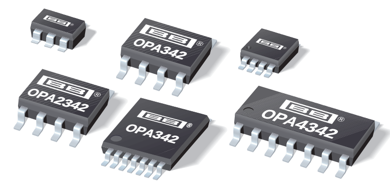
BURR - BROWN®



OPA342
OPA2342
OPA4342

For most current data sheet and other product information, visit www.burr-brown.com

Low Cost, Low Power, Rail-to-Rail OPERATIONAL AMPLIFIERS
*Micro**Amplifier*™ Series

FEATURES

- LOW QUIESCENT CURRENT: 150µA typ
- RAIL-TO-RAIL INPUT
- RAIL-TO-RAIL OUTPUT (within 1mV)
- SINGLE SUPPLY CAPABILITY
- LOW COST
- *Micro*SIZE PACKAGE OPTIONS:
  SOT-23-5
  MSOP-8
  TSSOP-14(1)
- BANDWIDTH: 1MHz
- SLEW RATE: 1V/µs
- THD + NOISE: 0.006%

APPLICATIONS

- COMMUNICATIONS
- PCMCIA CARDS
- DATA ACQUISITION
- PROCESS CONTROL
- AUDIO PROCESSING
- ACTIVE FILTERS
- TEST EQUIPMENT
- CONSUMER ELECTRONICS

DESCRIPTION

The OPA342 series rail-to-rail CMOS operational amplifiers are designed for low cost, low power, miniature applications. They are optimized to operate on a single supply as low as 2.5V with an input common-mode voltage range that extends 300mV beyond the supplies.

Rail-to-rail input/output and high-speed operation make them ideal for driving sampling analog-to-digital converters. They are also well suited for general purpose and audio applications and providing I/V conversion at the output of digital-to-analog converters. Single, dual, and quad versions have identical specs for design flexibility.

The OPA342 series offers excellent dynamic response with a quiescent current of only 250µA max. Dual and quad designs feature completely independent circuitry for lowest crosstalk and freedom from interaction.

The OPA342 is available in the microsize SOT-23-5 and SO-8 packages. The OPA2342 is available in the MSOP-8 and SO-8 packages. The OPA4342 is available in TSSOP-14(1) and SO-14 packages. All are specified for operation from –40°C to +85°C. A SPICE macromodel is available for design analysis.

NOTE: (1) TSSOP-14 package available Q4’99.

SPICE MODEL available at www.burr-brown.com.

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SPECIFICATIONS: V_S = 2.7V to 5.5V

At T_A = +25°C, R_L = 10kΩ connected to V_S/2 and V_{OUT} = V_S/2, unless otherwise noted.
Boldface limits apply over the specified temperature range, T_A = –40°C to +85°C.

PARAMETER		CONDITION	OPA342NA, UA OPA2342EA, UA OPA4342EA(1), UA MIN	TYP	MAX	UNITS
OFFSET VOLTAGE						
Input Offset Voltage	V_{OS}	V_{CM} = V_S/2		±1	±6	mV
T_A = –40°C to +85°C				**±1**	**±6**	**mV**
vs Temperature	**dV_{OS}/dT**			**±3**		**μV/°C**
vs Power Supply	PSRR	V_S = 2.7V to 5.5V, V_{CM} < (V+) – 1.8V		30	200	μV/V
T_A = –40°C to +85°C		**V_S = 2.7V to 5.5V, V_{CM} < (V+) – 1.8V**			**200**	**μV/V**
Channel Separation, dc				0.2		μV/V
f = 1kHz				132		dB
INPUT BIAS CURRENT						
Input Bias Current	I_B			±0.2	±10	pA
T_A = –40°C to +85°C				See Typical Curve		**pA**
Input Offset Current	I_{OS}			±0.2	±10	pA
NOISE						
Input Voltage Noise, f = 0.1Hz to 50kHz				8		μVrms
Input Voltage Noise Density, f = 1kHz	e_n			30		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	V_S = +5.5V, –0.3V < V_{CM} < (V+) – 1.8V	76	88		dB
T_A = –40°C to +85°C		**V_S = +5.5V, –0.3V < V_{CM} < (V+) – 1.8V**	**74**			**dB**
Common-Mode Rejection Ratio	CMRR	V_S = +5.5V, –0.3V < V_{CM} < 5.8V	66	78		dB
T_A = –40°C to +85°C		**V_S = +5.5V, –0.3V < V_{CM} < 5.8V**	**64**			**dB**
Common-Mode Rejection Ratio	CMRR	V_S = +2.7V, –0.3V < V_{CM} < 3V	62	74		dB
T_A = –40°C to +85°C		**V_S = +2.7V, –0.3V < V_{CM} < 3V**	**60**			**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, 10mV < V_O < (V+) – 10mV	106	124		dB
T_A = –40°C to +85°C		**R_L = 100kΩ, 10mV < V_O < (V+) – 10mV**	**100**			**dB**
		R_L = 5kΩ, 400mV < V_O < (V+) – 400mV	96	114		dB
T_A = –40°C to +85°C		**R_L = 5kΩ, 400mV < V_O < (V+) – 400mV**	**90**			**dB**
FREQUENCY RESPONSE		C_L = 100pF				
Gain-Bandwidth Product	GBW	G = 1		1		MHz
Slew Rate	SR	G = 1		1		V/μs
Settling Time, 0.1%		V_S = 5.5V, 2V Step		5		μs
0.01%		V_S = 5.5V, 2V Step		8		μs
Overload Recovery Time		V_{IN} • G = V_S		2.5		μs
Total Harmonic Distortion + Noise, f = 1kHz	THD+N	V_S = 5.5V, V_O = 3Vp-p(2), G = 1		0.006		%
OUTPUT						
Voltage Output Swing from Rail(3)		R_L = 100kΩ, A_{OL} ≥ 96dB		1		mV
		R_L = 100kΩ, A_{OL} ≥ 106dB		3	10	mV
T_A = –40°C to +85°C		**R_L = 100kΩ, A_{OL} ≥ 100dB**			**10**	**mV**
		R_L = 5kΩ, A_{OL} ≥ 96dB		20	400	mV
T_A = –40°C to +85°C		**R_L = 5kΩ, A_{OL} ≥ 90dB**			**400**	**mV**
Short-Circuit Current	I_{SC}	Per Channel		±15		mA
Capacitive Load Drive	C_{LOAD}			See Typical Curve		
POWER SUPPLY						
Specified Voltage Range	V_S		2.7		5.5	V
Operating Voltage Range				2.5 to 5.5		V
Quiescent Current (per amplifier)	I_Q	I_O = 0A		150	250	μA
T_A = –40°C to +85°C					**300**	**μA**
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
TSSOP-14 Surface Mount(1)				100		°C/W
SO-14 Surface Mount				100		°C/W

NOTES: (1) OPA4342EA available 4Q'99. (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, V+ to V–	5.5V
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, 3s)	240°C
ESD Capability (Human Body Model)	4000V

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

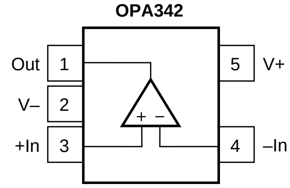
PRODUCT	PACKAGE	PACKAGE DRAWING NUMBER(1)	SPECIFIED TEMPERATURE RANGE	PACKAGE MARKING	ORDERING NUMBER(2)	TRANSPORT MEDIA
OPA342NA	SOT-23-5	331	–40°C to +85°C	B42	OPA342NA/250	Tape and Reel
"	"	"	"	"	OPA342NA/3K	Tape and Reel
OPA342UA	SO-8	182	–40°C to +85°C	OPA342UA	OPA342UA	Rails
"	"	"	"	"	OPA342UA/2K5	Tape and Reel
OPA2342EA	MSOP-8	337	–40°C to +85°C	C42	OPA2342EA/250	Tape and Reel
"	"	"	"	"	OPA2342EA/2K5	Tape and Reel
OPA2342UA	SO-8	182	–40°C to +85°C	OPA2342UA	OPA2342UA	Rails
"	"	"	"	"	OPA2342UA/2K5	Tape and Reel
OPA4342EA∗	TSSOP-14	357	–40°C to +85°C	OPA4342EA	OPA4342EA/250	Tape and Reel
"	"	"	"	"	OPA4342EA/2K5	Tape and Reel
OPA4342UA	SO-14	235	–40°C to +85°C	OPA4342UA	OPA4342UA	Rails
"	"	"	"	"	OPA4342UA/2K5	Tape and Reel

NOTES: (1) For detailed drawing and dimension table, please see end of data sheet, or Appendix C of Burr-Brown IC Data Book. (2) Models with a slash (/) are available only in Tape and Reel in the quantities indicated (e.g., /3K indicates 3000 devices per reel). Ordering 3000 pieces of “OPA342NA/3K” will get a single 3000-piece Tape and Reel. For detailed Tape and Reel mechanical information, refer to Appendix B of Burr-Brown IC Data Book.

∗ OPA4342EA available 4Q’99.

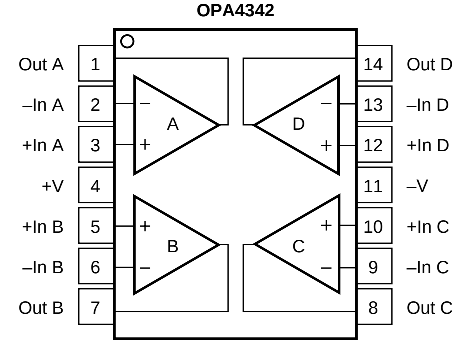
PIN CONFIGURATIONS

OPA342



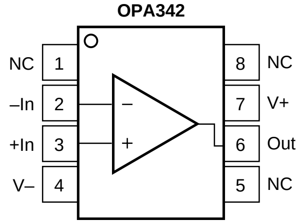
SOT-23-5

OPA4342



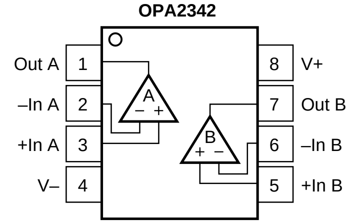
TSSOP-14(1), SO-14

OPA342



SO-8

OPA2342

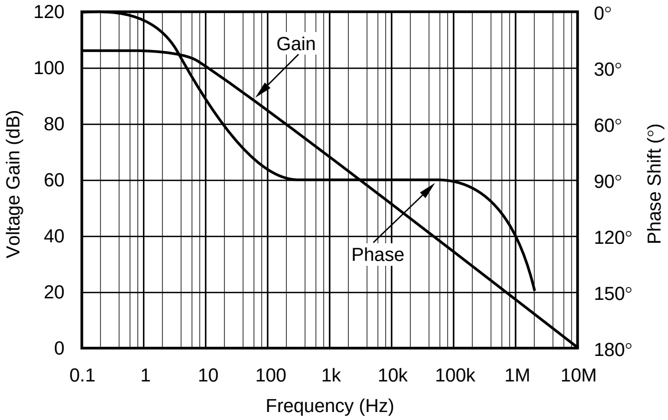


SO-8, MSOP-8

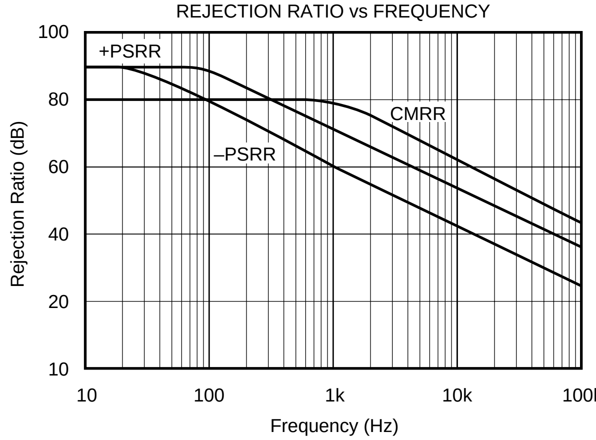
NOTE: (1) TSSOP-14 available 4Q’99.

TYPICAL PERFORMANCE CURVES

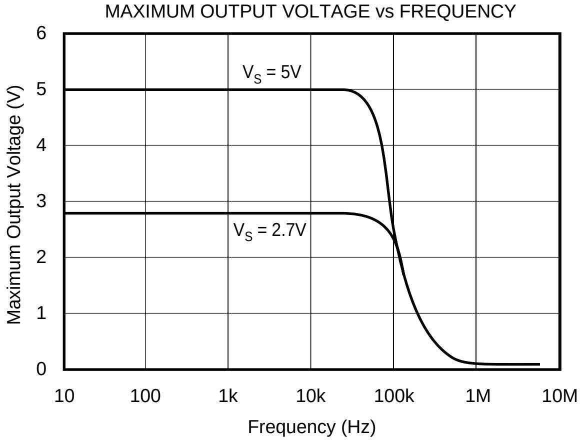
At T_A = +25°C, V_S = +5V, and R_L = 10kΩ, unless otherwise noted.



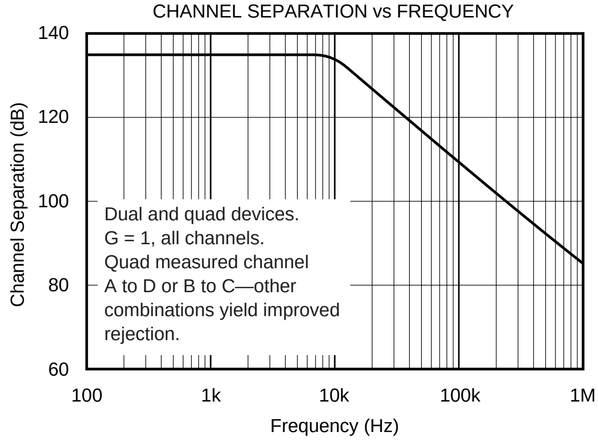
OPEN-LOOP GAIN/PHASE vs FREQUENCY



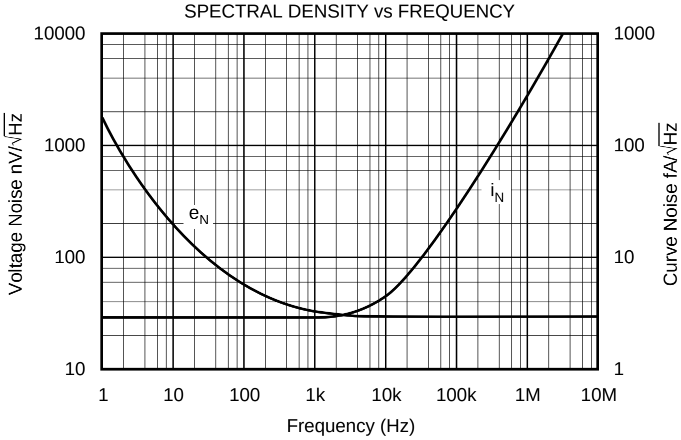
POWER SUPPLY AND COMMON-MODE REJECTION RATIO vs FREQUENCY



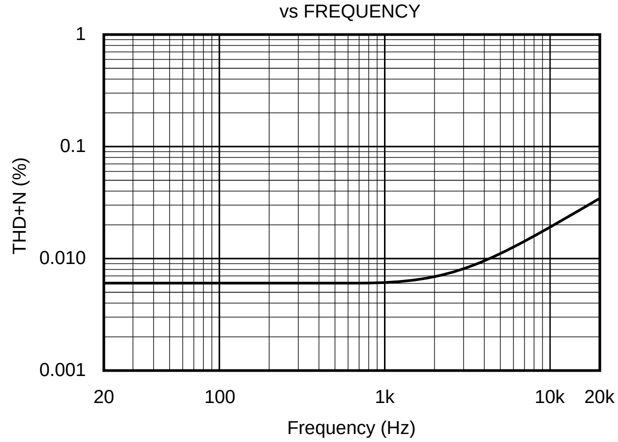
MAXIMUM OUTPUT VOLTAGE vs FREQUENCY



CHANNEL SEPARATION vs FREQUENCY



VOLTAGE AND CURRENT NOISE SPECTRAL DENSITY vs FREQUENCY

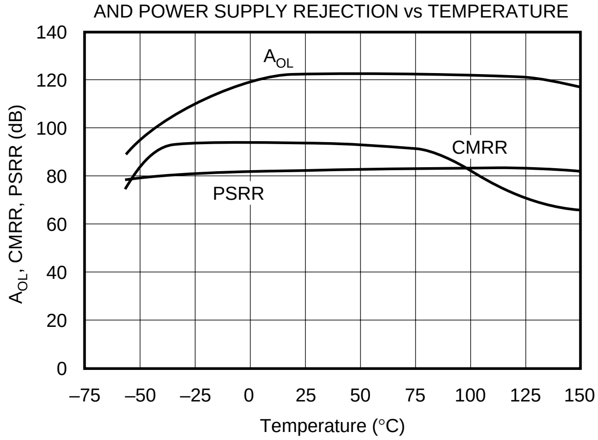


TOTAL HARMONIC DISTORTION + NOISE vs FREQUENCY

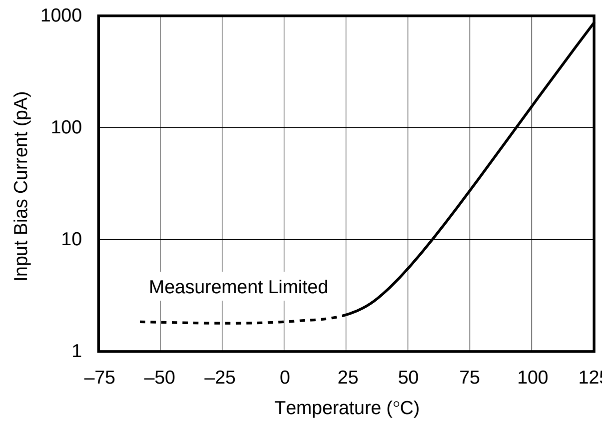
TYPICAL PERFORMANCE CURVES (Cont.)

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

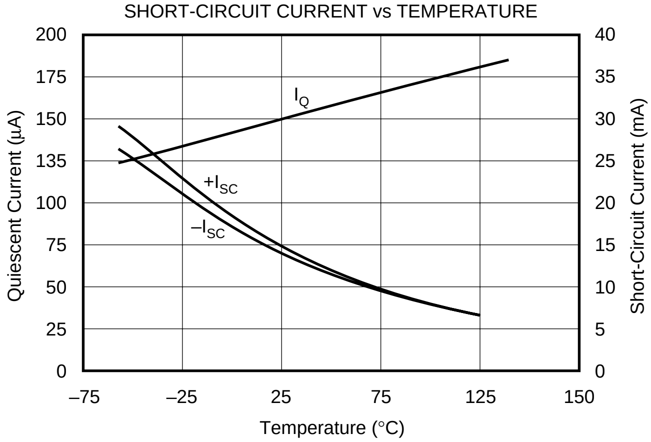
OPEN-LOOP GAIN, COMMON-MODE REJECTION RATIO, AND POWER SUPPLY REJECTION vs TEMPERATURE



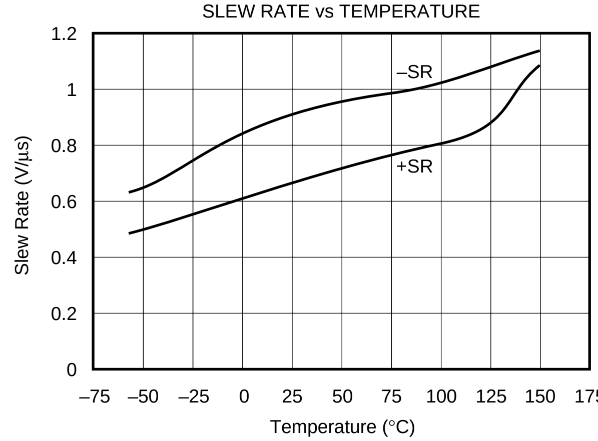
INPUT BIAS CURRENT vs TEMPERATURE



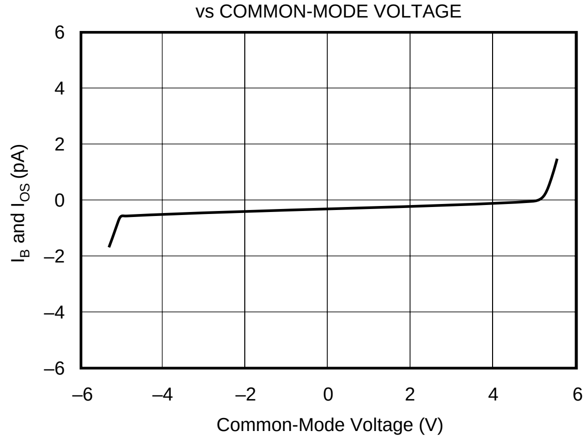
QUIESCENT CURRENT AND SHORT-CIRCUIT CURRENT vs TEMPERATURE



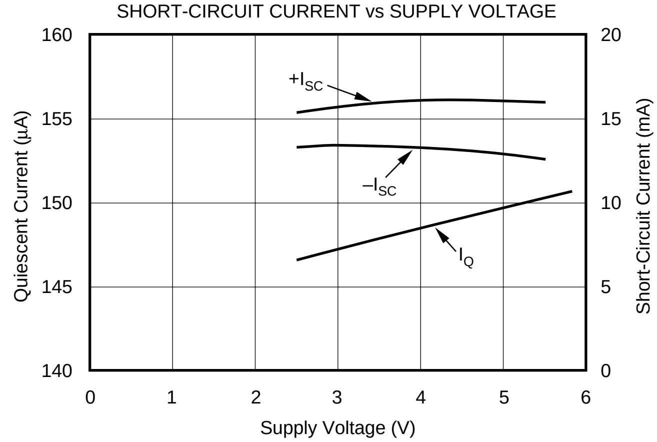
SLEW RATE vs TEMPERATURE



INPUT BIAS CURRENT vs COMMON-MODE VOLTAGE

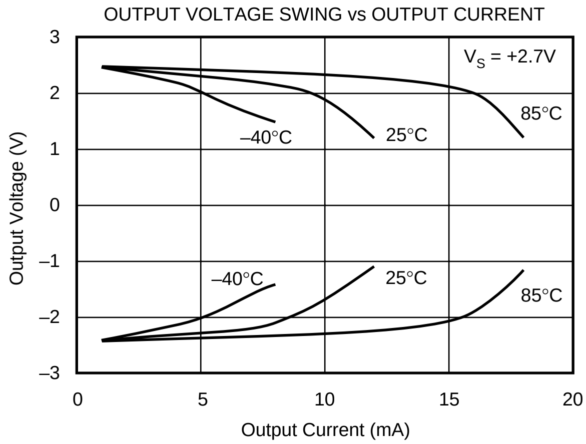


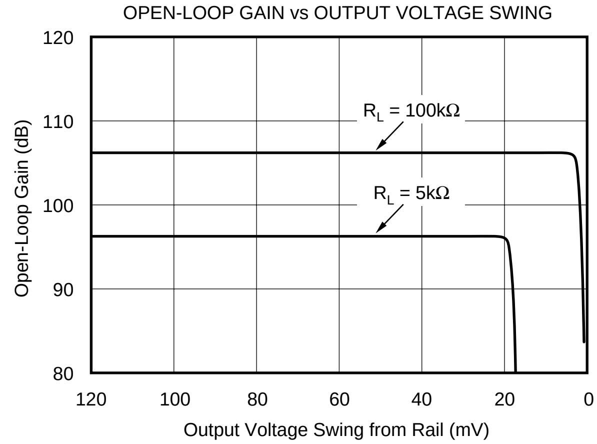
QUIESCENT CURRENT AND SHORT-CIRCUIT CURRENT vs SUPPLY VOLTAGE

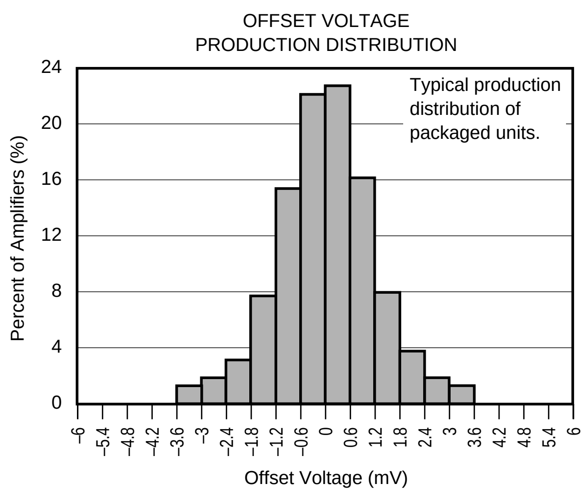


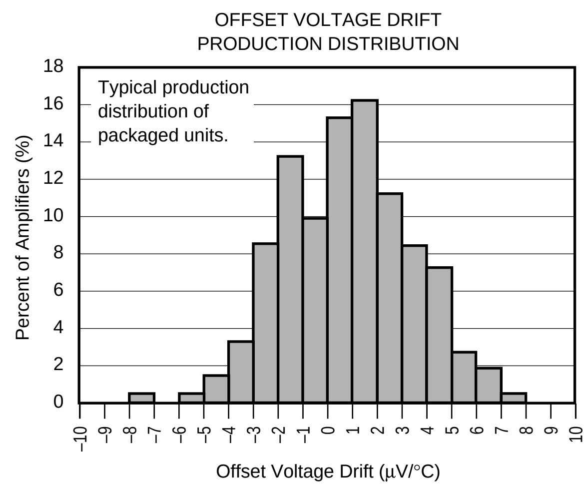
TYPICAL PERFORMANCE CURVES (Cont.)

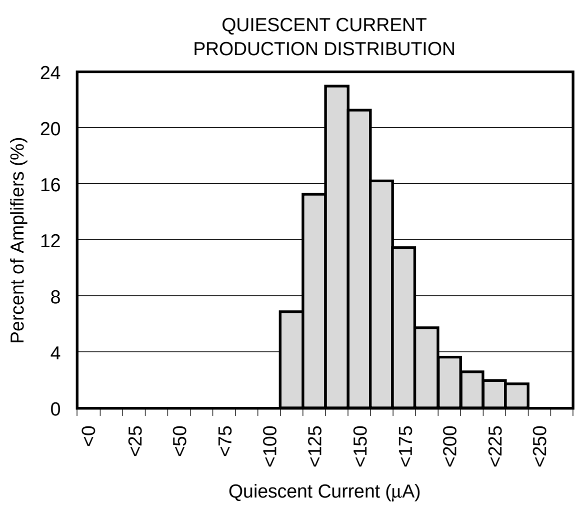
At T_A = +25°C, V_S = +5V, and R_L = 10kΩ, unless otherwise noted.

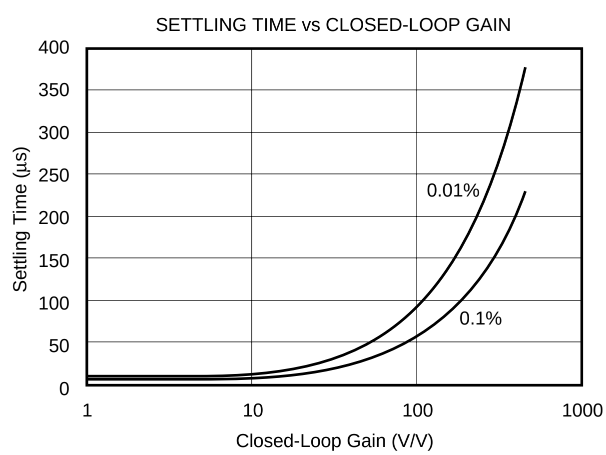








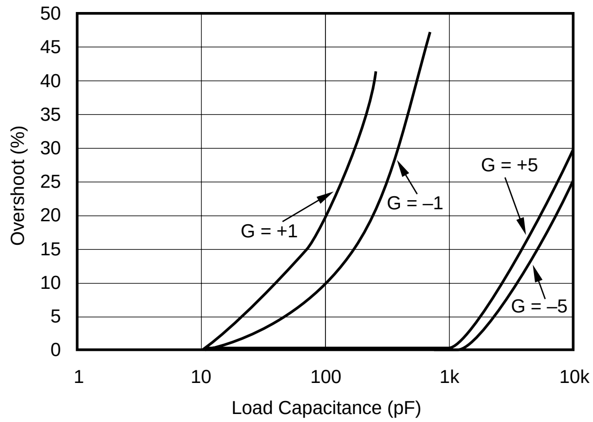




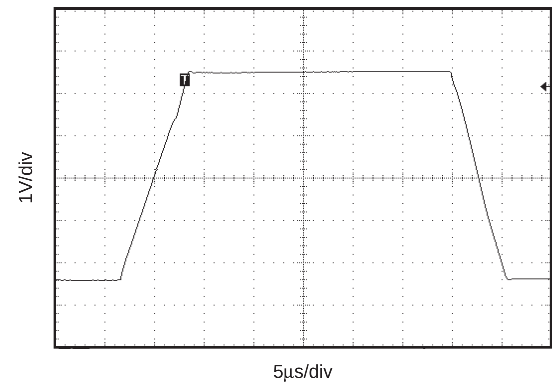
TYPICAL PERFORMANCE CURVES (Cont.)

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

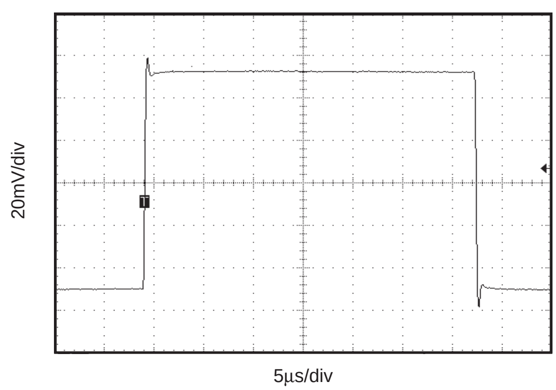
SMALL-SIGNAL OVERSHOOT vs LOAD CAPACITANCE



LARGE-SIGNAL STEP RESPONSE
V_S = ±2.5V, G = +1, R_L = 10kΩ, C_L = 100pF



SMALL-SIGNAL STEP RESPONSE
V_S = ±2.5V, G = +1, R_L = 10kΩ, C_L = 100pF



APPLICATIONS INFORMATION

OPA342 series op amps are unity-gain stable and can operate on a single supply, making them highly versatile and easy to use.

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 OPA342 in unity-gain configuration. Operation is from ±2.5V supplies with a 10kΩ load connected to ground. The input is a 5Vp-p sinusoid. Output voltage is approximately 4.997Vp-p.

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

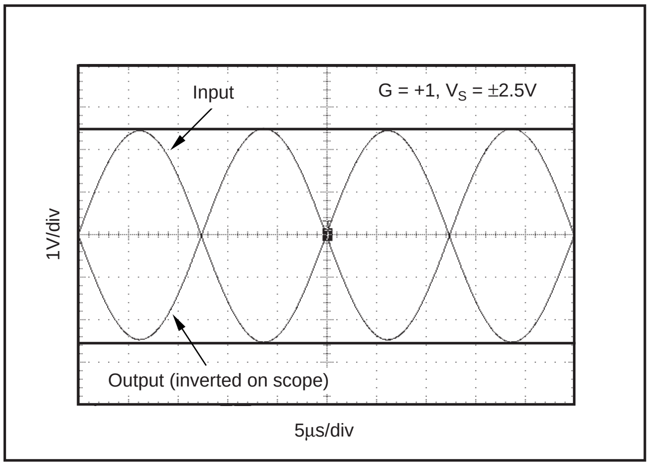


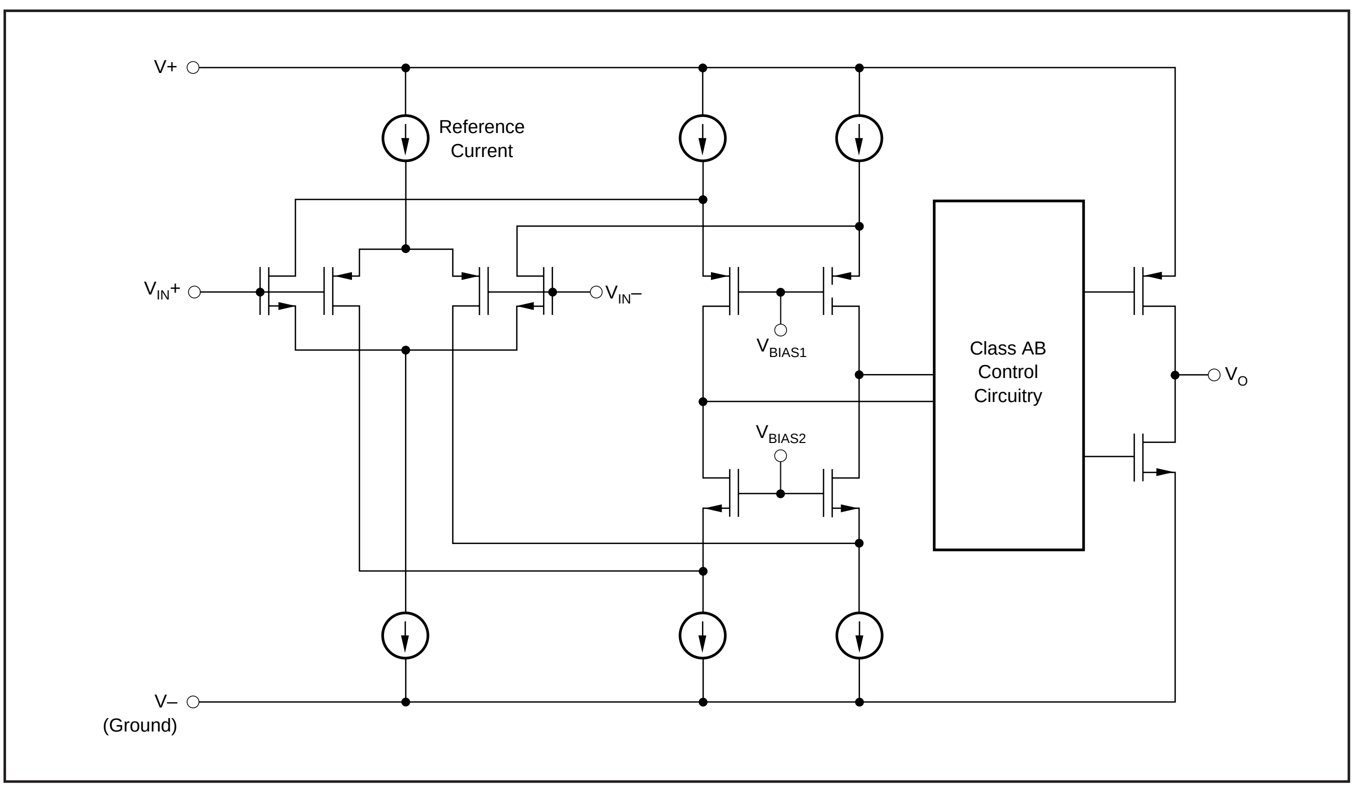
FIGURE 1. Rail-to-Rail Input and Output, Gain = +1.

OPERATING VOLTAGE

OPA342 series op amps are fully specified and guaranteed from +2.7V to +5.5V. In addition, many specifications apply from –40°C to +85°C. Parameters that 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 OPA342 series extends 300mV 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 (see Figure 2). The N-channel input pair is active for input voltages close to the positive rail, typically (V+) – 1.3V to 300mV above the positive supply, while the P-channel input pair is active for inputs from 300mV 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 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. For more information on designing with rail-to-rail input op amps, see Figure 3 “Design Optimization with Rail-to-Rail Input Op Amps.”



COMMON-MODE REJECTION

The CMRR for the OPA342 is specified in several ways so the best match for a given application may be used. First, the CMRR of the device in the common-mode range below the transition region (V_{CM} < (V+) – 1.8V) is given. This specification is the best indicator of the capability of the device when the application requires use of one of the differential input pairs. Second, the CMRR at 5.5V over the entire common-mode range is specified. Third, the CMRR at 2.7V over the entire common-mode range is provided. These last two values include the variations seen through the transition region.

RAIL-TO-RAIL OUTPUT

A class AB output stage with common-source transistors is used to achieve rail-to-rail output. This output stage is capable of driving 600Ω loads connected to any point between V+ and ground. For light resistive loads (> 50kΩ), the output voltage can typically swing to within 1mV from the supply rail. With moderate resistive loads (2kΩ to 50kΩ), the output can swing to within a few tens of millivolts from the supply rails while maintaining high open-loop gain. See the typical performance curve "Output Voltage Swing vs Output Current."

INPUT PROTECTION

Device inputs are protected by ESD diodes that will conduct if the input voltages exceed the power supplies by more than 300mV. Momentary voltages greater than 300mV 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 4. Many input signals are inherently current-limited to less than 10mA, therefore, a limiting resistor is not required.

CAPACITIVE LOAD AND STABILITY

The OPA342 series op amps in unity-gain configuration can drive up to 250pF pure capacitive load. Increasing the gain

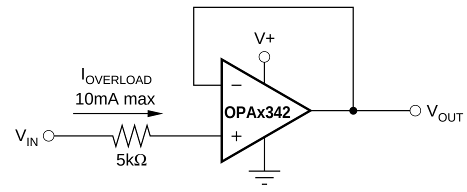


FIGURE 4. Input Current Protection for Voltages Exceeding the Supply Voltage.

enhances the amplifier's ability to drive greater capacitive loads. See the typical performance curve "Small-Signal Overshoot vs Capacitive Load."

In unity-gain configurations, capacitive load drive can be improved by inserting a small (10Ω to 20Ω) resistor R_S in series with the output, as shown in Figure 5. This significantly reduces ringing while maintaining dc performance for purely capacitive loads. However, if there is a resistive load in parallel with the capacitive load, a voltage divider is created, introducing a dc error at the output and slightly reducing the output swing. The error introduced is proportional to the ratio R_S/R_L and may be negligible.

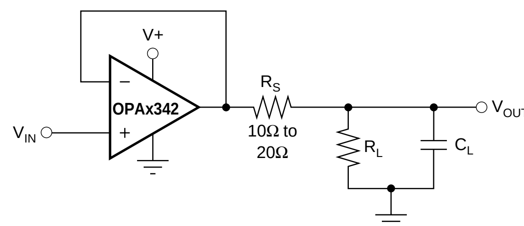


FIGURE 5. Series Resistor in Unity-Gain Configuration Improves Capacitive Load Drive.

DESIGN OPTIMIZATION WITH RAIL-TO-RAIL INPUT OP AMPS

In most applications, operation is within the range of only one differential pair. However, some applications can subject the amplifier to a common-mode signal in the transition region. Under this condition, the inherent mismatch between the two differential pairs may lead to degradation of the CMRR and THD. The unity-gain buffer configuration is the most problematic—it will traverse through the transition region if a sufficiently wide input swing is required. A design option would be to configure the op amp as a unity-gain inverter as shown below and hold the noninverting input at a set common-mode voltage outside the transition region. This can be accomplished with a voltage divider from the supply. The voltage divider should be designed such that the biasing point for the noninverting input is outside the transition the region.

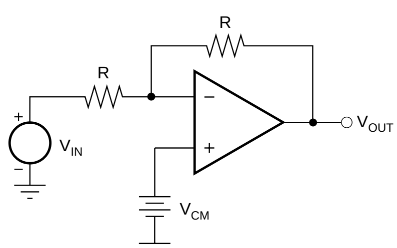


FIGURE 3. Design Optimization.

DRIVING A/D CONVERTERS

OPA342 series op amps are optimized for driving medium speed sampling A/D converters. The OPA342 series provides an effective means of buffering the A/D's input capacitance and resulting charge injection while providing signal gain.

Figures 6 shows the OPA342 in a basic noninverting configuration driving the ADS7822. The ADS7822 is a 12-bit, micro-power sampling converter in the tiny MSOP-8 package. When used with the low power, miniature packages of the OPA342, the combination is ideal for space-limited and low-power applications. In this configuration, an RC network at the A/D's input can be used to filter charge injection.

Figure 7 shows the OPA2342 driving an ADS7822 in a speech bandpass filtered data acquisition system. This small, low-cost solution provides the necessary amplification and signal conditioning to interface directly with an Electret microphone. This circuit will operate with +2.7V to +5V at less than 500µA quiescent current.

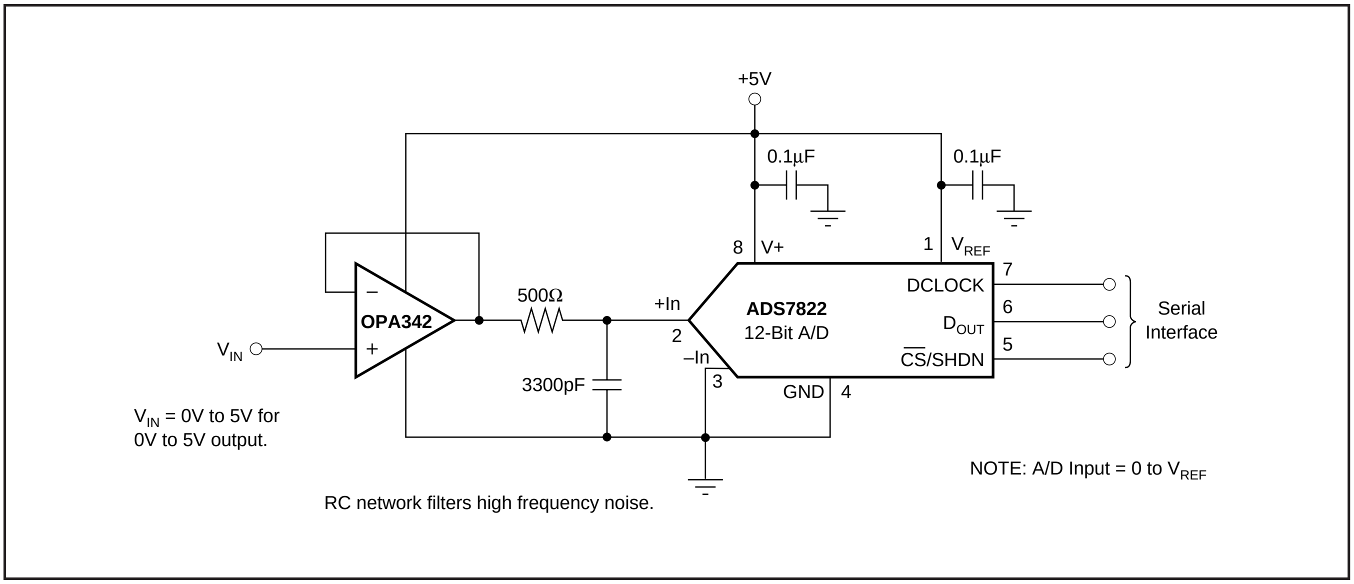


FIGURE 6. OPA342 in Noninverting Configuration Driving ADS7822.

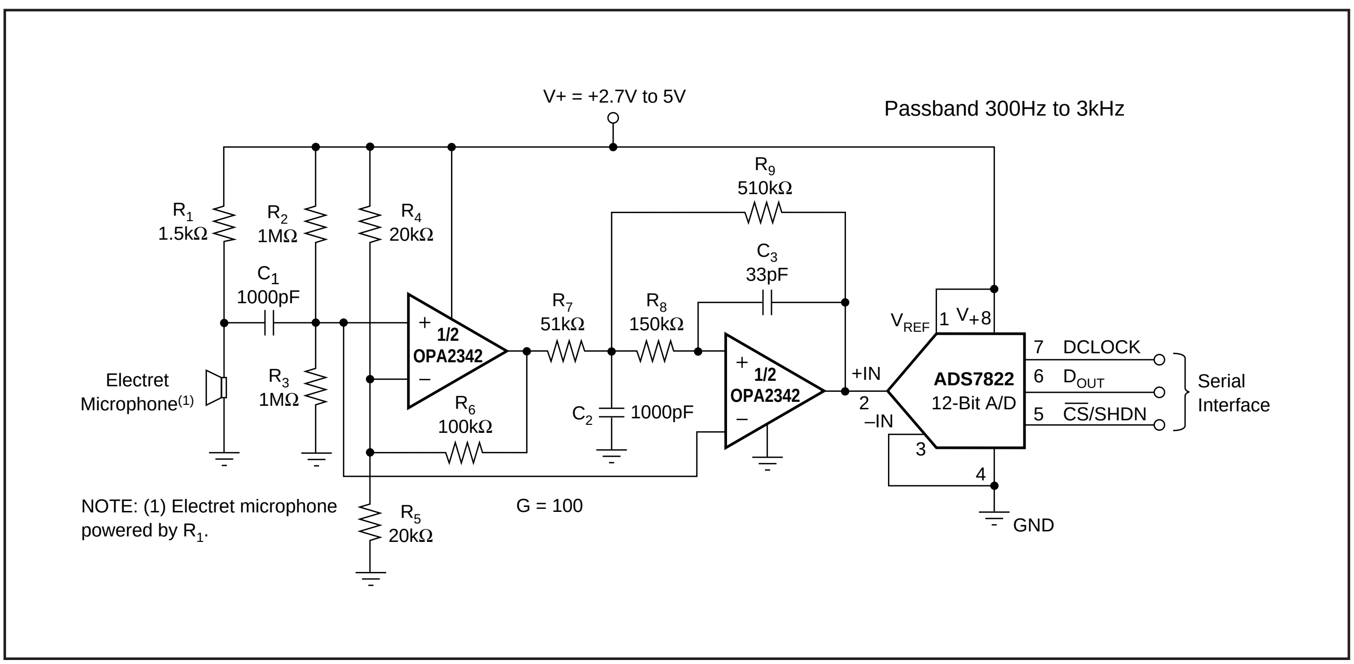


FIGURE 7. Speech Bandpass Filtered Data Acquisition System.

INFLUENCE OF COMMON-MODE REJECTION ON OFFSET VOLTAGE

The offset voltage (V_{OS}) of the OPA342 is guaranteed to be within ±6mV over the power supply range 2.7V to 5.5V with the common-mode voltage at $V_S/2$. This specification can be combined with the common-mode rejection ratio specification to determine worst-case offset under the conditions of a given application.

Common-Mode Rejection Ratio (CMRR) is specified in dB, which can be converted to μV/V using the equation:

$$\text{CMRR (in V/V)} = 10^{[(\text{CMRR in dB})/-20]} \quad (1)$$

For the OPA342, the worst-case CMRR at 5.5V supply over the full common-mode range is 66dB, or approximately 501μV/V. This means that for every volt of change in common-mode, the offset could shift up to approximately 501μV.

These numbers can be used to calculate excursions from the specified offset voltage under different application conditions. For example, a common application might configure the amplifier with a +5.5V single supply with 0V common-mode. This configuration varies from the specified offset measurement configuration, representing a 2.75V variation in common-mode voltage ($V_S/2$ = 2.75V in the specification versus 0V in the application).

Calculation of the worst-case expected offset would be as follows:

$$\text{Worst Case } V_{OS} = \text{Maximum specified } V_{OS} + (\text{common-mode variation} \cdot \text{CMRR}) \quad (2)$$

$$V_{OSWC} = 6\text{mV} + (2.75\text{V} \cdot 501\mu\text{V/V}) = \pm 7.38\text{mV}$$

For the OPA342, a specification is also provided for power supply rejection. This information is useful for established expected offset variations in applications with varying supply voltage. Because the OPA342 offset is guaranteed over the full supply range, power supply rejection errors do not need to be factored into the worst-case offset analysis.