Low Pass SCAF Filter

This filter is designed to help out any radio that lacks selectivity when used in CW mode. It operates on the audio output of the radio and should be fitted inline between the radios output and the speaker. The kit will produce a standalone unit that can quickly be transferred between radios if required. The unit has a built in audio amplifier that can be set to boost the audio output from radios that normally would only drive headphones.

The kit is complete with its enclosure and custom printed drilled panels to help you build a professional looking filter that you can be proud of.

Specification:-

Power Source :-	12-15v DC
Max filter Bandwidth :-	Approx 1.6Khz
Min Filter Pass Frequency:-	Approx 300Hz
Stop Band rejection:-	Approx 40dB
Filter Type :-	5th order Low Pass SCAF
Building Difficulty level (1-5):-	3 (some experience helpful)

Building the Filter

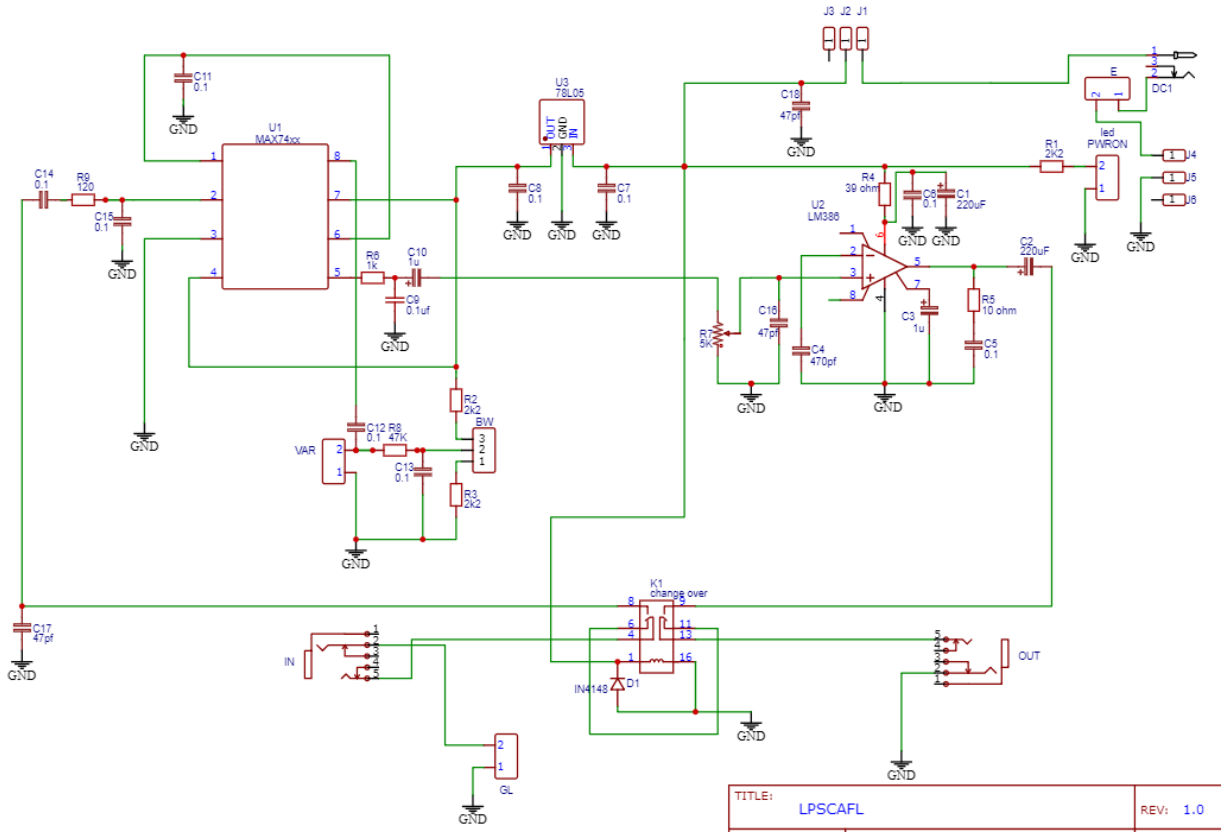
The filter is relatively straightforward to build but does require some care as the finished board needs to fit correctly into its case. So take your time and read ALL the instructions first to make sure you don't missing something.

Check you have all the parts before you start:

1 x	SCAF LPFilter PCB	☐
R1,R2,R3	2K2 ¼ Watt Resistor	☐
R4	39 Ohm ¼ Watt Resistor	☐
R5	10 Ohm ¼ Watt Resistor	☐
R6	1K ¼ Watt Resistor	☐
R7	10K Blue Trimmer	☐
R8	47K ¼ Watt Resistor	☐
R9	120 Ohm ¼ Watt Resistor	☐
C1,C2	220uF Electrolytic Capacitor	☐
C3,C10	1uF Electrolytic Capacitor	☐
C4	470pf Disk	☐
C5, C6, C7, C8, C9, C11, C12, C13, C14	0.1uF Disk Capacitor (Marked 104)	☐

C15	0.1uf MLCC 5.08mm spacing yellow Disk Capacitor ☐
C16, C17, C18	47pf Disk Capacitor (Marked 47) ☐
IC1	MAX7426 SCAF Chip ☐
IC2	LM386 Audio Amplifier ☐
IC3	78L05 5V regulator ☐
VAR	Var-Cap Diode 1SV149 ☐
1 x	10K Bandwidth Pot & Knob ☐
1 x	1N4148 Diode ☐
2 x	8 Pin IC Socket ☐
2 x	PCB Mounting Jack Socket ☐
1 x	2.1mm PCB Power Socket ☐
1 x	PCB Changeover Relay ☐
1 x	PCB Mounting Power Switch ☐
1 x	3mm Power LED ☐
1 x	SCAF Case and front/Rear panels c/w Top Sticker ☐
1 x	Set of case/PCB fixing screws and Feet ☐
2 x	2 pin headers and jumpers
1 x	spacer 'stick'

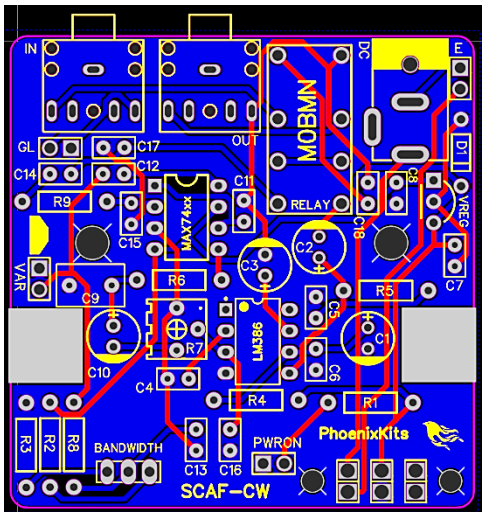
Ok so let's make a start, here is the circuit diagram



The heart of this filter is the MAX7426 Chip, the circuit for this part is more or less straight out of the data sheet, by changing the frequency of the internal oscillator the cut off frequency can be changed from about 1.6K down to just a few hundred Hz. The oscillator operates in an X100 mode so if the oscillator is running at 100KHz the cut off frequency will be 1KHz. The oscillator's frequency is changed by a single capacitors value, to make it easy to adjust this we are using a var-cap diode. The voltage for this must remain stable or the cut-off point would keep changing. The filter uses a small 5v regulator to ensure that the control voltage for the frequency selection is stable and also to power the SCAF chip which needs 5v supply max. The output from the chip goes to a simple RC lowpass filter with a cut off around 1.6KHz then into an audio amplifier, the amplifier uses a well-known chip and a Zobel Network on the output makes sure that it performs at its best. The gain of the amplifier is fixed to 20dB which will produce plenty of audio.

The filter has an on board volume control that is set once during the setup stage after that the volume level with or with the filter will be the same.

Building the Filter



All parts are board mounted. This makes for a very neat professional looking filter when finished.

The filter fits into a case that comes with front and back panels that are pre-drilled and screen printed.

The first task is to fit the two IC sockets. On one of the short sides of the sockets you will see a small cut out or dimple. When fitting the sockets on the board line up this dimple with the dimple shown on the silk screen printing.

1) 2 x 8 pin Sockets fitted ☐

Now let's move onto fitting the resistors.

2) Start with fitting R1, R2 and R3. All are 2K2 resistors ☐

3) Now continue fitting the other fixed value resistors
   R4 39 Ohm ☐
   R5 10 Ohm ☐
   R6 1K ☐
   R8 47K ☐
   R9 120 ohm ☐

4) Next fit the small Blue variable trimmer R7, this is the volume balance control. ☐

5) Now move onto the Capacitors, fit C4 which is a small 470pf Ceramic disk. ☐

6) Now to fit the large number of 0.1uf disk capacitors.
   C5 is the first of a number of decoupling capacitors , all of the are 0.1uF disks marked '104'
   Now fit C5, C6, C7, C8, C11, C12, C13, C14, C15 (all 0.1uF Disks) ☐

7) C9 is to be fitted next this is also 0.1uf in value but it's a little larger than the others and is yellow in colour with a 5mm pin spacing . ☐

8) Now fit C16, C17, and C18, all of which are 47pf Disk Capacitors. These are to help with RF immunity. ☐

9) Now fit C1 (But don't be tempted to fit C2 at this stage)
   C1 is a 220uF capacitor, it has one leg longer than the other. It MUST be fitted the correct way round on the PCB. The long leg is the +V side, if you look at the PCB you will see the silk screen printing for this part as below.

   Note the '+' sign. Make sure you put the long lead in this side.
   This is the same arrangement for C2,C3 & C10.
   The value of the capacitor is written on the body but the two 220uF capacitors are the largest in the kit.

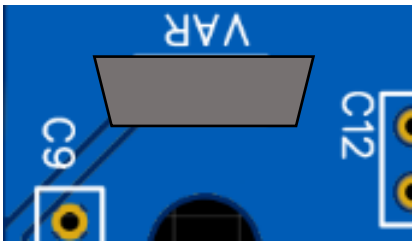
   C1 fitted and polarity checked. ☐

10) Locate and fit C3 and C10, these are similar to the last two parts just smaller and are marked 1uF (make sure you fit them the right way round as above) ☐

It's about time you took a break now, take the opportunity to rest your eyes. When ready spend a few minutes checking your work and that the right parts are in the right place. Check the soldering, are there any solder bridges between pads? Poor soldering is the number 1 problem with all kits. ☐

11) The filter has three active devices, you have fitted sockets for two of them. The third device (VREG on the board) is a 5V regulator, it will be marked 78L05. Push this into the place shown on the PCB, make sure you fit it as shown on the silk screen. Do NOT push this flush to the board, you would break its legs, it should sit 5 or 6mm above the PCB. ☐

12) Now to fit the var-cap diode, this is 1SV149 device, it has two legs and must be fitted the correct way round.



This device is trapezoidal in shape, it should be fitted as shown on the left. This is an easy part to fit the wrong way round so take care. ☐

13) Now fit the large orange relay, it will only fit one way, just make sure you don't have any pins folded under it when you solder it. ☐

14) Now fit C2 , instructions as in step 9 above. It's a tight fit just behind the relay.

15) Fit the flyback diode D1 which is a 1N4148 (its by the Power socket) ☐

16) You have three 2 pin jumpers and PCB 2 way pin blocks, fit these in positions marked GL and E on the PCB. You must fit the jumpers onto these pins. ☐

17) You have two audio jack sockets, the pins need to be very straight to drop into their holes so take your time fitting them. ☐

18) Now we need to fit the last connector the DC Power socket, when you fit this part make sure its as close to the edge of the board as you can. ☐

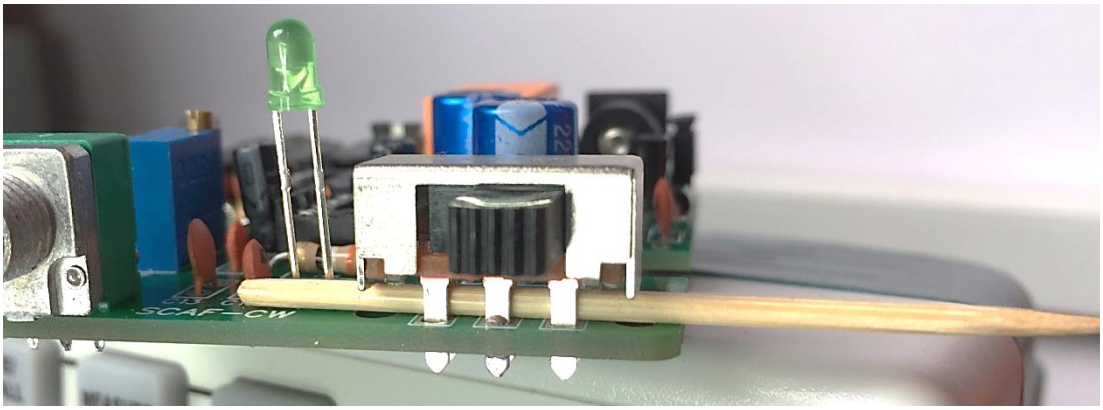
19) Now the Bandwidth control. This control has a small metal tag, this tag should line up with a small hole on the front panel. More on this tag later…. ☐

20) Fit the two IC's, make sure you fit them the right way round. Pin 1 of each chip has a small dot in the plastic on top of the chip by its side. Pin one of the LM386 audio chip is near to C10 and pin 1 of the SCAF chip is near C12. Make sure no pins are folded under the chips. If unsure which chip should be fitted in which socket take a look at the pcb layout drawing above. ☐

21) Now we need to fit the Power ON LED. This will be bent over and pushed into a hole on the front panel in the end. You will see that the LED has two legs, one shorter than the other, this short leg goes into the square hole in the position

shown for the LED. Do not push this right down, just put the LEDs legs through the board so about 12 mm of the LED's leads are above the board. This will allow you to use pliers to bend the legs so the LED can be pushed into its hole on the front panel. ☐

22)Last part, now find the on/off switch, DO NOT FIT IT yet, You will also find a short 'Cocktail' stick, this stick is used as a spacer for the switch to make sure its fitted at the correct hight, once fitted just throw the stick away. Drop the switch into position. Push the stick between the two rows of pins so the switch is sitting on it, this is the correct height needed. Now solder a couple of pins, make sure the switch is square and solder the pins. Once done remove the spacer stick. ☐



23)Now fit the PCB in the case, this can be a little fiddly. Loosely fit the front panel first and place the rear panel in the rear grove of the case. Now you should be able to fit the PCB into the case with its fixing screws. Bend the LED so it protrudes through the front panel. Fit the control knob and then fit the stick on feet to the bottom of the case to stop it sliding around your desk. There is also a sticker for the top of the case but that's up to you if you want to fit it. (May be fitted already) ☐

Note

If you feel the mounting slot for the switch could do with being moved up /down, left/right a little which can happen depending on how you fitted the switch all is not lost. Remember the tag on the bandwidth control? Well if you remove the front panel again and now snap off the short tag. This will allow a little jiggle room on the front panel before you tighten the bandwidth nut.

Well done its built!, now to set it up.

Setting up your filter.

This filter is very easy to setup, there is very little to adjust! In fact the only setting to adjust is the balance between the filter on and off volume levels. With the speaker output of the radio and external speaker connected apply 12 to 15v dc to the power input. With the unit in 'Bypass' mode the audio from the radio is fed via the relay to the external speaker jack with no filtering at all. Turn the filter on and the audio is now routed through the filter and its on board amplifier. The volume should be the same level (some people like a little boost,that's fine) turn the bandwidth control to the widest postion. On the filter board you will see the volume trimmer so with the filter turned on adjust this control to get the volume balanced or how you like it. Turn the filter on and off to check the levels. Once done that's it you are ready to go! Put the lid on and give yourself a pat on the back (if that's possible), do not over tighten the lid screws as it can distort the case. Now you can enjoy a big reduction in QRM and noise. Do remember that this is a low pass filter so if you tune in a CW signal with a side tone of 600Hz as you adjust the filter you will be able to reduce the bandwidth down to match the sidetone, if you adjust it past that point you will start to filter out the signal you are trying to listen to. Its very easy to use and highly effective I am sure you will agree.

I Hope you enjoy building and using the Phoenix LPSCAF. 73 Paul. M0BMN

Extra Information

You can just use the filter as above, which was how it was designed to be used after all, but…

If you are looking to get a sharper cut-off and deeper out of band cut-off you can change the MAX7426 chip for a few other pin for pin compatible alternatives, the standard chip gives just under 40dB out of band rejection, you could swap this out for a MAX7403 chip that will give upto 82dB rejection, the cut-off slope is not quite that of the standard chip but a big difference in out of band rejection. Alternatively you can fit a MAX7400 chip that has a similarly cut-off slope to the original but with about 60dB cut-off band rejection.

Trouble shooting….

Hopefully you will not have problems. I have had a few people use this filter for a number of months and on many different setups. Any problems have been traced to poor station grounding and earth loops. The proper way to do things would be to earth each piece of equipment in the shack with a sizable earth wire and make sure you have no daisy chaining. Not that easy to do. I have a few ways to get round this problem.

If you find you have a problem with buzz or hum it's likely an earth loop,

Now you can remove jumper 'GL' (this breaks the ground connection from the audio input). Try this first, if that doesn't cure it then try the jumper 'E' this breaks the 0v connection from the Power supply. You cannot do both options at the same time. This should sort out this problem, it's not the right way to do it at all. The proper way is to sort out the station earths! With most of us using shacks indoors and often in an upstairs spare room proper earths are a real issue. Your station reception will be better, less noise, and less chance of receiving AND generating RFI too if you can get this sorted.

Enjoy the filtered audio.

Vy 73 Paul M0BMN