

SPREAD

Volume 2 - Number 1

SPECTRUM

April, 1993

SCENE

The Wireless, PCS and Advanced Digital Communications
Monthly News Magazine

ISSN 1066 - 0550

Single Copy Price \$5.00

Copyright 1993 by RF/SS

The Wireless Information Overload / Can We Slow It? -- See page 5

SS System Data Bit Error Detection -- See page 12

PDA Players Partner Up

Wireless future:
Is it worth
all the hype?

Apple spin-off latest to announce a PDA.

PCN

Tandy's Zoomer

channel a wireless world

PCs move into

wireless land

A long wait

for personal

communicators

SHARP BRIDGES
BARRIERS

Apple
Newt

KILLER APPS

Spread Spectrum Scene

An RF/SS Publication

P.O. Box 2199

El Granada, CA 94018-2199

FORWARDING REQUESTED

BULK RATE
U.S.
POSTAGE
PAID
PERMIT NO. 7
EL GRANADA, CA

Highlights

Article	Page
Full Table of Contents	4
Editorial	5
Cartoon	9
Int'l. & Washington Scenes	10
Apex Advice	12
GEC-Marconi XCVR MMIC	14
Technical Tricks	16
New Products	20

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and is now out of date!**

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and is now out of date!**

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 a targeted circulation publication. We have chosen a distinguished cadre of the most important decision makers in this new industry to be the readers of SSS. SSS is sent by first class mail to this important cadre of industry "movers and shakers" each month. SSS can present your advertising message to the key designers, equipment developers, 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 Editor:

Norm Holsing

(aka Dr. Document)

Editorial Consultant:

Marty Roberts

Contributors:

Dan Douglas, Gary Mitchell,
Matthew Johnson,
Peter Onnigian

R&D Staff:

Chris Kilgus, Benedict Tse

ISSN 1066 - 0550

Published by: RF/SS

P. O. Box 2199

El Granada, CA 9401 8-2199

Telephone Numbers:

Voice: 415-726-6849

FAX: 415-726-0118

Internet/UUCP Email:

hithr@well.sf.ca.us

Advertising & Subscription Hotline:

Voice: 800-524-9285



SSS is published monthly and is available by subscription. You can receive a sample copy by sending \$1.00.

Subscription Rates:

12 Months - US First Class Mail - \$49.95

12 Months - Foreign, AIR MAIL - \$70.00

US Funds

Rumors & Ramblings

• Stanford Telecom has introduced the STEL-300 Communication Performance Analyzer. The STEL-300 is designed to interface with virtually any BPSK/QPSK/MSK receiver and provide performance measurements during normal operation. The versatility of the STEL-300 permits observation during actual operation without the need for test patterns and transmission disruptions. The STEL-300 utilizes patented Stanford Telecom (No. 5,144,642) IDAC technology and advanced DSP chips.

• Motorola's Iridium project gains 20 Japanese investors, including Sony Corp., Mitsubishi Corp. and DDI, a long distance telephone carrier. The combined investment for the group was about \$132 million. Washington based Iridium Inc., has said that it has already raised some \$800 million of the required \$3.37 billion it will need. Current US partners Lockheed and Raytheon have been brought on the Iridium "Bandwagon" as subcontractors.

• Send us your latest rumors or tidbits for inclusion here.

Decipherings

Life is a play.
It's not its length,
but its performance
that counts.

- Seneca -

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

Table of Contents

Article	Page
-----	-----
Editorial	5
Aerial	6
Consultant's Corner	7
Equipment Corner	8
Cartoon	9
Int'l. & Washington Scenes	10
DSP for Spread Spectrum	11
Apex Advice	12
Technical Tricks	16
Subscription Post Card	18
Nibbles & Bits	19
New Products	20
Book Review	26
Novel PN Generator	27
Minaret's New UHF VCO	28
Boolean Logic Review	29
Help Wanted	29

Think
Spread Spectrum!

May Preview

• Report on the San Jose PLD Design Conference & Exhibit.

• Pacific Monolithic's newest GaAs MMIC chips for PCS and wireless applications.

• Ed Stoneham on MathCad models for demodulation.

• News, Columns, Tips and Tidbits.

EDITORIAL



Wireless Information Overload

Can We Slow it?

Have you ever felt like Alice in "Wireless Land" when looking through the trade journals or pop press? My apologies to Lewis Carrol -- but, as our front cover graphically highlights, the "Wireless" information explosion/overload **has happened**. One year ago SSS was handed out at the San Diego RF EXPO and mailed to a few hundred prospective readers. At that time I read about "Wireless" stuff maybe once every two weeks. Now it seems that every other day I'm inundated with information or hype about "Wireless" this and that. Was our timing good -- or has something really started to happen?

As the Bard has said: *Timing is everything* -- and we were a bit lucky. We saw a void, a niche and grabbed it. While we were well positioned by experience, training and interest, without the right timing SSS could have fizzled like a bad Fourth of July firecracker. Instead we succeeded and it seems that other magazines (they shall remain nameless) are regularly running features and special in-

serts on SS technology. If we judge reality by what appears in print -- then "Wireless" is starting to happen. If we judge reality by the amount of money being spent -- then "Wireless" is certainly starting to happen. If we judge reality by people's attendance at trade shows or the rate of new subscribers to SSS -- again then it seems that *something* is really happening.

We were the **First** special interest publication devoted to SS and wireless technologies. Now we have some competition:

- Andrew Seybold's new *OUTLOOK on MOBILE COMPUTING*, a monthly high tech newsletter with a substantial price, but excellent quality and very interesting.

- *WCCN*, another high priced monthly newsletter for the "busy executive."

- Ardis' own quarterly *On The Air*.

Surely there are other imitators out there, that I've forgotten to mention. But my point is: the subjects of "Wireless" and SS have gotten very popular lately. All the news, new product announcements and advertising hype seems to grow at an exponential rate doesn't it?

This brings me to one of the main reasons we founded SSS -- remember our purpose statement (printed in our masthead every month):

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.

The active phrase "committed to being the primary source" is just what can slow the "Wireless" information overload for you, dear reader. We carefully sift through dozens of press clippings, countless trade journals, carefully scan several news/wire services and otherwise screen a huge volume of information for you -- every month. What you read in SSS is the "Creme de la creme" of what's going on in this field every month. Stay with SSS -- stay tuned in every month and we'll all escape the information overload. We might also prosper and learn some things together, if we're lucky.

Thanks for your support this past year. Please keep it up! **Together SSS and it's readers will make a difference!**

How's this month's mug shot of yours truly? I'm shown in action, giving a talk on SS to the Santa Clara Valley Amateur Radio Club last January. We also presented a 1 1/2 hour lecture to the annual joint CITEA/CCEI Conference on March 26. This conference is for a nice large group of high school, community college and university teachers/professors and was held at the Santa Clara Convention Center. My talk was attended by some 40 enthusiastic, curious educators. I enjoyed it very much.

Talk about meetings -- there was a little trade show last month in San Jose as well -- enough said. see Editorial page 18

The Aerial

by Peter Onnigian, P.E., W6QEU

In the last several columns we have discussed many different characteristics of antennas suitable for use with SS systems. This month we present some general purpose information and a small recap of some of our past columns. New readers may appreciate this review, while readers that have been with us a while may judiciously use/read only what they need.

Power (dBm)	Milli-Watts	Power (dBm)	Milli-Watts	Power (dBm)	Milli-Watts
-40	.00010	-13	.0001	15	31.622
-37	.00019	-10	.1000	17	50.119
-35	.00032	-7	.1995	20	100.00
-33	.00080	-5	.3162	23	199.53
-30	.00100	-3	.5012	25	316.23
-27	.00200	0	1.000	27	501.19
-25	.00316	3	1.9953	30	1,000
-23	.00501	5	3.1623	33	1,995.3
-20	.01000	7	5.0119	35	3,162.3
-17	.01995	10	10.000	37	5,011.9
-15	.03162	13	19.953	40	10,000

ALLIS ASSOCIATES (406) 282-2883

● **Re: FCC Rules, Part 15, paragraph 15.249, 50,000 microvolts per meter at 3 meters is radiated by an isotropic antenna when fed by 0.75 milliwatts into 50 ohms. Thought you'd like to know!**

Gain Over What?

It seems many technical people do not know the difference between an isotropic (dBi) and a half wave dipole (dBd) reference. They also had difficulty understanding why the gain of the same antenna may be expressed as a higher number in

dBi than in dBd!

Antenna Gain References

To understand an isotropic antenna, imagine the radiator totally enclosed in a hollow sphere. The radiation from its center is distributed uniformly over the interior surface of the sphere. This uniform radiation is said to be isotropic by definition.

Assume further, it takes one watt of power to cover the entire surface of the sphere with 100 milliwatts of intensity. If we were to illuminate only a small portion of the sphere with the same surface intensity, it follows that the radiation source power required would be much less than the one watt required to illuminate the entire sphere. In fact, a dipole would illuminate a wide band only on the sphere with the same 100 milliwatts intensity.

In fact, it would require only 0.61 watts of power for the same intensity as required to coat the entire sphere. This reduction to 61 percent by a dipole is equal to -2.146 dB, rounded off to -2.15 dB. Thus the isotropic sphere has 2.15 dB more gain since it requires more power to illuminate the entire sphere! Gain is the ratio of the maximum radiation in a given direction to the maximum radiation produced in the same direction from a reference antenna both with the same input power.

Another definition: The directivity is the antenna's ability to concentrate radiation in a particular direction. Useful antennas exhibit some directivity unlike an isotropic, which radiates equally in all directions. As stated in last month's column, an isotropic antenna exists only as a mathematical model, and is not realiz-

Beginners Box

FEDERAL COMMUNICATIONS COMMISSION
RULES - PART 15
Paragraph 15.249
OPERATION WITHIN THE BANDS 902-928 MHz, 2400-2483.5 MHz, 5725-5875 MHz, AND 24.0-24.25 GHz.

(a) The field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental frequency	Field strength of fundamental (millivolts/meter)
902-928 MHz	50
2400-2483.5 MHz	50
5725-5875 MHz	50
24.0-24.25 GHz	250

Fundamental frequency	Field strength of harmonics (microvolts/meter)
902-928 MHz	500
2400-2483.5 MHz	500
5725-5875 MHz	500
24.0-24.25 GHz	2500

(b) Field strength limits are specified at a distance of 3 meters.

(c) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or 10 to the general radiated emission limits in 15.209 whichever is the lesser attenuation.

(d) As shown in 15.35(b), for frequencies above 1000 MHz, the above field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.

(e) Parties considering the manufacture, importation, marketing or operation of equipment under this section should also note the requirement in 15.37(d).

Thanks to:

Rules Service Company
Rockville, MD - (301) 424-9402

able in practice. The gain of an

antenna is a basic property and is frequently used as the figure of merit. Gain is the directivity of an antenna, less the various losses inherent in it. These include IR, dielectric, VSWR mis-match, undesired side lobes, front to back ratios and other losses.

Gain Numbers

Our interest is the relative gain of commercially available antennas. The common practice expresses gain in decibels relative to that of a half wave dipole. This gain is expressed as dBd, that is decibels over a dipole. However this does not hold true for all those available in the marketplace.

For example antenna brand X is rated as 8.5 dBd. This is equal to brand H antenna which is rated as 10.65 dBi[8.5 + 2.15 = 10.65] Misleading: '!' To some yes, very misleading! The worst offense is stating gain in dB without reference to isotropic or dipole. Maybe it's gain over a wet noodle!

Send your antenna questions to Peter Onnigian at Ham-Pro Antennas

ANTENNAS FOR WIRELESS ALARMS AND DATA

Extend your wireless range up to 30 miles using Ham-Pro antennas specifically designed for 150,450 and 915 MHz.

Spread spectrum and alarm system reliability is greatly improved using these Yagi antennas indoors or outdoors.

HAM-PRO

ANTENNAS

6199 B Warehouse Way
Sacramento, CA 95826
(916) 381-4469 • Fax: (916) 381-4332

Consultant's corner

by Gary Mitchell

Company Type

One of the first questions that a consultant has to answer is the question of what form the new company is to take. Typically, this is either a sole proprietorship, partnership or corporation. Instead of analyzing the pros and cons of each one of these, (which can be found in any business text), I'll just say that if you want to be taken seriously by clients, you need to be able to add the "Inc." after the name of your company. This also has advantages in dealing with suppliers, landlords, etc. Also, when you try to establish credit in your company's name, instead of your own, it's much easier if your company is incorporated.

I'll just say that if you want to be taken seriously by clients, you need to be able to add the "Inc." after the name of your company.

You can incorporate easily by just going to an attorney, paying a small fee (it cost me \$350.00) and then waiting for the charter to come through from the state. In some places you can also purchase do-it-yourself incorporation kits, and I would

recommend these in the states where they are available.

There are some bookkeeping requirements associated with this, but they are outweighed by the benefits. It typically means filing a report once a year with the state, and filing two extra tax returns (federal and state).

Networking

I got a call a couple of days ago from Dan Douglas, President of Apex Systems, Inc. of Boulder, CO. Dan saw my column and called me (like I asked the rest of you to). He seems like a good guy, and runs a very successful company that specializes in the area of analog and RF design.

We need to have a professional image as consultants, and Apex does a great job at this.

Dan will also be writing some articles in the future for SSS on some very interesting subjects, so look for him in these pages.

Seeing Apex Systems marketing package brings up an important point. We need to have a professional image as consultants, and Apex does a great job at this. They have a very impressive marketing tool, that consists of a brochure and a videotape, all very professionally done. This is a marked contrast to some guy who has a faded photocopy of a six-page resume. Apex is a first-class company -- they can be reached at (303) 443-3393.

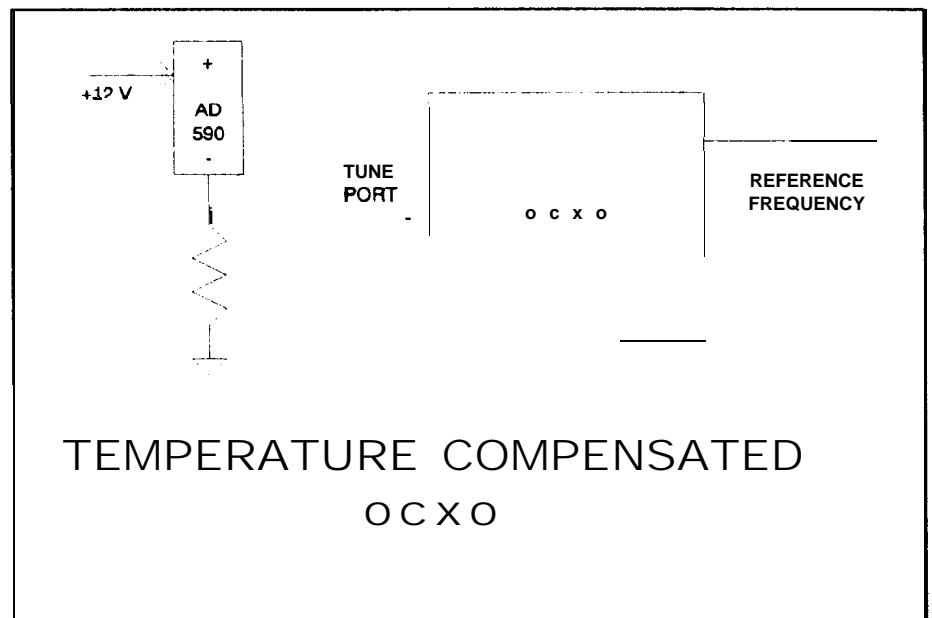
Product Review

This month's product review is a little different. Instead of reviewing a new product, I will review a not-so-new product and present a novel application for it.

The product this month is the AD-590 Temperature Sensor from Analog Devices. This device is a highly-linear current output temperature sensor that is inexpensive and operates over a wide temperature range. Price on these is \$4.69, singles, from Newark.

The novel application is using it in an extremely simple circuit to build a high-accuracy OCXO. I acquired a handful of medium-quality OCXOs a while back. They have a tolerance of about +/- .5 ppm over a wide temperature range. They also have an electrically-tuned trim port. The really interesting thing about them, though, is that they have an almost exactly lineal frequency vs. temperature curve. And a very linear tuning port.

Coupling all these factors together, (the linear frequency vs. temperature, the temperature sensor linearity, and the linear control ports on the OCXO), I came up with what I call a TC-OCXO, shown in the figure below. This is obviously a very simple, almost trivial, concept. But the performance of the device is nothing short of amazing. Instead of the 1 .0 ppm performance window of the OCXO, I now had much better performance. The temperature tolerance over the -30 to +60 degrees C range was on the order of +/- 1E-8, a factor of fifty improvement. This is very good

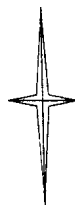


performance for an inexpensive OCXO, and the cost is minimal compared to the normal cost of a high-quality reference. Consider this the next time you need a high-quality reference but don't want to spend a bunch of money.

That's all for now. See you next time; until then, give me a call at:

NOVA RF Systems, Inc.

The Complete RF/Microwave Solution



- RF/Microwave Systems
- Custom Design/Consulting
- Simulation Software
- Synthesizers (PLL/DDS)
- Complete Lab/Machine Shop
- TDMA/CDMA/Spread Spectrum

1740 Pine Valley Dr. Vienna, VA 22182
(703) 255-2353

*Consultants -- any
feedback for Gary?
Drop him or SSS a note or
a FAX -- Thanks.*

Equipment Corner

by Chris Kilgus

For fun, and to pick up or unload equipment, check out your local electronic swap meet. One of the best ones around is at Foothill College in Silicon Valley every second Saturday of the month starting in March. I went a couple weeks ago and it was really interesting.

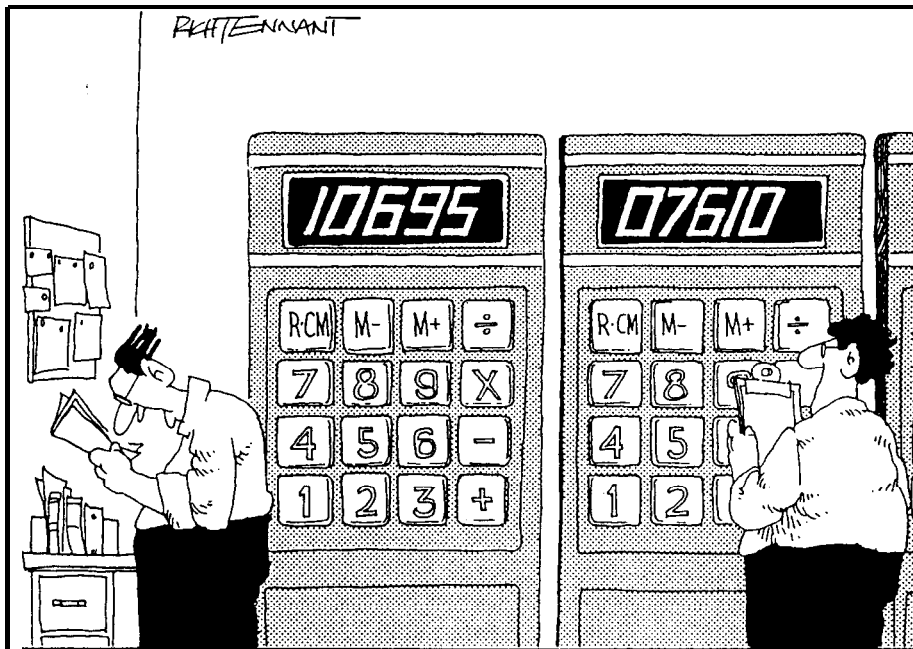
We decided to get there early, 5 AM. I am not much of a morning person so this wasn't exactly my idea of a good time. I was still trying to park my truck when people were jumping in the back going through my stuff. They all had flashlights and HT's (handy talkies, 2 meter ham radio walkie talkies). They were telling their friends to come look. I had sold most of my good stuff before the sun came up. Literally everything else I brought was gone by 10 AM. I picked up a

good Ungar solder station for \$15. There was another RF trade show in San Jose, last month. This one comes one month after Mobile '93 and only two months after the Wireless Symposium. I don't think the low turnout had to do with a lack of interest in RF, but just how many shows does an industry need in the same town, in three months'!

I took the course, Filters and Matching Networks by Randall Rhea of Eagleware. It was excellent. He was able to cover a huge amount of material in this short course. I am trying to justify buying his software package and to use what I learned.

I spent a lot of time at the show and I have to hand it to all the guys who man the booths. I am always looking for a fresh deal on test equipment. I found an interesting Sweep/Signal Generator made by Dorado International Corp., Seattle, WA (see their ad on the back cover). My main interest is in the G4-196 that covers 2 - 8 GHz. It offers some nice feature but, its phase noise and stability specs aren't outstanding. However, its price is \$29001

Information overload is the cover story in this issue. This saturation/overload has been a real problem for me. With at least four good magazines devoted to RF issues plus *EDN*, *Electronic Design*, newsletters, data sheets, etc., there is a ton of information to assimilate. There is no way I have the time to read all of this stuff, ever. One way to keep up to date is read this news magazine. The other is to look at the material as soon as it arrives and then get rid of it. I give myself one day to scan through it, circle the bingo card numbers, then I rip



"It says here if I subscribe to this magazine, they'll send me a free desktop calculator. Desktop calculator?! Whoaaa—where hncv I been?!"

out the really good articles for future reference and throw the rest away. Don't start a stack of things to "look at later," you may bury yourself.

We could all save time if the manufacturers would simply tell us pricing, availability and provide samples. Maxim does a pretty good job of doing this. I really dislike this availability/price game.

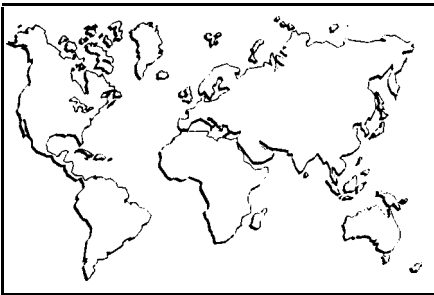
I am amazed at the number of semiconductor companies that are supposedly producing RF chips. When you get right down to it, I suspect many of the parts don't exist except on paper. Preliminary data sheets and product announcements are an easy way to for them to judge the market potential. When samples are available you know it's really a product.

Recently I found an ideal SAW filter for a design from Fujitsu. The price from the distributor was good. I went ahead and laid out the PC board to accept the part. Guess what, the original distributor doesn't carry Fujitsu any

more and all other sources are more expensive! Is this highway robbery or what!

I was holding out for SAW devices to create some solutions for battery powered high frequency designs. I had read an article about how RFM of Dallas, TX had created some unique SAW delay lines for a super-regenerative receiver design at 900 MHz. I saw them at the show and even went to their seminar. They must have problems because most of the parts don't even exist. At this point, it looks like this technology is destined to be garage door opener level and not a real contender for the PCS market. I received a letter from Webb Labs concerning the delay in delivery of the software I was promised at their receiver design workshop at the Wireless Show. To make a long story short, it's in the mail. The whole thing was poorly managed, but I will reserve final judgment on the results of Webb's enhanced program. It should be here any day

More next month.



International Scene

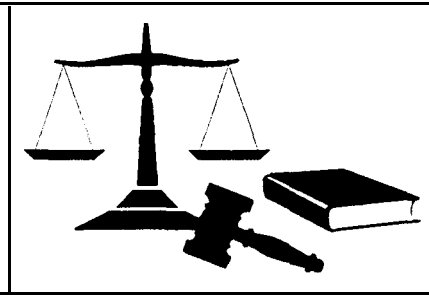
● Something like ten European semiconductor firms are readying chips for the worldwide market of PCN/PCS. The table below highlights some of the many standards being foisted upon us around the world. The USA is far behind the rest of the model-n world in this regard -- IEEE 802.11 is still years away and even WinForum can't meet its own interim deadlines for an interoperability standard. The US has adopted AMPS/NAMPS and is still fighting it out over CDMA and SS use for the long awaited PCS service -- *will it ever happen?*

WIRELESS BANDWAGON TRAVELS THE GLOBE
 Existing markets Future markets

	Europe	North America	Japan	Asia-Pacific
Cordless	CT-2; DECT	ISM band	Personal Handiphone	CT-2; DECT
Personal communication	CT-2 DCS1800	CT-2; PCS Cellular	Personal Handiphone	CT-2; DECT
Cellular	GSM	U.S. Digital Cellular; Code Division Multiple Access	Japan Digital Cellular	GSM; U.S. Digital Cellular

SOURCE: EE TIMES AND AMI

Ever thought about the FCC Part 94, 31 to 31.3 GHz band for your PCS or Wireless LAN/MAN? The FCC has opened up the technical requirements in this band and you can use as much as 50 milliwatts transmitter power and a 38dB gain antenna.



Washington Scene

● The Emerging Telecommunications Act of 1993, H.R. 707, has passed the House of Representatives. This bill requires the Federal Government to release 200 MHz for commercial use to foster new communications technologies in the private sector. At least 180 MHz of this new spectrum must be below 5 GHz. The Senate version of the bill, S. 335, includes specific protections for the Amateur Service that the ARRL actively sought during the last session of Congress. Action awaits a conference committee's attention.

● The wonderful FCC, in all its wisdom, (still without a chairperson and missing two other commissioners) has done us another significant "dirty trick." Last month the FCC issued an NRPM (Notice of Proposed Rule Making) asking for comments on the subject of selling at auction, or by lottery, licenses in our 902-928 ISM band (also a Ham band). They proposed that the importance of Vehicle Location Services and other new radio services should have a licensed priority over unlicensed operations in this frequency range. They must be feeling the 1993 budget pinch, and are still following the past Republican administration's mandate that they should generate revenue.

● **LATE BREAKING NEWS --** Stanford Telecom announces sample quantities of its New **Single Chip Wireless Signal Processor, The STEL-2000.** The first silicon prototypes of the STEL-2000 digital, fast acquisition, spread spectrum communications processor have arrived from the foundry and are being evaluated. Preliminary results indicate that the device performs according to specification. Samples will soon be available for Beta-site use.

The STEL-2000 is a single CMOS ASTC device which performs all the digital processing functions required to implement the baseband functions of a fast acquisition direct sequence, spread spectrum, radio link. Capable of transmission in BPSK or QPSK modes, it operates at 10 MChips per second in transmit and receive modes.

A proprietary acquisition technology is used in the STEL-2000 that permits acquisition of bursts of data with a single preamble, making the modem extremely efficient when operating with short bursts, thereby minimizing loss of data. All parameters in the device are fully programmable, allowing it to operate over a wide range of conditions, in a large number of applications that include: Wireless LANs, wireless point-of-sale terminals and inventory control systems.

Hatch Graham, VP and General Manager of STel's ASIC and Custom Products Division, is the person to call for more information or samples:

Stanford Telecom, Inc.
ASIC & Custom Products Division
Tel: 408-748-1010 FAX: 408-980-1066

DSP for Spread Spectrum

by Matthew Johnson
and Randy Roberts

The DSP column is back, but before we fulfill our promises to our dear readers (including coverage of MUSE HDTV, etc.), we will cover some late breaking news. We will also indicate another project that we will complete -- the SSS DSP Project. This project is an assembly of off-the-shelf DSP components for state of the art SS development.

The recent announcement of Stanford Telecom's STEL-2000 may just take all of the "fun" out of DSP system development for SS. If this new ASIC does anything like what it promises to do and is readily available at a reasonable price, then there goes customized code and general purpose DSPs for SS systems! We hope to get our hands on one or two of these chips very soon so we can really see what it will do.

Two new DDS (Direct Digital Synthesizer) development/evaluation boards have also recently come to our attention. The first is Analog Devices \$200 DDS DAC Evaluation Kit, announced in recent *Electronic Design* issues. We ordered the board from Newark using VISA, but are still waiting

for delivery. This board and its components are breakthroughs in speed and performance, as we will see when SSS actually gets the Kit.

Another recent DDS development/evaluation board, using the cheaper QUALCOMM DDS chip, is available for about \$150 from NOVATECH in Seattle. We have interfaced this little board to an 8031 microcontroller and are using it to generate really fast (chip rate speeds) frequency hop signals at frequencies up to about 10 MHz. While about one fifth the speed of the Analog Devices DDS, this DDS is very inexpensive, readily available and can easily be mixed up to any desired operating frequency with image reject mixers and some discrete analog filtering.

On the subject of Analog Devices, a new DSP development board, using an 8 bit PC bus, for the ADSP-2105 (or at slightly higher cost, the ADSP-2101) is available from Lewis Electronics in Gainesville, Florida. The ATHENA GROUP also distributes this great little product. It is available, in minimum configuration for about \$150 and with a full 8 K of RAM/ROM and a 100 kbps A/D and D/A is still only about \$250. The board comes with some demo programs and can be used with most code generators or C compilers for the 2105 / 2101 family of DSP chips. Analog Devices simulator and cross assemble software also make complete, but rather pricey development tools for this inexpensive board.

So now we've all got lot's more tools and toys to play with -- is there anything significant

we can do with them? You bet there is! See our feature on the PIC RISC microprocessor based PN generator and sliding correlator in this issue. With it and some very simple DSP tricks for coding, decoding, filtering and, for good measure, a DDS, we could design an impressive SS LAN or digital voice / cordless telephone system using SS. The tools are there, the chips are there, the prices are reasonable and if these things are really available, we can get to work on our off-the-shelf DSP SS project.

Have you seen the *DSP Applications* journal? It is a very well done little monthly, that picks up where we leave off in level of erudition and level of detail:

Look for more details in coming months and look for our wrap up of MUSE HDTV, next month.

Resources:

Analog Devices, Inc.
One Technology Way
Norwood, MA 02062-9106
Please cull your local distributor for price and delivery information.

Lewis Electronics, Inc.
4609 NW 6th St., #B5
Gainesville, FL 32609
TEL: 904-371-2567
FAX: 904-3775844

DSP Applications
Golden Gate Enterprises Inc.
P. O. Box 428
Los Altos, CA 94023
TEL: 415-969-6920
FAX: 415-969-0222

NOVATECH INSTRUMENTS
1530 Eastlake Avenue E, Suite 303
Seattle, WA 98102
TEL: 206-328-6902
FAX: 206-328-6904

APEX ADVICE

by Dan Douglas, President,
Apex Systems, Inc.

Have you ever found yourself in the middle of an RF design project and thought you were in control? The transmitter puts out the maximum power allowed by the law. The receiver has that ingenious low noise amplifier you developed. Every oscillator is temperature stabilized and optimized for low phase noise. The IF frequencies have been selected and every filter meets your gain, phase, and group delay requirements.

The only problem is your customer doesn't think in terms of bit error rate -- his or her specification states clearly, "the received data will have no errors."

Data synchronization and detection are working perfectly. You know for a fact that your system will achieve a bit error rate of 10^{-6} under optimum conditions and 10^{-6} under worst case conditions because the computer simulations agree perfectly with the measurements. The only problem is your customer doesn't think in terms of bit error rate -- his or her specification states clearly, "the received data will have no errors."

You need an error control strategy, which is the subject for the first two months of Apex Advice. The first strategy, Error Detection and Retransmission (EDR) is implemented as follows:

- (1) break up the data to be transmitted into blocks
- (2) add error detection bits to each block
- (3) transmit the block
- (4) in the receiver check the block for errors

(5) transmit an acknowledgement code from the receiver to the transmitter

(6) if an error was detected return to step 3

(7) return to step 1 and continue the process until all of the data is received correctly

If the block size is too small, the data rate will be reduced because of the overhead associated with the error detection bits and the time necessary to receive the acknowledgment code. If the block size is too high, retransmissions will be frequent and again the data throughput rate will be reduced. The block failure rate is given by the formula:

$$BFR = 1 - (1 - BER)^{8n} \quad (1)$$

where:

BFR is the Block Failure Rate,
BER is the Bit Error Rate, and
N is the Number of bytes in each block.

Solve for n to get

$$n = \frac{\ln(1 - BFR)}{8 \ln(1 - BER)} \quad (2)$$

which is plotted in Figure 1 to help you select the block size.

An effective error detection scheme must detect most of the errors, add a minimum number of redundancy bits and be easy to use. Cyclic Redundancy

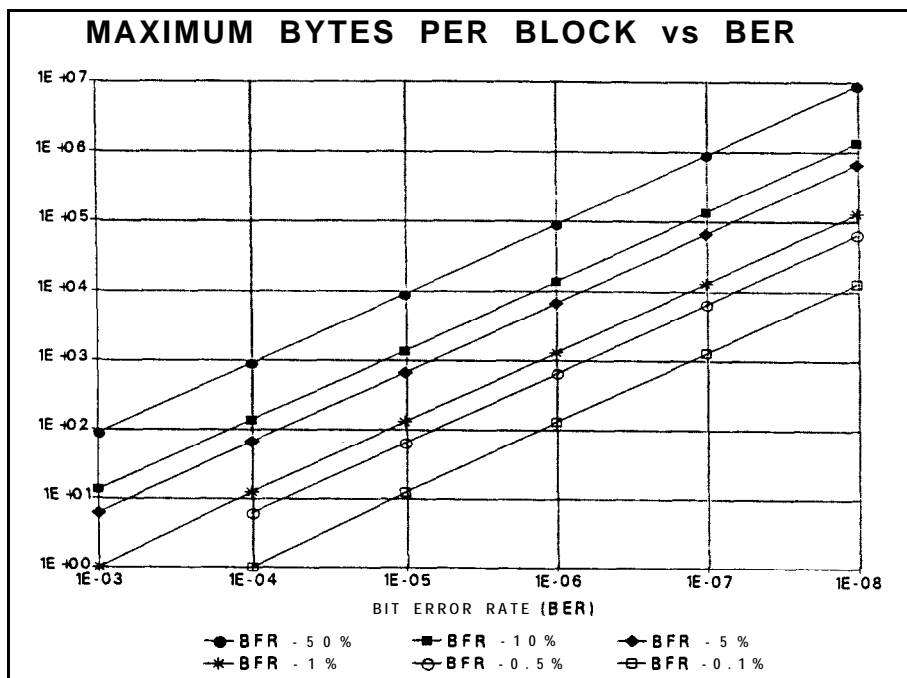


Figure 1

Codes (CRCs) satisfy all these requirements. The redundancy bits, which are added to each data block, force the remainder to be zero when the block is divided by the CRC polynomial. The process is illustrated using integer arithmetic.

If we define:

- M = the message
- D = the divisor
- R = the remainder.

Example: with M = 537938 and D = 4999; multiply M by 10000.

- M' = 5379380000
- R = 1091

Then add D - R to M':

- M'' = 5379383908
- R'' = 0

Transmit the value 5379383908. The receiver divides the incoming message by D. If the remainder is 0, it is assumed no error occurred. The probability of an error going undetected is $1/D = 1/4999$.

Two polynomials designed and tested for error detection are: **CRC-CCITT:** $h(x) = x^{16} + x^{12} + x^5 + 1$; and **CRC-32:** $h(x) = x^{32} + x^{26} + x^{23} + x^{22} + x^{16} + x^{12} + x^{11} + x^{10} + x^8 + x^7 + x^5 + x^4 + x^2 + x + 1$.

The CRC-CCITT code has the following properties:

- (1) Detects all occurrences of an odd number of bits in error.
- (2) Detects all single-bit, double-bit, and triple-bit errors if the total block length is less than 4096 bytes.
- (3) Detects any single burst error shorter than 17 bits.
- (4) Detects 99.99695% of all sin-

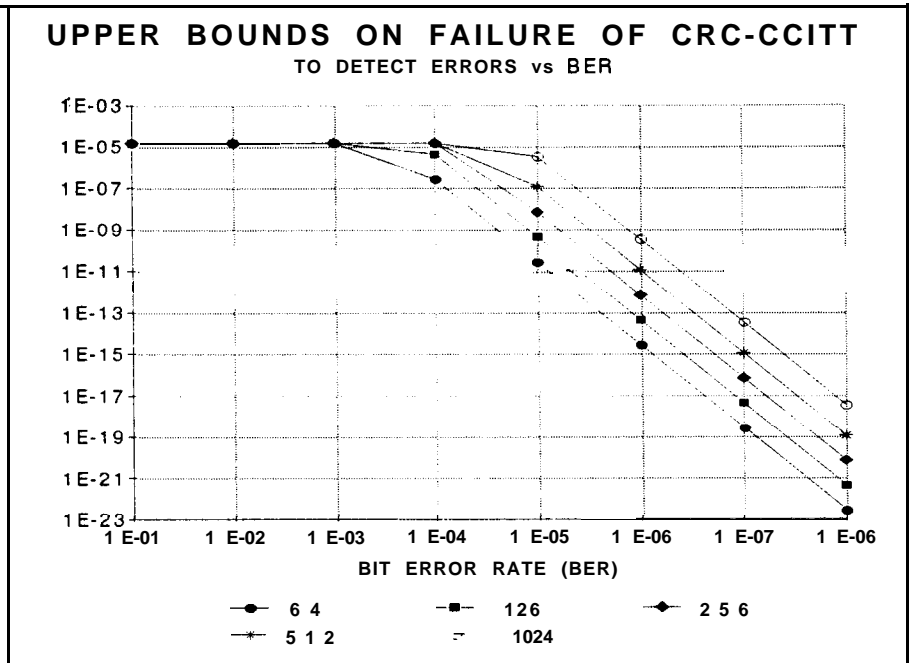


Figure 2: Note block size is given in bytes.

gle burst errors exactly 17 bits in length.

(5) Detects 99.99847% of all possible single burst errors greater than 17 bits in length.

(6) The fraction of all possible errors that go undetected is 0.00153%.

The 2nd and 6th property were combined to develop upper bounds on P_{fd} , the probability of failing to detect an error, for the CRC-CCITT. The results are plotted in Figure 2.

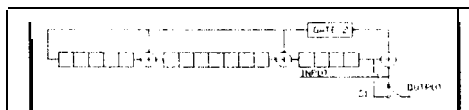


Figure 3: CRC-CCITT Encoder & Detector, $h(x) = x^{16} + x^{12} + x^5 + 1$

The 32-bit code detects all burst errors shorter than 33 bits in length. The fraction of all possible errors not detected is $2.3E-10$.

I recommend Campbell's book (see Reference) for a good software implementation of the CRC calculations. A circuit for implementing CRC-CCITT in both the transmitter and the receiver is given in Figure 3. Each circle with a '+' is an exclusive-or gate. Each unlabeled square is a shift register stage.

The transmitter algorithm is:

- (1) Clear the shift register.
- (2) With S1 in the upper position and GATE 2 open, shift the data into the circuit and simultaneously out of the output.
- (3) Close GATE 2 and set S1 to the lower position.
- (4) Shift the contents of the shift register out. These are the CRC bits.

*Next month: the receive algorithm and more!
Stay tuned . . .*

PART 15 DATA COMMUNICATIONS

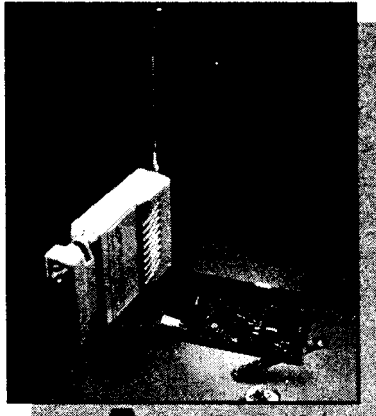
Total RF Product Development

Founded in 1986, and with over 70 years of combined experience in Electronic Design, **APEX SYSTEMS** is your source for total Part 15 Data Communication Development.

SATISFIED CUSTOMERS

NASA • 3M • Polaroid • Digital Equipment • Kodak • SERI • US West • Ampex • StorageTek • University of Southern California • Iomega •

- RF Identification Devices
- Intelligent RF&Embedded Controllers
- Frequency Synthesizers
- Digital Signal Processing



APEX
SYSTEMS, INC.

- Spread Spectrum Systems
- Portable, Low Power, Small Size
- Battery Operated Designs

• **FREE** •
APEX VIDEO

For a **FREE** video and information highlighting some of our Part 15 design projects, check below and FAX to: 303-443-4974 or call: 303-443-3393.

- Yes, please send **FREE VIDEO**.
- Please have **ENGINEER CALL**.
- Please add my name to your newsletter mailing list.

2400 CENTRAL AVE., SUITE A • BOULDER, CO 80301 • PH. (303) 443-3393 • FAX (303) 443-4974

A GaAs MMIC TRANSCEIVER FOR 2.4 GHz WIRELESS LAN APPLICATIONS

by the Scientific Staff of GEC-Marconi Materials Technology Limited, Caswell, Towcester, Northants NN12 8EQ

Introduction

The Industrial, Scientific and Medical (ISM) frequency bands include the frequency range 2.4 - 2.483 GHz. In the USA, unlicensed operation using spread spectrum modulation at a transmitter power of 1W is permitted on this band. This paper describes a transmit/receive front end for a 2.4 GHz wireless communications transceiver, the entire circuit of which has been integrated onto a single GaAs Microwave Monolithic Integrated Circuit (MMIC). The 3.3 mm x 5.2 mm chip, is available in an SSOP28 style plastic package. A low receive current of 30 mA from a +5V supply and a standby current of less than 0.5 mA,

make this an ideal component for battery powered operation.

Transceiver Architecture

A block diagram of the complete transceiver is shown in figure 1 (on the next page). The circuit can be switched between receive, transmit and standby states. In receive mode, input signals are down converted to differential IF signals. Although designed specifically for the 2.4-2.5 GHz band, RF signals between 1.9 GHz and 2.6 GHz could be utilized. The off-chip filters can be selected for the band of interest.

In transmit mode, the IF input signal, either balanced or single ended, is between 200 MHz and 500 MHz. The IF input is up converted to a single ended signal at the RF frequency. The circuit has been designed to provide a constant output power for a wide range of IF signal levels. A switched attenuator has been included to allow a 10 dB step in the output power level.

The frequency of the

VCO, and hence the IF frequency, is selected by appropriate choice of an off-chip resonator. Local oscillator frequencies of between 1.4 GHz and 2.7 GHz are available. A diversity switch has also been included to allow antenna selection. DC supply to the chip is +5V and -5V, with complementary 0V/-5V switching. The -5V supply takes less than 0.5 mA of current, regardless of transceiver operating mode. Typical current requirements from the +5V supply are 30 mA in receive mode and 20 mA in transmit mode. A standby state is also available and requires a current of less than 0.5 mA.

In addition to the complete transceiver chip, all of the subcircuits have been manufactured as individually measurable components. The design and measured performance of these subcircuits is described below. The circuits were realized on the standard GMMT F20 GaAs MMIC process.

Subcircuit Design and Measurements

LNA -- The LNA has a gain of 17.5 dB +/- 0.5 dB from 2 to 3 GHz. It has a noise figure of 2.5 dB at 2.4 GHz and a return loss of better than 13 dB.

Switches -- The T/R and diversity switches all use simple series mounted FETs. The measured "on" insertion loss is typically 0.7 dB, while isolation is 20 dB.

Mixers -- A quad ring of zero biased FETs was used to realize a balanced conductance mixer.

VCO -- A Clapp type Voltage Controlled Oscillator with both an on chip inductor/capacitor or an off chip coaxial resonator is used in the transceiver design.

VCO Balun -- A common gate and a common source stage are used to provide an equal amplitude split with 180 degrees phase difference.

RF Balun -- The RF balun is similar to the VCO balun but implemented at a higher frequency.

Buffer Amplifier -- A high isolation, small single finger FET is used to provide some 40 dB of isolation.

Differential Amplifier -- The two stage differential amplifiers use low gain, well matched, actively biased amplifiers.

Pre-Amplifier -- A resistively matched, low gain stage is used as the Transmit preamplifier.

Power Amplifier -- A two stage, 23 dB gain amplifier is used as the transmitter output stage.

Switched Attenuator -- A 10 dB switched resistive attenuator is used for power control.

Transceiver Measurements

Measurements have been

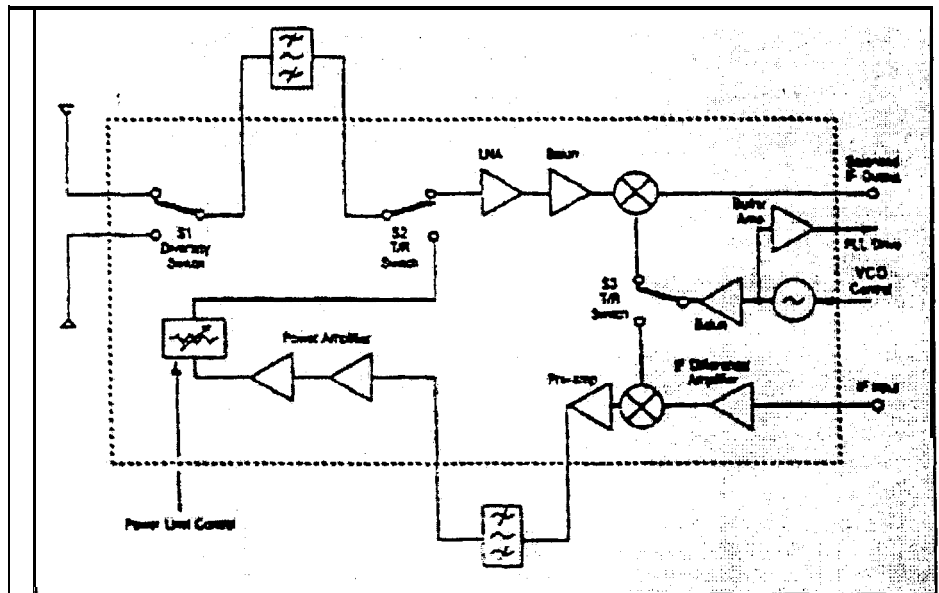


Figure 1: P35-4701 Block Diagram.

made on the complete transceiver chip. These were made on an unpackaged device in a special purpose jig. The output power level is -12 dBm with a phase noise of -122 dBc/Hz at 1 MHz off carrier. This signal is used to drive the phased lock loop of the transmit/receive circuit.

The receiver's conversion gain and double sideband noise figure versus IF frequency was measured for a fixed LO frequency of 2.035 GHz with the IF varying from 50 MHz to 500 MHz. A slight roll off with increasing IF frequency is a result of on-chip IF path losses and the off-chip balun used to combine the differential IF signal developed by the chip.

The power transfer characteristic through the power amplifier, attenuator and T/R switch chain has been measured. A 1 dB compression point of +18.5 dBm with a saturated output power capability of +21 dBm was demonstrated. We also measured the gain versus frequency through the entire

transmit chain from the differential IF input to the T/R common port output with the LO frequency fixed at 2.0 - 3.5 GHz.

It showed a gain of 38 dB +/- 1 dB for IF frequencies between 200 MHz and 500 MHz.

Conclusions

A single chip GaAs transceiver to cover the 2.40 - 2.48 GHz ISM band has been described. Receive gain is 13 dB with differential IF outputs and a double sideband noise figure of 4 dB. Current consumption in the receive mode is just 30 mA from a +5V supply. A standby mode is available with a current consumption of less than 0.5 mA. The transmit mode offers a constant output power level switchable by 10 dB, for a large range of IF input levels. These features combine to give a component which is ideally suited to spread spectrum Wireless LAN applications. Contact Daico at 310-631-1143 for more information on GEC-Marconi products in the USA.

Technical Tricks

About Correlators

(A Never Ending Saga?)

Last month we presented some ideas about delay lock and tau dither circuits for sliding correlators. We also discussed parallel and hybrid digital correlators. This month we will discuss some correlation basics and show some detailed issues that must be addressed when implementing correlators. We also hint at how to build that "nifty" hybrid digital correlator.

The basic definition of mathematical correlation is the integral:

$$\psi(\tau) = \int_{-\infty}^{\infty} f(t) f(t - \tau) dt$$

Don Lancaster in the August 1992 issue of *Electronics Now* showed that correlation can be performed in the three different ways shown in figures 1 and 2.

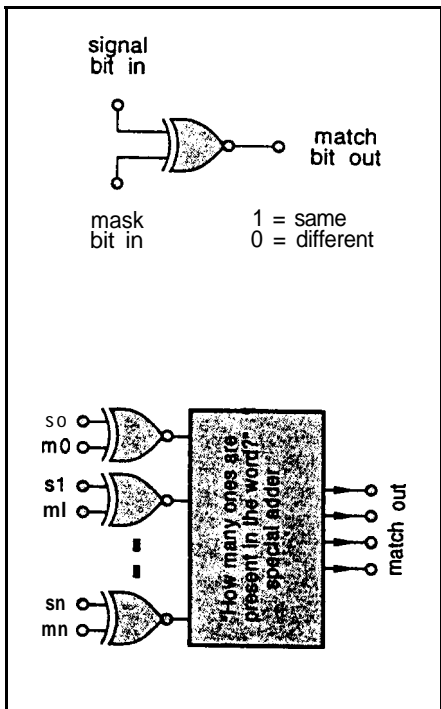


Figure 1: Don Lancaster's Correlator ideas.

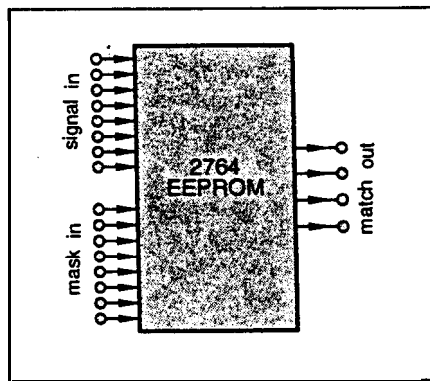


Figure 2: Another Don Lancaster correlator concept.

One of the problems inherent in the implementation of digital correlator circuitry, is that the correlator's ideal triangular shape usually gets digitized as shown in figure 3.

Another real world problem is time sidelobes and poor

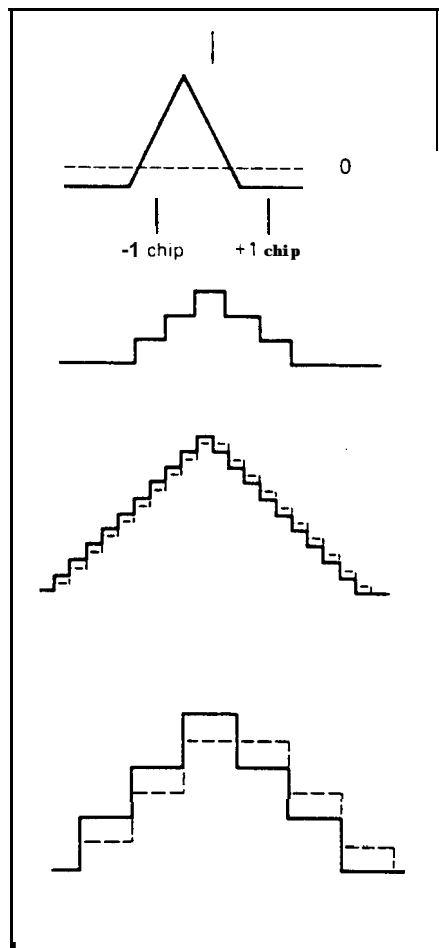


Figure 3: The ideal triangle is digitized in the real world.

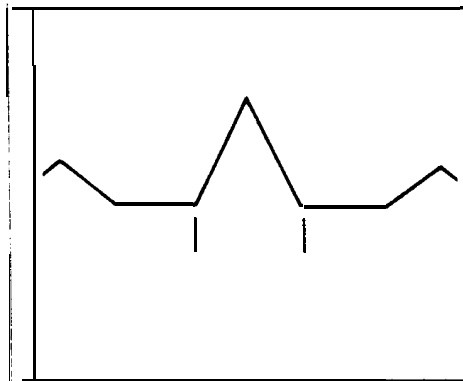


Figure 4: Time sidelobes in correlation functions.

choices of PN codes. Figure 4 shows what these can look like.

So now you know some of the real world limitations of correlators. You may ask--how bad are these effects?! You may also ask--al-e there other effects that must be accounted for? The answers to these questions are not a simple yes or no. First, you may need to model all the imperfections, quantization errors, noise and code effects before you really know how bad they are. Second, other imperfections can creep into your design. The foremost among these other effects is the effect of bandlimiting on the shape of the correlation triangle. In most cases, some RF or IF bandpass filtering is used in any real world transmitter or receiver. This rounds out the peak of the correlation triangle, loses a little correlation gain and spreads out/rounds out the sharp corners of the correlation function near the baseline. Other problems to watch out for are in-chip multipath signals and intersymbol interference.

All this sounds complicated -- doesn't it? Well that's part of 'what keeps us SS consultants busy. It's not really so bad if you

use TESLA or COMDISCO communications block diagram analysis and system modeling tools. TESLA is a PC based tool widely used for electronic system modeling and optimization. COMDISCO has an expensive, workstation-based package that does everything but wash the dishes. It is a super package, but it costs an arm and a leg!

Figure 5 shows how to build an analog "parallel" correlator. You might use a SAW device or a CCD shift register for this scheme. It is essentially an analog perfectly matched filter for the PN code being transmitted. The output sum can be fed to a threshold circuit (a comparator) to mark the time occurrence of synchronization. Once correlation sync is obtained, the tracking function (delay lock or tau-dither) can be initiated and you are now ready to demodulate the data that follows the unmodulated "sync preamble."

An all-digital, baseband version of the "matched filter" correlation detector is shown in figure 6. This scheme is also implemented at baseband and re-

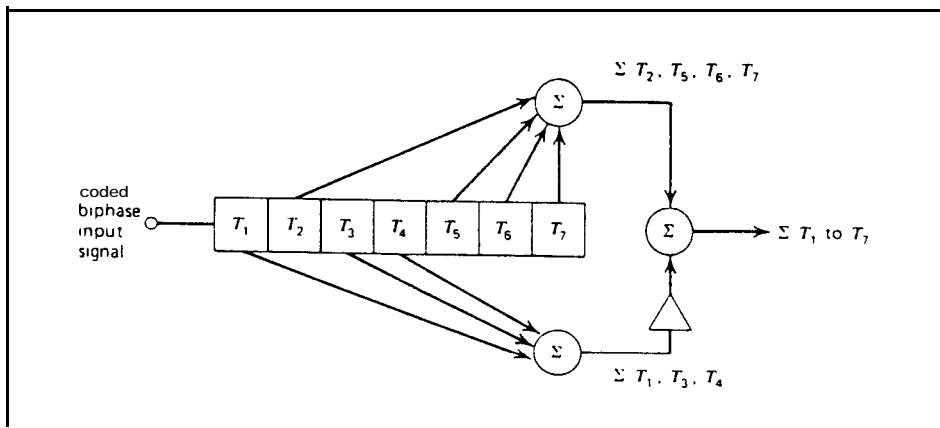


Figure 5: Analog "Matched Filter" correlator concept.

quires a few changes before it's a receiver's IF. This requires sampling the IF signal at a rate equal for real world SS communication, or above, the PN clock. See how you might do that hybrid correlator yet? More (quadrature) components of the next month.

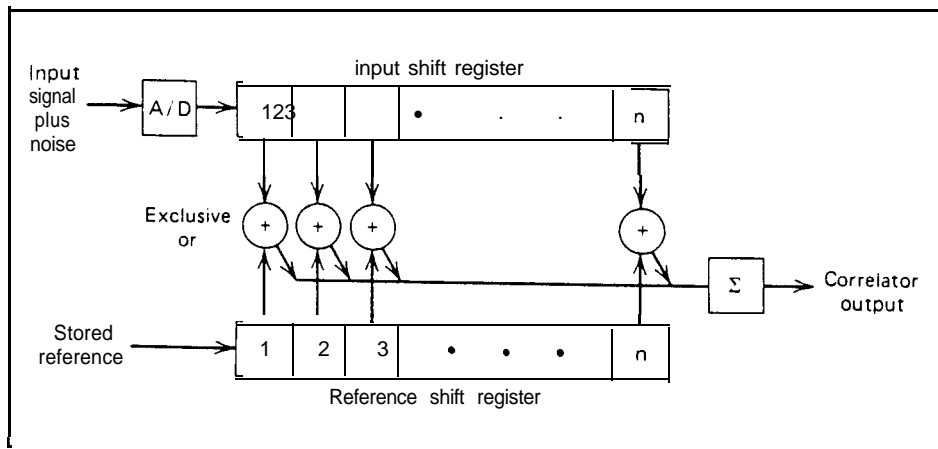


Figure 6: Baseband all-digital "Parallel" correlator concept.

Cut along this line for mail back card.

Name _____ Title _____
 Company _____ Dept _____
 Address _____
 City _____ State _____ ZIP _____



NO POSTAGE
 NECESSARY
 IF MAILED
 IN THE
 UNITED STATES

BUSINESS REPLY MAIL
 FIRST-CLASS MAIL PERMIT NO. 7 EL GRANADA CA
 POSTAGE WILL BE PAID BY ADDRESSEE

RF/SPREAD SPECTRUM

P. O. Box 9904
 El Granada, CA
 94018-9904



Editorial from page 5 --

While I'm on the soapbox, I think I'll share some of the secrets of our success, during the last year, with you.

First -- don't start a newsletter, it's a heck of a lot of work! Seriously, SSS has certainly helped our consulting business, RF/SS. But SSS is getting to be nearly a half time job now and that's cutting into our billable hours. So if you start a newsletter -- don't try too hard on it, otherwise your other business interests may suffer!

Second, read Don Lancaster's book *The Incredible Secret Money Machine*, second edition (By the way it's reviewed on page 26 of this issue). While I didn't do this before I started RF/SS or SSS, Don and I seem to be on the same wavelength and think in parallel directions. My own personal business philosophy is very much like Don's -- but developed empirically and independently through my own school of hard knocks and mistakes made in the bad old days.

Third, get very busy and stay very busy. If you don't have a client or a job or any other way of gainfully supporting yourself,

then simply invent stuff to do. Not just busy work or ham projects though! You must actively seek out opportunities and promote yourself, your professional image, your capabilities and most of all, cultivate your contacts (read: your own personal support network). Don't go to school or take a course in some neglected or long forgotten skill -- make the most of what you are and what you've already got.

Finally, and probably most importantly -- take a long hard look at yourself in a mirror in the most revealing light that you can muster. What are your goals, ambitions, desires, retirement plans, finances, skills, personal strengths, personal weaknesses and what can you do with this bag of tricks that is you? Don't forget to assess what you like to do -- that's very important -- because you will most likely be good at whatever it is. Use this self-assessment period to set realistic, written plans, goals and objectives for yourself. As time goes by monitor your progress against those written plans. The major point is very simple: *get and stay focused -- otherwise*

you'll never make it!

Good luck in your endeavors, whatever they may be, dear reader. Now you know some of the things that have worked for us -- maybe you can learn from my recent experiences.

In closing this first anniversary editorial, let me make a few announcements. Number one -- please look at our newest column from Apex, I think you'll really enjoy it and learn from it. Number two -- please let us know how you like our new format and breadth of coverage. Thanks to our advertisers, we are able to bring a pretty good sized issue to you this month. Number three -- look for some SSS publications to be published soon by Tiare Publications of Lake Geneva, Wisconsin. Gerry Dexter, President, has made arrangements with us to print App. Note #1 and the 1992 Anthology.

Our final reminder -- renewal time is coming up for most readers -- please don't forget us. During April and May you can save \$10, by using the card on pages 17 and 18.

Cut along this line for mail back card.

SPREAD SPECTRUM SCENE

The Wireless, PCS/PCN and Advanced Digital Communications Monthly News Magazine
SSS is the only publication devoted exclusively to the art and science of Spread Spectrum Digital Communications. Dedicated to the Spread Spectrum Professional, this acclaimed journal provides:

NEWS - ARTICLES - FEATURES;
HARDWARE - SOFTWARE

APPLICATIONS - DEVELOPMENTS - PRODUCTS

SUBSCRIBE NOW to the Primary Source for the Latest News and Information on the Growth, Regulation, and Opportunities in this Emerging Science and \$30 Billion Industry.

APRIL/MAY SPECIAL--Save \$10 Off Regular Rate

One Year/12 Issues: \$39.95 US (\$60 International)

JNew Subscription Renewal Senior*

Check MC VISA # _____

Complete Entry on Reverse. Card Exp : _____

18 'Seniors/Students/Educators: Take Another \$10 Off

SPREAD SPECTRUM SCENE
The PCS / PCN / LAN / MAN / WAN and CIMA / TDM
Monthly Newsletter

Number 3
June 1, 1992
Pages 16 to 18

EDITORIAL

FCC Grants the Buasas Spread Spectrum STA on April 17!

The long awaited amateur radio SS request for Special Temporary Authority (STA) was finally granted in a letter from Ralph Haller, Chief, FCC Private Radio Bureau, to Mr. Robert A. Buasas, K4KGS, on April 17, 1992. While the STA did not grant everything Mr. Buasas asked for in his original filing, it does provide relief from the restrictive regulations now in effect under the FCC's part 97 rules for amateur radio spread spectrum operation.

The STA is valid for one year and allows SS operation at 50.54, 144.144 and 222 to 225 MHz. The full text of the official FCC letter appears on page 5, in the Amateur Radio STA article. On the same page is Mr. Buasas' original request to the FCC. The direct result of this government action should be an opening up of possibilities for amateur experimentation in spread spectrum techniques. While we feel there will be no flood of enthusiasts unleashed, we do hope this action does not go unnoticed.

In related developments, this issue includes a Technical Tracks column on Gird orders and an article on SS propagation. We are also including another installment of the forthcoming book "Introduction to Spread Spectrum" in this issue. New features this month are three new columns: one on SS activating software by our Editor, another on DSP techniques for SS by Matthew Johnson, K1NWA, and a reader/advertiser services column by Karel Kuelman, K9RWC1. We are also proud to be starting a series of hands-on, how-to-build-it articles on a simple SS transceiver for use under the new STA -- see page 10.

Table of Contents

Articles	1
SS Review	1
Amateur Radio Station	1
Letters	1
Advertisement Index	1
Technical Tracks	1
Amateur Radio STA	1
SS Hardware	1
SS for Spread Spectrum	1
Technical Tracks	1
SS Propagation	1
Introduction to Spread Spectrum	1
Build Your Own SS STA Transceiver Part 1	1
SS Propagation	1
SS Review	1



Watch for SS Legislation Soon!

Watch for US House and Senate action, very soon, on several bills introduced last year that may greatly affect the future of commercial spread spectrum on the air spectrum in the US. Senate: Daniel Inouye (D-Hawaii) introduced S.218, the Emerging Telecommunications Technologies Act of 1991. It is an act on the books for Senate consideration. Last year's omnibus House Bill, sponsored by John Dingell (D-Michigan), Dan Rosten (R-Pa.) Michael Oshry (R-Cal.) and Bob Byrd (D-La.) are also due for action soon. All of this activity is the result



Nibbles & Bits

● A select group of Walnut Creek, CA residents are getting a chance to try out the latest PCS devices from Telesis Technology Laboratories, a Pacific Telesis subsidiary that is conducting the largest of 13 authorized Bay Area consumer tests. Under an experimental authorization from the FCC, new gadgets are being loaned to participants. Said to cost as little as \$100 when they get to production, these PCS pocket phones are probably using the latest SS CDMA technology.

● Stanford Telecommunications, Inc. of Santa Clara, CA has announced full production of its STEL-9230 Digital PSK demodulator assembly. The STEL-9230 performs BPSK, coherent DBPSK and QPSK demodulation. Working at an IF of 70 MHz and measuring only 5 by 6.5 inches. The unit has an AGC range of 30 dB and includes all symbol and carrier tracking functions, as well as demod and error correction. Data rates range from 9.6 kbps to 5 12 kbps in QPSK. Small quantities of this "super" board are available for only \$4300 each.

● The July 1992 issue of *Telesis* from BNR is a real collector's item on PCS. Contact: Dave Salbourn, TEL: 6 13-763-2008 or FAX: 6 13-765-2520.

● Send us your news briefs or clippings for insertion here.

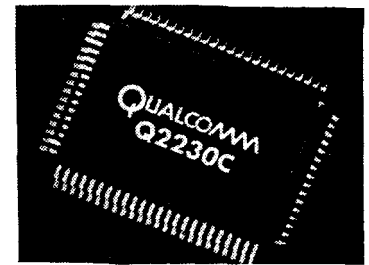
Dr. DOCUMENT

SEVEN RULES OF TECHNICAL WRITING

- 1 You can't tell what it is until it is.
- 2 Never re-invent the wheel.
- 2 When in doubt, leave it out.
- 3 Never tell them what isn't there.
- 4 Never modularize the book parts.
- 5 No compound sentences.
- 6 No personal pronouns.
- 7 No articles.

BREAK THE INFORMATION GRIDLOCK! Dr DOCUMENT WILL SHOW YOU HOW.

Phone/FAX 510527-8736

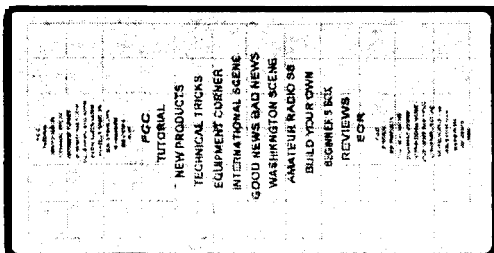


Announcing:

The 1992 Spread Spectrum Scene Anthology

SPREAD SPECTRUM SCENE ANTHOLOGY 1992

Volume 1, Number 1 (April) through Number 8 (November/December)

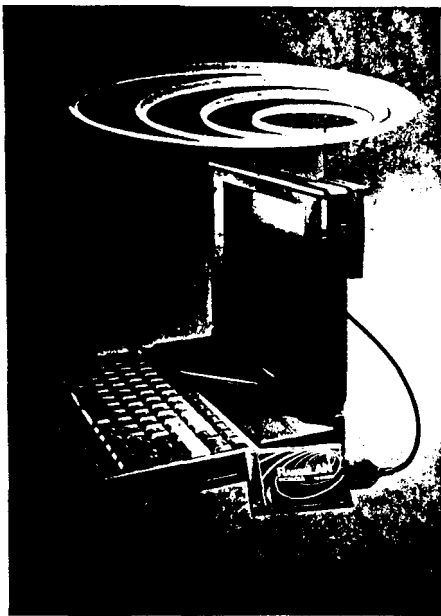


**Application Note #2
Pre-Print Edition
Over 180 pages -- Fully
Indexed -- With New Intro-
ductions and the full text
of everything published in
SSS in 1992!**

**Only \$17.95 plus \$3.00 S & H
Order Yours Today!**

**Spread Spectrum Scene
800-524-9285**

New Products



Proxim's RangeLAN/PCMCIA -- the first wireless LAN adapter designed to fit the TYPE II PCMCIA (Personal Computer Memory Card International Association) I/O card sockets that are becoming increasingly popular in new laptop, notebook and palmtop computers.

PROXIM SHIPPING THE INDUSTRY'S FIRST PCMCIA WIRELESS LAN ADAPTER

RangeLAN/PCMCIA Provides
Mobile Computer Users
With Instant, Wireless LAN
Connection

Mountain View, Calif., March 29, 1993 -- Proxim, Inc., the 9 year old supplier of wireless networking products, today announced that it has begun shipping its RangeLAN/PCMCIA wireless LAN adapter.

RangeLAN/PCMCIA is the first wireless LAN adapter designed to fit the specification of the TYPE II PCMCIA (Personal Computer Memory Card International Associ-

ation) I/O card sockets that are becoming increasingly popular in new laptop, notebook and palmtop computers. According to PCMCIA's forecasts, more than four million mobile PCs with integrated PCMCIA slots will be shipped by 1995.

Providing a true wireless networking solution, RangeLAN/PCMCIA is the only wireless LAN adapter that enables mobile computer users to communicate with existing wired client/server networks or to instantly set up a peer-to-peer LAN between mobile PCs. Proxim provides RangeLAN drivers for most popular LAN operating systems including Novell NetWare 3x, NetWare Lite and Microsoft Windows For Workgroups.

"The PCMCIA slot offers today's serious mobile computer user the first truly wireless LAN connection," said Rick Heller, president and CEO of Proxim. "With RangeLAN/PCMCIA just about anyone can now gain convenient wireless access to their server, desktop or another portable."

"We have used RangeLAN/PCMCIA to demonstrate the benefits of wireless computing using Microsoft Windows for Workgroups and Microsoft Windows for Pen Computing," said Richard **Tong**, director of Windows Marketing, Microsoft Corporation. "We've been impressed with RangeLAN/PCMCIA and believe it will play a key role in expanding the power and value of mobile computing with Windows."

All RangeLAN wireless network adapters use spread spectrum radio frequency technology that, unlike conventional radio frequencies, does not require end-user Federal Communication Commission (FCC) licensing. It has an in-building range of 300 to 500 feet and an 800 to 1,000 foot range outdoors or in warehouse-type environments.

RangeLAN provides users with three full channels that effectively triple the available bandwidth. This approach to wireless networking enables users to have three independent wireless LANs in the same physical space and provides a significantly higher interference immunity than other wireless technologies. In addition, RangeLAN also features a highly reliable signal reception that provides a consistent data rate over the entire range.

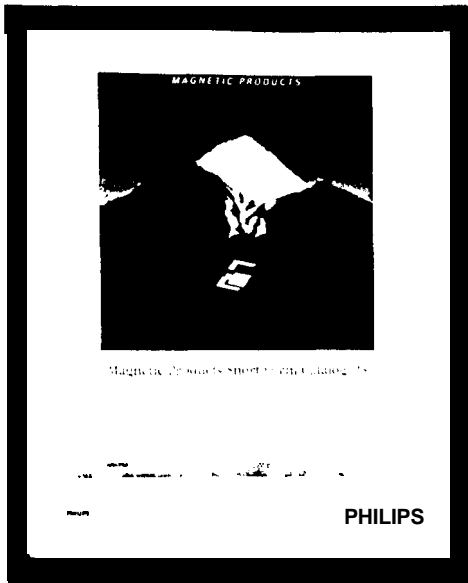
"Now, the portable computer user can function as part of a client/server environment or communicate on a peer-to-peer basis with other computers for critical applications such as E-mail, printer sharing, terminal emulation, and file transfer without a wired connection," said David King, Proxim's vice president of Marketing. "RangeLAN/PCMCIA also provides new networking solutions for vertical markets such as retail, medical and manufacturing where the need for mobile computing is paramount."

Suggested retail price for RangeLAN/PCMCIA is \$595. In addition, RangeLAN adapters are available in several form factors including RangeLAN/ISA for servers and desktop PCs, \$495; RangeLAN/LT for Compaq notebooks, \$595; and, RangeLAN/Parallel, for connections to the printer port of any PC, \$595. RangeLAN/ISA for desktop PCs and servers began shipping in early 1992, with RangeLAN/LT for Compaq portables released in the summer of 1992. Contact:



Proxim, Inc.
295 North Bernardo Avenue
Mountain View, CA 94043
Tel: (415) 960-1930
Fax: (415) 964-5181

New Products



The new Magnetic Products Short Form catalog for 1993 offered by Philips Components.

PHILIPS COMPONENTS INTRODUCES MAGNETIC PRODUCTS SHORT FORM CATALOG '93

RIVIERA BEACH, FL - Philips Components has prepared the new Magnetic Products Short Form Catalog for 1993 containing condensed specifications on all Ferrite Materials, Pot Cores, Square Cores, Toroid Cores, E,U, and I Cores, EC Cores and ETD Cores.

This 24-page short form catalog is designed to serve as a quick reference guide for design engineers and purchasing agents looking for general electrical data to conform to their applications. The catalog lists general specifications on RM Cores (solid center), Pot Cores, T type Pot cores, solid center Pot Cores, PQ Cores, E, EC, ETD, EFD, EP and U&l Cores and Toroidal Cores. Other literature and reference materials are listed in the back. To receive

information on bobbins and hardware including shielding beads, chokes rods, and tubes, call the local Philips Components sales office listed on the back cover.

Philips Components Discrete Products Division is a division of North American Philips Corporation, a wholly-owned subsidiary of N.V. Philips in the Netherlands. To receive a copy of the Magnetic Products Short Form Catalog 93, contact Philips Components, Technical Literature Center, 200 1 W. Blue Heron Blvd., Riviera Beach, FL 33404 or call: 1 800-447-3762 or (407) 88 1-3200 and ask for PC060.

PHILIPS COMPONENTS INTRODUCES THREE NEW NTC SENSORS SERIES

MINERAL WELLS, TEXAS - Philips Components introduces three new series of NTC long-leaded temperature sensors.

Featuring long PCV leads, the new NTC temperature sensors series 2338 6409 features three different lead-ends including standard, sleeve encapsulated, and solid brass tube encapsulated executions. The sensors have excellent humidity endurance and operate accurately in a wide temperature range from -40°C to 80°C . They are ideal for refrigeration and air conditioning applications.

The sensors are made from pure metal oxides responding quickly to the slightest change in temperature. They are stable throughout a long lifetime, have a high impedance and are small and inexpensive. Accurate

and dependable, they have a typical negative temperature coefficient of approximately -4.5% per K at room temperature (25°C).

Typical pricing for the Series 2338 6409 in quantities of 1,000 is \$0.35 each.

For more technical information, contact Emmanuel Orban at Philips Components, 5101 Airport Road, Mineral Wells, TX 76067, TEL: 8 17-325-787 1.

April 1, 1993 -- For Immediate Release:

YBH Computers Inc., a small Silicon Valley start-up in Campbell, CA announces development of the "MX Bus" Direct Connect Interface, Spread Spectrum Wireless Computer LAN System. This remarkable product was first shown at the recent CCITT conference in Geneva, Switzerland, and today was demonstrated during a press conference in San Jose. Outstanding researchers in the computer, communications and medical fields who played a part in the product development were present to share in the unveiling.

After months of delays in sourcing parts, the first beta units have been completed and implemented on a temporary government network installation in New Mexico. According to "MX Bus" designers J. Sinotreb and V. Illeñif, all current CISC and RISC architectures, including the new Intel Pentium were evaluated for bus control, and ruled out when the two designers realized

New Products

that there was no microprocessor available which could address faster than the human mind.

The "MX Bus" radio can be operated at a maximum data rate of 20 MBit/Sec. and is fully FCC part 15 compliant. The interface is claimed to allow complete control of all file transfer operations, including both client/server and peer-to-peer applications. The currently supplied drivers support Novell Netware, ArtiSoft LanTastic, Microsoft, and IBM O/S-2 operating systems. Internal NV-ROM and SRAM memory are arranged in a four dimensional matrix.

The YBH staff also demonstrated utilization of a mind training sequence (MTS) where the effects of delay spread and reflective multipath interference, which until now have plagued all other high speed wireless LANs, are totally eliminated. Essentially the brain acts as a real time rake receiver and restores the data bits back to the correct phase relationship. At the same time noise and interference are removed in an adaptive psychic filtering process.

The MX system is available with both internal and optional external "Top Hat" antennas. Although the first prototype installation was performed in the sanitary facility of Walter Reed Army Hospital, the designers feel confident that design refinements will allow installation only four hours time by most computer VARs.

All hardware, including three Teflon coated stainless steel self tapping screws, are included for installation. The twelve page instruction manual is written in a

format which most surgeons can easily understand. All pages are plasticized and easily wipe clean with a damp cloth. A toll free HOTLINE is provided for support.

Production units are scheduled for early July. Pricing has not yet been established. For more information contact: YBH Computers, 2470 S. Winchester Blvd., M/S D, Campbell, CA

NEW REPORT REVIEWED

Mountain View, CA -- March 15, 1993 -- Strategies Unlimited announced today that it has completed a major report on the five-year outlook for RF components, both GaAs and silicon, used in wireless personal communication systems. This 164-page report, entitled *RF Components for Wireless Personal Communications*, includes an analysis of cellular and cordless phones, handsets for personal communications services (PCS), pagers, and wide-area data networks. The report covers the three world regions of the U.S., Europe and Japan.

Between 1987 and 1992, annual sales of handheld wireless communication devices, cellular and cordless phones, pagers, and wide-area data terminals worldwide increased from 9 million units to 33 million units, representing a compound annual growth rate (CAGR) of 30%. The largest category was cordless phones, followed by cellular phones.

Between 1992 and 1997, the world market for cellular, cordless, and PCS handsets is forecast to increase from 29 million units to almost 69 million units, representing a CAGR of 19%

Of the three world regions covered by the report, Europe is expected to be the leader in the transition to digital for both cordless and cellular systems. The swift adoption of digital standards and allocation of spectrum has encouraged the growth of digital networks in Europe. In addition, the need for Pan-European standards, allowing international "roaming," is expected to further speed the move to digital networks. In contrast, the U.S. has been slow to adopt a digital cellular standard or allocate spectrum for emerging wireless communication services. Consequently, the U.S. has fallen behind both Europe and Japan in developing and implementing the digital cellular and cordless networks that will provide the backbone for PCS.

The evolution towards Personal Communication Services (PCS) will be based on a combination of digital cordless and cellular telephone technologies. The Japanese are conducting PCS network trials based on the digital cordless standard known as the Personal Handy Phone (PHP) operating at 1.9 GHz. The Europeans, on the other hand, are moving towards PCN via micro-cellular networks based on digital cellular standards such as GSM, operating at 900 MHz, and DCS 1300, operating at 1.8 GHz. The U.S. appears to be moving in all

New Products

directions, with PCS trials being conducted using almost every conceivable technology and standard. While the use of GaAs MICs and MMICs are currently limited to the lightweight, hand-portable class of cellular telephones, over the next five years GaAs will find its way into the majority of cellular handsets and next-generation digital cordless phones operating at 900 and 1,900 MHz. GaAs insertions will be predominantly in the form of MMIC power amplifiers, switches, and possibly up/down-converters.

RF Components for Wireless Personal Communications is available immediately for a fee of \$2,950.

Strategies Unlimited, Mountain View, CA, publishes single-client and multi-client market research reports on wireless communications, RF components, optoelectronics, photovoltaics, and related technology and industry structure.



Strategies Unlimited

201 San Antonio Circle, Suite 205
Mountain View, CA 94040
(415) 941-3438 FAX (415) 941-5120



Piezo Crystal Company has introduced the "DHXO" (Directly Heated Crystal Oscillator). This patented technology bridges the gap between TCXO's and Ovenized oscillators. Using an SC cut crystal with a "heater" deposited on the crystal blank, more rapid warm-up can be achieved with lower DC power consumption compared to a conventional ovenized crystal oscillator. Also, the use of the SC cut crystal provides improved aging, phase noise and vibrational sensitivity compared to TCXO's and some ovenized oscillators of larger physical size. The "DHXO" is available in a frequency range of 7 to 20 MHz. Frequency stability over temperature is 2×10^{-7} over 70 degrees C. Aging is 1×10^{-7} per year. DC power input is less than 1 watt at +12 VDC. SSB phase noise is -153 dBc/Hz at 10 KHz. Allen Variance offered is 1×10^{-11} per second. The small volume of one cubic inch makes the "DHXO" desirable for portable applications where size, power consumption and performance are of importance. Estimated price is \$2.10 at 1,000 quantity. For more information call Jon Lehr at:

Piezo Crystal Company
100K Street
P.O. Box 619
Carlisle, Pa. 17013
FAX: 717-249-7861
TEL: 717-249-2151

Send your New Product Announcements and Press Releases to SSS -- If it fits our areas of interest, we'll publish it for free!



MINISTOR INCREASES CAPACITIES OF 1.8-INCH DISK DRIVES TO 42 AND 85 MB

Subminiature Disk Drives Offer Industry's Highest Operating and Non-Operating Shock Resistance of 200 Gs

SAN JOSE, Calif., -- MiniStor Peripherals Corporation has announced two new 1.8-inch disk drives with data storage capacities of 42 and 85 megabytes (MB) and the industry's highest operating and non-operating shock resistance -- 200 Gs. Higher capacities in the drives were achieved by increasing recording density to over 140 megabits per square inch. Available with both Personal Computer Memory Card International Association (PCMCIA) and Integrated Device Electronics (IDE) interfaces, the subminiature drives offer OEMs industry standard storage solutions for mobile computers.

New Products

Called the MiniPORT 42 and MiniPORT 85, the new drives offer 42 and 85 MB capacities, respectively. Data storage capacities were increased to address the growing demand for higher data storage requirements in battery powered systems. MiniStor's operating shock resistance enhancements support the expanding market for mobile computing.

MiniStor introduced its PORTables Series of 1.8-inch disk drives in March 1992, and has been shipping these drives since Q392. The original family included 32 MB and 64 MB drives with IDE and PCMCIA interfaces and 20 Gs operating and 100 Gs non-operating shock resistance.

MiniStor Peripherals Corp.
2801 Orchard Parkway
San Jose, Ca 95134
408-943-0165
FAX: 408-434-0784

MAGELLAN ANNOUNCES NEW LINE OF GPS RECEIVERS FOR SYSTEMS INTEGRATORS AND OEMs

SAN DIMAS, CA -- Expanding its line-up of GPS BRAIN Global Positioning System (GPS) receiver products for original equipment manufacturers and systems integrators, Magellan Systems has introduced a smaller module, a new firmware set for timing, enhancements for its standard navigation firmware and a significant reduction in the price of its OEM receiver modules.

Magellan offers its board-level module in two sizes. The newest size measures a mere 2.9" X 4.5" X .5" and requires just five volts to power. The down-sized board is available in small quantities for less than \$300 per unit, according to Magellan OEM Sales and Marketing Manager Mike Brower.

"We can now offer systems integrators the full power of GPS at a fraction of the size and cost. The reduced dimensions of the small module permit easy integration into a variety of other systems where size is a critical factor," Brower said.

The new Single Satellite Timing Firmware joins the company's Standard Navigation Firmware in Magellan's growing line of application-specific OEM GPS receiver products. The two firmware sets are available on both the Power Supply and new

Five-Volt hardware versions of the Magellan GPS Brain.

"The result is a growing product line of GPS receiver modules which offers OEMs and systems integrators innovative solutions to meet a variety of plotting, mapping, tracking, locating, navigation, positioning and timing needs."

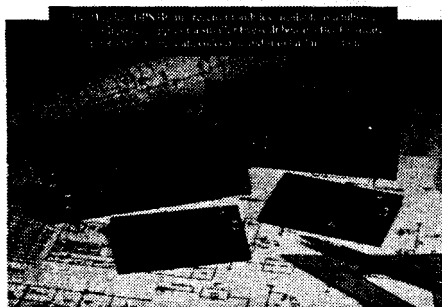
MAGELLAN SYSTEMS
CORP.
960 OVERLAND COURT
SAN DIMAS, CA 91773
TEL: (714) 394-5000
FAX : (714) 394-7050

RF PROTOTYPE SYSTEMS OFFERS NEW-LOW COST MINIATURE CELLULAR/PCS SYNTHESIZERS

These synthesizers provide a simple low-cost solution for Local Oscillators (LOs) in all the standard Cellular/PCS and EAMPS Cellular radios that have the following frequency plans:

- Common LO for both transmit and receive sections
- Separate PLL's for transmit and receive sections

These synthesizers offer excellent phase noise, low noise, and small size. They have one big plus -- the software is available with the serial interface models that run on IBM/Compatible computer so the synthesizers can be easily programmed to your desired frequen-



New Products

cies. PLLIP-XXX units have dip switches on board so that no external interface is required.

Availability: Two weeks. Please call for pricing. For more information, contact Dan Gavin at:

RF Prototype Systems
9400 Activity Road, Suite J
San Diego, CA 92126
TEL: 6 19-689-97 15
FAX: 6 19-689-9733
Or toll free 1-804-874-8037

CAPS PLD Now Available from LOGICAL DEVICES, INC.

DEERFI ELD, FLORIDA -- March 30, 1993 -- Logical Devices Inc. announces plans to unveil a new product. CAPS PLD, a CD-ROM based database containing information on over 16,000 PLD and FPGA devices, with more than 15,000 pages of technical documentation, for only \$495.00 at the PLD Conference, held March 30-31, 1993 in Santa Clara, California. CAPS PLD will be available for Demonstration at the Logical Devices, Inc., booth 514.

CAPS PLD was developed by CTIS, which is a division of Cahners Publications. Logical Devices and CTIS have signed a joint marketing agreement to promote the product worldwide through a large network of the Logical distributors and dealers. CTIS' decision to choose Logical as its marketing partner for this product has been based on the large market share and customer base of PLD users

that Logical has acquired over the years.

CAPS PLD is a complete reference source for researching PLD, complex PLD, and FPGA devices including part numbers, parameters, alternate sourcing, and technical documentation on one CD-ROM.

CUPL PLD SOFTWARE JS NOW AVAILABLE FOR WINDOWS!

Logical Devices announces immediate availability of CUPL for Windows 3.0 and 3.1. This product was completely redone for windows and it makes use of the advanced features available in Windows. "This is not just a straight port, it is a real Windows application" said David Mot, president of Logical Devices. CUPL for Windows includes minimization, simulation and flexible design entry just like its DOS and UNIX counterparts. The advantage is that it uses the standard Windows interface features like menus, dialog, and a variety of buttons. For users who like Windows, it allows them to add yet another tool to their Windows arsenal. Since it runs in Windows standard and enhanced modes only, it does not have the 640K memory limitation imposed on the standard DOS version of CUPL. Interfaces to several Windows based schematic programs are currently being tested. These will be available to customers before the end of the year.

Users will really like the context sensitive help. Choose any dialog, menu or button and

press F1 and the help related to that item is displayed. This also occurs with the message window where the compiler sends all its output. Select a line containing a warning or error and press F1 and the explanation of that warning or error is displayed. Also in April of this year, Logical Devices introduced the ALLPRO XR, the first programmer with a true Windows interface. CUPL and ALLPRO XR can be used together to create a total development station for programmable logic.

Since the compiler core is a Windows Dynamic Link Library, other tools can link it to add the CUPL compiler to their environment. This opens the possibility for other tools that would like to have a built in LOGIC compiler. It is also possible to use the Windows Dynamic Data Exchange (DDE) feature to communicate with CUPL for Windows.

For more information on either of LDI's new product offerings contact:

David Mot, President
Logical Devices, Inc.
692 South Military Trail
Deerfield Beach, FL 33442
TEL: 305-428-6868
FAX: 305-428- 18 11

That's all the New Products we have room for in this month's SSS. Look more more exciting new announcements in our May issue!

Book Review

Microcomputer pioneer and guru Don Lancaster is the author of 28 books, 2 videos, and countless articles. When you include his *TTL Cookbook* and *CMOS Cookbook* he has published more than one million books. He is considered by some to be the father of the personal computer, for his early ground-breaking work with hacker digital electronics and low cost video terminal displays. He is considered by others to be the patron saint of the Walter Mitties of the World.

Don is the *Hardware Hacker* in *Electronics Now*, runs his *Resource Bin* in *Nuts & Volts* and his the *Blatant Opportunist* in *Midnight Engineering* are always interesting. Don is also the Sysop for *GENie* PSRT, a leading Money Machine, laser publishing, PostScript, and hardware hacking on-line resource. His popular *Ask the Guru* columns continue to be published electronically in PSRT.

Don Lancaster's



A HOW-TO COOKBOOK FOR SETTING
UP YOUR VERY OWN COMPUTER,
CRAFT, OR TECH VENTURE.

UPDATED NEW
EDITION!

Don is also the head honcho at *Synergetics*, a new-age design and consulting firm that specializes in Apple computing, laser printing, PostScript development work, electronic prototype, book-on-demand publishing, technical writing, and innovative software design. His avocations include firefighting, cave exploration, bicycling and of course *tinaja questing*.

One could do worse than to read and heed his timely entrepreneurial advice presented in the new update of his now classic, ISMM. At RF/SS we developed ideas similar and parallel to what Don has in his book, even before we read ISMM. Don's individually autographed copies of *The Incredible Secret Money Machine II* are available directly from Synergetics Press -- you may use the order form below:



Individual copies of Don Lancaster's new **Incredible Secret Money Machine II** are currently available at **\$18.50 plus \$2.00 UPS shipping and handling.**

Most orders are shipped within 24 hours.

All copies are personally autographed.

Featured In Spread Spectrum Scene

Please rend me copies of the new **Incredible Secret Money Machine II** at \$18.50 plus \$2.00 s/h. (AZ residents add 6.5% tax.)

I enclose payment of \$ _____ by Check VISA MASTERCARD

_____ exp ___/___ Signature: _____

Name: _____ Phone [] _____

Company: _____

UPS Address: _____

City, State, Zip: _____

Synergetics 3860 West 1st Street, Box 809-W, Thatcher, AZ 85552 (602) 428-4073

A Novel Software/Firmware Based PN Generator and Sliding Correlator

by Benedict Tse and Randy Roberts

Benedict Tse, a senior BSEE/BSCS student at UC Berkeley undertook a small project using the Microchip PIC17C42 RISC microcontroller to see what could be done with fast microprocessors used to generate PN codes. He did exceedingly well on this little project and was able to generate PN at rates up to 4 MHz. He undertook further coding and de-bugging and was able to not only generate PN codes but perform a sliding serial correlation function (in a half duplex mode) at TX and RX PN clocks of greater than 2 MHz. A photo of our development system and breadboard I/O area is shown in figure 1.

RF/SS plans to make available the code and further application assistance, by license agreement, to any interested company or individual. We think this fully firmware programmable concept can make a lot of waves in the SS arena, especially for SS cordless telephones or new CDMA cellular / PCN / PCS voice / FAX or data applications.

We utilized a Cyberwave Proto-17 Evaluation board, fully populated with 64 kBytes of FLASH memory, the LD-17 monitor/serial loader and Universal Cross-Assemblers' Cross-16 Meta Assembler for this development project.

The following paragraphs describe some of the problems and limitations we faced in this

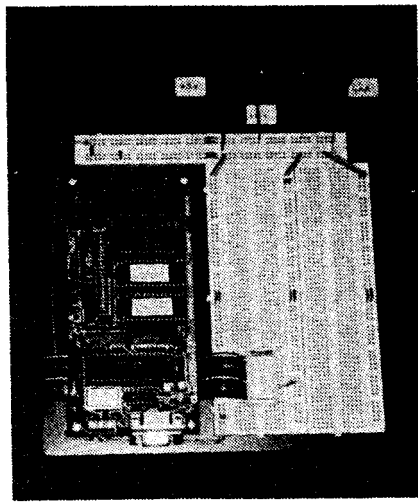


Figure 1: PIC17C42 Firmware PN Generator and Sliding Correlator.

development.

Memory Map

The PIC17C42 has a separate program memory and data memory, with all the run time variables stored or read from the data memory which is allocated from 0x00 to 0xff and 8 bits wide. If more than 256 bytes of data memory are desired, a swap between data memory and program memory can be done by using TABLRD and TABLWT instructions (a time consuming process).

Parallel Port

Since the proto-17 runs in microprocessor mode, only parallel port A is available as a built in I/O port, and most of the bits of port A are input only and with very few output bits. Since the PIC17C42 doesn't have a direction register for its parallel port, a pullup resistor is needed for output and a 0 must not be written to the port when configured as output.

Timing problem

A low to high or high to low transition appears to have different but consistent delays. A single bit high has a cycle time 60ns shorter than the regular instruction time, 250ns, and a single bit low has a cycle time 60ns longer than the regular instruction time, 250ns. For multiple high bits, the cycle time will still be 60ns shorter than the expected cycle length. Thus 5 high bits will result a cycle time of $5 \times 250\text{ns} - 60\text{ns} = 1190\text{ns}$.

From bit to bit, several instructions need to be executed in order to call up a new PN sequence. The number of instructions that we can put in will depend on how much we can tolerate between bit to bit --more detailed analysis needs to be done.

Hardware problem

Since there are only 256 bytes of data RAM on chip, if more memory is desired, two external RAM chips are needed to provide more program memory (RAM) for swapping. And it will be even more complicated if the 2K internal EPROM is not large enough to hold the program. If that is the case, 2 external EPROMs will also be needed besides the external RAM which implies an address decoder will also be needed.

Conclusion

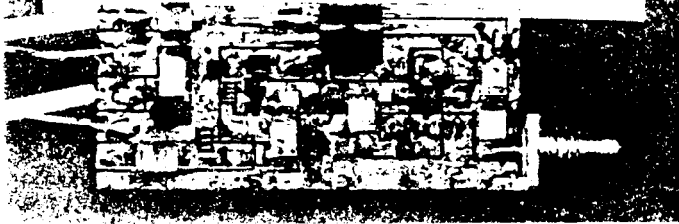
More work still needs to be done, but so far this little concept seems to be a "killer." What do you think'!

More next month.

VCO

1.384 MHz - 8.6dBm

1.728 MHz - 5.6dBm



This short note from John Horvath of Minaret Radio may give you some ideas for wideband VCOs of your own. Give John a call if you have any questions.

VCO. 1.220 GHz - 1.5464 GHz
1.7 dBm - 3 dBm
output.

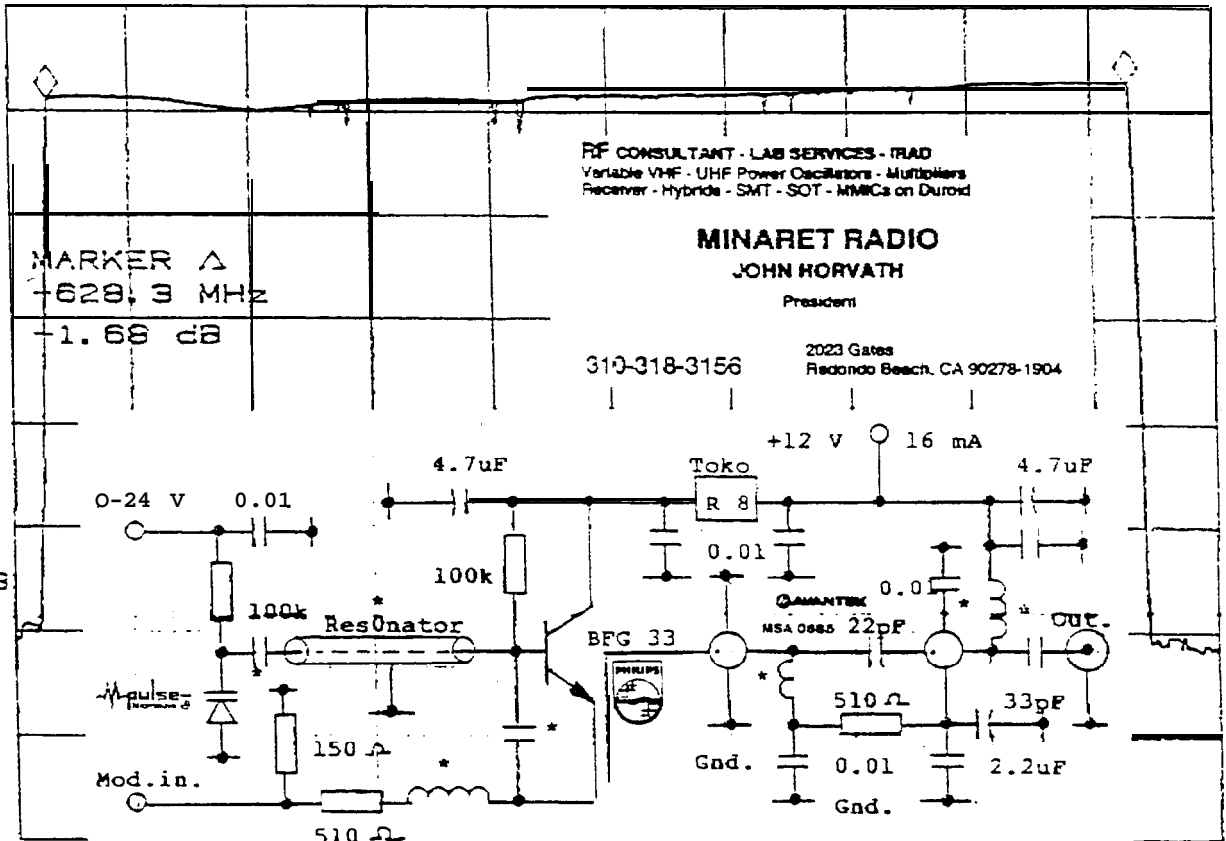


REF . 0 dBm

ATTEN 10 dB

MKR Δ -628.3 MHz
-1.68 dB

PEAK
LOG
10
dB/



START 1.200 GHz

RES BW 3 MHz

VEW 1 MHz

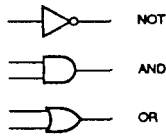
STOP 1.900 GHz

SWP 20 msec

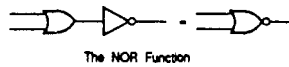
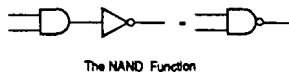
Beginners Box

Boolean Logic Review

Basic Logic Elements



A	B	/A	A*B	A+B
0	0	1	0	0
0	1	1	0	1
1	0	0	0	1
1	1	0	1	1



Precedence of Operators

A	B	C	D	A*B+A* C+D	A*B+A* (C+D)	A*(B+A)* C+D	A*(B+A)* (C+D)
0	0	0	0	0	0	0	0
0	1	1	0	1	1	0	0
1	0	0	1	1	0	1	0
1	1	1	1	1	1	1	1

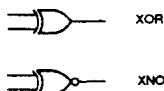
Commutative, Associative, Distributive Laws

A	B	A*B	B*A	A+B	B+A
0	0	0	0	0	0
0	1	0	0	1	1
1	0	0	0	1	1
1	1	1	1	1	1

Commutativity

A	B	C	(A*B)*C	A*(B*C)	(A+B)+C	A+(B+C)
0	0	0	0	0	0	0
0	1	1	0	0	1	1
1	0	1	0	0	1	1
1	1	1	1	1	1	1

Associativity



A	B	A:+:B	A:::B
0	0	0	1
0	1	1	0
1	0	1	0
1	1	0	1

Join a winner from the start.

This might be your once in a lifetime opportunity to participate in the \$11 billion telecommunications revolution right here in San Diego. Here you will be a key part of a new team with a well financed and well established international market leader. You will be creating solutions for the emerging industry. If you want to be on the cutting-edge of integrating wireless voice and data, you will want to respond quickly.

MARKETING/PRODUCT MANAGER

Will be responsible for product from concept through rollout. Must be a conceptual thinker with the ability to communicate effectively, both internally and externally. You will drive specifications and product design and development for low cost, low power commercial systems ranging from 700 Mhz to 5 Ghz. Successful candidates will have a BSEE and MBA with 5-10 years' experience. The selected individual will have a proven track record in managing products in leading-edge, often ill defined markets. Experience with datasheet and product support material creation is a benefit. Dept. MPM-SSS.7.

DIRECTOR OF ENGINEERING

Will be responsible for product engineering from functional specification through product release. Must understand the market and be a conceptual thinker with the ability to communicate ideas effectively with internal staff and external customers. As an overall systems architect, you will need to understand the tradeoffs of various modulation, collision avoidance MAC and PHY requirements and inherent channel problems. You will be tasked with the integration of software, firmware, mechanical, RF, MMIC and ASICs. Successful candidates will have a BSEE with 10 or more years of circuit-level design and development management experience. Working knowledge of work load spreading, PERT charting, program planning and reporting is a must. Dept. DOE-SSS.

COMPONENT ENGINEER

Will be responsible for device specifications, circuit testing and vendor selections for low cost, low power commercial components in the 700 Mhz - 5 Ghz range. Successful candidates will have a BSEE with 5 years of development experience in RF devices including active, ASICs and passives. Dept. CE-SSS.

SR. RF DESIGN ENGINEERS

Will be responsible for specifications, circuit design and development of low cost, low power commercial circuits ranging from 700 Mhz to 5 Ghz. Successful candidates will have a BSEE with 8 years' direct development experience in different modulation techniques spread spectrum, VCOs, filters, synthesizers, power amplifiers LNAs and AGC designs. Experience in full and half duplex radio systems and microcellular architectures as well as experience with FCC is a must. Dept. SRF-SSS.

ASIC DIGITAL H/W DESIGN ENGINEERS

Responsible for creating a variety of designs for TDMA, CDMA and mixed-signal applications. Successful candidates will have a BSEE with 4 or more years' circuit-level development experience in ASIC, VLSI, CMOS and GaAs top down design including interfacing to microcontrollers. Duties will include system integration/test from product conception to manufacturing. Experience with commercial DSR in hardware and system integration into communications products is a plus. Dept. ADE-SSS.

SR. RF TECHNICIAN

Successful candidate will possess hands-on assembly experience 10 Mhz to 5 Ghz, and a background with active and passive devices network analyzer, signal generators and spectrum analyzer. The ability to troubleshoot to the component level is a must. Dept. SRF-SSS.

DIGITAL ENGINEERS

Responsible for device specifications, circuit design and development of low cost, low power commercial electronics to control communications hardware. Successful candidates will have a BSEE with 5 years direct development experience in Xilinx FPGAs, DSR and various microprocessor platforms as well as CAD and circuit/logic simulation. Dept. DE-SSS.

MECHANICAL ENGINEERS

Will conceive, develop and implement designs of housings and plastic packaging of communications devices. Successful candidates will have a BSME with 4 years' development experience in commercial applications design with working knowledge of AUTOCAD, PCAD and other modelling programs, knowledge of thermal effects, various plastics used in injection molding, RF shielding and packaging density for SMT and snap together assembly is a must. Dept. ME-SSS.

SOFTWARE ENGINEERS

You must have experience in telecommunications operating systems and internetworking systems, device drivers, diagnostic software and assembly language coding. Successful candidates will have a BS/MS in CS or EE with 4 years' development experience in commercial applications using C and other compilable languages. Dept. SE-SSS.

Opportunities also exist for New Product Purchasing, Quality and Documentation Engineers, and support staff. All applicants must be versatile, tenacious and team players who enjoy the success of directed individual effort towards organizational objectives.

Join a winning team and realize the satisfaction of being a winner. For immediate consideration, send your resume specifying appropriate department code to: BSA Confidential Reply Service, Attn: Dept. (7), 3111 Camino del Rio North, Suite 202, San Diego, CA 92108. All resumes will be held in strictest confidence. Our client is an EOEM/F/D/V. No phone calls, please.

**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!**

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

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

TEST & MEASUREMENT EQUIPMENT



1066 LINDA VISTA AVENUE
MT.VIEW, CA 94043
415-969-1142
FAX 415-969-6579

selling quality reconditioned test equipment for 22 years

- Over 30,000 instruments by 200 + manufacturers
- All fully guaranteed and supplied with standard accessories
- Most equipment can ship within 2 days

Visit our facility to see for yourself our wide selection of test equipment and microwave hardware,

or call us with your requirements

800-442-5835

SEE OUR SPECIALS AD IN THIS ISSUE !

Think

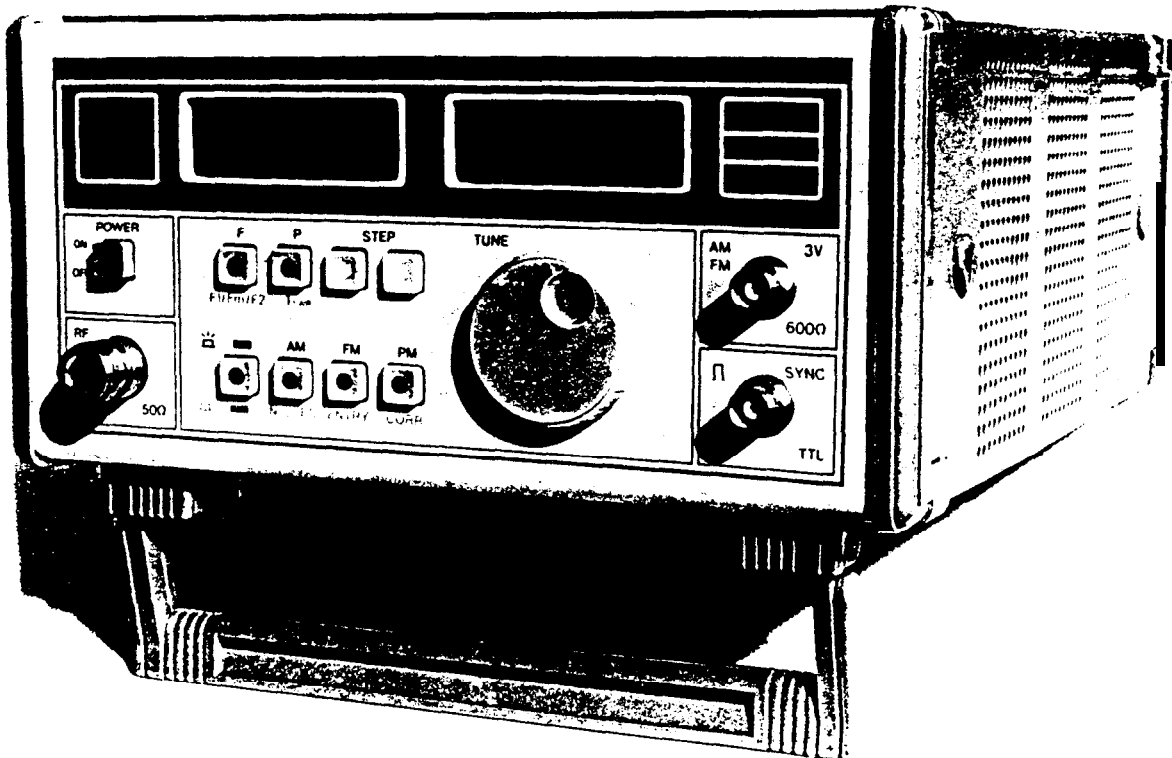
Spread Spectrum!

TEST LAB CO. SPECIALS / 800-442-5835

THE FOLLOWING ITEMS ARE CURRENTLY IN STOCK AT THESE GREATLY REDUCED PRICES, FOR A LIMITED TIME

ENI 603L .8-1000MHz, 3 WATT AMPLIFIER	\$ 1795.00
ENI 601 L .8-1000MHz, 1.2 WATT AMPLIFIER	\$ 895.00
HPC 435A / 8481A POWER METER / SENSOR	\$1250.00
STRUTHERS 502 THROUGH ONE WATT METERS. 2-1000MHz,	
10,50,100,500 WATT RESOLUTION ,NEVER USED	\$ 250.00
EIP 548A/0610MHz TO 26GHz FREQUENCY COUNTER	\$ 5000.00
WAVETEK 2002A 1-2500MHz SIGNAL GENERATOR	\$ 1995.00
FLUKE 8840A/09 5.5 DIGIT TRUE RMS MULTIMETER	\$ 695.00
HPC 141T/8555A .01-18GHz SPECTRUM ANALYZER	\$ 3995.00
ENI 240L 20KHz-10MHz, 40 WATT AMPLIFIER	\$ 2150.00
HPC 8660C/86603A/86632B 2600MHz SYNTHESIZER	\$ 6500.00
PHILLIPS 6654C/526 DC-I .5GHz UNIVERSAL COUNTER	\$ 1200.00
HPC 8405A VECTOR VOLTMETER	\$ 2495.00
HPC 53310A /001/030 MODULATION ANALYZER	\$ 7300.00

Have you subscribed yet?



DORADO INTERNATIONAL CORPORATION

Models G4-196, G4-197 & G4-198

Microwave Sweep/Signal Generators -- Priced from \$2800 -- 2 to 18 GHz

Tel: 206-583-0000 -- 270 So. Hanford St., Seattle, WA 98134 -- FAX: 206-583-0345