

# NE5534, NE5534A, SE5534, SE5534A LOW-NOISE OPERATIONAL AMPLIFIERS

SLOS070 – JULY 1979 – REVISED SEPTEMBER 1990

- **Equivalent Input Noise Voltage**  
3.5 nV/ $\sqrt{\text{Hz}}$
- **Unity-Gain Bandwidth . . . 10 MHz Typ**
- **Common-Mode Rejection Ratio**  
100 dB Typ
- **High DC Voltage Gain . . . 100 V/mV Typ**
- **Peak-to-Peak Output Voltage Swing**  
32 V Typ With  $V_{CC\pm} = \pm 18 \text{ V}$  and  $R_L = 600 \Omega$
- **High Slew Rate . . . 13 V/ $\mu\text{s}$  Typ**
- **Wide Supply Voltage Range  $\pm 3 \text{ V}$  to  $\pm 20 \text{ V}$**
- **Low Harmonic Distortion**
- **Designed to Be Interchangeable With**  
Signetics NE5534, NE5534A, SE5534,  
and SE5534A

## description

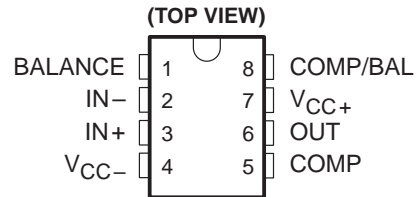
The NE5534, NE5534A, SE5534, and SE5534A are monolithic high-performance operational amplifiers combining excellent dc and ac characteristics. Some of the features include very low noise, high output drive capability, high unity-gain and maximum-output-swing bandwidths, low distortion, and high slew rate.

These operational amplifiers are internally compensated for a gain equal to or greater than three. Optimization of the frequency response for various applications can be obtained by use of an external compensation capacitor between COMP and COMP/BAL. The devices feature input-protection diodes, output short-circuit protection, and offset-voltage nulling capability.

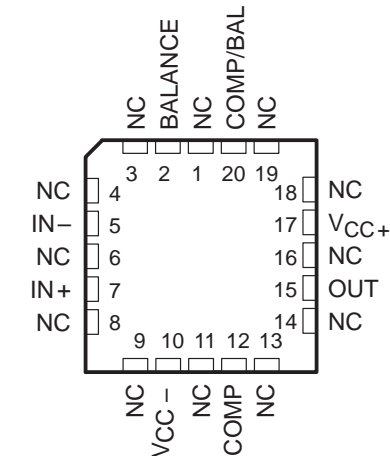
For the NE5534A, a maximum limit is specified for equivalent input noise voltage.

The NE5534 and NE5534A are characterized for operation from 0°C to 70°C. The SE5534 and SE5534A are characterized for operation over the full military temperature range of –55°C to 125°C.

NE5534, NE5534A . . . D OR P PACKAGE  
SE5534, SE5534A . . . JG PACKAGE

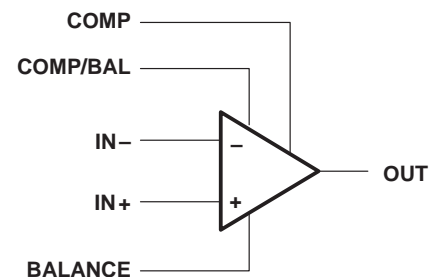


SE5534, SE5534A . . . FK PACKAGE  
(TOP VIEW)



NC – No internal connection

## symbol



**SE5534A FROM TI NOT RECOMMENDED  
FOR NEW DESIGNS**

## AVAILABLE OPTIONS

T <sub>A</sub>	V <sub>IO</sub> max AT 25°C	PACKAGE			
		SMALL OUTLINE (D)	CERAMIC (FK)	CERAMIC DIP (JG)	PLASTIC DIP (P)
0°C to 70°C	4 mV	NE5534D NE5534AD	— —	— —	NE5534P NE5534AP
–55°C to 125°C	2 mV	— —	SE5534FK SE5534AFK	SE5534JG SE5534AJG	— —

The D package is available taped and reeled. Add the suffix R to the device type (e.g., NE5534DR).

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

**TEXAS  
INSTRUMENTS**

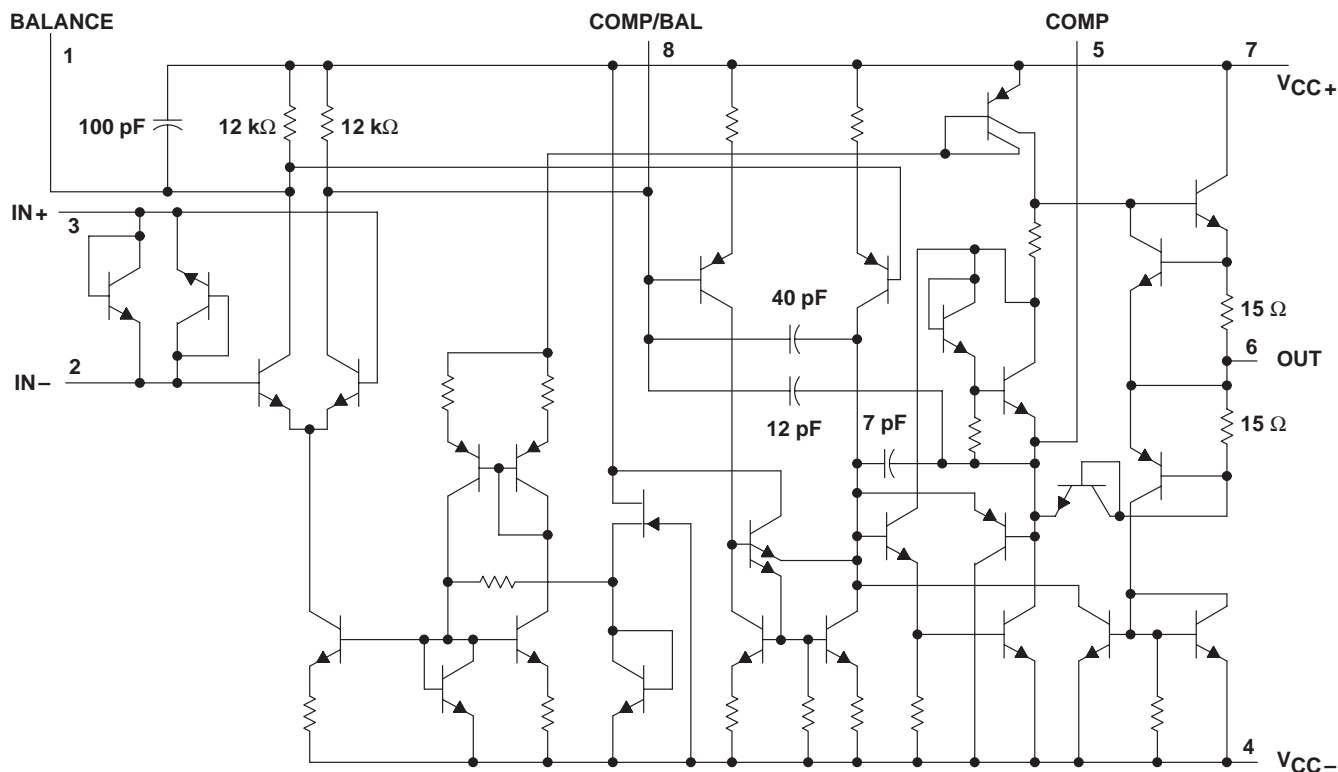
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## schematic



All component values shown are nominal.  
Pin numbers shown are for D, JG, and P packages.

## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, $V_{CC+}$ (see Note 1)	22 V
Supply voltage, $V_{CC-}$ (see Note 1)	-22 V
Input voltage either input (see Notes 1 and 2)	$V_{CC+}$
Input current (see Note 3)	$\pm 10$ mA
Duration of output short circuit (see Note 4)	unlimited
Continuous total power dissipation	See Dissipation Rating Table
Operating free-air temperature range:	
NE5534, NE5534A	0°C to 70°C
SE5534, SE5534A	-55°C to 125°C
Storage temperature range	-65°C to 150°C
Case temperature for 60 seconds: FK package	260°C
Lead temperature range 1,6 mm (1/16 inch) from case for 60 seconds: JG package	300°C
Lead temperature range 1,6 mm (1/16 inch) from case for 10 seconds: D or P package	260°C

- NOTES:
1. All voltage values, except differential voltages, are with respect to the midpoint between  $V_{CC+}$  and  $V_{CC-}$ .
  2. The magnitude of the input voltage must never exceed the magnitude of the supply voltage.
  3. Excessive current will flow if a differential input voltage in excess of approximately 0.6 V is applied between the inputs unless some limiting resistance is used.
  4. The output may be shorted to ground or to either power supply. Temperature and/or supply voltages must be limited to ensure the maximum dissipation rating is not exceeded.



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**DISSIPATION RATING TABLE**

PACKAGE	$T_A \leq 25^\circ\text{C}$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$	$T_A = 70^\circ\text{C}$ POWER RATING	$T_A = 125^\circ\text{C}$ POWER RATING
D	725 mW	5.8 mW/°C	464 mW	N/A
FK (see Note 5)	1375 mW	11.0 mW/°C	880 mW	275 mW
JG	1050 mW	8.4 mW/°C	672 mW	210 mW
P	1000 mW	8.0 mW/°C	640 mW	N/A

NOTE 5: For the FK package, power rating and derating factor will vary with actual mounting technique used. The values stated here are believed to be conservative.

## recommended operating conditions

	MIN	NOM	MAX	UNIT
Supply voltage, $V_{CC+}$		5	15	V
Supply voltage, $V_{CC-}$	-5		-15	V

## electrical characteristics, $V_{CC} \pm = \pm 15\text{ V}$ , $T_A = 25^\circ\text{C}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS†		NE5534, NE5534A			SE5534, SE5534A			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_O = 0$ , $R_S = 50\ \Omega$	$T_A = 25^\circ\text{C}$	0.5	4	0.5	2	mV		
		$T_A = \text{Full range}$		5		3			
$I_{IO}$ Input offset current	$V_O = 0$	$T_A = 25^\circ\text{C}$	20	300	10	200	nA		
		$T_A = \text{Full range}$		400		500			
$I_{IB}$ Input bias current	$V_O = 0$	$T_A = 25^\circ\text{C}$	500	1500	400	800	nA		
		$T_A = \text{Full range}$		2000		1500			
$V_{ICR}$ Common-mode input voltage range			$\pm 12$	$\pm 13$	$\pm 12$	$\pm 13$	V		
$V_{O(PP)}$ Maximum peak-to-peak output voltage swing	$R_L \geq 600\ \Omega$	$V_{CC\pm} = \pm 15\text{ V}$	24	26	24	26	V		
		$V_{CC\pm} = \pm 18\text{ V}$	30	32	30	32			
$A_{VD}$ Large-signal differential voltage amplification	$V_O = \pm 10\text{ V}$ , $R_L \geq 600\ \Omega$	$T_A = 25^\circ\text{C}$	25	100	50	100	V/mV		
		$T_A = \text{Full range}$	15		25				
$A_{vd}$ Small-signal differential voltage amplification	$f = 10\text{ kHz}$	$C_C = 0$		6		6	V/mV		
		$C_C = 22\text{ pF}$		2.2		2.2			
$B_{OM}$ Maximum-output-swing bandwidth	$V_O = \pm 10\text{ V}$ , $V_{CC\pm} = \pm 18\text{ V}$ , $R_L \geq 600\ \Omega$	$C_C = 0$		200		200	kHz		
		$C_C = 22\text{ pF}$		95		95			
		$V_O = \pm 14\text{ V}$ , $C_C = 22\text{ pF}$		70		70			
$B_1$ Unity-gain bandwidth	$C_C = 22\text{ pF}$ , $C_L = 100\text{ pF}$		10		10	MHz			
$r_i$ Input resistance			30	100	50	100	k $\Omega$		
$z_o$ Output impedance	$A_{VD} = 30\text{ dB}$ , $C_C = 22\text{ pF}$ , $f = 10\text{ kHz}$	$R_L \geq 600\ \Omega$ , $f = 10\text{ kHz}$		0.3		0.3	$\Omega$		
CMRR Common-mode rejection ratio	$V_O = 0$ , $R_S = 50\ \Omega$	$V_{IC} = V_{ICRmin}$	70	100	80	100	dB		
$k_{SVR}$ Supply voltage rejection ratio ( $\Delta V_{CC}/\Delta V_{IO}$ )	$V_{CC+} = \pm 9\text{ V to } \pm 15\text{ V}$ , $V_O = 0$	$R_S = 50\ \Omega$	80	100	86	100	dB		
$I_{OS}$ Output short-circuit current				38		38	mA		
$I_{CC}$ Supply current	$V_O = 0$ , No load	$T_A = 25^\circ\text{C}$	4	8	4	6.5	mA		
		$T_A = \text{Full range}$				9			

† All characteristics are measured under open-loop conditions with zero common-mode input voltage unless otherwise specified. Full range is  $T_A = 0^\circ\text{C}$  to  $70^\circ\text{C}$  for NE5534 and NE5534A and  $-55^\circ\text{C}$  to  $125^\circ\text{C}$  for SE5534 and SE5534A.



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operating characteristics,  $V_{CC} \pm = \pm 15\text{ V}$ ,  $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	SE5534, NE5534			SE5534A, NE5534A			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
SR Slew rate at unity gain	$C_C = 0$	13			13			V/ $\mu\text{s}$
	$C_C = 22\text{ pF}$	6			6			
$t_r$ Rise time	$V_I = 50\text{ mV}$ , $A_{VD} = 1$ , $R_L = 600\ \Omega$ , $C_C = 22\text{ pF}$ ,	20			20			ns
Overshoot factor	$C_L = 100\text{ pF}$	20%			20%			
$t_r$ Rise time	$V_I = 50\text{ mV}$ , $A_{VD} = 1$ , $R_L = 600\ \Omega$ , $C_C = 47\text{ pF}$ ,	50			50			ns
Overshoot factor	$C_L = 500\text{ pF}$	35%			35%			
$V_n$ Equivalent input noise voltage	$f = 30\text{ Hz}$	7			5.5	7		nV/ $\sqrt{\text{Hz}}$
	$f = 1\text{ kHz}$	4			3.5	4.5		
$I_n$ Equivalent input noise current	$f = 30\text{ Hz}$	2.5			1.5			pA/ $\sqrt{\text{Hz}}$
	$f = 1\text{ kHz}$	0.6			0.4			
$\bar{F}$ Average noise figure	$R_S = 5\text{ k}\Omega$ , $f = 10\text{ Hz to }20\text{ kHz}$				0.9			dB

## TYPICAL CHARACTERISTICS†

NORMALIZED INPUT BIAS CURRENT  
AND INPUT OFFSET CURRENT  
vs  
FREE-AIR TEMPERATURE

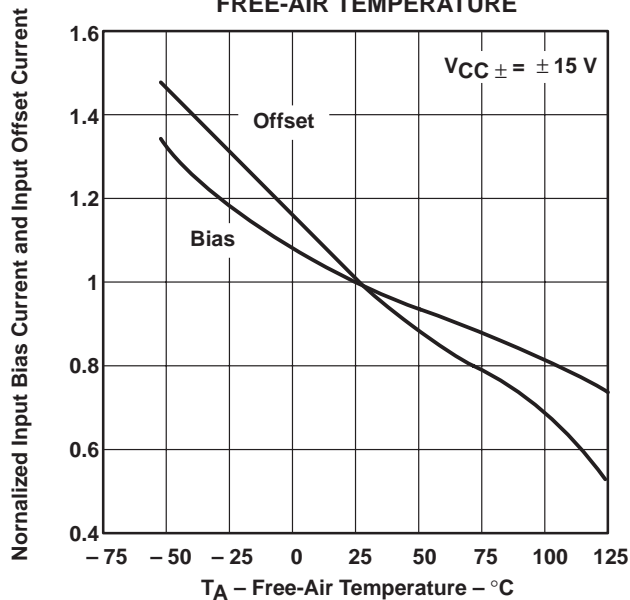


Figure 1

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE  
vs  
FREQUENCY

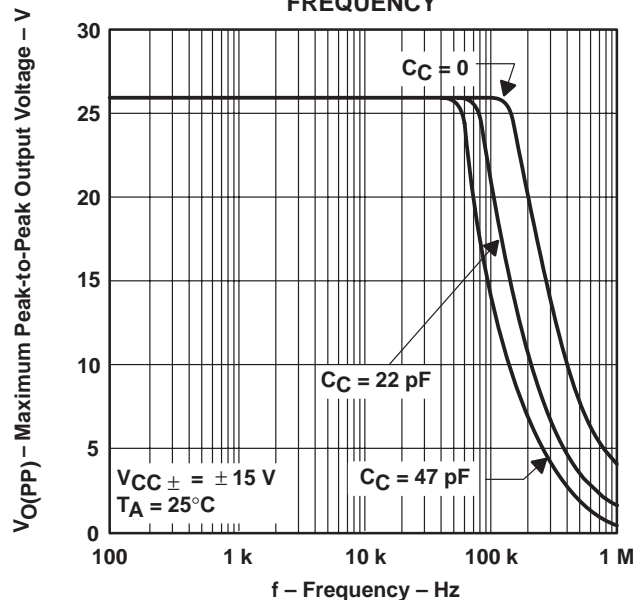


Figure 2

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.



TYPICAL CHARACTERISTICS†

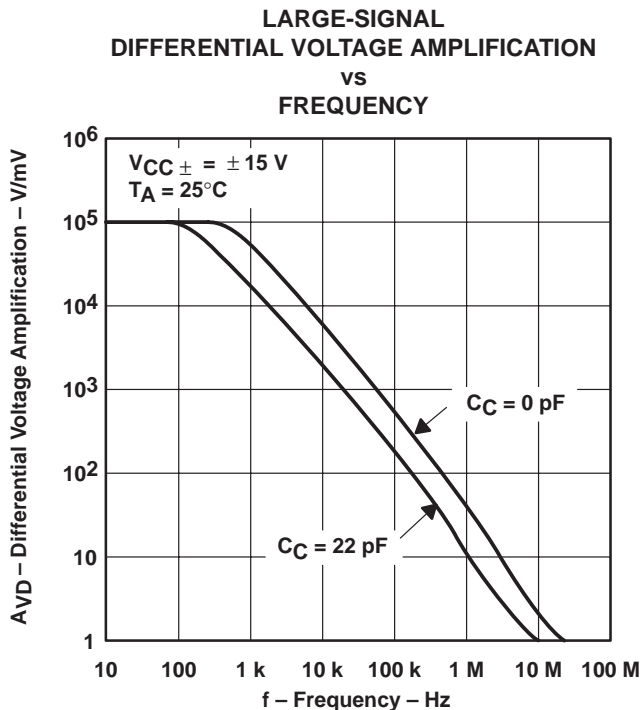


Figure 3

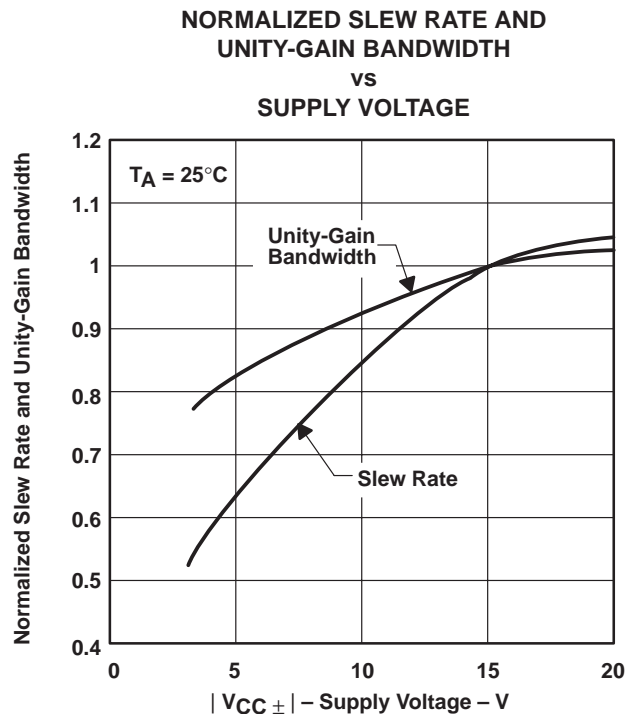


Figure 4

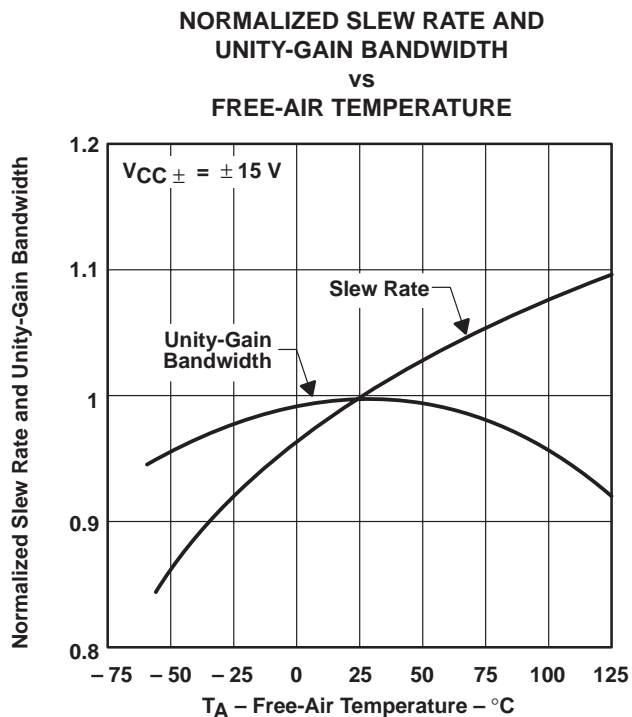


Figure 5

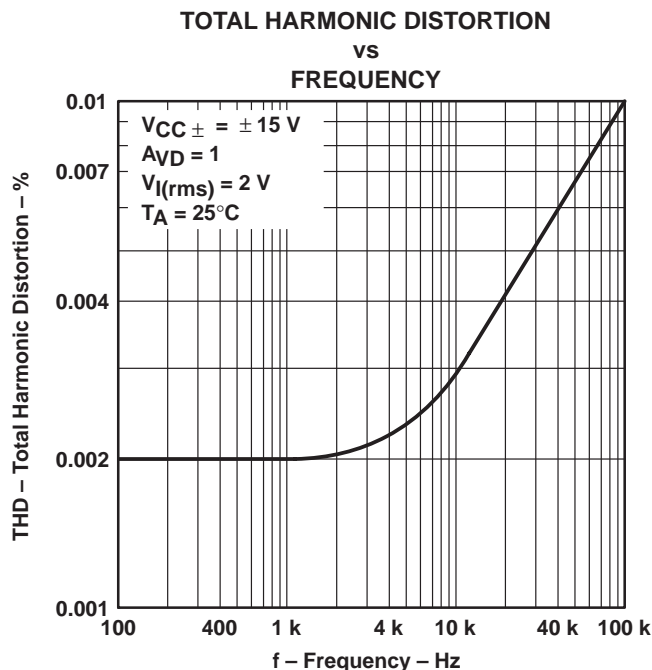


Figure 6

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

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## TYPICAL CHARACTERISTICS

EQUIVALENT INPUT NOISE VOLTAGE  
vs  
FREQUENCY

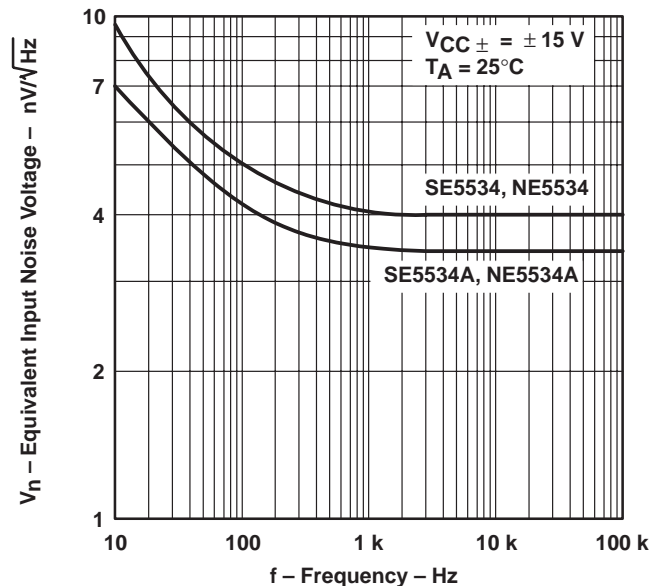


Figure 7

EQUIVALENT INPUT NOISE CURRENT  
vs  
FREQUENCY

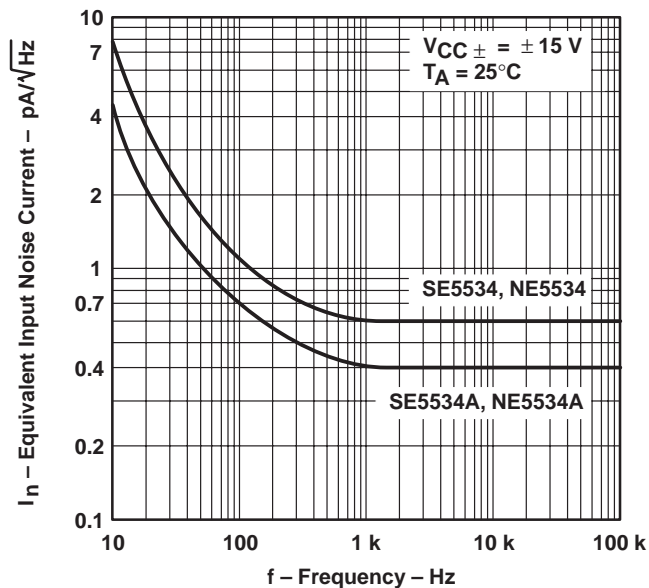


Figure 8

TOTAL EQUIVALENT INPUT NOISE VOLTAGE  
vs  
SOURCE RESISTANCE

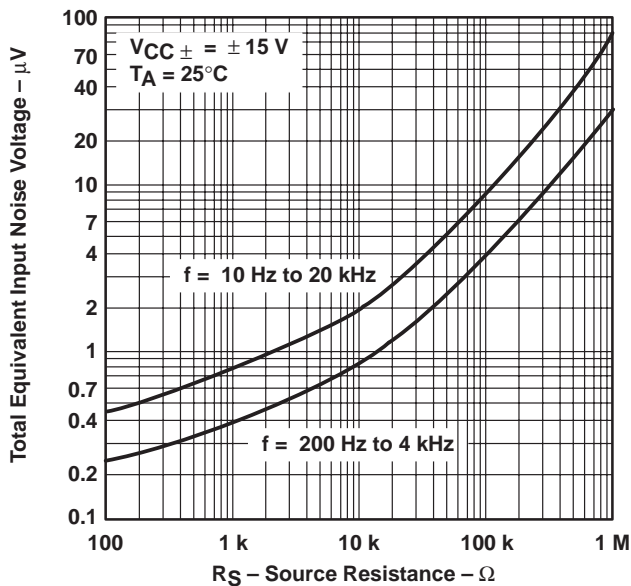


Figure 9



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