

# NE5534, SA5534, SE5534, NE5534A, SA5534A, SE5534A

## Single Low Noise Operational Amplifier

The NE/SA/SE5534/5534A are single high-performance low noise operational amplifiers. Compared to other operational amplifiers, such as TL083, they show better noise performance, improved output drive capability, and considerably higher small-signal and power bandwidths.

This makes the devices especially suitable for application in high quality and professional audio equipment, in instrumentation and control circuits and telephone channel amplifiers. The op amps are internally compensated for gain equal to, or higher than, three. The frequency response can be optimized with an external compensation capacitor for various applications (unity gain amplifier, capacitive load, slew rate, low overshoot, etc.).

### Features

- Small-Signal Bandwidth: 10 MHz
- Output Drive Capability: 600  $\Omega$ , 10 V<sub>RMS</sub> at V<sub>S</sub> =  $\pm 18$  V
- Input Noise Voltage: 4 nV/ $\sqrt{\text{Hz}}$
- DC Voltage Gain: 100000
- AC Voltage Gain: 6000 at 10 kHz
- Power Bandwidth: 200 kHz
- Slew Rate: 13 V/ $\mu\text{s}$
- Large Supply Voltage Range:  $\pm 3.0$  to  $\pm 20$  V
- Pb-Free Packages are Available

### Applications

- Audio Equipment
- Instrumentation and Control Circuits
- Telephone Channel Amplifiers
- Medical Equipment

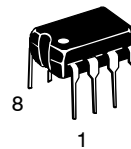


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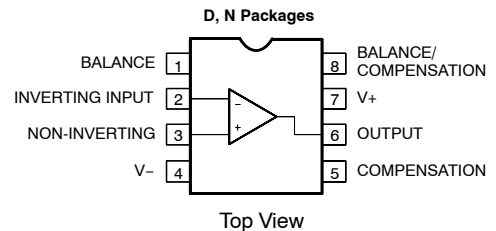


SOIC-8  
D SUFFIX  
CASE 751



PDIP-8  
N SUFFIX  
CASE 626

### PIN CONNECTIONS



### DEVICE MARKING INFORMATION

See general marking information in the device marking section on page 8 of this data sheet.

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 8 of this data sheet.

# NE5534, SA5534, SE5534, NE5534A, SA5534A, SE5534A

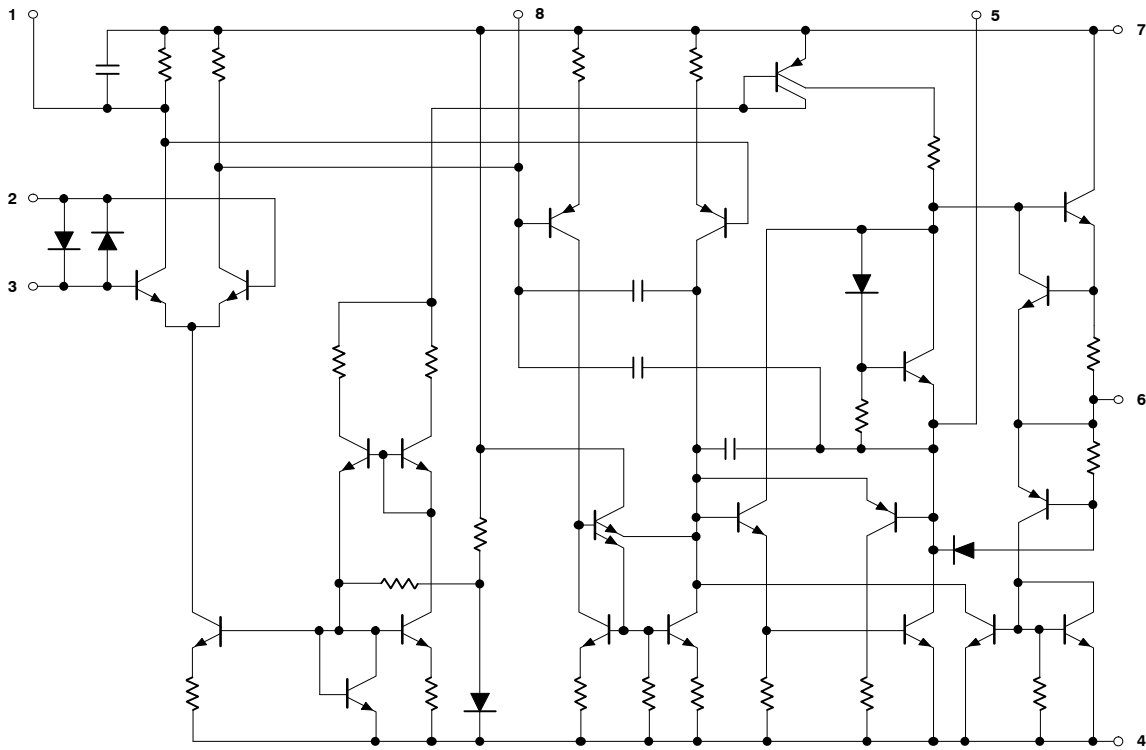


Figure 1. Equivalent Schematic

## MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply Voltage	$V_S$	$\pm 22$	V
Input Voltage	$V_{IN}$	$\pm V_{Supply}$	V
Differential Input Voltage (Note 1)	$V_{DIFF}$	$\pm 0.5$	V
Operating Temperature Range NE SA SE	$T_{amb}$	0 to +70 -40 to +85 -55 to +125	$^{\circ}C$
Storage Temperature Range	$T_{stg}$	-65 to +150	$^{\circ}C$
Junction Temperature	$T_j$	150	$^{\circ}C$
Power Dissipation at 25 $^{\circ}C$	$P_D$	N Package D Package 1150 750	mW
Thermal Resistance, Junction-to-Ambient	$R_{\theta JA}$	N Package D Package 130 158	$^{\circ}C/W$
Output Short-Circuit Duration (Note 2)	-	Indefinite	-
Lead Soldering Temperature (10 sec max)	$T_{slid}$	230	$^{\circ}C$

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. Diodes protect the inputs against overvoltage. Therefore, unless current-limiting resistors are used, large currents will flow if the differential input voltage exceeds 0.6 V. Maximum current should be limited to  $\pm 10$  mA.
2. Output may be shorted to ground at  $V_S = \pm 15$  V,  $T_{amb} = 25^{\circ}C$ . Temperature and/or supply voltages must be limited to ensure dissipation rating is not exceeded.

# NE5534, SA5534, SE5534, NE5534A, SA5534A, SE5534A

## DC ELECTRICAL CHARACTERISTICS ( $T_{amb} = 25^{\circ}\text{C}$ ; $V_S = \pm 15\text{ V}$ , unless otherwise noted.) (Notes 3, 4 and 5)

Characteristic	Symbol	Test Conditions	NE/SA5534/5534A			SE5534/5534A			Unit
			Min	Typ	Max	Min	Typ	Max	
Offset Voltage	$V_{OS}$	Overtemperature	-	0.5	4.0	-	0.5	2.0	mV
			-	-	5.0	-	-	3.0	mV
	$\Delta V_{OS}/\Delta T$		-	5.0	-	-	5.0	-	$\mu\text{V}/^{\circ}\text{C}$
Offset Current	$I_{OS}$	Overtemperature	-	20	300	-	10	200	nA
			-	-	400	-	-	500	nA
	$\Delta I_{OS}/\Delta T$		-	200	-	-	200	-	$\text{pA}/^{\circ}\text{C}$
Input Current	$I_B$	Overtemperature	-	500	1500	-	400	800	nA
			-	-	2000	-	-	1500	nA
	$\Delta I_B/\Delta T$		-	5.0	-	-	5.0	-	$\text{nA}/^{\circ}\text{C}$
Supply Current Per Op Amp	$I_{CC}$	Overtemperature	-	4.0	8.0	-	4.0	6.5	mA
			-	-	10	-	-	9.0	
Common Mode Input Range Common Mode Rejection Ratio Power Supply Rejection Ratio	$V_{CM}$		$\pm 12$	$\pm 13$	-	$\pm 12$	$\pm 13$	-	V
	CMRR		70	100	-	80	100	-	dB
	PSRR		-	10	100	-	10	50	$\mu\text{V}/\text{V}$
Large-Signal Voltage Gain	$A_{VOL}$	$R_L \geq 600\ \Omega$ , $V_O = \pm 10\text{ V}$	25	100	-	50	100	-	V/mV
		Overtemperature	15	-	-	25	-	-	
Output Swing	$V_{OUT}$	$R_L \geq 600\ \Omega$	$\pm 12$	$\pm 13$	-	$\pm 12$	$\pm 13$	-	V
		Overtemperature	$\pm 10$	$\pm 12$	-	$\pm 10$	$\pm 12$	-	
		$R_L \geq 600\ \Omega$ ; $V_S = \pm 18\text{ V}$	$\pm 15$	$\pm 16$	-	$\pm 15$	16	-	
		$R_L \geq 2.0\ \text{k}\Omega$	$\pm 13$	$\pm 13.5$	-	$\pm 13$	$\pm 13.5$	-	
		Overtemperature	$\pm 12$	$\pm 12.5$	-	$\pm 12$	$\pm 12.5$	-	
Input Resistance	$R_{IN}$		30	100	-	50	100	-	k $\Omega$
Output Short Circuit Current	$I_{SC}$		-	38	-	-	38	-	mA

3. For NE5534/5534A,  $T_{MIN} = 0^{\circ}\text{C}$ ,  $T_{MAX} = 70^{\circ}\text{C}$ .

4. For SA5534/5534A,  $T_{MIN} = -40^{\circ}\text{C}$ ,  $T_{MAX} = +85^{\circ}\text{C}$ .

5. For SE5534/5534A,  $T_{MIN} = -55^{\circ}\text{C}$ ,  $T_{MAX} = +125^{\circ}\text{C}$ .

# NE5534, SA5534, SE5534, NE5534A, SA5534A, SE5534A

## AC ELECTRICAL CHARACTERISTICS ( $T_{amb} = 25^{\circ}\text{C}$ ; $V_S = \pm 15\text{ V}$ , unless otherwise noted.)

Characteristic	Symbol	Test Conditions	NE/SA5534/5534A			SE5534/5534A			Unit
			Min	Typ	Max	Min	Typ	Max	
Output Resistance	$R_{OUT}$	$A_V = 30\text{ dB}$ closed-loop $f = 10\text{ kHz}$ ; $R_L = 600\ \Omega$ ; $C_C = 22\text{ pF}$	–	0.3	–	–	0.3	–	$\Omega$
Transient Response		Voltage-follower, $V_{IN} = 50\text{ mV}$ $R_L = 600\ \Omega$ ; $C_C = 22\text{ pF}$ ; $C_L = 100\text{ pF}$							
Rise Time	$t_R$		–	20	–	–	20	–	ns
Overshoot	–		–	20	–	–	20	–	%
Transient Response		$V_{IN} = 50\text{ mV}$ ; $R_L = 600\ \Omega$ ; $C_C = 47\text{ pF}$ ; $C_L = 500\text{ pF}$							
Rise Time	$t_R$		–	50	–	–	50	–	ns
Overshoot	–		–	35	–	–	35	–	%
Gain	$A_V$	$f = 10\text{ kHz}$ , $C_C = 0$ $f = 10\text{ kHz}$ ; $C_C = 22\text{ pF}$	–	6.0	–	–	6.0	–	V/mV
Gain Bandwidth Product	GBW	$C_C = 22\text{ pF}$ ; $C_L = 100\text{ pF}$	–	10	–	–	10	–	MHz
Slew Rate	SR	$C_C = 0$ $C_C = 22\text{ pF}$	–	13	–	–	13	–	V/ $\mu\text{s}$
Power Bandwidth	–	$V_{OUT} = \pm 10\text{ V}$ ; $C_C = 0\text{ pF}$ $V_{OUT} = \pm 10\text{ V}$ ; $C_C = 22\text{ pF}$ $V_{OUT} = \pm 14\text{ V}$ ; $R_L = 600\ \Omega$ ; $C_C = 22\text{ pF}$ ; $V_{CC} = \pm 18\text{ V}$	–	200	–	–	200	–	kHz
			–	95	–	–	95	–	
			–	70	–	–	70	–	

## ELECTRICAL CHARACTERISTICS ( $T_{amb} = 25^{\circ}\text{C}$ ; $V_S = 15\text{ V}$ , unless otherwise noted.)

Characteristic	Symbol	Test Conditions	NE/SA/SE5534			NE/SA/SE5534A			Unit
			Min	Typ	Max	Min	Typ	Max	
Input Noise Voltage	$V_{NOISE}$	$f_O = 30\text{ Hz}$ $f_O = 1.0\text{ kHz}$	–	7.0	–	–	5.5	7.0	nV/ $\sqrt{\text{Hz}}$
Input Noise Current	$I_{NOISE}$	$f_O = 30\text{ Hz}$ $f_O = 1.0\text{ kHz}$	–	2.5	–	–	1.5	–	pA/ $\sqrt{\text{Hz}}$
			–	0.6	–	–	0.4	–	
Broadband Noise Figure	–	$f = 10\text{ Hz}$ to 20 kHz; $R_S = 5.0\text{ k}\Omega$	–	–	–	–	0.9	–	dB
Channel Separation	–	$f = 1.0\text{ kHz}$ ; $R_S = 5.0\text{ k}\Omega$	–	110	–	–	110	–	dB

TYPICAL PERFORMANCE CHARACTERISTICS



Figure 2. Open-Loop Frequency Response



Figure 3. Slew Rate as a Function of Compensation Capacitance



Figure 4. Closed-Loop Frequency Response



Figure 5. Large-Signal Frequency Response



Figure 6. Output Short-Circuit Current



Figure 7. Input Bias Current

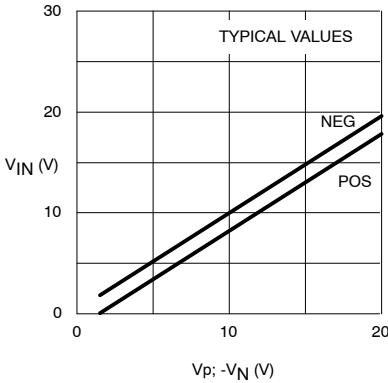


Figure 8. Input Common-Mode Voltage Range

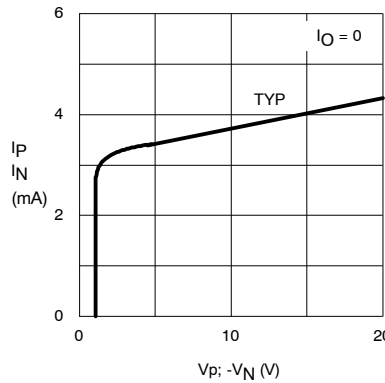


Figure 9. Supply Current Per Op Amp

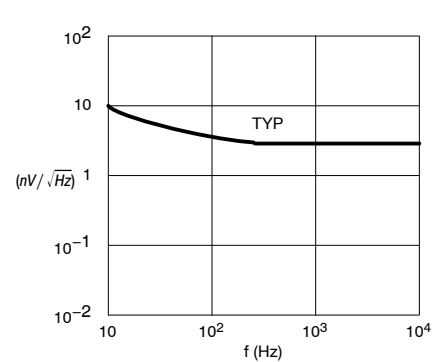


Figure 10. Input Noise Voltage Density

TYPICAL PERFORMANCE CHARACTERISTICS

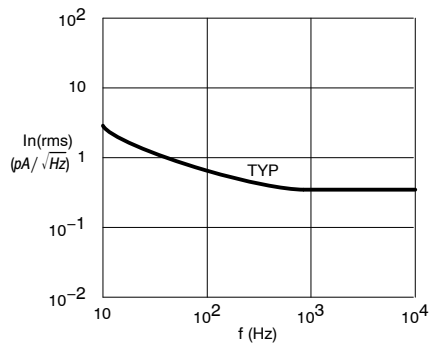


Figure 11. Input Noise Current Density



Figure 12. Total Input Noise Density

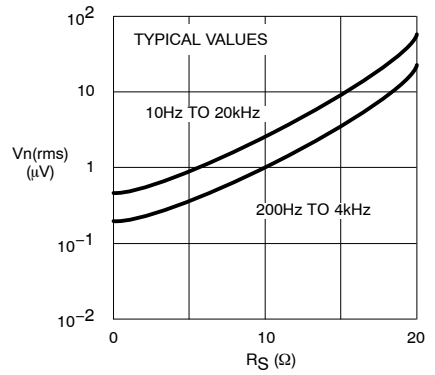


Figure 13. Broadband Input Noise Voltage

TEST LOAD CIRCUITS



Figure 14. Frequency Compensation and Offset Voltage Adjustment Circuit



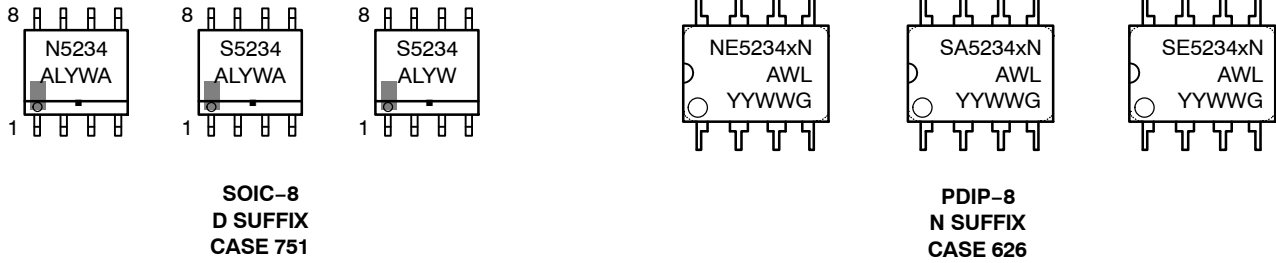
Figure 15. Closed-Loop Frequency Response



Figure 16. Noise Test Block Diagram

# NE5534, SA5534, SE5534, NE5534A, SA5534A, SE5534A

## MARKING DIAGRAMS



x = Blank or A  
 A = Assembly Location  
 WL, L = Wafer Lot  
 YY, Y = Year  
 WW, W = Work Week  
 G or ■ = Pb-Free Package

## ORDERING INFORMATION

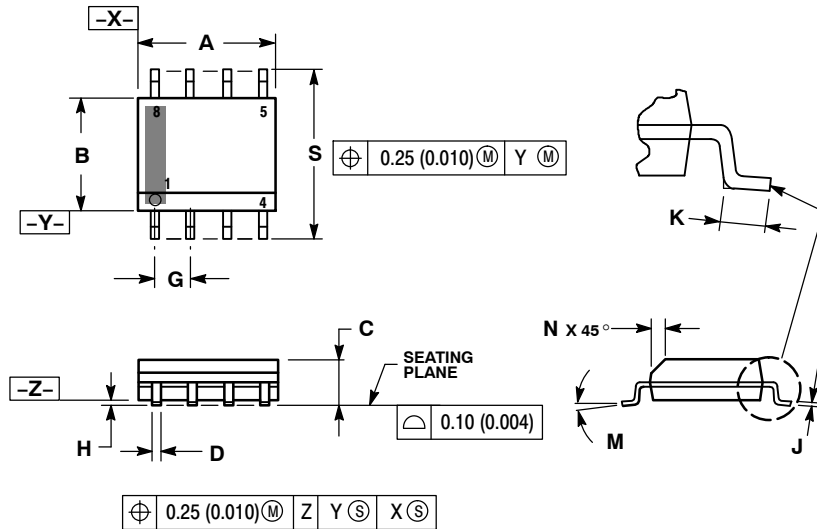
Device	Description	Temperature Range	Shipping <sup>†</sup>
NE5534AD	8-Pin Plastic Small Outline (SO-8) Package	0 to +70°C	98 Units / Rail
NE5534ADG	8-Pin Plastic Small Outline (SO-8) Package (Pb-Free)	0 to +70°C	98 Units / Rail
NE5534ADR2	8-Pin Plastic Small Outline (SO-8) Package	0 to +70°C	2500 / Tape & Reel
NE5534ADR2G	8-Pin Plastic Small Outline (SO-8) Package (Pb-Free)	0 to +70°C	2500 / Tape & Reel
NE5534AN	8-Pin Plastic Dual In-Line Package (PDIP-8)	0 to +70°C	50 Units / Rail
NE5534ANG	8-Pin Plastic Dual In-Line Package (PDIP-8) (Pb-Free)	0 to +70°C	50 Units / Rail
NE5534D	8-Pin Plastic Small Outline (SO-8) Package	0 to +70°C	98 Units / Rail
NE5534DG	8-Pin Plastic Small Outline (SO-8) Package (Pb-Free)	0 to +70°C	98 Units / Rail
NE5534DR2	8-Pin Plastic Small Outline (SO-8) Package	0 to +70°C	2500 / Tape & Reel
NE5534DR2G	8-Pin Plastic Small Outline (SO-8) Package (Pb-Free)	0 to +70°C	2500 / Tape & Reel
NE5534N	8-Pin Plastic Dual In-Line Package (PDIP-8)	0 to +70°C	50 Units / Rail
NE5534NG	8-Pin Plastic Dual In-Line Package (PDIP-8) (Pb-Free)	0 to +70°C	50 Units / Rail
SA5534AD	8-Pin Plastic Small Outline (SO-8) Package	-40 to +85°C	98 Units / Rail
SA5534ADG	8-Pin Plastic Small Outline (SO-8) Package (Pb-Free)	-40 to +85°C	98 Units / Rail
SA5534ADR2	8-Pin Plastic Small Outline (SO-8) Package	-40 to +85°C	2500 / Tape & Reel
SA5534ADR2G	8-Pin Plastic Small Outline (SO-8) Package (Pb-Free)	-40 to +85°C	2500 / Tape & Reel
SA5534AN	8-Pin Plastic Dual In-Line Package (PDIP-8)	-40 to +85°C	50 Units / Rail
SA5534ANG	8-Pin Plastic Dual In-Line Package (PDIP-8) (Pb-Free)	-40 to +85°C	50 Units / Rail
SA5534N	8-Pin Plastic Dual In-Line Package (PDIP-8)	-40 to +85°C	50 Units / Rail
SA5534NG	8-Pin Plastic Dual In-Line Package (PDIP-8) (Pb-Free)	-40 to +85°C	50 Units / Rail
SE5534AN	8-Pin Plastic Dual In-Line Package (PDIP-8)	-55 to +125°C	50 Units / Rail
SE5534ANG	8-Pin Plastic Dual In-Line Package (PDIP-8) (Pb-Free)	-55 to +125°C	50 Units / Rail
SE5534N	8-Pin Plastic Dual In-Line Package (PDIP-8)	-55 to +125°C	50 Units / Rail
SE5534NG	8-Pin Plastic Dual In-Line Package (PDIP-8) (Pb-Free)	-55 to +125°C	50 Units / Rail

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.



PACKAGE DIMENSIONS

SOIC-8 NB  
CASE 751-07  
ISSUE AK

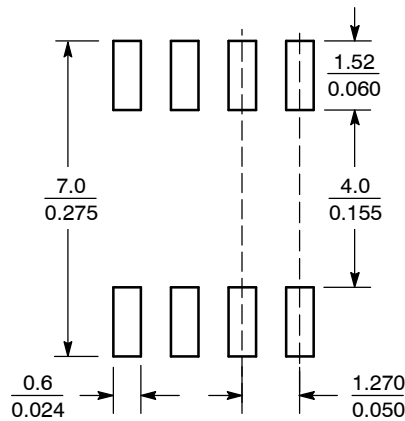


NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. 751-01 THRU 751-06 ARE OBSOLETE. NEW STANDARD IS 751-07.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.197
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.053	0.069
D	0.33	0.51	0.013	0.020
G	1.27 BSC		0.050 BSC	
H	0.10	0.25	0.004	0.010
J	0.19	0.25	0.007	0.010
K	0.40	1.27	0.016	0.050
M	0°	8°	0°	8°
N	0.25	0.50	0.010	0.020
S	5.80	6.20	0.228	0.244

SOLDERING FOOTPRINT\*



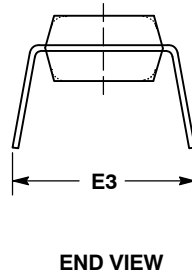
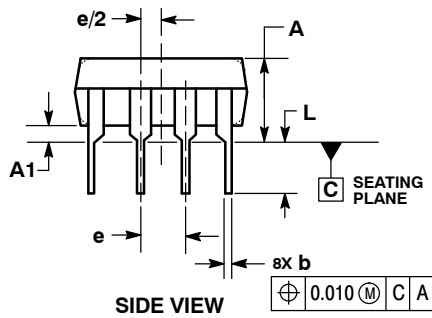
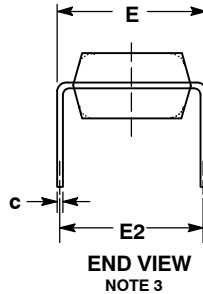
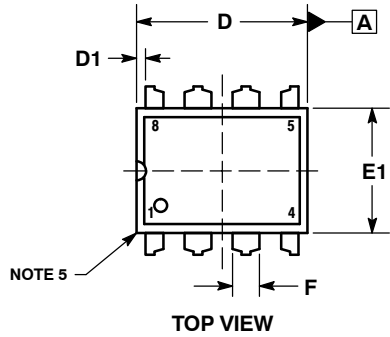
SCALE 6:1 (mm / inches)

\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

# NE5534, SA5534, SE5534, NE5534A, SA5534A, SE5534A

## PACKAGE DIMENSIONS


PDIP-8  
N SUFFIX  
CASE 626-05  
ISSUE M



### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCHES.
3. DIMENSION E IS MEASURED WITH THE LEADS RESTRAINED PARALLEL AT WIDTH E2.
4. DIMENSION E1 DOES NOT INCLUDE MOLD FLASH.
5. ROUNDED CORNERS OPTIONAL.

DIM	INCHES			MILLIMETERS		
	MIN	NOM	MAX	MIN	NOM	MAX
A	----	----	0.210	----	----	5.33
A1	0.015	----	----	0.38	----	----
b	0.014	0.018	0.022	0.35	0.46	0.56
C	0.008	0.010	0.014	0.20	0.25	0.36
D	0.355	0.365	0.400	9.02	9.27	10.02
D1	0.005	----	----	0.13	----	----
E	0.300	0.310	0.325	7.62	7.87	8.26
E1	0.240	0.250	0.280	6.10	6.35	7.11
E2	0.300 BSC			7.62 BSC		
E3	----	----	0.430	----	----	10.92
e	0.100 BSC			2.54 BSC		
L	0.115	0.130	0.150	2.92	3.30	3.81

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