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20V, Low Input Bias-Current, Low-Noise, Dual Op Amplifier

MAX44242

General Description

The MAX44242 provides a combination of high voltage, low noise, low input bias current in a dual channel and features rail-to-rail at the output.

This dual amplifier operates over a wide supply voltage range from a single 2.7V to 20V supply or split ±1.35V to ±10V supplies and consumes only 1.2mA quiescent supply current per channel.

The MAX44242 is a unity-gain stable amplifier with a gain-bandwidth product of 10MHz. The device outputs drive up to 200pF load capacitor without any external isolation resistor compensation.

The MAX44242 is available in 8-pin SOT23 and μMAX® packages and is rated for operation over the -40ºC to +125ºC automotive temperature range.

Benefits and Features

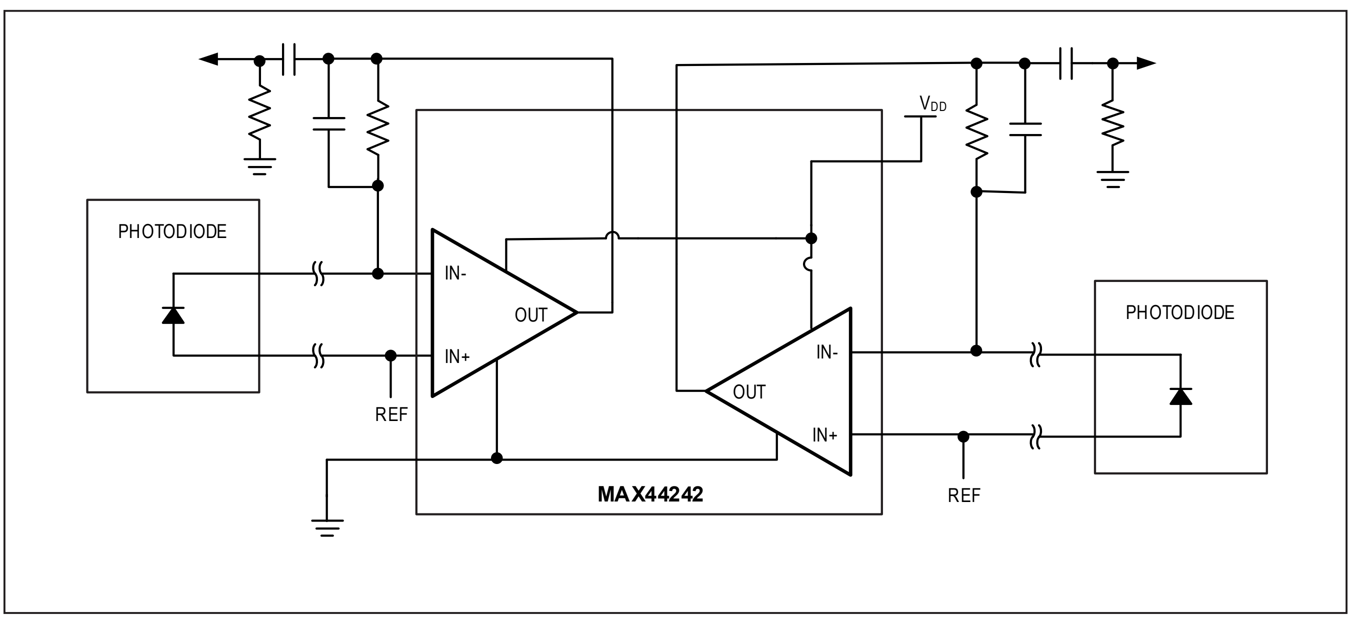
- 2.7V to 20V Single Supply or ±1.35V to ±10V Dual Supplies
- 0.5pA (max) Input Bias Current
- 5nV/√Hz Input Voltage Noise
- 10MHz Bandwidth
- 8V/μs Slew Rate
- Rail-to-Rail Output
- Integrated EMI Filters
- 1.2mA Supply Current per Amplifier

***Ordering Information* appears at end of data sheet.**

Applications

- Chemical Sensor Interface
- Photodiode Sensor Interface
- Medical Pulse Oximetry
- Industrial: Process and Control
- Precision Instrumentation

Typical Application Circuit



19-6827; Rev 3; 3/21

Absolute Maximum Ratings

Supply Voltage (V_{DD} to V_{SS}) ....-0.3V to +22V
All Other Pins ....(V_{SS} - 0.3V) to (V_{DD} + 0.3V)
Short-Circuit Duration to V_{DD} or V_{SS}.................................... 1s
Continuous Input Current (Any Pins) ....±20mA
Differential Input Voltage .... ±6V
Continuous Power Dissipation (T_A = +70°C)
8-Pin SOT23 (derate 5.1mW/°C above +70°C) 408.2mW
8-Pin µMAX (derate 4.5mW/°C above +70°C)...........362mW

Operating Temperature Range........................ -40°C to +125°C
Junction Temperature..+150°C
Storage Temperature Range........................... -65°C to +150°C
Lead Temperature (soldering, 10s) ....+300°C

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 in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Package Thermal Characteristics (Note 1)

SOT23
Junction-to-Ambient Thermal Resistance (θ_{JA}) ....196°C/W
Junction-to-Case Thermal Resistance (θ_{JC})..............70°C/W

µMAX
Junction-to-Ambient Thermal Resistance (θ_{JA}) ....221°C/W
Junction-to-Case Thermal Resistance (θ_{JC})..............42°C/W

Note 1: Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board. For detailed information on package thermal considerations, refer to www.maximintegrated.com/thermal-tutorial.

Electrical Characteristics

(V_{DD} = 10V, V_{SS} = 0V, V_{IN+} = V_{IN-} = V_{DD}/2, R_L = 10kΩ to V_{DD}/2, T_A = -40°C to +125°C, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
POWER SUPPLY							
Supply Voltage Range	V_{DD}	Guaranteed by PSRR		2.7		20	V
Power-Supply Rejection Ratio	PSRR	V_{DD} = 2.7V to 20V, V_{CM} = 0V	T_A = +25ºC	106	130		dB
			-40ºC ≤ T_A ≤ +125ºC	100			
Quiescent Current Per Amplifier	I_{DD}	R_{LOAD} = infinity	T_A = +25ºC		1.2	1.6	mA
			-40ºC ≤ T_A ≤ +125ºC			1.8	
Power-Up Time	t_{ON}				20		µs
DC CHARACTERISTICS							
Input Common-Mode Range	V_{CM}	Guaranteed by CMRR test		V_{SS} - 0.05		V_{DD} - 1.5	V
Common-Mode Rejection Ratio	CMRR	V_{CM} = V_{SS} - 0.05V to V_{DD} - 1.5V	T_A = +25ºC	94	111		dB
			-40ºC ≤ T_A ≤ +125ºC	90			
Input Offset Voltage	V_{OS}	T_A = +25ºC			50	600	µV
		-40ºC ≤ T_A ≤ +125ºC				800	
Input Offset Voltage Drift (Note 3)	TC V_{OS}				0.25	2.5	µV/ºC
Input Bias Current (Note 3)	I_B	T_A = +25ºC			0.02	0.5	pA
		-40ºC ≤ T_A ≤ +85ºC				10	
		-40ºC ≤ T_A ≤ +125ºC				50	

Electrical Characteristics (continued)

(V_{DD} = 10V, V_{SS} = 0V, V_{IN+} = V_{IN-} = V_{DD}/2, R_L = 10kΩ to V_{DD}/2, T_A = -40°C to +125°C, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 2)

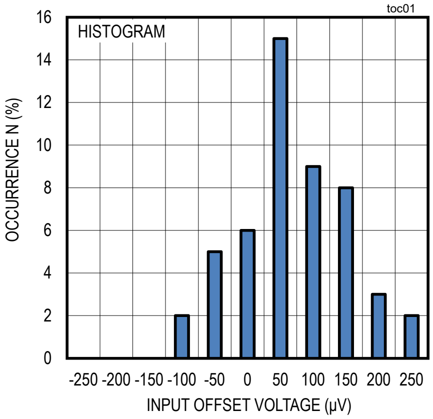
PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Input Offset Current (Note 3)	I_{OS}	T_A = +25°C			0.04	0.5	pA
		-40°C ≤ T_A ≤ +85°C				10	
		-40°C ≤ T_A ≤ +125°C				25	
Open Loop Gain	A_{VOL}	250mV ≤ V_{OUT} ≤ V_{DD} - 250mV	T_A = +25°C	134	145		dB
			-40°C ≤ T_A ≤ +125°C	129			
Input Resistance	R_{IN}	Differential			50		GΩ
		Common mode			200		
Output Short-Circuit Current		To V_{DD} or V_{SS}	Noncontinuous		95		mA
Output Voltage Low	V_{OL}	V_{OUT} - V_{SS}	R_{LOAD} = 10kΩ to V_{DD}/2			25	mV
			R_{LOAD} = 2kΩ to V_{DD}/2			85	
Output Voltage High	V_{OH}	V_{DD} - V_{OUT}	R_{LOAD} = 10kΩ to V_{DD}/2			37	mV
			R_{LOAD} = 2kΩ to V_{DD}/2			135	
AC CHARACTERISTICS							
Input Voltage-Noise Density	e_n	f = 1kHz			5		nV/√Hz
Input Voltage Noise		0.1Hz ≤ f ≤ 10Hz			1.6		µV_{P-P}
Input Current-Noise Density	I_N	f = 1kHz			0.3		pA/√Hz
Input Capacitance	C_{IN}				4		pF
Gain-Bandwidth Product	GBW				10		MHz
Phase Margin	PM	C_{LOAD} = 20pF			60		deg
Slew Rate	SR	A_V = 1V/V, V_{OUT} = 2V_{P-P}, 10% to 90%			8		V/µs
Capacitive Loading	C_{LOAD}	No sustained oscillation, A_V = 1V/V			200		pF
Total Harmonic Distortion Plus Noise	THD+N	V_{OUT} = 2V_{P-P}, A_V = +1V/V	f = 1kHz		-124		dB
			f = 20kHz		-100		
EMI Rejection Ratio	EMIRR	V_{RF_PEAK} = 100mV	f = 400MHz		35		dB
			f = 900MHz		40		
			f = 1800MHz		50		
			f = 2400MHz		57		
Settling Time		To 0.01%, V_{OUT} = 2V step, A_V = -1V/V			1		µs

Note 2: All devices are production tested at T_A = +25°C. Specifications over temperature are guaranteed by design.
Note 3: Guaranteed by design.

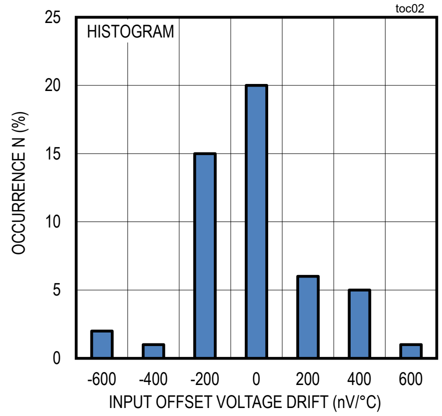
Typical Operating Characteristics

(V_{DD} = 10V, V_{SS} = 0V, outputs have R_L = 10kΩ to V_{DD}/2. T_A = +25°C, unless otherwise specified.)

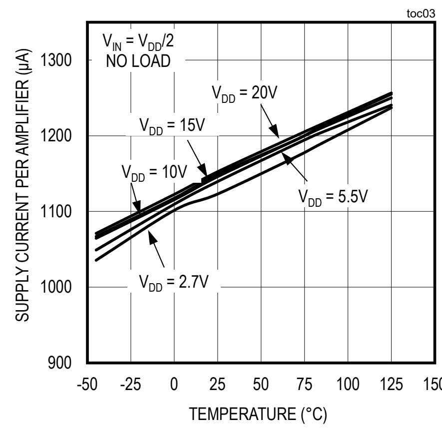
INPUT OFFSET VOLTAGE HISTOGRAM



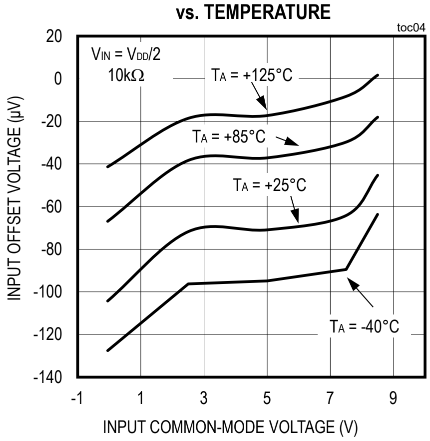
INPUT OFFSET VOLTAGE DRIFT HISTOGRAM



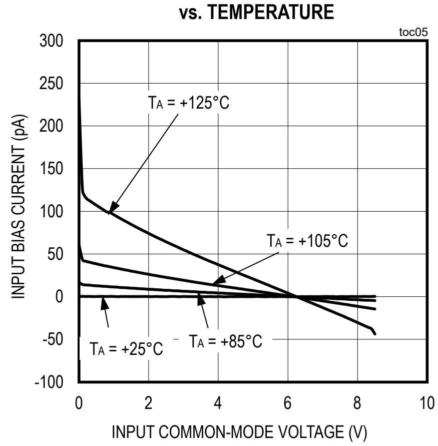
SUPPLY CURRENT PER AMPLIFIER vs. TEMPERATURE



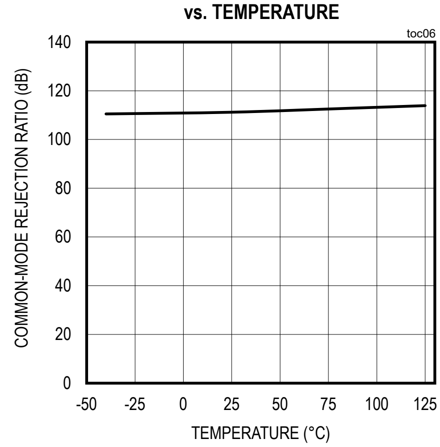
INPUT OFFSET VOLTAGE vs. INPUT COMMON-MODE VOLTAGE vs. TEMPERATURE



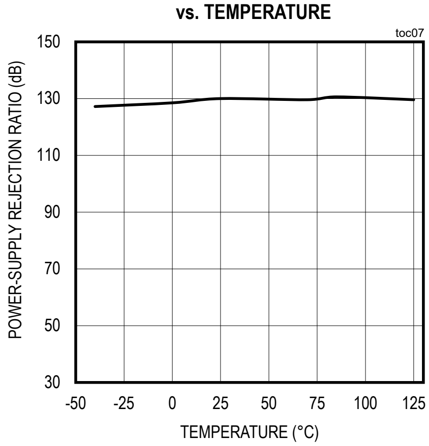
INPUT BIAS CURRENT vs. INPUT COMMON-MODE VOLTAGE vs. TEMPERATURE



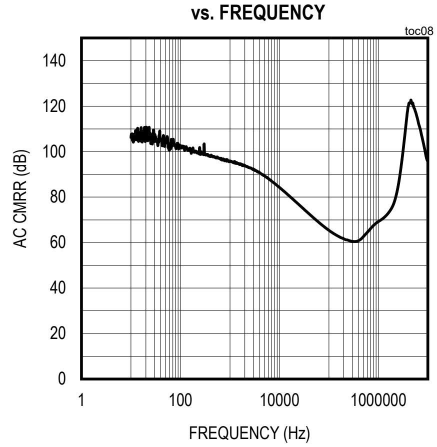
COMMON-MODE REJECTION RATIO vs. TEMPERATURE



POWER-SUPPLY REJECTION RATIO vs. TEMPERATURE



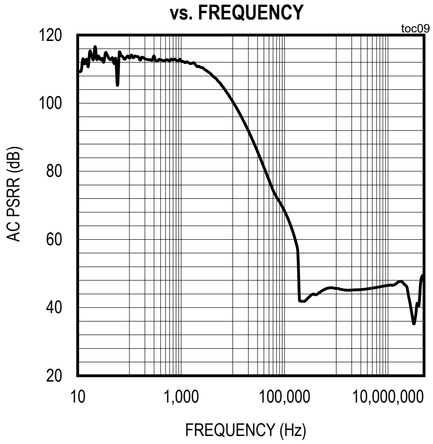
AC CMRR vs. FREQUENCY



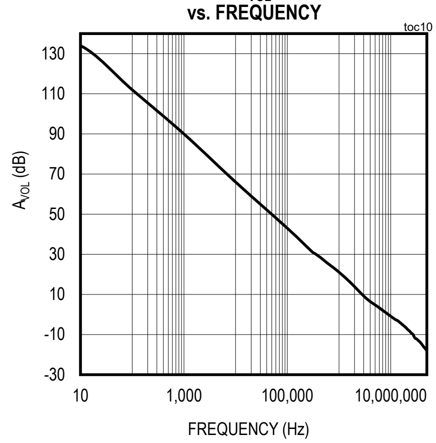
Typical Operating Characteristics (continued)

(V_{DD} = 10V, V_{SS} = 0V, outputs have R_L = 10kΩ to V_{DD}/2. T_A = +25°C, unless otherwise specified.)

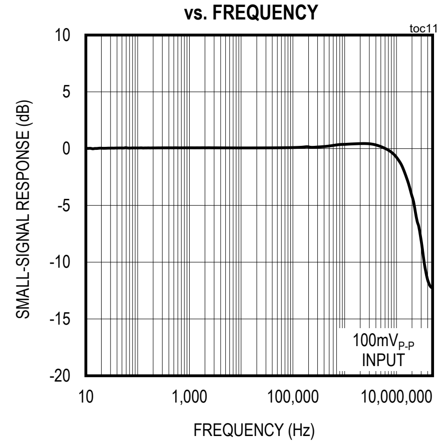
AC PSRR vs. FREQUENCY



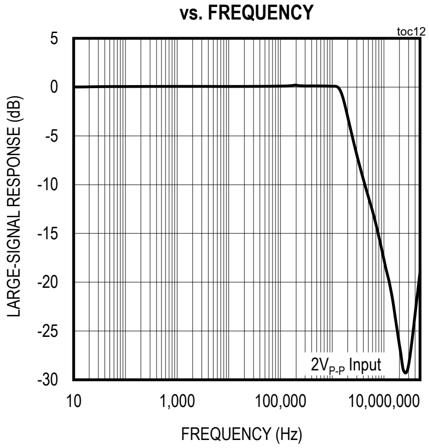
A_{VOL} vs. FREQUENCY



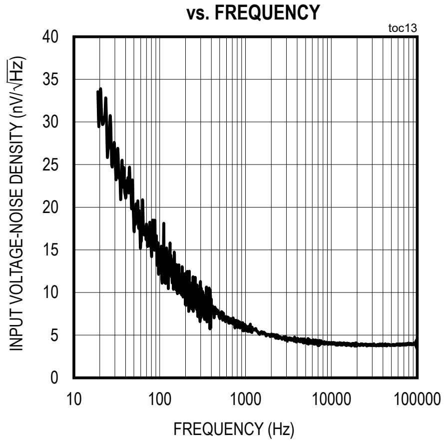
SMALL-SIGNAL RESPONSE vs. FREQUENCY



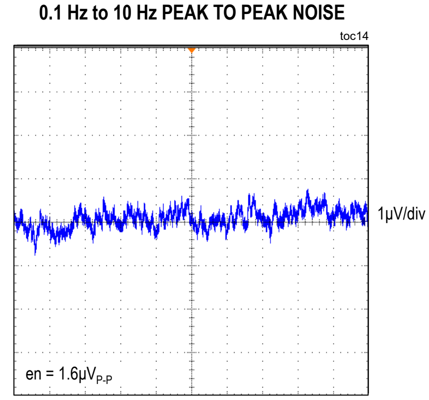
LARGE-SIGNAL RESPONSE vs. FREQUENCY



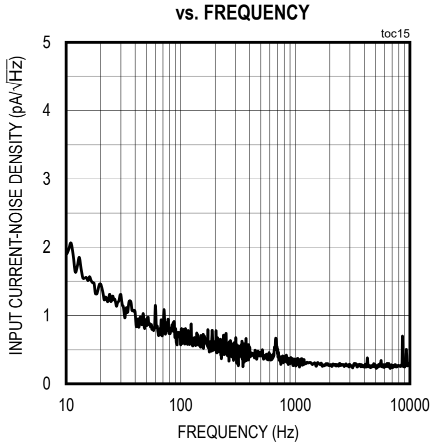
INPUT VOLTAGE-NOISE DENSITY vs. FREQUENCY



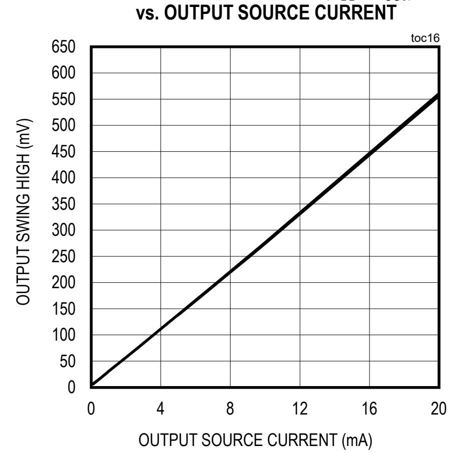
0.1 Hz to 10 Hz PEAK TO PEAK NOISE



INPUT CURRENT-NOISE DENSITY vs. FREQUENCY

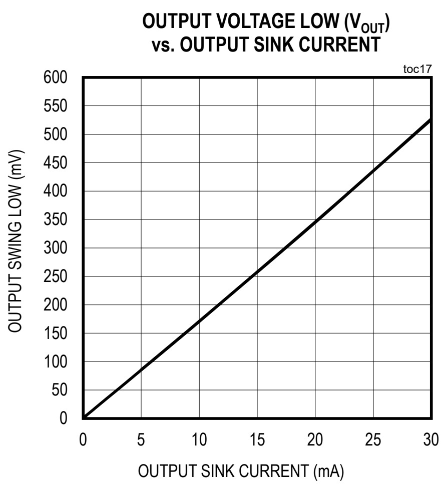


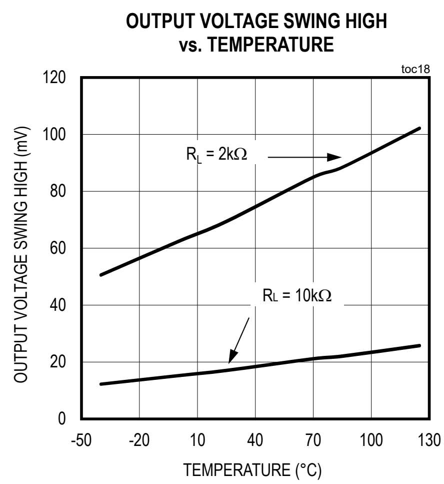
OUTPUT VOLTAGE HIGH (V_{DD} - V_{OUT}) vs. OUTPUT SOURCE CURRENT

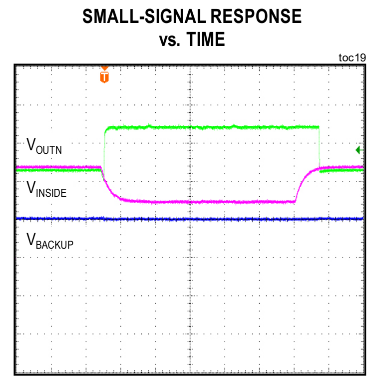


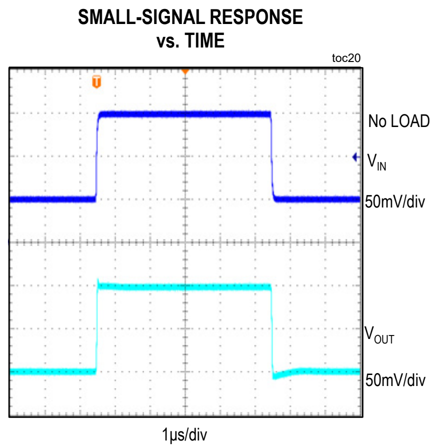
Typical Operating Characteristics (continued)

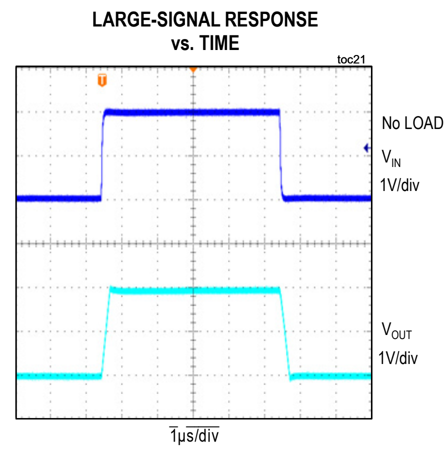
(V_{DD} = 10V, V_{SS} = 0V, outputs have R_L = 10kΩ to V_{DD}/2. T_A = +25°C, unless otherwise specified.)

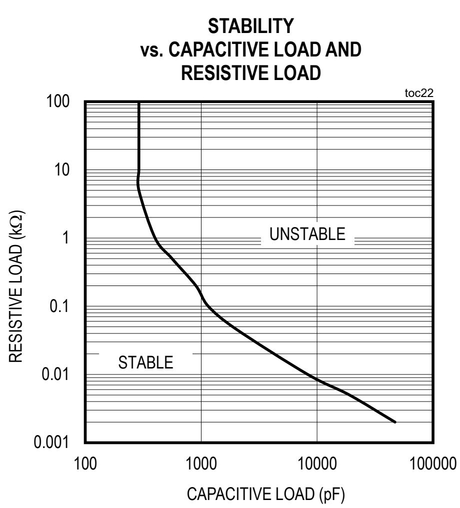


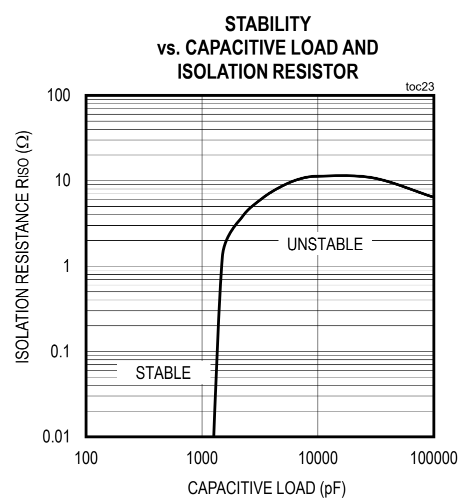






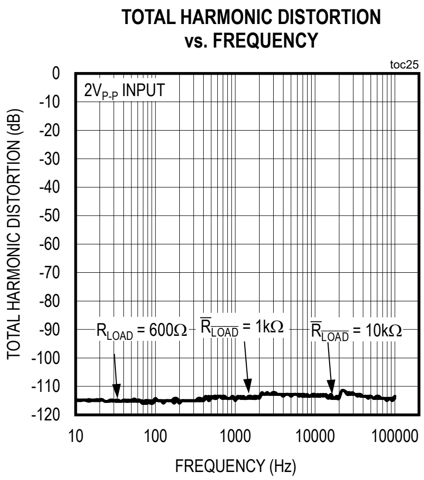


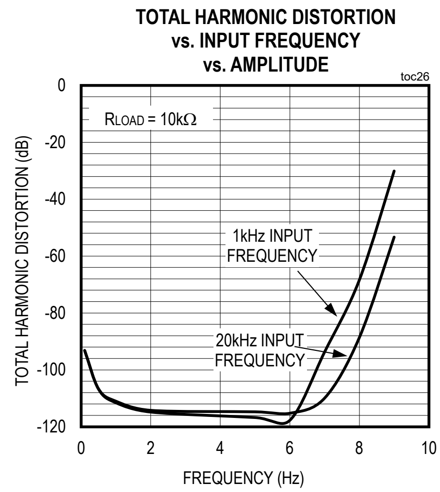


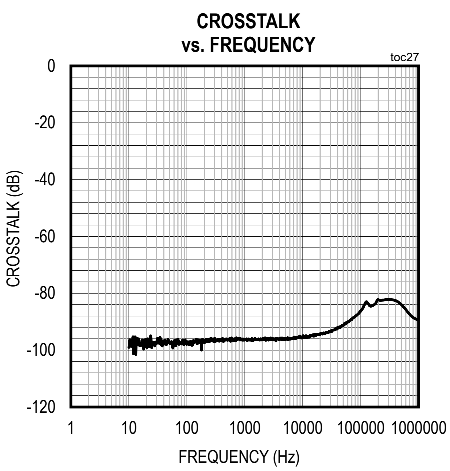


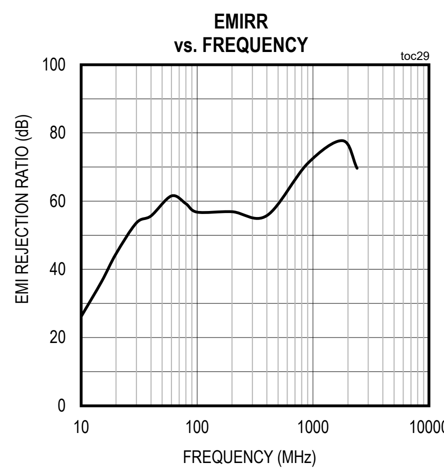
Typical Operating Characteristics (continued)

(V_{DD} = 10V, V_{SS} = 0V, outputs have R_L = 10kΩ to V_{DD}/2. T_A = +25°C, unless otherwise specified.)

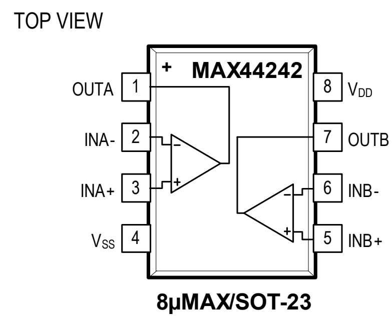








Pin Configuration



Pin Description

PIN	NAME	FUNCTION
1	OUTA	Channel A Output
2	INA-	Channel A Negative Input
3	INA+	Channel A Positive Input
4	V_{SS}	Negative Supply Voltage. Connect V_{SS} to ground if single supply is used.
5	INB+	Channel B Positive Input
6	INB-	Channel B Negative Input
7	OUTB	Channel B Output
8	V_{DD}	Positive Supply Voltage

Detailed Description

Combining high input impedance, low input bias current, wide bandwidth, and fast settling time, the MAX44242 is an ideal amplifier for driving precision analog-to-digital inputs and buffering digital-to-analog converter outputs.

Input Bias Current

The MAX44242 features a high-impedance CMOS input stage and a special ESD structure that allows low input bias current operation at low-input, common-mode voltages. Low input bias current is useful when interfacing with high-ohmic or capacitive sensors and is beneficial for designing transimpedance amplifiers for photodiode sensors. This makes the device ideal for ground-referenced medical and industrial sensor applications.

Integrated EMI Filter

Electromagnetic interference (EMI) noise occurs at higher frequency that results in malfunction or degradation of electrical equipment.

The MAX44242 has an input EMI filter to avoid the output from getting affected by radio frequency interference. The EMI filter, composed of passive devices, presents significant higher impedance to higher frequencies.

High Supply Voltage Range

The device features 1.2mA current consumption per channel and a voltage supply range from either 2.7V to 20V single supply or ±1.35V to ±10V split supply.

Typical Application Circuit

High-Impedance Sensor Application

High impedance sources like pH sensor, photodiodes in applications require negligible input leakage currents to the input transimpedance/buffer structure. The MAX44242 benefits with clean and precise signal conditioning due to its input structure.

The device interfaces to both current-output sensors (photodiodes) (Figure 1), and high-impedance voltage sources (piezoelectric sensors). For current output sensors, a transimpedance amplifier is the most noise-efficient method for converting the input signal to a voltage. High-value feedback resistors are commonly chosen to create large gains, while feedback capacitors help stabilize the amplifier by cancelling any poles introduced in the feedback loop by the highly capacitive sensor or cabling. A combination of low-current noise and low-voltage noise is important for these applications. Take care to calibrate out photodiode dark current if DC accuracy is important. The high bandwidth and slew rate also allow AC signal processing in certain medical photodiode sensor applications such as pulse-oximetry. For voltage-output sensors, a noninverting amplifier is typically used to buffer and/or apply a small gain to the input voltage signal. Due to the extremely high impedance of the sensor output, a low input bias current with minimal temperature variation is very important for these applications.

Transimpedance Amplifier

As shown in Figure 2, the noninverting pin is biased at 2V with C2 added to bypass high-frequency noise. This bias voltage to reverse biases the photodiode D1 at 2V which is often enough to minimize the capacitance across the junction. Hence, the reverse current (I_R) produced by the photodiode as light photons are incident on it, a proportional voltage is produced at the output of the amplifier by the given relation:

$$V_{OUT} = I_R \times R1$$

The addition of C1 is to compensate for the instability caused due to the additional capacitance at the input (junction capacitance C_j and input capacitance of the op amp C_{IN}), which results in loss of phase margin. More information about stabilizing the transimpedance amplifier can be found in **Application Note 5129**: *Stabilize Your Transimpedance Amplifier*.

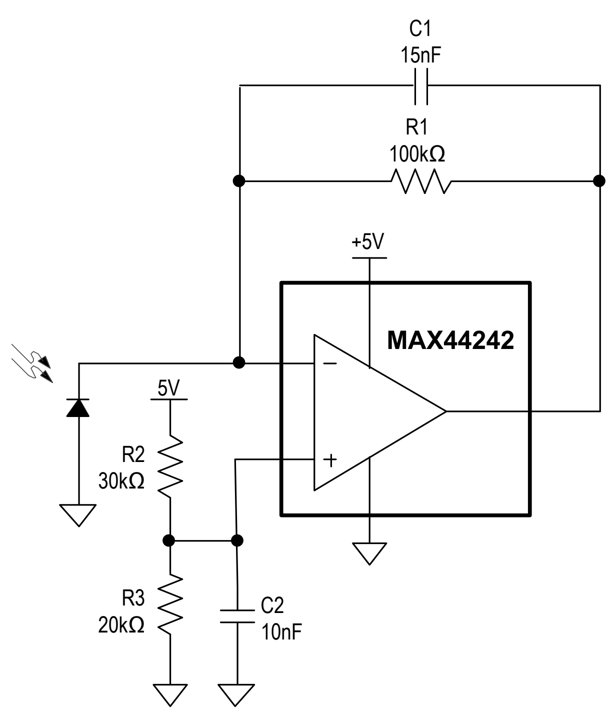


Figure 1. High-Impedance Source/Sensor Preamp Application

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE	TOP MARK
MAX44242AKA+	-40ºC to +125ºC	8 SOT23	AETK
MAX44242AUA+	-40ºC to +125ºC	8 µMAX	—

+Denotes lead(Pb)-free/RoHS-compliant package.

Chip Information

PROCESS: BiCMOS

Package Information

For the latest package outline information and land patterns (footprints), go to **www.maximintegrated.com/packages**. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

PACKAGE TYPE	PACKAGE CODE	OUTLINE NO.	LAND PATTERN NO.
8 SOT23	K8+5	**21-0078**	**90-0176**
8 µMAX	U8+1	**21-0036**	**90-0092**

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	12/13	Initial release	—
1	11/15	Updated *Pin Configuration* diagram	8
2	4/18	Updated *Typical Application Circuit*	1
3	3/21	Updated *Electrical Characteristics* table	3