

Deluxe Transverter for 1750 Meters

Your Ticket to the VLF Experimenter's Band

by David Curry WD4PLI

What could possibly be interesting about a group of frequencies that are so low, most people mistake them for bandwidth? Or how about an antenna that for all practical purposes could be long enough to be used as a telegraph line between two mid-western towns? These large dimensions, and the mystery that follows the 1750 meter band, are just a part of the fascination that a few people, often referred to as "Lowfers," share in experimenting and communicating on this otherwise neglected band.

Unknown to many amateur radio enthusiasts, the FCC has allowed license-free use of frequencies from 160 to 190 kHz, with a power restriction of up to 1 watt input to the final, and a maximum antenna length (including feedline) of 50 feet. There are no restrictions placed on the receiving equipment used or the type of receiving antenna.

Surprisingly, one watt often offers powerful flexibility. My CW beacon "PLI" transmitting on 183.63 kHz is regularly heard several hundred miles away. Another station, Z2 transmitting from San Simeon, CA, has received reception reports from even greater distances: over 2000 miles away in Hawaii! The FCC does not restrict the mode of transmission, and everything from AM and SSB to CW and RTTY have been used successfully.

Few people have mastered the 1750-meter band because of the lack of readily-available commercial equipment. You simply don't go out and choose the transmitter, receiver, and antenna you want. In most cases, you have to build your own gear, and with the right equipment and the right choice of antenna, the 1750 meter band becomes truly addicting.

Easy to Build Transverter

Transverting from 80 meters provides a simple way to get onto the Experimenter's Band. Home-brew transceivers often present complications, but transverting from most commercial equipment eliminates most problems. When the transverter is in the receive mode, the 80-meter band of your transceiver is converted into a longwave receiver capable of receiving any signal from 5 to 450 kHz.

Any type of signal from AM to FSK can be received, only limited by the mode capabilities of your ham transceiver. The transverter is broadband, and does not require tweaking nor tuning either for receive or transmit operations.

During transmit operation, you simply transmit normally on 80 meters between the legal band limits from 3.66 to 3.69 MHz. The signal is converted down converted from 160 to 190 kHz, which are the lower and upper frequency limits of the 1750-meter band.

Remember not to transmit outside the band limits, either below 160 kHz or above 190 kHz, because these frequencies are used heavily by government, aircraft, and many other services. The transverter features a bandpass filter to eliminate transmission outside the 1750 meter band, as well as harmonic energy above 200 kHz.

Much of the guesswork and trouble that often leads to disappointment is eliminated with this proven circuit, leaving more time to explore and enjoy this truly amateur band.

Transverter Mixer

The heart of transverter is, of course, the mixer MX1. It upconverts receive signals on the longwave band to 80 meters, and down-converts transmit signals from 80 meters to the 1750-meter band. Remember that 1750 meters (160-190 kHz) is just a small portion of total longwave spectrum and the only area where you are allowed to transmit. The circuit uses a doubly-balanced diode ring, which provides an excellent dynamic range, low noise, and local oscillator rejection. You might think it would be necessary to use two mixers, one for receiving and the other for transmitting, but the diode ring mixer is changed to either receive or transmit by the relays K1 and K2. This eliminates the need or cost of using two. Let's imagine the transverter in the receive mode and start at the beginning of the circuit with the input port J1.

Receive Conversion

As you can see in the schematic (Figure 1),

the input signal flows from J1 through relay K1A to S1 which is the "receive select" switch. This switch is useful if a different antenna for receive is required for improved reception such as a loop or active whip. In the normal position, it's connected to the 1750-meter port, J1, or switched to the auxiliary input. The received signal is sent through switch S1 to the input of the low-pass Chebyshev filter, comprised of C1-C4 and L1, L2. This filter has a very sharp roll-off starting at 450 kHz, which eliminates overload or IMD from strong AM broadcast stations and other out-of-band signals. Signals below 450 kHz pass with minimum attenuation.

Filter output is matched into the input port of Q1, a low noise, high gain J-FET operating in a grounded-gate, broadband configuration. The grounded-gate type of operation is known for good stability and low signal distortion. The gain of the amplifier is approximately 10 dB and compensates for the 6 dB loss in the mixer and the 4 dB lost in Q4 and the low-pass filter. The transverter is set as close as possible to unity gain. Output of this stage is transformed to 50Ω via T1 and routed through K1B to the input of mixer MX-1.

Unique LO Design

The local oscillator used here is an unusual design, first brought to my attention from an article about crystal oscillators by Ulrich Rohde. What makes this circuit so worthwhile is the way the crystal, Y1, is configured between the oscillator transistor Q2, and the Class A amplifier, Q3. Y1 placed in this fashion acts as a high-Q filter, which greatly attenuates harmonics and local oscillator noise. Capacitor C9 is used to adjust the crystal frequency to 3.5 MHz. Q3 operates in the common base configuration and amplifies the LO to approximately +7 dBm. At this point, the Pi-matching circuit, consisting of C15, L5, and C16, match the output of Q3 to the 50Ω input impedance of mixer MX-1.

The sum and difference frequencies from the output of the mixer go directly to load resistor R9 and the input gate of Q4, which is

used as a source follower. This gives optimum isolation between the mixer output and the next stage. There is a loss in using this type of circuit—the source of Q4 and the next stage acts as a voltage divider—but the advantages outweigh this disadvantage.

By using R9 as a load resistor for the output of mixer MX-1, all the sum and difference frequencies including their harmonics will see a true 50Ω load, which optimizes the 3rd order intercept point. Gate capacitance of Q4 is minimal and ignorable at these frequencies. This approach obviates the need for triplexers in the receive and transmit path. The source of Q4 is coupled to the receive port of the 80-meter transceiver through relay K2A and K2B, and the DC blocking capacitor C17.

J4 provides +12 Volts DC for operating any accessories or preamplifiers during receive mode, and goes low during transmission.

Transmit Downconversion

This next situation is the transverter in the transmit state, taking an 80 meter transmit signal from the amateur transceiver and downconverting it to 1750 meters. Point J1 is used as the control point to turn the Transverter from transmit to receive, or visa versa, and is connected to the terminal on the back of the transceiver that has a NORMALLY-OPEN and COMMON relay points.

Almost all transceivers have auxiliary or accessory terminals for controlling outboard equipment like this. A careful look in the manual or even a check (with the help of a VOM) of each point on the terminal, will reveal the points corresponding to the normally-open, common, and normally-closed relay positions.

Usually, the accessory jack is female with eight or nine pins, and includes a normally-open, common or ground, and a normally-closed pin. The normally-closed pin is not used while the common is connected to ground, and the normally-open pin connected to J3 on the transverter. This will synchronize

the transverter to the transceiver by energizing K1 and K2, when going from receive to transmit and vice versa. If no connection to the transceiver is possible, a manual switch can change the transverter mode. One part of the switch is connected to J3, and the other part of the switch goes to ground.

During transmit K1 and K2 are energized. The RF power from the transceiver goes into the 80-meter port J2, through K2B and into the 30 dB attenuator pad which consists of R13-R18, R19, and R20. This pad lowers the signal to an acceptable level for the mixer MX-1. The signal goes through relay K1B, and into the mixer where it is mixed with the local oscillator. The output sum and difference frequencies from the mixer are sent to the source-follower transistor Q4, then through K2A to the low pass filter comprised of C19, L6, and C20. The filter eliminates the sum frequencies around 3.68 MHz, but allows the difference frequencies from 160 to 190 kHz to pass.

With the signal already filtered, it is ready to be amplified to a usable output for transmission. Transistors Q5 and Q6 operating in Class-A mode amplify the low-level signal from the output of the filter to drive output transistor Q7. Q7 is an inexpensive, durable audio transistor that has ample gain at these frequencies for maximum performance. The bias that sets Q7 in class AB operation is controlled by regulating transistor Q10. R32 adjusts the current through Q10, which in turn controls the quiescent current of Q7.

The collector of the PA transistor Q7 is coupled to the 50 Ω output impedance by transformer T3. T3 and C30, C31 form a tank circuit with a loaded Q that is low enough to cover the entire 1750-meter band. The output power from T3 is passed through relay K1A to J1, which is the 1750-meter antenna port.

For best results, it is very important that the transmitting antenna resonate at the desired frequency, and coupled to the transmitter efficiently. The transmitter PA is flexible to various forms of matching circuits, and a proven method follows later.

The transverter operates from a 24 VDC regulated supply, or any well-filtered and regulated supply capable of delivering at least 1 amp from 18 to 26 VDC. Q12 supplies a regulated 12 volts to all active components except the PA transistor Q7, which uses the power directly from the 18 to 24 VDC power input.

Construction

Figure 2 shows the circuit board positive to aid construction. A ground plane on the component side of the circuit board adds stability. An easy way to make the ground plane is to cover the ground plane side of the circuit board with masking tape before etching the board. Make sure the corners are especially well-covered. Only the foil side is etched; the ground plane side is left untouched. Remove the tape after etching and drill the holes from the foil side. Finally, use a larger drill bit to countersink the holes from the ground plane side enough to adequately clear all part leads through the board. The ground holes do not need to be countersunk.

The parts are inserted into the board using the component layout (Figure 3), viewed from the foil side through the board to the actual component. Each type of component has its own symbol, as shown in the illustration, to help visualize the type of part and its value. All components, except for three resistors R16-R18 (which mount against the foil side), are mounted on top of the ground plane side and part leads soldered on the foil side. Some grounded leads are soldered on both sides to improve the ground on the foil side, and are marked in Fig. 4 by the symbol, "/". Install resistors and capacitors first.

Q7 also uses the ground plane of the circuit board as a heat sink. Use a mica insulator between it and the board, and cover both sides of the insulator with heat sink compound.

Wind all toroid inductors evenly and tightly, winding the side that has the most turns first. After a toroid has been wound, strip the enamel from the wire almost to the body of the toroid, and insert the leads carefully into the circuit board. *Double check* to make sure that the transformer and coil leads are in their correct hole, as shown in the illustration. After all leads are pulled reasonably tight through the board and soldered, use a small drop of Krazy Glue™ between the toroid and the board to insure rigidity. Double check the parts layout against the drawing after installation. This will save you from a lot of head scratching later!

Receiver Alignment

This is very simple. You need an accurate receiver (preferably a frequency counter), and a VOM or VTVM. Apply any voltage between 18-24 VDC to the B+ point on the circuit board, and the ground connection to the point labelled "G". Next, confirm that the LO is working correctly and aligned. A frequency counter gives the most accurate frequency calibration. Connect the counter probe to Test Point 1, and the ground lead to

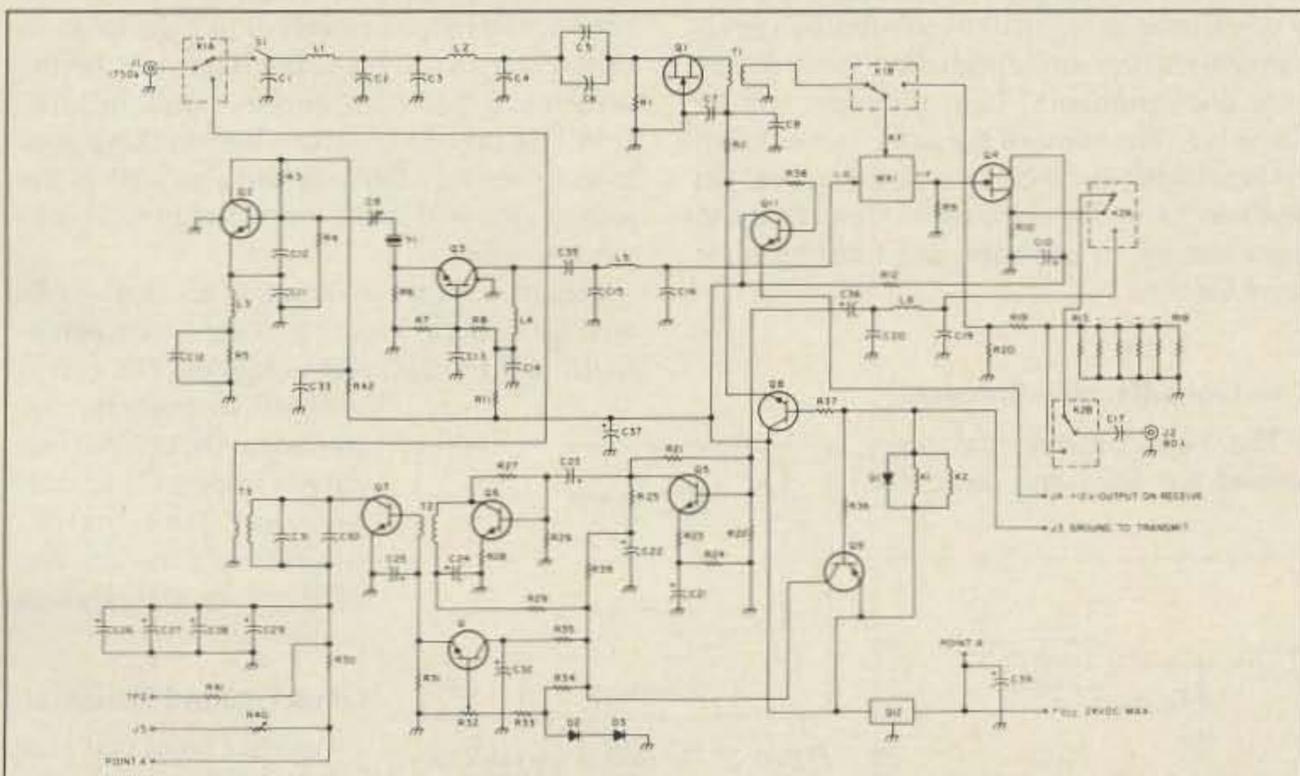


Figure 1. Schematic of the 1750 meter transverter. Note the unusual design of the local oscillator, which greatly attenuates harmonics and oscillator noise.

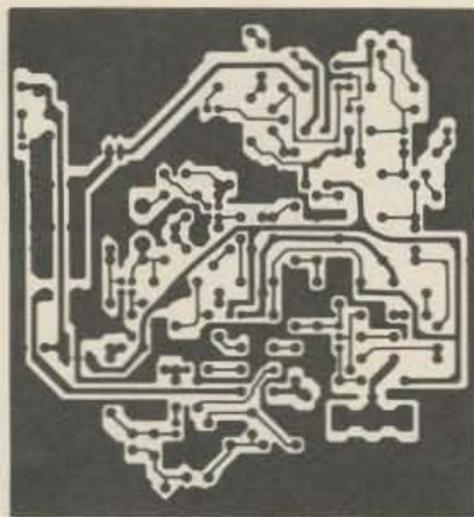


Figure 2. Circuit board positive for the project. Actual dimensions are approximately 4.7" x 4.3".

circuit board ground. The frequency should be displayed and C9 adjusted so that a frequency of 3.500 MHz is displayed. This now calibrates the LO.

If a frequency counter is not available, then first calibrate the transceiver as closely as possible to its reference, and tuning to 3.5 MHz. A piece of wire connected from the transceiver RF jack and layed close to the transverter board will pick up the LO signal. Adjust C9 for a zero-beat while watching the S-meter on the transceiver for minimum meter movement. This alternative approach is not as accurate as the first, but done correctly gives excellent results. This completes the alignment for the receive section.

Transmit Calibration

Connect a coaxial line between the transceiver RF jack and transverter 80-meter terminal J1. Place a 50Ω dummy load made of two 100Ω, two-watt resistors connected in parallel to the 1750 terminal J2. This will simulate the 1750 meter antenna during our power test. Get out the VOM or VTVM and connect the red or positive lead to J5, and the black or negative lead to TP2. Adjust the meter so it can be capable of reading 200 mV DC.

Ground point J3 and listen for relays K1 and K2 to change over. With J3 grounded, check the bias of Q7 on the meter and set to 15 mV by adjusting potentiometer R32. The voltage read on the meter is actually the current to Q7, and so 15 mV is really 15 mA of bias current to operate the final stage in Class AB.

Now connect the transmit/receive control point J3 to the transceiver normally-open point on its accessory or transverter plug. Make sure that the common, or other point of the relay in the transceiver, is grounded. Tune the transceiver to 3.675 MHz, which corresponds to 175 kHz. Put the transceiver in Tune mode and listen for transverter relays K1 and K2 to close. Only 10 watts of peak output are needed to drive the transverter to full output, more may over-saturate and damage the transverter.

Set the transceiver to 5 watts of output and check the meter connected across points J5 and TP2 of the transverter. It should read a

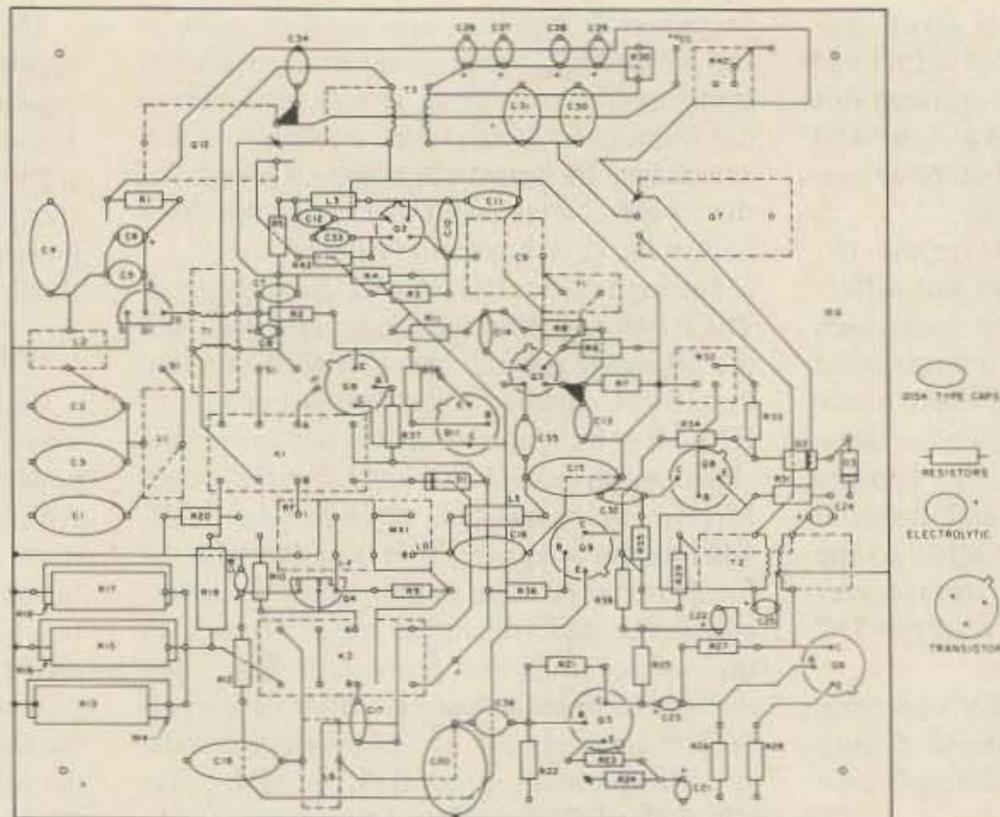


Figure 3. Parts placement for the transverter. A circuit board and parts kit are available. See text for details.

value above 100 mA. Avoid using higher currents beyond 500 mA for more than a few seconds. Adjust the output of the transceiver so the current on the meter is within the legal limits. For example, if the power supply voltage is 24 volts, and the meter current is 100 mA, the peak-to-peak input power is 2.4 watts ($24 \times .1$). This is just under the maximum legal input because 2.4 watts PEP is just under 1 watt RMS ($2.4/2 \times .707 = .848$ watts) DC input power.

The 50Ω dummy load should feel warm to the touch, indicating output power. The voltage can be measured between TP2 and ground for easy calculation of the input power. Return to the receive mode, and remove the dummy load.

The Antenna System

The transverter is now ready to be connected to the antenna system. Often separate antennas are used for transmission and reception. A long and high transmitting antenna may not be the best receive antenna, especially when used in urban or even suburban environments where noise radiating from power lines and neighbors' light dimmers can be obtrusive. The name of the game is to achieve the best signal-to-noise ratio possible, and the best way to do this at the receive end is to use some strategy in choosing and locating a receive antenna.

Two Good Receive Antennas

The Loop antenna has been around for ages and there are

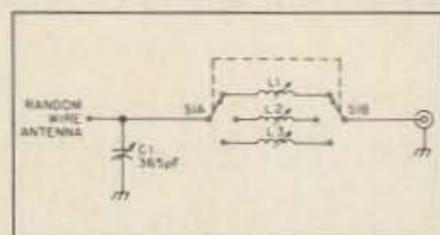


Figure 4. A simple random wire antenna tuner used for reception.

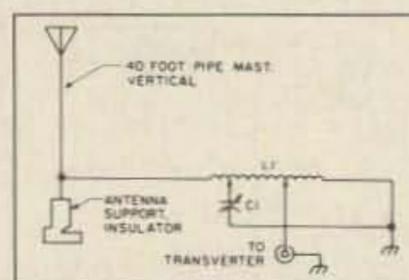


Figure 5. The author uses this antenna configuration, which allows operation on both 160 and 1750 meter bands.

many articles covering its proper design and application. In my location, I would be helpless without using one of these for reception, since the high level of power line hash can be easily nulled out. The loop is made of 30 conductor computer ribbon cable with the wires at each end stagger-soldered to produce one continuous electrical path. This is tuned easily with a standard 365 pF variable capacitor and is preamplified before going to S1 on the transverter. I experimented placing the loop in different parts of the yard and discovered a quiet spot furthest from the power lines and equidistant between two

apartments. The loop was planted at this spot and rotated for the deepest null in the noise obtainable. Simpler forms of noise such as light dimmers and pulses can usually be eliminated with the noise-blanking switch on the transceiver while complex noise, such as power line hash, is eliminated better by nulling with a loop or phase cancelling.

Another effective way to reduce noise is by using an active whip antenna. This is a high impedance, broad-band vertical antenna that is usually around 3' high and has its own preamplifier. It is mounted in a remote location away from power lines and in an area clear of structures. I also use an active whip mainly for general LF listening, and it is mounted on a wood pole at the top of a tree 60' in the air above all the houses and powerlines. I would not receive a tenth of the signals at the base of the tree as I could high in the clear. There are some excellent articles by Ralph Burhans on building or buying active whips, and I highly recommend both the active whip and the broad-band active loop. Remember that the location of the antenna, even a few feet, can be the difference between success and failure. Don't let anyone snow you into thinking your loop or active whip will work as well in the garage as it will in the clear part of the backyard. It won't.

Figure 4 shows a simple tuner that works well for general listening using a wire antenna from 50 to 200 feet in length. The coil is selected to resonate the antenna at the desired frequency, using C1 for additional flexibility. Again, erect the antenna as much in the clear as possible.

Good Ground Essential

Another point that cannot be overstated is the importance of a good ground, which is neces-

sary for transmitting efficiently and receiving a lower noise floor. A ground radial system for the transmitting antenna works well and will be discussed in more detail. Ground rods work, but several copper 10' pipes driven into the ground around 10 feet apart and strapped together will outdo a single 3' ground rod.

In areas of rocky, sandy or otherwise poor soil conductivity, it's better to concentrate entirely on a good radial system around the transmitting antenna. Treat the cold water pipe grounding system as a last resort only.

The transmitting antenna I recommend is a vertical antenna with the largest capacity hat possible. In general, a 50' 1750 meter vertical antenna acts much like a 160 or 80 meter mobile antenna, and there is plenty of information in the handbooks to gain a deeper understanding of this similarity. In fairly quiet locations, the transmitting vertical antenna works well for receiving, but limited to the resonant frequency of the antenna. By following a few simple tips, a good transmitting antenna can overcome even the worst locations. Keep the vertical antenna in a primarily clear area away from trees and structures. This type of antenna has a very high Q and becomes sensitive to nearby objects.

The largest ground plane possible should consist of as many wires as practical, starting from the antenna base and laid outward in a radial fashion, which contributes greatly to a strong signal.

It is not necessary for the radials to go beyond a length of 60 feet, since a resonant $\frac{1}{4}$ wave radial at these frequencies is impractical for most uses.

The antenna-loading coil should be wound with either Litz wire, or #18 gauge or heavier Formvar™ enameled wire. The coil form should be made of a high, dielectric quality and usually ranges in size around 4 to 8 inches in diameter, and 6 to 8 inches in length. A glass water bottle, large PVC pipe, or several wood dowels mounted in a circle on a wood base that could simulate a large coil form will work quite well. Do not use the black type of PVC pipe or cardboard forms for loading coils as these and similar types can spoil the Q of the coil or fall apart later. Fiberglass resin or liquid Varathane™ work very well for weatherproofing the coil once completed.

Dual Band Antenna

I use a transmitting vertical antenna with an 8' capacity hat and a small loading coil so the antenna can be switched over and also used on 160 meters as a top-loaded current-fed vertical (see Figure 5). The antenna uses a large diameter Coke bottle half-sunk in a concrete block as the base support insulator. In my particular installation, I use a high-voltage relay to switch the antenna from either 160 or 1750 meters.

The antenna is current fed on 160 meters using a large, air-type variable capacitor, but when switched to 1750 meters, the antenna is connected to the top of the loading coil with

the bottom part of the coil grounded to the radial and/or ground system. The coax braid from the transverter coax line is also grounded, while the center conductor is experimentally taped 4 or 5 turns up the coil from the ground end. A small neon bulb like the NE-2 can be held close to the vertical during transmission to indicate resonance at maximum brilliance.

A field strength meter built out of any of the handbook circuits is very effective to indicate resonance. It is easy to accidentally resonate any antenna of this type on a harmonic, which can cause confusion later. One way of telling if this occurs is if there is a large increase in background noise when receiving at frequency. If the noise floor increases and peaks somewhere above the band limit (190 kHz), then C1 in Figure 4 can be added and adjusted to pad the coil down within band limits.

It is much more efficient to use as little capacitance of C1 as possible, and simply means that more turns must be added to L1 to increase the inductance, and bring the vertical antenna to resonance within band limits. If the coil is wound too large, you will notice it will resonate below the band limit (160 kHz). C1 should be disconnected, and turns gradually taken off L1. When the antenna is resonant within the band, a good listen will reveal the activity in your area, and clear frequencies free of carriers and other signals.

***"If the
1750 meter
band seems
tough at first,
don't give up!"***

Usually, once a clear spot is found, it is used as the transmitting frequency, and final matching of the transmitter to the antenna will happen. Place the transceiver in the "tune" mode and experimentally adjust the coaxial tap point on L1. Using the neon bulb as an indicator, find the best tap point on the coil when the bulb indicates maximum brightness. A more scientific way to find the coaxial tap point is to use a 50Ω simulation.

Connect the 50Ω dummy load, and while transmitting, find the AC voltage or current using an oscilloscope or AC voltmeter or current meter. Once the value has been noted, connect the transmitter to the antenna and adjust the tap point, monitoring the voltage or current at that point and setting the tap point where the voltage or current is the same as the one that was checked across the 50Ω load. This will simulate a 50Ω load at resonance.

The final adjustment is made by adjusting C1 and the tap points on L1 while transmitting a peak indication on the neon bulb or signal strength meter, which coincides with the right value of voltage or current measured at the tap point. Once you do it a few times and gain a "feel" for matching the antenna, it becomes quite simple. It's worth keeping an eye out for RF current meters in the .1 to 1 amp range at swap meets and related ham functions, since they are worth their weight in gold to the experimenter.

Final Thoughts

If the 1750 meter band seems tough at first, don't give up! Working harder to gain an understanding of the way things work on LF has kept me devotedly interested in this band for over 15 years, and the possibilities of what can really be done here is limited only to the imagination. 1750 meters has grown up over the past couple of years thanks to experimenters introducing better circuits and more state-of-the-art equipment.

Full detail on the different aspects of 1750 meter equipment and operating techniques can be found in a number of *The Lowdown*, published by the Long Wave Club of America, 45 Wildflower Rd., Levittown, PA 19057. Membership is \$10 per year in the US, and \$18 per year overseas. This is worthwhile for general LF activity including 1750 meters, and is published monthly. Another publication that specifically focusses on 1750 meter activity is the *1750 Meter Western Update*, 226 Charles St., Sunnyvale, CA 94086. This is a monthly newsletter and can be obtained by sending 12 business-size, SASE (22-cent) envelopes to the above address, with a donation for copy costs for a full year of issues.

Some specific issues for further information about receiving and antennas is the June 1985, May 1985 and March 1987 *Lowdown* issues featuring circuits by Ralph Burhans and Mitchell Lee on active broadband loop receive antennas.

Ralp Burhan has details of various 1750 meter accessories available by writing: Ralph Burhan, 161 Grosvenor St., Athens, OH 45701.

The transverter shown in this article is available in kit form and includes all parts, circuit board, and instructions from Seden Communications, 1272 Harold Ave., Simi Valley, CA 93065. Also available from Seden Communication is the 1750-meter antenna loading coil and other related items. Call (805) 583-5687 or write for prices and more details.

The Southern California SSB Net meets every Saturday morning at 10 AM local time on upper sideband on 182 kHz. We welcome local response.

David Curry is an avid Lowfer and holds a General class license. He can be reached at 4415 Cahuenga Blvd., Toluca Lake, CA 91602.

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1750 METER TRANSVERTER PARTS LIST

Resistors	(Ohms)	Resistors	(Ohms)	Resistors	(Ohms)
R1, R26	470	R9, R20	51	R29	4.7
R2, R11, R12	47	R10	560	R30	1.0 1Watt
R3	82k	R13-R18	300 2W	R32	2k PC Pot
R4	22k	R19	2.5K 1/2W	R33, R41	4.7k
R5, R31, R36	1k	R22	1.5k	R34	680
R6, R24	270	R23	33	R35	100
R7, R21, R27	2.7k	R25	180	R37, R38	2k
R8	6.8k	R28, R39	10	R40	10k PC Pot

All resistors are 1/4 watt, unless noted. K = 1000, all pots are linear type, printed circuit top adjust.

Capacitors

C1, C2, C4, C19	.01 50 Vdc Min. Polystyrene
C30, C31	.01 50 Vdc Min. Polystyrene Radial
C3, C20	.005 16 Vdc Min. Polystyrene
C5, C7, C12-C14, C33-C35	.1uF 50 Vdc Monolythic
C9	25pF Variable "highQ" type
C15	820pF Silver Mica
C16	.001 250 Vdc Min. Polystyrene
C17, C23	1uF 50 Vdc Electrolytic
C18, C21, C22, C24	4.7uF 35 Vdc Electrolytic
C25, C32	10uF 16 Vdc Electrolytic
C26-C29, C36, C37	2.2uF 50 Vdc Electrolytic

Transistors, Diodes, Misc

Q1, Q4	J310	Q6	2N2102	HS1	Q7 Heatsink
Q2, Q3	2N2857	Q7	TIP31A	HS2	Q6 Heatsink
Q5, Q8, Q9	2N2907				
Q10, Q11	2N2222	Q12	LM7812CT		
MX1	SBL-3	D1	1N4001		
K1, K2	DPDT PC Relay	D2, D3	1N914		
Y1	3.4995 MHz Crystal		.005% Tolerance .32 pF load. HC-18/U type case.		
F1A	1 Amp fuse "fast acting"	F1B	Fuse holder		

Transformers, Chokes, Coils

L1, L2	27.5uH Amidon T-44-3	39 turns, #28 Enameled wire
L3	4.7uH Choke	
L4	100uH Choke	
L5	3.3uH Inductor	
L6	180uH Amidon FT-50-61	54 Turns, #28 Enameled wire

T1	55 Turns Primary, 16 Turns Secondary. Primary uses #28 Enameled Wire, Secondary uses #30 AWG Wire Wrap type wire wound evenly over primary. Use Amidon FT-50-75 Toroid.
T2	55 Turns Primary, 6 Turns Secondary. Primary uses #28 Enameled Wire, Secondary uses #30 AWG Wire Wrap type wire wound evenly over primary. Use Amidon FT-50-77 Toroid.
T3	50 Turns of #28 Enameled Wire, twisted pair aprox. 4 or 5 twists per inch. Wind tightly and evenly over an Amidon T-68-3 Toroid.

PARTS ACQUISITION

K1, K2	Digikey Z304ND	MX1	Minicircuits SBL-3
L4	Digikey M7101	L5	Digikey M8019
Y1	Jan Crystals	R30	Digikey 1.0W-1
R32	Digikey SOG23	R40	Digikey SOG14
HS1	Digikey HS115	HS2	Digikey HS101
C17, C23	Digikey P6749	C18, C21,	
C25, C32	Digikey P6746	C22, C24	Digikey P6752
C26-C29, C36	Digikey P6750	L3	Digikey M8021
F1A	Digikey F115-ND	F1B	Digikey F002-ND
C1, C2,		C30, C31	Mouser 23PW310
C4, C19	Mouser 23PS310	C3, C20	Mouser 23PS250
C16	Mouser 23PS212	C15	Mouser ME232-1900-820
C9	Mouser 530-189-0509-5		

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12033 Otsego St.
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(818)760-4429

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2400 Crystal Drive
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Experimenter Band Beacon List

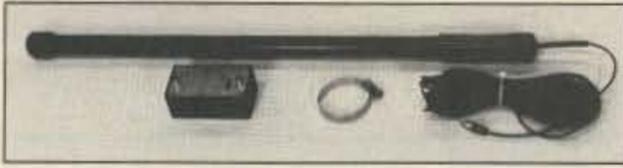
FREQUENCY (kHz)	CALL	QTH	SKED	FREQUENCY (kHz)	CALL	QTH	SKED	FREQUENCY (kHz)	CALL	QTH	SKED	FREQUENCY (kHz)	CALL	QTH	SKED	
160.025	MAX	Wheatland WY	24 hrs/7 days	176.46	6RDJ	So. Whitley IN (EN71)	Weekends	184.320X	JR	West Hartford CT (FN31)	24 hrs/7 days, remote beacon	187.50	RM	Duluth MN (FM29)	2200-2400 GMT	
160.800XX	NH	Monroeville NJ (FM29)	Occ. Secondary beacon, see MOO	176.925	HB	Hamden CT (FN31)	24 hrs/7 days	184.390	HO	near Hilo HI	Off air	187.56X	JM	Broken Arrow OK	Off for summer	
163.93	AVV	Independence OR	Off air	177.00K	KJ	Chicago IL (EN61)	24 hrs/7 days	184.500	JKS	San Anselmo CA	24 hrs/7 days, BPSK/ASCII	187.594XX	SM	San Jose CA (CM97)	24 hrs/7 days	
163.930X	MSG	Paso Robles CA	Intermittent	177.2	ABK	Akron NY	Weekends	184.599	Q	Boulder CO	24 hrs/7 days	187.700SK	SD	East Haven CT (FN31)	Occ.	
164.44	D	Des Moines IA (EN31)	24 hrs/7 days	177.26	NVA	Pahrump NV	Off for summer	184.750XX	1SNN	Waltham MA (FN42)	1100-0100 WD/ 1100-2400	187.845XX	XY	Kearny NJ (FN20)	24 hrs/7 days	
169.863XX	1SUN	Durant OK (DM23)	24 hrs/7 days	177.506	UCP	Saratoga CA (CM97)	1400 to 1700 GMT daily	184.795XX	MEL	San Jose CA (CM97)	24 hrs/7 days	187.900XX	MOO	Monroeville NJ (FM29)	Weekends	
171.000XX	CB	Portsmouth NH (FN43)	24 hrs/7 days	177.520	DW	Middlesboro MA (FN41)	Weekends	185.00	ZYK	Redway CA	24 hrs/7 days	188.470X	9HDQ	Daleville IN (EN70)	24 hrs/7 days (back on air)	
172.38V	1LM	Plymouth MA (FN41)	24 hrs/7 days	177.750S	CT	Flagstaff AZ (DM45)	24 hrs/7 days BPSK/ASCII	185.00X	ZYK	Redway CA	24 hrs/7 days	188.700SK	WI	Owings MD (FM18)	24 hrs/7 days	
174.39	SUK	Eldorado Hills CA	24 hrs/7 days	178.0+1V	N	Maiden NC (call change)	24 hrs/7 days, 19 N's/min.	185.410XX	XMGR	Cleveland TN (EM75)	24 hrs/7 days	189.00	JUG	Cincinnati OH (EM79)	24 hrs/7 days	
174.600X	8TXT	Sandusky OH (EN81)	BR	178.977	TIM	Pitman NJ	Occ.	185.49	AZ	Tucson AZ	24 hrs/7 days	189.210XX	QYV	Donora PA (FN00)	24 hrs/7 days	
174.527	3KLR	Glenside PA (FN20)	24 hrs/7 days	179.000	MPM	Salt Lake City UT	24 hrs/7 days, BPSK/ASCII for 5 mins., CW 5 mins., alternately.	185.50	UM	Rehoboth MA (FN41)	Occ.	189.360XX	TH	Colts Neck NJ (FN20)	24 hrs/7 days	
174.85V	7FS	Montesano WA	On air soon	180.030	NTD	Oakland FL (EI98)	24 hrs/7 days	186.404XX	HRM	Oakland NJ (FN21)	24 hrs/7 days	189.56VK	1RB	Foxboro MA (FN42)	Off for summer	
175.00X	HG	Toledo OH (EN81)	Nights	181.168	IZJ	San Gabriel CA	Daily, silent 0700-1100 GMT	186.900XX	DBQ	Ft. Washington PA (FN20)	TO	189.700XX				
175.350XX	GEO	Wintergarden FL (EL98)	24 hrs/7 days	182.00X	ZZZ	Loretto TN (EM65)	24 hrs/7 days	187.000XX	KP	Murrysville PA (FN00)	BR and occ. Weekends	189.729XX	GHK	Palm Bay FL (EL98)	24 hrs/7 days	
175.388XX	KRY	Chardon OH (EN91)	Off for summer	182.270XX	G	Palo Alto CA (CM97)	TO	187.006VK	OWR	Paso Robles CA	On air soon	189.729XX	8LXJ	Morrow OH (EM79)	Off for summer	
175.472	MUK	San Luis Obispo CA	TO	182.62	FPV	Granada Hills CA	24 hrs/7 days	187.04	TUG	Bel Air MD	Occ.	189.800XX	NTS	Mercury NV	24 hrs/7 days	
175.70	ARK	Leslie AR	Off for summer	182.900XX	Z2	San Simeon CA	24 hrs/7 days	187.263	Z2	San Simeon CA	Weekend Days. This is the SKY station of Z2, horizontal polarization	189.834X	ABC	Hilton Head Islands SC (EM92)	24 hrs/7 days	
175.703	FAW	Orem UT	24 hrs/7 days	183.180XX	PRK	Saratoga CA (CM97)	24 hrs/7 days	187.30	UPN	Cincinnati OH (EN79)	Off for summer					
175.85	R	Utica MI (EN82)	24 hrs/7 days	183.65	PLI	Toluca Lake CA	24 hrs/7 days	187.50	J	Los Angeles CA	24 hrs/7 days					
176.000X	HDO	Morro Bay CA (CM95)	24 hrs/7 days BPSK/ASCII	184.016	EK	Sunnyvale CA (CM97)	24 hrs/7 days	187.50	KEN	Pt. Pleasant Beach NJ	1000-1230 and					
176.263	CO	Glenwood Springs CO (DM69)	24 hrs/7 days													
176.30	BA	Lancaster IL (EM68)	On air soon													

NOTES: Column 1—Frequency, Column 2—Identification, Column 3—Location, Column 4—Grid, Column 5—Operation schedule. X—Crystal control, S—Synthesized, V—VFO, frequency may vary. K—Programmable Keyer, BR—By request, Occ—Occasionally, TO—Temporarily off air. Thanks to Brice Anderson's On the Air.

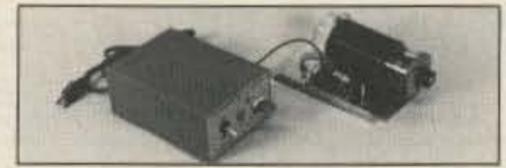
1750m

THE EXPERIMENTERS BAND

Here's How to Dabble on 160—190 kHz



by Ken Cornell W2IMB



Tired of the 20m SSB crowd? Hate contest weekends? Have a hankering to build a simple transmitter? Want a real challenge? C'mon down to the low frequency (LF) band and join the fun, and you can leave your ham license behind!

It's a great big world out there! All hams know about Part 97 of FCC Rules and Regulations, which governs licensed amateur operations. Most have yet to discover the great fun that Part 15 allows, although some may recognize this section covers the use of nonlicensed transmitting devices.

In Subpart D, Section 15.112, they permit the operation of a radio transmitter as follows:

- (a) The power input to the final radio frequency stage (exclusive of filament or heater power) does not exceed one watt.
- (b) All emissions below 160 kHz or above 190 kHz are suppressed 20 dB below the unmodulated carrier.
- (c) The total length of the transmission line and antenna does not exceed 15 meters.

Any type of transmission mode can be used with the exception of Class B (damped waves).

Let me tell you, 1750m can rejuvenate that radio experimenter's spirit so many hams find fading these days. QRP operations at 160 kHz are like no other ham experience. It's a challenge, alright, and a heck of a lot of fun.

Who Uses 1750m?

The 1750m band was a "sleeper" until the late 1960s when small groups of experimenters, mainly hams, began to operate on it. They call themselves "Lowfers," short for Low Frequency Experimental Radio Station. Lowfers make up their own calls. The rules allow use of any callsign unless it belongs to an authorized station, including those in the amateur radio service.

Initially, small groups clustered in the Northeast and on the West Coast. They ran beacons and used the 160m and 75m phone bands as back-up communications. Contacts over more than 100 mile were considered real DX! Vast improvements since then in antennas, transmitting, and especially receiving techniques, led to reception reports over 2000 miles away.

Make no mistake, 1750m presents some serious challenges for the experimenter. These require strategy to overcome, and

those with successful strategies reap the rewards of true radio pioneers. Take a look at some of the common problems of LF and how to get around them.

The high noise level in LF is the worst problem. Unfortunately, most of this noise is man-made. Appliances, light dimmers, and power lines are common sources. Some of the noise comes in on power line feeds into the home.

Assuming a good, efficient receiver, first sort out all the possible noise sources within the home. A good power mains filter will help reduce imported noise. Running the receiver on battery power is better still. Fluorescent lights are noisy and can cause serious trouble if located in the shack. Schedule appliance use as much as possible around your operating schedule.

About Antennas & Transmitter

Avoid automatically slinging up the highest and longest wire antenna possible. Depending on the location, it may be a terrific noise collector! Try, instead, to achieve the best signal-to-noise ratio (S/N) possible.

An active antenna may help for a noisy location. This is a relatively short whip mounted on a weathertight housing that contains a broadband preamplifier. Use coax to connect it to the receiver and power source through an isolating network. This type of antenna is small and easy to mount and can be moved around the average home to find the best S/N location.

Another popular antenna is the loop type. They come in various designs, but they all have the classic "figure 8" pattern. Use the nulls off the sides to attenuate a noise source.

The transmitting antenna should be vertical and located in as clear an area as possible to avoid RF-absorbing structures and trees. Use a good ground system. Lay as many radials as possible on the ground around the antenna.

Try to get an antenna configuration that fits into an imaginary cylinder 15 meters high by 15 meters in diameter, to take maximum advantage of the legal size. The transmitter should be within, or at the periphery, of the circle. Despite the low power, high RF voltage will be on the antenna, so all supports should be extremely well insulated.

Practically all Lowfers today use solid-state transmitters. Most of the popular

designs use high frequency crystals with ICs that divide the frequency to come out at the desired frequency. Most use power FETs, such as the IRF series or the VN types, as a final amplifier. When using ICs, the only coil normally required is the antenna loading/coupling coil. This coil should have a high "Q." Most Lowfers use Litz wire for the coil.

Information Sources

Palomar Engineers (Box 455, Escondido, CA 92025) market a number of receiving accessories for LF, including loop antennas and a VLF converter to receive 10–500 kHz on a standard shortwave receiver. An excellent source of transmitting and receiving hardware is LF Engineering (17 Jeffry Road, East Haven, CT 06512) founded by Sal DeFrancesco K1RGO. LF Engineering publishes a sizeable catalog of receive converters, preamplifiers, antennas, a transmitter, and miscellaneous accessories. Their catalog also provides some useful engineering information on operating in the 1750m band.

The Longwave Club of America publishes *The Lowdown*, essential reading for Lowfers. The monthly bulletin shares readers' experiences, prints projects, and covers LF propagation.

It is available for \$12 per year from LWCA, 45 Wildflower Road, Levittown, PA 19057.

On the Air is published by Brice Anderson and is a useful source for a list of active Lowfers and their operating schedules. Write to Brice at Box 14, Lancaster, PA 62855. Hal Murken (19 Hobby Lane, Oakland, NJ 07436) publishes *The Lowfer Letter*, an excellent forum for LF DXers. The *Western Update* lists beacons and includes construction projects and other information of interest to Lowfers. Write to Jim Ericson, 226 Charles Street, Sunnyvale, CA 94086. Send business-sized 22 cent SASEs for these publications.

There are more than 100 known Lowfers—plenty of room for more! Here's a chance to really have some fun running QRP in an area where radio started, and it doesn't even require a license! For the circuit builder, antenna experimenter, or just the serious listener, the challenge of "lowfing" could really add the spark of inspiration that's missing from a lot of hams' hobby lives. Give it a shot. See you down the log! **73**