FCC 84-169
98 F.C.C.2d 380

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Authorization of spread spectrum and other wideband emissions not presently provided for in the FCC Rules and Regulations.	)	Gen Docket No. 81-413
	)	
	)	

FURTHER NOTICE OF INQUIRY AND NOTICE OF PROPOSED RULEMAKING

Adopted: May 21, 1984 **Released: April 26, 1984**

By the Commission:

INTRODUCTION AND BACKGROUND

1. On June 30, 1981, the Commission adopted a Notice of Inquiry ("Inquiry") *(46 Fed. Reg. 51259; 87 FCC 2d 876),* for the authorization of certain types of wideband modulation systems. The Inquiry is unusual in the way that it deals with a new technology. In the past, the Commission has usually authorized new technologies only in response to petitions from industry. However in the case of spread spectrum, the Commission initiated the Inquiry on its own, since its current Rules implicitly ban such emissions in most cases, and this prohibition may have discouraged research and development of civilian spread spectrum systems. As the next step in this proceeding, we are proposing in this Notice of Proposed Rulemaking rules that would authorize the use of spread spectrum under conditions that prevent harmful interference to other authorized users of the spectrum. We anticipate that this authorization will stimulate innovation in this technology, while meeting our statutory goal of controlling interference. We are issuing a Further Notice of Inquiry to solicit comments that will enable us to develop the appropriate test procedures for spread spectrum devices.

2. Spread spectrum is a term applied to communications systems that spread radio frequency energy over a wide bandwidth by means of an auxiliary spreading code. The spreading of the bandwidth can be accomplished in many different ways and the systems are usually classified by the type of spreading technique which they employ. They are commonly referred to as: direct sequence (or pseudonoise), frequency hopping, time hopping, pulsed FM (or chirp) and hybrid systems. (These terms are defined in Section 15.4 of the proposed rules in Appendix B.) The spreading or dilution of the energy in spread spectrum systems over a wide bandwidth results in several possible advantages: short range interference-free overlays on other emissions, resistance to interference from other emissions, and low detectability. While we do not anticipate that spread spectrum will replace other types of modulations, the unique characteristics of spread spectrum offer important options for the communications system designer.

3. Although most spread spectrum systems are presently used in government applications, there are some non-government systems also in operation. In some instances, the existing Rules and Regulations allow such operation, in other cases, permission to operate has been obtained through special authorization. Under Section 90.209(b) and under footnote US217 in Section 2.106 of the Rules and Regulations, spread spectrum systems for radio location purposes can be licensed for operation in the 420-435 MHz band. Also, special authorization was given to the Amateur Radio Research and Development Corporation to conduct spread spectrum tests in the 50.0-54.0, 144-148 and 220-225 MHz bands. Under Part 25 of the Rules and Regulations which deals with Satellite Communications, licensees are only required to meet certain power attenuation standards and are not limited in operation by any specific emission designators.

This, plus the wide bandwidth available in the 4.4-4.7 GHz band, has enabled Equatorial Communications Company to use spread spectrum in its satellite communications. n1

n1 On April 14, 1980, Equatorial was granted permission to provide a 9600 bit per second data distribution service using spread spectrum transmissions. The signals were broadcast from a large earth station in Mountain View, California and were rebroadcast from a satellite to customers which received them with 0.6 meter (2 foot) diameter receiving antennas. Over 6000 of these systems were sold in 1983. Equatorial's filings with the Commission concerning this system have been given the reference file numbers W-P-C-3078 and W-P-C-3476. On March 5, 1984, Equatorial was granted permission to use spread spectrum in a 1200 bit per second satellite uplink using a 1.2 meter (4 foot) transmitting antenna. Equatorial's filings with the Commission for this system have been given the reference file numbers 962-DSE-P/L-83 and 963/964/965-DSE-ML-83. In both of these cases, the data is spread to 5 MHz using direct sequence pseudonoise modulation. This spreading is essential for these applications in order to allow the use of small antennas and prevent interference to other satellites and terrestrial users.

4. These are some of the services in which spread spectrum systems are now operating in accordance with the current FCC Rules and Regulations. In the Inquiry, we sought to determine whether it would be in the public interest to authorize spread spectrum in an additional number of services and over a broader range of frequencies. There is some interest in spread spectrum communications because these systems offer certain advantages over conventional communications systems. For example, since the spreading functions for these systems are not uniquely specified, different codes can be used to obtain selective addressing as well as message privacy. As a result, code-division multiple access systems can be implemented using spread spectrum techniques. Also, the low spectral density needed for spread spectrum communications systems, as well as the ability of some of these systems to process signals that are buried far into the noise, offer a potential for shared spectrum use with existing systems on a non interference basis. Finally, spread spectrum systems could be useful in applications to control multipath interference.

5. In the Inquiry, we also requested comments on the interference potential of spread spectrum systems to existing services, their frequency allocations, and the measurement of their emissions for monitoring as well as equipment authorization purposes. Information was also solicited concerning what services might be authorized, what transmitted power should be allowed, how can the transmissions be measured, should spectrum overlay of existing systems be allowed and what potential exists for interference with existing communications.

6. We also brought to the public's attention a study made by the MITRE Corporation on the potential use of spread spectrum techniques in non-government applications ("Scales Report") and a second study made by the IIT Research Institute (IITRI) on the analysis of interference caused by spread spectrum signals ("Newhouse Report"). n2 Comments were invited on the appropriateness of using the theoretical models developed in these reports as a basis for rulemaking.

n2 Walter C. Scales, "Potential Use of Spread Spectrum Techniques in Non-Government Applications", the MITRE Corporation, PB 81-165284, December 1980.

Paul Newhouse, "Procedures for Analyzing Interference Caused by Spread-Spectrum Signals", IIT Research Institute, Report #ESD-TR-77-003, AD-A056911, February 1978.

Copies of these reports may be purchased from the National Technical Information Service, Springfield, Va., 22161, Tel. (703)-487-4650. Scales and Newhouse have presented tutorials at the FCC on their reports. These presentations are useful background information for those preparing comments in this area and copies of videotapes are available from the Prism Corporation, 4545 42nd St., NW, Suite 109, Washington, D.C., 20016, Attn: Donna Edwards, Tel: (202)-686-8250.

DISCUSSION OF COMMENTS AND REPLY COMMENTS

7. Sixteen comments and twelve reply comments were filed in response to the Inquiry. A list of those filing comments is contained in Appendix A. The comments received were primarily in reply to the questions raised in the Inquiry and no new matters or issues of significance were raised. Although several questions in the Inquiry specifically

addressed the use of spread spectrum in police applications, there were no responses to the Inquiry from police agencies or associations or from any public safety group. The replies to the Inquiry were primarily from manufacturers, individuals and broadcast groups.

8. In general, most of the replies were favorable to the overall concept of spread spectrum communications. It was felt that there are many useful communications applications which could be achieved with spread spectrum techniques that could not be satisfactorily developed with any other technology. However, many had reservations about the particular implementation of spread spectrum systems and expressed concern over the potential for interference with existing communications systems. Because the technology is so new, many urged the Commission to proceed slowly with its implementation until we have had successful operating experience with these systems, including the identification and measurement of spread spectrum signals and their interference potential. There was particular concern among some parties that regular communications might be interrupted and the Commission might not be able to detect the source of the interference.

9. Various parties as well as the Commission suggested many civilian applications of spread spectrum techniques. These were:

a. wireless data terminals

b. wireless microphones

c. cordless telephones

d. wireless intercoms

e. remote area telephone service

f. Radio navigation and ranging

g. intrusion alarms

h. police radar

i. police tracking and trailing devices

j. a wide range of telemetry applications

k. remote control applications both domestic and industrial

Although many of these applications duplicate existing services, there are some instances where spread spectrum systems could provide a superior and less expensive alternative to the systems presently in use. Lucasfilm Ltd., which makes extensive use of wireless microphones, made this observation in their comments:

[W]e would like to offer the Commission comment from a potential user for whom spread-spectrum techniques may provide the only solution to a standing problem. . .. special circumstances surround the use of FCC-authorized "radio microphones" in the production of theatrical motion pictures. It is the experience of every user with whom I have compared notes, that narrow-band FM radio microphones provide unreliable communications. Multiple transmission paths cause frequent complete drop-outs of signal, with the resultant loss of a great deal of time and money. . . . One need only listen to the tapes from the locations of C3PO of the next "Star Wars" film with its nearly continuous drop-outs to realize the potential importance of spread spectrum techniques.

[Lucasfilm Ltd., Comments, June 28, 1982; pages 1 and 2]

10. Regarding the use of spread spectrum techniques in police communications, only GE and the IEEE Communications Society Subcommittee commented on whether non-jammable police radars could be developed using spread spectrum. Both thought that this type of spread spectrum implementation was not needed at the present time. Although no formal responses were received on this issue, we did receive an informal inquiry from Transcript/International Inc. concerning the use of spread spectrum in police trailing applications. n3

n3 Transcrypt/International Inc. has developed frequency hopping transmitters which they have been demonstrating to law enforcement agencies for possible use in the police radio service.

11. Concerning the parameters that characterize spread spectrum emissions and the methods for their detection and measurement, there was much broad comment but very little concrete detail. It was generally felt that each type of wideband modulation system has its own unique characteristics, and that different measurement techniques would be needed for each of the different spread spectrum systems. Some thought that the average power per unit of bandwidth would be an adequate measure of the spectral emissions and that this measurement could be made on a spectrum analyzer. However, no specific procedures were given for making these measurements, and no useful analysis was provided of the levels and character of the emissions to be expected at various distances from a spread spectrum transmitter. It was suggested that the American National Standards Committee C63 on Radio-Electrical Coordination might be of some help to the Commission in setting up adequate monitoring and measurement standards.

12. Although few parties commented on the Newhouse and Scales theoretical models, those who did felt that the models were not sufficiently accurate or complete to be used as a basis for frequency allocation or to predict the interference to conventional systems from spread spectrum signals. They felt that both Newhouse and Scales have greatly expanded our knowledge in this area; but, that for any theoretical model to be accepted as a standard, it would have to be first thoroughly checked against experimental data over a wide range of test conditions.

13. The topic that caused the most concern was the potential interference that spread spectrum systems might cause to existing services. Some concern was also expressed about the possibility of spread spectrum systems interfering with each other. GE felt that the interference problems presented by spread spectrum systems may be so great as to preclude their successful implementation in the land mobile services. Because of this, they thought that spread spectrum systems should not be authorized in mobile services but should be confined to the FIXED services.

14. Both GE and RCA objected to authorizing spread spectrum systems in the Industrial, Scientific and Medical (ISM) bands because m any Part 15, low power consumer devices, such as home security devices and video disc systems, have already been authorized to operate in some of the bands. Not only were they concerned that spread spectrum systems operating in the ISM bands might cause interference to these devices, they also feared that any interference could lead to restrictions on the ISM bands for all Part 15 devices. Although RCA's objections were limited to the ISM bands below 1000 MHz, GE did not qualify its objections. All other parties responding to this issue felt that spread spectrum systems should be authorized in the ISM bands.

15. With the exception of NTIA, all of the respondents who specifically addressed the issue were against the overlay of spread spectrum systems upon existing services. However, these respondents made no explicit objection to the use of spread spectrum in low-powered, limited range applications. Indeed, most of the suggested applications for spread spectrum implementation were for systems of this type. Nevertheless, there was considerable concern about the interference to existing services from spread spectrum systems, regardless of the power levels involved. It was hoped that the interference could be minimized or completely eliminated, through the establishment of sufficient standards for the measurement and monitoring of spread spectrum emissions. In their comments, NTIA has pointed out that there are military and government spread spectrum systems which are presently operating in the frequency bands of other services, and are apparently causing no harmful interference to these services. However, they also state that in order to prevent interference to the overlayed services, some constraints and limitations had to be placed upon the operation of the spread spectrum systems.

PROPOSED RULEMAKING FOR SPREAD SPECTRUM AUTHORIZATION

16. It appears that most low power communication devices, currently authorized under Part 15 of our Rules and Regulations, could be considered as potential candidates for spread spectrum. As the staff at the Commission's Laurel Laboratory facility has considerable experience in measuring the emissions from Part 15 devices, the authorization of spread spectrum devices under this section of the Rules is attractive, since the expertise of the Laboratory staff could be drawn upon in establishing measurement standards for these devices and monitoring their emissions. However, most of the measurements at the Laboratory have been made on narrowband transmitting systems. Consequently, we will also have to rely on comments and help from outside the Commission in developing meaningful measurement standards for broadband systems. We would like to draw upon industry's knowledge and resources in this area and invite their comments on the development of such broadband measurement standards.

17. The authorization of spread spectrum systems under Part 15 of the Rules is attractive from another point of view. With the exception of frequency hopping systems, spread spectrum devices require continuous bands of spectrum in which to operate. But since Part 15 low power communication devices are authorized to operate on all frequencies above 70 MHz, subject to certain restrictions, spread spectrum systems authorized under this Part of the Rules would have access to this broad continuous area of spectrum. This essentially unlimited amount of spectrum is therefore

important to spread spectrum use. Also, authorization of spread spectrum devices under Part 15 would allow considerable experimentation to be done on devices such as wireless microphones and wireless data terminals without Commission regulations restricting their development. At the same time, the Commission might be spared the immediate need to allocate additional spectrum space for these services and for other requested services such as cordless telephones. Many specific problem areas, such as those pointed out by Lucasfilm Ltd., could perhaps also be eliminated by Part 15 spread spectrum authorization. The use of spread spectrum in existing types of Part 15 devices, such as cordless phones and garage door openers, might increase their interference rejection capability while decreasing their potential interference to other systems and improving their privacy.

18. The authorization of spread spectrum systems under Part 15 of the Rules and Regulations would be unrestrictive and unregulatory in nature, since devices operating under Part 15 do not have to be licensed and users do not face eligibility requirements, content regulation, or coordination requirements. This would allow the forces of the marketplace to drive the implementation of this new technology, unhampered by regulations other than those needed to prevent harmful interference to licensed systems. Because of this, we are proposing to allow spread spectrum usage, under Part 15 of our Rules, for all low power communication devices which transmit or receive information on frequencies on or above 70 MHz. For frequency hopping, time hopping and pulsed FM systems, the levels of emissions which are being proposed are comparable with those presently authorized in the Rules for low power communication devices. For direct sequence systems, the levels of emission have been chosen so that the signals will not affect passable television quality (TASO grade 3) at a distance of 10 meters from the transmitter. Television receivers, because of their wide channel bandwidth, are generally more sensitive to interference than narrowband receiving systems. Hence, the emission limits which have been chosen to protect the television services, should be sufficient to protect narrowband systems from interference also. Emergency and radio astronomy bands have been protected in the proposed rules by placing stringent limits on the radiation which can be emitted in these bands. (See paragraph 15.126(c) of the proposed rules in Appendix B.) These constraints should minimize the probability of harmful interference to any of the existing services.

19. Spread spectrum devices, authorized under the rules proposed in this NPRM, will be required to be certified as a prerequisite to marketing. The Rules for the certification of Part 15 low power communication devices are given in the Rules and Regulations under Part 15, Subpart B. The Commission has the discretionary authority to call in sample devices for testing as part of the certification process. As we have done in the past with cordless telephones, CB radios, home computers and other devices and in response to the comments received in this proceeding, we expect to engage in a thorough sampling program until we are confident that the manufacturers have gained sufficient knowledge and skill in building them, so that they pose no potential interference problems.

20. The present Rules specify power and bandwidth limits for all low power communication devices. They also specify that, for devices authorized under the general provisions of Section 15.122, periodic operation in the bands 41.66-40.70 MHz and above 70 MHz, the duration of each transmission shall not be greater than one second and the silent period between transmissions shall be at least 30 times the transmission duration but in no case less than 10 seconds. Although, we are proposing to authorize spread spectrum systems under a new, separate section of the Part 15 Rules, Section 15.126, the new proposed rules were modeled after those of Section 15.122 and were made consistent with the rules and requirements of that section to the greatest extent possible. Nevertheless, in order to accommodate spread spectrum systems under this Section of the Rules, some of these requirements have to be amended.

21. As we have indicated above, we are proposing to allow spread spectrum systems to operate on any range of frequencies above 70 MHz without any restrictions on their occupied bandwidths. And since a requirement of a 10 second minimum time between transmissions for spread spectrum devices could severely hamper the development of this technology, we are proposing to eliminate this restriction for these devices. However, spread spectrum systems would be subject to power and spectral occupancy limits that are comparable with those presently in the Rules, and for frequency hopping, time hopping and pulsed FM systems, a modified form of the 1/30 transmission on/off time requirement would apply also.

22. Time hopping and pulsed FM, spread spectrum systems can meet the present power and transmitting time on/off limits, if the measured field strength of their emissions on any frequency is no greater than those presently specified in this Part of the Rules, and if their duty cycles are less than 3.3%. Frequency hopping systems will also meet these requirements, if they are subject to this same field strength criteria, if 30 or more hopping frequencies are used, and if the transmission time on any one frequency is less than 1 second. However, because frequency hopping, time hopping and pulsed FM systems could cause considerable interference to television reception if they were allowed to indiscriminately operate within the television bands, restrictions have been placed upon the use of the television bands by these systems. If these systems operate on frequencies which fall within the television bands, it is proposed that

they either be designed so that they do not have a total time of occupancy on any single television channel that is greater than one second out of every 30 seconds, or that they be provided with a switch or switches, that will enable the equipment to be operated on channels which are unused in that area. A television channel will be considered as used in an area, if the spread spectrum transmitter under consideration will produce a field, within the grade A contour of the television station using that channel, which is greater than 10 microvolts per meter.

23. With regards to interference, direct sequence systems pose a different type of problem since they require a continuous occupancy of the frequency bands in which they are operating. Juroshek has shown that the interference to television by direct sequence signals is of the same magnitude as that from narrowband signals of equivalent power. n4 But for narrowband interference, a signal to interference ratio of 50 dB will yield a television picture of passable quality. n4,n5 At the grade A contour, most locations can tolerate a wideband or narrowband interference signal of approximately 10 microvolts per meter. Thus, the proposed maximum emission level of 33 microvolts per meter, measured at 3 meters, corresponds to no significant interference to most TV receivers that are 10 meters away from the emitter at the grade A contour, or 15-100 meters away (depending on channel number) at the grade B contour. It should be noted that this level of radiation is far below that presently allowed for Part 15, low power communication devices. The proposed changes to Part 15 of the Rules and Regulations for spread spectrum devices are presented in Appendix B.

n4 John R. Juroshek, "A Preliminary Estimate of the Effects of Spread-Spectrum Interference on TV", NTIA Report 78-6, June 1978.

n5 CCIR Report 523, 1974, "System Models for the Evaluation of Interference", International Telecommunications Union, Geneva.

24. The limits on the effective radiated power from spread spectrum devices, operating on frequencies on or above 70 MHz, are presented in Section 15.126(a) (cf. Appendix B). It should be noted that no fixed limits are being placed on the radiated power of spread spectrum devices operating in the 902-928 MHz, 2400-2483.5 MHz and 5725-5875 MHz ISM bands. n6 In these bands, all devices are allowed sufficient power for satisfactory operation, providing they do not cause harmful interference to other users of the bands, or produce unacceptable levels of radiated emissions outside the bands. The proposed rules would authorize spread spectrum systems to share these bands on a secondary non-interference basis with the primary users. n7 The majority of the comments favored allowing spread spectrum systems to operate in these bands. Also, in the previously cited report, "Potential Use of Spread Spectrum Techniques in Non-Government Applications", Scales recommended that the Commission consider the implementation of spread spectrum systems in the ISM bands. Although GE and RCA have presented arguments against the shared usage of the ISM bands, we do not feel that they outweigh the considerable advantages to be gained from sharing these bands with spread spectrum systems. If spread spectrum systems can contend with the heavy interference from the other users of these bands, then these bands could offer an excellent proving ground for high power spread spectrum applications. Comments are requested on this issue.

n6 RM-4426, a petition for rulemaking filed by Geostar Corporation for a radio location satellite service, requested use of the 2483.5-2500 MHz band. The availability of this band for spread spectrum communications systems will depend on the final disposition of the Geostar petition.

n7 NTIA has recently studied the current and potential electromagnetic usage of these three bands. Their findings are contained in the following reports.

Bohdan Bulawka, "Spectrum Resource Assessment in the 902-928 MHz Band", NTIA Report 80-46, September 1980.

Robert T. Watson, "Spectrum Resource Assessment in the 2300-2450 MHz Band", NTIA Report 81-78, September 1981.

William B. Grant, John C. Carroll and Charles J. Chilton, "Spectrum Resource Assessment in the 5650-5925 MHz Band", NTIA Report 83-115, January 1983.

25. In response to Transcrypt/International's inquiry concerning the use of spread spectrum in police communications, we are proposing to authorize frequency hopping and direct sequence systems to operate on a limited basis on certain frequencies in the Public Safety Radio Services. This authorization would be only for Police Departments' use

of Public Safety spectrum for the purpose of communications in connection with physical surveillance, stakeouts, raids and other such activities and would be on a secondary basis to operations of licensees regularly authorized on these frequencies. Approval of the area frequency coordinator must be obtained prior to operation. The proposed changes to Part 90 of the Rules and Regulations to accomplish this are presented in Appendix B.

26. Because criminals have become increasingly more sophisticated in the means which they use to monitor police communications and detect surveillances, law enforcement officers must use increasingly sophisticated methods to guard their communications. Since spread spectrum transmissions are not readily detectable by criminals monitoring the air waves and are difficult to jam, this form of communications can become an extremely valuable tool for police. Federal law enforcement agencies, operating radio systems under *47 USC 305,* have been authorized on a case by case basis by the National Telecommunications and Information Administration to use spread spectrum in their operations. This proposed rule gives state and local law enforcement agencies this same, important capability.

27. Under the proposed changes to Part 90 of the Rules, frequency hopping systems would be allowed to operate on any of the frequencies which are presently available to the Police Radio Service and listed in Section 90.19(d) of the Rules. The power limit specified for the users of these frequencies is 2 watts. Hence, frequency hopping systems, which are operating on these frequencies, are not expected to cause harmful interference to other users, if their maximum output power is kept below 2 watts. However, if the hop rate of these systems is greater than 10 hops per second and more than 10 hopping frequencies are used, then we feel that a maximum output power of 15 watts can be allowed and still not cause objectionable interference to the other users, since the time of continuous occupancy of any single frequency, by the frequency hopping system, will be less than one tenth of a second. Also, direct sequence spread spectrum systems will be allowed to operate in the 37.01-37.43, 39-40, 44.61-46.6, 154.6375-156.250 and 158.715-159.48 MHz Public Safety bands, if their maximum integrated output power is limited to 10 mW per kHz. The level of this signal is about one-tenth of that allowed for the other users of these bands and therefore the potential for interference is small.

28. We recognize that there is a potential for increased interference in allowing spread spectrum systems to share spectrum with conventional radio services. The proposed operation of spread spectrum devices under Part 15 of the Rules on frequencies above 70 MHz could depending upon power levels allowed and other technical details, potentially affect Private Radio, Mass Media, and Common Carrier Services. We are particularly determined to avoid harmful interference to the Public Safety Radio Services from devices operating under both Part 15 and Part 90 of the Commission's Rules. Communications in the public safety services are directly related to the safety of life and property. As such, harmful interference could have a direct and adverse effect on the public. Public safety licensees operate radio systems in the 30 MHz, 150 MHz, 450 MHz, 470 MHz, and 800 MHz private land mobile bands. We have attempted to minimize this potential for interference by choosing conservative technical standards and, in the case of operation under Part 90, by requiring frequency coordination. We request comments on the ability of our proposed rules to ensure the integrity of public safety communications as well as other services.

29. Although automatic identifiers for spread spectrum systems are not being considered in this proceeding, we may in the future have to consider some form of transmission identifier to assist us in identifying and locating units which may be causing interference. Hence, comments are sought on the feasibility of using such identifiers and the particular form that they might take. (As an example, Del Norte Technology Inc. uses a blanking technique to superimpose Morse code on their emissions with the identifiers DN and DNT for their spread spectrum radio location devices.) n8 It should be noted that there could be some difficulties with using these identifiers. For instance, the transmitted designator could be so strong that it could cause interference even when the signal it is identifying is not causing any, and on the other hand, it could be so weak that it might remain undetected while the signal which it is identifying is causing interference. We are requesting comments as to whether these difficulties pose real hindrances to the use of transmitter designators with spread spectrum communications systems. If not, what form should the designator take and what power levels should be specified?

n8 *47 Fed. Reg. 34415,* "Revisions of Parts 2 and 90 of the Commission's Rules and Regulations to permit inland assignment of frequencies in the 420-450 MHz band for non-Government radio location", Second Report and Order, General Docket No. 80-135, Paragraph 14.

30. We may wish to consider spread spectrum transmissions that are carried by line conducted carrier current. There are many practical applications of spread spectrum systems which could be realized if the transmissions could be carried by this means. At the present time, line conducted transmissions are only allowed in restricted instances be-

cause of the danger of feeding interference back into the mains. Anticipating a possible future concern of the Commission in this area, we are requesting comments on the conditions under which this method of transmission would be practical for spread spectrum systems in domestic, business and industrial environments. Also, what power levels and frequency ranges should be specified and what range of transmission frequencies should be allowed? What precautions should be taken so that excessive spread spectrum signal strength does not feed back into the mains?

31. One area in which we expect significant growth for spread spectrum systems is in its use in wireless data terminals. The Commission has already received several inquiries concerning this use for spread spectrum and experimental licenses for such devices have already been issued. n9 To help us anticipate industry's needs in this area, we are requesting comments as to whether the Rules, proposed here, are sufficient to allow spread spectrum wireless data terminals to operate efficiently in domestic, business and industrial environments. Also, in order to further promote this promising application, should we consider authorizing two classes of wireless data terminals under Part 15 as is presently done with computing devices? Alternatively, should such data terminals require a license if they exceed a certain emission limit? If so, what power and emission limits should be imposed? On the other hand, if in order to operate efficiently, these terminals would require bands of their own, where should they be located and what should the power limits be?

n9 Hewlett-Packard has been issued experimental licenses under Part 5 of the Rules to develop and operate direct sequence, spread spectrum wireless data terminals in the 2450-2550 MHz band. All of the licensed facilities are in California. Although the need to broadcast call signs has been waived by the Commission in this instance, the identifying call signs associated with these facilities are: KM2XPS, KM2XPV, KM2XPW, KM2XPX AND KM2XPY.

NOTICE OF INQUIRY

32. For equipment authorization and monitoring purposes, standards will have to be established for the measurement of spread spectrum emissions. However, because of the unique problems associated with the detection and measurement of these signals, we are unable at this time to furnish the appropriate procedures for their measurement. These will be released with the final Report and Order. To develop these procedures, we will need considerable assistance from business and industry to help solve the many difficult problems associated with these types of measurements. Some areas of concern about which we seek comments are:

1. With the power levels proposed for Part 15, spread spectrum transmitters, is it feasible, or even possible with our present measurement techniques, to measure the field strength of emissions from this equipment at outdoor 3 meter test sites? If so, what antennas would be the most suitable for making the measurements? (It should be kept in mind that, since most antennas become very inefficient at high frequencies, i.e., their antenna factors become very large, it may not be possible to detect and accurately measure low powered, spread spectrum signals, at these test sites. Also, remember that, since it is proposed that spread spectrum operations be allowed on all frequencies above 70 MHz, several different antennas will be needed to span the range over which these systems will be operating.)

Would the same measurement procedures suffice if field strength levels listed in Section 15.126(a) were to be decreased by 20 dB? What would the test procedures be in this case?

2. Measurements could perhaps be made more easily and accurately indoors, by measuring the output signal from the devices at a point just prior to any passive antenna tuning network that is used. What should be measured here: the total power of the unmodulated carrier, the power density over a specified frequency range or some other parameter? How can these measurements be coordinated with the field strengths specified in Section 15.126(a) of the proposed Rules (cf. Appendix B)? Will there be any difficulty in adjusting the data for transmission line loss and antenna gain?

3. Perhaps all of the equipment authorization measurements will have to be made indoors on a test bench. For accuracy and repeatability in making these measurements, we may require that the manufacturer install, on devices that are submitted for test, some type of low loss RF connector at a point on the device just prior to any passive antenna tuning network that is used. What type of a connector should be specified? (If possible, the generic name of the connector should be used rather than the brand name.)

4. How should the connector be coupled to the network to prevent it from loading down the device? What impedance matching standards should be specified to prevent either the connector or the measuring equipment, which is to be attached to the connector, from interfering with the operation of the device? (Remember, that these connectors, if re-

quired, will only be mounted on the piece of communications equipment which the manufacturer submits for testing. They will not be allowed on devices which are produced for the general public. Hence, the addition of the connector to the device should not substantially change its operating characteristics.)

5. What equipment should be used to make the measurements? Are both spectrum analyzers and field intensity meters adequate for making these measurements or would the noise floors of these instruments mask the signals which are being measured?

6. What IF bandwidth should be used? Although the specification of a 1 MHz IF bandwidth is appealing and is easily attainable on most instruments, it is perhaps not adequate for measuring spread spectrum signals because their bandwidth is so large. The trade-off for reduced IF bandwidth is the speed of making the measurements and it would take 10 times longer to scan a given spectrum with an instrument with a 1 MHz IF bandwidth as it would with one that had a 10 MHz bandwidth. And for signals which may span several GHz, even a 10 MHz IF bandwidth may not be adequate.

7. What scanning speed should be used to ensure that a representative sample of the spread spectrum transmission is actually being measured? Would a scanning speed that is one twentieth that of the spreading code be sufficient?

8. To speed up the measurements, what equipment could be used that will provide a greater IF bandwidth and yet would not sacrifice the accuracy of the measurements?

9. How can the test procedures for both indoor and outdoor measurements be automated?

10. What test data should we ask the manufacturers to supply for equipment authorization purposes?

We will give consideration to the information, which is submitted, in setting up our internal measurement standards, which we will make available to the public in a technical note or report.

HOW TO FILE COMMENTS

33. In accordance with the procedures set forth in Section 1.415 of the Commission's Rules, interested persons may file comments on or before September 14, 1984 and reply comments on or before October 12, 1984. All relevant and timely comments will be considered by the Commission before final action is taken in this proceeding. In reaching its decision, the Commission may take into consideration information and ideas not contained in the comments, providing that such information, or a writing indicating the nature and source of such information, as placed in the public file, and provided that the fact of the Commission's reliance on such information is noted in the Report and Order.

34. In accordance with the provisions of Section 1.419 of the Commission's Rules, formal participants shall file an original and 5 copies of their comments and other materials. Participants wishing each Commissioner to have a copy of their comments should file an original and 10 copies. Members of the general public who wish to express their interest by participating informally may do so by submitting one copy. All comments are given the same consideration, regardless of the number of copies submitted. All comments should be clearly marked General Docket No. 81-413, and will be available for public inspection during regular business hours in the Commission's Public Reference Room at its headquarters at 1919 M St., NW. Washington, D.C. All written comments should be sent to: Secretary, Federal Communications Commission, Washington, D.C., 20554. For general information on how to file comments, please contact the FCC Consumer Assistance and Small Business Division at (202) 632-7000. For further information on this proceeding, contact Dr. Joseph McNulty at (301) 725-1585 or Dr. Michael Marcus at (202) 632-7040.

INITIAL REGULATORY FLEXIBILITY ANALYSIS

35. Reason for Action. The Commission believes that its rules and policies should be reviewed in the context of current social, technological and financial environments in which licensees and applicants operate, so that service to the public may be facilitated while the least regulatory cost is imposed. It is in this light that it is considering modification of its Part 15 and Part 90 rules.

36. The objectives. The Commission proposes to accommodate spread spectrum systems by reducing regulation to the maximum extent feasible. The commission believes that such action will lead to a more rapid development of spread spectrum technology in the civilian sector.

37. Legal basis. Action proposed herein is taken pursuant to Sections 4(i) and 303 of the Communications Act of 1934, as amended.

38. Description, potential impact and number of small entities affected. We do not believe that this NPRM will have a detrimental impact upon small entities. Indeed, insofar as our action contemplates spectrum reuse, it is likely that it will benefit both small and large entities which seek to enter the new markets that this action will create. Also, since the action is deregulatory in nature and no new, more restrictive regulations are being proposed, it should provide expanded business opportunities for all vendors and users of communications equipment, both small and large. Beyond this, we are unable to quantify the potential effects of this action on small entities. Comments are requested on this point by interested parties.

39. Recording, record keeping and other compliance requirements. The proposed modifications to Part 15 of the Rules would require only record generation by the manufacturer sufficient to meet type acceptance standards for the equipment. Modifications of the Part 90 rules require only a simple onetime notification to the area coordinator of the Police Radio Service of the district in which the license and equipment are to be used.

40. Federal rules which overlap, duplicate or conflict with this rule. The proposed rules were coordinated with the National Telecommunications and Information Administration. Their replies on this issue will be carefully considered to ensure no conflict will be encountered with Federal rules.

41. Any significant alternatives minimizing impact on small entities and consistent with the stated objective. None.

OTHER PROCEDURAL MATTERS

42. EX PARTE CONSIDERATIONS: For purposes of this non-restricted notice and comment rulemaking proceeding, members of the public are advised that ex parte contacts are permitted, from the time the Commission adopts a notice of proposed rulemaking, until the time a public notice is issued stating that a substantive disposition of the matter is to be considered at a forthcoming meeting, or until a final order disposing of the matter is adopted by the Commission, whichever is earlier. In general, an ex parte presentation is any written or oral communication (other than formal written comments/pleadings and formal oral arguments) between a person outside the Commission and a Commissioner or a member of the Commission's staff which addresses the merits of the proceeding. Any person, who submits a written ex parte presentation, must present a copy of that presentation to the Commission's Secretary for inclusion in the public file. Any person, who makes an oral ex parte presentation addressing matters not fully covered in any previously-filed written comments for the proceeding, must present a written summary of that presentation to the Commission's Secretary for inclusion in the public file on the day that the presentation is made. A copy of the summary must also be presented to the Commission official who receives the oral presentation. The written presentation and summary, described above, must state the docket number of the proceeding to which they relate. For further information, see Section 1.1231 of the Commission's Rules, (47 C.F.R. 1.1231). A summary of the Commission's procedures governing ex parte presentations in informal rule making proceedings is available from the FCC Consumer Assistance and Small Business Division, Federal Communications Commission, Washington, D.C., 20554.

43. THE COMMISSION'S ACTION IN THIS PROCEEDING: Accordingly, the Commission adopts this Notice of Proposed Rulemaking (NPRM) under the authority contained in Sections 4(i) and 303 of the Communications Act of 1934, as amended.

Federal Communications Commission

William J. Tricarico

Secretary

APPENDIX A

LIST OF PARTIES SUPPLYING COMMENTS AND REPLY COMMENTS TO THE NOTICE OF INQUIRY

The following parties supplied Comments to the Notice of Inquiry:

Association of Maximum Service Telecasters, (MST)

American Petroleum Institute,

American Telephone and Telegraph Company, (ATT)

Communications Satellite Corporation, (COMSAT)

Cryptext Corporation

General Electric, (GE)

GTE

Hewlett-Packard, (HP)

M/A-COM

Motorola

National Association of Broadcasters, (NAB)

National Association of Business and Educational Radio, Inc., (NABER)

RCA

Telecommunications Engineering, Inc., (TEI)

Special Industrial Radio Service Association, (SIRSA)

U.S. Dept. of Transportation, Maritime Administration

The following parties supplied Reply Comments to the Notice Of Inquiry:

American Broadcasting Companies, Inc., (ABC)

American Telephone and Telegraph Company, (ATT)

Wesley G. Bush

Lawrence F. Chesto

Communications Theory Committee of the IEEE Communications Society

Del Norte Technology, Inc.

Equatorial Communications Company (Equatorial)

General Electric, (GE)

Hewlett-Packard, (HP)

IEEE Committee on Communications and Information Policy

Lucasfilm, Ltd.

U.S. Dept. of Commerce, National Telecommunications and Information Administration, (NTIA)

APPENDIX B

PROPOSED CHANGES FOR FCC RULES AND REGULATIONS PART 15 AND PART 90 CHANGES

1. Section 15.4, General Definitions, is amended by insertion of the following definitions:

(t) Spread Spectrum Systems. A spread spectrum system is an information bearing communications system in which: (1) information is conveyed by modulation of a carrier by some conventional means, (2) the bandwidth is deliberately widened by means of a spreading function over that which would be needed to transmit the information alone. (In some spread spectrum systems, a portion of the information being conveyed by the system may be contained in the spreading function.)

(u) Direct Sequence Systems. A direct sequence system is a spread spectrum system in which the incoming information is usually digitized, if it is not already in a binary format, and modulo 2 added to a higher speed code sequence. The combined information and code are then used to modulate a RF carrier. Since the high speed code sequence dominates the modulating function, it is the direct cause of the wide spreading of the transmitted signal.

(v) Frequency Hopping Systems. A frequency hopping system is a spread spectrum system in which the carrier is modulated with the coded information in a conventional manner causing a conventional spreading of the RF energy about the carrier frequency. However, the frequency of the carrier is not fixed but changes at fixed intervals under the direction of a pseudorandom coded sequence. The wide RF bandwidth needed by such a system is not required by a spreading of the RF energy about the carrier but rather to accommodate the range of frequencies to which the carrier frequency can hop.

(w) Time Hopping Systems. A time hopping system is a spread spectrum system in which the period and duty cycle of a pulsed RF carrier are varied in a pseudorandom manner under the control of a coded sequence. Time hopping is often used effectively with frequence hopping to form a hybrid time-division, multiple-access (TDMA) spread spectrum system.

(x) Pulsed FM Systems. A pulsed FM system is a spread spectrum system in which a RF carrier is modulated with a fixed period and fixed duty cycle sequence. At the beginning of each transmitted pulse, the carrier frequency is frequency modulated causing an additional spreading of the carrier. The pattern of the frequency modulation will depend upon the spreading function which is chosen. In some systems the spreading function is a linear FM chirp sweep, sweeping either up or down in frequency.

(y) Hybrid Spread Spectrum Systems. Hybrid spread spectrum systems are those which use combinations of two or more types of direct sequence, frequency hopping, time hopping and pulsed FM modulation in order to achieve their wide occupied bandwidths.

2. New Section 15.126 is added to read as follows:

Section 15.126 Operation of spread spectrum systems above 70 MHz.

Low power spread spectrum communication devices may be operated above 70 MHz subject to the following conditions:

(a) Low power spread spectrum communications systems are limited to operation on frequencies above 70 MHz. With the exception of the frequency bands listed in paragraph (c) of this section, the emission of RF energy on any frequency shall not exceed the field strengths in the following table:

	Field Strength at 3 m (uv/m)	
Frequency (MHz)	Frequency Hopping Time Hopping Pulsem FM Systems	Direct Sequence Systems
70 to 130	500	33
130 to 174	500-1500 *	33
174 to 260	1500	33
260 to 470	1500-5000 *	33
470 and above	5000 **	33

* Linear interpolation

** These power limits apply on all frequencies above 470 MHz except in the 902-928 MHz, 2400-2483.5 MHz and 5725-5875 MHz frequency bands, where adequate power to perform the particular communications task will be allowed, providing that the device causes no harmful interference to other authorized users of these bands, and does not produce spurious or harmonic emissions outside the bands which are larger than the values listed in this Table. Power, in excess of that which is necessary for satisfactory operation, is not allowed.

Note: Spread spectrum systems using the 902-928 MHz, 2400-2500 MHz and 5725-5875 MHz bands should be cautioned that they are sharing these bands on a secondary basis with systems, supporting critical government requirements, that have been allocated the usage of these bands on a primary basis. Many of these systems are airborne radio location systems that emit a high EIRP which can cause harmful interference to other users. For further information about these systems, write to:

Director, Office of Plans and Policy, U.S. Department of Commerce, National Telecommunications and Information Administration, Room 4096, Washington, D.C. 20230

Also, future investigations of the effect of spread spectrum interference to Government operations in the 902-928 MHz band may necessitate that the general limit on radiated power, as specified in the proposed rules, not be relaxed in this band and that the general limit apply.

(b) Hybrid spread spectrum systems, which use direct sequence modulation in combination with other types of modulation, are restricted to the emission limits given in paragraph (a) of this section for direct sequence systems.

(c) Emission of RF energy shall not fall in any of the bands listed below:

MHz	GHz
73 to 75.4	10.6 to 10.7
108 to 118	15.35 to 15.4
121.4 to 121.6	19.3 to 19.4
156.7 to 156.9	23.6 to 24.0
240 to 285	31.3 to 31.8
328.6 to 335.4	51.4 to 54.25
404 to 406.2	58.2 to 59.0
608 to 614	64 to 65
960 to 1215	86 to 92
1400 to 1427	100 to 102
1535 to 1670	105 to 116
2690 to 2700	164 to 168
4200 to 4400	182 to 185
4990 to 5250	217 to 231

Note: A radiation level below 5 microvolts per meter at 3 meters will be considered to meet this requirement. For type acceptance of spread spectrum equipment whose emissions overlay these frequency bands, it must be demonstrated, by either measurements or analysis, that this emission limit is met.

(d) For frequency hopping systems, at least 30 hopping frequencies, separated by at least 20 kHz, shall be used, and the time of occupancy on any frequency shall not be greater than 1 second. For time hopping and pulsed FM spread spectrum devices, the duty cycle shall be less than 3.3%.

(e) Frequency hopping, time hopping and pulsed FM spread spectrum systems that operate on frequencies which fall within the television bands, shall either (1) be designed so that they do not have a total time of occupancy on any single television channel that is greater than one second out of every 30 seconds or (2) be provided with a switch or switches, that will enable the equipment to be operated on channels which are unused in that area. A television channel will be considered as used in an area, if the spread spectrum transmitter under consideration will produce a field, within the grade A contour of the television station using that channel, which is greater than 10 microvolts per meter. For

type acceptance of frequency hopping, time hopping and pulsed FM spread spectrum transmitters, it must be demonstrated, by either measurements or analysis, that these conditions are met.

(f) The antenna of the spread spectrum device shall be permanently mounted on the enclosure containing the device. A microphone, keyboard, data entering or signal entering unit may be external to the device, providing that it is permanently connected to the enclosure with a cable not longer than 1.5 meters. If a power cable is used, it must not be longer than 3 meters and be permanently attached to the device. If the device is operated outdoors, it must not be mounted at a height greater than 10 meters above the ground. If it is operated indoors, it must be operated at a height which is not greater than 10 meters above the lowest level where a receiving unit is located.

(g) If the device is to be operated from public utility lines, the RF energy fed back into the power lines shall not exceed 250 microvolts at any frequency between 450 kHz and 30 MHz.

3. Section 90.7, Definitions, is amended by inserting the following definitions in the list of definitions which make up this Section.

* * *

Direct Sequence Systems. A direct sequence system is a spread spectrum system in which the incoming information is usually digitized, if it is not already in a digital format, and modulo 2 added to a higher speed code sequence. The combined information and code are then used to modulate a RF carrier. Since the high speed code sequence dominates the modulating function, it is the direct cause of the wide spreading of the transmitted signal.

* * *

Frequency Hopping Systems. A frequency hopping system is a spread spectrum system in which the carrier is modulated with the coded information in a conventional manner causing a conventional spreading of the RF energy about the carrier frequency. However, the frequency of the carrier is not fixed but changes at fixed intervals under the direction of a pseudorandom coded sequence. The wide RF bandwidth needed by such a system is not required by a spreading of the RF energy about the carrier but rather to accommodate the range of frequencies to which the carrier frequency can hop.

* * *

Spread Spectrum Systems. A spread spectrum system is an information bearing communications system in which: (1) information is conveyed by modulation of a carrier by some conventional means, (2) the bandwidth is deliberately widened by a spreading function over that which would be needed to transmit the information alone. (In some spread spectrum systems, a portion of the information being conveyed by the system is contained in the spreading function.)

4. Section 90.19 (g)(3), Police Radio Service, is amended as follows:

(3) A licensee may use, without special authorization from the Commission, any mobile service frequency between 40 and 952 MHz listed in paragraph (d) of this section for communications in connection with physical surveillance, stakeouts, raids, and other such activities. Such use shall be on a secondary basis to operations of licensees regularly authorized on the assigned frequencies. The maximum power that may be used for such communications is 2 watts output. Other provisions of this part, including the requirements for station identification, shall apply. Spread spectrum transmitters may be operated on Public Safety frequencies between 37 and 952 MHz, providing that they are type accepted by the Commission under the provisions of Sections 2.803 and 90.203, and meet the following conditions:

(i) Frequency hopping transmitters can be operated, with a maximum output power of 2 watts, on any mobile service frequency between 40 and 952 MHz listed in paragraph (d) of this section. If their hop rate is greater than 10 hops per second and 10 or more hopping frequencies are used, their maximum output power may be increased to 15 watts.

(ii) Direct sequence spread spectrum transmitters may be operated in the 37.01-37.43, 39-40, 44.61-46.6, 154.6375-156.250 and 158.715-159.48 MHz bands with a maximum integrated output power of 10 mW per kHz.

(iii) Use of spread spectrum transmitters under this section of the Rules is subject to approval by the local area coordinator of the Police Radio Service of the district in which the license and equipment are to be used.

5. Section 90.207, Types of emissions, is amended as follows:

(k) For stations in the Fire, Police and Power Radio Services utilizing digital voice modulation, in either the scrambled or unscrambled mode, F3Y emission will be authorized. Authorization to use F3Y emission is construed to include

the use of F9Y emission subject to the provisions of Section 90.233. P2D emission is allowed for stations using direct sequence spread spectrum transmitters in the Police Radio Service.

6. Section 90.209, Bandwidth limitations, is amended by inserting new paragraph (h) as follows:

(h) Direct sequence spread spectrum transmitters which are operating in the 37.01-37.43, 39-40, 44.61-46.6, 154.6375-156.250 and 158.715-159.48 MHz bands will have any radiated emissions outside these bands attenuated by the following factors:

(1) On any frequency removed from the edge of the band by a displacement up to 40 kHz, the attenuation will be at least 50 dB.

(2) On any frequency removed from the edge of the band by a displacement greater than 40 kHz, the attenuation will be at least 80 dB.