Zero-Drift, Single-Supply, Rail-to-Rail Input/Output Operational Amplifier

1 FEATURES

- **Lowest Auto-Zero Amplifier Noise**
- **Low Offset Voltage: ±1 µV**
- **Input Offset Drift: ±0.1 µV/°C**
- **Rail-To-Rail Input and Output Swing**
- **5 V Single-Supply Operation**
- **High Gain, CMRR, and PSRR: 125 dB**
- **Very Low Input Bias Current: ±100 pA Typical**
- **Low Supply Current: 500 µA**
- **Overload Recovery Time: ≤4 µs**
- **No External Components Required**
- **Qualified for Automotive Applications**

2 APPLICATIONS

- **Automotive Sensors**
- **Pressure and Position Sensors**
- **Strain Gage Amplifiers**
- **Medical Instrumentation**
- **Thermocouple Amplifiers**
- **Precision Current Sensing**
- **Photodiode Amplifiers**

3 DESCRIPTIONS

This amplifier has ultralow offset, drift, and bias current. The RS8547/RS8548 are wide bandwidth auto-zero amplifiers featuring rail-to-rail input and output swing and low noise. Operation is fully specified from 2.5 V to 5.5 V single supply (±1.25 V to ±2.75 V dual supply).

The RS8547/RS8548 provide benefits previously found only in expensive auto-zeroing or chopper-stabilized amplifiers. Using topology, these zero-drift amplifiers combine low cost with high accuracy and low noise. No external capacitor is required. In addition, the RS8547/RS8548 greatly reduce the digital switching noise found in most chopper-stabilized amplifiers.

With an offset voltage of 1 µV, drift of 0.1 µV/°C, and noise of only 0.55 µV p-p (0.1 Hz to 10 Hz), the RS8547/RS8548 are suited for applications where error sources cannot be tolerated. Position and pressure sensors, medical equipment, and strain gage amplifiers benefit greatly from nearly zero drift over their operating temperature range. Many systems can take advantage of the rail-to-rail input and output swings provided by the RS8547/RS8548 to reduce input biasing complexity and maximize SNR.

The RS8547/RS8548 are specified for the extended industrial temperature range (−40°C to +125°C). The RS8547 is available in 5-lead SOT23 plastic packages. The RS8548 is available in the standard 8-lead narrow SOP and MSOP plastic packages.

Device Information (1)

PART NUMBER	PACKAGE	BODY SIZE(NOM)
RS8547	SOT23-5	2.90mm×1.60mm
RS8548	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	2025/04/01	Preliminary version completed
A.1	2025/05/20	Initial version completed

5 PACKAGE/ORDERING INFORMATION (1)

Orderable Device	Package Type	Pin	Channel	Op Temp (°C)	Device Marking (2)	MSL (3)	Package Qty
RS8547XF	SOT23-5	5	1	-40°C ~ 125°C	8547	MSL3	Tape and Reel, 3000
RS8548XK	SOP8	8	2	-40°C ~125°C	RS8548	MSL3	Tape and Reel, 4000
RS8548XM	MSOP8	8	2	-40°C ~125°C	RS8548	MSL3	Tape and Reel, 4000

NOTE:

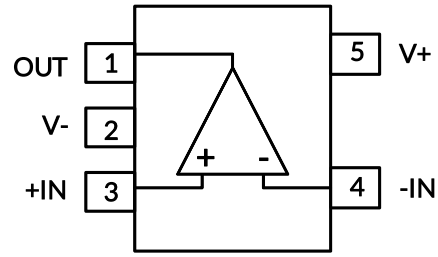
(1) This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the right-hand navigation.

(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

RS8547



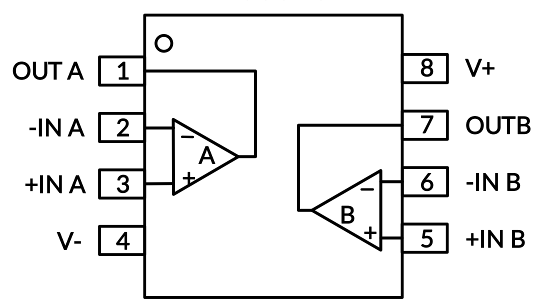
SOT23-5

PIN DESCRIPTION

NAME	PIN	I/O (1)	DESCRIPTION
	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.

RS8548



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, V_S= (V+) - (V-)			6	V
	Signal input pin (2)		(V-) - 0.3	(V+) + 0.3	
	Signal output pin (3)		(V-) - 0.3	(V+) + 0.3	
	Differential input voltage		(V-) - (V+)	(V+) - (V-)	
Current	Signal input pin (2)		-10	10	mA
	Signal output pin (3)		-50	50	mA
	Output short-circuit (4)		Continuous		
θ_{JA}	Package thermal impedance (5)	SOT23-5		230	°C/W
		SOP8		110	
		MSOP8		170	
Temperature	Operating range, T_A		-40	125	°C
	Junction, T_J (6)			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 0.3V 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 0.3V beyond the supply rails should be current-limited to ±50mA or less.
(4) Short-circuit to ground, one amplifier per package.
(5) The package thermal impedance is calculated in accordance with JESD-51.
(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.

7.2 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	±2000	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, V_S= (V+) - (V-)	Single-supply	2.5		5.5	V
	Dual-supply	±1.25		±2.75	

7.4 Electrical Characteristics, V_S=5V

At T_A = +25°C, V_S= 5V, R_L = 10kΩ, R_L = 10kΩ connected to V_S/2, and V_{OUT} = V_S/2, V_{CM} = V_S/2, Full [9] = -40°C to +125°C, unless otherwise noted. [1]

PARAMETER		CONDITIONS	T_A	RS8547, RS8548			UNIT
				MIN[2]	TYP[3]	MAX[2]	
POWER SUPPLY							
V_S	Operating Voltage Range		Full	2.5		5.5	V
I_Q	Quiescent Current per Amplifier	V_S=±2.5V, I_O=0mA	25°C		500	650	μA
			Full			700	
PSRR	Power-Supply Rejection Ratio	V_S=2.5V to 5.5V, V_{CM}=0V	25°C	110	125		dB
			Full	100			
INPUT							
Vos	Input Offset Voltage	V_S=5V, V_{CM}=2.5V	25°C	-5	±1	5	μV
			Full	-15		15	
Vos Tc	Input Offset Voltage Drift	V_S=5V, V_{CM}=2.5V	Full		±0.1		μV/°C
IB	Input Bias Current [4] [5]	V_S=5V	25°C	-500	±100	500	pA
I_{OS}	Input Offset Current [4]	V_S=5V, V_{CM}=2.5V	25°C	-500	±100	500	pA
A_{OL}	Open-loop Voltage Gain	R_{LOAD}=10kΩ, V_{OUT}=0.1 V to 5.4 V	25°C	110	130		dB
			Full	115			dB
V_{CM}	Common-Mode Voltage Range		Full	(V-)-0.1		(V+)+0.1	V
CMRR	Common-Mode Rejection Ratio	V_S=5V, (V−)-0.1V< V_{CM} < (V+)+0.1V	25°C	110	125		dB
			Full	105			dB
OUTPUT							
V_{OH}	Output Swing from Positive Rail	V_S=5V, R_{LOAD}=10kΩ to V_S/2	25°C		5	15	mV
V_{OL}	Output Swing from Negative Rail	V_S=5V, R_{LOAD}=10kΩ to V_S/2	25°C		5	15	mV
I_{SC}	Short-Circuit Current [6] [7]	Source, V_S=5V	25°C	45	60		mA
		Sink, V_S=5V	25°C	45	60		
AC Specifications							
SR	Slew Rate [8]	G=1, V_{IN} = 2V Step	25°C		1.4		V/μs
GBW	Gain-Bandwidth Product		25°C		2.4		MHz
t_s	Settling Time, 0.1%	G=1, V_{IN} = 2V Step	25°C		10		μs
t_{OR}	Overload Recovery Time	V_{IN} • Gain ≥ V_S	25°C		3		μs
t_{ON}	Turn on Time		25°C		15		μs
PM	Phase Margin [4]	R_L=10kΩ, C_L=50pF	25°C		60		°
GM	Gain Margin [4]	R_L=10kΩ, C_L=50pF	25°C		10		dB
C_{LOAD}	Capacitive Load Drive		25°C		100		pF
NOISE							
En	Input Voltage Noise	V_S=5V, f=0.1Hz to 10Hz	25°C		0.55		μVpp
en	Input Voltage Noise Density [4]	f=1kHz	25°C		25		$nV/\sqrt{Hz}$
		f=10kHz	25°C		24		

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 Electrical Characteristics, V_S=2.5V

At T_A = +25°C, V_S= 2.5V, R_L = 10kΩ, R_L = 10kΩ connected to V_S/2, and V_{OUT} = V_S/2, V_{CM} = V_S/2, Full [9] = -40°C to +125°C, unless otherwise noted. [1]

PARAMETER		CONDITIONS	T_A	RS8547, RS8548			UNIT
				MIN[2]	TYP[3]	MAX[2]	
POWER SUPPLY							
V_S	Operating Voltage Range		Full	2.5		5.5	V
I_Q	Quiescent Current per Amplifier	V_S=±1.25V, I_O=0mA	25°C		500	650	μA
			Full			700	
PSRR	Power-Supply Rejection Ratio	V_S=2.5V to 5.5V, V_{CM}=0V	25°C	110	125		dB
			Full	100			
INPUT							
Vos	Input Offset Voltage	V_S=2.5V, V_{CM}=1.25V	25°C	-8	±1	8	μV
			Full	-20		20	
Vos Tc	Input Offset Voltage Drift	V_S=2.5V, V_{CM}=1.25V	Full		±0.1		μV/°C
IB	Input Bias Current [4] [5]	V_S=2.5V	25°C	-500	±100	500	pA
I_{OS}	Input Offset Current [4]	V_S=2.5V, V_{CM}=1.25V	25°C	-500	±100	500	pA
A_{OL}	Open-loop Voltage Gain	R_{LOAD}=10kΩ, V_{OUT}=0.1 V to 2.4 V	25°C	110	115		dB
			Full	100			dB
V_{CM}	Common-Mode Voltage Range		Full	(V-)-0.1		(V+)+0.1	V
CMRR	Common-Mode Rejection Ratio	V_S=2.5V, (V−)-0.1V< V_{CM} < (V+)+0.1V	25°C	110	125		dB
			Full	105			dB
OUTPUT							
V_{OH}	Output Swing from Positive Rail	V_S=2.5V, R_{LOAD}=10kΩ to V_S/2	25°C		5	15	mV
V_{OL}	Output Swing from Negative Rail	V_S=2.5V, R_{LOAD}=10kΩ to V_S/2	25°C		2.5	15	mV
I_{SC}	Short-Circuit Current [6] [7]	Source, V_S=2.5V	25°C	10	20		mA
		Sink, V_S=2.5V	25°C	15	24		
AC Specifications							
SR	Slew Rate [8]	G=1, V_{IN} = 2V Step	25°C		1.3		V/μs
GBW	Gain-Bandwidth Product		25°C		2.2		MHz
t_s	Settling Time, 0.1%	G=1, V_{IN} = 2V Step	25°C		10		μs
t_{OR}	Overload Recovery Time	V_{IN} • Gain ≥ V_S	25°C		4		μs
t_{ON}	Turn on Time		25°C		10		μs
PM	Phase Margin [4]	R_L=10kΩ, C_L=50pF	25°C		60		°
GM	Gain Margin [4]	R_L=10kΩ, C_L=50pF	25°C		10		dB
C_{LOAD}	Capacitive Load Drive		25°C		100		pF
NOISE							
En	Input Voltage Noise	V_S=2.5V, f=0.1Hz to 10Hz	25°C		0.55		μVpp
en	Input Voltage Noise Density [4]	f=1kHz	25°C		25		$nV/\sqrt{Hz}$
		f=10kHz	25°C		24		

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.

7.6 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.

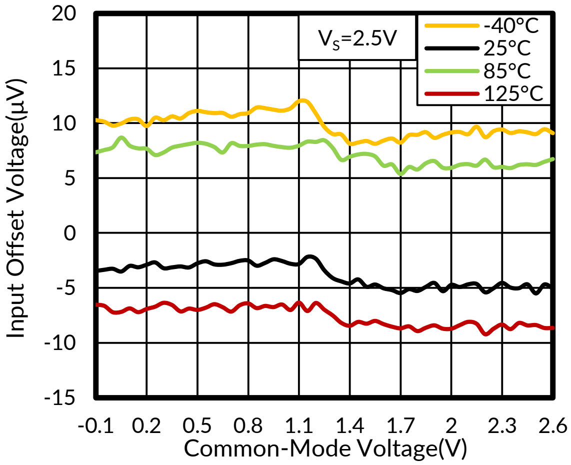


Figure 1. Input Offset Voltage vs Common-Mode Voltage

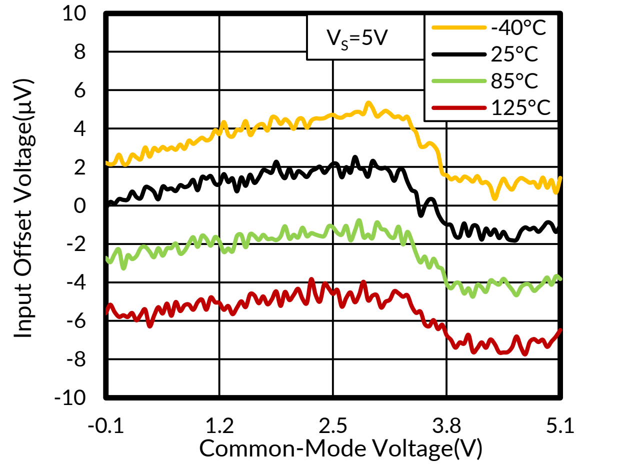


Figure 2. Input Offset Voltage vs Common-Mode Voltage

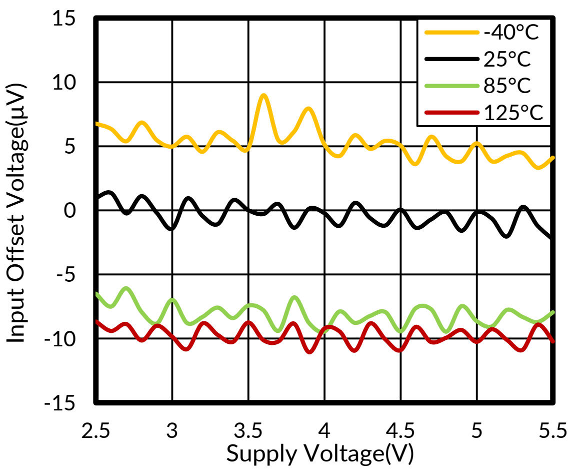


Figure 3. Input Offset Voltage vs Supply Voltage

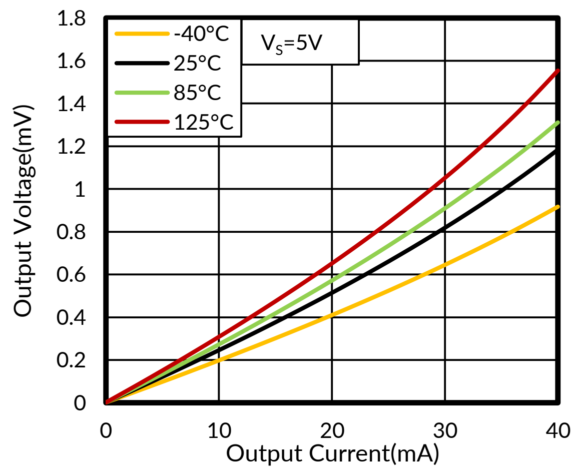


Figure 4. Output Swing from Positive Rail vs Output Current (Sourcing)

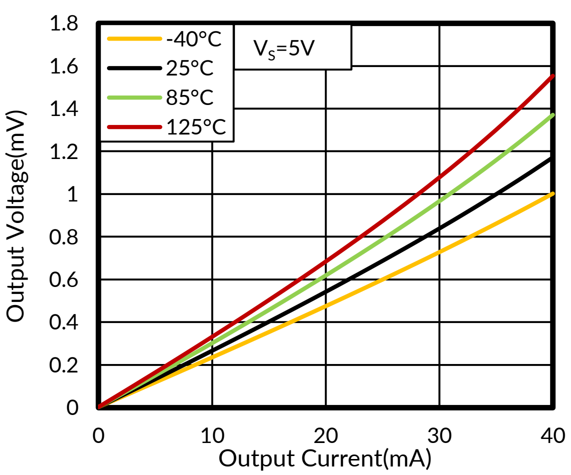


Figure 5. Output Swing from Negative Rail vs Output Current (Sinking)

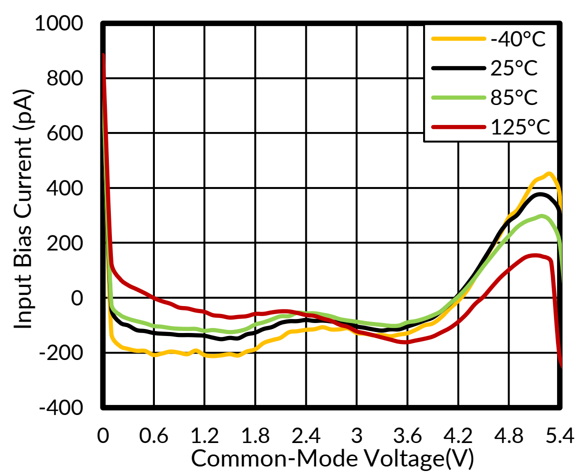


Figure 6. Input Bias Current vs Common-Mode Voltage

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.

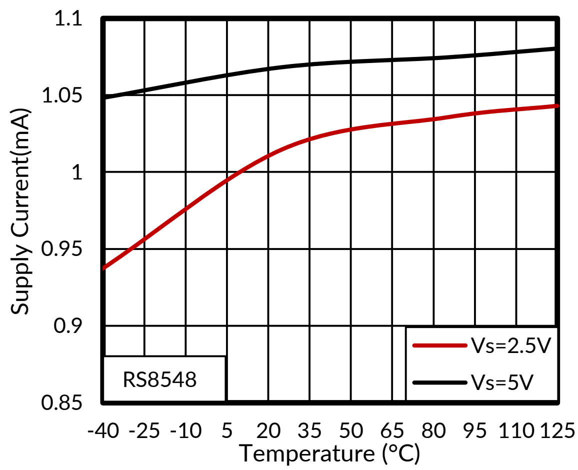


Figure 7. Supply Current vs Temperature

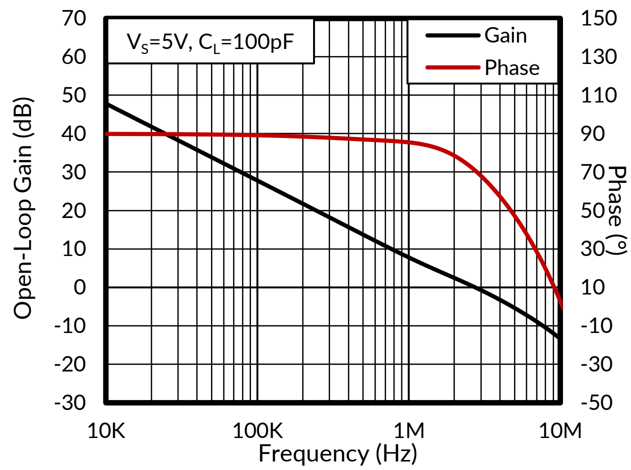


Figure 8. Open-Loop Gain and Phase vs Frequency

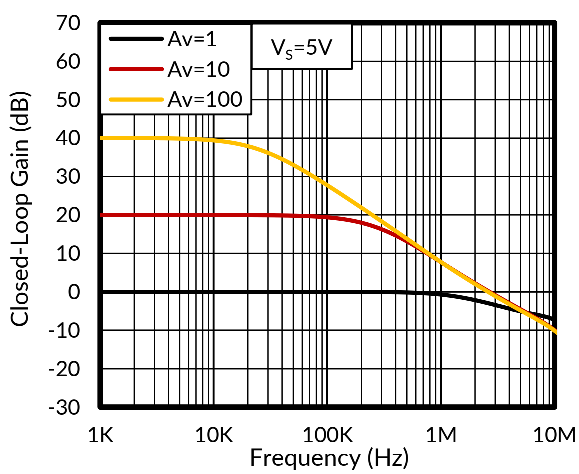


Figure 9. Closed-Loop Gain vs Frequency

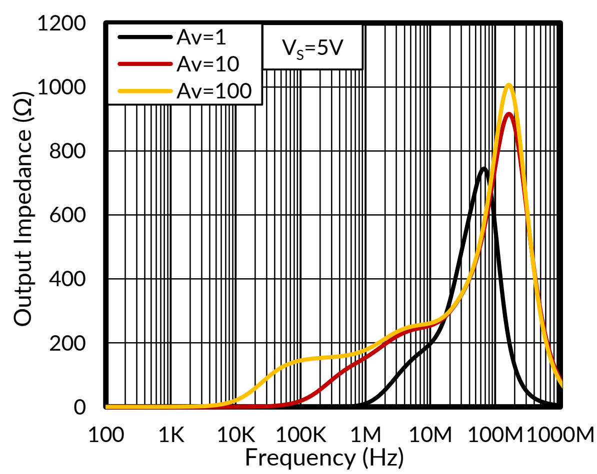


Figure 10. Output Impedance vs Frequency

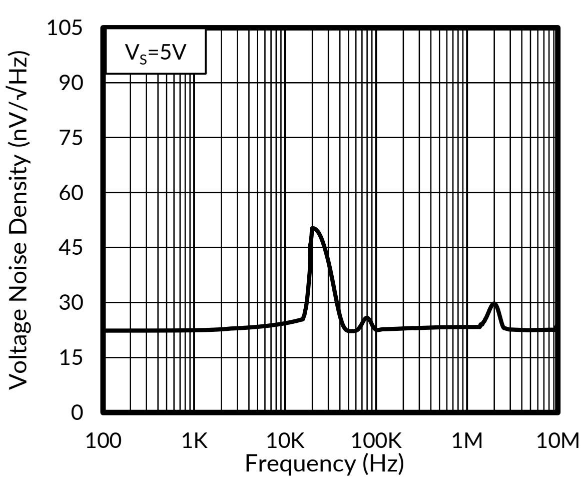


Figure 11. Voltage Noise Density

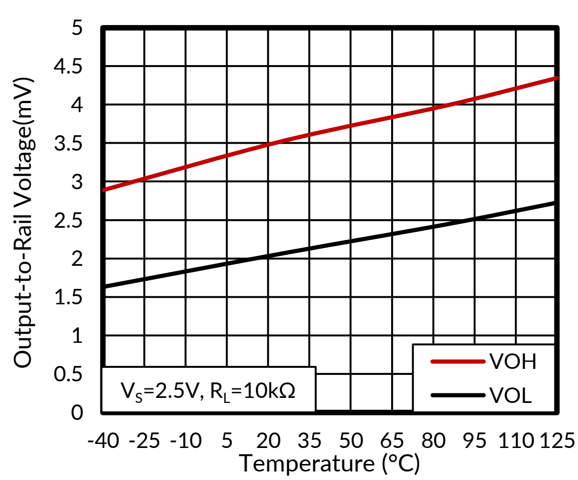


Figure 12. Output-to-Rail Voltage vs Temperature

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.

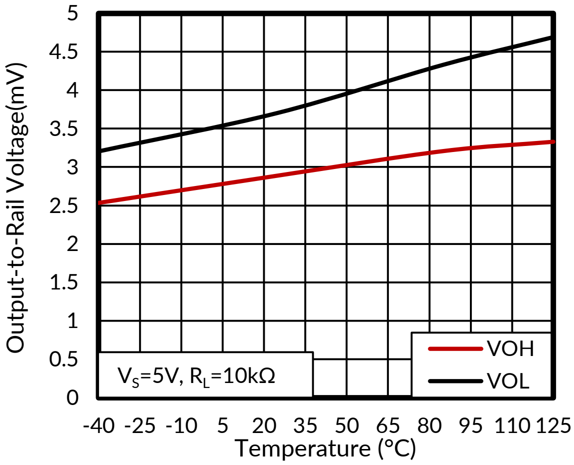


Figure 13. Output-to-Rail Voltage vs Temperature

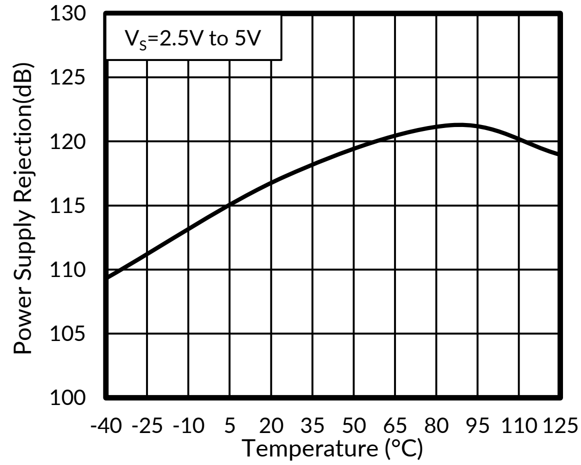


Figure 14. Power Supply Rejection vs Temperature

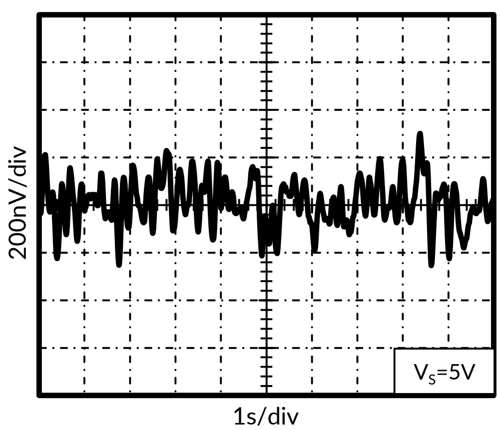


Figure 15. 0.1 Hz to 10 Hz Noise

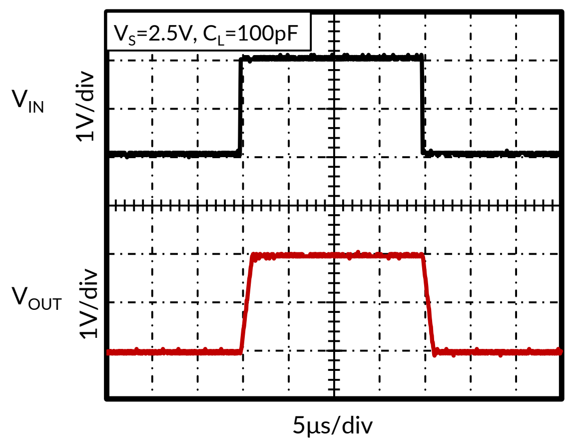


Figure 16. Large Signal Transient Response

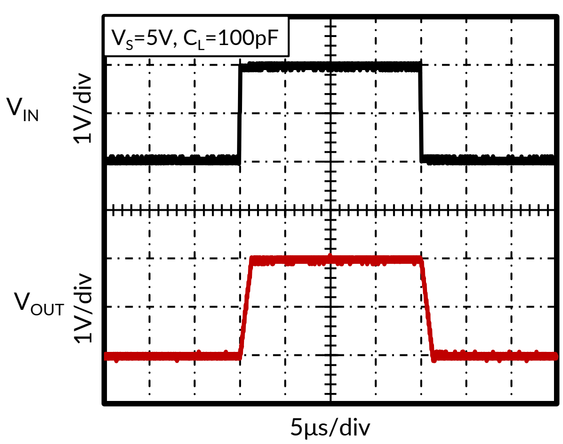


Figure 17. Large Signal Transient Response

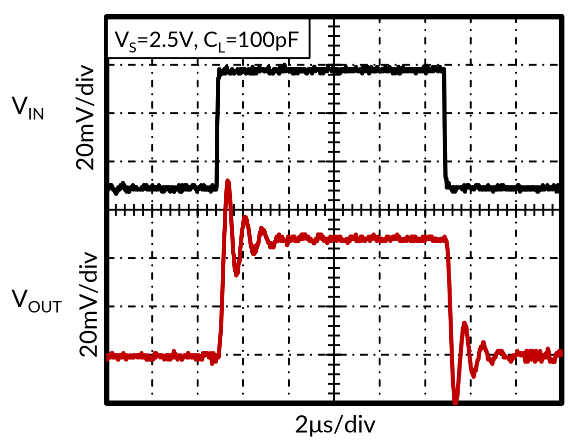


Figure 18. Small Signal Transient Response

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.

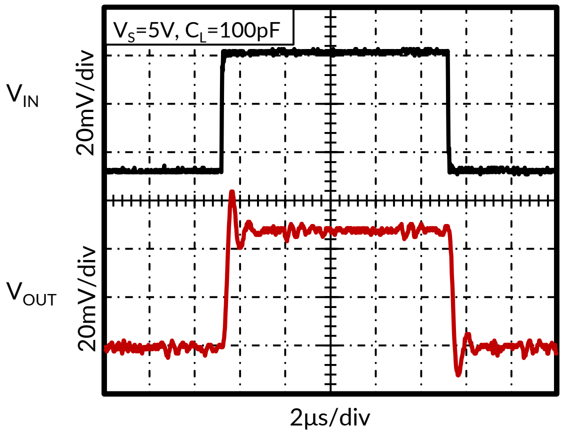


Figure 19. Small Signal Transient Response

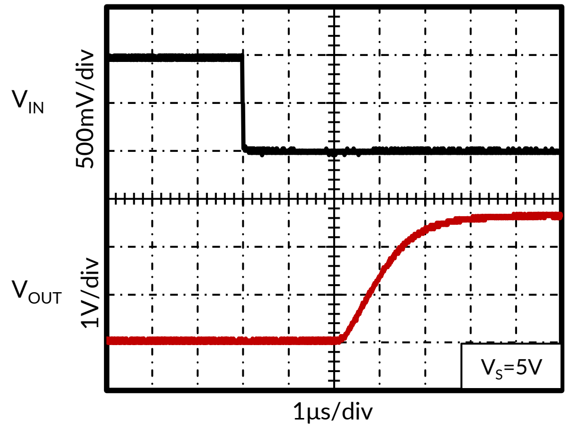


Figure 20. Positive Overvoltage Recovery

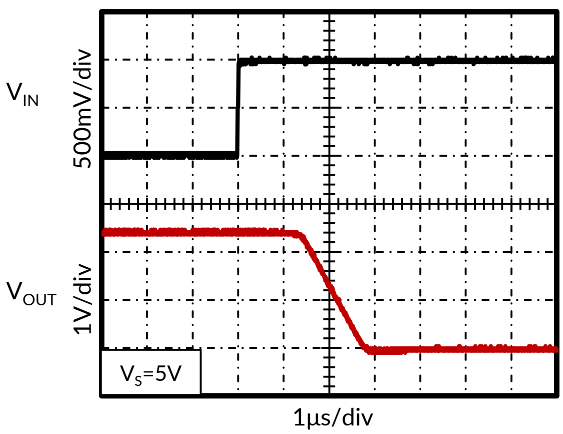


Figure 21. Negative Overvoltage Recovery

8 FUNCTIONAL DESCRIPTION

The RS8547/RS8548 are single-supply, ultrahigh precision rail-to-rail input and output operational amplifiers. The typical offset voltage of 1 μV allows these amplifiers to be easily configured for high gains without risk of excessive output voltage errors. The extremely small temperature drift of 0.1 μV/°C ensures a minimum offset voltage error over their entire temperature range of −40°C to +125°C, making these amplifiers ideal for a variety of sensitive measurement applications in harsh operating environments.

The RS8547/RS8548 achieve a high degree of precision through a patented combination of auto-zeroing and chopping. This unique topology allows the RS8547/RS8548 to maintain their low offset voltage over a wide temperature range and over their operating lifetime. The RS8547/RS8548 also optimize the noise and bandwidth over previous generations of auto-zero amplifiers, offering the lowest voltage noise of any auto-zero amplifier by more than 50%.

Previous designs used either auto-zeroing or chopping to add precision to the specifications of an amplifier. Auto-zeroing results in low noise energy at the auto-zeroing frequency, at the expense of higher low frequency noise due to aliasing of wideband noise into the auto-zeroed frequency band. Chopping results in lower low frequency noise at the expense of larger noise energy at the chopping frequency. The RS8547/RS8548 family uses both auto-zeroing and chopping in a patented ping-pong arrangement to obtain lower low frequency noise together with lower energy at the chopping and auto-zeroing frequencies, maximizing the signal-to-noise ratio for the majority of applications without the need for additional filtering. The relatively high clock frequency of 22 kHz simplifies filter requirements for a wide, useful noise-free bandwidth.

The RS8547/RS8548 have low noise over a relatively wide bandwidth (0.1 Hz to 10 kHz) and can be used where the highest dc precision is required. In systems with signal bandwidths of from 5 kHz to 10 kHz, the RS8547/RS8548 provide true 16-bit accuracy, making them the best choice for very high resolution systems.

8.1 1/f Noise

1/f noise, also known as pink noise, is a major contributor to errors in dc-coupled measurements. This 1/f noise error term can be in the range of several μV or more, and, when amplified with the closed-loop gain of the circuit, can show up as a large output offset. For example, when an amplifier with a 5 μV p-p 1/f noise is configured for a gain of 1000, its output has 5 mV of error due to the 1/f noise. However, the RS8547/RS8548 eliminate 1/f noise internally, thereby greatly reducing output errors.

The internal elimination of 1/f noise is accomplished as follows. 1/f noise appears as a slowly varying offset to the RS8547/RS8548 inputs. Auto-zeroing corrects any dc or low frequency offset. Therefore, the 1/f noise component is essentially removed, leaving the RS8547/RS8548 free of 1/f noise.

One advantage that the RS8547/RS8548 bring to system applications over competitive auto-zero amplifiers is their very low noise. The comparison shown in Figure 22 indicates an input-referred noise density of 25 nV/$\sqrt{\text{Hz}}$ at 1 kHz for the RS8547, which is much better than the Competitor A and Competitor B. The noise is flat from dc to 1.5 kHz, slowly increasing up to 20 kHz. The lower noise at low frequency is desirable where auto-zero amplifiers are widely used.

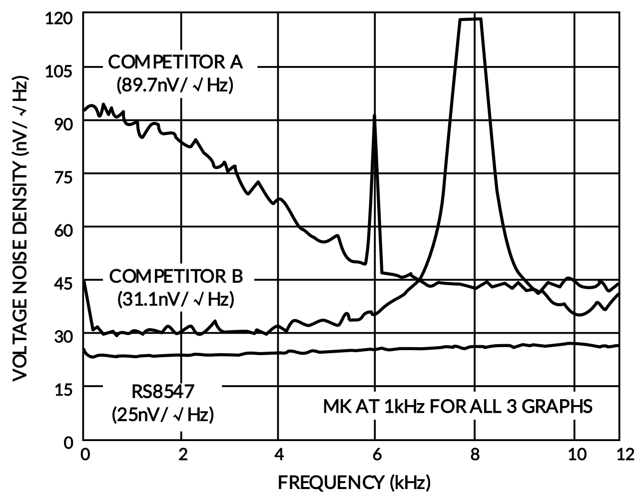


Figure 22. Noise Spectral Density of RS8547 vs Competition

8.2 Peak-To-Peak Noise

Because of the ping-pong action between auto-zeroing and chopping, the peak-to-peak noise of the RS8547/RS8548 is much lower than the competition. Figure 23 and Figure 24 show this comparison.

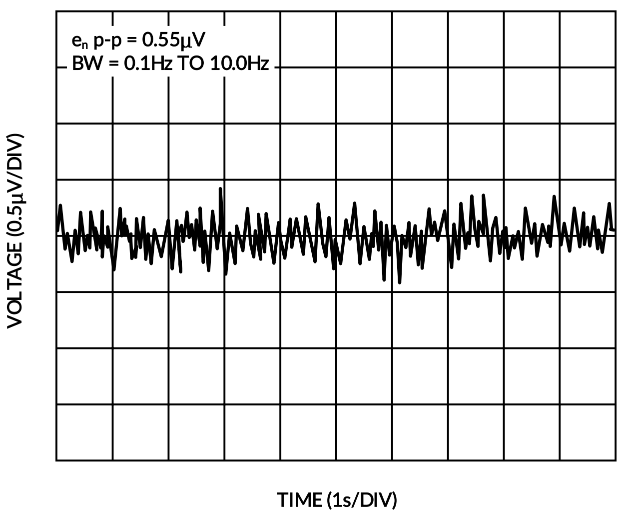


Figure 23. RS8547 Peak-to-Peak Noise

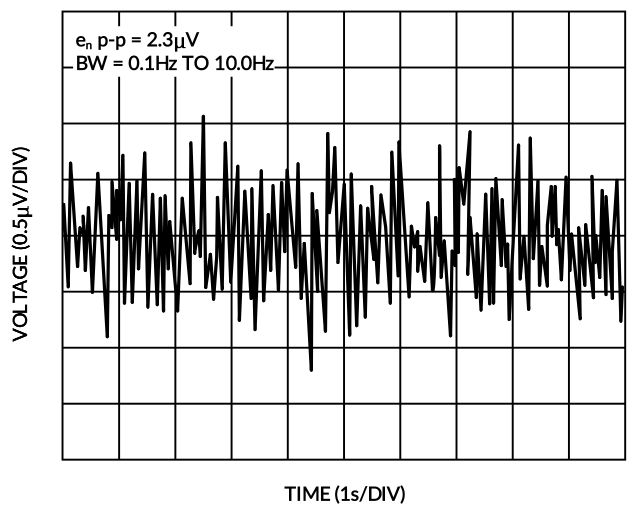


Figure 24. Competitor A Peak-to-Peak Noise

8.3 Noise Behavior with First-Order, Low-Pass Filter

The RS8547 was simulated as a low-pass filter (see Figure 26) and then configured as shown in Figure 25. The behavior of the RS8547 matches the simulated data. It was verified that noise is rolled off by first-order filtering. Figure 26 and Figure 27 show the difference between the simulated and actual transfer functions of the circuit shown in Figure 25.

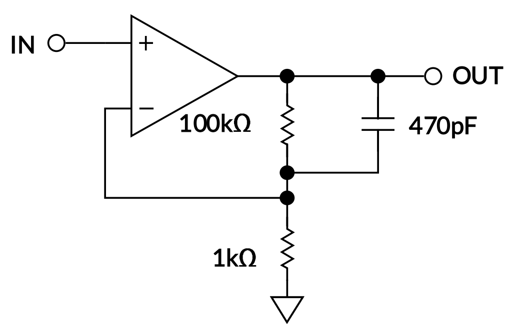


Figure 25. First-Order Low-Pass Filter Test Circuit, ×101 Gain and 3 kHz Corner Frequency

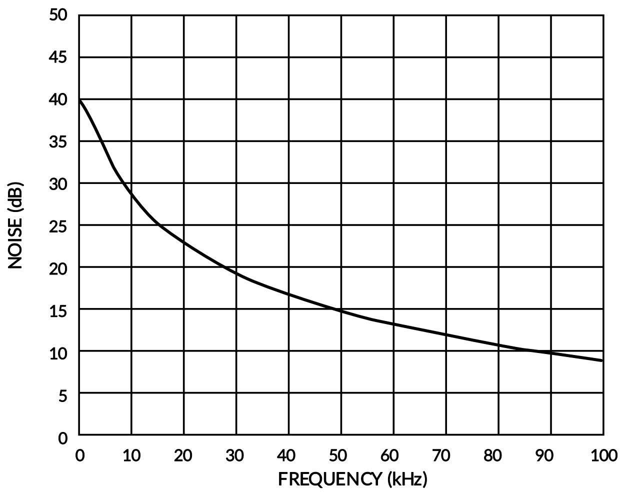


Figure 26. Simulation Transfer Function of the Test Circuit in Figure 25

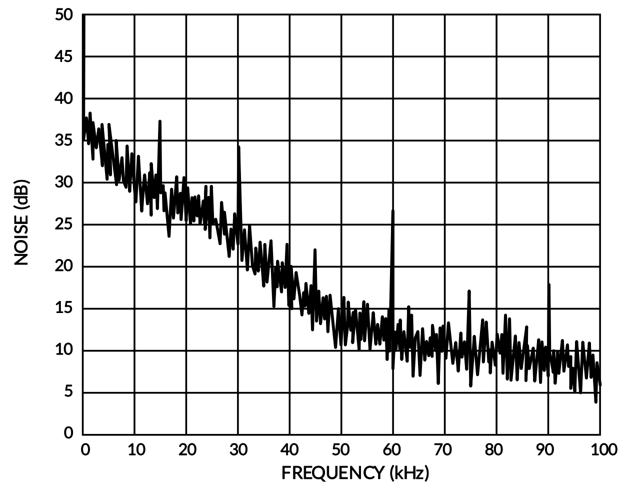


Figure 27. Actual Transfer Function of the Test Circuit in Figure 25

The measured noise spectrum of the test circuit charted in Figure 27 shows that noise between 5 kHz and 45 kHz is successfully rolled off by the first-order filter.

8.4 Total Integrated Input-Referred Noise for First-Order Filter

For a first-order filter, the total integrated noise from the RS8547 is lower than the noise of Competitor A.

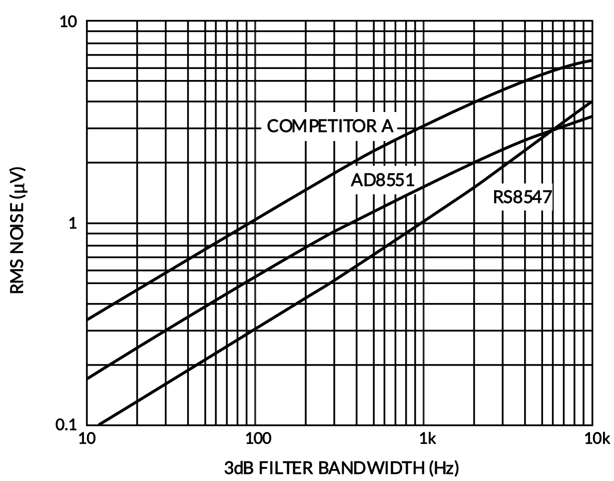


Figure 28. RMS Noise vs 3 dB Filter Bandwidth in Hz

8.5 Input Overvoltage Protection

Although the RS8547/RS8548 are rail-to-rail input amplifiers, care should be taken to ensure that the potential difference between the inputs does not exceed the supply voltage. Under normal negative feedback operating conditions, the amplifier corrects its output to ensure that the two inputs are at the same voltage. However, if either input exceeds either supply rail by more than 0.3 V, large currents begin to flow through the ESD protection diodes in the amplifier.

These diodes are connected between the inputs and each supply rail to protect the input transistors against an electrostatic discharge event, and they are normally reverse-biased. However, if the input voltage exceeds the supply voltage, these ESD diodes can become forward-biased. Without current limiting, excessive amounts of current could flow through these diodes, causing permanent damage to the device. If inputs are subject to overvoltage, appropriate series resistors should be inserted to limit the diode current to less than 10 mA maximum.

8.6 Output Phase Reversal

Output phase reversal occurs in some amplifiers when the input common-mode voltage range is exceeded. As common-mode voltage is moved outside the common-mode range, the outputs of these amplifiers can suddenly jump in the opposite direction to the supply rail. This is the result of the differential input pair shutting down, causing a radical shifting of internal voltages that results in the erratic output behavior.

The RS8547/RS8548 amplifiers have been carefully designed to prevent any output phase reversal, provided that both inputs are maintained within the supply voltages. If one or both inputs could exceed either supply voltage, a resistor should be placed in series with the input to limit the current to less than 10 mA. This ensures that the output does not reverse its phase.

8.7 Overload Recovery Time

Many auto-zero amplifiers are plagued by a long overload recovery time, often in ms, due to the complicated settling behavior of the internal nulling loops after saturation of the outputs. The RS8547/RS8548 have been designed so that internal settling occurs within two clock cycles after output saturation occurs. This results in a much shorter recovery time, less than 4 µs, when compared to other auto-zero amplifiers. The wide bandwidth of the RS8547/RS8548 enhances performance when the parts are used to drive loads that inject transients into the outputs. This is a common situation when an amplifier is used to drive the input of switched capacitor ADCs.

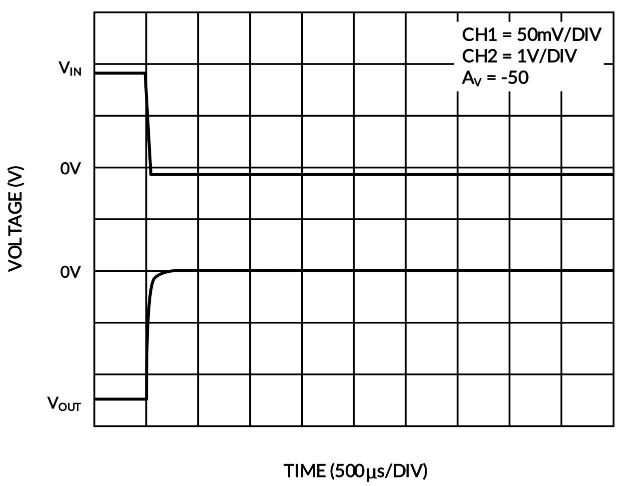


Figure 29. Positive Input Overload Recovery for the RS8547

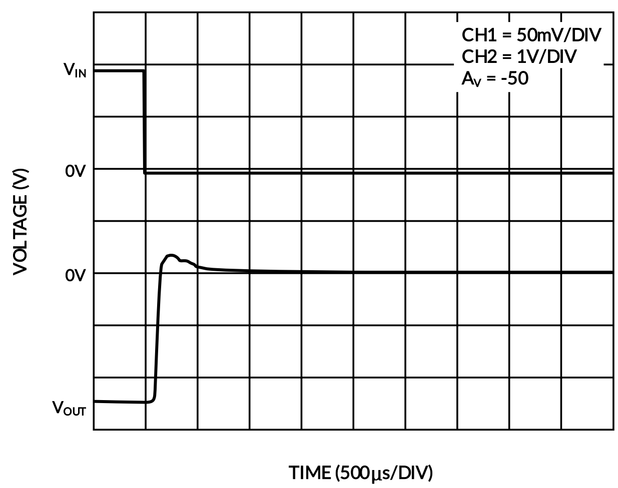


Figure 30. Positive Input Overload Recovery for Competitor A

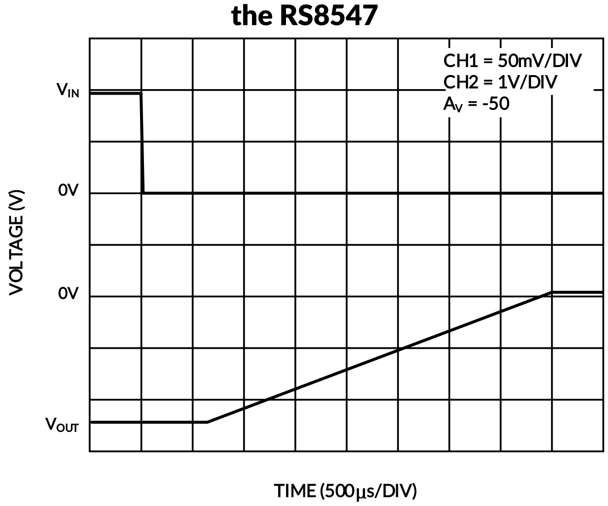


Figure 31. Positive Input Overload Recovery for Competitor B

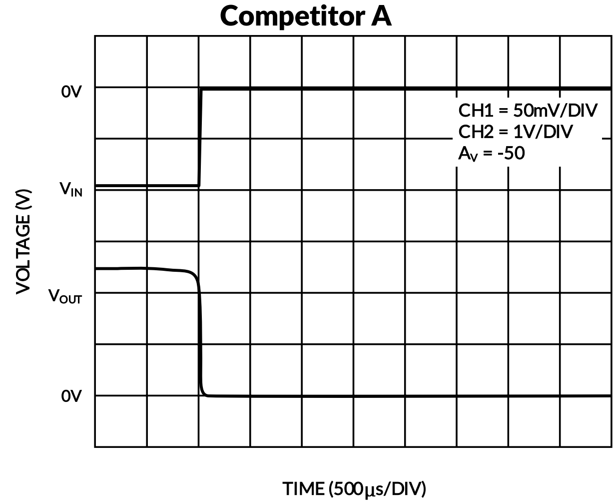


Figure 32. Negative Input Overload Recovery for the RS8547

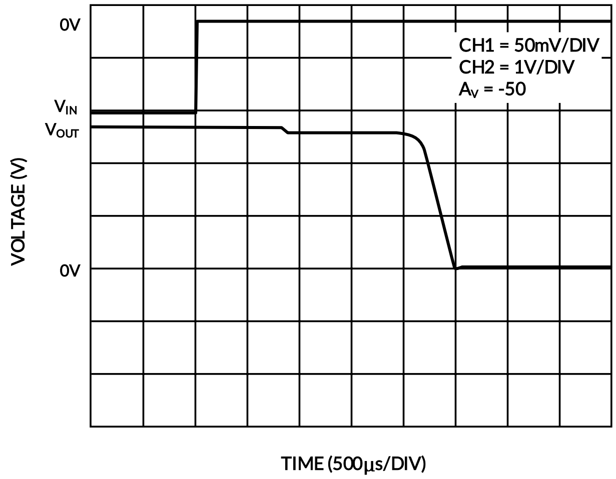


Figure 33. Negative Input Overload Recovery for Competitor A

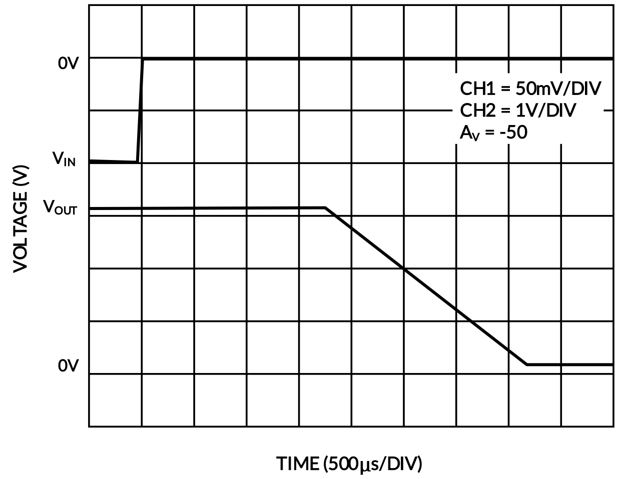


Figure 34. Negative Input Overload Recovery for Competitor B

The results shown in Figure 29 to Figure 34 are summarized in Table 1.

Table 1. Overload Recovery Time

Model	Positive Overload Recovery (µs)	Negative Overload Recovery (µs)
RS8547	3	3
Competitor A	650	25000
Competitor B	40000	35000

8.8 Infrared Sensors

Infrared (IR) sensors, particularly thermopiles, are increasingly being used in temperature measurement for applications as wide ranging as automotive climate control, human ear thermometers, home insulation analysis, and automotive repair diagnostics. The relatively small output signal of the sensor demands high gain with very low offset voltage and drift to avoid dc errors.

If interstage ac coupling is used, as in Figure 35, low offset and drift prevent the output of the input amplifier from drifting close to saturation. The low input bias currents generate minimal errors from the output impedance of the sensor. As with pressure sensors, the very low amplifier drift with time and temperature eliminate additional errors once the temperature measurement is calibrated. The low 1/f noise improves SNR for dc measurements taken over periods often exceeding one-fifth of a second.

Figure 35 shows a circuit that can amplify ac signals from 100 µV to 300 µV up to the 1 V to 3 V levels, with a gain of 10,000 for accurate analog-to-digital conversion.

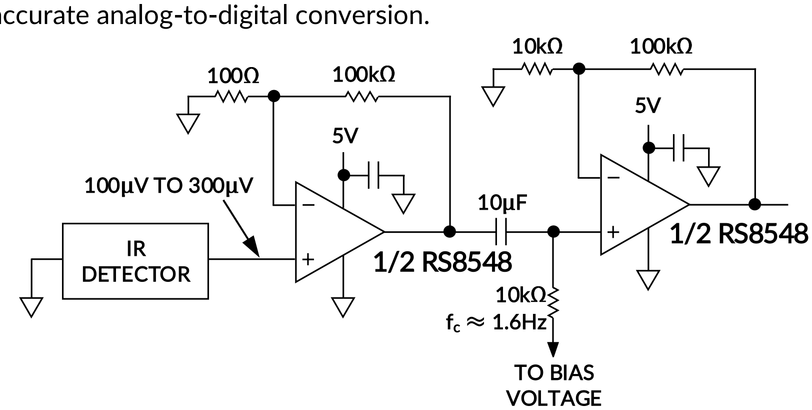


Figure 35. RS8548 Used as Preamplifier for Thermopile

8.9 Precision Current Shunt Sensor

A precision current shunt sensor benefits from the unique attributes of auto-zero amplifiers when used in a differencing configuration, as shown in Figure 36. Current shunt sensors are used in precision current sources for feedback control systems. They are also used in a variety of other applications, including battery fuel gauging, laser diode power measurement and control, torque feedback controls in electric power steering, and precision power metering.

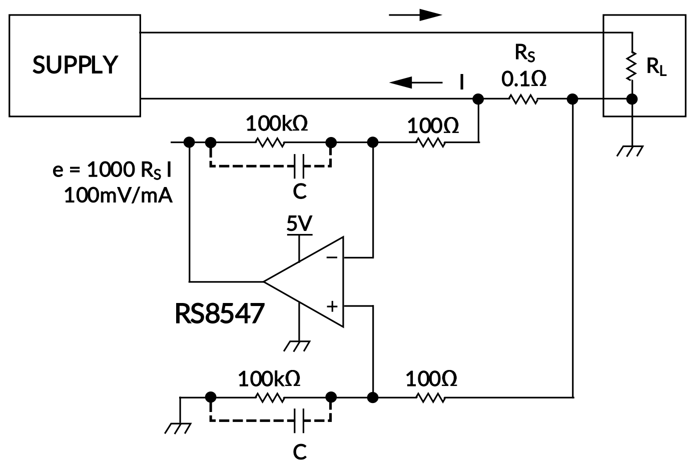


Figure 36. Low-Side Current Sensing

In such applications, it is desirable to use a shunt with very low resistance to minimize the series voltage drop; this minimizes wasted power and allows the measurement of high currents while saving power. A typical shunt might be 0.1 Ω. At measured current values of 1 A, the output signal of the shunt is hundreds of millivolts, or even volts, and amplifier error sources are not critical. However, at low measured current values in the 1 mA range, the 100 µV output voltage of the shunt demands a very low offset voltage and drift to maintain absolute accuracy. Low input bias currents are also needed, so that injected bias current does not become a significant percentage of the measured current. High open-loop gain, CMRR, and PSRR help to maintain the overall circuit accuracy. As long as the rate of change of the current is not too fast, an auto-zero amplifier can be used with excellent results.

8.10 Output Amplifier for High Precision DACs

The RS8547/RS8548 are used as output amplifiers for a 16-bit high precision DAC in a unipolar configuration. In this case, the selected op amp needs to have a very low offset voltage (the DAC LSB is 38 µV when operated with a 2.5 V reference) to eliminate the need for output offset trims. The input bias current (typically a few tens of picoamperes) must also be very low because it generates an additional zero code error when multiplied by the DAC output impedance (approximately 6 kΩ).

Rail-to-rail input and output provide full-scale output with very little error. The output impedance of the DAC is constant and code independent, but the high input impedance of the RS8547/RS8548 minimizes gain errors. The wide bandwidth of the amplifiers also serves well in this case. The amplifiers, with settling time of 1 µs, add another time constant to the system, increasing the settling time of the output. The settling time of the AD5541 is 1 µs. The combined settling time is approximately 1.4 µs, as can be derived from the following equation:

$$t_s(TOTAL) = \sqrt{(t_s DAC)^2 + (t_s RS8547)^2} \quad (1)$$

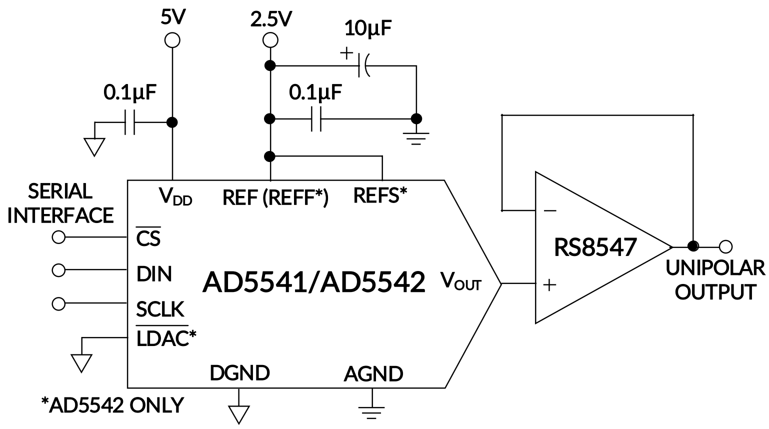
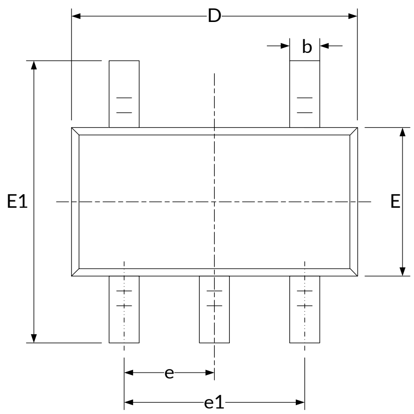
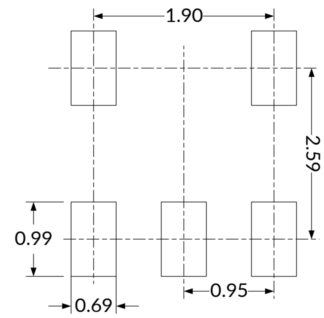


Figure 37. RS8547 Used as an Output Amplifier

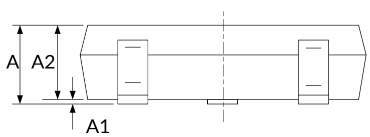
9 PACKAGE OUTLINE DIMENSIONS

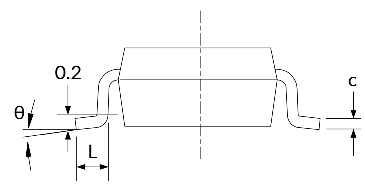
SOT23-5 (3)





RECOMMENDED LAND PATTERN (Unit: mm)

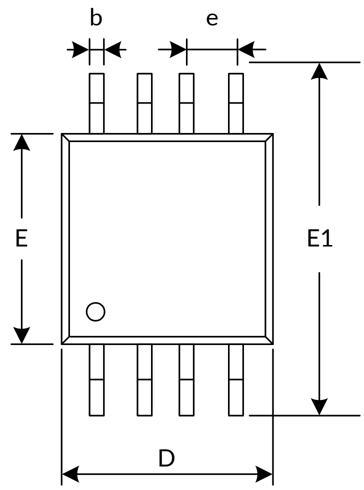


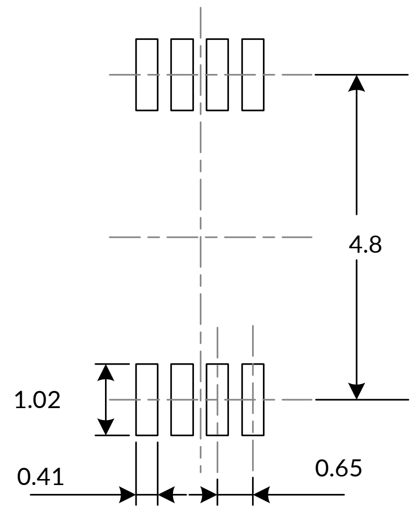


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A (1)	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D (1)	2.820	3.020	0.111	0.119
E (1)	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)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

MSOP8 [3]





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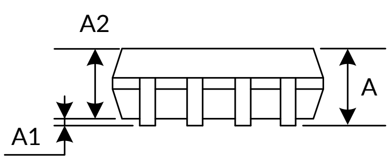
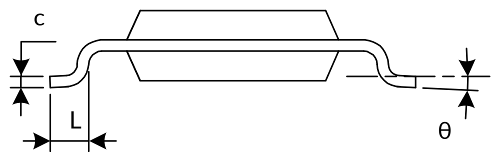
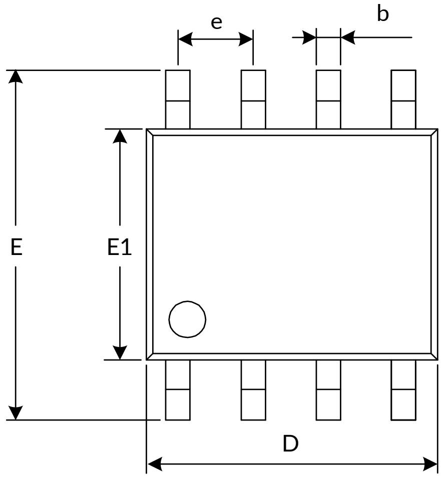


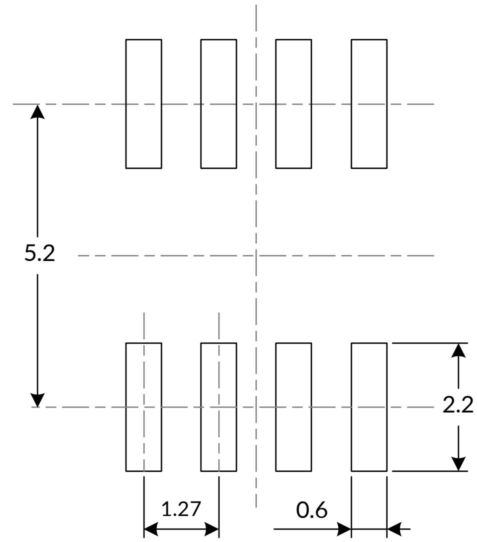


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A [1]	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D [1]	2.900	3.100	0.114	0.122
e	0.650(BSC) [2]		0.026(BSC) [2]	
E [1]	2.900	3.100	0.114	0.122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

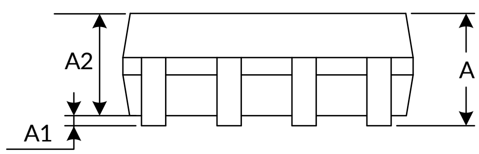
NOTE:
1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

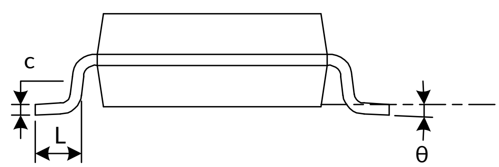
SOP8 (3)





RECOMMENDED LAND PATTERN (Unit: mm)



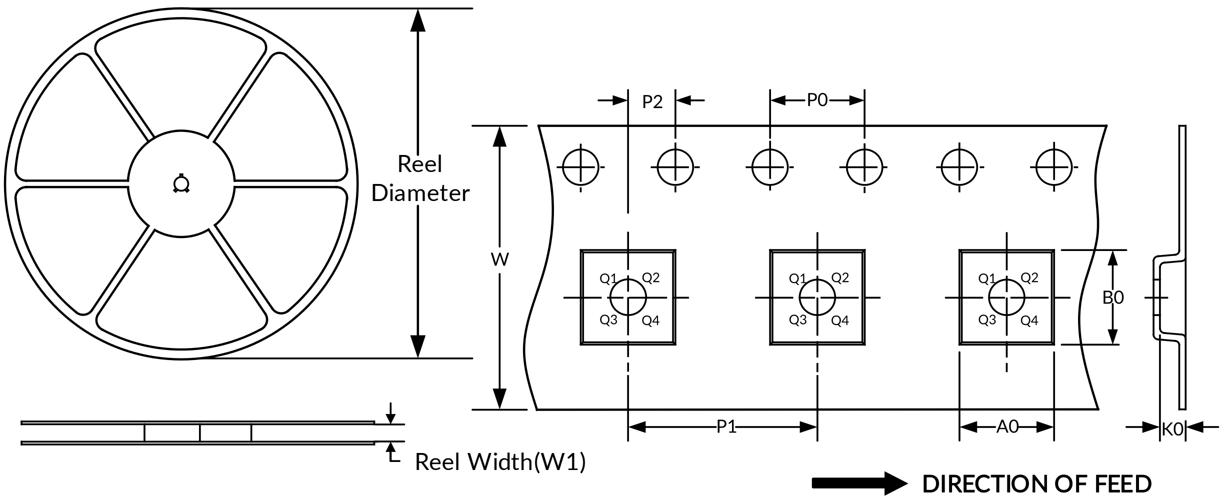


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A (1)	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D (1)	4.800	5.000	0.189	0.197
e	1.270(BSC) (2)		0.050(BSC) (2)	
E	5.800	6.200	0.228	0.244
E1 (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.

10 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
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.

IMPORTANT NOTICE AND DISCLAIMER