# Spread Spectrum Scene

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

Volume 1, Number 5
August, 1992




## RF / Spread Spectrum Announces Sister Publication: Spread Spectrum Scene/Update

After publishing five monthly issues of Spread Spectrum Scene, we have decided that it is nearly impossible to keep up with important political and regulatory events in a newsletter published once a month. SSS will continue to be published monthly and will provide the detailed background and tutorial material that our readers expect. Update will publish at least 26 issues per year, covering the rapid developments in legislation, FCC rulemaking and international events.

You can receive a free sample copy of Volume 1, Number 1 of SSS/Update by sending us a self addressed stamped envelope.

### What's Inside



## FCC Proposes New PCS Rules and Asks for Comments

The FCC has proposed new rules for personal communications services (PCS) and issued tentative frequency assignments for HDTV.

The proposed FCC PCS rules settled very few controversies. In fact, some of the remaining issues are:

(a) There are three unused 1 MHz pieces they would like to shift to PCS use, with each licensee getting from 50 kHz to 1 MHz.

(b) FCC will give the very first pioneer's preference to MTEL of Jackson, Mississippi. The FCC may allocate an additional 20 MHz or more in the 1.8 to 2.2 GHz band for unlicensed part 15 use.

(c) FCC would have PCS include mobile data, voice and paging services. FCC wants to give PCS "a federally protected right to interconnect with the PSTN."

The FCC wants comments on a myriad of subjects related to PCS. Some of their questions are:

- How much bandwidth per licensee?
- How many licensees per area?
- How will the lottery process actually work?
- Is PCS a common carrier or private carrier service?
- How big and how many service regions should there be?

The FCC proposed a 6 MHz simulcast channel in the UHF band for HDTV use by each existing broadcast station. The FCC wants to maximize HDTV service areas.

## Good News and Bad News

### Editorial

*We recently received a denial of our earlier request to participate in the current FCC Special Temporary Authority (STA) for Spread Spectrum Amateur Radio operations. This issue will show how to use the STA transceiver under existing part 97 rules at 420 MHz and above -- Canadiun hams can use either this new STA-I design approach or the original STA-1 design on the 902 MHz band if DOC acts as promised.*

*To simplify these matters and open Spread Spectrum Exverimentation to all who want to particivute, I have drafted the following new STA to be submitted to the FCC officially in August, 1992. A nation-wide group of hums seems to be interested in supporting this new Spread Spectrum STA. This group is forming a new amuteur radio group, tentatively culled the "Amateur Radio Experimental Society" or AMRES. Anybody who wants to participate may join in. Please call or write, for further information.*

The following is the first draft of the proposed STA request:

The commission is hereby requested to grant special temporary authority (STA) to permit experimental see Good/Bad page 2

SPREAD SPECTRUM SCENE is dedicated to the Spread Spectrum professional and is committed to being the primary source for the latest news and information about the growth, regulation and opportunities in this emerging science.

SSS provides a forum for publication of technical information, advertising, editorials, opinions and news relating to the emerging fields of our coverage and emphasis. SSS is read by over 4000 technical decision makers each month. SSS can present your advertising message to the key designers, programmers, system integrators and end users in this new industry. Call our 800 number Hotline to request a Media Kit.

Editor & Publisher:
Randy Roberts
Associate Publisher:
Chris Kiigus
Editorial Consultants:
Tom Diskin, Donn Fisher,
M. N. Roberts
Contributors:
Tom Diskin, Dan Doberstein,
John Greene, Matthew
Johnson, Peter Onnigian
Director of Advertising
& Circulation:
Koert Koeiman
Art Director:
Paula Christensen
R&D Staff:
Doug Guiiiot, Wait Jensen,
Dr. Andy Korsak
Published by: RF/SS
P. 0. Box 2199
El Granada, CA 94018-2199
New Telephone Numbers:
Voice: 47 6-726-6849
FAX: 415-726-0118
Internet/UUCP Emaii:
hithr@well.sf.ca.us
AMIX: RROBERTS
AOL: randyrfss
COMPUSERVE:
177000,1666

**Advertising & Subscription**
Hotline:
Voice: 800-524-9285

SSS is published monthly and is available by subscription. You can receive a complimentary copy by sending a us a self addressed 9 x 12 inch stamped (5.52 US postage) envelope.

Subscription Rates:
12 Months - US First Class Mail 529.95
12 Months - Foreign, AIR MAIL, $45.00
US Funds

*Good/Bad from pg. 1* -- frequency hop correlators and simple microprocessor based Pseudo Noise (PN) generators would also allow inexpensive spread spectrum implementation. The "average" or even advanced experimentally inclined radio amateur cannot afford to buy expensive commercial equipment &signed to meet FCC part 15.247 rules for use under an FCC STA for spread spectrum.

DESCRIPTION OF NEED: An STA is needed to permit experimental operations until such time that a permanent rule change becomes effective. The existing amateur radio STA under Mr. Robert Buaas precludes the use of the simple, inexpensive SS modulation techniques to be evaluated under this STA request.

TYPE OF OPERATIONS: An m-sequence implemented as specified in paragraph 97.311(d)(l) will be used as a 'generating function.' Spreading codes will be selected from continuous segments of bits produced in the output of the generating function based on their suitability to provide uniformly distributed spectral density, code orthagonality and maximal coding gain. Each spreading code will represent one symbol in the data to be transmitted. Only the selected spreading codes will be transmitted, and each will be transmitted in its entirety.

DSSS generators using SAW &vices, micropocessors, and E(E)PROMS with fixed spreading codes not related to the m-sequences specified in paragraph 97.31 l(d)(l) will also be used. Independent frequency hopping (non-hybrid waveforms) may also be evaluated as a means for further distributing the transmitted energy.

TRDSSS and MCDS emissions utilizing transmitted coded reference signals and/or PN clock center frequency sub-carriers may be evaluated for the purpose of determining if these very simple techniques can inter-operate with existing amateur radio communications and co-exist with same without undue interference being generated to either existing narrow band users or STA spread spectrum users.

TDMA/CDMA techniques may be evaluated for efficacy in increasing spectrum occupancy and reducing/mitigating in-band interference.

Purpose: The purpose of the tests is to experiment with spread spectrum hansmission, reception and processing techniques. A secondary purpose is to provide on-the-air operational experience with spread spectrum system and data networking techniques, software and protocols in terrestrial based as well as satellite relayed communications. A third purpose of this experiment is to evaluate effective methods for data linking, telemetry data reporting, process control and monitoring with spread spectrum systems.

Objectives: Specific objectives of the STA are to:
(1) assess the strengths and weaknesses of the proposed systems; see **Good/Bad page 16**

## Reader & Advertiser Services

This month brings ever more changes to SSS. Unfortunately this month we did not have space left to run another installment of *Introduction to Spread Spectrum* -- we'll pick it up again in September (promise). Please write us with your comments and suggestions. **Koert Koelman**

## Rumors & Ramblings

- Stanford Telecom Inc. announced recently that it is joint venturing with Zilog to develop custom chips for the previously announced Stanford Telecom wireless PABX pact that it recently won in the Pacific Rim.

- Phillips Kommunikation Industrie AG (PKI), Nuremberg, Germany, has announce it's new product line of DECT wireless productss.

- The EC's oldest evolving telecomm spec, ETS 300/001 now has support from 18 nations. Equipment meeting this new standard will be granted free trade status throughout the EC.

- Several Silicon Valley and international GaAs MMIC and Silicon chip suppliers are considering R&D projects or new product announcements for complete wireless radio/modem chipsets for the 1.8 to 2.5 GHz bands.

- Look for a new Wireless LAN hardware company in San Diego, CA going by the name of SymComm. No details on what they will be doing -- but they claim to have working hardware!

- Ever wonder what some of the myriad applications of Spread Spectrum are? Well, see our sidebar on page 5 and hold on -- at least three Silicon Valley entrepreneurs are nearly ready to hit the market or seek venture funding with products ranging from industrial control and telemetry products to consumer games and gadgets using Spread Spectrum.

- Heard a good rumor -- want to "leak" some info to your competition --call our 800 number and we may print it!

## Decipherings

HE WHO PROVES THINGS RY EXPERIENCE INCREASES HIS KNOWLEDGE; HE WHO BELEIVES BLINDLY INCREASES HIS ERRORS.
- CHINESE PROVERB -

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

# The Aerial

by Peter Onnigian, P.E., W6QEU

## Spread Spectrum Antennas

For wide area networks using spread spectrum three bands have been set aside by the Federal Communications Commission (FCC) under their Part 15.247 Rules. These include the 5725-5850 MHz, 2400-2483.5 MHz and 902-928 MHz. This lower frequency band has several advantages over the higher frequency bands including better propagation conditions, lowercostantennas, andelectronics.

These bands have an effective radiated power limit of 6 dBi This is equal to an effective radiated power (ERP) of 3.85 dBw which is 2.426 watts.

Recent tests have indicated highly reliable SS communications at relatively high modulation rates on a 26 mile path in the San Francisco bay area. Height of the transmitting antenna is not a limiting parameter by the FCC Rules for SS as it is for FM and TV broadcasting and some other communication services.

In some applications a hub or central control facility is used with several outlying stations. Omni-directional antennas are desirable at the center of these hub cells. In some applications directional azimuth coverage from 120 to 270 degrees are useful.

Equipment costs are very important in most sales in this market and very economical SS antennas are available, which have been specially designed for the 902-928 MHz band. Ham-Pro offers a line of Yagi directional antennas with gains from 6.5 dBd to more than 16 dBd. These may be used as either horizontally or vertically polarized. Omni-directional, and wide azimuth antenna, horizontally polarized with gains of up to 10 dBd are also available.

Polarization plays an important part in SS propagation in the low SS band. Most existing operations in this band are vertically polarized. These 902-928 MHz band occupants include amateur radio operators, Industrial Scientific and Medical (ISM), airborne radio direction finding and other FCC licensed services all have priority over SS services. Its important to prevent interference to the licensed services. One way to avoid such interference to them and from them to SS is to use horizontal polarization. There is a vast improvement in desired to undesired signal ratios when using horizontal polarization in this band.

The FCC warns in Part 15.247 (c) that SS interference to the government services in the 902-928 MHz band may require the further reduction in the effective radiated power in the future.

There are several other limitations to radiated power levels under the FCC authorization. For example for direct sequence systems, the transmitted powerdensityaveraged over any 1 second can't exceed 8 dBm in any 3 kHz bandwidth within this band

High quality coaxial cable should be used to prevent RF loss in transmission as well as reception. Belden type 9913 has quite low loss but requires special connectors. Belden's 9914 is more flexible and not subject to as much mechanical damage, but has slightly higher attenuation. There is no real need to use hard line.

Type N connectors are highly recommended due to their low cost, waterproof qualities, and excellent 50 ohm match. Type UHF connectors should never be used at these frequencies. They are neither 50 ohms nor weatherproof, and subject to rapid deterioration.

Antennas should have good VSWR and sufficient gain over the entire band to preserve the digital pulse amplitude shape. More importantly low VSWR at the antenna input prevents coaxial line radiation and reception. Gain over the operating band should be as flat as possible to prevent amplitude distortion of the modulated information.

No FCC licensing of any kind is required to operate an SS facility. However equipment used must comply with certain FCC Part 15 Rules. It is strongly recommended that those who seriously work in SS subscribe to Part 15 of the FCC Rules. You may do this by subscribing to the government contractor that will supply you with a complete set of the current Part 15 in a binder, and keep it current with timely update mailings for one year at a cost of $23 per year. Contact Rules Service Company at 7658 Standish Place, Suite 106, Rockville, MD 20855. Or phone them at (301) 424-9402

Prices and data sheets of Ham-Pro 902-928 MHz SS antennas may be obtained by contacting them at (9 16) 381-4469 Or write to them at 6199 Warehouse Way, Sacramento, CA 95826.

Next month we'll cover methods of computing the 6 dBi maximum radiated power and define its meaning in practical terms.

***About the author:*** ***Peter Onnigian, President of Ham-Pro Antennas, is a registered professional engineer with many years of antenna design and manufacturing experience. His Sacramento based Ham-Pro Antennas make 450 and 915 MHz spread spectrum antennas in addition to a line of amateur HF and VHF single frequency band products.***

***Mr. Onnigian has written dozens of technical papers and antenna columns in other publications and SSS welcomes his contributions.***

## New Products

A new line of Yagi antennas was announced by Ham-Pro Antennas, a division of Kopps, Corporation, in Sacramento. They are ideal 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.

Using computer aided design Ham-Pro says these antennas yield the highest possible gain for the number of elements and boom lengths. Low VSWR provides excellent digital and analog transmission of any type modulation.

Mechanically all models are designed to withstand 87 MPH winds and slight ice coatings following EIA RS-409 standards. Strong plastic booms eliminate RF intermod and element to boom electrical contact noise. Their weather proof driven Yagi element feed points keep moisture out for years of trouble free service, Ham-Pro adds. Mounting is easy to vertical pipe masts or attachment to walls with the stainless steel hardware supplied.

Ham-Pro also has a series of horizontally polarized omni directional antennas for hub or control center use, with gains of up to 10 dBd In addition to the omnis, the Zig-Zag line includes antennas with half power beam widths of 180 and 270 degrees.

For price and data sheets, contact Peter Onnigian, Ham-Pro Antennas, at I-800 879-7569. You may write to them at 6199 Warehouse Way, Sacramento, CA 95826.

HAM-PRO ANTENNAS

## STANFORD TELECOM to DESIGN and SUPPLY WIRELESS EQUIPMENT for VEHICLE LOCATION and TRACKING SERVICE

Santa Clara, California - Stanford Telecom announced an agreement to design and provide the wireless signal **processing** hardware for a leading partnership in vehicle location and tracking.

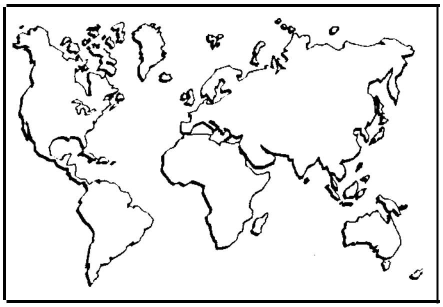
Ameritech Mobile Communications, Inc. and METS, Inc. recently announced a partnership to expand the boundaries of wireless technology by offering wireless data networks targeted at communications with motor vehicles. Stanford Telecom's ASIC and Custom Products Division will design and provide to METS the Digital Signal Processing hardware that will accommodate precise positioning of the mobile units, as well as perform the data communication between cell sites and the mobile equipment. Using Stanford Telecom's technology, the Ameritech/METS system will he able to locate a stolen vehicle with 14 feet precision.

Stanford Telecom's state of the art wireless products and technology are a natural selection for the Ameritech Mobile/METS Partnership from the standpoints of technological performance and market leadership. In 1983, Ameritech Mobile, a suhsidiary of Ameritech Corporation of Chicago, was the first to introduce commercial mobile communications service to the United States. Likewise, Stanford Telecom is considered a pioneer in wireless spread spectrum technology products and has enjoyed lead position in the industry, especially with the FCC's recent allocation of limited restriction "wireless" frequency hands requiring spread spectrum.

Additionally, METS, Inc., based in Indiana, is in the forefront of the emerging growth areas of mobile communications, fleet management systems, and stolen vehicle recovery systems which include functions ranging from central control stations management to computerized mapping to precise calculations of vehicle positions.

The **versatility** and cost effectiveness of Stanford Telecom's wireless technology enables the Ameritech Mobile/METS partnership to address long term plans which include nationwide data connectivity. Meanwhile, because Stanford Telecom will base its immediate design on existing standard ASICs, the short term requirements will not be jeopardized hy a need for new component development. The unique design will provide extremely robust signal transmission in environments severely affected hy disturbances common In urban areas.

Hatch Graham, Vice President of Stanford Telecom's ASK and Custom Product Division stated, "Precision of the transmission will enable highly accurate determination of a vehicle's position, as well as provide reliable ata communications using techniques tha 'aditionally have been kept within the confine f products for space and advanced governmei rograms." Graham went on to say, "With th icreased activity level in wireles ommunications, higher volume sales hav ramatically reduced the the cost of Stanfor 'elecom's spread spectrum ASICs thereb iaking the solution for METS an innovativ nd cost effective product." Th 1ETS/Ameritech systems are expected to b ffered first in the Chicago area.



## International Scene

### EC Micro-Cellular Alphabet Soup?

In this hyper-speed Techno wor ve are bound to develop our own jargo The enthusisam for what we do creat lifferentiation between similar ideas ar oncepts. Every company wants to preve heir intellectual properties from theft, well as promote their products. So alphab oup is unavaidable -- right? Maybe, but th idebar below should help clear up some he fog on CT-2, CT-3, GSM, etc.

## Beginner's Box

### EC's Alaphabet Soup Explained

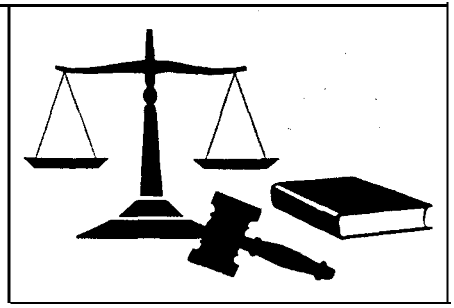
**CT-2:** The EC's **current 800-915 MHz TDMA, demand assigned cellular FDMA system.**

**CT-3: The EC's evolving digital standard. Still TDMA/FDMA, demand assigned, but much more digital.**

**DECT: The latest EC system at 1.8-2.0 GHz. ETSI finally evolving an agreed upon spec. DECT allocates 1.1 Megabits per second maximum to a user up to 100 foot (30.5 meters) *way.**

**GSM: Groupe Superior Mobile -- an analog filtered FM modulation format. Can be used for modems, FAX's and something like TFM.**

**HyperLan: The EC "next generation," based on a new standard, RES-10. Uses 150 MHz of bandwidth at 5 GHz and allows 20 Megabit data rates.**



## Washington Scene

Even though the national democratic convention was in full swing this month, Washington was still ablaze with the pushings, shovings and other "tricks" between Senators Inouye and Hollings, FCC chairman Sykes and other notable personna. Any action you might ask? Yes and no -- the FCC took the opportunity while the Democratic cat was away to propose new rules for personal communications services (PCS) and issue tentative frequency frequency assignments for HDTV.

For more complete details on these and other US regulatory happenings, just send us a SASE (#10 with S.29 postage) and we will mail you a free sample copy of our new sister publication: **Spread Spectrum Scene/Update** (S/Update for short.) S will continue to have a Washington Scene column -- it just cannot get in sync with today's hyper-speed developments.

# DSP
## for Spread Spectrum
### by Matthew Johnson

### More about the Basic All-Purpose Digital Signal Processor

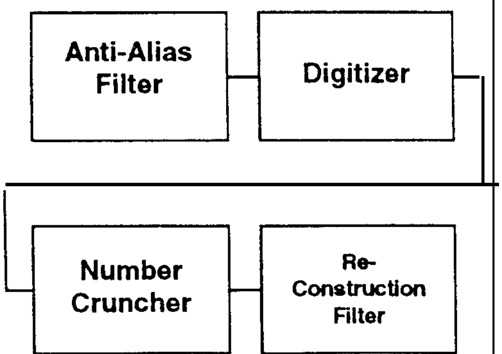
Last month we introduced the concept of the "BADSP" to you the reader. his month we wilt give a little more rigorous information that is needed to fully grasp all DSP concepts.

As an "exercise for the reader" sketch a signal consisting of two equal amplitutde sine waves: say, 1200 and 1500 Hz in frequency. Show that if your sampling pulse train just the wrong phase, w.r.t (with respect to) these two signals, the samples fall on the intersections of these curves! White you are at it, (and this is much easier,) sketch the spectra before and after sampling (remember -- AM modulation sidebands at @ 700 Hz, 600 Hz, etc.).

This result, that sampling is equivalent to AM modulation by an infinite set of carriers, is very important for all DSP. As an exercise, for the reader who plays chess, it immediately preceeds the Nvauist Sampling Theorm which is often mistakenly presented as the ‘most fundamental result. Later, we will see how this same result illuminates applications where the Nyquist Theorm does not apply. However, most DSP” applicationms do assume that the Nyquist Theorm applies. The Nyquist Sampling Theorm says that if the input signal is band-limited to twice the sampling frequency (this is called the Nyquist Criterion) then no information is lost in sampling, the input can be reconstructed perfectly. Band-limiting the input is the job of the anti-aliasinn filter in the BADSP. Furthermore, if the “knee” of the anti-aliasing filter is too soft, I may need to choose a cutoff frequency below the Nyquist frequency to get enough attenuation to prevent aliasing. Of couse, whether or not the knee is too soft depends in turn on how strong the expected out-of-band signals really are.

The most important consideration for the digitizer is chosing how many bits to digitize to. This is the point where we must remember the difference between digitizing (= quantization) and sampling. Recall that I said earlier that we can easily ignore this difference. But since quantization noise is not band-limited, we must first make sure the out-of-band noise is small enough to result in negligible aliasing. A 12 bit ADC will almost always do the trick, the phone company has figured out a clever trick (mu-law companding in US and Japan, A-law companding in Europe) to acheive this goal with a mere 8 bits, with a sample frequency of 8 kHz for an input signal of 3.4 kHz bandwidth.

Except for the non-ideal properties of the ADC, the digitizer is completely defined by the sampling frequency and the quantization. **More next month.**




**The BADSP Block Diagram**

# Technical Tricks

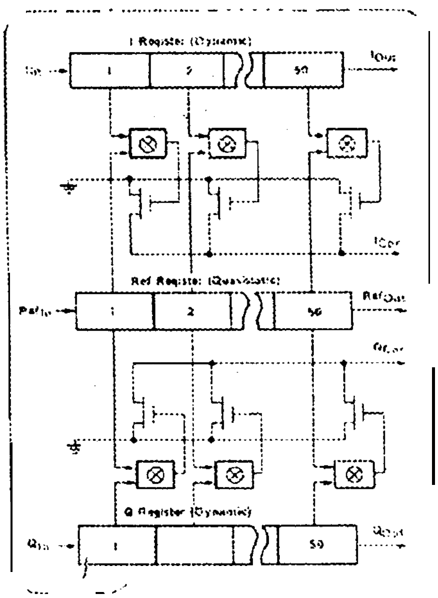
## Correlator Potpourri

:hnical Tricks is back this month! We starting a three part series here on relators:

- How they work.

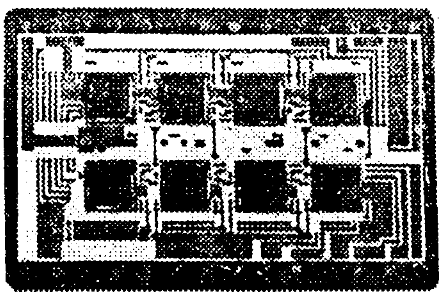
- What kinds & configurations are there.

- How to design your own.



**Hughes GSG developed SO stage ›arallel correlator LSI chip (c. 1975.)**

town here is a nearly 20 year old GM-ıghes parallel LSI correlator. The author ›rked on this design as a “boy engineer.” ›w you can buy similar devices from an ford Telecom, TRW LSI and ıalcomm. **More next month.**



**Hughes GSG 400 stage, chip and wire ıybrid correlator (from PLRS & PJH.)**

# Beginner's Box

## Nearly 101 SS Applicaions

***For years the military has referred to SS systems as CNI or Communications, Navigation and Identification systems. The following list of SS application possibilities, while not exhaustive, may spur other new ideas.***

**COMMUNICASTIONS:**

- **LAN, MAN, WAN, UAN (Universe Area Networks).**
- **PCN, PCS, Micro-cellular digital data, voice and FAX.**
- **Low power “covert” hidden signal communications.**
- **Industrial or public service telemetry, monitoring and control.**
- **Shared spectrum operations like data under a TV channel on cable TV.**
- **Extremely weak signal, high processing gain needs, such as amateur radio “Moon Bounce.”**
- **Encoding/Encryption of slower data such as Teletype or bank’s ATM machine communications.**
- **Enabling two (or more) players on a neighborhood wireless network of kid’s video games.**

NAVIGATION:

- **Systems like GPS but without expensive satellites and earth based.**
- **Car, truck, boat or airplane navigation, distance measuring, direction finding or collision avoidance systems.**
- **Integrated systems to find things, like cartons in warehouses.**

IDENTIFICATION:

- **Friendly, commercial uses of “Identification, Friend or Foe” techniques.**
- **Automatic User ID'ing for BBS’s, ATM machines or computer networks.**
- **Two way auto-ID. auto ack. transaction authentication.**

Technical Trends in Education

by Tom Diskin

## Technical Trends in Education

This month we are going to look at a typical college electronics technology program. Although the following is a description of a specific program at a specific college, it is typical of many programs found throughout the world.

The community college is an American institution which has provided easily accessible, inexpensive and high quality post-secondary education for many years. In the electronics profession. these colleges have provided the vast majority of technicians needed by the industry more than any other single source. Ever since the days of the "junior" college, these colleges have provided transfer programs for students wishing to transfer to four year engineering and technical programs at a university. With the advent of the "community" college several additional "missions" were added, including two year vocational programs. It is from this mission that the two year electronics technician programs have grown.

At College of San Mateo in California the electronics technology program is typical of many programs at community colleges throughout the country. It includes. first of all. a core program consisting of DC/AC Fundamentals. Active Circuit Devices, Introduction to Circuits and introduction to Digital Electronics. Included in this part of the program is also an electronics mathematics course and basic fabrication skills. The core program also includes two courses which are designed primarily for non-majors: a survey course for students majoring in other technology areas, which is in a lecture/lab format; and a lecture-only course which covers the fundamentals of electronics for those who need a single technology-based elective course.

As the student proceeds into the second year of the program, he/she can now elect to "specialize" in any of several areas. There is a specialization in digital electronics, including Introduction to Microprocessors, Microcomputer Interfacing and 68000 System Design. In the analog/ communications area, students can take courses in Modulation/ Demodulation, Analysis of Linear Circuits, RF Transmission and Microwave Fundamentals and Advanced RF Circuits. Given these options, students can take courses in either of these two major specialty areas or take courses in both areas to help prepare them for a- particular segment of the industry that interests them.

The curriculum also offers specialty courses in a number of areas that are relatively new to the electronics industry. Because of more and more specialization in the industry, these courses are equally popular both with regular full-time students preparing for their first job and with returning part-time students who are looking for refresher courses and updating their technical skills to meet the new demands of their current position. An example of this type of specialty course is one call "Sound Synthesis and Design", which is a highly technical course that is part of a new program in Music Technology being jointly sponsored by the music and electronics departments at the college. Another example of a specialty program at San Mateo is the new Avionics Technology program, which has been developed to support the large commercial airline' maintenance industry which exists locally. Programs and courses such as these point out the need for community college electronics programs to continually add new courses and specializations which reflect the rapidly changing nature of today's electronics industry.

So how does all of this affect a newly emerging field like spread spectrum? Just as this new technology must make a serious mark in the industry by solving a particular problem or serving a need, it must also attract the attention of technical educators who are preparing the technicians and engineers to fill the positions at our companies now and in the future. We are interested in hiring qualified technicians and engineers, and preferably those with experience in spread spectrum communications technology. In order to do this. we must convince colleges to offer specialty courses which provide both the prerequisite skills and actual hands-on laboratory experience needed to give today's students the skills they will need in the workplace. These courses are a natural "application" of their existing curriculum, and allow students to experience a real-world application of their newly-acquired skill and knowledge to a real world state-of-the-art technology.

Elsewhere in this issue is a description of the STA - the special temporary authorization proposal allowing amateur radio operators to experiment in spread spectrum technology using portions of the amateur radio spectrum. I would like to suggest that this is a natural opportunity to combine the needs for a real-world education laboratory with those for experimentation to advance the state-of-the-art in this new technology. By combining a new specialty course in spread spectrum with an FCC-authorized STA amateur radio station, students can learn the technology of spread spectrum first hand while at the same time participating in the advancement of the new technology.

*Next month: a proposed curriculum model for a lecture/lab course in Spread Spectrum Technology, including the provision for including (optionally) STA authorized laboratory work.*

**Follow new developments in education -- in SSS!**

# SECRET SPREAD SPECTRUM SIGNALS

Since we're fairly new at finding these "secret" signals on satellites and places where the military/aerospace folks would never look for them, I decided to research some of the available publications on the subject. We will review three interesting discoveries:

- The Hidden Signals on Satellite TV, Third Edition, by Thomas P. Harrington, published by Universal Electronics, Inc., Columbus, OH.
- "VIDEO TEC NEWS," published monthly by C-Band DBS STV Publications, Greenville, NC.
- "Satellite Watch News," published monthly by Waiker Media Group, Inc., Gainesville, VA.

The Harrington book is a good general purpose survey of the various types of signals out there on the birds today. Unfortunately, it devotes only about 1 page out of a book of 238 pages to spread spectrum signals. Even then most of the information presented is sketchy and furnished by an out of business vendor (Equatorial). Needless to say this book is little help in learning anything about "secret" SS signals.

The VTN newsletter is off the mark too. It seems designed for the satellite systems dealer or wealthy satellite dish owner/hobbyist who wants to "cheat" the pay TV services. You can buy almost anything you want from the advertising pages of VTN.

The "Satellite Watch News" is a professionally prepared newsletter that suffers from the same "Alice's Restaurant" problem that VTN does -- you can get almost anything through their ads. But get technical information or data on "secret" SS signals -- "you gotta be kidding!"

Since there is such a dearth of hard information out there where will we find out about these signals? Evidently these so called "underground" publications don't help -- so where to turn? If you readers will help -- we'll give some tutorial and general info right here. Tune **in next month!**

# Spread Spectrum Networking Software

by John Greene

*John Greene picks up this column somewhat from a different angle than Kim Robinson had -- but since John has volunteered to help out, we're giving him near free rein. John has been project manager on software development for a wireless network system of several hundred handheld terminals and a file server/base station. His primary responsibilities were the design and implementation of the network protocol und the driver code to interface the 82530 Serial Communications Controller to the Proxim 242 Kbit/second spread spectrum radios. Additional responsibilities included writing interrupt handlers and the Application Programmers Interface for the 80386, 80186, and 8088 processors used.*

*John writes device drivers for the 82530 Serial Communications Controller (SCC) in assembly language and writing network software in C for a highly modified version of an Appletalk Network. He served as project lead on the design of a networking card for the IBM PC/XT/AT or compatible. This involved designing interface circuitry to allow the SMC ARCNET Controller to utilize the Broadband Local Area Network. He used PAL devices to covert from the bipolar baseband format to a NRZ format for amplitude modulating a carrier John has also designed a 2 Megabits/sec AM Modem in the 40-1 50 MHz range and an IEEE 802.7, 2.5 Mbits/sec, FSK Modem utilizing a PLL for frequency agility with an occupied bandwidth of only 6 MHz. John helped design a Video-Intercom Security System for use on a Broad-band LAN with 280 video cameras, 120 intercoms. Each video terminal was a single two wuy voice intercom whereon digital communication to the VIU was transmitted via a 20 kHz subcarrier on a 140 MHz FM carrier modulated with voice and data.*

Having worked for Networking companies all of my professional career, I have been exposed to many different methods of digital communications. Some of them quite unique, some of them dismal failures. I started out tweaking RF modems back in 1983 and have progressed through designing modems, designing systems, to most recently developing the network protocol and driver software for a wireless network system.

Trying to develop a networking protocol for a wireless system is bad enough given all the problems associated with communication loss, power conservation on portables, and contention. However. programming the 8530 Serial Communications Controller was a challenge in itself. In this particular design the RTS signal on the SCC was used to control the Transmit Enable line of the Spread-Spectrum modem. You are notified that the transmission is near completion by an Transmitter Underrun interrupt from the SCC. The annoying thing about this is the fact that the 8530 still has to shift out the CRC and at least one flag before you shut down the transmitter. So You have to sit and wait until you are certain that the flag has been sent.

This starts to get complicated when the same code is to run on machines with different speed processors. One solution is to use a delay routine that calibrates itself to the processor speed when the software is initialized. However, delay loops are wasteful, especially when you have an application running above that is very processor hungry. Fortunately for me, all of the processors were identical and I found the right combination of instructions to use in this routine that insured the proper timing.

Another feature of this Controller is what you have to go through to get the Transmitter Underrun interrupt at the end of a transmission. You need to reset the Tx Underrun/EOM latch in order to get an interrupt when DMA completes sending data to the SCC. However, the latch can only be reset:

- after DMA has loaded the first data character into the transmit buffer, but

- before the SCC has finished shilling the last data character out of the transmit buffer.

So the delay between starting the DMA and resetting the Tx Underrun/EOM latch must be as small as possible, but not so small that the latch is reset before the first character is loaded. You can sit in a loop monitoring the TX Buffer Empty bit which will tell you when the first character has been loaded and then immediately reset the latch. This has to be done quickly especially in my case where there were packets with as little as 4 bytes.

This only scratches the surface of the many little quirks of the 8530. It was thought that upgrading to ZiLOG's Z16C35 would take care of many of these problems but as it turns out, the Z16C35 carried over all of the quirks of the X530 and then added a few more of it's own.

**More next** month -- John E. **Greene**

# SOME GOOD USES FOR THE STA-1 TRDSSS TRANSCEIVER IN HAM RADIO

By Andy Korsak, Ph.D., VE3FZK
("Dr. Andy", SSS R&D Stan)

This note expresses my recent thoughts about the value (as far as ham radio is concerned) of the STA-1 TRDSSS (Transmitted Reference Direct Sequence Spread Spectrum) simplified SS (Spread Spectrum) transceiver design being promoted by our prodigious editor and publisher of this "rag". For some time now, since I first heard about the STA-1, I have been having rather cool feelings about the concept, as it did not allow for any form of "tuning in" (to draw an analogy with "normal" radio) a particular SS signal from any other possible SS traffic that may be occupying the same bandwidth segment at the same time.

It just struck me, while thinking about the TRDSSS limitations, that a good use for it is in the area of packet radio where highest achievable speed is desired. Some examples are:

* BBS (Bulletin Board Systems) transactions, in particular between BBS's when they pass large amounts of forwarded traffic; this is now handled often on higher frequency ham bands (e.g. 220 MHZ & up) while the normal "end users" are mostly on 144-148 MHz.

* BBS access by "end users" when requiring access to large amounts of data, as opposed to regular message box checking.

* DX (long distance) clusters, which are reporting "nets", often used by hams on VHF to share discoveries of a "rare" or for some other reason desirable DX call sign and the HF frequency it appeared at, on a "real time" basis; one problem with DX clusters has been that they occupy too much packet channel time to send and confirm the DX contact report with each and every one of the hams logged in to the cluster, one at a time.

*Other "clusters", e.g. RDF[1] (Radio Direction Finding) networks, such as those currently undergoing development by San Francisco Bay Area hams, including this author.

The currently popular AX.25 protocol (based on X.25) deals with signal bursts on a time shared basis within one "packet channel", and "tuning" over various selected channels for packet use provides an opportunity to distribute the traffic into groups of users, each group concentrating their interests usually in only one or a few BBS's on a limited subset of the channels allocated by "gentlemen's agreement" (actually, by organizations such as the ARRL). All users on a typical VHF packet channel 20 kHz wide suffer *from* the same collision and capture effects as in any comparable TDMA environment.

Consider, therefore, the alternative situation that would occur if packet stations from a given narrow band channel were all spreading instead, using the TRDSSS concept. If the spreading were as in the proposed STA-1, the current 1.2 kilobaud rate could be "bumped up" to 38.4 kilobaud (if not significantly higher, if the design works out as anticipated). That's a 32:1 ratio, consequently, all of the current ham radio packet traffic occupying 10 slots from 144.91 through 145.09 MHz, and much more, could be "TDMA squeezed" into one wide "TRDSSS slot" overlaying the lower FM utilized segment of the 2 meter hand.

So, the prime disadvantage of TRDSSS, i.e. the inability to "tune", and rather simply decode any "self correlating" traffic within the IF passband, is no more of a road block than in the case of any "clustered" traffic within some defined bandwidth segment. There is an open question, however, as to how well the TRDSSS scheme would function with regard to the "capture effect" occurring with the currently used FM detectors on the 2 meter hand. When an FM packet signal gets "clobbered", any signal that is only moderately strongest "takes out" any competing signals, and retransmission eventually succeeds for the "wiped out" signals at any receiver.

In the case of TRDSSS, there is no such thing as a "limiter" in FM, i.e. things are all linear up to the "correlator"; therefore, there is the possibility that retransmissions would he more frequent, because the stronger of two colliding packets may not he "strong enough", so to speak. Such considerations would need to he evaluated by a more knowledgeable RF engineer than I, who am merely speculating in this case. Perhaps this issue can he laid to rest by a knowledgeable response to this article.

When more advanced S S designs arrive at an affordable level *(Editors note: or SSS publishes the promised performance upgrades to the basic STA-1)*, the more "crude hut cheap" TRDSSS units could he upgraded. The TRDSSS approach at least gives hams a starting "crystal set and spark gap" method to get into the SS technology on a reasonably wide use basis, i.e. beyond the isolated cases of a small number of "high tech" ham experimenters who are capable of advancing the state of the art with the more sophisticated SS code lock-on (correlator) techniques.

A final remark: when discussing the relative merits, or lack thereof, for the STA-1 with one of the two radio amateurs who established the currently approved STA, I was told that the TRDSSS concept had been previously thoroughly and adequately investigated by hams and that more progressive methodologies should he pursued. I tended to agree at the time, hut now I an having second thoughts, for the above mentioned reasons. Also, the same individual expressed the opinion that assessment of the "compatibility" of SS along side with "normal" ham communications is not a major factor in allowing hams the new SS freedoms.

I'm not sure I can agree with that -- how can a new mode in ham radio he considered to have been "adequately evaluated", when only a scattering of isolated experiments occurred in limited areas of the country.

References: (1) Proposed Design and Strategy for a Radio Direction Finding Network Using Doppler Antennas, Packet, Spread Spectrum, and Transmitter Signatures by Digital Signal Processing, ARRL AMATEUR RADIO 18th COMPUTER NETWORKING CONFERENCE, Sept. 27-29, 199 1.

## Beginner's Box

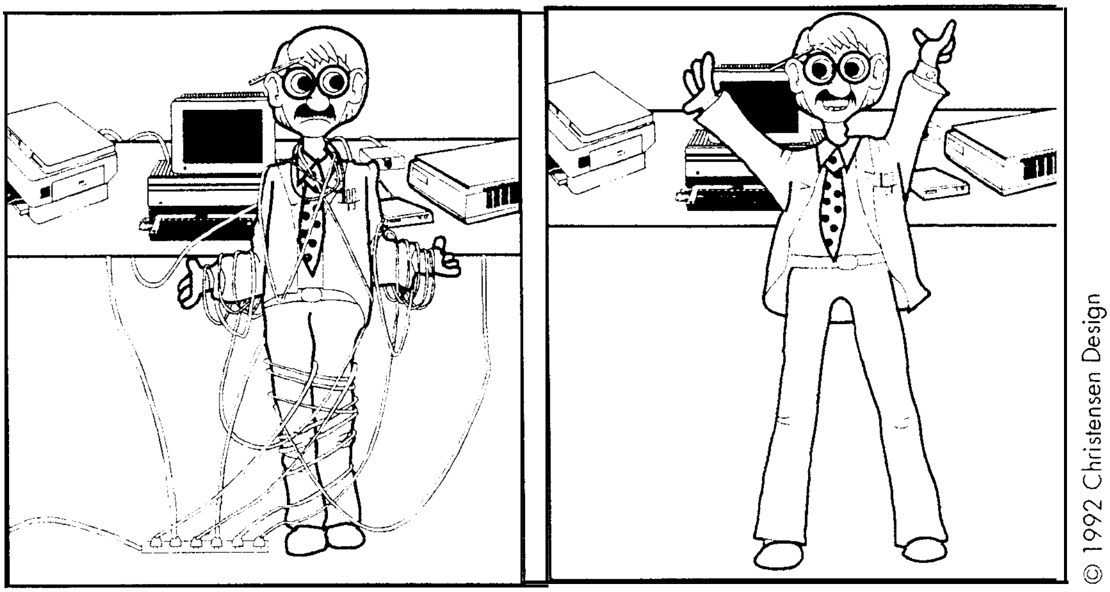
**Got an idea or comment on anything you've seen in SSS? Follow Dr. Andy's lead and send it in to us -- we'll publish anything containing constructive or informative comments.**

This page contained only advertising
and is now out of date!

This page contained only advertising
and is now out of date!

This page contained only advertising
and is now out of date!

This page contained only advertising
and is now out of date!




MARCONI & ARMSTRONG NEVER ENVISIONED THIS

## AN ANALOG GPS DATA RECEIVER -- Part 2

By Dan Doberstein
President, DKD Instruments

*Lust month we presented the first half of this interesting idea article on a home built analog GPS data receiver. That article covered GPS system basics, a receiver block diagram introduction and some discussion of the problems one faces when designing a GPS receiver. This month Dan gets into the "Nitty-Gritty" of the tracking and demod loops within his receiver. He also provides some answers to frequently asked questions about GPS and his receiver.*

### C/A CODE TAU-DITHER LOOP TRADE-OFFS

The C/A code loop is a feedback loop and like all such loops there are trade offs in the design. The selection of the dither clock frequency is bounded by the IF bandwidth and by the need to "measure" the code error as frequently as possible. The maximum scan rate is limited primarily by CNR which in turn is related to IF bandwidth. The remaining "jitter" on the code lock is affected by the CNR, the loop filter, IF bandwidth, dither clock frequency and dither delay.

Using a Tau-Dither type of code tracking loop reduces the correlated IF amplitude by about 1.5 db for this design. This loss gets larger for longer dither delays. Longer delays give better acquisition performance but result in more jitter. Consequently the C/A code loop design is a trade off between the various requirements that are at odds with one another. The bibliography section lists a number of references on this topic.

### DOPPLER SCAN/TRACK SYSTEM

As discussed above the narrow IF bandwidth of 1 khz and the + or - 7 khz doppler on the L1 carrier make it necessary to do a doppler scan and track operation. Figure 1 (next page) shows the doppler scan/track sub-system.

The scan function is implemented by letting an 8 bit UP/DOWN counter free run with the UP/DN input held low. The counter is driven by a 1.5 sec period clock. The output of the counter is converted to analog by the DAC. This results in a sawtooth waveform at output of the DAC. This is summed with a zero doppler bias and fed to the 114.613 Mhz VCXO. In other words the L1 signal is swept through all possible doppler offsets by the VCXO until it "falls" into the doppler filters. The range of the doppler scan is determined by the voltage divider at the DAC output amp.

All three filters will have some of the signal in them since they are about 500 hz apart and have approximately 1 khz bandwidths. When this condition occurs in conjunction with correlation the carrier detect circuit is tripped. This activates both code and doppler track circuits.

During track the output of the two doppler filters is detected and low pass filtered. The comparator subtracts these two levels to determine which filter has more of the L1 signal in it. In the track mode control of the Up/Down input of the 8 bit counter is switched to the output of the comparator. If the L1 signal is more in the lower doppler filter the comparator tells the counter to count up. If the L1 signal is more in the upper doppler filter the comparator tells the counter to count down. This closed loop process keeps the L1 signal centered in the 20 Khz IF filter.

### ACQUISITION TIMES

The combined requirements of scanning the C/A code and doppler lead to some questions about how long it takes acquire the L1 signal. Assuming that the scan rates and bandwidths remain constant CNR is the determining factor. Larger CNR's result in shorter acquisition times while smaller CNR's lead to longer ones. For a CNR of about 20 db this system will have a average acquisition time of 5 minutes. Within limits this time could be decreased by increasing the scan rates.

### DATA DEMODULATOR

A block diagram for the data demodulator is shown in figure 2 (next page). After the C/A code is removed a 50 Bits/sec data stream remains. This is present on the 20 khz IF as BPSK modulation. The first step in the demodulation of this data is to hard limit the 20 kHz carrier. This removes any amplitude variation. The **limited** IF is now fed to PLL. The PLL responds to PHASE changes on the data with an impulse, not a pulse. The impulses occur at every phase transition. Since there are two phase transitions per data bit, one for the rising edge and one for the falling edge, there are hvo impulses per data bit.

The impulses can have either positive or negative polarity and can flip arbitrarily. To make all impulses have a positive polarity a fullwave rectifier is used. After rectification a TTL gate in conjunction with a one shot is used to clean up the impulses and bring them to TTL levels.

The data pulse train is now divided by two in order to eliminate the two pulses per bit and to "square it up". Now that we have the data signal we still need to know when to sample the data waveform. The data clock is needed. The data clock can be reconstituted by dividing the 1kHz C/A code epochs by 20. The C/A code epochs occur once at the beginning of the C/A code hence their frequency is 1 kHz. This gives the needed 50 Hz data clock.

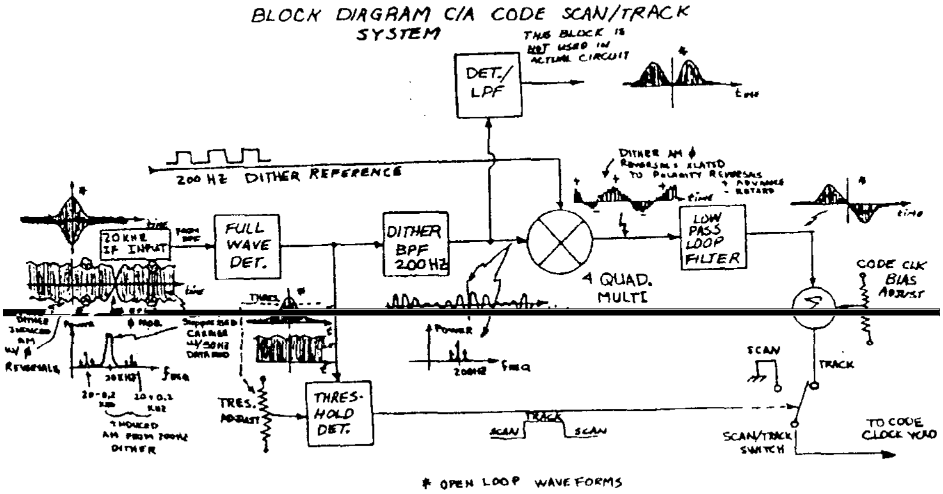
The performance of the data demodulator could be better. Signals with CNRs below about 15 db will produce bit errors on the order of I in 600 or *worse.* Above this the performance is quite acceptable and good results were obtained.

## RESULTS

This receiver has been used to successfully acquire, track and demodulate data from satellite vehicle 9, the C/A code generator was "hard wired" for only this vehicle. Tracking performance was quite good and the received data was accurate.

Although in many ways the design of this receiver could be improved the design as presented worked and that's what counts. For a more complete description of this receiver the reader is encouraged to read the paper "A GPS DATA RECEIVER" , see references.

**Figure 1:**




## REFERENCES

A GPS Data Receiver, Dan Doberstein, ARRL/CRRL 9th Computing Networking Conference, London, Ontario Canada, 1990.

The 1987 ARRL Handbook, 64th Edition.

Solid State Design for the Radio Amateur, Wes Hayward and Doug DeMaw.

VHF/UHF Manual, 4th Edition, G.R. Jessop, G6JP. Published by the Radio Society of Great Britain (RSGB).

ICD-GPS-200, Interface Control Document, Rockwell International Corp.

GPS Signal Structure and Performance Characteristics, J.J. Spliker, Jr. Journal of the Institute of Navigation, Vol. 25, No. 2, Summer 1978, pp. 121-146.

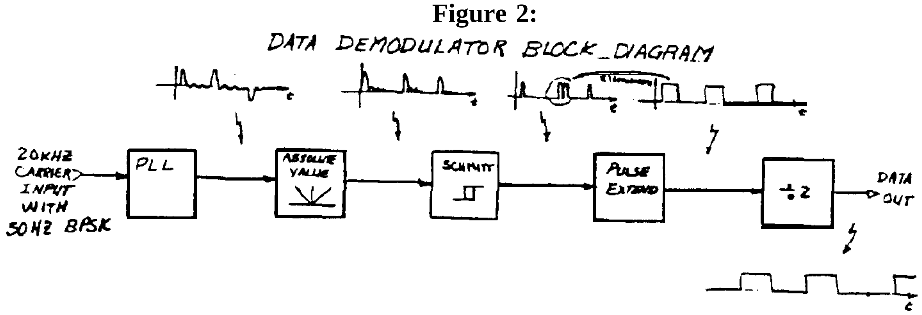
A Low Cost Receiver for Land Navigation, Kai P. Yiu, Richard Crawford and Ralph Eschenbach, Global Positioning System Papers, Institute of Navigation Vol. II, pp. 44-60.

The Delay Lock Discriminator - An Optimum Tracking Device, J.J. Spilker, Jr. and D.T. Magill, Proceedings of the IRE, September 1961, pp. 1403-1416.

Analysis of a Dithering Loop for PN code Tracking, Peter Hartmann, IEEE Transactions on Aerospace and Electronic Systems, January 1974, pp. 2-9.

Spread Spectrum Sourcebook, ARRL 1991, Ed. Andre Kesteloot and Charles Hutchinson

**Figure 2:**



Spread Spectrum Systems, Robert Dixon, 2nd edition, John Wiley and Sons, 1984. For those not familiar with spread spectrum systems read this book first.

Digital Communications and Spread Spectrum Systems, Rodger E. Ziemer and Roger L. Peterson, Macmillan Pub., 1984.

Coherent Spread Spectrum Systems, J.K. Holmes, Wiley, 1082.

Phase Locked Loops, Roland E. Best, McGraw-Hill Inc., 1984.

## COMMON QUESTIONS

(Q) What is a pseudo random sequence?
(A) A pseudo random sequence is a stream of binary numbers, l's and O's that APPEAR to be random. They are not random though, and after some fixed number of bits the stream repeats itself. The repeatability of these sequences makes them extremely useful, especially in spread spectrum systems such as GPS. If some sort of decoding is provided to detect the start or end of the sequence an EPOCH marker is generated. These sequences can be generated by a variety of methods from clocked ROM's to shift registers. The shift register technique is employed in this design.

(Q) What is BPSK?
(A) BPSK stands for Binary Phase Shift Keying. It also sometimes called Bi-Phase modulation, or PSK (Phase Shifl Keying). BPSK modulates the phase of a carrier by either 0 Degrees or 180 Degrees. BPSK modulators arc many and varied all you need is a switch and something that produces 180 degrees of phase shift and you have a modulator. Because of this simplicity BPSK modulation finds many applications, however you pay a price at the demodulator!

(Q) What is QPSK?
(X) QPSK stands for Quadrature Phase Shift Keying. QPSK modulates the phase of the carrier by 45, 135, 225 or 315 degrees. You can make a QPSK modulator by combining two BPSK modulators that have 90 degrees phase shift between the carriers.

(Q) What is Correlation?
(A) Correlation has many different interpretations and can be thought of in many different ways. Correlation is also referred to as despreading or carrier reconstruction for spread spectrum type systems. In terms of spread spectrum receivers correlation is used to remove the pseudo random sequence(or code) that is impressed on the carrier via BPSK modulation for GPS. This random sequence must be removed before the data can be recovered. Correlation is the technique that is used to accomplish this. By generating an exact replica of the transmitters pseudo random sequence the receiver multiplies or mixes its version with the received RF/IF/BASEBAND signal thereby removing pseudo sequence modulation leaving just the data modulation. The only hitch here, and its a big one, is that the two codes have to be lined up exactly in time. Keeping the receivers code aligned with the transmitters code is the whole ball game for spread spectrum receivers.

(Q) How can all satellites use the same frequency to transmit on?
(A) Each satellite has its own unique pseudo random sequence. The receiver picks which satellite it wants to listen to by selecting the pseudo code sequence for the particular satellite and performing correlation. Only the satellite with this code will be received and for all practical purposes the other satellite signals just don't exist EVEN THOUGH they arc present in the receiver! This feature of spread spectrum systems is called Code Division Multiple Access or CDMA.

(Q) What does "C/A code" stand for?
(A) C/A stands for Coarse Acquisition. The C/A code is used to get enough information on your position, GPS time and other data to allow correlation lock with the much longer P code. The P code has many millions of bits so the C/A code is provided to assist in the capture of the P code. The P code is a military secret and therefore useless for civilian applications. Since the C/A code provides position information the P code is ignored for civilian uses.

(Q) I don't understand the Tau Dither Circuit. What is its purpose?
[A) The Tau Dither circuit is the control circuit that is used to keep the receivers code locked up with the transmitters code. Without this control loop the receivers code would wander in time causing correlation to he hroken and a resultant loss of carrier.

(Q) Are there other methods for keeping the receivers code locked to the transmitters?
(A) The Tau dither technique is just one of many techniques used for this purpose. One of the advantages of the Tau Dither technique is its simplicity believe it or not!

(Q) Why is the delayed version of the phase code nccdcd?
(A) The delayed version of the code is necessary for proper operation of the Tau Dither control circuit. By switching between the delayed and undelayed versions of the code at the dither frequency, or "dithering, Amplitude modulation is induced on the received signal where previously there was none. This amplitude modulation contains the information on which way the code should be moved, either advance or retard, to keep the receivers code locked to the transmitters code.

(Q) I see that alter the correlation point the carrier has just the data modulation left on it, but the Tau dither circuit is demodulating a signal with phase modulation on it. Is this from the data or the code phase modulation?
(A) Your confusing the different phase modulations. Both the code and the data modulate the transmitted signal via a BPSK process. The Tau dither circuit INDUCES Amplitude Modulation on the carrier by its "rocking" or "dithering" between delayed and undelayed versions of the code. This induced AM is NOT transmitted it is created by the dither process inside the receiver. The AM is itself phase modulated by the shape of the correlation triangle. On one side you get an AM signal with 0 degrees phase shift on the other side you get AM with 180 degrees phase shift. It is the phase of the dither induced AM that carries the Advance/Retard information that is needed to maintain code lock. It is this bi-phase modulation the Tau dither circuit is demodulating, after appropriate AM demodulation.

Your observation is correct with regards to the code phase modulation being removed after the correlation point. In fact if the Tau Dither circuit is doing its job and there are no "biases". The signal after correlation will virtually be pure carrier with 50 Hz phase modulated data on it. The dither induced AM will be very small in amplitude and of virtually no consequence to the data demodulator.

(Q) You mean there are THREE different hi-phase modulation processes in this receiver'! **Cont'd next page**

**So, what du you think. dear readers? Write Dan c/o SSS with your comments or questions.**

(A) Precisely. The code bi-phase modulates the carrier at a 1.023 Mhz rate, the data bi-phase modulates the carrier at a 50 Hz rate and finally the dither induced AM is itself bi-phased modulated.

## AFTERTHOUGHTS

A lot has changed since this paper was first published. The cost of GPS receivers is falling every day and there are a lot manufactures in the race for a GPS market share (See Microwaves and RF, Dec. 1991). One thing has not changed to my knowledge, none of them will tell you how they did it! That's what makes this paper still valid even though the design is cumbersome and obsolete.

I would be negligent not to mention the line book released by the ARRL in 1991, Sourcebook on Spread Spectrum. This is a compendium of papers and circuits for use primarily by Radio Amateurs. I have reviewed this text and found some very good ideas in it, but of the various code lock techniques presented I feel that none would be directly suited to GPS. This is due to the very low signal levels, High spectral purity requirements and the need to have precisely controlled code scan rates. There is also the problem of Doppler tracking which, of course, the amateur efforts are not very concerned with.

I have, in the course of my conversations with interested individuals, found a commonly held misconception on observing the GPS signal which I myself once held. The idea is you put up an antenna with .a good LNA behind it and using a spectrum analyzer you view the transmitted GPS signal in all its glory. I did this experiment with a IO db gain helix antenna and saw nothing! I knew the satellite was over head but still zip. The reason you cant see the GPS signal is that it has a NEGATIVE signal to noise ratio for receivers at the earths surface. In other words the signal is BELOW the noise floor. All you will see is noise. Now maybe with a very high gain antenna with satellite directly overhead (closest approach) you might just see a small hump but I doubt it. And besides very high gain antennas are not practical for GPS as you do not wish to have to point your antenna for satellite tracking. This below noise floor stuff may seem strange but with correlation you can despread the signal and raise it out of the noise floor. This is what makes these receivers so interesting and difficult, you can't even see the signal until you have code lock!

Turning to the design presented here I feel its biggest flaw is the complicated IF/LO chain. It should be possible to get it down to three IF's maybe even two. The NE615 by Signetics and the MC3362/3 receivers by Motorola are both much better choices for IF chain elements. I have tried without success to use the mixer of the MC3362/3 as mixer/correlator point. I would be very interested to know if anyone has been able to do this with either the NE615/NE602 or MC3362/3. I have tried also to come up with IF chain based on one oscillator at 10.23 Mhz. The 10.23 if mixed with a 10.685 Mhz IF gives a IF of 455 khz. Inexpensive ceramic filters are available for both these IF's. The 10.23 also makes a good reference frequency for PLL techniques. Possibly both the first and the second LO could be synthesized. One sticky here is the purity of the LO needed, which could rule out some PLL LO synthesis configurations. I have not investigated the minimum purity needed by the LO's. The driving point here, I believe, is that 50 Hz data modulation bandwidth. If you have any insights here let me know.

Another point of improvement would be to get away from the VCXO code lock technique. I am currently working on a pure phase modulation technique that does not need a VCXO and uses just the 10.23 Mhz reference. Many commercial designs use NCO's but my understanding of these is zip. Maybe you can help me.

The data demodulator should be changed to Costas loop type. A very simple analog implementation of this type of demodulator was presented in Spread Spectrum Source book. Chuck Phillips is the designer. Also there are some commercially available phase shift keying demodulators used in modems, maybe these could be adapted? One idea that continually intrigues me is the possibility of using the Costas loop to both demodulate the data AND to track doppler by using the average value of the error signal as a measure of doppler offset and driving a VCXO or VCO with this signal so as to maintain doppler lock. A search ramp voltage would drive the VCXONCO as to find zero doppler point, as done in this design, and at code lock control handed over to the Costas Loop. Perhaps I am all wet on this one but I think it could be done.

Please let me know if you come up with anything. I still have a lot to learn and if you do decide to build a GPS receiver don't build this one, you can do better! One last thing , I would very much appreciate any information on making the position measurement both for single channel receivers and multiple channel receivers. Especially the pseudo range measurement.

**Good/Bad from page 2**

(2) evaluate the potential of spread spectrum overlay on conventional FM systems;
(3) determine interference impact, if any, to existing users;
(4) evaluate immunity to intersymbol interference due to multipath propagation;
(5) evaluate potential for improved spectrum utilization;
(6) evaluate performance improvement olaimed for CDMA/TDMA;
(7) gain operational experience;
(8) evaluate digital signal processing techniques useful for spread spectrum operations; and
(9) evaluate SS networking, protocol and supervisory/control techniques

DATES AND TIMES OF OPERATION: The applicants request that operation under the STA commence immediately upon the granting of authority by the Commission, and that such authority be permitted for one year, with leave to renew the STA.

CLASS OF STATIONS AND RADIO SERVICE: All stations are licensed'in the amateur service, and all licensees hold a minimum of a Technician class license.

OPERATING FREQUENCIES: Operating frequencies will be as follows: 50.500-54 MHz, 144.250-146.75, 146-148 MHz, 222.500-225 MHz, 420-432 and 436-450 MHz, 902-928 MHz, 1240-1270 MHz and 2390-2450 MHz.

WAIVERS REQUESTED: Waivers of the following sections of the rules are requested:

97.305(c) Column entitled "Emission types authorized" is requested to be waived in order to transmit emission type SS in the bands 6 m, 2 m and 1.25 m.

97.3 11 (c) is requested to be waived to lift the prohibition against hybrid SS transmissions.

97.31 l(d) is requested to be waived to permit the use of other spreading codes.

SUMMARY: The undersigned on behalf of the group of experimenters respectfully requests that the Commission grant this request for special temporary authority. If you have any questions or need additional information, please contact the undersigned.

**Please write us with your comments and suggestions about this STA request. Anybody want to try for an SS STA on HF for TTY, AMTOR or PACTOR use?**

## Build The STA-1 TRDSSS Transceiver -- Part 3

**If you** read our front page Good News/Bad News story, you know that the STA-1 cannot be used under the current FCC STA (administered by K6KGS). That is the major justi tication for undertaking a new STA request from the FCC -- which is Published here, in draft form, for your edification. Please let us know by phone, Email, Packet, or cards & letters what your thoughts are on this subject.

With this interesting challenge at hand, we are changing the name of this project to the "STA-1*." The STA-1* will operate, initially at least, under existing FCC part 97 rules. If our new STA is granted, the STA-1 * transceiver can be enabled by cutting a jumper (or some such artifice) under the revised STA. For now, however, US **hams will have to be happy using frequencies of 420 MHz and above and a 7 stage (7,1 MLSRG) PN code generator, with the STA-1*.**

Canadian hams can go ahead with the original STA-1 design if, indeed, DOC implements their verbal plan to allow Canadians to use the STA-1 on the 902 to 928 MHz band.

These changes will delay the introduction of the STA-1* kit by about a month -- (we hope!) This little schedule break also allows us to greatly simplify the design of the STA-1* and thereby further reduce the cost of the kit. This month we will only outline the proposed changes and hint at what is to come in the September issue of SSS. We will also take this opportunity to better define a performance speci tication and clearly define the performance upgrades we have planned for the STA-1*.

To start with, performance spec highlights are:

- 3 PC boards comprise the STA-1* -- TX, RX and digital / microprocessor -- each PCB approximately 3.5" by 4.5".

- Basic unit utilizes TRDSSS modulation and 7 stage (127 bit) PN gen. -- no RX correlator required.

- Unit is designed for easy upgrade in three steps:

1 - serial sliding correlator / DPSK modulation -- synch time <102 milliseconds

2 - parallel digital correlator / DPSK modulation -- synch time under 1 millisecond -- custom FPGA design using AMD Mach 110 or 130 chips

3 - Full custom ASIC design with frequency hop and 31 stage Gold code EPROM PN generator for full CDMA or TDMA high speed packet operation -- will require new STA from FCC -- can be used in Canada, if DOC continues its understanding and encouragement of amateur radio development of new technology

- The basic STA-1* kit will cost less than $200. Each upgrade option will be about $100.

- The basic STA-1* kit requires a TNC or PC with ASYNC serial port, a mike or key for ID'ing and can be ordered for 28-29.7, 50-54 or 144-148 MHz operation.

Other frequencies require a transverter such as DEM's DEM432K 420350 MHz unit or

## DOWN EAST MICROWAVE SHF SYSTEMS 902K OVERVIEW

**The** construction and operation of the SHF 902K linear transverter kit, designed by Richard Campbell KK7B, is briefly described in what follows.. This transverter features an Integral, on-board local oscillator. No additional modules are required to get the tnnsvertcr on the air.

The SHF 902 K is a complete, single board transverter allowing linear operation across the amateur 900 MHz band. It features an on-board local oscillator and produces about +13 dBm output for O dBm i-f drive In the range 144-148 MHz. Barefoot receive noise figure is 4 dB with an RF - IF gain of 40 dB. As supplied, the 902K IF frequency of 144 MHz corresponds to a tx/rx frequency of 902 MHz. Optional LO crystals are available to correspond 144 MHz to 904 MHz.

### CIRCUIT

**The 902** K consists of a crystal controlled Butler oscillator at a nominal frequency of 94.75 MHz., a x8 diode multiplier and filters and separate receive and transmit mixers with IF at two meters. The LO frequency of 758 MHz is applied to Mini-Circuits SBL-1X mixers. On the transmit side, the resulting signal at 902 MHz is filtered and amplified by two MMIC stages, producing about +13 dBm (20 mW) output. On receive, two MMIC gain stages drive the mixer to produce an IF output at two meters. The only tuning required is the LO frequency trimmer capacitor. A nominal 6 dB pad is specified between TX IF input to the SBL-1X mixer and between the mixer and RX IF port. On the TX side, no more than 0 dBm of two meter power should be applied to the pad. The SHF 902K kit is available for $139 with crystal, from DEM, Bill, W3HQT at 207-948-3741 or FAX 207-948-5157. He also has antennas, pre-amps and linear amps for all bands 420 and up.

This page contained only advertising
and is now out of date!

This page contained only advertising
and is now out of date!

## September SSS Preview

**Special:** Fourth installment of *Introduction to Spread Spectrum.*

**Build-it:** Continuation of build the Spread Spectrum STA-1 -Transceiver. Detailed TRDSSS and MCDS tradeoffs and RCVR design details.

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

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

**NEWS:** All about the Navy Postgraduate School, Monterey, CA, PANSAT satellite for ham radio & Navy use, due for launch In '95. Plus tbe latest news on The Spectrum Auction, H. R. 73 and other legislative developments.

**Ham Radio:** More on Canadian D.O.C. SS developments & KC6YJY STA request.


**Spread Spectrum Scene**
**An RF/SS Publication**
**P. 0. Box 2199**
**El Granada, CA 94018-2199**

**FORWARDING & ADDRESS CORRECTION REQUESTED**

FIRST CLASS MAIL
U.S. POSTAGE
**PAID**
PERMIT NO. 7
EL GRANADA, CA