NE/SE5535 Dual High Slew Rate Op Amp

Product Specification

DESCRIPTION

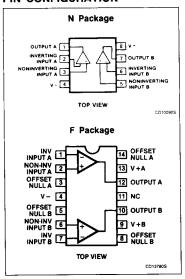
The NE/SE5535 is a new generation operational amplifier featuring high slew rates combined with improved input characteristics. The 5535 is a dual configuration. Internally compensated for unity gain, the SE5535 features a guaranteed unity gain slew rate of 10V/µs with 4mV maximum offset voltage. Industry standard pinout and internal compensation allow the user to upgrade system performance by directly replacing general purpose amplifiers, such as 747 and 1558.

FEATURES

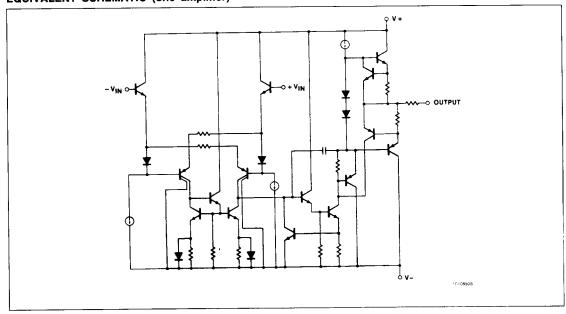
- 15V/μs unity gain slew rate
- Internal frequency compensation
- Low input offset voltage 2mV
- Low input bias current 80nA max
- Short-circuit protected
- Large common-mode and differential voltage ranges

- Pin compatibility 747,1558
- Dual configuration
- Low noise current 0.15pA/√ Hz typ.

PIN CONFIGURATION



EQUIVALENT SCHEMATIC (one amplifier)



NE/SE5535

ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE NE5535N			
8-Pin Plastic DIP	0 to +70°C				
8-Pin Plastic DIP	-55°C to +125°C	SE5535N			
14-Pin Cerdip	0 to +70°C	NE5535F			
14-Pin Cerdip	-55 to +125°C	SE5535F			

ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	SE5535	NE5535	UNIT	
Vs	Supply voltage	± 22	± 18		
P _D	Internal power dissipation ¹ N package F package	1275 1250	1275 1250	mW mW	
V _{IN}	Differential input voltage	± 30	± 30	v	
VIN	Input voltage ²	± 15	± 15	V	
T _A	Operating temperature range	-55 to +125	0 to +70	°C	
T _{STG}	Storage temperature range	-65 to +150	-65 to +150 -65 to +150		
T _{SOLD}	Lead soldering temperature (10sec max)	300	300 300		
Isc	Output short-circuit ³	Indefinite	Indefinite		

NOTES:

Rating applies at T_A = 25°C for thermal resistances junction to ambient of 98°C/W and 100°C/W for N and F packages, respectively. Maximum junction temperature is 150°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 75°C ambient temperature.

DC ELECTRICAL CHARACTERISTICS $T_A = 25^{\circ}C$, $V_S = \pm 15V$, unless otherwise specified.*

SYMBOL	PARAMETER	TEST CONDITIONS	SE5535			NE5535			
			Min	Тур	Max	Min	Тур	Max	UNIT
Vos	input offset voltage	$R_S \le 10k\Omega$ $R_S \le 10k\Omega$, over temp.		0.7	4.0 5.0		2.0	6.0 7.0	mV mV
$\Delta V_{OS}/\Delta T$		$R_S = 0\Omega$, over temp.		4.0			6.0		μV/°C
los	Input offset current	Over temp.		5	20 40		15	40 80	nA nA
$\Delta l_{OS}/\Delta T$		Over temp.		25			40		pA/°C
I _B	Input bias current	Over temp.		45	80 200		65	150 200	nA nA
$\Delta I_B/\Delta T$		Over temp.		50			80		pA/°C
V _{CM}	Common-mode voltage range		± 12	± 13		± 12	± 13		٧
CMRR	Common-mode rejection ratio	$R_S \le 10 k\Omega$, over temp.	70	90		70	90		dΒ
PSRR	Power supply rejection ratio	$R_S \le 10k\Omega$, over temp.		30	150		30	150	μV/V
R _{IN}	Input resistance		3	10		1	6		МΩ
A _{VOL}	Large-signal voltage gain	$\begin{aligned} R_L &\geqslant 2k\Omega, \ V_{OUT} = \pm10V \\ R_L &= 2k\Omega, \ V_{OUT} = \pm10V, \\ \text{over temp.} \end{aligned}$	50 25	500		50 25	500	l	V/mV V/mV
V _{OUT}	Output voltage	$R_L \geqslant 2k\Omega$, over temp. $R_L \geqslant 10k\Omega$, over temp.	± 10 ± 12	± 13 ± 14		± 10 ± 12	± 13 ± 14		V
lcc	Supply current	Per amplifier Per amplifier, over temp.		1.8 2	2.8 3.3		1.8 2	2.8	mA mA
PD	Power dissipation	Per amplifier Per amplifier, over temp.		54 60	84 99		54 60	84	mW mW
Isc	Output short-circuit current		10	25	50	10	25	50	mA
Rout	Output resistance			100			100		Ω

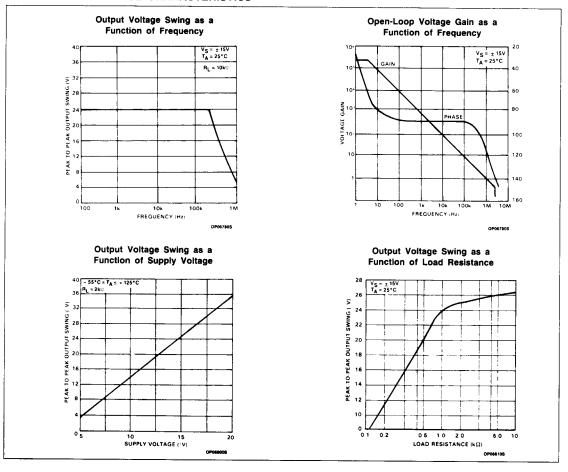
NOTE:

AC ELECTRICAL CHARACTERISTICS $T_A = 25^{\circ}C$, unless otherwise specified.

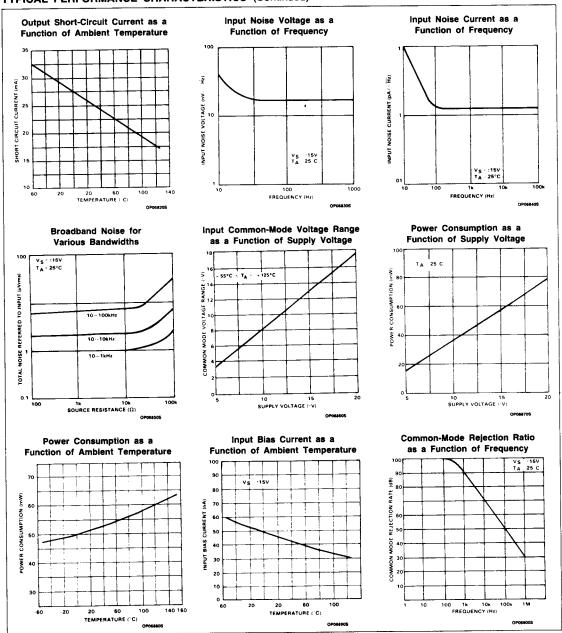
SYMBOL	PARAMETER		SE5535			NE5535			UNIT
		TEST CONDITIONS		Тур	Max	Min	Тур	Max	UNIT
GBW	Gain bandwidth product			1			1		MHz
t _R t _S SR	Transient response Small-signal rise time Small-signal overshoot Settling time Slew rate	To 0.1% $R_L \geqslant 10kΩ, \text{ unity gain, non-inverting}$	10_	0.25 6 3 15		10	0.25 6 3 15		μs % μs V/μs
	Input noise voltage	f = 1kHz, T _A = 25°C		30			30		nV/√H:

^{*} Temperature range: SE types -55°C ≤ T_A ≤ 125°C NE types 0°C ≤ T_A ≤ 70°C

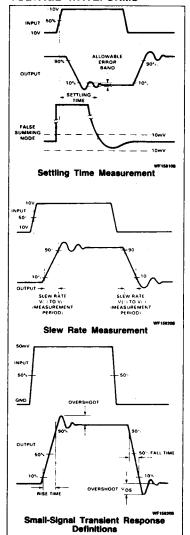
TYPICAL PERFORMANCE CHARACTERISTICS



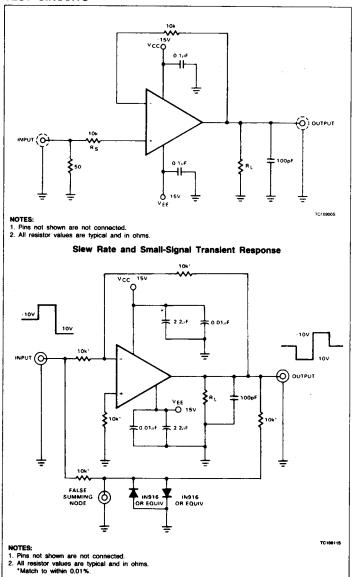
TYPICAL PERFORMANCE CHARACTERISTICS (Continued)



VOLTAGE WAVEFORMS



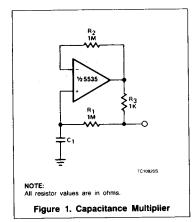
TEST CIRCUITS



Settling Time

INTRODUCTION

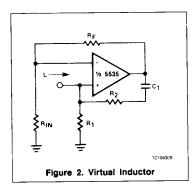
The NE5535 is a new generation monolithic op amp which features improved input characteristics. The device is compensated to unity gain and has a minimum guaranteed unity gain slew rate of $10V\mu s$. This is achieved by employing a clamped super beta input stage which has lower input bias current.

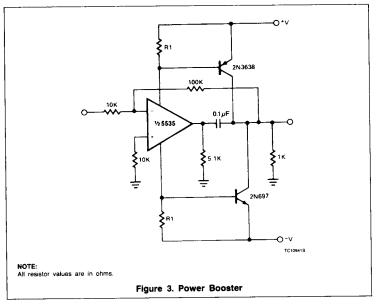


APPLICATIONS

These improved parameters can be put to good use in applications such as sample and hold circuits which require low input current and in voltage-follower circuits which require high slew rates. The circuit that follows will yield maximum small-signal transient response and slew rate for the NE5535 at unity gain.

It is always good practice in designing a system to use dual tracking regulators to power the dual-supply op amps. This will





guarantee the positive and negative supply voltage will be equal during power-up. With the NE5535, it is possible to degrade the input circuit characteristics by not applying the power supplies simultaneously. The NE5535 is capable of directly replacing the μ A741 with higher input resistance which will improve such designs as active filters, sample and hold, as well as voltage-followers.

The NE5535 can be used either with single or split power supplies.

Capacitance Multiplier

The circuit in Figure 1 can be used to simulate large capacitances using small value components. With the values shown and $C=10\mu F,$ an effective capacitance of $10,000\mu F$ was obtained. The Q available is limited by the effective series resistance. So R1 should be as large as practical.

Simulated Inductor

With a constant current excitation, the voltage dropped across an inductance increases with frequency. Thus, an active device whose output increases with frequency can be characterized as an inductance. The circuit of Figure 2 yields such a response with the effective inductance being equal to: $L = R_1 R_2 C$

The Q of this inductance depends upon R_1 being equal to R_2 . At the same time, however, the positive and negative feedback paths of the amplifier are equal leading to the distinct

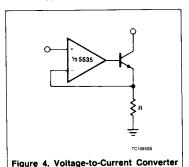
possibility of instability at high frequencies. R_1 should therefore always be slightly smaller than R_2 to assure stable operation.

Power Amplifier

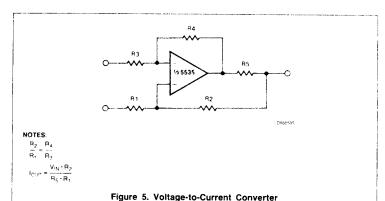
For most applications, the available power from op amps is sufficient. There are times when more power handling capability is necessary. A simple power booster capable of driving moderate loads is offered in Figure 3.

The circuit as shown uses an NE5535 device. Other amplifiers may be substituted only if R_1 values are changed because of the I_{CC} current required by the amplifier. R_1 should be calculated from the expression

$$R_1 = \frac{600 \text{mV}}{I_{CC}}$$



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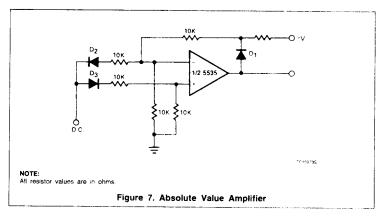
0 - IV CLAMP -0.6) = 2.4 V

0 - (V CLAMP -0.6) = 2.4 V

Vout

Totageos

Figure 6. Active Clamp-Limiting Amplifier



Voltage-to-Current Converters

A simple voltage-to-current converter is shown in Figure 4. The current out is $I_{OUT}\cong V_{IN}/R$. For negative currents, a PNP can be used and, for better accuracy, a Darlington pair can be substituted for the transistor. With careful design, this circuit can be used to control currents of many amps. Unity gain compensation is necessary.

The circuit in Figure 5 has a different input and will produce either polarity of cutput current. The main disadvantages are the error current flowing in $\rm R_2$ and the limited current available.

Active Clamp-Limiting Amplifier

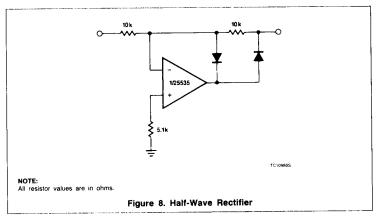
The modified inverting amplifier in Figure 6 uses an active clamp to limit the output swing with precision. Allowance must be made for the VBE of the transistors. The swing is limited by the base-emitter breakdown of the transistors. A simple circuit uses two back-to-back zener diodes across the feedback resistor, but tends to give less precise limiting and cannot be easily controlled.

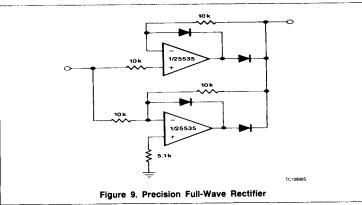
Absolute Value Amplifier

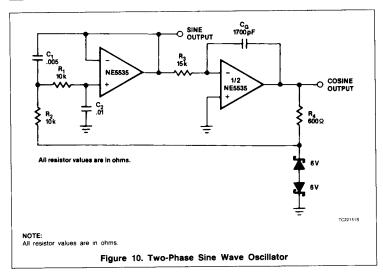
The circuit in Figure 7 generates a positive output voltage for either polarity of input. For positive signals, it acts as a noninverting amplifier and for negative signals, as an inverting amplifier. The accuracy is poor for input voltages under 1V, but for less stringent applications, it can be effective.

Half-Wave Rectifier

Figure 8 provides a circuit for accurate half-wave rectification of the incoming signal. For positive signals, the gain is 0; for negative signals, the gain is -1. By reversing both diodes, the polarity can be inverted. This circuit provides an accurate output, but the output impedance differs for the two input polarities and buffering may be needed. The output must slew through two diode drops when the input polarity reverses. The NE5535 device will work up to 10kHz with less than 5% distortion.







Precision Full-Wave Rectifier

The circuit in Figure 9 provides accurate full-wave rectification. The output impedance is low for both input polarities, and the errors are small at all signal levels. Note that the output will not sink heavy currents, except a small amount through the $10 k\Omega$ resistors. Therefore, the load applied should be referenced to ground or a negative voltage. Reversal of all diode polarities will reverse the polarity of the output. Since the outputs of the amplifiers must slew through two diode drops when the input polarity changes, 741 type devices give 5% distortion at about 300Hz.

Two-Phase Sine Wave Oscillator

The circuit (refer to Figure 10) uses a 2-pole pass Butterworth, followed by a phase-shifting single-pole stage, fed back through a voltage limiter to achieve sine and cosine outputs. The values shown using the μ A741 amplifiers give about 1.5% distortion at the sine output and about 3% distortion at the cosine output. By careful trimming of C_G and/or the limiting network, better distortion figures are possible. The component values shown give a frequency of oscillation of about 2kHz. The values can be readily selected for other frequencies. The NE5535 should be used at higher frequencies to reduce distortion due to slew limiting.