A Single Board No-Tuning 23-cm Transverter

By Rick Campbell, KK7B

(This article, which originally appeared in the *Proceedings of the Central States VHF Society 1989*, is reprinted from *The ARRL Handbook for Radio Amateurs*.)

This transverter uses bandpass filtering with printed hairpin filters. It will work with any MMICs capable of operating at 1.3 GHz at the appropriate input and output levels. New MMIC types may be easily substituted simply by changing the MMIC and its bias resistor.

System Block Diagram

Fig 1 is the transverter block diagram and Fig 2 is the schematic diagram. Fig 3 shows the layout of the 5- × 7-inch G-10 board with all functional blocks labeled. In the transmit path, FL1 removes the image, LO (local oscillator) and higher-order spurious outputs. FL3 selects the desired LO harmonic. The LO signal is filtered again in FL4 before the LO is split and applied to the transmit and receive mixers.

The received signal passes through FL5, which attenuates out-of-band signals. After amplification, image noise added to the received signal is attenuated by FL6.

One noteworthy feature of this transverter is that the choice of LO drive frequency is left to the builder. The filters are narrow enough to permit use of outputs at 1152, 576, 384, 288 and 230.4 MHz. Fig 3 shows component values for 576-MHz drive from the LO board described in note 1. Other

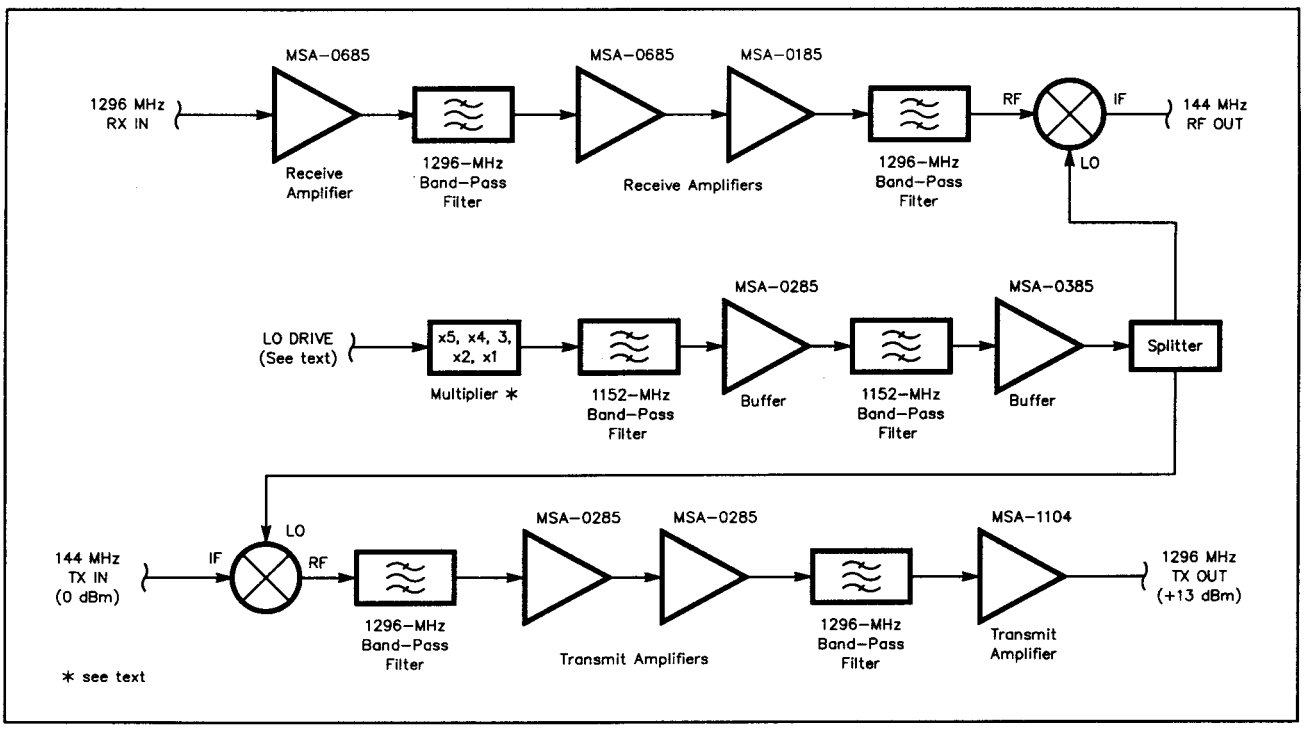

Fig 1—Block diagram of the single-board transverter. Extensive use of printed-circuit band-pass filters simplifies construction and alignment.

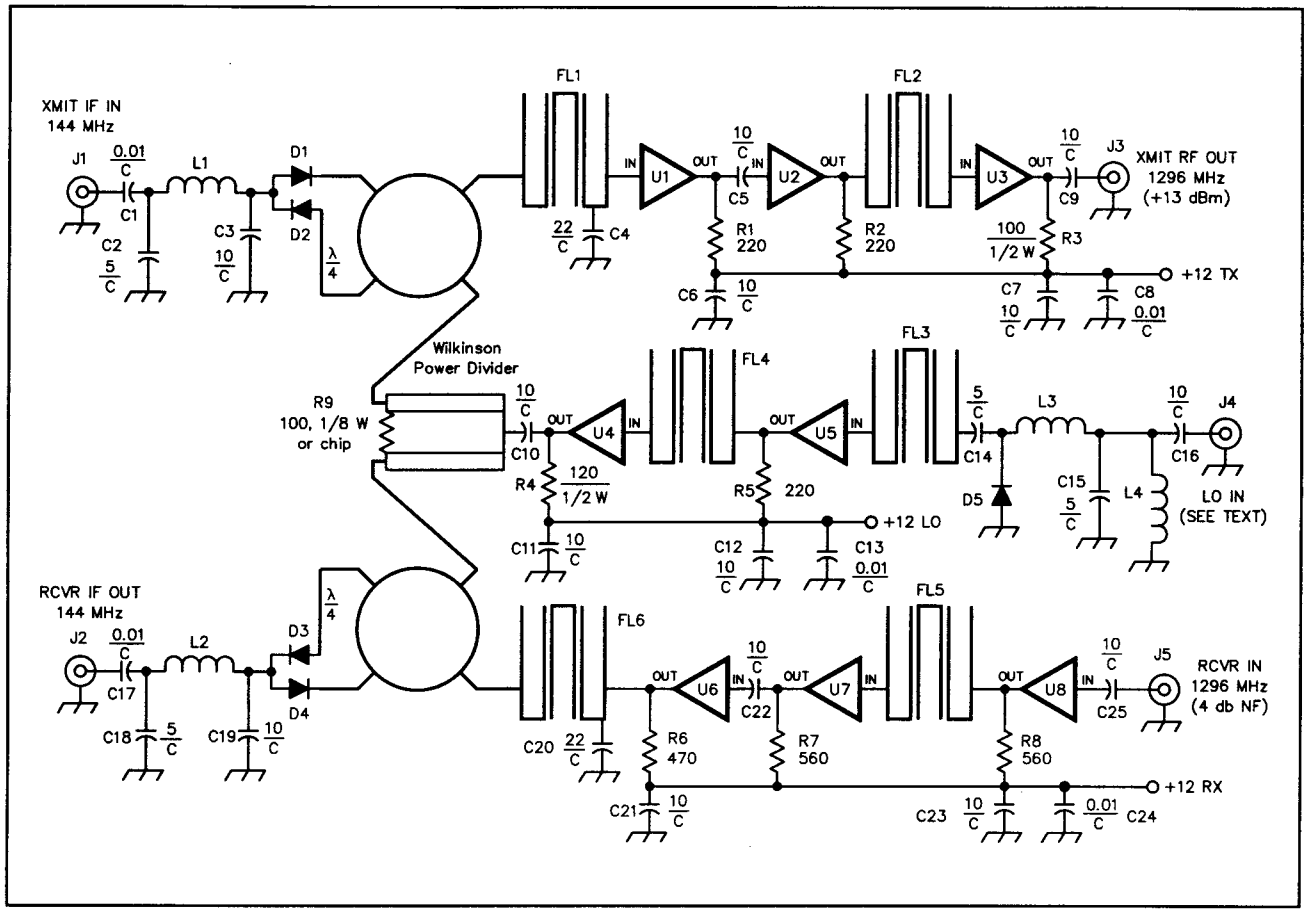

Fig 2—Schematic of the 1296-MHz transverter. All resistors and capacitors are chip types except as noted. Diodes D1 through D4 are HP 5082-2835. FL1 through FL6, the mixer tuned circuits and the Wilkinson power divider are etched on the circuit board.

LO frequencies may require minor component changes.

Circuit Performance

Careful measurements show a mixer conversion loss of 5.5 dB. The output for 1-dB compression is 0 dBm. LO suppression is about 25 dB. The mixers compare favorably with more-expensive packaged units.

Transmit output is about 13 dBm, which is suitable for some applications without further amplification. A major advantage of the MMIC output stage is that it offers an unconditionally stable, near-50-ohm source to the following stage or antenna.

Receive noise figure is less than 4 dB. The unconditionally stable 50-ohm load presented by the input MMIC is useful for direct connection to an antenna, and ideal as the stage following an external GaAsFET preamp.

The filters allow coverage of the entire 1240- to 1300-MHz band with a 144-MHz IF and appropriate LO drive. The bandpass filters used, although not mechanically critical, remove significant spurious responses. The passband response of one RF and one LO filter section is shown in Fig 4.

Construction

All components are surface mounted on the etched side of the board. The most tedious step is drilling the holes next to the MMIC mounting pads and soldering the "C" wires to provide a low-impedance ground. Plated-through holes would eliminate this step. After preparing the board with its "C" wires, mount the chip capacitors, inductors and connectors. Finally, install the MMICs and bias resistors.

The bottom of the hairpin U is a low-impedance point for signals in the filter passband. A bypass capacitor at that point has little effect on the filter passband but provides a ground path for VHF signals. Although 22-pF capacitors are specified, values from 12 to 30 pF gave good results in the prototypes.

The multiplier works best with drive levels of 0 to 10 dBm, without a bias resistor. For higher drive levels, the bias circuit described in Note 2 will provide more output. With 10-dBm drive at 230.4 MHz, output from FL3 is about –20 dBm, so about 33 dB of additional gain is needed. With 10-dBm drive at 576-MHz, output from FL3 is –3 dBm, so only 16 dB of gain is required.

Pads are included on the board for up to three MMICs. Choose the appropriate number of MMICs based on available LO drive level and frequency. FL3 and FL4 must be isolated. If only one MMIC is used it should be between them. If sufficient LO drive is already available at 1152 MHz, use a

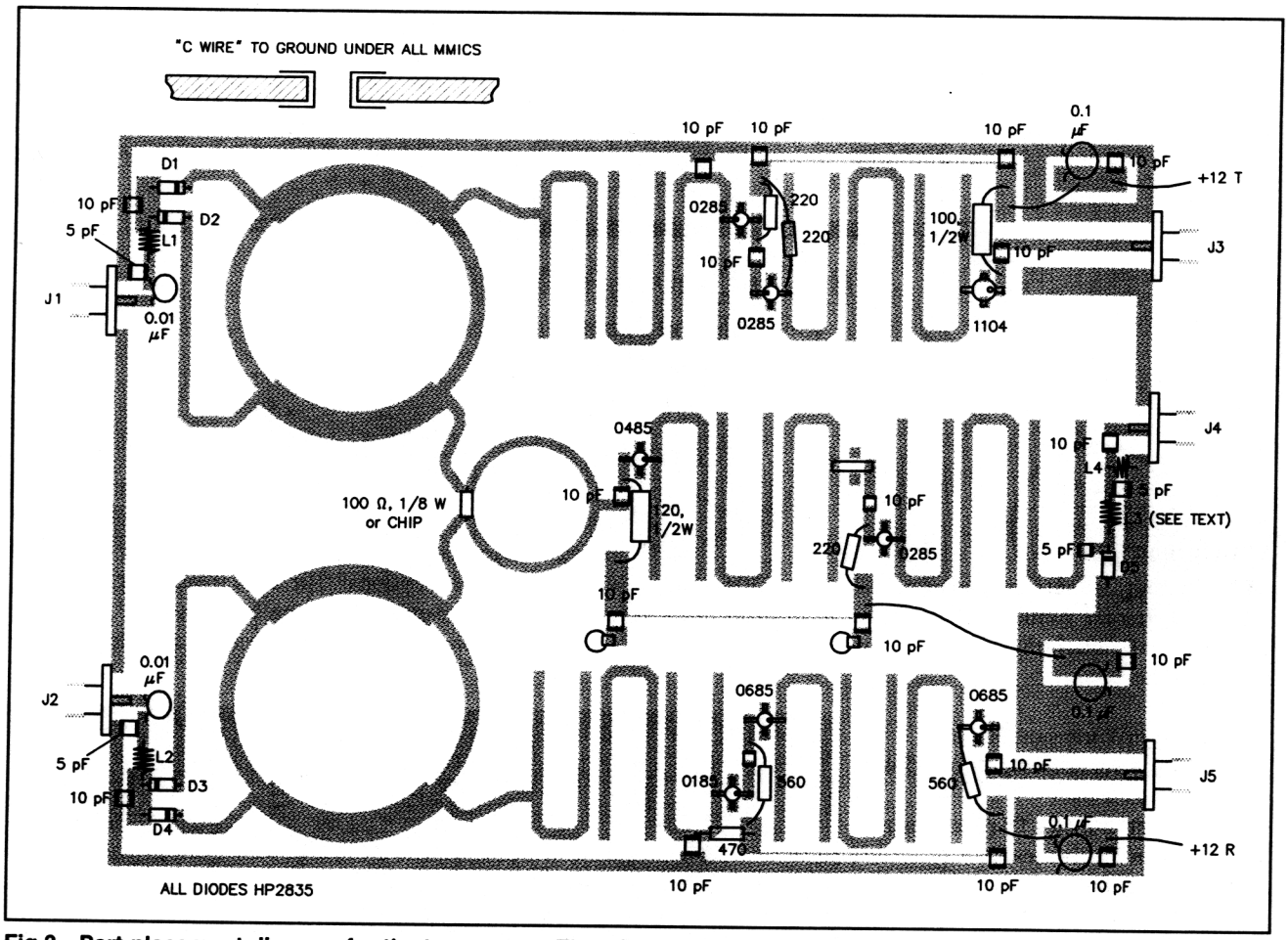

Fig 3—Part-placement diagram for the transverter. The "C" wires under each MMIC connect the component pad to the ground plane on the other side of the board.

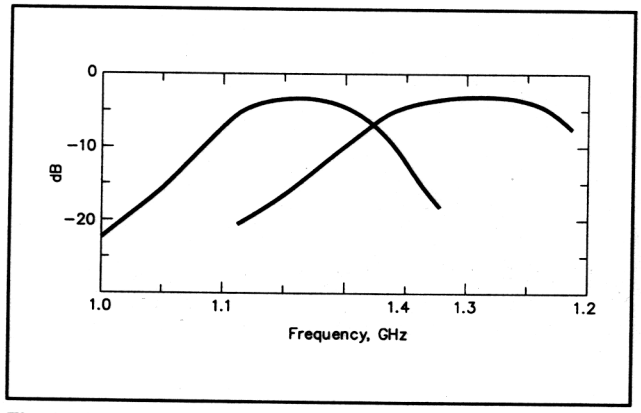

Fig 4—Passband response of one LO filter (A) and one RF filter (B) in the transverter. With appropriate choice of LO frequency, the transverter is suitable for use across the entire 23-cm band.

6-dB attenuator pad between FL3 and FL4.

Alignment

The tuning components in the LO multiplier are quite broad: network Q is about 1. The 576-MHz network will also work for lower frequency inputs, but the component values can be optimized for each drive frequency. L3 and L4 may be increased to 3 turns for 384 MHz, 4 turns for 288 MHz and 5 turns for 230.4 MHz if necessary. If LO drive is sufficient to saturate U4, however, mixer performance will be relatively unaffected by small changes in LO level, and tuning is unnecessary. A high-level MMIC is recommended for the LO-output stage.

Parts and Circuit Boards

Components are available from Microwave Components of Michigan, whose address appears elsewhere in this chapter. Etched and plated FR-4 circuit boards, complete kits and assembled transverters are available from Down East Microwave, whose address also appears elsewhere in this chapter.

The author acknowledges the assistance of Jim Davey, WA8NLC, John Miller of Michigan Technological University, Bob Dryden, W4OJK and John Molnar, WA3ETD.

Notes

[1]R. Campbell, "A Single-Board No-Tuning 23 cm Transverter," *Proceedings of the 23rd Conference of the Central States VHF Society* (Newington: ARRL, 1989), pp 44-52.

[2]R. Campbell, "A Clean Microwave Local Oscillator," *Proceedings of the 21st Conference of the Central States VHF Society* (Newington: ARRL, 1987), pp 51-57.