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 an SOT-23 package.

Datasheets and support documentation are available on Micrel's web site at: www.micrel.com.

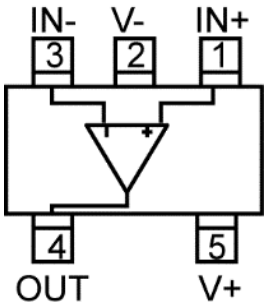
Features

- 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
- Drives large capacitive loads

Applications

- Portable equipment
- PDAs
- Pagers
- Cordless phones
- Consumer electronics

Functional Pinout



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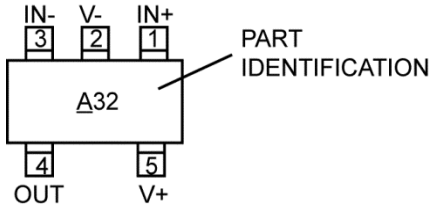
Ordering Information

Part Number	Marking[1]	Junction Temp. Range	Package
MIC860YC5	A32	–40ºC to +85ºC	5-Pin SC-70

Note:

1. Underbar marking may not be to scale.

Pin Configuration



5-pin SC-70 (C5)
(Top View)

Pin Description

Pin Number	Pin Name	Pin Function
1	IN+	Non-inverting input.
2	V-	Negative power supply connection. Connect a 10µF and 0.1µF capacitor in parallel to this pin for power supply bypassing.
3	IN-	Inverting input.
4	OUT	Output of operational amplifier.
5	V+	Positive power supply input. Connect a 10µF and 0.1µF capacitor in parallel to this pin for power supply bypassing.

Absolute Maximum Ratings[2]

Supply Voltage ($V_{V+} – V_{V-}$) ..... +6.0V
Differential Input Voltage ($|V_{IN+} – V_{IN–}|$)[5] ..... +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[4] ..... ESD Sensitive

Operating Ratings[3]

Supply Voltage ($V_{V+} – V_{V-}$) ..... +2.43V to +5.25V
Ambient Temperature (T_A) ..... –40°C to +85°C
Packaging Thermal Resistance
5-pin SC-70 (θ_{JA}) ..... 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 = 5kΩ, V_{OUT}= 2V_{PP}	**50**	66		dB
		R_L = 100kΩ, V_{OUT}= 2V_{PP}	**66**	81		dB
		R_L = 500kΩ, V_{OUT}= 2V_{PP}	**76**	91		dB
V_{OUT}	Maximum Output Voltage Swing	R_L = 5kΩ	**V±70mV**	V±34mV		V
		R_L = 500kΩ	**V±2mV**	V±0.7mV		V
V_{OUT}	Minimum Output Voltage Swing	R_L = 5kΩ		V±11mV	**V±50mV**	mV
		R_L = 500kΩ		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

Notes:

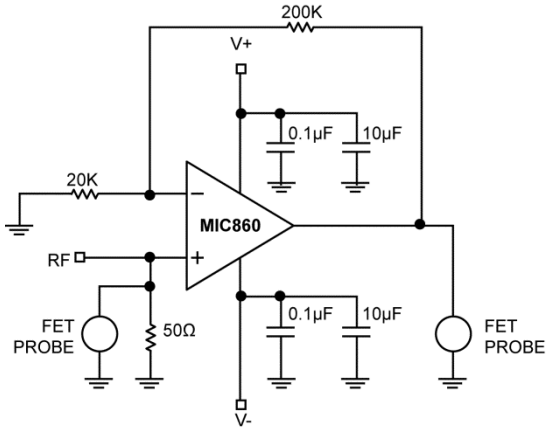
2. Exceeding the absolute maximum ratings may damage the device.
3. The device is not guaranteed to function outside its operating ratings.
4. Devices are ESD sensitive. Handling precautions are recommended. Human body model, 1.5kΩ in series with 100pF. Pin 4 is ESD sensitive.
5. Exceeding the maximum differential input voltage will damage the input stage and degrade performance (in particular, input bias current is likely to increase.

Electrical Characteristics[5] (Continued)

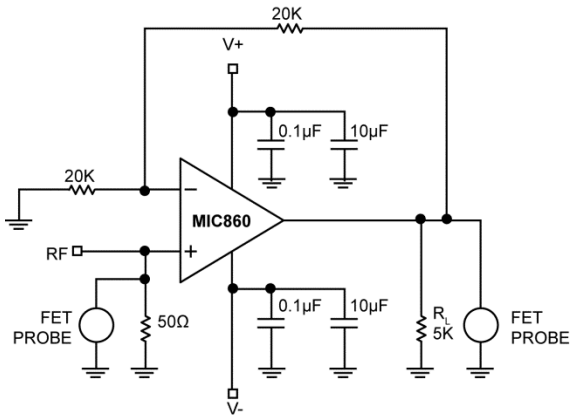
V+= +5V, V–= 0V, V_{CM}= V+/2; R_L= 500kΩ to V+/2; T_A= 25°C, unless otherwise noted. **Bold** values indicate –40°C≤ T_A≤ +85°C.

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
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 = 5kΩ, V_{OUT} 4.8V_{PP}	**52**	66		dB
		R_L = 100kΩ, V_{OUT} 4.8V_{PP}	**67**	80		dB
		R_L = 500kΩ, V_{OUT} 4.8V_{PP}	**75**	90		dB
V_{OUT}	Maximum Output Voltage Swing	R_L = 5kΩ	**V±75mV**	V±37mV		V
		R_L = 500kΩ	**V±35mV**	V±4mV		V
V_{OUT}	Minimum Output Voltage Swing	R_L = 5kΩ		V±14mV	**V±40mV**	mV
		R_L = 500kΩ		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

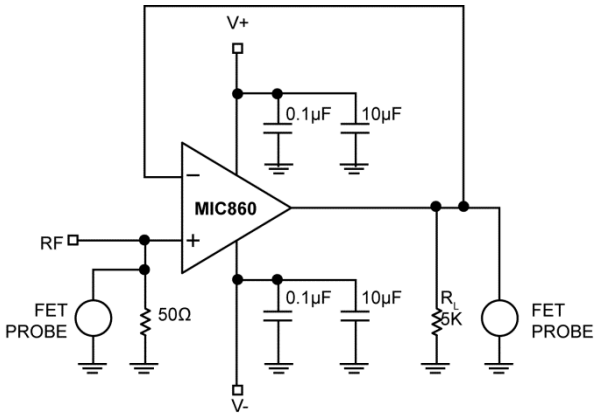
Test Circuits



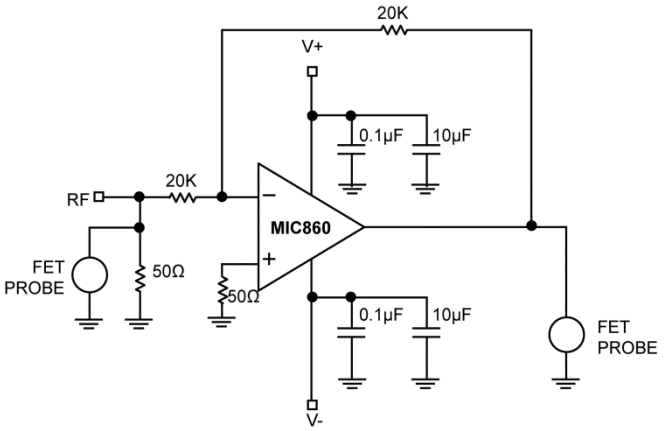
Test Circuit 1. $A_V = 10$



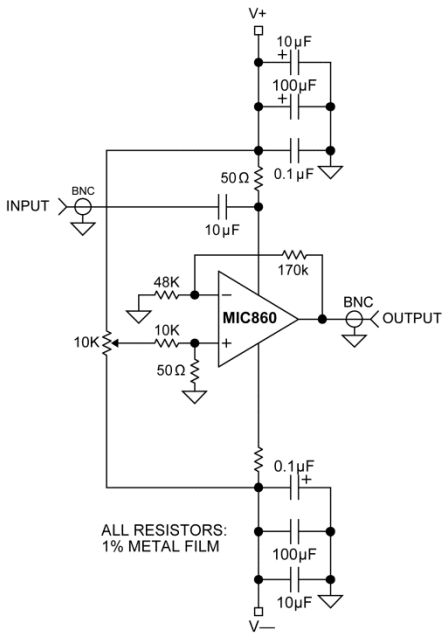
Test Circuit 2. $A_V = 2$



Test Circuit 3. $A_V = 1$



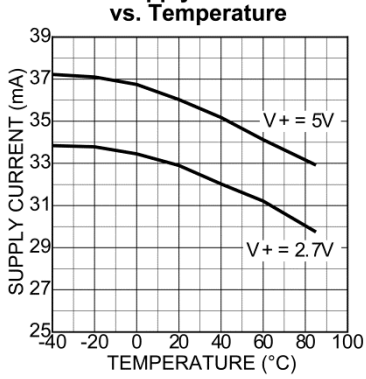
Test Circuit 4. $A_V = -1$



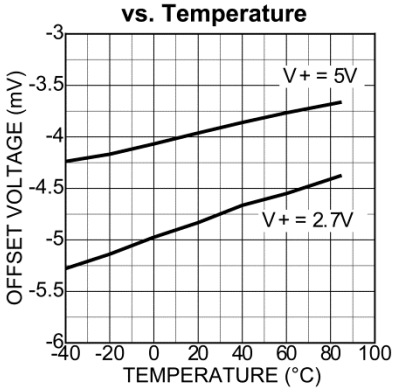
Test Circuit 5. Positive Power Supply Rejection Ratio Measurement

Typical Characteristics

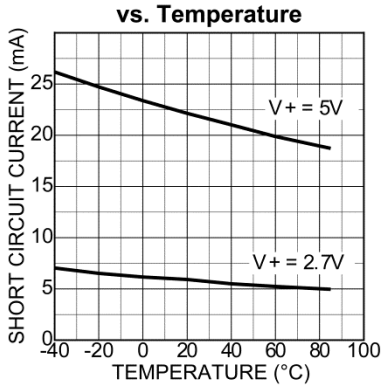
Supply Current vs. Temperature



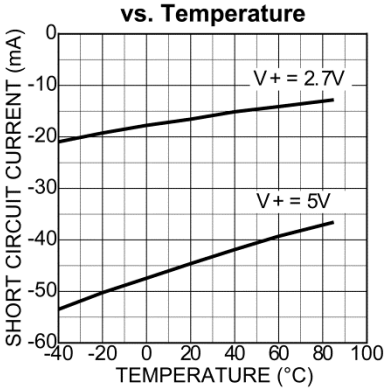
Offset Voltage vs. Temperature



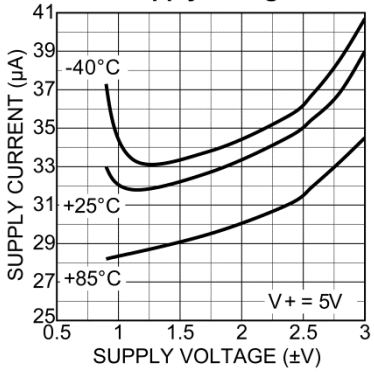
Short Circuit Current (source) vs. Temperature



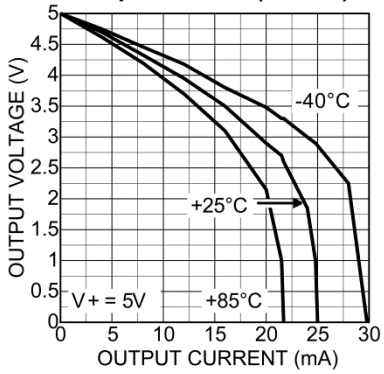
Short Circuit Current (sink) vs. Temperature



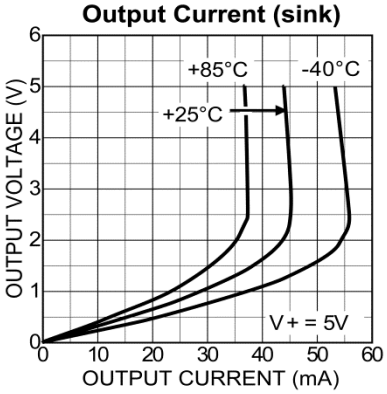
Supply Current vs. Supply Voltage



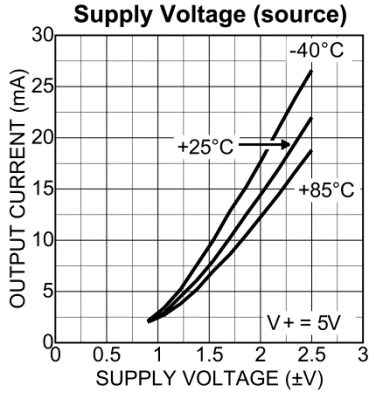
Output Voltage vs. Output Current (source)



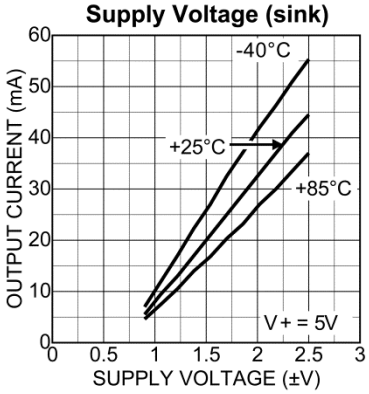
Output Voltage vs. Output Current (sink)



Short Circuit Current vs. Supply Voltage (source)

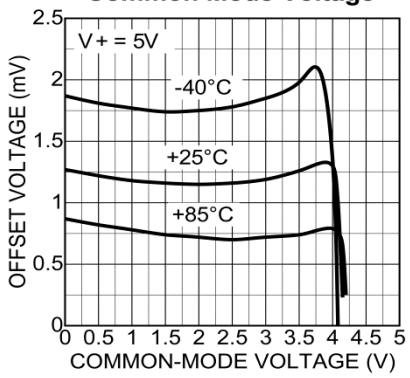


Short Circuit Current vs. Supply Voltage (sink)

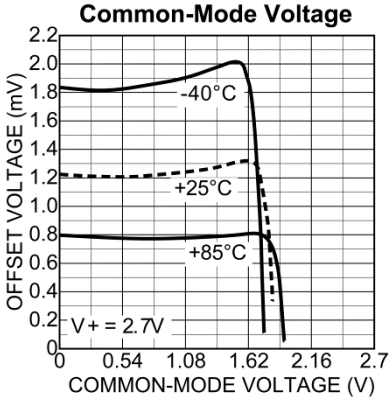


Typical Characteristics (Continued)

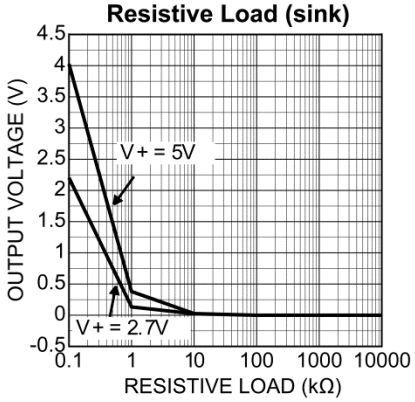
Offset Voltage vs. Common Mode Voltage



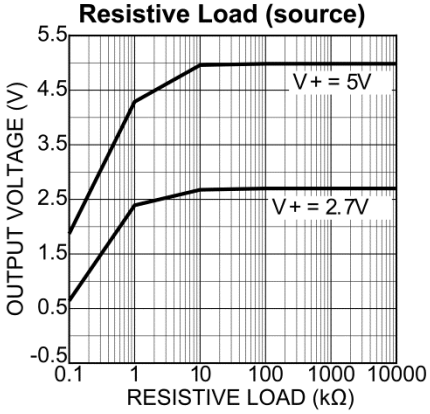
Offset Voltage vs. Common-Mode Voltage



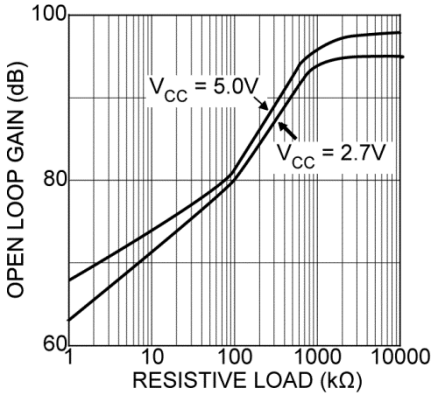
Output Voltage Swing vs. Resistive Load (sink)



Ouput Voltage Swing vs. Resistive Load (source)

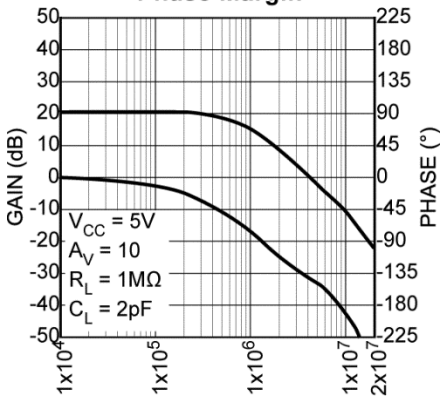


Open Loop Gain vs. Resistive Load

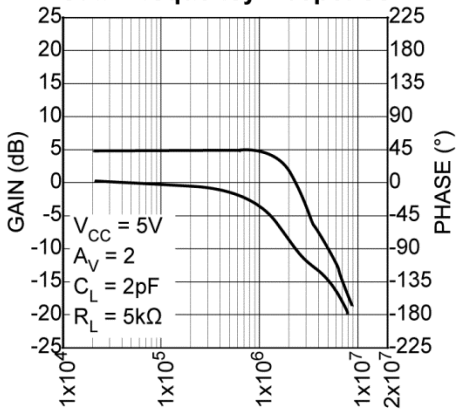


Typical Characteristics (Continued)

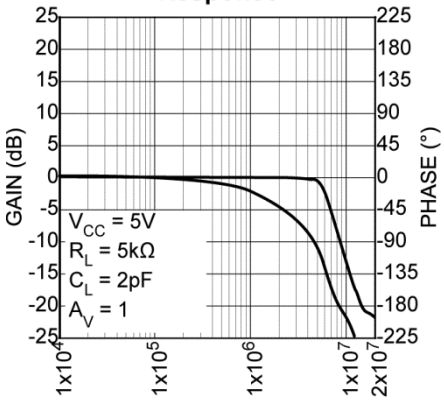
Gain Bandwidth and Phase Margin



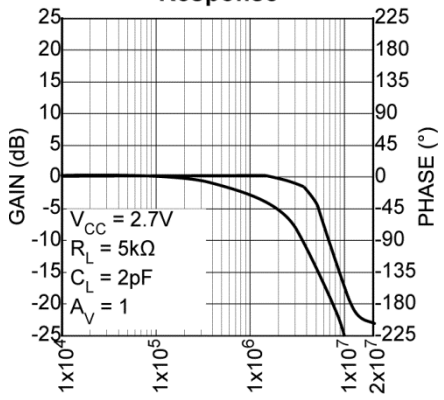
Gain Frequency Response



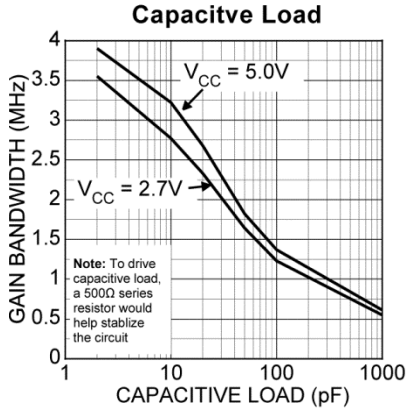
Unity Gain Frequency Response



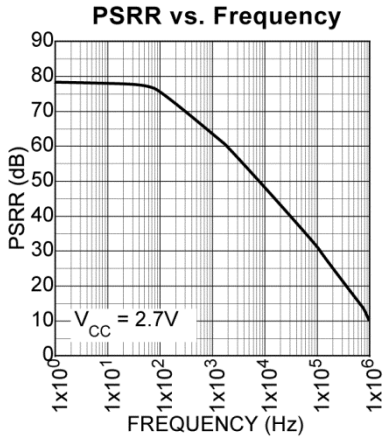
Unity Gain Frequency Response



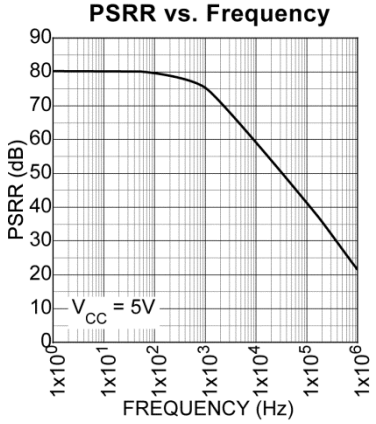
Gain Bandwidth vs. Capacitve Load



PSRR vs. Frequency

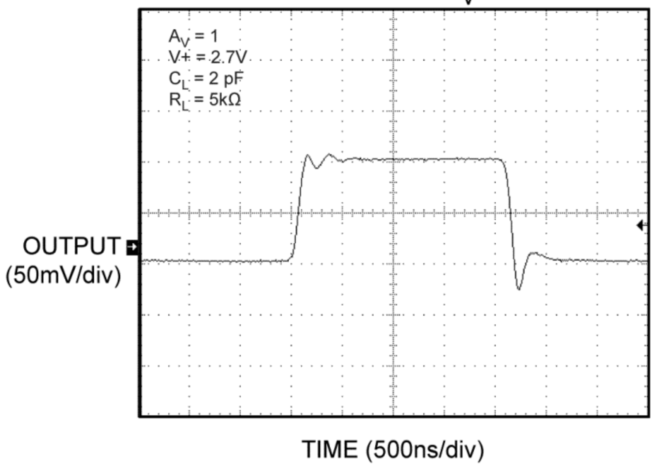


PSRR vs. Frequency

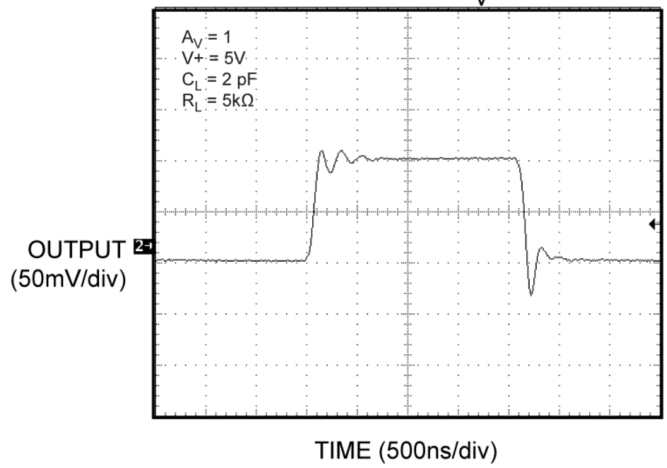


Functional Characteristics (Continued)

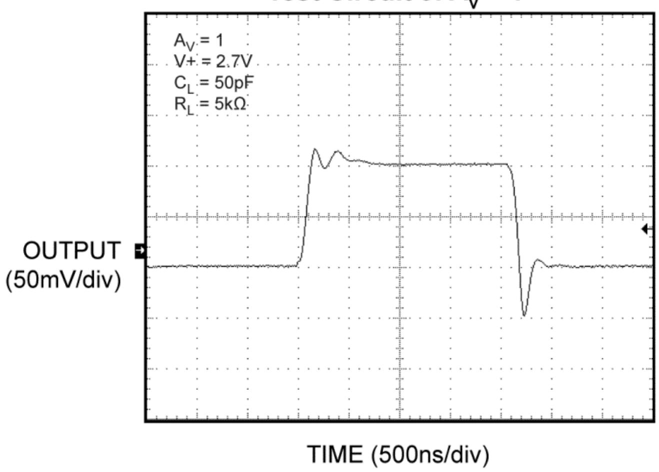
Small Signal Response
Test Circuit 3: A_V = 1



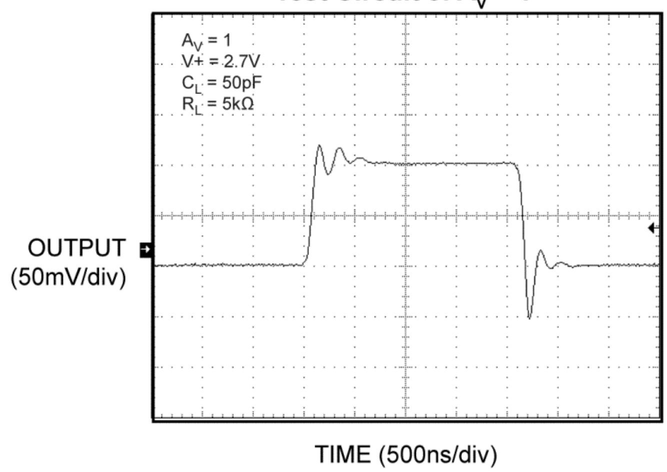
Small Signal Response
Test Circuit 3: A_V = 1



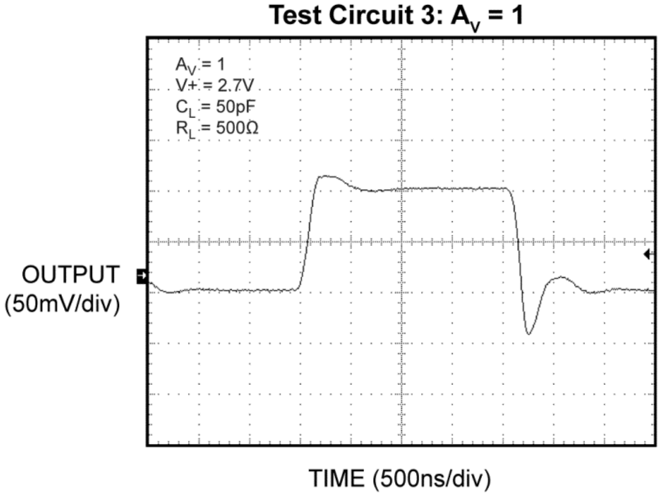
Small Signal Response
Test Circuit 3: A_V = 1



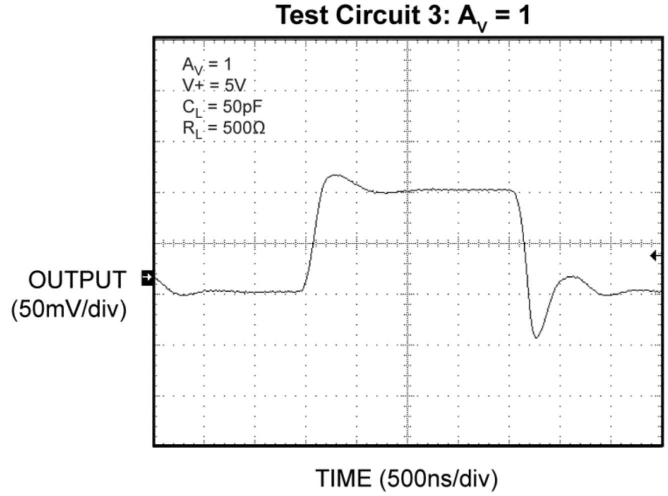
Small Signal Response
Test Circuit 3: A_V = 1



Small Signal Response
Test Circuit 3: A_V = 1

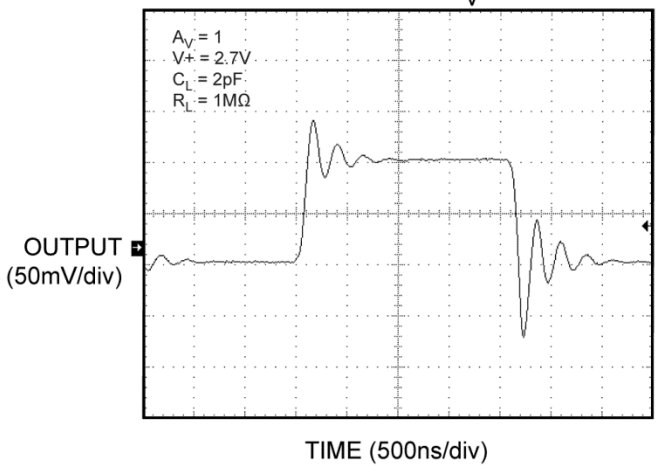


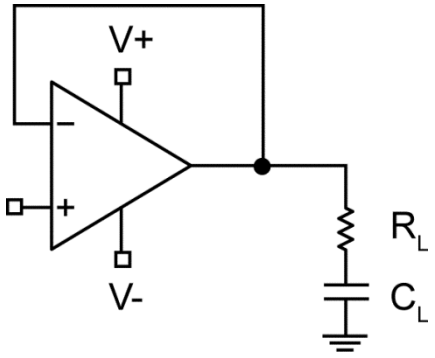
Small Signal Response
Test Circuit 3: A_V = 1



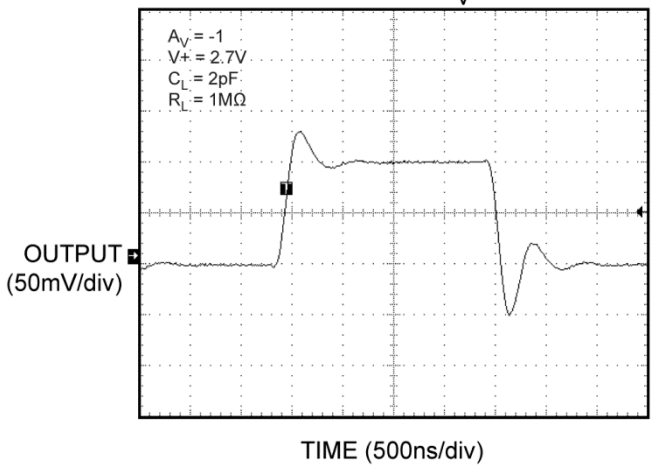
Functional Characteristics (Continued)

Small Signal Response
Test Circuit 3: A_V = 1

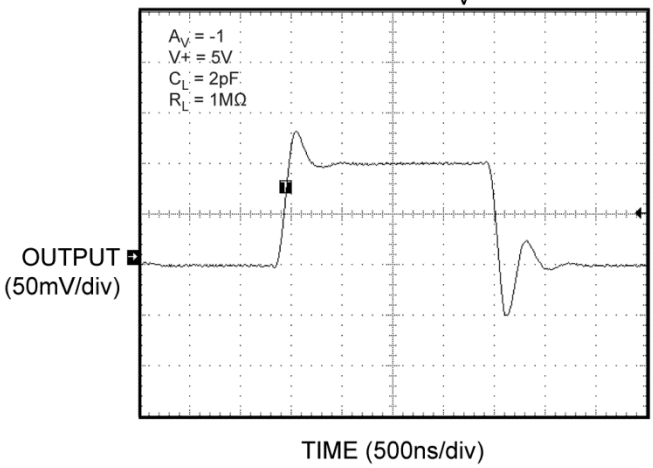




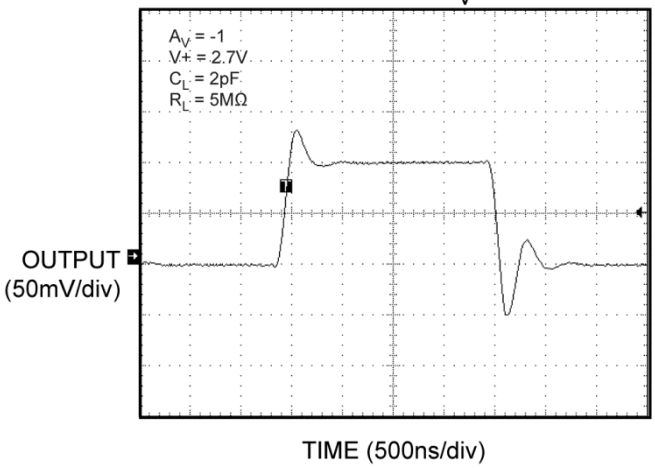
Small Signal Response
Test Circuit 4: A_V = -1



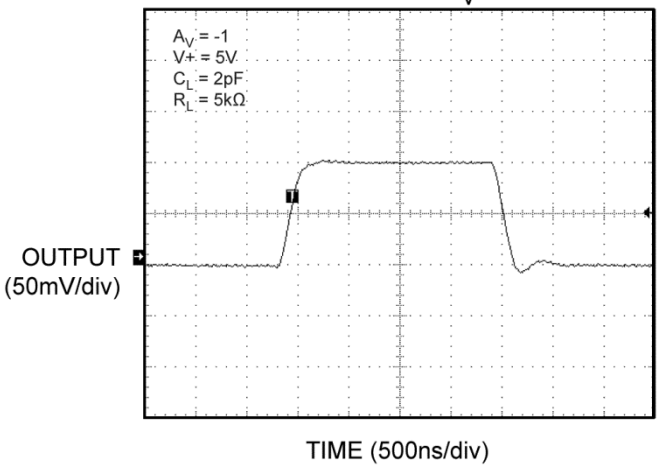
Small Signal Response
Test Circuit 4: A_V = -1



Small Signal Response
Test Circuit 4: A_V = -1

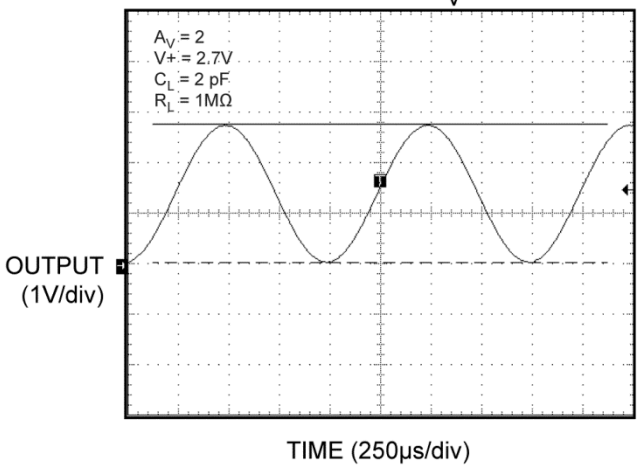


Small Signal Response
Test Circuit 4: A_V = -1

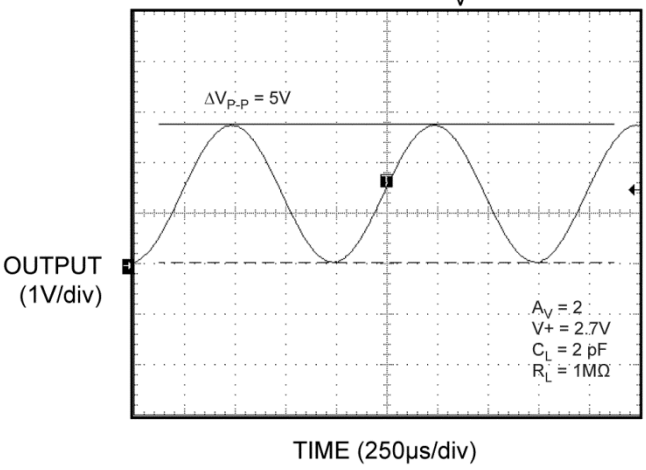


Functional Characteristics (Continued)

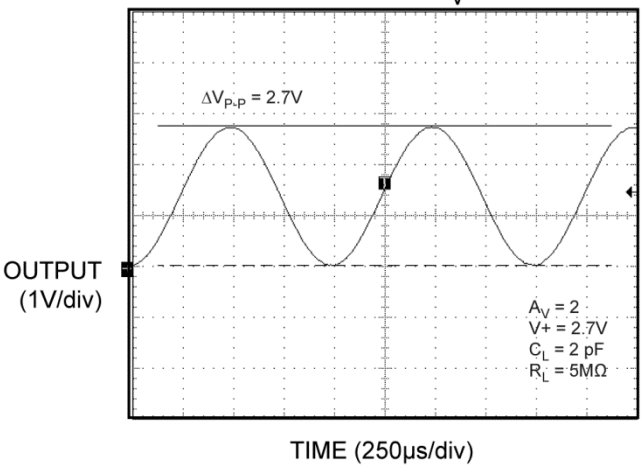
Rail to Raill Output Operation
Test Circuit 2: A_V = 2



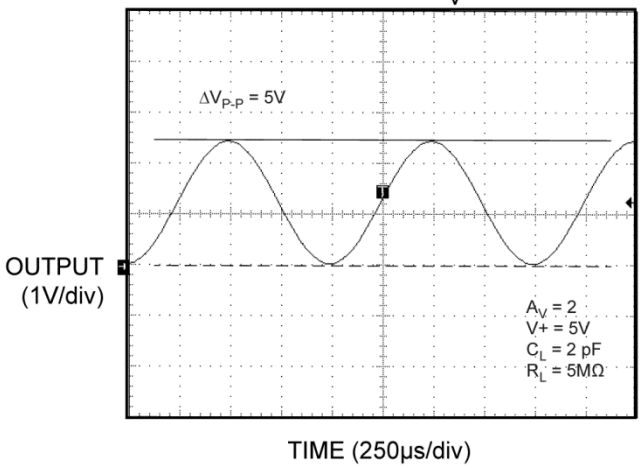
Rail to Raill Output Operation
Test Circuit 2: A_V = 2



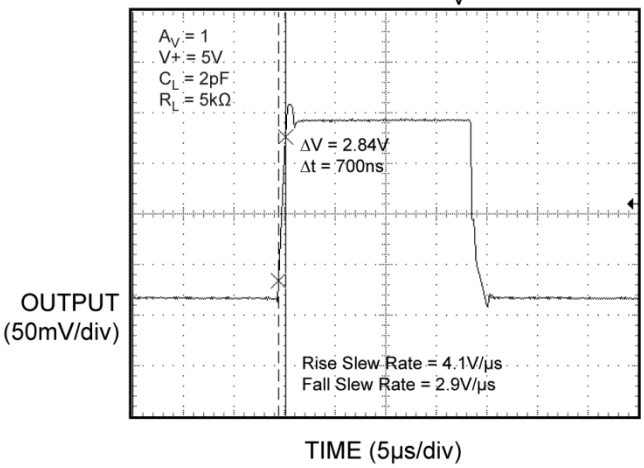
Rail to Raill Output Operation
Test Circuit 2: A_V = 2



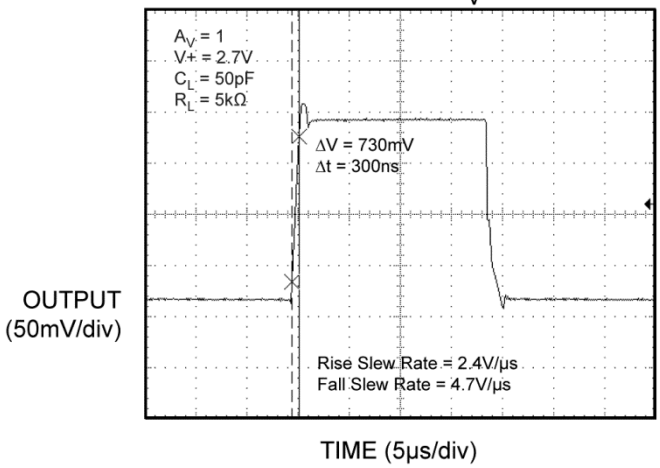
Rail to Raill Output Operation
Test Circuit 2: A_V = 2



Large Signal Pulse Response
Test Circuit 3: A_V = 1



Large Signal Pulse Response
Test Circuit 3: A_V = 1



Application 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 perfor- mance 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

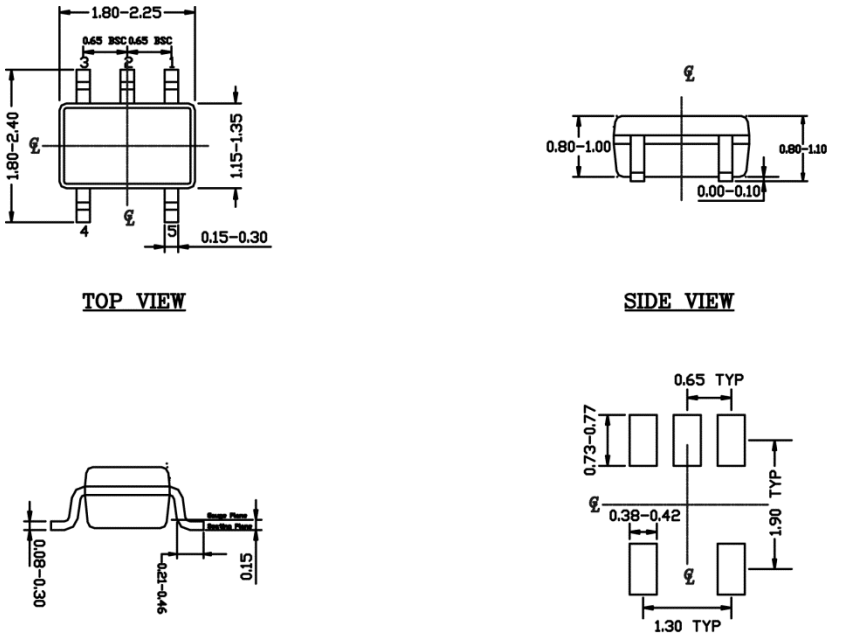
The MIC860 is intended for single supply applications configured with a grounded load. It is not advisable to operate the MIC860 with either:

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 20kΩ and the output swing is greater than 1V(peak), there may be some instability when the output is sinking current.

Package Information and Recommended Land Pattern[6]



5-pin SC70 (C5)

Note:

6. Package information is correct as of the publication date. For updates and most current information, go to www.micrel.com.

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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