Data Sheet | December 21, 2005 | FN1925.5

0.5MHz, Low Supply Voltage, Low Input Current BiMOS Operational Amplifiers

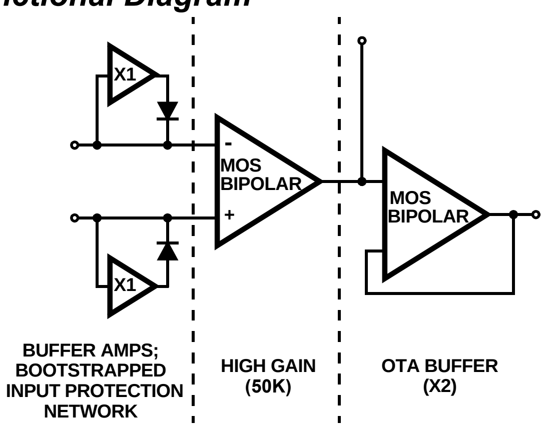
The CA5420A is an integrated circuit operational amplifier that combines PMOS transistors and bipolar transistors on a single monolithic chip. It is designed and guaranteed to operate in microprocessor logic systems that use V+ = 5V, V- = GND, since it can operate down to ±1V supplies. It will also be suitable for 3.3V logic systems.

The CA5420A BiMOS operational amplifier features gate-protected PMOS transistors in the input circuit to provide very high input impedance, very low input currents (less than 1pA). The internal bootstrapping network features a unique guardbanding technique for reducing the doubling of leakage current for every 10°C increase in temperature. The CA5420A operates at total supply voltages from 2V to 20V either single or dual supply. This operational amplifier is internally phase compensated to achieve stable operation in the unity gain follower configuration. Additionally, it has access terminals for a supplementary external capacitor if additional frequency roll-off is desired. Terminals are also provided for use in applications requiring input offset voltage nulling. The use of PMOS in the input stage results in common-mode input voltage capability down to 0.45V below the negative supply terminal, an important attribute for single supply application. The output stage uses a feedback OTA type amplifier that can swing essentially from rail-to-rail. The output driving current of 1.0mA (Min) is provided by using nonlinear current mirrors.

This device has guaranteed specifications for 5V operation over the full military temperature range of -55°C to 125°C.

The CA5420A has the same 8 lead pinout used for the industry standard 741.

Functional Diagram



Features

- CA5420A at 5V Supply Voltage with Full Military Temperature Range Guaranteed Specifications
- CA5420A Guaranteed to Operate from ±1V to ±10V Supplies
- 2V Supply at 300μA Supply Current
- 1pA (Typ) Input Current (Essentially Constant to 85°C)
- Rail-to-Rail Output Swing (Drive ±2mA Into 1kΩ Load)
- Pin Compatible with 741 Op Amp
- Pb-Free Plus Anneal Available (RoHS Compliant)

Applications

- pH Probe Amplifiers
- Picoammeters
- Electrometer (High Z) Instruments
- Portable Equipment
- Inaccessible Field Equipment
- Battery Dependent Equipment (Medical and Military)
- 5V Logic Systems
- Microprocessor Interface

Ordering Information

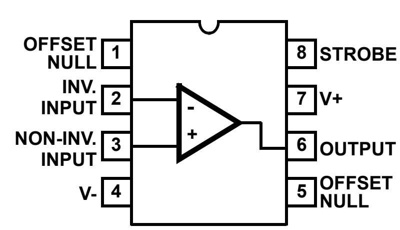
PART NUMBER	PART MARKING	TEMP. RANGE (°C)	PACKAGE	PKG. DWG. #
CA5420AM	5420A	-55 to 125	8 Ld SOIC	M8.15
CA5420AMZ* (Note)	5420AMZ	-55 to 125	8 Ld SOIC (Pb-free)	M8.15

*Add "96" suffix for Tape and Reel.

NOTE: Intersil Pb-free plus anneal products employ special Pb-free material sets; molding compounds/die attach materials and 100% matte tin plate termination finish, which are RoHS compliant and compatible with both SnPb and Pb-free soldering operations. Intersil Pb-free products are MSL classified at Pb-free peak reflow temperatures that meet or exceed the Pb-free requirements of IPC/JEDEC J STD-020.

Pinout

CA5420A (SOIC)
TOP VIEW



NOTE: Pin is connected to Case.

Absolute Maximun Ratings

Supply Voltage (Between V+ and V- Terminals) 22V
Differential Input Voltage 15V
Input Voltage . . . . (V+ + 8V) to (V- -0.5V)
Input Current 1mA
Output Short Circuit Duration (Note 1). . . . . Indefinite

Operating Conditions

Temperature Range. . . . . -55°C to 125°C

Thermal Information

Thermal Resistance (Typical, Note 2)	θ_{JA} (°C/W)	θ_{JC} (°C/W)
SOIC Package	157	N/A

Maximum Junction Temperature (Plastic Package) . . . . 150°C
Maximum Storage Temperature Range (All Types) . . . -65°C to 150°C
Maximum Lead Temperature (Soldering 10s) . . . . 300°C
(SOIC - Lead Tips Only)

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

NOTES:

1. Short circuit may be applied to ground or to either supply.
2. θ_{JA} is measured with the component mounted on an evaluation PC board in free air.

Electrical Specifications

Typical Values Intended Only for Design Guidance. V+ = +5V; V- = GND, T_A = 25°C

PARAMETER		SYMBOL	TEST CONDITIONS		CA5420A	UNITS
Input Resistance		R_I			150	TΩ
Input Capacitance		C_I			4.9	pF
Output Resistance		R_O			300	Ω
Equivalent Input Noise Voltage		e_N	f = 1kHz	R_S = 100Ω	62	nV/√Hz
			f = 10kHz		38	nV/√Hz
Short-Circuit Current To Opposite Supply	Source	$I_{OM}+$			2.6	mA
	Sink	$I_{OM}-$			2.4	mA
Gain Bandwidth Product		f_T			0.5	MHz
Slew Rate		SR			0.5	V/μs
Transient Response	Rise Time	t_r	R_L = 2kΩ, C_L = 100pF		0.7	μs
	Overshoot	OS			15	%
Current from Terminal 8 To V-		I_8+			20	μA
Current from Terminal 8 To V+		I_8-			2	mA
Settling Time		0.01%	A_V = 1	$2V_{P-P}$ Input	8	μs
		0.10%	A_V = 1	$2V_{P-P}$ Input	4.5	μs

Electrical Specifications

T_A = 25°C, V+ = 5V, V- = 0, Unless Otherwise Specified

PARAMETER	SYMBOL	TEST CONDITIONS	CA5420A			UNITS
			MIN	TYP	MAX	
Input Offset Voltage	V_{IO}	V_O = 2.5V	-	1	5	mV
Input Offset Current	I_{IO}	V_O = 2.5V	-	0.02	0.5	pA
Input Current	I_I	V_O = 2.5V	-	0.02	1	pA
Common Mode Rejection Ratio	CMRR	V_{CM} = 0 to 3.7V, V_O = 2.5V	75	83	-	dB
Common Mode Input Voltage Range	$V_{ICR}+$	V_O = 2.5V	3.7	4	-	V
	$V_{ICR}-$		-	-0.3	0	V
Power Supply Rejection Ratio	PSRR	ΔV+ = 1V; ΔV- = 1V	75	83	-	dB
Large Signal Voltage Gain	A_{OL}					
V_O = 0.5 to 4V		R_L = ∞	85	87	-	dB
V_O = 0.5 to 4V		R_L = 10kΩ	85	87	-	dB
V_O = 0.7 to 3V		R_L = 2kΩ	80	85	-	dB

Electrical Specifications T_A = 25°C, V+ = 5V, V- = 0, Unless Otherwise Specified (Continued)

PARAMETER	SYMBOL	TEST CONDITIONS	CA5420A MIN	CA5420A TYP	CA5420A MAX	UNITS
Source Current	I_{SOURCE}	V_O = 0V	1.2	2.7	-	mA
Sink Current	I_{SINK}	V_O = 5V	1.2	2.1	-	mA
Output Voltage	$V_{OM}+$	$R_L = \infty$	4.9	4.94	-	V
	$V_{OM}-$		-	0.13	0.15	V
	$V_{OM}+$	R_L = 10kΩ	4.7	4.9	-	V
	$V_{OM}-$		-	0.12	0.15	V
	$V_{OM}+$	R_L = 2kΩ	3.5	4.6	-	V
	$V_{OM}-$		-	0.1	0.15	V
Supply Current	I_{SUPPLY}	V_O = 0V	-	400	500	μA
		V_O = 2.5V	-	430	550	μA

Electrical Specifications T_A = -55°C to 125°C, V+ = 5V, V- = 0, Unless Otherwise Specified

PARAMETER	SYMBOL	TEST CONDITIONS	CA5420A MIN	CA5420A TYP	CA5420A MAX	UNITS
Input Offset Voltage	V_{IO}	V_O = 2.5V	-	2	10	mV
Input Offset Current	I_{IO}	V_O = 2.5V	-	1.5	3	nA
Up to T_A = 85°C			-	2	10	pA
Input Current	$\|I_I\|$	V_O = 2.5V	-	2	5	nA
Up to T_A = 85°C			-	10	15	pA
Common Mode Rejection Ratio	CMRR	V_{CM} = 0 to 3.7V, V_O = 2.5V	70	80	-	dB
Common Mode Input Voltage Range	$V_{ICR}+$	V_O = 2.5V	3.7	4	-	V
	$V_{ICR}-$		-	-0.3	0	V
Power Supply Rejection Ratio	PSRR	ΔV+ = 1V; ΔV- = 1V	70	83	-	dB
Large Signal Voltage Gain	A_{OL}					
V_O = 0.5 to 4V		$R_L = \infty$	85	87	-	dB
V_O = 0.7 to 4V		R_L = 10kΩ	80	87	-	dB
V_O = 0.7 to 2.5V		R_L = 2kΩ	75	80	-	dB
Source Current	I_{SOURCE}	V_O = 0V	1	2.7	-	mA
Sink Current	I_{SINK}	V_O = 5V	1	2.1	-	mA
Output Voltage	$V_{OM}+$	$R_L = \infty$	4.8	4.9	-	V
	$V_{OM}-$		-	0.16	0.2	V
	$V_{OM}+$	R_L = 10kΩ	4.7	4.9	-	V
	$V_{OM}-$		-	0.15	0.2	V
	$V_{OM}+$	R_L = 2kΩ	3	4	-	V
	$V_{OM}-$		-	0.14	0.2	V
Supply Current	I_{SUPPLY}	V_O = 0V	-	430	550	μA
		V_O = 2.5V	-	480	600	μA

Electrical Specifications

For Equipment Design at V_{SUPPLY} = ±1V, T_A = 25°C, Unless Otherwise Specified

PARAMETER	SYMBOL	TEST CONDITIONS	CA5420A MIN	CA5420A TYP	CA5420A MAX	UNITS
Input Offset Voltage	V_{IO}		-	2	5	mV
Input Offset Current	$\|I_{IO}\|$		-	0.01	4 (Note 3)	pA
Input Current	$\|I_I\|$		-	0.02	5 (Note 3)	pA
Large Signal Voltage Gain	A_{OL}	R_L = 10kΩ	20	100	-	kV/V
			86	100	-	dB
Common Mode Rejection Ratio	CMRR		-	560	1000	μV/V
			60	65	-	dB
Common Mode Input Voltage Range	$V_{ICR}+$		0.2	0.5	-	V
	$V_{ICR}-$		-1	-1.3	-	V
Power Supply Rejection Ratio	PSRR		-	32	320	μV/V
			70	90	-	dB
Maximum Output Voltage	$V_{OM}+$	$R_L = \infty$	0.9	0.95	-	V
	$V_{OM}-$		-0.85	-0.91	-	V
Supply Current	I_{SUPPLY}		-	350	650	μA
Device Dissipation	P_D		-	0.7	1.1	mW
Input Offset Voltage Temp. Drift	$\Delta V_{IO}/\Delta T$		-	4	-	μV/°C

Electrical Specifications

For Equipment Design at V_{SUPPLY} = ±10V, T_A = 25°C, Unless Otherwise Specified

PARAMETER	SYMBOL	TEST CONDITIONS	CA5420A MIN	CA5420A TYP	CA5420A MAX	UNITS
Input Offset Voltage	V_{IO}		-	2	5	mV
Input Offset Current	$\|I_{IO}\|$		-	0.03	4 (Note 3)	pA
Input Current	$\|I_I\|$		-	0.05	5 (Note 3)	pA
Large Signal Voltage Gain	A_{OL}	R_L = 10kΩ	20	100	-	kV/V
			86	100	-	dB
Common Mode Rejection Ratio	CMRR		-	100	320	μV/V
			70	80	-	dB
Common Mode Input Voltage Range	$V_{ICR}+$		9	9.3	-	V
	$V_{ICR}-$		-10	-10.3	-	V
Power Supply Rejection Ratio	PSRR		-	32	320	μV/V
			70	90	-	dB
Maximum Output Voltage	$V_{OM}+$	$R_L = \infty$	9.7	9.9	-	V
	$V_{OM}-$		-9.7	-9.85	-	V
Supply Current	I_{SUPPLY}		-	450	1000	μA
Device Dissipation	P_D		-	9	14	mW
Input Offset Voltage Temperature Drift	$\Delta V_{IO}/\Delta T$		-	4	-	μV/°C

NOTE:

3. The maximum limit represents the levels obtainable on high-speed automatic test equipment. Typical values are obtained under laboratory conditions.

Typical Applications

Picoammeter Circuit

The exceptionally low input current (typically 0.2pA) makes the CA5420A highly suited for use in a picoammeter circuit. With only a single 10GΩ resistor, this circuit covers the range from ±1.5pA. Higher current ranges are possible with suitable switching techniques and current scaling resistors. Input transient protection is provided by the 1MΩ resistor in series with the input. Higher current ranges require that this resistor be reduced. The 10MΩ resistor connected to pin 2 of the CA5420A decouples the potentially high input capacitance often associated with lower current circuits and reduces the tendency for the circuit to oscillate under these conditions.

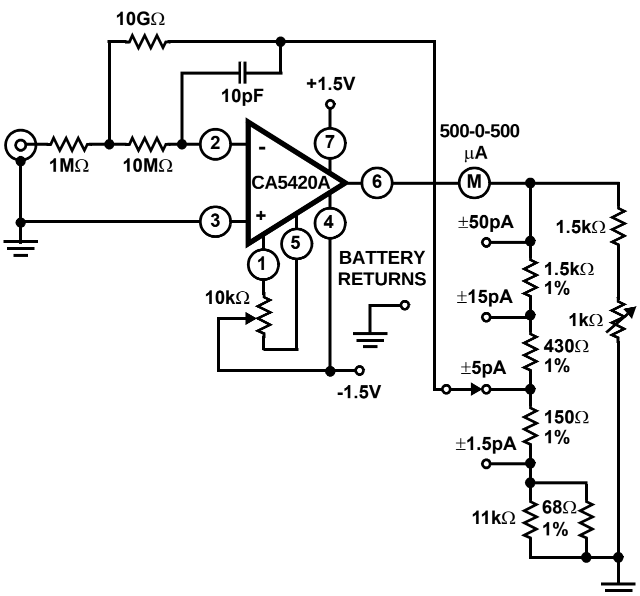


FIGURE 1. PICOAMMETER CIRCUIT

High Input Resistance Voltmeter

Advantage is taken of the high input impedance of the CA5420A in a high input resistance DC voltmeter. Only two 1.5V “AA” type penlite batteries power this exceedingly high-input resistance (>1,000,000MΩ) DC voltmeter. Full-scale deflection is ±500mV, ±150mV, and ±15mV. Higher voltage ranges are easily added with external input voltage attenuator networks.

The meter is placed in series with the gain network, thus eliminating the meter temperature coefficient error term.

Supply current in the standby position with the meter undeflected is 300μA. At full-scale deflection this current rises to 800μA. Carbon-zinc battery life should be in excess of 1,000 hours.

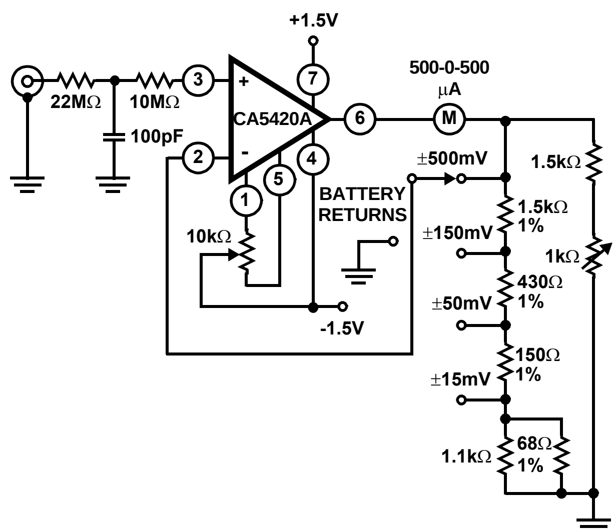


FIGURE 2. HIGH INPUT RESISTANCE VOLTMETER

Typical Performance Curves

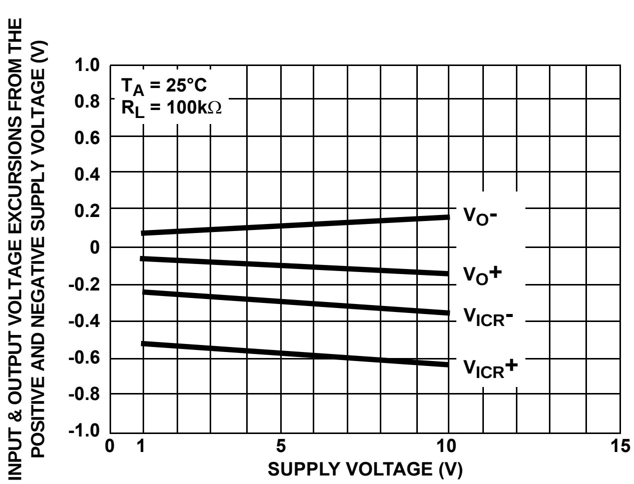


FIGURE 3. OUTPUT VOLTAGE SWING AND COMMON MODE INPUT VOLTAGE RANGE vs SUPPLY VOLTAGE

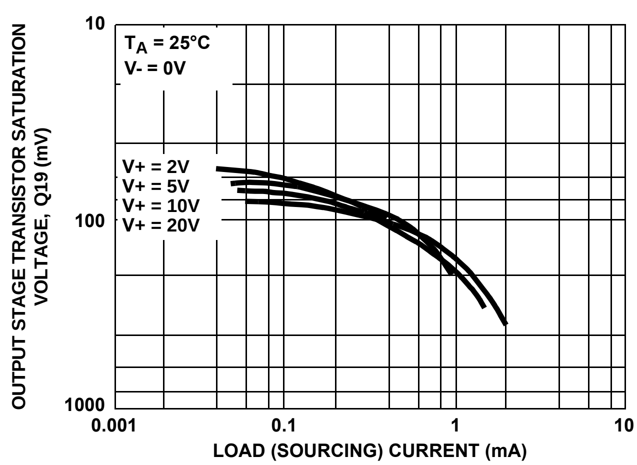


FIGURE 4. OUTPUT VOLTAGE vs LOAD SOURCING CURRENT

Typical Performance Curves (Continued)

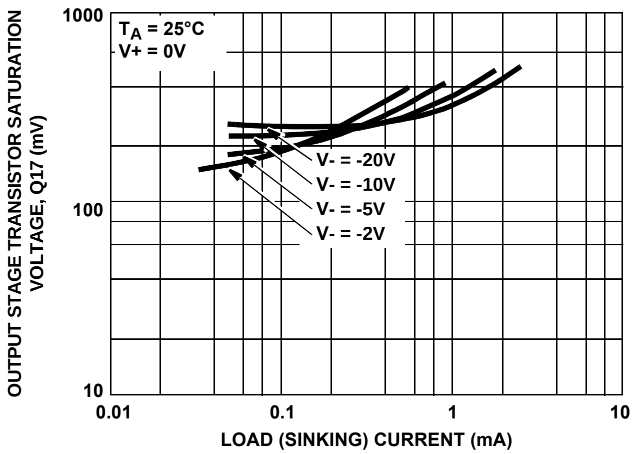


FIGURE 5. OUTPUT VOLTAGE vs LOAD SINKING CURRENT

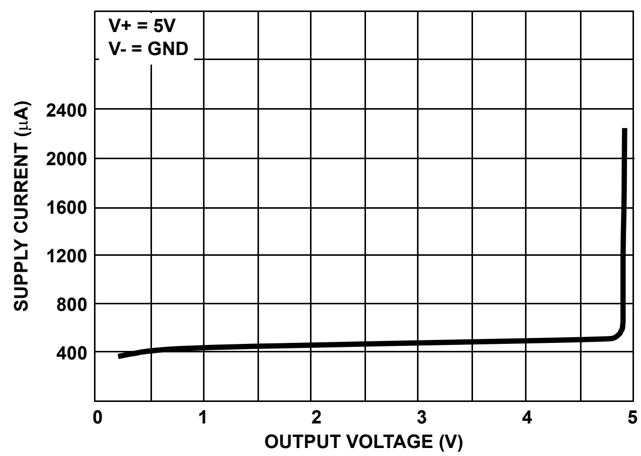


FIGURE 6. SUPPLY CURRENT vs OUTPUT VOLTAGE

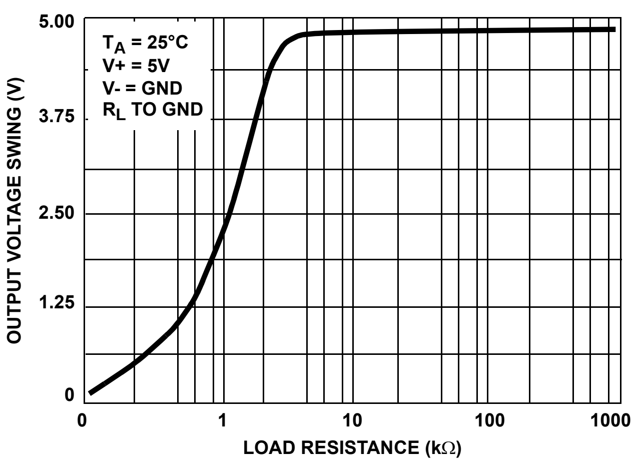


FIGURE 7. OUTPUT VOLTAGE SWING vs LOAD RESISTANCE

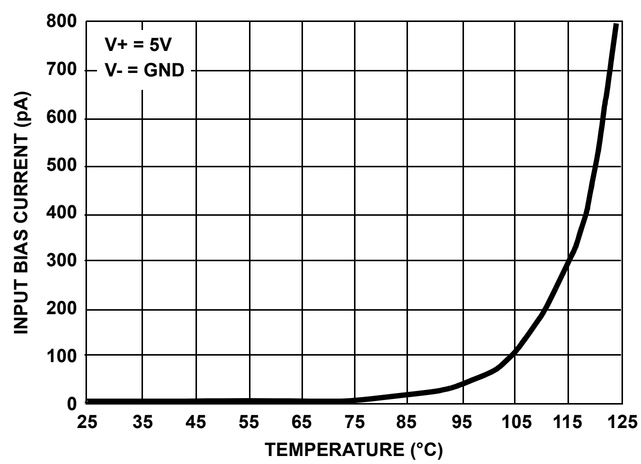


FIGURE 8. INPUT BIAS CURRENT DRIFT ($\Delta I_B/\Delta T$)

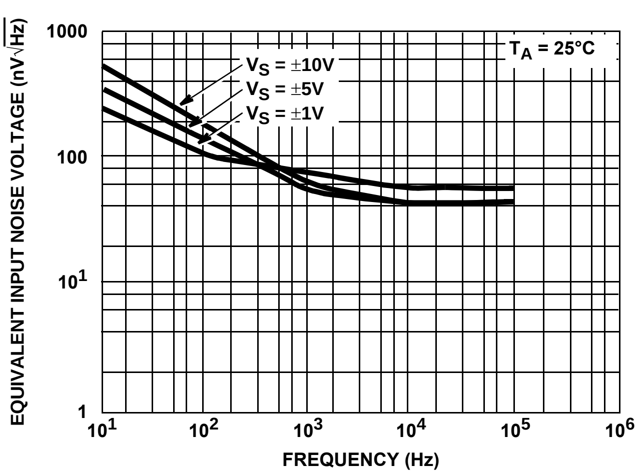


FIGURE 9. INPUT NOISE VOLTAGE vs FREQUENCY

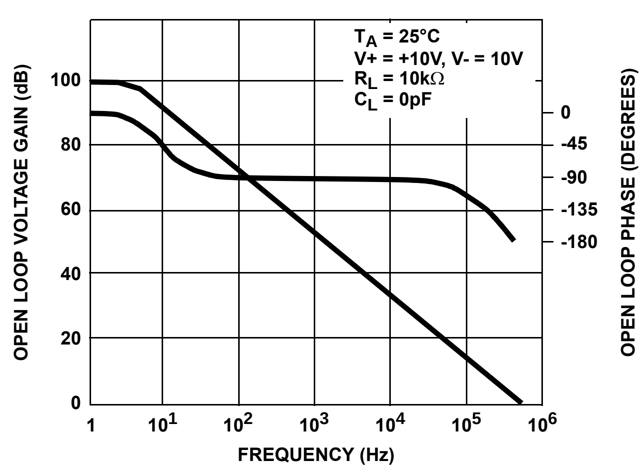


FIGURE 10. OPEN LOOP GAIN AND PHASE SHIFT RESPONSE