

Features

- Supply Voltage: 4.5 V to 36 V, ± 2.25 V to ± 18 V
- Gain Setting Option:
 - TPA9361: 1
 - TPA9363: 0.48
- Offset Voltage: ± 300 μ V (Max)
- Gain Error: 0.05% (Max)
- Bandwidth: 3 MHz, Slew Rate: 5 V/ μ s
- EMI Enhancement
- Over-Temperature Protection
- Operating Temperature Range: -40°C to 125°C

Applications

- Instrumentation
- Industrial Control
- Audio
- Building Block for the Precision Amplifier Circuit

Description

The devices are general-purpose, fixed-gain difference amplifiers which are intended for precision signal conditioning. The on-chip resistors are trimmed for excellent gain accuracy and high CMRR. The devices have extremely low-gain drift within the operating temperature range. The devices also provide an exceptional common-mode rejection ratio (100 dB typical) and high bandwidth while amplifying signals are well beyond the supply rails. The common-mode range of the amplifiers exceeds the supply voltage rails, making the devices ideal for single-supply applications that require a wide common-mode voltage range.

Typical Application Circuit - TPA9361

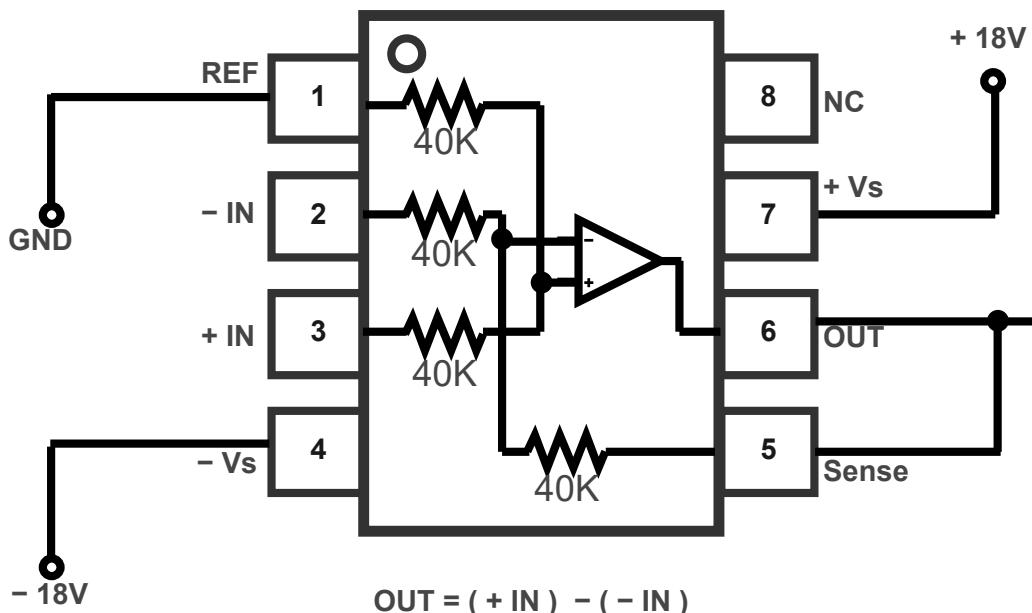


Table of Contents

Features.....	1
Applications.....	1
Description.....	1
Typical Application Circuit - TPA9361.....	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 - TPA9361.....	6
Electrical Characteristics - TPA9363.....	8
Typical Performance Characteristics - TPA9361.....	9
Tape and Reel Information.....	10
Package Outline Dimensions.....	11
SOP8.....	11
Order Information.....	12
IMPORTANT NOTICE AND DISCLAIMER.....	13

Revision History

Date	Revision	Notes
2021-03-20	Rev.A.0	Initial version
2022-11-08	Rev.A.1	Updated the document format. Updated HBM value: from 1 kV to 500 V.
2024-04-04	Rev.A.2	Added a new part number: TPA9363-SO1R. 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 test condition of PSRR in Electrical Characteristics of the TPA9361.
2024-12-03	Rev.A.3	Updated the Max value of Vs in Recommended Operating Conditions: <ul style="list-style-type: none">• from "16V "to "36V" in Single Supply condition ;• from "$\pm 8V$" to "$\pm 16V$" in Dual Supply Condition Updated the Typical value of Gain Drift in the Electrical Characteristics from "5" to "1".

Pin Configuration and Functions

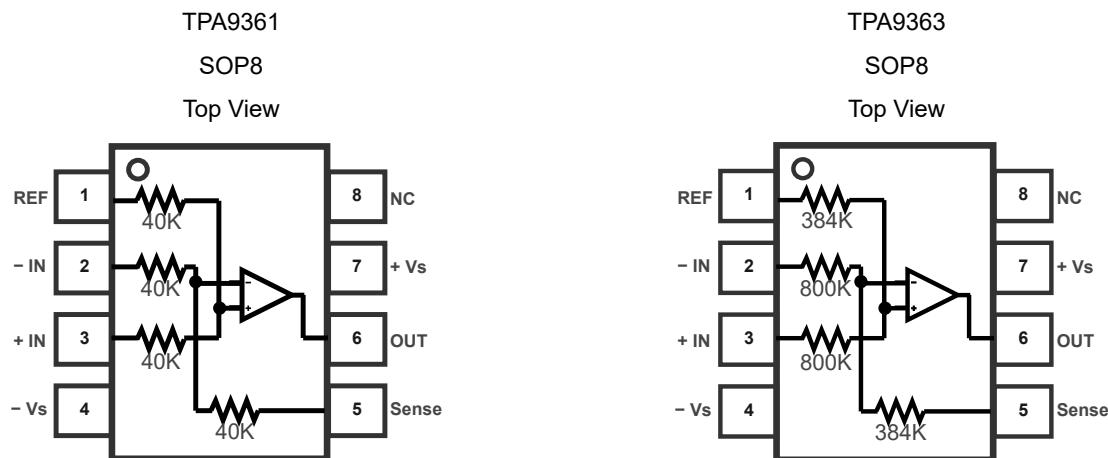


Table 1. Pin Functions: TPA936x

Pin No.	Pin Name	I/O	Description
1	REF	I	Reference input
2	-IN	I	Inverting input
3	+IN	I	Non-inverting input
4	-Vs	-	Negative power supply (1)
5	Sense	I	Sense input
6	OUT	O	Output
7	+Vs	-	Positive power supply (1)
8	NC		Not connect

(1) In this document, $(+Vs) - (-Vs)$ is referred to V_s .

Specifications

Absolute Maximum Ratings (1)

Parameter		Min	Max	Unit
	Supply Voltage: (+Vs) – (-Vs)		36	V
	Input Voltage Range, TPA9361		2 × (Supply Voltage)	V
	Input Voltage Range, TPA9363		3 × (Supply Voltage)	V
	Input Current: +IN, -IN (2)	-10	+10	mA
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.

ESD, Electrostatic Discharge Protection

Symbol	Parameter	Condition	Minimum Level	Unit
HBM	Human Body Model ESD	ANSI/ESDA/JEDEC JS-001 (1)	500	V
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	Single Supply	4.5		V
		Dual Supply	±2.25		±18
T _A	Operating Temperature Range		-40		125 °C

Thermal Information

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

Electrical Characteristics - TPA9361

All test conditions: $(+V_S) = +15 \text{ V}$, $(-V_S) = -15 \text{ V}$, $R_L = 10 \text{ k}\Omega$ to ground, reference pin connected to ground, sense pin connected to OUT pin, $T_A = 25^\circ\text{C}$, unless otherwise noted.

Symbol	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	No load			1.5	2	mA
			$-40^\circ\text{C} \text{ to } 125^\circ\text{C}$			2.5	mA
Gain							
	Initial	$V_{OUT} = \pm 10 \text{ V}$			1		V/V
GE	Gain Error	$V_{OUT} = \pm 10 \text{ V}$			0.02	0.05	%FSR
			$-40^\circ\text{C} \text{ to } 125^\circ\text{C}$			0.1	%FSR
	Gain Drift		$-40^\circ\text{C} \text{ to } 125^\circ\text{C}$		1		PPM/°C
	Nonlinearity				0.0005		%FSR
Offset Voltage							
V_{OS}	Input Offset Voltage	$V_{CM} = 0 \text{ V}$			150	300	μV
			$-40^\circ\text{C} \text{ to } 125^\circ\text{C}$			800	μV
$V_{OS\ TC}$	Offset Voltage Drift		$-40^\circ\text{C} \text{ to } 125^\circ\text{C}$		2		$\mu\text{V}/^\circ\text{C}$
PSRR	Power Supply Rejection Ratio	$V_S = 4.5 \text{ V} \text{ to } 36 \text{ V}$, $V_{CM} = 0 \text{ V}$		100	120		dB
			$-40^\circ\text{C} \text{ to } 125^\circ\text{C}$	95			dB
Input							
	Impedance	Differential mode			80		$\text{k}\Omega$
		Common mode			40		$\text{k}\Omega$
	Input Voltage Range	Differential mode		$-2 \times (-V_S)$		$2 \times [(+V_S) - 1.5]$	V
CMRR	Common-Mode Rejection	$V_{CM} = -30 \text{ V} \text{ to } 27 \text{ V}$		80	100		dB
			$-40^\circ\text{C} \text{ to } 125^\circ\text{C}$	78			dB
Output							
	Output Swing from Supply Rail	$R_{LOAD} = 10 \text{ k}\Omega \text{ to } V_S / 2$			50	200	mV
		$R_{LOAD} = 2 \text{ k}\Omega \text{ to } V_S / 2$			400	500	mV
I_{SC}	Output Short-Circuit Current				100		mA
AC Specifications							
GBW	Gain-Bandwidth Product				3		MHz
SR	Slew Rate	10-V step			5		$\text{V}/\mu\text{s}$
t_s	Settling Time, 0.1%	$G = -1, 10 \text{ V}$ step			0.8		μs
Noise Performance							
E_N	Input Voltage Noise	$f = 0.1 \text{ Hz} \text{ to } 10 \text{ Hz}$			0.2		μV_{RMS}

Precision Difference Amplifier

Symbol	Parameter	Conditions	T _A	Min	Typ	Max	Unit
e _N	Input Voltage Noise Density	f = 1 kHz			30		nV/ $\sqrt{\text{Hz}}$

Electrical Characteristics - TPA9363

All test conditions: $(+V_S) = +15 \text{ V}$, $(-V_S) = -15 \text{ V}$, $R_L = 10 \text{ k}\Omega$ to ground, reference pin connected to ground, sense pin connected to OUT pin, $T_A = 25^\circ\text{C}$, unless otherwise noted.

Symbol	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	No load			1.5	2	mA
			$-40^\circ\text{C} \text{ to } 125^\circ\text{C}$			2.5	mA
Gain							
	Initial	$V_{OUT} = \pm 10 \text{ V}$			0.48		V/V
GE	Gain Error	$V_{OUT} = \pm 10 \text{ V}$	$-40^\circ\text{C} \text{ to } 125^\circ\text{C}$	-0.05	0.01	0.05	%FSR
	Gain Drift		$-40^\circ\text{C} \text{ to } 125^\circ\text{C}$		1		PPM/ $^\circ\text{C}$
	Nonlinearity				0.0005		%FSR
Offset Voltage							
V_{OS}	Input Offset Voltage	$V_{CM} = 0 \text{ V}$		-350	± 100	300	μV
			$-40^\circ\text{C} \text{ to } 125^\circ\text{C}$	-650		650	μV
$V_{OS\text{TC}}$	Offset Voltage Drift		$-40^\circ\text{C} \text{ to } 125^\circ\text{C}$		2		$\mu\text{V}/^\circ\text{C}$
PSRR	Power Supply Rejection Ratio	$V_S = 4.5 \text{ V} \text{ to } 36 \text{ V}$, $V_{CM} = 0 \text{ V}$		100	120		dB
			$-40^\circ\text{C} \text{ to } 125^\circ\text{C}$	95			dB
Input							
	Impedance	Differential mode			800		$\text{k}\Omega$
		Common mode			400		$\text{k}\Omega$
	Input Voltage Range	Differential mode		$-3 \times (-V_S)$		$3 \times [(+V_S) - 1.5]$	V
CMRR	Common-Mode Rejection	$V_{CM} = -30 \text{ V} \text{ to } 27 \text{ V}$		80	100		dB
			$-40^\circ\text{C} \text{ to } 125^\circ\text{C}$	78			dB
Output							
	Output Swing from Supply Rail	$R_{LOAD} = 10 \text{ k}\Omega$ to $V_S/2$			50	200	mV
		$R_{LOAD} = 2 \text{ k}\Omega$ to $V_S/2$			400	500	mV
I_{SC}	Output Short-Circuit Current				100		mA
AC Specifications							
GBW	Gain-Bandwidth Product				3		MHz
SR	Slew Rate	10-V step			5		V/ μs
t_s	Settling Time, 0.1%	$G = -1$, 10-V step			0.8		μs
Noise Performance							
E_N	Input Voltage Noise	$f = 0.1 \text{ Hz} \text{ to } 10 \text{ Hz}$			0.5		μV_{RMS}
e_N	Input Voltage Noise Density	$f = 1 \text{ kHz}$			80		nV/ $\sqrt{\text{Hz}}$

Typical Performance Characteristics - TPA9361

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

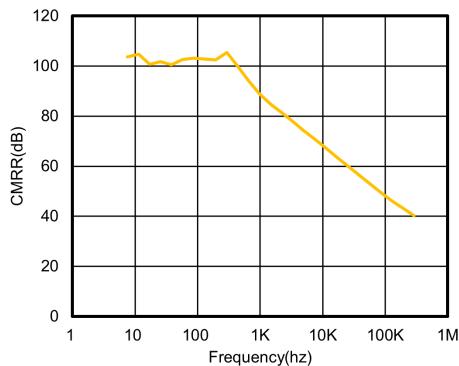


Figure 1. CMRR vs. Frequency

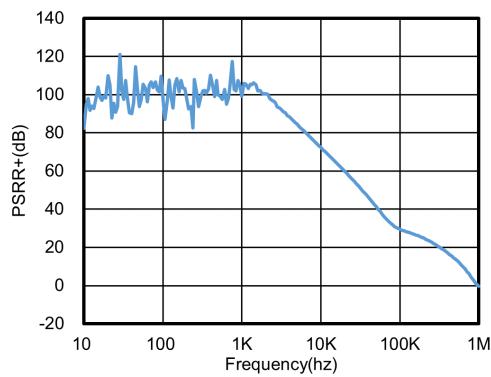


Figure 2. PSRR+ vs. Frequency

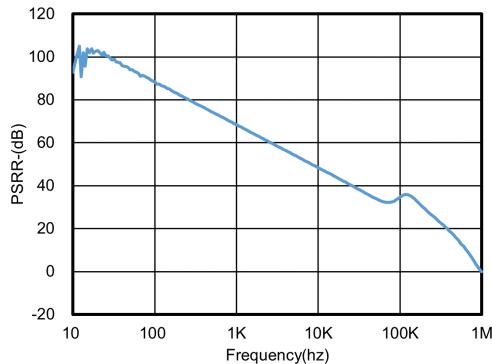


Figure 3. PSRR- vs. Frequency

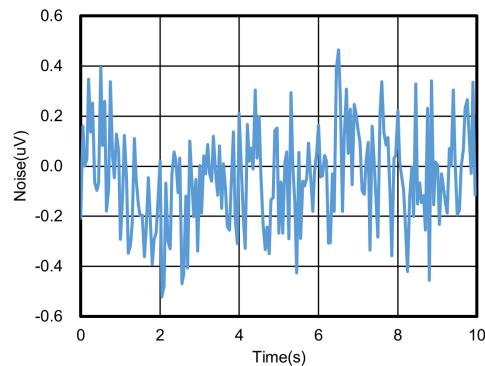
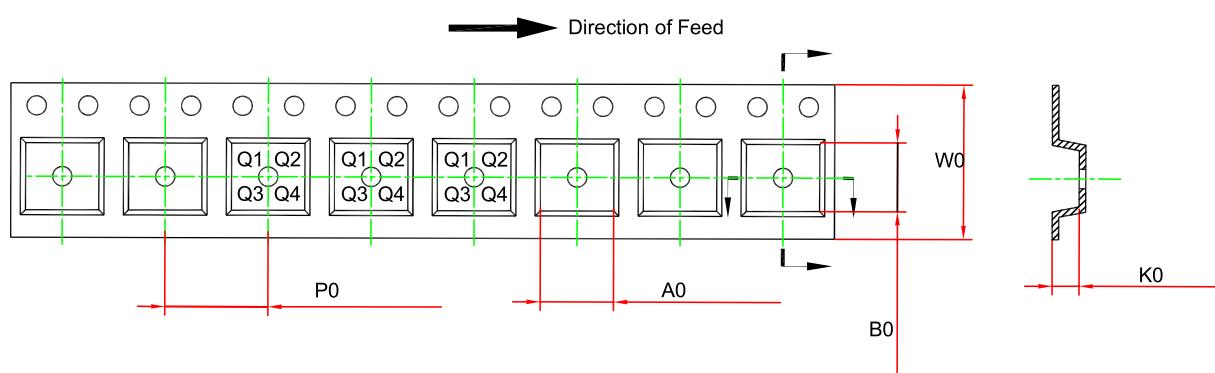
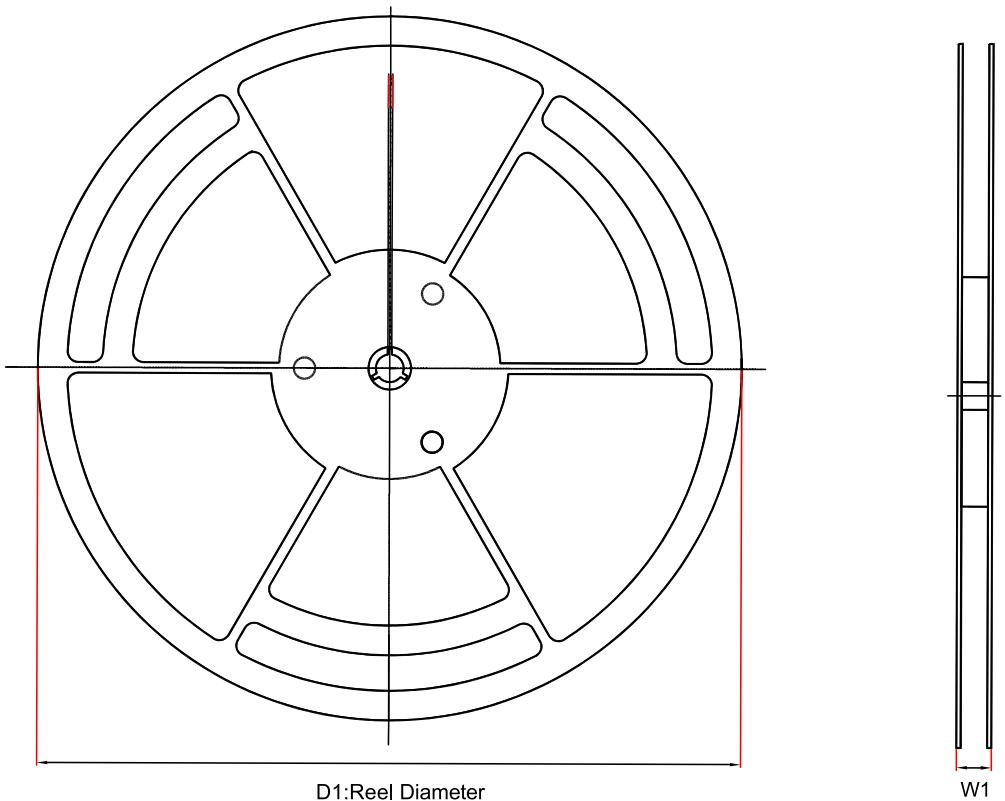


Figure 4. 0.1-Hz to 10-Hz Voltage Noise

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
TPA9361-SO1R	SOP8	330.0	17.6	6.5	5.4	2.0	8.0	12.0	Q1
TPA9363-SO1R	SOP8	330.0	17.6	6.5	5.4	2.0	8.0	12.0	Q1

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

Package Outline Dimensions

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
TPA9361-SO1R	-40 to 125°C	SOP8	A9361	3	Tape and Reel, 4000	Green
TPA9363-SO1R	-40 to 125°C	SOP8	A9363	3	Tape and Reel, 4000	Green

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

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TPA9361/TPA9363

Precision Difference Amplifier

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