Trap for increasing 12 m image rejection of the Elecraft K2

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Summary

The image rejection of the K2 was measured in the ARRL Product Review (March 2000) to 74 dB (preamp off). The band is not specified, but a guess based on the other measurements in that report is either 80 m or 20 m. The 12 m image band overlaps with the 19 m broadcast band and several K2 owners have had interference from broadcast images. The 12 m band image rejection, before the trap modification, on my K2 is 48 dB (preamp on). It improves to 59 dB with the trap. The trap is simple to build on a small piece of board and can easily be fitted on top of the RF-board.

K2 image frequencies

The image frequency bands of the K2 are found by addition of twice the 4.915 MHz intermediate frequency up to and including the 17 m band, and by subtraction for the three higher bands. This gives:

Band	Start	End	Image start	Image end	Note
160	1.800	2.000	11.630	11.830	25 m BC (11.6 - 12.1)
80	3.500	4.000	13.330	13.830	22 m BC (13.57 - 13.87)
40	7.000	7.300	16.830	17.130	
30	10.100	10.150	19.930	19.980	
20	14.000	14.350	23.830	24.180	
17	18.068	18.168	27.898	27.998	
15	21.000	21.450	11.170	11.620	25 m BC (11.6 - 12.1)
12	24.890	24.990	15.060	15.160	19 m BC (15.1 - 15.8)
10	28.000	29.700	18.170	19.870	15 m BC (18.9 - 19.02)

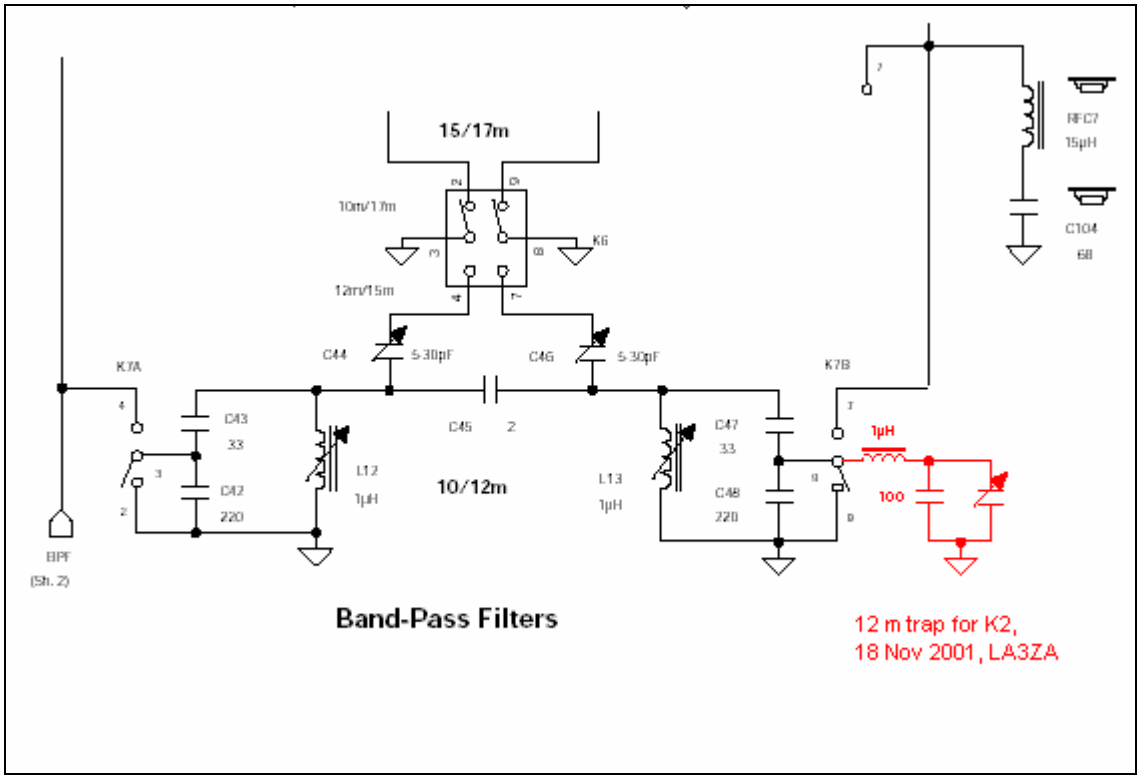
The higher the desired frequency, the more difficult it will be for the input bandpass filter to have enough suppression at the image. There have been reports of image leak-through both in the 15 m and the 12 m bands. As is evident from the table above, these image bands overlap with broadcast bands.

Design of a trap for suppression of image of 12 m band

For most bands, the image can be suppressed if the input bandpass filter is tightened to have a narrower passband and better out-of-band rejection. But the 10 m/12 m bandpass filter cannot be tightened much before the 10 m bandwidth becomes smaller than the width of the 10 m amateur band. For instance satellite operation could suffer if the

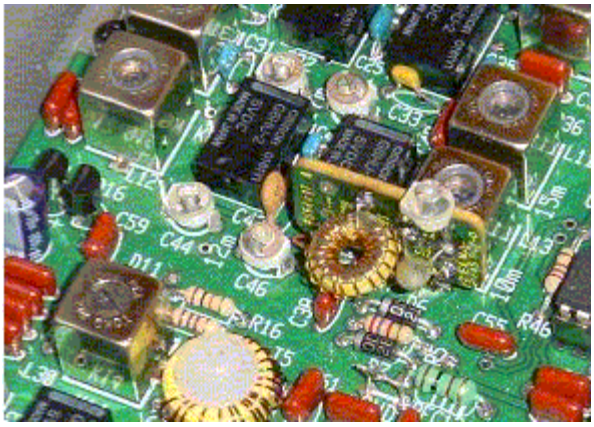
bandwidth was made that small. In this case a trap tuned to the undesired image can give the extra suppression needed. A series tuned L-C network from the junction of C47 and C48 to ground can do the trick in the same way that C104 and RFC7 today traps the IF frequency.

To test this I made some traps and did some measurements. The test frequencies were 24940 kHz (middle of 12 m band) with image at 15110 kHz (24940-2*4915). I made a trap from a 1 µH inductor in series with 100 pF in parallel with a small 20 pF trimmer capacitor (1 µH and 111 pF resonate at 15110 kHz). I tried several locations to connect it, but the maximum rejection, with no influence on the desired signal, was at the junction of C47 and C48. The output of the BP filter, junction of C42 and C43, did not give as much suppression and connection inside the BP filter (either end of C45) would attenuate the desired signal. Also, I should add that the trap does not affect any other band than 12/10 m since the junction of C47 and C48 is shorted to ground for all the other bands.



The initial image rejection was 48 dB, and it was improved by 7 dB when the inductor was a standard 1 µH inductor (pulled from an old video-recorder). The improvement increased to 11 dB when I made the inductor from 18 turns of 0.40 mm (26 AWG) on a T37-6 toroid. The capacitance has to be tuned exactly for maximum rejection, but since the 12 m band is so narrow it should cover the whole band. The up-side is that it did not change sensitivity at all in the 12 or 10 m bands, as checked at the ends of the bands.

I measured sensitivity by turning up the output from my Leader LSG-216 signal generator dB by dB until the second green LED in the K2's S-meter would light up, and noted down the setting.



The trap is easiest made on a small piece of perforated board which is mounted on top of the RF board. The ground of the trimmer capacitor and the 100 pF capacitor should be connected to the ground connection of L13, the one facing the front of the K2. The wire from the coil should be soldered to the junction of C47/C48. I did this by warming the junction from the underside while holding the wire on the top. Be careful not to overheat C47/C48 while doing this. The board can be mounted vertically and fastened to the front of L13 with double-sided tape and with the trimmer capacitor facing upwards.

The main source of image interference at my location near Oslo, Norway (60^0 N, 10^0 E) is at about 24911 kHz (15031 kHz station). The trap decreased the level from lighting up 4 LED segments on the indicator to 2 segments. This was measured in the 0.70 kHz CW setting. Another image is at 24932 kHz. The images are easy to identify in that their carrier beat tones are reversed compared to the real carriers. Both images are also heard by Dave Johnson, G4AON, who first reported the 12 m image problem of the K2.

This trap will improve 12 m image frequency rejection from about -50 dB to -60 dB. It is therefore an alternative to tightening the bandpass filter. Also, if the image is real strong, the two methods can be combined.

Not really a new idea

The idea for this trap came from restoration I did this fall of a Tandberg Huldra 4, 1950-vintage (http://www.qsl.net/la3za/Tandberg.html). This is a receiver with 11 bands, of which 8 are band spread short-wave bands. Its intermediate frequency is 455 kHz and the image frequency is below the desired frequency. It feeds the signal to a parallel tuned circuit via a series capacitor. Since the parallel tuned circuit will be inductive at the image frequency, the series combination can be made to resonate at the image and suppress it. This is implemented with 1% or 0.5 pF tolerance series capacitors and works on the 7 lowest short-wave bands, from 49 m to 13 m. On 11 m, the resonance is not sharp enough, so it is not used. In this way the receiver has variable traps for suppression of the image, with tuning that tracks the signal frequency.