

Low-Noise Operational Amplifier

GENERAL DESCRIPTION

The XR-5534 is a high performance low-noise operational amplifier especially designed for application in high quality and professional audio equipment. It offers five-fold improvement in noise characteristics, output drive capability and full-power bandwidth over conventional 741-type op amps. The op amp is internally compensated for gain equal to, or higher than, three. The frequency response can be optimized with an external compensation capacitor for various applications such as operating in unity gain mode or driving capacitive loads.

The XR-5534A is a specially-screened version of the XR-5534, with guaranteed noise specifications.

FEATURES

Direct Replacement for Signetics NE/SE 5534
Wide Small-Signal Bandwidth: 10 MHz
High-Current Drive Capability
(10V rms into 600Ω at $V_S = \pm 18V$)
High Slew Rate: 13 V/μs
Wide Power-Bandwidth: 200 kHz typ.
Very Low Input Noise: 4 nV/√Hz typ.

APPLICATIONS

High Quality Audio Amplification
Telephone Channel Amplifiers
Servo Control Systems
Low-Level Signal Detection
Active Filter Design

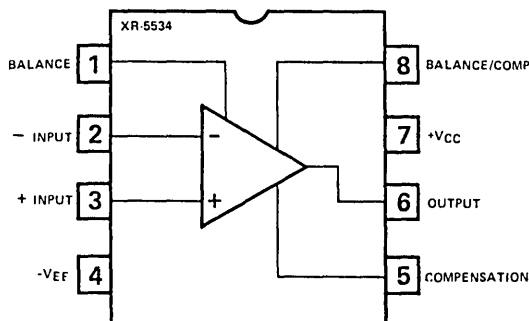
ABSOLUTE MAXIMUM RATINGS

Power Supply	$\pm 22 V$
Input Common-Mode Voltage	$+V_{CC}$ to $-V_{EE}$
Differential Input Voltage (Note 1)	$\pm 0.5 V$
Power Dissipation (Package Limitation)	
Ceramic Package	385 mW
Plastic Package	300 mW
Derate Above +24°C	2.5 mW/°C
Short Circuit Duration (Note 2)	Indefinite
Storage Temperature	-60°C to +150°C

Note 1: Diodes protect the inputs against over-voltage. Therefore, unless current-limiting resistors are used, large currents will flow if the differential input voltage exceeds 0.6V. Maximum current should be limited to ± 10 mA.

Note 2: Output may be shorted to ground at $V_S = \pm 15V$, $T_A = 25^\circ C$. Temperature and/or supply voltages must be limited to ensure dissipation rating is not exceeded.

FUNCTIONAL BLOCK DIAGRAM



ORDERING INFORMATION

Part Number	Package	Operating Temperature
5534AM	Ceramic	-55°C to +125°C
5534M	Ceramic	-55°C to +125°C
5534ACN	Ceramic	0°C to +70°C
5534CN	Ceramic	0°C to +70°C
5534ACP	Plastic	0°C to +70°C
5534CP	Plastic	0°C to +70°C

SYSTEM DESCRIPTION

The XR-5534 and XR-5534A are monolithic operational amplifiers featuring low noise and a very large gain bandwidth product. The devices offer low output resistance and can drive 10 Vrms into 600Ω. Input noise is 100% tested on the XR-5534A, and is typically only 4 nV/√Hz. The small signal bandwidth is 10 MHz and slew rate exceeds 13 V/μs.

Reverse parallel diodes provide input protection; maximum differential input voltage is 0.7 V. Balance pins are provided to zero offset voltage. The device is internally compensated for gains ≥ 3 and provides external compensation pins for unity gain applications. Supply voltage may range from $\pm 3V$ to $\pm 20V$.

XR-5534/5534A

ELECTRICAL CHARACTERISTICS

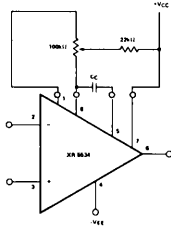
Test Conditions: $T_A = 25^\circ\text{C}$, $V_{CC} = V_{EE} = 15\text{V}$, unless otherwise specified.

PARAMETERS	XR-5534M/5534AM			XR-5534AC/XR-5534C			UNITS	SYMBOL	CONDITIONS
	MIN	TYP	MAX	MIN	TYP	MAX			
DC CHARACTERISTICS									
Input Offset Voltage		0.5	2 3		0.5	4 5	mV mV	V _{OS}	T _A = 25°C I _A = Full Range
Input Offset Current		10	200 500		20	300 400	nA nA	I _{OS}	T _A = 25°C I _A = Full Range
Input Bias Current		400	800 1500		500	1500 2000	nA nA	I _B	T _A = 25°C I _A = Full Range
Large Signal Voltage Gain	50 25	100		25 15	100		V/mV V/mV	A _{VOL}	R _L ≥ 600Ω, V _O = ±10V T _A = 25°C I _A = Full Range
Supply Current		4	6.5		4	8	mA	I _{CC}	R _L = Open
Output Swing	±12 ±15	±13 ±16		±12 ±15	±13 ±16		V V	V _{OUT}	R _L ≥ 600Ω V _{CC} = V _{EE} = 15V V _{CC} = V _{EE} = 18V
Output Short Circuit Current		38			38		mA	I _{SC}	(Note 2)
Input Resistance	50	100		30	100		kΩ	R _{IN}	
Common-Mode Range	±12	±13		±12	±13		V	V _{ICM}	
Common-Mode Rejection	80	100		70	100		dB	CMRR	
Power Supply Rejection		10	50		10	100	μV/V	PSRR	
AC CHARACTERISTICS									
Transient Response									Voltage Follower
Rise Time		20			20		nSec	t _r	R _L ≥ 600Ω, C _C = 22 pF
Overshoot		20			20		%	t ₀	C _L = 100 pF
AC Gain		6 2.2			6 2.2		6 2.2	V/mV V/mV	f = 10 kHz C _C = 0 C _C = 22 pF
Unity-Gain Bandwidth		10			10		MHz	BW	C _C = 22 pF, C _L = 100 pF
Slew Rate		13 6			13 6		V/μsec V/μsec		C _C = 0 C _C = 22 pF
Power Bandwidth		95 200			95 200		kHz kHz	f _p	V _{OUT} = ±10V, C _C = 22 pF C _C = 0
NOISE CHARACTERISTICS									
PARAMETERS	XR-5534A			XR-5534			UNITS	SYMBOL	CONDITIONS
	MIN	TYP	MAX	MIN	TYP	MAX			
Input Noise Voltage		5.5 3.5	7 4.5		7 4		nV/√Hz nV/√Hz	e _n	f ₀ = 30 Hz f ₀ = 1 kHz
Input Noise Current		1.5 0.4			2.5 0.6		pA/√Hz pA/√Hz	i _n	f ₀ = 30 Hz f ₀ = 1 kHz
Broadband Noise Figure		0.9					dB	F _N	R _S = 5 kΩ f = 10 Hz to 20 kHz

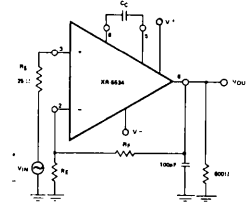
XR-5534/5534A

TEST CIRCUITS

FREQUENCY COMPENSATION AND OFFSET VOLTAGE ADJUSTMENT CIRCUIT

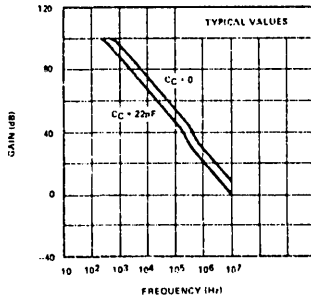


CLOSED LOOP FREQUENCY RESPONSE

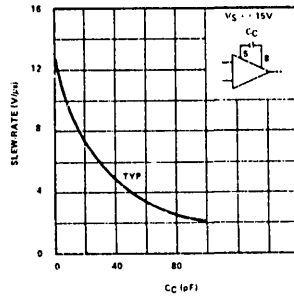


TYPICAL PERFORMANCE CHARACTERISTICS

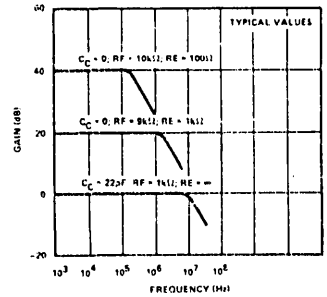
OPEN LOOP FREQUENCY RESPONSE



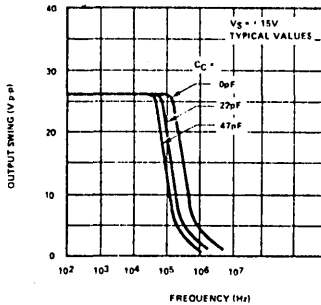
SLEW-RATE AS A FUNCTION OF COMPENSATION CAPACITANCE



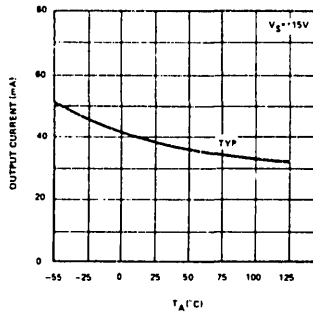
CLOSED LOOP FREQUENCY RESPONSE



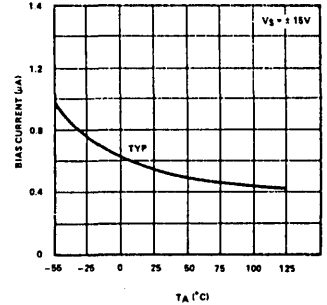
LARGE-SIGNAL FREQUENCY RESPONSE



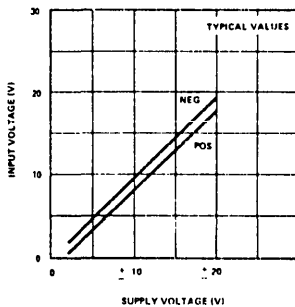
OUTPUT SHORT-CIRCUIT CURRENT



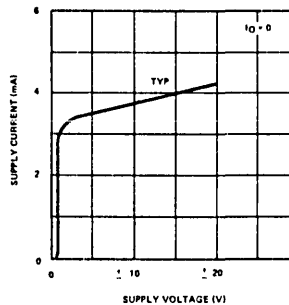
INPUT BIAS CURRENT



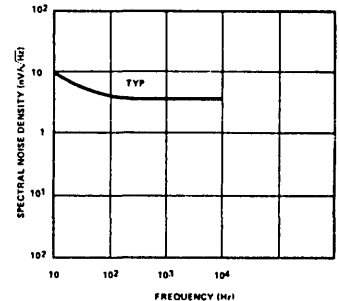
INPUT COMMON MODE VOLTAGE RANGE



SUPPLY CURRENT



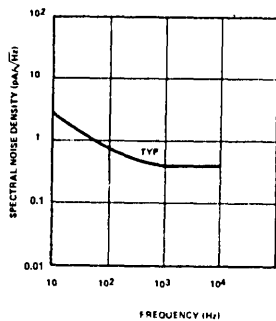
INPUT NOISE VOLTAGE DENSITY



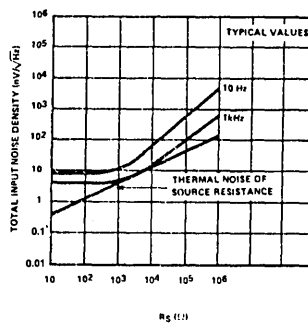
XR-5534/5534A

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

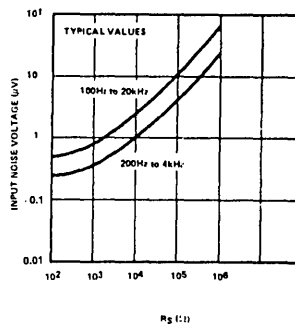
INPUT NOISE CURRENT DENSITY



TOTAL INPUT NOISE DENSITY

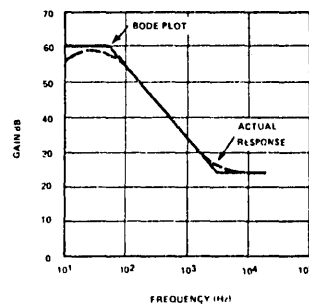
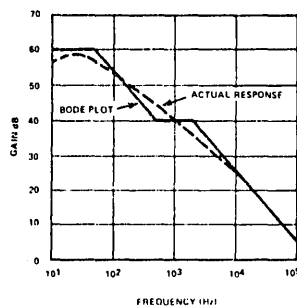
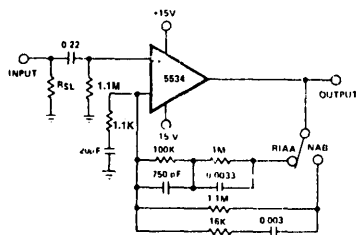


BROADBAND INPUT NOISE VOLTAGE



TYPICAL APPLICATION

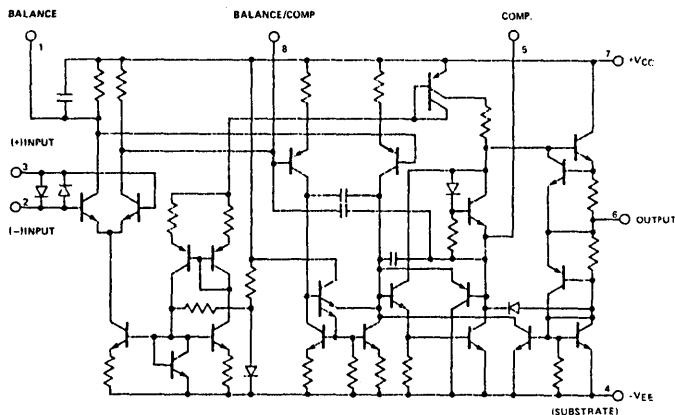
PREAMPLIFIER-RIAA/NAB COMPENSATION



*SELECT TO PROVIDE SPECIFIED TRANSDUCER LOADING
OUTPUT NOISE = 0.8 mV rms (WITH INPUT SHORTED)
ALL RESISTOR VALUES ARE IN OHMS

BODE PLOT OF RIAA EQUALIZATION AND THE
RESPONSE REALIZED IN AN ACTUAL CIRCUIT
USING THE XR-5534.

BODE PLOT OF NAB EQUALIZATION AND THE
RESPONSE REALIZED IN THE ACTUAL CIRCUIT USING
THE XR-5534.



EQUIVALENT SCHEMATIC DIAGRAM