

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

FCC 85-245
35747

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

FIRST REPORT AND ORDER

Adopted: May 9, 1985

Released: May 24, 1985

By the Commission:

INTRODUCTION AND SUMMARY

1. Spread spectrum modulation is a wideband modulation which was originally developed for military applications but which has several interesting civil applications ^{1/}. This technology has been implicitly forbidden by the FCC rules with a few limited exceptions. On June 30, 1981, the Commission adopted a Notice of Inquiry ("Inquiry") ^{2/} in this proceeding seeking comments on a rule structure that would permit civil use of this technology ^{3/}.

^{1/} The spreading or dilution of the energy in spread spectrum systems over a wide bandwidth results in several possible advantages: short range overlays on other emissions, resistance to interference from other emissions, and low detectability. While it is not anticipated that spread spectrum will replace other types of modulations, in general, the unique characteristics of spread spectrum offer important options for the communications system designer.

^{2/} 87 FCC 2d 876

^{3/} A companion Notice of Proposed Rulemaking was adopted in Docket 81-414 proposing use of spread spectrum in the Amateur Radio Service and has been implemented, in part, in a Report and Order we are adopting today.

2. Based on the comments received in the Inquiry, we adopted a Further Notice of Inquiry and Notice of Proposed Rulemaking ("Further Notice"), 4/ on May 26, 1984, proposing specific rules for spread spectrum in Parts 15 and 90 of our Rules. In this First Report and Order we are adopting some of the proposals of the Further Notice with some modification. The remaining issues in the Further Notice raised significant controversy in the Comments and we are continuing to review these to see what action is appropriate.

3. In general, the replies to the Inquiry favored the Commission's effort to introduce this communications technique. However, many of the respondents were concerned that implementation of this technique might cause unacceptable interference to existing services unless its development was restricted to low-powered, limited range applications and that the allowable frequencies and powers were carefully chosen. Because the technology is new and unfamiliar to the civilian sector, many urged the Commission to proceed slowly with its implementation until sufficient experience in the identification and measurement of spread spectrum signals had been gained and an assessment had been made of their interference potential. Without this information, the majority of the respondents were firmly against a general overlay of spread spectrum systems upon existing services. However, few objected to the use of these systems in an overlay fashion, as long as they were restricted to low-power and limited range applications.

4. From the responses to the Inquiry the FCC developed rulemaking proposals for the operation of spread spectrum systems as licensed devices in the Police Radio Service under Part 90 of the Rules and as low-powered, limited range devices to be authorized under Part 15 of the Rules. As a further incentive for the development of this technology, the rules would allow spread spectrum systems of higher power to operate in the 902-928, 2400-2483.5 and 5725-5875 MHz Industrial, Scientific and Medical ISM bands. However, the record was still not sufficiently complete to allow a drafting of the equipment authorization procedures and measurement standards that would be used to determine the equipment compliance for these systems. Accordingly, the Further Notice was released by the Commission on May 21, 1984 to solicit further information on the equipment authorization and measurement procedures and to obtain comments on the proposed rules.

DISCUSSION OF COMMENTS AND REPLY COMMENTS

5. Thirty seven comments and fifteen reply comments were filed in response to the Further Notice. These came from a wide range of parties and interest groups. A list of those filing comments is contained in Appendix A.5.6/. Along with comments from individuals, comments were received from amateur radio, broadcasting, business and industry, cordless telephone manufacturing, police and public safety, and radiopositioning and radionavigation interest groups. Most of the comments which were received were directed to issues or questions posed in the Further Notice and no significant new matters relative to the proceeding were raised.

6. Many of the respondents favored the proposed authorization of spread spectrum for low-power limited range communications devices and considered the proposed rules conservative enough for immediate adoption. Others, including broadcasting interests in particular, expressed concern over interference to their services from these devices. Though not opposing the Commission's action in general, they did oppose the overlay of spread spectrum systems on the frequency bands in which they are operating.

7. More specifically, broadcasting groups and some large consumer product manufacturers (RCA, GE and others) suggested that the present level of television service would be seriously degraded if spread spectrum systems were allowed to operate in the television bands. Even though the proposed rules were formulated to offer to this service a level of protection from direct sequence systems equivalent to a TASSO 3 level of reception at the Grade A service

5/ Some of the comments which were received were not pertinent to this proceeding. ONI, Racal-Decca Survey, Inc., Sercel Inc. and Teledyne Hastings-Raydist all filed comments which were concerned solely with radiolocation operations in the 1600-3000 kHz band. These comments are outside the scope of this proceeding which is concerned with spread spectrum systems operating on frequencies above 70 MHz. The comments of these parties will be considered under Docket 84-874 which is dealing with radiolocation allocations in the 1900-2000 kHz band.

6/ Exxon's comments which described a downward looking impulse radar system being developed under a Special Temporary Authorization from the Private Radio Bureau, were also outside the scope of this proceeding. Although the Exxon system operates on frequencies between 100 and 1000 MHz, its relatively high output power (33 watts) and antenna height (to be operated from a hovering aircraft) may require a special allocation under Part 2 of the Rules rather than any consideration in this proceeding under Part 15. We have not received sufficient information in this proceeding in the type of system Exxon proposes to formulate a specific proposal.

contour, it was argued that an interference level based on this criterion would produce a degradation of picture quality for those living outside of this contour. It was also argued that interference from these systems would cause a loss of picture quality in those areas, both within and outside the Grade A service contour, where reception is superior to TASSO 3 at the present time.

8. COMSAT, STC and AT&T were concerned that some microwave, cellular and satellite facilities may be especially vulnerable to interference from spread spectrum devices particularly in those services where wide bandwidths are employed and weak signals are involved.

9. ARRL and several individual amateurs were concerned about possible interference from spread spectrum systems operating in the amateur bands at 144-146, 220-225 and 420-450 MHz. They argued that since amateurs operate in residential environments, which could conceivably contain many Part 15 spread spectrum devices, their systems would be more susceptible to interference from these devices than those in other services which are operating principally in nonresidential environments. It was further argued that in many amateur operations the level of the ambient noise is critical since they are often dealing with very weak signals which in many cases are barely on the fringes of detection. These signals can be easily masked and lost in interference coming from other sources.

10. Of the parties submitting comments that opposed the proposed authorization of spread spectrum systems, RCA was the only one that supported its position with analysis. RCA's analysis dealt with possible interference to FM and television broadcasting from spread spectrum systems operating in the broadcast bands. However this is not a consideration in this item which is concerned with the authorization of spread spectrum systems in the ISM bands and on Public Safety Radio frequencies.

11. Several police and public safety groups filed comments on the proposed authorization of spread spectrum systems in the Police Radio Service bands under Part 90 of the Rules. The major concern of all of these parties was not interference to their service from the police use of spread spectrum systems in these bands, but rather from other spread spectrum systems that would be authorized to use these bands on a secondary basis. The only major difficulty that was foreseen with the police use of spread spectrum systems in these bands was a possible increase in band congestion. To ease this congestion, as well as to provide a broader range of frequencies that could be used for covert operations, it was suggested that the proposed Part 90 spread spectrum authorization be extended to all frequencies in the Public Safety Radio Services.

12. Both APCO and the County of Orange, California, thought that there was no need to increase the present power limit of 2 watts for fast frequency hopping systems operating in the Public Safety bands and that the proposed 15 watt limit for these systems should be reduced to 2 watts. They stated that a 2 watt limit should be sufficient for all of their present and future frequency hopping needs and can easily be increased later if necessary. They also requested that the station identification requirement of Section 90.19 (g)(3) of the present Rules should be eliminated for undercover operations, since it not only jeopardizes the security of these operations but it also creates a real danger to the agents involved.

We have long noted that this is an ambiguous rule, providing use "without special authorization", while at the same time requiring "station identification". This inconsistency has led to some problems which would no doubt be perpetuated and possibly increased by the rules as proposed. We would suggest some special type of provision which would allow the frequency coordinator to recommend or assign these channels on a secondary basis, but without the necessity for a formal license, which defeats the intent of maintaining security through anonymity. 1/

County of Orange also requested the use of other Public Safety frequencies for surveillance operations using modulations other than spread spectrum only if approval of the coordinator had been obtained.

13. No serious objections were raised to the authorization of spread spectrum systems in the 902-928, 2400-2483.5 and 5725-5875 MHz ISM bands as long as these operations did not cause interference to systems that have been authorized the use of these bands under other Parts of the Rules. Both NTIA and GE thought that there should be a cap on the maximum output power which these systems can use. NTIA suggested a power limit of 10 watts, GE a limit of 7 watts. COMSAT expressed concern that use of 5850-5875 MHz might cause interference to the new Fixed Satellite Service allocation in that band.

14. In the Further Notice, we asked if the proposed rules would be sufficient to allow the development of wireless data terminal systems or whether more power should be allowed for these devices, either by the creation of a special business-industrial class permission under Part 15 or by authorizing them in one of the licensed services. Hewlett-Packard, which has been developing these systems on an experimental basis under Part 5 of the Rules suggested that the power limits proposed in the Further Notice are

not sufficient for these devices. Based upon the field strengths which they consider to be adequate for the development of these devices, the proposed level for direct sequence emissions of 33 uV/m at 3 meters per 4 MHz of bandwidth is at least 10 times too small. If this power limit cannot be raised for these systems, then Hewlett-Packard suggested that wireless data terminals be licensed in the Private Land Mobile Radio Services as a separate service under Part 90 of the Rules. RCA felt that since these terminals would be mainly business and not consumer devices, they should be licensed under Part 94 of the Rules for the Private Operational-Fixed Microwave Service, rather than under Part 15.

15. Comments were also solicited in the Further Notice concerning the feasibility of authorizing carrier current spread spectrum systems. Hewlett-Packard has already made measurements on an experimental 5 milliwatt system and finds that the technology is very promising. Hewlett-Packard can foresee little interference to other authorized services from these systems as long as the carrier current operations are confined to large buildings or areas within buildings which have their power supplied from transformers rather than by a direct connection to the AC power lines. These power transformers with their large interwinding capacitances would prevent much of the RF energy generated by the spread spectrum systems from being fed back into the AC power lines. Carrier current systems are limited to operation on frequencies below 20 MHz because of the excessive signal losses that occur when operated on frequencies above this. We find the two Hewlett-Packard suggestions to be promising new applications of this technology and will consider in the near future further action to authorize their use.

16. A request was made in the Further Notice for assistance in developing measurement procedures for spread spectrum systems. Although many parties addressed this matter, there was little consensus as to what these procedures should be. However, most parties did agree that a measurement bandwidth must be specified before any meaningful measurement procedures could be drawn up.

17. Some cordless telephone manufacturers expressed concern in the comments that the proposed spread spectrum authorizations could prejudice their petition for 2 MHz of spectrum in the 900 MHz band.^{8/} They felt that the present action by the Commission might force them to utilize a technology which they do not have the resources at the present time to develop, and which may not provide sufficient power for their needs.

18. Of the bands presented above, only two were addressed in a degree which allows for a well reasoned decision. We are deferring without prejudice action on all other issues addressed in the Further Notice. The two issues to be decided at this time are the use of spread spectrum in the Police Radio Service and the use of spread spectrum in the ISM bands.

FINDINGS

Spread Spectrum in the Police Radio Service

19. The record of this proceeding is sufficiently complete at the present time to enable us to authorize frequency hopping systems to be operated on a limited basis on certain frequencies in the Public Safety Radio Service. This would expand the provisions currently given in Section 90.19 (g)(3). This authorization is limited to law enforcement officers and its purpose is to allow them to set up communication links on these frequencies that can be used in connection with physical surveillance, stakeouts, raids and other such activities. Operation on these frequencies will be on a noninterference basis to the operations of other licensees who have been authorized the use of these frequencies under other sections of the Part 90 Rules. In addition, their use of these frequencies is subject to the approval of the applicable frequency coordinators of the Public Safety Radio Service of the district in which the license and equipment are to be used and if non-police Public Safety frequencies are to be used the coordination of the other service's coordinator is also needed. The changes to Part 90 of the Rules and Regulations to accomplish this authorization are presented in Appendix B.

20. Since spread spectrum transmissions are not readily detectable by criminals who may be monitoring the air waves and since they are

^{8/} See Electronic Industries Association Petition for Rulemaking, RM 4780; (requesting an allocation of 2 MHz of spectrum for cordless telephone use in the 900 MHz band) (filed March 1, 1984.)

difficult to jam, this authorization gives law enforcement officers an extremely valuable tool to use in their operations. Federal law enforcement agencies operating radio systems under 47 USC 305 are already authorized by the National Telecommunications and Information Administration to use spread spectrum in their operations on a case by case basis. These new rules extend this same capability to state and local law enforcement agencies as well.

21. Under the new Part 90 Rules frequency hopping systems with a maximum output power of 2 watts are allowed to operate on any of the frequencies presently available to the Public Safety Services as listed in Subpart B of Part 90 of the Rules. The 2 watt power limit for these systems is the same as that which is permitted for all present users of these frequencies, on a "without prior FCC approval" basis, irrespective of the modulation which they may be using. Hence, frequency hopping systems which are operating on these frequencies are not expected to cause harmful interference to other users of this spectrum. The 2 watt output power limit applies to all frequency hopping systems that are operating on these frequencies no matter what their hop rate is. Requests to use higher powers will be considered on a case-by-case basis for special temporary authorizations. Appendix C gives guidelines for coordinators to use in considering requests to use frequency hopping systems which we feel should be adequate to prevent harmful interference.

22. While the Commission and some law enforcement agencies have experience with frequency hopping systems, at this time there is very little non-military experience with direct sequence systems. We have traditionally been extremely careful in minimizing the likelihood of harmful interference to critical public safety systems. Thus we shall defer at the moment the permanent authorization of direct sequence systems for police use until we have more data available. We plan to conduct tests at our Laboratory and will invite representatives of the police community to participate. Pending further action in this area, experimental and developmental licenses and special temporary authorization will be available to manufacturers and police licensees who wish to try direct sequence systems.

23. Both APCO and the County of Orange, California have brought to our attention the inherent danger that the station identification requirement of Section 90.19 (g)(3) of the present rules poses to both the security of undercover operations and the safety of the agents involved. Since the frequencies allocated for these operations can only be used by the law enforcement officers for spread spectrum, and, since approval must be obtained from the applicable frequency coordinators prior to the use of these frequencies for police spread spectrum operations, it would seem that any unauthorized use of these frequencies can be readily

detected. Thus, we feel that the station identification requirement present in this section of the Rules is superfluous and can be deleted safely.

Spread Spectrum in the ISM Bands

24. Spread spectrum systems are also being authorized under Part 15 for general usage in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz ISM bands. Due to COMSAT's concern in its comments about the possibility for interference to the Fixed Satellite Service allocated at 5850-5875 MHz, we have excluded these frequencies from spread spectrum usage. These systems may operate within these bands with a maximum output power of 1 watt. RF output power outside these bands over any 100 kHz bandwidth must be 20 dB below that in any 100 kHz bandwidth within the band which contains the highest level of the desired power. For certification of spread spectrum equipment that is to be used in these bands, the applicant applying for certification must demonstrate by either measurement or analysis that this limit has been met. Spread spectrum systems are allowed to operate within the ISM bands only on a noninterference basis to other operations that have been authorized the use of these bands under other Parts of the Rules. They must not cause any harmful interference to these operations and must accept any interference which these systems may cause to their own operations.^{9/}

25. Although both NTIA and GE found no great difficulty with spread spectrum systems operating within the ISM bands with maximum output powers of 7 watts, GE did take exception to the opening of these bands to communications systems which have been accustomed to operation with some degree of protection from interference. GE fears that the steady encroachment on these bands by other services will eventually lead to petitions from these other users for protection from interference from ISM devices. This would be unfortunate since industry is constantly finding new uses of these frequencies in many diverse applications ranging from coal desulphurization to food sterilization.

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

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

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

See 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

26. We appreciate GE's concern in this regard and acknowledge the danger in opening these bands to high power communications devices. In addition, Part 15 of the Rules is intended to provide authorization for low power communications devices and not for communications devices of considerable output power. To open the Part 15 rules to high-powered communications devices, even in a band where other authorized high powered industrial and government equipment is already operating, would not be in keeping with the purpose of this Part of the Rules. Therefore we have reduced considerably the original power limits that we proposed for systems operating in these bands, even below the levels proposed by NTIA and GE. Even at that, the limit of 1 watt that we are allowing for these systems is still much higher than the level of power that we would normally authorize for devices. However, both because of the unique nature of these bands and because the systems being authorized under these rules will be spreading this energy over a wide bandwidth, we believe an output power level of 1 watt is justified. In view of the 1 watt power limit which we are adopting in the final rules we believe the possibility of these systems interfering with other authorized users of these bands is small.

CONCLUSION

27. The rules which are adopted here for spread spectrum systems operating in the Police Radio Service and in the ISM bands have been kept deliberately conservative in order to minimize any possibility of interference from these systems to existing services. As a further safeguard, all spread spectrum devices which will be permitted under the Part 15 rules proposed in this Report and Order are 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. See also Part 2, Subpart J, for general certification and type acceptance procedures. In addition, 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, we expect to engage in a thorough sampling program until we are confident that the manufacturers have gained sufficient knowledge and skill in building these devices, so that they pose no potential interference problems to other uses of the radio spectrum. The procedures for the type acceptance of equipment to be used in the Police Radio Service are given in Section 90.203 of the Rules and in Subpart J of Part 2.

28. With the above mentioned safeguards that have been built into the Rules, we do not feel that requiring spread spectrum transmitters to use automatic identifiers is warranted at the present time. However in the future, when a much broader authorization of spread spectrum systems may be considered, we may wish to consider some form of transmission identifier to assist us

in identifying and locating units which may be causing interference.

29. We are deferring without prejudice action on the remaining issues which were discussed in the Further Notice, such as, the operation of low powered spread spectrum devices on frequencies above 70 MHz, the measurement procedures to be used in the certification of these devices and the possibility of licensing spread spectrum wireless data terminals and carrier current systems under other Parts of the Rules. For further information about this Report and Order contact, Dr. Joseph Mc Nulty at (301) 725-1585 or Dr. Michael Marcus at (202) 632-7040.

REGULATORY FLEXIBILITY FINAL ANALYSIS

30. 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 at least regulatory cost is imposed. It is in this light that it is considering modification of its Part 15 and Part 90 rules.

31. 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.

32. Legal basis. Action proposed herein is taken pursuant to Sections 4(i), 7(a), 302 and 303(r) of the Communications Act of 1934, as amended.

33. Description, potential impact and number of small entities affected. The ability to develop communications equipment which employs spread spectrum modulation techniques as described in the attached Rules will be beneficial to all entities which are involved. Therefore, we foresee only positive impacts on small entities.

34. Recording, record keeping and other compliance requirements. The modifications to Part 15 and 90 of the Rules would require record generation by the manufacturer sufficient to meet the usual equipment authorization requirements. Additionally, the modifications of the Part 90 Rules require a simple onetime notification to the applicable frequency coordinators of the district in which the license and equipment are to be used.

35. Federal rules which overlap, duplicate or conflict with this rule. None.

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

37. Accordingly, IT IS ORDERED, that effective June 15, 1985, Part 15 and Part 90 of the Rules and Regulations ARE AMENDED as set forth in the attached Appendix B. The authority for this action is found in Sections 4(i), 7(a), 302, and 303(r) 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 FURTHER NOTICE

The following parties supplied Comments to the Further Notice of Inquiry and Notice of Proposed Rulemaking:

Aeronautical Radio, Inc., (ARINC)
American Radio Relay League, (ARRL)
American Telephone and Telegraph Company, (AT&T)
Associated Public-Safety Communications Officers, Inc., (APCO)
Association of Maximum Service Telecasters, (MST)
California Public Safety-Radio Association, Inc., (CPRA)
Communications Satellite Corporation, (COMSAT)
Jonathan C. Dahm
Joint submission by Dr. George R. Cooper and Dr. William W. Chapman
Del Norte Technology, Inc.
Door Operator & Remote Controls Manufacturers Association, (DORCMA)
Dynascan Corporation
The Consumer Electronics Group of the Electronic Industries Association, (EIA/CEG)
The Personal Communications Section, Telecommunications Group, of the Electronic Industries Association
Exxon Communications Company
General Electric, (GE)
Geostar Corporation
Hewlett-Packard, (HP)
County of Los Angeles, Department of Communications
Mura Corporation
National Association of Broadcasters, (NAB)
National Association of Business and Educational Radio, Inc., (NABER)
National Broadcasting Company, Inc., (NBC)
Offshore Navigation, Inc., (ONI)
Radscan, Inc.
RCA Corporation, (RCA)
Ronald E. Reder
Cortland E. Richmond
Satellite Television Corporation, (STC)
Schenectady Amateur Radio Association, Inc.
Sercel Incorporated
Telesciences International Limited
Joint submission by 15 telephone companies
Texas VHF-FM Society
U. S. Dept. of Commerce, National Telecommunications and Information Administration, (NTIA)
Wilkins Engineering
Zenith Electronics Corporation

The following parties supplied Reply Comments to the Further Notice of Inquiry and Notice of Proposed Rulemaking:

American Petroleum Institute, (API)
American Telephone and Telegraph Company, (AT&T)
Association of Maximum Service Telecasters, (MST)
Communications Satellite Corporation, (COMSAT)
County of Orange, California
Del Norte Technology, Inc.
The Personal Communications Section, Telecommunications Group,
of the Electronic Industries Association
General Electric, (GE)
Hewlett-Packard, (HP)
National Association of Broadcasters, (NAB)
Offshore Navigation, Inc., (ONI)
Racal-Decca Survey, Inc.
Radscan, Inc.
Teledyne Hastings-Raydist
Joint submission by 19 telephone companies
U. S. Dept. of Commerce, National Telecommunications and
Information Administration, (NTIA)

APPENDIX B

CHANGES TO PARTS 2, 15 AND 97 OF THE FCC RULES AND REGULATIONS

A. Part 2 of Chapter I of Title 47 of the Code of Federal Regulations is amended as follows:

1. Section 2.1, General Definitions, is amended by inserting the following definitions in alphabetical order.

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.)

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.

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.

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 frequency hopping to form a hybrid time-division, multiple-access (TDMA) spread spectrum system.

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.

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.

B. Part 15 of Chapter I of Title 47 of the Code of Federal Regulations is amended as follows:

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

Section 15.126 Operation of spread spectrum systems

Spread spectrum systems may be operated in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz frequency bands subject to the following conditions:

(a) They may transmit within these bands with a maximum peak output power of 1 watt.

(b) RF output power outside these bands over any 100 kHz bandwidth must be 20 dB below that in any 100 kHz bandwidth within the band which contains the highest level of the desired power. The range of frequency measurements shall extend from the lowest frequency generated in the device (or 100 MHz which ever is lower) up to a frequency which is 5 times the center frequency of the band in which the device is operating.

(c) They will be operated on a noninterference basis to any other operations which are authorized the use of these bands under other Parts of the Rules. They must not cause harmful interference to these operations and must accept any interference which these systems may cause to their own operations.

Note: Spread spectrum systems using the 902-928 MHz, 2400-2500 MHz and 5725-5850 MHz bands should be cautioned that they are sharing these bands on a noninterference 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 radiolocation 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 require a future decrease in the power limits.

(d) For frequency hopping systems, at least 75 hopping frequencies, separated by at least 25 kHz, shall be used, and the average time of occupancy on any frequency shall not be greater than four-tenths of one second within a 30 second period. The maximum bandwidth of the hopping channel is 25 kHz. For direct sequence systems, the 6 dB bandwidth must be at least 500 kHz.

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

C. Part 90 of Chapter I of Title 47 of the Code of Federal Regulations is amended as follows:

1. 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 Subpart B of this Part of the Rules, 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 output power that may be used for such communications is 2 watts. Transmitters, operating under this provision of the Rules, shall be exempted from the station identification requirements, of Section 90.425. Use of Public Safety frequencies not listed in paragraph (d) of this section is conditional on the approval of the coordinator corresponding to each frequency. 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 of the Rules, and meet the following conditions:

(i) frequency hopping transmitters can be operated, with a maximum output power of 2 watts, on any Public Safety mobile service frequency between 37 and 952 MHz listed in Subpart B of this section. At least 20 hopping frequencies shall be used and the average time of occupancy on any frequency shall not be greater than 1/10 second in every 2 seconds;

(ii) use of spread spectrum transmitters under this section of the Rules is subject to approval by the applicable frequency coordinator of the radio services of the district in which the license and equipment are to be used.

2. 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.

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

(h) All out of band emissions, including spurious emissions from switching, that are produced by frequency hopping systems, shall be kept below the limits specified in this Section of the Rules for similar systems which are modulated about a fixed frequency and do not frequency hop.

APPENDIX C

INITIAL COORDINATOR GUIDELINES
FOR SPREAD SPECTRUM

Spread spectrum can be an important tool for law enforcement use in applications where it is vital that radio transmissions must not be detected. While conventional voice privacy systems protect the contents of a message, the presence of encrypted communications is readily detectable and in itself could jeopardize the security of a sensitive operation.

These guidelines are intended to help coordinators in approving requests to use spread spectrum. Requests that do not comply with these guidelines may not be interference-prone, but would require either more detailed calculations or a field test to determine the likelihood of interference. Coordinators may also wish to consider approving uses that have a small interference potential if they feel the value of the operation supported exceeds the cost of the interference.

A frequency hopping (FH) system which hops at a rate of over 100 hops/sec and which hits a conventional voice channel less than 5% of the time will not cause harmful interference regardless of field strength. The interaction of FH with traditional systems becomes more noticeable as the hopping rate is decreased. Hopping rates of less than 10 hops/sec are not recommended for this reason. Frequency hopping systems may trigger carrier operated repeaters on frequencies that they use. (Such repeaters are rare in the public safety services and the Commission has consistently discouraged their use because of their susceptibility to false triggering.) Thus, special steps are needed to protect such repeaters. Interaction with conventional receivers will be further minimized if the hopping frequencies are interleaved between conventional channels.

The following conditions should be met for coordination without a field test:

1. All FH systems should hop at more than 10 hops/sec. As hopping rates greater than 100 hops/sec are preferred, coordinators may wish to have a field demonstration of slower systems.
2. The coordinator should ensure that the sum of the inverse of the processing gain (that is, the number of frequencies used) of all FH systems operated in a given band within a 70 mile diameter does not exceed .05.

3. All frequencies used by carrier operated repeaters within 50 miles should be excluded from the set of hopping frequencies unless it can be demonstrated that the turn-on delay of the repeater is adequate to prevent false triggering (50 - 100 ms is probably needed).
4. All frequencies used by digital data systems and paging systems within 50 miles should be excluded from the set of hopping frequencies unless a field test can show absence of harmful interference.