



# MIC861

## Teeny™ Ultra Low Power Op Amp

### General Description

The MIC861 is a rail-to-rail output, input common-mode to ground, operational amplifier in *Teeny™* SC70 packaging. The MIC861 provides 400kHz gain-bandwidth product while consuming an incredibly low 4.6µA supply current.

The SC70 packaging achieves significant board space savings over devices packaged in SOT-23 or MSOP-8 packaging. The SC70 occupies approximately half the board area of a SOT-23 package.

### Features

- *Teeny™* SC70 packaging
- 400kHz gain-bandwidth product
- 650kHz, -3dB bandwidth
- 4.6µA supply current
- Rail-to-Rail output
- Ground sensing at input (common mode to GND)
- Drives large capacitive loads (1000pF)
- Unity gain stable

### Applications

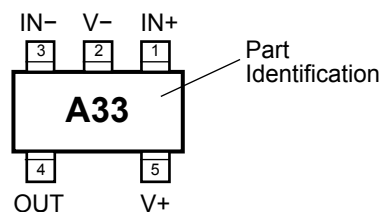
- Portable equipment
- PDAs
- Pagers
- Cordless Phones
- Consumer Electronics

### Ordering Information

Part Number				Ambient Temp. Range	Package
Standard	Marking	Pb-Free	Marking*		
MIC861BC5	A33	MIC861YC5	<u>A</u> 33	-40°C to +85°C	SC-70-5

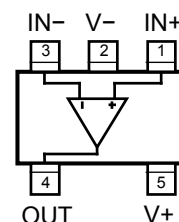
\* Underbar marking may not be to scale.

### Pin Configuration



SC-70

### Functional Pinout



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**Absolute Maximum Ratings (Note 1)**

Supply Voltage ( $V_{V+} - V_{-}$ ).....	+6.0V
Differential Input Voltage ( $ V_{IN+} - V_{IN-} $ ), Note 4 .....	+6.0V
Input Voltage ( $V_{IN+} - V_{IN-}$ ) .....	$V_{+} + 0.3V$ , $V_{-} - 0.3V$
Lead Temperature (soldering, 5 sec.).....	260°C
Output Short Circuit Current Duration .....	Indefinite
Storage Temperature ( $T_S$ ) .....	150°C
ESD Rating, <b>Note 3</b>	

**Operating Ratings (Note 2)**

Supply Voltage ( $V_{+} - V_{-}$ ) .....	+2.43V to +5.25V
Ambient Temperature Range.....	-40°C to +85°C
Package Thermal Resistance.....	450°C/W

**Electrical Characteristics**

$V_{+} = +2.7V$ ,  $V_{-} = 0V$ ,  $V_{CM} = V_{+}/2$ ;  $R_L = 500k\Omega$  to  $V_{+}/2$ ;  $T_A = 25^{\circ}C$ , unless otherwise noted. **Bold** values indicate  $-40^{\circ}C \leq T_A \leq +85^{\circ}C$ .

Symbol	Parameter	Condition	Min	Typ	Max	Units
$V_{OS}$	Input Offset Voltage	<b>Note 5</b>	<b>-10</b>	2	<b>10</b>	mV
	Input Offset Voltage Temp Coefficient			15		$\mu V/^{\circ}C$
$I_B$	Input Bias Current			20		pA
$I_{OS}$	Input Offset Current			10		pA
$V_{CM}$	Input Voltage Range	CMRR > 60dB		1.8		V
CMRR	Common-Mode Rejection Ratio	$0 < V_{CM} < 1.35V$	<b>45</b>	77		dB
PSRR	Power Supply Rejection Ratio	Supply voltage change of 3V	<b>50</b>	83		dB
$A_{VOL}$	Large-Signal Voltage Gain	$R_L = 100k$ , $V_{OUT}$ 2V peak to peak	<b>60</b>	74		dB
		$R_L = 500k$ , $V_{OUT}$ 2V peak to peak	<b>73</b>	83		dB
$V_{OUT}$	Maximum Output Voltage Swing	$R_L = 500k$	<b>V+-2mV</b>	$V+-0.7mV$		V
$V_{OUT}$	Minimum Output Voltage Swing	$R_L = 500k$		$V+-0.2mV$	<b>V+-2mV</b>	V
GBW	Gain-Bandwidth Product	$R_L = 200k\Omega$ , $C_L = 2pF$ , $V_{OUT} = 0$		350		kHz
BW	-3dB Bandwidth	$A_V = 1$ , $C_L = 2pF$ , $R_L = 1M\Omega$		500		kHz
SR	Slew Rate	$A_V = 1$ , $C_L = 2pF$ , $R_L = 1M\Omega$		0.12		V/ $\mu s$
$I_{SC}$	Short-Circuit Output Current	Source		6		mA
		Sink		5		mA
$I_S$	Supply Current	No Load		4.2	<b>9</b>	$\mu A$

$V_{+} = +5V$ ,  $V_{-} = 0V$ ,  $V_{CM} = V_{+}/2$ ;  $R_L = 500k\Omega$  to  $V_{+}/2$ ;  $T_A = 25^{\circ}C$ , unless otherwise noted. **Bold** values indicate  $-40^{\circ}C \leq T_A \leq +85^{\circ}C$ .

Symbol	Parameter	Condition	Min	Typ	Max	Units
$V_{OS}$	Input Offset Voltage	<b>Note 5</b>	<b>-10</b>	2	<b>10</b>	mV
	Input Offset Voltage Temp Coefficient			15		$\mu V/^{\circ}C$
$I_B$	Input Bias Current			20		pA
$I_{OS}$	Input Offset Current			10		pA
$V_{CM}$	Input Voltage Range	CMRR > 60dB		4.2		V
CMRR	Common-Mode Rejection Ratio	$0 < V_{CM} < 3.5V$	<b>60</b>	80		dB
PSRR	Power Supply Rejection Ratio	Supply voltage change of 1V	<b>45</b>	85		dB
$A_{VOL}$	Large-Signal Voltage Gain	$R_L = 100k$ , $V_{OUT}$ 4.0V peak to peak	<b>60</b>	76		dB
		$R_L = 500k$ , $V_{OUT}$ 4.0V peak to peak	<b>68</b>	83		dB
$V_{OUT}$	Maximum Output Voltage Swing	$R_L = 500k$	<b>V+-2mV</b>	$V+-0.7mV$		V
$V_{OUT}$	Minimum Output Voltage Swing	$R_L = 500k$		$V+-0.7mV$	<b>V+-2mV</b>	V
GBW	Gain-Bandwidth Product	$R_L = 200k\Omega$ , $C_L = 2pF$ , $V_{OUT} = 0$		400		kHz
BW	-3dB Bandwidth	$A_V = 1$ , $C_L = 2pF$ , $R_L = 1M\Omega$		650		kHz

Symbol	Parameter	Condition	Min	Typ	Max	Units
SR	Slew Rate	$A_V = 1, C_L = 2\text{pF}, R_L = 1\text{M}\Omega$		0.12		V/ $\mu\text{s}$
$I_{SC}$	Short-Circuit Output Current	Source	<b>10</b>	24		mA
		Sink	<b>10</b>	24		mA
$I_S$	Supply Current	No Load		4.6	<b>9</b>	$\mu\text{A}$

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

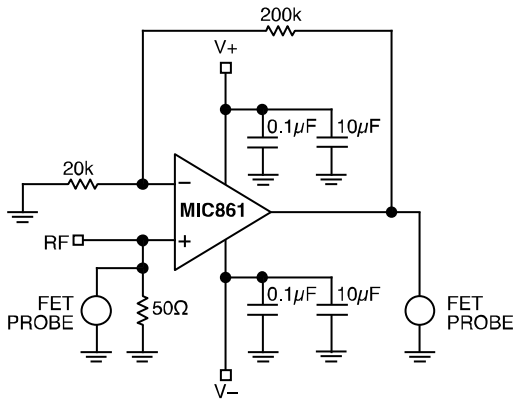
**Note 2.** The device is not guaranteed to function outside its operating rating.

**Note 3.** Devices are ESD sensitive. Handling precautions recommended. Human body model, 1.5k in series with 100pF. Pin 4 is ESD sensitive

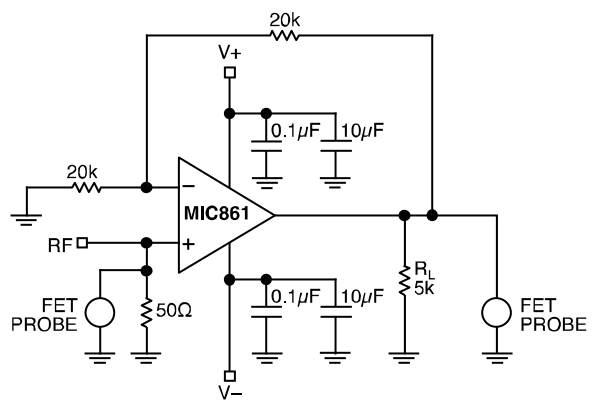
**Note 4.** Exceeding the maximum differential input voltage will damage the input stage and degrade performance (in particular, input bias current is likely to increase).

**Note 5.** The offset voltage distribution is centered around 0V. The typical offset number shown, is equal to the standard deviation of the voltage offset distribution.

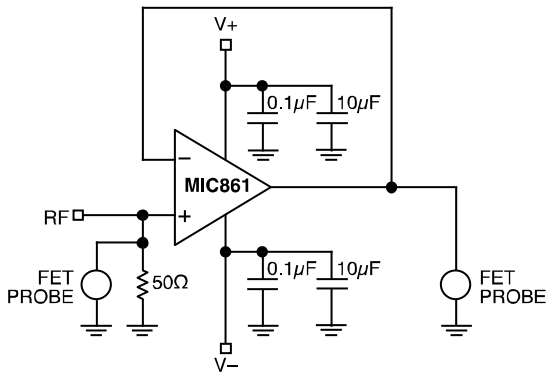
Test Circuits



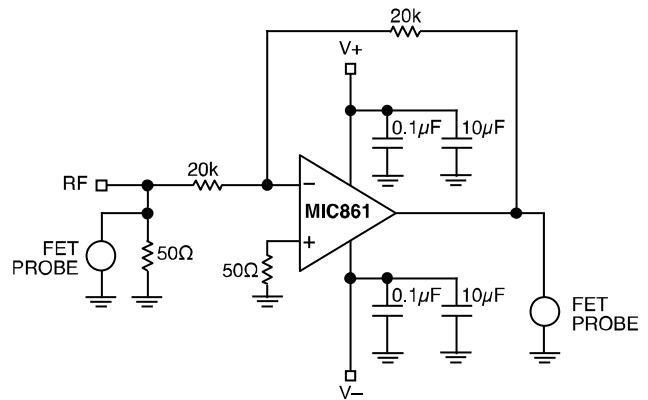
Test Circuit 1.  $A_V = 11$



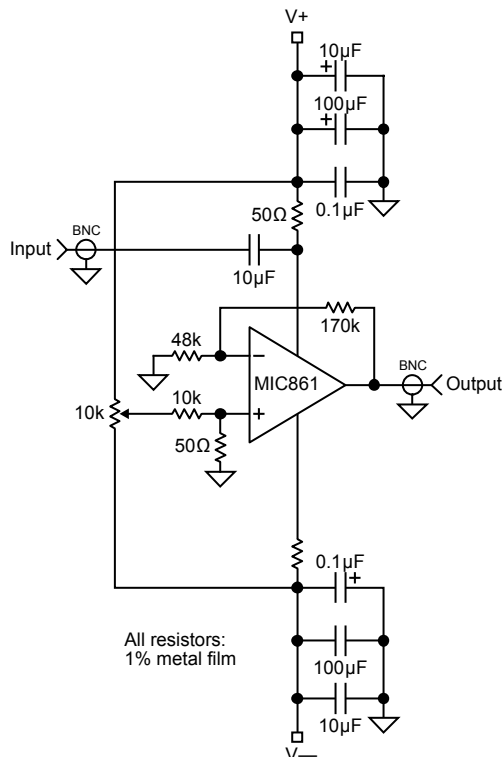
Test Circuit 2:  $A_V = 2$



Test Circuit 3.  $A_V = 1$

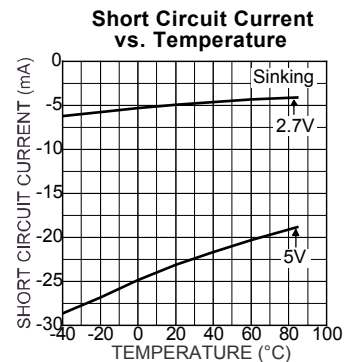
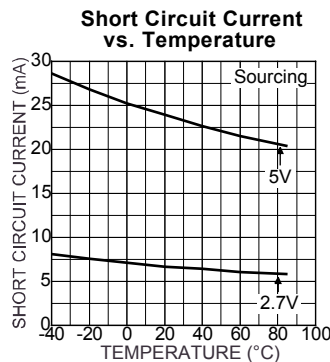
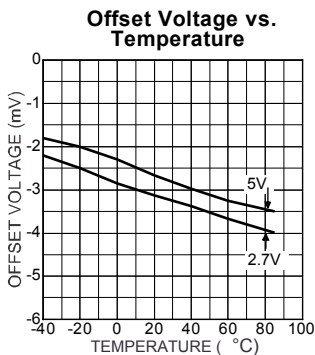
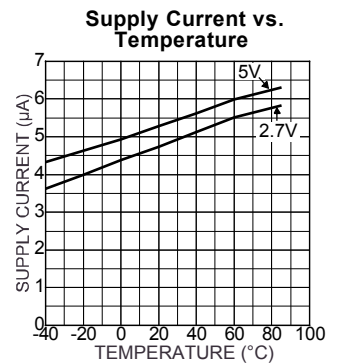
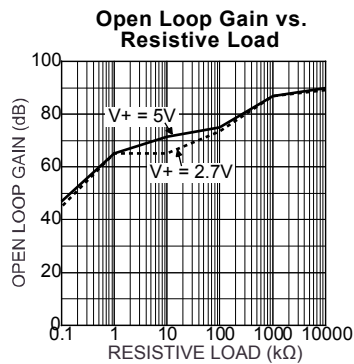
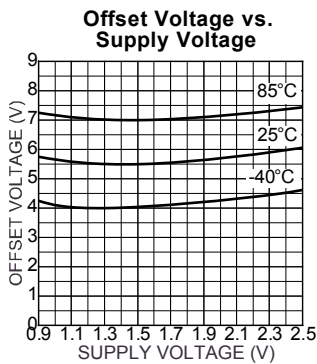
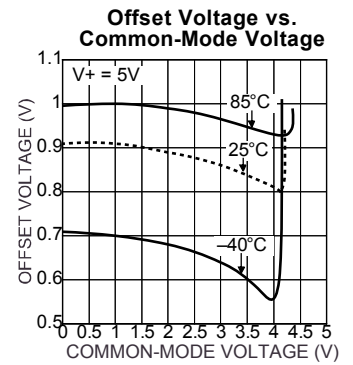
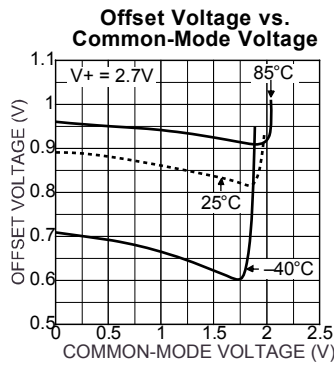
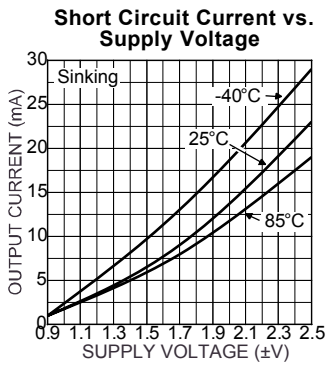
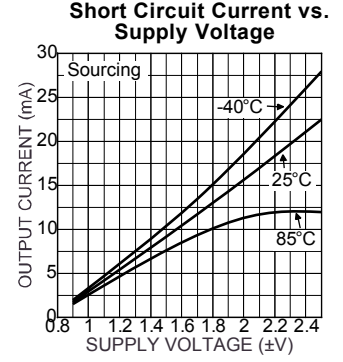
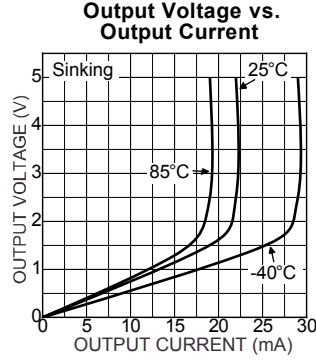
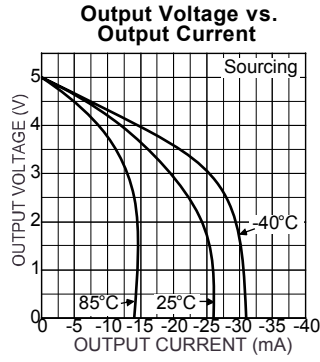


Test Circuit 4.  $A_V = -1$

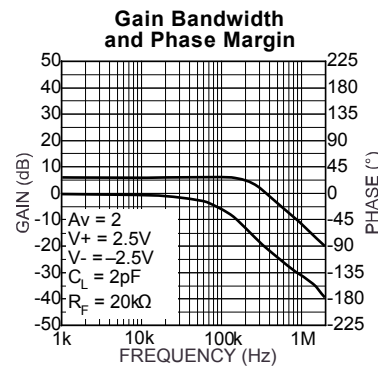
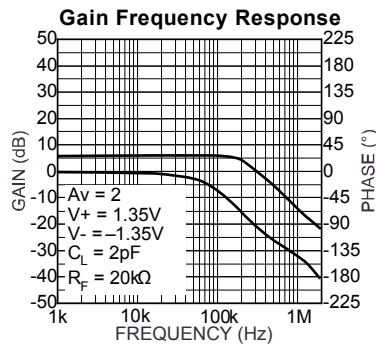
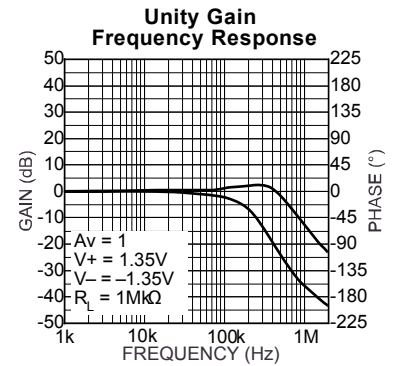
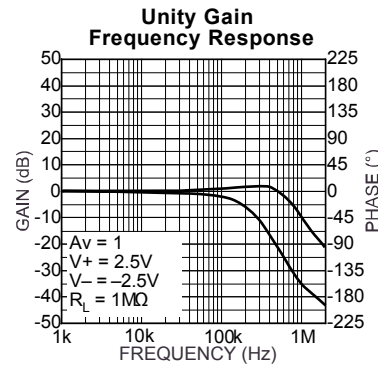
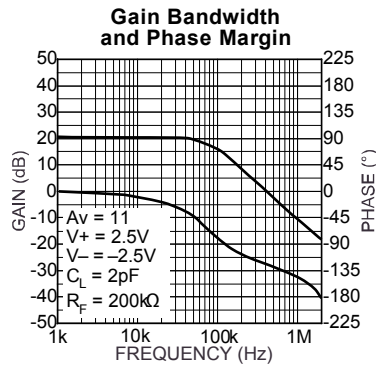
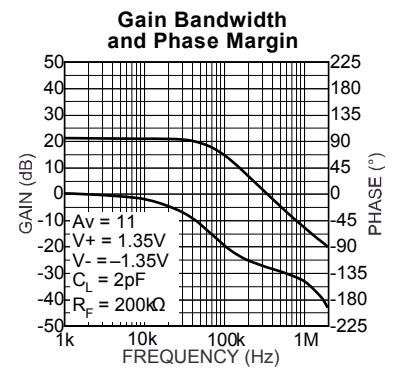
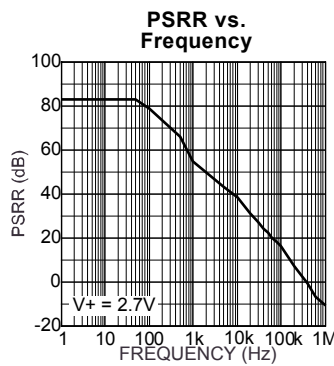
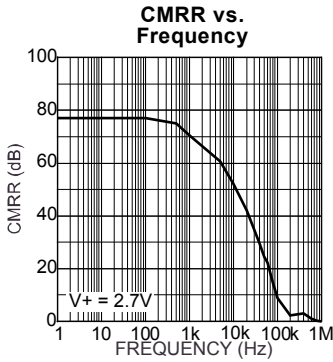
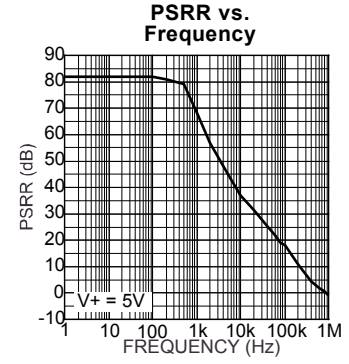
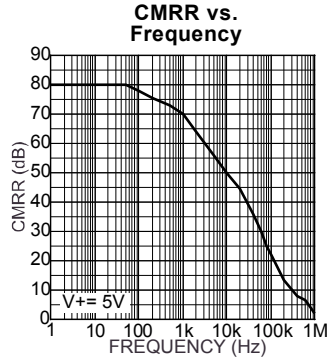
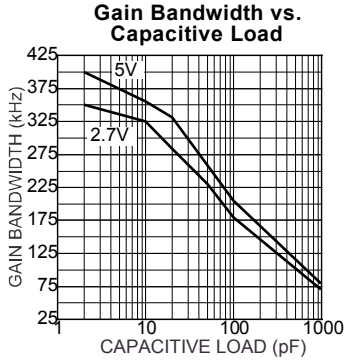


Test Circuit 5. Positive Power Supply Rejection Ratio Measurement

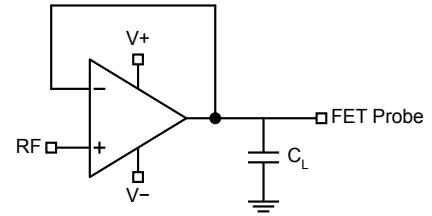
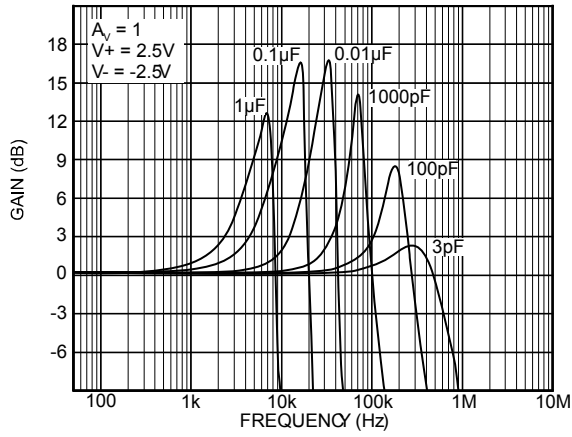
# DC Performance Characteristics



# AC Performance Characteristics

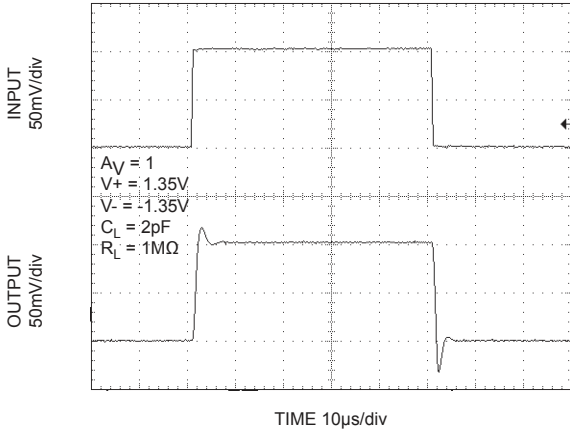


Close-loop Unity Gain Frequency Response

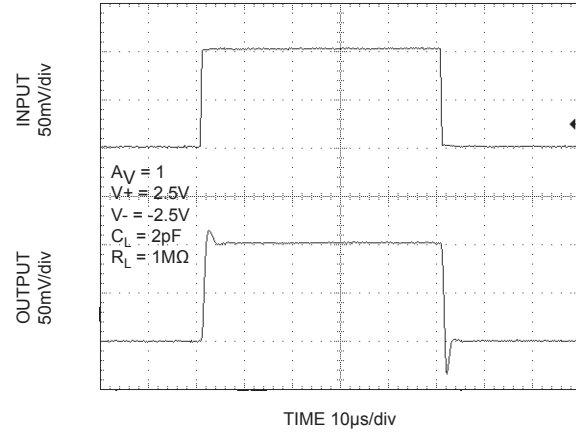


# Functional Characteristics

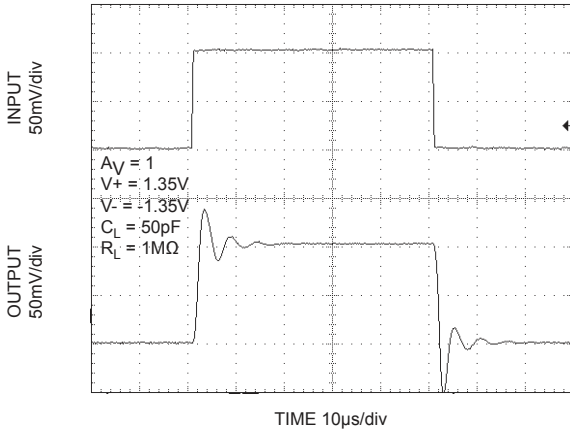
**Small Signal Pulse Response**  
Test Circuit 3:  $A_V = 1$



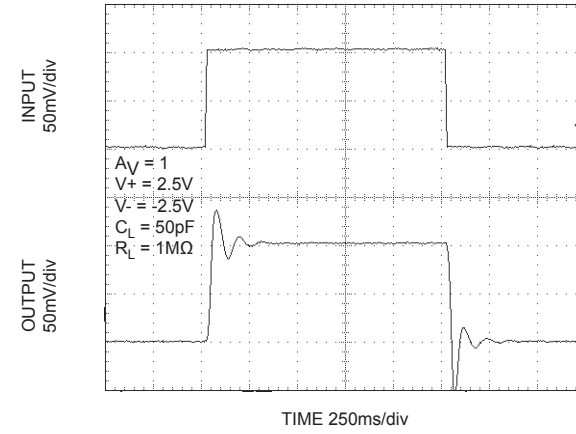
**Small Signal Pulse Response**  
Test Circuit 3:  $A_V = 1$



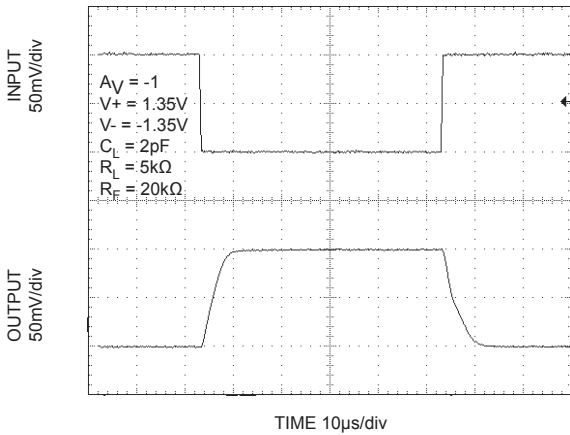
**Small Signal Pulse Response**  
Test Circuit 3:  $A_V = 1$



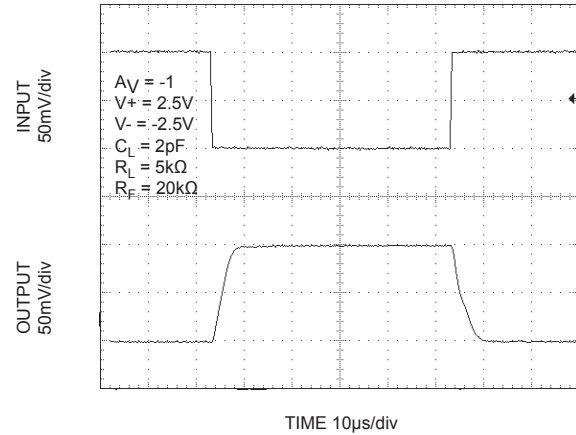
**Small Signal Pulse Response**  
Test Circuit 3:  $A_V = 1$



**Small Signal Pulse Response**  
Test Circuit 4:  $A_V = -1$

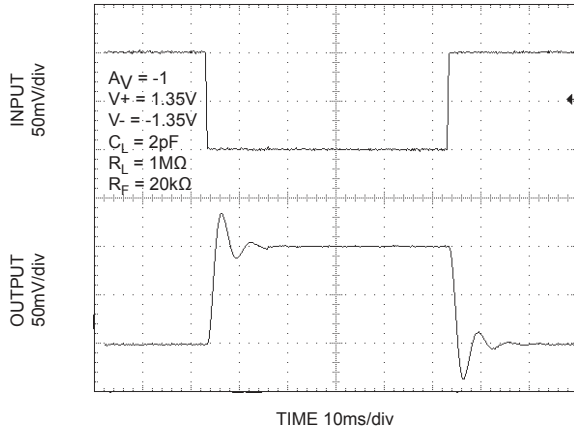


**Small Signal Pulse Response**  
Test Circuit 4:  $A_V = -1$

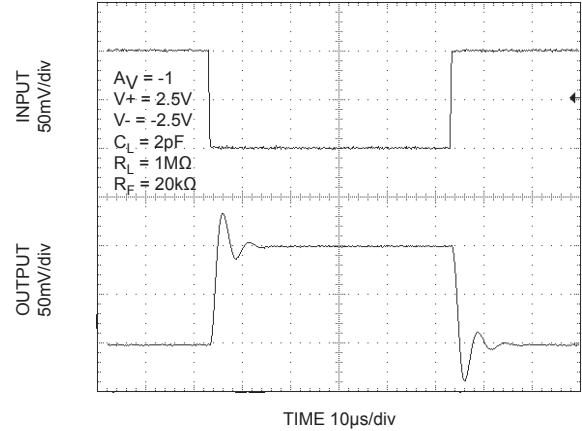




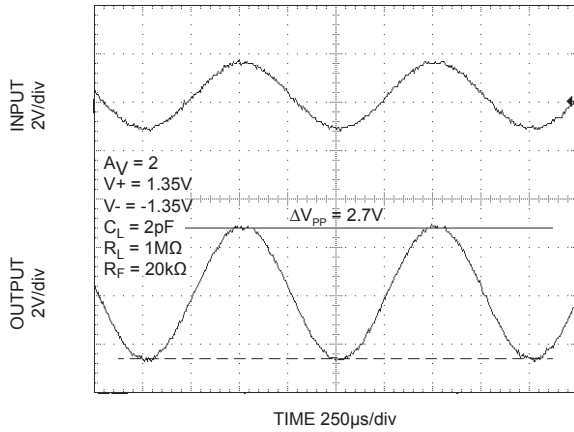
**Small Signal Pulse Response**  
**Test Circuit 4:  $A_V = -1$**



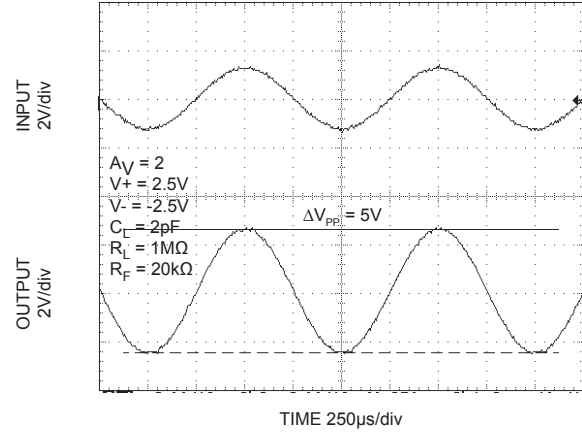
**Small Signal Pulse Response**  
**Test Circuit 4:  $A_V = -1$**



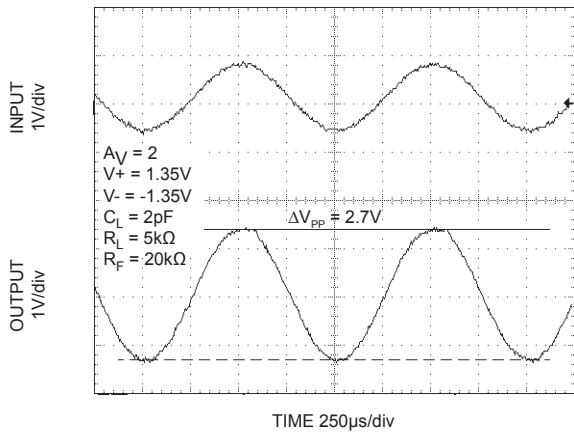
**Rail to Rail Output Operation**



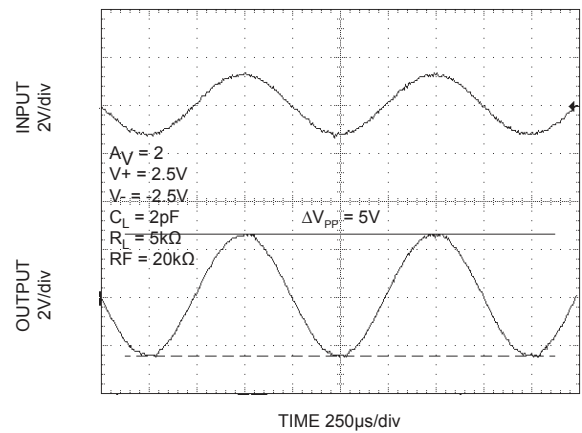
**Rail to Rail Output Operation**



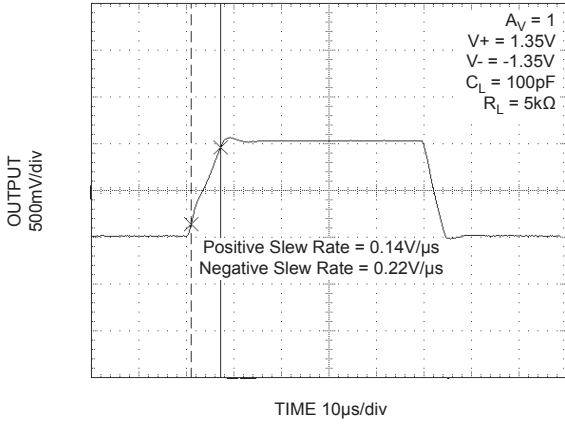
**Rail to Rail Output Operation**



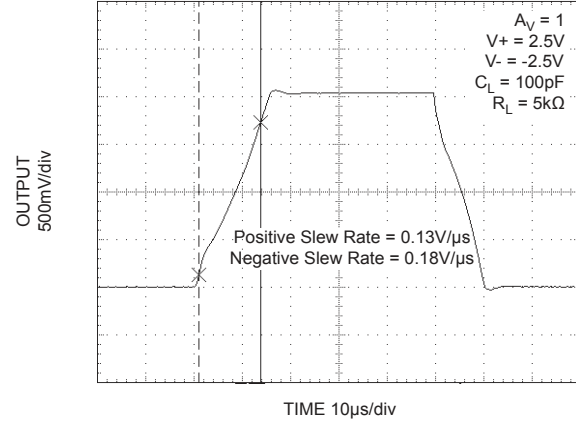
**Rail to Rail Output Operation**



Large Signal Pulse Response  
Test Circuit 3:  $A_V = 1$



Large Signal Pulse Response  
Test Circuit 3:  $A_V = 1$

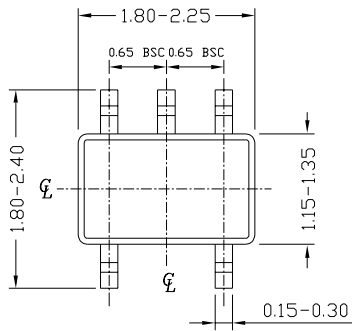


## Applications Information

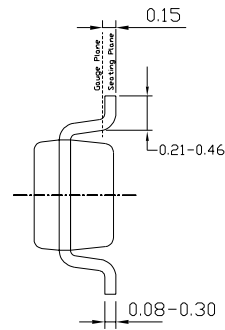
### Power Supply Bypassing

Regular supply bypassing techniques are recommended. A 10 $\mu$ F capacitor in parallel with a 0.1 $\mu$ F 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.

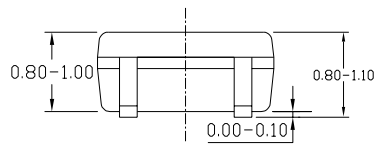
## Package Information



TOP VIEW



END VIEW



SIDE VIEW

NOTE:

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONS ARE INCLUSIVE OF PLATING.
3. DIMENSIONS ARE EXCLUSIVE OF MOLD FLASH & METAL BURR.

### SC70-5

**MICREL INC. 2180 FORTUNE DRIVE SAN JOSE, CA 95131 USA**  
 TEL + 1 (408) 944-0800 FAX + 1 (408) 474-1000 WEB <http://www.micrel.com>

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