The SAM1 Transverter

For the challenge of LF/VLF.

by David Curry WD4PLI

Why would anyone ever want to work 1750 meters!? What possible excitement would such frequencies, that can be riddled with noise and strange propagational characteristics, offer anyone?

The answer is simple, and can be found in the calling that our radio ancestors experienced when they also marveled at radio, as most of us do now. 1750 meters is a band of antiquity. Electrically, long wave frequencies follow the same laws and principles that other frequencies do, but how and why they behave often seems peculiar and elusive. Challenges exist for the skilled amateur whose dive to the low frequency depths of 1750 meters to visit this once antiquated band of frequencies using a state-of-the-art transceiver and proper antenna, may be surprised by the opportunity that long wave operation has to offer. Old tube regenerative radios of that time stand in the shadow of today's highly sophisticated radio equipment and boast superior features such as IF shift and noise blanking that not only make the difference on our ham bands, but also make effective tools for amateurs who have "what it takes" for this true amateur band. Building a transverter such as the SAM 1 will allow you to enjoy top-notch reception of the entire LF spectrum from 5 to 450 kHz on your 80 meter transceiver, and transmit virtually any mode within the legal limits of the license-free 1750 meter band (160–190 KHz). This transverter design is in use by the 1750 meter Southern California net that meets every Saturday morning at 9 a.m., LSB. Stations hundreds of miles away are regularly monitored at my location under good conditions, while local stations only 30 miles distant can not be heard under poor conditions. This gives the obvious impression that this band can be one of extremes on many levels, and a challenge on all levels.

Enter the SAM1

The SAM1 transverter provides a practical way for anyone who has an 80 meter amateur transceiver to use the 1750 meter/long wave band in two-way communications. The third generation of transverters optimized by "lowfers" (anyone operating in the 1750 meter band) in the Los Angeles area, it uses only 10 transistors, one IC, and a few other parts.

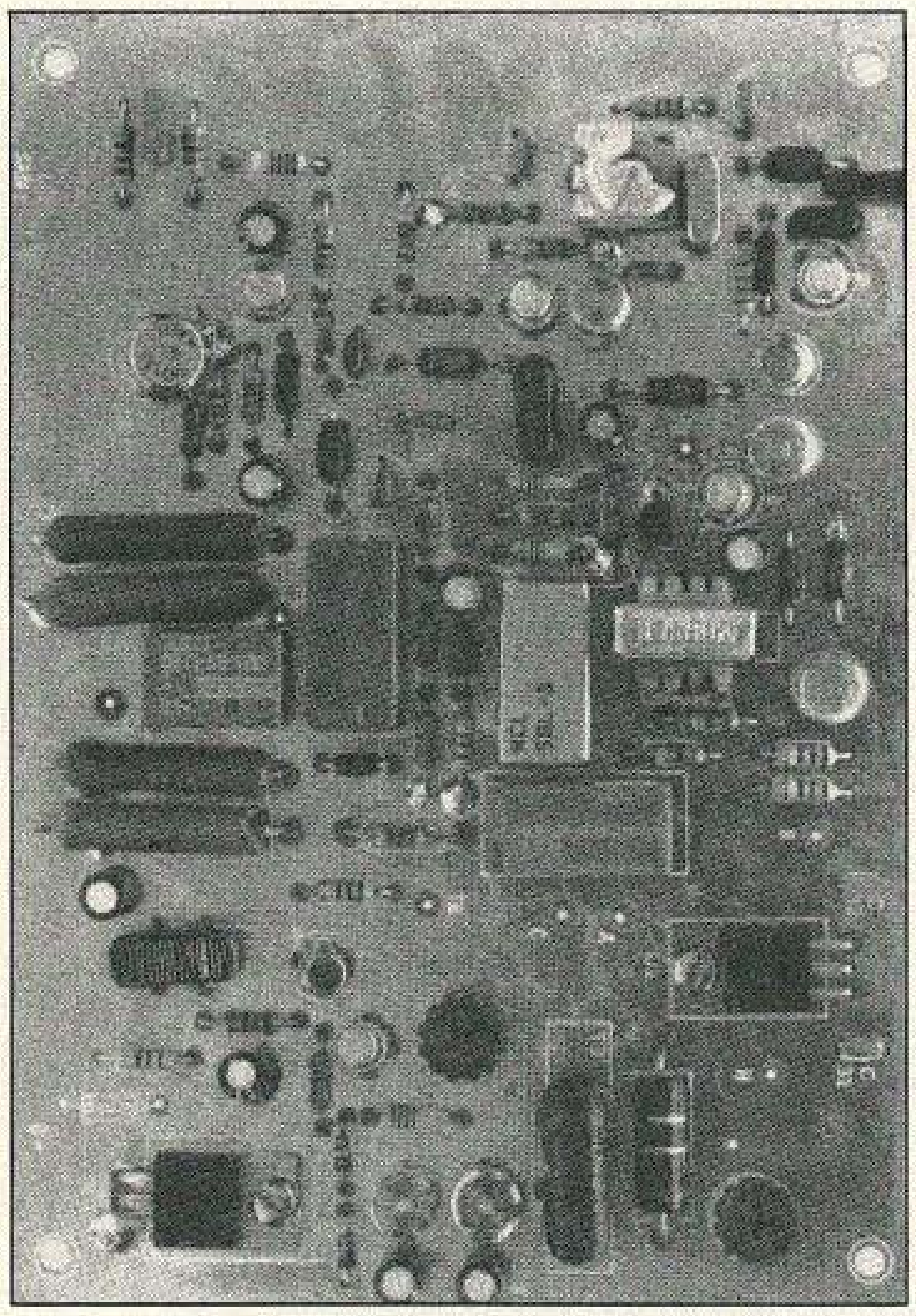

Photo A. The completed board.

With this transverter, you can operate all modes on long wave. You can also, while operating on long wave, have all the communication features, such as noise blanking, filtering, and speech processing, that are available on any HF or state of the art transceiver.

The transverter connects between any resonate 1750 meter/long wave antenna (a good choice is the "Dual-Band Vertical" in the September 1991 issue of *73*) and your transceiver, and operates on any well-filtered DC voltage supply between 12 and 24 volts (a 24 volt supply is recommended). The SAM1 has provisions for separate receive and transmit antennas and includes "phantom" power for remote active receive antennas or relays... or whatever! When you shut your SAM1 transverter off, automatic through-switching allows your transceiver to operate as normal, eliminating the hassle of connecting and disconnecting it.

The 1750 meter band offers a lifetime of interesting communications and challenge to appliance-weary hams looking for fresh soil, as well as to beginners and do-it-yourselfers who appreciate the art of building. Many have called it a "true amateur band." Wishing you and all the Southern California lowfers the best of luck on 1750 meters, I dedicate the SAM1 to Charles Faulkner, the father of the first practical transverter for regular SSB on 1750 meters in our area, and quite possibly in the U.S.

The SAM1 Transverter, Step by Step

See Figure 2 for parts placement, and refer to the table for parts identification, and let's go.... Be sure to use a good quality rosin core solder and a clean soldering iron tip.

1. Locate audio transformer T1. One side of the body is printed with the letter "P," which should match up with the "P" on the component side of the board. Insert all 6 leads and bend the transformer lugs for a tight fit.
2. Next, mount transistor Q7 (TIP31B). Bend the 3 leads near the body away from the top and insert them into the board. Line up the hole at the top of the transistor with the hole on the board and slip the small insulated gray washer in between. Clamp it tightly with a 4/40 nut and bolt (but not overly tight).
3. You can mount regulator U1 (MC7812CT) in the same way as Q7, but you don't need a washer.
4. Relays K1, K2, and K3 are next.
5. U2 is the doubly-balanced 8-pin mixer. Be sure to line up pin 1 with the dot marked on the circuit board.
6. Insert C14, the variable capacitor, so that the capacitor plates are located away from Y1. This gives room for inserting Y1.
7. Y1 (3.4995 MHz) can be inserted next. Be sure it's snugly mounted against the board while you're soldering.
8. Insert resistors R37–R40. Bend the leads close to the body, leaving the corners slightly rounded. Make sure that the bodies of the resistors stay at least ⅛" away from the board. They can get quite hot, and the space will help dissipate the heat. Solder all component ground leads on both sides of the board marked by an "S."
9. Insert and solder R31, R35, and R41. Notice the "S" marking where component leads are soldered on the component side to insure a good ground connection. Resistors R1, 8, 9, 14, and 21 must be checked for this.
10. Next come diodes D1, 2, and 3. Notice the band marking on the diodes before inserting, making sure to match up the band on the

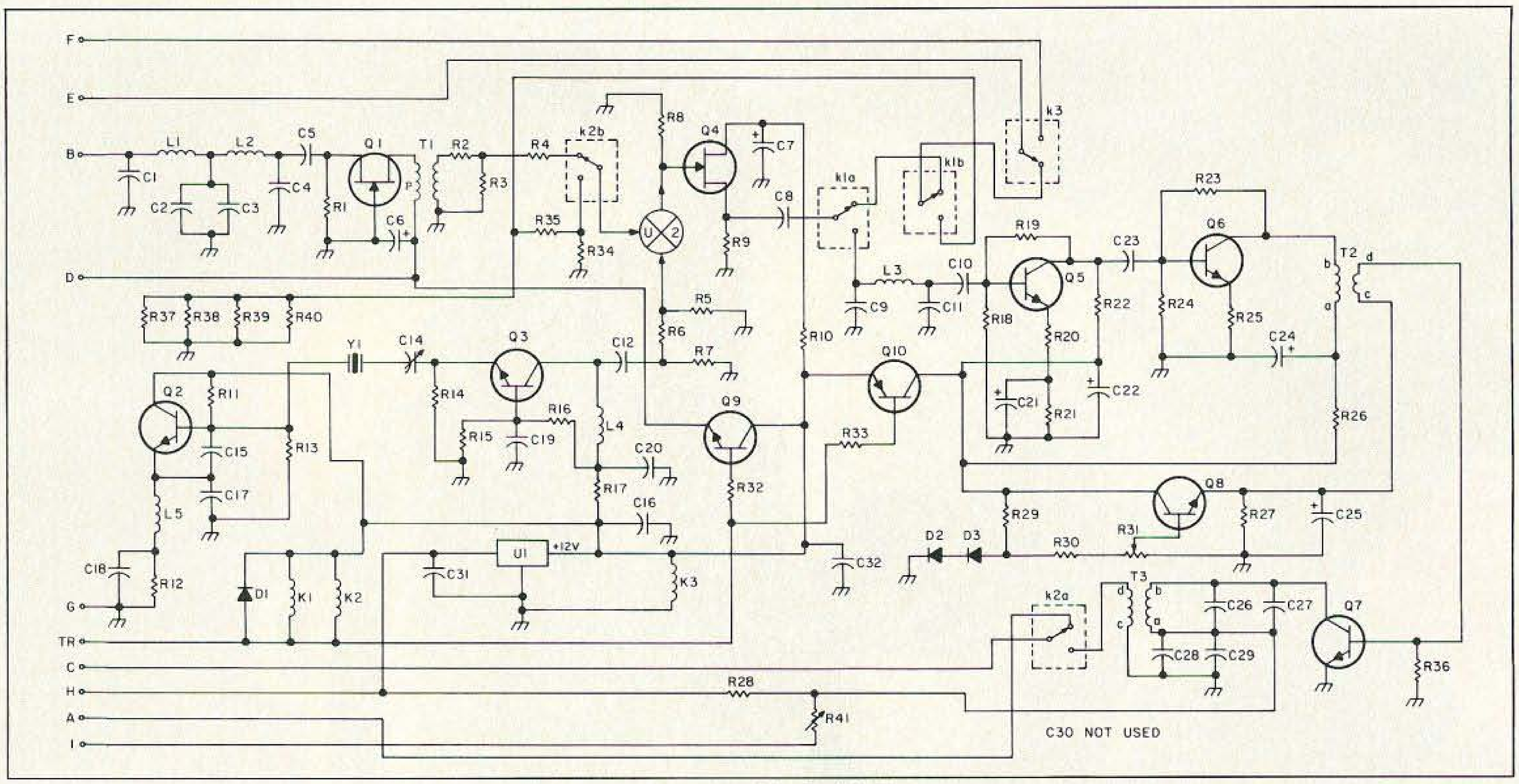

Figure 1. Schematic of the SAM1 Transverter.

part with the parts placement diagram. Diodes D2 and 3 should be directly against the board, nice and snug.

11. Insert and solder all capacitors, going right down the parts list, starting with C1 through 3, 4, 26, and 27. Do one section or type of part at a time, to avoid mixing them up. Solder and clip leads when done with each type. Notice that C5, 6, 7, 24, 25, 28, and 29 are electrolytic, so pay careful attention to polarity when installing them!

12. Inductors L1, 2, 3, 4, and 5 are mounted away from the board about ⅛" to avoid any possibility of shorting one of the fine wires. Notice the inductor part number for correct part insertion.

13. Transformers T2 and T3 are both toroid transformers (see the parts list for winding details). The smaller toroid should be inserted at the T2 location. Mount the toroid on its side, with the secondary wires going to the holes marked C and D, and the primary wires going to holes A and B. With fine sandpaper, carefully strip the enamel insulation from all four wires next to the body of the toroid, leaving the bare wires ready for soldering on the foil side. Pull each wire so that the toroid is snug against the board. Then mount transformer T3, also on its side, with the secondary wires going to holes C and D, and the primary wires going to holes A and B. Strip and pull the correct wires through the marked holes, and solder all four. Clip excess leads. Both T2 and T3 should rest snugly against the circuit board.

14. Transistors Q1 and 4 are FET devices and should be handled carefully. Notice the positioning of the part with reference to the outline on the board. The "g" marks the gate of both FETs. Insert and position the body of each FET about ¼" from the circuit board. Solder all six leads on the foil side and clip excess. Also solder the "g" of Q1 to the ground plan marked by letter "S." DO NOT use an excessive amount of heat.

15. Remaining transistors may be done next, in the above manner. Notice Q6. The base lead, or the middle lead on the part, should be bent and inserted across the board. Leave ⅓" or so from the body to the board for the part. Check that the TABS of all transistors match the TAB drawn on the board.

16. Visually inspect the bottom of the board, looking for any possible solder bridges or cold solder joints. Inspect the TOP or component side of the board against the layout diagram and parts list to ensure proper part location. The circuit board is now complete.

Operating the Circuit

The SAM1 is a basic transverter design with a few interesting tricks that greatly improve performance. On the schematic, follow the receive path from input C1.

C1, 2, 3, and 4, and L1 and 2 form a 5-element, low-pass network that greatly attenuates all frequencies above 480 kHz. This is desirable to prevent overload from local AM broadcast stations and to minimize any IMD. Below this frequency, all signals are allowed to pass with a minimum of insertion loss. The phase and filter curve is included in this manual. C5 is a DC blocking capacitor, so that operation of Q1 will be maintained. Q1 is a low-noise, 12 dB amplifier operating in the classic grounded-gate configuration for best stability. In parallel with R1, it provides a 50 ohm input at the source for the filter.

T1 transforms a load of 450 ohms for the drain of Q1 to a nominalized value of 50 ohms. A 50-ohm "T" pad consisting of R2, 3, and 4, with an attenuation value of 1 dB, provides stability and improved return loss for mixer U2. Local oscillator Q2 is the classic Colpitts circuit, with C14 adjusting the frequency of crystal Y1. Typically, the output of such an oscillator is usually taken from where L5 and the emitter of Q2 connect, and the end of C14 would go to ground. However, in this arrangement the end of C14 goes instead to the very low input resistance of common base amplifier Q3, which when in parallel with R14 has an input resistance of less than 10 ohms. This is important because any significant resistance in series with crystal Y1 would spoil Y1's *Q*.

With such high *Q* (over 1000), a simple crystal filter is formed with an extremely narrow bandwidth (less than 10 Hz). We can attenuate local oscillator harmonics by as much as 60 dB, and cut our noise floor down to −110 dB! Q3 works as a stable low-noise amplifier, taking the −2 dBm signal output of Y1/Q2 and amplifying it to an acceptable level of 9 dBm. Inductor L4 and capacitor C12 form a resonant "L" network, matching the collector impedance to the 50 pi attenuators R5, 6, and 7, at 3.5 MHz. The attenuator network provides optimum stability and good return loss for mixer U2.

While the receive amplifier Q1 is only on during receive operation, Q2 and 3 operate during both receive and transmit. U2 acts as both the receive and transmit mixer. Buffer stage Q4 simply provides optimum isolation between U2 and any other stage connected through C8. Resistor R8 is a broadband 50-ohm termination for U2 at all mixer frequencies and harmonics.

This configuration has a small loss (approximately 2 dB); however, using a true 50-ohm termination for U2, with good insulation between U2 and the next section, the advantages outweigh the disadvantages. Q4 operates as a typical source follower with a 50-ohm output across R9. C8 is simply a DC blocking capacitor.

K1A and B are part of the switch-over team

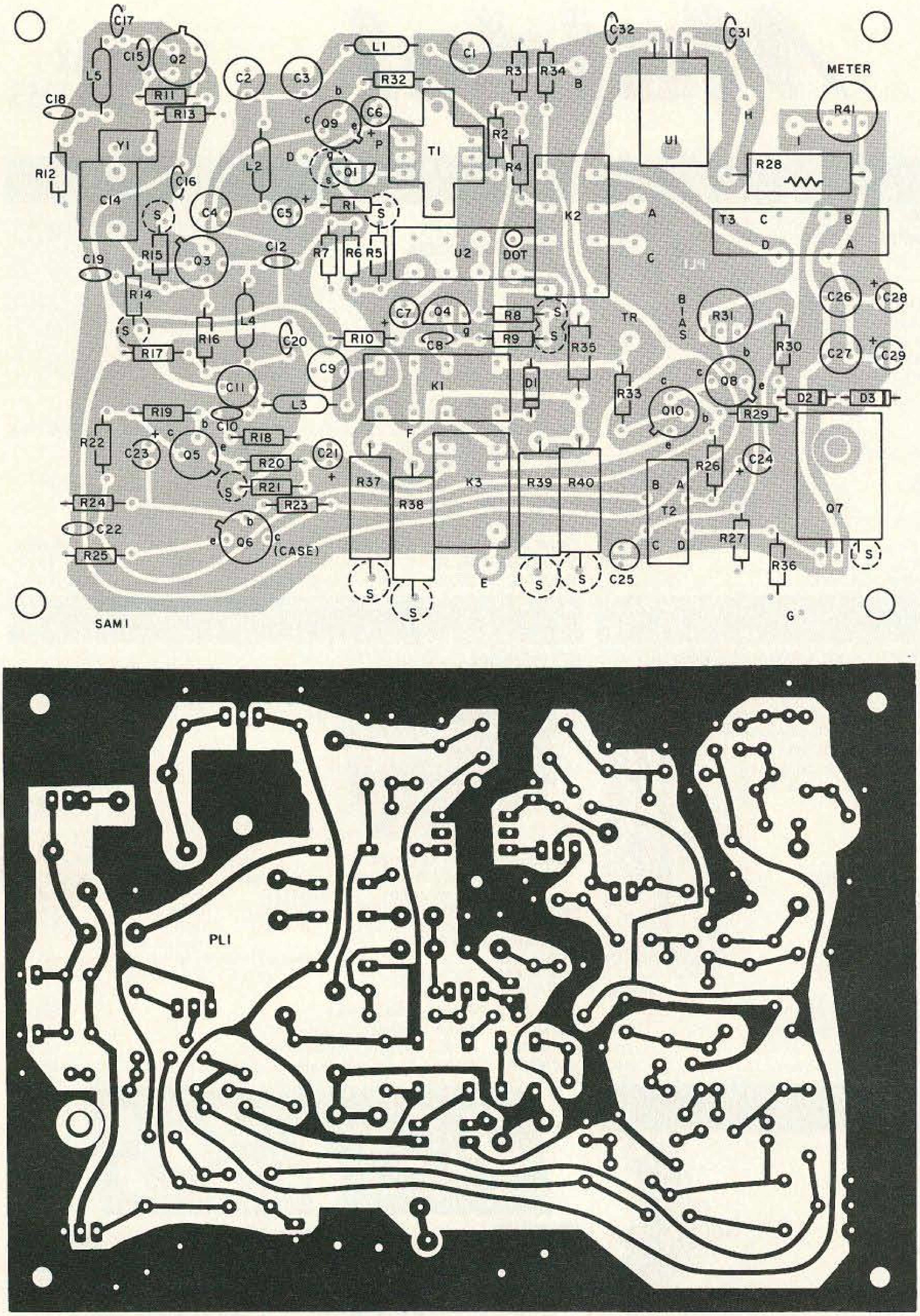

Figure 2. Parts layout and foil diagram, from the component side of the circuit board. Be sure to use a good quality rosin core solder and a clean soldering iron tip, with a wattage of 25 to 60 watts.

The Transmitting System

The SAM1's transmitting system is a simple broadband design that uses many of the same stages of the receive circuitry to save space and, of course, money. Point TR is used to activate relays K1 and K2 that switch over the input and output ports of mixer U2. When TR is grounded, the relays close, switching the input of mixer U2 to the 40 dB attenuator transmitting pad, consisting of resistors R34, 35, and 37–40. The pad will dissipate virtually all the power from your transceiver, allowing only a very small signal of 0 dBm to reach the mixer.

The 50-ohm pad also helps minimize IMD and the return loss characteristics of U2. The low-level RF signal from your 80 meter rig (between 3.66 to 3.69 MHz) is mixed with the local oscillator output from Q3, leaving the *sum* and *difference* frequencies across R8 and the input-to-source follower circuitry provided by Q4.

Again, R8 is the optimum match for U2, with a pure 50-ohm nonreactive load for these relatively low frequencies. With relay K1 closed, the output at the source of Q4 is connected to the pi matching circuitry of inductor L3 and capacitors C9 and 11. The pi match gives good attenuation of all harmonics of the *difference* signal from the mixer and eliminates all *sum* frequencies and their harmonics. It also provides a good match from the 50-ohm source of Q4 and R9 in parallel to the 600-ohm input impedance at the base of Q5. Both Q5 and 6 operate in a broadband class A mode, simplifying system design. With the elimination of frequencies above and beyond 240 kHz by the pi match, the two-stage broadband amplifier of Q5 and 6 gives about 20 dB of gain of the *difference* frequencies that fall within the 1750 meter spectrum.

As an example, an HF transceiver that transmits a signal at 3.6 MHz mixes with LO in U2 (3.675E6/3.5E6 = 175 kHz), and presto, you have your signal right in the middle of the 1750 meter band at 175 kHz!

Q6 will run very warm because it is biased to allow good linearity of voice peaks. The output of Q6 is transformed to an impedance level of 40 ohms through the action of trans-

that transfers the output from C8 to either your receiver input through point E or to the 1740 meter amplifier and low-pass matching filter, starting with C9. The received signal is simply the *sum* of the local oscillator frequency (3.5 MHz) and the low frequency input at point B (5–450 kHz). All signals within the low frequency spectrum are mixed together with the local oscillator, providing *sum* (3.5 MHz + LF) and *difference* (3.5 MHz - LF) frequencies and their harmonics.

The *sum* frequencies are those being received on the 80 meter transceiver, while all *difference* frequencies are simply ignored. You might say that half the signal power (−3 dB) is lost because, as the signal is converted, it is split in two, one half being the *difference* and the other half being the *sum*. This is one reason that the doubly-balanced mixer, U2, has an approximate loss of 5 dB and extra amplification (Q1 and 3) is needed to overcome the loss.

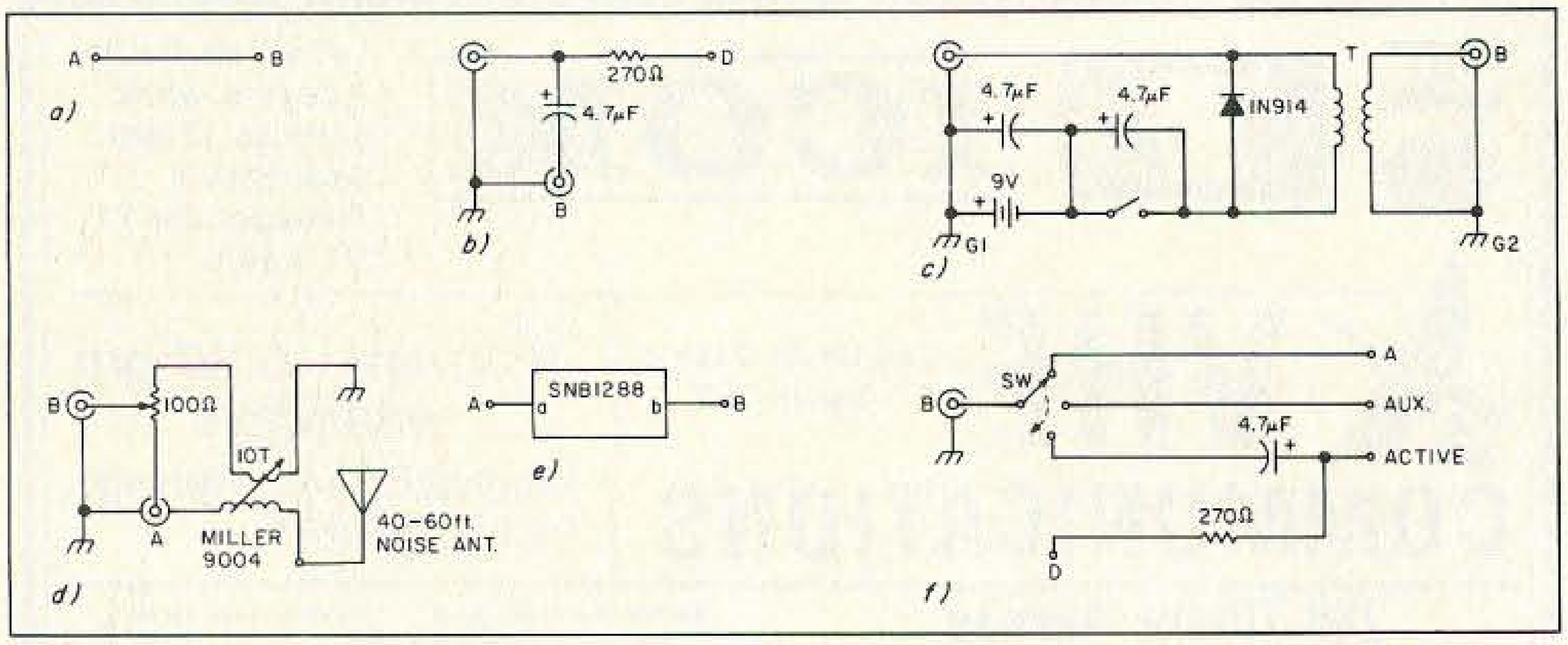

Figure 3. Noise-eliminating circuits: a) using the transmitting antenna; b) using "phantom power"; c) same as "b" but the DC supply and ground remain independent of the transverter and house ground; d) phase-canceling device; e) the SNB1288 snychronous noise blanker; and f) a switching arrangement for three antennas.

former T2, which is also operated in a broadband manner.

Transistor Q7 is a hefty 30-watt device, deliberately used here to overcompensate for mismatch conditions. Q7 is normally operating the class AB or class B mode with good gain and acceptable linearity for voice communications. Under ideal circumstances, efficiency has reached as high as 70%. Output power in the neighborhood of 10 watts is also possible, but discouraged. The heat sink for Q7 will not accomodate this; if you use the device incorrectly, you may destroy it.

You can adjust the bias potentiometer R31 for zero volts of bias to Q7 for class C operation, if you wish. The bias transistor Q8 is a simple current amplifier/voltage regulator, providing a bias potential from the emitter through the secondary of T2, where the RF signal is added to the bias voltage and over to the base of Q7.

Diodes D2 and 3 provide a steady 1.2 voltage reference for R31, which you adjust to set the idle current through Q7 to approximately 10 to 15 mA. The amplified output from the collector of Q7 is applied to tank circuitry of transformer T3 and capacitors C26 and 27. C25, 28, and 29 create a virtual short for all RF in the PA section. The output impedance of transistor Q7 and the 50-ohm load connected to the secondary (your antenna) via point C, dampen the *Q* of T3 so that full coverage and more across the 1750 meter band is possible. Excellent linearity and harmonic attenuation are found using the carbonyl HP material in this toroid.

Resistor R36 is not normally used, but if you experience any problems with oscillation of Q7 during transmission, a resistor with an approximate value of 47 ohms, or even lower, may be placed in this spot. Be careful not to use too low a value, though, since this will load down transistor Q8, which may burn out.

System Operation

All interconnections to the SAM1 are done through points on the circuit board (see the schematic). Let's look at each point and examine what each one is used for.

A: 1750/LF "thru" port. In receive mode, the transmitting antenna connected to port C will go to point A. This point can be connected to point B for using the transmitting antenna for receiving, or left unused if a separate antenna for receiving is desired.

B: 1750 meter receive input port. 50-ohm input for long wave and 1750 meters.

C: 1750 meter transmit port. Used for connection with 1750 meter transmitting antenna. You can also use it for 1750 meter receiving if you wish to use the same antenna for both.

D: "Phantom" power during receive operation. Provides 12 volts DC for accessory connections. Voltage goes off during transmit. 200 mA maximum recommended current.

E: 80 meter transceiver port. Using coax cable, connect this port to your 80 meter transceiver. Miniature coax is acceptable. Ground the braid of the coax to the ground plane on the component side of the circuit board, next to the hole where the center conductor of the coax is connected.

F: Transceiver "through" port. When the transverter is off, relay K3 will also turn off, allowing regular use of your transceiver at port F. Regular antenna connections that would normally go to your transceiver SO-239 jack should go to port F instead.

G: Ground. Use this point for a good ground connection.

H: VCC. 12–24 volts DC. Well-filtered, 24 volt supply recommended.

I: PA meter terminal. Negative connection for using a milliamp meter for monitoring input current to the PA. Positive connection should go to point H. You can use almost any type of milliamp meter, but I recommend one with a range of 1 mA. Calibrate the meter with R41. You can make PA current measurements with any VOM, VTVM, or digital meter, measuring the voltage across points H and I after adjusting R41 for minimum resistance.

TR: Transmit/Receive switch. Turns transverter from receive to transmit. By grounding this point, the transverter system will go into transmit mode. This point should go to your transceiver's auxilary relay for automatic switch over. Consult your transceiver's manual for correct connection. Connect the normally open relay terminal on your transceiver to point TR and the common relay point going to ground. This will automatically switch both systems over at the same time. For manual operation, you can switch between point TR and ground.

VLF Information Sources

The Longwave Club of America 45 Wildflower Rd. Levittown PA 19057	Membership is $12/yr ($20 foreign) which includes a subscription to the Lowdown which promotes DXing and experimentation on frequencies below 550 kHz and the 1750m band.
The Northern Observer c/o Herb D. Balfour 91 Elgin Mills Rd. West Richmond Hill, Ontario L4C 4M1 Canada	$15 donation (U.S.) for this newsletter with information about LF, VLF, ULF, MF and some HF operations in the east coast, mid-west, central states and Canada.
Western Update c/o Jim Ericson 226 Charles St. Sunnyvale CA 94086-6063	Western newsletter for MF, LF and VLF experimenters. $10/yr or $1 per issue (with 25 cent stamped envelope).

Optional Circuits

Once you have built your transverter, mount the board inside a suitable housing with appropriate connectors and switches. Use quality RF connectors, such as SO-239s or BNCs to simplify interconnections to other pieces of equipment. You have to decide whether you want one antenna or more than one, and whether you want to add noise-eliminating circuitry, such as the options shown in Figure 3.

Figure 3a shows a simple connection to turn the 1750 meter transmitting antenna into a receiving antenna. Just solder a wire jumper from points A and B. Figure 3b is a basic circuit for using "phantom power" to supply an active whip or other remote device, and to separate the signal to point B, the LF receive port. The unmarked port in Figure 3b should connect to RG-58AU coax or similar shielded cable, to carry both the RF and DC power to the remote device.

Another possibility is shown in Figure 3c, which is the same as circuit 3b except that the DC supply and the ground remain independent of the transverter and the house ground. This is important because a lot of the noise that plagues reception can be traced to the ground system. Frequently, many ground systems are "dirty"; they carry pow-

SAM1 Transverter Parts List

Resistors

R1,14,21	270Ω	R10,17,20	33Ω	R22	180Ω
R2,4	3Ω	R11	82kΩ	R24,30	470Ω
R3	430Ω	R12, 33	1kΩ	R25, 26	12Ω
R5,7	910Ω	R13	22kΩ	R28	1Ω 1W
R6	6.2Ω	R15,19,23	2.7kΩ	R31	2k pot
R8,27,34	51Ω	R16	6.8kΩ	R32	2kΩ
R9,29	560Ω	R18	1.5kΩ	R35	4.3kΩ
R36	NOT USED	R37–40	200Ω 6W	R41	1k pot

All resistors are ¼W unless noted.

Capacitors

C1,3,4,26,27	0.01 μF, 50 VDC poly
C2	0.0047 μF, 50 VDC poly
C5,6,7,21,23,24,25,28,29	4.7 μF, 35 VDC, electrolytic
C8,10,16,18,19,20,31,32	0.1 μF/50 VDC monolythic chip
C9	0.022 μF/50 VDC monolythic chip
C11	0.0082 μF/50 VDC monolythic chip
C22	1 μF/50 VDC monolythic chip
C15	68 pF NPO
C17	270 pF NPO
C12	390 pF S.M.

Inductors, Transformers

L1,2	27 μH Inductor J.W. Miller #70F275AI
L3,5	120 μH Inductor J.W. Miller #70F124AI
L4	5.6 μH Inductor J.W. Miller #70F566AI
T1	200:8Ω audio transformer Mouser #42TL004
T2	FT-50-77 toroid. Primary: 45 turns #28 wire. Secondary: 6 turns #22 wound over primary.
T3	T68-3 toroid. Secondary: 61 turns #28 wire. Primary: 46 turns #28 wound on top of secondary.

Transistors and Other

Q1,4	J310	U1	MC7812CT
Q2,3	2N2857	U2	SBL-3
Q5,8,9	2N2222A	1	Q7 mica insulator
Q6	2N2102	1	4/40 nut and bolt for Q7
Q7	TIP31B	K1,2	DPDT 12 VDC relays, 8-pin Digi-Key #Z440-ND
Q10	2N2907A	K3	SPDT 12 VDC relay, 5-pin Mouser #ME431-1212
D1	1N4001	D2,3	1N914A

A kit is available from Curry Communications, 737 N. Fairview St., Burbank, CA 91505. Tel: (818) 846-0617. It includes JFETs, so be sure that your soldering iron is grounded—and your body, too! No milliamp meter is included. Options for using the SAM1 with other equipment, and articles on recommended antenna designs, come with the kit. The silk-screened component side of the circuit board is marked for parts placement. The complete kit costs $89.95. The silk-screened, double-sided, predrilled board alone is available for $19.95 postpaid.

er line hash and the remains from light dimmers (G1).

Active whip antennas, for example, have an extremely high impedance and couple easily to local structures, wires, and of course, to the braided shield of the coax delivering power to the active whip. Noise along the grounded braid is capacitively coupled to the antenna, wrecking the signal-to-noise ratio in an otherwise quiet area. For a separate (G2), "clean" ground independent of the house or system ground, put a rod or similar item directly under or near the active whip and connect it to the active whip circuitry as shown in Figure 3c.

Transformer "T" is made by winding 50 turns for both primary and secondary on an Amidon FT-82-77 coil form with #32 gauge wire. The polarized capacitors can be any value from 1 μF to 10 μF electrolytic. A battery supply is highly recommended. If you decide to use an active whip, which is quite effective as a receiving antenna, be sure to place it away from power lines and buildings. Often the best places for this type of antenna are in the front yard, on a wooden pole on the roof, or at the top of a tree.

Figures 3d and 3e are both noise-canceling devices. Figure 3d uses phase canceling, which can be highly successful for power line hash or complex noise. The noise antenna can be any length of wire from 40 to 60 feet, laid horizontally on the floor or outside on the ground. The goal, of course, is to maximize noise on the noise antenna by placing it near house wiring where it will couple to the wiring and radiate noise. You'll need to experiment with this circuit to get the best results, since noise at each location is different.

J.W. Miller coil #9004 is used to resonate the noise antenna at the frequency of interest (in this case, in the 1750 meter band). The secondary of the transformer uses a low impedance of only 10 turns; that is, 180 degrees out of phase. Antenna input at "A" contains both signal and noise, and the noise is canceled by rotating the 100-ohm potentiometer to a point where the noise is of equal and opposite current, and adjusting the resonance and phase with the Miller inductor.

Vertical resonant antennas work well at port "A". Figure 3e is the Curry Communications SNB1288 synchronous noise blanker, which can be inserted between points "A" and "B" of the SAM1 transverter as shown. This will eliminate all types of synchronous noise, such as light dimmers, and could even be added in series with the phase-canceling circuitry in Figure 3d (point "B" in 3d going to point "B" in 3e, and point "A" in 3e going to point "B" on the SAM1). Don't forget that "A" in Figure 3d goes to point "A" on the SAM1. So you can see that there really are many ways to do it.

This leads us to Figure 3f, which shows a switching arrangement capable of letting you use three different antennas, which could be quite convenient. This switch is recommended with one or both of the noise-canceling devices in Figures 3d and 3e. If you live in a suburban area, you can almost bet that light dimmers and similar devices will plague reception, and the noise blanker on your HF transceiver may not have a long enough time constant to eliminate these pulses. First check your reception to decide how elaborate you want to get with these receiving aids.

Once you have decided on the system, if any, you wish to use with the SAM1, and you've decided on how you want to mount the circuit board, remember to use ¼" spacers when you position the board inside the housing. Anything under ¼" may short the screw or bolt on Q7, which has full potential.

Connect the power supply to points G (ground) and H (positive). A 24-volt DC supply is recommended, but a 12-volt supply is adequate. When the SAM1 is properly connected, relay K3 will close.

Bias and Oscillator Adjustments

At this point, align the bias and PA meter. Rotate R31 fully counterclockwise (bias control) for minimum bias voltage on Q7. R28 is used as a current reference so you can accurately measure and monitor the PA current of Q7. A meter would be the easiest way to do this, using 1 mA across points I and H. Adjust resistor R41 to align the meter for a calibrated indication. Use a VOM or digital meter and connect leads across R28. Apply power to the SAM1. You should hear relay K3 close when you turn the power on. If you don't, your power supply potential is too low and you have to increase it.

Place the SAM1 in the transmit mode by grounding the TR point. Relays K1 and 2 should change over, and you may get a reading of 1 mA or so across R28. Remember that the VOM or digital multimeter is actually measuring the voltage across R28, but because of the resistance of R28 (1 ohm), you can interpret the reading as the actual current flowing through R28 to Q7. R31 is rotated slowly clockwise for an indication of 10 mA (or 0.01 volts measured across R28). If desired, you can use a jack or plug and simply monitor the current externally with a VOM or multimeter. Use points I and H, adjusting R41 for minimum resistance. Any meter other than a multimeter or VOM will have a significant amount of resistance, and R41 compensates for this.

Some meters can measure up to 300 ohms of internal resistance, and you can calibrate a meter of this type simply by monitoring the current across R28 with a VOM or digital multimeter and turning R41 so the current on the meter will be the same as the current across R28. This concludes the bias adjustment of the SAM1.

Unground point TR and connect point "E" to the RF terminal on your HF transceiver. Zero beat the local oscillator on the SAM1 by tuning your HF transceiver to 3.5 MHz and rotating C14. If you own a calibrated frequency counter, you can check the frequency of the local oscillator at the output of Q3, or across C12 or L4. Make sure your transceiver is calibrated to the internal oscillator most modern HF transceivers are equipped with. If your transceiver has one, turn the oscillator on and zero beat the two signals, listening in the AM mode.

Checking Connections

With all connections to the SAM1 completed, check to make sure the points on the SAM1 are going to their correct places on the transceiver and antenna. Apply power and again listen to make sure you heard relay K3 kick over. Your HF transceiver will operate just as it would on any amateur band, along with any controls you wish to use to improve the reception or transmission within the 1750 meter band. The readout on the analog dial or digital display is simple to read: Ignore the 3.5 MHz; read only the kHz readout.

For example, let's say you're working an SSB station on 183 kHz. What would the readout be on your transceiver? Simple: 3.683 MHz; 3.683 - 3.5 = 183 kHz! Shortly you will become accustomed to ignoring the 3.5 MHz and the fact that your HF transceiver has been transformed into a complete LF/VLF station.

Make extra sure that the TR point on the SAM1 board is connected to the external relay port on your HF transceiver so the SAM1 will automatically follow the transceiver going from receive to transmit. Check this by placing the transceiver in the send or key-down (transmit) mode, but don't let any RF leave the transceiver.

Keep all carrier and mike controls on the transceiver to a minimum! Both relays (K1 and 2) on the SAM1 should key over. If you do not hear this, your wiring on the TR line is incorrect. Point TR must be grounded during transmit mode. If all is well and the relays key over, you're ready to check the transmitter half of the SAM1. Be sure to connect a *resonant* 1750 meter antenna to point "C" on the SAM1, or a 50 ohm, 2 watt load resistor as a termination. With both the transceiver and transverter in the transmit mode, send a low-level carrier of approximately 10 watts on the transceiver anywhere between 3.66 to 3.69 MHz (160 to 190 kHz), the legal band limits of the 1750 meter band.

Check the PA current of the SAM1 as discussed previously. The legal input power for continuous duty or CW to the PA is 1 watt. Not much, but surprisingly effective! Hundreds of miles have been successfully and regularly worked on such low power, which adds to the challenge of the 1750 meter band. When operating SSB, however, 2.8 watts peak-to-peak is allowable, and the transverter can handle this easily.

The bias current to Q7 is adjusted to a class AB condition (15 mA) to accomodate SSB operation. The drive level from the HF transceiver controls the RF output of the SAM1, with only a small amount (10 watts) required for legal output on 1750 meters. With too much power or a too-high bias, transistor Q7 can go into thermal runaway. The bias will naturally increase as the temperature of Q7 increases, so don't be concerned about this. Temperature-tracking diodes D2 and 3 are help minimize this condition.

Because of their continuous duty operation, digital modes such as RTTY and AMTOR require that you keep the drive to the SAM1 low. Check the PA current to Q7 often. If desired, you may lift Q7 from the circuit board and set it down vertically, with a heat sink attached to the metal body for improved heat dissipation. The TIP31 transistor Q7 is quite rugged; because of this virtue, I chose it as the PA amplifier. 73

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Monoband Yagi

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Radio Shack. I mounted the antenna at the top of the pole, with the sections uniformly telescoped to yield a total height of 30 feet. I obtained additional strength by telescoping the sections to this shorter length. A short mast cut from 1-1/4" aluminum tubing and mounted above the rotor brought the total antenna height to 33 feet. If you use a pole, as I did, don't attempt to extend the pole to its maximum height. Very little will be gained in radiation angle, but the structure will be weakened considerably.

I attached the pole to my eaves at a height of 10 feet using the mounting bracket. I then guyed the pole near the top using Kevlar™ line sheathed in Dacron™ (available from Radio Works). This produces a strong, inconspicuous guying system.

Performance Tests

In three months I have logged 107 countries with the new antenna, most of those on SSB and most with signal reports of 5-9 or 5-9 plus. "Big Signal, AB4GX" has commonly been heard. The power used varied between 50 and 1200 watts output, although the antenna should handle full legal power with no problems. The front-to-back-ratio agrees with the computer analysis, and I've used the existence of the null off the sides to advantage. When working East (Europe and Africa) or West (South Pacific or Asia), I can effectively null the strong South and Central American stations adjacent to my Florida QTH.

This is the first time in 27 years of hamming that I have used a yagi, and the first occurrences of QSOs interrupted by hams telling me that there must be "something wrong with your equipment because you are pinning my S-Meter and blocking my receiver." This sometimes while barefoot, and while I have ended QSOs in the interest of peace and harmony, I have also developed a new respect for the gain of this antenna. I have found I can work almost anyone I hear, most often on the first call, and power management coupled with operating courtesy are much more visible requirements. You cannot have a "Big Signal" without also having a "Big Responsibility." And all this on a push-up pole, and with shortened elements! Enjoy, and please let me know your experiences if you construct this "residential yagi." 73

Parts List

QTY	Item
2	½" x 12" hardwood dowel
4	1" x 6.5" hardwood dowel
1	1-¼" x 3' aluminum mast pipe
4	½" I.D. x 1' clear plastic tubing
4	½" diameter x 5' aluminum tubing
4	½" diamater x 16.5" aluminum tubing
4	⅜" diameter x 4' aluminum tubing (cut for proper length, as shown in Figure 6.)
8	⅜" diameter x 5" aluminum rod
2	1-¼" I.D. U-bolts for mast
8	plumbing clamps for ½" pipe
12	pipe clamps for ½" pipe
1	1" x 3" x 24" pine
1	1" x 3" x 22" pine
1	1" x 2" x 4' pine
1	1" x 3" x 6' pine
1	1' x 1' x ¼" plywood (cut up for the 4 cleats)
	#12 wire
	#16 enameled wire
1	1:1 balun - Radio Works #Y1-4K
	Kevlar support wire - Radio Works
12	self-tapping screws
12	eyelets
1	Fiberglas kit (optional) - K-Mart or equivalent

Contact Ken Kemski AB4GX at 3745 Allenwood Street, Sarasota FL 34232.