SELECTIVITY

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While the most obvious requirement for a good receiver is sensitivity, i.e., the ability to receive the desired signal even when it is very weak (as it often is), equally important to BCB DX is selectivity, the ability to reject stations on nearby frequencies. Selectivity is best expressed by a frequency response curve and its parameters.

Let us first consider what would be the ideal response curve for broadcast band DXing. Stations in the BCB have amplitude modulated (AM) signals. Such signals consist of a carrier, a constant frequency signal, and a pair of sidebands located symmetrically on either side of the carrier. The sidebands carry the information (voice, music, etc.) in the signal. To detect the signal (i.e., to recover the audio from it) by a normal AM detector, the entire signal - carrier and sidebands - must be present. Thus a filter that would pass only one frequency (say, the carrier) would not do. Figure 1 shows the frequency response of an ideal filter - one that will pass the complete signal of one station unattenuated while rejecting any adjacent signals. H(f) is the ratio, in decibels, of the output signal to the input. $H(f) = 20 \log_{10}(E_o/E_i)$, where E_o and E_i are the voltages of the output and input, respectively. The center frequency (f_o) is tuned to the carrier; B is the bandwidth and it must be wide enough to pass enough of the sidebands for intelligibility. B is twice the highest audio frequency that will appear in the detector output. For voice, B = 2 kc. will give sufficient intelligibility, but for music better fidelity would require B = 5 kc. or more. Note that the sides drop to $-\infty$db., i.e. E_o is zero no matter how high E_i is when the incoming frequency is outside the bandwidth; thus adjacent signals are completely rejected.

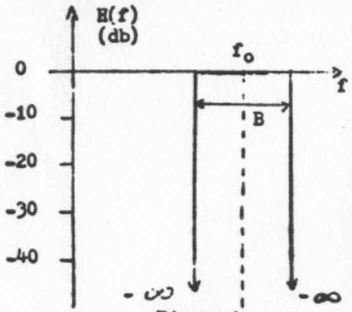
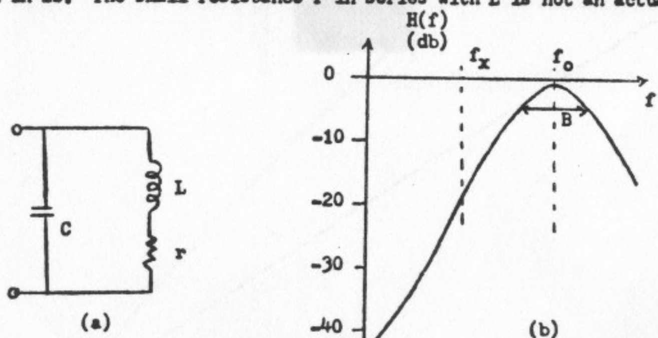


Figure 1

Very nice, but ... an ideal filter can't exist: if one did, one of its required characteristics would be to give an output before an input was applied! So let us consider what possible filters can be built and how close we can approximate the ideal filter.

First is the simple LC tuned circuit of Figure 2a with the response shown in 2b. The small resistance r in series with L is not an actual



(a) (b)

Figure 2

resistor but rather represents the resistance of the coil winding. Note how this differs from the ideal - a strong station on a nearby frequency f_x, although attenuated by 20 db., will if strong enough produce more output than the desired station will. For such a circuit, B is given by the width where the response has fallen 3 db. A parameter often given for a filter circuit is "Q." Q is given by $Q = f_o/B$ for any filter. For the circuit above, Q is also given by: $Q = 2\pi f_o L/r$.

While most receivers will have such a tuned circuit at their input, they achieve much better selectivity by the use of double tuned LC circuits in the i.f. strip (see Fig. 3). These curves have a flatter top and steeper

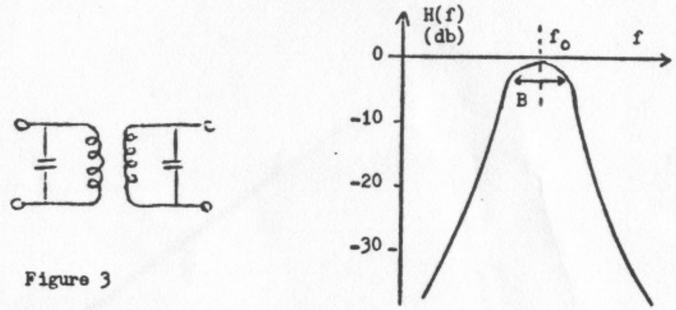


Figure 3

sides than the single LC circuit. A cascade of several stages with such tuned circuits will reduce B and steepen the sides. A typical communications receiver with 3 such circuits has a response that is down 40 db. at 10 kc. from f_o. Such selectivity is usually good enough for separating domestic stations (10 kc. apart) except on channels adjacent to strong locals; in some cases, especially if a loop antenna is used, it may be good enough for splits.

Usually, however, the separation of split frequency stations requires other techniques, the most common of which is the "Q-multiplier." As the name implies, it increases the Q - i.e., reduces B as in figure 4. While

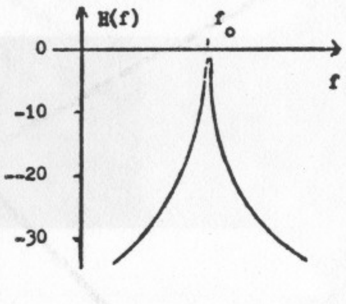


Figure 4

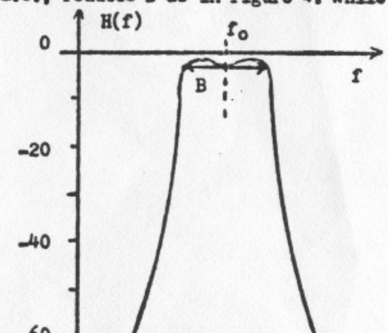


Figure 5

this does make the receiver more selective it unfortunately has a shape so sharp at the top that a large portion of the sidebands are lost, resulting in audio distortion (too much bass). Also, should the receiver drift slightly, it may reject the carrier while still passing part of the sidebands; without the carrier, the detector is unable to operate properly and the result is pure garble. Thus, for best results, a Q-multiplier should not be used in its most selective condition for BCB DXing. A Q-multiplier can also be used to produce a "notch" in the selectivity (Figure 4 turned upside down) and reject a particular interfering carrier.

Another method is to use a crystal filter which has a response somewhat similar to that of the Q-multiplier (sharp peak and notch) and many of the above comments apply in this case. A more detailed discussion of these circuits can be found in the Radio Amateur's Handbook.

Finally, we have a device that is becoming increasingly more popular for DXing - the mechanical filter. A comparison of its frequency response (Fig. 5) with that of the ideal filter (Fig. 1) will show why. Typically, B will be around 2 kc. Narrower bandwidths can be achieved with a Q-multiplier, but the mechanical filter's advantage lies in its more nearly flat top which permits enough sideband to pass relatively unattenuated to get reasonable intelligibility. The bottom of the curve, being more than 60 db. down, means that adjacent channel rejection is very good. A cascade of several such filters (some DXers are now using 2 or 3) gives even steeper sides and lowers the bottom of the curve, further improving selectivity. Also, mechanical filters have dropped in price over the past few years, so that you will probably see them being used more and more.