BATTLEFIELD SURVEILLANCE RADAR

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Abstract. This review article outlines the operational requirement for Battlefield Surveillance Radar, and the design challenges that result. It is shown that the clutter problem on the battlefield leads to a Pulse Doppler solution. Design requirements are outlined and a typical current design is addressed. Possible future developments are discussed, and it is argued that future developments will be driven by the need for covert operation, with a drive towards active phased array antennas and LPI waveforms. In both cases, this takes advantage of expected advances in technology, and will lead to a more effective equipment.

REQUIREMENT

Ground-based Battlefield Surveillance Radar is intended to provide coverage of the local area, detecting all targets of interest out to the local horizon. The distance to this horizon depends on the terrain, but is typically 6 km in North West Europe. In other part of the world, however, the terrain is flatter, giving longer horizon distances. These considerations lead to a typical range requirement of anything from 6-25 km for radars of this type.

Typical targets would be:

- tanks and other moving vehicles,
- personnel,
- spoil from fall of shot from own mortar and artillery firings, and
- helicopters.

The main difficulty faced by the radar is the competing radar echo provided by the stationary clutter background. This tends to be very much larger than the echoes from wanted targets, and results in the need to use Doppler discrimination. This allows good clutter rejection, and also gives some capability for target classification on the basis of radial velocity measurement. Since there is also a requirement to measure target range, the obvious radar design is pulse Doppler.

INTERNAL COHERENCE AND CLUTTER REFERENCE AS DOPPLER RADAR DESIGNS

All Doppler measuring radars operate by comparing the frequency of the target echo with that produced by the transmitter. The idea is illustrated in Figure 1.

Any movement by the target towards or away from the radar results in a frequency change in its echo, caused by the Doppler effect. In the radar receiver, this target echo is compared directly with a reference waveform from the transmitter, and any difference in frequency is extracted. The value of this difference is then measured in a bank of filters. Echoes from stationary clutter are not Doppler shifted and consequently do not produce a frequency difference to be measured and detected by the filter bank. Hence moving targets are detected by virtue of their motion, while the competing clutter echo is suppressed. This type of radar detection is known as internally coherent detection.

However, it should be noted that the target echo is subject to the time delay caused by the echo time. Therefore it is very important that the transmitter frequency does not change between transmission and reception. If this does happen, then the Doppler measurement would contain an error that would cause stationary targets to appear to have non-zero Doppler. This places a severe stability requirement on the transmitter. Nowadays, this requirement is easy to meet, and so all modern systems are internally coherent, since this is by far the best method. However, in the past, transmitter stability was not normally good enough, and this led to the use of clutter reference as a method of extracting the Doppler from moving targets. Since equipments using this method still exist around the world, it is necessary to mention the technique, and Figure 2 illustrates the idea.

Clutter reference radars do not feed the transmitter

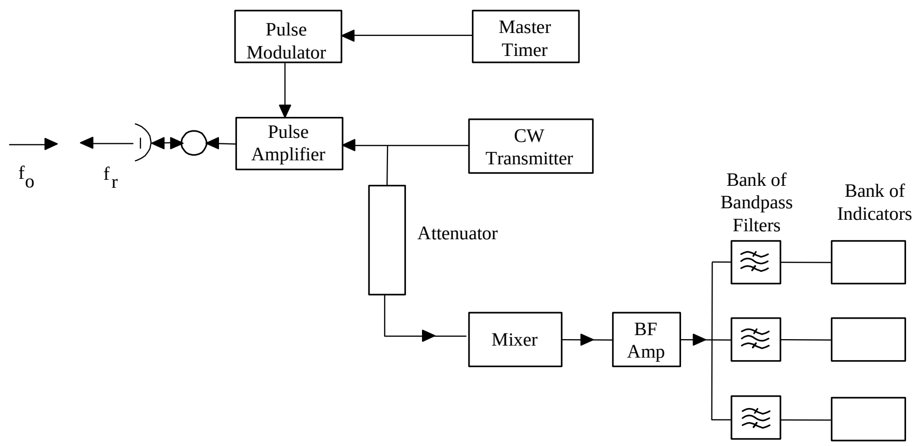

Figure 1. Block diagram of a pulse doppler radar.