PW REVIEW

THE ERA BP34 COMMUNICATIONS FILTER

An advanced "one knob" audio filter for the radio amateur and short wave listener. The Rev. G.C. Dobbs G3RJV, an experienced amateur, who knows the value of simple-to-operate equipment, puts this unpretentious filter through its paces.

The radio amateur world needs another commercial audio filter like my garden needs slugs-so I thought as I was asked to test run the ERA Communications Filter. Everyone seems to do one and I have tried a lot of them. My interest in simple home built communications equipment often involves in me playing with relatively simple receivers, most of which lack inherent selectivity and can be improved by audio filtering. I have built several types of audio filter and have used many varieties of commercial filter.

Audio Filtering

Without doubt the best audio filter that the radio amateur possesses is a pair of ears. To avoid drifting into a homily, it is enough to say that those of us fortunate enough to have our full sense of hearing posess a remarkable instrument. One of its most useful facilities for listening to signals on a crowded amateur band is what has sometimes been called "the cocktail party effect"- the ability we have, in a crowded and noisy room, to pick out one conversation at the expense of the others. An experienced radio amateur can bring this facility into full effect when listening to c.w. signals on an overcrowded band.

Relying upon the ears alone does demand great concentration and can be very tiring for long periods of time and an optional filter is often very welcome. The problem with many types of audio filter is that they can become a distraction in themselves. In the attempt to introduce the filtering, the operator may have to concentrate on the unwanted signals, at the expense of losing the required signal, or have to perform a sequence of controls distracting the mind from the information being copied. Sophisticated filters may be complicated to use and defeat their very purpose.

Audio filters, however good, which simply switch in and out of the receiver circuitry can be just as bad. I have owned well-designed, narrow bandwidth, c.w. audio filters and switched them in when listening conditions have been difficult only to find I have lost the signal. The signal may not have been tuned exactly to the centre of the passband and in the effort to retune the signal so that I can hear it through the filter, it has been lost. Many active audio filters, commercial models not excepted, suffer from "over shoot" and give an unpleasant ringing effect. Initially the signal can sound good and clear but after a little time the brain begins to object to listening to "a penny rattling in a jam jar".

Why Bother?

Modern communications receivers tend to have well-designed mixer and i.f. stages, the products of today's technology. The audio stages can rarely claim such advances. It might be argued that hi-fi quality is not needed but I am disappointed by some communications receivers which offer poor quality audio amplification fed into an inadequate loudspeaker. Most receiver filtering is carried out before the high gain i.f. stages, where the inherent wideband noise from the i.f. amplification can degrade the signal to noise ratio. After which, the audio stages will probably pass higher and lower frequencies than are required for communication. An audio bandpass filter which passes signals within the required band of audio frequencies and blocks those above and below that band, can be a very useful addition to a receiver.

In single sideband (s.s.b.) communication the audio range covered is roughly between 300Hz and 2700Hz; a bandwidth of 2400Hz. In amplitude modulation (a.m.) the bandwidth is wider but most other forms of data transmission fall within the s.s.b. range. Morse (c.w.) communication requires very little bandwidth, but requires special attention because an intermittent tone can be heard at levels 10 to 20dB below that of a continuous tone. A good audio filter should cater for various modes by having a flat passband without introducing unnecessary ripples.

For a simple mode, the audio requirements for c.w. filtering are quite complex. The optimum listening frequency for a c.w. note depends upon the operator's hearing ability but a generally found range is as low as 400Hz and up to 1200Hz. It can be greatly affected by interfering signals which may superimpose one or more additional tones. In general, c.w. operators will have their own preferred listening audio frequency. This should be arranged to coincide with the transmitter's sidetone frequency, usually adjustable, so that the sidetone remains audible through a filter's narrowest passband.

In theory, a c.w. filter can have a very narrow bandwidth. Only a few hertz are needed for manually sent Morse. The limit is imposed by the technology. The aim is to produce a clean note without any overshoot, ringing or other unwanted side-effects. A narrow steep-sided filter may look good on paper but may give blurred or ringing responses even at moderate speeds of sending. A super-narrow filter is useful until the required signal drifts out of the passband or (heaven forbid!) the operator's receiver drifts away from the signal. In these days of synthesisers and stable, solid state, variable frequency oscillators, a practical limit can probably be set at around a 100Hz or a little less.

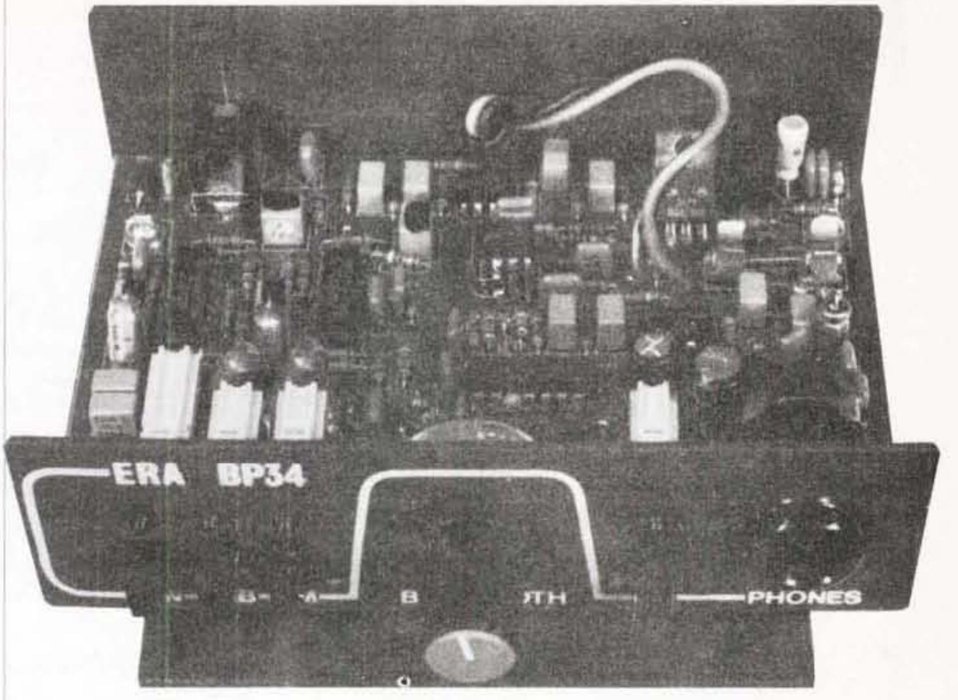
Stopband attenuation can be an important factor especially on the 7MHz band where strong interfering signals can appear. A filter with 40dB of unwanted signal rejection may seem adequate but weak stations may well be 40dB down on unwanted signals. A weak station at -40dB will be masked by a signal 100 times stronger (0dB). So a high level of stopband attenuation is desirable.

The BP34 Filter

The first thing I noticed on unpacking the BP34 were the impressive specification figures (see maker's specification). The BP34 is a cascaded elliptic audio bandpass filter with two fixed lower cut-off frequencies and continuously variable upper cut-off frequencies. It combines 34 poles of filtering for maximum selectivity and stopband attenuation with minimum passband ripple. The block diagram in Fig. 1 shows that the BP34 contains several filter types; a 5th order bi-quad elliptic highpass, a 4th order Sallen-Key aliasing lowpass, three 7th order switched capacitor elliptic lowpass and a 4th order Sallen-Key smoothing lowpass.

The heart of the filter is a switched capacitor elliptic filter. In fact, it is three XR-1015 integrated circuits piggy-back cascaded on the top of each other for superior roll-off. For a description of switched capacitor audio filters see the article by Christopher Page G4BUE, on the SuperSCAF Filter in the May 1988 issue of *PW*. It is sufficient to say here that it is a digital process which stores samples of the signal on a capacitor. A clock controls the sampling and transfer rates. Whereas analogue active filters require critically matched component values, in this system only the ratio of the components is critical. The clock rate controls the high and low cut-off frequencies.

The SuperSCAF Filter uses thumbwheel switches to pre-set the values of lowpass and highpass cut-off frequencies but the BP34 has two fixed lower cut-off frequencies and variable upper cut-off frequencies. This allows for ease of operation with continuously variable bandwidths available from one control knob



during operation. The low cut-off frequency depends upon the mode required and is 620Hz for c.w. and 200Hz for all other modes. The single control knob determines the upper cut-off frequency. The ranges are shown in maker's specification.

An example of this control range is shown in Fig. 2, which represents the filter response in the s.s.b. mode. The control range of the adjustable low pass has been chosen such that it only operates in the range that removable interfering signals occur. It should, therefore, be impossible to filter out required signal information. In the case of s.s.b. the lower lower cut-off -3dB point is set at 250Hz. This is lower than the theoretical 300Hz ideal point to give a more pleasant sound to the signals. Having the bottom end cut-off point variable would give very little gain in performance at the expense of addition complication in operating the filter. The upper cut-off frequency control gives a continuously variable bandwidth between 1500Hz and 3000Hz.

The c.w. range has a lower cut-off point at 620Hz and a continuously variable bandwidth from 80Hz to 1080Hz. On c.w. the filter is centred at 700Hz. This is a little lower than the common 800Hz frequency used in many filters, which is an advantage in that the conventional 800Hz is probably a little high in frequency for comfort of listening. In fact, given the choice, I would come down even lower to around 650Hz for comfortable listening. It depends upon our listening ability and taste, although as our age increases our hearing acuity, especially at higher frequencies, decreases. Men hear lower frequencies better than women. If you want a subjective indication of a comfortable listening pitch, listen to medieval plainsong! When using the BP34, the sidetone on the transmitter should be adjusted to 700Hz.

The minimum stopband attenuation is better than any other audio filter I have seen quoted. It cuts off steeper and goes down deeper than most, if not all, other filters. The passband is flat with very little ripple. The lack of ripple is useful for RTTY or data communications as both mark and space tones may be received at the same levels. The filter also has very low (typically -95dB) inherent noise with no signal present.

The Filter In Use

The BP34 certainly has impressive specifications but how does it perform in practice? I used the BP34 for over six months and have been most impressed. My first good impression was the simplicity of operation. Four push buttons select the main functions which are indicated by red l.e.d.s. A filter ON/OFF switch brings the filter into the speaker or phones lead. With the filter connected the signals should be heard at about the same level as they would come directly from the receiver. Releasing the filter ON button allows the signal to pass directly to the speaker or phones. In this direct switching position all frequencies from the receiver are allowed to pass with some reduction in low frequency hum.

The three other buttons provide the c.w., s.s.b. and a.m. modes. These switches can also be used in combination and the s.s.b. plus a.m. is quoted in the maker's specification.

Wide shift data transmissions may be received in the s.s.b.+c.w. combination. The a.m. bandwidth is tailored for speech reception and loss of bass and treble will be noticed when receiving music.

In short the BP34 was a joy to use. The combination of mode choice and one knob control of bandwidth helped it to do what a good filter should do: aid the readablity of a chosen signal. It is a great advantage to be able to locate required signals with the bandwidth fully or partly open and then with the simple operation of one control reduce the bandwidth by an appropriate amount depending upon the conditions. The value of the ears as a filter became noticable the more I used the BP34. The more I used the filter over the months the less often I seemed to find myself fully closing the passband. I was able to adjust the bandwidth to "my" advantage, not to any pre-determined bandwidth governed by a manufacturer.

The reduction in wide-band receiver noise was helpful even at the widest filter settings and the narrowest c.w. setting gave a pleasing signal quality which seemed clear of ringing and overshoot. Bringing the filter into operation did not interfere with my reading of the signal. The operation of the filter is so simple that total concentration can be given to the required signal, not to the change in the interfering signal, or the process of operating the filter. Even if the required signal had not been tuned into the centre of the passband, I found I could still concentrate on the signal as the bandwidth was reduced. I soon got into the practice of being able to operate the filter bandwidth control and as the passband got narrower, adjust the receiver incremental tuning (r.i.t.) with the other hand, if this was required.

Much of my use of the BP34 has been on 3.5MHz band QRP c.w., where my interest is in working other QRP stations. These are often weak signals on a noisy band and provide a good test for any filter. Without doubt the BP34 is the best filter I have used, so far, for this type of operating.

The BP34 Filter costs £94.50 inc. VAT/postage and is available from the makers ***ERA Ltd. Unit 26 Clarendon Court, Winwick Quay, Warrington WA2 8QP. Tel: (0925) 573118***

I would commend its use for any serious radio amateur and short wave listeners and especially c.w. fanatics. It is a sophisticated device and like any good sophisticated device, it works well and is simple to use. I think the makers may have a problem; it also looks simple. Sadly these days, many radio amateurs like their equipment to "look" complex with lots of controls. Quite a paradox when technical advance, to be any real advantage should make equipment simpler to use. I wonder....?

Maker's Specification

Cut-off frequencies: at -3dB points in all cases

c.w.	high pass 620Hz,	low pass (min 700Hz to max 1700Hz)
s.s.b.	high pass 200Hz,	low pass (min 1700Hz to max 3200Hz)
a.m.	high pass 200Hz,	low pass (min 2500Hz to max 4200Hz)
s.s.b. + a.m.	high pass 200Hz,	low pass (min 3200Hz to max 5100Hz)

Bandwidth: continuously variable, all at -3dB points

c.w.	min 80Hz to max 1080Hz
s.s.b.	min 1500Hz to max 3000Hz
a.m.	min 2300Hz to max 4000Hz
s.s.b. + a.m.	min 3000Hz to max 4900Hz

Passband ripple:

c.w.	between 680Hz and 1650Hz <0.25dB
s.s.b.	between 250Hz and 3000Hz <0.30dB
a.m.	between 250Hz and 4000Hz <0.50dB
s.s.b. + a.m.	between 250Hz and 4500Hz <1dB

Minimum stopband attenuation: low pass >80dB, high pass >60dB

Gain: unity gain of 1 or 0dB

Input impedance: >100kΩ all filter modes

Maximum input signal: 5V p.p. or 1.8V r.m.s.

Output power: typical 400mW into 8Ω speaker at maximum input

Connections:

Signal input to phono socket on rear panel
Speaker output to 3.5mm chassis socket on rear panel
Phone output to 0.25 inch jack socket on front panel (switches off speaker output when phone jack is used).
DC power, via hard-wired red and black cable (red is positive).

Protection:

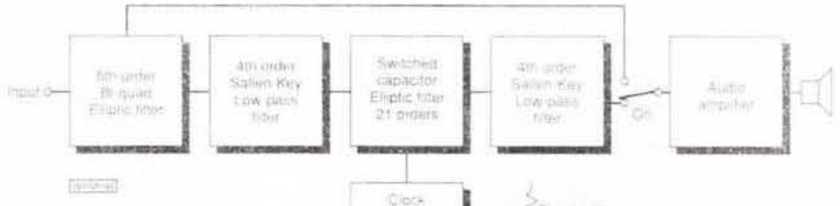
Reverse polarity on d.c. supply via diode, d.c. input current limited by 500mA slow-blow fuse, audio output devices short circuit protected.

Supply:

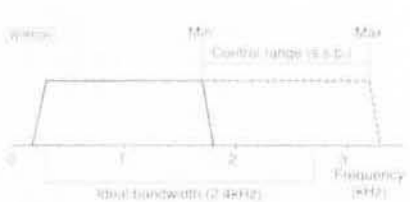
Nominal +13.8V d.c., 12V to 26V d.c. at full rated audio output. Current 60mA quiescent 200mA at maximum input to an 8Ω load.

Dimensions: W x H x D, 134 x 54 x 123mm (including feet).

Weight: 540g



Block diagram of BP34 filter.



Filters response in s.s.b. mode.