

# The Rockless, a VFO Controlled Low Power Transceiver

*Make a version of this transceiver that lets you move around the band.*

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When I first read Dave Benson's article "The Rock-Mite — A Simple Transceiver for 40 or 20 Meters," I decided it was my kind of low power (QRP) rig.<sup>1</sup> It was small, had straightforward circuitry and some nifty features, including a built-in keyer — all for a reasonable price. So for the last 5 years I have had a barrel of fun and made many contacts with my 40 and 20 meter versions of this kit from Dave's Small Wonders Lab.<sup>2</sup>

It really is a unique and clever design. In my opinion, small rigs like this provide the real thrill of QRP operating. Sure, I can crank my commercially built 100 W home station down to 5 W and work anyone I hear and call it a QRP contact. But it's not the same enjoyment as working them from a collection of small parts you put together in some clever housing. I am sure there are many QRP operators who share the same opinion.

## Almost Perfect

There was, however, one enhancement that I always wanted to try — to see if this basic CW transceiver could be modified to work with a variable frequency oscillator (VFO). As provided, the Rock-Mite transmits on a single frequency controlled by a crystal (the "rock"). It would be a major improvement, in my opinion, to be able to tune across the band and answer CQ calls beyond the rock bound QRP meeting spot. Well, I dreamed about it long enough, and finally set out on a long trail resulting in this little rig very similar to the Rock-Mite circuit, but one with an added VFO board. Since it has no crystals I call it the *Rockless*.

## The Two Packages

This article describes two packaging ideas for my Rockless circuitry. One version completely fits in the popular QRP housing, an Altoids tin. This miniature version incorporates a 9 mm square, single turn potentiometer

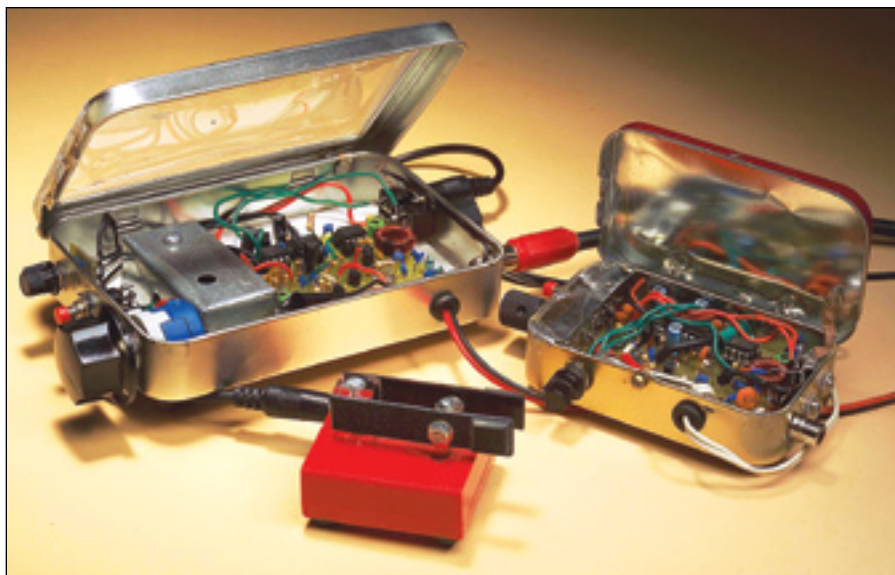


Figure 1 — Both versions of completed Rockless transceivers.

for VFO frequency control using a varactor variable capacitance diode. The second and slightly larger Rockless package uses a 10 turn potentiometer for enhanced band spread tuning. The 10 turn tuning potentiometer version just won't fit in an Altoids tin sized housing. I found a slightly larger light gauge box for the 10 turn version that measures about  $3\frac{1}{2} \times 5\frac{3}{8} \times 1$  inches. See Figure 1.

Both versions incorporate the same circuitry and boards. My complete Rockless transceiver circuitry consists of two printed circuit boards: one for the VFO, referred to as the VFO board — the other for the rest of the transmitter and receiver circuitry, called the main board. This arrangement provides for flexibility in packaging and, more importantly, allows the VFO board to be easily shielded. If you are a QRP enthusiast, or Rock-Mite user, read on — this may be something you want to build.

## The VFO

The VFO circuit uses a 2N4401 transis-

tor and is based on a circuit shown as the "Practical 40 Meter VFO" found in an old copy of *W1FB's QRP Notebook*.<sup>3</sup> I modified this circuit for varactor tuning using a 10 k $\Omega$  potentiometer. The schematic of either version of the VFO board is shown in Figure 2.

The oscillator inductance (L1) is a shielded miniature 8.2  $\mu$ H coil. The lower frequency of the tuning range is adjusted by trimmer capacitor C7. The tuning range is set by selection of R3. The oscillator can be set to tune approximately 30, 50, 70 or 100 kHz of the 40 meter band, depending on the value of R3, as shown in the schematic (Figure 2).

So with your lower tuning set to say 7025 kHz you can tune from about 7025 to 7075 kHz when the value of R3 is 22 k $\Omega$ . That covers the QRP hot spots on the band and lets you move around over 50 kHz of the band. This seems like a real luxury after being rockbound at a single frequency. There is a give and take between R3 and the setting of the trimmer to get to the lowest frequency you want in your tuning range. Smaller values of

<sup>1</sup>Notes appear on page 8.

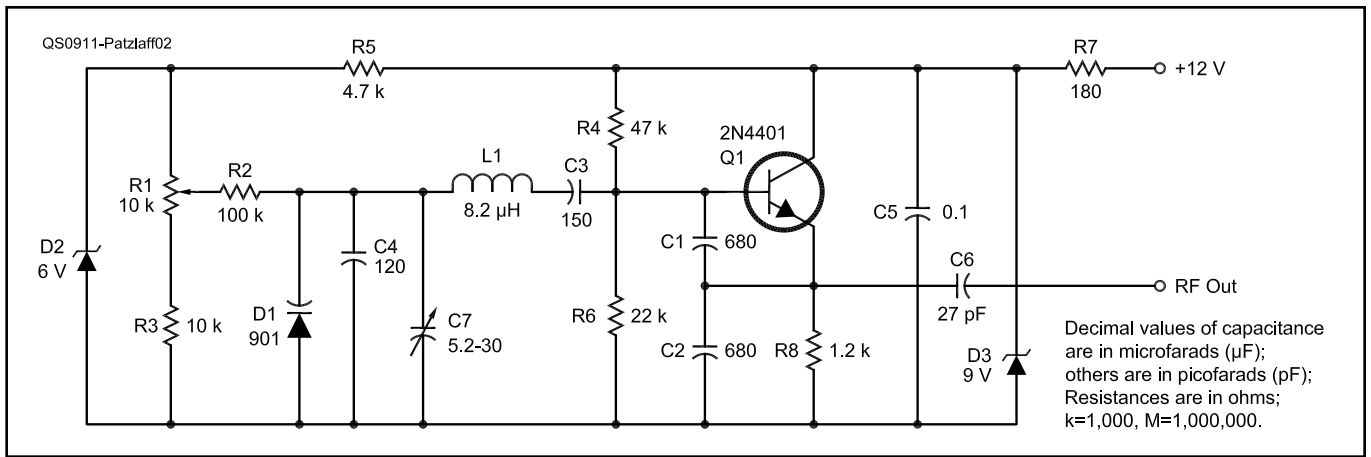


Figure 2 — Schematic of either version of the VFO board. R1 is the tuning potentiometer with parts shown for both the single and 10 turn versions, as described in the text. Only one is required. The value of R3 sets the tuning range. For R3 at 10 kΩ, the range is about 100 kHz, at 15 kΩ about 75 kHz, at 22 kΩ about 50 kHz and at 30 kΩ about 30 kHz. Digi-Key parts are available at [www.digikey.com](http://www.digikey.com).

- C1, C2 — 680 pF ceramic COG capacitor (Digi-Key P4904-ND).
- C3 — 150 pF ceramic COG capacitor (Digi-Key 495-1027-1-ND).
- C4 — 120 pF ceramic COG capacitor (Digi-Key 495-1483-1-ND).
- C5 — 0.1 μF ceramic XTR capacitor (Digi-Key 495-3350-1-ND).
- C6 — 27 pF ceramic COG capacitor (Digi-Key P4842-ND).
- C7 — 5.2-30 pF variable capacitor trimmer (Digi-Key 490-1960-ND).
- D1 — Type 901 varicap diode (Digi-Key MV2090S-ND).
- D2 — 6 V Zener diode

- (Digi-Key 1N5233BDICT-ND).
- D3 — 9 V Zener diode (Digi-Key 1N5239BDICT).
- L1 — 8.2 μH shielded inductor (Digi-Key DN41822-ND).
- Q1 — 2N4401 NPN transistor (Digi-Key 2N4401-ND).
- R1 — 10 kΩ, single turn, 9 mm, potentiometer (Digi-Key 3310Y-001-103L), or:  
R1 — 10 kΩ, 10 turn, potentiometer, optional, see text (Digi-Key 3590S-2-103I-ND).
- R2 — 100 kΩ ¼ W resistor (Digi-Key 100KQBK-ND).

- R3 — See text, ¼ W resistor.
- R4 — 47 kΩ, ¼ W resistor (Digi-Key 47KQBK-ND).
- R5 — 4.7 kΩ, ¼ W resistor (Digi-Key 10kQBK-ND).
- R6 — 22 kΩ, ¼ W resistor (Digi-Key 22KQBK-ND).
- R7 — 180 Ω, ¼ W resistor (Digi-Key 180QBK-ND).
- R8 — 1.2 kΩ, ¼ W resistor (Digi-Key 1.2KQBK-ND).
- Tuning knob — ½ inch shaft (Digi-Key 226-4120-ND).

Figure 3 — Photograph of the completely wired oscillator board ready for mounting in an Altoids tin.

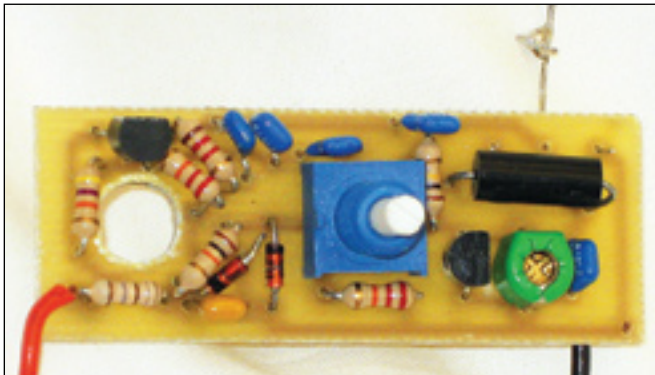
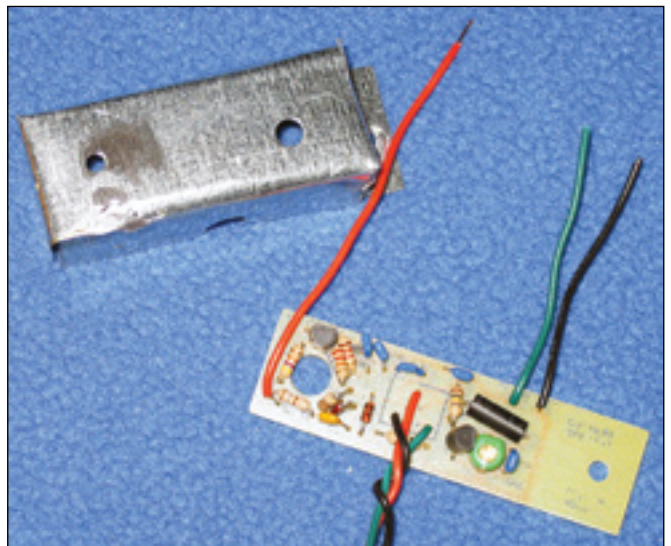


Figure 4 — Oscillator wired and with leads for the 10 turn tuning control and the fabricated oscillator shield of Figure 5.



R3 will let you tune lower in the band without the need to change the value of any of the oscillator tuning capacitors. My intent was to keep the tuning in the linear portion of the MV 209 Epicap diode's tuning range.

#### For Altoid Tin Packaging

I use a value of 22 kΩ for R3 in my miniature Rockless in the Altoids tin to tune about 50 kHz of the 40 meter band. By limiting the overall tuning range, the tuning "feel" is slightly delicate, but reasonable with the

single turn 9 mm square potentiometer used in the oscillator for an Altoids tin housing. In this package the VFO Circuit Board measures 19 × 51 mm.

Figure 3 is a photograph of the completely wired oscillator board ready for mounting in an Altoids tin. The VFO circuit board is mounted vertically, within the front ½ inch or so of an Altoids can housing. It mounts using the mounting hardware for the single turn miniature tuning potentiometer mounted on

the oscillator board.

The VFO board is further mechanically stabilized by allowing the code speed changing switch to pass through a hole in the VFO circuit board. A piece of scrap Altoid tin metal is soldered over the oscillator board to shield it on the top and stabilize it from "oil can" type movements of the housing lid. I found it a good practice to put a screw in the lid to hold it securely after the entire rig is wired, tested and working.

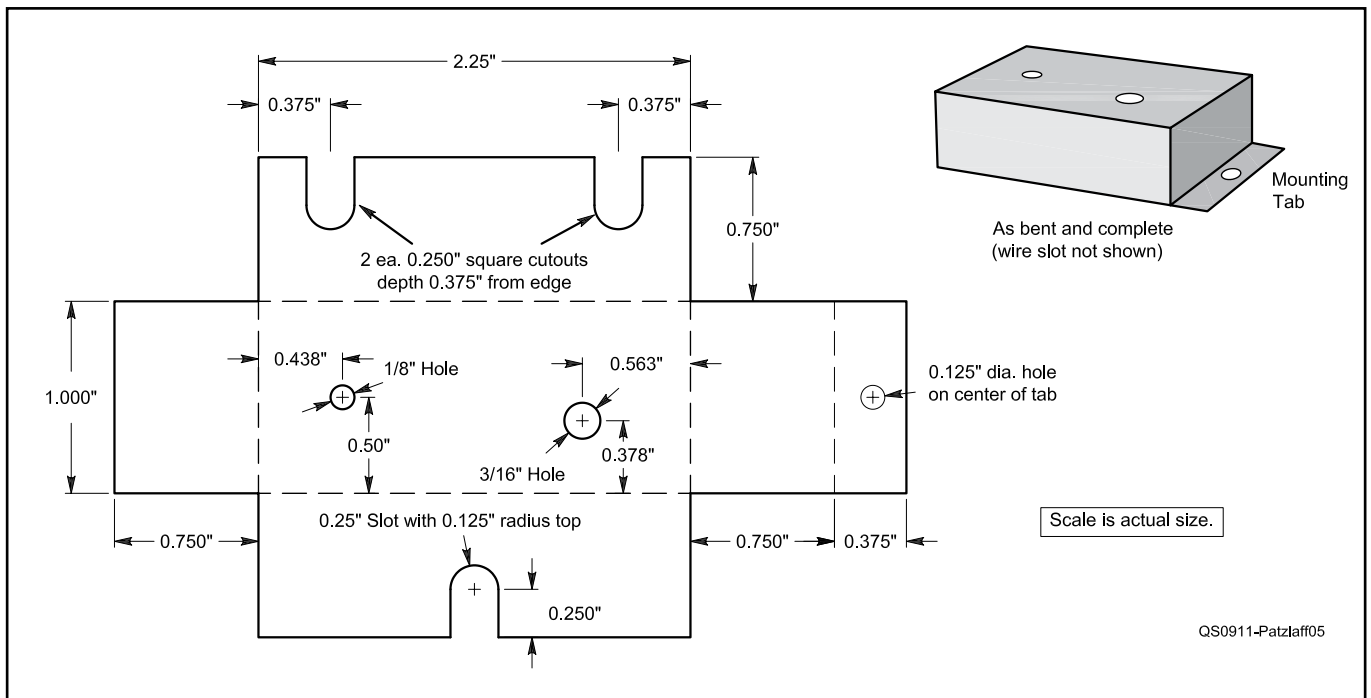


Figure 5 — Fabrication drawing of the oscillator shield.

### Oscillator with 10 Turn Tuning Potentiometer

The circuitry of the VFO is the same except wire leads mount in the holes for the 9 mm control and extend to where you want to mount the 10 turn tuning potentiometer in your housing. That's the beauty of the varactor tuning because there is no RF on the leads to the tuning potentiometer.

The oscillator board is extended at one end to provide mounting holes so the board can be secured to the bottom of the housing. In this package the entire VFO board is covered with a fabricated metal shield. It exhibits excellent mechanical stability due to the rigidity of the shield. With R3 set at 10 kΩ you can tune about 100 kHz of the 40 meter band with excellent band spread feeling because of the 10 turn tuning control.

Figure 4 shows an oscillator wired with leads for the 10 turn tuning control and the fabricated oscillator shield of Figure 5.

The caption of Figure 2 lists the parts in the VFO circuit along with Digi-Key part numbers for reference. The shaft of the 9 mm square tuning control is 1/8 inch diameter. The 10 turn potentiometer requires a knob for a 1/4 inch shaft.

### Preliminary Checkout and Test of the VFO Board

After completing the parts mounting and soldering, visually inspect again, and apply 12 V dc to the oscillator board from your power source or a battery supply. Insert a milliammeter in series so you can immediately see the current draw. If you see a current over 100 mA on your meter, turn off the power

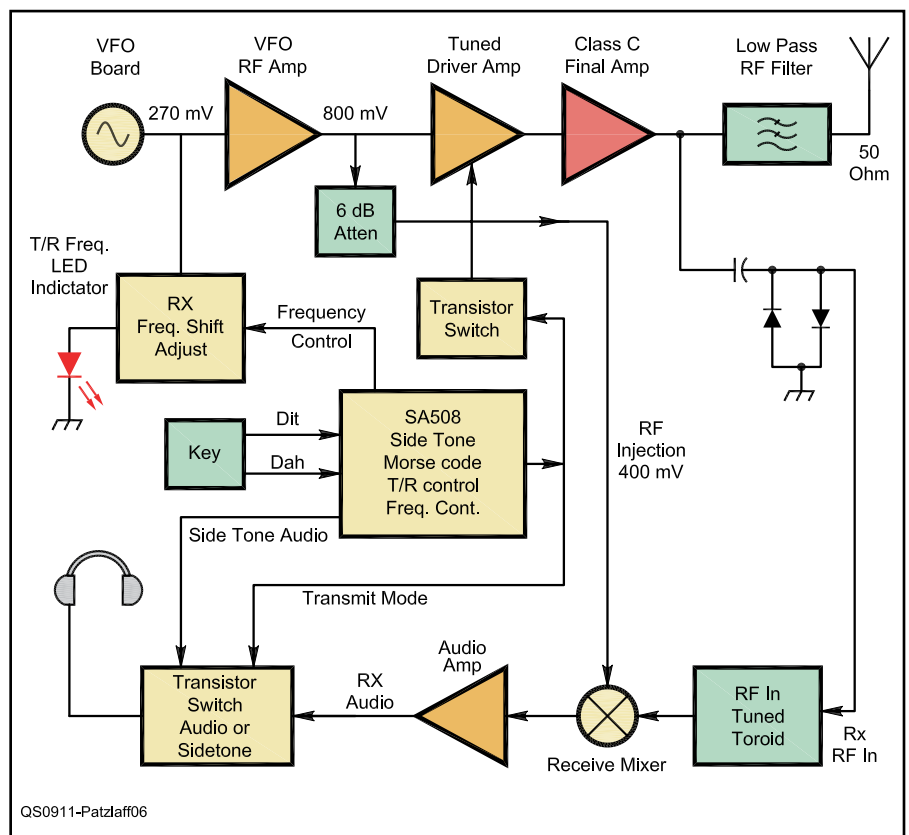


Figure 6 — Block diagram of the Rockless CW QRP transceiver.

supply immediately and carefully look over the circuit board again, checking for solder bridges or wiring mistakes. Normal oscillator current at 12 V should be about 16 mA.

Turn on a communication receiver and lis-

ten for the oscillator signal. It may be found below the 40 meter band. In this case carefully adjust C7 on the oscillator circuit board. Do this with the tuning potentiometer in the far counter clockwise rotation (lowest fre-





**Figure 7 — Schematic of the main board. Note that volume control R5 can be either fixed or variable (recommended) as described in the text; only one 2Is required. Digi-Key parts are available at [www.digikey.com](http://www.digikey.com).**

**C1 — 180 pF ceramic COG (NPO) capacitor (Digi-Key 495-1028-1-ND).  
 C2, C30 — 5-30 pF miniature variable capacitor (Digi-Key 490-1960-ND).  
 C4 — 0.022  $\mu$ F ceramic XTR (Digi-Key 495-1079-1-ND).  
 C5, C8, C13, C15, C24, C26 — 0.1  $\mu$ F ceramic or mono (Digi-Key 495-3350-1-ND).  
 C6, C26, C27, C28 — 100 pF ceramic COG (NPO) capacitor (Digi-Key 495-3293-1-ND).  
 C7, C11 — 47  $\mu$ F, 25 V, electrolytic radial lead capacitor (Digi-Key P13458-ND).  
 C9 — 3.3  $\mu$ F, 25 V, electrolytic radial lead capacitor (Digi-Key 493-1101-ND).  
 C10, C12, C14, C21 — 0.01  $\mu$ F ceramic XTR capacitor (Digi-Key 495-1078-1-nd).  
 C16, C18 — 470  $\mu$ F ceramic COG (NPO) capacitor (Digi-Key 495-3330-1-ND).  
 C17 — 1000  $\mu$ F ceramic COG (NPO) capacitor (Digi-Key P4937-ND).  
 C19 — 150 pF ceramic COG (NPO) capacitor (Digi-Key 495-1027-1-ND).  
 C20 — 68 pF ceramic COG (NPO) capacitor (Digi-Key 495-3310-1-ND).  
 C23 — 560 pF ceramic COG (NPO) capacitor (Digi-Key 495-1033-1-ND).  
 C25 — 47 pF ceramic COG (NPO) capacitor (Digi-Key 495-3277-ND).  
 C31 — 27 pF ceramic COG capacitor (Digi-Key P4842-ND).  
 D1, D2, D3, D4, D8 — 1N4148 diode (Digi-Key 1N4148FS-ND).  
 D5, D6 — 1N5231B, 5.1 V, Zener diode (Digi-Key 1N5231BDICT-ND).  
 D7 — LED, 3 mm green lamp (Digi-Key 754-1210-ND).  
 L1 — T50-2 core toroid, hand wound (Amidon T50-2).  
 L2, L3 — 1  $\mu$ H Mini Coated (Digi-Key DN7683-ND).  
 L4 — 3.9  $\mu$ H Mini Coated (Digi-Key DN2534-ND).  
 L5, L6 — 10  $\mu$ H Mini Shielded (Digi-Key DN42077-ND).  
 Q1, Q2 — 2N7000 Switching FET (Digi-Key 2N7000FS-ND).  
 Q3-Q5 — 2N4401 NPN Transistor (Digi-Key 2N4401-ND).  
 R1, R12-R14, R17-R19 — 1 k $\Omega$ ,  $\frac{1}{4}$  W, resistor (Digi-Key 1KQBK-ND).  
 R2, R3 — 4.7 k $\Omega$ ,  $\frac{1}{4}$  W, resistor (Digi-Key 4.7KQBK-ND).  
 R4 — 1 M $\Omega$ ,  $\frac{1}{4}$  W, resistor (Digi-Key 1MQBK-ND).  
 R5 — 1 M $\Omega$ ,  $\frac{1}{4}$  W, resistor, optional; see text (Digi-Key 1MQBK-ND), or:  
 R5 — 1 M $\Omega$  9 mm volume control, optional, see text (Digi-Key 3310Y-001-105L-ND).  
 R6 — 10  $\Omega$ ,  $\frac{1}{4}$  W, resistor (Digi-Key 10QBK-ND).  
 R7 — 100 k $\Omega$ ,  $\frac{1}{4}$  W, resistor (Digi-Key 100KQBK-ND).  
 R9, R15, R21 — 47 k $\Omega$ ,  $\frac{1}{4}$  W, resistor (Digi-Key 47KQBK-ND).  
 R10, R11 — 22 k $\Omega$ ,  $\frac{1}{4}$  W, resistor (Digi-Key 22KQBK-ND).  
 R15, R16 — 51  $\Omega$ ,  $\frac{1}{4}$  W, resistor (Digi-Key 51QBK-ND).  
 R20 — 180  $\Omega$ ,  $\frac{1}{4}$  W, resistor (Digi-Key 180QBK-ND).  
 U1 — SA 612 8 IC DIP package receiver mixer (Digi-Key 568-2089-5ND).  
 U2 — LM 1450 8 IC DIP package AF amplifier (Digi-Key LM1458NFS-ND).  
 U3 — 12F508A memory IC, programmed as in Rock-Mite (Small Wonders Lab).  
 Hardware for 8 pin DIP sockets for U1, U2 and U3 (Digi-Key ED3308-ND).**

■ The addition of capacitor C10 between pin 4 of U1 and ground. Early editions of this VFO controlled rig had a real problem with night time shortwave broadcast interference. It was not tunable interference, just an overloading of signals getting into the audio. The addition of C10 removed the majority of this interference. Without C10, night-time reception of CW signals was masked by the interference. C10 took out all but occasional interference from a Florida 6.986 MHz short-wave station — at least here at my location in Illinois. Now, even if it is occasionally heard in the background, 40 meter CW signals can still be copied well.

■ Local oscillator output is now taken from a resistive voltage divider at the collector of Q3 to provide a higher level injection signal to the receiver and to reduce frequency shift. The data sheet for U1, the SA512 mixer chip, advises that for separate oscillator injection to this chip the level should be over 200 mV<sub>pp</sub>. This change provides plenty of RF to the chip.

■ The driver coupling to the final uses an LC circuit tuned to about 7.04 MHz and a capacitor divider to feed the final. This adds frequency selectivity to the signal reaching the final.

■ Changes in capacitor values of the output pi network filter improved power output and stability in the Rockless.

I strongly urge the use of the VOLUME control discussed in the original Rock-Mite article achieved by replacing R5, a 1 M $\Omega$  fixed resistor connected between pins 6 and 7 of U2, with a 1 M $\Omega$  potentiometer. The receiver has high sensitivity and plenty of gain with the new input circuit. The VOLUME control is really needed when the band is hot. It also improves signal to noise ratio, when the band is noisy and you reduce the volume level.

### Frequency Shift Circuit

The Rockless includes an adjustable trimmer capacitor for setting the frequency offset between transmit and receive. Capacitor C30 is switched in and out of the circuit using diode switching. C30 is adjusted for proper frequency shift between transmit and receive mode. When receiving with the Rockless you should tune to the lower frequency sideband of the incoming signal, then you will transmit on the incoming station's frequency.

When you key the transmitter or operate the frequency shift key, 4.5 V appears on pin 3 of U3. Resistor R19 and LED2 are in series with this voltage and the switching diode. The LED serves as an indicator so you know when you are in the receive position. The switching diode conducts when the LED lights, thereby putting C30 into the circuit.

### Rock-Mite Control Operation Review

The push button switch connected to pin 4 of U3 controls the functions of U3. A tap

quency setting). Walk the signal into range by adjusting C7 until you hear it on your receiver at the lowest frequency you want to cover on the 40 meter band.

This adjustment is touchy, so tune carefully and be patient. After setting the lowest frequency, turn the oscillator tuning control clockwise to determine that the frequency changes. You can listen on your communications receiver to find the tuning range. In your listening to the oscillator signal, determine that the signal sounds clean and that it is tuning the approximate range of the 40 meter band that you selected by your choice of R3.

During this initial testing process you will find that the oscillator frequency changes when you bring your hand near it. Don't be concerned at this stage but be aware that the entire oscillator board must be completely shielded after it's installed in your housing. This will be discussed in the section about packaging the circuitry. You should again check the lowest frequency and tuning range after the board is in its final assembled location.

### The New "Main Board"

To accommodate changes to the Rock-Mite circuitry for VFO operation I made a new layout of the basic transmitter-receiver board that I call the "Main Board." It is a single sided board, with block diagram and schematic shown in Figures 6 and 7. The design includes the following features:

■ All three ICs are 8 pin DIP size that plug into sockets.

■ A toroid coil tuning circuit at the front end of the receiver matches the 1500  $\Omega$  RF mixer input.

■ It fits in an Altoids can with the single turn version VFO board and all the other associated jacks.

■ It is a single sided board requiring only two wire jumpers, one for keying, one for RF injection.

■ The board uses most of the parts from a Rock-Mite kit.

■ All RF transistors are 2N4401.

Circuitry that is different from the Rock-Mite include the following:

of the switch shifts the frequency. A slightly longer push of the switch results in three dits being heard in the earphones, indicating you have switched to CW keying speed mode. In this mode hold the paddle to the DIT side and keying speed increases and holding it to the DAH side reduces speed. No activation of the keying paddle for about 2 or 3 seconds resets to operating mode. Note that in the Rockless you should tap the switch right after applying power so that the LED glows. This indicates you are on the receive frequency.

Those who have used the Rock-Mite are familiar with this switch control. Note, too, that frequency shifting also actuates while keying the transmitter. This capability is programmed into the Rock-Mite 508 micro-processor as purchased from Small Wonder Labs. The procedure for setting the Rockless frequency shift capacitor (C30) is discussed later in this article.

## Circuit Assembly

First, some helpful reminders:

- Use a small wattage iron (25 to 30 W) with a clean, sharp and well tinned tip.

- Have a damp sponge handy so you can wipe the soldering tip clean from time to time.

- Have a good magnifying glass, wire cutting and handling tools and soldering wick at hand. Also have a good light over your work area.

Packaging and wiring is a matter of choice for the builder. You may have most parts in your shack junk box. For convenience I offer my circuit boards if the builder chooses to use them.

## Construction Notes for My Boards

### Oscillator Board

The VFO board is supplied extended on one end to provide a mounting hole for mounting the board to the bottom of the larger housing. If you are building the package for the Altoid can version, cut the board at the line to shorten it to fit.

Put the oscillator board together first. It is rather straightforward and goes together quickly. Follow the parts location drawing that comes with the board. Use caution since some terminals are close together. Carefully check constantly for solder bridges between unwanted points. Inspect for good solder adherence and no shorts before applying power. Also note and double check the orientation of all the diodes for proper polarity, particularly the tuning varactor diode. Solder short wire leads for power and RF connections to the main board.

Mount the 9 mm square 10 k $\Omega$  tuning potentiometer on the oscillator board if you are using an Altoid size or similar housing for the radio. If you choose to build using the 10 turn tuning control, just put some wire



Figure 8 — Case with the mounting nuts soldered in place.

leads in the holes long enough to reach the 10 turn tuning control. Use three different color wires, so you can identify where they came from later when you connect to the potentiometer. Check to make sure you have installed the correct value of R3 on the oscillator board for the tuning range you want. I suggest a value of 10 k $\Omega$  for R3 if you use the 10 turn potentiometer.

### Preliminary Checkout and Test of the VFO Board

After completing the parts mounting and soldering, visually inspect again, and apply 12 V dc to the oscillator board from your power source or a battery supply. Insert a milliammeter in series so you can immediately see the current draw. If you see a current over 100 mA on your meter, turn off the power supply immediately and carefully look over the circuit board again, checking for solder bridges or wiring mistakes. Normal oscillator current at 12 V should be about 16 mA.

Turn on a communication receiver and listen for the oscillator signal. It may be found below the 40 meter band. In this case carefully adjust C7 on the oscillator circuit board. Do this with the tuning potentiometer in the far counter clockwise rotation (lowest frequency setting). Walk the signal into range by adjusting C7 until you hear it on your receiver at the lowest frequency you want to cover on the 40 meter band.

This adjustment is touchy, so tune carefully and be patient. After setting the lowest frequency, turn the oscillator tuning control clockwise to determine that the frequency changes. You can listen on your communications receiver to find the tuning range. In your listening to the oscillator signal, determine that the signal sounds clean and that

it is tuning the approximate range of the 40 meter band that you selected by your choice of R3.

During this initial testing process you will find that the oscillator frequency changes when you bring your hand near it. Don't be concerned at this stage but be aware that the entire oscillator board must be completely shielded after it's installed in your housing. This will be discussed in the section about packaging the circuitry. You should again check the lowest frequency and tuning range after the board is in its final assembled location.

### Assembling the Main Board

If you use choose to use my circuit board you can insert the parts according to the "Rockless component location" drawing supplied with the board. I recommend that you first wind and mount the toroid coil to the circuit board. Note that the link is placed at the opposite end of the toroid than that which connects to the 180 pF and trimming capacitors. This provides for balanced feeding of the RF signal to the SA 602 mixer. Use enamel coated 22 gauge wire. Be sure to scrape the leads clean at the end where they will solder.

After winding the toroid, leave the leads longer than needed so you can hold and scrape the wire clean next to the coil where you will solder it to the circuit board solder pads. Clip the wire slightly beyond the clean bare wire point and insert and solder the four leads from the toroid. You can run a quick continuity check after soldering to make sure you have a good solder connection to the coil ends. Check the main winding at the pads for the trimmer capacitor, and the four turn link coil at their solder points on the circuit board.

Next mount and solder the three dip sockets. Note orientation of the pin numbers. Pin 1 goes to the left when looking at the top of the board, with the toroid at the right. Then install components for the receiver circuitry first, since these components are rather tightly packed on the board. Now proceed to install the transmitter components.

Constantly check your work for good soldering and particularly for excess solder that may bridge close tracings. Connect the two board jumper wires shown in the drawing that comes with the boards. If you are using the VOLUME control (highly recommended) install two leads for the control to the solder points for R5, the 1 M $\Omega$  resistor at terminals 6 and 7 of the LM 1458. If you decide not to use the VOLUME control, you may want to consider using a smaller value resistor (about 500 k $\Omega$ ) at this position.

After both boards are fully assembled with components, don't rush to mount them in the housing. First insert the DIP ICs into their respective sockets. Then make temporary connection of the oscillator power leads and RF output leads from the oscillator



board to solder pads provided on the main board. Then connect leads for key, headphones, switch control, main power and a 50 Ω RF load at the antenna output.

Connect a wattmeter or a 50 Ω resistor load and an RF probe at your RF output to check RF power output. If you use an RF probe, use Ohm's law ( $P = E^2/R$ ) to calculate an approximate power output. My RF probe connected to a milliammeter shows RF voltage of 4.5 to 6.8 V. Output will of course vary with input supply voltage. Remember, too, that homemade probes are often more relative than absolute in reading values. You are now ready to test the whole circuitry.

### Initial Current Draw Check

Connect your bench power supply set at 12 V with a milliammeter in series to the power input. The Rockless standby current should be about 40 mA. Quickly turn on the power supply, and check for this current. If you get a sudden high current draw, turn power off and recheck circuit board and connections. After you observe a standby current of about 40 mA, then using a straight key in the KEY jack, key up and check transmit current. It should be about 130 mA. Look at your wattmeter and confirm output power of 450 to 1000 mW. If currents and RF power check out okay you have reached the first good news step!

### Initial Setup and Receiver Check

Using your communication receiver as a monitor, key the transmitter and check the note. Check the tuning range by moving the VFO TUNING knob from one end to the other. At this point you may want to reset the TUNING adjustment on the oscillator board for the desired lowest frequency.

Next, see that the receiver is working by either generating a signal in the 40 meter CW band using a signal generator, an antenna analyzer, or equivalent. Hold a wire from your RF signal source near your receiver and find the beat note as you tune the VFO control. If you don't hear a beat note, and your oscillator is operating in the correct range, check receiver wiring. Tap the key and monitor the keyed transmitter on your communications receiver. The note should key clean and crisp.

Check the frequency shift indicator by momentarily tapping the push button switch and observe that the green LED lamp illuminates. With the lamp illuminated, it is in the receive position. (The frequency-shift capacitor adjustment should be made after all boards are mounted in the housing.)

Assuming all of the above went smoothly you are ready to mount the boards in the housings.

### Large Housing Preparation — Multi-Turn Tuning Version

Here are some hints if you package your



**Figure 9 — Rubber stick on pads are used to elevate the front of the case about 1 inch and the rear about ½ inch.**

transceiver as I did. I soldered #4 brass machine nuts to the bottom of the case for mounting the circuit boards. This light metal galvanized steel takes solder nicely. If you build the multi-turn tuning potentiometer version in the larger case, you will also need to solder two #4 brass nuts to the bottom of the case for mounting the two boards. Figure 8 shows a case with the mounting nuts soldered in place.

Use the empty circuit boards as a template to mark the position of mounting holes in the rig housing. Drill ⅝ inch holes. Then put a brass #4 bolt in from the bottom and temporarily fasten the nut to hold it in place while you solder the brass nuts to the bottom of the case. Remove these bolts used to hold the nuts in place after the solder cools. You will use short #4 bolts inserted from the top of the circuit boards to mount the boards onto the bottom of the housing.

Make sure you have some plastic sheet to fit between the boards and the bare metal bottom of the case to insulate the circuit board traces and component connections from the case before you mount the circuit boards. Heavy plastic covers from report folders work nicely for this purpose. You will need to punch holes in the plastic to pass the mounting bolts.

Before installing the boards you will also need to punch or drill all holes in the sides of the case for controls, jacks and a power wire. If you need to cut away the lid of the tin to accommodate mounting hardware, you can smooth sharp edges and then tin with solder to strengthen the cut out. Use a punch if possible, or else drill and then smooth interior burrs with a rotary tool sanding wheel. Use a ¼ inch diameter hole for the power wires and insert a ¼ inch rubber grommet in the hole. After all drilling is completed, and the insulating material is in place, install all items in the housing.

In the 10 turn tuning package, two mounting nuts are used for mounting the VFO board to the bottom of the housing. One goes through the center of the hole provided on the VFO board for passing the pushbutton switch

used if using the Altoids tin. A 1 inch bolt passes through the top of the shield and into the mounting nut on the bottom of the housing. This bolt should be covered with an insulated tube. A ¾ inch length of ¼ inch wood dowel rod with a hole drilled through the length provides support and insulation. If you have access to ¼ inch diameter nylon tubing, it can also be used for this purpose. Carefully place the oscillator shield over the VFO board and use a ¼ inch #4 bolt at the outside end, and the 1 inch #4 bolt through the other hole and insulating tube as discussed above.

After all items are installed and mounted in the case use rubber stick on pads to elevate the front of the case about 1 inch and the rear about ½ inch (see Figure 9).

### Altoids Size Housing

I made a paper template to tape around the edge of the housing to show hole locations. When the tin is completely prepared with all holes and mounting nuts in place you are ready to install the boards. Wire all connections between the VFO and main boards so you can install the two boards as a unit. Make sure all wire leads from the main board for external connecting jacks are soldered on the main board and long enough to reach their respective jacks. Now insert the two boards as a unit.

A nylon and or rubber washer inserted over the threaded connection on the tuning potentiometer will adjust the spacing of the vertically oriented VFO board from the inside of the case. Fasten the VFO with the hardware supplied with the tuning potentiometer. Now complete all connections to the jacks and switch. A miniature 1 MΩ, 9 mm square VOLUME control similar to the tuning control can be installed on the right side of the case.

### Setting Frequency Shift

Connect your 50 Ω antenna for 40 meters, your keyer and you headphones. Turn on the power and tune across the band, listening for signals. Hopefully the band doesn't seem dead. If you don't hear signals, double

check with your communications receiver. Remember that the Rockless uses the direct conversion receiver as in the Rock-Mite, so you will hear both side bands. Now peak the RF input trimmer (C2) for maximum signal.

This transceiver requires that you tune to the side band note of incoming signals that is lower in frequency than zero beat. Ideally you will tune about 800 Hz lower. So remember, always tune desired signals to the desired audible note lower in frequency than a zero beat with the incoming signal.

Before setting the frequency shift capacitor (C 30) it is very helpful if you have a means to switch your antenna between your QRP Rockless and your communication rig. I have found the MFJ-1703 antenna/transceiver RF safety switch is very helpful for switching my antenna between QRP and high power (QRO) rigs. I set mine up with a 100 W dummy load on the second antenna receptacle. That way when one rig is on the antenna the other is on the dummy load.

First make sure the LED is illuminated. If not tap the CONTROL push button. Then tune to a strong CW signal on your Rockless (again adjust to an audio tone below the frequency of zero beat). Now switch your antenna to your QRO rig set for CW reception and tune it to receive the same station you heard on the QRP Rockless. Switch antenna back to QRP and with key down turn the Rockless TUNING control for maximum S-meter signal on your communication receiver.

Release the key, and switch your antenna back to the Rockless. Without moving the Rockless TUNING, adjust C30 for best receive signal and a pitch of about 800 Hz. Turn the Rockless tuning knob now and make sure you are on the low side of zero beat. With this adjustment you will transmit on the incoming station's frequency when you are tuned below his zero beat.

Now tune around the band for some other signals, locate them on your QRO rig receiver,

and check that when you transmit, you hear it as maximum signal on your QRO rig receiver tuned to the same incoming signal. With practice you will get an idea of the incoming signal note that grabs him on your first call!

### On The Air Experience

Throughout the design of this project, from breadboard to final package, I have been delighted with the many contacts I have made using a simple doublet, 110 feet of wire with 600  $\Omega$  feeder to an antenna transmatch to match my 50  $\Omega$  output requirement. The wattmeter on the transmatch reads between  $\frac{1}{2}$  and 1 W. Almost all contacts have been made while powered by 8 D batteries, often running well below 12 V. The Rockless operates with supply voltages from 10.5 to 14 V. I like the idea of a battery supply — no hum and always available.

Over 50 QSOs have been logged with the Rockless while in various stages of development over the past eight months. I would like to thank all those I contacted for their contacts, patience, QSL cards and helpful comments. It has been an effort of learning and enjoyment.

### Getting the Parts

All new electronic parts will cost approximately \$30 to \$40. Some hams may have many parts already on hand and can start with them. You can use whatever style of construction you prefer for parts mounting. The parts lists provide ordering information for individual parts from a popular mail order dealer. A source of the memory chip, with stored message features and automatic CQ sending, is the Ham Gadgets Store at [www.hamgadgets.com](http://www.hamgadgets.com).

For those who wish to use my boards, I offer a "get started kit" that includes the two printed circuit boards and other basic items.<sup>4</sup> Building time to build up the circuit boards, package and test is probably about 10 hours.

## In Summary

The Rockless is a very basic circuitry QRP rig. If you are looking for narrow receive filters and other advanced technology features, this may not be your choice of a radio. Remember it receives both sidebands — always tune below zero beat.

If you like to build simple circuitry then you will enjoy making this straightforward rig for QRP and get back the thrill of contacts made from a radio put together with your own hands and experience first hand what can be accomplished with low power on 40 meters.

As mentioned earlier in the article, credit for the basic circuitry goes to Dave Benson's Rock-Mite. The change of the addition of the VFO has added greater flexibility to this radio for general CW operating in the 40 meter band. The ability to move around the band obviously provides more opportunities for contacts. Don't worry about the low power — a  $\frac{1}{2}$  W transmitter is only 23 dB, or about 4 S-units, below a 100 W station!

### Notes

<sup>1</sup>D. Benson, K1SWL, "The Rock-Mite — A Simple Transceiver for 40 or 20 Meters," *QST*, Apr 2003, pp 35-38.


<sup>2</sup>[www.smallwonderlabs.com](http://www.smallwonderlabs.com).

<sup>3</sup>D. DeMaw, W1FB, *W1FB's QRP Notebook* (1989 edition, p 29, overleaf) Available from your ARRL dealer or the ARRL Bookstore, ARRL order no. 3657. Telephone 860-594-0355, or toll-free in the US 888-277-5289; [www.arri.org/shop/](http://www.arri.org/shop/); [pubsales@arri.org](mailto:pubsales@arri.org).

<sup>4</sup>The Get Started kit includes the following items: both circuit boards, schematic drawings of both boards and oversized parts placement drawings. Price, \$12. Contact the author for more information.

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