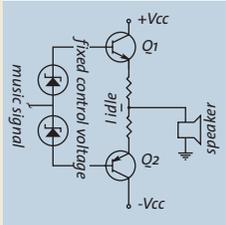


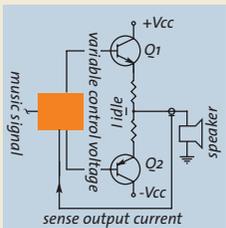
## [ HOW VIRTUAL CLASS A<sup>®</sup> WORKS ]

### CONVENTIONAL CLASS AB OUTPUT STAGE



*I* idle changes with music signal

### VIRTUAL CLASS A<sup>®</sup> OUTPUT STAGE

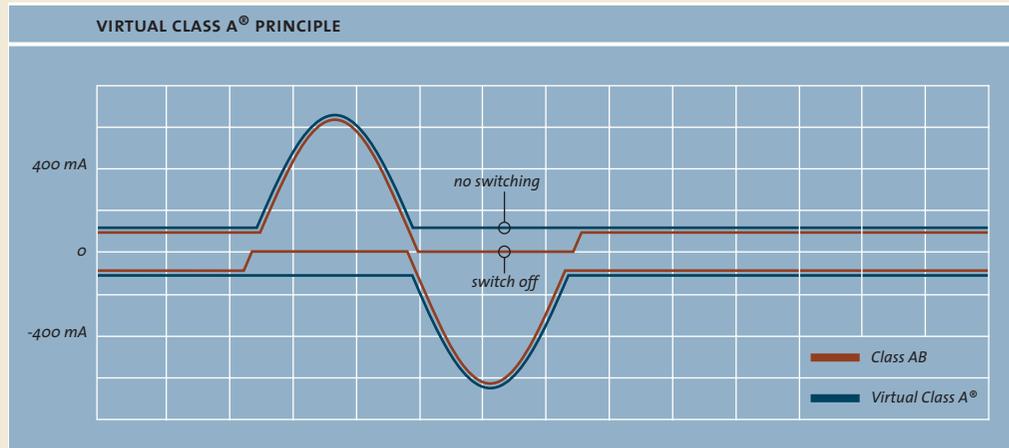


Virtual Class A control circuit

*I* idle is constant

With Virtual Class A<sup>®</sup>, a variable control voltage in tune with the musical signal, is used to set the idle current, so that the idle current is maintained through both output transistors regardless of the output current. This means that both output transistors stay active the entire time.

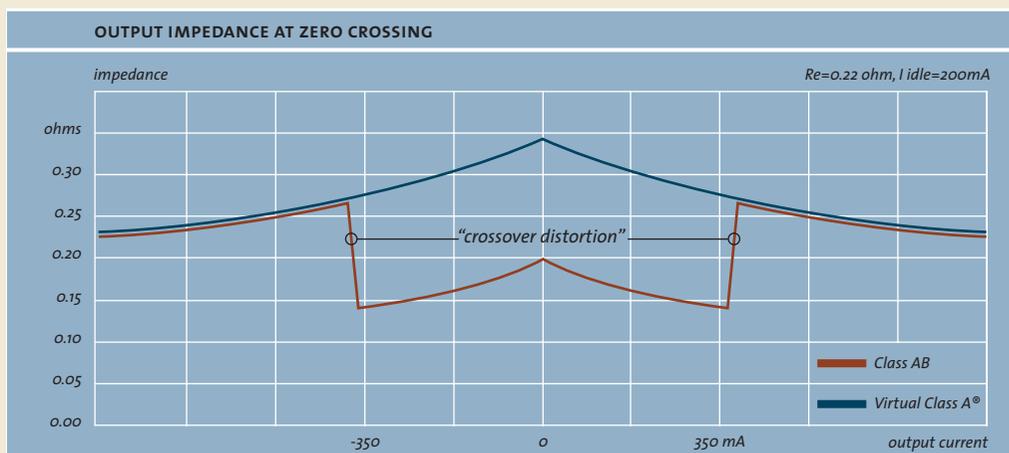
In the normal class AB amplifiers, the negative and positive output transistors are switching in tune with the music signal, when the output current to the speakers is larger than twice the idle current. For example at the figure on the left side, if the idle current is 100mA, transistor Q2 switches off when transistor Q1 delivers 200mA to the speaker with a positive musical signal, and vice versa with a negative musical signal.



In the picture, you see the current through the output transistors when one sinus pulse is delivered to the speaker. It shows that for Virtual Class A<sup>®</sup> (green line) both the negative and positive output transistors remain active the entire time (“no switching”), because the lower edges of the scale are approximately 100mA respectively over and under zero. In Class AB (red line) the output transistors are switched on and off in tune with the music signal.

In Virtual Class A<sup>®</sup> operation the output transistors are always active, therefore they are both always ready to start fast when the music signal changes polarity. It is the same way with automobiles, which also start faster from idle than from the ignition. Because of this faster reaction with Virtual Class A<sup>®</sup>, glitches and other transient currents are avoided.

In class AB operation the output transistors are turned on and off during zero crossing. This switching can generate glitches and transients, which blur small treble details.



With class AB operation, there is a characteristic change in the output impedance from the amplifier when one of the output transistors switches off. This switching introduces an unequal distortion that sounds particularly harsh and unmusical, called “crossover distortion”. This means that several types of feedback must be used to compensate for the crossover distortion, but the feedback itself in some cases sounds even worse than the original distortion because of increased instability (flat Japanese sound). With Virtual Class A<sup>®</sup> the output impedance sequence is significantly smoother, ensuring that the Virtual Class A<sup>®</sup> generates much less distortion.

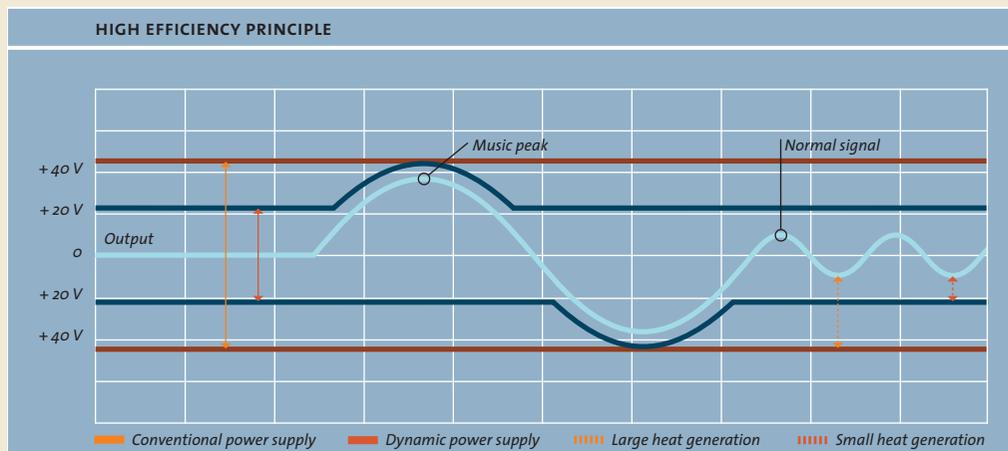


With PA350B, IA350B and PA250B no global feedback is employed and the amplifiers are incredibly stable. Even with no global feedback the distortion is very, very low due to the Virtual Class A® output stage: Less than 0.003% distortion for 4 ohms load up to over 500w of power.

## [ HOW THULE AUDIO REDUCES HEAT GENERATION BY 60% ]

Normally the supply voltage must be around +/-45v to the output transistors in order to deliver 350w power output in 8 ohm load with a balanced output stage.

With IA/PA350B and PA250B the normal supply voltage is, however, only half of that: approximately +/-23v. If the musical signal exceeds approximately 20v the dynamic power supply increases the voltage accordingly, so that the amplifier can deliver the full voltage capacity up to +/-40v.



The picture shows a large music peak output signal and how the supply voltage to the output transistors changes so that the full capacity of 350w output power can be achieved with the dynamic power supply. However, over 90 % of the time the music signal is much smaller even at full power and no change of the voltage supply is necessary. During all this time the power is taken from the lower voltage supply leading to much less heat generation in the big heat sinks.

Another advantage of the “high efficiency” technology is that the output transistors receive much less strain, leading to increased product reliability.

