

ACSF CAT C Radar Sensor Range

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Radar Cross-Section as key element for detection/evaluation

- › **Radar Cross-Section (RCS)** is an indication of object detectability by RADAR.
=> **the larger the RCS of an object is, the easier it can be detected**
- › Factors that affect the RCS/radar detectability:
 - › **Size** – the larger an object, the stronger its radar reflection
 - › **Material** – Most metals are strongly radar reflective and tend to produce strong signals. Wood, cloth, plastic, fiberglass and human/animal body parts are less reflective.
 - › **Shape and orientation** – Any ray incident along the normal will reflect back along the normal axis. Rounded surfaces often have some portion of the surface normal to the Radar source and thus result in reflections relatively independent of orientation.
 - › **Surfaces smoothness** – The relief of a surface could contain indentations that act as corner reflectors (which would increase RCS from many orientations). This could arise from engine or cooler intakes, joints clearance etc.

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Radar detectability of different object types

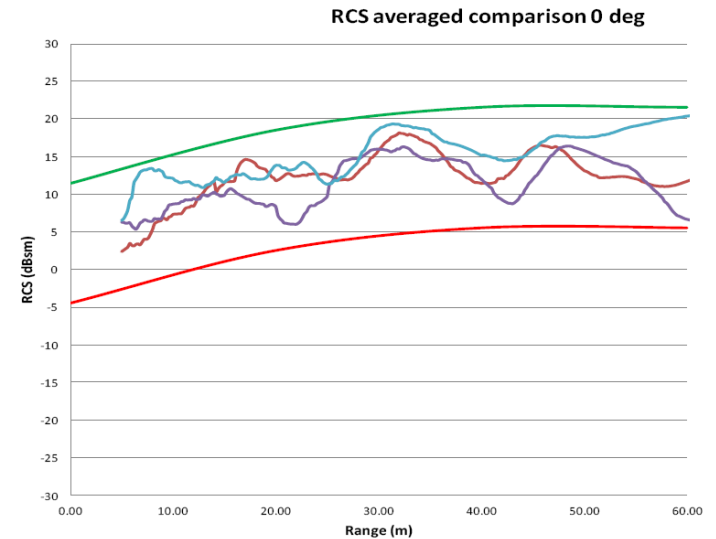
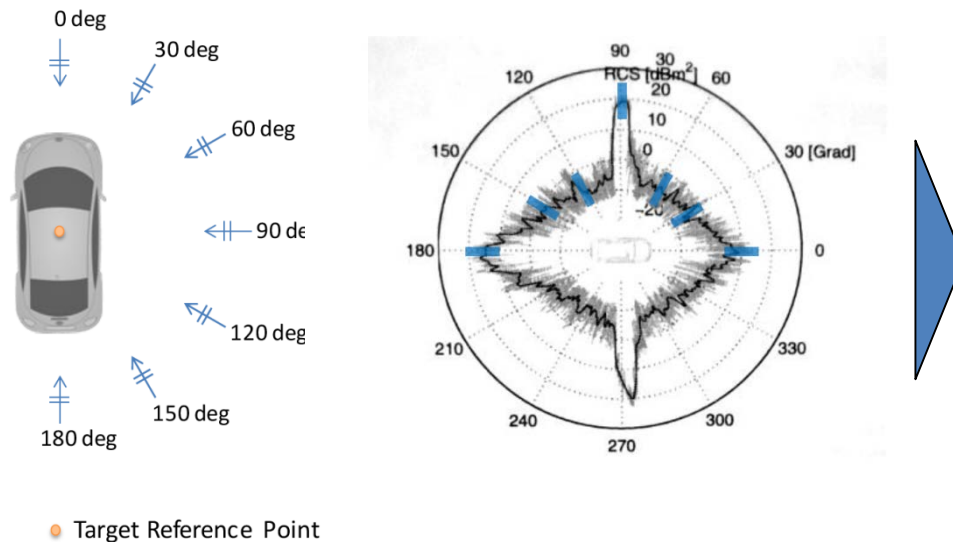
› Typical Radar Cross Section values:

› Passenger car: ~ 10 dBm²

› Motorcycle: ~ 5 dBm²

› Non-linear correlation of RCS and detection distance

› Due to high variance of motorcycles and influence of motorcycle rider, the detection distance for motorcycles varies



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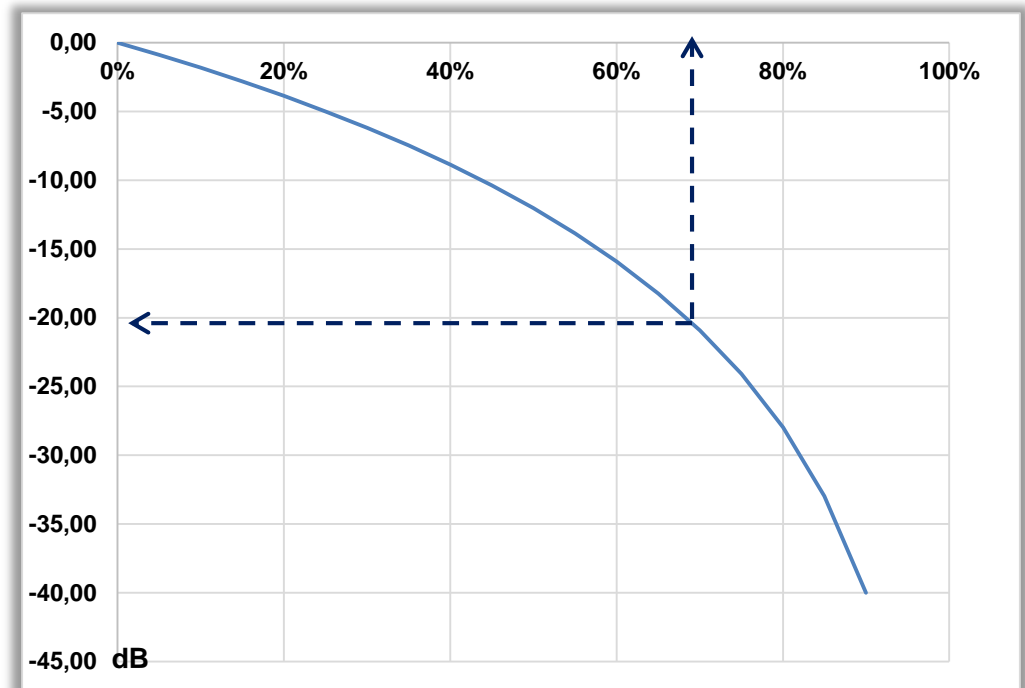
Influences on radar performance

The performance of a radar sensor is compromised by multiple factors, due to its technology, which cannot be omitted or influenced

- › Deterioration and tolerances of the sensor : up to 4,5 dB
- › Environmental conditions (rain, snowfall, dirt, etc.): up to 5,0 dB (-> threshold)

Example:

A loss of 20dB leads to range reduction of 70%



Worldwide available frequency bands

Power limitation

Frequency	Harmonized EU standard	Transmit power	Range (no bumper)	Status	International recommendation
24 GHz ISM	ETSI EN 302 858	EU: 20 dBm Japan: 27 dBm US: 12.7 dBm China: 13 dBm	60 -100 m	<ul style="list-style-type: none"> › Globally available ISM band (Industry, Scientific, Medical), › but no specific automotive band (no protection against interference & too narrow band) 	
76-77 GHz	ETSI EN 301 091	EU,US, China: 50 dBm	150 m	Worldwide coverage	Recommended for vehicle usage Front ITU-R M.1452-2 Category 1
77-81 GHz	ETSI EN 302 264	EU: -9 dBm /MHz JPN: 45 dBm US: 50 dBm exp. (*)	30 - 100 m max. 150 m	Status 2017 <ul style="list-style-type: none"> › EU, RUS, JPN Expected for 2018 <ul style="list-style-type: none"> › US, China, Korea 	Recommended for vehicle usage Side/Rear ITU-R M.1452-2 Category 2

(*) FCC: NOTICE OF PROPOSED RULEMAKING AND RECONSIDERATION ORDER Adopted: February 3, 2015 Released: February, https://apps.fcc.gov/edocs_public/attachmatch/FCC-15-16A1.pdf