20 Hz audio bandpass filter for filtering and amplification of weak DXTV video carriers

By Tony Mann and Todd Emslie

Introduction

This audio bandpass filter is useful for amplification and filtering of weak AM TV video carriers. For example, a DFM (digital frequency audio multimeter) may have insufficient input sensitivity for measuring extremely weak SSB TV video audio signals. By using the 20 Hz filter to peak the wanted carrier, the DFM will display the carrier frequency.

Another possible application for this filter is increased amplification and reduced bandwidth of weak BCB heterodyne AM carriers. The filter is also very useful for separating video carriers that are in close proximity of each other.

By definition, a bandpass filter is usually a low-pass and high-pass filter in series, allowing only a certain range of frequencies through. Because the cut-off frequencies are close to one another, the effect will be similar to that of a peaking filter.

The bandwidth of the filter, when peaked is approximately 20 Hz. This is much narrower than the typical 2.4 KHz SSB bandwidth of most communications receivers. The advantage of this filter is a constant 20 Hz bandwidth, regardless of the resonant frequency, when peaked between 400-4000 Hz.

Typical set up

The audio line-out or headphone output from a VHF/UHF scanning or communications receiver is connected to the input of the bandpass filter. The output of the bandpass filter is connected to a digital frequency meter (DFM), and/or audio monitor speaker. A monitor speaker is used when tweaking the filter's resonant frequency. If a DFM is not used, a PC program, such as Spectrum Lab could be used for spectral display of TV video carriers on a computer screen.

The tuning range of the filter is from ~ 400 Hz to 4 KHz, when using a 50 KHz potentiometer. The writer typically tunes the filter to resonate around ~ 1000-1300 Hz. This frequency range corresponds to the maximum output level of 2.4 KHz USB mode.

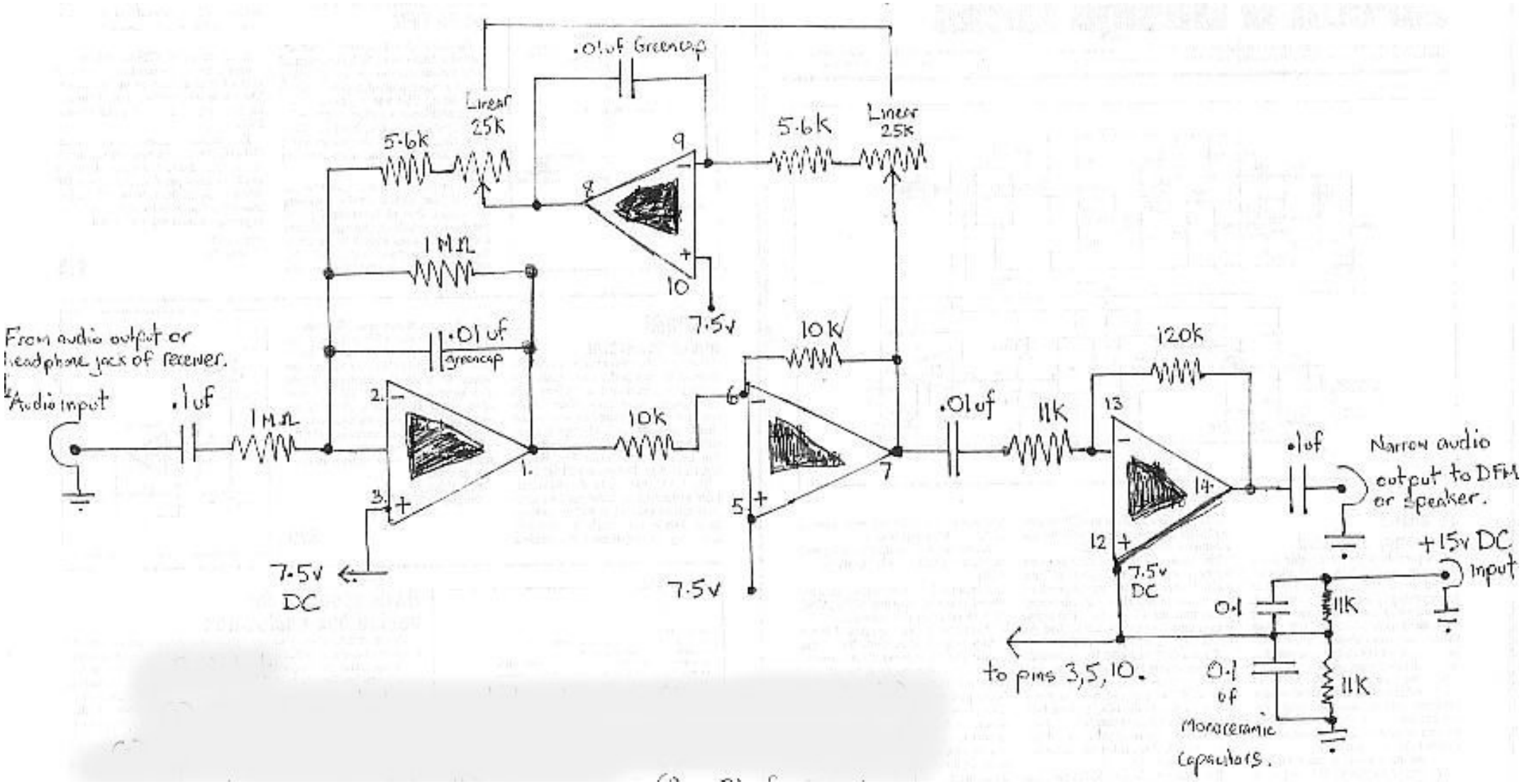
A 10K fine tuning potentiometer has also been added (not shown on the schematic). This can be included in series with the main 50K pot. I did this on my filter, and the centre of the tuning range moved from 300 Hz to 1000 Hz and improved the bandspread by a factor of about 4 times up to 2 kHz. A fine tune pot is useful for use with receivers that have 100 Hz minimum tuning steps, for example, Icom R7000/7100/8500, etc.

Initially, a LM348 op-amp was used in the circut. Although this worked ok, it was found that by replacing the LM348 with a LM6134BIN IC, improved high frequency response was obtained.

Please note that only one single IC is used in the band pass circuit. The four op-amps indicated on the circuit diagaram are all contained within one IC.

The author has also fitted a by-pass switch, to enable audio frequencies above the filters resonant frequency.

Bandpass filter Schematic (all four op-amps are used in the LM-348)


.01uf Greencap
Linear 25K
5.6K
9
8
5.6K
Linear 25K
1 MΩ
10
7.5v
.01 uf greencap
From audio output or headphone jacks of receiver.
Audio input
.1uf
1 MΩ
2.
3.
1.
7.5v DC
10K
10K
6
5
7
7.5v
.01uf
11K
120K
13
14
12
7.5v DC
.1uf
Narrow audio output to DFM or speaker.
+15v DC input
0.1
11K
to pins 3,5,10.
0.1 uf
11K
Monoceramic capacitors.

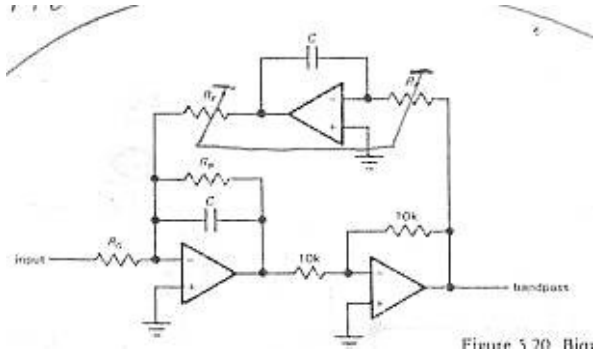
Part list:

(1) 50K linear dual-gang potentiometer.
(1) 10K linear dual-gang potentiometer (optional fine tune control).
(2) .1 uf ceramic capacitors.
(1) .01 uf ceramic.
(2) .01 uf greencap capicitors.
(2) .1 uf monoceramic capacitors.
(2) 5.6K resistors.
(2) 10K resistors.
(3) 11K resistors.
(1) 120K resistor.
(1) 1M ohm resistor.
(1) LM6134BIN op-amp IC,
OR:
(1) LM348 (or similar) op-amp.

Note: all resistors are 1/4 watt, metal film 1% tolerence.

Bandpass filter Schematic without extra amplification (only three op-amps used)

Biquad filter. A close relative of the state variable filter, is showm below. This circut uses three op-amps. It has the interesting property that you can tune its frequency (via the single double-gang pot) while maintaining constant bandwidth (rather than constant Q).



The audio output is from pin 7 of the LM348 IC.

National Semiconductor

Operational Amplifiers/Buffers

LM148, LM149 Series Quad 741 Op Amps

LM148/LM248/LM348 quad 741 op amps
LM149/LM249/LM349 wide band decompensated ($A_{V(MIN)}$ = 5)

General Description

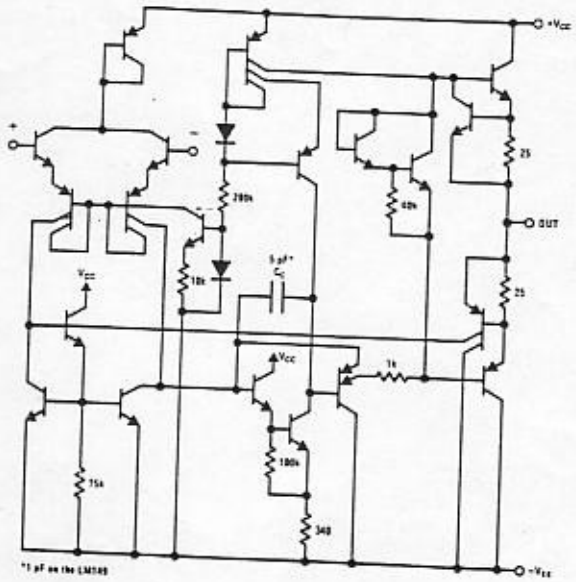
The LM148 series is a true quad 741. It consists of four independent, high gain, internally compensated, low power operational amplifiers which have been designed to provide functional characteristics identical to those of the familiar 741 operational amplifier. In addition the total supply current for all four amplifiers is comparable to the supply current of a single 741 type op amp. Other features include input offset currents and input bias current which are much less than those of a standard 741. Also, excellent isolation between amplifiers has been achieved by independently biasing each amplifier and using layout techniques which minimize thermal coupling. The LM149 series has the same features as the LM148 plus a gain bandwidth product of 4 MHz at a gain of 5 or greater.

The LM148 can be used anywhere multiple 741 or 1558 type amplifiers are being used and in applications where amplifier matching or high packing density is required.

Features

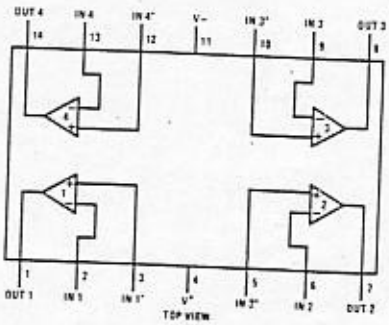
- 741 op amp operating characteristics
- Low supply current drain — 0.6 mA/Amplifier
- Class AB output stage—no crossover distortion
- Pin compatible with the LM124
- Low input offset voltage — 1 mV
- Low input offset current — 4 nA
- Low input bias current — 30 nA
- Gain bandwidth product
  LM148 (unity gain) — 1.0 MHz
  LM149 ($A_V \geq 5$) — 4 MHz
- High degree of isolation between amplifiers — 120 dB
- Overload protection for inputs and outputs

Schematic and Connection Diagrams



*1 pF on the LM148

Dual-In-Line Package



Order Number LM148J, LM248J, LM348J, LM149J, LM249J or LM349J
See NS Package J14A
Order Number LM348N or LM349N
See NS Package N14A

Pin connections for LM348 IC

Pin 1: out 1
Pin 2: in 1
Pin 3: in 1*
Pin 4: +7.5 v
Pin 5: in 2*
Pin 6: in 2
Pin 7: out 2
Pin 8: out 3
Pin 9: in 3
Pin 10: in 3*
Pin 11: -V
Pin 12: in 4*
Pin 13: in 4
Pin 14: out 4.

Acknowledgements

Horowitz & Hill, *The Art of Electronics*, Cambridge University Press, 2nd edition, p.278.

Anthony Mann for developing the prototype and choosing the LM6134BIN IC.