

Features

- Voltage Offset: $\pm 350 \mu\text{V}$ (Max) at $V_{\text{CM}} = 12 \text{ V}$
- Wide Common-Mode Voltage: -0.3 V to $+36 \text{ V}$
- Supply Voltage: 2.7 V to 36 V
- High Bandwidth
 - TPA192A1Q: 270 kHz
 - TPA192A2Q: 210 kHz
 - TPA192A3Q: 130 kHz
- Accuracy and Zero-Drift Performance:
 - $\pm 1\%$ Gain Error (Max over Temperature)
 - $0.2\text{-}\mu\text{V}/^\circ\text{C}$ Offset Drift (Typ)
 - $15\text{-ppm}/^\circ\text{C}$ Gain Drift (Max)
- Gain Options for Voltage Output
 - TPA192A1Q: 20 V/V
 - TPA192A2Q: 50 V/V
 - TPA192A3Q: 100 V/V
- Low Supply Current: $160 \mu\text{A}$ (Typ)
- Rail-to-Rail Output
- Package: SOT23-6
- Industrial Operating Range: -40°C to 125°C
- Qualified for Automotive Applications with AEC-Q100 Reliability Test
 - Grade 1: -40°C to 125°C T_A

Applications

- Current Sensing (High-Side/Low-Side)
- Battery Charger
- Power Management
- Cell Phone Charger
- Electrical Cigarette
- Wireless Charger
- Telecom Equipment

Description

The TPA192Q is a series of zero-drift, bi-directional current sense amplifiers that can sense voltage drops across shunts at common-mode voltages from -0.3 V to 36 V , independent of the supply voltage. Three fixed gains are available: 20 V/V , 50 V/V , and 100 V/V . The integration-matched gain resistor network minimizes gain errors and reduces the temperature drift. The low offset of the zero-drift architecture enables current sensing with the maximum drops across the shunt as low as 10 mV full-scale.

The TPA192Q series operates from a single 2.7-V to 36-V power supply, while drawing $160\text{-}\mu\text{A}$ supply current (typical). All versions are specified from -40°C to $+125^\circ\text{C}$, and offered in the SOT23-6 package.

Typical Application Circuit

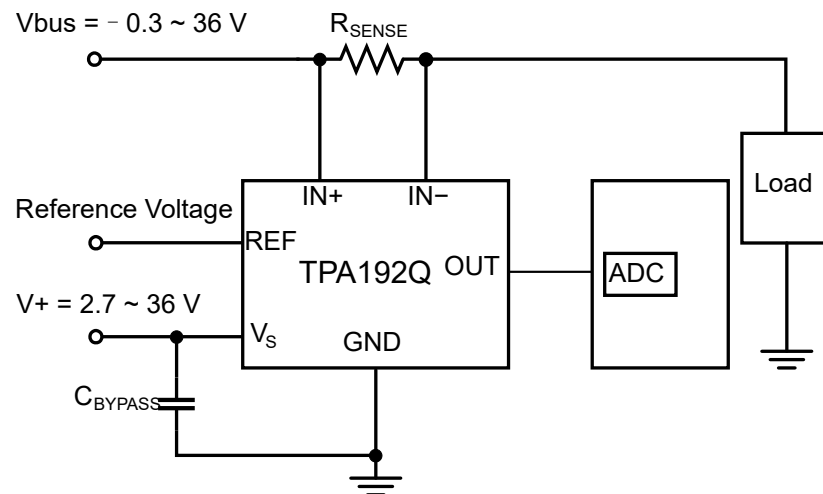


Table of Contents

Features	1
Applications	1
Description	1
Typical Application Circuit	1
Revision History	3
Pin Configuration and Functions	4
Specifications	5
Absolute Maximum Ratings ⁽¹⁾	5
ESD, Electrostatic Discharge Protection.....	5
Recommended Operating Conditions.....	5
Thermal Information.....	5
Electrical Characteristics.....	6
Typical Performance Characteristics.....	8
Detailed Description	11
Overview.....	11
Functional Block Diagram.....	11
Feature Description.....	11
Application and Implementation	12
Application Information	12
Typical Application.....	12
Layout	14
Layout Guideline.....	14
Layout Example.....	14
Tape and Reel Information	15
Package Outline Dimensions	16
SOT23-6.....	16
Order Information	17
IMPORTANT NOTICE AND DISCLAIMER	18

Revision History

Date	Revision	Notes
2025-08	Rev.A.0	Initial version.
2025-12	Rev.A.1	The following updates are all about the new datasheet formats or typos, and the actual product remains unchanged. • Changed the Typical Bandwidth of TPA192A3Q from "150kHz" to "130kHz". • Added the Typical Performance Characteristics of TPA192A1Q and TPA192A3Q in the figures. • Changed the limit of V_{os} ($V_{IN+} = 2.75\text{ V}$) from $\pm 150\mu\text{V}$ to $\pm 500\mu\text{V}$ in the Electrical Characteristics: TPA192A1Q. • Changed the minimum value of CMRR from 90dB to 87dB and minimum value of PSRR from 97dB to 91dB in the Electrical Characteristics: TPA192A1Q. • Changed the Minimum Level of CDM from 1.5kV to 1kV.
2026-01	Rev.A.2	The following updates are all about the new datasheet formats or typos, and the actual product remains unchanged. • Added Output Swing From GND specification under test condition of $R_L = 10\text{ k}\Omega$ to GND in Electrical Characteristics table. • Added new orderable part number "TPA192A1Q-S6TR-S" and "TPA192A3Q-S6TR-S".

Pin Configuration and Functions

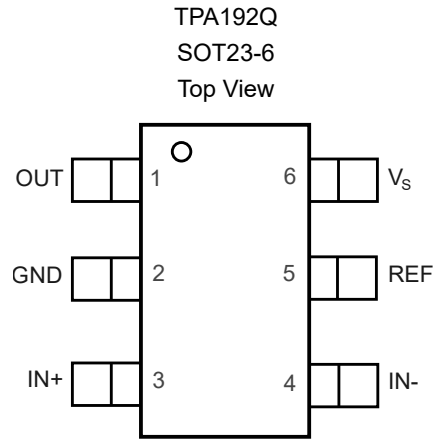


Table 1. Pin Functions: TPA192Q

Pin No.	Pin Name	I/O	Description
1	OUT	O	Output
2	GND		Ground
3	IN+	I	Non-inverting input
4	IN–	I	Inverting input
5	REF	I	Reference voltage
6	V _s	I	Power supply, 2.7 V to 36 V

Zero-Drift, Bi-Directional Current Sense Amplifier

Specifications

Absolute Maximum Ratings ⁽¹⁾

Symbol	Parameter	Min	Max	Unit
	Supply Voltage		42	V
Analog Input, IN+, IN-	Differential (IN+) – (IN-)	-42	42	V
	Common Mode	GND – 0.3	42	V
	REF Input	GND – 0.3	V _S + 0.3	V
	Output	GND – 0.3	V _S + 0.3	V
	Input Current into All Pins ⁽²⁾	-10	10	mA
T _A	Operating Temperature Range	-40	125	°C
T _J	Maximum Junction Temperature		150	°C
T _{STG}	Storage Temperature Range	-65	150	°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) Input voltage at any pin can exceed the voltage shown if the current at that pin is limited to 10 mA.

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	Operating Supply Voltage	2.7		36	V
V _{CM}	Common-Mode Input Voltage	-0.3		36	V
T _A	Operating Free-Air Temperature	-40		125	°C

Thermal Information

Package Type	θ _{JA}	θ _{JC}	Unit
SOT23-6	161	64	°C/W

Zero-Drift, Bi-Directional Current Sense Amplifier
Electrical Characteristics

All test conditions: $T_A = 27^\circ\text{C}$, $V_S = 5\text{ V}$, $V_{IN+} = 12\text{ V}$, $V_{SENSE} = V_{IN+} - V_{IN-}$, $V_{REF} = V_S / 2$, unless otherwise noted.

Parameter			Conditions	Min	Typ	Max	Unit
Supply Voltage and Current							
V _S	Operating Voltage Range		T _A = −40°C to 125°C	2.7		36	V
I _Q	Quiescent Current		V _{SENSE} = 0 mV, T _A = −40°C to 125°C		160	260	μA
Input							
V _{OS}	Input Offset Voltage		V _{SENSE} = 0 mV, TPA192A1Q, TPA192A2Q, TPA192A3Q	−350	±100	350	μV
			V _{IN+} = 2.75 V, V _{SENSE} = 0 mV, TPA192A1Q	−500	±50	500	
			V _{IN+} = 2.75 V, V _{SENSE} = 0 mV, TPA192A2Q, TPA192A3Q	−150	±50	150	
V _{OS} TC	Input Offset Voltage Drift		T _A = −40°C to 125°C		0.2		μV/°C
V _{CM}	Common-Mode Input Range		T _A = −40°C to 125°C	−0.3		36	V
CMRR	Common Mode Rejection Ratio		V _{IN+} = 0 V to 26 V, V _{SENSE} = 0 mV, T _A = −40°C to 125°C, TPA192A1Q	87	120		dB
			V _{IN+} = 0 V to 26 V, V _{SENSE} = 0 mV, T _A = −40°C to 125°C, TPA192A2Q, TPA192A3Q	90	120		dB
I _B	Input Bias Current		V _{SENSE} = 0 mV		22	30	μA
I _{OS}	Input Offset Current		V _{SENSE} = 0 mV		±0.05	2	μA
PSRR	Power Supply Rejection Ratio		V _S = 2.7 V to 18 V, V _{IN+} = 18 V, V _{SENSE} = 0 mV, T _A = −40°C to 125°C, TPA192A1Q	91	128		dB
			V _S = 2.7 V to 18 V, V _{IN+} = 18 V, V _{SENSE} = 0 mV, T _A = −40°C to 125°C, TPA192A2Q, TPA192A3Q	97	128		dB
Output							
G	Gain	TPA192A1Q			20		V/V
		TPA192A2Q			50		
		TPA192A3Q			100		
GE	Gain Error		V _{OUT} = 0.5 V to V _S − 0.5 V, T _A = −40°C to 125°C		±0.05	±1	%
GE TC	Gain Error vs. Temperature		T _A = −40°C to 125°C		3	15	ppm/°C
NE	Nonlinearity Error		V _{OUT} = 0.5 V to V _S − 0.5 V		±0.05		%
C _{LOAD}	Maximum Capacitive Load		No sustained oscillation		1		nF

Zero-Drift, Bi-Directional Current Sense Amplifier

Parameter			Conditions	Min	Typ	Max	Unit
V _{OH}	Output Swing from V _S		R _L = 10 kΩ to REF, T _A = −40°C to 125°C		0.1	0.15	V
V _{OL}	Output Swing from GND		R _L = 10 kΩ to REF, T _A = −40°C to 125°C		0.03	0.07	V
			R _L = 10 kΩ to GND, T _A = −40°C to 125°C ⁽¹⁾		2.75	10	mV
Frequency Response							
BW	Bandwidth	TPA192A1Q	C _{LOAD} = 10 pF		270		kHz
		TPA192A2Q			210		
		TPA192A3Q			130		
SR	Slew Rate		T _A = −40°C to 125°C		6		V/μs
Noise, RTI							
e _n	Input Voltage Noise Density		f _{IN} = 1 kHz		40		nV/ √Hz
Reference Input							
	Reference Input Range		V _S = 2.7 V to 5.5 V	0		V _S	V
			V _S = 5.5 V to 36 V	0		5.5	V

(1) Provided by bench test and design simulation.

Typical Performance Characteristics

All test conditions: $T_A = 25^\circ\text{C}$, $V_S = 5\text{ V}$, $V_{IN+} = 12\text{ V}$, $V_{REF} = V_S / 2$, unless otherwise noted.

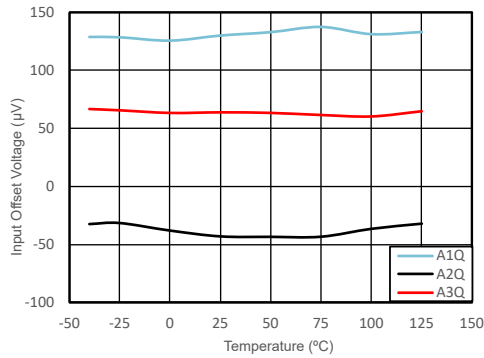


Figure 1. Offset Voltage vs. Temperature

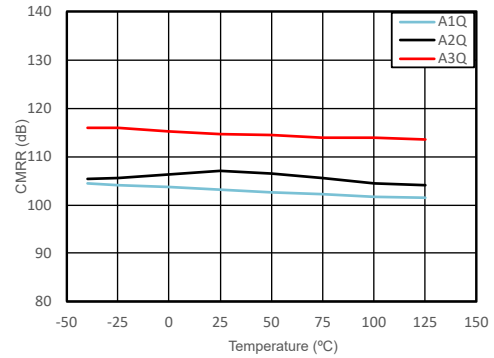


Figure 2. Common-Mode Rejection Ratio vs. Temperature

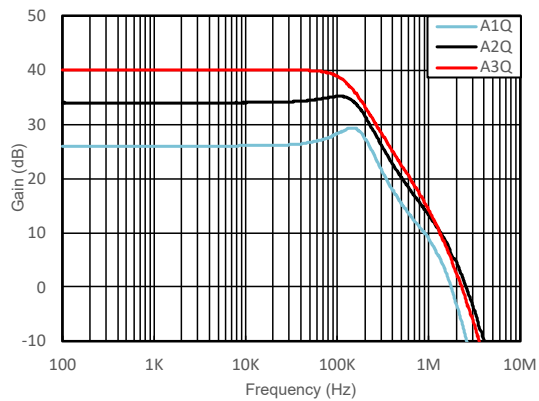


Figure 3. Gain vs. Frequency

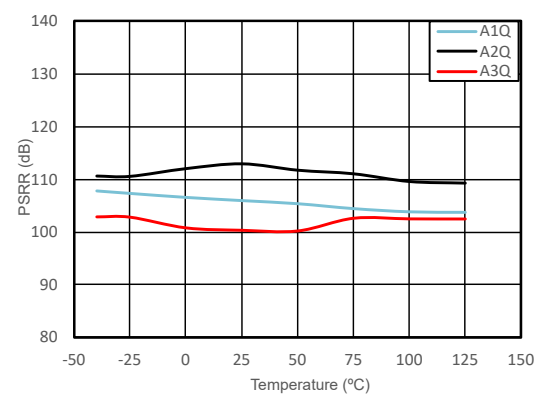


Figure 4. Power-Supply Rejection Ratio vs. Temperature

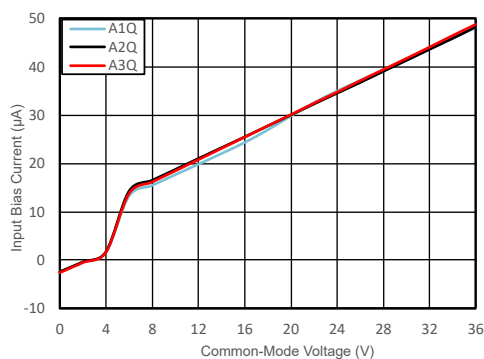


Figure 5. Input Bias Current vs. Common-Mode Voltage

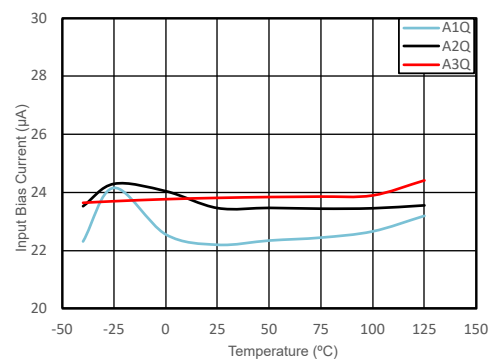
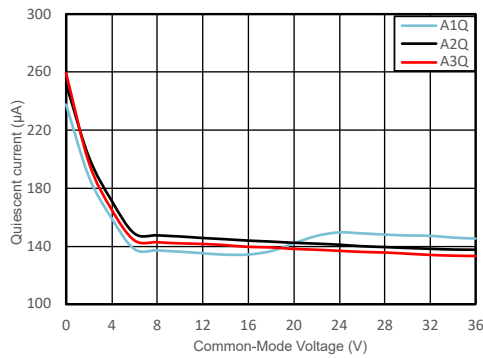
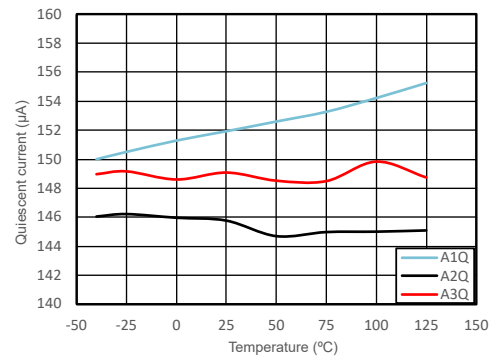
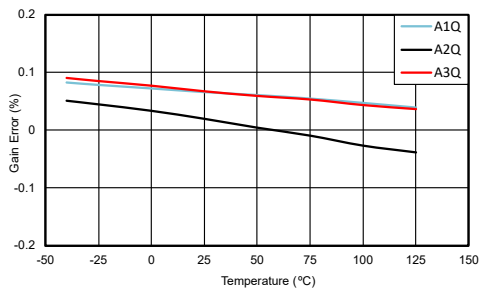
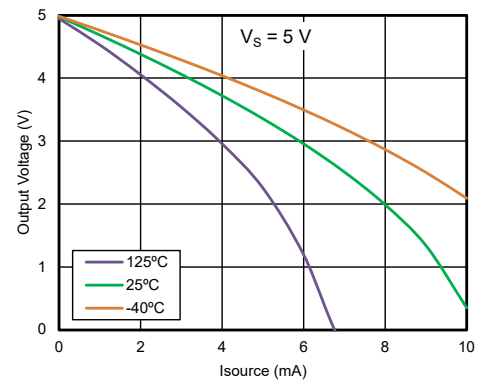
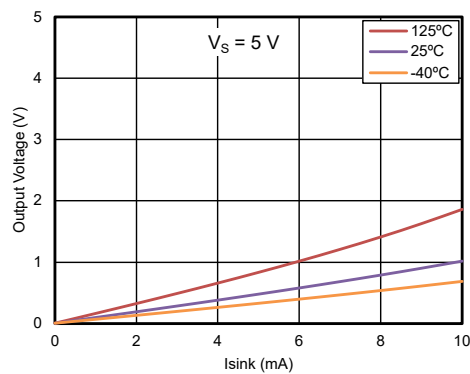
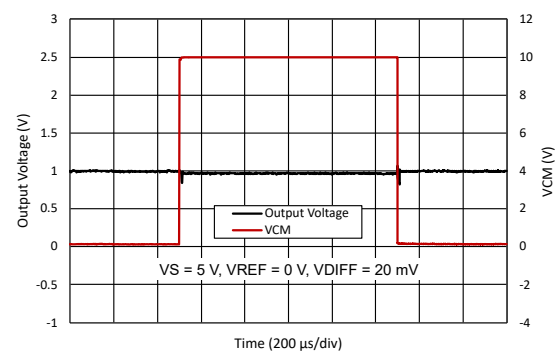


Figure 6. Input Bias Current vs. Temperature

Zero-Drift, Bi-Directional Current Sense Amplifier


Figure 7. Quiescent Current vs. Common-Mode Voltage

Figure 8. Quiescent Current vs. Temperature

Figure 9. Gain Error vs. Temperature

Figure 10. Output Voltage Swing vs. I_{source}

Figure 11. Output Voltage Swing vs. I_{sink}

Figure 12. Common-Mode Voltage Transient Response

Zero-Drift, Bi-Directional Current Sense Amplifier

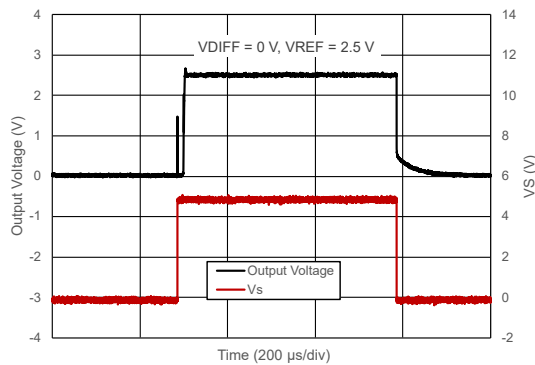


Figure 13. Start-up Response

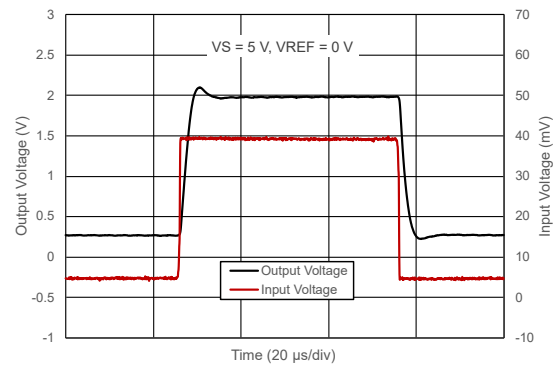


Figure 14. Step Response

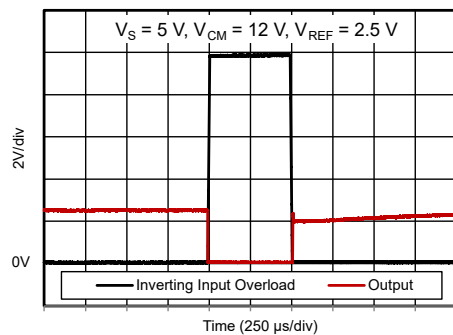


Figure 15. Inverting Differential Input Overload

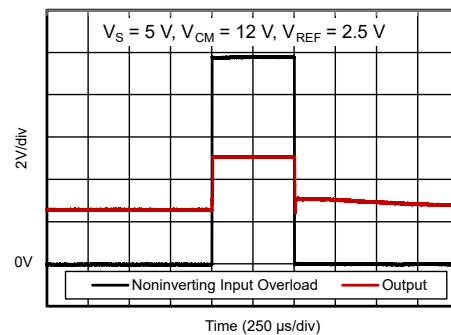


Figure 16. Noninverting Differential Input Overload

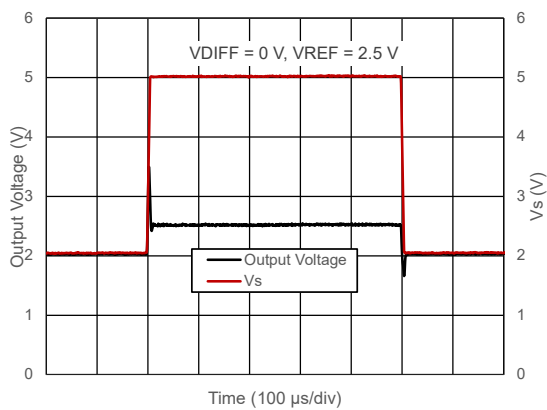


Figure 17. Brownout Recovery

Detailed Description

Overview

The TPA192Q series features a high-accuracy bidirectional, current-sense amplifier in various gain options, and a -0.3-V to 36-V input common-mode range that is independent of supply voltage (V_S). The low input offset voltage, tight gain error, and low-temperature drift characteristics allow the use of small-sense resistors for current measurements to improve power-supply conversion efficiency and accuracy of measurements. This feature allows monitoring power-supply load current even when the rail is shorted to ground. High-side current monitoring does not interfere with the ground path of the load measured, making the IC particularly useful in a wide range of high-reliability systems. Because of its extended common-mode range below ground, the TPA192Q can also be used as a low-side current sensing element.

Functional Block Diagram

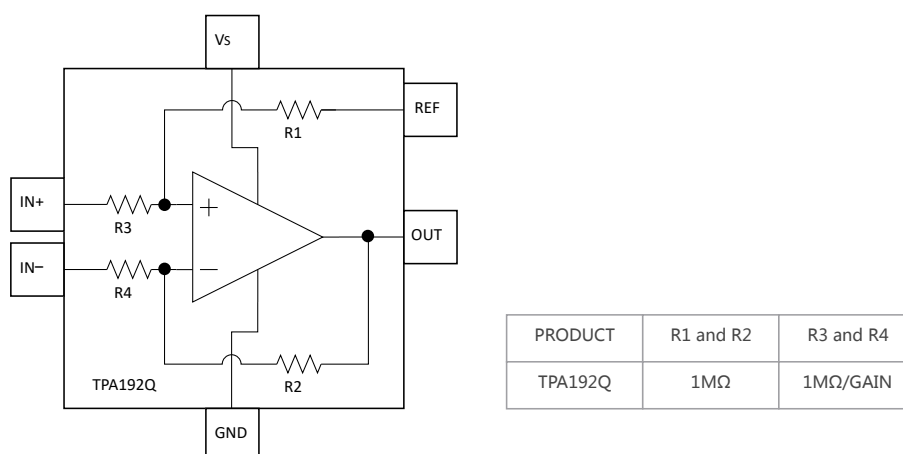


Figure 18. Functional Block Diagram

Feature Description

Wide-Input Common-Mode Voltage Range

Because of the internal topology, the TPA192Q supports -0.3-V to 36-V input common-mode voltage that is independent of the supply voltage (V_S). The ability to operate with common-mode voltages greater or less than V_S allows the TPA192Q to be used in high-side and low-side current-sensing applications.

Reference Input, REF

The TPA192Q supports both unidirectional and bidirectional current-sensing operations. Connecting the reference input (REF) to ground configures the TPA192Q for unidirectional current sensing. For unidirectional current sensing, the output is referenced to ground, and the output voltage V_{OUT} is proportional to the positive voltage drop (V_{SENSE}) from $IN+$ to $IN-$. The TPA192Q operates as a bidirectional Current-Sense-Amplifier (CSA) by the application of a low source impedance reference voltage to REF above ground, typically $V_S / 2$. In the bidirectional current-sensing mode of operation, the output voltage V_{OUT} is referenced to V_{REF} .

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

The TPA192Q monitors the current through a current-sense resistor and amplifies the voltage across the resistor. The 36-V input common-mode voltage range of the TPA192Q is independent of the supply voltage. It is a bidirectional, current-sense amplifier capable of measuring currents through a resistive shunt in two directions.

Typical Application

Figure 19 and Figure 20 show the typical application schematics of unidirectional and bidirectional applications.

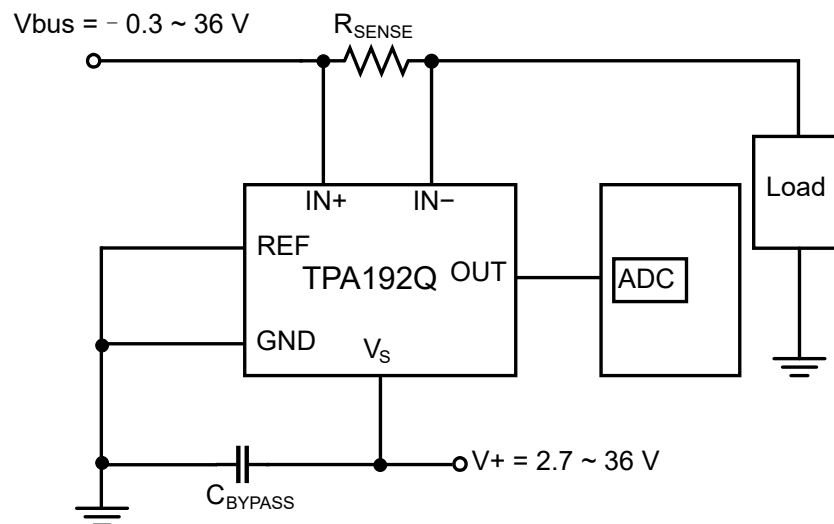


Figure 19. Unidirectional Application Schematic

Zero-Drift, Bi-Directional Current Sense Amplifier

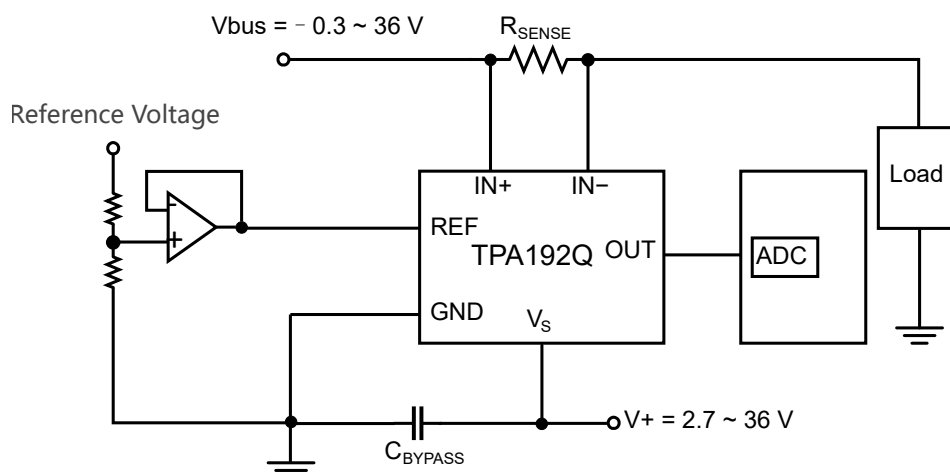


Figure 20. Bidirectional Application Schematic

Bidirectional and Unidirectional Operation

The TPA192Q series is capable of both unidirectional and bidirectional operations. For unidirectional current-sense applications, connect the REF input to GND. For bidirectional, connect REF to a reference. This sets bidirectional current sense with $V_{OUT} = V_{REF}$ for $V_{SENSE} = 0$ mV. Positive V_{SENSE} causes OUT to swing toward the positive supply, while negative V_{SENSE} causes OUT to swing toward GND. This feature allows the output voltage to measure both charge and discharge currents. Use $V_{REF} = V_S / 2$ for the maximum dynamic range.

Battery-powered systems require a precise bidirectional current-sense amplifier to accurately monitor the charge and discharge currents of the battery. Measurements of OUT with respect to V_{REF} yield positive and negative voltages during charge and discharge cycles.

Choosing the Sense Resistor

A high R_{SENSE} value causes the power-source voltage to drop due to IR loss. For the minimal voltage loss, use the lowest R_{SENSE} value. At high-current levels, the I^2R losses in R_{SENSE} can be significant. This should be taken into consideration when choosing the resistor value and its power dissipation (wattage) rating. The value of the sense resistor drifts if it is allowed to heat up excessively. A high R_{SENSE} value allows lower currents to be measured more accurately because offsets are less significant when the sense voltage is larger. Note that the tolerance and temperature coefficient of the chosen resistors directly affect the precision of any measurement system. For best performance, select R_{SENSE} to provide the approximately maximum input differential sense voltage with full-scale output voltage for each application. Sense resistors of 5 mΩ to 100 mΩ are available with 1% accuracy or better.

Layout

Layout Guideline

- Because the high currents may flow through R_{SENSE} based on the application, take care to eliminate solder and parasitic trace resistance from causing errors in the sense voltage. Either use a four-terminal current sense resistor or use Kelvin (force and sense) PCB layout techniques.
- Ensure that the sense resistor has as much copper trace area as possible to dissipate heat as the resistor value changes slightly with temperature. Also, see the resistor manufacturing datasheet or application notes for further layout guidelines.
- The power-supply bypass capacitor should be placed as close as possible to the supply and ground. The recommended value of this bypass capacitor is 0.1 μF . Additional decoupling capacitance can be added to compensate for noisy or high-impedance power supplies.

Layout Example

Figure 21 shows the location of external components as they appear on the PCB diagram.

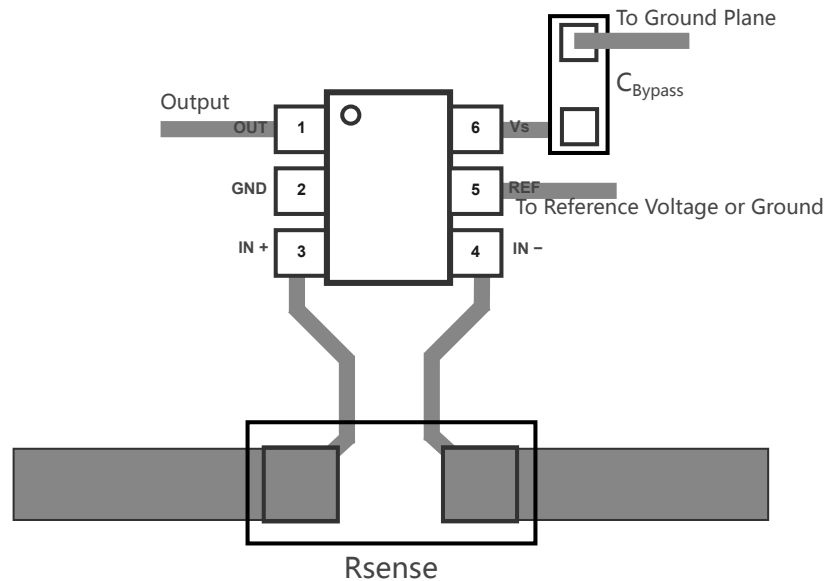
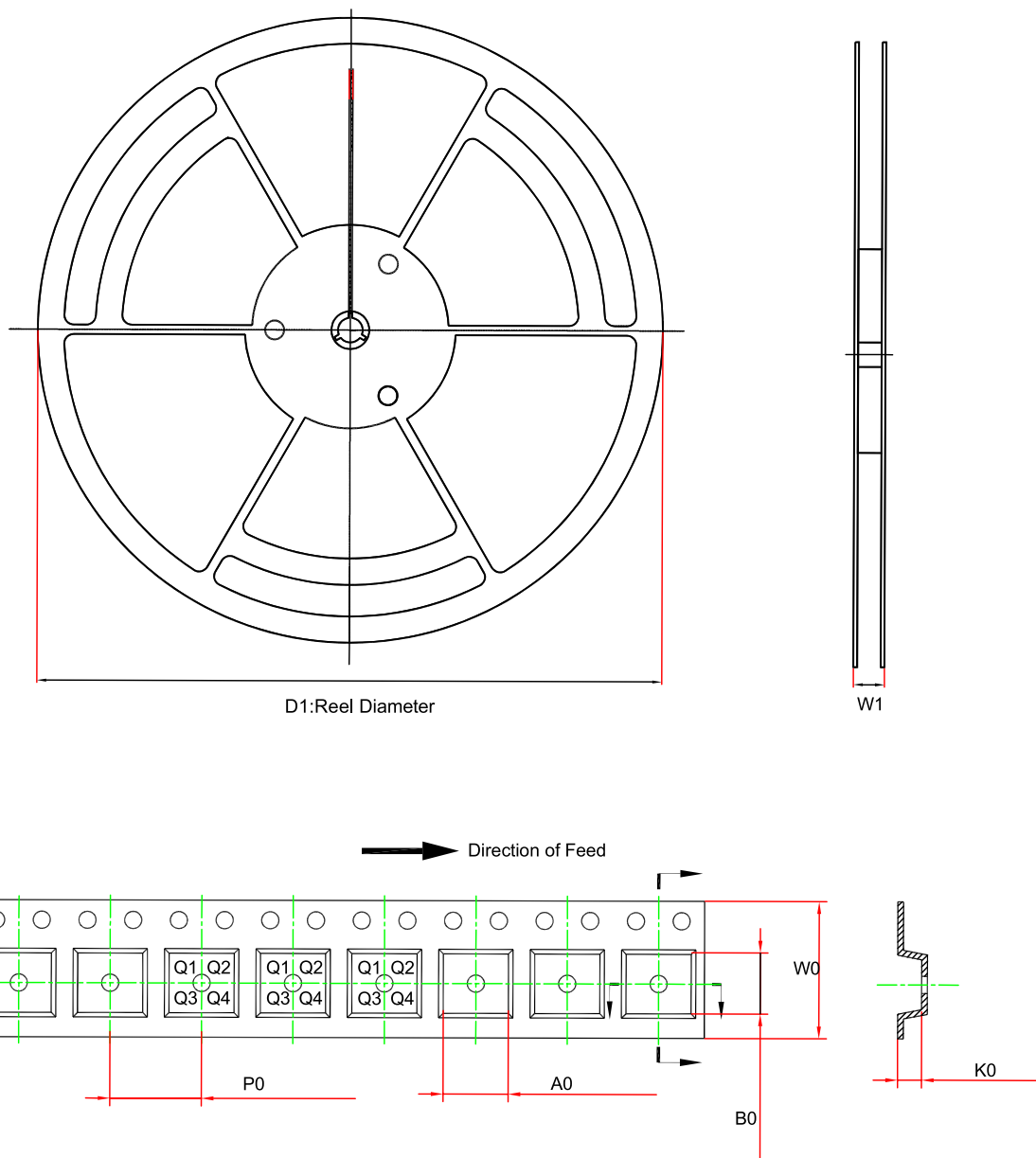


Figure 21. Recommended Layout

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
TPA192AxQ-S6TR-S	SOT23-6	180.0	12	3.3	3.2	1.4	4.0	8.0	Q3

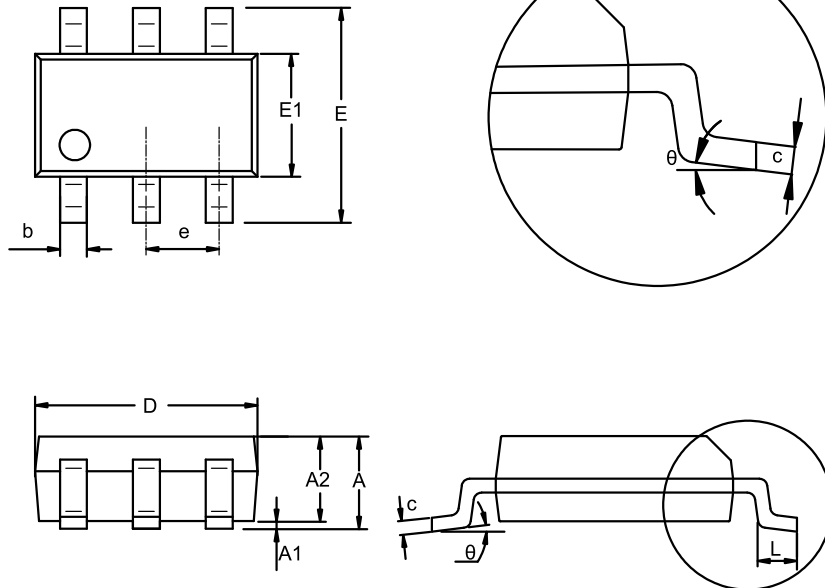
(1) The value is for reference only. Contact the 3PEAK factory for more information.

Package Outline Dimensions

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.
3. Reference JEDEC MO-178.

Order Information

Order Number	Gain Option	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
TPA192A1Q-S6TR-S	20	-40 to 125°C	SOT23-6	A9I	1	Tape and Reel, 3000	Green
TPA192A2Q-S6TR-S	50	-40 to 125°C	SOT23-6	A9J	1	Tape and Reel, 3000	Green
TPA192A3Q-S6TR-S	100	-40 to 125°C	SOT23-6	A9K	1	Tape and Reel, 3000	Green

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

IMPORTANT NOTICE AND DISCLAIMER

Copyright© 3PEAK 2012-2026. 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.