

ITU-R

Radiocommunication Sector of ITU

Recommendation ITU-R M.2069-0 (12/2014)

Antenna rotation variability and effects on antenna coupling for radar interference analysis

M Series
**Mobile, radiodetermination, amateur
and related satellite services**



Foreword

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SA	Space applications and meteorology
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Note: This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.

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RECOMMENDATION ITU-R M.2069-0

**Antenna rotation variability and effects on antenna coupling
for radar interference analysis**

(2014)

Scope

This Recommendation describes the effect of antenna rotation on antenna coupling for interference and compatibility analysis.

Keywords

Antenna coupling, antenna rotation mismatch, radar

Abbreviations/Glossary

CDF cumulative distribution function

The ITU Radiocommunication Assembly,

considering

- a) that there is a need to estimate antenna coupling of rotating antennas for use in interference assessments;
- b) that Recommendation ITU-R M.1851 – Mathematical models for radiodetermination radar systems antenna patterns for use in interference analyses, can be used to obtain theoretical antenna patterns to be used in antenna coupling estimates,

recommends

that for estimating the effects of antenna coupling, the information described in Annex 1 should be considered.

Annex 1**Antenna coupling effects**

In this annex, the effects of antenna rotation variability on antenna coupling are discussed.

Antenna coupling

When two radars are operating within line of sight of one another, or when anomalous propagation conditions allow, the radiation from one radar antenna can be received by the other radar's antenna and its associated receiver. This interaction could result in mutual interference which would lead to performance degradation. When this situation happens, the two systems are said to be coupled. The magnitude of antenna coupling between the two radars must be calculated in order to anticipate any problems caused by the offending system and to implement relevant preventative measures. Antenna coupling between two radars depends on:

- atmospheric propagation conditions;
- the power of the transmitter;
- the losses due to the cables and other units of both systems;
- the coupling between the antennas due to radiation patterns;
- the sensitivity of the victim receiver;
- spatial separation and terrain elevations between the radars;
- antenna heights above the ground and antenna elevation tilt angle;
- the absolute gains of the antennas at the angles at which the direct rays leave the transmit antenna and are incident on the receive antenna, and
- the mismatch in the antenna rotation rates.

Primary radars use highly sensitive receivers in order to detect aircraft reflected signals with two way propagation losses (forward and return paths), affecting the radar's equation by $1/R^4$ where R is the aircraft distance.

Radar to radar interference is a one way path ($1/R^2$ propagation path) that results in a larger required separation distance between the interfering and victim radar.

With such considerations, we can conclude that in a full radar coverage network, radars will always have interferences with other surrounding radars.

Radar to radar coupling occurs mainly then both radars are operating co-frequency or in frequency vicinity where the frequency dependent rejection (FDR) or peak FDR value is small. So, in order to suppress these radar-to-radar interferences, the current mitigation technique is to attribute different frequencies to radars in the coverage area. A set of frequencies, with sufficient frequency separation are needed to reduce interference, and to obtain a full coverage of a region through a geographical frequency plan.

The rotational speed mismatch between two antennas can cause high levels of interference to be repetitive and long lasting. Figures 1 to 6 show examples of antenna rotation mismatch (Rec. ITU-R M.1464-1 Radar-C to Radar-C). This mismatch in rotational speed is not unreasonable. For example, the following are sample requirement specifications for airport surveillance radar pedestal azimuth drive and antenna scan rate requirements:

“Antenna Pedestal Azimuth Drive. The pedestal azimuth drive shall have a controllable velocity of 0 to 30 degrees per second in steps no greater than 1 degree per second with accuracy of $\pm 0.5\%$. The azimuth drive positions and holds the antenna within ± 0.05 degrees of the selected azimuth angle when commanded. In normal operation, antenna rotation is in the clockwise direction.”

Another specification for antenna scan rate states that “antenna scan rate is one revolution every 4.8 seconds, $+0.53$ or -0.44 second” this equates to antenna rotation values between $67.54^\circ/\text{s}$ to $82.57^\circ/\text{s}$.

This above specification means that even if the antennas are synchronized in rotation, high levels of antenna coupling can occur. The results of antenna coupling for three values of two radar antenna rotation mismatches of a maximum of $0.5^\circ/\text{s}$, $0.25^\circ/\text{s}$ and $7.46^\circ/\text{s}$ are shown in the figures below. It is shown that as the antenna rotation speed mismatch is reduced, the repetition rate of high level of antenna couplings is reduced.