

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

In the Matter of)	
)	
WaveSense, Inc. Request for Waiver of)	ET Docket No. 19-241
the Commission's Part 15 Rules)	
Applicable to Ultra-Wideband Devices)	

REPLY COMMENTS OF WAVESENSE, INC.

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October 1, 2019

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REPLY COMMENTS OF WAVESENSE, INC.

I. INTRODUCTION AND SUMMARY

WaveSense, Inc. (“WaveSense”) submits these reply comments concerning its requested waiver of certain Part 15 rules governing ultra-wideband (“UWB”) devices.¹ As the Waiver Request² explained, the requested waivers are necessary to permit the marketing of WaveSense’s driver-assistance and autonomous vehicle technology, which relies on UWB ground-penetrating radar (“GPR”) to enable and improve active, accurate lanekeeping in otherwise unsafe or unreliable conditions. Since the important safety benefits of WaveSense’s UWB GPR technology far outweigh the negligible risk of harmful interference, good cause exists to grant a waiver.³

¹ See 47 C.F.R. §§ 15.509(b) (limited field of use) and 15.525 (federal coordination requirements).

² WaveSense, Inc. Request for Waiver, ET Docket No. 19-241 (filed July 25, 2019) (“Waiver Request”).

³ See 47 C.F.R. § 1.3 (“The provisions of this chapter may be . . . waived for good cause shown”); *see also* 47 C.F.R. § 1.925(b)(3) (“The Commission may grant a request for waiver if it is shown that . . . [t]he underlying purpose of the rule(s) would not be served or would be frustrated by application to the instant case, and that a grant of the requested waiver would be in the public interest . . .”).

WaveSense appreciates the input and concerns raised by Aviation Spectrum Resources, Inc. (“ASRI”) and the GPS Innovation Alliance (“GPSIA”).⁴ In response, WaveSense strongly urges the Federal Communications Commission (“FCC” or the “Commission”) to reject GPSIA’s proposed limited waiver of a few thousand units permitted to operate for 2-3 years, as this would create significant regulatory uncertainty, fail to meet the needs of auto manufacturers seeking to incorporate the WaveSense GPR, and wholly undermine the commercial viability of WaveSense’s technology.

WaveSense’s requested waivers are consistent with both the Commission’s waiver standard and precedent. Concern regarding proliferation of the WaveSense GPR is misplaced. Wide-scale deployment of millions of vehicular radars emitting Linear Frequency Modulation (“LFM”)⁵ signals—whose unwanted emissions are permitted to operate at the same frequencies and amplitudes used by the WaveSense GPR—demonstrates that mass proliferation of on-vehicle UWB devices has not impaired Aeronautical Mobile or GPS operations.⁶ To address technical concerns raised by ASRI, WaveSense provides further technical analysis demonstrating the negligible risk of interference to VHF ground stations. Finally, WaveSense confirms that a waiver of Section 15.503(d) of the Commission’s rules is not needed.

II. A WAIVER LIMITED TO 2-3 YEARS FOR A RESTRICTED NUMBER OF UNITS WOULD WHOLLY UNDERMINE THE COMMERCIAL VIABILITY OF THE WAVESENSE GPR.

Rather than granting a “blanket waiver” of Sections 15.509(b) and 15.525, GPSIA proposes that the “FCC should instead adopt a condition similar to that set forth in the recent

⁴ Opposition of Aviation Spectrum Resources, Inc., ET Docket No. 19-241 (filed Sept. 16, 2019) (“ASRI Opposition”); Comments of the GPS Innovation Alliance, ET Docket No. 19-241 (filed Sept. 16, 2019) (“GPSIA Comments”).

⁵ See *infra* note 21.

⁶ See *infra* note 22.

GSSI Waiver Request and authorize a limited number (*e.g.*, up to 2,000 units) of evaluation kits for a period of 2-3 years.”⁷ WaveSense appreciates GPSIA’s proposed compromise, but restricting the duration of the waiver or the number of units is inconsistent with the automotive product development cycle, would create regulatory uncertainty for the WaveSense GPR, and would wholly undermine the commercial viability of the product. Geophysical Survey System, Inc.’s (“GSSI”) proposal reflected a private market agreement limiting the number of units that they were authorized to sell, whereas WaveSense has no such restrictions.⁸

Automotive development requires a substantial commitment and investment 4-5 years in advance—at the beginning of the process—and confidence that the new product or technology will become part of the vehicle line for which it is being developed. No vehicle manufacturer would commit to spending millions of dollars and producing a vehicle line with a sensor that is not certain to be available for mass production and for the life of the vehicle, which is usually at least ten years after the completion of the 4-5 year development cycle. This type of regulatory uncertainty would kill investment in the WaveSense GPR technology and result in a substantial loss to the public.

More importantly, granting a brief waiver for an “evaluation period” of 2-3 years without an expectation of another waiver grant would stifle the deployment of WaveSense’s GPR technology and create uncertainty, which would render it unadoptable by the automotive industry. In effect, the public interest benefits of broad deployment of WaveSense’s driver assistance technology would be undermined by the limited adoption of this technology.

⁷ GPSIA Comments at 4.

⁸ Request for Waiver of GSSI, ET Docket No. 19-155, at 7 n.11 (filed Apr. 11, 2019) (“GSSI Waiver Request”) (“GSSI will manufacture the devices under a patent license agreement with MIT that limits the company to 2,000 units.”).

III. WAIVER OF SECTIONS 15.509(B) AND 15.525 IS CONSISTENT WITH THE COMMISSION’S WAIVER STANDARD, WOULD NOT UNDERMINE THE PURPOSE OF THOSE RULES, AND WOULD PROMOTE THE PUBLIC INTEREST.

WaveSense seeks a waiver of Sections 15.509(b) and 15.525 of the Commission’s rules.⁹

As demonstrated in the Waiver Request, good cause exists to grant the requested waivers because the risk of harmful interference to authorized users is negligible and the public interest benefits of the WaveSense GPR heavily outweigh any public interest in strict application of Sections 15.509(b) or 15.525. Despite this straightforward application of the Commission’s waiver standard, ASRI and GPSIA argue that grant of the requested waivers would be inconsistent with the Commission’s waiver standard and the purpose of Section of 15.509(b) and 15.525. The Commission should disregard these arguments.

A. The Commission’s flexible waiver standard permits a limited waiver of Sections 15.509(b) and 15.525 for the WaveSense GPR.

ASRI claims that “although fashioning its filing as a waiver request, [WaveSense] seeks a modification of the Commission’s rules, which the Commission may not do through a waiver request.”¹⁰ This is an incorrect statement of the Commission’s longstanding waiver process and standards.

As a threshold matter, waivers do not modify the Commission’s rules, but merely adapt the application of those rules in limited circumstances. The Commission may also decide to further narrow these circumstances through conditions set forth in a waiver order, where

⁹ See 47 C.F.R. §§ 15.509(b) and 15.525.

¹⁰ ASRI Opposition at 1. In support of its tenuous position, ASRI mischaracterizes the GSSI waiver position, stating, “[A]s GSSI intimates, proliferation of GPR devices on motor vehicles generally should occur *only* after notice and comment rulemaking, and not through the backdoor of a waiver request.” ASRI Opposition at 5 (emphasis added). GSSI clearly states, however, that “marketing of LGPR-equipped vehicles to the general public, were it to occur, would require further *waiver* or modification of these provisions.” GSSI Waiver Request at 6 (emphasis added).

warranted.¹¹ A limited waiver here would not result in a modification of the Commission’s rules, as the waiver would only apply to WaveSense’s GPR, which would be subject to the conditions set forth in a waiver grant. Other GPR devices would require full compliance with the Commission’s rules or a separate waiver request and grant.

In determining whether a waiver is appropriate, the question is not whether the waiver would modify the Commission’s rules, but rather whether good cause exists to grant the waiver. Good cause exists when (1) “particular facts would make strict compliance inconsistent with the public interest;”¹² (2) the waiver does not undermine the purpose of the rule; and (3) there is a stronger public interest benefit in granting the waiver than in applying the rule.¹³ As discussed in the Waiver Request and reiterated below, the waivers sought by WaveSense readily meet the Commission’s standard. And the Commission has granted numerous of Part 15 waivers in similar circumstances, after careful evaluation of the appropriateness of the waiver request on a case-by-case basis.

¹¹ See, e.g., *Evolv Technologies, Inc. Request for Waiver of Sections 15.31(c) and 15.35(b) of the Commission’s Rules to Permit the Deployment of Security Screening Portal Devices that Operate in the 24.0-28.8 GHz Range*, Order, 32 FCC Rcd 9271 (2017) (“This waiver is subject to the following conditions . . .”).

¹² *Ne. Cellular Tel. Co. v. FCC*, 897 F.2d 1164, 1166 (D.C. Cir. 1990); see also *WAIT Radio v. FCC*, 418 F.2d 1153, 1157 (D.C. Cir. 1969) (stating that even though the overall objectives of a general rule have been adjudged to be in the public interest, it is possible that application of the rule to a specific case may not serve the public interest if an applicant’s proposal does not undermine the public interest policy served by the rule).

¹³ See *Headsight, Inc. Request for Waiver of Part 15 of the Commission’s Rules Applicable to Ultra-Wide Band Devices*, Order, 32 FCC Rcd 1551, at ¶ 7 (2017) (“*Headsight Order*”).

B. The purpose of Sections 15.509(b) and 15.525 is to protect authorized users from harmful interference, not to limit proliferation.

ASRI and GPSIA incorrectly state that the purpose of Sections 15.509(b) and 15.525 of the Commission's rules is to limit proliferation of GPR devices, rather than to limit the risk of harmful interference to authorized users.

The Commission's recent order granting a waiver of Section 15.509(b) for use of Headsight, Inc.'s GPR technology in a variety of agricultural applications clearly lays out the purpose of its UWB rules: "The UWB technical and operational standards in Part 15 were adopted to ensure that UWB devices, including ground penetrating radars, *do not cause harmful interference to authorized radio services, including Federal services.*"¹⁴

Similar reasoning supported the Commission's initial adoption of its UWB rules: "To ensure that UWB devices *do not cause harmful interference*, this Order establishes different technical standards and operating restrictions for three types of UWB devices based on their potential to cause interference."¹⁵

Nonetheless, the ASRI Opposition selectively quotes from the *Headsight Order* to support its claim that the end goal of Section 15.509(b) is to limit proliferation: "The Commission found that the waiver would not undermine the purpose of the rule to ensure that GPR devices are 'used infrequently with a low proliferation rate.'"¹⁶ The full quote clearly states

¹⁴ *Headsight Order* at ¶ 8 (emphasis added) (citing *Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems*, First Report and Order, 17 FCC Rcd 7435 (2002) ("1st UWB R&O"); 47 C.F.R. §§ 15.501-15.525).

¹⁵ 1st UWB R&O at ¶ 5.

¹⁶ ASRI Opposition at 4 (quoting *Headsight Order* at ¶ 9) (citing incorrectly *Headsight Order* at ¶ 13). ASRI also argues that "WaveSense's alternative proposal . . . to stand in for [its] users . . . would effectively eliminate the [Section 15.525] coordination requirement." ASRI Opposition at 6. ASRI claims that the purpose of this rule is to track GPRs and identify their operators. *Id.* This is incorrect. The purpose of coordination requirement is to protect federal users from harmful interference. 1st UWB R&O at ¶ 184 ("To further ensure that the operation of

that the purpose is to avoid harmful interference: “The purpose of [Section 15.509(b)] is to ensure that GPR devices are used infrequently with a low proliferation rate, *in order to avoid causing harmful interference to authorized users.*”¹⁷

GPSIA reasons that the *Headsight Order* is inapposite because “the Headsight agricultural application and WaveSense’s driver-assistance application are fundamentally different.”¹⁸ While there clearly are some differences between Headsight’s vehicle-mounted GPR and WaveSense’s vehicle-mounted GPR, the question before the Commission both there and here is whether a limited waiver of Section 15.509(b) would increase the risk of harmful interference to authorized users. As the Commission found in the *Headsight Order* and WaveSense demonstrated in the Waiver Request, the answer in both cases is clearly “no.”

Furthermore, the Commission acknowledged that “standards contained in [its *1st UWB R&O*] are *extremely* conservative,” due to an “unusually controversial proceeding” in which “parties [were] unable to agree on the emissions levels necessary to protect [authorized users].”¹⁹ The *1st UWB R&O* conceded that the UWB rules “may be overprotective and could unnecessarily constrain the development of UWB technology.”²⁰ Under those circumstances and without more information, limiting proliferation appears to have been a compromise approach.

these UWB devices does not result in harmful interference, we also are requiring coordination with NTIA through the Commission of the imaging systems.”). Accordingly, because the risk of harmful interference to federal users is negligible, federal coordination by WaveSense on a one-time basis would not undermine the purpose of Section 15.525.

¹⁷ *Headsight Order* at ¶ 9 (emphasis added).

¹⁸ GPSIA Comments at 4.

¹⁹ *1st UWB R&O* at ¶ 2 (emphasis added).

²⁰ *Id.* at ¶ 1.

Since then, however, wide-scale deployment of vehicular radars emitting LFM²¹ signals—whose unwanted emissions are permitted to operate at the same frequencies and amplitudes used by the WaveSense GPR²²—demonstrates that mass proliferation of on-vehicle UWB devices has not impaired Aeronautical Mobile or GPS operations. Such long-range vehicular radars have been deployed pursuant to a 1995 Commission order²³ and the Commission’s *1st UWB R&O*,²⁴ and these radars are commonplace on vehicles sold today and already number in the millions.

Indeed, Robert Bosch LLC recently observed, “In the intervening sixteen years [since the adoption of the *1st UWB R&O*] there have been no documented complaints of interference from UWB devices as far as Bosch has been able to determine, and there are no known residual debates ongoing in technical literature dealing with determination of the proper emission levels.”²⁵ For the same reason that Robert Bosch proposes revisions to the “extremely conservative” UWB rules, WaveSense seeks a limited waiver of Sections 15.509(b) and 15.525 for the marketing and operation of its GPR.

²¹ Buller, W. *et al.*, *Radar congestion study*, National Highway Traffic Safety Administration, Report No. DOT HS 812 632, at 7 (Sept. 2018), *available at* <https://bit.ly/2msa89D>.

²² WaveSense seeks permission to market a GPR that intentionally radiates at power levels that automotive radars are able to spuriously radiate at. *Compare* 47 C.F.R. § 95.3379(a)(1) (establishing the power limits for spurious emissions of vehicular radar operations in the 76-81 GHz band, including spurious emissions into the 103-403 MHz band) *with* 47 C.F.R. §§ 15.209(a), 15.509(d) (establishing the power limits for radiated emissions of GPR devices operating below 960 MHz).

²³ *Amendment of Parts 2, 15, and 97 of the Commission’s Rules to Permit Use of Radio Frequencies Above 40 GHz for New Radio Applications*, First Report and Order and Second Notice of Proposed Rulemaking, 11 FCC Rcd 4481, ¶¶ 15-17 (1995); 47 C.F.R. § 15.252.

²⁴ *1st UWB R&O* at ¶ 21.

²⁵ Petition for Rulemaking of Robert Bosch LLC, RM-11844, at 4 (filed June 18, 2019).

While limiting proliferation of GPR devices is obviously one way to limit the risk of harmful interference,²⁶ it is unnecessary where the risk of harmful interference is negligible. The WaveSense GPR operates within the prescribed UWB power limits.²⁷ The Waiver Request demonstrates that limited proliferation of the WaveSense GPR is not needed to protect authorized users from harmful interference because the risk of harmful interference—even under extremely conservative assumptions—is already negligible.²⁸ Accordingly, the purpose of the Commission’s UWB rules—protecting authorized users from harmful interference—would not be undermined by granting the waivers requested by WaveSense.

C. The Waiver Request meets the Commission’s waiver standard because the risk of harmful interference is negligible and the public interest benefits far outweigh rigid enforcement of the Commission’s rules.

The risk of harmful interference to federal and non-federal users from the WaveSense GPR is negligible.²⁹ Indeed, the Commission’s waiver process is designed exactly for situations like the instant case: the purpose of the rules (*i.e.*, protecting authorized users from harmful interference) would not be undermined and the public interest benefits far outweigh any interest in strict application of the rule.

²⁶ *1st UWB R&O* at ¶ 185 (“One method of reducing interference potential is to restrict the applications for using UWB devices and the locations where UWB devices may be operated.”).

²⁷ *See* Waiver Request at 3 (“WaveSense’s GPR technology has been formally tested and complies with the power levels under Section 15.509(d) and 15.509(e).”); *see also* 47 C.F.R. §§ 15.209(a), 15.509(d), (e).

²⁸ ASRI also claims “[t]here is nothing in the Request to suggest that the devices would not be always on while equipped-vehicles are in operation.” ASRI Opposition at 2-3. The WaveSense Petition states, however, that “signals also are transmitted only when a vehicle is moving.” WaveSense Petition at 3.

²⁹ Waiver Request, Technical Appendix at 1-3.

ASRI argues that “WaveSense has failed to offer such particular facts or to offer such special circumstances to justify the extreme relief it proposes.”³⁰ As an organization that represents the aviation industry, ASRI surely appreciates the importance of technologies that improve safety and limit risks to life and limb. The safe and reliable operation of driver-assistance technologies—and eventually autonomous vehicles—could similarly improve public health and safety. According to the National Highway Traffic Safety Administration (“NHTSA”), there are over 37,000 traffic deaths and over 2.4 million traffic injuries per year in the United States.³¹ It is estimated that “94 percent of serious crashes are due to human error”³² and 52 percent of all fatalities in the U.S. are the result of roadway departures.³³ Driver-assistance technologies and autonomous vehicles present an opportunity to minimize the risk of human error and, by extension, save lives and reduce injuries. WaveSense applauds the aviation industry and FAA for achieving a remarkably low fatality rate. WaveSense believes it is possible to also reduce the automotive fatality rate—which is currently around 90 times the aviation fatality rate—if it is given permission to operate its GPR technology.³⁴

WaveSense’s GPR enables precise vehicle positioning, which can enhance driver-assistance technologies and autonomous vehicle navigation. A grant would serve the public interest by increasing the reliability and safety of driver-assistance technologies and autonomous

³⁰ ASRI Opposition at 7.

³¹ See NHTSA, “Quick Facts 2016,” <https://bit.ly/2C0zptv> (last visited Oct. 1, 2019).

³² NHTSA, “Automated Vehicles for Safety,” <https://bit.ly/2w4Mzrr> (last visited Oct. 1, 2019).

³³ Federal Highway Administration, U.S. Department of Transportation, “Roadway Departure Safety,” <https://bit.ly/2JNQNrs> (last visited Oct. 1, 2019).

³⁴ *2016–2017 US Transportation Fatalities*, National Transportation Safety Board <https://bit.ly/2nkQexU> (last visited Oct. 1, 2019).

vehicle navigation, and this public safety benefit strongly outweighs continued application of the rules to WaveSense's UWB GPR technology.

IV. THE WAIVER REQUEST'S TECHNICAL APPENDIX IS SUFFICIENT FOR THE COMMISSION TO GRANT WAVESENSE'S WAIVER PETITION.

ASRI claims that the Waiver Request's Technical Appendix is "wholly insufficient."³⁵ But the purpose of the Technical Appendix is to provide highly conservative bounding cases to demonstrate the extremely low probability that harmful interference may occur for even a small fraction of a second.³⁶ Indeed, GPSIA "commend[ed] WaveSense" for its testing of potential interference to GPS systems. As noted in the Technical Appendix, these scenarios use simple, very conservative assumptions, and most can be easily replicated. These scenarios were studied based on discussions with staff members of the Federal Communications Commission, the Department of Defense, and the Department of Transportation.

While ASRI found no errors in the submitted calculations, it identified VHF ground stations as another scenario to be included in WaveSense's analysis.³⁷ Accordingly, appended to these reply comments is an amended analysis of the aviation case study to address ASRI's concern.³⁸ The amended study confirms that even when VHF ground stations are taken into account, emissions are so far below Part 15 levels that they will not cause harmful interference. Any risk of harmful interference is negligible.

Also, GPSIA requested that WaveSense provide its anechoic chamber measurements for GPS frequencies, which showed that system emissions from a single emitter at GPS frequencies

³⁵ ASRI Opposition at 7.

³⁶ GPSIA Comments at 3. Even in the extremely unlikely event that signals were to aggregate to create power in excess of the Section 15.209 power limits, the anomaly would last for only a few microseconds.

³⁷ ASRI Opposition at 7.

³⁸ See *infra* Appendix 1; Waiver Request, Technical Appendix at 2.

were at least 29 dB below the Part 15 emissions standard.³⁹ As requested, a copy of these results is appended.⁴⁰

V. THE WAVESENSE GPR DOES NOT REQUIRE A WAIVER OF SECTION 15.503.

GPSIA states that WaveSense “also needs to seek a waiver of Section 15.503,” which requires a fractional bandwidth of 0.20 or greater.⁴¹ The GPSIA Comments appear to have incorrectly calculated the WaveSense GPR’s fractional bandwidth as approximately 0.18577.⁴² The WaveSense GPR has a fractional bandwidth of approximately 1.18577.⁴³ For the avoidance of doubt, 1.18577 is greater than 0.20, and therefore no waiver of Section 15.503(d) is needed.

GPSIA also requested copies of WaveSense counsel’s correspondence with Commission staff concerning whether the Linear Frequency Modulation waveform used by the WaveSense GPR meets the definition of “ultra-wideband (UWB) transmitter” as described in Section 15.503 and is not subject to the requirement of Section 15.31(c).⁴⁴ As requested, a copy of this correspondence is appended.⁴⁵

VI. CONCLUSION

Waiver of Sections 15.509(b) and 15.525 is necessary to permit the marketing of WaveSense’s vehicle safety and navigation technology, which relies on UWB GPR to enable

³⁹ GPSIA Comments at 2-3.

⁴⁰ *See infra* Appendix 3.

⁴¹ GPSIA Comments at 3; *see also* 47 C.F.R. § 15.503(d).

⁴² Fractional bandwidth is defined as the bandwidth of the transmission ($f_H - f_L$) divided by the center frequency ($(f_H + f_L) / 2$). Section 15.503(c) sets forth the simplification of this formula. *See* 47 C.F.R. § 15.503(c). Accordingly, the formula does not call for subtracting 1 from the result.

⁴³ $2(f_H - f_L) / (f_H + f_L) = 2(403 - 103) / (403 + 103) \approx 1.18577$.

⁴⁴ GPSIA Comments at 2-3.

⁴⁵ *See infra* Appendix 2.

active, accurate lanekeeping in otherwise unsafe or unreliable conditions. By improving driver-assisted and autonomous vehicle safety, WaveSense's UWB GPR technology serves the public interest. Grant of the requested waiver would be consistent with Commission precedent. The Commission should avoid adopting a limited waiver, which would wholly undermine the commercial viability of WaveSense's technology. WaveSense urges the Commission to expeditiously grant the requested waivers.

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October 1, 2019

Respectfully submitted,

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Counsel to WaveSense, Inc.

Appendix 1 – Amended Aviation Technical Analysis Concerning VHF Towers

Assuming a VHF tower is conservatively located 5 feet from the road and using a typical 55 foot tower, an omnidirectional unobstructed Part 15 emitter—conservatively assumed to be at the road’s edge and the same polarization—would yield power levels of 26dB below Part 15 limits as measured at 3 meters. As noted in the earlier scenarios, aggregation of emissions is highly improbable, would exist for a miniscule amount of time even if it did occur, and would remain well below existing Part 15 limits.

Appendix 2 – Correspondence with Commission Staff Regarding Section 15.31(c)

From: oetech@fcc.gov [<mailto:oetech@fcc.gov>]

Sent: Friday, July 12, 2019 3:12 PM

To: Peters, Tom

Subject: Response to Inquiry to FCC (Tracking Number 908926)

Inquiry on 07/08/2019 :

Inquiry:

Our client would like to confirm that a device that employs Linear Frequency Modulation (LFM) meets the definition of Ultra-wideband as defined in 15.503(d). LFM waveforms (also known as “chirp” signals) are traditional waveforms for UWB that transmit a signal that is a continuously varying frequency waveform, but there does not appear to be a precedent or a similar KDB inquiry to confirm that this waveform meets the FCC’s definition of UWB.

Also, since LFM is a single continuous waveform, our client would like to confirm that devices using chirps/LFM waveforms are not considered "swept frequency equipment" for purposes of meeting 15.31(c).

FCC response on 07/09/2019

Does the frequency spectra represented by the LFM waveform rely on the frequency variation to produce a

-10 dB bandwidth that is equal to or greater than 500 MHz, or alternatively, a fractional bandwidth that is equal to or greater than 0.20 as specified in 15.503(d)? A number of sources do in fact use the term 'chirped signal' interchangeably with 'swept signal', which would suggest that 15.31(c) does indeed apply. Given that, please provide an explanation as to what distinguishes this type of chirped (LFM) signal from a swept signal for which 15.31(c) should not apply.

---Reply from Customer on 07/10/2019---

Responses to the two questions:

1) A LFM/Chirp signal is a single waveform rather than just a series of individual frequencies swept through over time. As an example, the LFM transmitter may not even reach a single full wavelength at some frequencies. A swept frequency system, such as a stepped frequency system, would adjust through one frequency at a time and have many wavelengths at each frequency. The fractional bandwidth of the client's LFM device is well over the 0.2 requirements specified in 15.503(d) and defined in 15.503(c).

2) As the signal is a single waveform rather than a series of frequencies, it does not rely on

varying the frequency to meet the specification, but rather includes the range of frequencies inherently in the waveform itself. Therefore, 15.31(c) should not apply.

FCC response on 07/12/2019

There are no specified modulation requirements in the UWB rules, and although we are not aware of a previous grant to a device utilizing an LFM scheme, there is no apparent reason that a device employing such modulation would not qualify, assuming that all of the specified technical requirements are satisfied. If, as has been explained, the methodology for implementing the chirped waveform is continuous rather than a frequency swept or stepped implementation, then the requirement of §15.31(c) would not be applicable.

Attachment Details:

Do not reply to this message. Please select the [Reply to an Inquiry Response](#) link from the OET Inquiry System to add any additional information pertaining to this inquiry.

Appendix 3 – Anechoic Chamber Measurements

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**COMPLIANCE WORLDWIDE INC.
TEST REPORT 159-19R1**

**In Accordance with the Requirements of
Federal Communications Commission 47 CFR Part 15, Subpart F
Technical Requirements for Ground Penetrating Radar Systems**

Issued to

**WaveSense
444 Somerville Avenue
Somerville, MA 02154**

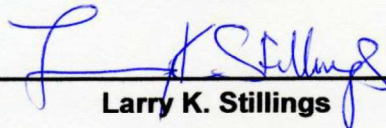
For the

**Ground Penetrating Radar
Linear FM Chirp Mode
Model: GPR**

FCC ID: TBD


**Report Issued on April 12, 2019
Revision R1 issued on July 17, 2019**

Tested by

A blue ink signature of Larry K. Stillings, written over a horizontal line.

Larry K. Stillings

Reviewed By

A blue ink signature of Brian F. Breault, written over a horizontal line.

Brian F. Breault

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Test Number: 159-19R1

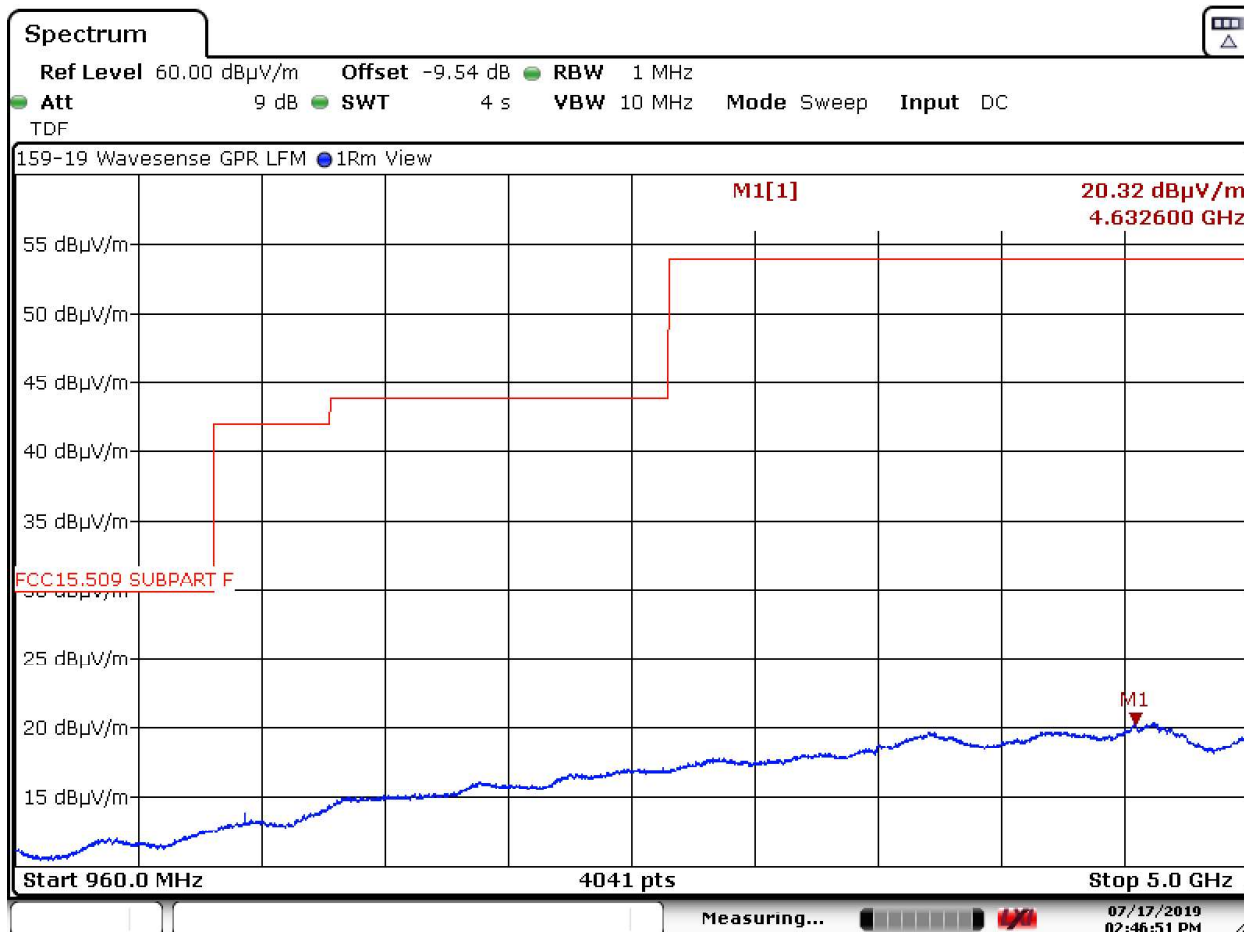
Issue Date: 7/17/2019

6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.509 (d))

6.4.5. 960 MHz to 5 GHz at 1 meter

6.4.5.1 Plot of RMS Power 960 to 5000 MHz Horizontal Polarity



Date: 17.JUL.2019 14:46:50

Notes: Using: 1 MHz RBW / 10 MHz VBW and 1mS/MHz RMS Average Detector.

Due to site ambient, the measurements were performed in an anechoic chamber at a distance of 1 Meter. The antenna was placed on RF absorber and support structure that allowed the product to be rotated through 360 degrees.

Test Number: 159-19R1

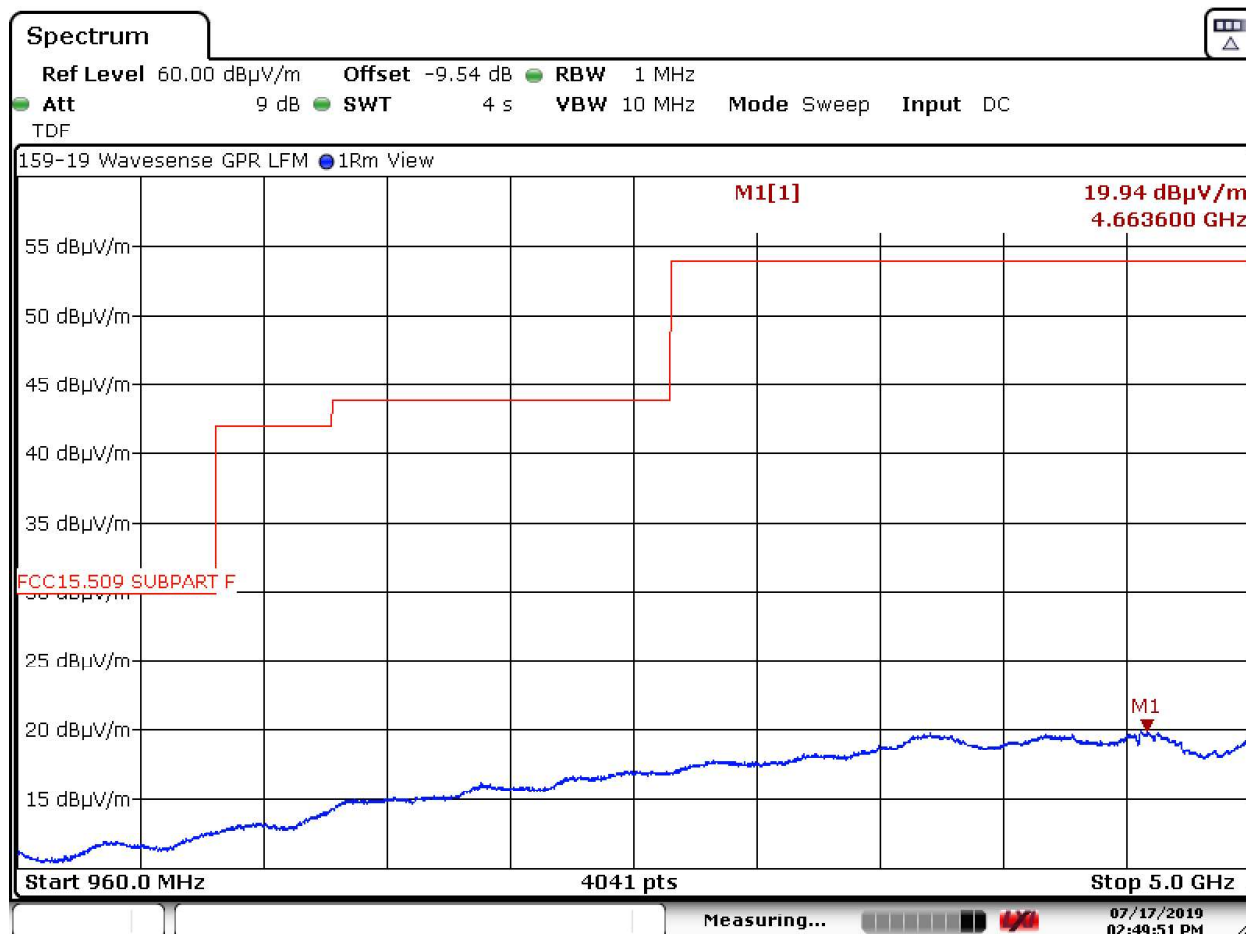
Issue Date: 7/17/2019

6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.509 (d))

6.4.5. 960 MHz to 4 GHz at 1 meter

6.4.5.2 Plot of RMS Power 960 to 5000 MHz Vertical Polarity



Date: 17.JUL.2019 14:49:50

Notes: Using: 1 MHz RBW / 10 MHz VBW and 1mS/MHz RMS Average Detector.

Due to site ambient, the measurements were performed in an anechoic chamber at a distance of 1 Meter. The antenna was placed on RF absorber and support structure that allowed the product to be rotated through 360 degrees.

6. Measurement Data (continued)**6.5. Spurious Radiated Emissions in GPS Bands (15.509 (e))**

Requirement: In addition to the radiated emission limits specified in the table in paragraph (d) of this section, UWB transmitters operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of no less than 1 kHz:

Frequency (MHz)	EIRP (dBm)	Field Strength (dB μ V/m) at 3 Meters
1164 - 1240	-75.3	19.9
1559 - 1610	-75.3	19.9

6.5.1. Measurement & Equipment Setup

EMI Receiver IF Bandwidth: 1 kHz
EMI Receiver Avg Bandwidth: 10 kHz
Detector Function: RMS Average, 1mS/point

6.5.2. Test Procedure

Test measurements were made in accordance with ANSI C63.10:2013, American National Standard for Testing Unlicensed Wireless Devices.

6.5.3. 1164 to 1240 MHz & 1559 to 1610 MHz

There were no broadband emissions related to the UWB transmitter. Measured signals were narrowband and related to the microprocessor / clocks and do not fall under the requirements of this section. The -75.3 dBm limit was converted to a field strength limit of 19.9 dB μ V/m using a distance correction factor of 95.2. A distance correction factor of 9.54 dB was entered to the analyzer for taking the measurements at 1 Meter.

Due to site ambient, the measurements were performed in an anechoic chamber at a distance of 1 Meter. The antenna was placed on RF absorber and support structure that allowed the product to be rotated through 360 degrees.

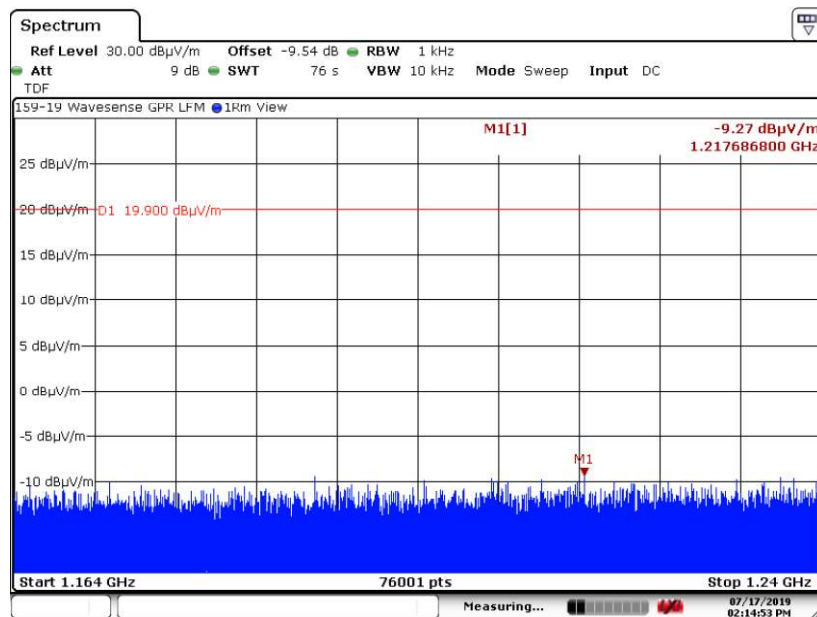
Test Number: 159-19R1

Issue Date: 7/17/2019

6. Measurement Data (continued)

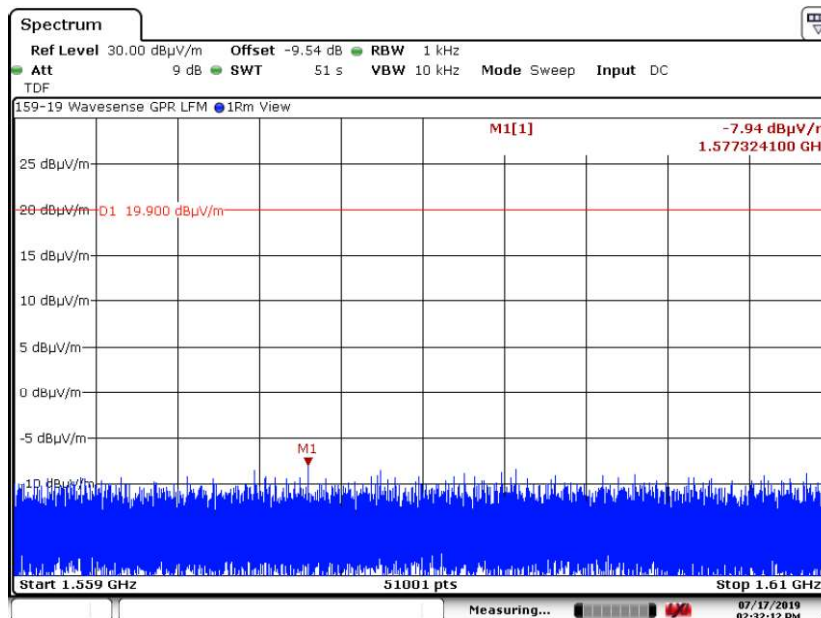
6.5.4 Spurious Radiated Emissions in GPS Bands (15.509 (e) continued)

6.5.4.1 1164 to 1240 MHz - Horizontal



Date: 17.JUL.2019 14:14:52

6.5.4.2 1164 to 1240 MHz - Vertical



Date: 17.JUL.2019 14:32:11

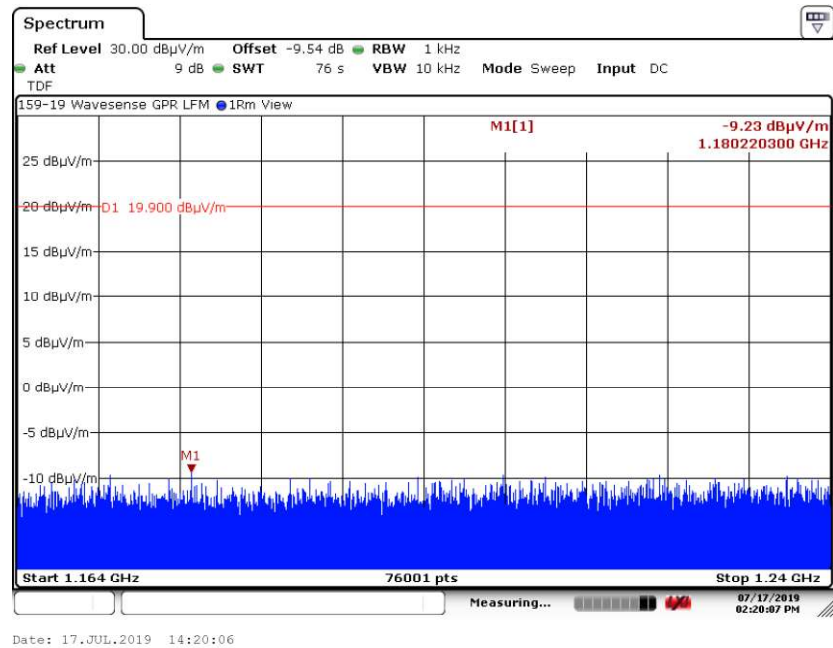
Test Number: 159-19R1

Issue Date: 7/17/2019

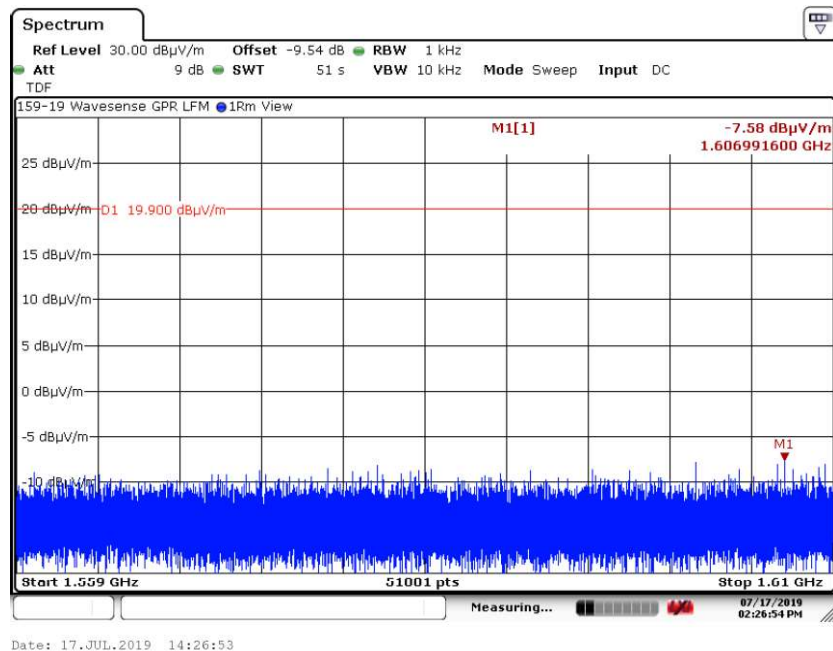
6. Measurement Data (continued)

6.5.4 Spurious Radiated Emissions in GPS Bands (15.509 (e) continued)

6.5.4.3 1559 to 1610 MHz - Horizontal



6.5.4.4 1559 to 1610 MHz - Vertical



7. Test Site Description

Compliance Worldwide is located at 357 Main Street in Sandown, New Hampshire. The test sites at Compliance Worldwide are used for conducted and radiated emissions testing in accordance with the Federal Communications Commission (FCC) and Industry Canada standards. Through our American Association for Laboratory Accreditation (A2LA) ISO Guide 17025:2005 Accreditation our test sites are designated with the FCC (designation number **US1091**), Industry Canada (file number **IC 3023A-1**) and VCCI (Member number 3168) under registration number A-0274.

Compliance Worldwide is also designated as a Phase 1 CAB under APEC-MRA (US0132) for Australia/New Zealand AS/NZS CISPR 22, Chinese-Taipei (Taiwan) BSMI CNS 13438 and Korea (RRA) KN 11, KN 13, KN 14-1, KN 22, KN 32, KN 61000-6-3, KN 61000-6-4.

The radiated emissions test site is a 3 and 10 meter enclosed open area test site (OATS). Personnel, support equipment and test equipment are located in the basement beneath the OATS ground plane.

The conducted emissions site is part of a 16' x 20' x 12' ferrite tile chamber and uses one of the walls for the vertical ground plane required by EN 55022. A second conducted emissions site is also located in the basement of the OATS site with a 2.3 x 2.5 meter ground plane and a 2.4 x 2.4 meter vertical wall.

Both sites are designed to test products or systems 1.5 meters W x 1.5 meters L x 2.0 meters H, floor standing or table top.

8. Test Images

8.3. Spurious Emissions – 960 MHz – 5 GHz Side

