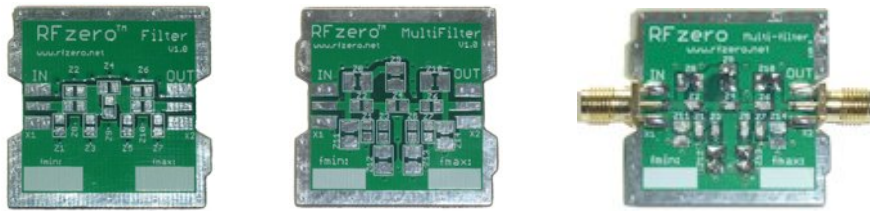


RFzero filter design and general assembly guide



Filter design

For the RFzero but also for general use a two types of filter PCBs have been designed. The PCBs fit into a 37 mm x 37 mm x 30 mm metal sheet box (Weissblechgehäuse) for best RF performance and shielding.

You can design your very own filter that matches the topology of the PCB e.g. using the free Elsie by Tonne Software Jim, W4ENE: <http://www.tonnesoftware.com/elsie.html>

The PCB is designed for 0805 SMD components. High Q capacitors, NP0 or better, and inductors should be used for best performance especially as the frequency increases and/or for best stop-band attenuation. The maximum power is 1 W. The benefit of using SMD and fixed component values is that the filter does not require any tuning and has better RF characteristics than leaded components do.

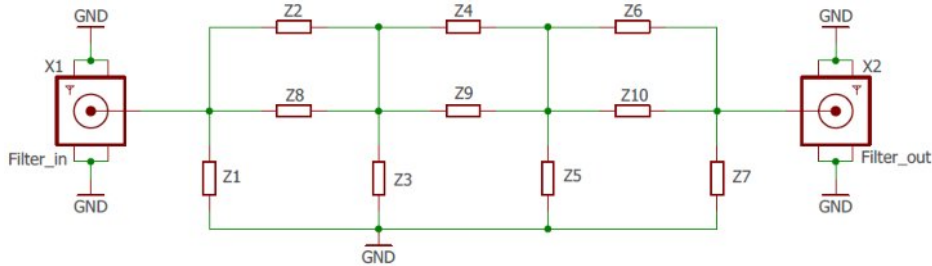
Below are series of possible low pass filter designs where the second harmonic is attenuated at least 10 dB and the third harmonic is attenuated at least 55 dB by the low pass filter itself. When used in combination with a RFzero the harmonics will then be attenuated at least 60 dBc but often more. Remember to short Z12 and Z13 if using the Filter Multi PCB. If you go below f_{min} , in the table below, the attenuation of the harmonics no longer apply. Filters where the f_{min} is 10 MHz or above typically show an attenuation of 1 dB at f_{max} . At lower f_{min} high Q value SMD inductors are difficult to find, thus a higher insertion loss should be expected. The above values do not take into account the stray capacitance in the filter PCB which is about 2 pF.

f_{min} [MHz]	f_{max} [MHz]	Z1 [pF]	Z2 [pF]	Z3 [pF]	Z4 [pF]	Z5 [pF]	Z6 [pF]	Z7 [pF]	Z8 [nH]	Z9 [nH]	Z10 [nH]
0,4	0,55	4700	680	10000	1500	10000	3300	3900	18000	18000	12000
1.6	3	1000	120	1500	560	1500	470	820	3900	2700	2700
2.9	5.1	680	68	1000	360	820	220	470	1800	1500	1500
5	9.3	390	56	560	220	470	150	330	1000	820	820
9.1	16.4	220	39	270	120	220	82	120	560	470	470
16	30	100	12	180	56	150	39	56	330	270	270
30	56	47	2.2	100	12	100	8.2	47	180	180	180
54	72	33	2.2	68	15	82	10	47	150	120	120
100	150	15	1	33	3.9	33	3.3	12	68	68	68

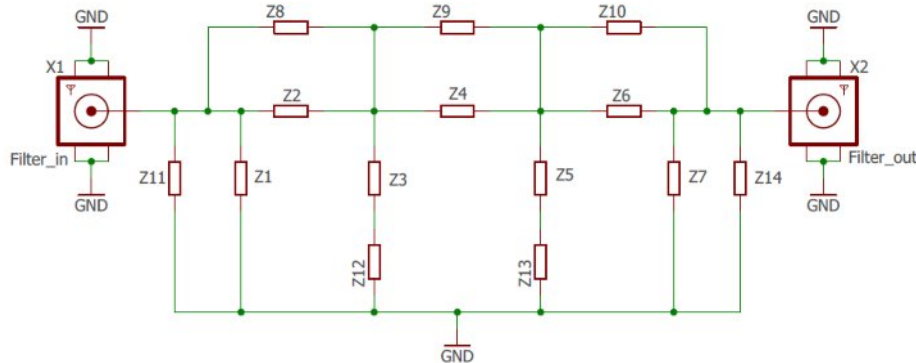
Below is a possible high pass filter design that can be used to extract third and higher harmonic above 400 MHz, e.g. to get a 432 MHz signal. Remember to short Z12 and Z13.

f_{\min} [MHz]	Z1 [nH]	Z2 [nH]	Z3 [nH]	Z4 [nH]	Z5 [nH]	Z6 [nH]	Z7 [nH]	Z8 [pF]	Z9 [pF]	Z10 [pF]
400	6,8	130	6,8	27	6,8	39	8,2	10	12	12

The generic Filter topology where each Z# is replaced with either a C or L or shorted/omitted.

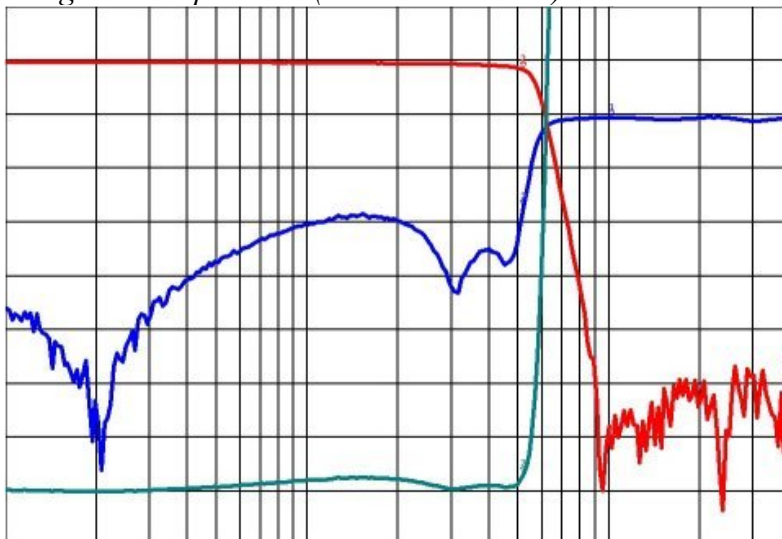


The generic Filter Multi topology where each Z# is replaced with either a C or L or shorted/omitted.



You do not have to use all the positions from Z1 to Z10 if the filter you design has fewer components. If so just leave the relevant pads empty but make sure that there is a way from the input to the output, e.g. short Z10 if Z8 and Z9 are each mounted with a component etc. The short(s) are typically done using 0 Ω resistors but a solder blob will do just fine too.

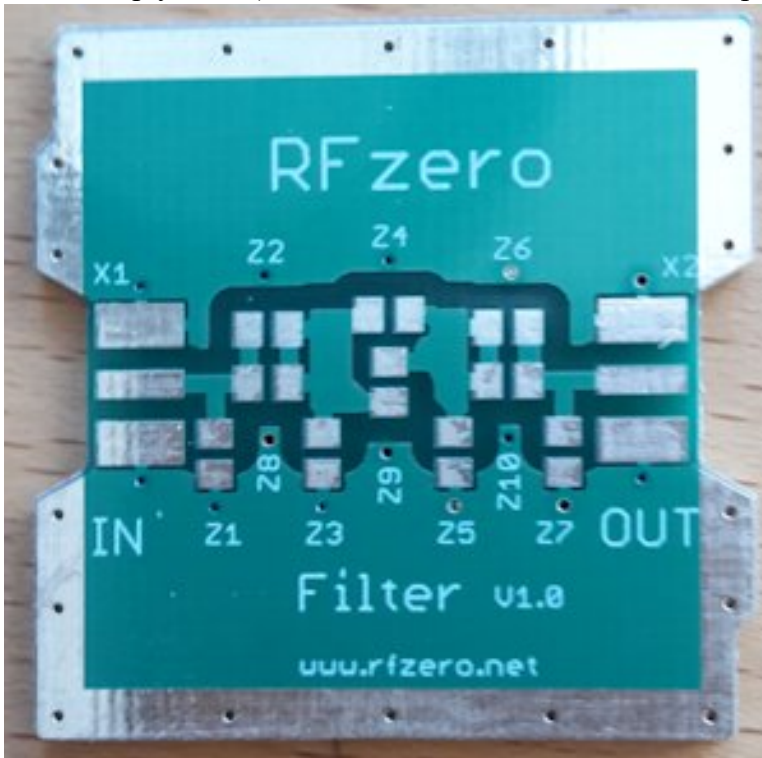
Filter characteristics of a 52 MHz low pass filter from 1 MHz to 400 MHz. The insertion loss is 0,7 dB at 52 MHz. Red is transfer function (10 dB/div), blue is input return loss (10 dB/div) and green is input SWR (At 1 MHz it is 1:1).



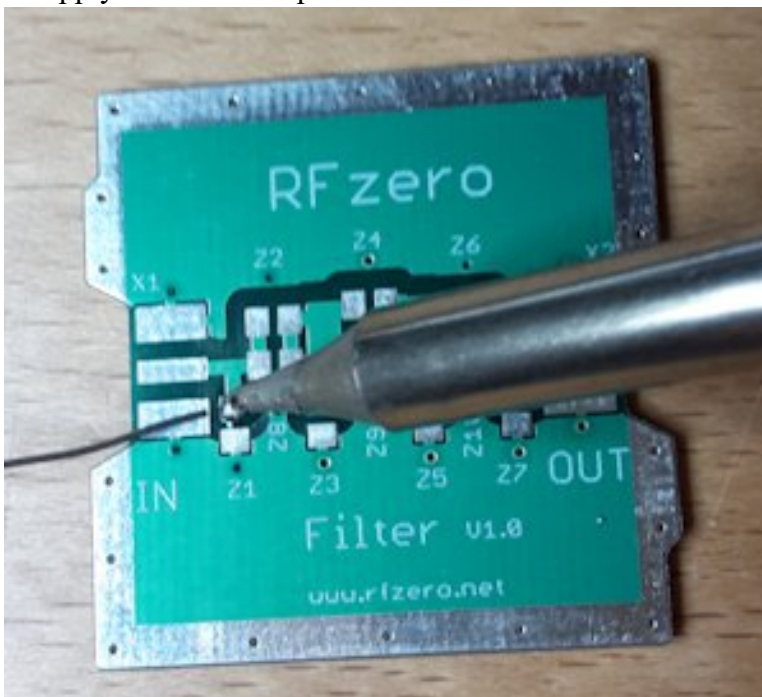
Assembly

Below is a principal step by step guide that shows how to mount the components on a PCB. You don't need a university degree to mount the components. All you need is attention to details, patience, a fine tip soldering iron, a piece of thin solder and a pair of fine tip tweezers. You can mount the SMD component in any order you like.

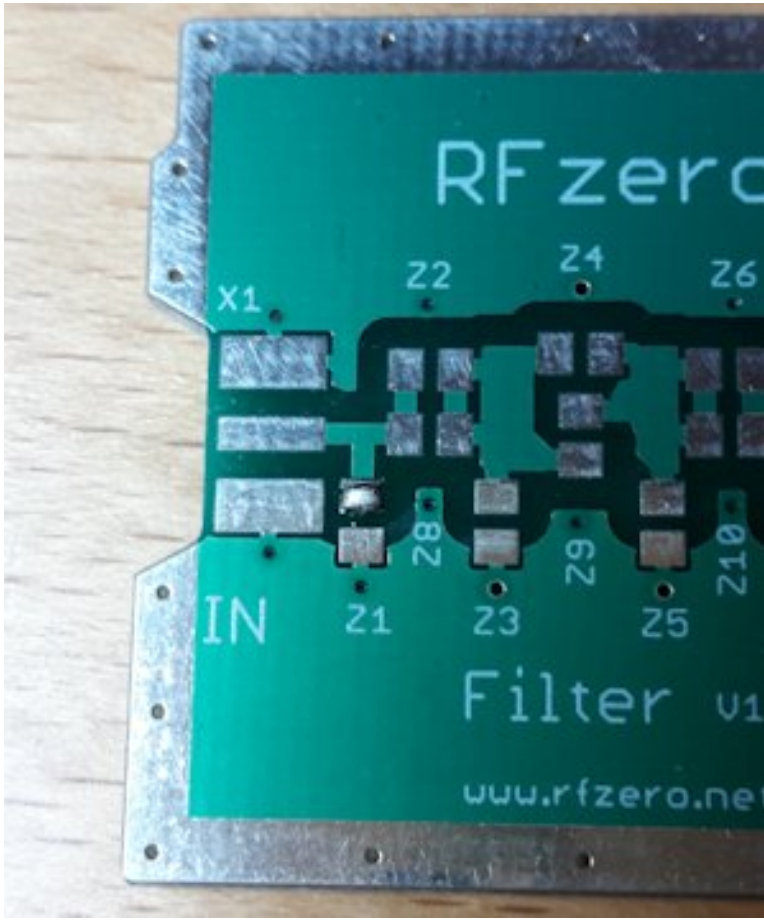
1 The empty PCB (in this case a filter PCB but the same principle applies to all PCBs)



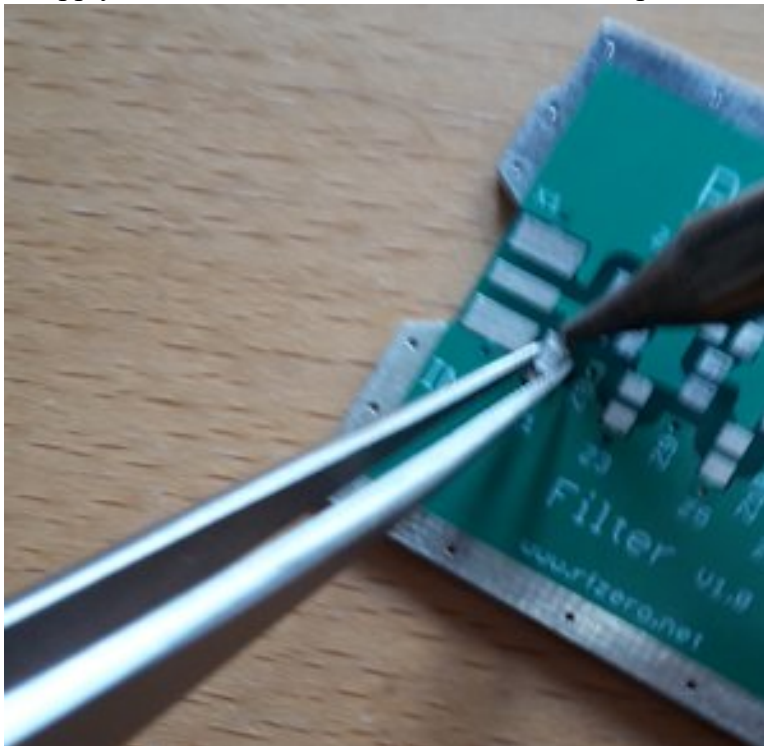
2 Apply solder to one pad.



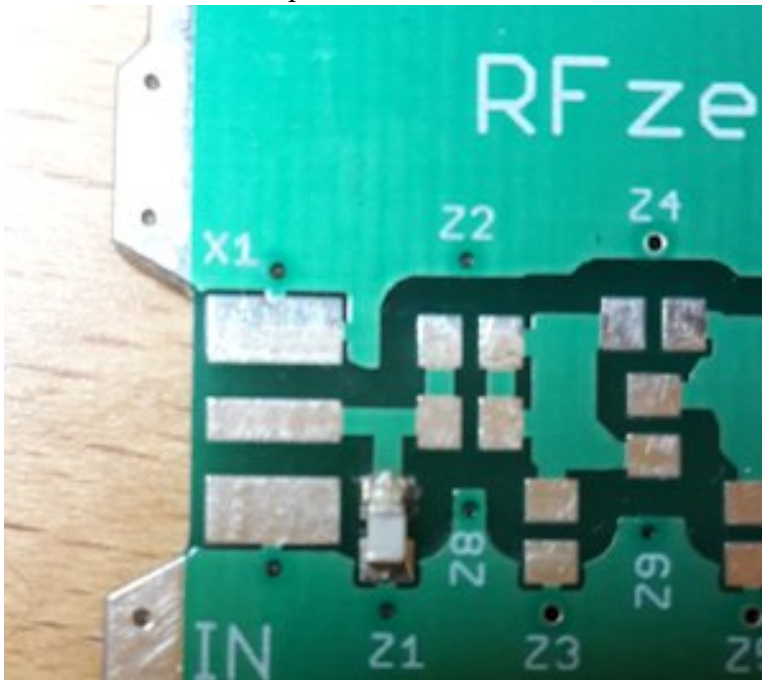
3 Solder on one pad only.



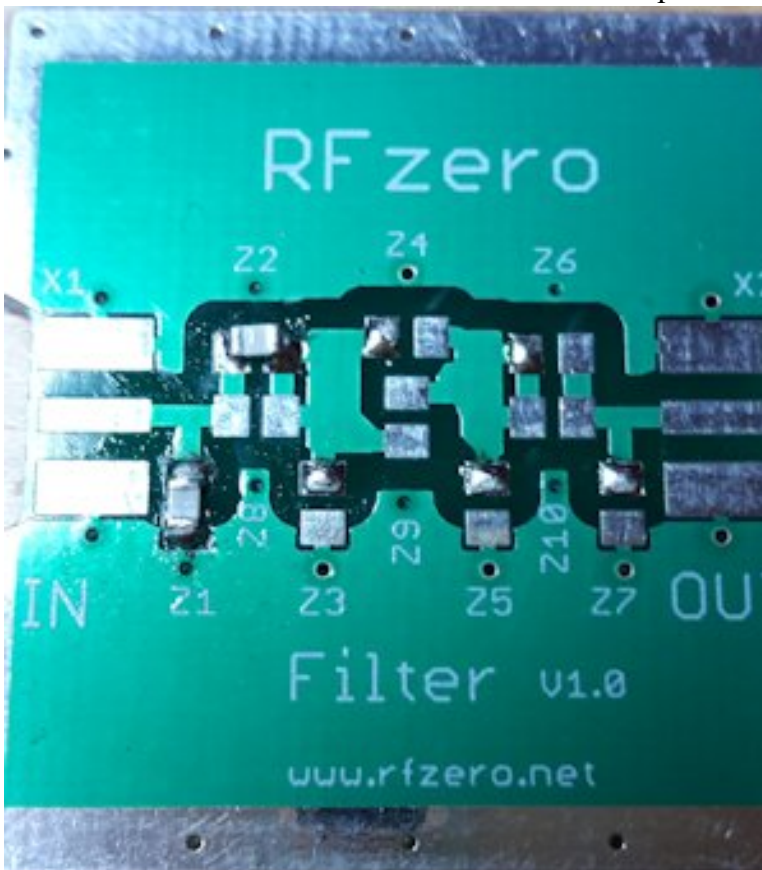
4 Apply heat to the end with the solder blob and place the component.



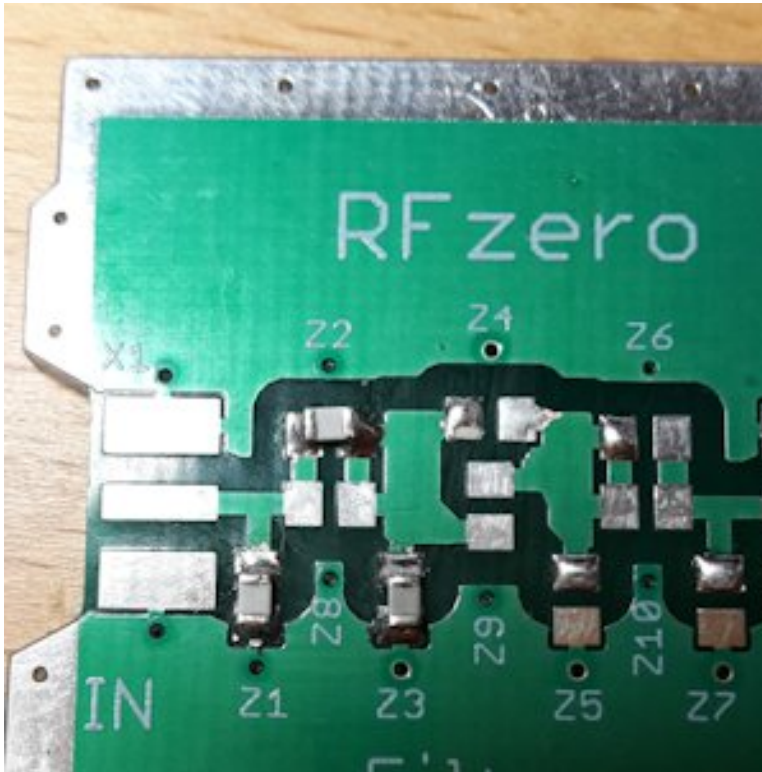
5 One end of the component soldered to the PCB.



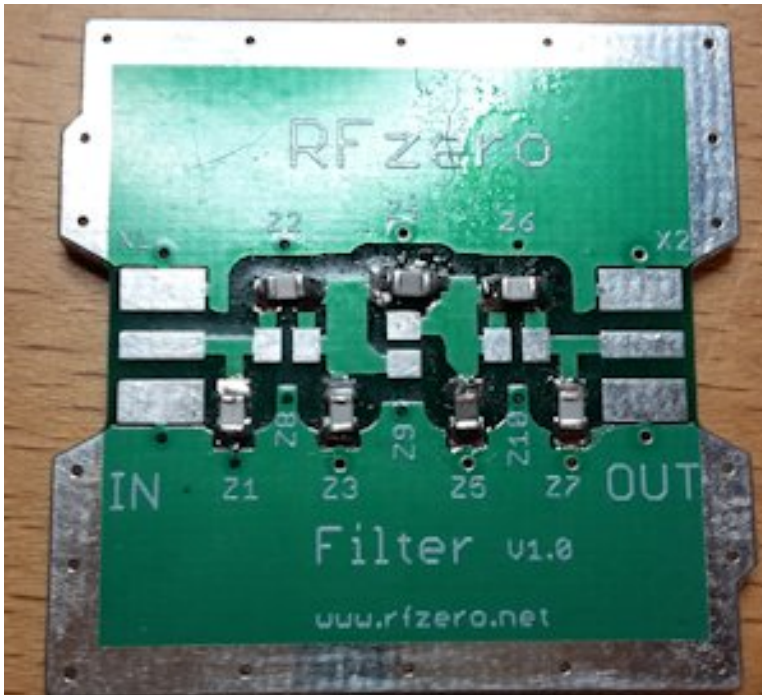
6 Solder the other end and continue with next component.



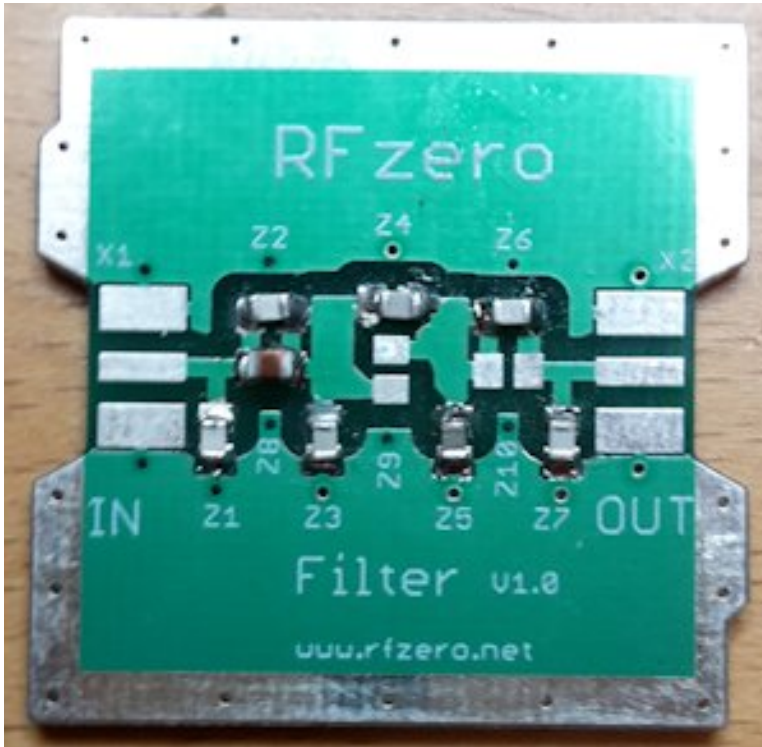
7 Three capacitors in place.



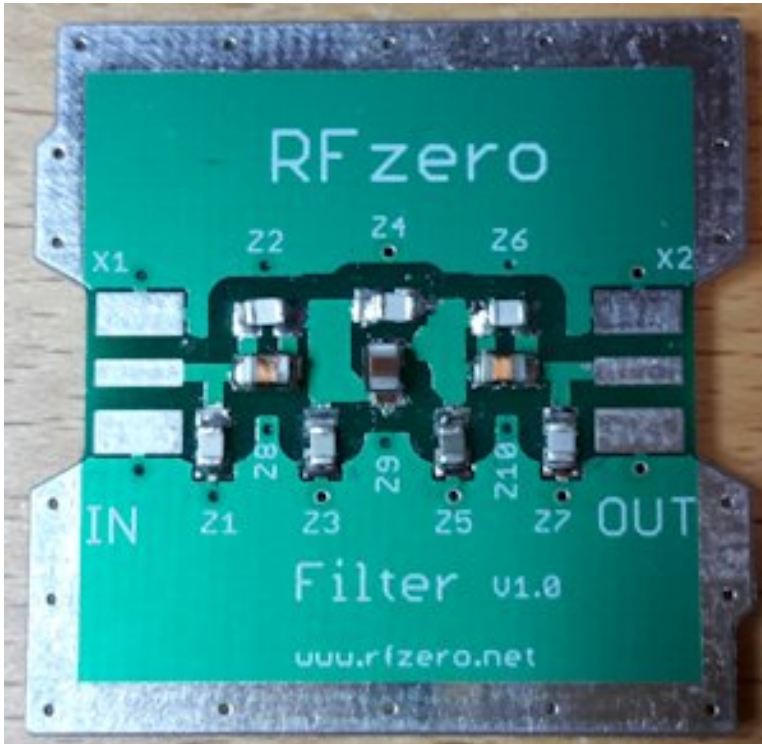
8 All capacitors in place.



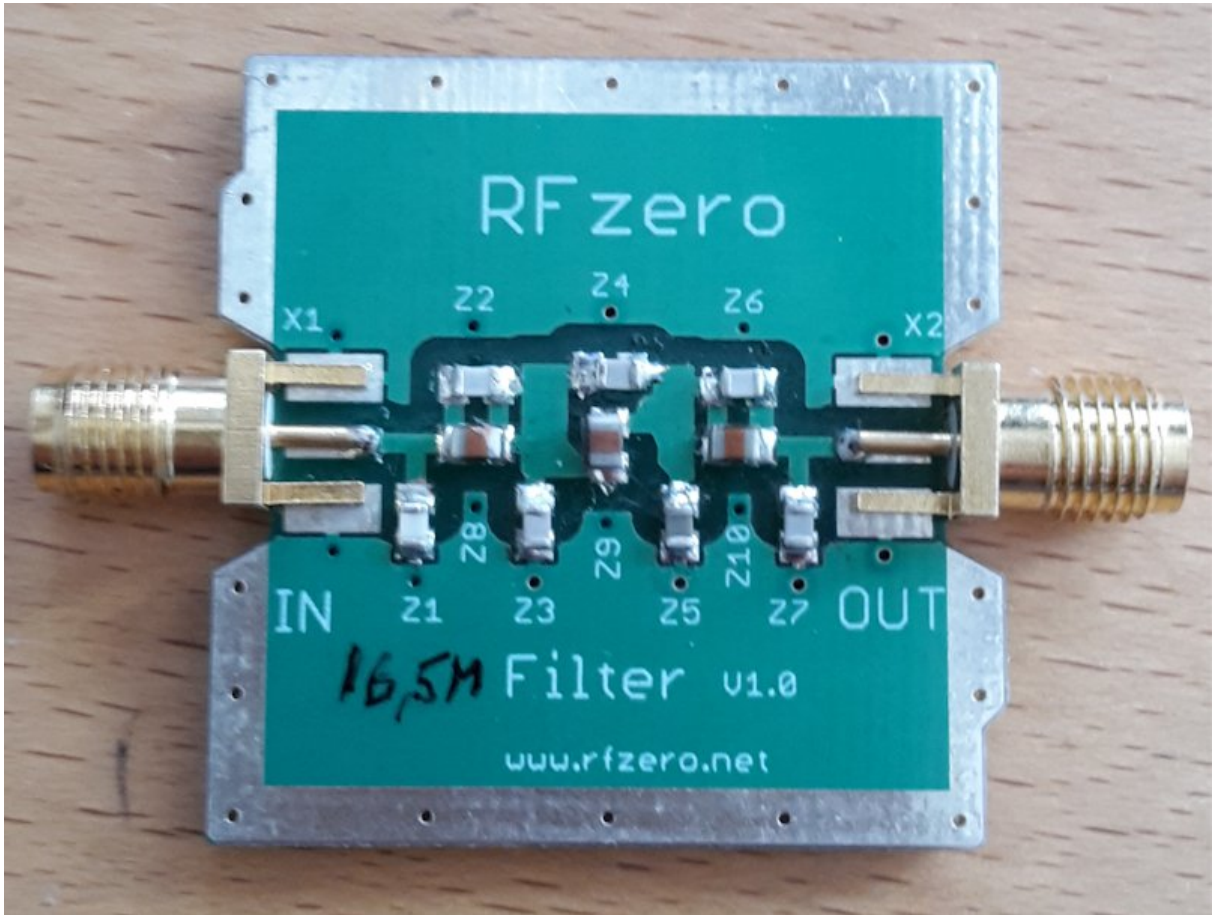
9 Continue with the inductors.



10 All components in place – for this particular filter design.



11 Mount connectors and solder all pads - also on the bottom side! This requires some heat.



Congratulations you have just mounted the components and the circuit is now ready for use.