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## FAN4852

# 9MHz Low-Power Dual CMOS Amplifier

### Features

- 0.8mA Supply Current
- 9 MHz Bandwidth
- Output Swing to within 10mV of Either Rail
- Input Voltage Range Exceeds the Rails
- 6V/ $\mu$ s Slew Rate
- 11nV/ $\sqrt{\text{Hz}}$  Input Voltage Noise
- Fully Specified at +3.3V and +5V Supplies

### Applications

- Piezoelectric Sensors
- PCMCIA, USB
- Mobile Communications / Battery-Powered Devices
- Notebooks and PDAs
- Active Filters
- Signal Conditioning
- Portable Test Instruments

### Description

The FAN4852 is a dual, rail-to-rail output, low-power, CMOS amplifier that consumes only 800 $\mu$ A of supply current, while providing  $\pm$ 50mA of output short-circuit current. This amplifier is designed to operate supplies from 2.5V to 5V.

Additionally, the FAN4852 is EMI hardened, which minimizes EMI interference. It has a maximum input offset voltage of 1mV and an input common-mode range that includes ground.

The FAN4852 is designed on a CMOS process and provides 9MHz of bandwidth and 6V/ $\mu$ s of slew rate. The combination of low-power, low-voltage operation and a small package make this amplifier well suited for general-purpose and battery-powered applications.

### Ordering Information

Part Number	Operating Temperature Range	Package	Packing Method
FAN4852IMU8X	-40 to +85°C	8-Lead MSOP Package	3000 on Tape and Reel

## Pin Configuration

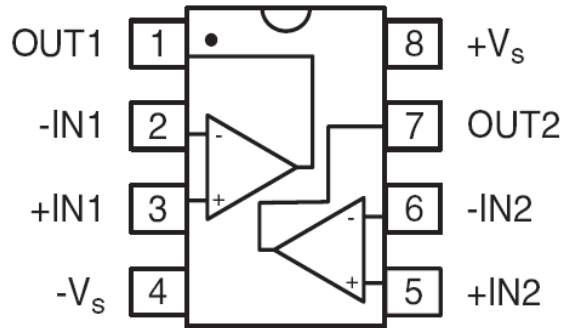


Figure 1. Pin Assignments

## Pin Definitions

Pin #	Name	Description
1	OUT1	Output, Channel 1
2	-IN1	Negative Input, Channel 1
3	+IN1	Positive Input, Channel 1
4	-Vs	Negative Supply
5	+IN2	Positive Input, Channel 2
6	-IN2	Negative Input, Channel 2
7	OUT2	Output, Channel 2
8	+Vs	Positive Supply

## Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only. Functional operation under any of these conditions is NOT implied. Performance and reliability are guaranteed only if operating conditions are not exceeded.

Symbol	Parameter	Min.	Max.	Unit
V <sub>CC</sub>	Supply Voltage	0	6	V
V <sub>IN</sub>	Input Voltage Range	-V <sub>S</sub> -0.5	+V <sub>S</sub> +0.5	V
T <sub>J</sub>	Junction Temperature		+150	°C
T <sub>STG</sub>	Storage Temperature	-65	+150	°C
T <sub>L</sub>	Lead Soldering, 10 Seconds		+260	°C
Θ <sub>JA</sub>	Thermal Resistance <sup>(1)</sup>		206	°C/W

### Note:

1. Package thermal resistance JEDEC standard, multi-layer test boards, still air.

## ESD Information

Symbol	Parameter	Min.	Typ.	Max.	Unit
ESD	Human Body Model, JESD22-A114		8		kV
	Charged Device Model, JESD22-C101		2		

## Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. Fairchild does not recommend exceeding them or designing to Absolute Maximum Ratings.

Symbol	Parameter	Min.	Typ.	Max.	Unit
T <sub>A</sub>	Operating Temperature Range	-40		+85	°C
V <sub>s</sub>	Supply Voltage Range	2.5	3.3	5.0	V

**Electrical Specifications at +3.3V**

+V<sub>S</sub>=+3.3V, -V<sub>S</sub> = 0V, V<sub>CM</sub> = +V<sub>S</sub>/2, and R<sub>L</sub> = 10KΩ to +V<sub>S</sub>/2, unless otherwise noted.

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
I <sub>S</sub>	Supply Current <sup>(2)</sup>	T <sub>A</sub> =25°C		0.8	1.0	mA
		Full Temperature Range			1.1	
I <sub>SC</sub>	Short-Circuit Output Current <sup>(2)</sup>	Sourcing V <sub>O</sub> =V <sub>CM</sub> , V <sub>IN</sub> =100mV, T <sub>A</sub> =25°C	25	50		mA
		Sourcing V <sub>O</sub> =V <sub>CM</sub> , V <sub>IN</sub> =100mV, Full Temperature Range	20			
		Sinking V <sub>O</sub> =V <sub>CM</sub> , V <sub>IN</sub> =-100mV, T <sub>A</sub> =25°C	28	46		
		Sinking V <sub>O</sub> =V <sub>CM</sub> , V <sub>IN</sub> =-100mV, Full Temperature Range	20			
EMIRR	EMI Rejection Ratio, +IN and -IN <sup>(4)</sup>	V <sub>RFpeak</sub> =100mVp, (-20dBVp) f=400MHz		75		dB
		V <sub>RFpeak</sub> =100mVp, (-20dBVp) f=900MHz		78		
		V <sub>RFpeak</sub> =100mVp, (-20dBVp) f=1800MHz		87		
PSRR	Power Supply Rejection Ratio <sup>(2)</sup>	2.7V≤V+≤3.3V, V <sub>O</sub> =1V, T <sub>A</sub> =25°C	75	95		dB
		2.7V≤V+≤3.3V, V <sub>O</sub> =1V, Full Temperature Range	74			
CMRR	Common Mode Rejection Ratio <sup>(2)</sup>	-0.2V<V <sub>CM</sub> <V+1.2V, T <sub>A</sub> =25°C	76	117		dB
		-0.2V<V <sub>CM</sub> <V+1.2V, Full Temperature Range	75			
CMIR	Input Common Mode Voltage Range <sup>(2)</sup>	CMRR≥76dB	-0.2		2.1	V
V <sub>OS</sub>	Input Offset Voltage <sup>(2)</sup>	T <sub>A</sub> =25°C		±0.3	±1.0	mV
		Full Temperature Range			±1.2	
dV <sub>IO</sub>	Average Drift <sup>(3)</sup>			±0.4	±2.0	μV/°C
I <sub>OS</sub>	Input Offset Current			1		pA
		T <sub>A</sub> =				
I <sub>bn_Char</sub>	Input Bias Current <sup>(3)</sup>	T <sub>A</sub> =25°C		0.1	10.0	pA
		Full Temperature Range			500	
e <sub>n</sub>	Input-Referred Voltage Noise	f=1kHz		11		nV/√Hz
		f=10kHz		10		
i <sub>n</sub>	Input-Referred Current Noise	f=1kHz		0.005		pA/√Hz

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## Electrical Specifications at +3.3V

+V<sub>S</sub>=+3.3V, -V<sub>S</sub> = 0V, V<sub>CM</sub> = +V<sub>S</sub>/2, and R<sub>L</sub> = 10kΩ to +V<sub>S</sub>/2, unless otherwise noted.

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit	
V <sub>O</sub>	Output Voltage Swing High <sup>(2)</sup> V <sub>O</sub> = (+V <sub>S</sub> ) - V <sub>OUT</sub>	R <sub>L</sub> =2kΩ to V+/2, T <sub>A</sub> =25°C		21	35	mV	
		R <sub>L</sub> =2kΩ to V+/2, Full Temperature Range			43		
		R <sub>L</sub> =10kΩ to V+/2, T <sub>A</sub> =25°C		4	10		
		R <sub>L</sub> =10kΩ to V+/2, Full Temperature Range			12		
	Output Voltage Swing Low <sup>(2)</sup> V <sub>O</sub> = V <sub>OUT</sub> + (-V <sub>S</sub> )	R <sub>L</sub> =2kΩ to V+/2, T <sub>A</sub> =25°C			20	32	mV
		R <sub>L</sub> =2kΩ to V+/2, Full Temperature Range				43	
		R <sub>L</sub> =10kΩ to V+/2, T <sub>A</sub> =25°C		3	11		
		R <sub>L</sub> =10kΩ to V+/2, Full Temperature Range				14	
GBW	Gain Bandwidth Product			9		MHz	
A <sub>VOL</sub>	Large Signal Voltage Gain <sup>(3)</sup>	R <sub>L</sub> =2kΩ, V <sub>O</sub> =0.15 to 1.65V, V <sub>O</sub> =3.15 to 1.65V, T <sub>A</sub> =25°C	100	114		dB	
		R <sub>L</sub> =2kΩ, V <sub>O</sub> =0.15 to 1.65V, V <sub>O</sub> =3.15 to 1.65V, Full Temperature Range	97				
		R <sub>L</sub> =10kΩ, V <sub>O</sub> =0.1 to 1.65V, V <sub>O</sub> =3.2 to 1.65V, T <sub>A</sub> =25°C	100	115			
		R <sub>L</sub> =10kΩ, V <sub>O</sub> =0.1 to 1.65V, V <sub>O</sub> =3.2 to 1.65V, Full Temperature Range	97				
R <sub>OUT</sub>	Closed-Loop Impedance	f=6MHz		6		Ω	
R <sub>IN</sub>	Input Resistance			10		GΩ	
C <sub>IN</sub>	Input Capacitance	Common Mode		11		pF	
		Differential Mode		6			
Φ <sub>M</sub>	Phase Margin			86		°	
SR	Slew Rate	A <sub>v</sub> =+1, V <sub>O</sub> =1V <sub>pp</sub> 10%-90%		6.1		V/μs	
THD+N	Total Harmonic Distortion + Noise	f=1kHz, A <sub>v</sub> =1, BW=>500kHz		0.006		%	

### Notes:

- 100% tested at T<sub>A</sub>=25°C.
- Guaranteed by characterization.
- EMI rejection ratio is defined as EMIRR – 20log (V<sub>RFpeak</sub> / ΔV<sub>OS</sub>).

**Electrical Specifications at +5V**

+V<sub>S</sub>=+5V, -V<sub>S</sub>=0V, V<sub>CM</sub>=+V<sub>S</sub>/2, and R<sub>L</sub>=10KΩ to +V<sub>S</sub>/2, unless otherwise noted.

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
I <sub>S</sub>	Supply Current <sup>(5)</sup>	T <sub>A</sub> =25°C		0.9	1.1	mA
		Full Temperature Range			1.2	
I <sub>SC</sub>	Short-Circuit Output Current <sup>(5)</sup>	Sourcing V <sub>O</sub> =V <sub>CM</sub> , V <sub>IN</sub> =100mV, T <sub>A</sub> =25°C	60	90		mA
		Sourcing V <sub>O</sub> =V <sub>CM</sub> , V <sub>IN</sub> =100mV, Full Temperature Range	48			
		Sinking V <sub>O</sub> =V <sub>CM</sub> , V <sub>IN</sub> =-100mV, T <sub>A</sub> =25°C	58	90		
		Sinking V <sub>O</sub> =V <sub>CM</sub> , V <sub>IN</sub> =-100mV, Full Temperature Range	44			
EMIRR	EMI Rejection Ratio, +IN and -IN <sup>(7)</sup>	V <sub>RFpeak</sub> =100mVp, (-20dBVp) f=400MHz		75		dB
		V <sub>RFpeak</sub> =100mVp, (-20dBVp) f=900MHz		78		
		V <sub>RFpeak</sub> =100mVp, (-20dBVp) f=1800MHz		87		
PSRR	Power Supply Rejection Ratio <sup>(5)</sup>	2.7V≤V+≤5.5V, V <sub>O</sub> =1V, T <sub>A</sub> =25°C	75	105		dB
		2.7V≤V+≤5.5V, V <sub>O</sub> =1V, Full Temperature Range	74			
CMRR	Common Mode Rejection Ratio <sup>(5)</sup>	-0.2V≤V <sub>CM</sub> ≤V+ -1.2V	77	122		dB
CMIR	Input Common Mode Voltage Range <sup>(5)</sup>	CMRR≥77dB	-0.2		3.8	V
V <sub>OS</sub>	Input Offset Voltage <sup>(5)</sup>	T <sub>A</sub> =25°C		±0.3	±1.0	mV
		Full Temperature Range			±1.2	
dV <sub>IO</sub>	Average Drift <sup>(6)</sup>			±0.4	±2.0	μV/°C
I <sub>OS</sub>	Input Offset Current			1		pA
I <sub>bn_Char</sub>	Input Bias Current <sup>(6)</sup>	T <sub>A</sub> =				pA
		T <sub>A</sub> =25°C		0.1	10.0	
e <sub>n</sub>	Input-Referred Voltage Noise	Full Temperature Range			500	
		f=1kHz		11		nV/√Hz
i <sub>n</sub>	Input-Referred Current Noise	f=10kHz		10		nV/√Hz
		f=1kHz		0.005		pA/√Hz

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**Electrical Specifications at +5V**

+V<sub>S</sub>=+5V, -V<sub>S</sub> = 0V, V<sub>CM</sub> = +V<sub>S</sub>/2, and R<sub>L</sub> = 10kΩ to +V<sub>S</sub>/2, unless otherwise noted.

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
V <sub>O</sub>	Output Voltage Swing High <sup>(5)</sup>	R <sub>L</sub> =2kΩ to V+/2, T <sub>A</sub> =25°C		25	39	mV
		R <sub>L</sub> =2kΩ to V+/2, Full Temperature Range			47	
		R <sub>L</sub> =10kΩ to V+/2, T <sub>A</sub> =25°C		4	11	
		R <sub>L</sub> =10kΩ to V+/2, Full Temperature Range			13	
	Output Voltage Swing Low <sup>(5)</sup>	R <sub>L</sub> =2kΩ to V+/2, T <sub>A</sub> =25°C		24	38	mV
		R <sub>L</sub> =2kΩ to V+/2, Full Temperature Range			50	
		R <sub>L</sub> =10kΩ to V+/2, T <sub>A</sub> =25°C		3	15	
		R <sub>L</sub> =10kΩ to V+/2, Full Temperature Range			1	
GBW	Gain Bandwidth Product			9		MHz
A <sub>VOL</sub>	Large Signal Voltage Gain <sup>(6)</sup>	R <sub>L</sub> =2kΩ, V <sub>O</sub> =0.15 to 2.5V, V <sub>O</sub> =4.85 to 2.5V, T <sub>A</sub> =25°C	105	118		dB
		R <sub>L</sub> =2kΩ, V <sub>O</sub> =0.15 to 2.5V, V <sub>O</sub> =4.85 to 2.5V, Full Temperature Range	102			
		R <sub>L</sub> =10kΩ, V <sub>O</sub> =0.1 to 2.5V, V <sub>O</sub> =4.9 to 2.5V, T <sub>A</sub> =25°C	105	120		
		R <sub>L</sub> =10kΩ, V <sub>O</sub> =0.1 to 2.5V, V <sub>O</sub> =4.9 to 2.5V, Full Temperature Range	102			
R <sub>OUT</sub>	Closed-Loop Impedance	f=6MHz		6		Ω
R <sub>IN</sub>	Input Resistance			10		GΩ
C <sub>IN</sub>	Input Capacitance	Common Mode		11		pF
		Differential Mode		6		
Φ <sub>M</sub>	Phase Margin			94		°
SR	Slew Rate	A <sub>v</sub> =+1, V <sub>O</sub> =1V <sub>pp</sub> 10%-90%		6.2		V/μs
THD+N	Total Harmonic Distortion + Noise	f=1kHz, A <sub>v</sub> =1, BW=>500kHz		0.006		%

**Notes:**

- 100% tested at T<sub>A</sub>=25°C.
- Guaranteed by characterization.
- EMI rejection ratio is defined as EMIRR – 20log (V<sub>RFpeak</sub> / ΔV<sub>OS</sub>).



## Typical Performance Characteristics

+V<sub>S</sub>=+3.3V, -V<sub>S</sub>= 0V, V<sub>CM</sub> = +V<sub>S</sub>/2, and R<sub>L</sub> = 10KΩ to +V<sub>S</sub>/2, unless otherwise noted.

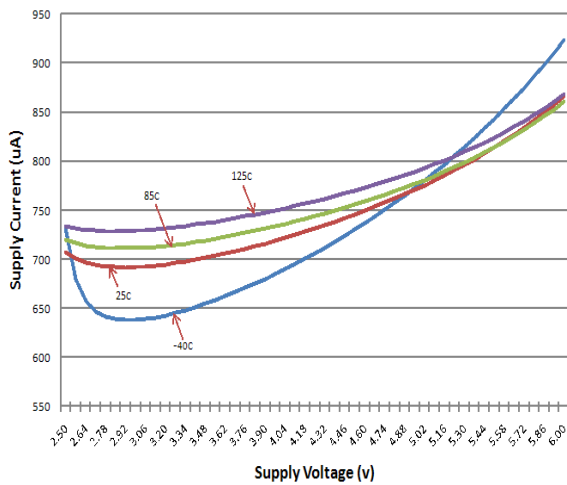


Figure 2. Supply Current vs. Supply Voltage

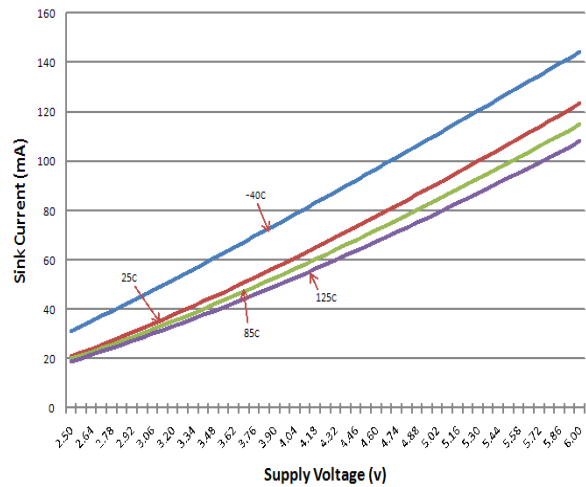


Figure 3. Sink Current vs. Supply Voltage

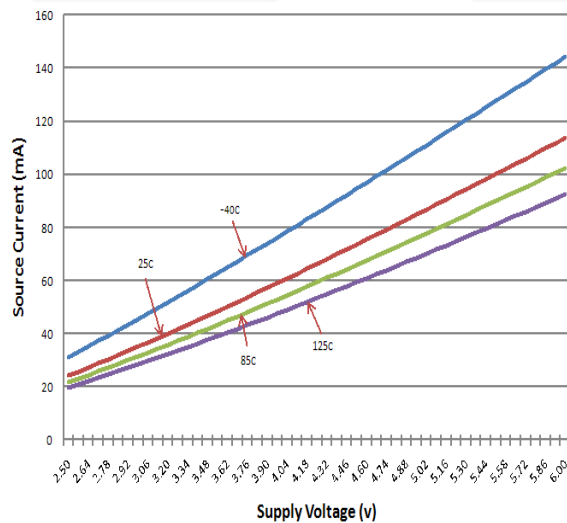


Figure 4. Source Current vs. Supply Voltage

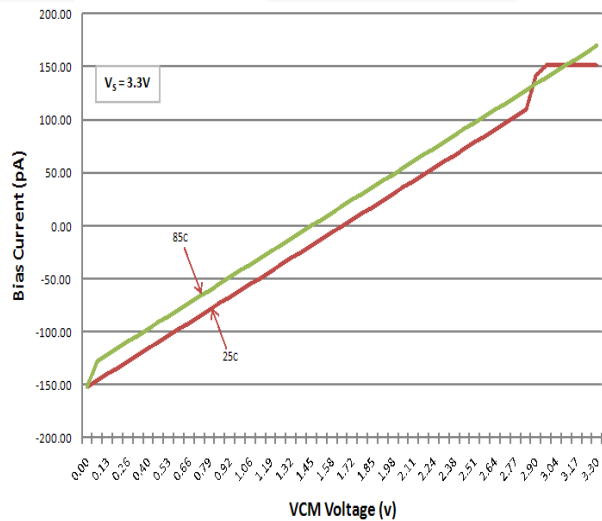


Figure 5. Input Bias Current vs. V<sub>CM</sub> (3.3V)

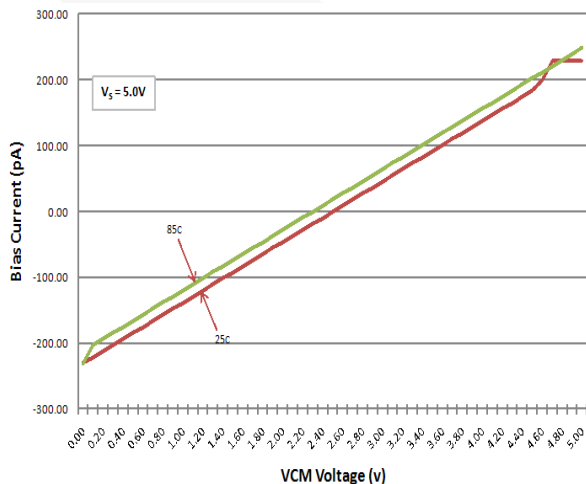


Figure 6. Input Bias Current vs. V<sub>CM</sub> (5.0V)

## Typical Performance Characteristics

$+V_S = +3.3V$ ,  $-V_S = 0V$ ,  $V_{CM} = +V_S/2$ , and  $R_L = 10K\Omega$  to  $+V_S/2$ , unless otherwise noted.

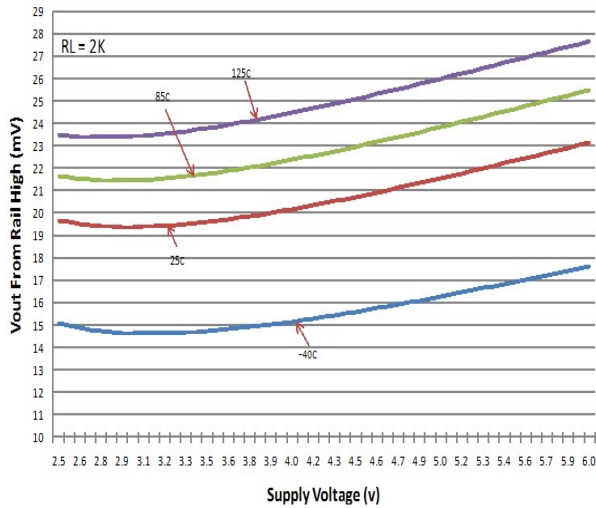


Figure 7. Output Swing High vs. Supply Voltage

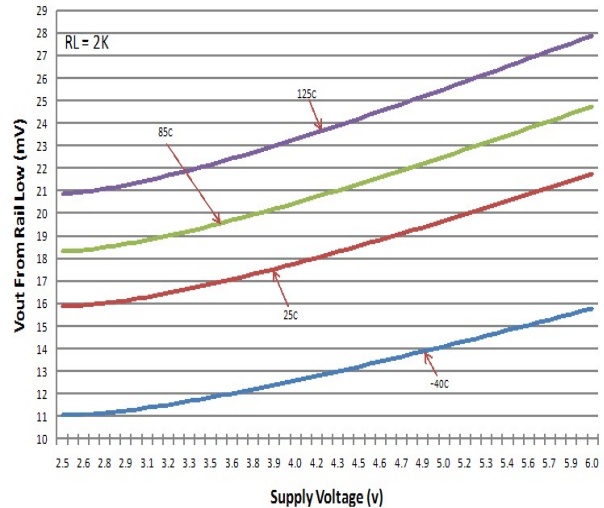


Figure 8. Output Swing Low vs. Supply Voltage

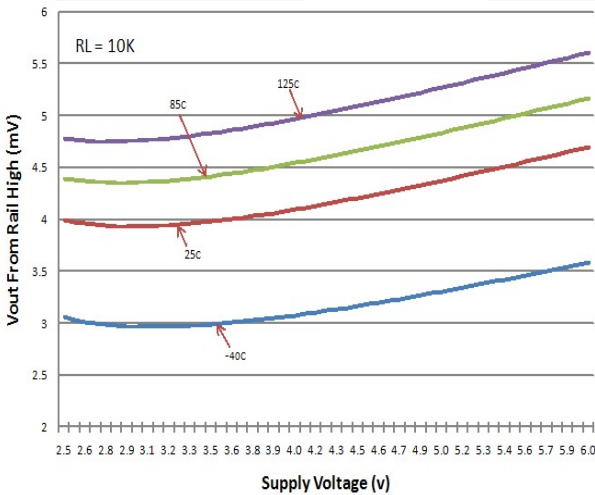


Figure 9. Output Swing High vs. Supply Voltage

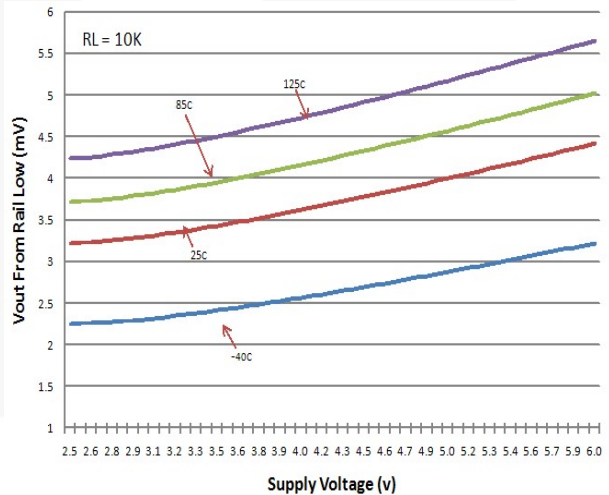


Figure 10. Output Swing Low vs. Supply Voltage

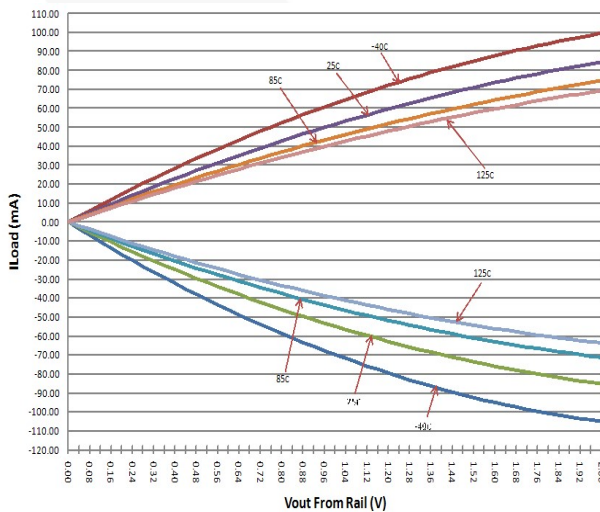


Figure 11. Output Voltage Swing vs. Load Current at 5.0V

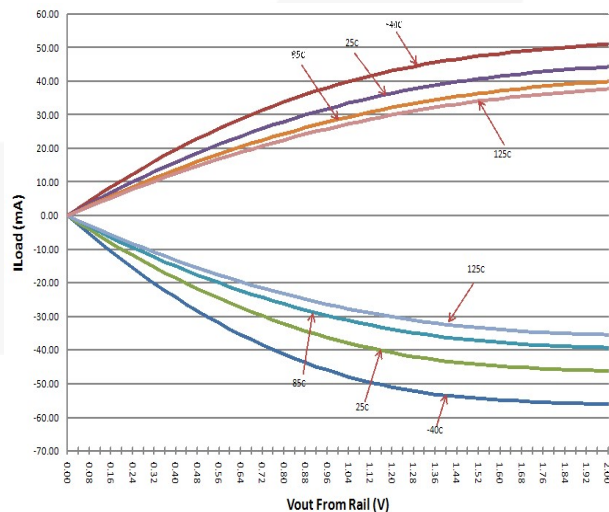


Figure 12. Output Voltage Swing vs. Load Current at 3.3V

### Typical Performance Characteristics

+V<sub>S</sub>=+3.3V, -V<sub>S</sub>= 0V, V<sub>CM</sub> = +V<sub>S</sub>/2, and R<sub>L</sub> = 10KΩ to +V<sub>S</sub>/2, unless otherwise noted.

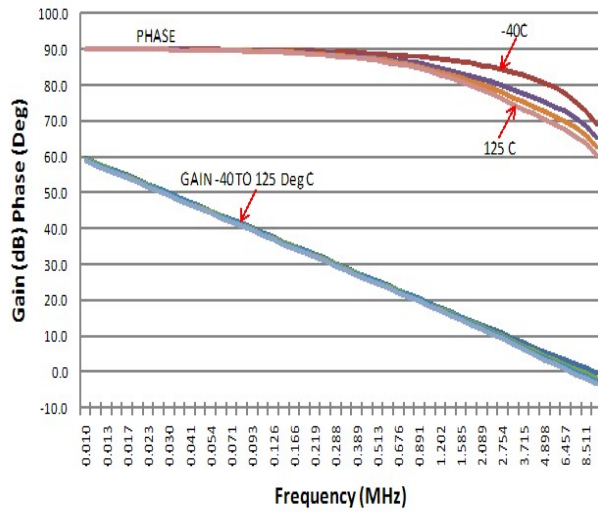


Figure 13. Open-Loop Gain/Phase vs. Temperature

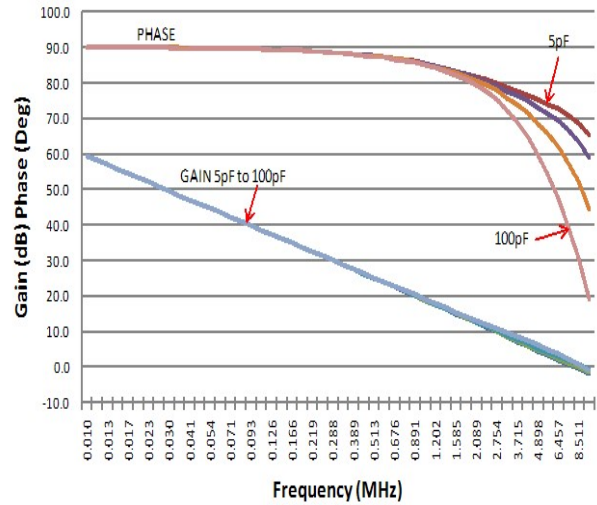


Figure 14. Open-Loop Gain/Phase vs. Load

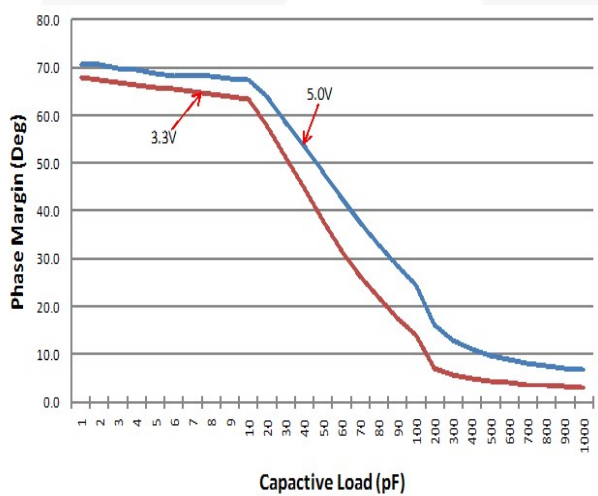


Figure 15. Phase Margin vs. Capacitive Load

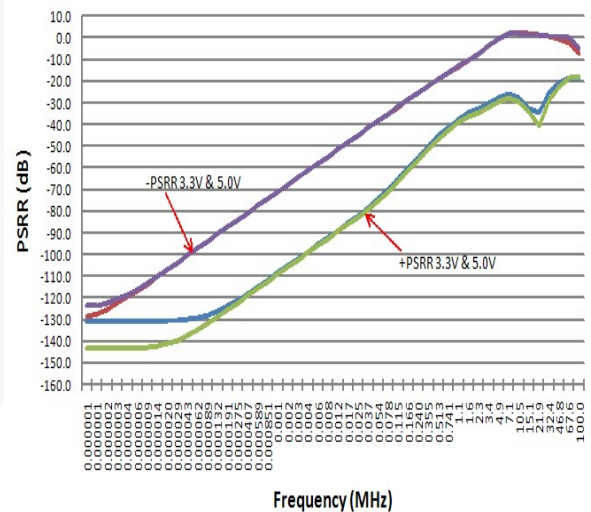


Figure 16. PSRR vs. Frequency

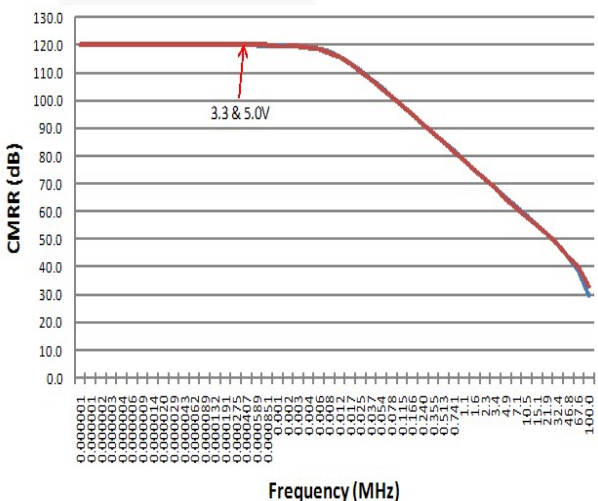


Figure 17. CMRR vs. Frequency

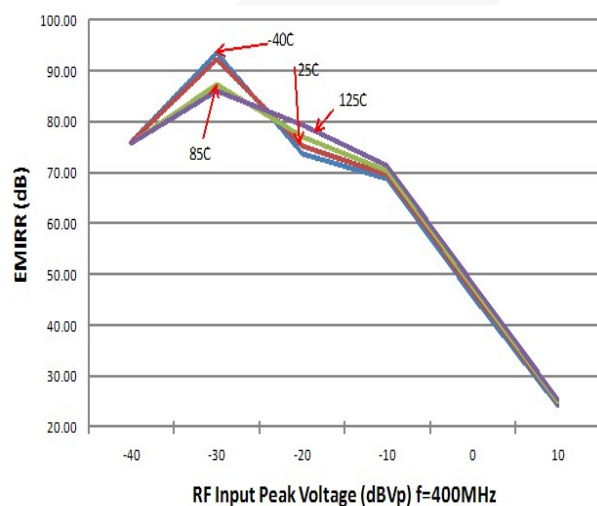


Figure 18. EMIRR vs. Power at 400MHz

### Typical Performance Characteristics

+V<sub>S</sub>=+3.3V, -V<sub>S</sub>= 0V, V<sub>CM</sub> = +V<sub>S</sub>/2, and R<sub>L</sub> = 10KΩ to +V<sub>S</sub>/2, unless otherwise noted.

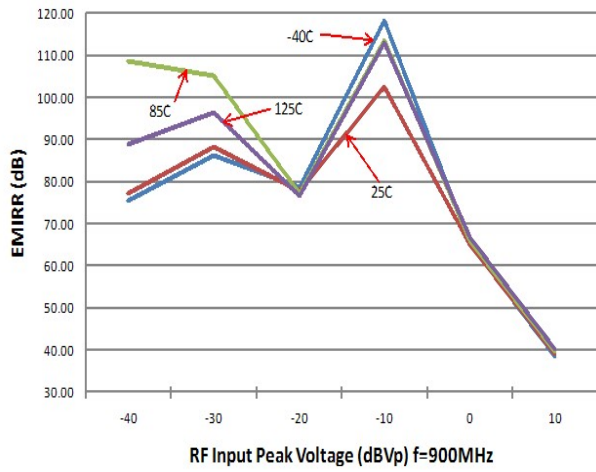


Figure 19. EMIRR vs. Power at 900MHz

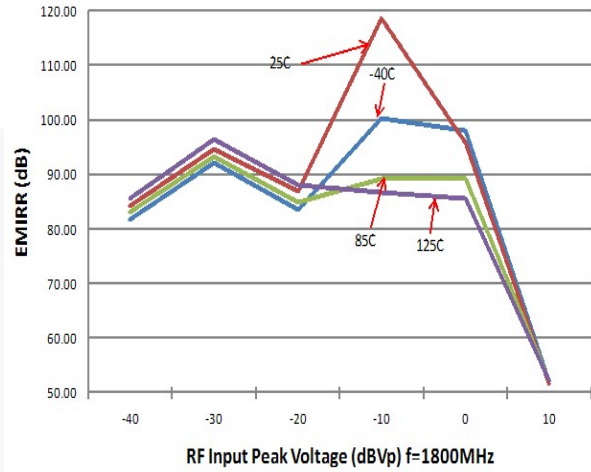


Figure 20. EMIRR vs. Power at 1800MHz

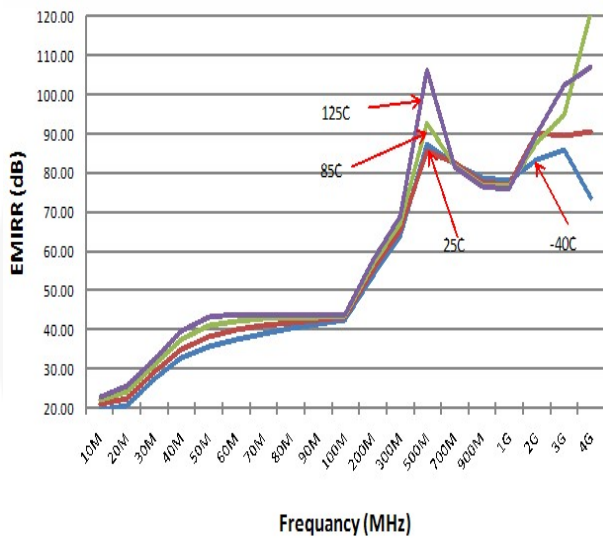


Figure 21. EMIRR vs. Frequency at 5.0V

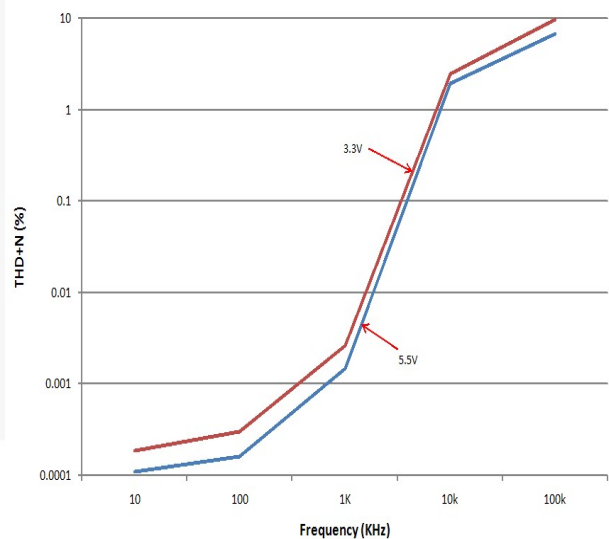


Figure 22. THD+N vs. Frequency

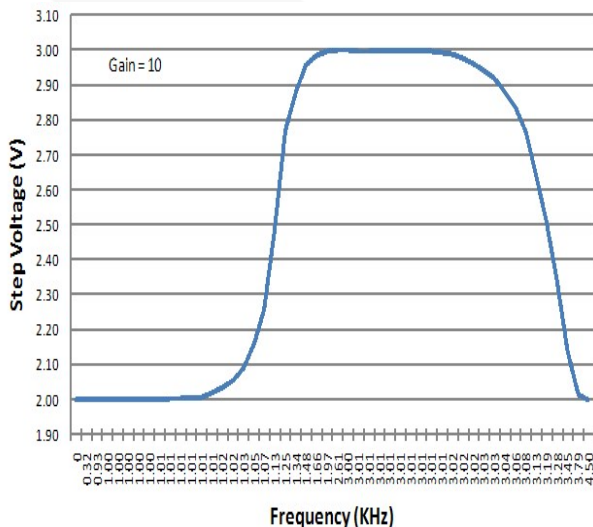


Figure 23. Large Signal Step Response

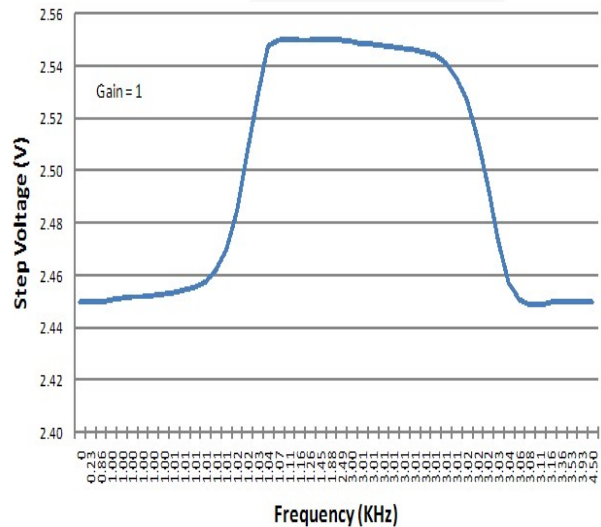


Figure 24. Small Signal Step Response

## Typical Performance Characteristics

+V<sub>S</sub>=+3.3V, -V<sub>S</sub>= 0V, V<sub>CM</sub> = +V<sub>S</sub>/2, and R<sub>L</sub> = 10KΩ to +V<sub>S</sub>/2, unless otherwise noted.

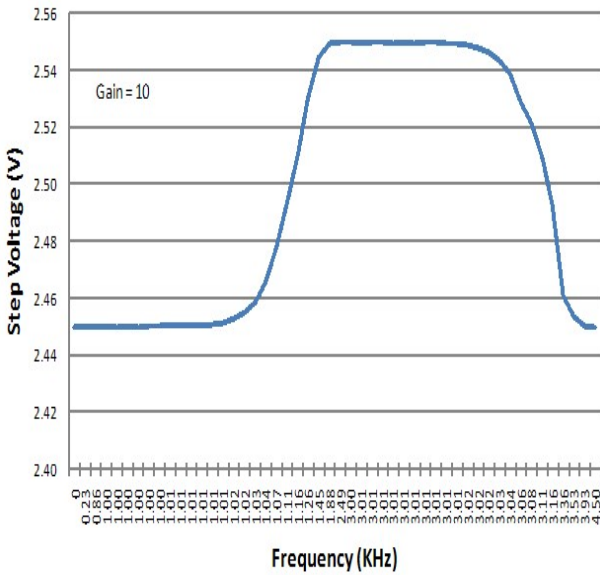


Figure 25. Small Signal Step Response

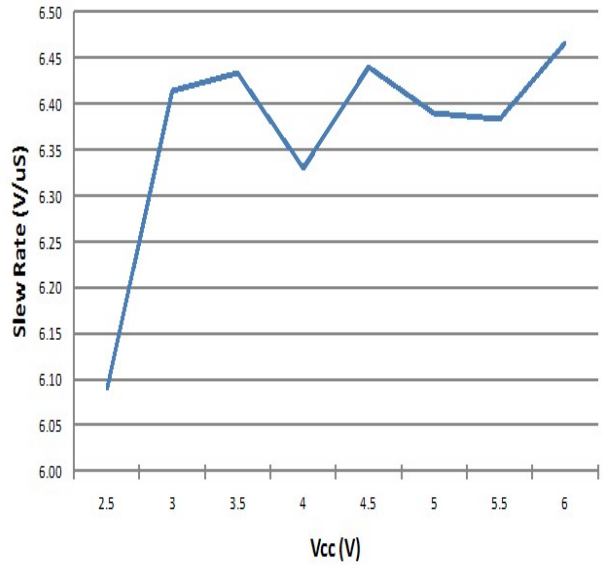


Figure 26. Slew Rate vs. Supply Voltage

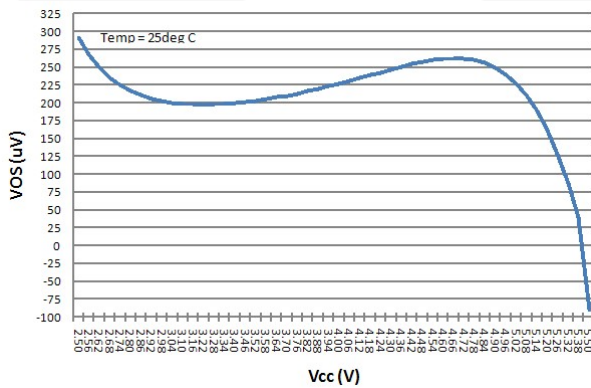


Figure 27. Vos vs. Supply Voltage

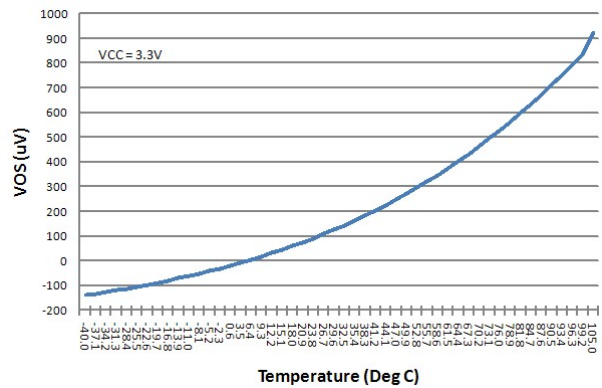


Figure 28. Vos vs. Temperature

## Application Information

### General Description

The FAN4852 amplifier includes single-supply, general-purpose amplifiers, fabricated on a CMOS process. The input and output are rail-to-rail and the part is unity gain stable. The typical non-inverting circuit schematic is shown in Figure 29.

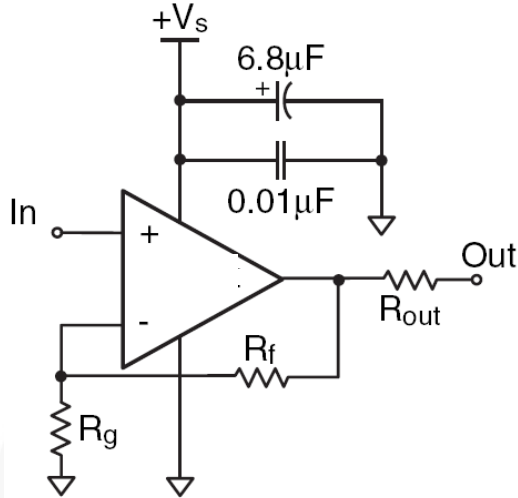


Figure 29. Typical Non-Inverting Configuration

### Input Common Mode Voltage

The common mode input range includes ground. CMRR does not degrade when input levels are kept 1.2V below the rail. For the best CMRR when using a  $V_s$  of 5V, the maximum input voltage should be 3.8V.

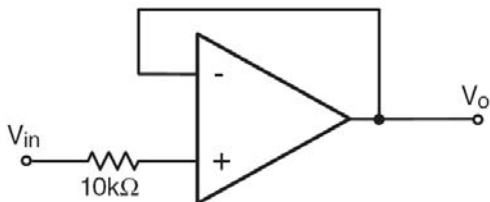


Figure 30. Circuit for Input Current Protection

### Power Dissipation

The maximum internal power dissipation allowed is directly related to the maximum junction temperature. If the maximum junction temperature exceeds 150°C, performance degradation occurs. If the maximum junction temperature exceeds 150°C for an extended time, device failure may occur.

### Overdrive Recovery

Overdrive of an amplifier occurs when the output and/or input ranges are exceeded. The recovery time varies based on whether the input or output is overdriven and by how much the range is exceeded. The FAN4852 typically recovers in less than 500ns from an overdrive condition. Figure 31 shows the FAN4852 amplifier in an overdriven condition.

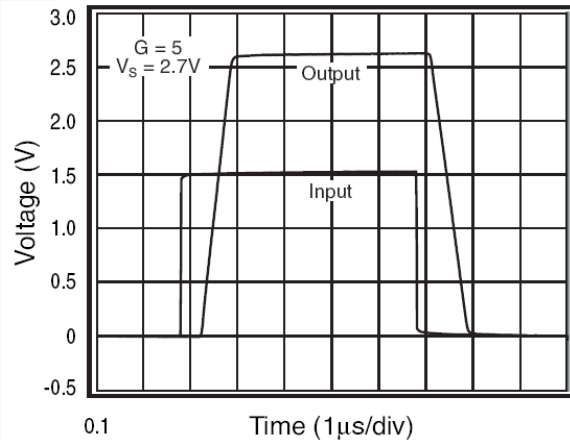


Figure 31. Overdrive Recovery

### Driving Capacitive Loads

Figure 31 illustrates the response of the amplifier. A small series resistance ( $R_s$ ) at the output, illustrated in Figure 32, improves stability and settling performance.  $R_s$  values provided achieve maximum bandwidth with less than 2dB of peaking. For maximum flatness, use a larger  $R_s$ . Capacitive loads larger than 500pF require the use of  $R_s$ .

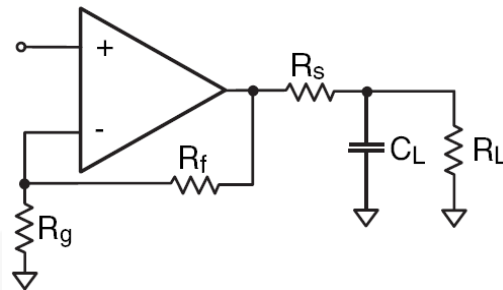


Figure 32. Typical Topology for Driving a Capacitive Load

Driving a capacitive load introduces phase-lag into the output signal, which reduces phase margin in the amplifier. The unity gain follower is the most sensitive configuration. In a unity gain follower configuration, the amplifier requires a 300Ω series resistor to drive a 100pF load.

## Layout Considerations

General layout and supply bypassing play major roles in high-frequency performance. Fairchild evaluation boards help guide high-frequency layout and aid in device testing and characterization. Follow the steps below as a basis for high-frequency layout:

1. Include 6.8 $\mu$ F and 0.01 $\mu$ F ceramic capacitors.
2. Place the 6.8 $\mu$ F capacitor within 0.75 inches of the power pin.
3. Place the 0.01 $\mu$ F capacitor within 0.1 inches of the power pin.
4. Remove the ground plane under and around the part, especially near the input and output pins, to reduce parasitic capacitance.

Minimize all trace lengths to reduce series inductances.

Refer to the evaluation board layouts shown in Figure 33 for more information.

When evaluating only one channel, complete the following on the unused channel:

1. Ground the non-inverting input.
2. Short the output to the inverting input.

Evaluation Board	Description
FAN4852-010	Single Channel, Dual Supply

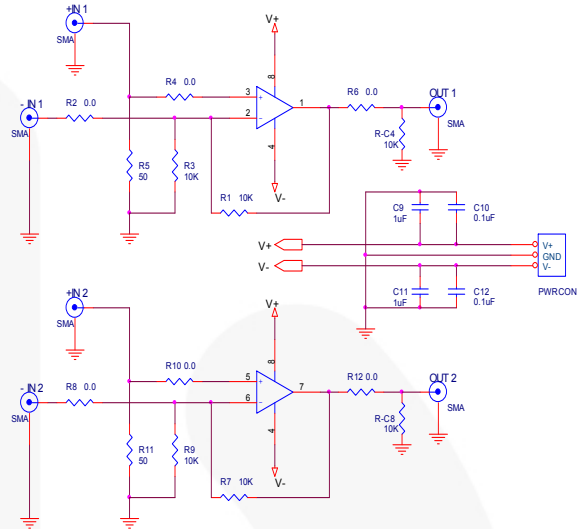
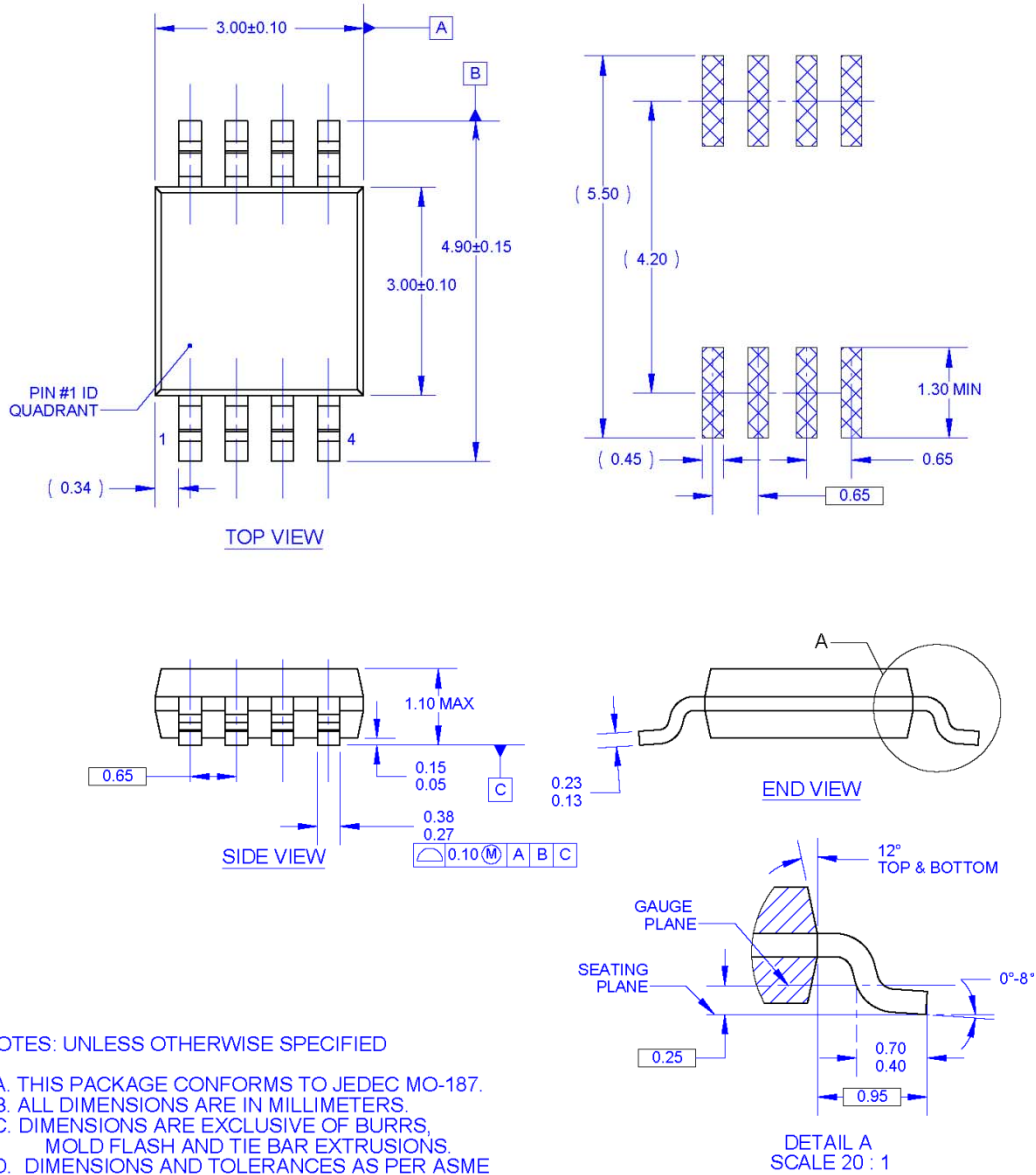


Figure 33. Evaluation Board Schematic

## Physical Dimensions



**Figure 34. 8-Lead, Molded Small-Outline Package (MSOP)**

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
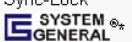
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