350MHz CMOS Rail-to-Rail Output Opamps

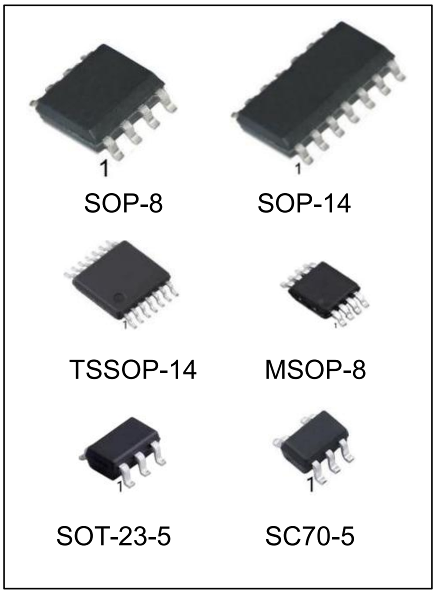
Features

- Single-Supply Operation from +2.5V ~ +5.5V
- Rail-to-Rail Output
- -3dB Bandwidth(G=+1): 350MHz (Typ)
- Low Input Bias Current: 1pA (Typ)
- Quiescent Current: 4.2mA/Amplifier (Typ)
- Operating Temperature: -40°C ~ +85°C
- Small Package:

AD8091 Available in SOT23-5、SC70-5、SOP-8 and MSOP-8 Packages

AD8092 Available in SOP-8 and MSOP-8 Packages

AD8094 Available in SOP-14 and TSSOP-14 Packages



Ordering Information

DEVICE	Package Type	MARKING	Packing	Packing Qty
AD8091M5/TR	SOT-23-5	8091	REEL	3000pcs/reel
AD8091M7/TR	SC70-5(SOT-353)	8091	REEL	3000pcs/reel
AD8091MM/TR	MSOP-8	8091	REEL	3000pcs/reel
AD8091M/TR	SOP-8	AD8091	REEL	2500pcs/reel
AD8092MM/TR	MSOP-8	8092	REEL	3000pcs/reel
AD8092M/TR	SOP-8	AD8092	REEL	2500pcs/reel
AD8094M/TR	SOP-14	AD8094	REEL	2500pcs/reel
AD8094MT/TR	TSSOP-14	AD8094	REEL	2500pcs/reel

Note：SOT-353 equal to SC70-5 Package Type.

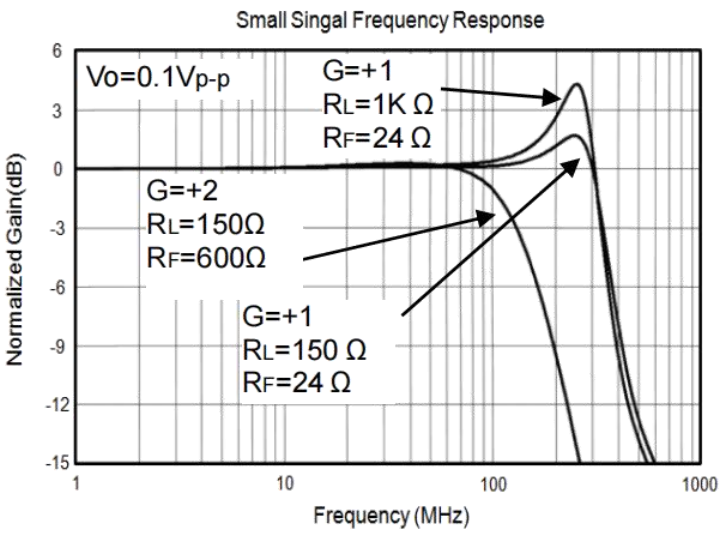
General Description

The AD8091(single), AD8092(dual), AD8094(quad) are rail-to-rail output voltage feedback amplifiers offering ease of use and low cost. They have bandwidth and slew rate typically found in current feedback amplifiers. All have a wide input common-mode voltage range and output voltage swing, making them easy to use on single supplies as low as 2.5V. Despite being low cost, the AD809X series provide excellent overall performance. They offer wide bandwidth to 350MHz (G = +1) along with 0.1dB flatness out to 58MHz (G = +2) and offer a typical low power of 4.2mA/amplifier.

The AD809X series is low distortion and fast settling make it ideal for buffering high speed A/D or D/A converters. All are specified over the extended -40℃ to +85℃ temperature range.

Applications

- Imaging
- Photodiode Preamp
- DVD/CD
- Filters
- Professional Video and Cameras
- Hand Sets
- Base Station
- A-to-D Driver



Pin Configuration

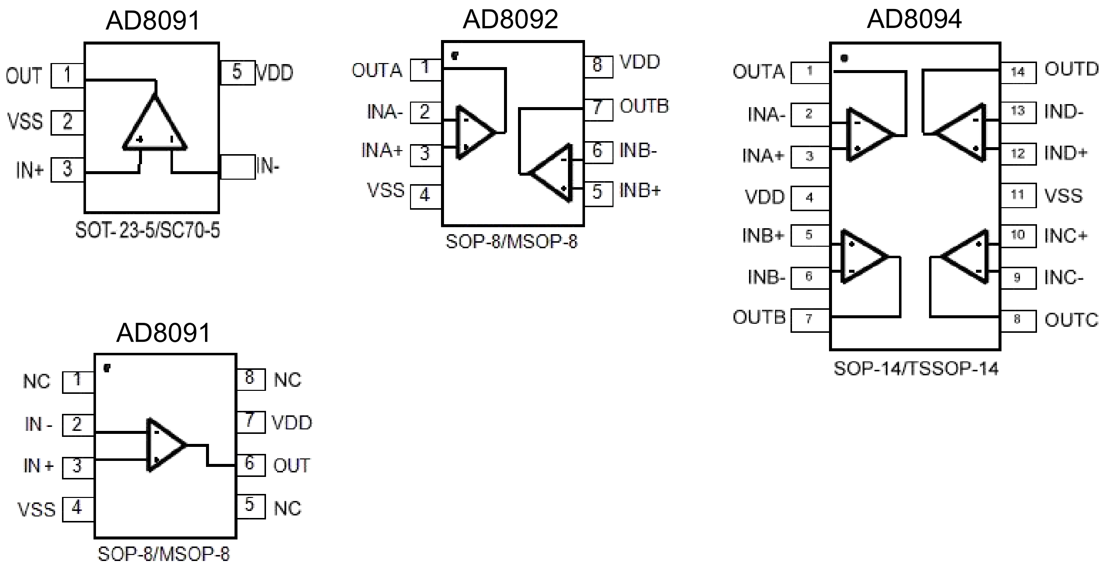


Figure 1. Pin Assignment Diagram

Absolute Maximum Ratings

Condition	Min	Max
Power Supply Voltage (V_{DD} to Vss)	-0.5V	+7.5V
Analog Input Voltage (IN+ or IN-)	Vss-0.5V	V_{DD}+0.5V
PDB Input Voltage	Vss-0.5V	+7V
Operating Temperature Range	-40°C	+85°C
Junction Temperature	+160°C	
Storage Temperature Range	-55°C	+150°C
Lead Temperature (soldering, 10sec)	+260°C	
Package Thermal Resistance (T_A=+25℃)		
SOP-8, θ_{JA}	125°C/W	
MSOP-8, θ_{JA}	216°C/W	
SOT-23-5, θ_{JA}	190°C/W	
SC70-5, θ_{JA}	333°C/W	
ESD Susceptibility		
HBM	6KV	
MM	400V	

Note: Stress greater than those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions outside those indicated in the operational sections of this specification are not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

Electrical Performance Characteristics

(G= +2, R_F=600Ω, R_G=600Ω, and R_L=150Ω connected to V_S/2, unless otherwise noted. Typical values are at T_A =+25°C.)

PARAMETER	CONDITIONS	AD8091/AD8092/AD8094					
		TYP	MIN/MAX OVER TEMPERATURE				
		+25℃	+25℃	0℃ to70℃	-40℃to 85℃	UNITS	MIN/ MAX
DYNAMIC PERFORMANCE							
-3dB Small Signal Bandwidth	G=+1, Vo=0.1V_{p-p},R_F=24Ω, R_L = 150Ω	335				MHz	TYP
	G = +1, Vo = 0.1V $_{p-p}$, R_F = 24Ω, R_L = 1kΩ	330				MHz	TYP
	G = +2, Vo = 0.1V $_{p-p}$, R_L = 50Ω	79				MHz	TYP
	G = +2, Vo = 0.1V $_{p-p}$, R_L = 150Ω	130				MHz	TYP
	G = +2, Vo = 0.1V $_{p-p}$, R_L = 1kΩ	165				MHz	TYP
	G = +2, Vo = 0.1V $_{p-p}$, R_L = 10kΩ	172				MHz	TYP
Gain-Bandwidth Product	G = +10, R_L = 150Ω	180				MHz	TYP
	G = +10, R_L = 1kΩ	195				MHz	TYP
Bandwidth for 0.1dB Flatness	G = +2, Vo = 0.1V $_{p-p}$, R_L = 150Ω, RF =600Ω	71				MHz	TYP
Slew Rate	G = +1, 2V Output Step	119/-232				V/μs	TYP
	G = +2, 2V Output Step	135/-180				V/μs	TYP
	G = +2, 4V Output Step	142/-206				V/μs	TYP
Rise-and-Fall Time	G = +2, Vo = 0.2V_{p-p}, 10% to 90%	3.5				ns	TYP
	G = +2, Vo = 2V_{p-p}, 10% to 90%	8.5				ns	TYP
Settling Time to 0.1%	G = +2, 2V Output Step	35				ns	TYP
Overload Recovery Time	V_{IN} · G = +VS	14.5				ns	TYP
NOISE/DISTORTION PERFORMANCE							
Input Voltage Noise	f = 1MHz	4.3				nV/ Hz	TYP
Differential Gain Error (NTSC)	G = +2, R_L = 150Ω	0.004				%	TYP
Differential Phase Error (NTSC)	G = +2, R_L = 150Ω	0.08				degree	TYP
DC PERFORMANCE							
Input Offset Voltage (V_{OS})		±2	±8	±8.5	±9	mV	MAX
Input Offset Voltage Drift		2				μV/℃	TYP
Input Bias Current (IB)		1				PA	TYP
Input offset Current (I_{OS})		2				PA	TYP
Open-Loop Gain (A_{OL})	V_O = 0.3V to 4.7V, R_L = 150Ω	80	75	74	74	dB	MIN
	V_O = 0.2V to 4.8V, R_L = 1kΩ	104	92	91	91	dB	MIN
INPUT CHARACTERISTICS							
Input Common-Mode Voltage Range (V_{CM})		-0.2 to +3.8				V	TYP
Common-Mode Rejection Ratio (CMRR)	V_{CM} = -0.1V to +3.5V	80	66	65	65	dB	MIN

Electrical Performance Characteristics

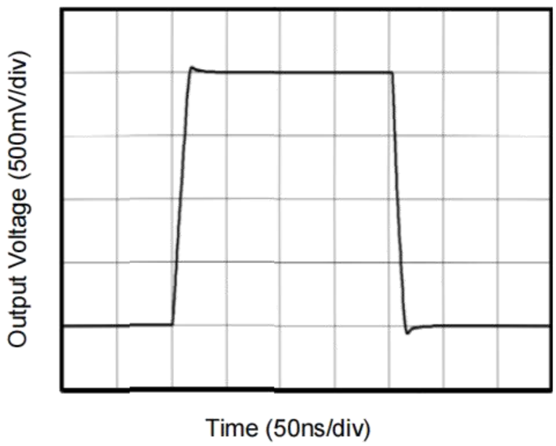
(G= +2, R_F=600Ω, R_G=600Ω, and R_L=150Ω connected to V_S/2, unless otherwise noted. Typical values are at T_A =+25°C.)

PARAMETER	CONDITIONS	AD8091/AD8092/AD8094					
		TYP	MIN/MAX OVER TEMPERATURE				
		+25℃	+25℃	0℃ to70℃	-40℃to 85℃	UNITS	MIN/ MAX
OUTPUT CHARACTERISTICS							
Output Voltage Swing from Rail	RL = 150Ω	0.12				V	TYP
	RL = 1kΩ	0.03				V	TYP
Output Current		120	100	98	93	mA	MIN
Closed-Loop Output Impedance	f < 100kHz	0.045				Ω	TYP
POWER SUPPLY							
Operating Voltage Range			2.5	2.7	2.7	V	MIN
			5.5	5.5	5.5	V	MAX
Quiescent Current (per amplifier)		4.2	5.3	5.6	5.7	mA	MAX
Power Supply Rejection Ratio (PSRR)	ΔVS = +2.7V to +5.5V, V_{CM} =(-VS) +0.5	80	67	67	65	dB	MIN

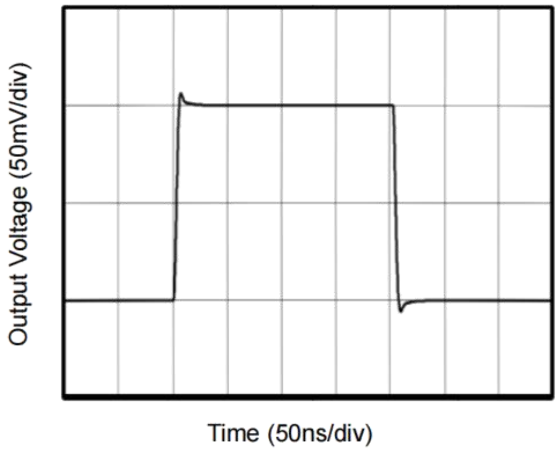
Typical Performance characteristics

(V_s=+5V,G= +2, R_F=600Ω,R_G=600Ω,and R_L=150Ω connected to Vs/2, unless otherwise noted. Typical values are at T_A =+25°C.)

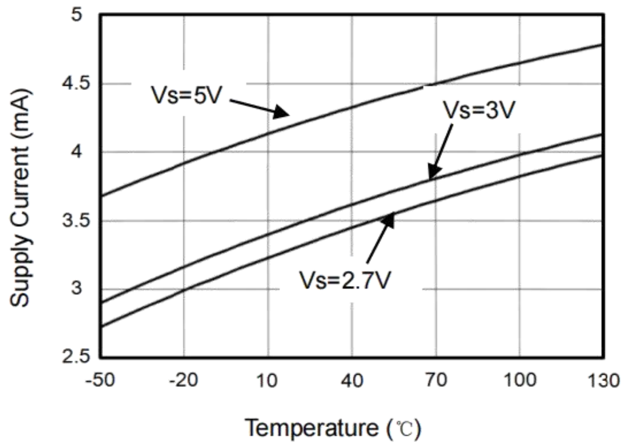
Non-Inverting Large-Signal Step Response



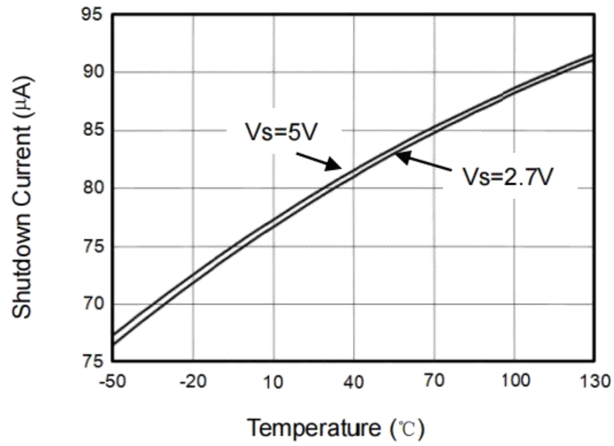
Non-Inverting Small-Signal Step Response



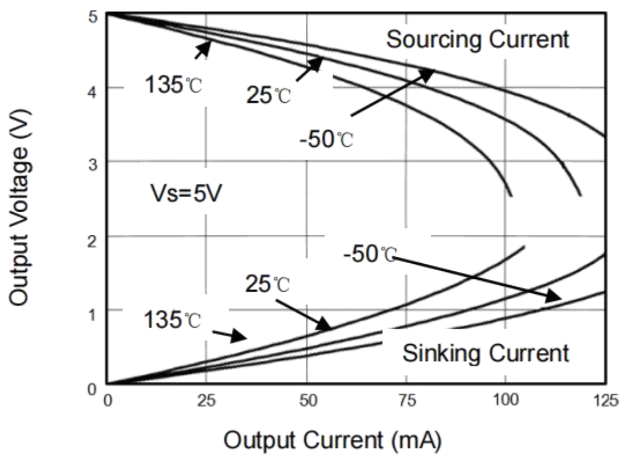
upply Current vs. Temperature



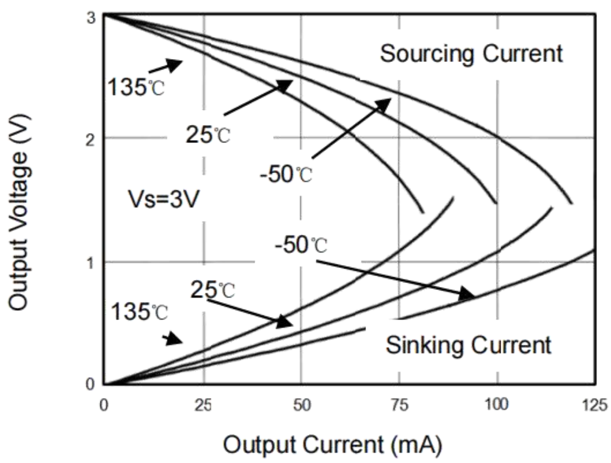
Sutdwn Current vs. Temperature



Outp t Voltage Swing vs. Output



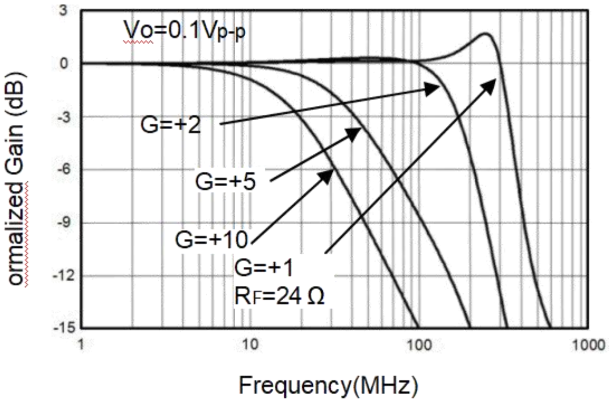
Current Outp t Voltage vs. Output Current



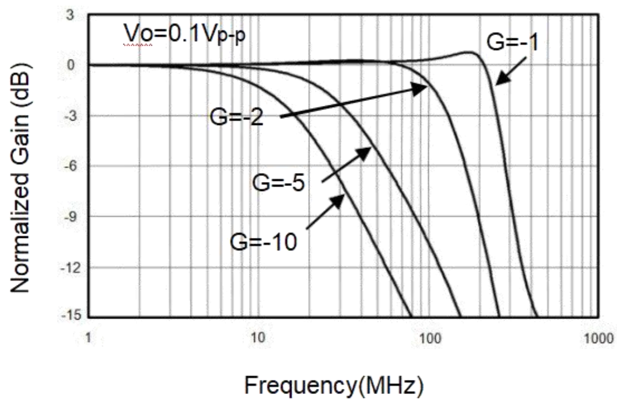
Typical Performance characteristics

(Vs=+5V,G= +2, R_F=600Ω,R_G=600Ω,and R_L=150Ω connected to Vs/2, unless otherwise noted. Typical values are at T_A =+25°C.)

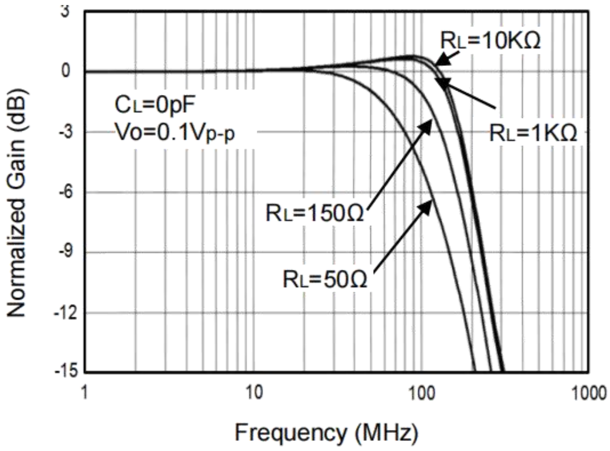
Non-Inverting Small Signal Frequency Response



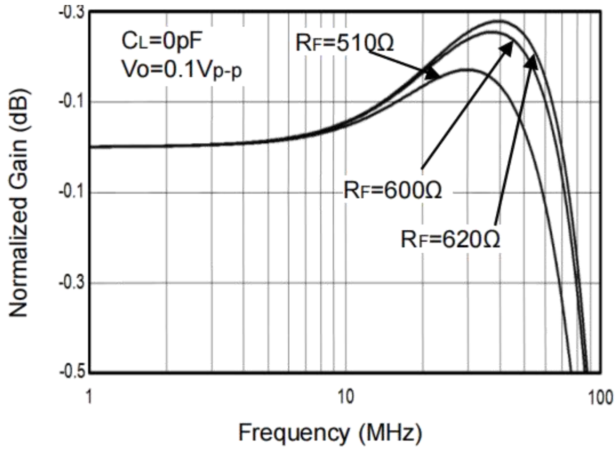
Inverting Small Signal Frequency Response



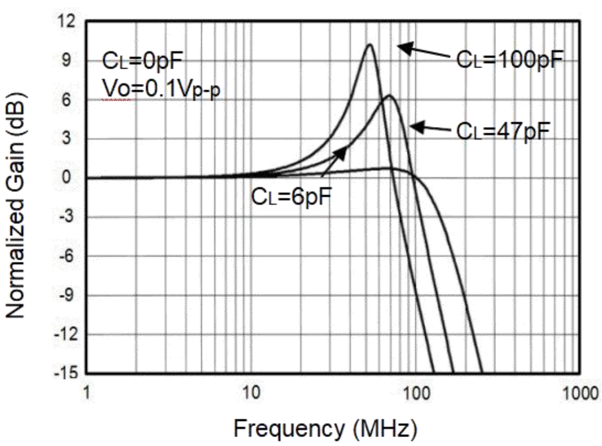
Frequency Response For Various R_L



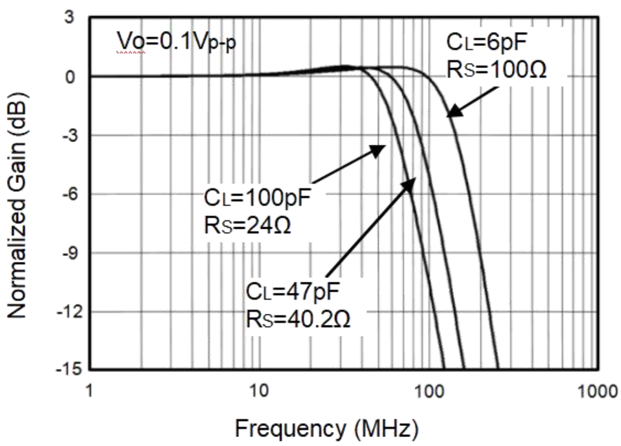
0.1dB Gain Flatness For Various RF



Frequency Response For Various C_L



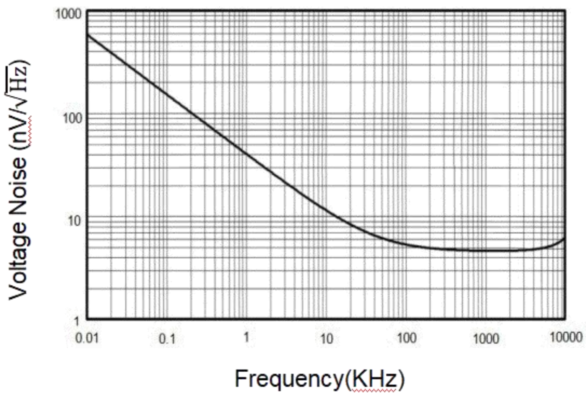
Frequency Response vs.Capacitive Load



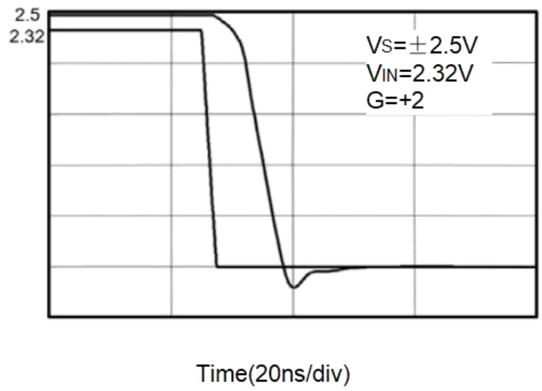
Typical Performance characteristics

(Vs=+5V,G= +2, R_F=600Ω,R_G=600Ω,and R_L=150Ω connected to Vs/2, unless otherwise noted. Typical values are at T_A =+25°C.)

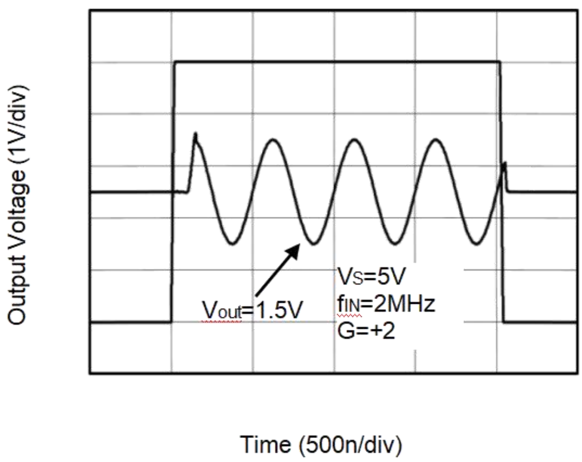
Input Voltage Noise Spectral Density vs. Frequency



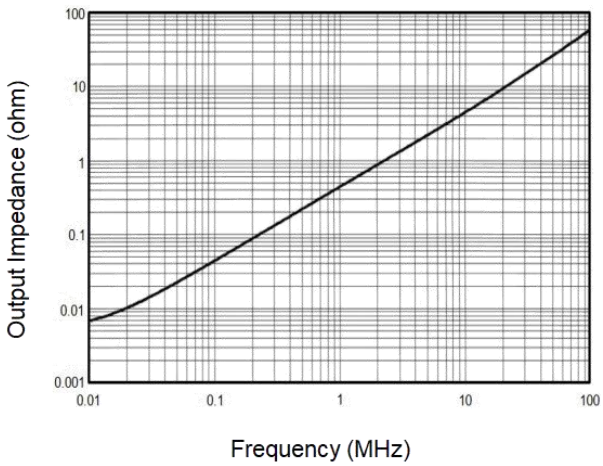
Overload Recovery Time



Large-Signal Disable/Enable Response



Closed-Loop Output Impedance vs Frequency



Application Note

Driving Capacitive Loads

AD809X series op amps are unity-gain stable and suitable for a wide range of general-purpose applications. The small footprints of the AD809X series packages save space on printed circuit boards and enable the design of smaller electronic products.

Power Supply Bypassing and Board Layout

AD809X series operates from a single 2.5V to 5.5V supply or dual ±1.25V to ±2.75V supplies. For best performance, a 0.1μF ceramic capacitor should be placed close to the V_{DD} pin in single supply operation. For dual supply operation, both V_{DD} and VSS supplies should be bypassed to ground with separate 0.1μF ceramic capacitors.

Low Supply Current

The low supply current (typical 4.2mA per channel) of AD809X series will help to maximize battery life. They are ideal for battery powered systems.

Operating Voltage

AD809X series operate under wide input supply voltage (2.5V to 5.5V). In addition, all temperature specifications apply from-40°C to +85°C. Most behavior remains unchanged throughout the full operating voltage range. These guarantees ensure operation throughout the single Li-Ion battery lifetime.

Rail-to-Rail Output

Rail-to-Rail output swing provides maximum possible dynamic range at the output. This is particularly important when operating in low supply voltages. The output voltage of AD809X series can typically swing to less than 30mV from supply rail in light resistive loads (>1kΩ), and 120mV of supply rail in moderate resistive loads (150Ω).

Capacitive Load Tolerance

The AD809X family is optimized for bandwidth and speed, not for driving capacitive loads. Output capacitance will create a pole in the amplifier's feedback path, leading to excessive peaking and potential oscillation. If dealing with load capacitance is a requirement of the application, the two strategies to consider are (1) using a small resistor in series with the amplifier's output and the load capacitance and (2) reducing the bandwidth of the amplifier's feedback loop by increasing the overall noise gain. Figure 2. shows a unity gain follower using the series resistor strategy. The resistor isolates the output from the capacitance and, more importantly, creates a zero in the feedback path that compensates for the pole created by the output capacitance.

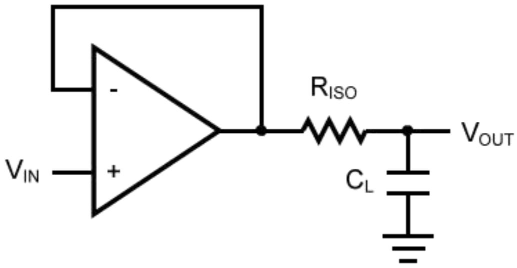


Figure 2. Indirectly Driving a Capacitive Load Using Isolation Resistor

The bigger the R_{ISO} resistor value, the more stable V_{OUT} will be. However, if there is a resistive load RL in parallel with the capacitive load, a voltage divider (proportional to R_{ISO}/R_L) is formed, this will result in a gain error.

The circuit in Figure 3 is an improvement to the one in Figure 2. R_F provides the DC accuracy by feed-forward the V_{IN} to R_L. C_F and R_{ISO} serve to counteract the loss of phase margin by feeding the high frequency component of the output signal back to the amplifier's inverting input, thereby preserving the phase margin in the overall feedback loop. Capacitive drive can be increased by increasing the value of C_F. This in turn will slow down the pulse response.

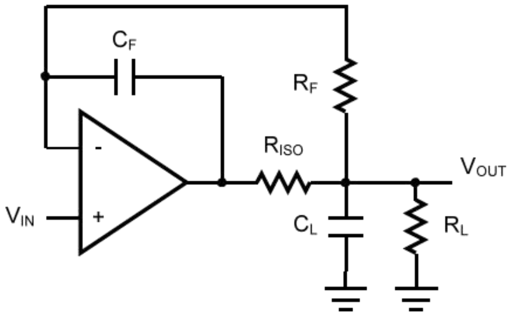


Figure 3. Indirectly Driving a Capacitive Load with DC Accuracy

Typical Application Circuits

Differential amplifier

The differential amplifier allows the subtraction of two input voltages or cancellation of a signal common the two inputs. It is useful as a computational amplifier in making a differential to single-end conversion or in rejecting a common mode signal. Figure 4. shown the differential amplifier using AD809X.

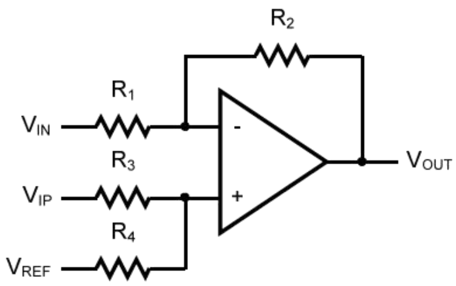


Figure 4. Differential Amplifier

$$V_{OUT}=\left(\frac{R1+R2}{R3+R4}\right)\frac{R4}{R1}V_{IN}-\frac{R2}{R1}V_{IP}+\left(\frac{R1+R2}{R3+R4}\right)\frac{R3}{R1}V_{REF}$$

f the resistor ratios are equal (i.e. $R_1=R_3$ and $R_2=R_4$), then

$$V_{OUT}=\frac{R2}{R1}(V_{IP}-V_{IN})+V_{REF}$$

Low Pass Active Filter

The low pass active filter is shown in Figure 5. The DC gain is defined by –R2/R1. The filter has a -20dB/decade roll-off after its corner frequency $f_C=1/(2\pi R_3C_1)$

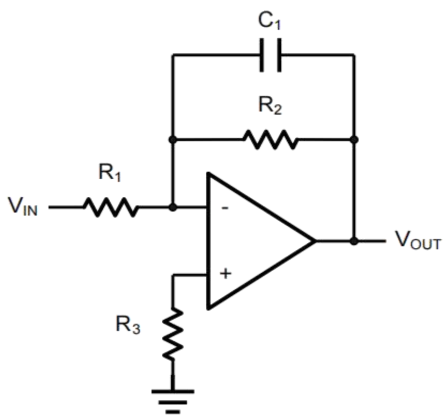


Figure 5. Low Pass Active Filter

Driving Video

The AD809X can be used in video applications like in Figure 6.

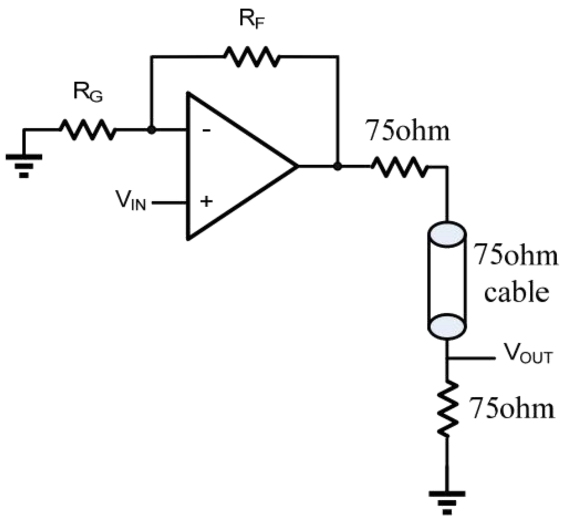
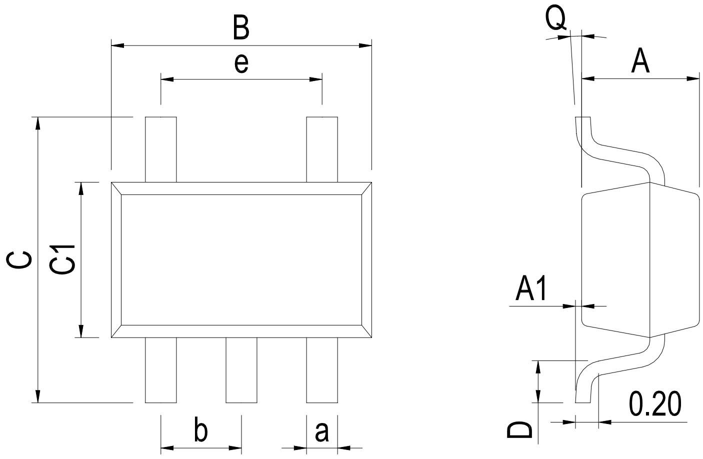


Figure 6. Typical video driving

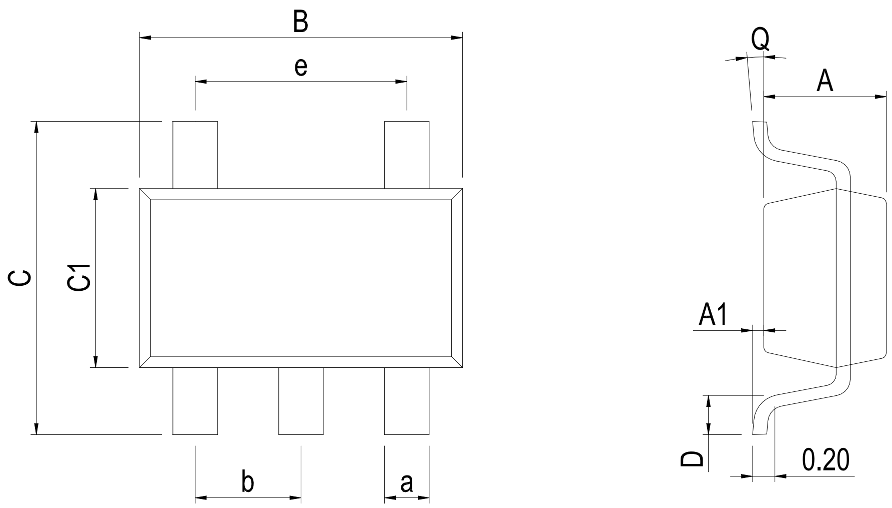
Physical Dimensions

SOT-23-5



Dimensions In Millimeters(SOT-23-5)									
Symbol:	A	A1	B	C	C1	D	Q	a	b	e
Min:	1.00	0.00	2.82	2.65	1.50	0.30	0°	0.30	0.95 BSC	1.90 BSC
Max:	1.15	0.15	3.02	2.95	1.70	0.60	8°	0.50		

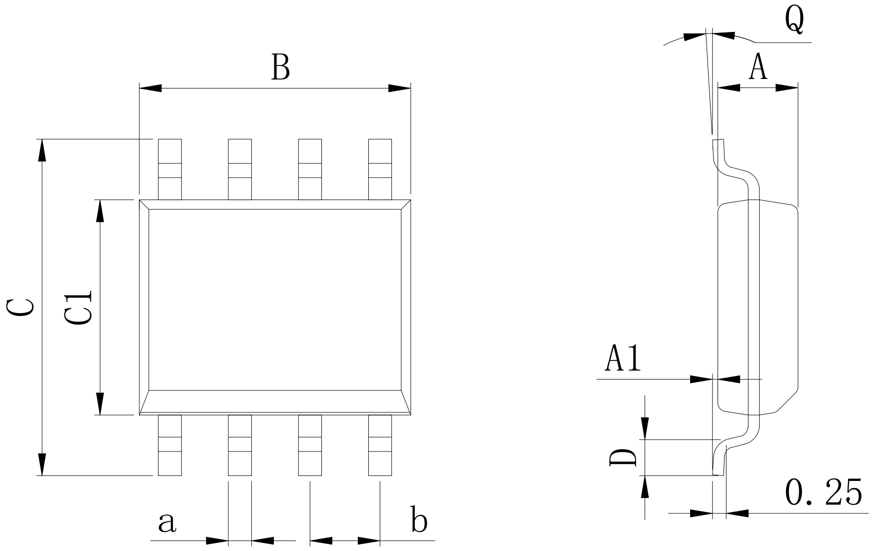
SC70-5



Dimensions In Millimeters(SC70-5)										
Symbol:	A	A1	B	C	C1	D	Q	a	b	e
Min:	0.90	0.00	2.00	2.15	1.15	0.26	0°	0.15	0.65 BSC	1.30 BSC
Max:	1.00	0.15	2.20	2.45	1.35	0.46	8°	0.35		

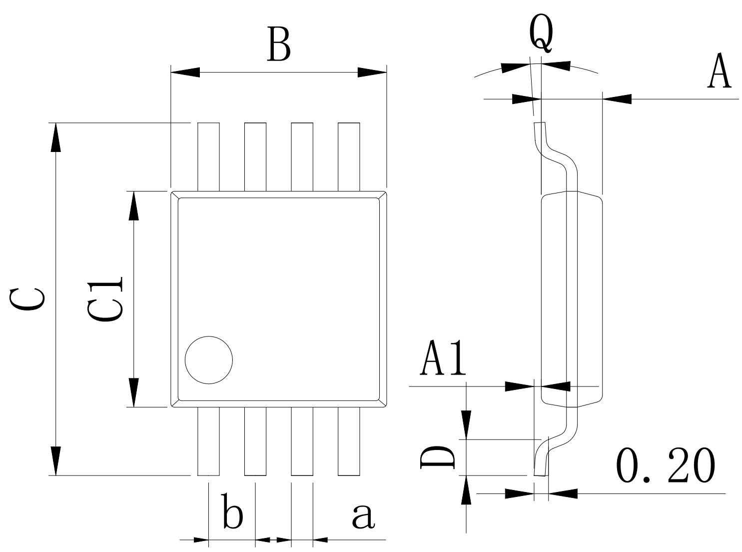
Physical Dimensions

SOP-8 (150mil)



Dimensions In Millimeters(SOP-8)									
Symbol:	A	A1	B	C	C1	D	Q	a	b
Min:	1.35	0.05	4.90	5.80	3.80	0.40	0°	0.35	1.27 BSC
Max:	1.55	0.20	5.10	6.20	4.00	0.80	8°	0.45	

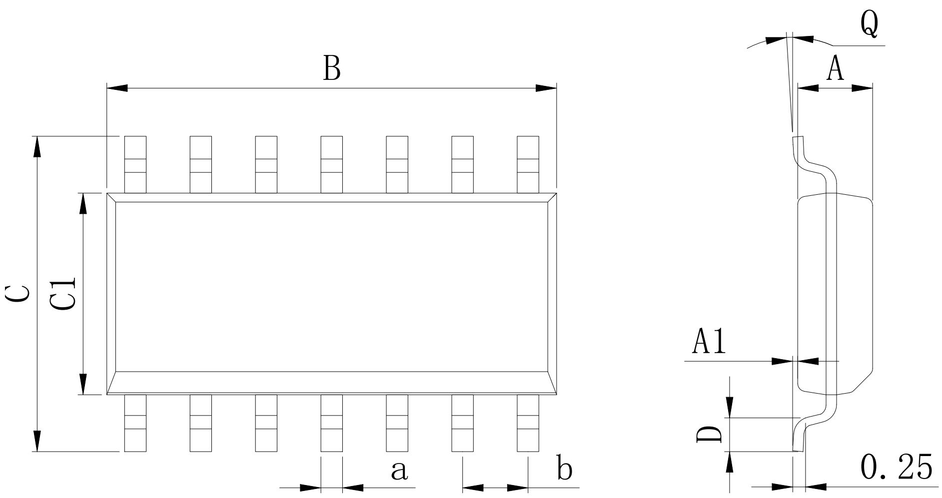
MSOP-8



Dimensions In Millimeters(MSOP-8)									
Symbol:	A	A1	B	C	C1	D	Q	a	b
Min:	0.80	0.05	2.90	4.75	2.90	0.35	0°	0.25	0.65 BSC
Max:	0.90	0.20	3.10	5.05	3.10	0.75	8°	0.35	

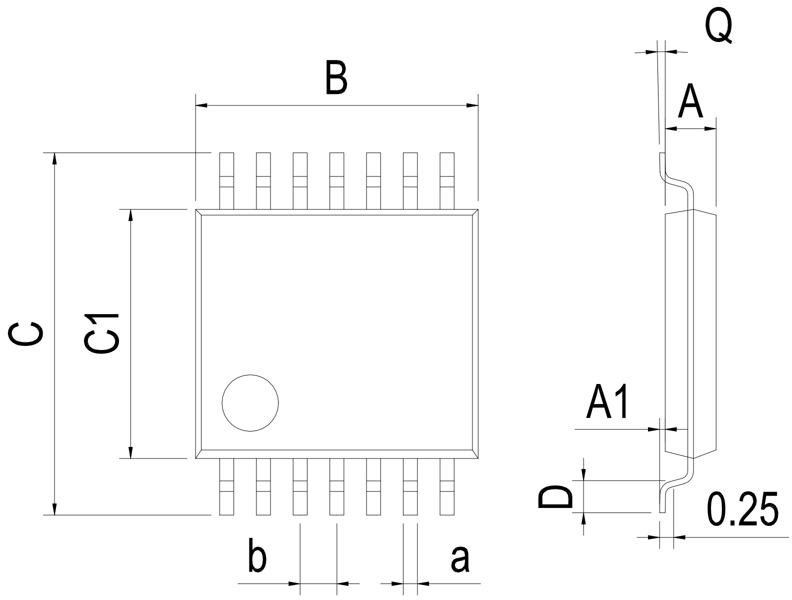
Physical Dimensions

SOP-14



Dimensions In Millimeters(SOP-14)									
Symbol:	A	A1	B	C	C1	D	Q	a	b
Min:	1.35	0.05	8.55	5.80	3.80	0.40	0°	0.35	1.27 BSC
Max:	1.55	0.20	8.75	6.20	4.00	0.80	8°	0.45	

TSSOP-14



Dimensions In Millimeters(TSSOP-14)									
Symbol:	A	A1	B	C	C1	D	Q	a	b
Min:	0.85	0.05	4.90	6.20	4.30	0.40	0°	0.20	0.65 BSC
Max:	0.95	0.20	5.10	6.60	4.50	0.80	8°	0.25	

Revision History

REVISION NUMBER	DATE	REVISION	PAGE
V1.0	2014-4	New	1-19
V1.1	2016-10	update sc70-5 Physical Dimensions	13
V1.2	2025-5	Document Reformatting	1-17

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