SPREAD SPECTRUM SCENE

Happy Holidays

Volume 1 - Number 8

November/December, 1992

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The Wireless LAN, PCS and Advanced Digital Communications
Monthly News Magazette

Special Year End November/December Issue: *It was a very good year!*

Photo thanks to the San Francisco Examiner

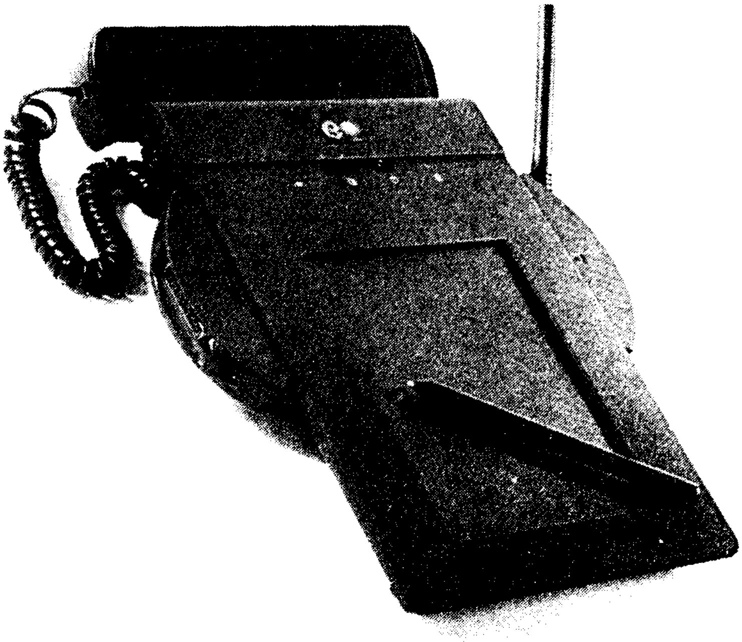

Photo thanks to PC World, Dec. 1992

Apple's Newton (Left)

Apple may not be saying much about the Newton, but the photo above shows John Sculley holding a prototype unit. See "Wireless PDAs" story on page 6 for more information and details.

EO's Hobbit Based PDA

EO, a well funded team of ATT and Fujitsu, has also been quiet until very recently. Their Hobbit based pen input, PDA., shown above, is further described on page 6.

Spread Spectrum Scene
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Seasons Greetings

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

SSS provides a forum for publication of technical information, advertising, editorials, opinions, and news relating to the emerging fields of our coverage and emphasis. SSS is read by over 6000 technical decision makers each month. SSS can present your advertising message to the key designers, programmers, system integrators and end users in this new industry. Call our 800 number Hotline to request a Media Kit.

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Rumors & Ramblings

- Local Area Telecommunications Inc. (LOCATE) awarded an initial contract to Qualcomm, San Diego to supply CDMA technology and equipment for PCS applications at 1850 to 1900 MHz, in New York and New Jersey.
- AT&T awarded a development contract to M/A-Corn Inc. for PCN equipment at 5.7 GHz.
- Matsushita Electric Industrial Co. will start manufacture of "the world's first personal communicator -- a pocket cell phone, fax machine and pen based computer. They will also join with AT&T and Marubeni Corp. to acquire a stake in EO Inc.. Mountain View, CA.
- Nokia and Kansai Digital Phone will introduce a handheld phone to Japan operating in the 1.5 GHz frequency range. The first cellular network using these new radios will be in Osaka, Kyoto and Kobe. This gives Nokia its first piece of Japan's cellular market.
- Heard a good rumor -- want to "leak" some info to your competition -- call our 800 number and we may print it!

Decipherings

THE ANSWER IS SO CLOSE TO US
THAT WE CANNOT SEE IT.
LOOK TO THE PRESENT.

- Dhiravamsa -

EDITORIAL

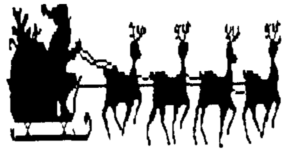
It was a very good year!

SSS and RF/SS had a very good year in 1992 -- we hope your year also brought success and at least some stability. In these troubled economic times. not everyone or even many companies are having good years. Everyone blames the election. the economy, the environment, competition. the government or whatever their favorite complain: happens to be.

Of course, in our competitive marketplace not everyone can be successful -- some are winners / some must end up loscrs. Howe\-sr. in a field as exciting as SS currently is, there is just no excuse for grousing about lack of success. The economic opportunites and technical challenges abound in this wide open field!

We do not mean to brag. but in nine short months, this "Magazette" has gone from a hurriedly put together, 4 page little newsletter to what you see in the this and the previous issue: a maturing, moderately successful, commercially viable piece of written communication on one of our favorite subjects. Our consulting practice has also matured to the point where we are very busy -- we still want more work, but we will carefully choose it.

Many of you may ask why we are not moving with the crowd -- some of you may even have thought wc would certainly fail in our endeavors. Let me just add: ***A successful person or organization is easy to spot -- they do something, the other talks about doing something!***



Seasons Greetings

Spread Spectrum Scene

Wishes all of its readers a great Holiday Season and a wonderful New Year!

May success and profit come your way in 1993!

Randy Roberts

The Aerial

by Peter Onnigian, P.E., W6QEU

In last month's column we went through the process of gain reference, and tried to clarify dBi and dBd antenna gain references. The number in dBi is 2.15 dB higher than the gain of the same antenna expressed in dBd.

This month's column discusses antenna construction and performance for antennas operating between 100 and 1,000 MHz, used for spread spectrum, WLAN, wireless alarms and other applications. This discussion covers the Yagi type of parasitic antenna invented in 1926 by Prof. Yagi and Prof. Uda in Japan.

ANTENNACONSTRUCTION

The construction quality of these antennas varies with its price! Most of the better quality antennas use 6061 -T6 alloy aluminum elements and booms. To eliminate inter-modulation problems and electrical noise creation, the contact between the parasitic elements and the metallic boom is either insulated or welded. They should never be bolted or riveted together. Some firms use a plastic boom, which also eliminates this problem.

Most good Yagis are designed using computer software programs which are readily available. Designs are possible for maximum forward gain, best front to back ratio, best VSWR for a given bandwidth, and of course compromise designs.

Construction of the elements vary from solid relatively soft alloy welding-rods of small diameter to tubes of one half inch diameter and larger. The larger tube reduces the length to diameter ratio, increasing gain and VSWR bandwidth performance. Booms are square, round, and sometimes of plastic.

Most of the cheaper antennas available use the common unbalanced gamma feed method in the driven element. This is fine for the smaller (number of element) antennas, but produces pattern skew, feed line radiation (and pickup) and distorts beamwidth.

The patented new balanced double gamma feed eliminates these problems by feeding the un-split driven element with equal power, 180 degrees out of phase, at its electrical center.

The advantages of the balanced double gamma feed include a natural non-frequency sensitive balun, and slightly higher gain since the feed mechanism itself does not radiate. Only the driven element radiates, producing side nulls approaching computer calculated values, excellent VSWR, and a non-skewed pattern. The feed line does not radiate because of the near perfect balun, which is an integral part of the gamma feed system. The non-radiating feed-line has some obvious advantages over the conventional simply (and cheap) old fashioned unbalanced gamma, which feeds current to one side of the driven element, while the other side is parasitically excited. The excellent balun eliminates RF pick up from the outside of the coax line, which may pass close to electrical noise generating sources, such as computers, printers, duplicators, HVAC, florescent lighting, etc.

CONNECTORS

C0mm0n amateur practice is to use UHF type connectors 0n coaxial transmission lines. UHF connectors are very poor for use at these frequencies for several reasons. They arc not weatherproof. Letting in water or moisture in the shield produces corrosion on the conductors, which increases the RF loss, but improves the VSWR!

These relatively cheap connectors are available with teflon insulation, and some firms even silver plate them. But these "improved versions" do nothing to better the long term performance, due to moisture ingress. Amateurs have used them for decades when they first came out in the 40's. They are not even useful for indoor use because UHF connectors arc not 50 ohms. There arc no military or EIA specs for their electrical performance, s0 their performance varies depending on make and model.

TYPE N

This is the connector of choice for this frequency range and application. They maintain 50 ohm impedance and have two gaskets to keep moisture out. One is inside the male connector and another is placed around the cable jacket. Wrapping them with tape is not at all necessary, if they are properly assembled on the cable.

The N connector is five to six times more expensive than the UHF, but meets close mechanical specs in order to maintain 50 ohm impedance. Adapters are available to fit RG-58 size cables instead of the more popular RG-8 size. N connectors are also available for 75 ohm impedance.

This is a smaller diameter connector and also carries a military spec number. It is 50 ohms, and waterproof. However it was meant to be used indoors where mechanical abuse is not present. This connector maintains an excellent 50 ohm very low VSWR pass through.

The BNC connector has a bayonet feature for connection with 1/4 turn and then locks. This connector is quite similar to the N when it comes to installing either a male or female cable connector. Suitable cables are the RG-58 size, such as RG-142 and RG-303 series.

The BNC is popular in industrial and domestic wireless alarm systems because the outer cover can be removed on the male cable end. This reduces the OD of the cable to about 0.30 inches for easier insertion through ceilings, walls, etc.

Cover Story

The Latest Wireless PDA's

by Randy Roberts

The latest harvest of wireless PDAs (Personal Digital Assistants) is in. Our cover showed photos of Apple's and EO's latest entries. Wilmette, Illinois based Telular Group L. P. also recently announced a cellular phone based wireless data radio/modem. Motorola is advertising its EMBARC Wireless E-Mail system, again using tariff based cellular phone technology. *Arc these guys really serious?*

How can anybody try to peddle another rehash of ARDIS or similar cellular telephone technology to 3 market that is ripe for cutting the umbilical with "Ma Bell'?" Most potential wireless customers have no intention of paying by the minute or by the page for Local, Metropolitan or Wide Area wireless data services. Certainly they don't want to pay for these "last mile" hook-up charges. Do they have a choice'?

We think they do -- use real technology: Spread Spectrum! Throw away your outdated AMPS/NAMPS FM/TDMA analog with digital kludge radios. Get with today's technology. Spend some of your cash and develop spread spectrum systems that offer a viable alternative to pay by the minute cellular technology. Get with the PCN/PCS program -- build us some data communications infrastructure using spread spectrum, VSATs and cellular alternatives.

Technical Trends in Education

by Tom Diskin

Technical Trends In Education

The Career-Technical Assessment Project

There is a new movement taking place in the nation's schools these days. It addresses the question, "When 'college prep' has taken its 'slice' of the high school graduating class, what happens to the rest of the class?" For many years, these students have had no specific direction, although many have gone on to trade, technical or vocational occupations. Called "Tech Prep", this new plan specifically tracks students who choose a technical career path or at least prepares them for the technology they will be expected to use in today's world.

In California, Tech Prep is an important part of current high school restructuring efforts. Many high school electronics instructors have or will be involved in the planning and teaching of Tech Prep curriculum. Even at the 2-year community college level, Tech Prep is considered a part of the curriculum offerings under the new Perkins Act. Tech Prep prepares students with skills and competencies necessary to meet employer's performance standards for entry jobs and later career advancement. Tech Prep also links high school curriculum to a 2-yr college to produce skilled technicians responsive to changes in technology.

The California Department of Education is developing a "new vision" that will radically change the way high schools throughout the state are structured. Several coordinated efforts are defining the new vision. Prominent among them are the report of the 75 member High School Task Force which was charged with proposing an overhaul of high school structures and practices and the newly enacted statewide assessment program.

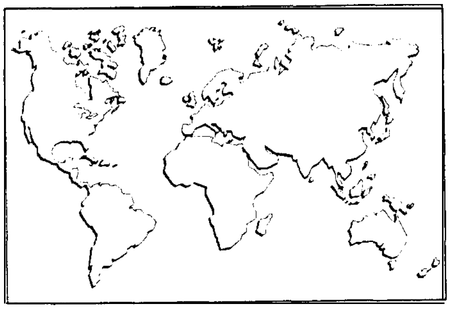
A key feature of the restructured high school is an integration of curriculum for all students. Traditional barriers which prevented teachers across disciplines from collaborating in planning, teaching and assessment activities will be removed. Students must be prepared to achieve at world-class levels, to graduate from high school as "self-motivated, competent, and lifelong learners", equipped with the knowledge and skills to make decisions about career options.

The California plan calls for students to graduate from high school with "an individual record of accomplishment." The key feature of this record will be the student's results from the revised assessment program. This will consist of:

- grade 10 high school performance tests in English/Language Arts, Mathematics, History, Social Science and Science;
- end-of-course exams; and
- career-technical certification assessment

Each of these components of the revised statewide assessment program is geared for all students, not just for "traditional" college-bound or vocational students. Collectively, they measure important skills and knowledge in a coordinated (integrated) fashion. Taken together, they present a picture of a high school graduate that truly represents a record of accomplishment that can be presented to a post-secondary institution or a prospective employer.

All components of the plan assess content, career-performance, and academic standards in an integrated format. To ensure that these standards are appropriate for a performance-based certification system, each discipline area has revised its model curriculum standards to consist of a cognitive and behavioral component. The career performance standards represent workplace readiness skills which cut across all career paths (e.g., problem solving, group interaction). Academic skills are included as they are needed to perform a specific task (e.g., trigonometry needed for construction activities; biology for a plant science or animal science experiment).



International Scene

● A study group set up by Japan's MPT (Ministry of Posts and Telecommunications) expects to issue a report on how Japan should deregulate it's cellular telephone industry. Under current regulations you can only lease cellular phones from the telephone system operators. Reports from ministry officials suggest that fees may go down as much as 5000 yen if phones were competitively available for purchase.

Beginner's Box

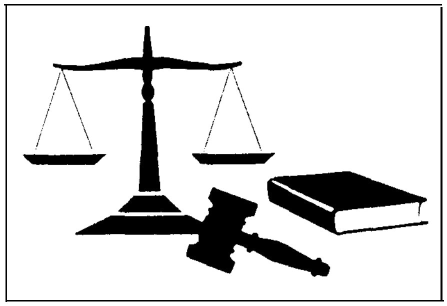
CONVERSION OF POWER (dBm TO MILLIWATTS)

Power (dBm)	Milli-Watts	Power (dBm)	Milli-Watts	Power (dBm)	Milli-Watts
-40	.00010	-13	.0501	15	31.623
-37	.00019	-10	.1000	17	50.119
-35	.00032	7	.1995	20	100.00
-33	.00050	-5	.3162	23	199.53
-30	.00100	-3	.5012	25	316.23
-27	.00200	0	1.000	27	501.19
-25	.00316	3	1.9963	30	1.00 w
-23	.00501	5	3.1623	33	1.99 w
-20	.01000	7	5.0119	35	3.16 w
-17	.01995	10	10.000	37	5.01 w
-15	.03162	13	19.953	40	10.00 w

ALLIS ASSOCIATES (408) 252-2883

● **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!***

See you at the "Wireless" show in January



Washington Scene

● On December 10, the FCC proposed opening another chapter in the Cable TV wars. This time, they intend to authorize advanced 41 to 49 channel "Wireless Cable" MMDS type service in the 27.5 to 29.5 GHz frequency range. Already used in field trials in New York City, CellularVision's technology uses a cellular telephone-like network of transceivers to provide local, almost block by block coverage. The FCC may authorize full scale system development by next summer and open up **489** local service areas around the nation. New licenses for operating the local systems would be awarded on a lottery basis. Here we go again -- *another cellular or SMR lottery boondoggle!*

● AT&T Company plans to buy a 33 percent stake in McCaw Cellular Communications, based in Kirkland, Washington for $3.8 billion. The pact would put AT&T back in competition with the regional Bell companies for the first time since the 1984 breakup of the Bell system.

● Pacific Telesis (aka Pacific Telephone and Pac Bell) plans to break into two separate corporate entities. This will allow it to provide long distance service in a deal with MCI and provide even more service for it's currently more than 33 million cellular telephone customers. By the way, the split allows Pac Bell to circumvent "little things" like California's PUC and the 1983 Judge Green breakup of the Bell system. *Hmm -- it looks like if you have enough money, you can flaunt any old regulations!*

● *Now* that the election is over and our new President-elect is out there beating the bushes and trying to find people to fill all those Washington jobs -- how about picking an *Electronics or Radio or TV Engineer* to sit on the commission at FCC? What do you say, Bill? ***It's about time technocrats had a sav, not lawyers!***

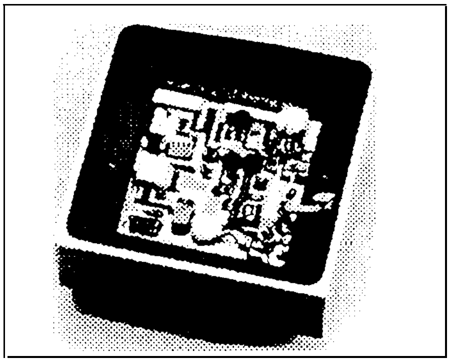
DSP
for Spread Spectrum
by Matthew Johnson

Matthew's column will not appear this month -- sorry about that!

Have you seen the new ***HDTV* NEWSLETTER,** yet? Published by Advanced Television Publishing, A Cripps Communications Company, 753 East Fall Creek Road, Alsea, Oregon, 97324. Tel. (503) 487-4186, FAX: (503) 487-4187. Good luck, gentlemen.

Ever think about writing an article for SSS?

New Products



ST MICROSONICS ANNOUNCES NEW LOW PROFILE OCXO

Model TK802, hybrid ovenized oscillator, operates over 50 to 100 MHz frequency range with temperature stabilities of +/- 0.05 pprn over -20 to +70 degrees C. Fast warm up time (less than 5 minutes) achieves 5 x 10^{-8} stability with +28V at 250 mA heater current. TK802 has phase noise performance of -135 dBc/Hz at 1 kHz and - 155 dBc/Hz at 10 kHz. Standard output power is +7 dBm minimum; higher output power is optional. The low profile package is 2" x 2" x 0.75", hermetically sealed and will meet MIL-STD-883 fine leak requirements. Price is $790.00, l-9 quantity, delivery: 6-8 weeks, samples available. Contact: Mr. Ken Lambert, ST Microsonics Corp., 60 Winter St., Weymouth, MA 02188, Tel. (617) 337-4200, FAX (617) 337-4208.

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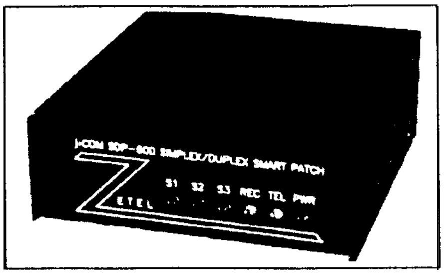
j-Com Model SDP-600 Autopatch

The new j-Com Model SDP-600 autopatch is a low cost microprocessor controlled



interface between a VHF/UHF transceiver and a telephone line, allowing the user to make and receive telephone calls from any HT or mobile rig within range of the base station.

Control and programming of the autopatch is done by DTMF tones issued from the remote. The shielded metal enclosure SDP-600 measures 4.6" wide by 1.6" high by 5.05" deep and is manufactured in the United States by Zetel exclusively for j-Com. The introductory price is $199.95. Contact: j-Com, Box 194, Ben Lomond, CA 95005, Tel. (408) 335-9120, FAX (408) 335-9121.

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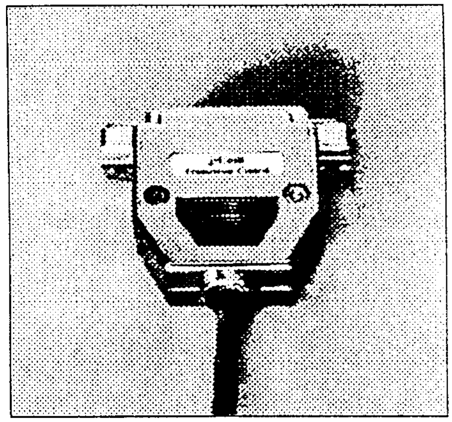
j-Com Transceiver Control Computer Interface

j-Com has also introduced a line of Transceiver Control Computer Interface cables designed to interface Personal Computers with all receivers and transceivers which have the ability to be controlled over a serial TTL link.

Unlike the interfaces supplied by the manufacturers, the j-Com interface cable requires no external power supply. The unit requires only 3.5 mA of total power for the Icom and Yaesu models, and 6 mA of power for the Kenwood version. This small amount of power can be



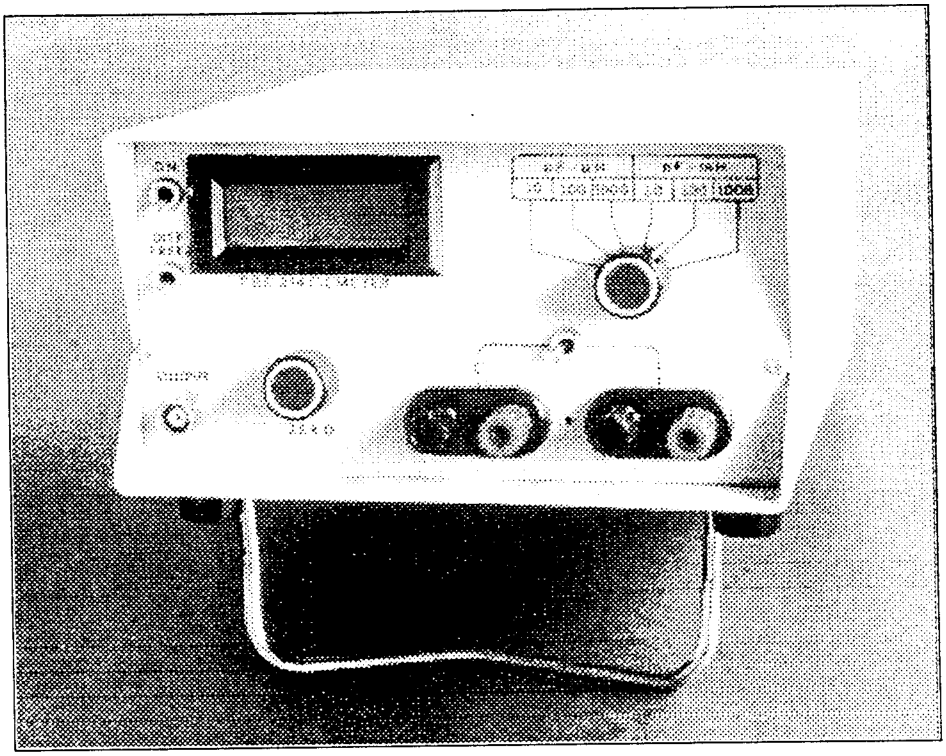
"borrowed" directly from the computer's serial interface.

The entire interface has been sandwiched into the shielded hood of a DB-25 connector compatible with the serial interface of most PC compatible computers.

All four models are priced at $54.95 (plus $5 shipping and handling). Contact: j-Com, Box 194, Ben Lomond, CA 95005, Tel. (408) 335-9120, or FAX (408) 335-9121.

EQUIPMENT CORNER

by Chris Kilgus



I recently started a new job as an RF Design Engineer. One of the first things I had to do is set up a lab. The company had the basic stuff; o'scope, meters, etc. But, the RF test equipment was all going to have to be acquired. I am going to describe some of the experiences I have had, and do equipment reviews in a series of articles that will be in SSS in the next few months.

This month will be an equipment review on an LC Meter. In most RF work, one will be dealing with small values of L and C., typically going down to 1uH and 10 pF. There is plenty of equipment around from the big guns like HP and Fluke that will resolve these readings, but they are in excess of $1500. In the low end there are a few units, including some DVMs that have a capacitance range. I in fact bought a B&K model 878 LCR meter for $275. It was pretty good, especially on capacitance, being able to resolve to 0.1 pF. But, I needed more inductance resolution than a minimum reading of .1uH. I wanted to know if a coil was .120, .165 or .183 uH for example. The B&K would read .1 or .2 for that range of values.

Don't get me wrong. The B&K is still a good instrument. It has many features that would be useful in a production environment such as bin sorting, autozeroing, and a tolerance mode. The tolerance mode beeps when a component is outside a specified range to allow rapid inspection of production parts. It remembers minimum and maximum values and has a useful resistance range.

The problem with the B&K and other inexpensive LC meters is that they use a low test frequency, usually 1kHz. Recalling the formula for impedance in an inductor, $XL = 2\pi fL$, assuming a frequency of 1 kHz, a .1uH coil would be .000628 ohms -- hardly enough to work with.

I was referred to a small company in New York, TBE electronics. They have a line of LC meters, The model 2 14 for $345 had very impressive specs and one was ordered.

Their meter uses a phase detector circuit. Other meters use techniques that are subject to errors from leakage currents. The minimum readings are .001 pF and .001uH. One hundred times lower than the B&K. Basic accuracy is an impressive 0.3 %. The B&K was anywhere from .7 to 10 % depending on the range.

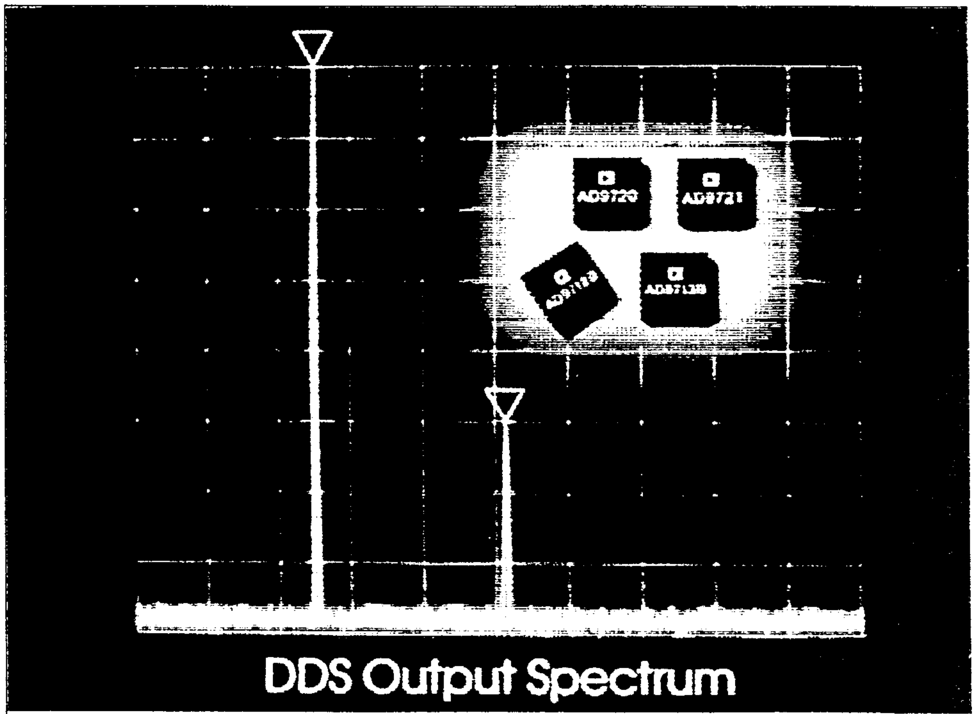
The TBE 2 14 uses a 1 MHz test frequency on the lowest ranges. Using our example from before, the inductive reactance of the .1uH coil would be .628 ohms.

Operation is straight forward. Select either L or C and the range. You must manually zero the unit before each measurement. This is perhaps the only downside to the instrument. TBE said that they elected to not have an autozeroing feature to keep the cost down. Zero the meter with open connectors in the C mode and with the supplied shorting block in the L mode. Dialing in the zero with the multi-turn pot takes a little patience. A +/- tuning indicator would be helpful. The unit is well built and ruggedly designed. I leave mine on all of the time. TBE has an excellent warranty, 3 years on the instrument, 1 year on the calibration and a 30 day money back guarantee.

I have tested a multitude of components. Measurements were accurate and consistent. I found the instrument particularly useful in a recent project. A computer designed filter called for 15 pF caps and .68uH coils. With a goal of developing a circuit that would not need tuning in production, one could specify 2 % coils, which are readily available in SMD from Coilcraft, and precision capacitors. The circuit was breadboarded using variable caps and 2% coils. It was then tuned for optimal performance. The caps were then removed and measured on the LC meter. Fixed caps were substituted in the circuit and performance verified. The cost of test equipment, trained personnel and time in production would greatly exceed the price for precision components.

Since the unit measures such low values, it is possible to use it to verify pc board layouts for microstrip applications. TBE is developing a new unit that can measure picofarads at the end of a 4 foot coax. This would allow any test fixture to be attached and zeroed out. The projected price of this unit is $500. They also supplied me with a prototype of a SMD test fixture. The fixture uses pins that can punch right through and measure components still in tape reels. The fixture is only $65 and is quite a bargain.

TBE has done a great job getting lab grade test equipment on the market at an affordable price. TBE can be contacted at: TBE Electronics, 442 Cass Hill Rd., Candor, NY 13743, phone 607-659-3030.



Analog Devices' AD9712B, AD9713B, AD9720, and AM721 are the industry's fastest 10- and 12-bit DACs designed specifically for DDS.

INDUSTRY'S FASTEST 10- AND 12-BIT D/A CONVERTERS OPTIMIZED FOR DIRECT DIGITAL SYNTHESIS

NORWOOD, Mass. -- Analog Devices, Inc., has announced four of the industry's fastest 10- and 12-bit monolithic silicon digital-to-analog (d/a) converters designed specifically for direct digital synthesis (DDS) applications such as communications and instrumentation. For design flexibility, both ECL- and TTL-compatible input versions are offered in either resolution. Two 12-bit converters, the AD-9712B (ECL) and AD9713B (TTL), operate at encode rates of 100 MSPS and 80 MSPS, respectively. The IO-bit d/a converters, AD9720 (ECL) and AD9721 (TTL), operate at corresponding word rates of 400- and 100-MSPS.

In addition to setting a new speed performance benchmark, the four converters do not compromise either ac or dc performance. The AD9720 and AD 9721 guarantee low 1.5 pV-s glitch impulse, 4.5-ns settling time, 1,000 V/us slew rate, and 75 dBc spurious-free dynamic range (SFDR) for 2.02-1MHz signals sampled at 100 MSPS. Glitch impulse and settling time increase slightly for the AD-9712B and AD9713B to 28 pV-s and 27 ns, differential nonlinearity is typically 0.5 LSB. SFDR is 72 dBc for 5.055-MHz input sampled at 20 MSPS. Designers working in frequency- or time--domain applications will find these converters attractively priced and easy to use. Evaluation boards, available to examine functional parameters, reduce design-in problems. Maximum power dissipation for the AD-9712B and AD9713B is 800 mW, increasing to 1.1 W for the

AD9720 and AD9721. When compared with alternative solutions operating at equivalent word rates, Analog's TTL-compatible versions can effectively decrease system power requirements as these speeds could only be achieved by employing ECL-compatible D/A converters and interfacing them to TTL-to-ECL translators (that add considerable power consumption to the circuit).

Pricing in 100's for the AD97 12B and AD97 13B begin at $35; AD972 1 and AD9720 prices begin at $40 and $79 in 100's, respectively. Delivery is from stock.

Contact: David Buchanan, Analog Devices, Inc., 79 10 Triad Center Drive, Greensboro, NC 27409, 919/668-9511. For Applications Assistance; FAX requests to 6 17/82 1-4273.

ANALOG DEVICES

Application Note 237 Summary

Choosing DACs for Direct Digital Synthesis

by David Buchanan

INTRODUCTION

Direct Digital Synthesis (DDS) is a technique for deriving, under digital control, an analog frequency source from a single reference clock frequency. This technique provides high frequency accuracy; temperature and time stability; widcband tuning; and very fast, phase continuous frequency tuning. The performance of synthesizers using this technique is often limited by the performance of available (DACs). This application note explains the basic architecture of DDS and some of its advantages in system design, and outlines some of the performance characteristics designers should look for when choosing DACs for DDS applications. Performance trade-offs are also explored, and recommendations are made for characterizing the DACs.

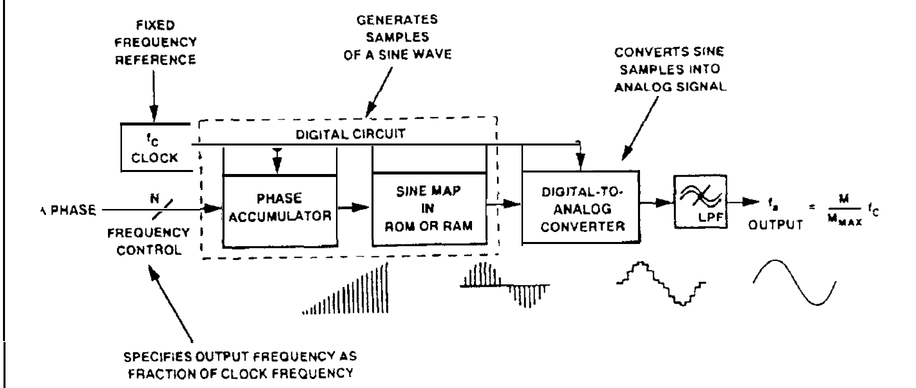


Figure 1. Block *Diagram of DDS Generator*

DDS BACKGROUND

A simplified block diagram of a direct digital synthesizer is shown above. The synthesizer has two digital inputs: a frequency control word (Δ Phase) and a reference clock signal (fc). The output of the synthesizer is an analog sine wave with frequency fa The relationship between fc and fa is determined as:

$$fa = [(\Delta \text{Phase})/2^N]fc$$

Where N is the resolution of the frequency control word, Phase.

As illustrated in the figure, the circuit is easily divided into three blocks: a phase accumulator, a phase-to-sine converter, and a DAC. The first two blocks are both digital circuits. The phase accumulator is simply an adder with a programmable step size, Δ Phase, representing the phase step taken by the output waveform during each clock cycle. On each clock cycle, the phase accumulator output represents the phase of the output sine wave, with all zeros representing 0 radians, and all ones representing 2π radians. This signal is a digital ramp with a frequency equal to the output sine wave.

The phase-to-sine converter circuit takes the M most significant bits of the phase accumulator's output and provides an M-2 bit sine amplitude output; M-2 deter mines the resolution of the circuit to follow, usually a DAC. Truncation of the N-M least significant bits is necessary to reduce the complexity of the phase-to-sine conversion. This function may be performed by a look up table stored in memory, or the sine value may be calculated from a digital algorithm to make a faster or smaller circuit.

The phase accumulator and phase-to-sine converter together form a DDS system with a digital output. The digital output is useful in many applications as a frequency reference (digital demodulation as an example), but most applications require a transformation of the digital sine wave into an analog frequency reference. This makes the digital to analog converter extremely important.

DDS PERFORMANCE CHARACTERISTICS

DDS has both advantages and disadvantages over other frequency synthesis techniques such as phased locked loops. While it is not the intent of this paper to explore fully the tradeoffs of choosing DDS architecture for a synthesizer, it will point out some of the more obvious ones and discuss the important performance characteristics.

A DDS system effectively provides a frequency reference that is a fraction of the clock input frequency. The DDS is digitally tuned by the Δ Phase input, usually controlled by a micro-controller or digital signal processor. Once the digital data are registered on board the phase accumulator, the controlling circuits are free to perform other functions in the system. The digital nature of the DDS eliminates the inconvenience associated with the "tweaking" of synthesizer designs that rely on analog component values to determine frequencies.

The frequency resolution is determined by N, the resolution of Δ Phase, as:

$$(1/2^N)\ fc$$

As an example, if the DDS clock reference, fc, is 20 MHz, and N = 32, the frequency resolution of the synthesizer will be 4.66 millihertz (mHz). This is an advantage over phased locked loops, in which the reference frequency directly determines the frequency resolution and must be large enough to avoid large multiplication ratios.

DDS TECHNOLOGY TODAY

As in other digital circuits, the phase accumulator and phase-to-sine conversion circuit designs must be optimized for cost and power. The DAC design must also address power and cost concerns, but dynamic performance of the converter is of premium consideration.

There are CMOS digital devices available that provide DDS solutions for clock rates up to 100 MHz. A few bipolar devices cover clock frequencies up to 300 MHz, and there are also GaAs devices that provide digital solutions up to 1.4 GHz clock rates.

Most DACs used in DDS are bipolar, although a few GaAs DAC designs see service in the higher frequency applications. Designers prefer monolithic DACs to keep the cost of the converter reasonable. Some 12-bit monolithic DACs can clock up to 100 MSPS (AD97 13B), while higher speed applications can take advantage of monolithic 10-bit designs that clock up to 400 MSPS (AD9720). Above 400 MSPS, there are a few 8-bit devices. As a later section of this paper will point out, resolution and speed of a DAC do not always determine the DAC's suitability for DDS applications.

ADVANTAGES AND DISADVANTAGES

While the available clock frequencies described above indicate that DDS circuits can generate output frequencies well into the UHF band, in practice the frequency range of a DDS system is limited by the real world characteristics of the DACs . . .

For the complete text of this application note contact: Analog Devices.

January SSS Preview

New: **"A Tale of two Chips," compares Motorola's MC13176 to Pacific Monolithic's GaAs cellular phone chip, for use at 900 MHz.**

Intreresting: **More on DSP, HDTV, The Aerial and our other regular features.**

Tutorial: **The long awaited continuation of Technical Tricks -- this time with the scoop on correlators.**

News. **Latest news on Spread Spectrum regulatory, new products and market developments.**

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A 16Kbs Full Duplex Spread Spectrum RF Data Link -- Part 2

by Dan Doberstein, President
DKD Instruments

Code Lock Circuitry

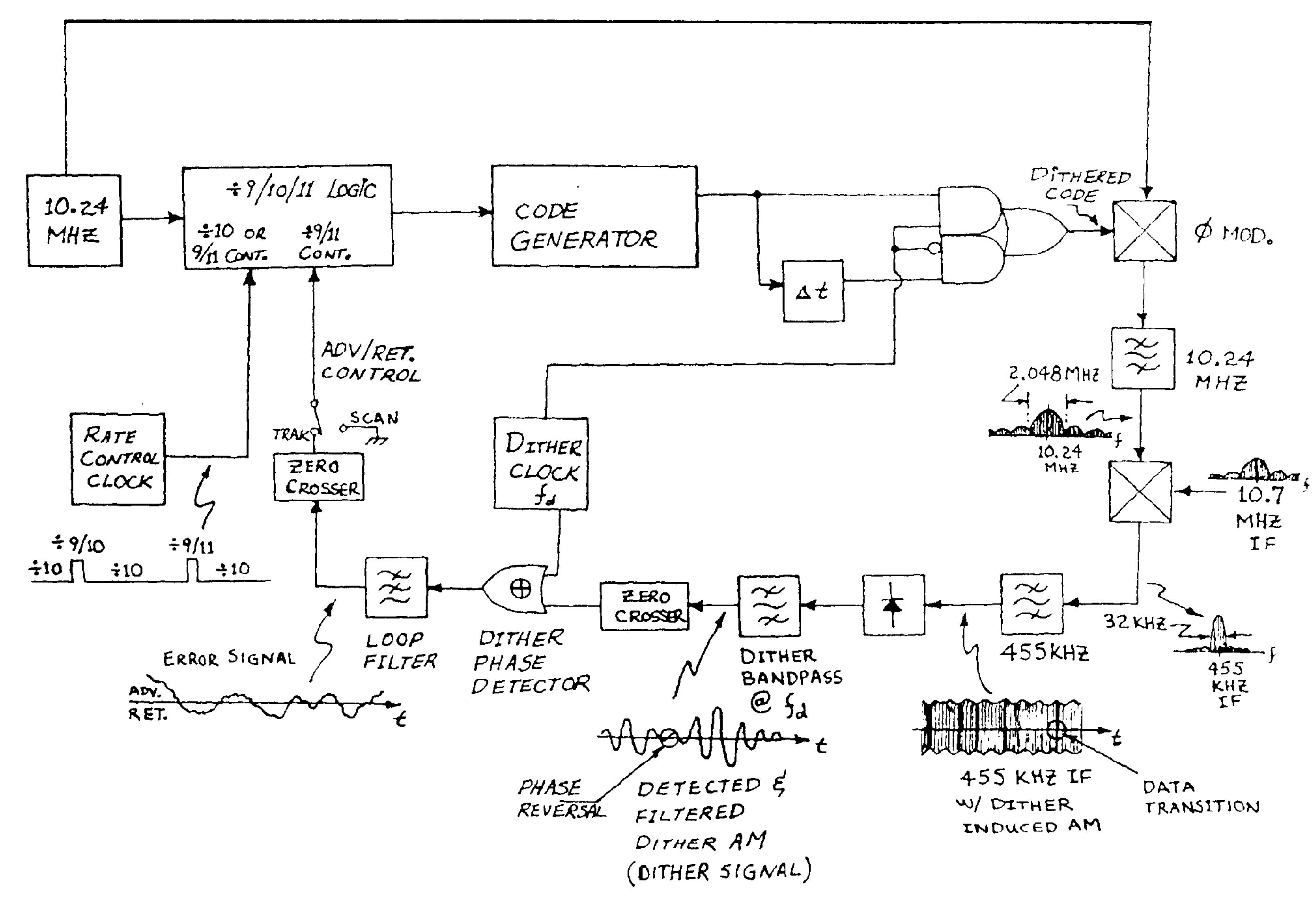
Last month we covered the overall system. This month we focus on the code lock circuitry. The code lock systems job is to keep the receivers code locked or correlated with the transmitted code. The technique used is a modified Tau Dither system. Referring to the block diagram we see the 10.24 Mhz clock is modulated by the divide by 9/10/1 1 circuitry before it is passed to the code generator. The divide by 9/10/1 1 block serves the same purpose as a VCXO code clock in a conventional Tau Dither circuit.

The divide by 9/1 O/l 1 provides the mechanism to modulate the code clock so as to keep the receivers code locked to the transmitters. This circuit sends most of the time in the divide by 10 state. When a rate clock pulse is detected the 10.24 Mhz clock is divided by 9/1 1 for one cycle. The net effect is that for every rate pulse one input clock pulse is added or subtracted depending on the 9/11 input. The rate control input functions as a gain control point. The higher the rate clock frequency the higher the gain for a given ADV/RET command. Lower rate clock frequencies result in slower reaction to ADV/RET commands. Jitter during code lock will always be +/- 1/10 of a chip because of the discrete nature of the clock modulation.

Modulated code clock is sent to the code generator. The output of the code generator is split with one path passing through a delay element. The dithered code is created by toggling between the delayed and undelayed versions of the code. The rate of toggling is set by the dither clock.

The dithered code is used to phase modulate the 10.24 Mhz clock which here is used as the 2nd LO. The modulated LO is then bandpassed to bandlimit the resultant wide band signal. The LO is now mixed with the rec-

CODE SYNCHRONIZER USING TAU DITHER



eived signal which creates the 455 Khz IF. The spectrum shown for the 455 IF assumes code lock. If the codes are not locked the 455 IF would just be noise. The despread 455 IF still has the data modulation on it so its bandwidth is about 16Khz.

In addition to the data phase modulation on the 455 IF there is Amplitude Modulation induced by the dithering process. The dither induced AM is itself phase modulated via the correlation process. In order to keep the receivers code locked this AM signal must be recovered and processed to provide the error signal used to drive code misalignment to zero (+/- 1/10 chip). After bandpassing and detection we now have the desired AM component, the dither signal. A bandpass centered at the dither frequency is used to separate the dither AM signal from other AM signals which may be present on the 455 IF. The output of the band pass is hardlimited via the zero crosser and passed to the Dither Phase Detector. This process ignores the amplitude information contained in the dither signal and concerns itself only with the PHASE information. This is a simplification of the text book Tau Dither technique where both the phase and amplitude of the Dither signal are used. This is possible since the phase modulation on the dither signal contains the code advance/retard information while the amplitude of the dither signal contains the "how much" information. In short the circuit disregards the amplitude information present in the dither signal and uses just the phase information to maintain code lock. This simplification has a price in that higher SNR's arc needed to maintain and obtain code lock.

It is easy to get confused here with all the modulations present. Remember the 455 Khz IF has the 16Kbs Biphase modulation on it and the dither induced AM is itself Biphase modulated. These two Biphase modulations are separate and distinct from each other and can be processed independently from each other as done here.

The phase of the dither signal is recovered by using an EXOR gate and comparing with the dither reference clock. The signal is low passed using the loop filter. The filter serves as an averager. This filter in large part determines Lock range, Pull In range, Steady State code alignment error and the general dynamic behavior of the closed loop code tracking process. After zero crossing detection the signal is passed to the divide by 9/10/11 circuit. The signal out of the loop filter is also a measure of code clock frequency offsets between the transmitters code clock and the receivers code clock. If the offset is zero, i.e the code clocks are exactly the same frequency, the average value of the error will be exactly zero, or equivalent zero bias DC value. If the frequencies are not equal, the usual case, the error signal will have a non zero average value. Depending on the circuit you could run out of "headroom", hit your voltage rails, and break lock. This imposes a limit on the amount of code clock offset allowed between transmitter and receiver code clocks. It should be noted that the high dynamics from excessive frequency offsets can itself lead to failure to obtain or maintain lock.

We have closed the code tracking loop and only have the TRACK/SCAN switch left to explain. This switch is controlled by the carrier detect output of the MC3362. When no carrier is present the switch is set to scan which holds the 9/10/11 circuit in the RETARD position for scanning purposes. This switch ensures the searching in one direction as without it a random search caused by noise on ADV/RET control line would result.

That's it for this month, next month we will discuss the CVSD Data Mod./Demod. and the Costas Loop Demodulator.

Beginner's Box

OPTIMUM FRAME SYNC PATTERNS

# BITS	OCTAL	HEX	FALSE-LOCK PROBABILITY
7	540	B0	5.7 E-1
8	560	B8	4.2 E-1
9	560	B88	2.9 E-1
10	6700	DC0	1.8 E-1
11	5560	B78	9.1 E-2
12	6540	B60	5.1 E-2
13	72600	EB00	2.8 E-2
14	71500	E680	1.5 E-2
15	73120	ECA0	8.6 E-3
16	727100	EB90	3.5 E-3
17	746500	F3500	1.7 E-3
18	746500	F3500	8.2 E-4
19	7631200	F9940	3.8 E-4
20	7336100	EDE20	2.2 E-4
21	7361300	EE9600	1.1 E-4
22	7466500	F36A00	4.9 E-5
23	75348400	F5CD00	2.5 E-5
24	78571440	FAF320	1.3 E-5
25	782670400	F86E200	6.4 E-6
26	784664200	FABB100	3.1 E-6
27	785514600	FAD3300	1.6 E-6
28	7536263000	F5E5980	8.8 E-7
29	7536315000	F5E66800	4.1 E-7
30	7657146400	FAF33400	2.1 E-7
31	[illegible]	[illegible]	*

Report on the IEEE "Wireless LAN Implementation" Conference

Held September I 7-I 8, 1992 at Dayton, Ohio

The first annual IEEE conference, sponsored by the IEEE Computer Society was quite a success. It was attended by nearly three dozen "movers and shakers" from government, industry and education. This intimate conference was attended by Mr. Barney Ichikawa of Pacific Monolithics, who provided SSS with a copy of the conference pro&dings. Thanks to Barney we present the abstracts from five of the most interesting papers from the conference. The complete conference proceedings is available from:

IEEE Computer Society
Press Order Number 2625
IEEE Catalog Number
91-75559
10662 Los Vaqueros Circle
PO Box 30 14
Los Alamitos, CA 90720-1264

Individual article reprints are also available, at very nominal cost from the same source. SSS is publishing the following articles for the benefit of our readers who were not able to attend the conference and we acknowledge that all material presented below is the property of the IEEE Computer Society and/or the authors.

Radio-LAN Standardization Efforts

V. Hayes

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Abstract

This paper focus on the standardization of wireless Local Area Networking for computer communications. Following a review of the activities around the world, a more detailed description of the IEEE P802.11 working group is given.

Simplified routing for mobile computers using TCP/IP

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Abstract

We present a new solution to the problem of providing continuous network access for mobile computers using the Intemet Protocol (IP). Our solution is fault tolerant, scales well, is easy to administer, is invisible to applications running either on mobile computers or their servers, and requires no changes to existing systems. Our solution will handle movement between connected networks (e.g., different buildings) without noticeable degradation of performance (except, of course, when the mobile computer user is out of range of any base station). We expect to enable mobility of computers in general, including wired computers.

EFFICIENT USE OF SPACE, SPECTRUM AND TIME IN RADIO LAN

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0 *VERVIEW*

The context is the design of radio systems for widespread use in work-places and public areas with service capacities that are a substantial fraction of that provided with wires. The capacity must bc both for high peak-to-average LAN data traffic and bandwidth on demand virtual connections.

Access method plays as much of a part in determining the efficiency and capacity of a radio system as do radio modulation and available band width Some of the most important factors that enable maximization of total communication capacity within a given geographic area and spectrum bandwidth are now summarized as general principles rather than as implementations.

Frequency space will be a given. The system designer can only define time and space utilization and an approximation of efficient radio transmission technology.

High-efficiency design has been avoided in many existing radio and LAN systems because the underutilization in quick and convenient designs is not obvious. One of the most important aspects of time efficiency is consolidating frequency assignments and traffic loads of unrelated users in a common facility. At a minimum, the peak and average traffic of each group will have different patterns. This is politically difficult because un shared channels are seen as an asset even if their capacity is insufficient for peak need.

The largest sharable pool of resources, and demand-assignment from that pool, is increasingly efficient as the number and types of users increase.

Time-Variant Throughput Versus Delay Characteristics and Communication Reliability of a Wireless Local Area Network

Larry Wasson, Richard Lee, and Allen Rossmiller
U.S. Department of Energy,
Computer Data Systems Inc.

Abstract

Industry introduced wireless local area networks (LANs) to satisfy changing operational requirements, including the provision of flexibility, mobility, and portability. "Wireless" refers to the use of radio frequency (RF) electromagnetic waves radiated through free space as the transmission medium for transferring information between end users in lieu of wire or cable. A performance evaluation was conducted to determine the communications throughput, delay, and reliability characteristics of various wireless LAN test configurations located in and between two high-rise office buildings. The locations of the workstations and file servers, the time of their operation, and the type of architecture and building materials of the office buildings resulted in variable throughputs rather than constant throughputs, as observed in the wired LANs.

A Comparison of High Frequency IC Technologies for Wireless LANs

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Abstract

Commercially available high frequency IC wafer fabrication processes are reviewed for their applicability to low-cost, high performance RF front ends for emerging wireless LAN applications at 2.4 and 5.8 GHz Wafer fabrication cost, yield, integration density, DC power consumption, and electrical performance are compared for GaAs MESFET, GaAs HBT, GaAs HEMT, Si BJT and Si BiCMOS processes. Representative RF block diagrams and key performance and interface requirements are discussed. Applicable FCC regulations, modulation methods, and chip packaging issues will be summarized.

Report on September WinForum Meeting

Again thanks to Barney Ichikawa of Pacific Monolithics we have some information from this important meeting. The Chairperson of WinForum is Ben Kobb, who can be reached at (703) 715-6165. WinForum is a professional association of companies that are setting interim standards for wireless networks.

One of the working papers from the meeting was promulgated for comment. The abstract of this IEEE 802.11 paper is presented below.

Document: IEEE P802.11-92/106

Wireless Access Method and Physical Layer Specifications

Title: Mixed Bandwidth Dynamic Listen Before Talk (DLBT) analyses

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Abstract

This paper gives an analyses of the medium sharing characteristics of Dynamic Listen Before Talk (DLBT) as it is currently under discussion within the Packet sub-group of Wintech. The objective of this industry group is to propose FCC rule making by specifying an Etiquette to allow co-existence between different dissimilar systems. An interference analyses is done based on the power limits as suggested, and a selected Defer Threshold. In particular the impact of unchannelized mixed bandwidth systems is addressed.

It is argued that DLBT approach- does not work with mixed bandwidth overlapping systems.

Report on "THE WIRELESS DATA CONFERENCE AND EXPOSITION"

Held October 13-15, 1992
Santa Clara, California

Thanks to Mr. Ira Brodsky, president of Datacomm Research Company, as well as Probe Research, Inc. we were able to attend this exciting and informative conference. More than 400 people from our business were in attendance at this show. One full day of tutorial was presented by Mr. Brodsky and the remaining two days contained dual track sessions of papers and panels on various subjects related to all aspects of "wireless."

The sessions that I was able to attend highlighted the main technological approachs in use today:

- Diffuse Infrared
- Cellular Based Systems
- Spread Spectrum

Three papers presented Wednesday afternoon, October 14 in the "WAN TECHNOLOGIES" session were very useful. Slides from each of these talks are presented in the following figures.