All about Bucking Transformers and Windings – reducing line voltage to your vintage gear

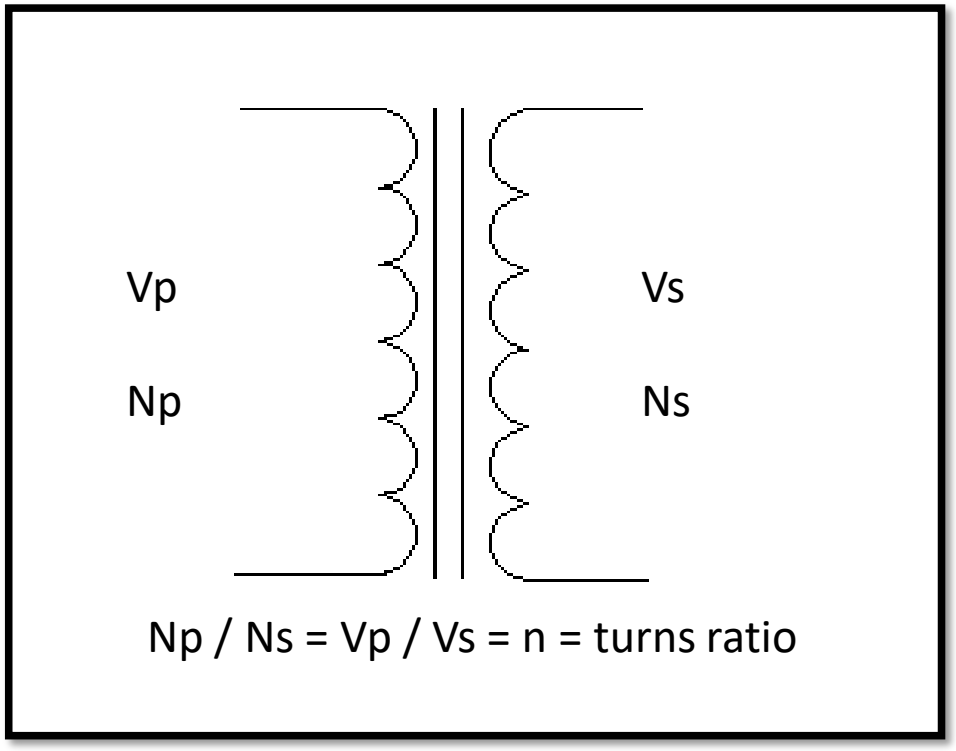
The Problem

- When much of our coveted audio gear was created, line voltages were lower than they are today. Up until the late 1950's line voltages to our houses was 110v.
- 110v, 115v, 117v were used at different time points and locations in the USA (similar stories exist in other countries)
- The current US standard is 120v. Regulations allow for +/- 5% (114-126v) to be seen at the meter box level. These voltages can also vary throughout the day depending on load.

Practical Example

A tube amp designed to operate at 110v that is now running on a 124v outlet.
Primary to filament winding designed for tube filaments at 6.3v @ at 110v
Now produce 7.10v @ 124v. These filaments aren't going to last near as long…

Transformer Basics



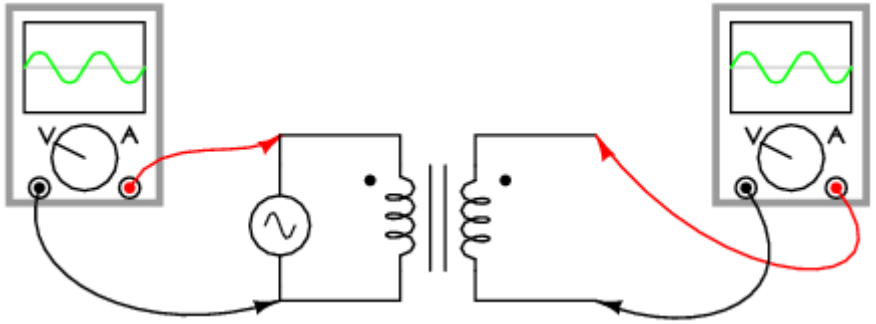
Example: 1000 turns in primary, 100 turns in secondary
Translates to 1000/100 = 10/1 = 10:1

1. Transformers work off electromagnetic currents created by alternating currents flowing through windings on the primary that induce a current in the secondary
2. The ratio of the windings in the primary to the secondary determines if the transformer steps the voltage up or down in the secondary. If number of turns in primary and secondary are equal, then the voltage is identical in the secondary to the primary, however you have created an isolation transformer.
3. The size and length of wire used in the primary & secondary affect how much power the transformer can “transfer” effectively without damage to the windings.
4. The metal characteristics and size of the transformer core affect other attributes of the transformer such as saturation of the core’s magnetic flux causing the transformer to overheat or loose linearity

Thus if we fed 120v into the primary, we would get 12v on the secondary

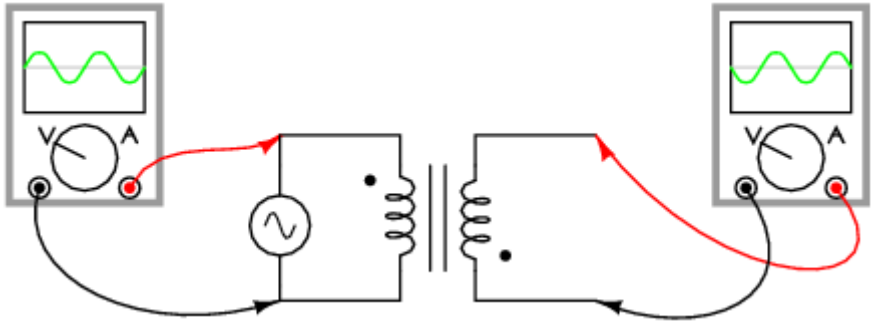
Transformer Basics - Phasing

In-Phase Transformer Configuration



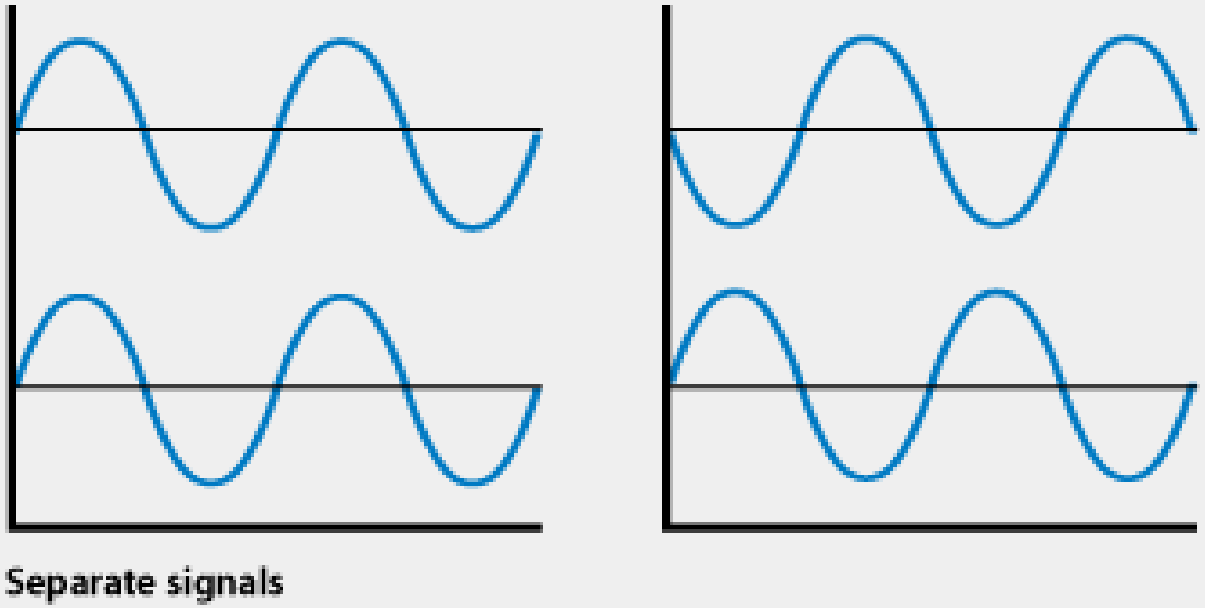
- Secondary transformer windings can be in-phase with the primary windings. This is denoted by the two dots at the top of the transformer being aligned.
- As the input goes up, the output goes up, etc.

Out-of-Phase Transformer Configuration

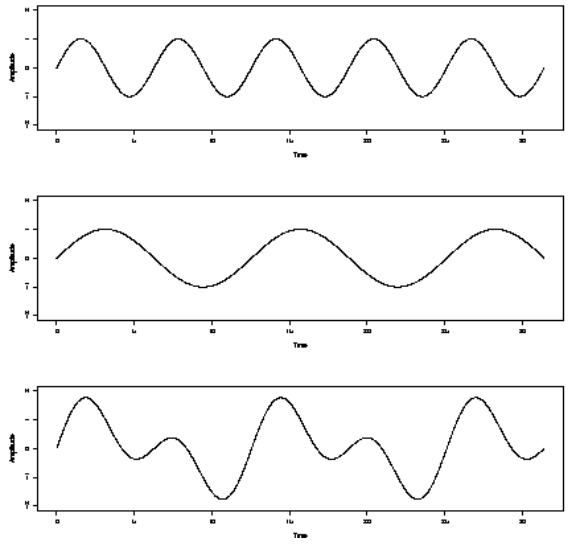


- Secondary transformer windings can be out-of-phase with the primary windings. This is denoted by the two dots at the top of the transformer being out of alignment.
- As the input goes up, the output goes down, etc.

Electronics Basics – Adding AC Waveforms

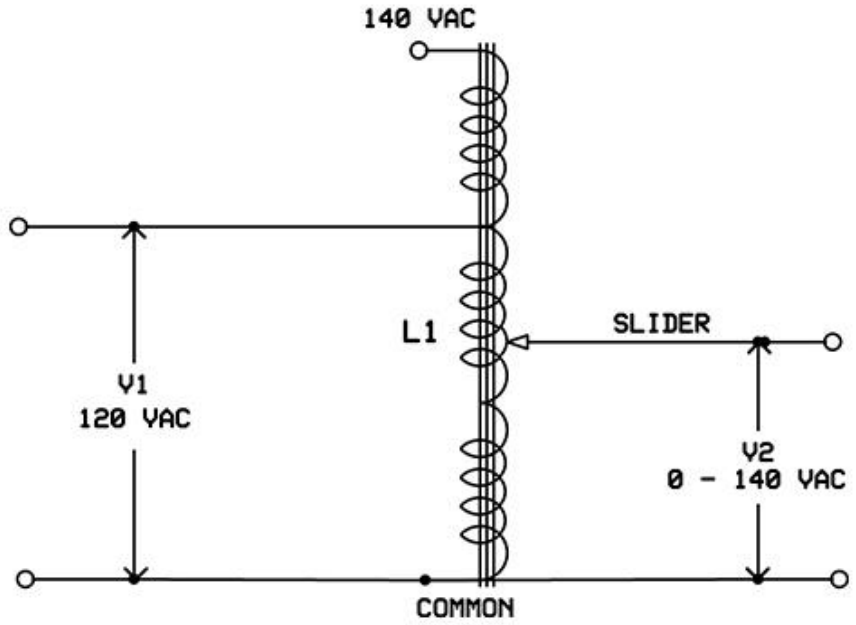


- In phase signals add to create a higher amplitude waveform
- 180 degree out of phase waveforms add together to “cancel” each other out if each amplitude is equal
- If they are out of phase 180 degrees but not equal, the sum is equal to the addition of the positive and negative values of the waveform at any given point.

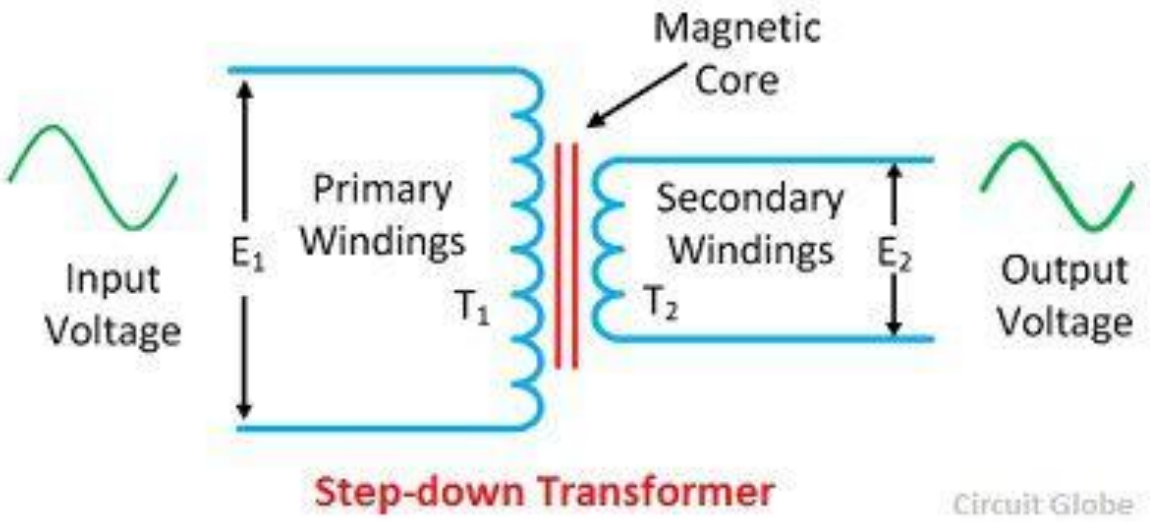


Possible Solutions

1. Variac (version of autotransformer) – not inexpensive, can get bumped easily and change voltage
2. Voltage reducing transformer 120v to 110v – while it seems simple, not commonly seen / mass produced, larger in size and costly
3. External bucking transformer – cheap DIY alternative to this solution
4. Utilize an unused set of windings in the power transformer to “buck” down the voltage

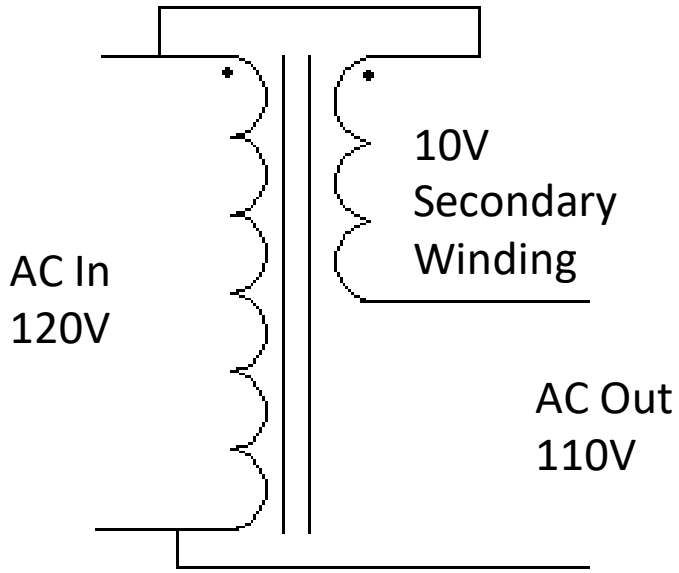


Variac



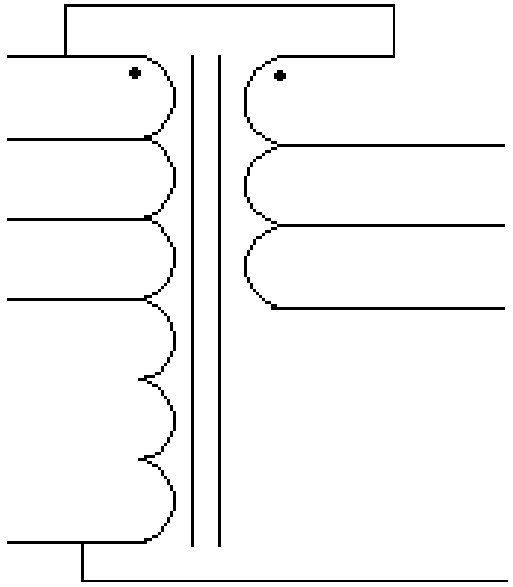
External Bucking Transformer

- How does it work?
  - Placing the secondary in series with the mains, but wired out of phase so the voltage is “bucked” down by the ratio of the primary to secondary windings
- Mathematically its viewed as 120V + (-10V) = 110V
- If this was a 10 Amp rated Transformer, it would only have to buck 10v @ 10A or 100VA to produce 110V on the output at full current. If you were to buy a step down transformer, it would need to be large enough to handle 110v @ 10A or 1100VA. This is a significant savings in terms of size of the transformer required and the cost associated. Thus bucking transformers seem to be a magical win!



Commercially Available Solution

$249…



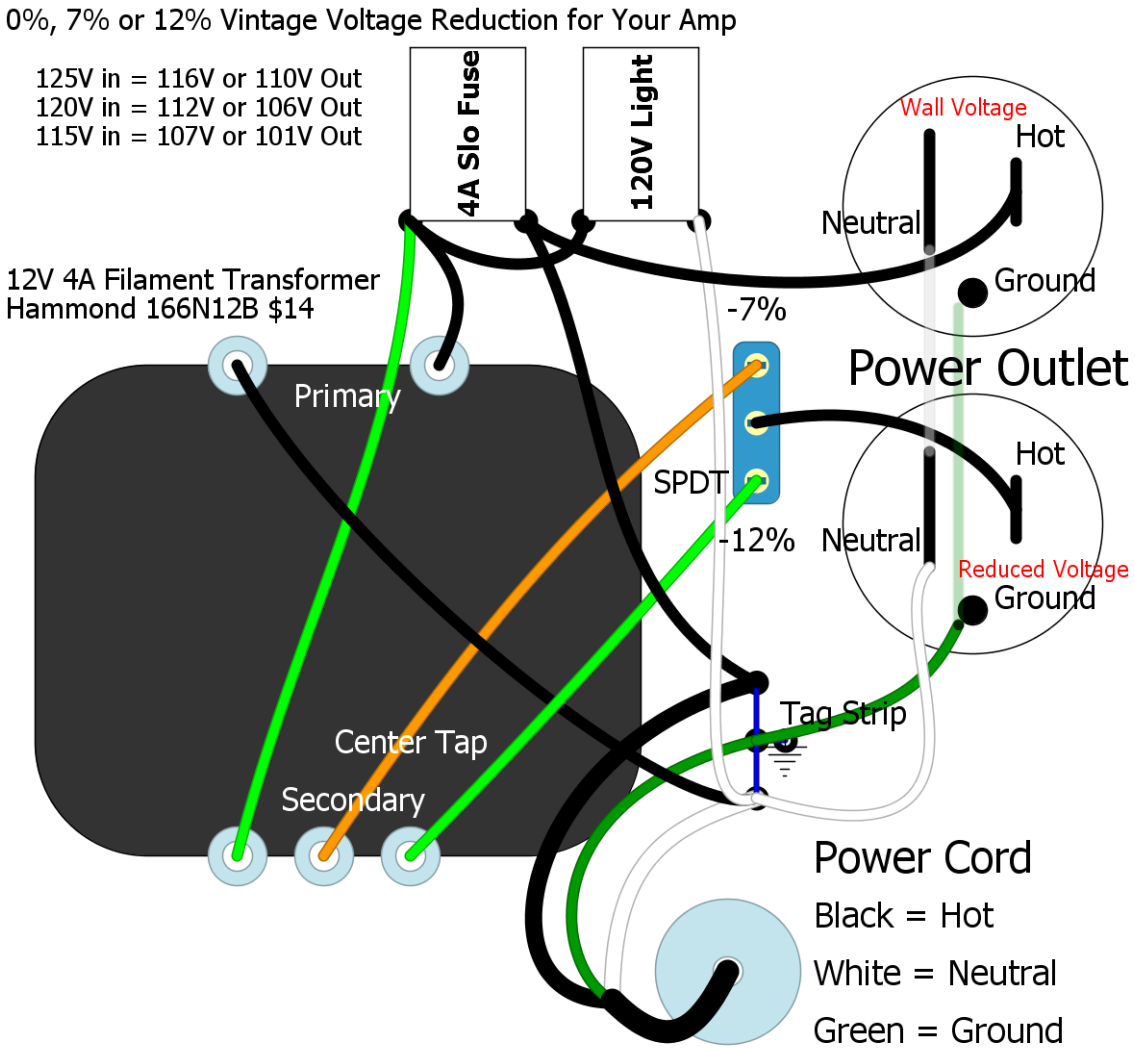
Top Primary Voltage Selector

Reduction Level

- Very neat little devices that are commercially available to provide voltage reduction
- Top selector switches between various taps on the primary to select the input voltage
- Bottom selector selects between various taps on the secondary to determine the voltage reduction (adding or reducing # of windings)
- While these are neat, they are insanely priced! Parts to build something close to this would easily be under $100, maybe as low as $60…

DIY Solutions

BuckMinister Bucking Transformer



By Rob Robinette
If voltage out is higher than wall, swap the green wires
You must remove outlet's metal tab connecting the hot terminals

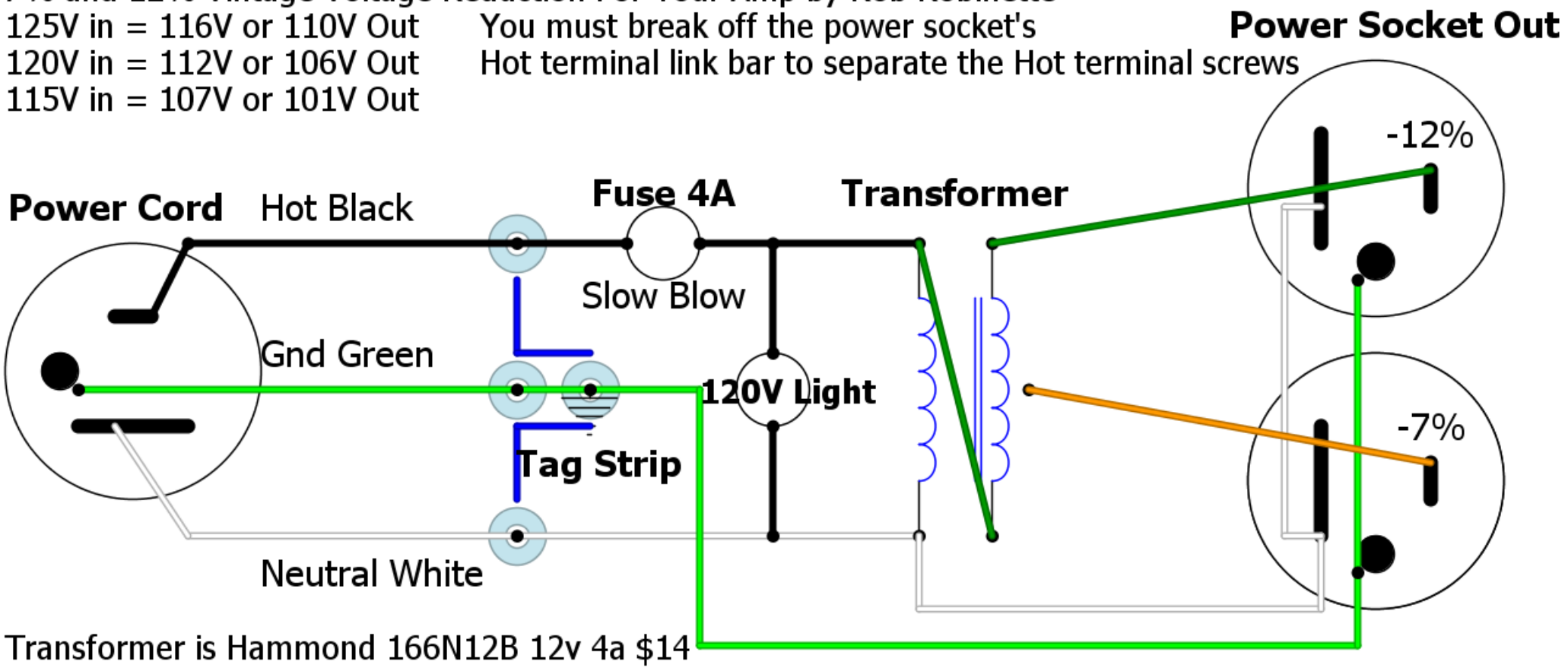
DIY Solutions

Simple Bucking Transformer

7% and 12% Vintage Voltage Reduction For Your Amp by Rob Robinette

125V in = 116V or 110V Out
120V in = 112V or 106V Out
115V in = 107V or 101V Out

You must break off the power socket's Hot terminal link bar to separate the Hot terminal screws

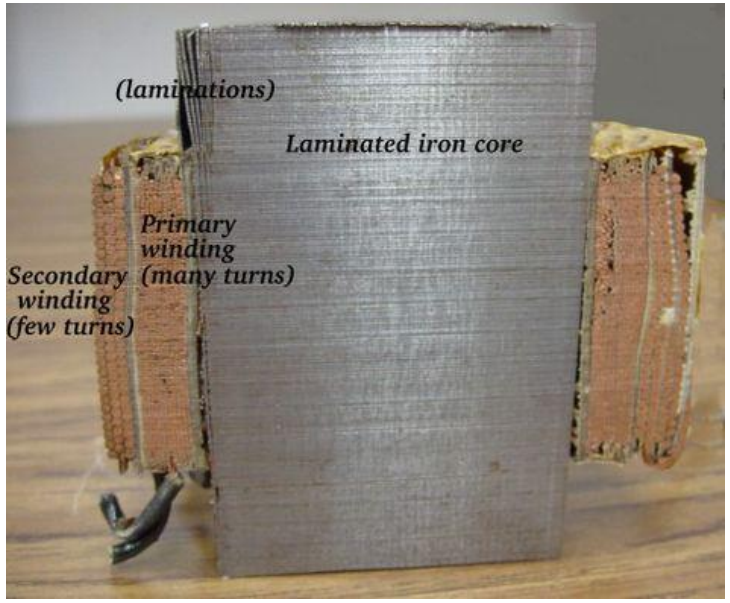


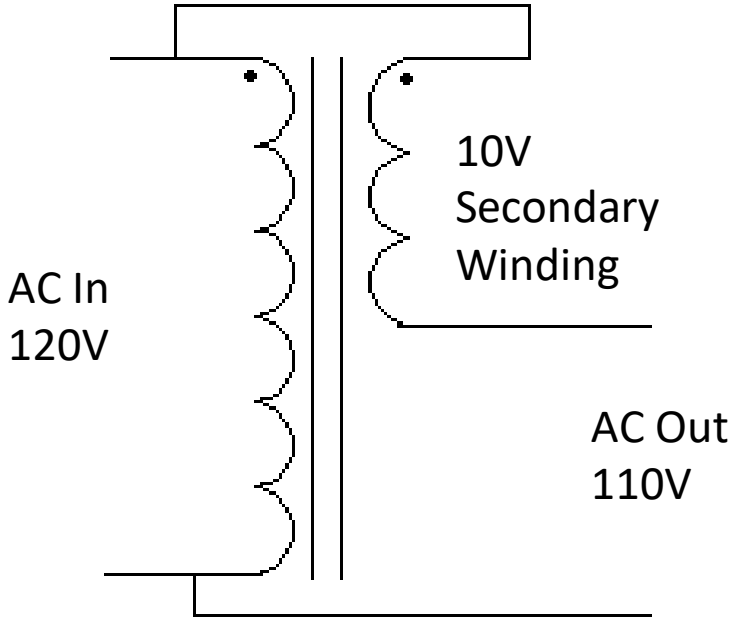
Transformer is Hammond 166N12B 12v 4a $14

DIY Solutions

Internal Bucking – Using Existing Transformer

- Scenarios where this makes sense to implement:
  - Existing transformer has an unused winding set – often seen in console amps where one winding was designed to feed power to the FM/AM/Preamp section
  - Utilize the 5v rectifier filament winding when using solid state rectification
- Same concept as before, just using an existing winding out of phase with the primary wired in series with it (try it one way, if doesn't reduce voltage, flip the two wires and try again)





Advantage of the 5v winding

Due to the fact that the 5v winding in power transformers designed for tube gear also frequently carries the B+ DC of 400+V, the winding is heavily insulated and passes a HiPot test, making it an excellent choice for "bucking".