License-Free Spread Spectrum Packet Radio

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ABSTRACT

Under Part 15.126 of CFR Title 47 the FCC has authorized the use of unlicensed spread spectrum transmitters with output power not to exceed one watt in the 902-928 MHz, 2400 MHz, and 5800 MHz bands shared by the amateur service. Several manufacturers have already offered products which have been approved by the FCC for this class of operation. Although this is not ham technology authorized by Part 97 of the FCC Rules, it may be advantageous for amateurs to be aware of the use and possibilities of such equipment to augment our regulated packet communications. Conversely, the proliferation of unlicensed transmitters in these amateur shared bands could spell trouble for weak signal work in densely populated areas.

Introduction

Amateur experiments with spread spectrum techniques under an STA have provided a basis for FCC rule changes in 1986 allowing restricted forms of spread spectrum modulation on the amateur bands. Only frequency hopped (FH) and direct sequence (DS) spreading has been authorized, though, prohibiting hybrid spreading techniques which are often preferred in modem designs. The pseudo-noise (PN) code sequences available for DS are also restricted by the amateur rules to a set of three linear feedback shift register (LFSR) sequences. Further, transmitted power is restricted to one-hundred watts and a technical log of all spread spectrum activity must be kept. Unfortunately, work in this area has not yet yielded commercial or even kit-form amateur spread spectrum transceivers in spite of the fine engineering effort spent on this technique by several groups around the country.

Deciding to bring industrial resources to bear on the technology transfer from the military to consumer electronics, the FCC added Part 15.126 of its Rules in June, 1985 in order to speed along the development efforts already authorized for several amateur groups under a 1981 STA. This new section of the low-power communication devices regulations mandates only the power distribution uniformity, the occupied bandwidth for DS transmitters, and the bandwidth and number of hopped channels for FH transmitters. The FCC's attitude toward this technology appears to foster commercial applications which are capable of taking advantage of "wasteland" properties used by Industrial, Scientific, and Medical (ISM) equipment for non-communication purposes and by high EIRP radiolocation systems [4] without undue interference to amateur transmissions on these shared bands. The ability of spread spectrum systems to improve signal-to-noise ratio should enable communication transceivers to overcome the high noise floor resulting from RF sources operating on these bands. Narrowband interference sources such as amateur transmissions on these shared bands would also be combatted by a properly designed spread spectrum system.

Commercial Systems

The commercial systems currently approved for operation under this Part have centered so far on data communications requirements although some wireless alarm type applications have been discussed. One system marketed by O'Neill Communications Inc. claims to have a channel transmission rate of 38.4 kbps and a radio-computer transmission rate of 9.6 kbps [1]. It also claims to use AX.25 as its communication protocol between radio nodes. With a transmit power of 20 milliwatts, this system states an indoor range of 100 feet and an outdoor range in excess of 500 feet. For range extension, the manufacturer suggests the use of up to two of the radio units in repeater operation. With an estimated cost of approximately $500 per node, this is one of the less expensive systems being marketed.

The other data communication system now marketed is called ARLAN and is sold by a Canadian firm, Telesystems SLW of Ontario. There are two versions of ARLAN: one supports asynchronous communication between terminal ports of standalone radio units, the other consists of an IBM PC-type circuit board with an antenna connection at the rear of the card. Shipped with a stub antenna, the card uses the 902-928 MHz band to connect computers together using the Novell Netware protocols at 200 kbps and up to 1 watt of transmitted power. Interestingly, the company claims to have tested a pair of the IBM PC-type machines together with beam antennas successfully at a distance of six miles. The price on these units, however, is approximately $1500 per node which may be prohibitive for use by individuals.

Implications for the Radio Amateur

While it may be disheartening that commercial systems have become available before their amateur couterparts, it should be mentioned that these license-free systems may be used to augment or supplement our communications abilities even though they are not regulated under Part 97 of the Rules. It is also possible that a system which qualifies under 15.126 could be modified to be pursuant to Part 97 spread spectrum rules and thus allowed to operate at the higher power limit, one hundred watts, available for amateur spread spectrum as long as the control operator satisfied all appropriate requirements of the Rules. And of course, placing a 15.126 unit on a Microsat-class vehicle [5] could pave the way for license-free space operation although there may be other restrictions which come into play in that situation.

The design of a power-limited spread spectrum network with realistic inter-node distances would require substantial antenna engineeering skills which could be provided by amateur operators familiar with propagation conditions on these bands. However, the resulting network would be free of Part 97 restrictions in the spirit of the pre-Commission Ham activities. Realistically, a Wild West scenario of competing BBS networks and CB-style chaos could make this non-Ham world an unpleasant environment. Unfortunately, unless a pro-active position on this technology is taken, we may see a digital CB world forming around our shared allocations.

Neglecting intentional interference to amateur transmissions and power-limit abuses, there is still the issue of a high noise floor on the weak signal portions of the shared bands. Although these bands now suffer from their shared status, some feel that an influx of consumer electronics items which may each transmit up to one watt will cause unacceptable degradation on the “quiet regions” of the band plan. Considering the possible density to be tens of radiators per city block, the argument of RF pollution seems credible.

Recommendations

To responsibly address this technology, we feel amateur operators should experiment with the commercial systems now available in establishing long distance communication paths using high-gain antenna systems coupled with the maximum legal power of one watt, determining interference levels seen by weak signal receivers attributable to spread spectrum transmissions, and carefully introducing this technology to computer bulletin board operators who could financially support development of an unlicensed computer intemet.

References

1. Information from “Computer Shopper”, September 1989, pp. 448-450, relayed to the tcp-group@ucsd.edu Internet mailing list by N6PLO
2. “Spread Spectrum Communications”, Volume 1, Simon, Omura, Sholtz, and Levitt, Computer Science Press, **1985**
3 “The ARRL 1985 Handbook for the Radio Amateur”, Edited by Mark Wilson, ARRL, 1985
4: See “NOTE” in Appendix concerning high EIRP radiolocation; See Chapter 38 of [3] concerning the ISM status of these bands.
5. ‘‘AMSAT’s MICROSAT/PACSAT Program”, Tom Clark, W3IWI, ARRL Seventh Computer Networking Conference Proceedings, October 1988

Appendix:

Code of Federal Regulations Title 47: Part 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 100MHz whichever 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 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.

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