Precision Difference Amplifier

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 μV Maximum
- Gain Error: 0.05% Maximum
- Bandwidth: 3 MHz, Slew Rate: 5 V/μs
- EMI Enhancement
- Over-Temperature Protection
- −40°C to 125°C Operation Temperature Range

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

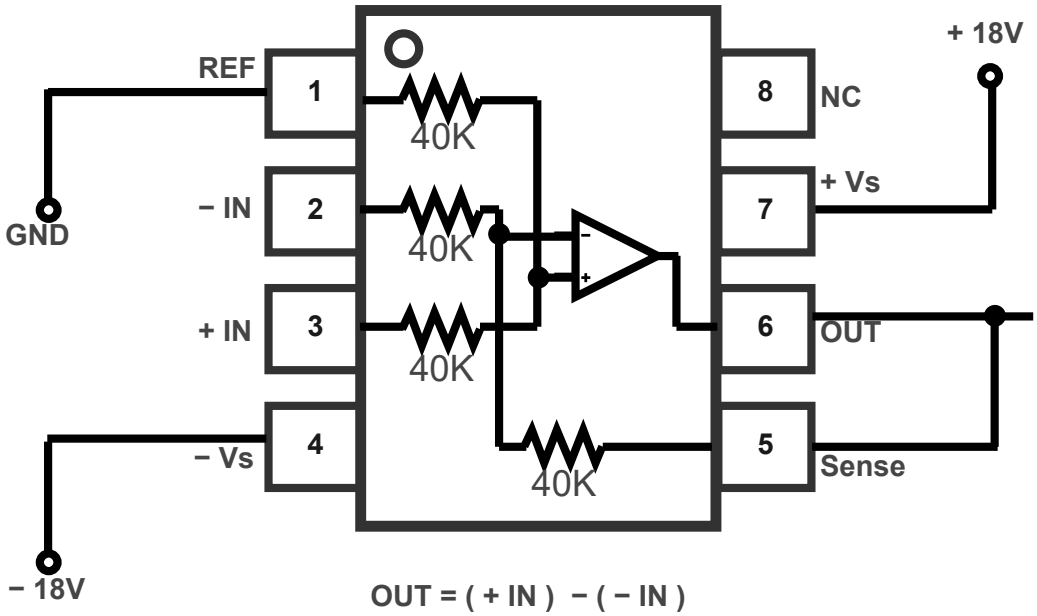


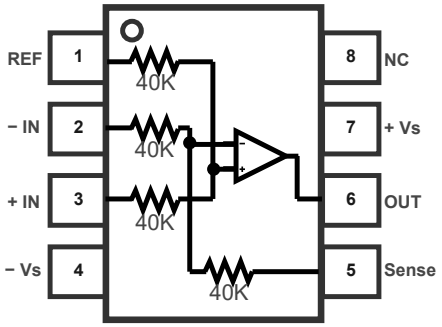
Table of Contents

Revision History

Date	Revision	Notes
2021-03-20	Rev.A.0	Initial version
2022-11-08	Rev.A.1	Updated document with new format. Updated HBM value: 1 kV → 500 V.
2024-04-04	Rev.A.2	Added part number: TPA9363-SO1R. The following updates are all about the new datasheet formats or typo, the actual product remains unchanged. Updated the test condition of PSRR in Electrical Characteristics of TPA9361.

Pin Configuration and Functions

TPA9361
SOP8 Package
Top View



TPA9363
SOP8 Package
Top View

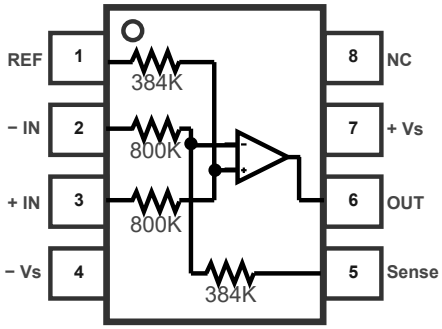


Table 1. Pin Functions: TPA936x

Pin No.	Pin Name	I/O	Description
1	REF	I	Reference input.
2	−IN	I	Inverting input.
3	+IN	I	Noninverting input
4	$-V_S$	-	Negative power supply (1)
5	Sense	I	Sense input.
6	OUT	O	Output
7	$+V_S$	-	Positive power supply (1)
8	NC		Not Connect

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

Specifications

Absolute Maximum Ratings (1)

Parameter		Min	Max	Unit
	Supply Voltage: ($+V_S$) − ($-V_S$)		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		16	V
		Dual Supply	±2.25		±8	V
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 V and ($-V_S$) = –15 V, R_L = 10 kΩ to ground, reference pin connected to ground, sense pin connected to OUT pin, T_A = 25°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°C to 125°C			2.5	mA
Gain							
	Initial	VOUT = ±10 V			1		V/V
	Gain Error	VOUT = ±10 V			0.02	0.05	%FSR
			−40°C to 125°C			0.1	%FSR
	Gain Drift		−40°C to 125°C		5		PPM/°C
	Nonlinearity				0.0005		%FSR
Offset Voltage							
V_{OS}	Input Offset Voltage	V_{CM} = 0 V			150	300	µV
			−40°C to 125°C			800	µV
V_{OS} TC	Offset Voltage Drift		−40°C to 125°C		2		µV/°C
PSRR	Power Supply Rejection Ratio	V_S = 4.5 V to 36 V, V_{CM} = 0 V		100	120		dB
			−40°C to 125°C	95			dB
Input							
	Impedance	Differential			80		kΩ
		Common-mode			40		kΩ
	Input Voltage Range	Differential		–2 * (–V_S)		2 * [($+V_S$) – 1.5]	V
CMRR	Common-Mode Rejection	V_{CM} = −30 V to 27 V		80	100		dB
			−40°C to 125°C	78			dB
Output							
	Output Swing from Supply Rail	R_{LOAD} = 10 kΩ to V_S/2			50	200	mV
		R_{LOAD} = 2 kΩ 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

Symbol	Parameter	Conditions	T_A	Min	Typ	Max	Unit
Noise Performance							
E_N	Input Voltage Noise	f = 0.1 Hz to 10 Hz			0.2		μV_{RMS}
e_N	Input Voltage Noise Density	f = 1 kHz			30		nV/√Hz

Electrical Characteristics - TPA9363

All test conditions: (+V_S) = +15 V and (−V_S) = –15 V, R_L = 10 kΩ to ground, reference pin connected to ground, sense pin connected to OUT pin, T_A = 25°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°C to 125°C			2.5	mA
Gain							
	Initial	VOUT = ±10 V			0.48		V/V
	Gain Error	VOUT = ±10 V	−40°C to 125°C	-0.05	0.01	0.05	%FSR
	Gain Drift		−40°C to 125°C		5		PPM/°C
	Nonlinearity				0.0005		%FSR
Offset Voltage							
V_{OS}	Input Offset Voltage	V_{CM} = 0 V		-350	±100	300	µV
			−40°C to 125°C	-650		650	µV
V_{OS} TC	Offset Voltage Drift		−40°C to 125°C		2		µV/°C
PSRR	Power Supply Rejection Ratio	V_S = 4.5 V to 36 V, V_{CM} = 0 V		100	120		dB
			−40°C to 125°C	95			dB
Input							
	Impedance	Differential			800		kΩ
		Common-mode			400		kΩ
	Input Voltage Range	Differential		-3 * (–V_S)		3 * [(+V_S) – 1.5]	V
CMRR	Common-Mode Rejection	V_{CM} = −30 V to 27 V		80	100		dB
			−40°C to 125°C	78			dB
Output							
	Output Swing from Supply Rail	R_{LOAD} = 10 kΩ to V_S/2			50	200	mV
		R_{LOAD} = 2 kΩ 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							

Symbol	Parameter	Conditions	T_A	Min	Typ	Max	Unit
E_N	Input Voltage Noise	f = 0.1 Hz to 10 Hz			0.5		μV_{RMS}
e_N	Input Voltage Noise Density	f = 1 kHz			80		nV/√Hz

Typical Performance Characteristics - TPA9361

All test conditions: V_S = ±15 V, V_{CM} = 0 V, R_L = 10 kΩ, unless otherwise specified.

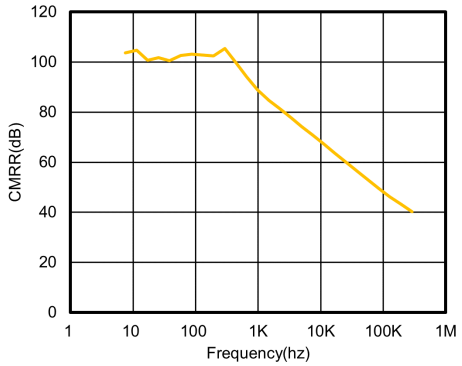


Figure 1. CMRR vs. Frequency

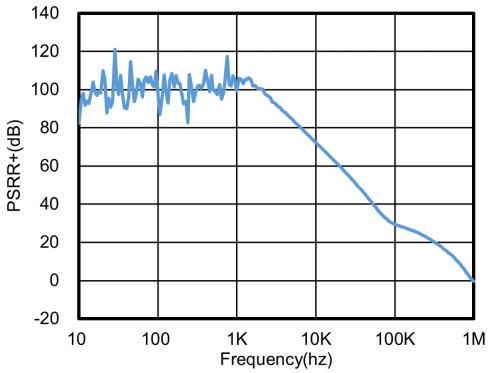


Figure 2. PSRR+ vs. Frequency

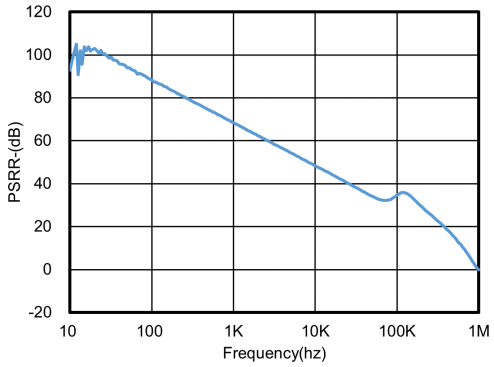


Figure 3. PSRR- vs. Frequency

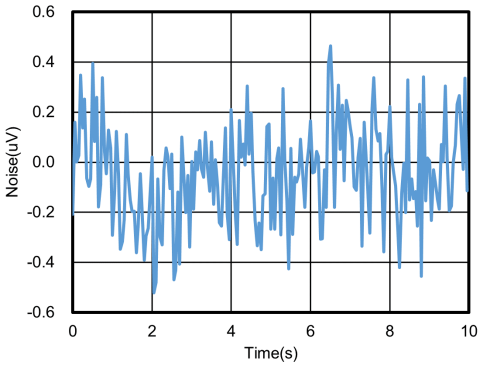
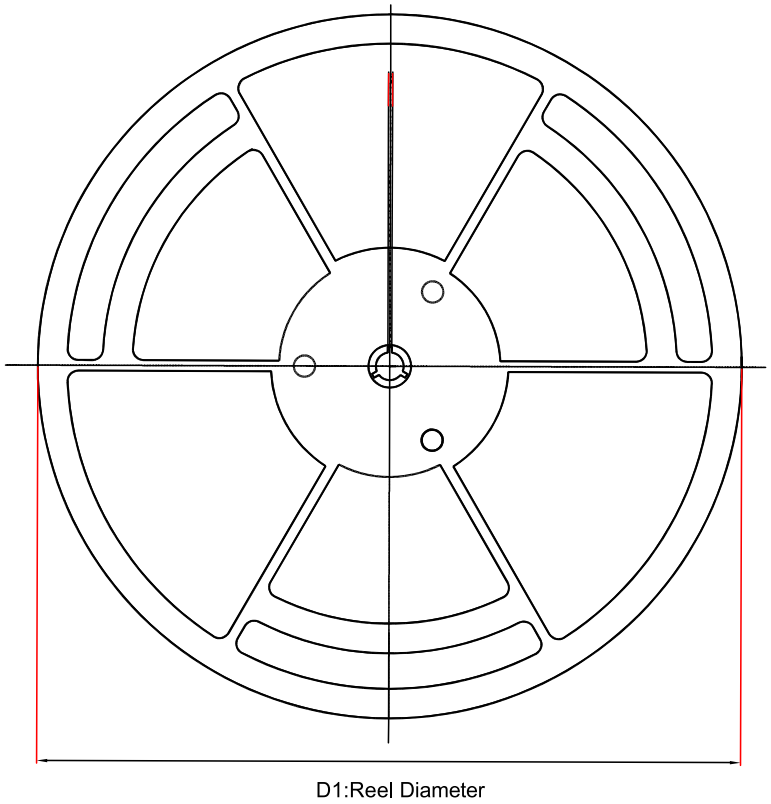
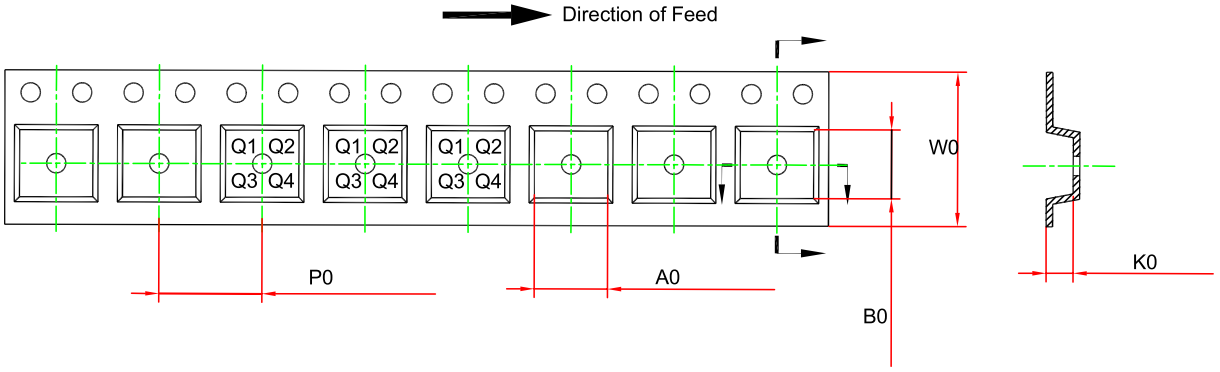


Figure 4. 0.1 to 10 Hz Voltage Noise

Tape and Reel Information



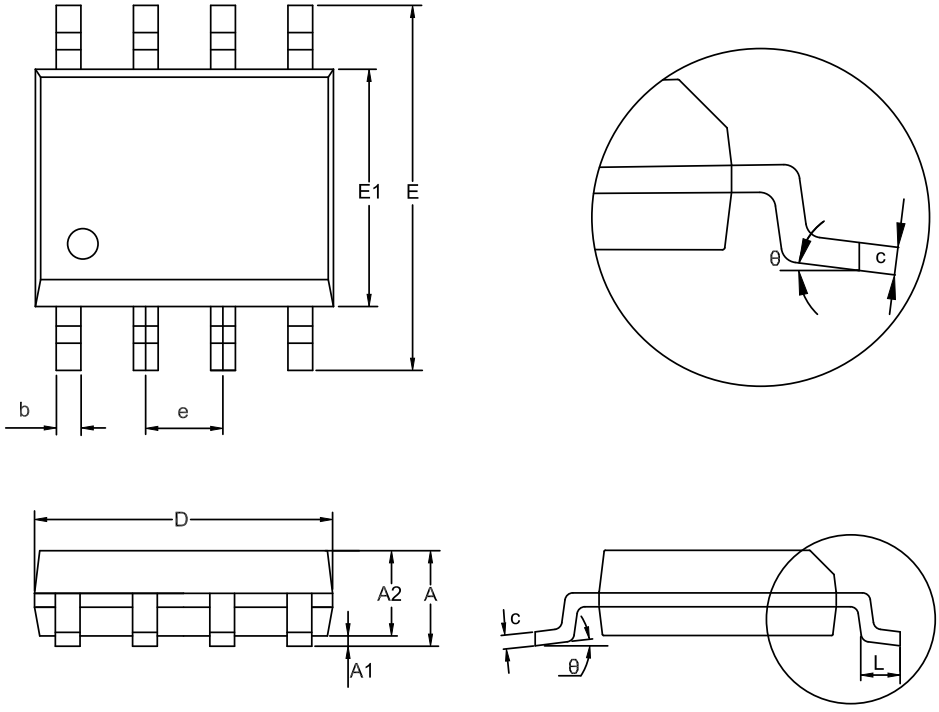


Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPA9361-SO1R	SOP8	330.0	17.6	6.5	5.4	2.0	8.0	12.0	Q1
TPA9363-SO1R	SOP8	330.0	17.6	6.5	5.4	2.0	8.0	12.0	Q1

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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