MIC911

105MHz Low-Power SOT23-5 Op Amp

General Description

The MIC911 is a high-speed operational amplifier which is unity gain stable regardless of resistive and capacitive load. It provides a gain-bandwidth product of 105MHz, a very low 1.25mA supply current, and features the Ittybitty® SOT23-5 package.

Supply voltage range is from ±2.5V to ±9V, allowing the MIC911 to be used in low-voltage circuits or applications requiring large dynamic range.

The MIC911 is stable driving any capacitive load and achieves excellent PSRR and CMRR, making it much easier to use than most conventional high-speed devices. Low supply voltage, low power consumption, and small packing make the MIC911 ideal for portable equipment. The ability to drive capacitive loads also makes it possible to drive long coaxial cables.

Data sheets and support documentation can be found on Micrel's web site at: www.micrel.com.

Features

- 05MHz gain bandwidth product
- 1.25mA supply current
- Unconditionally unity gain stable
- Drives any capacitive load
- SOT23-5 package
- 120V/µs slew rate
- 112dB CMRR

Applications

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

Ordering Information

Part Number	Temperature Range	Package	Lead Finish
MIC911BM5	–40° to +85°C	5-Pin SOT23	Standard
MIC911YM5	–40° to +85°C	5-Pin SOT23	Pb-Free

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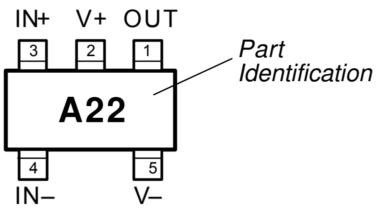
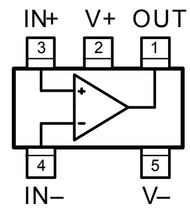
Pin Configuration



SOT23-5

Functional Pinout



SOT23-5

Pin Description

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

Absolute Maximum Ratings[1]

Supply Voltage ($V_{V+} – V_{V–}$) 20V
Differential Input Voltage ($|V_{IN+} – V_{IN–}|$)[3] 4V
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[4] 1.5kV

Operating Ratings[2]

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

Electrical Characteristics (±5V)

V_{V+} = +5V, $V_{V–}$ = –5V, 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	**10**	mV
	Input Offset Voltage Temperature Coefficient			4		µV/°C
I_B	Input Bias Current			1.5	4 **8**	µA µA
I_{OS}	Input Offset Current			0.03	2 **3**	µA µA
V_{CM}	Input Common-Mode Range	CMRR > 60dB	**–3.5**		**+3.5**	V
CMRR	Common-Mode Rejection Ratio	–3V < V_{CM} < +3V	**80**	110		dB
PSRR	Power Supply Rejection Ratio	±5V < V_S < ±9V	**75**	88		dB
A_{VOL}	Large-Signal Voltage Gain	R_L = 2k, V_{OUT} = ±2V	**65**	78		dB
		R_L = 200Ω, V_{OUT} = ±1V	**65**	78		dB
V_{OUT}	Maximum Output Voltage Swing	positive, R_L = 2kΩ	+3.3 **+3.0**	3.5		V V
		negative, R_L = 2kΩ		–3.5	–3.3 **–3.0**	V V
		positive, R_L = 200Ω	+2.8 **+2.5**	3.2		V V
		negative, R_L = 200Ω, **Note 5**		–2.5	–1.7 **–1.0**	V V
		negative, R_L = 200Ω, 25°C ≤ T_J ≤ +85°C, **Note 5**			**–1.7**	V
GBW	Unity Gain-Bandwidth Product	R_L = 1kΩ		95		MHz
BW	–3dB Bandwidth	A_V = 2, R_L = 470Ω		70		MHz
SR	Slew Rate			100		V/µs
I_{GND}	Short-Circuit Output Current	source		65		mA
		sink		17		mA
	Supply Current			1.25	1.8 **2.3**	mA mA

Electrical Characteristics

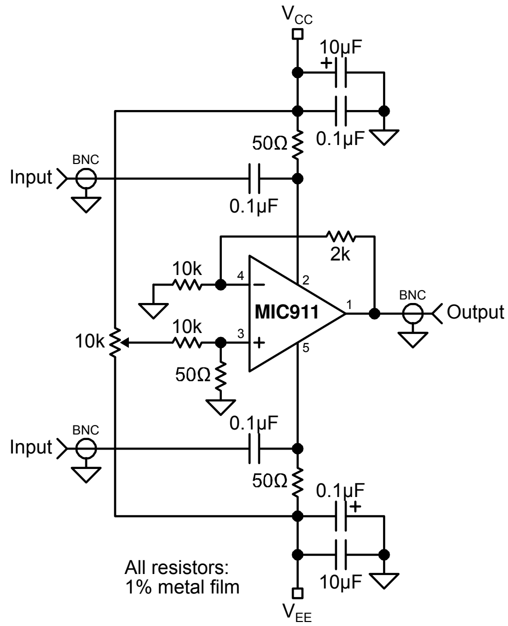
V_{V+} = +9V, V_{V-} = –9V, V_{CM} = 0V, V_{OUT} = 0V; R_L = 10MΩ; T_J = 25°C, **bold** values indicate –40°C ≤ T_J ≤ +85°C; unless noted.

Symbol	Parameter	Condition	Min	Typ	Max	Units
V_{OS}	Input Offset Voltage			1	**10**	mV
	Input Offset Voltage Temperature Coefficient			4		µV/°C
I_B	Input Bias Current			1.5	4	µA
					8	µA
I_{OS}	Input Offset Current				2	µA
				0.03	**3**	µA
V_{CM}	Input Common-Mode Range	CMRR > 60dB	**–7.5**		**+7.5**	V
CMRR	Common-Mode Rejection Ratio	–7V < V_{CM} < 7V	**80**	112		dB
A_{VOL}	Large-Signal Voltage Gain	R_L = 2kΩ, V_{OUT} = ±6V	**65**	80		dB
V_{OUT}	Maximum Output Voltage Swing	positive, R_L = 2kΩ	+7.2	+7.4		V
			+6.8			V
		negative, R_L = 2kΩ		–7.4	–7.2	V
					–6.8	V
GBW	Unity Gain-Bandwidth Product	R_L = 1kΩ		105		MHz
BW	–3dB Bandwidth	A_V = 2, R_L = 470Ω		80		MHz
SR	Slew Rate			120		V/µs
I_{GND}	Short-Circuit Output Current	source		80		mA
		sink		22		mA
	Supply Current			1.35	1.9	mA
					2.4	mA

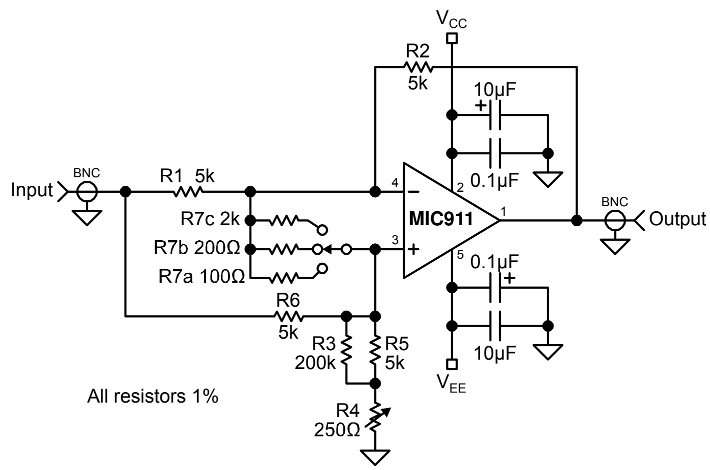
Notes:

1. Exceeding the absolute maximum rating may damage the device.
2. The device is not guaranteed to function outside its operating rating.
3. Exceeding the maximum differential input voltage will damage the input stage and degrade performance (in particular, input bias current is likely to change).
4. Devices are ESD sensitive. Handling precautions recommended. Human body model, 1.5k in series with 100pF.
5. Output swing limited by the maximum output sink capability, refer to the short-circuit current vs. temperature graph in “Typical Characteristics.”

Test Circuits

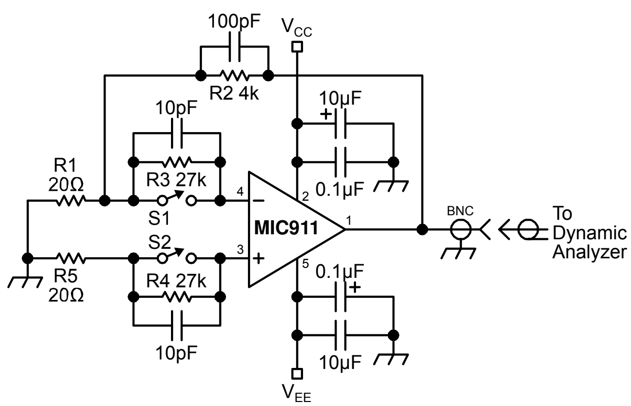


PSRR vs. Frequency



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

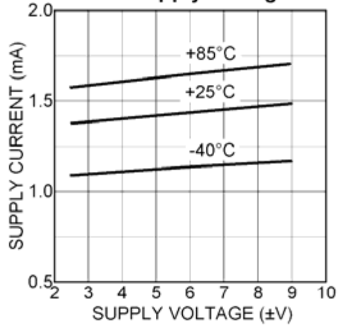
CMRR vs. Frequency



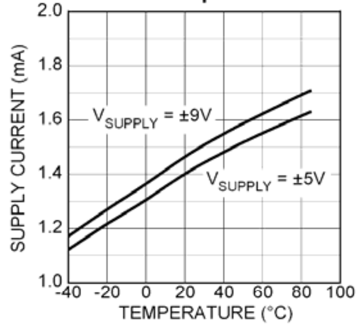
Noise Measurement

Typical Characteristics

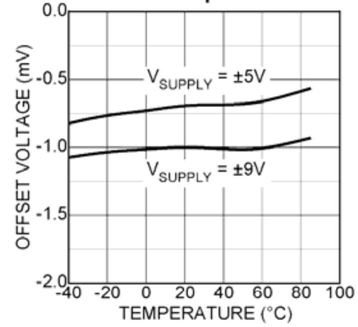
Supply Current vs. Supply Voltage



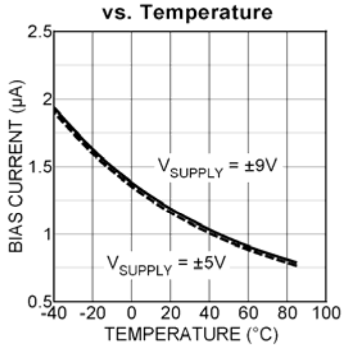
Supply Current vs. Temperature



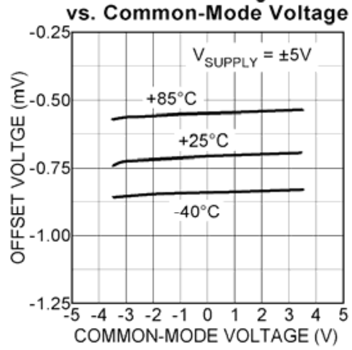
Offset Voltage vs. Temperature



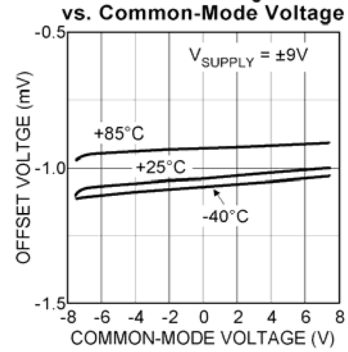
Bias Current vs. Temperature



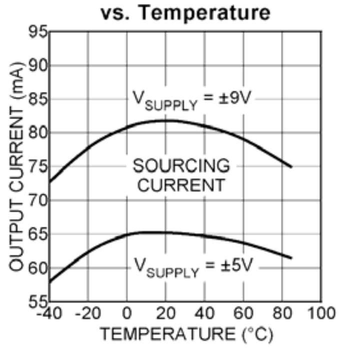
Offset Voltage vs. Common-Mode Voltage



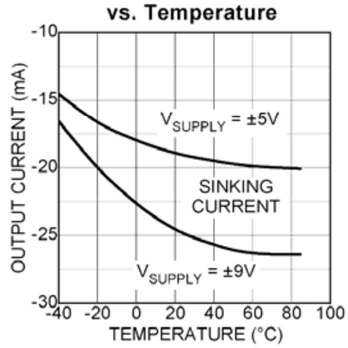
Offset Voltage vs. Common-Mode Voltage



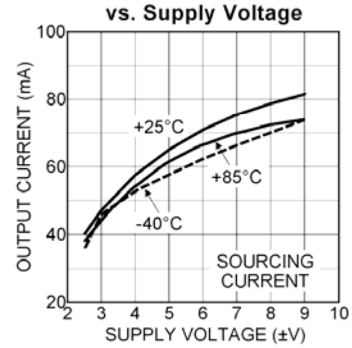
Short-Circuit Current vs. Temperature



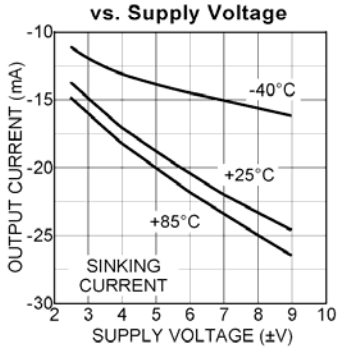
Short-Circuit Current vs. Temperature



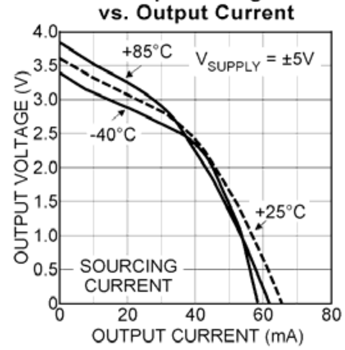
Short-Circuit Current vs. Supply Voltage



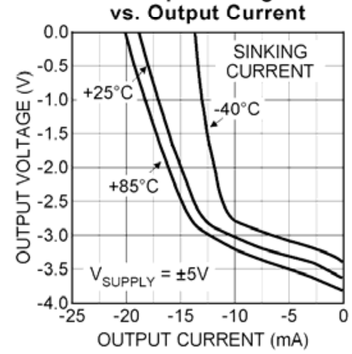
Short-Circuit Current vs. Supply Voltage



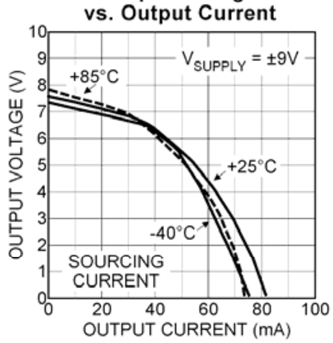
Output Voltage vs. Output Current



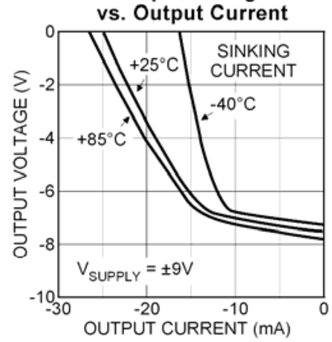
Output Voltage vs. Output Current



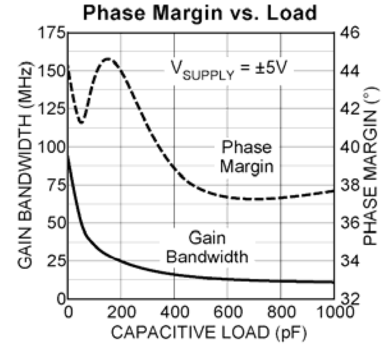
Typical Characteristics (continued)



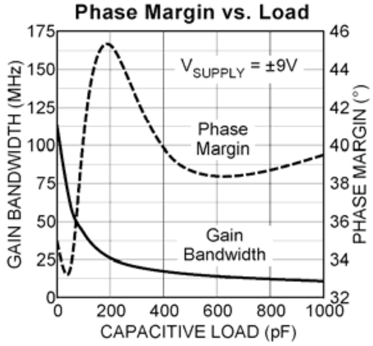
Output Voltage vs. Output Current



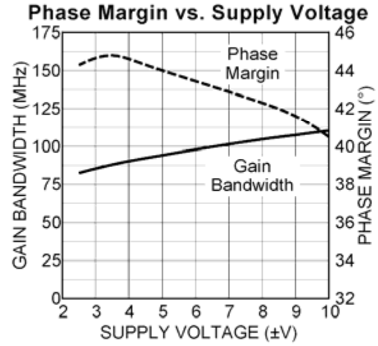
Output Voltage vs. Output Current



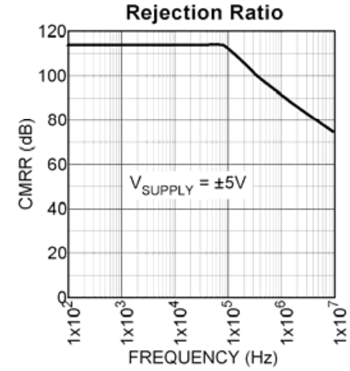
Gain Bandwidth and Phase Margin vs. Load



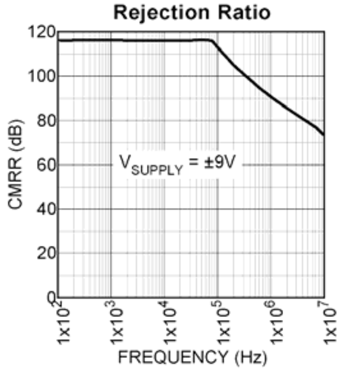
Gain Bandwidth and Phase Margin vs. Load



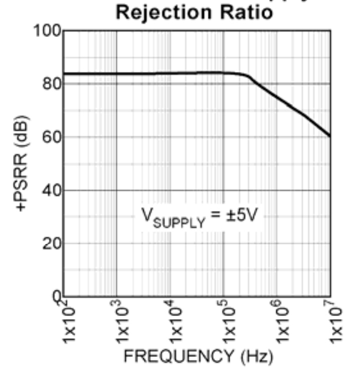
Gain Bandwidth and Phase Margin vs. Supply Voltage



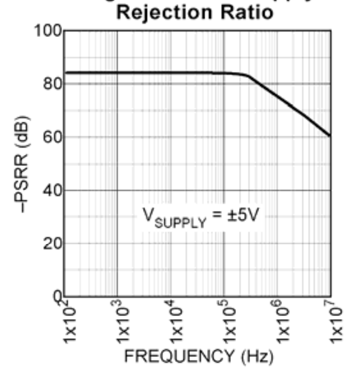
Common-Mode Rejection Ratio



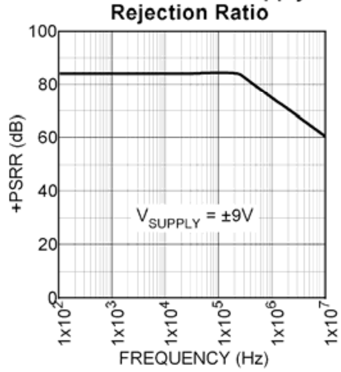
Common-Mode Rejection Ratio



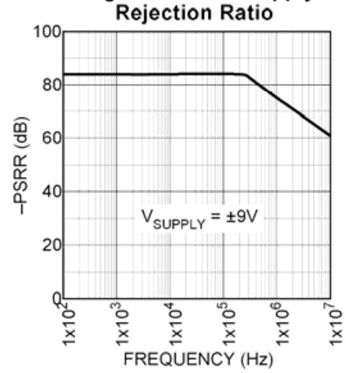
Positive Power Supply Rejection Ratio



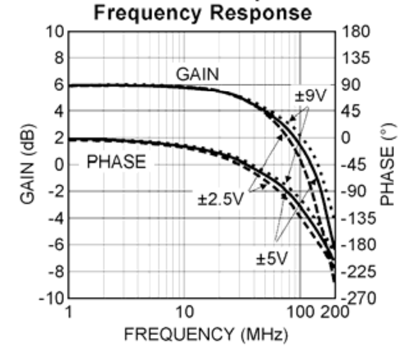
Negative Power Supply Rejection Ratio



Positive Power Supply Rejection Ratio



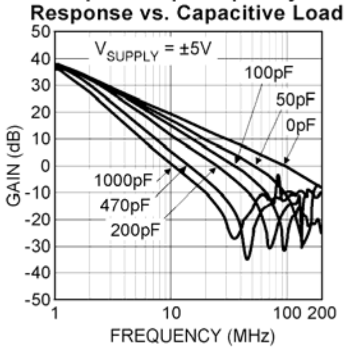
Negative Power Supply Rejection Ratio



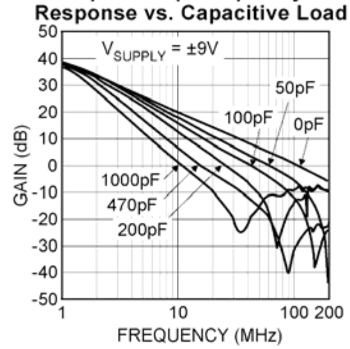
Closed-Loop Frequency Response

Typical Characteristics (continued)

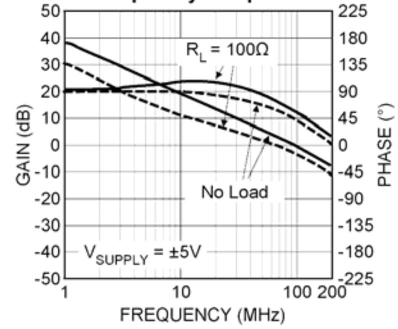
Open-Loop Frequency Response vs. Capacitive Load



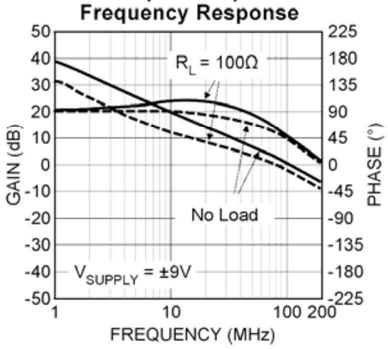
Open-Loop Frequency Response vs. Capacitive Load



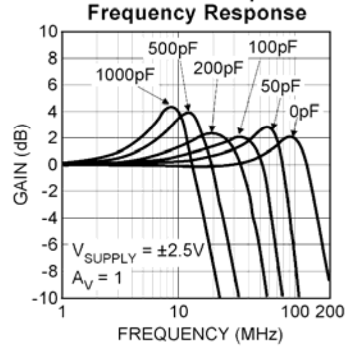
Open-Loop Frequency Response



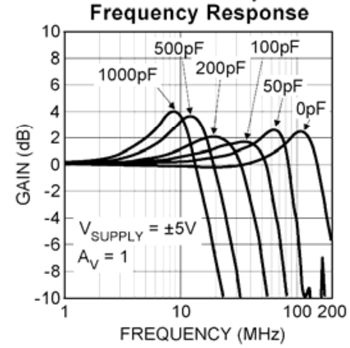
Open-Loop Frequency Response



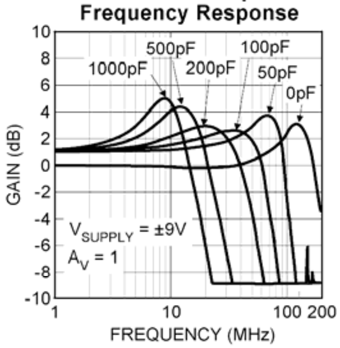
Closed-Loop Frequency Response



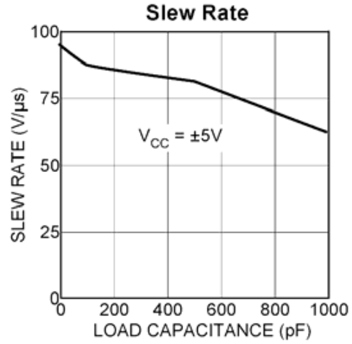
Closed-Loop Frequency Response



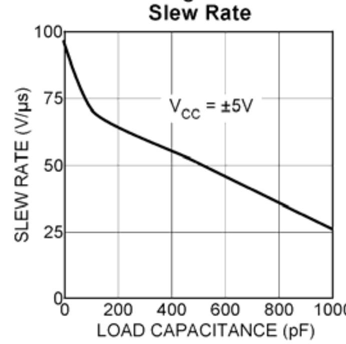
Closed-Loop Frequency Response



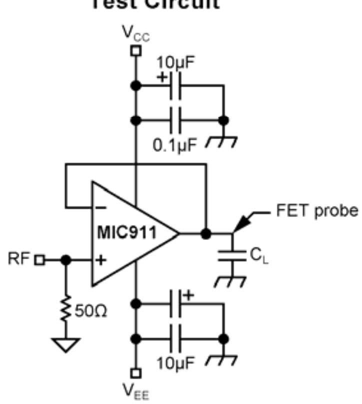
Positive Slew Rate



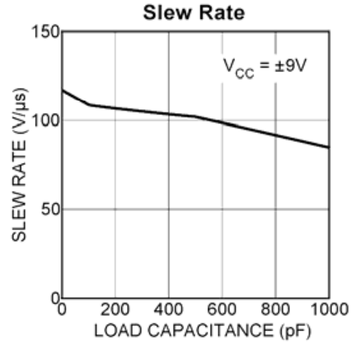
Negative Slew Rate



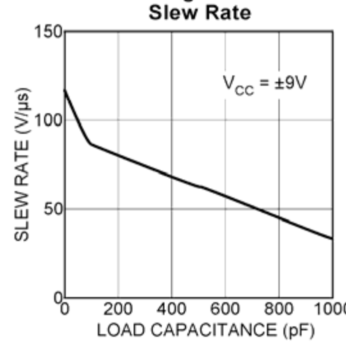
Closed-Loop Frequency Response Test Circuit



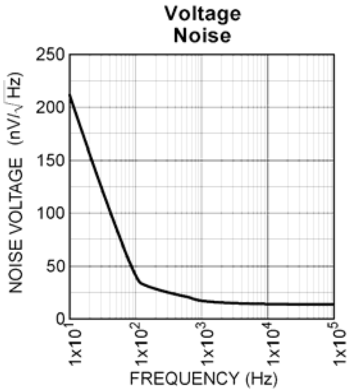
Positive Slew Rate

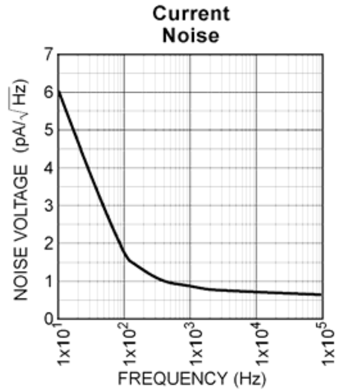


Negative Slew Rate



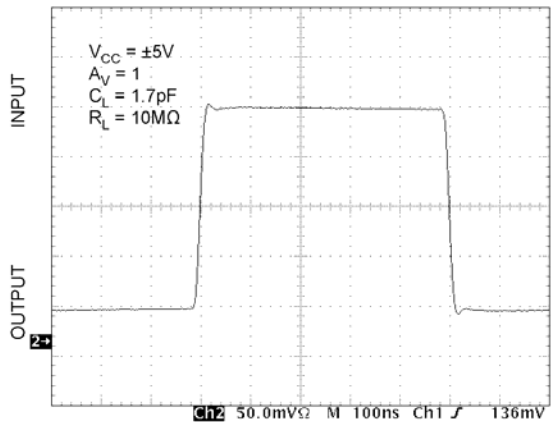
Typical Characteristics (continued)



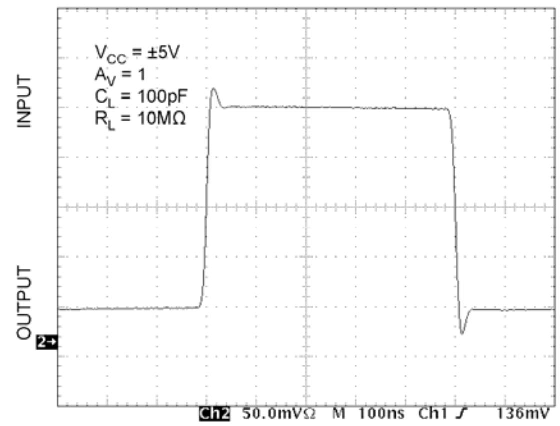


Functional Characteristics

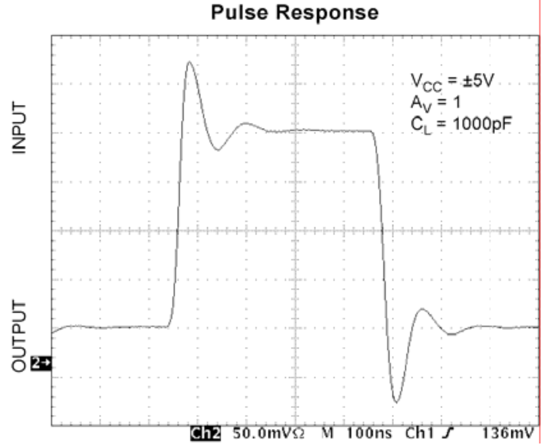
Small-Signal Pulse Response



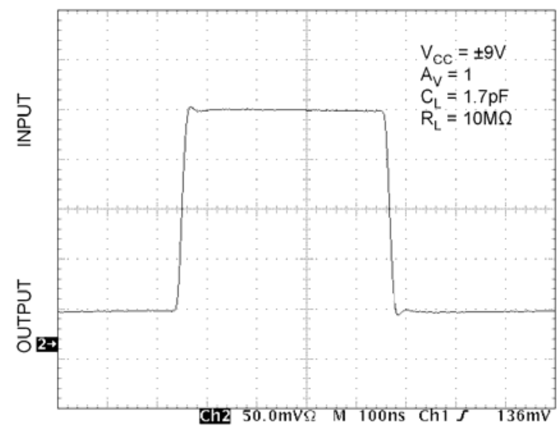
Small-Signal Pulse Response



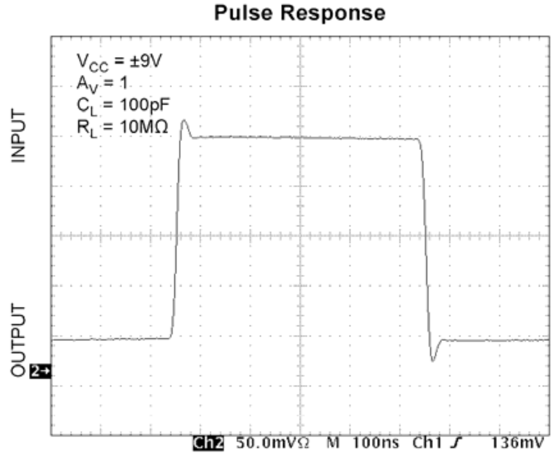
Small-Signal Pulse Response



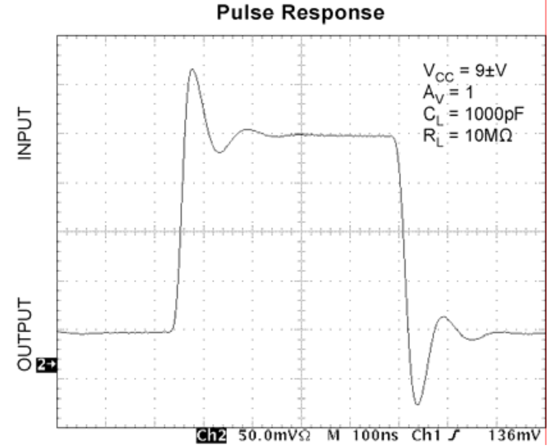
Small-Signal Pulse Response



Small-Signal Pulse Response

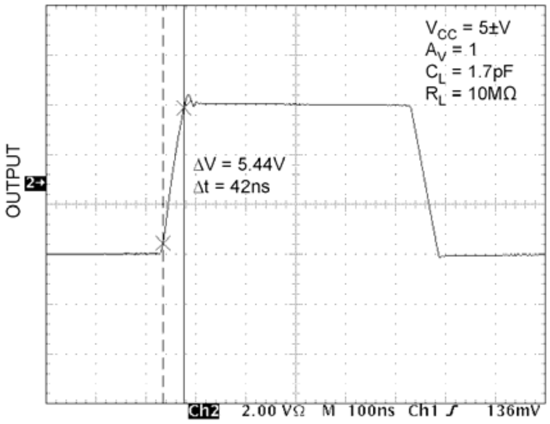


Small-Signal Pulse Response

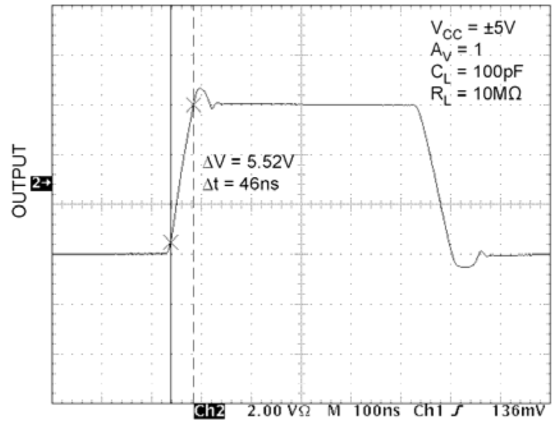


Functional Characteristics (continued)

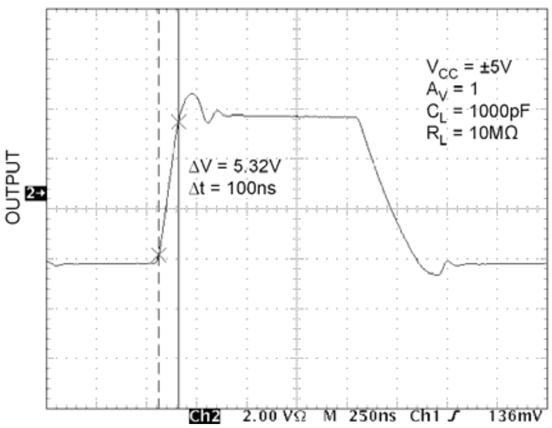
Large-Signal Pulse Response



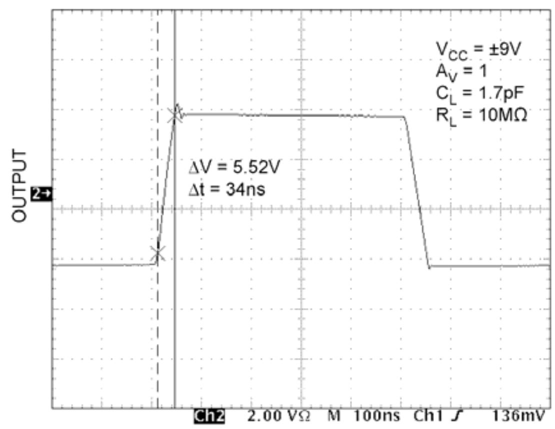
Large-Signal Pulse Response



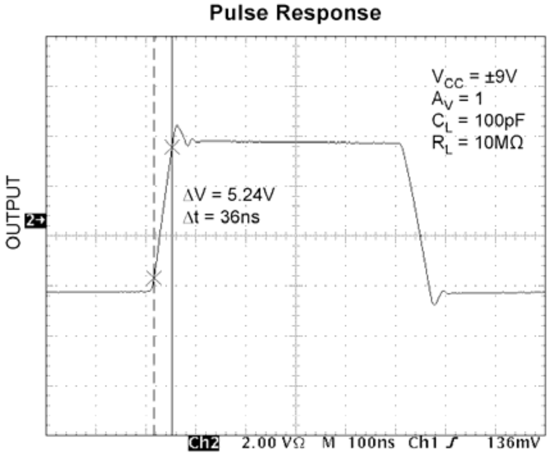
Large-Signal Pulse Response



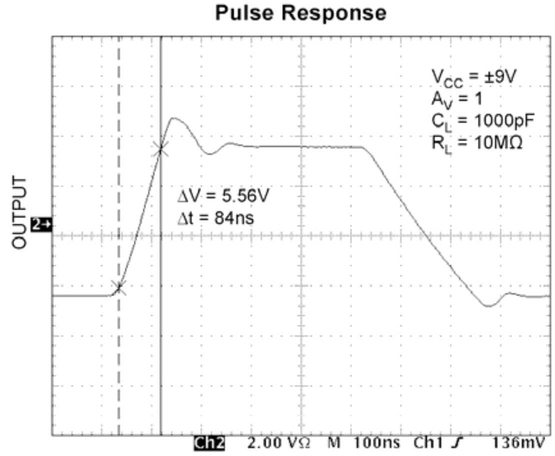
Large-Signal Pulse Response



Large-Signal Pulse Response



Large-Signal Pulse Response



Application Information

The MIC911 is a high-speed, voltage-feedback operational amplifier featuring very low supply current and excellent stability. This device is unity gain stable and capable of driving high capacitance loads.

Driving High Capacitance

The MIC911 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 MIC911 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 MIC911 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 is 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 SOT23-5 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 MIC911 with no load, dissipates power equal to the quiescent supply current * supply voltage.

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

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.

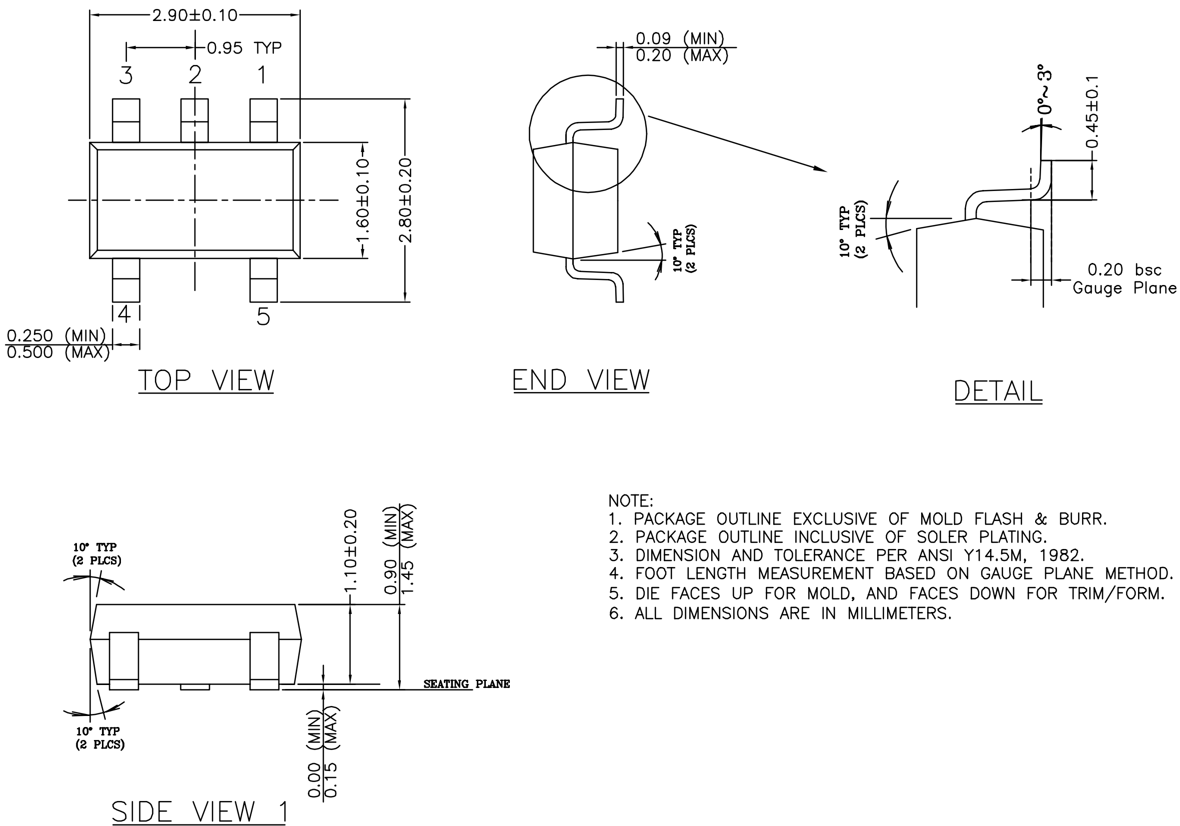
$$P_{D(output\ stage)} = (V_{V+} - V_{V-})I_{OUT}$$

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

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.

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

Package Information



5-Pin SOT23 (M5)

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