# Spread Spectrum Scene

*The PCS, Wireless Network and CDMA Monthly News Magazette*

**Volume 1, Number 6**
**September, 1992**



*Single Copy Price $3.00*

## Spread Spectrum Scene Celebrates 6 Months of Publication!

***We made it happen!***

RF/SS proudly celebrates publishing six monthly issues of *Spread Spectrum Scene* and would like to thank our readers., subscribers, advertisers and all the other supporters who've helped us along the way tc "moderate maturity."

Many people thought SSS would only publish one or two issues -- many people thought our coverage area and target technology too narrow -- I guess we'll see about those doubters!

We like success -- don't you'?

## What's Inside



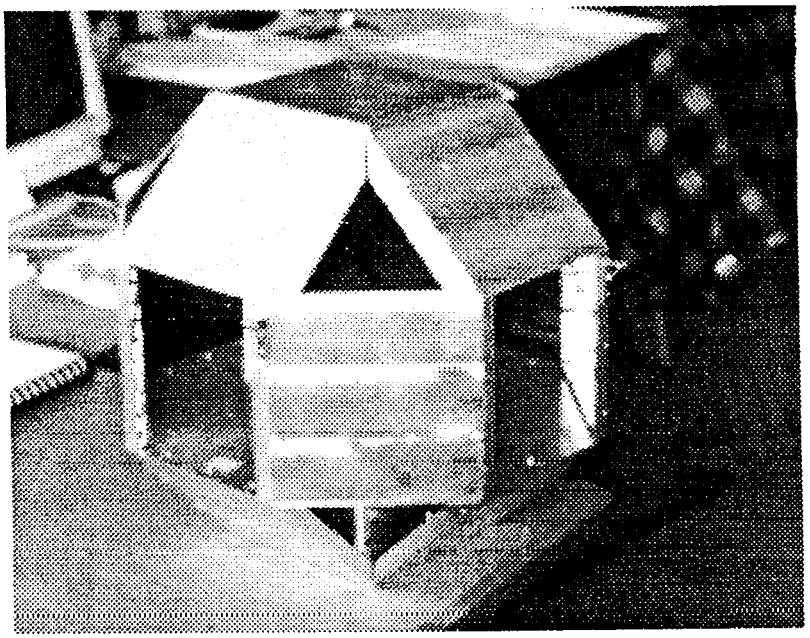

**Photo of NPS Monterey PANSAT mockup, for more see page 7.**

## SSS Exhibits at HAMCON 92

SSS shared a booth with Ham-Pro antennas at the ARRL 1992 National Convention (HAMCON 92) in Los Angeles, August 20, 21 and 22. Over 500 copies of our August issue were distributed to some of the interested 3200 attendees of the convention.

The convention seemed to be a big success for all involved, even though sales (and in our case new subscriber) orders were a little slow in coming. The ARRL sponsored technical programs were very well attended (many were standing room only.) We attended the FCC forumn and heard excellant talks by FCC's Ralph Haller and John Johnston. See you at PACIFICON in October.

## FCC STA Request May Become Request for Permanent Rulemaking to Part 97 Rules

A lot of behind the scenes activity is going on about the "new STA request" we highlighted last month. First, a meeting of 14 SF bay area hams in Redwood City decided to seperate VHF/UHF SS from HF SS operations in any FCC request.

Second, informal discussions with ARRL Washington staffer Paul Rinaldo has focused the "draft" STA request to the bare essentials. Finally discussions with FCC PRB Chief Ralph Haller at Hamcon 92 suggested that the FCC would be interested in a request for a **see STA page 2**

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**STA cont'd from page 1** -permanent part 97 SS operations rule change. Paul Rinaldo and ARRL general Counsel Chris Imlay are busy on this latter possibility.

## Rumors & Ramblings

- High speed LANs and WANs are the top subject in Silicon Valley rumors about who's doing what and who's about to show what new SS products. Is everybody too gun-shy to jump on the 1.8 to 2.4 GHz PCS bandwagon?
- Maxim, the acknowledged leader in new chip introductions in any given year, is hard at it still -- see our new products section for some interesting tidbits that might help SS system designers.
- Signetics is putting out a lot of new chips lately -- some of them targeted for SS and newer cellular radio systems. See our new products section.
- Heard a good rumor -- want to "leak" some info to your competition -- call our 800 number and we may print it!

## Decipherings

PROGRESS HAS NOT FOLLOWED A STRAIGHT ASCENDING LINE, HUT A SPIRAL WITH RHYTHMS OF PROGRESS AND RETROGRESSION, OF EVOLUTION AND DISSOLUTION.
**- Goethe -**

**Don't miss an issue of Spread Spectrum Scene. Subscribe now!**

## Reader Feedback -- How You Influence What's Inside SSS

This month brings more changes to SSS. We are still evolving our format and subject emphasis (focus). You -- dear reader have a great deal of influence in this area. I assume from the lack of feedback that whatever SSS does is OK. Is that what you mean? If not -- **please** call, write or FAX us and say what you want.

This month we are dropping the Business Card ad section, just like we dropped the classified ad section -- you don't seem interested. No one is willing to **pay** for our business card ads! So they are now history.

A similar story involves the serialization of our forthcoming book, Introduction *to Spread Spectrum, we* are just going to wait until the book is complete and published -- then you may buy it or not. No reader feedback -- it goes away! Get it?

As one of our cover stories says August's feature about a new request for an STA to FCC part 97 rules for Ham Radio SS probably will become a request for permanent rulemaking -- until this political issue is resolved or until you readers show some interest, any construction articles on the STA-1 or STA-1*, or whatever, are hereby terminated. If you want to see things like this -- let us know. Major amounts (for RF/SS) of time and money have to be invested to bring these things and possible kits to you.

Why should this time and money be wasted if it falls on deaf ears'!

## EDITORIAL

### To Spread or Not to Spread

***W. Shakespeare***
***please forgive us***

Many of RF/SS' consulting clients are finding that blind adherence to FCC part 15.247 rules is costly or otherwise undesirable. Is Spread Spectrum always the most desirable technique of unlicensed communications?

Some of these clients are finding out, before it's too late, that (as the title of this editorial suggests) it may not pay to always "Spread." Specifically another part of FCC part 15, paragraph 15.249 allows intentional radiators to occupy the same ISM bands as Spread Spectrum communications, but without the burden of much wider bandwidths and hardware complexity. Of course there is a penalty: the maximum radiated average signal is limited to 50,000 microvolts/meter measured at 3 meters.

In other words, why use spread spectrum systems just to communicate short range, low power data or voice information, when simpler narrowband, non-spread techniques may work just as well? The answer quoted by most equipment developer CEO's and company Presidents and VP Engineering people is simply that is what all the competition is doing. Oh boy -- watch out in the board room! You guys are supposed to make "profits" for your shareholders -- not make the same mistakes as your competition. Let me suggest that "some" applications exist that are best implemented without spreading.

An example may be appropriate here:

- Suppose your company wants to design and build wireless short range in-home burglar or intrusion or fire alarms. Naturally the first reaction would be to use SS at 915 MHz -- right?

I think you would be dead wrong in today's commercial market place! Why not develop the same kind of equipment using NBFM techniques at 915 MHz, with no spreading, and just keep the range and/or transmitted power levels down to the limits of FCC paragraph 15.249? Your equipment could be developed quicker, at far less NRE cost, with maybe 1/2 or 1/3 of the recurring cost of an equivalent SS design.

Am I all wet or are you following me? RF/SS has clients who really need Spread Spectrum -- we also have other clients who are far better off (or would be) just designing and developing equipment for FCC part 15.249 Do you and your products fit in this later category? What do you think about this subject?

Please write us with your company's (non-proprietary, please) experiences in this area -- we will be glad to share any input received with our readers in these pages.

**Randy Roberts**
**SSS Publisher**

# The Aerial

by Peter Onnigian, P.E., W6QEU

## DETERMINING RADIATED POWER IN SPREAD SPECTRUM OPERATION

Last month we discussed antennas, coaxial cable and connectors suitable for SS use in the **902-928** MHz (915) band. This concluding article explains the maximum allowable radiated power and how its computed.

Simple vertical dipoles over a ground plane, mounted on the equipment chassis, rubber "duckies" and other forms of radiators have found their way into the SS equipment field, for relatively short range communications out to about 800 feet. For longer ranges, the low cost high gain Yagi antenna is the antenna of choice. Because of their small size at this frequency, Yagi antennas can be used indoors, for greater reliability than possible with built on equipment type radiators, where necessary. Outdoor Yagis will increase the circuit range to 25 miles and even more depending on line of sight conditions and other propagation factors.

Part 15.247 (b) of the FCC Rules covers antenna gain and radiated power limitations. This part states:

"The maximum peak output power of the intentional radiator shall not exceed 1 watt. If trans-

mitting antennas of directional gain greater than 6 dBi are used the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi." What does all this mean? Part 15.203 clarifies this restriction on SS antennas by stating:

"An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. (SS transceiver)... The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. . . ..This requirement does not apply to intentional radiators that must be professionally installed."

The intent of these Rules is to prevent the use of high gain antennas which would cause the operation to have an Effective Isotropic Radiated Power (EIRP) of more than 6 dBi.The FCC believes an EIRP of 6 dBi will not cause heavy interference with the priority users assigned to the 915 band.

An isotropic radiator which radiates equally in all directions is used as the theoretical reference antenna in FCC Part 15.247 (b). Such an antenna is not physically realizable. So the isotropic value must be converted to a dipole value by subtracting 2.15 dB.

This Rule says you can radiate up to, but not more than 6 dBi times one watt. This is 4 watts above isotropic when using directional antennas. The FCC may just as well have stated this as 3.85 dB above a dipole, since 3.85 dBd is the same as 6.0 dBi. And 3.85 dBd in power over one watt is 2.4266 watts.

Lets take a practical example. We have a directional Yagi to be used above the building, with a rated gain of 9.0 dBd. The 50 foot coaxial line run has a loss of 2.125 dB at 915 MHz. Antenna gain of 9.0 minus 2.125 line loss equals antenna system net gain of 6.875 dB. Maximum allowable antenna system input power output from the SS transceiver is 3.85 dB minus 6.875 dB. This is -3.025 dB below one watt. Minus 3.025 dB is equal to 0.498 percent of one watt. (498 milliwatts)

Lets work this forward for proof. The 50 foot of line allows 61.3 percent of the 498 milliwatts to reach the antenna. This is 305 milliwatts or 0.305 watts. The 9.0 dB antenna power gain multiplier is 7.94 times 0.305 watts equals 2.422 watts radiated. And 2.422 watts is equal to 3.843 dBw, close enough to maximum allowable of 3.85 dBw.

**CONCLUSIONS:**

The maximum allowable ERP is limited to 2.422 watts when using a directional SS antenna. Power ratio of 2.422 is also 3.85 dB above 1 watt, which may also be expressed as 3.85 dBw. This value is also 6.0 dB over isotropic (6.0 dBi) The 6 dBi and 3.85 dBd are equal.

orizontal polarization is best in the 915 MHz band in most parts f the country. Linear vertical, ant, dual, and circular polarization may also be used as ng as the radiated power with eference to a half wave dipole oes not exceed 2.422 watts.

lext month we'll cover methods f converting from radiated field trengths in microvolts per meter as often specified by the FCC) o radiated power at a given -equency for typical SS antenna ypes.

***bout the author:*** *Peter Onnigian, President of Hum-Pro ntennas, is a registered rofessional engineer with many ears of antenna design and anufacturing experience. His acramento based Hum-Pro ntennas makes wideband 450 nd 91.5 MHz spread spectrum ntennas in addition to a line of mateur monobanders for VHF nd HF operation.*



## New Products I

A new line of Yagi antennas was announced by Ham-Pro Antennas, a division of Kopps Corporation, n Sacramento. They are idea1 for spread spectrum, wireless alarms, automated data collection, wireless area networks and other FCC Part 15 services, where a low power economical antenna is desired.

# DSP

**for**
**Spread Spectrum**

**by Matthew Johnson**

## Conclusion of the Basic All-Purpose Digital Signal Processor Discussion

Last month we presented more discussion of the concept of the "BADSP." This month we conclude this introductory DSP discussion. Remember the BADSP block diagram (shown the last two months)? We now discuss the remaining two blocks, the whimsically named Number Cruncher does whatever processing is required to extract the desired information from the digitized signal. This could be the digital implementation of a familiar function from the analog world, such as bandpass filters or notch filters; it could be a non-linear filter without an analog counterpart, such as the median filter. Since no information is lost in the digitization, your imagination is the limit!

Finally, the name I chose for the last block makes a more limiting assumption about the intended application of the BADSP. The name "Reconstruction Filter" assumes you are using the BADSP to reconstruct an analog signal out of your processed digital signal. For example, if the Number Cruncher is the identity function, i. e. it passes input to output unchanged, then the Reconstruction Filter takes the Staircase response of a DAC and smooths it out to reconstruct the continuously varying analog signal represented by that staircase signal. But this requires a physically unrealizable filter, one with the transfer function:

$H(\Omega) = \text{sync}((1/2)\Omega T)e^{(1/2)\Omega T}$ when $|\Omega| < \pi/2$

$H(\Omega) = 0$ when $|\Omega| > \pi/2$

where sync(x) = (sin(x))/x, T = sampling period, $\Omega = 2\pi f$, the normalized frequency.

Here is another exercise for the reader: sketch the transfer function.

In practice following the Number Cruncher, we usually have a low pass filter with cutoff below the Nyquist frequency. Of course, this block, like the Anti-Aliasing filter, consists of analog components, so I nlight deliberately choose a high sampling frequency just to ease the requirements on this filter! Now that I've covered all the blocks of the BADSP, I will discuss the interesting features of the new digital proposal for HDTV, with some comparisons to the previous analog proposals -- next month.

## International Scene

**(From the W5YI Report - Sept. 1992)**

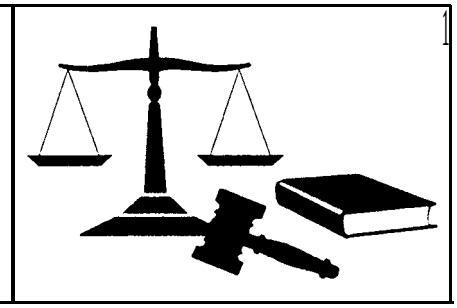
***New electromagnetic compatibility (EMC) regulations coming to Great Britain and the European Community.***

A new European Community EMC Directive (89/336/EEC) requires manufacturers of virtually all electrical and electronic equipment and their authorized representatives to ensure that the products they sell in the Community comply with EMC protection requirements.

Manufacturers must construct their products so that (a) the "electromagnetic disturbance generated does not exceed a level allowing radio and telecommunications equipment and other apparatus to operate as intended and (b) products have an "adequate level of intrinsic immunity to electromagnetic disturbance" to enable it to operate as intended.

Approved products will carry a "CE" approval marking, even if they are sold in the UK only. Non-compliant products will be banned from the marketplace. The new rules go into effect after a transitional period - currently scheduled for the end of 1995.

Each member of the European Community will assign an agency to issue *EMC Type Examination Certificates*. While home-brew ham radio rigs are exempt from the new directive, commercially available amateur radio transmitters will require an EMC type examination certificate. *(Source: 1992 Radiocommunications Agency information sheet, London, England. UK.)*



## Washington Scene

The dust has just settled fiom the two major parties political conventions, H. Ross Perot still can't decide to run or not and much of Washington is still out to lunch, but the FCC is still busy with its own NO1 (notice of inquiry) on PCS. How will this all turn out? Will the phone companies, cable companies or other common carriers pick up pieces of the 1.8 to 2.4 GHz band? Time and political vagaries will certainly decide these critical issues. We feel its time to "play turtle" and wait to see how it all turns out. You might do some breadboarding or re-tune some of your *2.45* GHz equipment down a few hundred MHz -- but don't launch any new products yet!

# Spread Spectrum Networking Software

by John Greene

Most Serial Communication Controllers are intended to be used in some sort of wired environment. I say this mainly because the Controllers seem to be really capitalize on being able to use certain encoding schemes when transmitting the data. Most of which cannot be used with a radio modem because of bandwidth limitations. This can cause some minor problems when adapting for use with a radio modem, one of which I will go into here.

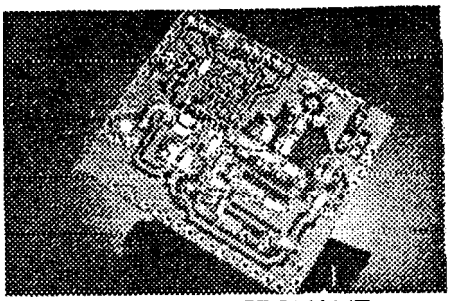
Ideally the SCC likes to use a data encoding scheme that will embed the clock within the data. FM1, FMO, and Manchester are a few examples of this. However, this requires twice as much bandwidth when modulating a carrier than a NRZ or NRZI encoded signal. The 8530 SCC that I am familiar with pmvides a Digital Phase Locked Loop to do clock recovery when using NRZ or NRZI so recovering the clock is not a real problem. When you start looking at how an abort is handled, the plot of the story begins to thicken.

An abort sequence is define as eight consecutive "1s" being transmitted. A condition that would normally not exist because of the zero insertion mechanism of the SCC. The idea behind the abort function is if the packets tend to be very large and an error occurs on the transmit side of the link, the transmitter has a way of telling the receiver that the packet is bad, disregard and immediately set up to receive again. This starts to get a little sticky when using wireless modems. With FM1, FMO, or Manchester encoding, you always have at least one transition per bit. However, with NRZ or NRZI encoding, a zero or one can be a steady-state condition and an idle line can look a lot like a continuous stream of aborts. Well, I never intended to use the abort function so how about I just don't enable abort interrupts and ignore them? That works line until the first time you suffer a loss of carrier in the middle of a packet. This is a problem because of the way the SCC handles abort, whether the interrupt is enabled or not'

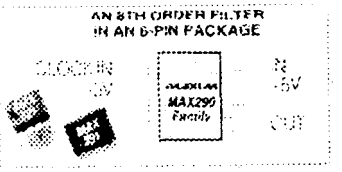
The data line on a RF modem is usually squelched when carrier is lost If it is squelched in the proper polarity such that it looks like a '1' to the SCC, it is interpreted as an abort. The SCC, upon receiving an abort, will immediately return to 'HUNT' mode and be ready to receive again. The CRC checker is reset and everything looks just line. However, DMA has written the first part of the packet into memory and unless the DMA counter and pointer is reset, it will start writing the next packet onto the end of the partial first packet. This will continue on until a valid EOF is received by the SCC. This can make for some extremely long packets if the carrier is dropping out frequently. If you enable the abort interrupt, you will be deluged with interrupts at the end of every packet when the line goes idle.

So, you need to either 1) enable the abort interrupt only after a valid sync character has been received and disable it after the EOF is detected. These interrupts must be serviced quickly if the packet size is small. Or you could 2) make sure that the polarity of the squelched dta line is the opposite of a '1' when using NRZ encoding. NRZI is not an option here because polarity doesn't matter. Unfortunately the hardware I received was in the worse possible configuration causing me to use solution number 1 and write everything in assembly to be fast enough. Even then, I would suffer around 50 abort interrupts at the end of every packet before I could disable it. To work around this I found that 1 could set a 'active-receive' flag faster than I could disable the interrupt so the state of this flag determined how I **processed the abort** interrupt. If I had received the EOF I would just return from any abort interrupt. This would continue until I received another sync interrupt. If an abort was detected, the SCC and DMA were set up to receive again. The rest of the packet would be ignored because a sync character was not received and worse case the flag at the end of the packet would cause a sync interrupt immediately followed by an abort. The abort would cause the SCC and DMA to be setup again to receive after which the line would have finally gone idle.

## New Products II

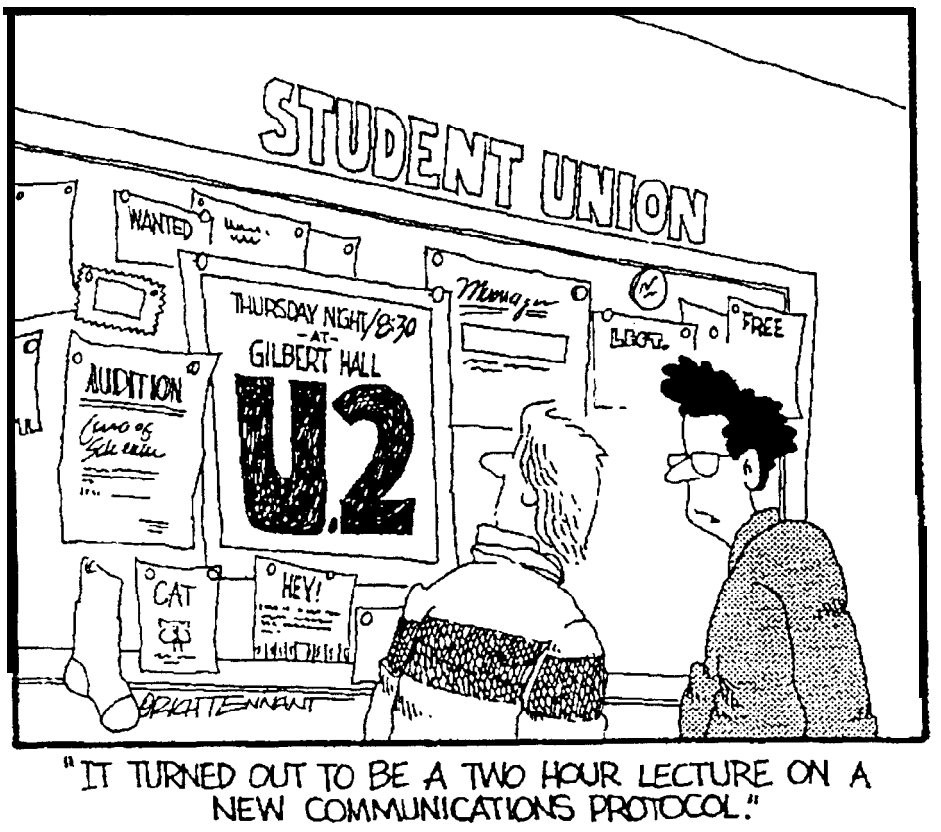


**The new Signetics UMA1014T chip provides a cost-effective solution for new battery powered SS frequency synthesis.**




**The new MAXIM MAX291 family of 8th order low pass filters for less than $3.00.**

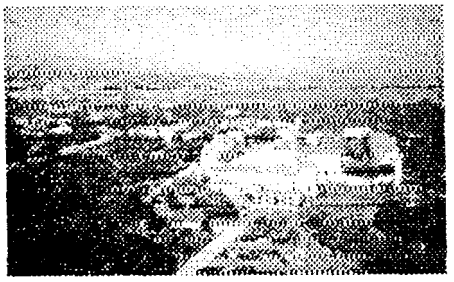
**The new Maxim MAX910 4ns SOIC comparator with digital threshold setting.**




"IT TURNED OUT TO BE A TWO HOUR LECTURE ON A NEW COMMUNICATIONS PROTOCOL."

# Introduction to The Navy's PANSAT Project

**by Randy Roberts, KC6YJY & RF/SS Director**



*The author visited the Naval Postgraduate School (NPS) in Monterey, California on July 28, 1992. Randy was graciously hosted by Professor Rudy Panholzer, PANSAT Principal Investigator and his staff. Most of our questions about PANSAT and how it will operate were answered at a weekly development/project status review meeting chaired by PANSAT Project Lead, Professor Ed Euler. The following article highlights the mission, current status and plans for the 1995 launch of PANSAT.*

The NPS is situated in a beautiful part of the Monterey peninsula and is the home of the Navy's prestigious graduate school for its career officers. Rear Admiral Ralph W. West Jr., USN, Superintendent, Naval Postgraduate School described NPS in the May/June, 199 l issue of "Defense 9 l" magazine:

"The Naval Postgraduate School in Monterey, Calif., was created to keep the Navy abreast of critical new technologies. The institution, a fully accredited graduate university, provides rigorous, fast-paced and challenging academic programs along with an opportunity to work directly with a fhculty that has earned acclaim for its expertise in science, engineering, management and national security affairs. Its programs are available to officers from all U.S. services and fiiendly nations to prepare them for technical and strategic leadership roles in the 21st century."

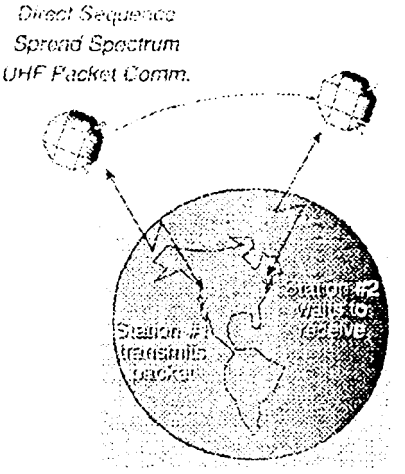
Rear Adm. West goes on to explain the curriculum emphasis at NPS: "At the heart of the Naval Postgraduate School are its curricular programs, which blend service needs and academic rigor. Most curricula integrate several academic disciplines to address special military requirements and applications For example, some of the school's programs focus on broad technical and engineering education, physical fundamentals and analytical concepts that govern operational use of military platforms, sensors and weapons systems; and current electronics technology and its application to modem warfare, including DOD command, control and communications systems."

## PANSAT Project Introduction

PANSAT is the acronym for "Petite Amateur Navy Satellite". The Navy's experiment is listed as Experiment Number NPS-901. The basic concept of PANSAT is to store and forward a packetized uplink message until the destination station is in view of the satellite and then re-transmit the message on the downlink. Thus PANSAT will be functionally another Pacsat -- the big difference is the signals needed to access the satellite will be Spread Spectrum (SS), with direct sequence modulation. The primary military objective of the experiment is to significantly enhance the education of military officers in the NPS's Space Systems Curricula by the design, fabrication, testing and operation of a low-cost, low earth orbit (LEO), digital communications satellite. PANSAT will also demonstrate the feasibility of a simple,low-cost communicationsatellite featuring:

- Digital over-the-horizon communications
- Orbital mailbox concept
- Low probability-of-intercept
- Low probability-of-jamming

CONCEPT




PANSAT engineering objectives include:

(1) Evaluate the performance of spread spectrum packet radio communications using amateur community as the user base.

(2) Provide an experiment platform to research an innovative method of measuring solar cell parameters and sensing sun direction.

The preliminary PANSAT launch date is late in 1995 -- of course, military priorities and funding may slip this somewhat. The actual satellite will weigh about 150 pounds and be about 19 inches in diameter. The communications payload is envisioned to be a 1200 Bit Per Second, AX.25 protocol, Direct Sequence Spread Spectrum receiver / demodulator / remodulator / transmitter operating near 437.25 MHz with 1 MHz bandwidth and full duplex data links. The actual on-the-air modulation type to be used is the subject of four different Master's degree theses -- the best performing modulation and most cost effective ground station demodulator will probably be selected for PANSAT's on-the-air signal modulation.

**Concludes next month**

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## October SSS Preview

**Finally:** Another Dan Doberstein Idea Article on a General Purpose SS Radio (GPSSR) for commercial, industrial or ham use, designed around the 49 MHz cordless telephone chips.

**Interesting:** More on DSP, "Secret" Signals, The Aerial and Technical Education in our columns.

**Conclusion:** Final part of the article on the Navy Postgraduate School, Monterey, CA, PANSAT satellite for ham radio & Navy use, due for launch in '95.

**News:** Latest news on The Spectrum Auction, H. R. 73 and other legislative developments.

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