

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

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

To: The Commission

**COMMENTS OF ARRL, THE
NATIONAL ASSOCIATION FOR AMATEUR RADIO**

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September 12, 2000

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SUMMARY

ARRL, The National Association for Amateur Radio ("ARRL"), submits its comments in response to the *Notice of Proposed Rule Making*, FCC 00-163, 65 Fed. Reg. 37332, released May 11, 2000 (the Notice). The Notice proposes to permit operation of ultra-wideband radio systems (UWB) on an unlicensed basis under Part 15 of the Commission's Rules in certain configurations, to be determined. Such devices and systems can provide radar applications where precise distance resolution is required. UWB devices can also permit transmission of voice or data communications for business, public safety and consumer applications

ARRL submitted comments and reply comments earlier in this proceeding, addressing Commission questions posed in the *Notice of Inquiry*, FCC 98-208, released September 1, 1998. ARRL's comments noted concerns about permitting UWB in bands already heavily used by amateur radio operators, due to the potential of such devices, individually or in the aggregate, to cause interference to licensed radio services. It is unclear to ARRL that these concerns have been adequately addressed as a technical matter, either in comments submitted in response to the 1998 Notice of Inquiry, or in the instant Notice. Furthermore, this Notice of Proposed Rule Making includes no proposed rules. Instead, the Notice lists a few generalized, tentative conclusions about UWB configurations, and asks for comment on them. Thus, the Notice in this proceeding is more akin to a further Notice of Inquiry. It leads ARRL to the conclusion that this Notice remains extremely premature, and something of a rush to judgment.

While ARRL does not dispute the public interest in accommodating UWB devices to the extent consistent with protection of licensed services from interference, and it does not object to such devices being operated on an unlicensed basis under Part 15 of the Commission's Rules as a general principle, UWB devices cannot be authorized on a blanket basis at this point without making assumptions which could very well be erroneous, and with potentially disastrous results for licensed radio services. This proceeding should be placed on hold until test results are available, and a further round of comments should be sought thereafter. This Notice makes no specific proposals for UWB station configurations, but merely makes further inquiries. Following the submission of test results from the waivers permitted by the Commission, and comments in response to those test results, there should be a further notice, with specific rules proposed, taking into account empirical evidence of interference potential from UWB devices. At this point, it is not reasonable to adopt rules for UWB devices, notwithstanding an apparent public interest in accommodating such.

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ARRL, The National Association for Amateur Radio (also known as the American Radio Relay League, Incorporated) (hereinafter "ARRL"), by counsel and pursuant to the *Notice of Proposed Rule Making*, FCC 00-163, 65 Fed. Reg. 37332, released May 11, 2000 (the Notice), hereby respectfully submits its comments in the captioned proceeding. These comments are timely filed¹. The Notice proposes to permit operation of ultra-wideband radio systems (UWB) on an unlicensed basis under Part 15 of the Commission's Rules in certain configurations, to be determined. Such devices and systems can provide radar applications where precise distance resolution is required. UWB devices can also permit transmission of voice or data communications for business, public safety and consumer applications. For its comments, ARRL states as follows:

¹ The Comment date is 90 days from the date of Federal Register publication, which occurred June 14, 2000.

I. Background

1. ARRL submitted comments and reply comments earlier in this proceeding, addressing Commission questions posed in the *Notice of Inquiry*, FCC 98-208, released September 1, 1998. ARRL's comments noted concerns about permitting UWB in bands already heavily used by amateur radio operators, due to the potential of such devices, individually or in the aggregate, to cause interference to licensed radio services. It is unclear to ARRL that these concerns have been adequately addressed as a technical matter, either in comments submitted in response to the 1998 Notice of Inquiry, or in the instant Notice.

2. Nevertheless, ARRL notes the Commission's unequivocal pledge at paragraph 7 of the Notice that "any new rule provisions for UWB devices must ensure that radio services are protected against interference." Efficient use of the spectrum would necessitate such protection. The Commission recognizes that spreading RF energy over frequency does reduce the interference potential to narrowband users, but also that an interference threshold still exists. ARRL views this commitment by the Commission as satisfactory as a premise for this proceeding, and as the result, does not oppose the amendment of Part 15 regulations to accommodate UWB devices as a general principle.

3. However, ARRL is concerned with UWB devices that could be located in residential neighborhoods, mobile UWB installations, high power UWB devices or those that may be located at locations where propagation of signals may be significant. ARRL is especially interested in UWB devices that could be in common use in residential neighborhoods; the same environments in which licensed Amateur Radio stations are usually located. UWB devices that transmit continuously, or for periods of several minutes at a time, pose much more interference threat

than do those that transmit only for brief periods. With respect to UWB mobile devices, these can pose an interference potential that simply cannot be addressed by the no-harmful-interference clause of the Part 15 rules because it is not possible or practical to identify the operator of the device to seek corrective action. As a practical matter, if the interference is not prevented at the outset, licensed radio services are without a remedy.

II. The Record, And The Notice, Contain Insufficient Information To Proceed To A Report And Order Or Provide Meaningful Comments

4. The Notice in this proceeding is somewhat unsettling in several other respects. First of all, this Notice of Proposed Rule Making includes no proposed rules. Instead, the Notice lists a few generalized, tentative conclusions about UWB configurations, and asks for comment on them. Thus, the Notice in this proceeding is more akin to a further Notice of Inquiry. It leads ARRL to the conclusion that this Notice remains extremely premature, and something of a rush to judgment. The Commission notes in paragraph 1 of the Notice that:

UWB technology is relatively new. Further testing and analysis is needed before the risks of interference are completely understood. Such testing is already being planned by a number of organizations. We will provide ample opportunity to complete these tests and ensure that analyses of the test results are submitted in the record for public comment before adopting any final rules in this proceeding. We invite broad comment on this Notice so that the Commission may ultimately provide for the introduction of this new and exciting technology.

5. It is difficult to understand what comment, beyond that already provided in response to the Notice of Inquiry, can be offered *at this time*. The Commission has apparently not obtained nor reviewed the results of the testing that was authorized pursuant to waivers granted to three entities more than a year ago.² ARRL believes that operation of these devices pursuant

² At paragraph 6 of the Notice, the Commission discussed the grant, but not the results, of waivers granted to U.S. Radar [for ground-penetrating radars (GPR) to detect buried objects],

to waivers or experimental authorizations for a reasonable period provides the proper means of ascertaining the interference potential of various configurations of UWB devices, and thus the proper operating parameters. It would have been appropriate to await the results of those tests, thus to determine the proper operating parameters for Part 15 UWB devices, prior to issuing the Notice. ARRL's comments in response to the Notice of Inquiry suggested that manufacturers of UWB devices and systems be tasked with developing proposed standards as part of a unified plan. This not having been done, and because no specific technical operating parameters are specified in the Notice, determination of the proper UWB operating parameters in various operating environments under Part 15 is, at this stage, difficult.³

6. It is obvious from the record in this proceeding that UWB technology has potentially beneficial applications which should be accommodated, subject to appropriate interference avoidance regulations. Some UWB applications cannot be easily accommodated using alternative technologies. However, it is unclear whether ubiquitous UWB uses, in the aggregate, will result

Time Domain Corp. (for systems used by public safety personnel for high-resolution imaging of persons and objects behind walls or other debris), and Zircon Corporation (for devices to be used in the construction industry to detect objects hidden behind walls or other building materials). The record does not contain any indication of the results of these tests.

³ At paragraph 31 of the Notice, the Commission notes that various parties have at least planned, if not commenced, experimental programs to study the interference potential of UWB devices. These entities include the NTIA Institute for Telecommunications Sciences in Colorado and the Department of Transportation through Stanford University. ARRL would be pleased to contribute to these studies, or others, either through the contribution of hypothetical reference circuits or actual testing of interference potential to typical amateur station configurations. The Commission suggests that all interested parties work together cooperatively to complete the work in a timely and efficient manner. However, it also urged the parties to submit test results into the record in this proceeding by October 30, 2000, which does not appear a reasonable time frame to complete necessary studies. The Notice also suggests that the Commission will issue a public notice, providing an opportunity to comment and reply to test results and analyses, which is right and proper. What is unclear is why this rulemaking proceeding, which proposes no actual standards or even rules, was issued in advance of the receipt of these test results and analyses.

in substantial interference over wide segments of spectrum. If, as claimed, UWB devices are used for high-speed communications across short distances, through walls and impediments, connecting printers, peripherals, and other electronic devices, last-mile connectivity, security systems, proximity detectors, collision avoidance systems, and other applications, the extensive deployment of the devices would have no upper limit. It is unclear whether, in this context, imposition of spectrum etiquette is feasible, or whether the proper solution is a low power spectral density or simply frequency limitations.

7. The Commission tentatively proposes that UWB devices be permitted to operate under Part 15 as unlicensed devices, since the current list of applications involve relatively low power and short operating ranges. However, even so, this is not a typical Part 15 rulemaking proceeding, and as the result, the apparent absence of any empirical information is troubling. The Commission, for the first time, is proposing tentatively to permit these devices to operate, albeit at low power, in the restricted bands listed in Section 15.205 of the Commission's Rules. Many parties commenting on this subject suggested that it would be infeasible to filter the restricted bands, or otherwise preclude operation in those segments. If this is correct, then the Commission should not make assumptions concerning interference potential. Instead, it should insist on some technical test results which would allow an objective determination of interference potential, especially with respect to the sensitive and safety-related services operating in the restricted bands.

III. The General Need to Protect Licensed Services Against Interference

8. The changes herein proposed represent a major paradigm shift from what has previously been authorized under Part 15 rules. Under existing Part 15 rules, most emitters that are broadband in nature are incidental radiators or spread spectrum devices. The incidental radiators are not designed to radiate and can be engineered to generate very low noise levels without affecting their intended operation, and some are so engineered at relatively low cost. Spread-spectrum devices are intentional radiators, and their interference potential can be considerable, so those devices that use significantly high power and antenna gains have been relegated to specific frequency bands and are subject to specific operating constraints in some cases.

9. The Notice of Inquiry brought forth a wide range of possible UWB uses, ranging from ground-penetrating radar, whose emissions would primarily be directed toward the ground, to communications systems, with a wide range of interference potentials to systems installed in automobiles, presumably operating continuously, with unknown interference potential and no easy way to secure cooperation from the Part 15 device operator in the event of harmful interference. The comments indicate that UWB devices are under development or being proposed over a wide frequency range, from a few hundred Hertz well into tens of GHz. While ARRL appreciates the general operating conditions specified at Section 15.205 of the Rules, the Commission is aware that this rule is difficult or impossible to enforce in many cases. ARRL also asks the Commission in this proceeding not only to determine reasonable operating conditions for UWB devices, but also to consider *how it will address the cases of harmful interference that may occur*. At this time, many of the frequency bands in which higher-power

Part 15 devices may operate are allocated to and significantly used by licensees in the Amateur Radio Service. ARRL has often been able to help Part 15 device users or operators resolve interference problems directly, with no specific assistance offered or needed from the Commission. However, the anticipated ubiquitous applications of UWB devices substantially affect entire amateur bands, the Commission will undoubtedly be called upon to enforce the non-interference provisions of Part 15, by convincing manufacturers and consumers or operators that the device that they just purchased is being operated in violation of Federal law. As the interference potential of Part 15 devices is extended to impact more and more additional frequencies, the Commission will be faced more and more with enforcement issues that cannot be resolved easily, despite the technical abilities of the involved radio operators.

10. Until fairly recently, many Part 15 devices were in use in relatively small numbers. More recently, Part 15 devices have been in much wider use. In many cases, Amateurs are not aware of the source of unidentified, and unidentifiable noise emitters heard on the amateur bands or for a number of reasons do not report interference to the Commission. More report those cases to the ARRL. In instances where interference problems have received widespread publicity, ARRL has documented a significant number of reported cases. Although those cases do not involve UWB devices, the point is that the number of Part 15 devices has increased exponentially in recent years, and that noise generators are beginning to have a significant effect on Amateur Radio operation in residential areas. The introduction of yet another noise generator with the capacity to affect numerous bands is to be done only conservatively.

IV. UWB Interference To Amateur Radio

11. Assuming that the Commission intends to proceed with the present rulemaking on the

current record based on its tentative conclusions, ARRL notes that, because of the wide bandwidth of such devices, and the resultant inability of the Commission to make license assignments to such devices and systems in accordance with the Table of Allocations in the International Radio Regulations, the only practical means of authorizing these devices and systems is on an unlicensed basis. However, ARRL once again is constrained to note that the Commission's jurisdiction under the Communications Act of 1934 to permit the operation of RF devices without licenses is limited. It must be concluded in advance that such devices do not have the potential for interference to licensed services. Otherwise, any radio transmitter must have a license, pursuant to Section 301 of the Communications Act of 1934. If the Commission cannot make that determination, it has no jurisdiction to authorize the use of the device. Since the Commission intends to permit only low-power UWB devices at this time, it would appear that Part 15 authorization of these devices is possible, subject to the foregoing caveats. Furthermore, given the extensive consumer deployment of the devices, individual licensing is impractical, and Part 15 operation is the only possible regulatory scheme. In any case, ARRL agrees with the Commission's conclusion that the record in this proceeding is *insufficient* to justify any authorization for high-power UWB applications, such as wide-area mobile services, and that such should not be authorized.

12. Even with respect to low power UWB devices, the Commission correctly recognizes that almost any transmitter will cause interference if it is too close to a receiver. This is certainly true for those transmitters that intentionally radiate on the desired receive frequency. UWB devices are not exceptions to this rule; spreading radio frequency energy does reduce the interference potential to a narrow channel within that spectrum, but it does not reduce it to

negligible levels in all cases. To discuss round numbers that are easily manipulated to other bandwidths, a 1 GHz-wide UWB signal would have an interference potential to a 1 kHz-wide receiver that is reduced approximately 60 dB from what it would be if the entire energy of the transmitter was contained in the 1 kHz channel of the transmitter. At the frequencies that are being considered for this UWB allocation, receivers would have bandwidths that are considerably larger: 15 kHz would be a typical bandwidth for a UHF-FM receiver. This would decrease the protection to 48.2 dB. The Commission suggested a maximum receiver bandwidth of 50 MHz as being likely in the frequency range of interest. This would decrease the protection to only 13 dB.

13. ARRL has included as Attachment A hereto several rough calculations of the interference potential of various potential UWB systems. These calculations assume uniform distribution of spectral energy within the bandwidth of the UWB transmitter and assume that the received signal in the narrow bandwidth will be noise-like or that there is at least one discrete modulation product present in each narrowband channel. For these reasons, the calculations offer only an approximation of the interference potential, but they will serve as a point of discussion until the various studies discussed in the Notice are available for public comment.

V. The Restricted Bands

14. At paragraph 3 of the Notice, the Commission indicates that intentional emitters are generally not permitted to operate in certain sensitive or safety-related frequency bands. There is nothing in this record to indicate that the restricted bands should be made available to intentional UWB emitters. The advent of UWB technology does not ameliorate any of the factors that led to this requirement in the first place: the need to protect emergency-

communications and radio astronomy frequencies still exists. ARRL also notes that, although Amateur bands are not presently included among the restricted bands for intentional radiators, the Amateur Radio Service has characteristics that are similar to those operating in the restricted bands: it is a Service that uses low-level signals for communication and often conducts communications related to public service and emergency communications protecting life and property. For that reason, especially in light of the important public service and emergency communications the Amateur Radio Service provides, ARRL asks that the protections the Commission is considering for safety services be extended to the Amateur Service in this proceeding.

VI. Testing

15. In the Part 15 rules, the Commission has chosen to offer general protection to all radio services by limiting the emissions of emitters to moderate levels. In addition, the Commission has historically placed considerable constraints on the operating frequency of most Part 15 devices, by prohibiting operation on certain frequencies for even the lowest-powered intentional radiators and by authorizing higher-power intentional emitters only in a few frequency ranges. The Commission states at paragraph 39 of the Notice that the Part 15 general emissions limits have a long history of controlling interference. That "long history" is principally a period of slow growth of Part 15 devices which has only recently ended. There is a significant number of cases of interference to the Amateur Radio Service of recent vintage.

16. For these reasons, ARRL urges the Commission not to make significant changes to its radiated emissions limits and frequency limitations on intentional radiators without the benefit of studies of interference potential. In its comments in response to the earlier Notice of Inquiry

in this proceeding, ARRL provided some approximate calculations. These revealed that UWB devices which operate in such a way that their emissions could be directed toward the antennas of receivers operating in the Amateur Radio Service do have a significant interference potential. ARRL agrees with the Commission that UWB emissions do not represent the same interference potential as unintentional radiators. Most unintentional radiators have emissions that consist of single frequencies or groups of frequencies that have an interference potential that is limited to only those frequencies. Radio Services with frequency agility, such as the Amateur Radio Service, can often avoid harmful interference by selecting a different frequency in the band for its communications. Although spread spectrum operation authorized under Part 15 does occupy a broad frequency range, the Part 15 authorization generally does not permit spread spectrum devices to operate in an entire Amateur band. Authorization of UWB systems and devices would be very different, offering an interference potential that would persist across entire frequency ranges, including, potentially, several amateur bands simultaneously.

17. The interference potential of the vast majority of proposed UWB devices has not been studied to any degree and it may not be possible to extrapolate from the few unrelated interference studies that have been done to date to obtain any assurance that the wide range of devices, frequency ranges, modulation methods, pulse width, pulse repetition rate and power levels proposed would be able to coexist with authorized radio services. The Commission should authorize only those UWB devices, frequencies and power levels for which adequate studies have been done, preferably studies involving representatives from organizations representing affected radio services. Rather than a blanket authorization for essentially unspecified types of devices, the Commission should authorize classes of devices based on specific performance criteria,

supported by the necessary engineering studies to demonstrate a minimal interference potential. This would have the added benefit of possibly permitting higher power levels and emissions for specific classes of UWB devices with a lower interference potential than could be permitted with a generic authorization for devices with unknown interference potentials. The requirements for a device intended for ground imaging should be different than for a device intended for communications use in residential neighborhoods. The former could be permitted higher emissions levels, but may require control of side-lobe emissions, while the latter may need more stringent emissions and frequency controls.

VI. UWB Power Levels

18. UWB devices should not be permitted at peak or average levels that would warrant licensing and coordination with other users of that spectrum. Although the present Class B emissions levels and general intentional emitter limits have not been adequate to protect all amateur operation, ARRL could, with some reluctance, accept that permitting UWB operation at those levels is not much different in kind from the types of operation permitted under Part 15 rules. Part of ARRL's reluctance is that some types of UWB operation will result in wideband noise across multiple Amateur Bands, something not likely to occur with most presently authorized Part 15 devices. For those UWB devices that result in a spectrum consisting of discrete signals, it is possible that only portions of an Amateur band could experience harmful interference, but if the Commission is going to rely on this to offer interference protection, the rules would have to stipulate the specific authorized pulse parameters that would result in specific spectral output. ARRL hesitates to consider this approach because of the regulatory difficulties of writing such regulations, while still being flexible for the industry, and because of the tight

controls that would have to be placed on the shape, amplitude, spacing and rise and fall times of the pulses.

VII. Bandwidth

19. The Commission proposes that UWB devices be considered as any device with a fractional bandwidth of greater than 0.25. While ARRL sees no major difficulty in this definition under most circumstances, a lower frequency limit does need to be applied. Under the 0.25 rule, a device operating at 3.5 MHz would not be considered ultra-wide-band by any reasonable interpretation. ARRL agrees that it is appropriate to consider the bandwidth of any permanent antenna used when determining the bandwidth of UWB devices as long as that antenna is a permanent, unchangeable part of the device.

VIII. Cumulative Effects

20. ARRL disagrees with the assessment that only the closest radiators will have an effect on the received noise at a particular location. While this would be true for a comparison between two or three emitters at various distances, in a real-world environment (if there was significant deployment of emitters across an area), although the more distant radiators would indeed create less noise at a particular point than closer radiators, this would be offset by the fact that there are more and more radiators in each expanding circle around a particular point, resulting in a steady increase of noise versus the number of emitters. In a given wide area with a significant number of radiators, doubling the number of emitters will result in a 3 dB noise increase, assuming equal separation of the emitting source. For many radio services, it is possible that only the nearest emitters would be problematic, but the Amateur Radio Service often uses very high gain antennas at UHF and higher frequencies, very sensitive receiving

systems and its operators work with signals that are just above the system noise floor. A large antenna overlooking an urban area would very much see a cumulative effect.

IX. General Proposals

21. The Commission is considering whether to adopt the same emissions limits applicable to unintentional radiators or intentional radiators. For those signals that are noise-like, for the most part, the impact on receivers used in the Amateur Radio Service will be determined by the average power present in the receiver bandwidth, at the levels that ARRL believes represent a reasonable worst case for interference to amateurs. In some extreme cases, the peak signal could exceed the dynamic range of the receiver, but this would occur only under circumstances under which the performance of the system was already degraded to the point of being unusable. However, as the Commission correctly notes, for slower pulse repetition frequencies (PRFs), it is possible for the noise to appear as impulse and/or for multiple discrete signals to appear within the receiver passband. Under these circumstances, the peak levels would be more important. ARRL sees no reason that UWB devices, if authorized, should be treated any differently with respect to peak emissions than are other devices authorized under Part 15.

22. With respect to PRFs and the selection of PRFs to avoid generating signals in certain frequency ranges, this could have some merit for some types of devices, but would add a layer of regulatory complexity that could, perhaps, be better addressed through other means. If this method is chosen by the Commission, the ability to select different PRFs in the field to mitigate actual harmful interference to any frequency within the bandwidth of the UWB should be required. Information about the field adjustments should also be included in the operators manual or other literature supplied with the product. The effectiveness of this technique would also

depend heavily on the stability and accuracy of the pulses, so these factors would also have to be mandated in the regulations. Perhaps some of the pending studies will be able to suggest what level of pulse stability is needed to accomplish this goal, if the Commission chooses to pursue it.

23. The Commission suggests that the general emissions limits would be an appropriate level for UWB devices. Although these limits do have provisions that address broadband emissions, ARRL points out that, until fairly recently, relatively few broadband emitters have been brought into the market under Part 15. It is ARRL's experience with radio-frequency interference that it sometimes takes years before reports are generated, especially if users do not know the source of the interference. In FM systems, noise-like interference would not be manifested as noise in the baseband of the receiver, but instead as a reduction in sensitivity and range from that which would be attainable in the absence of noise. As just one example in which the Commission was involved, a number of California Amateurs had suffered high levels of RF noise on HF from nearby power lines literally for years before finally pursuing the matter as an enforcement proceeding. With the upcoming development and market release of unlicensed broadband spread-spectrum devices, the true interference potential of the deployment of a large number of noise-like sources may not be known for some time. It is, therefore, difficult for anyone to assess whether the present Part 15 general radiated limits are truly reasonable protection when applied to broadband devices in the aggregate. Perhaps some of the approximations that ARRL has supplied in Attachment A will offer some indication to the Commission and others whether the present radiated limits are adequate, or whether 12 dB, or more, of additional protection is required.

24. ARRL believes that there is no reason to treat the conducted emissions limits of UWB devices any differently than other devices regulated by Part 15 rules. The Commission is quite correct to believe that it would be very difficult to regulate the residential versus non-residential use of UWB devices and that many of them would be used in locations where the potential for power-line radiation is significant.

X. Frequency Bands for UWB Should Be Above 2.5 GHz

25. In view of the variety of applications for these devices; the apparent difficulty of notch-filtering specific bands; the potential for significant aggregate noise created by devices which may in the short term number in the thousands or millions in varying environments; and the difficulties with identifying individual interference sources⁴, it is difficult to anticipate and implement the appropriate power spectral density for these devices. While such might be approximated, Pandora should not be allowed to escape the box at the outset. Frequency limitations are the only objective means of avoiding interference to licensed services from UWB devices. ARRL does not object to permitting GPRs to be operated anywhere in the spectrum, as proposed at paragraph 25 of the Notice, subject to appropriate emission limits. Those devices are obviously going to be deployed in limited numbers for limited times, and the majority of the RF energy is aimed at the ground. Shielding of GPR devices, to limit signal propagation above the ground, would seem a simple matter. However, other UWB devices, which are not aimed at the ground, are of greater concern. The Commission is tentatively of the opinion that non-GPR UWB devices can be operated above approximately 2 GHz without causing harmful interference

⁴ For example, because the output of multiple UWB devices may appear in an offended receiver as noise, rather than an interfering signal, it would be difficult or impossible to determine whether the interference source is one or more UWB devices. Furthermore, many applications of these devices involve mobile, rather than fixed, use.

to other radio services. Approximately two-thirds of the restricted bands are below this range, and the bands below 2 GHz are the most heavily occupied portions of the spectrum presently.⁵ Given the propagation characteristics of these bands, omnidirectional antennas are typically deployed, and those do not reject desired signals.

26. The bands below 2 GHz should be protected, and the Commission should not permit UWB operation (save for GPRs) below 2.5 GHz. The band 2400-2450 MHz is used substantially for Amateur Radio operation, including wideband video and satellite communications, both of which stand to be disrupted by aggregate noise levels from UWB devices. That band is also used increasingly for spread-spectrum consumer devices, and a host of other Part 15 devices, including Bluetooth wireless connections. It would make little sense indeed to prohibit UWB devices below 2 GHz, but to permit such to operate within the 2400-2450 MHz band, given the rapid development of that band currently for various broadband applications (including wireless Internet access) by both the Amateur Service and by Part 15 manufacturers. Though the Commission left the door open for alternatives to blanket prohibitions of non-GPR UWB devices below approximately 2 GHz, it could suggest only extremely low power levels as a means of avoiding interference to sensitive uses below that threshold, such as GPS receivers, and only where actual test results lead to the conclusion that interference in those segments would not be a problem. ARRL can offer no suggested alternative at present that would permit UWB devices to operate below 2.5 GHz without potentially causing harmful interference to Amateur and other services. However, compatibility testing could be conducted which might provide some additional

⁵ The Commission notes that the bands below 2 GHz are used for public safety, aeronautical and maritime navigation and communications, AM, FM and TV broadcasting, private and commercial mobile communications, medical telemetry, amateur communications and GPS operation, all services which demand protection from interference.

options at a later date.

27. ARRL asks for protection at 2400-2450 MHz because the Amateur Radio Service is bearing a significant interference burden already in that band, with additional interference from unlicensed devices expected in the near term. High-power part 15 devices operate in part within the amateur 2.4 GHz allocation. Spectral analysis of over-the-air signals in the Los Angeles area shows that the noise floor of that portion of the Amateur band is being degraded by about 10 dB at a location that overlooks the Los Angeles basin. As 2.4 GHz becomes increasingly occupied by Part 15 devices, the interference burden on the Amateur Radio Service and the Part 15 manufacturers and users will only increase. If a lower limit for UWB devices in the 2 GHz region is determined to be appropriate by the Commission, it should be established at approximately 2500 MHz, or at least above 2450 MHz, a relatively small change, to accommodate at least minimally compatible development of the 2400-2450 MHz band.

28. For the purposes of a lower frequency limit, ARRL recommends that a -23 dB level be considered as the point at which to determine bandwidth, to keep the bandwidth specification in line with other regulations on spurious and out-of-band emissions.

XI. Hypothetical Reference Circuits

29. The Notice asks about the nature of the signals, power levels, antenna pattern and modulation methods used in the various Services that could be affected by this proceeding. ARRL has prepared reference circuits for each of the amateur allocations at 10 GHz and below, providing information on all of these parameters for each Amateur band and operating mode. Because one of the companies that commented in response to the Notice of Inquiry has designed a UWB system with a lower frequency limit of a few hundred Hertz, ARRL has included

herewith reference circuits for Amateur bands down to the 1.8 MHz allocation as Attachment B hereto.

XII. Conclusions

30. This proceeding remains difficult to address due to the virtual absence of any test results. UWB devices cannot be authorized on a blanket basis without making assumptions which could very well be erroneous, and with disastrous results for licensed radio services. This proceeding should be placed on hold until test results are available, and a further round of comments should be sought thereafter. This Notice makes no specific proposals for UWB station configurations, but merely makes further inquiries. Following the submission of test results from the waivers permitted by the Commission, and comments in response to those test results, there should be a further notice, with specific rules proposed, taking into account empirical evidence of interference potential from UWB devices. At this point, it is not reasonable to adopt rules for UWB devices, despite an apparent public interest in accommodating some such devices.

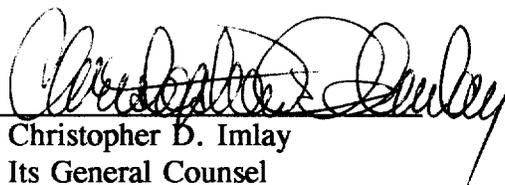
Therefore, the foregoing considered, ARRL, the National Association for Amateur Radio, respectfully requests that the Commission not proceed to adopt final rules for Ultra-Wideband

devices based on the instant notice and the comments thereon. Instead, the Commission should proceed in accordance with the recommendations contained herein.

Respectfully submitted,

**ARRL, THE NATIONAL ASSOCIATION
FOR AMATEUR RADIO**

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ATTACHMENT A

Attachment A: Calculated Interference Potential of a UWB Transmitter

RESULTS: 0 dBm average UWB transmit power, 1 GHz UWB BW

Receive antenna = 0 dBi

Frequency = 2500 MHz

Transmit spread = 1000 MHz

Receiver bandwidth = 1000 Hz

Transmit power in 1 Hz = -90 dBm/Hz

Transmit power in 1000 Hz = -60 dBm

Transmit antenna gain = 0 dBi

Receive antenna gain = 0 ; dBi

Distance to receiver = .03 km

Free-space pathloss = -69.95123 db

System loss (path loss +/- antenna gains) = -69.95123 dB

Total loss (path loss +/- antenna gains - spreading loss) = -129.9512 dB

Specified receive system Noise Figure = 3 dB (includes external noise)

Calculated receive system sensitivity in 1000 Hz bandwidth = -141 dBm

Received noise in receiver bandwidth = -129.9512 dBm

Receive system noise floor increase in dB = 11.37715 dB

RESULTS: 0 dBm average UWB transmit power, 1 GHz UWB BW

Receive antenna = 20 dBi

Frequency = 2500 MHz

Transmit spread = 1000 MHz

Receiver bandwidth = 1000 Hz

Transmit power in 1 Hz = -90 dBm/Hz

Transmit power in 1000 Hz = -60 dBm

Transmit antenna gain = 0 dBi

Receive antenna gain = 20 ; dBi

Distance to receiver = .03 km

Free-space pathloss = -69.95123 db

System loss (path loss +/- antenna gains) = -49.95123 dB

Total loss (path loss +/- antenna gains - spreading loss) = -109.9512 dB

Specified receive system Noise Figure = 3 dB (includes external noise)

Calculated receive system sensitivity in 1000 Hz bandwidth = -141 dBm

Received noise in receiver bandwidth = -109.9512 dBm

Received noise in receiver bandwidth = S 3

Receive system noise floor increase in dB = 31.05218 dB

RESULTS: 0 dBm average UWB transmit power, 1 GHz UWB BW

Receive antenna = 20 dBi

Frequency = 2500 MHz

Transmit spread = 1000 MHz

Receiver bandwidth = 10000 Hz

Transmit power in 1 Hz = -90 dBm/Hz

Transmit power in 10000 Hz = -50 dBm

Transmit antenna gain = 0 dBi

Receive antenna gain = 20 ; dBi

Distance to receiver = .03 km

Free-space pathloss = -69.95123 db

System loss (path loss +/- antenna gains) = -49.95123 dB

Total loss (path loss +/- antenna gains - spreading loss) = -99.95123 dB

Specified receive system Noise Figure = 3 dB (includes external noise)

Calculated receive system sensitivity in 10000 Hz bandwidth = -131 dBm

Received noise in receiver bandwidth = -99.95123 dBm

Received noise in receiver bandwidth = S 5

Receive system noise floor increase in dB = 31.05218 dB

RESULTS: 0 dBm average UWB transmit power, 1 GHz UWB BW

Receive antenna = 20 dBi

Frequency = 2500 MHz

Transmit spread = 1000 MHz

Receiver bandwidth = 5E+07 Hz

Transmit power in 1 Hz = -90 dBm/Hz

Transmit power in 5E+07 Hz = -13.0103 dBm

Transmit antenna gain = 0 dBi

Receive antenna gain = 20 ; dBi

Distance to receiver = .03 km

Free-space pathloss = -69.95123 db

System loss (path loss +/- antenna gains) = -49.95123 dB

Total loss (path loss +/- antenna gains - spreading loss) = -62.96152 dB

Specified receive system Noise Figure = 3 dB (includes external noise)

Calculated receive system sensitivity in 5E+07 Hz bandwidth = -94.0103 dBm

Received noise in receiver bandwidth = -62.96152 dBm

Received noise in receiver bandwidth = S9 + 10.03848 dB

Receive system noise floor increase in dB = 31.05219 dB

RESULTS: 0 dBm average UWB transmit power, 100 MHz UWB BW

Receive antenna = 20 dBi

Frequency = 420 MHz

Transmit spread = 100 MHz

Receiver bandwidth = 1000 Hz

Transmit power in 1 Hz = -80 dBm/Hz

Transmit power in 1000 Hz = -50 dBm

Transmit antenna gain = 0 dBi

Receive antenna gain = 20 ; dBi

Distance to receiver = .03 km

Free-space pathloss = -54.45741 db

System loss (path loss +/- antenna gains) = -34.45741 dB

Total loss (path loss +/- antenna gains - spreading loss) = -84.45741 dB

Specified receive system Noise Figure = 3 dB (includes external noise)

Calculated receive system sensitivity in 1000 Hz bandwidth = -141 dBm

Received noise in receiver bandwidth = -84.45741 dBm

Received noise in receiver bandwidth = S 8

Receive system noise floor increase in dB = 56.54259 dB