How to tell if a power supply is noisy ?

use the *'Power-supply sniffer'* and a set of ears !

I know a lot of DIY'ers are always wondering about how quiet their power supply rail(s) is/are.
Power supply is rather 'grey' area where lots of facts, fiction and assumptions create various opinions.
Rarely are any measures performed by DIY'ers (except for DC voltage levels) or understand the implications or influence of the power supply on the amplifier circuits it feeds.

There are a few rather easy ways to check how well a power supply behaves and what the influence on the sound may be.

An oscilloscope is not something everyone owns or has access to, nor knows how to operate for that matter.
It cannot be used to search for the final microvolts either and says little about the frequencies that reside there unless you have a scope that can do FFT analysis.

Voltmeters can tell you little except the AC and DC voltages and perhaps the amplitude of the 100Hz AC component in the unregulated DC part of the circuit with a suited multimeter.

Some service engineers use(d) a small signal tracer/injector for fault finding.
It's a small amplifier with a small speaker with which you can 'trace' certain signals (even an injected signal it had on-board) in amplifiers and TV's but is not very useful for everything.
It certainly was not 'hifi' and gave little clues about how big the signal was in amplitude.

listening to the power-supply line(s) seems a simple solution, but you cannot simply connect a headphone to the power rails as it will go out with a nice display of fireworks emanating from the drivers voice-coil.

Also we van use headphone amplifiers to increase the gain and when we want to visualize the noise and it's spectrum it is quite easy to use a sound-card from a PC and make a recording of the noise and analyze this afterwards with freeware audio software such as Audacity.

For the odd occasion we want to check power supply rails for noise, hum or other nasties it's not really needed to buy (expensive) equipment and there is a rather simple circuit, I use now and then, and thought I'd share it as it may be of use to other DIY'ers playing with amplifiers.

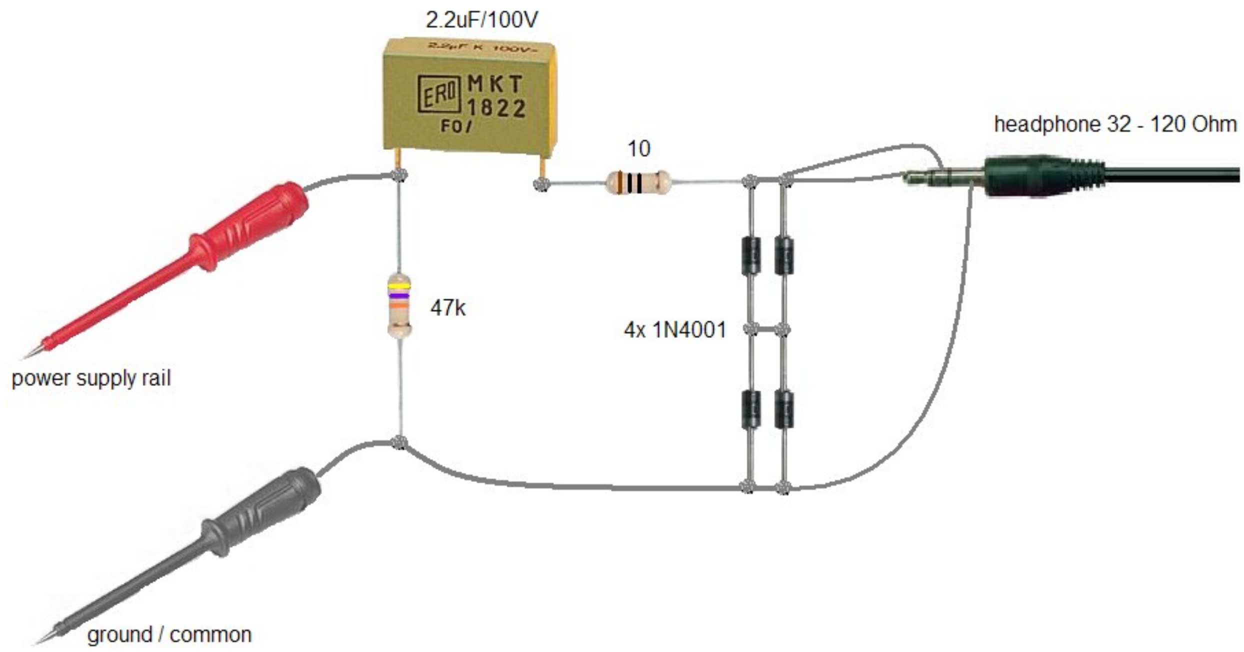
It has limits in applicability and can really only be used on DC power-supply lines (which we want to check or know something about).
It cannot be used **in** the regulator circuit itself nor for AC power-supply lines before the rectifier nor in the amplifier circuit itself to check for problems.
Also you can NOT check for nasties outside the audible band such as oscillations, increased impedance at say 100kHz, HF-RF noise, switch mode power-supply ripples.
Therefore 'garbage' on the power lines below 40Hz and above 15kHz cannot be 'monitored' unless a soundcard is used and a recording is made. With a high enough sampling rate 10Hz to 50kHz should not be a problem.

Even without these limitations you can still check DC voltages behind the rectifier, on the input and output of the regulator (circuit) and power supply add-ons.
It can check voltage rails up to +/- 100V DC.
This is more than enough and quite handy for those tinkering with audio circuits and power supplies for these circuits.

All we really want to know in amplifiers is how quiet the power supply actually is and if the power-supply rails has 'audio components' on it, caused by loads of the same amplifier, that might in turn affect the amplifier circuit itself.
This can be checked for pre-amps, control amps, CD players, analog parts of DAC, headphone amps and power amplifiers as well.
It relies on the fact that power supply rails are low Ohmic and are able to handle the relatively small AC currents drawn by the circuit (except when connecting the test device itself which gives a small surge load while charging the DC blocking capacitor).

All we need really is a (cheap) headphone in the range of 32 to 120 Ohm, like those supplied with portable gear e.t.c. which disappear in the a drawer, or if we want to know more accurately as well headphones like the HD681 (that cost around E 20) can also be used.

Below you can see the circuit that is needed for 'passive' testing using only a headphone.



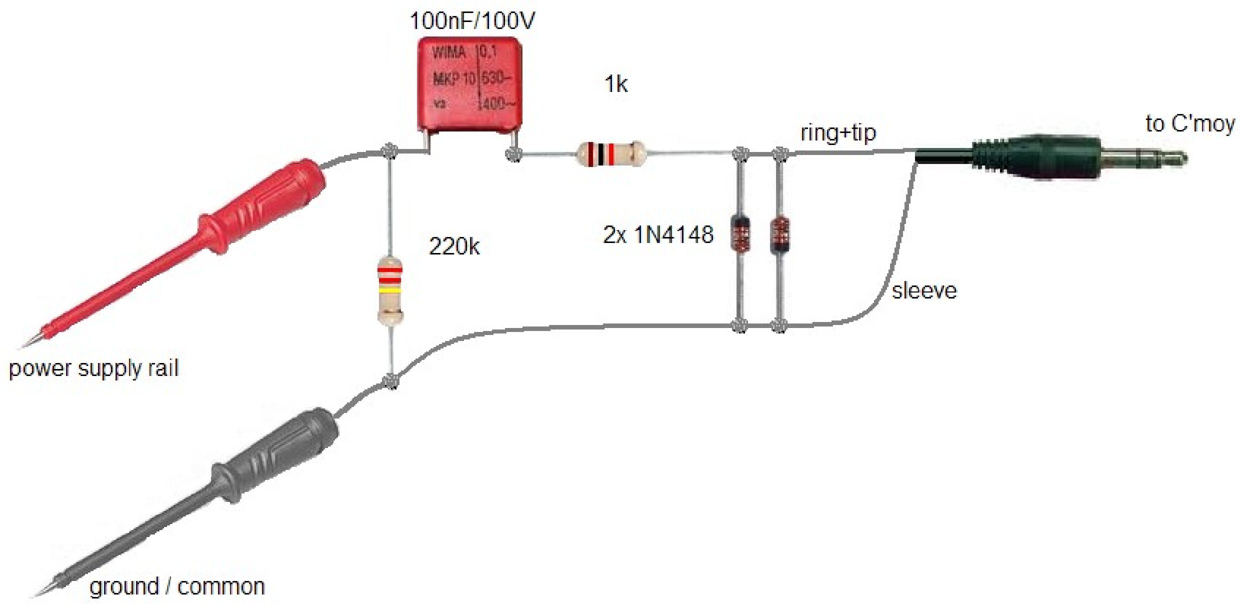
The headphone is connected in parallel to 4 diodes of which 2 of those are in anti parallel.
NOTE the orientation (silver stripe) of the diodes which are polar devices.
What these diodes do is 'clip' any signal (DC and AC) to +/- 1.5V so the headphones won't receive any high voltage levels. This protects the ears as well as the headphone.
So max 1V AC signals will give max 30mW power in 32 Ohm headphones (lower when a higher impedance headphone is used) or when clipping large AC signals 50mW so the headphone will not be destroyed.
IF this is too loud you use only a set of 2 diodes and clip at +/- 0.7V.

To ensure only AC signals reach the headphone an input coupling cap is needed.
This MUST have a minimal voltage rating of 100V and MUST be non-polar or bi-polar, so polar caps like 'normal' electros and tantalum caps can NOT be used.
The value should be between 2.2 µF and 10µF, the bigger the value the lower frequencies you can hear (hum e.t.c.).
Values above 10µF are NOT recommended.
In series with this capacitor and diodes a small resistor is added which acts as a current limiter.
When the circuit is connected to a voltage rail a short and relatively high peak current occurs while charging the coupling cap and this current is somewhat limited by this resistor.

When connected to an AC power-supply it will act as a fuse and burn out if connected too long.
a 0.5W rating is O.K. and 10Ω will limit enough for the short period the capacitor is charged, while at the same time not cause too much attenuation of the monitored signal when a 32Ω headphone is used
(2x 32Ω in parallel = 16 Ω)
When a 120 Ω headphone is used the 10Ω resistor can be increased to 47 Ω limiting the current even more.

Directly on the input of the circuit there is a resistor that 'bleeds' the capacitor when it is disconnected from the monitored power supply.
This prevents a high voltage from remaining at the input (across the cblocking cap) after it has been disconnected from a power supply rail.
When this resistor is not present this could potentially destroy parts of the circuit or power supplies it is connected to after another voltage was monitored.
The value must be high enough to not load the DC power supply too much or use up too much power and low enough to drain a 10uFcapacitor in a few seconds.
A 47k resistor will do, at 100V DC this will draw 0.2W so a 0.4W to 0.6W resistor is recommended.

For those wanting to have a smaller load on the power supply lines and also seeking a higher sensitivity (gain so you can hear 'deeper') and perhaps also want to listen out for low level hum e.t.c. it is possible to use a slightly different 'front-end' that connects to a BATTERY fed C'Moy type of amplifier.



This circuit has a much higher impedance and goes lower in frequency range as well.
Connecting it to the power supply lines will give a considerable louder 'tick' in the headphone that is connected to the C'moy because of the gain and the higher output voltage.
The amplifier itself (input) can NOT be damaged when this front-end is used, nor is it likely you will be damaging your ears and headphones because of the limited output power these C'Moy amplifiers have.

This circuit is also well suited to be connected to the line-in of a sound-card.
When a good quality sound-card is used at the highest possible sampling rate you can look far below (10Hz) and above (50kHz) the audible range and even with levels down to -120dB.
Simply make a recording and analyze the frequency spectrum with a freeware program such as audacity.

How to use this circuit ?

Connect the 'ground' (black probe in the drawing) to the 'common' or 'ground' of the power supply at the point where the ground is the same as the signal ground .
connect the test pin to the power line you want to check and LISTEN to the actual power supply line or record it using the sound-card of a PC. You can test circuits under load conditions or when 'idle'.
While connecting the probe you will hear a loud tick or 'sparky' sound (this is the charging of the coupling cap) and after that you will actually hear the noise/hum on the power line in the same volume as you would while listening to an audio signal from an amplifier.
Do NOT use this circuit to test any signals before the rectifier.
If you have no clue what a rectifier is or does I do not recommend to use this 'sniffer circuit'.

Educate yourself about HOW much noise or garbage is present before and after regulators or what signals are present on a power supply of a power amp during actual operation with real music and the actual load.

a word of **CAUTION !**

Be careful NOT to short any power supply (line) or slip off measuring points with the test probes.
WAIT with connecting this circuit to another power supply rail for about 2 to 3 seconds after it had been disconnected from an earlier measurement.
USE this circuit at your own RISK

I hope you find this circuit useful... I have.

Solderdude