

Radar Cross Section

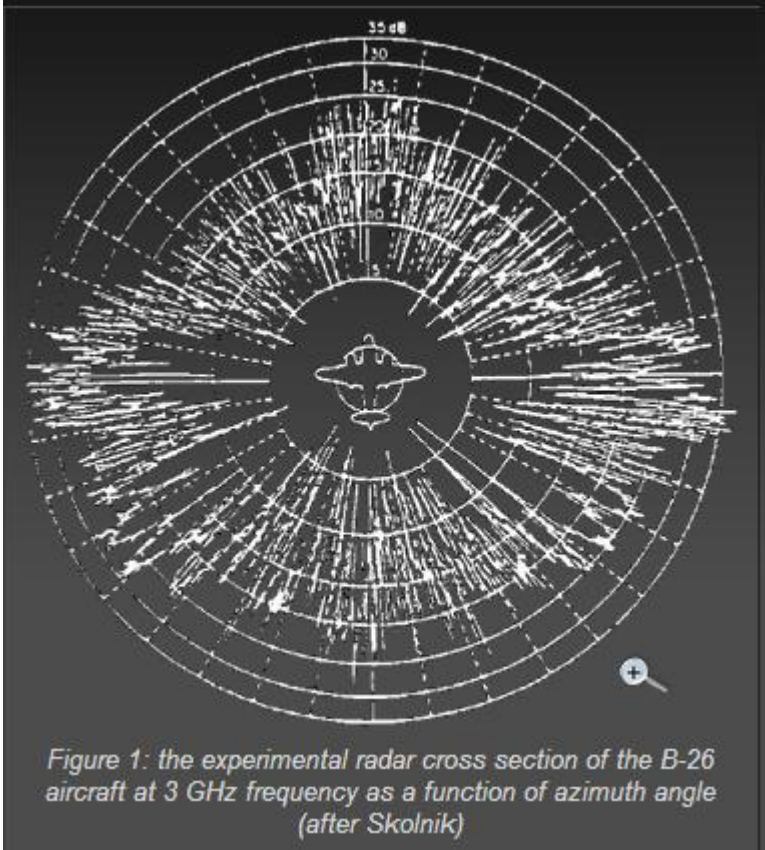


Figure 1: the experimental radar cross section of the B-26 aircraft at 3 GHz frequency as a function of azimuth angle (after Skolnik)

The size and ability of a target to reflect radar energy can be summarized into a single term, σ , known as the radar cross-section, which has units of m^2 . This unit shows, that the radar cross section is an area. If absolutely all of the incident radar energy on the target were reflected equally in all directions, then the radar cross section would be equal to the target's cross-sectional area as seen by the transmitter. In practice, some energy is absorbed and the reflected energy is not distributed equally in all directions. Therefore, the radar cross-section is quite difficult to estimate and is normally determined by measurement.

The target radar cross sectional area depends of:

- the airplane's physical geometry and exterior features,
- the direction of the illuminating radar,
- the radar transmitters frequency,

- the used material types.

The use of stealth technology to reduce radar cross section increases the survivability and decreases the target detection of military aircraft. But the stealth technology depends of the used radar transmitters frequency and has none effect against VHF- radars like P-12 or P-18, both used by serbian air defense units during the Kosovo war.

Calculation of the radar cross section

Radar cross section (RCS) is the measure of a target's ability to reflect radar signals in the direction of the radar receiver, i.e. it is a measure of the ratio of backscatter density in the direction of the radar (from the target) to the power density that is intercepted by the target. Since the power is distributed on the shape of a sphere, a small part of this ($(4 \cdot \pi \cdot r^2)$) can be received by the radar.

Radar cross section σ is as defined as:

$$\sigma = 4 \cdot \pi \cdot r^2 \cdot S_r / S_t \quad \text{mit} \quad (1)$$

σ : measure of the target's ability to reflect radar signals in direction of the radar receiver, in [m²]

S_t : power density that is intercepted by the target, in [W/m²]

S_r : scattered power density in the range r , in [W/m²]

The RCS of a target can be viewed as a comparison of the strength of the reflected signal from a target to the reflected signal from a perfectly smooth sphere of cross sectional area of 1 m².

The following backscattering formulas from shapes occurs in an optical independent of frequency region.



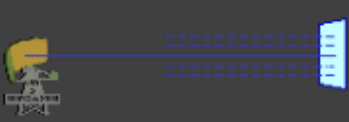

 <p>reflected signal from a spherical shape</p>	$\sigma_{max} = \pi \cdot R^2 \quad (2)$
 <p>reflected signal from a cylinder</p>	$\sigma_{max} = \frac{2 \cdot \pi \cdot r \cdot h^2}{\lambda} \quad (3)$
 <p>reflected signal from a flat plate</p>	$\sigma_{max} = \frac{4 \cdot \pi \cdot b^2 \cdot h^2}{\lambda^2} \quad (4)$
 <p>reflected signal from a tilted plate</p>	<p>...Real as the previous example. Unusual feature: the reflected energy is reflected in another direction. Well, the transmitting radar cannot receive this energy. Therefore there are bistatic radars at which the transmitter and the receivers are separated from each other spatially.</p>

Table 1: RCS for geometrically bodies

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RCS for Point-Like Targets

Some targets have large values of RCS owing to their size and orientation and consequently, reflect a large portion of the incident power. The beside table shows the values of RCS for some targets at X-Band

<i>Targets</i>	<i>RCS</i> <i>[m²]</i>	<i>RCS</i> <i>[dB]</i>
<i>bird</i>	0.01	-20
<i>man</i>	1	0
<i>cabin cruiser</i>	10	10
<i>automobile</i>	100	20
<i>truck</i>	200	23
<i>corner reflector</i>	20379	43.1

Table 2: RCS for Point-Like Targets

(Table from: M. Skolnik, "Introduction to radar systems", 2nd Edition, McGraw-Hill, Inc 1980, page 44.

The RCS of the corner reflector is given for a triangular reflector with a length of 1.5 m.)

Source:

<http://www.radartutorial.eu/01.basics/Radar%20Cross%20Section.en.html>