QEX 21 November 1983

The ARRL Experimenters' Exchange

Call for QEX Articles

Experimenters take note! We need some more articles for QEX. If you've been thinking about writing an article, now's the time to sit down at the typewriter or word processor when the shack is so cozy and warm in contrast to the chilly outside.

Comments are heard from time to time that QEX is heavily digital communications and light on something else, such as vhf and microwaves. That's less by design than it reflects the interests of the people who are sending us manuscripts. What we'd like to achieve is a balanced selection of topics representing what experimenters are doing or even thinking about.

So don't put it off. Send us your material for publication in either manuscript or correspondence form. The only preparation requirements are that the text be legible and the artwork camera ready.

Call for Antenna Papers

We're looking for previously unpublished papers on Amateur Radio antennas of all types for the ARRL Antenna Compendium to be printed in May 1984. Papers on transmission lines, devices which may be installed along the transmission line and antenna mounting structures are also welcome. We'd like to receive a one-page, double-spaced abstract from each potential contributor by December 2, 1983. We will send preparation guidelines to each author. The papers are due before March 15, 1984.

Call for Packet-Radio Papers (Trenton, NJ)

The American Radio Relay League will hold its Third Amateur Radio Computer Networking Conference on April 15, 1984 in Trenton, NJ. The conference will be in cooperation with the 9th Trenton Computer Festival (TCF84) being held April 14-15, at Trenton State College.

The deadline for camera-ready papers is March 1, 1984. All papers should be mailed to Paul L. Rinaldo, W4RI, American Radio Relay League, 225 Main Street, Newington, CT 06111. If you plan to present a paper, please request an author's guide and identify the title of your paper immediately. Proceedings will be sold at the conference and by mail from ARRL Hq.

Technical papers are invited on all aspects of amateur packet radio, AMTOR, computer-based message systems, digital speech, presentation-level graphics and related Amateur Radio digital communications via terrestrial, ionospheric, meteor-scatter and satellite media including AMSAT-OSCAR 10 and PACSAT. Topics may include network and system architecture, proposed standards, hardware, software, protocols, modulation and encoding schemes, applications, and practical experience.

Call for Packet-Radio Papers (Sweden)

You are invited to submit an original paper for consideration at the Experimental Packet Radio Networks International Symposium to be held at Linköping University, Linköping, Sweden, May 26-27, 1984. Areas of interst are: experimental packet radio, network routine and control, distributed processing, channel-access protocols, standard proposals, and SOFTNET.

A letter of intent is due January 31, 1984. By February 29, you should receive your author's kit. Camera-ready manuscripts are due March 31. Please write: SOFTNET User Group, Department of Electrical Engineering, Linköping University, S-581 83 Linköping, Sweden, or telephone 46 13 28 10 00 and ask for Per Lundgren or Gunilla Svahn (secretary), Dept. of EE. -- Thanks, Jens Zander, SM5HEV.

Six Meters in Australia

As of July 22, 1983, Austalian amateurs can operate in the 50 - 50.15-MHz band subject to: no interference to reception of TV channel Ø, operation outside the hours of channel Ø broadcasting, and with no time limit from Western Australia, external territories or from Antarctica.

Correspondence

AMTOR: N1BEE Replies to N2WX

Mr. Howard Goldstein, N2WX, makes some interesting comments in his "Reply to N1BEE on AMTOR," (QEX, August 1983), in regard to my "An AMTOR Protocol Change?" (QEX, July 1983). I did not intend my ideas to be viewed as "somewhat nostalgic." The major objective of my suggested change is increased ease of implementation of AMTOR on existing systems, particularly on low-cost, commercially available microcomputers. I, and most of the Amateur Radio community, are in agreement that error-correcting codes will be and should be part of our future.

I am under no illusions about the likely effectiveness of proposing a change in amateur use of an internationally standardized code. At the very least, I want to provoke some thought regarding the design priorities of amateur digital codes. Hams want to use their purchased computers and will build unique and non-replicatable hardware. Never before have they chosen their digital codes on the basis of inherent superiority. The fact that almost all RTTY still uses the Murray (Baudot) Code is evidence of that. I believe the Murray Code was originally designed so that frequently used characters would punch fewer holes in paper tape!

As I originally noted, AMTOR can be and has been implemented using dedicated microprocessors. Perhaps I spent an improperly short amount of space discussing this method. The microprocessor runs a program which tests the state of an input line from the terminal unit at regular intervals. This requires precise timing achieved using carefully written software timing loops or an externally clocked interrupt generator. Using the microprocessor in a low-cost computer for character generation and reception can be difficult, as this usually derives the timing from the system clock. I have seen variations of plus or minus 10% from the nominal frequency in one popular computer which uses a 555 timer for its clock. This is more than enough to throw off timing loops. From a recent article by Swirsky, AF2M, I gather that software loops will become complicated in the Atari, which uses DMA for its display, although I have no personal knowledge of this. [1]

As the bits are individually received, they are shifted into a register and assembled into characters. This often takes all of the microprocessor's time. The characters must then be sent to another microprocessor for decoding, error checking, display or anything else, but it can be done differently.

For standard RTTY, this is not the approach I favor. Many low-cost computers include UART chips that perform the laborious character generation and reception process. This leaves the microprocessor free to tend to more useful tasks. From my on-the-air observations, I am convinced that the popularity of standard RTTY is a result of the popularity of low-cost computers with UARTs. UARTs allow use of relatively simple, non-critical software capable of significant functional power and operating convenience.

Unlike standard RTTY, the current AMTOR protocol demands the dedicated microprocessor approach because there is no UART-like chip to relieve the computing burden. A dedicated microprocessor system is versatile and will work well, as I am sure Mr. Goldstein's system does. However, it should be obvious that I am not describing off-the-shelf hardware along the lines of the average low-cost microcomputer. Designing, building and programming such a system is a very rewarding challenge, but is no small project. If my proposed change were adopted, the many current and future owners of low-cost, commercially available computers could use AMTOR without the need to invest a great amount of time, effort and expertise in adding homebrew hardware and developing the associated specialized software.

As for Mr. Goldstein's other points, he is correct in stating that AMTOR can be monitored by locking on the sync from the sending station. My proposed change would allow monitoring of both stations, thus eliminating possible ambiguity. This is a relatively minor point. Resynchronization by the monitor must be carried out for each exchange, however, and my proposed protocol would make this unnecessary.

The reduction in data rate is adequately discussed in my original item. Mr. Goldstein and I are in agreement that it is undesirable, but I am willing to accept it as a trade-off for ease of implementation.

Lessening of noise immunity because of false start bit detection would be serious if Mr. Goldstein is right; I do not know if he is or not. My proposed protocol is called "semi synchronous" in that "non-critical synchronization" on characters would replace critical synchronization on bits and would allow all noise pulses outside of a time window to be ignored. If a noise pulse fell within this time window, it would destroy the data regardless of the protocol used. Even if the criticism is partly valid, I would be surprised if any consequences other than occasional repeats became necessary. This whole matter is more complicated than it first appears, and I would have little confidence in any attempt to resolve it short of actual testing.

Finally, I repeat that the main reason for raising this issue is to provoke an analysis of desirable design objectives for amateur digital protocols. If my proposal is ever adopted, it will be in the distant future. We have the current AMTOR protocol, and we should work with what we have now. The point of my proposal is increased ease of implementation leading to wider

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(Correspondence continued)

use and no one should wait for these questions to be resolved before doing something. Working AMTOR systems should be drafted and published (note well, Mr. Goldstein). - Michael S. Bilow, N1BEE, Forty Plantations, Cranston, RI 02920.

References

[1] Swirsky, "Dr. Digital," October 1983, 73.

More on the Turnstile Antenna for STS-9

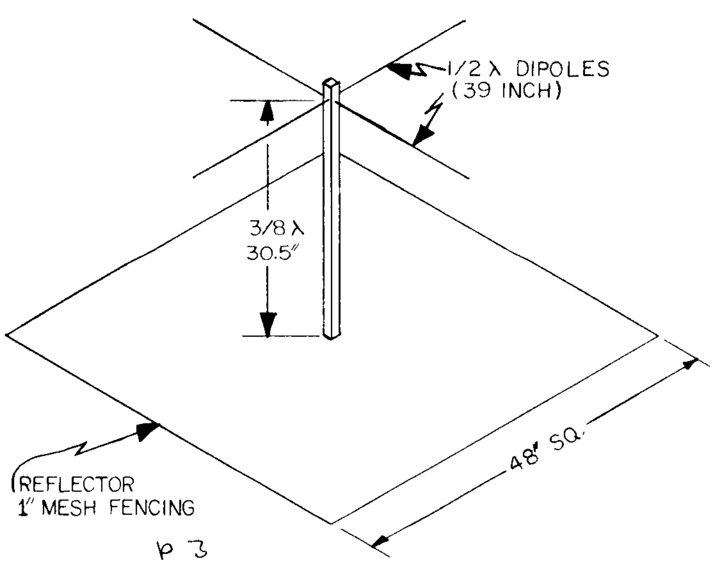
Thank you for the September issue of QEX. The turnstile antenna article clarifies the subject of the STS-9 application and the solution by Jerry Hall, K1TD, is more elegant than he suspected. Since the 1/2-wave dipoles appear to be Z=95 ohm, the circularity phasing section of a 1/4 wave (17.07 in.) of RG62/7 (Zo=93 ohm) is almost perfect. Moreover, the two 95-ohm sections combine, theoretically, to be 47.5 ohm, yielding a VSWR of 1.1:1 when coupled to a 50-ohm feed-line system.

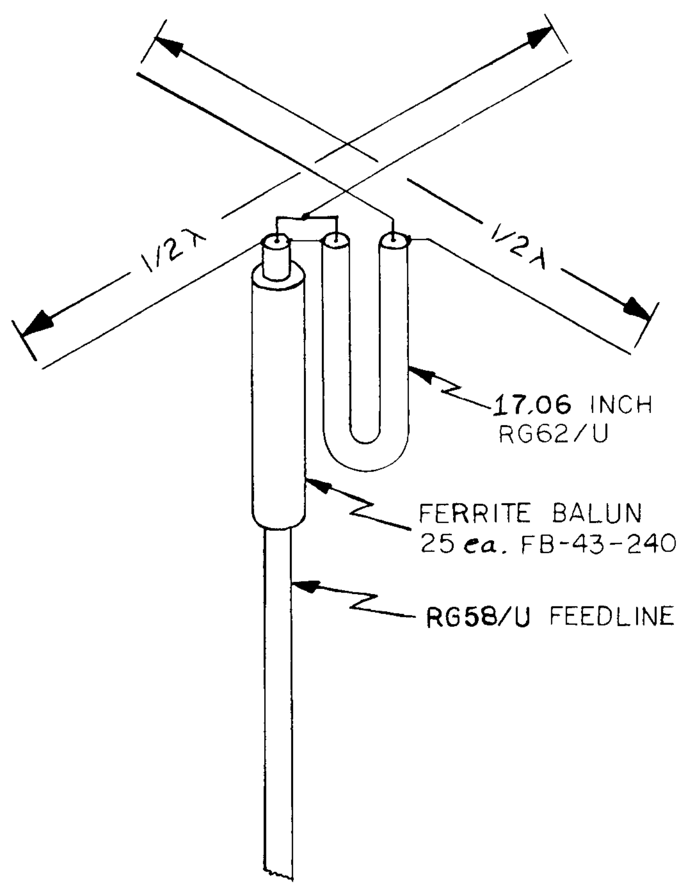
While probably academic by the time November QEX appears, the illustrations shown below is what I present at club talks on the STS-9/W5LFL mission. The practical implementation of this antenna has taken the form of five pieces of 1/2-in. PVC pipe 31 in. long. Three 1/2-in. tees and two short 1/2 pipe pieces supply a central hub with one vertical tube and four horizontal radial tubes. A 1-in. "chicken wire" mesh is tied to the radials for the reflector and the driven elements are no. 12 AWG house wire attached to the vertical tube. The radial tubes are not glued to the tees, just pressed in. The driven elements can be folded down along the vertical tube for transportability.

One point overlooked by K1TD is the use of a simple ferrite bead balun on the feed line. QST has had many articles promoting balanced feeds for balanced antennas and the March 1983 issue made the vhf balanced feed dreadfully easy, as illustrated.

On another matter, your reprinting of the G4COM article and its followers in the October 1983 QEX is greatly appreciated. - Dick Jansson, WD4FAB, 1130 Willowbrook Trail, Maitland, FL 32751.

STS-9 TURNSTILE ANTENNA





Equipment for CW-Meteor Scatter Operation

By Jan-Martin Noeding, LA8AK *

Two important accessories for operating meteor scattor (ms) are the cassette tape recorder and memory-keyer. Their performance, and the addition of other equipment, may be desired for easy operation and good communication. Five years ago, the speed of 600-750 letters per minute (lpm) was believed to be the cw-ms limit. Indications today show the limit is far beyond this figure and 2000 lpm may be achieved easily. Distortion, however, seems to be one limitation because of receiver crystal filter frequency dependent group delay. At around 1200-1500 lpm, the cw signal in my Kenwood TR-7010 is distorted, but still readable.

Most newcomers start at a low speed and have the notion that elaborate equipment is needed to operate higher speeds. I started at 1100 lpm and have spent hours coaching many amateurs up to 1200 lpm. The result was good even when reflections were present. It seems that the received message increases by a factor of two with speed increase from 800 to 1200. I suggest that you listen to another operator at a distance of 200-400 miles away before you have operational experiences of your own. Very high speed cw may also be worked via auroral reflection.

Requirements for Cassette Recorders

The cassette recorder you've chosen for your ms station should be easy to operate and placed in a position not far from the vhf transceiver. Operation should be made from the front. When you choose the recorder, consider whether it is possible to obtain the following features:

1) Maximum/minimum speed ratio of at least 1:8 on record and play.

2) It should have a built in counter.

3) Fast wind/rewind.

4) VU-meter for record audio level.

5) Mechanically good construction.

6) Good rf immunity.

I have found it advantageous to include the following extra functions:

7) Automatic switch to HIGH SPEED when recording (facility selected by a switch).

8) Indication/warning (LED flashing) if low speed is used for recording. MONO recorders are sufficient. I use the right channel only in my stereo cassette recorder (SM5CHK 9282 MSS).

Your cw operating speed depends on your practice, but you may receive higher speeds on replay than the usual operation speed on hf with simple messages transmitted by ms. With 1500 lpm received and replayed at 1/8 of this speed, you will be listening to 180 lpm. This is not particularly worse than 100 lpm (20 wpm) contest working.

Keep in mind only short messages are exchanged such as: UA1ZCL LA8AK R26 R26 UA1ZCL LA8AK R26 R26 R26 UA1... Because it is difficult to install a counter, look for this feature when purchasing your recorder from the manufacturer. Remember the handles take abuse and if they are weak, heavy use will cause them to break or malfunction. This will cost you operational time.

Good rf immunity is required since you will most likely be transmitting while replaying. This can be achieved by winding 10-15 turns of the main cord and the af cable on ferrite cores. (Straight cores for ferrite antennas are usually better than toroids.) One stressing problem is the forgetfulness of switching to high speed for recording. I have installed an LED indicator in my recorder to avoid this. During "record," an 80-kHz bias oscillator is switched on. The dc voltage for it may be used to operate a relay to short circuit the motor regulator, thus, the motor will operate at full speed.

Some recorders use electronic regulators that are easy to modify for variable speed operation. If your motor uses a mechanical one, you will have to build a regulator. First tighten the regulator, otherwise a 6-V motor will rotate at the same speed from 4-15 V. I have found that conventional dc regulators suffer at low speed. After a while, the motor tends to slow down and stop. I have tried simple pulse width regulators with dc feedback and they have proven to be good.

Requirements for Memory Keyer

Many manufactured types of keyers are easy to modify for high-speed operation, but be aware that the later Heath unit will not operate above 1000 lpm. I would suggest at least 1500 lpm or better, preferably 2000 lpm. My keyer, described in an article by K3CU (February 1978 QST), has the ranges of 50-200 lpm and 400-1500 lpm.

To calibrate the speed with the frequency counter, these indications may be used:

100 lpm	dots gives a reading of:	8.333 Hz
500 lpm		41.7 Hz
1000 lpm		83.3 Hz
1500 lpm		125 Hz
2000 lpm		166.7 Hz

*Voielia 39/B, N-4620 Vaagsbygd, Norway

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MS Equipment
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Stability and accuracy are minor requirements. Variation of more than 10% is tolerable.

I have described modifications for the memory keyer earlier in my article. It is important to switch the weight control in the signalling path, but it should be used for the sidetone oscillator exclusively. The usual memory is 1024 bit. This is more than necessary and many keyers have possibilities to divide this into smaller messages.

It is an advantage to use most of the full memory to repeat the transmission message many times with little time difference. In addition, I use an automatic reset if the memory reads more than 12 blank bits.

An address counter display is utilized to make an easy to follow display. Six LEDs for the most significant bits are easier to follow than a 3-1/2 digit, 7-segment display.

I am not a cw perfectionist and do not like to use an "awkward" keyer for normal QSOs. Therefore, I have connected another simple keyer in parallel, using the common paddle. Since the keyer operates several transmitters on hf/vhf/uhf/shf, I use "positive" (cathode keying), and convert the polarity within each transceiver.

A crystal controlled 5-minute timer is also connected inside the keyer to start the keyer and operate the PTT (push-to-transmit-line). Transmit first or second pass may be selected. This last feature enables the operator to provide sufficient food and drink during busy ms operation hours! A few years ago, vhf managers tried to change the timing period to 1 minute. This increased equipment stress and found little use.

References

[1] Opal, "Memorykeyer," QST, February 1978

[2] Noeding, "Variable Memory for the TO MSG Keyer," QST, January 1980.

[3] Noeding, "Experimental Active Key Click Filter," QST, January 1982, p. 46.

[4] Hawker, "Technical Topics: Meteor Scatter Traffic" Radio Communication, October 1981.

[5] Noeding, "Technical Topics: Up-Converter for Cw Meteor Scatter Recording," Radio Communication, September 1982.

[6] IARU Region 1 Conference, "Meteor Scatter QSO Procedure," 1981.

[7] Neie, "A Variable Memory CMOS-Keyer," DUBUS INFO, January 1980.

[8] Noeding, "Equipment for Cw Meteor Scatter Operation," Amatør Radio, April 1983.

[9] Noeding, "Up-Converter for Cw Ms Recording," Amatør Radio, June 1983.

[10] Neie, "Vhf Uhf Technique," DUBUS INFO.

[11] NRRL, "Timer for Ms Operation," Amatør Radio, April 1983.

[12] Noeding, "Keying Modifications for FT-7," QTC, (SSA), March 1983.

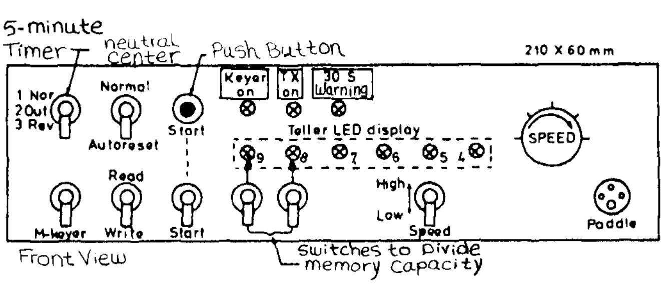

Fig. 1 -- My homemade memory keyer. On the rear are controls for the electronic (ordinary) keyer speed, sidetone level, timer reset and KEY/PTT connection, +12-V dc. A telephone capsule for the sidetone is built in.

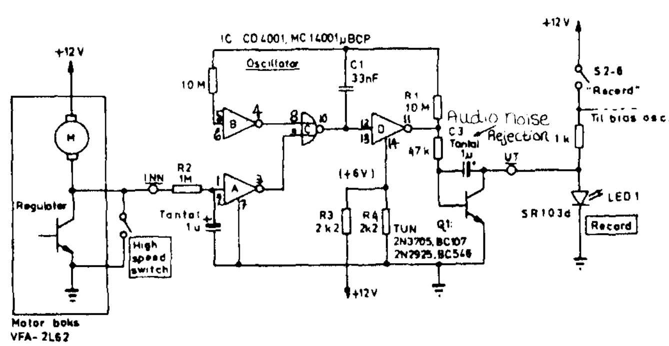

Fig. 2 -- See Amatør Radio, April 1983, p. 107. Simple low speed record alarm. At low speed, the voltage from the motor regulator is "high," the oscillator runs and the LED will flash. At high speed, the LED will light continuously.

Miscellany

Missing Parts

October 1983 QEX features the article, "A 12/70-Watt Class C Amplifier for 146 MHz," by WB2SZK. Unfortunately, the parts list for this amplifier and COR circuit was overlooked in that issue. Listed below are the parts and corresponding numbers for the featured circuits.

Amplifier Circuit
C1, 2, 4 = ARCO 404
C3 = ARCO 400
C6, 13 = ARCO 462
C5 = ARCO 461
C7, 8 = ARCO 463
C9, 10 = Unelco 100 pF
C11, 12 = Unelco 120 pF
C13 = Unelco 330 pF
J1, 2 = BNC (UG-657/U)
L1 = 2t no. 18, 3/4-in. diameter close spaced
L2 = .22 uH with ferrite bead at ground end
L3 = 1-1/2t on VK-200
L4 = 1-3/4t no. 16, 1/4-in.
L5 = .22 uH with ferrite bead at ground end
L6 = 5t no. 16, 1/4-in. diameter close spaced
L7 = 3t no. 16, 1/4-in. diameter close spaced
L8 = 1t no. 10, 1/4-in. diameter 3/4-in. leads
L9 = 1-1/2t on VK-200
L10 = hairpin loop 1/8-in. copper tubing, 3/4-in. high x 1-in. wide
L11 = 4t no. 16, 3/8-in. diameter
Q1 = 2N4426 with heat sink
Q2 = SD1143
Q3 = SD1477

(NOTE: For 12-W out change C5 to 422.)

COR Circuit
D1, D2 = HP-2835
Q4 = 2N5370
Q5 = MJ-4032

Packet-Radio Program Exchange

Since early 1983, five amateurs in the Little Rock (Central Arkansas) area have been active in a packet-radio group using the Tucson (TAPR) TNC boards. These amateurs, known as the TAPR Beta Test Site Group, are Perry Tilden, W5PYZ, Victor Johnson, K4GXV, Rick Mobley, WB5FDP, Donald Reaves, KC5JH and Elmer Wingfield, W5FD. Pete Eaton, WB9FLW, KC5JH and W5FD instituted packet radio in Arkansas early in 1982 using the Vancouver terminal node controller (TNC). Pete has since left the Little Rock area for St. Louis after the initial testing. (Pete is the co-founder and current president of SLAPR, the St. Louis Packet Radio Group, and is active in TAPR.)

In an effort to generate more interest and activity in packet radio, the Central Arkansas Radio Emergency Net, Inc. (CAREN, Inc.) set up a demonstration, including a packet-radio bulletin board system in actual on-the-air operation. Two separate packet-radio systems were set up at the club meeting with W5PYZ and K4GXV operating.

The packet-radio bulletin board system used was based on public-domain software, "RBBS" and "MODEM7", both of which were adapted for SIO Port A of the "Big Board" computer system (Z80A at 4 MHz, two 8-inch drives with an SWP dual density mod and a CP/M as configured by W5FD). An additional public-domain program, "BYE" could be adapted to provide user access to the host computer system but this has not yet been implemented by the Little Rock packet group.

The Little Rock packet group would like to exchange information with other packet groups using the TAPR boards. Address correspondence to: Don Reaves, KC5JH, 35 Aloha, North Little Rock, AR 72116.

Calculator/Computer Program Source

Numerous magazines pass QEX desks each month pertaining to a variety of subjects in the electronic and computer industry. One such magazine is r.f. design. Its September/October 1983 issue overflows with information on computer and calculator programs. A "for instance" is the HP-41 and TI-59 calculator program on low-noise amplifier design. Another is the general purpose ladder analysis with the hand-held calculator.

If you can't locate this magazine locally or in your nearest library, r.f. design is published bi-monthly by Cardiff Publishing, Cardiff Communications, Inc., 6430 S. Yosemite St., Englewood, CO 80111. Single copies are $5 each. - KA1DYZ.

ARRL Tutorials

Since its first issue, QEX has twice promoted FCC Science and Technology Tutorials. If your organization is interested in obtaining one from the FCC, here's something to consider. The ARRL film library has a number of tutorials available free on loan to ARRL members, ARRL affiliated clubs and affiliated instructors. If you or your group fit into one of these categories and would like to view one listed, contact Karl Townsend, ARRL film librarian. Each is available in color U-matic and VHS. Be sure to specify which format you want when ordering. If you have questions about the ARRL film library and borrowing items, write or call Karl at ARRL Headquarters.

VT-6 Digital Speech (1 hour, 19 min.)
VT-11 Communication Satellites: Achievements, Trends and Projections (1 hour, 15 min.)
VT-12 Biological Effects on Radio Frequencies and Microwaves (1 hour, 3 min.)
VT-13 Potential Use of Spread Spectrum Techniques in Non-Governmental Applications (1 hour, 15 min.)
VT-14 Computer Protocol (1 hour, 8 min.)
VT-15 Fiber Optics (1 hour, 5 min.)
VT-25 Amateur Radio Technology (1 hour, 12 min.)

MINIMUF for the Ham and the IBM Personal Computer

By John E. Anderson, * WD4MUO

The December 1982 issue of QST featured an article and computer program by Rose, K6GKU, for the prediction of the maximum usable frequency (muf) in communications between two locations given the sunspot number. [1] This program sparked my interest because of its possible application in predicting 6-meter F-layer openings during peaks in the sunspot cycle. This program can also benefit amateurs using the hf bands.

The published program had to be converted to code so that it would run on my IBM Personal Computer. This was not difficult. The task consisted of revising the "print" statements and their formatting, and substituting the appropriate formula for the arc cosine function as this is not present in the IBM PC Basic. "Bells and whistles" were added to increase program ultility and friendliness to the amateur operator. Principal additions are inputting the sunspot number or the available solar flux number, default values for station parameters, menu selection of common transmission paths, graphic presentation of results and threshold alarming when the muf exceeds a specified frequency.

Fig. 1 shows a sample printout from the program. Fig.2 is the menu for path selection and Fig.3 is the data entry form.

Program Details

After some credits in lines 1 through 13, the program establishes initial data and definitions (lines 15-30) for later use. Included is a default string in line 30 for the station call sign; the call sign within the quotation marks should be replaced to customize the printout for your station. Line 31 sends the program to a subroutine to print the screen header implemented in lines 238-244. The path selection menu follows in lines 32-53. Error trapping for an out-of-range selection is included. Upon selection, the menu is cleared and the screen header reprinted for data input.

Line 55 presents a program branch based on the selected option to either a standard path defined in lines 267-284 or the input of a specific path identified by end points entered in lines 56-71. (Throughout the data input process the error trapping concept in the original program is maintained.) Line 268 defines the default latitude and longitude of the station designated in line 30. These values must be changed for proper program operation using the default options. Testing indicates that there is no reason to specify latitude or longitude to greater accuracy than the nearest degree. Lines 269-283 can be changed for any desired location(s) as long as the format is maintained; the corresponding location in the menu should be changed to reflect any customization. (Note that implementation of an array for "R$" would save a small amount of typing in the menu, at the cost of program clarity.) Additional default paths can be defined, however, the menu will exceed screen size. Each line of default path definition ends with "GOTO 72", returning the program to parameter input following the section allowing input of a specific path. Line 284 preserves the default station's location, but returns to line 65 allowing specification of a non-default receive location (menu option 16).

A choice of solar activity data source is available in line 80. This option was added with the assumption that most amateurs use the solar flux data reported by WWV at 18 minutes after the hour. The subroutine in lines 263-266 converts flux to sunspot number which is used in the calculation of the muf. A polynomial curve fitting routine was used to derive the necessary formula from Rose's Fig. 2. [2]

Lines 92-94 allow defeating the hard copy printout of results. This is a useful feature when experimenting with the program and it allows you to review the results on screen prior to selecting paths for printout.

The threshold feature is selected in lines 95-98. When in force, graphic data points above the specified frequency are printed as asterisks, while points below the frequency are represented by periods. In the normal mode all data points are printed as asterisks.

Lines 146-237 are the main calculation loop. With the exception of the arc cosine function, it is identical to the loop developed by Rose. Considerable care should be exercised in entering the program loop as a typographical error will produce an insidious situation and frustration. The loop contains a number of branches which can hide an error for long periods. The error will appear only on certain paths and possibly on specific dates or for specific values of flux. [3]

The remaining program lines deal primarily with either screen (IBM monochrone) or hard copy printout (on an Epson MX-100). The program has been run through the IBM Basic Programming Development System utilities.

*JUSMMAT TLO, APO New York 09254

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(MINIMUF for the Ham and IBM PC continued from previous page)

Results

Using the initial parameters given by Rose, the program closely duplicates the example in his article. Test runs of the program for various paths have been compared to the muf predictions given in QST over a period of several months. In each case, the resulting curves correspond in shape with those in QST and fall within the range of predicted values at any given hour. Although no consistent offset from the QST values has been confirmed in these comparisons, there appears to be a tendency for the program to produce muf values on the high side. [4] Unfortunately, I have no method of determining the muf and thus checking the accuracy of the predictions.

Other Possible Modifications

While implementing the program, I gave serious consideration to adding two additional features to aid the amateur. The first is suggested by Rose and involves making calculations based on a running average of the sunspot number. The second was a capability to project a future sunspot number and thus "tomorrow's" muf. Both efforts were abandoned after some preliminary development work.

The smoothing produced by using an average sunspot value was inconsistent with my original objective of predicting possible vhf openings, no matter how slight the possibility. Amateurs interested in determining muf values for hf band schedules or net communications may desire to pursue the smoothing concept. A running average can be implemented by writing the input sunspot number (or flux value) to a disk file, recovering x days of previous values from the file, calculating the average, and using the average in the main calculation loop. Error trapping to insure that no day has been skipped is a little complex, but the basic data required is already available in the program (i.e. line 21).

The prediction of "tomorrow's" sunspot number is consistent with my original objective and a projection technique borrowed from a financial analysis program was investigated. Although the method is supposed to be statistically valid, the results appeared to be highly suspect in the real and volatile world of solar flux values. Over the short term (five days) a constant increase or decline in flux tended to produce unrealistically exaggerated extrapolations of the trend. Investigation of other projection techniques might produce more believable results.

Incidentally, implementation of flux projection inherently incurs wrestling with most of the program elements (including trapping of continuity errors) required in determining a running average flux value. Conversely, once smoothing is established the data necessary for extrapolation is present. Thus if you opt to develop either modification, you might as well include the other. Keeping this linkage in mind may influence the structure of your program and data file.

The avid DXer might desire to experiment with a "FOR...NEXT" loop to print all or several possible menu paths without the need to input date, flux and other initial data multiple times. A similar loop, incrementing the flux value by 5 or 10 might be beneficial to 6-meter enthusiasts. Caution is advisable as either modification can turn your printer into a paper eating monster!

References

[1] R. Rose, "MINIMUF 3.5," QST, Dec. 1982, pp. 36-38.

[2] J. Gilder, Basic Computer Programs in Science and Engineering, Hayden, 1980.

Notes

[3] Occasionally I have noted that an overflow error message will appear on the screen in the graphic plot. This condition produces no apparent discrepency in the hardcopy printout.

[4] A number of comparisons between MINIMUF and QST data for the Sept. 1982 to Feb. 1983 period indicated that when MINIMUF projections exceeded the 10% (upper) curve presented in QST, the discrepency was normally a few MHz. A spot check against curves in the July 1983 QST, pp. 68-69, showed that MINIMUF data for certain hours exceeded QST data by 10 MHz or more on several paths. Curve shape was comparable between the two sources for all paths checked.

(MINIMUF Program data appears on page 9 .)

Double DIPpers Anyone?

Is anyone aware of a manufacturer who makes double-throw DIP switches? We've seen an oblique reference to their existence but have not received data sheets, catalogs or press releases giving any hard data. It would also be nice to have some 3-position DIP switches for on-board testing of RS-232 lines. Three positions would permit +12 V, center off, and -12 V possibilities. If you know of anything along these lines, please drop me a note at ARRL Hq. - W4RI.

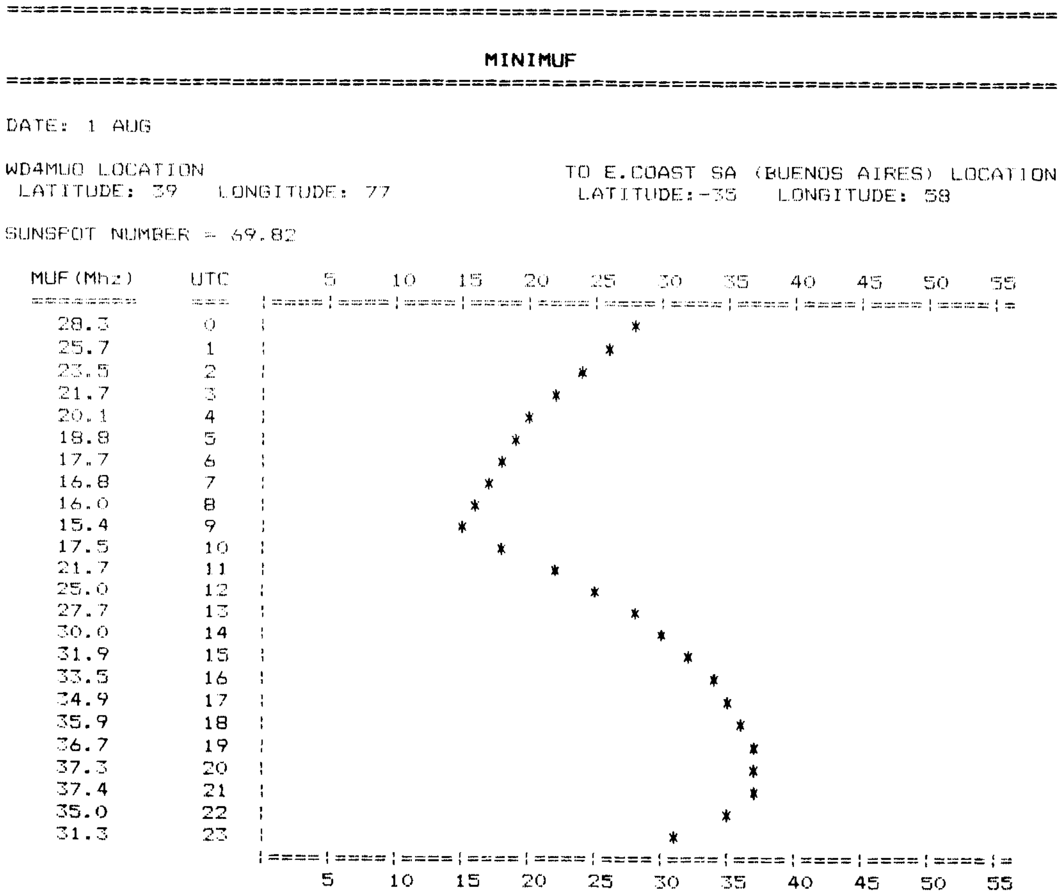

Fig. 1A: Normal Printout

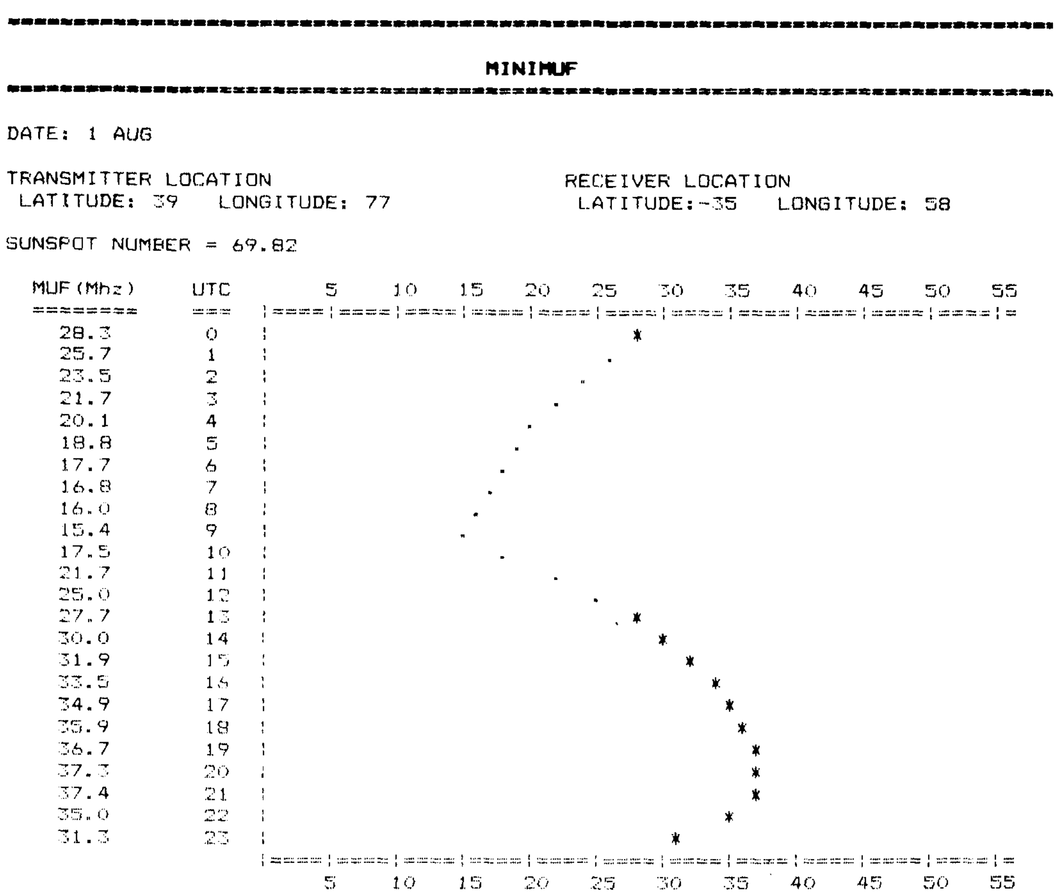

Fig. 1B: "Alarm" Printout (27.5 MHz)

```
================================================================
                                                  MINIMUF
================================================================

PATH OPTIONS

 1              WD4MUO TO W.COAST USA (SAN FRANCISCO)
 2              WD4MUO TO E.COAST SA (RIO DE JANEIRO)
 3              WD4MUO TO E.COAST SA (BUENOS AIRES)
 4              WD4MUO TO W.COAST SA (LIMA)
 5              WD4MUO TO HAWAII
 6              WD4MUO TO JAPAN
 7              WD4MUO TO AUSTRALIA (SYDNEY)
 8              WD4MUO TO S.ASIA (DACCA)
 9              WD4MUO TO W.EUROPE (PARIS)
 10             WD4MUO TO E.EUROPE (WARSAW)
 11             WD4MUO TO USSR (MOSCOW)
 12             WD4MUO TO N.AFRICA (TUNIS)
 13             WD4MUO TO E.COAST AFRICA (LIBERIA)
 14             WD4MUO TO W.COAST AFRICA (KENYA)
 15             WD4MUO TO S.AFRICA (PRETORIA)
 16             WD4MUO TO A SPECIFIED POINT
 17             BETWEEN SPECIFIED POINTS
CHOICE?
```

Fig. 2: Path Selection Menu.

```
================================================================
                                                  MINIMUF
================================================================

DATE (DAY, MONTH) ? 01,08

STATE SOURCE OF SOLAR ACTIVITY - S=sunspot #  F= solar flux  F
SMOOTHED MEAN 10.7cm SOLAR FLUX  ? 119
A FLUX OF 119 EQUATES TO A SUNSPOT NUMBER OF 69.82


WANT HARD COPY PRINTOUT ? Y


WANT FLAG ON MUF ABOVE GIVEN FREQ ? N
```

Fig. 3A: Data Entry for Paths 1-15.

```
================================================================
                                                  MINIMUF
================================================================

TRANSMITTER LAT, LON (''-'' for East & South)? 39,77

RECEIVER LAT, LON (''-'' for East & South)? -35,58

DATE (DAY, MONTH) ? 01,08

STATE SOURCE OF SOLAR ACTIVITY - S=sunspot #  F= solar flux  F
SMOOTHED MEAN 10.7cm SOLAR FLUX  ? 119
A FLUX OF 119 EQUATES TO A SUNSPOT NUMBER OF 69.82


WANT HARD COPY PRINTOUT ? Y


WANT FLAG ON MUF ABOVE GIVEN FREQ ? Y
SPECIFY FREQ IN MHZ 27.5
```

Fig. 3B: Data Entry for Specified Points (Option 17).

```
1 REM     MINIMUF.BAS     VERSION 3.5
2 REM
3 REM     ADAPTATION 1.23 FOR IBM PC  AS AT 1700  26 DEC 82
4 REM
5 REM     SOURCE: QST DECEMBER 1982  Pg 38
6 REM     SOURCE OF POLYNOMIAL FLUX TO SUNSPOT # CONVERSION: GILDER, JAMES H.;
7 REM      BASIC COMPUTER PROGRAMS IN SCIENCE AND ENGINEERING; HAYDEN 1980.
8 REM
9 REM     ADAPTION BY JOHN E ANDERSON   WD4MUO
10 REM
11 REM
12 REM
13 REM
14 REM   SAMPLE DRIVER FOR MINIMUF 3.5
15 REM   INITIAL DATA
16 CLS:KEY OFF
17 DIM M$(37),A$(4),M(12)
18 FOR I=1 TO 12
19 READ M(I)
20 NEXT I
21 DATA 31,28,31,30,31,30,31,31,30,31,30,31
22 M$="JANFEBMARAPRMAYJUNJULAUGSEPOCTNOVDEC"
23 PI=3.141593
24 RO=PI/180
25 P1=2*PI
26 R1=180/PI
27 PO=PI/2
28 DEF FNACS(X)=-ATN(X/SQR(-X*X+1))+1.5708
29 X$=STRING$(79,61)
30 CS$="WD4MUO"   :REM  DEFAULT VALUE; INSERT STATION CALL SIGN
31 GOSUB 238   :REM   TO PRINT SCREEN HEADER
32 REM   OPTION MENU
33 PRINT :PRINT "PATH OPTIONS"
34 PRINT
35 PRINT 1,CS$;" TO W.COAST USA (SAN FRANCISCO)"
36 PRINT 2,CS$;" TO E.COAST SA (RIO DE JANEIRO)"
37 PRINT 3,CS$;" TO E.COAST SA (BUENOS AIRES)"
38 PRINT 4,CS$;" TO W.COAST SA (LIMA)"
39 PRINT 5,CS$;" TO HAWAII"
40 PRINT 6,CS$;" TO JAPAN"
41 PRINT 7,CS$;" TO AUSTRALIA (SYDNEY)"
42 PRINT 8,CS$;" TO S.ASIA (DACCA)"
43 PRINT 9,CS$;" TO W.EUROPE (PARIS)"
44 PRINT 10,CS$;" TO E.EUROPE (WARSAW)"
45 PRINT 11,CS$;" TO USSR (MOSCOW)"
46 PRINT 12,CS$;" TO N.AFRICA (TUNIS)"
47 PRINT 13,CS$;" TO E.COAST AFRICA (LIBERIA)"
48 PRINT 14,CS$;" TO W.COAST AFRICA (KENYA)"
49 PRINT 15,CS$;" TO S.AFRICA (PRETORIA)"
50 PRINT 16,CS$;" TO A SPECIFIED POINT"
51 PRINT 17,"BETWEEN SPECIFIED POINTS"
52 INPUT "CHOICE";CH
53 IF CH<1 OR CH>17 THEN CLS:LOCATE 12,30:PRINT "BAD CHOICE NUMBER":FOR X=1 TO 2
000:NEXT X:CLS:GOTO 31
54 GOSUB 238   :REM   TO PRINT SCREEN HEADER
55 IF CH=17 GOTO 56 ELSE 267
56 REM   DATA INPUTS
57 T$="TRANSMITTER": R$="RECEIVER"
58 PRINT :INPUT "TRANSMITTER LAT, LON (''-'' for East & South)";L1,W1
59 IF L1=>-90 AND L1<=90 THEN 62
60 PRINT "INVALID LATITUDE.  MUST BE IN RANGE (-90 TO +90)"
61 GOTO 58
62 IF -360<=W1 AND W1<=360 THEN 65
63 PRINT "INVALID LONGITUDE.  MUST BE IN RANGE (-360 TO +360)
64 GOTO 58
65 PRINT :INPUT "RECEIVER LAT, LON (''-'' for East & South)";L2,W2
66 IF -90<=L2 AND L2<=90 THEN 69
67 PRINT "INVALID LATITUDE.  MUST BE IN RANGE (-90 TO +90)"
68 GOTO 65
69 IF -360<=W2 AND W2<=360 THEN 72
70 PRINT "INVALID LONGITUDE.  MUST BE IN RANGE (-360 TO +360)
71 GOTO 65
```

```
72 PRINT :INPUT "DATE (DAY, MONTH) ";D6,MO
73 IF 1<=MO AND MO<=12 THEN 76
74 PRINT "INVALID MONTH.  MUST BE IN RANGE (1 TO 12)"
75 GOTO 72
76 IF 1<=D6 AND D6<=M(MO) THEN 80
77 PRINT "INVALID DAY.  MUST BE IN RANGE (1 TO";M(MO);")"
78 GOTO 72
79 REM   SUN SPOT DATA
80 PRINT :INPUT "STATE SOURCE OF SOLAR ACTIVITY - S=sunspot #  F= solar flux  ",
AN1$
81 IF AN1$="S" OR AN1$="s" THEN 88 ELSE IF AN1$="F" OR AN1$="f" THEN 82 ELSE 80
82 INPUT "SMOOTHED MEAN 10.7cm SOLAR FLUX  ";SF
83 IF SF<65 THEN PRINT"INVALID FLUX NUMBER, MUST BE GREATER THAN 65.":GOTO 82
84 IF SF>245 THEN PRINT "RESULTS MAY BE INACCURATE FOR FLUX GREATER THAN 245."
85 GOSUB 263  :REM   TO ROUTINE FOR FLUX TO SUNSPOT NUMBER CONVERSION
86 PRINT "A FLUX OF";SF;"EQUATES TO A SUNSPOT NUMBER OF";S9
87 GOTO 93
88 PRINT :INPUT "SMOOTHED INTERNATIONAL SUNSPOT NUMBER= ";S9
89 IF S9>=0 THEN 93
90 PRINT "INVALID SUNSPOT NUMBER.  MUST BE NON-NEGATIVE."
91 GOTO 88
92 REM   HARD COPY FLAG
93 PRINT :PRINT :INPUT "WANT HARD COPY PRINTOUT ";AN$
94 IF AN$="Y" OR AN$="y" THEN LP=1 ELSE IF AN$="N" OR AN$="n" THEN LP=0 ELSE GOT
O 93
95 REM   THRESHOLD FLAG
96 PRINT :PRINT :INPUT "WANT FLAG ON MUF ABOVE GIVEN FREQ ";TA$
97 IF TA$="Y" OR TA$="y" THEN TA=1 ELSE IF TA$="N" OR TA$="n" THEN TA=0 ELSE GOT
O 96
98 IF TA=1 THEN INPUT "SPECIFY FREQ IN MHZ ",TAM
99 CLS
100 A$=MID$(M$,3*MO-2,3)
101 GOSUB 238   :REM   TO PRINT SCREEN HEADER
102 PRINT :PRINT "DATE:";D6;A$
103 PRINT :PRINT T$;" LOCATION" TAB(43) R$;" LOCATION"
104 PRINT " LATITUDE:";L1;"  LONGITUDE:";W1; TAB(43) " LATITUDE:";L2;"  LONGITUD
E:";W2
105 PRINT :PRINT "SUNSPOT NUMBER =";S9
106 PRINT
107 COLOR 10
108 PRINT "  MUF(Mhz)    UTC";
109 FOR I=5 TO 55 STEP 5
110 COLOR 7:LOCATE ,19+I:PRINT I;
111 NEXT I
112 COLOR 10
113 PRINT "  =========     ===";
114 COLOR 7
115 LOCATE ,20:PRINT"¦====¦====¦====¦====¦====¦====¦====¦====¦====¦====¦====¦="
116 IF LP=1 THEN GOSUB 245  :REM   TO PRINT HARD COPY HEADER
117 L1=L1*RO
118 W1=W1*RO
119 L2=L2*RO
120 W2=W2*RO
121 FOR T5=0 TO 23
122 GOSUB 146   :REM   TO MAIN CALCULATION LOOP
123 REM   SCREEN AND PRINTER DATA PRINT
124 IF TA=0 THEN D$="*"
125 IF TA=1 THEN IF J9=>TAM THEN D$="*" ELSE D$="."
126 PRINT USING "     ##.#";J9;:PRINT TAB(15) T5 TAB(20) "¦";
127 LOCATE ,20+CINT(J9):COLOR 10:PRINT D$ :COLOR 7
128 IF LP=1 THEN LPRINT USING "     ##.#";J9;:LPRINT TAB(15) T5 TAB(20) "¦" TAB(2
0+CINT(J9)) D$
129 NEXT T5
130 REM   SCREEN AND PRINTER ENDING
131 LOCATE ,20:PRINT"¦====¦====¦====¦====¦====¦====¦====¦====¦====¦====¦====¦="
132 FOR I=5 TO 55 STEP 5
133 LOCATE ,19+I:PRINT I;
134 NEXT I
135 IF LP=1 THEN 136 ELSE 141
136 LPRINT TAB(20) "¦====¦====¦====¦====¦====¦====¦====¦====¦====¦====¦====¦="
137 FOR I=5 TO 55 STEP 5
138 LPRINT TAB(19+I) I;
139 NEXT I
```

```
140 LPRINT CHR$(12)
141 BEEP:BEEP:BEEP:BEEP:PRINT
142 FOR X=1 TO 4000:NEXT X
143 INPUT "PRESS RETURN TO PERFORM NEXT CASE.",X
144 CLS
145 GOTO 31
146 REM     MINIMUF 3.5 CALCULATION LOOP
147 K7=SIN(L1)*SIN(L2)+COS(L1)*COS(L2)*COS(W2-W1)
148 IF K7=>-1 THEN 151
149 K7=-1
150 GOTO 153
151 IF K7<=1 THEN 153
152 K7=1
153 G1=FNACS(K7)
154 K6=1.59*G1
155 IF K6>=1 THEN 157
156 K6=1
157 K5=1/K6
158 J9=100
159 FOR K1=1/(2*K6) TO 1-1/(2*K6) STEP .9999-1/K6
160 IF K5=1 THEN 162
161 K5=.5
162 P=SIN(L2)
163 Q=COS(L2)
164 A=(SIN(L1)-P*COS(G1))/(Q*SIN(G1))
165 B=G1*K1
166 C=P*COS(B)+Q*SIN(B)*A
167 D=(COS(B)-C*P)/(Q*SQR(1-C^2))
168 IF D=>-1 THEN 171
169 D=-1
170 GOTO 173
171 IF D<=1 THEN 173
172 D=1
173 D=FNACS(D)
174 WO=W2+SGN(SIN(W1-W2))*D
175 IF WO=>O THEN 177
176 WO=WO+P1
177 IF WO<P1 THEN 179
178 WO=WO-P1
179 IF C=>-1 THEN 182
180 C=-1
181 GOTO 184
182 IF C<=1 THEN 184
183 C=1
184 LO=PO-FNACS(C)
185 Y1=.0172*(10+(MO-1)*30.4+D6)
186 Y2=.409*COS(Y1)
187 K8=3.82*WO+12+.13*(SIN(Y1)+1.2*SIN(2*Y1))
188 K8=K8-12*(1+SGN(K8-24))*SGN(ABS(K8-24))
189 IF COS(LO+Y2)>-.26 THEN 198
190 K9=O
191 GO=O
192 M9=2.5*G1*K5
193 IF M9<=PO THEN 195
194 M9=PO
195 M9=SIN(M9)
196 M9=1+2.5*M9*SQR(M9)
197 GOTO 223
198 K9=(-.26+SIN(Y2)*SIN(LO))/(COS(Y2)*COS(LO)+9.999999E-04)
199 K9=12-ATN(K9/SQR(ABS(1-K9*K9)))*7.639437
200 T=K8-K9/2+12*(1-SGN(K8-K9/2))*SGN(ABS(K8-K9/2))
201 T4=K8+K9/2-12*(1+SGN(K8+K9/2-24))*SGN(ABS(K8+K9/2-24))
202 CO=ABS(COS(LO+Y2))
203 T9=9.7*CO^9.6
204 IF T9>.1 THEN 206
205 T9=.1
206 M9=2.5*G1*K5
207 IF M9<=PO THEN 209
208 M9=PO
209 M9=SIN(M9)
210 M9=1+2.5*M9*SQR(M9)
211 IF T4<T THEN 214
212 IF (T5-T)*(T4-T5)>O THEN 215
```

```
213 GOTO 228
214 IF (T5-T4)*(T-T5)>0 THEN 228
215 T6=T5+12*(1+SGN(T-T5))*SGN(ABS(T-T5))
216 G9=PI*(T6-T)/K9
217 G8=PI*T9/K9
218 U=(T-T6)/T9
219 G0=C0*(SIN(G9)+G8*(EXP(U)-COS(G9)))/(1+G8*G8)
220 G7=C0*(G8*(EXP(-K9/T9)+1))*EXP((K9-24)/2)/(1+G8*G8)
221 IF G0=>G7 THEN 223
222 G0=G7
223 G2=(1+S9/250)*M9*SQR(6+58*SQR(G0))
224 G2=G2*(1-.1*EXP((K9-24)/3))
225 G2=G2*(1+(1-SGN(L1)*SGN(L2))*.1)
226 G2=G2*(1-.1*(1+SGN(ABS(SIN(L0))-COS(L0))))
227 GOTO 234
228 T6=T5+12*(1+SGN(T4-T5))*SGN(ABS(T4-T5))
229 G8=PI*T9/K9
230 U=(T4-T6)/2
231 U1=-K9/T9
232 G0=C0*(G8*(EXP(U1)+1))*EXP(U)/(1+G8*G8)
233 GOTO 223
234 IF G2>J9 THEN 236
235 J9=G2
236 NEXT K1
237 RETURN
238 REM   SCREEN HEADER
239 CLS:COLOR 0,7
240 PRINT X$
241 PRINT TAB(37) "MINIMUF" STRING$(36,32)
242 PRINT X$
243 COLOR 7,0
244 RETURN
245 REM HEADER FOR PRINTER
246 LPRINT CHR$(27);"E";:
247 LPRINT X$
248 LPRINT TAB(37) "MINIMUF"
249 LPRINT X$
250 LPRINT CHR$(27);"F";
251 LPRINT :LPRINT "DATE:";D6;A$
252 LPRINT :LPRINT T$;" LOCATION" TAB(43) R$;" LOCATION"
253 LPRINT " LATITUDE:";L1;"  LONGITUDE:";W1; TAB(43) " LATITUDE:";L2;"  LONGITU
DE:";W2
254 LPRINT :LPRINT "SUNSPOT NUMBER =";S9
255 LPRINT
256 LPRINT "  MUF(Mhz)     UTC";
257 FOR I=5 TO 55 STEP 5
258 LPRINT TAB(19+I) I;
259 NEXT I
260 LPRINT "  ========     ===";
261 LPRINT TAB(20) "|=====|=====|=====|=====|=====|=====|=====|=====|=====|=====|=====|="
262 RETURN
263 REM CALCULATION OF SUNSPOT NUMBER FROM SOLAR FLUX
264 S9=-103.7767+1.797429*SF-(3.384356E-03)*SF^2+(4.525515E-06)*SF^3
265 S9=INT(100*S9+.5)/100
266 RETURN
267 REM   PATH OPTION LAT/LON
268 L1=39:W1=77:T$=CS$   :REM   L1&W1 DEFAULT VALUES;CHANGE FOR YOUR STATION
269 IF CH=1 THEN L2=38:W2=122:R$="TO W.COAST USA (S.F.)":GOTO 72
270 IF CH=2 THEN L2=-23:W2=44:R$="TO E.COAST SA (RIO)":GOTO 72
271 IF CH=3 THEN L2=-35:W2=58:R$="TO E.COAST SA (BUENOS AIRES)":GOTO 72
272 IF CH=4 THEN L2=-12:W2=77:R$="TO W.COAST SA (LIMA)":GOTO 72
273 IF CH=5 THEN L2=22:W2=158:R$="TO HAWAII":GOTO 72
274 IF CH=6 THEN L2=36:W2=-140:R$="TO JAPAN":GOTO 72
275 IF CH=7 THEN L2=-34:W2=-151:R$="TO AUSTRALIA (SYDNEY)":GOTO 72
276 IF CH=8 THEN L2=23:W2=-90:R$="TO S.ASIA (DACCA)":GOTO 72
277 IF CH=9 THEN L2=49:W2=-2:R$="TO W.EUROPE (PARIS)":GOTO 72
278 IF CH=10 THEN L2=52:W2=-21:R$="TO E.EUROPE (WARSAW)":GOTO 72
279 IF CH=11 THEN L2=56:W2=-38:R$="TO USSR (MOSCOW)":GOTO 72
280 IF CH=12 THEN L2=37:W2=-10:R$="TO N.AFRICA (TUNIS)":GOTO 72
281 IF CH=13 THEN L2=-12:W2=-10:R$="TO W.COAST AFRICA (LIBERIA)":GOTO 72
282 IF CH=14 THEN L2=-2:W2=-37:R$="TO E.COAST AFRICA (KENYA)":GOTO 72
283 IF CH=15 THEN L2=-26:W2=-28:R$="TO S.AFRICA (PRETORIA)":GOTO 72
284 IF CH=16 THEN R$="RECEIVER":GOTO 65
```

New Products from RAK

RAK Electronics of Florida now offers two new programs for use on the VIC-20 and Commodore 64. The PREFIX LOCATOR AND MUF FORECASTER is designed to allow a quick, easy method of locating any prefix worldwide. Once the prefix is located, the MUF portion of the program is entered and the best frequency for QSO capability determined.

Prefixes are located by entering the prefix, name of city, state or country. These different modes of location appear in the main menu. Once the prefix or country is found, the computer displays the name of the country, prefix, antenna bearing, long path antenna bearing and distance in miles and kilometers.

This program is available in two versions for the VIC-20 -- the 16k version that uses all the ram of the VIC, but can be expanded by a 16k expansion cartridge. The 28k version has all the prefixes and countries of the world and includes enough space to add your own listings.

PREFIX LOCATOR AND MUF FORECASTER is available on cassette tape for $9.59. LOCATOR/MUF II (VIC-28k) sells for $12.95.

The second product from RAK is COMPUTERIZED ANTENNA DESIGN. It is written to give the antenna builder proper sizes for construction and planning different types of antenna arrays. Antennas covered in the program are: Quad, Yagi, Dipoles, Inverted vee's, Verticals and Log Periodic Arrays. Routines such as Phasing lines, Phased Vertical Spacings and Stacking, needed in the planning and construction stages of multi antenna arrays, are also covered.

ANTENNA DESIGN is available on tape for the Commodore 64 and VIC-20 for $9.59 or on diskette for $12.95. There is a $2.00 shipping and handling fee on these items. A catalog is available by writing RAK Electronics, P. O. Box 1585, Orange Park, FL 32067-1585.

AMSAT-OSCAR 10 Develops Problems

AMSAT-OSCAR 10 Mode L has an antenna relay problem; so reads AMSAT's best estimate. The 1296-MHz uplink requires about 10 dB more power than initially planned. The suspicion is that a relay is stuck with the 1269-MHz turnstile in the line and AMSAT has not been able to switch to the 1269-MHz gain antenna.

The turnstile is the perigee antenna that is mounted on the surface of the spacecraft that faces away from earth at apogee, the point near which Mode L is usually attemped. Because of this, a larger uplink power is needed (on the order of 10-12 dB+). The best signal was from a European station running 30 kW eirp, however, lesser signals from the northern hemisphere have been heard (15-20 kW eirp), but only a couple of dB above the noise. Of recent interest is a southern hemisphere station running much less power with a much stronger downlink. (The 1269-MHz turnstile was facing the earth and comparatively close to it.)

Mode L has been scheduled for 2 hours of operation centered on apogee, on each of its two orbits (Wednesday and Saturday, UTC). Performance has recently improved because of sequential switching of the Mode L antenna relay.

During the end of September, Mode B was missing unexpectedly. AMSAT has determined that in its present period of longer-than-normal eclipse (in shadow), when the high-power-consumption magnetorquers are operated, the battery voltage dropped to below the arbitrarily set 13-V trigger level. The onboard computer quite properly shut the transponder down. This problem is a normal seasonal occurrence that can be solved by lowering the software-set trigger level to 12 V and not loading the batteries excessively during eclipse.

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2) document advanced technical work in the Amateur Radio field, and

3) support efforts to advance the state of the Amateur Radio art.

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