

# DATA SHEET

## **NE/SA/SE5534/5534A**

Single low noise operational amplifier

Product data  
Supersedes data of 1994 Aug 31  
File under Integrated Circuits, IC11 Data Handbook

2001 Aug 03

# Single low noise operational amplifier

# NE/SA/SE5534/5534A

## DESCRIPTION

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  $\Omega$ , 10V<sub>RMS</sub> at V<sub>S</sub> =  $\pm 18$  V
- Input noise voltage: 4nV/  $\sqrt{\text{Hz}}$
- 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:  $\pm 3$  to  $\pm 20$  V

## ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE	DWG #
8-Pin Plastic Small Outline (SO) package	0 °C to +70 °C	NE5534D	SOT96-1
8-Pin Plastic Dual In-Line Package (DIP)	0 °C to +70 °C	NE5534N	SOT97-1
8-Pin Plastic Small Outline (SO) package	0 °C to +70 °C	NE5534AD	SOT96-1
8-Pin Plastic Dual In-Line Package (DIP)	0 °C to +70 °C	NE5534AN	SOT97-1
8-Pin Plastic Dual In-Line Package (DIP)	-40 °C to +85 °C	SA5534N	SOT97-1
8-Pin Plastic Small Outline (SO) package	-40 °C to +85 °C	SA5534AD	SOT96-1
8-Pin Plastic Dual In-Line Package (DIP)	-40 °C to +85 °C	SA5534AN	SOT97-1
8-Pin Plastic Dual In-Line Package (DIP)	-55 °C to +125 °C	SE5534N	SOT97-1
8-Pin Plastic Dual In-Line Package (DIP)	-55 °C to +125 °C	SE5534AN	SOT97-1

## PIN CONFIGURATIONS

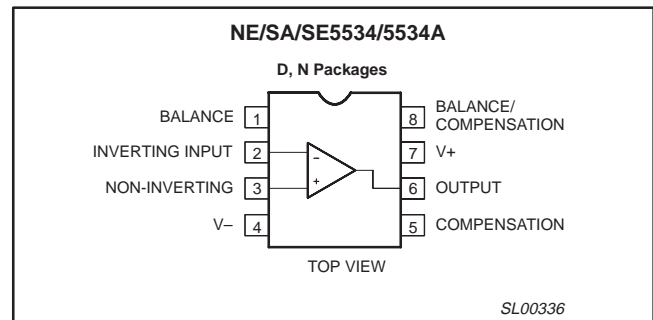


Figure 1. Pin Configuration

## APPLICATIONS

- Audio equipment
- Instrumentation and control circuits
- Telephone channel amplifiers
- Medical equipment

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## ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNIT
V <sub>S</sub>	Supply voltage	±22	V
V <sub>IN</sub>	Input voltage	±V supply	V
V <sub>DIFF</sub>	Differential input voltage <sup>1</sup>	±0.5	V
T <sub>amb</sub>	Operating temperature range		
	NE	0 to +70	°C
	SA	-40 to +85	°C
	SE	-55 to +125	°C
T <sub>stg</sub>	Storage temperature range	-65 to +150	°C
T <sub>j</sub>	Junction temperature	150	°C
P <sub>D</sub>	Power dissipation at 25 °C <sup>2</sup>		
	SO8 package	750	mW
	DIP8 package	1150	mW
	Output short-circuit duration <sup>3</sup>	Indefinite	
T <sub>sld</sub>	Lead soldering temperature (10 sec max)	230	°C

## NOTES:

- Diodes protect the inputs against over voltage. 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 ±10 mA.
- For operation at elevated temperature, derate packages based on the following junction-to-ambient thermal resistance:
  - 8-pin plastic DIP 105 °C/W
  - 8-pin plastic SO 160 °C/W
- Output may be shorted to ground at V<sub>S</sub> = ±15 V, T<sub>amb</sub> = 25 °C. Temperature and/or supply voltages must be limited to ensure dissipation rating is not exceeded.

## DC ELECTRICAL CHARACTERISTICS

T<sub>amb</sub> = 25 °C; V<sub>S</sub> = ±15 V, unless otherwise specified. 1, 2, 3

SYMBOL	PARAMETER	TEST CONDITIONS	NE/SA5534/5534A			SE5534/5534A			UNIT
			Min	Typ	Max	Min	Typ	Max	
V <sub>OS</sub>	Offset voltage	Over temperature		0.5	4		0.5	2	mV
ΔV <sub>OS</sub> /ΔT			5	5	5	3	μV/°C		
I <sub>OS</sub>	Offset current	Over temperature		20	300		10	200	nA
ΔI <sub>OS</sub> /ΔT			200	400	200	500	pA/°C		
I <sub>B</sub>	Input current	Over temperature		500	1500		400	800	nA
ΔI <sub>B</sub> /ΔT			5	2000	5	1500	nA/°C		
I <sub>CC</sub>	Supply current per op amp	Over temperature		4	8		4	6.5	mA
			10	9	mA				
V <sub>CM</sub>	Common mode input range		±12	±13		±12	±13	V	
CMRR	Common mode rejection ratio		70	100		80	100	dB	
PSRR	Power supply rejection ratio			10	100		10	50	μV/V
A <sub>VOL</sub>	Large-signal voltage gain	R <sub>L</sub> ≥ 600 Ω, V <sub>O</sub> = ±10 V	25	100		50	100		V/mV
		Over temperature	15		25		V/mV		
V <sub>OUT</sub>	Output swing	R <sub>L</sub> ≥ 600 Ω	±12	±13		±12	±13		V
		Over temperature	±10	±12		±10	±12		V
		R <sub>L</sub> ≥ 600 Ω; V <sub>S</sub> = ±18 V	±15	±16		±15	±16		V
		R <sub>L</sub> ≥ 2 kΩ	±13	±13.5		±13	±13.5		V
		Over temperature	±12	±12.5		±12	±12.5		V
R <sub>IN</sub>	Input resistance		30	100		50	100	kΩ	
I <sub>SC</sub>	Output short circuit current			38			38	mA	

## NOTES:

- For NE5534/5534A, T<sub>MIN</sub> = 0 °C, T<sub>MAX</sub> = 70 °C
- For SA5534/5534A, T<sub>MIN</sub> = -40 °C, T<sub>MAX</sub> = +85 °C
- For SE5534/5534A, T<sub>MIN</sub> = -55 °C, T<sub>MAX</sub> = +125 °C

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**AC ELECTRICAL CHARACTERISTICS**T<sub>amb</sub> = 25 °C, V<sub>S</sub> = ±15 V, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	NE/SA5534/5534A			SE5534/5534A			UNIT
			Min	Typ	Max	Min	Typ	Max	
R <sub>OUT</sub>	Output resistance	A <sub>V</sub> = 30 dB closed-loop f = 10 kHz; R <sub>L</sub> = 600 Ω; C <sub>C</sub> = 22 pF		0.3			0.3		Ω
	Transient response	Voltage-follower, V <sub>IN</sub> = 50 mV R <sub>L</sub> = 600 Ω; C <sub>C</sub> = 22 pF, C <sub>L</sub> = 100 pF							
t <sub>R</sub>	Rise time			20			20		ns
	Overshoot			20			20		%
	Transient response	V <sub>IN</sub> = 50 mV, R <sub>L</sub> = 600 Ω C <sub>C</sub> = 47 pF, C <sub>L</sub> = 500 pF							
t <sub>R</sub>	Rise time			50			50		ns
	Overshoot			35			35		%
A <sub>V</sub>	Gain	f = 10 kHz, C <sub>C</sub> = 0 f = 10 kHz, C <sub>C</sub> = 22 pF		6 2.2			6 2.2		V/mV V/mV
GBW	Gain bandwidth product	C <sub>C</sub> = 22 pF, C <sub>L</sub> = 100 pF		10			10		MHz
SR	Slew rate	C <sub>C</sub> = 0 C <sub>C</sub> = 22 pF		13 6			13 6		V/μs V/μs
	Power bandwidth	V <sub>OUT</sub> = ±10 V, C <sub>C</sub> = 0 pF V <sub>OUT</sub> = ±10 V, C <sub>C</sub> = 22 pF V <sub>OUT</sub> = ±14 V, R <sub>L</sub> = 600 Ω C <sub>C</sub> = 22 pF, V <sub>CC</sub> = ±18 V		200 95 70			200 95 70		kHz kHz kHz

**ELECTRICAL CHARACTERISTICS**T<sub>amb</sub> = 25 °C, V<sub>S</sub> = 15 V, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	NE/SA/SE5534			NE/SA/SE5534A			UNIT
			Min	Typ	Max	Min	Typ	Max	
V <sub>NOISE</sub>	Input noise voltage	f <sub>O</sub> = 30 Hz f <sub>O</sub> = 1 kHz		7 4			5.5 3.5	7 4.5	nV/√Hz nV/√Hz
I <sub>NOISE</sub>	Input noise current	f <sub>O</sub> = 30 Hz f <sub>O</sub> = 1 kHz		2.5 0.6			1.5 0.4		pA/√Hz pA/√Hz
	Broadband noise figure	f = 10 Hz to 20 kHz; R <sub>S</sub> = 5 kΩ					0.9		dB
	Channel separation	f = 1 kHz; R <sub>S</sub> = 5 kΩ		110			110		dB

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## EQUIVALENT SCHEMATIC

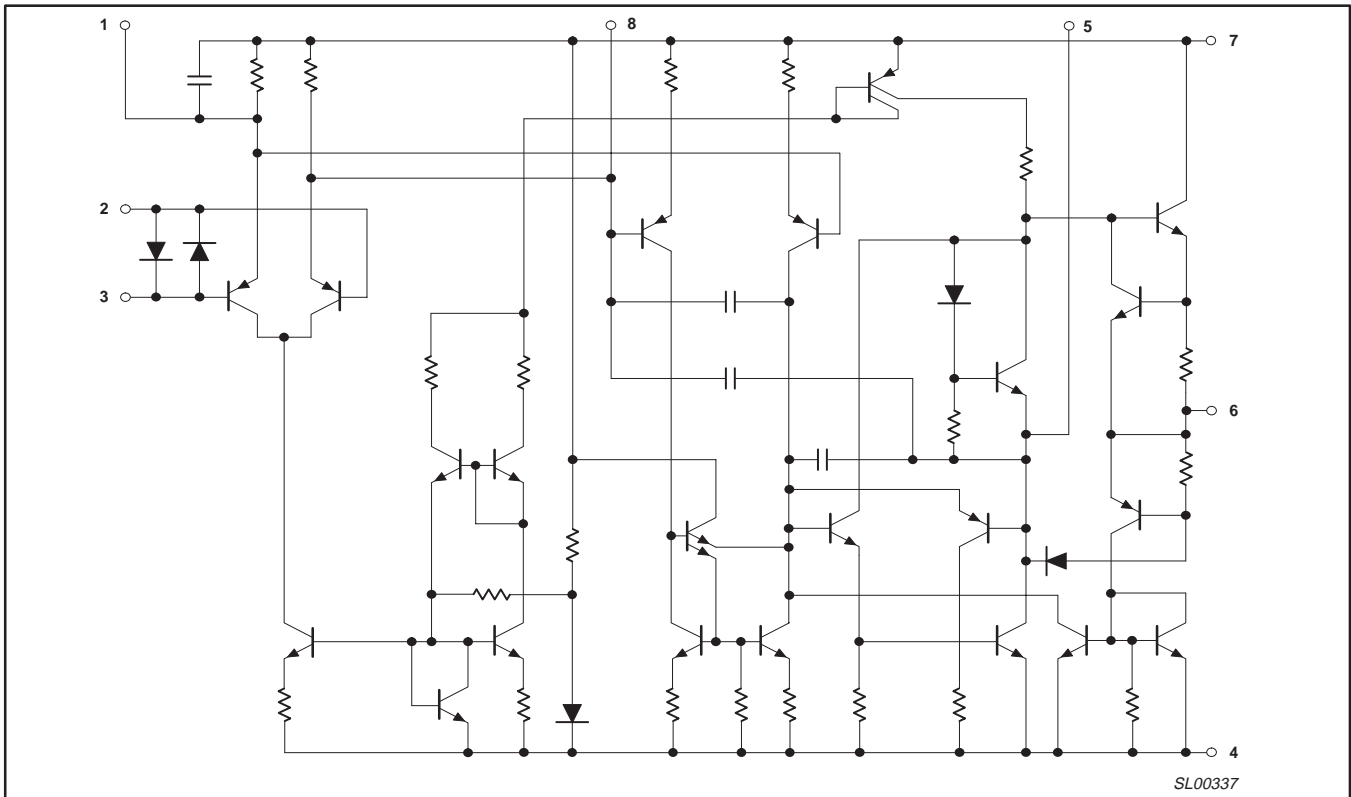


Figure 2. Equivalent Schematic

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# NE/SA/SE5534/5534A

## TYPICAL PERFORMANCE CHARACTERISTICS

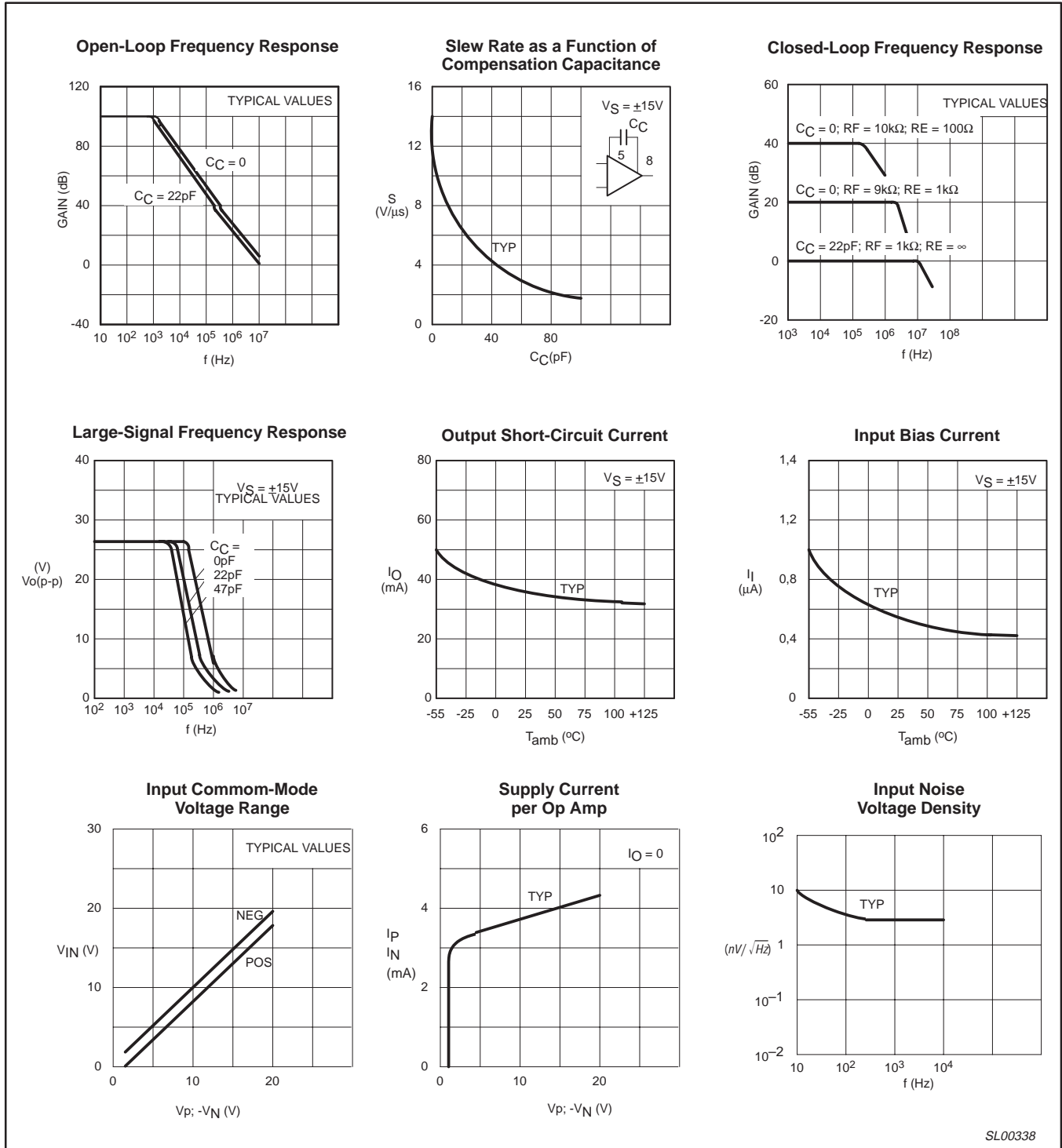


Figure 3. Typical Performance Characteristics

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## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

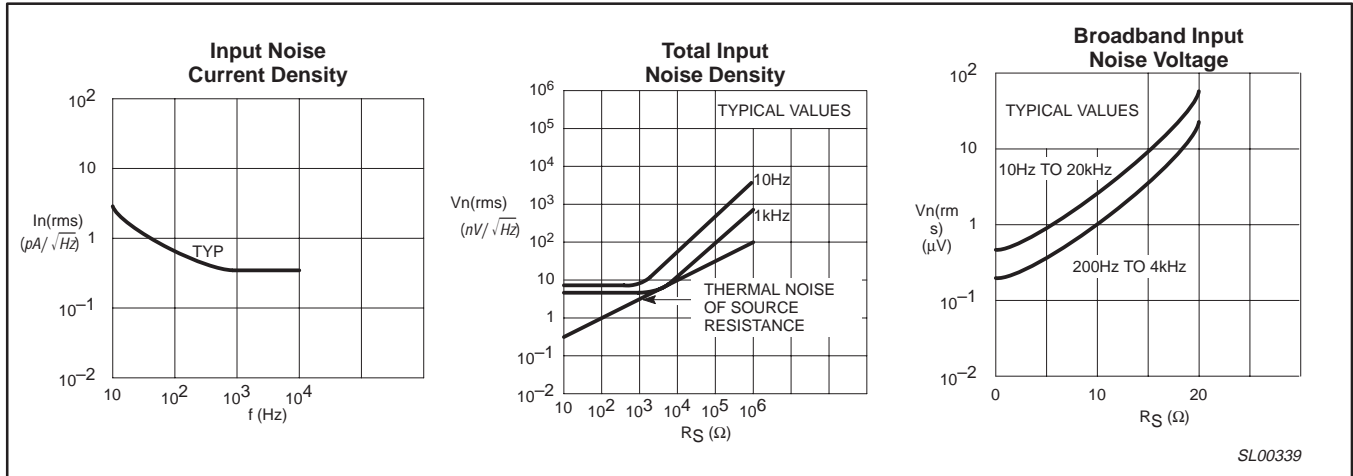


Figure 4. Typical Performance Characteristics (cont.)

## TEST LOAD CIRCUITS

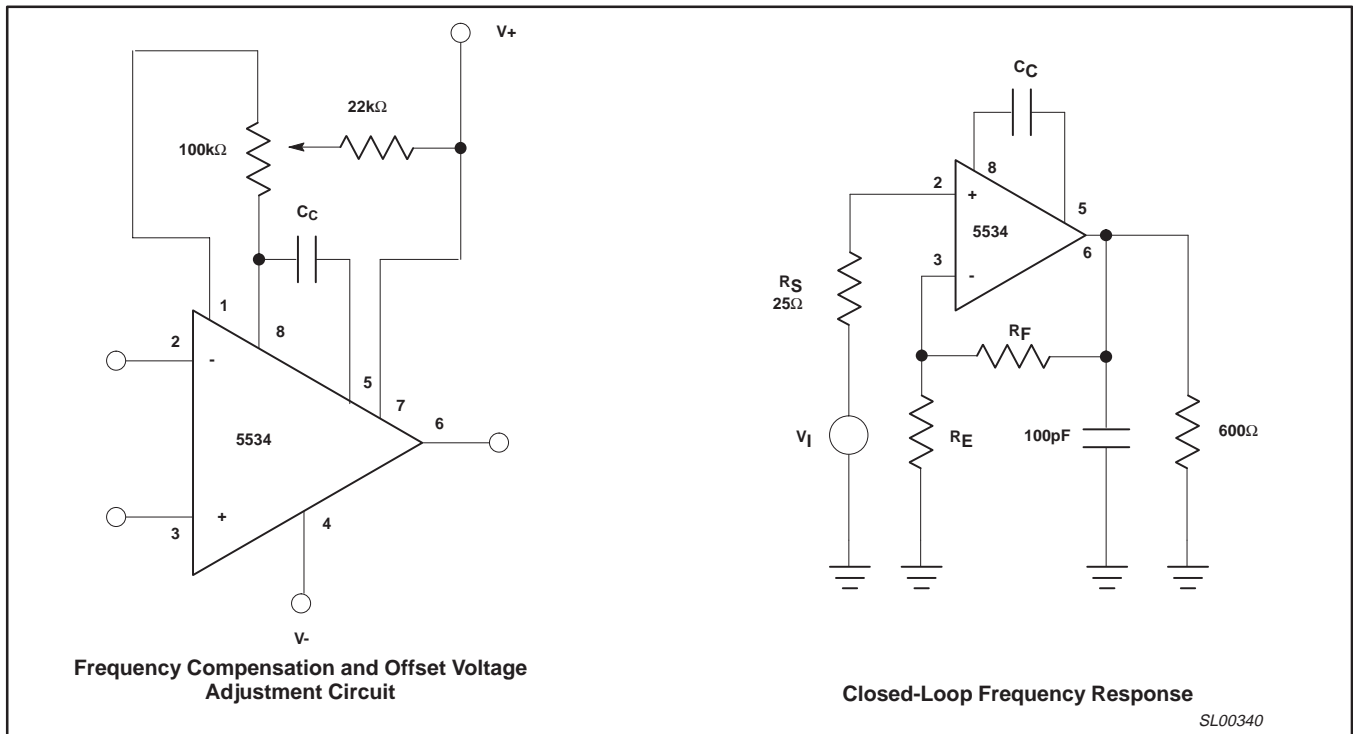


Figure 5. Test Load Circuits

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## NOISE TEST BLOCK DIAGRAM

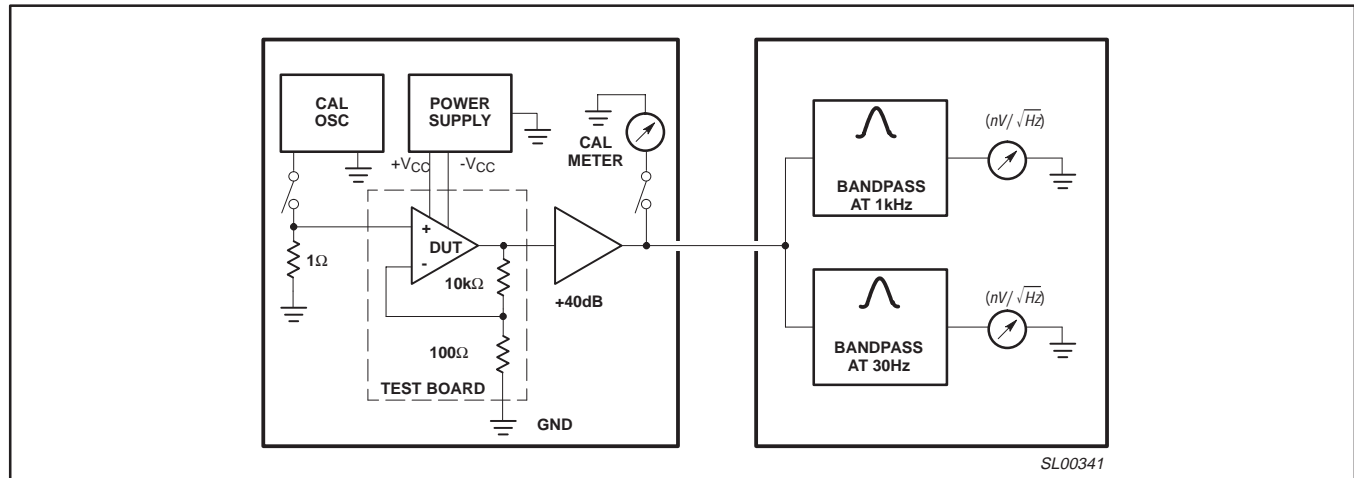


Figure 6. Noise Test Block Diagram

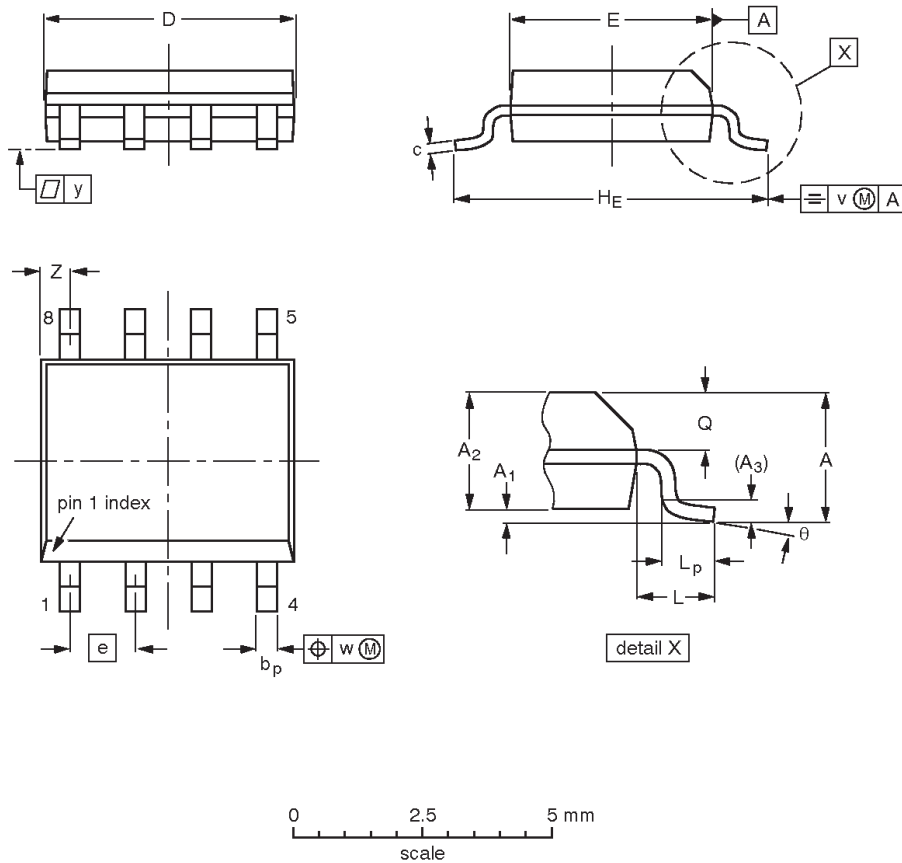


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**S08:** plastic small outline package; 8 leads; body width 3.9 mm

**SOT96-1**



**DIMENSIONS (inch dimensions are derived from the original mm dimensions)**

UNIT	A max.	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	E <sup>(2)</sup>	e	H <sub>E</sub>	L	L <sub>p</sub>	Q	v	w	y	Z <sup>(1)</sup>	θ
mm	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	5.0 4.8	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8° 0°
inches	0.069	0.010 0.004	0.057 0.049	0.01	0.019 0.014	0.0100 0.0075	0.20 0.19	0.16 0.15	0.050	0.244 0.228	0.041	0.039 0.016	0.028 0.024	0.01	0.01	0.004	0.028 0.012	

**Notes**

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
2. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

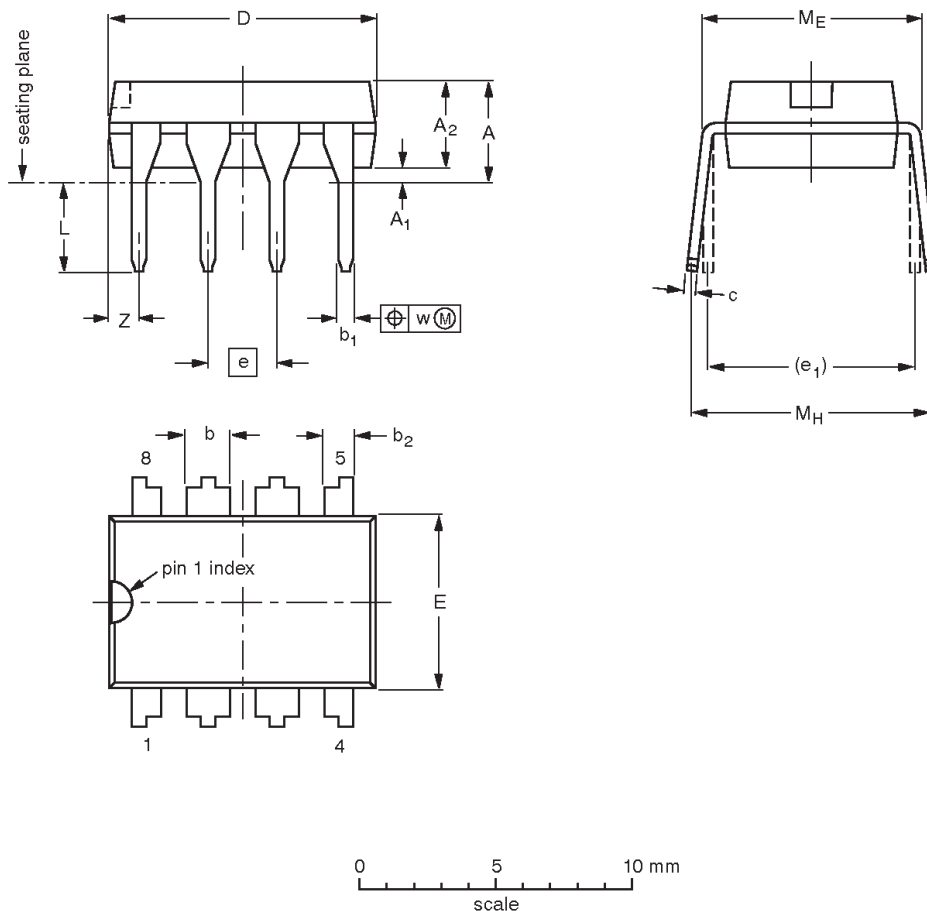
OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT96-1	076E03	MS-012				97-05-22 99-12-27

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DIP8: plastic dual in-line package; 8 leads (300 mil)

SOT97-1



**DIMENSIONS (inch dimensions are derived from the original mm dimensions)**

UNIT	A max.	A <sub>1</sub> min.	A <sub>2</sub> max.	b	b <sub>1</sub>	b <sub>2</sub>	c	D <sup>(1)</sup>	E <sup>(1)</sup>	e	e <sub>1</sub>	L	M <sub>E</sub>	M <sub>H</sub>	w	Z <sup>(1)</sup> max.
mm	4.2	0.51	3.2	1.73 1.14	0.53 0.38	1.07 0.89	0.36 0.23	9.8 9.2	6.48 6.20	2.54	7.62	3.60 3.05	8.25 7.80	10.0 8.3	0.254	1.15
inches	0.17	0.020	0.13	0.068 0.045	0.021 0.015	0.042 0.035	0.014 0.009	0.39 0.36	0.26 0.24	0.10	0.30	0.14 0.12	0.32 0.31	0.39 0.33	0.01	0.045

**Note**

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT97-1	050G01	MO-001	SC-504-8			95-02-04 99-12-27

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**NOTES**

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