

# 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.

### FEATURES

- 35V/ $\mu$ s slew rate at unity gain
- Pin-for-pin replacement for  $\mu$ A709,  $\mu$ A748, or LM101
- Compensated with a single capacitor

### 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

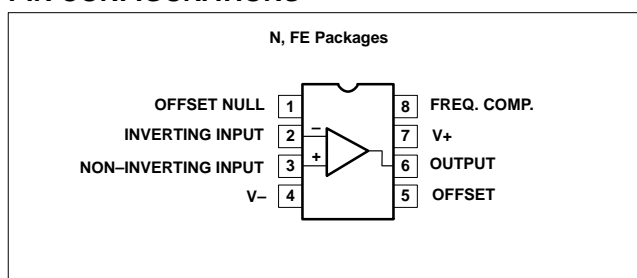
### ABSOLUTE MAXIMUM RATINGS

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

#### NOTES:

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

### PIN CONFIGURATIONS

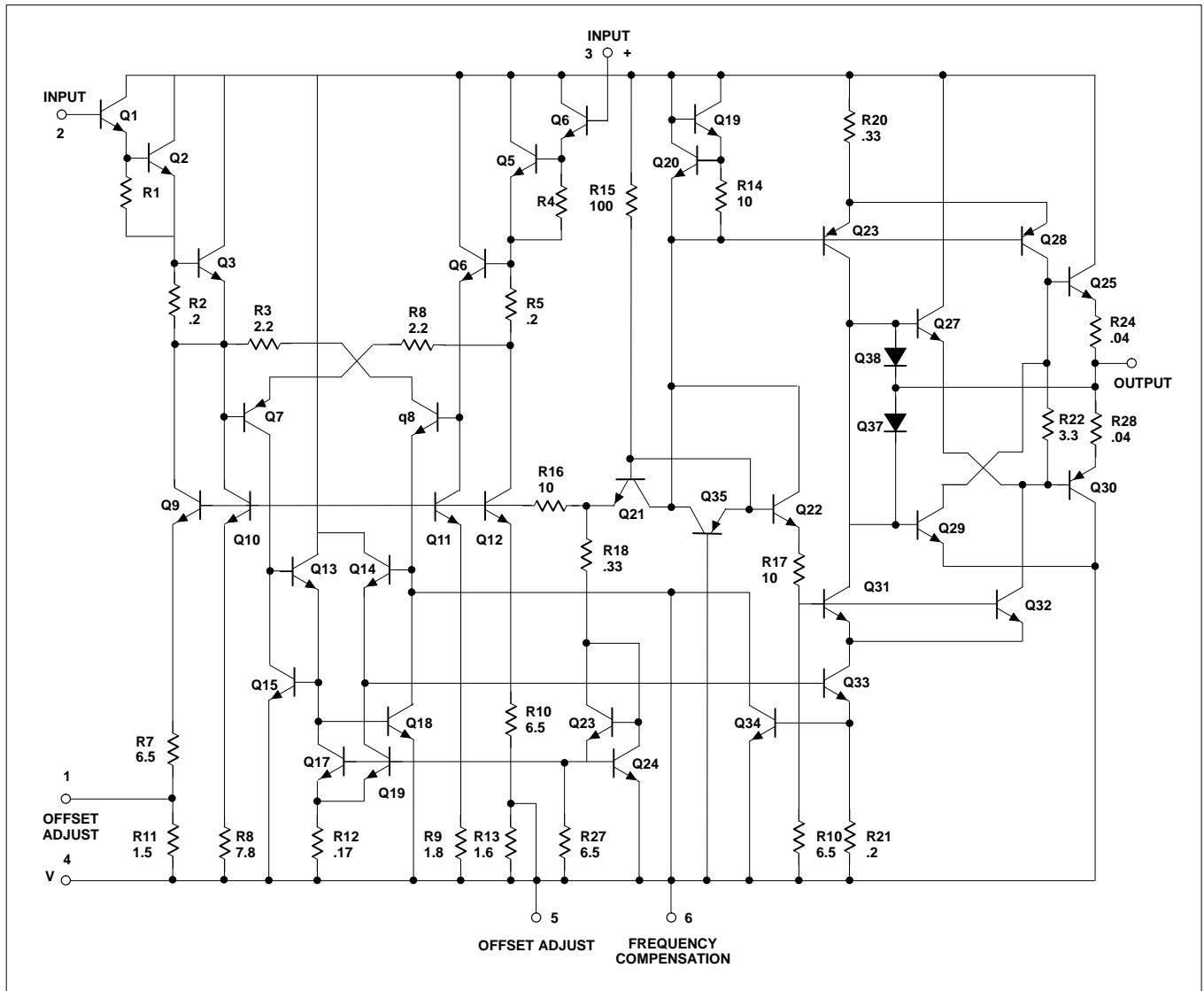


- Same low drift offset null circuitry as  $\mu$ A741
- Small-signal bandwidth 1MHz
- Large-signal bandwidth 500kHz
- True op amp DC characteristics make the 531 the ideal answer to all slew rate limited operational amplifier applications

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## EQUIVALENT SCHEMATIC



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**DC ELECTRICAL CHARACTERISTICS** $V_S = \pm 15V$ , unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	SE531			NE531			UNIT
			Min	Typ	Max	Min	Typ	Max	
$V_{OS}$	Offset voltage	$R_S \leq 10k\Omega$ , $T_A = 25^\circ C$ $R_S 310k\Omega$ , over temp		2.0	5.0 6.0		2.0	6.0 7.5	mV mV
$\Delta V_{OS}$		Over temp		10			10		$\mu V/^\circ C$
$I_{OS}$	Offset current	$T_A = 25^\circ C$ $T_A = \text{High}$ $T_A = \text{Low}$		30	200 200 500		50	200 200 300	nA nA nA
$\Delta I_{OS}$		Over temp		0.4			0.4		$nA/^\circ C$
$I_{BIAS}$	Input bias current	$T = 25^\circ C$ $T_A = \text{High}$ $T_A = \text{Low}$		300	500 500 1500		400	1500 1500 2000	nA nA nA
$\Delta I_{BIAS}$		Over temp		2			2		$nA/^\circ C$
$V_{CM}$	Common-mode voltage range	$T_A = 25^\circ C$	$\pm 10$			$\pm 10$			V
CMRR	Common-mode rejection ratio	$T_A = 25^\circ C$ , $R_S \leq 10k\Omega$ Over temp $R_S \leq 10k\Omega$	70	90		70	100		dB dB
$R_{IN}$	Input resistance	$T_A = 25^\circ C$		20			20		M $\Omega$
$V_{OUT}$	Output voltage swing	$R_L \geq 10k\Omega$ , over temp	$\pm 10$	$\pm 13$		$\pm 10$	$\pm 13$		V
$I_{CC}$	Supply current	$T_A = 25^\circ C$ $T_{MAX}$			7.0 7.0			10 10	mA mA
$P_D$	Power consumption	$T_A = 25^\circ C$			210			300	mW
PSRR	Power supply rejection ratio	$R_S \leq 10k\Omega$ , $T_A = 25^\circ C$ $R_S \leq 10k\Omega$ , over temp		10	150		10	150	$\mu V/V$ $\mu V/V$
$R_{OUT}$	Output resistance	$T_A = 25^\circ C$		75			75		$\Omega$
$A_{VOL}$	Large-signal voltage gain	$T_A = 25^\circ C$ , $R_L \geq 10k\Omega$ , $V_{OUT} = \pm 10V$	50	100		20	60		V/mV
		$R_L \geq 10k\Omega$ , $V_{OUT} = \pm 10V$ , over temp	25			15			V/mV
$V_{INN}$	Input noise voltage	$25^\circ C$ $f = 1kHz$		20			20		nV/ $\sqrt{Hz}$
$I_{SC}$	Short-circuit current	$25^\circ C$	5	15	45	5	15	45	mA

**AC ELECTRICAL CHARACTERISTICS** $T_A = 25^\circ C$   $V_S = +15V$ , unless otherwise specified.<sup>1</sup>

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%)	$A_V = +1$ , $V_{IN} = \pm 10V$		1.5			1.5		$\mu s$
				2.5			2.5		$\mu s$
	Large-signal overshoot	$A_V = +1$ , $V_{IN} = \pm 10V$		2			2		%
	Small-signal overshoot	$A_V = +1$ , $V_{IN} = 400mV$		5			5		%
$t_R$	Small-signal rise time	$A_V = +1$ , $V_{IN} = 400mV$		300			300		ns
SR	Slew rate	$A_V = 100$		35			35		V/ $\mu s$
		$A_V = 10$		35			35		V/ $\mu s$
		$A_V = 1$ (non-inverting)	20	30			30		V/ $\mu s$
		$A_V = 1$ (inverting)	25	35			35		V/ $\mu s$

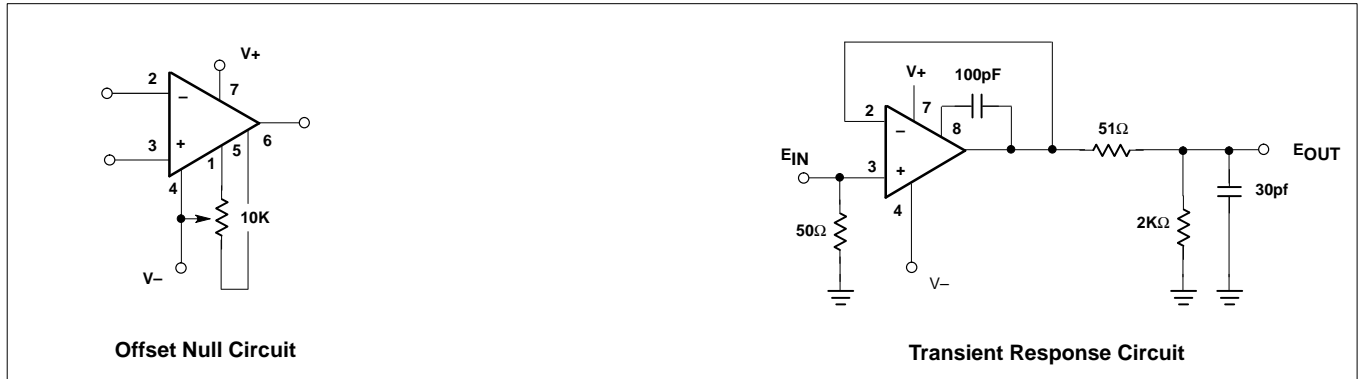
**NOTES:**

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

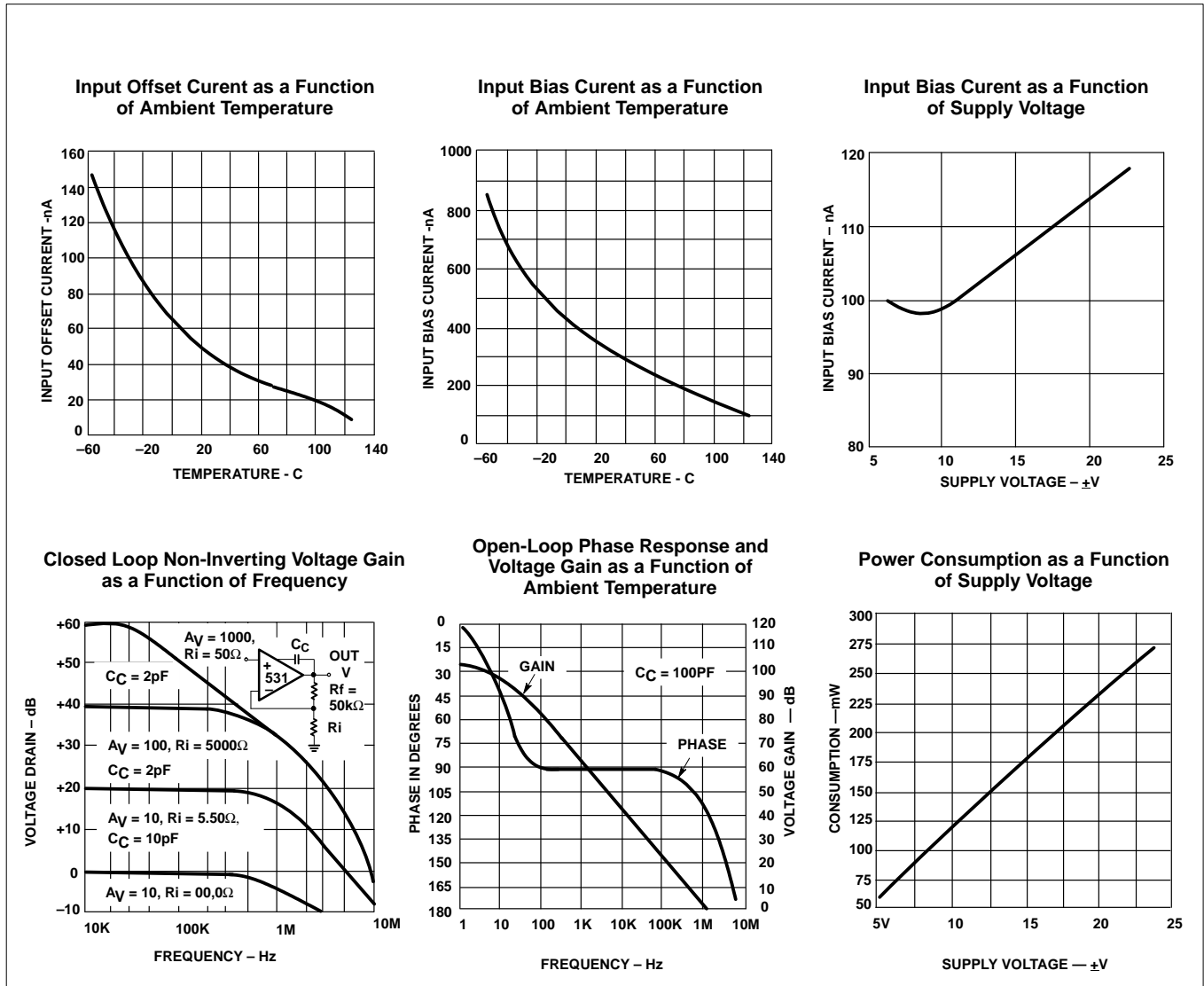
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## TEST LOAD CIRCUITS



## TYPICAL PERFORMANCE CHARACTERISTICS $V_S = +15V, T_A = +25^{\circ}C$ , unless otherwise specified.

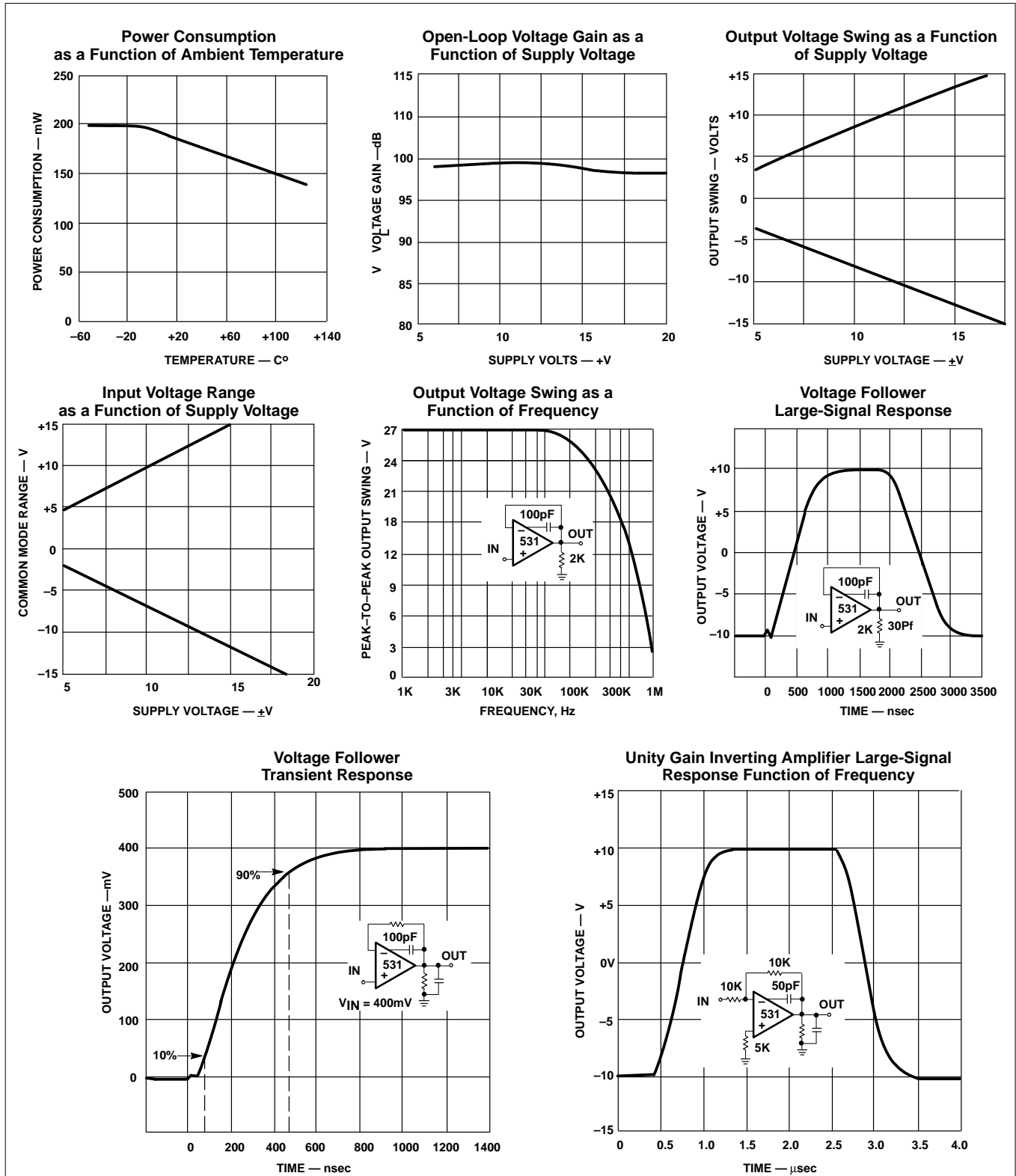


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## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

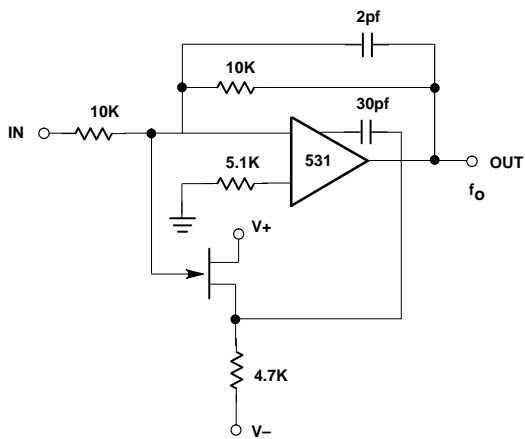
$V_S = +15V$ ,  $T_A = 25^\circ C$ , unless otherwise specified.



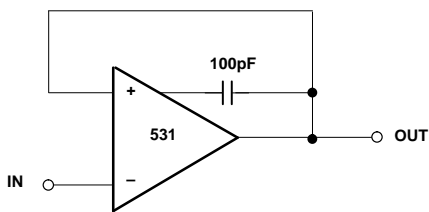
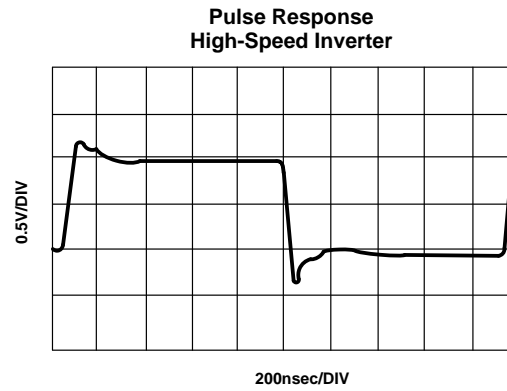
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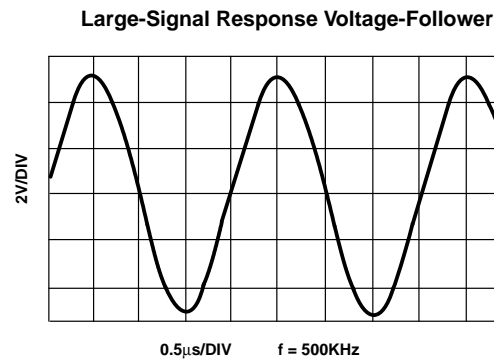
## TYPICAL APPLICATIONS



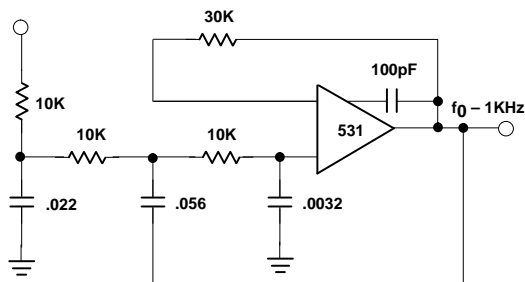
**High-Speed Inverter  
(10MHz Bandwidth)**



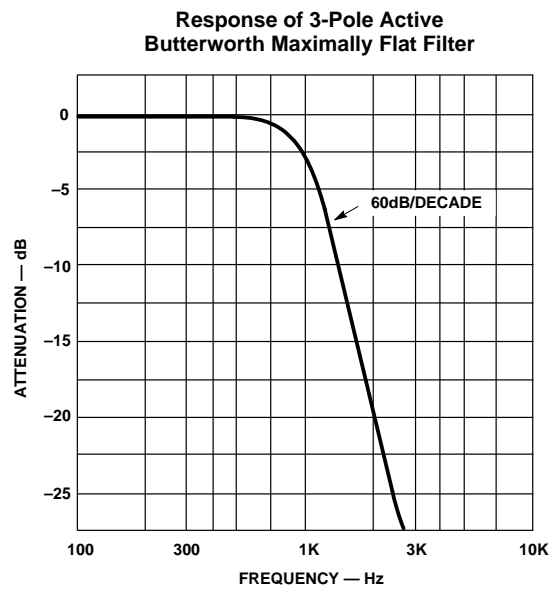
**Fast Settling Voltage-Follower**



**Large-Signal Response Voltage-Follower**



**Three-Pole Active Low-Pass Filter Butterworth Maximally Flat Response<sup>1</sup>**



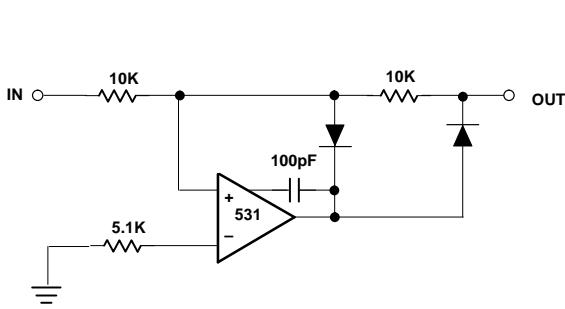
**Response of 3-Pole Active Butterworth Maximally Flat Filter**

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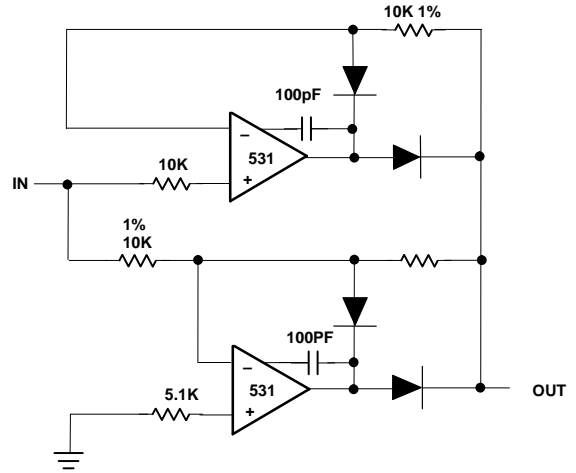
## NE/SE531

### TYPICAL APPLICATIONS (Continued)

#### Precision Rectifiers

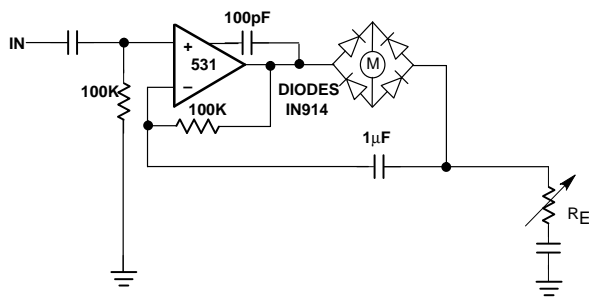


a. Half-Wave

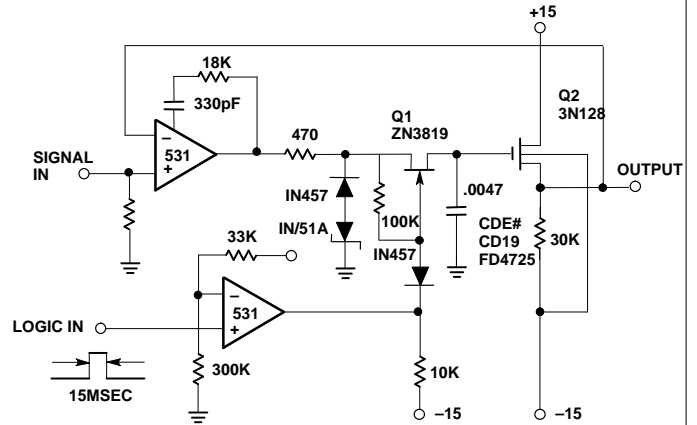


b. Full-Wave

#### AC Millivoltmeter



#### Sample-and-Hold



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## 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 5 $\mu$ s.

## 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:

$$f = \frac{1}{4RC} \cdot \frac{R2}{R1} \tag{1}$$

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.

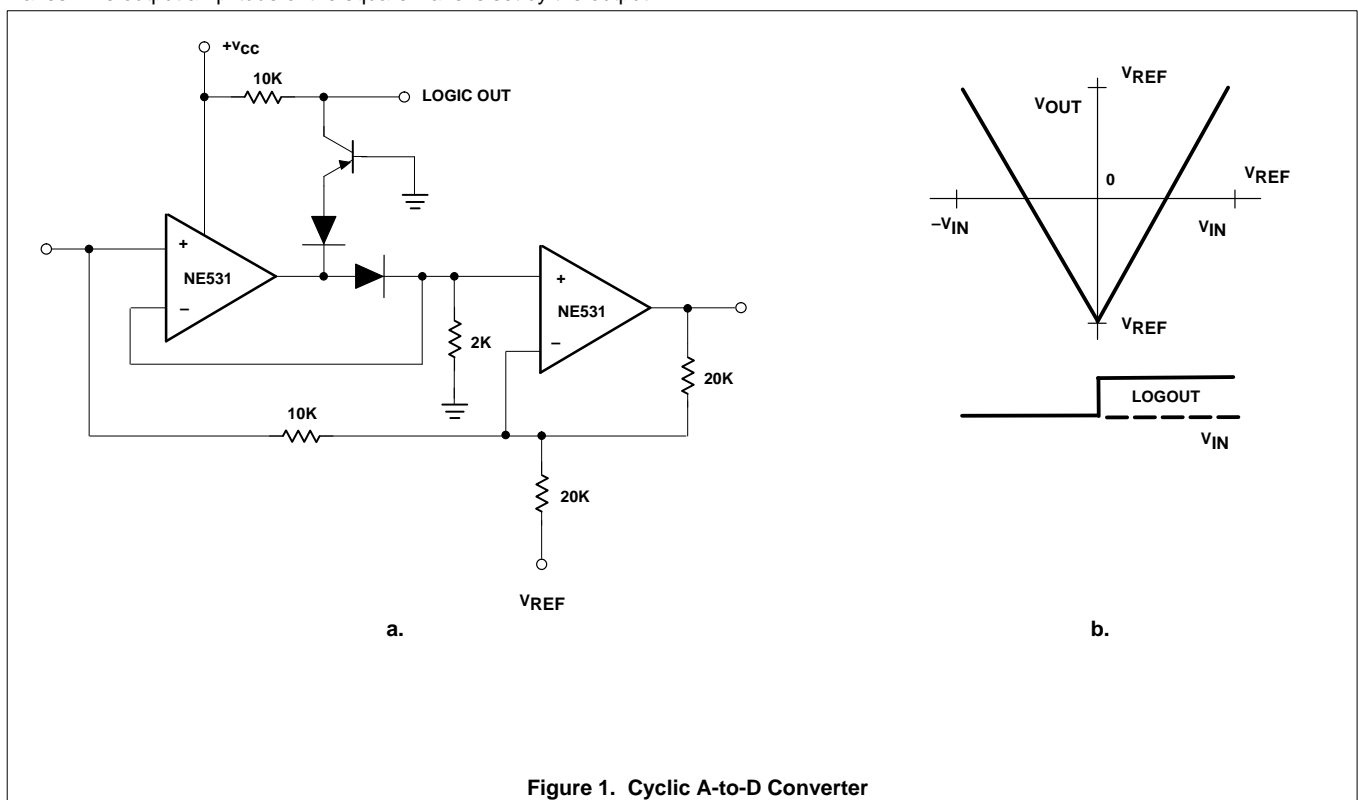


Figure 1. Cyclic A-to-D Converter