MICREL

The Infinite Bandwidth Company™

MIC913

350MHz Low-Power SOT-23-5 Op Amp

General Description

The MIC913 is a high-speed, operational amplifier. It provides a gain-bandwidth product of 350MHz with a very low, 4.2mA supply current, and features the tiny SOT-23-5 package.

Supply voltage range is from ±2.5V to ±9V, allowing the MIC913 to be used in low-voltage circuits or applications requiring large dynamic range.

The MIC913 requires a minimum gain of +2 or –1 but is stable driving any capacitative load and achieves excellent PSRR, making it much easier to use than most conventional high-speed devices. Low supply voltage, low power consumption, and small packing make the MIC913 ideal for portable equipment. The ability to drive capacitative loads also makes it possible to drive long coaxial cables.

Features

- 350MHz gain bandwidth product
- 4.2mA supply current
- SOT-23-5 package
- 500V/µs slew rate
- Drives any capacitive load
- Low distortion
- Stable with gain of +2 or –1

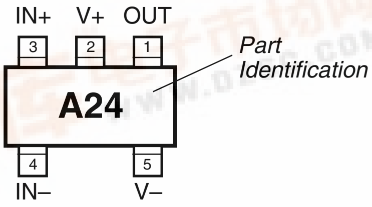
Applications

- Video
- Imaging
- Ultrasound
- Portable equipment
- Line drivers
- XDSL

Ordering Information

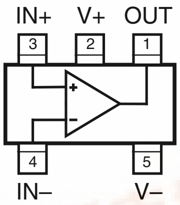
Part Number	Junction Temp. Range	Package
MIC913BM5	–40°C to +85°C	SOT-23-5

Pin Configuration



SOT-23-5

Functional Pinout



SOT-23-5

Pin Description

Pin Number	Pin Name	Pin Function
1	OUT	Output: Amplifier Output
2	V+	Positive Supply (Input)
3	IN+	Noninverting Input
4	IN–	Inverting Input
5	V–	Negative Supply (Input)

Absolute Maximum Ratings (Note 1)

Supply Voltage ($V_{V+} - V_{V-}$)	20V
Differential Input Voltage ($\lvert V_{IN+} - V_{IN-} \rvert$)	4V, **Note 3**
Input Common-Mode Range (V_{IN+}, V_{IN-})	V_{V+} to V_{V-}
Lead Temperature (soldering, 5 sec.)	260°C
Storage Temperature (T_S)	150°C
ESD Rating, **Note 4**	1.5kV

Operating Ratings (Note 2)

Supply Voltage (V_S)	±2.5V to ±9V
Junction Temperature (T_J)	–40°C to +85°C
Package Thermal Resistance	260°C/W

Electrical Characteristics (±5V)

$V_{V+} = +5V$, $V_{V-} = -5V$, $V_{CM} = 0V$, $V_{OUT} = 0V$; $R_L = 10M\Omega$; $T_J = 25°C$, **bold** values indicate $-40°C \le T_J \le +85°C$; unless noted.

Symbol	Parameter	Condition	Min	Typ	Max	Units
V_{OS}	Input Offset Voltage			1	**16**	mV
V_{OS}	Input Offset Voltage Temperature Coefficient			4		µV/°C
I_B	Input Bias Current			5.5	9 **15**	µA µA
I_{OS}	Input Offset Current			0.05	**3**	µA
V_{CM}	Input Common-Mode Range	CMRR > 60dB	–3.25		+3.25	V
CMRR	Common-Mode Rejection Ratio	$-2.0V < V_{CM} < +2.0V$	70	85		dB
PSRR	Power Supply Rejection Ratio	$\pm5V < V_S < \pm9V$	70 **65**	81		dB dB
A_{VOL}	Large-Signal Voltage Gain	$R_L = 2k$, $V_{OUT} = \pm2V$	**60**	71		dB
		$R_L = 200\Omega$, $V_{OUT} = \pm2V$	**60**	71		dB
V_{OUT}	Maximum Output Voltage Swing	positive, $R_L = 2k\Omega$	+3.3 **+3.0**	3.5		V V
		negative, $R_L = 2k\Omega$		–3.5	–3.3 **–3.0**	V V
		positive, $R_L = 200\Omega$	+3.0 **+2.75**	3.2		V V
		negative, $R_L = 200\Omega$		–2.8	–2.45 **–2.2**	V V
GBW	Gain-Bandwidth Product	$f = 80MHz$, $R_L = 1k\Omega$		300		MHz
BW	–3dB Bandwidth	$A_V = 2$, $R_L = 150\Omega$		213		MHz
		$A_V = 4$ or $A_V = -3$, $R_L = 400\Omega$-		104		MHz
THD	Total Harmonic Distortion	$R_F = R_G = 470\Omega$, $A_V = 2$, $V_{OUT} = 2Vpp$, $f = 2MHz$		0.01		%
		$A_V = 2$, $V_{OUT} = 2Vpp$, $f = 2MHz$, $R_L = 500\Omega$		0.05		%
SR	Slew Rate			350		V/µs
I_{GND}	Short-Circuit Output Current	source		72		mA
		sink		25		mA
I_{GND}	Supply Current			4.1	4.9 **5.4**	mA mA

Electrical Characteristics

V_{V+} = +9V, V_{V-} = –9V, V_{CM} = 0V, V_{OUT} = 0V; R_L = 10MΩ; T_J = 25°C, **bold** values indicate –40°C ≤ T_J ≤ +85°C; unless noted

Symbol	Parameter	Condition	Min	Typ	Max	Units
V_{OS}	Input Offset Voltage			1	**16**	mV
V_{OS}	Input Offset Voltage Temperature Coefficient			4		µV/°C
I_B	Input Bias Current			5.5	9 **15**	µA µA
I_{OS}	Input Offset Current			0.05	**3**	µA
V_{CM}	Input Common-Mode Range	CMRR > 60dB	–7.25		+7.25	V
CMRR	Common-Mode Rejection Ratio	–6.0V < V_{CM} < 6.0V	70	88		dB
A_{VOL}	Large-Signal Voltage Gain	R_L = 2kΩ, V_{OUT} = ±6V	**60**	73		dB
V_{OUT}	Maximum Output Voltage Swing	positive, R_L = 2kΩ	+7.2 **+6.8**	+7.4		V V
		negative, R_L = 2kΩ		–7.4	–7.2 **–6.8**	V V
GBW	Gain-Bandwidth Product	R_L = 1kΩ, f = 80MHz		350		MHz
BW	–3dB Bandwidth	A_V = 2 or A_V = –1, R_L = 150Ω		240		MHz
		A_V = 4 or A_V = –3		140		MHz
THD	Total Harmonic Distortion	R_F = R_G = 470Ω, A_V = 2, V_{OUT} = 2Vpp, f = 2MHz		0.01		%
		A_V = 2, V_{OUT} = 2Vpp, f = 2MHz, R_L = 500Ω		0.04		%
SR	Slew Rate			500		V/µs
I_{GND}	Short-Circuit Output Current	source		90		mA
		sink		32		mA
I_{GND}	Supply Current			4.2	5.0 **5.5**	mA mA

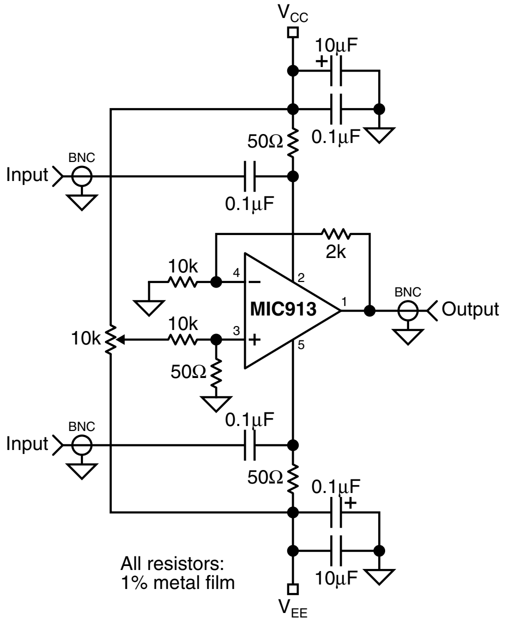
Note 1. Exceeding the absolute maximum rating may damage the device.

Note 2. The device is not guaranteed to function outside its operating rating.

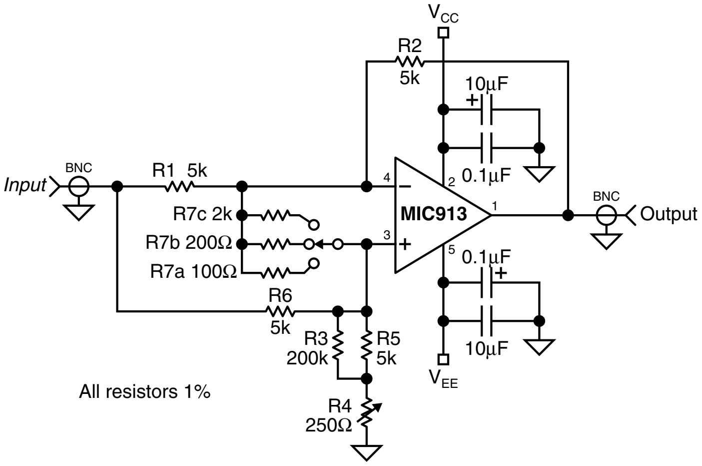
Note 3. Exceeding the maximum differential input voltage will damage the input stage and degrade performance (in particular, input bias current is likely to increase).

Note 4. Devices are ESD sensitive. Handling precautions recommended. Human body model, 1.5k in series with 100pF.

Test Circuits

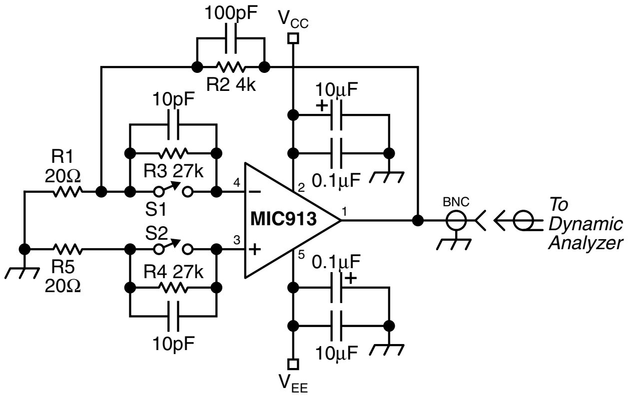


PSRR vs. Frequency



$$V_{OUT} = V_{ERROR}\left(1+\frac{R2}{R1}+\frac{R2+R5+R4}{R7}\right)$$

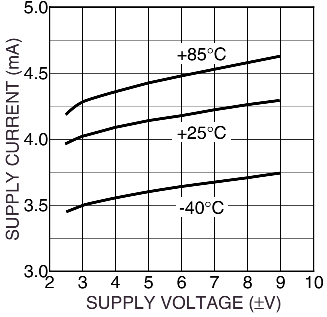
CMRR vs. Frequency



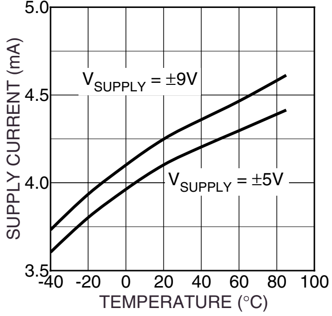
Noise Measurement

Electrical Characteristics

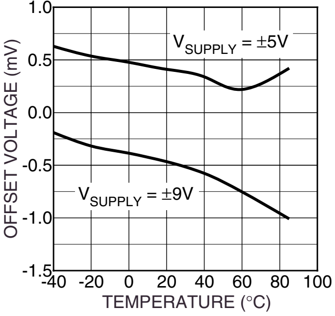
Supply Current vs. Supply Voltage



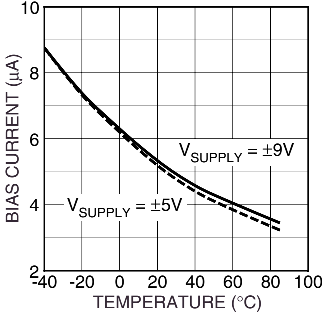
Supply Current vs. Temperature



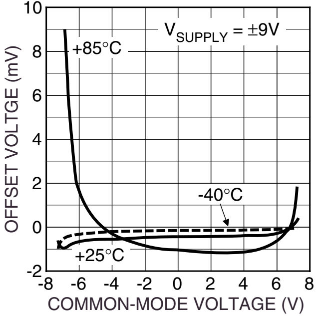
Offset Voltage vs. Temperature



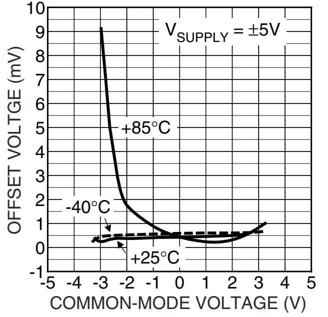
Bias Current vs. Temperature



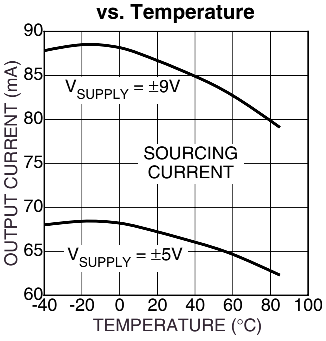
Offset Voltage vs. Common-Mode Voltage



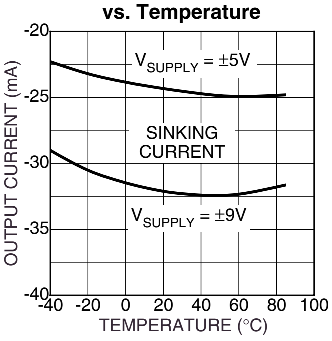
Offset Voltage vs. Common-Mode Voltage



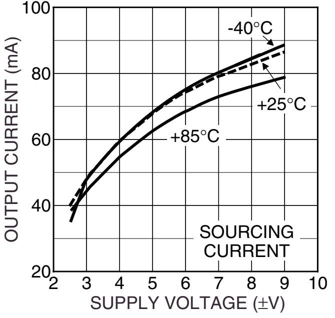
Short-Circuit Current vs. Temperature



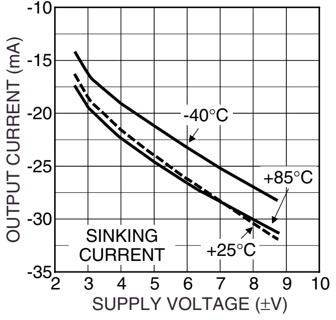
Short-Circuit Current vs. Temperature



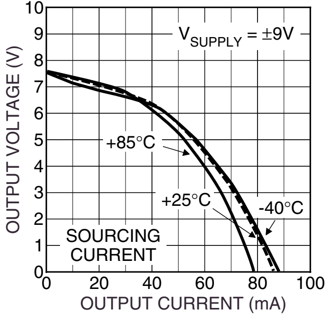
Short-Circuit Current vs. Supply Voltage



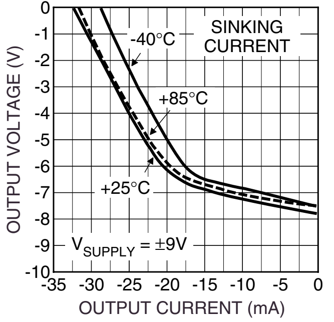
Short-Circuit Current vs. Supply Voltage



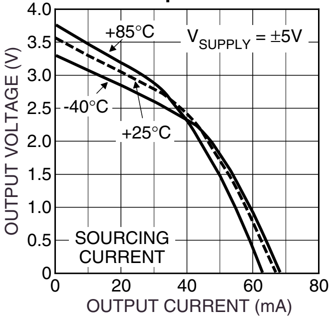
Output Voltage vs. Output Current



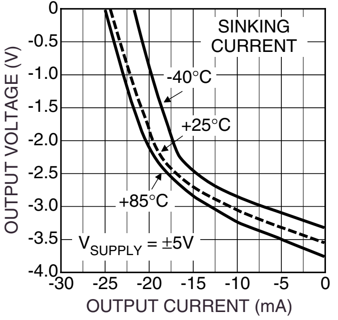
Output Voltage vs. Output Current



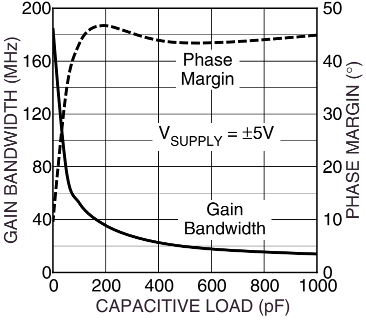
Output Voltage vs. Output Current



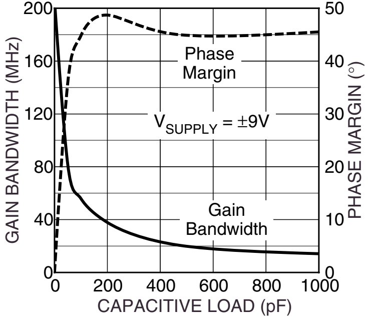
Output Voltage vs. Output Current



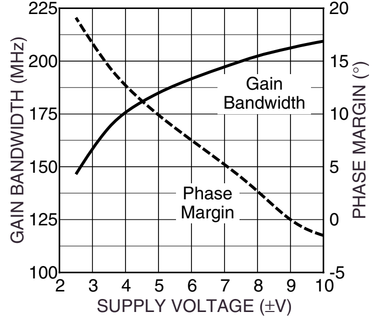
Gain Bandwidth and Phase Margin vs. Load



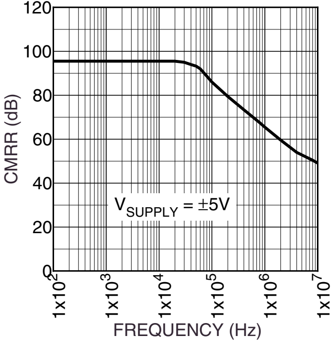
Gain Bandwidth and Phase Margin vs. Load



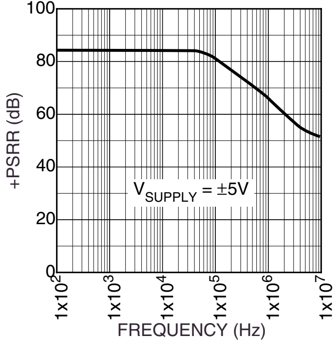
Gain Bandwidth and Phase Margin vs. Supply Voltage



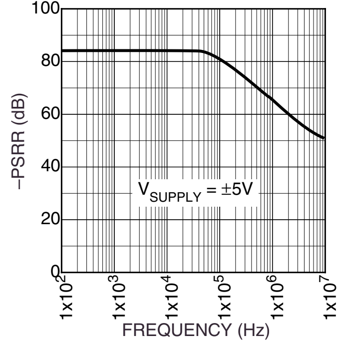
Common-Mode Rejection Ratio



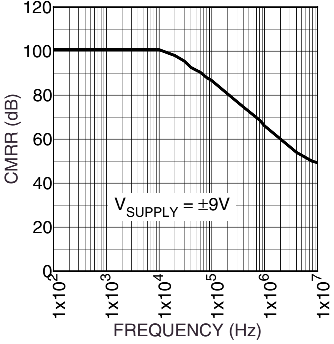
Positive Power Supply Rejection Ratio



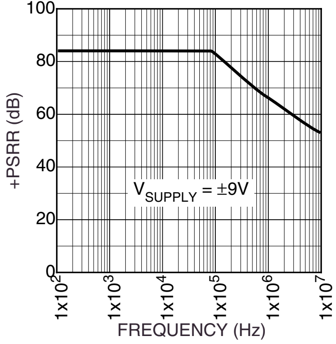
Negative Power Supply Rejection Ratio



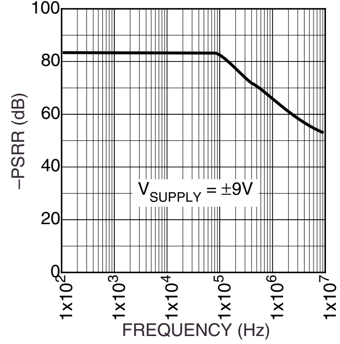
Common-Mode Rejection Ratio



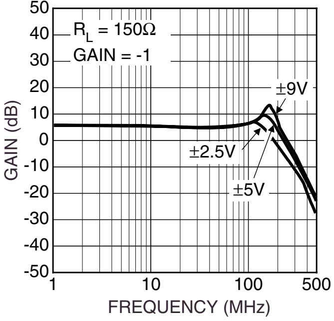
Positive Power Supply Rejection Ratio



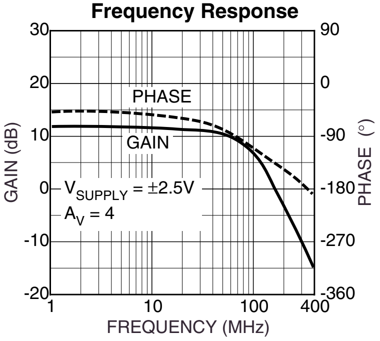
Negative Power Supply Rejection Ratio



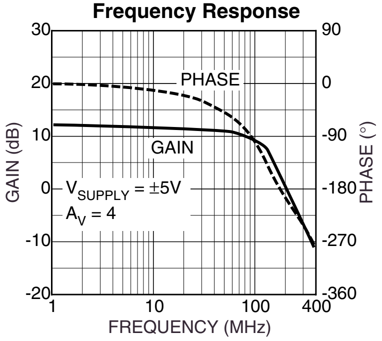
Closed-Loop Frequency Response



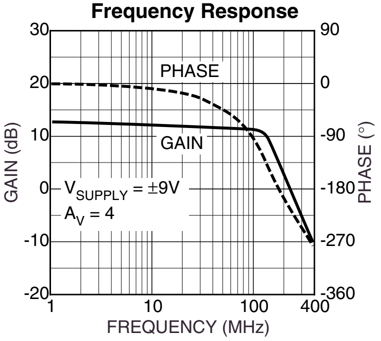
Closed-Loop Frequency Response



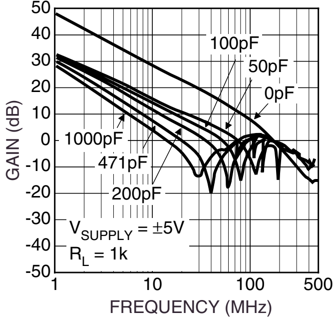
Closed-Loop Frequency Response



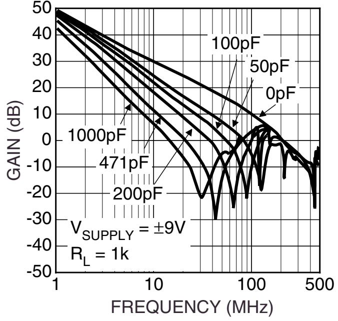
Closed-Loop Frequency Response



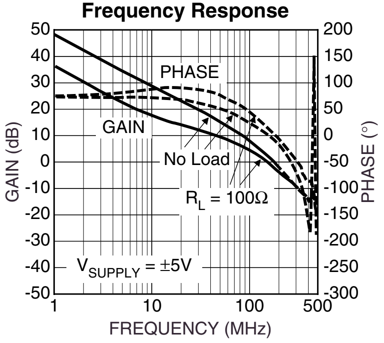
Open-Loop Frequency Response



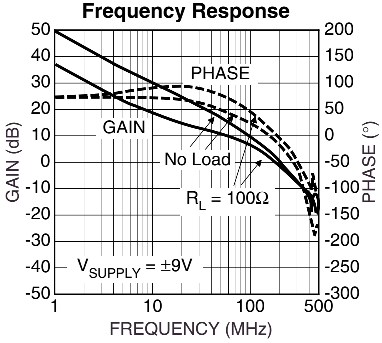
Open-Loop Frequency Response



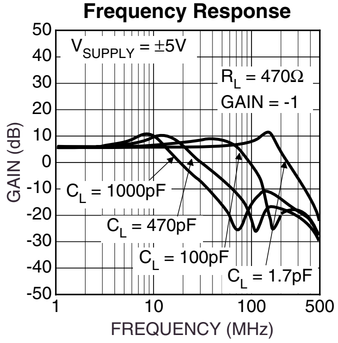
Open-Loop Frequency Response



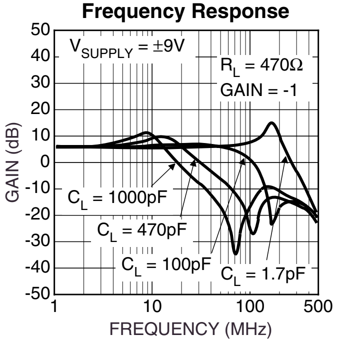
Open-Loop Frequency Response



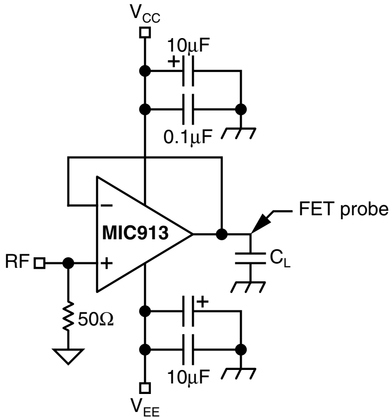
Closed-Loop Frequency Response



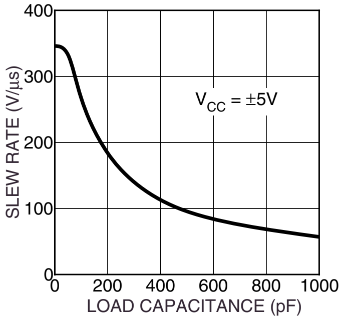
Closed-Loop Frequency Response



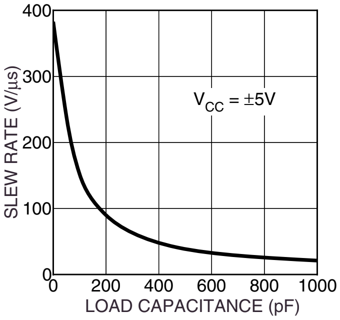
Closed-Loop Frequency Response Test Circuit



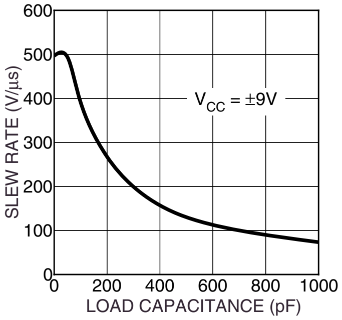
Positive Slew Rate



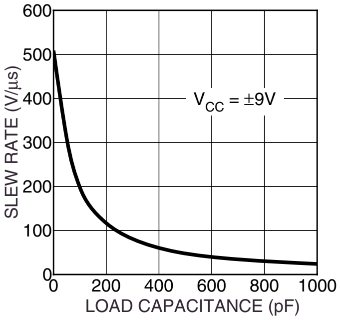
Negative Slew Rate



Positive Slew Rate

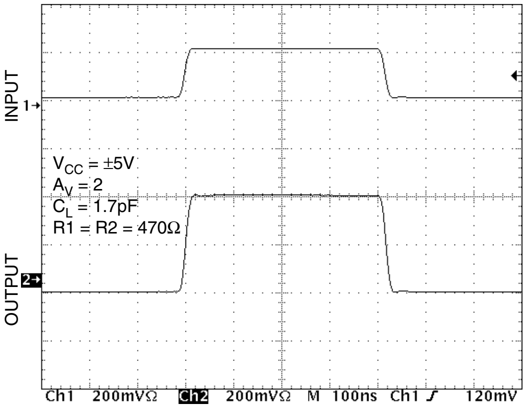


Negative Slew Rate

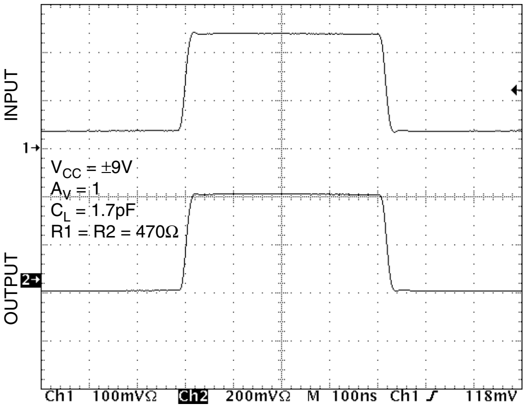


Functional Characteristics

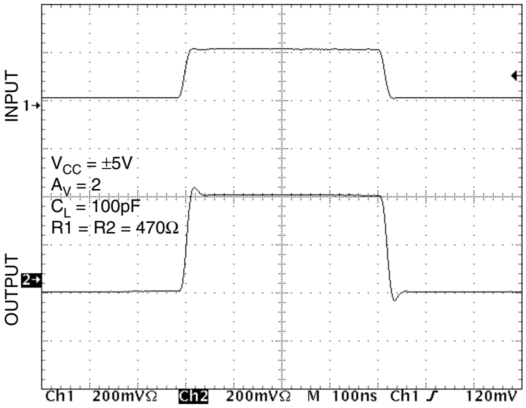
Small-Signal Pulse Response



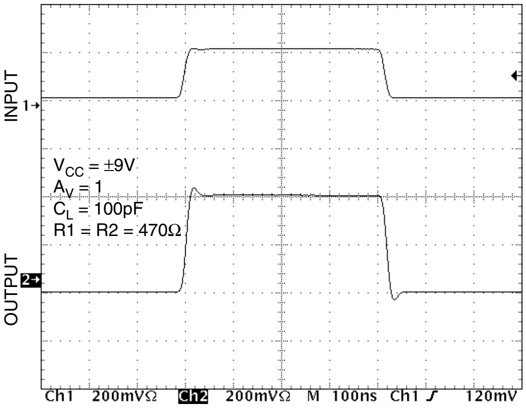
Small-Signal Pulse Response



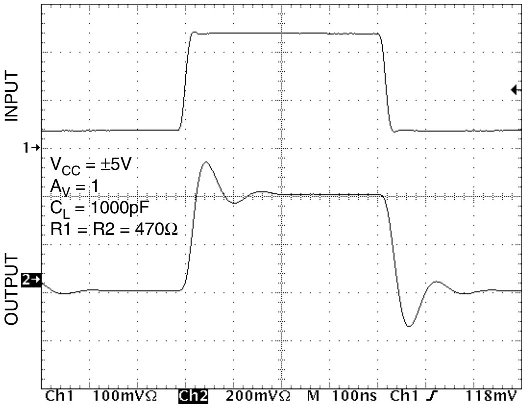
Small-Signal Pulse Response



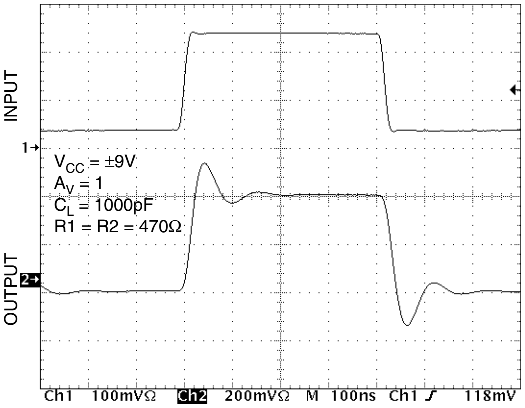
Small-Signal Pulse Response



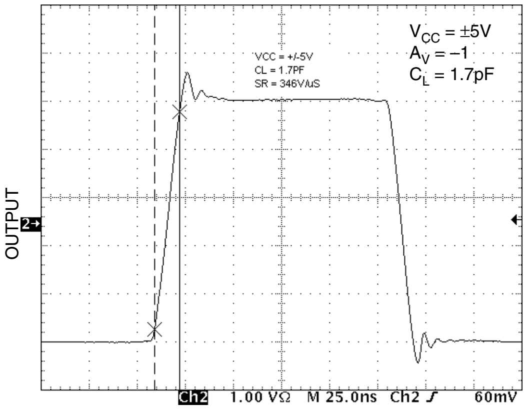
Small-Signal Pulse Response



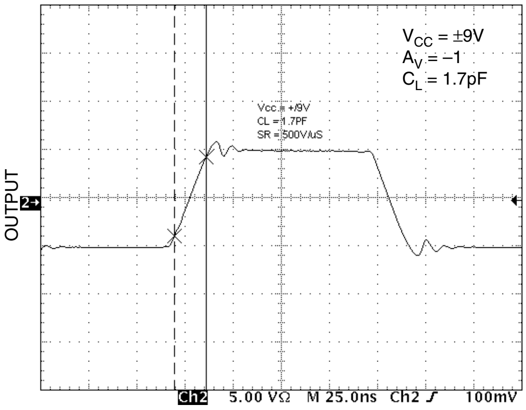
Small-Signal Pulse Response



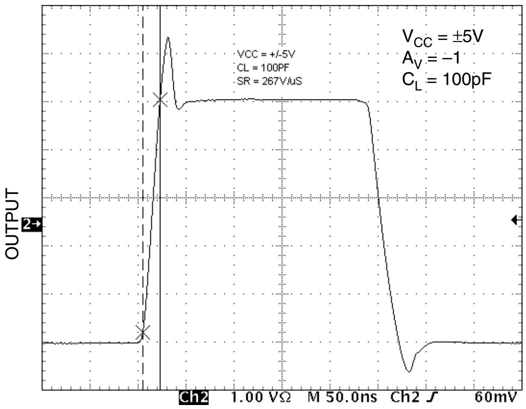
Large-Signal Pulse Response



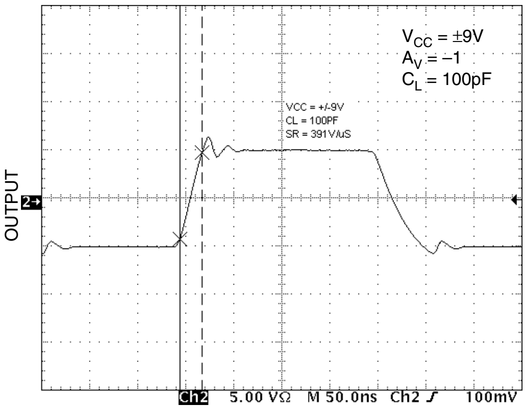
Large-Signal Pulse Response



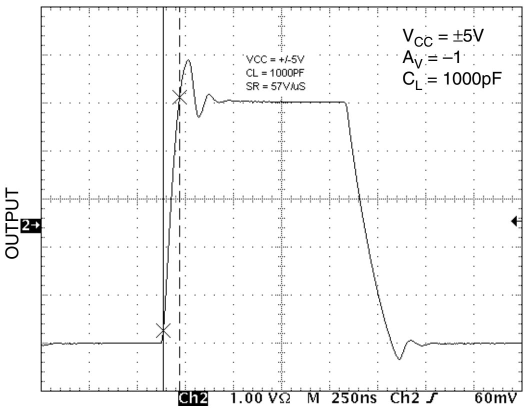
Large-Signal Pulse Response



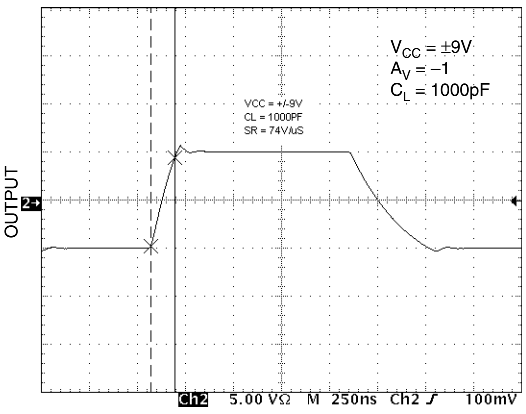
Large-Signal Pulse Response



Large-Signal Pulse Response



Large-Signal Pulse Response



Applications Information

The MIC913 is a high-speed, voltage-feedback operational amplifier featuring very low supply current. The MIC913 is not unity-gain stable, it requires a minimum gain of +2 or –1 to ensure stability. The device is however stable even when driving high capacitance loads.

Driving High Capacitance

The MIC913 is stable when driving any capacitance (see “Typical Characteristics: Gain Bandwidth and Phase Margin vs. Load Capacitance”) making it ideal for driving long coaxial cables or other high-capacitance loads.

Phase margin remains constant as load capacitance is increased. Most high-speed op amps are only able to drive limited capacitance.

> Note: increasing load capacitance does reduce the speed of the device (see “Typical Characteristics: Gain Bandwidth and Phase Margin vs. Load”). In applications where the load capacitance reduces the speed of the op amp to an unacceptable level, the effect of the load capacitance can be reduced by adding a small resistor (<100Ω) in series with the output.

Feedback Resistor Selection

Conventional op amp gain configurations and resistor selection apply, the MIC913 is NOT a current feedback device. Resistor values in the range of 1k to 10k are recommended.

Layout Considerations

All high speed devices require careful PCB layout. The high stability and high PSRR of the MIC913 make this op amp easier to use than most, but the following guidelines should be observed: Capacitance, particularly on the two inputs pins will degrade performance; avoid large copper traces to the inputs. Keep the output signal away from the inputs and use a ground plane.

It is important to ensure adequate supply bypassing capacitors are located close to the device.

Power Supply Bypassing

Regular supply bypassing techniques are recommended. A 10µF capacitor in parallel with a 0.1µF capacitor on both the positive and negative supplies are ideal. For best performance all bypassing capacitors should be located as close to the op amp as possible and all capacitors should be low ESL (equivalent series inductance), ESR (equivalent series resistance). Surface-mount ceramic capacitors are ideal.

Thermal Considerations

The SOT-23-5 package, like all small packages, has a high thermal resistance. It is important to ensure the IC does not exceed the maximum operating junction (die) temperature of 85°C. The part can be operated up to the absolute maximum temperature rating of 125°C, but between 85°C and 125°C performance will degrade, in particular CMRR will reduce.

A MIC913 with no load, dissipates power equal to the quiescent supply current * supply voltage

$$P_{D(no\,load)} = \left(V_{V+} - V_{V-}\right) I_S$$

When a load is added, the additional power is dissipated in the output stage of the op amp. The power dissipated in the device is a function of supply voltage, output voltage and output current.

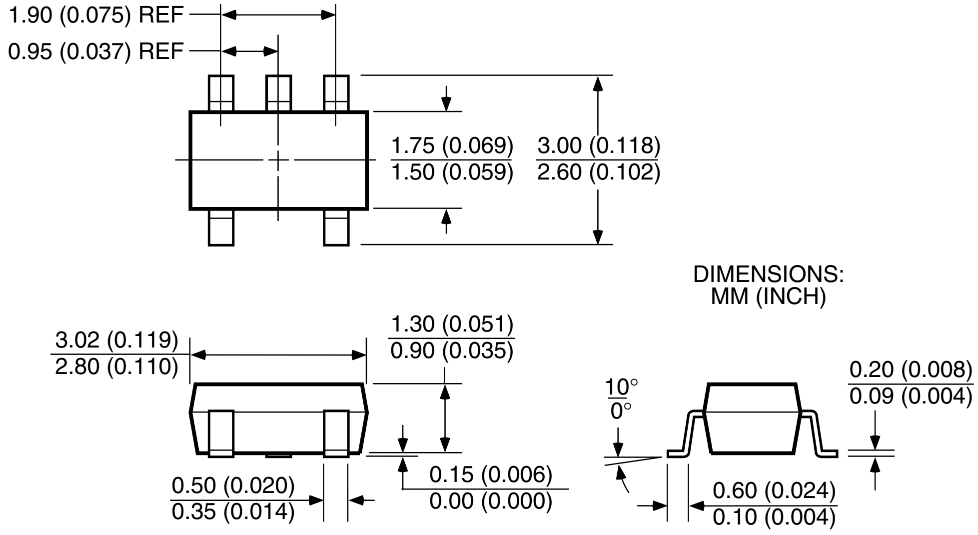
$$P_{D(output\ stage)} = \left(V_{V+} - V_{OUT}\right) I_{OUT}$$

$$Total\ Power\ Dissipation = P_{D(no\,load)} + P_{D(output\ stage)}$$

Ensure the total power dissipated in the device is no greater than the thermal capacity of the package. The SOT23-5 package has a thermal resistance of 260°C/W.

$$Max.\,Allowable\,Power\,Dissipation = \frac{T_{J(max)} - T_{A(max)}}{260W}$$

Package Information



SOT-23-5 (M5)

MICREL INC.   1849 FORTUNE DRIVE   SAN JOSE, CA 95131   USA
TEL + 1 (408) 944-0800 FAX + 1 (408) 944-0970 WEB http://www.micrel.com