Tube DAC Toroid Power Transformer Kit Assembly Instructions

July 18, 2000

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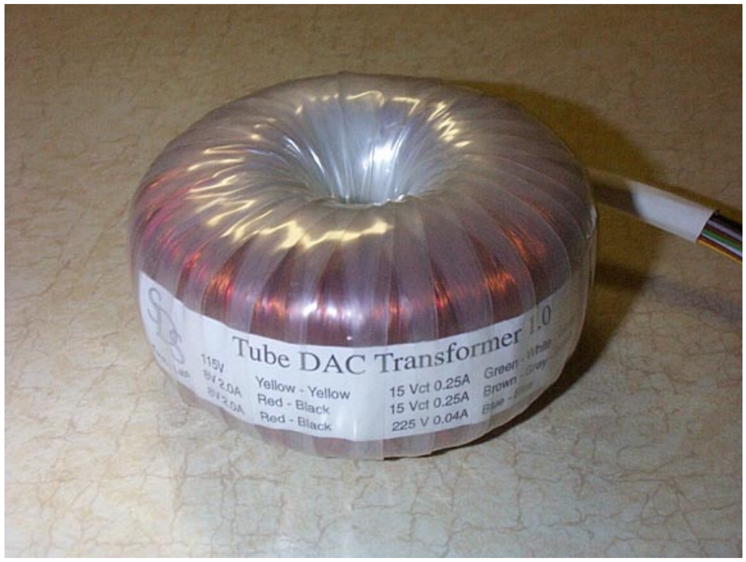

Figure 1: Completed Tube DAC Transformer

Introduction:

The Tube DAC design requires quite a few different transformer secondaries to power all the varieous power supplies. These different windings can be supplied using several transfrormers or can be wound onto one single transformer. Toroid Corperation of Maryland has a custom design for the analog side of the DAC and another toroid transformer can power the digital side. These transformers work quite well, but are expensive. A more cost effective solution is to buy a toroid kit (also from Toroid Corp. of Maryland), and wind whatever secondaries are needed onto the core. The kit currently costs $27.00, and consists of a toroid core with the primary (110 volt only) wound on it, a mount kit, and an insulating outter wrap tape. The user has to supply the needed secondary wire.

What is saved in cost, is made up for in labor. The complete construction takes about 4 hours or so. Most of this time is adding the high voltage winding. Due to it's doughnut shape, each winding must be passed through the center. This is done by using a shuttle. Hand cramps aren't all that unusual either. However these kits are really very nice. The secondary wire spools should contain enough wire to complete several transformers. The transformer kits are really great for tube projects, a transformer with exactly the windings need can be made cheaply.

The toroid transformer kits are sold in five sizes, 80 VA, 200 VA, 400 VA, 700 VA, and 1400 VA. The 80 VA kit is more than enough for the Tube DAC.

Company Info:

Toroid Corperation Of Maryland
6000 Laurel - Bowie Road
Bowie, MD 20715-4037

Voice: (888) 2-Toroid
Voice: (301) 464-2100
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Design Specifications:

Tube DAC transformer secondary target values:

B+:	250 V @ 0.04 A
Filament 1:	8 V @ 2 A
Filament 2:	8 V @ 2 A
Analog:	15 Vct @ 0.25 A
Digital:	7.5 Vct @ 0.25 A

Total: 49.5 VA

80 VA transformer Specifications:

Current Density (max):	2.4 A/mm^2
No Load Volts per Turn:	0.187 V
Full Load Volts per Turn:	0.15 V
Total Copper Area:	160 mm^2
Length of 1 turn:	0.42 Ft.

$$\frac{\text{Winding Current}}{\text{Current Density}} = \text{Wire Crossection}$$

$$\frac{\text{Winding Voltage}}{\text{Volts Per Turn}} = \text{Number Of Turns}$$

Number of Windings * Number Of Turns * Wire Crossection = Copper Area

Number of Turns * Length Per Turn = Wire Length

Filament Windings:

$$\frac{2\ \text{A}}{2.4\ \frac{A}{mm^2}} = 0.833mm^2$$

18 Gauge Wire is 0.823 mm^2

$$\frac{8\ \text{V}}{0.17\ \text{V/turn}} = 47\ \text{turns}$$

2 * 47 * 0.823 = 77.36 mm^2

47 * 0.42 = 19.74 ft. per winding

B+ Windings:

$$\frac{0.04\ \text{A}}{2.4\ \frac{A}{mm^2}} = 0.017mm^2$$

32 Gauge Wire is 0.039 mm^2

$$\frac{225\ \text{V}}{0.17\ \text{V/turn}} = 1324\ \text{turns}$$

1324 * 0.039 = 51.36 mm^2

1324 * 0.42 = 556 ft.

Low Voltage Windings:

$$\frac{0.25\ \text{A}}{2.4\ \frac{A}{mm^2}} = 0.104 mm^2$$

26 Gauge Wire is 0.129 mm^2

$$\frac{7.5\ \text{V}}{0.17\ \text{V/turn}} = 44\ \text{turns}$$

4 * 44 * 0.129 = 23 mm^2

44 * 0.42 = 18.5 ft.

Total Copper Area:

77.362 + 51.36 + 23 = 152 mm^2

This is close, and means that the final insulating wrap will be a bit of a pain.

Construction:

The first thing needed is to construct the transformer is a shuttle to wind the secondary wire onto. Figure 4 shows an oak shuttle; the ends are notched on each end to hold the wire. The shuttle is slightly longer than 6 inches, thus each loop around the shuttle is about a foot.

The largest gauge winding are wound first, in this case that is the filament windings. Figure 2 shows both filament windings on the toroid core. Both filament windings can be would together, which makes for a neater wind, and saves time. The two wires can be measured out on the ground and wound on the shuttle. It's a good idea to measure out extra wire. After the filament wire is carefully wound on the core, the ends of the copper wire can be sanded and insulated wires can be soldered to the copper enameled wire. Small pieces of heat shrink tubing insulates the solder joints nicely.

The low voltage center tapped windings are actually two windings that are joined together in the transformer. These four windings can all be wound on the core together, although keeping the ends straight can be tricky. It's easier to wind the four windings in two pairs. The start of one wire is attached to the end of the other wire, this is the center tap. This procedure is repeated for the second low voltage winding. The center taps and winding ends are soldered to color coded insulated wires, and the solder joints are insulated with heat shrink tubing. Figure 3 shows the low voltage windings wrapped on the core and the insulated wire added. Note the quarter added to show the transformer size.

The b+ winding is wound on last. The wire is much too long to roll out and measure on the ground. Counting wraps on the shuttle is the easiest way to estimate the length of the wire. The b+ will take a lot of winding, find a comfy chair. Figure 4 shows the filament winding on the transformer and the shuttle used for this transformer.

All the windings should be uniformly spaced around the core as much as possible. They should be wrapped tightly and overlap as little as possible. The b+ windings will totally cover all the other windings. Rather than count the number of turns for the b+ winding, it's easier to plug the transformer in and measure the b+ winding voltage from time to time when winding it. This is done by carefully scraping off the enamel on the wound end of the wire on the transformer, and carefully scraping the end of the wire on the shuttle. The coil on the shuttle will not effect the voltage reading.

Figure 4 shows the completed windings, and wires dressed and ready for the insulating wrap. The wrap is applied in much the same way as the secondary windings. The instruction book supplied by toroid corp recommends two layers of insulating tape. It is pulled tight after each turn. The completed transformed is should in Figure 5. Note the label showing the winding wire color code on a label wound under the top layer of insulating tape.

Conclusion:

The toroid kit is a very cost effecting way to build a transformer that contains all the necessary windings used with the Tube DAC. It is time consuming, and can be frustrating, but does work well. After the user gets used to making power transformers from these kits, they represent an easy and cheap way to get the exact power and voltages needed for other projects.

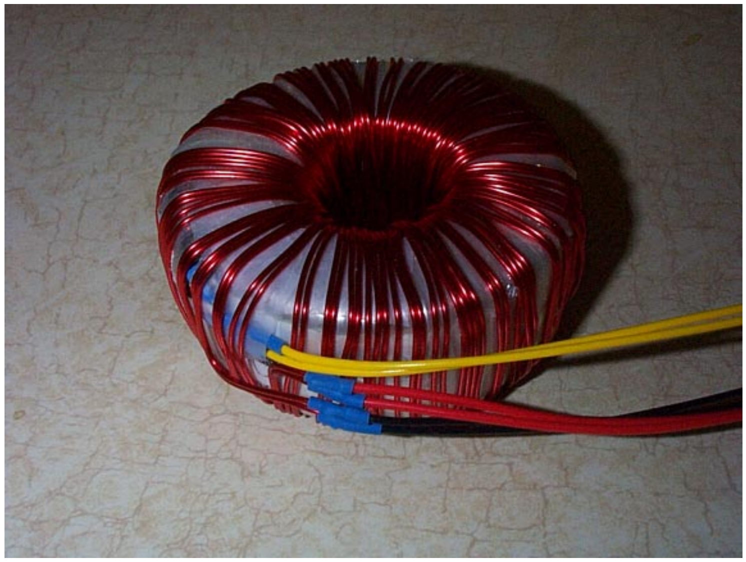

Figure 2: Transformer With Filament Windings

Figure 3: Transformer With Filament & Low VoltageWindings

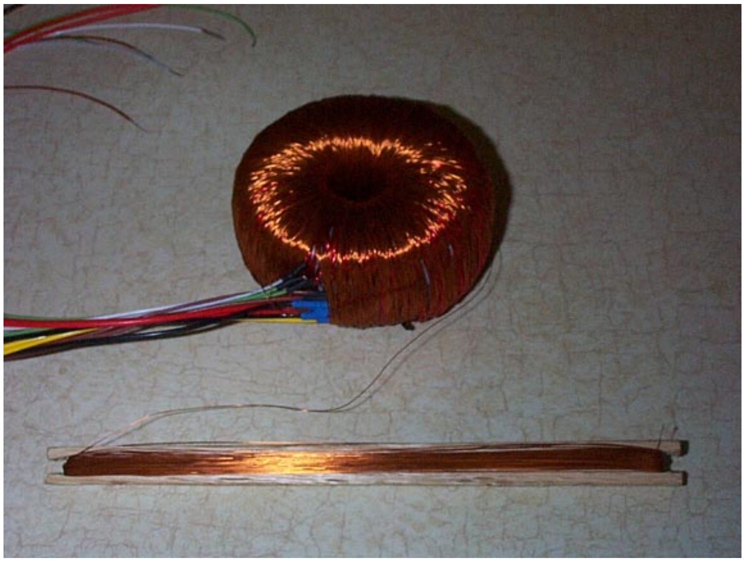

Figure 4: Transformer With Filament, Low Voltage, & B+ Windings

Figure 5: Transformer Ready For Insulating Wrap