19-3860; Rev 0; 12/05

EVALUATION KIT AVAILABLE

Quad Audio Line Driver with $3V_{RMS}$ Output

General Description

The MAX9727 quad audio line driver with $3V_{RMS}$ output is ideal for portable audio devices where board space and cost is at a premium. The device uses Maxim's DirectDrive™ architecture that produces a ground-referenced output from a single supply, eliminating the need for large DC-blocking capacitors and saving cost, board space, and component height. A high 100dB PSRR and low 0.0005% THD+N ensures clean, low-distortion amplification of the audio signal. Each MAX9727 amplifier can provide $3V_{RMS}$ to a 1kΩ load with less than 0.003% THD+N while operating from a single +5V supply. Each MAX9727 amplifier can provide $2V_{RMS}$ to a 1kΩ load with less than 0.003% THD+N while operating from a single +3.3V supply.

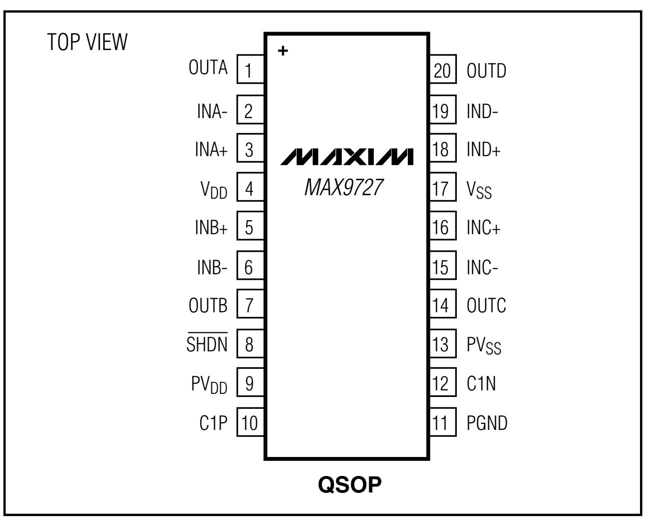
A shutdown input disables the amplifiers and reduces quiescent current consumption to less than 100nA. The MAX9727 features Maxim's comprehensive click-and-pop suppression circuitry that reduces audible clicks and pops during startup and shutdown.

The MAX9727 operates from a single 2.7V to 5.5V supply, consumes only 3mA of supply current per channel, and is specified over the -40°C to +85°C extended temperature range.

Applications

- Set-Top Boxes
- Consumer and Professional Audio Equipment
- A/V Receivers
- CD and DVD Players
- Soundcards
- Portable Audio Devices

Pin Configuration



Features

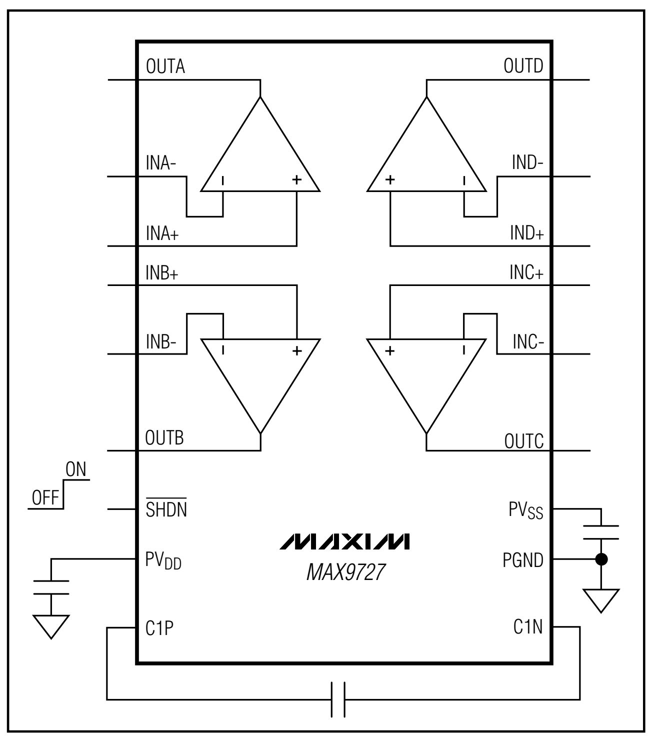
- ♦ 2.7V to 5.5V Single-Supply Operation
- ♦ High 100dB PSRR
- ♦ 109dB Signal-to-Noise Ratio (SNR)
- ♦ Ground-Referenced Outputs
- ♦ No Audible Clicks or Pops at Power-Up/Down
- ♦ Differential Inputs
- ♦ $3V_{RMS}$ into 1kΩ Load at 5V
- ♦ $2V_{RMS}$ into 1kΩ Load at 3.3V
- ♦ 3mA Supply Current Per Channel
- ♦ Unity-Gain Stable
- ♦ 100nA Low-Power Shutdown Mode
- ♦ C_{LOAD} Drive > 220pF
- ♦ ±8kV HBM ESD-Protected Outputs

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE	GAIN
MAX9727EEP+	-40°C to +85°C	20 QSOP	Adjustable

+Denotes lead-free package.

Simplified Block Diagram



For pricing, delivery, and ordering information, please contact Maxim/Dallas Direct! at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

Quad Audio Line Driver with 3V$_{RMS}$ Output

ABSOLUTE MAXIMUM RATINGS

V_{DD}, PV_{DD} to PGND ....-0.3V to +6V
V_{SS}, PV_{SS} to PGND ....-6V to +0.3V
IN_ to PGND ....(V_{SS} + 0.3V) to (PV_{DD} - 0.3V)
OUT_ to PGND..............................(V_{SS} - 0.3V) to (PV_{DD} + 0.3V)
$\overline{SHDN}$ to PGND..........................(PGND - 0.3V) to (PV_{DD} + 0.3V)
C1P to PGND............................(PGND - 0.3V) to (PV_{DD} + 0.3V)
C1N to PGND ....(PV_{SS} - 0.3V) to (PGND + 0.3V)
Output Short Circuit to PGND or P_{VDD}......................Continuous
Continuous Power Dissipation (T_A = +70°C)
20-Pin QSOP Single-Layer Board
(derate 9.1mW/°C above +70°C).................................727mW
20-Pin QSOP Multilayer Board
(derate 11mW/°C above +70°C)..................................884mW
Operating Temperature Range ....-40°C to +85°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.

ELECTRICAL CHARACTERISTICS

(V_{DD} = PV_{DD} = 3.3V, PGND = 0V, $\overline{SHDN}$ = V_{DD}, V_{CM} = 0V, C1 = C2 = 1µF, R_{IN} = R_F = 5kΩ, R_L = ∞, T_A = T_{MIN} to T_{MAX}. Typical values are at T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
GENERAL							
Supply Voltage Range	V_{DD}	Inferred from PSRR test		2.7		5.5	V
Quiescent Current	I_{DD}	Current into V_{DD} and PV_{DD}			12	14	mA
Shutdown Current	$I_{DD, SHDN}$	$V_{\overline{SHDN}}$ = 0V			0.1	10	µA
AMPLIFIERS							
Input Offset Voltage	V_{OS}				±0.5	±5	mV
Input Bias Current	I_{BIAS}				1000		nA
Input Offset Current	I_{OS}				500		nA
Open-Loop Gain	A_V	V_{OUT} = -3V to +3V, R_L = 1kΩ			82		dB
Input Common-Mode Voltage Range	CMR	V_{DD} = 2.7V		-1.6		+1.6	V
		V_{DD} = 3V		-2.3		+2.3	
		V_{DD} = 5V		-3.5		+3.5	
Common-Mode Rejection Ratio	CMRR	V_{DD} = 2.7V, V_{CM} = ±1.6V		80	100		dB
		V_{DD} = 3V, V_{CM} = ±1.9V		80	100		
		V_{DD} = 5V, V_{CM} = ±3.5V		80	100		
Power-Supply Rejection Ratio	PSRR	V_{DD} = PV_{DD} = 2.7V to 5.5V		80	100		dB
		f = 1kHz, V_{DD} = PV_{DD} = 5V + 100mV$_{P-P}$ ripple			60		
Output Voltage		R_L = 1kΩ, V_{DD} = 3.3V, THD+N = 1%		1.6	2.0		V_{RMS}
		R_L = 1kΩ, V_{DD} = 5V, THD+N = 1%		2.0	3.0		
Output Voltage Swing	V_{OUT}	R_L = 1kΩ, V_{DD} = 3.3V	Positive	2.6	3.0		V
			Negative	-2.6	-3.0		
		R_L = 1kΩ, V_{DD} = 5V	Positive	3.5	4.2		
			Negative	-3.5	-4.1		
Output Short-Circuit Current	I_{SC}	Sinking			40		mA
		Sourcing			5		

ELECTRICAL CHARACTERISTICS

(V_{DD} = PV_{DD} = 3.3V, PGND = 0V, $\overline{SHDN}$ = V_{DD}, V_{CM} = 0V, C1 = C2 = 1µF, R_{IN} = R_F = 5kΩ, R_L = ∞, T_A = T_{MIN} to T_{MAX}. Typical values are at T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Total Harmonic Distortion Plus Noise	THD+N	V_{OUT} = 1.6V_{RMS}, BW = 22Hz to 22kHz, f = 1kHz, unweighted, R_L = 10kΩ			0.0005		%
		V_{OUT} = 2V_{RMS}, BW = 22Hz to 22kHz, f = 1kHz, unweighted, R_L = 10kΩ			0.0006		
		V_{OUT} = 1.6V_{RMS}, BW = 22Hz to 22kHz, f = 1kHz, unweighted, R_L = 1kΩ			0.003		
Signal-to-Noise Ratio	SNR	V_{OUT} = 1.6V_{RMS}, R_L = 1kΩ	22Hz to 22kHz		109		dB
			A-weighted		113.6		
		V_{OUT} = 2V_{RMS}, R_L = 1kΩ	22Hz to 22kHz		111		
			A-weighted		115.5		
Click-and-Pop Level	K_{CP}	Peak voltage, A-weighted, 32 samples/s (Notes 2, 3)	Into shutdown		-62.2		dBV
			Out of shutdown		-54.3		
Slew Rate		R_L = 1kΩ, C_L = 100pF			0.9		V/µs
Turn-On Time	t_{ON}				90		µs
Turn-Off Time	t_{OFF}				1		µs
Capacitive Drive	C_L	No sustained oscillations			220		pF
Crosstalk		f = 10kHz			-70		dB
Large-Signal Open-Loop Gain	A_{VOL}	V_{OUT} = 2V_{RMS}			82		dB
Small-Signal Open-Loop Gain	A_{VOS}	V_{OUT} = 100mV_{RMS}			95		dB
Gain Bandwidth	GBW				3		MHz
Charge-Pump Switching Frequency	f_{OSC}			150	300	450	kHz
Charge-Pump Output Impedance		Measured at PV_{SS}			20		Ω
ESD Protection	ESD	HBM			±8		kV
DIGITAL INPUTS ($\overline{SHDN}$)							
Input-Voltage High	V_{IH}			2.0			V
Input-Voltage Low	V_{IL}					0.8	V
Input Leakage Current	I_{LEAK}					±1	µA

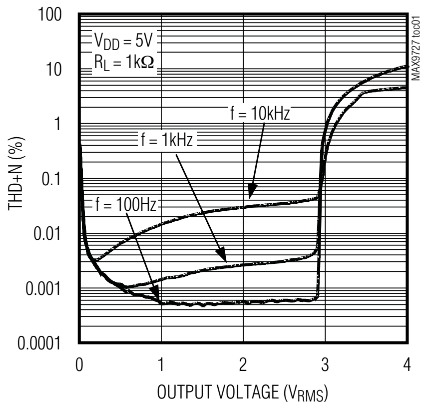
Note 1: All devices are 100% tested at T_A = +25°C. Specifications over temperature are guaranteed by design.
Note 2: Inputs AC-coupled to PGND.
Note 3: Click-and-pop testing performed with a 1kΩ resistive load connected to ground. Mode transitions are controlled by $\overline{SHDN}$. K_{CP} level is calculated as 20log[(peak voltage during mode transition, no input signal)/1V_{RMS}]. Units are expressed in dBV.

Quad Audio Line Driver with 3V$_{RMS}$ Output

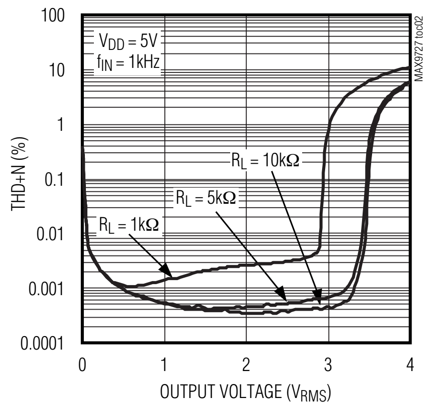
Typical Operating Characteristics

(V_{DD} = PV_{DD} = 3.3V, V_{CM} = 0V, R_{IN} = R_F = 5kΩ, THD+N measurement bandwidth = 22Hz to 22kHz, T_A = +25°C, unless otherwise noted.)

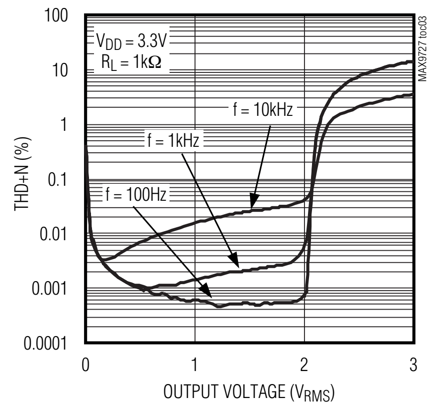
TOTAL HARMONIC DISTORTION PLUS NOISE vs. OUTPUT VOLTAGE



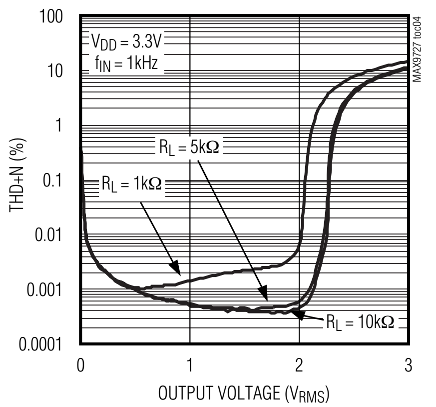
TOTAL HARMONIC DISTORTION PLUS NOISE vs. OUTPUT VOLTAGE



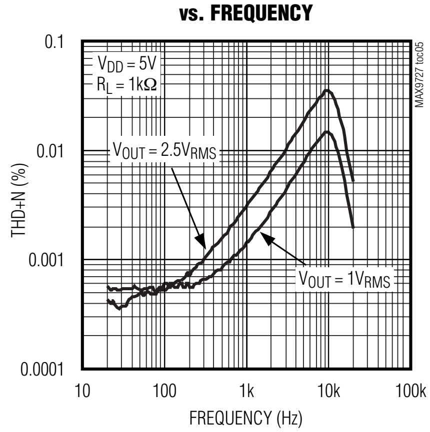
TOTAL HARMONIC DISTORTION PLUS NOISE vs. OUTPUT VOLTAGE



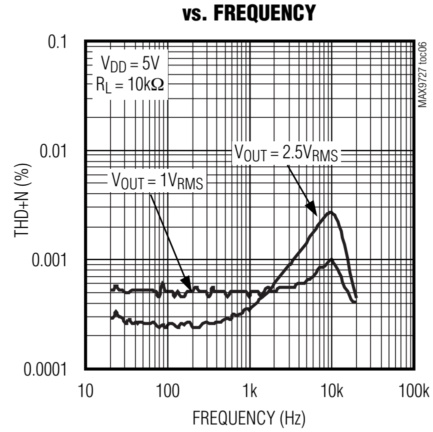
TOTAL HARMONIC DISTORTION PLUS NOISE vs. OUTPUT VOLTAGE



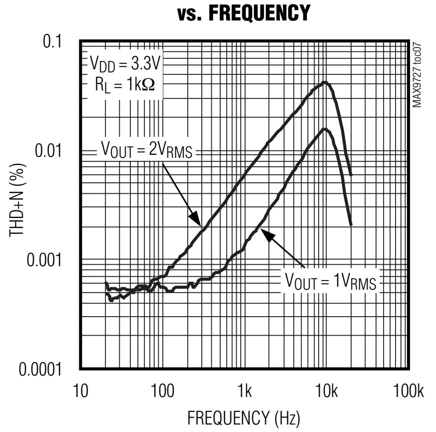
TOTAL HARMONIC DISTORTION PLUS NOISE vs. FREQUENCY



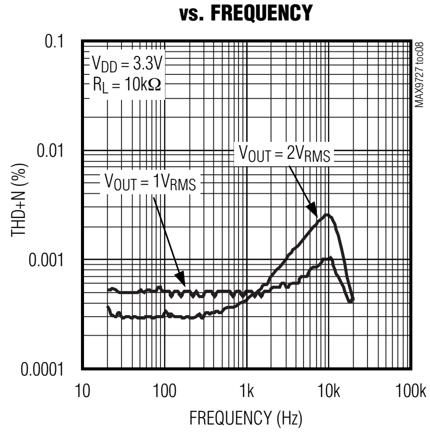
TOTAL HARMONIC DISTORTION PLUS NOISE vs. FREQUENCY



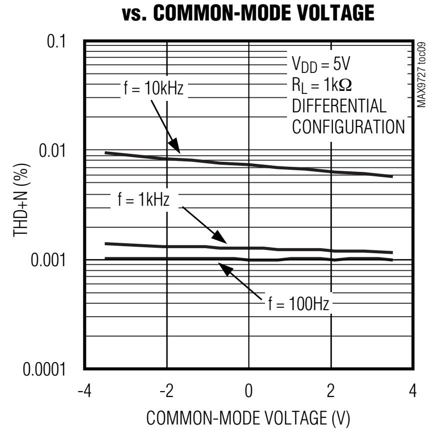
TOTAL HARMONIC DISTORTION PLUS NOISE vs. FREQUENCY



TOTAL HARMONIC DISTORTION PLUS NOISE vs. FREQUENCY



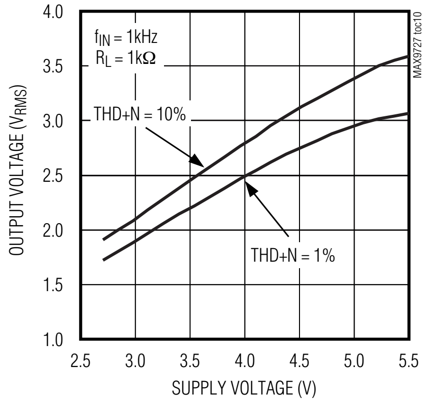
TOTAL HARMONIC DISTORTION PLUS NOISE vs. COMMON-MODE VOLTAGE



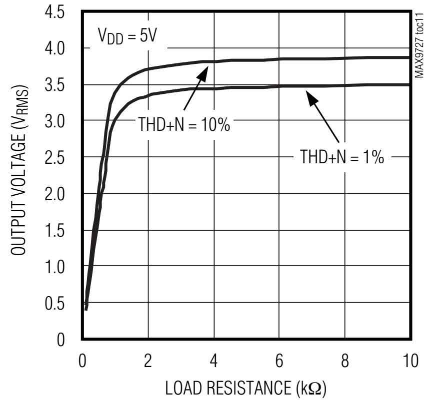
Typical Operating Characteristics (continued)

(V_{DD} = PV_{DD} = 3.3V, V_{CM} = 0V, R_{IN} = R_F = 5kΩ, THD+N measurement bandwidth = 22Hz to 22kHz, T_A = +25°C, unless otherwise noted.)

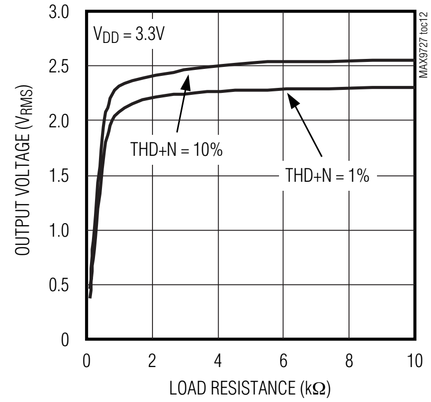
OUTPUT VOLTAGE vs. SUPPLY VOLTAGE



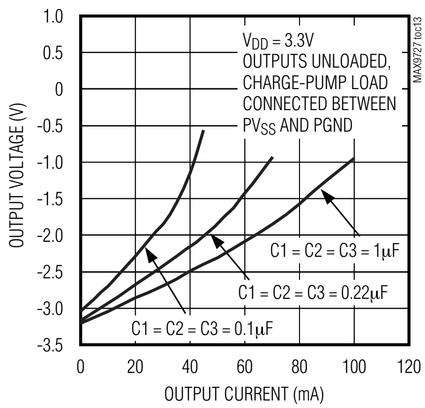
OUTPUT VOLTAGE vs. LOAD RESISTANCE



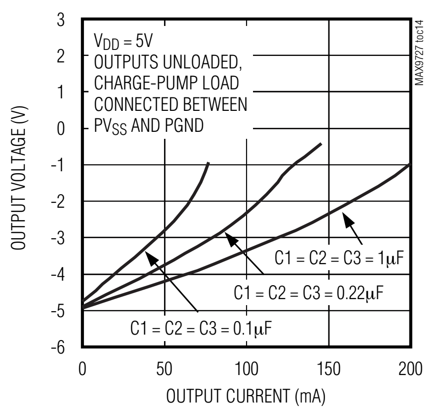
OUTPUT VOLTAGE vs. LOAD RESISTANCE



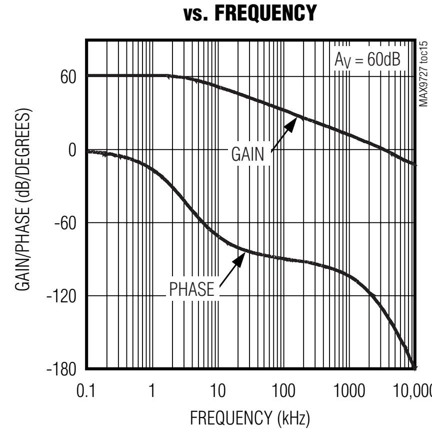
CHARGE-PUMP OUTPUT VOLTAGE vs. OUTPUT CURRENT



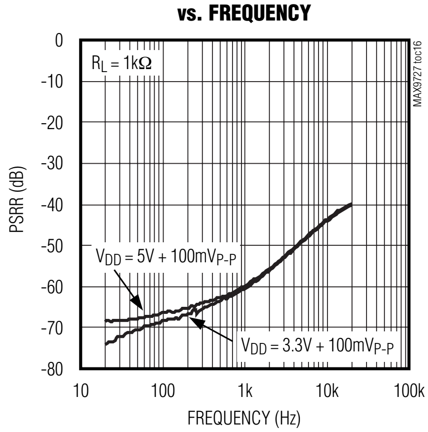
CHARGE-PUMP OUTPUT VOLTAGE vs. OUTPUT CURRENT



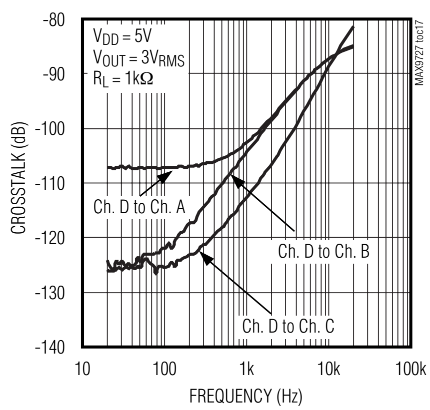
GAIN AND PHASE vs. FREQUENCY



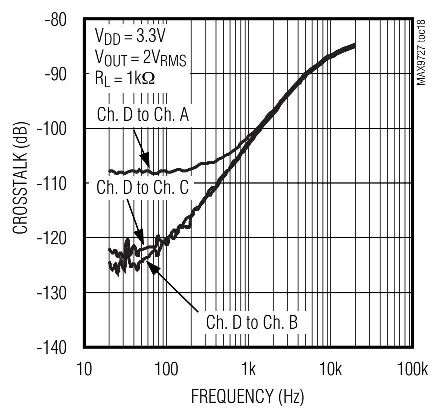
POWER-SUPPLY REJECTION RATIO vs. FREQUENCY



CROSSTALK vs. FREQUENCY



CROSSTALK vs. FREQUENCY

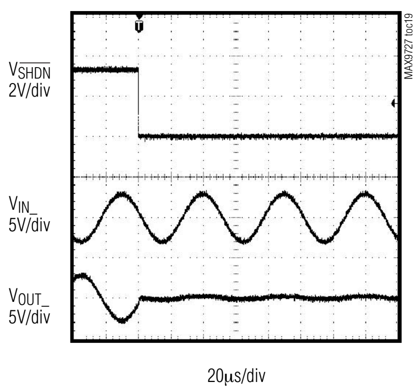


Quad Audio Line Driver with $3V_{RMS}$ Output

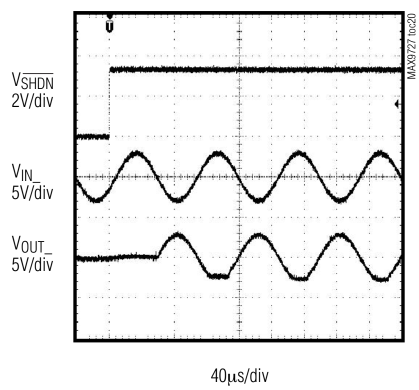
Typical Operating Characteristics (continued)

(V_{DD} = PV_{DD} = 3.3V, V_{CM} = 0V, R_{IN} = R_F = 5kΩ, THD+N measurement bandwidth = 22Hz to 22kHz, T_A = +25°C, unless otherwise noted.)

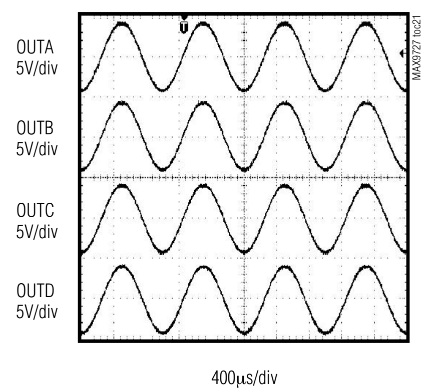
ENTERING SHUTDOWN



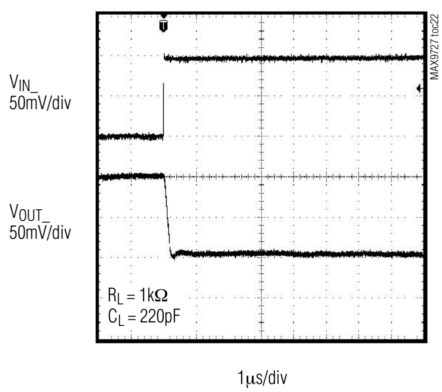
EXITING SHUTDOWN



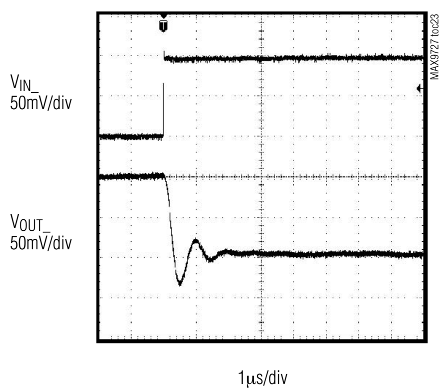
OUTPUT AT $2V_{RMS}$ AT 1kHz (V_{DD} = 5V, R_L = 1kΩ)



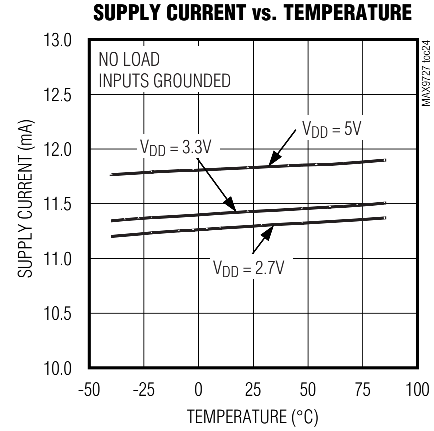
STEP RESPONSE



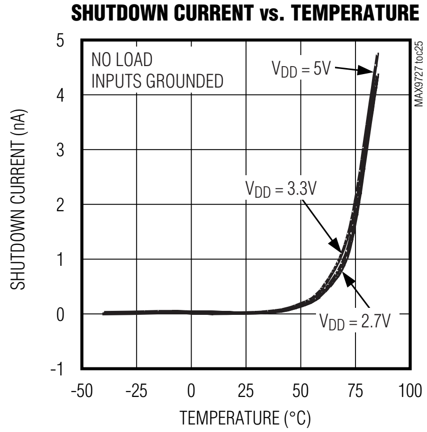
STEP RESPONSE



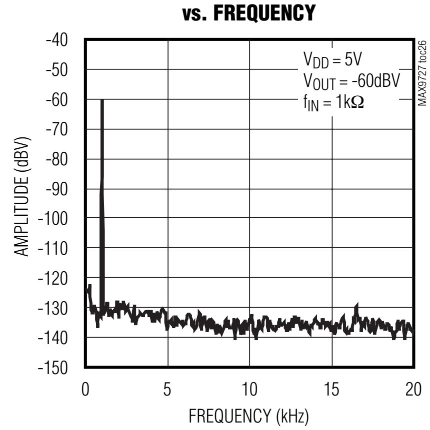
SUPPLY CURRENT vs. TEMPERATURE



SHUTDOWN CURRENT vs. TEMPERATURE



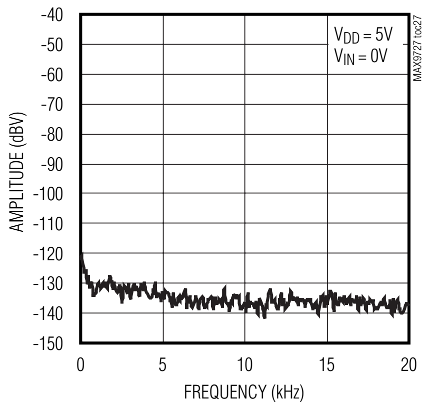
OUTPUT SPECTRUM vs. FREQUENCY



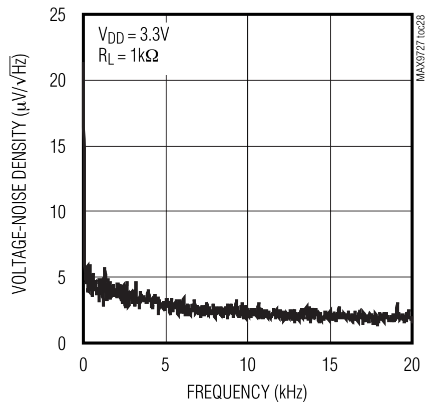
Typical Operating Characteristics (continued)

(V_{DD} = PV_{DD} = 3.3V, V_{CM} = 0V, R_{IN} = R_F = 5kΩ, THD+N measurement bandwidth = 22Hz to 22kHz, T_A = +25°C, unless otherwise noted.)

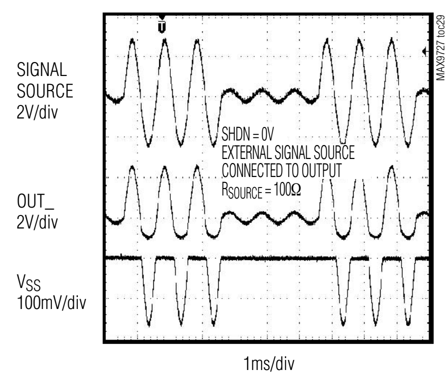
OUTPUT NOISE SPECTRUM vs. FREQUENCY



OUTPUT NOISE DENSITY vs. FREQUENCY



OUTPUT BACKDRIVEN DURING SHUTDOWN



Pin Description

PIN	NAME	FUNCTION
1	OUTA	Output A
2	INA-	Inverting Input A
3	INA+	Noninverting Input A
4	V_{DD}	Analog Positive Supply. Bypass with a 0.1µF capacitor to PGND.
5	INB+	Noninverting Input B
6	INB-	Inverting Input B
7	OUTB	Output B
8	$\overline{SHDN}$	Active-Low Shutdown Input. Connect $\overline{SHDN}$ to V_{DD} for normal operation.
9	PV_{DD}	Charge-Pump Positive Supply. Bypass with a 1µF capacitor to PGND.
10	C1P	Charge-Pump Flying Capacitor Positive Terminal. Connect a 1µF capacitor between C1P and C1N.
11	PGND	Power Ground
12	C1N	Charge-Pump Flying Capacitor Negative Terminal. Connect a 1µF capacitor between C1P and C1N.
13	PV_{SS}	Charge-Pump Negative Supply. Bypass with a 1µF capacitor to PGND.
14	OUTC	Output C
15	INC-	Inverting Input C
16	INC+	Noninverting Input C
17	V_{SS}	Amplifier Negative Rail. Connect to PV_{SS}.
18	IND+	Noninverting Input D
19	IND-	Inverting Input D
20	OUTD	Output D

Detailed Description

The MAX9727 is a quad audio line driver with an output of $3V_{RMS}$ from a single +5V supply and $2V_{RMS}$ from a single +3.3V supply. The device employs Maxim's patented DirectDrive architecture that produces a ground-referenced output from a single supply, eliminating the need for large DC-blocking capacitors. An internal charge pump creates an internal negative supply voltage. This allows the amplifier outputs of the MAX9727 to be biased at GND, almost doubling dynamic range while operating from a single supply.

An active-low shutdown input disables the amplifiers and reduces quiescent current consumption to less than 100nA.

The MAX9727 also features click-and-pop suppression circuitry that reduces audible clicks and pops during startup and shutdown.

DirectDrive

Maxim's DirectDrive architecture uses a charge pump to create an internal negative supply voltage, allowing the MAX9727 outputs to be biased about ground. This allows for a symmetrical output biased around 0V. The MAX9727's charge pump requires two small ceramic capacitors, conserving board space, reducing cost, and improving the frequency response of the amplifiers. See the Charge-Pump Output Voltage vs. Output Current graphs in the *Typical Operating Characteristics* for details of the possible capacitor sizes. There is a low DC voltage on the amplifier outputs due to amplifier offset. However, the offsets of the MAX9727 are typically 500µV, which, when combined with a 1kΩ load, results in less than 500nA of DC current flow to the line-in device.

Charge Pump

The MAX9727 features a low-noise charge pump. The 300kHz switching frequency is well beyond the audio range and does not interfere with audio signals. The switch drivers feature a controlled switching speed that minimizes noise generated by turn-on and turn-off transients. The di/dt noise caused by the parasitic bond wire and trace inductance is minimized by limiting the switching speed of the charge pump. Although not typically required, additional high-frequency noise attenuation can be achieved by increasing the value of C2 (see the *Functional Diagram*/*Typical Operating Circuit*).

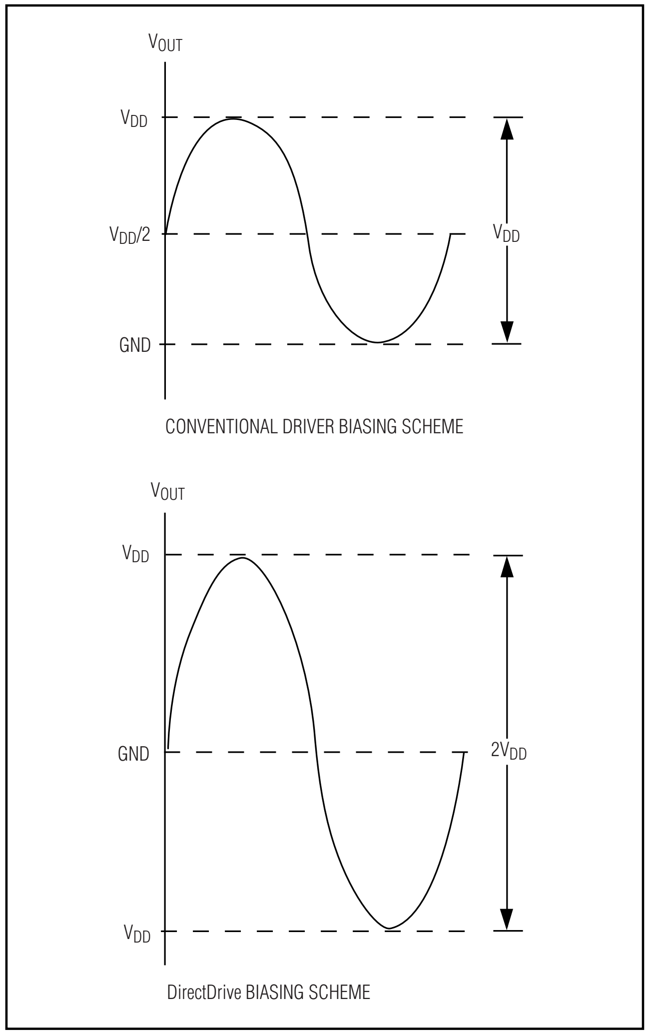


Figure 1. Conventional Driver Output Waveform vs. MAX9727 Output Waveform

Shutdown Mode

The MAX9727 features a low-power shutdown mode that reduces quiescent current consumption to less than 0.1µA and extends battery life for portable applications. Drive $\overline{SHDN}$ low to disable the amplifiers and the charge pump. In shutdown mode, each amplifier's output resistance is high impedance to small signals. The resulting output resistance seen by the load is determined by the series combination of the amplifier's external gain-setting resistors in parallel with the amplifier's shutdown output resistance.

Click-and-Pop Suppression

In conventional single-supply audio amplifiers, the output-coupling capacitor contributes significantly to audible clicks and pops. Upon startup, the amplifier charges the coupling capacitor to its bias voltage, typically half the supply. Likewise, on shutdown, the capacitor is discharged. This results in a DC shift across the capacitor, which appears as an audible transient at the speaker connected to the output of the power amplifier of the audio system. Since the MAX9727 does not require output-coupling capacitors, this problem does not arise. Additionally, the MAX9727 features extensive click-and-pop suppression that eliminates any audible transient sources internal to the device.

In some applications, the output of the device driving the MAX9727 may have a DC bias. At startup, the input-coupling capacitor is charged to the input device's DC-bias voltage through the input and feedback resistors of the MAX9727, resulting in a DC shift across the capacitor and an audible click/pop. Delay the rise of $\overline{SHDN}$ 4 to 5 time constants based on R_{IN} and C_{IN} (4 x R_{IN} x C_{IN}), relative to the startup of the input device, to eliminate clicks-and-pops caused by the input filter.

Applications Information

Amplifier Configurations

The MAX9727 works in many standard op-amp configurations such as inverting, noninverting, voltage follower, summing, difference, active filters, and many others. No special design considerations are required. The DirectDrive architecture of the MAX9727 simplifies many circuits due to the ground-referenced outputs.

Differential Input Configuration

Figure 2 shows a single channel of the MAX9727 configured as a differential input amplifier. A differential input offers improved noise immunity over a single-ended input. In systems that include high-speed digital circuitry, high-frequency noise can couple into the amplifier's input traces. The signals appear at the amplifier's inputs as common-mode noise. A differential input amplifier amplifies the difference of the two inputs, and signals common to both inputs are subtracted out. When configured for differential inputs, the voltage gain of the MAX9727 is set by:

$$A_V = \frac{R_{F1}}{R_{IN1}}$$

where A_V is the desired voltage gain in V/V. R_{IN1} must be equal to R_{IN2}, and R_{F1} must be equal to R_{F2}.

The common-mode rejection ratio (CMRR) is limited by the external resistor-matching. Ideally, to achieve the highest possible CMRR the following condition should be met:

$$\frac{R_{F1}}{R_{IN1}} = \frac{R_{F2}}{R_{IN2}}$$

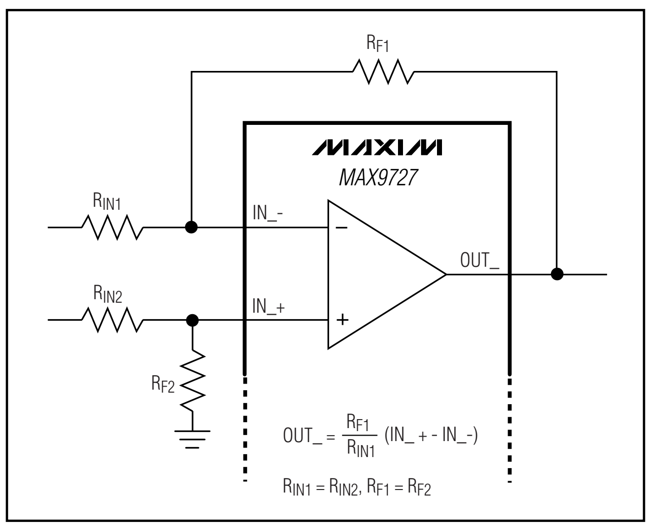


Figure 2. Differential Input Configuration

Inverting Amplifier Configuration

Figure 3 shows a single channel of the MAX9727 configured as an inverting amplifier. External resistors R_F and R_{IN} set the voltage gain of the amplifier as follows:

$$A_V = -\frac{R_F}{R_{IN}}$$

where A_V is the desired voltage gain in V/V.

R_F can be either fixed or variable, allowing the use of a digitally controlled potentiometer to alter the gain under software control.

Active Filter Configuration

When the MAX9727 is used as a line driver to provide outputs that feed audio equipment (notebooks, desktops, receivers, and set-top boxes) with a digital-to-analog converter (DAC) used as an audio input source, it is often desirable to eliminate any high-frequency quantization noise produced by the DAC output before it reaches the load. This high-frequency noise can cause the input stages of the line-in equipment to exceed slew-rate limitations or create excessive EMI emissions on the cables between devices.

In order to suppress this noise, and to provide a 2V$_{RMS}$ standard audio output level from a single 5V supply, the MAX9727 can be configured as an active lowpass filter. The *Functional Diagram/Typical Application Circuit* shows the MAX9727 connected as 2-pole Rauch/Multiple Feedback filter with a passband gain of 6dB and a -3dB (below passband) cutoff frequency of approximately 27kHz (see Figure 4 for Gain vs. Frequency plot).

Input Filter

The input capacitor C_{IN}, in conjunction with R_{IN}, forms a highpass filter that removes the DC bias from an incoming signal. The AC-coupling capacitor allows the amplifier to bias the signal to an optimum DC level. Assuming zero-source impedance, the -3dB point of the highpass filter is given by:

$$f_{-3dB} = \frac{1}{2\pi R_{IN} C_{IN}}$$

Setting f_{-3dB} too high affects the low-frequency response of the amplifier. Use capacitors with dielectrics that have low-voltage coefficients, such as tantalum or aluminum electrolytic. Capacitors with high-voltage coefficients, such as ceramics, can increase distortion at low frequencies.

Charge-Pump Capacitor Selection

Use capacitors with an ESR of less than 100mΩ for optimum performance. Low-ESR ceramic capacitors minimize the output resistance of the charge pump. For best performance over the extended temperature range, select capacitors with an X7R dielectric.

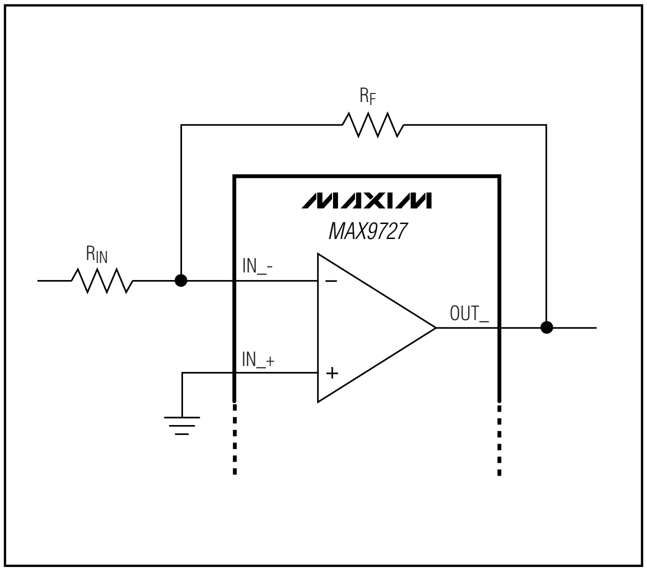


Figure 3. Inverting Amplifier Configuration

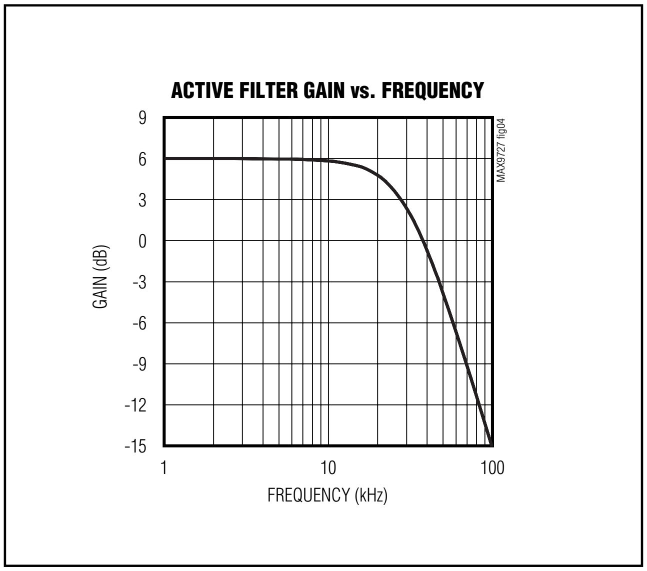


Figure 4. MAX9727 Active Filter Gain vs. Frequency

Flying Capacitor (C1)

The value of the flying capacitor (C1) affects the load regulation and the output resistance of the charge pump. A C1 value that is too small degrades the device's ability to provide sufficient current drive, which leads to a loss of output voltage. Increasing the value of C1 improves the load regulation and reduces the charge-pump output resistance to an extent. See the Charge-Pump Output Voltage vs. Output Current graphs in the *Typical Operating Characteristics*. Above 2.2µF, the on-resistance of the switches and the ESR of C1 and C2 dominate.

Hold Capacitor (C2)

The hold capacitor value and ESR directly affect the ripple at PV_{SS}. Increasing the value of C2 reduces the output ripple. Likewise, decreasing the ESR of C2 reduces both ripple and output resistance. Lower capacitance values can be used in systems with low maximum output voltage levels. See the Charge-Pump Output Voltage vs. Output Current graphs in the *Typical Operating Characteristics*. C2 should be greater than or equal to the value of C1.

PV_{DD} Bypass Capacitor (C3)

The PV_{DD} bypass capacitor lowers the output impedance of the power supply and reduces the impact of the MAX9727's charge-pump switching transients. Bypass PV_{DD} with C3 and place it physically close to PV_{DD} and PGND. C3 should be greater than or equal to the value of C1.

Supply Bypassing

Proper power-supply bypassing ensures low-noise, low-distortion performance. Connect a 1µF ceramic capacitor from V_{DD} to PGND.

Layout and Grounding

Good PC board layout is essential for optimizing performance. Use large traces for the power-supply inputs and amplifier outputs to minimize losses due to trace resistance. Good grounding improves audio performance, minimizes crosstalk between channels, and prevents any digital switching noise from coupling into the audio signal. Route PGND and all traces that carry switching transients away from traces and components in the audio signal path.

Place the charge-pump capacitors (C1 and C2) as close to the device as possible. Connect V_{SS} and PV_{SS} together at capacitor C2.

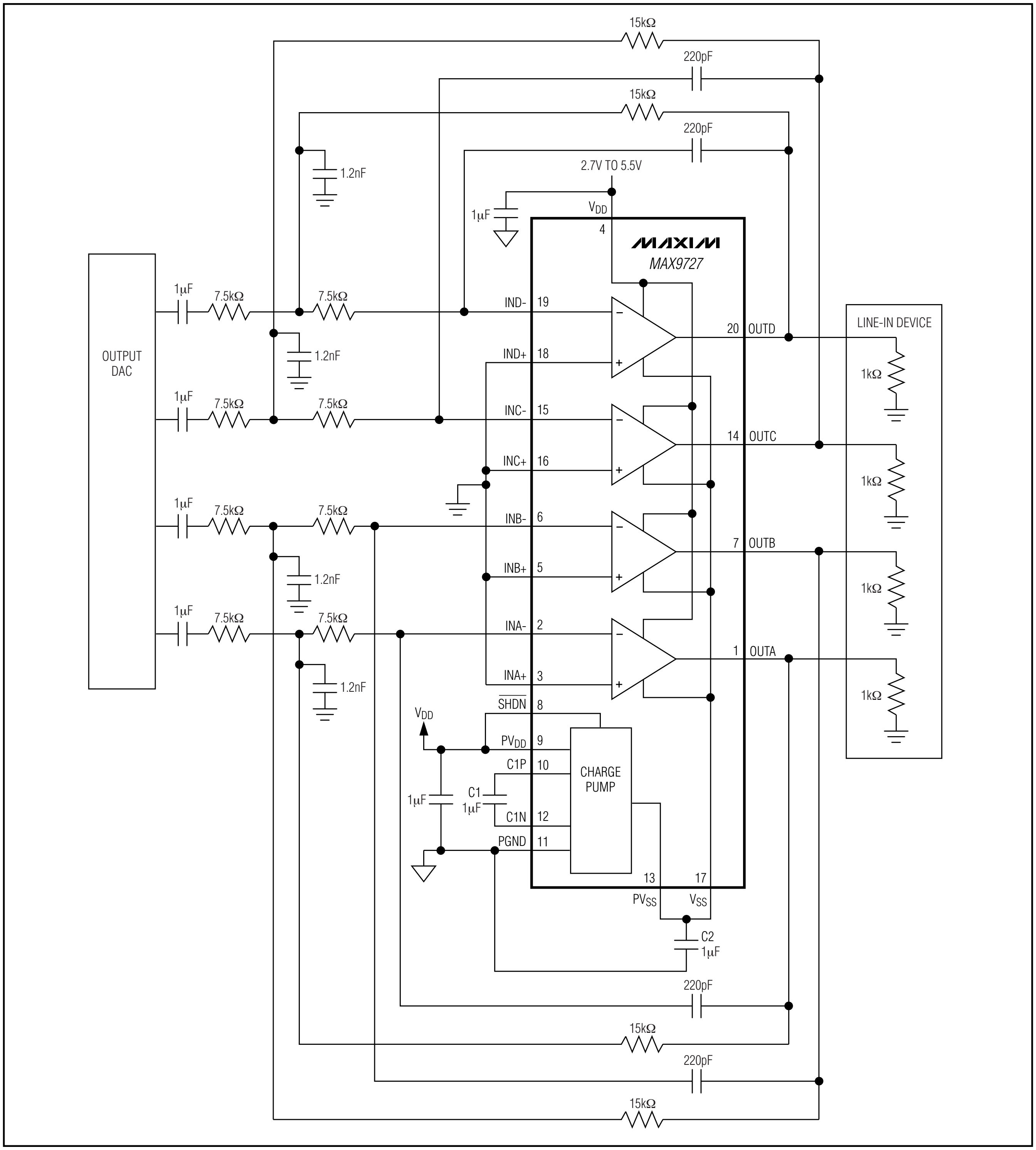
Thermal-Overload Protection

Thermal-overload protection limits the total power dissipation in the MAX9727. When the junction temperature exceeds +160°C, the thermal protection circuitry disables the amplifier output stages. The junction temperature must cool by 15°C before normal operation can continue.

Chip Information

PROCESS: BiCMOS

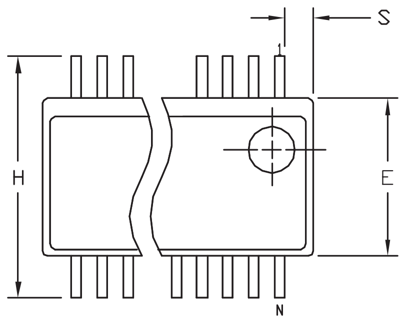
Functional Diagram/Typical Operating Circuit



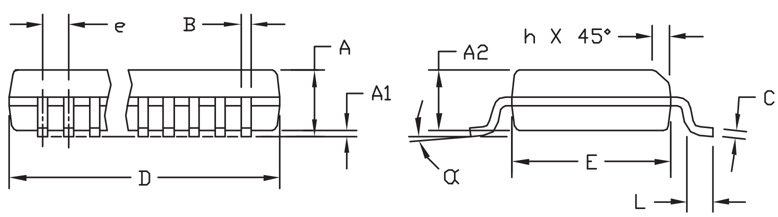
Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to **www.maxim-ic.com/packages**.)

QSOP.EPS



DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	.053	.069	1.35	1.75
A1	.004	.010	.102	.254
A2	.049	.065	1.245	1.651
B	.008	.012	0.20	0.30
C	.0075	.0098	0.191	0.249
D	SEE VARIATIONS			
E	.150	.157	3.81	3.99
e	.025 BSC		0.635 BSC	
H	.230	.244	5.84	6.20
h	.010	.016	0.25	0.41
L	.016	.035	0.41	0.89
N	SEE VARIATIONS			
α	0°	8°	0°	8°



VARIATIONS:

	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	N	
D	.189	.196	4.80	4.98	16	AB
S	.0020	.0070	0.05	0.18		
D	.337	.344	8.56	8.74	20	AD
S	.0500	.0550	1.270	1.397		
D	.337	.344	8.56	8.74	24	AE
S	.0250	.0300	0.635	0.762		
D	.386	.393	9.80	9.98	28	AF
S	.0250	.0300	0.635	0.762		

NOTES:
1). D & E DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
2). MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .006" PER SIDE.
3). CONTROLLING DIMENSIONS: INCHES.
4). MEETS JEDEC MO137.

DALLAS SEMICONDUCTOR MAXIM
PROPRIETARY INFORMATION
TITLE:
PACKAGE OUTLINE, QSOP .150", .025" LEAD PITCH
APPROVAL | DOCUMENT CONTROL NO. 21-0055 | REV. F | 1/1

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