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Popular Electronics

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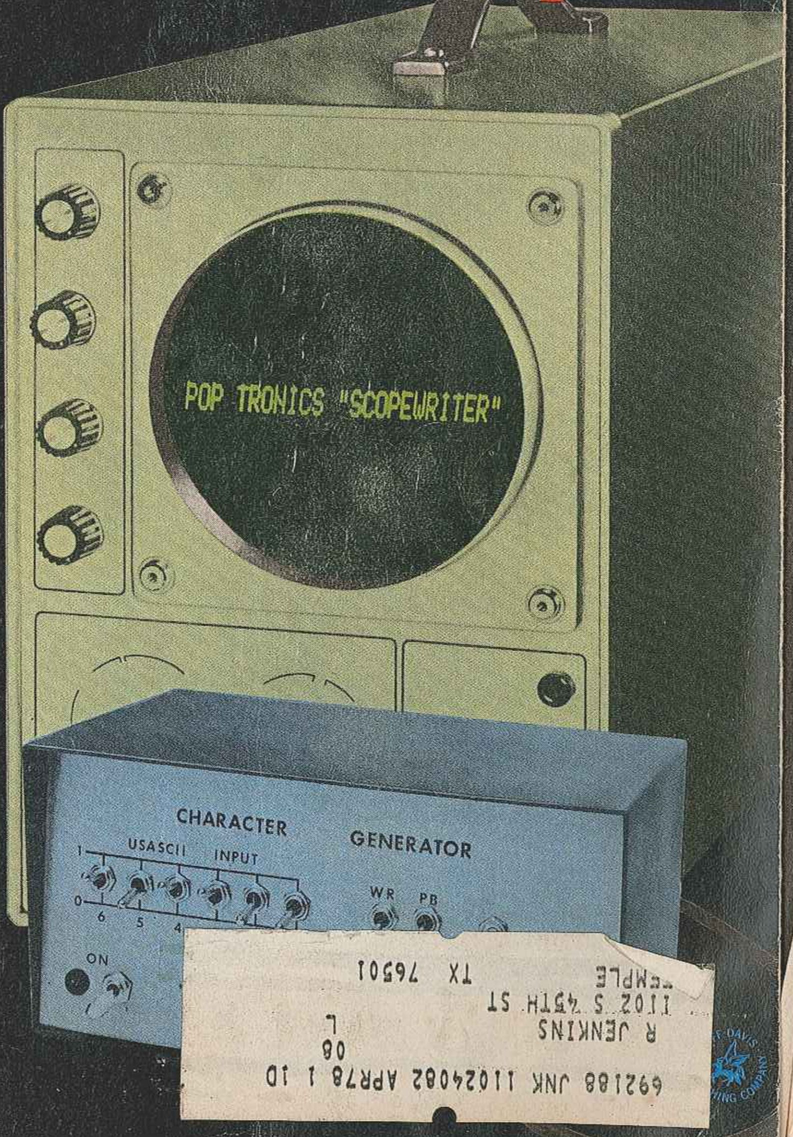
Starting this issue: NEW BIG SIZE

A Breakthrough Project!

Add the "Scopewriter" to any Oscilloscope

PE TESTED



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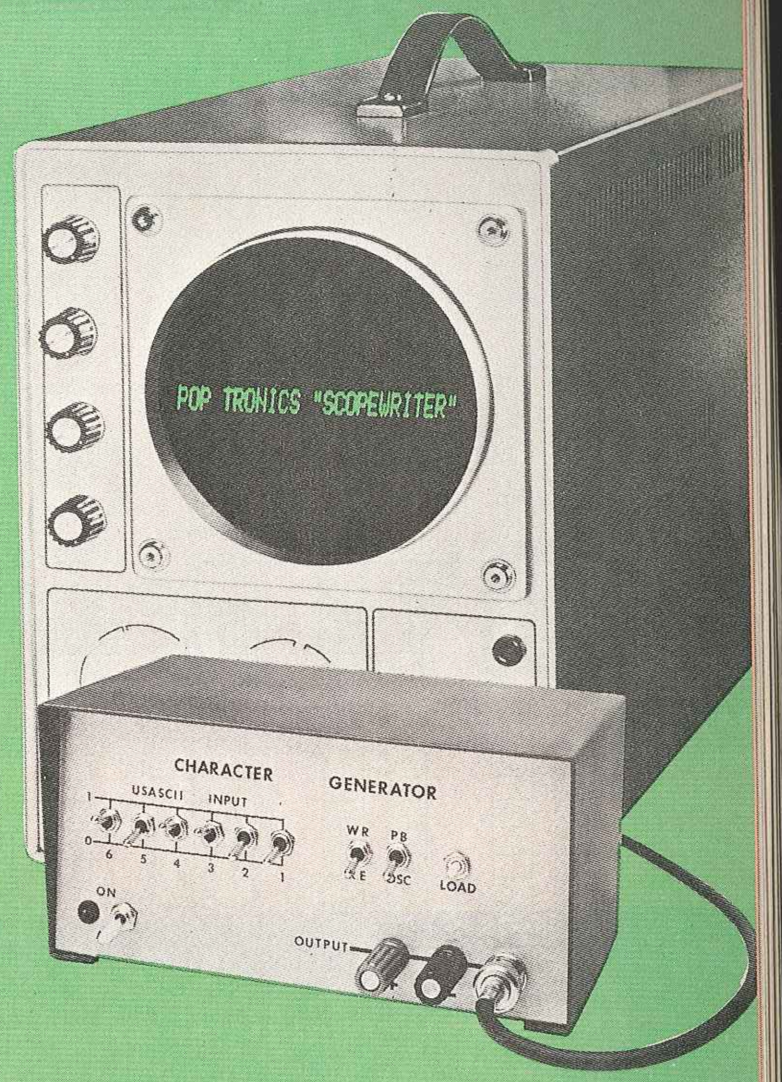

Breakthrough Project!

Now you can convert any oscilloscope to display alphanumerics with this unique under $50 character generator

the "Scopewriter"

BY GARY STEINBAUGH

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CONSTRUCTION PROJECT

WE HAVE all been fascinated, at one time or another, by those video displays in banks and airline offices that print out alphanumeric information received from a central computer. Now you can have your own character generation system at low cost. With it, you can communicate with a fellow hobbyist over the telephone lines. Your messages to each other can be printed out on a standard oscilloscope CRT. And, if you're a ham, character-coded messages can be sent and received over the air, with CRT printout. The system can also be an inexpensive boon for the deaf and mute, of course.

The "Scopewriter" will display any of 64 different characters in a message up to 32 characters long on a common CRT. (It can be used with a TV screen, but the application is somewhat more complex.) The Scopewriter uses large-scale integrated circuits so it is easy to build and it can be very simply connected to the scope's Y-axis input. Although it uses switch addressing, it will accept conventional ASCII keyboard inputs. (See "ASCII Keyboard and Encoder," April 1974.)

It is not necessary to use the Scope writer with special display oscilloscopes because of the sweep and blanking techniques employed. The scope's internal sweep supplies horizontal deflection while a ramp generation circuit supplies vertical deflection to form a raster. When the logic indicates a space, the ramp is disconnected and the scanning dot is rapidly deflected beyond the top of the screen. The resulting vertical traces are very

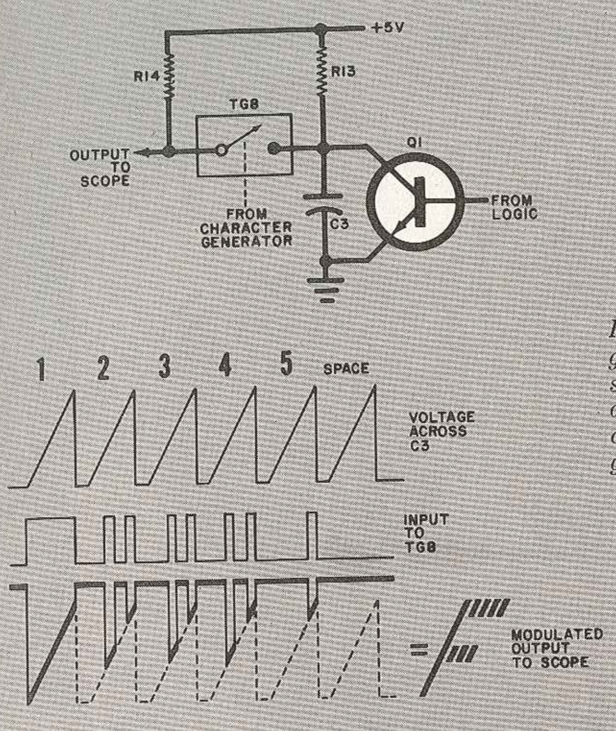


Fig. 1. Basic character generating circuit is shown above. Waveforms at left show how the capital letter F is generated.

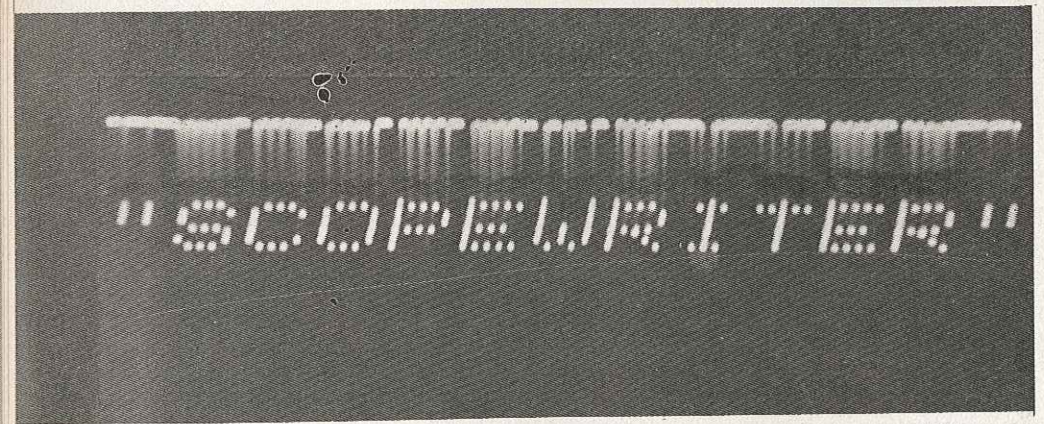


Photo of scope CRT shows letters as printed out by Scopewriter. During rapid transitions to the +5-volt level (at top), the trace is very dim.

dim and do not interfere with the character being formed. An internal memory, using a standard computer code, stores the character shapes and the line of alphanumerics selected.

Generating Characters. The basic modulator circuit is shown in Fig. 1. Also shown are waveforms describing how a character is generated on the CRT. Capacitor *C3* charges up through resistor *R13* to form the leading edge of a sawtooth waveform. Other logic circuits in the system turn on switching transistor *Q1* to short out the charge on *C3* and produce the rapid trailing edge of the sawtooth. The frequency of the sawtooth wave is selected to be about 25 kHz so that it will match the persistence of the phosphor found on most scope CRT's.

The sawtooth output is connected to the scope's vertical input through a high-speed electronic switch, which we call here a transmission gate (symbol *TG*). When this switch is open, the scope line is at +5 volts through *R14*. When the switch is closed, certain selected portions of the leading edge of the sawtooth are applied to the scope. The portions selected are determined by the closing of *TG8* to allow the signal to pass. The operation of *TG8* is determined by a signal from a digital generator whose synchronized output pulses look like the center waveform of Fig. 1. (The particular waveforms shown here are used to generate the capital letter F.) Note that six sawtooth signals are used to define one character—five for the character itself and one for the space after the character.

During the first sawtooth, the entire leading edge of the waveform is allowed to pass to the scope, thus producing the sloping left-hand line of the F. The next five intervals use digital pulses that allow different points on the slope to produce dots that define the horizontal elements of the character.

With the high speed of the scope's horizontal sweep, the dots appear close together to make the letter readable. Where the scope trace remains on to make long lines, the trace is bright; during rapid transitions (to the +5-volt level), the trace is dim. This gives the characters an appearance of "hanging" below a line.

The digital generator is actually a MOS read-only-memory (ROM) whose contents are permanently programmed at the time of manufacture

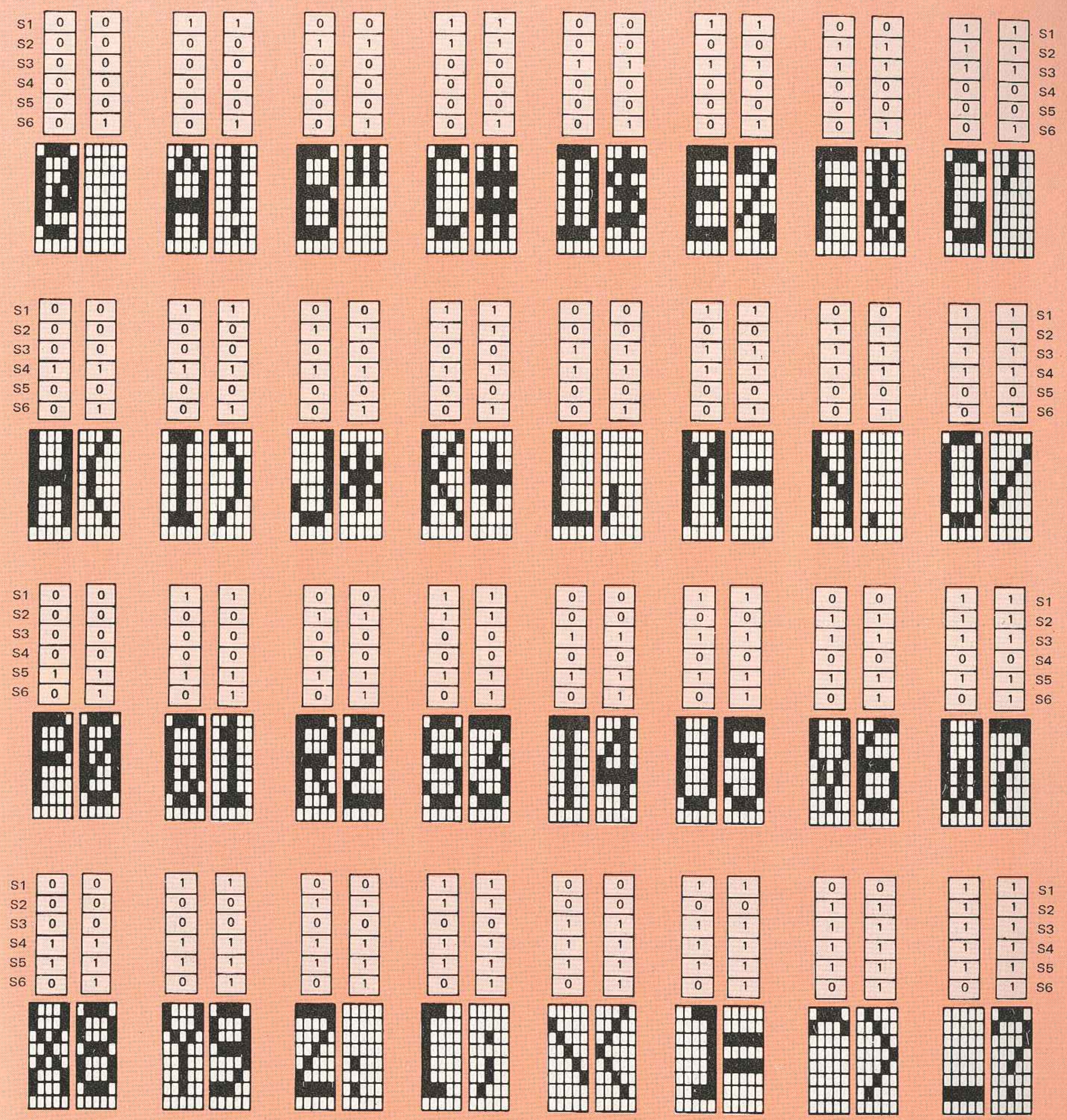


Fig. 2. The 64 characters that can be generated and the required ASCII inputs.

and can't be changed. However, they can be read out when desired. The 64 alphanumeric characters are stored in the form of a matrix of five columns and seven rows (an eighth row is not used). The columns appear as five output lines which are switched through their respective seven rows by three input lines and a row decoder. An additional six input lines and a character decoder select one of the 64 characters.

The 64 characters and the required ASCII inputs are shown in Fig. 2. Figure 3 shows the internal arrangement of the ROM.

Circuit Operation. The complete schematic of the Scopewriter is shown in Fig. 4. Two NOR gates (formed by portions of *IC1*), in conjunction with *C1*, *R3*, and *R4* form the 25-kHz oscillator. The oscillator output drives two flip-flops (*IC2*) to produce a 3-bit binary count. The latter is connected to the character generator (*IC6*, pins 21, 22, and 23) to run the ROM outputs through their seven rows in the proper sequence.

The sawtooth generator is made up of *Q1*, *C3*, and *R13*. The base of *Q1* is driven by a pair of transmission gates (*TG6* and *TG7*) arranged as an AND gate. (The transmission gates are in *IC4* and *IC5*.) The AND gate is driven by the 3-bit binary counter. The voltage across *C3* increases until it is shorted

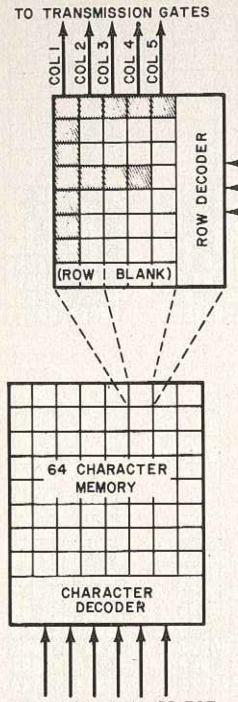


Fig. 3. Diagram showing internal arrangement of the character generator read only memory (IC6).

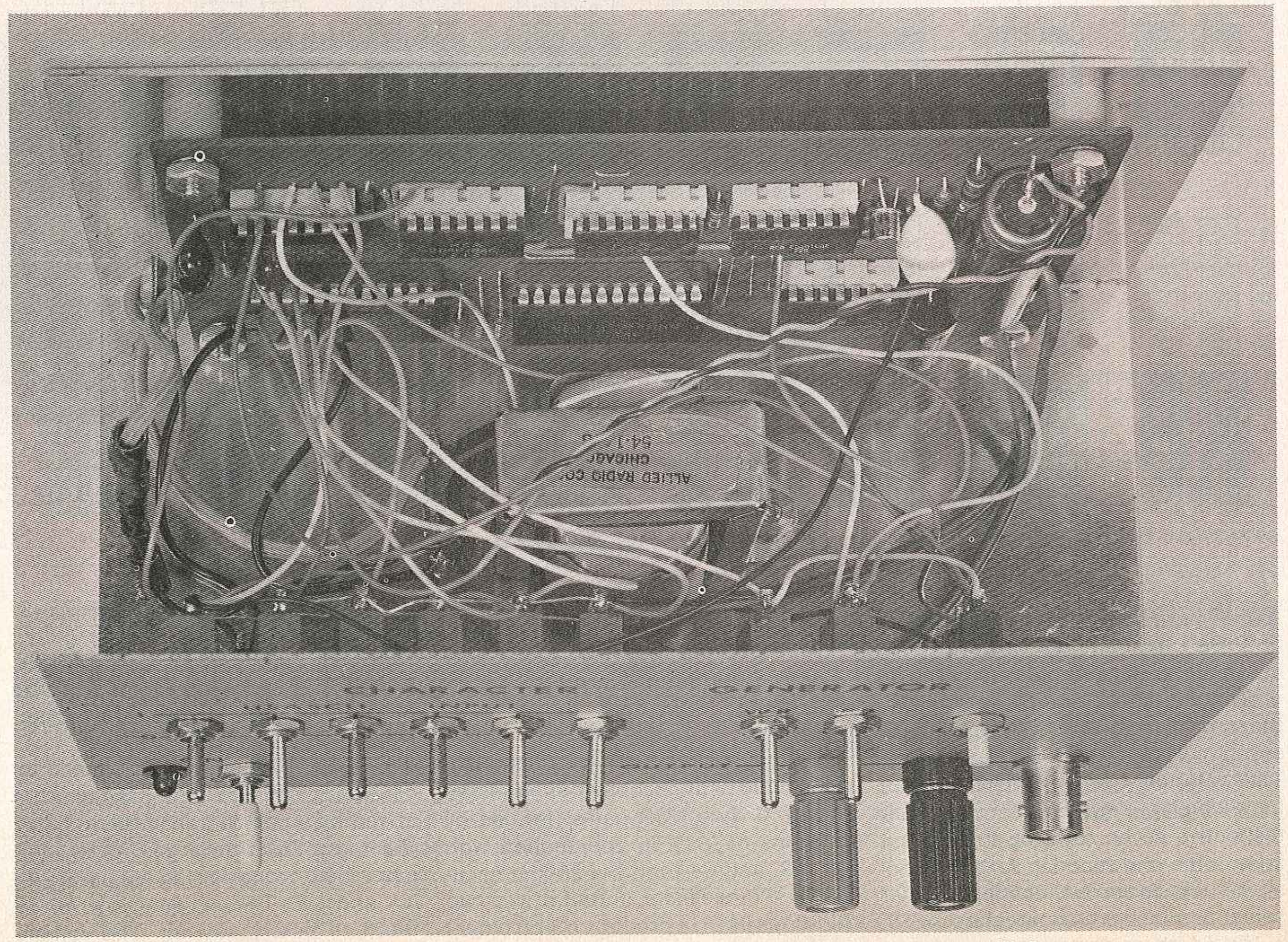
by *Q1* on the eighth binary count. The cycle then repeats to produce the sawtooth waveform.

The output of the last *IC2* flip-flop triggers a divide-by-8 counter (*IC3*) which is connected so that it resets itself on the seventh count, producing a divide-by-6 counter. The five outputs of *IC3* turn on *TG1* through *TG5*, which are connected to the five ROM outputs, to provide the output code one column at a time.

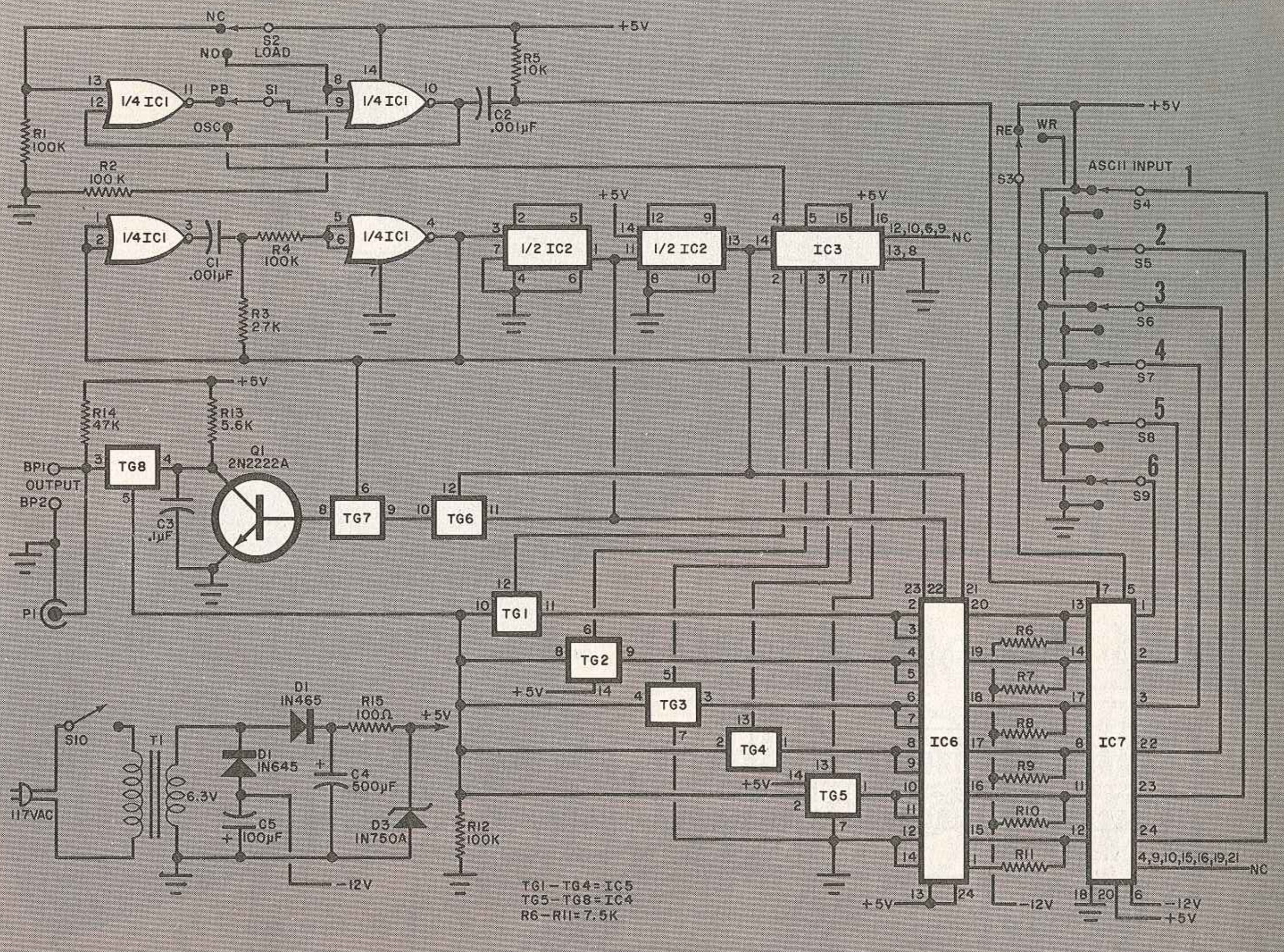
The six character inputs to the ROM are supplied by shift register *IC7*. Resistors *R5* and *R6* through *R11* and capacitor *C2* provide the correct conditions for the shift register. The latter is analogous to six long tubes, each capable of holding a string of 32 binary 1's and 0's. When triggered by a clock pulse, each tube takes in a new bit (either 1 or 0) while pushing one bit out the other end. A write recirculate switch (*S3*) connects the end of each tube to its input so that none of the bits is lost. Instead they flow around, forming a memory for the message.

The clock pulses come from the divide-by-6 counter (*IC3*) through *S1* and ¼ *IC1* when a character is completed. The clock pulse can also come from switch *S2* through the debounce circuit made up of two sections of *IC1*. Pushbutton switch *S2* is used to enter a message one character at a time.

Construction. Although the circuit can be assembled using point-to-point wiring, the use of a pc board, such as that shown in Fig. 5, is recommended. This illustration also shows the component layout. Use a low-power soldering iron and fine solder and be sure to install the jumpers where indicated. Observe the notch code for positioning IC's and the polarity markings on electrolytic capacitors. The use of sockets for the IC's is also recommended. Although they are protected against damage due to static buildup, it is good practice to handle them as little as possible and insert them as the last step in construction.



This photo shows how the prototype of the character generator was assembled.



PARTS LIST

BP1, BP2—5-way binding post (red and black)
C1, C2—0.001-μF, 50-volt Mylar capacitor
C3—0.1-μF, 50-volt, Mylar capacitor
C4—500-μF (or larger), 15-volt electrolytic capacitor
C5—100-μF (or larger), 15-volt, electrolytic capacitor
D1, D2—1N645 silicon rectifier diode
D3—1N750A, 4.7-volt, ½-watt zener diode
IC1—4001 CMOS quad 2-input NOR gate
IC2—4013A CMOS dual D flip-flop
IC3—4022A CMOS divide-by-8 counter
IC4, IC5—4016A CMOS quad bilateral switch (transmission gate)
IC6—TMS2501NC ROM character generator (Texas Instruments)
IC7—TMS3112NC hex 32-bit static shift register (Texas Instruments)
P1—BNC connector (optional)
Q1—2N2222A transistor
R1, R2, R4, R12—100,000-ohm, ¼-watt resistor
R3—27,000-ohm, ¼-watt resistor
R5—10,000-ohm, ¼-watt resistor
R6-R11—7500-ohm, ¼-watt resistor
R13—5600-ohm, ¼-watt resistor
R14—47,000-ohm, ¼-watt resistor
R15—100-ohm, ½-watt resistor
S1, S3-S9—Dpst toggle switch (miniature)
S2—Spdt momentary-action pushbutton switch
S10—Spst switch
T1—Filament transformer; sec: 6.3. V, 0.6A (Allied Radio 6K32HF or similar)
Misc.—LED and current-limiting resistor (optional), suitable chassis, line cord, spacers, mounting hardware, press-on type, rubber feet (4), etc.
Note—The following are available from Systems West, Inc., 900 Dartmouth Dr., NE, Albuquerque, NM 87106: pc board (SWPC) at $4.95; electronics kit with pc board and semiconductors (SWE) at $49.95; complete kit including prepunched case at $79.95; assembled unit (1-year warranty) at $99.95; compatible ASCII keyboard at $39.95.

Fig. 4. This is complete schematic, including power supply, of the Scopewriter.

The photograph shows the front panel of the prototype. Mount the ASCII input switches (*S4-S9*) in a row, with the top positions marked 1 and the bottom position 0. An optional LED power-on indicator can be mounted on the front panel. (Use a current-limiting resistor for the LED.)

The transformer can be located in any convenient part of the enclosure.

Although both binding posts and a BNC connector were used for the output on the prototype, either one or some other type of terminal can be used.

Testing and Operation. Connect *BP1* to the scope vertical input and *BP2* to the scope ground. (If you use the BNC connector, the proper connections will be made automatically.) Turn on the scope and set the horizontal sweep for about 10 ms. When the Scopewriter is turned on, a line should appear on the CRT with random characters below it. Adjust the sweep

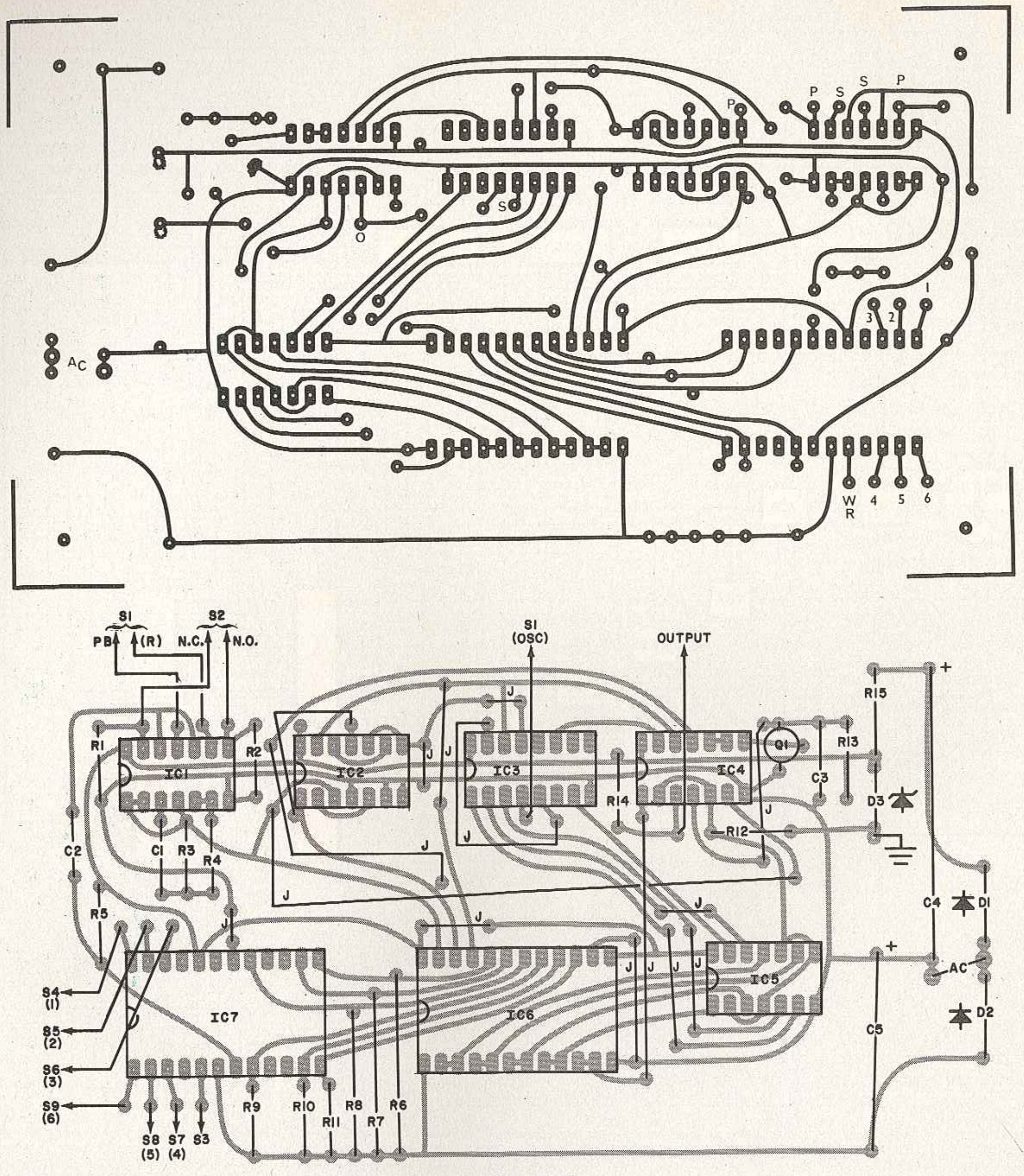


Fig. 5. Though the Scopewriter can be assembled on perforated board, a printed circuit board is recommended. Actual-size foil pattern is at top, component layout shown beneath it.

vernier so that the characters are stationary, and adjust the scope's intensity control so that the blanking lines are not too prominent. Use the scope's vertical gain to vary the character height.

To enter a message, perform the following steps, using the ASCII character coding shown in Fig. 2. Note that the six-element code starts with 6 (*S9*) on the left and proceeds to 1 (*S4*) on the right.

1. Place the switches in the 100000 position. This should produce a blank.
2. Set *S1* (PB/OSC) on OSC.
3. Set *S3* (WR/RE) on WR. This clears the memory.
4. Set *S1* to PB.
5. Insert a code on the ASCII switches for some specific character and press *S2* (LOAD) to enter the code into the memory. You can insert up to 32 characters, including blanks.
6. Place *S3* on RE.
7. Place *S1* on OSC. The message should appear on the CRT. Adjust the horizontal sweep/sync to position the message.

Should you notice a mistake in spelling within the message, perform the following steps to erase the wrong character and insert the correct one.

1. Set *S1* to PB. One of the characters (or spaces) will appear repeated across the face of the CRT.
2. Operate the LOAD switch to step through the message until the desired character appears.
3. Set the ASCII input switches for the correct character.
4. Set *S3* to WR.
5. Depress the LOAD switch to insert the correct character. Note that the next character in the message appears.
6. Set *S3* to RE.
7. Set *S1* to OSC. The entire corrected message should now appear.

Conclusion. The breakthrough project presented here is only the beginning of a variety of projects that POPULAR ELECTRONICS will present in this area, using read-only-memories for display purposes. ◈

Hirsch-Houck Labs TESTS THE NEW 'PREMIUM' CASSETTE TAPES

By Julian D. Hirsch

A CASSETTE deck is no better than the tape used in it. Hence, it is not surprising that tape manufacturers are continually improving their products to keep pace with, or even get ahead of, the steady improvements made in the recorders themselves.

Currently, a number of "premium" cassette tapes are available to tape recordists. Since they are priced higher than "standard" tapes, it is normal to ask what practical sonic advantages they have.

To find an answer to the question, we tested several of these tapes, from different manufacturers, on a single high-quality cassette recorder. The relative performances of the tapes should be valid in any machine, though the specific results we obtained would probably not be duplicated on any other make of recorder.

Tapes Tested. We did not attempt to test every "high-evergy" or "low-noise" tape on the market. The ones we chose are representative of the available premium-grade cassettes. As a control, we used an Audio Magnetics cassette marketed for audio-visual applications in schools under the name "AV Educator." This tape is similar in its bias requirements to the few standard hi-fi tapes we have been able to identify.

The tapes arbitrarily chosen for testing were:

Brand	Model
Ampex	363
BASF	LHSM
Capitol	2
Memorex	MRX2
TDK	SD
TDK	ED

The Ampex 363 is a chromium-dioxide tape which was included to provide a second frame of reference (All American-made CrO_2 cassettes use Dupont Crolyn ® tape and have similar magnetic properties.) The other tapes are all ferric-oxide, high-output types, though the new TDK ED is modified with magnetite which is said to improve its magnetic qualities.

The recorder's "regular" bias was optimized for the test's control tape, while its CrO_2 bias was correct for the Ampex tape. The bias was not changed throughout the tests.

Our purpose was to find as many dif-