RADCOM TECHNICAL FEATURE

The Ferret Audio Filter

by Paul Lovell, G3YMP

SIMPLE RECEIVERS for the HF amateur bands can give excellent results, but reception can often be improved by the addition of a variable bandwidth audio filter. The Ferret was designed with just such a purpose in mind, and the design is based around the Maxim MAX294 low-pass filter IC featured in the March '94 *Simply Silicon* column.

HOW DOES IT WORK?

ESSENTIALLY, THE CIRCUIT consists of three sections, as shown in the circuit diagram **(Fig 1)**. R1 provides a suitable load where the filter is driven from the speaker output of a receiver.

The first section is a band-pass filter (BPF) which has a switch selectable cut-off frequency. The top position of S1 by-passes this for SSB reception, with the audio input being applied to IC1 via capacitor C4. The second position (CW HI) has a resonant circuit consisting of inductor L1 and capacitors C2 and C3 in series. These components resonate at about 600Hz and give a response which is approximately 100Hz wide at the –3dB points. The third switch position (CW LO) shorts out C2 bringing the filter 'nose' to a frequency in the region of 410Hz.

Although this band-pass characteristic is useful for CW reception, the skirt selectivity and in particular the response above 600Hz leave much to be desired. This is where the second section of the circuit, based around IC1, really comes into its own. The chip is an eighth-order switched capacitor low-pass filter, with an internal oscillator operating at 100 times the cut-off frequency. This can be set by means of an external capacitor. In the case of the Ferret a dual varicap (D1A and D1B) is used to provide a variable capacitance from approximately 60pF to 1000pF.

Varying the applied voltage on RV1 gives a low-pass filter whose cut-off frequency (f_o) can be set anywhere between about 240Hz and 3.5kHz when the circuit is operated from a 9V supply. Since the response is in the

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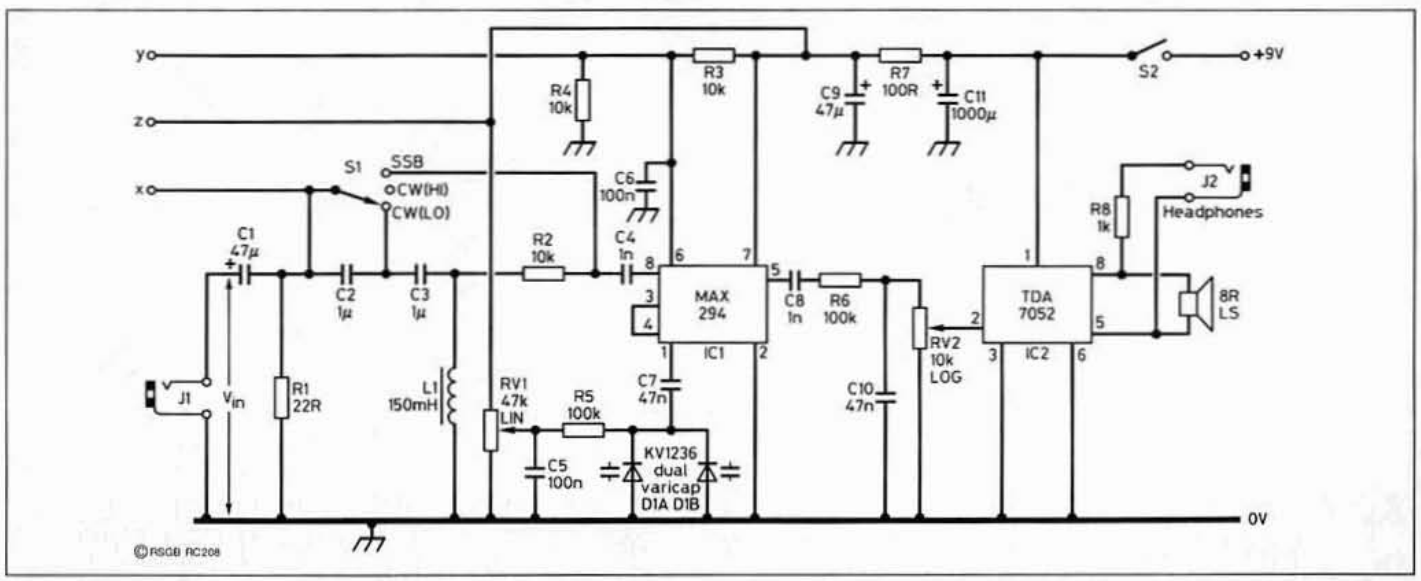

Fig 1: Most component values are not critical. The value of resistor R8 may need to be increased for high impedance phones.

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order of –58dB at 1.2 x f_o, setting RV1 to give a cut-off at 500Hz means that signals above 600Hz are practically inaudible. For SSB, the setting can be 2.4kHz which results in practically a zero response to audio signals above 2.9kHz.

The relatively small value of C8 limits the LF response in all modes, and C10 filters clock frequencies from the audio signal before this is applied to the final stage, a TDA7052 audio amplifier. Plenty of output is available for either headphones or a speaker, as required.

LET'S FERRET AROUND

TO TEST THE CIRCUIT, I selected a receiver with a very broad audio response, tuned to the CW end of the 7MHz amateur band during a contest. This is rather the radio equivalent of 'throwing a Christian to the lions', but the Ferret emerged unmauled and with its credentials relatively intact! My own preference was for the lower of the two CW centre frequencies, although each was helpful in picking out weak stations.

I found it best to tune around with the filter set to a relatively wide position, and then reduce the LPF cut-off with RV1 when necessary. On a number of occasions it was most effective in 'splitting' two CW stations of similar strength, separated by less than 100Hz. On SSB, the low-pass filter could be adjusted to deal with some fierce adjacent channel QRM.

Some experimentation with the value of inductor L1 and its associated tuning capacitors (C2 and C3) may be required to achieve best results, or to suit individual preference. If the filter is to be used in conjunction with a transceiver, then it might be useful to make the centre frequency the same pitch as the side-tone. Some constructors may opt to delete the audio amplifier IC2 completely, and feed the filtered audio signal back into the rig's existing output stage.

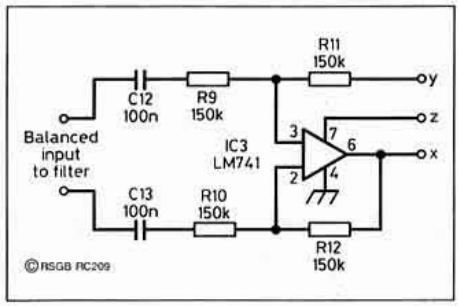


Fig 2: Balanced inputs may be used with the circuit shown above. Sensitivity can be increased by raising the value of resistor R11.

JUNK BOX FRIENDLY

VEROBOARD CONSTRUCTION proved perfectly satisfactory for the prototype, as signal levels on the board are relatively high. Note that switch S1 is a two-pole changeover type in the prototype, although only one pole is used. It has a centre-off position which corresponds to the 'CW HI' mode. Although 9V operation is specified, a stabilised mains adaptor of up to 12V may be used, and this is advisable for extended operation.

The MAX294 and dual-varicap diode may be the only components that some constructors need to buy. Practically any audio amplifier could be used for the output stage – a bipolar emitter follower stage should be sufficient to drive headphones. Inductors such as the surplus (ex-BT) 88mH types could also be pressed into service, with suitable selection of the resonating capacitors, C2 and C3.

Although this circuit is suitable for single ended output stages such as the LM386, balanced circuits such as the TDA7052 (used in the Yearling, *RadCom*, Jan 1994) may also be used. The balanced/unbalanced (balun) converter shown in **Fig 2**, has been used successfully to match a variety of inputs. If such a circuit is used, then capacitor C1 and resistor R1 will not be required. In fact C1 may not be necessary in any case, but was included for protection against any possible DC voltage at the speaker output of the receiver.

With a higher resonant frequency for the band-pass filter, the circuit could also be useful for datacomms applications. In any event, it should provide readers with some useful ideas for experiments. Whilst not up the same performance as a top-notch filter using Digital Signal Processing (DSP) techniques, the Ferret has the advantage of simplicity and it can be constructed at low cost.

COMPONENTS LIST

Resistors

All 0.25W 5% unless stated

R1	22R 1W
R2,R3,R4	10k
R5,R6	100k
R7	100R
R8	1k0
RV1	47k linear
RV2	10k log.

Capacitors

C1,C9	47µF 25V
C2,C3	1µ0 100V polyester
C4,C8	1n0 25V ceramic
C5,C6	100n 25V ceramic
C7,C10	47n 25V ceramic
C11	1000µF 16V

Inductors

L1	150mH toroidal type: Toko 10RBH series or similar

Semiconductors

IC1	Maxim MAX294CPA
IC2	Philips TDA7052
D1A,D1B	Toko KV1236 dual varicap diode

Additional Items

S1	Single or double-pole changeover switch, with centre-off position
S2	On/Off toggle switch
J1	3.5mm jack plug
J2	0.25in or 3.5mm output socket

2 control knobs

LS 8 to 64Ω speaker or headphones

PP3 battery and connector, or external power adaptor.

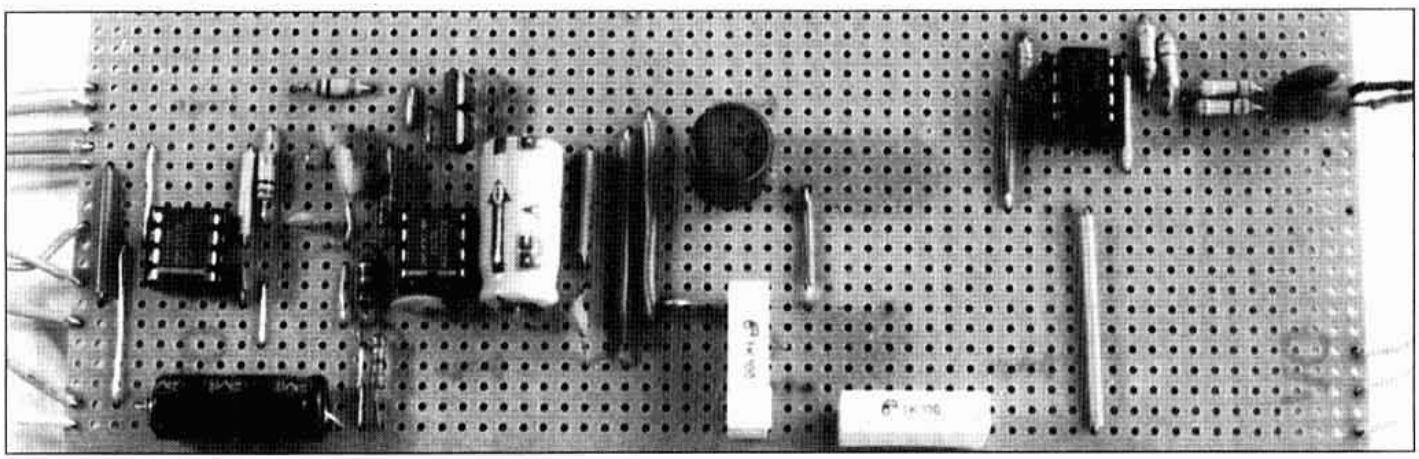
Stripboard 2.54mm(0.1in) matrix, at least 20 tracks x 50 holes

Case approx. 8 x 3 x 6in (200 x 75 x 150mm) such as type JA83 from JAB Electronic Components (see below).

Additional Items for Balanced Input (Fig 2)

IC3	LM741 Op-amp integrated circuit
C12,C13	100n ceramic
R9,R10,R11, R12	150k

A kit for the Ferret is available from: JAB Electronic Components, The Industrial Estate, 1180 Aldridge Road,Great Barr, Birmingham B44 8PB



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