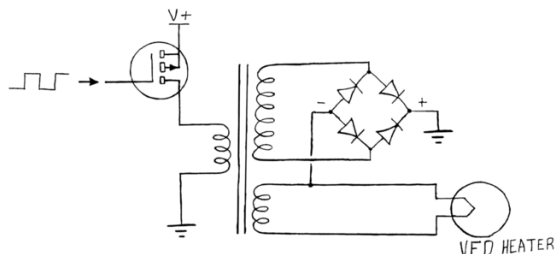


19:07 Never Fret that Unobtainium

by Matthew Peters

with kind thanks to DDR.



My friends and colleagues, my students and teachers; never fret that component of unobtainium. Though scouring the great suppliers may be fruitless, and though purchasing from Ali may be fraught with danger, all is not lost. It is important to step back and understand the problem before relegating a project to the fate of gathering dust on some forgotten shelf. Or perhaps more often, gathering dust while covering half your desk.

Components of unobtainium are often needed, for you will find they have snuck into your design unnoticed like parasitic current in a parallel trace. They will sneak in just as you receive your latest PCB after checking the stocks at all the vendors mere weeks before. That critical component you had access to thousands of will disappear, leaving only the alternative – made of pure of unobtainium. They will show up when that last component lets its magic smoke out in the most inopportune moment, just when everything was working. This will happen when it is most important that it doesn't happen. It is because of the demon named Murphy this will happen, and by his word that it will never cease to happen!

So go, look at your board. Find the smoking remains of the original part, and put aside the sadness in your heart. Seek an alternative replacement; but do not seek too far or too long, for that way lies abandonment and despair. Remember that you seek only the function of the component, rather than its form. Look upon your circuit and understand it; what was the part there for? Was it to keep something from bursting into flame? Was it to empower or advance something else? Was it there simply to keep the board that small amount warmer and take make it look pretty? While often not that last one, we can hope.

Now, it is only partly true that we can use a substitution with similar function. It is mostly untrue of Products whose virtues and qualities must be made the same, time and time again. However, to a degree even these can be saved in dire times. Let us instead focus on Projects for the duration of this sermon. Projects are to be made, not fretted over or set aside until that missing component is found or, equally likely, falls out of the sky.

The other case which must be dealt with separately is that of safety; for even if there are alternatives to the unobtainable component it is often far better to use the right component over the one that just about works. Even if a software check can react in the same manner, as the Therac-25 has shown us, software is not the same. A failure where someone's life is on the line is not an option; we must treat these cases with the respect and discipline they deserve.

That said, let us examine a practical example I encountered on a project some time ago. I was in need of a Vacuum Fluorescent Display power supply, a component I never could find though hints were made of it in catalogues long expired. I knew what this component was to do; it was to make the thirty to sixty volts needed to get electrons to jump a gap of nothing and strike the elements inside the tube and produce light. It was to take a small voltage and make it a large one. I had its brother, a filament supply, which would keep the currents flowing back and forth on the tiny wires, heating them and allowing those electrons to jump free. The two of them had a sister as well, a component that could keep each of the grids and plates in line and display only what you wanted rather than making all of them glow.

I spent many days and many nights wandering the catalogs of the great supply houses, finding nothing but shadows and broken references. I never did find a VFD supply chip for sale. Sure, there were chips that could do part of this or combinations that could work, but they were large, complex beasts – and always power hungry.



But hear me when I say all was not lost! For the VFD is a simple device, once you peel back its layers. It needs the filament to be hot and strongly negatively biased against the grids and plates. The grids don't need to be driven to block the excited electrons; they can instead be left floating and will bias themselves enough to shield the plates. There was a difficult part, of course, for the filament must be near ground while the grids and plates must be way up near 60 volts. But this was a false truth! A simplification, by those who sought to keep things aligned in tables and books. The truth was that there just needed to be more than 30 volts of difference and it mattered not where the ground was.

With this knowledge in hand I sought a component; something that would keep things biased and powered. But again and again I came up with only components made of unobtainium. Long hours I sat until the simplicity of the whole problem came clear – it was a supply with two purposes and the rest was just discrete MOSFETs of the P-type. The supply needs to do two things at once; it needs to couple current back and forth across the heaters and at the same time it needs to bias those wires down until the electrons leap free. A transformer can do this when coupled with source for changing currents. The source would be very easy, I had a controller nearby and could turn on and off a MOSFET, while a transformer could take those pulses of current and wash the electricity back and forth to heat the wire. A second winding on the transformer could even be attached to diodes and they can push together to bias the heaters down far enough.

But lo, the ugly head of the unobtainium component reared again! For though transformers are common enough, ones with the ratio set of one-to-one and one-to-ten together aren't. The suppliers were barren, once more having only the holes and echos where the transformers may have been.

But again, all was not lost! There are things very similar to transformers, for they have cousins, inductors. These devices do similar tasks and often have similar features. They can load up their cores with a magnetic fields made by current loops, but they only have one length of wire to receive that magnetic field with when it collapses. A transformer is just an inductor with more than one wire, and more than one loop to share the magnetic field. I anew sought something far easier to find, an inductor with enough loops around to make up a good start of the unfound transformer. Ferrite, the powder used to form the core of inductors, has an interesting feature; a handy one for those who care not for math – for each loop around it the inductance is about 1 microHenry. Though not precise, this is enough to find the base – an inductor with $100\mu\text{H}$ will have around 100 turns. The inductor must also have other commonly found features – it must be without shield, and naked, and large enough to wind more loops around. The requirements thus listed; not five minutes later an acceptable component was found.

Thus by using a cheap inductor and simply wrapping the extra windings needed around it, the transformer was made. With the pulsed current from a MOSFET, the field inside the transformer formed and collapsed and the dual output of the bridge rectifier and the filament heater could share the field and regulate with it.

The rest was simple software, secrets whispered to sand that made it do tasks over and over, with just a little more power to keep the sand thinking. A CPU can turn on and off the grids and plates allowing current where needed and blocking where not. The project, a watch, could now show numbers and count out the passage of time as a river counts the passage of fishes.

And so, no components of unobtainium were needed, and none were sourced. No sums of money were traded for things too rare to be affordable. Do not fret when a component seems to only come from unobtainium; fear not when the stores of the great component suppliers run empty and lead times are only given in cycles of the seasons. Often it is not the components that you seek but rather their function, the result of them being there. You can look deeper, understand the need, and fill the empty spot with something better.

Thank you.