A Long-wave Upconverter

Explore VLF and LF even if your receiver doesn't tune below 500 kHz.

Fred Brown, W6HPH

This upconverter permits you to tune down to 10 kHz on your ham-band receiver. Operation of the converter is simple (see Figure 1). The VLF or LF signal is amplified and then heterodyned up to the 40- or 80-meter band using a 7,000 kHz or 3,500 kHz oscillator. Your receiver dial becomes direct-reading if you ignore the MHz position.

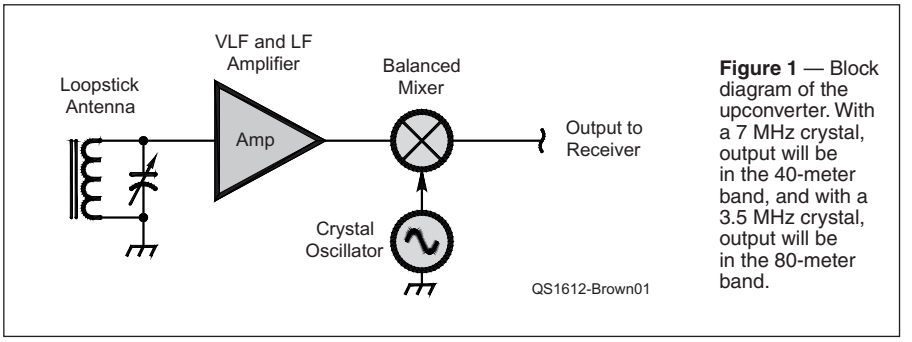

Figure 1 — Block diagram of the upconverter. With a 7 MHz crystal, output will be in the 40-meter band, and with a 3.5 MHz crystal, output will be in the 80-meter band.

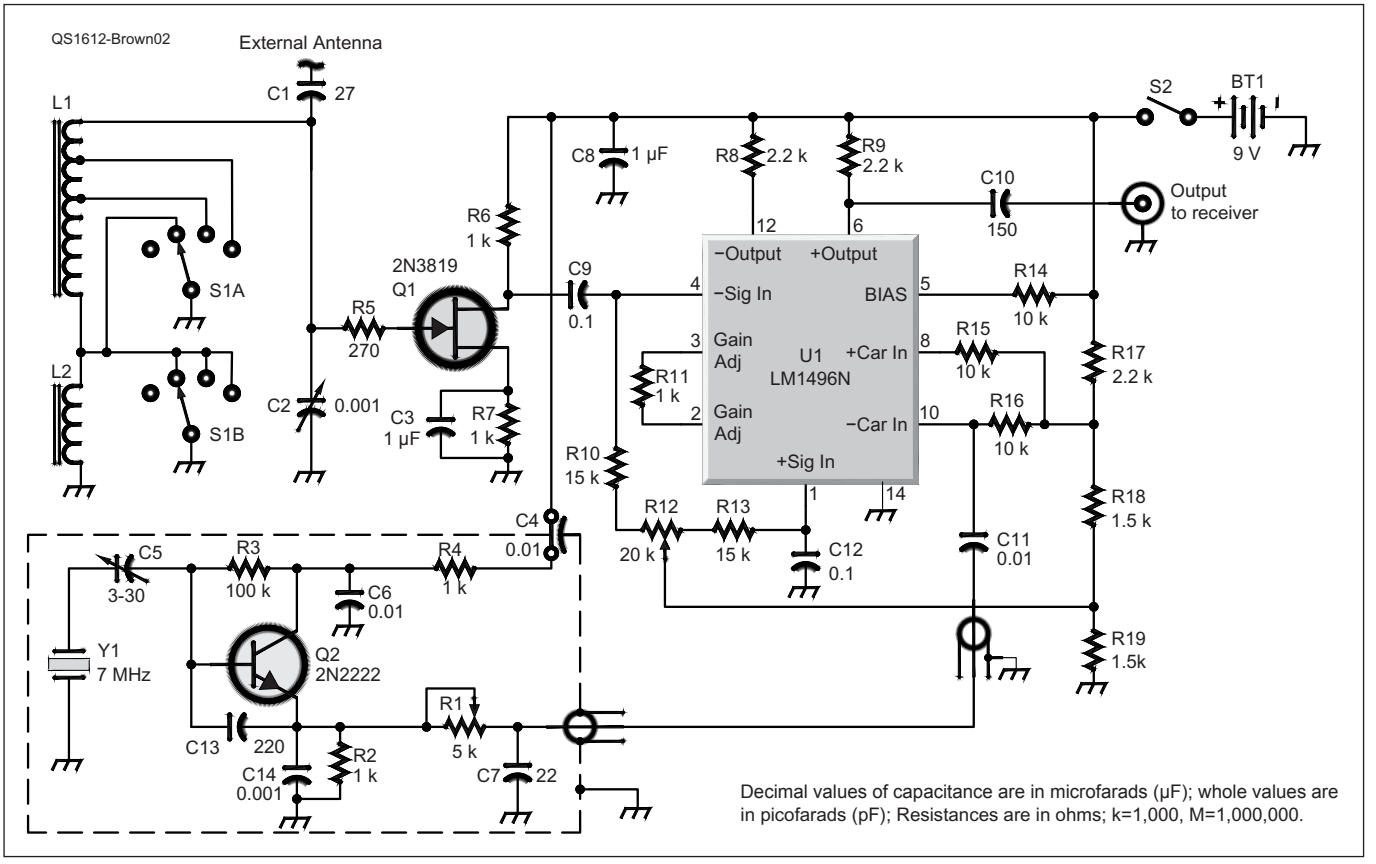

Figure 2 — Printed circuit board (all parts from **mouser.com**).

BT1 — 9 V battery
C1 — Capacitor, 27 pF
C2 — Capacitor, three-gang, 330 pF per gang, all stators connected in parallel
C3, C8 — Capacitor, 1 µF
C4 — Feed-through capacitor, 0.01 µF
C5 — Capacitor, 3-30 pF trimmer
C6, C11 — Capacitor, 0.01 µF
C7 — Capacitor, 22 pF
C9, C12 — Capacitor, 0.1 µF
C10 — Capacitor, 150 pF
C13 — Capacitor, 220 pF
C14 — Capacitor, 0.001 µF
L1 — 600 turns #34 AWG enameled on ⅝ inch diameter by 7.5 inch long ferrite rod; tapped 48 turns, 155 turns from top. Total inductance 37.5 mH.
L2 — Inductor 218 mH pot core (see text)
Q1 — 2N3819 N-channel JFET
Q2 — 2N2222 NPN transistor
R2, R4, R6, R7, R11 — Resistor, 1 kΩ ¼ W
R3 — Resistor, 100 kΩ ¼ W
R5 — Resistor, 270 Ω ¼ W
R8, R9, R17 — Resistor, 2.2 kΩ ¼ W
R10, R13 — Resistor, 15 kΩ ¼ W
R12 — Potentiometer, 20 kΩ
R14, R15, R16 — Resistor, 10 kΩ ¼ W
R18, R19 — Resistor, 1.5 kΩ ¼ W
S1 — Rotary switch; four-position, two sections (A and B)
S2 — SPST switch
U1 — LM1496N balanced mixer IC
Y1 — 7 MHz crystal (see text)

Circuit Details

The LM1496N balanced mixer can be adjusted for almost total rejection of the local oscillator (LO) in the output. With a shielded local oscillator and a careful adjustment of the balanced mixer, the LO level at the converter output can be less than 500 μV — a level not normally a problem for a good receiver.

The converter front end covers 10 to about 980 kHz in four bands. The inductor L1 — see the schematic of Figure 2 — is a tapped loop stick, which also serves as an antenna. An additional inductance L2 is switched in series with L1 for 10 to 28 kHz coverage. The loop stick resonates on the desired frequency with a three-gang variable capacitor C2, which has a maximum capacitance of about 1,000 pF. For weak signal enhancement, a terminal is provided for connecting a long-wire antenna.

A 2N3819 N-channel JFET provides 6 dB gain, and couples to the LM1496N double-balanced mixer. This RF stage presents a very high input impedance to the front-end tuned circuit.

A conventional Colpitts oscillator Q2 operates at a very low dc power level. Its output level can be adjusted by trim potentiometer R1. About 50 mV of injection is needed at Pin 10 of U1. R2 is a balance control and is adjusted for minimum LO level at the converter output.

Construction Details

Nothing is particularly critical about construction, as seen in Figure 3. I used a wooden chassis and mounted the loop stick on non-metallic supports spaced at least an inch from the chassis. My loop stick is wound on a ⅝ inch diameter by 7.5 inch long ferrite rod (see the details in Figure 2).

L2 might be hard to find; I used an adjustable toroid made by Burnell & Co. However, any inductor of about 218 mH with reasonably good Q will work. One possibility is three 88 mH toroids in series.

Mount the RF stage and mixer components on a circuit board roughly 2.5 × 3 inches. The local oscillator has it own 1.5 × 2 inch circuit board, which is housed in a completely shielded box made of tin-can metal. Power is fed into the shielded box through feed-through capacitor C4. Output is delivered through a short length of miniature coax. The LO can be set to exactly 7,000 kHz (or optionally 3,500 kHz) with the trimmer C5.

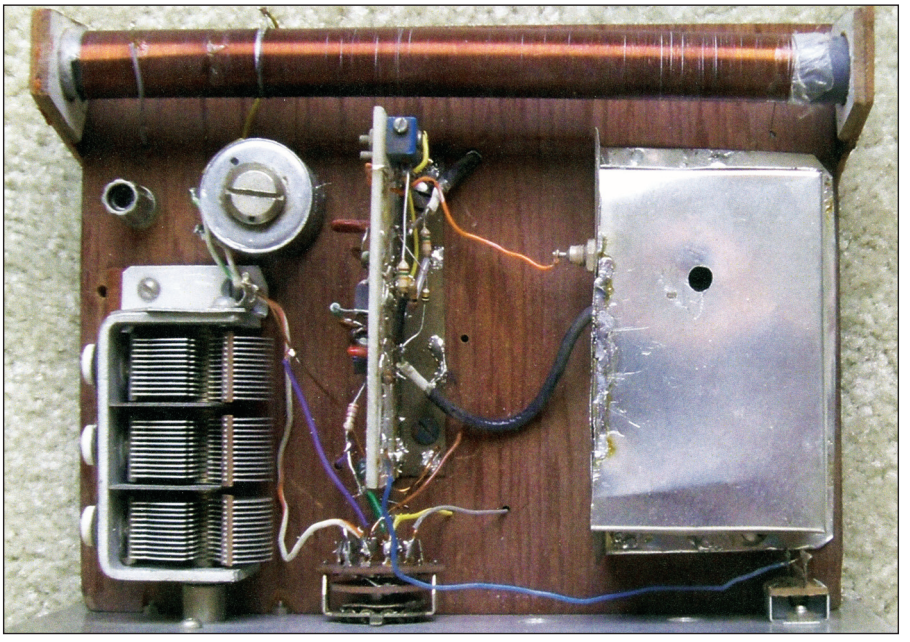

Figure 3 — Internal view shows the loop stick antenna on top, and three-gang tuning capacitor on the left. The round component above the tuning capacitor is inductor L2.

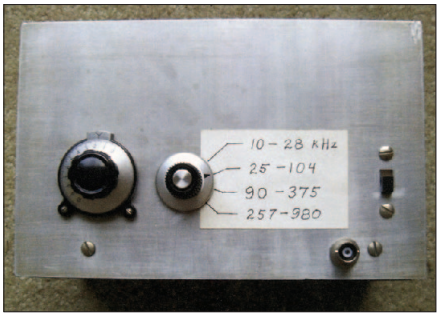

Figure 4 — The vernier dial on the left is for tuning, and the band switch selects LF and MF band segments.

Operation

Figure 4 shows the front panel. Tune the front end by selecting the desired tuning range with the band switch, then peaking the signal with the vernier dial. Generally, the radio spectrum becomes noisier as you go lower in frequency. A loop stick antenna responds to the magnetic component of the electromagnetic wave, whereas a short wire antenna will respond to the electric field component. Most manmade noise will be from sources no farther away than a wavelength (remember that a wavelength at 100 kHz is longer than a mile), where the electric field noise is usually stronger than the magnetic component. So a loop stick will pick up less manmade noise than a wire antenna.

The loop stick is also directional. It has a null off each end. It can be used as a direction finder, but very often a substantial reduction in noise can be accomplished simply by orienting the loop stick properly. If you live in an urban area, you will probably find that manmade noise from computers, TVs, and power lines obliterates all but the strongest signals.

If you really want to hear everything on LF and VLF, you will probably want to take the converter and a battery-powered receiver on your next camping trip.

Fred Brown, W6HPH, has held his call sign since 1949. He earned a BS in Electronics Engineering from California Polytechnic State University and an MSEE from the University of Illinois. Fred has worked as an engineer and has taught electronics in college. He has authored more than 100 technical articles in amateur and professional journals. You can reach Fred at **w6hph@yahoo.es**.

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