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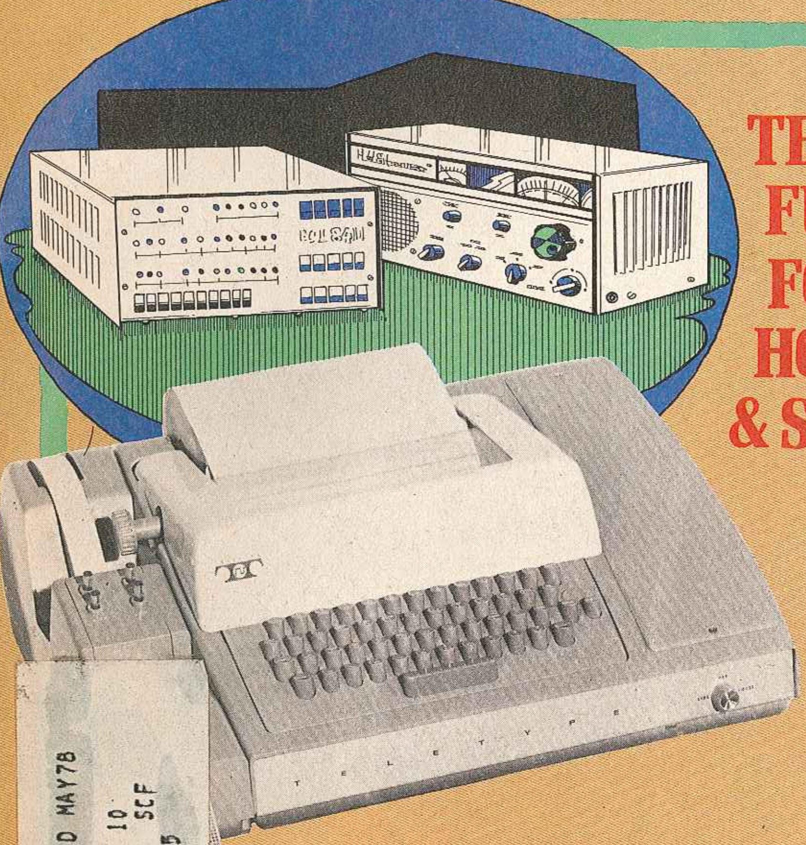

TELETYPEWRITER FUNDAMENTALS FOR COMPUTER HOBBYISTS, HAMS & SWL'ers

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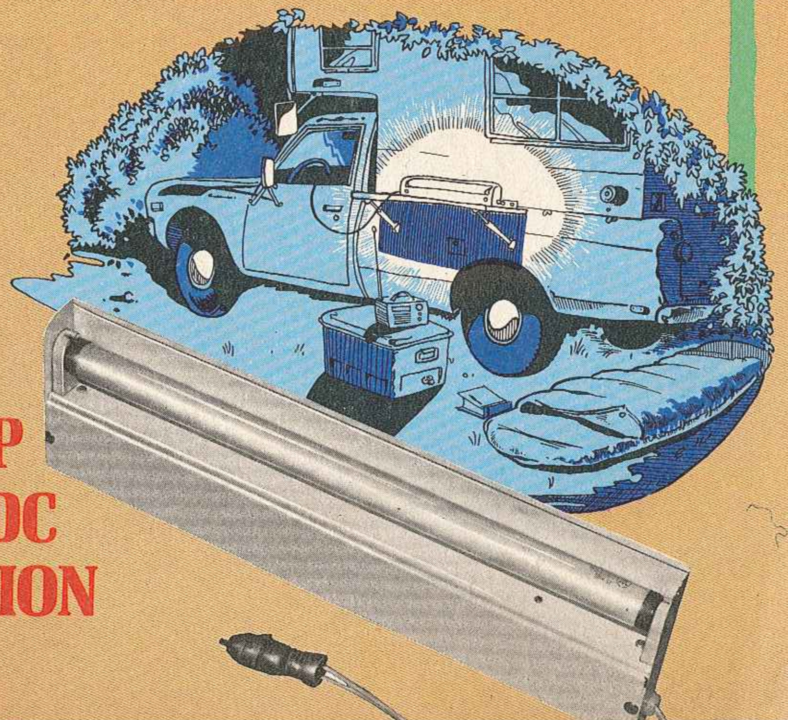

BUILD A FLUORESCENT LAMP FOR 12 VDC OPERATION

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Popular Electronics

BY LARRY KAHANER

How RTTY equipment works and how to get started using it.

TELETYPEWRITER FUNDAMENTALS FOR HAMS, SWL'ers & COMPUTER HOBBYISTS

HAVE you ever wondered about those strange "deedle-deedle" signals on the shortwave bands? They are actually radioteletype (RTTY) transmissions. You can receive them using your communication receiver and readily available teletypewriter equipment. In this article, we will cover the basics of radioteletype and detail how to set up an RTTY listening post at home.

The Teletype Code. All teletypewriters, whether they communicate by radio or land-line links, "talk" to each other in a language called Baudot, or five-level code. Each character (letter, numeral, punctuation mark) in the Baudot code is uniquely defined by a sequence of five time slots, or *elements*, each of which contains a *mark* or a *space*. For example, the letter A is "mark-mark-space-space-space." When the teletypewriter is operating at 60 wpm (words per minute), each mark or space is exactly 22 milliseconds (ms) long.

A sixth slot is added to the basic five-level code to act as a "flag" that indicates the end of a character. To make this stop flag stand out from the others, its interval is 31 ms instead of 22 ms. Still another time slot is placed at the beginning of each character to give the teletypewriter time to prepare itself for a new character. This is the "start" slot. The 31-ms stop slot contains a mark, while the 22-ms start slot contains a space. A complete character, therefore, consists of seven slots, six 22-ms intervals and one 31-ms interval for a total of 163 ms (see Fig. 1).

The Equipment. A complete station for transmitting and receiving radioteletype signals is shown in Fig. 2. The transmitter and receiver are of conventional "communication" design. The teletypewriter is a combination keyboard/printer. On transmit, the keyboard drives a keyer that, in turn, modulates the transmitter. On receive, signals are coupled from the communication receiv-

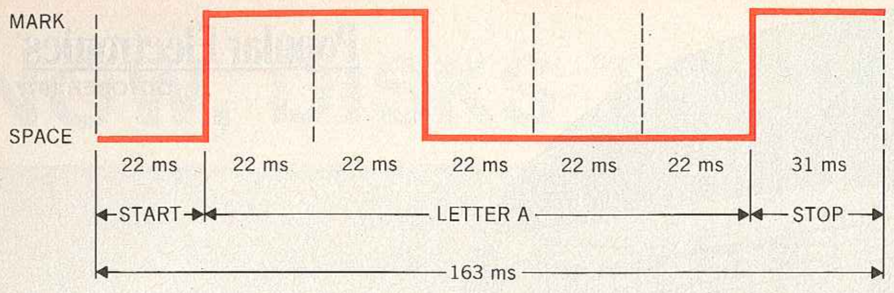


Fig. 1. Waveform showing the pulse sequences that make up the letter "A".

er to the demodulator or terminal unit (TU), which drives the printer.

Now let us examine each component in the system in detail:

Keyboard. A mechanical teletypewriter keyboard resembles the keyboard on a conventional typewriter, but its operation is quite different. When a key is operated, it selects mechanical levers that produce mark and space pulses that correspond to the key's character. Also, there are no lower-case letters—all are capitals. To type punctuation marks, the SHIFT key is pressed first, followed by operation of a key that corresponds to the character you wish to type.

The diagram in Fig. 3 illustrates how one keyboard might work. Each key has a notched lever, which when pressed down can touch five "fingers" that will be either depressed or not, depending upon the notch positions of the lever.

After the key is pressed and the mark and space levers have moved accordingly, a wiper arm sweeps across the mark levers but cannot touch the space levers. An electrical connection is made between the wiper arm and mark fingers, but no current can flow on the spaces. The motion of the wiper arm is controlled by a motor so that it touches each lever for exactly 22 ms. This results in the five-element code described above. Start and stop commands are generated automatically by the keyboard.

The above process is typical of keyboard operation, but it is not absolute. There are variations in keyboard design from one teletypewriter to another. The latest generation of teletypewriters, however, uses electronic instead of electromechanical means for generating the Baudot code. Digital matrix keyboards with clock-controlled digital IC's that generate precisely timed code elements have recently become common.

Transmitter Keying. Dc pulses produced by the keyboard drive a keyer that, in turn, modulates the transmitter. Most often used is frequency shift keying (FSK), a form of frequency modulation. Transmission of FSK signals allows the use of FM demodulation techniques so that there is some discrimination against noise.

When a transmitter is FSK modulated, two output frequencies result, one at the carrier frequency and the other at a slightly lower frequency. The simplest way to accomplish the frequency shift is to add more capacitance to the transmitter's vfo tank circuit or in parallel with the oscillating crystal. In practice, the dc pulses from the keyboard control a relay or solid-state switch that rapidly connects and disconnects the additional capacitor. Hence, the transmitted frequency varies in step with a character's mark and space code.

Most commercial systems employ a 425-Hz shift. A 170-Hz shift is common on the hf amateur bands, but FCC regulations allow use of any shift up to 900 Hz. For example, if the carrier frequency is 15.000000 MHz and the shift is 425 Hz, the output frequency will alternate between 15.000000 and 14.999575 MHz. By convention, the space is the lower and the mark the higher frequency. In this example, marks appear at 15.000000 MHz and spaces appear at 14.999575 MHz.

Receiving FSK. A bfo (beat frequency oscillator) is commonly used for CW reception. The bfo generates a signal that beats against the incoming CW signal to produce an audible tone. If the frequency of the bfo's output is variable, the frequency of the audible tone can be changed. In RTTY communication, signals are received as in ordinary CW, but the bfo is tuned to provide 1275- and 1700-Hz tones, which are 425 Hz apart.

The reason for using 1275- and 1700-Hz tones is that a terminal can demodulate only one pair of frequencies at a time. This pair was chosen by TU manufacturers for demodulation of a 425-Hz shift. (However, you can adjust the bfo or the main tuning knob if the bfo is fixed to produce any pair of tones your TU can demodulate.) Other shifts and tone pairs used in RTTY communication are listed in Table I.

The new breed of teleprinter equipment: Morse and RTTY keyboard (left), demodulator (right bottom), video display unit (right top) and video monitor (top center). Courtesy HAL Corporation.

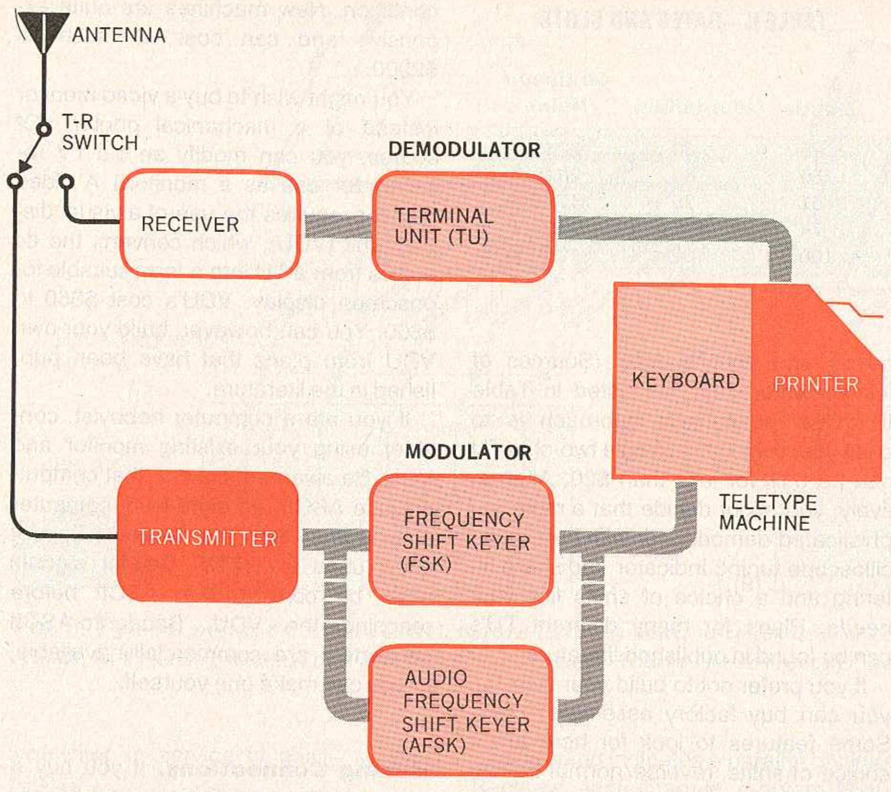


Fig. 2. Block diagram of the equipment in a complete RTTY station.

An RTTY terminal unit looks and acts like an FM receiver, but it accepts audio signals. Called an *audio TU*, its block diagram is shown in Fig. 4. The limiter accepts the audio outputs of the receiver and amplifies and clips them to keep the signal level fairly constant. Mark and space filters remove any extraneous signal content. The two filtered tones are converted into dc pulses by the audio discriminator. Any ripple on the dc pulses is smoothed by the low-pass filter. The dc pulses are then applied to the keyer, which uses them to generate commands for the printer's magnets.

AFSK. Another method of keying is audio-frequency shift keying, or AFSK. It produces a result similar to FSK but is derived in a different manner. Two audio tones, separated by the frequency shift, modulate an AM or an SSB transmitter. The low-distortion sine-wave tones are applied to the transmitter's microphone input.

If the output from the transmitter is conventional AM, no bfo is required in the receiver. The detected envelope is coupled to the TU from the receiver's audio output. If, on the other hand, SSB equipment is used, the receiver must be carefully tuned for the correct output frequencies and allowances must be made in the transmitter for a 100% duty cycle. As in FSK, the two tones commonly used are 1275 and 1700 Hz.

The Printer. Although printer design varies from one machine to another, the following description is representative of printer operation. A simplified printer is shown in Fig. 5. The selector magnet is energized by each mark pulse. This closes the relay that corresponds to a moving cam connected to each mark and space lever. At the proper time, the cam either pulls down or does not affect the lever. Each lever is connected to a bar with many notches, which are placed at different intervals along the bar.

In the illustration shown in Fig. 5, the first, third, and fifth levers are pulled by the cam. The other levers remain in their original positions. After a character is completed (all five pulses received), one set of notches lines up directly under the appropriate character's striker. (Strikers are in a row, as in a regular typewriter.) When the stop pulse is received, a hammer hits all strikers, but only the one with the lined-up notches moves and imprints the paper. After the strike occurs, the bars and their notches return to their original positions.

The new teletypewriter printers literally do not print at all. They are actually special types of TV receivers that process the dc pulses and apply control signals to form letters on-screen. The advantages of screen printers are that they are quiet, clean, and have no moving

TABLE I—STANDARD SHIFTS AND TONE PAIRS (Hz)

Shift	170	425	850
Space	1275	1275	1275
Mark	1445	1700	2125
OTHER PAIRS IN USE			
Space	2125	2125	2125
Mark	2295	2550	2975

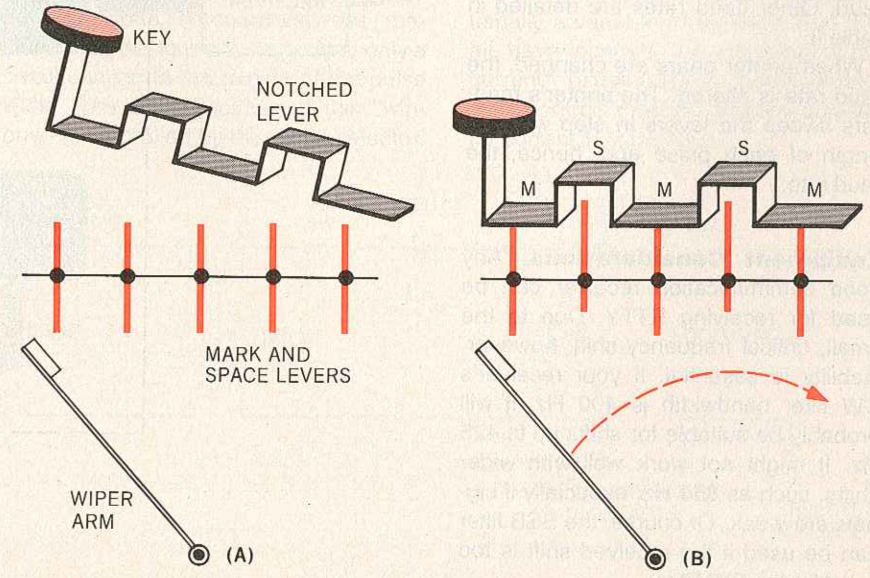


Fig. 3. Simplified diagram shows how key depresses levers at (B).

parts to wear out. Some screen printers have memories that allow storage and playback of messages. These "glass teletypewriters" cannot produce "hard" copy on paper; for this, you must use a regular teletypewriter printer.

Some teletypewriters have perforators that punch holes in 1" (25.4-mm) wide paper tape. The holes in the tape correspond to character codes. Tapes can be made from either an incoming signal or from a message typed on the machine's keyboard. To play back the message, you feed the tape through a tape reader called a transmitter-distributer (TD). The teletypewriter then prints the message. You can also transmit taped messages over the air.

The most commonly used speed is 60 wpm, but stations also transmit at 66, 75, and 100 wpm. To receive different speeds, no changes need be made in the terminal unit, but the printer must be altered. Printers rely on gears to set the speed. Changing gears allows the machine to print at different speeds. TV teletypewriters usually accommodate many speeds with just the turn of a switch.

The number of words per minute tells you only part of the printer's story because each speed requires different slot lengths. A slot for 60-wpm copy is not the same length as one at 100 wpm. So, another word—"baud"—was invented to take slot length into account. The baud is a measure of the rate at which data is sent and is defined as a rate of one pulse (of the shortest duration used in the system) per second. The baud rate is calculated by finding the reciprocal of the shortest slot length. For 60 wpm, the shortest length is 22 ms or 0.022 s; the baud rate is 1/0.022 = 45.5 baud. Other baud rates are detailed in Table II.

When printer gears are changed, the baud rate is altered. The printer's magnets sweep the levers in step with the length of each pulse and, hence, the baud rate.

Equipment Considerations. Any good communication receiver can be used for receiving RTTY. Due to the small, critical frequency shift, however, stability is essential. If your receiver's CW filter bandwidth is 400 Hz, it will probably be suitable for shifts up to 425 Hz. It might not work well with wider shifts, such as 850 Hz, especially if signals are weak. Of course, the SSB filter can be used if the received shift is too great for the CW filter.

Your choice of TU's hinges on your needs and your budget. (Sources of teletypewriter gear are listed in Table III.) One inexpensive approach is to build your own TU. A simple two-chip TU can be built for less than $20. Alternatively, you might decide that a more sophisticated demodulator with built-in oscilloscope tuning indicator and sharp filtering and a choice of shifts fills your needs. Plans for many different TU's can be found in published literature.

TABLE II—RATES AND SLOTS

Bauds	Words/Min.	Millisec./ Pulse
45	60	22.0
50	66	20.0
57	75	17.57
74	100	13.47
100	132	10.0

If you prefer not to build your own TU, you can buy factory assembled units. Some features to look for here are a choice of shifts, reverse/normal switching, filtering, tuning indicator, baud-rate selection, adequate loop current for the printer magnets, and selectivity.

Most RTTY enthusiasts buy "surplus" printer/keyboard combinations. After these machines are used commercially, surplus dealers buy, recondition, and resell them. Old teletypewriters are rugged and, if properly reconditioned, should last a long time. Prices range from $50 to $250, depending on model, age, and condition. New machines are quite expensive and can cost as much as $2000.

You might wish to buy a video monitor instead of a mechanical printer. (Of course, you can modify an old TV receiver for use as a monitor.) A video monitor requires the use of a visual display unit (VDU), which converts the dc pulses from a TU into a form suitable for onscreen display. VDU's cost $350 to $600. You can however, build your own VDU from plans that have been published in the literature.

If you are a computer hobbyist, consider using your existing monitor and VDU. Be aware, of course, that computers use ASCII, an eight-level computer code, rather than the five-level Baudot code used in RTTY. Baudot signals must be converted to ASCII before reaching the VDU. Baudot-to-ASCII converters are commercially available, or you can make one yourself.

Making Connections. If you buy a teletypewriter, be sure you get the manual, because it contains the machine's wiring diagram and color code. Each machine is wired differently. Bear in mind that, in spite of the jungle of wires inside the teletypewriter, only six wires are necessary for RTTY operation. Two are for the motor, two for the printer magnets, and two for the keyboard. Once you locate the appropriate wires, the hookup necessary to put the teletypewriter in service is easily accomplished.

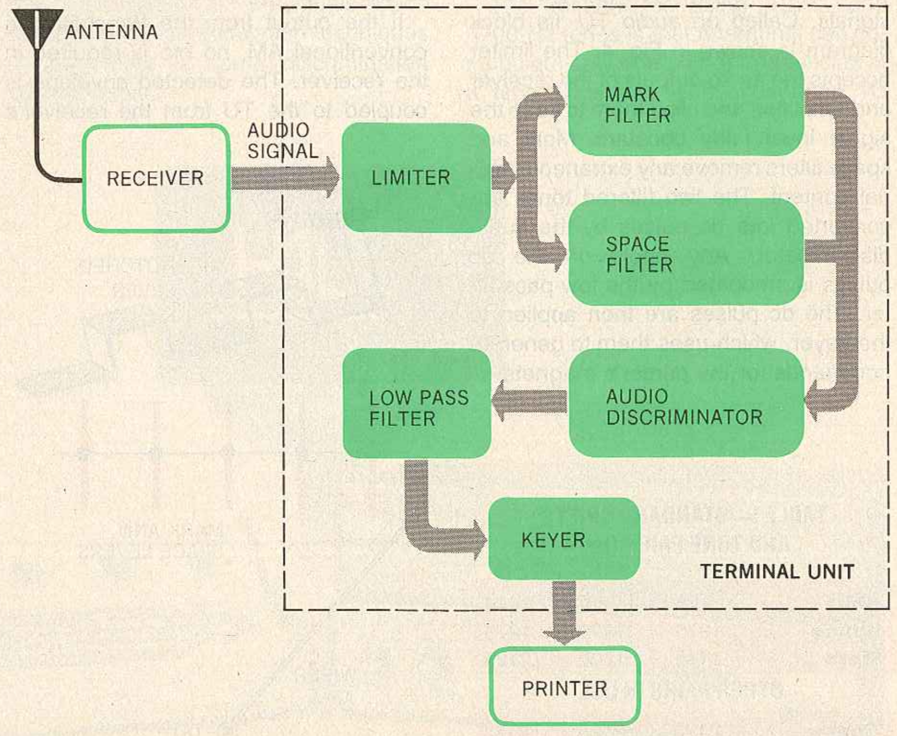


Fig. 4. Block diagram of typical audio terminal unit.

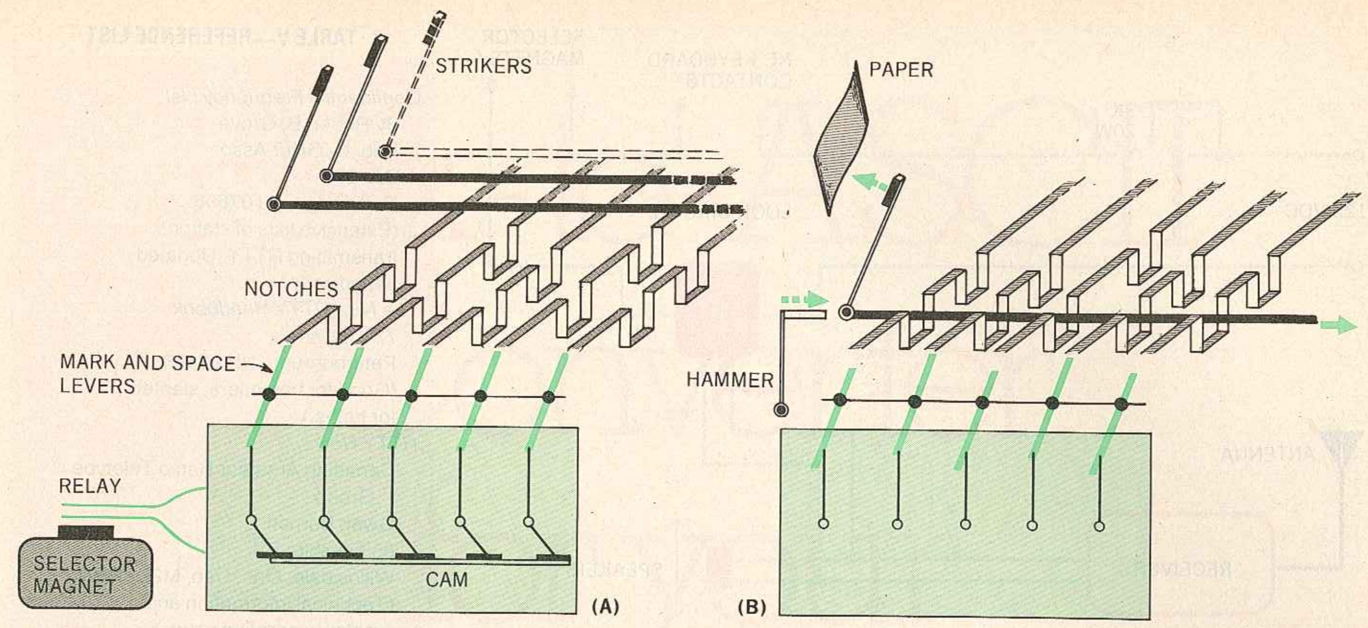


Fig. 5. Typical printer action. At (A), before letter is sent, notches are in random order. At (B), after letter is sent, one set of notches lines up under the correct striker.

Local copy (typing on the keyboard and obtaining a print-out but no transmission) can be accomplished with the circuit shown in Fig. 6. Many teletypewriters employ two selector magnets (check your manual on this) that are connected either in series or in parallel with each other. Use an ohmmeter to check the resistance of the magnet circuit. Each magnet has approximately 100 ohms of dc resistance; so, an ohmmeter reading of 200 ohms indicates a series connection, while a 50-ohm reading indicates a parallel hookup. Because each magnet requires about 30 mA of current, parallel wiring calls for 60 mA in the loop circuit, while series wiring requires 30 mA in the loop. Adjust the series resistor for the proper magnet current.

Turn on the motor by applying 117 volts ac to its winding. With proper magnet current flowing and the motor running, you should be able to type on the keyboard and obtain a printed hardcopy message. If you have trouble obtaining local copy, check your wiring. Garbled or no printing at all could also be caused by poor adjustment of the "range selector."

Sometimes, distortion occurs in RTTY transmissions. Pulses often become longer or shorter because of propagation conditions. To counteract this, machines are designed to respond to only a small section in the middle of the pulse width. The exact location of this "window" is controlled by the range selector, a movable arm that has graduations from 0 to 120.

To test the range selector, type the letters RY. These letters, when alternately typed, produce a mark pulse in each of the five slots. Move the range selector toward 0. As you approach 0, the teletypewriter will begin to lose intelligibility and print random characters. Note the setting at which this occurs. Then increase the setting until the machine's printer "locks up," again noting the setting. Set the range selector midway between these two points.

The terminal unit should be connected as shown in Fig. 7. TU's vary in design, but some share basic characteristics. For example, they all have a method for adjusting the shift frequency, which is usually a variable inductance. And they all have controls for adjusting printer current, usually via a potentiometer. Both controls must be properly adjusted for correct TU operation.

TABLE III—SOURCES OF RTTY EQUIPMENT

Alltronics-Howard
Box 19
Boston, MA 02101

Atlantic Surplus Sales
3730 Nautilus Ave.
Brooklyn, NY 11224

Dovetron
627 Fremont Ave.
S. Pasadena, CA 91030

Fair Radio Sales
Box 1105
Lima, OH 45802

Teletype Corp.
5555 Touby Ave.
Skokie, IL 60076

Typetronics
Box 8873
Fort Lauderdale, FL 33310

Nat Stinette Electronics
890 Virginia Ave.
Tavares, FL 32778

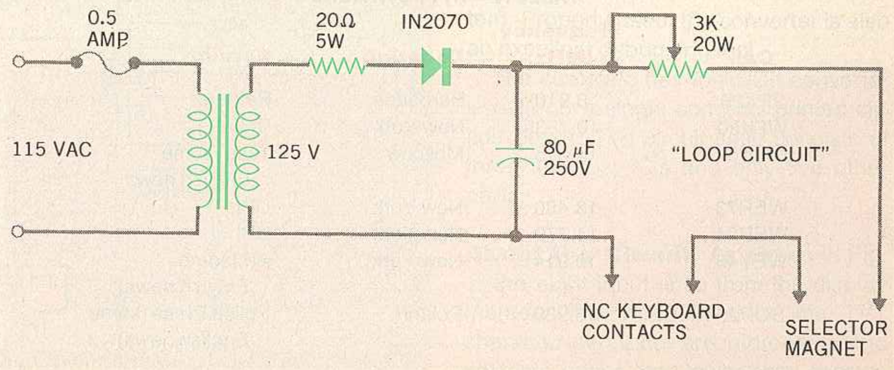


Fig. 6. Local copy can be obtained using the loop circuit shown here.

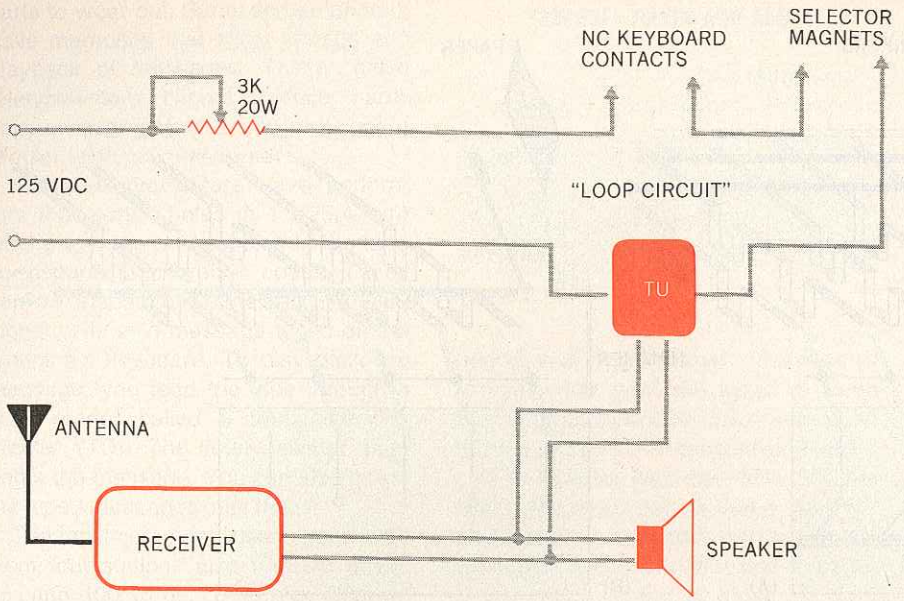


Fig. 7. How to set up an RTTY receiving station with a terminal unit.

Connect the TU to the receiver's audio output, keeping the speaker online so that you can hear the incoming signals. Find an RTTY station and tune it in carefully, using the TU's tuning indicator for accuracy. Because tuning in RTTY stations is tricky, you may get garbled copy until you become accustomed to tuning. Some operators tune until legible copy appears, while others can tune in the proper tones by ear. Either method is fine, but do not expect to be able to emulate this right away. It takes lots of practice.

If you get garbled copy, it may be due to one of several causes. The most common is that the station is transmitting at a different shift or speed from your settings. Again, experienced operators can "hear" different speeds and shifts. You will, too, after a while.

A station might be transmitting in reverse shift, with the space high and the mark low. Switching sidebands on your receiver or shifting the bfo output to the other side of zero beat will compensate for this. Many TU's have a reverse/normal switch that accomplishes the same thing. Military stations often transmit secret cipher messages that look like gibberish. If you are not aware of this practice, you can go crazy trying to copy them.

Listening. At least 200 stations, excluding radio amateurs and the military, transmit RTTY (see Table IV). Most use shifts of 425 to 850 Hz and speeds of 60 to 100 wpm. By tuning to them, you can receive news reports, weather forecasts, and commercial radiograms, as well as conversations between radio amateurs and military traffic. However, you should read Section 605 of the Communications Act of 1934 that concerns secrecy of communications.

In brief, the Act prohibits a listener from divulging to a third party or using for his own or a third party's benefit the contents of any interstate or foreign communication by radio or wire. Note, however, that this section does not apply to the contents of any radio communication broadcast or transmission by radio amateurs or others for use of the public or relating to ships in distress.

Getting Help. Besides the books listed in Table V, there are other sources of information and help to which you can turn. Although relatively few shortwave listeners use RTTY, many hams transmit and receive radioteletype messages. Most of them will be glad to show you the "tricks of the trade" they use to obtain perfect copy. Also, many computer hobbyists use teletypewriters to get hard copy or punch tape. ◇

TABLE IV—RTTY STATIONS

Call	Frequency (MHz)	Location	Service
9PX29	6.910	Barbados	Reuters
WFK80	10.7535	New York	Reuters
RVW57	12.315	Moscow	Tass (some English news
WER73	13.480	New York	UPI
WER24	14.770	New York	UPI
WEY45	15.914	New York	AP (some English news)
SOP29	15.989	Poland	Polish Press (some English news)

Note: Most ham operators use a 170-Hz shift at 60 wpm near 3.620, 7.040, and 14.090 MHz.

TABLE V—REFERENCE LIST

Confidential Frequency List
By Robert B. Grove
Pub. by Gilfer Assoc.
Box 239
Park Ridge, NJ 07656
(Extensive lists of stations transmitting RTTY. Updated periodically.)

The New RTTY Handbook
73 Publishers
Peterborough, NH 03458
(Good for beginners, slanted for hams.)

RTTY News
Canadian Amateur Radio Teletype Group
Gwen Burnett
85 Fifeshire Rd.
Willowdale, Ont., Can. M2L 2G9
(Technical information and amateur operating news.)

Teleprinter Handbook
By D. L. Goacher & J. G. Denney
Radio Society of Great Britain
35 Doughty St.
London, WC1N 2AE, England
(Thorough treatment of RTTY. Large section on machine repair and maintenance.)

RTTY Journal
P. O. Box 837
Royal Oak, MI 48068
(Published 10 times per year. Slanted for the ham, but has classified ads, technical pieces, and a DX-RTTY column. Publishers of *The Beginner's RTTY Handbook.*)

The Radio Amateur's Handbook
and
Specialized Communications Techniques for the Radio Amateur
American Radio Relay League
225 Main St.
Newington, CT 06111

Hex-to-ASCII Converter for your TVT-6

Simple module produces op-code display for entire computer.

BY DON LANCASTER

THE LOW-COST "Hex-to-ASCII Converter" described here allows you to simultaneously display the contents of every register, stack location, and memory slot in your microcomputer. The converter fits easily between the TVT-6 (July 1977) or most any other TVT and the µC with which it is working.

In operation, the video monitor used in the system automatically converts and displays the hex op codes for the ASCII character set. This allows your TVT to act as a super "front panel" that permits you to check as many memory locations as there are in your system. This includes all registers, accumulator, stacks, RAM and ROM programs, I/O, or anything else connected to the system. Properly used, the converter is also an excellent debugging tool.

The complete hex-to-ASCII converter is built on a single compact printed circuit board. The circuit itself consists of three low-cost IC's and only five other parts.

About the Circuit. As shown in Fig. 1, the eight input lines from the display memory that normally drive the TVT character generator are intercepted and split into upper- and lower-case charac-

(Continued on page 51)

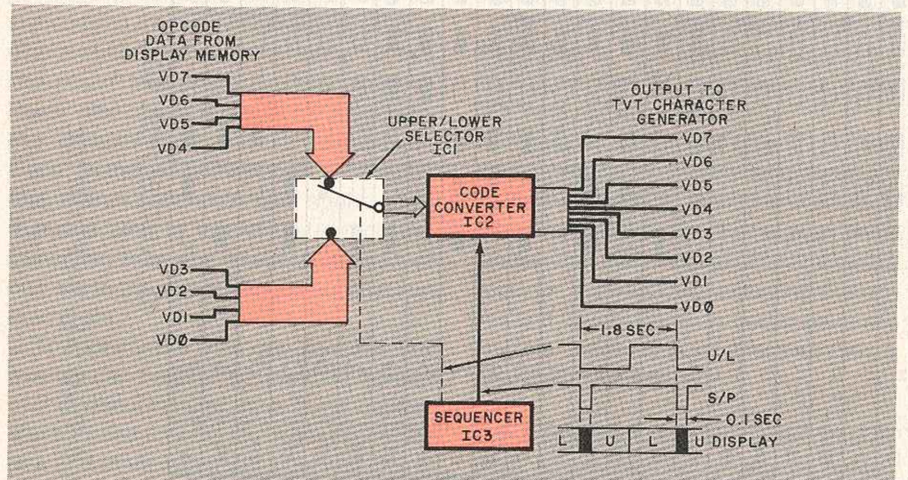


Fig. 1. Block diagram of system. Op code is displayed as brief blank, followed by upper then lower hex character.

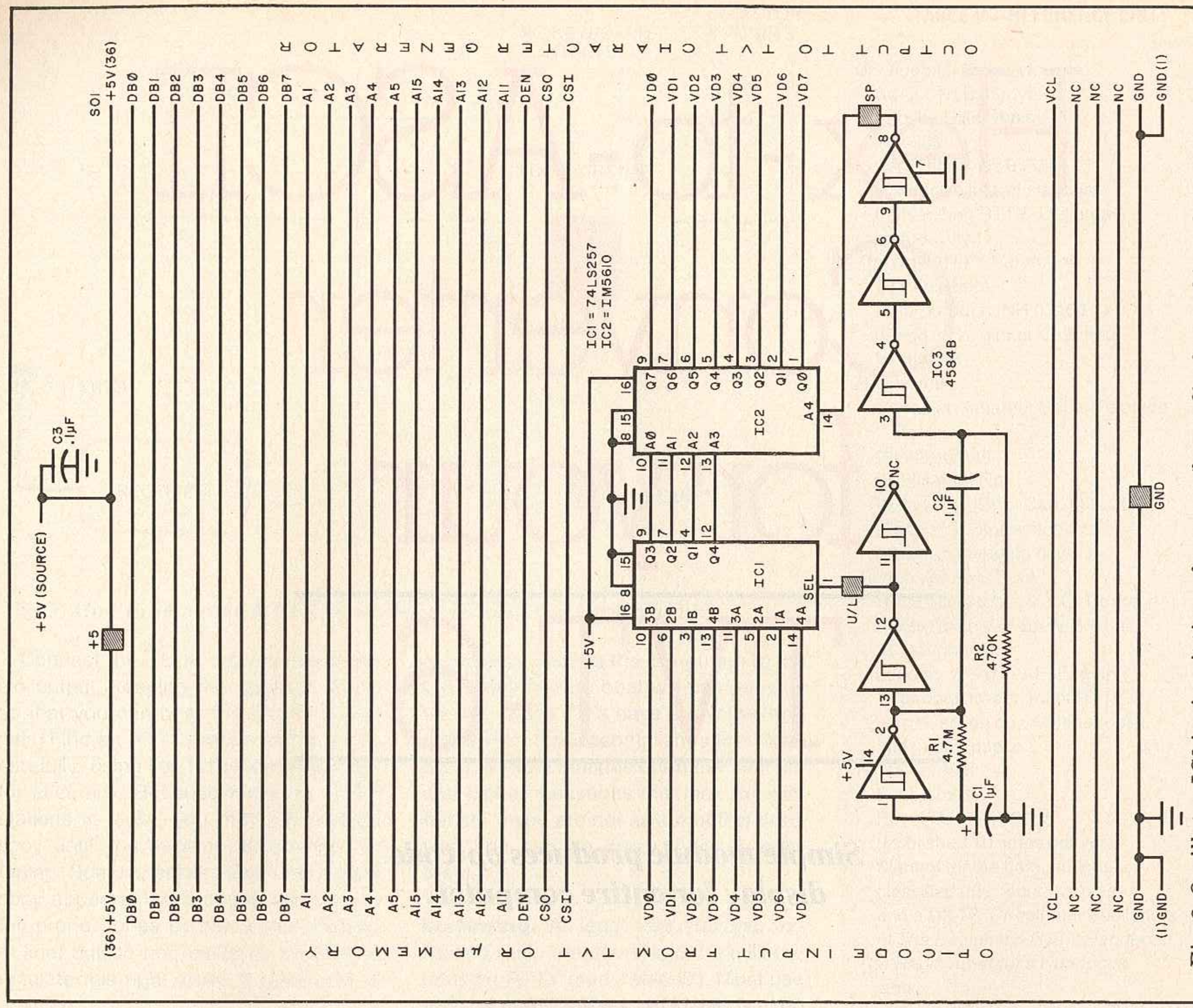
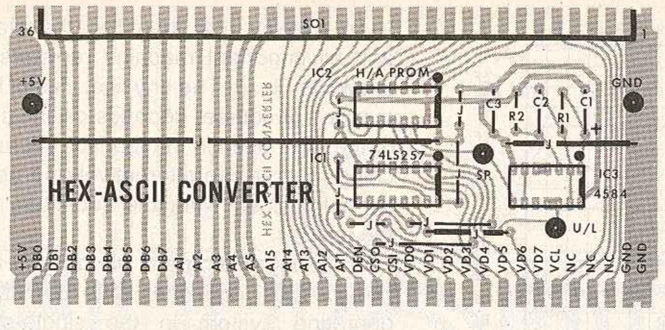


Fig. 2. Oscillator IC3 is circuit timer for upper/lower display and interbyte pause.

WORD	NOTES	8/7	7/6	6/5	5/4	4/3	3/2	2/1	1/0
0	Blank	0	0	0	0	0	1	0	0
1	"	0	0	0	0	0	1	0	0
2	"	0	0	0	0	0	1	0	0
3	"	0	0	0	0	0	1	0	0
4	"	0	0	0	0	0	1	0	0
5	"	0	0	0	0	0	1	0	0
6	"	0	0	0	0	0	1	0	0
7	"	0	0	0	0	0	1	0	0
8	"	0	0	0	0	0	1	0	0
9	"	0	0	0	0	0	1	0	0
10	"	0	0	0	0	0	1	0	0
11	"	0	0	0	0	0	1	0	0
12	"	0	0	0	0	0	1	0	0
13	"	0	0	0	0	0	1	0	0
14	"	0	0	0	0	0	1	0	0
15	"	0	0	0	0	0	1	0	0
16	0	0	0	0	0	1	1	0	0
17	1	1	0	0	0	1	1	0	0
18	2	0	1	0	0	1	1	0	0
19	3	1	1	0	0	1	1	0	0
20	4	0	0	1	0	1	1	0	0
21	5	1	0	1	0	1	1	0	0
22	6	0	1	1	0	1	1	0	0
23	7	1	1	1	0	1	1	0	0
24	8	0	0	0	1	1	1	0	0
25	9	1	0	0	1	1	1	0	0
26	A	1	0	0	0	0	0	1	0
27	B	0	1	0	0	0	0	1	0
28	C	1	1	0	0	0	0	1	0
29	D	0	0	1	0	0	0	1	0
30	E	1	0	1	0	0	0	1	0
31	F	0	1	1	0	0	0	1	0

0–WHITE; 1–BLACK

Fig. 3. Truth table for PROM IC2.



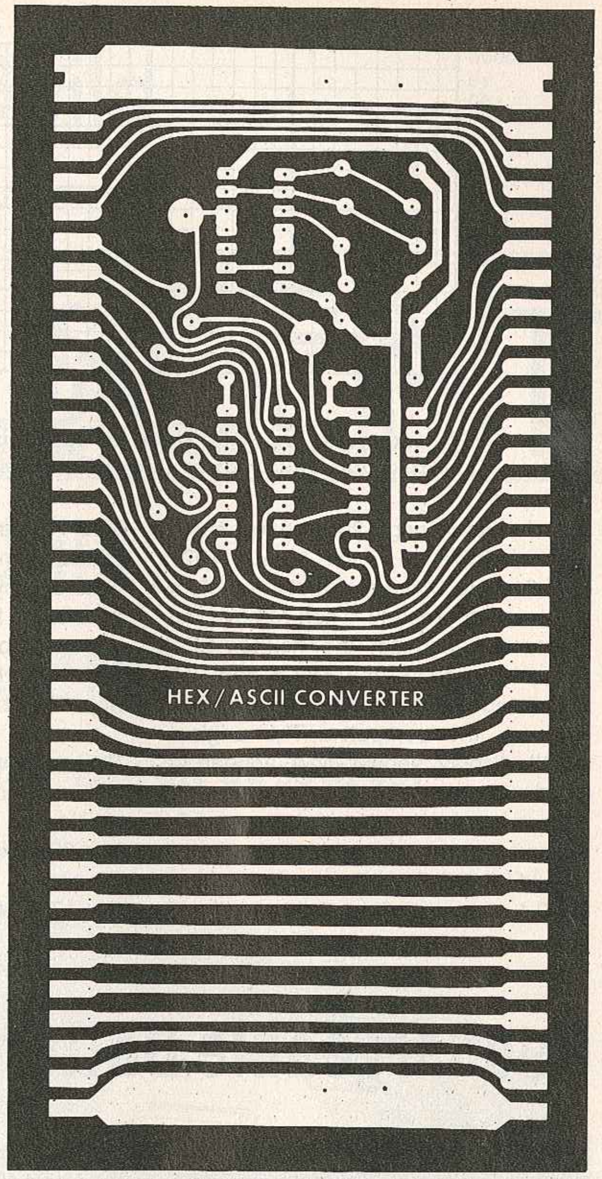


Fig. 4. Actual-size etching and drilling guide (right) and component layout (above) for the pc board. The board is connected between the TVT-6 and the KIM-1 microcomputer.

PARTS LIST

C1—1-µF, low-leakage tantalum electrolytic capacitor
C2,C3—0.1-µF Mylar capacitor
IC1—74LS257 quad 1-of-2 data selector
IC2—IM5610 or similar 32X8 bipolar tristate PROM (programmed in accordance with Fig. 3)
IC3—4584B CMOS hex Schmitt trigger
R1—4.7-megohm, ¼-watt resistor
R2—470,000-ohm, ¼-watt resistor
SO1—36-contact, single-entry edge connector with contacts located on 3.96-mm centers
Misc.—Sockets for IC's (one 14-pin, two 16-pin); press-fit test point terminals; printed circuit board; jumper wire; insulated sleeving; solder; etc.
Note: The following items are available from PAIA Electronics, Box 14359, Oklahoma City, OK 37114: No. HAC-1B etched and drilled pc board for $4; No. HAC-1P programmed IC2 for $5; No. HAC-1K complete kit of all parts for $14.95. All prices postpaid.

(Continued from page 49)

ters of four bits each. These two hex characters are alternately routed to a PROM that converts the hexidecimal input code to the equivalent ASCII output. The resultant display alternately flashes the upper hex character and then the lower hex character, with both appearing on-screen at the same location. Each character is displayed for slightly less than a second. A brief space command is sent to the PROM during the transition from the lower character of one set to the upper character of the following set.

To identify the memory locations, an overlay can be used on the CRT screen of the video monitor, or a china marker can be used to label the operating registers and other important slots with which you are working. If the TVT-6 is being used with the "Cruncher the Bear" mode in the August 1977 issue, it is possible to simultaneously display the 4096 hex characters that result from the 2048 op-code words simultaneously.

The complete schematic diagram of the converter is shown in Fig. 2 and the coding for the 32 × 8 code-converter PROM is shown in Fig. 3.

Integrated circuit *IC1* (Fig. 2) is used as a four-pole, double-throw data selector that drives *IC2*, the code converter. The hex CMOS Schmitt trigger (*IC3*) serves as a symmetrical oscillator that is used for automatically selecting the upper and lower character and to generate the brief blanking pulse that indicates a new character display.

Construction. The converter circuit is best assembled on a printed circuit board. The etching and drilling and components placement guides for the pc board are shown in Fig. 4.

Note on the components placement guide that 10 jumpers are used to interconnect various pads on the board. Only two of these jumpers, indicated by heavy lines, require insulated sleeving to be slipped over them before installation to preclude the possibility of accidental short circuits.

Install and solder into place press-fit terminals at the four test points labelled +5, GND, SP, and U/L. Then install and solder into place the three capacitors, two resistors, and the 36-contact connector. Sockets are recommended for the three IC's. Once the sockets are installed and soldered into place, install the IC's in their respective locations, taking care to properly orient them.

Checkout. To initially check out the converter, connect the TVT-6 to the KIM-1 microcomputer and use the

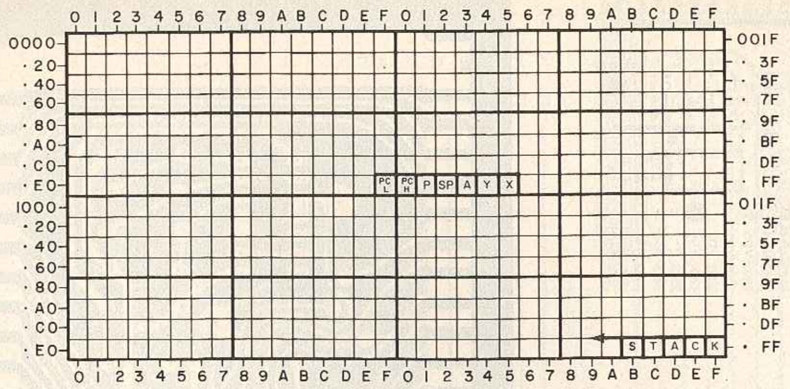


Fig. 5. Overlay mask for the KIM-1. All internal registers are displayed simultaneously with the entire stack.

512-character, page 2 and page 3 display of Table II in the August 1977 TVT-6 article. Make sure that the system is operating properly. Then remove the power and connect the hex-to-ASCII converter between the TVT-6 and μC. Power up again, reload the program, and run the computer. The original ASCII display should now appear in hexidecimal op code.

Test point U/L should have a 1.8-second square wave, while test point SP should be high for 1.7 seconds and low for 0.1 second. It is possible to "force feed" control signals into these test points. Connecting test point SP to +5 volts displays the characters; grounding SP blanks the screen. Connecting test point U/L to +5 volts displays the lower four bits, while grounding it displays the upper four bits.

Operation. If you are planning to run Table II from the August 1977 TVT-6 article, the usual display is of pages 02 and 03. This can be converted to a page 00 and 01 display by changing instruction 17AA to 82 and 17d2 to 80.

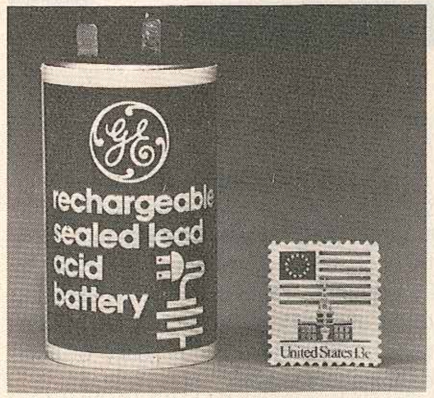
An overlay that identifies the stack and all important machine registers is shown in Fig. 5. The physical size of the overlay, of course, depends on the size of the CRT used in the monitor. A sharp china marker can alternatively be used as a low-cost, workable substitute for the overlay.

To debug a program, simply use the hex-to-ASCII converter with the KIM-1 operating system in the single-step mode. Each time the operating system returns to the keyboard display mode, all registers have their values reloaded into the proper slots shown in Fig. 5.

Hit AD 17 80, switch to SST OFF, and press GO to view the accumulator, stack pointer, program counter, status register, and the X and Y index registers simultaneously. To return to the keyboard display mode, simply press ST.

The Hex-to-ASCII converter can be used between memory and the character generator of many other TVT systems as long as an 8-bit word is used in the TVT's page memory. You can ignore the "Pass-through" lines on the converter, or you can redefine them in any way you need. The converter's processing delay is about 100 ns, which is fast enough usually to be ignored. ◇

Rechargeable Batteries for Consumer Products



THE USE of batteries to power electrical and electronic devices is on the rise. As more and more such products are introduced, the consumer is faced with the problem and cost of constant replacement of batteries.

General Electric has introduced an alternative with two new lines of rechargeable batteries and cells. A nickel-cadmium line consists of the most common-size cells and batteries used in such low- and medium-power items as hand-held calculators, photoflash camera units, and portable receivers. A sealed lead-acid (SLA) cell line is designed for devices that require medium-to-high-power, such as alarms, emergency lighting, and computer memory systems.

The new sealed lead-acid cells are designed to be completely maintenance-free. They can be used in any position without posing a problem with electrolyte spillage. The outer metal case of the cell is electrically isolated from the power-carrying plates. Both the positive and the negative terminals are at the top of the cell. A special glass fiber separator used in construction permits the cell to withstand high temperatures without suffering damage.

The discharge characteristics and cycle life of the SLA cells duplicate or exceed those of other lead-acid cells. The SLA cells are said to have a charge/discharge life of about 300 cycles, which favorably compares with the life of nickel-cadmium cells whose life is typically about 1000 cycles.

The internal resistance of the SLA cell is 10 milliohms (0.01 ohm). This low value makes possible high charge/discharge rates with minimum danger of overheating the cell. A resealable safety vent in the cell prevents cell bursting under extreme abuse.

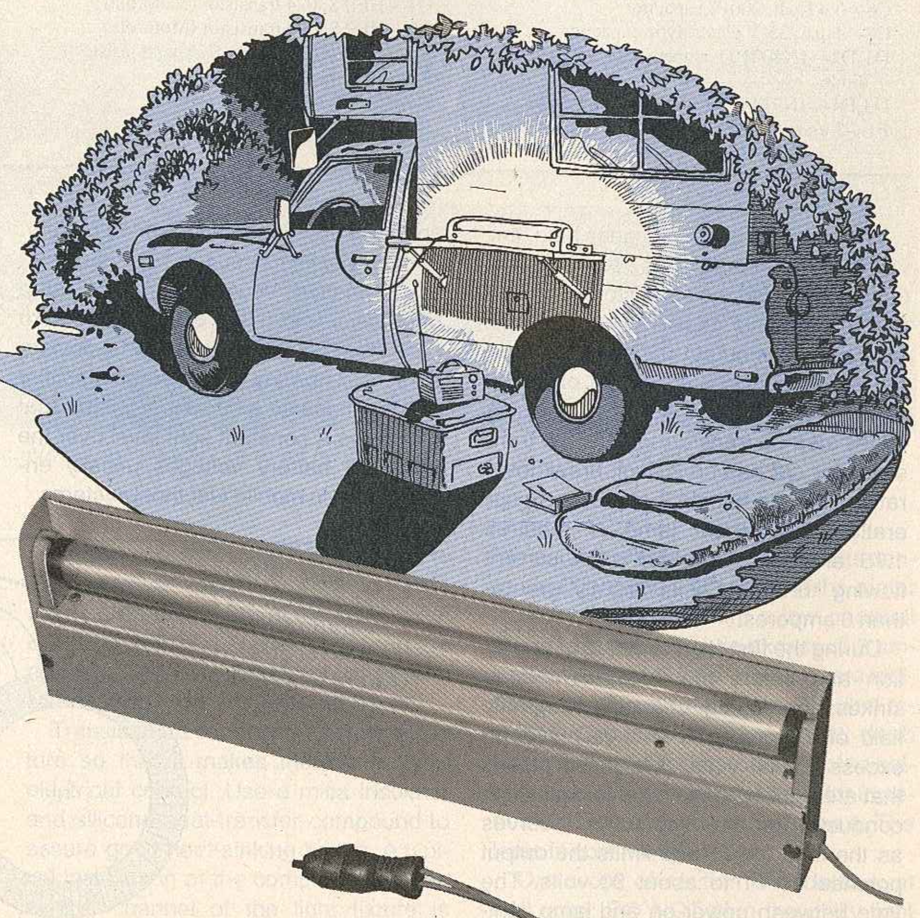
The first of the new SLA cells to come on the market is a cylindrical D cell. It is designed to deliver 2.5 ampere-hours at a 250-mA discharge rate. The cell is capable of delivering up to 40 amperes of continuous current and 75 amperes of momentary (1-second) current. The line of SLA cells will eventually include batteries rated at 6 and 12 volts and 2.5 AH.

The rechargeable nickel-cadmium battery system consists of AA, C, and D cells and a 9-volt transistor size battery, each of which is available separately or packaged with its appropriate snap-on module that connects it to the Model BC3 miniature charger. The rechargeable NiCd cells and batteries are designed for any application where ordinary carbon-zinc batteries are used. They are directly interchangeable with other AA, C, and D cells and 9-volt transistor batteries. ◇

Build a FLUORESCENT Utility Lamp

Operates from 12-volt dc source.

BY JOE DUNCAN



A PORTABLE, battery-powered emergency lamp can be a life-saver on the highway and a great convenience at camp sites. To be truly useful, it should provide reasonable illumination without quickly depleting the battery or confining its light output within too narrow a beam. The utility fluorescent lamp described here satisfies these requirements. It uses a conventional 15-watt fluorescent tube and drive circuitry compact enough to fit in the fixture that houses the tube. Operating power can be drawn from any 12-volt source capable of delivering 2 amperes continuously. Thus, the lamp can also be used to illuminate the inside of a camper.

Circuit Operation. Timer integrated circuit *IC1* in Fig. 1 serves as a pulse generator whose output frequency is determined by *R1, R2,* and *C3.* When the output of *IC1,* at pin 3, goes low, current flows from the base of *Q2* through *R4* and *R5* and then to ground via pin 1 of the 555 timer. The voltage drop developed by the load current across *R3* is applied to the base of *Q1,* turning on this transistor, while part of the load current from *R4* and *R5* flows through transistor *Q1* to ground.