HIGH SLEW RATE OPERATIONAL AMPLIFIER SE/NE531

DESCRIPTION

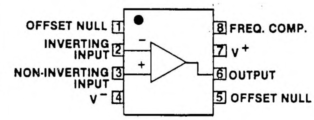
The 531 is a fast slewing high performance operational amplifier which retains dc performance equal to the best general purpose types while providing far superior large signal ac performance. A unique input stage design allows the amplifier to have a large signal response nearly identical to its small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

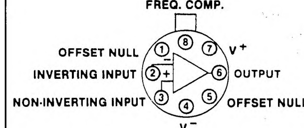


TOP VIEW

ORDER NUMBERS

NE531N SE531N
NE531FE SE531FE

H PACKAGE*

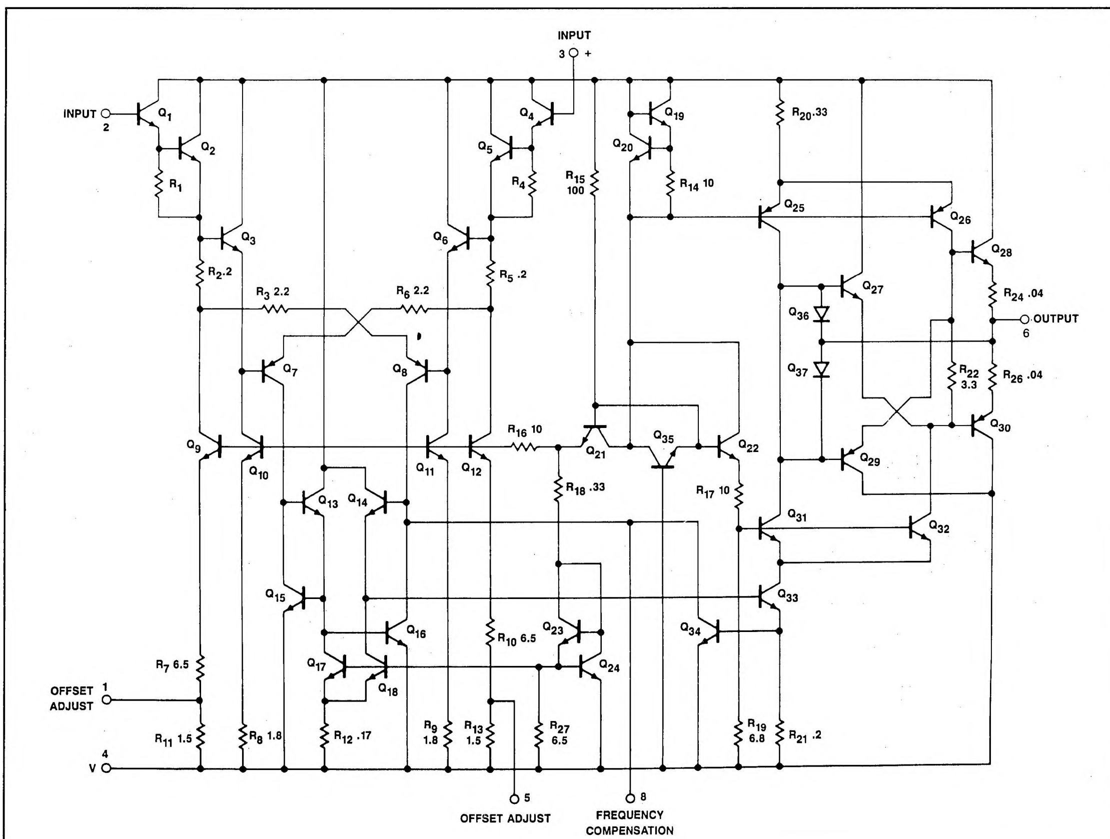


ORDER NUMBERS

NE531H/SE531H

*Metal cans (H) not recommended for new designs

EQUIVALENT SCHEMATIC



HIGH SLEW RATE OPERATIONAL AMPLIFIER — SE/NE531

ABSOLUTE MAXIMUM RATINGS

PARAMETER	RATING	UNIT
Supply voltage	±22	V
Internal power dissipation[1]	300	mW
Differential input voltage	±15	V
Common mode input voltage[2]	±15	V
Voltage between offset null and V-	±0.5	V
Operating temperature range		
NE531	0 to +70	°C
SE531	-55 to +125	°C
Storage temperature range	-65 to +150	°C
Lead temperature (soldering, 60 sec)	300	°C
Output short circuit duration[3]	indefinite	

NOTES

1. Rating applies for case temperature to 125°C, derate linearly at 6.5mW/°C for ambient temperatures above +75°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.

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

PARAMETER		TEST CONDITIONS	SE531[1]			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		$\mu V/°C$
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 current	$T_A = 25°C$		300	500		400	1500	nA
		$T_A =$ HIGH			500			1500	nA
		$T_A =$ LOW			1500			2000	nA
ΔI_B		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	$\mu V/V$
		$R_S \leq 10k\Omega$, over temp		10	150				$\mu V/V$
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		$nV/\sqrt{Hz}$
I_{SC}		25°C	5	15	45	5	15	45	mA

NOTE:
1. Temperature range:
   SE531 $-55°C \leq T_A \leq 125°C$
   NE531 $0°C \leq T_A \leq 70°C$

HIGH SLEW RATE OPERATIONAL AMPLIFIER

AC ELECTRICAL CHARACTERISTICS $T_A = 25°C$, $V_S = \pm15V$ unless otherwise specified.

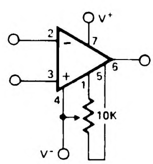
PARAMETER	TEST CONDITIONS	NE531 Min	NE531 Typ	NE531 Max	SE531 Min	SE531 Typ	SE531 Max	UNIT
Full power bandwidth			500			500		kHz
Settling time (1%) (.1%)	$A_V = +1$, $V_{IN} = \pm10V$		1.5 2.5			1.5 2.5		μs μs
Large signal overshoot Small signal overshoot	$A_V = +1$, $V_{IN} = \pm10V$ $A_V = +1$, $V_{IN} = 400mV$		2 5			2 5		% %
Small signal risetime	$A_V = +1$, $V_{IN} = 400mV$		300			300		ns
Slew rate	$A_V = 100$ $A_V = 10$ $A_V = 1$ (noninverting) $A_V = 1$ (inverting)		35 35 30 35		 20 25	35 35 30 35		V/μs V/μs V/μs V/μs

NOTE

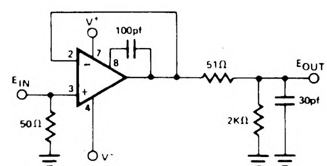
1. All AC testing is performed in the transient response test circuit.

TEST LOAD CIRCUITS

OFFSET NULL CIRCUIT

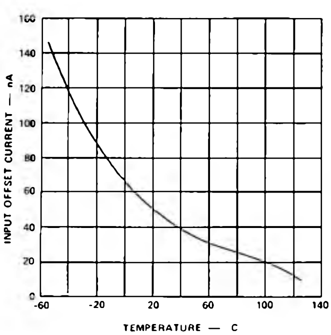


TRANSIENT RESPONSE CIRCUIT

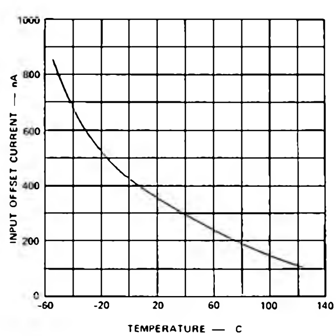


TYPICAL PERFORMANCE CHARACTERISTICS ($V_S = \pm15V$, $T_A = +25°C$, unless otherwise specified.)

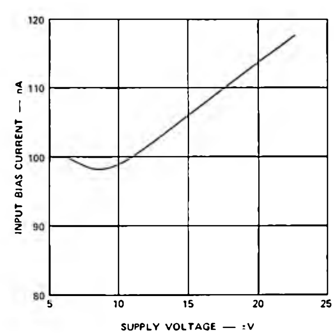
INPUT OFFSET CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



INPUT BIAS CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE

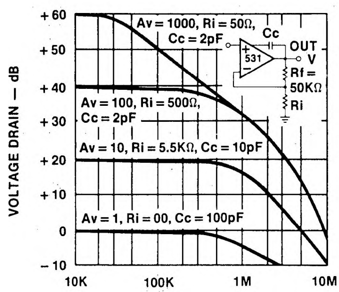


INPUT BIAS CURRENT AS A FUNCTION OF SUPPLY VOLTAGE

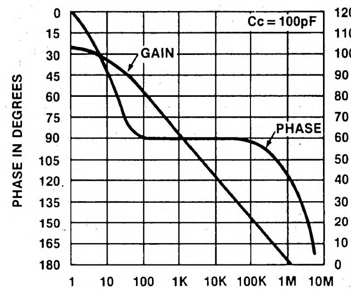


TYPICAL PERFORMANCE CHARACTERISTICS (Cont'd)

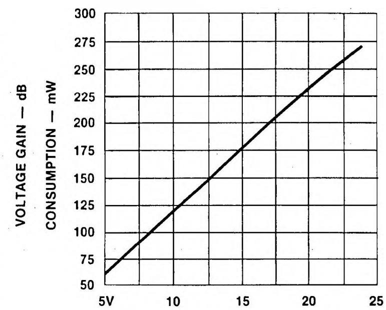
CLOSED LOOP NON-INVERTING VOLTAGE GAIN AS A FUNCTION OF FREQUENCY



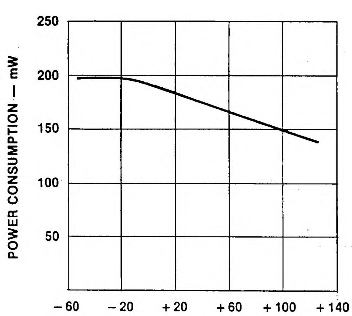
OPEN LOOP PHASE RESPONSE AND VOLTAGE GAIN AS A FUNCTION OF FREQUENCY



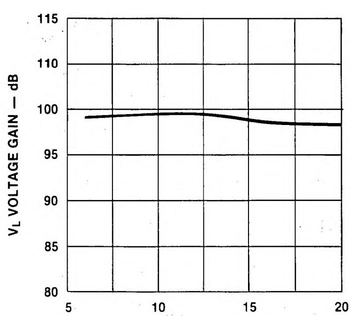
POWER CONSUMPTION AS A FUNCTION OF SUPPLY VOLTAGE



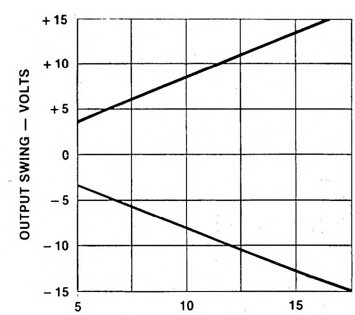
POWER CONSUMPTION AS A FUNCTION OF AMBIENT TEMPERATURE



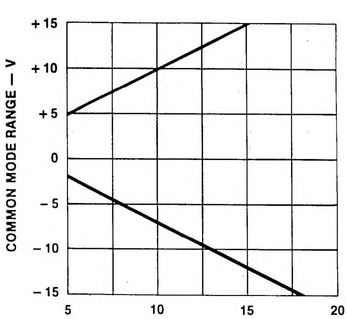
OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF SUPPLY VOLTAGE



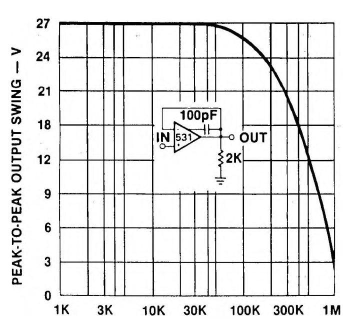
OUTPUT VOLTAGE SWING AS A FUNCTION OF SUPPLY VOLTAGE



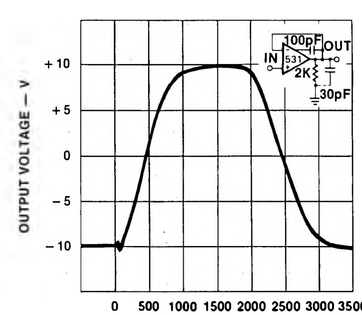
INPUT VOLTAGE RANGE AS A FUNCTION OF SUPPLY VOLTAGE



OUTPUT VOLTAGE SWING AS A FUNCTION OF FREQUENCY

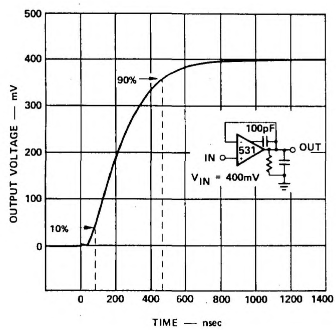


VOLTAGE FOLLOWER LARGE SIGNAL RESPONSE

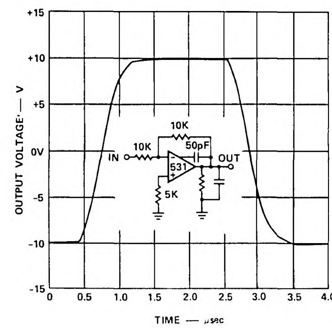


TYPICAL PERFORMANCE CHARACTERISTICS (Cont'd)

VOLTAGE FOLLOWER TRANSIENT RESPONSE

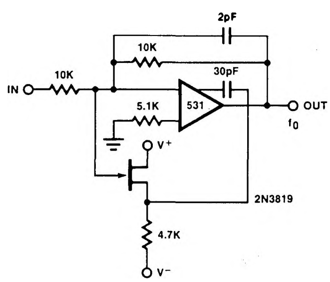


UNITY GAIN INVERTING AMPLIFIER LARGE SIGNAL RESPONSE

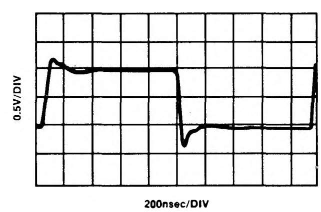


TYPICAL APPLICATIONS

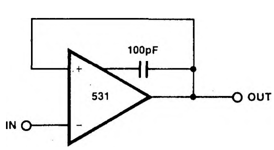
HIGH SPEED INVERTER (10MHz BANDWIDTH)



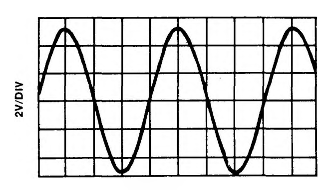
PULSE RESPONSE HIGH SPEED INVERTER



FAST SETTLING VOLTAGE FOLLOWER



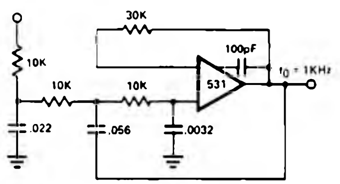
LARGE SIGNAL RESPONSE VOLTAGE FOLLOWER



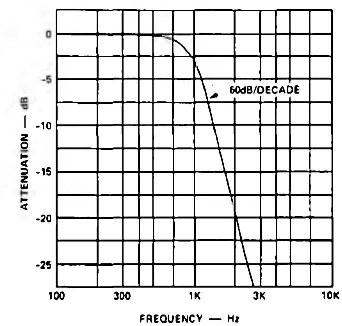
HIGH SLEW RATE OPERATIONAL AMPLIFIER SE/NE531

TYPICAL APPLICATIONS (Cont'd)

THREE POLE ACTIVE LOW PASS FILTER BUTTERWORTH MAXIMALLY FLAT RESPONSE*



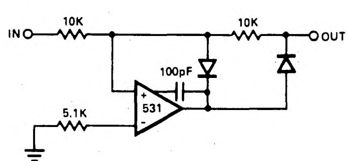
RESPONSE OF 3-POLE ACTIVE BUTTERWORTH MAXIMALLY FLAT FILTER



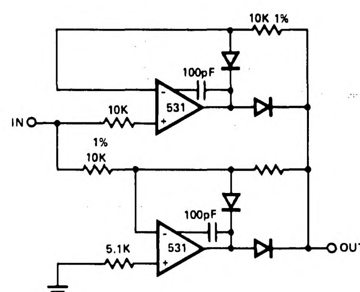
*Reference—EDN Dec. 15, 1970
Simplify 3-Pole Active Filter Design
A. Paul Brokow

PRECISION RECTIFIERS

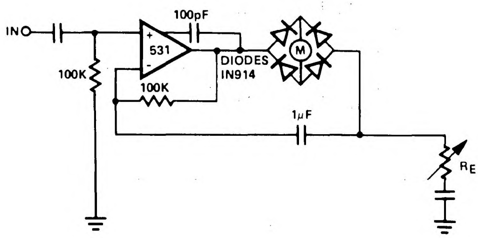
(a) HALF WAVE



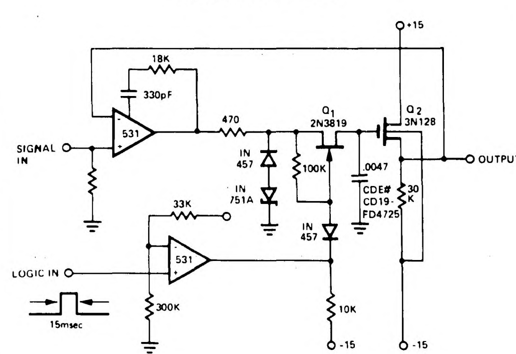
(b) FULL WAVE



AC MILLIVOLTMETER



SAMPLE AND HOLD



HIGH SLEW RATE OPERATIONAL AMPLIFIER — SE/NE531

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 the op amp A-1 and R1/R2 sets the triangle amplitude. The frequency of oscillation in either case is

$$f = \frac{1}{4RC} \cdot \frac{R2}{R1} \qquad (3\text{-}23)$$

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.

CYCLIC A TO D CONVERTER

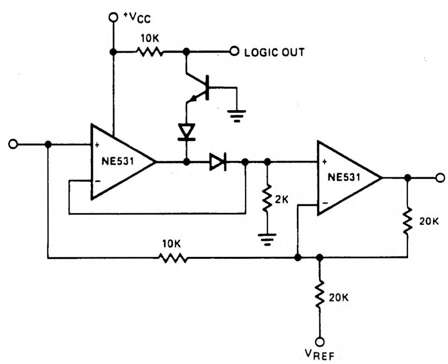


Figure 1a

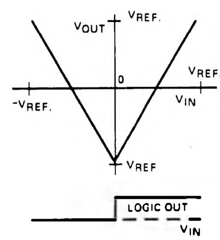


Figure 1b

TRIANGLE AND SQUARE WAVE GENERATOR

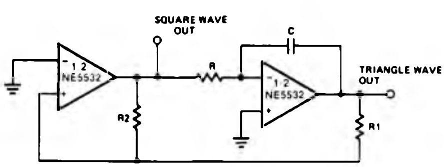


Figure 2