

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of)
Vayyar Imaging Ltd. Request for Waiver of) ET Docket No. 20-15
Section 15.255(c)(3) of the Commission's Rules)
for Radars used for Interactive Motion Sensing in)
the frequency band 57-64 GHz)
Valeo North America Inc. Request for Waiver of) ET Docket No. 20-121
Sections 15.255(a)(2) and (c)(3) of the)
Commission's Rules for In-Vehicle Radar)
Operation in the frequency band 57-64 GHz)
Infineon Technologies Americas Corp. Request) ET Docket No. 20-263
for Waiver of Sections 15.255(a)(2) and (c)(3) of)
the Commission's Rules for Short-Range)
Interactive Motion Sensors for In-Vehicle Radar)
Operation in the frequency band 57-64 GHz)
Tesla Inc. Request for Waiver of Sections) ET Docket No. 20-264
15.255(a)(2) and (c)(3) of the Commission's Rules)
for Short-Range Interactive Motion Sensors for)
Vehicle Radar Operation in the frequency band)
60-64 GHz)
IEE Sensing Inc. Request for Waiver of Sections) ET Docket No. 20-435
15.255(c)(2) and (c)(3) of the Commission's Rules)
for Vehicle Radar Operation in the frequency band)
60-64 GHz)
Brose North America Inc. Request for Waiver of) ET Docket No. 20-434
Section 15.255(c)(3) of the Commission's Rules)
for Vehicle Radar Operation in the frequency band)
57-64 GHz)

ORDER

Adopted: April 14, 2021

Released: April 14, 2021

By the Acting Chief, Office of Engineering and Technology:

I. INTRODUCTION

1. By this action, we are waiving the requirements of sections 15.255(a)(2) and 15.255(c)(3) of our rules, subject to certain conditions, to allow Vayyar Imaging Ltd. (Vayyar), Valeo North America Inc. (Valeo), Infineon Technologies Americas Corp. (Infineon), Tesla Inc. (Tesla), IEE Sensing Inc. (IEE

1 47 CFR §§ 15.255(a)(2) & (c)(3).

Sensing), and Brose North America Inc. (Brose) to operate radars in the 57-64 GHz frequency band in passenger motor vehicles² to perform detection of children inadvertently left in hot weather and other related passenger safety functions at higher power levels than specified in the rule.³ We find that grant of these waivers, along with specific conditions that take into account our coordination with the National Telecommunications and Information Administration Office of Spectrum Management on behalf of the federal agencies through the Interdepartment Radio Advisory Committee, will bring immediate relief to the industry and the public in this area. Specifically, our action will bring forth substantial public benefits by improving vehicular safety for children and providing opportunities for additional vehicular automation and theft prevention applications without increasing the potential for harmful interference to authorized users in the band.

II. BACKGROUND

2. The Commission received the six waiver requests described herein,⁴ all of which propose radar operation in either the 57-64 GHz band or a subset of this band (i.e., the 60-64 GHz band), on an unlicensed basis under Part 15 of the rules.⁵ With certain differences, all requests have one common purpose: to provide vehicular passenger safety and theft prevention applications when the radar is installed inside passenger motor vehicle cabins with the primary function to prevent risks of children inadvertently left unattended in a rear seat in hot weather. The requesters claim that these applications require higher power levels than our rules permit. Along with the child-left-unattended application, an in-cabin radar can support additional vehicle-related functions.

3. The Part 15 rules are designed to permit low-power devices to operate without an individual license where such use is not anticipated to cause harmful interference to authorized users of the radio spectrum.⁶ Section 15.255 of the rules stipulates operational policies and technical parameters for the 57-71 GHz band.⁷ Unlicensed devices in this band generally include indoor communication

² By “passenger motor vehicle” we mean a “passenger car” (a motor vehicle with motive power, except a low-speed vehicle, multipurpose passenger vehicle, motorcycle, or trailer, designed for carrying 10 persons or less) or a “multipurpose passenger vehicle” (a motor vehicle with motive power, except a low-speed vehicle or trailer, designed to carry 10 persons or less which is constructed either on a truck chassis or with special features for occasional off-road operation) that has more than one row of seats, as those terms are used by the National Highway Traffic Safety Administration at 49 CFR § 571.3.

³ See *Vayyar Imaging Ltd. Waiver Request*, filed Nov. 13, 2019; *Valeo North America, Inc. Waiver Request*, filed Mar. 31, 2020; *Infineon Technologies Americas Corp. Waiver Request*, filed July 23, 2020; *Tesla, Inc. Waiver Request*, filed July 31, 2020; *IEE Sensing Inc. Waiver Request*, filed Nov. 16, 2020; and *Brose North America, Inc. Waiver Request*, filed Nov. 25, 2020.

⁴ The Commission has received additional waiver requests that relate to unlicensed use of the 57-65 GHz band (or a subset thereof). See, e.g., *Husqvarna AB Request for Waiver of 47 CFR § 15.255(c)(3) for Collision Avoidance Radars* (filed Dec. 8, 2020); *Acconeer AB Request for Waiver of 47 CFR § 15.255(c)(3)* (filed Dec. 23, 2020); *Faurecia Clarion Electronics North America Petition for Declaratory Ruling and Request for Waiver of 47 CFR § 15.255(c)(3)* (filed Jan. 20, 2021). We intend to consider these requests separately and do not address them further here.

⁵ 47 CFR §§ 15.1 *et seq.*

⁶ The fundamental operating conditions under Part 15 are that the operator of a Part 15 device must accept whatever interference is received and must correct whatever harmful interference it causes. Should harmful interference occur, the operator is required to immediately correct the interference problem, even if correction of the problem requires ceasing operation of the Part 15 equipment causing interference. See 47 CFR § 15.5.

⁷ 47 CFR § 15.255. See *Revision of Part 15 of the Commission’s Rules Regarding Operation in the 57-64 GHz Band*, ET Docket No. 07-113, FCC 13-112, Report and Order, 28 FCC Rcd 12517 (2013). The rules were further amended in 2016 to specifically permit certain types of field disturbance sensors. See *Use of Spectrum Bands Above*

(continued...)

networking devices such as WiGig,⁸ outdoor fixed point-to-point communication links,⁹ and field disturbance sensors (FDS) (e.g., radars)¹⁰ that are either in fixed installations, or used as short-range devices for interactive motion sensing (SRIMS). A fixed FDS operating under the provisions of section 15.255(c)(2) is permitted to operate with average output power levels up to +40 dBm and peak output power levels up to +43 dBm but its occupied bandwidth must be fully contained within the 61.0-61.5 GHz band. For all other fixed FDS and SRIMS devices, section 15.255(c)(3) specifies that the peak transmitter conducted output power shall not exceed -10 dBm and the peak EIRP level shall not exceed +10 dBm.¹¹

4. In adopting the section 15.255 rules, the Commission's original intent was to foster the potential of the 60 GHz band "for allowing the development of short-range wireless radio systems with communications capabilities approaching those ... achievable only with coaxial' and optical fiber cable."¹² It is for this reason that section 15.255 has historically prohibited general mobile radar operation. In 2016, upon permitting short-range interactive motion sensing (SRIMS) despite the section 15.255 general prohibition on mobile radar operation, the Commission noted that it did not have sufficient information to allow for general operation of all mobile radars in the 60 GHz spectrum, but was nonetheless prepared to allow the "narrow application of mobile radars for short-range interactive motion sensing" but at reduced power levels to prevent harmful interference to authorized users.¹³ The Commission did not adopt a definition for SRIMS but intended it as a narrow application of the rules that would support technology such as that being developed by Google LLC (Google) under the "Soli" tradename which would allow the user of a smartphone or similar hand-held devices to control web pages opening and closing, or answering a call with hand gestures when the user is located at a short distance from the phone.¹⁴

5. Subsequently, in 2018, Google requested a waiver of the emission limits imposed on Soli by the 2016 rulemaking.¹⁵ It proposed to allow the radar to operate at a higher output power level than what had been authorized in the rulemaking.¹⁶ In granting that waiver, which was limited to use of the Soli sensor as described in Google's request, we permitted Google to deploy its Soli sensor technology to

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24 GHz For Mobile Radio Services, GN Docket No. 14-117, FCC 16-89, Report and Order and Further Notice of Proposed Rulemaking, 31 FCC Rcd 8014 (2016).

⁸ See Wi-Fi Alliance, *Wi-Fi Certified WiGig*, <http://www.wi-fi.org/discover-wi-fi/wigig-certified>.

⁹ See e.g., <http://www.airlinx.com>; <https://www.ignitenet.com/technology/metrolinq/>.

¹⁰ The Commission has a long history of considering radar devices in Part 15 of the rules as a subset of FDS. See e.g., 47 CFR §§ 15.503 & 15.515. The devices in the Instant Order will be referred to as a "radar" or "sensor."

¹¹ 47 CFR § 15.255(c)(3).

¹² *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*, ET Docket No. 94-124, First Report and Order and Second Notice of Proposed Rule Making, 11 FCC Rcd. 4481, 4488 (1995) at para. 14.

¹³ *Use of Spectrum Bands Above 24 GHz For Mobile Radio Services*, GN Docket No. 14-177, Report and Order and Further Notice of Proposed Rulemaking, FCC 16-89, 31 FCC Rcd 8014, 8133-8134, at para. 337 (2016).

¹⁴ Google developed the Soli sensor to capture motion in a three-dimensional space using a radar beam, which enables persons to use gestures and motions to control a smartphone's functions or features. See <https://atap.google.com/soli>.

¹⁵ *Google 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, DA 18-1308, 33 FCC Rcd 12542 (2018).

¹⁶ *Id.* Google stated that the higher power levels were necessary for the Soli device to provide sufficient resolution.

enable touchless control of device functions or features (such as its Pixel phone) at +10 dBm peak transmitter conducted output power, +13 dBm peak EIRP level, and +13 dBm/MHz peak power spectral density, with a 10% duty cycle in any 33 milliseconds (ms) interval. Because the Google Soli is integrated within a Google mobile phone, which can be carried by air travelers, Google also received a waiver of section 15.255(b)(2) to operate the device on-board aircraft without being part of the aircraft internal communication network.¹⁷

6. In granting the waiver to Google for operation of its Soli device at higher power levels than specified in the rules, we considered the particular use environment in which Google's devices would be operated. We noted that Google's submission of supportive studies regarding Soli's co-existence with other users in the 57-64 GHz band inspired confidence that all users of the 57-64 GHz band will be able to operate without experiencing harmful interference.¹⁸ While the 57-64 GHz band is allocated on a co-primary basis to the Federal Mobile, Fixed, Inter-Satellite and Radiolocation services and to non-Federal Fixed, Mobile and Radiolocation services, Passive Earth-Exploration-Satellite Service (EESS) users in particular expressed concern about the Google Soli's operation on-board aircraft.¹⁹ All of the pending waiver requests, as discussed below, are asking to operate radars specifically for automotive in-cabin applications at the same higher power levels that were granted to Google in 2018.²⁰

III. WAIVER REQUESTS

7. As indicated above, all pending waiver requests share a common element: operation on passenger motor vehicles to provide passenger safety functions, especially the ability to detect a child inadvertently left unattended on the rear seat of a hot car. Parties most prominently describe the risks associated with forgotten children in unattended vehicles and cite an automobile industry commitment to provide a widely deployed rear seat reminder no later than the 2025 model year.²¹ The parties further envision that their proposed devices would provide other automated vehicular functions, such as passenger presence detection, seatbelt alarm/airbag deployment, driver inattention detection, and vehicle intrusion detection. Each of the parties request to operate their respective radars at the same power levels and duty cycle we granted to Google in the 2018 waiver (i.e., +13 dBm EIRP, +13 dBm/MHz power spectral density and 10% duty cycle). We describe each of the waiver requests and the comments received in their respective dockets below.

A. Vayyar Imaging Ltd. (Vayyar) Waiver Request

8. On November 13, 2019, Vayyar asked for waiver of section 15.255(c)(3) of the Commission's rules to obtain a grant of equipment authorization for its V60G radar module to permit operation in the 57-64 GHz frequency band.²² At that time, Vayyar asked for a waiver so that its radar

¹⁷ 47 CFR § 15.255(b)(2). See also *supra* para. 3.

¹⁸ *Google 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, DA 18-1308, 33 FCC Rcd 12542, 12547 (2018), at para. 11.

¹⁹ 47 CFR. § 2.106. EESS operates in the 57-59.3 GHz sub-band for satellite-based remote sensing instruments to make important atmospheric, oceanic and land measurements of the Earth. 47 CFR. § 2.106, Note 5.138. Industrial, scientific and medical (ISM) equipment may also operate in the band at 61.00-61.50 GHz, pursuant to 47 CFR § 18.301.

²⁰ The Google Soli device integrated in a smartphone could operate on-board aircraft, thus Google also received a waiver of 47 CFR. § 15.255(a)(2). Because the devices subject to the instant waiver will all operate at ground level inside a vehicle, they do not require waiver of this section.

²¹ See <https://www.nhtsa.gov/campaign/heatstroke>; <https://www.consumerreports.org/car-safety/auto-industry-agrees-to-put-rear-seat-reminder-systems-in-most-new-cars-by-2025/>.

could be used broadly in a variety of interactive products, including use on-board aircraft. It subsequently filed a Modified Waiver Request to narrow the scope of radar applications to only include: 1) “in-home and medical imaging sensors” and 2) “in-vehicle safety applications.”²³ We are only addressing Vayyar’s requested vehicular use here and make no decision regarding Vayyar’s device for use in home and medical settings. Accordingly, that portion of Vayyar’s Modified Request remains pending.

9. Vayyar claims that the V60G is an interactive motion sensing device designed to operate under the same technical parameters (power and duty cycle limits) as the Google Soli sensor for which the Commission has previously granted a waiver. In support of its request, Vayyar asserts that the V60G will generate an identical “spectrum footprint” as the Google Soli sensor and will coexist with other spectrum users in the 57-64 GHz band in the same manner as does the Soli sensor. It asks the Commission to evaluate the V60G based on a general interference simulation study that Google submitted in its waiver request.²⁴ Vayyar states that the V60G is intended to be installed inside vehicle cabins to provide various passenger safety applications, including detecting a child left unattended in a hot car.²⁵

10. Vayyar describes the V60G devices as MIMO²⁶ radars with an array consisting of 20 transmit and 20 receive antennas, configured to provide azimuth and elevation resolution, resulting in 400 possible signal paths, which provides greater signal spatial resolution than the Google Soli.²⁷ Vayyar states that the wideband signals provide distance resolution for 3D imaging capability, while Doppler²⁸ processing identifies object motion and small displacements.²⁹ Vayyar claims that the V60G technology has the ability to detect respiration via chest movement which permits it to discriminate between people and inanimate objects, to limit system response to “people only” conditions, to provide accurate discrimination of seat occupancy (e.g., child vs. groceries) and to improve the efficiency of seatbelt reminder systems.³⁰

11. The Office of Engineering and Technology (OET) issued a Public Notice soliciting comments on the *Vayyar Request* on Jan. 14, 2020.³¹ Two parties filed individual comments³² and an

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²² *Vayyar Imaging Ltd. Request for Waiver of Section 15.255(c)(3) of the Commission’s Rules for Radars used for Interactive Motion Sensing in the frequency band 57-64 GHz* (filed Nov. 13, 2019) (*Vayyar Request*).

²³ *Vayyar Imaging Ltd. Modification of Request for Limited Waiver*, filed May 5, 2020 (*Vayyar Modified Request*).

²⁴ *Vayyar Request* at 2. The Google studies and simulations were filed March 8, 2018 and Oct. 12, 2018 in ET Docket No. 18-70. See <https://ecfsapi.fcc.gov/file/10307158658894/2018-03-07%20Soli%20Request%20for%20Waiver%20%2B%20Simulation%20Study.pdf>, and [https://ecfsapi.fcc.gov/file/101213308029/2018-10-12%20Google%20Letter%20re%20Project%20Soli%20%2B%20Studies%20\(ET%2018-70\).pdf](https://ecfsapi.fcc.gov/file/101213308029/2018-10-12%20Google%20Letter%20re%20Project%20Soli%20%2B%20Studies%20(ET%2018-70).pdf).

²⁵ *Vayyar Modified Request* at 4-6.

²⁶ MIMO (multiple-input and multiple-output) is a method for enhancing the capacity of a radio link using multiple transmission and receiving antennas.

²⁷ *Vayyar Request* at 5.

²⁸ The Doppler effect is the change in frequency of a wave as the wave source and an observer move towards or away from each other.

²⁹ *Vayyar Request* at 2.

³⁰ *Vayyar Request* at 6-7.

³¹ See *OET Seeks Comment on Vayyar Imaging Ltd. Request for Waiver of Sections 15.255(b)(2) and (c)(3) of the Commission Rules for Radars used for Interactive Motion Sensing in the 57-64 GHz band*, ET Docket No. 20-15, Public Notice, DA 20-68, 35 FCC Rcd 500 (2020).

³² Joe Gytrock and IEE Sensing filed individual comments.

additional comment (Joint Comment) was filed by a group of seven parties.³³ Vayyar filed reply comments.

12. *Comments.* IEE Sensing states that the FCC should consider more broadly any necessary changes to its rules for both the 57-64 GHz and the 77-81 GHz bands that would allow life-saving devices to operate, rather than simply proceeding on an individual case-by-case waiver approach.³⁴ The Joint Comment encourages the Commission to commence a comprehensive rulemaking proceeding to: (i) promote future applications, services, and devices in the 60 GHz band, and (ii) address the range of technical and policy issues necessary to preserve reasonable coexistence between radars/FDS, with higher power levels than currently permitted, and other users of the 60 GHz band.³⁵ One commenting party, Joe Gytrock, opposes the waiver by disputing Vayyar's technical claim that the V60G provides an "identical interference footprint" to the Google Soli.³⁶ Gytrock's arguments and Vayyar's responses are discussed, *infra*.³⁷ All other parties support the request.

B. Valeo North America Inc. (Valeo) Waiver Request

13. On March 31, 2020, Valeo filed a request for waiver of section 15.255(c)(3) of the Commission's rules to allow Valeo to obtain equipment certification for radar sensing devices operating in the 57-64 GHz band at a higher power than specified in the rule.³⁸ Valeo requests to operate its radar at the same technical conditions as specified in the waiver we granted to Google in 2018.³⁹ Valeo states that its sensors will be installed in a vehicle's interior roof, behind the headliner⁴⁰ and will issue an alert whenever a child is left behind. Valeo states that its sensors also could be used for other passenger safety functionalities such as seat belt reminders and decision criteria for airbag deployments based on seating position and occupant size (e.g. child versus adult).⁴¹

14. Valeo describes that its radar's modulation consists of consecutive frames, including an acquisition sequence comprised by a repetition of frequency chirps or stepped chirps. The acquisition sequence is followed by idle time where antennas are not transmitting. The frequency chirps will span over the 57-64 GHz band. For each acquisition sequence, the number of chirps and chirp duration can be

³³ Seven parties (Facebook Inc., Google LLC, Infineon Technologies, Intel Corporation, Qualcomm Incorporated, Samsung Electronics America, Socionext America) filed a joint comment (filed Feb. 3, 2020) (Joint Comment). These parties were joined by Continental Automotive GmbH, Texas Instruments Inc., and Vayyar Imaging Ltd, in a 10-party *ex parte* filing (filed Jul. 1, 2020) with essentially the same content.

³⁴ Comments of IEE Sensing at 3.

³⁵ Joint Comment at 2.

³⁶ See filings by Joe Gytrock filed Mar. 10, Jun. 2, and Aug. 3, 2020; and responses of Vayyar filed Mar. 19 and Jun. 17, 2020 in ET Docket No. 20-15. See also, Vayyar's Apr. 28, 2020 *ex parte* filing, titled "Comparison of V60G and Soli Interference Footprints."

³⁷ See discussion *infra* at paras. 43-44.

³⁸ *Valeo North America Inc. Request for Waiver of Sections 15.255(a)(2) and (c)(3) of the Commission's Rules for In-Vehicle Radar Operation in the frequency band 57-64 GHz* (filed Mar. 31, 2020) (*Valeo Request*). Valeo did not originally ask for waiver of 47 CFR 15.255(a)(2) because it considered its device a SRIMS. It later decided to request waiver of this section should the Commission decide the device is not a SRIMS but a general mobile radar, which would be prohibited under this section. *Valeo ex parte* (filed Oct. 29, 2020).

³⁹ *Valeo Request* at 3.

⁴⁰ The "headliner" is the material that is adhered to the vehicle cabin's inside roof.

⁴¹ *Valeo Request* at 3.

adjusted depending on the speed of the objects to be detected so that the total duty cycle that will be no greater than 10%.⁴²

15. OET issued a Public Notice soliciting comments on the *Valeo Request* on May 7, 2020.⁴³ The Commission also sought comment on whether Valeo's sensors, under the described application, could be operated as a SRIMS under section 15.255(a)(2) of the rules. Although Valeo did not ask for a waiver of this rule, the Commission raised the issue because its application differs from Google's in that detecting a child left in a vehicle is not the same as detecting hand gestures and movements associated with interactions between a user and a personal device such as a smartphone. Valeo subsequently requested waiver of section 15.255(a)(2) to the extent its device would not comply with the SRIMS requirement.⁴⁴

16. *Comments.* Nine comments were submitted⁴⁵ and Valeo filed reply comments. All parties support of Valeo's waiver request. With respect to qualification as a SRIMS, Brose, Infineon and Texas Instruments (TI) state their belief that Valeo's application for in-car sensing qualifies as SRIMS.⁴⁶ Vayyar Imaging Ltd. (Vayyar) argues that applications such as those described by Valeo's do not require a waiver to qualify as SRIMS.⁴⁷ Wiley Rein LLP (Wiley) states that "the Commission should clarify that "interactive motion sensing" includes the use of a field disturbance sensor to: (1) permit a person to control a device; (2) enable the control of a device by the device interacting with its environment; or (3) allow a device to monitor a person by the person interacting with the device."⁴⁸

C. Infineon Technologies Americas Corp. (Infineon) Waiver Request

17. On July 23, 2020, Infineon filed a request for waiver of section 15.255(c)(3) of the Commission's rules to allow Infineon to market its BGT60 family of radar system-on-chip (SoC) modules.⁴⁹ Infineon indicates that its devices would be used for in-vehicle child safety systems and other in-cabin safety-related monitoring such as seatbelt reminders, airbag optimization, and driver's health and attention alerting.⁵⁰ In particular, Infineon describes the risks of inadvertently leaving children in hot vehicles.⁵¹ Like other parties, Infineon requests to operate its devices at higher power than specified in

⁴² *Valeo Request* at 5. In its original request, Valeo asked to operate its radar with a duty cycle identical to the Google Soli, i.e., no more than 3.3 ms transmission time in each 33 ms time period; however, in its reply comments, Valeo modified this request to ask for a 16 ms transmission time in each 160 ms time period, to cover multi-sensor situations. *Valeo Reply* at 5. Subsequently, Valeo agreed that as long as the duty cycle is imposed on a per-radar-basis, its device can comply with the 3.3 ms duty cycle. *Valeo ex parte* (filed Dec. 7, 2020).

⁴³ *OET Seeks Comment on Valeo North America Inc. Request for Waiver of Section 15.255(c)(3) of the Commission's Rules for In-Vehicle Radar Operation in the 57-64 GHz band*, ET Docket No. 20-121, Public Notice, DA 20-486, 35 FCC Rcd 4582 (2020).

⁴⁴ *Valeo ex parte* (filed Oct. 29, 2020).

⁴⁵ Acconeer AB, Alps Alpine Co. Ltd., Brose North America Inc., IEE Sensing, Infineon Technologies AG, Texas Instruments, Inc. (TI), Vayyar Imaging Ltd., and Wiley Rein LLP (Wiley) filed individual comments. Ten parties (Facebook Inc., Google LLC, Infineon Technologies, Intel Corporation, Qualcomm Incorporated, Samsung Electronics America, Socionext America, Continental Automotive GmbH, Texas Instruments Inc., and Vayyar Imaging Ltd.) filed a joint comment.

⁴⁶ Comments of Brose at 1; comments of Infineon at 5; comments of TI at 1.

⁴⁷ Comments of Vayyar at 3.

⁴⁸ Comments of Wiley at 5.

⁴⁹ *Infineon Technologies Americas Corp. Request for Waiver of Sections 15.255(a)(2) and (c)(3) of the Commission's Rules for Short-Range Interactive Motion Sensors for In-Vehicle Radar Operation in the frequency band 57-64 GHz* (filed July 23, 2020) (*Infineon Request*).

⁵⁰ *Infineon Request* at 5.

our rules, under the same technical parameters as those we granted to Google in 2018.⁵² Infineon explains that it needs to operate the radar at higher power levels, because, depending on the installation within the vehicle cabin (e.g., the radar cross section of the target, random material, distance to the target, field-of-view of the radar system), there could be several dB of losses in the link budget⁵³ that have to be compensated with higher output power.⁵⁴

18. Infineon asserts that the life-saving technology associated with Infineon's BGT60 family of radars justifies granting its request in the near term rather than waiting for a lengthy rulemaking process to modify our rules, as has been suggested by commenters in similar waiver requests pending before the Commission.⁵⁵ Infineon further requests that the waiver, if granted, clearly apply to BGT60 radars that will be certified under the rules as modular transmitters, or that are otherwise incorporated, without change, as components by Infineon or Infineon's customers into other vehicular in-cabin devices or systems.⁵⁶

19. OET issued a Public Notice soliciting comments on the *Infineon Request* on Aug. 20, 2020.⁵⁷ Six parties filed comments⁵⁸ and Infineon filed reply comments. All parties support the request.

20. *Comments.* ADC Automotive Distance Control Systems GmbH (ADC), Ficosa International (Ficosa), and Magna International (Magna) state that the 57-64 GHz band is the most suitable band for in-cabin safety technologies and that there is broad industry support for use of this band for in-cabin safety applications.⁵⁹ Valeo and Ficosa believe that Infineon's in-cabin applications qualify as SRIMS and does not need a waiver of 15.255(a)(2).⁶⁰ Magna and MEAA fully support vehicle radar use in the 57-64 GHz frequency band.⁶¹ Tesla states that in-vehicle sensing devices have the potential to provide a number of significant safety and security benefits, including detecting children left unattended in hot cars, detecting seat occupancy for advanced airbag deployment and seatbelt reminders, monitoring driver health and engagement, enhancing theft prevention systems, and allowing for gesture recognition to control, for example, dashboard functions.⁶²

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⁵¹ *Infineon Request* at 6.

⁵² *Id.* at 3-4. We note that Infineon only seeks a waiver of 47 CFR § 15.255(c)(3). Google also received a waiver of 47 CFR § 15.255(b)(2), which restricts airborne operation; Infineon's proposed applications are limited to in-cabin automotive passenger vehicles. *Id.* at 5.

⁵³ A link budget is a design aid to determine all of the power gains and losses that a communication signal experiences in a telecommunication system; from a transmitter, through a medium (free space, cable, waveguide, fiber, etc.) to the receiver, to ensure that the information is received intelligibly.

⁵⁴ *Infineon Request* at 7.

⁵⁵ *Infineon Request* at 15-16.

⁵⁶ *Infineon Request* at 6, n.19.

⁵⁷ *OET Seeks Comment on Infineon Technologies Americas Corp. Request for Waiver of Section 15.255(c)(3) of the Commission Rules for Short-Range Interactive Motion Sensors for In-Vehicle Radar Operation in the 57-64 GHz band*, ET Docket No. 20-263, Public Notice, DA 20-897, 35 FCC Red 8815 (2020).

⁵⁸ ADC Automotive Distance Control Systems GmbH (ADC), Ficosa International (Ficosa), Magna International (Magna), Mitsubishi Electric Automotive America (MEAA), Tesla Inc., and Valeo North America, Inc.

⁵⁹ Comments of ADC at 3; comments of Ficosa 1; comments of Magna at 1.

⁶⁰ Comments of Valeo at 2; comments of Ficosa at 1.

⁶¹ Comments of Magna and MEAA at 1.

⁶² Comments of Tesla at 2.

D. Tesla Inc. (Tesla) Waiver Request

21. On July 31, 2020, Tesla filed a request for waiver of section 15.255(c)(3) of the Commission's rules to allow Tesla to obtain equipment certification for a radar operating in the 60-64 GHz band at a higher power than specified in the rule.⁶³ Tesla indicates that its device would be focused on the vehicle interior for applications such as child presence detection and seatbelt reminders; however, Tesla states that the device may be able to scan up to 2 meters (approximately 6 feet) outside of the vehicle, to provide vehicle security benefits such as detecting a broken window or a vehicle intrusion.⁶⁴ Like other parties, Tesla seeks a waiver to operate under the same technical parameters as those we granted to Google in 2018.⁶⁵

22. Tesla describes that its device will use 4 transmit and 3 receive antennas driven by a highly configurable radar front-end unit and in-vehicle radar modulation will consist of consecutive frames, including an acquisition sequence comprised by a repetition of frequency chirps or stepped chirps, a listening period, then a period for signal processing.⁶⁶

23. OET issued a Public Notice soliciting comments on the *Tesla Request* on Aug. 20, 2020.⁶⁷ As in the Public Notice for Valeo, *supra*, the Commission also sought comment on whether Tesla's sensors, under the application as described could be operated as SRIMS under section 15.255(a)(2) of the rules. Six parties filed comments⁶⁸ and Tesla and Infineon filed reply comments. All but one party support the request.

24. *Comments.* The Advocates for Highway and Auto Safety (Safety Advocates) state that "the ability of a vehicle to detect and classify all occupants will likely be critical as autonomous vehicles (AVs) are deployed onto our roads in the future... because... AVs will need to know the number of occupants and whether they are properly restrained before beginning to move."⁶⁹ Valeo, Acconeer and TI agree that Tesla's described applications qualify as SRIMS.⁷⁰ Duncan Armour, the sole party opposing the petition, characterizes Tesla's request as a "trivial or edge-case" use of radiofrequency (RF) energy

⁶³ *Tesla Inc. Request for Waiver of Sections 15.255(a)(2) and (c)(3) of the Commission's Rules for Short-Range Interactive Motion Sensors for Vehicle Radar Operation in the frequency band 60-64 GHz* (filed July 31, 2020) (*Tesla Request*). Tesla did not originally ask for waiver of 47 CFR § 15.255(a)(2) because it considered its device to be a SRIMS. It later decided to request a waiver of this section should the Commission decide the device is not a SRIMS but a general mobile radar, which would be prohibited under this section. Tesla Reply Comments at 4-5.

⁶⁴ *Id.* at 2-4.

⁶⁵ *Id.* at 13. We note that Tesla only seeks a waiver of 47 CFR § 15.255(c)(3). As discussed above, Google's receipt of a waiver of 47 CFR § 15.255(b)(2) pertains to airborne operation, which is not relevant to Tesla's use model. *Id.* at 3-4.

⁶⁶ Tesla further states that "the acquisition sequence is followed by idle time where antennas are not transmitting. The frequency chirps will span over the 60-64 GHz band and for each acquisition sequence, the number of chirps and chirp duration can be adjusted depending on system requirements so that the duty cycle will not exceed 10%." *Tesla Request* at 2-3.

⁶⁷ See *OET Seeks Comment on Tesla, Inc. Request for Waiver of Section 15.255(c)(3) of the Commission Rules for Short-Range Interactive Motion Sensors for Vehicle Radar Operation in the 60-64 GHz band*, ET Docket No. 20-264, Public Notice, DA 20-898, 35 FCC Rcd 8818 (2020).

⁶⁸ Acconeer AB, Alliance for Automotive Innovation (Auto Innovators), Texas Instruments (TI), Valeo North America, Inc., Duncan Armour, and Advocates for Highway and Auto Safety (Safety Advocates). Duncan Armour's comment was filed in the Valeo docket, ET Docket No. 20-121, but is titled "Comment on: Tesla Application" and exclusively discusses Tesla's waiver request. For this reason, we address it here.

⁶⁹ Comments of Safety Advocates at 2.

⁷⁰ Comments of Valeo at 2; comments of Acconeer at 1; comments of TI at 1.

that does not warrant approval, and speculates that “[t]he request is likely to be for other surveillance purposes ... than the ‘protection of cute vulnerable babies’ posited by Tesla.”⁷¹

25. In reply comments, Tesla states that although it did not request waiver of Section 15.255(a)(2) for mobile radar operation in its request, it seeks a waiver of this section to the extent its device would not comply with the SRIMS requirement.⁷² Subsequently, in an *ex parte* letter, Tesla provided further explanations for the use cases requested for waiver. Tesla identifies some potential use cases—child detection, cabin intrusion, and exterior detection—for which sensing would occur only while the vehicle is stationary; and other use cases—occupant detection and classification—for which the device would sense both while the vehicle is stationary and while in motion; and one use case—driver’s vital signs monitoring—for which the device would sense only while the vehicle is in motion. In addition, Tesla clarifies that the vast majority of sensing would be confined to the vehicle interior; the only exception being for exterior detection, but with the radar still installed inside the vehicle.⁷³

E. IEE Sensing Inc. (IEE Sensing) Waiver Request

26. On November 16, 2020, IEE Sensing, Inc. (IEE Sensing) filed a request for waiver of sections 15.255(c)(2) and/or 15.255(c)(3) of the Commission’s rules to allow IEE Sensing to obtain a grant of equipment authorization for its VitaSense sensor, a radar operating in the 60-64 GHz band, at a higher power than specified in the rule, limited to operation within automotive vehicle cabins.⁷⁴ According to IEE Sensing, the VitaSense is designed to detect the breathing and movements of children inadvertently left in an automobile to alert the vehicle’s alarm system. IEE Sensing states that the VitaSense is intended to be integrated into the vehicle by the vehicle manufacturers and not as an after-market product.⁷⁵

27. IEE Sensing indicates that its device would detect unattended children while the vehicle is completely stopped, thus it considers the VitaSense to be a “fixed” radar under the provisions of section 15.255(c)(2).⁷⁶ IEE Sensing states that the VitaSense needs a bandwidth of four gigahertz to eliminate errors in detection, thus it requests a waiver of the 500-megahertz bandwidth requirement in section 15.255(c)(2). This rule requires fixed field disturbance sensors/radars to comply with a 500-megahertz bandwidth contained within the 61.0-61.5 GHz band, and limits emission levels outside of this band (but within the 57-71 GHz band) to +10 dBm average EIRP and +13 dBm peak EIRP. IEE Sensing affirms that the VitaSense complies with the EIRP limits of this rule section across its proposed 60-64 GHz operating frequency band.

28. In the alternative, IEE Sensing requests to operate its VitaSense as a “fixed” radar at higher power limits than specified in section 15.255(c)(3). IEE requests to operate at +13 dBm peak EIRP, +4 dBm conducted output power and 1% duty cycle.⁷⁷

⁷¹ Comments of Duncan Armour at 1.

⁷² Reply comments of Tesla at 4-5.

⁷³ Tesla *ex parte* letter (filed Dec. 9, 2020).

⁷⁴ *IEE Sensing Inc. Request for Waiver of Sections 15.255(c)(2) and (c)(3) of the Commission’s Rules for Vehicle Radar Operation in the frequency band 60-64 GHz* (filed Nov. 16, 2020) (*IEE Sensing Request*). IEE Sensing supplemented its request on December 1, 2020 to provide additional detail and to ask to operate in the same manner as the Google Soli with the same technical conditions granted to Google. *IEE Sensing, Inc., Clarification to the IEE Sensing Petition for Waiver* (filed Dec. 1, 2020) (*IEE Sensing Supplement*).

⁷⁵ *IEE Sensing Request* at 2.

⁷⁶ 47 CFR § 15.255(c)(2). *IEE Sensing Request* at 1.

⁷⁷ *IEE Sensing Request* at 4.

29. As an alternative, if waiver of the requested bandwidth and power limits for fixed FDS are not possible, IEE Sensing requests waiver of section 15.255(c)(3) to allow the VitaSense to operate with the same technical parameters as those we granted to Google.⁷⁸

30. OET issued a Public Notice soliciting comments on the *IEE Sensing Request* on Dec. 31, 2020.⁷⁹ A single commenter, Advocates for Auto and Highway Safety (Advocates), filed in support. IEE Sensing filed reply comments.

F. Brose North America Inc. (Brose) Waiver Request

31. On November 25, 2020, Brose North America, Inc. (Brose) filed a request for waiver of section 15.255(c)(3) of the Commission's rules to allow Brose to obtain a grant of equipment authorization for a radar operating in the 57-64 GHz band at a higher power than specified in the rule, limited to operation within automotive vehicle cabins.⁸⁰ According to Brose, the main focus of its device is to detect humans (including infants and children) inadvertently left in an automobile and their associated body sizes and/or movements.⁸¹ Brose states that the Brose device is intended to be mounted behind a non-conductive headliner or a covering in the vehicle's roof area.⁸² Like other petitioners, Brose also requests to operate its devices under the same technical parameters as those we granted to Google in the 2018 waiver order.⁸³

32. OET issued a Public Notice soliciting comments on the *Brose Request* on Dec. 31, 2020.⁸⁴ A single commenter, Valeo, filed in support.⁸⁵ No parties filed reply comments.

IV. DISCUSSION

33. We are authorized to grant a waiver under section 1.3 of the Commission's rules if the petitioner demonstrates good cause for such action.⁸⁶ Good cause, in turn, may be found and a waiver granted "where particular facts would make strict compliance inconsistent with the public interest."⁸⁷ To

⁷⁸ *IEE Sensing Supplement* at 2 (citing *Google 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*, ET Docket No. 18-70, Order, 33 FCC Rcd 12542 (2018) (Google Waiver)). Because IEE Sensing only seeks a waiver for in-vehicle use, it does not seek nor require a waiver of 47 CFR § 15.255(b)(2) (restricting airborne operation) that we also granted to Google.

⁷⁹ See *OET Seeks Comment on IEE Sensing Inc. Request for Waiver of Sections 15.255(c)(2) and/or (c)(3) of the Commission Rules for In-Vehicle Radar Operation in the 60-64 GHz band*, ET Docket No. 20-435, Public Notice, DA 20-1515, 35 FCC Rcd 14676 (2021).

⁸⁰ *Brose North America Inc. Request for Waiver of Section 15.255(c)(3) of the Commission's Rules for Vehicle Radar Operation in the frequency band 57-64 GHz* (filed Nov. 25, 2020) (*Brose Request*).

⁸¹ *Brose Request* at 2.

⁸² *Brose Request* at 2.

⁸³ *Brose Request* at 4.

⁸⁴ See *OET Seeks Comment on Brose North America Inc. Request for Waiver of Sections 15.255(c)(3) of the Commission Rules for In-Vehicle Radar Operation in the 57-64 GHz band*, ET Docket No. 20-434, Public Notice, DA 20-1514, 35 FCC Rcd 14673 (2021).

⁸⁵ Comments of Valeo at 1-3.

⁸⁶ 47 CFR § 1.3; see also *ICO Global Communications (Holdings) Limited v. FCC*, 428 F.3d 264 (D.C. Cir. 2005); *Northeast Cellular Telephone Co. v. FCC*, 897 F.2d 1164 (D.C. Cir. 1990); *WAIT Radio v. FCC*, 418 F.2d 1153 (D.C. Cir. 1969).

⁸⁷ *Northeast Cellular*, 897 F.2d at 1166; see also *ICO Global Communications*, 428 F.3d at 269 (quoting *Northeast Cellular*); *WAIT Radio*, 418 F.2d at 1157-59.

satisfy this public interest requirement, the waiver cannot undermine the purposes of the rule, and there must be a stronger public interest benefit in granting the waiver than in applying the rule.⁸⁸

34. As with the Google waiver, these applications seek to use unlicensed radars for a particular use case. The exigency of the child-vehicular-heatstroke risks and the overwhelming passenger safety benefits provided by the use of radar technology in passenger motor vehicles in the 57-64 GHz band give us good cause to consider granting these waivers.⁸⁹ Parties assert that 57-64 GHz radars are uniquely well suited for these applications, and discuss why they considered but rejected alternate ways to perform these tasks.⁹⁰ Parties also describe why, like Google, they need a waiver of our technical rules to ensure their devices operate reliably.⁹¹

35. As an initial matter, devices operating pursuant to Part 15 of the Commission's rules are not afforded any right of interference protection and these provisions are applicable to all unlicensed users.⁹² Parties wishing to operate safety-related applications under Part 15 unlicensed provisions must be cognizant of the limitations of such operation. We will require instructions to be provided to users and installers of the radars operating under the provisions of this waiver to inform that these radars may only be operated on a non-interference basis to other authorized services in the 57-64 GHz frequency band, and that operators of these devices will be required to mitigate any instances of harmful interference that may occur.

36. We find it is appropriate for us to waive the operating restrictions in section 15.255(a)(2) to permit in-vehicle radar operation. We sought input on whether use of 60 GHz radar sensing in vehicular applications could be considered "short-range interactive motion sensing" (i.e. satisfy the SRIMS meaning) in the same way as the Google Soli technology meets the intent of the rule.⁹³ We noted that the Google Soli radar when installed in a smartphone (e.g., the Google Pixel phone) allows the user of the phone to control web pages opening and closing or answering a call with hand gestures when the user is located at a short distance from the phone. We indicated that vehicle radar applications (e.g., sensing a child's breathing pattern, etc.) are different from Google's in that the users will not be engaging in touchless control of device functions in the same way that a Google phone user uses gestures and hand movements to interact with his or her personal device. In response to our question, some commenters

⁸⁸ See, e.g., *WAIT Radio*, 418 F.2d at 1157 (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).

⁸⁹ See e.g., <https://www.nhtsa.gov/child-safety/help-prevent-hot-car-deaths>.

⁹⁰ See, e.g., Tesla Request at 4 (stating that, unlike cameras, radar devices operating in the requested frequency range provide depth perception and can "see" through soft materials, such as a blanket covering a child in a child restraint; and, unlike in-seat sensors, such radar devices can differentiate between a child and an object left on the seat, reducing the likelihood of false alarms).

⁹¹ See, e.g., Infineon Request at 7 (Stating that it needs to operate the radar at higher power levels than permitted by the rule, because, depending on the installation within the vehicle cabin (e.g. the radar cross section of the target, random material, distance to the target, field-of-view of the radar system), there could be several dB of losses in the link budget that have to be compensated with higher output power).

⁹² The operator of a Part 15 device must accept interference and may not cause harmful interference. Should harmful interference occur, the operator must immediately resolve the interference up to and including ceasing operation of the device. See 47 CFR § 15.5.

⁹³ See, e.g., *OET Seeks Comment on Valeo North America Inc. Request for Waiver of Section 15.255(c)(3) of the Commission Rules for In-Vehicle Radar Operation in the 57-64 GHz band*, ET Docket No. 20-121, Public Notice, DA 20-486, 35 FCC Rcd 4582 (2020).

assert that a device should not be considered to operate as a SRIMS device unless movements originate from the owner/user of the device; under this theory, applications such as vehicle theft intrusion would not represent SRIMS.⁹⁴ On the other hand, other commenters suggest including broad applications in the SRIMS designation such as any interaction with the device's environment, which could comprise a non-user's action such as a thief, or non-moving obstructions in the device's path, when they are part of the "device's environment."⁹⁵

37. The record on the SRIMS designation does not provide a clear bright line for determining the practical scope of SRIMS operation.⁹⁶ Moreover, we recognize that an overly broad interpretation risks blurring the distinction between SRIMS devices and more general mobile radar use in the 57-64 GHz band that the Commission clearly rejected when adopting the rule. We find that the appropriate course is to refrain from making the determination that the SRIMS designation applies to the instant case and to instead include section 15.255(a)(2) in our waiver analysis, where we are able to provide relief that is limited and narrowly tailored. We thus leave further consideration of the scope and definition of SRIMS for a later time.

38. As discussed below, we find that the waiver standard has been met and will permit the use of radar equipment mounted in a passenger motor vehicle—*i.e.*, a "passenger car" or a "multipurpose passenger vehicle" that has more than one row of seats, as those terms are defined at 49 CFR § 571.3⁹⁷—for child detection and other safety-related vehicular-monitoring purposes.

39. In evaluating the instant waiver requests, we first consider whether a waiver would undermine the purpose of our rules. As discussed above, the operational policies and technical parameters associated with sections 15.255(a)(2) and (c)(3) are both designed to ensure that users of devices operating under section 15.255 do not cause harmful interference. When the Commission expanded the base of uses to include SRIMS, it recognized that there were types of mobile radar applications that could operate without causing harmful interference to authorized users.

40. In general, we find that radar operation in the 57-64 GHz band in passenger motor vehicles where a child may be inadvertently left unattended on a rear seat will not cause harmful interference to other authorized users in the band. First, these radars will operate at comparatively much lower power levels than the levels already permitted to communication devices (indoors and outdoors) in the same band. The communication devices such as WiGig 60 GHz networking devices are allowed to operate at +40 dBm EIRP, as compared to the +13 dBm EIRP that we are allowing here. Although the proposed +10 dBm limit on transmitter conducted power is 20 dB higher than in the existing rule, the requested peak +13 dBm EIRP is only 3dB above the existing limit. While our existing rule in section 15.255(c)(3) does not currently place a restriction on power spectral density, the +13 dBm/MHz emission limit as an additional waiver condition provides supplemental protection from potential high peak emissions in a given bandwidth. Second, with the radar installed inside a vehicle, the vehicle's metallic chassis and the glass windows will block or attenuate the radar signals.⁹⁸ When combined with the extensive radio frequency propagation loss in the 57-64 GHz band, the radar signals will be further

⁹⁴ See, e.g., comments of Vayyar at 3 (stating that "intrusion detection involves the sensing of actions by a non-user of the device and thus, would not come within the scope or ordinary meaning of the SRIMS term.")

⁹⁵ See, e.g., comments of Wiley at 5.

⁹⁶ For example, those commenters that state that all the requested use cases should be considered as SRIMS generally provide little or no substantive analysis to support their assertion.

⁹⁷ See *supra* note 2.

⁹⁸ Some researchers indicate that at 60 GHz, regular glass provides 11 dB/centimeter attenuation and mesh glass, 32 dB/centimeter. See e.g., C. Anderson and T. Rappaport, *In-building Wideband Partition Loss Measurements at 2.5 and 60 GHz*, IEEE Trans. Wireless Communications, vol. 3, no. 3, pp. 922–928 (2004.)

attenuated outside the vehicle.⁹⁹ We note that the EIRP, power density and transmitter conducted output power limits here are identical to those we placed on Google in its 2018 waiver.

41. Furthermore, restricting the radar's transmit duty cycle to 10% in every 33 ms can provide additional assurance that the potential for harmful interference is minimal.¹⁰⁰ This restriction is identical to what we required in the Google waiver and was based on Google's extensive interference studies and its final agreement with stakeholders from the WiGig communications industry whose technology shares the 57-64 GHz spectrum.¹⁰¹ Because all parties agree that they can comply with the same duty cycle timing restriction as the Google Soli so long as that requirement applies per radar device, we are including this restriction as a waiver condition.¹⁰²

42. Because our decision addresses multiple distinct waiver requests, we next consider a number of application-specific matters that have been raised within the individual dockets. We find that none of these matters alter our overall finding that granting the waivers will not undermine the purpose of the rules—i.e., that operation under the waivers will not cause harmful interference to other authorized users in the band.

43. *Vayyar's V60G Spectral "Footprint."* In its request to operate its V60G device at the same power levels granted to Google in the 2018 waiver, Vayyar affirms that the V60G provides the same spectral footprint as the Google Soli.¹⁰³ In comments, Joe Gytrock (Gytrock) argues that the V60G integrates 40 transceivers, each capable of transmitting in the proposed frequency band, whereas the Google Soli integrates only two transmit channels, which is an increase by a factor of 20.¹⁰⁴ Gytrock asserts that the power accumulation in a phased-array beam would have some portion of the antennas adding up coherently in certain directions, resulting in a larger aggregate transmit power than the Google Soli.¹⁰⁵ Gytrock suggests Vayyar submit a test report to prove equivalency with the Soli and compliance with the rules.¹⁰⁶ Gytrock further requests that the Commission specify the pulsing scheme, including pulse timing as part of the waiver conditions to maintain equivalency to the Soli waiver.¹⁰⁷ Vayyar asserts in response that, irrespective of the phase combinations used, the aggregate power of the V60G remains exactly the same as the Soli sensors, with 20 elements transmitting only 1/20th of the overall power, whereas the Google Soli's 2 transmitting antennas would each transmit 1/2 of the overall power.¹⁰⁸ Vayyar

⁹⁹ Free space path loss (FSPL) for a 60 GHz signal is 77.56 dB at 3 meters from the transmitter (i.e., $FSPL \text{ (in dB)} = 20 \log F + 20 \log d - 147.55$, where F is the signal frequency in Hertz and d is the distance from the transmitter in meters).

¹⁰⁰ Duty cycle is defined as the fraction of one period in which transmission is active. A period is the time it takes for a signal to complete an on-and-off cycle. Duty cycle is commonly expressed as a percentage or a ratio. The existing rules do not place a restriction on duty cycle.

¹⁰¹ See Letter from Megan Anne Stull, Google LLC, and Pankaj Venugopal, Facebook, Inc., to Marlene Dortch, FCC, ET Docket No. 18-70 (filed Sept. 7, 2018) (*Google-Facebook Joint ex parte Filing*). Google agreed to the 3.3 ms duty cycle restriction after extensive consultation with Facebook and other stakeholders, as outlined in the above filing.

¹⁰² Both Valeo and Brose indicate that although they requested a longer duty cycle to cover multi-sensor situations in larger vehicles, each of their individual radar devices can comply with the 3.3 ms duty cycle per 33 ms time period. *Valeo ex parte* (filed Dec. 7, 2020) at 2; *Brose Request* at 4-5.

¹⁰³ *Vayyar Request* at 2.

¹⁰⁴ Gytrock Mar. 10, 2020 *ex parte* filing in ET Docket No. 20-15 at 1.

¹⁰⁵ *Id.*

¹⁰⁶ *Id.*

¹⁰⁷ *Id.*

¹⁰⁸ Vayyar Apr. 28, 2020 *ex parte* filing in ET Docket No. 20-15.

also asserts that it can configure the V60G operation to match that of the Google Soli.¹⁰⁹ Vayyar also submitted a detailed “Technical Comparison of the V60G and Soli Interference Footprints,” in which it affirms that “the higher EIRP during some of the slots is offset by having lower EIRP in other slots.”¹¹⁰ Further, Vayyar argues that, “in the rare case that the energy momentarily combines coherently in just one slot, the other slots are interference-free, bringing the interference-free time from 90% to 99.5%... [and because] WiGig systems themselves utilize beamforming... [they can] avoid interference arriving from a given direction for most of the time.”¹¹¹

44. We find that the V60G can be configured to comply with the same technical conditions imposed on the Google Soli, based on Vayyar’s technical description and comparison, and that our existing equipment authorization procedures are sufficient to ensure that this happens.¹¹² As an example, Vayyar has a pre-production V60G radar device, with an even higher number of antennas (up to 24 transmit and 24 receive), that has been tested and certified to comply with the power limits in the existing rules, which are even lower than the levels Vayyar requests here.¹¹³ As part of the Certification process, the V60G will be subject to rigorous compliance testing to ensure that it meets the technical requirements under our rules and waiver conditions, including the emission limits at the worst-case antenna configuration to produce the worst-case transmitted power. The device may not be sold or installed until this process has been completed. Furthermore, the +13 dBm EIRP limit will restrict what can be gained via the antenna array. For these reasons, we find that the EIRP limit and final compliance testing prior to a grant of certification are sufficient to address Gytrock’s concerns, and we deny Gytrock’s request to impose specific technical conditions such as pulsing scheme and pulse timing on the V60G, as unnecessary.¹¹⁴

45. Similarly, because our equipment authorization process will ensure that Tesla’s devices will operate within the radiofrequency emission standards set forth in our rules, we find Duncan Armour’s comments regarding RF energy unpersuasive.¹¹⁵ We note that low-power unlicensed devices operating under section 15.255,¹¹⁶ including the devices we are considering here, are already subject to the standards in sections 1.1307(b), 1.1310, 2.1091, and 2.1093 of the rules,¹¹⁷ and we have no reason to deviate from them in the context of Tesla’s waiver request.¹¹⁸

¹⁰⁹ Vayyar’s Jun. 17, 2020 Response at 3. Vayyar states that the V60G would transmit 20 chirps (one chirp per transmitter) each 150 μ s long and, when tested, the Soli transmitted 30 chirps each 108.6 μ s. By adjusting the timing of the chirp, Vayyar claims it can comply with the same specified power levels as the Google Soli.

¹¹⁰ Vayyar Apr. 28, 2020 *ex parte* filing in ET Docket No. 20-15 at 3-7.

¹¹¹ *Id.* at 7.

¹¹² *Id.* at 5-7.

¹¹³ This Vayyar pre-production unit has received FCCID 2AHIS-V60G-HOME.

¹¹⁴ Gytrock Aug. 3, 2018 *ex parte* filing in ET Docket No. 20-15 at 1.

¹¹⁵ Comments of Duncan Armour in ET Docket No. 20-121 at 1.

¹¹⁶ See 47 CFR § 15.255(g).

¹¹⁷ 47 CFR §§ 1.1307(b), 1.1310, 2.1091, and 2.1093.

¹¹⁸ These rules are designed to ensure safe levels of RF exposure for workers and for members of the public from RF devices. See *Targeted Changes to the Commission’s Rules Regarding Human Exposure to Radiofrequency Electromagnetic Fields*, ET Docket No. 19-226, *Resolution of Notice of Inquiry, Second Report and Order, Notice of Proposed Rulemaking and Memorandum Opinion and Order*, 34 FCC Rcd 11687, 11688, para. 2 (2019) (“Despite requests from some to increase and others to decrease the existing limits, we believe they reflect the best available information concerning safe levels of RF exposure for workers and members of the general public, including inputs from our sister federal agencies charged with regulating safety and health and from well-established international standards.”)

46. *Radar Intentional Emissions Outside of the Vehicle.* Tesla specifically requests to operate radar intentional emissions outside of the vehicle while the vehicle is stationary (e.g., in park or stop mode). Tesla requests to extend the intentional emissions of its radar device outward, up to 2 meters from the vehicle's body, for exterior monitoring, with the radar still installed inside the vehicle's cabin.¹¹⁹ Tesla explains that the vast majority of sensing would be confined to the vehicle's interior, except for the exterior detection use case which is accomplished while the vehicle is stationary.¹²⁰ We find that intentional emissions from Tesla's radar, which is installed inside the vehicle, that extend a short distance outward from the vehicle's body will not cause harmful interference because the signals will be significantly attenuated by vehicle's metallic chassis and the glass windows.¹²¹ Furthermore, free space path loss¹²² and oxygen absorption and atmospheric conditions at 60 GHz will severely limit 60 GHz outdoor signal travelling distance.¹²³ We therefore decline to impose specific restrictions on intentional emissions outside of the vehicle, as long as the radar itself is installed within the vehicle's cabin and operating under the technical limits required by our rules and associated waiver conditions.

47. *Passenger Motor Vehicle Operational Environment.* Our intent here is to provide limited relief within the scope of a waiver without promoting widespread radar deployments that operate at higher power than permitted in our rules, leaving any larger-scale review of the rules to whatever future actions the Commission may choose to undertake. We will therefore restrict the installation and operation of radars under this waiver to the following. The radar device shall be factory-installed on a new passenger motor vehicle. It must be installed within the passenger cabin (versus attached to the outside of the vehicle) and have the primary purpose of supporting in-cabin passenger monitoring functions (e.g., detecting children inadvertently left unattended on a rear seat). The grantee of the radar device shall provide clear instructions specifying these limitations to ensure that radars certified under the terms of this waiver shall not be marketed in after-market add-on automotive products. These restrictions will provide immediate relief to the industry and the public for this narrow type of use without undermining our general rule that limits radar operations in the band to fixed and SRIMS applications. Furthermore, any radar operating under this waiver, even if certified as a stand-alone product (if not installed behind the headliner of the vehicle) and not as a modular transmitter for installation inside host vehicles, must be marketed only for factory installation on a new passenger motor vehicle, in accordance with specific equipment grant conditions.

48. *Fixed vs. Mobile Radars Installed on Vehicles.* IEE Sensing initially framed its waiver request by distinguishing whether the vehicle on which the radar is installed is stationary (which IEE Sensing considers a "fixed" operation) or moving.¹²⁴ It is not necessary for us to address fixed versus

¹¹⁹ *Tesla Request* at 2-4.

¹²⁰ *Tesla ex parte* letter (filed Dec. 9, 2020.) at 1.

¹²¹ Researchers indicate that at 60 GHz, regular glass provides 11 dB/centimeter attenuation and mesh glass, 32 dB/centimeter. See e.g., C. Anderson and T. Rappaport, *In-building Wideband Partition Loss Measurements at 2.5 and 60 GHz*, IEEE Trans. Wireless Communications, vol. 3, no. 3, pp. 922-928 (2004.)

¹²² Free space path loss (FSPL) for a 60 GHz signal is 77.56 dB at 3 meters from the transmitter (i.e., FSPL (in dB) = $20 \log F + 20 \log d - 147.55$, where F is the signal frequency in Hertz and d is the distance from the transmitter in meter).

¹²³ See *Attenuation by Atmospheric Gases*, International Telecommunications Union, *Reports of the CCIR*, 1990, Vol. V, Report 719-3, at p. 189. See also *OET Bulletin 70, Millimeter Wave Propagation: Spectrum Management Implications, July 1997*, at http://www.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet70/oet70.pdf.

¹²⁴ *IEE Sensing Request* at 1-3. IEE Sensing claims that its radar should be treated as a fixed radar because the radar operates when the vehicle is parked. It therefore asks for waiver of the bandwidth requirement in section 15.255(c)(2) for fixed radar operation, as one of its alternative requests. 47 CFR § 15.255(c)(2). *IEE Sensing Request* at 1.

mobile operation to grant IEE Sensing its desired relief. This is because our waiver of section 15.255(a)(2) already allows radars to be used in passenger motor vehicles regardless of whether the vehicles are stationary or in motion.¹²⁵ Because the Commission did not specifically address whether section 15.255 permits something that is inherently mobile (such as an automobile) to be treated as fixed in certain circumstances, we decline to address the matter here and instead choose to grant IEE Sensing's alternative request to operate under the same technical parameters as Google and deny the other aspects of its request.¹²⁶ In doing so, we leave the determination of what constitutes "fixed" and "mobile" operation under section 15.255 for separate consideration, such as by the Commission in the context of a rulemaking proceeding.

49. *Decision.* We find that allowing radar operation limited to passenger motor vehicles at the same power levels and duty cycle granted to the Google Soli radar will not materially affect the 60 GHz operating environment. Because it will not increase the potential for harmful interference to authorized users in the band, a waiver of section 15.255(c)(3) will not undermine the purpose of the rule. Moreover, allowing use that is neither fixed nor SRIMS will not undermine the purpose of section 15.255(a)(2). In modifying the rule to permit SRIMS operations, the Commission found that limited non-fixed radar use could be permitted in narrow circumstances where harmful interference was unlikely to occur. Such is the case here. Notably, both the Google Soli radar and the in-cabin radars under consideration here have been evaluated to operate without causing harmful interference when they are used in specific environments that are characterized by a short distance between the radar and what it is sensing. And, unlike the Google device, which can be carried by a person and used anywhere, the radars subject to this waiver will be deployed exclusively within vehicular cabins.

50. We also find that the second element of the waiver standard has been met. It is clear from the record that granting the pending waivers will provide substantial public benefit in improving passenger safety—most notably the prevention of vehicular pediatric heatstroke deaths—while at the same time enhancing opportunities for additional vehicular automation and theft prevention applications. We thus disagree with Duncan Armour that heatstroke deaths caused by children inadvertently left in hot vehicles could be considered "trivial."¹²⁷ To the extent that some commenters suggest that a rulemaking proceeding would be a better approach, we believe that a waiver is an appropriate way to address the specific in-cabin automotive radar application under consideration here.¹²⁸ The narrow relief we provide will permit innovative radar systems to begin saving lives without posing interference threats to authorized users in the band while not precluding the Commission's future consideration of expanded unlicensed radar use under section 15.255 through the rulemaking process.

51. *Modular Transmitter Approval.* Vayyar and Infineon express the desire to certify their radars under the modular transmitter approval provisions of section 15.212.¹²⁹ The modular transmitter approval provision allows a grantee to certify a transmitter module to market it to any third-party host equipment integrator. Given that the instant waivers rely on an analysis of a specific use case and radar placement, we are not willing to allow an unidentifiable number of third parties to incorporate radars

¹²⁵ As a practical matter, the potential for harmful interference caused by the in-vehicle radars we consider here is minimal whether or not they are in motion. Harmful interference, if any, may be discovered when the vehicle is parked, and is otherwise generally transient, when the vehicle is in motion; thus, the effect of the radar on other users of the band is integral to the vehicle, whether it is moving or parked.

¹²⁶ Specifically, we will not further consider its requests to waive either the bandwidth or related power level requirements in sections 15.255(c)(2) and (c)(3) to operate its radar under the "fixed" radar provision.

¹²⁷ Comments of Duncan Armour in ET Docket No. 20-121 at 1.

¹²⁸ See, e.g., comments of ADC Automotive Distance Control Systems GmbH in ET Docket No. 20-263 at 4-5; comments of Acconeer AB in ET Docket No. 20-264 at 1.

¹²⁹ *Infineon Request* at 6 & n.19. *Vayyar Modified Request* at 2. See 47 CFR § 15.212.

without any effective control on the circumstances and purposes for which they are installed. Instead, we will permit limited modular transmitter approval to any party who so desires under the provisions of this waiver, restricted to the requirement that the module may only be factory installed and only in new passenger motor vehicles under the following conditions: (a) the operator's manual shall provide clear and complete installation instructions that explain the applicable restrictions and a copy of these instructions shall be submitted along with the application for equipment authorization; (b) the certification grant conditions shall clearly state that the module is limited to this type of installation; and (c) the grantee shall provide an attestation letter adhering to the limited conditions under which the module will be marketed and sold to ensure that it is installed according to the grant conditions.

52. *Future Rulemaking Proceedings.* The record indicates considerable interest in unlicensed use of the 60 GHz band that reaches far beyond the specific automotive-based radar use that we approve under this waiver. For example, a consortium of ten companies including Facebook and Google state that “a long-term solution is needed to allow for technological innovation while ensuring reasonable coexistence of all technologies operating pursuant to the Commission’s 60 GHz unlicensed rules,” and “encourage the Commission to commence a comprehensive rulemaking proceeding to (i) promote future applications, services, and devices in the 60 GHz unlicensed band, and (ii) address the range of technical and policy issues necessary to preserve reasonable coexistence between radars and field disturbance sensors, which require higher power levels than currently permitted, and other users of the 60 GHz unlicensed band.”¹³⁰ Moreover, our waiver only addresses the petition of Vayyar Imaging in part and does not attempt to resolve matters related to the definition of short-range interactive motion sensing or fixed operations under the rules in their current form. Such matters remain ripe for further consideration, including as part of a comprehensive review by the Commission through the rulemaking process that would include coordination with NTIA as the 57-71 GHz band contains co-primary Federal allocations.¹³¹ We note that operations pursuant to the waivers we grant today are expressly conditioned on compliance with the Commission’s rules except as waived, and where rules are modified as a result of any future Commission rulemaking these operations will be subject to those modified rules.

53. *Waiver Conditions.* To ensure that harmful interference to authorized operations and other spectrum users will not occur, we impose explicit conditions on the installation, operation, and certification of the device(s) under this waiver, as follows:

- The radar shall be certified for compliance with all the technical specifications applicable to operation under 47 CFR Part 15, with the exception of the following provisions in 47 CFR §§ 15.255(a)(2) and (c)(3), which are waived to allow the device to operate as a radar on new passenger motor vehicles in the 57-64 GHz band at a maximum +13 dBm EIRP, +10 dBm transmitter conducted output power, and +13 dBm/MHz power spectral density.¹³²
- Each individual radar device shall not exceed a maximum transmit duty cycle of 10% in any 33 milliseconds (ms) interval (i.e., the device will not transmit longer than a total of 3.3 ms in any 33 ms time period).
- The radar shall be restricted to factory installation in the interior cabin of new passenger motor vehicles for the primary purpose of in-cabin monitoring functions and shall not be marketed in after-market add-on products. The grantee shall include clear and complete installation instructions that explain this restriction and a copy of these instructions shall be submitted along with the application for equipment authorization. If the radar is installed

¹³⁰ Letter from Alan Norman, Facebook, Inc., et. al. to Marlene Dortch, Secretary, FCC, ET Docket No. 20-121 et al, at 2 (filed July 1, 2020).

¹³¹ Federal allocations in the 57-71 GHz band include Earth-Exploration-Satellite Service (EESS), Fixed, Inter-Satellite, Mobile, Mobile-Satellite, Radiolocation, Radionavigation, Radionavigation-Satellite, and Space Research.

¹³² A copy of this Order shall be provided with the application for certification of the device.

such that it is not visible (e.g., behind the headliner), then the required equipment labeling in accordance with the provisions of 47 CFR §§ 2.925 and 15.19 shall be provided in the vehicle's Owner's Manual. The certification grant shall specify these restrictions.

- Operations under this waiver may not be used to transmit data.
- Limited modular transmitter approval under 47 CFR § 15.212 shall also comply with the following conditions: (a) the operator's manual shall provide clear and complete installation instructions that explain the applicable restrictions and a copy of these instructions shall be submitted along with the application for equipment authorization; (b) the certification grant conditions shall clearly state that the module is limited to factory installation in new passenger motor vehicles; and (c) the grantee shall provide an attestation letter adhering to the limited conditions under which the module will be marketed and sold to ensure that host integrators install the device according to the specified grant conditions.
- Users of these radars must be made aware through a disclosure in the vehicle Owner's Manual or an equivalent means that that operation is subject to the conditions that no harmful interference is caused and that any interference must be accepted.
- This waiver and its conditions shall apply only to radars intended for installation in passenger motor vehicles as described herein and are not to be considered to apply generally to any other radars or field disturbance sensors that will operate in different environments where further analysis would be necessary to assess the potential for impact to other authorized users.
- The waiver conditions granted herein are not transferable to any third party via §2.933 or any other means of technology transfer.

V. ORDERING CLAUSES

54. Accordingly, pursuant to authority in Sections 0.31, 0.241, and 1.3 of the Commission's rules, 47 CFR §§ 0.21, 0.241, and 1.3, and Sections 4(i), 302, 303(e), and 303(r) of the Communications Act of 1934, as amended, 47 U.S.C. §§ 154(i), 302, 303(e), and 303(r), IT IS ORDERED that the Request for Waiver filed by Vayyar Imaging Ltd. IS GRANTED IN PART, consistent with the terms of this Order. This action is effective upon release of this Order.

55. Accordingly, pursuant to authority in Sections 0.31, 0.241, and 1.3 of the Commission's rules, 47 CFR §§ 0.21, 0.241, and 1.3, and Sections 4(i), 302, 303(e), and 303(r) of the Communications Act of 1934, as amended, 47 U.S.C. §§ 154(i), 302, 303(e), and 303(r), IT IS ORDERED that the Request for Waiver filed by Valeo North America Inc. IS GRANTED, consistent with the terms of this Order. This action is effective upon release of this Order.

56. Accordingly, pursuant to authority in Sections 0.31, 0.241, and 1.3 of the Commission's rules, 47 CFR §§ 0.21, 0.241, and 1.3, and Sections 4(i), 302, 303(e), and 303(r) of the Communications Act of 1934, as amended, 47 U.S.C. §§ 154(i), 302, 303(e), and 303(r), IT IS ORDERED that the Request for Waiver filed by Infineon Technologies Americas Corp. IS GRANTED, consistent with the terms of this Order. This action is effective upon release of this Order.

57. Accordingly, pursuant to authority in Sections 0.31, 0.241, and 1.3 of the Commission's rules, 47 CFR §§ 0.21, 0.241, and 1.3, and Sections 4(i), 302, 303(e), and 303(r) of the Communications Act of 1934, as amended, 47 U.S.C. §§ 154(i), 302, 303(e), and 303(r), IT IS ORDERED that the Request for Waiver filed by Tesla Inc. IS GRANTED, consistent with the terms of this Order. This action is effective upon release of this Order.

58. Accordingly, pursuant to authority in Sections 0.31, 0.241, and 1.3 of the Commission's rules, 47 CFR §§ 0.21, 0.241, and 1.3, and Sections 4(i), 302, 303(e), and 303(r) of the Communications Act of 1934, as amended, 47 U.S.C. §§ 154(i), 302, 303(e), and 303(r), IT IS ORDERED that the Request for Waiver filed by IEE Sensing Inc. IS GRANTED in part and DENIED in part, consistent with the terms of this Order. This action is effective upon release of this Order.

59. Accordingly, pursuant to authority in Sections 0.31, 0.241, and 1.3 of the Commission's rules, 47 CFR §§ 0.21, 0.241, and 1.3, and Sections 4(i), 302, 303(e), and 303(r) of the Communications Act of 1934, as amended, 47 U.S.C. §§ 154(i), 302, 303(e), and 303(r), IT IS ORDERED that the Request for Waiver filed by Brose North America Inc. IS GRANTED, consistent with the terms of this Order. This action is effective upon release of this Order.

60. IT IS FURTHER ORDERED that, if no petitions for reconsideration or applications for review are timely filed in ET Docket Nos. 20-121, 20-264, 20-265, 20-434, or 20-435, the docket(s) for which no such petitions or applications were filed SHALL BE TERMINATED, and the docket(s) CLOSED.

FEDERAL COMMUNICATIONS COMMISSION

Ronald T. Repasi
Acting Chief,
Office of Engineering and Technology