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Announcing the Yingling ET-1

A new QRP classic.

Did you ever want to see what you could do with just a few parts? Well, here's one experiment you might find interesting. I decided to see what I could do toward making a small transceiver that would operate from the power of one "D"-cell flashlight battery. This article describes how successful I was in reaching that goal.

My approach started out with the following objectives: (1) Use one transistor and switch it between the receiver and transmitter sections of the transceiver. (2) Design both to operate from 9 volts DC. (3) Find a good switch and mount the transistor directly onto its common terminals. (4) Put the receiver components on one printed circuit card and the transmitter components on another printed circuit card. (5) Wire everything up with cables and connectors so that if you wanted to change either circuit, you could just plug in a new circuit card. (6) Since a transceiver is defined as a transmitter and a receiver that share common parts, I will claim that what I have built can be called a "transceiver," not a "trans-receiver." Hi. And (7) to *minimize* the parts count and complexity, design the ET-1 to be a one-band, 40 meter rig.

The overall approach is illustrated in **Fig. 1**.

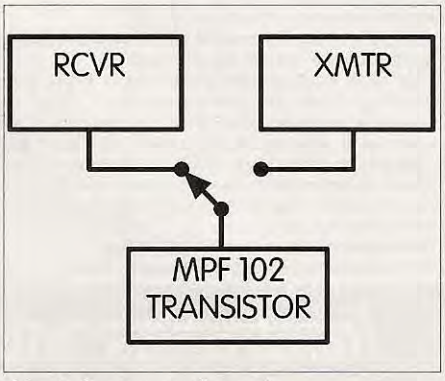

Fig. 1. *System configuration.*

Try it yourself

This project is easy to build. You don't need any special printed circuit cards, because for 40 meters the layout is not overly critical. You can use "ugly" construction if you desire. I chose to use pieces of the Radio Shack project card No. 276-150A because it makes everything a little neater. (A lot neater than my usual work!)

You can even build this project on a "pine board" if you like, and it will work fine on 40 meters.

Design source

The circuits described come from everywhere! Of course, as the project developed, I had to make my own engineering changes to make everything work to my satisfaction.

The receiver circuit is a regenerative detector (regen). The regen approach provides the best trade-off when considering parts count, sensitivity, and cost. It will receive both CW and SSB, and it will compete in sensitivity with your main rig. Sounds impossible, but it is true. I have heard weak signals on my main rig and have then verified that I can also hear them on the regen.

In fact, you can tune in a signal on both sides of "null" or "zero beat" on the regen, thereby getting two for the price of one! Of course, you should use high impedance earphones for this regen, since there is only one transistor in the circuit.

The transmitter circuit is essentially a Pierce oscillator. This circuit is made up of ideas given in the *ARRL Handbook,* the *QRP Notebook* (W1FB), and the *SPRAT* magazine No. 69 (GM3OXX).

The resulting circuit for the ET-1 has the following parts count: receiver, 8; transmitter, 6; common transistor, 1; total, 15.

The antenna connection for the ET-1 is a coaxial cable connecting directly to my normal 40 meter antenna system. My antenna is a centerfed Zepp with open wire feeders and a home-brew tuner.

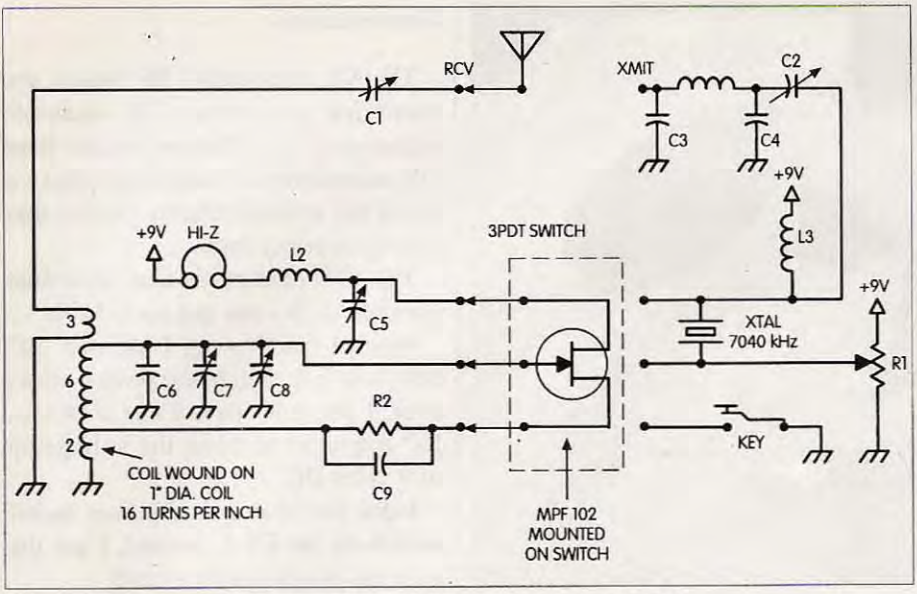

Fig. 2. The electrical schematic for the ET-1. Unlabeled coil is L1.

Detailed electrical circuit

Fig. 2 shows the electrical schematic of the ET-1. Please note that the MPF-102 transistor (Radio Shack, #276-2062) is mounted directly on the triple pole double throw (3PDT) common switch terminals. It is used for both the receiver and the transmitter sections. I selected the FET transistor because it works good in the regen. (See **Table 1** for the parts list of the **Fig. 2** schematic.)

Receiver notes

For the 40 meter band, tuning is set with the following: The 320 pF cap gets you to the 7.0 MHz range. The 6–70 pF cap lets you home in on the frequency of interest—in my case, 7040 kHz.

The small variable cap (one plate) lets you tune around 7040 kHz as a bandspread control.

The 5–50 pF variable cap provides feedback to the oscillator for sensitivity control. Adjust it until the regen is on the verge of oscillation. Any "squeal" indicates that you have gone too far!

This circuit works well and the layout for 40 meters is not critical, but try to keep your wires short.

You will hear a signal on both sides of "zero beat," allowing you to hear each signal "twice" on your dial, unlike your superheterodyne.

The 9-component (including the transistor) regen receiver will bring in signals comparable to those received by your expensive receiver. But, the selectivity will not be as good.

The downside of this story is that it is so sensitive that it can be easily overloaded by a strong signal or a nearby station. (I didn't care, so I did not try to put in any attenuation or volume control.) Also, at night with a contest on, the regen is pretty much unusable. (If you like, you can get some degree of attenuation by putting a variable resistor in series with the 9 volts supplied to the regen.)

With the limited frequency range that I wanted (7040 ± 15 kHz), once

C1, 2, 7	6–70 pF trimmer (Jim-Pak TC6-70)
C3	820 pF
C4	560 pF
C5	5–50 pF variable (regen control)
C6	320 pF (band select)
C8	Tiny one plate variable (band spread)
C9	0.1 µF
L1	T50-2 core with 14 turns
L2, 3	100 µH inductor
Q1	MPF102 FET (Radio Shack)
R1	50k pot
R2	22k

***Table 1.** Parts list.*

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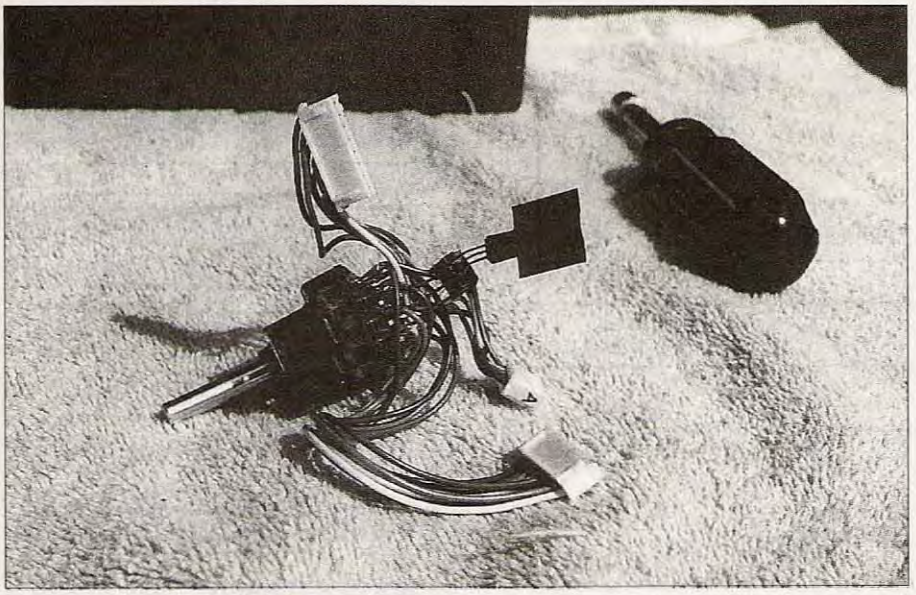

Photo A. *The switch after the transistor has been mounted, and the cables that are used to connect to the receiver and transmitter cards. A third cable is used to connect the switch to the external plugs and jacks, which include the antenna connector, the headphone jack, the key jack, and the power plug. When assembled, the switch is installed on the front panel so that all "switchover" is accomplished with one throw of the switch.*

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you set the regen control, you may not need to adjust it again.

Transmitter notes

Adjust the 50k pot and the 6–70 pF trimmer for maximum output of the transmitter into a 50 ohm resistor.

The transmitter puts out approximately 20 milliwatts. Power is calculated as follows:

1. (Peak to Peak volts)/2 x 0.707 = volts rms. For ET-1: 3 volts/2 x 0.707 = 1.06 Vrms.
2. (Vrms squared)/50 ohms = Power in watts. For ET-1: (1.06 x 1.06)/50 = 0.022 W = 22 mW.

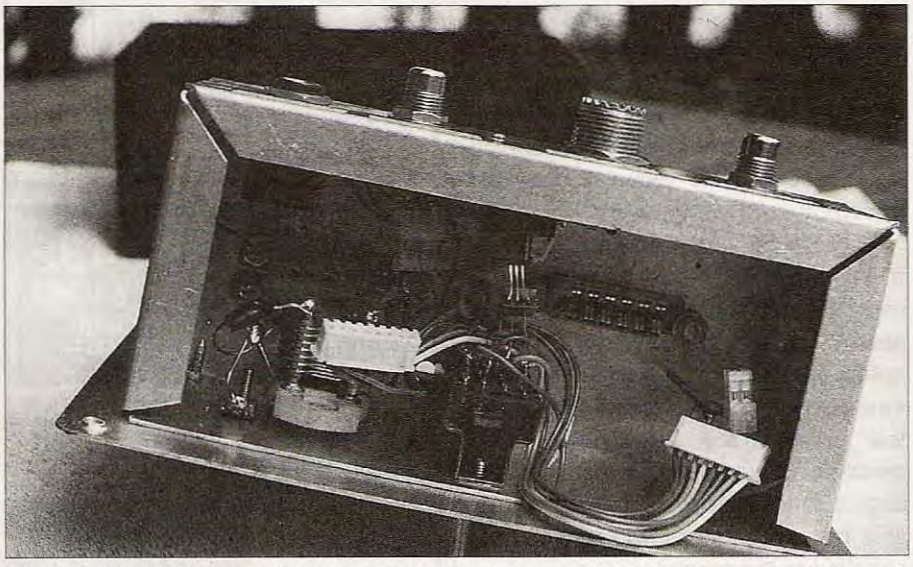

Photo B. *The inside of the ET-1 unit with the switch installed but without any of the cards installed. I used pieces of an old card connector to provide mounting for my cards. The connectors have pin connections on them, but they are not used for electrical connections. I used them because they provided a nice springlike pressure slot to hold the cards in position.*

General notes

The 100 microhenry RF chokes are somewhat noncritical. Try whatever values you have that are greater than 100 microhenrys. I happened to have a lot of the 100 microhenry chokes that cost me a penny each.

The 50 k-ohm pot is also somewhat noncritical. Try any pot up to 500k.

When I run this rig, I use one "D" cell from a flashlight for power. However, I cheat because I use a DC-to-DC converter to boost the voltage up to 9 volts DC.

I did not even put a power on/off switch on the ET-1; instead, I use the external power supply switch.

I did not put a sidetone monitor on the ET-1. I just use the sidetone from my keyer. There is plenty of space for later addition of a sidetone to the transmitter card if so desired in the future.

Detailed mechanical design

With the information already supplied, you should be able to construct your own ET-1 using your own mechanical design. However, you might be interested in what I ended up with when I started looking through my junk box for the various parts.

Almost immediately, I found "The SWITCH!!" I ran across a brand-new eight-pole double-throw switch that caused me to immediately go off on a tangent! I decided to switch everything at once instead of just the transistor.

I switched the transistor, the antenna, the 9 volt power, the headphones, the key, and I even switched the ground. However, I left the **Fig. 2** schematic with the 3PDT switch for simplicity. You can adjust according to your junk box.

Initial setup

The initial setup consists of connecting the ET-1 to a 50 ohm dummy load. Using an oscilloscope or an RF probe plus your multimeter, adjust the transmitter for maximum output. Adjust the 50 k-ohm pot first and then adjust the C2 trimmer cap. No adjustments to these controls will be needed again.

Set the receiver frequency to 7040 kHz, by adjusting the variable trimmer

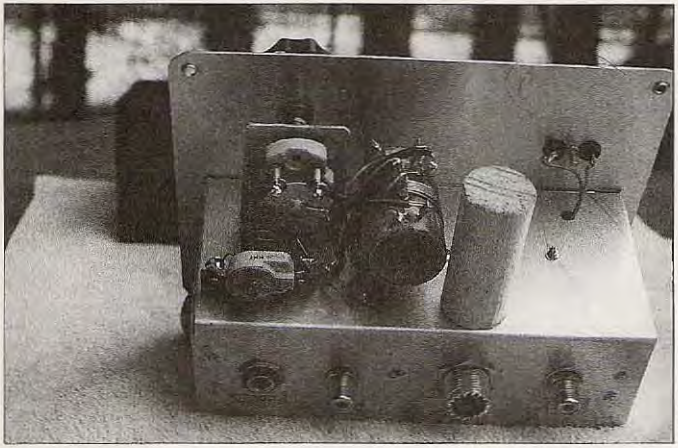

Photo C. *The top deck of the chassis, showing the tuning coil with its lumped capacitors and the one plate, variable bandspread, capacitor. The crystal socket cable plugs into the transmitter card when installed. If you look closely, you may see that I used parts from my junk box for the capacitors, but the parts that I show in the parts list, the JIM PAK TC6-70, etc., will work just as well.*

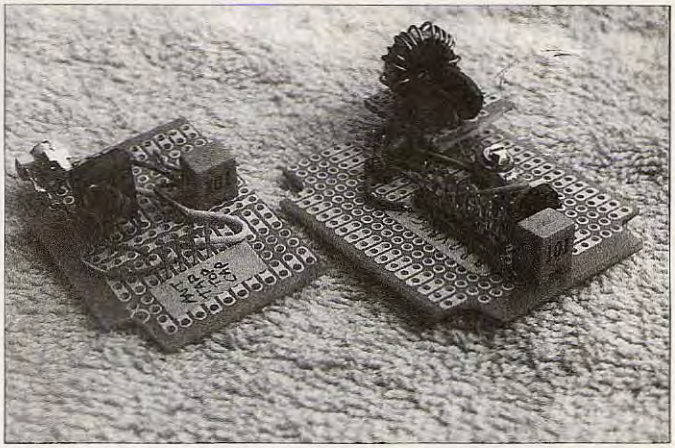

Photo D. *The two cards. The receiver card is on the left and the transmitter card is on the right. If you look carefully, you can see the pin headers soldered onto the cards for connection to the cable connectors. (If you consider the space that I used to mount these 15 components, this has got to be the world's least efficient packaging scheme!) Hi.*

on the top deck of the chassis. You can use a grid dip oscillator or a frequency meter, or you can even listen to the receiver oscillator on your main receiver. Next, adjust the "Regen control" on the receiver until just on the verge of a "squeal." Then adjust the antenna trimmer cap (C1) for best reception. One more tweak of the "Regen control" may be required. After that no further adjustments of these controls will be needed.

On-the-air performance

It is hard to believe how well the ET-1 performs on the air. I have had no reports of chirps or clicks, and the frequency is stable as a rock since it is crystal-controlled. My crystal is listed as 7040 kHz, but since I did nothing to "pull" it to that frequency, it ended up transmitting on 7040.7 kHz! Since I am "rockbound" I usually call a lot of CQs or wait around until someone calls on my frequency.

All of my contacts were made using a 1.5 VDC "D" cell connected to a DC-to-DC converter that I got from the Electronic Gold Mine (Part No. G6344), which boosts it up to 9 VDC. You may want to use a 9 volt battery instead.

Most of the contacts that I have made were the result of my calling CQ. This speaks well for a rig that only puts out 20 milliwatts. I estimate that 80% of the contacts were made by calling CQ.

All of the QSOs were made using the regen for reception. The regen is somewhat broad and other signals can always be heard, but it gives good performance. In fact, if there is

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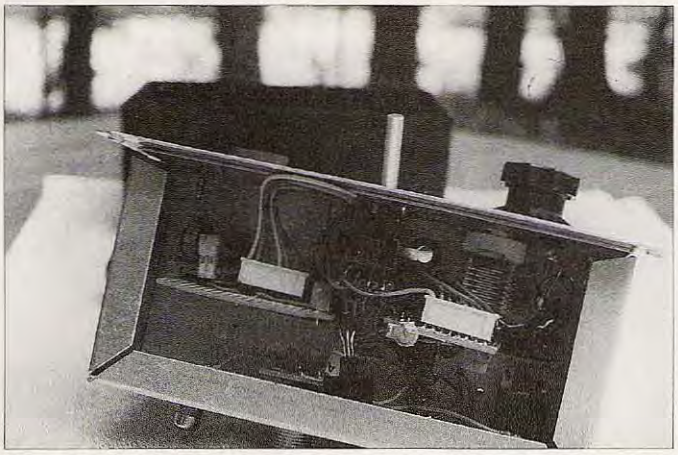

Photo E. *The underside of the chassis, with the switch and the cards installed. One receiver trimmer capacitor is available at the top, but all other trimmers and pots are adjusted by lifting the card up somewhat so that you can reach them without removing the cables. (Doing it over again, I would put all those adjustments at the top of the card.)*

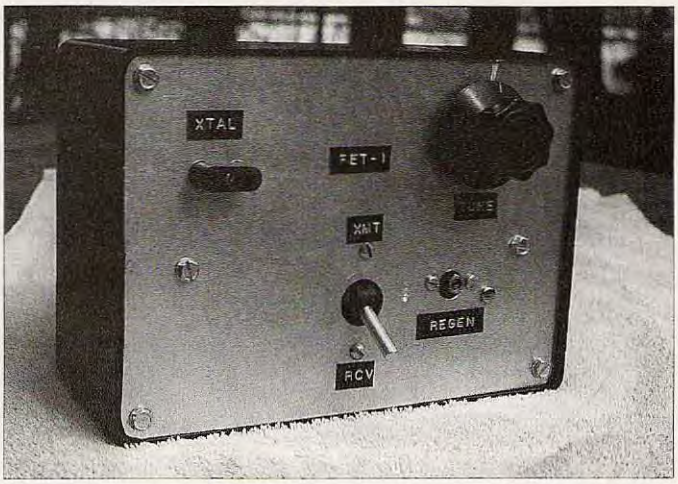

Photo F. *The front panel. I did not have a nice regen control capacitor, so I had to settle for one with a screwdriver slot. But, as I said in the text, once it is adjusted for the small bandspread of the ET-1, it requires little future adjustment.*

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interference, you can often tune to the other side of "zero beat" to get rid of it!

Using my centerfed Zepp antenna tuned to forty meters, I have worked 18 states and Canada. This was over a 60-day period and I averaged about 1 QSO a day. However, in my defense, I would give the following as a reason for the poor showing: After every QSO, I would sit back, pat myself on the back, and marvel for a long time, reveling in the glory of making a QSO with such a mini rig. However, the most credit should be given to those on the other end who were willing to put up with such a weak-signal station.

Most of the QSOs were 1/2 to 3/4 of an hour duration, with solid copy on both ends. Only once or twice was a QSO terminated for poor copy on the other end. My reports ranged from RST 339 to 569. In general, my best luck was making QSOs in the morning and afternoon hours, probably because of lower noise levels on forty meters during those times.

My best DX was with Art WA4HXS in Jonesboro TN, a distance of approximately 550 miles (as the crow flies), or 27,000 miles per watt!

States worked were: CT, DE, KY, ME, MA, MD, MI, NC, NH, NJ, NY, OH, PA, RI, TN, VA, VT, WI, plus ONT and QUE Canada.

During most of my QSOs, when I commented that my transceiver consisted of only 15 parts, that it was running only 20 mW, and that the power was coming from a "D" cell flashlight battery, I expected some statements of amazement. Instead, I mostly got a big "ho-hum"! So I guess that it may be true about ham radio operators being mostly "appliance operators." However, I would like to give a special thanks to Lenny W2BVH, who gave me a "Holy Cow!" and "Congrats!" Hi. 73

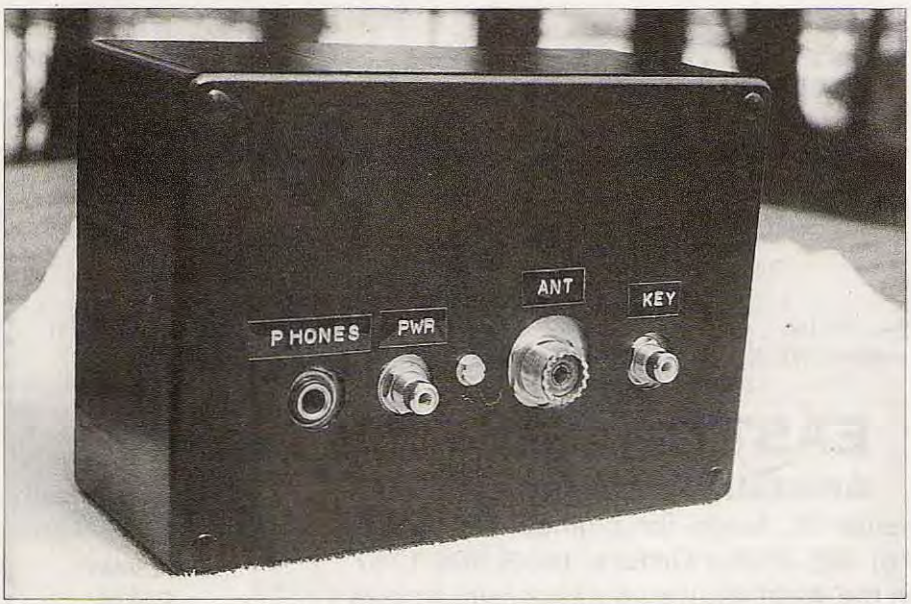

Photo G. *The rear panel. I should note that the phone jack shown is insulated so that it doesn't provide any connection to the chassis since the receiver 9 VDC power comes through this headphone jack.*