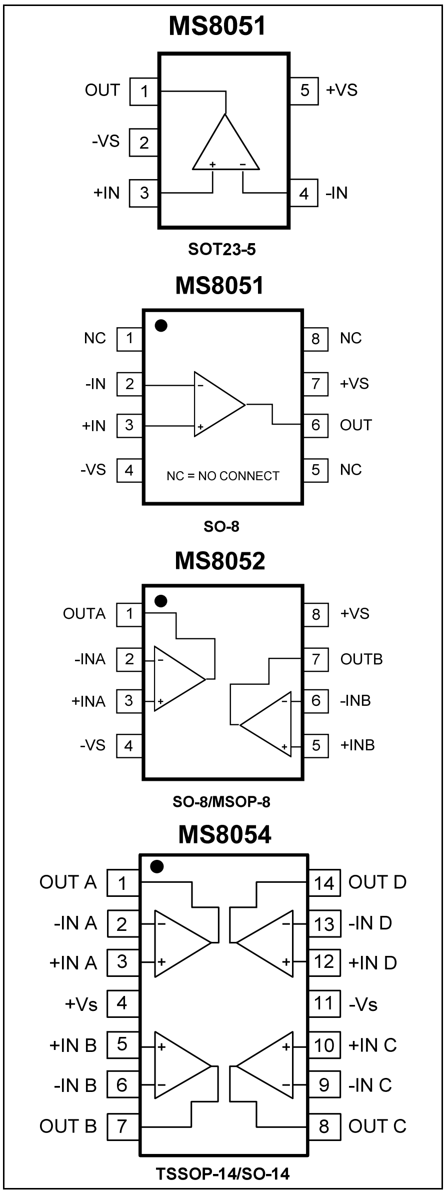
250MHz Rail-to-Rail Output CMOS Operational Amplifiers



DESCRIPTION

The MS805x 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 low cost, the MS805x provide excellent overall performance. They offer wide bandwidth to 250MHz (G = +1) along with 0.1dB flatness out to 37MHz (G = +2) and offer a typical low power of 4.3mA/amplifier.

The MS805x are low distortion and fast settling make them ideal for buffering high speed A/D or D/A converters. All are specified over the extended -40℃ to +125℃ temperature range.

FEATURES

- Low cost
- Rail-to-Rail Output
  2mV Typical VOS
- High Speed
  250MHz, -3dB Bandwidth (G = +1)
  130V/μs, Slew Rate
  58ns Settling Time to 0.1% with 2V Step
- Supply Voltage Range: 2.5V to 5.5V
- Input Voltage Range: -0.2V to +3.8V with VS = 5V
- Excellent Video Specs (RL = 150Ω, G = +2)
  Gain Flatness 0.1dB to 37MHz
  Diff Gain: 0.03%, Diff Phase: 0.08 Degree
- Low Supply Current
  4.3mA/Amplifier (TYP)

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE	MARKING
MS8051	SOT23-5	8051
MS8051SO	SO-8	MS8051SO
MS8052	SO-8	MS8052
MS8052M	MSOP-8	MS8052M
MS8054	SO-14	MS8054
MS8054T	TSSOP-14	MS8054T

APPLICATIONS

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

ABSOLUTE MAXIMUM RATINGS

PARAMETER			RANGER	UNIT
Supply Voltage, +VS to -VS		VDD	7.5	V
Input Common Mode Voltage		VCM	(-VS)-0.5 to (+VS)+0.5	V
Storage Temperature Range			-65℃ to +150℃	V
Junction Temperature			160℃	mW
Operating Temperature Range		TA	-55℃ to +150℃	℃
Package Thermal Resistance @T_A=25℃	SOT23-5	θ_{JA}	190	℃/W
	SO-8	θ_{JA}	125	℃/W
	MSOP-8	θ_{JA}	216	℃/W
ESD Susceptibility (HBM)			3000	V
ESD Susceptibility (MM)			400	V

ELECTRICAL CHARACTERISTICS: (V_S=+5V)

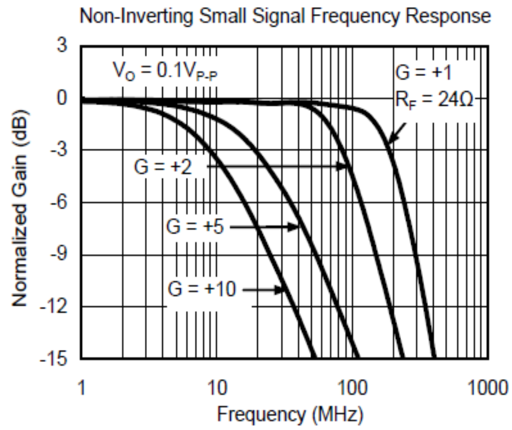
(G = +2,R_F = 887Ω,R_L = 150Ω, unless otherwise noted)

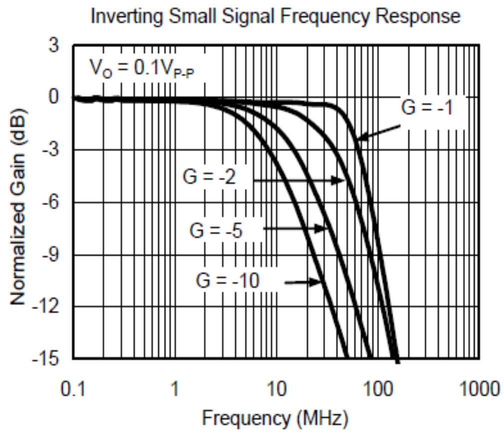
PARAMETER		CONDITIONS	MIN	TYP	MAX	UNIT
DYNAMIC PERFORMANCE						
-3dB Small Signal Bandwidth	BW	G = +1, V_O = 0.1Vp-p, R_F = 24Ω, R_L = 150Ω		180		MHz
		G = +1, V_O = 0.1Vp-p, R_F = 24Ω, R_L = 1kΩ		250		
		G = +2, V_O = 0.1Vp-p, R_L = 50Ω		40		
		G = +2, V_O = 0.1Vp-p, R_L = 150Ω		80		
		G = +2, V_O = 0.1Vp-p, R_L = 1kΩ		130		
		G = +2, V_O = 0.1Vp-p, R_L = 10kΩ		160		
Gain-Bandwidth Product	GBP	G = +2, R_L = 150Ω		90		MHz
		G = +2, R_L = 1kΩ		120		
Bandwidth for 0.1dB Flatness		G = +2, V_O = 0.1Vp-p, R_L = 150Ω, R_F = 887Ω		37		MHz
Slew Rate	SR	G = +1, 2V Output Step		93/-118		V/µs
		G = +2, 2V Output Step		116/-103		
		G = +2, 4V Output Step		130/-130		
Rise-and-Fall Time	tr/td	G = +2, V_O = 0.2Vp-p,10% to 90%		4		ns
		G = +2, V_O = 2Vp-p,10% to 90%		14		
Settling Time to 0.1%		G = +2, 2V Output Step		58		ns
Overload Recovery Time		V_{IN} · G = +VS		18		ns
NOISE/DISTORTION PERFORMANCE						

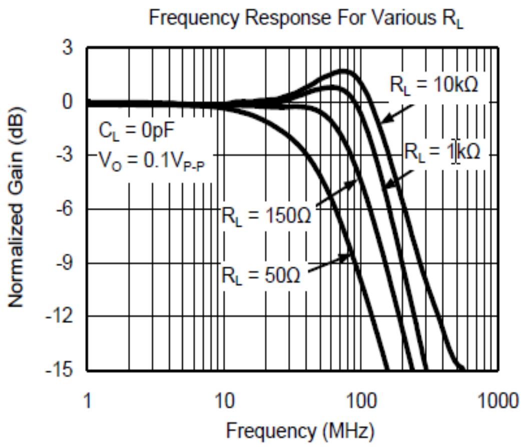
Input Voltage Noise		f = 1MHz		8.1		$nV/\sqrt{Hz}$
Differential Gain Error		G = +2, R_L = 150Ω		0.03		%
Differential Phase Error		G = +2, R_L = 150Ω		0.08		degree
DC PERFORMANCE						
Input Offset Voltage	V_{OS}			±2	±8.5	mV
Input Offset Voltage Drift				4.4		μV/℃
Input Bias Current	I_B			6		pA
Input offset Current	I_{OS}			2		pA
Open-Loop Gain	A_{OL}	V_O = 0.3V to 4.7V, R_L = 150Ω	73	80		dB
		V_O = 0.2V to 4.8V, R_L = 1KΩ	80	104		
INPUT CHARACTERISTICS						
Input Common Mode Voltage Range	V_{CM}			-0.2 to +3.8		V
Common Mode Rejection Ratio	CMRR	V_{CM} = - 0.1V to + 3.5V	62	80		dB
OUTPUT CHARACTERISTICS						
Output Voltage Swing from Rail		R_L = 150Ω		0.12		V
		R_L = 1KΩ		0.03		V
Output Current			84	130		mA
Closed-Loop Output Impedance		f＜100kHz		0.08		Ω
POWER-DOWN DISABLE (MS8053/5)						
Turn-On Time	t_{on}			236		ns
Turn-Off Time	t_{off}			52		ns
DISABLE Voltage-Off				0.8		V
DISABLE Voltage-On				2		V
POWER SUPPLY						
Operating Voltage Range	V_{MIN}			2.5	2.7	V
	V_{MAX}			5.5		V
Quiescent Current (per Amplifier)				4.4		mA
Supply Current when Disabled per Amplifier				75		μA
Power Supply Rejection Ratio	PSRR	ΔV_S = + 2.7V to + 5.5V, V_{CM}=($-V_S$)+0.5	62	80		dB

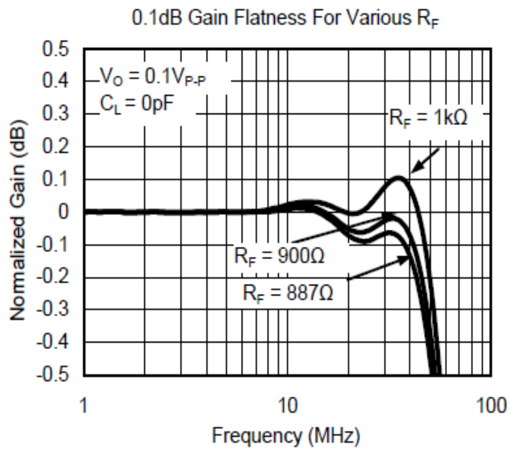
TYPICAL PERFORMANCE CHARACTERISTICS

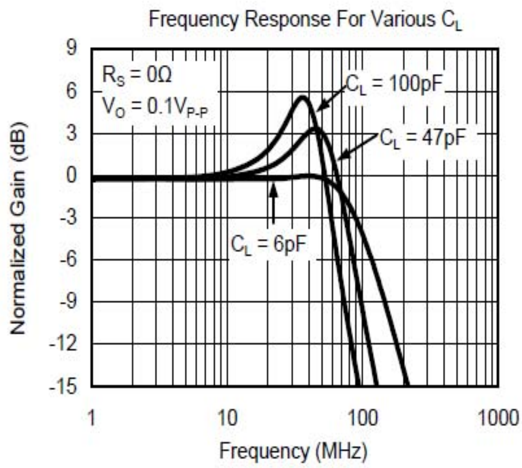
Condition: T_A = +25℃, V_S = +5V, R_F = 887Ω, R_G = 887Ω, R_L=150Ω to V_S/2, unless otherwise noted.

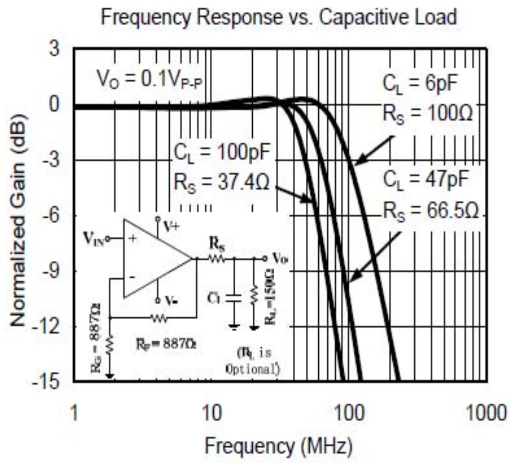








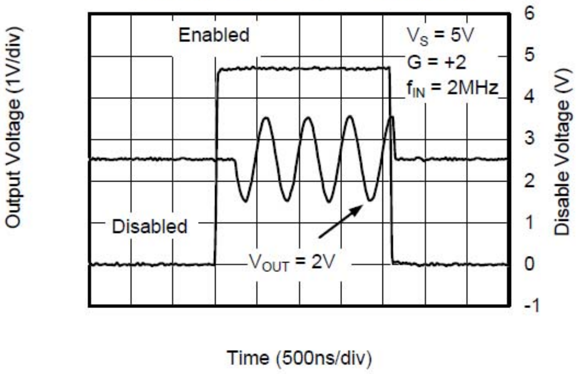




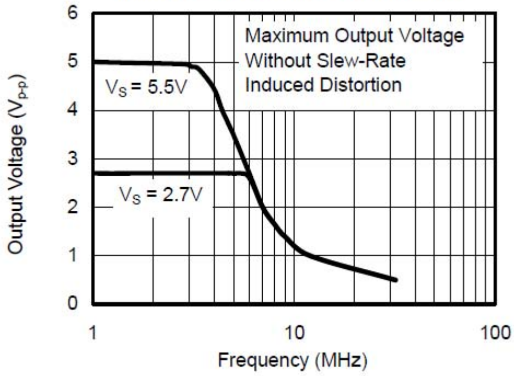
TYPICAL PERFORMANCE CHARACTERISTICS

condition：T_A = +25℃,V_S = +5V,R_F = 887Ω,R_G = 887Ω,R_L=150Ω to V_S/2， unless otherwise noted.

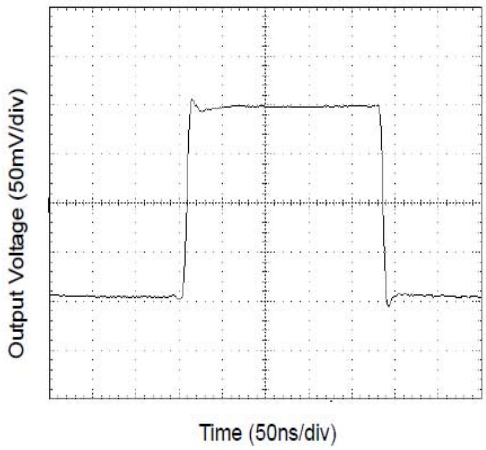
Large-Signal Disable/Enable Response



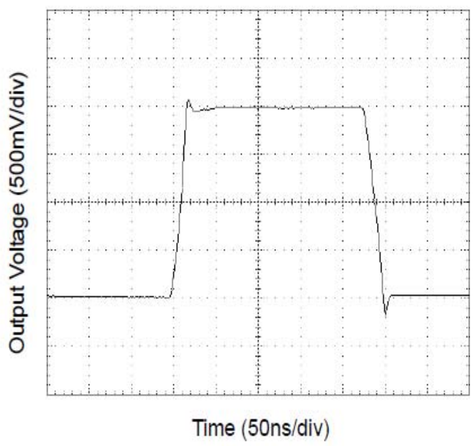
Maximum Output Voltage vs. Frequency



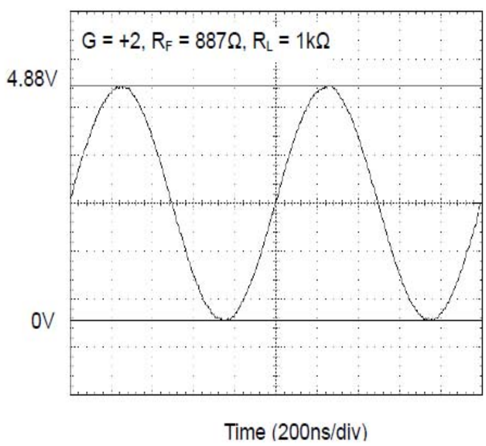
Non-Inverting Small Signal Step Response



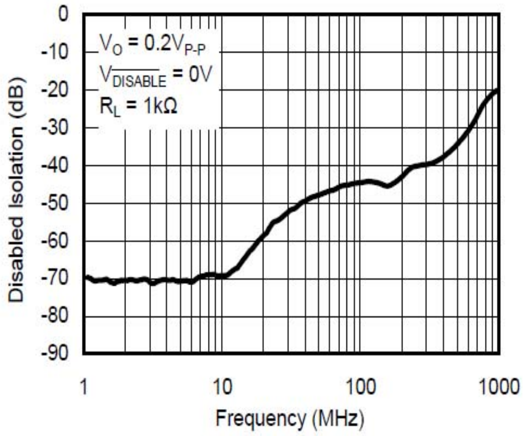
Non-Inverting Large Signal Step Response



Rail-to-Rail



Disabled Output Isolation Frequency Response



TYPICAL PERFORMANCE CHARACTERISTICS

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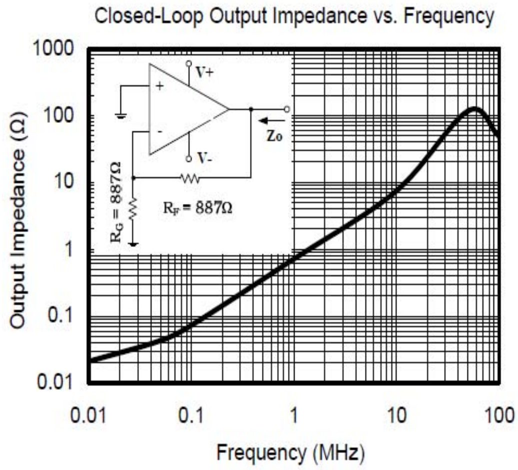

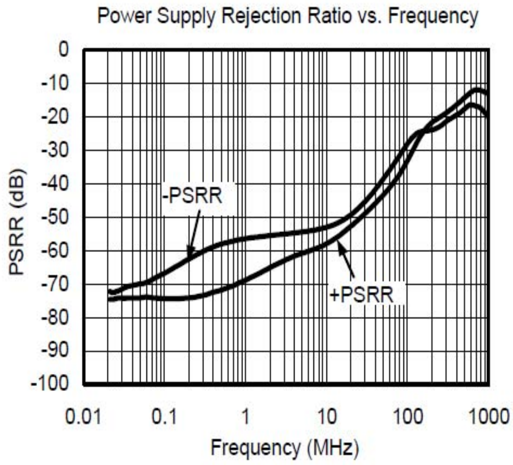

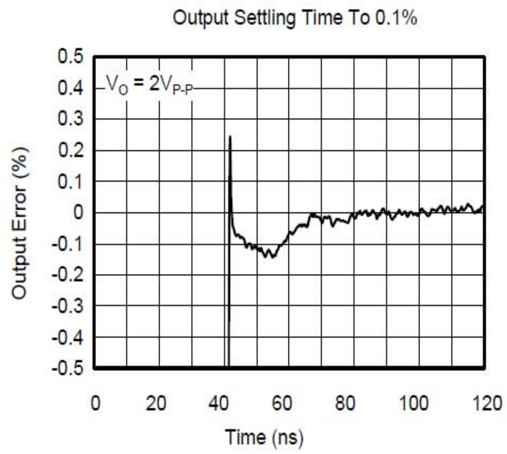

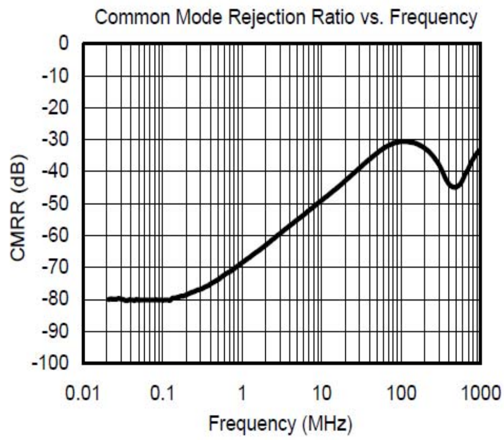

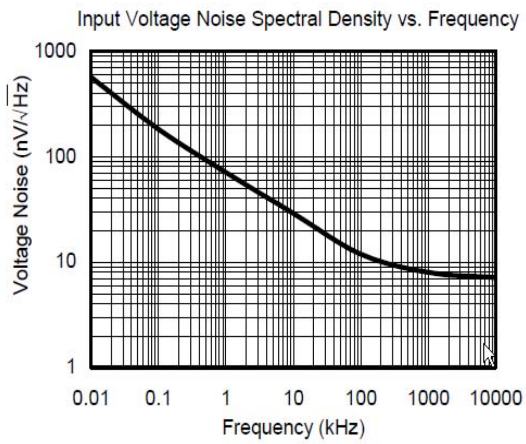

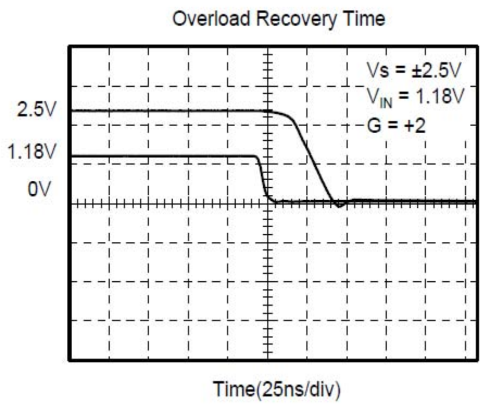

TYPICAL PERFORMANCE CHARACTERISTICS

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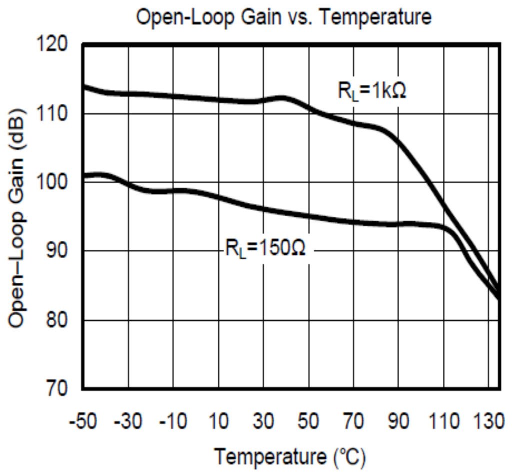
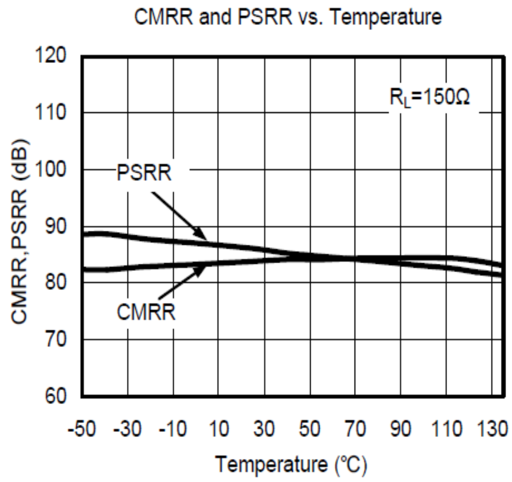
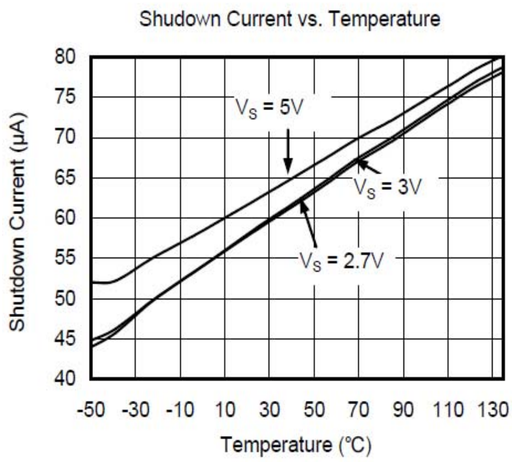
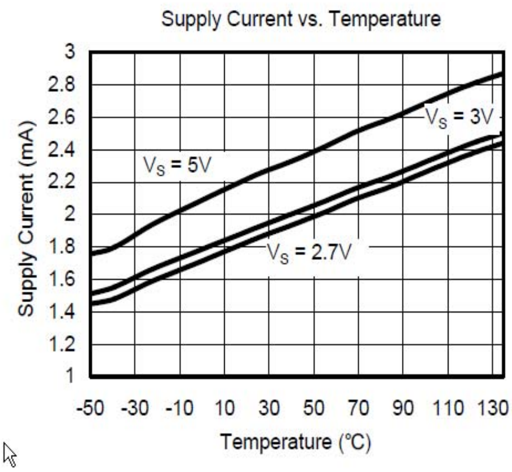
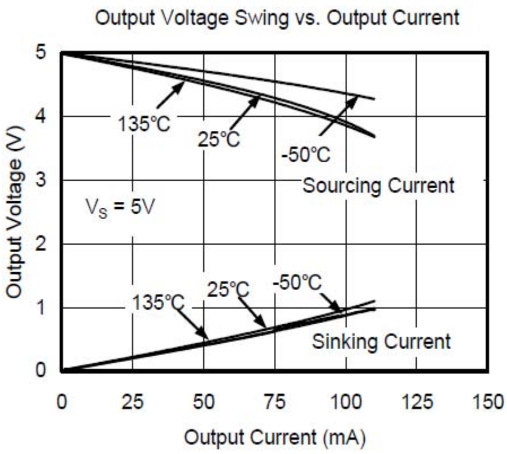
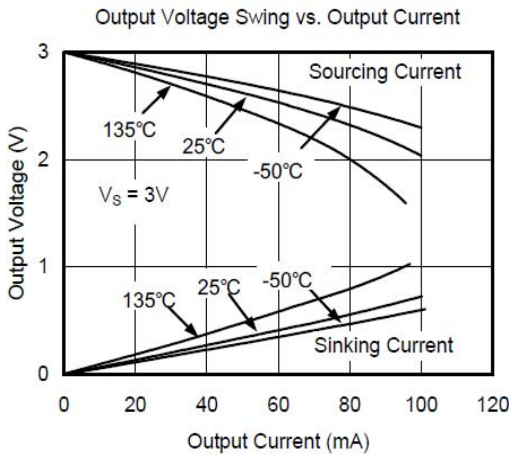






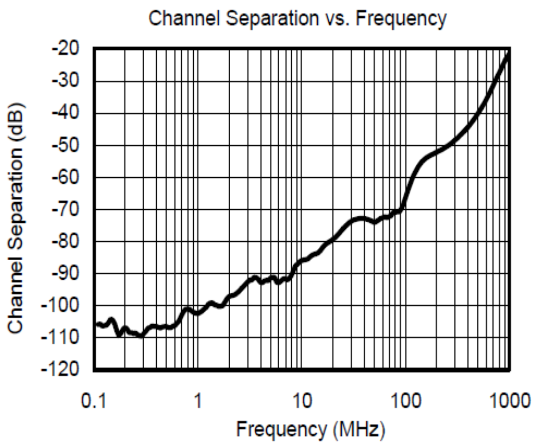


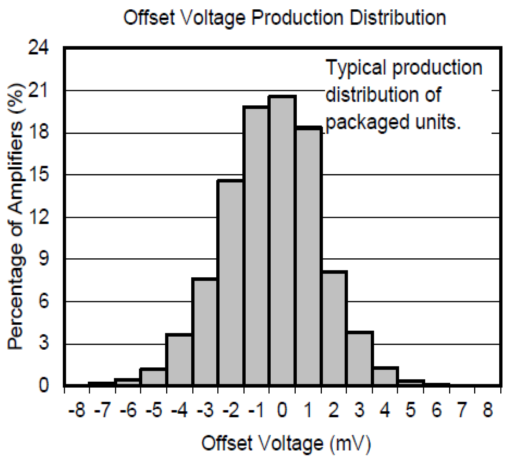

Output Voltage Swing vs. Output Current
Output Voltage (V)
Output Current (mA)
135°C
25°C
-50°C
Sourcing Current
V_S = 5V
Sinking Current
0
1
2
3
4
5
0
25
50
75
100
125
150


Output Voltage Swing vs. Output Current
Output Voltage (V)
Output Current (mA)
Sourcing Current
135°C
25°C
-50°C
V_S = 3V
Sinking Current
0
1
2
3
0
20
40
60
80
100
120

TYPICAL PERFORMANCE CHARACTERISTICS

condition：T_A = +25℃,V_S = +5V,R_F = 887Ω,R_G = 887Ω,R_L=150Ω to $V_S/2$, unless otherwise noted.





APPLICATION NOTES

Driving Capacitive Loads

The MS805x 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 1 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.

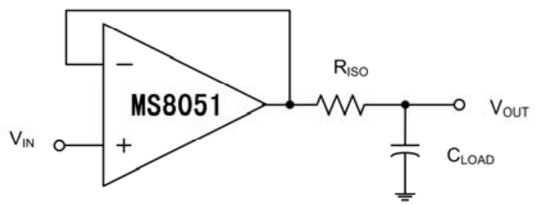


Figure 1. Series Resistor Isolating Capacitive Load

Power-Supply Bypassing and Layout

The MS805x operates from either a single +2.7V to +5.5V supply or dual ±1.35V to ±2.75V supplies. For single-supply operation, bypass the power supply +VS with a 0.1µF ceramic capacitor which should be placed close to the +VS pin. For dual-supply operation, both the +VS and the –VS supplies should be bypassed to ground with separate 0.1µF ceramic capacitors. 2.2µF tantalum capacitor can be added for better performance.

Good PC board layout techniques optimize performance by decreasing the amount of stray capacitance at the op amp's inputs and output. To decrease stray capacitance, minimize trace lengths and widths by placing external components as close to the device as possible. Use surface-mount components whenever possible. For the high speed operational amplifier, soldering the part to the board directly is strongly recommended. Try to keep the high frequency big current loop area small to minimize the EMI (electromagnetic interfacing).

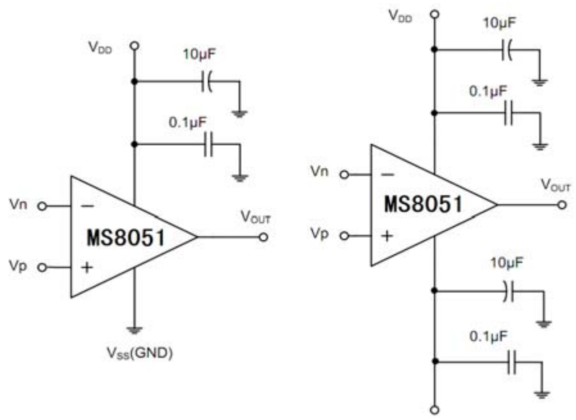


Figure 2. Amplifier with Bypass Capacitors

Grounding

A ground plane layer is important for high speed circuit design. The length of the current path speed currents in an inductive ground return will create an unwanted voltage noise. Broad ground plane areas will reduce the parasitic inductance.

Input-to-Output Coupling

To minimize capacitive coupling, the input and output signal traces should not be parallel. This helps reduce unwanted positive feedback.

TYPICAL APPLICATION CIRCUITS

Differential Amplifier

The circuit shown in Figure 3 performs the difference function. If the resistors ratios are equal ($R_4/R_3 = R_2/R_1$), then

$$V_{OUT} = (Vp - Vn) \times R_2/R_1 + V_{REF}$$

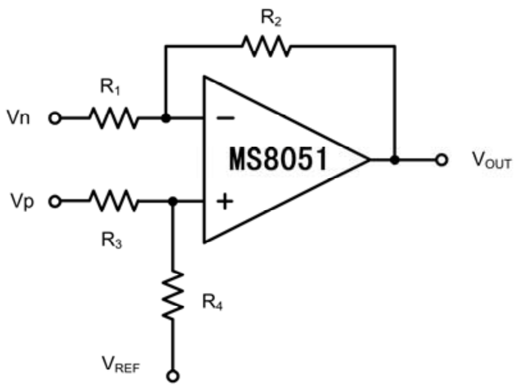


Figure 3. Differential Amplifier

Low Pass Active Filter

The low pass filter shown in Figure 4 has a DC gain of (-R2/R1)and the -3dB corner frequency is 1/2 R2C. Make sure the filter bandwidth is within the bandwidth of the amplifier. The largevalues of feedback resistors can couple with parasitic capacitance and cause undesired effects such as ringing or oscillation in high-speed amplifiers. Keep resistor values as low as possible and consistent with output loading consideration.

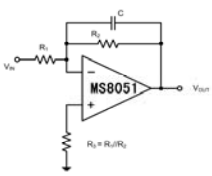


Figure 4. Low Pass Active Filter

Driving Video

The MS805x can be used in video applications like in Figure 5.

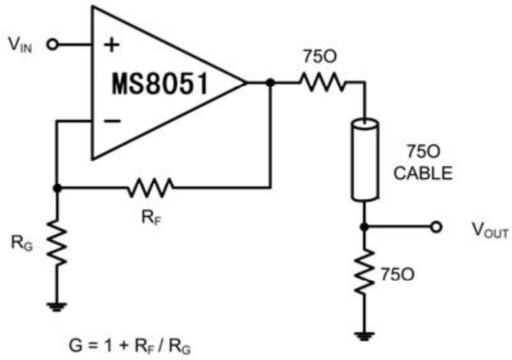
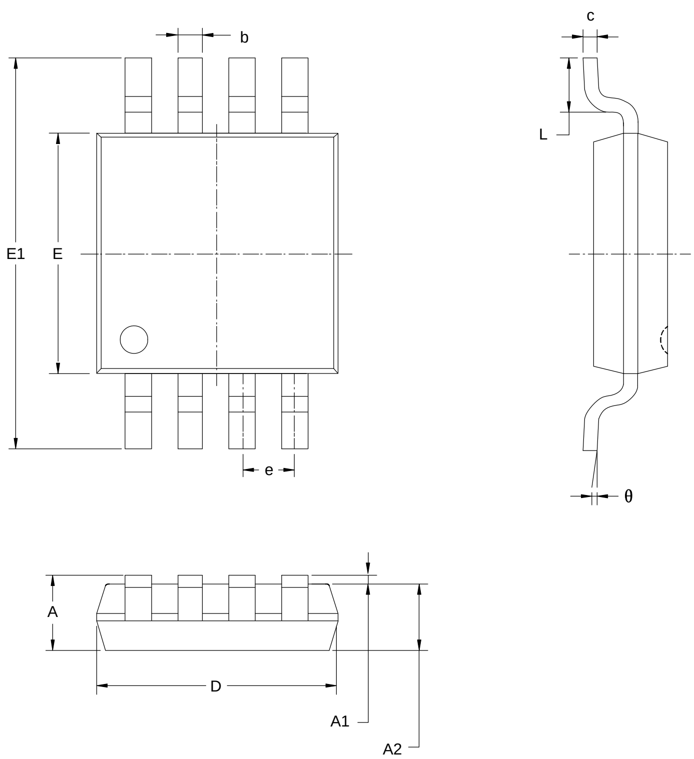


Figure 5. Typical Video Driving

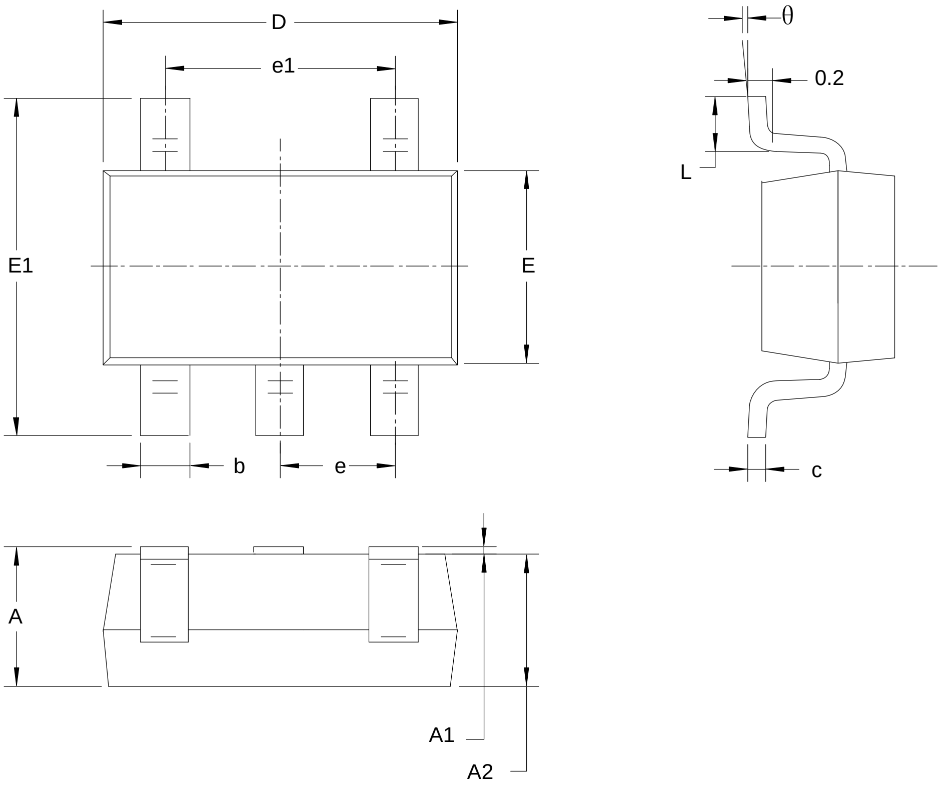
PACKAGE OUTLINE DIMENSIONS

MSOP-8



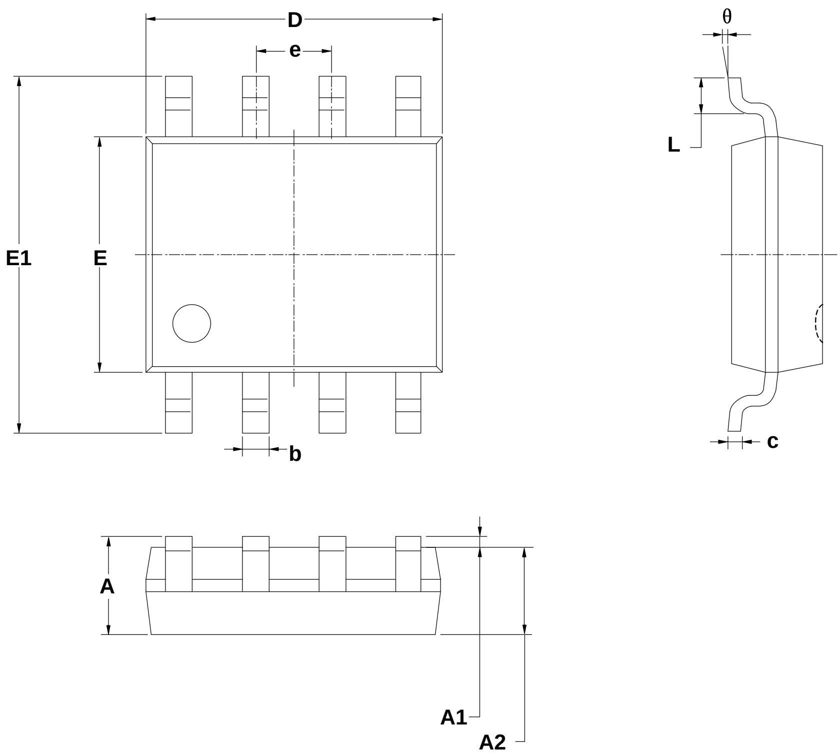
Symbol	Dimensions In Millimeters		Dimensions in Inches	
	min	max	min	max
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650BSC		0.026BSC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

SOT23-5



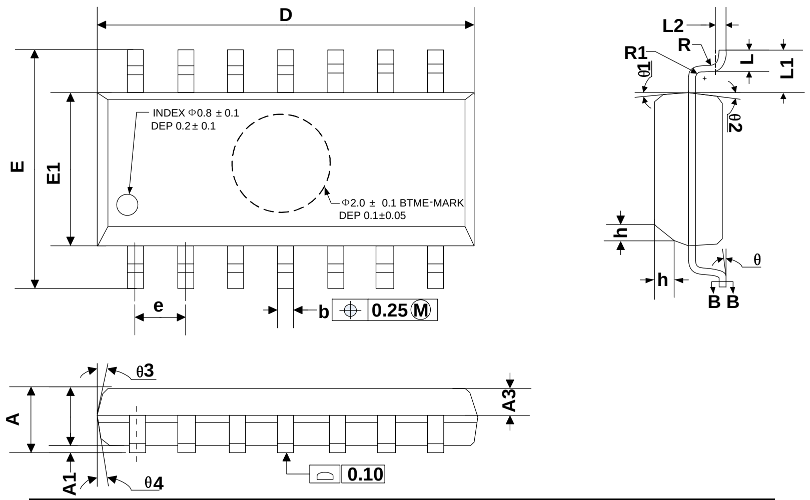
Symbol	Dimensions In Millimeters		Dimensions in Inches	
	min	max	min	max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.20	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950BSC		0.037BSC	
e1	1.900BSC		0.075BSC	
L	0.300	0.600	0.012	0.024
θ	0º	8º	0º	8º

SO-8



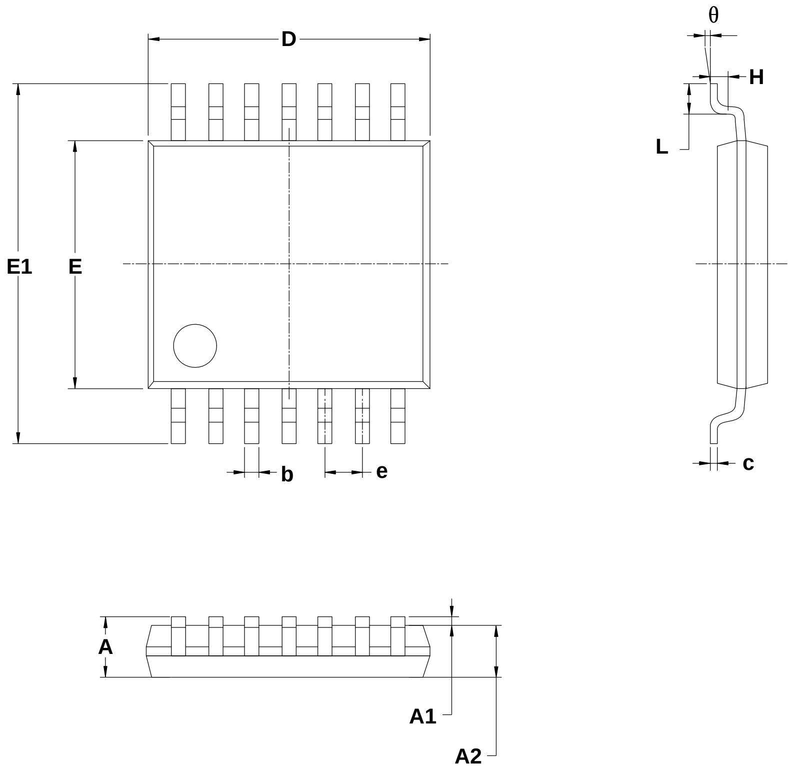
Symbol	Dimensions In Millimeters		Dimensions in Inches	
	min	max	min	max
A	1.350	1.750	0.053	0.069
A1	0.100	0.025	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050 BSC	
L	0.400	1.270	0.016	0.050
θ	0 º	8 º	0 º	8 º

SO-14



Symbol	Dimensions In Millimeters		
	min		min
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

TSSOP-14



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