

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/COG 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, labelled 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 COG 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:

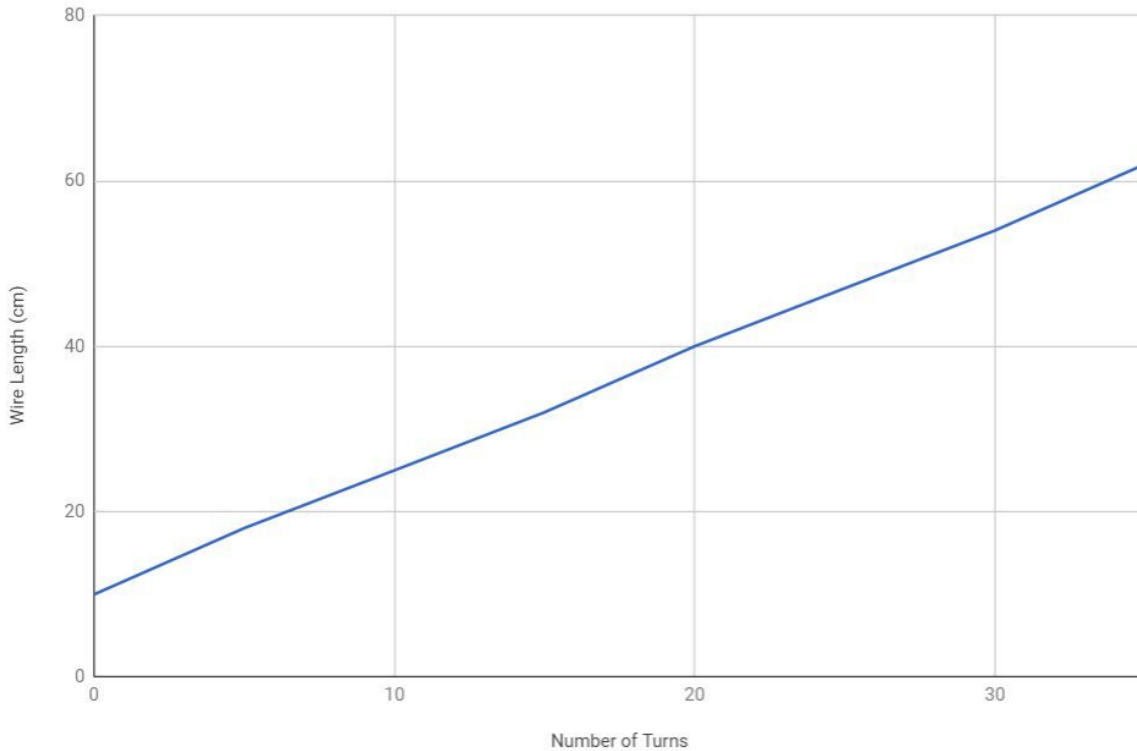
<https://www.youtube.com/watch?v=sDIWNHOoNh8>

<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).

Wire Length vs Number of Turns



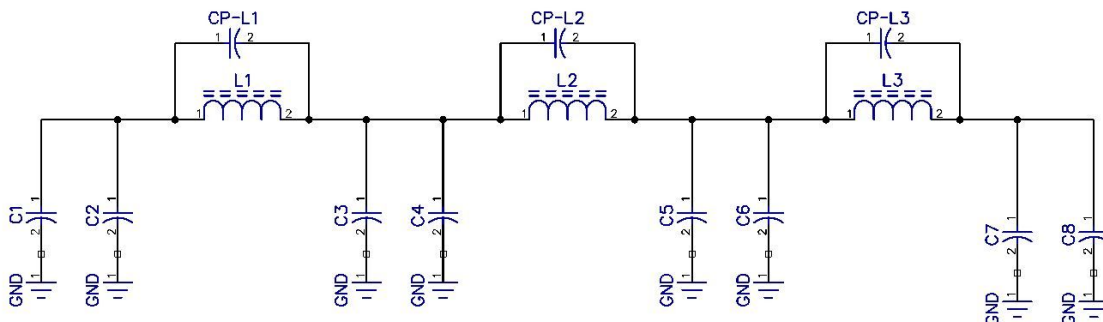
The enamelled copper wire supplied has an insulating enamelled cover. This must be removed to allow soldering to the wire. The usual way to do this is using a bead of solder on the tip of a hot soldering iron. Don't breathe the fumes as the enamel burns off.

<https://www.youtube.com/watch?v=Mijryf2aqaY>

You can also use fine glass-paper:

<https://www.youtube.com/watch?v=Pd5Q-XDmvyS>

Low Pass Filter, General Schematic



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 Farads (nF). 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).