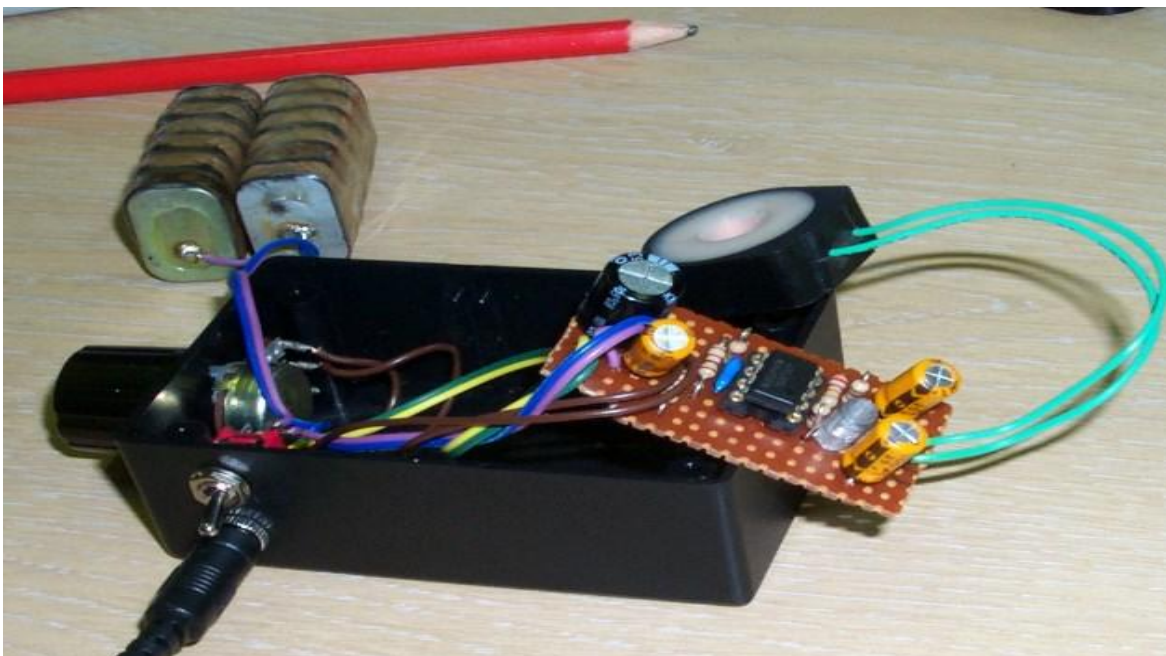


Mains Hum Survey Probe

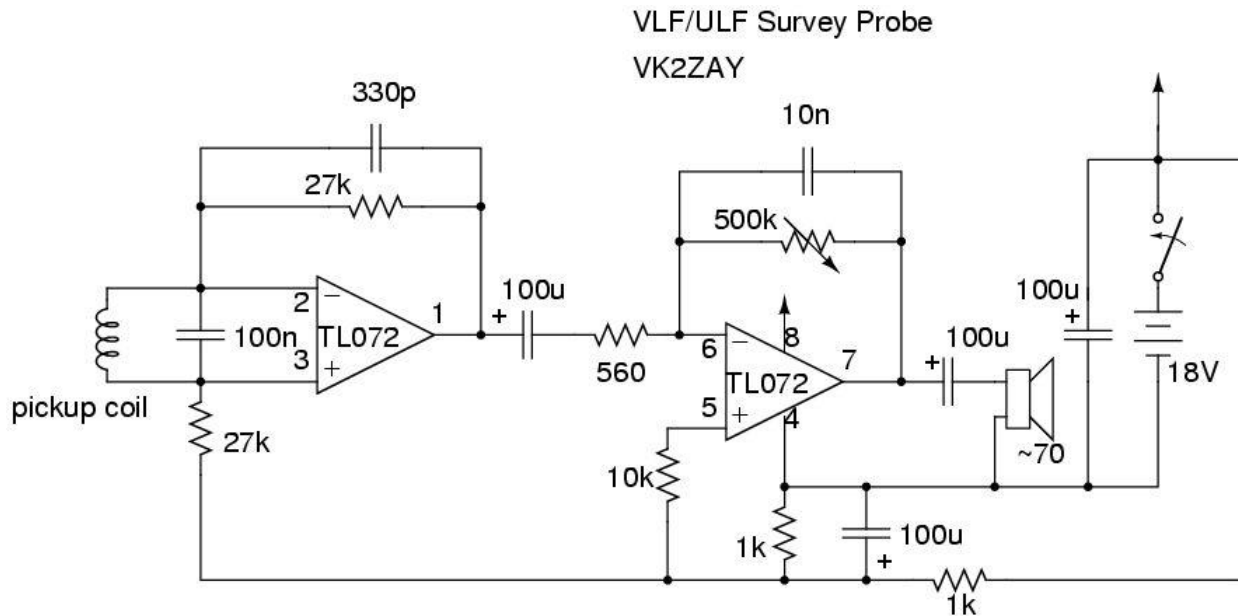
I've been working on VLF/ULF reception recently. In order to get a feel for the local mains noise I pieced together a simple opamp transimpedance loop preamp. With only a surplus solenoid coil for the transducer and moderate gain I got a huge signal out of the preamp, almost 500mV pk-pk. Clearly I'll need to go somewhere more electrically quiet for my VLF/ULF hunting.

I figured I may as well build the preamp into a portable unit so I could scout out quiet areas in the local region, hoping not to have to go too far into the bush to get away from the BUZZZZ!

I wanted to retain the TL702 opamp from the breadboard circuit for its fairly good noise factor. No where near as good as I'll need in the future full scale loop preamp, but I wanted to keep the noise low enough that when the mains garbage gets weak the circuit won't deafen me with hiss as I rack up the gain. This requires running the circuit off at least 10V. As hard as I tried, I just couldn't get the circuit to behave properly of 9V (especially as I am abusing the output with such a low impedance load, direct into a pair of 70 Ohm stereo headphones.) I settled with using 18V from a pair of 9V batteries. If I knew that voltage swing would be a problem in the first place I would have used the pair of 9Vs for a dual rail supply in a more conventional manner.



Fortunately the whole assembly fitted snugly inside the smallest Jaycar zippy box. At least once I skinned the batteries and soldered direct to their plates! The board was cut to mate neatly with the PCB slots in the box walls, the pickup coil nicely friction fitting between the chip at the end of the box. Just enough room was left once the middle of the box was consumed by the batteries to fix the gain pot, power switch, and 3.5mm stereo jack. Sometimes Murphy smiles on you and things come together perfectly.



The circuit is a fairly conventional frequency limited transimpedance amp of fixed gain, largely determined by the DC resistance of the pick-up coil. The other amp in the 8 pin package is used to provide a headphone acceptable power output, its gain is controlled by varying its feedback resistance to provide volume control and offer large dynamic range. I experimented with DC coupling of the two stages, but the untrimmed offset voltage of the preamp swings the output into saturation at any reasonable gain. This is only for aural use anyway so response below 20Hz is not required, still a largish 100uF coupling capacitor was used to get a good corner frequency (and I had a large packet of them sitting on the bench).

It takes a truly enormous signal to drive the preamp into clipping. Such signal levels would not be seen except perhaps when the device is used to locate mains wiring inside walls, or is accidentally turned on within a few inches of a computer monitor. I used carbon resistors, which was a mistake, noise wise, but the result seems fine, the transducer is too small

physically to pick up signals of the kind that would require excellent noise levels.



I used a transimpedance preamp because I am working with magnetic signals here. When I think magnetic, I think current. Unlike electric fields where potential is the thing you want to amplify, magnetism is all about moving charge. It is easier to get the current gain with the virtual earth/short of the opamp input to satisfy the inductive transducer than it would be to get the massive input impedance for a capacitive probe of similar dimensions. I guess I could have built a FET input device with a small capacitive plate or whip, but the magnetic transducer has an excellent null which is good for locating noise sources, while the vanishing short monopole is almost isotropic.

It is fun to go for a walk with the unit. Many man-made things produce near field magnetic radiation that this device picks up easily. It displays the awesome penetrating power of a magnetic field, AC hum is easily detected through inch thick slabs of iron. My mobile phone makes an almost melodic series of pocs and chirps as it goes about its maintenance cycle. Computer monitors make grating tones for many metres. Inside a car the alternator whine and ignition noise is unstoppable. Power cables inside walls are

easily located, and can be centred quite accurately because of the deep null pointing out the top-center of the unit. It is almost impossible to quiet the din however, so far I have never been in a location quiet enough to not hear the familiar buzz (or soft hum is the mains is pure enough - e.g. miles from fluros).

With a larger coil a circuit not unlike this one would be suitable for VLF/ULF monitoring. When I find a quiet enough spot, the transimpedance topology will likely feature in my preamp for the big loop. A lower noise opamp would be preferable, probably a LM833 or better, and more pains would be taken with metal film resistors, DC offset, and MF/HF rejection. The virtual earth/short property of the opamp inputs tends to neutralize the winding capacitance (there is almost no voltage across them), at least as fast as the opamp's slew

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