2kW Low Pass Filter
160m … 6m

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Where to buy: www.helitron.de

Overview:

All information, schematics, BOM and other documents can be downloaded from **www.dj0abr.de Chapter „2kW-Tiefpassfilter“**. (or “2kW-Low Pass Filter”, as soon as it is translated, in the meantime please use google translator)

A low pass filter can be built using a PI or a T configuration. Theoretically both are identical. But in practice we have to use different configurations for the lower and upper bands to compensate stray inductances and capacities as good as possible.

For the low bands (160m … 30m) the stray capacities are more relevant and we use PI filters. For the high bands (20m … 6m) the stray inductances are relevant and we use a T configuration. This T configuration allows to compensate the wire and relais inductances by trimming the outer air coil.

SMD and Relais Assembly:

1. at the very first beginning assemble all SMD parts. These parts are the relais drivers and decoupling capacitors. There is nothing special with these parts, just solder it to the board.

2. now assemble the 12 relais

3. the next step is to test if all relais are working correctly:

   Apply the 12V power supply to the board, the 12V and GND pads are labeled.
   Near the 12V pad you find the header for the band inputs which are labeled with the band names. Use a wire connected to +12V and touch one of the band inputs. The corresponding relais must switch on.

4. Now assemble the big SMD capacitors for the bands 20m to 6m as shown in the schematics. These capacitors must be 3kV types to withstand a power of 2kW.

5. Now as all SMD parts and the relais are assembled we start building the filters

Filters:

The filters are build step-by-step. We start with the 6m filter, finish it completely and the continue with the 12/10m filter and so on. Do not assembly all filter parts and then check if they are working, instead assemble only ONE filter at a time, finish it completely and the go to the next filter. Start with building the 6m filter.

Required tools:

* an inductance meter (either a professional meter, or one of the many home brew meters which work precisely too)

* some sort of winding aid for the air coils, like shafts with different diameters.

Air Coils:

use a silver plated solid copper wire with a diameter of 2mm.

The schematics show i.e.:
100nH L10 DM13.5 N3

which means:
100nH … the coil must have 100nH
L10 … the length (pin to pin9) must be 10mm to fit into the board
DM13.5 … the recommended diameter should be 13.5mm
N3 … make 3 turns

with these parameters you get a coil which is close to the required inductance. But we need a coil with exactly this inductance (+/- 5% max.). The length is fixed by the holes in the PCB. To trim the inductance you can vary the diameter.

Please avoid to mount and then unsolder the coils. The solid 2mm wires will damage the PCB's vias easily. So check the inductance before mounting the coils to the board.

As the first band, manufacture and solder the 4 coils for the 6m band.

Next check if the filter is working and has a low insertion loss. Activate the filter relais by setting the 6m input to +12V. The use i.e. an spectrum analyser to see if the filter is working.
We are talking about a lot of power (2kW) so it is necessary to measure each filter.

What to measure ?

The most important value is a low **insertion loss**. But be warned, we are talking about a fraction of a dB which is difficult to measure.

If using a spectrum analyser:

make sure that the cables between the filter and the analyser are as short as possible and use high quality cables. A cheap BNC cable which has i.e. 51 ohms instead of 50 ohms will distort your measurement ! "Normalize" the analyser before each measurement and then every two minutes, or let the analyser warm-up for at least 30 minutes.

We only measure the insertion loss which should be about 0,2dB. You can also measure the attenuation of the harmonics. The second harmonic will be attenuated (depending on the band) by about 20dB and the third harmonic by about 40dB or better. Precision is not required for the harmonics.

If using a generator and RF-voltmeter or oscilloscope:

set the generator to the pass band frequency, i.e. 50 MHz and set the generator as well as the measurement instrument to 50 ohms impedance. Measure the output of the generator, then insert the filter and measure the voltage after the filter. Alwasy use good 50 ohms coaxial cables. Never use an oscilloscope-probe ! Calculate the pass band attenuation from the voltage difference.

The second measurement is the filter's SWR (reflection attenuation). We need an directional coupler with at least 30dB accuracy. The reflecion attenuation should be > 20dB but never be lower 15dB.
20dB is the same as an SWR of 1.22 : 1

If you don't have a directional couple you can use your transceivers SWR meter.

The SWR can be tuned by squeezing the two outer coils (the inner coils will shift the filter frequency, so do not change them if not necessary).
By tuning the SWR to a better value the insertion loss will automatically get better.

Measuring the insertion loss of 0,2 dB is not an easy task. Don't believe your instruments until you have checked it several times. 0,3 dB can be tolerated, but if you measure 0,4dB or more then it is necessary to check what the problem is (either the filter, or the measurement setup).

Iron Powder Cores:

the big Amidon T200-6 and T200-2 are used with a solid copper wire diameter 1,5mm.

The schematics show i.e.:
1,34uH T200-6 N10

which means:
1,34uH … the coil must have 1.34uH
T200-6 … use this Amidon core
N10 … make 10 turns (count the number of turns in the inner diameter of the core)

wind the wire evenly spaced to the core. The position of the wire influences the inductance, so we start with an even spacing to leave some tolarance for later adjustments.

Check the inductance with your meter. It will not be possible to get the exact value due to the tolerances in the iron power cores. Try to get as close as +/- 5%.

There are some calculators available which show the number of turns for a specified inductance. From my experience these calculation results have an error of +/- 1 turn, which is a lot. So it is required to measure the inductance.

Mount the core and follow the measurement hints as described for the air coils.

As soon as the board is finished you can check all the filters again. With a spectrum analyser you will see some corners and edges in the filter curve because one air-coil filter can show influences on another filter path (even if the relais are open). These edges are not at a harmonic frequency and do not degrade the filter performance, so no need to take any action.