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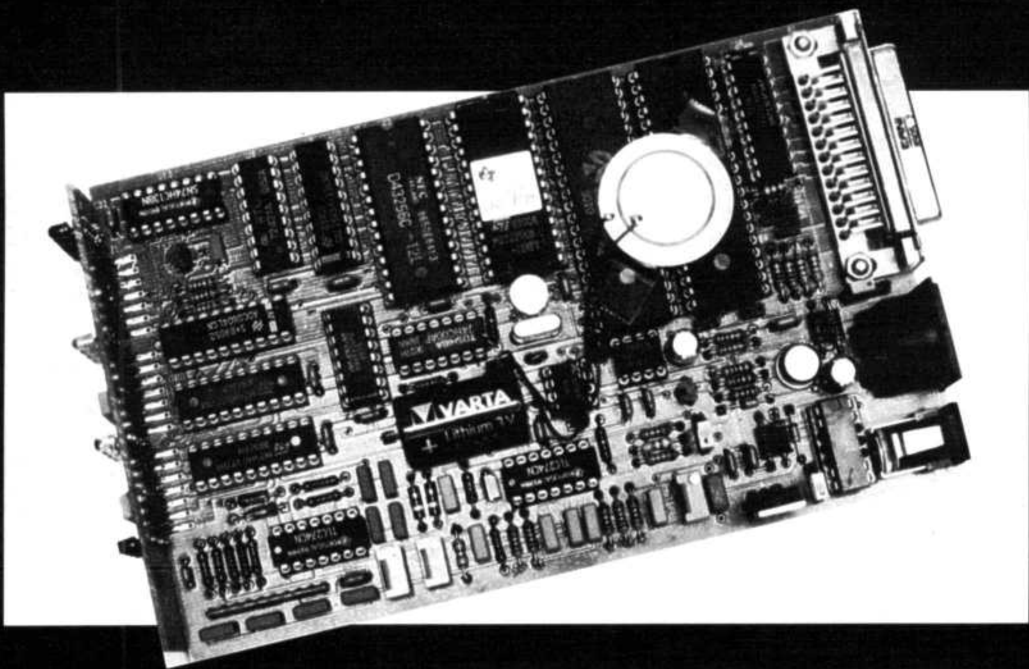
ARRL Experimenters' Exchange

OCTOBER 1991



PACTOR: *Two Articles*

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Both theoretical and practical technical articles are welcomed. Manuscripts should be typed and double spaced. Please use the standard ARRL abbreviations found in recent editions of *The ARRL Handbook*. Photos should be glossy, black-and-white positive prints of good definition and contrast, and should be the same size or larger than the size that is to appear in *QEX*.

Empirically Speaking. . .

Power Control in System Design

Amateur Radio Service rules require that amateur stations use minimum transmitter power. In his June 1991 *QST* editorial, Dave Sumner, K1ZZ, cited the ITU Radio Regulations, the Communications Act of 1934 and FCC Rules, and reflected on a recent FCC survey of amateur transmitter power. All of this says: It's a good idea to avoid running more power than you have to—the FCC, other amateurs and possibly your neighbors will like that. In spectrum management terms, the whole point is frequency reuse, ie, each station minimizes the area of the globe that is denied to other stations using that frequency.

Some, if not most, present-day amateur transmitters have some type of power control. Hand-helds may have power switches to change between a few watts and a few hundred milliwatts. Modern HF transmitters have knobs for continuous variable control of the output power level. Then, there is the possibility of switching in an RF power amplifier if more power is needed for a particular contact. Of course, all of these power controls are manual and left up to the operator to make adjustments. There are some clues as to when to increase power, such as a poor signal report or requests for repeats. Similarly, a 59+20 dB report may give the distinct impression that you ease back on the throttle. Nevertheless, it's easy to forget about controlling transmitter power when the feedback about reception quality is not constant and when there are other things going on.

A feature of cellular radiotelephone systems is Automatic Power control (APC). These systems are full duplex, and a chip in the mobile station equipment adjusts its transmitter power output level according to a three-digit Mobile Attenuation Code (MAC) signal sent by the base station. MAC is sent every six seconds or so to compensate for fading so prevalent in a mobile environment. According to the standards developed by the Telecommunications Industry Association (TIA), there are eight 4-dB steps downward from the maximum power levels specified for three mobile station classes: Class I, 6 dBW (4 W); Class II, 2 dBW (1.6 W); and Class III, −2 dBW (0.6 W).

Newer cellular systems are experimenting with more frequent exchange of APC signals, one system reportedly sampling on the order of four times a second. This particular system uses Code Division Multiple Access (CDMA), a form of spread spectrum. This faster sampling and power adjustment minimizes interference to other stations in the "near" area of the "near/far" effect found in spread spectrum systems.

In amateur simplex circuits, continuous real-time feedback is not practical, but there could be exchanges of inaudible attenuation codes with each "over" based on received signal quality averaged over the last transmission. It wouldn't be desirable to adjust power for a worst case, such as in the deepest fade of circa 30 dB magnitudes as this would defeat the whole purpose. In a phone or CW contact, deep fades can be compensated for by simply asking for a repeat of the lost information.

In packet radio or other digital systems, built-in Automatic Repeat reQuest (ARQ) features will cause retransmission; again, there is no need for "worst casing." However, no amount of simply jacking up the power may fix a reception problem due to intersymbol interference. So, any APC features need to be smart enough to tell when more power will help and when it will not.

Then, there is the problem of power escalation. If two circuits are contending for the same radio channel, it wouldn't be a good idea to get into the "APC wars," where each station is automatically maximizing its power to beat out the competition. Again, there has to be some intelligence in the system.

APC could be a particularly effective strategy when coupled with directional antennas, possibly even adaptive antennas. The idea is simply to minimize transmitter power to that required and minimize radiation in directions not intended to receive the signal. Maybe that's difficult to do with present hardware, but such features shouldn't be overlooked in future designs.

You may not have APC on your next rig, but such a feature would be an excellent one in future systems. Standards would need to be developed to ensure compatibility and use the more appropriate power control strategy for a particular amateur communication mode.—*W4RI*

PACTOR—Radioteletype with Memory ARQ and Data Compression

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Translated by Don Moe, KE6MN/DJ0HC, from the November 1990 issue of cq-DL, *published by the German Amateur Radio Club.*

Introduction

In the past ten years, Amateur Radio teleprinting has increasingly evolved from an elite operating mode for specialists into a regular means of daily communications. Under closer scrutiny it is apparent however, that the largest extent of progress has mainly benefited the VHF/UHF operating mode packet radio. In the short wave segment, amateurs still have to make do with relatively modest technical standards and ease of operation.

The transition from "Steam RTTY" of the T37 era to AMTOR (SITOR) and packet radio (PR) undoubtedly represents a large qualitative improvement. However, the question may be asked whether mere adaptation of commercially used transmission protocols provides a favorable solution for Amateur Radio. In the case of PR above 30 MHz, this can certainly be answered with "yes," since here the transmission conditions of the original system (data lines via telephone) are virtually identical with those found on VHF/UHF. In contrast, a PR connection on the 80-meter band in the evening often results in a serious test of patience.

SITOR was especially developed for operation on short wave; but the system standard is still limited to the technical possibilities of the "TTL days" in the 1960s, even if the amateur designation "Microcomputer Teleprinter Over Radio" suggests something more.

All important AMTOR system parameters such as character set and maximum transmission rate are geared to the typical data terminal at that time, the mechanical teleprinter. Electronic intermediate storage devices, taken for granted today, were not feasible economically. Since new developments can scarcely be expected from the commercial side, such as for nonmilitary short wave radio at sea, radio amateurs are left to their own devices.

The authors of this article advocate the position that even in the era of satellite communications, efficient transmission protocols for short wave cannot be ignored. In accordance with aspects of information theory, this must also include the operating mode CW.

1. AMTOR—Strengths and Weaknesses

Before designing a new system from scratch, it is appropriate to look for possibilities of extending or improving existing technology.

The popularity of AMTOR (see Ref 1 for functional description) is well founded: the system is relatively uncomplicated and can be combined with available teleprinters.

[1]References appear on page 6.

Even at poor signal-to-noise levels usable connections can still be maintained. The rather high error rate under these conditions is tolerable in normal amateur conversations due to the high amount of redundancy in text.

This is a different story in the case of technical messages, such as modification instructions, programs or the like. In addition to the fact that every error can have disastrous effects, such texts are mostly in ASCII format. When transmitted in 5-bit Baudot code, ambiguity results which must either be tediously clarified or left to the intuition of the reader.

Recoding techniques, such as suggested in Ref 2, merely shift this problem to a different level. In addition to significant speed reductions, transmission errors can cause even more disagreeable side effects.

A further disadvantage of AMTOR, which is particularly significant for mailbox operation, is the low effective maximum speed of less than 35 bauds, resulting in insufficient usage of the available channel capacity during phases with good signal-to-noise ratios.

2. Basis for the Development of PACTOR

The authors began experimenting with derivatives of the AMTOR technology, such as longer blocks, doubling the speed, etc. Although these achieved significant improvements in performance, the principal weaknesses of AMTOR, inadequate error correction and ASCII incompatibility, could not be overcome. Thus the design of a completely new technique was begun at the end of 1987.

Since the new system combined important characteristics of packet radio and AMTOR, the name PACTOR was chosen (Latin: mediator). The synchronous, half-duplex basic structure of AMTOR was retained: Information blocks sent at fixed time intervals are acknowledged by the receiver with brief control signals (CS).

The length of the information blocks and thus the duration of the transmission cycle is an important factor in determining the flexibility of a system. On a noisy channel long packets scarcely have a chance of survival, resulting in the PR blocking effect, which is largely minimized by Memory ARQ in PT. On the other hand, during periods of strong interference, the probability of reception increases when shorter packet lengths are used. The price in this case is a lower maximum data rate on a noise-free transmission channel.

For example: AMTOR requires a cycle length of 45 bits in order to transmit the message content of 15 bits. Two thirds of the capacity are thus swallowed up by overhead.

To arrive at the most favorable PACTOR block lengths, long-term tests were performed with short wave FSK transmissions and the results were evaluated by computer. The result was an optimal cycle time of nearly two seconds, which was then reduced to 1.44 seconds in the final version of the system in order to achieve short break-in times. The overhead portion now takes up only one third of the transmission capacity.

In a synchronous transmission system, the stability of the clocks at both stations is very important. During the development of PT this problem was circumvented in a very simple way: the system clock at both ends was derived from the 50-Hz power grid, which provides a phase stable and reliable synchronization framework for nearly all of western Europe. Since relying on the power grid would have naturally restricted the system's usefulness, crystal control with phase correction is now the standard mode.

Due to the narrow bandwidth limitations imposed by regulations and the receiver filters, only FSK came into consideration as the modulation type. Under normal conditions, the typical short wave channel width using a 600-Hz filter permits 200 bauds at 200-Hz shift, which is achievable with customary filter converters without significant modifications.

During periods of phase distortion, such as multipath propagation, which can occur on winter evenings on 80 meters, the speed must be reduced to 100 bauds. In PT this is accomplished by optionally filling the blocks with 100- or 200-baud information. Since the main timing remains constant, the switch over can happen automatically without loss of synchronization as soon as requested by the receiving station.

As described in the previous section, the relatively high error probability with AMTOR is its central weakness. Therefore PT uses a longer acknowledgement signal (12 bits) as well as the cyclical error recognition code used in PR (16 bits), which practically eliminates the problem of unrecognized transmission errors. Only under these prerequisites can this new method for amateur RTTY be fully effective with the following features:

- Memory ARQ, summing method for reconstructing the original block
- On-line data compression (Huffman encoding).

Additional system characteristics:

- faster and more reliable change of transmission direction (break-in)
- 100% compatible to ASCII and transmission of binary data
- QRT confirmed at both stations
- independent of shift direction, no mark and space conventions
- optional attachment to frequency standards such as DCF-77
- unique call address using complete call signs
- comprehensive capability for other stations to read along
- simple hardware requirements
- comfortable operation

3. Important System Details

Since a complete specification of the protocol would exceed the limits of this article, the authors will provide a complete description in the PR mailbox network so that interested parties can obtain further information easily. Here only a few of the special aspects will be described as they differ from the corresponding AMTOR/PR procedures.

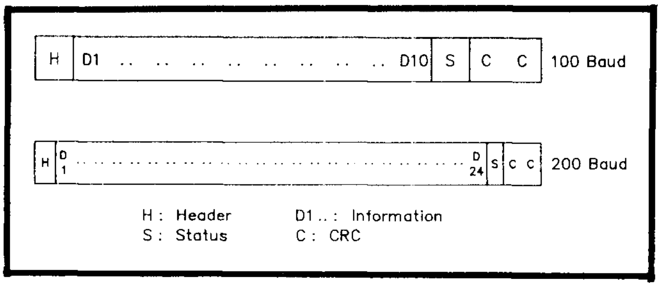

Fig 1—PACTOR packet format

3.1 Transmission Formats

a) Information Blocks

- All packets have the basic structure shown in Fig 1:
- Header: contains a fixed bit pattern for simplifying synchronization and reading along, also important for Memory ARQ
- Data: any binary information. 192 bits at 200 bauds, 80 bits at 100 bauds.
- Status: control byte containing 2-bit packet number, break or QRT request, transmission mode, etc.
- CRC: 16-bit block check code, effective on data, status and CRC.

b) Acknowledgment Signals

- PT uses four acknowledgment signals (CS1 to CS4), which correspond in their function to the AMTOR control signals except for CS4:
- CS1/CS2: normal acknowledgment function
- CS3: change of transmission direction (break-in), forms packet header
- CS4: requests a speed change at the sending station
- The acknowledgment signals have a length of 12 bits. The characters differ in pairs in 8 bits (Hamming offset) so that the chance of confusion is minimized. One of the most common causes of errors in AMTOR is the small CS Hamming offset of 4 bits.
- If the CS is not correctly received, the transmitting side reacts by repeating the last packet. The request status can be uniquely recognized by the 2-bit packet number so that wasteful transmissions of pure RQ blocks as in AMTOR are unnecessary.

c) Timing

- The receive pause between two blocks is 0.32 seconds. After deducting the CS lengths, 0.2 seconds remain (0.17 sec for AMTOR) for switching and propagation delays so that there is adequate reserve for DX operation.

3.2 Establishing Contact

The calling station (master) sends a special synchronization packet which only contains the call sign (address) of the called station (slave):

/Header/Address (8 bytes, 100 bauds)/Address (8 bytes, 200 bauds)/

Following synchronization, the slave responds with CS1, or CS4 if the 200-baud bit pattern was also recognized. Depending on channel quality the connection can be started at the optimal speed without delay. The number of significant synchronization bytes can be chosen by the slave. In practice, six characters should suffice. The unpleasant problem of ambiguous selcals in AMTOR is thus eliminated.

During the synchronization phase the relative shift direction is also determined. The converter or FSK setting of the two stations is irrelevant. Mark/space conventions can thus be dropped.

After receiving the first CS from the slave, the master begins sending normal information blocks. It has proven useful to send system specific data automatically at the beginning such as master call sign, software version number and other configuration parameter.

3.3 Changing Transmission Direction

Following each correctly received packet, the receiving station can transmit a CS3 (break-in). In contrast to AMTOR, an intermediate cycle containing no information is not required. The CS3 forms the header of the first information packet. In the ideal situation, the direction could be changed again in the next cycle, which would be advantageous for mailbox commands. Depending on whether only the CS3 header or the entire packet was received, the former master could reply with CS2 (repeat) or CS1/CS3.

Analogous to "+?" in AMTOR, the transmitting station can also request a break-in, which occurs by setting the BK status bit.

3.4 Changing Speed

Switching between the two speeds of 100 and 200 bauds is normally provided. Since an increase in speed is sensible only during good conditions and a reduction during bad conditions or a slow information flow such as manual text entry, each direction is handled differently in the protocol.

a) 200 -> 100 Bauds

Following receipt of a bad 200-baud packet, the receiving station can request a reduction in speed with CS4. While maintaining the time frame, the transmitting station will put the packets together with 100-baud information. The unacknowledged 200-baud information of the previous packet will then be repeated.

b) 100 -> 200 Bauds

A correctly received 100-baud packet could be acknowledged with CS4 which causes the transmitting station to double the speed. If the following 200-baud packet is not acknowledged after a predetermined number of attempts, the speed will automatically be set back to 100 bauds. The decision regarding a speed change is made at the receiving end. Normally this occurs by automatically evaluating the packet statistics such as error rate, number of retries, number of filler characters for manual text entry, etc.

3.5 Ending a Contact

In the normal ARQ protocol, the principle of mutual acknowledgment is violated at the end of a connection: One station sends the appropriate QRT signal and then switches the transmitter off. If the other station does not receive the QRT signal, it sends acknowledgment signals until the internal timer expires, which leads to undesirable interference, particularly in AMTOR mailbox operation.

PT solves this problem through a special mode: At the end of a connection special QRT synchronization packets are transmitted which contain the receiver address in the reversed order. If the slave station recognizes such a packet during the normal search phase, it responds with a single acknowledgment transmission in the established time frame. This process is repeated until the sending station has received the acknowledgment.

3.6 Data Compression

In amateur RTTY only constant length characters have been used to date. Frequently occurring letters such as E or N require the same transmission time as X or Q.

A frequency analysis of normal written texts shows that the average information content per character ("Entropy"[3]) only amounts to 4 bits, so that a normal ASCII transmission therefore contains nearly 50% ballast. Through clever encoding using variable character lengths, common in Morse telegraphy for the past 150 years, it should be possible to put this idle reserve to use.

The Huffman code (see Ref 3) used by PT approaches the optimal limit within a few percent so that nearly 100% increase compared to ASCII can be achieved in practice. This code can be automatically calculated as a tree structure based on the character frequency. The compression occurs by packet; the character lengths vary between 2 and 15 bits.

A prerequisite for using data compression methods is high data integrity. Techniques without block error recognition such as AMTOR are therefore not suitable.

3.7 Memory ARQ

Customary FSK RTTY converters route the demodulated received signal via a low-pass filter to a trigger stage where the binary data for the computer are extracted. Here a weakness becomes evident: The decision whether a signal is a "0" or a "1" is made outside the computer and is thus no longer accessible for "intelligent" analysis. The information whether a signal was only 1 millivolt or 1 volt above the threshold is lost forever. Additional distortions are caused by inaccurate calibration or drift of the trigger threshold.

In the past, error recognizing techniques for RTTY in Amateur Radio merely evaluated the information from complete blocks received error-free. It is obvious that this results in a significant waste of information particularly at poor signal-to-noise levels. In an ARQ system such as PACTOR, multiple repeats of an incorrectly received packet can be overlapped to recover the original information.

The ideal solution in the form of a direct computer evaluation of the audio receive signal is still constrained by the high price of the necessary signal processors. Practice with PACTOR has shown however, that important advances can be achieved using a low-cost 8-bit A/D converter instead of a trigger stage.

The incoming analog values are first converted to 0/1 decisions as before, but additionally are stored as a sequence of 8 bit values for later use. If the 0/1 evaluation does not yield a correct packet (CRC error), the analog values from subsequent repeats of the packet are combined into a "sum" packet which is then subjected to a 0/1 evaluation and CRC check.

There are two potential problems to be considered:

a) If the acknowledgement signal sent by the receiving station is not immediately heard, old RQ packets could be added to the sum for the new block.

b) Packets which were nearly completely destroyed, such as by an interfering carrier, should also be ignored.

To handle these cases, the information contained in the packet header is evaluated. This is inverted in phase

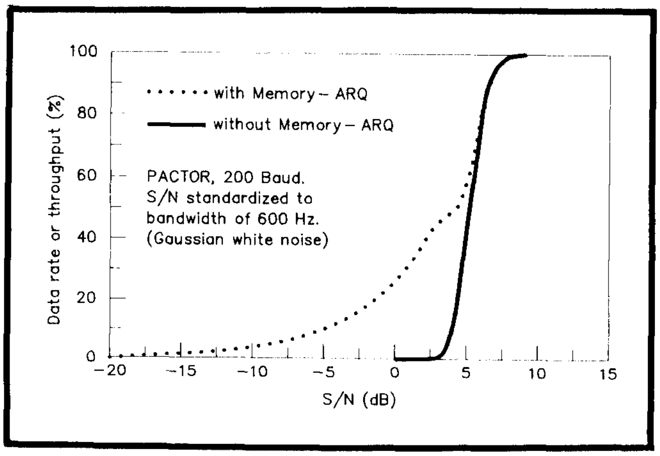

Fig 2—Increase in data rate when using Memory ARQ.

with the packet counter in order to guarantee a simple request recognition. Obviously unusable packets, such as those with a constant bit pattern or a destroyed header are not added to the summation.

Similar methods are used in professional transmission technology.[4] The term "Memory ARQ" comes from there.

Sample calculations confirmed in practice have shown that the data rate can be significantly improved at poor signal levels by using Memory ARQ. It is particularly apparent that the sharp PR limit at which the communication collapses has been eliminated. (See Fig 2.)

Memory ARQ can be limited to being used only if the error recognition technique has adequate reserve. In AMTOR a dramatic increase in the rate of incorrect characters would result.

3.8 Monitor Mode

The requirement that other stations be able to read the content of communications is specified in the Amateur Radio regulations. This is necessary when there are more than two active stations. PACTOR is similar here to the monitor mode in PR. The received bit stream is continuously evaluated and checked for valid packets according to CRC. Since several samples occur per bit and a separate CRC must be calculated for the two possible speeds, the capacity of the Z80 CPU is nearly at its limit in this mode. The result is an uncomplicated read-along operation, which works without operator intervention, in contrast to the L-mode in AMTOR.

Additionally an automatic CW identification occurs in 5-minute intervals.

3.9 Supervisor Mode

The definition of special control characters makes it possible to pass information from the receive buffer directly to the system level. Through this supervisor mode, various protocol versions could be automatically harmonized and thus future developments of the system could be taken into consideration.

4. Practical Operation

4.1 Hardware and Software

PT was designed from the start to be a self-contained system since a home computer solution (C64 or similar) nearly always has disadvantages such as space requirements, HF interference, etc.

The "PACTOR Controller" (PTC) was implemented as a single board computer based on the Z80 processor. Initially DL6MAA built a prototype with the new CMOS SMD chip TMPZ84C015 which contains all of the necessary Z80 peripheral modules. At the same time a compatible version was built by DF4KV using conventional Z80 components.

A battery-powered real-time clock is integrated along with two EIA-232 interfaces as terminal connections (XON/XOFF handshaking). The system status is displayed in a block of 12 LEDs, and an additional row of LEDs acts as a tuning indicator based on the incoming analog values. Important events such as connect or QRT are also signaled acoustically. The associated converter operates with filters. The output signal from the low-pass filter is fed via a level converter stage to the ADC input.

The software was developed primarily by DL6MAA and in addition to the pure PT system also contains a command interpreter with TNC compatible syntax. The free RAM memory is automatically configured as a private mailbox in which messages from callers can be deposited or read. The available program memory is large enough to accommodate additional software such as AMTOR or a CW keyer.

In the fall of 1989, DL2FAK installed a PTC on 80 meters with access to the message base of a 70-cm PR system. Using this PT link technique, ASCII compatibility and speed of the PT system were demonstrated very well.

In the meantime, further amateurs have become involved with PT tests: DK5FH, DF4WC, and DL3FCJ, who has developed a new PTC design with an integrated converter.

4.2 Operating Techniques

For users already familiar with packet radio, there is scarcely any adjustment needed. A series of commands allows checking and setting all important system parameters. Most commands can also be accessed by the remote station for reading directory contents, storing messages, etc.

5. Conclusion

PACTOR was developed as a purely amateur project in the context of the experimental radio service. Error robustness and short wave suitability were primary goals.

PTC kits based on the design of DL3FCJ should become available by the end of 1990. Interested parties can request circuit diagrams from the authors by sending an SASE. Programmed EPROMs and GALs are likewise available in limited quantity.

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PTC—The PACTOR Controller

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In the November 1990 issue of cq-DL *(see English translation beginning on page 3 of this issue of* QEX*) DF4KV and DL6MAA described the new radio teleprinter technique, that they had developed, called PACTOR and they announced that suitable hardware would soon become available. In the following article this hardware, the PACTOR Controller (PTC) is extensively described. The currently available software version, 1.0, also supports complete AMTOR and RTTY operation.*

The PTC is implemented on two circuit boards. The main board is Euro-Card size (160 × 100 mm) and contains the Z80 processor and its support components as well as all interfaces. The second circuit board contains the display field, consisting of 20 variously colored, low power, light-emitting diodes. This display board is soldered at right angles to the front of the main board. Double-sided circuit boards are used that have plated-through holes, a silk-screened component layout and solder resist, thus fulfilling requirements for high quality. The hardware is kept as simple as possible for equipment of this complexity. The entire assembly is mounted in a box of aluminum profile similar to that used by the TNC2c or the AMC.

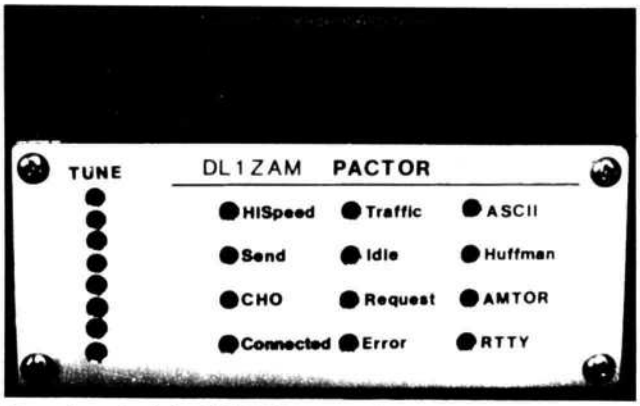
On the back panel are the connectors: a 25-pin sub-D for the EIA-232 connection to the terminal, a 5-pin DIN for the connection to the transceiver, and a third jack for power. The PTC is thus fully compatible with the connections on the TNC2c or the AMC. The holes and cutouts on the front and back panels are stamped out. The front panel has silk-screened labels.

The PTC can be powered from a dc source between 9 and 14 V and requires approximately 200 mA.

The Circuit Processor Section

The central unit of the processor section consists of the 8-MHz CMOS version of the well-known Z80 processor (U1) and a multipurpose component, STI (U4), which contains serial and parallel ports as well as four independently programmable timers. These are used to generate the AFSK and FSK signals as well as the clock frequency for the programmable filter (U15). The STI also contains the EIA-232 interface and a MAX233 (U5) converts the signals to/from the standard voltage levels. The port can be operated at 300, 1200, 4800 or 9600 baud, 8 bits, one stop bit and no parity.

The program is stored in a 27C256 EPROM or 27P256 PROM. A battery-powered CMOS RAM (U3) maintains the data and settings should the operating voltage be removed.



Sample unit of the PACTOR controller

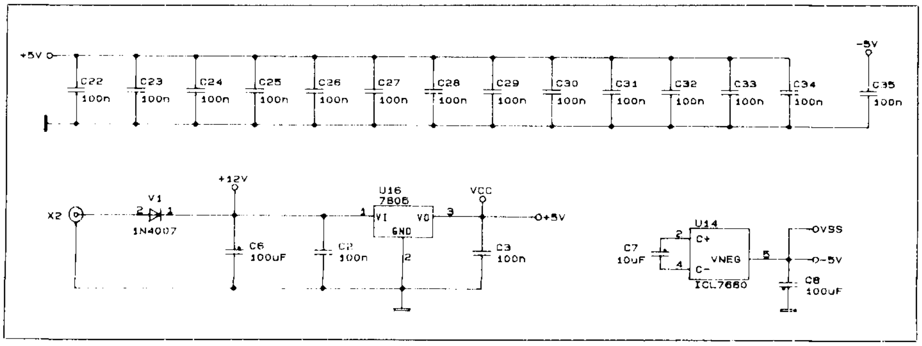
The processor clock is provided by inverter U11A together with crystal G1 and C1, TC1 and R5. The exact frequency can be set with TC1. The oscillator signal (C7) is fed via buffer U11B to the processor.

A MAX691 (U10) was chosen to provide a reliable power-on reset and backup power from a lithium battery. In case of loss of operating voltage, it maintains the RAM (U3) and the real-time clock (U8). The time and date will therefore not be lost whenever power is off or a reset is performed.

U10 also performs the "watchdog" function. The proper operation of the software is watched over by the WDI input (pin 11). If the pulses on WDI cease, U10 generates a reset and the program is restarted. Thus a program crash will not lead to a long term failure of the system, but only to a brief interruption. This is a major criterion for an independently operating system.

Components U6, U7 and U13 drive the light-emitting diodes. U6 and U7 are merely latches, and U13 decodes three data lines to drive the tuning indicator, which is controlled directly by the program. It displays what the processor has processed from the input signal. LEDs not needed for tuning are switched off by the software so that the user sees a better tuning indicator.

The PTC contains an analog-digital converter (U12) for transforming the preprocessed audio input signal from the radio receiver into the digital signals required by the processor. This function is necessary for the Memory ARQ, as described in Ref 1. Transistor T3 assures proper initialization of the A/D converter following a reset. The conversion



speed is determined by C21 and R18.

Address decoding for the various components of the PTC are performed by a programmed logic component, GAL 16V8 (U9). The GAL provides the chip select signals on its output. It is especially programmed for the PTC and thus cannot be substituted.

Audio Processing of the Received Signal

The demodulator operates as an envelope detector (filter converter), but differs from customary circuits of this type due to the sharp cutoff characteristics of the input bandpass and the optimization of the low-pass filter at baseband for 200 bauds.

U18B and U18C form an active fourth-order high-pass. U15 functions as an elliptical seventh-order low-pass with switched capacitances (SC filter) and raises the filter function to a sharp cutoff band-pass. The SC technique permits the processor to adjust the limit frequencies via FClk, permitting quick adaptation to the baud rate. U15's other advantages are its very small size and excellent long-term characteristics.

U18A amplifies the preselected signal into limiting. The actual discriminator filters are U17A and U17B. Their output signals are rectified by V5 and V6 and are combined in a summation low-pass (U17C). Before arriving at the A/D input, the freshly demodulated signal passes through another fourth-order low-pass, which is designed to achieve optimal immunity from noise or interference at a 200-baud data rate.

The characteristic curve of the demodulator indicates a sine-wave dependence between the input frequency and the output voltage.

A/FSK Transmit Signal

The tones to be transmitted by the transceiver are generated directly by component U4 (STI). Since it can only supply square-wave output signals, filtering by the active low-pass U18D is required before the tone signals arrive at the microphone input of the transmitter.

After removal of the harmonics, the signal passes through P3 and C39 to the interface to the transceiver (X3). The AFSK tone frequencies are 1200 Hz and 1400 Hz. In the case of a transmitter with a direct FSK input, FSK output from the PTC is provided by transistor T2.

The user sets jumper BR8 to chose whether FSK or AFSK should appear at jack X3.

Operation of the PTC

When power is applied, the PTC performs a test of the LEDs and sends a sign-on message containing the call sign stored in ROM to the terminal.

Since the PTC is command operated, it displays the prompt "cmd:" and waits for input. All commands are terminated with a CR. Corrections can be made using the backspace key. In the stand-by mode, the PTC is immediately ready for another command.

When establishing a connection and in the connected state, characters arriving over the EIA-232 interface are sent directly to the transmit buffer to be transmitted at the next opportunity, unless preceded by Escape. The size of the text buffer is set to 5000 characters. During a connection, all PTC commands must be prefixed with Escape, and only one command can be entered at a time. In case of an error in the command, PTC accepts an immediate reentry of the command.

The Command Structure

Some commands expect arguments, others not. An argument must be separated from the command by at least one space. If a command expecting an argument is entered without any argument, the current setting is displayed.

Nearly all commands can be drastically abbreviated; for example, the command "Call" can be shortened to "C". Characters following the minimal length are ignored up to the first space. Since describing the complete PTC command set would exceed the limits of this article, anyone interested in building or acquiring a PTC should contact the address provided at the end of this article, where he can obtain complete information, components and naturally a handbook.

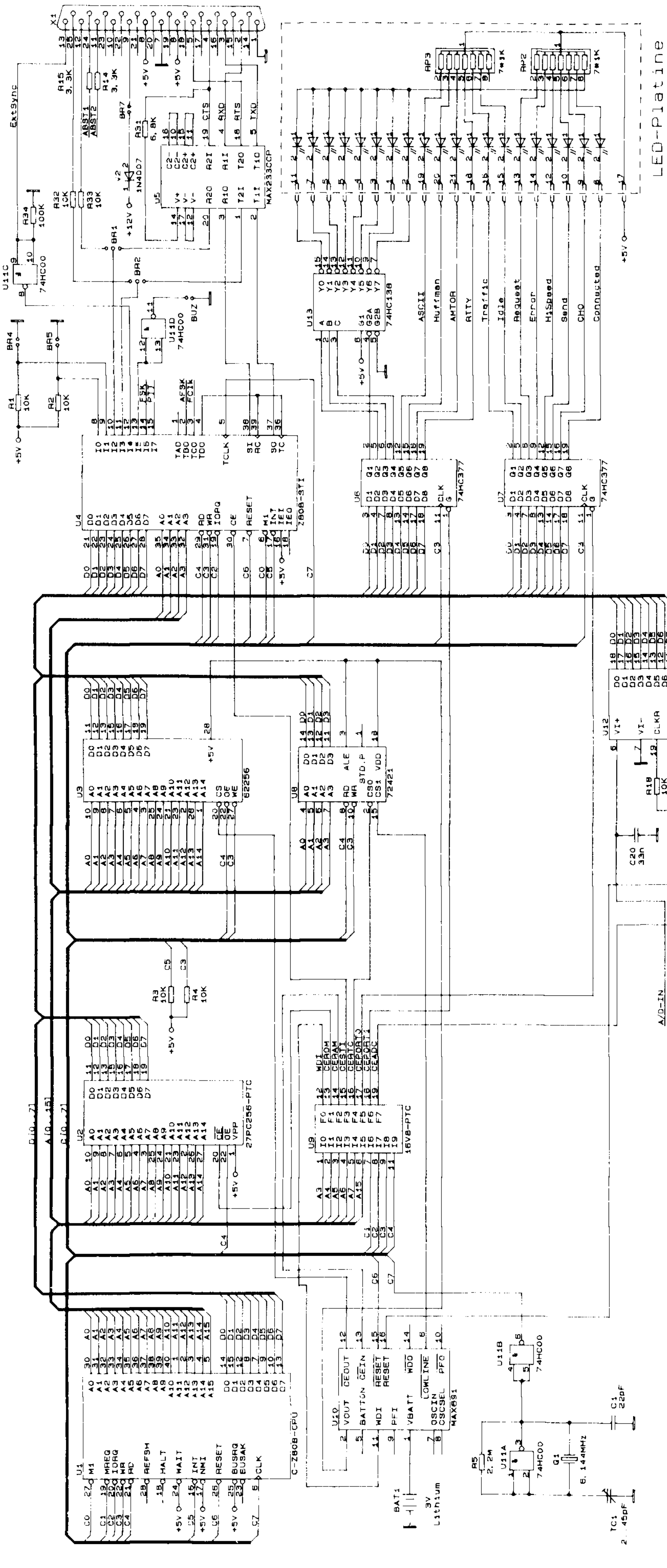
Several PTC commands are comparable to those in a TNC so that anyone with packet radio experience should have no trouble operating a PTC. For example, the command "C" is "Call" or "Connect", "D" is "Disconnect", and "MY" is "MyCall" which changes the call sign stored in ROM.

Special PTC Features

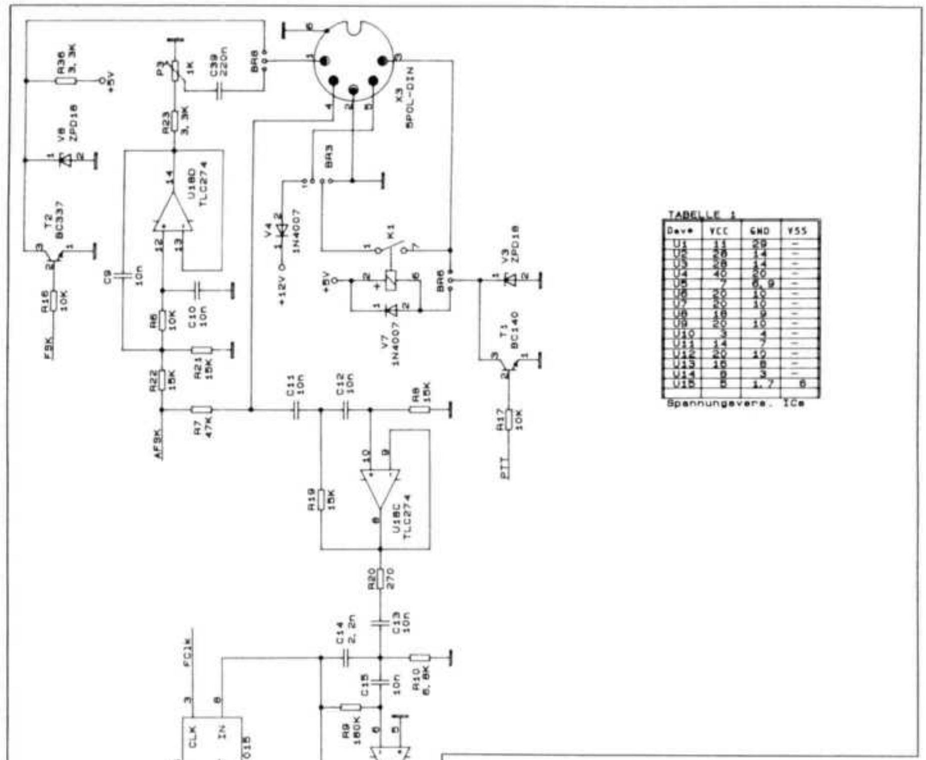
An intelligent piece of equipment such as the PTC is capable of operating more than just PACTOR. It can also support the operating modes of AMTOR in all its associated variations, such as ARQ, FEC, list, etc, and RTTY, at all speeds between 30 and 300 bauds.

When the command "AM" is entered, PTC switches to the AMTOR mode. The selcal stored in ROM then appears on the screen of the terminal and another selcal can be entered at any time. The AMTOR and PACTOR calls remain in memory until the restart command is executed. Restart resets all settings to those in ROM and completely erases the RAM.

The command "BAU <n>" switches to RTTY at the



Schematic of digital section

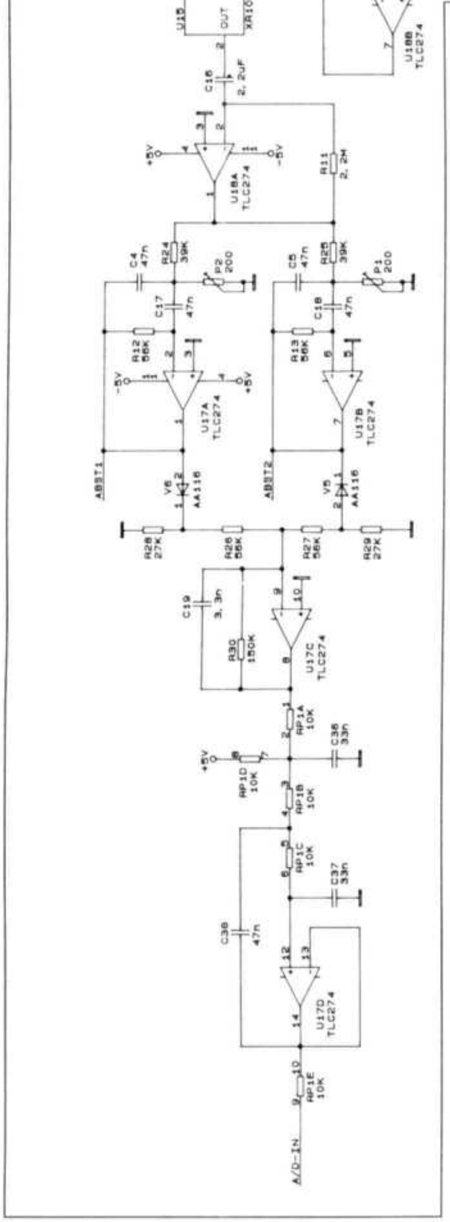


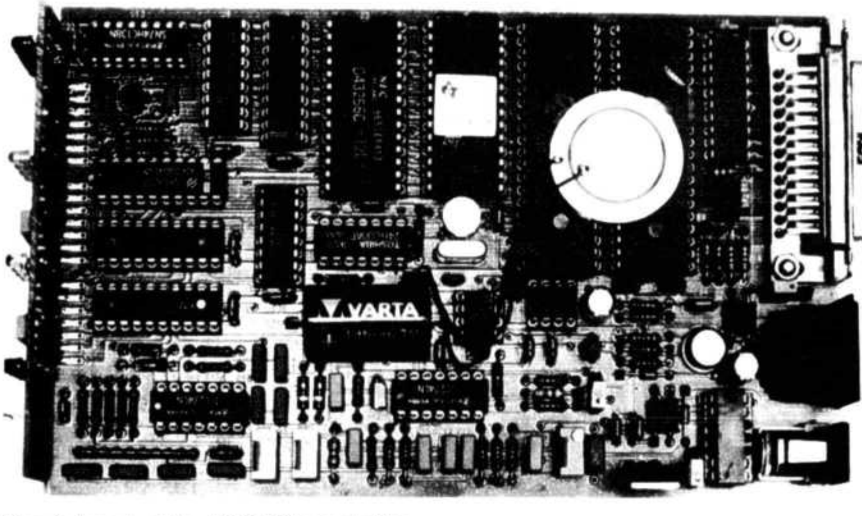
Schematic of analog section

TABELLE 1

Dev.	VCC	GND	VSS
U1	11	29	–
U2	28	14	–
U3	28	14	–
U4	40	20	–
U5	7	6, 9	–
U6	20	10	–
U7	20	10	–
U8	18	9	–
U9	20	10	–
U10	3	4	–
U11	14	7	–
U12	20	10	–
U13	16	8	–
U14	8	3	–
U15	5	1, 7	6

Spannungsvers. ICs





Circuit board of the PACTOR controller

messages with "//W", to read messages with "//R", to display the contents with "//DIR", etc. Commands with two slashes are remote control commands, and without a double-slash, these commands control the mailbox in the local PTC.

Naturally the contents of the mailbox are maintained by a battery in case of power loss. The size of the mailbox memory is 21,518 bytes. In version 1.0 of the PACTOR software, the mailbox is only accessible in the PACTOR mode.

Remote control of the local station can also be disabled.

The PTC keeps its own logbook which can be displayed with the command "LOG". This command is also available to remote stations so that it's possible to view the log of a remote station. Only the most recent 16 contacts are stored in the logbook, which is likewise maintained by the battery.

As already mentioned, the software also supports alignment of the PTC. Only four alignment points are provided: two in the demodulator, the audio level to the microphone input of the transceiver, and the crystal frequency. If the command "ME" is entered, a message appears requesting that the alignment point P1 should be set to the maximum value displayed on the screen. Following "return," PTC displays numbers on the screen and P1 should be adjusted to the maximum value. P2 is then set in the same manner. At the same time, the AFSK output produces audio for setting the audio level to the microphone input of the transceiver.

The setting of the crystal's frequency is very important for synchronous operating modes such as PACTOR and AMTOR. It is adjusted with TC1 in conjunction with a frequency counter. If the frequency is not set correctly, the software will automatically compensate for the offset during a PACTOR contact. This is naturally only possible within certain limits so that a proper adjustment should definitely be performed.

Using the command "Phase", the amount of compensation can be displayed during a contact, also remotely. This opens the possibility of setting the frequency by comparison to a correctly aligned reference station. Alignment is therefore possible without any test equipment. Alternatively, an external reference clock source can also be attached.

The "Show" command, followed by various arguments, displays the settings in the PTC system. The command is also usable from a remote station, so that the system parameters can be copied to the remote station. Among other things, the command can be used to redisplay the last 1,600 characters received. Thus text can be brought back that has already scrolled off the screen, which would be very helpful on simple terminals or small displays.

LED Status Display

The PTC contains a very practical tuning and status display with 20 LEDs. Eight LEDs are in the tuning indicator and the remaining twelve are in the status display. It can thus be seen who has the keys and whether a changeover takes place.

The changeover (CHO) can be initiated at any time by the transmitting station. The character for it can be freely chosen, but is normally set to Ctrl-Y. The receiving station also has the chance to force a CHO.

The display also indicates whether Huffman data compression is in operation or whether 8-bit ASCII is being transmitted. The latter is useful when text with IBM graphic characters or the like are to be sent.

The PTC adapts the transmission speed to the channel conditions, thus one LED displays the speed, 100 or 200. The switch-over criteria can be altered with special commands. Additionally, the indicators show whether data transmission is occurring, or if there are currently idle, request or error conditions, or whether AMTOR or RTTY are active. If the LEDs "Traffic" and "Error" illuminate simultaneously, data packets are being reconstructed using Memory ARQ.

One LED shows if the PTC is in connected mode. This LED flashes if a connect has taken place when the operator was not present, such as when a message was written into the mailbox. In this article, the PACTOR operating mode was not discussed in greater detail since this has already been done in Ref 1.

Anyone interested in building or buying a PTC should contact (include an SASE): Dr. Thomas Rink, DL2FAK, Röntgenstrasse 36, D-6450 Hanau 1, Germany or the authors of this article.

References

[1]DL6MAA, DF4KV: PACTOR - Funkfernschreiben mit Memory-ARQ und Datenkompression. *cq-DL* 11/90. (Radio Teletype with Memory ARQ and Data Compression)

VHF+ Technology

By Geoff Krauss, WA2GFP
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Dresher, PA 19025

More Thoughts on 135 cm

I am writing this column the week before the September VHF Contest, which will be the first real chance the US VHF+ community has to see how many 220 CW/SSB contesters actually made the change-over to 222 MHz at the end of August and in the early part of September. One of the better factors is that there are few 220/222 transceivers marketed by the very large Pacific Rim suppliers, mostly because 220-MHz operation is not allowed in their home country. Without the large sales volumes that would make it possible, there is no economic incentive to produce a unit for North American sales. (FM is an exception since even Novices—and now codeless Technicians—have 222-225 privileges, and there is just barely enough demand to make a 222-FM rig or two feasible.) Therefore, if a VHF+er is using a commercially built transverter, that transverter was probably built by a smaller, VHF-oriented company. The amount of information supplied with the transverter is probably adequate to allow the owner some opportunity to get inside, at some time, and the size of the equipment is probably such that there will also be some room in which to work, change parts, etc. I would suspect that almost all owners of 220-MHz non-FM equipment have indeed made the changeover and will appear on 222. There should be more than adequate activity. All this points to a good band for non-222ers to do some work on this winter. How about you?

One item about 222 MHz that did catch my eye was the guest proposal by Mike, W9IP, in the September '91 "World Above 50 MHz" column in *QST*. Mike suggests: Why doesn't everyone on 222 go to vertical antenna polarization! As often happens in other areas of history, this proposal has been made to the VHF+ community before (the last time, to my memory, being in the early '60s). Read Mike's proposal, make up your own mind and, if you feel strongly enough about it, one way or the other, respond to the columnist, W3XO. I would add only one comment: On a band that now has only 60% of its former width, stations using the various different modes want to keep as much out of each other's way as possible—if cross-polarization truly gives as much as 20-dB suppression between the vertically polarized local packet station and the horizontally polarized weak-signal operator on the next ridge over, then there is that much less signal at the receiver of each different user, and that much less potential interference. This sounds very desirable to *me*! True, if I only have a whip on the side of the tower I will not be able to work an FM station out to the same range as I would if I had a vertical-polarized multielement beam or two, but I will be able to work the local 223-FM repeater and the inability to directly work 223.5-FM simplex stations at 20+ miles may only be of any consequence during a contest (and I can always put up a vertical beam, or modify my horizontal beam to become two separate cross-polarized beams on the same boom—á la OSCAR—if needed or desired).

I directed the attention of the more technically minded to some new OKI HEMT low-noise devices in my column-before-last, only to have a reader direct my own attention to a commercially available Toshiba device, the 2SK1619, which is a microwave-packaged (-35 type) device with a noise figure in the 0.5-dB region, when used in the 2-6 GHz frequency range. I am told that the price is about $25 for each device. When I called a distributor to inquire about data sheets, prices and small-lot availability, I quickly got quite a bit of information about the company's super devices ("S" class, or space-rated, chips that are tested to withstand all sorts of rigors, . . . and have prices on the order of $1000 each, accordingly), but, after almost 4 weeks, I am still waiting for data on some things we hams cannot only afford, but can actually order in one and two piece quantities. I will write more about this device as soon as I receive additional material. If you happen to come across any information about other new low-noise, power or the like devices, send it and I will be sure to pass it on to the VHF+ readers. Because of the small quantities we VHF+ers tend to buy, data about known sources of supply are always welcome.

Rotating Towers for VHF+ Antennas

I received another letter recently from a reader who had read the review of a tower rotary joint product in September '91 *QST* and wanted to know if this was some sort of a joke. No, there is usually a tongue-in-cheek put-on in every April *QST*, but that product review was quite serious; this is an interesting VHF+ tower use, to the basics of which all of my readers should at least be exposed.

First, though, let's review some elementary physics of towers (see Fig 1). There are several important quantities acting at the top of a conventionally ground tower. The total weight W_R on the rotor R is a downward force (the sum of all objects supported by the rotor, ie, the weights of the mast W_M, the dish W_D and the Yagi W_Y) determines how rugged the rotor R must be. A rotor adequate for supporting a 5-foot piece of thin-wall aluminum tube and a TV antenna, will probably not support a few hundred pounds of dish and other goodies. You have to go to a much better grade of ham- or commercial-rated rotor to be able to take that kind of vertical force. This, of course, is with a fairly well balanced load in a static, or windless, condition. Once a wind starts to blow (say, from right towards left) there are other forces acting on the tower top. These horizontal wind forces act on the mast (F_M), the Yagi antenna (F_Y) and the dish (F_D). The total wind load is the sum of the individual loads, and will determine the quality of the tower itself (each of various tower sizes and styles has an individual wind load rating). Typically, a solid dish has by far the most wind-loading area in an amateur situation, although even a perforated dish will be more of a wind load than even several Yagis. In a VHF+ station situation where a number of different bands are to be used, the number of antennas and the total wind load can make use of more than one tower mandatory. A third quantity is torque, the bending effect at a fulcrum due to any force applied along a lever arm at a distance away from that fulcrum. In our simple example, the mast is fixed at the rotor and is torqued about the bottom (rotor) in the counter-clockwise direction by three forces and in the clockwise direction by the counter thrust T of a thrust bearing TB. The counter-clockwise torques are: (1) the product of the wind force F_Y acting at a distance D_Y between the rotor and the Yagi; (2) the product of the wind

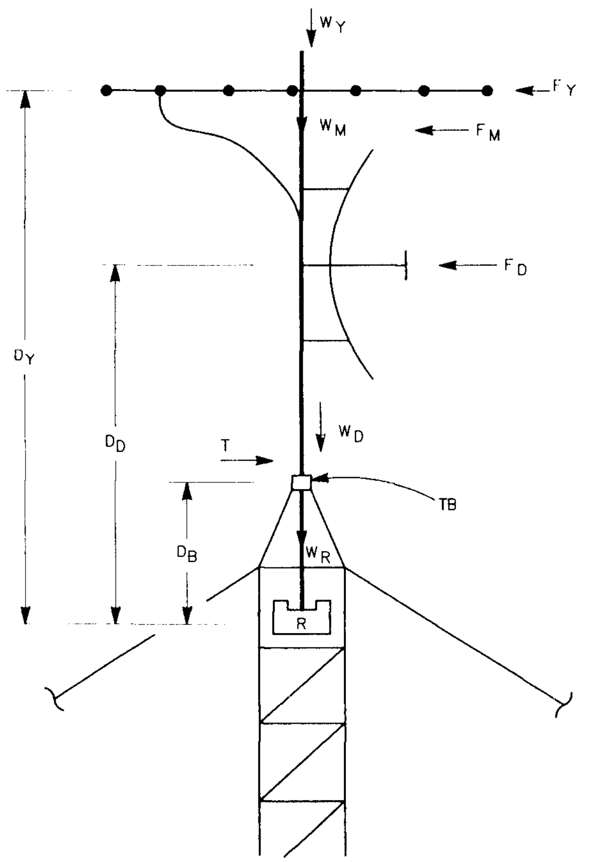

Fig 1

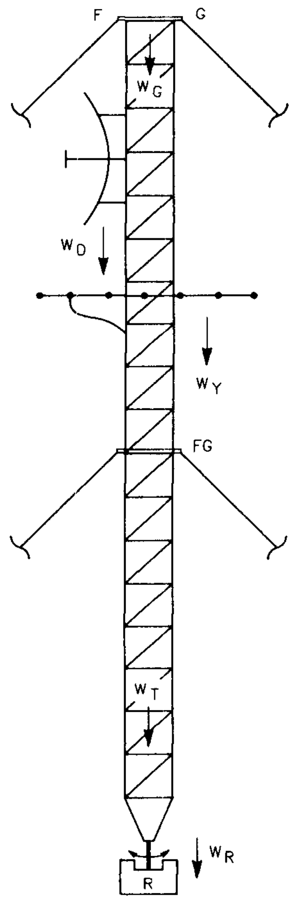

Fig 2

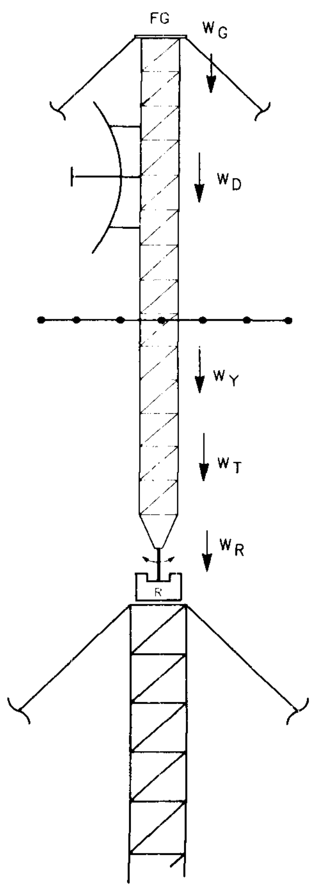

Fig 2a

force F_D acting at a distance D_D between the rotor and the dish; (3) and the distributed product of the wind force along the mast length. If the mast is not strong enough and if the torques are not balanced, the mast bends (usually at the bearing) and may snap. You will see that placing antennas for all the VHF + bands (50/144/222/430/900/1240 MHz and a dish with a common 2.3/3.4/5.6 GHz feed) on the single mast of one such guyed tower is impossible; if you cannot put up more than one tower, you just have to forget about doing certain kinds of operating!

One way around that problem (although not without its own unique set of difficulties) is the "Big Bertha" rotating tower (see Fig 2). While commercial versions are rare (one was available from Telrex at one time), they may be available from others now; several home-brew amateur versions have come to my attention. The basic difference here is that the tower is literally turned upside-down and the mast is inserted into a rotor mounted to the ground. A floating guy ring FG is attached to the top end of the tower. Any rotor motion turns the entire tower, with the bottom end held in the rotor and the top end held by the floating guy ring. The entire weight W_T of the tower and the additional guy ring weight W_G is added to the weight of the dish and Yagi. This can easily be hundreds, if not thousands, of pounds, especially for a tall tower, and precludes use of any ordinary base rotor. One 30-foot rotating tower, put up for each contest by the W2SZ/1 group, bearing 6-foot, 3-foot and 15-inch solid microwave dishes and some VHF-liaison Yagis, requires a prop-pitch motor (29 V dc at 50 A) and specially-machined mountings to take the vertical load. In spite of that costly and difficult base arrangement, note that the many antennas can now be rigidly attached directly to the tower itself and that the various wind forces and torques are all accounted for by the guy wires, acting at the tower top. While the guys do have to be spread out a fairly far distance, to reduce the top angle and so allow the antenna near the top to freely rotate, this is not as bad a constraint as it seems, since the further out the guys are anchored the better the horizontal portion of the guy force will be. Also note that there are certain antenna types, such as the parabolic dish, which can be placed much closer to the guy ring than other, longer antennas. However, each set of guys requires a separate, often expensive, floating guy ring. Here one has the entire length of the tower to mount many separate antennas. There is a real possibility of doing something which on a fixed guyed tower would be outrageous, like stacking 4 beams for 6 M on a 100-foot tower.

The variation shown in Fig 2a has certain advantages. Here, there is a fixed, guyed bottom portion, which may be made of very strong section (say, Rohn type 45 or 55) of any practical length and guyed as often as needed, and only a certain top portion, of somewhat smaller size (say, Rohn type 25) is arranged to rotate about the tower-twister rotor. At least one floating guy ring FG is still needed. The length of the rotated tower is now only that necessary for rigidly affixing the totality of antennas, so that a shorter rotating tower port can reduce the total weight W_R on the rotor and reduce the total forces/torques on the floating guys and ring (cutting costs in both cases).

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US AND USSR AMATEURS TO COORDINATE EMERGENCY PACKET-RADIO COMMUNICATIONS

In August, a memorandum of coordination for emergency Amateur Radio communications was signed in the USSR by Andrew Fyodorov, RW3AH, the coordinator of the Russian Amateur Radio Emergency Services, and Richard Palm, K1CE, Field Service manager of the ARRL. The memorandum refers to the development of packet radio in Russia using satellites for emergency communications. RW3AH commented, "I hope that our cooperation on this point will provide progress and a good start for our fellow joint work, which will serve us in the future."

—from Andrew Fyodorov, RW3AH, and Richard Palm, K1CE

PROCEEDINGS OF THE 10TH ARRL COMPUTER NETWORKING CONFERENCE

The following is a list of papers appearing in the *Proceedings of the 10th ARRL Amateur Radio Computer Networking Conference.* The conference was held September 27-29, in San Jose, California. The proceedings are available from ARRL Headquarters for $12, plus S&H.

"Extended Mail Transfer Protocol (XMTP)," by J. Gordon Beattie, Jr., N2DSY, Andrew R. Funk, KB7UV and Frank Warren, KB4CYC

"A Full-Duplex 56 Kb/s CSMA/CD Packet Radio Repeater System," by Mike Cheponis, K3MC and Lars Karlsson, AA6IW

"Characterization of PACSAT-1 Traffic Via Downlink Monitoring," by Robert J. Diersing, N5AHD

"Experimental Study of Shannon-Fano, Huffman, Lempel-Ziv-Welch and Other Lossless Algorithms," by D. Dueck and W. Kinsner, VE4WK

"Recent Hubmaster Networking Progress in Northern California," by Glenn Elmore, N6GN and Kevin Rowett, N6RCE

"Distributed Directory Services for the Amateur Packet Radio Network," by Andrew Funk, KB7UV

"Specification of the AVC-R-ISA Mac Layer Protocol," by A. Giordano, I1TD, A Imovilli, IW1PVW, C. Nobile, IW1QAP, G. Pederiva, IW1QAN and S. Zappatore, IW1PTR

"Spectral Efficiency Considerations for Packet Radio," by Phil Karn, KA9Q

"Lossless Data Compression Algorithms for Packet Radio," by W. Kinsner, VE4WK

"LZW Compression of Interactive Network Traffic, Anders Klemets," by SM0RGV

"Proposed Design and Strategy for a Radio Direction Finding Network Using Doppler Antennas, Packet, Spread Spectrum, and Transmitter Signatures by Digital Signal Processing," by Andrew J. Korsak, PhD, VE3FZK/W6

"Design and Implementation of CELP Speech Processing System Using TMS320C30," by A. Langi, VE4ARM and W. Kinsner, VE4WK

"Digital Networking with the WA4DSY Modem - Adjacent Channel and Co-Channel Frequency Reuse Considerations," by Ian McEachern, VE3PFH

"The 56 Kb/s Modem as a Network Building Block: Some Design Considerations," by Barry McLarnon, VE3JF

"Multi-Drop KISS Operation," by Karl Medcalf, WK5M

"The Shape of Bits to Come," by James Miller, BSc, G3RUH

"The Ottawa Packet Interface (PI): A Synchronous Serial PC Interface for Medium Speed Packet Radio," by Dave Perry, VE3IFB

"Clover II: a Technical Overview," by Raymond G Petit, W7GHM

"Improving the Packet Mail Transfer System," by Brian B. Riley, KA2BQE

"GUI Packet," by Keith Sproul, WU2Z and Mark Sproul, KB2ICI

"NOS Command Set Reference," by Ian Wade, G3NRW

"Higher Speed Amateur Packet Radio Using the Apple Macintosh Computer," by Doug Yuill, VE3OCU

ARRL 222-MHZ BAND PLAN

Recently, the ARRL Board of Directors approved the following band plan for 222-225 MHz. Note that packet radio and other digital modes are allotted the 223.520-223.640 and 223.710-223.850 MHz subbands. The latter is at the "local coordinator's option" which means that your local frequency coordinator will determine how that subband will be used (based on current usage and user needs).

SUBBAND	*MODE*
222.0-222.15	Weak-signal modes
222.0-222.025	EME
222.05-222.06	Propagation beacons
222.1	SSB and CW calling frequency
222.10-222.15	Weak-signal CW and SSB
222.15-222.25	Local coordinator's option; Weak-signal, ACSB, repeater inputs, control
222.25-223.38	FM repeater inputs only
223.40-223.52	FM simplex
223.5	Simplex calling frequency
223.52-223.64	Digital, packet
223.64-223.7	Links, control
223.71-223.85	Local coordinator's option; FM simplex, packet, repeater outputs
223.85-224.98	Repeater outputs only

NEW PACKET-RADIO SOFTWARE AVAILABLE

The following new packet-radio software became available during the last days of summer. You may download all of these programs from CompuServe's HamNet Library 9. They may also be available by other means such as TCP/IP FTP, landline BBSs and user's groups.

BPQ404.EXE

File name: BPQ404.EXE, binary, 110769 bytes

Version 4.04 of G8BPQ's node software for IBM PCs.

Call Sign Server Tools
File name CALLS.SEA, binary, 46976 bytes

The Apple Macintosh tools needed to format data for the call sign server in version 2.2 of NET/Mac, the Macintosh version of KA9Q's TCP/IP software. Uses *HyperCard* to format the data file.

F6FBB Packet BBS Version 5.13
File names: FBB5D1.ZIP, binary, 343040 bytes
FBB5D2.ZIP, binary, 316416 bytes
FBB5D3.ZIP, binary, 331776 bytes

Version 5.13 of F6FBB's multilingual PBBS for the IBM PC. It supports compressed transmission of forwarded messages and can use EMS memory. Said to be popular in Europe. Includes both French and English documentation and prompts.

LLBBS/Packet Link - Fido/WestNet Mail Interface
File name: TXM-V1.ZIP, binary, 198968 bytes

"TXM" is IBM PC shareware that interfaces a landline BBS and a packet-radio station. This allows a packet-radio user to connect with a landline BBS via an intelligent remote telephone link from a packet-radio station controlled by TXM. It also interfaces/gateways packet WestNet mail feeds into and out of Fido Net format landline BBS message bases.

METCON-1 Demo/Test Program
File name: METDMO.ZIP, binary, 3330 bytes

A BASIC program for testing and demonstrating the TAPR METCON-1 board and temperature sensor system.

MSYS Version 1.11 Multiconnect BBS
File name: MSY111.EXE, binary, 355114 bytes

Version 1.11 of *MSYS*, WA8BXN's full-featured PBBS that is compatible with the WØRLI, WA7MBL and AA4RE BBS programs and has NET/ROM-compatible node features and limited TCP/IP capabilities.

Packtalk PBBS System by N3DFD
File name: PT-109.EXE, binary, 353363 bytes

A full-featured PBBS system for the IBM PC that has many features for the SYSOP as well as for users. It is compatible with WØRLI and WA7MBL PBBSs compatible.

PMP Version 1.1
File name: PMP11.ZIP, binary, 237613 bytes

Version 1.1 of "Poor Man's Packet," an IBM PC TNC emulator, that includes additional documentation for assembling the required modem, interfacing to radios, and an errata. Also includes the "make cfg" utility for automatically building a configuration file from user inputs.

PRMBS/ROSErver v1.55 Complete Runtime
File name: RS155R.ZIP, binary, 250377 bytes
Documentation file name: RS155D.ZIP, binary, 93174 bytes

Version 1.55 of the complete PRMBS/ROSErver runtime package.

METCON-1 NOW AVAILABLE

Following the successful introduction of the METCON-1 in "alpha" form at the Dayton Hamvention, TAPR announced recently that production of kits has begun.

METCON-1, a simple telemetry and control system for packet radio, operates by connecting the main METCON-1 system board to an EIA-232 connection of a TNC. The remotely located packet TNC and METCON-1 system are then accessed by a packet-radio connection to the TNC. The METCON-1 system acts like a remote computer connected to the TNC, much like a PBBS operates. The system uses an 8751 microcomputer to allow a connected user to read and write on and off levels at the microcomputer's I/O port using a command line oriented command language. Outputs are dry relay contacts so you can hook up anything you want (within reason). A good upper limit is 24 V ac/dc at 0.5 A.

There are several ways that input signals can be detected by METCON-1. The standard input to METCON-1 consists of a 74HC14 inverter protected by a series and pull-up resistor to +5 volts. The other input terminal is system ground. The microcomputer can read the value at the input terminals and pass it along to the user via the serial port. There are six outputs possible with the standard METCON-1 printed circuit board.

An added feature of each standard input is that METCON-1 can measure the frequency of an input signal (0-10 kHz) as well as to simply indicate if the input is an open or closed circuit. The advantage of this type system is that an external voltage-to-frequency converter board configured to read either temperature or frequency can be placed right at the source to be measured. An opto-isolator is used to isolate the voltage-to-frequency converter board and the main METCON-1 system board. To measure temperature, some additional parts are required and TAPR is offering the board in both configurations.

Although METCON-1 is a simple system, it does have a number of interesting features. These include a time-of-day clock that can be used to time-stamp output, a status table can be dumped at predetermined intervals (0, 1, 15 minutes), block reads and writes are supported for fast memory transfers and notification can be set at different states.

Some of the applications described so far by beta-testers include using the METCON-1 board during a balloon ascent for sending telemetry regarding height, temperature and other balloon status to the ground control station as the mission proceeds. Other applications dealt with controlling and monitoring remotely located sites. Many of these remote sites included mountain top stations and other difficult access areas. Applications for the METCON-1 system are endless.

The basic METCON-1 kit costs $85. Voltage-to-frequency converter boards are $15 and temperature-to-frequency boards are $30. Analog-to-digital converter boards will be available soon. Contact TAPR at PO Box 12925, Tucson, AZ 85732-2925, phone 602-749-9479, fax 602-749-5636.

—*from* **Packet Status Register**

(*QEX* and the ARRL in no way warrant the hardware and software mentioned in Gateway.)

AMSAT-NA ANNUAL MEETING, SYMPOSIUM AND EDUCATIONAL WORKSHOP

This year's AMSAT-NA Annual Meeting and Symposium and a joint AMSAT/ARRL Educational Workshop will be held November 8-10, 1991, at the Los Angeles Airport Holiday Inn. The Symposium is hosted by the Jet Propulsion Laboratory Amateur Radio Club, the World Space Foundation and Los Angeles area AMSAT members.

The event begins Friday afternoon with registration and activities including the presentation of selected papers, informal get-togethers and family activities such as a trip to the Griffith Observatory.

Also on Friday afternoon, from 12 noon to 5 PM, is the joint AMSAT/ARRL Educational Workshop. This Workshop's theme is "Uses of Amateur Radio Satellites in Education." Topics include: using satellites to teach other subjects such as physics, geography, computers, language arts, etc; way to use satellites in grades kindergarten through college; designing a school science room including Amateur Radio and satellites; and, how to use satellites as a drawing card for recruiting new hams.

Saturday is symposium day with the presentation of technical and operational papers beginning at 8 AM continuing through 5:30 PM. Topics will include OSCAR 13's orbit status, development and progress of the Phase IIID bird, the Microsats, SAREX projects, AMSAT educational projects and many more! Prebanquet attitude adjustment session (6:30-7:15 PM) will feature an excellent choice of fare complemented by exciting keynote speakers, the president's report, current status of AMSAT-NA and other topics.

Sunday's activities include more sessions, formal and informal breakfast meetings, satellite equipment displays, a working OSCAR-13 and Microsat earth station and lots of family activities. Depending on interest, these might include a trip to Disneyland, the Museum of Science and Industry, and the Griffith Observatory.

The meeting, symposium, banquet and educational workshop will be held at the Los Angeles Airport Holiday Inn, located on Century and La Cienega Boulevard in Los Angeles, California. A special room rate of $55 per night for a single has been negotiated for all attendees. This rate includes a free buffet breakfast. Please register with the hotel early by calling 1 800 465-4329 and ask for the special AMSAT rate.

The AMSAT registration fee has not been finalized, but is expected to be between $15 and $18 for AMSAT members registering in advance. For complete information on registration, symposium activities and family activities please contact the Symposium Committee, c/o Talisman, 7217 Melrose Avenue, Los Angeles, CA 90046, tel 213 937-7942 from 11 AM to 6 PM Pacific time.

GATEWAY CONTRIBUTIONS

Submissions for publication in Gateway are welcome. You may submit material via the US mail to 75 Kreger Dr, Wolcott, CT 06716, or electronically, via CompuServe to user ID 70645,247, or via Internet to horzepa@gdc.com. Via telephone, your editor can be reached on evenings and weekends at 203-879-1348 and he can switch a modem on line to receive text at 300, 1200 or 2400 bit/s. (Personal messages may be sent to your Gateway editor via packet radio to WA1LOU@N1DCS or IP address 44.88.0.14.)

The deadline for each installment of Gateway is the tenth day of the month preceding the issue date of *QEX*.

Bits

Microwave Update '91

Sponsored by the North Texas Microwave Society, Microwave Update '91 will be held October 18-20, 1991, in Arlington, Texas.

Scheduled is a fine panel of speakers, including Mr. Paul Rinaldo, W4RI, Editor of *QST* and *QEX*, who will discuss what's ahead with the up coming WARC-92 conference.

Technical presentations will be held Friday and Saturday, noise figure measurements on Friday night, and a Texas-style BBQ will be served Saturday night. Special family activities are also planned.

Registration forms and a full schedule of events can be obtained from Al Ward, WB5LUA, 2375 Forest Grove Estates Road, Allen, TX 75002.