Low-Pass Filter Designs

Notes: These filters have been designed to allow WSPRlite units to meet regulatory requirements for spurious emissions. The filters are seven-element Chebyshev designs. The filters are symmetrical (either end can be an input or output). When implemented with NP0/C0G capacitors and inductors with a Q of 140, they will have an in-band loss < 0.4dB, a second harmonic attenuation > 43 dB and a third harmonic attenuation > 65dB.

Some of our low-pass filter circuit boards allow for more complex filter designs to be implemented with capacitors in parallel with the inductors. These capacitor, labelleled CP-Lx in the circuit diagram below, are not used in the following designs.

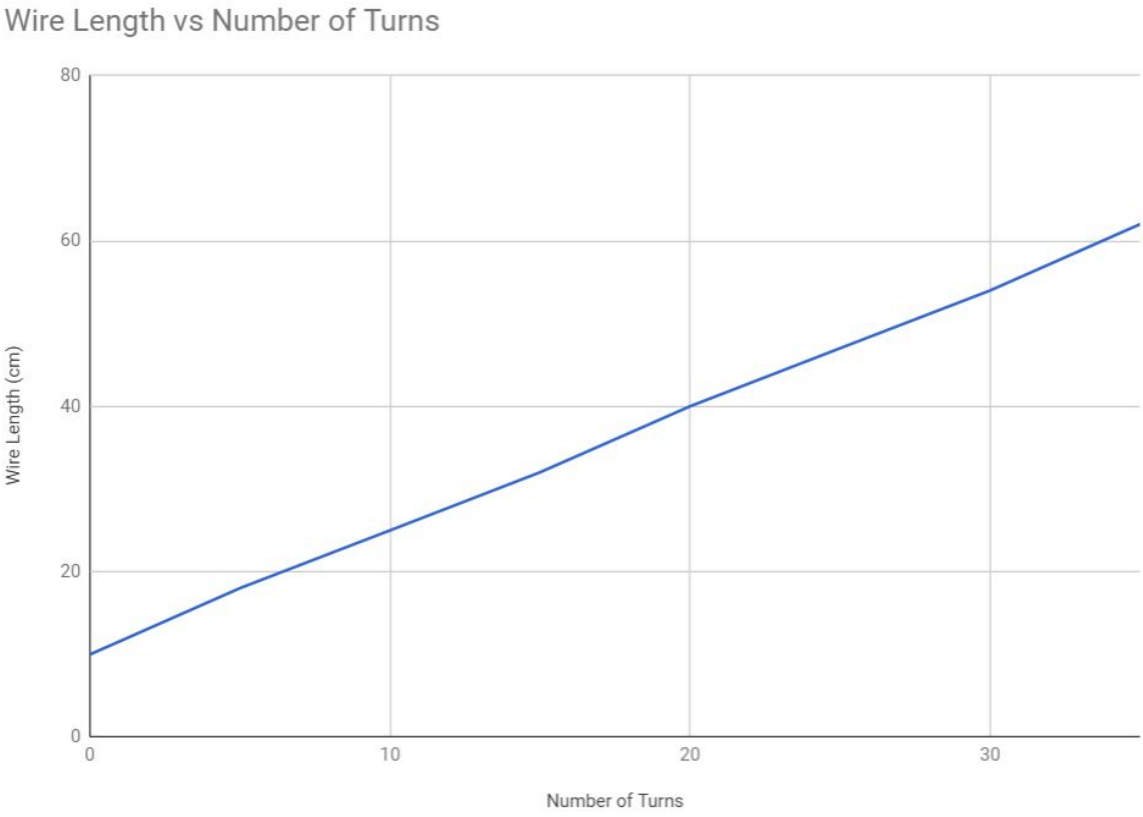
As our PCBs allow several filters to be implement, the component designators on the PCB will not be the same as those in the diagram below. However, it should be straightforward to work out which component goes where. If in doubt, contact us before soldering!

Tips about capacitors
For good performance in low pass filters we use only capacitors with a C0G or NP0 type dielectric. If you mislay or damage one of the capacitors we have supplied, you can replace it with one with a similar dielectric. Capacitors are marked with their value on the dipped case of the component. The markings are very small and are best viewed with a lens. To aid component identification, we colour-code the capacitors.

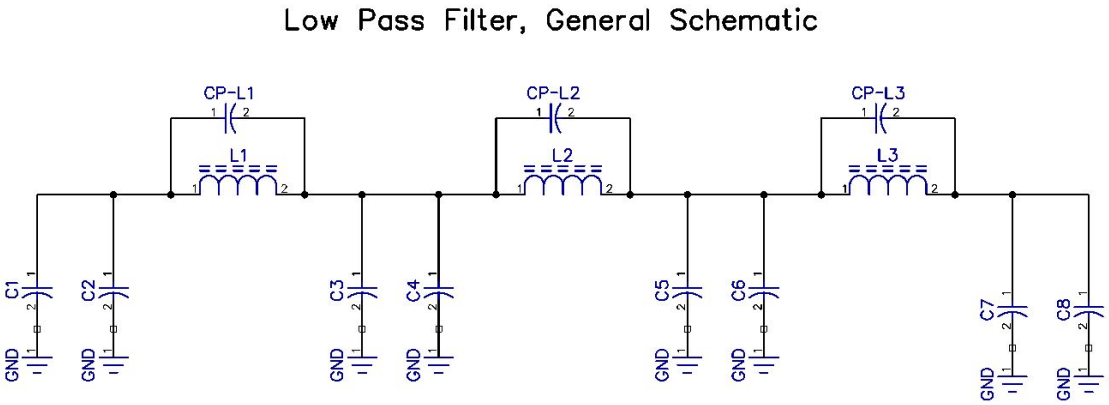
Tips about inductors
Winding toroidal inductors is very simple. Each time the wire passes through the centre of the core counts as a turn. As a general rule, spread the windings evenly so that they cover about 75% of the core's circumference. If there are lots of turns (such as in the case of the 160m filter), they can be overlapped. There are many videos showing ways to wind toroidal inductors:
https://www.youtube.com/watch?v=sDIWNHOoNh8
https://www.youtube.com/watch?v=VSLXcmE05zY

If you have an inductance meter, you can use this to get the values more exact by squeezing the turns together to increase inductance or spreading them apart to reduce it.

The following graph shows how much wire you need for various numbers of turns. The length includes an allowance for 5cm tails (T50 core).



The enamelled copper wire supplied has an insulating enamelled cover. This must be removed to allow soldering to the wire. The usual way to do this is using a bead of solder on the tip of a hot soldering iron. Don't breathe the fumes as the enamel burns off.
https://www.youtube.com/watch?v=Mjjryf2aqaY
You can also use fine glass-paper:
https://www.youtube.com/watch?v=Pd5Q-XDmvys



Notes:
CP-L1, CP-L2, CP-L3 are not used in the following designs.
All capacitor values in pico Farads (pF), marking below in quotation marks (e.g. “152”)

All inductor values in nano Henries (nH). Number of turns below in quotation marks (e.g. “10T”). If you have an inductance meter you can use that to adjust the inductors. However, be aware that many cheap LCR meters are not accurate. We recommend the LCR45 - click to view.

160m

C1	C2	L1	C3	C4	L2	C5	C6	L3	C7	C8
Not used	1500 “152”	4500 “32T”	1200 “122”	1500 “152”	5000 “34T”	1500 “152”	1200 “122”	4500 “32T”	1500 “152”	Not used

Other information
Inductors wound on T50-2 cores (red). 1200pF = bagged, 1500pF = blue line

80m

C1	C2	L1	C3	C4	L2	C5	C6	L3	C7	C8
Not used	820 “821”	2500 “24T”	Not used	1500 “152”	2700 “25T”	1500 “152”	Not used	2500 “24T”	820 “821”	Not used

Other information
Inductors wound on T50-6 cores (yellow). 820pF = bagged, 1500pF = blue band

60m

C1	C2	L1	C3	C4	L2	C5	C6	L3	C7	C8
390 “391”	220 “221”	1820 “20T”	1000 “102”	100 “101”	2020 “22T”	1000 “102”	100 101	1820 “20T”	390 “391”	220 “221”

Other information
Inductors wound on T50-6 cores (yellow).

40m

C1	C2	L1	C3	C4	L2	C5	C6	L3	C7	C8
Not used	470 “471”	1400 “18T”	Not used	820 “821”	1600 “20T”	820 “821”	Not used	1400 “18T”	470 “471”	Not used

Other information
Inductors wound on T50-6 cores (yellow). 470pF = bagged, 820pF = bagged

30m

C1	C2	L1	C3	C4	L2	C5	C6	L3	C7	C8
Not used	270 “271”	981 “15T”	470 “471”	100 “101”	1100 “16T”	100 “101”	470 “471”	981 “15T”	270 “271”	Not used

Other information
Inductors wound on T50-6 cores (yellow). 100pF = pink line, 270pF = thin red line, 470pF = bagged

20m

C1	C2	L1	C3	C4	L2	C5	C6	L3	C7	C8
Not used	180 “181”	705 “13T”	Not used	390 “391”	793 “14T”	390 “391”	Not used	705 “13T”	180 “181”	Not used

Other information
Inductors wound on T50-6 cores (yellow). 180pF = green line, 390pF = bagged

17m

C1	C2	L1	C3	C4	L2	C5	C6	L3	C7	C8
Not used	180 “181”	549 “11T”	Not used	270 “271”	617 “12T”	270 “271”	Not used	549 “11T”	180 “181”	Not used

Other information
Inductors wound on T50-6 cores (yellow). 180pF = green line, 270pF = thin red line

15m

C1	C2	L1	C3	C4	L2	C5	C6	L3	C7	C8
100 “101”	10 “100”	471 “11T”	Not used	270 “271”	530 “11T”	270 “271”	Not used	471 “11T”	10 “100”	100 “101”

Other information
Inductors wound on T50-6 cores (yellow). 100pF = pink line, 270pF = thin red line

12m

C1	C2	L1	C3	C4	L2	C5	C6	L3	C7	C8
100 “101”	10 “100”	398 “10T”	Not used	220 “221”	449 “10T”	220 “221”	Not used	398 “10T”	10 “100”	100 “101”

Other information
Inductors wound on T50-6 cores (yellow). 10pF = bagged, 100pF = pink line, 220pF = red line

10m

C1	C2	L1	C3	C4	L2	C5	C6	L3	C7	C8
Not used	100 “101”	343 “9T”	Not used	180 “181”	386 “9T”	Not used	180 “181”	343 “9T”	100 “101”	Not used

Other information
Inductors wound on T50-6 cores (yellow). 180pF = green line, 100pF = pink line.

6m

C1	C2	L1	C3	C4	L2	C5	C6	L3	C7	C8
10 “100”	47 “470”	198 “7T”	Not used	100 “101”	223 “8T”	Not used	100 “101”	198 “7T”	10 “100”	47 “470”

Other information
Inductors wound on T50-10 cores (black).