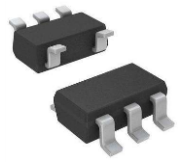
350MHz Rail-to-Rail Operational Amplifier

PRODUCT DESCRIPTION

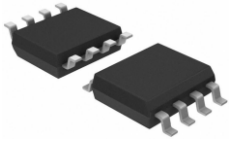
The MS809x is a rail-to-rail output voltage feedback amplifier with easy use and low cost. It has many advantages of typical bandwidth and conversion rate derived from current feedback amplifier. In addition, it has wider common-mode input range and output swing, which makes it easy to operate in 2.5V single power supply.

Even though it has low cost, the MS809x has perfect performance. It provides up to 350MHz (G=+1) bandwidth and 0.1dB flatness reaches 125MHz (G=+1). And each amplifier only consumes 4.3mA current.

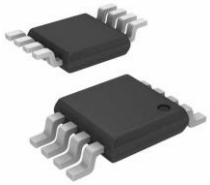
The features of low distortion and fast settling make the MS809x ideal for buffering high-speed ADC or DAC. The power-down feature can reduce the current consumption to 75μA. These features make the MS809x ideal for portable devices and battery-powered applications, because these applications have strict demands for size and power dissipation. The operating temperature ranges from -40°C to 125°C.



SOT23-5



SOP8



MSOP8

SOP14

TSSOP14

FEATURES

- Rail-to-Rail Output; 2mV Offset Voltage (Vos)
- High-speed
  -3dB Bandwidth: 350MHz (G = +1); Slew Rate: 265 V/μs
  0.1% Settling Time: 32 ns
- Wide Power Supply: 2.5V to 5.5V
- Input Common-mode Voltage (Vs=5V): -0.2V to +3.8V
- Video Characteristic (G=+2,RL=150Ω)
  0.1dB Gain Flatness: 70MHz
- Differential Gain Error: 0.004%, Differential Phase Error: 0.08°
- Low Power Dissipation: 4.3mA for Each Amplifier, Only 75μA at power-down

APPLICATIONS

- Image
- Photodiode Preamplifier
- Professional Video Device and Photo Device
- Handhold Device
- DVD/CD
- Base Station
- Active Filter
- Analog-to-Digital Conversion

PRODUCT SPECIFICATION

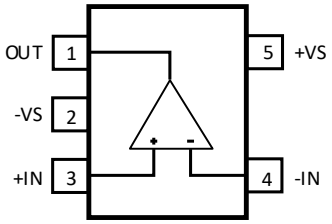
Part Number	Package	Marking
*MS8091S	SOT23-5	8091S
MS8091	SOP8	MS8091
*MS8092	SOP8	MS8092
*MS8092M	MSOP8	MS8092M
MS8094	SOP14	MS8094
MS8094T	TSSOP14	MS8094T

*The package is not available temporarily.

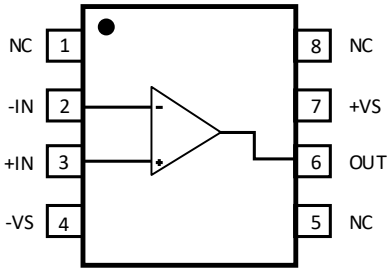
If necessary, please contact Hangzhou Ruimeng Sales Department Center.

PIN CONFIGURATION

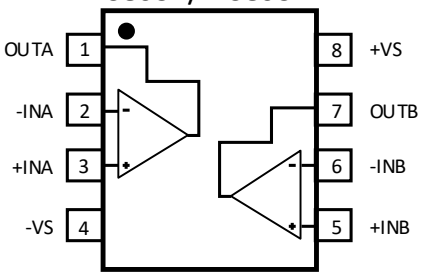
MS8091S



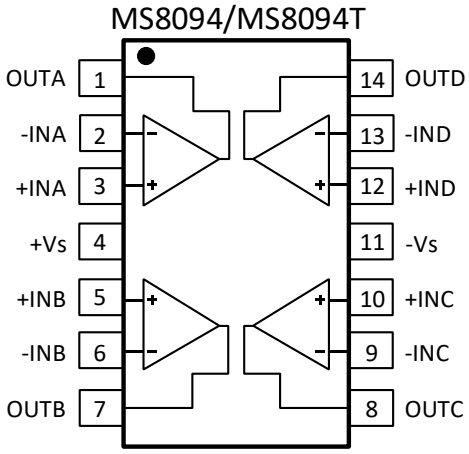
MS8091



MS8092/MS8092M



MS8094/MS8094T



PIN DESCRIPTION

Pin	Name	Type	Description
MS8091S			
1	OUT	O	Channel Output
2	-Vs	-	Negative Power Supply
3	+IN	I	Positive Input
4	-IN	I	Negative Input
5	+Vs	-	Positive Power Supply
MS8091			
1	NC	-	Not Connection
2	-IN	I	Negative Input
3	+IN	I	Positive Input
4	-Vs	-	Negative Power Supply
5	NC	-	Not Connection
6	OUT	O	Channel Output
7	+Vs	-	Positive Power Supply
8	NC	-	Not Connection
MS8092/MS8092M			
1	OUTA	O	Channel A Output
2	-INA	I	Negative Input (Channel A)
3	+INA	I	Positive Input (Channel A)
4	-Vs	-	Negative Power Supply
5	+INB	I	Positive Input (Channel B)
6	-INB	I	Negative Input (Channel B)
7	OUTB	O	Channel B Output
8	+Vs	-	Positive Power Supply

Pin	Name	Type	Description
MS8094/MS8094T			
1	OUTA	O	Channel A Output
2	-INA	I	Negative Input (Channel A)
3	+INA	I	Positive Input (Channel A)
4	+Vs	-	Positive Power Supply
5	+INB	I	Positive Input (Channel B)
6	-INB	I	Negative Input (Channel B)
7	OUTB	O	Channel B Output
8	OUTC	O	Channel C Output
9	-INC	I	Negative Input (Channel C)
10	+INC	I	Positive Input (Channel C)
11	-Vs	-	Negative Power Supply
12	+IND	I	Positive Input (Channel D)
13	-IND	I	Negative Input (Channel D)
14	OUTD	O	Channel D Output

ABSOLUTE MAXIMUM RATINGS

Any exceeding absolute maximum rating application causes permanent damage to device. Because long-time absolute operation state affects device reliability. Absolute ratings just conclude from a series of extreme tests. It doesn't represent chip can operate normally in these extreme conditions.

Parameter	Ratings	Unit
Power Supply, V+ to V-	7.5	V
Common-mode Input Voltage	$(-V_S)-0.5 \sim (+V_S)+0.5$	V
Storage Temperature	-65 ~ +150	°C
Junction Temperature	160	°C
Lead Temperature (Soldering, 10s)	260	°C
ESD (MM)	400	V

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min	Typ	Max	Unit
Operating Temperature	T_A	-40		125	°C
Operating Voltage		2.5		5.5	V

ELECTRICAL CHARACTERISTICS

Unless otherwise noted, power supply is 5V, TA=25°C. G=+2, RF=600Ω, RL=150Ω.

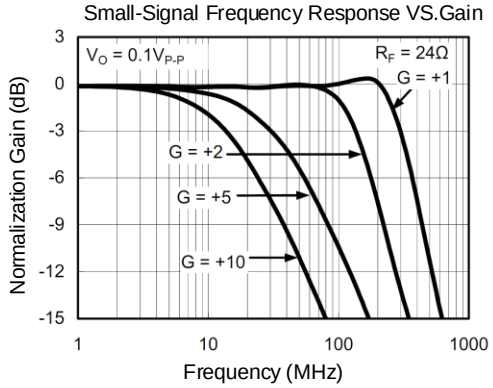
Parameter	Symbol	Condition	Min	Typ	Max	Unit
Dynamic Characteristics						
-3dB Small Signal Bandwidth	BW	G = +1, Vo = 0.1Vp-p, RF = 24Ω, RL = 150Ω		300		MHz
		G = +1, Vo = 0.1Vp-p, RF = 24Ω, RL = 1kΩ		350		
		G = +2, Vo = 0.1Vp-p, RL = 50Ω		70		
		G = +2, Vo = 0.1Vp-p, RL = 150Ω		140		
		G = +2, Vo = 0.1Vp-p, RL = 1kΩ		170		
		G = +2, Vo = 0.1Vp-p, RL = 10kΩ		230		
Gain Bandwidth Product	GBP	G = +2, RL = 150Ω		135		MHz
		G = +2, RL = 1kΩ		170		
0.1dB Flatness Bandwidth		G = +1, Vo = 0.1Vp-p		125		MHz
		G = +2, Vo = 0.1Vp-p, RF = 600Ω		70		
Slew Rate	SR	G = +1, 2V Output Step		194/-204		V/μs
		G = +2, 2V Output Step		236/-170		
		G = +2, 4V Output Step		265/-218		
Rise/Fall Time	tr/td	G = +2, Vo = 0.2Vp-p,10%~90%		3.8		ns
		G = +2, Vo = 2Vp-p,10% ~ 90%		7.8		
0.1% Settling Time		G = +2, 2V Output Step		32		ns
Overload Recovery Time		VIN · G = +VS		14.5		ns
Noise/Distortion Characteristics						
Input Voltage Noise		f = 1MHz		5.9		$nV/\sqrt{Hz}$
Differential Gain Error		G = +2, RL = 150Ω		0.004		%
Differential Phase Error		G = +2, RL = 150Ω		0.08		degree
DC Characteristics						
Input Offset Voltage	VOS			±2	±9.8	mV
Offset Drift				3.7		μV/°C
Input Bias Current	IB			6		pA

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Input Offset Current	I_{OS}			2		pA
Open-loop Gain	A_{OL}	Vo = 0.3V~4.7V, RL = 150Ω	73	80		dB
		Vo = 0.2V~4.8V, RL = 1kΩ	80	104		
Input Characteristics						
Input Common-mode Voltage	VCM			-0.2~+3.8		V
Common-mode Rejection Ratio	CMRR	VCM = - 0.1V~+ 3.5V	64	80		dB
Output Characteristics						
Output to Rail Swing		R_L = 150Ω		0.12		V
		R_L = 1kΩ		0.03		V
Output Current			88	115		mA
Closed-loop Output Impedance		f < 100kHz		0.02		Ω
Enable Time				108		ns
Disable Time				60		ns
DISABLE Input Low Voltage					0.8	V
DISABLE Input High Voltage			2			V
Power Characteristics						
Quiescent Current				4.3		mA
Operating Current at Disable				75		μA
Power Supply Rejection Ratio	PSRR	ΔVs=+2.7V~+5.5V, VCM=(-VS)+0.5	62	80		dB

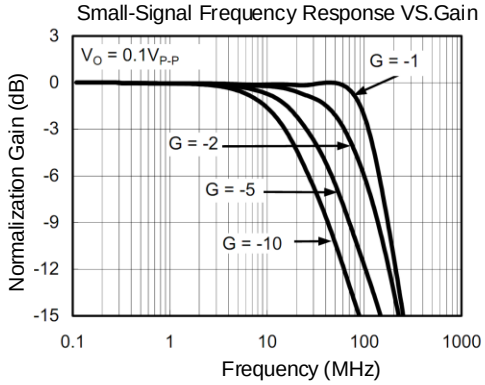
TYPICALC OPERATING CHARACTERISTICS

Unless otherwise noted,TA=+25°C, VS=+5V, G=+2, RF=600Ω, RG=600Ω, RL=150Ω (to Vs/2).

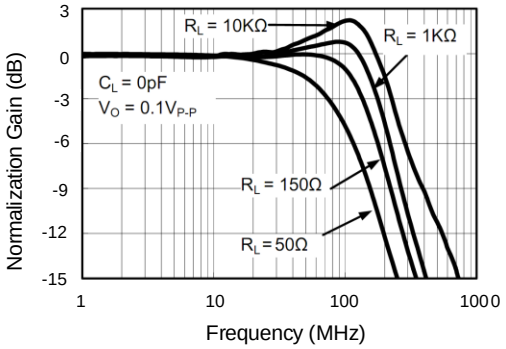
Small-Signal Frequency Response VS.Gain



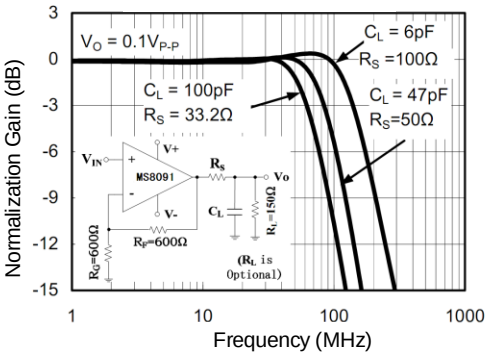
Small-Signal Frequency Response VS.Gain



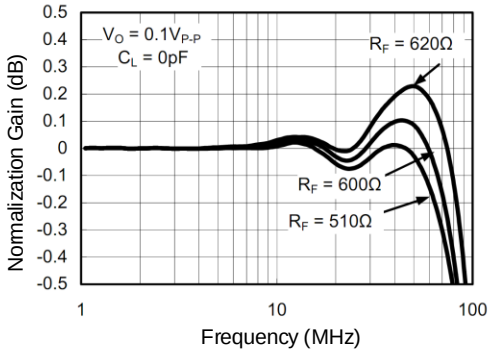
Small-Signal Frequency Response VS. Load Resistor



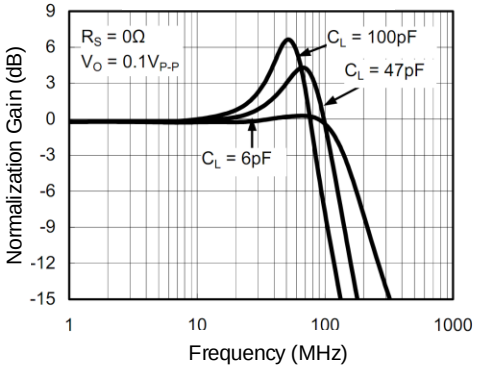
Small-Signal Frequency Response VS. Load Capacitor



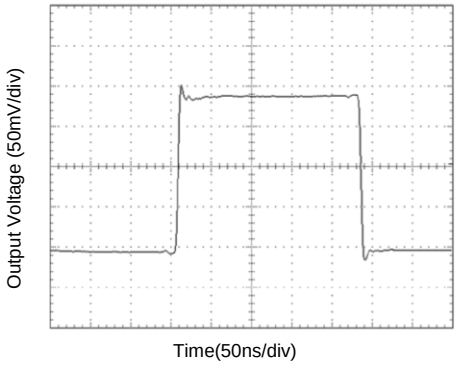
0.1dB Gain Flatness VS. Feedback Resistor



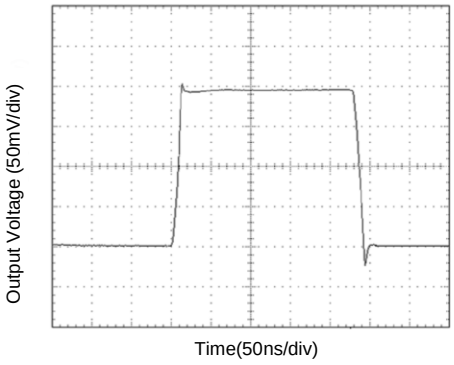
Small-Signal Frequency Response VS. Load Capacitor



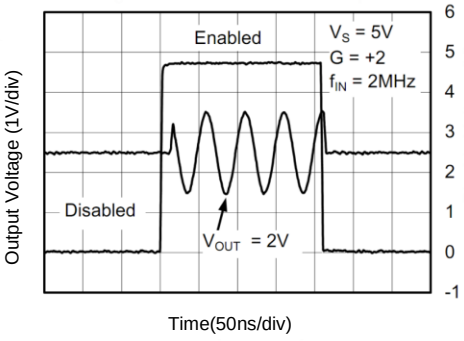
Positive Small-Signal Step Response



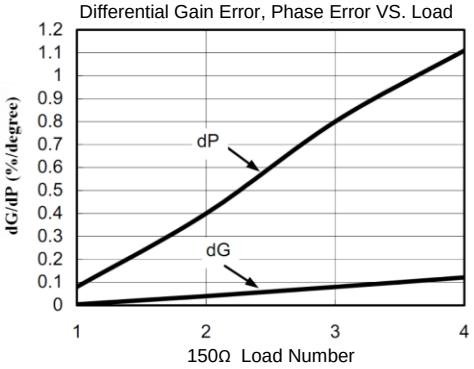
Positive Large-Signal Step Response



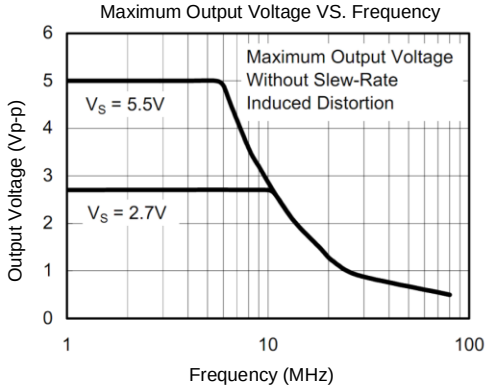
Large-Signal Enable/Disable Response



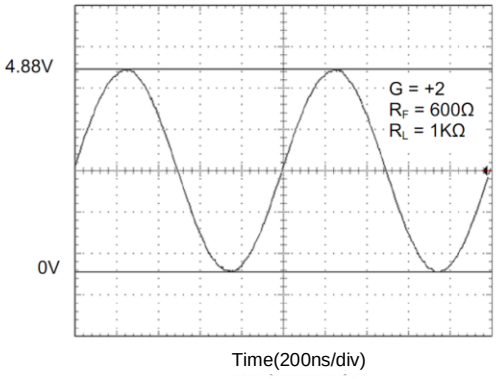
Differential Gain Error, Phase Error VS. Load



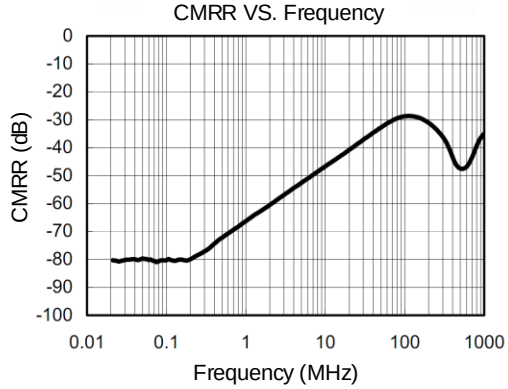
Maximum Output Voltage VS. Frequency



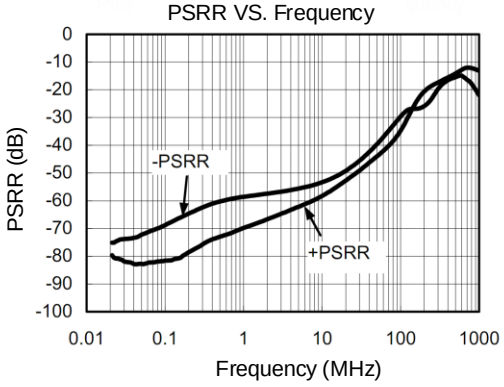
Rail-to-Rail Output



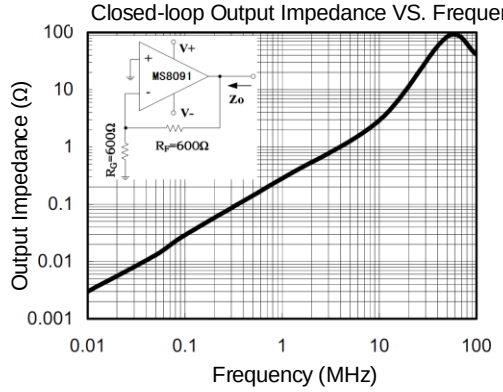
CMRR VS. Frequency



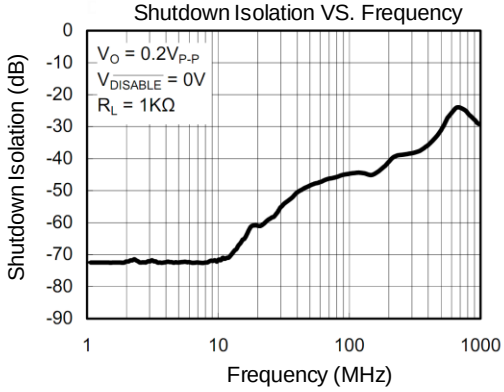
PSRR VS. Frequency



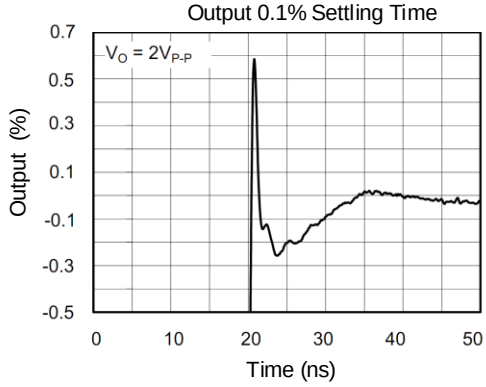
Closed-loop Output Impedance VS. Frequency



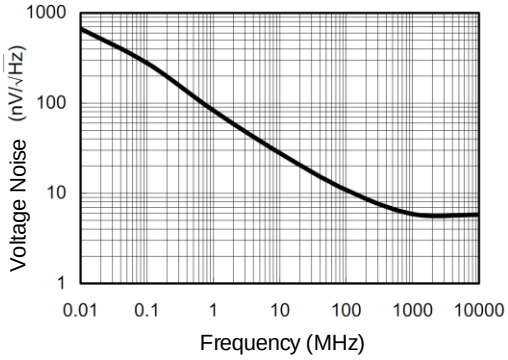
Shutdown Isolation VS. Frequency



Output 0.1% Settling Time

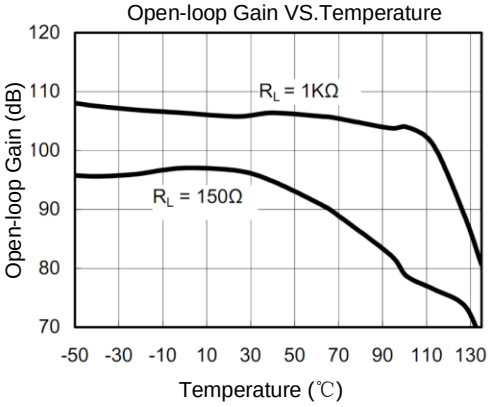


Input Voltage Noise Spectrum Density VS. Frequency

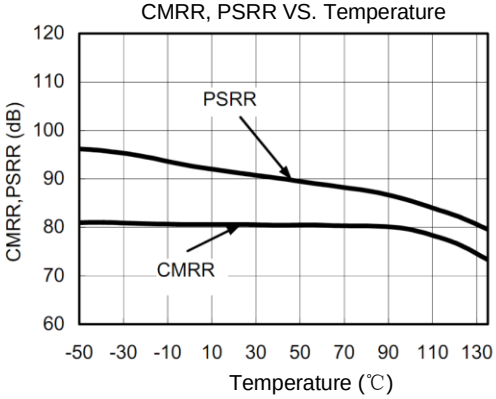


Shutdown Isolation

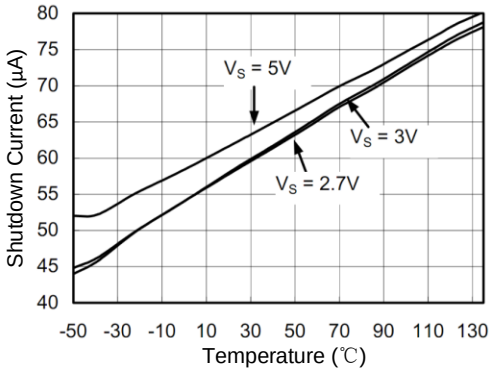
Open-loop Gain VS.Temperature



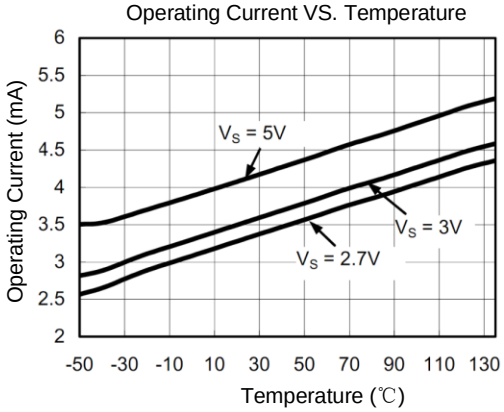
CMRR, PSRR VS. Temperature



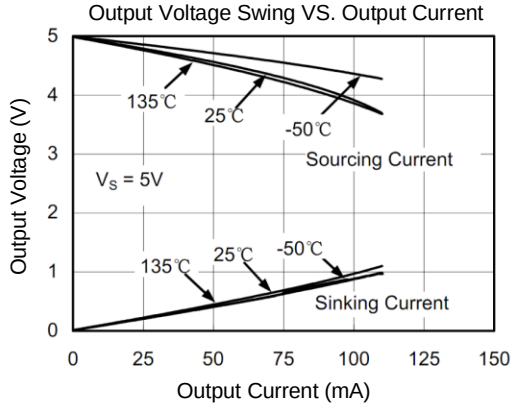
Shutdown Current VS. Temperature



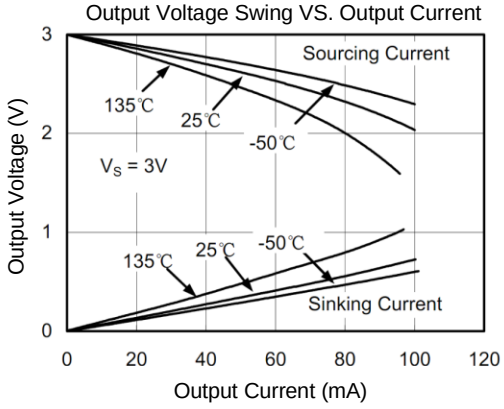
Operating Current VS. Temperature



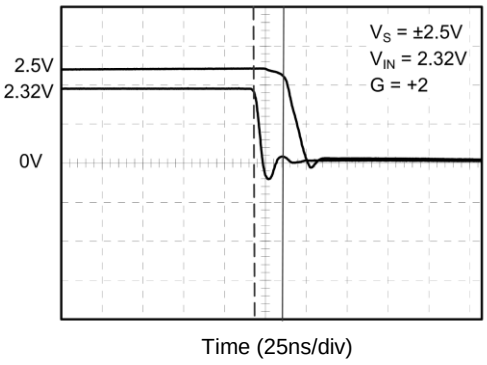
Output Voltage Swing VS. Output Current



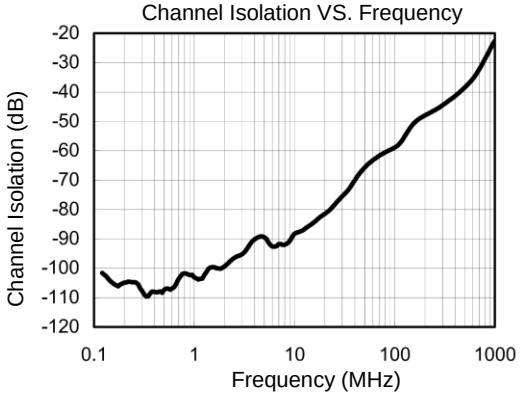
Output Voltage Swing VS. Output Current



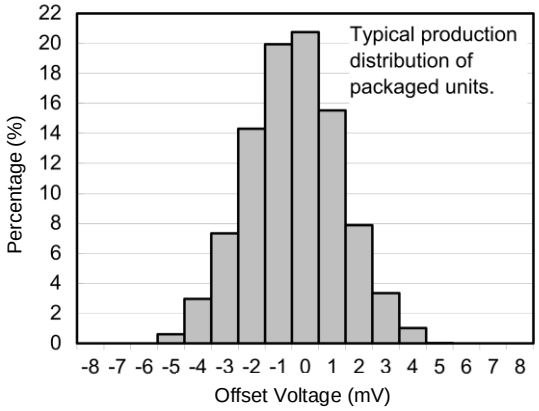
Overload Recovery Time



Channel Isolation VS. Frequency



Offset Voltage Distribution



Application Information

Drive Capacitive Load

The MS809x optimizes not only driving capacitive load, but also bandwidth and rate. Output capacitance would add a pole in the amplifier's feedback loop, which would result in excessive peak and possible oscillation. If there has requirement for driving capacitance in application, two schemes can be considered: (1) A small resistor is in series with amplifier's output and capacitive load . (2) Add overall noise gain to reduce the bandwidth of amplifier's feedback loop. Figure 1 shows a follower of unity gain using the series resistor way. The resistor separates the output from the capacitance, and it is more important that creating a zero in the feedback loop, which compensates for the pole of output capacitance.

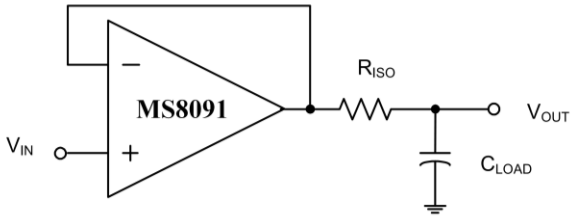


Figure 1. Series Resistor and Capacitive Load

Power Bypass Design

The MS809x operates in not only single +2.7V to +5.5V power supply, but also dual ±1.35V to ±2.75V power supply. For single power supply operation, use a 0.1μF ceramic capacitor close to the VDD pin to bypass VDD. For dual power supply operation, both the VDD and the VSS should be bypassed to ground with 0.1μF ceramic capacitor. Using 2.2μF tantalum capacitor can be for better performance.

Good PCB design technology can decrease the stray capacitance of the operational amplifier's input and output to improve performance. In order to decrease stray capacitance, minimize the trace length and width by placing external components as close to the device as possible. And surface-mount component should be used as mush as possible.

For high-speed operational amplifier, it is strongly recommended to directly solder the device to the board. Try to reduce the high-frequency big current loop area to minimize EMI (electromagnetic interference).

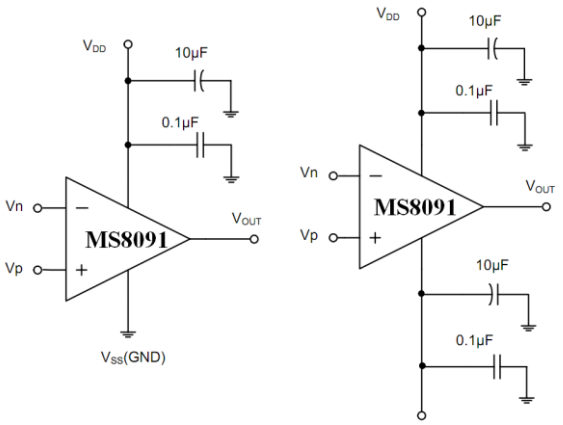


Figure 2. Amplifier with Bypass Capacitor

Grounding

For high-speed circuit design, ground plane is very important. The length of current path would make the current speed in inductive ground feedback, thus generate undesired voltage noise. Wide ground plane area would reduce the parasitic inductance.

Input to Output Coupling

To minimize capacitive coupling, input and output signal paths should not be parallel, which can reduce undesired positive feedback.

TYPICAL APPLICATIONS

Differential Amplifier

Figure 3 shows the different function. If the resistor coefficients are equal ($R_4/R_3=R_2/R_1$), $V_{OUT}=(Vp-Vn)\times R_2/R_1+V_{REF}$.

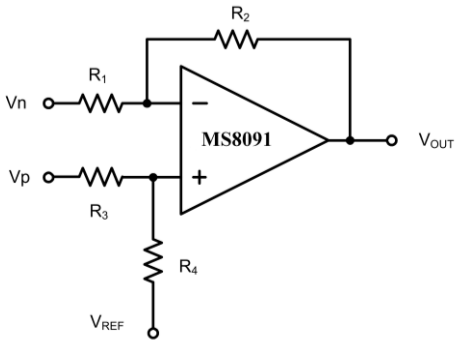


Figure 3. Differential Amplifier

Active Low-pass Filter

The DC gain of low-pass filter is ($-R_2/R_1$) shown in Figure 4. -3dB corner frequency is $1/2\pi R_2C$. At the same time, ensure the filtering frequency is within the bandwidth of the amplifier. The Large feedback resistor would double the parasitic capacitance and lead to undesired effect such as ringing or oscillation in high-speed amplifier. Resistance value should be as low as possible and keep the consistency in view of the output driving.

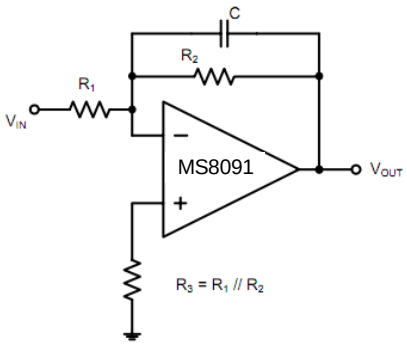


Figure 4. Activate Low-pass Filter

Drive Video Signal

The MS809x can also be used in video application as shown in figure 5.

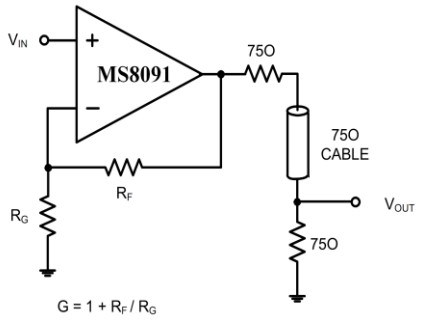
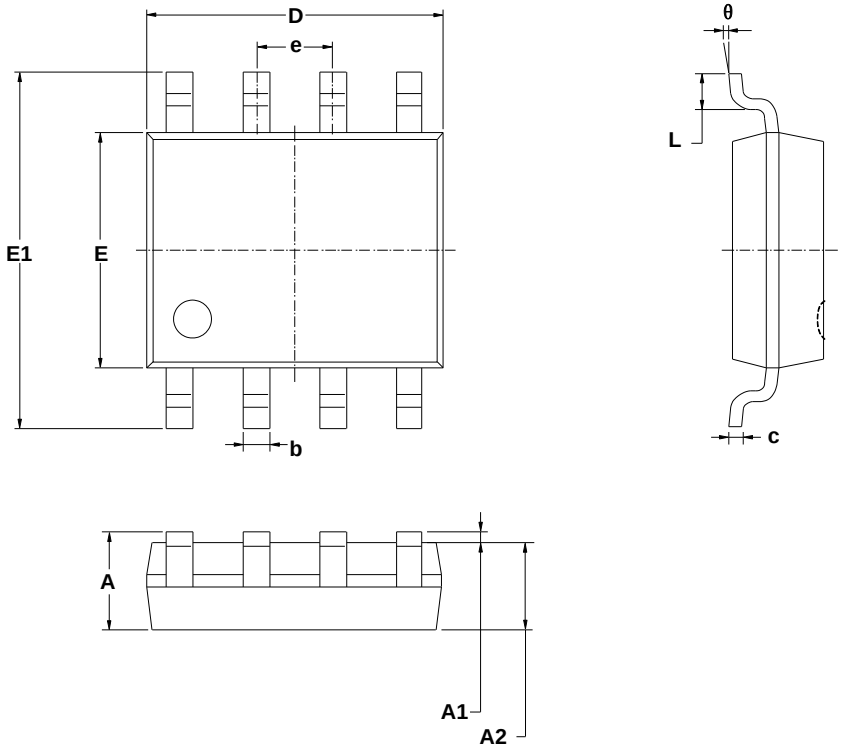


Figure 5. Typical Video Driving

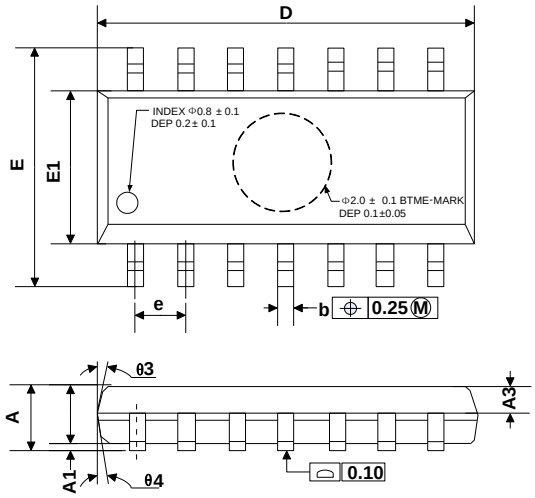
PACKAGE OUTLINE DIMENSIONS

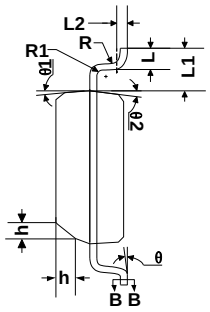
SOP8



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	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	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050 BSC	
L	0.400	1.270	0.016	0.050
θ	0 º	8 º	0 º	8 º

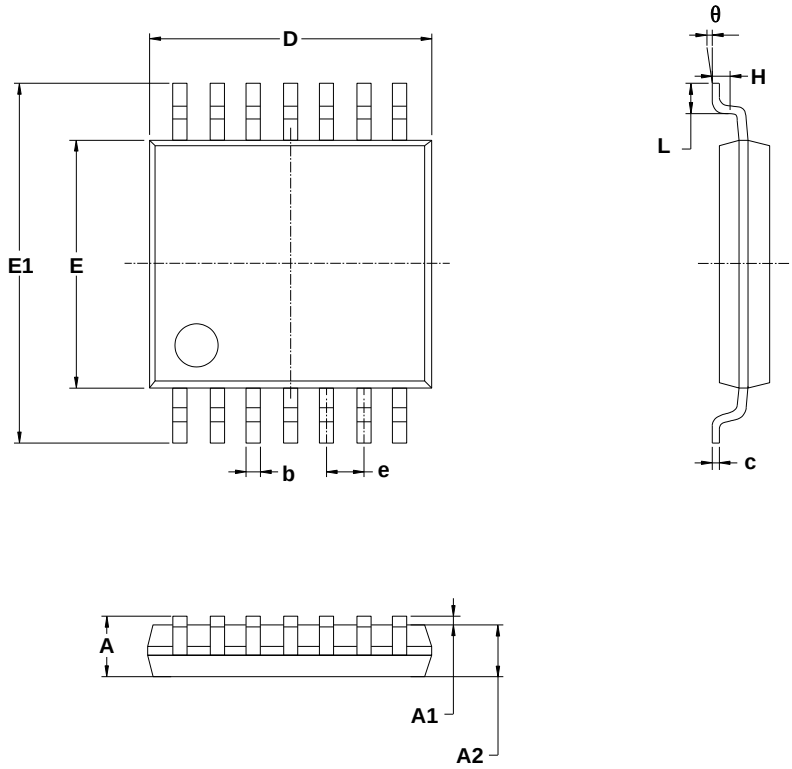
SOP14





Symbol	Dimensions In Millimeters		
	Min	Typ	Max
A	1.35		1.75
A1	0.10		0.25
A2	1.25		1.65
A3	0.55		0.75
D	8.53		8.73
E	5.80		6.20
E1	3.80		4.00
e	1.27 BSC		
L	0.45		0.80
L1	1.04 REF		
L2	0.25 BSC		
R	0.07		
R1	0.07		
h	0.30		0.50
θ	0 º		8 º
θ1	6 º	8º	10 º
θ2	6 º	8º	10 º
θ3	5 º	7º	9 º
θ4	5 º	7º	9 º

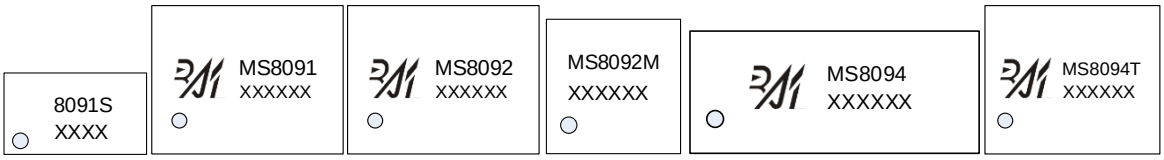
TSSOP14



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A		1.100		0.043
A1	0.050	0.150	0.002	0.006
A2	0.800	1.000	0.031	0.039
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.08
D	4.900	5.100	0.193	0.201
E	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650 BSC		0.026 BSC	
L	0.500	0.700	0.02	0.028
H	0.25 TYP		0.01 TYP	
θ	1 º	7 º	1 º	7 º

MARKING and PACKAGING SPECIFICATIONS

1. Marking Drawing Description



Product Name : 8091S, MS8091, MS8092, MS8092M, MS8094, MS8094T

Product Code : XXXX, XXXXXX

2. Marking Drawing Demand

Laser printing, contents in the middle, font type Arial.

3. Packaging Specifications

Device	Package	Piece/Reel	Reel/Box	Piece /Box	Box/Carton	Piece/Carton
MS8091S	SOT23-5	3000	10	30000	4	120000
MS8091	SOP8	2500	1	2500	8	20000
MS8092	SOP8	2500	1	2500	8	20000
MS8092M	MSOP8	3000	1	3000	8	24000
MS8094	SOP14	2500	1	2500	8	20000
MS8094T	TSSOP14	3000	1	3000	8	24000

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- The process of improving product is endless. And our company would sincerely provide more excellent product for customer.

MOS CIRCUIT OPERATION PRECAUTIONS

Static electricity can be generated in many places. The following precautions can be taken to effectively prevent the damage of MOS circuit caused by electrostatic discharge:

1. The operator shall ground through the anti-static wristband.
2. The equipment shell must be grounded.
3. The tools used in the assembly process must be grounded.
4. Must use conductor packaging or anti-static materials packaging or transportation.

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