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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Revision of Part 15 of the Commission's	)	**Docket No. 98-153**
Rules Regarding Ultra-Wideband	)	
Transmission Systems	)	

To: The Chief, Office of Engineering and Technology

COMMENTS OF THE AMERICAN RADIO RELAY LEAGUE, INCORPORATED

The American Radio Relay League, Incorporated (the League), the national association of Amateur Radio operators in the United States, by counsel and pursuant to the *Notice of Inquiry*, FCC 98-208, released September 1, 1998 (the Notice), hereby respectfully submits its comments in response thereto. These comments are timely filed. The Notice seeks information as to the possibility of permitting ultra-wideband radio systems on an unlicensed basis under Part 15 of the Commission's Rules. Such systems could provide radar applications where precise distance resolution is required and for covert voice or data communications which are not subject to multipath degradation.

1. The League's general concern with the concept of ultra- wideband (UWB) devices is relative to the interference potential therefrom to typical amateur installations, particularly broadband systems, such as amateur fast-scan television, which is conducted in portions of the bands 420-450 MHz, 902-928 MHz, 1240-1300 MHz, and 2390-2450 MHz. The League has previously submitted comments in response to a Commission Public Notice concerning a particular UWB device, designed by Zircon Corporation, which operates in the 200 MHz to 4

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GHz range, at an average radiated power of 125 uW. The League notes that there are two principal types of UWB devices: radar systems[1] and voice, data and control communications devices.

2. The League would suggest that potential victims of interference from radar-type UWB devices may include television over-the-air viewers with minimal receive antennas in residential areas, and amateur television communications.[2] There is also potential interference from these type devices to amateur SSB stations operating in various bands, at distances of more than a kilometer in free space, using typical receiver noise standards and signal-to-noise ratios.

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[1] The Zircon UWB imaging radar would be used in construction environments, including, presumably, residential construction, in relatively close geographic proximity to amateur stations in residential areas. Its 125 uW average power is substantially more than is permitted intentional or unintentional radiators under Part 15. This is an average power measurement, in a pulsed system. The automatic gain control of most amateur receivers responds to peak power. The peak-to-average ratio of this device is very high, based on the 100 pico second pulse width and the 1 MHz to 20 MHz repetition rate. Ignoring the waveshaping, it is transmitting a small percentage of the time. Thus, the peak power could be as much as 10,000 times the average power, or 1.25 watts. Even if Zircon measured 5 volts into a standard 50 Ohm load, a peak power of 0.5 watts would be emitted. This is, therefore, a fairly large amount of power spread over a wide bandwidth.

[2] Assuming a 6 MHz bandwidth, and the repetition rate and power density numbers of, for example, the Zircon device, one might calculate 0.9 mW to .045 mW PEP in a television channel (-0.4 to -13.4 dBm). An FCC study, project No. 2299-71, used -75 dBm as a reference input signal for TV interference. The viewed or desired signal was -75 dBm at Channel 13. This would be a typical viewing level for amateur television in the 420-450 MHz band using a commercial cable-ready television receiver or receive converter receiver. Using these calculations, the Zircon device would preclude or impair amateur television transmissions at distances of up to 3 kilometers from the operation of that radar device. The interfering signal would be just as loud as the desired signal at distances up to 0.31 kM. The interference potential would be somewhat diminished in the bands above 450 MHz, due to higher path loss for isotropic antennas.

3. Given the foregoing, the League is cautious that interference from UWB types of UWB devices on amateur frequencies could substantially degrade certain amateur operations in allocated bands, especially between 222 and 450 MHz. It is nonetheless understood that the radar-type UWB devices might be operated only for short periods in itinerant locations, and that these devices might, therefore, not present much interference to amateur receivers located at significant distance from the device.

4. The interference potential of communications-type UWB devices increases substantially if directional antennas are used to permit communications over long distances. These devices, unlike the radar-type devices, are likely to be fixed, permanent communications systems that are nonetheless difficult to identify by standard direction-finding techniques. As the devices emit signals perceived as wideband noise, the interference would be difficult for a radio amateur to resolve by locating the source.

5. Therefore, the League suggests that some experience with these devices is necessary before operational rules can be developed. Given the necessity that these devices operate even in the restricted Part 15 bands, and as well in amateur bands in which sensitive wideband receivers operate, these devices have a substantial potential interference characteristic.

6. The League acknowledges that the general requirements for Part 15 devices stipulated in Section 15.209 of the Rules were designed for narrowband radiators and that wideband signals spread out over a large frequency range generally have less interference potential relative to licensed narrowband communications systems than do narrowband signals. Thus, one might expect that, under some circumstances, it should be possible to relax the general requirements as applied to UWB devices without harmful interference to other users of the spectrum.

Unfortunately, UWB systems are in each case intentional radiators; in many cases itinerant devices with unpredictable operating characteristics; they create noise across very wide (but variable) frequency ranges; and they are intended to provide a diversity of services using different combinations of bandwidth, transmitter power, antennas, required system reliability, and other variable considerations. This means that any proposed changes must account for a large variety of interference considerations. It seems apparent that each device, or operating configuration, should be considered separately, at least until experience with interference characteristics can be obtained. The League understands that the Part 15 rules are not intended to be device-specific, and that the Commission specifically intended to avoid such when the Part 15 rules were rewritten several years ago.

7. However, these devices, due to their substantial configuration differences, require either technical rules specific to each device type, or else case-by-case authorization by waiver. The Notice alluded to a number of possible modulation techniques, frequency ranges and applications, each of which would have its own unique impact on each affected service whose allocations are included in the UWB occupied bandwidth. A signal that spreads across 4 GHz would be expected to have a significantly different (and lower) impact than one that spreads across only 100 MHz, for example. It may be possible to create a new general requirement that takes into account the broadband nature of some of these signals, but the League believes that any changes should be made only after considering all of the affected services and the systems they use. The League recommends that significant time and analysis precede any specific rule change and that these systems should be addressed by waiver until a track record of non-interference, or interference resolution, is established.

8. The use and operating environment of each proposed UWB system is relevant to interference potential, and should also be considered. A higher permitted noise level would apply to radar-type UWB devices intended for operation in controlled industrial environments than that which would apply to residential neighborhoods. Part 15 regulations have successfully dealt with this issue with respect to digital device emission levels, and this precedent should continue with respect to any relaxation of the general requirements applicable to UWB devices.

9. In light of the foregoing, the League requests that the Commission ask those manufacturers of UWB devices to develop some proposed standards for UWB operation and circulate them in support of a unified, comprehensive plan for UWB technical devices. In the meantime, those devices which have public interest application should be considered, as has been the Zircon device, on a case-by-case basis for grant of authority by experimental license or waiver. The League would be willing to participate in any experimental activities necessary to determine the proper technical regulations that would determine, or indicate the absence of, interference to amateur communications from UWB devices in each application, and offers the attached calculations of interference potential as a starting point for such discussions.

Therefore, the foregoing considered, the American Radio Relay League, Incorporated respectfully requests that the Commission proceed in accordance with the recommendations contained herein.

Respectfully submitted,

THE AMERICAN RADIO RELAY LEAGUE, INC.

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APPENDIX A
SAMPLE CALCULATIONS OF INTERFERENCE POTENTIAL FROM ULTRA-WIDEBAND TRANSMITTERS TO AMATEUR RADIO STATIONS

Sample Calculations of Interference Potential from Wideband Transmitters

Appendix A

These tables are examples of several path lengths, bandwidths and receive system parameters. The transmitter power has been set to 0 dBm to allow easy comparison of different transmit powers.

These analyses assume free-space, line-of-sight conditions. The transmit power is assumed to be evenly distributed across the transmit bandwidth.

Frequency = 432 MHz
Transmit power = .001 watts
Transmit bandwidth = 1000000 Hz
Receiver bandwidth = 2500 Hz
Spreading loss relative to receiver bandwidth = 26.0206 dB
Transmit antenna gain = 33 dBi
Receive antenna gain = 0 dBi
Distance to receiver = .03 km
Free-space path loss = 54.7021 dB
Received noise in receiver bandwidth = -47.7227 dBm
Receive system Noise Figure including ambient noise = 3 dB
Calculated receive system sensitivity in 2500 Hz bandwidth = -137.0206 dBm
Receive system noise floor increase in dB = 89.2979 dB

Frequency = 432 MHz
Transmit power = .001 watts
Transmit bandwidth = 1000000 Hz
Receiver bandwidth = 2500 Hz
Spreading loss relative to receiver bandwidth = 26.0206 dB
Transmit antenna gain = 33 dBi
Receive antenna gain = 10 dBi
Distance to receiver = .03 km
Free-space path loss = 54.7021 dB
Received noise in receiver bandwidth = -37.7227 dBm
Receive system Noise Figure including ambient noise = 3 dB
Calculated receive system sensitivity in 2500 Hz bandwidth = -137.0206 dBm
Receive system noise floor increase in dB = 99.2979 dB

Frequency = 432 MHz
Transmit power = .001 watts
Transmit bandwidth = 1000000 Hz
Receiver bandwidth = 2500 Hz
Spreading loss relative to receiver bandwidth = 26.0206 dB
Transmit antenna gain = 33 dBi
Receive antenna gain = 20 dBi
Distance to receiver = .03 km
Free-space path loss = 54.7021 dB
Received noise in receiver bandwidth = -27.7227 dBm
Receive system Noise Figure including ambient noise = 3 dB
Calculated receive system sensitivity in 2500 Hz bandwidth = -137.0206 dBm
Receive system noise floor increase in dB = 109.2979 dB

Frequency = 432 MHz
Transmit power = .001 watts
Transmit bandwidth = 1E+07 Hz
Receiver bandwidth = 2500 Hz
Spreading loss relative to receiver bandwidth = 36.0206 dB
Transmit antenna gain = 33 dBi
Receive antenna gain = 0 dBi
Distance to receiver = .03 km
Free-space path loss = 54.7021 dB
Received noise in receiver bandwidth = -57.7227 dBm
Receive system Noise Figure including ambient noise = 3 dB
Calculated receive system sensitivity in 2500 Hz bandwidth = -137.0206 dBm
Receive system noise floor increase in dB = 79.2979 dB

Frequency = 432 MHz
Transmit power = .001 watts
Transmit bandwidth = 1E+07 Hz
Receiver bandwidth = 2500 Hz
Spreading loss relative to receiver bandwidth = 36.0206 dB
Transmit antenna gain = 33 dBi
Receive antenna gain = 10 dBi
Distance to receiver = .03 km
Free-space path loss = 54.7021 dB
Received noise in receiver bandwidth = -47.7227 dBm
Receive system Noise Figure including ambient noise = 3 dB
Calculated receive system sensitivity in 2500 Hz bandwidth = -137.0206 dBm
Receive system noise floor increase in dB = 89.2979 dB

Frequency = 432 MHz
Transmit power = .001 watts
Transmit bandwidth = 1E+07 Hz
Receiver bandwidth = 2500 Hz
Spreading loss relative to receiver bandwidth = 36.0206 dB
Transmit antenna gain = 33 dBi
Receive antenna gain = 20 dBi
Distance to receiver = .03 km
Free-space path loss = 54.7021 dB
Received noise in receiver bandwidth = -37.7227 dBm
Receive system Noise Figure including ambient noise = 3 dB
Calculated receive system sensitivity in 2500 Hz bandwidth = -137.0206 dBm
Receive system noise floor increase in dB = 99.2979 dB

Frequency = 432 MHz
Transmit power = .001 watts
Transmit bandwidth = 1E+08 Hz
Receiver bandwidth = 2500 Hz
Spreading loss relative to receiver bandwidth = 46.0206 dB
Transmit antenna gain = 33 dBi
Receive antenna gain = 0 dBi
Distance to receiver = .03 km
Free-space path loss = 54.7021 dB
Received noise in receiver bandwidth = -67.72269 dBm
Receive system Noise Figure including ambient noise = 3 dB
Calculated receive system sensitivity in 2500 Hz bandwidth = -137.0206 dBm
Receive system noise floor increase in dB = 69.2979 dB

Frequency = 432 MHz
Transmit power = .001 watts
Transmit bandwidth = 1E+08 Hz
Receiver bandwidth = 2500 Hz
Spreading loss relative to receiver bandwidth = 46.0206 dB
Transmit antenna gain = 33 dBi
Receive antenna gain = 10 dBi
Distance to receiver = .03 km
Free-space path loss = 54.7021 dB
Received noise in receiver bandwidth = -57.7227 dBm
Receive system Noise Figure including ambient noise = 3 dB
Calculated receive system sensitivity in 2500 Hz bandwidth = -137.0206 dBm
Receive system noise floor increase in dB = 79.2979 dB

Frequency = 432 MHz
Transmit power = .001 watts
Transmit bandwidth = 1E+08 Hz
Receiver bandwidth = 2500 Hz
Spreading loss relative to receiver bandwidth = 46.0206 dB
Transmit antenna gain = 33 dBi
Receive antenna gain = 20 dBi
Distance to receiver = .03 km
Free-space path loss = 54.7021 dB
Received noise in receiver bandwidth = -47.7227 dBm
Receive system Noise Figure including ambient noise = 3 dB
Calculated receive system sensitivity in 2500 Hz bandwidth = -137.0206 dBm
Receive system noise floor increase in dB = 89.2979 dB

Frequency = 432 MHz
Transmit power = .001 watts
Transmit bandwidth = 1E+09 Hz
Receiver bandwidth = 2500 Hz
Spreading loss relative to receiver bandwidth = 56.0206 dB
Transmit antenna gain = 33 dBi
Receive antenna gain = 0 dBi
Distance to receiver = .03 km
Free-space path loss = 54.7021 dB
Received noise in receiver bandwidth = -77.72269 dBm
Receive system Noise Figure including ambient noise = 3 dB
Calculated receive system sensitivity in 2500 Hz bandwidth = -137.0206 dBm
Receive system noise floor increase in dB = 59.29791 dB

Frequency = 432 MHz
Transmit power = .001 watts
Transmit bandwidth = 1E+09 Hz
Receiver bandwidth = 2500 Hz
Spreading loss relative to receiver bandwidth = 56.0206 dB
Transmit antenna gain = 33 dBi
Receive antenna gain = 10 dBi
Distance to receiver = .03 km
Free-space path loss = 54.7021 dB
Received noise in receiver bandwidth = -67.72269 dBm
Receive system Noise Figure including ambient noise = 3 dB
Calculated receive system sensitivity in 2500 Hz bandwidth = -137.0206 dBm
Receive system noise floor increase in dB = 69.2979 dB

Frequency = 432 MHz
Transmit power = .001 watts
Transmit bandwidth = 1E+09 Hz
Receiver bandwidth = 2500 Hz
Spreading loss relative to receiver bandwidth = 56.0206 dB
Transmit antenna gain = 33 dBi
Receive antenna gain = 20 dBi
Distance to receiver = .03 km
Free-space path loss = 54.7021 dB
Received noise in receiver bandwidth = -57.7227 dBm
Receive system Noise Figure including ambient noise = 3 dB
Calculated receive system sensitivity in 2500 Hz bandwidth = -137.0206 dBm
Receive system noise floor increase in dB = 79.2979 dB

Frequency = 432 MHz
Transmit power = .001 watts
Transmit bandwidth = 1000000 Hz
Receiver bandwidth = 2500 Hz
Spreading loss relative to receiver bandwidth = 26.0206 dB
Transmit antenna gain = 33 dBi
Receive antenna gain = 0 dBi
Distance to receiver = 1 km
Free-space path loss = 85.15968 dB
Received noise in receiver bandwidth = -78.18027 dBm
Receive system Noise Figure including ambient noise = 3 dB
Calculated receive system sensitivity in 2500 Hz bandwidth = -137.0206 dBm
Receive system noise floor increase in dB = 58.84033 dB

Frequency = 432 MHz
Transmit power = .001 watts
Transmit bandwidth = 1000000 Hz
Receiver bandwidth = 2500 Hz
Spreading loss relative to receiver bandwidth = 26.0206 dB
Transmit antenna gain = 33 dBi
Receive antenna gain = 10 dBi
Distance to receiver = 1 km
Free-space path loss = 85.15968 dB
Received noise in receiver bandwidth = -68.18027 dBm
Receive system Noise Figure including ambient noise = 3 dB
Calculated receive system sensitivity in 2500 Hz bandwidth = -137.0206 dBm
Receive system noise floor increase in dB = 68.84032 dB

Frequency = 432 MHz
Transmit power = .001 watts
Transmit bandwidth = 1000000 Hz
Receiver bandwidth = 2500 Hz
Spreading loss relative to receiver bandwidth = 26.0206 dB
Transmit antenna gain = 33 dBi
Receive antenna gain = 20 dBi
Distance to receiver = 1 km
Free-space path loss = 85.15968 dB
Received noise in receiver bandwidth = -58.18027 dBm
Receive system Noise Figure including ambient noise = 3 dB
Calculated receive system sensitivity in 2500 Hz bandwidth = -137.0206 dBm
Receive system noise floor increase in dB = 78.84032 dB

Frequency = 432 MHz
Transmit power = .001 watts
Transmit bandwidth = 1E+07 Hz
Receiver bandwidth = 2500 Hz
Spreading loss relative to receiver bandwidth = 36.0206 dB
Transmit antenna gain = 33 dBi
Receive antenna gain = 0 dBi
Distance to receiver = 1 km
Free-space path loss = 85.15968 dB
Received noise in receiver bandwidth = -88.18027 dBm
Receive system Noise Figure including ambient noise = 3 dB
Calculated receive system sensitivity in 2500 Hz bandwidth = -137.0206 dBm
Receive system noise floor increase in dB = 48.84038 dB

Frequency = 432 MHz
Transmit power = .001 watts
Transmit bandwidth = 1E+07 Hz
Receiver bandwidth = 2500 Hz
Spreading loss relative to receiver bandwidth = 36.0206 dB
Transmit antenna gain = 33 dBi
Receive antenna gain = 10 dBi
Distance to receiver = 1 km
Free-space path loss = 85.15968 dB
Received noise in receiver bandwidth = -78.18027 dBm
Receive system Noise Figure including ambient noise = 3 dB
Calculated receive system sensitivity in 2500 Hz bandwidth = -137.0206 dBm
Receive system noise floor increase in dB = 58.84033 dB

Frequency = 432 MHz
Transmit power = .001 watts
Transmit bandwidth = 1E+07 Hz
Receiver bandwidth = 2500 Hz
Spreading loss relative to receiver bandwidth = 36.0206 dB
Transmit antenna gain = 33 dBi
Receive antenna gain = 20 dBi
Distance to receiver = 1 km
Free-space path loss = 85.15968 dB
Received noise in receiver bandwidth = -68.18027 dBm
Receive system Noise Figure including ambient noise = 3 dB
Calculated receive system sensitivity in 2500 Hz bandwidth = -137.0206 dBm
Receive system noise floor increase in dB = 68.84032 dB

Frequency = 432 MHz
Transmit power = .001 watts
Transmit bandwidth = 1E+08 Hz
Receiver bandwidth = 2500 Hz
Spreading loss relative to receiver bandwidth = 46.0206 dB
Transmit antenna gain = 33 dBi
Receive antenna gain = 0 dBi
Distance to receiver = 1 km
Free-space path loss = 85.15968 dB
Received noise in receiver bandwidth = -98.18027 dBm
Receive system Noise Figure including ambient noise = 3 dB
Calculated receive system sensitivity in 2500 Hz bandwidth = -137.0206 dBm
Receive system noise floor increase in dB = 38.84089 dB

Frequency = 432 MHz
Transmit power = .001 watts
Transmit bandwidth = 1E+08 Hz
Receiver bandwidth = 2500 Hz
Spreading loss relative to receiver bandwidth = 46.0206 dB
Transmit antenna gain = 33 dBi
Receive antenna gain = 10 dBi
Distance to receiver = 1 km
Free-space path loss = 85.15968 dB
Received noise in receiver bandwidth = -88.18027 dBm
Receive system Noise Figure including ambient noise = 3 dB
Calculated receive system sensitivity in 2500 Hz bandwidth = -137.0206 dBm
Receive system noise floor increase in dB = 48.84038 dB

Frequency = 432 MHz
Transmit power = .001 watts
Transmit bandwidth = 1E+08 Hz
Receiver bandwidth = 2500 Hz
Spreading loss relative to receiver bandwidth = 46.0206 dB
Transmit antenna gain = 33 dBi
Receive antenna gain = 20 dBi
Distance to receiver = 1 km
Free-space path loss = 85.15968 dB
Received noise in receiver bandwidth = -78.18027 dBm
Receive system Noise Figure including ambient noise = 3 dB
Calculated receive system sensitivity in 2500 Hz bandwidth = -137.0206 dBm
Receive system noise floor increase in dB = 58.84033 dB

Frequency = 432 MHz
Transmit power = .001 watts
Transmit bandwidth = 1E+09 Hz
Receiver bandwidth = 2500 Hz
Spreading loss relative to receiver bandwidth = 56.0206 dB
Transmit antenna gain = 33 dBi
Receive antenna gain = 0 dBi
Distance to receiver = 1 km
Free-space path loss = 85.15968 dB
Received noise in receiver bandwidth = -108.1803 dBm
Receive system Noise Figure including ambient noise = 3 dB
Calculated receive system sensitivity in 2500 Hz bandwidth = -137.0206 dBm
Receive system noise floor increase in dB = 28.84599 dB

Frequency = 432 MHz
Transmit power = .001 watts
Transmit bandwidth = 1E+09 Hz
Receiver bandwidth = 2500 Hz
Spreading loss relative to receiver bandwidth = 56.0206 dB
Transmit antenna gain = 33 dBi
Receive antenna gain = 10 dBi
Distance to receiver = 1 km
Free-space path loss = 85.15968 dB
Received noise in receiver bandwidth = -98.18027 dBm
Receive system Noise Figure including ambient noise = 3 dB
Calculated receive system sensitivity in 2500 Hz bandwidth = -137.0206 dBm
Receive system noise floor increase in dB = 38.84089 dB

Frequency = 432 MHz
Transmit power = .001 watts
Transmit bandwidth = 1E+09 Hz
Receiver bandwidth = 2500 Hz
Spreading loss relative to receiver bandwidth = 56.0206 dB
Transmit antenna gain = 33 dBi
Receive antenna gain = 20 dBi
Distance to receiver = 1 km
Free-space path loss = 85.15968 dB
Received noise in receiver bandwidth = -88.18027 dBm
Receive system Noise Figure including ambient noise = 3 dB
Calculated receive system sensitivity in 2500 Hz bandwidth = -137.0206 dBm
Receive system noise floor increase in dB = 48.84038 dB

Frequency = 100 MHz
Transmit power = .001 watts
Transmit bandwidth = 1E+09 Hz
Receiver bandwidth = 6000000 Hz
Spreading loss relative to receiver bandwidth = 22.21849 dB
Transmit antenna gain = 33 dBi
Receive antenna gain = 10 dBi
Distance to receiver = .03 km
Free-space path loss = 41.99242 dB
Received noise in receiver bandwidth = -21.21091 dBm
Receive system Noise Figure including ambient noise = 3 dB
Calculated receive system sensitivity in 6000000 Hz bandwidth = -103.2185 dBm
Receive system noise floor increase in dB = 82.00758 dB

Frequency = 100 MHz
Transmit power = .001 watts
Transmit bandwidth = 1E+09 Hz
Receiver bandwidth = 6000000 Hz
Spreading loss relative to receiver bandwidth = 22.21849 dB
Transmit antenna gain = 33 dBi
Receive antenna gain = 10 dBi
Distance to receiver = .03 km
Free-space path loss = 41.99242 dB
Received noise in receiver bandwidth = -21.21091 dBm
Receive system Noise Figure including ambient noise = 12 dB
Calculated receive system sensitivity in 6000000 Hz bandwidth = -94.21849 dBm
Receive system noise floor increase in dB = 73.00758 dB