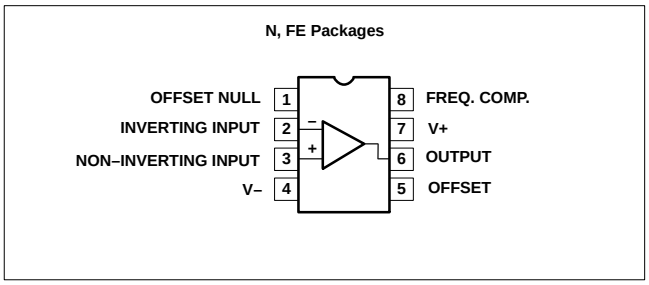
High slew rate operational amplifier — NE/SE531

DESCRIPTION

The 531 is a fast slewing high performance operational amplifier which retains DC performance equal to the best general purpose types while providing far superior large-signal AC performance. A unique input stage design allows the amplifier to have a large-signal response nearly identical to its small-signal response. The amplifier is compensated for truly negligible overshoot with a single capacitor. In applications where fast settling and superior large-signal bandwidths are required, the amplifier out-performs conventional designs which have much better small-signal response. Also, because the small-signal response is not extended, no special precautions need be taken with circuit board layout to achieve stability. The high gain, simple compensation, and excellent stability of this amplifier allow its use in a wide variety of instrumentation applications.

PIN CONFIGURATIONS



FEATURES

- 35V/μs slew rate at unity gain
- Pin-for-pin replacement for μA709, μA748, or LM101
- Compensated with a single capacitor
- Same low drift offset null circuitry as μA741
- Small-signal bandwidth 1MHz
- Large-signal bandwidth 500kHz
- True op amp DC characteristics make the 531 the ideal answer to all slew rate limited operational amplifier applications

ORDERING INFORMATION

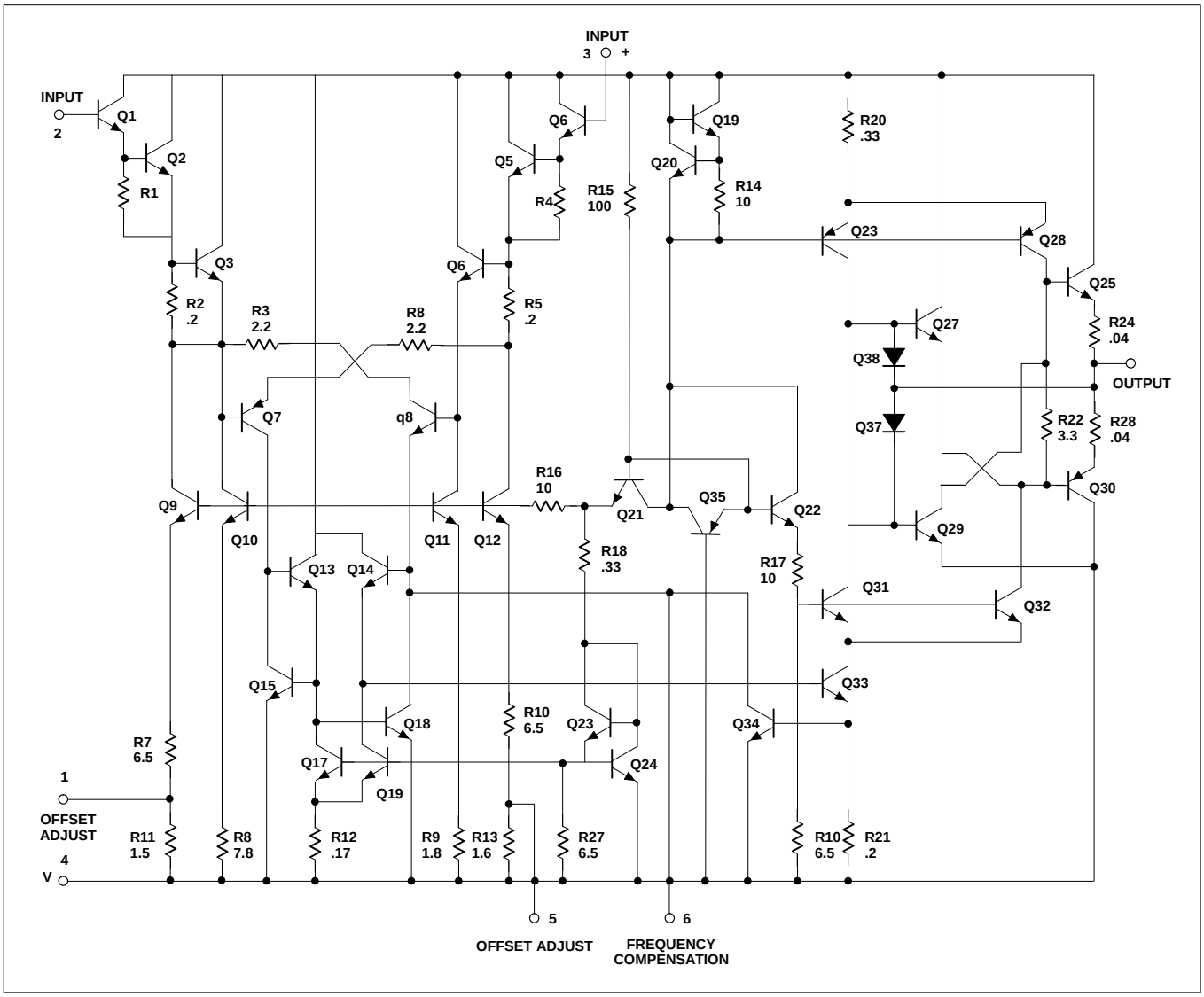
DESCRIPTION	TEMPERATURE RANGE	ORDER CODE	DWG #
8-Pin Plastic Dual In-Line Package (DIP)	0 to +70°C	NE531N	0404B
8-Pin Ceramic Dual In-Line Package (CERDIP)	-55°C to +125°C	SE531FE	0580A
8-Pin Ceramic Dual In-Line Package (CERDIP)	0°C to +70°C	NE531FE	0580A

ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNIT
V_S	Supply voltage	±22	V
$P_{D\ MAX}$	Maximum power dissipation		
	T_A=25°C (still-air)[1]		
	FE package	780	mW
	N package	1160	mW
	Differential input voltage	±15	V
V_{CM}	Common-mode input voltage[2]	±15	V
	Voltage between offset null and V-	±0.5	V
T_A	Operating ambient temperature range		
	NE531	0 to +70	°C
	SE531	-55 to +125	°C
T_{STG}	Storage temperature range	-65 to +150	°C
T_{SOLD}	Lead soldering temperature (10sec max)	300	°C
	Output short-circuit duration[3]	indefinite	

NOTES:
1. The following derating factors should be applied above 25°C:
   FE package at 6.2mW/°C
   N package at 9.3mW/°C
2. For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.
3. Short-circuit may be to ground or either supply. Rating applies to +125°C case temperature or to +75°C ambient temperature.

EQUIVALENT SCHEMATIC



DC ELECTRICAL CHARACTERISTICS

V_S=±15V, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	SE531			NE531			UNIT
			Min	Typ	Max	Min	Typ	Max	
V_{OS}	Offset voltage	R_S≤10kΩ, T_A=25°C R_S310kΩ, over temp		2.0	5.0 6.0		2.0	6.0 7.5	mV mV
ΔV_{OS}		Over temp		10			10		µV/°C
I_{OS}	Offset current	T_A=25°C T_A=High T_A=Low		30	200 200 500		50	200 200 300	nA nA nA
ΔI_{OS}		Over temp		0.4			0.4		nA/°C
I_{BIAS}	Input bias current	T=25°C T_A=High T_A=Low		300	500 500 1500		400	1500 1500 2000	nA nA nA
ΔI_{BIAS}		Over temp		2			2		nA/°C
V_{CM}	Common-mode voltage range	T_A=25°C	±10			±10			V
CMRR	Common-mode rejection ratio	T_A=25°C, R_S≤10kΩ Over temp R_S≤10kΩ	70	90		70	100		dB dB
R_{IN}	Input resistance	T_A=25°C		20			20		MΩ
V_{OUT}	Output voltage swing	R_L≥10kΩ, over temp	±10	±13		±10	±13		V
I_{CC}	Supply current	T_A=25°C T_{MAX}			7.0 7.0			10 10	mA mA
P_D	Power consumption	T_A=25°C			210			300	mW
PSRR	Power supply rejection ratio	R_S≤10kΩ, T_A=25°C R_S≤10kΩ, over temp		10	150		10	150	µV/V µV/V
R_{OUT}	Output resistance	T_A=25°C		75			75		Ω
A_{VOL}	Large-signal voltage gain	T_A=25°C, R_L≥10kΩ, V_{OUT}=±10V R_L≥10kΩ, V_{OUT}=±10V, over temp	50 25	100		20 15	60		V/mV V/mV
V_{INN}	Input noise voltage	25°C f=1kHz		20			20		nV/√Hz
I_{SC}	Short-circuit current	25°C	5	15	45	5	15	45	mA

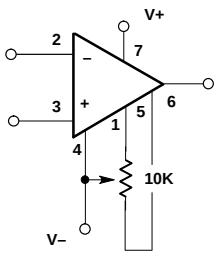
AC ELECTRICAL CHARACTERISTICS

T_A=25°C V_S=+15V, unless otherwise specified.[1]

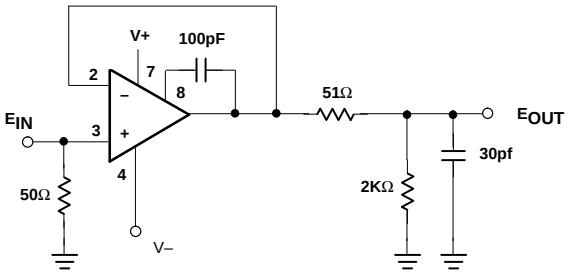
SYMBOL	PARAMETER	TEST CONDITIONS	SE531			NE531			UNIT
			Min	Typ	Max	Min	Typ	Max	
BW	Full power bandwidth			500			500		kHz
t_S	Settling time (1%) (0.1%)	A_V=+1, V_{IN}=±10V		1.5 2.5			1.5 2.5		µs µs
	Large-signal overshoot Small-signal overshoot	A_V=+1, V_{IN}=±10V A_V=+1, V_{IN}=400mV		2 5			2 5		% %
t_R	Small-signal rise time	A_V=+1, V_{IN}=400mV		300			300		ns
SR	Slew rate	A_V=100 A_V=10 A_V=1 (non-inverting) A_V=1 (inverting)	 20 25	35 35 30 35			35 35 30 35		V/µs V/µs V/µs V/µs

NOTES:
1. All AC testing is performed in the transient response test circuit.

TEST LOAD CIRCUITS



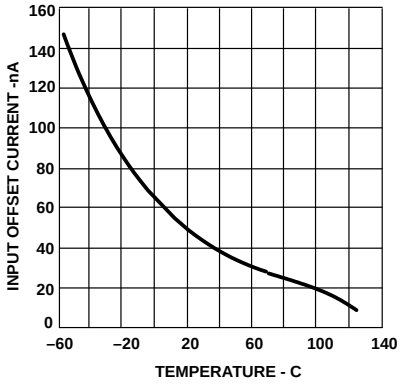
Offset Null Circuit



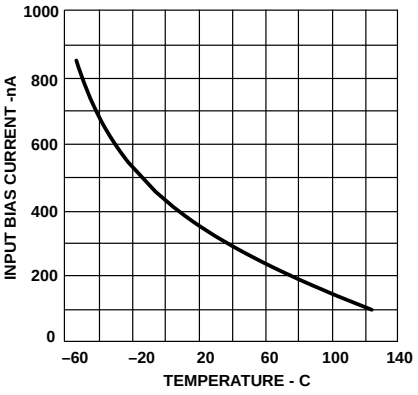
Transient Response Circuit

TYPICAL PERFORMANCE CHARACTERISTICS V_S = +15V, T_A = +255C, unless otherwise specified.

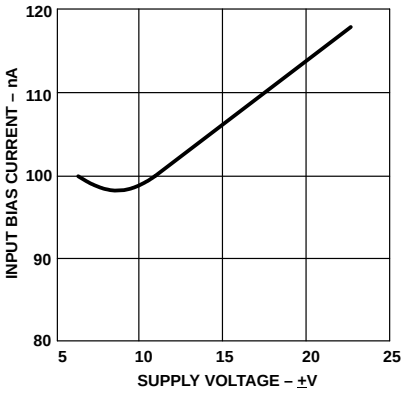
Input Offset Curent as a Function of Ambient Temperature



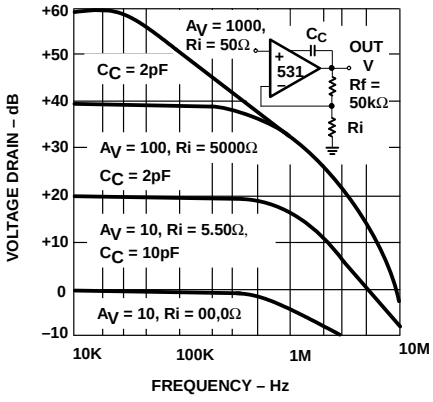
Input Bias Curent as a Function of Ambient Temperature



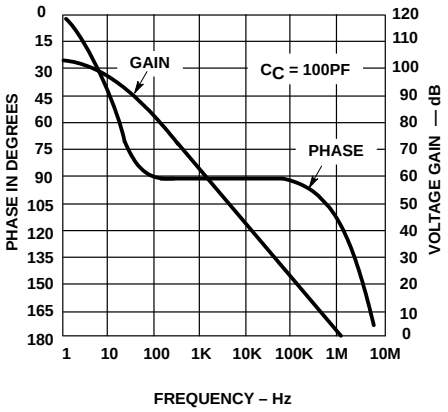
Input Bias Curent as a Function of Supply Voltage



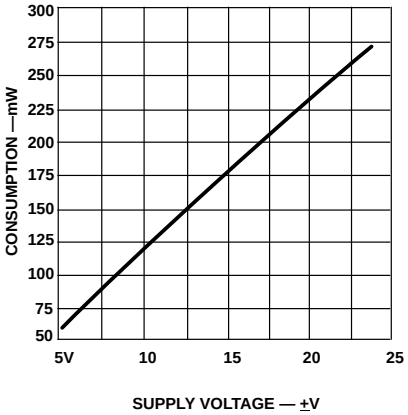
Closed Loop Non-Inverting Voltage Gain as a Function of Frequency



Open-Loop Phase Response and Voltage Gain as a Function of Ambient Temperature



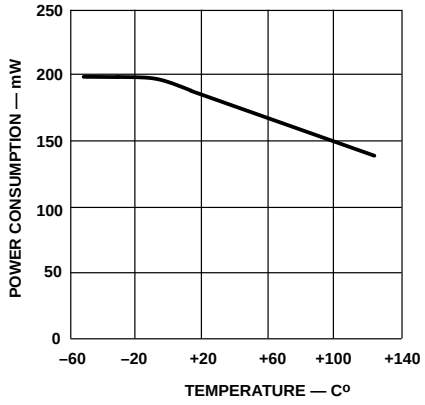
Power Consumption as a Function of Supply Voltage



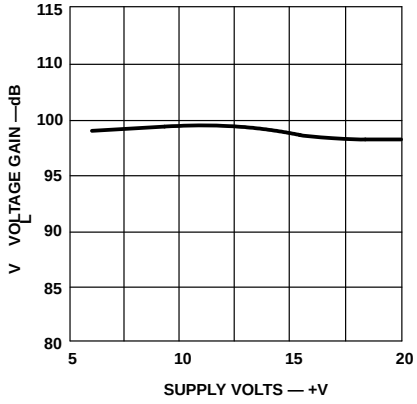
TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

V_S = +15V, T_A = 25°C, unless otherwise specified.

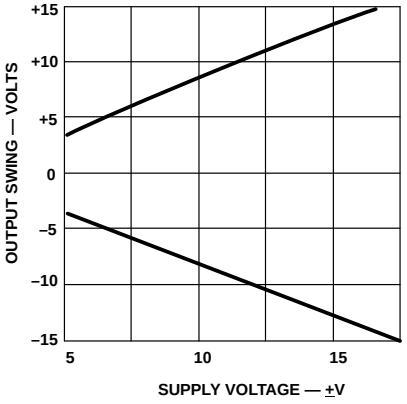
Power Consumption as a Function of Ambient Temperature



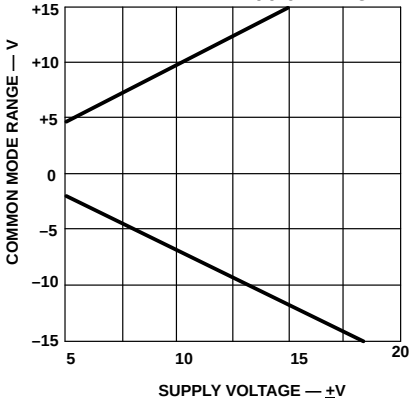
Open-Loop Voltage Gain as a Function of Supply Voltage



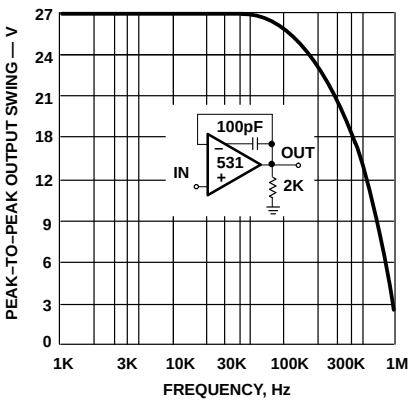
Output Voltage Swing as a Function of Supply Voltage



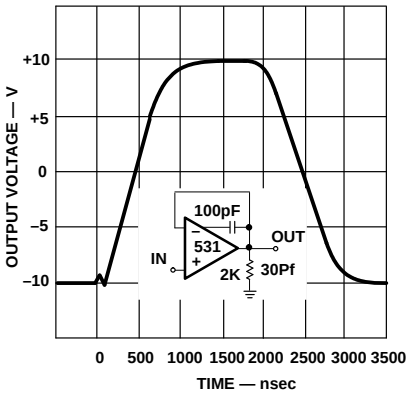
Input Voltage Range as a Function of Supply Voltage



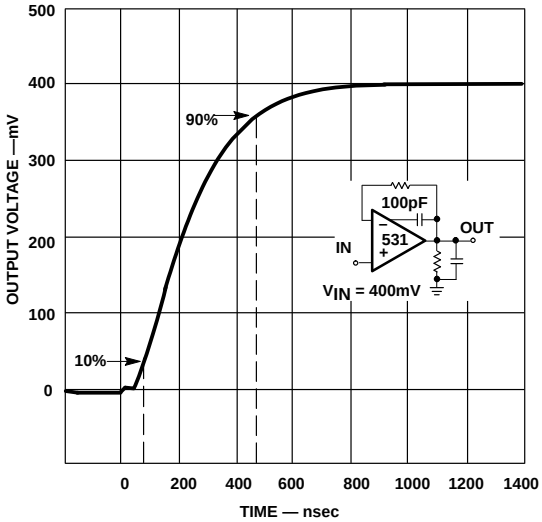
Output Voltage Swing as a Function of Frequency



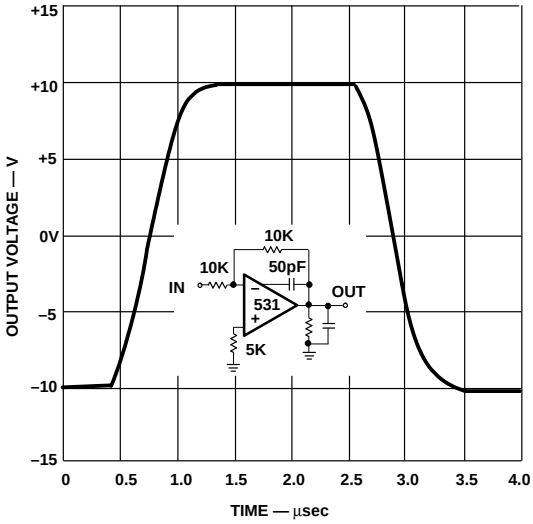
Voltage Follower Large-Signal Response



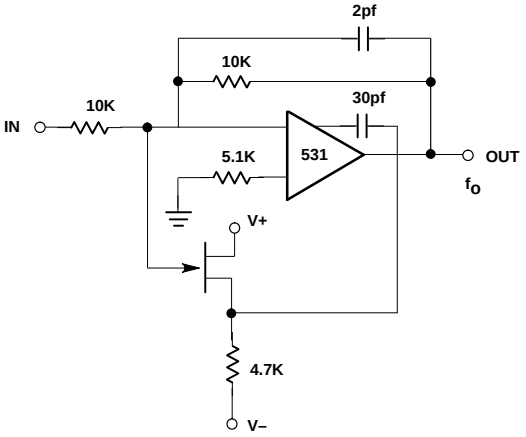
Voltage Follower Transient Response



Unity Gain Inverting Amplifier Large-Signal Response Function of Frequency

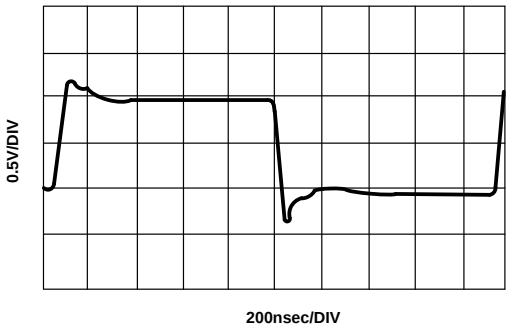


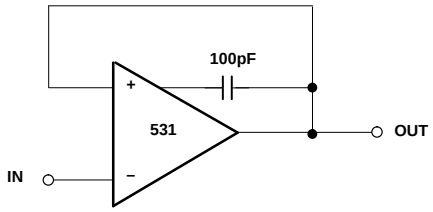
TYPICAL APPLICATIONS



High-Speed Inverter (10MHz Bandwidth)

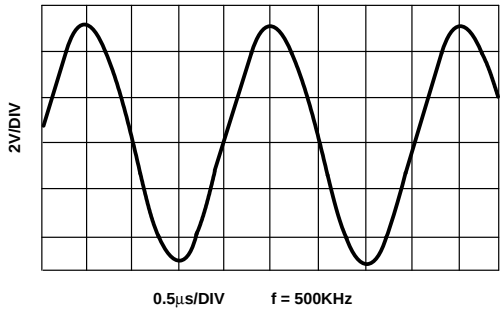
Pulse Response High-Speed Inverter

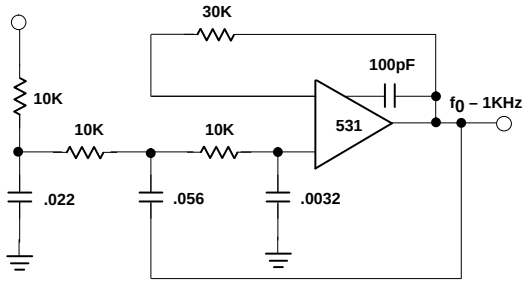




Fast Settling Voltage-Follower

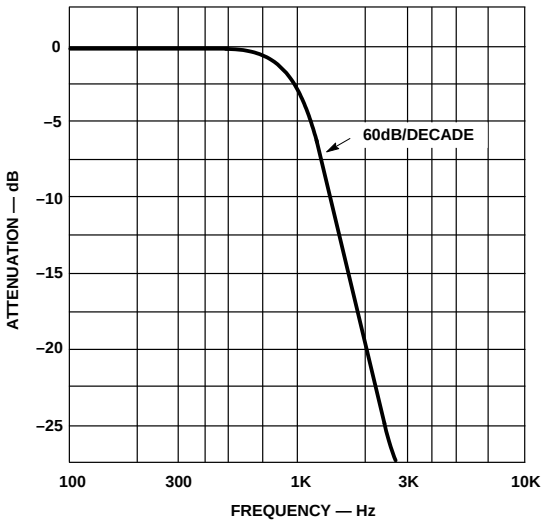
Large-Signal Response Voltage-Follower





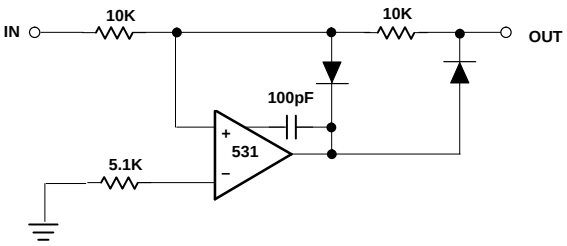
Three-Pole Active Low-Pass Filter Butterworth Maximally Flat Response[1]

Response of 3-Pole Active Butterworth Maximally Flat Filter

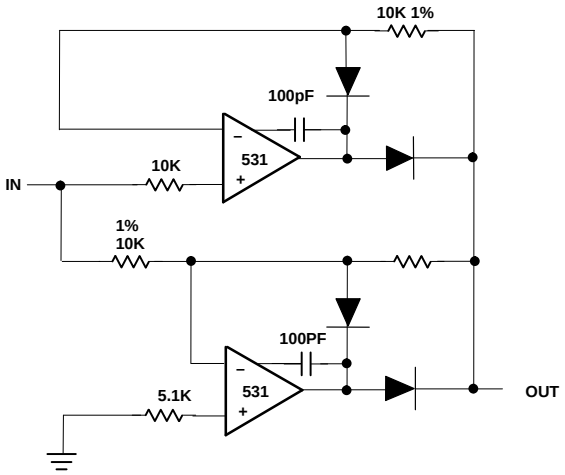


TYPICAL APPLICATIONS (Continued)

Precision Rectifiers

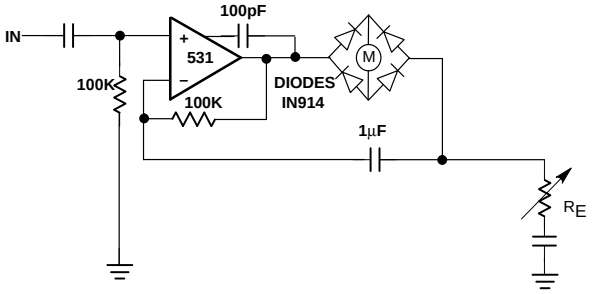


a. Half-Wave

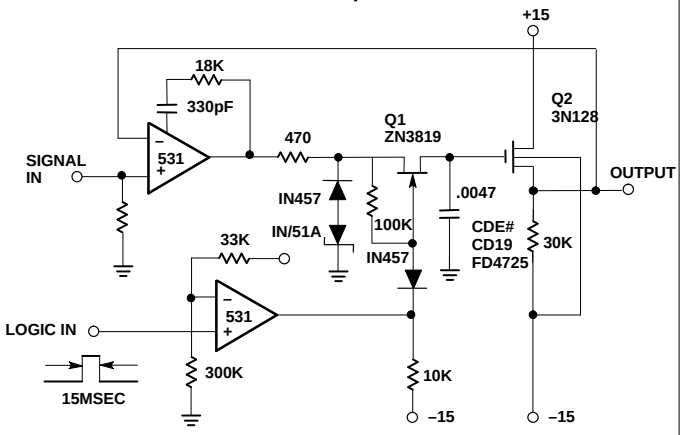


b. Full-Wave

AC Millivoltmeter



Sample-and-Hold



CYCLIC A-TO-D CONVERTER

One interesting, but much ignored, A/D converter is the cyclic converter. This consists of a chain of identical stages, each of which senses the polarity of the input. The stage then subtracts V_{REF} from the input and doubles the remainder if the polarity was correct. In Figure 1, the signal is full-wave rectified and the remainder of V_{IN}-V_{REF} is doubled. A chain of these stages gives the gray code equivalent of the input voltage in digitized form related to the magnitude of V_{REF}. Possessing high potential accuracy, the circuit using NE531 devices settles in 5µs.

TRIANGLE AND SQUARE WAVE GENERATOR

The circuit in Figure 2 will generate precision triangle and square waves. The output amplitude of the square wave is set by the output swing of op amp A-1, and R1/R2 sets the triangle amplitude. The frequency of oscillation in either case is:

$$f = \frac{1}{4RC} \cdot \frac{R2}{R1} \quad (1)$$

The square wave will maintain 50% duty cycle even if the amplitude of the oscillation is not symmetrical.

The use of the NE531 in this circuit will allow good square waves to be generated to quite high frequencies. Since the amplifier A1 runs open-loop, there is no need for compensation. The triangle-generating amplifier must be compensated. The NE5535 device can be used as well, except for the lower frequency response.

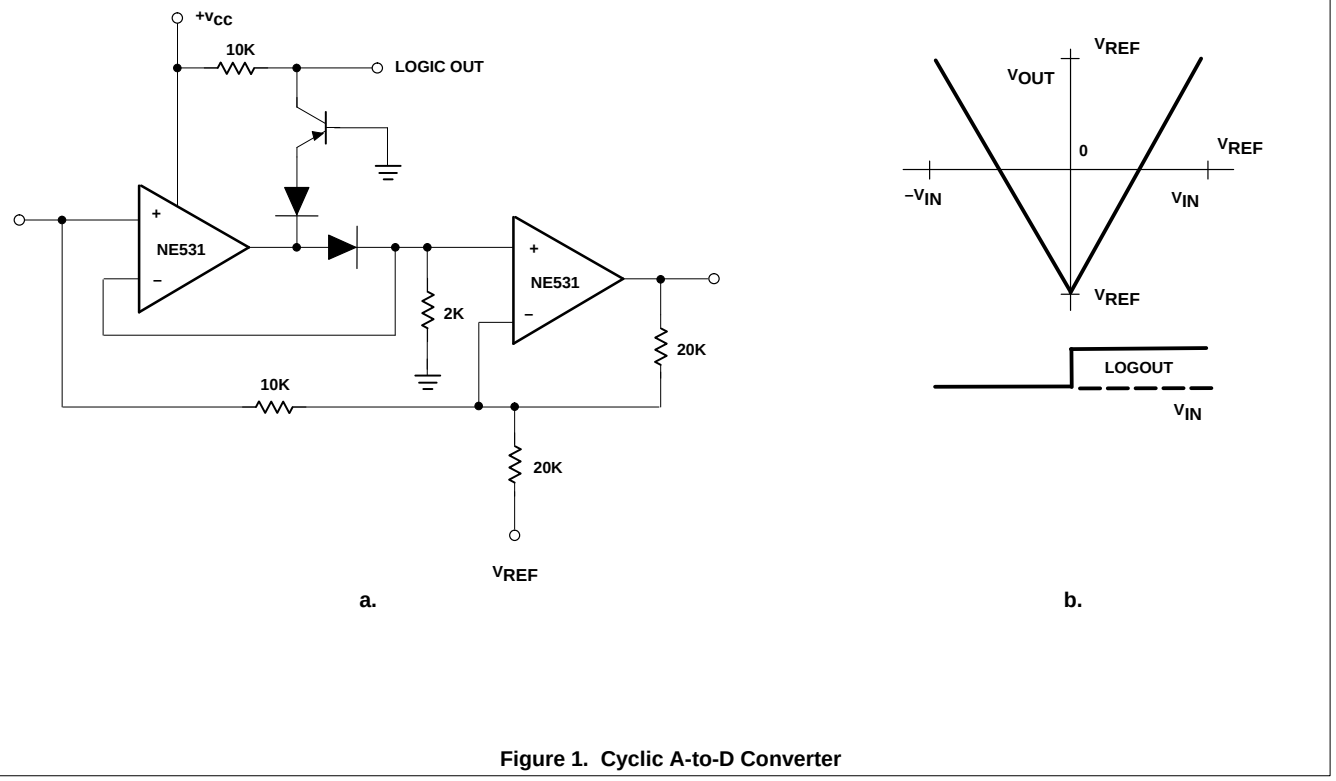


Figure 1. Cyclic A-to-D Converter