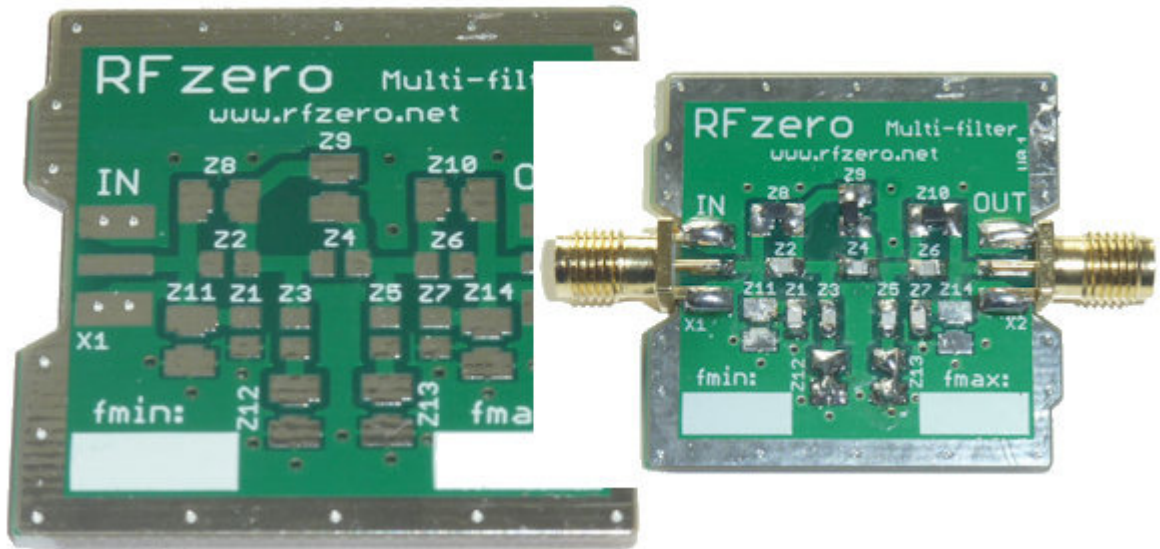


# RFzero filter design and assembly guide



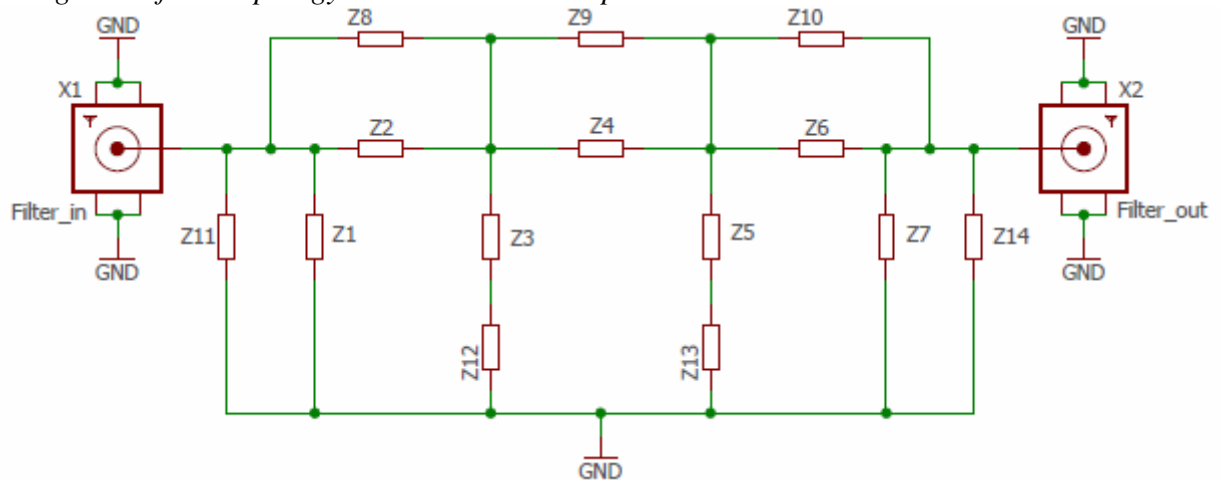
## Filter design

For the RFzero but also for general use a high/low pass filter PCB has been developed. The PCB fits 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 generic filter topology where each Z# is replaced with either a C or L or shorted.*



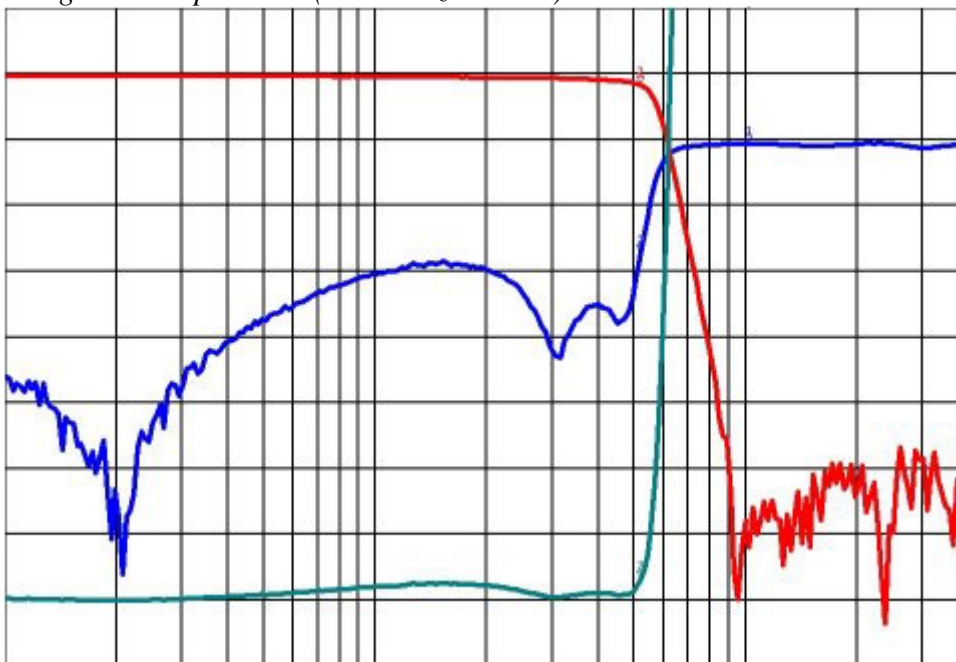
You do not have to use all the positions from Z1 to Z10 if the filter you design has fewer components. If so just leave the relevant pads empty but make sure that there is a way from the input to the output, e.g. short Z10 if Z8 and Z9 are each mounted with a component etc. The short(s) are typically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

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 you go below Fmin, in the table below, the attenuation of the harmonics no longer apply. Attenuation at Fmax is typically 1 dB. The component values take into account the additional capacitance in the filter PCB.

Fmin [MHz]	Fmax [MHz]	Z1 [pF]	Z2 [pF]	Z3 [pF]	Z4 [pF]	Z5 [pF]	Z6 [pF]	Z7 [pF]	Z8 [nH]	Z9 [nH]	Z10 [nH]
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

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).



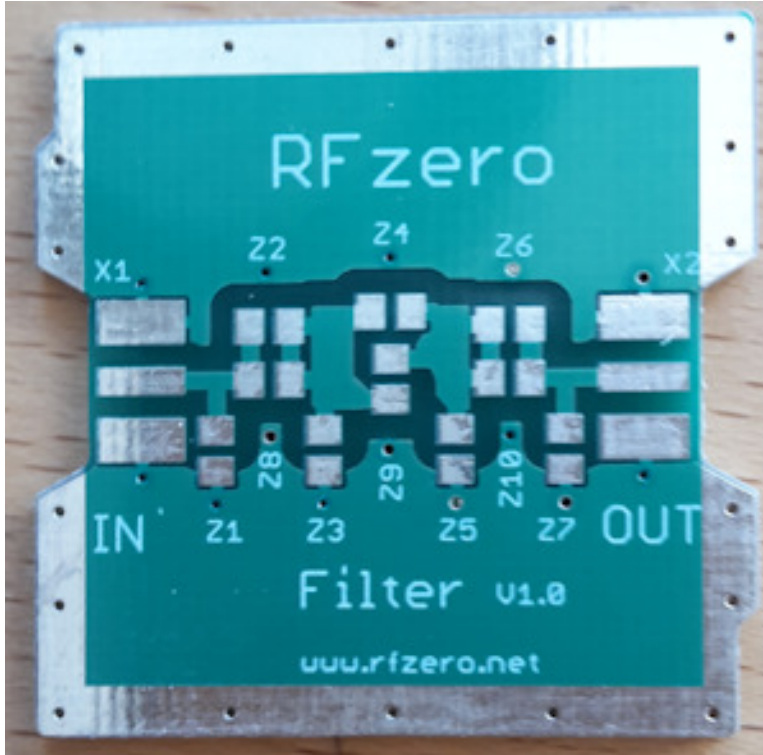
Below is a possible high pass filter design that can be used to extract third and higher harmonic above 400 MHz, e.g. to get a 432 MHz signal. Remember to short Z12 and Z13.

Fmin [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

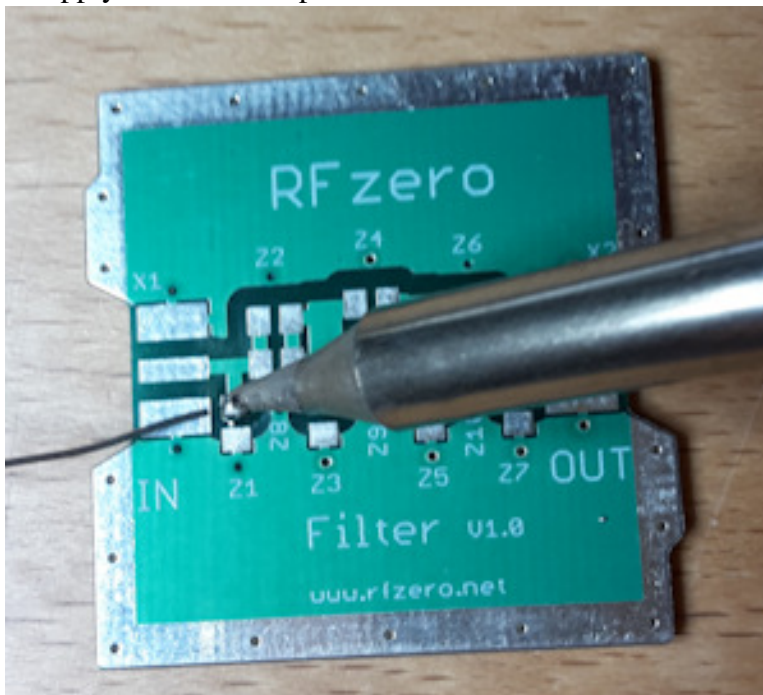
## Filter assembly

Below is a principal step by step guide that shows how to assemble a filter. You don't need a university degree to assemble the filter. 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.

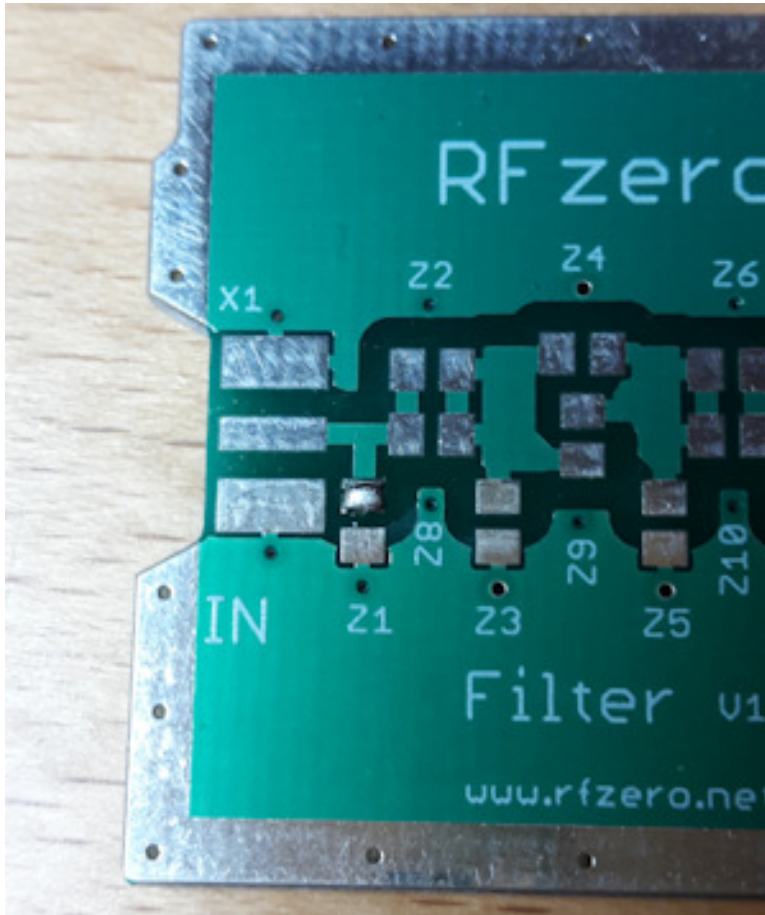
### 1 The empty filter PCB.



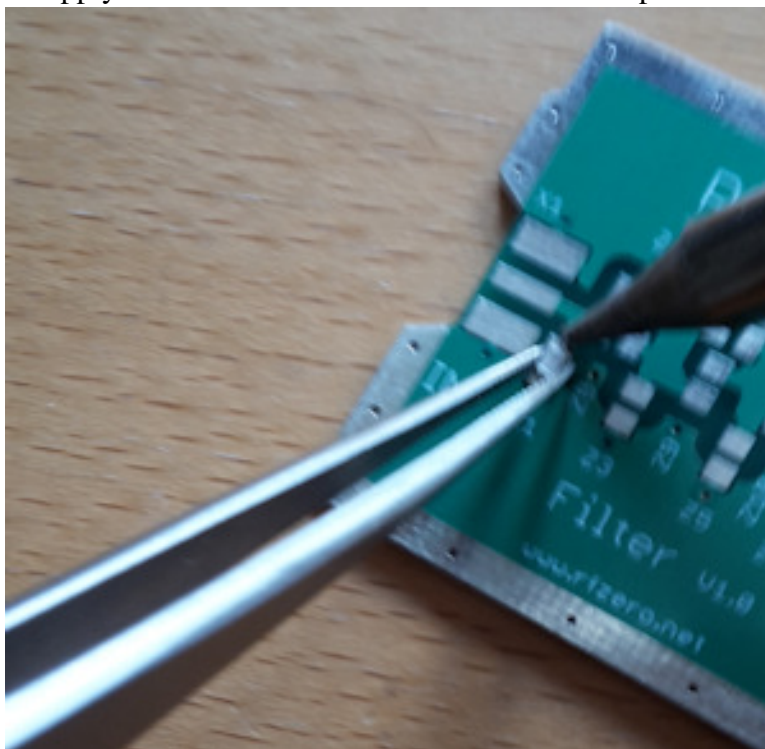
### 2 Apply solder to one pad.



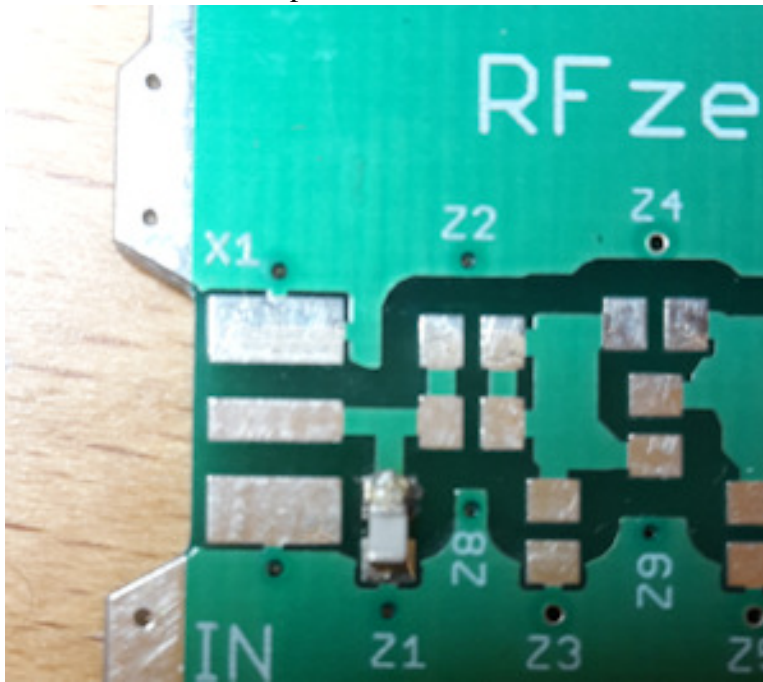
**3** Solder on one pad only.



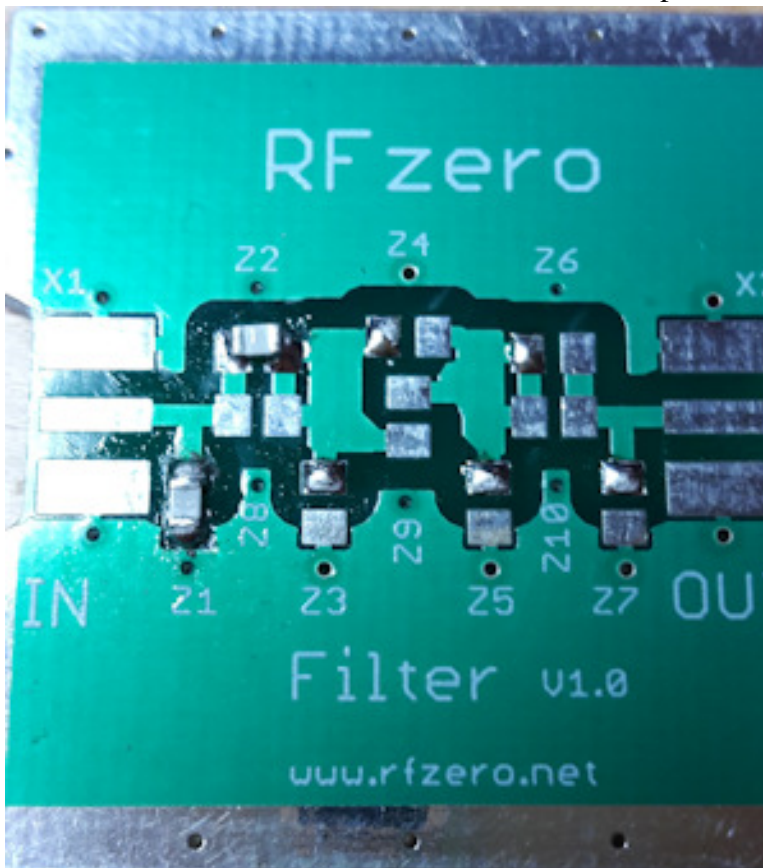
**4** Apply heat to the end with the solder blob and place the component.



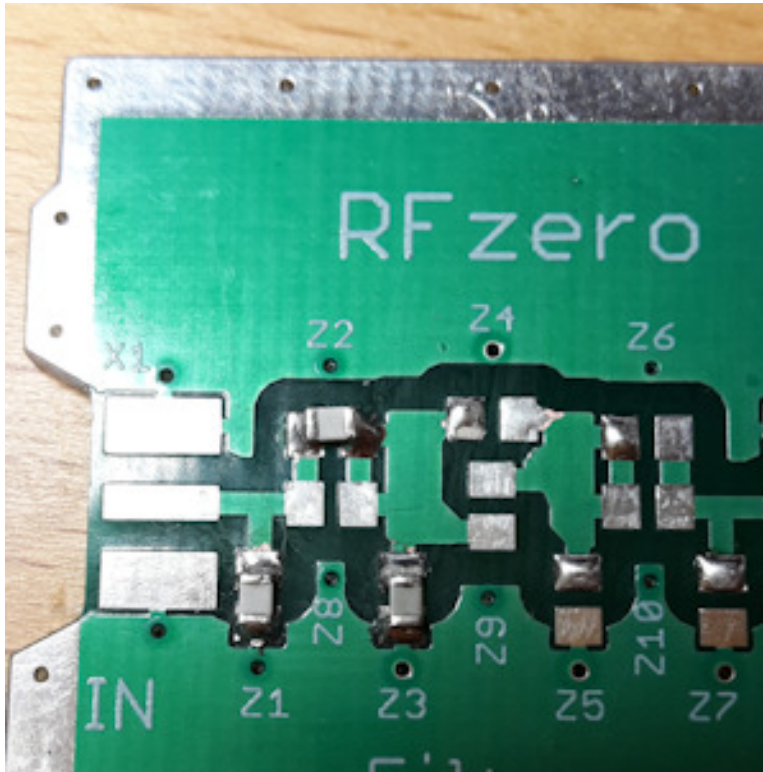
**5** One end of the component soldered to the PCB.



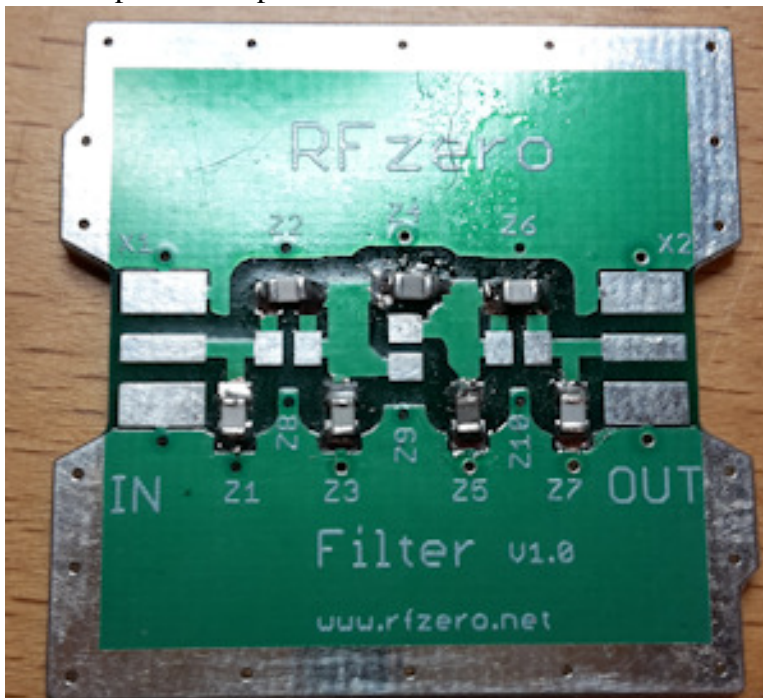
**6** Solder the other end and continue with next component.



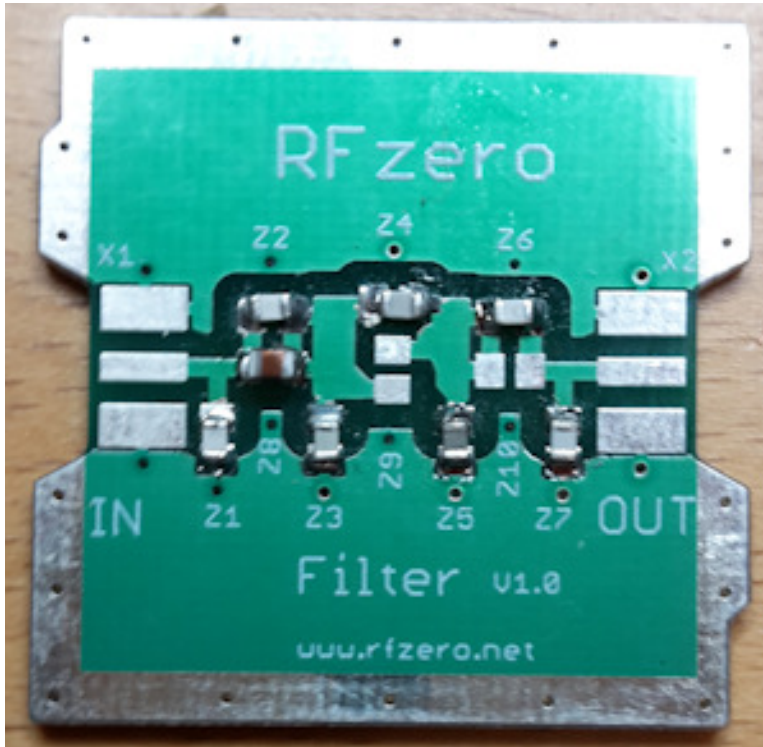
7 Three capacitors in place.



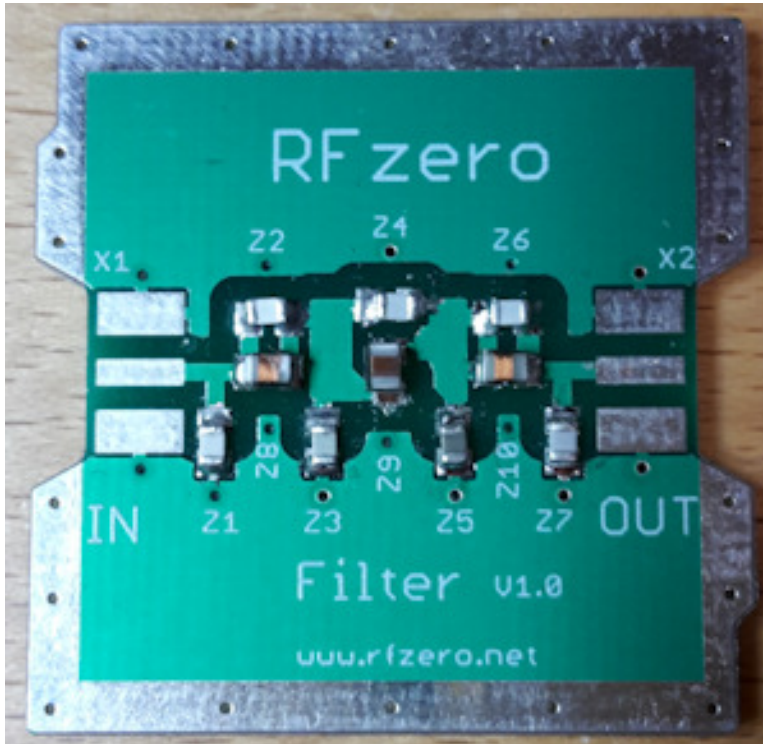
8 All capacitors in place.



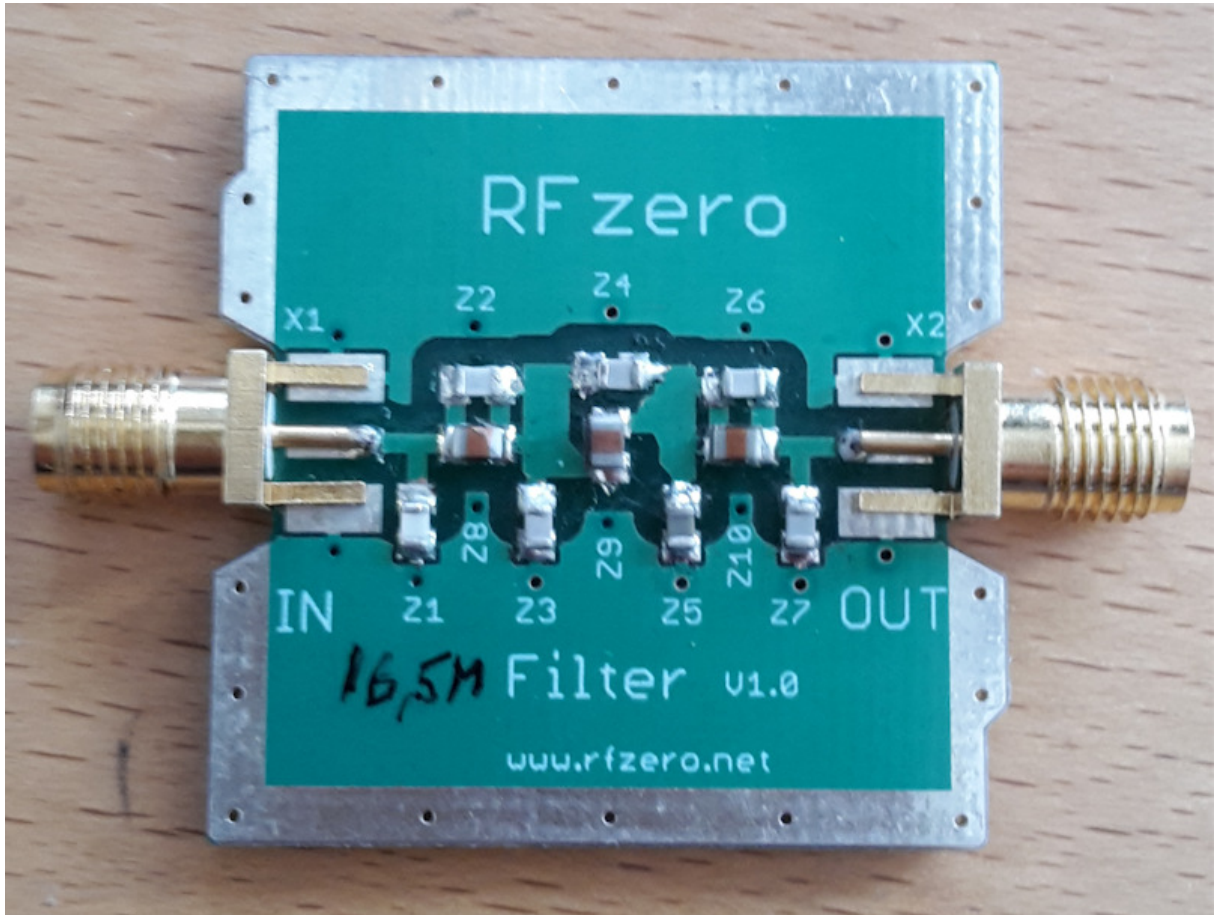
**9** Continue with the inductors.



**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 designed and assembled your filter and it is now ready for use.