

# PACKET STATUS REGISTER

Tucson Amateur Packet Radio Corporation

August 1988  
Issue #32

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Tucson Amateur Packet Radio  
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- AEA PK-232 Tips
- HF Modem Alignment Procedures from N7CL
- And much more!

Next Scheduled PSR Issue:  
November 1988  
Editorial Deadline: 10/20/88

## PRESIDENT'S CORNER

by Andy Freeborn, NØCCZ

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Earlier, the TAPR Board of Directors had elected to underwrite the communications development costs of the AMSAT-NA satellite. This will include all of the associated electronics communications equipment, including computers and radios, as well as the batteries and solar panels to operate the satellite. The actual development and fabrication of the necessary electronics equipment will be done almost entirely from within TAPR membership.

Each satellite consists of a bus of common design. Each bus carries a mission-specific payload. AMSAT-NA and AMSAT-LU payloads are packet radio transponders. BRAMSAT's payload is a voice synthesizer transmitting easily-heard VHF FM downlinks. The CAST payload is an earth-looking CCD camera.

The most unique characteristic of each satellite is its size and mass. Only 23cm (9 inches) on a side, each cubical spacecraft will weigh in at less than 10kg (22 lbs). The small mass and volume make it feasible to launch these spacecraft inexpensively using available launch vehicle space which might otherwise go unused.

The spacecraft are seen as pioneering a new class of payload analogous to NASA's Shuttle Getaway Special canister (GAS can) only smaller. GAS cans are capable of carrying several hundred pounds.

Since the tiny spacecraft can fit where larger ones cannot, many more near-term launch opportunities are available. While a major payload weighing a ton might have to wait 5 years or more to obtain a launch to orbit, the new AMSAT satellites

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Several design reviews have already taken place on the four satellites. Construction has begun and initial testing is planned for early autumn. Construction is being accomplished in a facility in Boulder, Colorado under the leadership of Jan King, W3GEY. Design activities are carried out in Boulder and several other cities in the U.S. and Canada.

AMSAT-NA contracted for an early 1989 launch for the first four satellites. The four satellites will be launched into a polar, low earth orbit by Arianespace early next year. The primary payload will be the French SPOT-II mission. A firm launch date is about to be announced. Late winter to early spring are AMSAT's estimates at this time.

TAPR members can expect updates on PACSAT progress in future PSR issues. Also see the AMSAT newsletter Amateur Satellite Review (ASR) for future news.

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73, Andy NØCCZ

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by Bob Gobrlick WA6ERB

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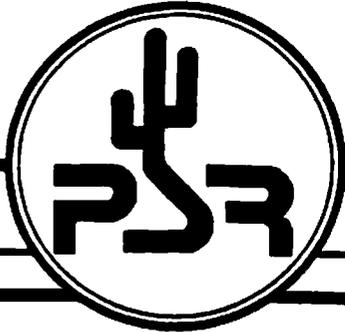
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## Big Sky Telegraph and Other Stories

by Dave Hughes

Let me begin by saying what I know about radio, including amateur, much less packet you can put on the head of a pin. But that's where I started in computers 11 years ago too, so I guess it is no disgrace.

But I also sure know an important thing when I see it - as I did microcomputers in 1977 and modems in 1979 - so when Andy Freeborn whom I had known for several years in Colorado Springs as we hacked around the mysteries of early Tandy computers mentioned in 1982 something called 'packet' I became keenly interested. My interest then, as now, was how to put packet radio to general beneficial public use as I had done dial up computer systems starting with a BBS and now with multi-user 386 unix with vpx, voice mail, fax, conferencing, email and data base use for business, politics, and education.

I swiftly learned that either I had to go the Ham route, or buy pricey equipment from some of the big commercial radio companies. That there was no 'public packet.' When Motorola showed me a \$4,000 device that cost more than an entire computer system for a small business, I knew that was not the route to take either.

I really admired the work TAPR had done in pioneering packet, but I knew that if I heeded the siren song of Ham Radio and became Ham licensed just so I could use packet, that I would not be able to apply it to small businesses, politics or formal educational uses, or secure the traffic by encryption. All the things that I was successfully developing using modem communications. So I decided to do it the hard way - get a business radio licence from the FCC that would permit packet, and put the system together out of all the parts needed, at the lowest cost consistent with being usable by small business.

The long and the short of it was that, with no one I could find who had tried this route, it took several years to pull

all the pieces together. And I had to work with some small local commercial radio companies who knew nothing about packet! I had bought a big fat copy of the Federal Telecommunications Regulations and I swear I read up on every frequency band which could conceivably be used for packet, and permit mobile operations with a base station. A group in the 150 mhz area looked promising. Then I learned one had to make application through some outfit called NABOR which does 'frequency coordination' for the FCC. So the helpful little radio store monitored the local frequencies for several weeks before deciding that 157.62 was silent all the time and application was made for that band. After an agonizingly long time I received a licence to operate at 157.62 mhz with a 100 watt base station in Old Colorado City and 6 mobile 50 watt stations. Which, all things being equal (and they never are) would let me cover all of urban Colorado Springs from a mobile station, hopefully from a hand held.

One day, while all this is going on, an international trader business associate of mine - Larry Fox - shows up in Old Colorado City with two ministers of government of the Zulu nation in South Africa! They were interested in packet because their field operations have

Partly because Gwyn Reedy of Paccom operated a Florida bulletin-board (813-874-3078) I chose to do business with him - cause I could do so via modem! I started with his TNC-220 and just as I was leaving for Montana to install and tend to a powerful small unix system that was designed to link the 116 one-room school houses of Montana to their teacher's college by modem, I got his newly released "Wireless Modem" - a TNC that was optimized for business use, had parallel printer ports, and even KISS - for eventual migration to TCP/IP and the Unix online world which I was familiar with.

I visited every commercial radio outlet in Colorado Springs when I was looking for a pair of radios. Not one had a handle on packet, and the Ham stores knew a lot about packet but were not very helpful on business-

frequency radios. Finally I settled on a pair of reasonably priced radios from Neutec - a 45 watt transceiver which could be used as either a base station, or operating at 12 volts, be mobile in a vehicle, and a 5 watt hand-held Neutec 'Marathon' which had the critical feature of external speaker and microphone jack ports for attachment to the controller.

Then on a local computer bulletin-board owned by Thom Foulks a helpful ham said that since 157.62 was so close to the ham 2 meter band frequencies that he thought a Ringo Ranger-type antenna would be just dandy. So that was it. I got one.

Now my concept of the value of packet radio to the general population was as much as an extension of telephone based modem communications as a thing separate from it. For in situation after situation I saw that the value of using lap portable microcomputers and modems was always limited by 'where is the nearest phone?' Or worse 'Where is the nearest phone not-a-multi-line-pbx-and-with-an-RJ11-jack.' Seldom found in any office. Even resorting to using the tiny Touchbase external battery-powered modems which have provisions for acoustic cups at 1200 baud is only a partial solution. One is always hooked to the end of the phone line. And not all phones are accessible by RJ-11 plugs.

And for schools! Well I am a passionate advocate of the formal teaching of 'telecommunications' right along with computers in schools, starting at a young age. For we are as much in a global 'communications' revolution as we are a 'computer' revolution. And nowhere do I see the subject taught. And frankly I am even tired of recent college Computer Science graduates telling me they never were exposed to digital communications in all four years of college, and never heard a modem tone!

But whenever I have suggested to educators that they integrate telecommunications into their curricula, I get back the argument that today's cost of telephone installation - especially into a modern large school whose architects never anticipated running phone

lines to classroom areas, plus the running monthly costs of a phone dedicated to modem use, is a major deterrent. For large modern schools the problem is cost of installation through new walls. For tiny rural schools it is the monthly cost for an instrument which may be only used a few hours a week, and only 9 months a year or less.

So to me, using packet radio is the answer, with a packet and low power radio at the classroom computer, or even on a rolling tray with the computer, a packet and radio at the nearest already-installed phone in the building, or nearby building, with a second external modem properly configured to permit a 'patch' into the phone to give outside access! With a total capital investment for the entire setup in the range of \$600 to \$1000, no real monthly running costs, the 'cost' problem for schools would be solved! (Or at least that 'excuse' dismissed conclusively)

Now I couldn't find any local hams who had used a packet hooked to a modem, rather than a computer. So I had to hack away with RS232 pin-outs, modem settings, and packet commands until I got that mighty modem AT command set 'OK' prompt back on my computer screen via packet and knew it was feasible.

I wanted to do something else. I may not know my radio, but I really do know my modem communications. On one of my dial-up systems for several years we have supported dual Ascii-NAPLPS sessions. NAPLPS is a very important ANSI-Canadian Communication's Board standard for the encoding, transmission and display of animated color graphics and text between unlike computers over telecommunications. So important that the new national 'Prodigy' computer dial up advertising-marketing service by IBM and Sears, after spending hundreds of millions on it and 4 years - is based on NAPLPS. And new services are being brought out by Bell Canada. No one yet has made a go of NAPLPS based services, but it is more than accidental that it is still being used as a standard. For it is highly compressed code - like 2 to 5 k for a full color screen, instead of 500k

for a 'bit mapped' one. And it is terminal independent. What you see on an IBM PC you can see on a Macintosh, a CAD/CAM workstation and a C-64. Thus, as all communications need be, it approaches universality.

But NAPLPS uses all 256 chars of an 8 bit set. It is a 'super-set' of ASCII. Yet it includes Ascii. So what goes over the modem line is any possible combination of all 256 chars. Would packet handle this without corruption? Lets try, I said. So on a trip to the IEEE Conference in Monterey, California, my host happened to be Ham Marc Kaufman. He and his Ham son picked me up at the San Jose Airport and we drove down US 101. As any self-respecting Ham would have, he had his 2 meter gear in his van, his MFJ packet, and his son operated a Model 100 hooking up to a rich variety of packet stations, starting with a guy on a bike in Mountain View through digipeaters. Aha, I said. Can we try my computer? A Toshiba 1100 at the time. So with me issuing the Procomm and PC commands, he running the packet commands, we connected to a Red Cross Packet BBS, opened an upload file and uploaded without either error-checking from the terminal programs or the Transparent Mode of the packet a 5 k NAPLPS file. Then turned around and slipped a NAPLPS Terminal Program into the lap top, and called for the remote BBS to 'type' the file.

Voilà! Uncorrupted, came back the code and smartly displayed the graphic of Old Colorado City's Roger's Bar on the screen.

We had Graphic Radio! Using a very compact, near universal graphic code standard! I knew we were home free.

So then I carried these just-proven-out (hardly perfected) techniques, economics, and standards to Montana last month, to introduce them to Western Montana College where, over the last six months I had been retained to set up a powerful desk top, multi-user unix dial in system to link the 116 one-room school houses of Montana in 'Rural Net' to their teacher's college. I designed the system running all the 300 features of

any good unix system, including e-mail, computer-conferencing, data base with 6 phone lines, including 800 numbers and it went on line in February 1988. The system, called Big Sky Telegraph has been an instant success, with teachers who had never seen a modem, but getting one for their tiny school's Apple through the mail, logging on and for the first time connecting up with, not only the college, but each other across the state.

But as I suspected, in case after case, the 'telephone' is not in the one-room school room. They have to lug the Apple to the phone. And school boards in schools with only 8 kids are understandably reluctant to go to the constant expense of an installed year round voice phone. So, my idea of a packet radio- phone patch was demonstrated to 9 faculty members of the college who immediately also saw the application as 'cordless LAN' across campus to link valuable resources to each other without the cost of hard wiring, or the limitation of modem phone.

But there was another reason to introduce packet to the educational needs of this very rural state. To introduce adult non-traditional 'students' from the tiny communities to the newest, but low cost, communications technologies so that they might better introduce them into their daily work. No reason a struggling rancher who already has a microcomputer to perfect his herd shouldn't be able to track the fluctuating price of beef on the Chicago Board of Trade, or the markets of Billings, from a pick-up truck - or even a horse - while out on the range. And instruct his agent to sell at the critical moment - while taking a break from patching the fence?

And then the college itself, in Dillon. Montana is 60 miles from Butte, where the closest Tymnet Packet Switching phone node is. Since part of the idea is to link those tiny schools, the teachers, students, and even ranchers, farmers, businesspersons from the surrounding community not only to the college, and each other, but the outside world via Unix's UUCP, Newnets, international telecom

networks, it will be necessary for Big Sky Telegraph to be linked to Tymnet. Either direct dial phone costs, or dedicated circuits are prohibitive for this purpose between Dillon and Butte. Packet radio digipeated off a tower, perhaps on Red Mountain to a local phone in Butte seems both economically and technically feasible.

Then as it happens, Asst Professor of Computer Education Frank Odasz, the key faculty member responsible for Big Sky Telegraph and his wife Reggie - both faculty members (with Master's Degrees in Educational Technology from University of Wyoming) live on a ranch 5 miles out of town. With one voice telephone. With two communicating computers. And the need to check into Big Sky in the early morning, evening and holidays. So the phone gets tied up too much. Could packet radio....?

So even before getting my packet rig set up in Colorado Springs, I carried it to Montana, and in a series of brief experiments, bench tests, demonstrations, and many calls to state officials who - as it turns out are using government packet radios for a variety of purposes- to determine both the regulatory and radio-technical scene, both very promising.

And the attitude of those Montanan's toward both the modem and packet radio technologies couldn't be better. Already Big Sky Telegraph is famous across the state - with its integrated modem communications, voice mail, fax, optical scanner, NAPLPS and over 5,000 messages having been left on it by exited teachers, student, faculty and outsiders who see the promise of digital devices overcoming their distance problems - which are both a blessing, for quality of life considerations, and a curse, for business and access to resources reasons.

We had many laughs too, as the juices started flowing when the possibilities were discussed. Elaine Garrett, Assistant Sysop for Big Sky Telegraph is also a Fishing Guide and Outfitter. So we started sketching out what it would take to make the fly rod the antenna, put the electronics in the handle and reel, the battery in the

tackle box and enable the big city guy to be a packet-connected stock-broker fisherman. And a three-day FCC licence to operate, just like a temporary fishing licence?

And during a day's horseback trip up into the high country we speculated on who would be the first to offer that cowboy a western saddle with a micro inside the saddle, an LCD on top of the saddle horn, the packet antennas extending down to the spurs.

They want packet, and I will be mosying up there in a few more months, help fill out their FCC licence applications, and as a consultant, system integrater, and trainer, bring the first packet radio equipment to the small business and educational communities of Big Sky Country and integrate it into their already successful phone based system. I can use all the help I can get.

Meanwhile here in Old Colorado City I have acquired an old brown brief-case in valise form, where I now carry not only my lap top portable IBM PC, a 3 lb ink jet printer, packet, power supply, and radio with a pop up antenna. I now routinely log on to my base station on 157.62, go through an external modem to an outside line, and call any system needed - but from wherever I happen to be in the area.

So I am doing business by packet radio. And am working with Pac-Com to deliver even a smaller packet controller with the radio built in. So others can do business too.

By daily use of packet learn those things you who read this already know. But which the small business, small government, small educational world already needs to extend its micros and modem reach to every corner of America and the world.

I might even understand what I am doing with these radios one of these days.

Dave Hughes WNKV696

**Keep TAPR Strong!  
Renew Your Membership !**

## DSP Project Update

by Bob McGwier, N4HY

The DSP project is slowing a little while we share our man power with the PACSAT project. However, it has not come to a complete halt. Phil Karn, KA9Q and I have spent several long weekends and even some weekdays before the launch of Phase IIIC, now Oscar-13, putting together a DSP based command station.

Some level of success has been achieved. We have a working 400 BPS, Biphase BPSK modem (both mo and dem) working on the DSP card. Any software hack will tell you, I am not yet 100% happy with it, but it does work. We managed to copy many frames of data before I had to shut down my station for a summer long hiatus to California for work. Phil wrote a nice C program that takes the bits coming out of the DSP board and performs the UART functions, including finding sync vectors and idles. The blocks of data are then decoded and selected channels are displayed and/or recorded to disk. The data format is 512 byte blocks with CRC-16 checking for data integrity. The modem works in low SNR's and the C display program makes the interface for the command station to the DSP card easy and transparent. I will working on optimizing the design when I return to NJ at the end of the summer. By then Oscar-13 should be fully operational!

As with all the DSP software developed to date, this was done on the TMS320C10 boards we have group purchased from Delanco Spry. The DSP hardware projects have not slowed completely either. Lyle and others involved in the DSP hardware development are also working on the PACSAT project. There are some very interesting and useful overlaps and commonality in the hardware needed for each and this has helped both of the projects to proceed forward. I will leave the hardware development details for Lyle to report (since I want you to go on believing IT's ONLY SOFTWARE).

The DSP5600t development work

has slowed to a snail's pace and I have had no updates on that in a while. I hope to be able to prod that along and begin code development on that clearly superior DSP chip this fall. In addition, let me tell you when it rains, it pours. I have a partner in crime at work. That is, we work in about the same area and work a lot on the same projects. She went to a major signal processing conference this past spring in New York. While there, she went around and picked up literature on DSP cards, chips, etc for me since I had other commitments. While doing this, she got a card stamped by all the vendors showing Texas Instruments based DSP products. She put it into the barrel at the T.I. booth and won the grand prize, which was a complete TMS320C25 development system, including a PC card with TMS320C25, 64K words of HIGH speed memory, development software and much more. She started to give it back thinking she didn't need it. She realized that witnesses from our work place had seen her win it. Knowing that I would probably have cardiac arrest if I found out, she brought it home and I have found a (semi) permanent home for it in my computer, with the 'promise' that she can use it if she ever REALLY wants to . . . . (thank you Maureen!)

Dave Truly, NN2Z, has joined the DSP development office for AT&T in Holmdel, NJ. He has managed to secure for us the pledge of a AT&T DSP-32 development system and the AMSAT office has sent them a letter confirming their 501c3 status so that AT&T can donate this to our project. I hope to be doing code development work on that engine along with Dave beginning this fall. Dave has been a real asset to the TCP/IP development effort and I hope to tap that enthusiasm for the DSP project as well.

We have had several new members added to the DSP development effort including Michael DB2GM, Paul KB5MU, and Franklin N6NKF. Franklin has written a nice spectrum analyzer showing how fast the FFT can be done on the PC using only the A/D ports on the Delanco Spry board. Tom now has NINE diskettes nearly chocked full of DSP software already

seperated on his arpanet ftp and mail server. You may do an anonymous ftp to tomcat.gsfc.nasa.gov and find the 'dsp', where x is a integer from one to nine, indicating the floppy full directory. FEEL FREE! We will be shipping these out REAL SOON NOW, if we live long enough since many members of the project are ready to throttle us. We have just refused to take the time to manually copy several hundred diskettes (I though that was everyone's favorite job). John Connor, WD0FHG, has volunteered himself and our illustrious president (see Andy, I told this was a glamor job!) for this thankless task.

Alberto Zagni, I2KBD, has been working hard on the weak signal detection problem with the DSP code. He has made wonderful progress and has now achieved reliable detection of his own echoes off the moon. It cannot be long before we must return to this and work out a protocol for weak signal exchange using this technique. Then the first true QSO via DSP EME with 100 W and OSCAR antennas will be a reality.

James Miller, G3RUH, DSP project member from the UK is working on a hardware using DSP in some of the work. James has been working on a K9NG compatible 9600 BPS FSK modem. There is a difference. Stored in ROM, there is a state table. No, this is not the state table normally found on K9NG and other packet modems. This is a DSP encoding for the transmitted data. The transmit voltages are developed by a digital to analog converter whose input comes from this ROM. Why take this approach? One of the best reasons to use DSP is the equalization of channels for data. This means, undoing the lousy things normally done to our signals by our radios that are designed for voice and not data. James takes the known transmitter filter response and the known receiver response from the intended receiver and shapes the pulses in the ROM so that what comes out of the receiver is equalized to the degree possible. This an exciting step forward and will allow us to use the K9NG modem approach with more 'off the shelf' radios than before. For it to work with your radio however, it MUST produce

TRUE FM and not FM. Many of the multimode rigs produce FM by swinging a crystal. This produces true FM. Most of the older FM rigs modulated in this manner. If you are interested, write to James directly. TAPR is talking to him about distributing in the US and these talks will go on through the beta test stage. We hope to be telling you more about this modem product soon.

73 and thanks for all the support and interest we have been getting. We hope that we can continue to keep you excited until you have a DSP gadget of your own to use with your equipment.

## More Satellite NEWS!

by Bob McGwier N4HY

Hold onto your seats! We have a signed sealed and delivered launch services agreement with Arianspace to ride the Spot-2 shot to sunsynchronous orbit next January to February. The launch could slip but not much. There will be FOUR satellites constructed by AMSAT-NA with partners. There will be two UOSAT's, UOSAT D and E. At least one will be an amateur radio satellite. There will be FIVE amateur radio satellites on board that launch. The common thread is packet radio. We are calling the satellite class that AMSAT-NA has developed, MicroSat internally. They are 228 mm cubes and has a mass of only 12 Kg (with the exception of one which has a mass of 14.5 Kg).

MicroSat A is PACSAT one. This will be a store and forward satellite. Your Fuji Oscar 12 modem will work with it on the day of launch. If you don't have one yet, get one from TAPR today. This satellite is done with TAPR.

MicroSat B is DOVE. Digital Orbiting Voice Encoder. This is a digital talker and digitized sound playback satellite that will be used for educational purposes. This is done with AMSAT-PY

MicroSat C is CCD camera plus a fully functional PACSAT in case the camera ever fails. Done with Weber

State in Utah. Pix copiable with TNC and a PC (betterpix with an Amiga or Mac or VGA or ???). Software will be available from AMSAT-NA some-time around launch.

MicroSat D is PACSAT 2 (done jointly with the AMSAT-LU folks). As PACSAT 1. All PACSAT's will be launched with aWORLD compatible BBS. Forwarding will be done ONLY in the reverse mode and with special stations (Hank, I told you reverse forwarding would be important;-).

This is one of the most ambitious projects AMSAT has taken on in that it must be done in such a short time. These satellites are quite complex little cubes and we have been working mostly quietly until the launch agreement was signed for the last several months. The first design meeting was held last December. This is the primary reason the DSP project has been delayed a bit since the very same people are producing the heart of these shows ;-) (The CPU and all the DSP hardware and software). The basic differences the PACSAT's will have with Fuji Oscar 12 are (1) WORLD BBS (2) power budget has been our primary concern since the day we started and is a design criteria for each module (3) THREE WATTS plus rather than one watt on the PSK downlink. (4) The orbit is 850km rather than over a thousand (not much needed to rx and xmit). (5) Power-agility (switchable to 3/4 to 1 watt if power budget slips) and will be power managed by going into 'I won't transmit unless I hear a valid packet mode if I am over sparsely populated areas'. (6) There will be the capability of 4800BPS as soon as the DSP-1 comes from TAPR/AMSAT project (or another hardware hack gives you another one) and we produce a simple 4800 BPS RX. 4800 BPS can work with many FM transceivers so XMIT may need nothing special.

The bottom line is that this is a very special project near and dear to many of us in AMSAT and TAPR. It has been a goal since around the time TAPR formed and gave us the first US tnc and changed amateur radio forever. We need your support to make the PACSAT project and the DSP project a reality. Join AMSAT-NA

yesterday and give a few bucks extra. We are pitching as hard for hamradio as we can and for no \$\$\$.

Bob McGwier N4HY AMSAT, P.O.  
Box 27 Washington DC 20044 (301)-  
589-6062

## NON-TECH TOPICS

by Andy Freeborn NØCCZ

### DAYTON '88

This is old news but I want to let you know that TAPR had a successful session at Dayton this year. We shared the AMSAT booth through the gracious courtesy of those folks. We want to particularly thank Doug Loughmiller, K05I, the AMSAT both honcho. He, and his fellow AMSAT boothers, extended us every courtesy. We had about the level of exposure at Dayton that was appropriate for this year considering that we did not have anything spectacular to introduce. Our booth arrangements were handled by Dave Toth, VE3GYQ and Pete Eaton, WB9FLW. Yes Packet Pete is alive and well and just as enthusiastic about TAPR and Dayton as ever. Thanks guys.

### DAYTON '89

We'll have a booth of our own again and the new toys will be spectacular. Put Dayton on your calendar now for late April '89.

### PACSAT IS COMING

I was fortunate in being able to sit in on the PACSAT Design Review Conference for three days the first week in June. The PACKET SATellite concept is going to have an earth-shaking (spaceshaking?) impact on how we operate in the digital modes. Almost as impressive as the PACSAT design itself is the tremendously talented technical expertise that we, the world's amateurs, have working for us in this area.

It is sometimes hard to comprehend the impact that dedicated packet satellites will have. We have been struggling for years trying to network through digipeaters. More recently we

have had the benefit of several new networking systems. Common to all of these, however, has been the need for line-of-sight terrestrial connections (except for the wormhole).

Imagine the possibilities. First we will see low earth orbit (LEO) packet store and forward birds, followed later by geostationary dedicated packet satellites.

It won't be long before we measure message delivery time in minutes instead of hours. And it won't be long until we QSO globally as readily as we now do through a single digipeater. This stuff is REALLY going to be exciting.

### BOOKS ON PACKET RADIO

A long time ago, about the time AX.25 was being defined, I asked my local bookstore to find me the book titled "Packet Radio". The book was written by Robert Rouleau, VE2PY and Ian Hodgson, VE2BEN. It was a good book for its era. The era, however, predated even the Vancouver protocol.

Since that time Jim Grubbs, K9EI, came out with "\*\*\*\* Get Connected". Here finally was a book that addressed current, up to date, packet radio matters.

Now the ARRL has published "Your Gateway to Packet Radio". This book was written by Stan Horzepa, WA1LOU. Stan is also editor of the ARRL packet newsletter "Gateway".

Stan has done his homework exceptionally well. The book provides the most comprehensive coverage of amateur packet radio that I have seen. It is a virtual encyclopedia of packet radio information. The Glossary of Packet Radio Terms alone is 13 pages in length. The book is about 220 pages. Stan's writing style is appealing and makes for very interesting reading. I highly recommend it to veteran packeteers and newcomers alike. Available from ARRL for \$10.00 plus \$2.50 S&H.

By the way I understand that Jim Grubbs will have another book out soon titled, I believe, "Digital Commu-

nications With Amateur Radio".

## TAPR BOARD OF DIRECTORS

Here are the current members of our Board of Directors, the officers, the year in which their board terms expire and those that have been appointed by the Board to the Executive Committee (XC) for this year.

Mike Brock, WB6HHV	1991	
Tom Clark, W3IWI	1990	XC
	Exec. VP	
Andy Freeborn, N0CCZ	1991	XC
	President	
Steve Goode, K9NG	1989	
Bob Gregory, KB6QH	1990	
Eric Gustafson, N7CL	1989	
Skip Hansen, WB6YMH	1991	
Lyle Johnson, WA7GXD	1989	XC
Phil Karn, KA9Q	1991	
Scott Loftness, W3VS	1991	XC
	Sec/Treas.	
Dianne Marshall, AL7FG	1990	
Bob McGwier, N4HY	1989	
Dan Morrison, KV7B	1991	
Harold Price, NK6K	1990	XC
Dave Toth, VE3GYQ	1990	XC

## HAPPY BIRTHDAY PACKET STATUS REGISTER

This month marks the sixth year of continuous publication of TAPR's PSR. The editor for issue No. 1, dated July 1982 was Margaret Morrison, KC7MA (now KV7D). The membership was fewer than 100.

Contained in the issue was a description of the first Amateur packet radio contact with the prototype TNC-1. The test was conducted by Den Connors, KD2S and Lyle Johnson, WA7GXD at the WA7GXD station. This experiment was then repeated with another test over a distance of 20 miles in Tucson.

Thanks to a handful of the very earliest TAPR pioneering experimenters we now have a flourishing new amateur communications mode.

73, Andy N0CCZ

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*Check your Membership Expiration Date as printed on your address label. Please RENEW your membership if required. You will not receive another notice of membership expiration!*

## A Brief History of TNC's

by Phil Karn, KA9Q

The origins and availability of TNC source code is an involved and somewhat controversial subject. Here's what I know about it.

The TNC-1 code was written by NK6K, KD4NL and KV7D in a combination of Pascal and 6809 assembler. This code (or large portions thereof, if not the whole thing) is available on disk from the authors. However, as a pioneering effort it was written on a rather obscure development system (an HP64000) and you're probably not going to be able to use it easily on other systems (e.g., a PC).

The TNC-2 code was written by N2WX in Z80 assembler. Howie decided not to release the source for general distribution, however, so it is available only to those who have purchased TAPR's \$5000 OEM kit for the TNC-2. (This is how manufacturers obtain non-exclusive rights to produce "clones" of the TAPR TNCs or to incorporate TAPR technology into their own products).

In general, code for the non-TAPR-clone TNCs (e.g., AEA PK-232/PK-87, Kantronics TNCs, etc) is written by employees of those companies and is regarded as trade secret information. In other words, you can't get it no how. Just to give you an idea of how bitter the competition is among certain TNC manufacturers, one such manufacturer got up in front of the TAPR annual meeting earlier this year and described the troubles they were having in FCC certifying one of their products. The problem was that the FCC requires the gear to be used with in a representative configuration, and in this case that meant it had to be connected to a computer. And most computers are so noisy that the tests failed. Finally, he said, they found a sufficiently quiet computer. "What was it?" somebody in the audience asked. "Sorry, that's proprietary information," the speaker replied.

Which brings us to the amateur TCP/IP development group. If there's one characteristic this group shares, it is a

strong dislike for impenetrable black boxes and the word "proprietary". A basic ground rule of this effort has been to make everything (i.e., full source code) freely available to all to encourage experimentation. The authors of the KISSTNC modules for the TNC-1 (WB6FCE) TNC-2 (K3MC) and VADCG (AJ9X) board have agreed to include their sources in the distributions of the KA9Q Internet Protocol package. This should give you a start in understanding how to program the TNCs. You are free to modify their code in any way you wish, and I encourage you to contribute your results back into the effort.

Some new products have recently become available that might interest you. Several PC adaptor cards containing HDLC controllers and specifically designed for amateur packet radio are now available. These eliminate the need for an external TNC entirely. Right now I know of three: PACCOMM's PC-100, with an 8530 and two low-speed modems, DRSI's PCPA, with an 8530, a low speed modem and an RS-232/TTL port, and the Hamilton Area Packet Network (HAPN) card, containing an Intel 8273 and a low speed modem. If you're really out to keep costs low, various non-amateur manufacturers have made HDLC cards for the PC that are designed to work with external modems, and these are occasionally available on the surplus market at very low prices. Drivers for the PC-100 and HAPN card are already in the TCP/IP package courtesy of KE3Z, N3EUA and myself, and a driver for the new DRSI board is in the works. A driver for the Eagle HDLC card (8530, no modem) was contributed by WA3CVG and NG6Q.

I think you'd find it much easier to use one of these boards for your experiments than to fool around with standalone TNCs. I consider the TNC to be a historical artifact that will disappear as more and more hams get personal computers and higher speed modems; the KISS TNC was never intended to be more than a temporary stopgap.

73, Phil KA9Q

## In the Mailbox

by Roy Engehausen, AA4RE

Keep those cards, letters, and packet messages flowing. I can use all the news especially on the non-IBMPC based systems. Please drop me a quick note and share this information with us all.

### WORLI News

Hank, WORLI, has unleashed his new BBS program on the world. Starting with 6.03, the programs are available from regional distributors. These are:

AsiaNet:	JA1KSO
California:	K6IYK, AA4RE
Canada:	VE3GYQ
Central:	W9ZRX
East Coast:	W3TMZ
Gulf Coast:	WA5DVV
MidWest:	N0AN
New England:	WB1DSW
NorthWest:	WB7DCH
NY/NJ:	N1DL

Currently, the available version is 6.12.

Hank's software is capable of handling multiple ports and can run under DesqView to obtain multiple connects (but only one per port). The ports get switched around between the different tasks allowing maximum connectivity and flexibility. The system files are shared between all the tasks.

### CBBS News

K3RLI has announced the availability of version 4.6 of the CBBS. It is now bid-compatible to the standard. A number of other fixes are also included.

### TheBox is coming

TheBox is an IBM/PC based mailbox program done by the NORD><LINK group in Europe. It supports multiple ports and multiple connects per port and uses the WA8DED HostMode. It is written in "C" and comes with source. Version 1.3 is currently in circulation and an English version of the documentation will be available soon. Copies are available from the

NORD><LINK group and should be on CompuServe's HAMNET soon.

### AMTOR Gateway

A mailbox where one port is on packet and another on AMTOR is now available. The program is called APLINK and Vic, W5SMM, is the author. The packet port implements a subset of the RLI command set and it can forward messages to another packet mailbox. My informant tells me the program runs on an IBM/PC or clone.

### AA4RE releases two programs

A new MBBIOS I/O package is now available. This is version 3.0. There are only a few new features for the average user but program writers will want to acquire a copy. Two new BIOS calls are defined to transmit and receive blocks of characters rather than having to each call individually. The speed difference is quite noticeable. Copies can be obtained from COMPUSERV or the author.

The AA4RE mailbox program is also available. Entitled "BB", the program features multiple ports and multiple connects per port. The test system is an IBM-XT (4.77 Mhz) capable of handling two TNCs at 4800 bps each and up to 7 connects.

The program requires a "HOSTMODE" TNC. Currently supported are the TNC-1, TNC-2 (and clones), and the AEA PK-87. Either NORD><LINK's or WA8DED's hostmode software must be installed. The WA8DED code is available on HAMNET. The DRSI PC/TNC as well as the PACCOM PC-110/120 are also supported.

Work in progress is to support the YAPP binary transfer as well as the native PK-87/PK-232 Hostmodes.

### BIDS

During the past few months, the Northern California area shifted from a "TREE" structured bulletin distribution system to a "FLOOD" system based on BIDS. The conversion was not easy. There were six different

software systems among the 23 mailboxes involved including the venerable Xerox 820. During the conversion, one message was erroneously duplicated over 400 times. Boy did our forwarding increase. However, thanks to W3IWI, KA2BQE, and WORLI, we were able to understand how things worked and what software changes to make.

To prevent route loops, both WORLI V6.08 (and higher) and AA4RE BB V1 support header checking. During an incoming message, the mailbox counts the number of times its own routing header appears. If this exceeds the limit set by the CONFIG file, the message is placed in HOLD.

In addition, both programs will regenerate bids. Any bulletins received that do not have bids will be assigned one based on the incoming message headers. The BID will have the format

```
messagenumber_originatingbbscall  
$ 10 --
```

The initial exchange between "smart" BBS systems uses what is called an "SID", short for System Identifier. All future work on BBS systems should adopt this standard. It will help to remove a GREAT deal of confusion as to which systems have what features, and how one should interface to them. In the longer future, perhaps all this junk can be done away with, and the computers can talk to each other in a more natural way.

The system identifier is structured:

```
"[ f1 - f2 - f3 ]"
```

The dashes delimit the end of the first field and the start of the last. There might be only one dash, if f2 is void. f2 may contain dashes.

f1, f2, and f3 may not contain "[" or "]".

f1 is the author identification. It may not contain a dash. Normally it will contain a few characters from the authors callsign.

f2 is author specific data. It may contain anything the author wishes, for example software version. It may

contain dashes.

f3 is the supported feature set. It may not contain a dash. It contains a string of non-numeric characters, one for each negotiable feature supported. Each character may also have trailing digits, giving the revision of that feature. If there is no trailing digit, the feature revision is revision zero.

Defined features are:

- C - Supports "forwarding" of date and time.
- W - Is a white pages server.
- Y - Supports YAPP binary protocol.
- \$ - Supports BID. MUST BE LAST CHARACTER IN f3 (downward compatibility).

The existence of the system ID implies that the system supports reverse forwarding and OKNO message rejection.

Some examples of existing standard system identifiers:

- [RLI-5.12-\$] - W0RLI  
version 5.12, supports BID
- [RLI-6.10-Cs] - W0RLI  
version 6.08, supports  
Clock, BID
- [RLI-\$] - CBBS  
flavor.
- [CBBS-4.5-\$] - VE3GYQ  
release of the RL/IGYQ  
cbbs.
- [MBL-\$] - WA7MBL  
version not given, supports  
BID
- [MBL-RLI3.2J2.5-\$] - JR1EDE  
unix port of RL/IGYQ CBBS  
version 3.2
- [CMU-1-W] - WD6CMU  
BBS and WP server.
- [4RE-01-M\$] - AA4RE  
V1, supports MID and BID.

There is some older code still running that requires special case handling. In these cases there is no f3 or feature letters.

Rule: OKNO message rejection is required, and BID is supported.

- [MBL320] - "old" WA7MBL  
systems.
- [MBL-RLI] - JA0ISK port of  
RL/IGYQ CBBS for NEC 9800

The connect rules:

Send the SID as first line at connect. Answer the SID (when seen as a command) with a short command prompt.

(Thanks to W0RLI for this article)

### Zip Codes Again

Just when you thought it was safe to use your mailbox, the zip codes are back.

Some time ago the idea of zip code routing for all messages was discussed but not many hopped on the bandwagon. The one enthusiastic crowd was the NTS packet people. Since that time, NTS has adopted zip-codes for routing third party messages. "ST 95020" will route a message to the mailbox responsible for delivering NTS to that area.

Now there is a growing usages of "SP AA4RE @ 95020" much like was proposed many moons ago. Unfortunately there is a hitch. The mailbox that handles NTS for 95020 may not be the same as the one that the local hams are using. This is certainly the case in California. What happens is that the message has to be manually rerouted by the SYSOP to send it to the proper mailbox thus causing delays and allowing mistakes.

Obviously we need to step back and reassess the situation. The whole concept of routing in packet needs a solution rather than the bandaids we have been applying? What do you think?

### Feedback Wanted

I would love to hear from you. Send any suggestions, comments, new tidbits, and hate mail (in good taste of course) to packet: AA4RE @ AA4RE, CompuServe: 76064,2107 or USMail: 8660 Del Rey Court, Gilroy, CA 95020.

## PACKET AT DAYTON HAMVENTION 88

by Bob Gobrlick WA6ERB

Dayton Hamvention was once again the gathering place for packet folks from around the world. There was no official theme for this year's packet gathering but I kept getting the feeling that the theme should have been "Packet Radio in Space". You began to get the flavor of this when you noticed that Tuscon Amateur Radio Association (TAPR) shared an adjoining booth with the folks from the Amateur Satellite Association (AMSAT). This all seems appropriate as we see a number of exciting joint projects being carried out by these two premier organizations.

PACSAT - One of the most talked about new joint projects is PACSAT. PACSAT (or PACKET SATellite) is the name of a new series of simple (i.e. inexpensive) circular orbiting amateur satellites dedicated to packet communications. Operation specifications will be similar to the Fuji Oscar 12 JD mode offering the packet satellite user a PBBS mailbox in the sky. Over the next two or so years up to half dozen of these small satellites will be launched into space (maybe 2-3 satellites at a time). The goal for AMSAT is to have an interim packet training satellite that fits between the Phase 3 satellites (OSCAR 13) that have limited packet capability and the Phase 4 birds which will have a limited user access and a heavy reliance on packet gateway stations. TAPR's involvement is to develop packet satellite communication techniques and encourage the development of digital gateways for future Phase 4 operation requirements.

PACSAT will be a designed for ease of use. Operational specifications call for Mode JD operation (2 meters up, 70 cm down) using the Manchester/Phase Shift Keying (PSK) decoding scheme (popularized by the TAPR PSK and G3RUH modem kits). User radio requirements call for a 10 watt FM uplink to a simple turnstile antenna and a 70cm SSB downlink from a turnstile antenna. Portability and simplicity of operation will be the

theme.

The first PACSAT launches are rumored to be less than a year away. So start honing up your satellite packet skills on Fuji Oscar 12. Also if you have a PSK modem (TAPR or G3RUH) give PSK terrestrial packet a try (rumor is that some folks may be giving PSK a try on Oscar 13).

DSP - The other major joint development project was the Digital Signal Processing (DSP) unit. Imagine a small "black box" the size of a TNC that has loaded in firmware (EPROM) just about every type of modem you can think of - Bell 202 tones, PSK, Manchester, RTTY, AMTOR, Packet, FAX, WEFAX - you name it, you got it - at the flip of a software bit. Sound unreal? Well stay tuned - The Tom and Bob Show (Tom Clark W3IWI and Bob McGuire N4HY) demonstrated a prototype at Dayton that decoded weather FAX and Oscar Fuji 12 packets and IT WAS ONLY SOFTWARE (well almost). Look for TAPR/AMSAT kits coming your way in the near future (I'm wondering if DSP will decode 20 wpm CW for the packet brass-pounders?).

Other Dayton Tidbits - The GRAPES packet group of Georgia was selling 56 Kbaud modem kits (repeat, 56 Kbaud - 46 times faster than 1200 baud). They sold out all units faster than the Hamvention barbecue bratwursts - talk about life in the "fast" lane.

AEA and GLB were again showing off their high speed 220 Mhz packet network boxes - interest among packeteers was still varied due to the high entry price. The other news from AEA was that the boys from Lynnwood have bought the manufacturing rights for the new PS-186 network "engine" (developed by N6NKF, WB6HHV and KA6IQA). The PS-186 board is slated to become the next-generation network switch (5-port, high speed) and if you would like more details check the ARRL 6th Networking Conference Proceedings. The good news is that AEA is making special arrangements with TAPR for "kit" orders.

HAL, the RTTY/digital folks have

jumped on the packet bandwagon with the RPC-2000 two channel packet radio controller card (plugs into an IBM or compatible PC) and the model ST-7000 dedicated HF packet demodulator that works with any packet TNC. HAL has drawn on their years of RTTY experience to come up with a highly selective HF packet front-end.

Digital Radio Systems (DRSI), a new company from Florida, introduced an inexpensive dual-ported TNC-on-a-card that plugs into the expansion slot of an IBM or compatible PC. The only connections are to your radio. Software, rather than firmware controls the TNC and I/O. DRSI plans to add software driver modules for PBBS's and TCP/IP.

Kantronics lost its premier plot on the HAMVENTION floor this year and ended up in a small corner booth. The exciting things out of Kantronics this year were TNC retrofit kits for a watchdog timer (about time) and memory battery backup so your personal mailbox messages don't go to never-never land during a power failure. Both of these kits are "musts" for the KPC's.

The good news was that Pac-Comm came in from the cold (outside) and secured the "old" Kantronics floor space. On display were the new TINY-2 and MICROPOWER-2 TNCs along with a prototype (tease) packet TINY TNC RADIO. The gang from ROSE (X.25 network switch software developers) joined the activities at the PAC-COMM booth.

MFJ had on display their new MFJ-1278 multi mode data controller that does it all, including SSTV and a contest memory keyer (are we getting close to having MFJ make the ICOM IC-781 of packet TNCs - by the way you have to see the IC-781 built in ASCII display to see what the term "bells and whistles" really means)

Finally Heath is rejuvenating its ham radio line by supplementing its kit line with imported finished products. Of special interest to packeteers is the new Heath Pocket TNC imported from Japan. No bigger than a deck of playing cards, this TNC-2 compatible

is battery powered and has a PBBS built in firmware - again you have to see it to believe it.

Well that's the word from Dayton this year. If you get a chance in the years to come try to plan a trip to the Dayton HAMVENTION - it is something you'll never forget. And, oh yes, I almost forgot to mention the great packet get-together that takes place at McNasty's restaurant (BBQ Barn) - there are more packet tall tales spun there than anywhere I know.

## PS-186 Project Status

by Franklin Antonio, N6NKF

What is it?

The PS-186 is a high-speed four-port packets switch designed by WB6HHV, KA6IQA, & N6NKF. It is described in detail in the ARRL 6th Computer Networking Conference Proceedings.

Status?

In late May we shipped one of the PS-186 prototypes to Gordon Beattie, N2DSY, of the RATS ROSE project. We applaud the progress the ROSE software project has had in the last year, and look forward to a version of the ROSE software that will run on the PS-186.

If you will recall, we originally built a run of eleven of the (prototype) PC boards, (Rev X). These were assembled, then distributed to several software developers. During the beta test, several small design errors were discovered, resulting in six cuts & jumps on the PC board. These were incorporated into the PC board design, and a UART was added to the board for use as a control port. This eliminates the need to use one of the four high-speed ports for control. This revised design is known as "Rev A". (Please ignore the fact that I accidentally called it "Rev B" in my last writeup in PSRI!)

The first (evaluation) run of the new Rev A PC boards arrived June 29th. We quickly assembled one, and are happy to report that the design changes appear to be completely

successful. The first rev A board passes all the diagnostic tests. We had a total of five boards built for this evaluation run, and now have #1 running, and #2,3,4 almost completely assembled (a few missing parts, as usual).

Now that the changes are checked out, the path is clear to production of larger quantities of the Rev A boards. These will be built by AEA. As described in the last PSR, TAPR is organizing a group purchase of PS-186 boards, which TAPR intends to sell in the form of skeleton kits. As mentioned in last PSR, TAPR needs an indication of interest from you if you would like to participate in the group purchase. Send TAPR a post card!

Finally, this last step has taken a little longer than expected, and I would like to emphasize that we take responsibility for these delays. They are not due to any action (or inaction) by either AEA or TAPR.

73, N6NKF (for N6NKF, KA6IQA, & WB6HHV)

## PS-186 KIT UPDATE

The TAPR PS-186 kit program is alive and well in spite of the fact that there has been little information put out since the last issue of PSR.

The PS-186 is a 5-port high speed (greater than 1Mbit/sec) packet switch. It was designed by WB6HHV, KA6IQA and N6NKF. Advanced Electronic Applications (AEA) has acquired the rights to produce the card commercially. TAPR is organizing a group purchase of bare PCBs and the necessary PALs directly from AEA. The TAPR PS-186 will only be sold in kit form.

Detailed information on the PS-186 can be found in two articles in the April 1988 issue of PSR and in the ARRL 6th Networking Conference proceedings, available from the ARRL.

As of the end of June, AEA was awaiting information from board manufacturers on their price quotes. Mike Lamb, N7ML, President of AEA

advised that they are struggling to keep the price of the PS-186 as low as possible in spite of the spiraling cost of chips. The program is moving ahead this summer but firm production dates are not yet available.

It is expected that TAPR will have two kit options available. The estimate of the kit costs at this time is \$130 (option A) and \$180 (option B). The \$130 kit will have bare boards and PALs while the \$180 kit will also contain the hard to find LSI.

If you are interested in participating in this group purchase please write to TAPR, Box 22888, Tucson AZ, 85734 indicating the number and type of kits you would like. SEND NO MONEY. Once the demand has been determined we will contact all with firm prices and order cut-off date. Naturally there is no obligation until a firm price is determined and an order is placed, but please be realistic about your needs.

## SOFTWARE & HARDWARE AVAILABLE FROM TAPR

Watch for an announcement soon that the new full release of TCP/IP software is available. Notices will be posted on PBBS's, CompuServe, Unix systems and wherever we can get the word out. It is likely that the next full release will be packaged quite differently than the current 3 disk set. Read the ordering information carefully so that you get exactly what you want.

Hardware kits that are currently available from TAPR are shown below. See separate articles in this issue concerning the status of the PS-186 kits and progress in the DSP program.

PSK Modem \$100.00 plus \$10 S&H  
9600 Baud Modem 25.00  
TNC-2 Tuning Indicator 25.00

The TNC-2 software version 1.1.5 is

available with the KISS capability from the TAPR office. If you have been using version 1.1.4 with the 32k RAM you will be able to upgrade directly to 1.1.5. For those still using 1.1.3 it will be necessary to install the 32k RAM chips at the same time that you install 1.1.5.

TAPR will program your EPROM's for \$2 per TNC-worth plus a prepaid return mailer. If you choose to buy EPROMs from TAPR, we will include the mailer and postage in the purchase price of the blank EPROM. The 32k RAM chips needed to upgrade are also available. Prices as follows:

32k RAM (includes update doc) \$20 postpaid  
Blank EPROM (27C256) \$10 add \$2 for programming  
Blank EPROM (2764) \$5 add \$2 for programming (may be 27C64 if avble)

## EPROMs

TNC-2 WA8DED (27C256)  
TNC-1 WA8DED (2 x 2764)  
TNC-1 KISS (2764)  
TNC-2 KISS (27C256)  
TNC-2 1.1.5 w/loader (27C256)  
TNC-2 1.1.5 w/KISS (27C256)  
TNC-2 1.1.5 (27C256)

## SOFTWARE

To simplify ordering of diskettes the prices have been revised to \$2.00 per diskette, including mailer and postage. Do not send blank diskettes or mailers. For orders to be shipped outside North America please add \$2.00 per order for airmail delivery.

WORLIVE3GYO C BBS (1 diskette)  
TCP/IP (KA9Q) (3 diskettes)  
Intro to TCP/IP (2 diskettes)  
TNC 1 Source Code (1 diskette)

## AEA PK-232 Notes

by Eric Gustafson, N7CL

Recently, several new packeteers using PK-232s have appeared on our local duplex repeater which is dedicated to packet radio. This is one environment where the collision frequency should be very low since there are no hidden terminals. Almost immediately we noticed that the collision frequency had risen dramatically. After some investigation we discovered certain stations were almost guaranteed to be involved in stepping on in-progress packets. These stations were contacted and in all but 1 case they were new users of PK-232s.

We were very puzzled as there have always been some stations on the repeater using PK-232s with no apparent problems. The new stations were asked how their station was configured and what method was used to get the DCD operation adjusted. We were very surprised at the answers we got. Every single one of the offending stations had set their station up exactly according to the instructions in the PK-232 manual. However, contrary to the advice given in the manual, none of these stations had configured their setup so that they could hear what was going on on the channel when the PK-232 was connected to the radio. None of these new operators knew what DCD meant, what it did, or why it was important that it should be working on a multiple access packet channel.

We obtained a PK-232 and manual to try and discover the exact nature of the problem. What we found was that although the manual is very complete and generally very well written, there are some areas where it leaves something to be desired. Specifically, in this case, the instructions given on page 2-16 (we had manual PK232UG Rev. B 9/86 for reference) for setting up the PK-232 and an FM radio for DCD operation are simply incorrect. If set up exactly as described, DCD will NEVER be asserted during a packet transmission by another station on the channel! We had found the cause of our problem.

If you have a PK-232 and haven't already discovered this problem for yourself, please disregard the instructions in the manual for setting up a PK-232 and NBFM radio for 1200 baud packet operation and use the method presented here. All your packet neighbors will appreciate it very much.

The manual is quite correct in all respects EXCEPT where they discuss setting the DCD THRESHOLD control and receiver audio output level for proper demodulation and DCD circuit operation. The correct way to set these adjustments is as follows:

1. At least temporarily, arrange to be able to hear the receiver audio signal which is being sent to the PK-232.
2. Set the squelch circuit on the radio for normal squelched operation. The DCD circuit in the PK-232 is incapable of proper operation with unsquelched audio from the receiver.
3. While monitoring incoming packets, adjust the receiver audio level so that the tuning indicator "spreads" fully when receiving a packet from the station on the channel which produces the LEAST amount of audio output level. There are several limiters in the PK-232 demodulator so louder stations will not be affected adversely by this.
4. Once the audio level is properly set, adjust the DCD THRESHOLD control on the PK-232 so that the DCD led lights when there is a packet being transmitted by the station on channel which produces the LEAST amount of audio output from the receiver. Make sure, however, that the DCD LED is extinguished when there is no signal and the radio's squelch circuit has cut off all audio from the receiver.

If the above procedure is followed, the PK-232 will properly hold off transmitting during a packet transmission from

another station and will not send acknowledgements to individual frames of a maxframe greater than 1 packet while it is still being transmitted.

We hope PK-232 owners will find this information useful and take steps to assure that their DCD is operating properly. Multiple access packet channel throughput is severely degraded when DCD is not working.

73 and happy packeting,

Eric Gustafson N7CL

## ACCURATE HF MODEM ALIGNMENT PROCEDURE FOR TERMINAL NODE CONTROLLERS (TNC) USING THE EXAR 2211 / 2206 BASED AFSK MODEMS

by Eric Gustafson, N7CL  
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*[Author's Note: Many thanks to Dan Morrison, KV7B for his valuable time spent reviewing this document and his constructive criticism during the compilation of this procedure.]*

This procedure, although primarily intended for TNC-2 and clones (including MFJ-1274), includes some information specific to the MFJ-1278. Some of the software calibration facilities present in the newer 1278 may not be available in the 1274 or TNC-2 (and clones). Specifically, references to RXCAL in the demodulator alignment procedure are for 1278 rev 7 board running VER 1.2 ( ROM checksum (\$A1) ) or later firmware.

The tune up principles presented here can be applied to any AFSK modem based on the Exar 2206 / 2211 ICs. This method consists essentially of using the modulator to send 50 percent duty cycle data to the demodulator for alignment purposes. This is not only the easiest but also the best, most consistent method for aligning this type of modem. Modems

not attached to one of the TNC-2 variants can also be aligned using this method. All that is required is a source of 50 percent duty cycle square wave data (at a baud rate appropriate for the modem application) injected at the modulator data input.

**IMPORTANT!** This procedure is a three step process. The three steps are:

1. Center the modulator tones over the required modem center frequency (Fc).
2. Align the demodulator center frequency.
3. Align the tuning indicator.

**ALL THREE STEPS SHOULD BE PERFORMED IN THE ABOVE ORDER!**

If they are not all done at the same time, or in the correct order, the modem may not be receiving and transmitting on the same frequency and the tuning indicator may not indicate properly.

The third step, alignment of the tuning indicator, should only be used in conjunction with alignment of the 300 baud 200 Hz shift demodulator.

References to part or jumper numbers which are specific to a particular TNC are noted. Part or jumper numbers without specific reference to a particular model are the same for all models not specifically referenced.

Some understanding of the use of ordinary test equipment is assumed.

The 1200 baud modem in the TNC-2 and 1274, and the other AFSK modems available in the 1278 can be aligned using exactly the same steps presented here but substituting the appropriate part numbers for the adjustments. However, do NOT align the tuning indicator to anything but the 300 baud 200 Hz shift HF packet modem.

#### **COMPREHENSIVE ALIGNMENT PROCEDURE**

It is important that the tuning indicator alignment be optimized for the 300

baud 200 Hz shift HF packet modem. It will indicate correctly for all other modes when aligned for the HF packet modem.

*NOTE! Regardless of the type of modem, whether or not the modem has audio filtering built in, 300 baud AFSK modem performance on a High Frequency linear mode (SSB as opposed to NBFM) radio channel will NOT be optimum UNLESS a filter of approximately 500 Hz bandwidth is used in the radio IF strip.*

There are two reasons why this is the case. First, for the filtering to be fully effective, it has to precede the first hard limiter in the system. This limiter is typically located in the first stage of the demodulator. Second, no filter at audio can prevent an off channel interfering signal from capturing the receiver AGC system and causing wide variation in the level of the audio presented to the demodulator. All demodulators are affected by audio level variations.

If a narrow (approximately 500 Hz) filter is to be used in the radio for HF packet and RTTY operation (and this is STRONGLY recommended), it may be necessary to use a tone pair centered on the radio's filter rather than the "standard" 2120/2320 or 1600/1800 Hz pair. If the radio lacks IF shift capability, this will almost certainly be necessary. It will be necessary to determine the center frequency of the audio passed by the IF filter when the narrow filter is selected and the radio is in the LSB mode.

*NOTE! If the radio to be used DOES have IF shift capability, the modem can be aligned on one of the "standard" tone pairs and the IF shift control can be used to center the radio's filter over the modem center frequency. You may find it convenient, however, to do the alignment so that the IF shift control remains centered, or on its detent, and therefore doesn't require readjustment when switching operating modes.*

Some radios will require slight modification to allow selection of a narrow filter in SSB mode.

Most radios which provide for direct FSK RTTY operation use the radio's narrow CW filter if one is installed. The Kenwood TS-820 is one example. Packet operation using direct FSK is a viable mode but extreme caution should be exercised to make sure TX and RX frequencies are identical and that the transmitted frequency pair is centered in the radio's 500 Hz filter passband. Once the required modem center frequency for the particular radio's FSK mode has been determined, the modem alignment procedure presented here may (should) be used to align the modem for this mode. A method for making the determination of transmitter FSK output frequencies and their relation to the LSB carrier oscillator and center of the 500 Hz filter is NOT presented here. Contact the manufacturer of the radio to obtain this information.

Radios which have provision for an auxiliary "narrow SSB" filter can have the 500 Hz bandwidth filter installed instead of the approximately 1.8 KHz wide "narrow" SSB filter. This will allow direct selection of the narrow filter for AFSK work when in SSB mode. If the filter is also desired for CW operation and you don't want to invest in 2 identical filters, it is usually a relatively simple modification to cause the radio to select this filter when in CW mode too. In the TS-430, for example, this requires moving one end of one diode on the IF board. The 270 Hz filter can then be installed in the "normal" narrow CW filter position making two bandwidths of narrow filter available for CW operation with all filters selectable from the front panel.

If the HF radio is to be dedicated to packet use, for instance as a BBS or for whatever reason (we really don't need any more privately run BBSs), the 500 Hz filter can be installed in place of the SSB filter. This is possible on ANY radio designed for SSB and CW use.

Once the radio is configured with a narrow filter for AFSK work, one of the following 2 methods should be used to make the radio filter center frequency (Fc) determination. Both methods require access to a frequency counter capable of measuring audio frequencies to a resolution of 1 Hz. Almost

any frequency counter should be capable of this.

*NOTE! the signal actually transmitted will cover a band of frequencies approximately 400 Hz wide and centered at the transmitter's indicated SSB carrier frequency (F(ind)) minus the modem center frequency (when using LOWER sideband for AFSK work). So use:*

$$F(\text{emission}) = [ F(\text{ind}) - F_c ]$$

to determine the actual operating frequency for band edge or netting purposes and remember to consider that you will be occupying a few hundred Hz on either side of F(emission).

#### First method: NOISE AVERAGE FREQUENCY

This method also requires an active noise source like a receiver noise bridge. I have been using a unit made by Palomar Engineering for this purpose.

1. Set the receiver to LSB mode with the 500 Hz filter selected.
2. Connect the noise source to the receiver input. Make sure there is no antenna connected to the system and that the receiver is tuned to a frequency which is free of coherent internally generated signals (birdies).
3. Set the noise source output for a reading of approximately S-9 on the receiver S meter.
4. Connect the counter to the receiver audio output
5. Adjust the receiver output level for enough audio to reliably trigger the counter.
6. Make sure the radio's IF shift control, if one is present, is in its proper position (centered or on detent).
7. Record the frequency indicated by the counter. The counter should indicate the average frequency of the noise spectrum passed by the filter in the receiver and translated

to audio by the product detector. This will be the frequency used for the modem center frequency (F<sub>c</sub>).

*NOTE! If the counter is a phase locked loop (PLL) based prescaling type, its PLL may not lock properly to the noise signal. If this is the case, use method 2 below. If your counter can resolve 1 Hz with a counting gate time of less than 1 second, it is a PLL prescaling counter.*

#### Second method: FILTER SKIRT AVERAGE FREQUENCY

1. Set the receiver to LSB mode with the 500 Hz filter selected.
2. Make sure the radio's IF shift control, if one is present, is in its proper position (centered or on detent).
3. Using either a signal generator or a stable, relatively strong carrier from an AM broadcast transmission (preferably ground wave signal), tune the receiver so that the carrier falls near the center of the filter passband. Choose a signal level near S-9 for this test. If your rig has a built in calibration oscillator, this is a good source for this signal.
4. Slowly and carefully tune the receiver so that the tone frequency is decreasing.
5. Find the point where the signal is reduced by 1 S-UNIT from the peak value reached near the center of the filter passband.
6. Measure this tone frequency with the counter. Record this value as F(low).
7. Slowly and carefully tune the receiver so that the tone frequency is increasing.
8. Find the point where the signal is reduced by 1 S-UNIT from the peak value reached near the center of the filter passband.
9. Measure this tone frequency with the counter. Record this value as F(high).
10. Calculate the required modem

center frequency as:

$$F_c = [F(\text{low}) + F(\text{high})] / 2$$

Once the required center frequency has been determined, the modem calibration can be carried out.

*NOTE! It is essential that the modulator tones be properly aligned FIRST as they will be used to align the demodulator center frequency.*

Set the modulator tones to F<sub>c</sub> MINUS 100 Hz for the low tone and F<sub>c</sub> PLUS 100 Hz for the high tone using one of the following two procedures.

#### SET MODULATOR TONES USING FREQUENCY COUNTER

1. Make sure that the modem and TNC are both configured for 200 Hz shift 300 baud operation. This is done by typing "MODE HP <CR>" from the command prompt on the 1278. On the 1274 this is accomplished by means of the HF/VHF pushbutton switch on the rear panel. On a TNC-2 or clone this is done by making sure the HF modem header parts are in place on the circuit board and that the rear panel radio port baud rate selector switch is set for 300 baud.
2. Install push on jumper at JMP-4. This is the watchdog timer defeat jumper.
3. Connect the counter input to JMP 9, pin 1. This is the TP 1 end of R61 in a TNC-2.
4. Command the TNC into calibrate mode by typing "CAL <CR>".
5. Command the TNC to key the modem by typing "K".
6. Select the low tone by pressing the space bar until a voltmeter connected to U16, pin 9 reads - 5 volts. This signal is more conveniently available at the junction of Q12 collector and R62.
7. Adjust R106 until the counter indicates the intended low tone frequency as determined above. This is R78 in a TNC-2.

8. Select the high tone by pressing the space bar once.
9. Adjust R105 until the counter indicates the intended high tone frequency as determined above. This is R77 in a TNC-2.
10. Return the TNC to command mode by typing "Q".

This completes the alignment of the modulator tones using a frequency counter.

#### SET MODULATOR TONES USING BUILT IN CALIBRATION SOFTWARE

This method will be slightly less accurate than using a frequency counter but it should be possible to get within +/- 5 Hz using this method.

1. Make sure that the modem and TNC are both configured for 200 Hz shift 300 baud operation. This is done by typing "MODE HP <CR>" from the command prompt on the 1278. On the 1274 this is accomplished by means of the HF/VHF pushbutton switch on the rear panel. On a TNC-2 or clone this is done by making sure the HF modem header parts are in place on the circuit board and that the rear panel radio port baud rate selector switch is set for 300 baud.
2. Place a push on jumper at JMP 4 as in the above procedure.
3. Place a push on jumper at JMP 9, pins 1 and 2. This connects the modulator square wave output to the SIO chip so that the CPU can measure the tone frequency for you. In a TNC-2 this jumper goes on JMP 9, pins 1 and 6.
4. Type "CALSET n <CR>". Where n is a number determined by:

$$n = \text{INT} [ 525000 / F(\text{low}) ] + 1$$

This tells the CPU what tone frequency you are trying to achieve.

A table of CALSET numbers to use for the various "standard" modem tone frequencies will be included in

an appendix at the end of this procedure.

5. Command the TNC into calibrate mode by typing "CAL <CR>".
6. Command the TNC to key the modem by typing "K".
7. Select the low tone by pressing the space bar until a voltmeter connected to U16, pin 9 reads - 5 volts.
8. Adjust R106 carefully until both the "CON" and "STA" LEDs on the front panel of the TNC are lit. This is R78 in a TNC-2.
9. Type a "Q". This exits the TNC from calibrate mode to command mode.
10. Type "CALSET n <CR>". Where n is a number determined by:
 
$$n = \text{INT} [ 525000 / F(\text{high}) ] + 1$$
11. Command the TNC into calibrate mode by typing "CAL <CR>".
12. Command the TNC to key the modem by typing "K".
13. Select the high tone by pressing the space bar until a voltmeter connected to U16, pin 9 reads + 5 volts.
14. Adjust R105 carefully until both the "CON" and "STA" LEDs on the front panel of the TNC are lit. This is R77 in a TNC-2.
15. Remove the jumper placed at JMP 9.

This completes the modulator tone alignment using the built in calibration facility.

Now that the modulator tones have been properly centered over the intended modem center frequency (Fc), the demodulator center frequency will be aligned using one of the following two methods. The second method using the built in calibration facility of the 1278 is preferred since it is as accurate as alignment with an oscilloscope but requires no digging around on the

1278's PC board looking for signals.

*NOTE!* If a TNC-2 or clone (including the 1274) is to be used on HF packet behind a radio with a 500 Hz filter in it, it will be necessary to modify the demodulator Data Carrier Detector (DCD) circuit.

The details of this modification are given in an appendix at the end of this procedure. The alignment procedure will work properly and result in correct alignment of the demodulator whether or not these modifications have been done.

#### DEMODULATOR CENTER FREQUENCY ALIGNMENT USING AN OSCILLOSCOPE

The oscilloscope used in this procedure will be used only to indicate when the output data stream from the demodulator has reached a duty cycle of exactly 50 percent. The 'scope can be used to do this in two ways. The first is on the basis of time and the second is by integrating the square wave for zero DC offset. The second method is the most accurate as it is insensitive to the normal jitter in the data introduced by the demodulation process. Both methods will be described in an appendix at the end of the procedure.

*NOTE!* If you are performing this alignment on a 1274 or a TNC-2 clone, please make sure that JMP 8 is installed. This jumper is required for normal operation of the demodulator.

1. Place push on jumpers at JMP 4 and JMP 7 if they are not already in place.
2. Remove jumper at JMP 9 if it is still in place.
3. Connect the vertical input of the oscilloscope to the end of R68 which is connected to Q13's collector. This is the data stream coming out of the 2211 demodulator chip.
4. Command the TNC into calibrate mode by typing "CAL <CR>".
5. Command the TNC to key the modulator by typing "K".

6. Command the TNC to send a 50 percent duty cycle test data stream from the modulator by typing "D".
7. Adjust R113 carefully until the DCD LED on the front panel is fully lit. Continue adjusting R113 until the oscilloscope indicates that the square wave at Q13's collector has a duty cycle of exactly 50 percent. This is R79 in a TNC-2

*NOTE! The threshold control on the 1278 must be set to a position which will allow the DCD circuit to function properly. A setting approximately 1/3 of the total range starting from maximum CCW should be adequate.*

8. Return the TNC to the command mode by typing "Q".

This completes the alignment of the demodulator center frequency using an oscilloscope.

#### DEMODULATOR CENTER FREQUENCY ALIGNMENT USING BUILT IN CALIBRATION FACILITY

*NOTE! If you are performing this alignment on a 1274 or a TNC-2 clone, please make sure that JMP 8 is installed. This jumper is required for normal operation of the demodulator.*

*NOTE! The RXCAL demodulator calibration routine used in this procedure is superior to the original TNC-2 and 1274 built in demodulator calibration routine. However, versions of the TNC-2 and 1274 firmware prior to 1.6 will NOT have the RXCAL feature available. As this is written, it is possible that Howie will get RXCAL into release 1.6 but not certain. I strongly recommend that you obtain firmware updates for your TNC-2 as soon as they become available.*

1. Place push on jumpers at JMP 4 and JMP 7 if they are not already in place.
2. Remove jumper at JMP 9 if it is still in place. If you are calibrating a TNC-2 which has firmware updated to include RXCAL, place the jumper removed from JMP 9 pins 1 and 6 on JMP-9 pins 3 and

- 4.
3. Set the baud rate for use by RXCAL to 300 baud by typing "CALSET 32 <CR>". This will cause the modulator to send a square wave FSK signal when RXCAL is invoked.
4. Command the TNC to do a demodulator calibration by typing "RXCAL <CR>".
5. CAREFULLY adjust R113 until the DCD LED on the front panel is fully illuminated. This is R79 in a TNC-2 or clone.

*NOTE! The threshold control on the 1278 must be set to a position which will allow the DCD circuit to function properly. A setting approximately 1/3 of the total range starting from maximum CCW should be adequate.*

Continue to VERY CAREFULLY adjust R113 until the STA and CON LEDs on the front panel either change state very slowly (alternate which one is lit) or until both are simultaneously illuminated.

*NOTE! This is a very critical adjustment and it is unlikely that you will be able to cause both LEDs to be turned on simultaneously for longer than a very brief instant.*

6. Return the TNC to command mode by typing a "Q".

This completes demodulator center frequency alignment using the built in calibration facility.

Now that the demodulator and modulator are properly aligned to one another, the tuning indicator can be set for proper center indication.

*NOTE! If you have a TNC-2 or clone which you intend to use on HF packet and it doesn't have a tuning indicator already installed, I STRONGLY recommend that you to obtain one of the TAPR tuning indicator kits or an exact clone of one if available from a separate source. Operation on HF packet without a tuning indicator will be very frustrating and contribute to much useless interference on already*

*overcrowded pseudo CSMA packet channels.*

#### TUNING INDICATOR ALIGNMENT

This procedure adjusts the tuning indicator so that it correctly indicates when a signal is properly tuned in relation to the demodulator center frequency.

*NOTE! The tuning indicator should ONLY be adjusted in reference to the 300 baud 200 Hz shift modem used for HF packet and RTTY. If adjusted for this modem, it will indicate with sufficient accuracy for all other modes.*

*NOTE! The tuning indicator is NOT effective for tuning the 1278 on CW receive. On CW, it should be used only to get into the ballpark. Final tuning for CW mode should be based on the DCD LED.*

1. If you have not just finished aligning the modem as per the above instructions, do so now. Otherwise you may be aligning the tuning indicator to an incorrect setting.
2. Install push on jumpers at JMP 4 and JMP 7 if they are not still in place from the modem alignment procedure.
3. Command the TNC into calibrate mode by typing "CAL <CR>".
4. Command the calibration routine to send 50 percent duty cycle square wave data from the modulator by typing "D".
5. Command the TNC to key the modem by typing "K".
6. While observing the LEDs in the tuning indicator, adjust R212 in the tuning indicator area so that either the 10th or 11th led from the left (or both) are illuminated. If you are using the add on tuning indicator, this is the only variable resistor on the board.
7. Return the TNC to command mode by typing "Q".
8. Remove jumpers at JMP 4 and JMP 7.

This completes the tuning indicator alignment.

Now the modulator, demodulator, and tuning indicator are all aligned to the same center frequency. If you notice that on the air reports suggest that you are transmitting and receiving on significantly different frequencies after successfully completing the above alignment procedure, it is possible that the radio needs realignment. Many different transceivers for HF are capable of being misaligned due to reference oscillator crystal aging or careless alignment by amounts exceeding 500 Hz. RIT inadvertently left on can also cause hard to detect problems in this area. Reliable HF packet communications requires that the frequency error presented to the demodulator be below 30 Hz. If several stations are to successfully share a single channel, transmitter / receiver offsets larger than this will be intolerable.

## APPENDIX A

### Using Oscilloscope for 50 Percent Duty Cycle Determination

The oscilloscope can be used to indicate a 50 percent duty cycle on square wave data in two different ways. The first is based on timing each half cycle of the square wave and comparing the time durations. This method requires an oscilloscope that can be reliably triggered on the incoming data. It also requires that the sweep speed can be operated in uncalibrated mode with continuous adjustment.

The second method uses the vertical input coupling capacitor to integrate the incoming square wave so the oscilloscope can display the DC offset. This method has no triggering requirements but the oscilloscope must be able to free run in the absence of triggering. This method also requires that the vertical position and the vertical gain be adjustable, and that the input can be AC coupled.

Both methods use the logic level data output from the demodulator. This means that the input impedance of just about any oscilloscope is plenty high enough for this application.

### First method: TIME BASED DUTY CYCLE DETERMINATION

1. Connect the 'scope vertical input to the end of R68 which connects to Q13's collector as described in the demodulator alignment procedure.
2. Do steps 4 through 7 in the demodulator alignment procedure so that there is a square wave data signal to observe on the 'scope.
3. Set the 'scope to trigger on the positive going edge of the square wave.
4. Adjust the sweep rate so that exactly 1 complete cycle of the square wave is displayed. Use the horizontal position control to exactly align the positive going trigger point edge of the signal with the left edge of the graticle on the 'scope face. Use the sweep rate controls to exactly align the next positive going edge of the signal with the right hand edge of the graticle area. There is some jitter present in the data at this point and it will appear as though there are really 2 transitions on the second positive going edge very close together. Use the midpoint of the 2 edges for alignment to the right hand side of the graticle. It will be necessary to use the continuously variable sweep rate capability of the 'scope for this adjustment as the calibrated steps are unlikely to result in an exact alignment.
5. Now adjust the demodulator center frequency using the appropriate variable resistor for the demodulator being aligned. Observe that the NEGATIVE going edge of the signal in the central graticle area moves in relation to the 2 POSITIVE going edges at the graticle extremes.
6. Set the demodulator center frequency so that the NEGATIVE going edge occurs exactly on the main vertical graticle line in the exact center of the graticle. This assures equal time for the data when it is in the high state as when it is in the low state. Again, use

the center of the jitter area.

End of method 1

### Second method: DC OFFSET DETERMINATION OF 50 PERCENT DUTY CYCLE

*NOTE! This is the PREFERRED method as it does not require estimation of jitter areas.*

1. Connect the 'scope vertical input to the end of R68 which connects to Q13's collector as described in the demodulator alignment procedure.
2. Do steps 4 through 7 in the demodulator alignment procedure so that there is a square wave data signal to observe on the 'scope.
3. Set the 'scope timebase to free run.
4. Adjust the vertical gain so that there are exactly 6 major graticle divisions (usually CM) between the 2 horizontal lines displayed on the 'scope face.
5. Ground the 'scope vertical input either by temporarily removing the probe from the test point and attaching it to ground or by using the switch provided for this purpose on the 'scope vertical amplifier. Adjust the vertical position so that the horizontal trace falls EXACTLY on the middle horizontal graticle line.
6. Make sure the 'scope vertical input is set for AC coupling during the rest of this procedure.
7. Reattach the probe to the test point if necessary.
8. Now adjust the demodulator center frequency using the appropriate variable resistor for the demodulator being aligned. Observe that the 2 horizontal lines move in the vertical plane in relation to the horizontal graticle lines.
9. Set the demodulator center frequency so that both lines are exactly the same distance from the middle horizontal graticle line. This should place one of them 3 divisions above it and the other 3

divisions below it.

End of method 2

APPENDIX B

CALSET Values for Various Modulator Tone Frequencies

Tone	CALSET *	(1274/78) Adjust	(THC-2) Adjust	Modem / Remarks
2120**	248	R106	R78	HF Packet & RTTY / Fc = 2220 200 Hz shift
2320**	227	R105	R77	Hf packet & RTTY / Fc = 2220
1600	329	R106	R78	HF Packet & RTTY / Fc = 1700 200 Hz shift
1800	292	R105	R77	HF Packet & RTTY / Fc = 1700
1300	404	R78	R78	Packet / Fc = 1700, 800 Hz shift
2100	250	R77	R77	CCITT V.23 standard, Preferable for HF 1200 baud use. Works on UHF FM too
1200	438	R78	R78	Packet / Old 1200 baud standard. Too wide to fit comfortably through SSB
2200	239	R77	R77	filters for linear mode 1200 baud use
2125	248	R122*	NONE	UHF RTTY / Fc = 2550, 850 Hz shift
2975	177	R119*	NONE	UHF RTTY / Fc = 2550, 850 Hz shift
750	701	R139*	NONE	CW
775	678	R139*	NONE	CW
800	657	R139*	NONE	CW
825	637	R139*	NONE	CW
850	618	R139*	NONE	CW / SSTU
1500	351	R138*	NONE	SSTU
2178	242	R122*	NONE	HF RTTY/ASCII/AMTOR / Fc = 2220, 85 Hz shift. Military standard for data rates below 110 baud. Allows use of very narrow IF filters for noise bandwidth reduction and interference rejection.
2263	233	R119*	NONE	Requires R141 value to be changed to 300 K. This will make wide shift RTTY unavailable on the "normal" demodulator. The 1200 baud packet demodulator can be selected for wide shift RTTY use by the OPMODE command. If HF RTTY / AMTOR is a primary consideration, and baud rates beyond 110 are not anticipated, some

\* These adjustments available on MFJ-1278 only.

\*\* This tone pair may require a change of resistor values on the modulator header so that the tuning range of the adjustment pots will cover the

This is a map of the physical locations of the adjustment potentiometers on the 1278 circuit board. They are shown as they appear when looking down on top of the board with the board oriented so that the rear panel connectors are to the left. Information in the boxes is organized as shown below.

PART	MODE
CALSET	*

PART	MODE	H/L	PART	MODE	H/L
FREQ	/	CALSET	FREQ	/	CALSET

DEMODULATOR

MODULATOR

R113	HP
CALSET	32

R106	HP	L	R77	UP	H
2120	248		2100	250	

R114	UB
CALSET	32

R122	UB	L	R105	HP	H
2125	248		2320	227	

R79	UP
CALSET	8

R78	UP	L	R119	UB	H
1300	404		2975	177	

R115	CW
NO CALSET	
SEE NOTE	

R138	SSTU	H	R129	MCH
1500	351		850	618
			SEE NOTE	

NOTE1 Separate procedure required to do alignment of CW demodulator center frequency.

NOTE1 MCH modulator tone is also used for SSTU transmission. However, CW receive through a narrow filter for HF CW operation will require the CW demodulator center frequency to be selected to align with the radio's filter passband. MCH operation on UHF FM will require that both stations have both the modulator tone and demodulator center frequency to the same frequency. Depending on the mode you feel is most important to you, a choice will have to be made that can adversely affect operation on the other modes (SSTU, MCH, or CW).

## APPENDIX D

### Modifications to TNC-2 Data Carrier Detector (DCD) Circuit

These modifications are to allow TNC-2 modem operation with a narrow IF filter on HF.

*NOTE! For 1200 baud HF work on 10 meters, the normal 2.4 KHz SSB filter constitutes a "narrow" filter for the demodulator.*

There are three objectives to these modifications:

1. Provide threshold control for the DCD circuit. This allows the operator to adjust the demodulator to compensate for the DCD threshold shift which accompanies bandwidth limiting the audio fed to the demodulator when a narrow filter is used in the radio. This also allows the operator to adjust the DCD threshold for operation at 1200 baud on VHF FM to prevent excessive DCD falsing when using unqueched audio.
2. Add hysteresis to the Data Carrier Detector. This reduces the DCD's sensitivity to noise. It does this **WITHOUT DEGRADING DCD ACQUISITION TIME** for a valid data carrier. It also prevents short glitches from appearing at the DCD output on attack and release.
3. Add DCD hang time on release. This is to keep DCD valid through a short multipath hit in the middle of a packet. Without this, a TNC watching the DCD line waiting to transmit will key up before the other station is finished sending its packet. Currently, this happens very frequently on HF packet channels. Again, this benefit is gained **WITHOUT DEGRADING DCD ACQUISITION TIME** for a valid packet.

The MFJ-1278 is currently the only commercially available TNC I know of for HF packet use which has a modem that is truly optimized for the mode in this respect. The modifications given here will upgrade the modem in any TNC-2 or clone (including MFJ-1274) which has a 2211 demodulator to the level of DCD performance of the 1278 modem.

Part numbers referred to are for the original TNC-2 as produced (briefly) by TAPR. I have not reviewed schematics of clones produced by all manufacturers so I cannot be sure that these numbers will be correct in all cases. Since I have seen information on the MFJ series, I can say that the numbers are ok for a 1270 and 1274. If you are in doubt about part number correspondence, obtain a schematic of the original TNC-2 as produced by TAPR. Comparison between the TAPR schematic and the schematic of your TNC should resolve any differences. The TNC I used to verify this modification was a 1274 which I use primarily on HF packet. Since the physical layout of the modem area of the 1274 is different that the layout of the original TNC-2 or "pure" unaltered clones, I have avoided giving specific physical location information in the modification procedure.

Any manufacturer of the TNC-2 can feel free to incorporate this change into their hardware if they wish without incurring any obligation to myself or TAPR. I am available to answer any questions in this area.

*NOTE! Do NOT use TNC-2 firmware earlier than version 1.6 with this modification. Firmware prior to V1.6 has no facility for detection of a DCD fault condition and therefore cannot warn you when the threshold control has been improperly set.*

### STEP BY STEP MODIFICATION

1. If you have a TNC-2 or clone (except MFJ-1274), and have not already removed the MF-10 filter and associated header parts, do so at this time. The reason for this is that the operation of this filter circuit is marginal at the supply voltages used in the TNC-2 and this drastically reduces the modem dynamic range. This is a very easy modification. Simply remove both the MF-10 and the header associated with the MF-10. Then under the board solder a jumper between pins 1 and 8 of the header socket. Removing the MF-10 also unloads the -5 volt supply, improving its regulation and reducing the noise generated by the charge pump circuit. There is **ABSOLUTELY NO PERFORMANCE PENALTY** for removing this filter.
2. Replace C35 and C42 with 0.01 microfarad caps.
3. Remove the 470 K resistor at R73. Be careful not to damage the circuit board pads or traces as they will be needed later in the modification.
4. Remove CR13.
5. Replace R70 with a 47 K resistor.

6. Lift the cathode end of CR15 from the circuit board. Install a 47 K resistor in series with CR15. Solder one end of this resistor to the hole vacated by CR15's cathode end. Solder the other end of this resistor to the cathode end of CR15 above the circuit board.
7. Replace R74 with a 4.7 K resistor.
8. Form a parallel network consisting of a 180 K resistor and a 0.01 microfarad cap. Make this network as compact as possible as it will have to fit underneath the circuit board. Solder this network in place under the board. One end goes to pin 3 and the other to pin 6 of the 2211 socket (U20).
9. Replace R38 with a 100 K resistor.
10. Above the circuit board, using leads as short as possible, install a 470 microfarad, 10 volt rated electrolytic capacitor between the -5 volt pad on the modem disconnect header (pin 1) and ground. Connect the positive lead to ground. Remember that this cap will have to clear the cabinet so position it as near the board as possible.
11. Under the circuit board, solder a 2.2 microfarad, 16 volt rated electrolytic capacitor from the junction of R38 and R42 to the -5 volt supply. The negative end of this cap goes to the -5 volt supply.
12. Under the circuit board, solder one end of a 22 ohm resistor to the junction of R38 and R42. The other end goes to pin 5 of the 2211 (U20).
13. On the front panel, Mount a miniature 100 K, linear taper potentiometer (yes, there really IS room for this). This will be the DCD threshold control. It will be used to set the DCD trigger point to the proper value.
14. Solder a wire from the wiper of the 100 K pot to the pad vacated by R73 which connects to C45 and pin 3 of the 2211 (U20).
15. Solder one end of a 27 K resistor into the pad vacated by R73 which connects to the -5 volt supply. Solder a wire from the other end of this resistor to one of the 2 remaining leads from the 100 K pot. Use the lead that is set to zero resistance when the shaft of the potentiometer is turned fully CCW.

When operating a TNC with a DCD threshold control, set the control so that the DCD LED on the front panel flashes occasionally when there is no signal present. The "false DCD" duty cycle should be approximately 20 percent.

When operating VHF FM with the radio squelched, the DCD will not false. If you MUST operate with the radio squelched (thus incurring the penalty of the additional delay time of the squelch circuit), set the threshold fully clockwise as described below.

The audio bandwidth of some VHF FM radios is so wide that the DCD will not false regardless of the threshold control setting. This will almost always be true when the audio is obtained ahead of the radio's squelch controlled stage before deemphasis. For these radios simply turn the control fully clockwise. This sets the DCD to maximum sensitivity. DCD operation will not be impaired.

This completes the TNC-2 modem modification.

## APPENDIX E

### TNC-2 Modem Header Parts for 300 Baud HF Packet Operation

This refers to the demodulator header U19.

PIN	PIN
1 -- M/C -- 16	
2 --- ----- 15 0.022 uF	
3 --/\//\//\-- 14 180 K	
4 --/\//\//\-- 13 15 K for Fc = 2200 Hz, 22 k for Fc = 1700 Hz	
5 --- ----- 12 0.0047 uF	
6 --- ----- 11 0.01 uF	
7 --/\//\//\-- 10 100 K	
8 --/\//\//\-- 9 750 K	

## APPENDIX F

### MFJ-1278 CW Modem Tuneup Procedure

The CW modem in the 1278 is fundamentally different than the other modems. It is NOT an AFSK modem. It sends and receives only 1 tone. For this reason, it requires a different alignment procedure than the others.

Depending on which of several modes of operation is most important to you, a choice will have to be made as to what frequency will be used for the modem Fc, and whether or not the modulator will be aligned to the same frequency as the demodulator.

**NOTE!** If the modulator AND demodulator are not EXACTLY on the same frequency for BOTH stations involved in VHF FM MCW operation, CW receive will be degraded if not eliminated.

**NOTE!** If the DEMODULATOR is not EXACTLY centered in the receiver's CW filter passband, CW receive performance through a narrow filter will be degraded. Also, the demodulator will likely not be receiving on the transmitted signal frequency. This note is for the HF direct keyed radio case (NOT MCW via SSB transmitter microphone audio which is discouraged).

**NOTE!** Since the modulator tone used for MCW is also one of the SSTV transmit tones, it will have to be set for 850 Hz if SSTV mode is important to you. This will mean that MCW receive will not work if the demodulator is aligned to a different frequency for HF CW work through a narrow filter. Code practice transmissions on VHF FM MCW with an 850 Hz tone will still be possible.

As can be seen from the above notes, there are definitely some conflicting requirements. Since MCW operation is primarily intended to provide a means to transmit code practice and not for CW reception, the demodulator center

frequency may be set to a different frequency than the modulator without penalty in most cases. Typically, the modulator will be set to 850 Hz, and the demodulator will be set to whatever frequency is dictated by the HF radio with which it is to be used.

The CW demodulator can be used without a narrow filter in the radio. It will of course be subject to more noise and QRM in this case. The tuning range for the demodulator will be VERY restricted even though the wide filter is used in the radio since the demodulator itself acts as a very narrow filter.

An oscilloscope will be required to adjust the demodulator to a 50 percent duty cycle square wave output just as for the AFSK demodulators. The difference is that there will be only 1 continuous tone presented to the demodulator for this adjustment.

Tuning this modem is basically a 4 step procedure. The steps should be followed in the order presented. The steps (in broad outline) are:

1. Determine the required demodulator Fc for the radio you intend using in the direct keyed CW mode.
2. Set the CW modulator tone to this frequency.
3. Set the demodulator center frequency using the modulator tone as reference.
4. If you care about 2 tone SSTV, set the modulator tone to 850 Hz.

#### DETAILED ALIGNMENT PROCEDURE

1. Determine the required Fc for the demodulator. If the radio has a narrow filter for CW, one of the 2 methods presented in the AFSK modem alignment procedure should be used to determine the filter center frequency. This frequency should be used for Fc. If the radio has no narrow CW filter, use the CW carrier offset frequency of the radio. This information should be available in the radio manuals.
2. Set the modulator tone to the required Fc using the following procedure.
  - a. Command the 1278 into MCW mode by typing "MODE MC <CR>".
  - b. Install push on jumper at JMP-4. This is the watchdog timer defeat jumper.
  - c. Connect the counter input to JMP 9, pin 1.
  - d. Command the TNC into calibrate mode by typing "CAL <CR>".
  - e. Command the TNC to key the modem by typing "K".
  - f. Select the MCW tone by pressing the space bar until a voltmeter connected to U16, pin 9 reads + 5 volts. This signal is more conveniently available at the junction of Q12 collector and R62.
  - g. Adjust R129 until the counter indicates the intended tone frequency as determined above.
  - h. Return the 1278 to command mode by typing "Q".

*NOTE! The internal calibration routine can be used instead of the counter to set this tone as described in the AFSK modem alignment procedure.*

3. Align the demodulator to Fc using the MCW tone. Use the following procedure.
  - a. Place a push on jumper at JMP 7. This connects the modulator output to the demodulator input.
  - b. Place a 'scope probe on left pin of JMP 10 (pin closest to Q 14). The oscilloscope will be used as described in appendix A to indicate when the square wave that will appear at this point during the adjustment procedure approaches 50 percent duty cycle.
  - c. Command the TNC into calibrate mode by typing "CAL <CR>".

d. Command the TNC to key the modem by typing "K".

e. Select the MCW tone by pressing the space bar until a voltmeter connected to U16, pin 9 reads + 5 volts. This signal is more conveniently available at the junction of Q12 collector and R62.

f. Turn R115 fully clockwise, until a click can be heard from turning the pot. g. Now begin to rotate R115 CCW slowly. Watch the 'scope while rotating R115. A stable square wave should appear between about turn 4 and turn 9. Which turn on the pot where you find the spot that produces a stable square wave may vary from unit to unit. There are only about 1 to 2 turns where the square wave will appear on the scope.

h. Adjust R115 so the square wave displayed has a 50 percent duty cycle. Note that when R115 is adjusted properly, the period of the square wave should be about 0.66 milliseconds.

*NOTE! If you have a square wave on the 'scope face but the tuning indicator is not near center, you are on a false setting. adjust R115 so that the tuning indicator is near center and THEN set the square wave duty cycle.*

4A. If 2 tone SSTV is of importance to you, use the above procedure to reset the MCW modulator tone to 850 Hz.

4B. If MCW transceive operation with another station is desired, do the above procedure to BOTH 1278s using an agreed upon frequency for Fc. Then leave the modulator tone on the agreed on frequency with the demodulator Fc.

This completes the CW modem alignment procedure.

## APPENDIX G

### Use of Tuning Indicator to Center Filter With IF Shift

The tuning indicator can be used to aid in centering the radio filter passband over the modem Fc. The modem and tuning indicator must first be properly aligned according to the procedure already presented.

The Phase Locked Loop (PLL) in the demodulator attempts to track the spectral components of the noise it sees on its input. If that noise has been bandlimited by a filter whose bandwidth is nearly the same as the PLL tracking range, the loop is largely successful in tracking the noise. In doing so, the loop control voltage, which is the signal used by the tuning indicator, takes on values which are centered over the value which would be required to lock the loop to the mean frequency of the noise coming through the filter. Since the tuning indicator can't tell whether it was signal or noise that generated the loop control voltages, it gleefully (and correctly) indicates the frequency error between the mean noise frequency and the demodulator Fc. When the indicator is centered, the error is zero.

*NOTE! To make use of this property of the demodulator and tuning indicator, there must be ABSOLUTELY NO coherent signals in the filter passband. The setting will not be correct unless it is based entirely on noise. If tuning the receiver frequency shows up as motion in the tuning indicator display, there is a coherent signal in the passband (even if you can't hear it!).*

To center the filter over the modem with the IF shift control:

1. Find a frequency which has plenty of noise but is free of coherent signals. Before I realized that the noise bridge could be helpful for this, I used the CW end of 80 meters during the daytime hours when propagation is shut down. If you have a noise bridge available, by all means use it as a source of noise for making this adjustment. Tune the receiver frequency back and forth to be sure that there really are NO coherent signals there. If there are, the tuning indicator will respond to receiver tuning.
2. Use the IF Shift control to move the filter apparent center frequency around. Observe that the tuning indicator follows the movement of the filtered audio spectrum.

*NOTE! If the tuning indicator stays all the way to one side or fails to respond to the IF Shift control movement, something is wrong. Either the modem center frequency is far outside the adjustment range of the IF Shift control or there is not enough noise coming through the filter for the demodulator to track.*

*Set the IF Shift control so that the tuning indicator is centered. The tuning indicator bar will appear quite jittery when responding to noise but this is normal. Use the center of the jitter area for the adjustment.*

3. If you are using a modem with a DCD threshold control, this adjustment can be made a little more precise. Now that

the tuning indicator is centered, adjust the DCD threshold control so that the DCD falsing rate is approximately 20 percent. Then SLOWLY and CAREFULLY move the IF Shift control back and forth to find the place where DCD duty cycle is maximized. This is the best position for the IF Shift control.

4. To keep from having to repeat this exercise, a small pencil mark can be placed on the radio panel to indicate the correct setting of the IF Shift control for use with the modem.

This completes the alignment of the IF Shift control for centering the radio's narrow filter over the modem's center frequency.

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