

**250W Class D Subwoofer Amplifier**



The HCA250ACREF Reference Design delivers 250W<sub>RMS</sub> power into a 2Ω load with less than 0.1% THD.

The amplifier will run continuously at rated power with no droop in output level. Since the efficiency is 90% at maximum power, no expensive, bulky heatsinks are required.

The design is part of Intersil's Cool Audio program that enables customers to achieve a minimum time-to-market for audio end products. The design is offered to Customers after execution of our Licensing Agreement, at which time, Intersil provides a documentation package containing 1) Circuit Description, 2) Schematics, 3) Test and Manufacturing Information, 4) A Bill of Materials with all vendor and vendor part numbers, 5) Intersil's Engineering Support Contacts, 6) One Sample Amplifier Board.

For more information, see us on the web, home page <http://www.intersil.com>. For technical assistance, call Central Applications at 1-800-442-7747, or email us at [centapp@intersil.com](mailto:centapp@intersil.com).

**Features**

- 250 Watt RMS Power (400 Watt Peak)
- Operation from a Single Supply
- Meets FCC Class B and CE Marking Requirements for EMC in a Typical Subwoofer Application
- 10Hz-20kHz Bandwidth (3dB)
- 0.1% THD (10Hz to 200Hz)
- 90% Efficiency at Maximum Power
- Pop-Free Start-Up
- Remote On/Off
- Soft Clipping
- Thermal Protection
- Protection for OUT1 or OUT2 to GND Short, and OUT1 to OUT2 Shorts

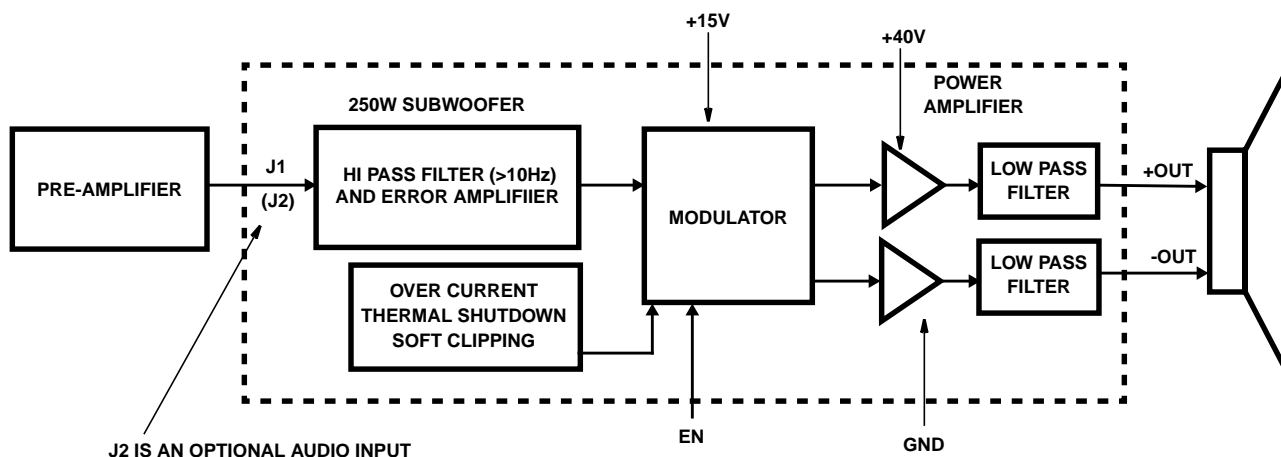
**Applications**

- Subwoofer- and "Bi-" Amplifiers

**Ordering Information**

Contact Intersil Licensing Agents Continental Far East or International Operations. See contact information provided in this document.

**Reference Design Block Diagram**



# HCA250ACREF

## Absolute Maximum Ratings

Supply Voltage,  $V_{BUS}$  (Note 1) ..... -0.3V to 50V  
 All Other Pin Voltages (Note 1) .....  $V_{GND}$  -0.3V to  $V_{BUS}$  +0.3V

## Operating Conditions

Supply Voltage,  $V_{BUS}$  (Relative to GND)..... +40V (+8, -4)  
 Voltage on  $V_{SS}$  ..... 0V  
 Temperature Range (Amplifier Ambient) ..... -40°C to 60°C

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

### NOTES:

1. All voltages are relative to  $V_{GND}$ , unless otherwise specified.

## Electrical Specifications $V_{BUS} = 40V, R_{LOAD} = 2.0\Omega, V_{COM} = 0V$

PARAMETER	SYMBOL	TEST CONDITIONS	$T_A = 25^\circ C$	UNITS
			TYP	
<b>SUPPLY MEASUREMENTS</b>				
+15V Current Quiescent - Switching		$V_{BIAS} = 12V, EN = V_{BIAS}$	70	mA
+15V Current Quiescent - Non Switching		$V_{BIAS} = 12V, EN = V_{COM} = 0V$	50	mA
$V_{BUS}$ Quiescent Current	$I_{BUS}$	Audio In = 0V, $EN = V_{BIAS} = 15V$	60	mA
REM On/OFF Quiescent Current (On)	$R_{EN}$		170	$\mu A$
Minimum 15V Input Supply Voltage			13.5	V
Maximum +15V Input Supply Voltage			20	V
<b>OUTPUT MEASUREMENTS (All In RMS)</b>				
Maximum Output Power at 36V	$P_{MAX}$	$V_{BUS} = 36V$	250	W
<b>PERFORMANCE MEASUREMENTS</b>				
Total Harmonic Distortion + Noise	THD+N	$P_{OUT} = 150W, 100Hz$	0.1	%
SNR	$V_{SNR}$	Relative to Full Scale Output, $\leq 5kHz$	-85	dB
PSRR ( $\Delta V_{OUT} / \Delta V_{BUS}$ )	$P_{SRR}$	$V_{BUS} = 40 \pm 10\%$	3	mV/V
<b>ADDITIONAL MEASUREMENTS</b>				
Cutoff Frequency	$F_{UPPER}$	-3dB (Note 2)	20	KHz
PWM Frequency	$F_{PWM}$		68	kHz
Amplifier Gain	$A_V$		26	dB
Input Impedance	$R_{IN}$		11.3	K $\Omega$

### NOTE:

2. See Figure 7, Frequency Response (Open and Closed Loop) Gain and Phase.
3. All measurements for this data sheet taken on Audio Precision "System 2 Analyzer".

## Reference Board Connector Assignment

SYMBOL	DESCRIPTION
EN	Remote on/off signal for the amplifier.
+40V	Amplifier output stage power source.
+OUT	The + polarity high power output.
-OUT	The -polarity high power output.
+15V	Logic supply voltage = 15V <sub>DC</sub> .
GND	Ground return for the amplifier.
SHLD	Shield connection for speaker cable.
J1	Audio input from preamp.

**Typical Performance Curves** ( $V_{BUS} = 40V$ ,  $R_{LOAD} = 2\Omega$ , Except as noted otherwise)

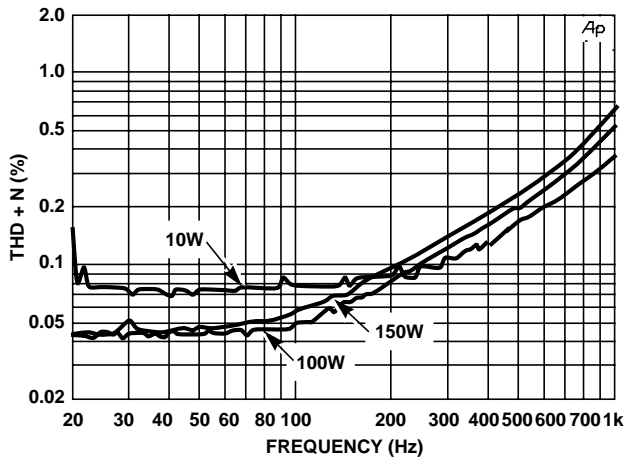


FIGURE 1. TOTAL HARMONIC DISTORTION PLUS NOISE vs FREQUENCY AS A FUNCTION OF OUTPUT POWER

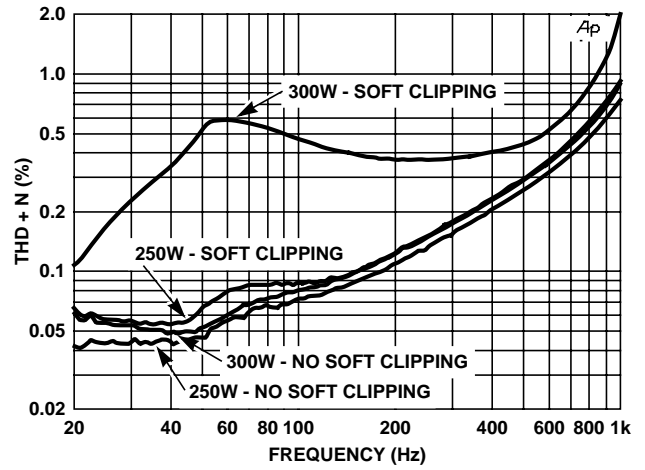


FIGURE 2. TOTAL HARMONIC DISTORTION PLUS NOISE vs FREQUENCY AS A FUNCTION OF OUTPUT POWER (WITH AND WITHOUT SOFT-CLIPPING)

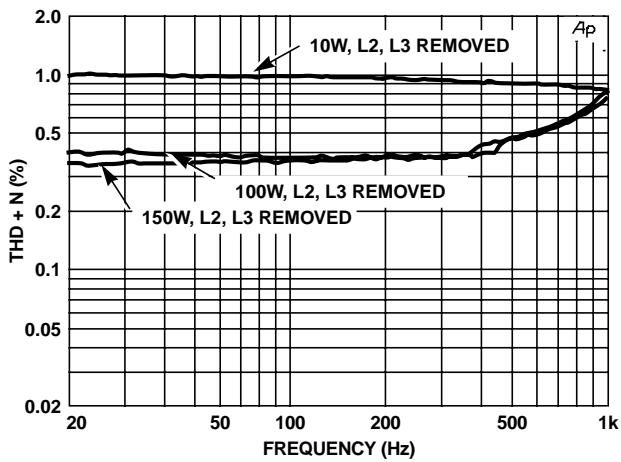


FIGURE 3. TOTAL HARMONIC DISTORTION PLUS NOISE vs FREQUENCY AS A FUNCTION OF OUTPUT POWER (L2 AND L3 OUTPUT CHOKES REMOVED)

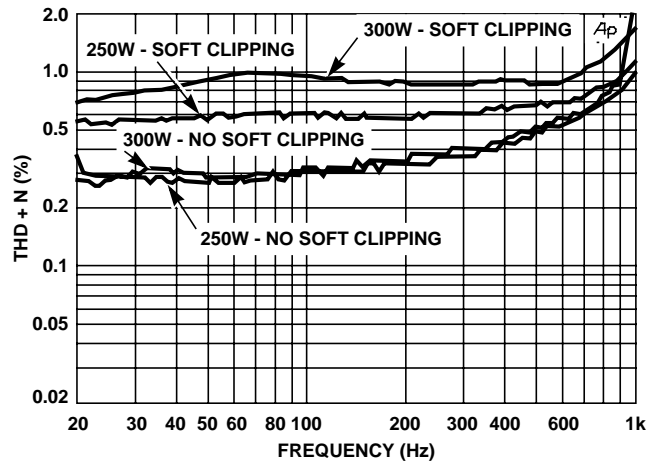


FIGURE 4. TOTAL HARMONIC DISTORTION PLUS NOISE vs FREQUENCY AS A FUNCTION OF OUTPUT POWER (L2 AND L3 OUTPUT CHOKES REMOVED FOR COST REDUCTION; WITH AND WITHOUT SOFT-CLIPPING)

**Typical Performance Curves** ( $V_{BUS} = 40V$ ,  $R_{LOAD} = 2\Omega$ , Except as noted otherwise) (Continued)

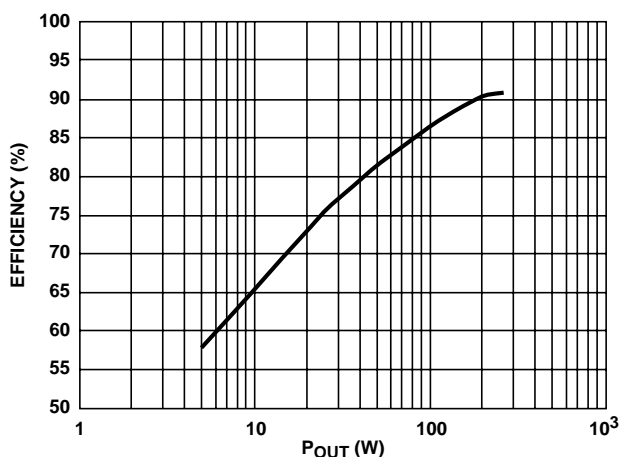


FIGURE 5. EFFICIENCY vs OUTPUT POWER AT 100Hz

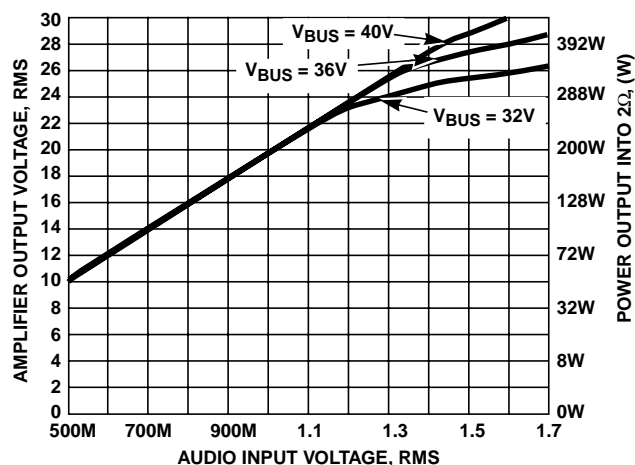
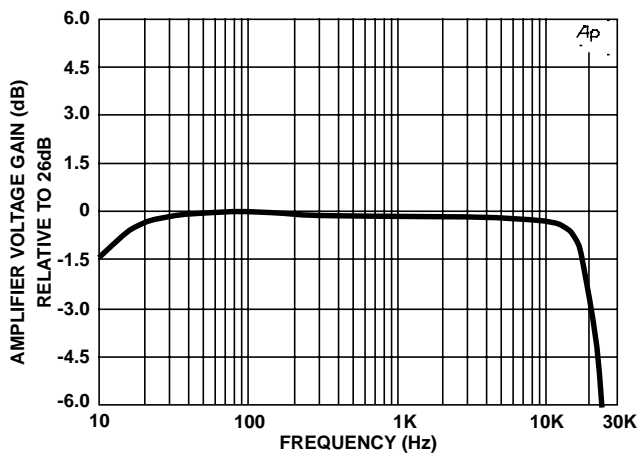


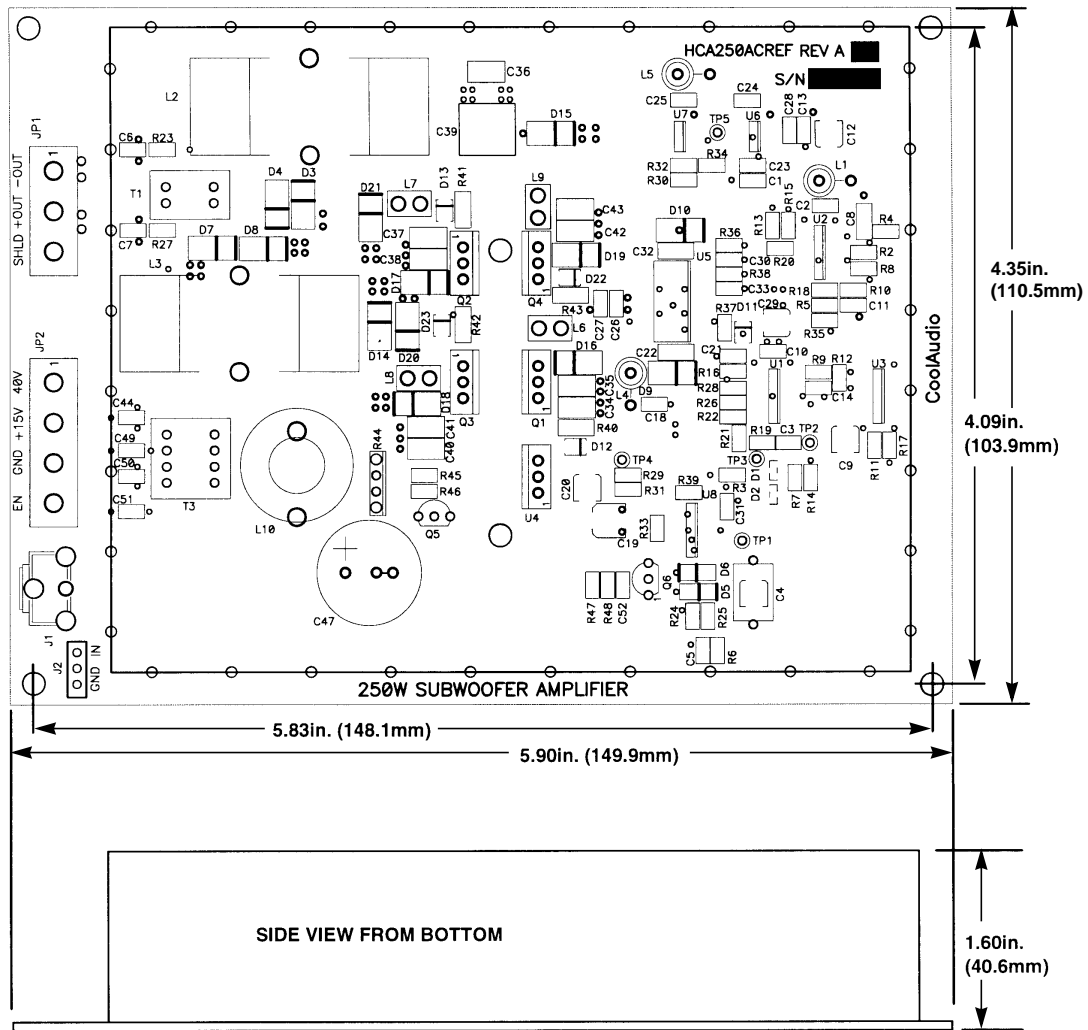
FIGURE 6. OUTPUT POWER AND VOLTAGE vs AUDIO INPUT VOLTAGE AS DC BUS VOLTAGE IS VARIED



NOTE: The above curve shows the frequency response from 10Hz to 20kHz at 250W output power. Note that the response is  $\pm 3dB$  from 10Hz -20kHz.

FIGURE 7. AMPLITUDE vs FREQUENCY

Reference Board Physical Layout



## Evaluation Test Procedure

HCA250ACREF Consumer Subwoofer Amplifier.

### Equipment

Test equipment required for proper evaluation of the 250W Intersil Subwoofer Amplifier are as follows:

Two Regulated DC Power Supplies will be needed for testing. A high power supply with clean output and capable of supplying a constant 40V<sub>DC</sub> at 10A minimum continuously; and a lower voltage supply capable of providing 15V continuously at 100mA. A power supply with the current limit set to those specified above is recommended. For power supplies which do not read the current limit set-point directly, the position of the set point control corresponding to the appropriate current levels should be determined prior to starting the test and marked on the power supply control panel.

Audio Precision System 1 Analyzer or equivalent, capable of providing clean audio input signals controllable in amplitude from 0V to 2.00V and frequencies from 10Hz to 20kHz. The system should also be capable of analyzing amplifier characteristics, Output Power, Frequency Response, Total Harmonic Distortion, and Noise. An output low pass filter may be needed (although the Audio Precision Analyzers with their Analyzer voltage scales set to 40 V will provide good results without a filter) to filter out the switching waveform components resulting from class D amplification. This filter can be made from the schematic shown in Figure 9. The filter's corner frequency is approximately 20kHz and is sufficient for verifying bandwidth.

A 2Ω non-inductive resistive load capable of handling a minimum of 250W.

### Procedure

1. Connect a shielded cable between the Audio Precision Analyzer signal output port and the RCA jack, J1, or the alternative jack, J2 on the amplifier. Connect a #16AWG twisted pair shielded cable between plug, JP1, and the 2.0Ω resistor set. Connect suitable wires between plug, JP2, on the amplifier and the 15V and 40V<sub>DC</sub> supplies using #16AWG twisted wire for GND and 40V<sub>DC</sub> and #22AWG for 15V<sub>DC</sub> and EN signals. Set the pin 2 to pin 3 voltage to 15V and the pin 1 to 3 voltage to 40V, before plugging in the JP2 plug into the amplifier board socket, JP2. Preset the current limit settings of the 15V<sub>DC</sub> supply to 100mA and the bus supply current to about 10A<sub>DC</sub>.
2. With the power supplies off, plug the J1, JP1 and JP2 external connectors into the appropriate ports on the amplifier board. Make sure the board is sitting on a non conductive surface prior to powering up. The wire from the remote EN(able) pin, pin 4 (JP2), should be disabled (not connected to +15V).
3. With the audio input signal set at 0mV, turn on the 15V power supply followed by the 40V supply. The indicated current from the 40V<sub>DC</sub> supply should be zero and for the 15V<sub>DC</sub> supply near 50mA. Next, connect the EN wire to the +15V supply. The 15V<sub>DC</sub> supply current should increase to ap-

proximately 70mA. The 40V<sub>DC</sub> power supply current with no input signal should be approximately 60mA.

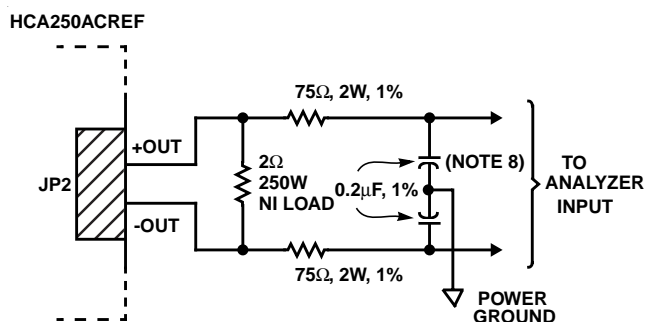
4. If the amplifier output is connected to a resistive load, 2Ω, 250W resistor, make sure the resistor is placed on a safe surface since it will get very hot during the evaluation test.
5. Depending on the type of testing to be conducted (Output Power, THDs etc.) select the menu and control panel settings on the Audio Precision Analyzer to conduct the test. Input frequency should be swept from 10Hz and 1KHz and input voltage level should be increased slowly until desired output power is achieved. At 250W output power, the 40V<sub>DC</sub> bus power supply current should be approaching 8A. It is important to have 40VDC at the JP2 plug in order to obtain results similar to those found in the data sheet.
6. Conduct the desired tests in accordance with the Audio Precision test procedures.
7. Power down audio signal input and power supplies before disconnecting the amplifier from the test set up.

### Expected Test Results

The Intersil 250W Subwoofer Amplifier is designed to provide 250W rms output power into 2Ω speaker load with THD+N as shown in the figures. As the amplifier output power approaches 250W, the output voltage swing approaches the limits of the supply voltage (36V min.) and the output waveform will begin to soft-clip, resulting in an increase in THD. Data sheet measurements were taken by measuring voltages at the JP1 and JP2 pin by soldering small wire stubs to the connector pins on the underside of the amplifier board.

The onset of soft-clipping can be viewed by looking at test point TP2 with an oscilloscope probe with respect to a suitable ground on the amplifier board (the shield fence makes an excellent ground). A slight compression of the signal will occur as the input amplitude is increased further and further. Figure 2 shows results with and without soft-clipping at 250W and 300W. The effects of soft-clipping or compression are reduced by a small increase in bus voltage. This is also evident from gain degradation of the amplifier with lowered bus voltage as shown in Figure 6.

The short-circuit shutdown circuit can be tested by simply shorting the 2Ω output resistors with a suitable means. Instantaneous disabling of the amplifier should be noticed. Also shorting either side of the load resistor to a suitable ground such as the shield fence will cause a similar shutdown. To reset the amplifier, remove the short circuit and then either the +15V<sub>DC</sub> supply potential or momentarily set the EN potential to GND.



NOTE: Use polypropylene filter capacitors only.

**FIGURE 8. FILTER CIRCUIT FOR USE WITH AUDIO PRECISION ANALYZER AND RESISTIVE LOADS**

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