Figure 9. Positive Overload Recovery



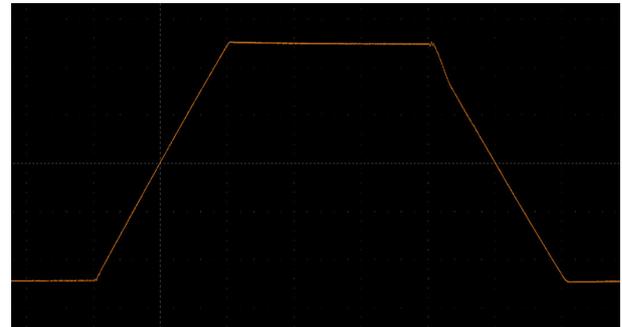
Time: 2 μ s/div, Measure Time: 420 ns
 $R_L = 2\text{ K}$, $C_L = 100\text{ pF}$, $G = 10$

Figure 10. Negative Overload Recovery



Voltage: 50 mV/div, Time: 2 μ s/div
 $R_L = 2\text{ K}$, $C_L = 100\text{ pF}$, $G = 1$

Figure 11. 100-mV Signal Step Response



Voltage: 2 V/div, Time: 2 μ s/div
 $R_L = 2\text{ K}$, $C_L = 100\text{ pF}$, $G = 1$

Figure 12. 10-V Signal Step Response

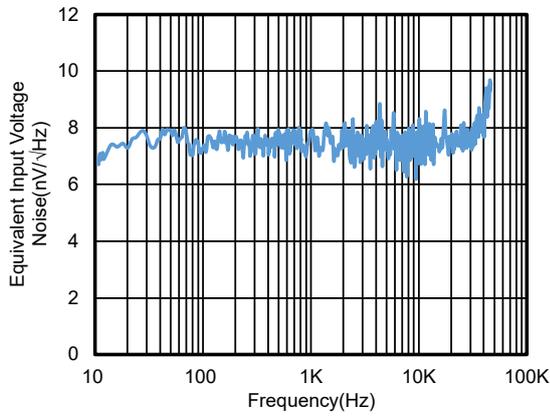


Figure 13. Voltage Noise Density vs. Frequency

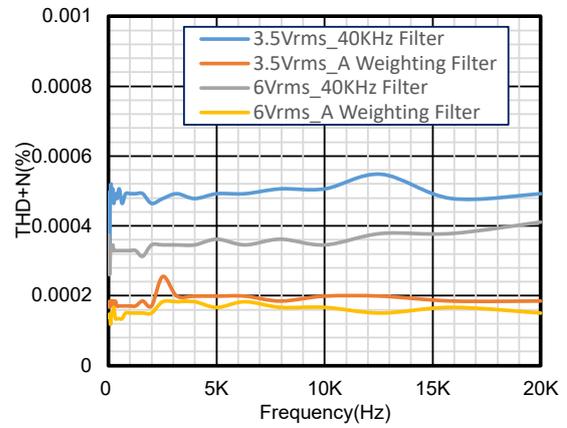


Figure 14. THD vs. Frequency, G = 1

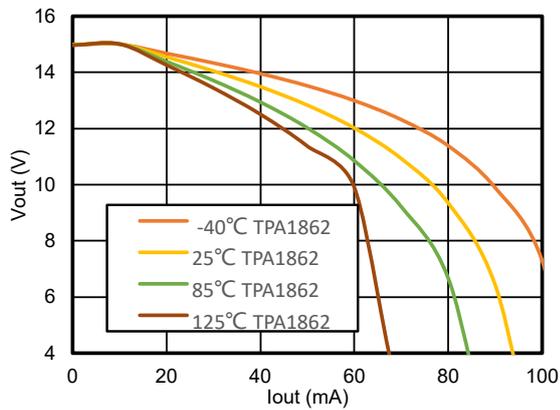


Figure 15. V_{OUT} vs. I_{OUT}, Source

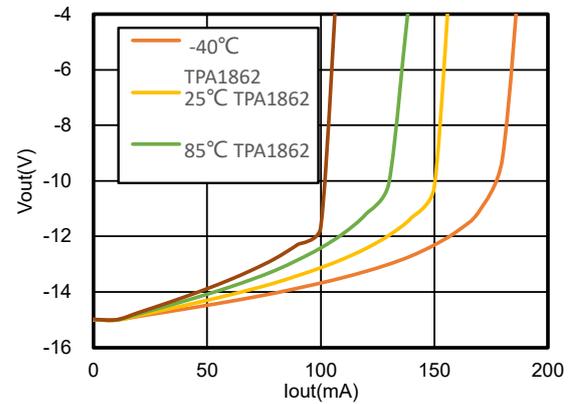


Figure 16. V_{OUT} vs. I_{OUT}, Sink

Detailed Description

Overview

The TPA186xQ is a series of the newest high-supply-voltage amplifiers. The TPA186xQ series can operate on a single-supply voltage (4.5 V to 36 V), or a split-supply voltage (± 2.25 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 μ F to 0.1 μ F). Parameters that exhibit variance with regard to the operating voltage or temperature are presented in the [Typical Performance Characteristics](#).

Functional Block Diagram

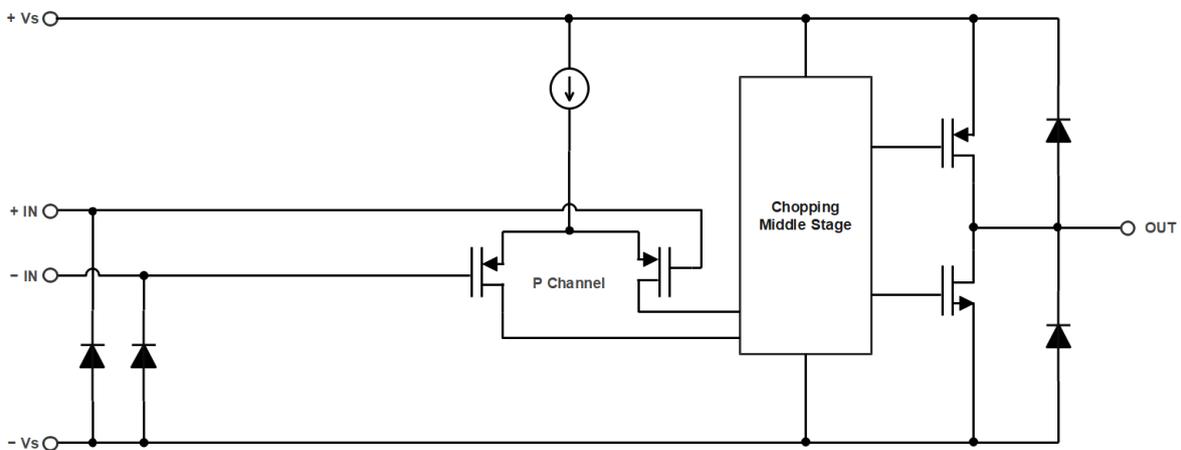


Figure 17. Functional Block Diagram

Feature Description

Operating Supply Voltage

The TPA186xQ series is designed for single-supply operation from 4.5 V to 36 V or dual-supply operation from ± 2.25 V to ± 18 V. The recommended operating voltage conditions are as follows:

Power supply voltage ($+V_S$) - ($-V_S$): 4.5 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 4.5 V to 36 V.

For example, when operating with a single supply, ($-V_S$) = 0 V, ($+V_S$) can support 4.5 V to 36 V. When using dual supplies with equal absolute voltage values, the minimum voltage is ± 2.25 V, and the maximum voltage is ± 18 V. The TPA186xQ can 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 Output

The TPA186xQ series delivers rail-to-rail output swing capability with a class-AB output stage. Different load conditions change the ability of the amplifiers to swing close to the rails.

Residual Voltage Ripple

Equipped with an internal notch filter, the chopping technique can be used in the amplifier design. 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. To suppress the noise at the chopping frequency, it is recommended that a post filter be placed at the output of the amplifiers.

The TPA186xQ series sets the chopping frequency to 150 kHz. If the frequency of the input signal is close to the chopping frequency, the signal may be interfered with by the residue ripple.

Application and Implementation

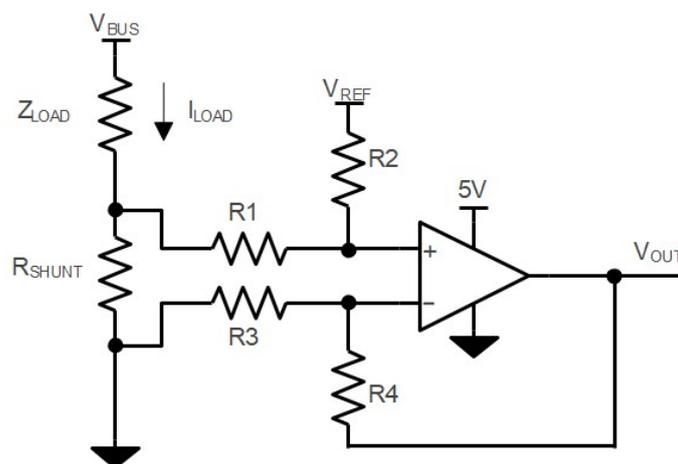
Note

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 18 shows the device 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 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.



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

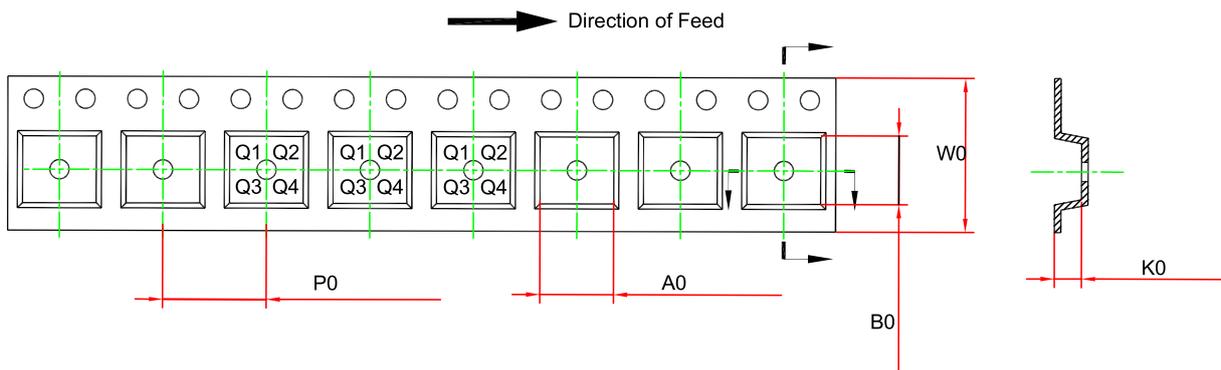
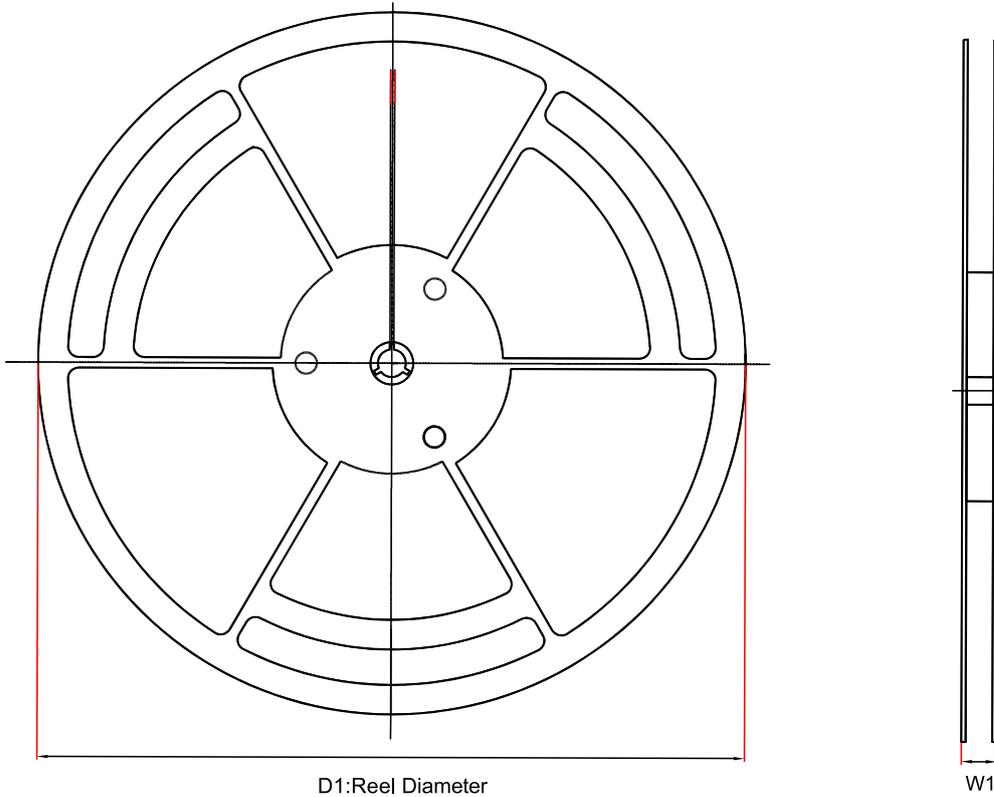
$$\text{When } R3 = R1, R2 = R4, R_{SHUNT} \ll R1$$

Figure 18. Low-Side Current Sensing Application

Power Supply Recommendations

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

Tape and Reel Information

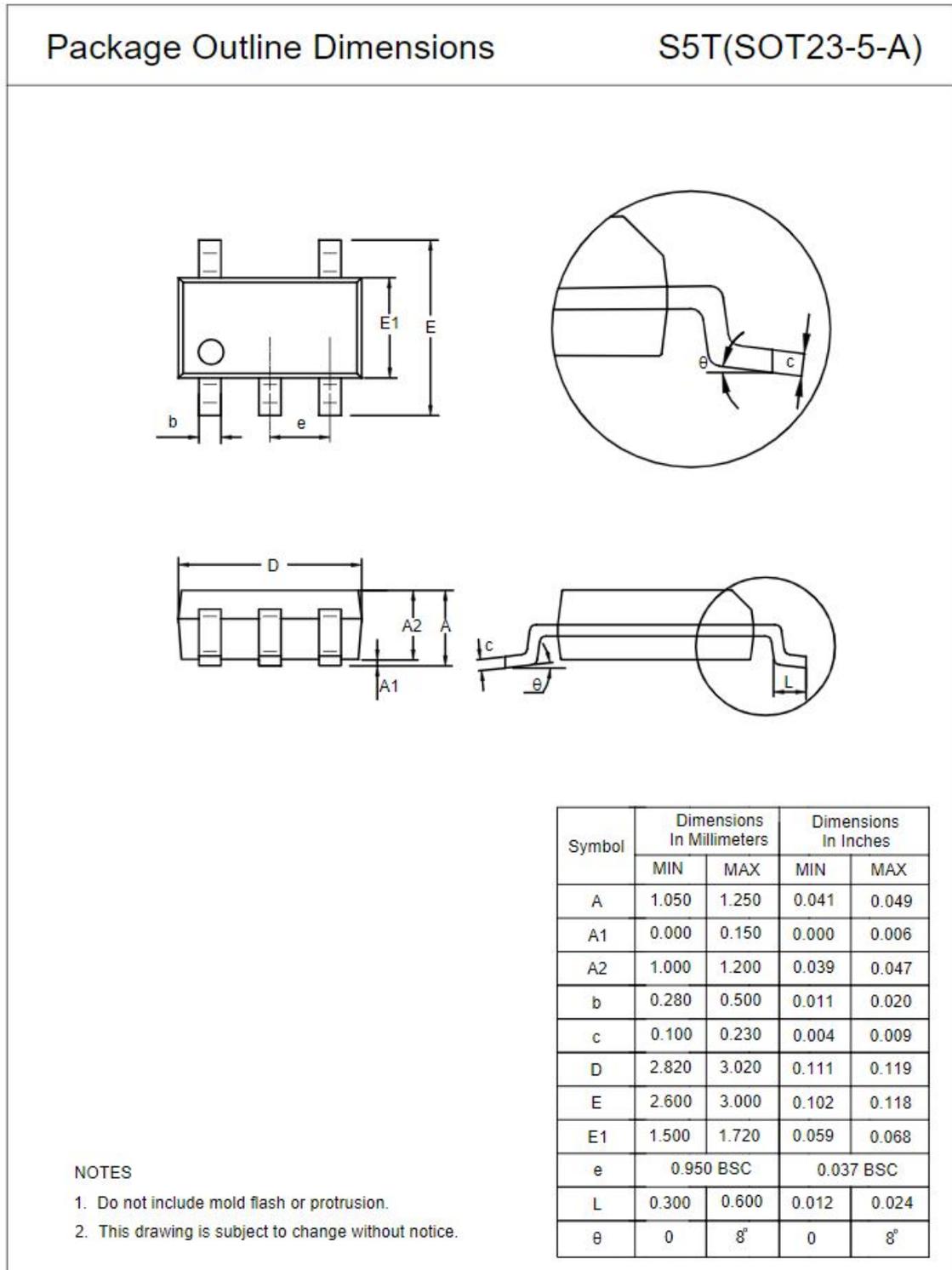


Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm) (1)	B0 (mm) (1)	K0 (mm) (1)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPA1861Q-S5TR-S	SOT23-5	180.0	12	3.3	3.25	1.4	4.0	8.0	Q3
TPA1862Q-SO1R-S	SOP8	330.0	17.6	6.5	5.4	2	8.0	12.0	Q1

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

Package Outline Dimensions

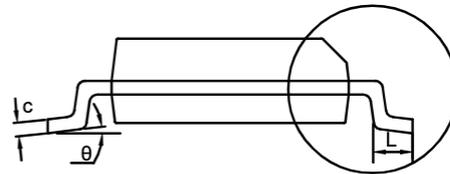
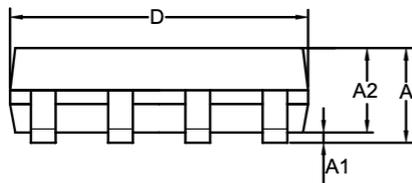
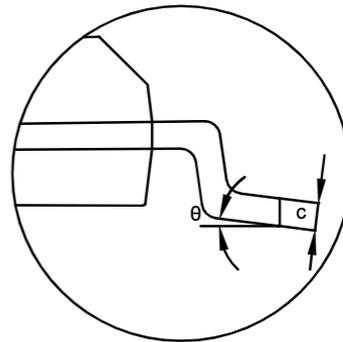
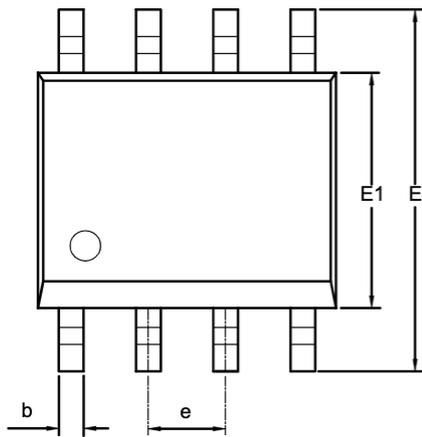
SOT23-5



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
TPA1861Q-S5TR-S	-40 to 125°C	SOT23-5	A41	1	Tape and Reel,3000	Green
TPA1862Q-SO1R-S	-40 to 125°C	SOP8	1862Q	1	Tape and Reel,4000	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.

IMPORTANT NOTICE AND DISCLAIMER

Copyright© 3PEAK 2012-2024. All rights reserved.

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.