Radar Frequency Bands

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***Abstract*- RADAR stands for RADIO DETECTION & RANGING. Radars are used to detect the presence of an aim (as object of detection) and to determine its location. The contraction implies that the quantity measured is range. While this is correct, modern radars are also used to measure range and angle. The following figure shows the operating principle of primary radar. The radar antenna illuminates the target with a microwave signal, which is then reflected and picked up by a receiving device. The electrical signal picked up by the receiving antenna is called echo or return. The radar signal is generated by a powerful transmitter and received by a highly sensitive receiver.**

I. INTRODUCTION

The electronic principle on which radar operates is very similar to the principle of sound-wave reflection. If you shout in the direction of a sound-reflecting object (like a rocky canyon or cave), you will hear an echo. If you know the speed of sound in air, you can then estimate the distance and general direction of the object. The time required for an echo to return can be roughly converted to distance if the speed of sound is known.

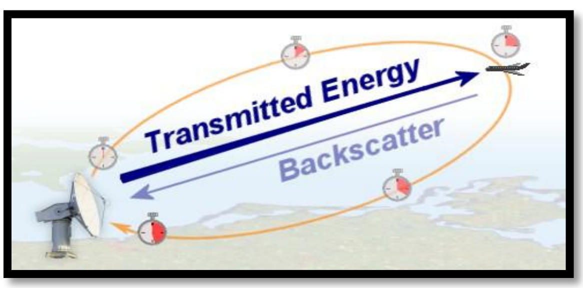

Fig: Radar Principle

The spectrum of the electric magnetic waves shows frequencies up to 1024 Hz. This very large complete range is subdivided because of different physical qualities in different subranges. The division of the frequencies to the different ranges was competed on criteria formerly, which arose historically and a new division of the wavebands which is used internationally is out-dated and arose so in the meantime. The traditional waveband name is partly still used in the literature, however. An overview shows the following figure:

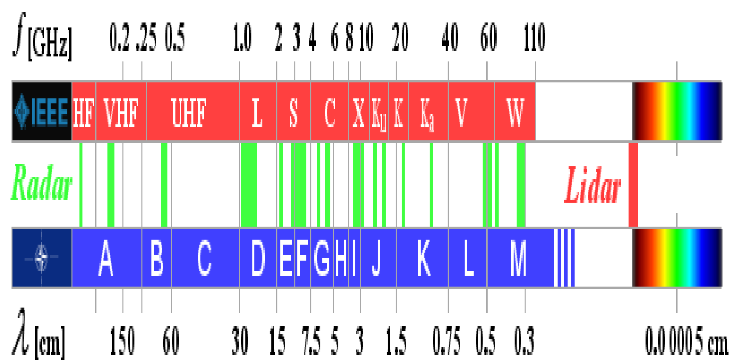

Figure : Waves and frequency ranges used by radar

There are two different significant radar frequency letter-band nomenclatures in use. One system uses a more historically originated system of letters and is defined even as an IEEE Standard. These letter designations were originally selected to describe the secret radar bands used in World War II. Military Radar-applications in NATO uses another nomenclature with easier abecedarian letters. This system allows an easy extension with higher frequencies and is originally devised for conducting electronic support measures, countermeasures and electronic warfare, and (at least military) radars are an important part of it. The boundaries of the frequency bands are distributed nearly logarithmical. Since without that the correct frequency is known, a transformation isn't always possible into the newer wavebands with NATO nomenclature. Often in the manufacturers documents are published the traditional wavebands. The different designations for Radar- Frequency Bands are very confusing. This is no problem for a radar engineer or technician. They can handle with these different bands, frequencies and wave lengths. The problem is now to assert, that a frequency generator for I and J-Band serves the Xand Ku-Band Radars and the D-Band Jammer interferes an L-Band Radar.

Radar systems work in a wide band of transmitted frequencies. The higher the frequency of a radar system, the more it is affected by weather conditions such as rain or clouds. But the higher the transmitted frequency, the better is the accuracy of the radar system.

A- and B- Band (HF- and VHF- Radar)

These radar bands below 300 MHz have a long historically tradition because these frequencies represented the frontier of radio technology at the time during the World War II. Today these frequencies are used for early warning radars and so called Over The Horizon (OTH) Radars. Using these lower frequencies it is easier to obtain high-power transmitters. The attenuation of the electro-magnetic waves is lower than using higher frequencies. On the hand the accuracy is limited, because a lower frequency requires antennas with very physical size which determines angle accuracy and angle resolution. These frequency bands are used by other communications and broadcasting services too, therefore the bandwidth of the radar is limited (at the expense of accuracy and resolution again). These Frequency bands are currently experiencing a comeback, while the actually used Stealth technologies don't have the desired effect at extremely low frequencies.

C- Band (UHF- Radar)

There are some specialized Radar sets developed for this frequency band (300 to1 GHz). It is a good frequency for the operation of radars for the detection and tracking of satellites and ballistic missiles over a long range. These radars operate for early warning and target acquisition like the surveillance radar for the Medium Extended Air Defense System (MEADS). Some weather radar-applications e.g. wind profilers work with these frequencies because the electromagnetic waves are very low affected by clouds and rain. The new technology of Ultra wideband (UWB) Radars uses all frequencies from A- to C Band. UWB- radars transmit very low pulses in all frequencies simultaneously. They are used for technically material examination and as Ground Penetrating Radar (GPR) for archaeological explorations.

D- Band (L-Band Radar)

This frequency band (1 to 2 GHz) is preferred for the operation of long-range air-surveillance radars out to 250 NM (≈400 km). They transmit pulses with high power, broad bandwidth and an intra pulse modulation often. Due to the curvature of the earth the achievable maximum range is limited for targets flying with low altitude. These objects disappear very fast behind the horizon.

In Air Traffic Management (ATM) long-range surveillance radars like the Air Route Surveillance Radar (ARSR) works in this frequency band. Coupled with a Monopulse Secondary Surveillance Radar (MSSR) they use a relatively large, but slower rotating antenna. The designator L-Band is good as mnemonic rhyme as large antenna or long range.

E/F-Band (S-Band Radar)

The atmospheric attenuation is higher than in D-Band. Radar sets need a considerably higher transmitting power than in lower frequency ranges to achieve a good maximum range. Example given the Medium Power Radar (MPR) with a pulse power of up to 20 MW. In this frequency the influence of weather conditions is higher than in D-band. Therefore a couple of weather radars work in E/F-Band, but more in sub tropic and tropic climatic conditions, because here the radar can see beyond a severe storm. Special Airport Surveillance Radars (ASR) are used at airports to detect and display the position of aircraft in the terminal area with a medium range up to 50…60 NM (≈100 km). An ASR detects aircraft position and weather conditions in the vicinity of civilian and military airfields. The designator S-Band (contrary to L-Band) is good as mnemonic rhyme as smaller antenna or shorter range.

G- Band (C-Band Radar)

In G- Band there are many mobile military battlefield surveillance, missile-control and ground surveillance radar sets with short or medium range. The size of the antennas provides an excellent accuracy and resolution, but the relatively small-sized antennas don't bother a fast relocation. The influence of bad weather conditions is very high. Therefore air-surveillance radars use an antenna feed with circular polarization often. This frequency band is predetermined for most types of weather radar used to locate precipitation in temperate zone like Europe.

I/J- Band (X- and Ku- Band Radars)

In this frequency-band (8 and 12 GHz) the relationship between used wave length and size of the antenna is considerably better than in lower frequency-bands. The I/J- Band is a relatively popular radar band for military applications like airborne radars for performing the roles of interceptor, fighter, and attack of enemy fighters and of ground targets. A very small antenna size provides a good performance. Missile guidance systems at I/J-band are of a convenient size and are, therefore, of interest for applications where mobility and light weight are important and very long range is not a major requirement. This frequency band is wide used for maritime civil and military navigation radars. Very small and cheap antennas with a high rotation speed are adequate for a fair maximum range and a good accuracy. Slotted waveguide and small patch antennas are used as radar antenna, under a protective radom mostly. This frequency band is also popular for space borne or airborne imaging radars based on Synthetic Aperture Radar (SAR) both for military electronic intelligence and civil geographic mapping. A special Inverse Synthetic Aperture Radar (ISAR) is in use as a maritime airborne instrument of pollution control.

K- Band (K- and Ka- Band Radars)

The higher the frequency, the higher is the atmospheric attenuation. Otherwise the achievable accuracy and the range resolution rise too. Radar applications in this frequency band provide short range, very high resolution and high data renewing rate. In ATM these radar sets are called Surface Movement Radar (SMR) or Airport Surface Detection Equipment (ASDE). Using of very short transmitting pulses of a few nanoseconds affords a range resolution, that outline of the aircraft can be seen on the radars display.

V-Band

By the molecular dispersion (here this is the influence of the air humidity), this frequency band stay for a high attenuation. Radar applications are limited for a short range of a couple of meters here.

W-Band

Here are two phenomena visible: a maximum of attenuation at about 75 GHz and a relative minimum at about 96 GHz. Both frequency ranges are in use practically. In automotive engineering small built in radar sets operate at 75…76 GHz for parking assistants, blind spot and brake assists. The high attenuation (here the influence of the oxygen molecules O2) enhances the immunity to interference of these radar sets. There are radar sets operating at 96 to 98 GHz as laboratory equipments yet. These applications give a preview for a use of radar in extremely higher frequencies as 100 GHz.

REFERENCES

[1] *www.google .com*

[2] *Wikipedia.com*

[3] *www.radartutorial.eu*

[4] *Ahamed Maruf et.al.(2012). Rectangular Microstrip Patch Antenna at 2GHz on Different Dielectric Constant for Pervasive Wireless Communication. International Journal of Electrical and Computer Engineering, Vol. 2, No. 3, pp. 31-39.*

[5] *Ali Dheyab and Karim Hamad (2011). Improving Bandwidth of Rectangular Patch Antenna using Different Thickness of Dielectric Substrate. ARPN Journal of Engineering and Applied Sciences, Vol. 6, No. 4, pp. 16-21. Balanis, Contantine A. (1997). Antenna Theory – Analysis and Design. John Wiley & Sons Inc., 2n Edition, pp. 722-*

[6] *Dafalla (2004). Design of a Rectangular Microstrip Patch Antenna at 1GHz. RF and Microwave Conference, Subang, Selangor, Malaysia, pp. 145-149. D. D. Sandu et.al.(2003). Microstrip Patch Antenna with Dielectric Substrate. Journal of Optoelectronics and Advance Materials, Vol. 5, No. 5, pp. 1381-1387.*