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

In the Matter of	**)**	
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Recommendations Approved by the Advisory Committee for the 2015 World Radiocommunication Conference	**)))**	**IB Docket No. 04-286**

To: The Chief, International Bureau
Via: Office of the Secretary

<u>COMMENTS ON WRC-15 ADVISORY COMMITTEE DRAFT RECOMMENDATIONS</u>

Robert Bosch LLC (Bosch), by and through counsel and pursuant to the International Bureau's *Public Notice*, DA 13-1937, released in the captioned proceeding on September 20, 2013, hereby respectfully submits its comments[1] with respect to the draft recommendations of the Advisory Committee for the 2015 World Radiocommunication Conference (WAC). The *Public Notice* notes that the Commission's International Bureau, after coordination with other bureaus of the Commission, tentatively concludes that it can generally support "most" of the WAC draft recommendations. However, the Bureau states that it has some unidentified "reservations" concerning recommendations in Documents WAC/049 and WAC/053. The Commission asks for comments on the draft WAC recommendations and the input thereon by the National Telecommunications and Information Administration (NTIA). It also asks for comment on the initial conclusions of the International Bureau with respect to the WAC draft recommendations. For its comments in support of draft recommendation WAC/049 (19.09.13) in

[1] These comments were, according to the *Public Notice*, due on October 11, 2013. However, the Commission was closed on that date and on days prior thereto, and its electronic filing systems were offline. Today, October 17, 2013 is the first day that the ECFS is available and the first date that these comments can be filed. Therefore, these comments should be deemed timely filed.

its present iteration, and relative to issues raised in the *Public Notice* thereon, Bosch states as follows:

1. Bosch is a multinational corporation which manufactures many different types of high-quality products for numerous industries, including vehicular radar systems and other automotive components and systems. Bosch is active in industry efforts in the establishment of international standards for automotive radar systems, anti-collision systems, and automatic braking systems.[2] Bosch manufactures Long-Range automotive Radar (LRR) systems for vehicles in the 76-77 GHz range, and high-resolution, Short-Range automotive Radar (SRR) systems to operate at 77-81 GHz (this latter band is typically referred to as the "79 GHz" band). On-vehicle, on-ground automotive radar systems are now permitted in Europe in the 77-81 GHz band and in many countries other than the United States. Bosch has a distinct interest in the effective performance of these advanced safety systems in motor vehicles in the United States and in their reliable performance, on which motor vehicle operators and passengers increasingly rely for their safety.

2. There is presently a worldwide plan to consolidate automotive radars in the 76-81 GHz band.[3] CEPT and the European Commission have concluded that, aside from 24 GHz automotive radars, the 79 GHz band should be the long-term, globally harmonized frequency band for all

[2] Among Bosch's automotive products is its Long Range Radar (LRR3), the world's first application of a silicon-germanium (SiGe)-based 77 GHz radar sensor. This device is a major step in bringing semiconductor-based radar technologies to the automotive mass market. In addition to being the key component for adaptive cruise control (ACC), LRR3 enables advanced safety functions such as predictive collision warning (PCW), emergency braking assist (EBA) and automatic emergency braking (AEB). These and other SRR technologies vastly enhance the safety features of modern automotive electronics.

[3] The 77-81 GHz band was designated by the European Conference of Postal and Telecommunications Administrations (CEPT) as early as July 2004 for automotive radar. The European Commission has adopted the decision 2004/545/EC on the harmonization of radio spectrum in the 79 GHz range for the use of automotive radar. The harmonized standard EN 302 264 has been adopted by ETSI for short-range radar (SRR) operating in the 77-81 GHz band. In March of 2010, the Ministry of Internal Affairs and Communications (MIC) in Japan started a study group in the info-Communications Council for the introduction of high-resolution radar in the 77-81 GHz frequency band. In October of 2010, the State Radio Frequency Committee of Russia allocated the 77-81 GHz band for automotive radar.

automotive radar applications. Long-range automotive radars now operate in the United States at 76-77 GHz pursuant to Section 15.253 of the Commission's Rules. However, that 1 GHz-wide band is used only for medium and long-range radars (i.e. vehicle and some limited, very specific types of infrastructure radar systems). Sharing studies conducted by the automotive industry have concluded that frequency sharing between SRR systems and LRR automotive radars is not possible. It is firmly settled that the 79 GHz frequency range should be considered as the most suitable band for short and medium-range automotive radar worldwide.[4] Indeed, the Commission has repeatedly acknowledged this.[5]

3. Vehicle-mounted automotive collision-warning automotive radars operating in the 79 GHz band are vehicle environmental sensing systems. These units require a typical operating range of up to 150 meters and are used for a number of applications to enhance the active and passive safety for all kinds of road users. Applications that enhance passive safety include obstacle avoidance, collision warning, lane departure warning, lane change aids, blind spot detection, parking aids and airbag arming. Automotive radar applications which enhance active safety include "stop and follow," "stop and go," autonomous braking, firing of restraint systems and pedestrian protection. The combination of these functions is also referred to as a "safety belt" for cars.

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[4] Sharing with the Radioastronomy Service has been studied in Europe and in the United States, as is extensively discussed hereinbelow. The European studies concluded (and the United States studies have confirmed – see *infra*) that regulatory measures can be developed enabling coexistence between SRRs in the frequency band 77-81 GHz and the Radioastronomy Service.

[5] For example, in Docket 03-102, resolved in 2004, the Commission adopted domestically the RAS and space research service allocations in the 77-81 GHz band. The Commission "recognize(d) that there [was] a great deal of ongoing international discussion about the current and future spectrum needs of SRR systems" in that band. The Commission at the time denied a request filed by Delphi Corporation to initiate a proceeding to establish rules to allow vehicular radar operations in the 77-81 GHz segment. *However, the Commission invited proposals in the future for such use*. The Commission said that "entities may file petitions for rule making requesting the Commission to take such action. Such petitions should include specific proposals for technical and other rules."

4. The value of automotive radar systems to the public as safety-of-life devices is beyond question, and the statistics supporting that are highly compelling. The Commission stated in 2002, when first permitting short-range vehicular radars at 24 GHz that it expected "vehicular radar to become as essential to passenger safety as air bags for motor vehicles…"[6] This prediction has largely been validated since that time. The National Telecommunications and Information Administration (NTIA) expressed its commitment to "work with the Commission to ensure that an adequate frequency allocation in the 77-81 GHz band is available for the operation of vehicular radar systems."[7] Automotive radar systems have been proven to substantially reduce injuries and death due to automobile collisions.[8] The National Highway Traffic Safety Administration (NHTSA) determined that the number one cause of death in persons aged 4 to 34[9] during 2005 were multiple-vehicle traffic crashes.[10] According to a Honda study in 2005, the use of its collision mitigation braking systems reduces the number of rear-end collisions by 38% and the number of fatal rear-end collisions by 44%. Bosch completed a 2009 study which concluded that emergency braking assist technology will reduce personal-injury rear-end

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[6] *Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems*, First Report and Order, ET Docket 98-153, released April 22, 2002, at ¶ 18.

[7] *See*, the Comments of NTIA in ET Docket No. 98-153, at 22-23 (filed January 15, 2004).

[8] Various studies on the safety benefit of automotive safety systems have been published. At the 21st International Technical Conference on the Enhanced Safety of Vehicles, Stuttgart, held in June of 2009 (www.esv2009.com), the following studies were presented:

(A) Daimler provided a study that showed that with its Brake Assist Plus (collision warning and partial braking) it is possible to prevent 53% of all rear-end collisions that otherwise cause injuries. To support this figure, a comparison of repair parts statistics of cars with and without radar-based functions was made. It could be clearly determined that at speed between 14 and 50 km/h could be reduced by 22%. It was also shown that the impact speed of collisions was reduced (e.g. impact speed between 14 and 45 km/h by 38%). In sum, crashes could be avoided or at least the impact speed can be reduced significantly.

(B) The Swedish Road Administration (SRA) published a study that reduction of collision impact speed by 10% would reduce the risk of fatalities by 30%.

(C) The German Insurers Accident Research (UDV) stated that autonomous partial braking could avoid 12% of all accidents. Systems with autonomous emergency (full) braking could avoid 40% of all kinds of collisions.

[9] The age groups in this study between ages 4 and 34 included young children (4-7), children (8-15), teens (16-20), young adults (21-24) and other adults (25-34).

[10] *See* National Highway Traffic Safety Administration, "Evaluation of an Automotive Rear-End Collision Avoidance System, DOT HS 810 569 (March 2006) *available at:* http://www.nhtsa.gov/DOT/NHTSA/NRD/Multimedia/PDFs/Crash%20Avoidance/2006/HS910569.pdf.

collisions by 39%; and that automatic emergency braking will reduce personal-injury rear-end collisions by 74%. The Insurance Institute of Highway Safety completed a 2010 study of the effects of forward collision warning radar systems on passenger car collisions. The study found that 20 percent (i.e. 1.2 *million*) of passenger car collisions can be avoided by the use of forward collision radars; 9% (i.e. 66,000) of accidents with injuries can be prevented by such use; and 3% (i.e. 879) of fatal accidents can be prevented by such use. Daimler made a presentation to the World Automotive Congress in September of 2008, reporting on a study of 66,000 real accidents, using the German In-Depth Accident Study database. The study was limited to analysis of rear-end collisions. The study concluded that 20 percent of all rear end crashes could have been avoided if the cars had been equipped with short-range radar-based intelligent brake assistance. Even in cases when the crash was unavoidable the reduction of crash energy was significant and the severity of the crash consequences would have been mitigated in 25 percent of the accidents.[11]

5. However, to date, the availability of these life-saving and injury-preventing technologies has been limited in the United States to equipment integrated into more high-end passenger vehicles due to the absence of an internationally harmonized standard for SRRs. Worldwide regulatory authorization would be beneficial in terms of efficient use of spectrum as well as in the economies of scale that would encourage substantial rollout of newer automotive radar technology. It would allow deployment of automotive radars in a *much* wider range of passenger vehicles cost-effectively, thus making the extensive safety features of those systems available to the widest number of motorists and passengers in motor vehicles.

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[11] See also Schittenhelm, Dr. Helmut., *Design of Effective Collision Mitigation Systems and Prediction of Their Statistical Efficiency to Avoid or Mitigate Real World Accidents* (Daimler AG), 14 September 2008.

6. Draft Proposal WAC/049 in its present iteration is critical to effectuating life-saving on-vehicle automotive radar technology worldwide. This will protect not only motorists but pedestrians as well. The allocation of the band 77.5-78 GHz on a co-primary basis to the radiolocation service for automotive applications in accordance with Resolution 654 (WRC-12) and Recommendation WAC/049 is a necessary step in making this 77-81 GHz technology affordable and integrated into all automobiles, not just high-end vehicles.

7. While the Bureau's "reservations" with respect to Recommendation WAC/049 are unstated and unexplained (and therefore difficult to address in comments in response to the *Public Notice*), the Bureau's reservations could be premised on the fact that WAC/049 proposes language for additional footnote 5.A118, which would read as follows:

> The use of the 77.5-78 GHz frequency band by the radiolocation service is limited to on-vehicle, on-ground automotive applications. [Emission power limits will be designated here if deemed necessary to avoid potential interference with the AS and RAS.]

To the extent that the Bureau's concerns relate to the exclusivity of the use of the proposed allocation for "on-vehicle, on-ground automotive applications" rather than a wider range of applications, the exclusivity of the allocation is necessary in order to ensure that on-vehicle automotive radars function reliably and provide the safety features for motorists and pedestrians that they are capable of providing and are expected to provide at 79 GHz. To the extent that there is a need for fixed roadside radar facilities, there are other bands that can accommodate such operation.

8. In 2012, the European Telecommunications Standards Institute (ETSI) released a Technical Report (ETSI TR 102 704, Version 1.2.1) titled *Electromagnetic compatibility and Radio Spectrum Matters (ERM); System Reference Document; Short Range Devices (SRD); Radar Sensors for non-automotive, ground based vehicular applications in the 76 GHz to 77*

GHz range. In relevant part, among the conclusions with respect to sharing and compatibility issues to be considered, the Report at Section 6.2.1.2. stated:

> Particular attention needs to be given to restrict the application in the 76 to 77 GHz to surveillance ground based vehicular radar applications and not allow applications for installations to fixed sites or certain mobile installations in order to insure compatibility. In addition, future UWB SRR systems in the adjacent band 77 GHz to 81 GHz have to be protected as the result of the compatibility studies. The most critical potential interference aspect for general surveillance radar applications is that this kind of application may overlap in the direction of automotive SRRs on public roads. In such scenarios, the surveillance radars potentially blind automotive radars operating in the same frequency and area.

9. The reason that the proposed footnote specifies use of the allocation for on-vehicle automotive applications is because unspecified, fixed radar siting, especially fixed roadside applications would preclude 79 GHz on-vehicle automotive radars. It would be impossible to coordinate any automotive radar operation with fixed radiolocation facilities without limiting geographic deployment and other parameters, which is not possible in the context of automotive radars. Automotive manufacturers and automotive radar manufacturers work closely together as a matter of necessity to coordinate standards for operation of these systems so that motor vehicles of different manufacture can utilize the newest automotive radar technology without interference, even in close traffic conditions. Such coordination could not be duplicated with respect to fixed or non-vehicular radar operations. Bosch is unaware of any studies that indicate that there is compatibility between present and future on-vehicle automotive radar systems at 79 GHz and fixed radar systems generally. Because the potential for harmful interference to vehicular radars at 76-77 GHz carries with it an attendant danger to persons and property, and because the public does and should be able to depend on the automotive radars’ functionality, the need for conclusive compatibility analyses are critical on this point.

10. While there are no studies available indicating compatibility between SRR automotive radars and fixed or off-vehicle radar systems in the range 76-81 GHz, there are studies indicating that there ***is*** reason for serious concern. Due to the increasing number of radars in automotive use, the automotive industry, between 2010 and 2012 investigated interference avoidance and compatibility technologies in a European-funded project that also examined the risk of interference from fixed radar installations in the same band. This project was named "MOSARIM," the acronym for "More Safety for All by Radar Interference Mitigation." Concluded in December 31, 2013, it was a European research platform funded and led by a consortium of European automotive industry members and the European Commission's Joint Research Centre (JRC), under the structure of the European Union Seventh Framework Programme (ICT for Transportation). It held its first workshop on automotive radar interference mitigation and countermeasures in Ispra, Italy, on May 26, 2011, at the JRC headquarters.[12] Bosch was one of the participants. One goal of the program was to prepare recommendations and guidelines for vehicular mutual radar interference mitigation. It also examined the interference effects of fixed 76-77 GHz installations on automotive radar sensors. While the project did not result in a definitive final report on that issue, results indicated that there is <u>not</u> compatibility between automotive radar deployments and fixed radar installations. Among the early conclusions of the MOSARIM project were that (A) fixed 76-77 GHz installations have significant interference potential to automotive radar sensors; (B) Simulation results showed that the interference power of an interferer with +45 dBm EIRP is up to 75 dB above the noise floor of the 76-77 GHz automotive radar sensor (i.e. beyond the interference rejection capacity of the radar sensor); and (C) while interference between and among different automotive radar sensors

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[12] Papers from the first MOSARIM workshop are available at http://www.mosarim.eu/.

could be mitigated by cooperative efforts of the automotive industry, an unlimited number of fixed radars in the same band precluded such mitigation arrangements.

11. In a MOSARIM Steering Group study concluded on 22 November, 2012 interference from fixed roadside traffic monitoring system radars was studied relative to a variety of on-vehicle automotive radars operating in the range of 77 GHz. In these studies, received interference signal levels were significantly above the receiver noise floor of all the vehicular radars. In some radars the interference alert mechanism was triggered. Currently, there is no threshold value for an interference over noise (I/N) level that is firmly defined, that can be used to avoid harmful interference to the operation of automotive, on-vehicle safety related applications such as automatic braking or collision avoidance. It was also noted that, while automotive radars are mounted on vehicles, the fixed infrastructure radars are mainly placed at dangerous road sections or inside tunnels. These are in close geographic proximity to on-vehicle automotive radars, and therefore pose a high interference risk due to unpredictable siting. There are other bands available for fixed radar applications so that the creation of an interference risk due to geographic proximity to on-vehicle applications is not necessary.

12. While the MOSARIM studies did not definitively resolve the issue of fixed radar compatibility with on-vehicle, on-ground automotive radar systems, there are other refereed, authoritative sources that, like the MOSARIM studies, strongly indicate a lack of such compatibility. In a 2010 paper published in *Advances in Radio Science* [13] it was noted that:

> In the past mutual interference between automotive radar sensors has not been regarded as a major problem. With an increasing number of such systems, however,

[13] *See*, Goppelt, Blöcher, and Menzel, *Automotive radar – Investigation of Mutual Interference Mechanisms*, Adv, Radio Sci., 8, 55-60, 2010; available at www.adv-radio-sci.net/8/55/2010/doi:10.5194/ars-8-55-2010 .

> this topic is receiving more and more attention … Up to now, interference has not been considered as a major problem because the percentage of vehicles equipped with radar sensors and therefore the probability of interference was low, and the sensors were used mainly for comfort functions. In this case it may be sufficient to detect interference and turn off the function for the duration of the interference. On the contrary, safety functions of future systems require very low failure rates. So in spite of a predicted higher number of radar systems, the probability of interference-induced problems has to be reduced considerably. Therefore effective countermeasures have to be introduced to minimize mutual interference even with high traffic density (e.g. in large cities) and a rising percentage of vehicles equipped with radar sensors.

The paper analyzes interference to FMCW radars from other FMCW radars; interference to FMCW radars from pulsed systems; and interference to pulsed radar systems from other pulsed systems or from FMCW radars. The paper concludes that there are two fundamental interference effects appearing in both FMCW and pulsed radar sensors thus far: (1) the appearance of ghost targets in the automotive radar; and (2) an increase in the noise or interference level in the radar receiver. Concerning the interference levels, the paper concludes that very high signal strengths can occur if two sensors directly face each other. Therefore, "[i]nterference mechanisms have to be precisely understood in order to design and to verify the effectiveness of countermeasures to minimize mutual interference." A similar study in 2011[14] by the same authors concludes that unwanted signals received by on-vehicle automotive radar can lead to ghost targets or to reduced sensitivity. An IEEE study in 2007[15] examined the probability that any millimeter-wave radar systems will interfere mutually by considering spatial, temporal, and operational frequency-related overlaps. It examined the nature and magnitude of the interference under different conditions and for different sensor types before concluding that in an overlapping

[14] *See,* Goppelt, Blöcher, and Menzel, *Analytical investigation of mutual interference between automotive FMCW radar sensors*; Proceedings of the 6th German Microwave Conference, 14-16 March 2011, Darmstadt, Germany.
[15] *See,* Brooker, *Mutual Interference of Millimeter-Wave Radar Systems,* IEEE Transactions On Electromagnetic Compatibility, Vol. 49, No. 1, February, 2007.

frequency band, the probability that interference will occur is high. It goes on to demonstrate that, though there are some forms of interference that can be identified and controlled, there are others which are impossible to isolate, resulting in degraded target detection performance and tracking. Among its conclusions was the following:

> This paper has shown that if two radars operating in overlapping bands are within the same vicinity, then some mutual interference will occur, the magnitude of which depends primarily on the alignments of the radar antennas and the numbers and types of targets within the mutually illuminated region in space. Whether this interference will be interpreted as a target vehicle or a roadside obstacle will depend on the similarities between the characteristics of the two radars and their relative timing.

13. It is apparent from the foregoing that there cannot be assumed to be compatibility between fixed radar installations and on-vehicle, on-ground automotive radar sensors and systems at 79 GHz, where large and increasing numbers of consumers are and will be relying on automotive radar for safety applications. Based on compatibility studies to date, fixed installations, and especially fixed roadside radar installations in the same frequency range present a substantial risk of interference to on-vehicle automotive radars. It is for this reason that the language in the proposed footnote providing for use of the 77.5-78 GHz band for use by on-vehicle, on-ground automotive applications (rather than for a broader category of radiolocation systems) was crafted, and it is for this reason that the language is absolutely necessary and should be supported by the Commission and by the United States delegation to WRC-15. There are other bands that can accommodate fixed radar applications and there is no need to provide for them in the 79 GHz band.

Therefore, the foregoing considered, Robert Bosch GmbH respectfully requests that the Commission, in its consultations with the Department of State and with NTIA in the development of the United States positions for WRC-15 support the recommendation provided in document WAC/049 in its entirety and without reservation.

Respectfully submitted,

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