

Re: 12 Volt Regulated Supply

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- *From:* "Dave.H" <the1930s@xxxxxxxxxxxxxxxx>
 - *Date:* Thu, 1 May 2008 11:17:47 -0700 (PDT)
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On May 2, 3:13 am, John Fields <jfie...@xxxxxxxxxxxxxxxxxxxxxxxx> wrote:

On Thu, 1 May 2008 07:33:05 -0700 (PDT), "Dave.H"

<the19...@xxxxxxxxxxxxxxxx> wrote:

On May 1, 10:42 pm, "Dave.H" <the19...@xxxxxxxxxxxxxxxx> wrote:

I was looking at a 12 volt regulated power supply at Dick Smith Electronics cat. number M9935 @www.dse.com.au for a regen radio I'm planning on building (<http://www.schmarder.com/radios/tube/1-12af6.htm>) but the AU\$24 is a bit too high for my liking. I was thinking of using a center tapped transformer, 6.3-0-6.3V @ 500mA, in series with a 1.3 watt zener diode, I need help with obtaining 12.6 volts from a center tapped transformer, I never had to do it before. I thought that the two positive primary leads were connected, I don't want to blow the transformer if this isn't the case.

Any help appreciated,

Thanks
Dave

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Transformer is M2853, and zener diode is Z3543
@www.dse.com.au

How would I install the zener diode? I thought they were used in series with the voltage source much like a rectifier diode, but I just read that they're used in parallel to the source. Excuse the dumb question, I've only ever had experience with rectifier diodes like the 1N4007.

For starters: (View in courier)

The way to get 12V out of the transformer is to ignore the center tap and use the the two ends of the secondary as your 12V source.

There are two ways to do that, one called half wave rectification and the other full wave rectification.

Half wave rectification works like this:

```
MAINS>--+ +--[DIODE>]--+----->17.1VDC
P||S |+
R||E--CT [BFC]
I||C |
MAINS>--+ +-----+----->GND
```

When the end of the secondary connected to the anode of the diode goes positive, charge is allowed to flow through the diode and accumulate in the BFC where, when the capacitor is full will be the peak value of the AC waveform minus the voltage dropped across the diode.

That is:

$$\begin{aligned} \text{VDC} &= (\text{VRMS} * \text{sqrt}(2)) - V_f \\ &= (12.\text{VRMS} * 1.414) - 0.7\text{V} \\ &\sim 17.1\text{V} \end{aligned}$$

Full wave rectification works like this:

```
MAINS>--+ +-----+-[CR1>]-----+----->16.4VDC
||| |+
P||S +--[<CR2>--+ | [BFC]
R||E-CT |||
I||C +--[<CR3>--+|----->GND
|||
MAINS>--+ +-----+-[CR4>]-----+
```

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This time, when the top of the secondary goes positive, charge will flow through CR1 into the BFC and then through CR3 back into the negative end of the secondary.

When the polarity reverses and the bottom of the secondary goes positive, charge will flow through CR4 into the BFC and then back into the negative end of the secondary through CR2.

The full wave rectifier has the advantage of using a capacitor with half the capacitance required for the same ripple out of a half-wave rectifier, plus some others, so lets assume that's the supply you'll build.

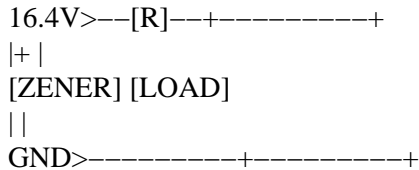
OK, now for the Zener.

A Zener diode belongs to a class of devices called "shunt regulators" because they shunt current that a load doesn't need to ground while maintaining the voltage across the load constant even as the supply voltage changes and the load current varies.

In your case since you have a 16.4V supply and you want to use that 12V Zener, we look at the data sheet for a 1N4742 and we find that I_{Zt} is 21mA and I_{Zmax} is 76mA.

I_{Zt} is the Zener test current and is the current through the Zener which will cause the voltage dropped it fall within the device's specifications, and I_{Zmax} is the maximum current which can be pushed through the diode without damaging it if the ambient temperature is 25C or lower.

Now, if we look at the regulator circuit we'll have:



Let's assume that your load draws 50mA and that we'll allow I_{Zt} to flow through the Zener.

Then we'll have, for the value of R:

$$V_{supply} - V_z \quad 16.4V - 12V$$
$$R = \frac{\quad}{I_{Zt} + I_l \quad 0.021A + 0.05A} = \quad = 61.9 \text{ ohms}$$

which is pretty close to 62 ohms, a standard 5% value.

The power the resistor will dissipate will be:

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$$\begin{aligned} P &= (V_{\text{supply}} - V_z) * (I_{Zt} + I_l) \\ &= (16.4\text{V} - 12\text{V}) * (0.021\text{A} + 0.05\text{A}) \\ &= 0.312 \text{ watts} \end{aligned}$$

So a half-watt resistor would be fine.

Your Zener circuit now looks like this:

```
6.3VAC 16.4VDC 12VDC
///
MAINS>--+ +-----+--[CR1>]----+-----+--[62R]--+-----+
||| |+ |K |
P||S +--[<CR2]--+ | [BFC] [1N4742] [LOAD]
R||E-CT ||| |
I||C +--[<CR3]--+ |----+-----+-----+
|||
MAINS>--+ +-----+--[CR4>]----+
\
6.3VAC
```

But...

There's a very much better way to go, and that's to use a series regulator like a 7812 in place of a Zener, like this:

```
6.3VAC 16.4VDC 12VDC
///
MAINS>--+ +-----+--[CR1>]----+-----+--[7812]--+
||| |+ ||
P||S +--[<CR2]--+ | [BFC] | [LOAD]
R||E-CT ||| |
I||C +--[<CR3]--+ |----+-----+-----+
|||
MAINS>--+ +-----+--[CR4>]----+
\
6.3VAC
```

Not only will this give you better regulation with line and load changes, it'll allow you to use the full output capability of the transformer (half an ampere) with a suitable heatsink on the 7812.

So, the last thing to figure out is how big the BFC has to be.

We start by looking at the dropout voltage of the 7805, (that's the voltage difference between the output and the input which will assure the output stays in regulation) and it's 2.5V, so that means we can never let the input fall below:

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$$V_{in} = V_{out} + V_{do} = 12V + 2.5V = 14.5 \text{ volts}$$

Since the BFC is being charged with sinusoidal pulses and being discharged by the load when the pulse voltage isn't high enough to supply the load current, ripple will appear across the capacitor and we have to make sure that ripple never falls below 14.5V or the 7812 will go out of regulation. to do that we can say:

$$C = \frac{I_{dt}}{dV}$$

where C is the capacitance in farads,
I is the load current in amperes,
dT is the ripple period in seconds, and
dV is the allowable ripple in volts.

Then:

$$C = \frac{I_{dt} 0.5A * 0.01s}{dV 2.5V} = \frac{0.005}{2.5} = 0.002F = 2000\mu F$$

Not bad, but that's cutting it pretty thin so let's lower the ripple to one volt and see what we get.

$$C = \frac{I_{dt} 0.5A * 0.01s}{dV 1V} = \frac{0.005}{1} = 0.005F = 5000\mu F$$

Still not bad, and that'll make up for the capacitor's tolerance on the low side.

So your final power supply will look like this:

```
MAINS>--+ +-----+-[1N4001>]----+-----+----[7812]--+----->+12VDC
||| |+||
P||S +-[<1N4001]-+ | [5100µF] | [100nF]
R||E-CT |||||
I||C +-[<1N4001]-+--|-----+-----+-----+----->GND
|||
MAINS>--+ +-----+-[1N4001>]----+
```

The 100nF cap on the output keeps everthing stable, and both caps should be mounted as close to the 7812 as possible.

Also, there's nothing critical about the BFC; a general purpose aluminum electrolytic will do fine and if you cant find 5100µF the next largest size rated at around 25V will be even better.

JF

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I like that 7812 idea. The tube (12AF6) draws 150 mA, then there's the current draw of the 12 volt B+, a zener won't handle all that. A 5600 MFD 40 volt capacitor is AU\$7.30, I don't like paying that for low quality Asian capacitors, so I'm paralleling 3 2200 MFD 25 volt caps in series to give a total 6600 MFD. Each of these caps cost \$0.97

Dave

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