SSB Microphone Filter

Build this circuit to tailor your microphone response to different band conditions.

W hile cleaning out a closet recently I discovered an old Shure 545S microphone that was used during my younger years in a rock band. This classic dynamic microphone features a built-in stand mount and was the precursor to the popular SM-57/58 series now in production. I decided to place this microphone into amateur radio service and proceeded to order a desk stand with room for a PTT switch. This project was later expanded to include a filter similar to my Yaesu MD-100A8X[1] desk microphone with the circuit powered from the radio's microphone voltage.

Circuit Description
The Yaesu MD-100A8X offers three selections of high pass filtering plus a high frequency emphasis setting. I designed a PC board to fit inside the desk stand and placed the switches on the front for easy access. A gain switch was also added to replace the gain jumper.

Controls
All four slide switches are mounted on the PC board with the slides protruding through the front of the desk stand. FILTER switch S1 selects whether the filter is in or bypassed. GAIN switch S3 selects voltage gains of 1 or 2 (0 dB or 6 dB). LOW CUT switch S4 selects between 1, 2, and 3 which corresponds to F_{-3dB} frequencies of 6 Hz, 150 Hz, and 325 Hz, respectively. DX switch S2 adds 8 dB of high frequency boost centered around 4.8 KHz and a low cut F_{-3dB} at 450 Hz. In the bandwidth limited world of SSB, this peak adds 6 dB at 2.5 KHz. When the DX switch is on the LOW CUT settings are inactive.

(U1-U2, NJM4580D)
The original circuit uses µPC4572C op amps which are either no longer in production or available only in large quantities. Because the circuit was designed to operate on the internal microphone power supplied from the radio (maximum of 15 mA) these op amps must be low supply voltage low current devices. They should also exhibit low-noise since they are in the direct path of the microphone signal. The NJM4580D exhibits low input noise (0.8µV RMS), operates down to 4VDC, and draws about 5mA.

U1A acts as a buffer amplifier with gain determined by R6/R4 or R6/(R4||R5). The low cut roll-off frequencies are determined by the equation $F_{-3db}=1/2\pi RC$, where R is R11 and C is switched between C12, C6, and C5. The U1B high emphasis circuit resembles circuits based on R.I.A.A. (Recording Industry Association of America) compensation[2]. A SPICE-based analog simulation program called TINA-TI[3] was downloaded and the filter schematic was entered (Figure 1). The

resulting plot of Figure 2 reveals how the filter influences the microphone signal using AC circuit analysis:
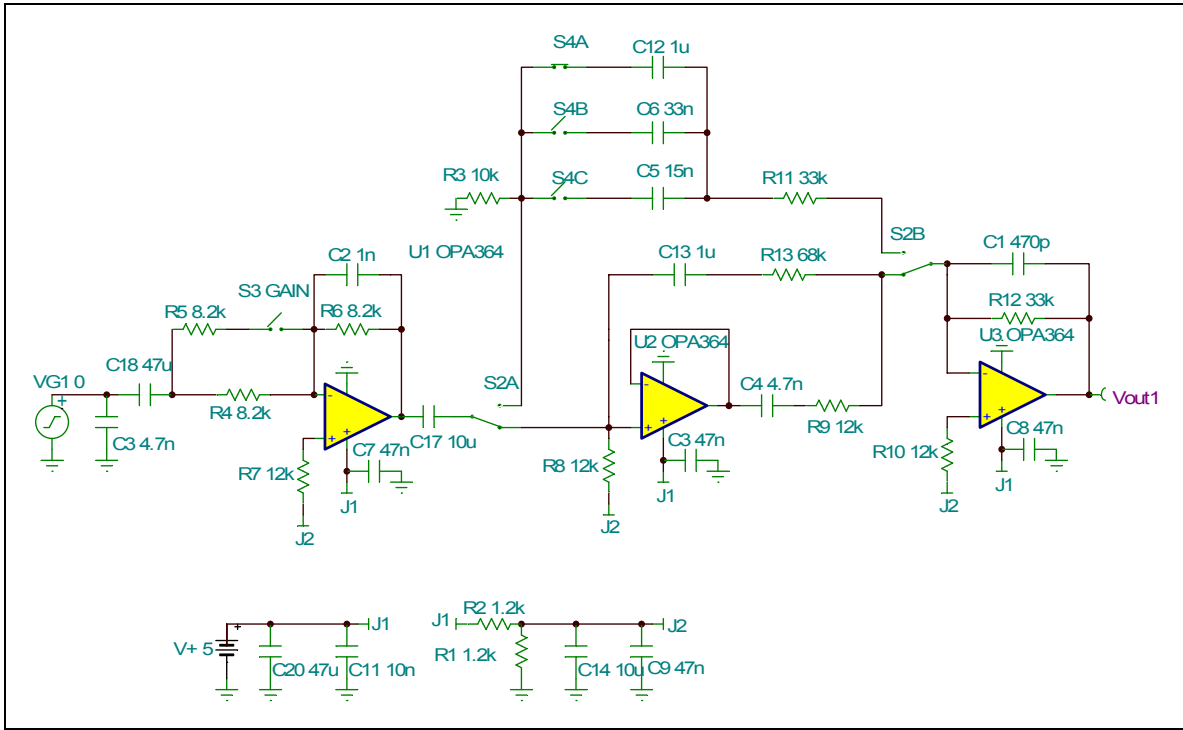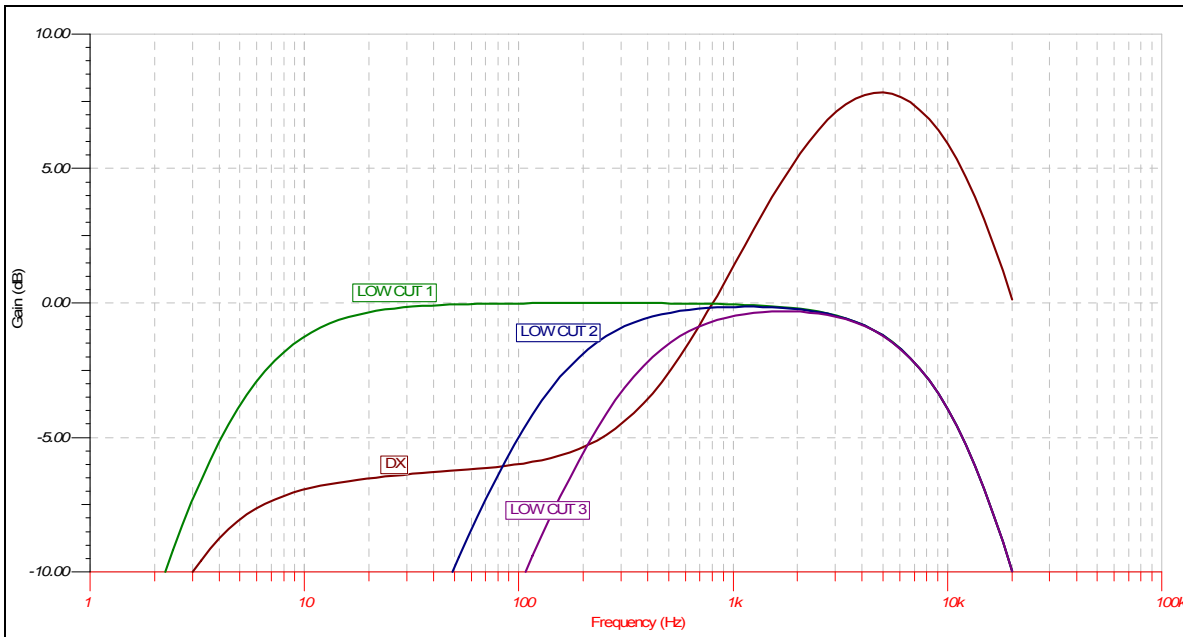

Figure 1

Figure 2

Experimenting with different resistance values will lead to different response curves. For example, to get the high frequency boost without the low cut roll-off, reduce the value of R13 from 68K to 34K. Halving the value of R9 from 24K to 12K reduces the amplitude and frequency of the peak from 8dB@4.8 KHz to 4dB@3.5 KHz.

PTT Switch
Several SPST momentary pushbutton switches were ordered and the one with the smoothest operation was selected. PTT switch S5 is mounted on the front top of the desk stand and wired to the PC board.

Microphone Output
An RJ-45 connector was chosen since it lends itself to direct PC board mounting, plus two of my radios use them for microphone connectors. The connector is mounted on the circuit side of the PC board so that the desk stand's cable slot can be enlarged to accommodate the connector. The microphone is then connected to the radio (FT-817/857/897) microphone input via a standard CAT-5 patch cord.

Power Requirements
Tests indicate that the 5VDC supplied by the Yaesu FT-817/857/897 in the microphone cable will deliver approximately 15mA before the voltage drops below 4.85VDC. The measured current for the filter circuit is approximately 10mA at 5VDC. Other radio microphone voltages such as 8VDC will also work if they can supply the required 10mA. In the event that the microphone cable voltage is not available, circuit power can be supplied from your radio's 12VDC power supply. The U3 voltage regulator reduces the 12VDC to 5VDC and is selected on jumper JP1. The 12VDC power connector J3 is also mounted on the circuit side of the PC board. The following components can be omitted when powering the circuit from 5VDC microphone power: J3, FB7, FB8, D1, C16, C21, and U3.

Microphone Wiring
The 545S microphone is wired for an unbalanced low impedance 150Ω connection. Microphone pins 1 and 3 are tied to ground via FB2, and pin 4 is wired to FB1. Shielded cable is used from the microphone connector to the PC board. Electret microphones can be powered by applying 5VDC through a 2.2K resistor to pin 2 of S1. Also, replace the short between pins 1 and 6 of S1 with a 10uF/16v electrolytic capacitor. The electret mic option is reflected in the Alternate schematic and PC board.

Construction
The circuit can be built using any style of construction but must be completely shielded and grounded to eliminate hum. The components are inexpensive which means that separate filters can be built to match different radio connectors.

The bottom of the PTT switch interferes with the PC board and must be mounted on a spacer to move it higher. I found a bronze thrust washer at my local hardware store with a 1"OD and ½"

ID that works well. Enlarge the inside diameter slightly with a round file to accommodate the PTT switch and then paint it black.

The miniature slide switches used for S1-S4 weren't my first choice as they are almost too short to protrude through the thickness of the desk stand. However, right angle printed circuit mount SP3T and DPDT toggle or rotary switches are expensive and somewhat hard to find.

Drill and cut all holes on the front and rear of the desk stand. Note that the holes should be cut so that they are parallel to the bottom of the stand, not perpendicular to the front or rear panels. I used a Dremel tool to remove the cable clamp inside the desk stand. After the drilling and filing are complete repaint the entire desk stand with flat black spray paint to cover the exposed aluminum. When dry, place the painted stand in the oven for an hour at 250ºF. Labeling can be added using a label maker with white characters on clear tape. An aluminum bottom plate is cut to fit the bottom of the desk stand and four holes are drilled to match the rubber feet mounting screws. The PC board is mounted on four 0.3125" long standoffs that are attached to the bottom plate. I used a disc sander to remove 1/16" from the length of 3/8" standoffs. A Shure A2WS microphone windscreen completes the setup.

Two PC board layouts are provided. The first layout, 2.5" x 5.85", was used on the prototype for this project. The second layout is smaller at 2.5" x 3.8" and takes advantage of the MiniBoard service offered by ExpressPCB[4] for considerable cost savings. Three MiniBoards cost less than two Standard Service boards. The smaller layout will fit inside a 4"x4"x2" enclosure with an XLR dynamic microphone input and a 1/8" phone jack for an electret microphone input on the front. The rear contains round 8-pin Foster and RJ-45 microphone output jacks. Internal jumpers allow the filter to be configured to most radios.

Conclusion

The SSB Microphone Filter is a great way to get different responses from one microphone to adapt to changing band conditions. It will help to reduce the low frequencies of a bassy voice to improve intelligibility in noisy band conditions, or boost the high frequencies to work that DX pileup. The circuit can be built into a desk stand or its own enclosure and powered by the microphone voltage or radio power supply. Comparable to antenna modeling, analog circuit simulations can be made using TINA-TI. This program is a great learning tool and allows the builder to customize the filter response before any solder is melted.

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