

Features

- Supply Voltage: 2.5 V to 5.5 V
- Offset Voltage: ± 3 mV Maximum
- Bandwidth: 6 MHz, Slew Rate: 5 V/ μ s
- Low Power: 0.8 mA per channel
- Rail-to-Rail Input and Output
- Low 1/f Noise: 25 nV/ $\sqrt{\text{Hz}}$ at 1 kHz
- -40°C to 125°C Operation Temperature Range

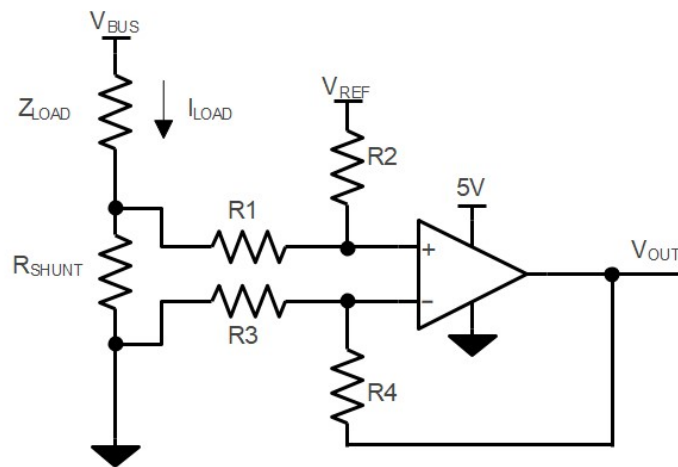
Applications

- Instrumentation
- Motor Control
- Industrial Control

Description

The device is a CMOS single and dual RRIO op-amp with low offset, low power, and stable high-frequency response. The device incorporate proprietary and patented design techniques to achieve high-performance AC with 6-MHz bandwidth, 5-V/ μ s slew rate, and low distortion while drawing only 0.8 mA of quiescent current per amplifier. The device is suitable for audio and motor control application.

Typical Application Circuit



$$V_{\text{OUT}} = (I_{\text{LOAD}} \times R_{\text{SHUNT}}) \times (R_2 / R_1) + V_{\text{REF}}$$

$$\text{When } R_3 = R_1, R_2 = R_4, R_{\text{SHUNT}} \ll R_1$$

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	5
ESD, Electrostatic Discharge Protection.....	5
Recommended Operating Conditions.....	5
Thermal Information.....	5
Electrical Characteristics.....	6
Electrical Characteristics (Continued).....	7
Typical Performance Characteristics.....	8
Detailed Description	11
Functional Block Diagram.....	11
Application and Implementation	12
Application Information	12
Tape and Reel Information	13
Package Outline Dimensions	14
MSOP8.....	14
Order Information	15
IMPORTANT NOTICE AND DISCLAIMER	16

Revision History

Date	Revision	Notes
2023-09-04	Rev.A.0	Initial release.

Pin Configuration and Functions

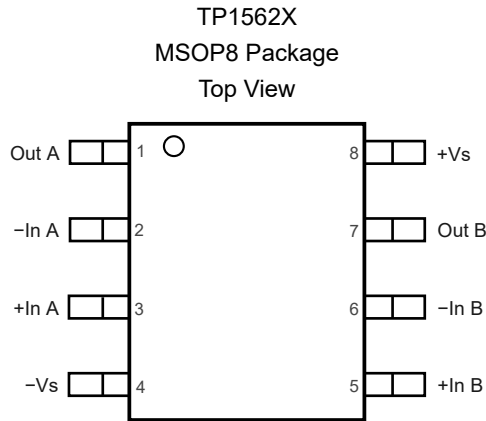


Table 1. Pin Functions: TP1562X

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

Specifications

Absolute Maximum Ratings

Over operating ambient temperature (unless otherwise noted) ⁽¹⁾

Parameter		Min	Max	Unit
	Supply Voltage, (+V _S) – (–V _S)		6.5	V
	Input Voltage	(–V _S) – 0.3	(+V _S) + 0.5	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 each power supply. If the input extends more than 300 mV beyond the power supply, the input current should be limited to less than 10 mA.
- (3) A heat sink may be required to keep the junction temperature below the absolute maximum. This depends on the power supply voltage and how many amplifiers are shorted. Thermal resistance varies with the amount of PC board metal connected to the package. The specified values are for short traces connected to the leads.

ESD, Electrostatic Discharge Protection

Parameter		Condition	Minimum Level	Unit
HBM	Human Body Model ESD	ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	6	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)	2.5		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

5-V, Rail-to-Rail Input/Output, 6-MHz Op Amp
Electrical Characteristics

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

Parameter		Conditions	Min	Typ	Max	Unit
Power Supply						
V_S	Supply Voltage Range		2.5		5.5	V
I_Q	Quiescent Current per Amplifier			0.8	1	mA
		$T_A = -40^\circ\text{C}$ to 125°C			1.2	mA
PSRR	Power Supply Rejection Ratio	$V_S = 2.5\text{ V}$ to 5.5 V , $V_{CM} = 1\text{ V}$	72	94		dB
		$V_S = 2.5\text{ V}$ to 5.5 V , $V_{CM} = 1\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C	60			dB
Input Characteristics						
V_{OS}	Input Offset Voltage	$V_{CM} = 0\text{ V}$ to 2.5 V	-3	1.5	3	mV
		$V_{CM} = 0\text{ V}$ to 2.5 V , $T_A = -40^\circ\text{C}$ to 125°C	-3.5		3.5	mV
		$V_{CM} = 3.5\text{ V}$ to 5 V	-6.8	1.8	6.8	mV
		$V_{CM} = 3.5\text{ V}$ to 5 V , $T_A = -40^\circ\text{C}$ to 125°C	-11		11	mV
$V_{OS\ TC}$	Input Offset Voltage Drift ⁽¹⁾	$V_{CM} = 0\text{ V}$ to 2.5 V , $T_A = -40^\circ\text{C}$ to 125°C		1		$\mu\text{V}/^\circ\text{C}$
		$V_{CM} = 3.5\text{ V}$ to 5 V , $T_A = -40^\circ\text{C}$ to 125°C		2		$\mu\text{V}/^\circ\text{C}$
I_B	Input Bias Current ⁽¹⁾	$V_{CM} = 2.5\text{ V}$	-300	10	300	pA
		$V_{CM} = 2.5\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C	-5		5	nA
I_{OS}	Input Offset Current ⁽¹⁾	$V_{CM} = 2.5\text{ V}$	-300	10	300	pA
		$V_{CM} = 2.5\text{ V}$, $T_A = -40^\circ\text{C}$ to 125°C	-5		5	nA
C_{IN}	Input Capacitance ⁽²⁾	Differential Mode		6		pF
		Common Mode		8		pF
A_v	Open-loop Voltage Gain	$V_O = 1\text{ V}$ to 4 V	85	100		dB
		$V_O = 1\text{ V}$ to 4 V , $T_A = -40^\circ\text{C}$ to 125°C	80			dB
V_{CMR}	Common-mode Input Voltage Range	$T_A = -40^\circ\text{C}$ to 125°C	$(-V_S)-0.1$		$(+V_S)+0.1$	V
CMRR	Common Mode Rejection Ratio	$V_{CM} = 0\text{ V}$ to 2.5 V	80	105		dB
		$V_{CM} = 0\text{ V}$ to 2.5 V , $T_A = -40^\circ\text{C}$ to 125°C	75			dB
		$V_{CM} = 0\text{ V}$ to 5 V	60	80		dB
		$V_{CM} = 0\text{ V}$ to 5 V , $T_A = -40^\circ\text{C}$ to 125°C	55			dB
Output Characteristics						
	Output Voltage Swing from Positive Rail or Negative Rail	$R_L = 10\text{ k}\Omega$ to $V_S/2$		10	15	mV
		$R_L = 10\text{ k}\Omega$ to $V_S/2$, $T_A = -40^\circ\text{C}$ to 125°C			20	mV

5-V, Rail-to-Rail Input/Output, 6-MHz Op Amp
Electrical Characteristics (Continued)

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

Parameter		Conditions	Min	Typ	Max	Unit
I _{sc}	Output Short-Circuit Current	Sink or Source	70	90		mA
		Sink or Source, $T_A = -40^\circ\text{C}$ to 125°C	50			mA
AC Specifications						
GBW	Gain-Bandwidth Product ⁽¹⁾			6		MHz
SR	Slew Rate ⁽¹⁾	$G = 1$, 2 V step, $T_A = -40^\circ\text{C}$ to 125°C	3	5		V/ μs
t _s	Settling Time, 0.1% ⁽¹⁾	$G = 1$, 2 V step		900		ns
	Settling Time, 0.01% ⁽²⁾	$G = 1$, 2 V step		1200		ns
PM	Phase Margin ⁽¹⁾	$R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$		70		°
GM	Gain Margin ⁽¹⁾	$R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$		10		dB
	Channel Separation ⁽¹⁾	$f = 100\text{ kHz}$		120		dB
Noise Performance						
E _N	Input Voltage Noise ⁽¹⁾	$f = 0.1\text{ Hz}$ to 10 Hz ,		2.1		μV_{RMS}
e _N	Input Voltage Noise Density ⁽¹⁾	$f = 1\text{ kHz}$		25		nV/ $\sqrt{\text{Hz}}$
i _N	Input Current Noise ⁽¹⁾	$f = 1\text{ kHz}$		20		fA/ $\sqrt{\text{Hz}}$
THD+N	Total Harmonic Distortion and Noise ⁽²⁾	$f = 1\text{ kHz}$, $G = 1$, $R_L = 10\text{ k}\Omega$, $V_{\text{OUT}} = 1\text{ V}_{\text{RMS}}$		0.002		%

(1) Provided by bench test and design simulation.

(2) Provided by design simulation.

Typical Performance Characteristics

All test condition: $V_S = 5\text{ V}$, $V_{CM} = 2.5\text{ V}$, unless otherwise noted.

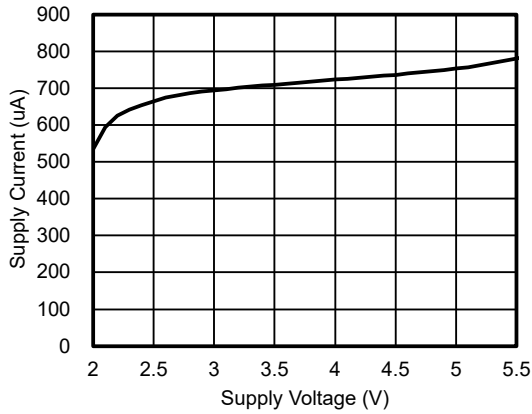


Figure 1. Supply Current vs Supply Voltage

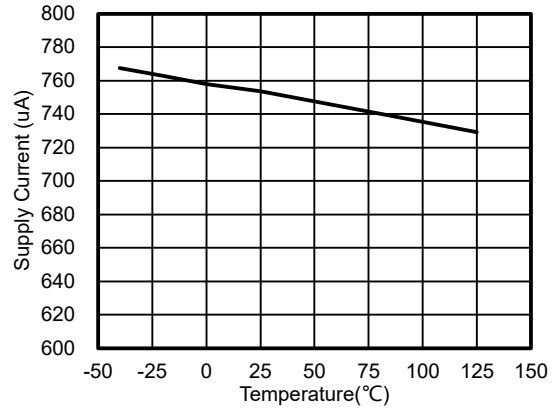


Figure 2. Supply Current vs Temperature

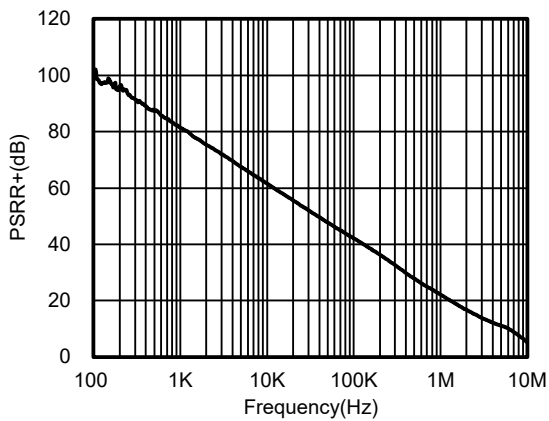


Figure 3. PSRR+ vs Frequency

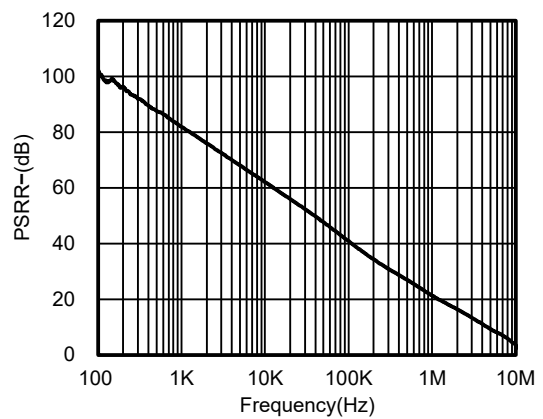


Figure 4. PSRR- vs Frequency

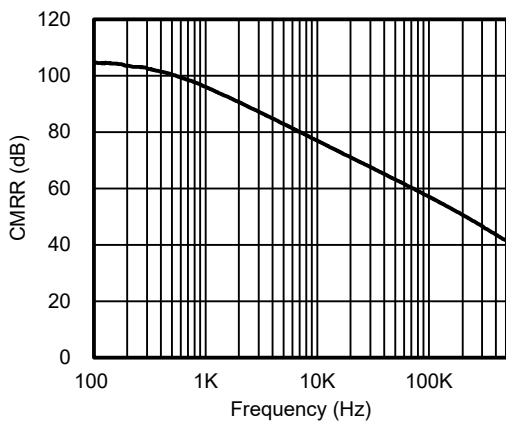


Figure 5. CMRR vs Frequency

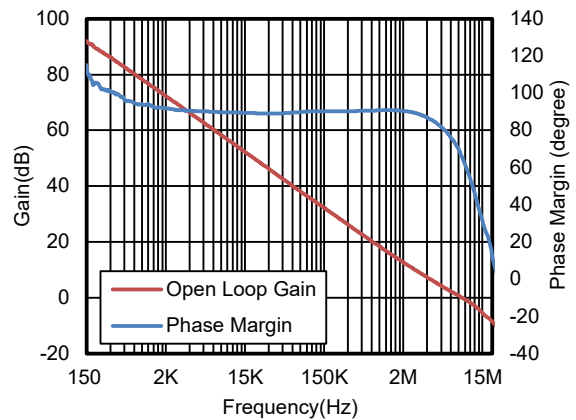


Figure 6. Open Loop Gain and Phase Margin vs Frequency, $R_L = 10\text{ k}\Omega$

5-V, Rail-to-Rail Input/Output, 6-MHz Op Amp

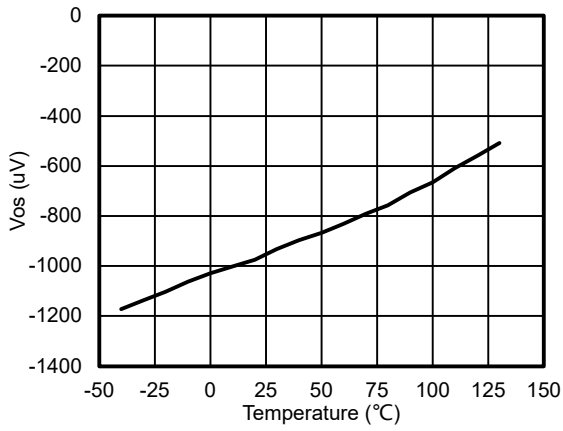


Figure 7. Vos vs Temperature

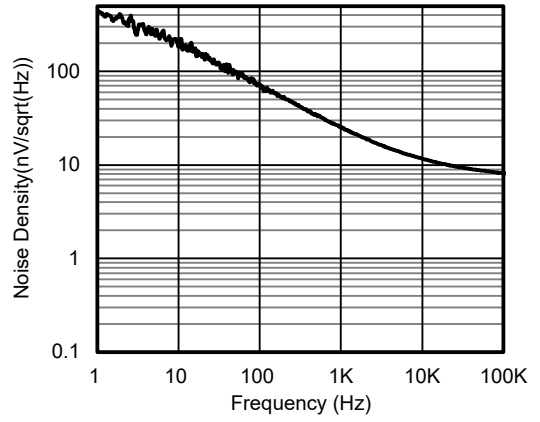


Figure 8. Voltage Noise Spectral Density vs Frequency, $V_{CM} = 2.5 V$

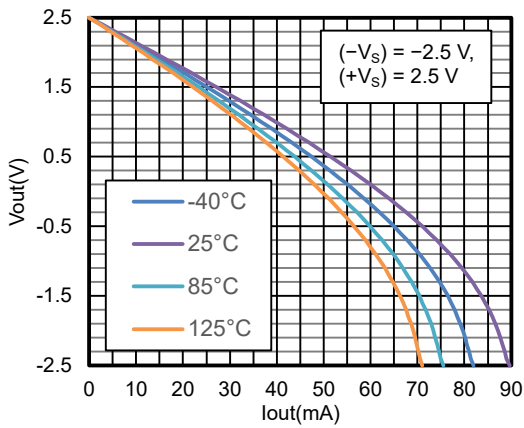


Figure 9. Output Voltage vs Output Current, $(-V_S) = -2.5 V$, $(+V_S) = 2.5 V$

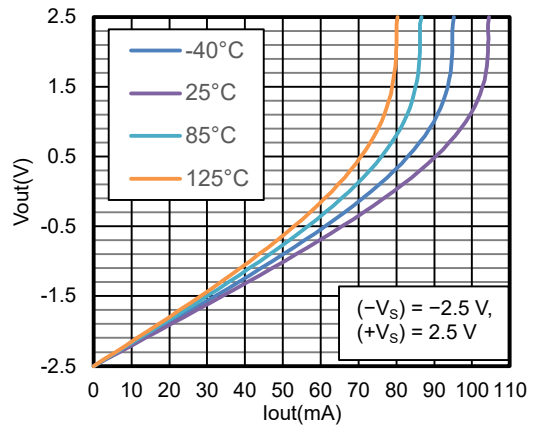


Figure 10. Output Voltage vs Output Current, $(-V_S) = -2.5 V$, $(+V_S) = 2.5 V$

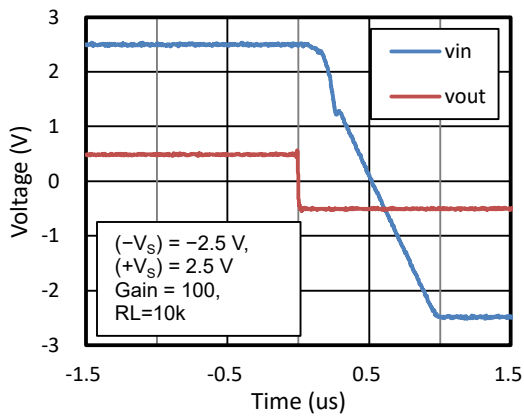


Figure 11. Overload Recovery at Negative Rail

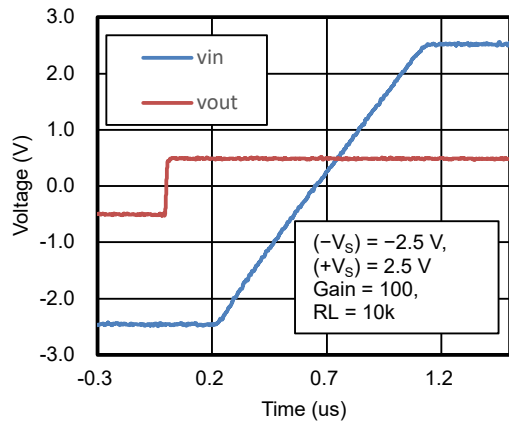


Figure 12. Overload Recovery at Positive Rail

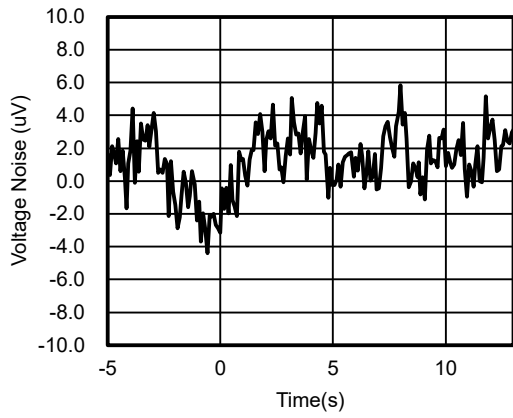
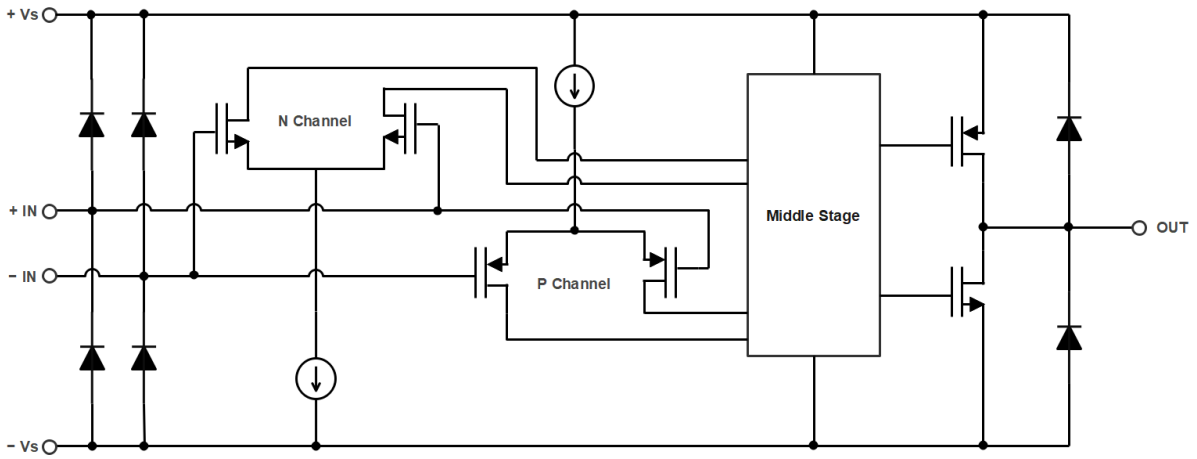


Figure 13. 0.1 to 10 Hz Voltage Noise, $V_{CM} = 2.5\text{ V}$

Detailed Description**Functional Block Diagram****Figure 14. Functional Block Diagram**

Application and Implementation

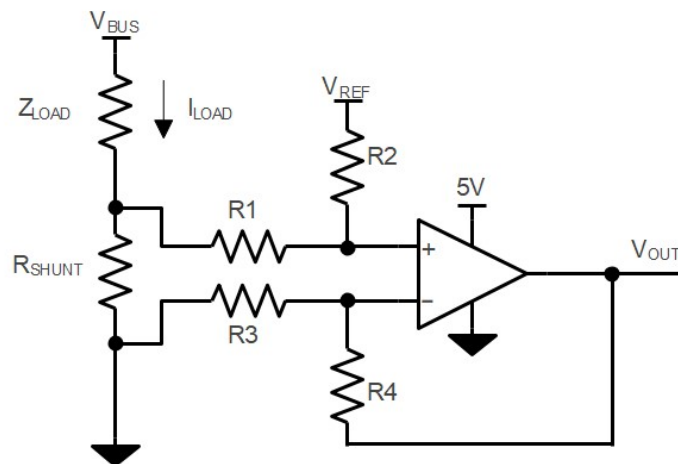
Note

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

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



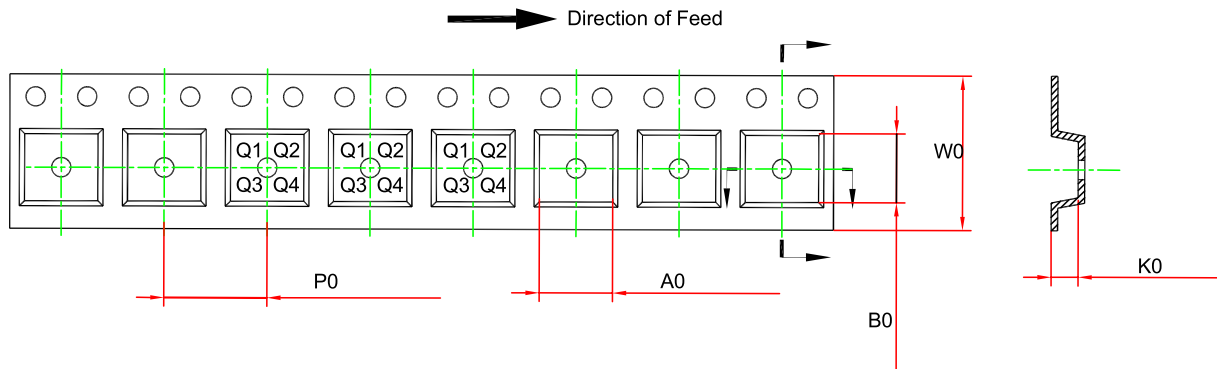
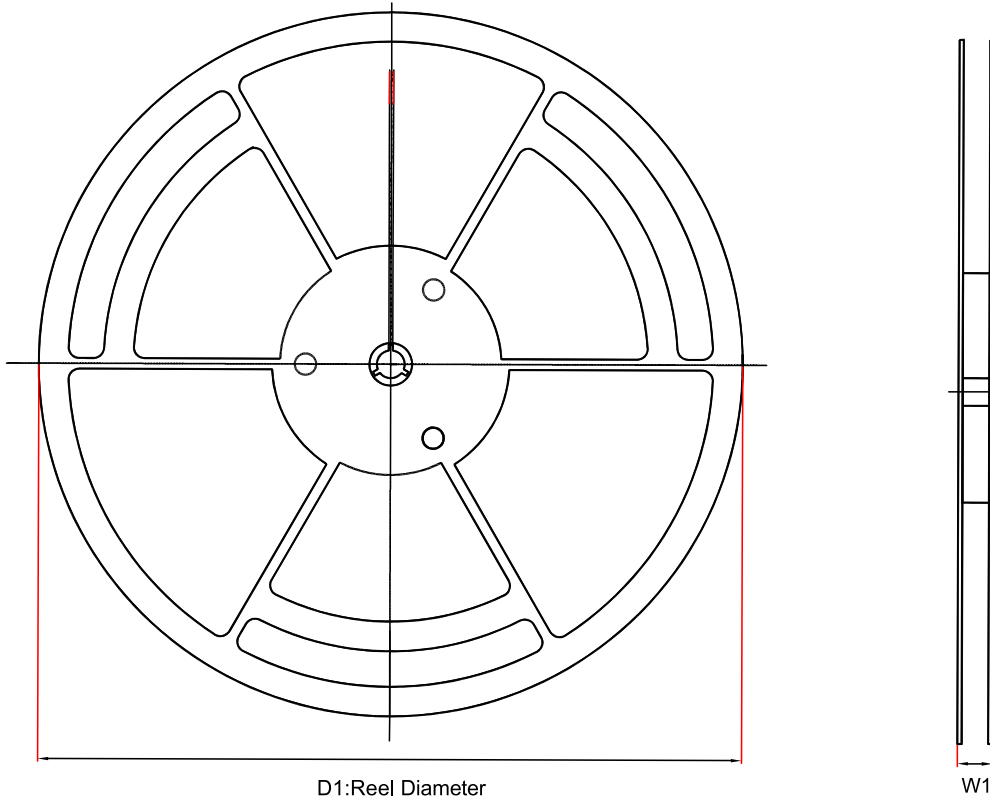
$$V_{OUT} = (I_{LOAD} \times R_{SHUNT}) \times (R2 / R1) + V_{REF}$$

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

Power Supply Recommendations

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

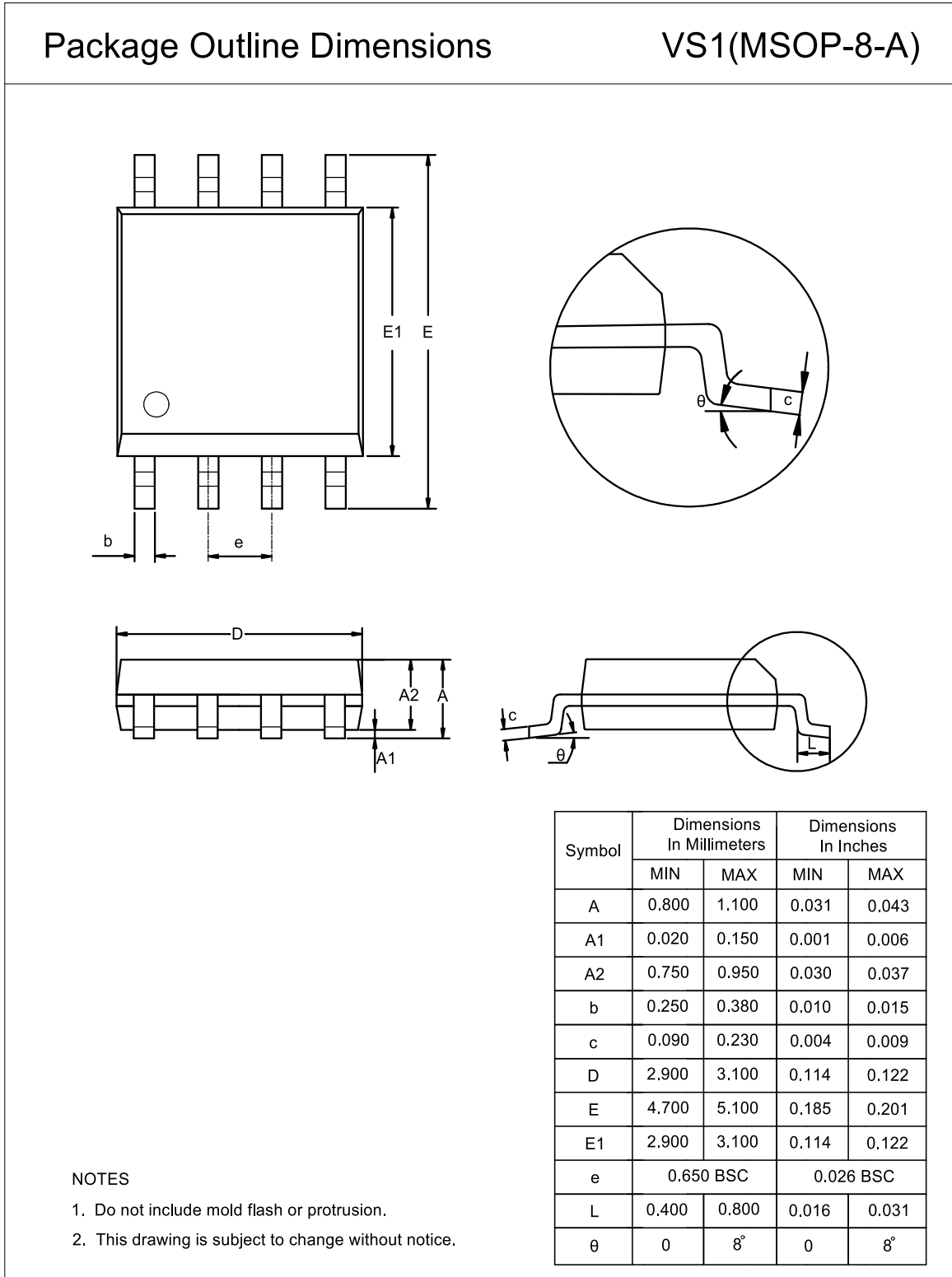
Tape and Reel Information



Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TP1562X-VS1R	MSOP8	330	17.6	5.4	3.3	1.3	8	12	Q1

Package Outline Dimensions

MSOP8



Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
TP1562X-VS1R	-40 to 125°C	MSOP8	1562X	MSL2	Tape and Reel,3000	Green

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

IMPORTANT NOTICE AND DISCLAIMER

Copyright© 3PEAK 2012-2023. 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.