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 a 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.

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

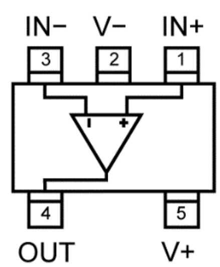
Features

- 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

Functional Pinout



Teeny is a trademark of Micrel, Inc.

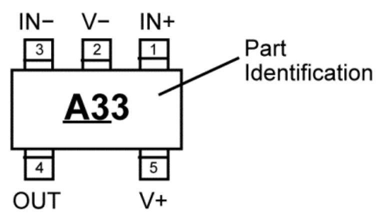
Ordering Information

Part Number	Marking[1]	Ambient Temperature Range	Package
MIC861YC5	A33	–40° to +85°C	5-Pin SC70

Note:

1. Underbar marking may not be to scale.

Pin Configuration



5-Pin SC70 (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-}| ....+6.0V
Input Voltage (V_{IN+} – V_{IN-})..................... V_+ + 0.3V, V_- - 0.3V
Lead Temperature (soldering, 5s)............................. 260°C
Output Short Circuit Current Duration ....Indefinite
Storage Temperature (Ts)... 150°C
ESD Rating..Note 4

Operating Ratings[3]

Supply Voltage (V_{V+} – V_{V-}) .... +2.43V to +5.25V
Ambient Temperature (T_A) .... –40°C to +85°C
Junction Thermal Resistance
5-Pin SC70 (Θ_{JA}) .... 450°C/W

Electrical Characteristics[5]

V+ = +2.7V, V- = 0V, V_{CM} = V+/2; R_L = 500kΩ to V+/2; T_A = 25°C, **bold** values indicate –40°C ≤ T_A ≤ +85°C, unless noted.

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
V_{OS}	Input Offset Voltage	Note 6	**-10**	2	**10**	mV
	Input Offset Voltage Temperature Coefficient			15		µV/°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	**45**	77		dB
PSRR	Power Supply Rejection Ratio	Supply voltage change of 3V	**50**	83		dB
A_{VOL}	Large Signal Voltage Gain	R_L = 100kΩ, V_{OUT} = 2V peak-to-peak	**60**	74		dB
		R_L = 500kΩ, V_{OUT} = 2V peak-to-peak	**73**	83		dB
V_{OUT}	Maximum Output Voltage Swing	R_L = 500kΩ	**V ±2mV**	V ±0.7mV		V
V_{OUT}	Minimum Output Voltage Swing	R_L = 500kΩ		V ±0.2mV	**V ±2mV**	V
GBW	Gain-Bandwidth Product	R_L = 200kΩ, C_L = 2pF, V_{OUT} = 0		350		kHz
BW	–3dB Bandwidth	A_V = 1, C_L = 2pF, R_L = 1MΩ		500		kHz
SR	Slew Rate	A_V = 1, C_L = 2pF, R_L = 1MΩ		0.12		V/µs
I_{SC}	Short-Circuit Output Current	Source		6		mA
		Sink		5		mA
I_S	Supply Current	No load		4.2	**9**	µA

Notes:

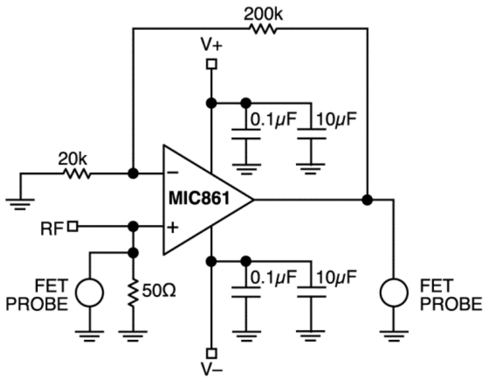
2. Exceeding the absolute maximum ratings may damage the device.
3. The device is not guaranteed to function outside its operating ratings.
4. Devices are ESD sensitive. Handling precautions are recommended. Human body model, 1.5kΩ in series with 100pF. Pin 4 is ESD sensitive.
5. Specification for packaged product only. Exceeding the maximum differential input voltage will damage the input stage and degrade performance (in particular, input bias will likely increase).
6. The offset voltage distribution is centered around 0V. The typical offset number shown is equal to the standard deviation of the voltage offset distribution.

Electrical Characteristics[5] (Continued)

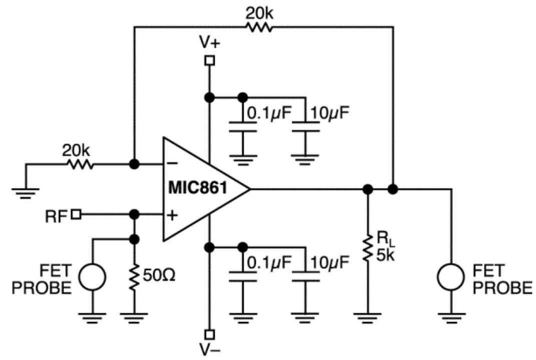
V+ = +5V, V- = 0V, V_{CM} = V+/2; R_L = 500kΩ to V+/2; T_A = 25°C, **bold** values indicate –40°C ≤ T_A ≤ +85°C, unless noted.

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
V_{OS}	Input Offset Voltage	Note 6	**-10**	2	**10**	mV
	Input Offset Voltage Temperature Coefficient			15		µV/°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	**60**	80		dB
PSRR	Power Supply Rejection Ratio	Supply voltage change of 1V	**45**	85		dB
A_{VOL}	Large Signal Voltage Gain	R_L = 100kΩ, V_{OUT} = 4V peak-to-peak	**60**	76		dB
		R_L = 500kΩ, V_{OUT} = 4V peak-to-peak	**68**	83		dB
V_{OUT}	Maximum Output Voltage Swing	R_L = 500kΩ	**V ±2mV**	V ±0.7mV		V
V_{OUT}	Minimum Output Voltage Swing	R_L = 500kΩ		V ±0.7mV	**V ±2mV**	V
GBW	Gain-Bandwidth Product	R_L = 200kΩ, C_L = 2pF, V_{OUT} = 0		400		kHz
BW	–3dB Bandwidth	A_V = 1, C_L = 2pF, R_L = 1MΩ		650		kHz
SR	Slew Rate	A_V = 1, C_L = 2pF, R_L = 1MΩ		0.12		V/µs
I_{SC}	Short-Circuit Output Current	Source	**10**	24		mA
		Sink	**10**	24		mA
I_S	Supply Current	No load		4.6	**9**	µA

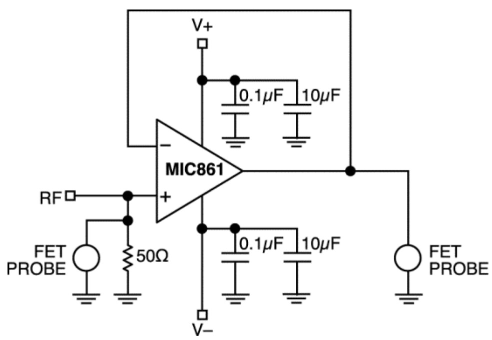
Test Circuits



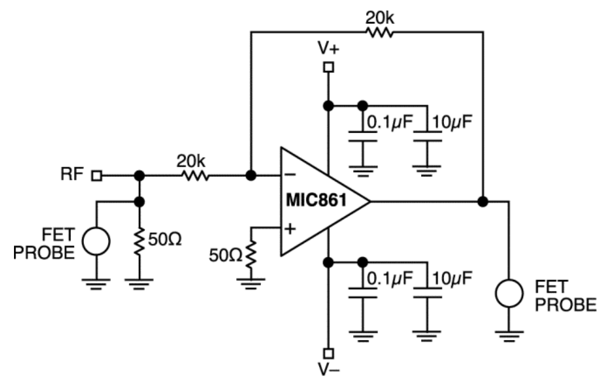
Test Circuit 1. $A_V = 11$



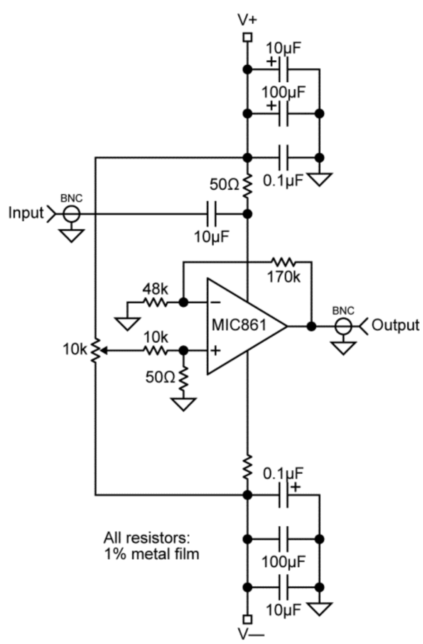
Test Circuit 2. $A_V = 2$



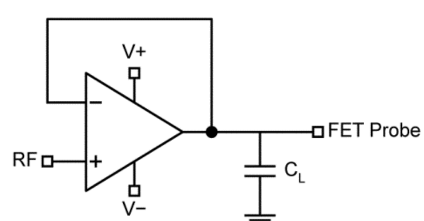
Test Circuit 3. $A_V = 1$



Test Circuit 4. $A_V = –1$



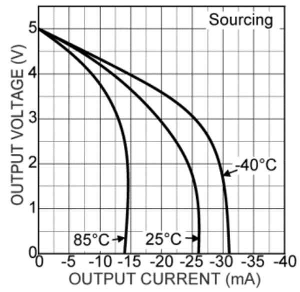
Test Circuit 5. Positive Power Supply Rejection Ratio Measurement



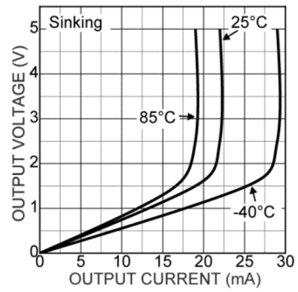
Test Circuit 6. Closed-Loop Unity Gain Frequency Response Measurement

DC Typical Characteristics

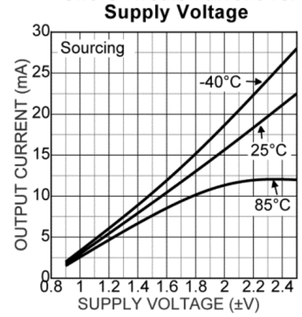
Output Voltage vs. Output Current



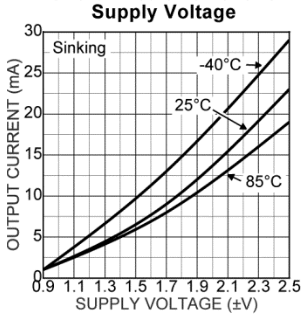
Output Voltage vs. Output Current



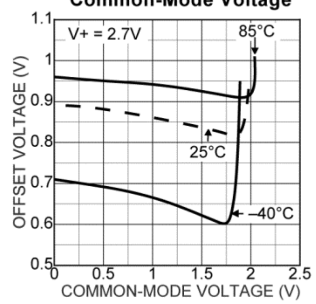
Short Circuit Current vs. Supply Voltage



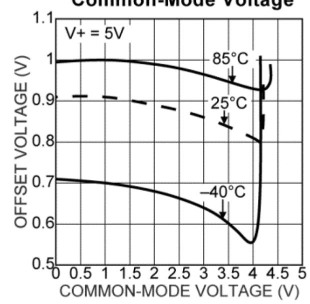
Short Circuit Current vs. Supply Voltage



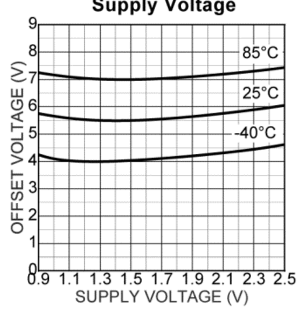
Offset Voltage vs. Common-Mode Voltage



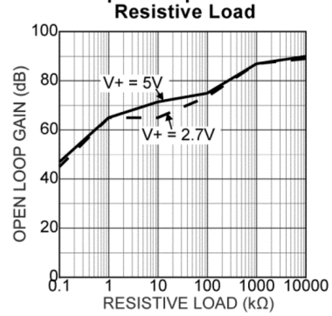
Offset Voltage vs. Common-Mode Voltage



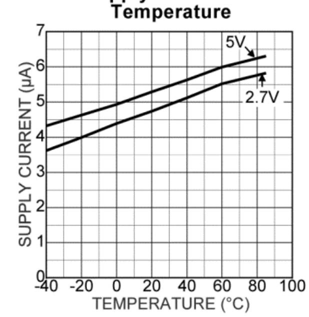
Offset Voltage vs. Supply Voltage



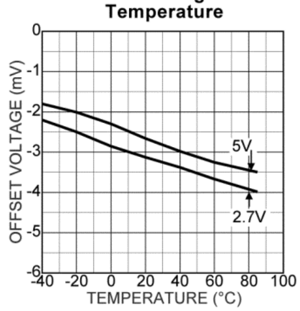
Open Loop Gain vs. Resistive Load



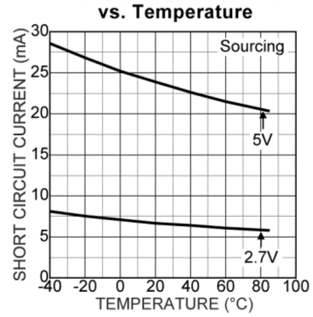
Supply Current vs. Temperature



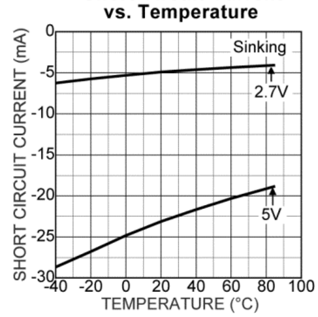
Offset Voltage vs. Temperature



Short Circuit Current vs. Temperature

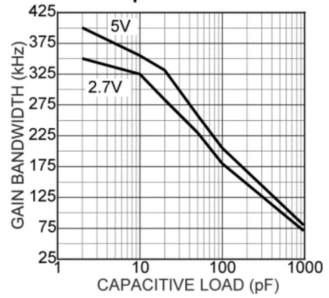


Short Circuit Current vs. Temperature

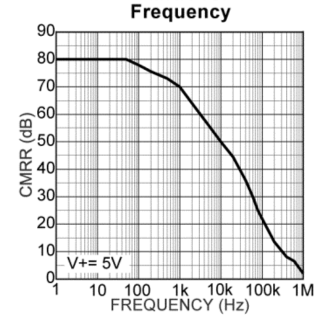


AC Typical Characteristics

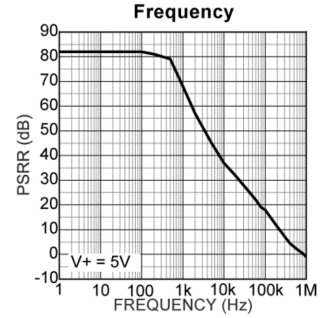
Gain Bandwidth vs. Capacitive Load



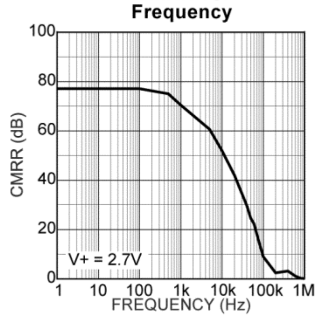
CMRR vs. Frequency



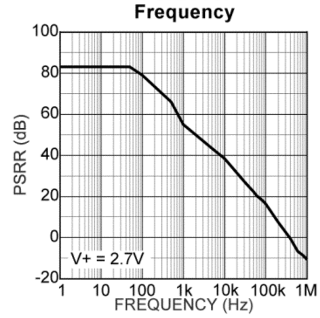
PSRR vs. Frequency



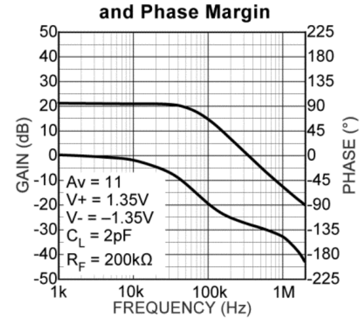
CMRR vs. Frequency



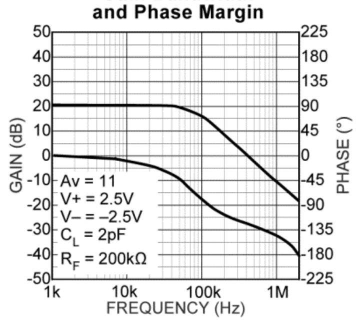
PSRR vs. Frequency



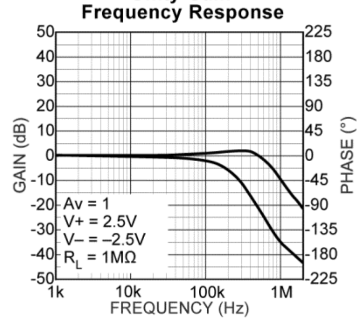
Gain Bandwidth and Phase Margin



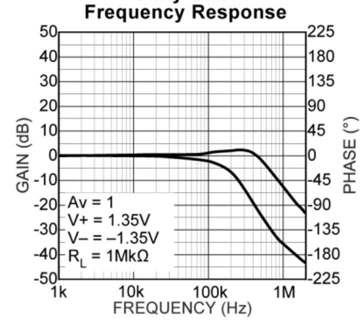
Gain Bandwidth and Phase Margin



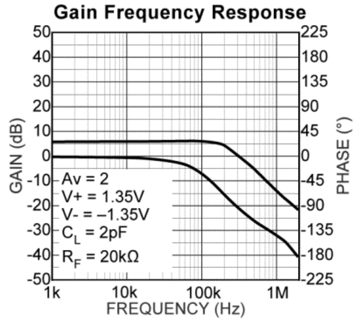
Unity Gain Frequency Response



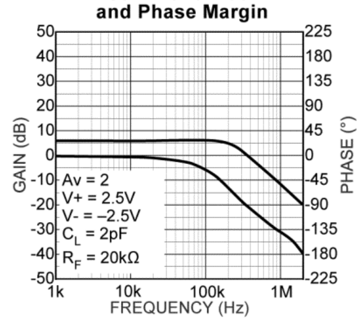
Unity Gain Frequency Response



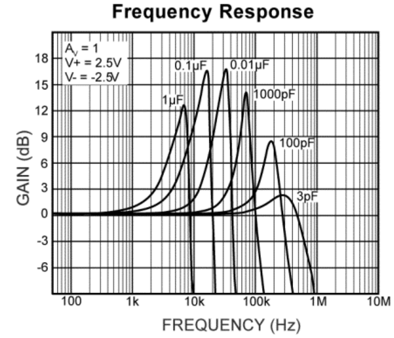
Gain Frequency Response



Gain Bandwidth and Phase Margin

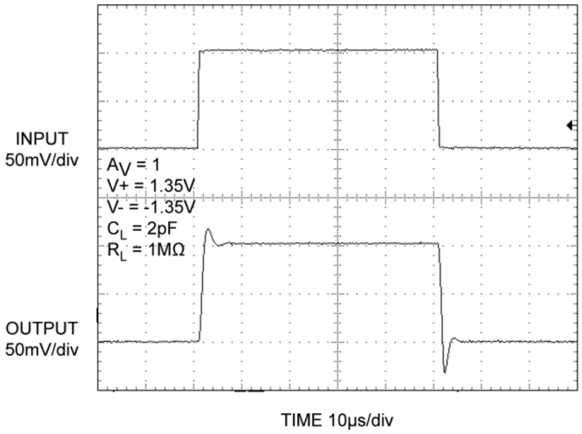


Closed-Loop Unity Gain Frequency Response

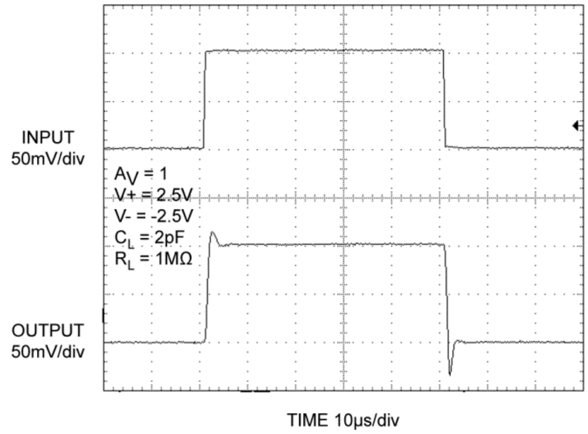


Functional Characteristics

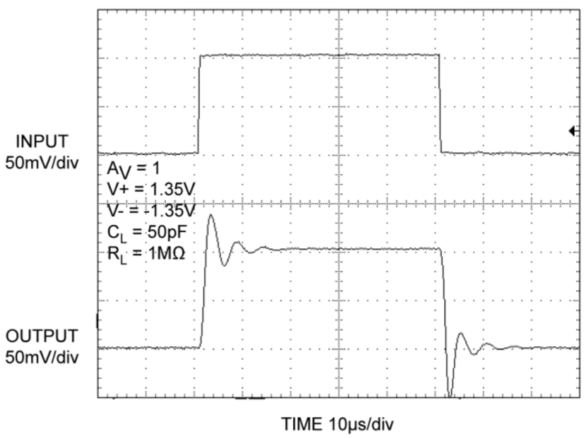
Small Signal Pulse Response
Test Circuit 3: A_V = 1



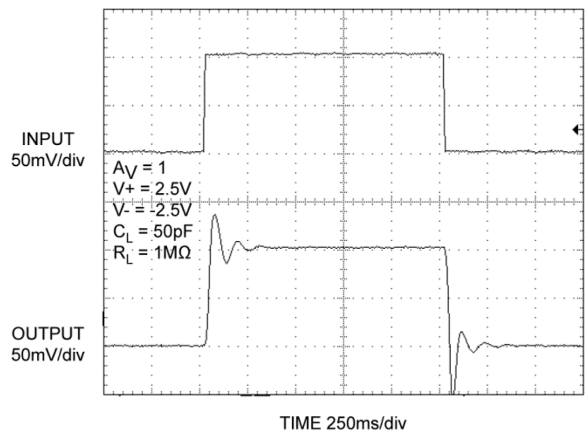
Small Signal Pulse Response
Test Circuit 3: A_V = 1



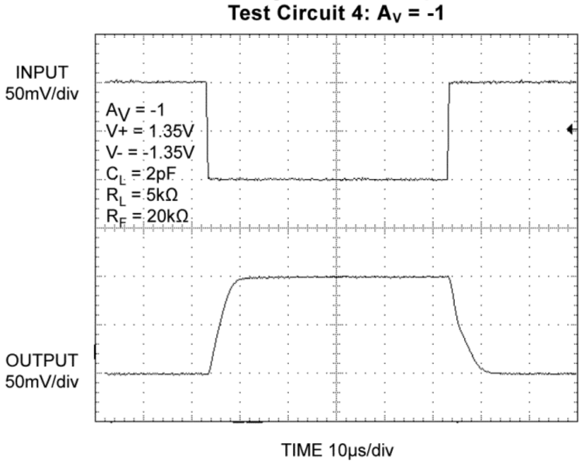
Small Signal Pulse Response
Test Circuit 3: A_V = 1



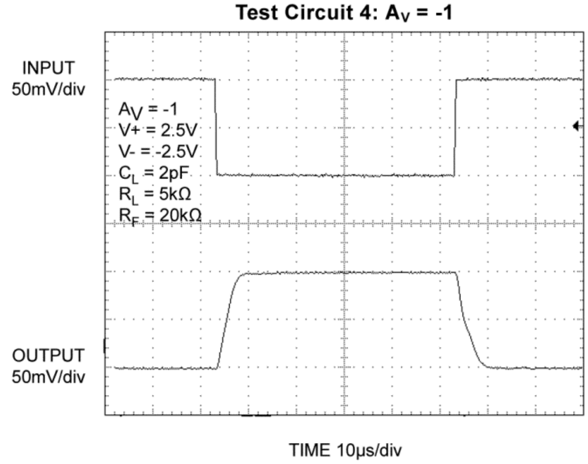
Small Signal Pulse Response
Test Circuit 3: A_V = 1



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

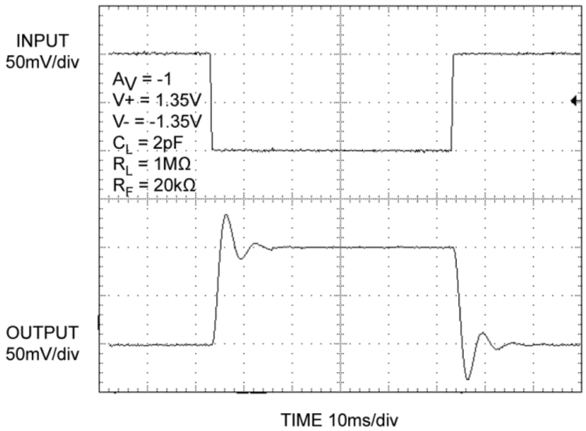


Small Signal Pulse Response
Test Circuit 4: A_V = -1

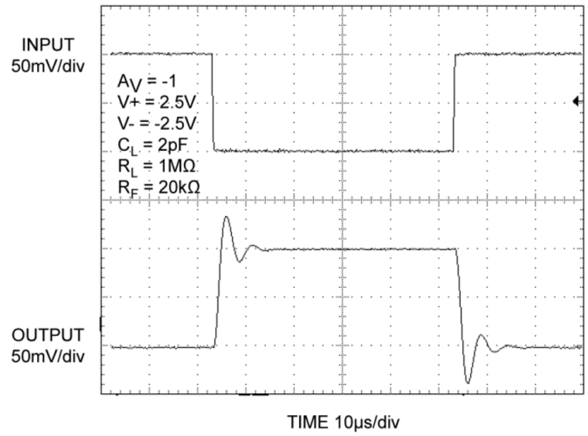


Functional Characteristics (Continued)

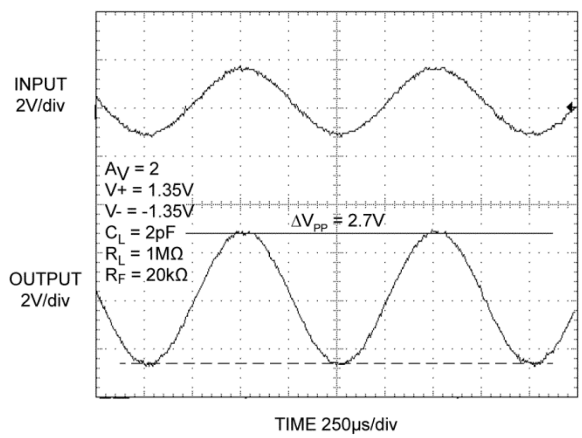
Small Signal Pulse Response
Test Circuit 4: A_V = -1



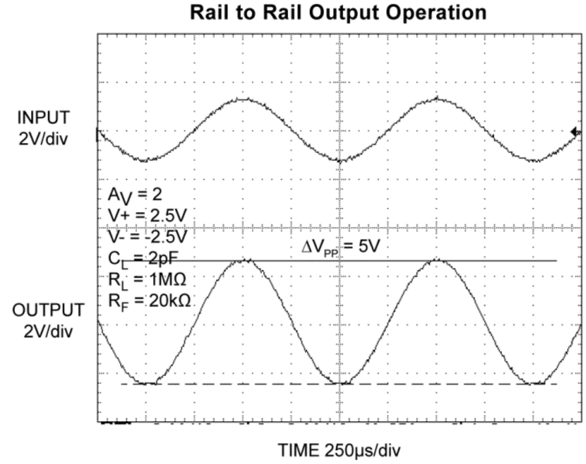
Small Signal Pulse Response
Test Circuit 4: A_V = -1



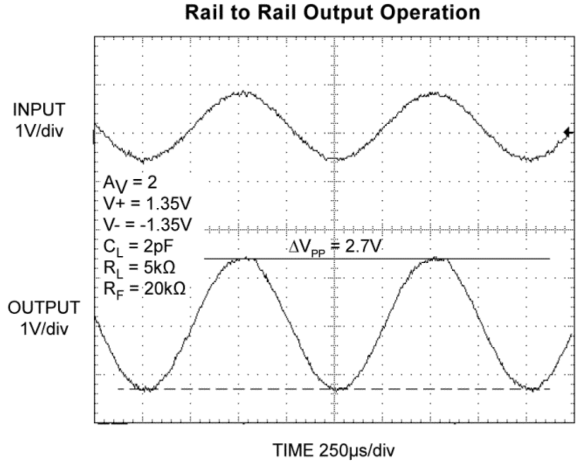
Rail to Rail Output Operation



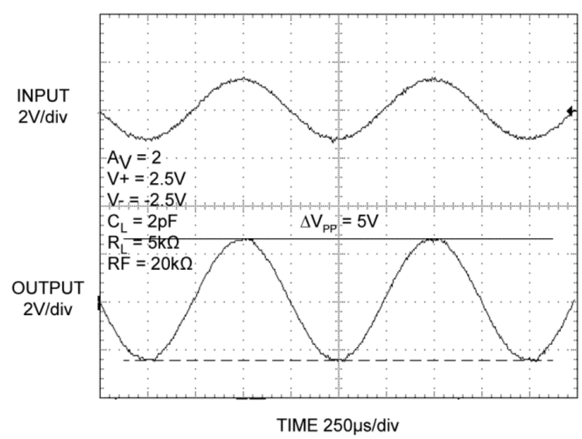
Rail to Rail Output Operation



Rail to Rail Output Operation

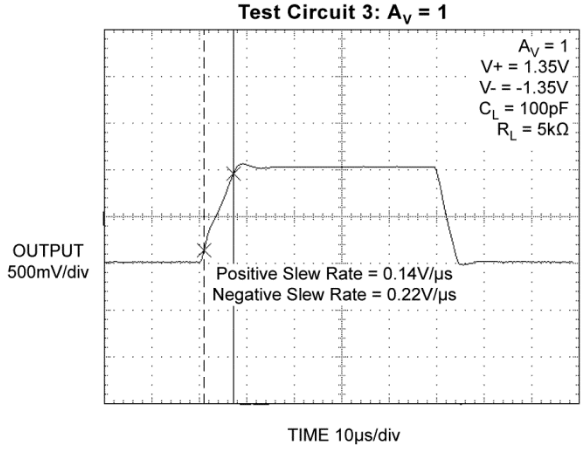


Rail to Rail Output Operation

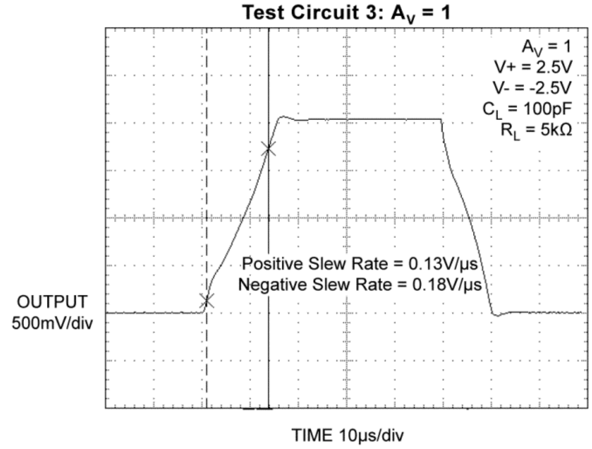


Functional Characteristics (Continued)

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



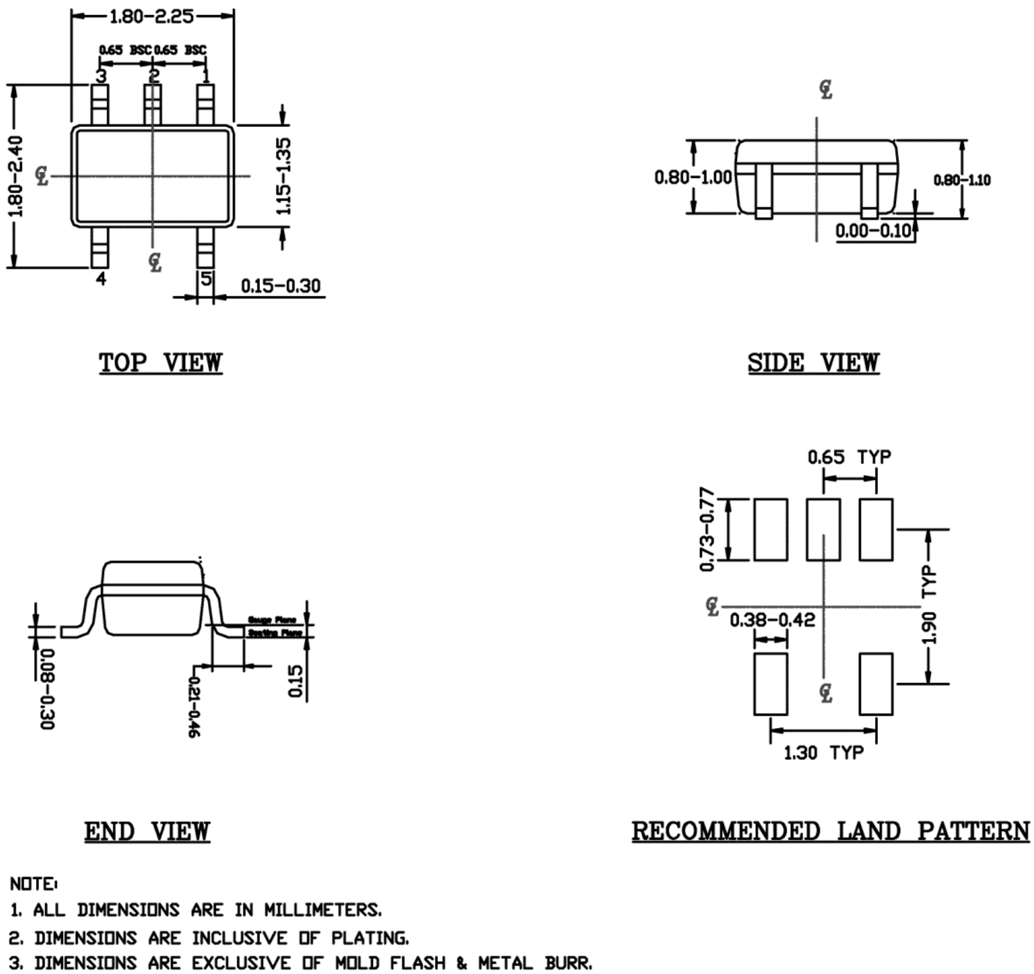
Large Signal Pulse Response
Test Circuit 3: $A_V = 1$



Applications Information

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 equivalent series inductance (ESL) and equivalent series resistance (ESR). Surface-mount ceramic capacitors are ideal.

Package Information[7]



5-Pin SC70 (C5)

Note:

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

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