HF Comms and the detection thereof

HF Communications

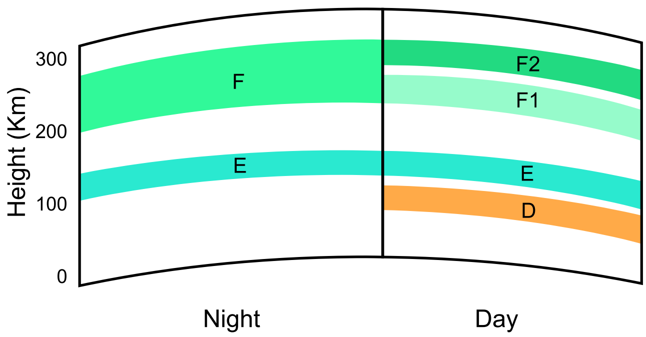
Effective communication has consistently proven to be of immense value during times of conflict. A robust communication infrastructure, facilitating the timely sharing of information, plays a crucial role in saving lives.

Battlefield communication ecosystems must be multilayered and provide resilience due to sophisticated electronic warfare systems. EW Counter measures will engage as soon as a threat within the threat profile of interest is detected. Such counter measures could completely inhibit high speed conventional communication channels and hence a second layer within the ecosystem should be in place.

One such communication system within the battlefield communications ecosystem is secure HF communication. For obvious reasons, HF communication systems are still in use today and is a sought-after method of communication to deploy throughout theatre.

NVIS propagation

One method employed by HF communications is a method of propagation called near vertical incident skywave (NVIS). The usability and effectiveness of such propagation method relies on the installation setup, type of antenna used and the ionospheric conditions.
For the NVIS propagation method to work, the ionosphere needs to refract transmitted HF signals back to earth, this is accomplished if the ionospheric conditions are such that layers of ionised particles reflect back to earth the original transmitted signal. The ionosphere is divided into various layers called the F, D and E layers.



Ionospheric layers

NVIS communications are transmitted on frequencies that are low enough to be refracted by the F layer. If the signal has too high frequency, it will not be refracted and will merely pass through the F layer. Then again, it is also important to note that the selected frequency of transmission needs to be high enough to not be excessively attenuated by the D layer if chosen too low.

NVIS communications uses frequencies within the 2 - 10MHz range. The highest frequency used is called the Maximum Usable Frequency (MUF). Any frequencies higher than the MUF frequency, passes through the ionosphere and is not refracting back to earth.

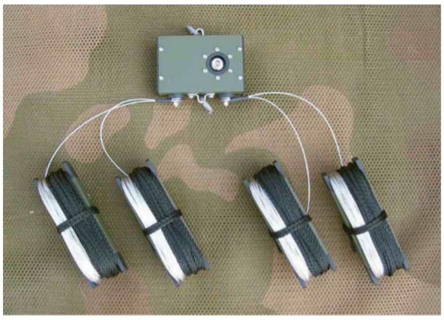
Likewise, when the signal frequency is chosen at a lower frequency, that lowest frequency cannot be lower than the Lowest Useable Frequency (LUF). When this happens too much of the signal gets attenuated. Note though that the LUF can be influenced by using higher transmit power as well as better antennas, which all contribute to a better system. But MUF on the flipside is totally dependent on the ionosphere.

So how do you know if you are transmitting far enough? The signal leaves the transmission antenna at a certain angle relative to earth. This is called the take-off angle. The take-off angle of the signal can be determined.

When the desired signal take-off angle is achieved, the transmitted signal will be refracted off the ionosphere at an angle and then transmit back to earth. Achieving the correct take-off angle has its roots in proper antenna choice and proper antenna placement with reference to ground. The higher the antenna is elevated above ground the lower the take-of angle and visa-versa. A low take-off angle results in a further transmission distance.

To implement the Near Vertical Incidence Skywave (NVIS) propagation method through a tactical setup, users commonly employ Alaris Antennas RWD125 or RTD2530 antennas. These antennas are typically paired with masts of varying lengths to achieve the required take-off angle.

Alaris Antennas also offer higher power versions of such antennas called the RWD500, DIPL-A0089 and RWD1000/1.5. The higher power version products can be deployed as permanent locations or as quick deployment solutions.



RWD125 (RA01-116-01)

RTD2530 (RA01-1022-01)

RWD1000/1.5 (RA01-0130-01) and DIPL-A0089

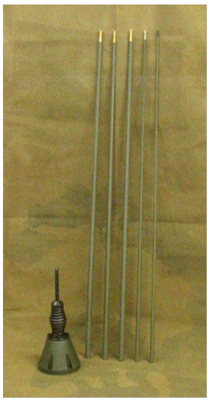
RWD500

Ground wave propagation

A second propagation method is ground wave communications.
For groundwave communication methods, a vertically polarised monopole whip antenna element is normally used, with an automatic tuning unit (ATU). Ground wave communication is highly dependent on the conductivity of the ground and the frequency of the transmitted signal. High conductivity offers greater transmit distance.

Alaris Antennas provide several groundwave antennas to be used on vehicles such as the HF5M below.

In summary, HF secure communications continues to be a valuable tool in long-distance, and reliable communications, with ongoing technological advancements and adaptability to changing needs.



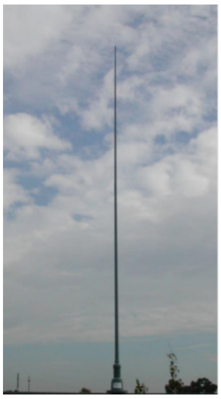
HF5M Vertical whip element
(ATU not included)

It serves either as a primary communications link or as a crucial backup system within the layered communications ecosystem, when other communication methods, such as SATCOM, are compromised. Thus making it a key component in ensuring command and control in challenging environments.

Monitoring HF signals

When transmitting signals across the electromagnetic spectrum, it becomes crucial for the receiving party to detect and pinpoint the location of the emitter. This is especially pertinent in high-frequency (HF) spectrum communication scenarios, where secure communication is paramount. Alaris Antennas specializes in providing comprehensive antenna solutions for spectrum monitoring, offering both active and passive monitoring antennas.

For ground wave propagation, the MONO-A0012 whip, used in conjunction with the MISC-A0022-01 power supply unit, is the preferred choice. Alternatively, for Near Vertical Incidence Skywave (NVIS) propagation, the DIPL-A0056-10 is recommended.



MONO-A0012 whip

DIPL-A0056-10 deployed

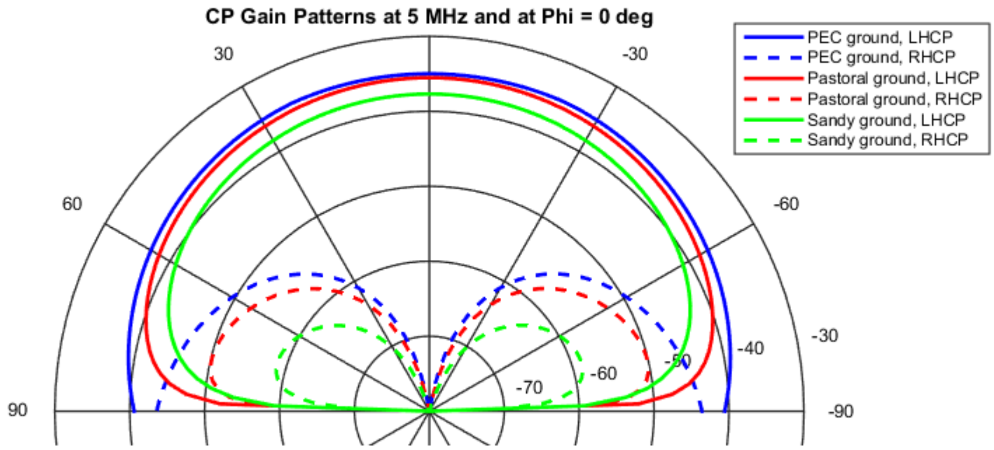
Direction Finding of HF Signals

Alaris Antennas excels in supplying antennas designed for determining the line of bearing for both NVIS and groundwave transmissions. Given the low operating frequency, large baseline arrays with elements spaced strategically are essential. Antenna elements with hemispherical radiation patterns are required for receiving NVIS transmissions. Circularly polarized cross loop elements, such as the Alaris Antennas DF-A0115 and DF-A0049, are employed for this purpose. The DF-A0115 is considered strategic and requires a concrete plinth for installation, while the DF-A0049 is a tactical unit designed for easy deployment and relocation.

Pictures of the two antennas and a typical radiation pattern below:

DF-A0115

DF-A0049



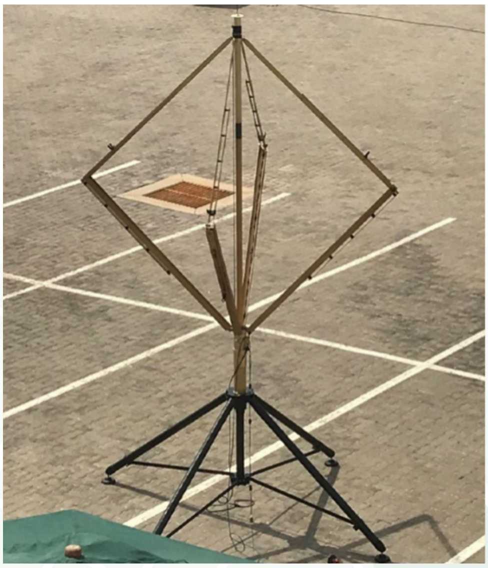
Hemispherical radiation pattern to allow NVIS reception

The user can parallel sample the array elements and feed the data to an estimation algorithm to determine the line of bearing for received spectra. Clients have the flexibility to use individual elements spaced in various configurations, such as circles or L-shaped patterns. Single side location estimation methods are feasible with large aperture arrays.

The DF-A0115 and DF-A0049 elements can also be configured for ground wave mode, simplifying the process by requiring only one array instead of two, as conventionally required. Alaris Antennas has successfully deployed DF-A0115 elements strategically in multiple countries for various clients.

Simulated array manifold data is offered to facilitate the integration process of the DF-A0115 and DF-A0049 elements. This data includes information for different ground types, such as PEC, Sandy ground, and Pastoral ground, aiding clients during their deployments.

For tactical groundwave DF solutions, Alaris Antennas provides the DF-A0016 and DF-A0048-01 Adcock DF antennas. These solutions offer fully contained Adcock DF outputs (N/S, E/W, and OMNI channels) and can be used with any Adcock processor using the ARCTAN() method for resolving the line of bearing.



DF-A0016 deployed

DF-A0048-01 deployed

Known for innovation in RF solutions, Alaris Antennas invites inquiries for any HF communications antenna requirements, whether for using or detecting HF spectrum.