

Before the
Federal Communications Commission
Washington DC 20554

In the Matter of)	
)	
Geophysical Survey Systems, Inc.,)	No. _____
Request for Waiver of Part 2 of the)	
Commission's Rules to Market an)	
Evaluation Kit to Makers of Autonomous)	
Vehicles	}	

REQUEST FOR WAIVER

Geophysical Survey Systems, Inc. (GSSI) requests a waiver of the Commission's rules to permit the marketing of an evaluation kit for an ultra-wideband (UWB) ground penetrating radar (GPR) device to be used in autonomous vehicles.

A. SUMMARY

The success of self-driving cars depends primarily on ensuring human safety. One basic safety-related task is simply keeping the vehicle in its own lane. Present-day technology uses a combination of GPS and optical sensors that read the lane indications marked on the pavement. But GPS is subject to multipath and other interruptions; and optical sensors can fail when snow, dust, or rain obscures the pavement markings. With current technology, a car travelling at speed may suddenly be unable to position itself relative to other traffic—including oncoming vehicles.

GSSI is developing a system based on GPR technology that looks down through the pavement and reads features of the roadbed beneath to guide a vehicle. The system consistently keeps the vehicle in its lane with an accuracy of 4 cm. Vehicle autonomy at SAE level 3 and above (conditional automation, high automation, and full automation) cannot be achieved without this or similar localization capability.

GSSI seeks to market to vehicle manufacturers a fully functional prototype in the form of an evaluation kit, in limited quantities not to exceed 2,000. Evaluation kits need not be certified, but ordinarily must be designed to comply with the Commission's technical rules. Rather than conventional UWB short-pulse modulation, this device uses stepped continuous wave (CW) frequencies to provide improved performance for this application with an interference potential no higher than compliant UWB systems in the same frequency range. The system has been tested and complies in full with the GPR emission limits, when measured with the system in normal operation.

In addition to marketing restrictions, GSSI proposes stringent operational conditions to minimize the risk of harmful interference to other spectrum users.

GSSI requests a waiver to permit sale of the evaluation kit despite its not having been designed to comply with UWB modulation requirements.

B. ABOUT GSSI

GSSI is the world leader in the commercial development, manufacture, sale, and support of GPR equipment. The company serves all major non-destructive testing and examination industries (NDT/NDE) including infrastructure (asphalt, concrete, utility locating, road and bridge deck evaluation), geophysics, forensics, archaeology, and Search and Rescue. New Hampshire-based GSSI created the first commercial GPR equipment in 1970 for nuclear power plant safety inspection. For 48 years its GPRs have been solving problems, saving lives, making important discoveries, and ensuring structural integrity on every continent. GSSI's 85 employees develop, manufacture, and support GPR equipment from its 72,000 sq. ft. headquarters in Nashua, NH. GSSI supports its customer base with 100+ training courses per year at locations around the globe.

C. ABOUT THE LOCALIZATION GROUND PENETRATING RADAR SYSTEM

GSSI's Localization Ground Penetrating Radar (LGPR) will make autonomous vehicles safer.

LGPR assists autonomous vehicles with lane keeping should snow, rain, dust, or fog obscure lane markers or other above-ground localizing references. A radar system permanently attached under the vehicle looks down through the pavement surface 2 to 3 meters to the roadbed, mapping the subsurface features. The unique and stable underground signature of rocks, soil layers, tree roots, pipes, etc. provides enough specificity for lane accuracies of about 4 cm. Tests have shown the approach to be valid and reliable in all kinds of road construction and soil conditions around the country.

As a vehicle first drives a particular route, the LGPR system creates a basemap of subsurface features. It determines locations for the basemap using precise GPS and/or visible elements such as lane markings and permanent roadside features. The same or another vehicle subsequently matches its real-time readings to the database map as needed to keep the vehicle in its lane.

We do not know of any other technology that performs the task as well – day or night and in any weather conditions.

Details of operation

The device has a row of twelve transmit-receive antennas mounted sideways under the car, from left to right. (For testing, the antennas may be mounted under a metal plate and towed behind the car.) The antennas operate sequentially in pairs: first 1&2, then 2&3, 3&4, and so on, through 11&12, for eleven pairs. Each pair in turn steps through 51 frequencies, from 103 MHz to 403 MHz, at 6 MHz intervals. Each pair dwells on one frequency for 12.3 μ s before moving to

the next frequency. At the end of each frequency series is a 32.7 μ s time pad. The sequence repeats for each of the eleven antenna combinations, plus a twelfth period of equal duration for calibration, during which the system does not emit RF. A full scan takes

$$(12.3 \mu\text{s} \times 51 \text{ frequencies} + 32.7 \mu\text{s}) \times 12 \text{ antenna pairs} = 7.92 \text{ ms}$$

This gives 126 complete scans per second.

The fraction of time on any one frequency is

$$0.0123 \text{ ms} \times 11 / 7.91 \text{ ms} = 1.7 \%$$

The design emits low-level RF energy less than 12 inches from the ground, with all energy directed into the ground. Both the antenna construction and the mounting location (under the vehicle or under a towed metal plate) provide shielding that minimizes radiation other than that directed at the ground.

D. REQUEST FOR WAIVER

GSSI seeks to market up to 2,000 LGPR units as evaluation kits.¹ The rules on evaluation kits provide, in part:

Any radiofrequency transmitter employed as part of an evaluation kit shall be designed to comply with all applicable FCC technical rules, including frequency use, spurious and out-of-band emission limits, and maximum power or field strength ratings applicable to final products that would employ the components or circuitry to be evaluated.²

¹ An evaluation kit is defined as

An assembly of components, subassemblies, or circuitry, including software, created by or for a component maker, system integrator, or product developer for the sole purpose of facilitating: (i) End product developer evaluation of all or some of such components, subassemblies, or circuitry, or (ii) the development of software to be used in an end product.

47 C.F.R. § 2.1.

² 47 C.F.R. § 2.803(c)(2)(iv)(D).

GSSI requests a waiver of this rule to permit the limited marketing described above, notwithstanding that the device departs from the technical rules in the method of modulation used for band occupancy. The modulation also requires a corresponding change in measurement procedure.

1. Method of band occupancy

The UWB rules specify minimum bandwidth requirements.³ The adopting order clarifies that a UWB device must comply “at all times during its transmission.”⁴ This language precludes stepped and swept modulations.

GSSI proposes to use a stepped frequency configuration because, in this application, it offers far better dynamic range than conventional UWB modulations. The added dynamic range results in improved performance.

The Office of Engineering and Technology has granted waivers in recent years that allow stepped operation similar to that requested here, in both cases using frequency ranges that overlap GSSI's device.⁵

2. Measurement method

The rules specify that measurements of swept frequency equipment be made with the frequency sweep stopped.⁶ Soon after authorizing UWB, the Commission waived this provision

³ 47 C.F.R. § 15.503(d).

⁴ *Ultra-Wideband Transmission Systems*, First Report and Order, 17 FCC Rcd 7435 at ¶ 32 (2002).

⁵ *Proceq USA, Inc.*, Order, 33 FCC Rcd 2258 (OET 2018) (200-4,000 MHz); *Curtiss-Wright Controls Inc.*, 27 FCC Rcd 234 (OET 2012) (140-3,000 MHz) *modified*, 28 FCC Rcd 12174 (OET 2013).

⁶ 47 C.F.R. § 15.31(c).

to allow the measurement of stepped systems with the transmitter operating in its normal transmission mode.⁷ It did the same for each of the two stepped-frequency waivers cited above.⁸

GSSI asks the Commission to follow these precedents in allowing emissions testing of the evaluation kit while in normal operation.

E. CONSIDERATIONS OUTSIDE THIS REQUEST

The Commission regulates GPR devices as to permissible applications and user eligibility,⁹ and requires prior coordination.¹⁰ The marketing of LGPR-equipped vehicles to the general public, were it to occur, would require waiver or modification of these provisions. The present request, being limited to evaluation kits for vehicle manufacturers, does not raise the issues.

Depending on how lane keeping technologies evolve, radar and vehicle manufacturers may look to other rule sections, or possibly seek the adoption of new rules. It is too soon to tell. In the meantime, a grant of this request will help both the radar and vehicle industries to evaluate their options efficiently, and thereby speed the delivery of safe autonomous vehicles to the public.

F. PROPOSED WAIVER CONDITIONS

The proposed conditions below are calculated both to restrict the distribution of LGPRs under the waiver, and to prevent harmful interference from those in operation.

1. The device will comply with all applicable Commission rules not addressed here, including Section 15.509 emissions limits.

⁷ *Multi-band OFDM Alliance Special Interest Group*, Order, 20 FCC Rcd 5528 (2005).

⁸ *Proceq USA, Inc. and Curtiss-Wright Controls Inc.*, above. Without the measurement waiver, the power levels permitted for stepped systems would be far too low to be practical.

⁹ 47 C.F.R. § 15.509(b).

¹⁰ 47 C.F.R. § 15.525.

2. GSSI will sell a maximum of 2,000 units under the waiver.¹¹
3. Sales will be limited to vehicle manufacturers and *bona fide* research organizations.
4. No vehicle equipped with an operational LGPR will be resold to the general public.
5. LGPR units will be sold only for evaluation purposes.
6. The device will operate only when mounted under (or towed behind) a vehicle and pointed at the ground.
7. The device will operate only (a) under road conditions that require its operation for safe lane keeping, and (b) for the purpose of testing its lane-keeping capabilities and accuracy.
8. The device will cease operation when the vehicle comes to a halt (as at a red light).
9. In no event will the device operate when the vehicle ignition is turned off.
10. GSSI will include conditions 4-9 above in its sale contracts with vehicle manufacturers.

G. PUBLIC INTEREST

Autonomous vehicles promise enormous advantages to society:

- sharp reductions in injuries and deaths due to accidents with other vehicles, bicycles, and pedestrians;
- improved independence for elderly people, blind people, and those with other physical disabilities;
- less traffic congestion (due to interaction and cooperation among vehicles);
- more efficient use of roadways (with cars safely traveling more closely together at higher speeds);
- less time needed for commuting and travel—and the option of using that time productively;

¹¹ GSSI will manufacture the devices under a patent license agreement with MIT that limits the company to 2,000 units.

- 24-hour truck operation for faster cargo delivery; and
- reduced pollution and fuel consumption (thanks to more efficient vehicle operation).

Grant of the requested waiver will constitute a small but important step toward the realization of these benefits.

H. WAIVER STANDARD

“Good cause ... may be found and a waiver granted ‘where particular facts would make strict compliance inconsistent with the public interest.’”¹² That is the case here.

The Commission assesses waiver requests according to the standards set out in *WAIT Radio v. FCC*.¹³ In that case, as here, the applicant sought to operate in contravention of the rules while explaining how it would nonetheless accomplish the purpose of the rules.¹⁴ The court required the Commission to consider the request:

[A] general rule, deemed valid because its overall objectives are in the public interest, may not be in the “public interest” if extended to an applicant who proposes a new service that will not undermine the policy, served by the rule, that has been adjudged in the public interest.¹⁵

The meaning is clear: Waiver is appropriate where the applicant furthers the public interest inherent in the underlying rule.

¹² *SafeView, Inc.*, 25 FCC Rcd 592 at ¶ 15 (2010), citing *Northeast Cellular Telephone Co. v. FCC*, 897 F.2d 1164, 1166 (D.C. Cir. 1990).

¹³ 418 F.2d 1153 (D.C. Cir. 1969). See also, 2002 *Biennial Regulatory Review*, 18 FCC Rcd 13620 at ¶ 85 n.130 (2003) (citing *WAIT Radio* as “setting out criteria for waivers of Commission rules.”)

¹⁴ *WAIT Radio* operated an AM broadcast station. It was limited to daylight hours so as to afford protection to “white areas” that had no local service, and that relied on nighttime skywave propagation from another station. *WAIT Radio* proposed to transmit at night using a directional antenna that would limit its signal in the white areas. *WAIT Radio v. FCC*, 418 F.2d at 1154-55.

¹⁵ *WAIT Radio v. FCC*, 418 F.2d at 1157.

The waiver requested here meets the *WAIT Radio* standard: it proposes a “new service” that will not undermine the policy served by the rule. To the contrary, the GSSI device will provide the added public benefits of progress toward autonomous vehicles, under conditions that will protect other spectrum users against harmful interference. The requested waiver fits easily into the boundaries drawn by *WAIT Radio*.

The Court of Appeals emphasized the importance of waiver procedures as part of the regulatory scheme:

The agency’s discretion to proceed in difficult areas through general rules is intimately linked to the existence of a safety valve procedure for consideration of an application for exemption based on special circumstances.¹⁶

Thus, it said, “allegations such as those made by petitioners, stated with clarity and accompanied by supporting data . . . must be given a ‘hard look.’”¹⁷

Here, too, the request fully qualifies. The “safety valve” of the waiver procedure is needed to make available an important tool that will advance roadway safety. The requested waiver is in the public interest, not only in terms of benefits to the public, but also in the absence of any likely increase in harmful interference. The request is entitled not only to the “hard look” mandated in *WAIT Radio*, but to a grant of the waiver.

¹⁶ *Id.*

¹⁷ *Id.* (citation footnote omitted).

CONCLUSION

For the reasons set out above, GSSI asks the Commission to consider and grant the requested waiver.

Respectfully submitted,

A handwritten signature in black ink, appearing to read "Mitchell Lazarus". The signature is written in a cursive, flowing style.

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August 23, 2018

TECHNICAL CERTIFICATION

I am a technically qualified person who contributed to and/or reviewed the foregoing Request for Waiver.
I certify that the technical statements therein are correct to the best of my knowledge.


(signature)


(date)

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