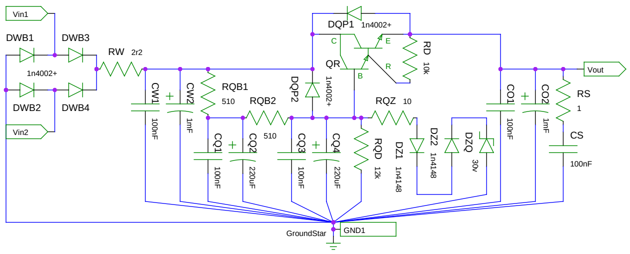
Floating Regulator/Filter with 30v Limit

2011−02−27



This is also known as a capacitance multiplier filter. It does not store charge but it does filter like the capacitor size times transistor beta. It tends to work better at high frequencies than lower. Transistors with higher beta filter more than ones with lower. To make this a negative supply regulator, swap the NPN with a PNP (emitter still at Vout), reverse the diodes, and flip the polarity of the electrolytics. Together, these can be used to make a full dual rail power supply. This circuit is good for (pre)filtering a noisy transformer or wall wart.

This circuit will float a few volts below the input voltage and will filter quite a bit of noise (2.5−3v below input with 100mA load). Since this circuit always floats a few volts below the input voltage, heat dissipation and power waste is greatly reduced compared to a fixed linear regulator. It is often used as a tracking pre−regulator. DZq is an optional clamp to limit how high the voltage can go. Zeners are approximate in this circuit and a little extra overhead should be allowed. DZq will need a minimum current load to regulate effectively. If Rqz is omitted, the impedance of DZq and the Cq* capacitors are paralleled. Adding Rqz forces the capacitors to do much more work and filter more before the zener starts dropping voltage (reducing ripple significantly). Higher values for Rqb* and Cq* increase filtering and will drop the output voltage more. DZ1 and DZ2 are used as matching voltage drop diodes for the darlington transistor. These will make the regulated clamp output much closer to the DZq voltage.

CW2 and CO2 should generally be 1mF per ampere pulled. Make sure the diodes and transistors can handle the pulse currents.

If this circuit is used stand alone, add large filtering capacitors after Dwp and at Vout (RC variation shown, Rw+Cw*, Co*). If this circuit is used as a pre−regulator, the large filtering capacitors should already be already be elsewhere nearby in the design. If the load gets heavy enough to pull the voltage down and break regulation, make the input capacitors bigger to help stabilize this. Likewise for the Vout capacitors. If regulation still breaks, increase Rqd (see below).

This circuit can filter up to very high voltages, but the transistor and capacitors should be carefully rated for that. Choose a transistor that can handle high ripple currents if this is used in a larger power supply. A darlington transistor may be used, but will add a little more voltage drop from the extra transistor. The higher darlington beta will filter better, though. Dqp* protects the transistor from reverse bias voltage from large capacitors if something is suddenly unplugged or from surges.

DWB* are a full wave diode bridge rectifier. A variation includes adding 10−22nF subber caps across each diode to help remove switching noise. If a diode bridge isn't needed, only solder DWB3, use Vin1 as positive and replace Vin2 with the star ground connection. This will still act as a half wave bridge and polarity protector and not drop as much voltage. A DPDT switch could be wired in to swap between single diode and full bridge if needed. The diodes should be able to handle the high pulse currents of this circuit.

Option Shown: Split the Rqb* and Cq* pair to form an RC−RC double pair filter. Qr's base still comes after the last capacitor. Keep DZq after it for current accuracy (Rqb* sets the bias current if the voltage gets high enough). This will form a second order filter at the RC frequency at −12db/octave. Try to keep the RC frequency around 3Hz so it is low enough to handle DC fluctuations fast enough, but not so high that noise starts getting into the audio band. Keep in mind that PSRR's tend to handle low frequencies far better than they handle high frequencies.

To avoid hum and buzzing in this circuit, a star ground must be used. Since there can be very large current pulses, use thick ground wire for least resistance.

Option Shown. Rqd is a dissipation resistor to help stabilize transistor gain and helps prevent problems with short term voltage fluctuations. Normal values are 10−15k. Reducing Rqd will add a little more regulation at the expense of a lower output voltage.

Option. Add a 36 ohm resistor to the base of the transistor for stability control. In most cases, this won't be needed but can help if there are oscillation problems.

Option Shown. The Rw+Cw* RC filter is not mandatory but will help with high frequency noise and some RF problems. If this is not going to be a high current supply, increase Rw to 4.7ohms. Rw's typical range is 1−10ohms. Note that for each ampere being pulled through Rw, a 1volt drop will occur. Rw's watt rating should be calculated carefully so it doesn't burn up. Another option is to split Rw+Cw* into a second order filter.

Option. For testing, add a DIP8 socket for the transistor. The other side of the socket could be wired for a darlington configuration.

Option (shown on another page). Wire an LM317 in as a tracking pre−regulator after Cw2, before Rqb1, and after Qr's emitter (as shown in the diagram). Technicaly the LM317 is wired like a normal standalone unit, but the adjust pin is connected to the output of the second regulator and raised that many volts above ground. The LM317 is good for low frequency filtering but is only tolerable for high frequency. This will add about another 5v of drop out voltage and would probably be unsuitable for lower voltage supplies. Increase Rl2 or lower Rl1 to raise the dropout voltage. Vdrop = 1.25 * (1+(Rl2/Rl1)). The LM317 will still need about 2.5v for regulating overhead. Note that the LM317 does not like low ESR capacitors (add 1−10ohm in series resistance?).