Before the
Federal Communications Commission
Washington DC 20554

In the Matter of	)	
Husqvarna AB,	)	
Request for Waiver of Section 15.255	)	
of the Commission's Rules for	)	
Collision Avoidance Radar	)	
		No. _____

REQUEST FOR WAIVER

Husqvarna AB
SE-561 82 Huskvarna
Sweden

Fatiha Djebbar
Therese Berg
Rickard Ladin

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To: Chief, Office of Engineering & Technology

REQUEST FOR WAIVER

Husqvarna AB respectfully requests a waiver of Section 15.255(c)(3) of the Commission's rules to permit the marketing of a fixed operation radar device in the 60-64 GHz band at a higher power level than specified in the rule. The radar system will be integrated in commercial robotic lawnmowers to enable an intelligent behavior by detecting 3D obstacles. It will then help to avoid collisions with stationary and moving objects including life forms such as children and pets. The device will be used to increase safety by reducing the risk of homeplace accidents and injuries. The robotic lawnmower is intended to work in a fixed area and commercialized as an end-user product. The radar device is employed to serve the public interest by improving the safety and efficiency of Husqvarna's robotic lawnmower while not increasing the potential for interference to other spectrum users, and because strict compliance with the rule

would reduce the accuracy and effectiveness of the device, good cause exists to grant this request.

Husqvarna is aware of the Section 15.255 waiver granted by the Federal Communications Commission (FCC) to Google LLC and the waivers requests from Tesla Inc, Vayyar Imaging Ltd and Leica Geosystems AG's. Following these waiver requests, tech companies Facebook, Google, Infineon, Intel, Qualcomm and Socionext America, in Feb 3rd, 2020 letter to the FCC, point out that "These recurring requests for special relief outside of the current FCC rules confirm the need for the FCC to promote future applications, services, and devices and improve its regulatory framework governing unlicensed use of the 60 GHz band." Tesla Inc. joined the group of 60 GHz waiver seekers on July 31, 2020.

I. Summary

The primary purpose for the radar is to make the robotic lawnmower onto which it is mounted, able to detect with high accuracy objects on the lawn even those with smaller sizes. The radar provides a geometric form of the object so the robotic lawnmower can move close and around it while avoiding collision. The frequency range of 60-64 GHz allows the detection and avoidance of small obstacles such as rocks, pets, baby feet, etc. This enable an increased homeplace safety by preventing machinery accidents and injuries. In addition, the choice of these frequencies and the specified power levels, will avoid interference with other spectrum users, including the Earth Exploration-Satellite Service (EESS).

The proposed system comes within the Commission's definition of a field disturbance sensor employed for fixed operation and apply to the provisions in Section 15.255 that relate to field disturbance sensors "even if the sensor itself moves within the equipment". For that, Husqvarna

requests a waiver for the use of the 60-64 GHz band. Grant of this waiver request would "encourage the provision of new technologies and services to the public" consistent with Section 7 of the Communications Act of 1934[1].

II. Background

1. About Husqvarna AB

Husqvarna AB mission is to create products and services for customers around the world. It specializes in forest and garden products and services. The Husqvarna AB works with constant innovation by accelerating their transformation from mechanical to digital, gasoline to battery and manual to autonomous. Husqvarna AB is part of Husqvarna AB which operates in 30 production facilities of which 20 are in Europe, four in the US, three in China, one in Brazil, Japan and Australia. The company has more than 12708 employees in 2019 with €4.03 billion (approximately US$ 4.53 billion) in Net sales.

2. Robotic lawnmower

The usage of robotic lawn mowers are expected to grow considerably in the US the coming years, following the trend in Europe where robotic lawn mowers are widely spread. Both in private and commercial lawns. The benefits are numerous and can be summarized in the following:

[1] 47 U.S.C. § 157(a).

- Time and cost saver: Mowing the lawn is often considered to be a tedious chore. With a robotic mower the consumers free up time to enjoy other things in life. From a Landscaper or municipality perspective, shortage and cost of labor for lawn mowing is an issue and commercial lawn management may also be a safety concern in e.g. steep slopes.
- Sustainable: Since the robotic mower is fully electric, there are no direct emissions which contributes to considerably reduce the environmental impact of green space management. The mowing concept is based on a principle to keep “short grass short”, resulting not only in a lawn that always looks good, but also in that the small grass clippings act as a fertilizer reducing the need for additional fertilization.
- Low Noise: A robotic mower does the job quietly. The cutting technique with small, sharp, pivoting blades and brushless electric motors significantly reduce noise, which allows for 24/7 mowing also in noise-restricted areas.
- Safe: The robotic mower comprises a number of safety sensors to ensure that the operation is safe by-standers at all times. Some of these sensors include: detection sensors when the device is lifted, tilted or that the body bumped into an object.

The utilization of a *radar* as an object detection sensor in a robotic mower would further add to the list of benefits for the user and society which are detailed in the next section.

3. The Radar Device

The radar mounted on the robotic lawnmower offers close-up views of structural exteriors that would otherwise be difficult or impossible to obtain. It provides three unique sets of data: range, velocity and angle. With this data combination the radar device can accurately determine the location of objects as well as their direction of movements. The data set enables the mower to avoid objects that are moving in the environment such as pets and children which will help preventing accidents, injuries and damage to the lawnmower. Using the radar's outputs, the

lawnmower system will facilitate the visual scanning of the lawn enabling an intelligent behavior, providing the following:

- Considerably enhance the perception of the robotic mower as an intelligent and trustworthy device, with the ability to avoid bumping into objects that are present on the lawn.
- Reduce the risk of the robotic mower getting stuck on, and potentially damage, objects that are present on the lawn.
- Provision of homeplace safety by lowering significantly the risk of robotic mower bumping into human beings or animals on the lawn, which may cause injuries.
- Increased ground speed when no object is in the vicinity, resulting in an increased mowing efficiency.
- Detection accuracy regardless of whether condition, i.e., bright sunlight, pitch darkness, fog.

- Lawn mowing service optimization by minimizing edges trimming.

Alternative technologies such as ultrasonic sensors used in similar products fail at detecting small objects, treat slopes as objects and detect only close view objects. Obstacle detection and avoidance radar-based system addresses the above problems. In addition, it reduces injuries, improves homeplace safety and increases the accuracy and efficiency of the robotic lawnmower work.

a. System requirements

- Resolution and frequency: The system must be able to detect and avoid narrow obstacles (such as ropes and shoes, baby arms and baby feet) down to 2.5 mm diameter. This require a radar wavelength of double that size or smaller, which translates to a frequency of 60 GHz or greater.
- Precision: The system must detect an obstacle with a resolution in measured distance of 50 mm. This requires an operating bandwidth of 3 GHz

b. The need for 60 GHz radar

Detecting and localizing obstacles are important to realize autonomous motion. In previous years, many obstacle detection systems have been developed. We present in the following, the challenges related to the currently used sensing technologies:

- 24 GHz radar: Low accuracy.
- 76-81 GHz radar: Risk of interference to and from automotive radars.
- Ultrasonic range sensor: Cannot accurately detect obstacles.

- LiDAR: Vision sensor do not work well under dust, dirt and strong sunlight.
- Stereo cameras: Computational requirements too high and they do not perform well under dust and dirt.
- Infrared time of flight: Fails in direct sunlight and it is not reliable against thin or dark-colored objects.

Husqvarna AB decided to discard the above technologies and opted for the 60 GHz radar for the following advantages:

- Reliable detection of thin obstacles regardless of ambient lightning.
- Enhanced homeplace safety.
- Could be constructed in small forms and easily mounted on Husqvarna lawnmower robots.
- Excellent immunity to interference.

c. Specifications for the waived device

The radar marketed under the requested waiver will conform to these specifications:

- Frequency: The radar spans over the 60-64 GHz band. It sweeps the whole band to get an angle view on the object.
- Power at 60-64 GHz: The maximum conducted output power is 10 dBm and maximum 13 dBm peak EIRP level (These values are respectively 20 dB and 3 dB above the FCC limit[2]).

[2] 47 C.F.R. § 15.255(c)(3)

- Duty cycle: will not exceed 20%.
- Range resolution: < 5 cm (distance to be detected as two different objects).

III. Request for Waiver

1. Field disturbance sensors installed in fixed equipment provision

Section 15.255 (a)(2) provides:

> "Field disturbance sensors, including vehicle radar systems, unless the field disturbance sensors are employed for fixed operation, or used as short-range devices for interactive motion sensing. For the purposes of this section, the reference to fixed operation includes field disturbance sensors installed in fixed equipment, even if the sensor itself moves within the equipment."

The Commission rule in 15.255 (a)(2), states: "the reference to fixed operation includes field disturbance sensors installed in fixed equipment, even if the sensor itself moves within the equipment". This conforms to the exact intended use of the radar system[3]. As described in previous sections, the radar is mounted on the robotic lawnmower that will move within a fixed limited area, in this case the "lawn". In addition, we found that the definition of "fixed equipment" is mainly contextual and in the absence of formal definition, we refer to the following:

- US department of labor, Occupational Safety and Health Standards 1910.333(b)(2):

  "Note 1: As used in this section, fixed equipment refers to equipment fastened in place or connected by permanent wiring methods."

[3] See 47 C.F.R. § 15.255(a)(2) ("[f]ield disturbance sensors, including vehicle radar systems"); see also Spectrum Bands above 24 GHz for Mobile Radio Services, 31 FCC Rcd 8014 at ¶ 335, n.915 (2016) ("Spectrum Frontiers Order").

the robotic lawnmower operates within a clearly defined and fixed area, i.e. its working area. This area is delimited by the lawn to be mowed. The mower is not allowed to move outside the working area and cannot operate, if placed, outside it. This is a basic safety requirement on robotic lawn mowers. The mower has a fixed docking station for charging within the working area. The charging station is connected to the mains power. The working area is defined either via a boundary wire or via high accuracy RTK-GPS systems: The boundary wire is an electric wire installed in the ground around the working area and it emits a low frequency magnetic field. To be allowed to operate, the mower must always detect the boundary wire signal and operate only within this boundary. The RTK GPS system requires the use of a fixed reference station, mounted within or in the vicinity of the working area and connected to mains power. The working area is defined in relation to the reference station. The mower is only allowed to operate when it has high GPS signal quality, a connection with the reference station and a validated map of the working area.

The radar system conforms to “fixed equipment” definition in the sense where it moves only within a fixed and well defined area i.e. “lawn”. In this logic, we consider a “fixed equipment” as an equipment fixed within a confined area and moves only within this area “lawn”. This definition is in perfect accordance with the intended use of Husqvarna robotic lawnmower. Thus, we ask the commission to consider the radar system as a field disturbance sensor employed for fixed operation.

2. ***Fixed Field disturbance sensor provision***

Husqvarna AB requests waiver of this provision:

Sec. 15.255(c)(3) provides:

"For fixed field disturbance sensors other than those operating under the provisions of paragraph (c)(2) of this section, and short-range devices for interactive motion sensing, the peak transmitter conducted output power shall not exceed −10 dBm and the peak EIRP level shall not exceed 10 dBm."

The stated purpose of this restrictions is to avoid causing harmful interference to co-channel communications devices.[4] In December 2018, the Commission granted a waiver to Google LLC.[5] for operation of a 57-64 GHz field disturbance sensor system onboard aircraft at power levels higher than what is provided in the rules. Google Inc. requested power level based on European standard ETSI EN 305 550 V1.2.1 (2014-10) [6]. For the 57-64 GHz band, the ETSI standard permits a 20 dBm peak EIRP, which is more than what the Commission's rules permit for field disturbance sensors in this frequency band.

The ETSI standard specifies requirements for short-range devices (e.g., radars for applications such as telemetry, telecommand, alarms, data transmissions in general) that operate in the 40 GHz to 246 GHz frequency range. Husqvarna AB also relies on the European Telecommunications Standards Institute (ETSI) standard EN 305 550 V1.2.1 (2014-10) [7] which defines the conducted power and mean

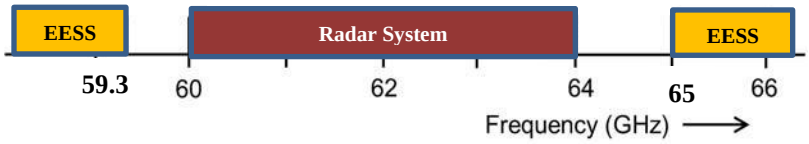
[4] *2016 Order* at ¶ 334 (2016).

[5] *Google LLC,* LLC Request for Waiver of Section 15.255(c)(3) of the Commission's Rules Applicable to Radars used for Short-Range Interactive Motion Sensing in the 57-64 GHz Frequency Band, Order, 33 FCC Rcd 12542 at ¶ 3 (OET2018) ("Google Waiver Order").

[6] Short Range Devices (SRD); Radio equipment to be used in the 40 GHz to 246 GHz frequency range; Harmonized Standard for access to radio spectrum, ETSI EN 305 550 V1.2.1 (2014-10), at 32-33 (2014). ETSI is republishing this standard under V2.1.0 (2017-10) with the same power limits. The standard is available at: http://www.etsi.org/deliver/etsi_en/305500_305599/305550/02.01.00_20/en_305550v020100a.pdf.

Equivalent, Isotropically Radiated Power (EIRP) parameters that Google Inc. said would allow optimization, while avoiding interference with other devices in the band.

The Commission has allowed the devices to operate at peak conducted output levels 20 dB higher than in the rules, and a peak EIRP level 3 dB higher than the rules[7]. This was despite the Commission On Radio Frequencies (CORF), which represents radio astronomy and EESS interests concerns about EESS interference[8].



The radar system and EESS frequency utilization

As shown in the above Figure, there will be no interference between the radar and EESS. The band 60-64GHz is occupied only by the radar and the EESS bands limits are either higher or lower than the radar with no effect on EESS operations[9]. In addition, there is no reason to expect the radar system to be more interfering than a communications device at similar power levels. Furthermore, if the subject device is operated at lower frequency bands, it will not be as accurate or efficient and the

[7] Google *LLC*, supra note 4, at ¶ 5

[8] *Spectrum Bands above 24 GHz for Mobile Radio Services*, Second Report and Order, Second Further Notice of Proposed Rulemaking, Order on Reconsideration, and Memorandum Opinion and Order, 32 FCC Rcd 10988 at ¶¶ 75-87 (2018).

[9] https://www.ecodocdb.dk/download/0383fd0a-d9e2/ECCREP114.PDF, Electronic Communications Committee (ECC) report 114

required safety will be greatly reduced. Thus, to achieve the full potential of this homeplace safety technology, the sensor must be operated at slightly higher power levels, although not more than those granted to Google for the Soli project. The radar system offers significant public interest benefits, and should not present any interference risk greater than a compliant Section 15.255 device, Husqvarna requests a waiver of Sections 15.255(a)(2) and 15.255(c)(3) to allow operation of the Radar system on their end-user product robotic lawnmower", under the conditions described above.

IV. Proposed Waiver Conditions

To ensure lack of harm to EESS and other spectrum users, we propose the following waiver conditions:

- Intentional emissions contained within 60-64 GHz;
- Peak transmitter conducted output power of +10 dBm and 13 dBm peak EIRP level;
- Duty cycle not to exceed 20%;
- The radar operates only while the lawnmower is in motion, moving within the delimited area, and automatically turns off when the lawnmower stops.

V. Public Interest

Significant benefits would arise from granting the waiver request. A collision between the robotic lawnmower and the objects on the lawn could cause potential injuries and damage to the machine. In case where objects include lifeforms such as: pets, babies, children or elderly

individuals who lack insight, capacity or fast reflexes to avoid collisions, every effort should be made to assure their homeplace safety. Furthermore, avoiding collisions to the robotic lawnmower will aid to prolong its life and save repair and replacement costs. In addition, lawn service quality is optimized through the proposed resolution values and slopes filtering characteristic, which all together improve consumer satisfaction. Preventing collisions and their associated harms and increasing consumers satisfaction are in the public interest.

VI. Good Cause to grant Husqvarna's waiver request.

The Commission is authorized to grant a waiver of its rules where good cause exists[10]. Good cause may be found "where particular facts would make strict compliance inconsistent with the public interest"[11]. To satisfy the good cause requirement, the waiver cannot compromise the purposes of the rule, and must provide a stronger public interest benefit in granting the waiver than in applying the rule[12]. In this context, the public interest would not be served by strict compliance with the rule. First, the requested waiver would not undermine the purpose of the rule, which is to reduce the potential for harmful interference within the 60 GHz band[13]. In connection with the Google Soli waiver, the Commission has already found that the Soli sensor, when operating under specified power identical to those requested here, posed no threat of harmful

[10] 47 C.F.R. § 1.3; ICO Global Communications (Holdings) Limited v. FCC, 428 F.3d 264 (D.C. Cir. 2005).
[11] Northeast Cellular Telephone Co. v. FCC, 897 F.2d 1164, 1166 (D.C. Cir. 1990).
[12] See, e.g., 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); Northeast Cellular, 897 F.2d at 1166 (stating that in granting a waiver, an agency must explain why deviation from the general rule better serves the public interest than would strict adherence to the rule).
[13] Spectrum Frontiers Order at ¶ 334, n. 913

interference to other spectrum users[14]. In addition, whether the robotic lawnmower is stationary or in motion, its working area "home lawn" is defined either via a boundary wire or via high accuracy RTK-GPS systems. The mower is not allowed to move outside the working area and cannot operate, if placed, outside it. Hence, zones for possible interference is nearly none. Since Husqvarna's device will pose no greater risk of harmful interference than those devices already permitted under the existing rules. The benefits of the technology are significant as detailed in the above section. Strict compliance with the stated power levels will slow down the innovation, and make it difficult, for the technology to reach its full potential[15]. The waiver procedure is needed to make available a commercial robotic lawnmower that will increase homeplace safety. The requested waiver is in the public interest, not only in terms of benefits to the public, but also because it won't induce any harmful interference.

VII. CONCLUSION

Husqvarna AB requests that the Commission waive Section 15.255(c)(3) of its Rules to enable equipment certification, marketing and effective operation of its robotic lawnmower technology in the 60-64 GHz band at higher power levels. Husqvarna AB seeks to operate within a peak conducted power and EIRP level consistent with those in ETSI standard EN 305 550. Specifically a maximum conducted power of +10 dBm, a peak EIRP level of +13 dBm and will operate with a maximum duty cycle of 20%. The requested waiver will enable Husqvarna to provide the home gardening industry with sensing solutions that increases the safety by detecting

[14] Google LLC, supra note 4, at ¶ 12

[15] See 47 U.S.C. § 157(a) ("It shall be the policy of the United States to encourage the provision of new technologies and service to the public.").

and avoiding collision with pets, babies, children or elderly individuals who lack insight, capacity or fast reflexes to avoid collisions and consequently possible injuries.

Respectfully submitted by,

Fatiha Djebbar
Therese Berg
Rickard Ladin

Husqvarna AB
SE-561 82 Huskvarna
Sweden

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