

## THE AWFUL TRUTH ABOUT OTL'S

Audiophiles have been either lovers or haters of OTL's for decades. The first OTL's came to life in the Fifties and the design has survived the best output transformers man (manley) could create and solid state amplifiers which have such low output impedances that they make great welding machines (at least there is one good use for them). After the preceding comments you can be sure that the person writing this is an OTL devotee. Yes, that's true, and I would own one even if I did not make them!

A transformer amp drives its load by changing the high impedance of the plates of the output tubes to an impedance low enough for conventional speakers using an inductively coupled transformer. An OTL uses many medium impedance output tubes operated in parallel to get an impedance that, although not perfect, at least can drive the load with a reasonable transfer characteristic. In the early days of OTL's speakers were fairly efficient (90 db) and some were designed with fairly flat impedance characteristics that worked well with OTL's.

With the advent of very low impedance amplifiers (solid state) the designers of speakers simplified their design approach by ignoring the impedance curve, and the result is speakers on the market that present loads as low as 1 ohm, as high as twenty or thirty ohms, and multiple peaks and dips in between. This requires that some care be exercised when trying to match OTL's to specific speaker systems. An excellent article that appeared in The Absolute Sound<sup>1</sup> explores the relationship of speaker input impedance and amplifier output impedance. This article provides a chart that allows any one who can read a speaker impedance curve to predict the ability of most amplifiers to drive most speakers.

The speaker impedance may vary greatly with frequency and several points on the impedance curve must be evaluated before a good idea of the compatibility of the speaker/amplifier interface is obtained. This is a good news/bad news situation because some speakers work very well with OTL's and some make very poor companions.

Let's look at the good news first. The Duntech Princess speaker has two peaks in impedance, one at 7 ohms for 45 cycles and the other at 5 ohms for 650 cycles. The basic curve shows the speaker to have a very flat impedance curve of about 3.5 ohms over most of its range. This speaker coupled with an OTL with an output impedance of 6 ohms makes a good combination.

The maximum sound pressure variation caused by the high impedance OTL is 3 db peak at 45 cycles. Since this is in the room dependent region, this peak cannot be measured under most home listening conditions. The nominal variation is then + 1.5 db at 650 cycles which also is unmeasurable under most home listening conditions. This is obviously a satisfactory match and in fact produces an extremely satisfying combination for home listening.

Another example is the Merlin VSM's. Even though this speaker has a large impedance peak

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<sup>1</sup> Robert Greenberg, Absolute Sound, No. 71, 1995.

at 1800 cycles and a smaller dip at 3500 cycles, the overall response is within  $\pm 2$  db compared to an average impedance of 8 ohms. The real problem with an OTL occurs when the speaker in question falls into the region below 2 ohms at some point in the usable frequency range. Even so, some speakers do this only at extreme high frequencies and still provide a very satisfactory listening experience when coupled with a good quality OTL.

From the foregoing it can be said that OTL's will drive most speakers with a minimum impedance of 4 ohms or higher with only modest frequency aberrations. The flatter the impedance the better the overall response as demonstrated in the case of the Duntechs above. An OTL will seldom mate well with speakers with a nominal impedance in the 2 ohm range or lower. This will require an output transformer or solid state amp.

The compromises mentioned above for satisfactory mating of OTL's to speaker loads may make one wonder why they have such a strong following. The simple fact is that an OTL delivers an analog voltage directly to the speaker voice coil without an intervening air space and inductive coupling. In addition the number of tubes required to get the low output impedance usually allows the amplifier to operate in Class A even at maximum output power.

The most common OTL utilizes the bridge output configuration which electrically looks like two single ended amplifiers operated in parallel. Yes, each channel really is in essence a pair of single ended amplifiers<sup>2</sup>.

To sum it up an OTL is:

- Direct coupled to the load
- Has response to DC
- Is singled ended
- Operates Class A
- Uses tubes, the ultimate analog device
- Has a clean open sonic signature that cannot be bettered by any other type of output stage.

Once you have listened to an OTL for a period of time coupled to a compatible high quality speaker system, nothing else will give you the same sense of musicality and realism.

Joule Electra has developed an OTL output stage that solves the problem of impedance matching. The amps are still direct coupled and the output impedance is continuously adjustable from .5 ohms to 6 ohms. This is accomplished by using local feedback only in the output stage and feedback being adjustable by a potentiometer.



The effect of reduced impedance is very subtle with speakers having a moderately high impedance or well damped internally like a closed box system. With ported speakers and systems with widely varying impedance characteristics the results are a dramatic improvement in overall performance of the amplifier/speaker combination.

At the 0.5 ohm level the VZN-100 exhibits excellent speaker control on the level of the best transformer designs. This is accomplished while still retaining the sonic beauty of the OTL direct coupled output stage. Yankee Audio is working with a pair of our new 160 watt monoblocks to drive their fine planar speakers. These are identical to the Joule Electra smaller amps but with 8 output tubes per side instead of six. We will probably have our development program complete by mid summer and look forward to showing with them at the 1998 CES.

In the meantime call us for the names of audiophiles who are now using this fine amplifier. They will be glad to tell about their experiences.

Best regards,

Jud Barber