Improved stopband of crystal ladder filters

Stein Torp, LA7MI, has found a relatively simple way to increase greatly the stopband attenuation. One result would be to provide an effective roofing filter in double-conversion receiver, but the technique could also be applied to narrow-band filters using three or more crystals.

LA7MI writes: My experiments were carried out with fifth harmonic 92.8611MHz (HC18/U) xtals. At their fundamental frequency (18.556MHz) they were free of spurious responses and I first constructed a simple ladder filter at that frequency. The stop-band attenuation was 35dB, which is about usual for such a filter

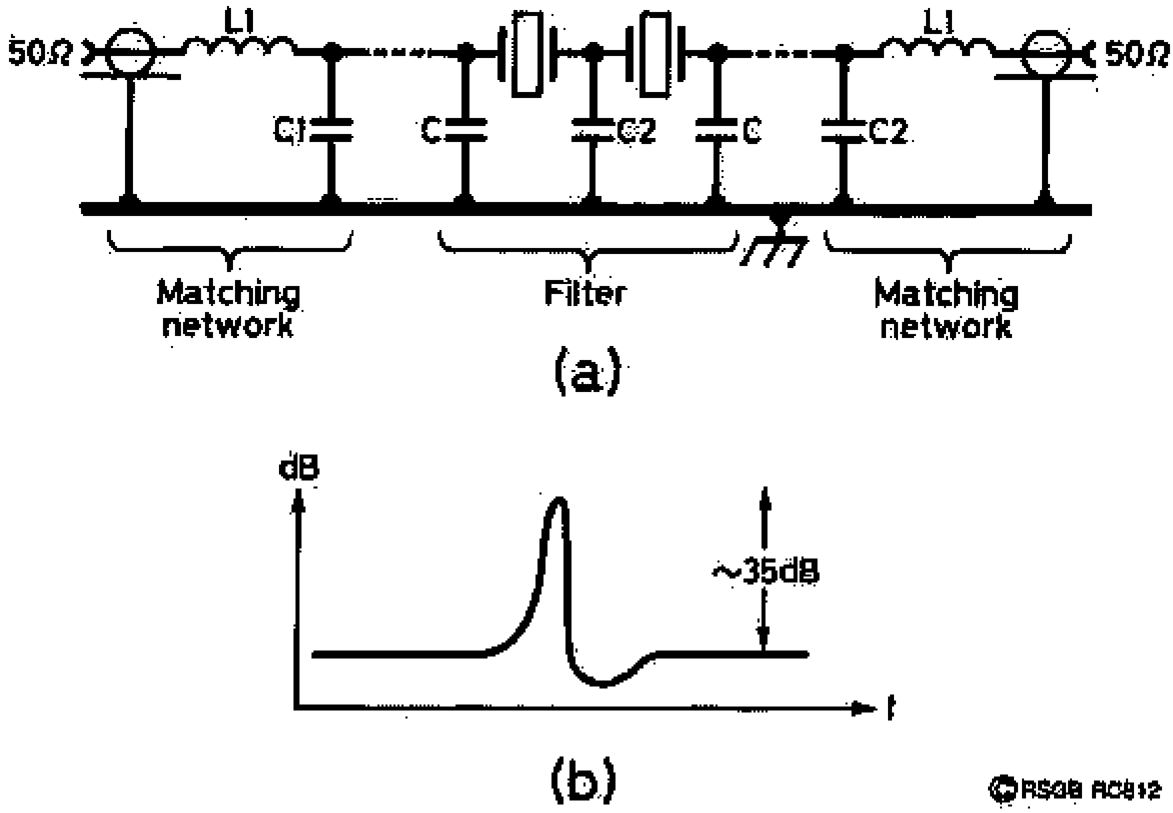

Fig 1a LA7MI's prototype two-crystal 18.5MHz ladder filter.

Fig 1b: Approximate shape of the response curve showing a stopband attenuation is only about 35dB.

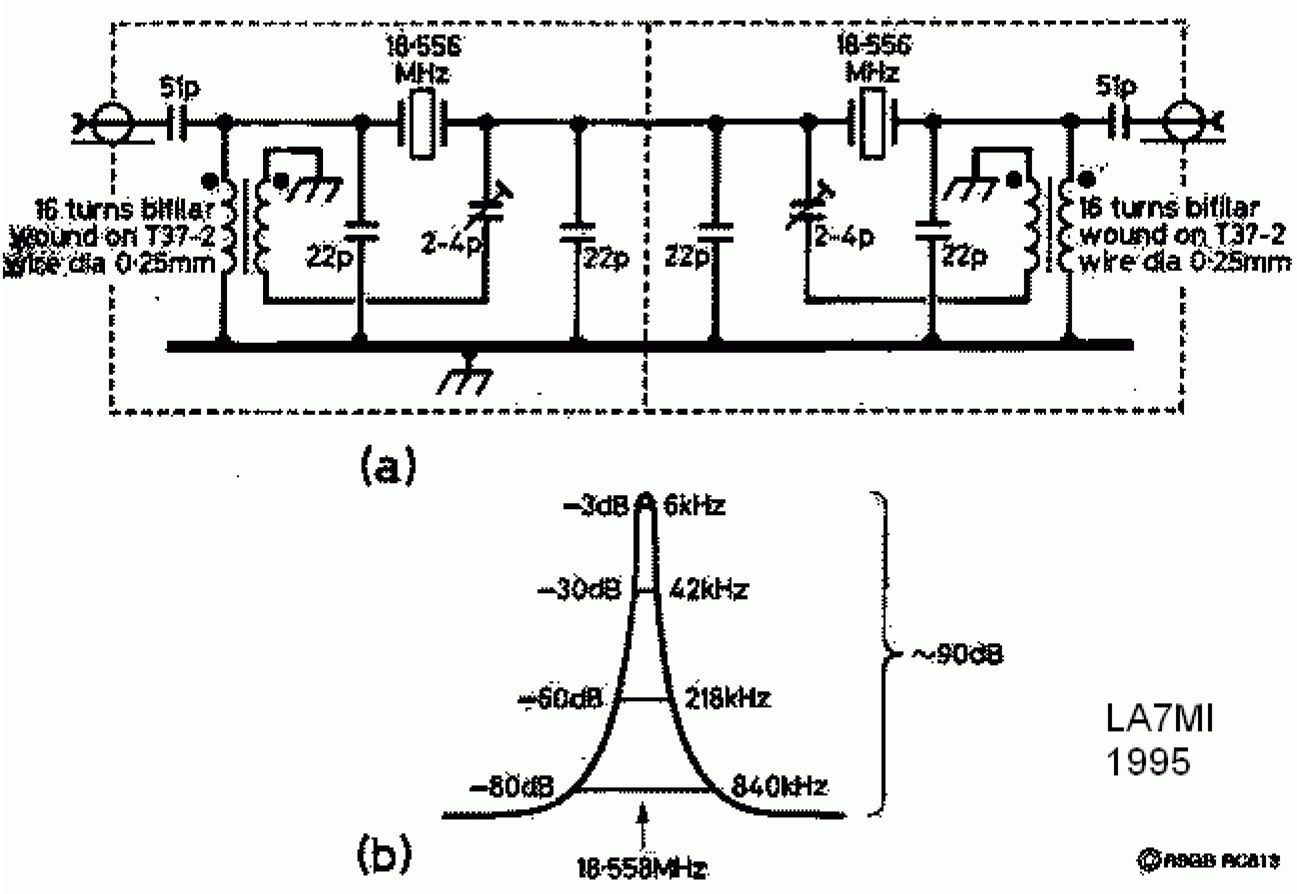

Fig 2a. LA7MI's improved two-crystal 18.5MHz crystal filterwith the crystal capacitance neutralised.
Fig 2b. Response curve showing a stop-band attenuation of almost 90dB. Such a filter would make an excellent low-cost roofing filter.

To build a better filter I first modified the matching network. L1 was replaced by a 51pF polystyrene capacitor. C1 was replaced by an inductance wound on an Amidon T37-2 toroid core. By using a bifilar winding and a 2-4pF ceramic trimmer the internal capacitance of the crystal (approximately 3.8pF) can be neutralized. After careful screening, the stopband attenuation is now close to 90dB which is the limit of measurement with the HP8505A Network Analyser. The passband is more symmetrical compared to the original unneutralized filter, insertion loss is only 1.5dB

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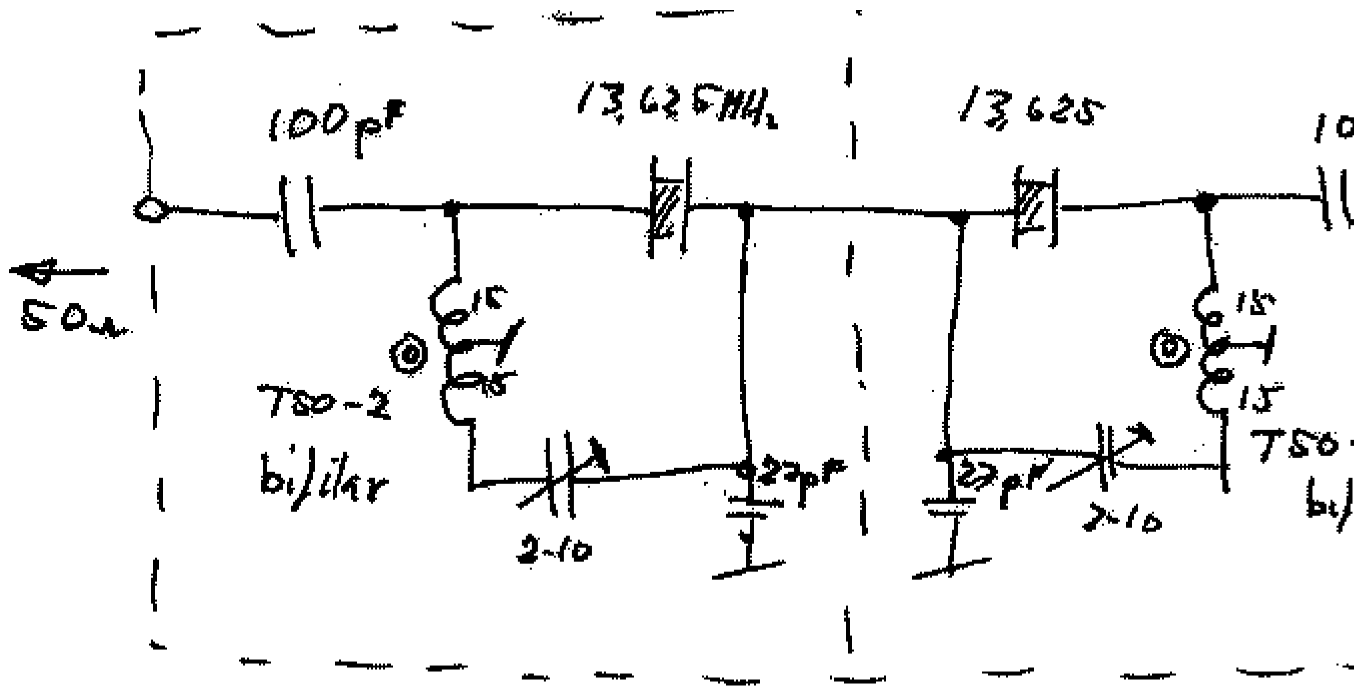


Fig 3a) Similar xtal filter for 13.5MHz. Uses xtals which are free from spurious resonnances, possibly overtone xtals on fundamental frequency.
Stopband attenuation is 80-90dB and insertion loss is less than 2dB. Good screeing is important. Reflection loss is better than 20dB
on center frequency, but drops to 10dB on the edges.
It is an unwanted passband on harmonic freequency, so a lowpassfilter is required. (LA7MI 2004.10.05)

Type components: T50-2 (2x15 turns bifilar wound), 13.625MHz xtals, 100pF, 27pF, 1-10pF trimmers

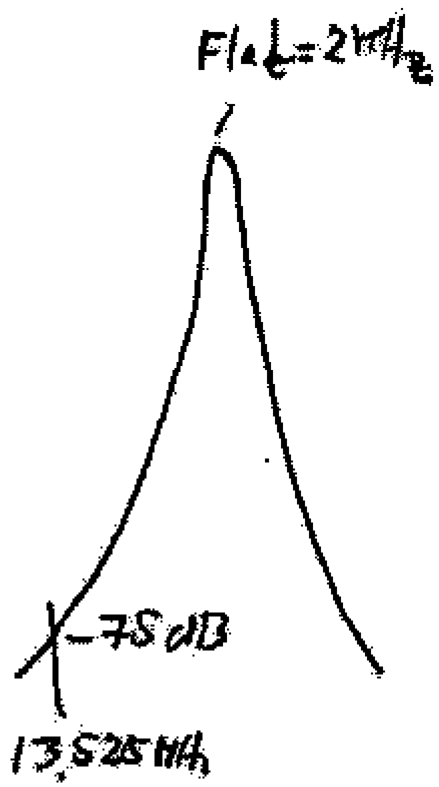
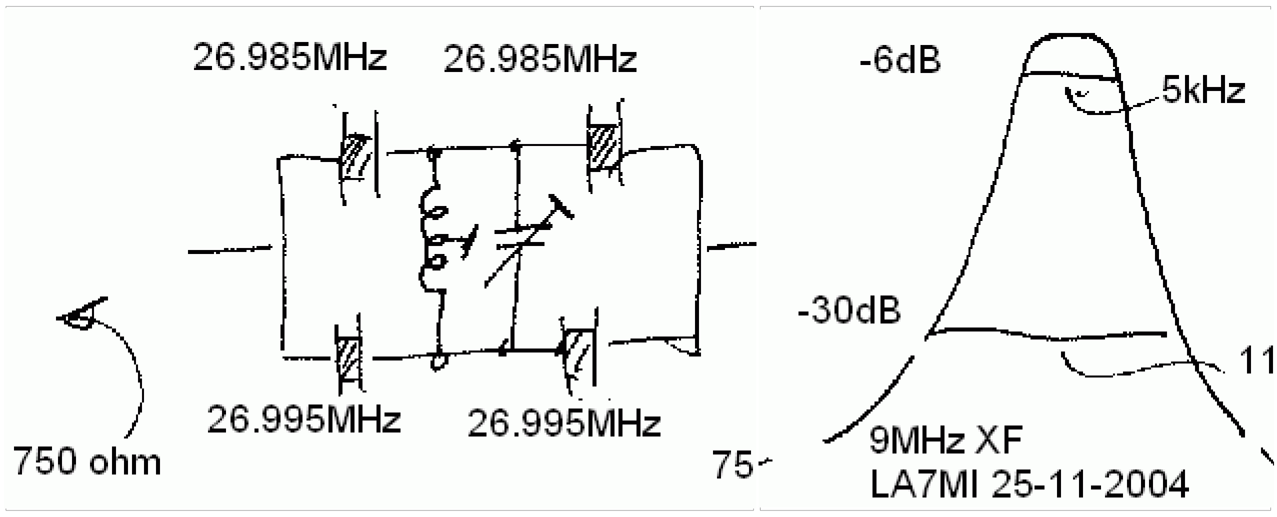


Fig 3b) Passband.



4) Lowcost filter on 9MHz using 27MHz CB xtals.

Many years ago I bought very lowcost CB xtals in Germany. When I measure the xtals, I find that there are false resonnances above the rated frequencies in 27MHz band. But the 9MHz filter has a reasonable clean curve without important false resonnances above 9MHz. I wondered why the insertion loss was over 10dB, but after measuring the xtals it turned out that the xtals has a series resistance of 100 ohm. It is far more than the xtals I've used in previous filters, so these CB-xtals have lower Q-value.

<LA7MI 2004.11.25>

About terminating mechanical filters, see page c12

Most topics are received in letters from LA7MI.
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