Minutes of the IEEE p802.4L Task Group

Irvine, California
March 11-14, 1990

Intermediate part on March 11 and 12.

Chairman. Vic Hayes

Secretary & Editor. Michael Masleid, Chuck Thurwachter, Tom Phinney.

Attendance

Mr. VICTOR HAYES	NCR Systems Engineering B.V	phone +31 3402 76528
Mr. MICHAEL MASLEID	Inland Steel Co. MS2-465	phone 219 399 2454
Mr. THOMAS L. PHINNEY	Honeywell	phone 602 863 5989
Mr. DONALD C. JOHNSON	NCR Corporation WHQ 5E	phone 513 445 1452
Mr. LARRY van der JAGT	Knowledge Implementations Inc	phone 914 986 3492
Mr. GUNTHER J. MARTIN	G&D Associates Inc	phone 203 438 2510
Mr. ROBERT S. CROWDER	Ship Star Associates Inc	phone 302 738 7782
Mr JAMES. NEELEY	IBM	phone 919 543 3259
Mr. JONATHAN CHEAH	HUGHES Network Systems	phone 619 453 7007
Mr. STAN KAY	HUGHES Network Systems	phone 301 428 7165
Mr. DOUG LOCKIE	Pacific Monolithics	phone 408 732 8000
Mr. KIWI SMIT	NCR Systems Engineering B.V.	phone +31 3402 76479

Sunday PM - 12:00 - 17:30 on 90.03.11

Vic Hayes opened the meeting at 1215. 10 people were in attendance.

Various new contributions were distributed and numbered.

The minutes of the Parsippany meeting were reviewed. The following corrections were made:

- Page 1, paragraph with 931.6125 MHz paging transmitter, change "EIRP" into "ERP"
- Page 2, top paragraph, read "Delaware"
- Page 2, Paragraph starting with "Larry van der Jagt", change "the prior two paragraphs" into "item D)"
- Page 3, top paragraph, add at the end of the paragraph: "(This last was later disproved, see add 11)"
- Page 5, paragraph just above Hadamard vectors, add to "the DQPSK system's resistance is 10.4" the following: "(with an 11 chip code)
- Page 5, last paragraph, change "two in series in two in series in quadrature" into "two in series and two in series in quadrature"

Tom Phinney moved adoption of the Parsippany minutes, as amended. Jonathon Cheah seconded. Carried without objection.

The corrections to the Running Objectives and Directives document made at the Parsippany meeting were reviewed. A long discussion of Table 1 of 3.1.4, and of whether or not Rayleigh fading was really possible, occurred. It was noted that the distribution of the attenuation of a received signal (relative to that transmitted) is the sum of the distribution of attenuation due to free-space losses plus the distribution of attenuation due to multi-path constructive and destructive interference. This discussion ended with the following observations (confirmed by Proakis, *Digital Communications*, Figs 7.1.3 and 7.1.4):

1. The spaced-frequency correlation function is the Fourier transform of the multipath intensity profile.
2. The spaced-time correlation function is the Fourier transform of the Doppler power spectrum.

A number of extensions to Table 1 were discussed. Jonathon Cheah proposed the addition of a footnote explaining what the terms "retail", "factory" and "office" represented. Another footnote should point out that the environment is not static and thus Doppler effects may occur even when the sending and receiving stations are not themselves moving (with respect to the earth, each other, the surrounding "building", etc.). Stan Kay proposed that an additional column, Coherence Time, should be added to the table to reflect these Doppler effects.

Coherence time is defined as follows:

Given a time-variant (wide-sense stationary) channel impulse response of $c(\tau;t) = \alpha(\tau;t)\, e^{-j2pfc\tau}$, where τ is the delay and $\alpha(\tau;t)$ is the attenuation of the signal components at delay τ at time instant t.

Let $C(f;t) = \int_{-\infty}^{\infty} c(\tau;t)\, e^{-\varphi 2\pi\phi\tau}\, dt$ be the Fourier transform of this impulse response.

$\phi_c(f_1,f_2;\Delta t) = 1/2\, E\, [(C^*(f_1;t)\, C(f_2;t+\Delta t)] = \phi_c(\Delta f;\Delta t)$, where E is expectation, is called the spaced-frequency spaced-time correlation function.

If you hold Δf to 0 you have the spaced-time correlation function. The period of time over which the magnitude of this function is essentially non-zero is the coherence time of the channel.

Paragraph 3.15 was deleted, as had been discussed in Parsippany, NJ. With these inclusions, the document was accepted as current.

Don Johnson presented Paul Pirillo's measurements of nine different microwave ovens from six different manufacturers. (IEEE p802.4L/90-07)

Jonathon Cheah presented his detailed measurements (over 300 pages) of three different microwave ovens from two manufacturers. (IEEE p802.4L/90-08a) His conclusion was "that the interference characteristics of the microwave ovens to the proposed radio LAN system cannot be taken as a possible line interferer as previously assumed, although it is impulsive in nature. Because of the perceived carrier frequency drifts from the interference source, it is also claimed that the interference energy existed over a broad frequency spectrum with rapidly varying amplitudes, and the resultant effect is a seemingly random and piece-meal contiguous frequency spectrum in time."

Discussion of Jonathon's sampling method indicated that the measurements were not synchronized to the power line. (The microwave magnetron is triggered by the rise of the power-line voltage, and is on during one half-wave of each power-line cycle.) Jonathon filtered the time-domain samples in this collection by not recording samples which showed little magnetron activity.

It appears that the magnetron has a negative resistance on turn-on and turn-off, and this causes relaxation oscillations at the beginning and end of each power cycle, which cause an apparent broadband emission. In reality, during the beginning and end of each power cycle, the magnetron produces a series of very short bursts of carrier (<< 300 ns each) with decaying power and a frequency which changes slightly during the burst, and with more substantial changes in frequency from one burst to the next.

In the middle of each power cycle the magnetron just stays on, with occasional instantaneous frequency changes due to shifts in mode-locking caused by the changing magnetron plate voltage and the motion of the stirrer in the oven cavity. (See addendum L1, and IEEE 802.4L-89/19 for time domain pictures of this phenomenon.) These instantaneous changes may be accompanied by additional bursts. (See IEEE 802.4L/90-8a figure 4-46.)

The group expressed its appreciation for the great deal of work and meticulous documentation provided by Jonathon's submission.

Mike Masleid gave a projected 3-D preview of coming attractions (his presentation).

Don Johnson moved adjournment for the day. Mike Masleid seconded. Carried 10-0-0.

Monday AM - 08:00 - 12:15 on 90.03.12

Vic Hayes opened the meeting at 0812. 9 people were in attendance. (This later grew to 12.)

Stan Kay presented IEEE 802.4L/90-03. A discussion of the **distribution system** approaches followed. Tom Phinney presented the different distribution system structures (addendum L2). Based on a similar analysis and discussion in Vancouver, BC in

Stan Kay moved to add a new item, item 8, to the Running Objectives document, paragraph 3.3 System Design Parameters, that the design goal for the overhead of each **Ph-PDU be 25 octets** or less. This includes synchronization pattern, network id, CRC on the Ph-PDU content, and FEC flush. It was noted that the overhead can be different for the forward and reverse channel overheads can differ. Tom Phinney seconded. Carried 10-0-0.

Bob Crowder moved that the running objectives document shall describe defined **points of interoperability**. Tom Phinney seconded. Larry van der Jagt moved to amend the above motion to read "... describe the defined point of interoperability, which shall be the air (ether) interface ." Tom Phinney seconded, and later withdrew his second, which caused the amendment to be withdrawn. The original (un-amended) motion carried 11-0-1.

Tom Phinney moved that 802.4L finish definition of the primary air interface before considering any other interfaces. Carried 11-0-1.

After a prolonged break (for most people to meet their 802 registration requirement), Larry van der Jagt presented IEEE p802.4L/90-09. In a **distribution system**, each remote receiver sees the sum of the signals received from the distribution system's various transmitters, after convolution of each of those transmitted signals by the impulse response of the effective channel which existed between the transmitter and receiver. Larry contended that this could be viewed as if it were a signal received from a single transmitter after convolution with the impulse response of a single hypothetical channel.

Kiwi Smit and Tom Phinney contended that this assumption was not valid unless the transmitters were phase locked, because the various LOs would operate at different frequencies due to crystal tolerances, etc. With 0.005% crystals, the carriers of two transmitters will precess at 0.01%, which is 100 kHz at 915 MHz and 250 kHz at 2.45 GHz. This limits the coherence time of the hypothetical channel to about 1 μs at 915 MHz and about 400 ns at 2.4 GHz.

Larry presented the following table (addendum L3), based on use of 5-CDM to send the output of a rate 9/15 Reed-Solomon encoder (4 codes), plus a reference code for channel impulse-response estimation and timing recovery.

Spread	Bandwidth (MHz) (915 MHz, 40 ns chip)	Bandwidth (MHz) (2.45 GHz, 16 ns chip)
31	1.8 Mbit/s 1.25 µs/symbol	5 Mbit/s 500 ns/symbol
63	900 kbit/s 2.5 µs/symbol	2.5 Mbit/s 1 µs/symbol
127	450 kbit/s 5 µs/symbol	1.25 Mbit/s 2 µs/symbol

Tom Phinney pointed out that the channel coherence time, due to carrier frequency drift caused by crystal tolerances, limited the usable modulation techniques and spreading lengths. For BPSK and learning channel equalization on each symbol for use on the immediately following symbol, a spread of 31 seemed feasible, while 63 is marginal and 127 is probably impossible.

Tom Phinney moved adjournment of the pre-plenary meeting. Don Johnson seconded. Carried 12-0-0.

Plenary part on March 13 and 14.

Chairman. Vic Hayes

Secretary & Editor. Michael Masleid, Chuck Thurwachter, Tom Phinney.

Attendance

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Mr. MARIS GRAUBE	Relcom inc	phone 503 357 5607
Mr. DARRELL R. FURLONG	Concord Communications Inc.	phone 508 460 4646
Mr GERALD K. GRAHAM	IBM	phone 919 543 1879
Mr. LARRY van der JAGT	Knowledge Implementations Inc	phone 914 986 3492
Mr. GUNTHER J. MARTIN	G&D Associates Inc	phone 203 438 2510
Mr. ROBERT S. CROWDER	Ship Star Associates Inc	phone 302 738 7782
Mr JAMES. NEELEY	IBM	phone 919 543 3259
Mr. JONATHAN CHEAH	HUGHES Network Systems	phone 619 453 7007
Mr. STAN KAY	HUGHES Network Systems	phone 301 428 7165
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Tuesday AM - 08:00 - 12:00 on 90.03.13

Vic Hayes opened the meeting at 0800. 13 people were in attendance, who went through a lengthy (half-hour) introduction process.

Stan Kay presented a description for computing Delay Spread. (I.4L/11) The ensuing discussion indicated that the description needed correction, and that such a description was sorely needed to clarify the meaning of, and method for calculating, delay spread.

A new issue was added to the issues list:

> Issue 11: Data on coherence time is needed. Part of the data could be recovered from Oshawa measurements and from Rappaport's report. More measurements are to be made when the results prove some parameters have been missed.

Jim Neeley presented information on the use of the 902-928 MHz band by Amateur Radio, and stated that this use is growing. (I.4L/10) He also presented some quotes from his probe of fellow IBM employees on the subject. (see addendum L4)

After a long break, discussion returned to Larry van der Jagt's paper (IEEE 802.4L/90-09). This led to the following straw poll regarding which type of ping-pong timing should be used if ping-pong is chosen as the distribution method. Ten of the thirteen present stated that they preferred the "synchronous" approach, where the inter-ping period is fixed (where the ping is the head-end component of the transmission). No one preferred the alternatives where the inter-ping period was variable. No vote was taken on whether the system should use a ping-pong (TDM) or concurrent (CDM) dual channel approach; in the latter case this issue vanishes.

A second straw poll queried whether the group wants to consider a separately coded reference signal (a "pilot" code), which would be transmitted (using CDM) as part of each Ph-PDU, for optional usage by receivers. Seven of the fourteen present were in favor of considering this approach. Two were opposed, and the rest abstained.

Stan Kay presented his second paper (IEEE p802.4L/90-04). Discussion turned to the **desirability of FEC coding** for achieving the required 10^{-8} BER at reasonable distances within the 1 W transmit power limit. Some members expressed concern about the cost, in both equipment complexity and reduction of raw data rate, caused by FEC.

Tom Phinney moved to adjourn for the day. Don Johnson seconded. Carried.

Wednesday AM - 8:00 - 12:00 on 90.03.14

Vic Hayes opened the meeting at 0819. 10 people (later 13) were in attendance.

Stan Kay referred the task group to the paper which defines π/4 QPSK - *Highly Efficient Digital Mobile Communications with a Linear Modulation Method*, IEEE Journal on Selected Areas in Communications, vol. SAC-5, no. 5, June 1987, pp.890-895.

Stan Kay presented a graph of BER vs. Eb/No for diversity L=1 and L=2, for Rayleigh fading. Don Johnson stated that the diversity level in the 802.4L system, due to spreading and multipath, was greater than two, and that the wideband fading was not Rayleigh distributed.

The discussion turned to a query of the channel characteristics. Tom Phinney stated that he believed that the rate of movement of vehicles in this application was slow enough that the vehicles would move only a small fraction of a wavelength in a single symbol time, and thus that the resultant effective channel was coherent enough for use.

Stan Kay said that interferers would have a Rayleigh distribution, but that is less severe than a Gaussian distribution.

Jonathon Cheah moved that any proposal or change in direction be supported by analytical or experimental evidence. Tom Phinney seconded. Carried 9-2-0.

Jonathon Cheah moved that the task group place its highest emphasis on channel characterization. Tom Phinney seconded. A long discussion followed, in which Mike Masleid, Larry van der Jagt and Don Johnson all opined that the existing channel measurements provided all of the raw data needed for such characterization. After further discussion, the vote was finally taken. Failed 2-4-5.

Stan Kay was then asked to enumerate the items which he felt were needed to characterize the channel. These were:

1. Coherence time of the channel.
2. Received Eb/No (for additive white Gaussian noise)
3. Received Eb/Io power and frequency distributions for narrowband interferers
4. Received Eb/Io amplitude and time distributions for impulse noise
5. High resolution complex impulse response of the channel

It appears that a substantial amount of information on all of these is contained within the 20 MB of sample data which is already before the committee. A brief discussion by Mike Masleid of the apparent coherence time of the channel which he had observed from his processing of this data indicated that the channel varies only slowly over at least a few hundred µs. This observation was supported by Larry van der Jagt's analysis, as shown in some of the plotted data in his prior submissions to the committee.

After a break, discussion continued on characterizing the channel. Stan Kay then presented the rest of IEEE p802.4L/90-04. Stan then discussed the advantages of π/4 QPSK - it permits use of a class C amplifier with feedback instead of a class A or AB amplifier. Stan stated that this advantage was marginal in the 915 MHz band, but was significant in the higher multi-GHz bands. Jonathon stated that Hughes had experience with $\pi/4$ QPSK, and that FSK is 3 dB worse than $\pi/4$ QPSK.

Larry van der Jagt moved that the group adopt as its model of the best channel a channel with Rayleigh fading and AWGN. Jim Neeley seconded. After discussion the motion was withdrawn.

Mike Masleid then began to present his model for a receiver structure suitable for this channel. This presentation was suspended at 12:00 for lunch.

Wednesday PM - 1:30 - 5:00 on 90.03.14

Vic Hayes reopened the meeting at 1315. 15 people were in attendance.

Mike Masleid restarted his presentation on a conceptual model for a receiver. He presented a means of deriving the initial weights for a linear transversal filter (I.4/6-1). He then showed a receiver structure which could use received symbols to initialize and then update an estimate of the channel impulse response, and could use analog integrate and dump techniques to provide the convolution of that impulse response with the received symbol stream.

Stan Kay moved that the task group place its highest emphasis on dual-channel operation. Jonathon Cheah seconded. Bob Crowder pointed out that the marginal cost of the broadband head-end remodulator in small systems was a major factor in driving the development and deployment of carrier-band. A lot of discussion followed on the possibility and impact of designing equipment which supports both dual-channel and single-channel operation.

Bob Crowder moved to amend the prior motion to append "while supporting single-channel operation where feasible". Jim Neeley seconded. After long discussion, the amendment carried 10-0-5. The original motion carried 10-4-1.

Discussion turned to the information that should be contained in future submissions. Each submitter should bring 15 copies of the paper and transparencies of the important pages, as appropriate. Vic Hayes asked that future submissions on modulation include

- a definition of the transmitted signal
- the transmit signal spectrum, with and without filtering
- system analysis of the performance in the channel.

Mike Masleid sketched his insight into the <u>electrical circuit of a microwave oven</u>, which showed a voltage doubler that could result in excitation for more than half of each power-line cycle. (see Addendum L7)

Tom Phinney moved to adjourn. Larry van der Jagt seconded. Carried 14-0-0.

The <u>next interim meeting</u> of 802.4L will be Monday, May 14 @ 13:00 to Friday, May 18 @ 12:00, at the Clubhouse Inn in Norcross, GA, N.E. of Atlanta.

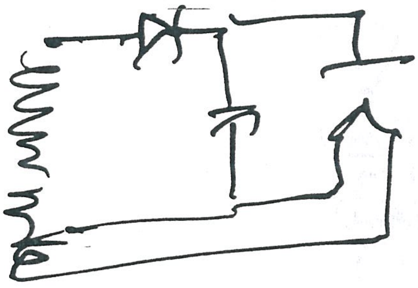
The <u>next plenary meeting</u> will be held at the Sheraton Tech Center in Denver, CO, the day before the next 802 plenary.

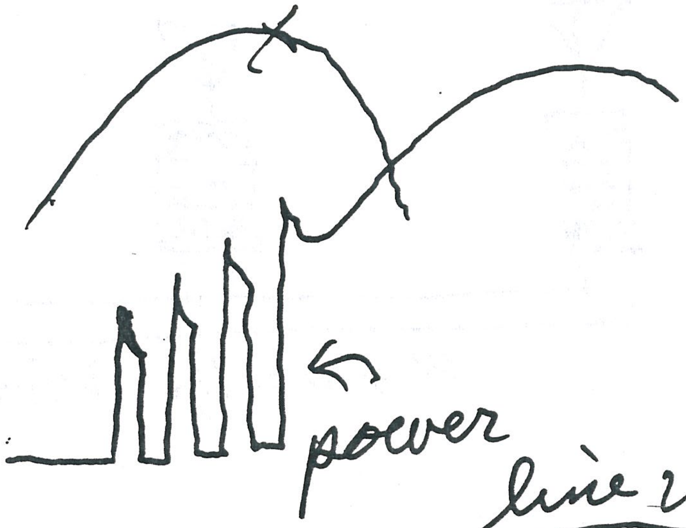
List of temporary documents

Temp.	Source	Title	Document number
I.4L/1	Hayes	Document list	
I.4L/2	Hayes	Agenda	
I.4L/3	Hayes	Attendance list	
I.4L/4	Cheah	Microwave Oven Interference Measurement	IEEE p802.4L/90-08a
I.4L/5	Pirillo	Microwave Oven Frequency Content Measurements	IEEE p802.4L/90-07
I.4L/6	Van der Jagt	Approaches to Indoor RADIOLAN which provide Processing Gain and Coding Gain 9	IEEE p802.4L/90-09
I.4L/7	Masleid	Optimal integrating and dump filters	
I.4L/8	Masleid	Channel Equalizers and intersymbol interference rejection	
I.4L/9	Masleid	Proposed receiver implementation to do /7 and /8	
I.4L/10	Neeley	Radio Amateur data	Running Obj & Dir Addendum L4
I.4L/11	Kay	Delay Spread definition	Addendum L5

ADDENDA

Addendum L1	Time domain pictures Microwave Ovens
Addendum L2	Distribution System pictures
Addendum L3	Table of 5 CDM encoders
Addendum L4	Amateur radio quotes
Addendum L5	Definition Delay Spread
Addendum L6	Filters and Receivers
Addendum L7	Microwave Oven sketches

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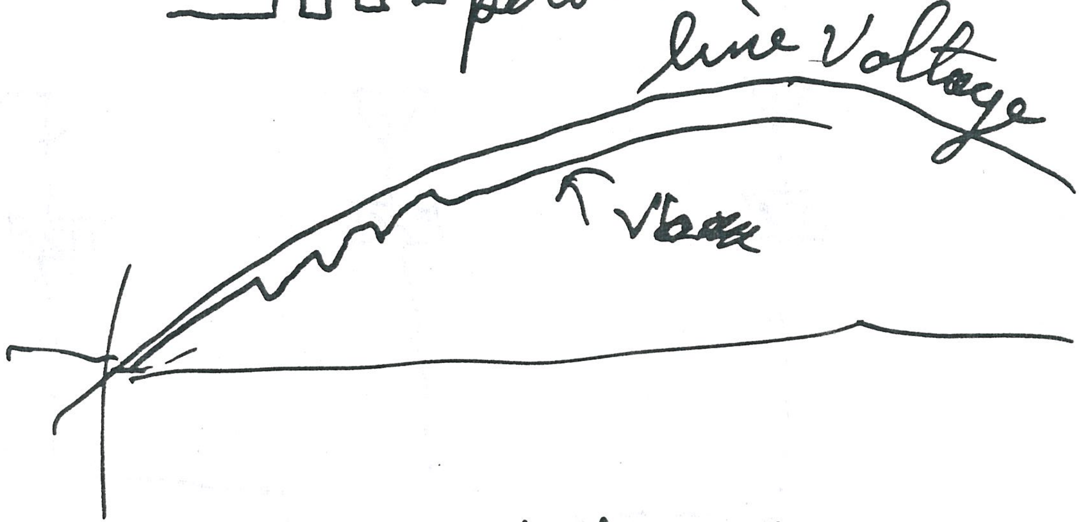
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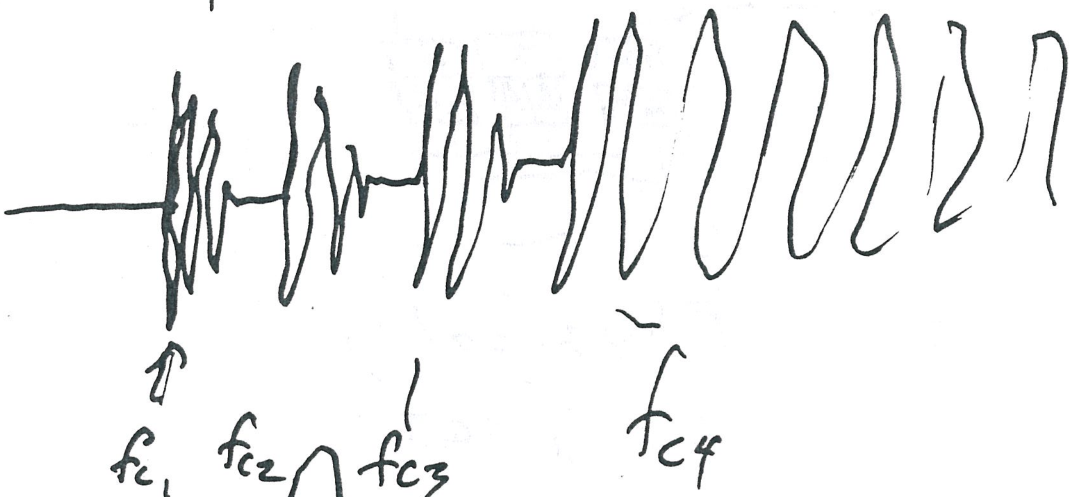
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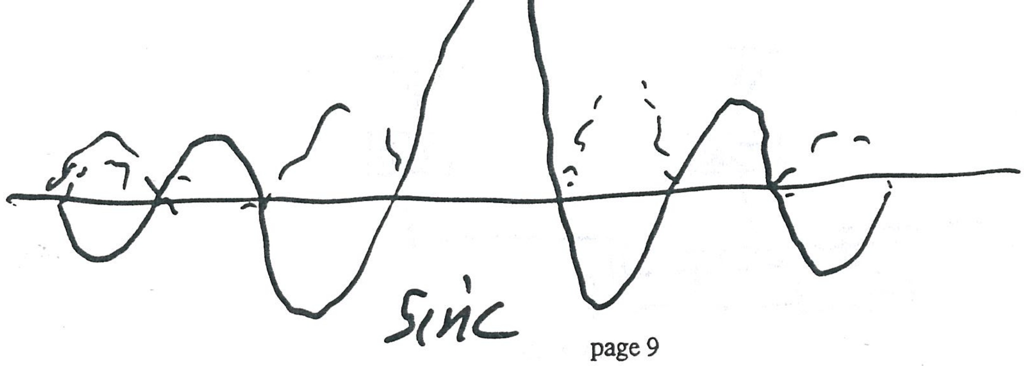
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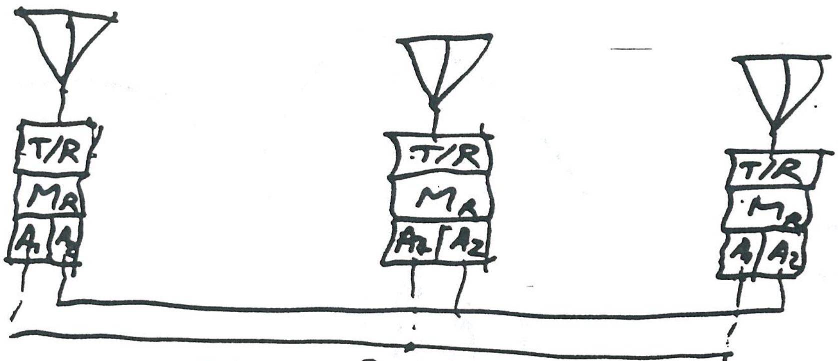

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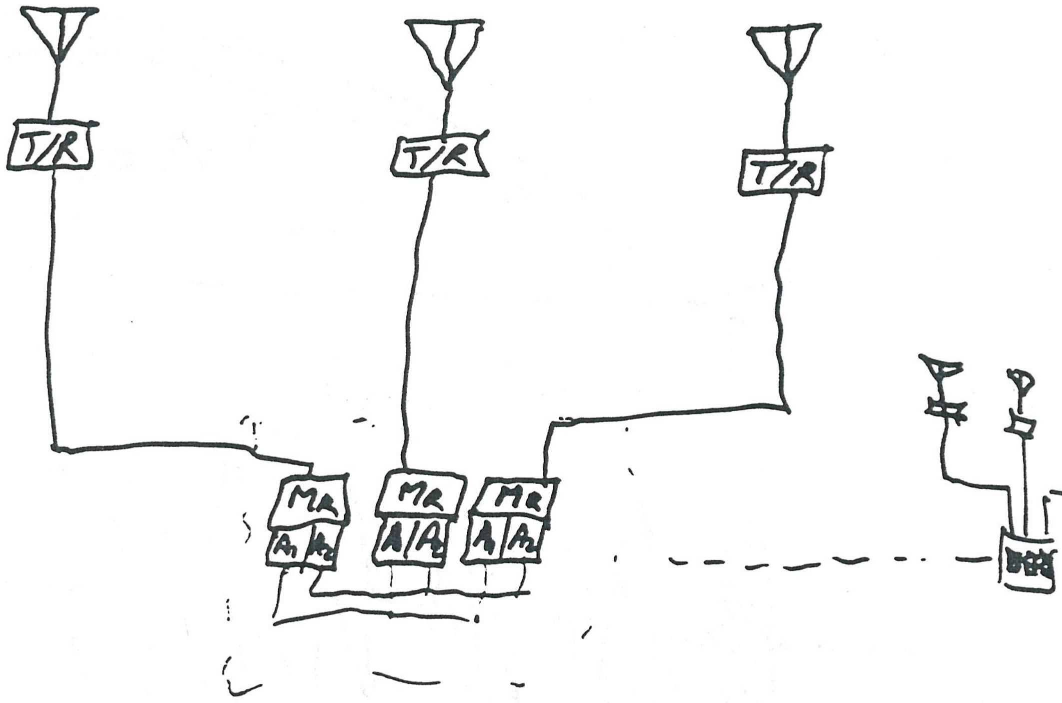
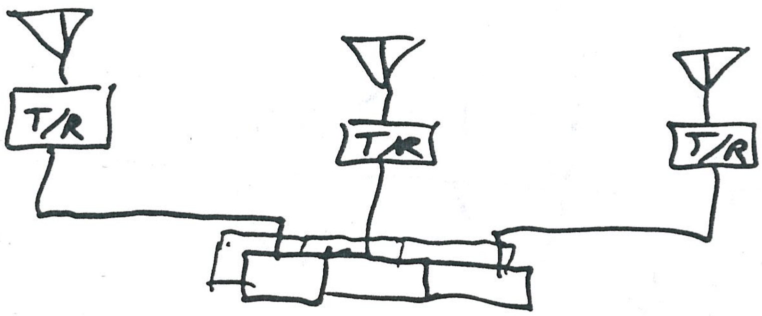


Physically Compact



SPREAD	BAND MHZ 900	BAND MHZ 2500
31	1.8 MBPS 1.25us	5 MBPS 500ns
64	900 KBPS 2.5us	2.5 MBPS 1us
127	450 KBPS 5us	1.25 MBPS 2us

40ns

16ns

BIT RATES ASSUME 4 CODE REED-SOLOMON (15, 9) ENCODED

FILE: 902-MHZ LOG A0 (PTH191) 03/09/90 17:43:13

MSG From: EDSTEP --RALVM0 To: NEELEY --RALVMK 02/09/90 09:57:19

==

Date: 9 February 90, 09:50:26 EST
From: EDSTEP at RALVM0
To: NEELEY at RALVMK
cc: WHARPER at RALYDPD4

Good morning. I have taken a little time and put together the couple of pages from the Repeater Directory containing the information you were looking for. Here it is:

Amateur Repeaters on 902-928 MHz band. Taken from "The ARRL Repeater Directory", 1989-1990 Edition

California	
Placer	905.500
Contra Costa	905.700
Contra Costa	905.800
San Mateo	906.100
Santa Clara	905.300
Santa Clara	905.400
Santa Clara	908.000
San Joaquin	908.900
So. Cal.	906.000
So. Cal.	906.750
So. Cal.	907.675
Los Angeles	905.100
Crestline	905.700
So. Cal.	905.200
So. Cal.	905.500
So. Cal. *	915.500
So. Cal.	906.500
So. Cal. *	903.500

* = Wide band data

Florida	
Ft. Lauderdale	921.100
Miami	921.300
Orlando	921.200
Tarpon Springs	921.700
Illinois	
Chicago	919.025
Elburn	920.100
Kansas	
Kansas City	921.600
Maryland	
Annapolis	919.100
Massachusetts	
Feeding Hills	919.500
Groveland	919.200
Pepperell	919.100
Adams	921.100
Missouri	
Kansas City	921.600
Hollister	921.500
New Jersey	
Kresson	920.025
North Carolina	
Lexington	920.000
Lexington	921.000
Ohio	
Columbus	920.000
Columbus	920.875
Pennsylvania	
Valley Forge	919.200
Phila/Roxboro	919.100
PGH/Homestead	920.500
Rhode Island	
Lincoln	921.200
Providence	921.700
Smithfield	921.900
Smithfield	921.950
Tennessee	
Fisherville	921.100
Hickory Valley	919.100
Texas	
Haslett	919.900
Roanoke	917.100
Quebec	
Montreal	920.000

ARRL Interim Band Plan for 902-928 MHz band:

902.0 - 904.0	Narrow bandwidth, weak signal communications
902.0 - 902.8	SSTV, Fax, ACSSB, experimental
902.3 - 902.4	Propagation beacons
902.8 - 903.0	Reserved for EME, CW expansion
903.0 - 903.05	EME exclusive
903.1	CW, SSB calling frequency
903.4 - 903.6	Crossband linear translator inputs
903.6 - 903.8	Crossband linear translator outputs
903.8 - 904.0	Experimental beacons exclusive
904.0 - 906.0	Digital communications
906.0 - 907.0	Narrow bandwidth, FM simplex services, 25 kHz channels
906.5	National simplex frequency
907.0 - 910.0	FM repeater inputs, paired with 919-922 MHz; 119 pairs every 25 kHz. rh 907/025. 050. 075. etc. 908-920 MHz uncoordinated pair.
910.0 - 916.0	ATV
916.0 - 918.0	Digital Communications
918.0 - 919.0	Narrow bandwidth, FM control links and remote bases.

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919.0 - 922.0  FM repeater outputs, paired with 907-910 MHz
922.0 - 928.0  Wide bandwidth experimental, simplex ATV, Spread
               Spectrum.

Note: Two 3-MHz-bandwidth channels are recommended for
      1.5 Mbit/s links. They are 903-906 MHz and 914-917 MHz
      with 10.7 MHz spacing.
-------------------------------------------------------------------
I hope this is of some help to you.

Ed Stephenson, EDSTEP at RALVM0
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~~Notes from IBM U-Net~~

If you want to communicate thru a wall, it will attenuate the radio signals severely.

If there is an interfering RF source on the other side of the wall, it will pass unabated.

73

Tom Enzger
IBM – Pok.

. . . I wouldn't want to DEPEND on shielding properties for much of anything.

Steven Phillips KI3Q
IBM RTP, NC

enough will escape through an open window to bring up a repeater with a high gain antenna on a mountaintop 16 miles away.

Such is life

Bob
BLASE@POKU. ...

I am planning a 902 MHz . . . at 200 & 500 watts.

Terry King
IBM Burlington

– the key word is YET.

Jerry Stuckle, A1OK
IBM Raleigh

In the 900 MHz amateur band there are several repeaters in densly populated areas and more are coming.

Tom Enzger –

Subject: IEEE 802.4L Through the air Physical media, Radio LAN
Ref: Append at 22:44:05 on 90/01/23 GMT (by TKING at BTVVMYQ)

As a "secondary user" aren't there two requirements? 1) You must be able to accept interference from other users. 2) You must not cause harmful interference to the primary users. In the 900 MHz amateur band, there are already several repeaters in densely populated areas and more are coming. The spread-spectrum experiments in the Washington, DC (or was it Baltomore) area caused interference to repeaters by appearing to be an incoming signal and putting the repeaters on the air. What you don't need is a LAN that anybody can demand be taken out of operation. That is a likely outcome of any spread-spectrum attempts in that band.

| That is, a primary user can demand a secondary user cease operations
| if harmful interference is being caused.

Tom En2ger — :3)- 73 de W2GIJ

Well I agree you don't need a perfect faraday cage, I have never been in a building where I can't talk to someone in the parking lot with my HT. The same with driving by the building. It all goes down to how much attenuation you need, and how much interference you are willing to put up with from outside sources.

Although the 900Mhz ham band is not too much utilized in most areas yet, the key word is YET. This is a fairly new band, and the equipment is just now becoming popular. As the other band usage (which is now overloaded in many areas) increases, look for more and more usage on 900 Mhz. Which means more and more interference - and the secondary user can't do a thing about it. Which means more and more dissatisfied customers. And so on and so on...

Jerry Stuckle, AIOK
Network Service Development
Raleigh, NC

--

"...normal building walls will shield..."

This may be true to an extent depending on what you call normal, and what the construction of the building is. I have been in some commercial buildings with largely steel construction where I in fact have not been able to use my handheld tranceiver, and have not been able to receive relatively nearby TV stations on my portable 2 inch TV. You don't need a perfect faraday cage to provide significant attenuation.

Seriously though, I wouldn't want to DEPEND on shielding properties of buildings for much of anything.

Steven Phillips, KI3Q
RTP Radiation Engineering Laboratory

Well, I am planning a 902 Mhz (Probably 912-913?) Backbone link that will run licensed (Radio Amateur) at 200 to 500 watts into a antenna with a gain of 8 to 10 db. If I point it at Mount Greylock, it points pretty much at the IBM plant. This band is also rapidly acquiring mobile and handheld users at the 1 to 20 watt level.

Burlington, VT.

I'll bet if you were to look at 902-928 in the San Francisco bay area with a spectrum analyzer you'd find a LOT of Amateur activity with ERP's in the range of 1W to 5000W. A lot of this activity is wideband Television and Data that runs 50 to 100% duty cycle when active. Some of the repeaters in the Bay area are active with Wideband Television a large percentage of the time, as I understand. I believe you should make actual spectrum-analyzer measurements of these bands in several Urban and Suburban areas the find out the reality of this stuff. High-power 1 Ghz amplifiers are within the capabilities of many Radio Amateurs, if they have a reason.

I don't have the ARRL Band Plan for 902 here at work, but someone else may. You should look at that, as well as the ARRL repeater directory for existing 902 Repeaters across North America.

I've read a little spread-spectrum stuff, but I don't know what ratio of CW In-Band to Desired signal it will withstand. Probably depends on the (coefficients? Factors?), the bandwidth, the Data Rate, the power, and acceptable Error Rate.

The Spread-Spectrum concept seems somehow like "something for nothing", so I wonder a little bit if it will realize its potential. Certainly is SOUNDS like a good way to share spectrum space without a lot of channelization and adaptive Cellular approaches.

I'll be interested in hearing how this progresses.

Regards, Terry King ...On the Air in Vermont

Sad but true. It seems very likely that the LAN won't be able to get enough signal through the concrete and steel floor to be heard on the floor above, especially if it's one that's poured onto sheet steel. But enough will escape through the window to bring up the repeater with a high gain antenna on a mountaintop 15 miles away. Such is life.

Bob

~~DELAY SPREAD~~ I.4L/11

Delay Spread measurements incorporate the following:

1. Transmit_Waveform, $s(t)$. One transmission of a time waveform capable of supporting fine resolution time domain characterization of the channel impulse responce, $h(t)$. For example, a narrow pulse or m-sequence.

2. Received_waveform, $r(t)$. Response of channel to $s(t)$, i.e. $r(t) = \int_{-\infty} s(\tau)\, h(t-\tau)\, d\tau$. ~~(If $s(t)$ is an m-sequence $r(t)$ should be taken as the correlated output of the channel.)~~

3. Truncation mechanism. A method for defining when ~~the~~ $r(t)$ starts, t_{start}, and when $r(t)$ ends, t_{stop}. For example $r(t)$ > measurement_quantization_noise, or when the envelope voltage (~~the~~ $\sqrt{r(t)\, r^*(t)}$) is no lower than one tenth of the peak envelope voltage.

4. Mean delay ~~spread~~, μ_d. $\mu_d = \int_{t_{start}}^{t_{stop}} t\, r(t)\, r^*(t)\, dt \Big/ \int_{t_{start}}^{t_{stop}} r(t)\, r^*(t)\, dt$

5. Delay variance, σ_d^2. ~~$\sigma_d^2 = \int_{t_{start}}^{t_{stop}} \left(\sqrt{r(t)\, r^*(t)} - \mu_d\right)^2 dt$~~

6. Rms delay spread $= \sigma_d$.

$$\sigma_d^2 = \frac{\int_{t_{start}}^{t_{stop}} t^2\, r(t)\, r^*(t)\, dt}{\int_{t_{start}}^{t_{stop}} r(t)\, r^*(t)\, dt} - \mu_d^2$$

~~$\sigma^2 = E(x^2) - (E(x))^2$~~

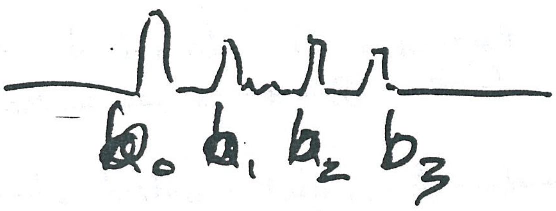
~~$\sigma^2 = E(x-\bar{x})^2$~~

X is ~~an r.v. (gaussian)~~ σ_x, η_x

then if $Z = a_0 x_0 + a_1 x_1 + \ldots$

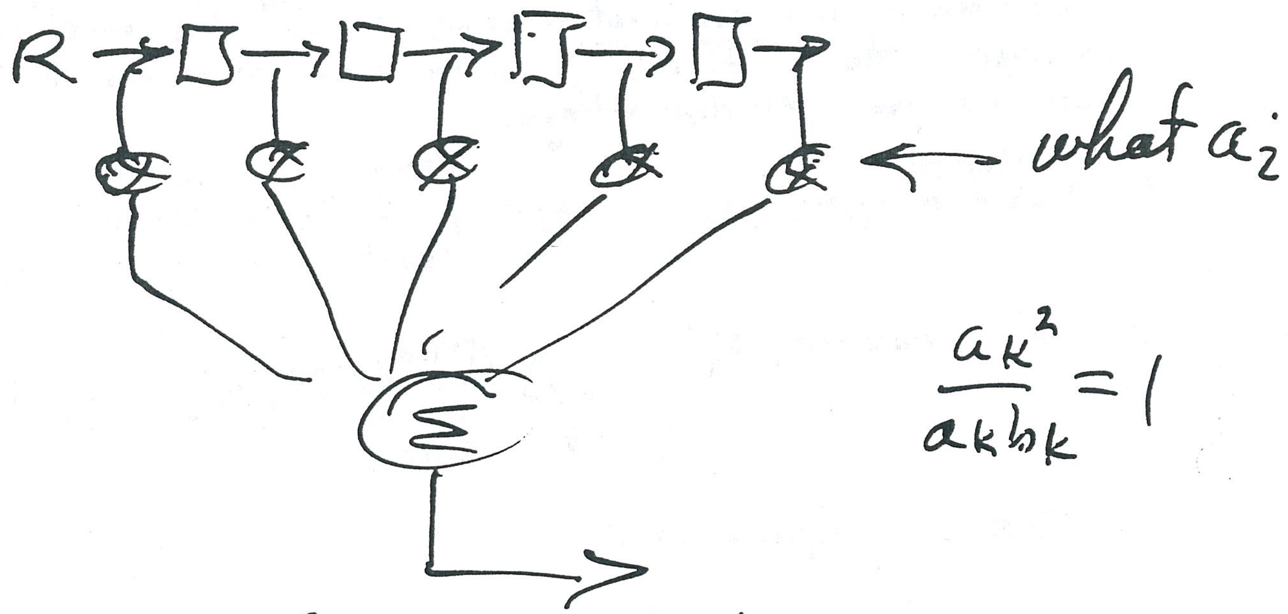
then Z is a gaussian,

$$\sigma_z^2 = \sigma_x^2 \sum_{i=0}^{n} a_i^2 \qquad \eta_z = \eta_x \sum_{i=0}^{n} a_i$$

if R = 

$R = X + K * \delta(t-0)$

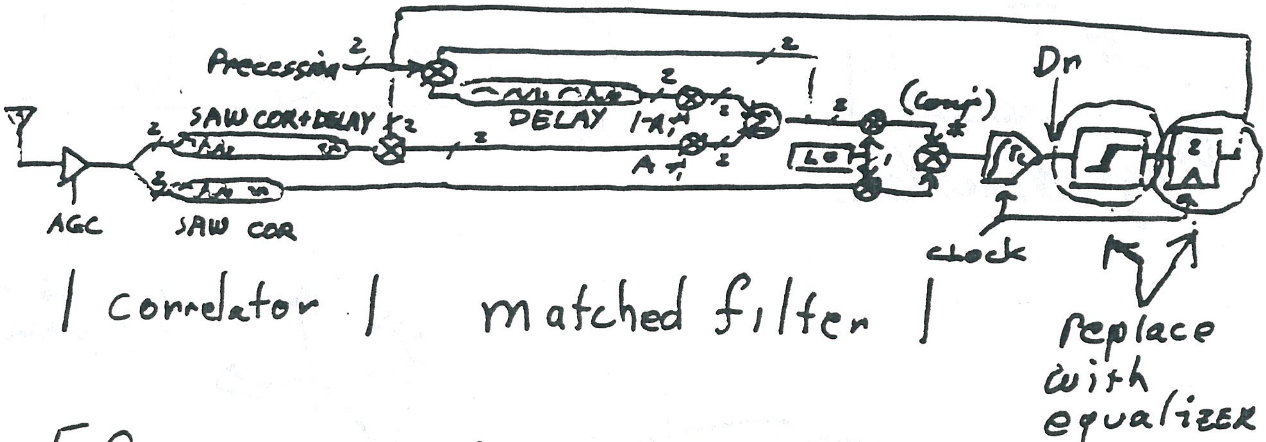
and receiver is



$$\frac{a_k^2}{a_k b_k} = 1$$

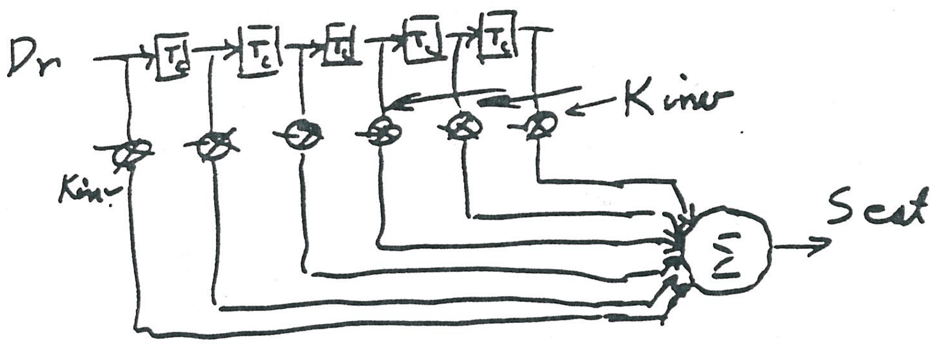
$$S_n = \frac{S^2}{\sigma_x^2} \frac{(a_0 b_0 + a_1 b_1 + \ldots)}{b_0^2 + b_1^2 + \ldots}$$

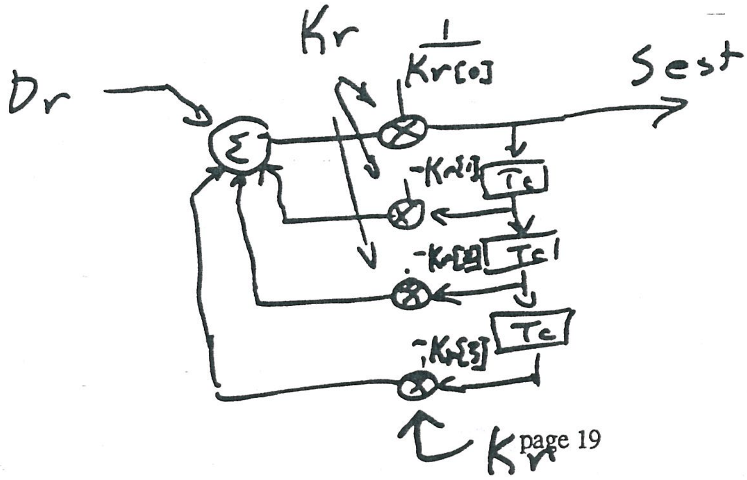
then $$b_k = \frac{(b_0^2 + b_1^2 + \ldots + b_k^2 + \ldots b_n^2) a_k}{(a_0 b_0 + a_1 b_1 + \ldots + a_k b_k + \ldots a_n b_n)}$$

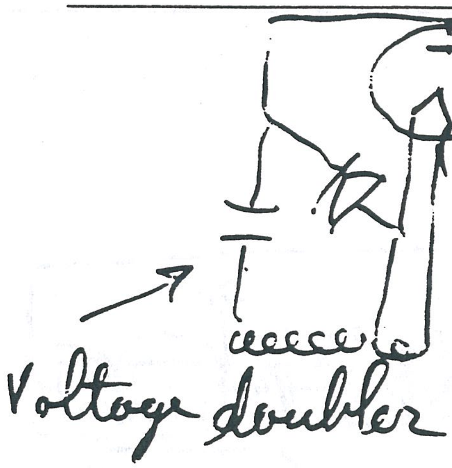


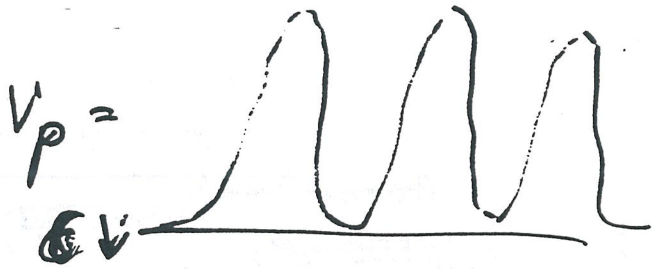
if delay spread is long
see equalizer:

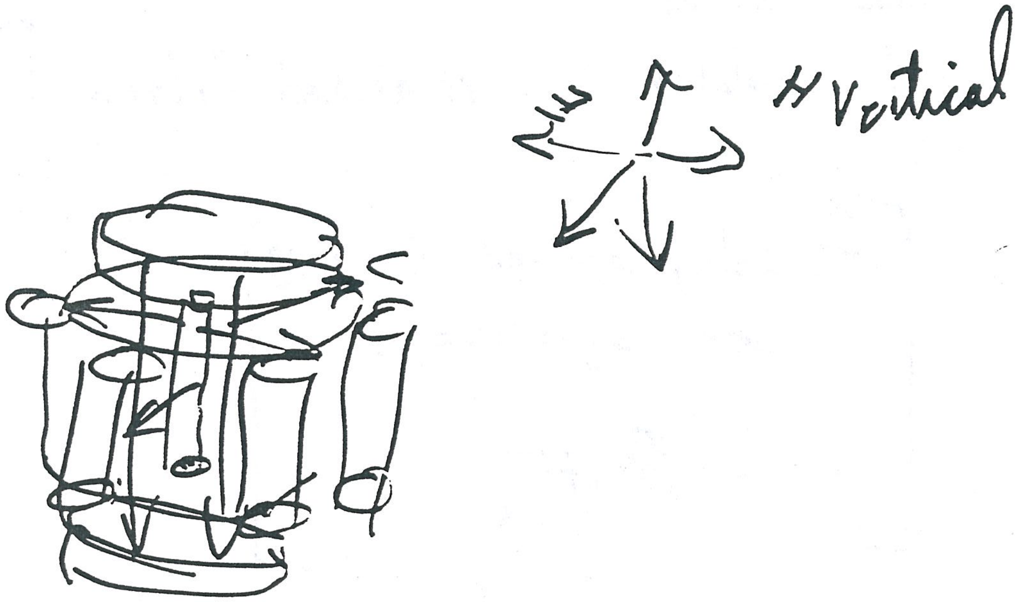
Kinv $\mathcal{F}^{-1} \frac{1}{\mathcal{F}(K)}$






Voltage doubler


Vp =
0 V


H Vertical