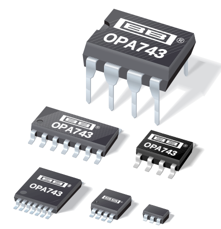
Burr-Brown Products
from Texas Instruments

OPA743
OPA2743
OPA4743



SBOS201 – MAY 2001

12V, 7MHz, CMOS, Rail-to-Rail I/O OPERATIONAL AMPLIFIERS

FEATURES

- **HIGH SPEED: 7MHz, 10V/µs**
- **RAIL-TO-RAIL INPUT AND OUTPUT**
- **WIDE SUPPLY RANGE:**
  Single Supply: 3.5V to 12V
  Dual Supplies: ±1.75V to ±6V
- **LOW QUIESCENT CURRENT: 1.1mA**
- **FULL-SCALE CMRR: 84dB**
- ***Micro*SIZE PACKAGES:**
  SOT23-5, MSOP-8, TSSOP-14
- **LOW INPUT BIAS CURRENT: 1pA**

APPLICATIONS

- **LCD GAMMA CORRECTION**
- **AUTOMOTIVE APPLICATIONS:**
  Audio, Sensor Applications, Security Systems
- **PORTABLE EQUIPMENT**
- **ACTIVE FILTERS**
- **TRANSDUCER AMPLIFIER**
- **TEST EQUIPMENT**
- **DATA ACQUISITION**

DESCRIPTION

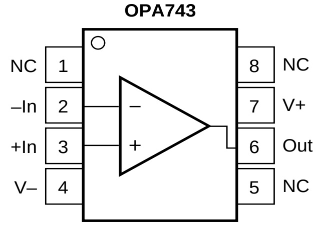
The OPA743 series utilizes a state-of-the-art 12V analog CMOS process and offers outstanding AC performance, such as 7MHz GBW, 10V/µs slew rate and 0.0008% THD+N. Optimized for single supply operation up to 12V, the input common-mode range extends beyond the power supply rails and the output swings to within 100mV of the rails. The low quiescent current of 1.1mA makes it well suited for use in battery operated equipment.

The OPA743 series' ability to drive high output currents together with 12V operation makes it particularly useful for use as gamma correction reference buffer in LCD panels.

For ease of use the OPA743 op-amp family is fully specified and tested over the supply range of ±1.75V to ±6V. Single, dual and quad versions are available.

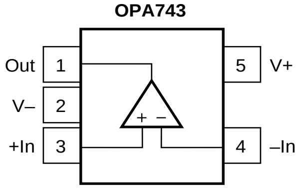
The single versions (OPA743) are available in the *Micro*SIZE SOT23-5 and in the standard SO-8 surface-mount, as well as DIP-8 packages. Dual versions (OPA2743) are available versions in the MSOP-8, SO-8, and DIP-8 packages. The quad versions (OPA4743) are available in the TSSOP-14 and SO-14 packages. All are specified for operation from –40°C to +85°C.

OPA743



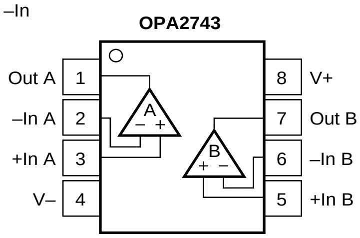
SO-8, DIP-8

OPA743



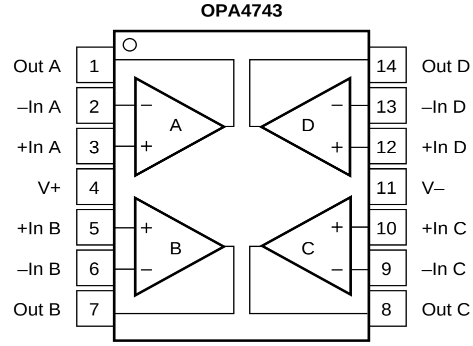
SOT23-5

OPA2743



MSOP-8, SO-8, DIP-8

OPA4743



TSSOP-14, SO-14

ABSOLUTE MAXIMUM RATINGS[1]

Supply Voltage, V+ to V–	13.2V
Signal Input Terminals, Voltage[2]	(V–) –0.3V to (V+) +0.3V
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 0.3V 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 MARKING	ORDERING NUMBER[1]	TRANSPORT MEDIA
Single					
OPA743NA	SOT23-5	331	D43	OPA743NA/250	Tape and Reel
"	"	"	"	OPA743NA/3K	Tape and Reel
OPA743UA	SO-8	182	OPA743UA	OPA743UA	Rails
"	"	"	"	OPA743UA/2K5	Tape and Reel
OPA743PA	DIP-8	006	OPA743PA	OPA743PA	Rails
Dual					
OPA2743EA	MSOP-8	337	E43	OPA2743EA/250	Tape and Reel
"	"	"	"	OPA2743EA/2K5	Tape and Reel
OPA2743UA	SO-8	182	OPA2743UA	OPA2743UA	Rails
"	"	"	"	OPA2743UA/2K5	Tape and Reel
OPA2743PA	DIP-8	006	OPA2743PA	OPA2743PA	Rails
Quad					
OPA4743EA	TSSOP-14	357	OPA4743EA	OPA4743EA/250	Tape and Reel
"	"	"	"	OPA4743EA/2K5	Tape and Reel
OPA4743UA	SO-14	235	OPA4743UA	OPA4743UA	Rails
"	"	"	"	OPA4743UA/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 "OPA743NA/3K" will get a single 3000-piece Tape and Reel.

ELECTRICAL CHARACTERISTICS: V_S = 3.5V to 12V

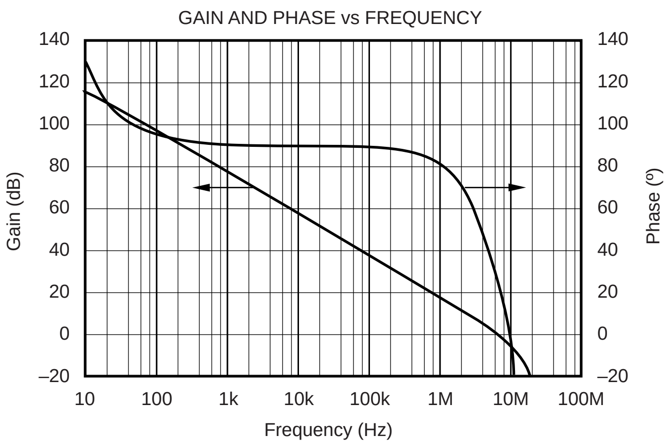
Boldface limits apply over the specified temperature range, **T_A = –40°C to +85°C**

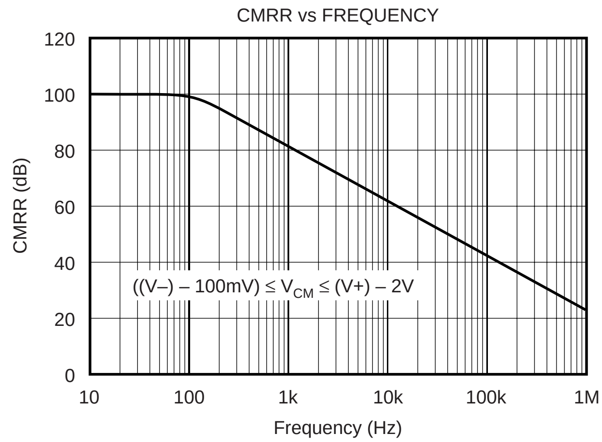
At T_A = +25°C, R_L = 10kΩ connected to V_S / 2 and V_{OUT} = V_S / 2, unless otherwise noted.

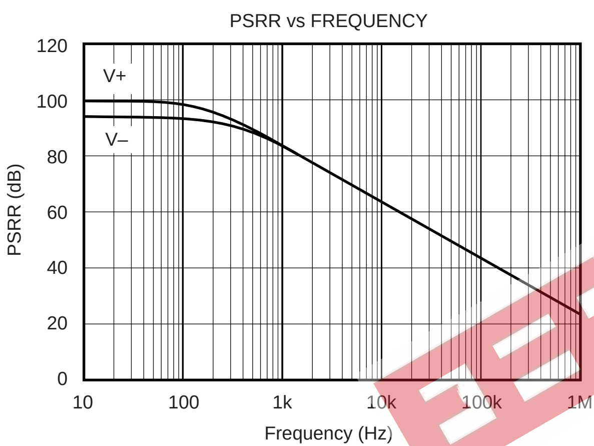
PARAMETER		CONDITION	OPA743NA, UA, PA OPA2743EA, UA, PA OPA4743EA, UA MIN	TYP	MAX	UNITS
OFFSET VOLTAGE						
Input Offset Voltage	V_{OS}	V_S = ±5V, V_{CM} = 0V		±1.5	±7	mV
Drift	**dV_{OS}/dT**	**T_A = –40°C to +85°C**		**±8**		**μV/°C**
vs Power Supply	PSRR	V_S = ±1.75V to ±6V, V_{CM} = –0.25		10	100	μV/V
Over Temperature		**V_S = ±1.75V to ±6V, V_{CM} = –0.25**			**200**	**μV/V**
Channel Separation, dc				1		μV/V
f = 10kHz				110		dB
INPUT VOLTAGE RANGE						
Common-Mode Voltage Range	V_{CM}		(V–) – 0.1		(V+) + 0.1	V
Common-Mode Rejection Ratio	CMRR	V_S = ±5V, (V–) – 0.1V < V_{CM} < (V+) + 0.1V	66	84		dB
over Temperature		**V_S = ±5V, (V–) < V_{CM} < (V+)**	**60**			**dB**
		V_S = ±5V, (V–) – 0.1V < V_{CM} < (V+) – 2V	70	90		dB
over Temperature		**V_S = ±5V, (V–) < V_{CM} < (V+) – 2V**	**70**			**dB**
		V_S = ±1.75V, (V–) – 0.1V < V_{CM} < (V+) + 0.1V	60			dB
INPUT BIAS CURRENT						
Input Bias Current	I_B	V_S = ±6V, V_{CM} = 0V		±1	±10	pA
Input Offset Current	I_{OS}	V_S = ±6V, V_{CM} = 0V		±0.5	±10	pA
INPUT IMPEDANCE						
Differential				$4 \cdot 10^9$ || 4		Ω || pF
Common-Mode				$5 \cdot 10^{12}$ || 4		Ω || pF
NOISE						
Input Voltage Noise, f = 0.1Hz to 10Hz		V_S = ±6V, V_{CM} = 0V		11		μVp-p
Input Voltage Noise Density, f = 10kHz	e_n	V_S = ±6V, V_{CM} = 0V		30		nV/√Hz
Current Noise Density, f = 1kHz	i_n	V_S = ±6V, V_{CM} = 0V		2.5		fA/√Hz
OPEN-LOOP GAIN						
Open-Loop Voltage Gain	A_{OL}	R_L = 100kΩ, (V–)+0.1V < V_O < (V+)–0.1V	106	120		dB
over Temperature		**R_L = 100kΩ, (V–)+0.125V < V_O < (V+)–0.125V**	**100**			**dB**
		R_L = 1k, (V–)+0.325V < V_O < (V+)–0.325V	86	100		dB
over Temperature		**R_L = 1k, (V–)+0.450 < V_O < (V+)–0.450V**	**96**			**dB**
OUTPUT						
Voltage Output Swing from Rail		R_L = 100kΩ, A_{OL} > 106dB		75	100	mV
over Temperature		**R_L = 100kΩ, A_{OL} > 100dB**		**100**	**125**	**mV**
		R_L = 1kΩ, A_{OL} > 86dB		300	325	mV
over Temperature		**R_L = 1kΩ, A_{OL} > 96dB**		**425**	**450**	**mV**
Output Current	I_{OUT}	|V_S – V_{OUT}| < 1V		±20		mA
Short-Circuit Current	I_{SC}			±30		mA
Capacitive Load Drive	C_{LOAD}			See Typical Characteristics		
FREQUENCY RESPONSE		C_L = 15pF				
Gain-Bandwidth Product	GBW	G = +1		7		MHz
Slew Rate	SR	V_S = ±6V, G = +1		10		V/μs
Settling Time, 0.1%	t_S	V_S = ±6V, 5V Step, G = +1		9		μs
0.01%		V_S = ±6V, 5V Step, G = +1		15		μs
Overload Recovery Time		V_{IN} • Gain = V_S		200		ns
Total Harmonic Distortion + Noise	THD+N	V_S = ±6V, V_O = 1Vrms, G = +1, f = 6kHz		0.0008		%
POWER SUPPLY						
Specified Voltage Range, Single Supply	V_S		3.5		12	V
Specified Voltage Range, Dual Supplies	V_S		±1.75		±6	V
Quiescent Current (per amplifier)	I_Q	I_O = 0		1.1	1.5	mA
over Temperature					**1.7**	**mA**
TEMPERATURE RANGE						
Specified Range			–40		85	°C
Operating Range			–55		125	°C
Storage Range			–65		150	°C
Thermal Resistance	θ_{JA}					
SOT23-5 Surface-Mount				200		°C/W
MSOP-8 Surface-Mount				150		°C/W
TSSOP-14 Surface-Mount				100		°C/W
SO-8 Surface Mount				150		°C/W
SO-14 Surface Mount				100		°C/W
DIP-8				100		°C/W

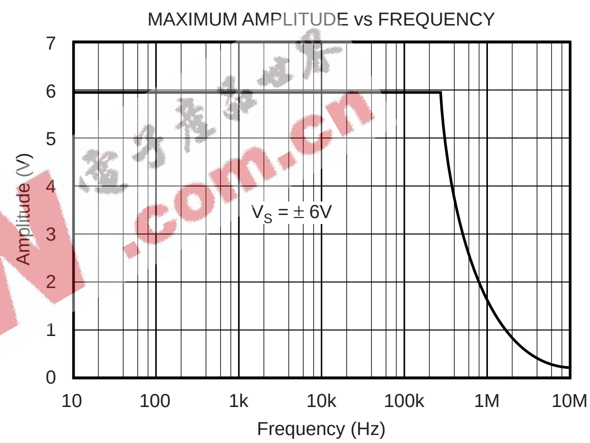
TYPICAL CHARACTERISTICS

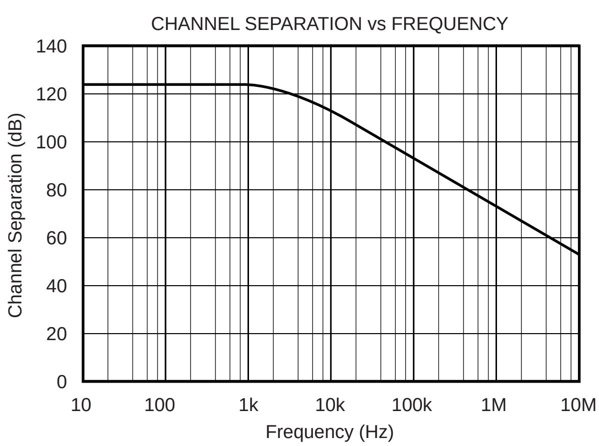
At $T_A = +25°C$, $V_S = ±6V$, and $R_L = 10kΩ$, unless otherwise noted.

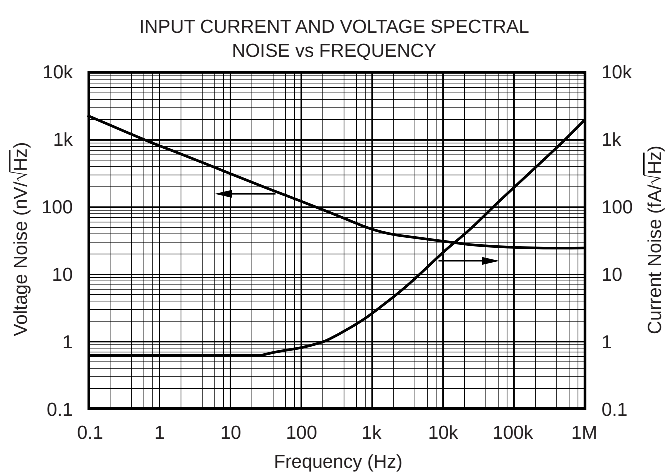








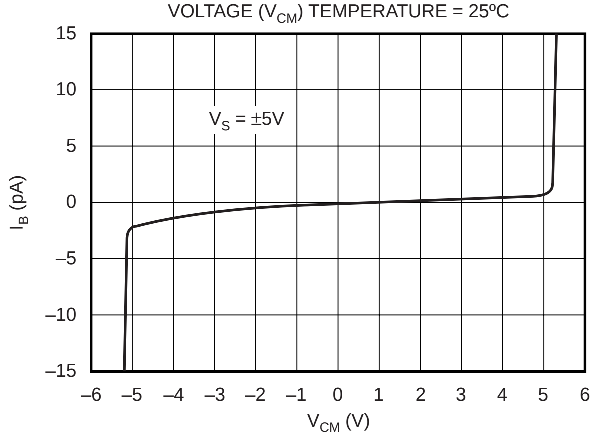




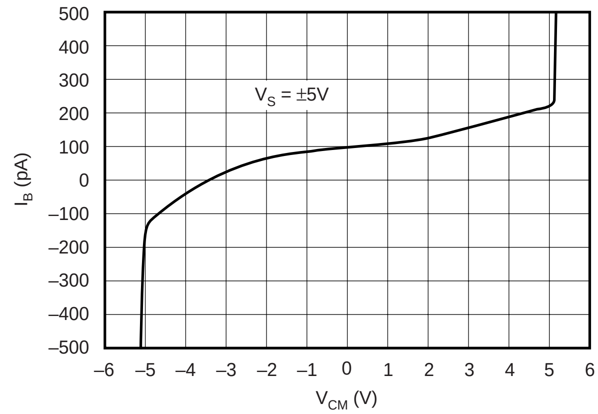
TYPICAL CHARACTERISTICS (Cont.)

At T_A = +25°C, V_S = ±6V, and R_L = 10kΩ, unless otherwise noted.

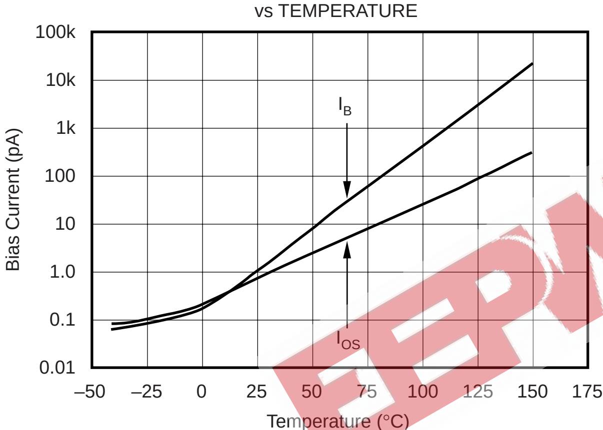
INPUT BIAS CURRENT (I_B) vs COMMON-MODE VOLTAGE (V_{CM}) TEMPERATURE = 25ºC



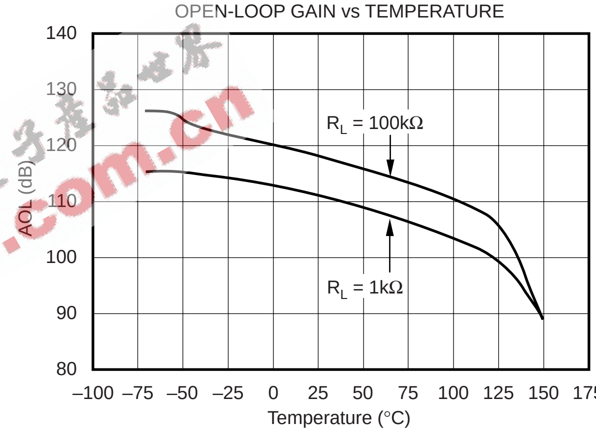
INPUT BIAS CURRENT (I_B) vs COMMON-MODE VOLTAGE (V_{CM}) TEMPERATURE = 85°C



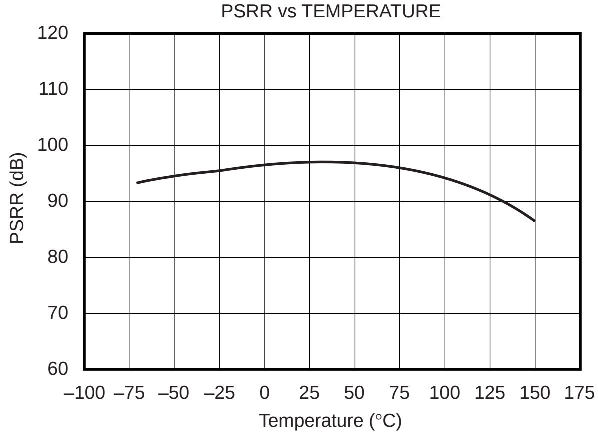
INPUT BIAS (I_B) AND OFFSET (I_{OS}) CURRENT vs TEMPERATURE



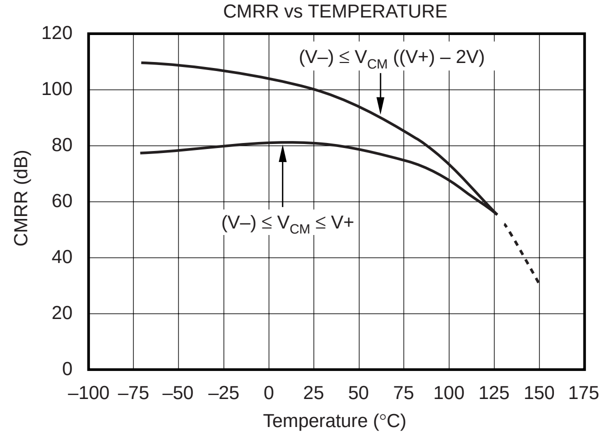
OPEN-LOOP GAIN vs TEMPERATURE



PSRR vs TEMPERATURE



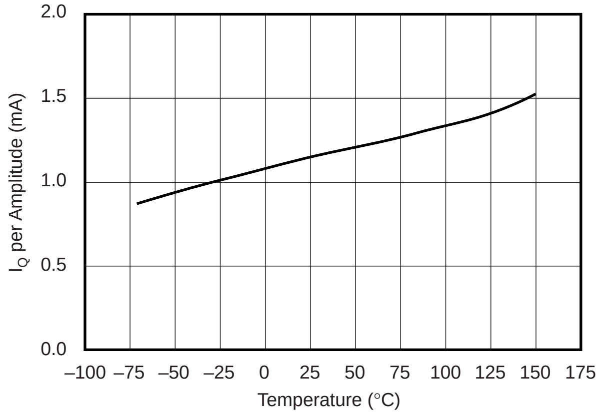
CMRR vs TEMPERATURE



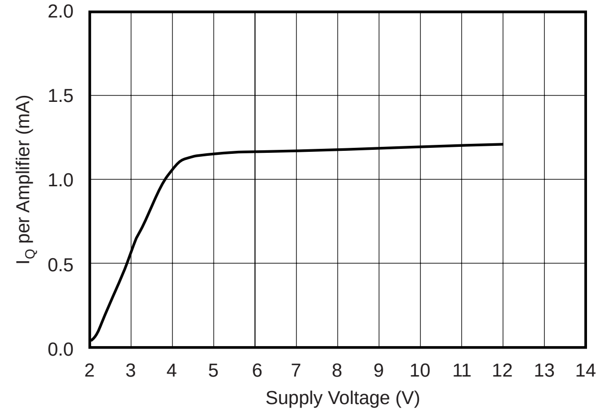
TYPICAL CHARACTERISTICS (Cont.)

At T_A = +25°C, V_S = ±6V, and R_L = 10kΩ, unless otherwise noted.

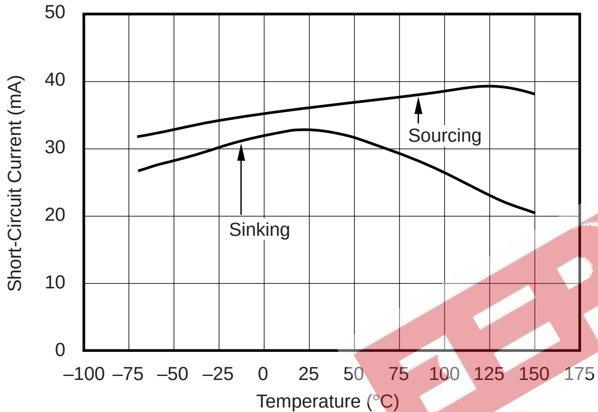
QUIESCENT CURRENT vs TEMPERATURE



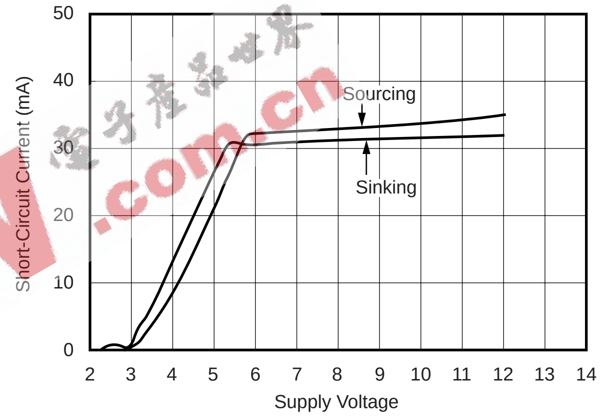
QUIESCENT CURRENT vs SUPPLY VOLTAGE



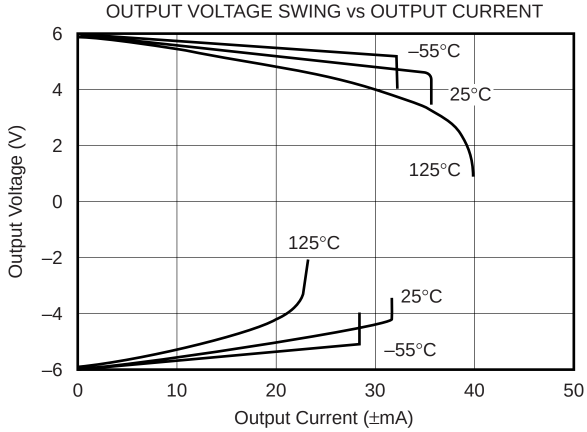
SHORT-CIRCUIT CURRENT vs TEMPERATURE



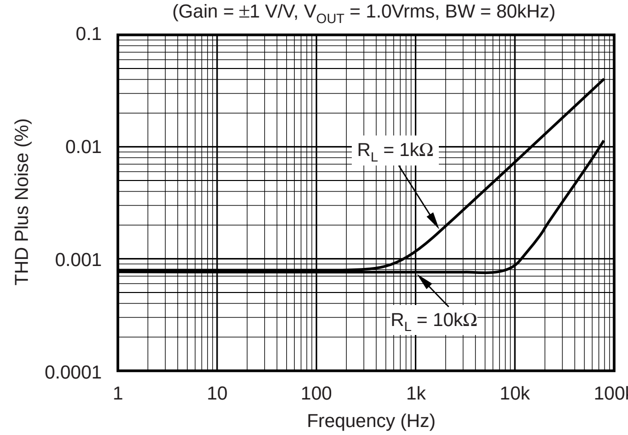
SHORT-CIRCUIT CURRENT vs SUPPLY VOLTAGE



OUTPUT VOLTAGE SWING vs OUTPUT CURRENT

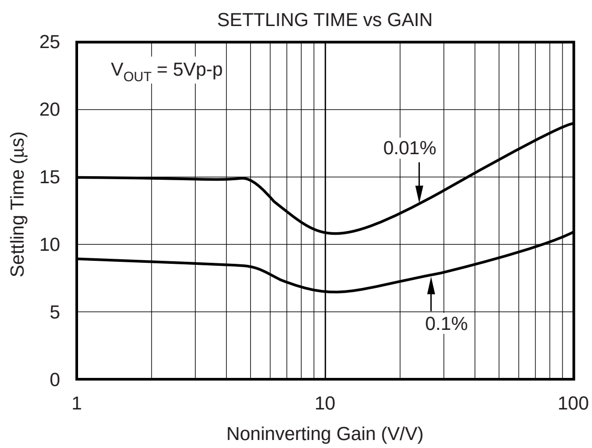


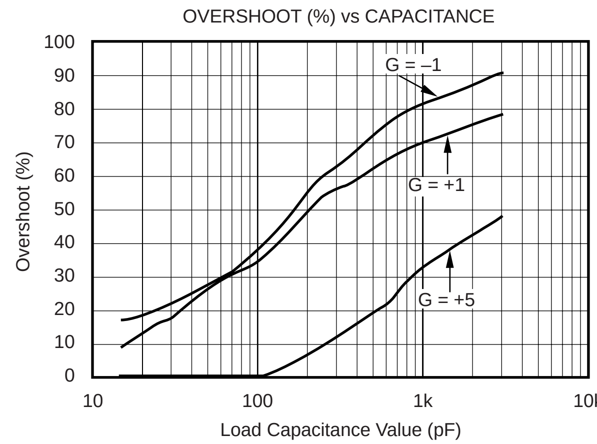
TOTAL HARMONIC DISTORTION PLUS NOISE
(Gain = ±1 V/V, V_{OUT} = 1.0Vrms, BW = 80kHz)

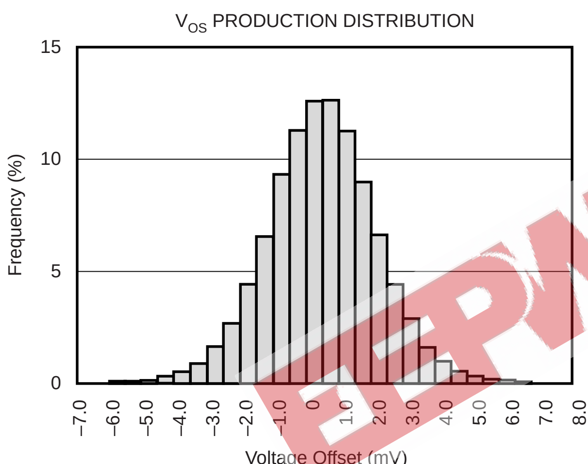


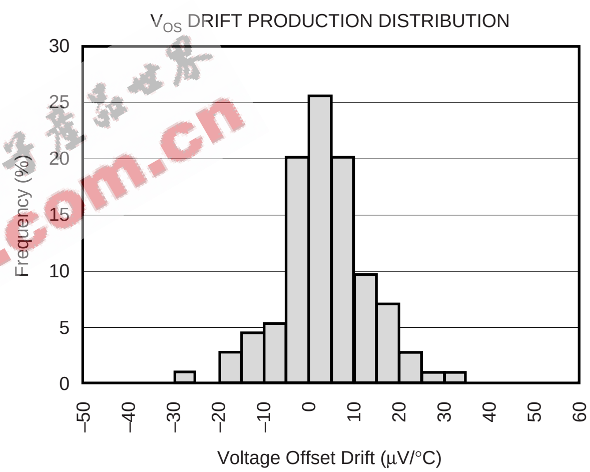
TYPICAL CHARACTERISTICS (Cont.)

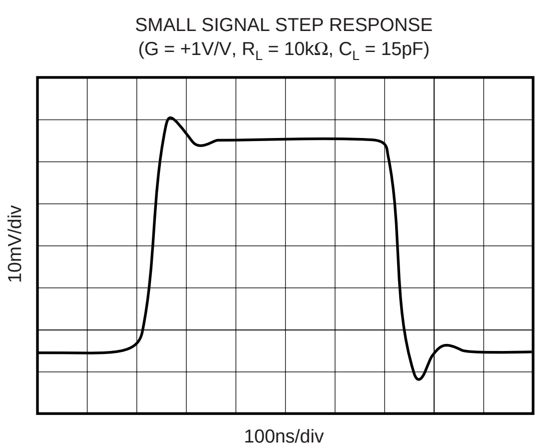
At T_A = +25°C, V_S = ±6V, and R_L = 10kΩ, unless otherwise noted.

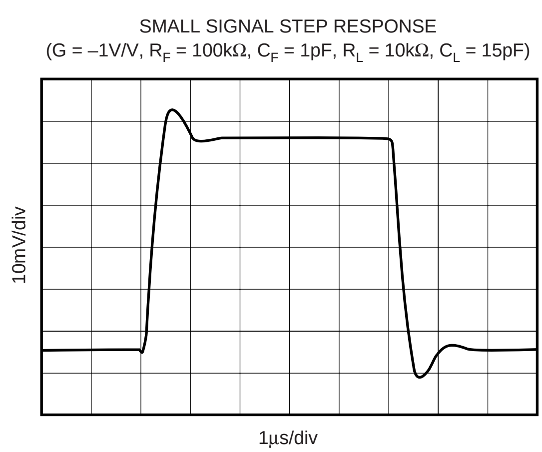










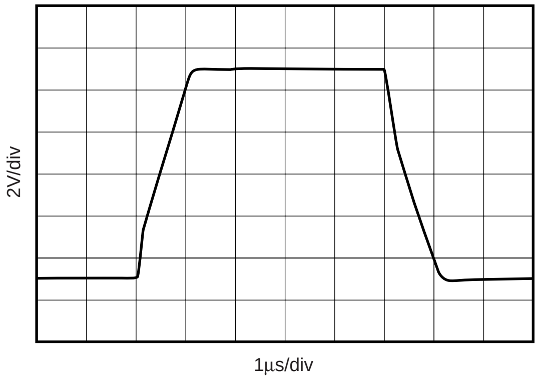


NOTE: C_F is used to optimize settling time.

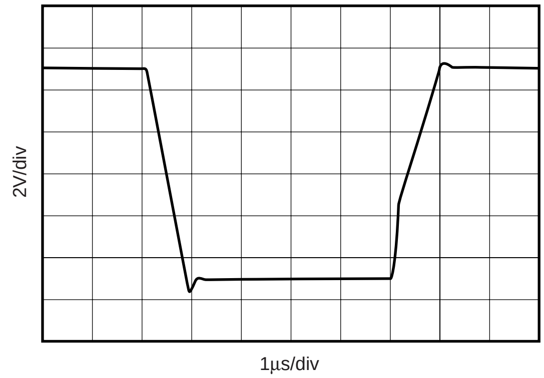
TYPICAL CHARACTERISTICS (Cont.)

At T_A = +25°C, V_S = ±6V, and R_L = 10kΩ, unless otherwise noted.

LARGE SIGNAL STEP RESPONSE
(G = +1V/V, R_L = 10kΩ, C_L = 15pF)



LARGE SIGNAL STEP RESPONSE
(G = –1V/V, R_L = 10kΩ, C_L = 15pF)



APPLICATIONS INFORMATION

OPA743 series op amps can operate on 1.1mA quiescent current from a single (or split) supply in the range of 3.5V to 12V (±1.75V to ±6V), making them highly versatile and easy to use. The OPA743 is unity-gain stable and offers 7MHz bandwidth and 10V/µs slew rate.

Rail-to-rail input and output swing helps maintain dynamic range, especially in low supply applications. Figure 1 shows the input and output waveforms for the OPA743 in unity-gain configuration. On a ±6V supply with a 100kΩ load connected to $V_S/2$. The output is tested to swing within 100mV to the rail.

Power-supply pins should be bypassed with 1000pF ceramic capacitors in parallel with 1µF tantalum capacitors.

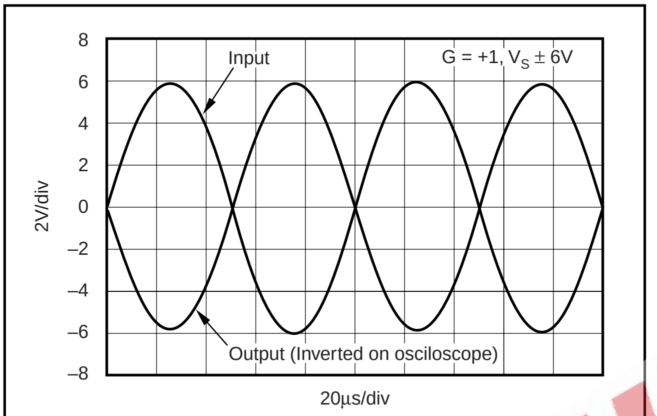


FIGURE 1. Rail-to-Rail Input and Output.

OPERATING VOLTAGE

OPA743 series op amps are fully specified and guaranteed from 3.5V to 12V over a temperature range of –40ºC to +85ºC. 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 OPA743 series extends 100mV beyond the supply rails at room temperature. This is achieved with a complementary input stage—an N-channel input differential pair in parallel with a P-channel differential pair. The N-channel pair is active for input voltages close to the positive rail, typically (V+) – 2.0V to 100mV above the positive supply, while the P-channel pair is on for inputs from 100mV below the negative supply to approximately (V+) – 1.5V. There is a small transition region, typically (V+) – 2.0V to (V+) – 1.5V, in which both pairs are on. This 500mV transition region can vary ±100mV with process variation. Thus, the transition region (both stages on) can range from (V+) – 2.1V to (V+) – 1.4V on the low end, up to (V+) – 1.9V to (V+) – 1.6V on the high end. Most rail-to-rail op amps on the market use this two input stage approach, and exhibit a transition region where CMRR, offset voltage, and THD may vary compared to operation outside this region.

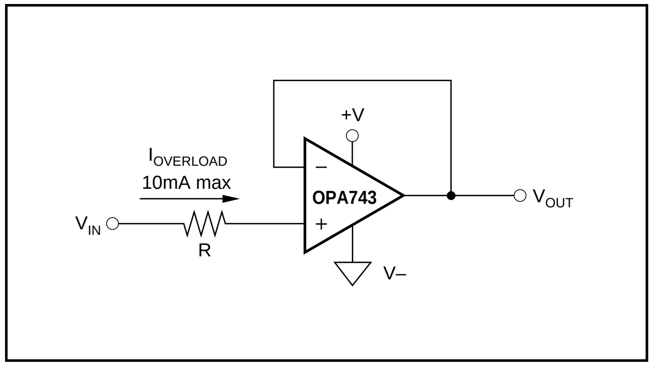


FIGURE 2. Input Current Protection for Voltages Exceeding the Supply Voltage.

INPUT VOLTAGE

Device inputs are protected by ESD diodes that will conduct if the input voltages exceed the power supplies by more than approximately 300mV. Momentary voltages greater than 300mV beyond the power supply can be tolerated if the current is limited to 10mA. This is easily accomplished with an input resistor, in series with the op amp input as shown in Figure 2. Many input signals are inherently current-limited to less than 10mA; therefore, a limiting resistor is not always required. The OPA743 features no phase inversion when the inputs extend beyond supplies if the input current is limited, as seen in Figure 3.

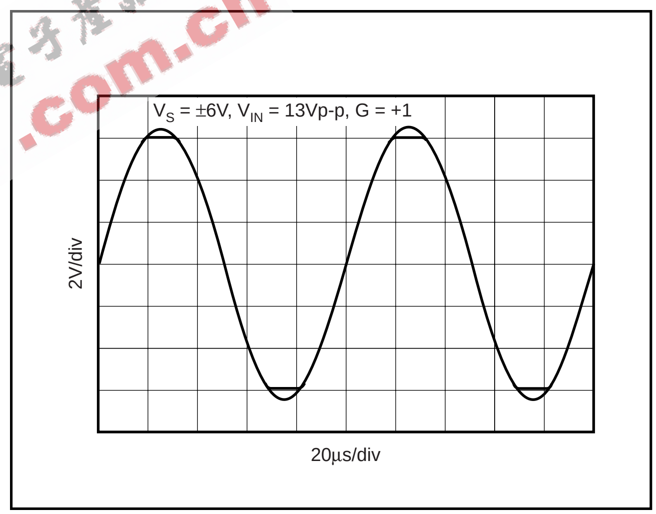


FIGURE 3. OPA743—No Phase Inversion with Inputs Greater than the Power-Supply Voltage.

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 1kΩ loads connected to any point between V+ and V–. For light resistive loads (> 100kΩ), the output voltage can swing to 100mV from the supply rail. With 1kΩ resistive loads, the output can swing to within 325mV from the supply rails while maintaining high open-loop gain (see the typical performance curve “Output Voltage Swing vs Output Current”).

CAPACITIVE LOAD AND STABILITY

The OPA743 series op amps can drive up to 1000pF pure capacitive load. Increasing the gain enhances the amplifier's ability to drive greater capacitive loads (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 inside the feedback loop, as shown in Figure 4. This reduces ringing with large capacitive loads while maintaining DC accuracy.

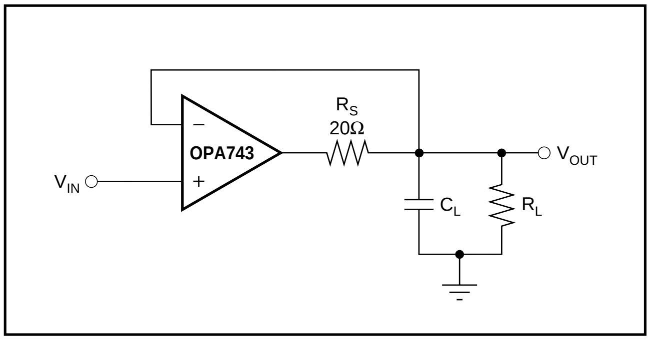


FIGURE 4. Series Resistor in Unity-Gain Buffer Configuration Improves Capacitive Load Drive.

APPLICATION CIRCUITS

The OPA743 series op amps are optimized for driving medium-speed sampling data converters. The OPA743 op amps buffer the converter's input capacitance and resulting charge injection while providing signal gain.

Figure 5 shows the OPA743 in a dual supply buffered reference configuration for the DAC7644.

REFERENCE BUFFER FOR LCD SOURCE DRIVERS

In modern high resolution TFT LCD displays, gamma correction must be performed to correct for nonlinearities in the glass transmission characteristics of the LCD panel. The typical LCD source driver for 64 Bits of Grayscale uses internal DAC to convert the 6-Bit data into analog voltages applied to the LCD. These DAC typically require external voltage references for proper operation. Normally these external reference voltages are generated using a simple resistive ladder, like the one shown in Figure 6.

Typical laptop or desktop LCD panels require 6 to 8 of the source driver circuits in parallel to drive all columns of the panel. Although the resistive load of one internal string DAC is only around 10kΩ, 6 to 8 in parallel represent a very substantial load. The power supply used for the LCD source drivers for laptops is typically in the order of 10V. To maximize the dynamic range of the DAC, rail-to-rail output performance is required for the upper and lower buffer. The OPA4743's ability to operate on 12V supplies, to drive heavy resistive loads (as low as 1kΩ), and to swing to within 325mV of the supply rails, makes it very well suited as a buffer for the reference voltage inputs of LCD source drivers.

During conversion, the DAC's internal switches create current glitches on the output of the reference buffer. The capacitor C_L (typically 100nF) functions as a charge reservoir that provides/absorbs most of the glitch energy. The series resistor R_S isolates the outputs of the OPA4743 from the heavy capacitive load and helps to improve settling time.

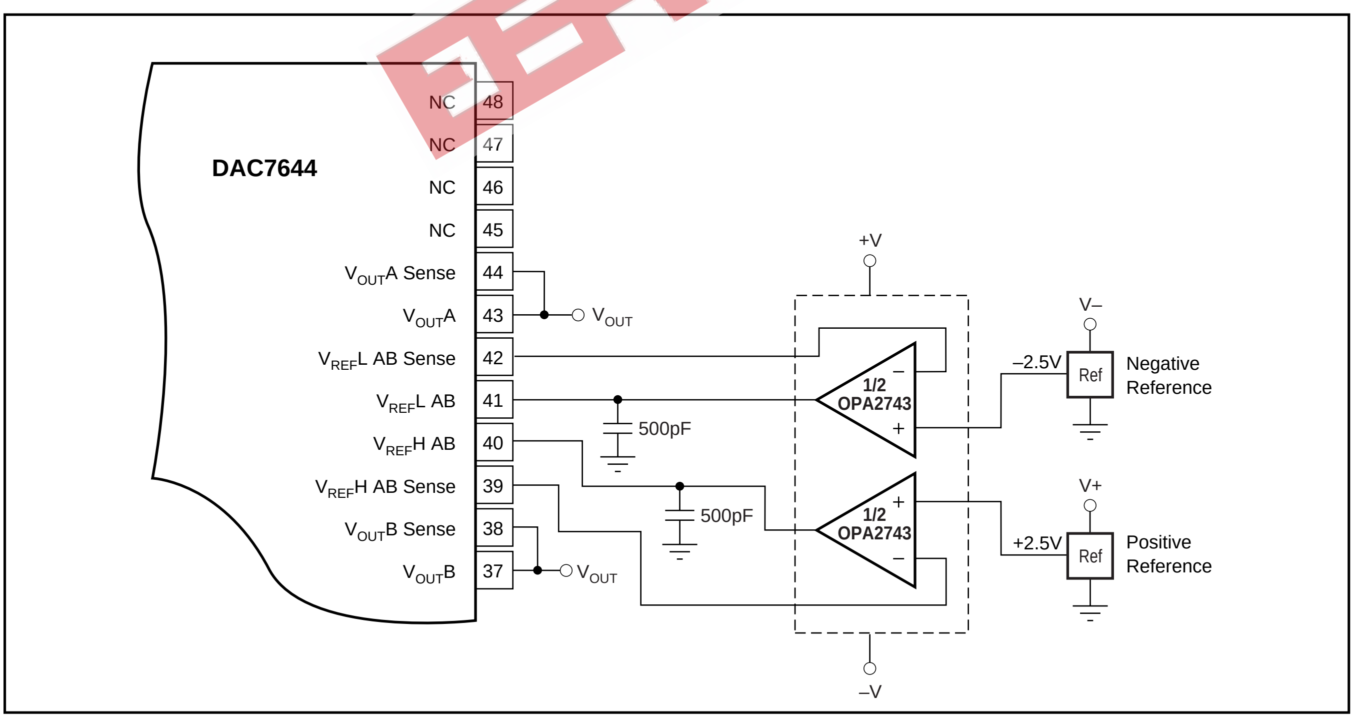
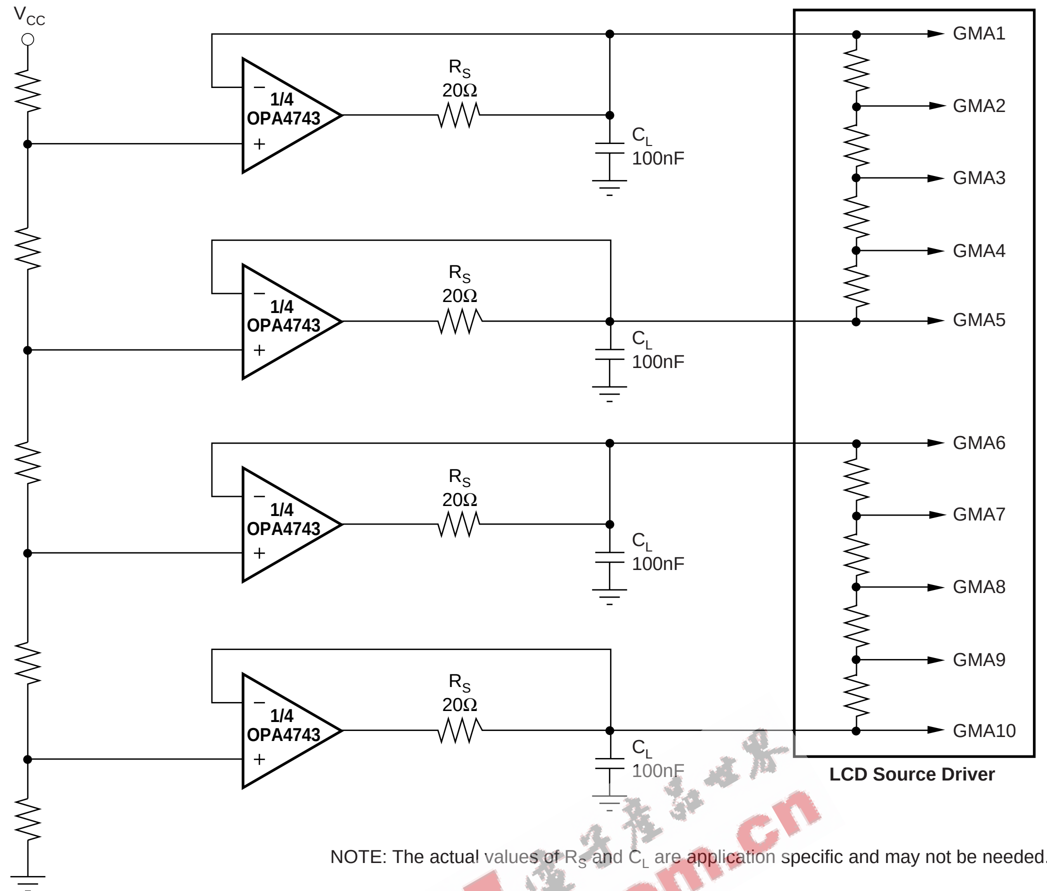


FIGURE 5. OPA743 as Dual Supply Configuration-Buffered References for the DAC7644.



NOTE: The actual values of R_S and C_L are application specific and may not be needed.

FIGURE 6. OPA743 Configured as a Reference Buffer for an LCD Display.

PACKAGING INFORMATION

Orderable Device	Status [1]	Package Type	Package Drawing	Pins	Package Qty	Eco Plan [2]	Lead/Ball Finish	MSL Peak Temp [3]
OPA2743EA/250	ACTIVE	MSOP	DGK	8	250	None	CU NIPDAU	Level-3-220C-168 HR
OPA2743EA/2K5	ACTIVE	MSOP	DGK	8	2500	None	CU NIPDAU	Level-3-220C-168 HR
OPA2743PA	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU SNPB	Level-NC-NC-NC
OPA2743UA	ACTIVE	SOIC	D	8	100	None	CU NIPDAU	Level-3-220C-168 HR
OPA2743UA/2K5	ACTIVE	SOIC	D	8	2500	None	CU NIPDAU	Level-3-220C-168 HR
OPA4743EA/250	ACTIVE	TSSOP	PW	14	250	None	CU NIPDAU	Level-3-220C-168 HR
OPA4743EA/250G4	ACTIVE	TSSOP	PW	14	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA4743EA/2K5	ACTIVE	TSSOP	PW	14	2500	None	CU NIPDAU	Level-3-220C-168 HR
OPA4743UA	ACTIVE	SOIC	D	14	58	None	CU SNPB	Level-3-220C-168 HR
OPA4743UA/2K5	ACTIVE	SOIC	D	14	2500	None	CU SNPB	Level-3-220C-168 HR
OPA743NA/250	ACTIVE	SOT-23	DBV	5	250	None	CU NIPDAU	Level-3-220C-168 HR
OPA743NA/3K	ACTIVE	SOT-23	DBV	5	3000	None	CU NIPDAU	Level-3-220C-168 HR
OPA743NA/3KG4	PREVIEW	SOT-23	DBV	5	3000	None	Call TI	Call TI
OPA743PA	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU SNPB	Level-NC-NC-NC
OPA743UA	ACTIVE	SOIC	D	8	100	None	CU NIPDAU	Level-1-235C-UNLIM
OPA743UA/2K5	ACTIVE	SOIC	D	8	2500	None	CU	Level-1-235C-UNLIM

(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 - May not be currently available - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
None: Not yet available Lead (Pb-Free).
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.
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(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDECindustry standard classifications, and peak solder temperature.

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