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Q-MAC ELECTRONICS

HF TRANSCEIVERS & ANTENNA SYSTEMS

HF HELP FILES

HF PROPAGATION

Q-MAC Electronics Pty Ltd

HF HELP FILES

HF Propagation

HEAD OFFICE 142 Hasler Road, Osborne Park WA 6017. Australia
Telephone: +618 9242 2900, Facsimile: +618 9242 3900
Email: info@qmac.com
Web: www.qmac.com

1 HF Propagation

HF radio signals (2-30MHz) can propagate from one location to another via ground wave (line of sight) and via the ionosphere.

1.1 Frequency and angle of radiation

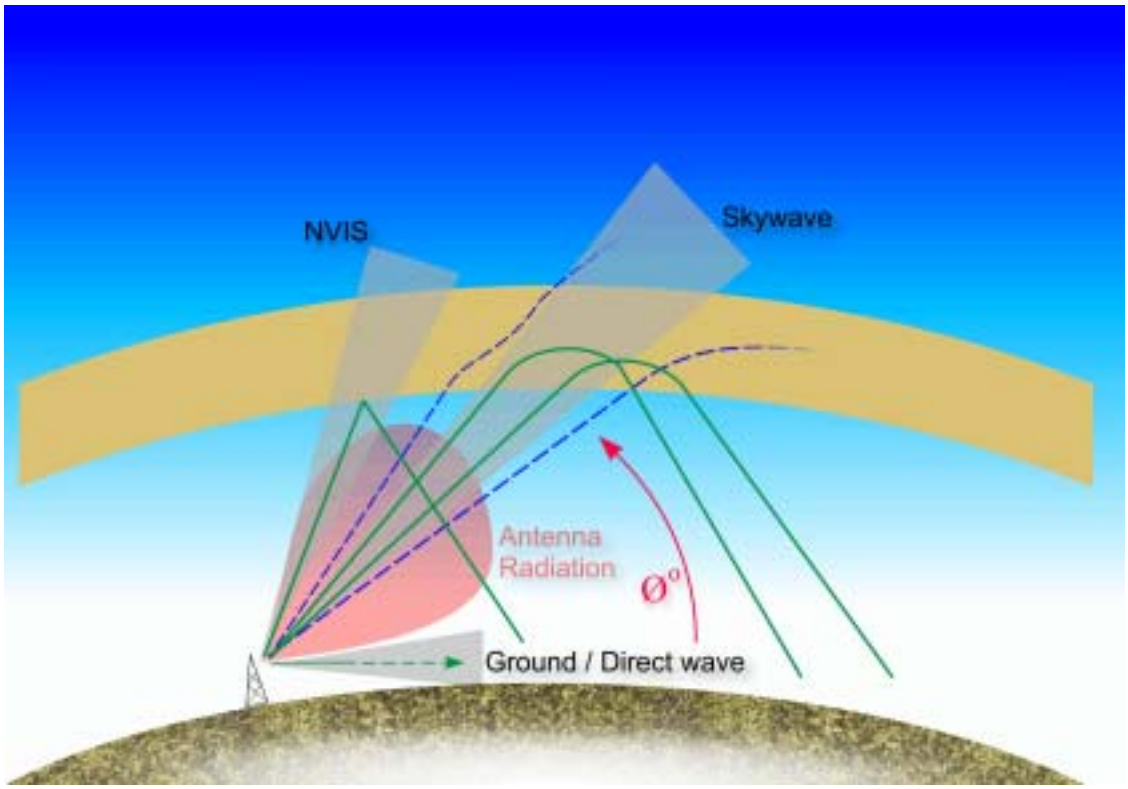

Figure 1 Frequency and angle of radiation

Energy is radiated from the antenna in an envelope. The shape of this envelope is dependent on the design of the antenna and the frequency being transmitted.

There are three portions of this radiation that are useful for communications. These useful portions are distinguished by the angle they radiate from the antenna. In the above diagram they are represented by the grey shaded triangles labelled NVIS, Skywave, Ground / Direct wave.

Note that the blue portions of radiation in Figure 1 represent angles at which the radiation either passes through the ionosphere or is totally absorbed by the ionosphere.

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1.2 Ground / Direct Wave

Ground wave communications are possible over relatively short distances. The effective distance achievable depends primarily on the conductivity of the terrain over which the signal passes. In extremely dry conditions, the signal may only travel a few kilometres; over water the signal may travel 100's of kilometres.

Typical ranges for different terrains:

Desert:	<15km
Moist farmland:	30km
Seawater:	100km

Dense tropical jungle will also dramatically attenuate (limit) the range of a ground wave.

Lower frequencies will provide the best range overall. But the noise floor on frequencies less than 3 to 4MHz is typically too great to be useful, especially during the day.

The optimum frequency range for ground wave is 4 – 8 MHz.

Doubling the output power on a ground wave signal will improve effective range by less than 2%. To double the range of a ground wave signal requires an increase in output power by a factor of 16!

1.3 Skywave

Propagation via the ionosphere is known as skywave propagation. This is the portion that is most commonly perceived as providing good long range communications.

In general, as frequency is increased, the angle (¢ in Figure 1) of the radiated envelope to the horizon becomes smaller (radiation is focussed more horizontally). Therefore, an increase in frequency leads to an increase in distance for a skywave (ref. Figure 1). The distance at which a skywave returns to earth is called the hop or **skip distance**, and the area in between is called the **skip zone**.

The state of the ionosphere is constantly changing, primarily due to the daily cycle of day and night. At night, the skywave also returns to earth at a greater distance because it is refracted from a higher layer in the ionosphere.

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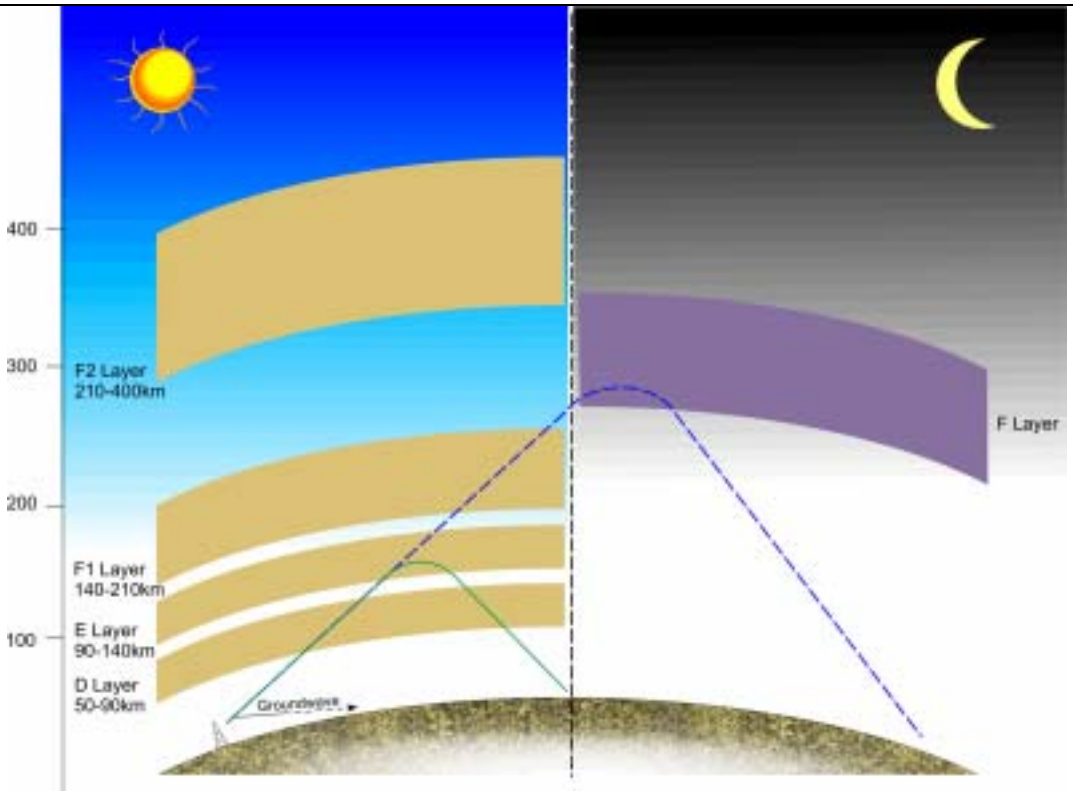

Figure 2 The effect of changing ionospheric layers

The same frequency will be refracted at a higher layer in the ionosphere during the night and will return to earth at a greater distance than it would during the day.

Using skywave propagation, it is possible to achieve typically 100 – 800km range.

The effective range of skywave propagation is primarily dependent on:

- Antenna System
- Frequency
- Time of Day

Optimum frequency range is 3 – 15MHz.

1.4 NVIS – Near Vertical Incident Skywave

The third portion of antenna radiation that is useful for communications, leaves the antenna at a near-vertical angle (ref. Figure 1) and is reflected back to the earth and providing good communications from 0 to 800km.

NVIS is exceptionally effective because it eliminates the skip zone and provides continuous coverage from the transmitter out to approximately 800km. It is ideally suited to regions / terrains of high attenuation (e.g dense forests, mountains, etc).

Effective NVIS propagation is primarily dependent on the design of the antenna system being used and choosing the correct frequency for the time of day.

Frequencies that provide good NVIS coverage are:

4 – 8 MHz during the day

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2 – 4 MHz during the night.

The Q-MAC ML-90 Magnetic Loop Antenna offers exceptional NVIS performance.

1.5 Summary

The primary factors that determine effective HF communications are:

- Frequency
- Time of day
- Antenna System
- Noise (NB. Electrical)
- Conductivity of terrain (ground wave propagation)

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2 Other Information

2.1 Author

Mr Rod Macduff BSc, BA, MIEEE, MIEE, FIEAust

Rod Macduff is Managing Director of Q-MAC Electronics which is a specialist supplier of HF Communications to the Humanitarian, Aid & Relief and Military organisations. Rod Macduff worked with Racal BCC for 10 years on the Jaguar V tactical hopping radio and travelled extensively consulting with armies on their secure communication issues. The Q-MAC HF-90 hopping radio is in service in 75 nations and has been adopted by Humanitarian, Aid & Relief, Army, Police and Intelligence organisations.

2.2 About Q-MAC Electronics

Q-MAC Electronics is specialist designer and manufacturer of HF Transceivers. The flagship product the HF-90 is the world's smallest high performance HF SSB Transceiver. The HF-90 and Q-MAC Electronics have been awarded many accolades and is currently used by thousands of users in over 80 countries worldwide. The HF-90 is one of the most versatile HF transceivers available and is suited to military, paramilitary and humanitarian aid and relief applications.

Q-MAC offers the HF-90 in a variety of configurations suited to manpack, vehicle and base station applications. A full complement of accessories is also offered for use with the HF-90; including antennas, field battery charging accessories, carry packs/cases and more. All Q-MAC products are backed by the company's strong commitment to after sales service, support and certified ISO9001 quality standards.

2.3 Contact Details

For Further Information Contact;

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