

So You Want To Get Into RTTY?

-- "Call For Papers" winner

So you want to get into radioteletype? Congratulations, you made the right decision. Radioteletype (abbreviated RTTY) is the most interesting, fascinating and rewarding mode of communication around today.

The burgeoning of integra-

ted circuits over the last decade and the rapid decrease in the cost of these circuits have made it easier than ever before to get into RTTY at a minimum cost. It is this proliferation that has also aided the development of RTTY systems that were heretofore impossible or impractical. For

example, how would you like to be able to turn your friend's teleprinter on and leave a message for him when he gets home? You can do it; it's called a selective calling system. Or how would you like to turn on a transmitter thousands of miles away to get an idea of current propa-

gation conditions? No problem. If the other station has an answer-back system, all you need do is type the station's access code. The transmitter is then automatically turned on and a short message is broadcast. If you are of an artistic bent, exchanging RTTY pictures should fulfill your desires. If you enjoy music, composing songs to be played on the teleprinter will prove fascinating. If building is your bag, you have come to the right place. While commercial equipment is available, building your own equipment should prove rewarding, not to mention the pecuniary savings. If contests are your main interest, RTTY has many throughout the year. You say collecting award certificates is your thing? Then try working all states or all continents on RTTY for a challenge. If you like to rag chew, you have come to the right place.

RTTY is a very relaxing way to communicate. Since the conversation is printed on paper, you can go get that cup of coffee or glass of soda pop while the other fellow is talking without missing any of the conversation. It is also possible to start answering the other fellow while he is still talking by punching your message into paper tape. When the other fellow is finished transmitting, you can send your prepared message back.

If you want to keep informed on different aspects of ham radio, W1AW broadcasts RTTY bulletins daily. Information on OSCAR crossings, propagation, and general comments about ham radio are given. You say you like to keep abreast of the news and weather? No problem. Many commercial stations such as the Associated Press broadcast news bulletins throughout the day. Other commercial stations broadcast weather conditions. This type of information could be most useful during



Photo 1. The author and friends. The basic RTTY equipment includes a Model 15 teleprinter, an ST-6 demodulator, and an AFSK modulator. The amenities include an electronic keyboard; a CRT RTTY tuning indicator; a UT-4 for signal regeneration and electronic speed conversion; a digital date, time, and message generator for the Selcal and W-R-U system; and a cassette tape recorder for storing and transmitting data. (Photo by Anthony R. Donaldson.)

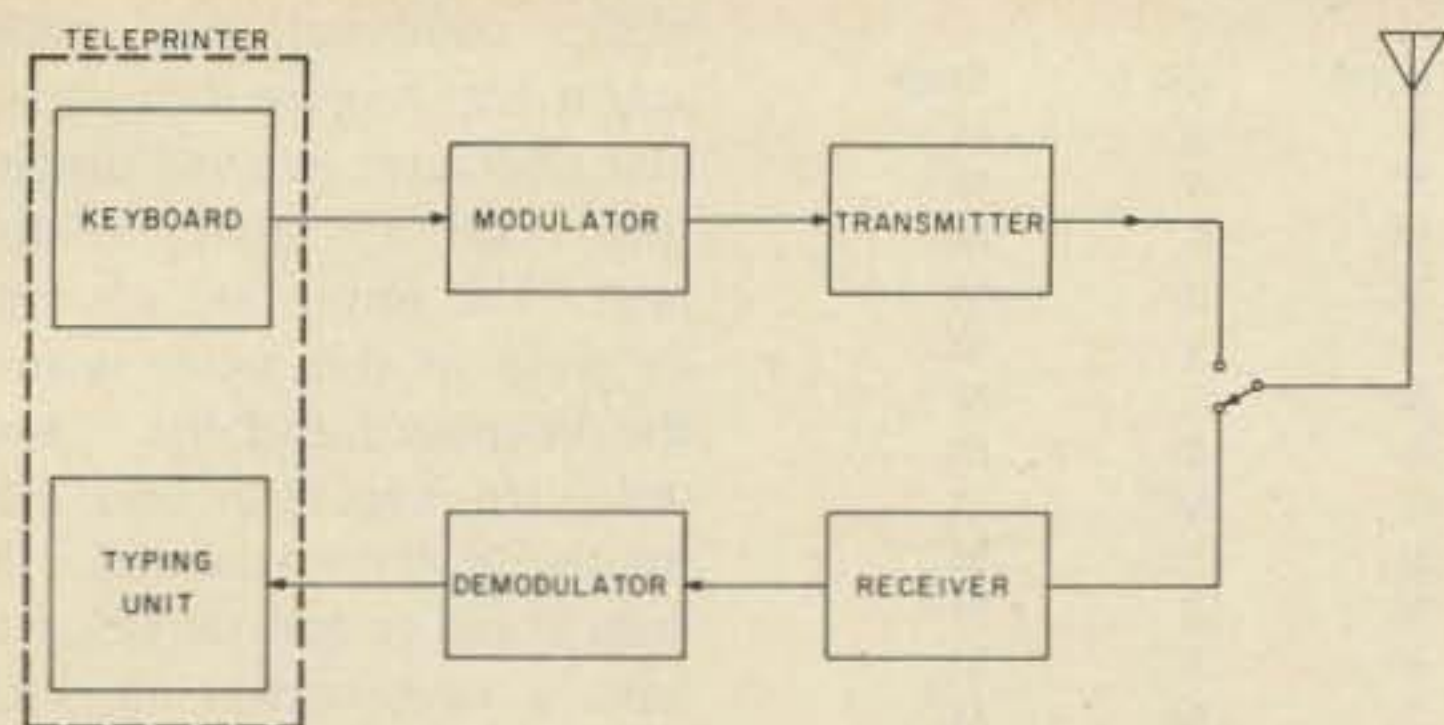


Fig. 1. Typical RTTY station block diagram.

the tornado or hurricane season.

If you are technically oriented, the flexibility of RTTY should interest you. Many amateurs are connecting microcomputers to their stations. With one of these, you are only limited by your imagination. You say you don't like the dampened roar of a teleprinter? Then an elegant video display is just what the doctor ordered. If any of these facets of RTTY intrigues you, then read on, and welcome to the wonder-

ful world of RTTY.

While the history of teleprinters goes back to as early as 1906, when the first American teletypewriter was invented, amateur use of teletypewriters is relatively new. Amateurs were involved in radioteletype as early as 1946. But it was not until 1953, when the FCC removed certain restrictions on amateur radioteletype, that the field of amateur RTTY really began to grow.

The amenities of RTTY are indeed myriad, but let's

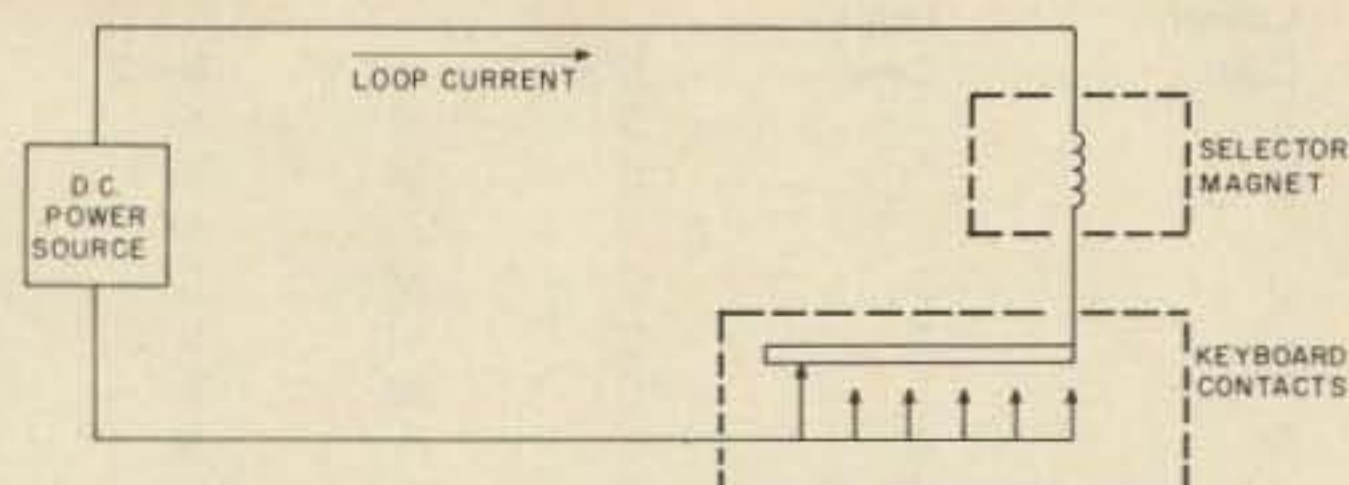


Fig. 2. The Local loop.

get down to basics. There are actually only three components necessary to get a RTTY station on the air — a teleprinter, a modulator, and a demodulator. Fig. 1 shows these three basic components and their interconnection in a typical RTTY station.

PART 1 THE BASICS

The Teleprinter

Before getting involved in the technical aspects of teleprinters, a clarification of the word teleprinter is in order. A teleprinter is often wrongly referred to as a "Teletype." Teletype is a registered trade-

mark of the Teletype Corporation. As such, it should always be capitalized and used as an adjective rather than a noun. The name Teletype has come to be used erroneously due to the popularity of the Teletype Corporation products. There are, however, other manufacturers of teleprinters including Kleinschmidt, Lorenz, Mite, and ITT Creed. Therefore, to be correct, I will use the word teleprinter to describe this family of machines.

At the heart of every amateur RTTY station is the teleprinter. The teleprinter is quite similar to a typewriter.



Photo 2. The Teletype Model 28 ASR shown here is a highly respected and sought-after machine. The unit includes a keyboard, a page printer, tape reader, tape punch, and a stunt box for adding special control functions. The Model 28 is built for heavy duty, 24 hour per day operation and easily operates at 100 wpm. Unlike the Model 15, the Model 28 is still manufactured by the Teletype Corporation. (Photo courtesy of the Teletype Corporation.)

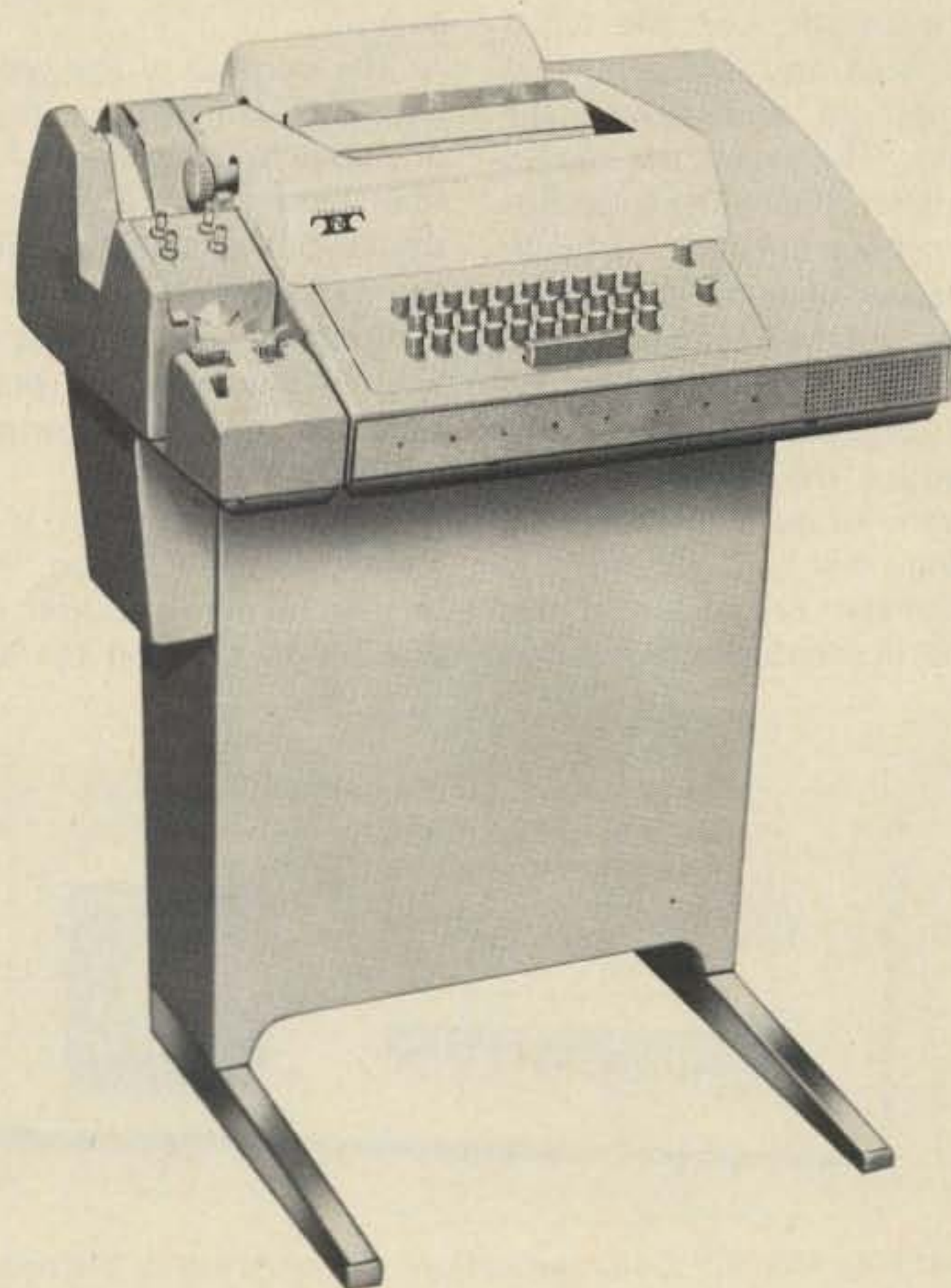


Photo 3. The Model 32 ASR, shown here, is the newest model teleprinter using the Baudot code manufactured by the Teletype Corporation. The machine includes a paper tape reader and punch shown on the upper left side in the photo. (Photo courtesy of the Teletype Corporation.)

Lower Case	Upper Case	Start	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Stop
A	—	S	M	M	S	S	S	M
B	?	S	M	S	S	M	M	M
C	:	S	S	M	M	M	S	M
D	\$	S	M	S	S	M	S	M
E	3	S	M	S	S	S	S	M
F	!	S	M	S	M	M	S	M
G	&	S	S	M	S	M	M	M
H	#	S	S	S	M	S	M	M
I	8	S	S	M	M	S	S	M
J	'	S	M	M	S	M	S	M
K	(	S	M	M	M	M	S	M
L	)	S	S	M	S	S	M	M
M	.	S	S	S	M	M	M	M
N	,	S	S	S	M	M	S	M
O	9	S	S	S	S	M	M	M
P	0	S	S	M	M	S	M	M
Q	1	S	M	M	M	S	M	M
R	4	S	S	M	S	M	S	M
S	bell	S	M	S	M	S	S	M
T	5	S	S	S	S	S	M	M
U	7	S	M	M	M	S	S	M
V	:	S	S	M	M	M	M	M
W	2	S	M	M	S	S	M	M
X	/	S	M	S	M	M	M	M
Y	6	S	M	S	M	S	M	M
Z	"	S	M	S	S	S	M	M
blank		S	S	S	S	S	S	M
car. ret.		S	S	S	S	M	S	M
line feed		S	S	M	S	S	S	M
space		S	S	S	M	S	S	M
letters		S	M	M	M	M	M	M
figures		S	M	M	S	M	M	M

Table 1. The Baudot code. M = mark, S = space.

However, in a typewriter there is a mechanical linkage between the key the typist depresses and the arm that comes up and strikes the paper. This is not the case in the teleprinter. The teleprinter consists of two virtually separate units — the typing unit, and the keyboard. When one depresses a character on the keyboard, the keyboard encodes the character as a stream of pulses. The exact coding will be discussed later in greater detail, but at this time it should be noted that

each character has a particular code much like the Morse code.

The purpose of the typing unit is to convert the stream of pulses back into a mechanical motion. Typically, the keyboard is also wired to the typing unit so that in addition to sending pulses to another machine, the pulses are received and printed locally.

Fig. 2 shows what is referred to as a local loop. With this circuit configuration, it is possible to type on the key-

board and obtain local copy. Current is flowing in the circuit until broken by the operation of the keyboard. The selector magnet senses the current pulses and prints the requested character.

The condition in which current is flowing in the loop is referred to as the "mark" state. The "space" state is characterized by the absence of current flowing in the loop. With these marks and spaces (current and no current), it is possible to make a code in which a par-

ticular combination of marks and spaces represents a particular character. We will discuss this code in greater detail later. The important concept to grasp at this point is that the keyboard and the typing unit are separate and not mechanically attached. In fact, some teleprinters do not have a keyboard at all, such as the Model 28RO. The RO indicates Receive Only. These machines are used where only one-way communication is desired, such as in a commercial newsroom.

While new teleprinters are available from the Teletype Corporation, the price is rather high for the average amateur. For this reason, most amateurs use teleprinters that have been retired from commercial use. A teleprinter may be obtained for as little as \$30. Hamfests or advertisements in the amateur radio magazines are good sources for machines.

There are several models of teleprinters that are currently used in amateur applications. However, Models 15 and 28 are the most popular. These models are called page printers. This means the message is printed on a continuous roll of paper rather than a narrow paper strip. The paper tape printer is virtually gone from amateur use.

The Code

Before we get into the two remaining basic units of the RTTY station, the modulator and the demodulator, we must discuss the code used for radioteletype communication.

The code used by the teleprinter is similar in nature to the Morse code. However, where the Morse code uses dots and dashes, the teleprinter code uses marks and spaces. One important difference between the teleprinter code and the Morse code is the length of each basic element or bit of information. For example, the length of a dot or dash is determined exclusively by the operator.

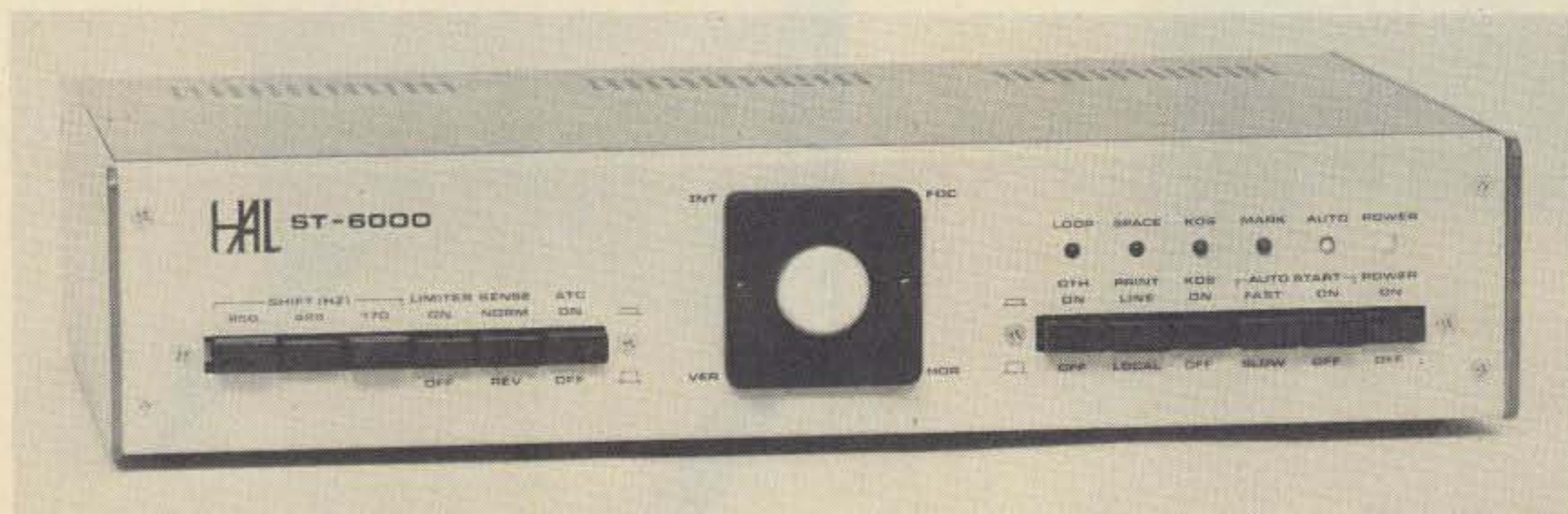


Photo 4. The Hal Communications Corporation is the most popular manufacturer of amateur RTTY equipment. Shown here is the ST-6000. Other demodulators manufactured by Hal include the ST-5000, the ST-6, and the ST-5. Of particular note is that most of the Hal products can be purchased already assembled or in kit form, or, for those with a well-stocked junk box, individual components such as printed circuit boards are available. For more information write Hal Communications Corporation, Box 365, Urbana, Illinois 61801 or call 217-367-7373. (Photo courtesy of Hal Communications Corporation.)

It would be difficult to design equipment that would have to copy correctly at all typing speeds. Therefore, a special teleprinter code, referred to as the Baudot code, is used. This code was designed so that each character contains the same number of elements or bits, and each element is of a fixed duration. One other important characteristic is required of our teleprinter code. When transmitting the code, the receiving teleprinter must be synchronized with the transmitting teleprinter, even though they may be thousands of miles apart. To accomplish this end, a start pulse is added at the beginning of the character, and a stop pulse is added at the end. These pulses are used to insure synchronization of the machines.

Table 1 shows the Baudot code that is used by teleprinters to communicate. All elements of the code are 22 ms (22/1000 seconds) except the stop pulse, which is 31 ms. Fig. 3 represents graphically a teleprinter character. The entire 7 bit word for this character may be written as SSMSMSM. Since the first and last bits are the start and stop bits respectively, the character is reduced to the following 5 bit code, SMSMS. Referring to Table 1, we see the character is the letter "R", or the number "4". Why are there two possibilities you ask? For those of a mathematical bent, you will notice with a 5 bit code that the maximum number of combinations is 32 ($2^5=2 \times 2 \times 2 \times 2 \times 2=32$). The alphabet and ten digits require 36 (26+10) combinations by themselves, and we still haven't allowed for punctuation and other special functions. To obviate this problem, the teleprinter is equipped with a lower and upper case character set. This is analogous to the upper and lower case of a modern electric typewriter. However, where the typewriter uses "shift" and "unshift" to control the case, the tele-

printer uses the "figures" and "letters" command. The upper case is attained by depressing the figures key. The teleprinter moves to the lower case when the letters key is depressed. Going back to our example, if the teleprinter is in the lower case (letters), it will print the letter "R". If a figures key has been depressed previously, the teleprinter will be in the upper case (figures) and print the number "4".

Since each character is of a finite duration, there must be an upper limit to the number of words that can be printed in one minute. Adding the duration of the 7 elements of the code, we arrive at a total time of 163 ms for each character (see Fig. 3). Since each character is 163 ms, the number of characters that can be printed in one minute is 368 (60 seconds/.163 seconds). One word is typically considered to be 5 letters plus 1 space. Thus, the number of words per minute is equal to 61.3 (368/6). This is then rounded off to 60. It would be nice to use machines that operate at higher speeds, but one should remember that teleprinters use mechanical parts that are limited to relatively slow speeds. Video display units are obviously not mechanical and hence are not limited to such low speeds. Speeds of several thousand words per minute are not uncommon. The 163 ms character length sets the upper typing limit at

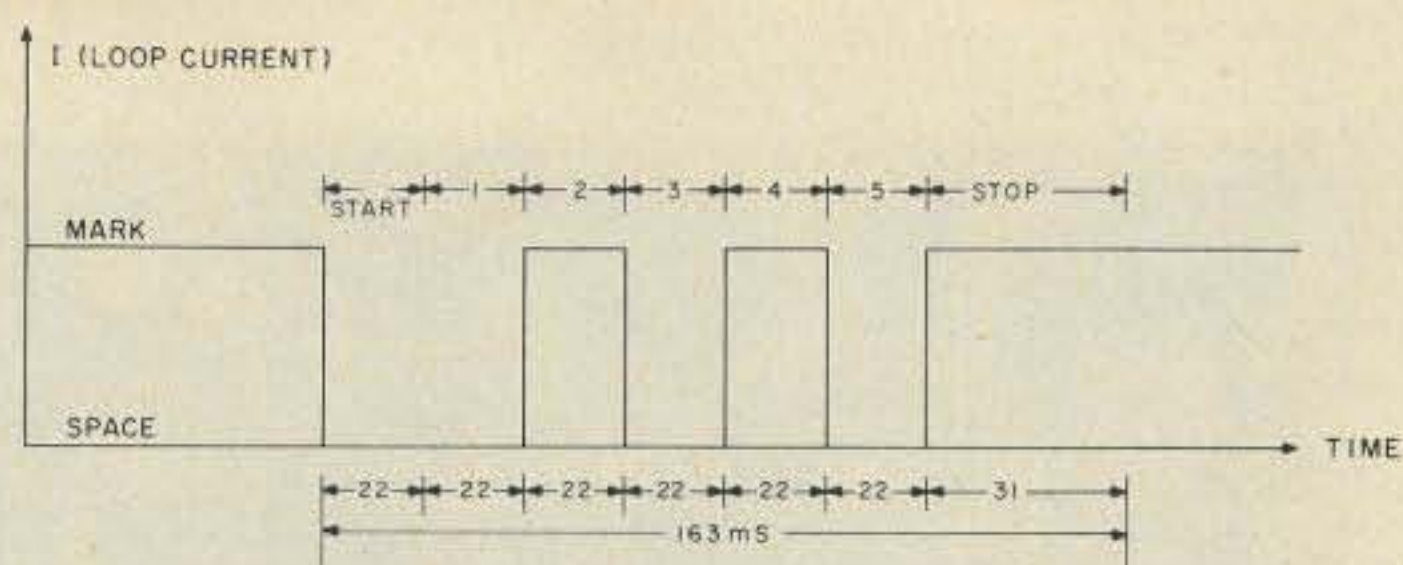


Fig. 3. Graphic representation of the letter "R" or the number "4".

60 wpm (actually 61.3). Since few amateurs are speed typists, this does not usually limit one's typing speed. While it is true that other speeds are used, such as 67, 75, and 100 wpm, amateurs use 60 wpm almost exclusively.

It is important to note that each and every character is 163 ms no matter who is typing or how fast. Contrasting this with CW, even if all operators sent CW at a specific speed, each character is of a different duration. This is a characteristic inherent in the Morse code.

We now know the code that we must use to talk to the teleprinter. Our next task is to put these marks and spaces in a form that can be transmitted over the air. This is the purpose of the modulator.

The Modulator

Modulation refers to the process of transmitting the RTTY signal. Let's return once again to our analogy between CW and RTTY. CW is transmitted by opening and closing a telegraph key. Since

a telegraph key is nothing more than a switch, and a teleprinter's keyboard is also a switch, why don't we substitute the keyboard contacts for the telegraph key? With this technique, the mark may be thought of as the transmitter's "on" condition, and the space the transmitter's "off" condition. This is called make-and-break keying and is sometimes used. However, a problem arises using this method. It occurs while the transmitter is off. Suppose a static crash occurs during the space condition (transmitter off); chances are the static crash may be misconstrued by the equipment as a mark, when it is really a space. The net outcome under this method is poor reliability, and thus a wrong character may be printed. We don't have this problem with CW because the incredible machine, the brain, can discriminate between a static crash and a signal.

So now what do we do? The answer is use frequency shift keying (FSK). With this method, the transmitter is on during both the mark and space states. If the transmitter

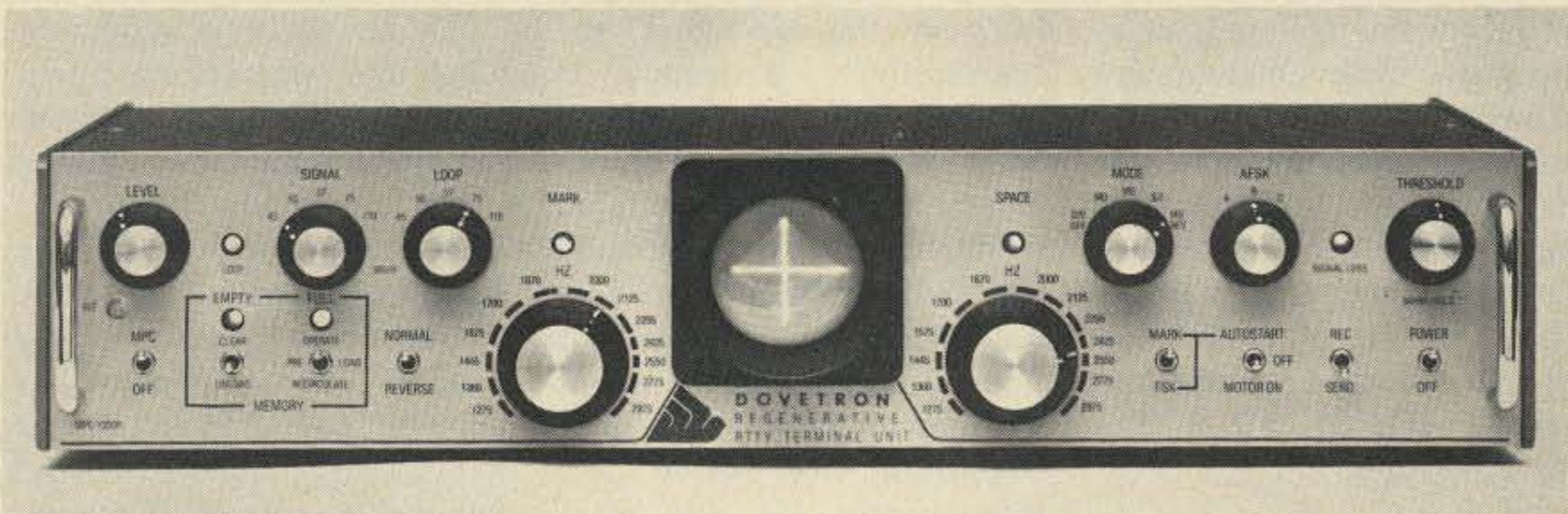


Photo 5. The Dovetron MPC-1000R is the Rolls Royce of terminal units. Some of the special features of the unit are electronic speed conversion, signal regeneration, a character memory up to 200 characters, error correction to erase misspelled words, Tee Dee inhibit, and variable character rate. Front panel controls permit "signal" and "loop" speed selections of 60, 67, 75, 100 wpm Baudot and 110 baud ASCII. (Photo courtesy of Dovetron.)

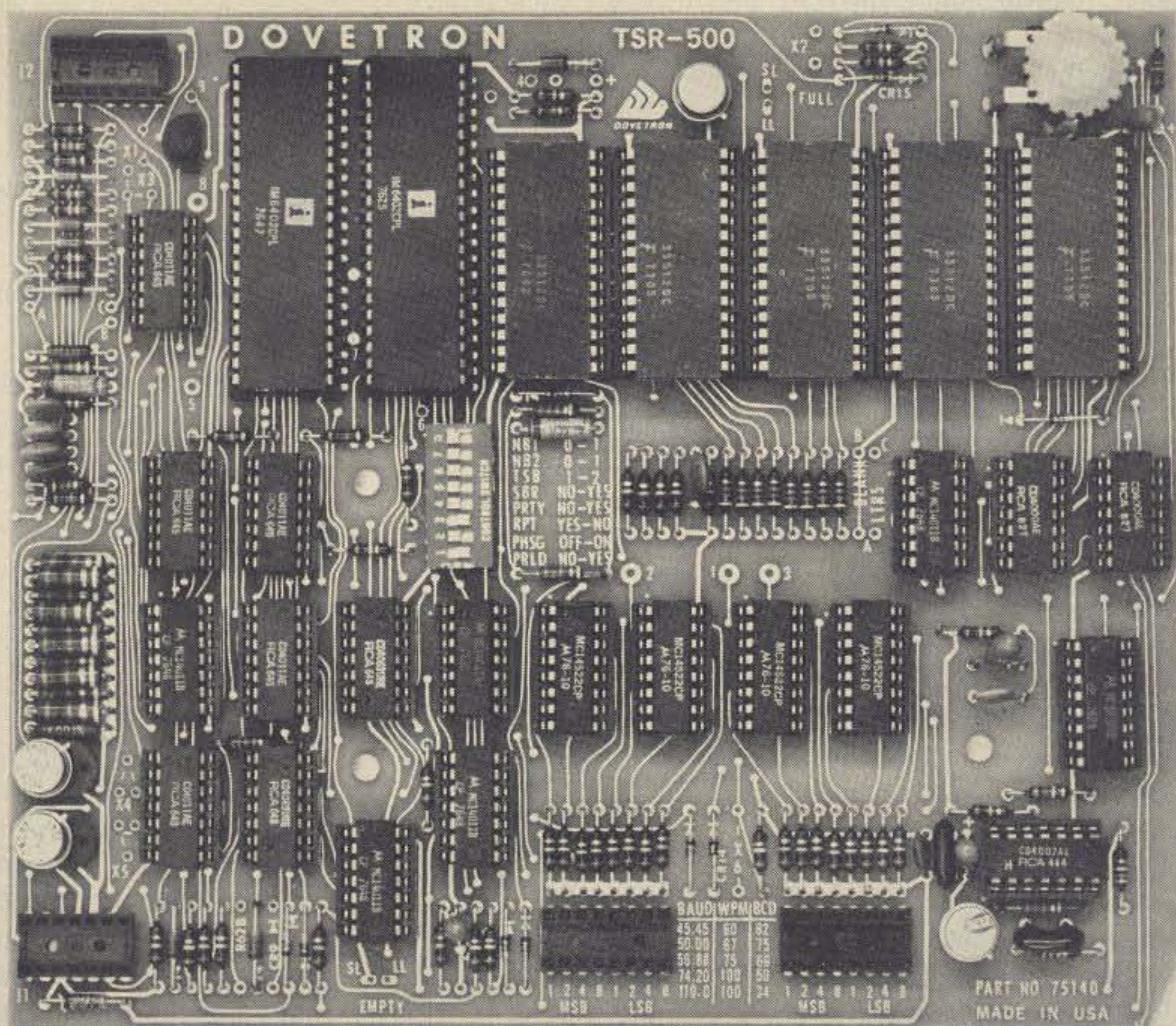


Photo 6. The TSR-500 is at the heart of all the special features of the Dovetron MPC-1000R and may be purchased separately. The error correction circuit allows one to erase the last word put in the memory by depressing a "blank" key. Information on this and other Dovetron products may be obtained from Dovetron, 627 Fremont Ave., South Pasadena, California 91030 or phone 213-682-3705. (Photo courtesy of Dovetron.)

is on during both states, how do we differentiate between the two? Simple, we let the transmitter transmit one frequency during the mark condition and transmit another frequency during the space condition. Thus, we are shifting between two frequencies, and hence the name, frequency shift keying. The difference between the two frequencies is referred to as the shift. While amateurs are allowed to transmit RTTY using any shift less than 900 Hz, the amateur fraternity has settled down to two standards, 170 and 850 Hz shifts. The 170 Hz shift is used almost exclusively on the low bands, while 850 Hz shift is typically used on the VHF bands.

Two methods are used to shift the transmitter's frequency — carrier frequency shift keying (FSK), and audio frequency shift keying

(AFSK). With the first technique, the carrier frequency is shifted by placing a capacitor across the transmitter's oscillator tank circuit. This capacitor is connected by the contacts of the keyboard. With the capacitor disconnected, the transmitter is transmitting a mark signal. When the capacitor is connected by depressing a key on the keyboard, the transmitter's frequency is lowered, and this represents the space condition. Typically, the keyboard is buffered from the tank circuit because the keyboard's contacts cannot efficiently control these radio frequency signals, but the idea of connecting a small capacitor for space and disconnecting it for mark remains unchanged.

With the second method, audio frequency shift keying, audio tones are generated and fed directly into the

microphone jack of the transmitter. For narrow shift, the AFSK unit generates 2125 and 2295 Hz signals ($2295 - 2125 = 170$ Hz shift). The 2125 Hz signal denotes the mark signal and the 2295 Hz signal represents the space signal. When the keyboard contacts are closed, a 2125 Hz signal is fed into the microphone jack. The 2295 Hz signal is generated when the contacts are open. Note that with this method, the space frequency is higher than the mark frequency. When using carrier FSK, the opposite is true; the mark frequency is higher than the space frequency. This apparent contradiction can be explained by noting that the heterodyne system of generating a lower sideband signal has the effect of flipping the frequencies over. Therefore, the final space frequency generated by the transmitter

is indeed lower than the mark frequency when using AFSK as it is when FSK is used.

The AFSK method of generating a RTTY signal requires a stable audio generator. Its main advantage lies in the ease of interfacing the keyboard with the transmitter. One need simply plug the output of the generator directly into the microphone jack of the transmitter.

The Demodulator

At the receiving end, our job is to decipher the tones and reconstruct the information in a form the teleprinter can handle. There are basically two methods that are used to differentiate between the two tones. The old technique, and still the most widely used, involves demodulation via two separate resonant LC (inductor and capacitor) circuits. In the case of 170 Hz shift, one LC resonant circuit is tuned to pass the 2125 Hz mark signal, and the other is tuned to pass the 2295 Hz space signal. These filter circuits, called discriminators, pass only their respective tones, mark or space, and drastically attenuate all other frequencies. Fig. 4 shows a simplified diagram of this type of demodulator. After the two tones have been segregated through the filtering process, they are fed to a stage called a slicer, which drives the keying transistor. When a mark signal is received, the slicer turns the transistor on, and we have a closed loop. With a space signal received, the slicer turns the keying transistor off, and we have an open loop. Thus the keying transistor acts as a switch. However, more to the point, it is simulating the keyboard switch contacts of the station transmitting.

A modernization of this method employs active filters to replace the passive LC filters. The main advantage of this technique comes from the fact that fairly large inductors (typically 88 mH) are not required. Tuning the

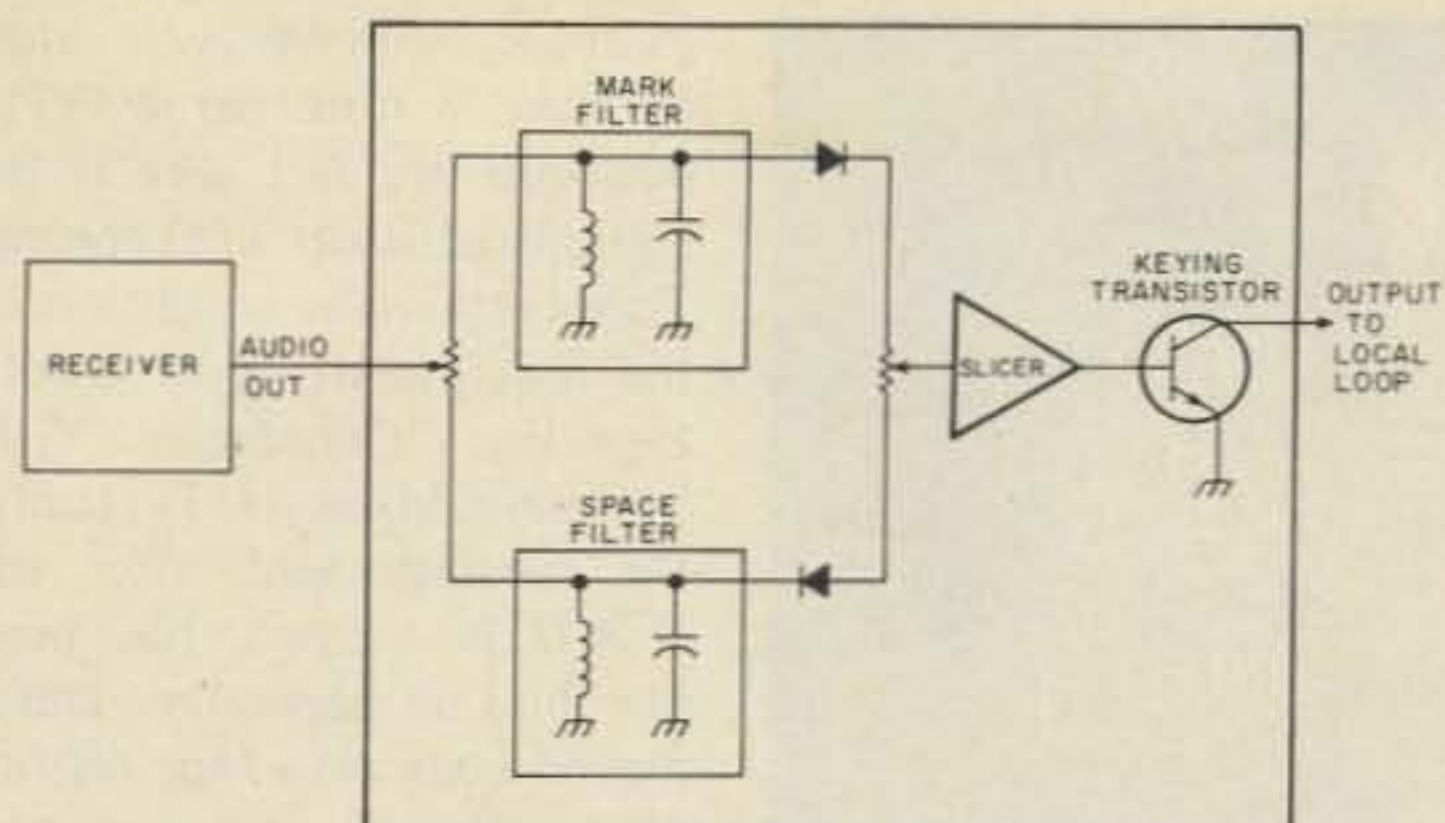


Fig. 4. Simplified circuit diagram of a RTTY demodulator using passive filters.

active filters for the exact frequency during calibration is also simpler, since it typically requires an adjustment of a resistor rather than the trial and error technique used in trimming an LC filter to the exact frequency.

The second method that is used to demodulate a RTTY signal uses a phase locked loop (PLL) integrated circuit. Despite its inferiority to the method described above, it is cheap and easy to build. As such, it makes a great demodulator to build to get on the air in a hurry.

PART 2 THE AMENITIES

As previously stated, all that one needs to get a RTTY station on the air is a teleprinter, a modulator, and a demodulator. However, several accessories may be added to a station to really increase the joy of RTTY and operating ease. Amenities available to the RTTY aficionado include an electronic keyboard, a video display, tape distributor, tape reperforator, magnetic tape recorder, a CRT RTTY tuning indicator, a Selcal, and a W-R-U answer-back system.

The Electronic Keyboard

Typing on a typical teleprinter keyboard will require some practice and patience, especially if you are accustomed to typing on a modern electric typewriter.

Referring back to Table 1, you can see that the alphabet is printed if the typing unit is in the lower case, and punc-

tuations and numbers are printed if the typing unit is in the upper case. Thus, typing a station call or an address, which contains both numbers and letters, would require extra operations to put the teleprinter into the upper or lower case as desired. An electronic keyboard, designed for the Baudot code, automatically inserts upper and lower case commands to insure the proper character is printed without the operator directly requesting the upper or lower case.

An electronic keyboard has other, more subtle, advantages. In addition to being attractive and quiet, the action of the keys is much smoother than a conventional teleprinter keyboard. These features decrease operator fatigue and increase the ease of operation.

The Video Display

For those who don't like the noise and maintenance of a teleprinter, state of the art technology has made video displays possible. An old black and white TV, coupled with a video display interface module, makes an attractive display.

Two notes of caution. Except for the Hal Corporation unit (see Photo 7), these video display units require a special code called ASCII. ASCII is the acronym for USA Standard Code for Information Interchange. Therefore a unit capable of translating the Baudot code to ASCII is required.

The second shortcoming



Photo 7. The RVD-1005 visual display unit is the modern answer to the teleprinter. The unit accepts demodulated Baudot signals at 60, 66, 75, and 100 wpm and displays the information on 25 lines with 40 characters per line. (Photo courtesy of Hal Communications Corporation.)

of a video display deals with the maximum amount of information that can be displayed on the screen. While the format of characters on the screen varies from manufacturer to manufacturer, 1000 characters is typical. This 1000 characters may seem like a lot, but it really isn't. A typical QSO consists of several thousand characters. This means that you cannot look back at the content of a previous transmission or leave the ham shack for more than a few minutes. Both are only slight disadvantages, but, nonetheless, something to consider before purchasing a video display.

The Reperforator

If one wished to record a message to be played back at some later date, he would use a reperforator. The reperforator records a message by punching holes in a narrow strip of paper tape. Messages may be recorded either locally, by typing on the local keyboard, or straight off the air. The Teletype Corporation Model 14RO is a reperforator typically used by amateurs. Of particular importance is that once the paper tape has been made, it may be transmitted at full machine speed (60 wpm), thus expediting

the transmission of information. A tape reperforator is used most often by amateurs to make and record RTTY pictures. More on this exciting facet of RTTY later.

The Tape Distributor

The tape distributor is used to read the punched paper tape made on the tape reperforator. The unit translates the holes in the tape into pulses so that they may be printed locally or sent to another station. The Teletype Corporation Model 14TD is a popular tape distributor used extensively on the ham bands.

The Magnetic Tape Recorder

Since the RTTY signals sent to the demodulator are in the audio range (2125 and 2295 Hz), why not record the information on a magnetic tape rather than on paper tape? After all, a cassette player is quieter, cheaper, and more convenient than a mechanical paper tape reperforator. The answer is that we can do just that. In fact, this technique is used extensively by computer hobbyists to record data. However, some problems can arise. For example, when using a narrow shift (170 Hz), this method becomes very sensitive to fluctuations in



Photo 8. Shown here is a small sampling of some of the RTTY pictures that are exchanged on the ham bands. The small uncomplicated pictures require approximately 10 minutes to reproduce at 60 wpm, while some of the large pictures with overlining can require an hour or more. The RTTY Journal sponsors an annual RTTY art contest for those interested in this facet of RTTY. The pictures were stored on the cassettes shown in the photo. (Photo by Anthony R. Donaldson.)

the tape speed. The mark and space tones will change frequency as the tape player changes speed. This problem can be remedied by using a high quality tape player with a low wow and flutter specification. There is still one additional complication, though. It would be difficult to find two machines that turn at exactly the same speed. Therefore, the cassettes could not be interchanged between machines. Both problems are solved by using a wider shift (850 Hz). For a mark tone of 2125 Hz to be misconstrued as a space tone of 2975 Hz, the tape player would have to be in very poor shape indeed. Photo 8 shows several RTTY pictures, all of which have been recorded on the cassette tapes shown.

The CRT Tuning Indicator

Several methods for tuning in a RTTY signal have been tried over the years. However, one of the oldest, and perhaps the best, makes use of a cathode ray tube (CRT). The mark and space signals

are depicted on the screen of a small CRT (see Photos 4 and 5). The mark is typically a line displayed horizontally, and the space signal is a line shown vertically. With such a unit, the operator tunes the receiver until the horizontal and vertical lines are of maximum length.

The Selcal

The station equipped with a selective calling (Selcal) system can be turned on and off by typing a predetermined access code. While a station may be programmed for any access code, the standard has become the use of the last three letters of the station's call. For example, if your friend's call were W9IUV, typing the last three characters of his call, IUV, at your station would turn on the teleprinter at the station of W9IUV. You can now leave a message. When you are finished, typing four Ns will shut your friend's teleprinter off. The four Ns at the end of the message are a universally accepted shut-down code. Such a system is

a great way to keep in touch with friends. Of particular importance is that there is no need for a person to be on the premises. Therefore, the equipment may be left running continuously. I still get a kick out of getting home to a few notes sent by friends. The distinct advantage of this system is that only notes addressed to you are received. In an all-call system, you would receive everyone's notes.

The W-R-U

A W-R-U (who are you) answer-back system is one step beyond a Selcal system. Leaving a note for a friend can be a hit or miss affair unless you are sure his equipment is on. A W-R-U system allows one to ascertain just that. By typing a predetermined access code, one can in essence interrogate the condition of the equipment. Adding the three characters figures, blank, and H after the last three letters of the station's call has become the customary code used to gain access to the equipment. For

example, suppose you want to leave a note for W9YPS, but you are not sure if his equipment is up and running. To ascertain the condition of the equipment, you would type the six characters Y, P, S, figures, blank, H. Typically, the message sent after the W-R-U is tripped has been punched on paper tape and is played back on a tape distributor. Having tripped the W-R-U and, thus, confirmed the status of the equipment, you can now proceed as with a Selcal system and leave a note with the assurance the note has been received.

PART 3 SOME UNIQUE ASPECTS OF RTTY

For those of you who are connoisseurs of art, you should enjoy designing, making, receiving, and sending RTTY pictures. The number and kinds are truly prodigious, ranging from angels to nudes. Making a RTTY picture requires a reperforator (paper tape puncher) and a tape distributor (paper tape reader). For those wishing more information on this fascinating aspect of amateur RTTY, consult any of the RTTY handbooks listed in the annotated bibliography.

RTTY Music

I got home late one night during the Christmas season and thought I would listen to a RTTY QSO or two before retiring. Instead of hearing the customary clatter of old faithful (my Model 15), my ears were treated to a chorus of Jingle Bells followed by Noel and other Christmas favorites. This aspect of RTTY makes use of a tape distributor and tape reperforator. Instead of printing a character, the bell of the teleprinter is actuated in time to the melody.

Conclusion

It has been the purpose of this article to give the reader

an introduction to the fascinating world of RTTY and to whet his appetite. For those wishing to pursue this mode of communication further, I have accumulated an annotated bibliography listing books and articles to read for further information on this subject. Good luck and

MMSMM MMMSS MSSSS. ■

ANNOTATED BIBLIOGRAPHY

Periodicals and Books Devoted to Radioteletype

American Radio Relay League. *Specialized Communications Techniques for the Radio Amateur*. Newington, Conn., The American Radio Relay League, 1975.

Only a portion of this book is devoted to radioteletype. Other topics include slow scan television, facsimile, and space communication. However, the approximately 70 pages that are devoted to radioteletype are well filled with useful information. I recommend this book highly.

RTTY Journal. *Beginners RTTY Handbook*. RTTY Journal, 1975.

If you want the most for the

least, this is it. As the title indicates, the handbook is designed specifically for the beginner. I find it an excellent reference book and recommend it highly. Send \$2.50 to RTTY Journal, PO Box RY, Cardiff-by-the-Sea CA 92007.

RTTY Journal

This short but useful periodical is devoted exclusively to

GLOSSARY

AFSK	Abbreviation for audio frequency shift keying. With this method of modulation, two tones (mark = 2125 Hz, space = 2295 Hz) are fed directly into the microphone jack of the transmitter.	Mark	local copy on the teleprinter (see Fig. 2).
Answer-Back (W-R-U) System	A system capable of being remotely controlled by another station. When tripped by a unique access code, a short predetermined message is broadcast.	Modem	In RTTY applications, the mark is one of two states. The mark condition is characterized by a closed circuit. The space, the other state, is characterized by an open circuit condition.
Autostart (All-Call) System	An autostart circuit may be thought of as a squelch circuit. If an authentic RTTY signal is detected, the teleprinter motor is turned on and the message is printed. Unlike a selective calling system that turns the teleprinter on only when a particular access code is received, autostart circuits act as an all-call system and, thus, print any RTTY signal. The cessation of the RTTY signal causes the teleprinter motor to turn off.	PLL	Acronym for modulator, demodulator. A modem is typically used in a system where tones are transmitted and received over telephone lines. It may be thought of as the equivalent to a RTTY station's terminal unit.
ASCII	Acronym for the USA Standard Code for Information Interchange. At present, this code cannot be used on the amateur bands without special FCC permission. Unlike the 5 level Baudot code, this is a 7 level code used extensively in the electronics industry.	RTTY	Abbreviation for a phase locked loop. A PLL integrated circuit can be employed in a RTTY demodulator to discriminate between the mark and space tones.
Baud	The basic unit of speed derived from the duration of the shortest code element. For 60 wpm operation, the baud rate is 45.45 (1/22 ms).	Selcal	Abbreviation for radioteletype. Often pronounced "ritty."
Baudot	The code used by amateur RTTY stations to exchange information. It is a 5 level code plus one start and one stop bit.	Selector Magnet	Acronym for selective calling system. This system allows the teleprinter to be remotely controlled by a unique code.
Discriminator	A discriminator, as used in RTTY circuits, consists of a filter, either passive or active, to pass one frequency and discriminate against all others.	Shift	An electromagnet that senses current flowing in the local loop and picks a character to be printed in response to the current pulses.
FIFO	Acronym for first-in/first-out. A special integrated circuit memory device that will accept parallel data and retransmit it on a first-in, first-out basis.	Space	The difference between the mark and space frequencies. For example, if the mark frequency is 2125 Hz and the space frequency is 2295 Hz, the difference of 170 Hz is referred to as the shift. The 170 and 850 Hz shifts have become two widely used standards.
FSK	Abbreviation for frequency shift keying. With this method of modulation, the frequency of the transmitter's crystal or vfo is shifted.	Stunt Box	One of two states describing the condition of a teleprinter's loop. The space is characterized by an open loop condition. The mark state indicates a closed loop.
KB	Abbreviation for keyboard.	Tape Distributor	A mechanical unit that allows the operator to add control features to the teleprinter; for example, an automatic "non-overline" control which prevents printing over a message already typed. Controlling a remote device is another use for the stunt box.
KOX	Acronym for keyboard operated transmission. A station equipped with a KOX system can turn on the transmitter and turn off the receiver simply by typing on the station's keyboard. When the operator ceases typing, the transmitter automatically turns off, and the receiver turns on after some preset delay.	Tape Reperforator	A machine that reads prerecorded paper tape.
Local Loop	The circuit containing a power source, the selector magnets and a keyboard. This connection allows	TU	A device that records data by punching holes in a paper tape.
		UART	Abbreviation for terminal unit. This is the RTTY equivalent to a modem. It contains a modulator, demodulator, and loop power supply.
		W-R-U	Acronym for universal asynchronous receiver transmitter. A sophisticated integrated circuit that accepts serial data and retransmits it as parallel data and vice versa.
			Abbreviation for who are you. See Answer-Back system.

amateur radioteletype. To subscribe send \$3.50 to RTTY Journal, P.O. Box RY, Cardiff-by-the-Sea CA 92007. Price differs outside the U.S., Canada, and Mexico.

73 RTTY Handbook

There are two RTTY handbooks, both of which are, or have been, distributed by 73. The old RTTY handbook, while probably a fine book several years ago, is currently outdated. Being aware of this shortcoming, 73 has recently released a new handbook called, appropriately enough, *The New RTTY Handbook*.

Teleprinters

McNatt, M.S. "A Guide to Baudot Machines: Part 1, Description of Available Devices," *Byte*, April 1977, p. 12.

An excellent, interesting, and succinct article describing many of the Teletype Corporation machines (i.e., Models 11, 12, 14, 15, 19, 20, 26, 28, 29, 31, 32, 33, 35, 37, 38, and 40). On page 158 of this article is a list of sources for Baudot equipment.

Modulators

Roos, J.C. "Universal AFSK Generator," 73, July 1974, p. 37.

This article describes a RTTY modulator using the AFSK method of modulation. The unit is somewhat advanced for the beginner, but it does a very nice job. This is the modulator I have been using for several years, and I can speak highly of its effectiveness and reliability.

Demodulators

Grossman, B., and John S. Reid. "Building the Safari RTTY Terminal," 73, August 1976, p. 122.

Unlike most demodulators that use passive filters (inductor and capacitor) to discriminate between the mark and space frequencies, this unit uses active filters. Inherent in active filters is

their ease of calibration. A resistor is used to trim the filter to the exact frequency, rather than the iterative method used in LC filters.

Hoff, I. M. "The Mainline ST-6 RTTY Demodulator," *Ham Radio*, January 1971, p. 6.

The author, Irvin Hoff, has probably done more for RTTY within the last 15 years than any other RTTY aficionado. He is responsible for many demodulators, of which this article describes the most advanced. This unit has become a standard of excellence in the RTTY community. For the amateur who is earnest about RTTY, this is the demodulator to get.

Joffe, A.S. "Ridiculously Simple RTTY System," 73, September 1976, p. 70. For those who want to get on RTTY in a hurry, this is the article you want. The demodulator, while lacking sophistication, works, and you can't argue with success.

Stinnette, N. "Phase Locked Loop RTTY Terminal Unit," *Ham Radio*, February 1975, p. 36.

This article describes a simple demodulator using the phase locked loop principle. This is probably the best demodulator for the neophyte to RTTY since it is cheap and simple.

Selcal, Answer-Back, and Related Equipment

Kelly, B. "Monitor Receiver for RTTY Autostart," *Ham Radio*, December 1972, p. 27. This article describes a fixed frequency receiver for the RTTY aficionado interested in autostart operation. Unattended autostart operation requires more than just a receiver with good sensitivity and selectivity. It requires the receiver to be ultrastable since, as previously stated, the station is unattended. For this reason, the receiver described in this article is crystal controlled.

Lichtenwalner, B.D. "The Computer QSO Machine," 73, January 1976, p. 80.

This unit is capable of sending the time (hours and minutes), the date (year, month, and day), a pre-programmed message, and a CW ID. This unit is typically used in an answer-back system. When tripped by an access code, the time, date, message, and CW ID are broadcast, indicating the equipment is up and running.

Sanders, L.W. "RTTY Autocall — the Digital Way," 73, February 1976, p. 76.

This article describes a selective calling unit (Selcal). Of particular note is that the unit uses integrated circuits rather than a mechanical stunt box.

Advanced Projects

Guthrie, R.D. "ASCII/Baudot with a PROM," 73, June 1976, p. 114.

There are many commercial video display units on the market for those who don't like the clatter of a teleprinter. Unfortunately, these commercial units are geared for the computer hobbyist and, as such, accept only the ASCII code. This article describes a circuit that will convert the Baudot code to ASCII, so an amateur RTTY station can use one of the commercially manufactured video display units.

Hoff, I.M. "The Mainline UT-4," *RTTY Journal*, February, March, April, May 1974.

This series of articles describes the UT-4 which is a UART/FIFO combination capable of regenerating the received signal and electronic speed conversion. It's an advanced project but most worthwhile to the serious RTTY aficionado.

Hutton, L.I. "Build This Exciting New TVT," 73, March 1976, p. 76.

This article describes two projects. The first is a home brew electronic keyboard that generates the Baudot code. The second portion of the article describes a Baudot to ASCII converter and a TVT character generator.

Levy, S.P. "A Morse to RTTY

Converter," 73, June 1976, p. 106.

If you like sending CW but not receiving, this article is for you. The circuit makes use of a microprocessor to convert CW to ASCII or Baudot. It sure would be nice to have the next time you have to take a code test at the FCC.

Mooring, E.E. "Phase-Shift RTTY Monitor Scope," *Ham Radio*, August 1972, p. 36.

There are many different methods that one can use to tune in a RTTY signal properly. This unit uses the phase shift method and a CRT display. This technique is superior to most other methods, since the CRT display gives a great deal of information. It is possible to tell at a glance if the other station is transmitting wide or narrow shift, if the mark and space signals are reversed, and much, much more. This is a nice amenity to add once you have a station running.

Miscellaneous

Alexander, D. "The First Computer-Controlled Ham Station," 73, August 1976, p. 82.

This very interesting article describes the amateur RTTY station of the grand prize winner at the 1976 Altair Computer Convention. If you want to get some idea of the flexibility of a computer-controlled amateur RTTY station, this article is for you.

Brehm, R.C. "RTTY Goes Modern," 73, February 1977, p. 82.

This article is a must for the beginner who wants to know the history of amateur RTTY. The author concludes with a prognosis for RTTY and its ever increasing comradeship with microprocessors.

Green, W. "Thirty Years of Ham RTTY," 73, November 1976, p. 110.

An interesting article describing the history of amateur RTTY and is by one who was around during its infancy. Also included are pictures of antique RTTY gear.

MULTI-BAND ANTENNA TRAPS

Having trouble finding air-space for an 80 meter dipole? Restricted to 40 meters? Let PACE-TRAPS provide the answer! Five-Band no-compromise coverage in 105 feet! Four bands in the same space as your 40 meter dipole! PACE-TRAPS are quality-built, use proved, resonant circuits, described in most hand-books and designed to make-up into an all-band system. Four models available. NG-series 300 watt rated ... 4 or 5 band model ... \$14.95 pair FG-series ... kw rated 4 or 5 band model ... \$17.95 pr. Stranded Copper-weld equiv. to #12 ... handles like soft drawn ... cut to length ... 112 feet ... \$6.50 + \$1.00 UPS. Full installation details provided. Use with or without a transmatch. Shipped post-paid in USA. CT residents add 7% tax. Check or MO to

BOX 234 Upland Rd.
PACE-TRAPS Middlebury CT 06862
(203) 758-9228 P15

COAKIT

P.O. BOX 101-A, DUMONT, N. J. 07628

RF & AUDIO CONNECTORS & ACCESSORIES

5 PL259 UHF male	\$3.50	2 M359 UHF right	
5 SO239 UHF chassis		angle adaptor	\$3.25
female	\$3.50	1 UG224/U UHF splice	\$2.45
5 UG175/U adaptor	\$1.20	1 UG363/U UHF splice	\$2.75
5 UG176/U adaptor	\$1.20	3 UG240/U BNC male	\$2.70
2 PL259PO push-on		3 UG1094/U BNC	
UHF male	\$2.25	chassis female	\$2.40
2 PL258 UHF splice	\$2.10	1 Lightning Arrestor	
1 M358 UHF "T"	\$2.80	in-line UHF	\$2.25

ALL ITEMS POSTPAID — NO C.O.D.'s
***** SEND FOR FREE CATALOG *****

SWAN'S SS747

DRAKE'S TR4CW

KENWOOD'S TR7400A

YAESU'S FT301D

Call for competitive prices!

BankAmericard

Master Charge

FRECK radio & supply
co., inc.

252 Patton Ave., Asheville, N.C. 28801
PHONE: (704) 254-9551 F3