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Senior Technical Editor

Designing a "modern" 6-meter AM rig is something that Rick and I have been tossing around for several months. I felt there would be interest in such a product, based on the number of hams resurrecting old Poycomms, Layfayettes, and "Gooney Birds" (Gonsets). Rick was a bit more skeptical.

Before I could even set pen to paper, or even warm the iron, Rick had a finished model debugged, running and on the air. Perhaps just as well...I am sure his mastery of the QRP arts exceeds mine. His little set rivals, or surpasses, the performance of those early tube clunkers.

After several weeks of operating, Rick finds no shortage of folds to work locally or during opening. An added bonus: Rick reports that 6-meter AM QSOs seem to be more leisurely and enjoyable that the routine hit-and-run "59 FM11 73" contacts offered on SSB.

Perhaps ragchewing is not a lost art. Six meters is a vast band normally begging for activity. Anything—including vintage AM—that gets more folks building projects and on the air and having fun is fair game in our book!

—de K1ZJH

Build the *Nor'easter* 6-meter AM Transceiver

This little radio brings back the nostalgia of AM.

Rick Littlefield, K1BQT

There's been a resurgence of interest in "ancient modulation" lately, due in part to growing legions of antique radio and AM-broadcast equipment collectors. Like CW, amplitude modulation remains a useful and enjoyable mode for those who appreciate its unique qualities. If you enjoy the dulcet tones only AM can deliver, here's a "back-to-the-future" VHF project mixing contemporary design with a touch of nostalgia.

Description

The *Nor'easter* is a kitchen-table construction project that yields a complete VHF-AM transceiver with all the familiar appointments found on old-style VHF rigs. These include a tunable receiver, adjustable squelch, AGC, transmit channel selector, spot switch, built-in speaker, and PTT switching. Although inspired by '60s thinking, construction is rooted in the '90s, with all parts mounted on a small double-sided pc board and the finished project housed in an attractive molded case (**Photo A**). A sensitive single-conversion superhet receiver pulls in weak signals, and the high-level AM-modulated transmitter delivers 5 watts to the antenna (that's 10 watts *input* by Heathkit standards).

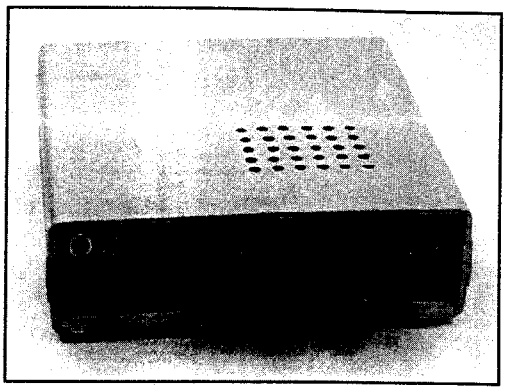

Photo A. The finished project housed in an attractive molded case.

Circuit Design

The receiver is a straightforward design using popular homebrew parts. A selective two-section bandpass filter rejects out-of-band signals and low-noise preamp Q1 boosts incoming signals by over 20 dB. Mixer U1 functions as both an active DBM and as a varactor-tuned VFO running at 39 MHz to down-convert 6-meter signals to the 10.7-MHz IF. The receiver's message-channel passband is established by cascaded crystal filters FL1, FL2 at around 15 kHz. Preamplifier Q2 boosts mixer output and overrides insertion loss of the tandem filters. IF amplifier U2 delivers 45 dB additional gain with an AGC range approaching 60 dB. AM detector D1 recovers audio plus a DC level for the AGC system. U3 is a four-section opamp providing AF preamplification, AGC drive, and a comparitor-driven squelch. AF-output stage U4 is a stock LM386 set up for minimum gain.

Giving credit where it's due, the receiver configuration was inspired by a Ramsey Electronics aircraft monitor I built from a kit about 10 years ago. Some redesign yielded a 50-MHz superhet with improved sensitivity and significantly sharper selectivity.

On the transmit side, third-overtone crystal oscillator Q3 is diode-switched to select

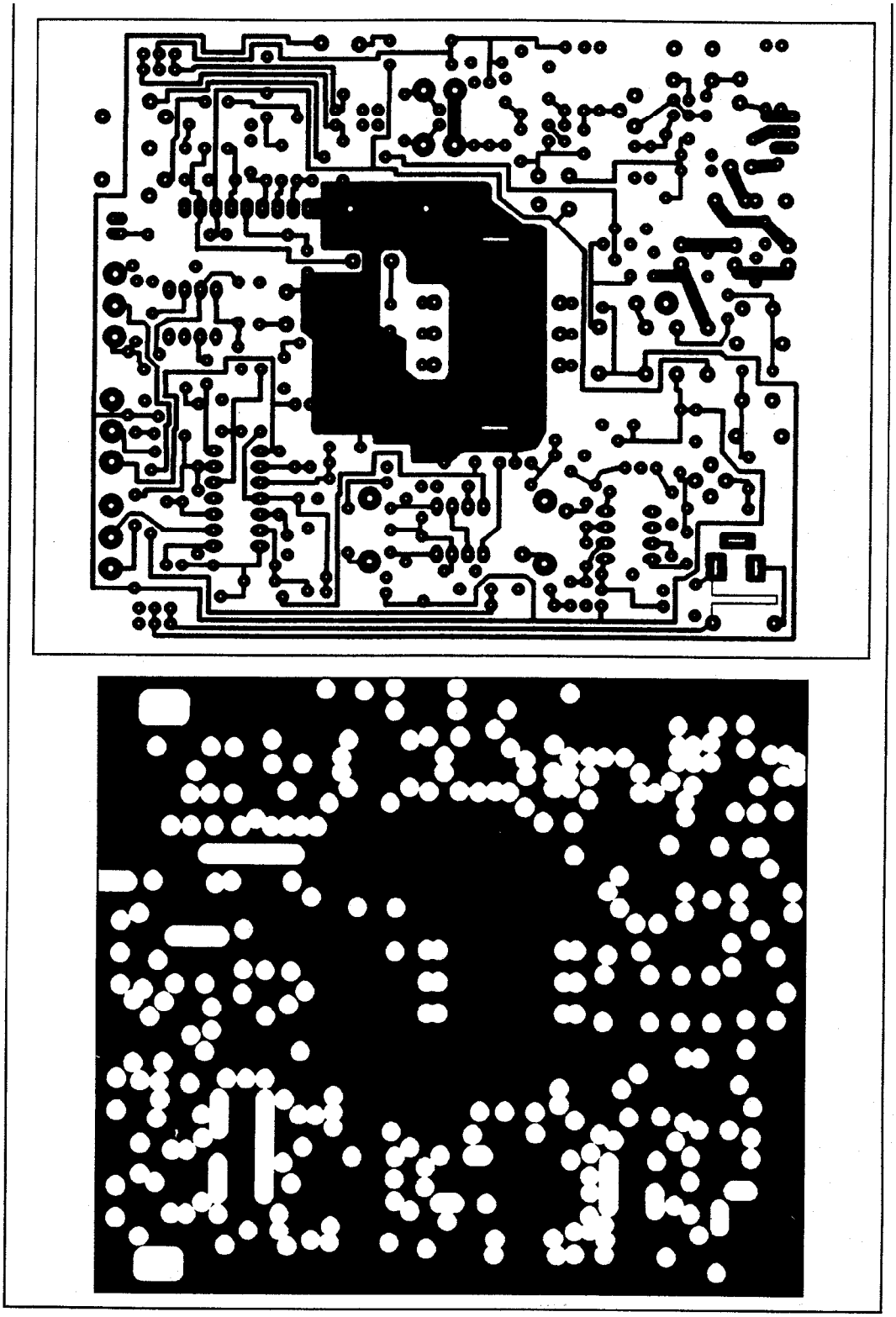

Figure 1. Printed circuit board art; (A) trace and (B) component side.

between two transmit channels (50.25 and 50.4 MHz). Q3 may be activated in receive mode to "spot" transmit channels with the radio's tunable receiver. Driver Q4 and PA Q5 operate in class C, and both stages are modulated by U5. U5 is a Phillips 4.5-watt audio preamp/power-amp chip. Modulation transformer T2 was parted out from a dead Uniden CB-radio, but other CB modulation transformers may be used. RF output from Q5 is matched by an L-network

Parts List

Capacitors (C)

1	2.7-pF disc ceramic
1	10-pF disc or monolithic
1	15-pF disc or monolithic
1	33-pF disc or monolithic
2	47-pF disc or monolithic
7	60-pF MuRata 50-V trimcap or equiv.
2	68-pF NPO disc or NPO monolithic
2	75-pF 100-V s.m. or monolithic (68-pF if 75-pF unavailable)
1	100-pF NPO disc or NPO monolithic
2	150-pF 100-V s.m. or monolithic (do not substitute ceramics in filter)
1	220-pF disc or monolithic
1	0.001-µF disc
1	0.0022-µF ceramic or mylar
15	0.01-µF disc
12	0.1-µF disc
4	1-µF electrolytic
1	10-µF electrolytic
1	22-µF electrolytic
4	100-µF electrolytic
1	470-µF electrolytic
1	1500- or 2200-µF electrolytic

Diodes (D)

2	1N5235B (6.8 V) zener
1	1N5239B (9.0 V) zener
1	MV2104 varactor
6	1N914 or 1N4148
1	1N34
1	1N4001

Filters (FL)

2	Mouser 520-107-15B, four-section 25-kHz spacing 10.7-MHz crystal filter.

Jacks (J)

1	BNC female chassis mounting (antenna)
1	2.1 x 5.5 power jack, pc mtg, Mouser 163-5004 or equiv.
1	5-pin DIN, female pc mtg, Mouser 161-0504 or equiv.

Relay (K)

1	DPDT sealed relay, 12-volt coil, Mouser 526-R40-11D2-12 or equiv.

Resistors (R): 1/4-watt unless noted

1	10
1	15
2	22
2	100
1	220
1	470
6	1K
3	2.2K
1	4.7K
1	5.6K

Resistors (Cont.)

1	8.2K
6	10K
1	22K
2	33K
5	47K
3	100K
1	330K
2	1M

Chokes (RFC)

1	0.22 µH molded
2	2.7 µH molded
1	10 µH molded
1	22 µH molded
1	100 µH molded

Coils (L)

2	7 turns #22, 0.25" ID x 0.4" (L1, L2)
1	Coilcraft 143-10J12S 10-1/2 turns shielded, 0.42 µH (L3)
2	4 turns #28 bifilar on T25-6 (L4, L5)
1	5 turns #22 on T37-6 (L6)
4	9 turns #22 on T37-12 (L7–L10)

Switches (Sw)

1	SPST miniature, momentary contact, RS 275-1571
2	DPDT miniature, push on-push off, Mouser 612MTH22

Transformers (T)

1	10-mm 10.7-MHz IF transformer, Toko 421F122 or equiv.
1	Modulation Transformer (Uniden TF-177 or equiv.)

Transistors (Q)

1	MRF901	TA 900-5584
1	2N3904	TA 900-5456
1	2N3906	TA 900-5457
1	2N2222A	TA 900-5428
1	2N5109	TA 900-5451
1	2SC2166	RF Parts

Integrated Circuits (U)

1	NE602, SA602, or NE612
1	MC1350P
1	LM324 or equiv. quad op-amp
1	LM386
1	TDA1015 (Philips)

Crystals (Y)

1	50.25-MHz 3rd-overtone GP (ICM 471270)
1	50.40-MHz 3rd-overtone GP (ICM 471270)

Case

1	RadioShack #270-214

TA = Tech America

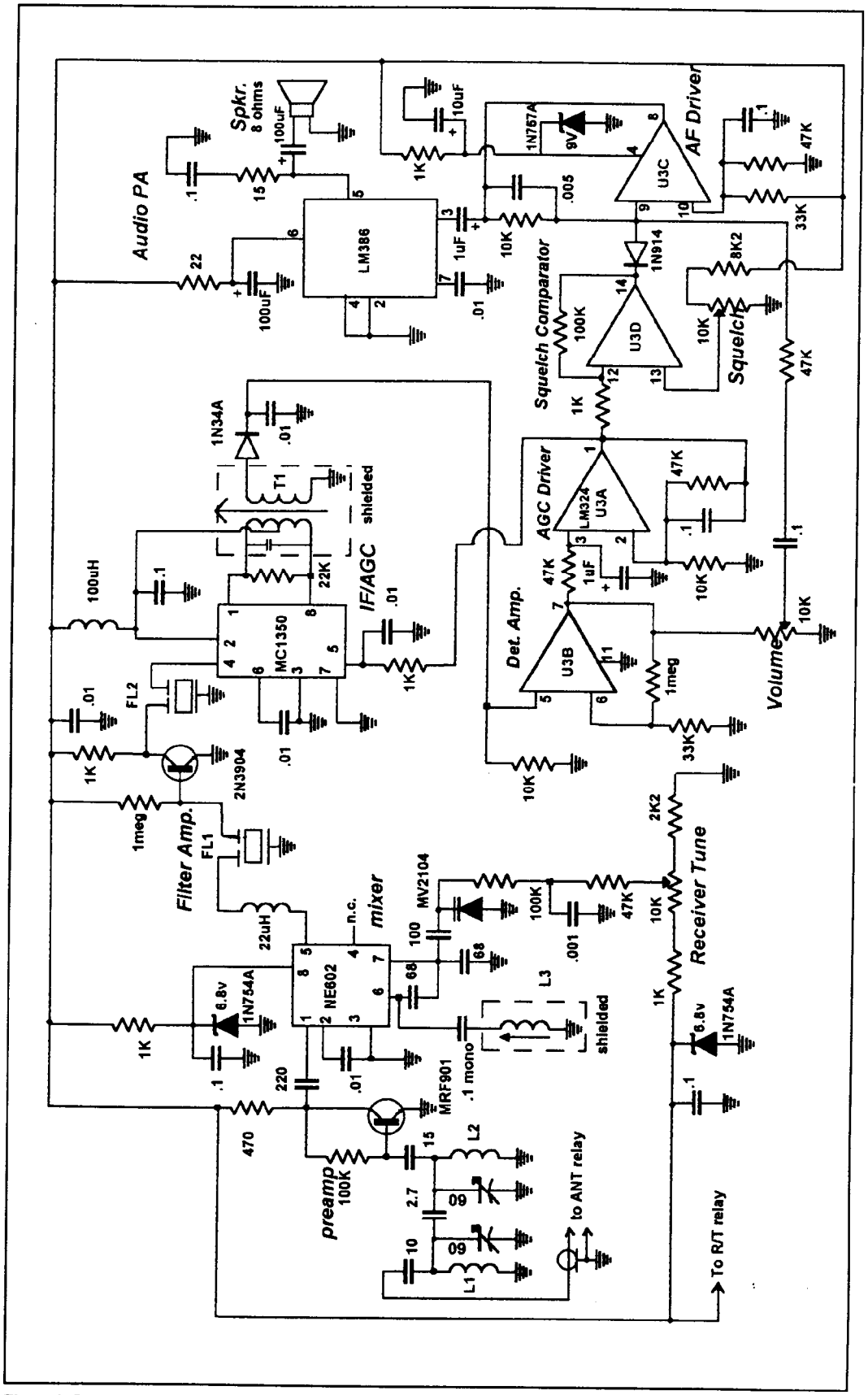

Figure 2. Schematic diagram, receiver section.

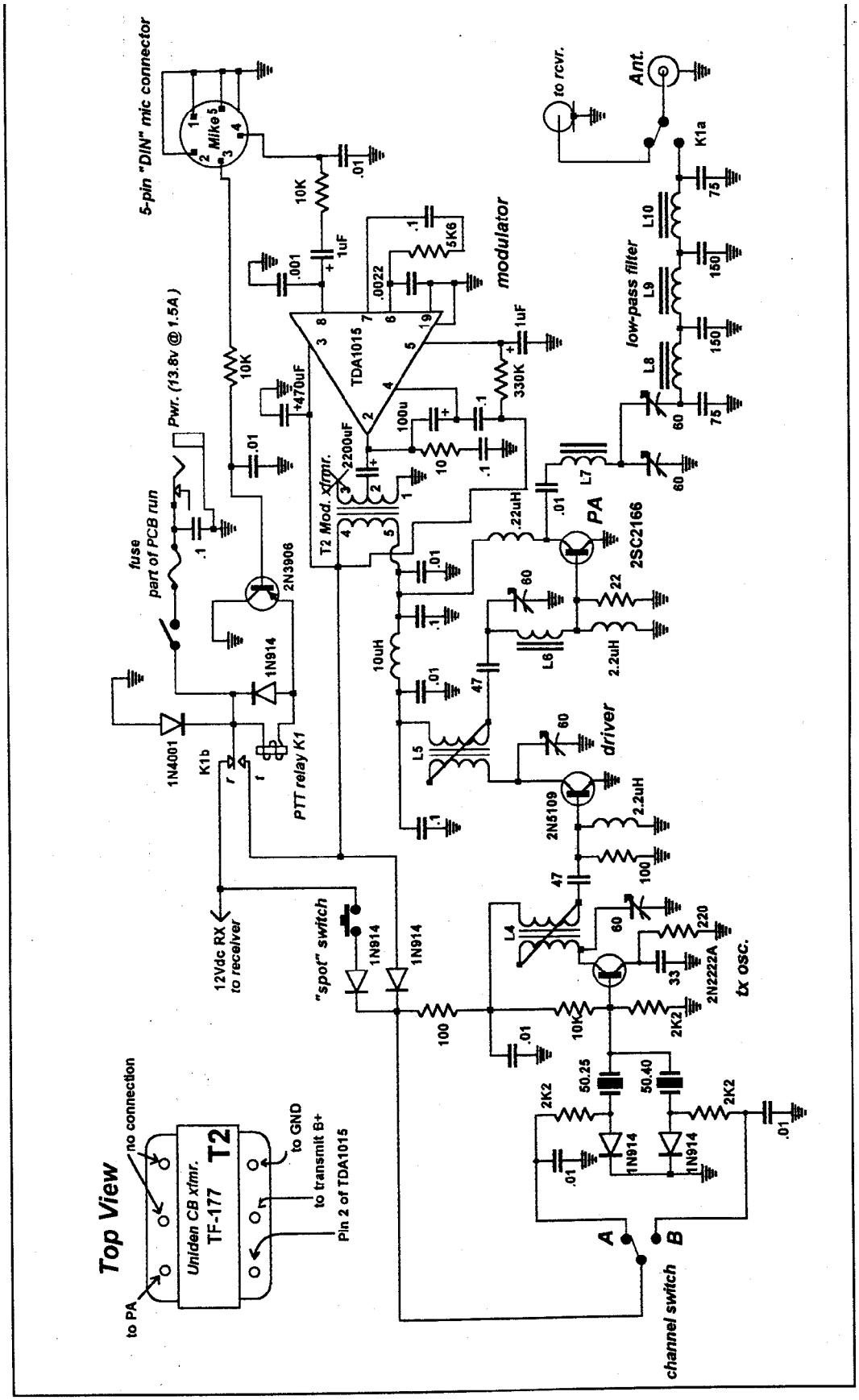

Figure 3. Schematic diagram, transmitter and control.

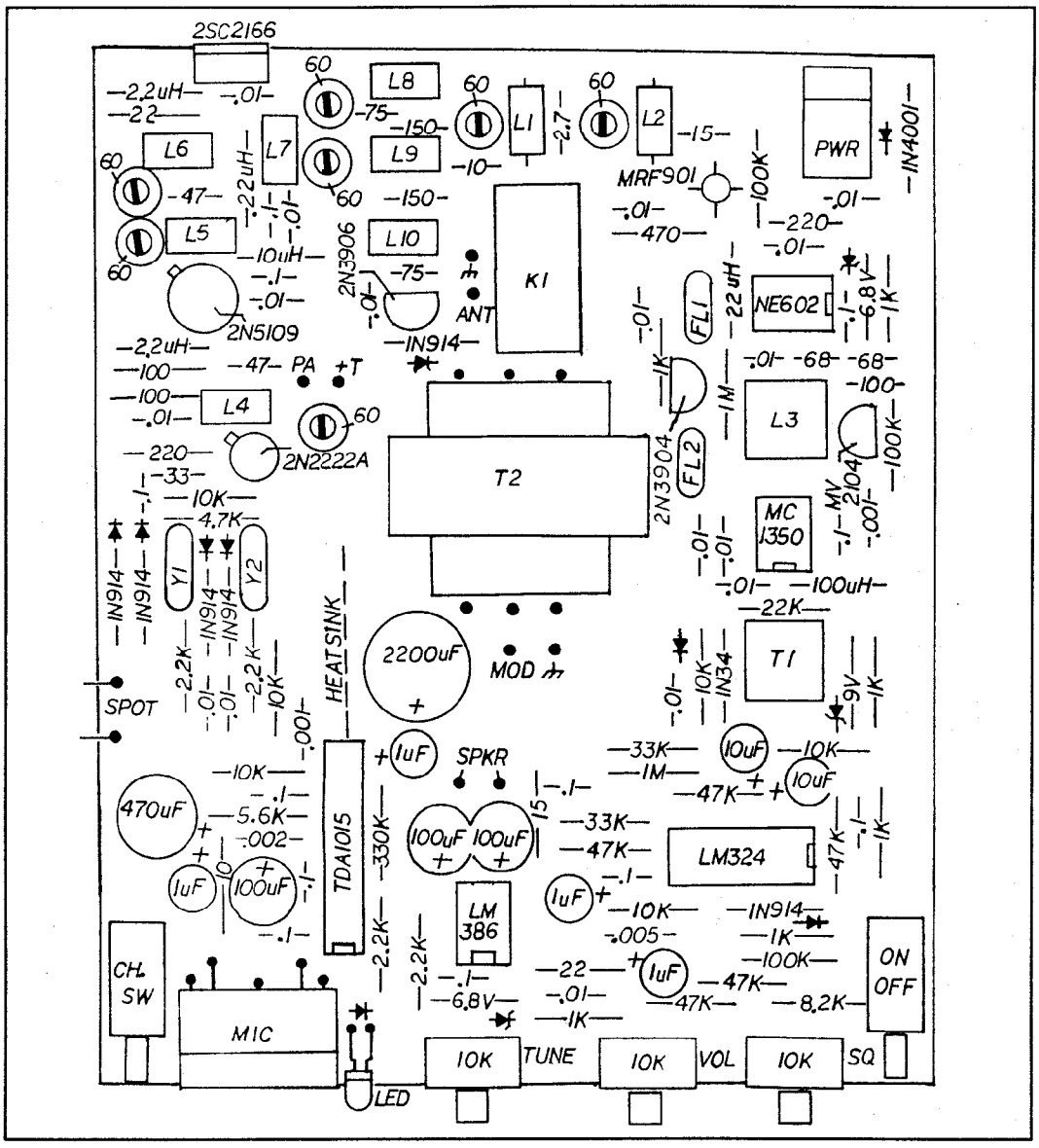

Figure 4. Parts placement diagram.

into a three-section, 50-ohm lowpass filter that reduces spurs and harmonics by -60 dBc or greater. DPDT relay K1 switches the antenna line and provides +T and +R voltages for various transceiver circuits. Switching transistor Q3 activates K1 when the microphone PTT line makes ground contact.

Construction

Virtually all parts, including switches and controls, are mounted on the radio's 3.9 by 4.6-inch double-sided pc board. Printed circuit art is provided in **Figures 1A** and **1B**, and boards are available from FAR Circuits.* To populate the board, follow schematic diagram (**Figures 2** and **3**) and parts-placement diagram (**Figure 4**). I suggest mounting L3, T1, and the ICs first, before installing resistors and capacitors. Install handwound coils and pots last, as these are more easily damaged by handling. Because the board isn't plated through, be sure to solder *all* grounded connections on both sides of the board, stripping the flash off ceramic bypass leads to minimize lead length.

Although a shielded cabinet is always more desirable for radio projects, the *Nor'easter* was laid out to fit into a RadioShack plastic modem case. You must replace the box's rear plastic panel with an aluminum duplicate to provide an efficient heatsink surface for PA transistor Q9. The front and rear panels are secured to the pc board by controls, components, and solder lugs. Panels slot-load into the clamshell-style case

*Far Circuits, 18N640 Field Court, Dundee, Illinois 60118. Boards are available for $13 each plus $1.50 shipping for two boards.

and support the pc board inside without need for internal mounting screws. **Figure 5** provides front and back panel templates, along with a pattern for the modulator's 1/32-inch thick copper heatsink. **Photo B** shows the final assembly.

Part substitutions are generally okay, but the layout is tight and only small components should be used. Avoid substituting disc-ceramic capacitors in the transmitter's output filter—multilayer or miniature silver-mica caps work much better and result in less power loss. I used four-section 10.7-MHz crystal filters, but lower-cost, two-section 10.7-MHz crystal filters may be substituted with some sacrifice in strong-signal selectivity. (Both types are available from Mouser Electronics at $6.60 and $3.41 each, respectively.) Although more sophisticated matching of the crystal filter I/O ports might improve passband shaping slightly, the circuit shown yields acceptable AM performance.

To mount the TDA1015 IC heatsink, attach it to the IC for positioning and tack-solder to the pc board. To complete the installation, unscrew the heatsink from the IC to prevent overheating, and run a bead of solder down one side to thermally bond the heatsink to the pc board. The *Nor'easter*'s modulation transformer came from a defunk Uniden CB, but other types will work, too. I easily obtained several pull-outs through fellow hams who operate radio service shops. Look for a later-model CB that uses a monolithic audio amplifier in the modulator—this will provide the best match for the TDA-1015. If a push-pull type is all you can locate, feed the center tap rather than the entire primary on the modulator side. Not all transformers have the same pinout, so jumper connections are provided on the pc board to facilitate various lead configurations. Connections are shown for the Uniden TF-177.

Tune-up Procedure

Begin receiver tune-up with ballpark alignment of the receiver oscillator. Set the receiver tuning pot fully counterclockwise and lightly couple a counter to pin 7 of U1. Adjust L3 for 39.3 MHz to obtain a receive frequency of 50.0 MHz. The VFO tuning range will be about 600 kHz with the parts specified. Because the counter will probably load down the oscillator tank circuit slightly, you'll need to use a signal generator for final receiver calibration. Once the VFO is tuned, open the squelch and increase volume for an audible background hiss, adjusting T1 for maximum noise in the speaker. Now, connect a weak 50.25-MHz AM-modulated signal source to the antenna jack and tune C2, C4, and T1 for maximum sensitivity. When properly adjusted, the receiver should detect a 0.3-μV carrier and recover a 1-μV AM signal at 12-dB SINAD.

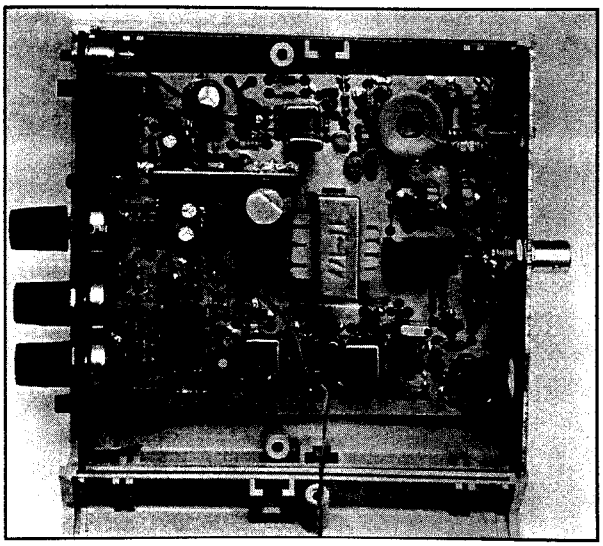

Photo B. The final assembly.

To tune the transmit oscillator, first press the spot switch and peak the oscillator trimcap for maximum signal (use a scope, RF voltmeter, or external receiver). Next, connect the radio to a 50-ohm dummy load through a RF wattmeter. Key the mic and carefully adjust the driver and PA trimcaps for maximum output. When tuned, confirm that each trim cap exhibits *two equal peaks* with each 360-degree revolution, indicating that resonance falls within the trimmer's range. If needed, spread or compress turns on the associated inductor to achieve this response.

Finally, sample the transmitter signal and view the modulation pattern on a 50-MHz scope. Touch up driver and PA tuning with modulation applied, adjusting for maximum p-p voltage. This will optimize the driver and PA for highest peak envelope power (PEP) and improve modulation depth. When done, you should obtain 100 percent modulation on peaks without driving the modulator into saturation, and there should be no visible downward modulation on the RF wattmeter.

Operation

In keeping with good VHF engineering practice, your antenna should exhibit a VSWR of 2:1 or less—the lower, the better. Six meters shares spectrum with a lot of home-entertainment media, and the *Nor'easter*'s built-in three-section low-pass filter suppresses FM-BCI and TVI better when properly terminated into a low VSWR load.

Almost any microphone should work; the input impedance of the TM1015 op-amp preamplifier stage is fairly high (over 20K). When driven with an AF signal generator, modulation response measured flat past 8 kHz, with gradual LF rolloff below 150 Hz, due mostly to the natural cut-off frequency of the small CB

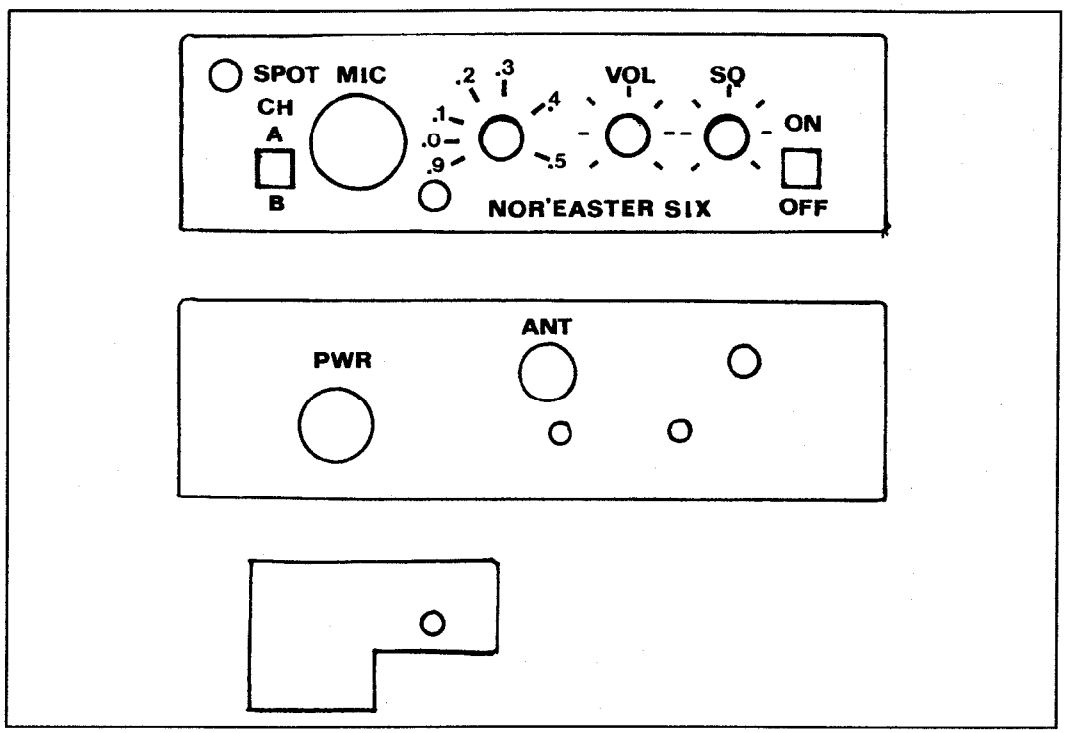

Figure 5. Panel and heatsink templates.

modulation transformer. With the right microphone, the *Nor'easter* delivers near-broadcast quality audio.

There's no mic-gain control, so it's possible to overdrive the speech amp if you crowd the microphone or use a cartridge with unusually high output. Overdriving typically results in over-modulation of the transmitter and/or in distortion of the audio waveform due to clipping in the modulator's output stage. If splatter and distortion are evident, increase the value of the 5.6-k coupling resistor between the preamp and modulator stages (pins 7 and 6) to reduce mic gain.

In receive mode, the relatively wide IF filters provide bandwidth characteristics typical of many vintage 6-meter receivers. This permits easy tuning with the radio's small front-panel knob, and you won't have to chase crystal-controlled stations operating a couple kHz off frequency or retune stations because of thermal drift from the 39-MHz VFO. On the negative side, some weak-signal sensitivity is undoubtedly sacrificed due to increased noise energy in the IF passband. However, AM signals under 1 μV should be readable under quiet band conditions and receiver noise should be well under the 50-MHz atmospheric noise floor present at most locations.

Cascaded filters provide relatively steep skirts to prevent strong off-channel SSB or packet signals from interfering with the AM channels. These filters also facilitate locating transmit channels with the spot switch. To spot channels accurately, turn the squelch off and the volume up; there's no BFO, so you'll need to hear the detector background noise. Once you are centered on the signal, you can reduce volume and set the squelch.

Conclusion

While ironing out the bugs in my prototype, it occurred to me there may not *be* any AM activity left on six! Like the Maytag repairman's telephone, I began to envision the *Nor'easter* sitting idle, week after week, without so much as a crackle to break the squelch. Fortunately, when I connected the antenna, the radio came to life almost immediately with a gathering of New Hampshire locals who meet daily on 50.25 MHz. In addition, over the next couple weeks I managed several QSOs on 50.4 MHz, including a number of single-hop *Es* contacts during two band openings. I also heard local activity on 50.51, but didn't have a transmit crystal for that channel. Six-meter AM has never been a hot-bed of activity in New England, but it surely isn't dead.

As for the future of 6-meter AM, the sunspot cycle is finally rising and some experts predict a rapid ascent peaking well over 200. If these optimistic forecasts are correct, little radios like the *Nor'easter* could rack up some fantastic worldwide frequent-flyer mileage (deja 1958) in the months and years to come! ■