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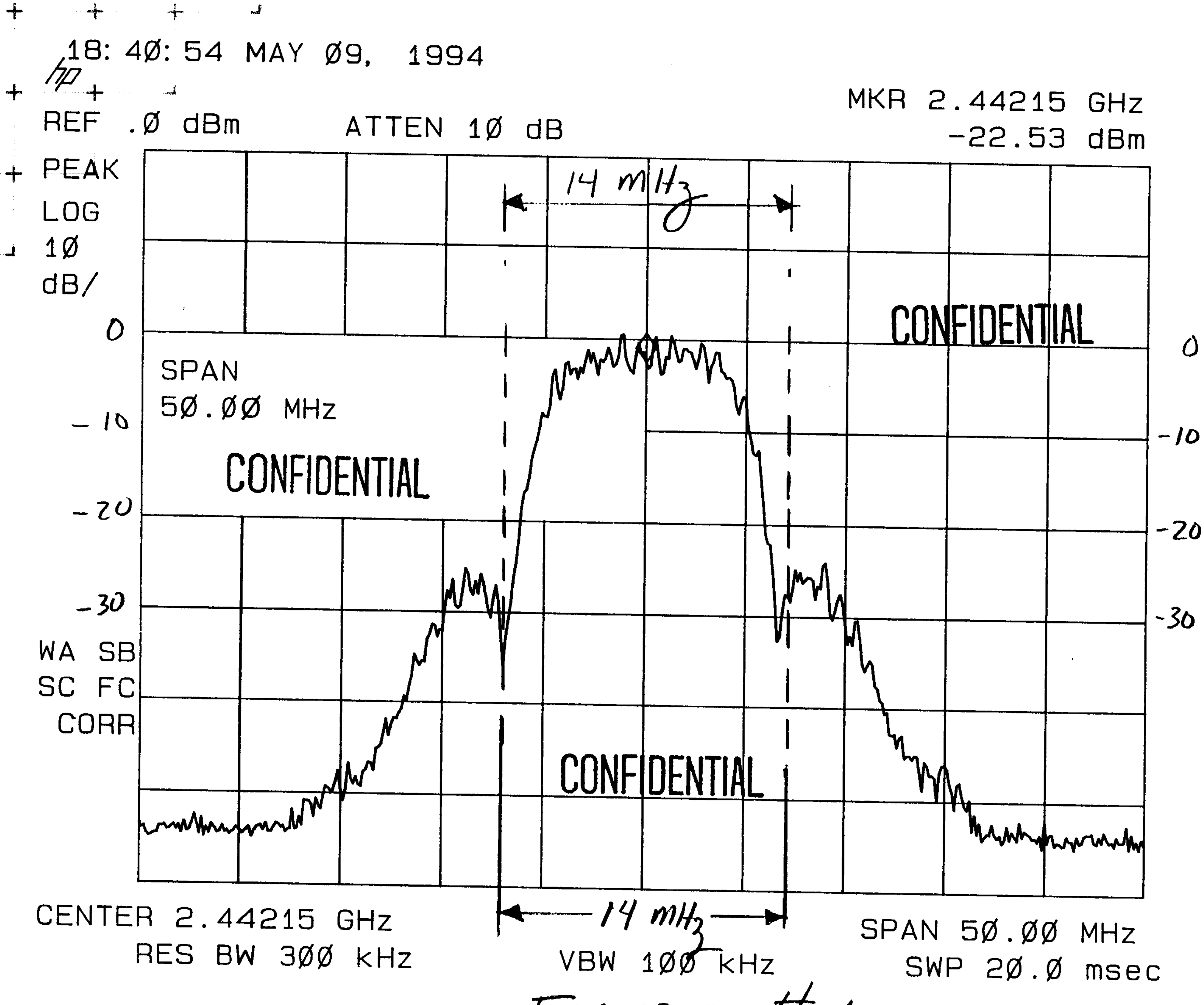
Appendix 1
Addendum to 4 - Particulars of Operation

Frequency:	1.8 - 2.5 GHz 5.0 - 6.0 GHz
Emission:	Q1D
Necessary Bandwidth:	14 MHz
Modulating Signal:	(F1) 10M Baud (F2) 5 MHz (F3) 5 MHz Peak Deviation (F4) 2 Milliseconds maximum pulse duration and approximately 500 pulses per second for a fully loaded network (30 - 50 radios in a network) (F4) 60 Microsecond minimum pulse duration and approximately 16,667 pulses per second for a fully loaded network (30 - 50 radios in a network)

(G4) The necessary bandwidth was determined by a combination of analytical and measurement techniques. Figure 1 is a plot of measured data taken from a developmental modulator and radio. The measurement was taken with a 256 bit pseudo random data sequence bit pattern input (to the modulator) at a 10 Mbps (100 nanoseconds/bit) data rate. Dashed vertical lines were drawn on the graph at the $\pm$ 7 MHz points. It can be seen that the power spectrum is better than 20 dB down at the desired channel edges. This indicates that the modulation technique and proposed implementation maintain 99% of the transmitted energy within the band.

The 20 dB (99%) occupied bandwidth is the same as the necessary bandwidth due to adjacent channel interference issues. Our plan is to have two (or more depending on available bandwidth) 14 MHz channels and as such, the radiated power spectrum must be down 20 dB to avoid excessive adjacent channel interference.



18: 40: 54 MAY 09, 1994
REF .0 dBm
ATTEN 10 dB
MKR 2.44215 GHz
-22.53 dBm
PEAK
LOG
10
dB/
0
-10
-20
-30
WA SB
SC FC
CORR
SPAN
50.00 MHz
CONFIDENTIAL
CONFIDENTIAL
CONFIDENTIAL
14 mHz
14 mHz
CENTER 2.44215 GHz
RES BW 300 kHz
VBW 100 kHz
SPAN 50.00 MHz
SWP 20.0 msec
SPAN
SPAN ZOOM
FULL SPAN
ZERO SPAN
LAST SPAN
PEAK ZOOM

FIGURE #1

Appendix 2
Addendum to 10 - Proposed Experimental Plan

(a) *The complete program of research and experimentation proposed including description of equipment and theory of operation.*

The background and reason for the experimental verification is to conduct tests in various in-building and campus environments to verify the applicability of high data rate radio-based communications network systems.

Program of Research and Experimentation

1. <u>RF Environment Definition:</u> The first development phase will include extensive (mostly in-building and campus facility) characterization of the RF environment in terms of path loss, interference, noise, and delay spread. Conventional RF signal generators, spectrum analyzers, and radio test equipment will be used.

2. <u>Radio System Characterization:</u> The second developmental phase will involve system level testing. This testing will include in-building and campus deployment of radio based transceivers for the purpose of evaluating area coverage, system management, Bit Error Rate (BER), traffic control, noise performance, and data throughput.

   The equipment consists of: fixed host transceivers, and portable data transceivers. The fixed host transceivers will be positioned in the candidate test facilities and form the center of a cell (or service area). The portable radio transceivers will be connected to personal computers and moved throughout the test facilities to measure performance.

3. <u>Experimental Variables and Control:</u> The primary variables will be transmitted output power and data rate. The goal is to determine optimum combination of transmitted output power, range, and data rate to obtain reliable in-building and inter-building communications. The matrix of tests will include

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varying transmitted output power and monitoring BER to determine effective range.

4. <u>Experimental Facilities:</u> While the majority of the early developmental and experimentation work will be conducted at the 3Com facility in Santa Clara, CA, alternative sites will be chosen to evaluate performance in buildings with different construction materials and techniques.

5. <u>Demonstrations:</u> Technology and product feasibility demonstrations would be conducted at various sites including, but not limited to, beta test sites, trade shows, and sales demonstrations.

6. <u>Methods and Logging Data:</u> All early phase testing and evaluation will be conducted by experienced RF engineers and test technicians. Data and observations will be logged in and a 3Com Corporation document controlled engineering notebook. Later testing phases will require deployment of multiple fixed host transceivers and portable transceivers to determine the effectiveness of multiple service areas.

   Experiments will be logged according to location of fixed host transceivers and portable transceivers. Information regarding building maps, floors, network locations, and users identification will be recorded. Information regarding times of system start and stop, transmit average and/or peak power, and modulation type will be recorded. Entries will be updated as number of transceivers are changed. Data taken and recorded will be BER and range as a function of transmitted power and data rate.

(b). *The specific objectives sought to be accomplished*

The specific objectives for this experimental verification is to verify the applicability of high data rate radio-based communications network systems for in-building and campus applications. This requires detailed understanding of path losses, interference, jammers and their effects on BER, range , and throughput.

(c). *How the program of experimentation has a reasonable promise of contribution to the development, extension, expansion, or utilization of the radio art, or is along a line not already investigated.*

High speed data communications systems have not yet been deployed (in large numbers) for in-building applications. Key issues that impact the system implementation are path loss, effects of multipath and delay spread, range, and non-uniform area coverage. All of these RF medium dependent characteristics affect the network integrity though high BER and degraded throughput. While the proposed experiments will not contribute to the state of the radio art, the information is not presently available for high speed networks in the form usable for network system level analysis and architecting.

The experiments we are proposing will provide the necessary RF medium analysis to develop a unique network system level solution to in-building high speed portable data communications. These experimental results will help define key radio parameters such as: transmitted output power, modulation scheme, link budget, delay spread, effects of multipath, antenna requirements, radio architecture.

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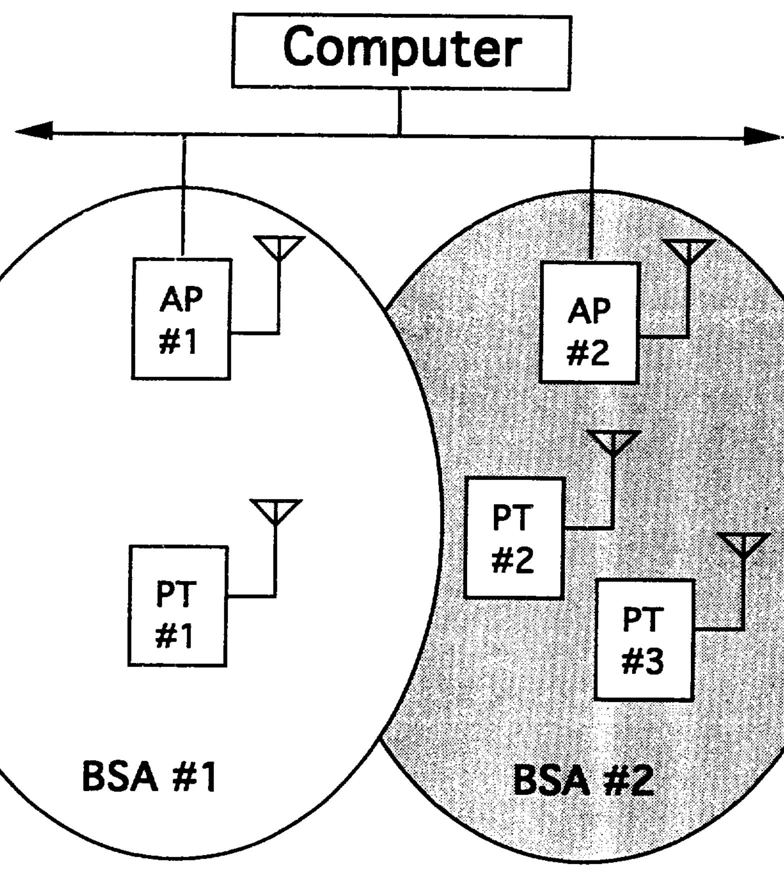
Appendix 3
Addendum to 13 - Transmitting Equipment

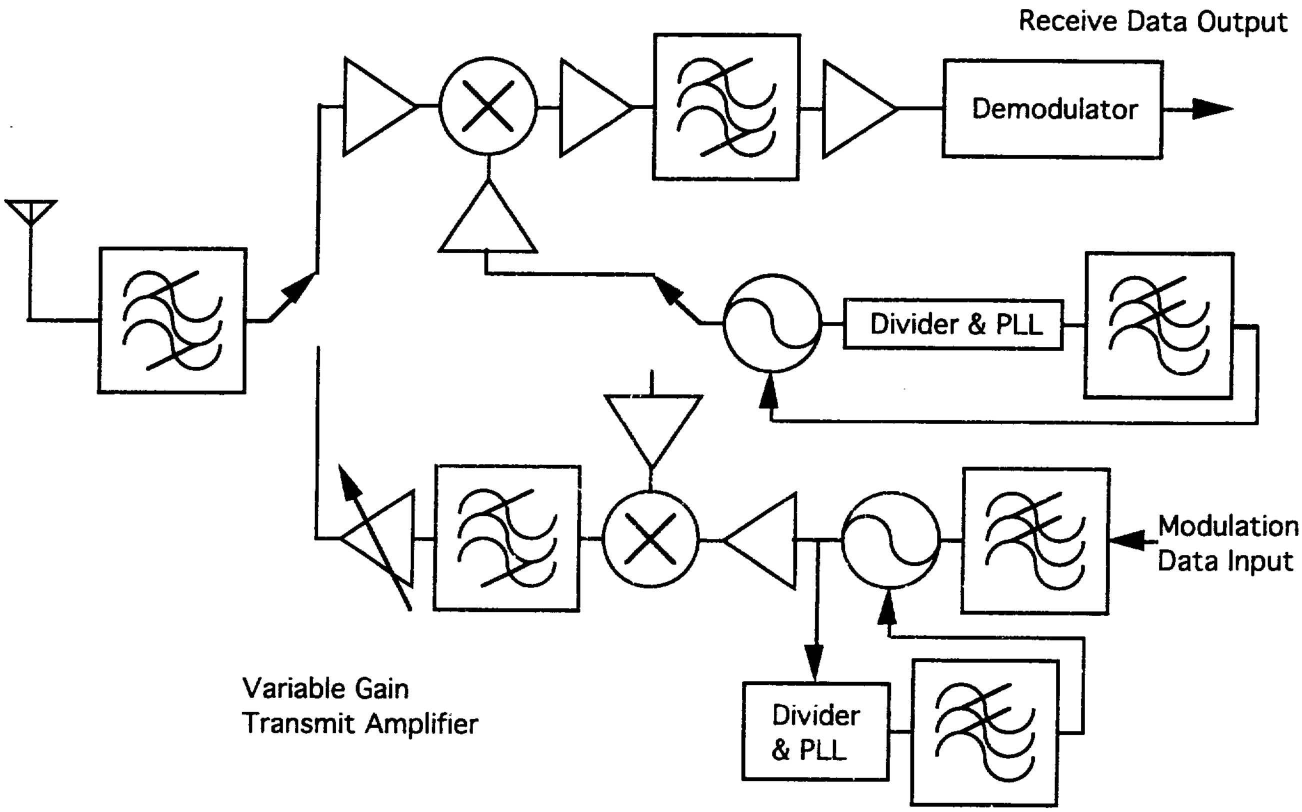
During the initial medium characterization phase, the transmitting and receiving equipment will consist of commercially available RF and microwave signal generators and spectrum analyzers. These will be used to gain a rough assessment of environmentally related propagation path losses.

Figure 1 is a general system level block diagram. In this diagram, the fixed host transceiver is called an Access Points (APs) and provides the connectivity from a wired environment to the radio environment. The portable transceivers are called PTs. The circles represent coverage areas. In this experimental phase, data traffic will be sent between the portable transceivers and a computer using the fixed host transceiver.



Block Diagram of General Evaluation System
Figure 1

Figure 2 is a block diagram of the test transceiver. Several modulation schemes will be considered for evaluation, they include: multi-level FSK, MSK, and GMSK. The test transceivers will include significant filtering and shielding to insure that radiated spurious signals stay below appropriate FCC limits.



Test Transceiver Block Diagram
Figure 2

The amplifiers and mixers are small to medium signal devices. The typical maximum transmit output power would be less then + 24 dBm ($P_{1\text{-dB}}$ of transmit amplifiers), into a 50 ohm load, and is controllable. The frequency sources are standard VCO designs locked through commercially available divider and phase locked loop chips. The frequency sources are locked to a common 19.668 MHz crystal and are agile. Modulation is accomplished by ac coupling the data into the loop of the VCO. The loop bandwidth was chosen to be below the minimum frequency component of the modulation input data.

The receiver is a simple broad-band block downconverter. The local oscillator is agile and steps the desired 14 MHz RF channel to the appropriate center frequency of the IF filter. A Surface Acoustic Wave (SAW) filter was chosen to provide tight filtering. The IF SAW filters provide sufficient rejection from out-of-band jammers and adjacent channel interference.

In addition to the above stated tests and equipment, a few additional tests may be run with and external linear power amplifier (up to 2 Watts peak) to determine extended ranges between buildings in a campus environment. Another possibility, in lieu of a linear power amplifier, would be a small directional antenna with 10 - 13 dB gain. These evaluations would likely be contained to the 3Com campus in Santa Clara, CA.