The Click Beetle

original, handmade, low-gain tube preamplifier design

Meet **The Click Beetle**. This beautiful, handcrafted, low-gain tube preamplifier has been carefully designed, resulting in exceptionally low noise and distortion.

Design Aesthetic

- **Beautiful bamboo and aluminum chassis** - made in house
- **All original design** - not a copy or knockoff of any existing preamp design
- **Modular design** - will make future service or updates much easier
- **Unique bamboo volume control** - adjusts a stepped attenuator

Quality Performance

- **Hand assembled** - all critical component values hand-chosen between channels for excellent gain and distortion matching
- **High quality Neutrik RCA inputs and outputs** - both beautiful and durable
- **Fully shielded and isolated signal section** - minimizes hum
- **Oversized toroidal power transformer** - is quieter and runs cooler than traditional types
- **Regulated filament and HV supplies** - for exceptionally low hum
- **Ground lift switch** - for eliminating ground loop hum
- **High shelf switch** - for baffle step compensation (useful in some systems)
- **Dual HV buffers** - provide excellent channel separation

From the circuit design to the chassis, every aspect of this amp is carefully and lovingly crafted and painstakingly tested. We hope it brings much enjoyment wherever it goes.
- Doug & Sean

The Gritty Details

The Click Beetle is a low-gain tube preamp. The design is all original, and many different topologies were considered, tested, built, and listened to before arriving at this circuit. The schematic is included for those interested. This circuit is *cathode-coupled*, meaning the signal from the first tube is transferred to the second via the cathodes. They are directly coupled and loaded by a current sink, providing the following benefits:

- non-inverting (preserves phase)
- high input impedance (Z)
- correct output Z (600R is standard)
- not too much gain

These are important qualities. A single tube stage will either lose gain (cathode follower) or require a feedback loop around the stage, significantly lowering the input Z and inverting the phase. A second stage fixes some of these issues but introduces new ones. A gain stage followed by a cathode follower will have high input Z and very low output Z but will still invert phase and the gain will be far too high, resulting in the need for feedback. This further lowers the output Z. Very low output Z is unnecessary and sometimes detrimental. Contrary to the usual thinking, lower is not always better and can cause issues when driving transformers. The cathode coupled topology solves all of these issues. It can be thought of as a cathode follower input directly coupled to a nearly unity gain grounded grid stage. All signal current is shared by both triodes so some of the nonlinearity of the first stage is then canceled by the second. The 6N6P dual triode used is a medium-gain, high-current, and low-distortion unit perfect for this application.

A lot of love, work, and listening has gone into this design. All components are hand matched, allowing us to get very close characteristics between channels.

A 50K stepped attenuator controls volume level at the input and sets the input Z at 50K. It also allows consistent channel balance throughout the volume range.

The power supply is mosfet-based. Mosfets make highly effective filters and allow an incredibly low ripple output in a space-efficient package. The filaments are also supplied by a small and efficient DC supply to eliminate the hum that is so often found in tube components.

The chassis is made in house on our benchtop CNC. We're using aluminum and bamboo and love the results.

So, how does it sound? Honestly, the distortion is so low and the frequency response is so linear that there shouldn't really be a "sound". The small amount of distortion that is generated is predominantly second order; this is asymmetrical and generally thought to be preferable to third order. However, many well-regarded instrument amplifiers have output stages that cancel second order and generate third order, so this should all be taken with a large grain of salt. Even so, just having a

lovingly handcrafted and attractive tube preamp in your system is enough to improve the listening experience - at least if you ask us!

Some explanation is necessary regarding our decision to include only one pair of inputs and outputs. Many preamps also act as a hub that connects many sources to the amp. Although a future version of the Click Beetle might include these, it would be a compromise. On this pre, the size is kept to a minimum and very high quality Neutrik RCAs can be used. Noise is also minimized due to using the shortest runs of low level signal wires. As a result the front of the pre is kept free of the clutter of extra knobs. A clean minimalist aesthetic is important to us.

There are two switches on the top of the pre. On the is a high shelf, and on the right is a ground lift. The high shelf can be thought of as a slight high-frequency cut (-2db). This can be helpful in some systems and for some source material. It can also act as a baffle step compensation for some speakers. Give it a try and see what you prefer. The difference is subtle.

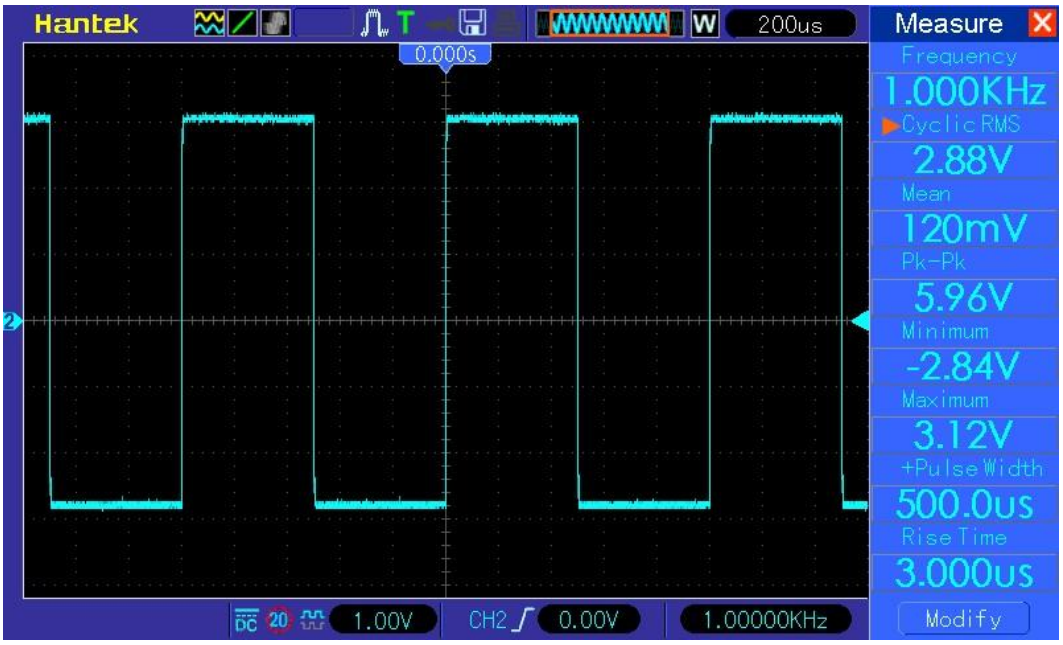
The ground lift should be left in the GND position unless you are experiencing a hum in your system. This is caused when several components are referencing Earth separately. The ground lift will interrupt this ground loop by inserting a 10R resistance between the audio circuit and Earth. It's typically unnecessary, but occasionally it's a lifesaver.

This pre requires 60hz 120v wall voltage. There is a 1A fuse in the IEC socket. This fuse should never blow. If it does, we recommend you contact us before replacement.

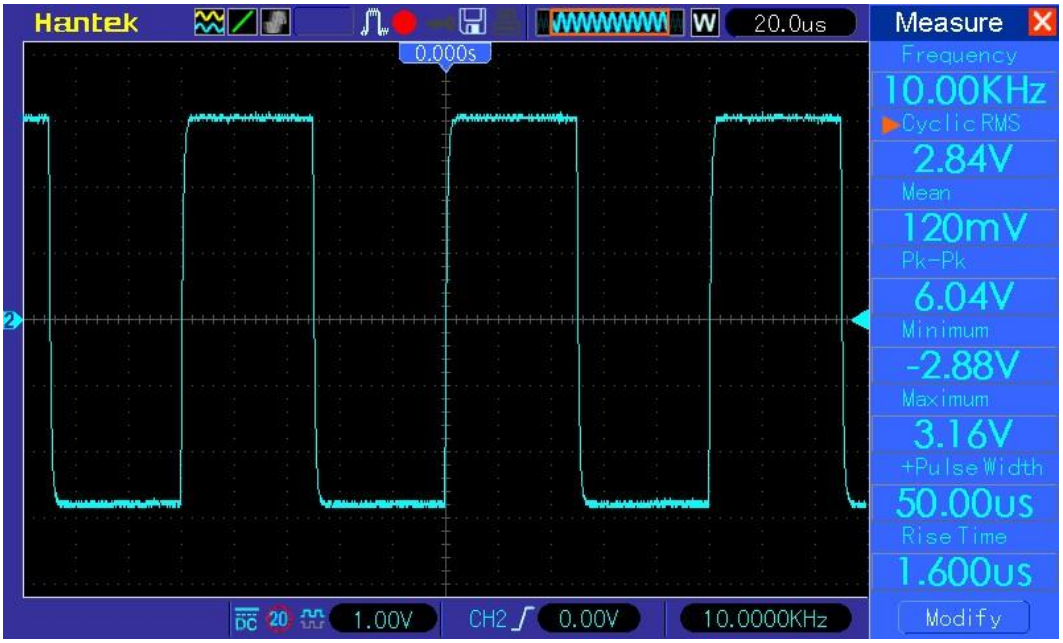
Measurements

Nominal gain	2.5dB
Channel balance	within 0.1dB*
Input impedance	50K ohm
Output impedance	600 ohm
Frequency response	5Hz-50Khz (-0.2 dB)
Channel separation	>110dB @ 1KHz
	>85dB @ 20KHz
Signal to noise ratio	>95dB unweighted 20-20K ref 1V
	>100dBA ref 1V
Distortion	0.005% at 1KHz at 0.5V into 50K ohm load**

* Supplied tubes will meet this specification. Gain does vary slightly by tube. In a test of 14 random tubes swapped through both channels the worst measured channel imbalance was 0.25dB.
** Supplied tubes will meet this specification. Distortion does vary slightly by tube. Additionally, because each channel uses a different half of the tube for the cathode follower, a particular tube can have low distortion when used in one channel and higher distortion in the other. In a test of 14 random tubes swapped through both channels, no tube exceeded 0.015% in either channel. Distortion is generally consistent over all relevant frequencies and is predominantly second order.

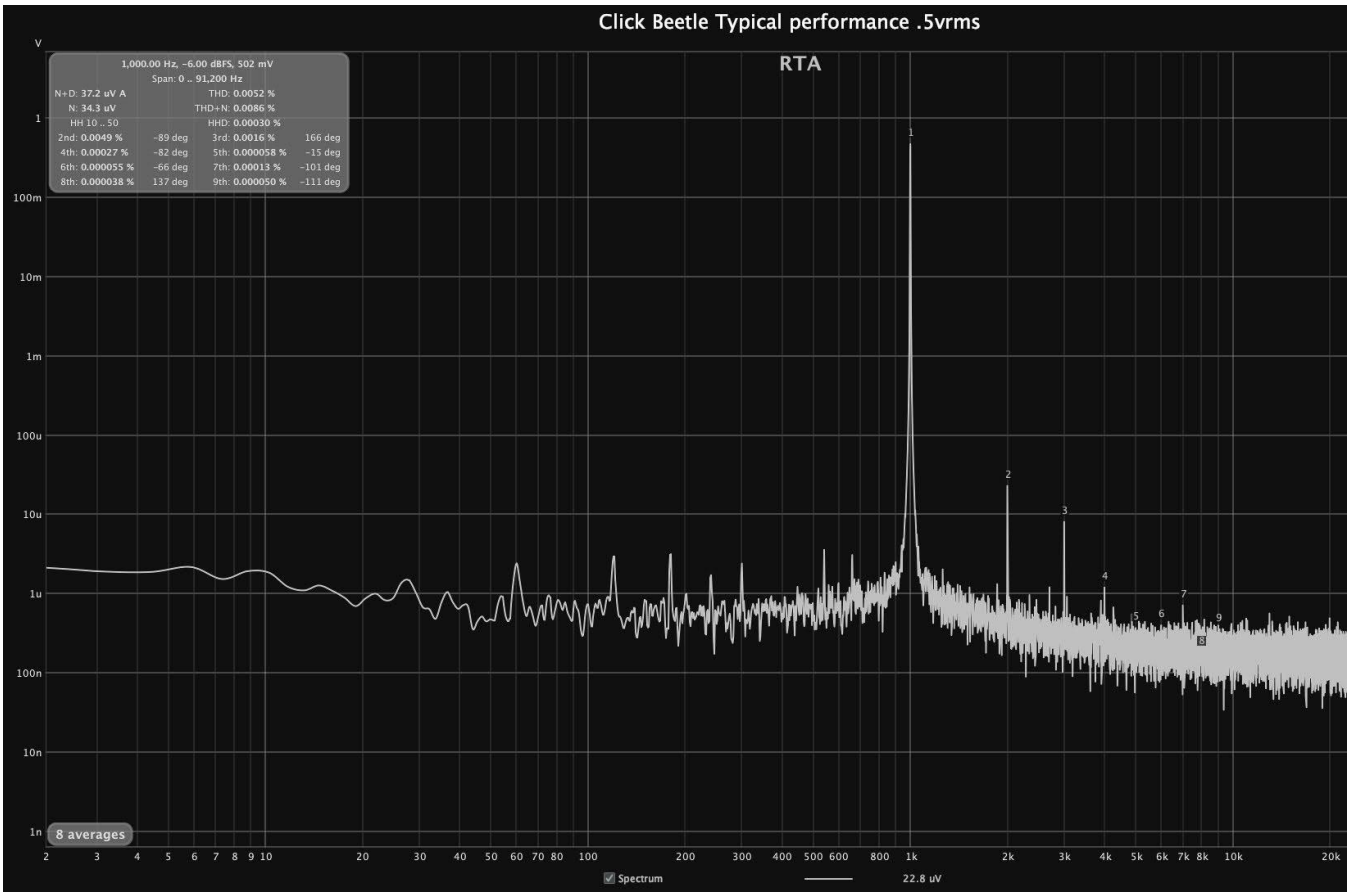


Here is a typical 1khz square wave from the Click Beetle. This shows the excellent linearity and frequency range.

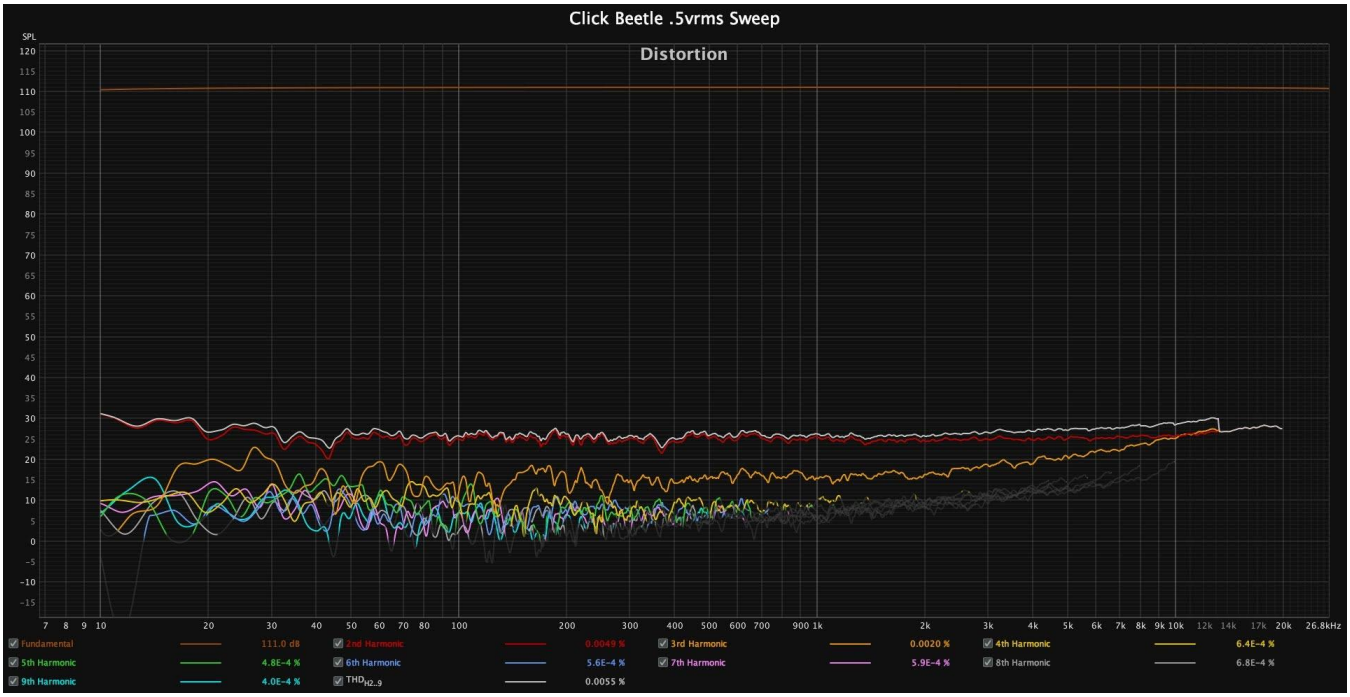


Here is a typical 10khz square wave from the Click Beetle. This shows the excellent high-frequency behavior of the circuit.

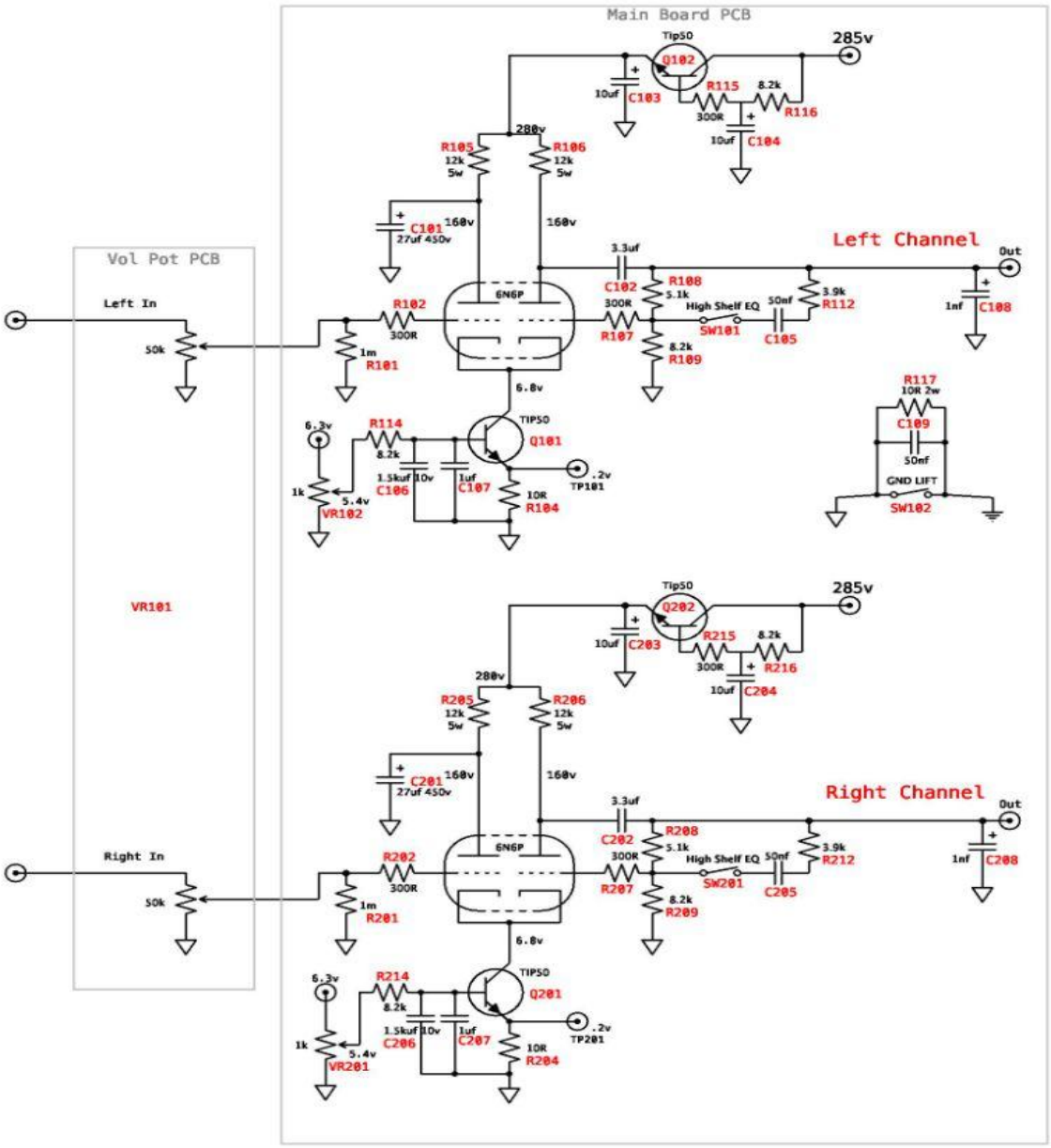
On the next page is a typical 1k .5vrms FFT from the Click Beetle. This shows the exceptionally low noise and distortion of the circuit. This measurement was taken with a Focusrite Scarlet Solo. This device does not have adequate signal-to-noise ratio to completely reveal the noise floor of the Click Beetle. The measurements in the official specs above were taken with the E1DA Cosmos ADC and more accurately represent the actual noise floor. Even so you can see all hum components are well below 5uV.

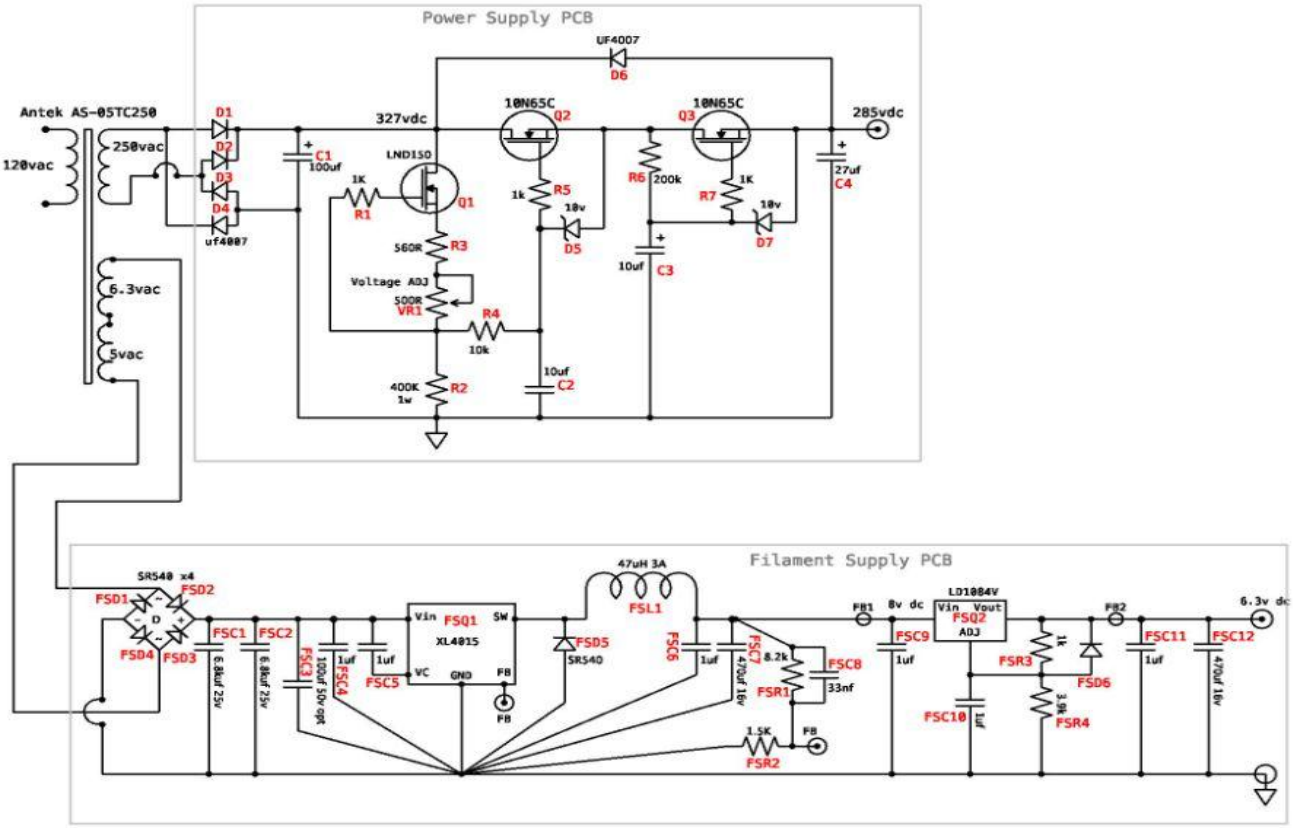


Below is a typical .5vrms sweep showing how consistent the distortion is vs. frequency.



Finally, here is the complete circuit for the Click Beetle. This design is licensed under the CERN OHL license version 2.0. If you would like to use any part of this circuit in your own build please attribute BUG for the design and do not use it for commercial use. Thanks.





The Click Beetle
BUG AMPS
Click Beetle V1.6
1.4x gain
600R output Z
Doug De Young 2022
.004 THD @ .5vrms
All resistors 1/4w unless noted otherwise

BUG AMPS		
Click Beetle V1.6		
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