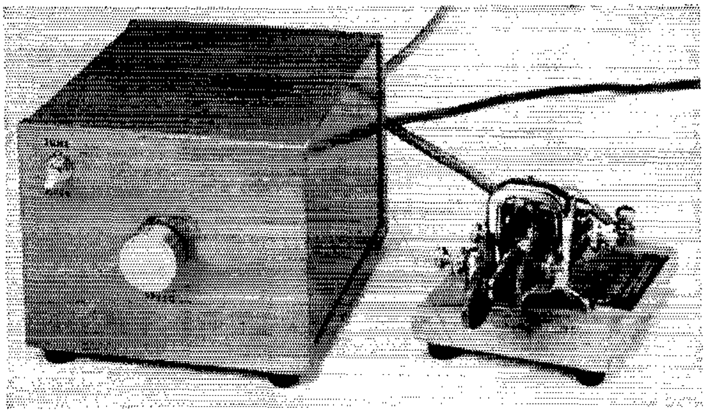
ICKEY—An Integrated-Circuit Electronic Keyer with Dot and Dash Memories



"ICKEY" is a keyer with both dot and dash memories, and can be actuated either by a single-lever paddle, as shown, or by a dual-lever key for "squeeze" operation.

Carrying the Micro-TO a step (or maybe two) farther, ICKEY will insert either a dot among dashes or a dash among dots. With the "squeeze" keying technique, this means fewer motions for some characters, an operating simplification once you get the hang of it.

Since preparing this article, the author has added another feature—automatic spacing of the correct length between letters. Two more inexpensive IC packages and an extremely simple change in the circuit given here are all it takes. Details in an early issue.

BY FRANK VAN CLEEF,* W1WCG

Several years ago I sat looking at the schematic diagram of a transistorized electronic key with dot and dash memories, dreaming of the smooth, effortless code soon to be mine, not to mention the relatively miniscule amount of power needed. Since the junk box was well stocked (and cold cash hard to come by) many liberal substitutions were intended. After much fussing and fretting, the keyer was finally put into operation, only to prove discouragingly r.f.-sensitive. The plain old self-completing keyer was plugged back into the rig, and all further key-building activity was temporarily suspended.

New interest in a key project was sparked by Chet Opal's article on the Micro-TO keyer,[1] using integrated circuits. The attractive possibility of adding an integrated-circuit memory to this excellent keyer resulted in the circuits presented here. No special parts are needed, apart from the output relay and the ICs themselves. The Motorola MC700-series industrial integrated circuits were used, both because of the low cost and because they are readily available.[2] Unfortunately, the ICs do not come with data sheets and if you must know what's inside the things, you will have to write to Motorola for the information.

Operation

Since the basic keyer, which includes the time base, dot and dash generators, relay output and monitor, is almost identical to the Micro-TO keyer, not much will be said about it. As Chet points out, a memoryless keyer with a free-running time base can be a problem to use, but since memories have been added, the time base is left free-running to enhance spacing between characters. When the paddle is depressed to either the dot or the dash side, the corresponding memory is actuated, and at the next pulse from the time base the requested character begins. At the end of the character, the memory is reset and the keyer is ready for

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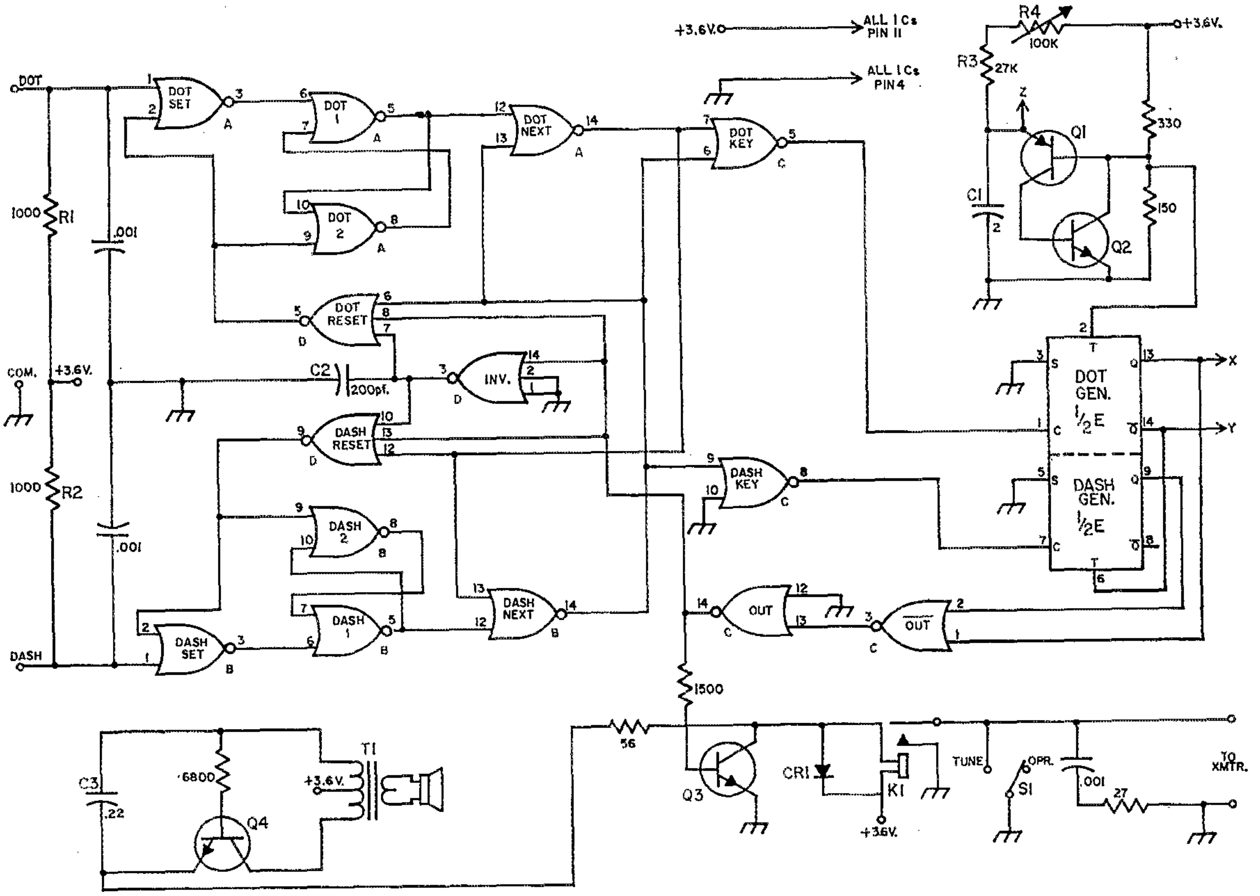
[1] Opal, "The Micro-TO Keyer," *QST*, August, 1967.

[2] The author obtained these and the Magnecraft relay from Cramer Electronics, 320 Needham St., Newton Upper Falls, Mass. The integrated circuits and relay also are available from Allied Radio, 100 N. Western Ave., Chicago, Ill. and Newark Electronic Corp., 500 N. Pulaski Road, Chicago, Ill.—*Editor.*



POWER SUPPLY

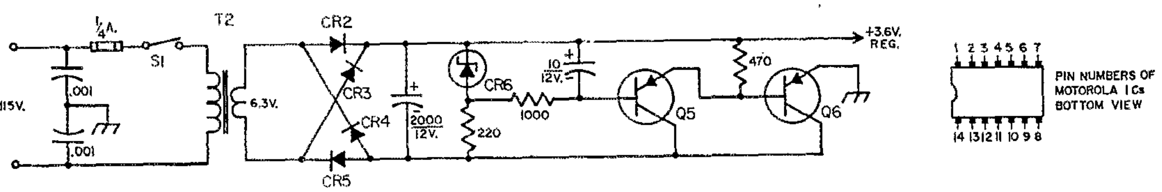


Fig. 1—Circuit diagram of the keyer. Fixed resistors are ½-watt composition; resistances are in ohms; K = 1000. Except as indicated, capacitances are in μf. Fixed capacitors with polarity indicated are electrolytic; others not listed below are disk ceramic.

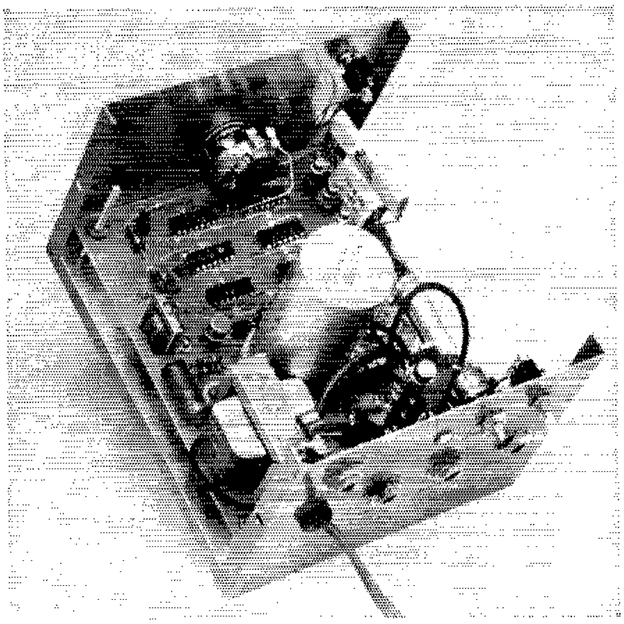
Logical 1 (high) 3.6 volts and logical 0 (low) 0.3 volt, approximately. Logic rules for all gates: Any input high gives low output (NOR); all inputs low give high output (NAND). Integrated circuits are designated A, B, C, D, E, to identify gates included in a particular unit. Pin numbers are shown alongside.

A, B, C—Quad 2-input gate (Motorola MC724P).
D—Triple 3-input gate (Motorola MC792P).
E—Dual JK flip-flop (Motorola MC790P).
C_1, C_3—Mylar.
C_2—Dipped silver mica.
CR_1—Any small silicon diode.
CR_2-CR_5, inc.—Silicon, 1 amp., 50 p.r.v.
CR_6—Zener, 5.6 volts.
K_1—Reed relay (Magnecraft W102X1).
Q_1—HEP52 (Motorola).
Q_2, Q_3, Q_4—2N706.
Q_5—HEP51 (Motorola).
Q_6—2N268 or equivalent.
R_1, R_2, R_3—For text reference.
R_4—100,000-ohm control, linear taper.
S_1—S.p.d.t. toggle.
S_2—S.p.s.t. toggle.
T_1—Transistor output, 500 ohms to voice coil, center-tapped primary.
T_2—6.3-volt, 1.2-amp. filament transformer.

another input. Both memories may be actuated concurrently, in which case the memory first actuated is emptied first. If a squeeze paddle is used and both contacts are held closed, a string of alternate dots and dashes results, starting with the character whose contact was closed first.

The Circuit

At this point, a few definitions will save a lot of words. A "character" is a dot or a dash. A

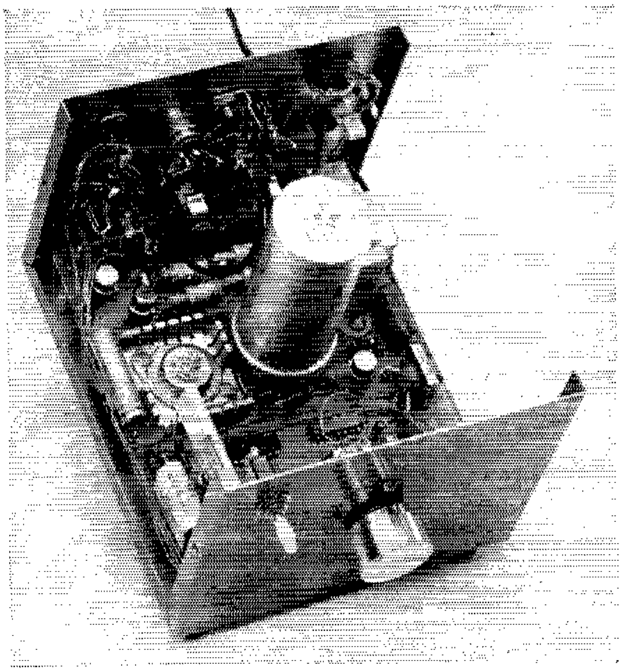


This view from the rear shows the ICs and associated components. The rear panel, foreground, has jack connections for external circuits, including one for the monitor speaker. (These jacks are not shown explicitly in the circuit diagram.) The variable resistor and switch at the top right of the rear panel are for the optional weight circuit of Fig. 2.

"set" memory is one storing a dot (or a dash). Since the memory circuit is symmetrical, it will be explained for dots, and it will be assumed unless stated otherwise that the dash side operates in a similar fashion. And, throughout the discussion of the circuit, "high" means a voltage greater than about 2 volts positive to ground, while "low" means a voltage less than 0.5 volt positive to ground. All of the gates used follow the same logical rules—*all* inputs low result in a high output; *one* input high results in a low output. Any unused input must be connected to ground to prevent it from affecting the other inputs in any way. Keeping these things in mind, we will go on to the details.

Dot Memory

Gates DOT 1 and DOT 2 are interconnected to form a bistable flip-flop. In the idle condition, the output of DOT 1 is high and the output of DOT 2 is low. The output of DOT SET is also low, due to the high on input 1 through R_1. The output of DOT RESET is low at this time. When the paddle is operated to the dot side, pin 1 of DOT SET is grounded, making all its inputs low and its output high. This high, applied to pin 6 of DOT 1, makes pin 5 of DOT 1 go low, which in turn



Ultra-compact construction was not attempted in this keyer, although the volume could be reduced considerably if desired. The power supply occupies the rear section of the 4 X 5 X 6 box. The integrated circuits are mounted on the insulating circuit board near the front panel.

causes the output of DOT 2 to go high, thus holding DOT 1 in the present state, with its output low. The dot memory is now set. The operation of DASH SET, DASH 1 and DASH 2 is identical for storing a dash.

Sequence And Control

The gates DOT NEXT and DASH NEXT insure that the first memory actuated is the first memory cleared. Both of these gates have a low output when neither memory is set. If a dash has been previously memorized (pin 5 of DASH 1 low), the high from pin 14 of DASH NEXT to pin 13 of DOT NEXT prevents a dot from being sent at this time. If no dash has been memorized, the low at pin 13 of DOT NEXT, together with the low to pin 12 from DOT 1 when set by the paddle, causes the output of DOT NEXT to go high. This high to pin 7 of DOT KEY makes its output low, allowing DOT GEN to begin keying a dot at the next pulse from the time base. Operation for a dash is similar, except that the high output from DASH NEXT activates both DOT KEY and DASH KEY to form a dash.

Reset

Either memory must be reset immediately upon completion of its character, and this is the function of gates INV, DOT RESET and DASH RESET. The output of gate OUT, which is high during key down, is an input to all three of these gates, and at the end of a character an extremely fast pulse is delivered to the dot or the dash memory, depending upon which character was being sent. The 200-pf. capacitor is an important factor in determining the length of this pulse, which must be neither too long nor too short. The memory that gets the reset pulse is determined by input 6 to DOT RESET and input 12 to DASH RESET. Both of these inputs cannot be high at the same time. Assuming from the previous discussion that a dot is being sent, the output of DOT NEXT is high, forcing the output of DASH NEXT low (through input 13 of DASH NEXT), regardless of the state of DASH 1 and DASH 2. The low from DASH NEXT to pin 6 of DOT RESET allows the fast reset pulse to be applied to DOT SET and DOT 2, forcing a reset of the dot memory regardless of the state of the paddle, and allowing a dash to be sent next if the dash memory is set. If the reset pulse is too long, the dash memory might be reset immediately after the dot memory is reset, due to the change in output from DOT NEXT. If the paddle is held continuously to the dot side, the dot memory stays set except during the extremely short reset pulse. If a squeeze paddle is used with both contacts closed simultaneously, then during the reset of one character the memory for the other character is allowed to take control, resulting in alternate dots and dashes.

Power Supply

Early consideration was given to a regulated power supply, to provide a ripple-free tone from the monitor. It proved to be a necessity as well, to keep the large change in load during key-down conditions from affecting the pulse generator. Three Nicad cells of the "D" size could probably be used if a silicon diode were placed in series with the battery to drop the resulting 4.12 volts down to 3.62 volts. Whatever power arrangements are made, the circuit should be supplied with about 3.6 volts d.c. at 250 ma., with minimal ripple.

Construction

No special effort was made to miniaturize the keyer. The unit is housed in a 6 × 4 × 5-inch aluminum utility box with plenty of room to spare. A piece of unpunched, unclad epoxy fiberglass board was obtained, and all components were mounted on this board by drilling holes for the leads and then connecting to them on the other side of the board. Layout is not critical, but it seems better not to crowd the ICs too closely together, or it will be difficult to get the wiring connected to them. Due care should be exercised when soldering to the pins of the ICs—use a low-wattage iron and complete the soldering operation as quickly as possible.[3] The transistors used were readily obtainable from the same source as the integrated circuits, but any high-frequency silicon transistors should be satisfactory. The driver transistor, Q_5, in the power supply should be capable of at least 300 mw. dissipation. No difficulty with r.f. sensitivity has been encountered so far, using the amount of bypassing shown.

The keyer has been used on the air almost every night for the past several months, with very satisfying results. The speed control is not particularly linear, but the values of R_3 and R_4 can be adjusted to provide almost any desired range. No weight control is necessary with this type of key, although one could be added if desired (Fig. 2). Some difficulty in getting the proper weight was experienced in the beginning at my station, and the problem turned out to be a slightly-long time constant in the differential keying circuit of the transmitter in use.

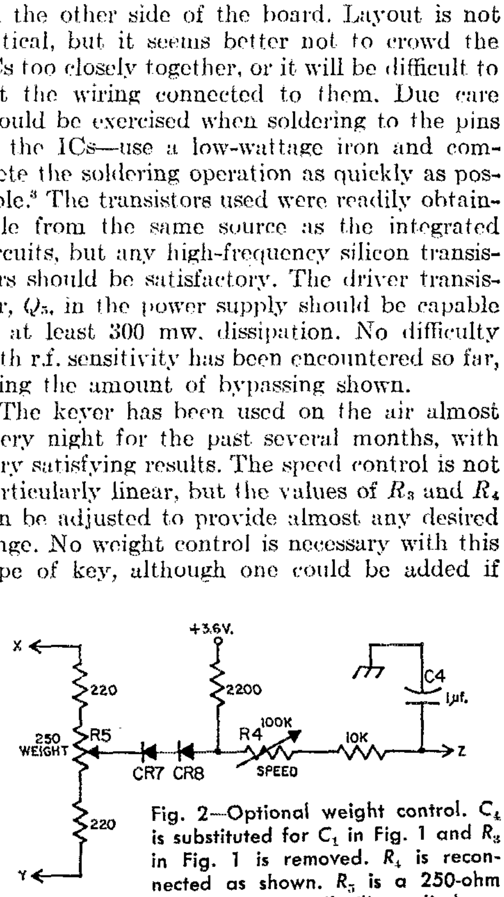


Fig. 2—Optional weight control. C_4 is substituted for C_1 in Fig. 1 and R_3 in Fig. 1 is removed. R_4 is reconnected as shown. R_5 is a 250-ohm linear control CR_7, CR_8—Any small silicon diode.

I wish to thank Bob Spindel, WA1HSN, for the advice, helpful criticism, and moral support he supplied during the construction and testing of the keyer. QST

[3] A simple heat sink for use during soldering can be made from a small piece of copper sheet. See "Hints & Kinks," *QST*, September, 1968.