High-Slew Operational Amplifier

1 FEATURES

- **Low Offset Voltage: ±0.3mV (TYP)**
- **Low Offset Voltage Drift: ±3.4µV/°C**
- **High Slew Rate: 24V/µs (TYP)**
- **High Gain Bandwidth: 10MHz**
- **Output Short-Circuit Protection**
- **Supply Voltage: 4.5V to 32V (±2.25V to ±16V)**
- **Extended Temperature: -40°C to 125°C**
- **Micro Size Packages: SOT23-5, SOP8, SOP14**

2 APPLICATIONS

- **Solar Energy: String and Central Inverter**
- **Motor Drives: AC and Servo Drive Control and Power Stage Modules**
- **Single Phase Online UPS**
- **Three Phase UPS**
- **Pro Audio Mixers**
- **Battery Test Equipment**

3 DESCRIPTIONS

The RS846XP family of devices provide outstanding value for cost-sensitive applications, with features including low offset (±0.3mV, TYP), high slew rate (24 V/µs). Integrated EMI and RF filters, and operation across the full –40°C to 125°C enable the RS846XP devices to be used in the most rugged and demanding applications.

The RS846XP is available in Green SOT23-5, SOP8, SOP14 packages. It operates over an ambient temperature range of -40°C to 125°C.

Device Information (1)

PART NUMBER	PACKAGE	BODY SIZE(NOM)
RS8461P	SOT23-5	2.92mm×1.62mm
RS8462P	SOP8	4.90mm x 3.90mm
RS8464P	SOP14	8.65mm x 3.90mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.

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4 REVISION HISTORY

Note: Page numbers for previous revisions may different from page numbers in the current version.

Version	Change Date	Change Item
A.1	2022/10/20	Initial version completed
A.2	2023/06/07	Add RS8461PXF Orderable Device
A.3	2023/06/14	Update PSRR PARAMETER
A.3.1	2024/03/01	Modify packaging naming
A.4	2024/08/01	1. Update PACKAGE/ORDERING INFORMATION 2. Update ESD Ratings 3. Delete 8.2 Test Circuit Diagram
A.5	2025/06/13	Add Typical Characteristics Figure 13. Open-Loop Gain and Phase vs Frequency

5 PACKAGE/ORDERING INFORMATION [(1)]

Orderable Device	Package Type	Pin	Channel	Op Temp(°C)	Device Marking [(2)]	MSL [(3)]	Package Qty
RS8461PXF	SOT23-5	5	1	-40°C ~125°C	8461P	MSL3	Tape and Reel, 3000
RS8462PXK	SOP8	8	2	-40°C ~125°C	RS8462P	MSL3	Tape and Reel, 4000
RS8464PXP	SOP14	14	4	-40°C ~125°C	RS8464P	MSL3	Tape and Reel, 4000

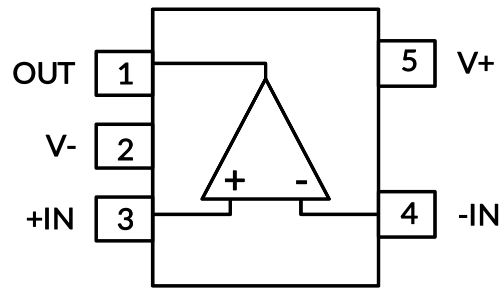
NOTE:

(1) This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the right-hand navigation.

(2) There may be additional marking, which relates to the lot trace code information (data code and vendor code), the logo or the environmental category on the device.

(3) RUNIC classify the MSL level with using the common preconditioning setting in our assembly factory conforming to the JEDEC industrial standard J-STD-20F, Please align with RUNIC if your end application is quite critical to the preconditioning setting or if you have special requirement.

6 PIN CONFIGURATION AND FUNCTIONS

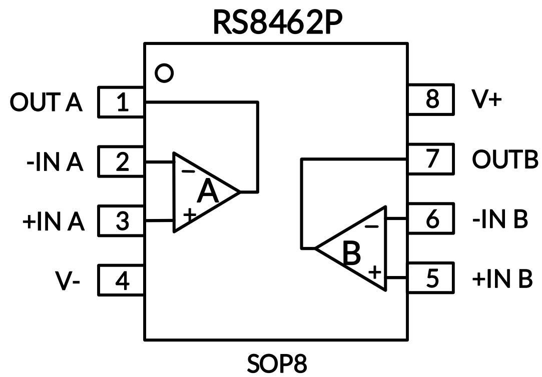


PIN DESCRIPTION

NAME	PIN	I/O (1)	DESCRIPTION
	RS8461P		
	SOT23-5		
-IN	4	I	Negative (inverting) input
+IN	3	I	Positive (noninverting) input
OUT	1	O	Output
V-	2	-	Negative (lowest) power supply
V+	5	-	Positive (highest) power supply

(1) I = Input, O = Output.

PIN CONFIGURATION AND FUNCTIONS

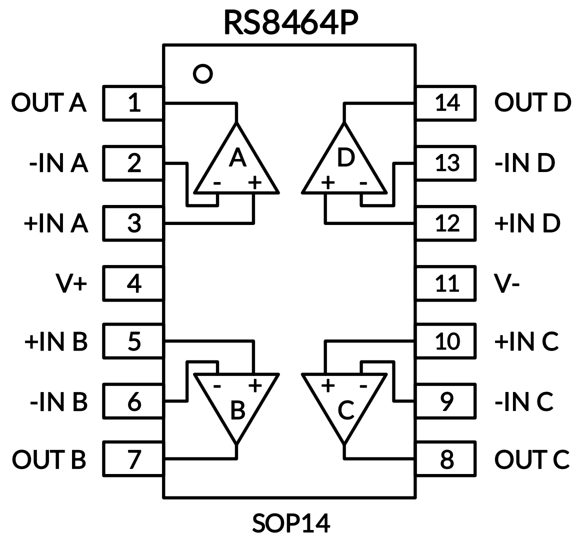


PIN DESCRIPTION

NAME	PIN	I/O (1)	DESCRIPTION
	SOP8		
-INA	2	I	Inverting input, channel A
+INA	3	I	Noninverting input, channel A
-INB	6	I	Inverting input, channel B
+INB	5	I	Noninverting input, channel B
OUTA	1	O	Output, channel A
OUTB	7	O	Output, channel B
V-	4	-	Negative (lowest) power supply or ground (for single supply operation)
V+	8	-	Positive (highest) power supply

(1) I = Input, O = Output.

PIN CONFIGURATION AND FUNCTIONS



PIN DESCRIPTION

NAME	PIN	I/O (1)	DESCRIPTION
	SOP14		
-INA	2	I	Inverting input, channel A
+INA	3	I	Noninverting input, channel A
-INB	6	I	Inverting input, channel B
+INB	5	I	Noninverting input, channel B
-INC	9	I	Inverting input, channel C
+INC	10	I	Noninverting input, channel C
-IND	13	I	Inverting input, channel D
+IND	12	I	Noninverting input, channel D
OUTA	1	O	Output, channel A
OUTB	7	O	Output, channel B
OUTC	8	O	Output, channel C
OUTD	14	O	Output, channel D
V-	11	-	Negative (lowest) power supply or ground (for single supply operation)
V+	4	-	Positive (highest) power supply

(1) I = Input, O = Output.

7 SPECIFICATIONS

7.1 Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted) (1)

			MIN	MAX	UNIT
Voltage	Supply, V_S= (V+) - (V-)			36	V
	Signal input pin (2)		(V-)-0.5	(V+) +0.5	
Current	Signal input pin (2)		-10	10	mA
	Output short-circuits (3)		Continuous		
θ_{JA}	Package thermal impedance (4)	SOT23-5		230	°C/W
		SOP8		110	
		SOP14		105	
Temperature	Operating range, T_A		-40	125	°C
	Junction, T_J (5)		-40	150	
	Storage, T_{stg}		-65	150	

(1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not implied.
(2) Input terminals are diode-clamped to the power-supply rails. Input signals that can swing more than 0.5V beyond the supply rails should be current-limited to 10mA or less.
(3) Short-circuit to ground, one amplifier per package.
(4) The package thermal impedance is calculated in accordance with JESD-51.
(5) The maximum power dissipation is a function of $T_{J(MAX)}$, $R_{\theta JA}$, and T_A. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(MAX)} - T_A) / R_{\theta JA}$. All numbers apply for packages soldered directly onto a PCB.

7.2 ESD Ratings

The following ESD information is provided for handling of ESD-sensitive devices in an ESD protected area only.

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-Body Model (HBM), per ANSI/ESDA/JEDEC JS-001 (1)	±2000	V
		Charged-Device Model (CDM), per ANSI/ESDA/JEDEC JS-002 (2)	±1500	
		Machine Model (MM)	±200	

(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.

ESD SENSITIVITY CAUTION

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

7.3 Recommended Operating Conditions

Over operating free-air temperature range (unless otherwise noted)

		MIN	NOM	MAX	UNIT
Supply voltage, V_S= (V+) - (V-)	Single-supply	4.5		32	V
	Dual-supply	±2.25		±16	
Operating range, T_A		-40		125	°C

7.4 Electrical Characteristics

(At T_A=+25°C, V_S=4.5V to 32 V (±2.25V to ±16 V), R_L=10kΩ connected to V_S/2, V_{CM}=V_S/2 and V_{OUT}=V_S/2, Full (9) =-40°C to 125°C, unless otherwise noted.) (1)

PARAMETER	SYMBOL	CONDITION	TEMP	MIN(2)	TYP(3)	MAX(2)	UNIT
INPUT CHARACTERISTICS							
Input Offset Voltage	V_{OS}	V_S=±16V, V_{CM}=V_S/2	+25°C	-1	±0.3	1	mV
			FULL		±0.36		
Input Offset Voltage Average Drift	V_{OS} T_C		FULL		±3.4		μV/°C
Input Bias Current (4) (5)	I_B		+25°C		±10	±60	pA
			FULL		±600		pA
Input Offset Current (4)	I_{OS}		+25°C		±10	±60	pA
			FULL		±600		pA
Power-Supply Rejection Ratio	PSRR	V_S=5V~32V, V_{CM}=V_S/2	+25°C	83	101		dB
			FULL		100		
Input Common-Mode Voltage Range	V_{CM}		FULL	(V-)		(V+)-2	V
Common-Mode Rejection Ratio	CMRR	V_S=32V, (V-) <V_{CM}<(V+)-2V	+25°C	94	110		dB
			FULL		108		
Open-Loop Voltage Gain	A_{OL}	V_S=32V, R_L=10 KΩ V_O=(V-)+0.5V to (V+)-0.5V	+25°C	101	124		dB
			FULL		117		
NOISE PERFORMANCE							
Input Voltage Noise	e_{np-p}	f=0.1Hz to 10Hz	+25°C		8.5		μV_{PP}
Input Voltage Noise Density (4)	e_n	f=1KHz	+25°C		40		$nV/\sqrt{Hz}$
DYNAMIC PERFORMANCE							
Slew Rate (8)	SR	G=+1, V_S=32V	+25°C		24		V/μs
Settling Time to 0.1%	t_S	V_S=32V, V_{PP}=7V, G=+1 C_L=100pF	+25°C		1.2		μs
Gain-Bandwidth Product	GBP	V_S=32V, V_{IN}=50mV_{P-P}	+25°C		10		MHz
Overload Recovery Time	t_{OR}	V_{IN} × G ≥ V_S	+25°C		0.35		μs
Phase Margin (4)	φ_O	V_{OUT}=100mV_{P-P}, C_L=70pF	+25°C		60		°
OUTPUT CHARACTERISTICS							
Output Voltage Swing from Rail	V_{OH}	V_S=±16V, R_L=10 KΩ	+25°C		90	150	mV
	V_{OL}		+25°C		65	150	
Output Source Current (6) (7)	I_{SOURCE}	V_S=32V	+25°C	40	75		mA
Output Sink Current (6) (7)	I_{SINK}			40	75		
POWER SUPPLY							
Operating Voltage Range	V_S		FULL	4.5		32	V
Quiescent Current Per Amplifier	I_Q	V_S=±2.5V, I_{OUT}=0mA	+25°C		2.2	4.1	mA
			FULL			4.5	
		V_S=±16V, I_{OUT}=0mA	+25°C		2.6	4.6	
			FULL			5.0	
Turn-On Time		V_S=32V	+25°C		52		μs

NOTE:
(1) Electrical table values apply only for factory testing conditions at the temperature indicated. Factory testing conditions result in very limited self-heating of the device.
(2) Limits are 100% production tested at 25°C. Limits over the operating temperature range are ensured through correlations using statistical quality control (SQC) method.
(3) Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration.
(4) This parameter is ensured by design and/or characterization and is not tested in production.
(5) Positive current corresponds to current flowing into the device.
(6) The maximum power dissipation is a function of $T_{J(MAX)}$, $R_{\theta JA}$, and T_A. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(MAX)} - T_A) / R_{\theta JA}$. All numbers apply for packages soldered directly onto a PCB.
(7) Short circuit test is a momentary test.
(8) Number specified is the slower of positive and negative slew rates.
(9) Specified by characterization only.

7.5 Typical Characteristics

NOTE: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only.
At T_A= +25°C, V_S= ±16V, unless otherwise noted.

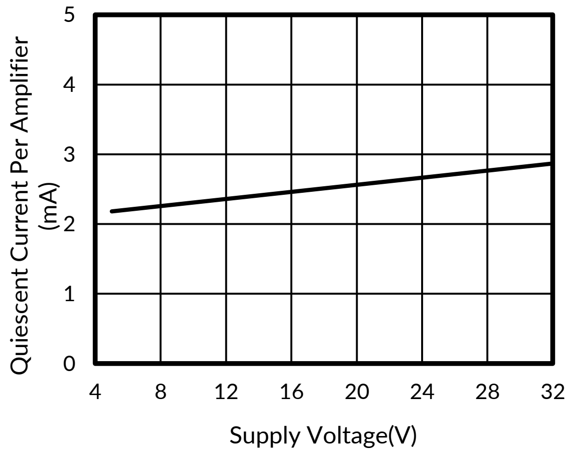


Figure 1. Supply Voltage vs Quiescent Current

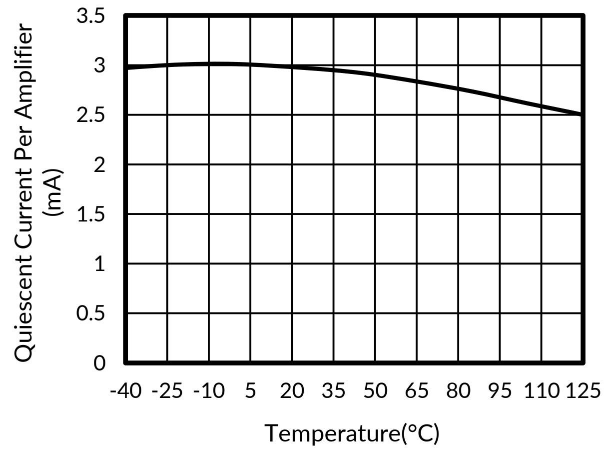


Figure 2. Quiescent Current vs Temperature

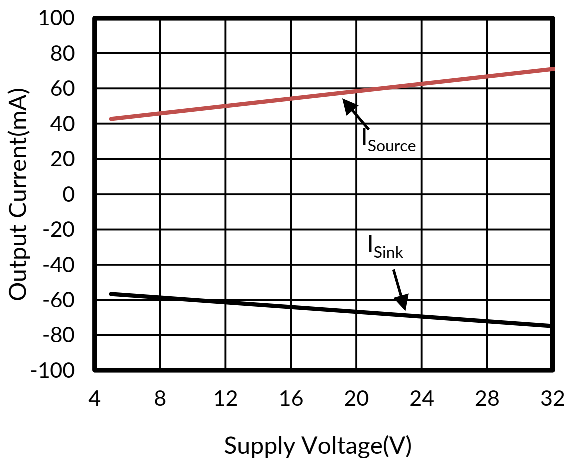


Figure 3. Supply Voltage vs Output Current

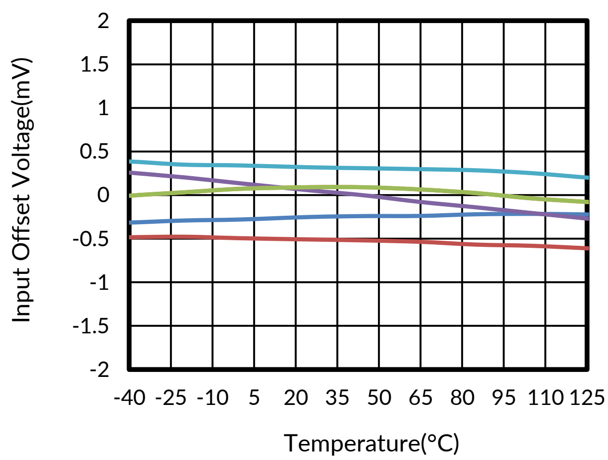


Figure 4. Input Offset Voltage vs Temperature

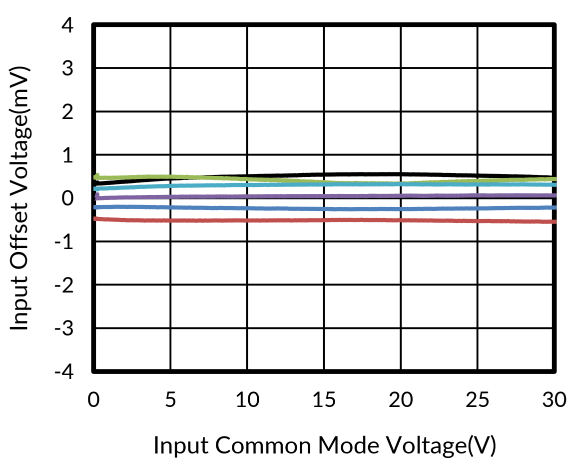


Figure 5. Input Offset Voltage vs Input Common Mode Voltage

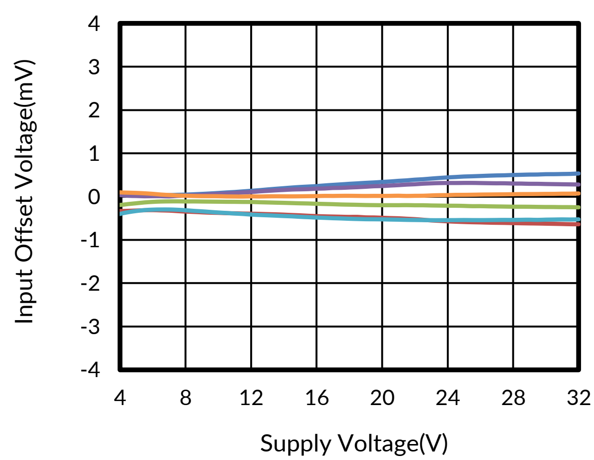


Figure 6. Input Offset Voltage vs Supply Voltage

Typical Characteristics

NOTE: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only.

At T_A= +25°C, V_S= ±16V, unless otherwise noted.

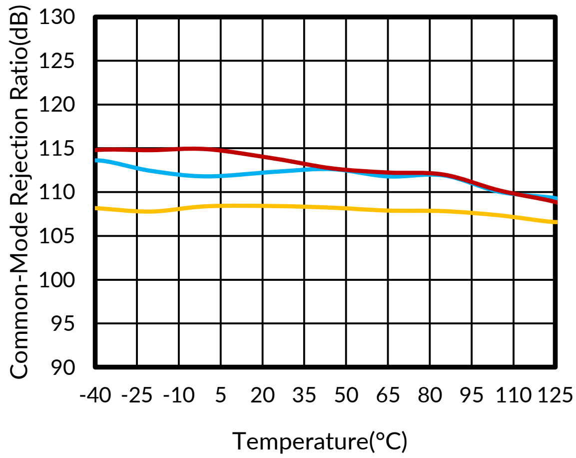


Figure 7. Common-Mode Rejection Ratio vs Temperature

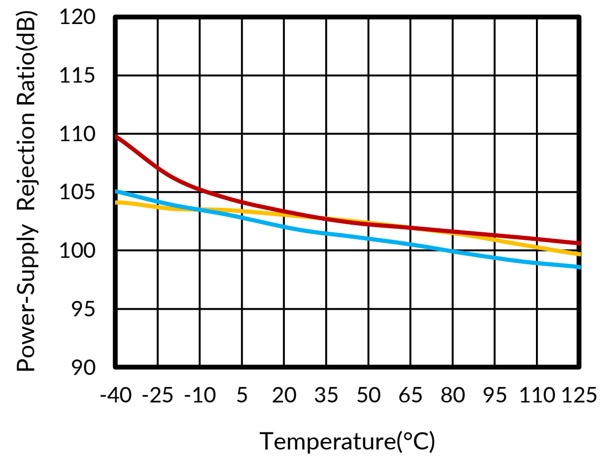


Figure 8. Power-Supply Rejection Ratio vs Temperature

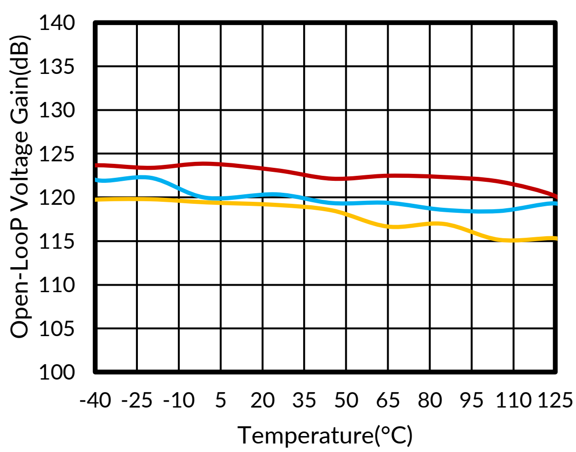


Figure 9. Open-Loop Voltage Gain vs Temperature

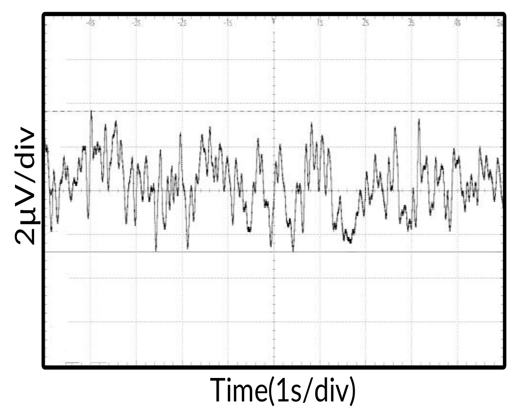


Figure 10. 0.1-Hz to 10-Hz Noise

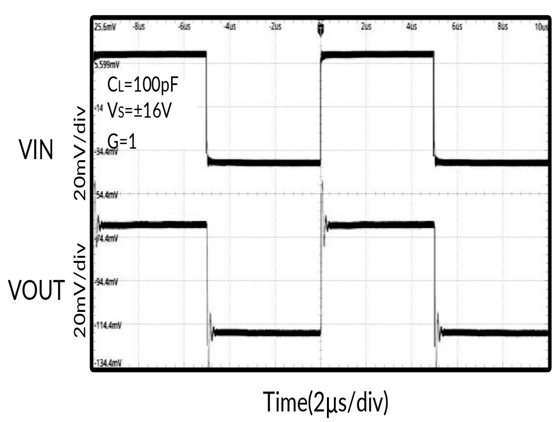


Figure 11. Small-Signal Step Response

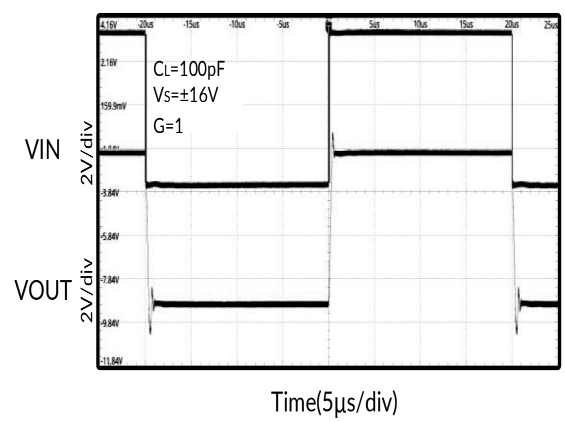


Figure 12. Large-Signal Step Response

Typical Characteristics

NOTE: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only.
At T_A= +25°C, V_S= ±16V, unless otherwise noted.

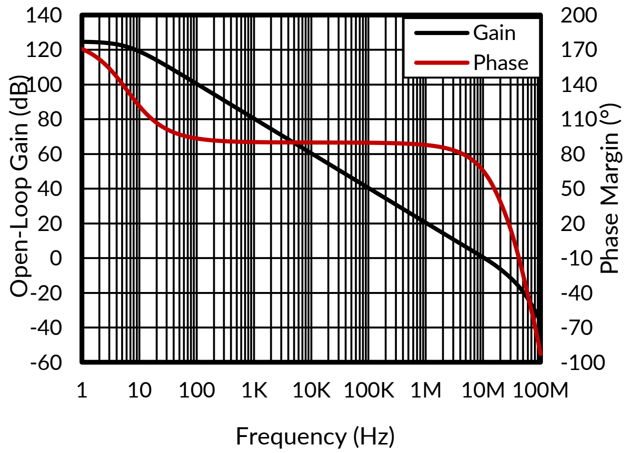


Figure 13. Open-Loop Gain and Phase vs Frequency

8 DETAILED DESCRIPTION

8.1 Overview

The RS846XP is the next-generation family of the industry standard RS845X high-voltage general purpose amplifiers. These devices provide outstanding value for cost-sensitive applications requiring high slew rate with high voltage signals, such as motor drive and inverter systems.

A robust MUX-friendly input stage enhances flexibility in design, with common-mode voltage range extending to the negative rail as well as improved settling time in multi-channel applications. Low offset voltage (±0.3mV, TYP) and low offset voltage drift (±3.4μV/°C) allows the RS846XP family to be used in rugged applications requiring precision current and voltage sensing. High voltage operation (up to 36 V) and high slew rate (24V/μs) make the RS846XP family a premier choice for high-voltage applications with fast transients.

8.2 Power Supply Recommendations

Supply voltages larger than 32 V for a single-supply or outside the range of ±16 V for a dual-supply can permanently damage the device. Place 0.1μF bypass capacitors close to the power-supply pins to reduce errors coupling in from noisy or high impedance power supplies.

8.3 Slew Rate

The slew rate is the rate at which an operational amplifier can change its output when there is a change on the input. These devices have a 24V/μs slew rate.

8.4 Device Functional Modes

These devices are powered on when the supply is connected. This device can be operated as a single-supply operational amplifier or dual-supply amplifier depending on the application.

9 APPLICATION AND IMPLEMENTATION

Information in the following applications sections is not part of the RUNIC component specification, and RUNIC does not warrant its accuracy or completeness. RUNIC's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

9.1 Application Information

The RS846XP series of operational amplifiers can be used in countless applications. The few applications in this section show principles used in all applications of these parts.

9.2 Inverting Amplifier Application

A typical application for an operational amplifier in an inverting amplifier. This amplifier takes a positive voltage on the input, and makes it a negative voltage of the same magnitude. In the same manner, it also makes negative voltages positive.

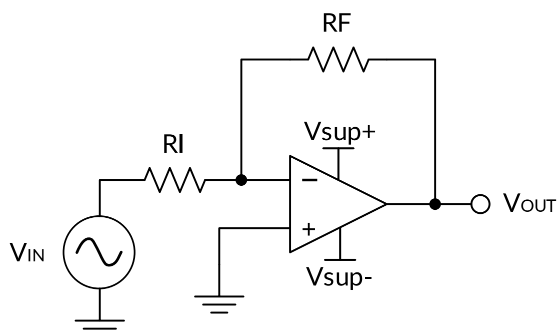


Figure 14. Schematic for Inverting Amplifier Application

10 LAYOUTS

10.1 Layout Guidelines

For best operational performance of the device, use good PCB layout practices, including:

- Noise can propagate into analog circuitry through the power pins of the circuit as a whole and operational amplifier itself. Bypass capacitors are used to reduce the coupled noise by providing low-impedance power sources local to the analog circuitry.
  – Connect low-ESR, 0.1µF ceramic bypass capacitors between each supply pin and ground, placed as close to the device as possible. A single bypass capacitor from V+ to ground is applicable for single supply applications.
- Separate grounding for analog and digital portions of circuitry is one of the simplest and most-effective methods of noise suppression. One or more layers on multilayer PCBs are usually devoted to ground planes. A ground plane helps distribute heat and reduces EMI noise pickup. Make sure to physically separate digital and analog grounds paying attention to the flow of the ground current.
- To reduce parasitic coupling, run the input traces as far away from the supply or output traces as possible. If these traces cannot be kept separate, crossing the sensitive trace perpendicular is much better as opposed to in parallel with the noisy trace.
- Place the external components as close to the device as possible. As shown in Figure 16, keeping RF and RG close to the inverting input minimizes parasitic capacitance.
- Keep the length of input traces as short as possible. Always remember that the input traces are the most sensitive part of the circuit.
- Consider a driven, low-impedance guard ring around the critical traces. A guard ring can significantly reduce leakage currents from nearby traces that are at different potentials.

10.2 Layout Example

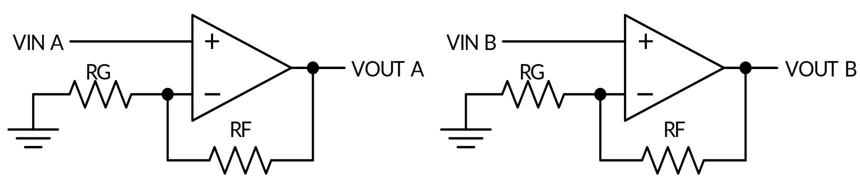


Figure 15. Schematic Representation

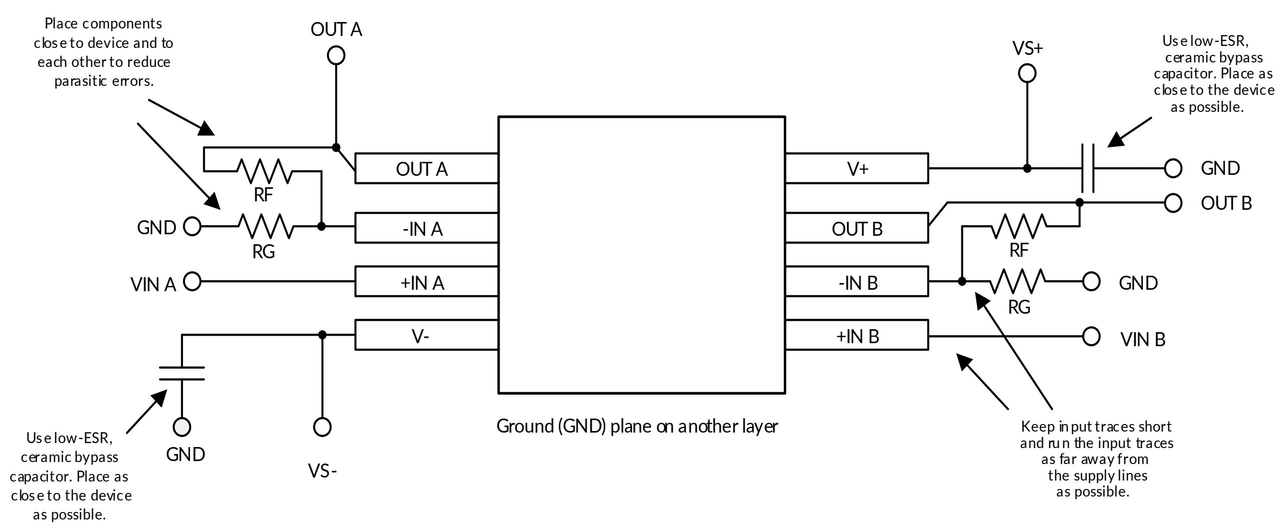
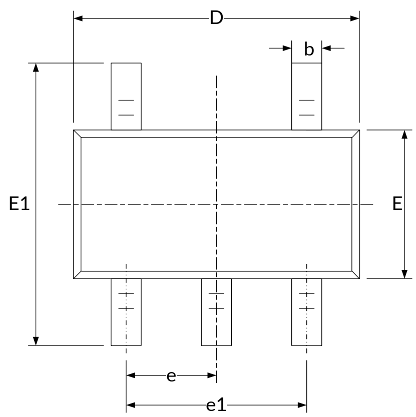


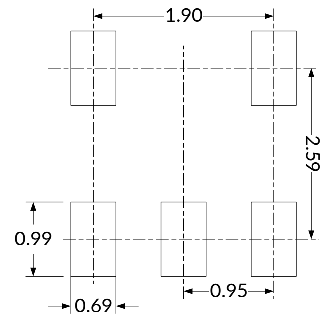
Figure 16. Layout Recommendation

NOTE: Layout Recommendations have been shown for dual op-amp only, follow similar precautions for Single and four.

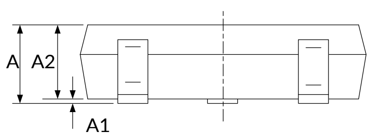
11 PACKAGE OUTLINE DIMENSIONS

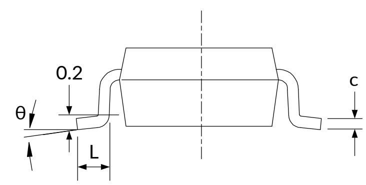
SOT23-5 (3)





RECOMMENDED LAND PATTERN (Unit: mm)

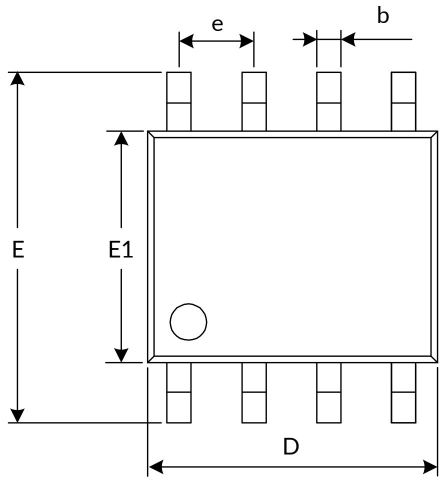


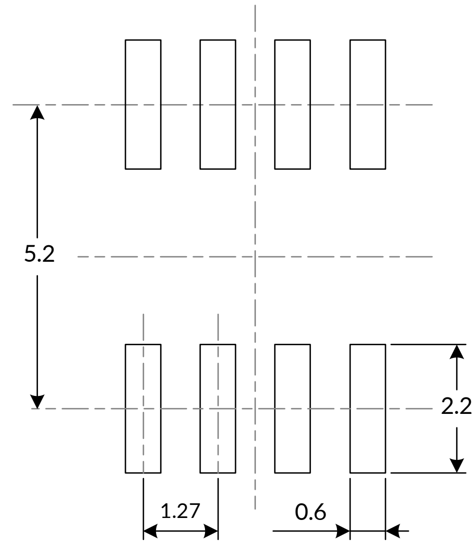


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A (1)	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D (1)	2.820	3.020	0.111	0.119
E (1)	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC) (2)		0.037(BSC) (2)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

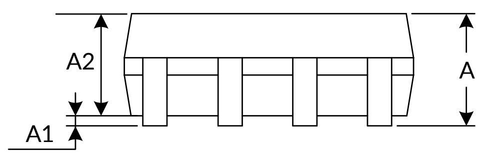
NOTE:
1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

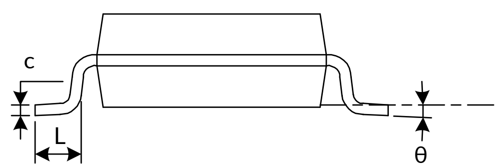
SOP8 (3)





RECOMMENDED LAND PATTERN (Unit: mm)

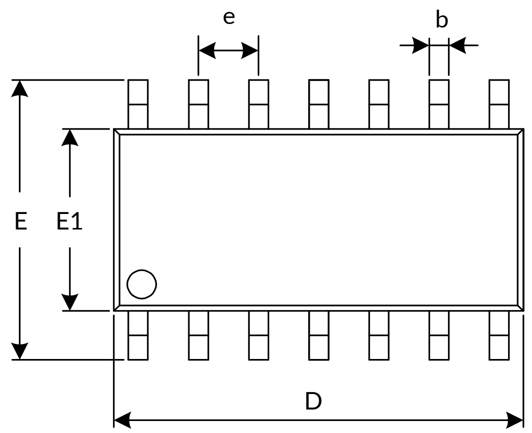


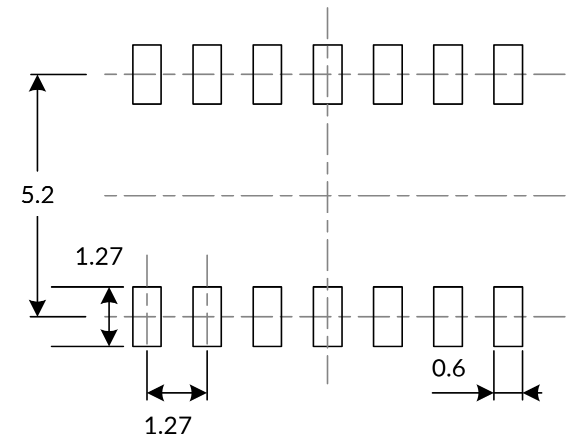


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A (1)	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D (1)	4.800	5.000	0.189	0.197
e	1.270(BSC) (2)		0.050(BSC) (2)	
E	5.800	6.200	0.228	0.244
E1 (1)	3.800	4.000	0.150	0.157
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

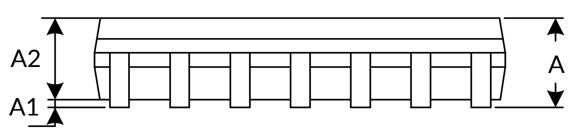
NOTE:
1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

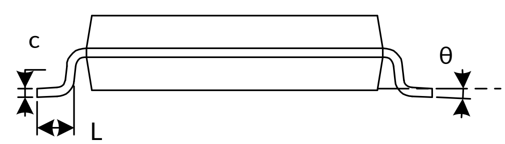
SOP14 (3)





RECOMMENDED LAND PATTERN (Unit: mm)





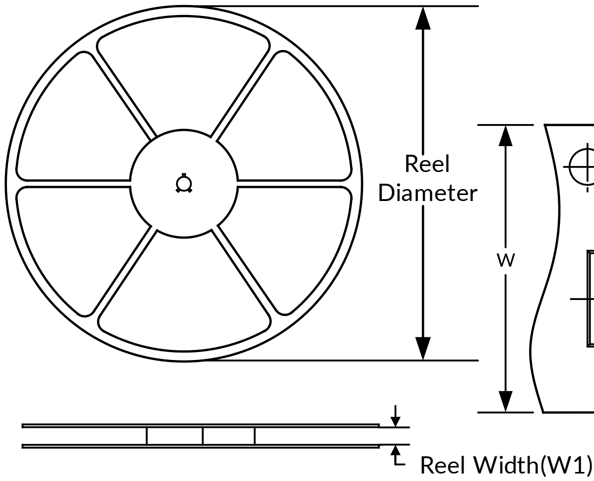
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A (1)	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.310	0.510	0.012	0.020
c	0.100	0.250	0.004	0.010
D (1)	8.450	8.850	0.333	0.348
e	1.270(BSC) (2)		0.050(BSC) (2)	
E	5.800	6.200	0.228	0.244
E1 (1)	3.800	4.000	0.150	0.157
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

NOTE:

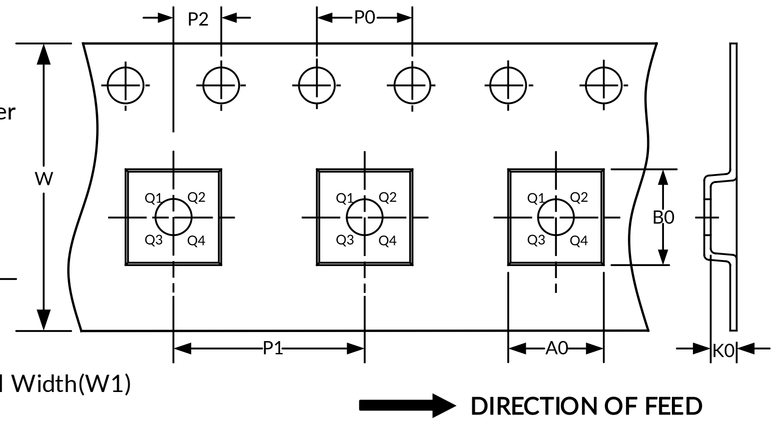
1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

12 TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSION



NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width W1(mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
SOT23-5	7"	9.5	3.20	3.20	1.40	4.0	4.0	2.0	8.0	Q3
SOP8	13"	12.4	6.40	5.40	2.10	4.0	8.0	2.0	12.0	Q1
SOP14	13"	16.4	6.60	9.30	2.10	4.0	8.0	2.0	16.0	Q1

NOTE:
1. All dimensions are nominal.
2. Plastic or metal protrusions of 0.15mm maximum per side are not included.

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