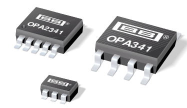
Burr-Brown Products
from Texas Instruments

OPA341
OPA2341



SBOS202A – AUGUST 2001

SINGLE-SUPPLY, RAIL-TO-RAIL OPERATIONAL AMPLIFIER WITH SHUTDOWN
*micro**Amplifier*™ Series

FEATURES

- RAIL-TO-RAIL INPUT AND OUTPUT SWING
- *Micro*SIZE PACKAGES
- BANDWIDTH: 5.5MHz
- SLEW RATE: 6V/µs
- QUIESCENT CURRENT: 750µA/Chan
- POWER SHUTDOWN MODE

APPLICATIONS

- SENSOR BIASING
- SIGNAL CONDITIONING
- DATA ACQUISITION
- PROCESS CONTROL
- ACTIVE FILTERS
- TEST EQUIPMENT

DESCRIPTION

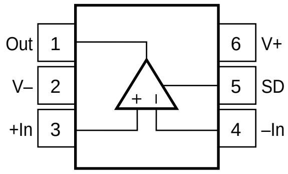
The OPA341 series rail-to-rail CMOS operational amplifiers are designed for low-cost, miniature applications. They are optimized for low-voltage, single-supply operation. Rail-to-rail input and output and high-speed operation make them ideal for driving sampling Analog-to-Digital (A/D) converters.

The power-saving shutdown feature makes the OPA341 ideal for portable low-power applications. The OPA341 series is 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 and dual versions have identical specifications for design flexibility.

The OPA341 series operate on a single supply as low as 2.5V, and input common-mode voltage range extends 300mV beyond the supply rails. Output voltage swings to within 1mV of the supply rails with a 100kΩ load. The OPA341 series offers excellent dynamic response (BW = 5.5MHz, SR = 6V/µs) with a quiescent current of only 750µA. The dual design features completely independent circuitry for lowest crosstalk and freedom from interaction.

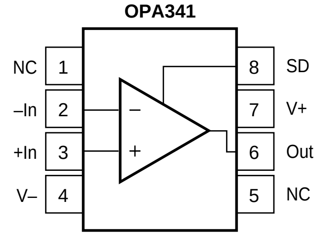
The single (OPA341) packages are the tiny SOT23-6 surface mount and SO-8 surface mount. The dual (OPA2341) comes in the miniature MSOP-10 surface mount. All are specified from –55°C to +125°C and operate from –55°C to +150°C. The OPA343 provides similar performance without shutdown capability.

OPA341



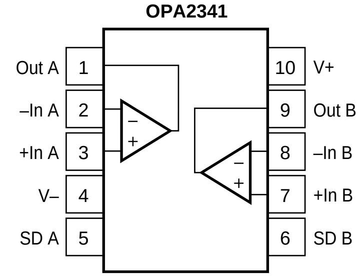
SOT23-6 (N)

OPA341



SO-8 (U)

OPA2341



MSOP-10 (DGS)

TEXAS INSTRUMENTS
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ABSOLUTE MAXIMUM RATINGS[1]

Supply Voltage, V+ to V–	6.0V
Input Voltage Range[2]	(V–) – 0.5V to (V+) + 0.5V
Input Terminal[3]	10mA
Output Short Circuit[3]	Continuous
Operating Temperature	–55°C to +150°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. Texas Instruments 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	PACKAGE DESIGNATOR	SPECIFIED TEMPERATURE RANGE	PACKAGE MARKING	ORDERING NUMBER[1]	TRANSPORT MEDIA
OPA341NA	SOT23-6	332	—	–55°C to +125°C	B41	OPA341NA/250	Tape and Reel
"	"	"	—	"	"	OPA341NA/3K	Tape and Reel
OPA341UA	SO-8	182	—	–55°C to +125°C	OPA341UA	OPA341UA	Rails
"	"	"	—	"	"	OPA341UA/2K5	Tape and Reel
OPA2341DGSA	MSOP-10	4073272	DGS	–55°C to +125°C	C41	OPA2341DGSA/250	Tape and Reel
"	"	"	"	"	"	OPA2341DGSA/2K5	Tape and Reel

NOTE: (1) 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 "OPA341NA/3K" will get a single 3000-piece Tape and Reel..

ELECTRICAL CHARACTERISTICS: V_S = 2.7V to 5.5V

Boldface limits apply over the specified temperature range, **T_A = –55°C to +125°C.**

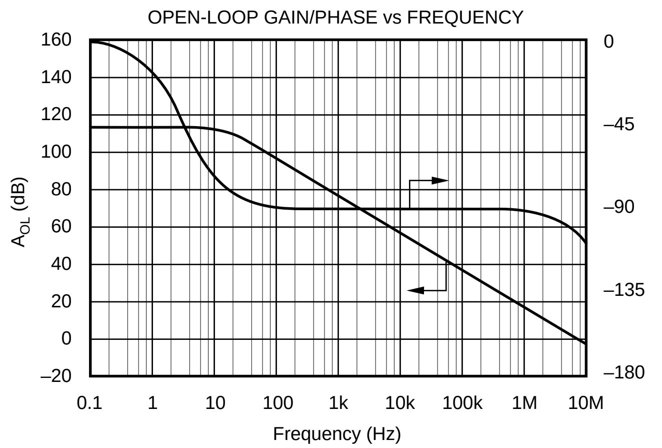
At T_A = +25°C, R_L = 10kΩ connected to V_S/2 and V_{OUT} = V_S/2, V_{ENABLE} = V_{DD}, unless otherwise noted.

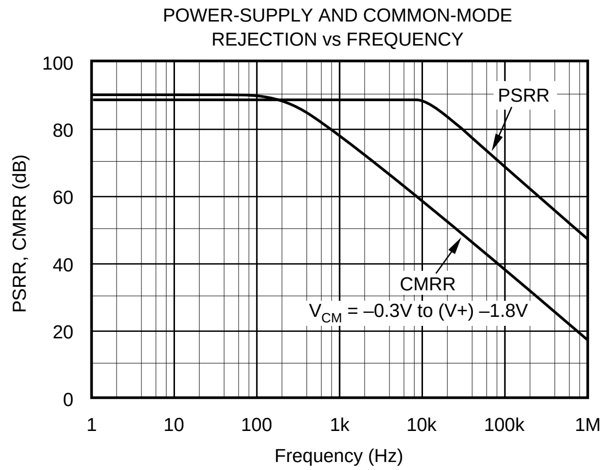
PARAMETER	CONDITION	OPA341NA, UA OPA2341DGSA			UNITS
		MIN	TYP	MAX	
OFFSET VOLTAGE					
Input Offset Voltage V_{OS}	V_S = 5V		±2	±6	mV
Drift dV_{OS}/dT			**±2**		**µV/°C**
vs Power Supply PSRR	V_S = 2.7V to 5.5V, V_{CM} = 0V		40	200	µV/V
Over Temperature	**V_S = 2.7V to 5.5V, V_{CM} = 0V**			**200**	**µV/V**
Channel Separation, dc			0.2		µV/V
INPUT BIAS CURRENT					
Input Bias Current I_B			±0.6	±10	pA
Over Temperature				**2000**	**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			25		$nV/\sqrt{Hz}$
Input Current Noise Density, f = 1kHz i_n			3		$fA/\sqrt{Hz}$
INPUT VOLTAGE RANGE		(V–) – 0.3		(V+) + 0.3	V
Common-Mode Voltage Range V_{CM}		**(V–) – 0.1**		**(V+) + 0.1**	**V**
Common-Mode Rejection Ratio CMRR	V_S = 5V, (V–) – 0.3V < V_{CM} < (V+) – 1.8V	76	90		dB
Over Temperature	**V_S = 5V, (V–) – 0.1V < V_{CM} < (V+) – 1.8V**	**74**			**dB**
	V_S = 5V, (V–) – 0.3V < V_{CM} < (V+) + 0.3V	60	74		dB
Over Temperature	**V_S = 5V, (V–) – 0.1V < V_{CM} < (V+) + 0.1V**	**58**			**dB**
	V_S = 2.7V, (V–) – 0.3V < V_{CM} < (V+) + 0.3V	57	70		dB
Over Temperature	**V_S = 2.7V, (V–) – 0.1V < V_{CM} < (V+) + 0.1V**	**55**			**dB**
INPUT IMPEDANCE					
Differential			$10^{13} \parallel 3$		$\Omega \parallel pF$
Common-Mode			$10^{13} \parallel 6$		$\Omega \parallel pF$
OPEN-LOOP GAIN					
Open-Loop Voltage Gain A_{OL}	R_L = 100kΩ, (V–) + 5mV < V_O < (V+) – 5mV	100	120		**dB**
Over Temperature	**R_L = 100kΩ, (V–) + 5mV < V_O < (V+) – 5mV**	**100**			**dB**
	R_L = 2kΩ, (V–) + 200mV < V_O < (V+) – 200mV	96	110		dB
Over Temperature	**R_L = 2kΩ, (V–) + 200mV < V_O < (V+) – 200mV**	**94**			**dB**
FREQUENCY RESPONSE	V_S = 5V				
Gain-Bandwidth Product GBW			5.5		MHz
Slew Rate SR	G = +1, C_L = 100pF		6		V/µs
Settling Time, 0.1% t_S	V_S = 5V, 2V Step, G = +1, C_L = 100pF		1		µs
0.01%	V_S = 5V, 2V Step, G = +1, C_L = 100pF		1.6		µs
Overload Recovery Time	V_{IN} • Gain ≤ V_S		0.2		µs
Total Harmonic Distortion + Noise THD+N	V_S = 5V, V_O = 3Vp-p(1), G = +1, f = 1kHz		0.0007		%
OUTPUT					
Voltage Output Swing from Rail	R_L = 100kΩ, A_{OL} > 100dB		1	5	mV
Over Temperature	**R_L = 100kΩ, A_{OL} > 100dB**			**5**	**mV**
	R_L = 2kΩ, A_{OL} > 96dB		40	200	mV
Over Temperature	**R_L = 2kΩ, A_{OL} > 94dB**			**200**	**mV**
Short-Circuit Current I_{SC}			±50		mA
Capacitive Load Drive C_{LOAD}		See Typical Characteristics			
SHUTDOWN					
t_{OFF}			1		µs
t_{ON}			3		µs
V_L (Shutdown)		V–		(V–) + 0.8	V
V_H (Amplifier is Active)		(V–) + 2		V+	V
I_{QSD}			10		nA
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 = 0, V_S = 5V		0.75	1.0	mA
Over Temperature				**1.2**	**mA**
TEMPERATURE RANGE					
Specified Range		–55		125	°C
Operating Range		–55		150	°C
Storage Range		–65		150	°C
Thermal Resistance θ_{JA}					°C/W
SOT-23-6 Surface Mount			200		°C/W
MSOP-10 Surface Mount			150		°C/W
SO-8 Surface Mount			150		°C/W

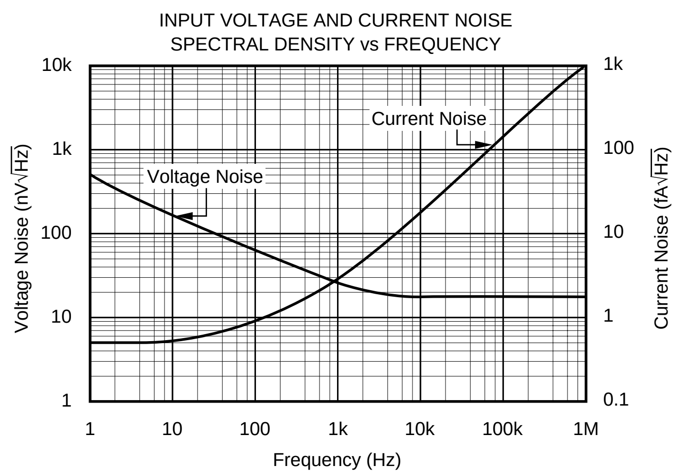
NOTE: (1) V_{OUT} = 0.25V to 3.25V.

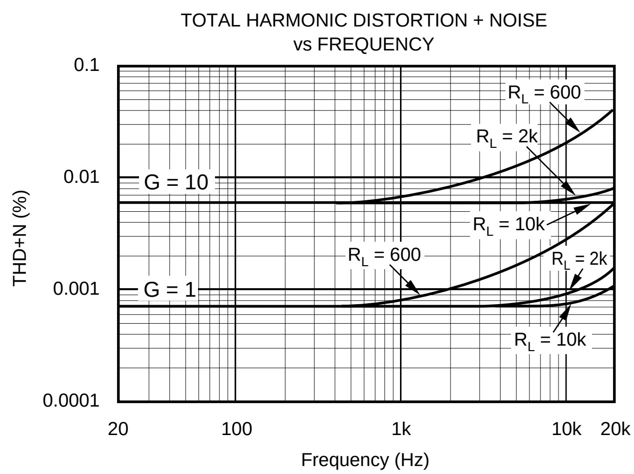
TYPICAL CHARACTERISTICS

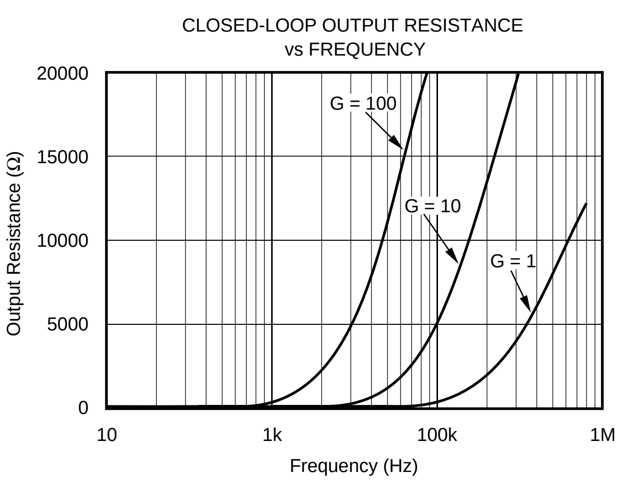
At T_A = +25°C, V_{ENABLE} = V_{DD}, V_S = +5V, R_L = 10kΩ, unless otherwise noted.

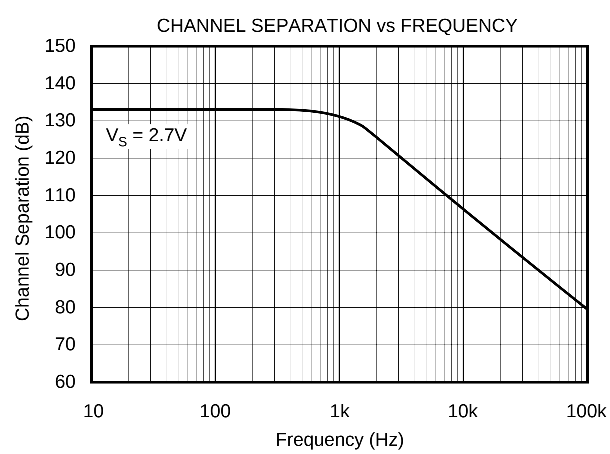






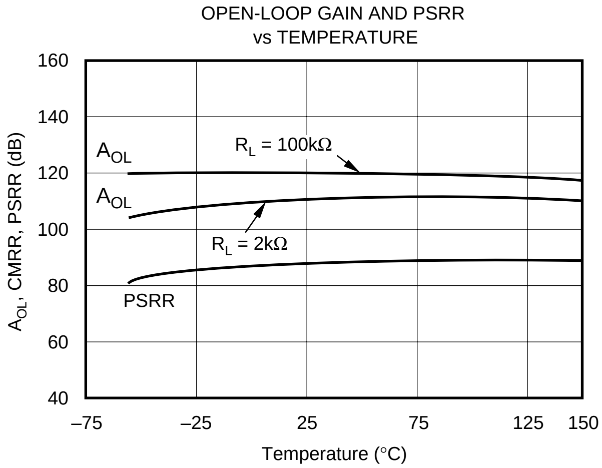


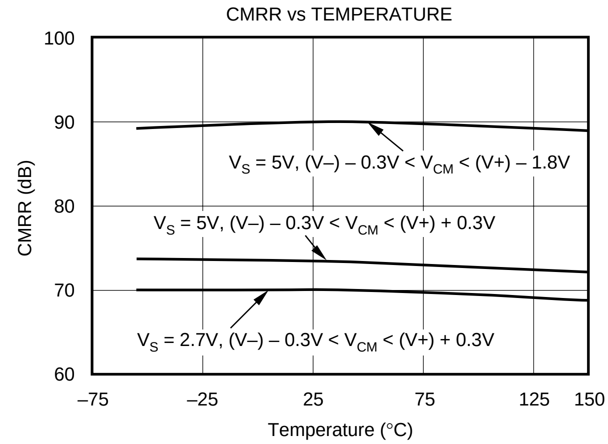


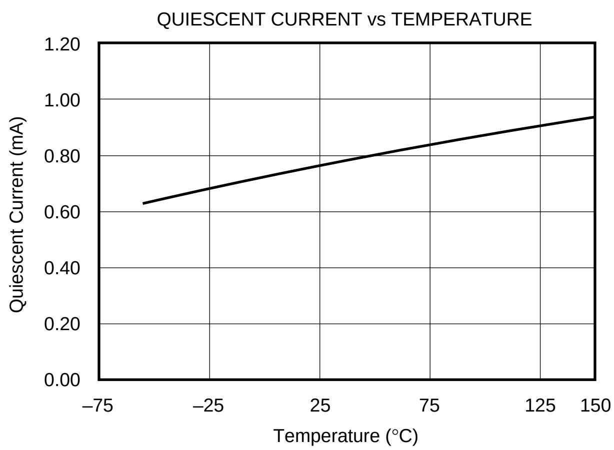


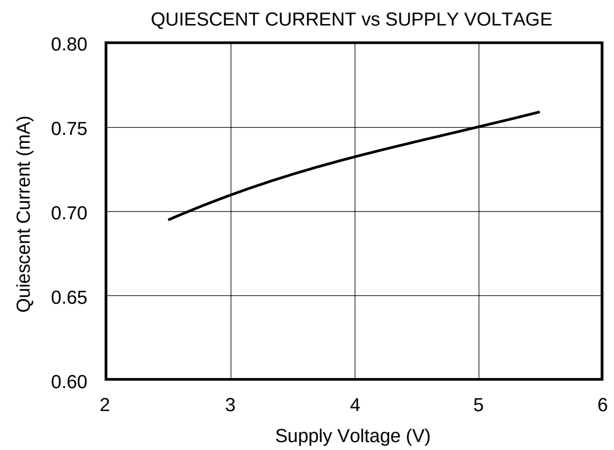
TYPICAL CHARACTERISTICS (Cont.)

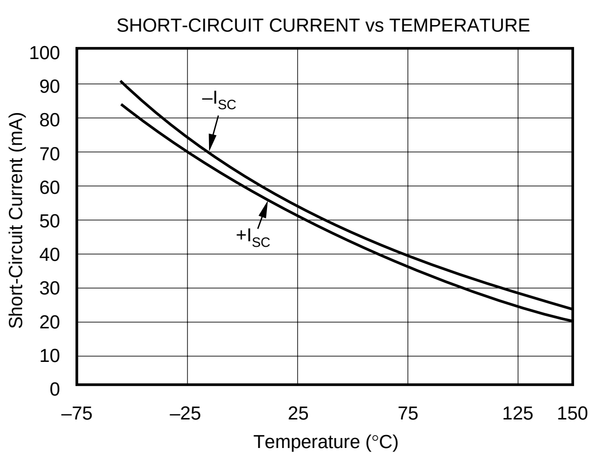
At T_A = +25°C, V_{ENABLE} = V_{DD}, V_S = +5V, R_L = 10kΩ, unless otherwise noted.

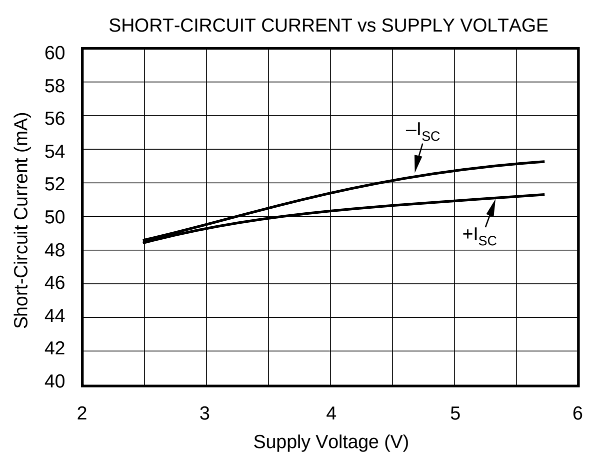








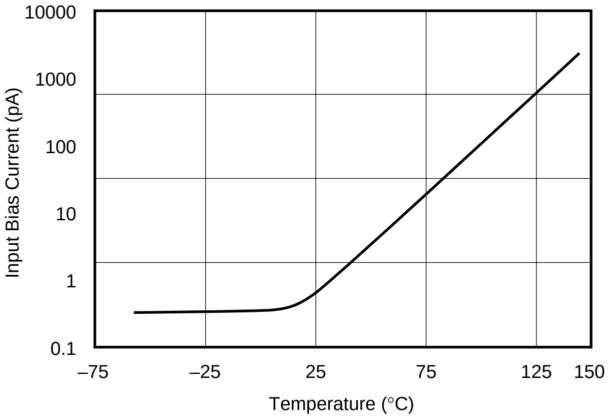




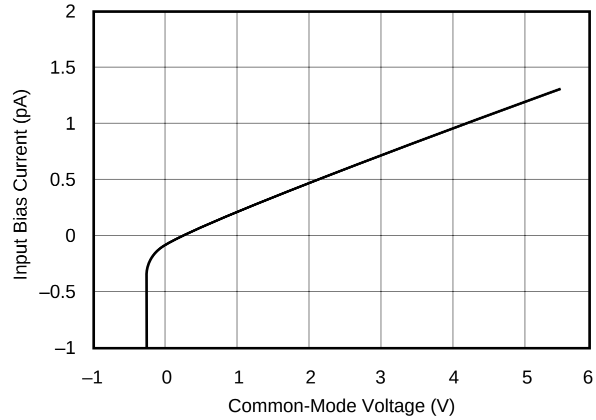
TYPICAL CHARACTERISTICS (Cont.)

At T_A = +25°C, V_{ENABLE} = V_{DD}, V_S = +5V, R_L = 10kΩ, unless otherwise noted.

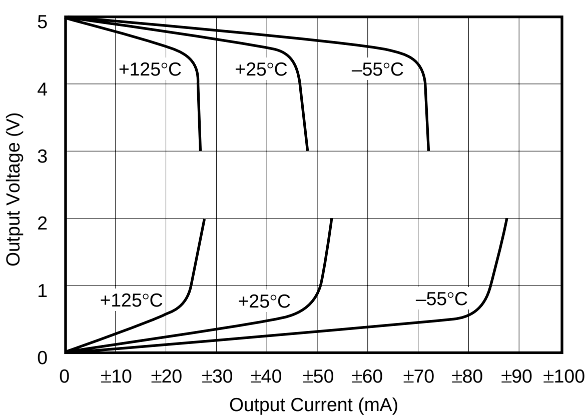
INPUT BIAS vs TEMPERATURE



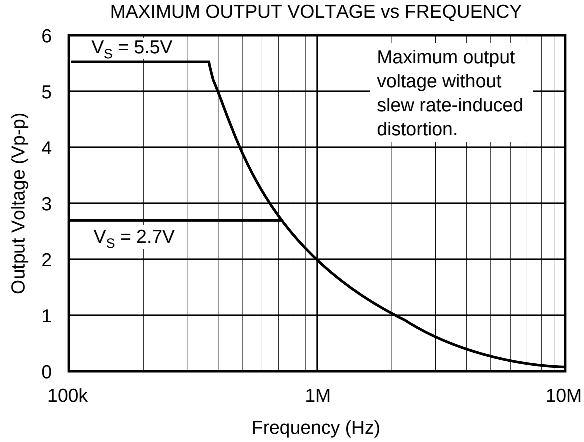
INPUT BIAS CURRENT vs INPUT COMMON-MODE VOLTAGE



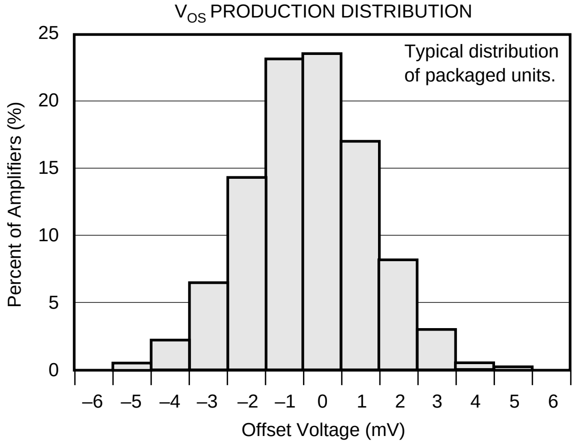
OUTPUT VOLTAGE SWING vs OUTPUT CURRENT



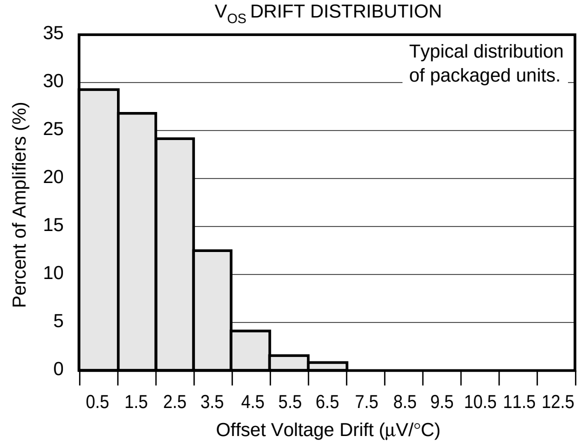
MAXIMUM OUTPUT VOLTAGE vs FREQUENCY



V_{OS} PRODUCTION DISTRIBUTION

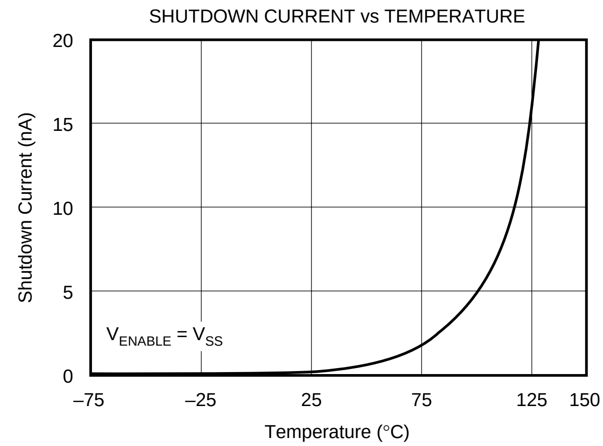


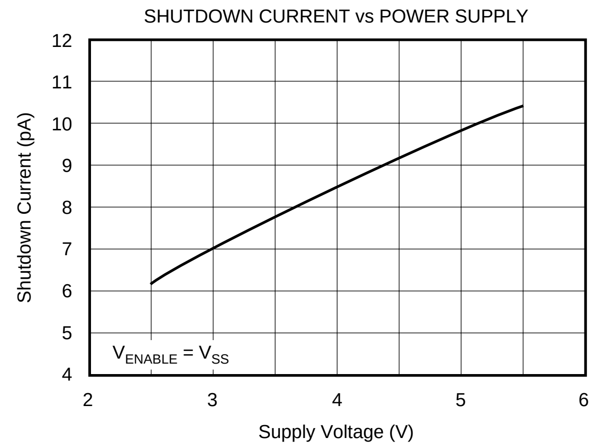
V_{OS} DRIFT DISTRIBUTION

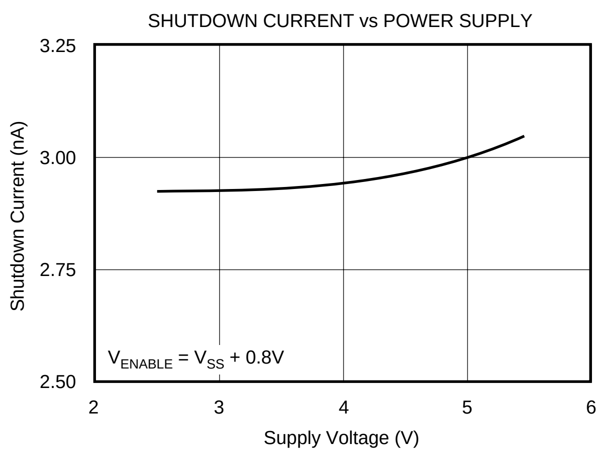


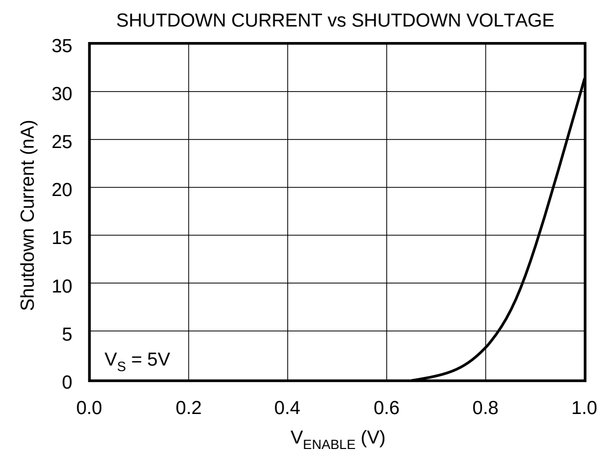
TYPICAL CHARACTERISTICS (Cont.)

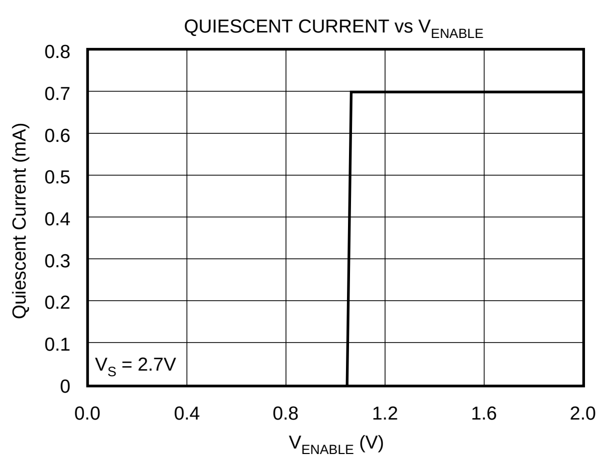
At T_A = +25°C, V_{ENABLE} = V_{DD}, V_S = +5V, R_L = 10kΩ, unless otherwise noted.

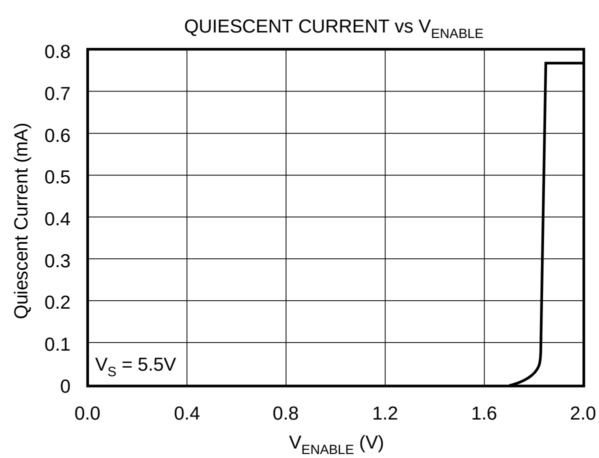






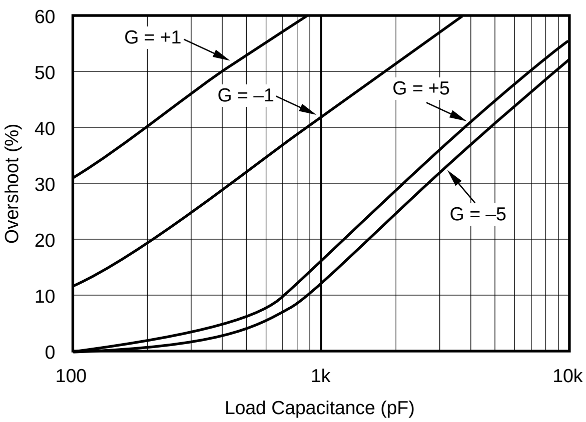




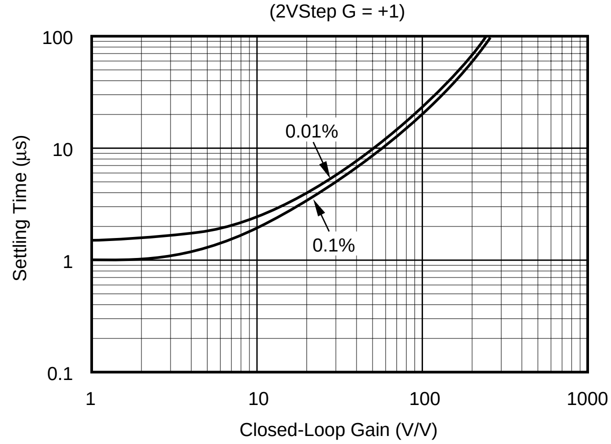


At $T_A = +25°C$, $V_{ENABLE} = V_{DD}$, $V_S = +5V$, $R_L = 10k\Omega$, unless otherwise noted.

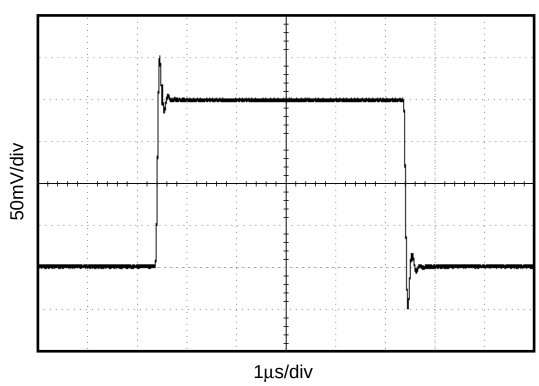
SMALL-SIGNAL OVERSHOOT vs LOAD CAPACITANCE



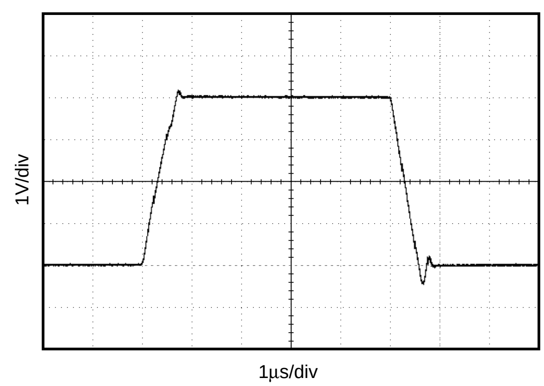
SETTLING TIME vs CLOSED-LOOP GAIN (2VStep G = +1)



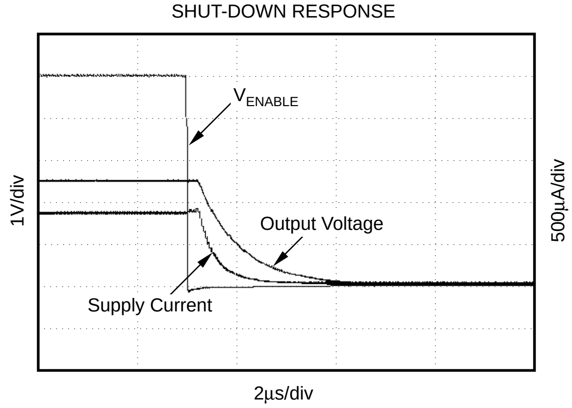
SMALL-SIGNAL STEP RESPONSE



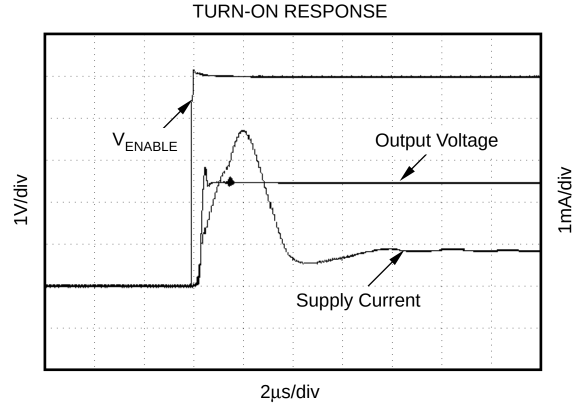
LARGE-SIGNAL STEP RESPONSE



SHUT-DOWN RESPONSE



TURN-ON RESPONSE



APPLICATIONS INFORMATION

OPA341 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 I/O 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 OPA341 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.

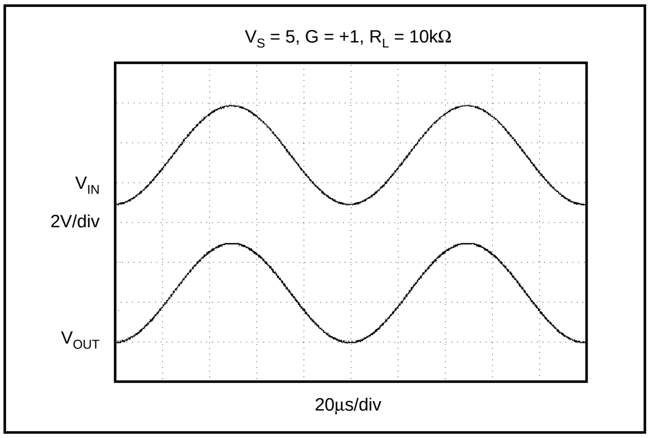


FIGURE 1. Rail-to-Rail Input and Output.

OPERATING VOLTAGE

OPA341 series op amps are fully specified from +2.7V to +5.5V. However, supply voltage may range from +2.5V to +5.5V. Parameters are tested over the specified supply range—a unique feature of the OPA341 series. In addition, many specifications apply from –55°C to +125°C. Most behavior remains virtually unchanged throughout the full operating voltage range. Parameters that vary significantly with operating voltages or temperature are shown in the Typical Characteristics.

RAIL-TO-RAIL INPUT

The input common-mode voltage range of the OPA341 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, as shown in Figure 2. The N-channel pair is active for input voltages close to the positive rail, typically (V+) – 1.3V to 300mV above the positive supply. The P-channel pair is on 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 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.

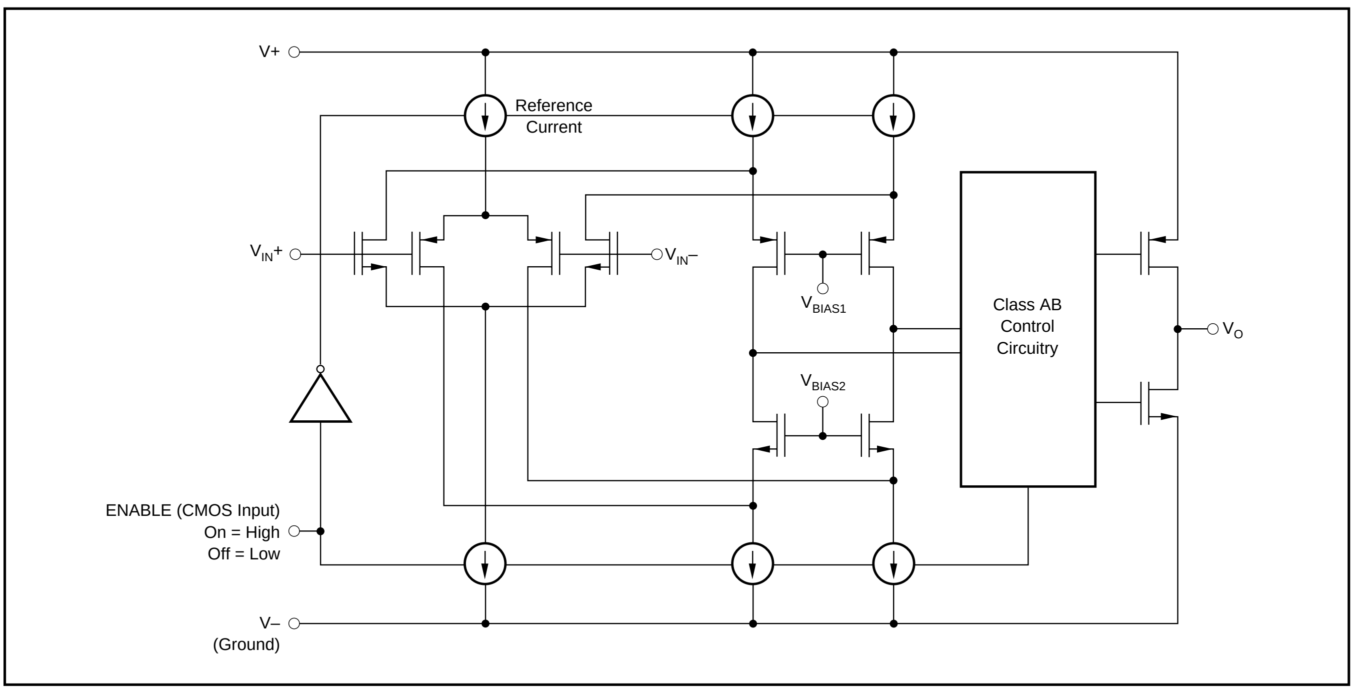


FIGURE 2. Simplified Schematic.

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 600fA, however, input voltages exceeding the power supplies by more than 300mV can cause excessive current to flow in or out of the input pins. 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 3. Many input signals are inherently current-limited to less than 10mA, therefore, a limiting resistor is not required.

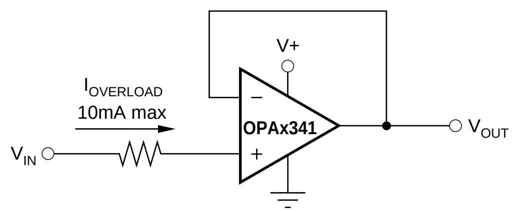


FIGURE 3. Input Current Protection for Voltages Exceeding the Supply Voltage.

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 characteristic "Output Voltage Swing vs Output Current."

CAPACITIVE LOAD AND STABILITY

OPA341 series op amps can drive a wide range of capacitive loads. However, all op amps under certain conditions may become unstable. Op amp configurations, 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, OPA341 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 characteristic "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

OPA341 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 OPA341 series provides an effective means of buffering the A/D converter's input capacitance and resulting charge injection while providing signal gain. For applications requiring high accuracy, the OPA340 series is recommended.

The OPA341 implements a power-saving shutdown feature particularly useful for low-power sampling applications. Figure 5 shows the OPA341 driving the ADS7816, a 12-bit micro-power sampling converter available in the tiny MSOP-8 package. With the OPA341 in non-inverting configuration, an RC network at the amplifier's output is used as an anti-aliasing filter. By tying the enable of the OPA341 to the shutdown of the ADS7816, additional power-savings can be used for sampling applications. To effectively drive the ADS7816, timing delay was introduced between the two devices, see Figure 5. Alternative applications may need additional timing adjustments.

Figure 6 shows the OPA341 configured as a speech band-pass filter. Figure 7 shows the OPA341 configured as a transimpedance amplifier.

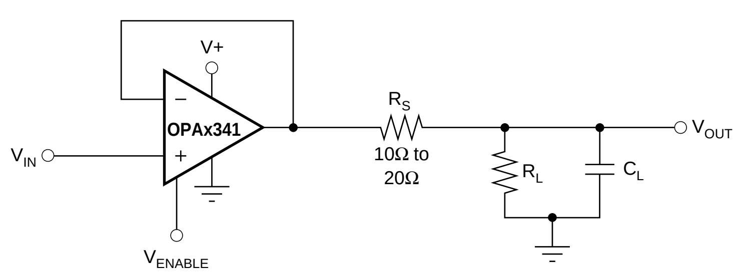


FIGURE 4. Series Resistor in Unity-Gain Configuration Improves Capacitive Load Drive.

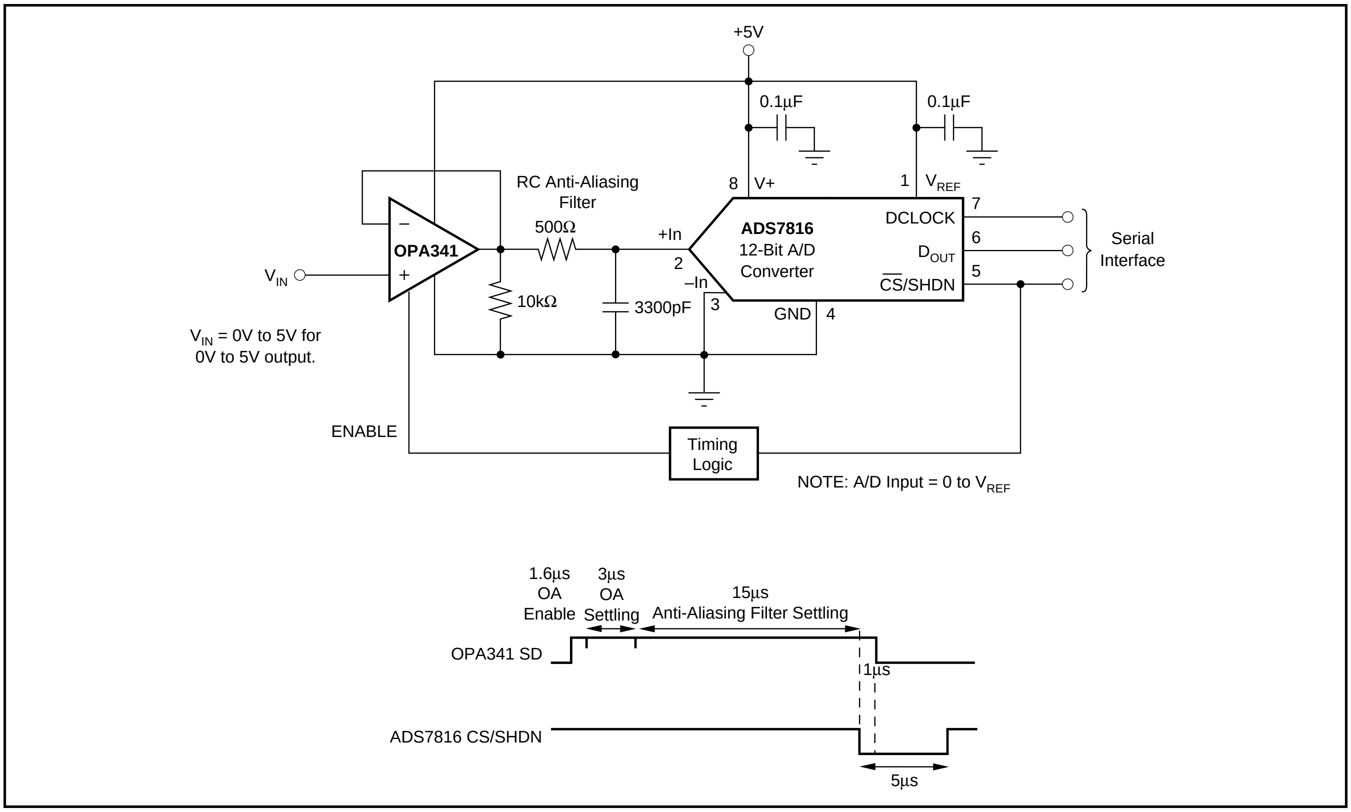


FIGURE 5. OPA341 in Noninverting Configuration Driving the ADS7816 with Timing Diagram.

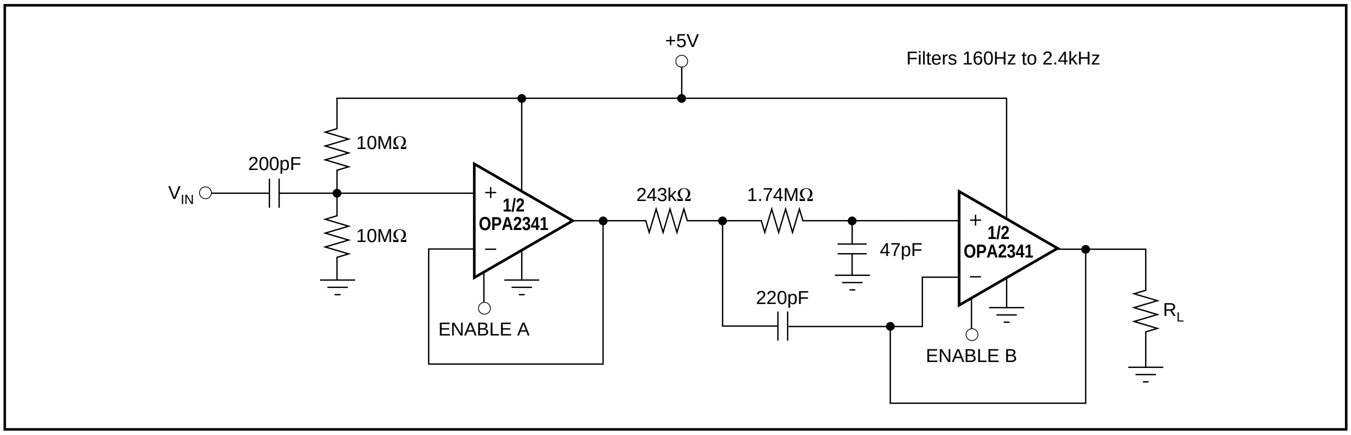


FIGURE 6. Speech Bandpass Filter.

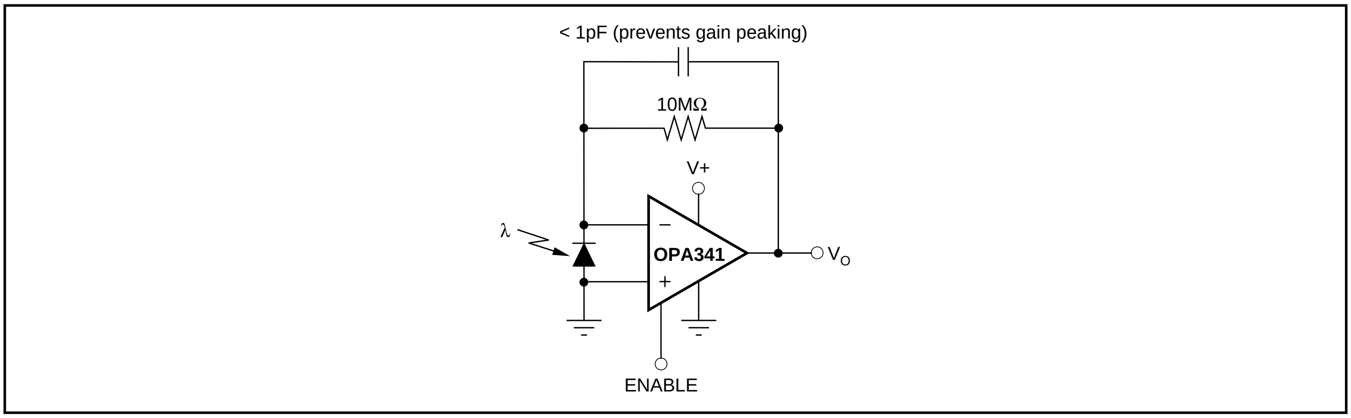


FIGURE 7. Transimpedance Amplifier.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
OPA2341DGSA/250	ACTIVE	VSSOP	DGS	10	250	RoHS & Green	Call TI | NIPDAUAG	Level-2-260C-1 YEAR	-55 to 125	C41	Samples
OPA341NA/250	ACTIVE	SOT-23	DBV	6	250	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-55 to 125	B41	Samples
OPA341NA/3K	ACTIVE	SOT-23	DBV	6	3000	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-55 to 125	B41	Samples
OPA341UA	ACTIVE	SOIC	D	8	75	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-55 to 125	OPA 341UA	Samples

(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.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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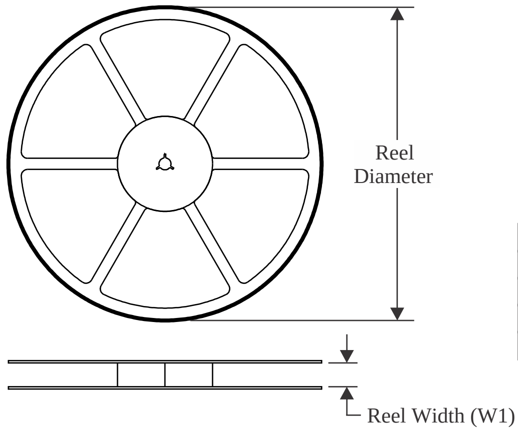
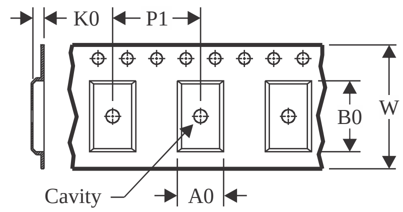
TAPE AND REEL INFORMATION

REEL DIMENSIONS

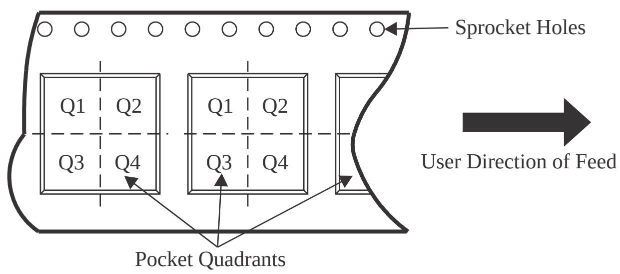


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

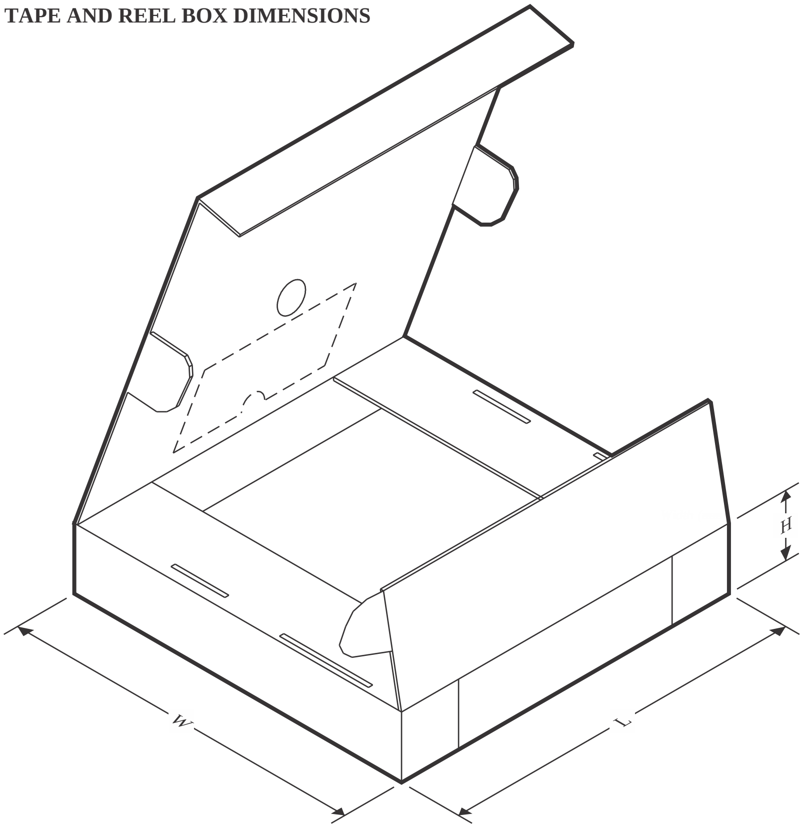
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
OPA341NA/250	SOT-23	DBV	6	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
OPA341NA/3K	SOT-23	DBV	6	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3

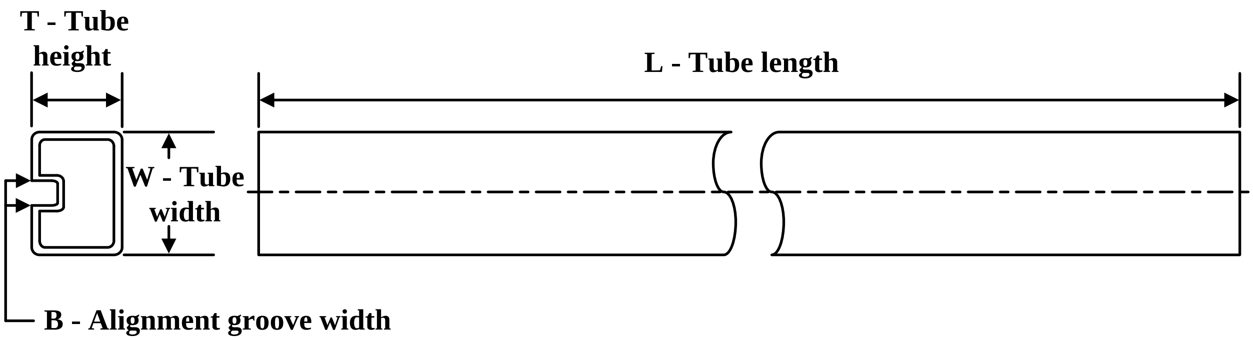
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
OPA341NA/250	SOT-23	DBV	6	250	445.0	220.0	345.0
OPA341NA/3K	SOT-23	DBV	6	3000	445.0	220.0	345.0

TUBE



*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
OPA341UA	D	SOIC	8	75	506.6	8	3940	4.32