

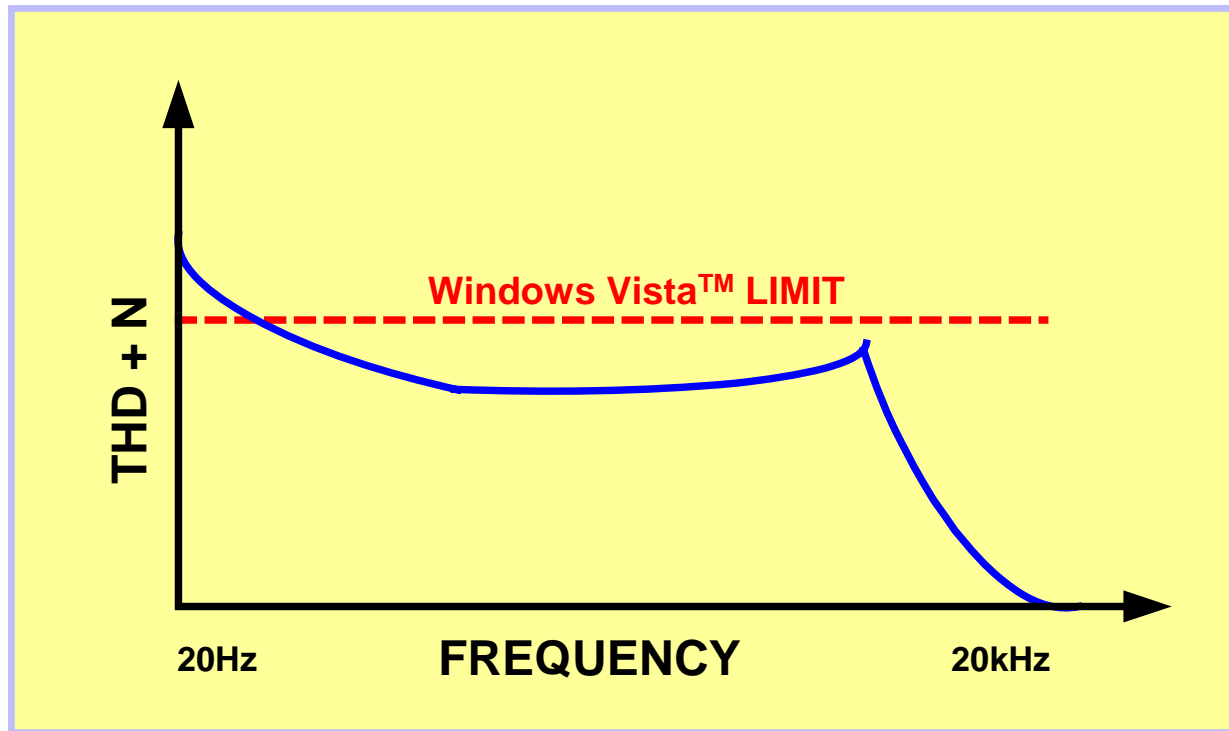
## Select the Audio Specification Your System Is Failing

1. THD+N
2. Crosstalk
3. Dynamic Range
4. Magnitude Response
5. Full-Scale Output Voltage
6. Click and Pop



## Total Harmonic Distortion Plus Noise

Does the audio output port fail THD+N at low frequencies?

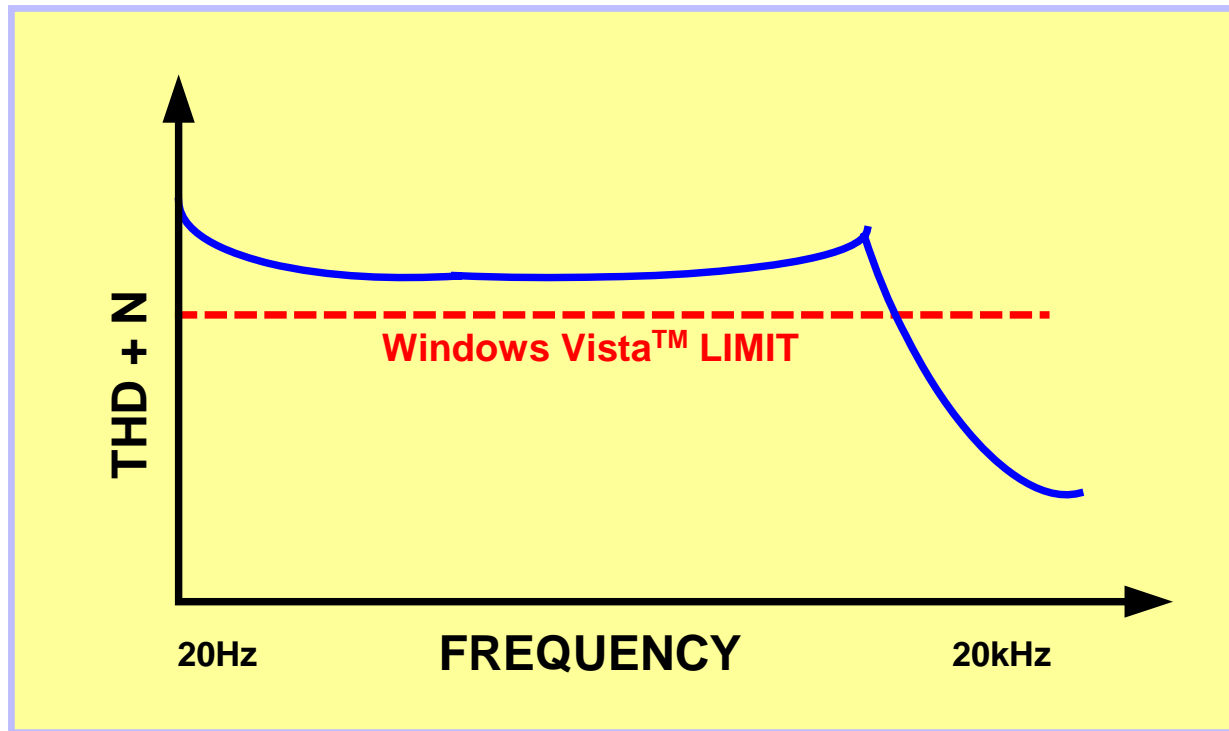


YES

NO

## Total Harmonic Distortion Plus Noise

Does the audio output port fail THD+N across the entire band?



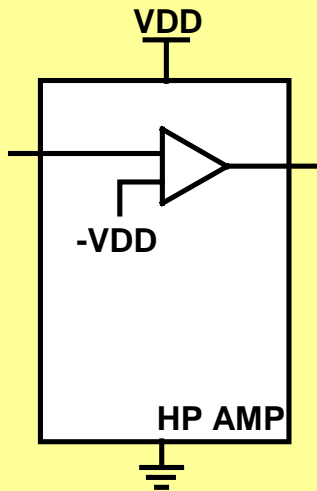
YES

NO

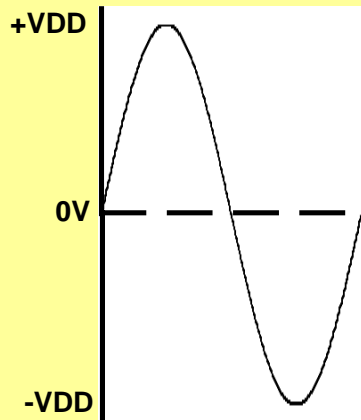
## Total Harmonic Distortion Plus Noise

Does your system utilize a DirectDrive™/capless headphone amplifier or a conventional headphone amplifier?

### DirectDrive Headphone Amplifier

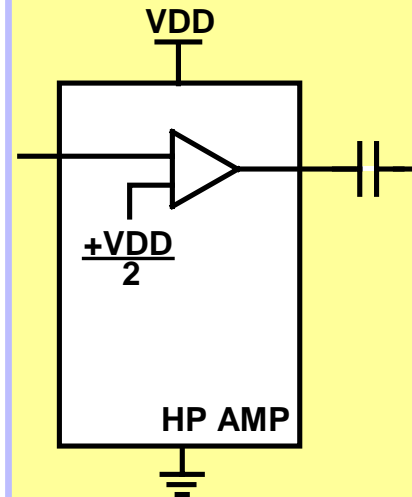


HEADPHONE OUTPUT SWINGS BETWEEN +VDD and -VDD

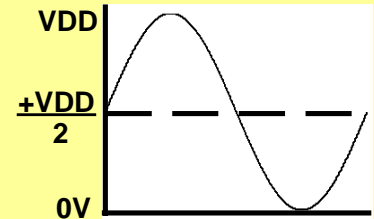


HEADPHONE OUTPUT BIASED AT 0V.

### Conventional Headphone Amplifier



HEADPHONE OUTPUT SWINGS BETWEEN 0V and VDD



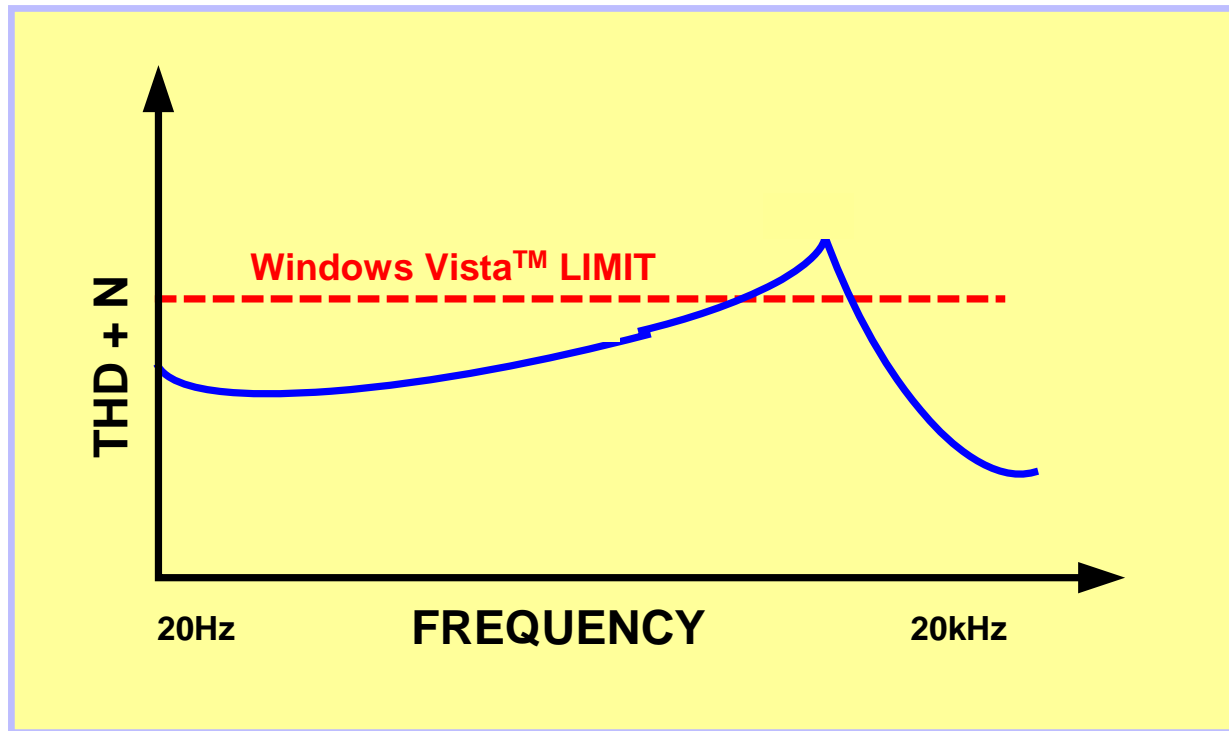
HEADPHONE OUTPUT BIASED AT +VDD/2.

DirectDrive

Conventional

## Total Harmonic Distortion Plus Noise

Does the audio output port fail THD+N at high frequencies?

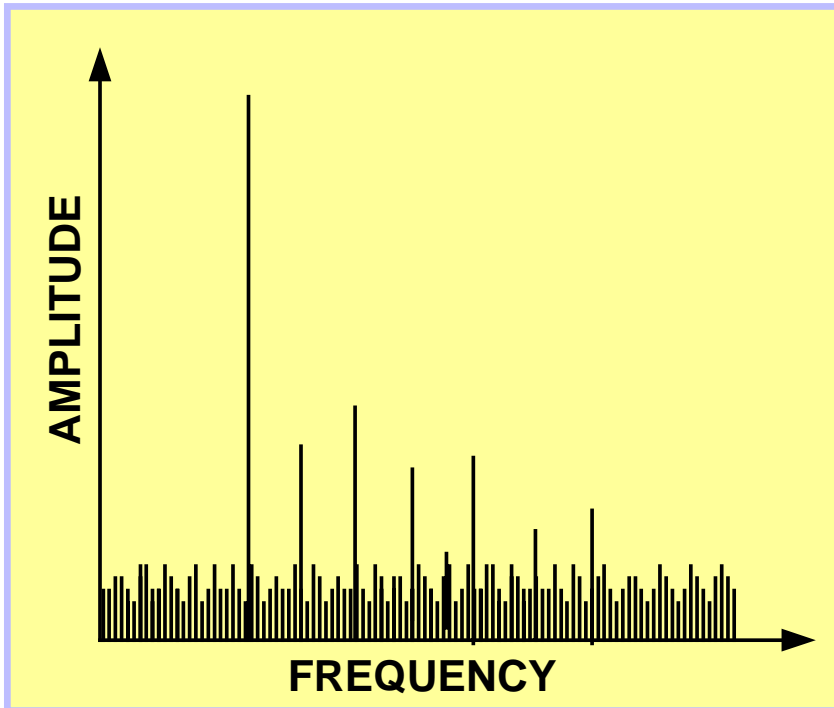


YES

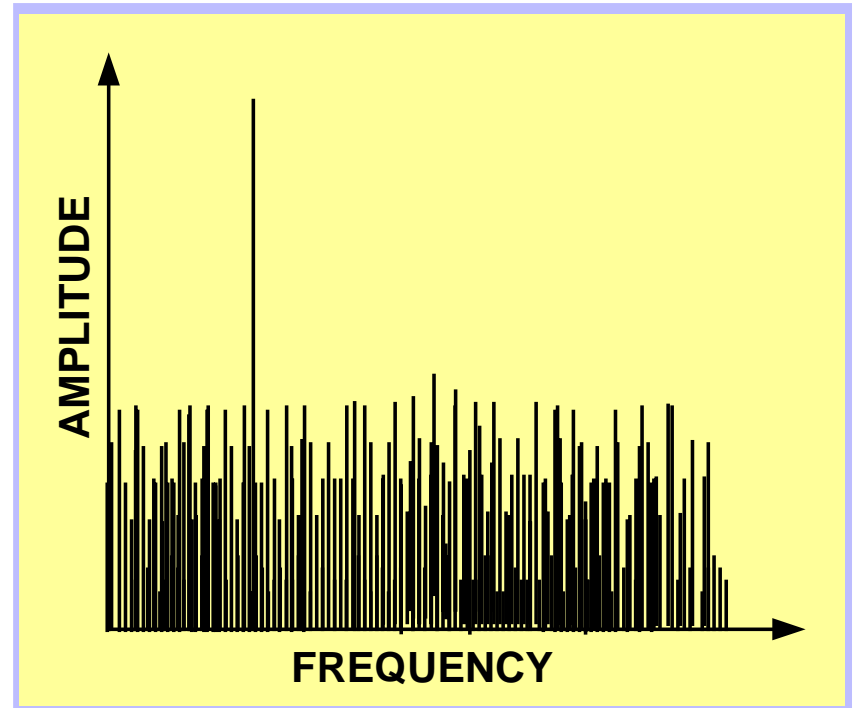
NO

## System Fails THD+N Across the Entire Audio Band

Is the THD+N across the audio band dominated by distortion (THD) or noise?



THD

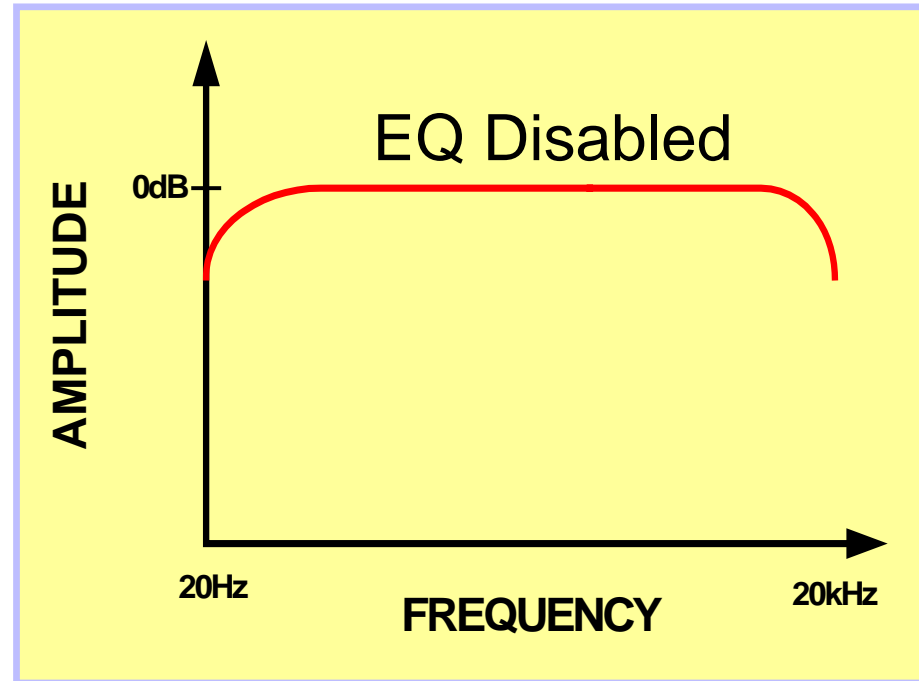
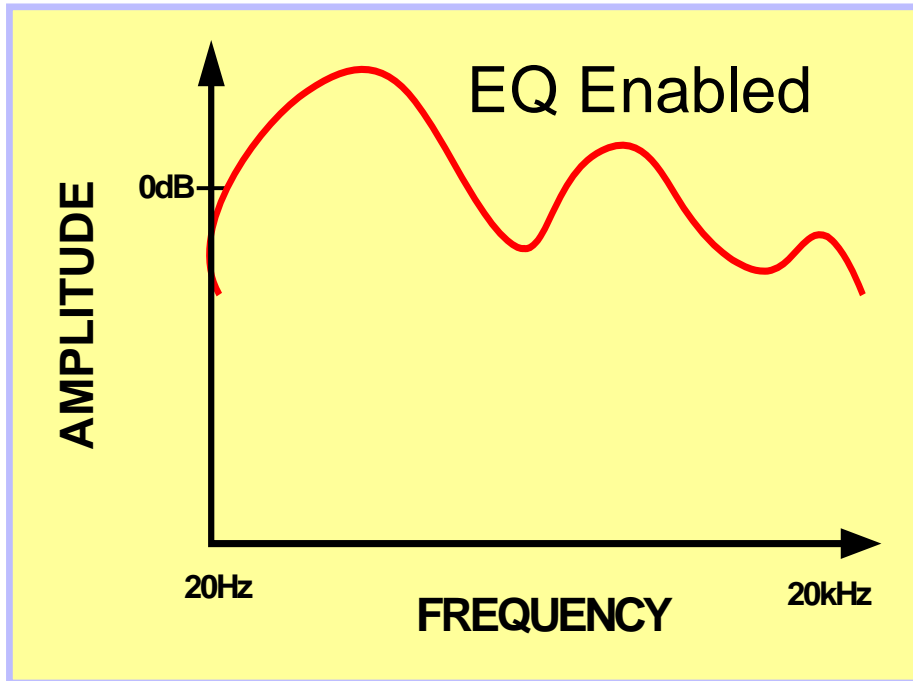


Noise

Hint: Perform an FFT

# System Fails THD+N Across the Entire Audio Band

Is the system EQ enabled?



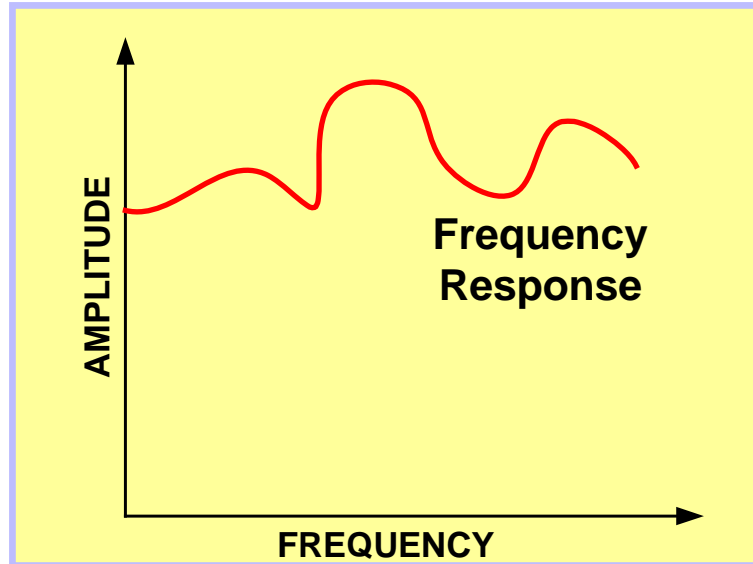
YES

Hint: Check frequency response.

NO

## System Fails THD+N Across the Entire Audio Band

**CAUSE:** EQ circuitry may be boosting harmonic components, leading to high THD+N measurements.



**ACTION:** Disable EQ and repeat THD+N vs. frequency measurement.

YES

Does the system still fail THD+N?

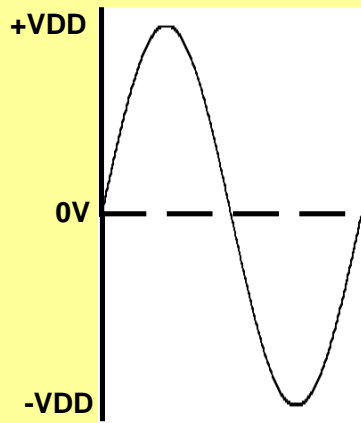
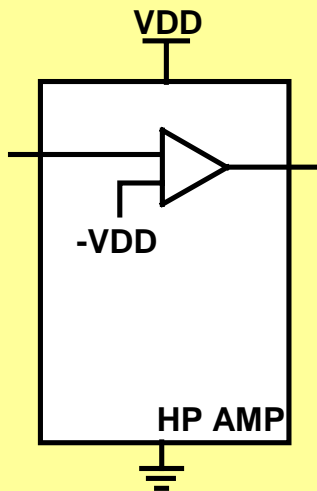
NO

## Total Harmonic Distortion Plus Noise

Does your system utilize a DirectDrive/capless headphone amplifier or a conventional headphone amplifier?

### DirectDrive Headphone Amplifier

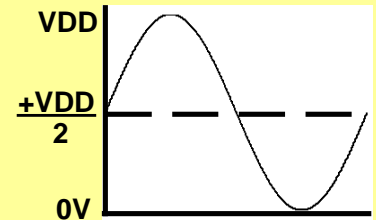
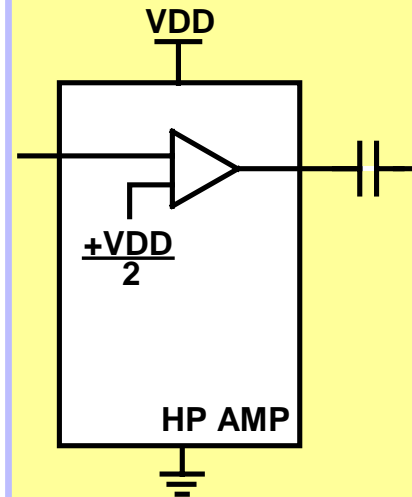
HEADPHONE OUTPUT SWINGS BETWEEN  $+VDD$  and  $-VDD$



HEADPHONE OUTPUT BIASED AT 0V.

### Conventional Headphone Amplifier

HEADPHONE OUTPUT SWINGS BETWEEN 0V and VDD



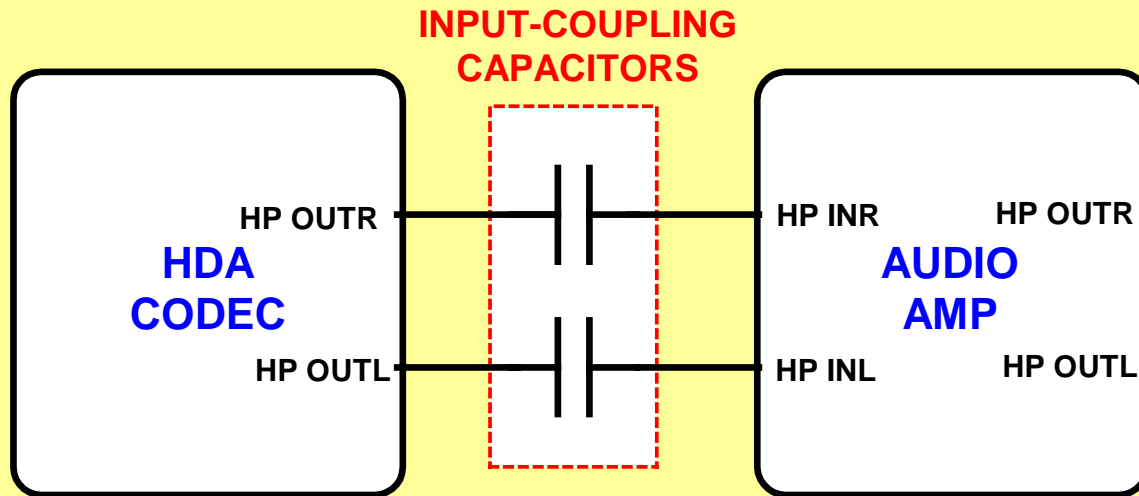
HEADPHONE OUTPUT BIASED AT  $+VDD/2$ .

DirectDrive

Conventional

## System Fails THD+N at Low Frequencies

**CAUSE:** Piezoelectric effect of the input-coupling capacitor ( $C_{IN}$ ) can contribute nonlinearities to the audio signal path.



**ACTION:** Replace  $C_{IN}$  with 25V X7R ceramic capacitors and measure THD+N performance again.

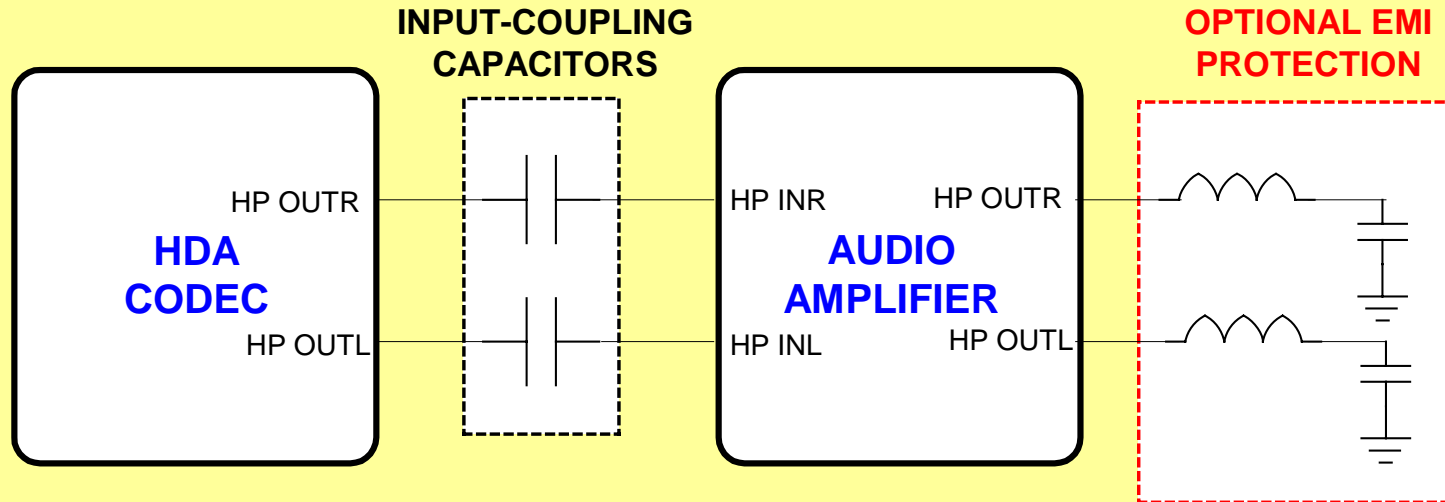
YES

Does the system still fail THD+N?

NO

## System Fails THD+N Across the Entire Audio Band

**CAUSE:** Ferrite beads used for EMI protection at the headphone jack can contribute nonlinearities to the audio signal path.



**ACTION:** Replace the ferrite beads in your system with  $0\Omega$  resistors and measure THD+N performance again.

YES

Does the system still fail THD+N?

NO

## Windows Vista™-Compliant Ferrite Beads

The following ferrite beads have been tested in-circuit for THD+N performance and have proven to be Windows Vista™ compliant.

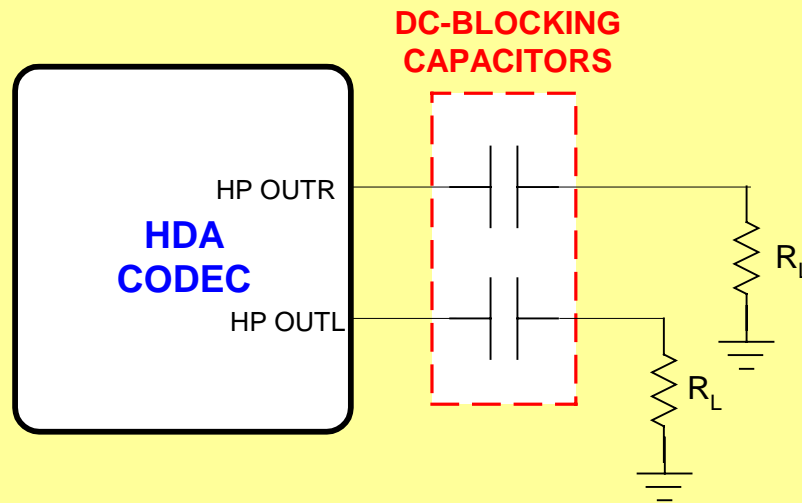
<b>TDK</b> .....	<b>MMZ1608Y601BTA</b>
<b>Murata</b> .....	<b>BLM18BD601SN1</b>
<b>Taiyo Yuden</b> .....	<b>LFBK1608HM601</b>

**Return to previous slide**



## System Fails THD+N at Low Frequencies

**CAUSE:** DC-blocking capacitors required for non-DirectDrive devices can contribute nonlinearities to the audio signal path.



**ACTION:** Replace the DC-blocking capacitors in your system with aluminum electrolytics and measure THD+N performance again.

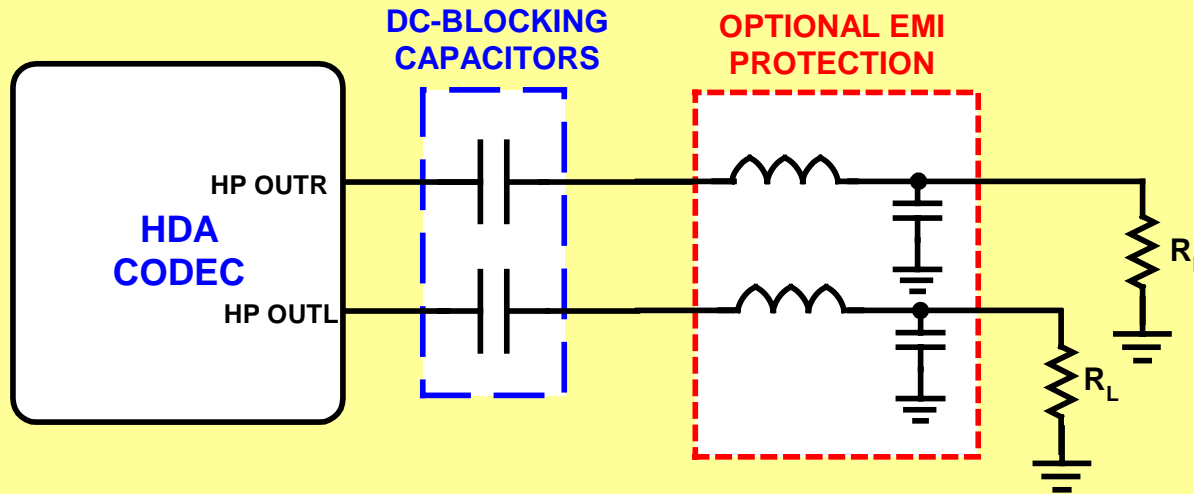
YES

Does the system still fail THD+N?

NO

## System Fails THD+N Across the Entire Audio Band

**CAUSE:** Ferrite beads used for EMI protection at the headphone jack can contribute nonlinearities to the audio signal path.



**ACTION:** Replace the ferrite beads in your system with  $0\Omega$  resistors and measure THD+N performance again.

YES

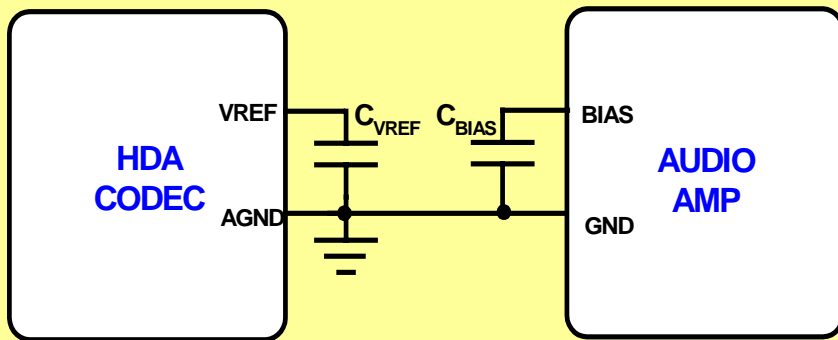
Does the system still fail THD+N?

NO

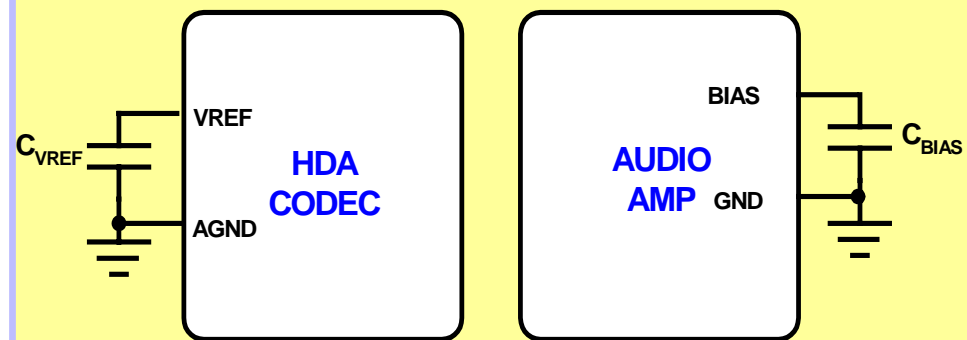
## System Fails THD+N Across the Entire Audio Band

**CAUSE:** Codec analog ground and amplifier analog ground may not be referenced to the same potential.

### IDEAL



### NON-IDEAL



**ACTION:** Ensure analog ground at codec's  $C_{VREF}$  sits at the same potential as the analog ground at the amplifier's  $C_{BIAS}$ .

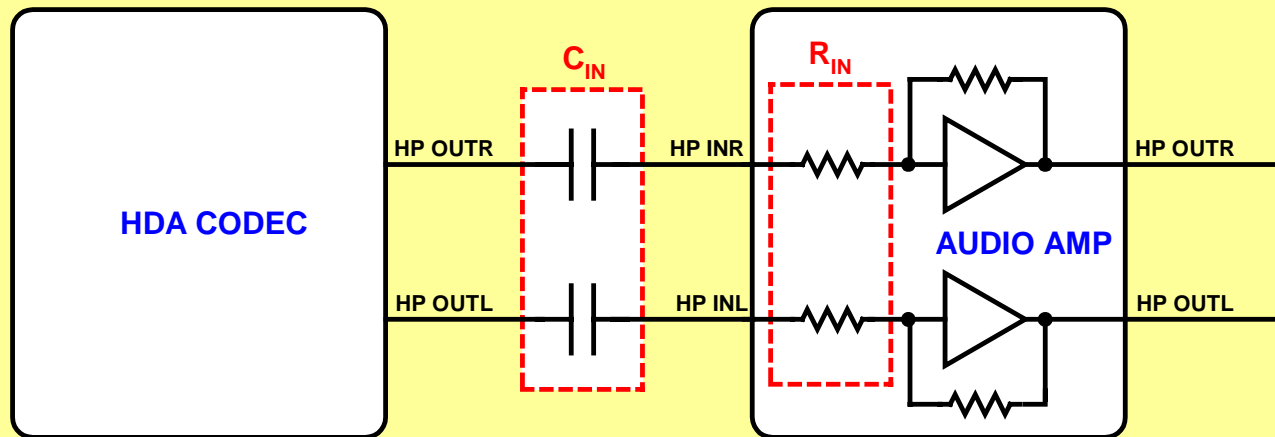
YES

Does the system still fail THD+N?

NO

## System Fails THD+N Across the Entire Audio Band

**CAUSE:** Noise may be coupled into the headphone amplifier inputs or onto the headphone amplifier outputs.

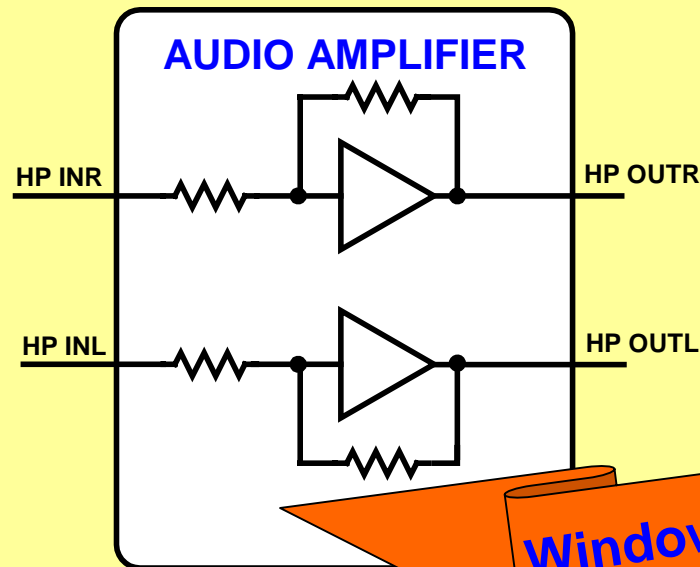


**ACTION:** Determine noise source. Ensure headphone amplifier sits on a quiet analog ground plane. Ensure headphone amplifier outputs are routed over a quiet analog ground plane.



## System Fails THD+N at High Frequencies Only

**CAUSE:** Most likely, amplifier linearity is not optimized for low THD+N at high frequencies.



**Windows Vista™  
Compliant**

**ACTION:** Select a Windows Vista™-compliant audio amplifier.



# CONGRATULATIONS!

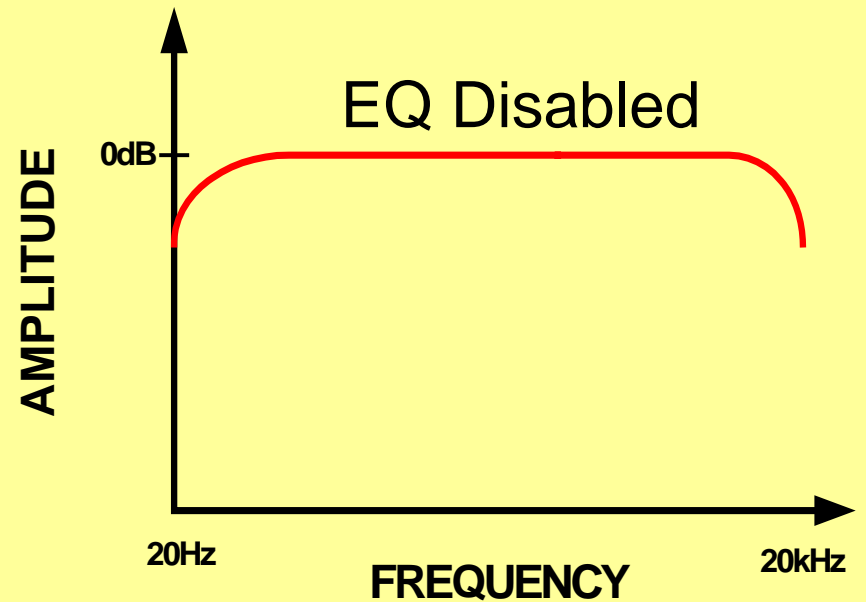
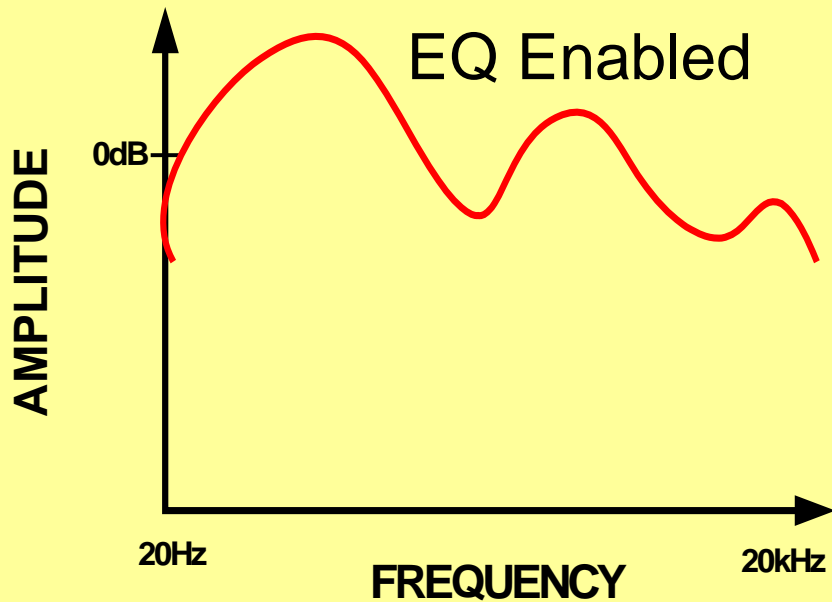
**Your system passes Windows Vista™ THD+N requirements!**

**Return to**  
**Main Menu**



## Magnitude Response

Is the system EQ enabled?



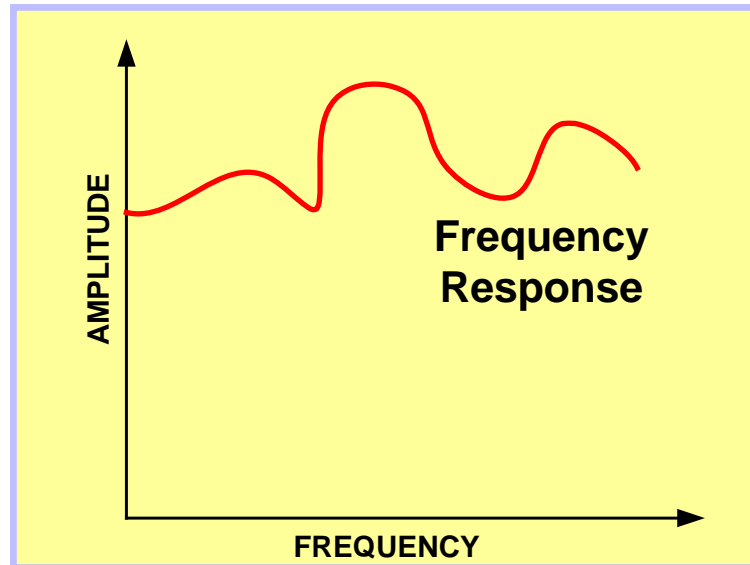
YES

Hint: Check magnitude response.

NO

## Magnitude Response

**CAUSE:** EQ circuitry may be boosting certain frequencies, leading to inaccurate response measurements.



**ACTION:** Disable EQ and repeat amplitude vs. frequency measurement.

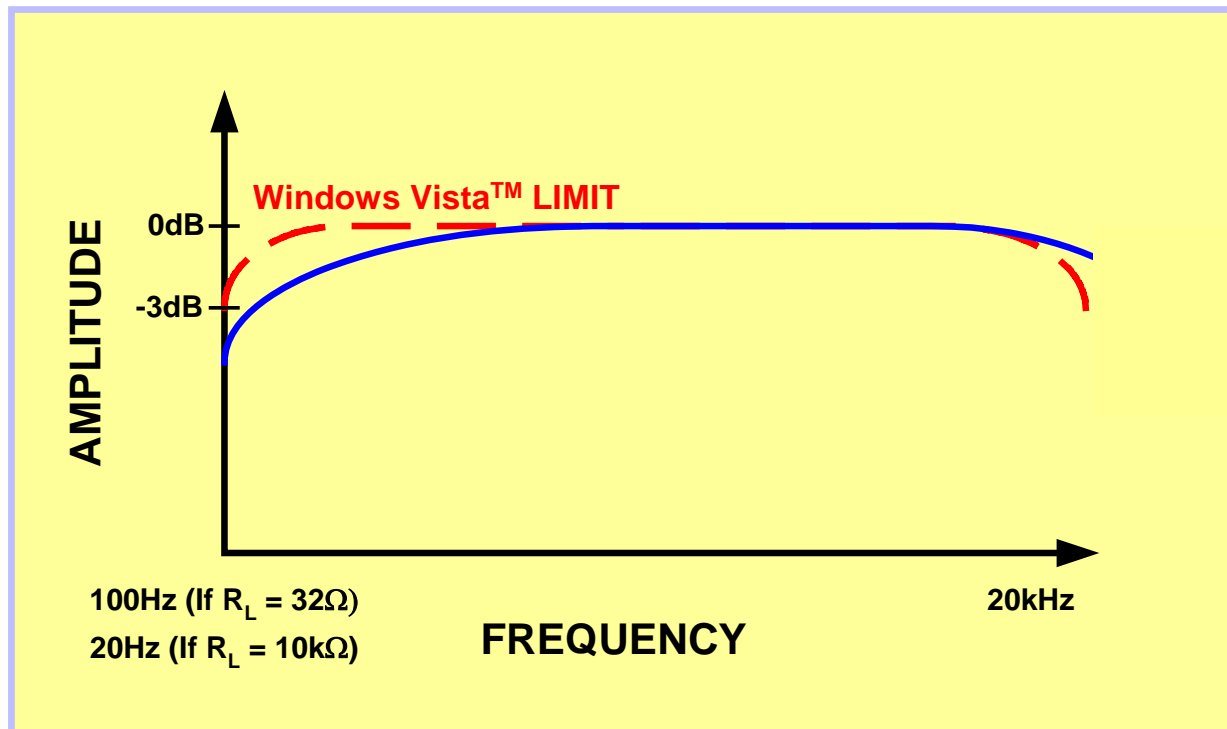
**YES**

Does the system still fail magnitude response?

**NO**

## Magnitude Response

Does the audio output port fail magnitude response at low frequencies?



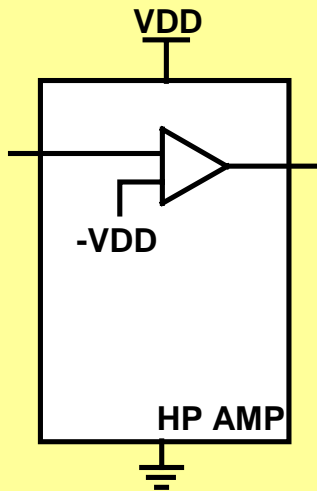
YES

NO

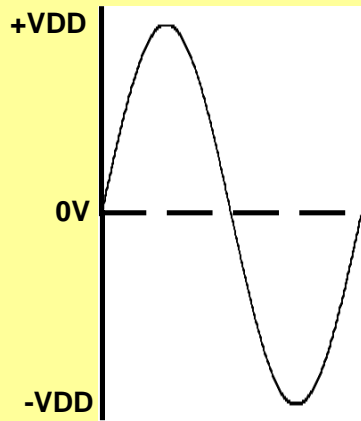
## Magnitude Response

Does your system utilize a DirectDrive/capless headphone amplifier or a conventional headphone amplifier?

### DirectDrive Headphone Amplifier

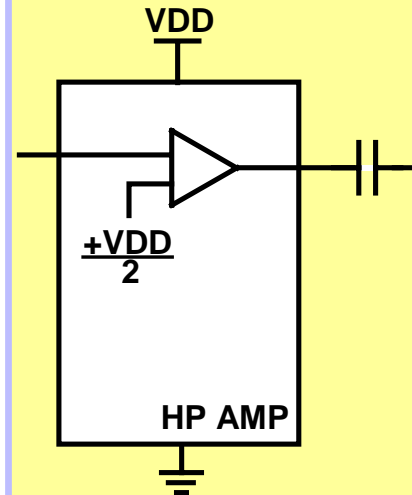


HEADPHONE OUTPUT SWINGS BETWEEN  $+VDD$  and  $-VDD$

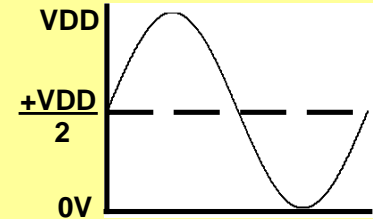


HEADPHONE OUTPUT BIASED AT  $0V$ .

### Conventional Headphone Amplifier



HEADPHONE OUTPUT SWINGS BETWEEN  $0V$  and  $VDD$



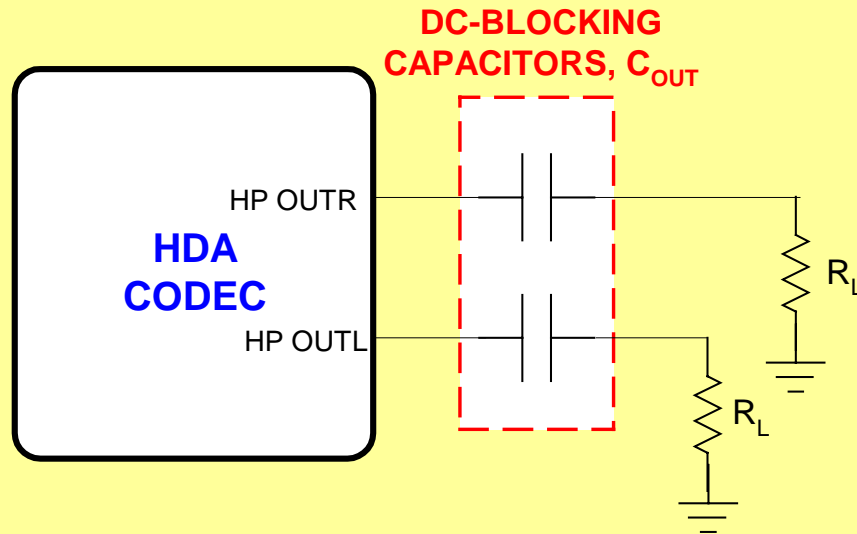
HEADPHONE OUTPUT BIASED AT  $+VDD/2$ .

DirectDrive

Conventional

## System Fails Magnitude Response at Low Frequencies

**CAUSE:** Amplifier DC-blocking capacitor ( $C_{OUT}$ ) and amplifier load resistance ( $R_L$ ) forms a highpass filter with a cutoff frequency ( $f_C$ ) that may be set too high.

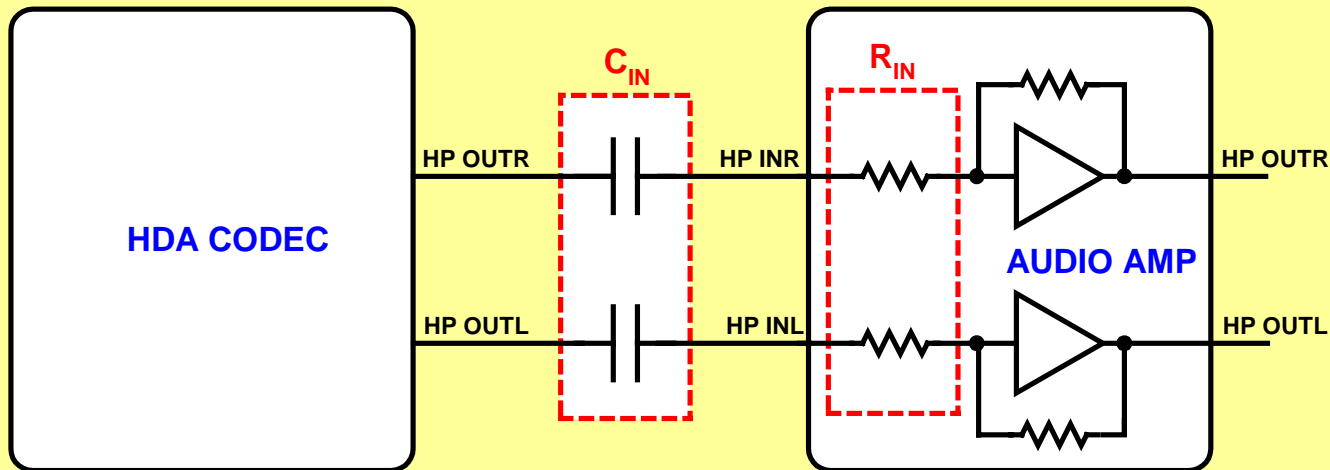


**ACTION:** Select  $C_{OUT}$  such that  $C_{OUT} = 1 / (2\pi R_L f_C)$ , where  $f_C = 100\text{Hz}$  and  $R_L = 32\Omega$  to ensure Windows Vista™ compliance. Be sure to account for the tolerance of  $C_{OUT}$  ( $\pm 20\%$ , typ).



## System Fails Magnitude Response at Low Frequencies

**CAUSE:** Amplifier input-coupling capacitor ( $C_{IN}$ ) and amplifier input resistance ( $R_{IN}$ ) forms a highpass filter with a cutoff frequency ( $f_C$ ) that may be set too high.



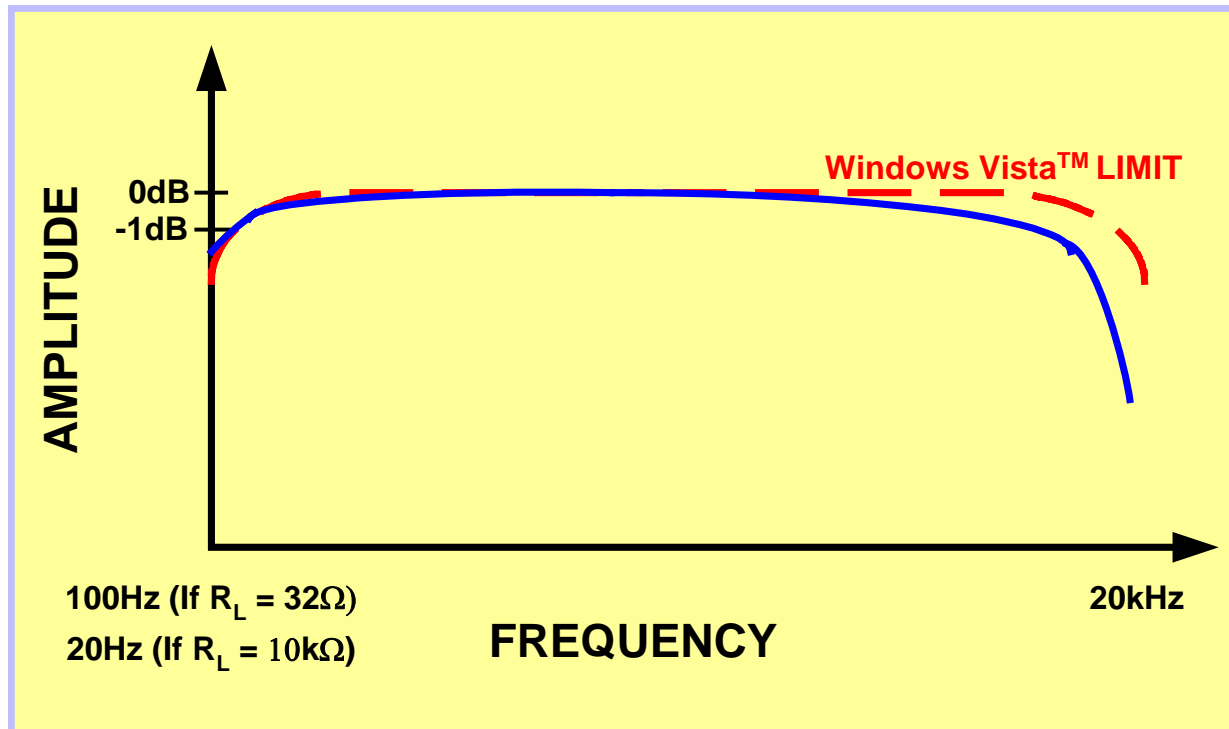
**ACTION:** Select  $C_{IN}$  such that  $C_{IN} = 1 / (2\pi R_{IN} f_C)$ , where  $f_C < 20\text{Hz}$  to ensure Windows Vista™ compliance into a  $10\text{k}\Omega$  load.

Be sure to account for the tolerance of the input-coupling capacitors and the input resistors when selecting components.



# Magnitude Response

Does the audio output port fail magnitude response at high frequencies?

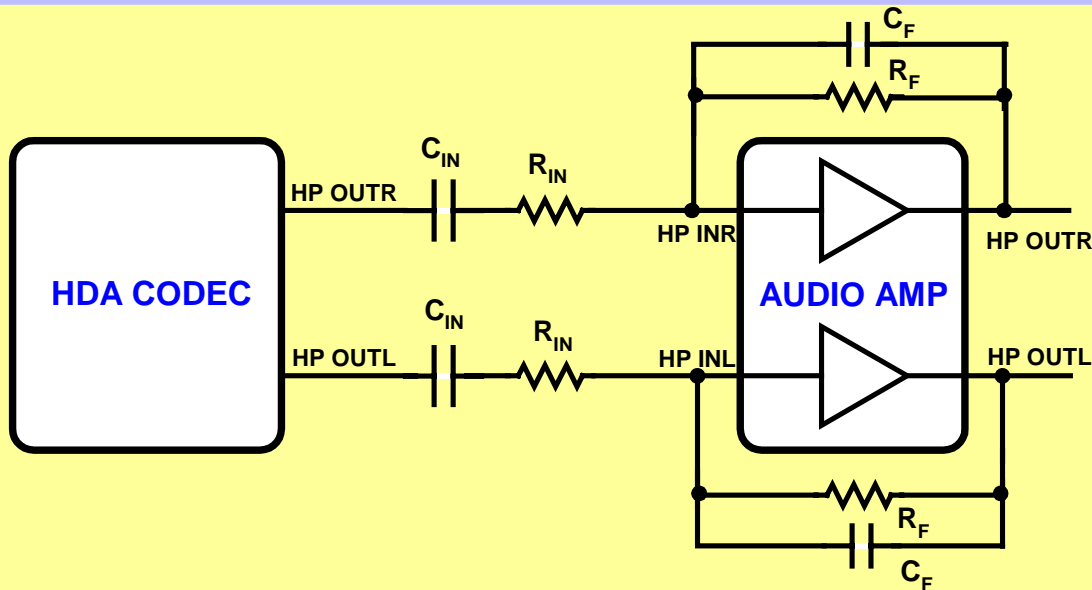


YES

NO

## System Fails Magnitude Response at 20kHz

**CAUSE:** Passive components around the headphone amplifier may be limiting the frequency response.



**ACTION:** Confirm that the feedback capacitors used for noise suppression around the headphone amplifier or RC network does not limit the frequency response.

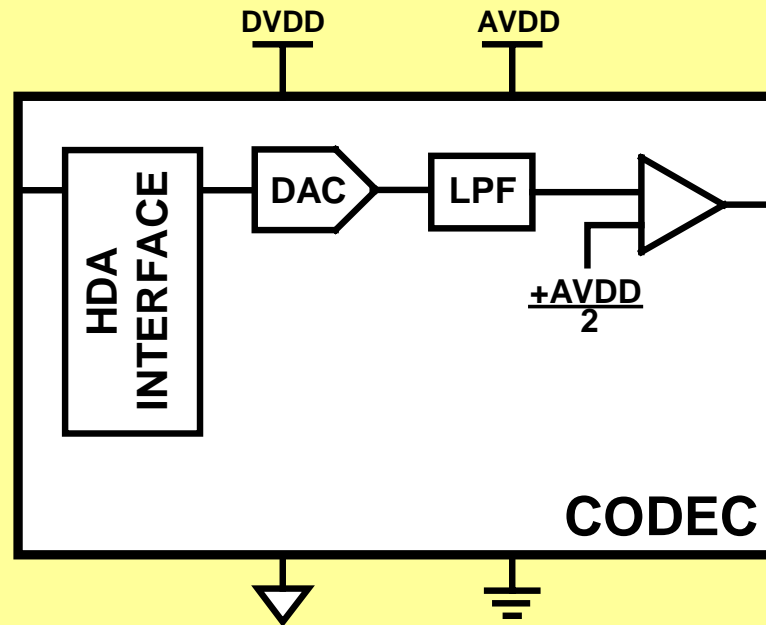
**YES**

Does the system still fail frequency response?

**NO**

## System Fails Magnitude Response at 20kHz

**CAUSE:** The codec's internal lowpass filter may be limiting the bandwidth at 20kHz.



**ACTION:** Ensure codec driver is configured for a 20kHz bandwidth.



# CONGRATULATIONS!

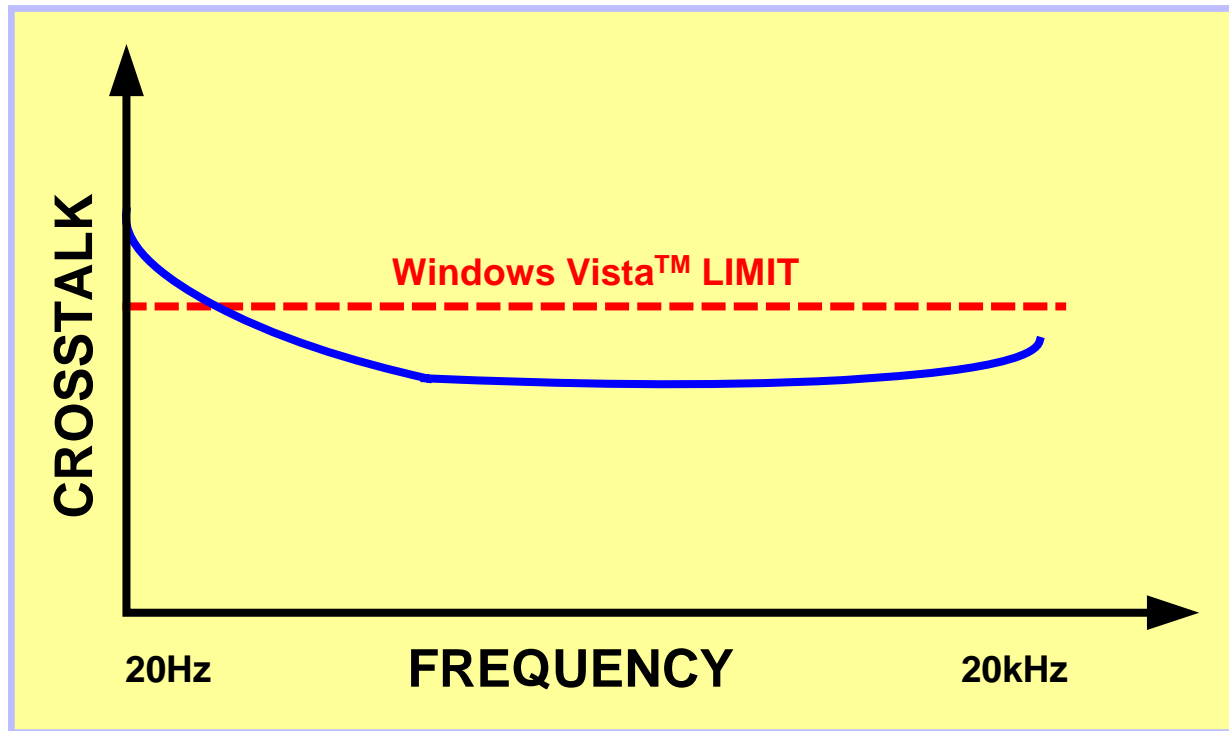
**Your system passes Windows Vista™ frequency-response requirements!**

**Return to  
Main Menu**



## Crosstalk

Does the audio output port fail crosstalk at low frequencies?

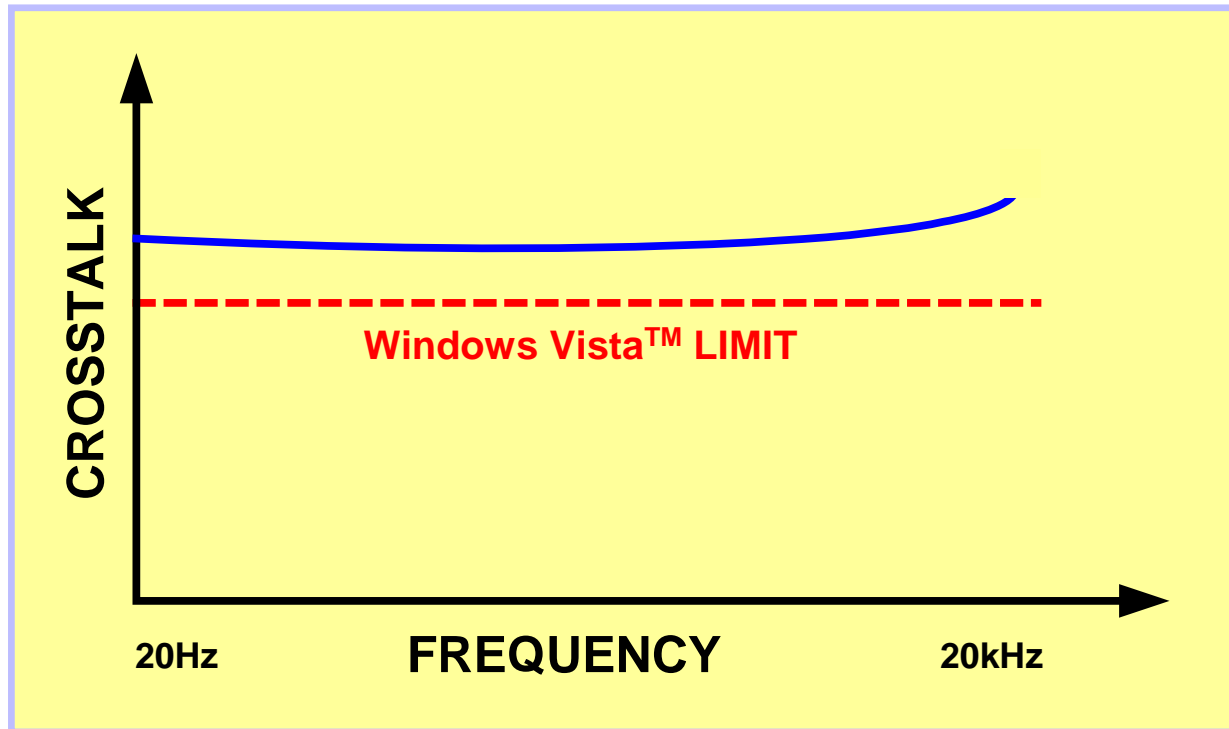


YES

NO

## Crosstalk

Does the audio output port fail crosstalk at midrange frequencies?

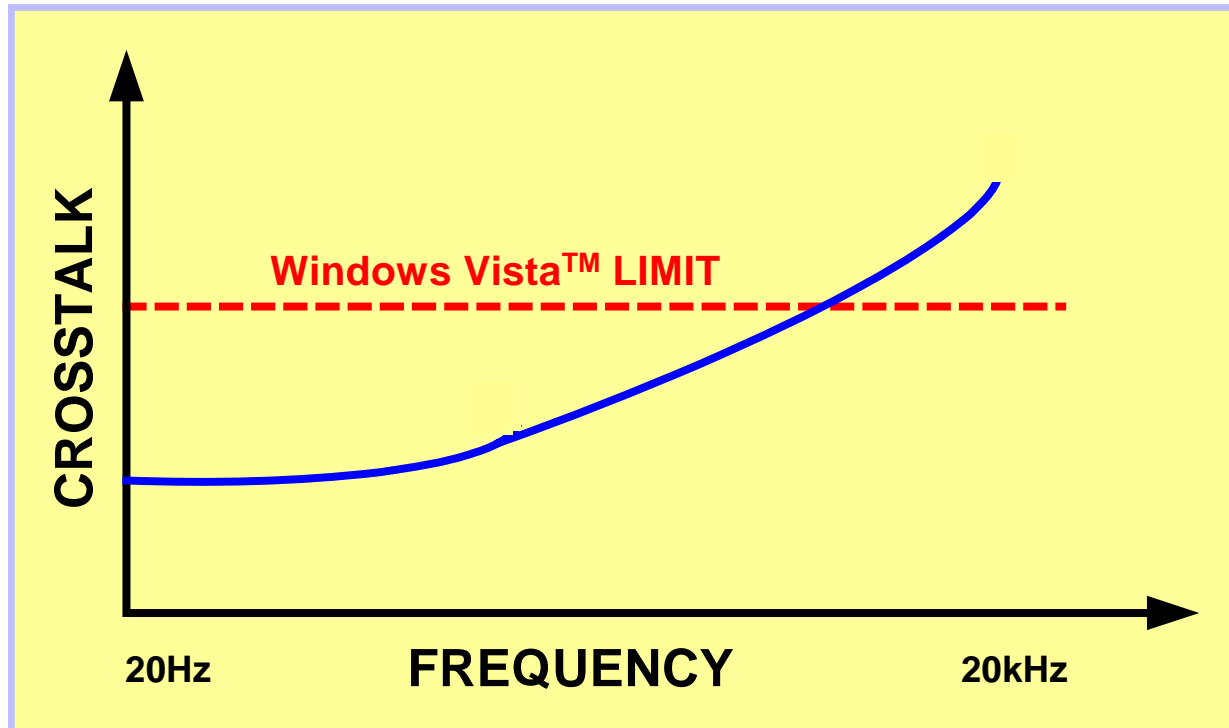


YES

NO

## Crosstalk

Does the audio output port fail crosstalk at high frequencies?



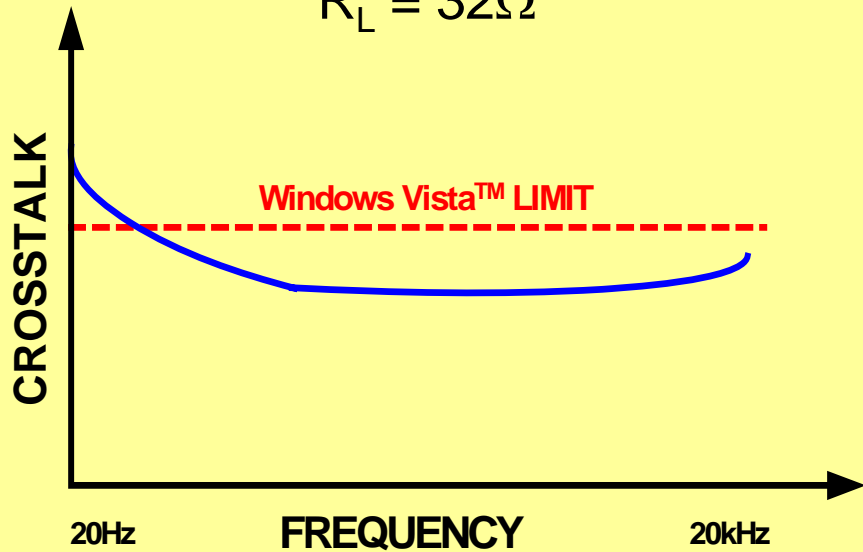
YES

NO

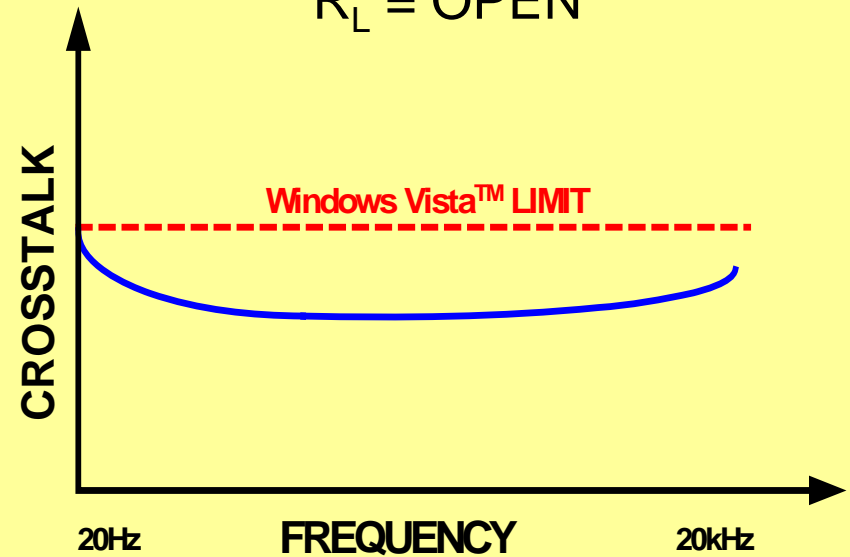
## System Fails Crosstalk at Low Frequencies

Does the crosstalk decrease as the load impedance increases?

$R_L = 32\Omega$



$R_L = \text{OPEN}$

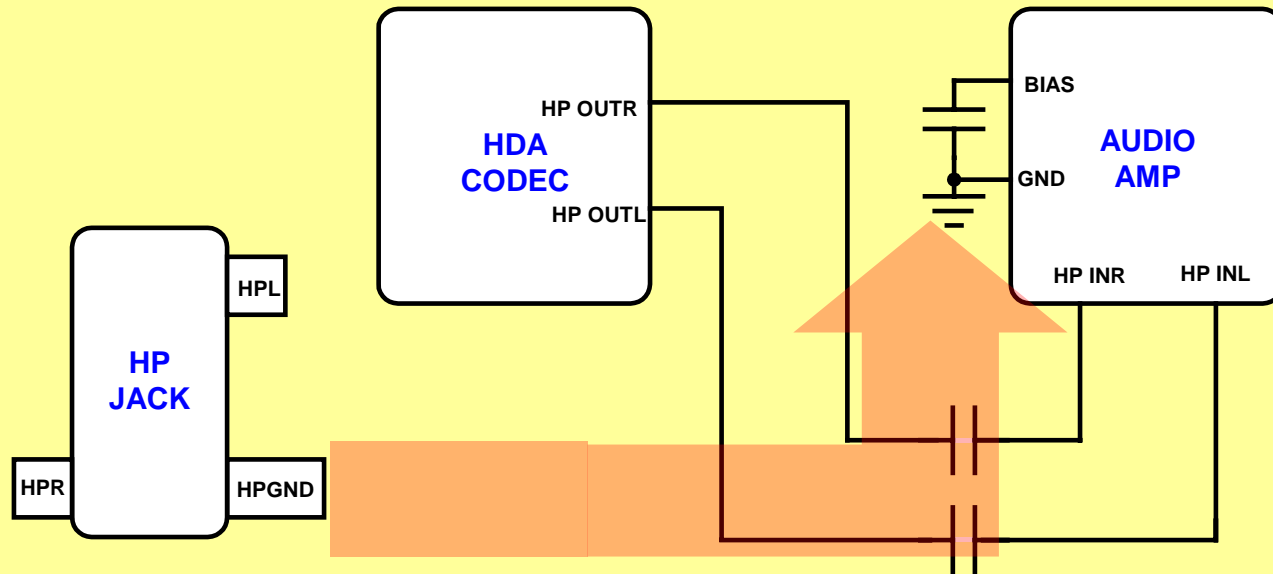


YES

NO

## System Fails Crosstalk at Low Frequencies

**CAUSE:** Ground return path from headphone jack may be corrupting audio performance.



**ACTION:** Ensure headphone-jack ground return path does not flow through sensitive analog ground references.



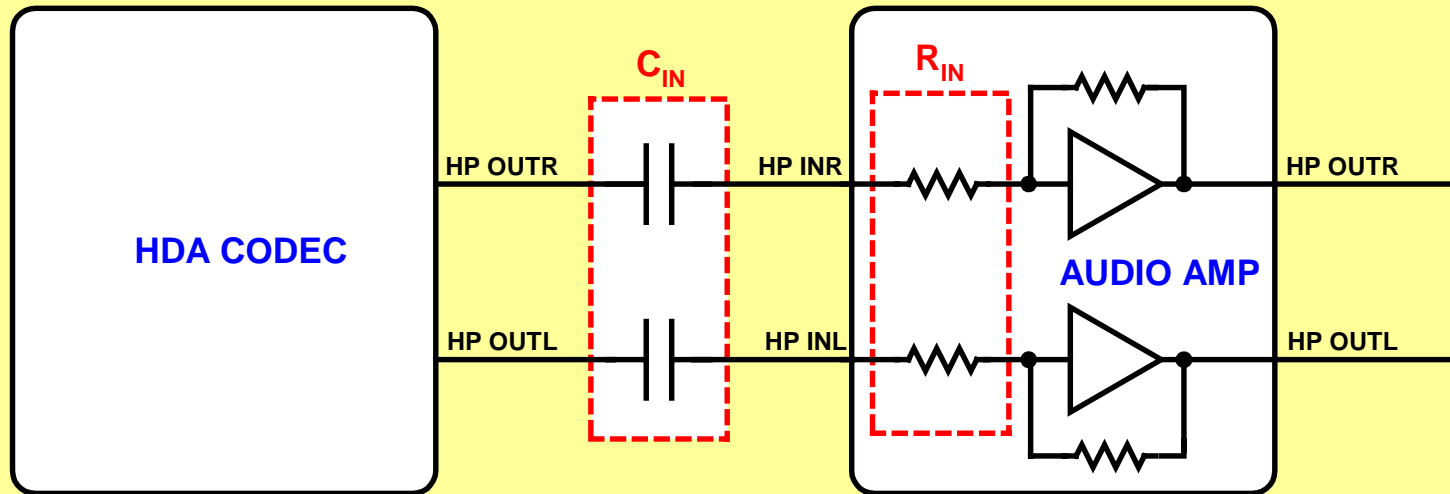
**YES**

Does the system still fail crosstalk?

**NO**

## System Fails Crosstalk at Low Frequencies

**CAUSE:** System noise may be corrupting stereo audio performance.

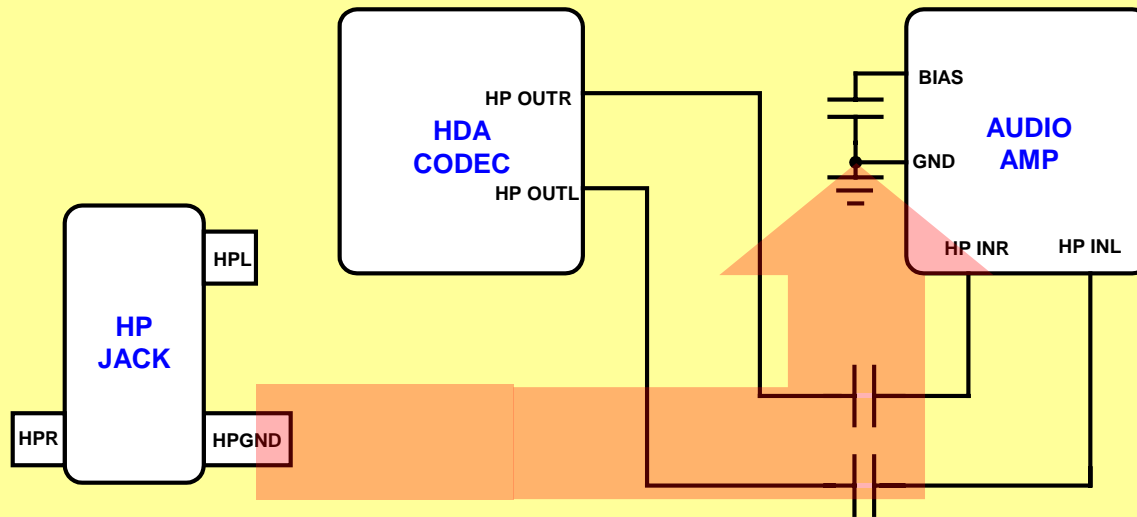


**ACTION:** Confirm system noise such as fan noise, hard disk drive noise, etc. is not coupling into stereo amplifier inputs.



## Crosstalk Fails at Midrange Frequencies

**CAUSE:** Impedance in headphone ground return path may be corrupting stereo audio performance.



**ACTION:** Ensure impedance of headphone ground return path is minimized. Short any series resistors in headphone ground return path. Minimize cable length. Locate audio amplifiers near the headphone jack to minimize ground return path length. Minimize contact resistance to sleeve in headphone jack.

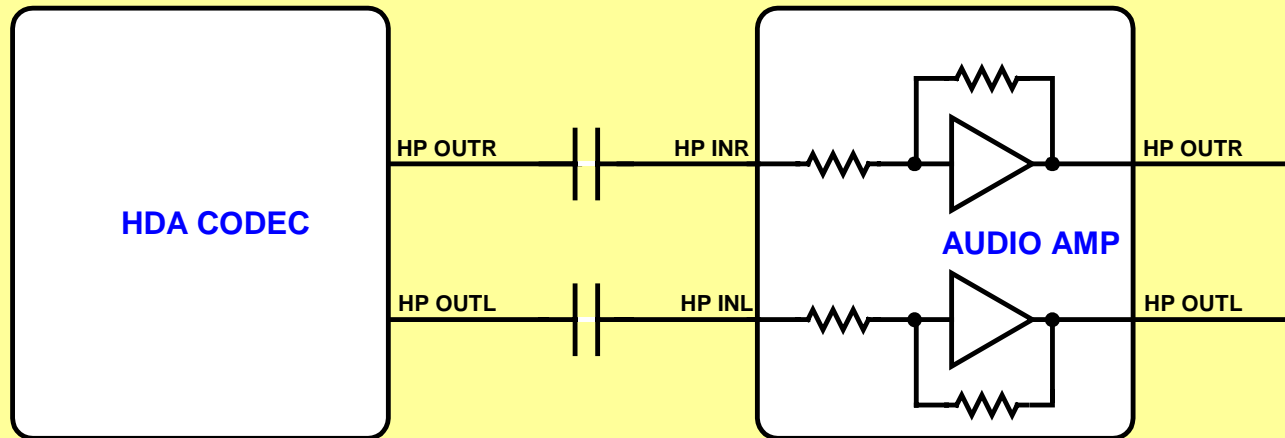
**YES**

Does the system still fail crosstalk?

**NO**

## Crosstalk Fails at High Frequencies

**CAUSE:** Capacitive coupling. High-impedance drive of codec may be corrupting audio performance.



**ACTION:** Ensure codec outputs are configured for low-impedance output drive ( $1\Omega$  to  $2\Omega$ ). If amplifier gain is set by external resistors, ensure series  $R_{IN}$  is located as close to the amplifier inputs as possible.



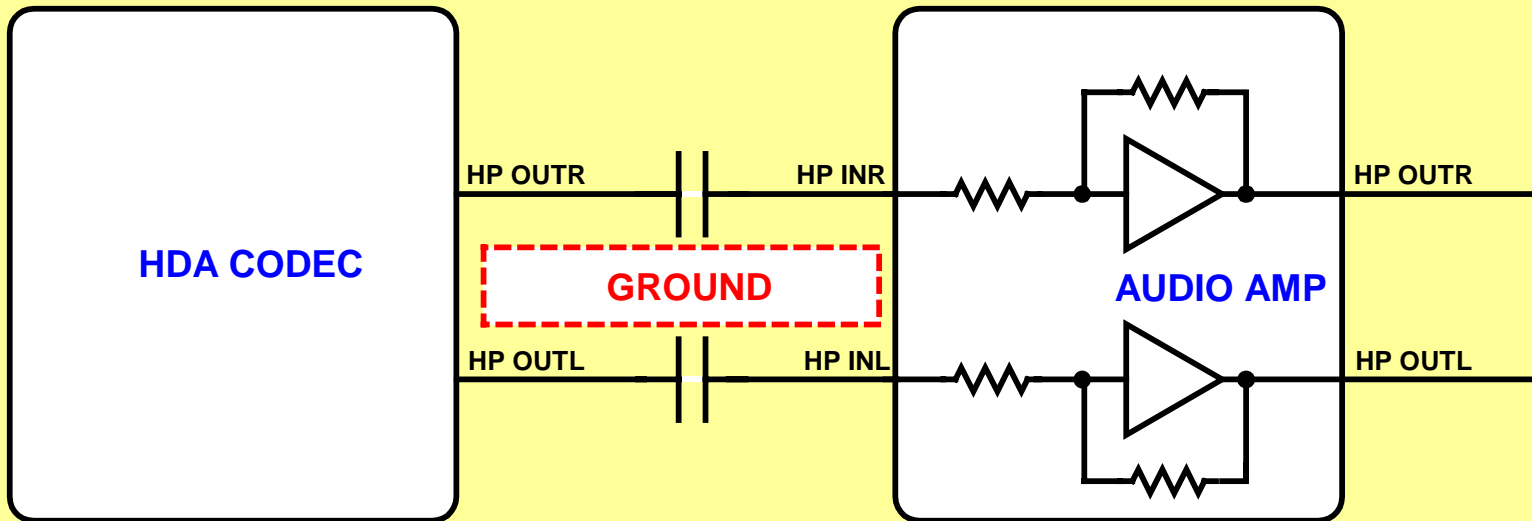
**YES**

Does the system still fail crosstalk?

**NO**

## Crosstalk Fails at High Frequencies

**CAUSE:** Capacitive coupling. Poor separation along stereo amplifier input path may be corrupting audio performance.



**ACTION:** Ensure stereo inputs are isolated by a thick ground trace on the same layer.



# CONGRATULATIONS!

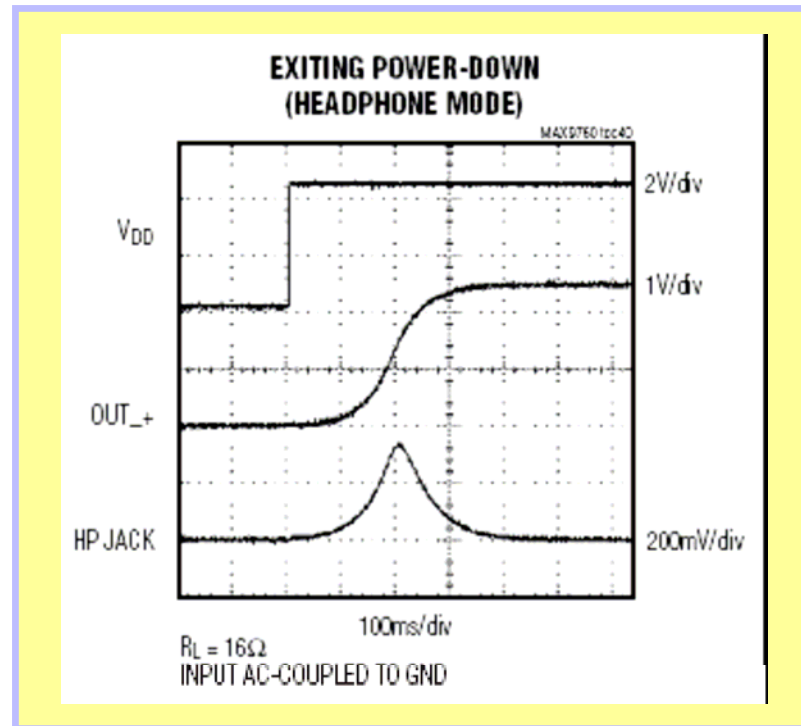
**Your system passes Windows Vista™ crosstalk requirements!**

**Return to**  
**Main Menu**



## Click and Pop

Does the audio output port fail click and pop when exiting shutdown?

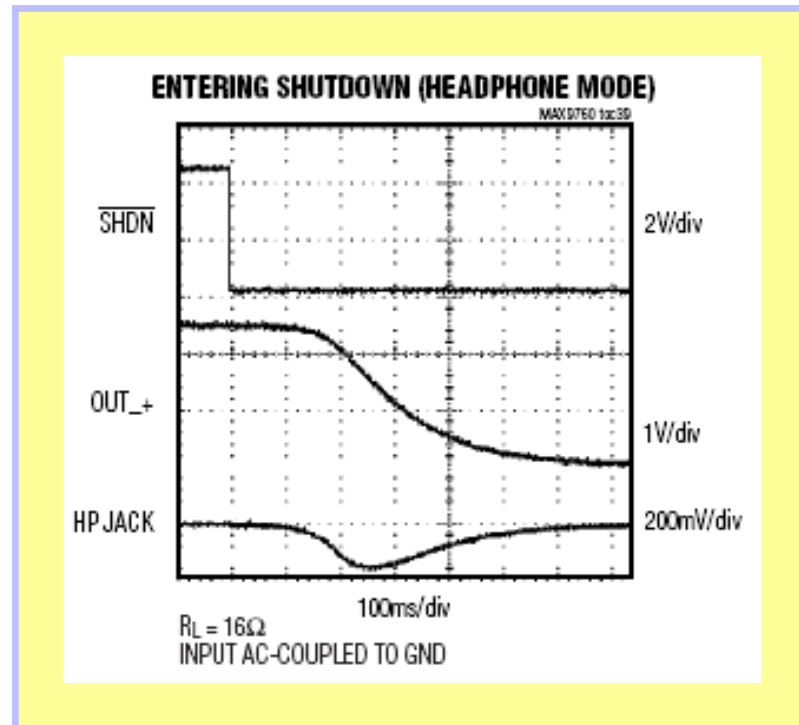


YES

NO

## Click and Pop

Does the audio output port fail click and pop when entering shutdown?

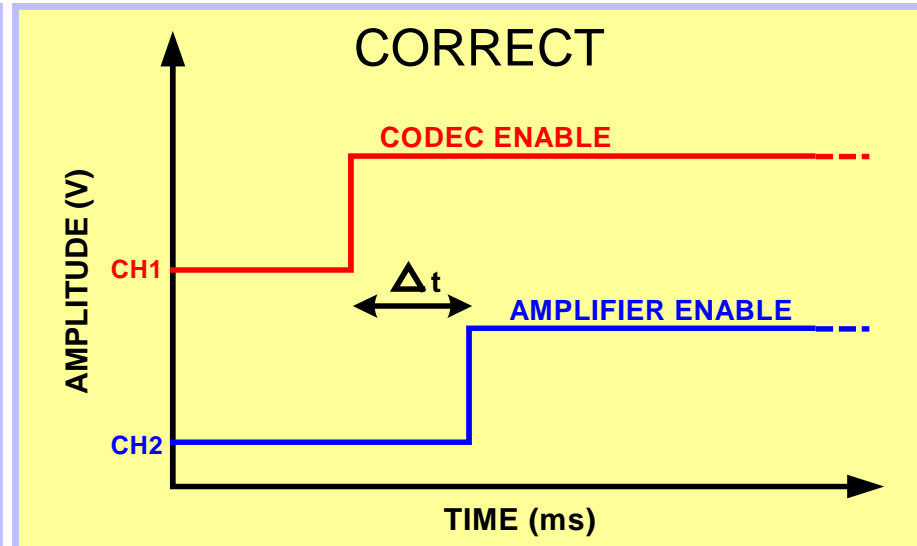
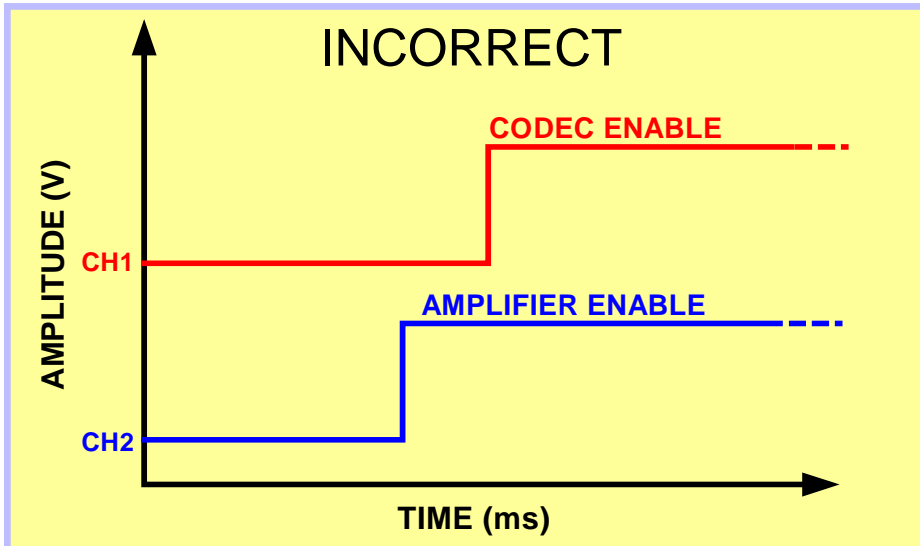


YES

NO

## System Fails Click and Pop When Exiting Shutdown

**CAUSE:** Amplifier is enabled before codec outputs are enabled. The amplifier passes any unwanted clicks and pops to the output.



**ACTION:** Ensure stereo amplifier is enabled AFTER the codec outputs are settled when exiting shutdown at BIOS. Time for codec outputs to settle is  $\Delta t$ .

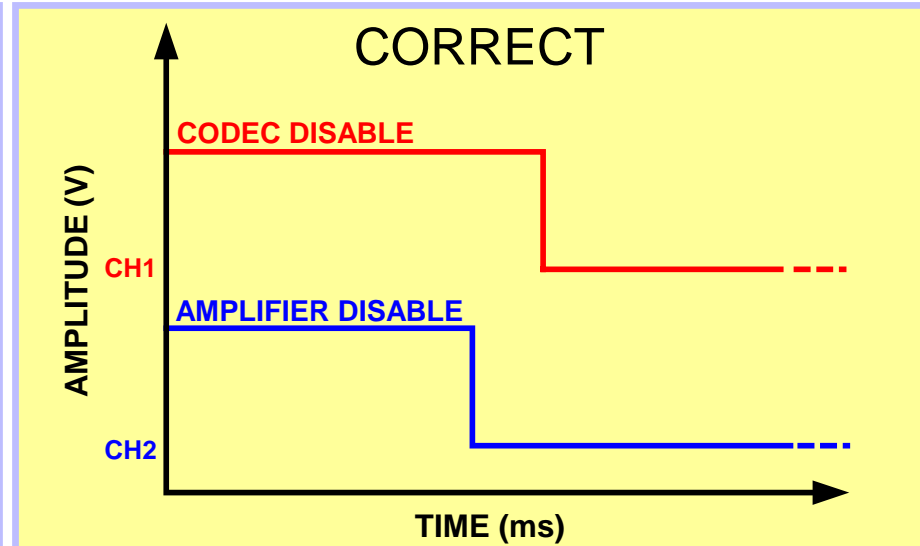
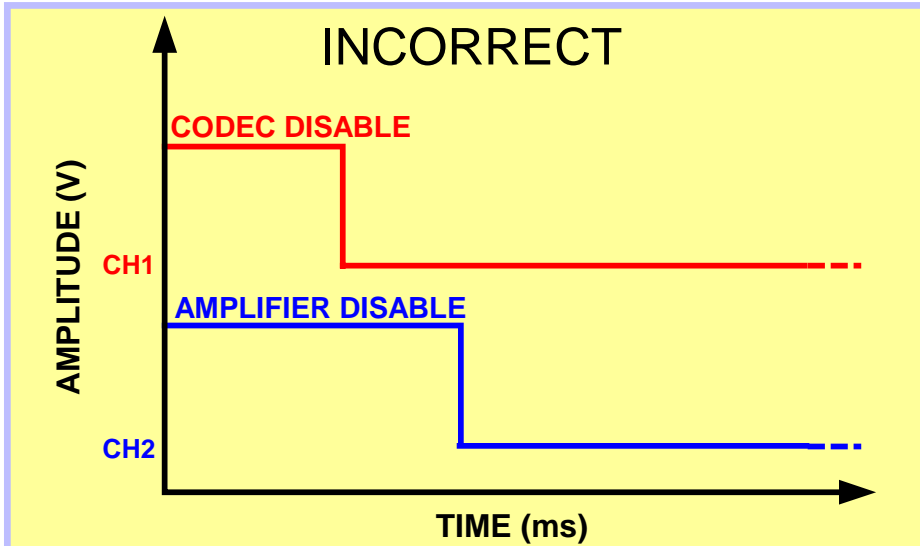
**YES**

Does the system still fail click and pop?

**NO**

## System Fails Click and Pop When Entering Shutdown

**CAUSE:** Amplifier is disabled after codec outputs are disabled. The amplifier passes any unwanted clicks and pops to the output.



**ACTION:** Ensure stereo amplifier is disabled BEFORE the codec outputs are disabled when entering shutdown.

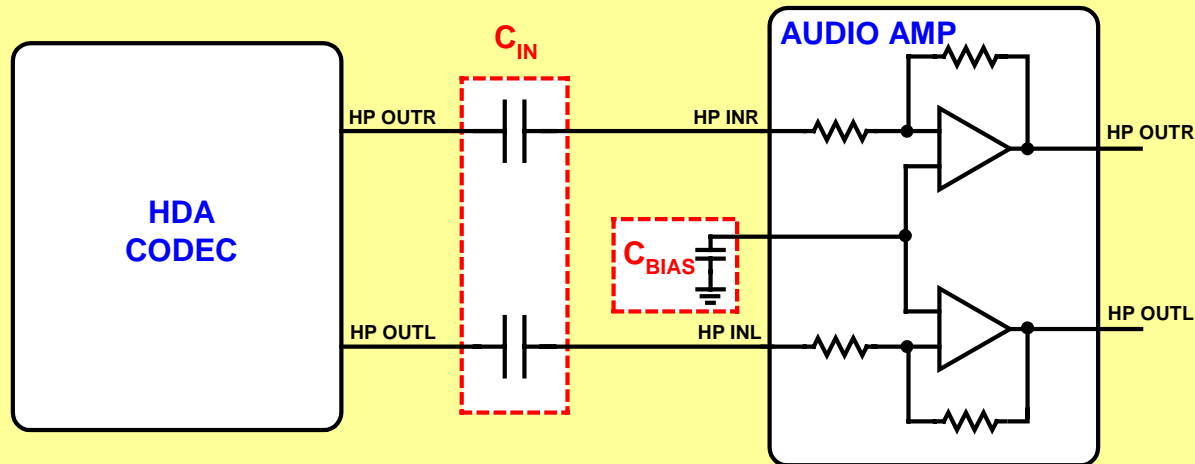
YES

Does the system still fail click and pop?

NO

## System Fails Windows Vista™ Click and Pop

**CAUSE:** Amplifier application circuit may not optimized for click-and-pop suppression.



**ACTION:** Contact the amplifier manufacturer to confirm application support components ( $C_{IN}$  and  $C_{BIAS}$ ) are optimized for click-and-pop performance.

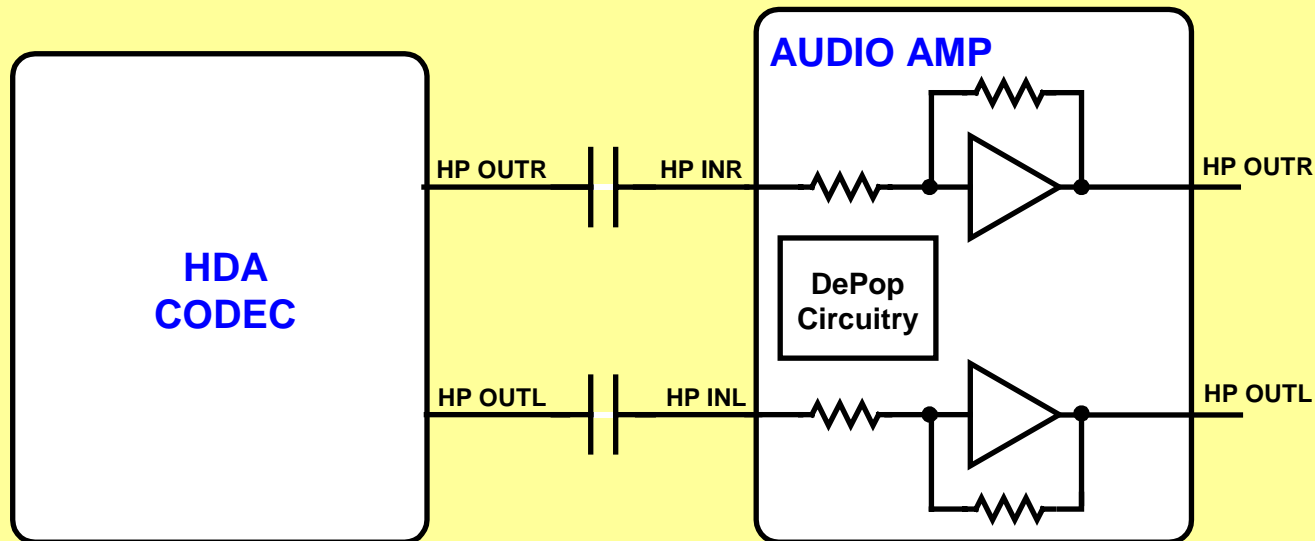
YES

Does the system still fail click and pop while exiting shutdown?

NO

## System Fails Click and Pop

**CAUSE:** Most likely, the amplifier's click-and-pop suppression circuitry is poor.



**ACTION:** Select a Windows Vista™-compliant audio amplifier with good click-and-pop suppression circuitry, or add the MAX9890 at the output of a conventional headphone amplifier to suppress unwanted clicks and pops caused by the DC-coupling capacitor.



# CONGRATULATIONS!

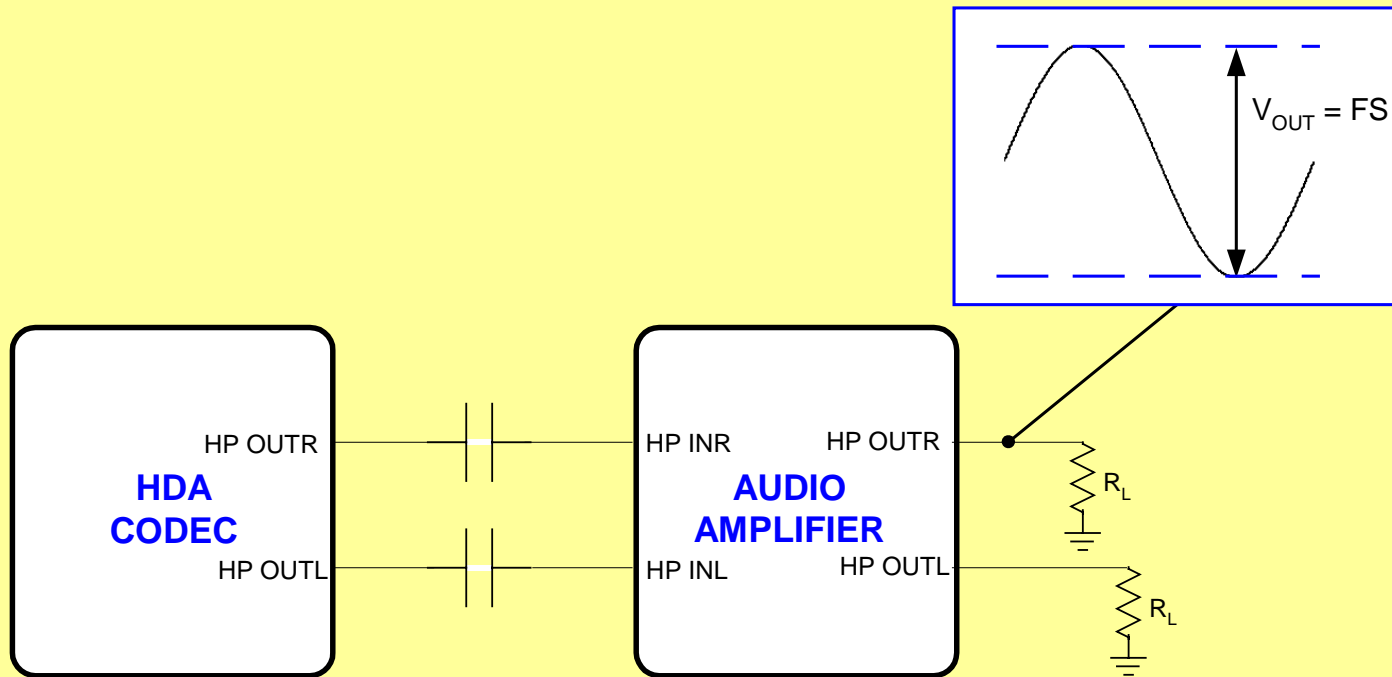
**Your system passes Windows Vista™ click-and-pop requirements!**

**Return to**  
**Main Menu**



## Dynamic Range

Does the system reproduce a full-scale output voltage that is greater than or equal to the minimum full-scale output defined for Windows Vista™?

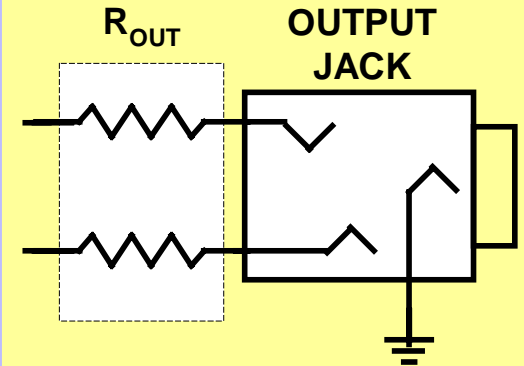
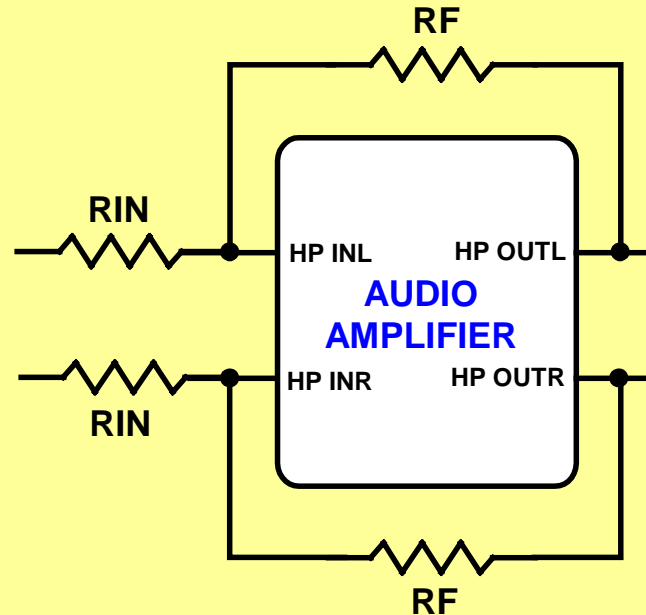
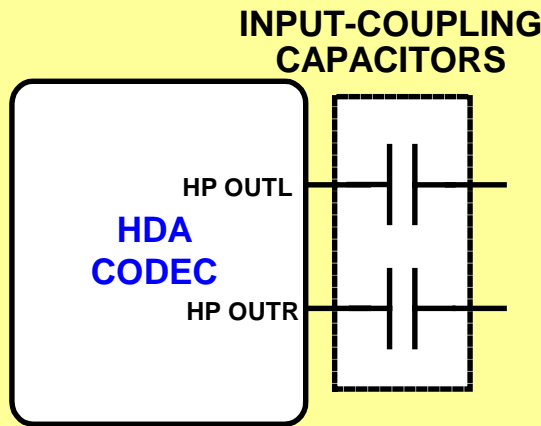


**YES**

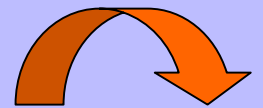
**NO**

## System Fails Dynamic Range

**CAUSE:** Attenuation in signal path.

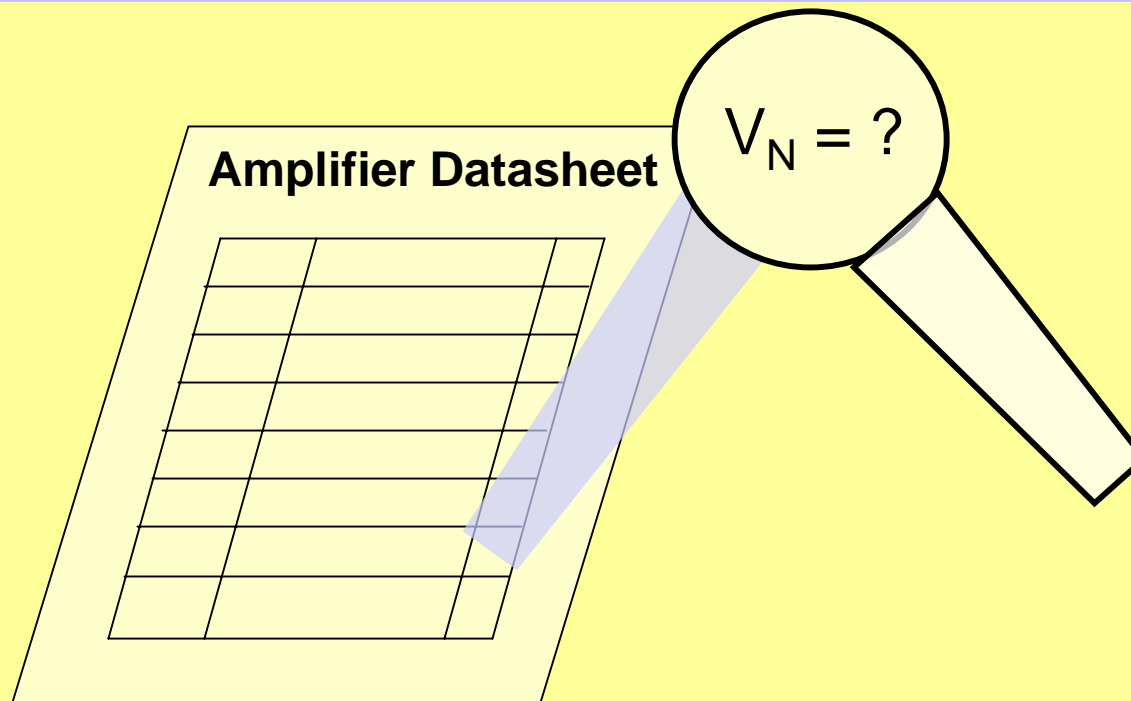


**ACTION:** Ensure the codec outputs a full-scale signal.  
 Ensure the audio amplifier gain is properly configured.  
 Ensure that any series resistors in headphone output path are not severely attenuating the output voltage.



## Dynamic Range

Is the amplifier's noise specification Windows Vista™ compliant?

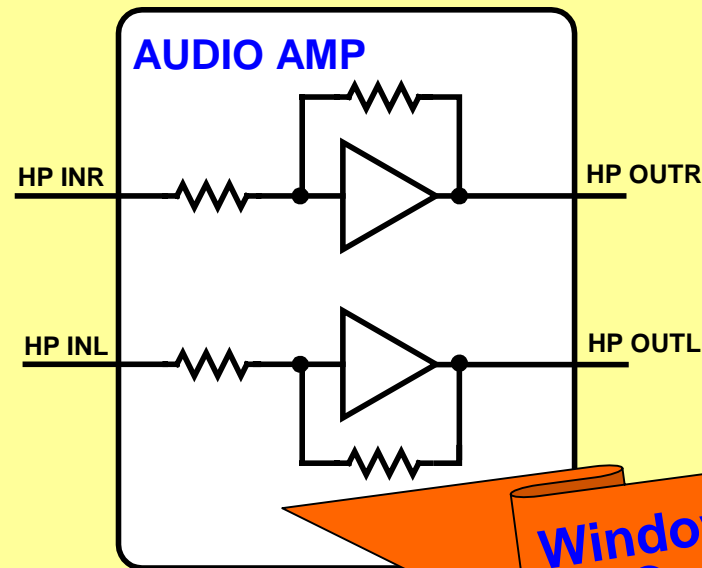


YES

NO

## System Fails Dynamic Range

**CAUSE:** Amplifier's noise performance may not be Windows Vista™ compliant.



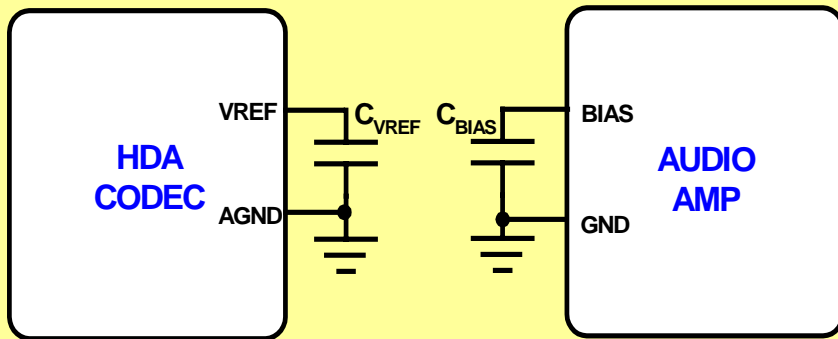
**ACTION:** Select a Windows Vista™-compliant audio amplifier.



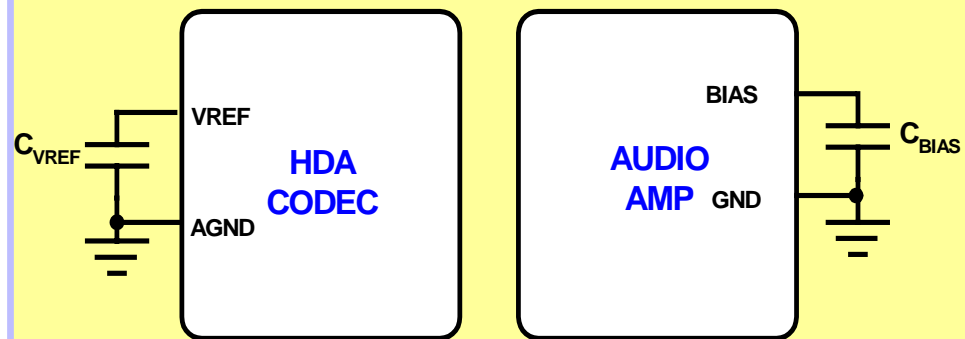
## System Fails Dynamic Range

**CAUSE:** Codec analog ground and amplifier analog ground may not be referenced to the same potential.

### IDEAL



### NON-IDEAL



**ACTION:** Ensure analog ground at codec's  $C_{VREF}$  sits at the same potential as the analog ground at the amplifier's  $C_{BIAS}$ .

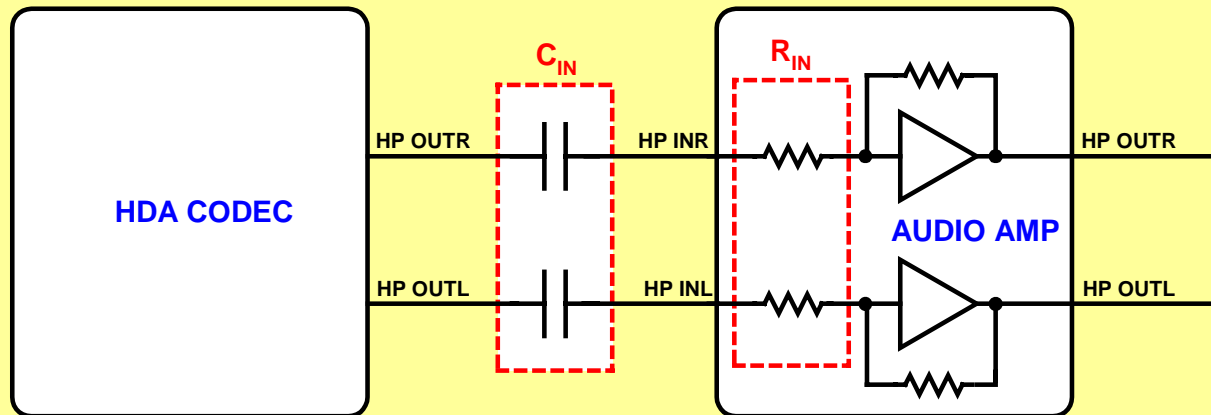
YES

Does the system still fail dynamic range?

NO

## System Fails Dynamic Range

**CAUSE:** Noise may be coupled into the headphone amplifier inputs or onto the headphone amplifier outputs.



**ACTION:** Determine noise source. Ensure headphone amplifier sits on a quiet analog ground plane. Ensure headphone amplifier outputs are routed over a quiet analog ground plane.



# CONGRATULATIONS!

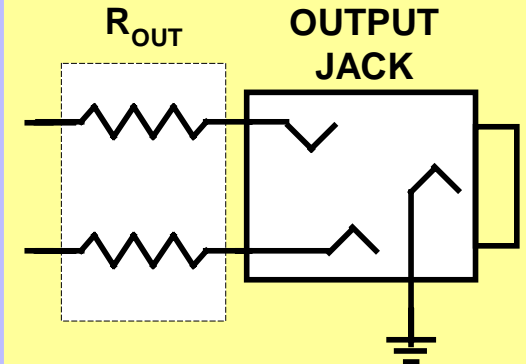
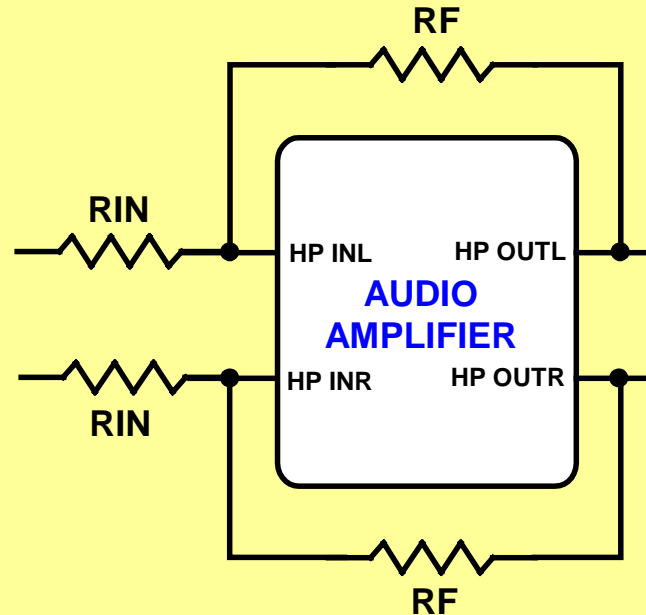
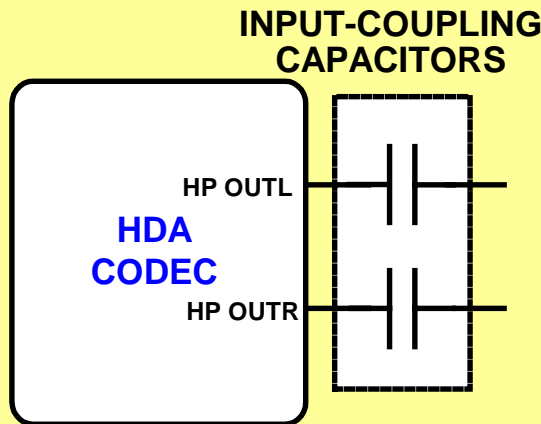
**Your system passes Windows Vista™ dynamic-range requirements!**

**Return to**  
**Main Menu**



## System Fails Full-Scale Output Voltage

**CAUSE:** Attenuation in signal path.



**ACTION:** Ensure the codec outputs a full-scale signal.  
 Ensure the audio amplifier gain is properly configured.  
 Ensure series resistors that may be in headphone output path are not severely attenuating the output voltage.

