



PACKET

STATUS

REGISTER

## Tucson Amateur Packet Radio Corporation

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8987-309 E. Tanque Verde Rd #337  
Tucson, AZ 85749-9399  
Phone: 940-383-0000  
FAX: 940-536-2544  
tapr@tapr.org  
www.tapr.org

**Office Hours:**

Tuesday - Friday  
9:00am-12:00, 3:00-5:00pm Central

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### President's Corner

Greetings all. This will be my last report for this decade and then we begin a new one. I have been wanting to write that for a while.

This past month we saw something happen that the organization has been working on for over five years now, the report and order on Spread Spectrum from the FCC was published. TAPR began to push this issue and we spent considerable money and man hours to see the process through. I can remember back to that Long Beach meeting when the ARRL and TAPR, with others, discussed the potential for Spread Spectrum rule making and the concerns. For those that were there, I am sure you think about that meeting with a smile now. You can look back and read on our web page the filings, comments, and reply comments during the process. I can remember well the effort required to get the STA filed, signed, and then renewed three additional times. Now we have the report and order. One thing is for sure -- the process for changing amateur radio rules is too long and in many ways too emotional for many (just read some of the comments filed).

I was initially disappointed at the final rule making, since the FCC in the report and order seemed to grasp the technical issues of many of the filings, but in the end decided to go with mostly what the ARRL filed. While the

### Look for TAPR at these Upcoming Events

May 2000 Dayton HamVention  
Sept. 2000 ARRL & TAPR Digital Communication Conference  
Orlando, Florida

Packet Status Register  
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## President's Corner continued

rule making is flawed in several ways. It still is a huge step forward for the amateur radio community and TAPR can be proud of our effort over the past several years on this issue. TAPR at its last Board meeting voted not to file a petition of reconsideration on the report and order based on the recommendation of the regulatory affairs committee.

The amusing thing is that many might think this issue is over. Far from it. The issue of changing the rules in order to promote technology innovation must continue and will. We now have Ultra Wide Band (UWB) starting to be discussed at the FCC. While many of the proponents of UWB seem to have vaporware for theory and technology others are showing some interesting technology demonstrations and the outcome over the next year or two is going to impact some aspects of what we might have available for technology. The amateur radio community as a whole must see and understand that if we don't allow the experimenters and visionaries in our hobby a more liberal hand at what they want to try and experiment on, we will continue to see less innovation coming from within our ranks. The attitude of some for maintaining the status quo and of trying to protect static usage of the bands is and will continue to take its toll.

Now that we have the report and order behind us, we must continue to develop technology. On that front, TAPR has signed a technology transfer and production agreement with the Dandis Group. The Dandis Group is focused on many of the same goals as TAPR, that of providing low cost wireless solutions. The synergy between our two groups and the fact that Dandis has money to pump into the project to get it into production in the near future makes this a good agreement for TAPR and its members.

As to the current progress and status of the FHSS radio project, a design review and handoff meeting for the RF section was held in Dallas in October. The outcome was very positive. We continued to be faced with a part here or there getting dropped by a manufacturer, but we are eliminating those design issues and moving forward. The next revision of the RF board is in layout now, with a prototype expected to be in the hands of the design team the first of December. We have now gone from a 6-8 month cycle to less than 2 months. That right there is going to help the project a lot! Steve Bible, N7HPR, has been added to the design team this quarter and will be responsible for the PIC development on the radio. The next step later in October will be to get closure on the technical issues of the digital board and hold a design review of that board and get it into a quick production cycle. The team is energized and we should have significant news to report in the next PSR. Tom

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### PSR Editor

Bob Hansen, N2GDE  
P.O. Box 1902, Elmsford, N.Y. 14902-1902  
Internet: psr@tapr.org

### Advertising

Contact the TAPR office.

### TAPR Officers:

President	Greg Jones, WD5IVD
Vice President	John Ackermann, N8UR
Secretary	Steve Stroh, N8GNJ
Treasurer	Jim Neely, WA5LMS

### TAPR Board of Directors:

Board Member	Term	Internet
Greg Jones, WD5IVD	2000	wd5ivd@tapr.org
John Koster, W9DDD	2000	w9ddd@tapr.org
Mel Whitten, K0PPX	2000	k0pfx@tapr.org
John Ackermann, N8UR	2001	n8ur@tapr.org
Barry McLarnon, VE3JF	2001	ve3jf@tapr.org
Doug McKinney, KC3RL	2001	kc3rl@tapr.org
Steve Bible, N7HPR	2002	n7hpr@tapr.org
Bob Hansen, N2GDE	2002	n2gde@tapr.org
Steve Dimse, K4HG	2002	k4hg@tapr.org

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The Tucson Amateur Packet Radio Corporation is a non-profit scientific research and development corporation (Section 501(c)(3) of the U.S. tax code). Contributions are deductible to the extent allowed by U.S. tax laws. TAPR is chartered in the State of Arizona for the purpose of developing and developing new systems in digital radio communication in the Amateur Radio Service and for disseminating information required during and obtained from such research.

### Article submission deadlines for upcoming issues:

Winter 2000	December 15, 1999
Spring 2000	March 15, 2000
Summer 2000	June 15, 2000
Fall 2000	September 15, 2000

### Submission Guidelines:

TAPR is always interested in receiving information and articles for publication. If you have the idea for an article you would like to see, or you, or someone you know is doing something that would interest digital communicators, please contact the editor and your work can be shared with the Amateur community.

The preferred format for articles is plain ASCII text; the preferred graphic alternatives are HTML or PCX. However, we can accept many popular word processor and graphic formats. All submissions on diskette should be formatted for MS-DOS.



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McDermott, N51GK, made a detailed report on the project at the DCC and the audio is available on our web site.

The DCC has come and gone and it was another very successful conference. Attendance was up this year and we hope that the Orlando location next year will allow us to boost attendance again. The full report is later in the PSR. I was very happy to see several of the ongoing HF-Digital projects presented at the conference. There are some exciting things happening in this field currently. If you haven't been following events, take a moment to listen to the conference audio. Special thanks to Tina Strub, Sheila Bible, and Jody Ackermann.

TAPR will shortly be back in the CD-ROM business. We will be focusing on more specialized CDs rather than the generic all-in-one CD we did the past several years. We simply outgrew trying to get all the information we had on one CD that had to be mass duplicated in the hundreds to make it profitable. Our new system will allow us to create several different CDs focused on more specific information needs. Initially, the software library will be offered. Then we will expand to CDs covering the DCC audio and later searchable PSR and DCC proceedings on CD. More next quarter.

Don't forget that nominations for the TAPR Board are due in December. If you are interested in running for the TAPR Board, please read over the information in the nominations section. If you have questions about duties, feel free to drop me an e-mail.

Until next quarter

Cheers - Greg, WD5IVD

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## Y2K Upgrade for AA4RE BBS

Mike Falmie, WA6ZTV  
MPFalmie@lbl.gov

I am about to distribute the Y2K upgrade to the AA4RE BBS program (V2.13S). If you are running AA4RE, you should be aware that it will crash on New Years Day without this upgrade.

To receive it via email, drop me a note and tell me which version you use; REAL mode (bb.exe) or PROTECTED mode (bbdpmi.exe) and I will send it to you within a few weeks.

[Also try looking on the TAPR FTP site.  
[http://tapr.org/software\\_lib/](http://tapr.org/software_lib/)]

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## A Practical Approach to Implementing H.F. Digital Voice in the Amateur Service

Charles Braun, G4GUD  
albrai@tdi.com.co.uk

[From the 1999 ARRL and TAPR Digital Communications Conference]

TAPR is currently working with Charles to make his Vocoder project available as a kit. Keep an eye out in the next issue for further details.

### Abstract

This paper describes a practical approach to building a working digital voice system suitable for NVIS operation on the HF Amateur bands.

### Introduction

This whole project began due to a comment a friend Andy, G4JNT, made over the telephone; he said that it would be fun to transmit real time digital speech on the amateur bands. Now there was a challenge! As he was located some 70 km away over a fairly obstructed path it would have to be on HF, even more of a challenge!

### Choosing the Vocoder

A number of candidate systems were studied. The Vocoder had to operate at a low data rate, be inexpensive, be standalone and relatively available. The systems looked at were, LPC-10e, MELP, AMBE and various CELP systems.

I experimented with LPC-10e and even managed to implement a version of it on a Motorola 56002EVM, the speech was understandable but I never did manage to get it to track the pitch correctly. Having listened to a commercial implementation of LPC-10e I decided that it did not have acceptable speech quality anyway.

I then went on to find an implementation of MELP (the new DDD standard) on the Internet, I managed to get the code to compile and added some Win95 sound handling routines. The speech quality was much better, but it consumed about 90% of the CPU resources on my Pentium 133 machine. Also after contacting the patent holders, I was told that they were not at all happy with what I was doing.

I then looked at CELP-based systems, these require large codebooks and clever search algorithms, something I thought was beyond the ROM capability of the Motorola EVM and my programming skills!

So finally I settled on the AMBE vocoder chip manufactured by DVS INC, this chip is relatively cheap, has very good sound quality, is scaleable between 2400

bps and 9600 bps and the manufacturer would sell me some!

### Choosing the Modem

After a literature search I came to the conclusion that the modem would have to use parallel tone technology. This was because it was easy to implement, was well proven, would run on my EVM and was more suitable for digital voice transmission than serial tone modems. Serial tone modems tend to produce long bursts of errors when the equalizer fails rather than the more random errors produced by a parallel tone modem. Speech is unlike computer data, in that the occasional error does not significantly affect the intelligibility.

### Designing the Modem

Amateur radio equipment has very poor filtering compared to military equipment. The filters tend to be quite narrow and have poor group delay characteristics. This means the modem has to use a narrower bandwidth than the equivalent military one would. This ruled out the MIL-STD 188-110A 39 tone modem.

In the end I decided on a 36 tone modem, with a baudrate to match the 20ms frame length of the AMBE vocoder chip. This provided a raw data rate of 3600 bps and enough time for a 4ms guard period. The guard period was required to give the modem multipath tolerance. The data was modulated using DQPSK which meant that each tone carried 2 bits of data during each baud interval. Unlike military modems my modem has no Doppler correction tone and no slow sync on data facility. So far both of these facilities have proven unnecessary. The modem remains in lock for long periods of time (well beyond my ability to carry on a monologue).

I then did some MATLAB computer simulations that showed that the modems had to be within 5Hz of the correct frequency to work properly.

To achieve initial timing and frequency offset correction the modem used three BPSK modulated preamble tones. It differentially decodes them using a delay of one baud interval it then integrates the received symbol over that time, from this it deduces the timing epoch. Then by looking at the energy in the 111 bins on either side of the preamble tones it calculates the frequency error and make a correction by translating the received signal in frequency using a complex mixer. The reason for three tones is to provide some frequency diversity as an air testing showed a single tone can get lost during deep fades.

Each symbol consists of 160 samples with a sample rate of 8ks/s. The 36 tones were created by using a 128 point complex FFT, the guard period is added by taking the last 32 samples from the output of the and adding them to the beginning of the samples to form a total of 160

samples. These 32 samples form the 4ms guard period. The data is differentially coded and mapped to the output phases using Gray coding before transmission.

After the preamble has been sent the modem sends a reference vector, i.e. transmits a known phase on each of the 36 tones, it follows this by a sync sequence. When the receiving modem detects the sync sequence it ceases hunting for the preamble and starts passing (hopefully) valid data to the vocoder board.

### The use of FEC

The modem has no inherent Forward Error Correction (FEC) embedded in it, instead it uses the FEC in the AMBE vocoder chip itself. The vocoder tailors the FEC to match the significance of the bits in the data stream, so it can probably do a much better job than I can. However it was a shame to not be able to use the soft decision information generated by the modem.

The AMBE chip uses both Golay and Hamming codes for correction and detection. It follows the normal convention during periods of errors, trying to guess what was sent by looking at previous frames then eventually giving up. The format used is 2400 bps speech and 1200 bps FEC.

The first tests were done without the FEC enabled, (whoops!) the system worked quite well but occasionally very loud screeches came out of it, however after the FEC was enabled fewer strange noises came from the system. When the modem was initially tested without the FEC, 1/3 of the tones were in fact transmitting no data whatsoever and were therefore wasting energy.

### The use of Interleaving

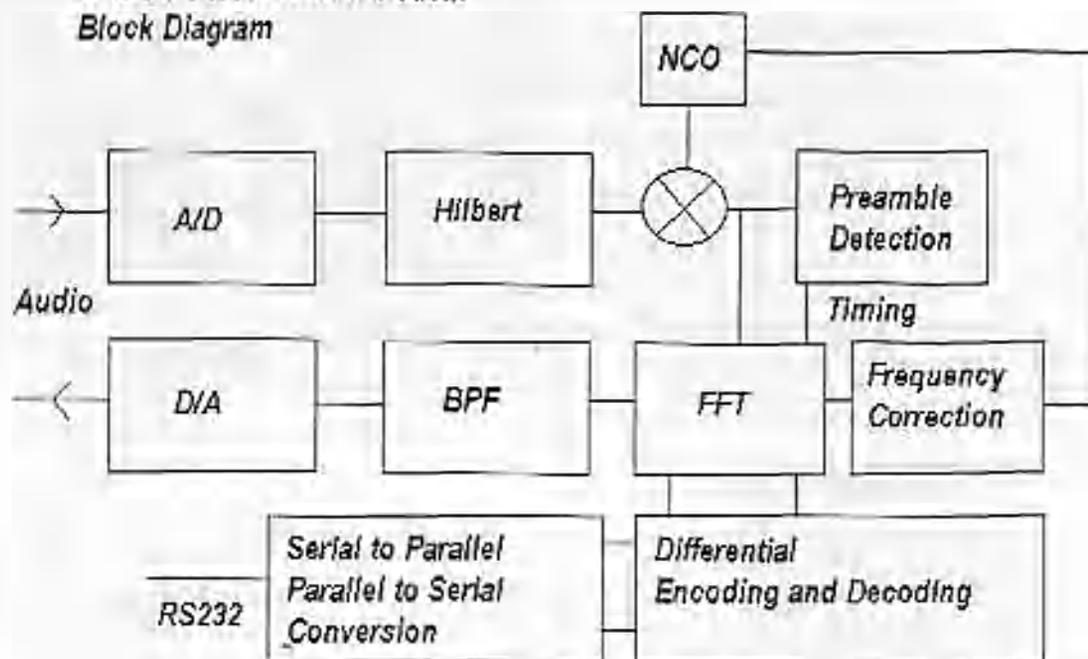
Some experiments were done using an interleaver but were abandoned because the interleaver adds a large delay to the voice and during deep fades or periods of interference spreads the errors over multiple vocoder frames and so prolongs the dropout.

### Development of the Vocoder PCB

The vocoder board consists of a Motorola MC 14LC5480P codec using mu law coding, an AMBE chip, a PIC 17C41W microcontroller, some 74HC series glue logic and a RS232 interface. The AMBE is a 100 pin SMT chip, which had to hand solder onto the board, it was when I got up to board number 5 that I began to get tired of doing it!

For the PCB I used the services of ExpressPCB in the US. This in hindsight was a mistake as their free PCB software is not compatible with anyone else, so it pretty much locked me into using them once I had started. Their service is very good however, I emailed the files on Monday and had the boards back in the UK by Thursday. I also sourced most of the components from Digispy in

## G4GUO Parallel Tone Modem Block Diagram



the U.S. as well, as it worked out cheaper than buying them in the U.K., especially the microcontrollers.

I used the 17C44 PIC microcontroller, for a number of reasons, first, so I could use one crystal to drive both the AMBE and the PIC (the AMBE requires a 27-30 Mhz clock). Second, the 17C44 PIC has enough ROM available to allow quite complex code to be added at a later date. In fact I have since done a version of my software that can encrypt the speech using triple DES encryption in real-time. Finally, because I already had the development tools available.

The boards cost me about \$150 each to make and I have so far made 5.

### On Air Testing

The system has been tested over a 70km path using frequencies in the 40m band. Andy and I made our first successful contact at the first attempt on the 27th of March 1999. This is not a weak signal mode and requires about 25 db S/N to function. However when working, it makes HF sound like a telephone conversation. There is no background noise, total silence, except for the comfort noise inserted during gaps in the speech by the vocoder itself. The system can tolerate strong CW interference and also the multipath induced selective fading found on HF. SSB interference is more troublesome as it affects more than one of the tones. If RTTY/CW interference gets too bad it is even possible to switch a DSP notch filter in circuit, there is enough power in the FEC to cope with the missing tones, however the notch filter must be switched out during the preamble phase.

The weakest part of the modem is the preamble phase, to help solve this I added the ability to save the frequency offset correction and timing epoch after each successful preamble synchronization. If for some reason the receiving modem misses the start of the transmission it is then possible to press a button on the front panel and revert to the last set of sync information. In a one to one QSO this works most times.

Another change that was made to the modem was to allow the different tones to be given different amplitudes to compensate for the amplitude response of the transceiver. The group delay in the transceiver will however reduce the modem's tolerance to multipath.

With the new generation of HF DSP radios this will not be a problem as their filter characteristics are much more suited to this kind of operation.

As well as HF testing I have also used it on 2m both on SSB and FM, and there is no reason it would not work via a repeater as there is no ARQ (but I have not tried it).

### Conclusion

It is now possible for the home constructor to build for about \$300, a portable, working digital voice for HF, with near phone quality audio. This system can equally be used to experiment with digital speech using different DSP modems on different frequencies.

For further information and a full technical description plus some sound files surf along to my website - <http://www.chbrain.diren.co.uk/dvlf.html>

## TAPR 900Mhz FHSS Radio Design Update

Greg Jones, WD5IVD

TAPR has signed an agreement with the Dandin Group to take the TAPR design from its current state into production, from which TAPR has access to production units for sale back into the amateur radio community. This is an agreement we have been working on for several months. The bringing together of TAPR's and Dandin's capabilities will help the speed of the project tremendously. We will be reporting more information in the next *PSR* about the progress of development.

### TAPR/Dandin RF Design Review - Status Report 10/6/99

The Dandin and TAPR groups meet Sunday, October 3rd, in Dallas, Texas to hold the RF design review in order to move the RF design from TAPR into Dandin's production schedule.

Attending the meeting: Greg Jones, Tom McDermott, Steve Bible, Steve Ludvik, David Cummings, John Schoreder, Bob Stricklin, and John Koster.



The TAPR FHSS Project Team. (L-R) Bob Stricklin, John Schoreder, David Cummings, Steve Bible, Tom McDermott, and Greg Jones.

### Functional Review

Tom went through the functional and operational design of the project. Steve L. had brought his block diagrams of the design and the group used this as a tool to follow the discussion and resolve identification of blocks to overall operations within the radio.



Steve Bible, Tom McDermott, and David Cummings reviewing issues regarding the PIC processor on the RF Board.

### Interfaces

The group resolved interface issues and assigned/changed interface specs to reflect current state of development. Further resolution on the interface was made later during the schematic review.

### Connectors

The group resolved for the prototype run the connector issues. Later in the meeting the master connector was broken into two connectors (Analog and Digital).

### Layout and Physical Issues

The group discussed the layout and physical issues of the design. Steve L. showed one of his examples of RF packaging. It was agreed later in the meeting that the current foot print would be kept during the layout of the board, but if the design allowed shrinkage Dandin would shrink the layout on the current size board.



Steve Ludvik, of the Dandin Group, working on a circuit analysis with Bob Stricklin and Tom McDermott.

## Schematic Review

The group did a component by component review of the design. Several changes and corrections were made to the master schematic as the group discussed the current design. Several action items were produced during this review which will be handled in the coming week.

## PIC

The group discussed the PIC controller on the RF Board. Steve Bible, who will be taking on the PIC programming, reviewed the PIC device and the group reviewed and made changes to the schematic in order for the design to work properly with the PIC selected. The group reviewed the operational working of the PIC with the overall design.

## Conclusion

I want to thank everyone that attended the RF review for making it such a successful meeting. The goals of 1. attain closure on the issues regarding the RF board, 2. be able to allow Dandin to take over RF layout and following production, 3. gain clear understanding of goals for the next 2-4 months, and 4. increase the communications between the two groups and the participant members were all achieved.

The next step will be to hold a design review on the digital board and start the process of technology transfer with the second half of the project.

## Phase 3D Accepted for "First Suitable" Ariane 5 Launch

*[From ARRL Headquarters]*

AMSAT-NA says the Phase 3 Amateur Radio satellite has been accepted as a payload for the "first suitable" Arianespace Ariane 5 vehicle launch. The announcement came today from Phase 3D Project Leader and AMSAT-Germany President Karl Meinzer, DJ4ZC, who said a launch opportunity could come during the first half of next year.

"As the primary agency responsible for securing a launch opportunity for Phase 3D, I am pleased to announce that AMSAT-Germany and Arianespace have now come to an agreement calling for the launch of P3D as a secondary payload aboard the 'first suitable' Ariane 5 flight," Meinzer said in a statement from Marburg, Germany. "From the very beginning of the Phase 3D project, we considered the Ariane 5 series our primary launch vehicle. Our long history of success and mutual cooperation with both the European Space Agency and Arianespace, coupled with our need to lift P3D into a high geostationary transfer orbit, made the Ariane 5 the unanimous choice by AMSAT."

Specific details of the launch agreement were not released.

AMSAT-NA President Keith Baker, KB1SF, was cited with the latest news. "I'm very pleased to see that AMSAT-DL's negotiations with Arianespace have resulted in a launch contract for Phase 3D, and I'm delighted we are again slated to fly on an Ariane vehicle," he said. "Following the resounding success of Ariane Flight 503, the Ariane 5 has now proven itself to be a very capable launcher."

Baker said that given past successes with ESA and Ariane, "I believe we now have an unbeatable combination." Once in orbit, Baker said, "the Phase 3D satellite will not only help us usher in the new Millennium, it will also signal the dawn of a brand new era for Amateur Radio."

While both AMSAT presidents expressed optimism for an early launch of the satellite, Meinzer expressed caution that the wait for the "first suitable" flight could still turn out to be a long one. "While the launch of Phase 3D could come as early as the first half of the year 2000, we must remember that Ariane's launch manifests are continually being updated to accommodate market changes as well as the availability of other payloads," he explained. Meinzer said "one or more changes" to P3D's anticipated launch date as well as its specific Ariane 5 mission number "are a very real possibility before our satellite actually flies."

ARRL Executive Vice President David Sumner, K1ZZ, welcomed the AMSAT announcement. "Congratulations to AMSAT's Phase 3D team on moving another important step closer to launch," Sumner said. "For those who have been putting off getting their stations ready for Phase 3D, the time for procrastination is just about over." The League has been a major contributor to the Phase 3D project.

Based on its new 'standby' launch status, Phase 3D is slated to be delivered to the Guiana Space Center in Kourou, French Guiana, later this month to be ready once a specific Ariane 5 launch is identified.

The Phase 3D project has been an international effort that has worked with donated resources. In addition to AMSAT-DL and AMSAT-NA teams, AMSAT groups from Austria, Great Britain, Japan, Canada, Finland, Russia, Belgium, the Czech Republic, Slovenia, France, New Zealand and Hungary also have participated.

AMSAT says that while Phase 3D's primary focus is on improved worldwide satellite communication, the satellite also will have a very positive influence on the future of Amateur Radio. "Phase 3D will be Amateur Radio's premier vehicle to continue the quest for new communications technologies for generations yet unborn," the AMSAT announcement said.

## 1999 ARRL and TAPR Digital Communications Conference Phoenix, Arizona

Greg Jones, WD3IVD

Another grand Digital Communications Conference! Special thanks go out to the workers at MARC for hosting locally and to PRUG ([www.prug.or.jp](http://www.prug.or.jp)) for being our international co-host again. Also, a very special thanks to Geoff Buehr, N6LXA, Chief Network Officer of Sun Microsystems, for attending and giving the dinner talk on Saturday. Steve Stroh, N8GJN, and Tina Stroh did an excellent job in working the arrangements with the hotel in Phoenix once it was selected. Tina wasn't able to attend because they are in the midst of adopting a child. Congratulations to Tina and Steve. Sheila Bible was a big help and will be working with Tina in the coming years to help coordinate the conferences as I take a lesser role in the conference. As in the past, audio and photos from the conference will be available on the TAPR web site ([www.tapr.org/dcc](http://www.tapr.org/dcc)).

Next year's DCC will be hosted in Orlando, FL. The date of the conference should be selected by the end of the year.

The conference started Friday afternoon with the third annual APRS National Symposium moderated by Steve Dimse, K4HG. The symposium was full of talks and projects. During the symposium yet another new mystery hardware project was discussed. This year's was a sneak preview provided by Kenwood to all those attending the DCC of their new mobile APRS equipped radio. The following people spoke at the APRS Symposium.

APRSdos and TrakNet update

Bob Bruninga, WB4APR

MacAPRS/WinAPRS Update

Keith Sproul, WU2Z

XAPRS

Keith Sproul, WU2Z

APRS+SA Update

Brent Hildebrandt, KH2Z

Internet and APRS

Steve Dimse, K4HG

WinCE version

Rob Wittner, KZ5RW

Kenwood TH-D7 Tricks, Treats, and Tragedies

Stan Horzempa, WA1LOU

Arizona APRS

David McCarthy, KC7AYX

APRS ICQ

Tom Schuefer, NY4I

Microcontrollers and APRS

Steve Bible, N7HPR

APRS Working Group Update

John Ackermann, N8UR



Keith Sproul WU2Z and Guy Story, KC5G0I

The Friday Technical Seminar on HDTV by Allen Finne, KH5SQK was cancelled at the last minute when Allen could not attend.

Friday night saw the annual DCC social, which was sponsored by PRUG. After the social, PRUG presented a technical paper highlighting their current development. The papers focused on what had been happening with their prototype direct-sequence radio operating in the 2.4 GHz band. This prototype appears to be very well designed from an experimentation point of view.

As with past years, Saturday was split into two strands -- a paper session and a session featuring selected topics. As in previous years, the selected topic strand had fewer topics with more time to present. Four selected topics were presented. Steve Bible, N7HPR, presented an introduction to PICs. Guy Story, KC5G0I, presented an overview to APRS and discussed some of the latest happenings in the mode. Johan Forrer, KC7WW, did an



Johan Forrer, KC7WW, Charles Brain, G4GUO, Frank Perkins, WB5IPM, and Tom McDermott, N5EG captured in the hall during one of the breaks.



Fried Heyn, WA6WZO and Greg Jones, WD5IVD

overview and current status on HF communications. Bob Nielsen, W6SWE, did a talk on the current status of Linux in the amateur community. Thanks to all the selected topic speakers for taking the time to present more in-depth materials during the DCC.

The paper sessions included the following talks:

Regulatory Issue and Update

Dewayne Hendricks, WA8DZP

ARRL Technology Task Force & The Technology Working Group

Rich Moseson, W2VU

Arizona Packet Radio, Past Present and Future

Keith Justice, KF7TP & Dan Meredith, N7MRP

APRS Mic-Lite

Bob Bruninga, WB4APR

APRS for X-Windows (Linux)

Keith Sproul, WU2Z

Automatic Weather Bulletins via APRS

Keith Sproul, WU2Z

APRS Generic Digipeating Satellites for HT and Mobile Satellite Communications

Bob Bruninga, WB4APR

XMI and APRS

Steve Dimse, K4HIG

APRN: Automatic Picture Relay Network and SSTV Picture Server

Keith Sproul, WU2Z & Bob Bruninga, WB4APR

APRS Stand Alone Message Receiver

Keith Sproul, WU2Z



Steve Bible, N7HPR and Bob McGwier, N4HY

Proposal for a Spread Spectrum Transponder Payload on the International Space Station

Matthew Eitus, N2MJI

UWB (Ultra Wide Band) Technology

Dewayne Hendricks, WA8DZP

Status Report on TAPR 900MHz SS Radio Project

Tom McDermott, N5EG

A Low-Cost HF Channel Simulator for Testing and Evaluating HF Digital Systems

Johan Forrer, KC7WW

(Non Technical) Lessons to be learned from the PSK31 Phenomena

Eduardo Jacob, EA2BAJ

A software Implementation for Federal Standard 1052 (Mil. Std. 188-110A HF Modems)

Robert McGwier, N4HY

A Practical Approach to Implementing HF Digital Voice in the Amateur Service

Charles Brain, G4GUO



Dorothy Jones, KA5DWR and Jody Ackermann, KC8KDC

**HamWeb and HamStation**  
Dale Puckett, KOHYD

For the banquet speaker, we were very fortunate to have Geoff Bachir, N6LXA, Chief Network Officer of Sun Microsystems. Geoff gave a very interesting and thought-provoking talk on the future of the Internet and networking in general and gave some comments on the future of amateur radio. We were very fortunate to have Geoff attend the conference and much thanks goes to Dwayne Hendricks, WA8DZP, for helping arrange another good banquet talk.

The Sunday morning seminar was a more time-intensive version of last year's introductory session on PIC development. Steve Bible, N7HPR, Steve Dimac, K4HG, John Hansen, W2FS, and Byron Garrabrant, N6HG gave a 5 hour long seminar on PIC development and programming issues. They showed lots of interesting projects and answered a lot of questions from the audience.

Thanks to all those that I missed mentioning who helped with the DCC and I look forward to seeing you next year!

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**18th DCC Proceedings Available from TAPR \$15**

**Title: Ham Web Node**

Authors: John Bandy W0UT (john.bandy@twsubbs.twsu.edu) and Dale Puckett KOHYD, (k0hyd@feist.com)

Abstract: This paper describes an existing amateur packet node that provides many graphic and text services to other amateur packet stations in the amateur radio 2 meter band.

**Title: Ham Web Station**

Authors: John Bandy W0UT (john.bandy@twsubbs.twsu.edu), Dale Puckett KOHYD, (k0hyd@feist.com)

Abstract: This paper explains the requirements for an amateur radio station that communicates with an amateur radio web station/node on the 2 meter band. It uses a graphic user interface (GUI) desktop of a personal computer (PC).

**Title: A practical Approach to Implementing H.F. Digital Voice in the Amateur Service**

Author: Charles Brain G4GUO (chbrain@dircon.co.uk)

Abstract: This paper describes a practical approach to building a working digital voice system suitable for NVIS operation on the H.F. Amateur bands.

**Title: XML and APRS**

Author: Steve Dimse K4HIG (k4hg@tapr.org)

Abstract: Recently, a number of pundits have been calling XML (eXtensible Markup Language) the "Next Big Thing" on the Web. New XML aware applications are being released all the time. Over the next few years, more and more information will be made available in XML. The ability to easily machine-interpret this information will be a watershed event in the development of the Internet. APRS will not be left out! In this paper I detail the first efforts in making APRS data available in XML.

**Title: Proposal for a Spread Spectrum Transponder Payload on the International Space Station**

Author: Matthew Elux N2MJ1 (matt@etms.com)

Abstract: A satellite payload for the International Space Station is proposed, which would provide high bandwidth, wide-area data communications capabilities for radio amateurs. Key features of the system are a simple space segment and low cost ground stations. Varying tiers of service can be provided depending on end-user equipment investment, from low-cost paging, through digital voice and high speed data communication.

**Title: A Low-Cost HF Channel Simulator for Testing and Evaluating HF Digital Systems**

Author: Johan Forrer KC7WW (forrerj@peak.org)

Abstract: The incentive and justification for this project was inspired by the author's desire to develop HF digital communications devices that effectively deal with the variable nature of the ionospheric propagation medium. Simulating the behavior of the ionosphere in real time allows for bench testing of HF modems and other communications devices. In the past, these so-called "HF channel simulators" used exotic and expensive computing hardware that was not available to the average amateur experimenter.

The simulator presented in this article is based on a low-cost floating-point DSP evaluation kit that accommodates a wide range of simulated conditions, including CCIR 520-1. The simulation model is an implementation of the Watterson, Gaussian-scatter, HF ionospheric channel model which is the de facto standard for this kind of work. The article concludes with a summary of test results for a number of contemporary, forward error-correcting (FEC) HF digital systems tested on this HF channel simulator: PSK31, CQPSK, and M163. This simulator is a worthy addition to anyone's array of testing tools for developing DSP modem algorithms, routing or protocol development for HF communication systems.

**Title: A Perspective on Open Source, Xastir, Amateur Radio and Linux**

Author: Frank Giannandrea KC0DGE (fgianzan@enzy.net)

Abstract: Linux and the Open Source way of thinking have recently been in hot debate throughout the world. Open fighting on this subject has brought out merits on either side of this discussion. Each point of view is applicable in different ways. This is my attempt to discuss how Open Source may be used to benefit Amateur Radio, and how I have used these ideas in my own project.

**Title: Automatic Weather Bulletins via APRS**

Authors: Dale Huguley KG5QD (kg5qd@worldnet.att.net) and Keith Sproul W1ZZ (ksproul@vger.rutgers.edu)

Abstract: This project was an outgrowth of a Pascal-based weather parser located at the Collier County Florida Emergency Operations Center called WXSVR, with stood for Weather Server or Weather Severe. Data from the GTE Weather Wire service was broken into products and made available on the local packet BBS, with hurricane data sent to the statewide network. In February 1997 I met Keith Sproul at the National Hurricane Center during the annual Amateur Radio Conference. I started communication with him and Mark Sproul concerning the use of WinAPRS(tm) for hurricane information display and dissemination. An interface protocol was agreed upon to allow the development of a parser as a possible plug-in to the MacAPRS(tm)/WinAPRS(tm) software. The Parser was originally for hurricanes only, but subsequently was developed for all types of weather bulletins.

**Title: (Non Technical) Lessons to be learned From the PSK31 Phenomena**

Author: Jacob Eduardo, EA2BAJ (jtpjtae@bioc001h.chu.es)

Abstract: The new PSK31 mode has raised much attention from both the technical press and the hams. We can get on the air from many operating systems using different hardware. We can read about it in many languages, ranging from English to Czech. There have been tests on satellites and on high frequencies. Many contests now include PSK31 as a valid mode. Yet, PSK31 has much more to offer. I believe that we can learn from the experience in benefit of new ham projects for the future.

**Title: Arizona Packet Radio, Past Present and Future(?)**

Authors: Keith Justice KF7TP (k17tp@cybertrails.com), Daniel Meredith N7MRP (meredithd@phx-sz.com)

Abstract: A brief history of packet radio in Arizona is presented. The current status of the network is described with a map showing node locations and major links, and a detailed node list is available in the Appendix. We speculate on the future, arguing that the Internet, while responsible for the decrease in the current user population, can also provide opportunity for future applications. An application particularly suited to Arizona is the provision of Internet e-mail gateways for the many vacationers, winter visitors, and campers who frequent the state. We are optimistic that other applications, not foreseeable in their exact nature, will certainly emerge.

**Title: A software Implementation for Federal Standard 1052 (Mil. Std. 188-110A HF Modems)**

Author: Robert McGwier N4ITY (rvmcgwier@home.com)

Abstract: Federal Standard 1052 is a modem designed for use on HF. It is specifically designed to overcome the effects of propagation on HF to a certain degree. This paper describes the approach taken by the author in a software implementation for the personal computer. The author has chosen to do the initial implementation on Pentium and Dec-Alpha based computers running Linux.

**Title: Next Generation of Amateur Radio Systems**

Author: Paul Rinaldo W4RI (prinaldo@arrl.org)

Abstract: The following PowerPoint presentation was originally prepared for a small group of representatives of ARRL, DARC and UBA at Friedrichshafen, Germany. During the discussion, it was acknowledged that HF digital voice was difficult (using LPC-10 or MELP, for example) and that early emphasis should be placed on VHF/UHF multi-media systems. This slide set is offered for your information.

**Title: An Inexpensive High Speed Modem for the Universal Serial Bus (USB)**

Author: Thomas Sailer HB9JNX/AE4WA (sailer@ife.cc.ethz.ch)

Abstract: This article describes a simple and inexpensive modem intended to link end users at 76.8kBits/s to the high speed backbone network. The modem can be connected to standard PC's using the Universal Serial Bus (USB).

**Title: APRN: Automatic Picture Relay Network SSTV Picture Server**

Authors: Keith Sproul W1ZZ (ksproul@vger.rutgers.edu), Douglas Quagliana KA2UPW (dqagliana@aol.com), and Hob Bruninga WB4APR (bruninga@nada-norcy.mil)

**Abstract:** SSTV, Slow Scan Television, has been around for years. In the past, it was primarily used on HF. The equipment was big, bulky, and somewhat expensive. Nobody even thought of doing SSTV on VHF or portable. With the introduction of the Kenwood VC-III this stereotype has changed. This paper discusses software that takes the SSTV images sent from these portable SSTV systems and automatically puts them on a server that makes these pictures available to other Hams. This allows a Ham to send his pictures to a common site that other hams can recalled the pictures from using touch-tone commands. This 'PICTURE SERVER' becomes a 'picture' repeater that also enables hams that do not have a good direct radio path to exchange pictures via this PICTURE NETWORK. In addition, the pictures can be viewed on a local network via Netscape or other web browser.

#### **Title: APRS for X-Windows (Linux)**

**Author:** Mark Sproul KB2ICL (msproul@vger.rutgers.edu)

**Abstract:** APRS, Automatic Position Reporting System, has been around for most of this decade. Part of the attraction of APRS is that it runs on many different platforms. There are versions that run on DOS, Macintosh, Windows, Palm Pilot, and now the Sproul Brothers (TSB) have introduced a version that runs on LINUX, using X-Windows. This is an important addition to the APRS community because many Hams are starting to use LINUX and there are lots of other Ham Radio related software available for LINUX.

#### **Title: APRS Stand Alone Message Receiver**

**Authors:** Mark Sproul KB2ICL (msproul@vger.rutgers.edu) and Keith Sproul WUZZ (ksproul@vger.rutgers.edu)

**Abstract:** APRS, Automatic Position Reporting System, has evolved quite a lot over the last eight years. We can run APRS from our home, we can run APRS from our car. We can run with a computer in the car, or we can run with just a tracker unit. In the later case, we have stand alone trackers, we have MIC-Es, PIC-Es and Kenwood Data Radios. In the case of MIC-E's, PIC-E's, and stand-alone trackers, the position data is being transmitted, but the received data is going nowhere. In these cases, for the most part it doesn't matter where the received data goes because we are not in a situation to use that data anyway. However, what if someone wanted to send you a message? If you have a MIC-E, PIC-E, or a stand-alone tracker, you just can't receive messages. The Kenwood TH-D7 can receive message, but the other tracker units cannot. Wouldn't it be nice if you could

receive messages even if you don't have a computer hooked up in your vehicle. In addition, wouldn't it be nicer if we could receive the messages via voice?

#### **Title: Detailed Remote Weather Reporting VIA Packet Radio**

**Author:** Mark Warbled N8LHG (m8lhg@midohio.net)

**Abstract:** This paper will describe a unique way to view real-time dynamic weather station information via packet radio in extreme detail and accuracy.

#### **Title: APRS Generic Digipeating Satellites for HT and Mobile Satellite Communications**

**Author:** Bob Bruninga WB4APR (bruninga@nadn.navy.mil)

**Abstract:** It's time for mobile and handheld amateur satellite communications and we can do it easily. Proposals for amateur satellite constellations have been made in the past, but they assume a coordinated effort. Such an effort is unrealistic in the catch-as-catch-can amateur environment. This paper suggests that the future growth of amateur satellites can in fact accommodate uncoordinated growth and still provide synergistic advantages to mobile and handheld operations.

#### **Title: APRS Mic-Lite**

**Author:** Bob Bruninga WB4APR (bruninga@nadn.navy.mil)

**Abstract:** The Mic-Lite is the ultimate APRS Mic-Encoder for maximum flexibility and versatility. It can be plugged into any radio in place of the microphone and gives you instant APRS position, telemetry and message reporting on any Radio. It is assembled from the MIM module and a few off-the-shelf Radio Shack components.

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### **Beginner's Introduction to APRS**

Ian Wade, G3NRW, has produced a Whitepaper on APRS. The 25-page document is a beginner's introduction to APRS, explaining what it is and how it works. The Whitepaper is fully illustrated with many diagrams and screenshots, and is available on the web at: <http://www.netro.co.uk/whitepaper.htm>.

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### **Xastir 0.1.2 Available**

A new version of Xastir is out! Xastir is an open source APRS(jm) like program for Linux. It's free and source is included. For more information visit [www.eazy.net/users/fgianmari/xastir](http://www.eazy.net/users/fgianmari/xastir).

73, Frank (KC0HGF)

## PRUG

Hello to all the people attending the DCC meeting.

PRUG, the Packet Radio User's Group, is very happy to be an international cohost of DCC meeting again. We received a warm welcome on the last meeting and again today. The previous DCC meeting encouraged us to work harder for wireless. We appreciate your kindness.

Since the last DCC meeting, we have been in the activities of networking on both wireless and wired media. I would like to summarize the activity as follows to give you an update.

The number of PRUG96 beta testers is now more than fifty, and they are located in more than ten regions in Japan.

We proposed a new wireless routing algorithm, and the paper was accepted at the Internet Conference 1998 in Kyoto, jointly hosted by Japan Society of Society for Software Science and Technology, Japan UNIX Society, and WIDE Project, as a part of the nation-wide annual gathering of the Internet engineers and researchers in Japan.

We received the demonstration award of this conference.

We had an expedition to the top of Mount Fuji, the highest mountain in Japan about 12,400 feet high, to build the distance record on 2.4GHz spread spectrum digital radio link. YFS, we are HAM RADIO OPERATORS!

We are involved in a commercial wireless router product, and it has been making good sales in Japan.

New applications are growing which fully utilize the continuous connectivity of our radio link. For example, we have a weather server link that reports the weather conditions over the Web and e-mail using cigarette-box sized Java computers.

The activities are derived from a small movement begun in 1984, 15 years ago. I remember the day when my own TNC-2 was delivered. The name of TAPR was on the printed circuit board. We have been collaborating with TAPR since the day I got the TAPR TNC.

We also made an original TNC called PARNET-TNC in those days and we established a special interest group for anybody who had activities on packet radio, whatever kind of TNC he or she used. That group is the PRUG.

The network exists to connect people.

We are happy to keep a good relationship with TAPR and all the radio networkers.

Thank you.  
Masaaki Yonezawa

## 1999 TAPR Technology Day

John Blawsky, kb2uc  
Guy Story, KC5G01  
Stan Horrope, WA1FOJ

The purpose of this event is to demonstrate technology independence at the location of Field Day. Technologies like Packet Radio, SSTV, ATV, Spread Spectrum, IGates and other operating modes accessed via RF; this reflects current emergency situations at disaster scenes in our present day world. The 1999 Technology Demo Day coincided with the ARRL Field Day.

### Results of the 1999 TAPR Technology Day

1) First place goes to Jim Duncan KU0G. With a score of 1928. Congratulations Jim!!

Mr. Duncan won by truly following the spirit of Technology Day. He set up an Igate station at his home then used a local packet frequency to stream the internet feed to his Technology station in the field. Which is not only fully allowed in the rules of Technology Day but also follows the intent of Technology Day. Way to Go Jim. This shows the adaptability that Amateur Radio operators in a time of emergency have been known to possess.

2) Number of operators who submitted scores 10.

This low number is a disappointment. Mainly because if you look at the breakdown of scores which is reported on the TDD web page (see below) you will see that Jim for example exchanged 69 APRS messages. Which means that we should have had at least half of that many scores submitted. Half because some of those 69 QSOs were with unattended stations. Last year we had 44 stations submit scores.

3) Modes of operation (For the 10 stations that submitted scores)

APRS	10
ATV	2
SSTV	3
Satellite	3
Spread Spectrum	0

As of now, we plan to hold TDD again next year. There has been continued discussion and debate with the ARRL about current Field Day rules as they pertain to new technologies in the hobby. The TDD committee is reviewing the results of this year's event and we are open to comments from anyone about the TDD. Please let us know if you have something you want changed or added for this coming year.

A full breakdown on the scores can be found on the TDD web page: [www.tapr.org/tapr/html/Ptdfd.html](http://www.tapr.org/tapr/html/Ptdfd.html).

**FCC Report and Order:  
Greater Use of Spread Spectrum  
Communication Technologies  
WT Docket No. 97-12  
RM-8737**

*[Edited for publication. The full text of the Report and Order and other information about the issue are available at [www.fcc.gov/oc/summary.html](http://www.fcc.gov/oc/summary.html).]*

## I. Introduction And Executive Summary

By this Report and Order, we adopt rules allowing amateur stations to transmit additional SS emission types. We conclude that the public interest would be served by removing the restriction in the Amateur Radio Service rules that limit the SS emissions that amateur stations may transmit. Moreover, we believe that this change will (1) allow amateur service licensees to experiment with additional SS emission types; (2) allow amateur radio operators to develop innovations and improvements to communications products and develop new communications technologies; (3) facilitate the ability of the Amateur Radio Service to contribute to the development of SS communications by allowing amateur stations to transmit and experiment with SS technologies currently used in consumer and commercial products; and (4) promote more efficient use of spectrum allocated to the Amateur Radio Service.

The major rule changes we adopt today are summarized below.

- We amend our rules to remove the limitation that amateur stations transmit SS emission types using only frequency hopping and direct sequence spreading techniques.
- We adopt a requirement that amateur stations use automatic transmitter power control to limit transmitter power to the minimum power necessary to maintain communications.
- We amend our rules to remove now-unnecessary recordkeeping and station identification requirements that apply only to stations transmitting SS emissions.

Our decisions are guided by three broad policy principles. First, we seek to provide a flexible regulatory framework that allows for continued development of new services through experimentation by amateur radio operators on amateur service spectrum. Second, we seek to promote technological innovation. Finally, we seek to eliminate unnecessary regulatory burdens.

## II. Background

SS is a modulation technique that distributes the energy of the transmitted signal over a segment of spectrum that is much larger than would be needed for a "traditional" modulation scheme. This technique results in the power

density of the transmitted signal being very low, and the duration of a transmission on any frequency in the frequency segment being but a fraction of a second, at any point of bandwidth the SS emission occupies. This technique also allows reuse of the bandwidth in the available frequency segment that the SS emission occupies, thereby allowing multiple stations transmitting SS and non-SS systems to use the segment of spectrum simultaneously.

Our current Part 97 rules permit amateur stations to transmit SS emissions subject to certain operational constraints. Amateur station SS transmissions may be used only for communications between points where the Amateur Radio Service is regulated by the FCC and may be made only on authorized Amateur Radio Service frequency bands above 420 MHz. SS emissions transmitted by amateur radio stations are limited to two types of spreading techniques — frequency hopping and direct sequence. Additionally, our rules require that documentation sufficient to enable the FCC to demodulate all transmissions be retained for a period of one year following the last entry in the station records. The rules also prohibit SS emission transmissions made for the purpose of obscuring the meaning of any communication. Further, amateur radio stations transmitting SS emission types are secondary to amateur radio stations transmitting other emission types.

## III. Discussion

### A. Elimination of restrictions on spreading techniques

**Background.** The Notice proposed to amend the Part 97 rules to authorize amateur stations to make greater use of SS type emission technologies. We proposed to allow amateur stations to transmit SS type emission technologies employing additional spreading sequences. Specifically, we proposed to eliminate Sections 97.311(c) and (d), which restrict amateur stations to transmitting SS emissions that use only frequency hopping and direct sequencing spreading techniques. We indicated that this change would allow amateur radio operators to develop innovations and improvements to communications products and technologies. We also stated that it would provide amateur radio operators more flexibility to use current and future communications technologies. Such a rule change also would encourage the amateur radio community to expand its experimental activities with SS and allow amateur stations to transmit SS emissions that presently are transmitted using other communications devices.

**Decision.** The comments we received on this proposal generally supported elimination of restrictions on the spreading techniques that amateur radio stations may use. We conclude that the public interest will best be served

by eliminating the rules that restrict amateur stations to using only two SS spreading techniques. In this connection, we note that one of the fundamental purposes underlying our Part 97 rules is accommodation of the amateur radio operator's proven ability to contribute to the advancement of the radio art. We agree with William Tynan that we should not continue restricting the spreading techniques available to the amateur service in order to protect Part 15 manufacturers. We also concur with the ARRL that elimination of this restriction makes it likely that amateur radio operators will use Part 15 devices as a source of SS equipment, and we note that Meccorum, a manufacturer of Part 15 devices, supports these changes, provided we also adopt our proposal for automatic power control. We also note that, because certain spreading codes and modulation methods used in Part 15 devices are not permissible in amateur radio communications, the most likely effect of the current rules is that experimentation is conducted by amateur radio hams under Part 15 rules rather than under the amateur service rules.

The manufacturers of unlicensed Part 15 devices argue that the proposed changes could upset the delicate balance that has been struck in the bands they share with the Amateur Radio Service, especially the 915 MHz and 2.4 GHz bands. This balance, however, appears to be based in large part on the unattractiveness of SS experimentation in the amateur service due to the restriction in the rules that limits amateur radio stations to using only two specified techniques for spreading emissions — frequency hopping and direct sequencing. We do not believe that this concern warrants retaining the current restrictions on amateur radio stations. As an initial matter, we note that Part 15 devices will only receive an SS transmission from an amateur radio station if the station is using the same spreading or coding scheme as the Part 15 device, if the amateur station is transmitting at the same time and on the same channels as the Part 15 device when it is in use, and if the amateur station is within the reception range of the Part 15 device. The Part 15 Coalition has not shown with any degree of certainty that this coincidence of events is likely to happen frequently. Further, Part 15 devices do not require the user to have any technical knowledge of how the device works or its potential for interference, and use of unlicensed Part 15 devices is conditioned on the user accepting interference from the operation of an authorized radio station, another Part 15 device or ISM equipment. Additionally, the use of automatic power controls by amateur stations that transmit SS emissions and other technical solutions discussed below are expected to further reduce the interference potential. We will, therefore, amend Section 97.311 of our rules as proposed.

## II. Automatic power control

**Background.** Under our current rules, an amateur station must use the minimum power necessary to carry out the desired communications regardless of the emission type, spreading technique, or frequency band used. In addition, amateur stations transmitting SS emission types are restricted to a maximum transmitter power of 100 watts (W). In the Notice, we proposed that automatic power control circuitry be required whenever an amateur station transmits an SS emission with more than 1 W. This requirement was intended to ensure that the output power is limited to the minimum level necessary to conduct communications so that interference with other amateur radio stations and users of the frequency bands would be minimized.

**Decision.** The comments are divided over the need and ability to implement automatic power controls. Some commenters believe that such controls would have an inhibiting effect on amateur service communications. For example, Messrs. Johnson and Tynan point out that automatic power control devices can not be used for either multi-point-to-multi-point applications or point-to-multipoint applications, such as spacecraft telemetry. Mr. Carpenter states that such control devices would constitute excessive government regulation. Tucson Amateur Packet Radio Corporation (TAPR) also believes that the proposed rule is unnecessary, and that current Section 97.313(a) is sufficient. While Mr. Karn points out that the use of the automatic power control and other technical measures could lead to an increase in the number of users that can simultaneously share the channel, he nonetheless believes that adoption of automatic power controls should not be mandatory. Further, TAPR and Mr. Karn criticize the present rule as impeding Earth-Moon-Earth (EME) communication experimentation using SS emission types because the 100 W limit is imposed only on stations transmitting SS emissions. They point out that the high antenna gains and skyward-pointing antennas generally used with EME protect terrestrial operations from interference regardless of the emission type the station is transmitting. They conclude, therefore, that the 100 W limit imposed only on stations transmitting SS emission types is unnecessary.

In contrast, the implementation of automatic power controls is supported by the American Radio Relay League, Inc. (ARRL). The Central States VHF Society also believes that automatic power controls are necessary. In this connection, it believes that amateur stations transmitting SS emissions will be using the maximum power available because these stations will be sharing spectrum with stations using other communication modes that require the transmission of considerable power.

After review of the record, we conclude that the automatic power control requirement proposed in the Notice should be adopted. We conclude that such a

requirement is reasonable in mixed-mode frequency bands until sharing protocols are sufficiently developed to satisfy users that stations can avoid inter-mode interference. Further, we believe that power limits are a reasonable tradeoff between the wideband characteristics of SS emissions and the ability and flexibility to use various spreading codes. We decline to adopt the suggestion by the ARRL and Mr. Carpenter that the power level of the SS emission be limited to one watt and the automatic power control requirement be dropped. We note that we did not propose to reduce the maximum authorized power for stations transmitting SS emissions. Additionally, we are concerned that reducing the authorized maximum power for SS emissions to the level suggested by the ARRL and Mr. Carpenter could adversely affect SS experimentation in the amateur service and would effectively reduce amateur stations transmitting SS emissions to the status of Part 15 devices.

### C. Methods to minimize potential interference.

**Background.** In the Notice, we also solicited comments regarding methods available, other than automatic power control circuitry, to minimize any potential interference between amateur station operations and Part 15 devices, even though Part 15 devices have no interference protection rights under our rules and no domestic or international allocation status. We solicited these comments because Metricom expressed concern that amateur radio operators will obtain commercial Part 15 SS devices and modify them for use under our Part 97 rules. Symbol, a manufacturer of unlicensed Part 15 devices, was concerned that the disparity between authorized power for amateur stations and unlicensed devices will affect the operation of unlicensed devices in the vicinity of amateur stations.

**Decision.** The comments contained technical and other non-regulatory suggestions for mitigating unwanted reception of SS transmissions. For example, Mr. Karn states that SS interference can be minimized by using directional antennas with point-to-point links. For communication over long distances, he recommends maximum power signal relaying over the use of high power and, to address the "near-by problem," he recommends geographical band plans. He further states that transmission sources can be found by using direction finding techniques. Another technique that can be useful in locating and resolving unwanted reception of an SS emission is to allow SS systems to voluntarily incorporate a Morse code identification transmitter that can be demodulated by a conventional receiver. Once the call sign of the transmitting station has been determined, the mailing address of the licensee can be found in many of the numerous internet databases that list licensee information or by accessing the Commission's databases. These suggestions are generally supported by the ARRL.

These suggestions also convince us that amateur radio operators interested in SS communication are willing to accommodate each other and other users of the spectrum and that they are willing and capable of resolving interference should it occur, through technical means. For this reason, we do not believe it is necessary or desirable for us to adopt rules, other than the automatic power control requirement, that specify or could limit methods available for resolving potential interference between amateur station transmissions and other users of these frequency bands.

### D. Other issues

#### I. Station record keeping and identification

**Background.** Section 97.311(e) of the Commission's rules requires that the station records document all SS emission transmissions and these records be retained for a period of one year following the last entry. Mr. Johnson is concerned that amateur radio operators may not have the technical expertise or know-how to comply with this rule, and that this rule does not have a hearing on their ability to use SS emission types. He also states that retention of this requirement unnecessarily burdens the station operator, thereby leading to a decline in the incentive to contribute to the development of SS modes within the Amateur Radio Service. TAPR would like the Commission to establish parity between SS and all other emission modes, and delete the requirement of this section. In contrast, ARRL does not believe that this requirement is too burdensome.

In addition, Section 97.119(b)(5) requires that a station transmitting an SS emission must transmit its assigned call sign at the end of each communication, and at least every ten minutes during a communication, by a CW or phone emission during SS emission transmission on a narrow bandwidth frequency segment. Alternatively, the station may identify itself by changing one or more parameters of the emission so that a conventional CW or phone emission receiver can be used to determine the station call sign. One of the purposes of station identification is to clearly make the identity of the station transmitting known to those receiving the transmission.

TAPR states that this requirement causes interference and, as a result, outweighs any benefits accrued regarding monitoring. Further, it suggests that conventions for station identification should be developed by the amateur radio community rather than the Commission. The Manager of the National Communications System points out there is no currently available Commercial Off The Shelf (COTS) spread spectrum equipment which complies with this rule. In fact, he believes that deletion of this rule could lead to an increase in the availability of COTS equipment. ARRL does not believe that this requirement is too burdensome; rather, it believes that the

requirement is "designed to permit self-regulation and compatibility determinations involving a mode that is difficult to monitor."

**Decision:** The basis for the station record keeping requirement was a concern that the Commission and amateur radio licensees could not monitor readily SS emissions and therefore ciphers or other prohibited messages could be transmitted by stations using SS emissions. To date, we are not aware of any instances of improper messages being transmitted by amateur stations and the record in this proceeding does not indicate to the contrary. We agree that this requirement no longer serves a useful purpose and that eliminating it is a logical outgrowth of our proposal to remove restrictions on the spreading techniques that amateur radio stations may transmit. Further, we are concerned that keeping these records may discourage amateur radio operators from experimenting with SS emissions. We see no regulatory purpose being served by requiring amateur radio stations that transmit SS emissions to keep different records than amateur radio stations transmitting any other emission type. Therefore, we will revise Section 97.311 to remove the recordkeeping and retention requirement as requested by Mr. Johnson and TAPR. With respect to the station identification requirement, we will revise the rule as TAPR requests because we find that Section 97.119(b)(5) of the Commission's rules is unclear and also duplicates Sections 97.119(b)(1) and (2). Stations transmitting SS emission types can identify themselves using the methods specified in either of these sections.

## 2. Types of SS

The Central States VHF Society and Mr. William Tynan suggest that we define a "Broad Band" SS that would incorporate the bandwidth proposed by the Commission in the Notice, and a "Narrow Band" SS that could occupy a bandwidth of perhaps 10 kHz and be authorized on all the amateur bands above 50 MHz, which are presently open to SSB and AM, so long as the bandwidth of the transmitted signal does not exceed that of an AM voice signal. ARRL opposes this suggestion on the basis that no additional frequency allocations for SS emission types were proposed. Instead, it states that the intent of the Notice is to permit the use of additional spreading codes in order to provide SS users with additional flexibility to determine which spreading codes provide the minimum interference to potential narrow-band amateur modes. We agree with the ARRL, and will not grant this request because it is premised on SS being transmitted on additional amateur service frequency bands. We also believe that subdividing SS emission types is unnecessary and inconsistent with the experimental nature of the Amateur Radio Service.

## 3. SS emissions and interference to satellite, EME and repeater communications

A number of commentors express concern that if a significant number of additional stations start transmitting SS emissions, interference to ongoing modes of amateur service communications will increase. In an effort to mitigate this anticipated problem, Central States VHF Society and Mr. William Tynan propose that spread spectrum emissions be restricted to band segments that are not used by amateur stations for weak signal communications. Mr. Carpenter also is concerned that the power of stations transmitting SS emissions will cause insurmountable interference for weak signal operators. AMSAT requests that the rules be amended to exclude SS emissions from specific frequency segments used for satellite communications. Mr. Ralph Soifer requests that frequency segments be reserved for EME operations. The Southern California Repeater and Remote Base Association expresses concern about potential interference between stations transmitting SS emissions and amateur stations operating as repeaters. The 220 MHz Spectrum Management Association of Southern California proposes that the burden of interference resolution between SS and the narrowband modes be placed on the "uncontrolled emitter."

In contrast, TAPR opposes these requests. It believes that we should restrict our role to setting technical standards and leave the setting of conventions for other operations to the amateur radio community. Mr. Kam states that interference between SS and other amateur use is rare. ARRL argues that most repeater usage is on frequency bands below the bands where SS emissions are authorized and further restrictions on SS spectrum are unnecessary. Its position is that the current rules have already placed stations transmitting SS as subordinate in the hierarchy of emission modes.

We agree with the ARRL that the rules we are adopting will adequately address this potential interference concern. Specifically, Section 97.311(b) will require that a station transmitting SS emissions must not cause harmful interference to stations employing other authorized emissions, and must accept all interference caused by stations employing other authorized emissions. This rule change clarifies that stations transmitting SS emissions will remain, as they are now, secondary to other stations on the frequency bands they are authorized to transmit on. We also note that the rule changes do not extend any new frequency allocations to stations transmitting SS emissions. Therefore, concerns about interference to repeater stations or other stations that transmit on frequency bands below the 70 centimeter (cm) frequency band are unfounded because SS emissions are not authorized below the 70 cm frequency band.

We will not revise the rules to prevent SS emission types from being transmitted in any frequency band on the basis that SS emissions may interfere with the operating activities of other Amateur Radio Service licensees. We agree with Mr. John C. Koster that the application of rules such as Sections 97.313 and 97.101(c) and (d) should help to minimize interference. We also note that interference between amateur radio stations is already addressed generally by Section 97.101(d), which prohibits operators from willfully or maliciously interfering with or causing interference to any radio communication or signal. Additionally, we believe that excluding specific emission types from additional frequency segments based on the specific operating interests of individual licensees or groups of licensees is inconsistent with the principle that each station licensee and each control operator must cooperate in selecting transmitting channels and in making the most effective use of the frequencies allocated to the Amateur Radio Service and that no frequency will be assigned for the exclusive use of any station. A hallmark of the Amateur Radio Service has been that all frequencies are shared. The expectation of any station that it can operate in a totally interference-free environment, therefore, is unreasonable. We also believe that subdividing amateur service frequency bands would undercut the voluntary band planning that the amateur service community does and would result in a loss of flexibility to reallocate spectrum as licensee's operating interests change, new technologies are incorporated, and frequency bands in the radio spectrum are reallocated.

#### **4. Outstanding Special Temporary Authority grants**

During the pendency of this proceeding, two Special Temporary Authority (STA) grants authorizing, among other things, certain amateur radio stations to transmit SS emission types that were not permitted by Section 97.311 and to transmit SS emissions on frequency bands not authorized by Section 97.305(c) have remained in force. Our decision in this proceeding obviates the need for the STAs because it eliminates the restriction on SS emission types that an amateur radio station may transmit.

#### **Appendix**

Part 97 of Chapter I of Title 47 of the Code of Federal Regulations is amended as follows:

#### **1. The authority citation for Part 97 continues to read as follows:**

Authority citation: 48 Stat. 1066, 1082, as amended; 47 U.S.C. 154, 303. Interpret or apply 48 Stat. 1064-1068, 1081-1105, as amended; 47 U.S.C. 151-155, 301-609, unless otherwise noted.

#### **2. Sections 97.3(a), (b), and (c) are amended by inserting numbers in front of each defined term in the**

**definitions, and revising Section 97.3(c)(8) to read as follows:**

#### **97.3 Definitions.**

(8) **SS.** Spread spectrum emissions using bandwidth-expansion modulation emissions having designators with A, C, D, F, G, H, J or K as the first symbol, X as the second symbol, X as the third symbol.

#### **3. Section 97.119(b)(5) is removed.**

#### **4. Section 97.305(b) is revised to read as follows:**

#### **97.305 Authorized emission types.**

(b) A station may transmit a test emission on any frequency authorized to the control operator for brief periods for experimental purposes, except that no pulse modulation emission may be transmitted on any frequency where pulse is not specifically authorized and no SS modulation emission may be transmitted on any frequency where SS is not specifically authorized.

#### **5. Section 97.311 is revised to read as follows:**

#### **97.311 SS emission types.**

(a) SS emission transmissions by an amateur station are authorized only for communications between points within an area where the amateur service is regulated by the FCC and between an area where the amateur service is regulated by the FCC and an amateur station in another country that permits such communications. SS emission transmissions must not be used for the purpose of obscuring the meaning of any communication.

(b) A station transmitting SS emissions must not cause harmful interference to stations employing other authorized emissions, and must accept all interference caused by stations employing other authorized emissions.

(c) When deemed necessary by a District Director to assure compliance with this Part, a station licensee must:

- (1) Cease SS emission transmissions;
- (2) Restrict SS emission transmissions to the extent instructed; and
- (3) Maintain a record, convertible to the original information (voice, text, image, etc.) of all spread spectrum communications transmitted.

(d) The transmitter power must not exceed 100 W under any circumstances. If more than 1 W is used, automatic transmitter control shall limit output power to that which is required for the communication. This shall be determined by the use of the ratio, measured at the receiver, of the received energy per user data bit ( $E_b$ ) to the sum of the received power spectral densities of noise ( $N_0$ ) and co-channel interference ( $I_0$ ). Average transmitter power over 1 W shall be automatically adjusted to maintain an  $E_b/(N_0 + I_0)$  ratio of no more than 23 dB at the intended receiver.

## Nominations Sought for TAPR Board of Directors

Tucson Amateur Packet Radio is incorporated in the State of Arizona as a non-profit scientific and educational institution. It is recognized by the IRS as a 501(c)(3) tax-exempt organization for these same purposes. TAPR is governed by a 9-member Board of Directors. Each member of the Board serves a three year term. Every year three positions are up for election.

Board members are expected to attend two board meetings held in conjunction with the Dayton Hamvention and the ARRL and TAPR Digital Communications Conference. They participate in the decision-making process and provide guidance to the officers. They receive no pay and must defray most of their own expenses to attend meetings. Board members should be prepared to be active in the continuing Board deliberations, which are conducted via the Internet. Active participation in TAPR activities by Board members is important to the furtherance of the objectives of TAPR. The officers of TAPR are elected by the members of the Board at the annual Board of Directors meeting.

The current members of the Board of Directors and their expiration dates of their terms are:

* Greg Jones, W5IVD	2000	President
* John Kester, W9DDD	2000	
* Mel Whitten, K0PFX	2000	
John Ackermann, N8UR	2001	Vice President
Doug McKinney, KC3RL	2001	
Barry McLarnon, VE3JF	2001	
Steve Biale, N7HPR	2002	
Steve Dimsa, K4HG	2002	
Bob Hansen, N2GDE	2002	PSR Editor

Nominations are now open for seats expiring in March 2000 (marked with an asterisk).

To place a person in nomination, please remember that he or she must be a member of TAPR. Confirm that the individual is willing to have their name placed in nomination. Send that person's name (or your own if you wish to nominate yourself) along with your call and their call, telephone numbers, mailing address, and Internet address. The person nominated should submit a short biographical sketch to be published along with the ballot.

Nominations and biographical sketches should be submitted to the TAPR office no later than December 15th, 1999.

Ballots will be mailed in January. TAPR will again use an Internet ballot in conjunction with a letter about the balloting. Results will be announced on March 30th, 2000.

Responsibilities of a board member include:

- 1) Attendance at both board meetings each year.

- 2) Regular participation with the continuous session of the board (currently held over the Internet). Typically this requires a minimum of 3 hours a week, although sometimes much more is required during active board discussions.

- 3) Participation with TAPR projects as volunteered. Board members, while not required, are involved with various project management, ongoing organization and/or supervision/triaison positions. Active board participation with various projects make many of the most important projects and tasks possible. Board members are expected to take an active part in TAPR in some form.

All nominated members will be placed on the ballot and the highest vote receivers will be placed in the open board positions. All directors shall serve for a term of three years.

## A Thank You to TAPR

Kenwood Communications Corporation would like to thank each member of TAPR. Our thanks are not only for purchasing so many of our radios, but also for what TAPR represents to the future of the entire Amateur Radio community. Kenwood will do its best to listen to you for new ideas and opportunities to help create your visions into the highest quality, state of the art, Amateur radios made anywhere in the world.

TAPR is what Amateur radio is all about. Over the past +100 years of Amateur radio, many things have changed. The technologies have grown and the users needs are constantly changing. The spirit that lived within the founders, Marconi, Maxim and others who helped to seed the imaginations for other experimenters to design, build, and improve ideas is alive in TAPR. Today we have a world full of wireless communications that society takes for granted. Without Amateur experimenters we might still be only dreaming of talking across the oceans. We might never have heard Neil Armstrong's famous words, "One small step for man, one giant leap for mankind." Amateurs made wireless communications what it is today!

TAPR is a special organization, of which, each of you should be proud to belong. Your mission is clear and your goal is pure in character and meaning. In many ways, Kenwood thinks of TAPR members as the "Green Beret" or "Samurai" of Amateur Radio.

Don't ever forget your focus and your meaning as an organization. Thank you for helping to keep the spirit and the fun of Amateur radio alive and well forever.

73

Kenwood Communications Corporation

September 24, 1999



## PIC-E FRAM Modification: Souping up your PIC-E

Mike Berg, N0QBII

I recently modified one of my PIC-E units to include a Ramtron 25160 2k serial FRAM IC, yet retain it's ability to run all of the original programs. (FRAM stands for Ferroelectric RAM which retains its memory contents without power applied.) I wrote a packet receive program to go with it which allows the PIC-E to receive and display entire packets up to 255 bytes on a Palm PDA w/PalmAPRS. It's at:

<http://ftp.tapr.org/picsig/software>

This differs from my previous code which would only copy up to 53 bytes of each packet due to the 16F84's limited memory. The mod is non-destructive and adds the 8 pin Ramtron 2k serial FRAM IC to the PIC-E using a small daughterboard and 6 pin connector. I used a 6 pin MTA-100 AMP brand connector and housing because I had access to the crimp tool and 28 ga. hookup wire.

I made mine from solder ringed proto board, but you can use your imagination in making the connection; the main requirement is being able to disconnect the FRAM daughterboard from the PIC-E pcb while programming the PIC processor. The whole works tucks neatly within the Radio Shack case.

I obtained my FM25160 chips as samples from Ramtron thru my employer. The Ramtron web page [www.ramtron.com](http://www.ramtron.com) says you can order them for about \$5 each and most states have a local distributor listed on the page as well.

I also added a 1/8" audio jack coupled to the receive audio path with a 1 uF capacitor. This makes it easy to set up a very portable monitor/tracking station using a handheld, modified PIC-E, and a PalmPilot running PalmAPRS.

### Making the Modification

To do this, I mounted the 8 pin FRAM IC on a daughterboard a bit larger than a stamp and used a 6 pin right-angle disconnect header to tie it into the PIC-E pcb. Five of the 6 pins on the connector are used, they include: +5v, Ground, RAM chip select, RAM clock and RAM data in/out on a common line.

The PIC-E pcb is viewed from the front (LED end).

FRAM pin	Goes To:
8 Vcc	PIC-E Vcc hole on wide, vertical trace, right side of C4: 5v reg.
7 /HOLD	Tied to FRAM Vcc on daughterboard
6 SCK	PIC-E R6 lower lead (ties to B:6)
5 SI	PIC-E R2 upper lead (common w/SO)*
4 GND	PIC-E D2 right lead (PIC-E ground)
3 /WP	Tied to FRAM Vcc on daughterboard
2 SO	PIC-E R2 upper lead (ties to A:0)*
1 /CS	PIC-E R4 lower lead (ties to B:7)

\* Pins 2 & 5 on the daughterboard are tied together (SO/SI) with a single wire, tied to (R2 upper lead) A:0). Vcc and ground can be taken from other places on the PIC-E, try to stay close to the regulator IC to minimize noise. I also included a 1 uF bypass cap on the RAM pcb between Vcc and ground.

**Programming is done with the FRAM pcb disconnected!**

To make use of this new hardware, I wrote a packet receive program called RAMPICER.ASM which can be assembled and programmed into the modified PIC-E. Just be sure to unplug the RAM board from it's connector while programming. This is because the FRAM shares 2 of the lines used to program the PIC-E; and we don't want to put programming voltage to the FRAM IC.

Afterwards, plug in the FRAM pcb and check the following jumpers.

JP 1	OFF
JP 2	"N" (on 1&2)
JP 3	ON
JP 4	ON (off to prgm)
JP 5	RXD (on 1&2)

Data is out the GPS male 9 pin connector on the PIC-E. Connect to your Palm hotsync serial cable with PalmAPRS or a serial communication program set to 4800,8,1 and apply power. You should see a sign on message:

TURBO PIC-E packet decoder v 0008 1999

Connect the RJ45 jumper from the PIC-E to the radio as usual. Audio from the mic connector must be squelched! Volume should be set low but audible. If all is well, packets should be appearing in the view packets screen on the PalmPilot. Since the serial output is 0-5v (instead of RS-232 voltage levels), I had mixed results when connecting to a PC. My old 486 works perfect, but my new AMD K6 doesn't.

To use the PIC-E with original software, unplug and remove the FRAM daughterboard, configure jumpers and program as usual.

## ARRL Task Force Seeks Future Technology Proposals

*(From the ARRL Bulletin)*

The ARRL Technology Task Force wants to hear from hams with ideas and proposals for new technology to carry Amateur Radio into the next century. The ARRL Board of Directors created the Task Force and the companion Technology Working Group last January, and ARRL President Rod Stafford, W6ROD, has appointed a number of leading amateurs to serve on both panels. The Task Force and the Working Group will work hand-in-hand to identify, evaluate, and promote the most promising 21st Century technologies for Amateur Radio.

The Task Force consists of members of the ARRL Board family and the Headquarters staff. Chairing the Task Force is ARRL First Vice President Steve Mendelsohn, W2ML. Other TTF members are Roanoke Vice Director Dennis Hodson, W4PWF; Hudson Director Frank Fallon, N2FF; New England Director Tom Frenaye, K1K1; Southwestern Vice Director Art Goddard, W6XD; Pacific Director-elect (and current Vice Director) Jim Maxwell, W6CF; International Affairs Vice President Larry Priebe, W4RA; and Rocky Mountain Director Walt Stinson, W0CP.

The Technology Working Group will evaluate technical proposals and make recommendations to the Technology Task Force, which, in turn, will make specific policy proposals to the ARRL Board of Directors.

The Working group is an expert panel selected from among League members representing a broad spectrum of Amateur Radio interests and activities. Chairing the Working Group is CQ Editor Rich Moseon, W2VU. Other members are AMSAT-NA President Keith Baker, KB1SP; Peter Coffee, AC6EN, a computer industry analyst; Mike Cook, AF9Y, Engineering Director of Communications Systems Engineering, ITT Aerospace/Communications Division; Gene McGahey, NR0NR, Deputy Manager of Communications Technology, NLECTC (NIJ/DOJ); ARRL Technical Relations Manager Paul Rinaldo, W4RI; Dennis Silage, K3DS, a Temple University professor involved in digital communications; and QEX Editor Doug Smith, KF6DX.

ARRL Laboratory Supervisor Ed Hare, W1RF1, will serve as ARRL HQ staff liaison to both committees.

The Task Force invites information and concepts on a wide range of technologies with the potential to improve Amateur Radio and to promote what the FCC calls "continuation and extension of the amateur's proven ability to contribute to the advancement of the radio art." The Task Force invites the submission of ideas and proposals from all parts of the amateur community, and will use the input to help formulate League policy recommendations on a wide range of technical issues.

Amateurs are invited to complete the form on the ARRL Website at [www.arrl.org/news/ttf/](http://www.arrl.org/news/ttf/), send e-mail to the Task Force at [trinput@arrl.org](mailto:trinput@arrl.org), or offer your ideas by mail to the ARRL Technology Task Force, c/o Ed Hare, W1RF1, 225 Main St, Newington, CT 06111. Suggestions are requested by November 30, 1999.

## APRS Protocol Specification

John Ackermann, 2N0UR  
[ja@fobu.com](mailto:ja@fobu.com)

The new draft of the APRS Protocol Reference specification is going through the final phases of update, and we expect to publish it towards the end of November.

This is a little later than originally anticipated -- the delay is due to the document's having grown from the original 17 pages to more than 70 over the last three weeks!

The new draft incorporates detailed packet format diagrams, the APRS symbol tables, descriptions of compressed data format and Mic-E format (with a complete appendix explaining in detail how to decode Mic-E packets), and many more examples of APRS packets in general.

There is an enormous amount of detail in the document which the APRS Working Group is now double-checking. We're sure you'll like the finished result, and will find it's been worth waiting for. Because the document has been virtually rewritten since the original draft, we will have another public comment period prior to final adoption of Version 1.0.

I'd like to thank the APRS authors as well as our technical editor, Ian Wade, G3NRW, who have exchanged hundreds of emails over the last few weeks trying to nail down obscure points in the protocol. Their hard work has made a real difference in the document we'll be delivering. I'd also like to thank everyone who commented on the original draft; all those comments have been taken into consideration for this iteration.

## Differential GPS Reference Station Interface Board



Differential GPS Reference Station Interface Board

### Description

The Differential GPS (DGPS) Reference Station Interface Board connects to a Motorola Oncore VP OEM GPS receiver to create a low cost 8-channel DGPS Reference Station. The Reference Station provides Pseudo-range Differential GPS corrections that conform to the RTCM SC-104 Type 1 message format. Corrections can be transmitted via data link to remote users. Possible data links are radio modems, terminal node controllers (TNC), or telephone modems. Remote users receive the corrections and apply them to their DGPS ready receiver to calculate a DGPS solution. For example, a Radio Amateur installation would use a 2-meter transmitter and TNC. Using the 2-meter frequency of 144.39 MHz, the new APRS frequency, APRS trackers can take advantage of DGPS accuracies (see performance below). No special equipment is needed by remote users. Corrections are received using a 2-meter (mobile or handheld) receiver and TNC. The output of the TNC is connected to a DGPS "ready" receiver. Commercial users can connect the DGPS Interface board to commercial data radios. The responsibility of using the correct frequencies is up to the user.

Possible uses include:

- Search and Rescue
- APRS Trackers
- Parades
- Marathons
- Balloon Tracking
- Research and Development
- Vehicle Location in a metropolitan areas
- Anything that requires increased GPS accuracy



Example of Oncore attached to DGPS Interface Board

Setup of the DGPS Reference Station is easy. The output baud rate and the Station ID is selectable via jumpers. The latitude, longitude, and altitude of the reference location and the rate at which corrections will be transmitted are programmed via software commands. The Reference Station then operates without any further intervention.

### Features

- Operates with the Motorola Oncore VP 8-Channel GPS Receiver
- Reference Station is Compatible with DGPS "ready" receivers that accept RTCM SC-104 Type 1 Messages
- Easy setup and operation, suitable for portable operations
- Programming via RS-232 serial port
- Outputs RTCM SC-104 Type 1 Message with a selectable RS-232 output baud rate: 1200, 2400, 4800, and 9600 baud
- Selectable Station ID: 0 - 1023
- Power Requirements: 7 - 30 VDC
- Power Consumption: 235 milliamps typical with Oncore VP with Active antenna
- Lithium; Battery Backup Option for Oncore VP's without battery backup

### Purchasing Information

The price is: \$179.00 US for members of TAPR or \$199.00 US for non-members and includes:

- DGPS Ref Station (semi-kit)
- Documentation

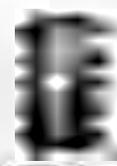
Please note: This is not an enclosed/sealed unit. It is assumed that the purchaser will be installing the unit in another enclosure for normal and experimental operations. No 10% Discount for TAPR Members. Due to the nature of the purchase, the \$179 purchase price for TAPR members represents the membership discount.

Kit	Price	Qty	Total
<b>PC's/Encoder</b>			
CompactFlash Card Adapter	\$65.00		
Motorola EVMS6002 Interface	\$150.00		
TAPR APRS™ MIC-Encoder™	\$149.00		
TAC-2 (Totally Accurate Clock)	\$139.00		
Differential GPS Member Price	\$129.00		
EA5 (U334) Accessory Squelch	\$60.00		
AN-93 HF Modem	\$90.00		
TAPR 9600 bps Modem	\$80.00		
Rit Regenerator	\$10.00		
Clock Opicon	\$5.00		
PK-232 Modem Disconnect	\$20.00		
PK-232MBX Installation Kit	\$20.00		
XR2211 DCD Mod	\$20.00		
State Machine DCD Mod	\$20.00		
State Machine DCD w/Int Clock	\$25.00		
<b>Firmware</b>			
32K RAM w/ TNC-2 update door	\$30.00		
TNC-2 1.1.9 w/KISS EPROM	\$15.00		
1.1.9 Commands Booklet (only)	\$8.00		
TNC-2 WAGED EPROM	\$12.00		
TNC-1 WAGED EPROM	\$12.00		
TNC-2 KISS EPROM	\$12.00		
TNC-1 KISS EPROM	\$12.00		
PK-87 WAGED EPROM	\$12.00		
<b>Publications</b>			
TAPR Spread Spectrum Update	\$18.00		
1998 TAPR CD-ROM	\$30.00		
1997 TAPR CD-ROM	\$20.00		
Wireless Digital Communications	\$39.99		
Packet Radio: What? Why? How?	\$12.00		
BBS Symp Guide	\$9.00		
NOSHiro, Intro to K4SO NOS	\$23.00		
TAPR's 94 Annual Proceedings	\$7.00		
TAPR's 95 Annual Proceedings	\$7.00		
PSR Set Vol 1 (#1 - #17 '81 - '85)	\$30.00		
PSR Set Vol 2 (#18 - #36 '86 - '89)	\$30.00		
PSR Set Vol 3 (#37 - #52 '90 - '93)	\$20.00		
PSR Set Vol 4 (#53 - #68 '94 - '97)	\$35.00		
ARRL/TAPR 1996 DCC	\$15.00		
ARRL/TAPR 1997 DCC	\$15.00		
ARRL DCC Proceedings 1st - 16th	call		
Gracie Set ARRL DCC 1st - 16th	\$120.00		
<b>Other</b>			
TAPR 1 for Coffee Mug Logo	\$11.00		
TAPR Badges	\$10.00		
TAPR Shirt - 4 styles			
1 1/2" Disk from TAPR Library	\$3.00		
<b>GPS</b>			
TAC-32 Software Registration	\$55.00		
Garmin GPS-25 (Member Price)	\$139.00		
Garmin GPS-2025 Interface/Power XA	\$40.00		
Garmin GPS-2025 Data Guide	\$18.00		
Garmin CA-71 GPS antenna	\$78.00		
Oncore VP GPS (Member Price)	\$269.00		
Oncore VP Interface/Power Kit	\$40.00		
Oncore GT+ GPS (Member Price)	\$169.00		
Minotaur Antenna 92	\$65.00		
MILC Rt-Ang Connector w/coax pigtail	\$15.00		

- 3. A FlashCard is not included in the kit
- 10. http://www.tapr.org/gpaplans/bbs/00000000.html
- 10. Register a GPS in your state
- 10. Register a GPS in your state
- 7. As seen in Dec 95 QST
- 7. Limited time available
- 1. Used for registration repeat operation and for registration repeat operation
- 2. simplifying commission of general meeting for installation of W00 in kit (1.1.9-2.11.11)
- 2. NEW DCC (w/ARL) 1996-1997 DCC kit disk
- 2. Includes 1.1.9 Commands booklet (booklet)
- 2. Full TNC-2 component set for 1.1.9
- 2. If course version for ARRL/DCC purchase
- 8. 200+ pages on APRS Spread Spectrum Topics
- 4. 150 WWA, 400 steps of intro w/ Mini kit page
- 4. 150 WWA, 400 Steps of Intro w/ Mini kit page
- 5. 100+ pages written by: Tom Whittemore, N4RQ
- 5. 100 pages - TAPR's Packet Radio book - 60 pages - by: Barry Buehler, W4OMT
- 6. 1st Week (1987W, TCRP) and Packet Radio
- 6. Papers from the Annual Meeting (Tucson)
- 6. Papers from the Annual Meeting (La Lunas)
- 4. 1996 DCC Proceedings Chicago, IL
- 4. 1997 DCC Proceedings Baltimore, MD
- 14. Individual Proceedings, call for prices - 12 Proceedings from 1981 to 1997
- 4. Logo in black and not-removable gilt
- 4. Include Name and Call for badge
- 0. http://www.tapr.org/page/firstkit.htm
- 0. \$3 and disk - see TAPR Software Library List
- 0. No Discount (also come included)
- 4. No Discount
- 2. No Discount

Subtotal:  Added Total Kit Codes

All prices subject to change without notice and are payable in U.S. funds. Members receive 10% off on Kits and Publications. Please allow six to eight weeks for your order to be shipped. For specific information on kits, see Product Description files.



**Tucson Amateur Packet Radio**  
 8987-309 E. Tanque Verde Rd #337  
 Tucson, Arizona • 85749-9399  
 Office: (940) 383-0000 • Fax: (940) 566-2544  
 Internet: TAPR@TAPR.ORG • www.tapr.org  
 Non-Profit Research and Development Corporation

May 1998

www.tapr.org • ftp.tapr.org • tapr@tapr.org  
 Office Hours: Tue-Fri 9am-12pm, 3pm-5pm CT

Membership	Price	Number of Years	Total
United States	\$20.00		
Canada/Mexico	\$20.00		
International	\$25.00		

Renewal     New Member

SubTotal

Membership 10% Discount

Member #: \_\_\_\_\_ (Place new if joining)

Total Sales (Subtotal minus discount)

Texas Residents (7.75% tax)

Membership (New or Renewal)

Shipping and Handling

For Total Kit Codes Between

1-3	4-7	8-15	16-27	28-55
Add \$3	Add \$5	Add \$6	Add \$7	Add \$8

Kit Codes above 55 or International orders must contact TAPR for amount.

TOTAL Order Amount

Charge my credit card (check only)

VISA     MasterCard

Acct # \_\_\_\_\_

Expiration Date: \_\_\_\_\_

Signature on card: \_\_\_\_\_

Name / Call: \_\_\_\_\_

Street Address: \_\_\_\_\_

City / State / Zip: \_\_\_\_\_

Country: \_\_\_\_\_ Phone Number: \_\_\_\_\_

Internet E-mail: \_\_\_\_\_