accu-keyer speed readout

Another addition to the feature-packed WB4VVF Accu-Keyer — a readout system for code speed

There are thousands of Accu-Keyers[1] already in use, and the appearance of articles[2-8] to add message memories to the basic keyer has undoubtedly resulted in another flurry of Accu-Keyer construction. It is an excellent and highly versatile keyer, and deserves the fine reputation that it has. It might seem that there is little else that one could want from this, or any other, keyer.

There is one useful addition, however. Most of us vaguely know our sending speed. It is true that a speed scale could be put on the front panel behind the control, but the speed vs rotation dependence of most controls is highly nonlinear, especially at the high-speed end of the range where the scale becomes compressed. Any semblance of accuracy is lost in the compressed scale.

A desirable feature, which I have incorporated into the Accu-Keyer system, is a direct words-per-minute speed readout. This is useful for many purposes, and at the least is an interesting conversation piece in the hamshack.

The readout and keyer clock, which I will describe, may be easily used in any Accu-Keyer design, and possibly in other types of keyers as well. The main precaution to be observed with the Accu-Keyer family is to be sure the 5-volt power supply in your keyer is capable of handling the extra current drain, about 370 mA.

I do not consider it feasible to use my readout with a battery-operated keyer,[9,10] but it should be possible to make relatively simple modifications to the circuit and use CMOS integrated circuits. It would be necessary to choose some other type of display, and I would recommend a liquid-crystal type.

principles of operation

A continuous speed readout in wpm *requires* a free-running clock. The Accu-Keyer clock, however, is not free running. It starts when either side of the paddle is closed, and is stopped by an inhibit signal from the logic when all characters have been completed. This method has a considerable advantage over a free-running clock, since the operator initiates a character at the time he chooses rather than at the time the clock is finally ready.

This dilemma is easily overcome, and the unit I have developed gives an accurate, continuous readout of the speed without sacrificing the advantages of the operator-started clock. A fringe benefit of the unit is that it does not have the problem, common to some keyer clocks, of a first clock pulse different in duration from the rest of the pulses in the sequence. Because of these features, it may be worthwhile to use the clock portion of this unit, even without the readout.

The speed is variable from five to around fifty wpm, an adequate range for almost anyone from Novice to Extra. The speed display is updated approximately six times each second, whether or not any sending is being done. I incorporated it into the WA9LUD memory version[2] of the Accu-Keyer, but of course it can be used with any similar keyer

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design. Different speeds may be selected as you build.

Recent editions of the ARRL *Radio Amateur's Handbook* give the relationship between code speed and keyer clock frequency as:

$$speed\ (wpm) = 1.2 \times f\ (clock\ frequency)$$

Twenty pulses per second of the clock result in a keying speed of 24 wpm. A scheme for reading out this relationship has been described previously,[11] but that system has several disadvantages which are overcome by my circuit.

Suppose you have a high-frequency pulse generator running at 2420 pulses per second. Three decade counters hooked in series would count to 242 if they are allowed to count for exactly 0.1 second. If the least-significant digit (2 in this example) is ignored, it is then possible to display 24 in the readout connected to the digital counters. The reason for this approach will be discussed more fully later.

The high-frequency pulse generator can also be divided down by a decade and a duodecimal (divide by twelve) divider, a total division of 120, to give twenty pulses per second for the keyer clock. If you gate the divide-by-120 divider on and off with the original inhibit line in the Accu-Keyer, the resulting keyer clock line acts much like the operator-started clock, which is the key to the success of the Accu-Keyer design. This scheme allows us to have a free-running clock that can be accessed at the operator's

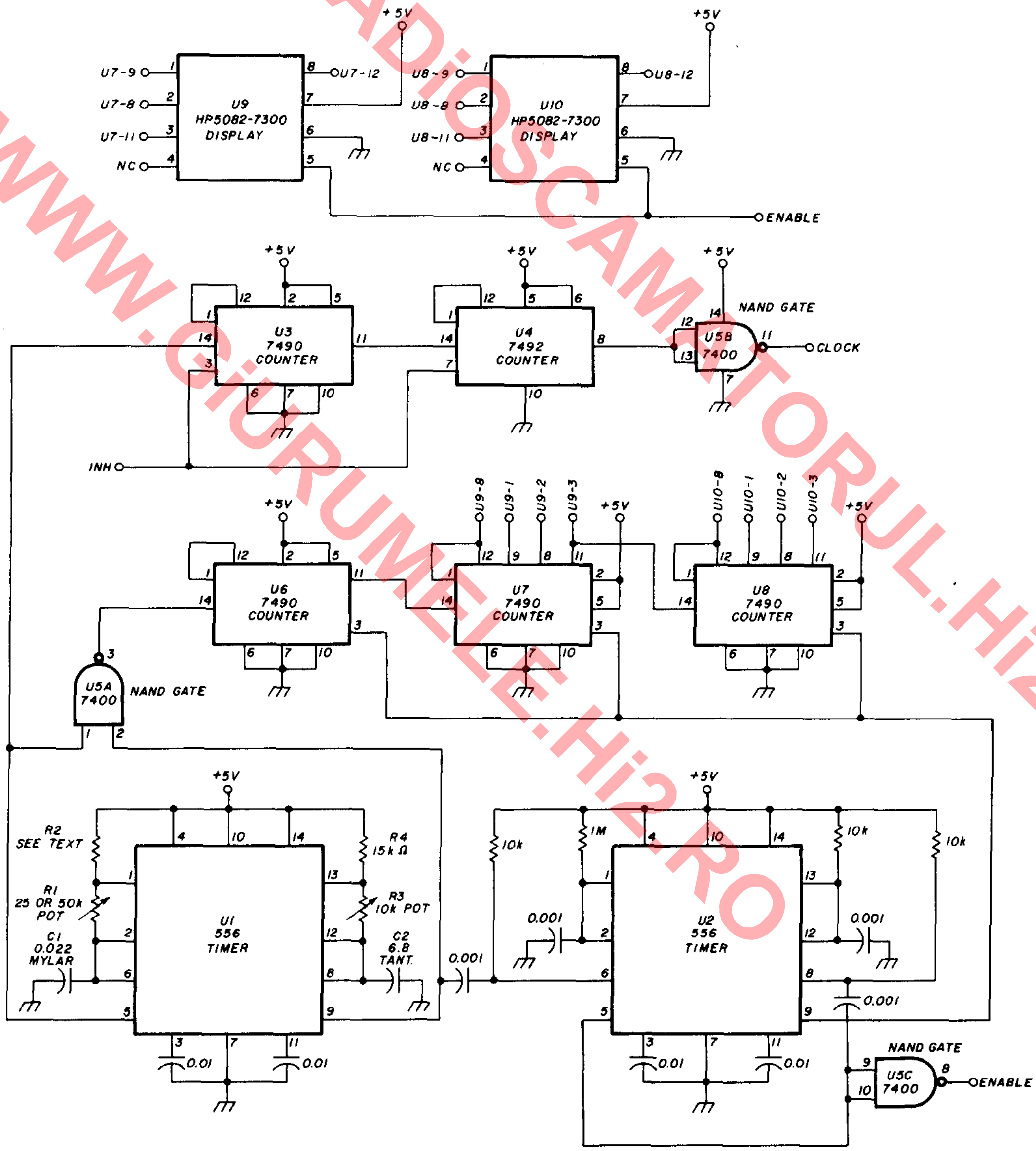


fig. 1. Schematic diagram for the Accu-Keyer speed readout. This circuit incorporates a free-running clock which can be accessed at will by the operator. The frequency of the clock is high enough that the delay between accessing and the first clock pulse is negligible. U9 and U10 are HP 5082-7300 displays that have the latches and display drivers incorporated within the display. C1 and C2 should be of the type indicated to ensure adequate stability.

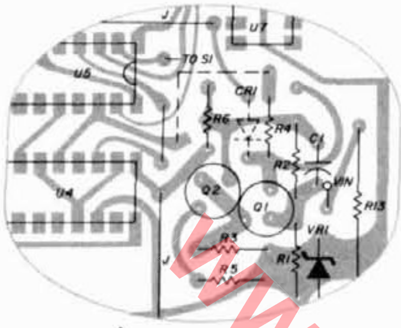


fig. 2. Blowup of the portion of the keyer board which is changed to incorporate the speed readout. CR1 and the original speed control wires must be removed. The foil is cut and new wires attached at the indicated spots.

convenience. I have never been able to detect any delay because of the free-running pulse generator, even at the slowest keying speed.

circuit description

The logic diagram for the clock/readout is given in **fig. 1**. U1 and U2 are 556 dual timers. One half of U1 generates the high-frequency pulses, available from pin 5, that form the basis of the clock/readout. The other half of U1 is the time base for the display counter, with the output on pin 9.

R1 is the speed control and is mounted on the front panel of the keyer. C1 must be a reasonably stable capacitor, *not* one of the ceramic bypass types. C1 and R2 determine the maximum keying speed, and the value of R1 determines the range. The value of R2 will probably be between 6,000 and 22,000 ohms for a 50 wpm maximum, and may be selected for this purpose. If C1 is changed for any reason at some later time, it may be necessary to change R2 to bring the maximum speed back to the one desired.

R3 is mounted on the printed circuit board and is used to adjust the 100-ms time base for the display counter. If it is not possible to adjust the "on" time at pin 9 of U1 to 100 ms, it may be necessary to change the value of R4 to bring the pot within the proper range. C2 is the most critical component in this entire circuit.

U2 is simply a sequential timer. The trailing edge of the 100-ms counter gate triggers a pulse of short duration at pin 5 of U2. This pulse, after inversion by U5C, strobes the count in the decade counters into the display. It also triggers another short pulse, at pin 9 of U2, which is used to reset the counters to zero, preparing them for the next update.

U3, a 7490 decade counter, and U4, a 7492 duodecimal counter, form the divide-by-120 divider that generates the clock pulses for the keyer logic. This divider is gated on and off by the inhibit line from the keyer, with the inhibit signal resetting the divider to zero and holding it there when all keyer action is complete. Inverter U5B ensures that the clock pulses have the right polarity for the Accu-Keyer, and might not be necessary in other keyer designs. This combination forms a keyer clock which is always within 1/120th of a dit of starting, a negligible delay at any speed.

U5A controls the display counting. The pulse generator pulses are fed to the counter only when pin 9 of U1 is high. When it is high for precisely 100 ms, exactly one tenth of the pulse generator frequency is counted. U6, another 7490 counter, is for the least significant digit and, by including it without display, the jitter inherent in this digit is eliminated. This results in a stable display considerably superior to using only two decade counters with a 10-ms time base. U7 and U8, both 7490 counters, are the actual display counters, with U8 serving as the most-significant-digit counter.

The displays themselves, U9 and U10, are easy to use, with an attractive, bright display, although they are a bit expensive. Other displays may be substituted, but it might be necessary to incorporate data-storing latches, which are built into the 5082-7300 displays. A nonblinking display is a necessity, so be sure to add latches if they are not in the displays you choose.

Connection to the Accu-Keyer is really quite simple. CR1 in the original Accu-Keyer clock *must* be

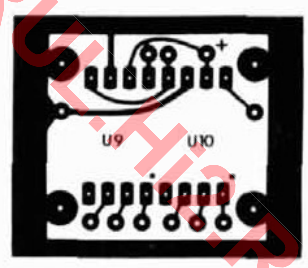
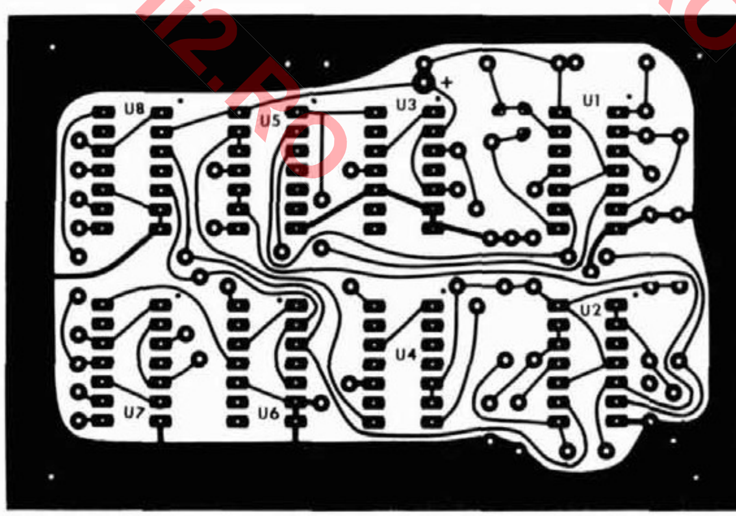


fig. 3. Full-size printed-circuit layout for the Accu-Keyer speed readout. Parts layout is shown in fig. 4.



removed from the circuit. A wire is connected to the vacated hole at the anode end for connection to the inhibit line in the new clock. The foil should be cut as indicated in **fig. 2** and the old speed control wires should be removed. The clock line may then be connected to the vacant hole near the cut in the foil. Connect V_{CC} and ground both the readout and the clock board, and you're in business. You may wish to remove the old clock components from the Accu-Keyer board, but that is not really necessary.

I have not included a power supply, since most will be able to use the supply in the Accu-Keyer. It might be necessary to increase the size of the input capacitor ahead of the regulator to keep the voltage high enough to maintain regulation. If your supply is incapable of providing the necessary current, any standard 5-volt power supply design will be satisfactory.

Full-size board layouts and the component placement diagram are shown in **figs. 3** and **4**. They are single-sided boards, and should be easy to duplicate by those who wish to roll their own. There is no reason why point-to-point wiring cannot be used, since the layout is not critical.

accuracy and calibration

The key to the accuracy of this unit is how carefully the 100-ms time base for the display counter is calibrated, and how stable it is. It would have been possible, of course, to use a crystal-controlled clock to control this counter, but that seemed quite unnecessary. One half of a 556 timer, with a high-quality, stable capacitor, results in quite adequate performance for this purpose. It saves considerably on circuit complication and expense.

There are three methods of calibration, and they will be described in order of increasing accuracy.

1. Set the keyer to match as closely as possible W1AW's 18-wpm bulletin broadcasts (or better yet their 35-wpm code practice), and adjust R3 until the readout indicates 18 (35).

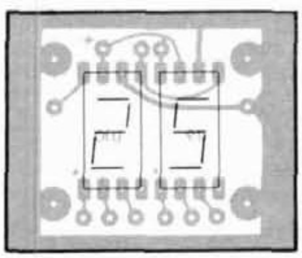
2. Use a calibrated scope to set the "on" time (output high), as seen at pin 9 of U1, while adjusting R3.

3. Connect a counter with a 1-second time base to U1, pin 5, to measure the pulse generator frequency, and adjust the keyer speed control until the counter reads about 4000. Adjust R3 until the display reads 40. This is the method I prefer, and should be used if a counter is available.

My own keyer has been in use for almost three years and seems to be accurate within one wpm at all speeds throughout its range at all temperatures encountered so far in my shack. Accuracy is not a problem if a sufficiently stable capacitor is used for C2.

I'll be happy to answer any correspondence regarding this readout or any modifications people may wish to make. I'll try to furnish circuit board availability information, provided that a self-addressed, stamped envelope is supplied.

It has been a pleasure to use this keyer with its readout. Now, when someone says QRQ by 5 wpm, I can do it quite accurately, depending on my skill of sending, of course!



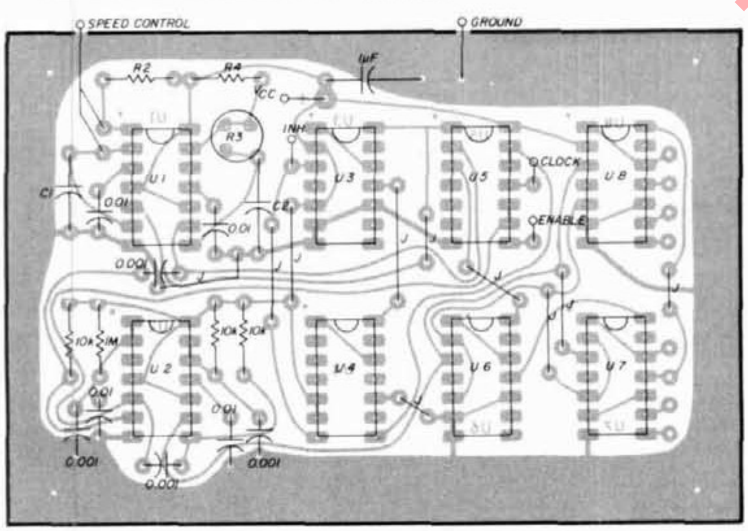


fig. 4. Component placement for the Accu-Keyer speed readout.

references

1. James M. Garrett, WB4VVF, "The WB4VVF Accu-Keyer," *QST*, August, 1973, page 19.
2. Andrew B. White, WA9LUD, "Programmable Memory Accessory for Electronic Keyers," *ham radio*, August, 1975, page 24.
3. James M. Garrett, WB4VVF, and D.A. Contini, W4YUU, "The Accu-Memory," *QST*, August, 1975, page 11.
4. James M. Garrett, WB4VVF, "Enhance the Performance of Your Accu-Memory," *QST*, July, 1976, page 29.
5. Edward B. Kalin, WA1JZC, "The WA1JZC Accu-Stop," *QST*, July, 1976, page 30.
6. Howard F. Batie, W7BBX, "Programmable Contest Keyer," *ham radio*, April, 1976, page 10.
7. David L. Madison, K3ACN, "A PROM for the Accu-Keyer," *QST*, May, 1976, page 22.
8. William E. Smith, III, WN9OVY, "The Accu-Mill," *ham radio*, September, 1976, page 26.
9. Gene Hinkle, WA5KPG, "The QRP Accu-Keyer," *73*, August, 1975, page 58.
10. Gene Hinkle, WA5KPG, "An Accu-Keyer for QRP_p Operation," *QST*, January, 1976, page 24.
11. Wilf Maillet, VE1BU/W3, "Code Speed Display," *73*, December, 1973, page 25.

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