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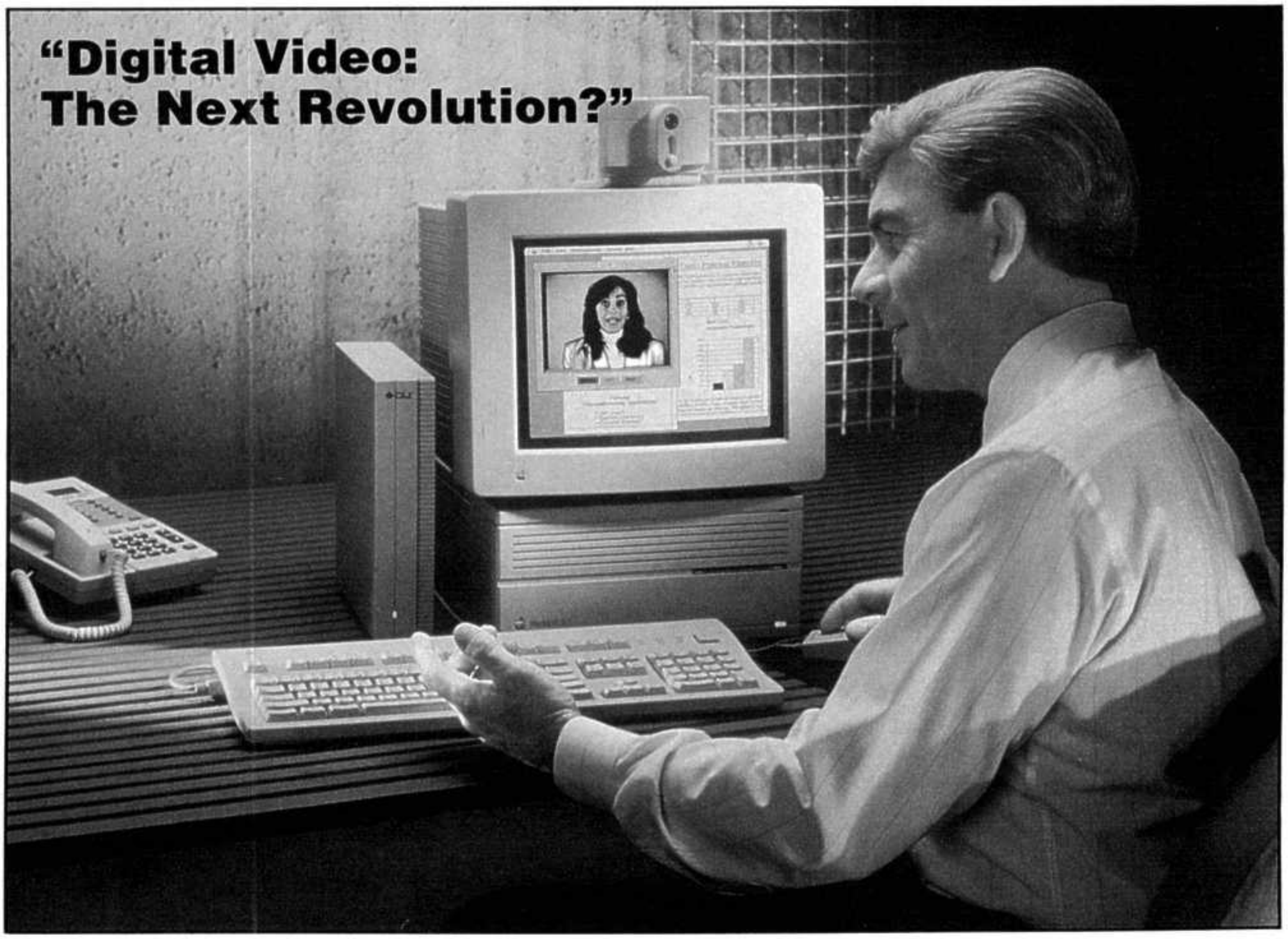
NOVEMBER 1992



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About the Cover:

Is digital video the next revolution to hit Amateur Radio? Someday we may all be doing "eyeball" QSOs! See John Champa's article on amateur digital video on page 3.

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THE AMERICAN RADIO RELAY LEAGUE

The American Radio Relay League, Inc, is a noncommercial association of radio amateurs, organized for the promotion of interests 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 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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Purpose of *QEX*:

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 doubled spaced. Please use the standard ARRL abbreviations found in recent editions of *The ARRL Handbook*. Photos should be glossy, black and white positive prints of good definition and contrast, and should be the same size or larger than the size that is to appear in *QEX*.

Empirically Speaking...

Help! CELP!

One of the forefronts of modern technology is the work being done in speech compression. For many years, much transmitted speech has been digitally encoded. The telephone network makes great use of digital encoding, for example, in part because it makes multiplexing of signals easier. Originally, digitized speech was sent at 64 kbit/s. But as digital techniques improved and as a better understanding of the characteristics of speech evolved, the rate at which communications-quality speech could be sent has steadily dropped. This reflects the fact that there is much redundant information in a speech signal.

Various speech-coding techniques have found favor over the years as technology has improved, and the one which has seen the most development recently is Code-Excited Linear Predictive encoding: CELP. The technical basis for CELP is interesting in itself, although we won't go into it here. (See "CELP High-Quality Speech Processing for Packet Radio Transmission and Networking," by A. Langi and W. Kinser, VE4WK, in the *Ninth Computer Networking Conference* proceedings.) Of more immediate importance is the existence of US Federal Standard 1016, which defines a 4800 bit/s CELP standard. The availability of a standard makes it likely that we will see commercial CELP implementations. But it also means that there is a well-defined system that amateurs can implement for our own use. Most of the focus of commercial implementation of FS 1016 is on real-time speech encoding and decoding. This is also of interest to amateurs, of course. But real-time CELP systems require significant processing speeds—speeds available from DSP systems and high-end computers.

There is no reason why amateurs shouldn't pursue real-time CELP systems, of course. But it is unfortunately true that we have no national amateur network capable of transmitting even a single real-time 4800-bit/s channel, much less the multiple channels needed to support digital voice as a general amateur network capability. In fact, most local networks can't support 4800-bit/s operations. But that doesn't mean that CELP isn't of interest to hams. There is no *requirement* that CELP encoding and decoding be done in real time. It is perfectly feasible to capture a file of audio using one of the many low-cost personal computer audio systems—built in or add-on—and then convert it to a (much smaller) file of CELP-encoded data. You then can transmit that file using our non-real-time network and decode it at the far end into an audio file suitable for "playing" on the PC sound system.

Such an approach would serve two purposes. First, it would add an exciting application to our existing packet network capabilities. Store-and-forward voice has many applications, as demonstrated by the explosion of voice-mail systems in offices and businesses. The second point of this approach is that if CELP implementations exist in the amateur world, there will be a natural pressure to upgrade them to real-time systems and construct a network capable of handling real-time voice. This might be labeled the "Network of Dreams" approach: if you code it, they will build. Not coincidentally, a

Continued on page 19

The New Age of Amateur Television: Amateur Digital Video

By Dr. John Champa, K8OCL
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The fact that most of the world of communications, both amateur and commercial, is "going digital" comes as no surprise to informed radio amateurs. The advantages to be gained by digitalization open up new, previously undreamed of capabilities, the most obvious of these being packet radio. This is merely the beginning of a long and increasingly rapid process of change in electronic communication. Digital signal processing (DSP) has an impact on equipment design; several products incorporating this technology have already appeared in the amateur market. This article explores much deeper into the digital world: not just the digitalization of data or text as in packet radio, but the transmission and reception of digitized motion images. This is a new form of Amateur Television (ATV) which is far more efficient, both in terms of spectrum use and power density, than its conventional analog relative. Just as SSB seemed much different than AM voice when you first experienced it, this new mode seems strange at first. In the same manner, it won't take long to realize the tremendous practical advantages of the new approach. Seeing the person with whom you're talking on the air won't be difficult. It's called digital video, and because the simplified approach suggested here is aimed at radio amateur experimenters, it is referred to as Amateur Digital Video, ADV for short.

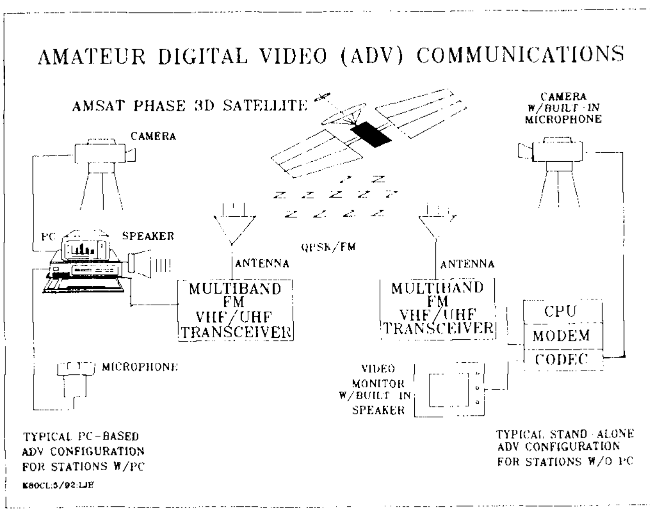
Background

The planning to construct the AMSAT Phase 3D Satellite, an advanced communications OSCAR in high-earth orbit, includes providing a wide bandwidth digital transponder with the capability of handling traffic in the range of 64 kbps or possibly higher speeds.

The use of Amateur Digital Video (ADV) communications is based on a device known as a coder/decoder, or simply a "codec." Progress in the areas of DSP and digital communications technology would eventually make compressed motion digital video communications possible. The availability of efficient and economical codecs has significantly accelerated developments. Such a codec, with the appropriate modem, could be used to digitize the motion video output from any standard baseband video such as NTSC, PAL, or SECAM source (the codec can be equipped to accept varied video inputs yet still permit communications compatibility), such as a home video camera or video cassette recorder (VCR) for a terrestrial digital video transmission on a suitable UHF band, or uplinked to the future AMSAT Phase 3D Satellite to span the continent. This codec could also take an incoming digital video motion signal from your receiver or downlink system and convert it to an analog video motion signal for display on any appropriate monitor.

Using digital video compression techniques such as vector quantization (VQ) or the newer discrete cosine transform (DCT) technology, or some combinations of both VQ and DCT, excellent communications-quality motion video can be achieved from digital speeds of 1.5 Mbps down to as little as 64 kbps. This need not be a monochrome, or black and white, image. By employing color sub-sampling compression algorithms, a color image suitable for interpersonal communications can be achieved while using as little as 20% of the available bandwidth for color information.

Digitized motion video can be taken from its uncompressed digital form requiring a data rate of approximately 90 Mbps down to a rate of 64 kbps. This makes for far more efficient transmission between ground stations, or between ground stations and a spacecraft, than conventional analog television. Current techniques, even at these tremendous compression ratios, provide acceptable color contrast and image resolution with moderate



motion compensation capability. Anticipated production of higher performance custom microchips for digital video such as the Vision Processor from Integrated Information Technology (IIT) promise even better image quality in the months and years ahead. The current line of IIT microchips perform well above the 50 Mips level, resulting in more than 2 Gops! More importantly for radio amateurs, the continued use of very large scale integration (VLSI) technology in chip production means a rapid decline in equipment cost. This will make experimentation, and later ADV development, less expensive.

This rapidly declining cost cycle has been the trend in digital video compression over the past few years. The net result has been a steady reduction in digital bandwidth requirements and equipment cost, while the motion image quality level has improved considerably. We are now quickly approaching the development stage where a simple codec system is starting to come within financial range for hams. Certainly, long before the launch of the AMSAT Phase 3D Satellite, now scheduled for the 1995-1996 time frame, we should literally begin to see many developments in digital video transmission. For example, ADV would provide acceptable signal-to-noise ratios and link margins for amateur ground stations without the need for the excessive power levels needed for even low earth orbit activities such as during the SAREX space shuttle video reception tests. This is an important consideration when planning future amateur activities from the space station. ADV could also provide a type of terrestrial video communication which is considerably more spectrum efficient than analog ATV. Schools, and other interested parties, could use an even simpler and less-expensive decoder (ie, receive only) unit.

Face-to-Face Contacts

Meeting face-to-face provides the most effective means of interpersonal communications. The apparent reason for this, as amateurs working in the visual modes are well aware, is that a great deal of the communications between two individuals is non-verbal. This important observation is one of the driving forces behind the explosive growth in the use of digital video teleconferencing by business. Developments in the area of very large scale integration (VLSI) and digital video compression technology are approaching the stage where radical changes in the economics of the situation are about to take place.

The day of the video telephone for interpersonal communications, envisioned long ago, has now arrived. Recently AT&T released a product called the Videophone 2500. However, this is an analog device using a codec which is compressing the video to an extreme degree (9.6 kbps) so that a modem can send it over analog telephone lines in the home. The effective frame rate is only about one frame per second. Amateurs can readily use a similar codec operating with different software at 64 kbps or higher speeds to obtain a much higher frame rate and fewer digital video artifacts. Even at digital bandwidths of 64 kbps, frame rates of 8-10 per second are feasible. A common frame rate at a digital video speed of 384 kbps is 30 per second, a rate similar to conventional television, in which even fewer artifacts are observed.

What Are Artifacts?

Because we are examining motion digital video and not analog television, it is necessary to discuss new terminology regarding image quality. The currently accepted P0 through P5 numerical measurement to describe the subjective quality of analog television is not adequate for this purpose. Although no similar numerical measurements are widely accepted for digital video, terms are developing to describe perceived distortions. The most common of these are: loss of sharpness, granular noise ("the dirty window effect"), motion judder, busyness around edges ("mosquito noise"), appearance of block boundaries, and chroma bleeding. A codec can be informally evaluated by the extent to which these artifacts are observed.

What Is Digital Video?

You have been watching a wide bandwidth form of digital video for years and may not have realized it! As mentioned earlier, to digitize an analog video signal takes about 90 Mbps. The national TV broadcast networks take this digitized video signal, compress it 2:1, and broadcast it to their affiliated stations. The digitalization and compression of television broadcasts allows networks to send their programming over special terrestrial circuits that handle the resulting 45-Mbps digital video signal. Digital video compression at this level, when converted back to analog, retains all of the characteristics of the original NTSC video.

And you're about to see a lot more digital video! The high definition television (HDTV) currently under industry development and FCC review for the consumer entertainment television broadcasting field is essentially a form of high-bandwidth digital video. Commercial direct digital video satellite broadcasting of movies and other forms of video entertainment to the home is under development by companies such as Compression Lab, Inc. (CLI). The system uses digital video bandwidths of 2.9 to 6.6 Mbps and dish antennas as small as 0.75 meters (about 30 inches across). Serious consideration is being given to replacing conventional private analog business television (BTV) broadcasts, generally via commercial Ku-band satellites, for university educational seminars, product announcements, training programs, etc, with digital video broadcasts, either via terrestrial commercial fiber optic lines or via commercial satellite. This approach allows companies to put as many as 12 channels of video on one commercial satellite transponder. If video signals are further compressed, say by a factor of 60:1 to 1.5 Mbps, there is still more than sufficient quality remaining to use digital video for relatively economical business two-way communications via a special digital circuit called a T1. This current method allows commercial organizations to hold group meetings without having to travel to distant locations. True, you would probably not want to use this highly compressed digital video medium for sending images of a fast action football game, but for purposes of meetings and presentations, it's more than adequate. Further developments in data compression techniques have allowed for the commercial use of digital video bandwidths down to 384 kbps, and recently, even to 128 kbps while still maintaining excellent image, color and voice quality.

The Advantages to Amateurs

Although these developments are impressive from a commercial perspective, they do not presently provide many alternatives for amateurs. However, amateurs are very resourceful and deal effectively with reduced quality of communications to put a new technology to use in an affordable manner. Recent developments to reduce the digital video bandwidth to as little as 64 kbps for commercial Integrated Services Digital Network (ISDN) video telephony start to look promising for amateur hardware applications. (ISDN is a new class of digital telephone line that is becoming widely available in Japan and will soon be available in the US.)

At the bandwidth of 64 kbps, the video image quality is significantly reduced as compared to standard television (NTSC, PAL, or SECAM), but it is far superior to the consumer video phone and is more than adequate for most amateur two-way motion video communications. More importantly for the Amateur Satellite Service, future OSCAR satellites may be able to transpond such a signal. Because of bandwidth and signal-to-noise requirements of present ATV analog signals, it is not feasible for any currently envisioned amateur satellites to transpond these signals. Even ATV communication with the space shuttle requires "big gun" ATV stations. Digital video techniques must be used for the average amateur to become involved with video space communications using moderate power levels and reasonably sized antennas. According to Dr. Karl Meinzer DJ4ZC, President of AMSAT-DL, based on a guideline of 350 bps per watt effective isotropic radiated power (EIRP), approximately 64 kbps are achievable on the planned semi-geostationary, high-altitude AMSAT Phase 3D satellite. By using quadrature phase shift keyed (QPSK) modulation, such a transponder would probably be suitable for ADV purposes. The Tele-Tech Corporation 9211 Series of QPSK Modulator/Demodulator devices is the hardware currently being investigated by the author for this application. This is the type of device that will be incorporated into the next generation of digital audio cellular telephones, replacing the current FM systems.

It is possible that by the time the AMSAT Phase 3D satellite is launched, acceptable digital video compressed down to a bandwidth of 19.2 kbps may be possible. Although this is twice the speed of the highest amateur satellite communications accomplished to date, it is only about one third of the digital transponder bandwidth now considered feasible for the AMSAT Phase 3D Satellite. This means that three digital video transmissions with frame rates of approximately 2 to 4 frames per second could be handled at the same time. Alternatively, the codec speed could be increased to 64 kbps for an ADV bulletin broadcast at 8 to 10 frames per second. When not being used for ADV, the transponder could handle packet radio trunks, or other high-speed digital traffic. There are tremendous possibilities in the amateur satellite community for technology that allows handling of motion video signals digitally. Not only would two-way digital video contacts via amateur satellite be possible in the future, but long duration connectivity via digital video with the space shuttle/space station relayed through the AMSAT Phase 3D Satellite for educational activities could also become a reality. An ADV team at an emergency site, with not much more gear than presently used by PACSAT and other packet radio operators, could transmit color motion digital video of the disaster to all suitably equipped sites on the satellite downlink across the country, greatly facilitating the shipment of the most appropriate relief supplies and assistance. The possibilities are numerous when you can see what it is you're talking about!

The Economics

Codec manufacturers are introducing models of PC-based codecs that operate satisfactorily at 384 kbps and currently sell for about $2,000 US (excluding the PC). These prices are still beyond the amateur market, but they are far less than half what they were last year. As all of you who may have purchased a 2400-baud modem long ago for nearly $1000 US well know, that's not the end of the story. Prices drop quickly once a product is accepted and is in wider use in the market place.

When the codec chips and chip sets become more available they are expected to initially sell for approximately $400 US. These prices will fall as supplies become plentiful, other manufacturers enter the market, and the initial supplier has recouped its research investment. Digital video codecs that are PC-based are already on the market, and video telephones began to make an appearance on the consumer scene in June 1992. Further along, it is likely that a codec-on-a-chip, which will make PC-based systems and video telephones even more economical, will be introduced. The Amateur Radio video experimenter will have plenty of options from which to choose.

These factors, coupled with the new international standards developments relating to digital video telecommunications (eg, CCITT H.261) are quickly combining to continue to drive prices rapidly downward. By the time the AMSAT Phase 3D Satellite is launched, a card that can be inserted into an expansion port on your PC probably will be available. This card, connected to a suitable modem and with appropriate modification of an FM transceiver for wider IF filtering, will enable the sending and receiving of motion color digital video transmissions from a suitably equipped future amateur satellite such as the AMSAT Phase 3D or for terrestrial communications. The codec output would be converted for display on your computer monitor (RGB). By connecting a home video camera or other NTSC, PAL, or SECAM video source such as a VCR, the video could be digitize and uplinked to the AMSAT Phase 3D satellite or beamed across the country-side to meet with friends many miles away for a two-way motion and color ADV contact. Remember, the much narrower bandwidth of ADV (possibly less than 0.5 MHz at 384 kbps) as compared to analog ATV (approximately 6 MHz) will allow for a much higher power density and significantly greater range, all other factors being equal. It also reduces the demands on other station equipment, eg antenna forward gain need not be sacrificed for the purpose of getting wide bandwidth, etc. Furthermore, the digital video speed or bandwidth could be varied to accommodate the signal-to-noise ratio available over the particular link being used for the communications. As long as the stations at both ends of the path are operating at the same digital speed (and using the same compression algorithm), they will continue to see each other. For example, if you have an ADV colleague who lives only across town and there is plenty of signal margin, you may wish to use an ADV speed of 384 kbps so that the images you each see appear more similar to TV. Correspondingly, if another friend lives several counties over or if you're operating through a future OSCAR digital transponder, you may need to reduce the speed to 64 kbps for improved signal to noise ratio. The image quality will be less depending on the lower bandwidth selected, but you can maintain a contact that otherwise might not have been possible. The operating technique would be something similar to switching in a tighter receiver filter to pick the weak signal out of the noise that you could barely hear, or not hear at all, with a wider IF passband filter.

Where Do We Go From Here?

Obviously much more research is needed, but the basic preliminary design of an amateur digital video system has been completed. Two configurations are currently being evaluated. One of these is a PC-based codec design while the other is a stand-alone unit having its own combined CPU, codec, and modem unit. Hardware work has started and discussions are underway with a commercial manufacturer of Amateur Radio equipment regarding the possibilities of producing an economical product. That doesn't necessarily mean that you can expect to see the first ADV product released at the next Dayton HamVention, but you can rest assured ADV is not in the too distant future for amateurs.

Summary

Amateur Digital Video (ADV) contacts could be made possible by a suitably equipped AMSAT Phase 3D satellite, while the terrestrial use of ADV instead of analog ATV would vastly improve spectrum efficiency. This would allow far more users to be accommodated in the increasingly popular 440 MHz, 900 MHz and 1.2-GHz video band segments. Some amateurs have noted that 64-kbps ADV could even be legally operated on the 222-MHz band or other amateur bands where high data rates are permitted. Once the feasibility, efficiency, economy and DX capability of Amateur Digital Video is demonstrated, existing analog ATV operations will go the way AM voice communication went when SSB was introduced. More importantly, it would be possible to have a wide area digital ADV telecast via the AMSAT Phase 3D satellite for Amateur Radio video bulletins and educational purposes. Amateur Digital Video from the space shuttle or the space station could be uplinked to an OSCAR for viewing directly by hams, ADV satellite gateway stations, and schools. You could even store images of your favorite QSO or your best ADV contact on your computer's CD-style hard disk for viewing later. Such a 3- to 5-inch disk should be able to hold almost 3 hours of video. This could give a whole new meaning to, "see you on the bands!"

Note

CDV is a trademark of Compression Labs, Inc.

John Champa, K8OCL, holds an Advanced Class license and has been licensed for over 30 years. He is employed by the Unisys Corporation, a major international producer of commercial and governmental information systems, as the Manager and Chief Engineer of the Unisys worldwide video teleconferencing network. He is a certified Master Engineer by the National Association of Radio and Telecommunications Engineers (NARTE). John is also the editor of OSCAR Satellite Report *and* Satellite Operator, *two leading publications in the Amateur Radio space communications field. In addition to being a life member of both the ARRL and AMSAT-NA, John is a Technical Advisor (TA) for the League. When not pursuing his telecommunication interests, he enjoys hunting, fishing, boating, and camping with his family in the Michigan wilderness. He also finds time to write about his adventures in the outdoors.*

Bibliography

1. Ackroyd, Brian. *World Satellite Communications and Earth Station Design.* Boca Raton: CRC Press, 1990.
2. Bishop, Clarke. "Compressed Digital Video Technologies For Business Television Applications." *ITCA Teleconferencing Yearbook* 1991.
3. Champa, John, and Todd Maxwell. "Motion and Color Video Via the Phase 3D Satellite: Replacing ATV with ADV—A Status Report." *Proceedings of the AMSAT-NA Ninth Space Symposium.* Newington: ARRL, 1991.
4. Freeman, Roger L. *Radio System Design for Telecommunications (1-100 GHz).* New York: Wiley, 1987.
5. Green, William B. *Digital Image Processing: A Systems Approach.*

New York: Van Nostrand Reinhold, 1983.
6. Gibson, Jerry D. *Principles of Digital and Analog Communications.* New York: Macmillan, 1989.
7. Jayant, N. S., and Peter Noll. *Digital Coding of Waveforms: Principles and Applications to Speech and Video,* Englewood Cliffs: Prentice-Hall, 1984.
8. Lee and Messerchmitt. *Digital Communication.* Kluwer Academic Press, 1988.
9. Lookabaugh, Tom. *Compressed Digital Video (CDV): A Technology Overview.* San Jose: Compression Labs, 1992.
10. Lynch, Thomas J. *Data Compression Techniques and Applications.* New York: Van Nostrand Reinhold, 1985.
11. Muskat, Lynn M. "Standards Development for Transmission of Video and Audio via Satellite." *Telecommunication Magazine,* Dec 1989.
12. Netravali and Haskell. *Digital Pictures: Representation and Compression.* Plenum Press, 1988.
13. Prentiss, Stan. *HDTV: High-Definition Television.* Blue Ridge Summit: Tab, 1990.
14. Ransom, Carter S. and John Champa. "The Integration of Digital Video Teleconferencing and Business Television at Unisys Corporation: A Case Study." *ITCA Teleconferencing Yearbook,* 1991.
15. Rorabaugh, C. Britton. *Communications Formulas & Algorithms For System Analysis & Design.* New York: McGraw-Hill, 1990.
16. Thomas, Graham. "HDTV Bandwidth Reduction Using Motion Compensation and DATV." *SMPTE Journal* Feb 1991.
17. Tynan, Bill. "Manned Space—Future Prospects." *Proceedings of the AMSAT-NA Ninth Space Symposium.* Newington: ARRL, 1991.

A Multi-Mode Computer/Radio Interface

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Introduction

The best way to learn about the Amateur Radio digital modes is to build the hardware required to interface a radio rig to a computer, then write the software to make the system work. It is, of course, much easier to go out and buy a multi-mode TNC, plug everything together, and turn it on. If one considers the time involved in building hardware and writing software, buying a TNC again looks attractive. One must decide whether the time invested is worth the knowledge gained.

This article describes a project I undertook to interface an older Z80 (IEEE 696 bus) computer to a radio system. There are probably many such computers gathering dust out there; this article describes how to put one back into use in the "shack." More importantly, the circuits and software techniques described can be adapted to other computers with a little work. Only the bus interface is machine-specific in this article, and the software algorithms are presented in flowchart form so that other experimenters can adapt the techniques to their specific machine and favorite programming language.

Design Goals

I desired to build a single interface board which would allow the computer to display Baudot and ASCII RTTY, AMTOR, and packet data from a radio receiver. A tuning indicator providing either a bar-graph display similar to commercial TNCs or an on-screen equivalent was desired.

Since the reception of the various modes was considered (by me) to be a more difficult problem than transmission, I opted to build only limited transmit capability into the board for the time being; circuits for controlling a transmitter would be easy to add later, as needed.

The Hardware

A block diagram of the interface board is shown in Fig 1. Audio signals going in and out of the radio interface are AC-coupled and buffered with op amps. The audio input is protected from overvoltage conditions with a passive diode clipper, and the audio output is protected against short circuits with an in-line resistance.

[1]Notes appear on page 17

Buffered audio inputs and outputs are tied to the modem, an Advanced Micro Devices AM7910 modem chip. The use of this modem chip for Amateur Radio is described in an article by Ward.[1] Logic-level data is passed between the modem and a Zilog Z8530 Serial Communications Controller (SCC). The SCC is a flexible serial communications device which has the ability to receive packet, (synchronous) data as well as asynchronous serial data for Baudot and ASCII RTTY.

A note to those desiring to build a similar circuit: obtain the data sheets for the AM7910 modem IC and the Z8530 SCC.[2,3] In the case of the Z8530 especially, having complete data is essential in understanding both how to properly connect it into your circuit and, just as important, how to program it properly for a given mode of operation.

AMTOR reception is readily achieved by simply using the SCC to generate a clock to drive a couple of flip-flops for sampling the incoming serial data and providing a CPU interrupt interface. Software can then be used to decode and display the AMTOR data.

The tuning indicator uses an XR2211 FSK demodulator IC to generate error and reference voltages which are buffered by op amps and used to drive a pair of LM3914 bar graph indicator chips. The bar graph ICs can be used to drive LEDs, or resistors can replace the LEDs and an 8255 parallel interface chip used to allow the computer to read the LED bits and generate a CRT display for tuning.

Several logic and bus-buffer ICs for the IEEE-696 bus interface to allow communications between the system Z80 CPU and the radio interface over the backplane. The logic determines whether the I/O address of the board is present on the backplane address bus, and if so, whether an I/O read or write operation is being performed by the CPU. If the board address appears and an I/O operation is performed, access to the Z8530 or 8255 is allowed by the data bus buffers. This circuit can be varied to suit a reader's particular computer system without difficulty.

Power is provided by on-board linear regulators. One 7805 linear regulator provides +5 V for the bus interface logic, SCC, and modem ICs, and op amps, while another provides +5 V to the tuning indicator and LEDs. One 7905 linear regulator provides –5 V for the modem IC and buffer op amps.

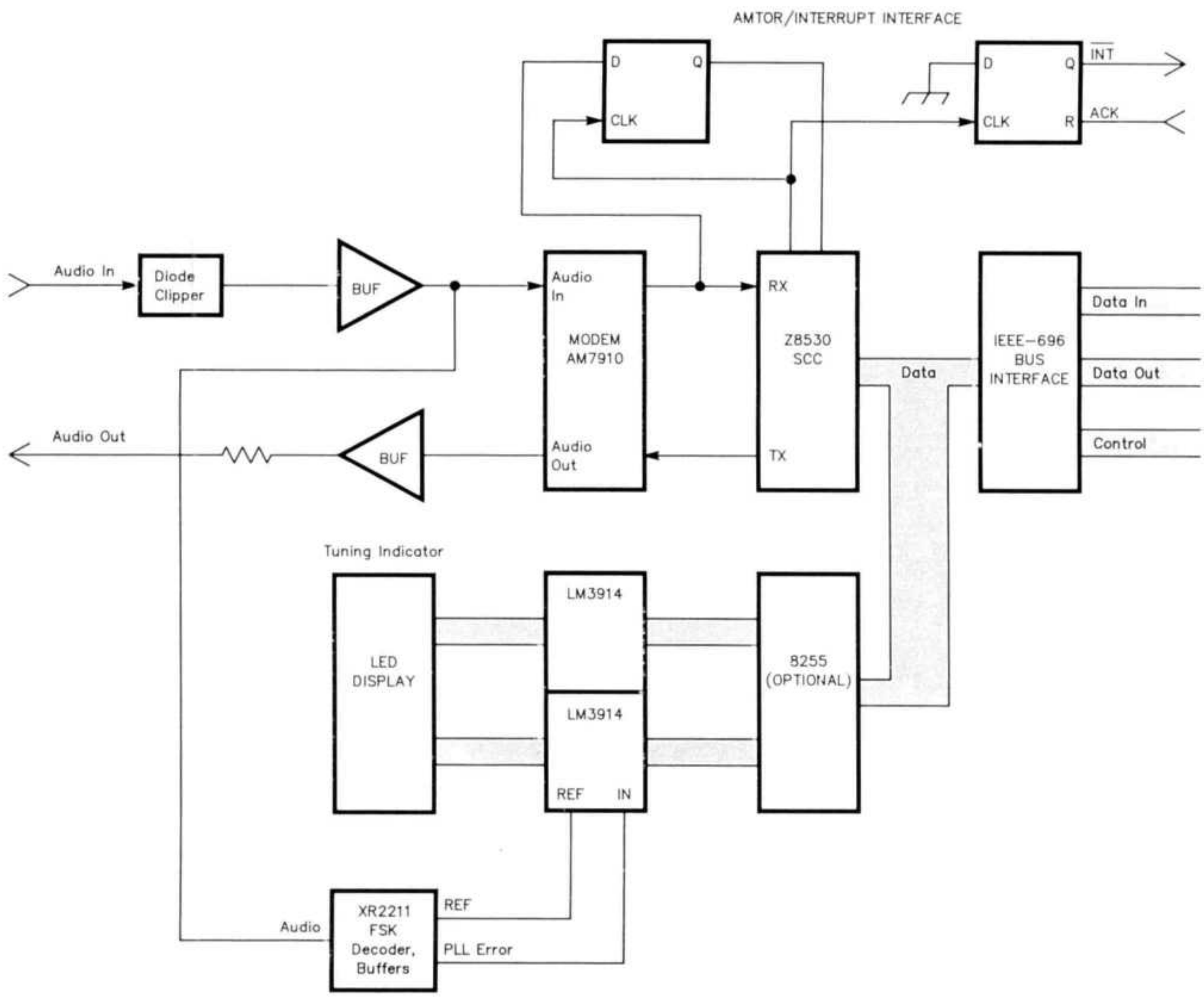

Fig 1—Computer/Radio Interface—Block Diagram

The schematic for the interface board is shown in Figs 2 through 6. I used wire-wrap techniques for constructing the board. Component placement was not particularly critical, although I did keep the leads to the crystal short, used bypass caps on all IC power pins, and kept the tuning indicator circuit separated from the rest of the circuits. For test purposes, I used sockets for mounting the LED bar graph displays directly on the board. For normal operation, ribbon cable could be used to allow the bar graph displays to be mounted remotely.

The Software

Reception of Baudot and ASCII RTTY requires the least complex software. One must simply program the Z8530 for the correct baud rate and other serial parameters, then wait for characters to come along. Baudot requires the handling of shift characters and a translation table to convert Baudot to ASCII for display purposes, while ASCII requires no translation. Code conversion tables for Baudot (and AMTOR) to ASCII may be found in the ARRL *Handbook*.[4]

The 45.45 baud (Baudot) and 110.0 baud (ASCII) rates typically used for amateur transmissions are so slow that one can write a program in a high-level language without being concerned about being able to keep up with the incoming data. This is exactly what I did, using Modula-2. This language looks a lot like Pascal, and could be easily converted to Pascal. One could use a compiled BASIC if desired. A flowchart for the Baudot/ASCII program is shown in Fig 7.

AMTOR reception is more easily achieved by letting the system CPU do most of the work. A stable time base is required since AMTOR is a synchronous mode with no "gaps" between characters. The approach I used is to program the Z8530 to generate an 800-Hz sampling clock which is used to "freeze" a sample of the serial data stream and also to interrupt the system CPU to tell it to read the value (0 or 1) of the sample. Assembly language

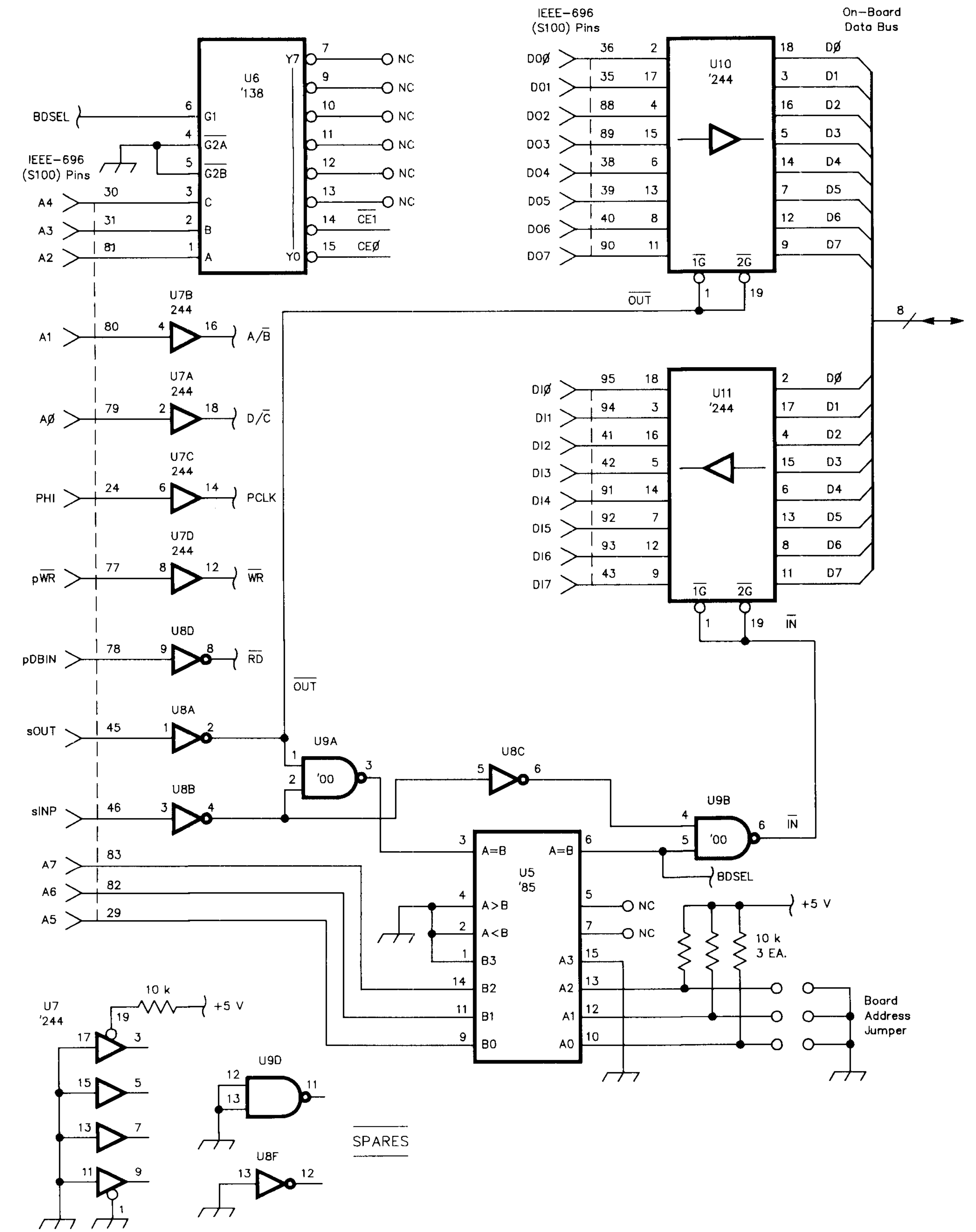

Fig 2—Computer/Radio Interface Board—Bus Interface

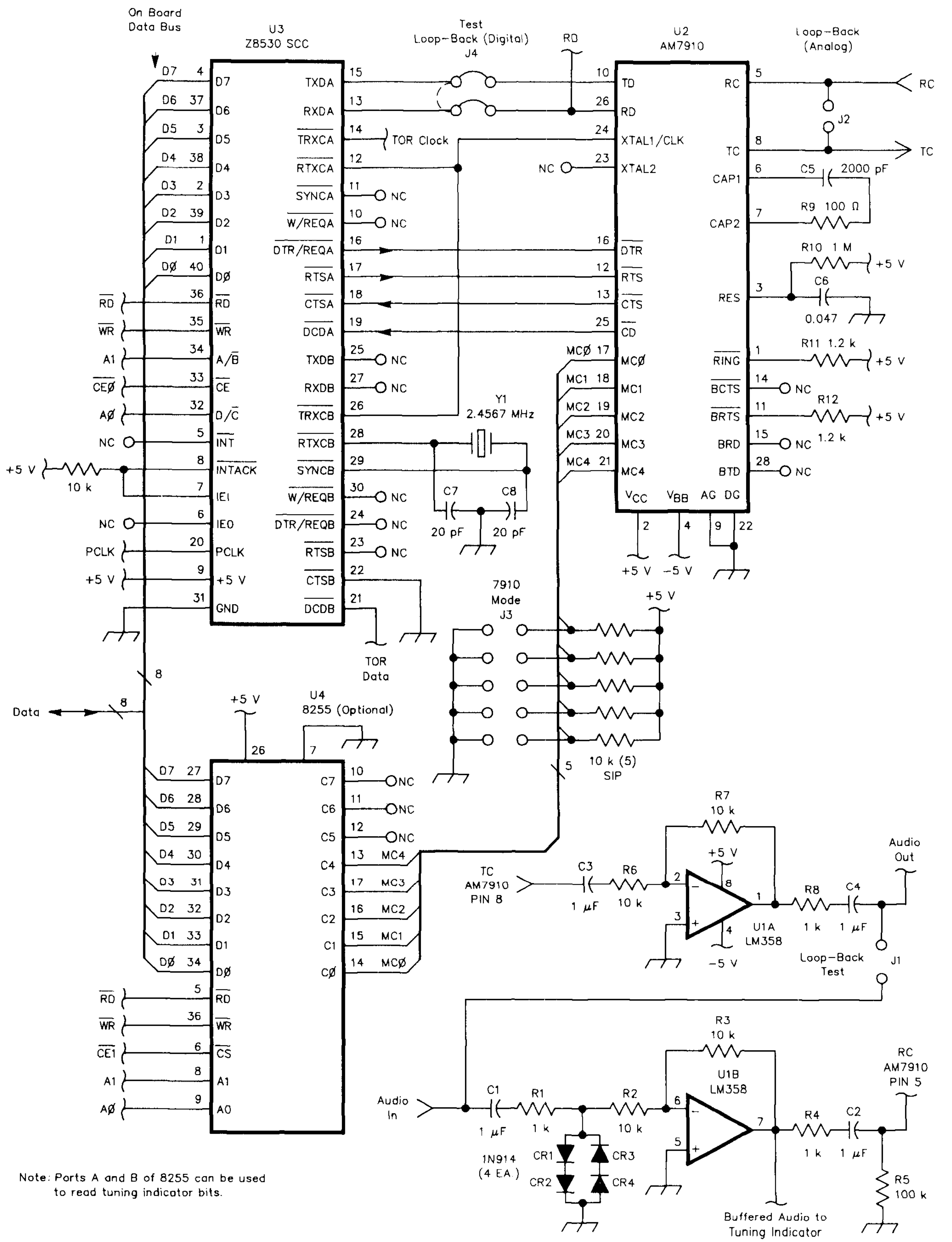

Fig 3—Computer/Radio Interface Board—SCC/Modem

was used to provide plenty of speed and easy implementation of the interrupt code.

The high-level flowchart of the FEC AMTOR program is shown in Fig 8. The computer sets up the SCC to generate the 800-Hz clock, prints an introductory message, initializes working memory, and enters a "main loop," where it waits for interrupts and user commands.

When an interrupt occurs, the CPU enters the interrupt routine, whose flowchart is shown in Fig 9. The first action after the interrupt is to read in the value of the serial data bit and store it. A "state variable" is then tested to see what action is to be taken; breaking the interrupt routine into "states" allows different things to be done at each interrupt time.

For example, the first four interrupt states, 0 through 3, are used to "debounce" the serial input and make sure a clean bit transition occurs for initial synchronization. State 4 is where the input bit is shifted into a 56-bit shift register (which exists in memory), and also where the search for sync characters and printing occurs. This state will be described in detail below.

States 5 through 11 form a software "phase-locked loop" that attempts to correct for relative drift between the sending and receiving station bit clocks. It does this by keeping track of where bit transitions occur, and adding or subtracting one interrupt time interval (⅛ bit time) to keep the transitions within an acceptable time window. During development of the program, maintaining sync throughout an entire ARRL bulletin, for instance, was next to impossible without this correction.

Note that after executing state 11, the interrupt routine executes state 4 during the next interrupt. States 4 through 11 form a cycle which lasts for one bit time under normal circumstances (when the system is synchronized). The "phase-locked loop" code can vary this time by plus or minus ⅛ bit time in order to maintain bit synchronization.

Now, back to state 4, which itself contains several

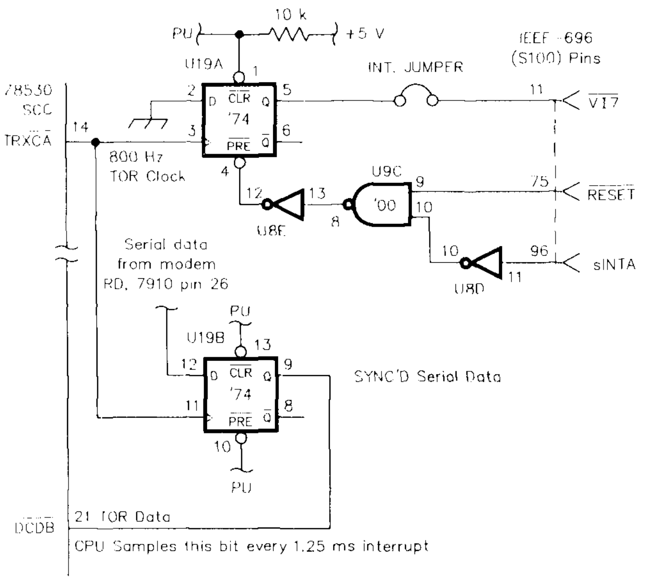

Fig 4—Computer/Radio Interface Board—AMTOR Circuits

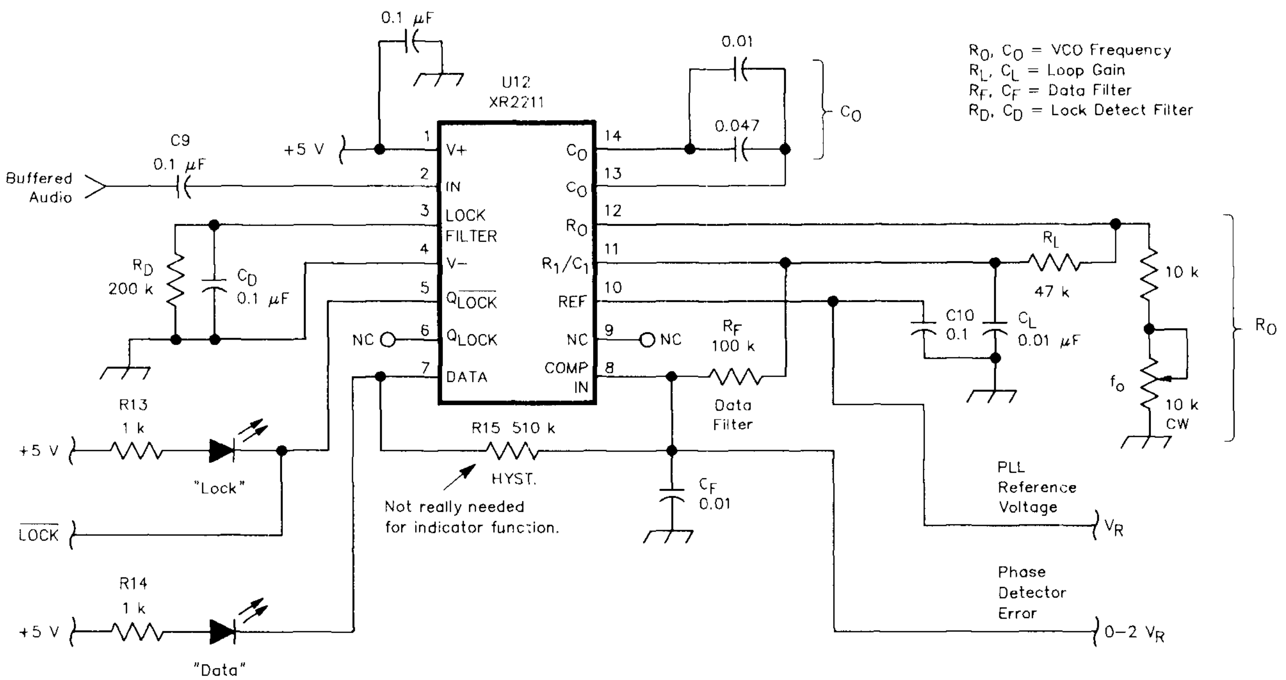

Fig 5—Computer/Radio Interface Board—Tuning Indicator

states which depend on the character-level synchronization of the system. State 4 is entered once every bit time. Immediately upon entering state 4, the value of the serial input bit is shifted into the 56-bit register. After this is done, a "framing state variable" is tested to see what action to take, in a manner similar to the high-level interrupt code.

A flowchart for state 4 is shown in Fig 10. States 0 through 5 are concerned with looking for sync characters. The algorithm is based on the description given in

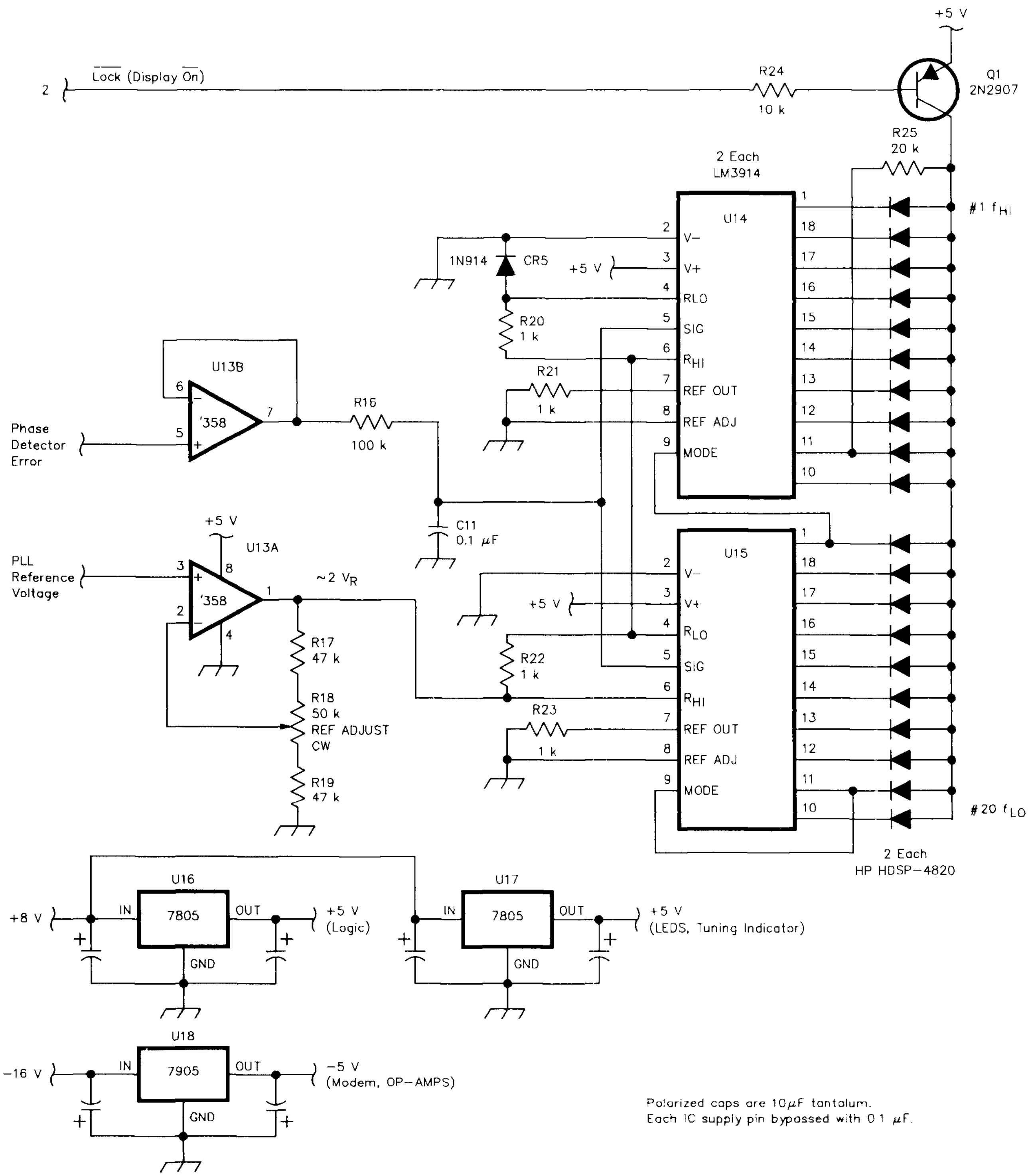

Fig 6—Computer/Radio Interface Board—Tuning Indicator

the article by Egleston.[5] It could be modified to look for spaces in addition to the sync characters, as described in the article.

Once the sync characters are received, states 6 through 19 form a 14 bit-time (2 character-time) loop which performs a table look-up operation to look for valid AMTOR characters, printing those which are valid, and indicating corrupt data (where both the DX and RX characters are bad) by printing an asterisk. The table look-up operation performs both AMTOR to ASCII translation, by using valid AMTOR codes to address the look-up table, and error detection, with all invalid inputs causing an error indicator byte to be returned.

A little more detail on the 56-bit shift register is in order, for those wishing to write their own software. The

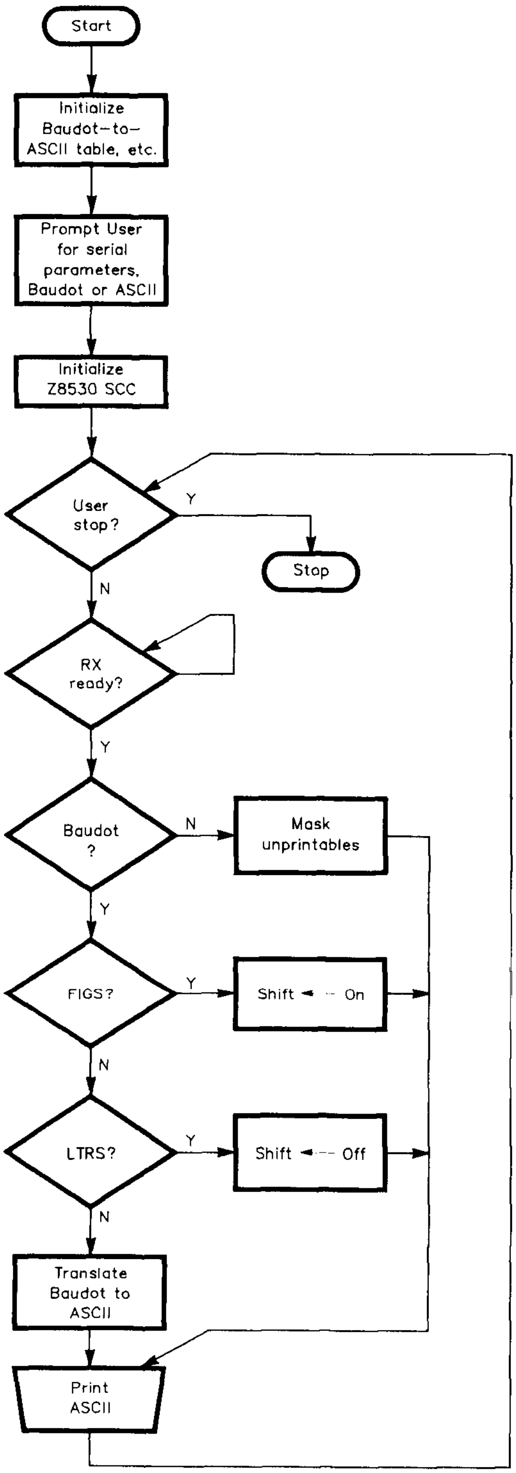

Fig 7—ASCII/Baudot RTTY Receive Program (Simplified)

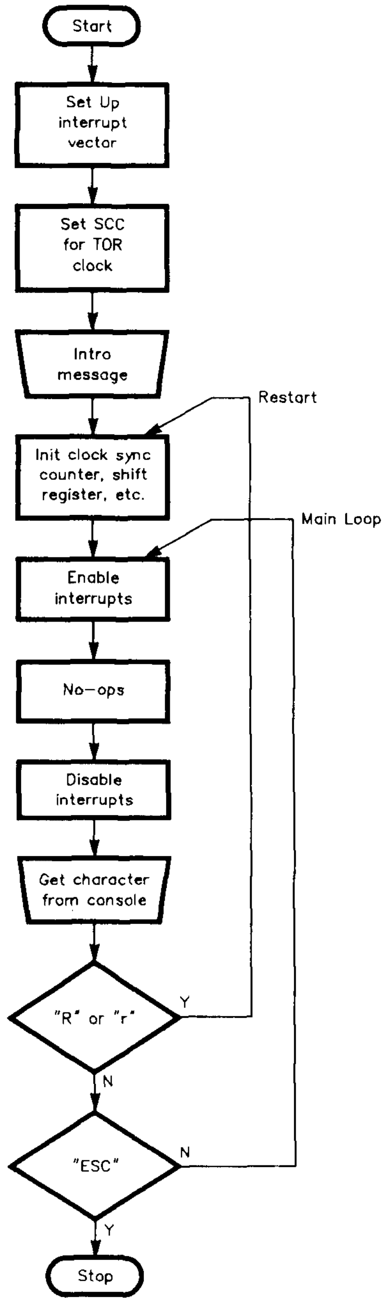

Fig 8—FEC Mode AMTOR Receive Program—Main Loop

shift register is seven consecutive bytes of memory. When a new sample bit is ready, it is placed into the carry bit of the CPU. The CPU then reads the first byte of the shift register, and rotates the byte right. The carry bit is rotated into bit seven of the byte, and bit 0 of the byte is rotated into the carry bit. The byte is written back into the shift register. The second byte is then read, and the rotate operation repeated. This places the bit 0 from the first byte into bit 7 of the second byte, and bit 0 of the second byte into the carry. Doing this in a loop for all seven bytes shifts the contents of the shift register to the right by one bit.

Implementing the shift register with a short loop is not difficult. Making use of it once implemented takes some care, however. This becomes clear if one considers a stream of seven-bit AMTOR characters being shifted through the register. The CPU can (easily) access only 8-bit bytes in the shift register, with bit 0 of the 7-bit character aligned with bit 0 of a byte (right justified). If one considers the data stream as it passes through the register, one will find that at any given time, one AMTOR character will be right justified in a byte. After one shift, the next byte in the register will contain a right-justified character. After the seventh byte, the next byte to contain a right justified character will be the first. This pattern repeats every seven shifts.

One can (and should) take advantage of this pattern in order to extract and check AMTOR characters from the shift register. For example, when the first sync character is detected in the last byte of the shift register, the CPU can simply wait for 3 shift times, then check the third byte for the other sync character.

Packet reception is also in the domain of assembly language programming. At this time, the packet reception program I am using is a modified version of a TNC debugging monitor available from Pac-Comm.[6] The source code, a hex file, and an EPROM for installation into a TNC are provided when this is purchased. I had to modify the I/O addressing used to match that of my system, but for a modest effort and little expense, I was able to receive packets easily.

For anyone else wishing to try this, please be aware that the monitor program does not contain the AX.25 protocol or a command interpreter such as you would have in an off-the-shelf TNC. It will allow you to send a beacon packet, and to display error-free packets which are received. By itself, however, the monitor will just present a jumble of packets from various stations on the screen.

The next step for the system is the completion of transmission software for the various modes and also the inclusion of AX.25 in the packet program. I have encoded the AX.25 state tables into a look-up table for use by a Z80 assembly language routine, and must complete packet assembly and analysis routines plus a command set inter-

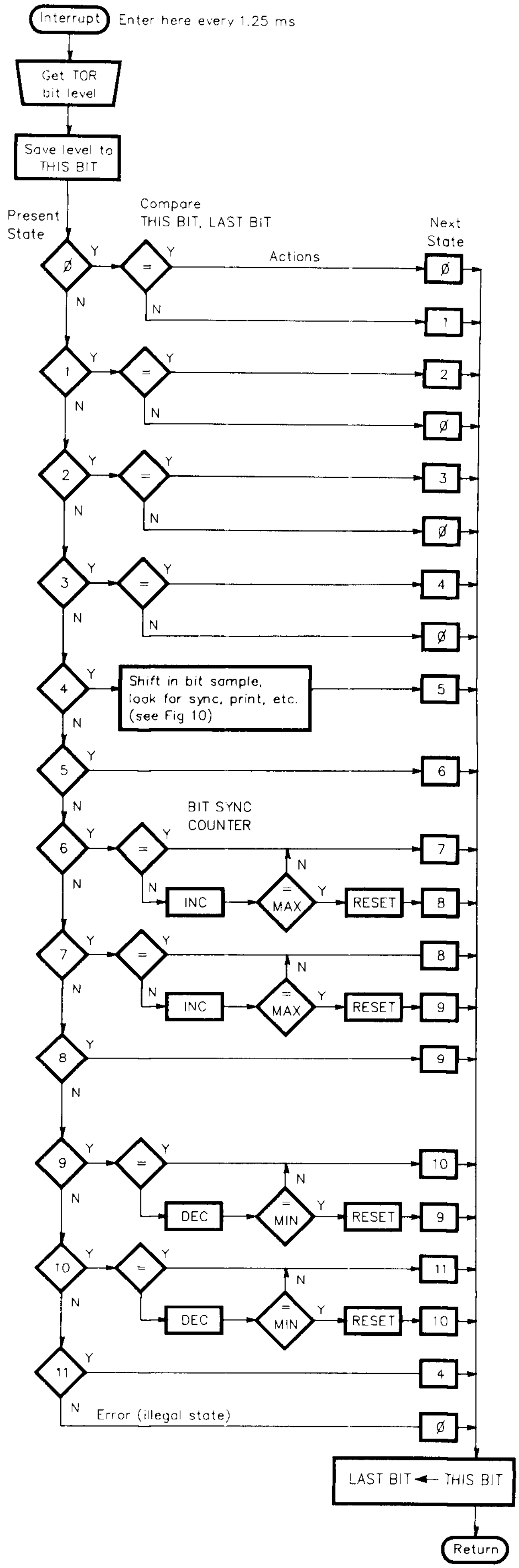

Fig 9—FEC Mode AMTOR Receive Program—Interrupt Routine

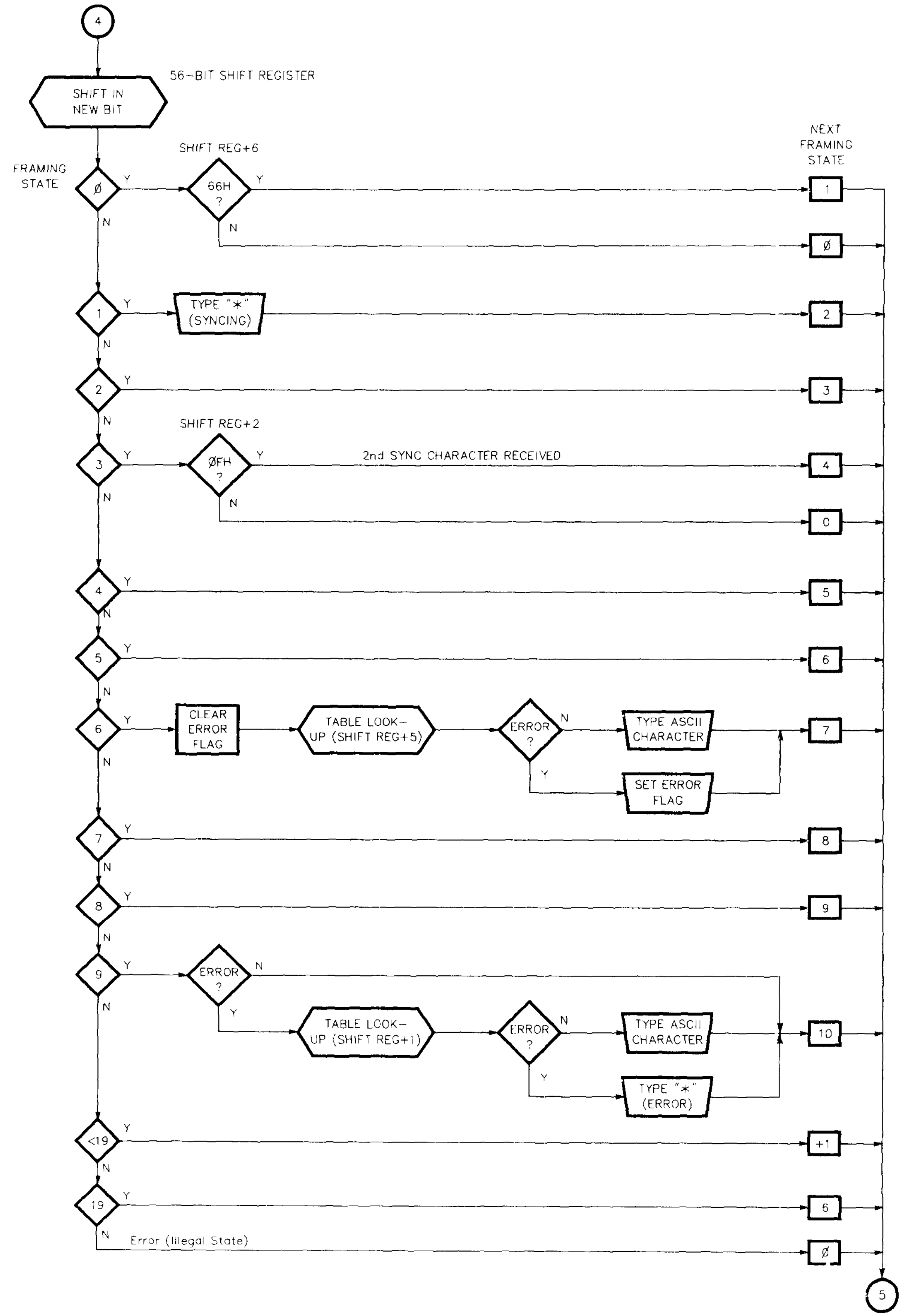

Fig 10—FEC Mode AMTOR Receive Program—Interrupt State 4 Detail

preter in order to have a TNC program written "from scratch."[7] Another approach might be to disassemble the TNC hex files available on amateur land-line bulletin board systems, change the I/O addressing, and attempt to run this "modified firmware" on a Z80-based computer.[8]

Software Availability

I have placed the AMTOR reception program on a bulletin system mentioned below (see Ref 8), so it is available as a public domain program. Please be aware that any of my programs are not "finished products" and will probably take some work to make them useful on another computer system. Anyone interested in the RTTY reception program can send a 5.25-inch, 360-k IBM-format floppy in an addressed disk mailer with sufficient return postage. If you have a CP/M system running, I can also accept an 8-inch, single-sided, single-density floppy.

Going Further

This project is indeed an ongoing one. Software improvements to be made include a complete packet program, as mentioned above, ARQ mode AMTOR reception, and transmission software for all modes. Hardware improvements include buffered and isolated transmitter control outputs, and audio filters to improve reception.

Conclusion

I undertook this project in order to learn more about the Amateur Radio digital modes and to begin equipping my station to use them. Also, it allowed me to make use of an older computer (that I spent too much money on in the early eighties!) which might otherwise sit unused. By adapting the circuits and software techniques described here, perhaps others will be able to convert an old computer into a useful station accessory.

Notes

1. Jeff Ward, "An LSI Modem for Amateur Radio", The ARRL Handbook for the Radio Amateur, 1985 edition, pp 29-15 through 29-19.
2. Advanced Micro Devices, Modem Technical Manual describes the AM7910 in detail. Available from Advanced Micro Devices, 901 Thompson Place, PO Box 3453, Sunnyvale, CA 94088-3453, tel 800 538-8450.
3. Zilog, Z8030/Z8530 Serial Communications Controller Technical Manual. Available from Zilog, Inc, 210 Hacienda Ave, Campbell, CA 95008-6609, tel 408 370-8120.
4. "Direct Printing Telegraphy", The ARRL Handbook for the Radio Amateur, 1985 edition, pp 19-10 through 19-17, and "Code Conversion", pp 19-17 through 19-20.
5. Jerry W. Egleston, Sr., "Faster Synchronizing for Mode B AMTOR", QEX 106, December 1990, pp 3 through 5.
6. Pac-Comm Radio Systems, Inc, 4413 N Hesperides St, Tampa, FL 33614-7618, tel 813 874-2980.

Correspondence

ASCII Over AMTOR

This scheme was originally proposed by Peter Martinez, G3PLX, and I implemented it in the APLINK and PAMS MBO/BBSs and Peter implemented it in his AMTOR MBO (the two systems use a common protocol for interchanging traffic). Virtually all the APLINK sysops are using it now so it has received pretty broad field testing. Packet operators never even know when their traffic was passed over to an AMTOR link and back.

In order for the system to be really effective the AMTOR controller needs to have a lower error rate than is implied by the 4/3 ratio detection on the data alone. Several units now also use some form of transition gating as well which makes a marked improvement in the error rates. Those controllers that I know about that have done that are the HAL PCI-3000, the AEA PK-232MBX, the AEA AMT-1 (using the latest ROM) and the ICS AMT-3.

HAL has implemented the whole ASCII over AMTOR scheme directly in the controller so that any terminal program that works well, the PCI-3000 will handle it. I have been told that ICS will be doing the same thing with the AMT-3.

The scheme transmits the ASCII *printed* character set, not control characters (other than line feed and carriage return). In other words, all the ASCII characters from 32 to 126 plus 10 and 13.

AMTOR uses the 5-bit Baudot code which handles A-Z, 0-9, space and a small number of punctuation marks. It also allows a "blank" character (all five bits are 0) that typically has no meaning assigned to it.

To extend the Baudot code to handle the ASCII set, the Baudot blank is used as a toggle/escape character to signal character replacement. At the start of a transmission the system is assumed to be in normal Baudot mode which is to say all letters are upper case and all figures and punctuation are from the Baudot set. To transmit one or more lower case letters a single blank is transmitted as a toggle. All the following letters are then assumed to be lower case until either another blank is received returning the controller to upper case or until a figures or punctuation character is received which also returns the controller to upper case mode. This simple function then extends that available character set to include all 52 upper and lower case letters.

To extend the Baudot code further to include all of the ASCII punctuation marks the Baudot blank is used again. If a punctuation mark to be sent is not in the Baudot set then a selected Baudot character preceded with a Baudot blank is transmitted. The receiver then sees the blank and "looks up" the alternate punctuation character. I have attached a table of the Baudot figures characters and their alternate values if the character is preceded by a Baudot blank.

That's all there is to it! It is remarkably efficient. If there are no non-Baudot characters sent then there is no overhead whatsoever. Far fewer bits are transmitted even if the full ASCII printing set is transmitted than if the ASCII code itself were transmitted. If a receiving AMTOR controller/terminal program does not have this scheme implemented then it received a perfectly readable message anyway. All characters are seen in upper case and all punctuation is taken from the Baudot set. Since the Baudot set includes all of the most common punctuation a recipient might not notice the difference.

In order to use this system some of the controller manufacturers had to modify their units to handle the Baudot blank correctly. APLINK and PAMS require the AAMT-1 version 07a ROM, the PCI-3000 Version 1.8 ROM, and the PK-232MBX ROM dated July 1990 or later.—*Victor Poor, W5SMM, San Antonio, Texas*

Table of Alternate Baudot Figures Characters

Figs-A:	- Dash	_ Underscore
Figs-B:	? Query	<not assigned>
Figs-C:	: Colon	; Semicolon
Figs-D:	<Reserved for WRU>	
Figs-E:	3	<not assigned>
Figs-F:	% Percent	' Reverse Apostrophe
Figs-G:	@ At Symbol	} Closing Bracket
Figs-H:	# Hash Mark	{ Opening Bracket
Figs-I:	8	<not assigned>
Figs-J:	* Asterisk	<not assigned>
Figs-K:	(Open Paren	[Opening Square Bracket
Figs-L:	) Close Paren	] Closing Square Bracket
Figs-M:	. Period	> Closing Angle Bracket
Figs-N:	, Comma	< Opening Angle Bracket
Figs-O:	9	~ Tilde
Figs-P:	0	<not assigned>
Figs-Q:	1	! Exclamation Point
Figs-R:	4	$ Dollar Sign
Figs-S:	' Apostrophe	" Quotation Marks
Figs-T:	5	<not assigned>
Figs-U:	7	& And Symbol
Figs-V:	= Equal Sign	| Vertical Bar
Figs-W:	2	<not assigned>
Figs-X:	/ Slash Mark	\ Reverse Slash Mark
Figs-Y:	6	^ Caret
Figs-Z:	+ Plus	<not assigned>

An Outlet for Amateurs/Experimenters

Some time ago I read (with great interest) "Direct Digital Synthesis," by Dr. P.H. Saul, G8EUX in *QEX* #109. I was surprised and delighted to read that the entire process (more or less) was available on a single chip (the SP2002). Now that I have time to play with this sort of thing, I'm left wondering just what it will cost, and where I can purchase this chip in the single quantities that we hams love to buy. I would really appreciate any help you can offer in finding a supplier of this component. I checked with the suppliers listed in "Parts for the 'SSB Exciter'" article *(QEX* #118), but they said they didn't have it. (Very helpful article by the way.)

While I'm on the subject, I have a suggestion for *QEX* in general. Since this is the "Experimenters' Exchange," I feel it would be helpful to include clues to component sources as a general practice, when an article deals with items that are somewhat uncommon. This seems to be appropriate since this magazine is not only written by experimenters but read by them as well. A good example of this practice is *Radio Electronics* which generally contains a side bar describing just where the reader can get parts and kits. I'm not suggesting that *QEX* become a kind of "warehouse of kits," as this might impose some restriction on the types of articles published. But I would like to see some supplier hints included as a general practice. This would help those of us who read an article like this and say, "Gee, that's great. How can I get one?"
—Fred Thompson, AA0CA, St. Charles, Missouri

Empirically Speaking...

Continued from page 2

network capable of handling real-time CELP speeds would also do a much better job of handling other digital data, such as the kinds of data we send via the existing network and other application data such as digital imagery like that described in John Champa's article in this issue of *QEX*.

Many readers are by now no doubt wondering just how tough it would be to implement CELP. It's not a trivial exercise, but it is doable. To aid those who are interested in implementing CELP for amateur uses, we've obtained several documents and disks from the National Communications System (NCS), a US Government agency. The documents are the FS 1016 standard and a NCS technical information bulletin giving implementation details. The disks, which are associated with the technical information bulletin, are three DOS-format disks that have FORTRAN and C implementations of CELP, along with sample audio in both CELP-encoded and unencoded forms. We are making copies of the documents and disks available to amateur experimenters. If you are interested in obtaining a copy of the documents, send $3 to cover copying and mailing costs to:

Technical Department (CELP)
ARRL
225 Main Street
Newington, CT 06111

For copies of the disks, send three blank, formatted, high-density (1.44 Mbyte) 3½-inch DOS diskettes and a disk mailer with return postage to the same address. These offers expire on January 31, 1993.

Thirteen years ago, when amateur packet radio was in its infancy, few would have predicted that amateur digital communications circa 1992 would still be performed mostly at 1200 bauds. But it is, and this probably reflects the fact that most packet users are satisfied with the level of service they receive from the network. Maybe digital voice is the application needed to induce hams to move ahead with digital communications.

This Month in *QEX*

John Champa, K8OCL, shares with us some of his expertise in the developing world of digital video systems. It's a technology that amateurs can exploit!

Making the computer do the work is one of the obvious trends in amateur development. James Vandiver, WB4LHG, follows this trend with his "Multi-Mode Computer/Radio Interface." Although implemented on an obsolete computer, the techniques he describes are applicable to any platform.

In this month's "Components" column, Mark Forbes rounds up some handy hardware, software and "bookware" for your consideration. "Gateway" this month reports on the results of a recent meeting between the ARRL Digital Committee and operators of the HF automatic-forwarding STA network.
—KE3Z, email: jbloom@arrl.org (Internet)

Components

By Mark Forbes, KC9C
PO Box 445
Rocklin, CA 95677

This month, several interesting components, plus a possible suggestion or two you can use for a good Christmas present.

Miniature Fuses

Everything in electronics has been miniaturized as time has progressed... except fuses. Now, Schurter Corporation has come up with a line of fuses which, in the smallest package, are about the size of a 1N914 diode. Each of the fuses bears UL, CSA, VDE and other certifications.

The fuses are available in three voltage ratings: 63 V, 125 V and 250 V. And current ratings are from 63 mA to 15 A, depending on the package.

The packages come in four styles. The most recognizable is a small, PC-board-mount fuse (models MSF and MSA) that is a miniaturized version of the standard glass package that we're all familiar with. The other packages are more "exotic."

Surface-mount fuses are available in two styles to keep pace with ultra-miniature designs. The OMF 63V handles 63 mA to 5 A, and is only 7.4-mm long. The MELF 125V is available in 63-mS to 15-A versions, and measures only 7.3 mm.

The other two packages resemble small electrolytic capacitor packages. The MSF series look just like the capacitor packages, and are available in ratings from 100 mA to 5 A, and have radial leads (so they "stand up" on the pcb). The final package, the PSC 125V, is a four-terminal fuse, roughly resembling a surface-mounted potentiometer. This interesting product also offers integral and remote indication capability so that its "blown" state can be detected without having to look at the circuit board.

If you are interested in these products, write or call Schurter, PO Box 750158, Petaluma, CA 94975-0158; phone 707 778-6311.

Connectors

Lemo USA, Inc, has published a new catalog of electronic connectors. This company is fairly new in the market, so most of us are not familiar with it. However, they offer a full line of quality connectors, including RF, fiber optic, cables, high-voltage, and other standard and custom connectors.

Their catalog is available free of charge and is certainly worth having. To get a copy, write or call them at Lemo USA, PO Box 11488, Santa Rosa, CA 95406; phone 800 444-5366.

Sensor Interface IC

Telephonic Corporation has a new IC which accepts low-voltage inputs from sensing devices (such as temperature, voltage and other status devices) and sends a serial data stream to a microprocessor. These could be used in remote or difficult-to-access repeater sites for conversion of telemetry to microprocessor-compatible data. The parts are inexpensive, about $5 for small quantities.

To obtain more detailed information, contact Telephonics Corporation, 815 Broad Hollow Road, Farmingdale, NY 11735; phone 516 755-7000.

EMI Filters

Anyone experiencing EMI from computer products or packet equipment, or generating EMI with their radio products, may be interested in a line of miniature EMI filters from Coilcraft. These come in a variety of packages for various applications.

Packet fans may find the cable filters useful. These are double-ended DB-25 and DB-16 connectors with integrated filters. They provide as much as 19-dB attenuation of RF noise over 30-250 MHz.

Also useful for hams are several telephone filters. The simplest of these is an "RJ-xx" style connector with a built-in filter. These are perfect for calming neighbors who can't understand why you are interfering with their phone that they received free with that magazine subscription!

For EMI help contact Coilcraft, 1102 Silver Lake Road, Cary, IL 60013; phone 800 322-2645.

Circuit Simulation Software

Intusoft has developed several analog and digital circuit simulation programs. These programs allow you to design circuits, then enter the schematics and view the performance parameters graphically without the expense of actually building the circuit. You can then debug or fine tune the circuit in the computer simulation before ever soldering any components together. Most designers today use computer simulation programs to speed up the design and allow "tweaking" before ever constructing the hardware.

These programs are inexpensive enough that any ham might find them a useful addition to his or her test bench. And they might make a nice Christmas present too! Prices start at $95.

To find out more, contact Intusoft, PO Box 710, San Pedro, CA 90733-0710; phone 310 833-0710.

RF Design Book

This would make a *great* Christmas gift for the ham who experiments with RF circuits. The book, entitled *Radio Frequency Transistors: Principles & Applications,* is not one of those books that simply provides pages of data sheets with cookbook circuits. This book will actually help you to understand how various active components work and how to design circuits for the exact application you need.

The book discusses selection of solid-state devices for specific applications, bipolar devices vs field effect transistors, general RF power design practices, test and measurement principles, and thermal aspects of RF designs. Also shown are application design examples for: amplifiers, oscillators, switches, pulsed power, power MOSFETs, and even wiring considerations with RF.

The book isn't exactly cheap, but if you want a good tutorial on RF design, it's worth its $49.95 price (plus $3.50 shipping). To order, contact Butterworths, 80 Montvale Avenue, Stoneham, MA 02180, or call 800 336-2665.

Correction

Mike Gruber, WA1SVF, notes that his September 1992 *QEX* article, "Synchronous Detection of AM Signals," didn't make sufficiently clear that the circuit of Fig 7 was designed by Steve Johnston, WD8DAS. *QEX* regrets this error.

Gateway

Conducted by: Stan Horzepa, WA1LOU
75 Kreger Drive, Wolcott, CT 06716-2755
email: horzepa@evax.gdc.com (Internet)
or 70645,247 (CompuServe)

AUTOMATIC HF DIGITAL FORWARDING RECOMMENDED

On September 26, the ARRL Digital Committee met in Dallas with five representatives of the HF automatic-forwarding STA networks and recommended that provisions for automatic HF digital forwarding be incorporated into US Amateur Radio regulations. The group met to discuss a means of continuing the benefits of the existing operational forwarding networks while protecting the interests of other users of the bands. The participants took note of the IARU Region 2 digital band plan which was adopted September 4 in Curacao (see following story). This international agreement opened the door to reconsideration of recent recommendations of the Committee to the ARRL Board of Directors.

The Dallas meeting resulted in a recommendation that the part of the IARU Region 2 band plan that provides for digital forwarding be incorporated into the US regulations. This recommendation will be forwarded by the Committee to the ARRL Board for their consideration as a potential petition for rulemaking to the FCC. An ARRL request for extension of the current STA for the period during which new rules are under consideration is also recommended.

In concert with the recommendations, which would both allow automatic operation and provide rules to protect non-automatic users of the band, the participants formulated a tentative voluntary band plan for the digital parts of the MF and HF bands. Interested parties are encouraged to comment on the tentative band plan, which will be made widely available.

The participants agreed that the changing nature of the digital state of the art requires that national and international band plans be reviewed periodically. The Committee pledges to work with all segments of the digital community to suggest such changes to the band plans as may be needed in coming years.

Those attending the Dallas meeting were Digital Committee members W5TOO (chairman), W5SMM, WA8DRZ, AD7I and W6IWO, ARRL Board liaison N5TC, ARRL Headquarters representative KE3Z and HF STA representatives W3IWI (spokesman), WØRLI, WAØCQG, KD7XG and AD8I.

The meeting, while intense, showed total cooperation by all the participants. The emphasis was that all the digital modes (RTTY, AMTOR, packet and newly developing technology) would sink or swim together and that we needed a scheme that would support orderly developments for the next 10 to 20 years.

The big breakthrough was possible because all parties wanted an amiable solution and because of the development of the IARU Region 2 digital band plan at the Curacao meeting.

—from Joe Subich, AD8I, and Tom Clark, W3IWI, via CompuServe's HamNet

REGION 2 ADOPTS DIGITAL BAND PLAN

Voluntary HF band-planning for packet radio and other digital modes was the main topic considered recently by amateurs from 34 Western Hemisphere nations. Meeting in Curacao, August 31 to September 4, the General Assembly of Region 2 of the International Amateur Radio Union (IARU) recommended new digital band segments on the amateur HF bands that more closely reflect actual activity patterns, as well as bring them in line with IARU Regions 1 and 3.

In particular, the 20-meter band plan has been brought into line by recognizing packet up to 14.112 MHz. Because 40-meter US operating patterns are somewhat different than those in the rest of the Region, this band posed the most difficult problem. While the US and its Region 2 possessions are allowed SSB operations from 7.150 MHz and up, the rest of Region 2 uses the band from 7.050 and up (and sometimes lower) for SSB. No agreement could be reached that reflected both existing packet activity and the strong desires of other countries for 7.050-7.100 MHz to be kept free of packet and other digital modes in favor of SSB.

The band segment favored by the rest of the Region (other than the US) for packet, 7.040-7.050 MHz, was not acceptable to the US delegation because of continuing high levels of CW activity. The US delegation made it clear to the conference that a packet segment in the 7.040-7.050 MHz slot could not be implemented in the US for that reason.

And while Region 2 non-US delegations supported a packet segment at 7.100-7.120 MHz, this would interfere with US Novice operators. However, with a general decline in HF broadcast activity in the band and expanded Novice privileges elsewhere, the problem may not be insurmountable, according to ARRL President George S. Wilson III, W4OYI.

The planning concept used by Region 2 is for a segment to be designated for "Digital Modes" (RTTY, AMTOR, packet, PACTOR, CLOVER, etc) with a sub-segment designated "packet priority." Packet, being an automatic mode, does not require much protection from itself, and would not have to protect other modes from interference in Packet Priority sub-segments (except for the 40-meter problem noted earlier). The Region 2 packet concept also assumes that forwarding should be limited to the sub-segments specifically designated for packet, but not on an exclusive basis. In recognition of what is expected to be a rapid adoption of new techniques such as PACTOR and CLOVER, the Assembly did not attempt a more detailed description of sub-segments.

Here are the recommended HF digital segments:

- 80 meters: 3580-3635 kHz, packet priority at 3620-3635 kHz.
- 40 meters: 7035-7050 kHz, packet priority at 7040-7050 kHz for international communications; 7100-7120 kHz packet priority for communication within Region 2.
- 30 meters: 10.130-10.150 MHz, packet priority at 10.140-10-150 MHz.
- 20 meters: 14.070-14.112 MHz (1-kHz guard band at 14.100 MHz for the beacon network); packet priority at 14.095-14.0995 MHz; packet shared with SSB at 14.1005-14.112 MHz.
- 17 meters: 18.100-18.110 MHz, packet priority at 18.105-18.110 MHz.
- 15 meters: 21.070-21.125 MHz, packet priority at 21.090-21.125 MHz.
- 12 meters: 24.920-24.930 MHz, packet priority at 24.925-24.930 MHz.
- 10 meters: 28.070-28.189 MHz, packet priority at 28.120-28.189 MHz.

STS-47 SAREX IS SUCCESSFUL

The latest in a series of Shuttle Amateur Radio Experiments (SAREX) flown on US Space Shuttle missions can only be described as a complete success. Not only did astronaut hams Jay Apt, N5QWL, and Mamoru Mohri, 7L2NJY, make many packet and voice contacts with ground stations, but the SAREX radio equipment also came to the rescue when a communications malfunction prevented normal Shuttle communications with Mission Control.

Communications were relayed to the ground using the SAREX portable 2-meter FM transceiver. Amateur Radio has always played an important role in providing communications in circumstances where regular communication links have failed, but this was the first time Amateur Radio emergency communications were used in space.

During "normal" SAREX operations involving packet radio communications, the "robot" firmware contained in the SAREX TNC performed flawlessly keeping a log of contacts and transmitting short beacon messages generated by the astronauts. A few examples of the packet transmissions follow:

W5RRR-1>WA8EBM [13-09-92 14:41:36] <I S0 R0>:
#638-is your STS-47 SAREX QSO number.

W5RRR-1>QSL <UI>:

WB4TBF/1209	KF5OJ/1205	KC4NHB/1204
N4TAE/1199	KCØLM/1198	W5VZF/1197
KØKJ/1195	YI1BGD/1181	KB1US/1138
KI4FN/1126	VK7ZBX/1115	VK7ZO/1114
VK6OD/1086	DLØCRE/1044	DL1YDD/1043

W5RRR-1>SAREX <UI>:
This is STS-47 SAREX Robot station W5RRR-1 onboard the Space Shuttle *Endeavour.*

W5RRR-1>QST <UI>:
It is 36 hours since launch, and everything is settling down to the routines of the wonderful life up here. We have had some wonderful views of Japan, Chicago, Boston harbor, China, and Kamchatka. We have seen the southern aurora. We just saw the lights of Palmer station on the Antarctic peninsula. Many countries have connected to us... keep having fun! 73, N5QWL.

During this mission, an uplink frequency of 144.700 MHz was used for packet operations. This caused some interference in areas served by FM voice repeaters with input frequencies near 144.700 MHz. A solution to this problem is under investigation.

QSL cards are available for all who heard the Shuttle or made two-way radio contact with the SAREX package. Send QSLs with an SASE to Jay Apt, N5QWL, 806 Shorewood Dr, Seabrook, TX 77586.

—from SpaceNews

NEW TNC-2 FIRMWARE HAS SATELLITE KISS PATCH

TAPR has released version 1.1.8a of the TNC-2 firmware. It contains a patch to KISS which now performs correctly when used for satellite applications. Those using version 1.1.8 for non-satellite applications will not notice any differences with the new version. The firmware code has been uploaded to Data Library 9 of CompuServe's HamNet, file name "TNC118.ZIP." Programmed EPROMs with a command booklet are available for $12 from TAPR, PO Box 12925, Tucson, AZ 85732.

—from Bob Nielsen, W6SWE, via CompuServe's HamNet