Precision Low Noise, Low Input Bias Current Operational Amplifiers

GENERAL DESCRIPTION

The OP2177/4177 family consists of very high precision, single, dual,and quad amplifiers featuring extremely low offset voltage and drift, low input bias current, low noise, and low power consump-tion. Outputs are stable with capacitive loads of over 1000 pF with no external compensation. Supply current is less than 500 µA per amplifier at 30 V. Internal 500 Ω series resistors protect the inputs, allowing input signal levels several volts beyond either supply without phase reversal.

APPLICATIONS

- Wireless base station control circuits
- Optical network control circuits
- Instrumentation
- Sensors and controls
  Thermocouples
  Resistor thermal detectors (RTDs)
  Strain bridges
  Shunt current measurements
- Precision filters

FEATURES

- Low offset voltage: 60 µV maximum
- Very low offset voltage drift: 0.7µV/°C maximum Low input bias current: 2 nA maximum
- Low noise: 8 nV/√Hz typical
- CMRR, PSRR, and AVO > 120 dB minimum
- Low supply current: 400 µA per amplifier
- Dual supply operation: ±2.5 V to ±15 V Unity-gain stable
- No phase reversal
- Inputs internally protected beyond supply voltage

ELECTRICAL CHARACTERISTICS

V_S = ±5.0 V, V_{CM} = 0 V, T_A = 25°C, unless otherwise noted.

Parameter	Symbol	Conditions	Min	Typ[1]	Max	Unit
Offset Voltage						
OP2177/OP4177	V_{OS}			15	75	μV
OP2177	V_{OS} T <	−40°C $_A$< +125°C		25	100	μV
Input Bias Current	I_B	−40°C < T_A < +125°C	−2	+0.5	+2	nA
Input Offset Current	I_{OS}T <	−40°C $_A$< +125°C	−1	+0.2	+1	nA
Input Voltage Range			−3.5		+3.5	V
Common-Mode Rejection Ratio	CMRR	V_{CM} = −3.5 V to +3.5 V	120	126		dB
		−40°C < T_A < +125°C	118	125		dB
Large Signal Voltage Gain	A_{VO}	R_L = 2 kΩ, V_O = −3.5 V to +3.5 V	1000	2000		V/mV
Offset Voltage Drift						
OP2177	$\Delta V_{OS}/\Delta T$	−40°C < T_A < +125°C		0.2	0.7	μV/°C
OP4177	$\Delta V_{OS}/\Delta T$	−40°C < T_A < +125°C		0.3	0.9	μV/°C
Output Voltage High	V_{OH}	I_L = 1 mA, −40°C < T_A < +125°C	+4	+4.1		V
Output Voltage Low	V_{OL}	I_L = 1 mA, −40°C < T_A < +125°C		−4.1	−4	V
Output Current	I_{OUT}	$V_{DROPOUT}$ < 1.2 V		±10		mA
Power Supply Rejection Ratio						
OP2177/OP4177	PSRR	V_S = ±2.5 V to ±15 V	118	121		dB
		−40°C < T_A < +125°C	114	120		dB
Supply Current per Amplifier	I_{SY}	V_O = 0 V		400	500	μA
		−40°C < T_A < +125°C		500	600	μA
Slew Rate	SR	R_L = 2 kΩ		0.7		V/μs
Gain Bandwidth Product	GBP			1.3		MHz
Voltage Noise	e_n p-p	0.1 Hz to 10 Hz		0.4		μV p-p
Voltage Noise Density	e_n	f = 1 kHz		7.9	8.5	nV/√Hz
Current Noise Density	i_n	f = 1 kHz		0.2		pA/√Hz
MULTIPLE AMPLIFIERS CHANNEL SEPARATION	C_S	DC		0.01		μV/V
		f = 100 kHz		−120		dB

ELECTRICAL CHARACTERISTICS

V_S = ±15 V, V_{CM} = 0 V, T_A = 25°C, unless otherwise noted.

Parameter	Symbol	Conditions	Min	Typ[1]	Max	Unit
Offset Voltage						
OP2177/OP4177	V_{OS}			15	75	µV
OP2177	V_{OS} T	<−40°C $_A$ < +125°C		25	100	µV
OP4177	V_{OS} T	<−40°C $_A$ < +125°C		25	120	µV
Input Bias Current	I_B T	< −40°C $_A$ < +125°C	−2	+0.5	+2	nA
Input Offset Current	I_{OS} T	<−40°C $_A$ < +125°C	−1	+0.2	+1	nA
Input Voltage Range			−13.5		+13.5	V
Common-Mode Rejection Ratio	CMRR	V_{CM} = −13.5 V to +13.5 V,				
		−40°C < T_A < +125°C	120	125		dB
Large Signal Voltage Gain	A_{VO}	R_L = 2 kΩ, V_O = –13.5 V to +13.5 V	1000	3000		V/mV
Offset Voltage Drift						
OP2177	$\Delta V_{OS}/\Delta T$	−40°C < T_A < +125°C		0.2	0.7	µV/°C
OP4177	$\Delta V_{OS}/\Delta T$	−40°C < T_A < +125°C		0.3	0.9	µV/°C
Output Voltage High	V_{OH}	I_L = 1 mA, −40°C < T_A < +125°C	+14	+14.1		V
Output Voltage Low	V_{OL}	I_L = 1 mA, −40°C < T_A < +125°C		−14.1	−14	V
Output Current	I_{OUT}	$V_{DROPOUT}$ < 1.2 V		±10		mA
Short-Circuit Current	I_{SC}			±25		mA
Power Supply Rejection Ratio						
OP2177/OP4177	PSRR	V_S = ±2.5 V to ±15 V	118	121		dB
		−40°C < T_A < +125°C	114	120		dB
Supply Current per Amplifier	I_{SY}	V_O = 0 V		400	500	µA
		−40°C < T_A < +125°C		500	600	µA
Slew Rate	SR	R_L = 2 kΩ		0.7		V/µs
Gain Bandwidth Product	GBP			1.3		MHz
Voltage Noise	e_n p-p	0.1 Hz to 10 Hz		0.4		µV p-p
Voltage Noise Density	e_n	f = 1 kHz		7.9	8.5	nV/√Hz
Current Noise Density	i_n	f = 1 kHz		0.2		pA/√Hz
MULTIPLE AMPLIFIERS CHANNEL SEPARATION	C_S	DC		0.01		µV/V
		f = 100 kHz		−120		dB

ABSOLUTE MAXIMUM RATINGS

Parameter	Rating
Supply Voltage	36 V
Input Voltage	V_{S-} to V_{S+}
Differential Input Voltage	±Supply Voltage
Storage Temperature Range R, RM, and RU Packages	−65°C to +150°C
Operating Temperature Range OP1177/OP2177/OP4177	−40°C to +125°C
Junction Temperature Range R, RM, and RU Packages	−65°C to +150°C
Lead Temperature, Soldering (10 sec)	300°C

TYPICAL PERFORMANCE CHARACTERISTICS

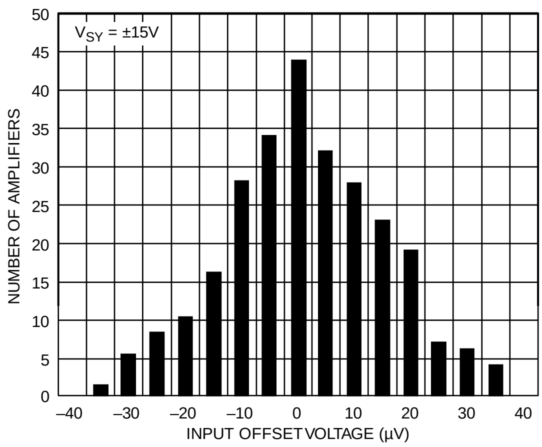


Figure 7. Input Offset Voltage Distribution

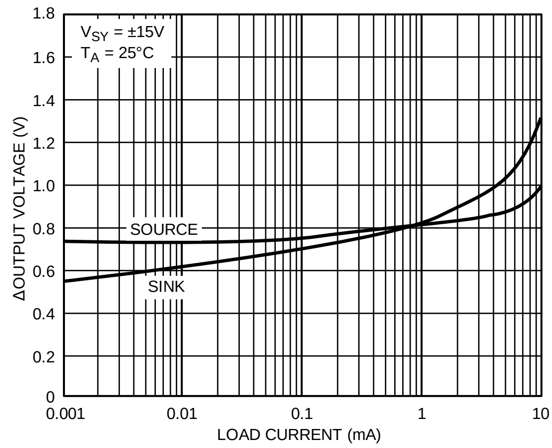


Figure 10. Output Voltage to Supply Rail vs. Load Current

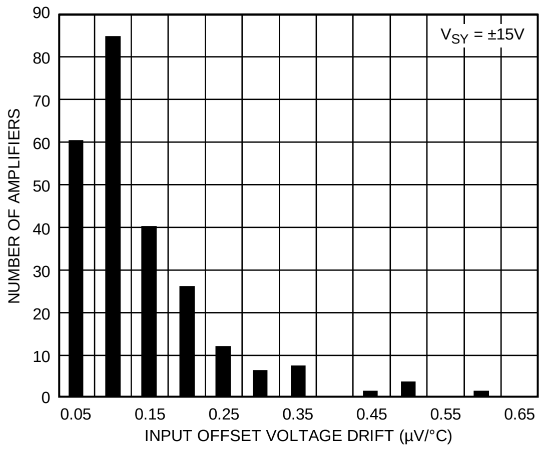


Figure 8. Input Offset Voltage Drift Distribution

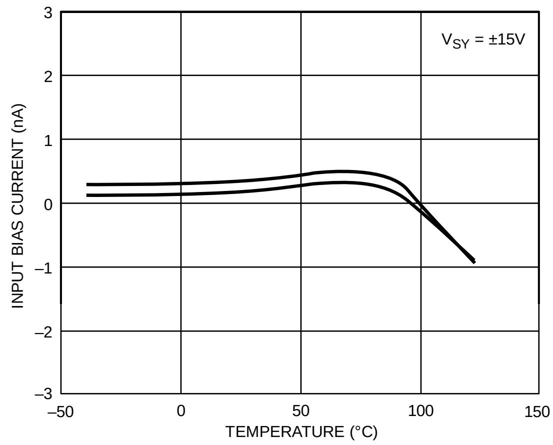


Figure 11. Input Bias Current vs. Temperature

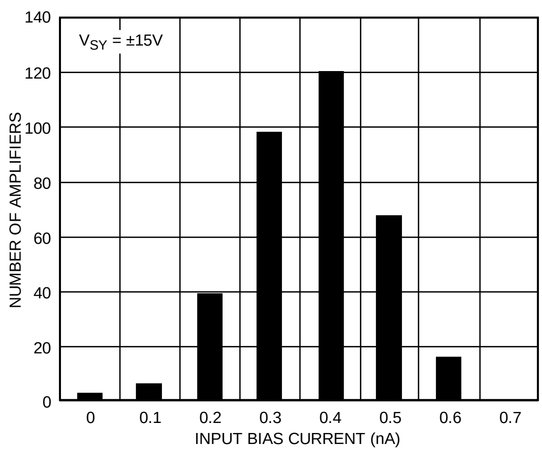


Figure 9. Input Bias Current Distribution

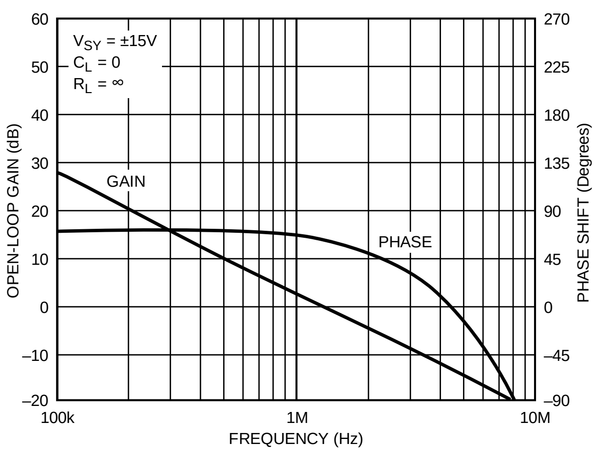


Figure 12. Open-Loop Gain and Phase Shift vs. Frequency

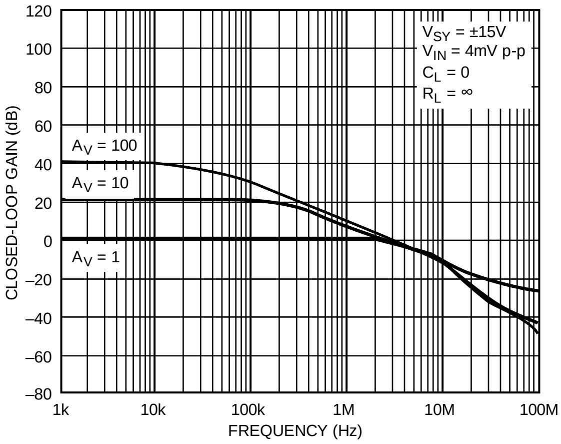


Figure 13. Closed-Loop Gain vs. Frequency

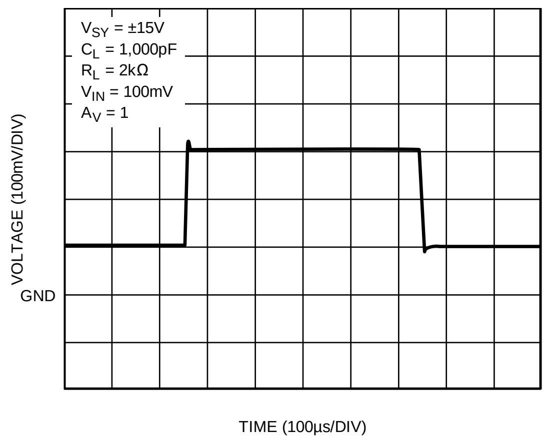


Figure 16. Small Signal Transient Response

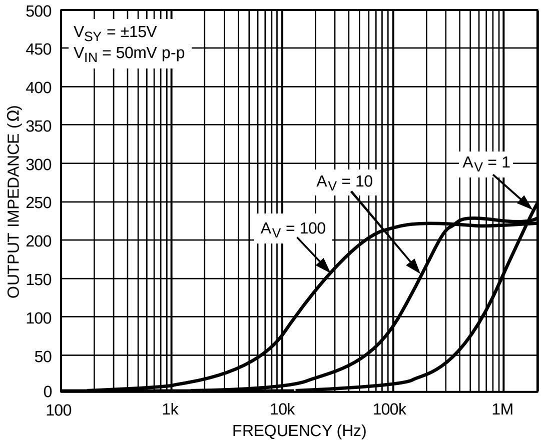


Figure 14. Output Impedance vs. Frequency

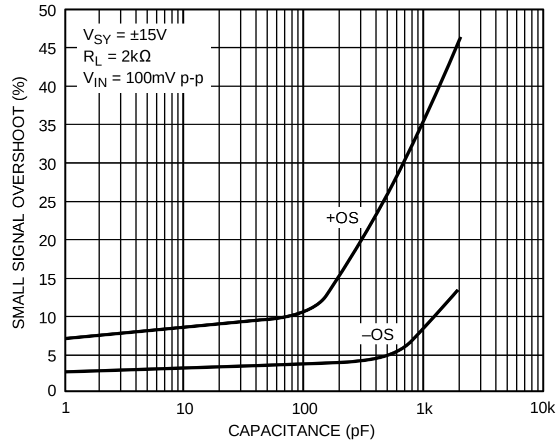


Figure 17. Small Signal Overshoot vs. Load Capacitance

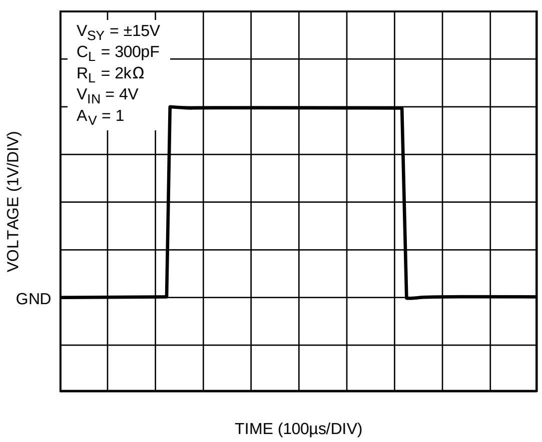


Figure 15. Large Signal Transient Response

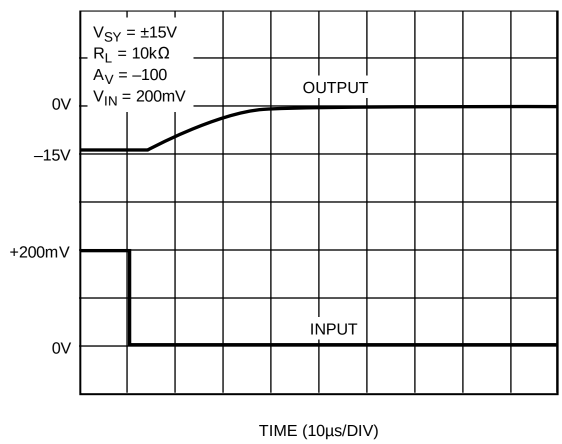


Figure 18. Positive Overvoltage Recovery

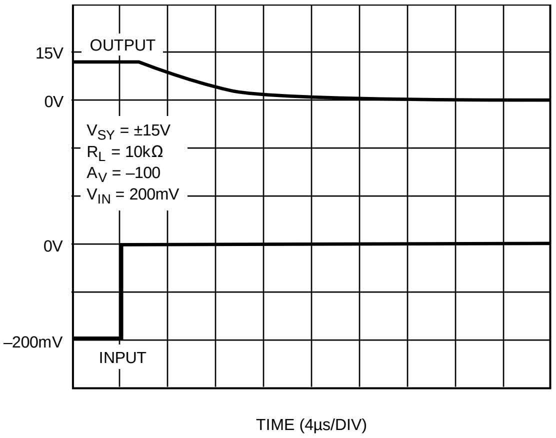


Figure 19. Negative Overvoltage Recovery

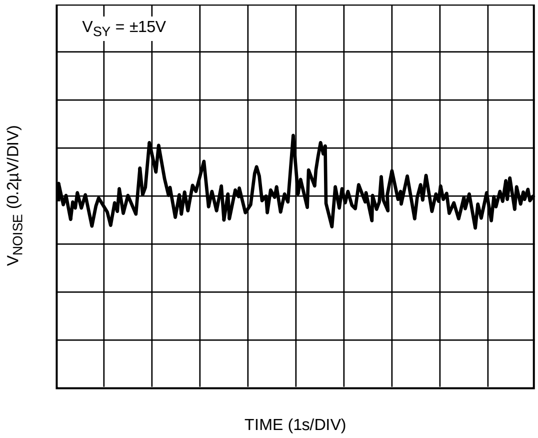


Figure 22. 0.1 Hz to 10 Hz Input Voltage Noise

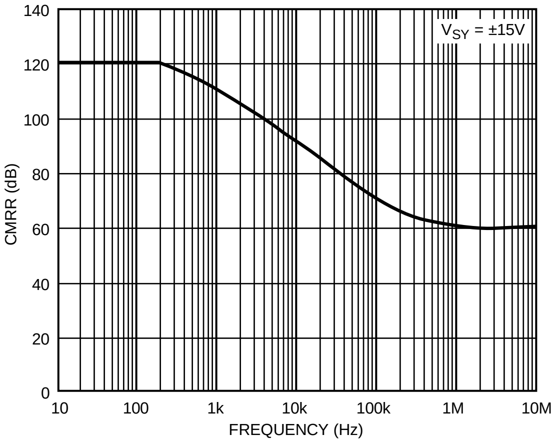


Figure 20. CMRR vs. Frequency

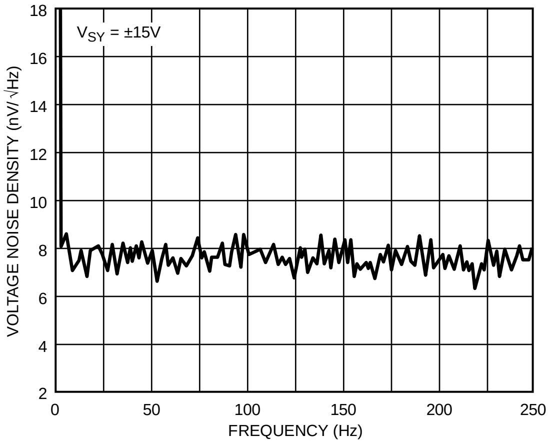


Figure 23. Voltage Noise Density vs. Frequency

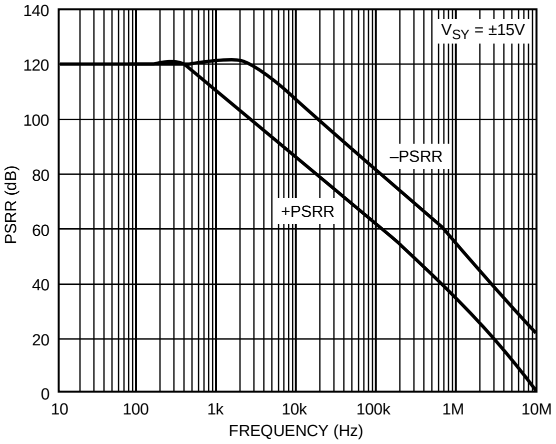


Figure 21. PSRR vs. Frequency

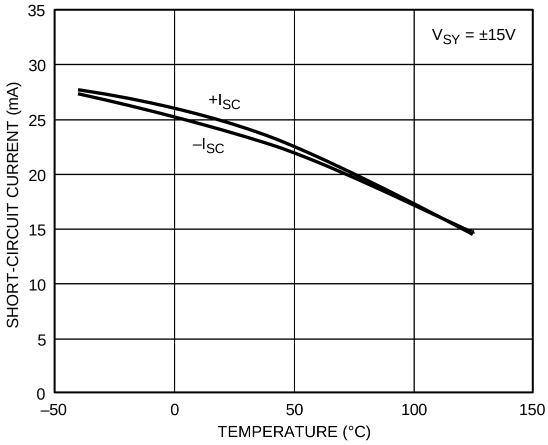


Figure 24. Short-Circuit Current vs. Temperature

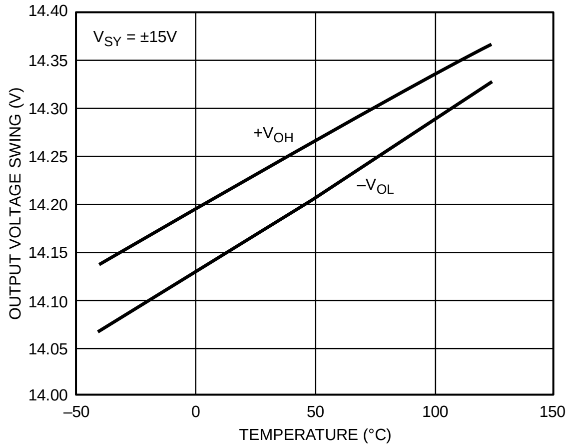


Figure 25. Output Voltage Swing vs. Temperature

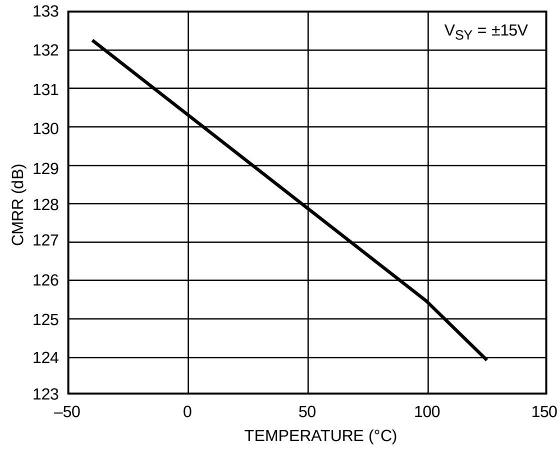


Figure 28. CMRR vs. Temperature

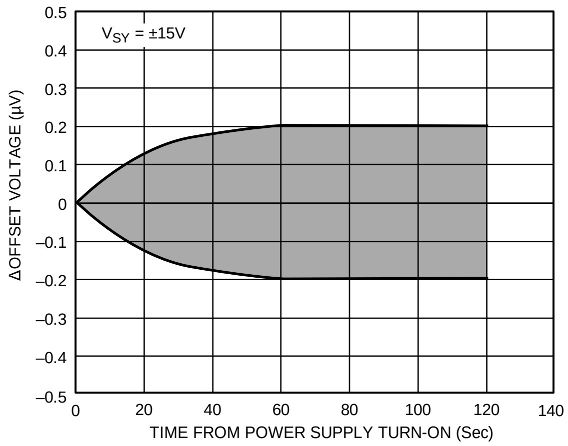


Figure 26. Warm-Up Drift

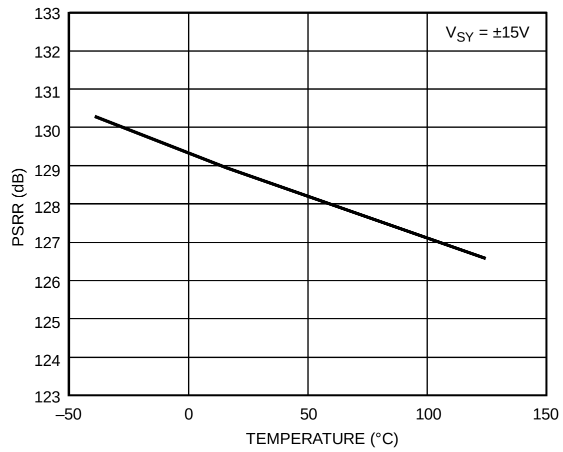


Figure 29. PSRR vs. Temperature

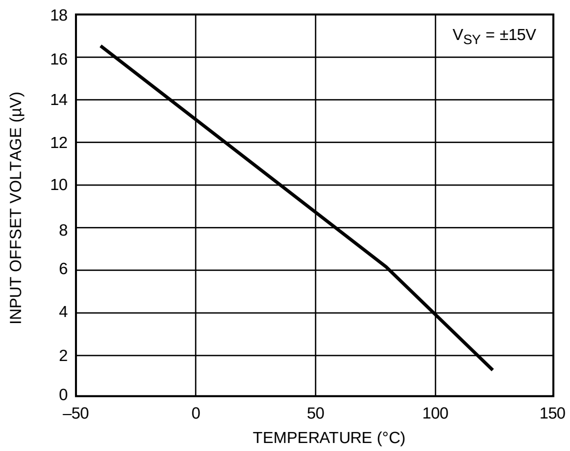


Figure 27. Input Offset Voltage vs. Temperature

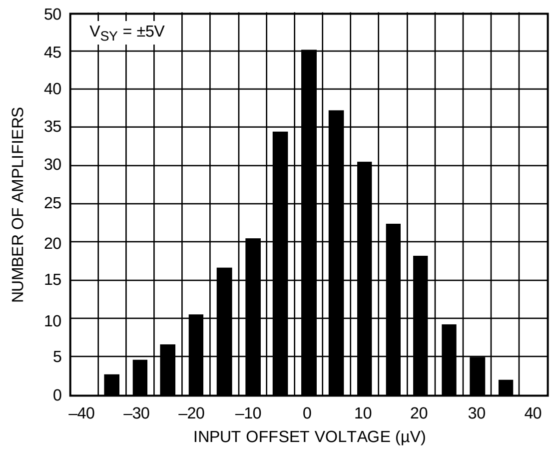


Figure 30. Input Offset Voltage Distribution

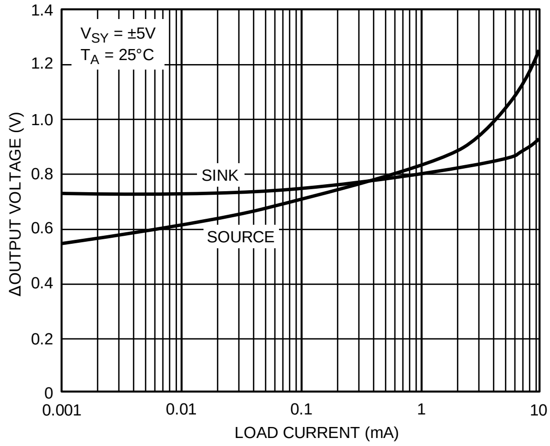


Figure 31. Output Voltage to Supply Rail vs. Load Current

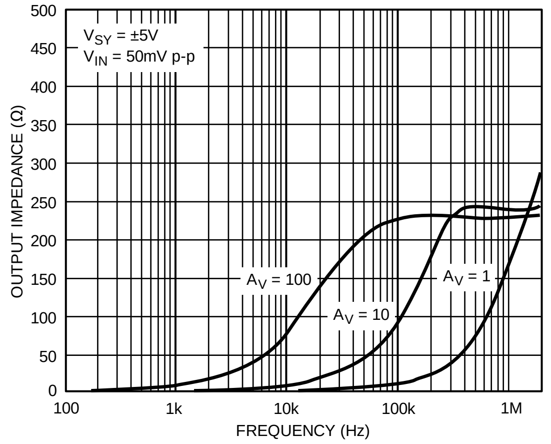


Figure 34. Output Impedance vs. Frequency

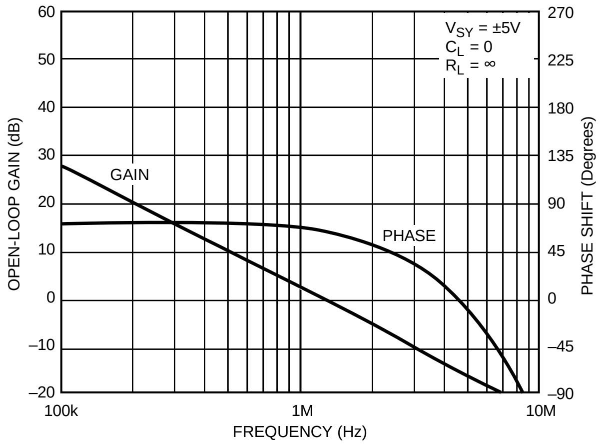


Figure 32. Open-Loop Gain and Phase Shift vs. Frequency

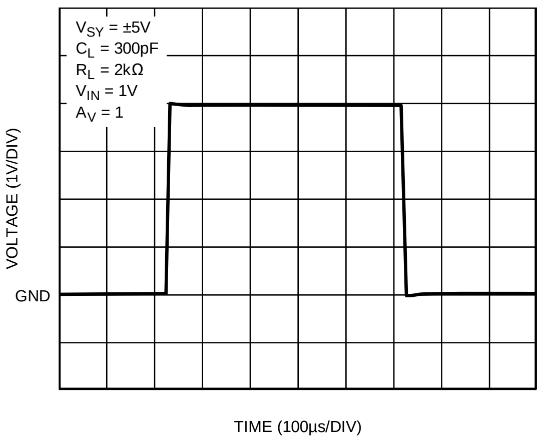


Figure 35. Large Signal Transient Response

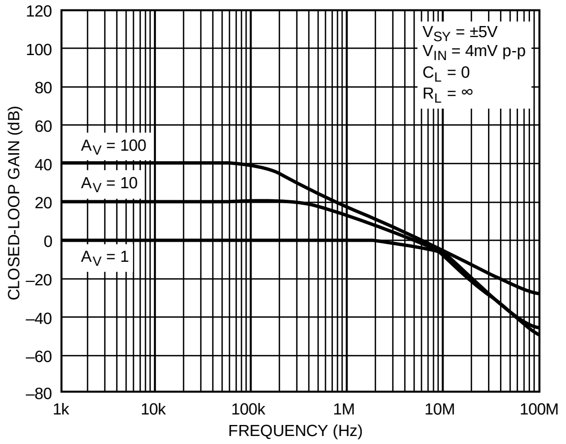


Figure 33. Closed-Loop Gain vs. Frequency

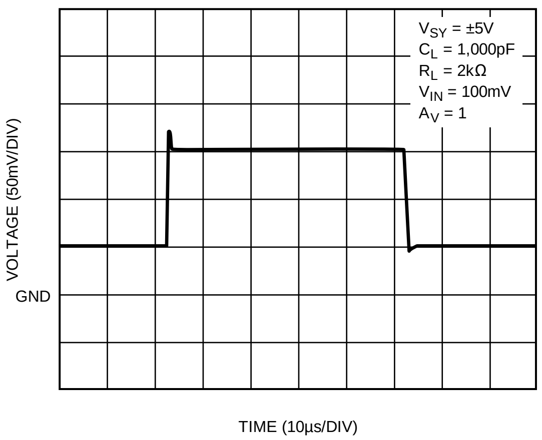


Figure 36. Small Signal Transient Response

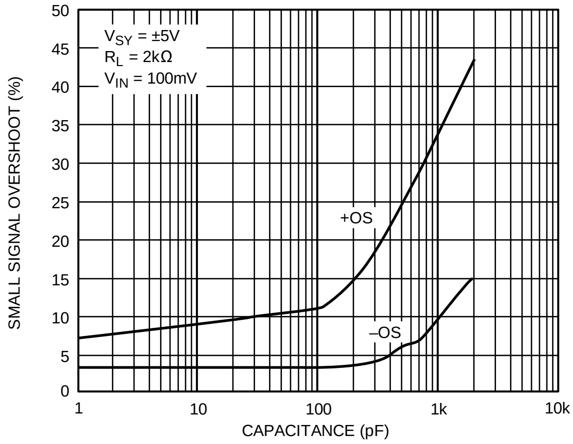


Figure 37. Small Signal Overshoot vs. Load Capacitance

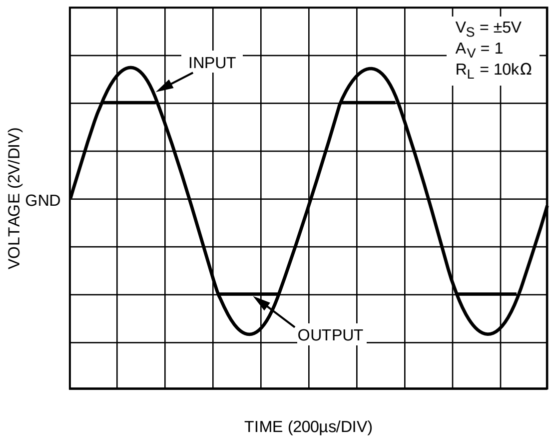


Figure 40. No Phase Reversal

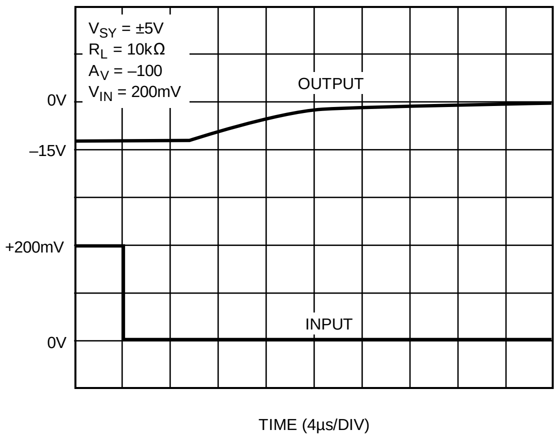


Figure 38. Positive Overvoltage Recovery

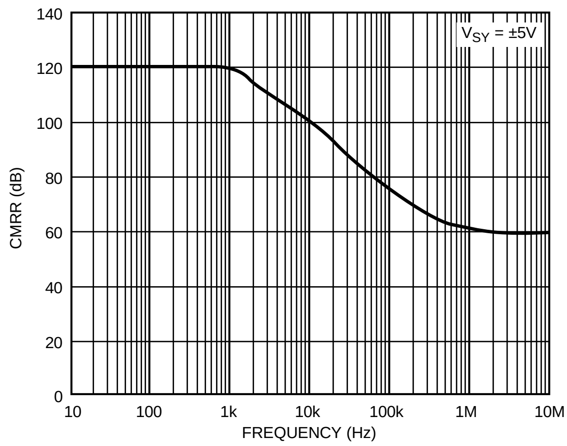


Figure 41. CMRR vs. Frequency

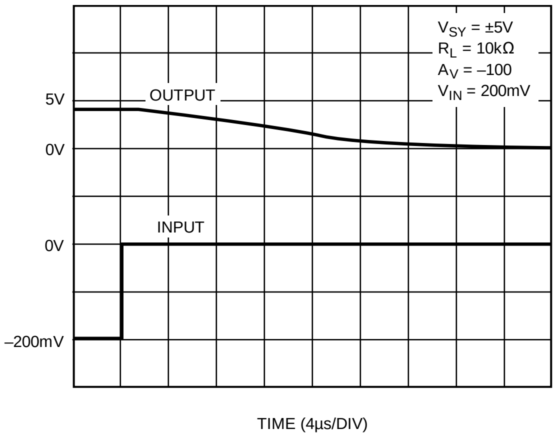


Figure 39. Negative Overvoltage Recovery

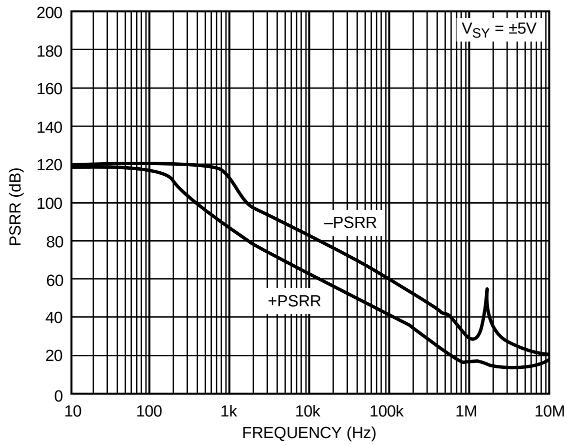


Figure 42. PSRR vs. Frequency

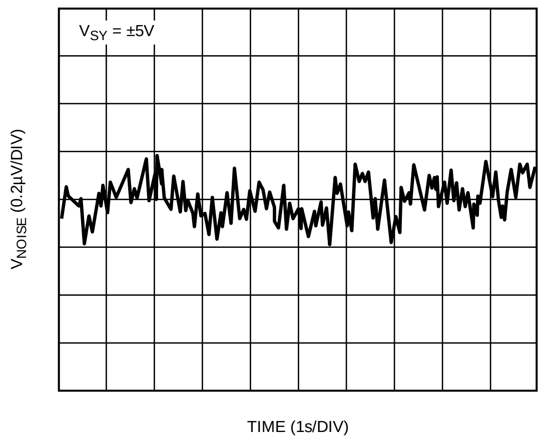


Figure 43. 0.1 Hz to 10 Hz Input Voltage Noise

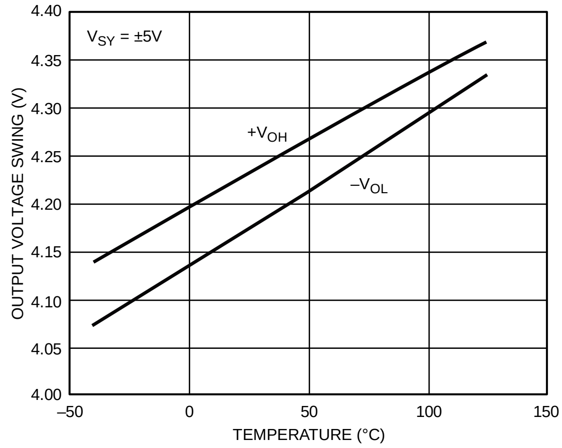


Figure 46. Output Voltage Swing vs. Temperature

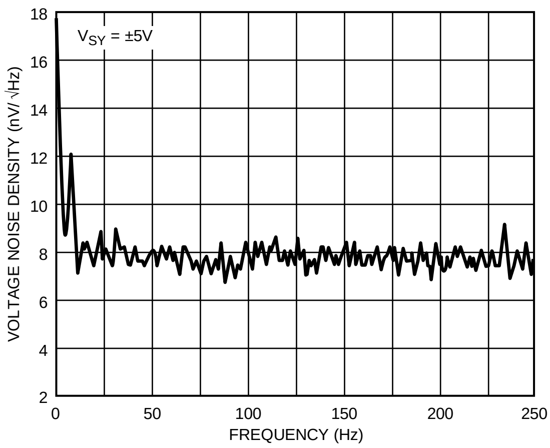


Figure 44. Voltage Noise Density vs. Frequency

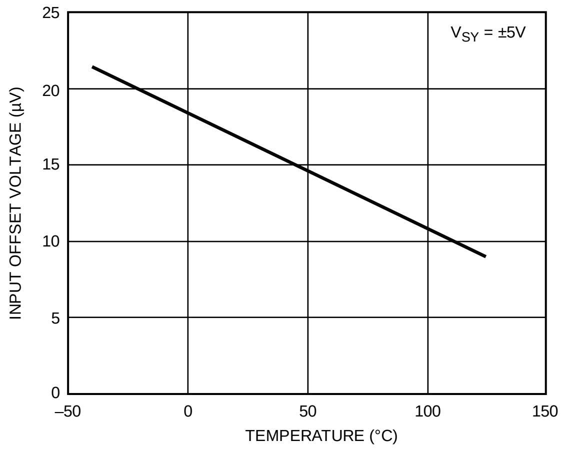


Figure 47. Input Offset Voltage vs. Temperature

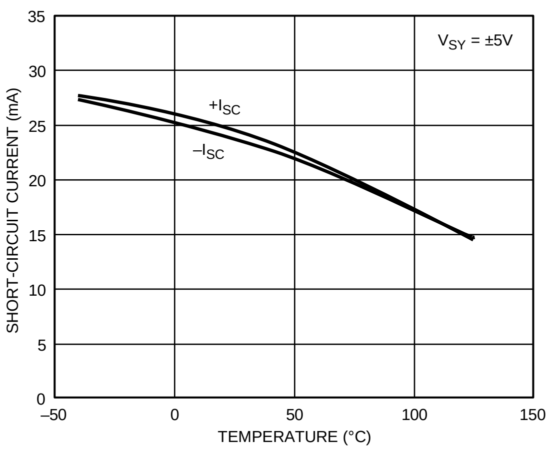


Figure 45. Short-Circuit Current vs. Temperature

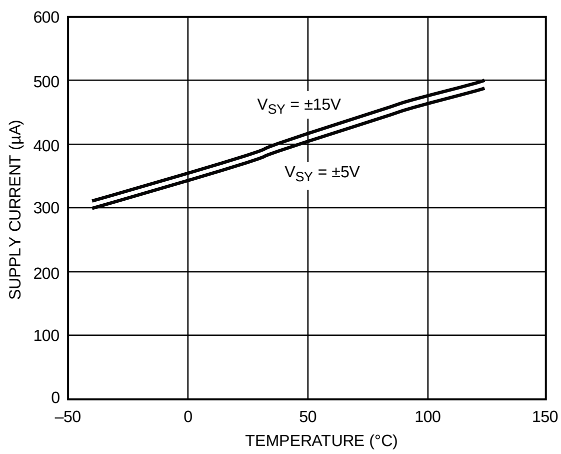


Figure 48. Supply Current vs. Temperature

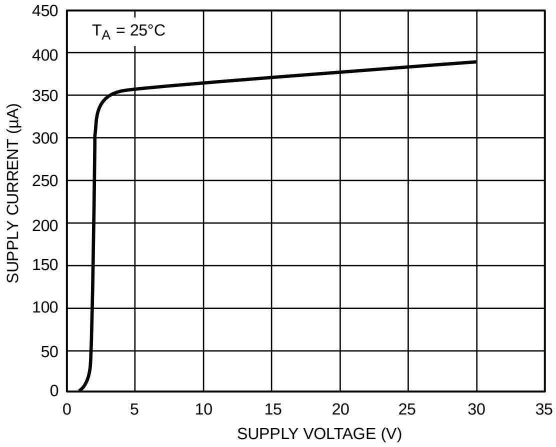


Figure 49. Supply Current vs. Supply Voltage

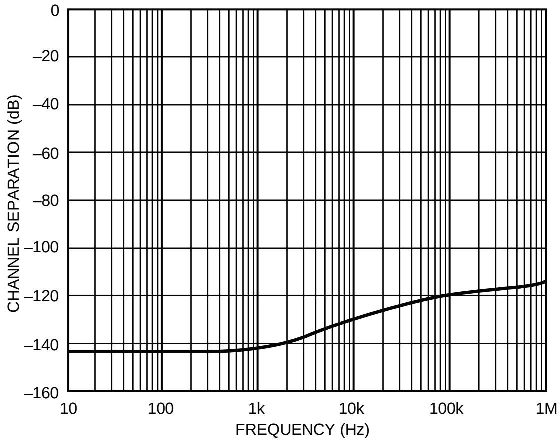
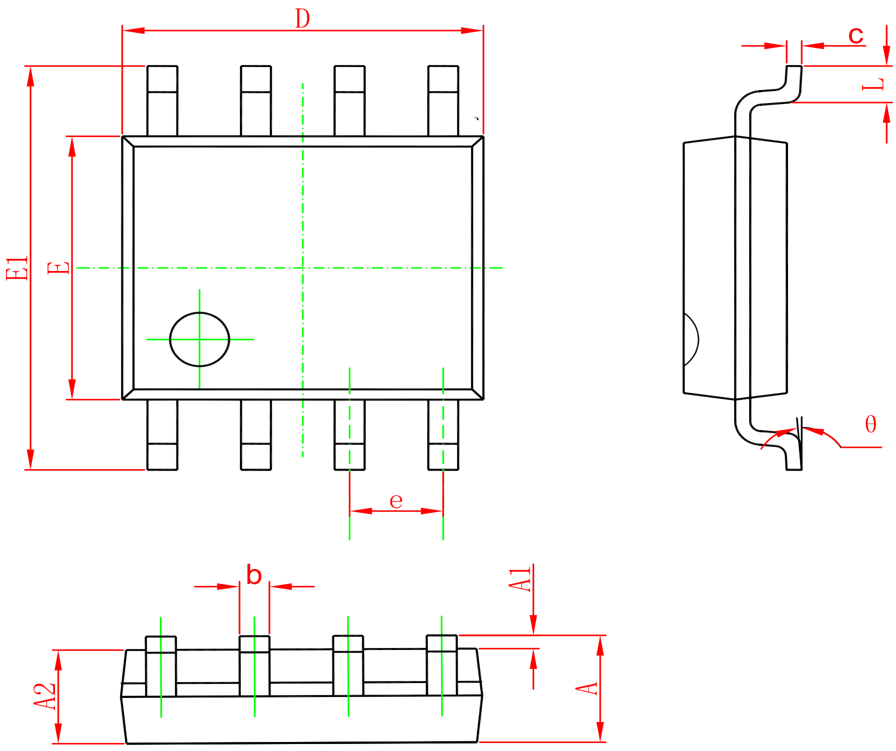


Figure 50. Channel Separation vs. Frequency

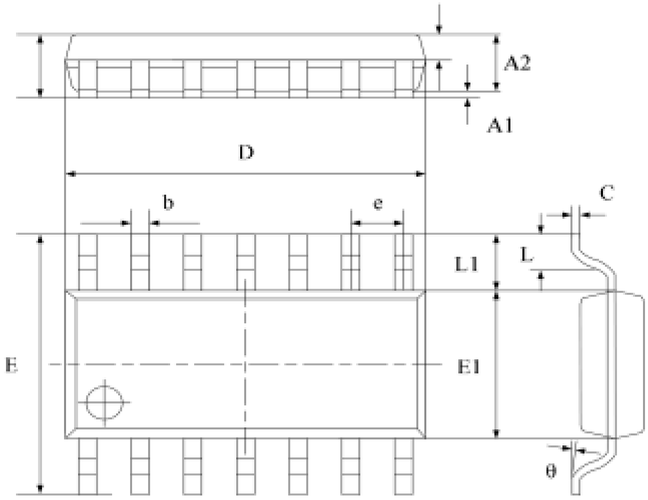
Package Dimension

SOP-8



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270(BSC)		0.050(BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

SOP-14



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.450	1.850	0.059	0.076
A1	0.100	0.300	0.004	0.012
A2	1.350	1.550	0.055	0.063
A3	0.550	0.750	0.022	0.031
b	0.406typ.		0.017typ.	
C	0.203typ.		0.008typ.	
D	8.630	8.830	0.352	0.360
E	5.840	6.240	0.238	0.255
E1	3.850	4.050	0.157	0.165
e	1.270 typ.		0.050 typ.	
L1	1.040 ref.		0.041 ref.	
L	0.350	0.750	0.014	0.031
θ	2°	8°	2°	8°

Ordering information

Order code	Package	Baseqty	Deliverymode	Marking
UMW OP2177ARZ	SOP-8	2500	Tape and reel	OP2177
UMW OP4177ARZ	SOP-14	2500	Tape and reel	OP4177