

By Sam Ulbing, N4UAU

The World's Smallest Code-Practice Oscillator

Using state-of-the-art technology, you can easily build a very small and flexible code-practice oscillator.

To some, CW is a “dead” language. I think that’s unfortunate, because I find CW to be a lot of fun! Sure, CW isn’t the most efficient way to communicate, which is why many commercial stations and the military no longer use it routinely. But how many sail-powered ocean freighters do you see? Yet people still sail for the *fun* of it. And how many horse-drawn 18-wheelers do you see on the interstate? None. But does that stop people from spending lots of time and money to enjoy the pleasures of horseback riding? Not at all! For those of you who want to experience the joy of CW, or want to upgrade from a codeless Tech license to a more advanced ticket, I can assure you it’s easy to do with a little practice.

Using Modern Technology

Many people use computer-generated Morse code just to get through the test. With a key, an oscillator, a battery and a small speaker or headphones, you can practice the code with a friend instead of an emotionless computer. To me, the difference is like that between playing solitaire versus a two-handed card game. Let me show you how to build a truly state-of-the-art code-practice oscillator and have some fun!

In years past, many code-practice oscillators were published in Amateur Radio literature. I thought it would be fun to apply state-of-the-art technology to this venerable project. Since 1996 when I first built a project using modern technology (ie, surface-mount [SM] devices),¹ I’ve been so intrigued with its possibilities for Amateur Radio use that I now work almost exclusively with SM parts. This project isn’t difficult to build.² It only uses five parts and it’s quite versatile.³

Circuit Description

Refer to Figure 1. Except for the key, battery and speaker, all of the parts used in this project are SM devices. Two state-of-the-art ICs are employed. U1, an MIC1557, is a much-improved version of the popular and versatile LM555. Q1, an IRLML2402, is a powerful little MOSFET. Here’s how the circuit works: Pin 4 of U1 is its power-supply pin and pin 3 is the shutdown pin, which is normally held at ground potential by R1. When the key is pressed, the voltage at pin 3 rises to Vcc, which takes U1 out of shutdown and causes it to oscillate at a frequency determined by the values of R2 and C1.

With values of C1 = 0.1 μF and R2 = 10 kΩ:

$$f_o = 1 \div (1.45 \times R2 \times C1) = 689 \text{ Hz} \quad (\text{Eq 1})$$

The output at U1 pin 5 is a square wave varying from 0 V to Vcc at a frequency of about 700 Hz. U1 cannot handle much power, so its output is used to control the gate of an N-channel

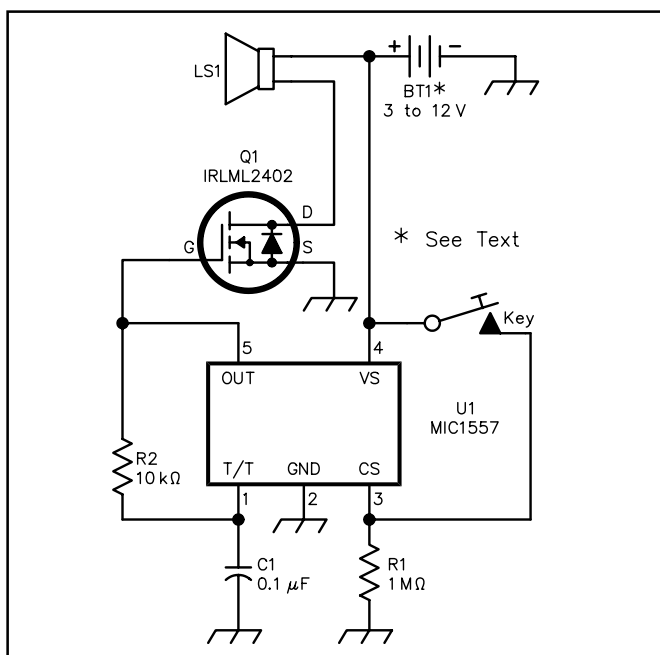


Figure 1—Schematic of the state-of-the-art code-practice oscillator. All on-board components are surface-mount devices (see text). Unless otherwise specified, resistors are 5%-tolerance units. Part numbers in parentheses are Newark (Newark Electronics, 4801 N Ravenswood Ave, Chicago, IL 06040-4496; tel 800-463-9275, 312-784-5100, fax 312-907-5217; www.newark.com) and Digi-Key (Digi-Key Corp, 701 Brooks Ave S, Thief River Falls, MN 56701-0677; tel 800-344-4539, 218-681-6674, fax 218-681-3380; www.digkey.com.) Equivalent parts can be substituted.

- BT1—3 to 12 V; see text.
- C1—0.1 μF ceramic, 0805 X7R (Digi-Key PCF1126CT)
- Q1—IRLM2402 FET (Newark 8F1207)
- LS1—8-Ω speaker of suitable power rating; see text.
- R1—1 MΩ, 0805 (Digi-Key P1.0MACT)
- R2—10 kΩ, 1206 (Digi-Key # P10KECT)
- U1—MIC1557BM5 (Newark 483F5883)

¹Notes appear on page 00.

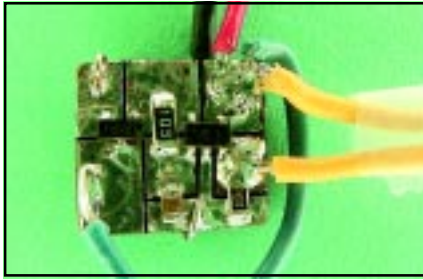


Figure 2—The entire project fits on a board measuring less than one-half inch (1×1 cm) square.

MOSFET, Q1, which acts as a simple power amplifier controlling the current through the speaker. When the potential at U1 pin 5 is 0 V, Q1 is off; when the voltage at pin 5 is greater than 1.5 V, Q1 is on. This action pulses current through the speaker at a 700-Hz rate and you hear the tone. Pretty simple, isn't it?

Despite the circuit's simplicity, it offers advantages over similar circuits built with older-technology components. Its first advantage is obvious: its small size (see Figure 2). The wires seem large because the board is so small—less than one-half inch square! As small as it is, the oscillator can blow your socks off if you use a suitable power supply and speaker, which makes it great for use in a code class.

Secondly, the circuit works over a wide voltage and power range with *no* modifications. Figure 3 shows a test setup I built using a common 5-W speaker and four AA NiCd batteries. You might have to look twice to see the oscillator circuit because it's so small, yet this setup produces a loud tone. There are two reasons the tone is so loud. First, the MOSFET switch has an *on* resistance of only 0.25Ω . This is less than the resistance of 10 feet of #24 hook-up wire! So there's little power lost in the switch. Compare that to the commonly available IRF510, an old-technology MOSFET that's physically much larger (see Figure 4) and has an *on* resistance of about 1.5Ω in a 5-V circuit. With an 8- Ω speaker, a 1.5- Ω switch greatly reduces the current flow through the speaker. For the values shown, the little switch allows a 33% greater power output than the larger switch. This tiny MOSFET can handle continuous currents of over 1 A and pulsed currents up to 7.4 A. Take a look at its size again and tell me electronic technology hasn't advanced!

The NiCds I used are the other reason for the loud sound. With a 5-V supply and an 8- Ω speaker, when the key is pressed, the current flow can be as high as 0.6 A. With that amount of current, the power output ($0.6 \text{ A} \times 5 \text{ V}$) is 3 W, lots of volume—if the batteries can supply the required peak current.

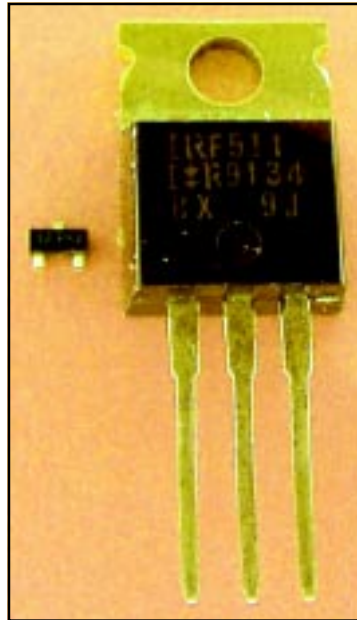


Figure 4—The little SM MOSFET does a better job than its larger, old-technology counterpart.

close to its limit. You'll also need a speaker capable of handling that desired power output.

On the other hand, if you want to practice your sending without disturbing others, you can use headphones. The circuit can be powered by a coin-size lithium 3-V cell (such as a CR2032) providing you add a current-limiting resistor of about 1 k Ω in series with the headphones. The resistor is required to offset the high internal resistance of the battery. Without the resistor, the circuit will try to draw about 100 mA causing the battery output voltage to drop excessively. With the resistor in line, the current demand is small and the sound is still ample for headphone practice. Figure 5 shows this configuration. The entire circuit and its battery easily fit on the key base.

There is yet another advantage of the new technology used in this project. Notice that the circuit has no power switch. When you are done using the code practice oscillator, you can just walk away from it. That's because when pin 3 is low and U1 is shut down, the circuit draws less than 1 μA . That makes the circuit very power efficient as well because in between the dots and dashes the circuit is shut down—it draws current only

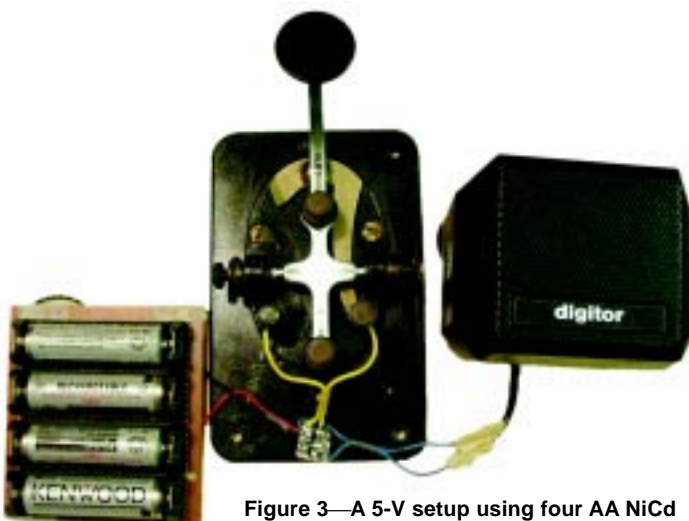


Figure 3—A 5-V setup using four AA NiCd batteries and a 5-W speaker.

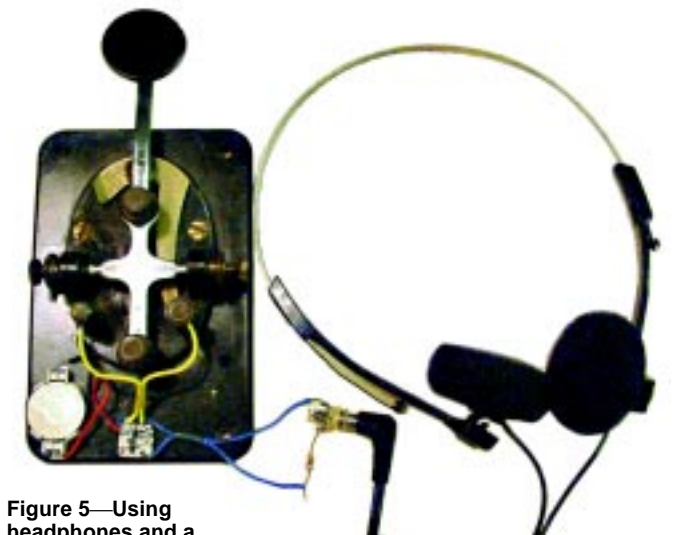


Figure 5—Using headphones and a lithium cell. There is a 1-k- Ω resistor in series with the headphones.

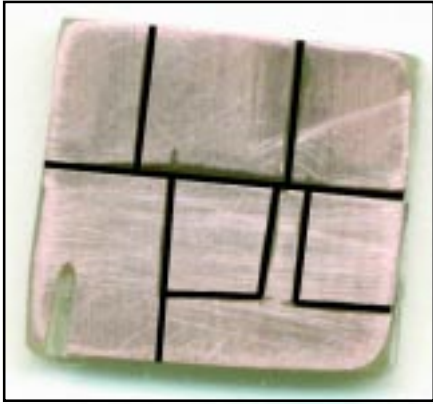


Figure 6—I made the pad-isolating cuts in this small PC board with my Dremel hobby tool.

when you close the key. Built-in shutdown circuitry is becoming quite common in SM ICs because of the explosion of portable devices that all need to conserve power.

Building the Project

There are no new construction skills needed from those I described in my earlier SM articles (see Notes 1 and 2). In fact, I made the prototype board and soldered the parts to it in a little over an hour.⁵ I formed islands on the top side of a double-sided board (see Figure 6) using my Dremel tool method and a 0.005-inch cutting wheel. I made the cuts first on a large piece of board, then cut out the 1 × 1cm finished circuit. I used jumper wires to make a common ground on the back side of the board. Use as low a soldering-iron temperature as possible and small-diameter solder to avoid overheating parts.⁶ An illuminated magnifier is a big help. Use double-stick tape to secure the board to the workbench, otherwise it is apt to slide around as you try to solder the parts to it. If you want to make the project a bit smaller, you could mount the MOSFET on the reverse side.

Summary

Give this project a try! You'll experience some of the advantages of using state-of-the-art electronics parts and learn how much fun CW can be!

Notes

¹Sam Ulbing, N4UAU, "SMALL—A Surface-Mount Amplifier that's Little and LOUD!," *QST* Jun 1996, pp 41-42.

²Although, if you have never built using SM parts, you might want to try a project with larger parts before you build this one. (See Note 1.) My four-part article series "Surface Mount Technology—You Can Work with It!"—*Part 1*, *QST* Apr 1999, pp 33-39; *Part 2*, *QST*, May 1999, pp 48-50; *Part 3*, *QST* Jun 1999, pp 34-36, and *Part 4*, *QST*, Jul 1999, pp 38-41, explains how I work with SM and provides several graduated projects to build.

³Some of you may point out that an even smaller oscillator could be made with a piezo buzzer with built-in driver and small battery. Although it's true that it would be smaller, I wouldn't consider it viable for code practice for two reasons. The resulting tone frequency is usually about 2 kHz. Although that's a good frequency for alarm systems, it's an annoying frequency for code practice and it's not anything like the note you'd hear on the air, so I feel that would hamper learning to copy code. Also, the piezo buzzer has a very low volume output and is limited in its applications.

⁴In fact, the absolute maximum power-supply voltage is 20 V.

⁵All parts and a PC board are available from the author for \$6 including postage in the US and Canada; add 50 cents for shipment to other locations. Florida residents please add sales tax. Payment should be made by a US or international money order, or a check payable by a US bank. Credit cards are not accepted. Send your order to Sam Ulbing, 5200 NW 43rd St, Suite 102-177, Gainesville, FL 32606.

⁶When I was tinning the first board, one of the copper pads detached from the board. Although this could have been a foil-adhesive defect, I suspect the lifting occurred because I was using too high an iron temperature (700° F). On the next board, I set the iron temperature to slightly under 600° F, had no pad-detachment problem and the solder melted just as quickly.

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All photos by the author.

