Signetics

NE/SE531
High Slew Rate Operational Amplifier

Product Specification

Linear Products

DESCRIPTION

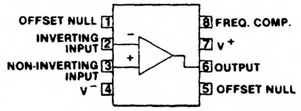
The 531 is a fast slewing high performance operational amplifier which retains DC performance equal to the best general purpose types while providing far superior large-signal AC performance. A unique input stage design allows the amplifier to have a large-signal response nearly identical to its small-signal 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/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**

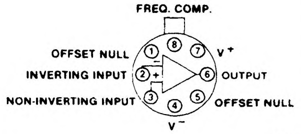
PIN CONFIGURATIONS

N, FE Packages



CD11771S

H Package[1]



CD11780S

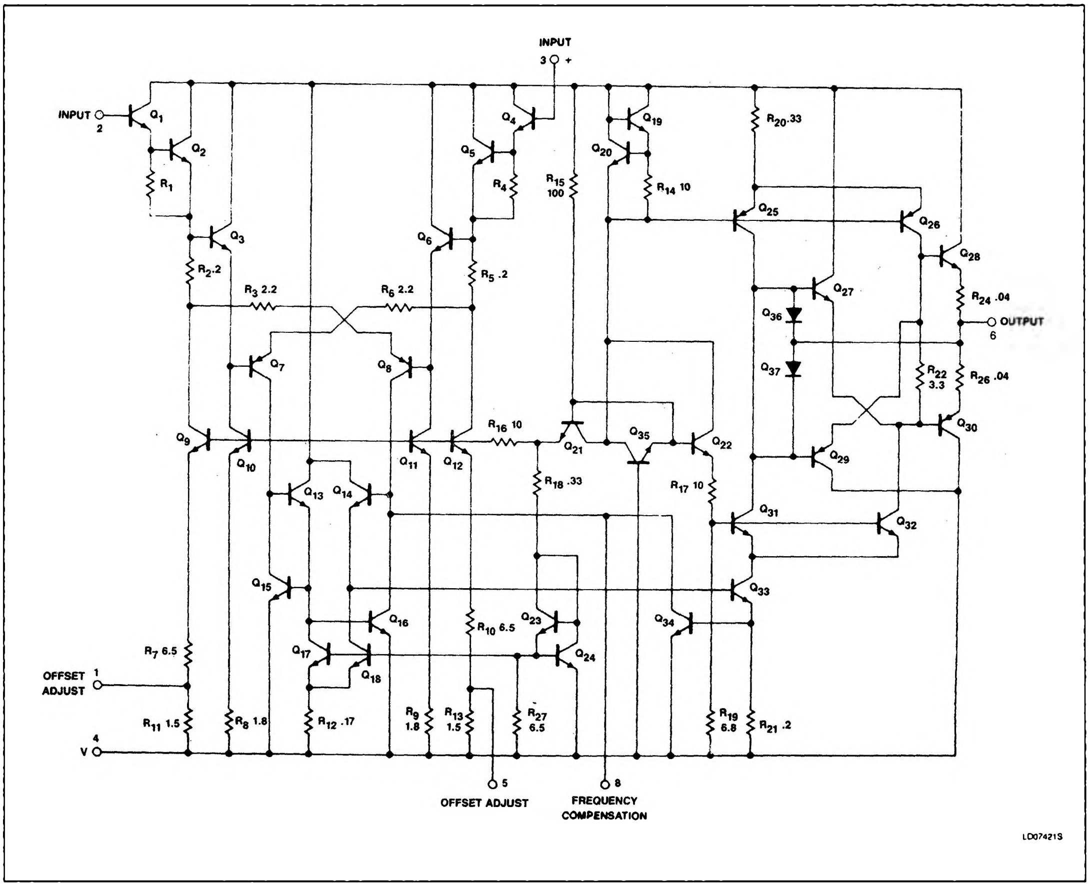
NOTE:
1. Metal cans (H) not recommended for new designs.

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 N package H package	 780 1160 830	 mW mW 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 SE531	 0 to +70 −55 to +125	 °C °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
   H package at 6.7mW/°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



ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE
8-Pin Plastic DIP	0 to +70°C	NE531N
8-Pin Ceramic DIP	0 to +70°C	NE531FE
8-Pin Metal Can	0 to +70°C	NE531H
8-Pin Ceramic DIP	-55°C to +125°C	SE531FE
8-Pin Metal Can	-55°C to +125°C	SE531H

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	$R_S \leq 10k\Omega$, $T_A = 25°C$		2.0	5.0		2.0	6.0	mV
		$R_S \leq 10k\Omega$, over temp			6.0			7.5	mV
ΔV_{OS}		Over temp		10			10		μV/°C
I_{OS}	Offset current	$T_A = 25°C$		30	200		50	200	nA
		T_A = High			200			200	nA
		T_A = Low			500			300	nA
ΔI_{OS}		Over temp		0.4			0.4		nA/°C
I_{BIAS}	Input bias current	$T = 25°C$		300	500		400	1500	nA
		T_A = High			500			1500	nA
		T_A = Low			1500			2000	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	$T_A = 25°C$, $R_S \leq 10k\Omega$				70	100		dB
		Over temp $R_S \leq 10k\Omega$	70	90					dB
R_{IN}	Input resistance	$T_A = 25°C$		20			20		MΩ
V_{OUT}	Output voltage swing	$R_L \geq 10k\Omega$, over temp	±10	±13		±10	±13		V
I_{CC}	Supply current	$T_A = 25°C$			7.0			10	mA
		T_{MAX}			7.0			10	mA
P_D	Power consumption	$T_A = 25°C$			210			300	mW
PSRR	Power supply rejection ratio	$R_S \leq 10k\Omega$, $T_A = 25°C$					10	150	μV/V
		$R_S \leq 10k\Omega$, over temp		10	150				μV/V
R_{OUT}	Output resistance	$T_A = 25°C$		75			75		Ω
A_{VOL}	Large-signal voltage gain	$T_A = 25°C$, $R_L \geq 10k\Omega$, $V_{OUT} = \pm 10V$	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°C, f = 1kHz		20			20		nV/√Hz
I_{SC}	Short-circuit current	25°C	5	15	45	5	15	45	mA

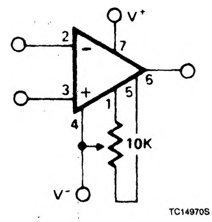
AC ELECTRICAL CHARACTERISTICS $T_A = 25°C$, $V_S = \pm 15V$, unless otherwise specified.[1]

SYMBOL	PARAMETER	TEST CONDITIONS	NE531			SE531			UNIT
			Min	Typ	Max	Min	Typ	Max	
BW	Full power bandwidth			500			500		kHz
t_S	Settling time (1%)	$A_V = +1$, $V_{IN} = \pm 10V$		1.5			1.5		μs
	(0.1%)			2.5			2.5		μs
	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/μs
		$A_V = 10$		35			35		V/μs
		$A_V = 1$ (non-inverting)		30		20	30		V/μs
		$A_V = 1$ (inverting)		35		25	35		V/μs

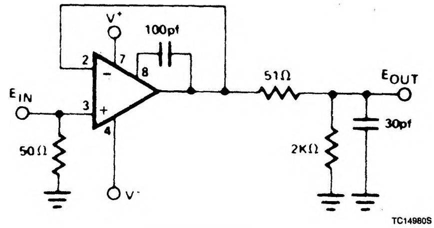
NOTE:

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

TEST LOAD CIRCUITS



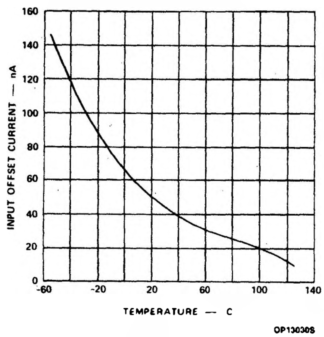
Offset Null Circuit



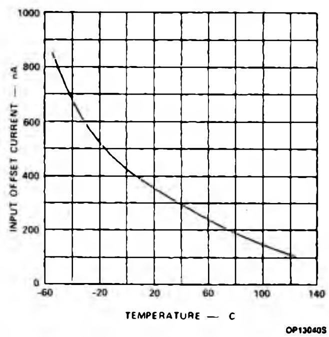
Transient Response Circuit

TYPICAL PERFORMANCE CHARACTERISTICS $V_S = \pm 15V$, $T_A = +25°C$, unless otherwise specified.

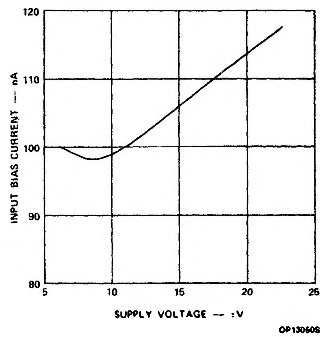
Input Offset Current as a Function of Ambient Temperature



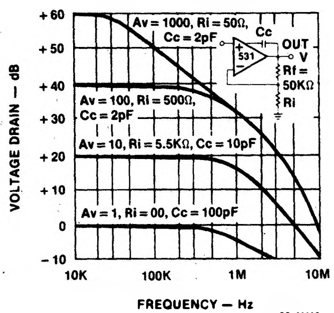
Input Bias Current as a Function of Ambient Temperature



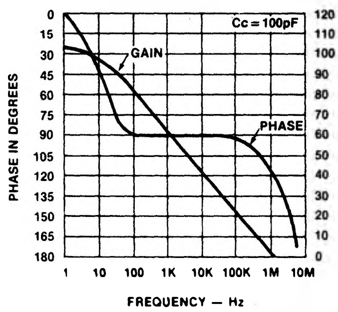
Input Bias Current as a Function of Supply Voltage



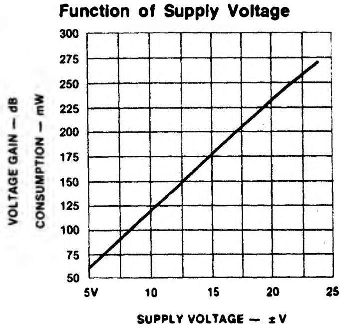
Closed-Loop Non-Inverting Voltage Gain as a Function of Frequency



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

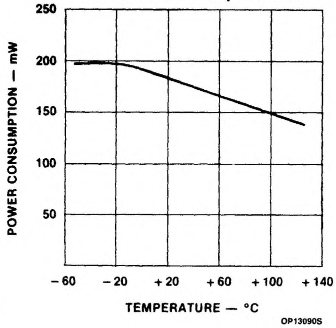


Power Consumption as a Function of Supply Voltage

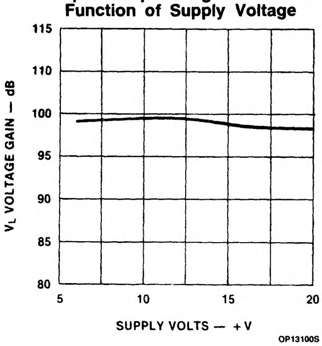


TYPICAL PERFORMANCE CHARACTERISTICS (Continued) $V_S = \pm 15V$, $T_A = +25°C$, unless otherwise specified.

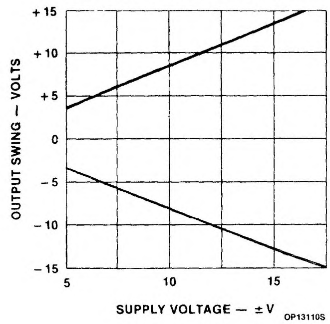
Power Consumption as a Function of Ambient Temperature



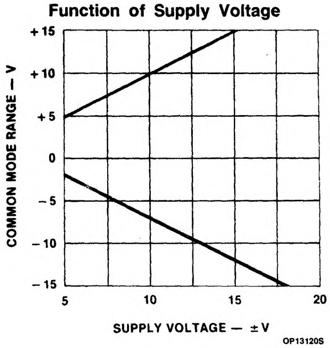
Open-Loop Voltage Gain as a Function of Supply Voltage



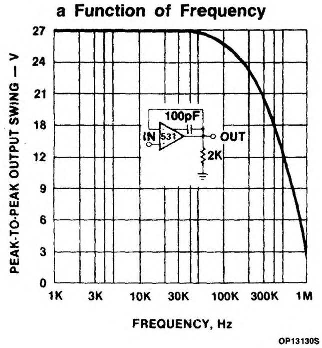
Output Voltage Swing as a Function of Supply Voltage



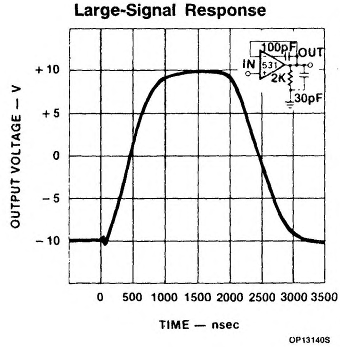
Input Voltage Range as a Function of Supply Voltage



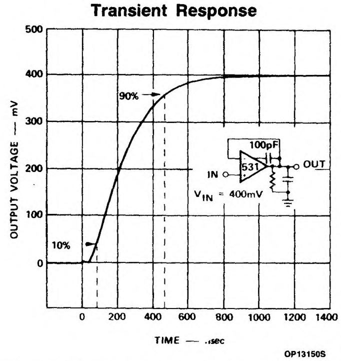
Output Voltage Swing as a Function of Frequency



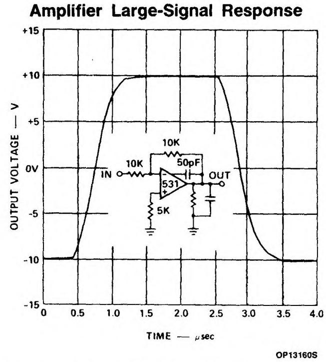
Voltage-Follower Large-Signal Response



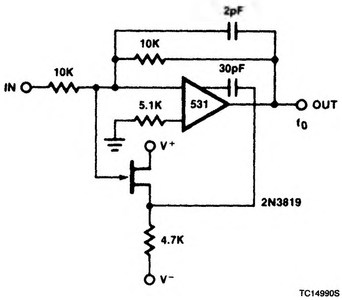
Voltage-Follower Transient Response



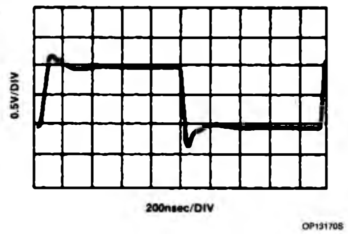
Unity Gain Inverting Amplifier Large-Signal Response



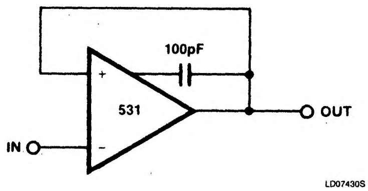
TYPICAL APPLICATIONS



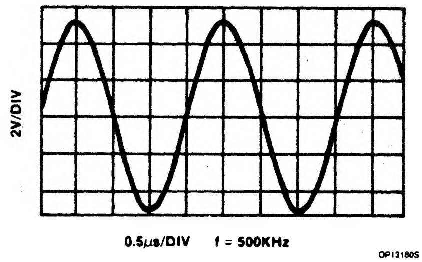
High-Speed Inverter (10MHz Bandwidth)



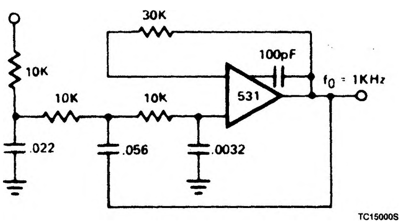
Pulse Response High-Speed Inverter

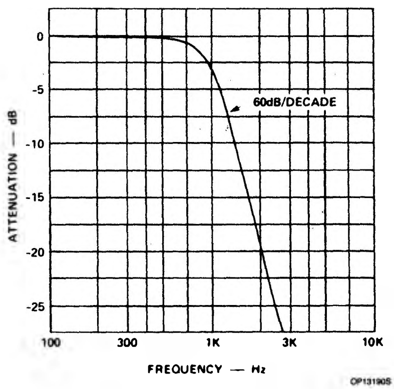


Fast Settling Voltage-Follower



Large-Signal Response Voltage-Follower



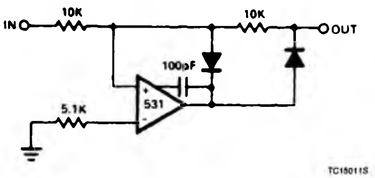


NOTES:
1. Reference — EDN Dec. 15, 1970
   Simplify 3-pole active filter design
   A. Paul Brokow

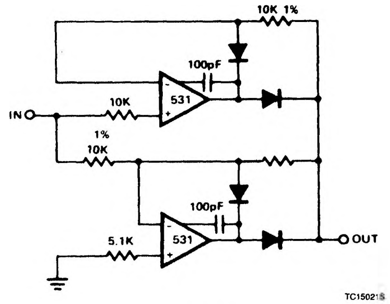
Three-Pole Active Low-Pass Filter Butterworth Maximally Flat Response[1]

Response of 3-Pole Active Butterworth Maximally Flat Filter

TYPICAL APPLICATIONS (Continued)

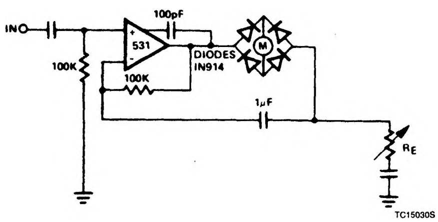


a. Half-Wave

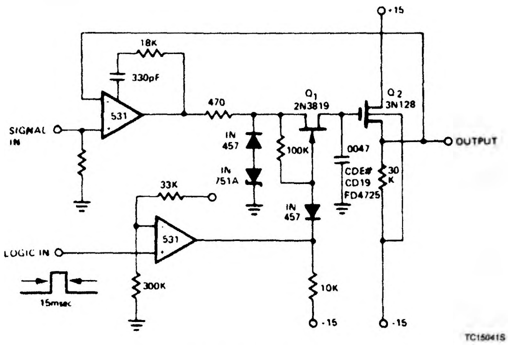


b. Full-Wave

Precision Rectifiers



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:

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

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.

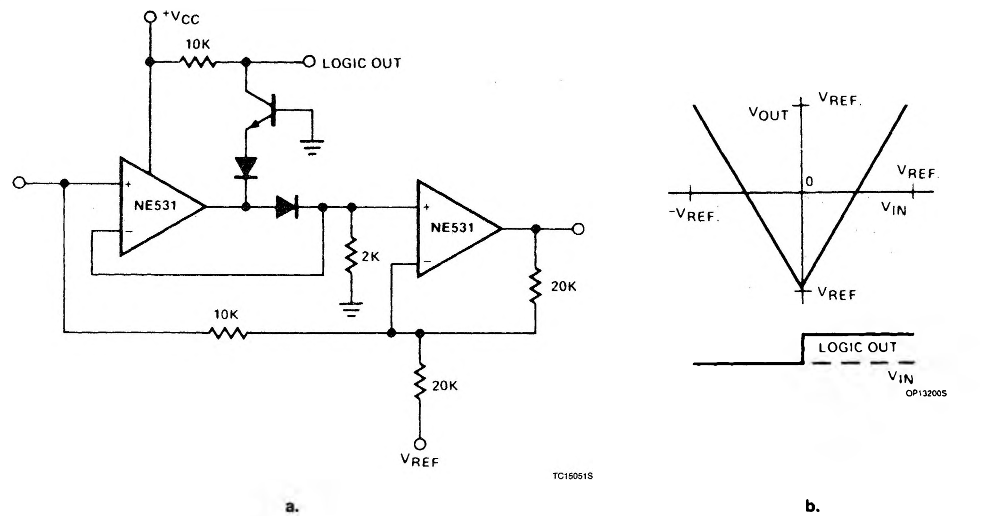


Figure 1. Cyclic A-to-D Converter

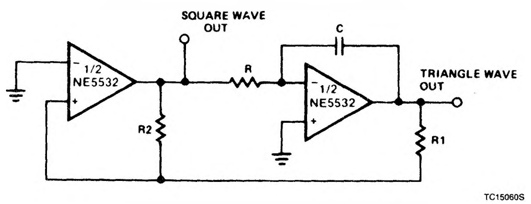


Figure 2. Triangle and Square Wave Generator