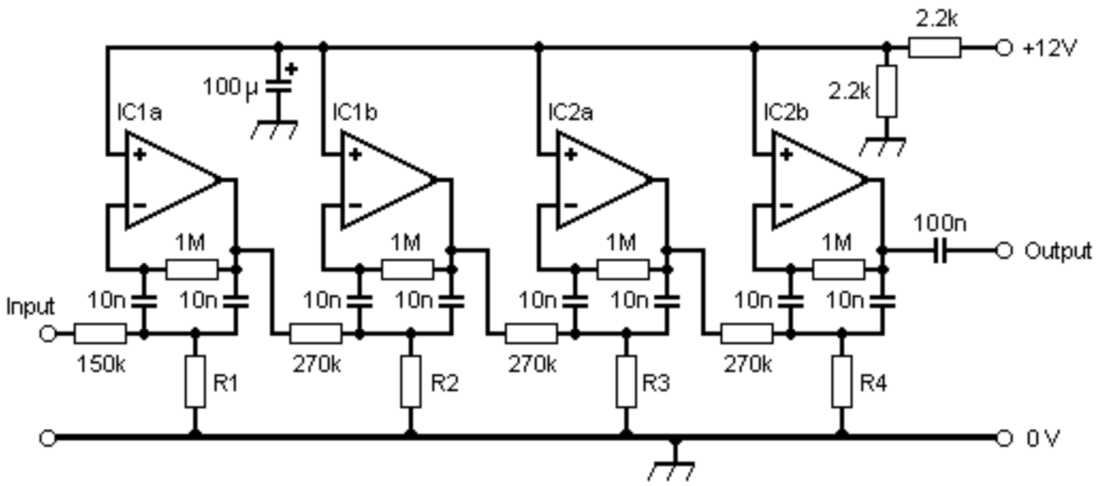
GW4ALG's 136 kHz Pages

Audio Filter

The PA0LQ Audio CW Filter

When Harry Grimbergen, PA0LQ started receiving noise on 136 kHz from thyristors and triacs, he developed a very effective AF Adaptor, with built-in noise blanker and 30 Hz CW filter modules. The circuit below (see Figure 1) shows the four-pole active filter section of the adaptor (built around the TL072 dual opamp IC), and centred on 1000Hz. The circuit and details have been extracted from Harry's original schematics and notes of the complete AF Adaptor which Harry sent to me in October 1999.

Figure 1 - The PA0LQ Active Filter



R1: Approximately 180 ohms, adjust for 966 Hz
R2: Approximately 180 ohms, adjust for 982 Hz
R3: Approximately 180 ohms, adjust for 1018 Hz
R4: Approximately 180 ohms, adjust for 1034 Hz

In his letter, Harry wrote, "For the alignment of the four pole 30 Hz opamp filters, a stable audio generator with frequency counter and an oscilloscope is needed as the adjust frequencies given above must be accurate to within 5 Hz in order to get the flat phase response for ringing-free reception. Adjusting R1 to R4 for the proper frequencies also compensate for the C tolerances, which can be up to 10%. But the components must be stable. So use either polystyrene or mica capacitors, and metal film resistors."

Results

I am absolutely delighted with the performance of my PA0LQ filter! In my case, I have centred my filter at about 800 Hz (not 1000 Hz), and it is indeed possible to adjust the filter to provide a very narrow passband, which is free of ringing. It is certainly the best audio filter I have ever used.

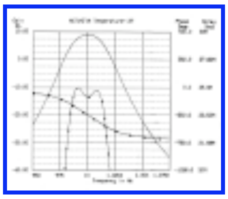
Providing that the receiver AGC is not being hit too hard by a strong signal, the filter readily separates stations which are only 100 Hz apart to yield a very pleasing CW tone that is easy to read - even at 25 wpm!

When I worked Ossi, OE5ODL at 09:45 UT on Saturday 26th February 2000, this was another new 'first' on 136 kHz (first OE-GW 2-way QSO). Of course, the 136 kHz band was quite busy (it always is on a Saturday) and I have no doubt that this QSO would not have been possible without my newly constructed audio filter. Whenever I switched the filter out, Ossi's signal simply disappeared into the QRM!

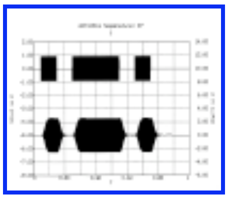
Computer Simulations

The graphs below show the computer predictions of filter performance forwarded to me by Harry PA0LQ. Click on the thumbnail sketch to show the full-size graph.

Performance: Frequency Domain



Performance: Time Domain

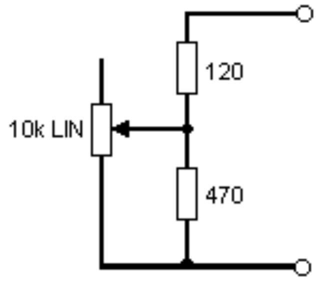


Alternative Alignment Method

One major problem in aligning the filter was that I did not (and still do not) have access to a frequency counter having a resolution better than 100 Hz. Given the choice, I would have followed Harry's alignment instructions exactly. However, without the ability to make accurate frequency measurements, I had to devise an alternative method. This section describes my approach, using a dual beam [two channel] oscilloscope.

Figure 2 - Adjustable Resistor Network

The first thing I did was to construct four adjustable resistor networks with which to



find the required values for R1 - R4.

Each of the four networks used resistor values as shown in Figure 2. Once the filter had been finally adjusted, a digital multimeter was used to measure the required value and hence select the required combination of fixed value components.

Initially, I peaked all four stages of the filter to the frequency of the FT707 sidetone generator, at about 800 Hz. This resulted in a very narrow bandwidth - perhaps about 20 Hz. But this was far too narrow for practical purposes, because:
- the backlash in the FT707 VFO mechanism prevented accurate tuning;
- the IRT (Clarifier control) adjustment was too coarse;
- the amount of ringing meant that normal-speed CW would not pass through the filter.

Of course, Harry's design necessitated that the filter was aligned using staggered tuning of the four stages.

Having decided to align the filter to the frequency of my sidetone generator, I used the oscilloscope's Channel 1 input to monitor the input to the filter (from the FT707). The output of the filter was monitored using Channel 2, and also fed to a separate amplifier & loudspeaker.

With all four stages of the filter still peaked to the frequency of the FT707 sidetone generator, the ringing could be seen quite clearly: when keying the FT707 with 'dots' from my electronic keyer - the output of the filter never went to 'zero'!

I then replaced the resistor network on the first stage (R1) with equivalent fixed-value components.

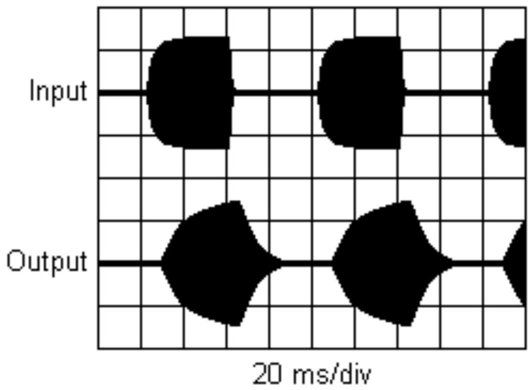
Then, I set the electronic keyer to send dots at about 30 wpm rate. Using the remaining three variable resistors, I adjusted them with 'skill and dexterity' [or was I guided by good fortune?] until the output waveform 'looked right' (see below). I then replaced the three adjustable resistor networks with fixed value components.

Output Waveform

Once I had soldered in fixed resistors for R1, the approach I used was to set the tuning of the remaining poles (R2-R4) for minimum ringing, as seen on Channel 2 of the oscilloscope. All adjustments were made while keying 'dots' on the FT707 at about 30 wpm.

Once aligned, the filter output signal had reduced to about 25 % of the maximum output voltage (which had occurred when all four poles were tuned to the same frequency). The final waveform showed an exponential increase in the keyed envelope, until, at peak amplitude, an exponential decrease to zero then followed. A hand-drawn illustration of what I saw on the oscilloscope is shown in Figure 3.

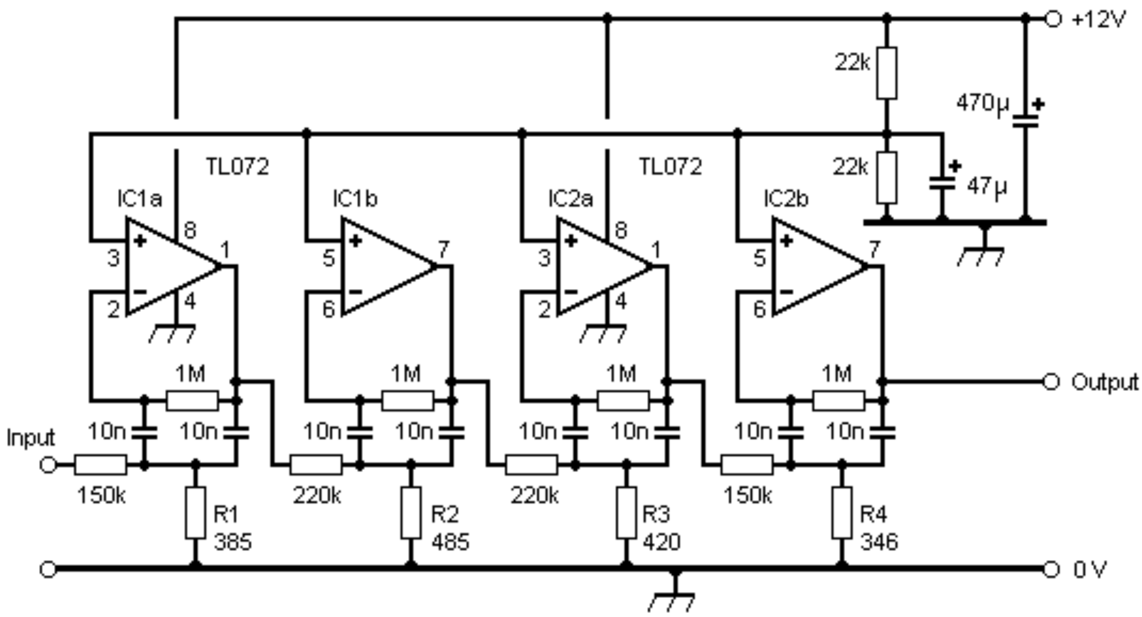
Figure 3 - Comparison of filter input and output waveform



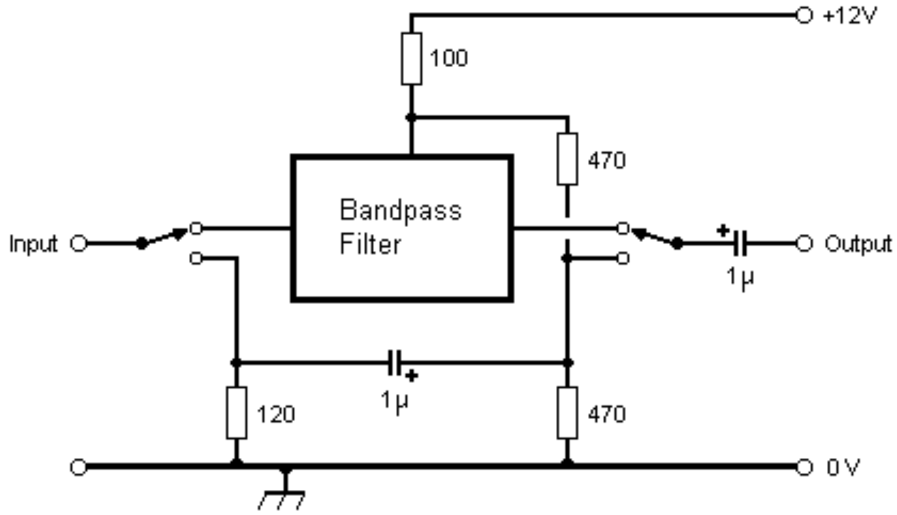
I do not know how close I got to Harry's intended alignment points, but the results are superb!
I can receive 25 wpm easily through the filter, and the bandwidth would seem to be less than 45 Hz, but I cannot measure it. Also, the VFO drive mechanism & IRT of my aging FT707 cope very well with the bandwidth & shape factor.

My procedure for aligning the filter may not result in optimum performance, but it produces much better results than just ‘tuning for maximum smoke’. The final values used are shown in Figure 4, and the filter bypass switching is shown in Figure 5.

<u>Figure 4 - Audio Filter, following alternative alignment procedure</u>



<u>Figure 5 - Filter IN/OUT switching arrangement</u>



The two 470 ohm resistors serve to hold the positive end of the 1 uF capacitor at about half rail - about the same potential as pin 7 of IC2b. This helps to reduce the level of the 'click' that occurs when switching the filter in and out of circuit.

The circuit of Figures 4 & 5 was built on plain matrix board into a modified 'multi-media' PC speaker unit ('Creative' model SBS20 - £15 from PC World).