

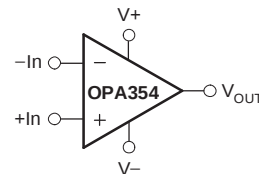
250 MHz, RAIL-TO-RAIL I/O, CMOS OPERATIONAL AMPLIFIERS

FEATURES

- Qualified for Automotive Applications
- Unity-Gain Bandwidth: 250 MHz
- Wide Bandwidth: 100-MHz GBW
- High Slew Rate: 150 V/ μ s
- Low Noise: 6.5 nV/ $\sqrt{\text{Hz}}$
- Rail-to-Rail I/O
- High Output Current: >100 mA
- Excellent Video Performance
 - Differential Gain Error: 0.02%
 - Differential Phase Error: 0.09°
 - 0.1-dB Gain Flatness: 40 MHz
- Low Input Bias Current: 3 pA
- Quiescent Current: 4.9 mA
- Thermal Shutdown
- Supply Range: 2.5 V to 5.5 V

APPLICATIONS

- Video Processing
- Ultrasound
- Optical Networking, Tunable Lasers
- Photodiode Transimpedance Amplifiers
- Active Filters
- High-Speed Integrators
- Analog-to-Digital (A/D) Converter Input Buffers
- Digital-to-Analog (D/A) Converter Output Amplifiers
- Barcode Scanners
- Communications



DESCRIPTION

The OPA354 series of high-speed, voltage-feedback CMOS operational amplifiers are designed for video and other applications requiring wide bandwidth. They are unity-gain stable and can drive large output currents. Differential gain is 0.02% and differential phase is 0.09°. Quiescent current is only 4.9 mA per channel.

The OPA354 series op amps are optimized for operation on single or dual supplies as low as 2.5 V (± 1.25 V) and up to 5.5 V (± 2.75 V). Common-mode input range extends beyond the supplies. The output swing is within 100 mV of the rails, supporting wide dynamic range.

The single version (OPA354), is available in the tiny SOT23-5 (DBV) package. The dual version (OPA2354) comes in the miniature MSOP-8 (DGK) package and features completely independent circuitry for lowest crosstalk and freedom from interaction. The devices are specified over the automotive temperature range of -40°C to 125°C .

Table 1. OPAX354 RELATED PRODUCTS

FEATURES	PRODUCT
Shutdown Version of OPA354 Family	OPAx357
200-MHz GBW, Rail-to-Rail Output, CMOS, Shutdown	OPAx355
200-MHz GBW, Rail-to-Rail Output, CMOS	OPAx356
38-MHz GBW, Rail-to-Rail Input/Output, CMOS	OPAx350/3
75-MHz BW, G = 2, Rail-to-Rail Output	OPAx631
150-MHz BW, G = 2, Rail-to-Rail Output	OPAx634
100-MHz BW, Differential Input/Output, 3.3-V Supply	THS412x



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.



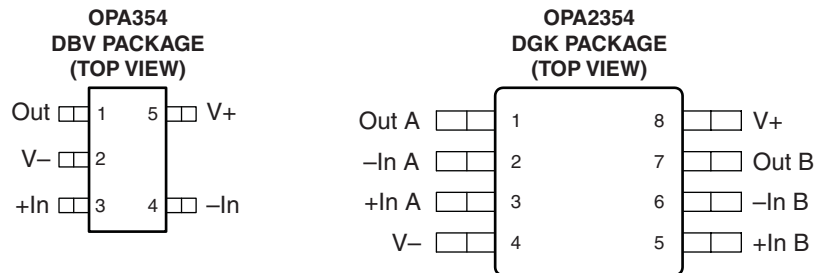
This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

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.

ORDERING INFORMATION⁽¹⁾

T _A	PACKAGE ⁽²⁾		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 125°C	SOT-23 – DBV	Reel of 3000	OPA354AQDBVRQ1	OSFQ
	MSOP – DGK	Reel of 2500	OPA2354AQDGKRQ1	OSLQ

- (1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.
(2) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.



ABSOLUTE MAXIMUM RATINGS⁽¹⁾

over operating free-air temperature range (unless otherwise noted)

V _S	Supply voltage, V+ to V–	7.5 V
V _{IN}	Signal input terminals voltage	(V– – 0.5 V) to (V+ + 0.5 V)
	Output short-circuit duration	Continuous
θ _{JA}	Thermal impedance, junction to free air	DBV package
		DGK package
		150°C/W
T _{OP}	Operating temperature	–55°C to 150°C
T _{STG}	Storage temperature	–65°C to 150°C
T _J	Junction temperature	150°C
T _{LEAD}	Lead temperature (soldering, 10 s)	300°C

- (1) Stresses beyond those listed under *absolute maximum ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *recommended operating conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

RECOMMENDED OPERATING CONDITIONS

		MIN	MAX	UNIT
V _S	Supply voltage, V– to V+	2.5	5.5	V
T _A	Operating free-air temperature	–40	125	°C

ELECTRICAL CHARACTERISTICS

 $V_S = 2.5\text{ V to }5.5\text{ V}$, $R_F = 0\ \Omega$, $R_L = 1\text{ k}\Omega$ connected to $V_S/2$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A ⁽¹⁾	MIN	TYP	MAX	UNIT
V_{OS}	Input offset voltage	$V_S = 5\text{ V}$, $V_{CM} = (V_-) + 0.8\text{ V}$	25°C		±2	±8	mV
			Full range			±10	
$\Delta V_{OS}/\Delta T$	Offset voltage drift over temperature		Full range		±4		µV/°C
PSRR	Offset voltage drift vs power supply	$V_S = 2.7\text{ V to }5.5\text{ V}$, $V_{CM} = V_S/2 - 0.15\text{ V}$	25°C		±200	±800	µV/V
			Full range			±900	
I_B	Input bias current		25°C		3	±50	pA
I_{OS}	Input offset current		25°C		±1	±50	pA
V_n	Input voltage noise density	$f = 1\text{ MHz}$	25°C		6.5		nV/√Hz
I_n	Input current noise density	$f = 1\text{ MHz}$	25°C		50		fA/√Hz
V_{CM}	Input common-mode voltage range		25°C	$V_- - 0.1$		$V_+ + 0.1$	V
CMRR	Input common-mode rejection ratio	$V_S = 5.5\text{ V}$, $-0.1\text{ V} < V_{CM} < 3.5\text{ V}$	25°C	66	80		dB
			Full range	64			
		$V_S = 5.5\text{ V}$, $-0.1\text{ V} < V_{CM} < 5.6\text{ V}$	25°C	56	68		
			Full range	55			
Z_{ID}	Differential input impedance		25°C		$10^{13} \parallel 2$		Ω pF
Z_{ICM}	Common-mode input impedance		25°C		$10^{13} \parallel 2$		Ω pF
A_{OL}	Open-loop gain	$V_S = 5\text{ V}$, $0.3\text{ V} < V_O < 4.7\text{ V}$	25°C	94	110		dB
		$V_S = 5\text{ V}$, $0.4\text{ V} < V_O < 4.6\text{ V}$	Full range	90			
f_{-3dB}	Small-signal bandwidth	$G = +1$, $V_O = 100\text{ mVp-p}$, $R_F = 25\ \Omega$	25°C		250		MHz
		$G = +2$, $V_O = 100\text{ mVp-p}$			90		
GBW	Gain-bandwidth product	$G = +10$	25°C		100		MHz
$f_{0.1dB}$	Bandwidth for 0.1-dB gain flatness	$G = +2$, $V_O = 100\text{ mVp-p}$	25°C		40		MHz
SR	Slew rate	$V_S = 5\text{ V}$, $G = +1$, 4-V step	25°C		150		V/µs
		$V_S = 5\text{ V}$, $G = +1$, 2-V step			130		
		$V_S = 3\text{ V}$, $G = +1$, 2-V step			110		
t_{rf}	Rise-and-fall time	$G = +1$, $V_O = 200\text{ mVp-p}$, 10% to 90%	25°C		2		ns
		$G = +1$, $V_O = 2\text{ Vp-p}$, 10% to 90%			11		
t_{settle}	Settling time	$V_S = 5\text{ V}$, $G = +1$, 2-V output step	25°C		30		ns
					60		
	Overload recovery time	$V_{IN} \times \text{Gain} = V_S$	25°C		5		ns
	Second-order harmonic distortion	$G = +1$, $f = 1\text{ MHz}$, $V_O = 2\text{ Vp-p}$, $R_L = 200\ \Omega$, $V_{CM} = 1.5\text{ V}$	25°C		-75		dBc
	Third-order harmonic distortion	$G = +1$, $f = 1\text{ MHz}$, $V_O = 2\text{ Vp-p}$, $R_L = 200\ \Omega$, $V_{CM} = 1.5\text{ V}$	25°C		-83		dBc
	Differential gain error	NTSC, $R_L = 150\ \Omega$	25°C		0.02		%
	Differential phase error	NTSC, $R_L = 150\ \Omega$	25°C		0.09		°
	Channel-to-channel crosstalk (OPA2354)	$f = 5\text{ MHz}$	25°C		-100		dB
	Voltage output swing from rail	$V_S = 5\text{ V}$, $R_L = 1\text{ k}\Omega$, $A_{OL} > 94\text{ dB}$	25°C		0.1	0.3	V
		$V_S = 5\text{ V}$, $R_L = 1\text{ k}\Omega$, $A_{OL} > 90\text{ dB}$	Full range			0.4	

(1) Full range $T_A = -40^\circ\text{C to }125^\circ\text{C}$

ELECTRICAL CHARACTERISTICS (continued)

$V_S = 2.5\text{ V to }5.5\text{ V}$, $R_F = 0\ \Omega$, $R_L = 1\text{ k}\Omega$ connected to $V_S/2$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_A ⁽¹⁾	MIN	TYP	MAX	UNIT
I_O Output current ⁽²⁾ ⁽³⁾	$V_S = 5\text{ V}$		100			mA
	$V_S = 3\text{ V}$			50		
Closed-loop output impedance	$f < 100\text{ kHz}$			0.05		Ω
R_O Open-loop output resistance				35		Ω
I_Q Quiescent current (per amplifier)	$V_S = 5\text{ V}$, $I_O = 0$, Enabled	25°C		4.9	6	mA
		Full range			7.5	
Thermal shutdown junction temperature	Shutdown			160		°C
	Reset from shutdown			140		

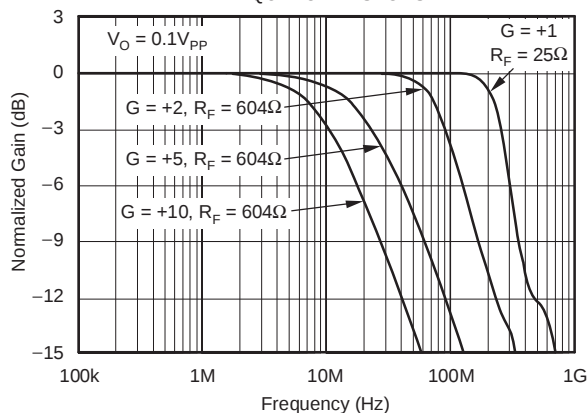
(2) See typical characteristic graph *Output Voltage Swing vs Output Current*.

(3) Not production tested

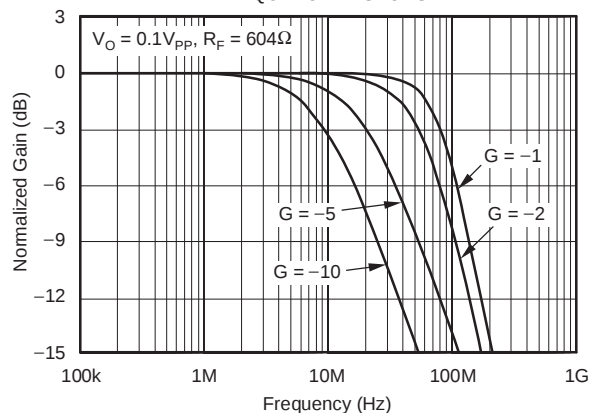
TYPICAL CHARACTERISTICS

$T_A = 25^\circ\text{C}$, $V_S = 5\text{ V}$, $R_F = 0\ \Omega$, $R_L = 1\text{ k}\Omega$ connected to $V_S/2$ (unless otherwise noted)

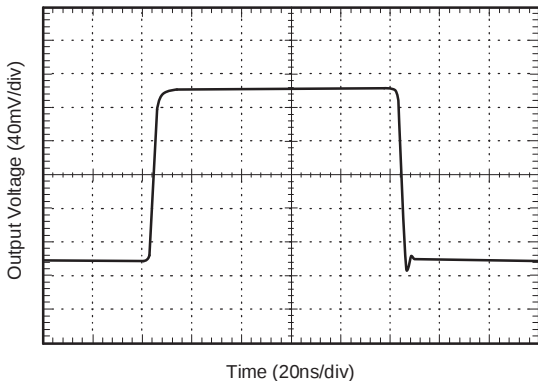
NONINVERTING SMALL-SIGNAL
FREQUENCY RESPONSE



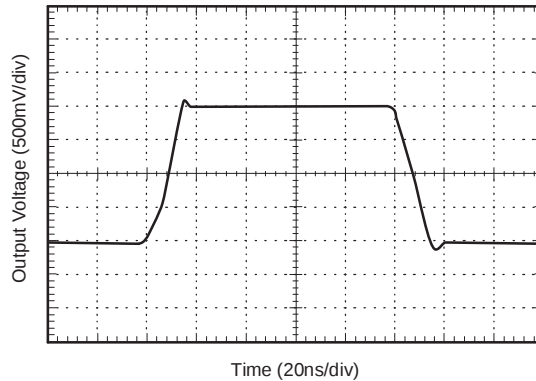
INVERTING SMALL-SIGNAL
FREQUENCY RESPONSE



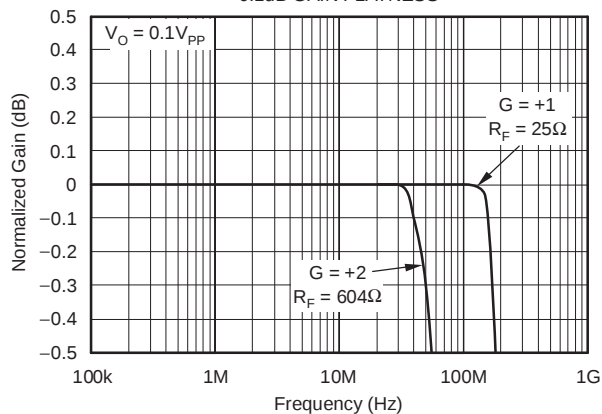
NONINVERTING SMALL-SIGNAL STEP RESPONSE



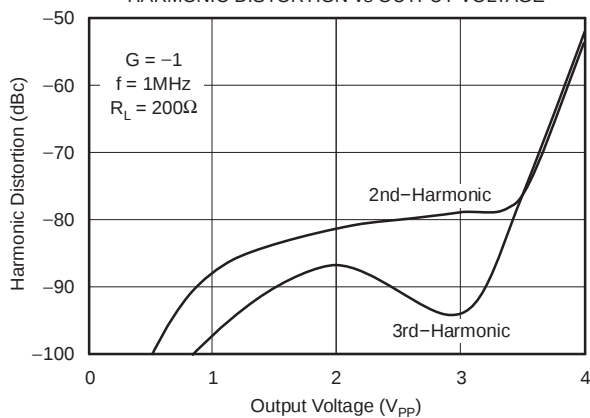
NONINVERTING LARGE-SIGNAL STEP RESPONSE



0.1dB GAIN FLATNESS

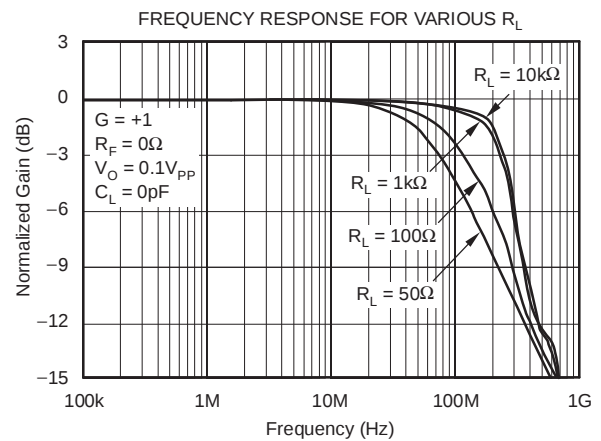
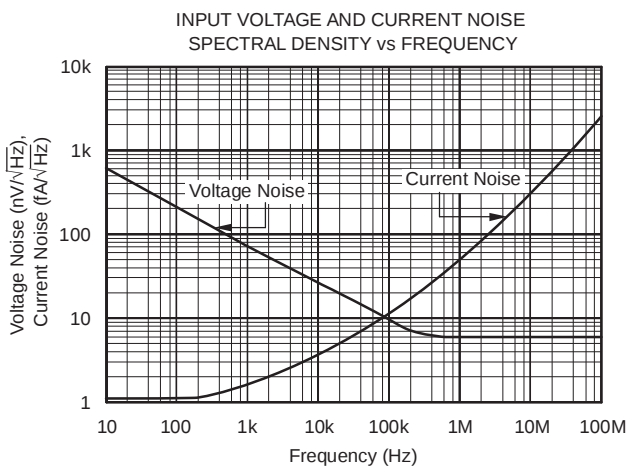
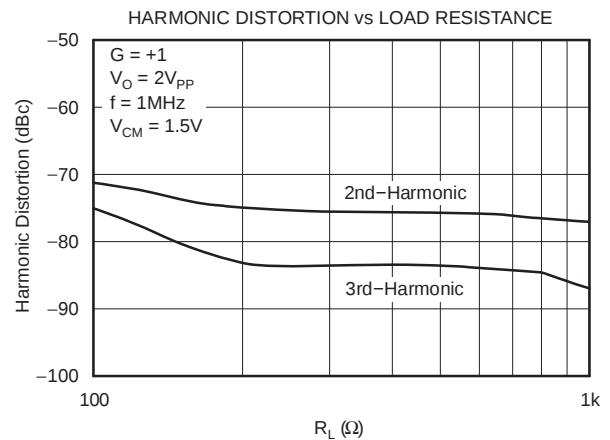
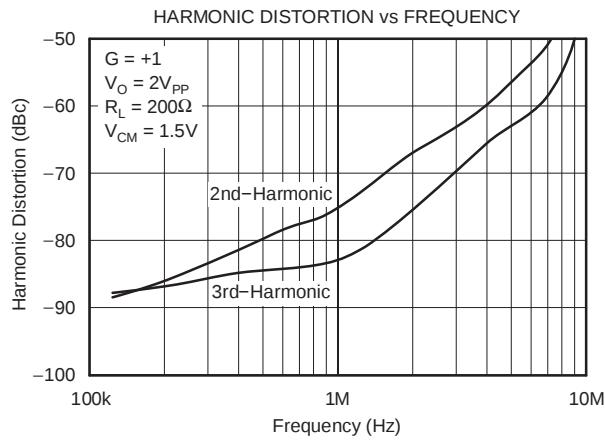
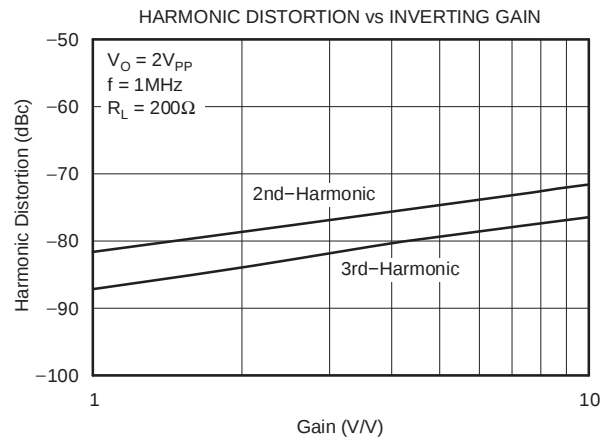
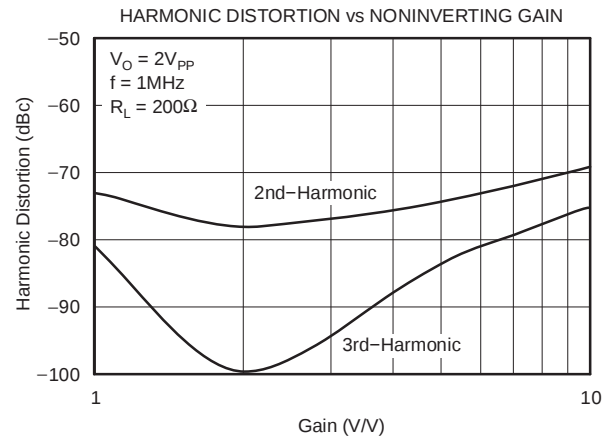


HARMONIC DISTORTION vs OUTPUT VOLTAGE



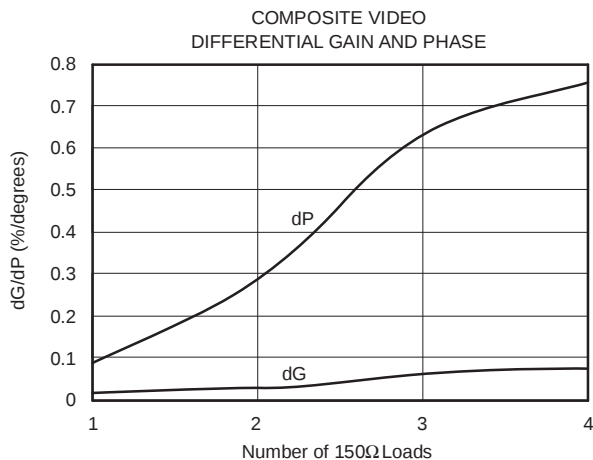
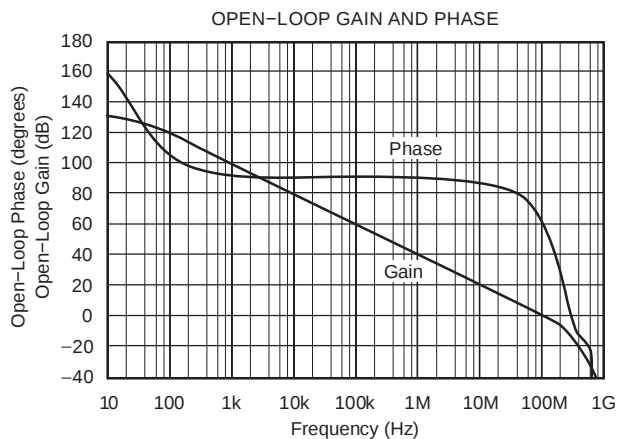
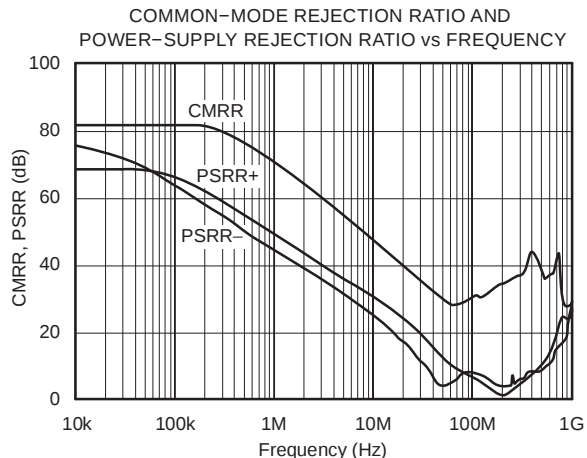
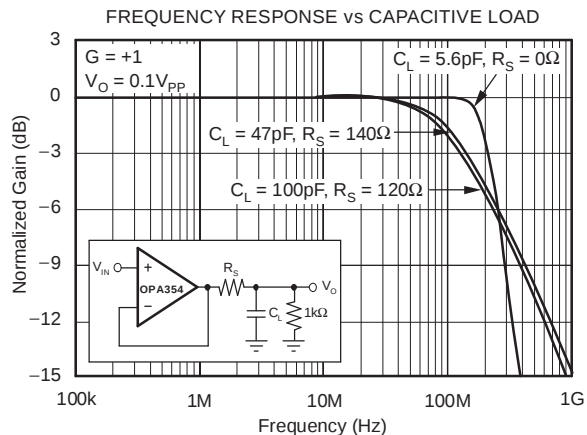
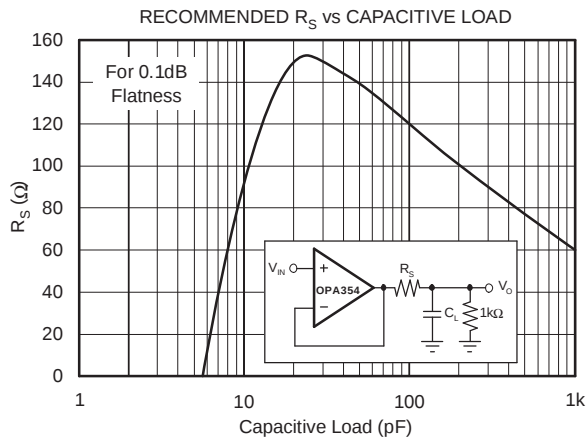
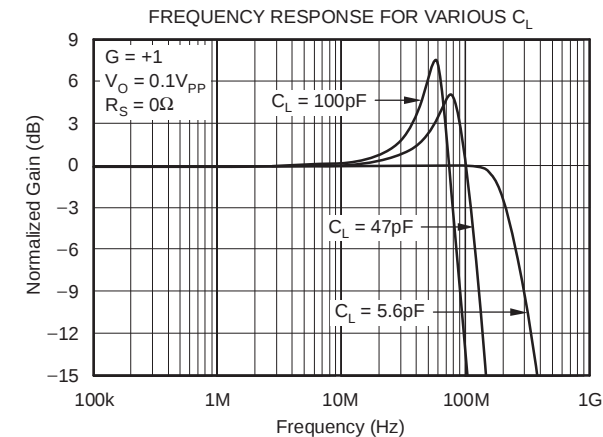
TYPICAL CHARACTERISTICS (continued)

$T_A = 25^\circ\text{C}$, $V_S = 5\text{ V}$, $R_F = 0\ \Omega$, $R_L = 1\text{ k}\Omega$ connected to $V_S/2$ (unless otherwise noted)



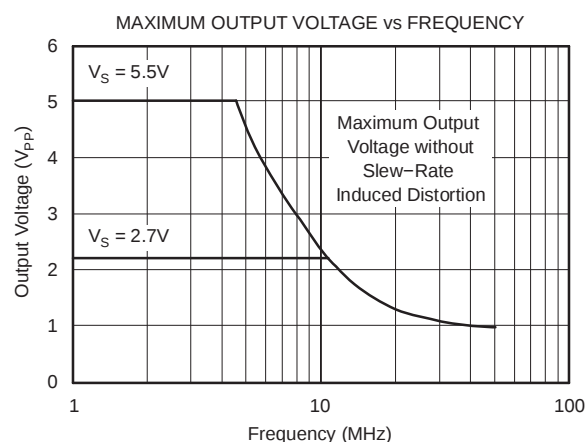
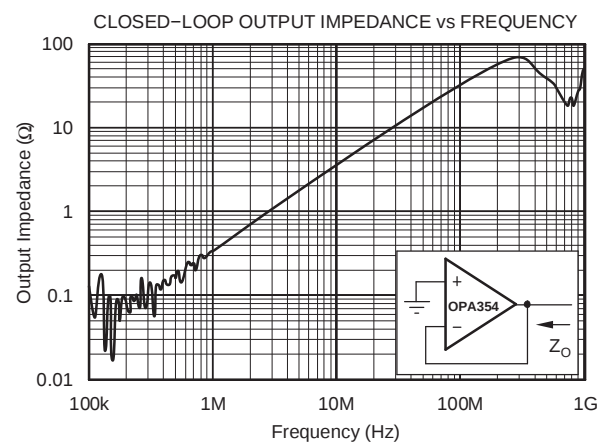
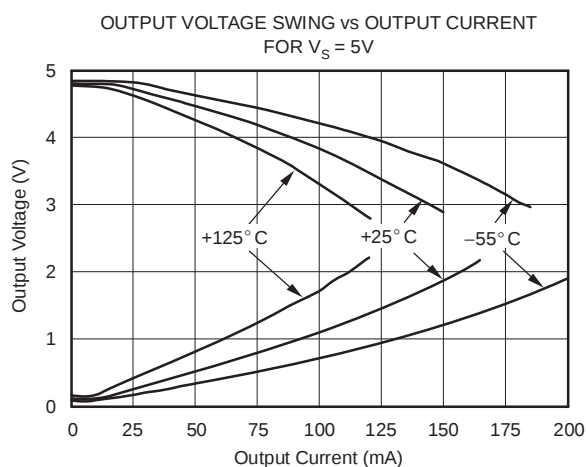
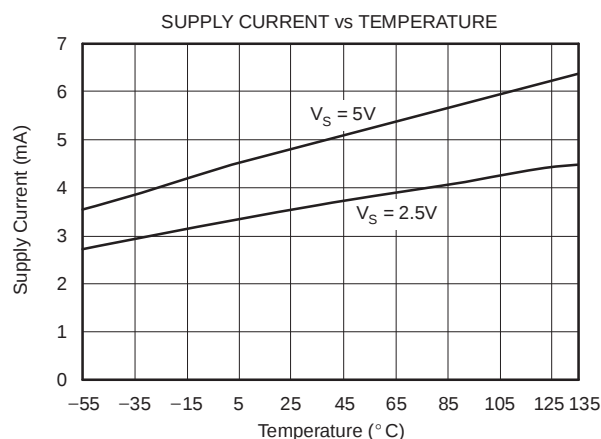
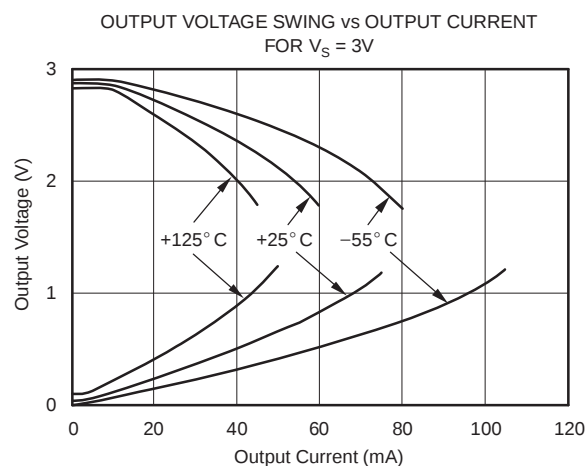
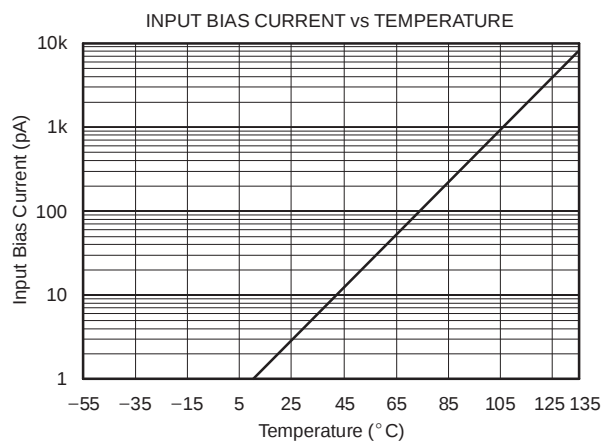
TYPICAL CHARACTERISTICS (continued)

$T_A = 25^\circ\text{C}$, $V_S = 5\text{ V}$, $R_F = 0\ \Omega$, $R_L = 1\text{ k}\Omega$ connected to $V_S/2$ (unless otherwise noted)



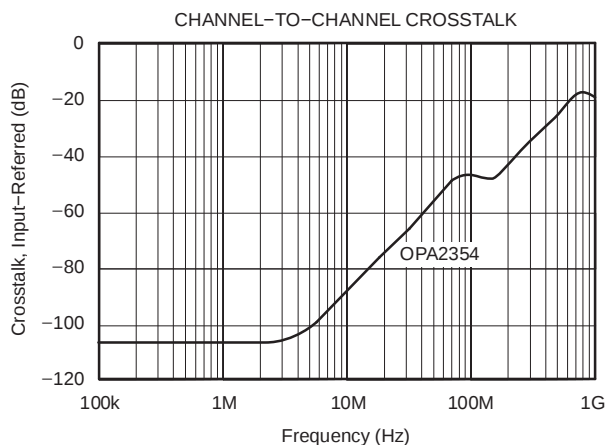
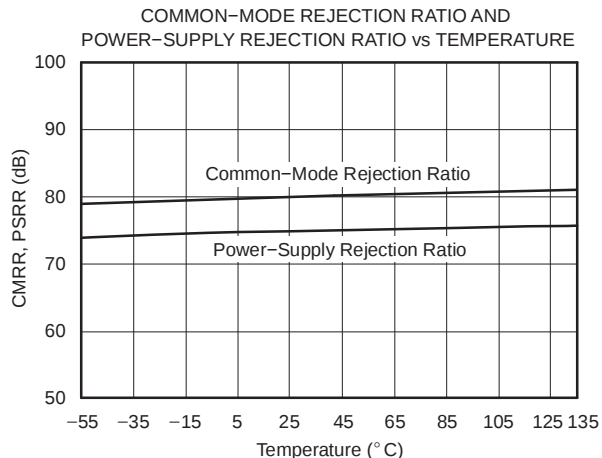
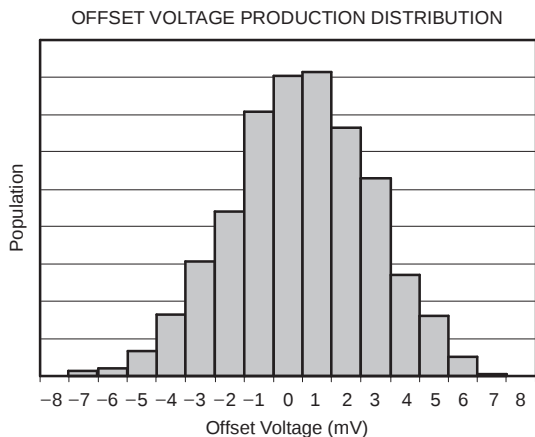
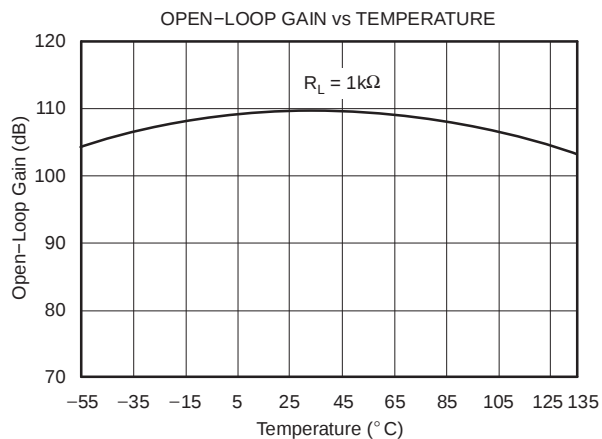
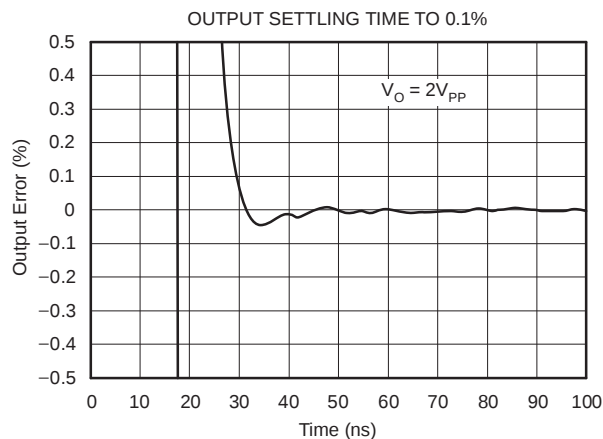
TYPICAL CHARACTERISTICS (continued)

$T_A = 25^\circ\text{C}$, $V_S = 5\text{ V}$, $R_F = 0\ \Omega$, $R_L = 1\text{ k}\Omega$ connected to $V_S/2$ (unless otherwise noted)



TYPICAL CHARACTERISTICS (continued)

$T_A = 25^\circ\text{C}$, $V_S = 5\text{ V}$, $R_F = 0\ \Omega$, $R_L = 1\text{ k}\Omega$ connected to $V_S/2$ (unless otherwise noted)



APPLICATION INFORMATION

The OPA354 is a CMOS, rail-to-rail I/O, high-speed, voltage-feedback operational amplifier designed for video, high-speed, and other applications. It is available as a single or dual op amp.

The amplifier features a 100-MHz gain bandwidth, and 150 V/ μ s slew rate, but it is unity-gain stable and can be operated as a +1-V/V voltage follower.

Operating Voltage

The OPA354 is specified over a power-supply range of 2.7 V to 5.5 V (± 1.35 V to ± 2.75 V). However, the supply voltage may range from 2.5 V to 5.5 V (± 1.25 V to ± 2.75 V). Supply voltages higher than 7.5 V (absolute maximum) can permanently damage the amplifier.

Parameters that vary over supply voltage or temperature are shown in the typical characteristics section of this data sheet.

Rail-to-Rail Input

The specified input common-mode voltage range of the OPA354 extends 100 mV 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 1. The N-channel pair is active for input voltages close to the positive rail, typically $(V^+) - 1.2$ V to 100 mV above the positive supply, while the P-channel pair is on for inputs from 100 mV below the negative supply to approximately $(V^+) - 1.2$ V. There is a small transition region, typically $(V^+) - 1.5$ V to $(V^+) - 0.9$ V, in which both pairs are on. This 600-mV transition region can vary ± 500 mV with process variation. Thus, the transition region (both input stages on) can range from $(V^+) - 2.0$ V to $(V^+) - 1.5$ V on the low end, up to $(V^+) - 0.9$ V to $(V^+) - 0.4$ V on the high end.

A double-folded cascode adds the signal from the two input pairs and presents a differential signal to the class AB output stage.

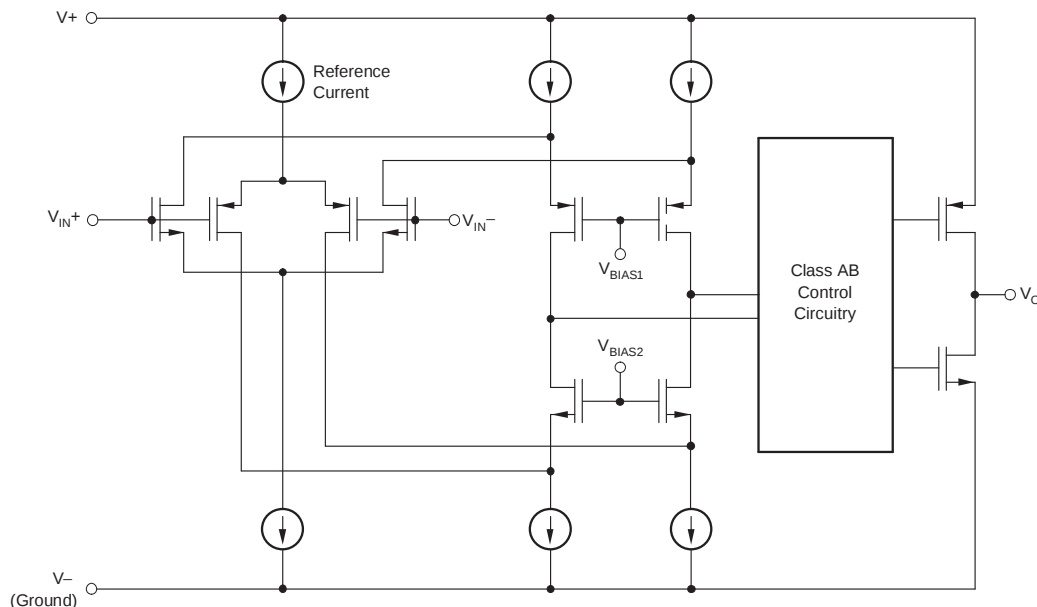


Figure 1. Simplified Schematic

Rail-to-Rail Output

A class AB output stage with common-source transistors is used to achieve rail-to-rail output. For high-impedance loads ($> 200 \Omega$), the output voltage swing is typically 100 mV from the supply rails. With 10- Ω loads, a useful output swing can be achieved while maintaining high open-loop gain. See the typical characteristic curve Output Voltage Swing vs Output Current.

Output Drive

The OPA354's output stage can supply a continuous output current of ± 100 mA and still provide approximately 2.7-V output swing on a 5-V supply, as shown in Figure 2.

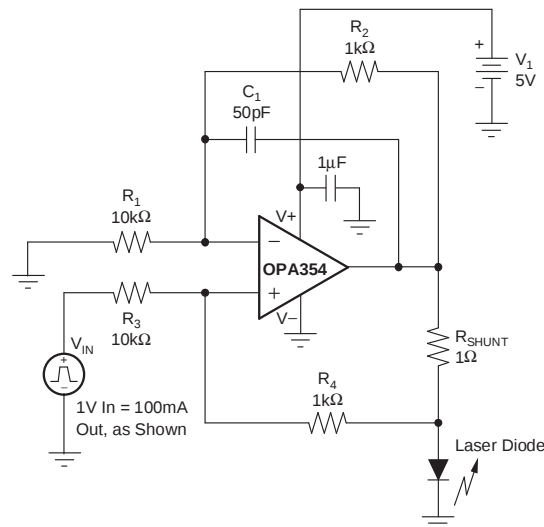


Figure 2. Laser Diode Driver

For maximum reliability, it is not recommended to run a continuous dc current in excess of ± 100 mA. See the typical characteristic curve Output Voltage Swing vs Output Current. For supplying continuous output currents greater than ± 100 mA, the OPA354 may be operated in parallel, as shown in Figure 3.

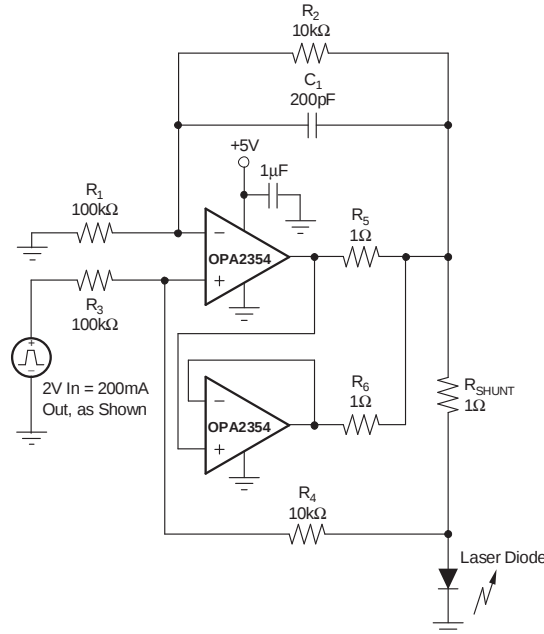


Figure 3. Parallel Operation

The OPA354 provides peak currents up to 200 mA, which corresponds to the typical short-circuit current. Therefore, an on-chip thermal shutdown circuit is provided to protect the OPA354 from dangerously high junction temperatures. At 160°C, the protection circuit shuts down the amplifier. Normal operation resumes when the junction temperature cools to below 140°C.

Video

The OPA354 output stage is capable of driving standard back-terminated 75-Ω video cables (see Figure 4). By back-terminating a transmission line, it does not exhibit a capacitive load to its driver. A properly back-terminated 75-Ω cable does not appear as capacitance; it presents only a 150-Ω resistive load to the OPA354 output.

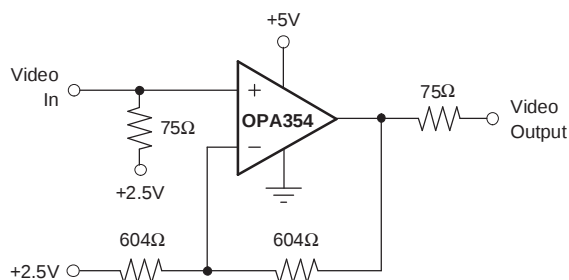


Figure 4. Single-Supply Video Line Driver

The OPA354 can be used as an amplifier for RGB graphic signals, which have a voltage of zero at the video black level, by offsetting and ac-coupling the signal (see Figure 5).

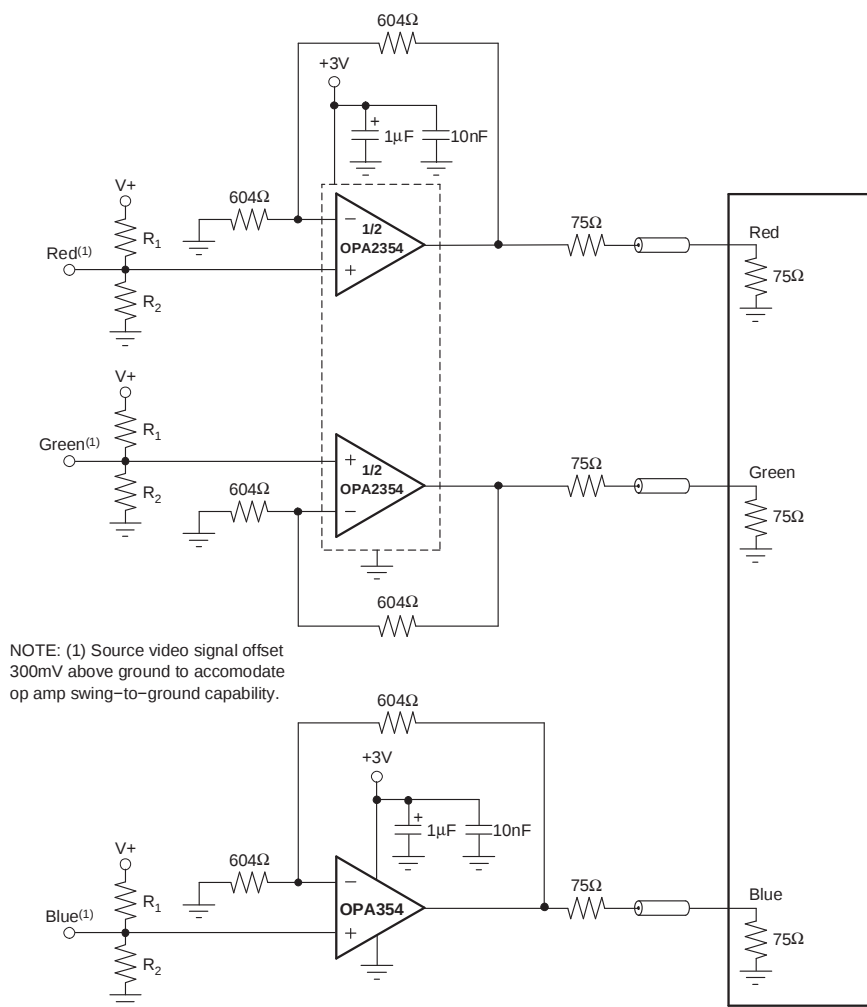


Figure 5. RGB Cable Driver

Driving Analog-to-Digital Converters

The OPA354 series op amps offer 60-ns settling time to 0.01%, making them a good choice for driving high- and medium-speed sampling A/D converters and reference circuits. The OPA354 series provide an effective means of buffering the A/D converter's input capacitance and resulting charge injection while providing signal gain. For applications requiring high DC accuracy, the OPA350 series is recommended.

Figure 6 shows the OPA354 driving an A/D converter. With the OPA354 in an inverting configuration, a capacitor across the feedback resistor can be used to filter high-frequency noise in the signal.

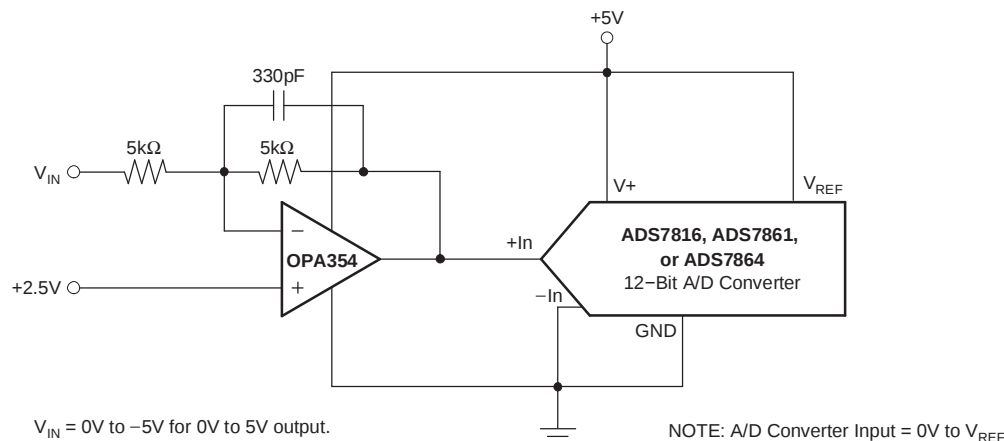


Figure 6. OPA354 Inverting Configuration Driving the ADS7816

Capacitive Load and Stability

The OPA354 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 most susceptible to the effects of capacitive loading. 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 that degrades the phase margin. See the typical characteristic curve Frequency Response vs Capacitive Load for details.

The OPA354's topology enhances its ability to drive capacitive loads. In unity gain, these op amps perform well with large capacitive loads. Refer to the typical characteristic curve Recommended R_S vs Capacitive Load and Frequency Response vs Capacitive Load for details.

One method of improving capacitive load drive in the unity-gain configuration is to insert a 10-Ω to 20-Ω resistor in series with the output, as shown in Figure 7. This significantly reduces ringing with large capacitive loads—see the typical characteristic curve Frequency Response vs Capacitive Load. 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 $R_L = 10\text{ k}\Omega$ and $R_S = 20\text{ }\Omega$, there is only about a 0.2% error at the output.

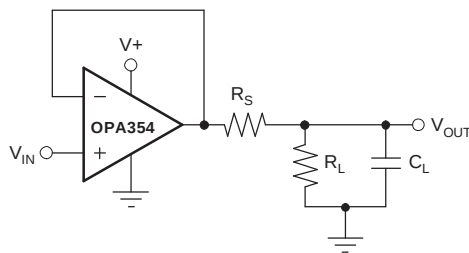


Figure 7. Series Resistor in Unity-Gain Configuration Improves Capacitive Load Drive

Wideband Transimpedance Amplifier

Wide bandwidth, low input bias current, and low input voltage and current noise make the OPA354 an ideal wideband photodiode transimpedance amplifier for low-voltage single-supply applications. Low-voltage noise is important because photodiode capacitance causes the effective noise gain of the circuit to increase at high frequency.

The key elements to a transimpedance design, as shown in Figure 8, are the expected diode capacitance (including the parasitic input common-mode and differential-mode input capacitance (2 + 2) pF for the OPA354), the desired transimpedance gain (R_F), and the gain-bandwidth product (GBW) for the OPA354 (100 MHz). With these three variables set, the feedback capacitor value (C_F) may be set to control the frequency response.

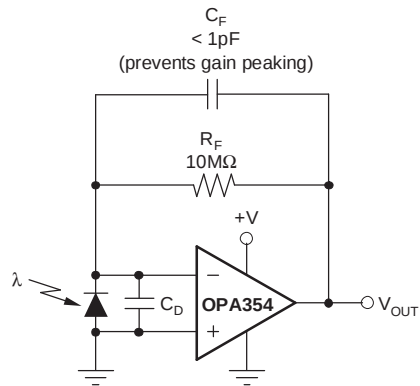


Figure 8. Transimpedance Amplifier

To achieve a maximally flat second-order Butterworth frequency response, the feedback pole should be set as shown in Equation 1.

$$\frac{1}{2\pi R_F C_F} = \sqrt{\frac{\text{GBP}}{4\pi R_F C_D}} \quad (1)$$

Typical surface-mount resistors have a parasitic capacitance of around 0.2 pF that must be deducted from the calculated feedback capacitance value.

Bandwidth is calculated as shown in Equation 2.

$$f_{-3\text{dB}} = \sqrt{\frac{\text{GBP}}{2\pi R_F C_D}} \text{ Hz} \quad (2)$$

For even higher transimpedance bandwidth, the high-speed CMOS OPA355 (200-MHz GBW) or the OPA655 (400-MHz GBW) may be used.

PCB Layout

Good high-frequency printed circuit board (PCB) layout techniques should be employed for the OPA354. Generous use of ground planes, short and direct signal traces, and a suitable bypass capacitor located at the V+ pin assures clean stable operation. Large areas of copper also provides a means of dissipating heat that is generated in normal operation.

Sockets are not recommended for use with any high-speed amplifier.

A 10-nF ceramic bypass capacitor is the minimum recommended value; adding a 1-μF or larger tantalum capacitor in parallel can be beneficial when driving a low-resistance load. Providing adequate bypass capacitance is essential to achieving very low harmonic and intermodulation distortion.

Power Dissipation

Power dissipation depends on power-supply voltage, signal and load conditions. With dc signals, power dissipation is equal to the product of output current times the voltage across the conducting output transistor, $V_S - V_O$. Power dissipation can be minimized by using the lowest possible power-supply voltage necessary to assure the required output voltage swing.

For resistive loads, the maximum power dissipation occurs at a dc output voltage of one-half the power-supply voltage. Dissipation with ac signals is lower. Application bulletin AB-039 ([SBOA022](#)), *Power Amplifier Stress and Power Handling Limitations*, explains how to calculate or measure power dissipation with unusual signals and loads, and can be found at www.ti.com.

Any tendency to activate the thermal protection circuit indicates excessive power dissipation or an inadequate heatsink. For reliable operation, junction temperature should be limited to 150°C, maximum. To estimate the margin of safety in a complete design, increase the ambient temperature until the thermal protection is triggered at 160°C. The thermal protection should trigger more than 35°C above the maximum expected ambient condition of the application.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
OPA2354AQDGKRQ1	ACTIVE	VSSOP	DGK	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAUAG	Level-2-260C-1 YEAR	-40 to 125	OSLQ	Samples
OPA354AQDBVRQ1	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	OSFQ	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) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

(4) Multiple Top-Side Markings will be inside parentheses. Only one Top-Side 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 Top-Side Marking for that device.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

OTHER QUALIFIED VERSIONS OF OPA2354-Q1 :

-
- Catalog: [OPA2354](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

TAPE AND REEL INFORMATION


*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
OPA2354AQDGKRQ1	VSSOP	DGK	8	2500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
OPA354AQDBVRQ1	SOT-23	DBV	5	3000	179.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3

TAPE AND REEL BOX DIMENSIONS

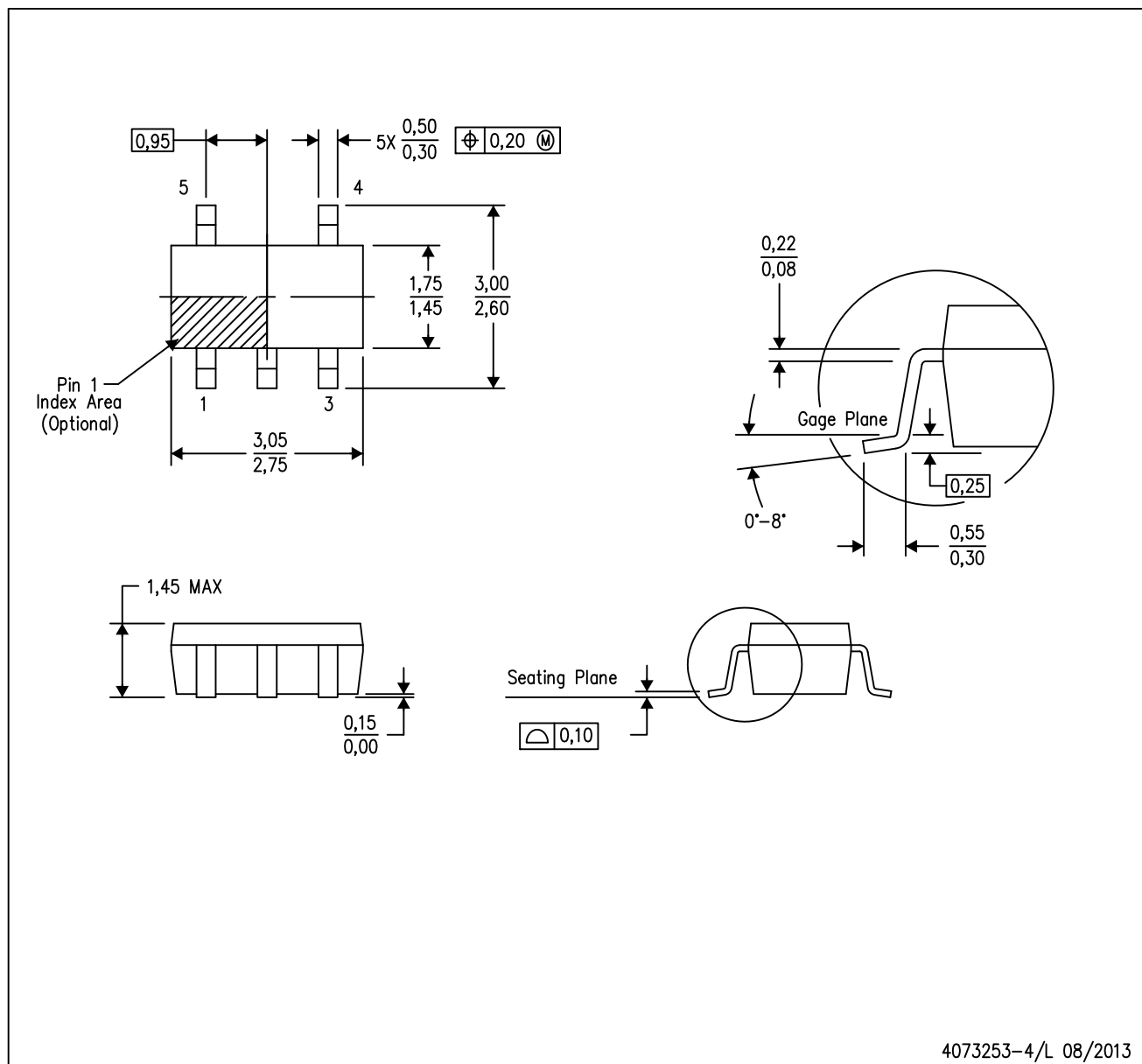


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
OPA2354AQDGKRQ1	VSSOP	DGK	8	2500	367.0	367.0	35.0
OPA354AQDBVRQ1	SOT-23	DBV	5	3000	195.0	200.0	45.0

DBV (R-PDSO-G5)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
 - D. Falls within JEDEC MO-178 Variation AA.

DBV (R-PDSO-G5)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
 - D. Publication IPC-7351 is recommended for alternate designs.
 - E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC-7525 for other stencil recommendations.

DGK (S-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 per end.
 - D. Body width does not include interlead flash. Interlead flash shall not exceed 0.50 per side.
 - E. Falls within JEDEC MO-187 variation AA, except interlead flash.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products

Audio	www.ti.com/audio
Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DLP® Products	www.dlp.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
OMAP Applications Processors	www.ti.com/omap
Wireless Connectivity	www.ti.com/wirelessconnectivity

Applications

Automotive and Transportation	www.ti.com/automotive
Communications and Telecom	www.ti.com/communications
Computers and Peripherals	www.ti.com/computers
Consumer Electronics	www.ti.com/consumer-apps
Energy and Lighting	www.ti.com/energy
Industrial	www.ti.com/industrial
Medical	www.ti.com/medical
Security	www.ti.com/security
Space, Avionics and Defense	www.ti.com/space-avionics-defense
Video and Imaging	www.ti.com/video

TI E2E Community

e2e.ti.com