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QEX 93

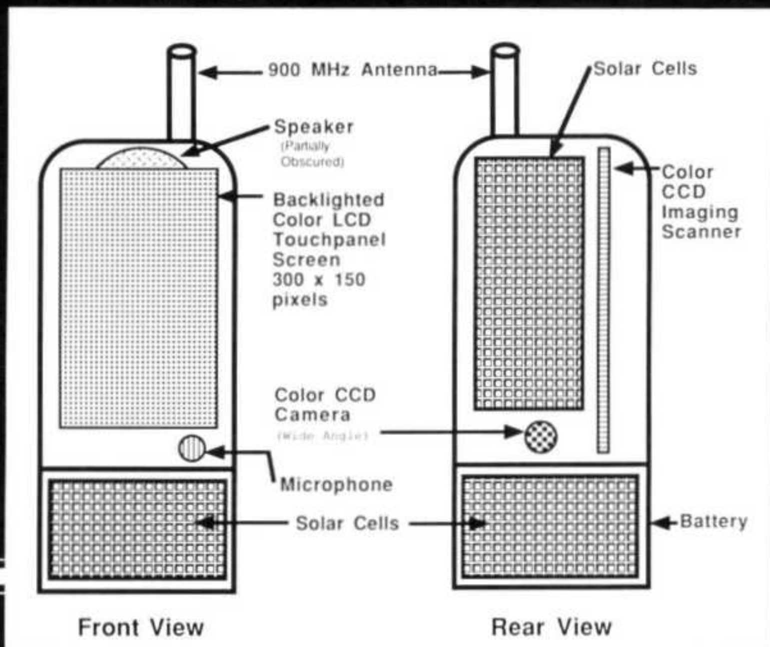
ARRL Experimenters' Exchange

NOVEMBER 1989

The Radio Of The Future?

Perhaps. A digital voice network was one of many topics discussed at the 8th Computer Networking Conference.

See Page 2



QEX: The ARRL
Experimenters' Exchange
American Radio Relay League
225 Main Street
Newington, CT USA 06111

Non-Profit Org.
US Postage
PAID
Hartford, CT
Permit No. 2929

QEX (ISSN: 0886-8093) is published monthly by the American Radio Relay League, Newington, CT USA.

Offices
225 Main St, Newington, CT 06111 USA
Telephone: 203-666-1541
Telex: 650215-5052 MCI
FAX: 203-665-7531 (24 hour direct line)
Electronic Mail: MCI MAIL ID:215-5052
(user name ARRL)
Telemail address: ARRL

Subscription rate for 12 issues:
In the US by Third Class Mail:
ARRL Member $10, nonmember $20;

US, Canada and Mexico by First Class Mail:
ARRL Member $18, nonmember $28;

Elsewhere by Airmail:
ARRL Member $38, nonmember $48.

QEX subscription orders, changes of address, and reports of missing or damaged copies may be marked: *QEX* Circulation.

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THE AMERICAN RADIO RELAY LEAGUE, INC

The American Radio Relay League, Inc, is a noncommercial association of radio amateurs, organized for the promotion of interest in Amateur Radio communication and experimentation, for the establishment of networks to provide communications in the event of disasters or other emergencies, for the advancement of the radio art and of the public welfare, for the representation of the radio amateur in legislative matters, and for the maintenance of fraternalism and a high standard of conduct.

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1) provide a medium for the exchange of ideas and information between Amateur Radio experimenters
2) document advanced technical work in the Amateur Radio field
3) support efforts to advance the state of the Amateur Radio art.

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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*.

Any opinions expressed in *QEX* are those of the authors, not necessarily those of the editor or the League. While we attempt to ensure that all articles are technically valid, authors are expected to defend their own material. Products mentioned in the text are included for your information; no endorsement is implied. The information is believed to be correct, but readers are cautioned to verify availability of the product before sending money to the vendor.

Empirically Speaking. . .

Computer Networking Conference

Andy Freeborn, NØCCZ, and the gang from TAPR, Academy Radio Club, USAFA Cadet Radio Club, and Rocky Mountain Packet Radio Association (RMPRA) outdid themselves. The hosting arrangements were about as good as they get for conferences, short of flying everyone to Morocco in a jumbo jet. The technical papers presented were of even a higher quality than in past years. Attendance was about 142 people, many of whom came from outside Colorado.

Paul Newland, AD7I, volunteered for the role of "sergeant at arms," which he performed digitally. By means of a cordless phone, he controlled a box on the lectern with green, amber and red LEDs, which first were solid, then flashing, to let the speaker know that time was up. Some people make the trains run on time; Paul managed the more difficult feat of keeping speakers on time.

The amateur packet-radio network shows many signs of maturing and some of rejuvenating. AX.25 version 2.0 has reached maturity, and the Digital Committee has had a version 2.1 in circulation for over a year. A prioritized acknowledgement (PRIACK) protocol enhancement has been proposed for version 2.1. TNC and multimode hardware abounds. TCP/IP is a full protocol suite, and ROSE is coming into bloom. So, what's really new? Mike Chepponis, K3MC, Glenn Elmore, N6GN, Bdale Garbee, N3EUA, Phil Karn, KA9Q and Kevin Rowett, N6RCE, have been scheming on a high-speed (1 Mbit/s) network. They say that, although the basic idea is not new, all the pieces are now available to make possible such a network across North America. They have demonstrated that a microwave radio, snow sled reflector and all, can be built for about $150, batteries not included. Of course, there needs to be some digital hardware and software between two radios to make a relay station work. The group feels that the technical part of the problem is perhaps the easiest, and that the organizational and funding aspects are those needing the most work. In addition to presentation of a paper on this subject at the Networking Conference, Bdale gave another talk the next day as part of the RMPRA session. There are some exciting prospects lurking here.

On October 8, the Digital Committee met to consider a number of issues. Most of the meeting was spent on the HF packet-radio development program undertaken by the committee. I was able to announce the good news that the Federal Emergency Management Agency (FEMA) made a two-year grant of $10,000 to the ARRL to help fund this program. ARRL has $6,000 in additional Technology Funds, most of which can be applied to this program. The Digital Committee identified four areas for development:

- More robust modem designs (suited to HF)
- Protocol improvements (for better error control)
- Diversity reception (to overcome multipath)
- Network management (to reduce collisions)

The committee agreed to form a working group consisting of Paul Newland, AD7I, Paul Rinaldo, W4RI, and Eric Scace, K3NA, which will meet in December to finalize the specific design goals. Meanwhile, a number of potential participants have indicated interest in the program, and we are now asking them for resumes and a general idea of their approach. Anyone interested in participating should contact Lori Weinberg at ARRL HQ. More background may be found starting on page 54 of May, 1989 *QST*.

The Digital Committee also decided to go ahead with completion of AX.25 version 2.1, more or less as published, with the addition of PRIACK (see above). The version 2.1 documentation and System Description Language (SDL) diagrams will be circulated to the Digital Committee for approval as soon as the paperwork can be completed.—*W4RI*

A Bar-Graph Tuning Indicator For FEC-DEC

By Paul Newland, AD7I
ARRL Technical Advisor
Post Office Box 205
Holmdel, NJ 07733

Want a better tuning indicator for FEC-DEC? This unit is simple to build as well as use.

Introduction

I recently outlined a simple selective-calling decoder that makes use of FSK transmissions.[1] I have received some feedback that users would be interested in a slightly easier-to-use tuning indicator. The circuit described here, although more complex than the original, meets that goal. I call this tuning indicator FEC-TUN since it's designed as an option for FEC-DEC.

Background

There are all sorts of tuning indicators in common use for RTTY. Probably the best is the cross-ellipse display of an oscilloscope. However, the oscilloscope is bulky, expensive, and requires high voltages. An effective, although not as convenient, tuning indicator can be constructed from an LED bar-graph. The bar-graph usually consists of 10 to 20 LEDs that represent a quantized meter display—values range from 1 to 10 (or 20), in integer steps. Typically, LED bar-graph displays fall into two major categories: the "center" display and the "spectral" display.

For the center-display mode, a single dot displays the tuning condition. Correct tuning is indicated by the dot being positioned in the center of the LED bar-graph. Commercial products that use the center-display include the TAPR packet tuning indicator and products from MFJ.

The spectral display consists of two dots that indicate the spectral position of the two data tones relative to the center frequency. For the spectral display, the user adjusts the receiver so that the two dots straddle the center line of the display. Commercial products that make use of the spectral display include AEA's PK-232 and Kantronics' KAM.

FEC-TUN can operate in either mode. For continuous FSK signals (AMTOR FEC) I prefer the center display. However, for burst FSK signals (AMTOR ARQ) I like the spectral display. Since FEC-DEC uses AMTOR FEC, I configured FEC-TUN for the center mode of operation.

[1]Paul Newland, AD7I, "A Selective Calling Decoder for MF/HF Radio Systems," *QEX*, No. 86, April 1989, pp 3-11.

FEC-DEC Circuit Additions

Some additions are needed to FEC-DEC's modem for it to be used with FEC-TUN. These additions add a connector to interface the modem to the tuning indicator as well as making the XR2211's lock detect operational.

Specifically, the additions are detailed in Fig 1A. R50 and C50 provide filtering for the XR2211's quadrature lock detector. The output at pin 5 of the XR2211 goes low when a signal is detected. R51 provides a pull up to +5-V when no signal is detected. FEC-TUN uses the lock signal to blank the display when the PLL is out of lock. J50 is a 5-pin SIP header that is used to interconnect FEC-DEC's modem with the tuning indicator.

Circuit Description

All input signals to FEC-TUN are provided to J101. Power for the circuit is derived from the +V (typically 12 volts) bus on FEC-DEC. The signal at J101 pin 3 is the demodulator output voltage from the XR2211. As the input-tone frequency becomes greater than the center frequency, the voltage at this point will become less than +4.3 volts. Conversely, as the input-tone frequency becomes less than the center frequency, the voltage at this point will become more than +4.3 volts.

U101A buffers the demodulator output from the XR2211 so that FEC-TUN doesn't load down this signal. D101 provides a positive peak detector while D102 provides a negative peak detector. The peak detectors function with attack times determined by R101 and C104/C105. The decay times are determined by R102/C104 and R103/C105. U101B adds algebraically the output of the positive and negative peak detectors, with a gain determined by R102, R103 and R104. The signal at the output of U101B is really just the average of the peak positive and negative swings of the demodulator voltage. R105 and C106 remove any high-frequency noise from the composite signal. U101C buffers the signal to ensure minimal loading.

The output of the averaging circuit is presented to the LED bar-graph display through R107 and J102. During normal operation, no significant voltage is dropped across R107. However, when the XR2211 is out of lock, Q101 will saturate, thus shunting the bar-graph input signal to ground, effectively blanking the bar-graph display.

The bar-graph's display range is determined by the voltages that are presented to pins 4 and 6 of U102. Pin 4 is connected to ground while pin 6 is connected to U102's voltage regulator. The voltage at pin 6 is set to values between 5.3 volts and +V by adjusting R111. R111 is adjusted during the calibration routine, outlined later in this article.

For the center-display mode, it's sometimes difficult to locate the center of the display. To aid in the tuning process, installing a short at J104 will cause LED number 5 to light dimly. This dim LED serves as a "target" to aid the user in locating the center of the display. Additionally, when the LED dot representing the current tuning position is placed over the dim target, the resulting display is slightly brighter than the dot would appear at any other position. This tends to give the user an extra indication that the system is properly tuned.

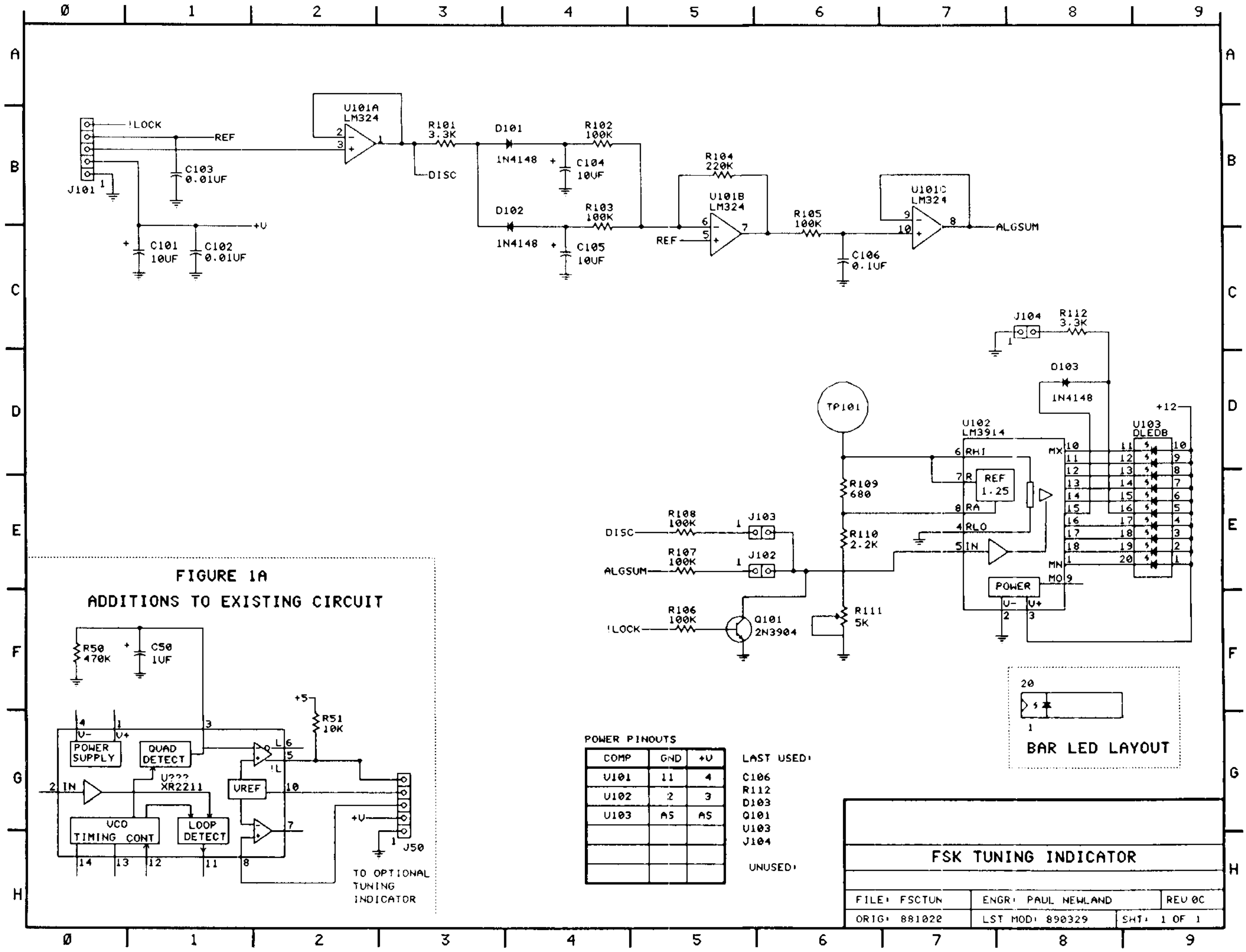
The above discussion assumes that the display is in the center mode. To make it function in the spectral mode, simply open J102 and install a shorting plug on J103. With J103 shorted the instantaneous voltage from the detector is presented to U102, resulting in the spectral display. Again, when the XR2211 is out of lock, Q101 is saturated, thus effectively blanking the display. The target created when J104 is shorted may or may not be helpful when FEC-TUN is operated in the spectral mode.

Calibration

Calibration is pretty straight forward. First, calibrate the XR2211 center frequency by following the FEC-DEC calibration procedure. Then, with an audio tone of a frequency half way between the mark and space tones presented to FEC-DEC, adjust R111 so that the moving LED dot appears at the same LED position as the target created when J104 is shorted. That's all there is to it.

Operating Notes

If you are using the center mode, ad-



just your radio so the movable LED dot appears over the target. If you are using the spectral mode, adjust your radio so that the two movable LED dots appear on either side of the target and equidistant from the target.

If FEC-DEC suffers from excessive audio input the XR2211 will always think it's in lock when either signal or noise is received. If the XR2211 thinks it's always in lock the display will never blank. The solution here is to decrease the audio signal given to FEC-DEC so that the lock output is only valid when FSK tones are being received.

Conclusion

This display is hardly novel, it's really just a rehash of the original TAPR tuning indicator developed for their TNC 2, which also used the XR2211 demodulator. Most all parts can be obtained from Jameco or other sources. Cost should be in the $10 to $15 neighborhood, assuming a barren junk box. I built mine using point-to-point wiring on a perf board. I don't have a PC board template for FEC-TUN. Suggestions for improvements are always welcome. Low-cost, effective RTTY tuning indicators are a special interest of mine. I would welcome the opportunity to share information and ideas with other like-minded people.

Bits

KO5I Named AMSAT General Manager

The AMSAT-NA Board of Directors has appointed Doug Loughmiller, KO5I, as General Manager. Loughmiller, who was elected AMSAT-NA President last November, will continue to serve in that volunteer capacity, but will no longer serve as a director.

The AMSAT Board, in consultation with the volunteer management team, felt that it was necessary to have a full-time professional manager. The need to fund Phase IV, many opportunities surrounding Microsat technologies, possible involvement in Phase III-D, design studies on the Lunar Polar Orbiter, teaming agreements with the World Space Foundation on a solar sail project and the need to build a solid financial foundation for AMSAT-NA all led to this decision.

Doug Loughmiller, KO5I, is a well known AMSAT volunteer, having held numerous positions within the organization over the past several years. His long commitment and dedication to AMSAT and its goals are amongst the reasons the Board of Directors deemed him the best man for the job.—*Bob McGwier, W4NHY*

XR-2900 FAXIDATA Modem Chip Set

The XR-2900 is a two chip set that provides the modem data pump function for 9600 bps half duplex applications. The XR-2900 supplies all the functions for implementing a modem for faxsmile or Y.29 applications. Further description and ordering information is available from EXAR Corporation, PO Box 49007, 2222 Qume Drive, San Jose, CA 95161-9007. Tel 408-434-6400.

Some Ideas for a Robust HF Packet Signal Design

By Allan H. Kaplan, W1AEL
Rte 1, Box 212
Ashburn, VA 22011

By now, many who were attracted by the potential that packet-radio operation might bring to the HF amateur bands are at least fairly disappointed by the excessive retry rate. Perfect copy, valuable though it may be for many applications, exacts a price we need not pay on the crowded HF bands. It is time for the Amateur Radio HF data communications community to adopt some techniques that have met with success in military communications, namely:

Error Detection and Correction Coding
Data Interleaving
Packet-Combining
Efficient Coding for Text
Multibit-per-Baud Modulation

I agree with Jerome Dijak[1] (and others) who blame lost throughput on the need for bit-perfect copy to satisfy the CRC computation. Dijak points out that we should use forward error correction coding (FEC) in the packet text, so that the TNC software can correct some small error rate on the first reception. When this happens, the FEC corrects a few bit errors in the packet and the CRC checks out, sparing the channel from the repeats otherwise necessary.

Borrowing and adapting some techniques used in military data communications, we can further avoid excessive repeats by better protecting our information from the channel and by wringing every possible bit of information from the damaged packets we receive. We must realize that it is worth some complication in TNC software to reduce the repeat rate and use more of our precious bandwidth for real throughput—not repeats ad nauseam. As we consider this, we realize that most radio amateurs enjoy packet and AMTOR operation with no great need to understand the complex and/or tedious details of the software driving their black boxes. There is nothing wrong with this—man does not live by software alone!

I will advocate the Golay (23, 11) block code and use it as an example below, though it might be worth considering the Reed-Solomon codes suggested by Mr Dijak in his thought-provoking article. The Golay code protects data in 12-bit blocks by adding 11 check bits for a word length of 23 bits total. An extended form of this code adds an overall parity bit to the word for very slightly more power and a more convenient 3-byte word length.

Notes appear on page 7.

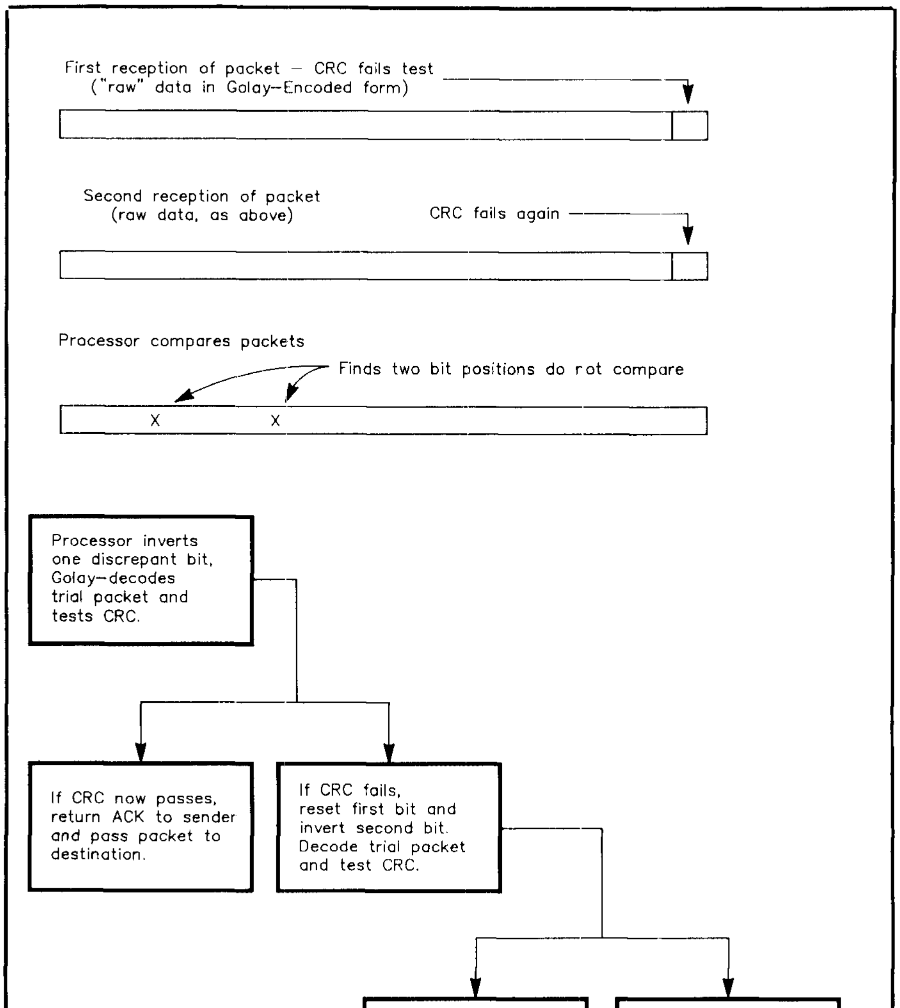


Fig 1—Packet-combining can make a good packet from two bad ones.

The Golay code will detect and correct any three bits in error in the 23-bit word. The 24-bit code will also detect, but not correct, a fourth error. It is easy to see that a Golay-encoded packet could have over 12 percent of its bits in error, correct itself, validate the CRC, and not need to ask for a repeat. The price we pay for this performance is the half-rate code that results. For every information-bearing bit, we have included a check bit. Considering how few HF packets are ACKed on the first try, it's not a bad price. Golay encoding and decoding are not difficult to implement in microprocessor software.

The major limitation of the Golay code is that it cannot correct more than three errors total in a 24-bit word. QRM and QRN conditions on our bands are such that four-bit and longer hits will happen. The well-known remedy for this "burst-

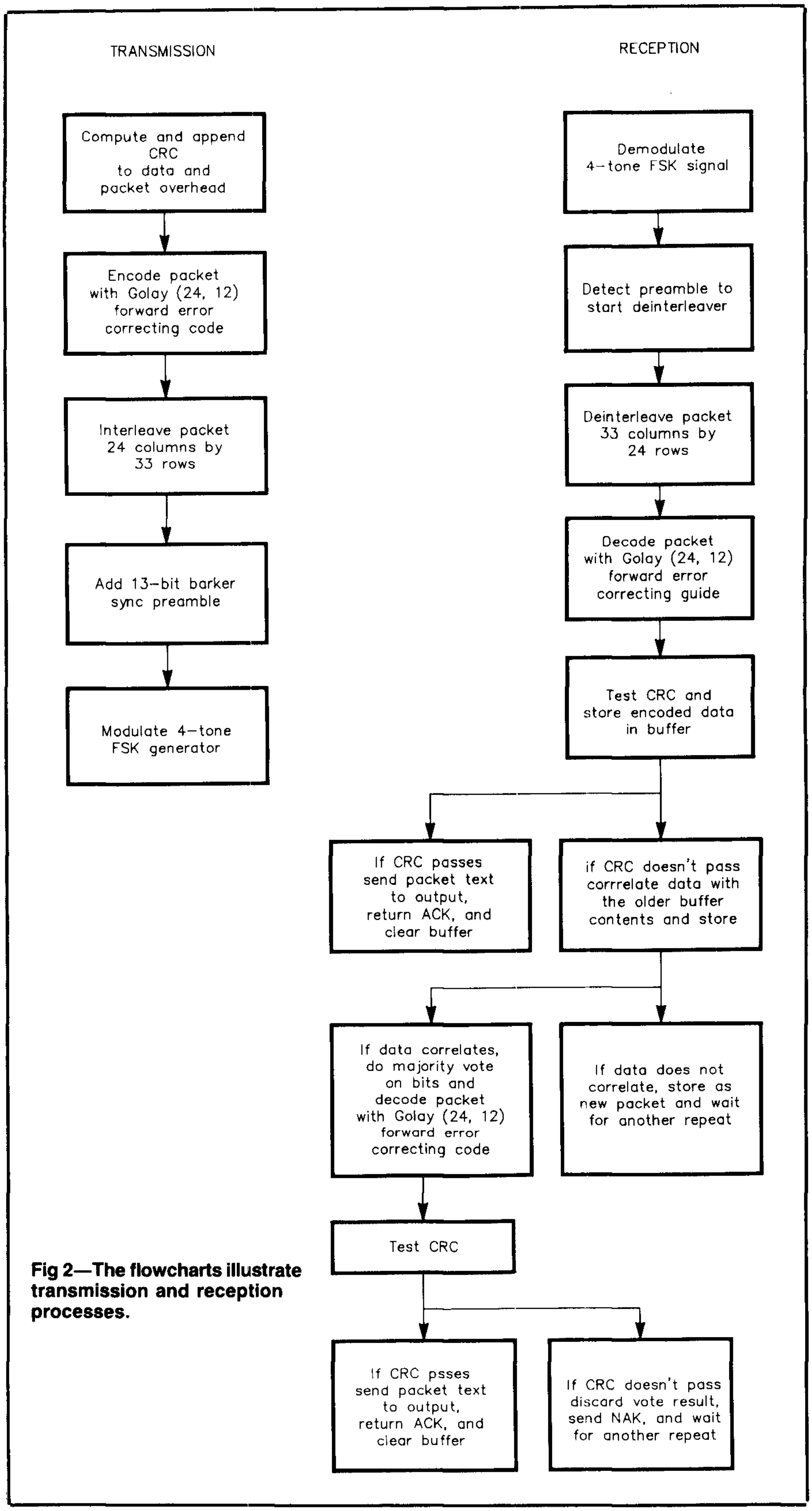


Fig 2—The flowcharts illustrate transmission and reception processes.

error" problem is interleaving, which spreads the 24 bits out so that a run of several bit errors will hit one bit in each of several words instead of overpowering the ability of the code to correct errors in a single word.

A usual way of implementing the interleaver is to set up an M-bit by N-bit array in memory, writing the message into the array by rows, and reading it out by columns. The transmitting and receiving software routines must agree on the M × N dimensions of the array. The interleaver block size will be an important issue in any emerging standard for an improved packet-radio format. An array size that holds an 80-character line might be a good starting point, but it could take over 4.9 seconds to transmit it at 300 bit/s. That is probably too long as things stand, but there is more. . .

The next robust communications stratagem to consider is packet combining. The software examines a damaged packet and one or more damaged repeats, each of which yields a bad CRC, but is identifiable as having the same message plus or minus a few "excess errors." Consider the case where each of the two copies has a single error beyond what the Golay code will correct—the probability is very low that the error is in the same bit in both copies of the packet. Making a bit-for-bit comparison, the software identifies the two bits that do not compare, and inverts one of them. If that bit was the only error, as we proposed, the TNC can now correct the packet, verify the CRC as correct, and ACK the packet without further repeats. If the first trial fails, the process resets the first bit and tries inverting the second "suspicious" bit. See Fig 1.

For cases where more than one bit in each copy of the packet is wrong, the software spots the bits in each copy that do not compare, and makes a series of trial bit corrections. The optimum strategy is the subject for more detailed study. Where the number of excess errors is small, there is a high probability that only a few trials will result in successfully decoding the packet without any more repeats. At any rate, we must realize that the TNC is normally idle between the time a packet fails to decode and the time of the next repeat. We are using that time productively if we get the software to dig out the message without another repeat.

Perhaps while our software is busy with trial error corrections, the transmitting station, having no ACK reception, sends another repeat. If the latest one does not compute, this gives us three copies to work with. The packet-combining strategy is simpler from now on. We vote on each bit in the three versions of the message—and the majority wins. There is no guarantee that the majority will be correct, but the chances of successful decode improve with each new sample of the packet, and clever programmers can use otherwise idle interpacket time to improve the chances of digging out the message by trial error correction and trial reprocessing.

Rinaldo's article[2] criticized AMTOR because it is limited to the "passé" Baudot character set. Amateur Radio campaigned long and hard to remove the strictures of a five-bit alphabet, and I am glad we did, but for well over 90 percent of amateur communications, the Baudot code with upper-case letters plus the numbers and punctuation is all we really need to communicate. When we want to pass computer data/graphics files, we have a use for 8-bit characters, but otherwise they impose a substantial time or bandwidth penalty that gains us nothing.

I propose that we use the five-bit code for alphanumeric text (90+ percent of all traffic) and use 8-bit data on HF only when necessary. A control byte in the packet overhead will identify which code is in the packet. The savings in bits per line will almost "pay for" the rate-½ error-detecting and -correcting code (EDAC) we used to minimize repeated packets. The EDAC, in turn, will all but eliminate the problems that errors in the LTRS and FIGS shift characters used to give us with Baudot. Nobody but your TNC firmware will see the old-fashioned code that saves 60 percent of channel time!

For the last topic in this proposal to improve HF packet efficiency, we turn to the actual modulation form. AFSK on an SSB signal is an appropriate modulation waveform for HF communication, but using four-tone modulation instead of two-tone will let us transmit 600 bits per second while staying inside the present 300-baud limit. We send only 300 symbols per second, but each of the four possible tones represents a pair of bits, ie, 00/01/11/10. The multibit modulation has proven itself in military applications, and communications analysts have argued that further increases in the number of bits per symbol yield rapidly diminishing returns at HF.

For orthogonal tone signaling, the separation should be 300 hertz, eg, 1100, 1400, 1700, and 2000 hertz. If the resulting bandwidth (1200 Hz including keying sidebands) is a problem, we could use as little as 200-hertz tone spacing (for 900-Hz BW) but the results would be poorer. The present tone standard of 200-hertz spacing at 300 bauds uses 500-hertz bandwidth and is not as resistant to selective fading as wider spacing would be.

So here is the skeleton of a robust HF packet scheme that embodies techniques that are successfully implemented in military communications systems. We get packets that "can pretty well take care of themselves" in a mild error-rate environment. In a heavier environment, the TNC packet combining and bit-majority voting increase the likelihood that a few repeats will build into a usable packet, even if no single repetition will pass CRC! We pay for this (at first blush) with "half-rate data," but modulating two bits per channel symbol pays us back, and the preponderance of amateur traffic, which needs neither ASCII control characters nor lower case window dressing, benefits by exploiting 5-bit text code to save another 60 percent in time. With the exception of the four-tone FSK modems, it's all done in the TNC software, entirely transparent to "Joe Ham." These modems lend themselves to very tractable solutions in either hardware or software. Fig 2 illustrates the transmission and reception signal flow.

This is an evolutionary HF datacomm strategy that requires no great leaps of technology to implement. The implementation would make a fine project for TAPR or AMRAD.

References

[1]Jerome T. Dijak, W9JD, "AMTOR, AX.25, and HERMES: a performance analysis of three systems," *Ham Radio*, December 1985, page 63.

[2]Paul L. Rinaldo, W4RI, "The Great 1989 HF Packet Design Quest," *QST*, May 1989, page 54.

Bits

Battery-Powered Directional Wattmeter

Bird Electronic Corporation is offering the Model 4410A portable, battery-powered THRULINE® RF Directional Wattmeter with seven power ranges per element, for measurement of signal power within ±5% of reading. Standard elements provide frequency ranges from 0.2-2300 MHz and power ranges from 0.002-10,000 watts. Special elements can provide measurements at frequencies as low as 50 kHz.

Other versions are available: Model 4411, battery powered portable or 115/230 V ac (50/60 Hz) operation; Model 4412, rechargeable NiCd battery or 115/230 V ac (50.60 Hz) operation; and for fixed location use, Model 4410P, 19-inch rack panel-mounted configuration with battery or 115/230 V ac (50/60 Hz) operation.

For more information contact Bird Electronic Corporation, Marketing Department, 30303 Aurora Road, Cleveland (Solon), OH 44139-2794. Tel 216-248-1200.

Super Mini-Mold

NEC's new Super Mini-Mold bipolar package is so small *thirty* devices can be stacked on the head of a common roofing nail.

Available from California Eastern Laboratories, these NEC microwave bipolars are ideal for pagers, police radar detectors, pocket-sized television, hand-held UHF mobile radio, or any high-volume, surface-mount design where size is critical.

Six bipolar are now available in the Super Mini-Mold package. All are available in tape and reel.

NE02130 and NE73430: Good performance for general applications.

NE85630: Low noise, high gain and high dynamic range applications.

NE68130 and NE68030: High gain and low noise, f_T to 8.5 GHz.

NE68330: Very low current, low voltage applications.

For further information contact Steve Morris, Product Marketing Manager, California Eastern Laboratories, 408-988-5183.

Pseudo-Sync, A Terminal Program For Mode B AMTOR

By Jerry W. Egleston, Sr, WAØSVG
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Independence, MO 64057

RTTY is a fun mode with many good features like plenty of DX, good rag chewing, and bulletin boards, to name a few. About a year ago, I chose to enter this mode by designing and building a modem to interface the Commodore 64™ computer using my own software for RTTY. This worked out well for me. The project provided me a good challenge and renewed my interest and love of ham radio. Recently, I added a new dimension to my home-written software: AMTOR FEC mode. This article will describe how the program works and can inexpensively add FEC mode to most stations equipped with a C64 computer and a conventional RTTY modem.[1] So, read on, then set up your RTTY modem to be QRV for AMTOR, with Pseudo-Sync.

Background

Many home computers come equipped with the necessary hardware and internal software device drivers to permit operating asynchronous communications modes by adding a "dumb" terminal program and a simple modem. Starting synchronous communications, however, is another story. Few, if any, home computers are equipped for synchronous communications modes. Normally, an external synchronous modem or data controller like the KAM™, PK-232, etc, must be used. These units communicate with the computer using asynchronous data while communicating with the distant terminal using the desired synchronous transmission. In other words, the data controller serves two functions, modem and protocol converter. Another way to conduct synchronous data communications with a home computer is with a synchronous terminal program. A synchronous terminal program permits the computer to send and receive using the synchronous mode directly, so that a simple modem can be used in much the same way as it would otherwise be used for asynchronous modes.

FEC, The Neglected Mode

Before getting into how the program works, permit me to describe some current uses for AMTOR FEC mode and present a case for using it more. Based upon HF monitoring at my QTH, FEC mode is used mostly for calling CQ with the intention of establishing an ARQ mode QSO.[2] A secondary use is whenever an ARQ contact does not go as expected, FEC is used to work out the bugs. Running a distant third are bulletin transmissions. There are a few BBSs that use FEC to post traffic lists and provide access information. Except for once or twice a day, W1AW sends FEC mode bulletins only as time permits, giving priority to Baudot and ASCII transmission modes.[3] Why is this excellent mode used so little? I believe that one answer is that AMTOR is still relatively new and operators of the time-tested Baudot RTTY gear may be reluctant to take the plunge and spend the money needed for a new data controller. Soon after getting a data controller, however, most operators find that ARQ mode is a better choice than FEC mode for the normal one-to-one QSO, so FEC mode QSOs have become relatively rare. However, for the HF bands, FEC mode is ideal for information bulletins, round tables, and nets, and is a better alternative to conventional 45-baud RTTY for a "normal" QSO. The built-in error-correction of FEC mode offers a welcome improvement over Baudot or ASCII RTTY during typical band conditions, and the average operator will find that FEC data throughput is comparable to the more popular 45-baud asynchronous RTTY.[4] Commercial stations recognize the advantages afforded by FEC. Weather and traffic lists are sent regularly using FEC mode and at least one station operates 100% FEC mode.[5] Fortunately for current RTTY operators, the operating procedures for FEC mode are very similar to Baudot RTTY, so this mode is easy to learn. Pseudo-Sync can help pave the way for many of these stations to participate in this improved technique for RTTY at a modest cost.

Program Features

To accommodate the 40-column format of the C-64 screen, the sequence: carriage return, line feed, letters case, is sent automatically by the terminal program after every 40 DX/RX characters (not counting idle periods) or can be sent by the operator typing the return key. Depressing the CTRL key in send mode starts the sequence for sending an end-of-transmission signal to the distant station after all transmit buffers are emptied. Depressing the Commodore key during receive mode forces the terminal to switch to letters case. There are four user-programmable transmit buffers. These buffers contain default contents that load as an integral part of the program. The buffer contents can be changed by using a monitor program and saving the modified file, or the buffer vectors can be changed to point to a different memory location containing the new data. I have written a support program to perform this function as well as handle disk transfers for the buffer data. Pseudo-Sync also offers a special-purpose user-loaded buffer that is accessible during transmission. Whatever is placed in the buffer by the operator is sent three times, followed by: DE WAØSVG WAØSVG WAØSVG PSE K K K. This message can be changed permanently with a monitor program, or the support program mentioned above can be used to make the change each time the terminal program is loaded. This buffer is ideal for calling another station and for "overs" and station ID during a QSO. This buffer contents can be changed as often as desired during sending, without disk transfers. The contents are limited to a maximum of 80 characters, however. Pseudo-Sync also has a 28-kbyte wrap-around QSO buffer with an operator-review option.

How the Program Works

Pseudo-Sync, as the name implies, is not a purely synchronous mode; that is, the clock within the computer is not really synchronized to the clock of the sending station. Instead, the computer clock produces constant interval pulses and periodically the sampled data are shifted in time position to simulate synchronization. The process used must be repeated throughout the communications and requires the reception of periodic idle characters to maintain synchronization.[6] Unfortunately, CCIR Recommendation 476-3 does not specifically address mode B resynchronizing so there is some variation between different equipment and station operating procedures.[7] However, most FEC transmissions contain plenty of

Notes appear on page 10.

idle characters and there is no problem. After the initial synchronizing process, a special routine evaluates each 02 idle character as it is received. The relative time displacement between the computers interrupt pulses and the received data transitions is determined and appropriate corrections are made to maintain synchronization. The routine passes over any noisy signal that might cause errors. The effect is similar to a digital automatic phase control.

Synchronous Receiver

When synchronizing, data samples are taken approximately every 1.43 milliseconds until the first six out of seven consecutive samples are of equal value (binary one or zero). Wherever a transition from one value to another occurs, a new bit position is assumed. When this is completed, one bit representing the value of this group of seven samples is rotated right into a byte that is compared after the entry of each bit. When an 02 idle character is decoded, the DX character position is established. From this point onward, the byte being built is not compared until all seven bits (49 samples) have been received. If the next character decoded is an 01 idle character, then the RX character position is established and the pseudosynchronizing process is well on its way. If not, the process reverts to the beginning, hunting bit by bit for the occurrence of the 02 idle character. The final step before printing can begin is the reception of a carriage return, line feed, or case (shift) character. A software flip-flop keeps track of the proper DX/RX relationship of each character as it is received. Fig 1 is a simplified flow chart of these routines.

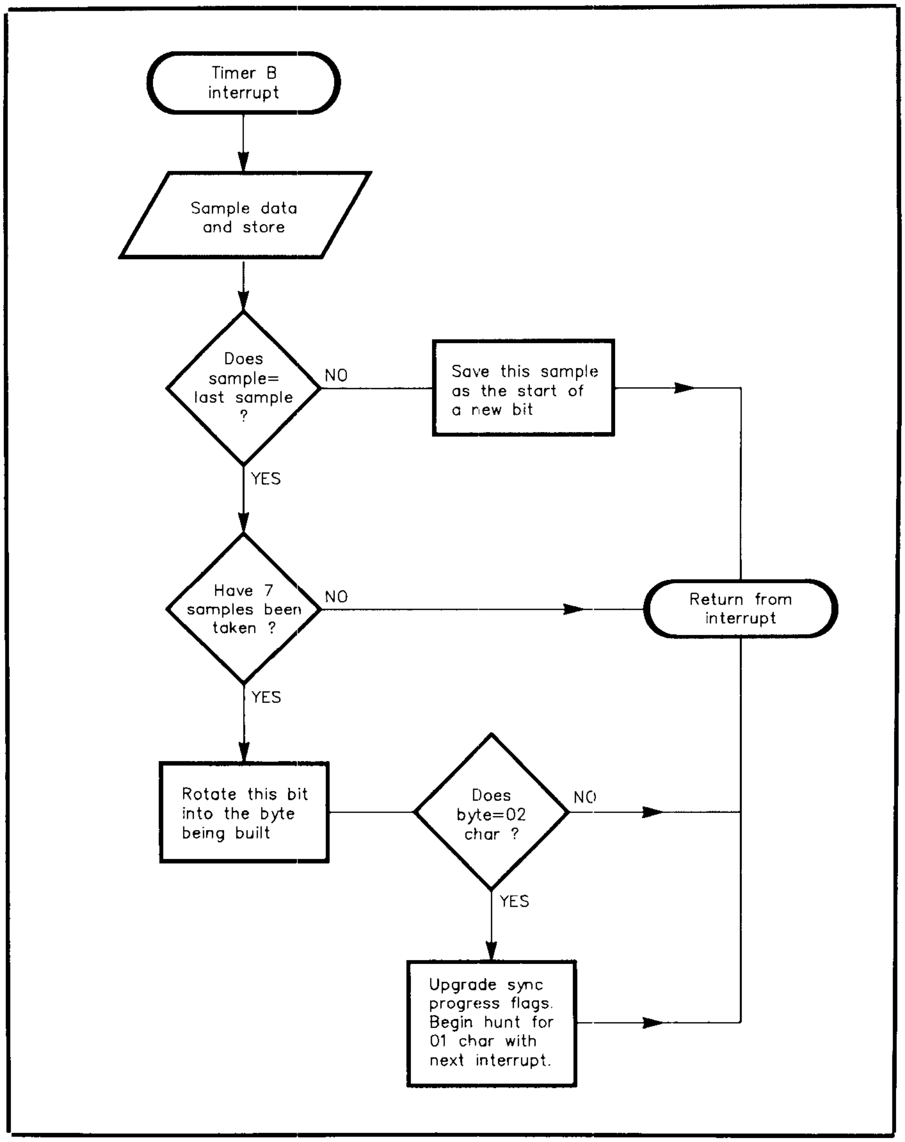


Fig 1—Synchronous receiver. Transition detector, bit time slot locator and byte time slot synchronization routines.

While seven samples are always taken for each bit, after the first Pseudo-Sync routine is completed the samples are used only to "vote" whether a bit will be decoded as a one or a zero. If four or more samples during the bit time slot indicate a one, then the bit is decoded as a one. When restarting from standby, however, the first six out of seven samples must all be the same value for each bit position.

Each character is checked for validity as it is received. Valid characters are stored in a buffer, but bad characters are overwritten with a substitute error symbol before storing. One RX character is then read from the buffer and if it is good it is printed, while the related DX character is ignored. However, when an error symbol is read for any RX character, the program checks the related DX character, and if it is good the DX is printed. When both the RX and DX characters are bad, the error symbol (_) is printed. Ten consecutive error symbols is assumed to indicate the loss of synchronization, and the terminal switches to standby.

Synchronous Transmitter

Fig 2 is a simplified flow chart of the synchronous transmitter used in Pseudo-Sync. CIA Timer A produces interrupts that drive the routines. A counter labeled ICTR on Fig 2 keeps track of the progress of each bit out of the transmitter as well as directs the buffer input and output operations. Synchronous transmission requires that every time period contains data. To accomplish this, the buffer control checks first for any buffered data, if none is present it checks the keyboard for input. If neither source provides a character to transmit, the buffer control inserts an idle signal character to keep the data flowing. The buffer control also automatically sends idle characters at the beginning, and after the transmission of 40 DX/RX character pairs for resynchronizing.

Conclusion

The program is an adaptation of the RTTY terminal program that I wrote originally for Baudot RTTY. However, the nonmaskable interrupt handler normally provided by the C-64 KERNAL was replaced, as were portions of the I/O driver routines in order to provide the direct synchronous data path through the user port.[8] Although the program is written specifically for the C-64 computer, the idea could be applied to other makes as well. Interfacing the user port involves only four wires: TX DATA, RX DATA, RTS, and GROUND. The RTS line is used to switch the external MODEM between receive and transmit modes. Refer to Fig 3 for pin numbers. Pseudo-

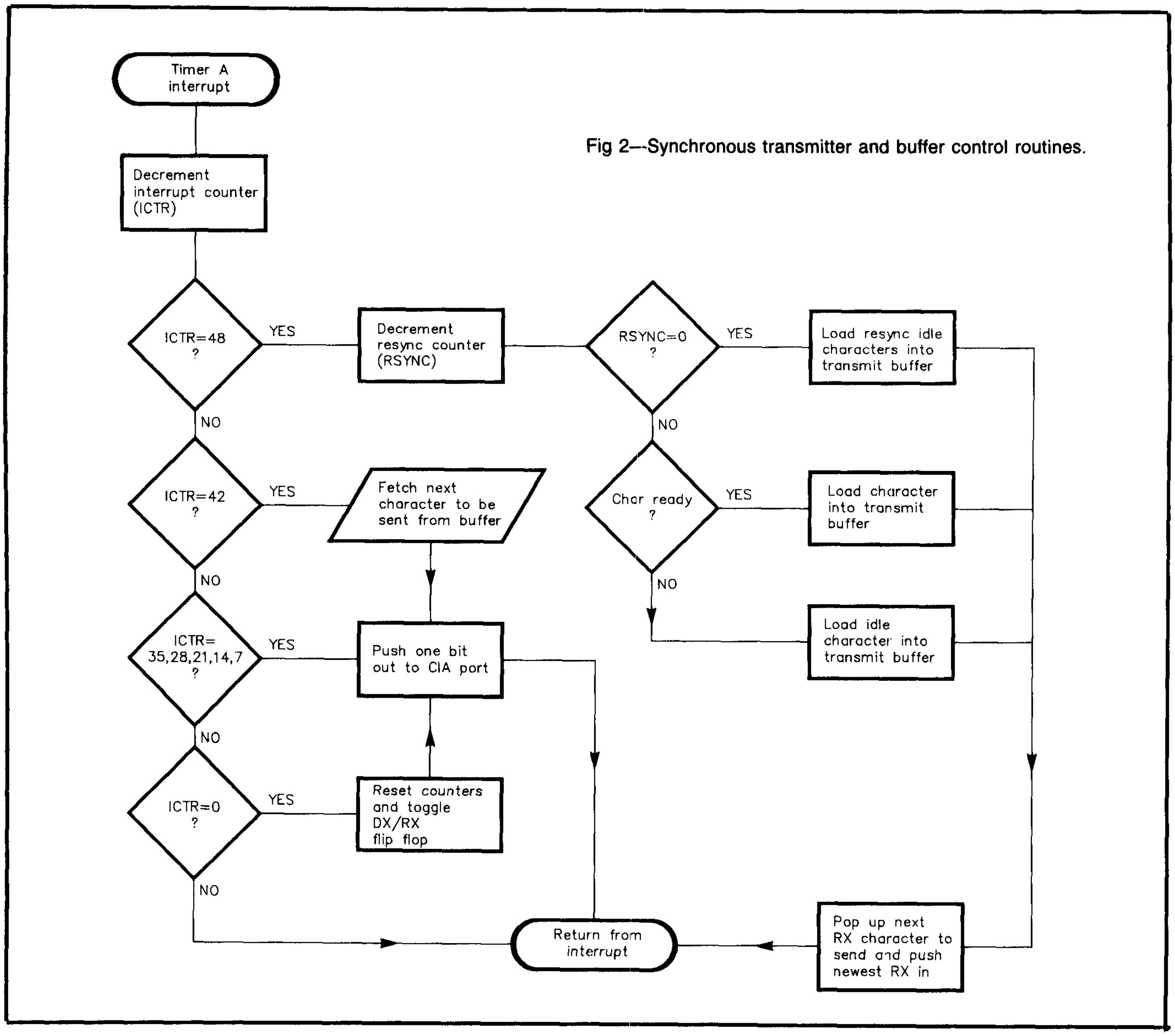


Fig 2—Synchronous transmitter and buffer control routines.

Sync is provided with the support program. To load, type: LOAD "BOOT",8. When the ready prompt appears type: RUN. Both programs are booted and when the menu is displayed you are ready for FEC. So, why not send for the program, plug up the ol' RTTY MODEM and give FEC MODE AMTOR a go![9]

References

[1] The MODEM must be capable of 100-baud half-duplex operation. The control line must switch the MODEM to transmit when +5 volts are applied, and switch to receive mode when ground (0 V) is applied. Neither the control or data line burden may exceed two standard TTL loads if direct connection to the C-64 is desired. The program is written for the NTSC video system (USA standards) only.

[2] FEC mode is recommended for calling CQ by P. Newland in, "A User's Guide to AMTOR," *QST*, October 1985, pages 31-34.

[3] W1AW Bulletin schedule as listed in *QST*, January 1989.

[4] More information on AMTOR FEC mode can be found in *The ARRL Handbook*, Mark J. Wilson, ed, (Newington, CT: ARRL, 1986) Chapter 19 and P. Newland, "An Introduction to AMTOR," *QST*, July 1983, Pages 11-13.

[5] The author knows of only one station that operates continuously using FEC mode only:

WOO . . . . 8051.5 kHz

Thanks to Mr Paul Newland, AD7I, for the following information:

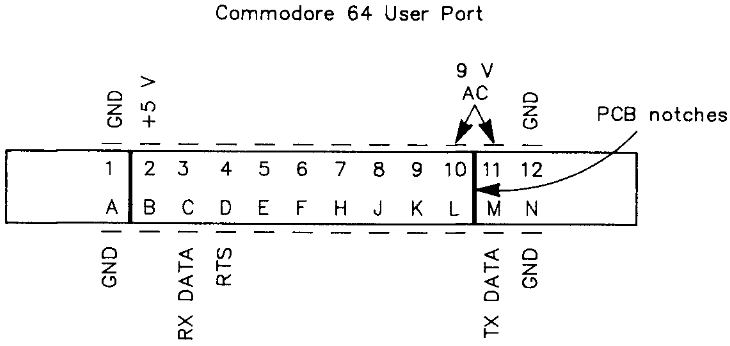
KMI . . . . 8087.0 kHz
WLO . . . . . . 8514.0 kHz and 12886.5 kHz
Coast Guard NAVTEX . . . . 518.0 kHz

[6] No matter how closely matched the transmit and receive clocks may be in frequency, they will tend to drift slowly apart as time passes. Unless some means is provided to track the drift, synchronization will be lost. This program uses the reception of idle characters in measuring the drift to determine when corrective action is needed.

[7] CCIR Recommendation 476-3 as reprinted in the *ARRL Computer Networking Conferences Proceedings 1-4* (Newington, CT: ARRL, 1985), Appendix 3.

[8] Information about the C64 KERNAL is given by Dan Heeb, *Tool Kit: Kernal* (Greensboro, NC: Compute! Publications, 1985).

[9] Custom copies of the program with user-supplied call sign, QTH and other information installed into the default buffers are available from the author for $10, postage paid in the USA. For a generic copy of the program, send a disk and return postage to the author. The *ARRL* and *QEX* in no way warrant this offer.



View from rear of computer of printed circuit edge connector on far right. Mates with C1–12 connector; available from Digi–Key.

+5 V from RTS = send mode Ground from RTS = receive mode	+5 V on TX DATA = TX mark Ground = TX space
+5 V on RX DATA = RX mark Ground = RX space	OK to jumper RX DATA pin C to $\overline{FLAG2}$ pin B.

Fig 3—Interfacing information for Pseudo-Sync Program.

Bits

Analog Simulation Package

Tatum Labs, Inc has announced a new release of Electronic Circuit Analysis (ECA-2), a computer aided engineering (CAE) software package, featuring multiple plot capability and enhanced custom user-program interface features. ECA-2 is used by engineers for simulating analog circuits.

ECA-2 is compatible with IBM® PC/XT/AT/PS-2 and equivalents; requires a minimum of 256 kbytes RAM and MS-DOS® 2.0 or later. A hard disk and coprocessor are recommended but not required. Cost is $775. An evaluation kit is available for $45. A free demo is also available. For additional information contact: Rachel Ebert, Tatum Labs, Inc, 3917 Research Park Drive B-1, Ann Arbor, MI 48108. Tel 313-663-8810. FAX 313-663-3640.

Spectrum Catalog

Spectrum Signal Processing, Inc, has available a catalog of DSP Development Tools and OEM Systems for the IBM® PC. To order call one of the following numbers: Canada 604-438-7266; Western USA 800-663-8986; Eastern USA 800-323-1842.

Selected Areas in Communications

The June 1989 IEEE Journal on Selected Areas in Communications (Volume 7, Number 5) contains several articles of interest to packet experimenters. Topic: Packet Speech and Video. Selected titles follow:

- Dynamic Priority Protocols for Packet Voice
- Error Control Techniques for Integrated Services Packet Networks
- Missing Packet Recovery Techniques for Low-Bit-Rate Coded Speech
- Packet Video and Its Integration into the Network Architecture
- Packet Communication Protocol for Image Services on a High-Speed Multimedia LAN
- Shared Access Packet Transmission Systems for Compressed Digital Video
- Encoding Facsimilie Images for Packet-Switched Networks.
- Models for Packet Switching of Variable-Bit-Radio Video Sources

For information on how to obtain this issue and/or on how to become an IEEE member, write or call IEEE at: IEEE Service Center, 445 Hoes Lane, PO Box 1331, Piscataway, NY 08855-1331, 201-981-0060.

Correspondence

More "Hams in Space" Operations Coming

Plans for another Shuttle "ham in space" operation have been underway since well before the Challenger tragedy. The opportunity for another such flight opened when Dr Ronald Parise, WA4SIR, of Silver Spring, Maryland, was selected as a Payload Specialist to operate the "Astro" equipment on a planned Shuttle mission. The Astro mission, which includes an infrared telescope, was to have been flown in March 1987, just following the ill-fated Challenger flight. As in the case of the other two NASA approved amateur operations from the Shuttle, a proposal seeking authorization for WA4SIR to operate from space had been jointly prepared by the ARRL and AMSAT, and submitted to NASA headquarters in Washington, DC sometime in 1986.

From the beginning, Ron's Amateur Radio mission centered around a packet station in space. Prior to the scheduled flight, hardware and software preparations were underway. With Tom Clark, W3IWI, and other AMSAT volunteers taking an active role, confidence was high that the equipment would be ready on time. However, the cessation of Shuttle flights after the Challenger accident brought amateur plans and preparations to a halt.

As NASA was preparing to get the Shuttle back in space, the ARRL Board of Directors, recognizing the need for increased and continuing Amateur Radio participation in manned space missions, authorized the establishment of a committee to promote this objective. Appointed to this committee were:

Roy Neal, K6DUE, Chairman
Jon Bloom, KE3Z, ARRL HQ Staff
Lou McFadin, W5DID, Johnson Space Center Amateur Radio Club Representative
Bill Tynan, W3XO, AMSAT Representative

The first formal meeting of the SAREX (Shuttle Amateur Radio Experiment) Committee was held in August 1988 at the Johnson Space Center in Houston. This meeting dealt primarily with identifying additional work needed to obtain final NASA approval for Amateur Radio participation on WA4SIR's flight, now designated as STS-35, as well as defining amateur-related experiments for that flight. In support of these objectives it was agreed that the following capabilities would be included.

- Retain the capability for 2-meter FM two-way voice communication.
- Retain the capability, demonstrated on WØORE's flight, to exchange slow-scan TV pictures between the Shuttle and ground stations.
- Add packet capability with several modes of operation.
- Add an experiment to demonstrate the capability of transmitting fast-scan TV pictures from designated ground stations to the Shuttle. (FSTV has not yet been sent up to a spacecraft.)

The committee also recognized the immediate need to send a letter to NASA headquarters reaffirming the amateur community's desire and willingness to participate in STS-35. As before, such a letter was jointly prepared and submitted by ARRL and AMSAT.

Packet and FSTV were new since the WØORE flight and required significant modifications to the SAREX equipment used during that mission. In order to add these two modes to the existing box (already housing the Robot slow-scan TV converter), Lou McFadin, W5DID, and his able associates at the Johnson Space Center Amateur Radio Club, found it necessary to accomplish a considerable amount of repackaging—among other things—to accommodate the small TNC donated by Heath. This repackaging required the use of new, more efficient and much smaller space-rated power supplies. Acquisition of these rather costly units was made possible through a substantial monetary contribution by the ARRL Foundation. A new flight deck window antenna was also needed to facilitate longer periods of operation. The antenna used on previous flights was mounted in the upper deck overhead window which is often needed for observation, which had precedence. The Motorola Amateur Radio Club in Schaumburg, Illinois agreed to design and build a new antenna assembly to include a 70-cm antenna and converter for the FSTV uplink as well as a 2-meter antenna for packet, SSTV and voice. A significant feature of this antenna is that it is capable of being mounted in either of the two flight deck side windows, which are seldom used during the on-orbit portion of Shuttle missions.

At the SAREX Committee's second meeting in March 1989, it was reluctantly agreed to not attempt to include the fast-scan TV experiment on the TS-35 mission. This decision was made necessary because of time considerations in readying the necessary scale equipment. It was further agreed, however, that this experiment will be included on a forthcoming flight.

On June 20 it was learned that the space needed to stow the SAREX equipment, as it existed, would not be available on STS-35. This was because that mission had been extended to 10 days, thus requiring more locker space than usual for essential items such as food. At WA4SIR's suggestion, the Committee agreed that slow-scan TV would be eliminated and that the packet TNC, a 12-volt power supply and an accompanying RFI filter be housed in a small box that could be stowed along with the Motorola handheld 2-meter transceiver. Once again W5DID and his crew came through and got the job done. This configuration retains one of the Committee's principal stated objectives—doing something new for each flight in which Amateur Radio participates. Most important, it enabled us to get NASA approval for WA4SIR to operate from space on STS-35.

There is still a lot to be done, including a mountain of paperwork which must be generated and approved before we can fly. John Nickel, WD5EEV, is representing ARRL/AMSAT at Johnson Space Center on SAREX matters and is coordinating much of this effort.

There is a chance of another "ham in space" shortly after Ron's mission, now slated for April 26, 1990. Ken Cameron, a pilot scheduled to fly on STS-37, has recently passed his amateur license exam and been issued the call KA5EWP. His success in obtaining a license is a result of the Johnson Space Center Amateur Radio Club's efforts to promote Amateur Radio, especially among the astronauts. Hopes are high that we can do the things on Ken's mission that we were unable to accomplish on STS-35, including the FSTV uplink experiment. *—Bill Tynan, W3XO, AMSAT Vice President for Manned Space Programs*

Components

By Mark Forbes, KC9C
5240 Whitney Blvd
Rocklin, CA 95677

NEC UPG107 Microwave Switch

California Eastern Laboratories, the importer of NEC's microwave and RF semiconductors, has a new component that should interest microwave experimenters. The UPG107 is a GaAsFET SPDT switch, developed for S-Band applications, and is also an excellent replacement for PIN diode switches. The switch operates from dc to 3.4 GHz, so it covers a lot of ham frequencies. Switching time is typically 5 ns.

The NEC switch is available in chip form for $25 (100 pc), or in a hermetically-sealed, 8-pin ceramic package (see photo). For more information, contact California Eastern Laboratories, Inc, 3260 Jay Street, Santa Clara, CA 95054; phone 408-988-3500.

NEC UPG106 Wideband AGC Amplifier

Another new and interesting component from NEC is the UPG106 wideband AGC amplifier. The new AGC amplifier provides high gain and wide bandwidth. It operates from 100 kHz to 2.5 GHz, with typical gain of 20 dB, and a dynamic control range of 35 dB. The input and output impedances are 50 ohms.

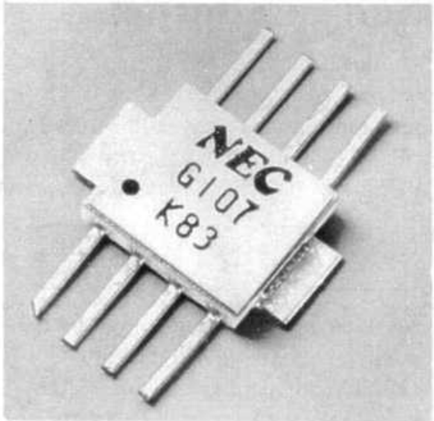
Like the UPG107, the UPG106 is available in either chip or hermetically-sealed ceramic packages. Price for the AGC amplifier is about $50. For more information, contact California Eastern Laboratories at the above address.

Microchip CMOS Digital Signal Processor

If you've experimented with electronics for very long, I'm sure you're familiar with General Instrument. Well, its Microelectronics Division has spun off and does business as Microchip Technology, Inc. Microchip has announced a Digital Signal Processor (DSP) in CMOS that has some impressive performance figures.

A DSP takes a digitized signal and performs a mathematical operation or series of operations on that signal and then outputs the result. Since the DSP is basically a specialized microcomputer (or set of microcomputers). The range of operations that can be performed on a signal is incredible. For example, DSPs make speech synthesis and recognition a much less complex task.

The DSP320C10 is its first low-power CMOS digital signal processor. The CMOS device is pin-for-pin compatible with the industry-standard DSP32010.



NEC UPG107B/P MMIC Switch

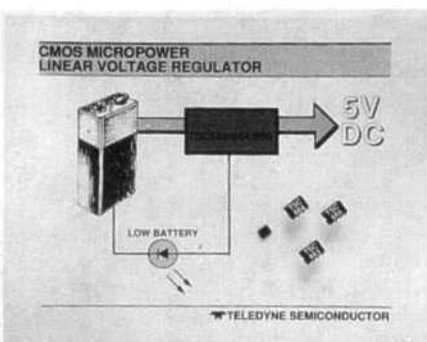
The specialized microcomputer combines a high-speed controller and an array processor for rapid processing of numerically intensive applications.

Onboard the DSP320C10 is a 32-bit ALU, a 16 x 16 parallel multiplier, 16 I/O channels, a 65 Mbit/s, 16-bit data bus, and 1.5 k x 16-bit ROM...a lot of power on a single chip. According to Microchip, this power allows the part to perform the multiple functions often required of an application. For example, the DSP32010 could enable an industrial robot to synthesize and recognize speech, sense objects with radar or optical intelligence, and perform mechanical operations with digital servo loops.

This sounds like a fun chip to play with! It comes in either a 40-pin DIP (in plastic, ceramic, or CERDIP), or a 44-pin PLCC. Get more data by contacting Microchip Technology, Inc, 2355 W Chandler Blvd, Chandler, AZ 85224-6100, or phone 602-963-7373.

Low-Cost Voltage Regulators

Teledyne Semiconductor claims to have optimized its wafer fabrication for CMOS analog ICs. By doing so, they are able to reduce prices by 15%. Sounds like a good deal for experimenters!



The new regulators are the TSC663, TSC664, and TSC666. Battery-powered applications are where the TSC663 positive regulator, and TSC664 negative regulator will find a perfect niche. They have a very low standby current, and a shutdown pin. In shutdown mode, they draw a quiescent current of less than 12 microamps. With no external components, they operate at ± 5 volts. Two external resistors program the regulators to any voltage between 1.3 and 16 volts. The TSC666 adds a low-battery detection circuit to the TSC663, and has a handshake signal to alert other circuitry of the impending power failure.

The regulators are pin-for-pin replacements for the Intersil ICL7663 and ICL7664, and Maxim's MAX663, 664, and 666. You can get the regulators in either 8-pin plastic mini DIPs or in SOIC packages. They should be priced under $2. Data can be obtained from Teledyne Semiconductor, 1300 Terra Bella Avenue, Mountain View, CA 94039-7267, or phone 800-888-9966.

Bits

High-Voltage Multilayer Ceramic Chip Capacitors

The new Type 12C High Voltage MONOLYTHIC® Multilayer Ceramic Chip Capacitors (in voltage rating from 500 to 2500 V dc) are available from Sprague Components Group.

These chips capacitors are designed for surface-mount or hybrid circuits in high-voltage applications. Features include EIA characteristics COG and X7R and capacitance range from 10 pF to 0.68 μF.

Type 12C capacitors are available taped and reeled or in bulk packaging. For information on pricing and delivery contact Francis E. DeBlois, Marketing Communications Manager, Passive Components at 508-339-8900 ext 320 or write Sprague Technical Literature Services, PO Box 9102, Mansfield, MA 02048-9102. Catalog available.