Precision, Ultralow Noise, RRIO, Zero-Drift Operational Amplifiers

1 FEATURES

- **Low Offset Voltage: ±1.2 μV Typical**
- **Low Offset Voltage Drift: ±0.1 μV/°C Typical**
- **Low Noise: 0.15 μV_{PP} at f = 0.1Hz to 10Hz**
- **Open-Loop Gain: 140 dB Typical**
- **CMRR: 125 dB Typical**
- **PSRR: 125 dB Typical**
- **Gain Bandwidth Product: 3.7 MHz**
- **Single-Supply Operation: 2.2 V to 5.5 V**
- **Dual-Supply Operation: ±1.1 V to ±2.75 V**
- **Rail-to-Rail Input and Output**
- **Unity-Gain Stable**

2 APPLICATIONS

- **Thermocouple/Thermopile**
- **Load Cell and Bridge Transducers**
- **Precision Instrumentation**
- **Electronic Scales**
- **Medical Instrumentation**
- **Handheld Test Equipment**

3 DESCRIPTION

The RS8531/RS8532 are ultralow noise, zero-drift operational amplifiers featuring rail-to-rail input and output swing. With an offset voltage of ±1.2 μV, offset voltage drift of ±0.1 μV/°C, and typical noise of 0.15 μV_{PP} (0.1Hz to 10Hz), the RS8531/RS8532 are well suited for applications in which error sources cannot be tolerated.

The RS8531/RS8532 have a wide operating supply range of 2.2 V to 5.5 V, high gain, and excellent CMRR and PSRR specifications, which make it ideal for applications that require precision amplification of low level signals, such as position and pressure sensors, strain gages, and medical instrumentation.

The RS8531/RS8532 are specified over the extended industrial temperature range (−40°C to +125°C). The RS8531 is available in SOT23-5, SC70-5 and MSOP8 packages. The RS8532 is available in SOP8 and MSOP8 packages.

Device Information (1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
RS8531	SOT23-5	2.90mm×1.60mm
	MSOP8	3.00mm×3.00mm
RS8531B	SC70-5	2.10mm×1.25mm
RS8532	SOP8	4.90mm×3.90mm
	MSOP8	3.00mm×3.00mm

(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.0	2024/10/24	Preliminary version completed
A.1	2025/05/13	Initial version completed

5 PACKAGE/ORDERING INFORMATION (1)

Orderable Device	Package Type	Pin	Channel	Op Temp(°C)	Device Marking (2)	MSL (3)	Package Qty
RS8531XF	SOT23-5	5	1	-40°C ~125°C	8531	MSL1	Tape and Reel, 3000
RS8531XM	MSOP8	8	1	-40°C ~125°C	RS8531	MSL1	Tape and Reel, 3000
RS8531BXC5	SC70-5	5	1	-40°C ~125°C	8531B	MSL1	Tape and Reel, 3000
RS8532XK	SOP8	8	2	-40°C ~125°C	RS8532	MSL1	Tape and Reel, 4000
RS8532XM	MSOP8	8	2	-40°C ~125°C	RS8532	MSL1	Tape and Reel, 4000

NOTE:

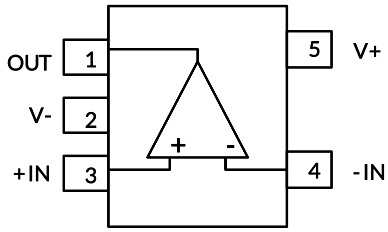
(1) This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the right-hand navigation.

(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.

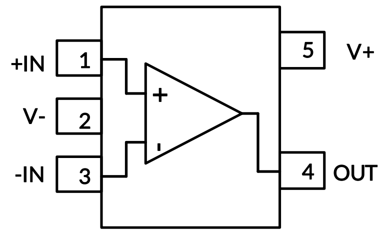
6 PIN CONFIGURATION AND FUNCTIONS

RS8531



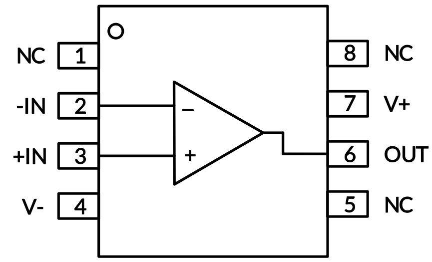
SOT23-5

RS8531B



SC70-5

RS8531



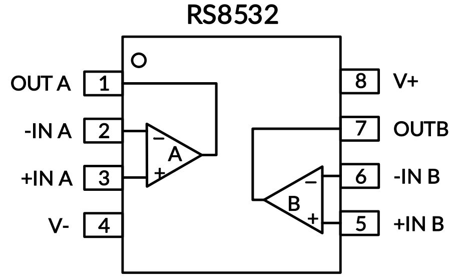
MSOP8

PIN DESCRIPTION

NAME	PIN			I/O [1]	DESCRIPTION
	RS8531		RS8531B		
	SOT23-5	MSOP8	SC70-5		
NC	-	1,5,8	-	-	No internal connection (can be left floating)
-IN	4	2	3	I	Negative (inverting) input
+IN	3	3	1	I	Positive (noninverting) input
V-	2	4	2	-	Negative (lowest) power supply
OUT	1	6	4	O	Output
V+	5	7	5	-	Positive (highest) power supply

(1) I = Input, O = Output.

RS8532



SOP8,MSOP8

PIN DESCRIPTION

NAME	PIN	I/O [1]	DESCRIPTION
	SOP8/MSOP8		
-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
V+	8	-	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, Vs=(V+) - (V-)		0	6	V
	Signal input pin (2)		(V-) -0.5	(V+) +0.5	
	Signal output pin (3)		(V-) -0.5	(V+) +0.5	
	Differential input voltage		(V-) - (V+)	(V+) - (V-)	
Current	Signal input pin (2)		-10	10	mA
	Signal output pin (3)		-10	10	mA
	Output short-circuit (4)		Continuous		
θ_{JA}	Package thermal impedance (5)	SOT23-5		230	°C/W
		SC70-5		380	
		SOP8		110	
		MSOP8		170	
Temperature	Operating range, T_A		-40	125	°C

(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) Output terminals are diode-clamped to the power-supply rails. Output signals that can swing more than 0.5V beyond the supply rails should be current-limited to ±10mA or less.
(4) Short-circuit to ground, one amplifier per package.
(5) The package thermal impedance is calculated in accordance with JESD-51.

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), ANSI/ESDA/JEDEC JS001-2024	±4000	V
		Charged-Device Model (CDM), ANSI/ESDA/JEDEC JS-002-2022	±1000	

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, Vs= (V+) - (V-)	Single-supply	2.2		5.5	V
	Dual-supply	±1.1		±2.75	

7.4 Electrical Characteristics

At T_A = +25°C, V_S= 5V, R_L = 10kΩ, Full [9] = -40°C to +125°C, unless otherwise noted. [1]

PARAMETER		CONDITIONS	T_A	RS8531, RS8532			UNIT
				MIN[2]	TYP[3]	MAX[2]	
POWER SUPPLY							
V_S	Operating Voltage Range		Full	2.2		5.5	V
I_Q	Quiescent Current per Amplifier	V_S = ±2.5V, I_O=0mA	25°C		1.5	1.9	mA
			Full			2.1	
PSRR	Power-Supply Rejection Ratio	V_S = 2.2V to 5.5V	25°C	95	125		dB
			Full	90			
INPUT							
V_{OS}	Input Offset Voltage	V_S = 2.2V, V_{CM} = 1.1V	25°C	-10	±1.2	10	µV
		V_S = 5V, V_{CM} = 2.5V	25°C	-15	±2	15	
Vos Tc	Input Offset Voltage Drift		Full		±0.1		µV/°C
IB	Input Bias Current [4] [5]	V_{CM} = 2.5V	25°C		100		pA
I_{OS}	Input Offset Current [4]	V_{CM} = 2.5V	25°C		100		pA
A_{OL}	Open-Loop Voltage Gain	V_{OUT} = 0.1 V to 4.9 V	25°C	105	140		dB
			Full	100			
V_{CM}	Common-Mode Voltage Range		Full	(V-)		(V+)	V
CMRR	Common-Mode Rejection Ratio	V_{CM}=0V to 5V	25°C	105	125		dB
			Full	100			
OUTPUT							
V_{OH}	Output Swing from Positive Rail	V_S=5V, R_{LOAD} = 10kΩ to V_S/2	25°C		5	20	mV
V_{OL}	Output Swing from Negative Rail	V_S=5V, R_{LOAD} = 10kΩ to V_S/2	25°C		5	20	
I_{SC}	Short-Circuit Current [6] [7]	Source	25°C	20	40		mA
		Sink		30	50		
AC SPECIFICATIONS							
SR	Slew Rate [8]	G=1, C_L = 100 pF	25°C		0.7		V/µs
GBW	Gain-Bandwidth Product	G=11, V_{IN} = 50 mV	25°C		3.7		MHz
t_S	Settling Time, 0.1%	G=1, V_{IN} =2 V Step	25°C		25		µs
t_{OR}	Overload Recovery Time	V_{IN} · Gain ≥ V_S, G=11	25°C		1.5		µs
t_{ON}	Turn On Time		25°C		60		µs
PM	Phase Margin	R_L=10K, C_L= 50pF	25°C		60		°
GM	Gain Margin	R_L=10K, C_L= 50pF	25°C		10		dB
C_{LOAD}	Capacitive Load Drive				100		pF
NOISE							
En	Input Voltage Noise	V_S = 5V, f = 0.1Hz to 10Hz	25°C		0.15		µVpp
en	Input Voltage Noise Density [4]	f = 1kHz	25°C		5.5		nV/√Hz

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 $T_{J(MAX)}$, $R_{θJA}$, and T_A. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(MAX)} - T_A) / R_{θJA}$. 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, unless otherwise noted.

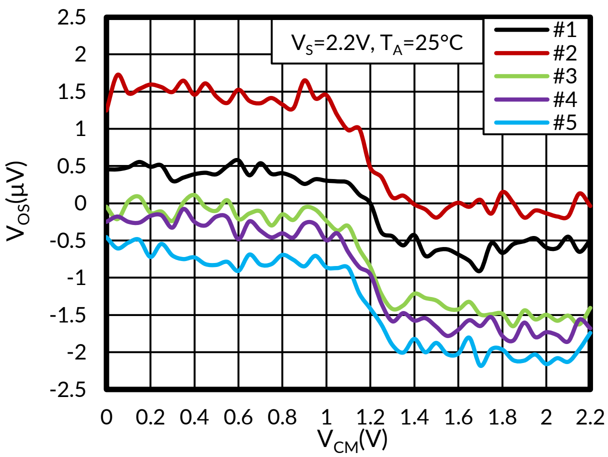


Figure 1. Input Offset Voltage vs Common-Mode Voltage

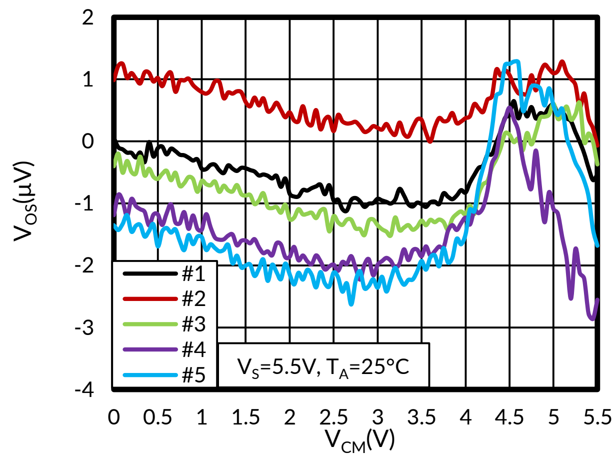


Figure 2. Input Offset Voltage vs Common-Mode Voltage

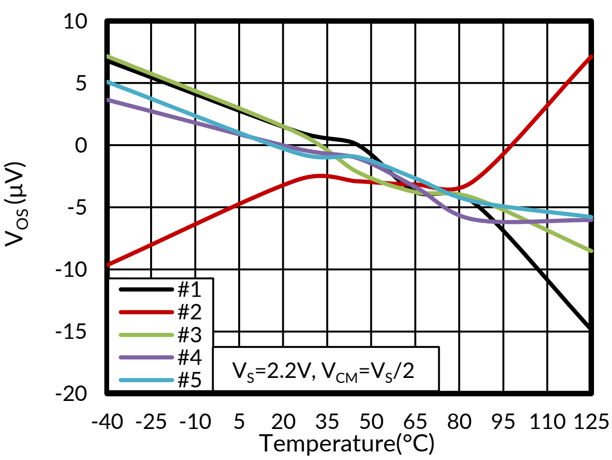


Figure 3. Input Offset Voltage vs Temperature

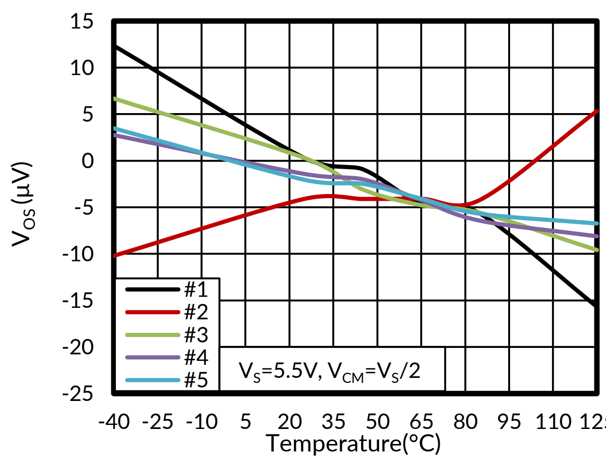


Figure 4. Input Offset Voltage vs Temperature

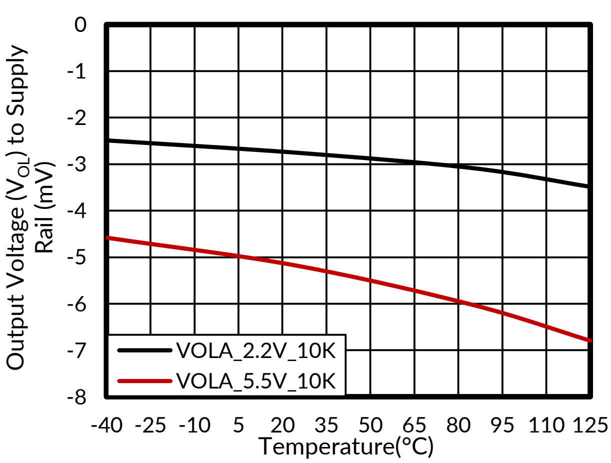


Figure 5. Output Voltage (V_{OL}) to Supply Rail vs Temperature

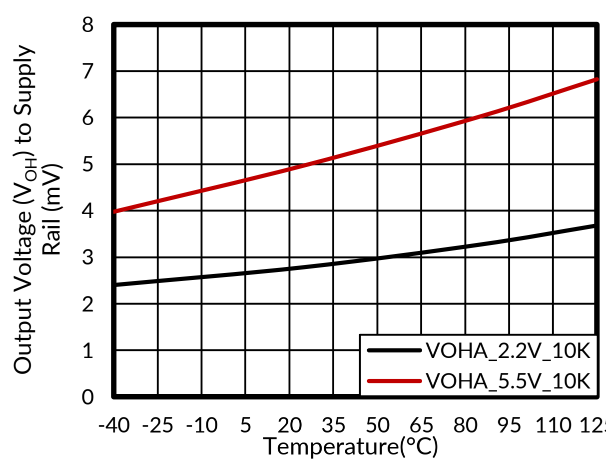


Figure 6. Output Voltage (V_{OH}) to Supply Rail vs Temperature

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, unless otherwise noted.

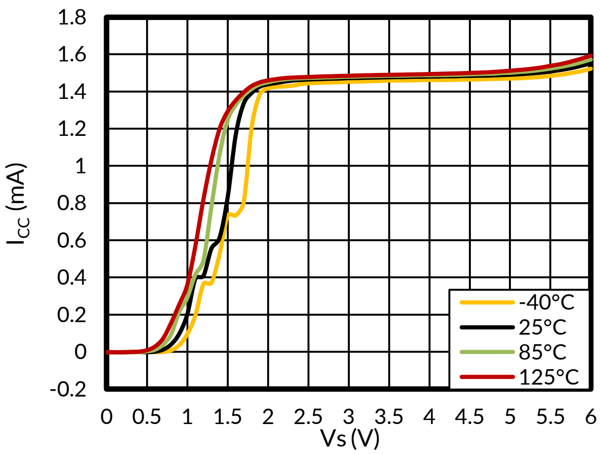


Figure 7. Supply Current vs Supply Voltage

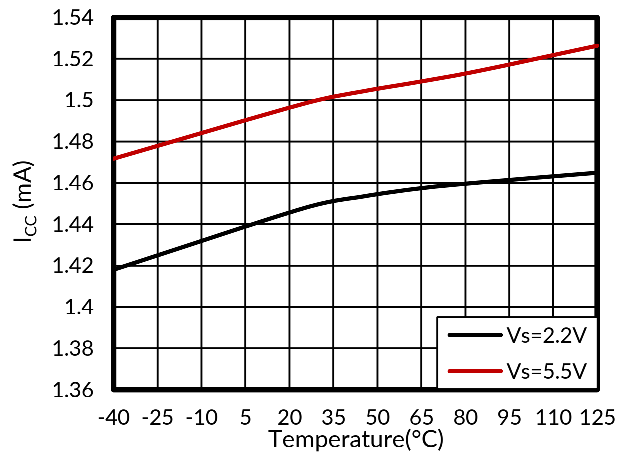


Figure 8. Supply Current vs Temperature

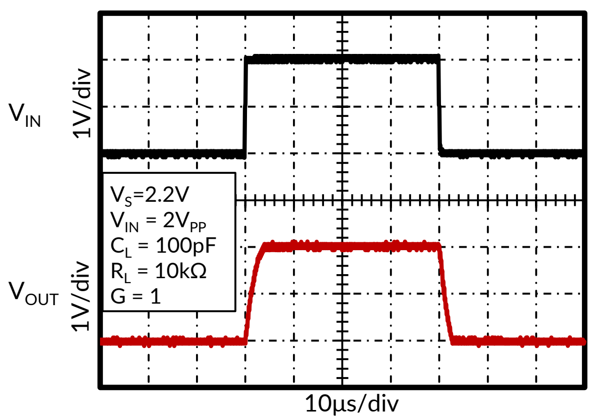


Figure 9. Large Signal Transient Response

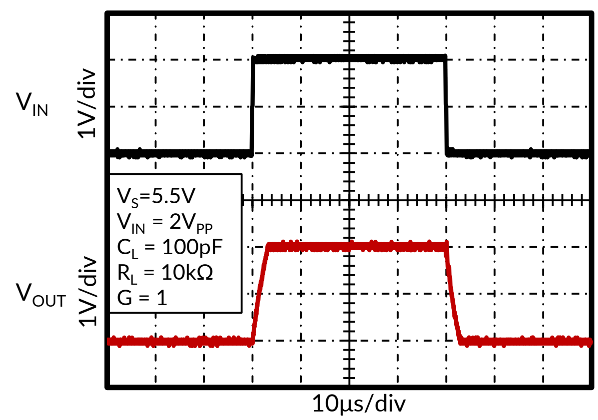


Figure 10. Large Signal Transient Response

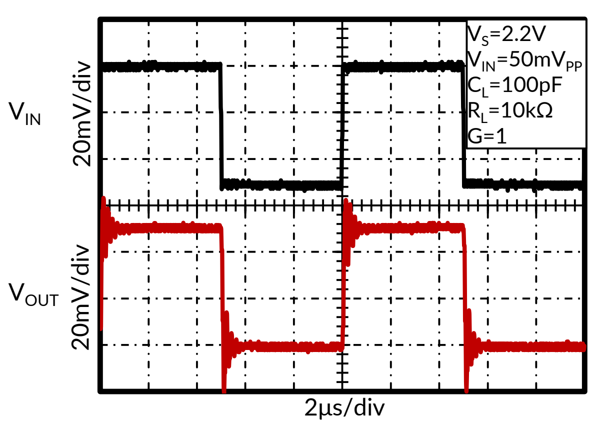


Figure 11. Small Signal Transient Response

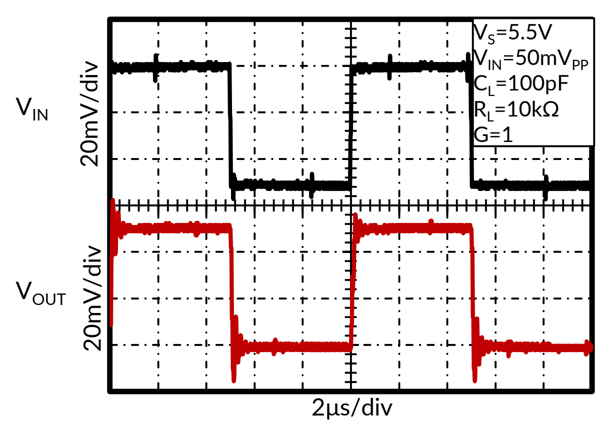


Figure 12. Small Signal Transient Response

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, unless otherwise noted.

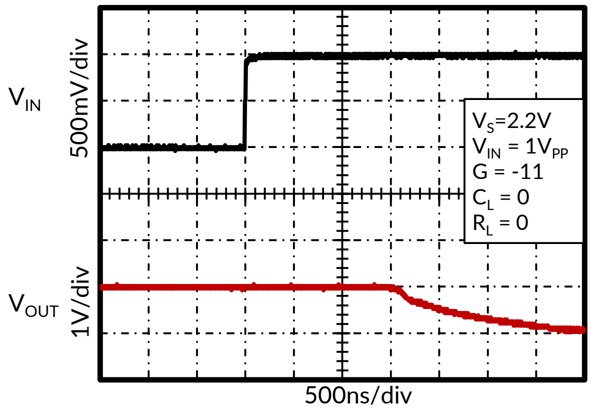


Figure 13. Positive Overload Recovery

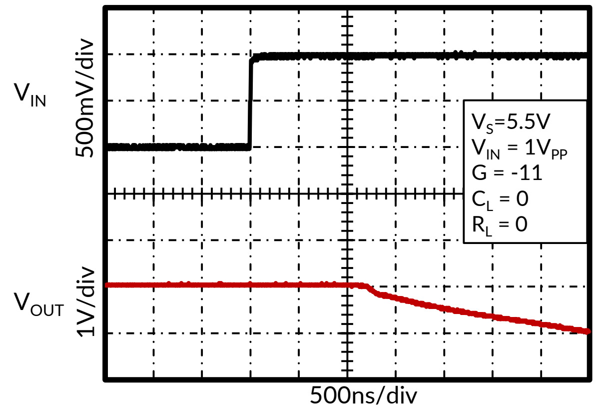


Figure 14. Positive Overload Recovery

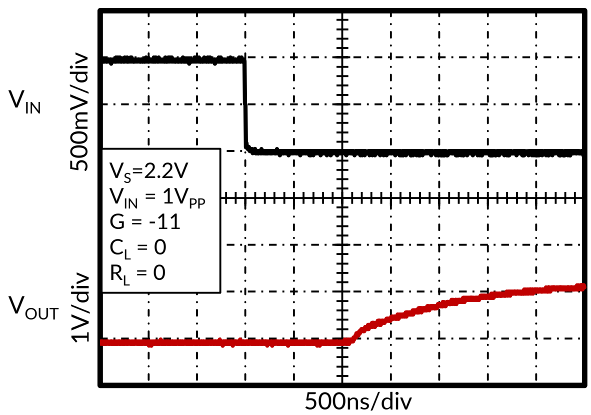


Figure 15. Negative Overload Recovery

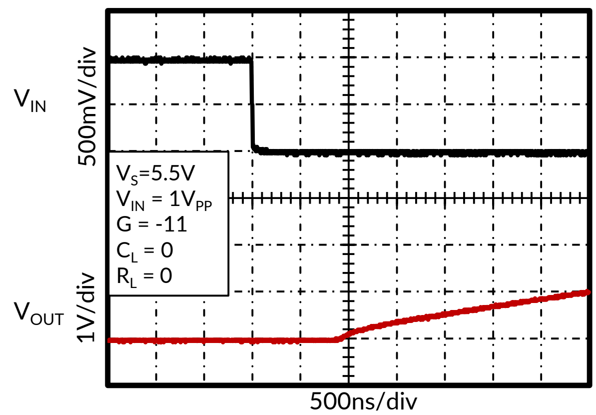


Figure 16. Negative Overload Recovery

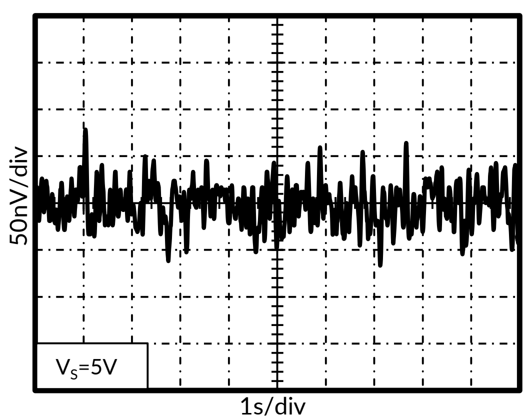


Figure 17. 0.1Hz to 10Hz Noise

8 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.

8.1 Applications Information

The RS8531/RS8532 are precision, ultralow noise, zero-drift operational amplifiers that feature a patented chopping technique. This chopping technique offers ultralow input offset voltage of ±1.2 µV typical and input offset voltage drift of ±0.1 µV/°C typical.

Offset voltage errors due to common-mode voltage swings and power supply variations are also corrected by the chopping technique, resulting in a typical CMRR figure of 125 dB (at V_{CM}=0V to 5V) and a PSRR figure of 125 dB (at V_S=2.2 V to 5.5 V). The RS8531/RS8532 have low broadband noise of 0.15 µV_{PP} (at f = 0.1Hz to 10Hz and V_S =5 V) with no 1/f noise component. These features are ideal for amplification of low level signals in dc or subhertz high precision applications.

8.2 Input Protection

The RS8531/RS8532 have internal ESD protection diodes that are connected between the inputs and each supply rail. These diodes protect the input transistors in the event of electrostatic discharge and are reverse biased during normal operation. This protection scheme allows voltages as high as approximately 500 mV beyond the rails to be applied at the input of either terminal without causing permanent damage.

When either input exceeds one of the supply rails by more than 500 mV, the ESD diodes become forward biased and large amounts of current begin to flow through them. Without current limiting, this excessive fault current causes permanent damage to the device. If the inputs are subjected to overvoltage conditions, insert a resistor in series with each input to limit the input current to 10 mA maximum. However, consider the resistor thermal noise effect on the entire circuit.

8.3 Rail-to-Rail Input and Output

The RS8531/RS8532 feature rail-to-rail input and output with a supply voltage from 2.2 V to 5.5 V. Figure 18 shows the input and output waveforms of the RS8531/RS8532 configured as a unity-gain buffer with a supply voltage of ±2.5 V and a resistive load of 10 kΩ. With an input voltage of ±2.5 V, the RS8531/RS8532 allow the output to swing very close to both rails. Additionally, the devices do not exhibit phase reversal.

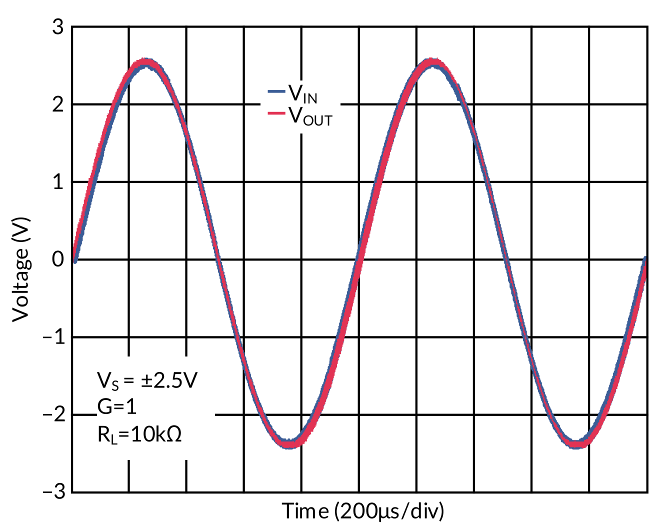


Figure 18. Rail-to-Rail Input and Output

8.4 Noise Considerations

8.4.1 1/f Noise

1/f noise, also known as pink noise or flicker noise, is inherent in semiconductor devices and increases as frequency decreases. At low frequency, 1/f noise is a major noise contributor and causes a significant output voltage offset when amplified by the noise gain of the circuit. However, the RS8531/RS8532 eliminate the 1/f noise internally, thus making these devices an excellent choice for dc or subhertz high precision applications. The 0.1 Hz to 10 Hz amplifier voltage noise is only 0.15 µVpp at a supply voltage of 5 V.

The low frequency 1/f noise, which appears as a slow varying offset to the RS8531/RS8532, is greatly reduced by the chopping technique. This reduction in 1/f noise allows the RS8531/RS8532 to have much lower noise at dc and low frequency compared to standard low noise amplifiers that are susceptible to 1/f noise.

8.4.2 Source Resistance

With 5.5 nV/$\sqrt{Hz}$ of broadband noise at 1 kHz (V_S = 5 V), the RS8531/RS8532 are among the lowest noise zero-drift amplifiers currently available in the industry. Therefore, it is important to carefully select the input source resistance to maintain a total low noise.

The total input referred broadband noise (en total) from any amplifier is primarily a function of three types of noise: input voltage noise, input current noise, and thermal (Johnson) noise from the external resistors.

These uncorrelated noise sources can be summed up in a root sum squared (rss) manner using the following equation:

$$e_n\ total = [\ e_n^2 + 4kTR_S + (\ i_n \times R_S\ )^2\ ]^{1/2}$$

where:
e_n is the input voltage noise of the amplifier (V/$\sqrt{Hz}$).
k is the Boltzmann's constant (1.38×10^{-23} J/K).
T is the temperature in Kelvin (K).
R_S is the total input source resistance (Ω).
i_n is the input current noise of the amplifier (A/$\sqrt{Hz}$).

The total equivalent rms noise over a specific bandwidth is expressed as

$$e_{n,rms} = e_n\ total \times \sqrt{BW}$$

where BW is the bandwidth in hertz.

This analysis is valid for broadband noise calculation. If the bandwidth of concern includes the chopping frequency, more complicated calculations must be made to include the effect of the noise energy spectrum at the chopping frequency (see the Residual Voltage Ripple section).

With a low source resistance of R_S < 1 kΩ, the voltage noise of the amplifier dominates. As source resistance increases, the thermal noise of R_S dominates. As the source resistance increases further, where R_S > 100 kΩ, the current noise becomes the main contributor to the total input noise.

8.4.3 Voltage Noise Density with Different Gain Configurations

Figure 19 shows the voltage noise density vs closed-loop gain of a zero-drift amplifier from a leading competitor. The voltage noise density of the amplifier increases from 11 nV/$\sqrt{Hz}$ to 21 nV/$\sqrt{Hz}$ as the closed-loop gain decreases from 1000 to 1.

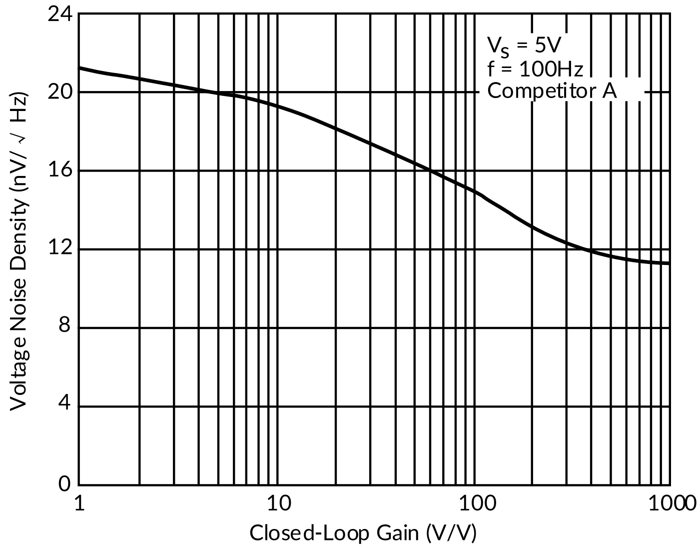


Figure 19. Competitor A: Voltage Noise Density vs Closed-Loop Gain

Figure 20 shows the voltage noise density vs frequency of the RS8531/RS8532 for three different gain configurations. The RS8531/RS8532 offer a constant input voltage noise density of 6 nV/$\sqrt{Hz}$ to 7 nV/$\sqrt{Hz}$, regardless of the gain configuration.

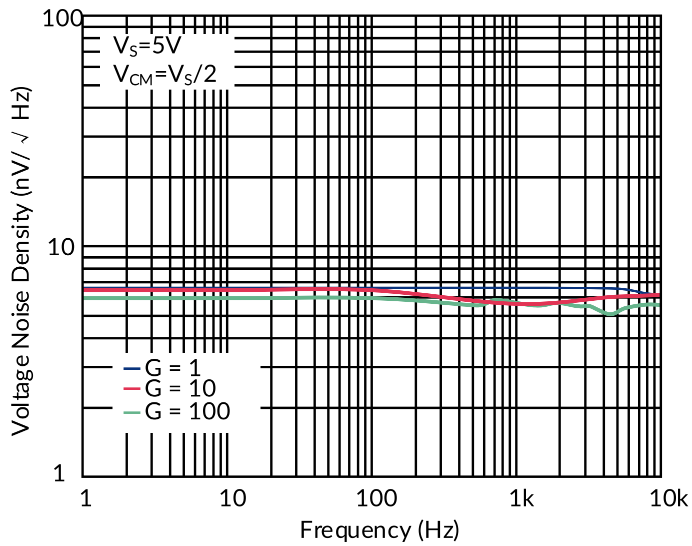


Figure 20. Voltage Noise Density vs Frequency with Different Gain Configurations

8.4.4 Residual Voltage Ripple

Although autocorrection feedback (ACFB) suppresses the chopping related voltage ripple, higher noise spectrum exists at the chopping frequency and its harmonics due to the remaining ripple. Figure 21 shows the voltage noise density of the RS8531/RS8532 configured in unity gain. A noise energy spectrum of 50 nV/$\sqrt{Hz}$ can be seen at the chopping frequency of 200 kHz. This noise energy spectrum is significant when the op amp has a closed-loop frequency that is higher than the chopping frequency.

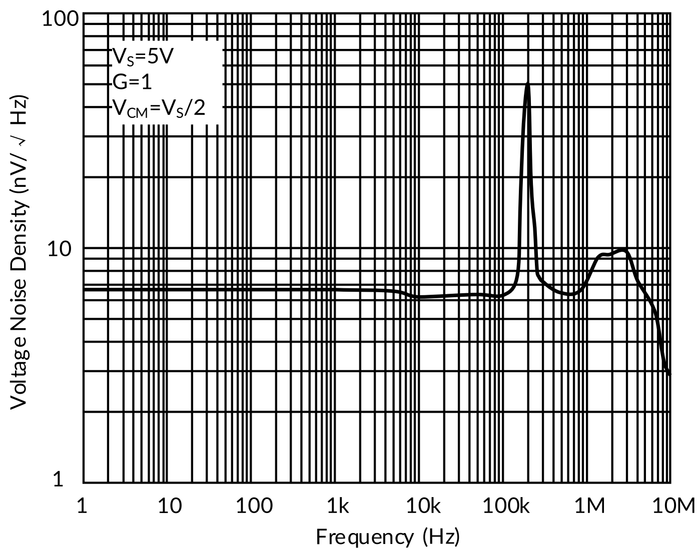


Figure 21. Voltage Noise Density vs Frequency

To further suppress the noise at the chopping frequency, it is recommended that a post filter be placed at the output of the amplifier.

8.5 Comparator Operation

Figure 22 shows the RS8532 configured as a voltage follower with an input voltage that is always kept at midpoint of the power supplies. The same configuration is applied to the unused channel. A1 and A2 indicate the placement of ammeters to measure supply current. As shown in Figure 23, as expected, in normal operating condition, $I_S+ = I_S- = 3$ mA for the dual RS8532 at 5 V of supplies.

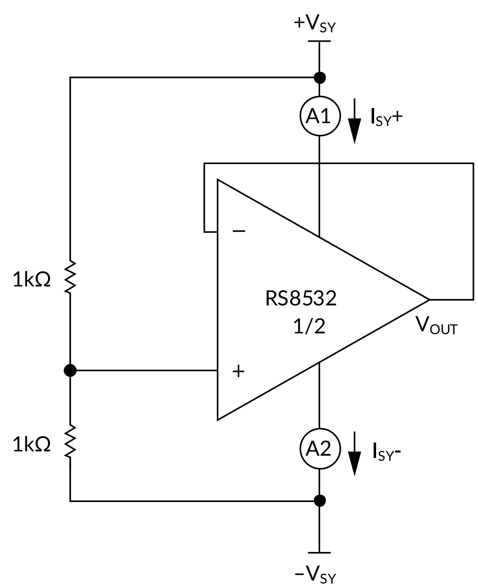


Figure 22. Voltage Follower

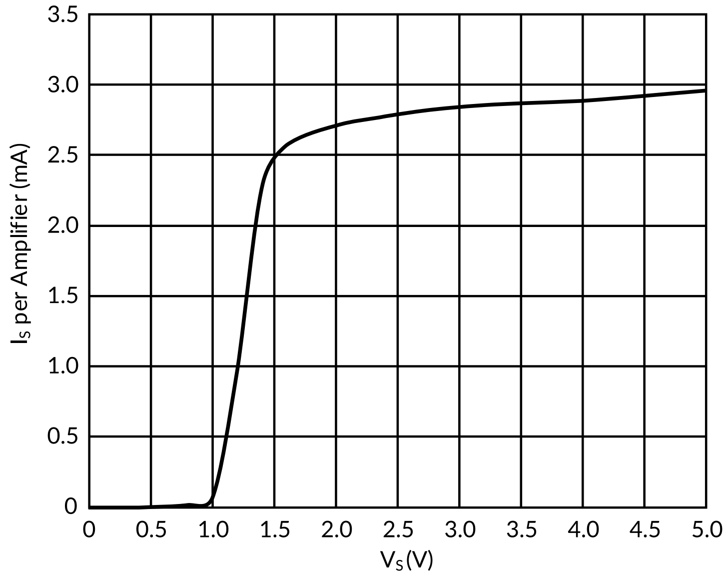


Figure 23. Supply Current vs Supply Voltage (Voltage Follower)

Figure 24 and Figure 25 show the RS8532 configured as comparators, with 1kΩ resistors in series with the input pins. Figure 26 shows the supply currents for both configurations. Supply currents increase slightly to 3.2 mA per dual amplifier at 5 V of supplies.

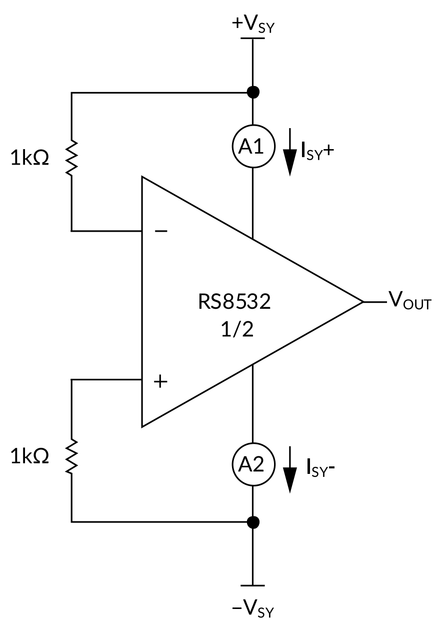


Figure 24. Comparator A

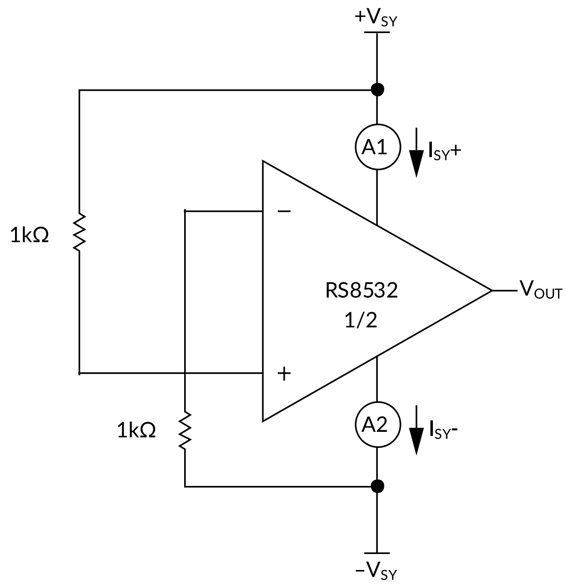


Figure 25. Comparator B

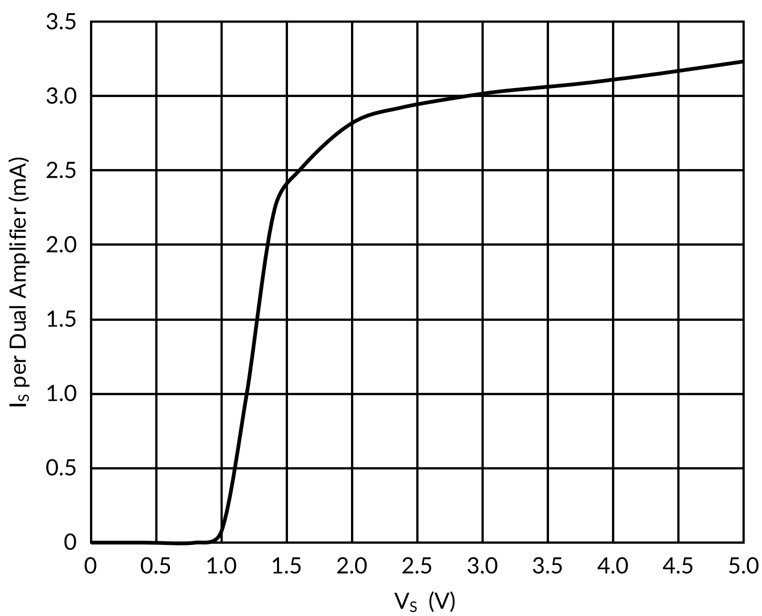


Figure 26. Supply Current vs Supply Voltage (Comparator A and Comparator B)

9 LAYOUT

9.1 Layout Guidelines

Attention to good layout practices is always recommended. Keep traces short. When possible, use a PCB ground plane with surface-mount components placed as close to the device pins as possible. Place a 0.1μF capacitor closely across the supply pins.

These guidelines should be applied throughout the analog circuit to improve performance and provide benefits such as reducing the EMI susceptibility.

9.2 Layout Example

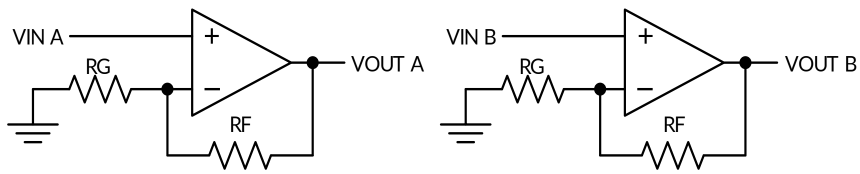


Figure 27. Schematic Representation

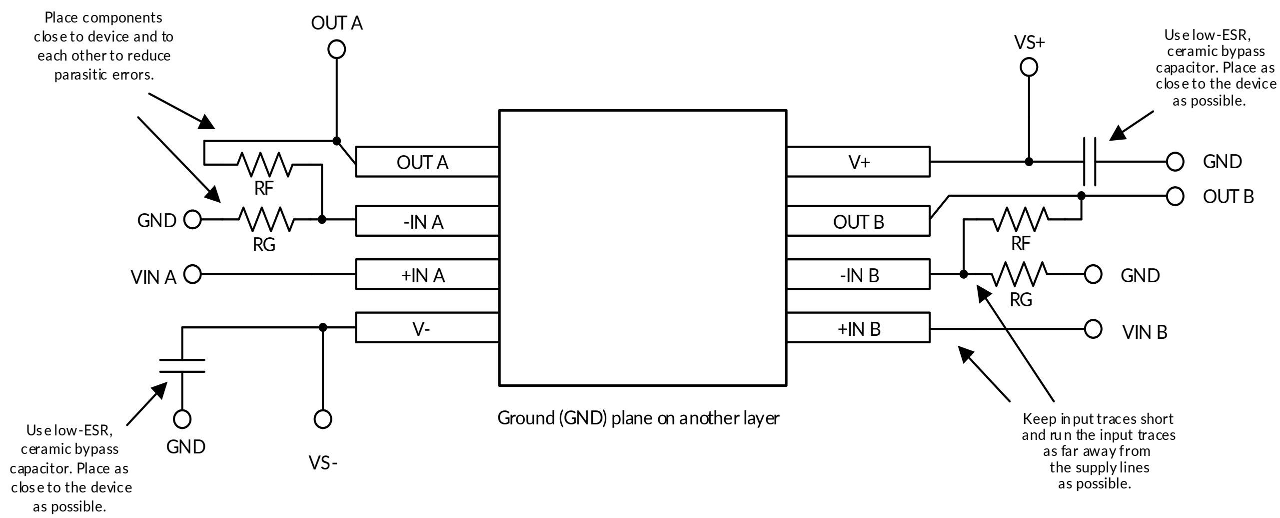
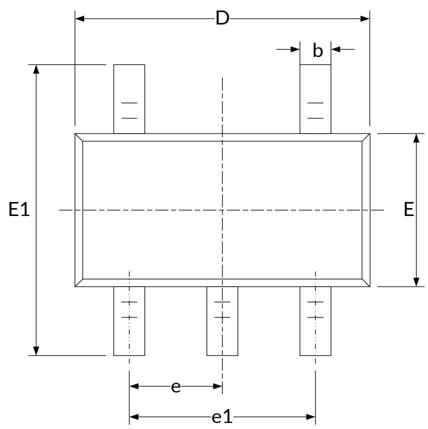


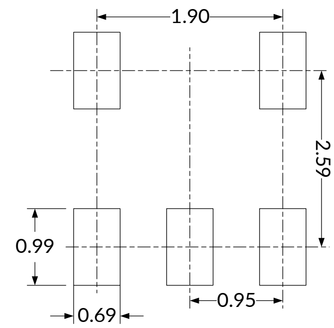
Figure 28. Layout Example

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

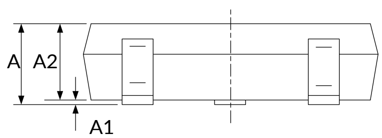
10 PACKAGE OUTLINE DIMENSIONS

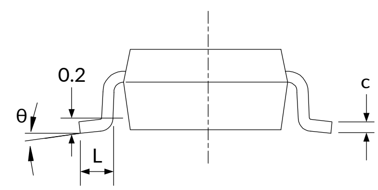
SOT23-5 (3)





RECOMMENDED LAND PATTERN (Unit: mm)

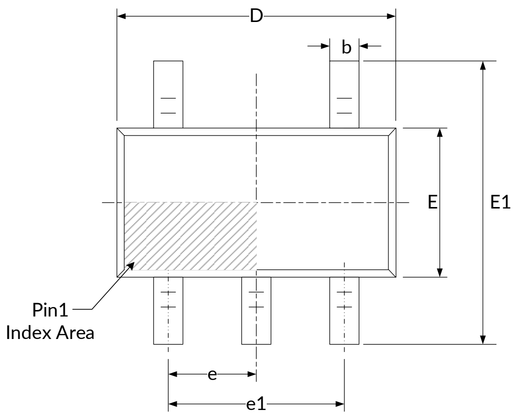


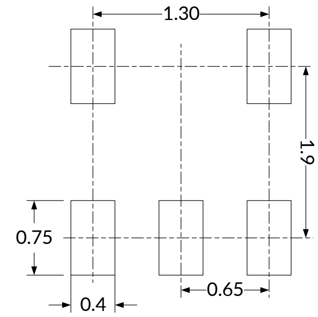


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A (1)	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D (1)	2.820	3.020	0.111	0.119
E (1)	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC) (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°

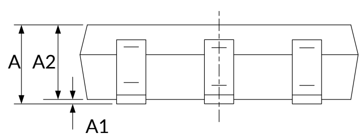
NOTE:
1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

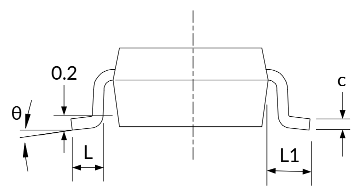
SC70-5 (3)





RECOMMENDED LAND PATTERN (Unit: mm)



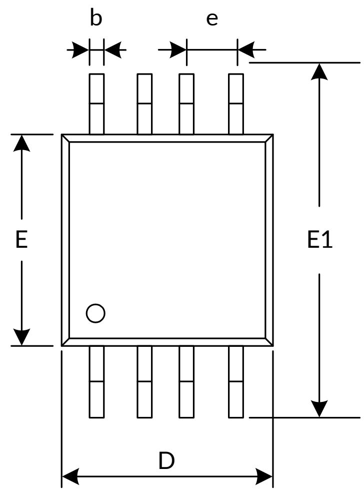


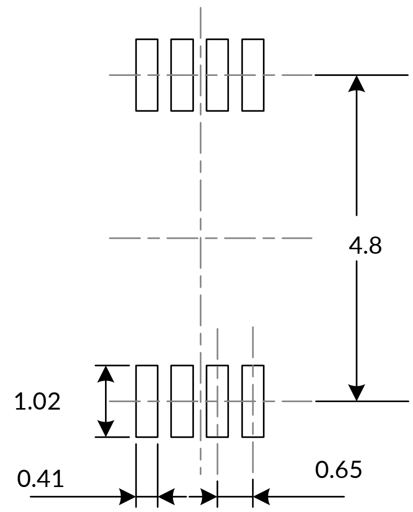
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A (1)	0.900	1.100	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.900	1.000	0.035	0.039
b	0.150	0.350	0.006	0.014
c	0.080	0.150	0.003	0.006
D (1)	2.000	2.200	0.079	0.087
E (1)	1.150	1.350	0.045	0.053
E1	2.150	2.450	0.085	0.096
e	0.650(BSC) (2)		0.026(BSC) (2)	
e1	1.300(BSC) (2)		0.051(BSC) (2)	
L	0.260	0.460	0.010	0.018
L1	0.525		0.021	
θ	0°	8°	0°	8°

NOTE:

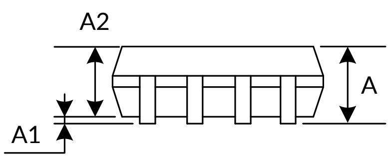
1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

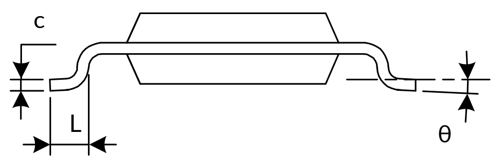
MSOP8 (3)





RECOMMENDED LAND PATTERN (Unit: mm)

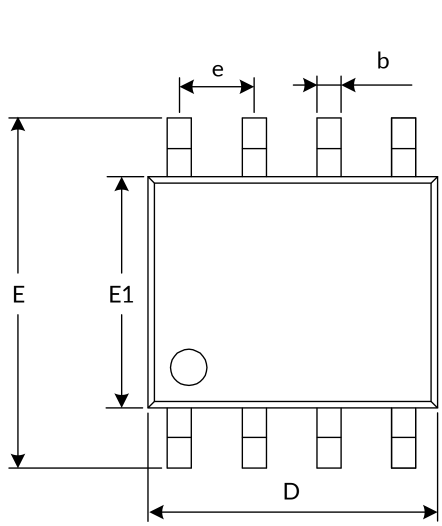


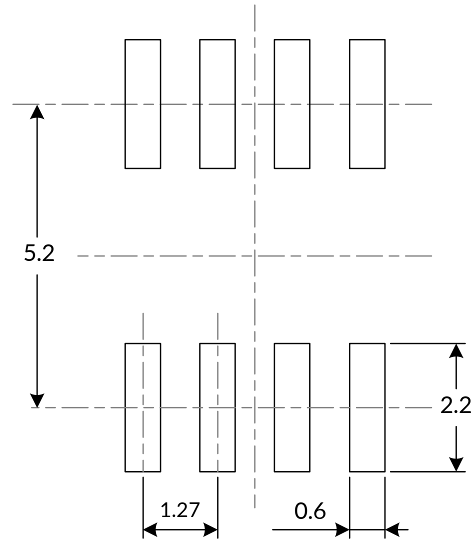


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A (1)	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D (1)	2.900	3.100	0.114	0.122
e	0.650(BSC) (2)		0.026(BSC) (2)	
E (1)	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
L	0.400	0.800	0.016	0.031
θ	0°	6°	0°	6°

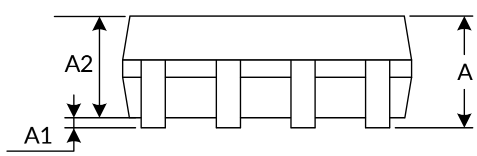
NOTE:
1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

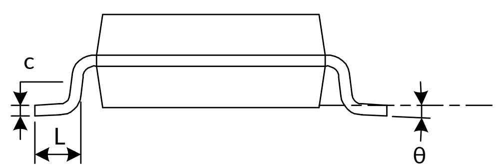
SOP8 (3)





RECOMMENDED LAND PATTERN (Unit: mm)





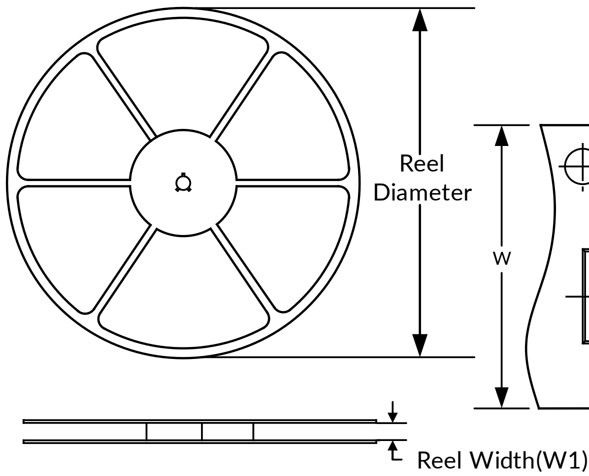
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A (1)	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D (1)	4.800	5.000	0.189	0.197
e	1.270(BSC) (2)		0.050(BSC) (2)	
E	5.800	6.200	0.228	0.244
E1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

NOTE:

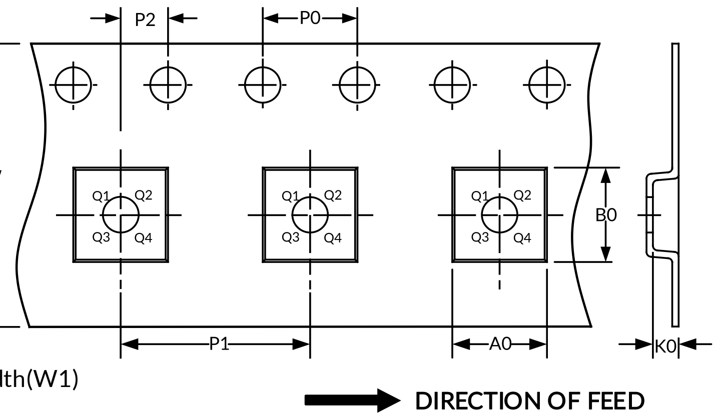
1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

11 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 (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
SC70-5	7”	9.5	2.25	2.55	1.20	4.0	4.0	2.0	8.0	Q3
MSOP8	13”	12.4	5.20	3.30	1.50	4.0	8.0	2.0	12.0	Q1
SOP8	13”	12.4	6.40	5.40	2.10	4.0	8.0	2.0	12.0	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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