Krell iBias Theory of Operation

Abstract

The Krell intelligent Bias or iBias™ system delivers the unmatched sonic performance of Class A operation while minimizing the power consumption and heat generation that a traditional passive Class A design suffers. Krell iBias extends the legacy of Class A Krell amplifiers with an elegantly executed solution to a frustrating problem.

Krell iBias is an innovative Krell circuit which maintains a precise amount of bias current in the inactive half of the amplifier's output stage, the Class B portion in a Class A/B amplifier, to maintain Class A operation. iBias measures the current through the output stage and uses a closed loop controller to maintain the bias current at the correct level.

Operation

The iBias circuit consists of three main sections: the output stage current measurement circuits, the correction amplifiers, and the bias adjustment circuit.
The underpinning of iBias is the unique Krell current mode circuitry deployed throughout the audio signal path. Using similar proprietary current mirror topology, the current measurement circuits continuously monitor the current through the positive and negative halves of the output stage. The correction amplifiers compare these currents to a precision reference value and produce a control signal for the bias adjustment circuit. In the bias adjustment circuit an optically isolated variable voltage reference translates the control signal into a bias voltage which sets up the bias current in the output stage. This closed loop system precisely maintains the bias current at the reference value regardless of temperature or device tolerances.

No Input Signal

In the case of no signal applied to the amplifier, the iBias circuit maintains the output stage bias current at a low quiescent value, similar to a traditional Class A/B amplifier. This results in low heat output and low power consumption which are the benefits of a traditional Class A/B design.

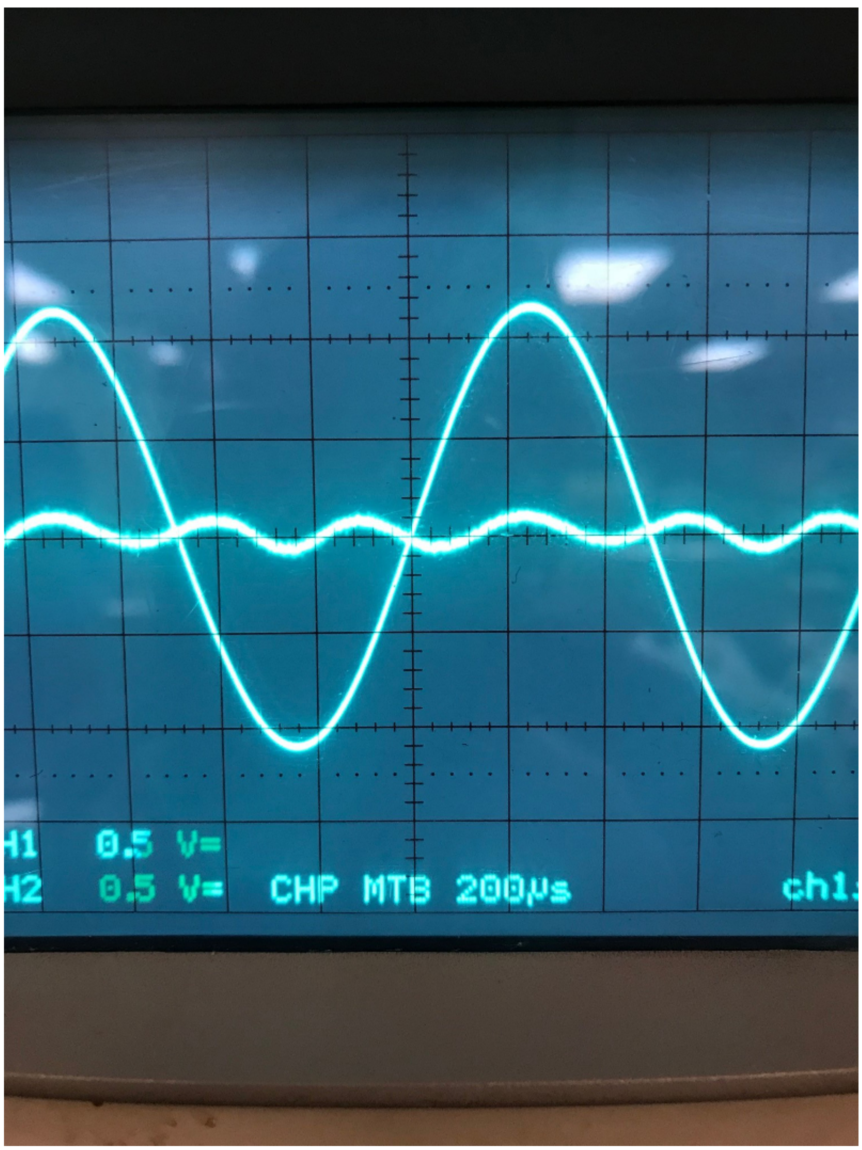
Input Signal Applied

As a music signal is applied to the amplifier, current begins to flow into the speaker load. When the signal swings positive, the positive half of the output stage delivers current to the speaker. During this time the positive output transistors are on and require no additional input from the bias circuit to maintain their conductive state. The negative half of the output stage, however, starts to see the current it needs to maintain its conductive state being shunted away to the speaker load. The iBias circuit sees the current drop in the negative half of the output stage and increases the bias current so that it stays at the reference level.This ensures that the negative half of the output stage is always on, the definition of Class A operation. The same process occurs in reverse during negative swings of the music signal. The result, no crossover distortion.

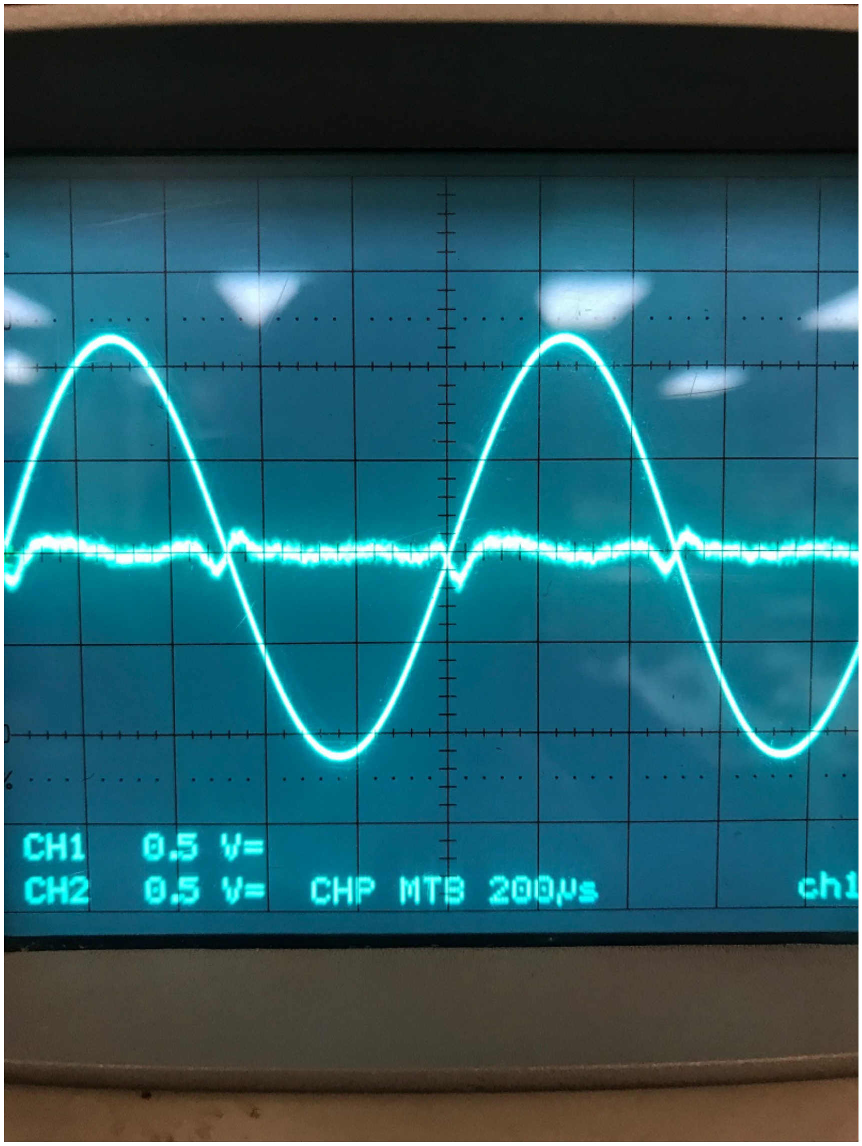
In a traditional Class A/B amplifier one half of the output stage shuts off as soon as the speaker current exceeds the bias current. This occurs very quickly because the quiescent bias current is usually set to a low value in order to reduce the heat and power consumption. At this point you get the crossover distortion inherent in a Class A/B design.

1kHz sine wave, 50 watts, 8Ω load

iBias amplifier with no crossover distortion



Standard Class A/B amplifier with crossover distortion



Efficiency

Since the iBias circuitry monitors the output stage current directly, it provides just enough bias current to maintain pure Class A operation regardless of the speaker impedance, signal level or frequency. This enables the amplifier to effectively vary its thermal “size” based on the listening conditions. If you are listening at moderate levels and require only 10 watts of power an iBias amplifier acts like a 10 watt Class A amplifier, if you require 100 watts of power it acts like a 100 watt Class A amplifier and so on. A passive 100 watt Class A amplifier, for example, running at 10 watts will still be dissipating nearly its maximum amount of heat even though it is only running at 1/10th its rated output power.

iBias is also superior to typical “sliding” bias designs which monitor the input signal in order to adjust the bias current. This design results in either an approximation of Class A operation because it can’t account for variations in speaker impedance or excessive heat dissipation because it must apply enough bias to handle the worst case speaker impedance.