RF Exposure Evaluation Report

1. Product Information

Manufacturer	Furuno Electric Co., Ltd. 9-52 Ashihara-cho, Nishinomiya city, Hyogo, 662-8580 Japan
Trade name	Furuno
Type	RTR-131
Model	Transceiver for RADAR SENSOR FAR-2018-MARK-2/3015
Product Description	Marine Radar operating in the band of 9300-9500 MHz
FCC ID	ADB9ZWRTR131
IC ID	1281B-RTR131
Frequency Range	9380MHz ~ 9440MHz
Peak Envelope Power (PEP)	12kW
Antenna Gain (G_p)	XN12AF：28.2dBi / XN20AF：30.0dBi / XN24AF：31.1dBi
Beam Width (θ)	XN12AF：1.9 ° / XN20AF：1.23 ° / XN24AF：0.95 °
Maximum Pulse Width (τ)	1.2μs
Pulse Repetition Frequency (PRF)	600Hz
Minimum separation distance	XN12AF：4.2m / XN20AF：2.6m / XN24AF：1.73m

2. Evaluation method and Limit

FCC requirements

According to FCC CFR 47 part1 1.1307 (b)(3)(i)(C): The criteria listed in the following table shall be used to determine the exemption of further evaluation.

RF Source frequency (MHz)	Threshold ERP (watts)
0.3-1.34	1,920 R^2.
1.34-30	3,450 R^2/f^2.
30-300	3.83 R^2.
300-1,500	0.0128 $R^2 f$.
1,500-100,000	19.2R^2.

R is the separation distance and is XN12AF：4.2m / XN20AF：2.6m / XN24AF：1.73m instructed in the installation manual.

Threshold ERP* is

ERP_{TH}(XN12AF) = 19.2×4.2^2 = 338.69 [W]

ERP_{TH}(XN20AF) = 19.2×2.6^2 = 129.79 [W]

ERP_{TH}(XN24AF) = 19.2×1.73^2 = 57.46 [W]

* ERP: refer to FCC CFR 47 part1 1.1307 (b)(2)

ISED requirements

According to RSS-102 Issue 5 2.5.2: Exemption Limits for Routine Evaluation is defined as follows “device operates ~ at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance).”

3. Evaluation Results

Calculated ERP

$$ERP = PEP \times 10^{\wedge}\left(\frac{G_p - 2.15}{10}\right) \times (\tau \times PRF) \times \frac{\theta}{360}$$

$$ERP(XN12AF) = 12000 \times 10^{\wedge}\left(\frac{28.2 - 2.15}{10}\right) \times (1.2 \times 10^{-6} \times 600) \times \frac{1.9}{360} = 18.36\ [W] \leq 338.69\ [W]$$

$$ERP(XN20AF) = 12000 \times 10^{\wedge}(\frac{30.0 - 2.15}{10}) \times (1.2 \times 10^{-6} \times 600) \times \frac{1.23}{360} = 17.99\ [W] \leq 129.79\ [W]$$

$$ERP(XN24AF) = 12000 \times 10^{\wedge}(\frac{31.1 - 2.15}{10}) \times (1.2 \times 10^{-6} \times 600) \times \frac{0.95}{360} = 17.90\ [W] \leq 57.46\ [W]$$

where:

PEP is converted to the mean power using the pulse width and the pulse repetition frequency.

G_p is converted to a gain relative to a dipole.

The antenna rotates continuously over 360 degrees in the horizontal plane and illuminates the subjects only by its main lobe. Therefore, time-averaged power is derated by the beamwidth and the angle of rotation.

Calculated e.i.r.p.

$$e.i.r.p. = PEP \times 10^{\wedge}\left(\frac{G_p}{10}\right) \times (\tau \times PRF) \times \frac{\theta}{360}$$

$$e.i.r.p.(XN12AF) = 12000 \times 10^{\wedge}(\frac{28.2}{10}) \times (1.2 \times 10^{-6} \times 600) \times \frac{1.9}{360} = 30.13\ [W] \geq 5\ [W]$$

$$e.i.r.p.(XN20AF) = 12000 \times 10^{\wedge}(\frac{30.0}{10}) \times (1.2 \times 10^{-6} \times 600) \times \frac{1.23}{360} = 29.52\ [W] \geq 5\ [W]$$

$$e.i.r.p.(XN20AF) = 12000 \times 10^{\wedge}(\frac{31.1}{10}) \times (1.2 \times 10^{-6} \times 600) \times \frac{0.95}{360} = 29.37\ [W] \geq 5\ [W]$$

where:

PEP is converted to the mean power using the pulse width and the pulse repetition frequency.

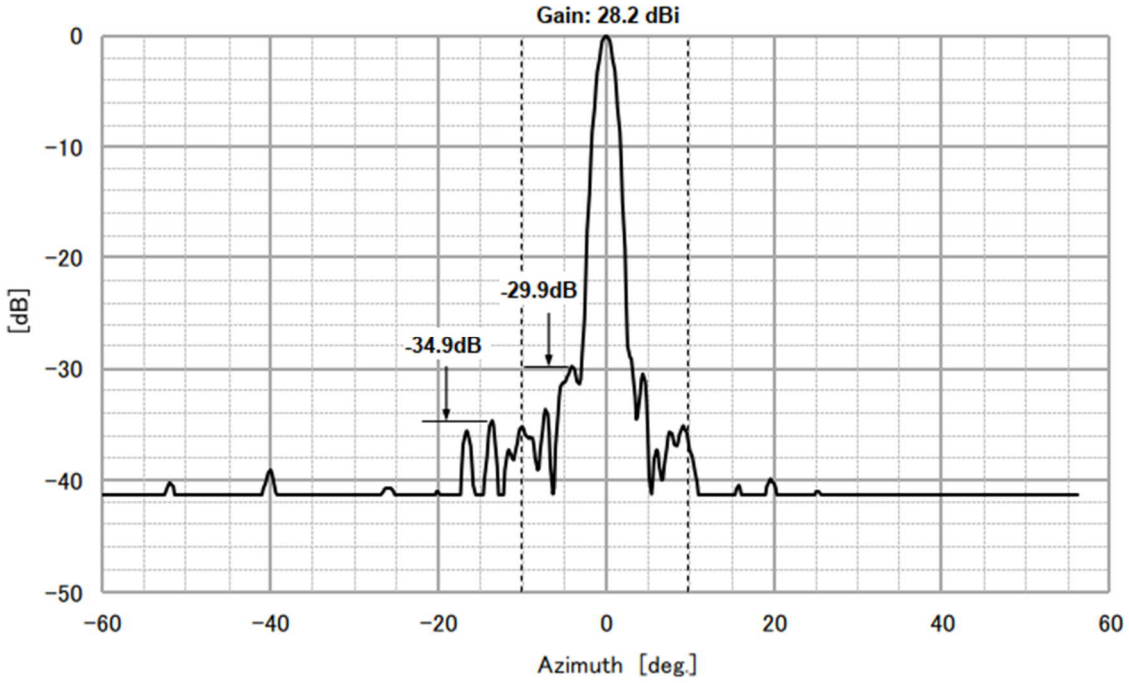
The antenna rotates continuously over 360 degrees in the horizontal plane and illuminates the subjects only by its main lobe. Therefore, time-averaged power is derated by the beamwidth and the angle of rotation..

Annex.1

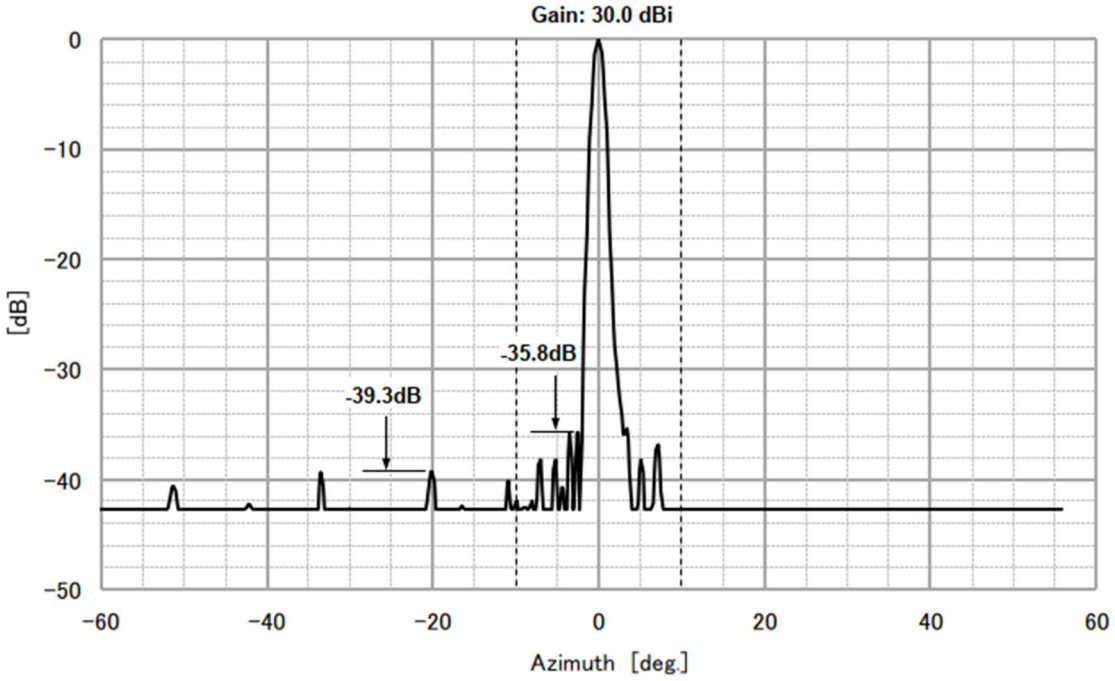
RTR-133 radiation pattern (normalized)

Main beam width: XN12AF：1.9 °　/ XN20AF：1.23 °　/ XN24AF：0.95 °　(Horizontal polarization)

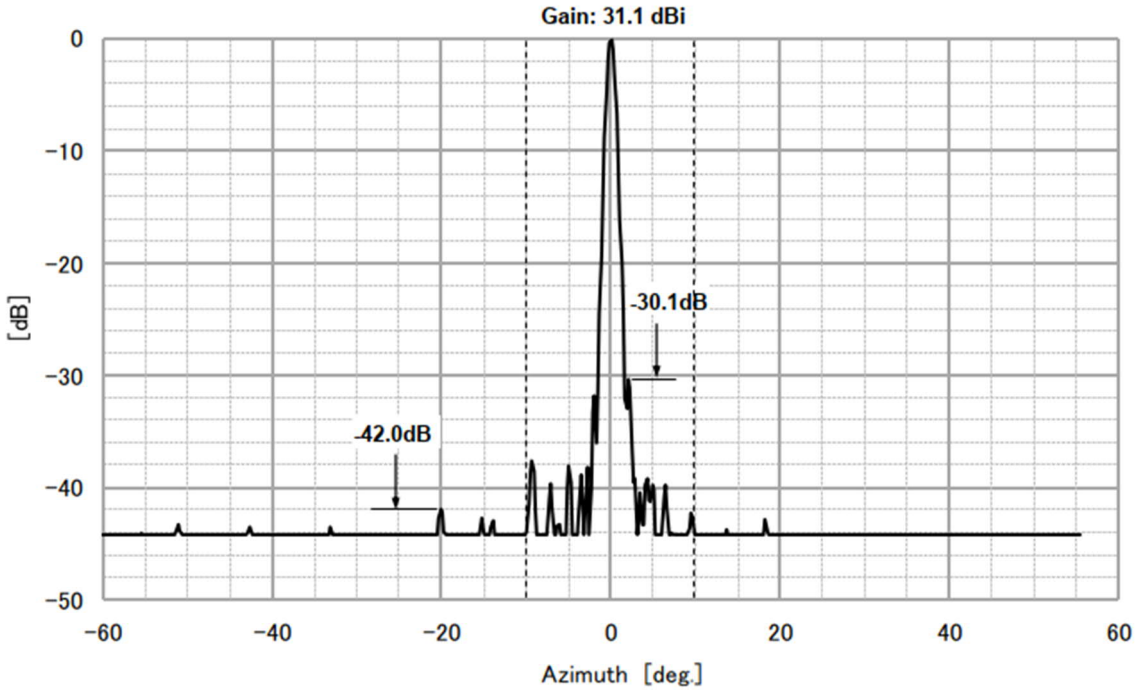
Any other radiation is 20dB, almost 30dB, below than mainlobe



XN12AF radiation pattern



XN20AF radiation pattern



XN24AF radiation pattern