RAYTHEON

Programmable Quad Operational Amplifiers LM146/246/346

Features (ISET = 10μA)

- Programmable electrical characteristics
- Battery-powered operation
- Low supply current 350μA amplifier
- Guaranteed gain bandwidth product 0.8 MHz min
- Large DC voltage gain 120 dB
- Low noise voltage 28 nV/√Hz
- Wide power supply range ±1.5V to ±22V
- Class AB output stage—no crossover distortion
- Ideal pin out for Biquad active filters
- Input bias currents are temperature compensated

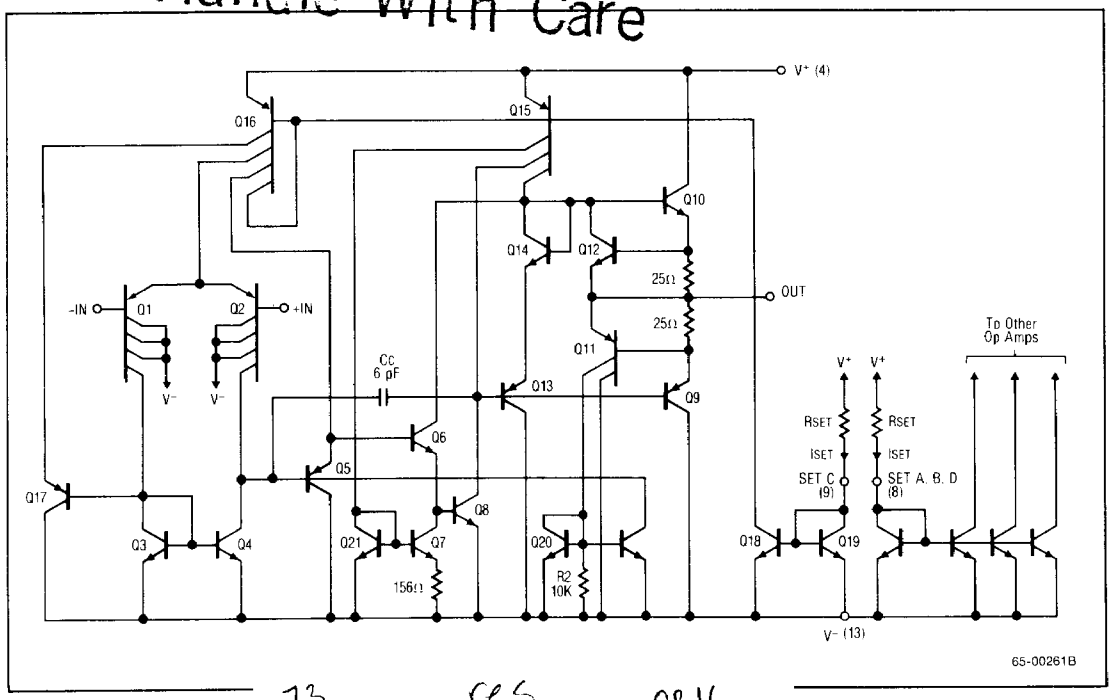
Description

The LM146 series of quad op amps consists of four independent, high gain, internally compensated, low power, programmable amplifiers. Two external resistors (RSET) allow the user to program the gain bandwidth product, slew rate, supply current, input bias current, input offset current and input noise. For example, the user can trade-off supply current for bandwidth or optimize noise figure for a given source resistance. In a similar way, other amplifier characteristics can be tailored to the application. Except for the two programming pins at the end of the package, the LM146 pin-out is the same as the LM124 and LM148.

Single Copy

Handle With Care

Schematic Diagram



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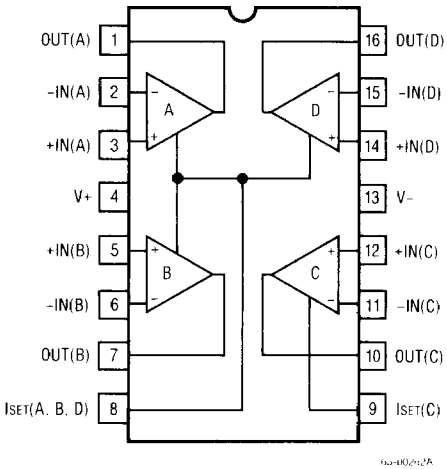
Pin Out Diagrams

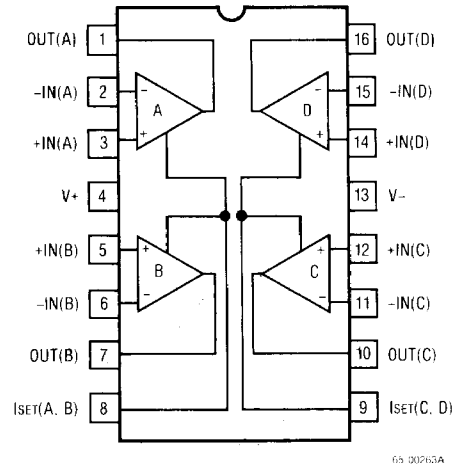
LM146

Dual In-Line
(Top View)



LM146-2

Dual In-Line
(Top View)

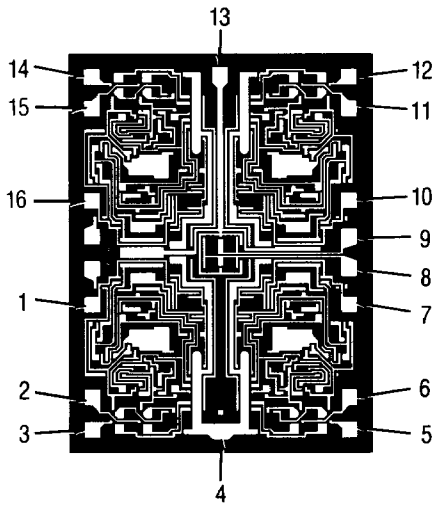


Programming Equations

Total Supply Current = 1.4mA ($I_{SET}/10\mu A$)
Gain Bandwidth Product = 1MHz ($I_{SET}/10\mu A$)
Slew Rate = 0.4V/μSec ($I_{SET}/10\mu A$)
Input Bias Current ≃ 50nA ($I_{SET}/10\mu A$)
I_{SET} = Current into Pin 8 or Pin 9

$$I_{SET} = \frac{V^+ - V^- - 0.6V}{R_{SET}}$$

Mask Pattern



Die Size: 98 x 74 mils
Min. Pad Dimensions: 4 x 4 mils

Absolute Maximum Ratings

Supply Voltage
- LM146 ..... ±22V
- LM246, 346 ..... ±18V

Differential Input Voltage[1] ..... ±30V
CM Input Voltage[1] ..... ±15V
Output Short Circuit
- Duration[2] ..... Indefinite

Operating Temperature Range
- LM146 ..... -55°C to 125°C
- LM246 ..... -25°C to 85°C
- LM346 ..... 0°C to 70°C

Storage Temperature
- Range ..... -65°C to 150°C

Lead Soldering
- Temperature (10sec) ..... 300°C

Notes: 1. For supply voltages less than ±15V, the absolute maximum input voltage is equal to supply voltage.
2. Any of the amplifier outputs can be shorted to ground indefinitely; however, more than one should not be simultaneously shorted as the maximum junction temperature will be exceeded.

Ordering Information

Part Number	Package	Operating Temperature Range
LM146J	Ceramic	-55°C to +125°C
LM146J/883B*	Ceramic	-55°C to +125°C
LM146-2J	Ceramic	-55°C to +125°C
LM146-2J/883B*	Ceramic	-55°C to +125°C
LM246N	Plastic	-25°C to +85°C
LM246-2N	Plastic	-25°C to +85°C
LM246J	Ceramic	-25°C to +85°C
LM246-2J	Ceramic	-25°C to +85°C
LM346N	Plastic	0°C to +70°C
LM346-2N	Plastic	0°C to +70°C
LM346J	Ceramic	0°C to +70°C
LM346-2J	Ceramic	0°C to +70°C

*MIL-STD-883, Level B Processing

Thermal Characteristics

	16-Lead Plastic DIP	16-Lead Ceramic DIP
Max. Junction Temp.	125°C	175°C
Max. P_D $T_A < 50°C$	555mW	1042mW
Therm. Res. θ_{JC}	—	60°C/W
Therm. Res. θ_{JA}	135°C/W	120°C/W
For $T_A > 50°C$ Derate at	7.41mW per °C	8.33mW per °C

DC Electrical Characteristics

(V_S = ±15V, I_{SET} = 10μA, and T_A = 25°C unless otherwise specified.)

Parameter	Conditions	LM146			LM246/346			Units
		Min	Typ	Max	Min	Typ	Max	
Input Offset Votlage	V_{CM} = 0V, $R_S \leq 50\Omega$ T_A = 25°C		0.5	5		0.5	6	mV
Input Offset Current	V_{CM} = 0V, $T_A \leq 25°C$		2	20		2	100	nA
Input Bias Current	V_{CM} = 0V, $T_A \leq 25°C$		50	100		30	250	nA
Supply Current (4 Op Amps)	T_A = 25°C		1.4	2.0		1.4	2.5	mA
Large Signal Voltage Gain	$R_L \geq 10k\Omega$, T_A = 25°C V_{OUT} = ±10V	100	1000		50	1000		V/mV
Input CM Range	T_A = 25°C	±13.5	±14		±13.5	±14		V
Common Mode Rejection Ratio	$R_S \leq 10k\Omega$, T_A = 25°C	80	100		70	100		dB
Power Supply Rejection Ratio	$R_S \leq 10k\Omega$, T_A = 25°C	80	100		74	100		dB
Output Voltage Swing	$R_L \geq 10k\Omega$, T_A = 25°C	±12	±14		±12	±14		V
Short Circuit Current	T_A = 25°C	5.0	20	30	5.0	20	30	mA
Gain Bandwidth Product	T_A = 25°C	0.8	1.2		0.5	1.2		MHz
Phase Margin	T_A = 25°C		60			60		Deg
Slew Rate	T_A = 25°C		0.4			0.4		V/μS
Input Noise Voltage	f = 1kHz, T_A = 25°C		28			28		$nV/\sqrt{Hz}$
Channel Separation	R_L = 10kΩ, T_A = 25°C ΔV_{OUT} =0V to ±12V		120			120		dB
Input Resistance	T_A = 25°C		1.0			1.0		MΩ
Input Capacitance	T_A = 25°C		2.0			2.0		pF

DC Electrical Characteristics

(V_S = ±15V, I_{SET} = 10μA over the full operating temperature range)

Parameter	Conditions	LM146			LM246/346			Units
		Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage	V_{CM} = 0V, $R_S \leq 50\Omega$		0.5	6.0		0.5	7.5	mV
Input Offset Current	V_{CM} = 0V		2.0	25		2.0	100	nA
Input Bias Current	V_{CM} = 0V		50	100		50	250	nA
Supply Current (4 Op Amps)			1.5	2.0		1.5	2.5	mA
Large Signal Voltage Gain	R_L = 10kΩ ΔV_{OUT} = ±10V	50	1000		25	1000		V/mV
Input CM Range		±13.5	±14		±13.5	±14		V
Common Mode Rejection Ratio	$R_S \leq 50\Omega$	70	100		70	100		dB
Power Supply Rejection Ratio	$R_S \leq 50\Omega$	76	100		74	100		dB
Output Voltage Swing	$R_L \geq 10k\Omega$	±12	±14		±12	±14		V

DC Electrical Characteristics (V_S = ±15V, I_{SET} = 1μA)

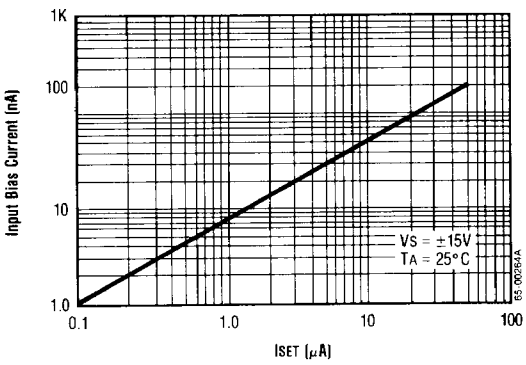
Parameter	Conditions	LM146			LM246/346			Units
		Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage	V_{CM} = 0V, $R_S \leq 50\Omega$ T_A = 25°C		0.5	5.0		0.5	7.0	mV
Input Bias Current	V_{CM} = 0V, T_A = 25°C		7.5	20		7.5	100	nA
Supply Current (4 Op Amps)	T_A = 25°C		140	250		140	300	μA
Gain Bandwidth Product	T_A = 25°C	80	100		50	100		kHz

DC Electrical Characteristics (V_S = ±1.5V, I_{SET} = 10μA)

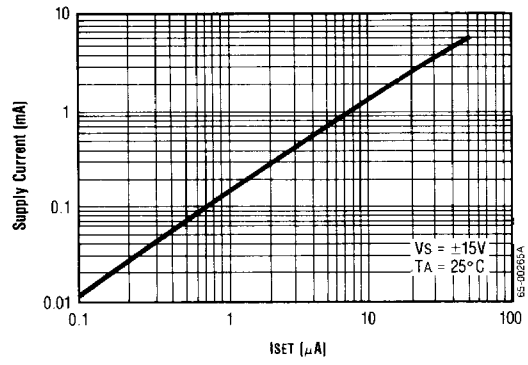
Parameter	Conditions	LM146			LM246/346			Units
		Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage	V_{CM} = 0V, $R_S \leq 50\Omega$ T_A = 25°C		0.5	5.0		0.5	7.0	mV
Input CM Range	T_A = 25°C	±0.7			±0.7			V
Common Mode Rejection Ratio	$R_S \leq 50\Omega$, T_A = 25°C		80			80		dB
Output Voltage Swing	$R_L \geq 10k\Omega$, T_A = 25°C	±0.6			±0.6			V

Typical Performance Characteristics

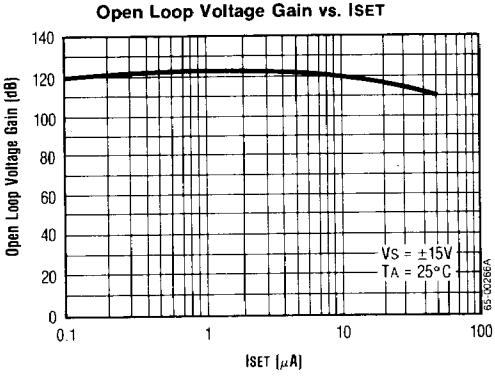
Input Bias Current vs. ISET



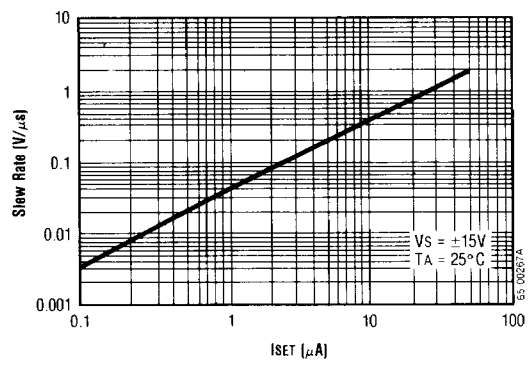
Supply Current vs. ISET



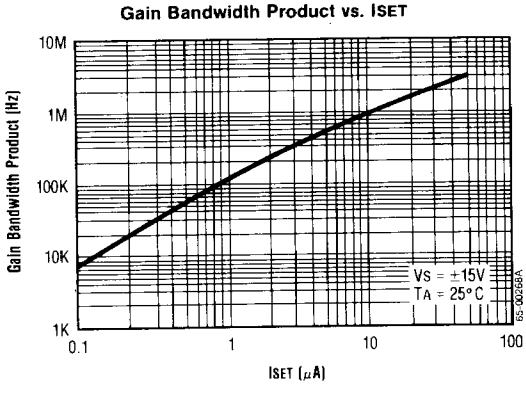
Open Loop Voltage Gain vs. ISET



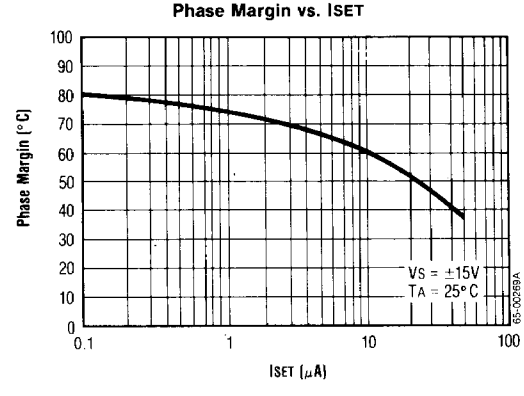
Slew Rate vs. ISET



Gain Bandwidth Product vs. ISET

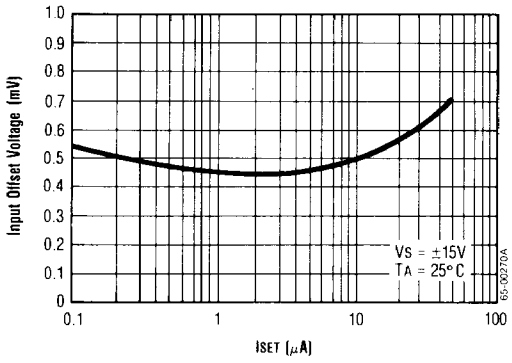


Phase Margin vs. ISET

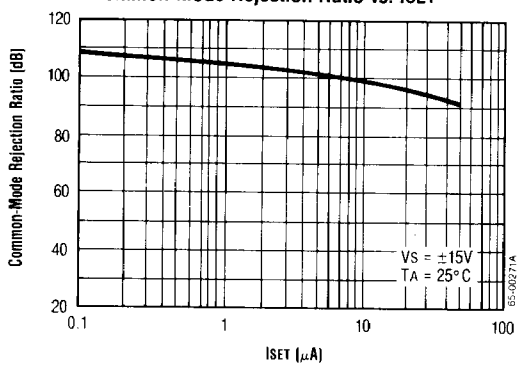


Typical Performance Characteristics (continued)

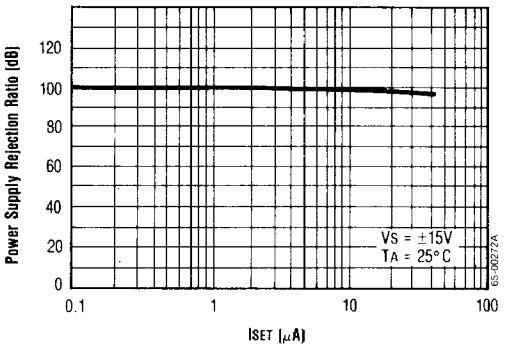
Input Offset Voltage vs. ISET



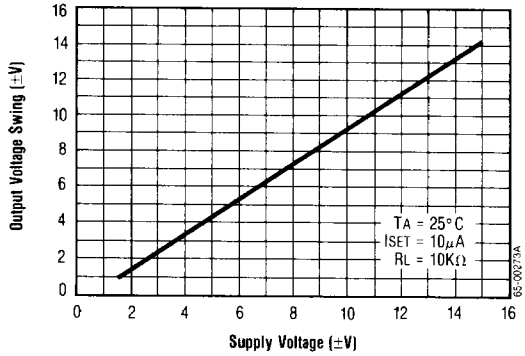
Common-Mode Rejection Ratio vs. ISET



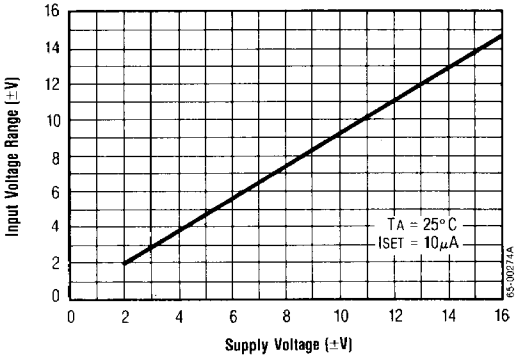
Power Supply Rejection Ratio vs. ISET



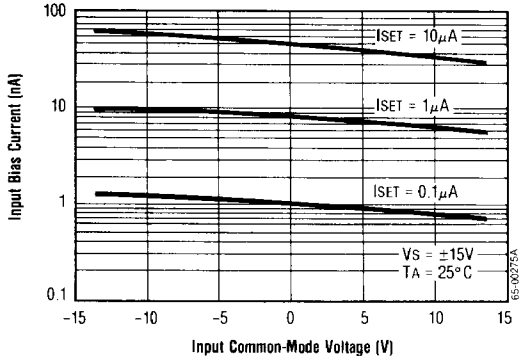
Output Voltage Swing vs. Supply Voltage



Input Voltage Range vs. Supply Voltage

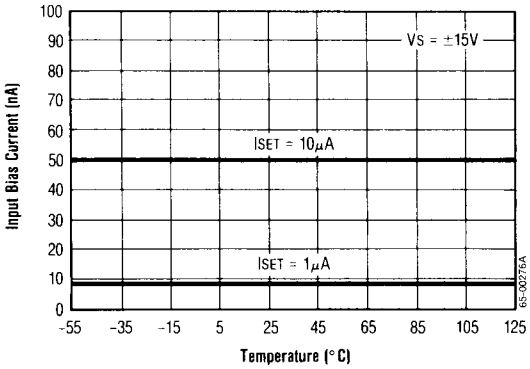


Input Bias Current vs. Input Common-Mode Voltage

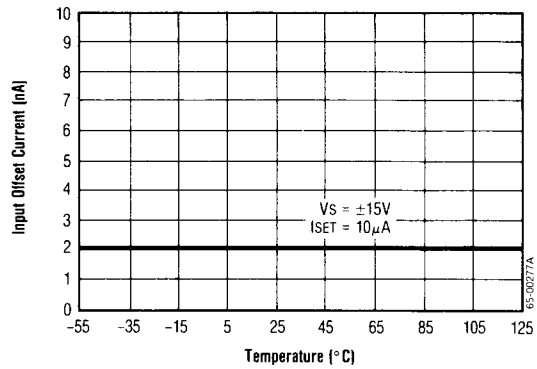


Typical Performance Characteristics (continued)

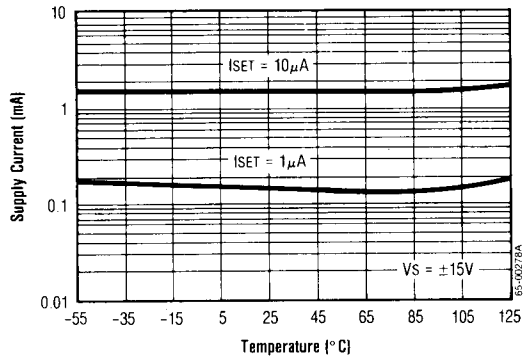
Input Bias Current vs. Temperature



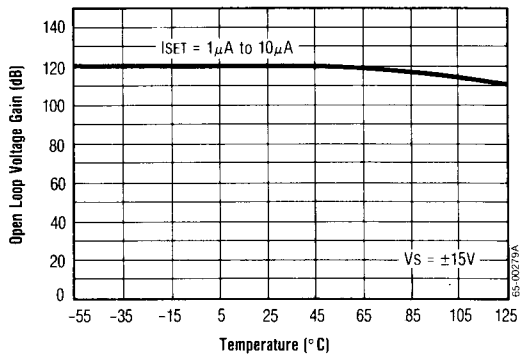
Input Offset Current vs. Temperature



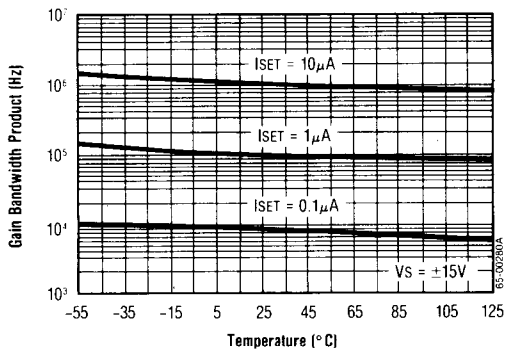
Supply Current vs.Temperature



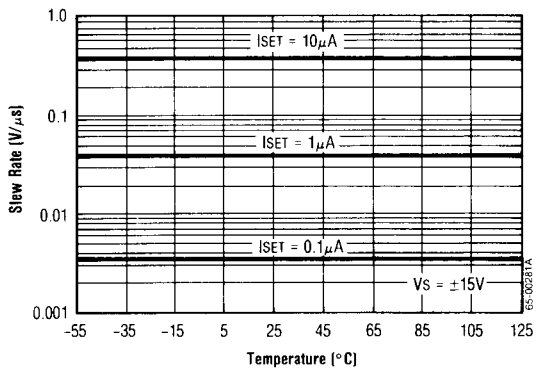
Open Loop Voltage Gain vs. Temperature



Gain Bandwidth Product vs. Temperature

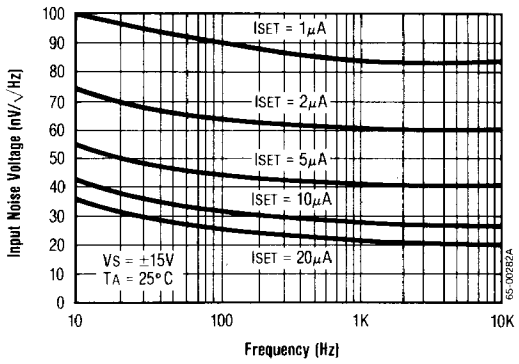


Slew Rate vs. Temperature

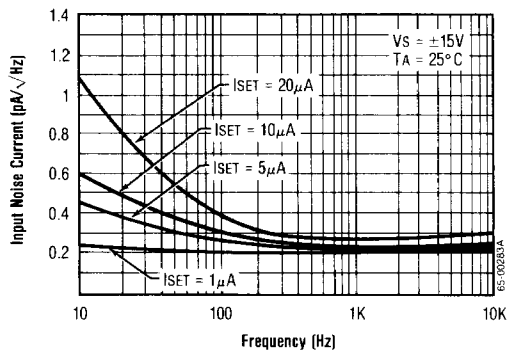


Typical Performance Characteristics (continued)

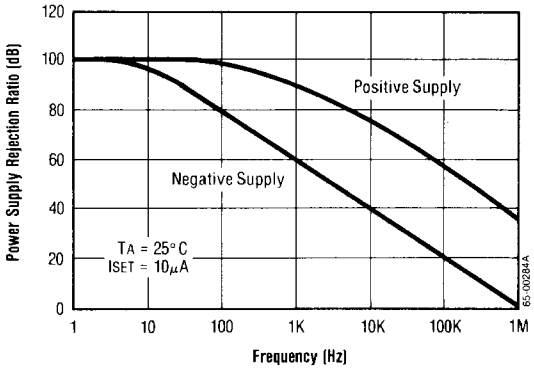
Input Noise Voltage vs. Frequency



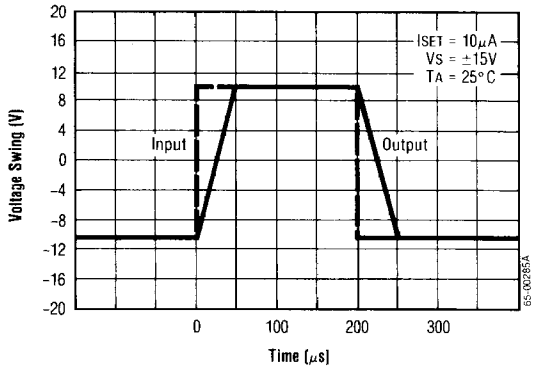
Input Noise Current vs. Frequency



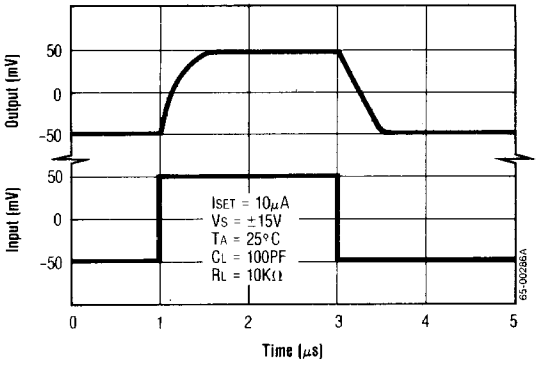
Power Supply Rejection Ratio vs. Frequency



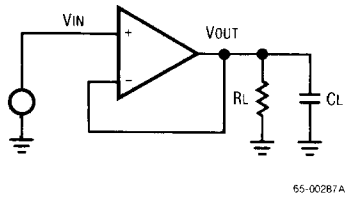
Voltage Follower Pulse Response



Voltage Follower Transient Response

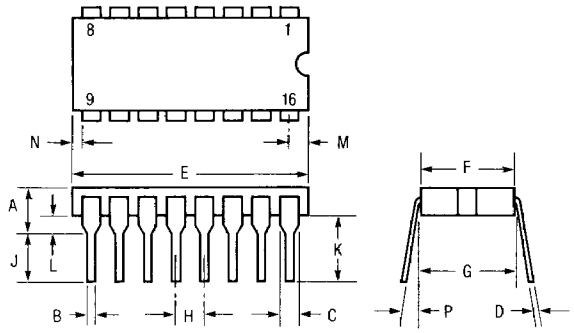


Transient Response Test Circuit



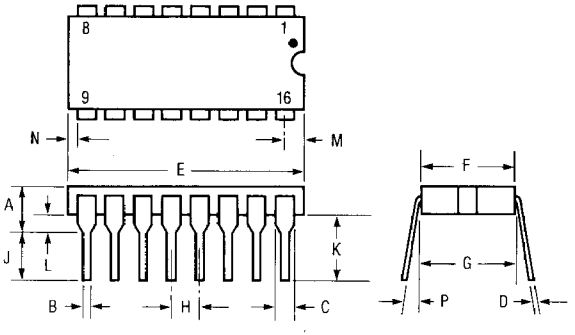
Packaging Information

16-Lead
Ceramic Dual-in-Line



Dimension	Inches		Millimeters	
	Min.	Max.	Min.	Max.
A		.200		5.08
B	.014	.023	.36	.58
C	.030	.070	.76	1.78
D	.008	.015	.20	.38
E		.840		21.34
F	.220	.310	5.59	7.87
G	.290	.320	7.37	8.13
H	.100BSC		2.54BSC	
J	.125	.200	3.18	5.08
K	.150		3.81	
L	.015	.060	.38	1.52
M		.080		2.03
N	.005		.13	
P	0°	15°	0°	15°

16-Lead
Plastic Dual-in-Line



Dimension	Inches		Millimeters	
	Min.	Max.	Min.	Max.
A		.200		5.08
B	.014	.023	0.36	0.58
C	.030	.070	0.76	1.78
D	.008	.015	0.20	0.38
E	.740	.760	18.80	19.30
F	.240	.260	6.10	6.60
G	.290	.320	7.37	8.13
H	.100BSC		2.54BSC	
J	.125	.200	3.18	5.08
K	.135		3.43	
L	.015	.060	0.38	1.52
M	.020		0.51	
N	.005		0.13	
P	0°	15°	0°	15°