diyhifisupply®

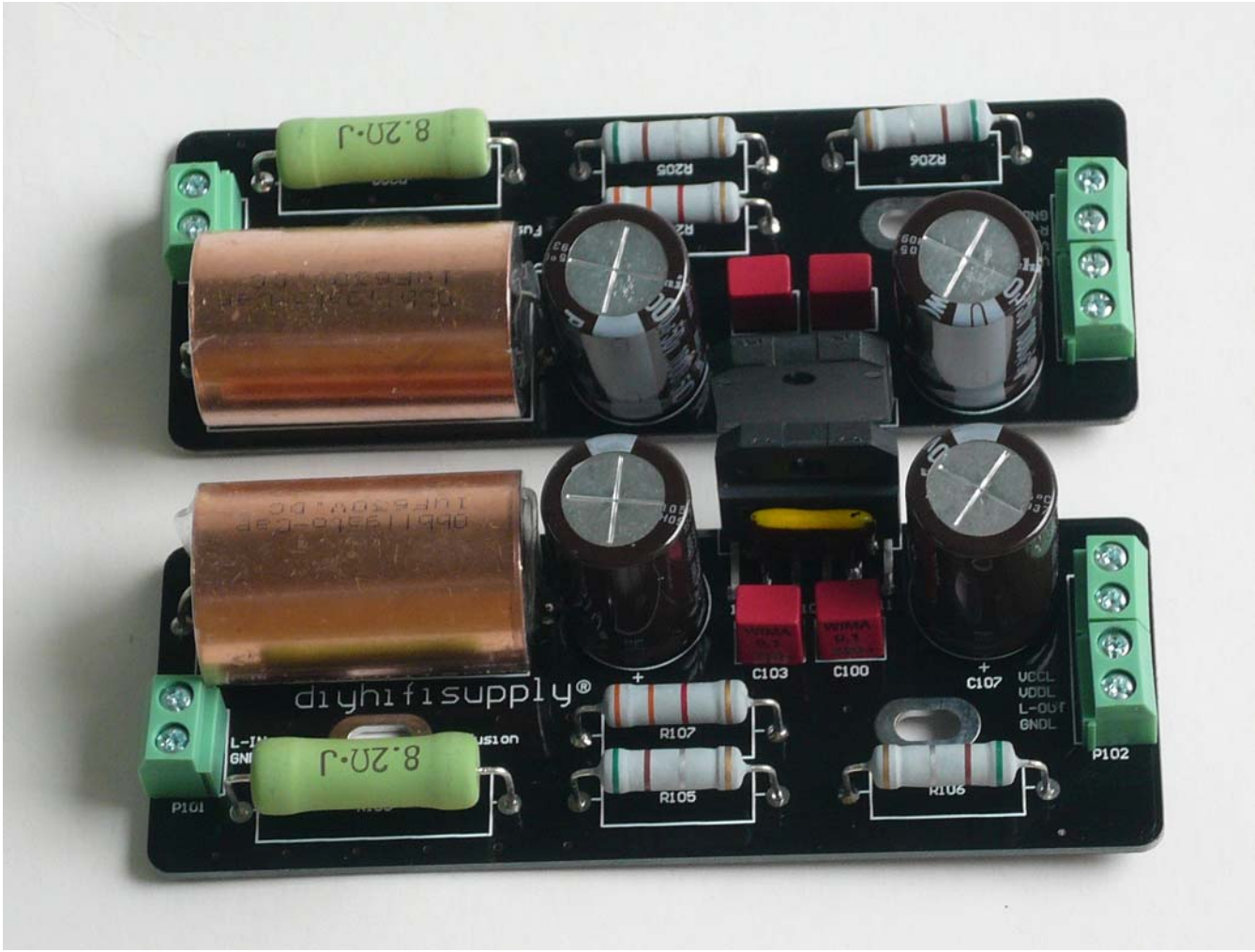
# Fusion Power Multiplier Whitepaper

## Fusion

Pronunciation: \□fyü-zhən\

Etymology: Latin fusion-, fusio, from fundere

Usage: A union by or as if by melting: as a merging of diverse, distinct, or separate elements into a unified whole



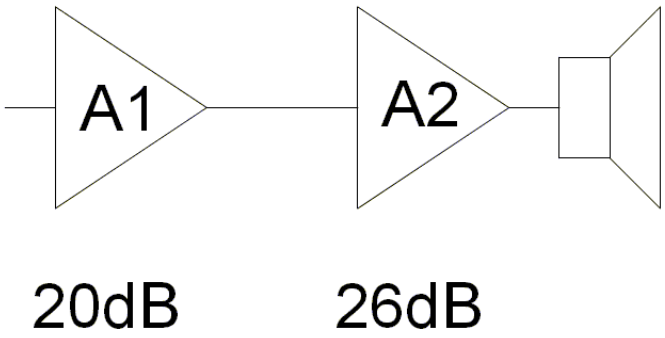
# Fusion Power Multiplier Installation Manual

## *Hybrid Amplifiers*

Hybrid amplifiers have been with us decades. They generally promise to combine (or fuse) the best traits of tube amplification with the best traits of solid state amplification. They attract us with the promise of relatively high power and good bass control while promising tube sound like qualities and minimal idle power consumption (an important consideration in this green age) as well as minimal tube replacement costs compared to a tube amplifier of the same power.

They usually attempt to do so by combining a tube preamplifier with a conventional solid state power amplifier.

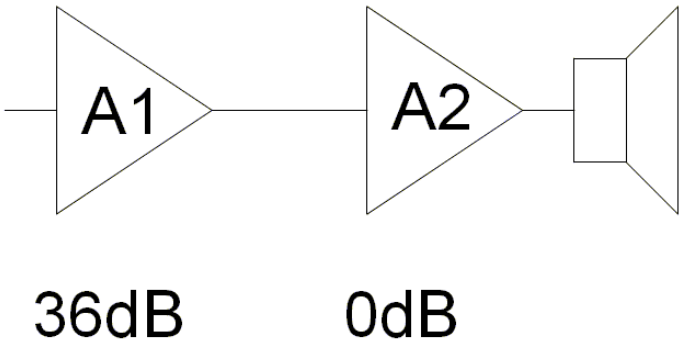
The principle looks something like this:




In this case one has basically merely placed a tube line stage and a solid state power amplifier into one case. Both amplifier sections contribute their own distortions to the final signal. As the solid state output amplifier has not only gain but also the usual Class AB output stage and a negative feedback loop.

So we hear the typical low level distortion (aka crossover distortion[1]) from the solid state amplifier and the high level distortion from the tube stage. Hence such types of hybrid amplifiers tend to combine not only the relative strength of each technology, but also show significantly the weaknesses of both technologies.

Somewhat smarter designers tend to use the tubes to develop the whole gain and just follow this with a transistor output stage. This kind of design was most likely pioneered by Moscode and Counterpoint in the USA. This kind of design looks like this:




Well, at least now the tube stages produce all the gain, while the solid state power stage merely adds current drive to the signal.

However, if this output stage operates in Class AB (and most if not all do), we still experience the low level crossover distortion from the Class AB output stage. And now, as our solid state stage no longer uses any feedback of it's own this distortion is much more noticeable.

To overcome this usually extra tube stages are added negative loop feedback is applied.

The result is amplifier that compares well with conventional high power push-pull tube amplifiers using significant amounts of negative feedback and is in fact often closer in sonic characteristics to an OTL Amplifier, perhaps not surprising as the basic principle is quite similar to an OTL Amplifier.

Some designers (generally not in the commercial arena, but only among DIY Enthusiasts) elect not to address the crossover distortion from the Class AB operation and omit the secondary tube stage and feedback loop. As most of the music listening tends to happen at fairly low levels this kind of scheme can work very well if a significant amount of Class A operation is present in the Class AB operation setting.

Here at diyhifisupply we have experience with all of these approaches to making hybrid amplifiers. Many such designs are worthy applications with fine sound quality. Yet we did ultimately not find ANY of them to be able to match the sound quality of a good single ended tube amplifier.

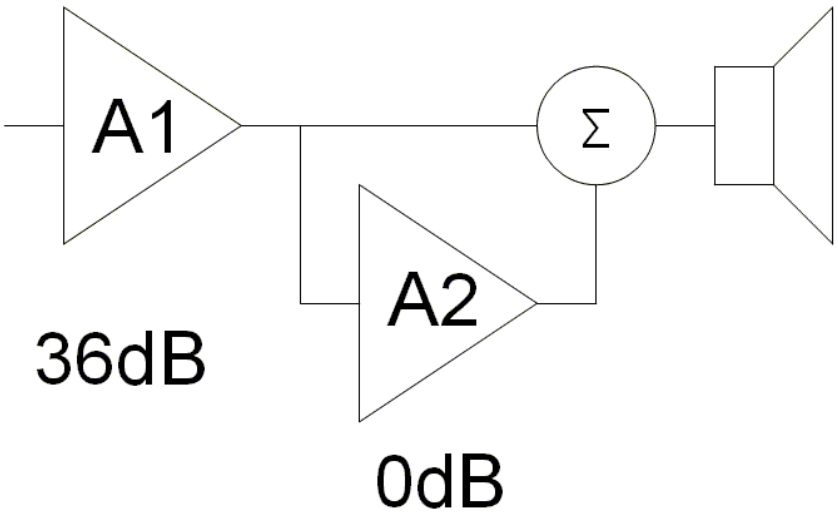
Our search for "A Better Way" led to the technology we have dubbed *Fusion*. Unlike all previous attempts at hybrid Amplifiers the Fusion technology does not daisy-chain amplifier stages using different technologies, it combines them in a new and unique manner.

# Fusion Power Multiplier Installation Manual

## *Fusion Amplifiers*

Clearly, any form of using tube and solid state stages daisy chained in series cannot deliver what can be considered the best of both technologies without the sonic drawbacks.

The solution is as simple as it is ingenious. Instead of letting the tube section of the amplifier drive the solid state section of the amplifier, we let the tube amplifier drive the speaker. In order to "help out" the tube in delivering a lot of current we add a solid state power multiplier, which for every amount of current delivered by the tube adds many time the current.




The Tube amplifier provides all the Voltage gain and a certain amount of the total current to speaker.

The current multiplier can operate in Class AB. The crossover distortion from the class AB operation will simply be compensated by the speaker drawing more current from the tube amplifier section, which at the low levels around zero volt output voltage has fairly large current reserves.

The summing stage shown is a simple passive combiner which combines the currents from the (single ended) tube amplifier and the solid state current multiplier. It also sets the multiplication ratio.

Compared to the classic hybrid amplifiers the Fusion principle has one key draw back. We can no longer just use a simple small signal tube to drive the rest, we must provide a full Amplifier with the ability to provide appreciable power into the speaker.

However the benefits of the Fusion principle are clear and have been shown in repeated listening tests with amplifiers that allow the Fusion power multi. Other than adding extra power the fusion circuit has no appreciable sonic impact, preserving the original sound quality of the tube amplifier section completely intact.

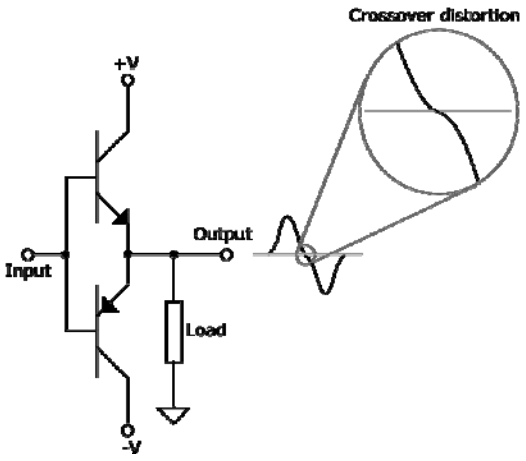
Our first commercial uses a complete 300B Amplifier based on our Lux as the driving tube Amplifier, one can conceive easily other applications. With a small circuit change to adjust the power multiplication ratio for example one could use a single tube plus a transformer of a suitable ratio (perhaps the Russian 6S45 'supertube' with a 4:1 line-output transformer) or perhaps a tube based headphone amplifier. Even a quite low powered OTL Amplifier may serve in the driving seat. The possible application are literally endless.

1) **Crossover Distortion**

**(Excerpt quoted under fair use from: http://en.wikipedia.org/wiki/Crossover_distortion)**

**Crossover distortion** is a type of distortion which is caused by switching between devices driving a load, most often when the devices (such as a transistor) are matched. It is most commonly seen in complementary, or "push-pull", Class-B amplifier stages, although it is occasionally seen in other types of circuits as well.

The term *crossover* signifies the "crossing over" of the signal between devices, in this case, from the upper transistor to the lower and vice-versa. The term is not related to the audio crossover—a filtering circuit which divides an audio signal into frequency bands.



# Fusion Power Multiplier Installation Manual

## *Fusion Module Outline and Specification*

- Operates in parallel with the tube amplifier
- Leaves the sound characteristics of the Tube amplifier intact
- Allows the power from almost any(*) Tube amplifier to be multiplied
- Can deliver up to 65 Watt into 4 Ohm for a single fusion module
- Using four fusion modules can deliver up to 260 Watt into 4 Ohm (**)

Technical Data for single fusion module

- Output Power (<2% THD): 40W into 8 Ohm<br>65W into 4 Ohm
- Distortion at 1W/8Ohm: < 0.3%
- Power Supply Voltage: +/-35V @ 1.5A
- Full Power Bandwidth: 20Hz – 80KHz (fusion module only)

Tested driven by a 300B SE Amplifier from the 16Ohm transformer tap using a Sovtek 300B output tubes unless listed otherwise

*) The tube amplifier should be able to provide at least 16V RMS without clipping when not loaded by a speaker. Normally this is possible from the 16 Ohm Tap for 2A3 and 300B SE Amplifiers and for many tube circuits designed to drive headphones.

**) for 260W into 4 Ohm the Tube Amplifier needs to have a balanced output with at least 32V RMS without clipping when not loaded by a speaker.