

## Low noise power

M. Simon, Technical Contributor



I recently designed a low power, low noise, power supply for digital work. The nominal output voltages as designed are +5 volts and +3.3 volts. One hundred and fifty milliamps each. With a lightly regulated five volt supply for powering LED back lights. These links will tell you [how to build it](#) [1] with schematics and data sheets. Bare boards are available from [OSH Park](#) [2] if you are in a building mood. The precision regulators are a two stage design. There is a pre-regulator which reduces the input line frequency noise (actually 2X the line frequency) by about 60dB and a final low noise regulator which reduces the line frequency noise by a further 70 dB. In theory you should see less than 1 microvolt peak to peak of rectified line frequency in the output of the supply. That then leaves only the 15.4 microvolts of intrinsic supply noise (10Hz to 100KHz). Not the best you can do but not bad for off the shelf parts.

Which brings up an interesting question. Why would you need a low noise digital power supply? I'm glad you asked. One place you need low noise power is for characterizing digital ICs. Not too many people do that in a home lab though (neither do I) so some more practical reasons will be needed. Precision voltage controlled oscillators (VCOs) and precision voltage controlled crystal oscillators (VCXOs) which are designed to respond to voltage changes quickly (the basic design can be influenced by a very small voltage change in nanoseconds unless you go to some pains to slow the response down), need low noise power. Phase locked loops (PLLs) need low noise power because they use VCOs and VCXOs. Low noise amplifiers (LNAs) need low noise power.

These are all devices which may show up on a home lab bench. Depending on your interests and luck with eBay. Any noise supplied by the power supply is going to influence how noisy the operating circuit is. The quieter and more precision the circuit the more effort you have to put into making the power supply quiet. Except for low noise amplifiers, amplitude noise by itself is not a problem. What is a problem is the phase noise it causes by directly modulating the desired signal and often worse by noise modulating components. Varicaps (semiconductor variable capacitors) are a very big culprit here. There is no getting around that if you want a variable frequency oscillator something has to vary in response to a signal, which

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for varicaps is a voltage. But you want that voltage to change only if the change is signal. Noise is usually not helpful. [3]

[Ken Kundert](#) [3] has an excellent paper on how to reduce power supply noise by using decoupling capacitors and damped LC filters. There are lots of design equations and rules of thumb in the paper. If you prefer getting your information by video TI has a video on [LC filters for power supplies](#) [4]. For low noise power it is a very good idea to avoid switching supplies. The switching is an inherent noise generator that is difficult to contain. Some companies claim [low noise switching supplies](#) [5]. I'm doubtful. Wenzel Associates, makers of precision RF components (like low phase noise oscillators), has an excellent page on exotic techniques for [reducing power supply noise](#) [6]. KO4BB has a page on how to [build amplifiers](#) [7] to help detect and measure power supply noise. There are ultra low noise power supplies on the market. [This one has](#) [8] four different output voltages and at only \$400 dollars a copy is touted as low cost. They haven't talked budget with my wife.

M. Simon's e-mail can be found on the sidebar at [Space-Time Productions](#) [9].

*Engineering is the art of making what you want from what you can get at a profit.*

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<http://www.ecnmag.com/blogs/2013/05/low-noise-power>

### Links:

[1] <http://spacetimepro.blogspot.com/2013/05/power-supply-digital-ww.html>

[2] <http://store.oshpark.com/collections/space-time-productions/products/power-supply-digital-ww>

[3] <http://www.designers-guide.org/Design/bypassing.pdf>

[4] <http://dangerousprototypes.com/2013/04/13/2-section-filter-for-low-noise-power-supply/>

[5] <http://daitronpower.com/>

[6] <http://www.wenzel.com/documents/finesse.html>

[7] <http://www.ko4bb.com/~bruce/LowNoisePowerSupplies.html>

[8] <http://www.digikey.com/product-detail/en/ABPSM-ULN-A/535-10307-ND/2242563?cur=USD>

[9] <http://spacetimepro.blogspot.com/>