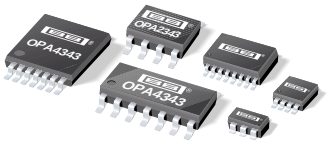
Burr-Brown Products
from Texas Instruments

OPA343
OPA2343
OPA4343



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SINGLE-SUPPLY, RAIL-TO-RAIL OPERATIONAL AMPLIFIERS
*micro*Amplifier™ Series

FEATURES

- RAIL-TO-RAIL INPUT/OUTPUT
- MICRO SIZE PACKAGES
- WIDE BANDWIDTH: 5.5MHz
- HIGH SLEW RATE: 6V/μs
- LOW THD+NOISE: 0.0007% (f = 1kHz)
- LOW QUIESCENT CURRENT: 850μA/chan
- SINGLE, DUAL, AND QUAD VERSIONS

APPLICATIONS

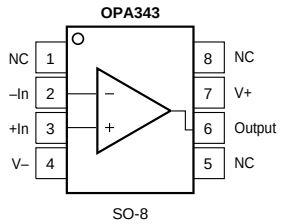
- DRIVING A/D CONVERTERS
- PCMCIA CARDS
- DATA ACQUISITION
- AUDIO PROCESSING
- COMMUNICATIONS
- ACTIVE FILTERS
- TEST EQUIPMENT

DESCRIPTION

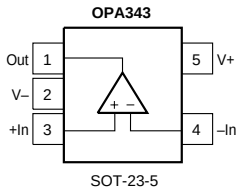
OPA343 series rail-to-rail CMOS operational amplifiers are designed for low-cost, miniature applications. They are optimized for low-voltage, single-supply operation. Rail-to-rail input/output and high-speed operation make them ideal for driving sampling Analog-to-Digital (A/D) converters. They are also well suited for general-purpose and audio applications as well as providing I/V conversion at the output of Digital-to-Analog (D/A) converters. Single, dual, and quad versions have identical specifications for design flexibility.

The OPA343 series operates on a single supply as low as 2.5V, and input common-mode voltage range extends 500mV beyond the supply rails. Output voltage swings to within 1mV of the supply rails with a 100kΩ load. They offer excellent dynamic response (BW = 5.5MHz, SR = 6V/μs), yet quiescent current is only 850μA. Dual and quad designs feature completely independent circuitry for lowest crosstalk and freedom from interaction.

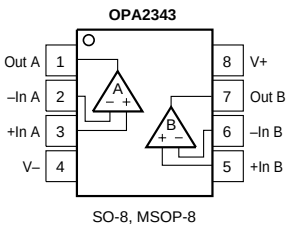
The single (OPA343) packages are the tiny SOT-23-5 surface mount and SO-8 surface mount. The dual (OPA2343) comes in the miniature MSOP-8 surface mount and SO-8 surface mount. The quad (OPA4343) packages are the space-saving SSOP-16 surface mount, SO-14 surface mount, and TSSOP-14 surface mount. All are specified from –40°C to +85°C and operate from –55°C to +125°C. A SPICE macromodel is available for design analysis.



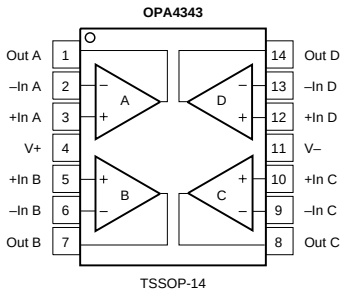
SO-8



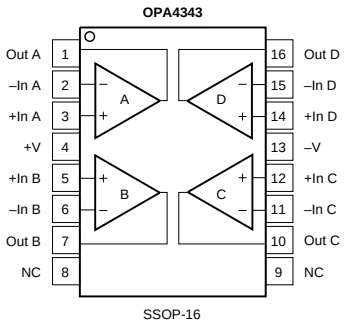
SOT-23-5



SO-8, MSOP-8



TSSOP-14



SSOP-16

TEXAS INSTRUMENTS

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SPECIFICATIONS: V_S = 2.7V to 5.5V

Boldface limits apply over the specified temperature range, **T_A = –40°C to +85°C. V_S = 5V.**

At T_A = +25°C, R_L = 10kΩ connected to $V_S/2$ and $V_{OUT} = V_S/2$, unless otherwise noted.

PARAMETER		CONDITION	OPA343NA, UA OPA2343EA, UA OPA4343EA, UA, NA MIN	TYP[1]	MAX	UNITS
OFFSET VOLTAGE						
Input Offset Voltage	V_{OS}	V_S = 5V		±2	±8	mV
vs Temperature	dV_{OS}/dT			±3		µV/°C
vs Power Supply	PSRR	V_S = 2.7V to 5.5V, V_{CM} = 0V		40	200	µV/V
Over Temperature		V_S = 2.7V to 5.5V, V_{CM} = 0V			**200**	µV/V
Channel Separation, dc				0.2		µV/V
INPUT BIAS CURRENT						
Input Bias Current	I_B			±0.2	±10	pA
Over Temperature					**±60**	pA
Input Offset Current	I_{OS}			±0.2	±10	pA
NOISE						
Input Voltage Noise, f = 0.1 to 50kHz				8		µVrms
Input Voltage Noise Density, f = 1kHz	e_n			25		nV/√Hz
Current Noise Density, f = 1kHz	i_n			3		fA/√Hz
INPUT VOLTAGE RANGE						
Common-Mode Voltage Range	V_{CM}		–0.3		(V+) + 0.3	V
Common-Mode Rejection Ratio	CMRR	–0.3V < V_{CM} < (V+) – 1.8V	74	92		dB
		V_S = 5V, –0.3V < V_{CM} < 5.3V	60	75		dB
		V_S = 2.7V, –0.3V < V_{CM} < 3V	54	70		dB
INPUT IMPEDANCE						
Differential				10^{13} || 3		Ω || pF
Common-Mode				10^{13} || 6		Ω || pF
OPEN-LOOP GAIN						
Open-Loop Voltage Gain	A_{OL}	R_L = 100kΩ, 5mV < V_O < (V+) – 5mV	100	120		dB
Over Temperature		R_L = 100kΩ, 5mV < V_O < (V+) – 5mV	**100**			dB
		R_L = 10kΩ, 50mV < V_O < (V+) – 50mV	100	117		dB
Over Temperature		R_L = 10kΩ, 50mV < V_O < (V+) – 50mV	**100**			dB
		R_L = 2kΩ, 200mV < V_O < (V+) – 200mV	92	110		dB
Over Temperature		R_L = 2kΩ, 200mV < V_O < (V+) – 200mV	**92**			dB
FREQUENCY RESPONSE						
Gain-Bandwidth Product	GBW	G = 1		5.5		MHz
Slew Rate	SR	V_S = 5V, G = 1, C_L = 100pF		6		V/µs
Settling Time, 0.1%		V_S = 5V, 2V Step, C_L = 100pF		1		µs
0.01%		V_S = 5V, 2V Step, C_L = 100pF		1.6		µs
Overload Recovery Time		V_{IN} • G = V_S		0.2		µs
Total Harmonic Distortion + Noise	THD+N	V_S = 5V, V_O = 3Vp-p[2], G = 1, f = 1kHz		0.0007		%
OUTPUT						
Voltage Output Swing from Rail[3]		R_L = 100kΩ, A_{OL} ≥ 100dB		1	5	mV
Over Temperature		R_L = 100kΩ, A_{OL} ≥ 100dB			**5**	mV
		R_L = 10kΩ, A_{OL} ≥ 100dB		10	50	mV
Over Temperature		R_L = 10kΩ, A_{OL} ≥ 100dB			**50**	mV
		R_L = 2kΩ, A_{OL} ≥ 92dB		40	200	mV
Over Temperature		R_L = 2kΩ, A_{OL} ≥ 92dB			**200**	mV
Short-Circuit Current	I_{SC}			±50		mA
Capacitive Load Drive	C_{LOAD}			See Typical Curve		
POWER SUPPLY						
Specified Voltage Range	V_S		2.7		5	V
Operating Voltage Range				2.5 to 5.5		V
Quiescent Current (per amplifier)	I_Q	I_O = 0, V_S = +5V		0.85	1.25	mA
Over Temperature		I_O = 0, V_S = +5V			**1.4**	mA
TEMPERATURE RANGE						
Specified Range			–40		+85	°C
Operating Range			–55		+125	°C
Storage Range			–65		+150	°C
Thermal Resistance	θ_{JA}					
SOT-23-5 Surface Mount				200		°C/W
MSOP-8 Surface Mount				150		°C/W
SO-8 Surface Mount				150		°C/W
SSOP-16 Surface Mount				100		°C/W
SO-14 Surface Mount				100		°C/W
TSSOP-14 Surface Mount				125		°C/W

NOTES: (1) V_S = +5V. (2) V_{OUT} = 0.25V to 3.25V. (3) Output voltage swings are measured between the output and power supply rails.

ABSOLUTE MAXIMUM RATINGS[1]

Supply Voltage	7.5V
Signal Input Terminals, Voltage[2]	(V–) –0.5V to (V+) +0.5V
Current[2]	10mA
Output Short-Circuit[3]	Continuous
Operating Temperature	–55°C to +125°C
Storage Temperature	–65°C to +150°C
Junction Temperature	150°C
Lead Temperature (soldering, 10s)	300°C

NOTES: (1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. (2) Input terminals are diode-clamped to the power supply rails. Input signals that can swing more than 0.5V beyond the supply rails should be current-limited to 10mA or less. (3) Short-circuit to ground, one amplifier per package.

ELECTROSTATIC DISCHARGE SENSITIVITY

This integrated circuit can be damaged by ESD. Burr-Brown recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

PACKAGE/ORDERING INFORMATION

PRODUCT	PACKAGE	PACKAGE DRAWING NUMBER	SPECIFIED TEMPERATURE RANGE	PACKAGE MARKING	ORDERING NUMBER[1]	TRANSPORT MEDIA
Single						
OPA343NA	5-Lead SOT-23-5	331	–40°C to +85°C	B43	OPA343NA/250	Tape and Reel
"	"	"	"	"	OPA343NA/3K	Tape and Reel
OPA343UA	SO-8 Surface-Mount	182	–40°C to +85°C	OPA343UA	OPA343UA	Rails
"	"	"	"	"	OPA343UA/2K5	Tape and Reel
Dual						
OPA2343EA	MSOP-8 Surface-Mount	337	–40°C to +85°C	C43	OPA2343EA/250	Tape and Reel
"	"	"	"	"	OPA2343EA/2K5	Tape and Reel
OPA2343UA	SO-8 Surface-Mount	182	–40°C to +85°C	OPA2343UA	OPA2343UA	Rails
"	"	"	"	"	OPA2343UA/2K5	Tape and Reel
Quad						
OPA4343EA	SSOP-16 Surface-Mount	322	–40°C to +85°C	OPA4343EA	OPA4343EA/250	Tape and Reel
"	"	"	"	"	OPA4343EA/2K5	Tape and Reel
OPA4343UA	SO-14 Surfac-Mount	235	–40°C to +85°C	OPA4343UA	OPA4343UA	Rails
"	"	"	"	"	OPA4343UA/2K5	Tape and Reel
OPA4343NA	TSSOP-14 Surface-Mount	357	–40°C to +85°C	OPA4343NA	OPA4343NA/250	Tape and Reel
"	"	"	"	"	OPA4343NA/2K5	Tape and Reel

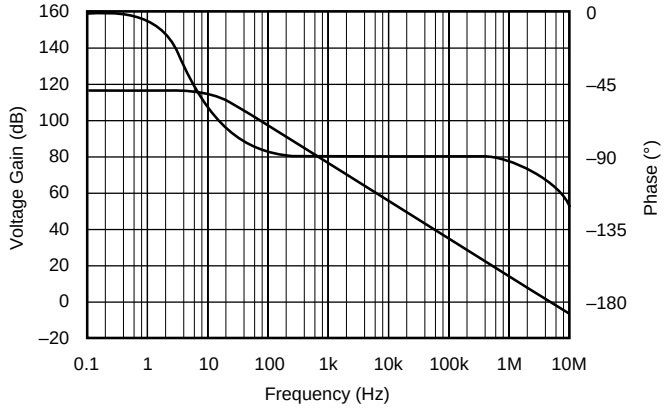
NOTE: (1) Models with a slash (/) are available only in Tape and Reel in the quantities indicated (e.g., /2K5 indicates 2500 devices per reel). Ordering 2500 pieces of "OPA2343EA/2K5" will get a single 2500 piece Tape and Reel.

The information provided herein is believed to be reliable; however, BURR-BROWN assumes no responsibility for inaccuracies or omissions. BURR-BROWN assumes no responsibility for the use of this information, and all use of such information shall be entirely at the user's own risk. Prices and specifications are subject to change without notice. No patent rights or licenses to any of the circuits described herein are implied or granted to any third party. BURR-BROWN does not authorize or warrant any BURR-BROWN product for use in life support devices and/or systems.

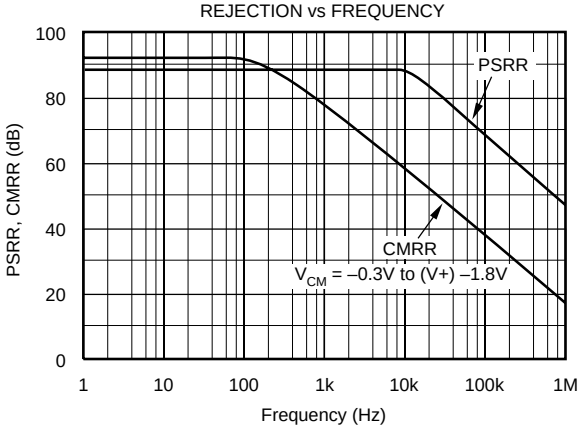
TYPICAL PERFORMANCE CURVES

At T_A = +25°C, V_S = +5V, and R_L = 10kΩ connected to V_S/2, unless otherwise noted.

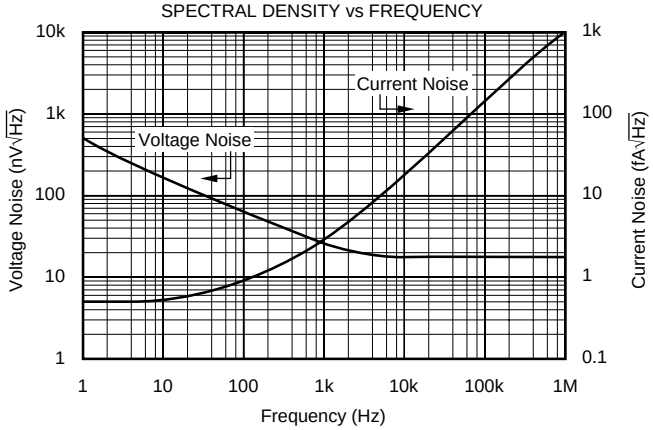
OPEN-LOOP GAIN/PHASE vs FREQUENCY



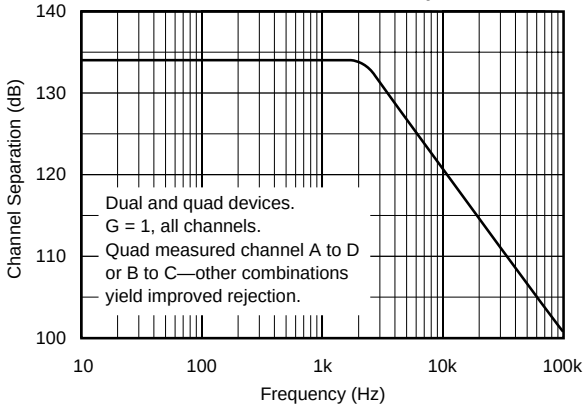
POWER-SUPPLY and COMMON-MODE REJECTION vs FREQUENCY



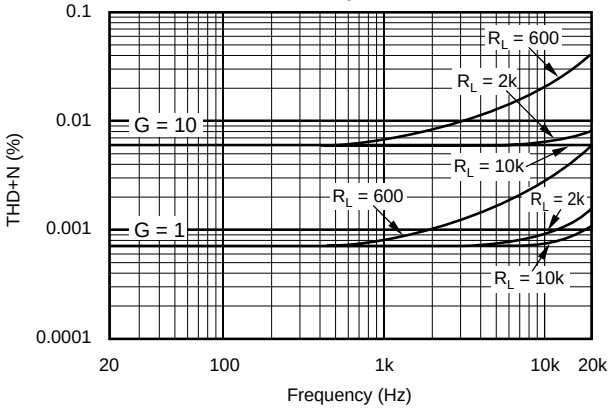
INPUT VOLTAGE AND CURRENT NOISE SPECTRAL DENSITY vs FREQUENCY



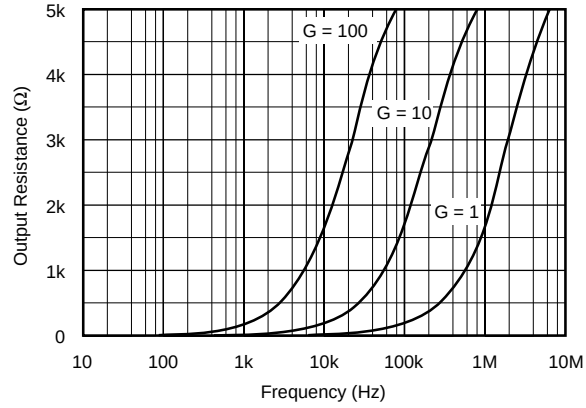
CHANNEL SEPARATION vs FREQUENCY



TOTAL HARMONIC DISTORTION + NOISE vs FREQUENCY



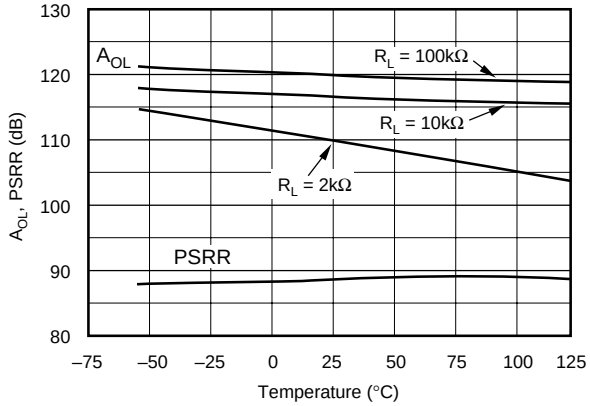
CLOSED-LOOP OUTPUT IMPEDANCE vs FREQUENCY



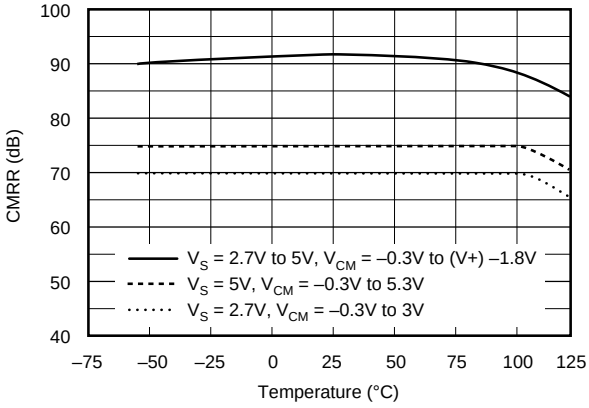
TYPICAL PERFORMANCE CURVES (Cont.)

At T_A = +25°C, V_S = +5V, and R_L = 10kΩ connected to V_S/2, unless otherwise noted.

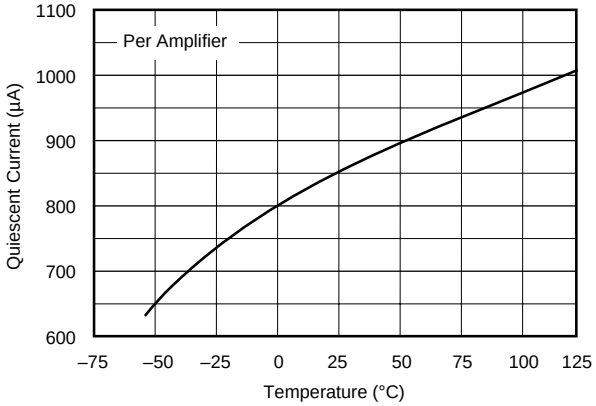
OPEN-LOOP GAIN AND POWER-SUPPLY REJECTION vs TEMPERATURE



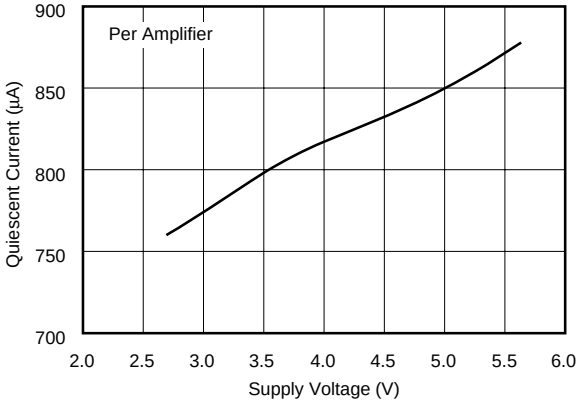
COMMON-MODE REJECTION vs TEMPERATURE



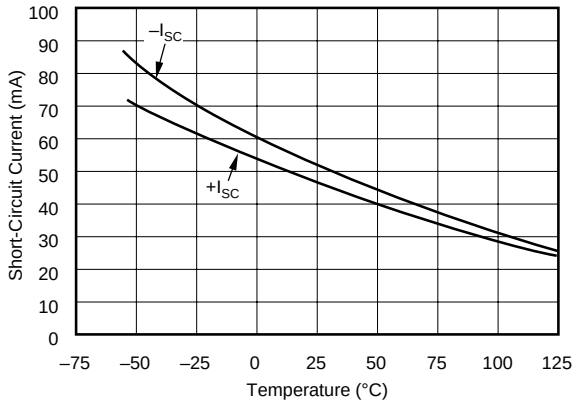
QUIESCENT CURRENT vs TEMPERATURE



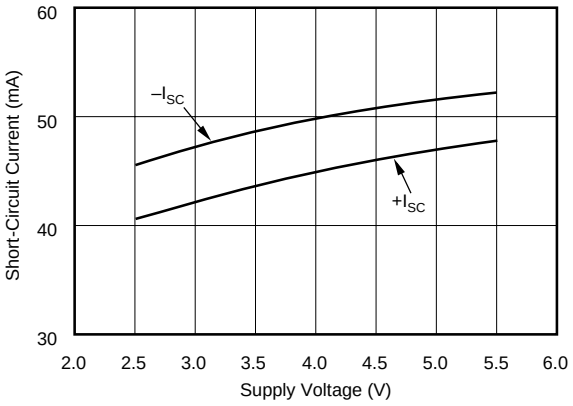
QUIESCENT CURRENT vs SUPPLY VOLTAGE



SHORT-CIRCUIT CURRENT vs TEMPERATURE



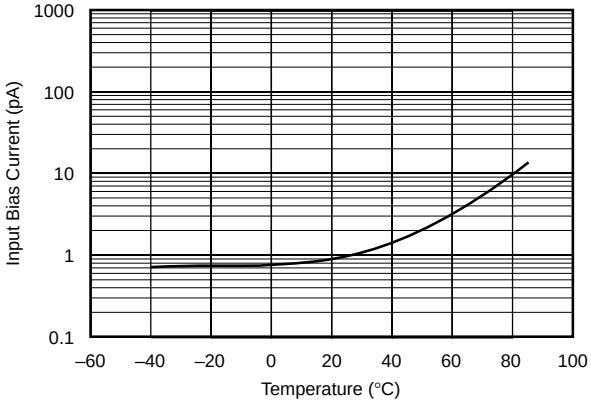
SHORT-CIRCUIT CURRENT vs SUPPLY VOLTAGE



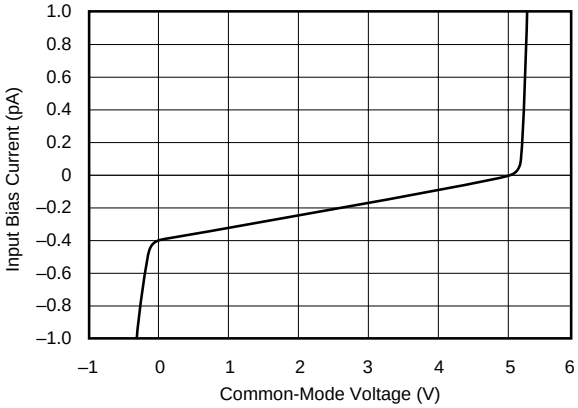
TYPICAL PERFORMANCE CURVES (Cont.)

At T_A = +25°C, V_S = +5V, and R_L = 10kΩ connected to V_S/2, unless otherwise noted.

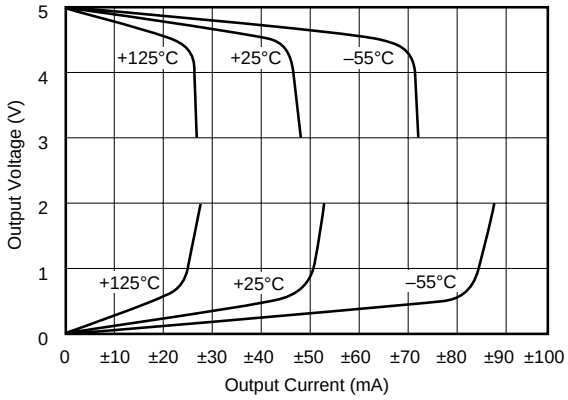
INPUT BIAS CURRENT vs TEMPERATURE



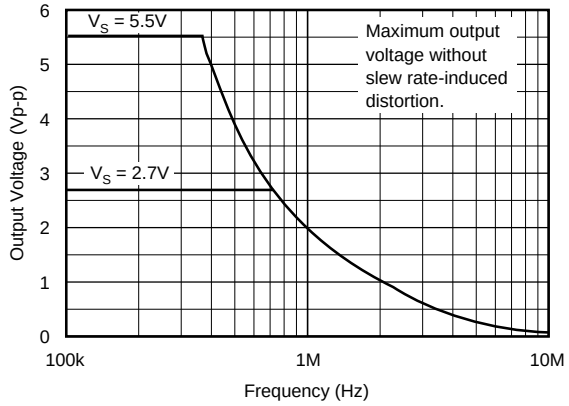
INPUT BIAS CURRENT
vs INPUT COMMON-MODE VOLTAGE



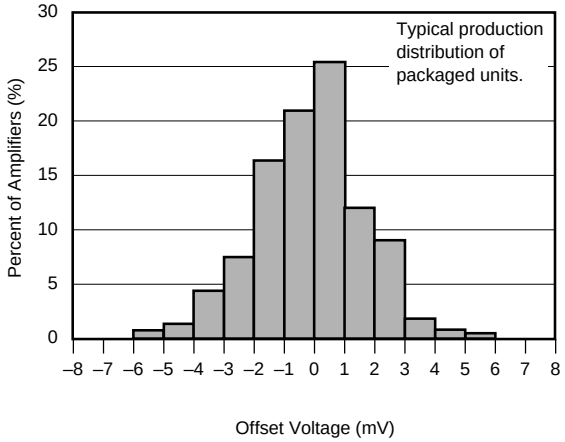
OUTPUT VOLTAGE SWING vs OUTPUT CURRENT



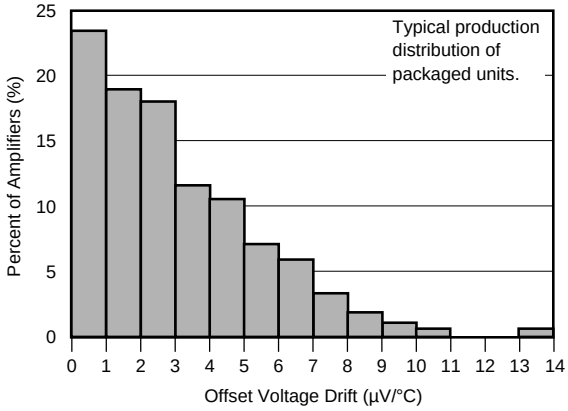
MAXIMUM OUTPUT VOLTAGE vs FREQUENCY



OFFSET VOLTAGE
PRODUCTION DISTRIBUTION



OFFSET VOLTAGE DRIFT
PRODUCTION DISTRIBUTION

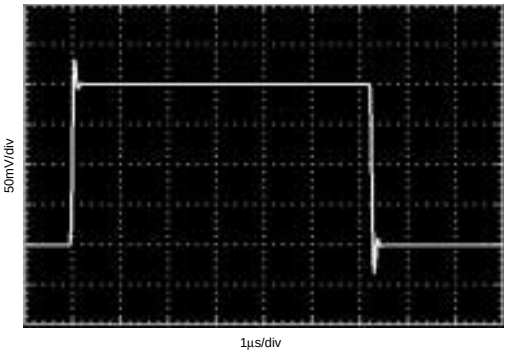


TYPICAL PERFORMANCE CURVES (Cont.)

At T_A = +25°C, V_S = +5V, and R_L = 10kΩ connected to V_S/2, unless otherwise noted.

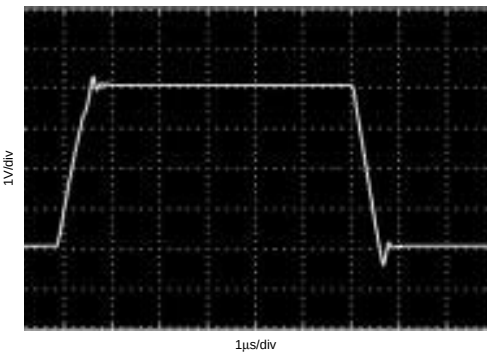
SMALL-SIGNAL STEP RESPONSE

C_L = 100pF

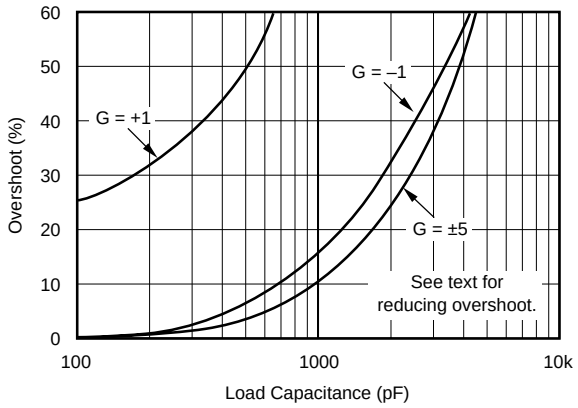


LARGE-SIGNAL STEP RESPONSE

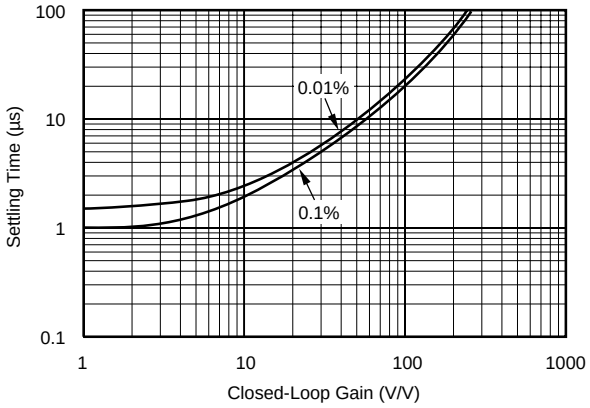
C_L = 100pF



SMALL-SIGNAL OVERSHOOT vs LOAD CAPACITANCE



SETTLING TIME vs CLOSED-LOOP GAIN



APPLICATIONS INFORMATION

OPA343 series op amps are fabricated on a state-of-the-art 0.6 micron CMOS process. They are unity-gain stable and suitable for a wide range of general-purpose applications. Rail-to-rail input/output make them ideal for driving sampling A/D converters. In addition, excellent ac performance makes them well-suited for audio applications. The class AB output stage is capable of driving 600Ω loads connected to any point between V+ and ground.

Rail-to-rail input and output swing significantly increases dynamic range, especially in low-supply applications. Figure 1 shows the input and output waveforms for the OPA343 in unity-gain configuration. Operation is from a single +5V supply with a 10kΩ load connected to $V_S/2$. The input is a 5Vp-p sinusoid. Output voltage is approximately 4.98Vp-p.

Power-supply pins should be bypassed with 0.01µF ceramic capacitors.

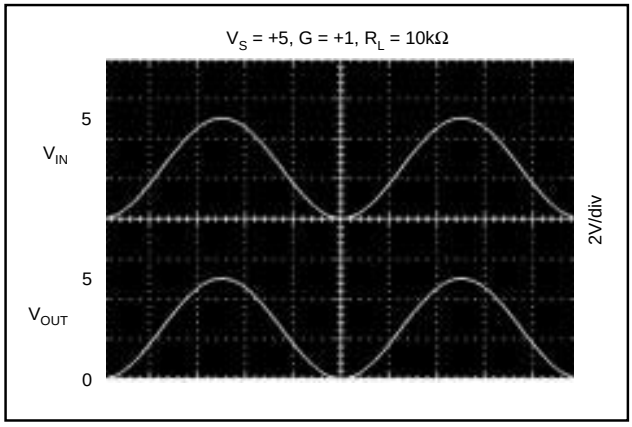


FIGURE 1. Rail-to-Rail Input and Output.

OPERATING VOLTAGE

OPA343 series op amps are fully specified from +2.7V to +5V. However, supply voltage may range from +2.5V to +5.5V. Parameters are guaranteed over the specified supply range—a unique feature of the OPA343 series. In addition, many specifications apply from –40°C to +85°C. Most behavior remains virtually unchanged throughout the full operating voltage range. Parameters which vary significantly with operating voltages or temperature are shown in the Typical Performance Curves.

RAIL-TO-RAIL INPUT

The input common-mode voltage range of the OPA343 series extends 500mV beyond the supply rails. This is achieved with a complementary input stage—an N-channel input differential pair in parallel with a P-channel differential pair, as shown in Figure 2. The N-channel pair is active for input voltages close to the positive rail, typically (V+) – 1.3V to 500mV above the positive supply. The P-channel pair is on for inputs from 500mV below the negative supply to approximately (V+) – 1.3V.

There is a small transition region, typically (V+) – 1.5V to (V+) – 1.1V, in which both input pairs are on. This 400mV transition region can vary ±300mV with process variation. Thus, the transition region (both stages on) can range from (V+) – 1.8V to (V+) – 1.4V on the low end, up to (V+) – 1.2V to (V+) – 0.8V on the high end. Within the 400mV transition region PSRR, CMRR, offset voltage, offset drift, and THD may be degraded compared to operation outside this region.

A double-folded cascode adds the signal from the two input pairs and presents a differential signal to the class AB output stage. Normally, input bias current is approximately 200fA, however, input voltages exceeding the power supplies by

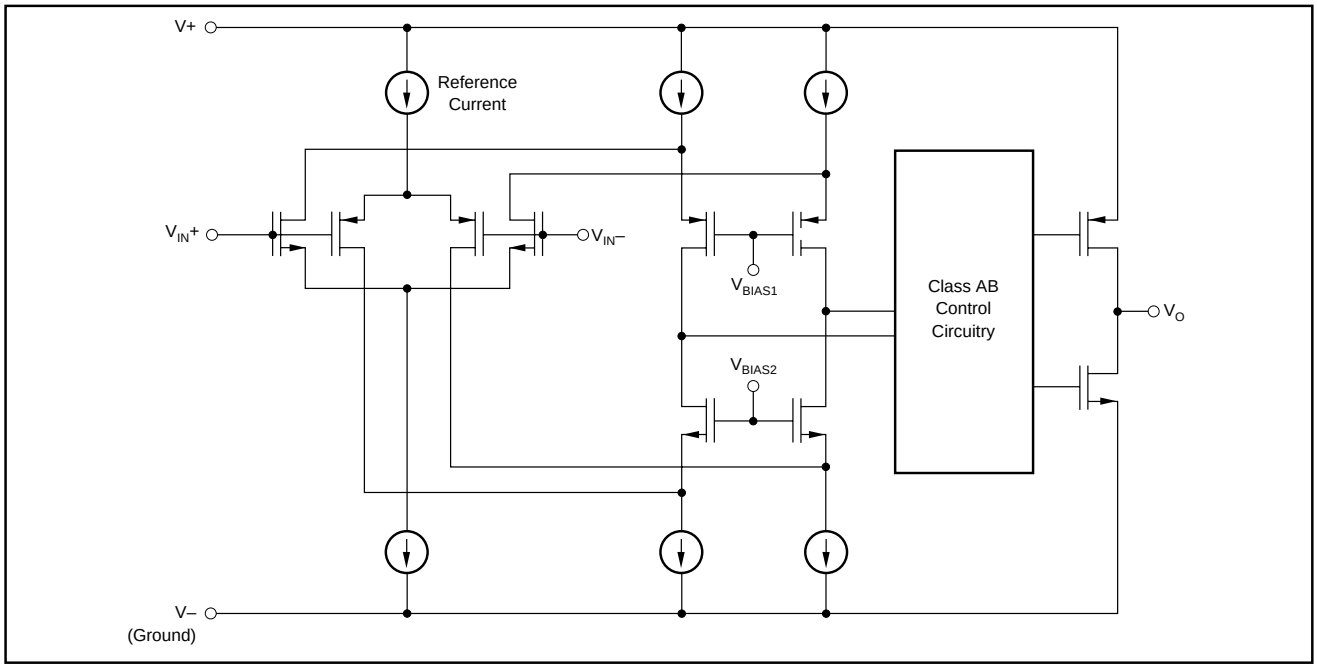


FIGURE 2. Simplified Schematic.

more than 500mV can cause excessive current to flow in or out of the input pins. Momentary voltages greater than 500mV beyond the power supply can be tolerated if the current on the input pins is limited to 10mA. This is easily accomplished with an input resistor, as shown in Figure 3. Many input signals are inherently current-limited to less than 10mA, therefore, a limiting resistor is not required.

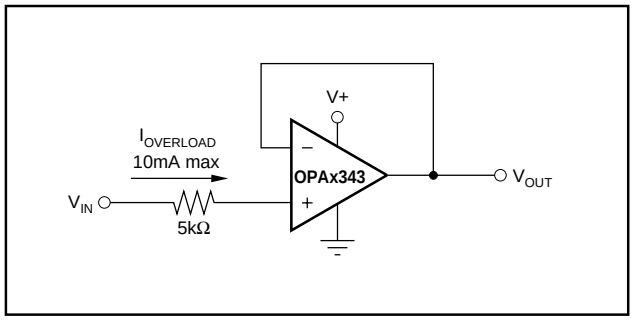


FIGURE 3. Input Current Protection for Voltages Exceeding the Supply Voltage.

RAIL-TO-RAIL OUTPUT

A class AB output stage with common-source transistors is used to achieve rail-to-rail output. For light resistive loads (>50kΩ), the output voltage is typically a few millivolts from the supply rails. With moderate resistive loads (2kΩ to 50kΩ), the output can swing to within a few tens of millivolts from the supply rails and maintain high open-loop gain. See the typical performanc curve "Output Voltage Swing vs Output Current."

CAPACITIVE LOAD AND STABILITY

OPA343 series op amps can drive a wide range of capacitive loads. However, all op amps under certain conditions may become unstable. Op amp configuration, gain, and load value are just a few of the factors to consider when determining stability. An op amp in unity gain configuration is the most susceptible to the effects of capacitive load. The capacitive load reacts with the op amp's output resistance, along with any additional load resistance, to create a pole in the small-signal response which degrades the phase margin. In unity gain, OPA343 series op amps perform well, with a pure capacitive load up to approximately 1000pF. Increasing gain enhances the amplifier's ability to drive more capacitance. See the typical performance curve "Small-Signal Overshoot vs Capacitive Load."

One method of improving capacitive load drive in the unity gain configuration is to insert a 10Ω to 20Ω resistor in series with the output, as shown in Figure 4. This significantly reduces ringing with large capacitive loads. However, if there is a resistive load in parallel with the capacitive load, R_S creates a voltage divider. This introduces a dc error at the output and slightly reduces output swing. This error may be insignificant. For instance, with R_L = 10kΩ and R_S = 20Ω, there is only about a 0.2% error at the output.

DRIVING A/D CONVERTERS

OPA343 series op amps are optimized for driving medium speed (up to 100kHz) sampling A/D converters. However, they also offer excellent performance for higher-speed converters. The OPA343 series provides an effective means of buffering the A/D's input capacitance and resulting charge injection while providing signal gain. For applications requiring high accuracy, the OPA340 series is recommended.

Figures 5 and 6 show the OPA343 driving an ADS7816. The ADS7816 is a 12-bit, micro-power sampling converter in the tiny MSOP-8 package. When used with the miniature package options of the OPA343 series, the combination is ideal for space-limited and low-power applications. For further information consult the ADS7816 data sheet.

With the OPA343 in a noninverting configuration, an RC network at the amplifier's output can be used to filter high frequency noise in the signal (see Figure 5). In the inverting configuration, filtering may be accomplished with a capacitor across the feedback resistor (see Figure 6).

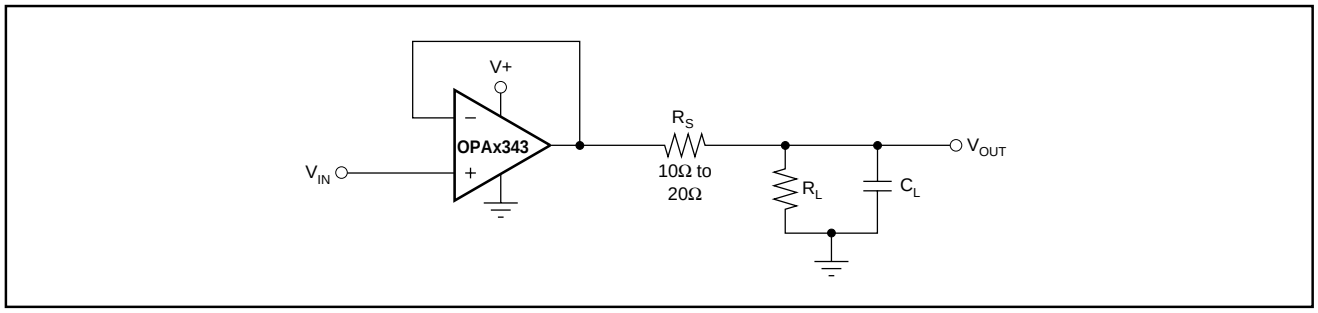


FIGURE 4. Series Resistor in Unity-Gain Configuration Improves Capacitive Load Drive.

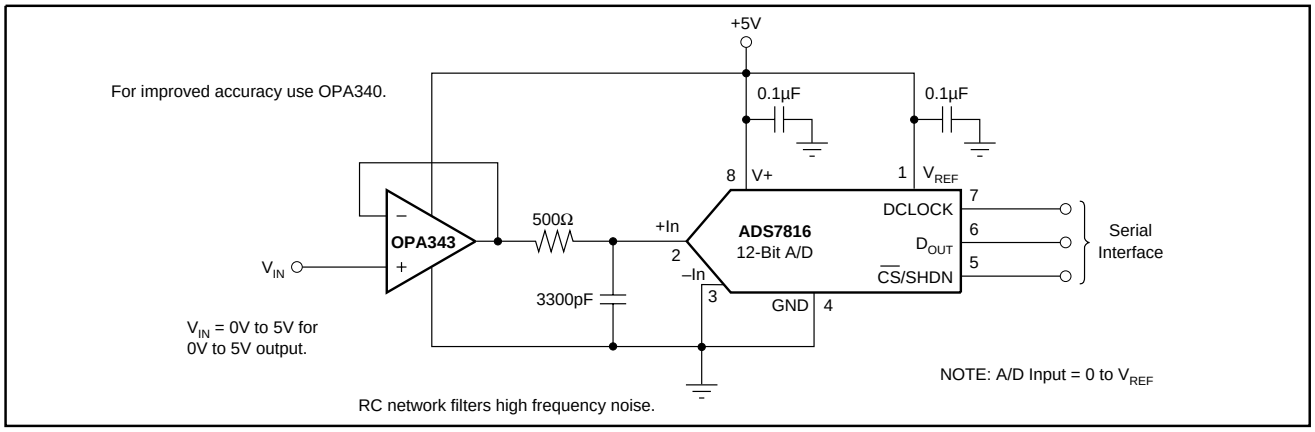


FIGURE 5. OPA343 in Noninverting Configuration Driving ADS7816.

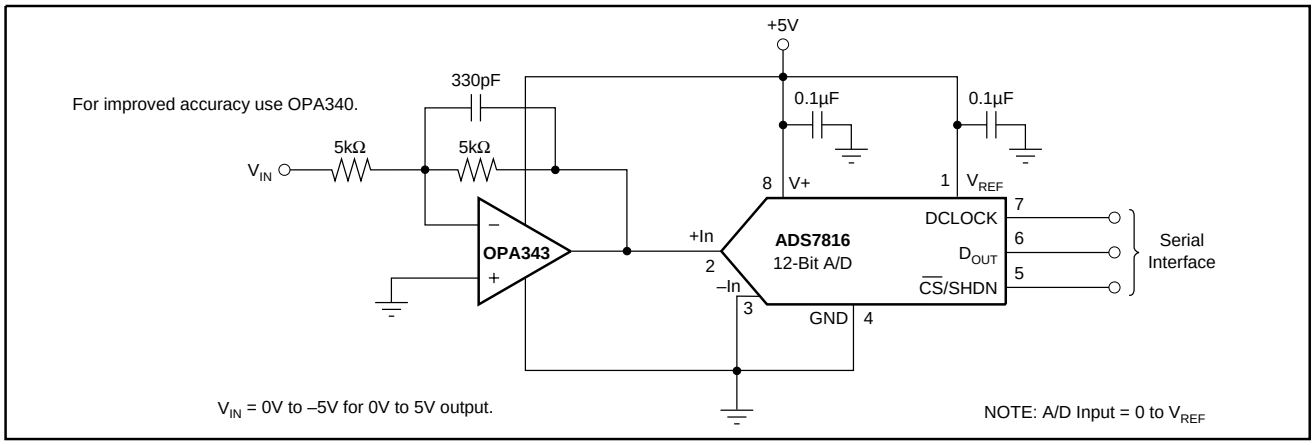


FIGURE 6. OPA343 in Inverting Configuration Driving ADS7816.

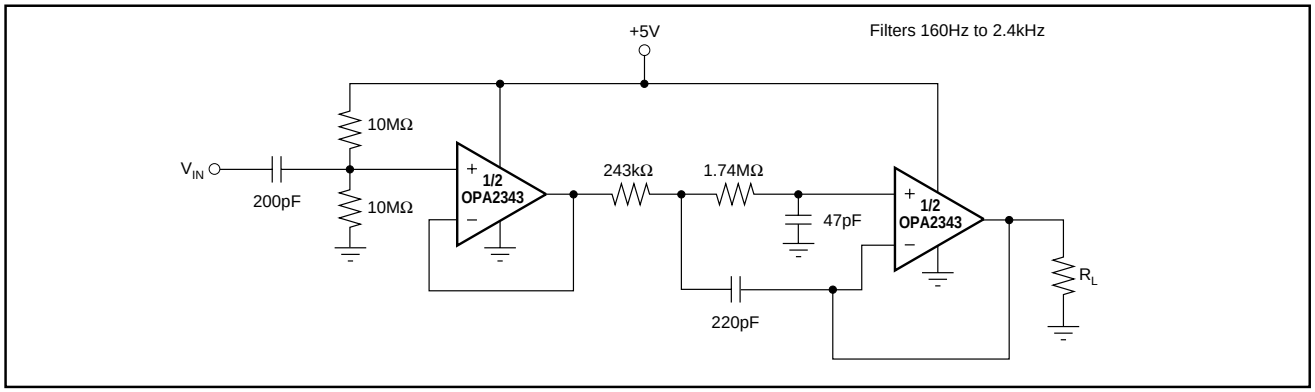


FIGURE 7. Speech Bandpass Filter.

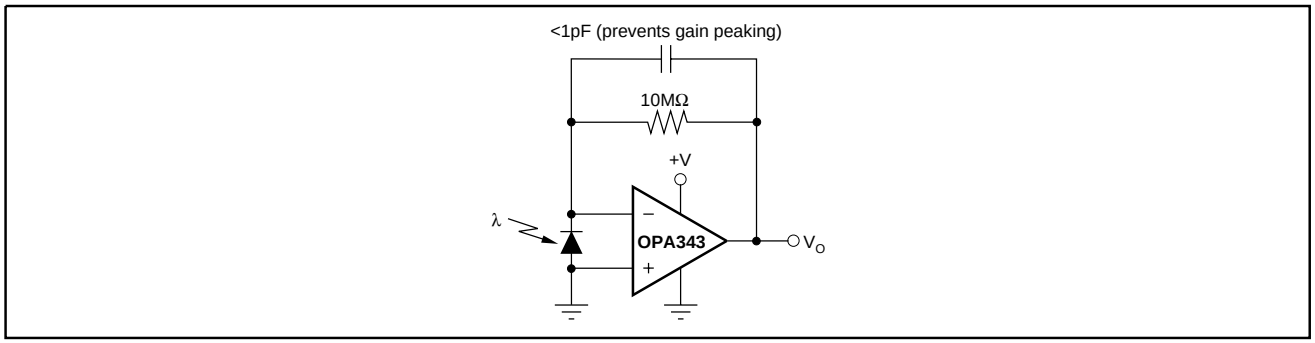


FIGURE 8. Transimpedance Amplifier.

PACKAGING INFORMATION

ORDERABLE DEVICE	STATUS(1)	PACKAGE TYPE	PACKAGE DRAWING	PINS	PACKAGE QTY
OPA2343EA/250	ACTIVE	VSSOP	DGK	8	250
OPA2343EA/2K5	ACTIVE	VSSOP	DGK	8	2500
OPA2343UA	ACTIVE	SOIC	D	8	1
OPA2343UA/2K5	ACTIVE	SOIC	D	8	2500
OPA343NA/250	ACTIVE	SOP	DBV	5	250
OPA343NA/3K	ACTIVE	SOP	DBV	5	3000
OPA343UA	ACTIVE	SOIC	D	8	100
OPA343UA/2K5	ACTIVE	SOIC	D	8	2500
OPA4343EA/250	ACTIVE	SSOP	DBQ	16	250
OPA4343EA/2K5	ACTIVE	SSOP	DBQ	16	2500
OPA4343NA/250	ACTIVE	TSSOP	PW	14	250
OPA4343NA/2K5	ACTIVE	TSSOP	PW	14	2500
OPA4343UA	ACTIVE	SOIC	D	14	58
OPA4343UA/2K5	ACTIVE	SOIC	D	14	2500

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

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