RADAR CROSS SECTION MEASUREMENTS pdf

1: National Radar Cross Section Test Facility (NRTF)

Radar cross-section (RCS) is a measure of how detectable an object is by radar.A larger RCS indicates that an object is more easily detected. An object reflects a limited amount of radar energy back to the sourc.

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 as shown in Figure 1. The conceptual definition of RCS includes the fact that not all of the radiated energy falls on the target. The percent of intercepted power reradiated scattered by the target. Figures 2 and 3 show that RCS does not equal geometric area. Experimentally, radar return reflected from a target is compared to the radar return reflected from a sphere which has a frontal or projected area of one square meter i. Using the spherical shape aids in field or laboratory measurements since orientation or positioning of the sphere will not affect radar reflection intensity measurements as a flat plate would. If calibrated, other sources cylinder, flat plate, or corner reflector, etc. To reduce drag during tests, towed spheres of 6", 14" or 22" diameter may be used instead of the larger 44" sphere, and the reference size is 0. If the results are then scaled to a 1 m2 reference, there may be some perturbations due to creeping waves. See the discussion at the end of this section for further details. Backscatter From Shapes In Figure 4, RCS patterns are shown as objects are rotated about their vertical axes the arrows indicate the direction of the radar reflections. The sphere is essentially the same in all directions. The flat plate has almost no RCS except when aligned directly toward the radar. The corner reflector has an RCS almost as high as the flat plate but over a wider angle, i. The return from a corner reflector is analogous to that of a flat plate always being perpendicular to your collocated transmitter and receiver. Targets such as ships and aircraft often have many effective corners. Corners are sometimes used as calibration targets or as decoys, i. An aircraft target is very complex. It has a great many reflecting elements and shapes. The RCS of real aircraft must be measured. It varies significantly depending upon the direction of the illuminating radar. Figure 5 shows a typical RCS plot of a jet aircraft. The plot is an azimuth cut made at zero degrees elevation on the aircraft horizon. Within the normal radar range of GHz, the radar return of an aircraft in a given direction will vary by a few dB as frequency and polarization vary the RCS may change by a factor of It does not vary as much as the flat plate. As shown in Figure 5, the RCS is highest at the aircraft beam due to the large physical area observed by the radar and perpendicular aspect increasing reflectivity. Typical radar cross sections are as follows: Again, Figure 5 shows that these values can vary dramatically. These RCS values can be very misleading because other factors may affect the results. For example, phase differences, polarization, surface imperfections, and material type all greatly affect the results. Therefore, an RCS reduction can increase aircraft survivability. The equations used in Figure 6 are as follows: From the 2-way range equation in Section The crossover equation in Section has: Equating the received signal return Pr in the two way range equation to the received jammer signal Pr in the one way range equation, the following relationship results: Likewise, 2 If Jammer power is held constant, then burn-through range is 0. In this region, the RCS of a sphere is independent of frequency. This area is known as the Mie or resonance region. If we were using a 6" diameter sphere, this frequency would be 0. Any frequency ten times higher, or above 6 GHz, would give expected results. The largest positive perturbation point A occurs at exactly 0. Just slightly above 0. If we used a one meter diameter sphere, the perturbations would occur at 95 MHz, so any frequency above MHz -1 GHz would give predicted results. There is a region where specular reflected mirrored waves combine with back scattered creeping waves both constructively and destructively as shown in Figure 8. Creeping waves are tangential to a smooth surface and follow the "shadow" region of the body. Radar Cross Section of a Sphere Figure 8.

2: NADIR Ship RCS Measurement Radar | IDS Ingegneria Dei Sistemi S.p.A.

Radar Cross Section Measurements is a valuable source for professional people needing reference material on the measurement of RCS targets both indoors and outdoors. It will be especially useful to aerospace engineers and scientists working with modern radar systems.

What does radar cross section mean? What does it have to do with stealth? In particular, an article on stealth provides an overview of various methods used in designing aircraft so that they are more difficult to detect. The detection method related to your question is by means of radar. The word "radar" is actually an acronym standing for RAdio Detection And Ranging since the device uses radio waves to detect targets. Radar works by sending out pulses of these electromagnetic waves and then "listening" for echoes bounced back by targets of interest. Concept of pulse radar Even though a radar may transmit megawatts of power in a single pulse, only a tiny fraction of that energy is typically bounced back to be received by the radar antenna. The amount of power returned from a target to the transmitting radar depends on four major factors: The power transmitted in the direction of the target The amount of power that impacts the target and is reflected back in the direction of the radar The amount of reflected power that is intercepted by the radar antenna The length of time in which the radar is pointed at the target Factors that determine the energy returned by a target A term used to describe the relationship between these variables is power density, sometimes also called power flux. To understand power density, consider the following diagram. The power transmitted by a radar is dissipated the further it travels because it is spread over an increasingly larger area. The area over which the power is spread is proportional to the square of the distance, or range R , from the transmitting radar. The amount of power spread over a given area is called the power density, and this quantity decreases by the square of the range. The power density of the transmitted radar wave at the range of the target has a special name called the incident power density Pincident. Effect of distance from the radar to the target on the power density Once the radar power reaches the target, some portion of that power will be reflected back to its source. However, this reflected power also dissipates and spreads out as it echoes back to the radar receiver. The ability of a radar to detect the target depends on whether the amount of power returned is large enough to be differentiated from internal noise, ground clutter, background radiation, and other sources of interference. The goal of stealth techniques is to bounce so little radar power back to its source that the target is nearly impossible to detect or track. The amount of power that is reflected back to the radar depends largely on a quantity called the radar cross section RCS. The geometric cross section refers to the area the target presents to the radar, or its projected area. This area will vary depending on the angle, or aspect, the target presents to the radar. In other words, the target will probably present the smallest projected area to a radar if it is flying directly toward the radar and is viewed head-on. A view from the side, top, or underneath will present a much larger projected area. The geometric cross section A determines how much power transmitted by the radar Pincident is intercepted by the target Pintercepted according to the following relationship: Reflectivity refers to the fraction of the intercepted power that is reflected by the target, regardless of direction. Radar power does not necessarily reflect equally from all parts of an aircraft, and some components produce stronger radar reflections than others. In addition, some radar power is usually absorbed by the target. This absorption is especially true of aircraft coated with special substances called Radar Absorbent Materials RAM or those using internal reflectors called Radar Absorbent Structures RAS that trap incoming radar waves. Regardless, the power that is reradiated, or scattered, after reflecting off the target is equal to the intercepted power less whatever portion of that power is absorbed by the target. Reflectivity is defined as the ratio of power scattered by the target Pscatter to the power intercepted by the target Pintercepted. Directivity is related to reflectivity but refers to the power scattered back in the direction of the transmitting radar. The power that is reflected toward the radar is called the backscattered power Pbackscatter. If the power were to scatter equally, it would form a sphere expanding uniformly in all directions from the target. This type of behavior is called isotropic expansion. Isotropic power Pisotropic is defined as the power that is scattered in a perfect sphere over a unit solid angle of that sphere, as shown in the following equation. We have mentioned that the power reflected by the target can be much stronger in some directions than in others. As a result, that reflected power will be much greater or much smaller than the isotropic power depending on how the target is oriented to the transmitting radar. The directivity, therefore, will be much greater than 1 when the target returns a strong backscatter in the direction of the radar and much less than 1 when the backscatter is small. Simplifying that expression yields the following relationship for radar cross section. The importance of radar cross section can best be understood by looking at an equation relating the RCS of the target to the energy received by the radar. In this case, the target presents the same aspect to the radar at ranges from 1 to 50 miles. At a range of 50 miles, the relative power received by the radar is only 0. This diagram graphically illustrates how significant the effect of energy dissipation is with distance, and how sensitive radars must be to detect targets at even short ranges. Reduction in the strength of target echoes with range Furthermore, every radar has a minimum signal energy that it can detect, a quantity we will call Smin. This minimum signal energy determines the maximum range Rmax at which a given radar can detect a given target. While that reduction alone is significant, even greater reductions in RCS are possible. At this point, you may be wondering what terms like gain and aperture mean, but we will address those in a future article that discusses the principles of radar in greater detail. For now, let us return to radar cross section and describe how it is measured. The greatest challenge aircraft designers have traditionally faced in creating a vehicle difficult to detect by radar is the ability to predict what the RCS will be for a complicated shape from any given direction. That difficulty was only overcome in recent decades when computers became powerful enough to solve a series of equations describing how radar waves scatter off complicated shapes. While the four equations Maxwell derived are relatively simple, they can become quite complex when trying to predict the electromagnetic properties of shapes reflecting radar energy. Presented here are equations that predict the RCS of simple shapes like spheres, cylinders, and flat plates, and shapes are ordered based on the relative strength of the maximum RCS. The strength of the radar return is also a function of the angle at which the radar waves impact against the surface, or the incident angle.

3: Radar Cross Section | Antenna Measurement Solutions

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.

Stealth technology RCS reduction is chiefly important in stealth technology for aircraft, missiles, ships, and other military vehicles. With smaller RCS, vehicles can better evade radar detection, whether it be from land-based installations, guided weapons or other vehicles. The distance at which a target can be detected for a given radar configuration varies with the fourth root of its RCS. Due to the energy reflection, this method is defeated by using Passive multistatic radars. Purpose-shaping can be seen in the design of surface faceting on the FA Nighthawk stealth fighter. This aircraft, designed in the late s though only revealed to the public in , uses a multitude of flat surfaces to reflect incident radar energy away from the source. Yue suggests [12] that limited available computing power for the design phase kept the number of surfaces to a minimum. The B-2 Spirit stealth bomber benefited from increased computing power, enabling its contoured shapes and further reduction in RCS. Redirecting scattered energy without shaping[edit] This technique is relatively new compared to other techniques chiefly after the invention of metasurfaces [13]. As mentioned earlier, the primary objective in geometry alteration is to redirect scattered waves away from the backscattered direction or the source. However, it may compromise performance in terms of aerodynamics [14]. One feasible solution, which has extensively been explored in recent time, is to utilize metasurfaces which can redirect scattered waves without altering the geometry of the target [15]. Such metasurfaces can primarily be classified in two categories: Active cancellation[edit] With active cancellation, the target generates a radar signal equal in intensity but opposite in phase to the predicted reflection of an incident radar signal similarly to noise canceling ear phones. This creates destructive interference between the reflected and generated signals, resulting in reduced RCS. To incorporate active cancellation techniques, the precise characteristics of the waveform and angle of arrival of the illuminating radar signal must be known, since they define the nature of generated energy required for cancellation. Except against simple or low frequency radar systems, the implementation of active cancellation techniques is extremely difficult due to the complex processing requirements and the difficulty of predicting the exact nature of the reflected radar signal over a broad aspect of an aircraft, missile or other target. Radar absorbent material[edit] Main article: Radar-absorbent material Radar absorbent material RAM can be used in the original construction, or as an addition to highly reflective surfaces. There are at least three types of RAM: The thickness of the material corresponds to one-quarter wavelength of the expected illuminating radar-wave a Salisbury screen. The incident radar energy is reflected from the outside and inside surfaces of the RAM to create a destructive wave interference pattern. This results in the cancellation of the reflected energy. Deviation from the expected frequency will cause losses in radar absorption, so this type of RAM is only useful against radar with a single, common, and unchanging frequency. Non-resonant magnetic RAM uses ferrite particles suspended in epoxy or paint to reduce the reflectivity of the surface to incident radar waves. Because the non-resonant RAM dissipates incident radar energy over a larger surface area, it usually results in a trivial increase in surface temperature, thus reducing RCS without an increase in infrared signature. A major advantage of non-resonant RAM is that it can be effective over a wide range of frequencies, whereas resonant RAM is limited to a narrow range of design frequencies. Large volume RAM is usually resistive carbon loading added to fiberglass hexagonal cell aircraft structures or other non-conducting components. Fins of resistive materials can also be added. Thin resistive sheets spaced by foam or aerogel may be suitable for spacecraft. Thin coatings made of only dielectrics and conductors have very limited absorbing bandwidth, so magnetic materials are used when weight and cost permit, either in resonant RAM or as non-resonant RAM. Interactions between electromagnetic radiation and ionized gas have been extensively studied for many purposes, including concealing aircraft from radar as stealth technology. Various methods might plausibly be able to form a layer or cloud of plasma around a vehicle to deflect or absorb radar, from simpler electrostatic or radio frequency RF discharges to more complex laser discharges. It is theoretically possible to reduce RCS in this way, but it may be very difficult to do so in practice. Although, the RCS effect was shown in experiments, pre injection for a rocket as well as a fighter jets improved manoeuvrability and speed. Optimization methods[edit] Thin non-resonant or broad resonance coatings can be modeled with a Leontovich impedance boundary condition see also Electrical impedance. This is the ratio of the tangential electric field to the tangential magnetic field on the surface, and ignores fields propagating along the surface within the coating. This is particularly convenient when using boundary element method calculations. The surface impedance can be calculated and tested separately. For an isotropic surface the ideal surface impedance is equal to the ohm impedance of free space. A perfect electric conductor has more back scatter from a leading edge for the linear polarization with the electric field parallel to the edge and more from a trailing edge with the electric field perpendicular to the edge, so the high surface impedance should be parallel to leading edges and perpendicular to trailing edges, for the greatest radar threat direction, with some sort of smooth transition between. To calculate the radar cross-section of such a stealth body, one would typically do one-dimensional reflection calculations to calculate the surface impedance, then two dimensional numerical calculations to calculate the diffraction coefficients of edges and small three dimensional calculations to calculate the diffraction coefficients of corners and points. The cross section can then be calculated, using the diffraction coefficients, with the physical theory of diffraction or other high frequency method, combined with physical optics to include the contributions from illuminated smooth surfaces and Fock calculations to calculate creeping waves circling around any smooth shadowed parts. Optimization is in the reverse order. First one does high frequency calculations to optimize the shape and find the most important features, then small calculations to find the best surface impedances in the problem areas, then reflection calculations to design coatings. Large numerical calculations can run too slowly for numerical optimization or can distract workers from the physics, even when massive computing power is available. The two components of the RCS relates to the two scattering phenomena that takes place at the antenna. When an electromagnetic signal falls on an antenna surface, some part of the electromagnetic energy is scattered back to the space. This is called structural mode scattering. The remaining part of the energy is absorbed due to the antenna effect. Some part of the absorbed energy is again scattered back into the space due to the impedance mismatches, called antenna mode scattering.

4: RADAR Cross Section Measurement and Training Lab

RADAR Cross Section Measurement and Training Lab is a comprehensive indoor facility with a highly modular setup. The complete setup consists of a USB powered.

5: Radar cross-section - Wikipedia

The aim of this work is to present radar cross section (RCS) measurements of a panel constituted of a ï¬‚at aluminum plate with and without radar absorbing materials (RAM) type thin rubber sheets, in the range of.

6: Radar Cross-Section Facility Design - The Howland Company

Radar cross-section (RCS) is an important study parameter for defence applications specially dealing with airborne weapon system. The RCS parameter guides the detection range for a target and is therefore.

7: Radar Basics - Radar Cross Section

quality in measurements of radar signatures at RCC member ranges and associate facilities. The range commanders encourage other organizations engaged in the practice of radar cross section.

8: Electronic Warfare and Radar Systems Engineering Handbook - Radar Cross Section (RCS) - RF Cafe

Range Design & Evaluation In the early 's The Howland Company became heavily involved in the design and evaluation of radar cross section measurement facilities. Stealth technology had advanced to the point where the signals being returned from targets were at very low levels and could not be effectively measured using the existing.

9: www.enganchecubano.com | Ask Us - Radar Cross Section

The National Radar Cross Section (RCS) Test Facility (NRTF) is the premier DoD facility for RCS testing. Formerly known as RATSCAT, which began measuring radar scattering in , it is comprised of two complementary sites, Mainsite and RATSCAT Advanced Measurement System (RAMS).

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You cant still be hungry Appendix 22: Communications plan template Into the woods piano sheet Teacher (This Is What I Want to Be) Chocolate Choo Choo A Dictionary of the Language of Bugotu, Santa Isabel Island, Solomon Islands Fastest growing service business filetype Change your magnetism change your life Proceedings of the 2005 International Conference on Machine Learning and Cybernetics Pick and place robot project umentation Legalines: Family Law Defense Working Capital Fund Pricing Policies American Cocker Book Funny Boy versus the bubble-brained barbers from the Big Bang The Lieder Anthology Low Voice Face-to-face reference service policies 40 mb file Basic Field Manual V10, Military Intelligence Intelligibility and the speech community Development economics todaro and smith Nsca cpt practice exam The effect in national law of the European Convention on Human Rights Strengthening Aging Families Experimental design research methods Britain and Palestine during the Second World War Pension Asset Management Womanly dominion deceitfully assaulted Manipulation: theory, practice, and education Labor at the polls The prairie riders Categories of computers Females and Autonomy Hesychios the Priest, On watchfulness and holiness First Paper Girl in Red Oak, IO Where you are jh trumble Economics and systems analysis: introduction for public managers Masilo, Masilonyane, and the old woman. In Praise and Celebration of Friends (Special Occasions) Cool Brand Leaders The Peerless Christ