MIC860

Teeny™ Ultra Low Power Op Amp

General Description

The MIC860 is a rail-to-rail output, operational amplifier in *Teeny*™ SC70 packaging. The MIC860 provides 4MHz gain-bandwidth product while consuming an incredibly low 30µA 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
- 4MHz gain-bandwidth product
- 30µA supply current
- Rail-to-Rail output
- Ground sensing at input common mode to GND
- Common mode to GND
- Drive large capactive loads

Applications

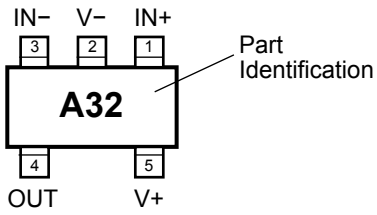
- Portable equipment
- PDAs
- Pagers
- Cordless Phones
- Consumer Electronics

Ordering Information

Part Number				Ambient Temp. Range	Package
Standard	**Marking**	**Pb-Free**	**Marking***		
MIC860BC5	A32	MIC860YC5	A32	–40°C to +85°C	SC-70-5

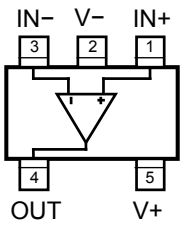
* Underbar marking may not be to scale.

Pin Configuration



SC-70

Functional Pinout



Teeny is a trademark of Micrel, Inc.

Absolute Maximum Ratings (Note 1)

Supply Voltage ($V_{V+} – V–$) ..... +6.0V
Differentail 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, **Note 3**

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 = 500kΩ to V+/2; T_A = 25°C, unless otherwise noted. **Bold** values indicate –40°C≤ T_A≤ +85°C.

Symbol	Parameter	Condition	Min	Typ	Max	Units
V_{OS}	Input Offset Voltage		–20	–5	15	mV
			–25		20	mV
	Input Offset Voltage Temp Coefficient			20		µV/°C
I_B	Input Bias Current			20		pA
I_{OS}	Input Offset Current			10		pA
V_{CM}	Input Voltage Range	CMRR > 60dB	**1**	1.8		V
CMRR	Common-Mode Rejection Ratio	0 < V_{CM} < 1.35V	**38**	76		dB
PSRR	Power Supply Rejection Ratio	Supply voltage change of 3V	**40**	78		dB
A_{VOL}	Large-Signal Voltage Gain	R_L = 5k, V_{OUT} 2V peak to peak	**50**	66		dB
		R_L = 100k, V_{OUT} 2V peak to peak	**66**	81		dB
		R_L = 500k, V_{OUT} 2V peak to peak	**76**	91		dB
V_{OUT}	Maximum Output Voltage Swing	R_L = 5k	**V+–70mV**	V+–34mV		V
		R_L = 500k	**V+–2mV**	V+–0.7mV		V
V_{OUT}	Minimum Output Voltage Swing	R_L = 5k		V–+11mV	**V–+ 50mV**	mV
		R_L = 500k		V–+0.2mV	**V–+ 2mV**	mV
GBW	Gain-Bandwidth Product			4		MHz
SR	Slew Rate			3		V/µs
I_{SC}	Short-Circuit Output Current	Source	**4.5**	6		mA
		Sink	**10**	16		mA
I_S	Supply Current	No Load		30	50	µA

V+= +5V, V–= 0V, V_{CM}= V+/2; R_L= 500kΩ to V+/2; T_A= 25°C, unless otherwise noted. **Bold** values indicate –40°C≤ T_A≤ +85°C.

V_{OS}	Input Offset Voltage		–20	–5	20	mV
	Input Offset Voltage Temp Coefficient			20		µV/°C
I_B	Input Bias Current			20		pA
I_{OS}	Input Offset Current			10		pA
V_{CM}	Input Voltage Range	CMRR > 60dB	**3.5**	4.2		V
CMRR	Common-Mode Rejection Ratio	0 < V_{CM} < 3.5V	**44**	77		dB
PSRR	Power Supply Rejection Ratio	Supply voltage change of 1V	**40**	79		dB
A_{VOL}	Large-Signal Voltage Gain	R_L = 5k, V_{OUT} 4.8V peak to peak	**52**	66		dB
		R_L = 100k, V_{OUT} 4.8V peak to peak	**67**	80		dB
		R_L = 500k, V_{OUT} 4.8V peak to peak	**75**	90		dB

Symbol	Parameter	Condition	Min	Typ	Max	Units
V_{OUT}	Maximum Output Voltage Swing	R_L = 5k	**V+–75mV**	V+–37mV		V
		R_L = 500k	**V+–35mV**	V+–4mV		V
V_{OUT}	Minimum Output Voltage Swing	R_L = 5k		V–+14mV	**V–+ 40mV**	mV
		R_L = 500k		V–+0.4mV	**V–+ 5mV**	mV
GBW	Gain-Bandwidth Product			4		MHz
SR	Slew Rate			3		V/µs
I_{SC}	Short-Circuit Output Current	Source	**15**	23		mA
		Sink	**30**	47		mA
I_S	Supply Current	No Load		33	**55**	µA

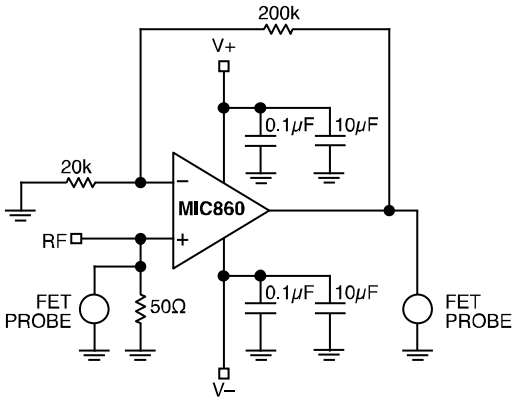
Note 1. Exceeding the absolute maximum rating may damage the device.

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

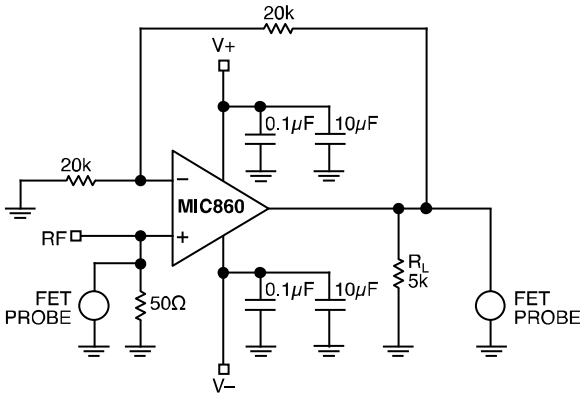
Note 3. Devices are ESD sensitive. Handling precautions recommended. Human body model, 1.5k in series with 100pF. Pin 4 is ESD sensetive

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.

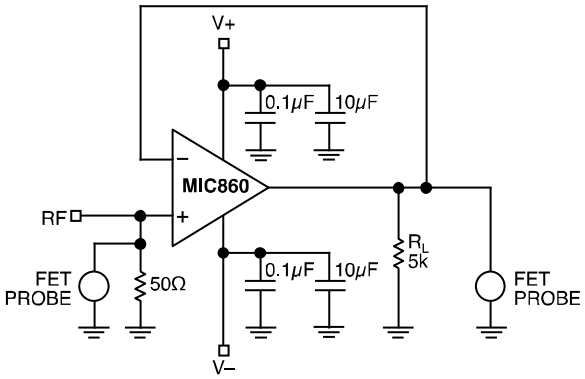
Test Circuits



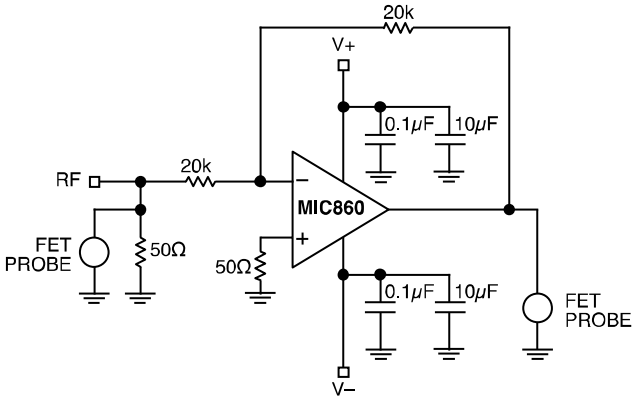
Test Circuit 1. $A_V = 10$



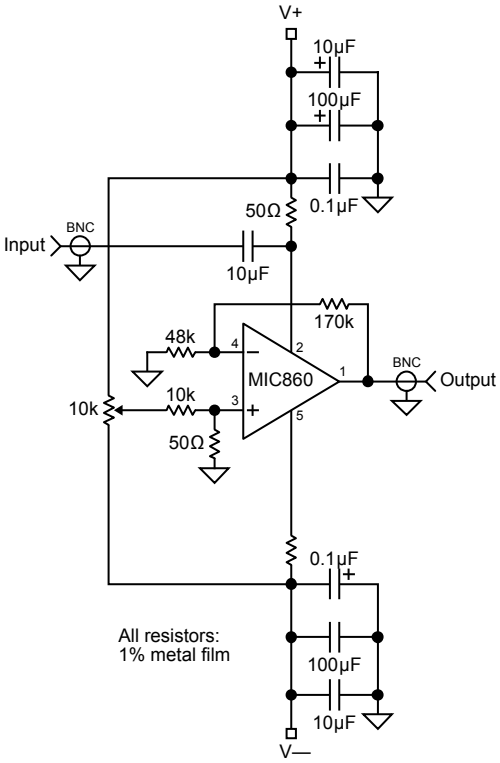
Test Circuit 2. $A_V = 2$



Test Circuit 3. $A_V = 1$



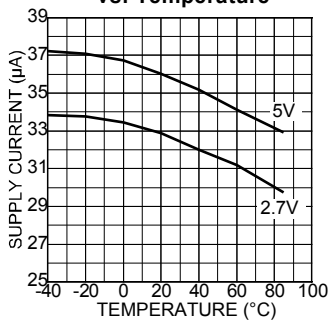
Test Circuit 4. $A_V = -1$



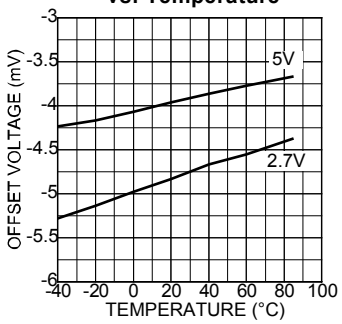
Test Circuit 5. Positive Power Supply Rejection Ratio Measurement

Typical Characteristics

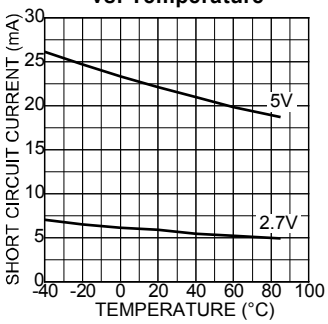
Supply Current vs. Temperature



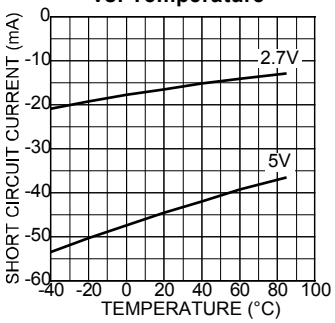
Offset Voltage vs. Temperature



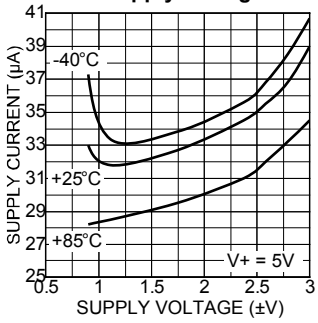
Short Circuit Current (source) vs. Temperature



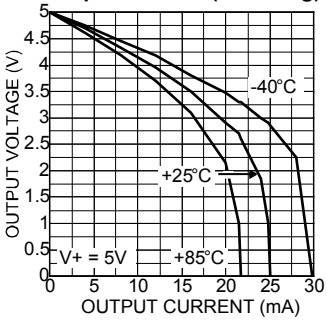
Short Circuit Current (sink) vs. Temperature



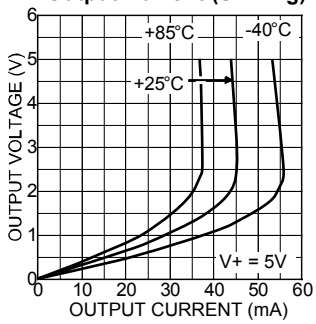
Supply Current vs. Supply Voltage



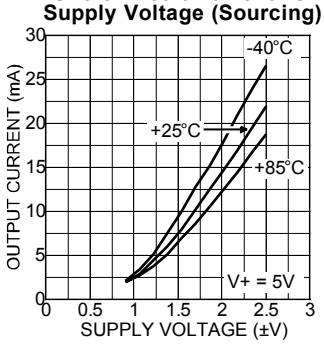
Output Voltage vs. Output Current (Sourcing)



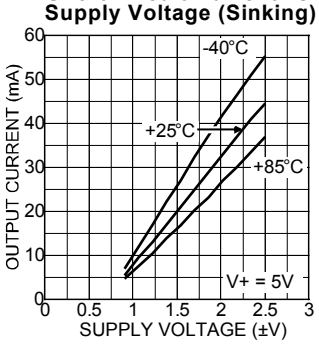
Output Voltage vs. Output Current (Sinking)



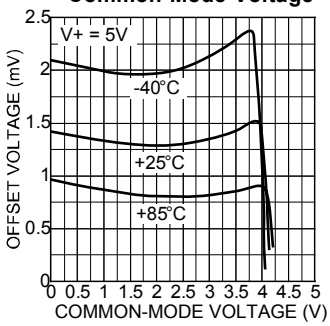
Short Circuit Current vs. Supply Voltage (Sourcing)



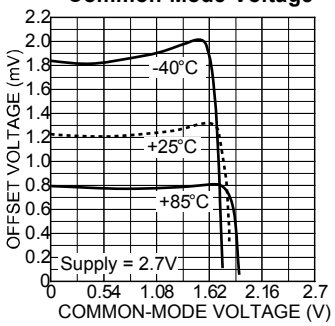
Short Circuit Current vs. Supply Voltage (Sinking)



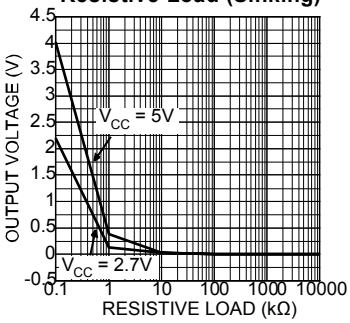
Offset Voltage vs. Common-Mode Voltage



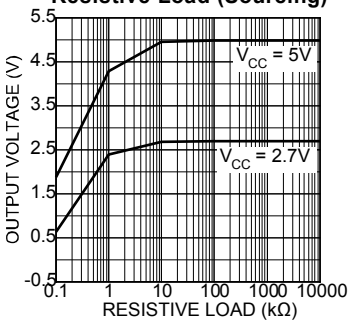
Offset Voltage vs. Common-Mode Voltage



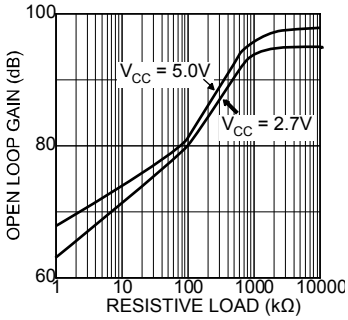
Output Voltage Swing vs. Resistive Load (Sinking)



Output Voltage Swing vs. Resistive Load (Sourcing)

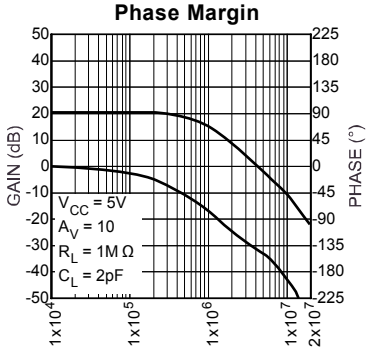


Open Loop Gain vs. Resistive Load

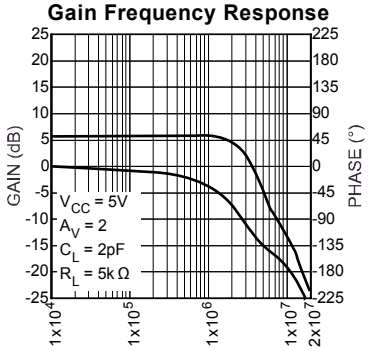


Functional Characteristics

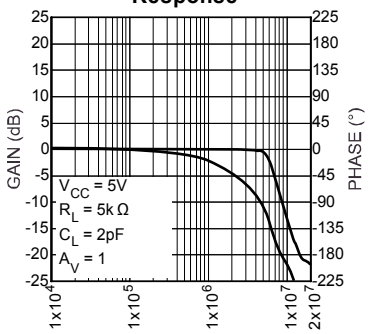
Gain Bandwidth and Phase Margin



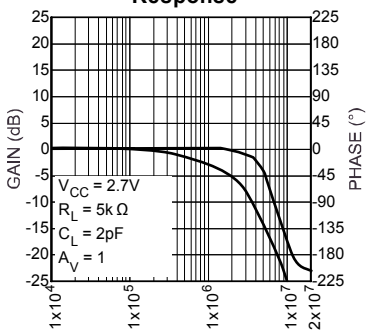
Gain Frequency Response



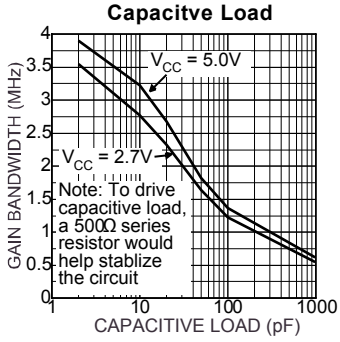
Unity Gain Frequency Response



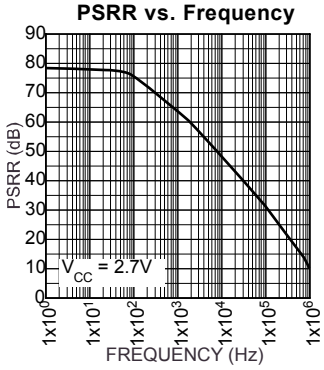
Unity Gain Frequency Response



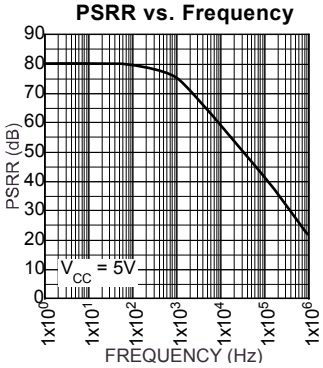
Gain Bandwidth vs. Capacitve Load



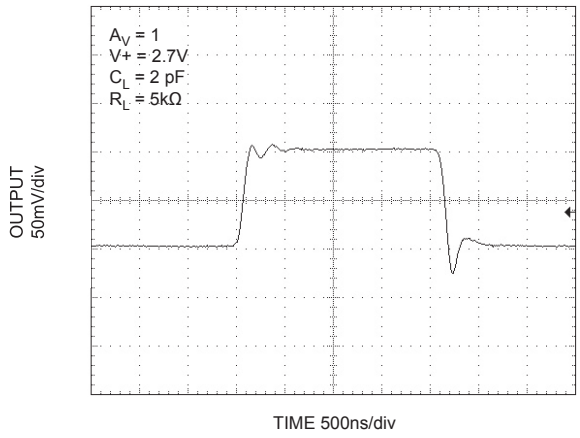
PSRR vs. Frequency



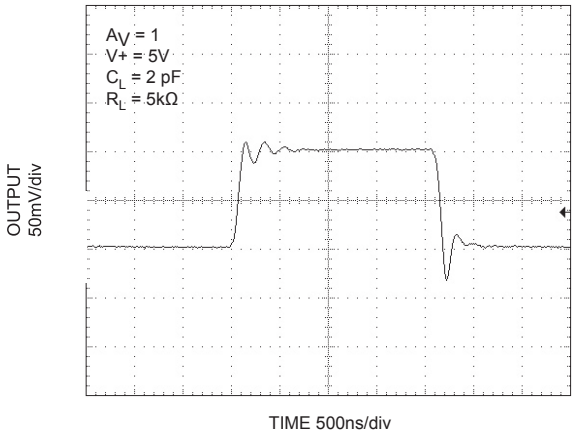
PSRR vs. Frequency



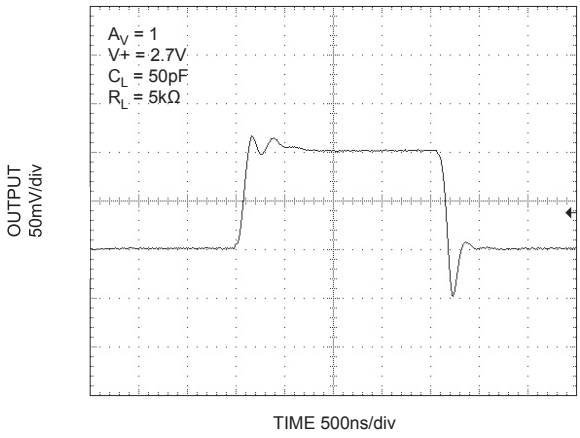
Small Signal Response
Test Circuit 3: A_V = 1



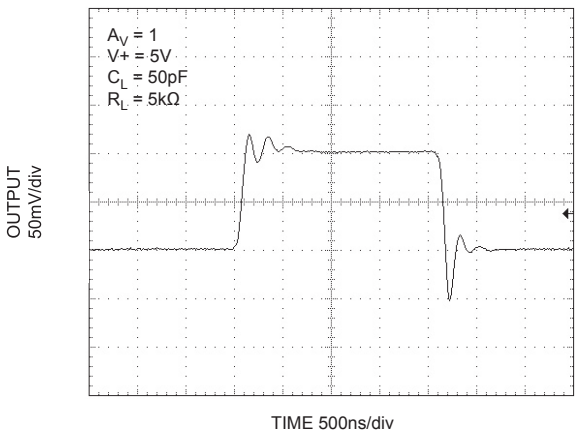
Small Signal Response
Test Circuit 3: A_V = 1



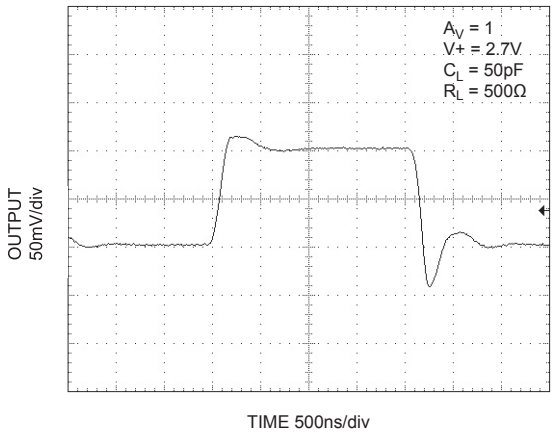
Small Signal Response
Test Circuit 3: A_V = 1



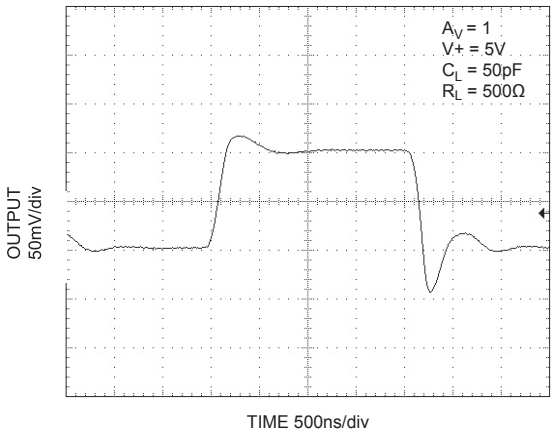
Small Signal Response
Test Circuit 3: A_V = 1



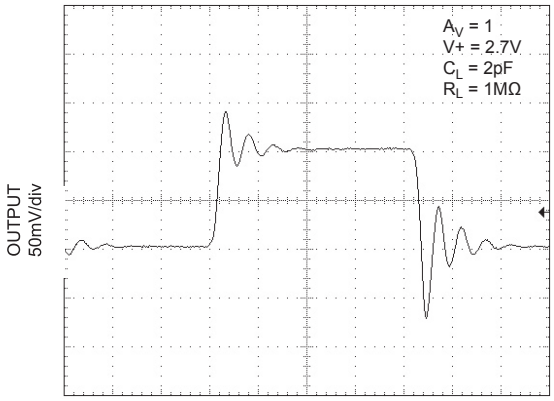
Smal Signal Response
Test Circuit 3: A_V = 1

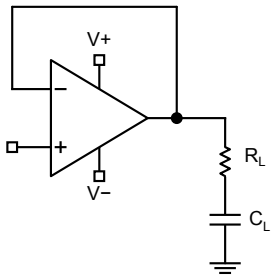


Smal Signal Response
Test Circuit 3: A_V = 1

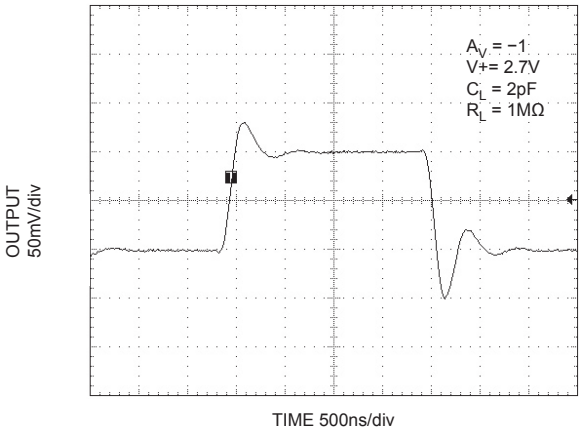


Smal Signal Response
Test Circuit 3: $A_V = 1$

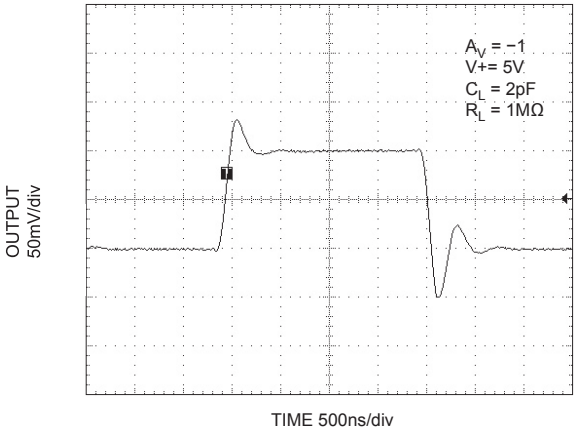




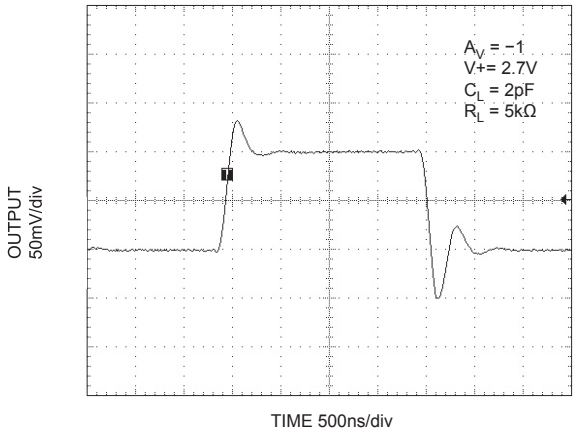
Small Signal Response
Test Circuit 4: $A_V = -1$



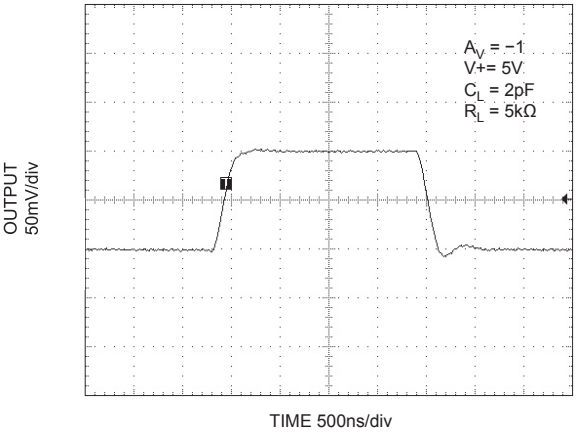
Small Signal Response
Test Circuit 4: $A_V = -1$



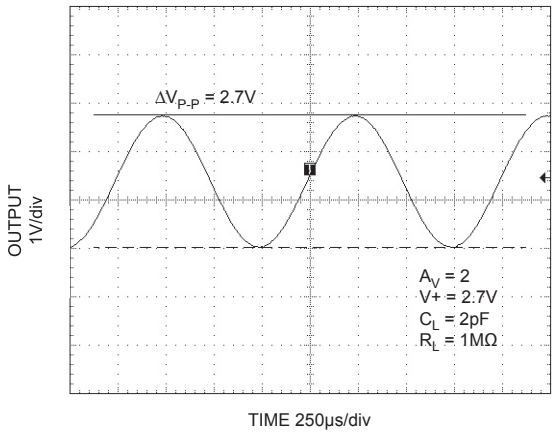
Small Signal Response
Test Circuit 4: $A_V = -1$



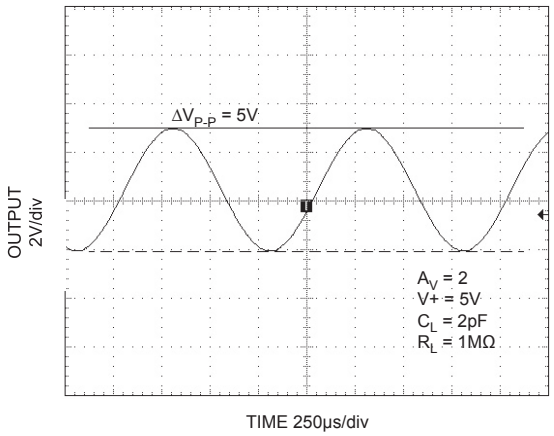
Small Signal Response
Test Circuit 4: $A_V = -1$



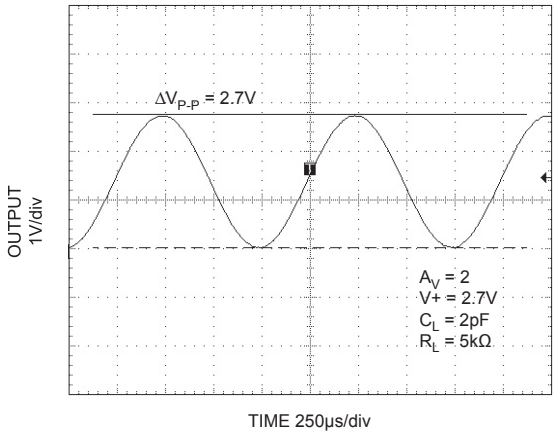
Rail to Rail Output Operation
Test Circuit 2: $A_V = 2$



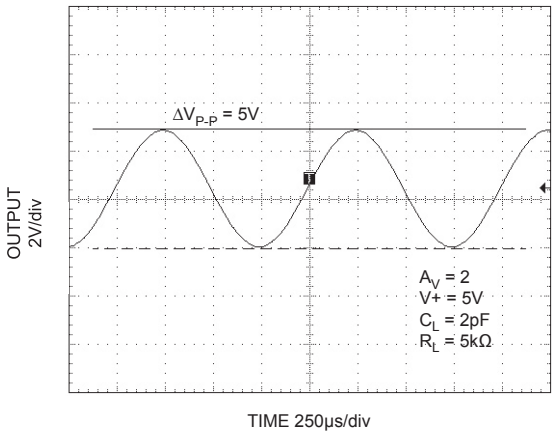
Rail to Rail Output Operation
Test Circuit 2: $A_V = 2$



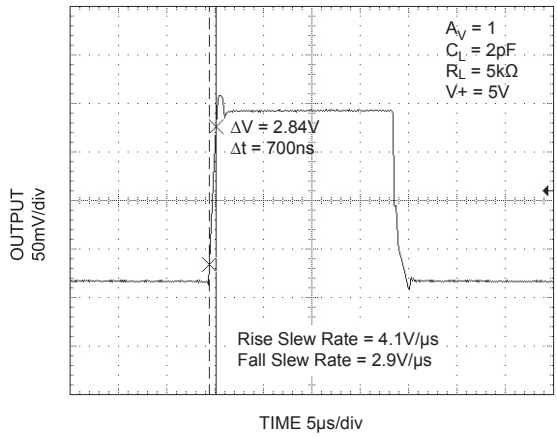
Rail to Rail Output Operation
Test Circuit 2: $A_V = 2$



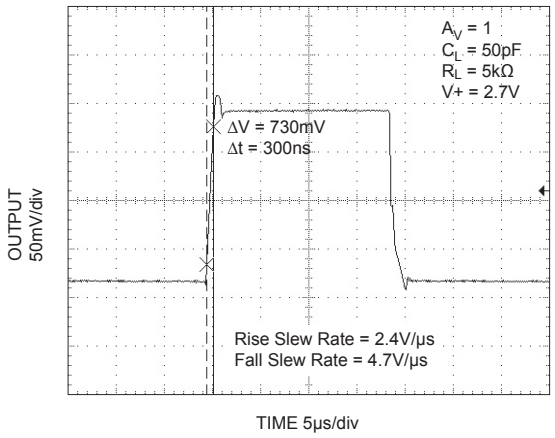
Rail to Rail Output Operation
Test Circuit 2: $A_V = 2$



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 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.

Supply and Loading Considerations

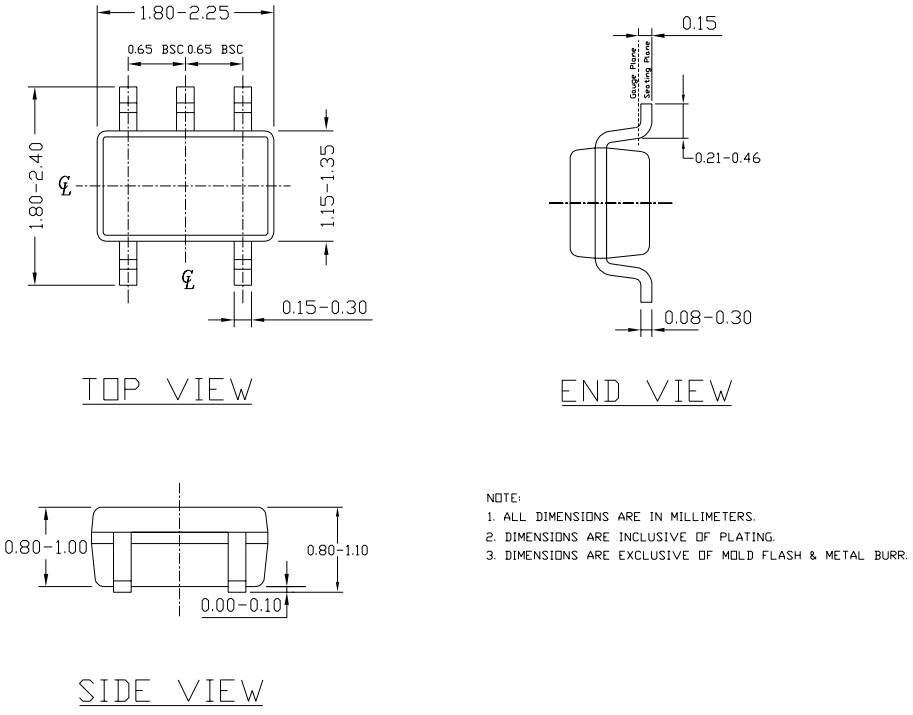
The MIC860 is intended for single supply applications configured with a grounded load. It is not advisable to operate the MIC860 with either:

1). A grounded load and split supplies (+/-V) or

2). A single supply where the load is terminated above ground.

Under the above conditions, if the load is less than 20kOhm and the output swing is greater than 1V(peak), there may be some instability when the output is sinking current.

Package Information



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