



NATIONAL RADIO ASTRONOMY OBSERVATORY

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Before the Federal Communication Commission

Request by iRobot Corporation for waiver)	
of Section 15.250(c) of the Commission's)	ET Docket No. 15-30
rules)	

Comments on the waiver request by the iRobot Corporation to allow outdoor use of robotic lawn mowers

by

National Radio Astronomy Observatory

1. Here, the National Radio Astronomy Observatory (“NRAO” or “the Observatory”) replies to the request by the iRobot Corporation (“iRobot”) for a waiver of Section 15.250(c) of the Commission’s rules to allow outdoor use of Robotic Lawn Mowers (RLMs) and their control beacons in the frequency band 6240 - 6740 MHz.
2. NRAO (<http://www.nrao.edu>) is the largest observatory dedicated to radio astronomy and one of the largest astronomical observatories in the world. NRAO operates the 10-antenna Very Long Baseline Array, the 27-antenna Jansky Very Large Array and the 100 m Robert C. Byrd Green Bank Telescope, all of which observe at frequencies around 6.7 GHz and stand to be affected by grant of a waiver to iRobot. The William E. Gordon telescope at Arecibo Observatory (<http://www.naic.edu>) also observes in the band and stands to be comparably affected.
3. The frequency band 5925 – 6700 MHz is protected by footnote US 342 that reads in part “In making assignments to stations of other services to which the bands ... 6650 – 6675.2 MHz ... are allocated ... all practicable steps shall be taken to protect the radio astronomy service from harmful interference.” The purpose of singling out this frequency band is to allow interference-free observation of the 6.66852 GHz spectral line of methanol (CH₃OH) that is abundant in star-forming regions and serves as a galactic beacon of star-forming activity owing to its maser-like qualities. This also allows the Observatory’s telescopes to do a kind of celestial cartography that measures distances to star-forming regions with high precision, charting the course of galactic evolution.
4. Given their potential for interference (see below), the method proposed by iRobot to protect radio astronomy operations does not nearly rise to the standard set by US342. More specifically the proposed method is that *‘iRobot will commit to placing a notice in the user manual and on the robot body that states: “Consumer use only; use must be limited to residential areas.” This should ensure that the RLMs are not operated near*

highways, where DSRC operations will occur, or near observatories, where there is RAS use of the spectrum.' [italics NRAO]

5. The RLMs and beacons in question will operate with power density levels -41.3 dBm/MHz or -131.3 dBW/Hz (a difference of 90 dB, from $10 \log \text{MHz} = 60$ and $10 \log \text{W/mW} = 30$). At 6.7 GHz the protection criterion for detrimental interference to RAS operations is -241 dB W/m²/Hz (ITU-R Recommendation RA. 769) implying a line of sight separation distance of $d = \sqrt{10^{11}/4/\pi}$ m = 89 km. This is almost as large as the entire National Radio Quiet Zone, whose area is 13,100 sq mi.
6. Indeed, the beacons used to control the RLM would qualify as the sort of fixed infrastructure transmitters whose use inside the NRQZ is coordinated with NRAO's operation in Green Bank West Virginia on behalf of NRAO and the US Navy operations in Sugar Grove.
7. iRobot's RLMs can certainly operate over most of this country without interfering with radio astronomy operations but they equally certainly must be prevented from operating across the protected methanol band when this will cause interference, especially within the NRQZ. Without attempting to provide an exhaustive list of measures that might be undertaken to satisfy the obligations of US342, the Observatory notes the following possibilities for the RLMs: exclusion zones based on geolocation; notching of the protected RAS band within the RLM operating band; relocation or narrowing of the RLM operating frequency band to avoid the protected RAS band.

Respectfully submitted,
National Radio Astronomy Observatory



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