THE WEST RAND AMATEUR RADIO CLUB

June 2003
Volume 3, Issue 11

ANODE

Inside this issue:

Editor's Comments

The A.g.m. is Coming!

Yep, soon you will be getting the snail mail notifications for the Annual General Meeting. Please attend and vote in the new committee.

We have an excellent article on Antenna's and propagation for you in this issue of the Anode. It might be nearly 20 years old but it explains a lot of basic principles.

"Amateur Radio is DEAD man"

Well, I don't think so just yet. A search of 'amateur+radio' on Google turned up over 1.5 million pages. The newsgroups, 'rec.radio. amateur', have plenty of new and interesting questions from new amateurs and experimenters.

The International Space Station (www.ariss.net) appears to be back on packet (145.800MHz) but there are no ZS stations on the log.

PEARS Microwave & Digital contest

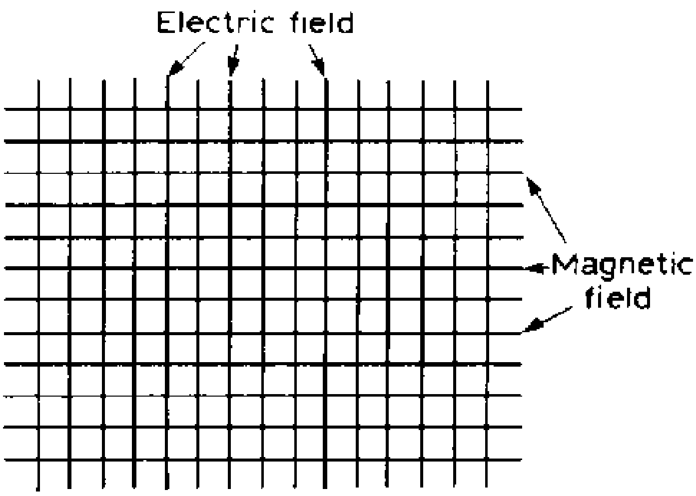
The first-ever Microwave contest in the RSA, running concurrently with the second Digital contest, will take place from 1800 SAST on Friday 13 June until Sunday 15 June 2003.

The microwave contest

(Continued on page 2)

An Introduction to Antennas

by Gordon J. King T. Eng(CEI), AMIERE, G4VFV - Practical Wireless article August 1984



A radio signal is part of the electromagnetic wave family—like light, infra-red, X-rays, etc—and can be regarded as a form of dynamic energy. It has the astonishingly high velocity of 300,000km/s which means that it will travel 300m in 1ps. Nothing can travel faster than an electromagnetic wave - nothing, that is, which we know of at the present? It is called an electromagnetic wave because it consists of two intrinsically linked component parts - an electric field and a magnetic field - which have the ability to exist in a

(Continued on page 2)

Special points of interest:

- Contact details on back page

Editors Comments

(Continued from page 1)
features both terrestrial and EME categories and covers the 1,3 - 2,3 - 5,6 - 10 - 24 and 47 GHz bands. CW or any analogue mode may be used. The Digital contest also includes the abovementioned categories but covers 50, 144, 432 and 1296 MHz bands where JT6M, JT44, PSK31 and WSJT are permitted.

The 48 hour contest over the long weekend may offer wonderful opportunities to establish very long distance records, especially where Rover operators are active.

DX Cluster JHB Area - back on air

QTH: Bramley Johannesburg.
Frequency: 144.725 MHz
packet mode 1200Bd.
At this stage you can only monitor the packets that will carry up to minute DX information .

DX Cluster is linked via telnet session to OH2AQ DX Cluster in Columbus , Ohio , USA.

Call sign: at this stage (till software licence is sorted out) is ZS6MG. Dedicated / ICASA assigned and licensed call sign for future will be ZS0DXT.

Please circulate this info to all HAM's interested in DX activities. All reports and comments regarding signal of the DX Cluster station are gladly welcomed and appreciated . Any ideas of linking it up to PTA area??? Or East Rand , West Rand ....South ..

Please let me know .
73 Vlado ZS6MG
(vlado@multisource.co.za)

Dates of Note

13 - 15 June - PEARS mid-year Microwave and Digital contest
www.sarl.org.za

(Continued on page 5)

An Introduction to Antennas

(Continued from page 1)
vacuum without any conductive supporting medium. The velocity of wave travel just given, in fact, applies to space travel. The carrier wave is generated by a powerful oscillator and the energy is launched into space by the transmitting antenna. The electric and magnetic components are perpendicular to each other and to the direction of wave travel. This means that an electromagnetic wave is a transverse wave as distinct from the longitudinal type of wave, such as a sound wave whose supporting particles vibrate in the same direction as the wave travels.

In Fig. 1.1 (a) I have attempted to give an impression of an electromagnetic wave front advancing towards you out of the page, while Fig. 1.1 (b) gives a rough idea of how the electric and magnetic components effectively link together at right-angles on their trip through space. The two components, of course, are alternating in polarity at the carrier frequency of the radio signal. Let us consider the wave starting on an alternating electric field. This automatically creates an alternating magnetic field which then produces an alternating electric field, and so on, each one being at right-angles to the other as the wave spreads out into Near the transmitting an-

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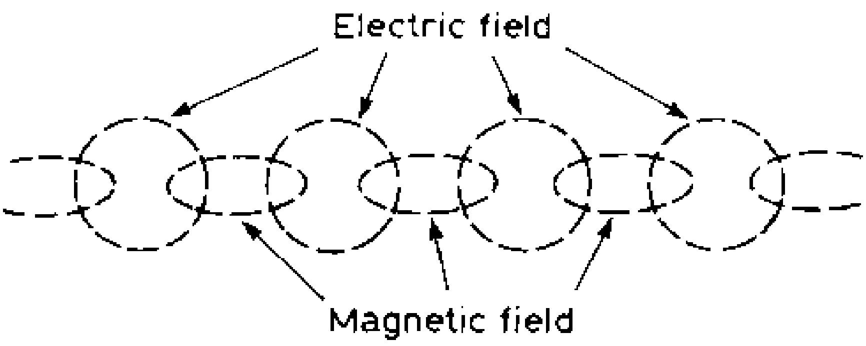


Fig. 1.1 (b)

An Introduction to Antennas

(Continued from page 2)

Table 1.1		
Band Frequency Range	**Wavelength**	**Definition**
v.l.f.	3 to 30kHz 100km to 10km	myriametric
l.f.	30 to 300kHz 10k to 1km	kilometric
m.f.	300 to 3000kHz 1000 to 100m	hectometric
h.f.	3 to 30MHz 100 to 10m	decametric
v.h.f.	30 to 300MHz 10 to 1m	metric
u.h.f.	300 to 3000MHz 1 to 0.1m	decimetric
s.h.f. 3 to 30GHz	10 to 1cm	centimetric
e.h.f. 30 to300GHz	1 to 0.1cm	millimetric
300 to 3000GHz	0.1 to 0.01 cm	decimillimetric

tenna the electric and magnetic fields alternate 90 degrees out of phase with each other, but as the wave spreads away from the antenna and the wave becomes what is known as a plane wave, so the two components get into step and remain that way. An electromagnetic wave can thus be looked upon as a sine wave. This, of course, applies to the carrier wave part of the radio signal.

Unless a pure tone is being carried by the wave the audio information will be far removed from a simple sine wave. I will go into this modulation business later.

Frequency and Wavelength

Let us suppose that the radio signal falls in the very high frequency (v.h.f.) f.m. band (Band II) at say, 96MHz. This means that the vibration rate or frequency of the carrier wave is 96 million times per second—obviously, far too fast for human ears to detect—and we can represent it by a sine wave as shown in Fig. 1.2. Now, the distance occupied in space by one cycle of this signal is equal to the velocity in space divided by the frequency. When the frequency is given in MHz, the formula merely resolves to:

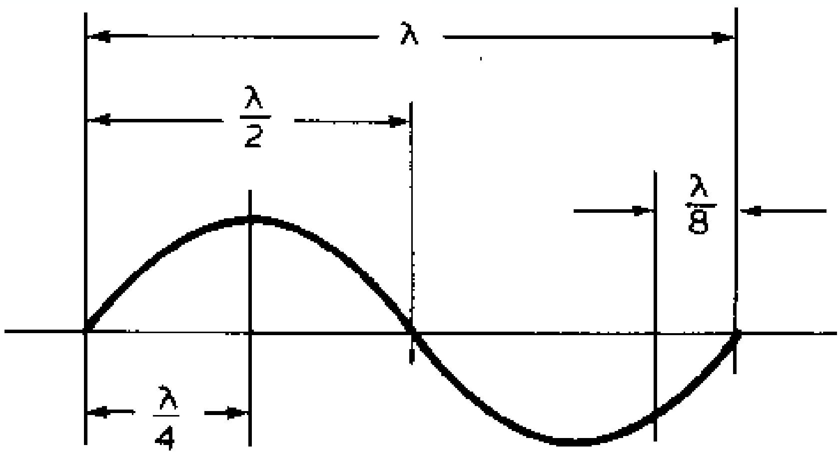


Fig. 1.2

Wavelength (l) = 300 / frequency (f) MHz in metres

You will see from this that the distance occupied in space by one cycle has now been called wavelength since wavelength is, in fact, equivalent to one complete cycle, as shown on Fig. 1.2. In radio antenna applications we often work in submultiples of wavelength such as 1/2 and 1/4, where you will have noticed that the term wavelength is signified by the Greek letter lambda (l). Frequency is denoted by the lower case f

(Continued on page 4)

An Introduction to Antennas

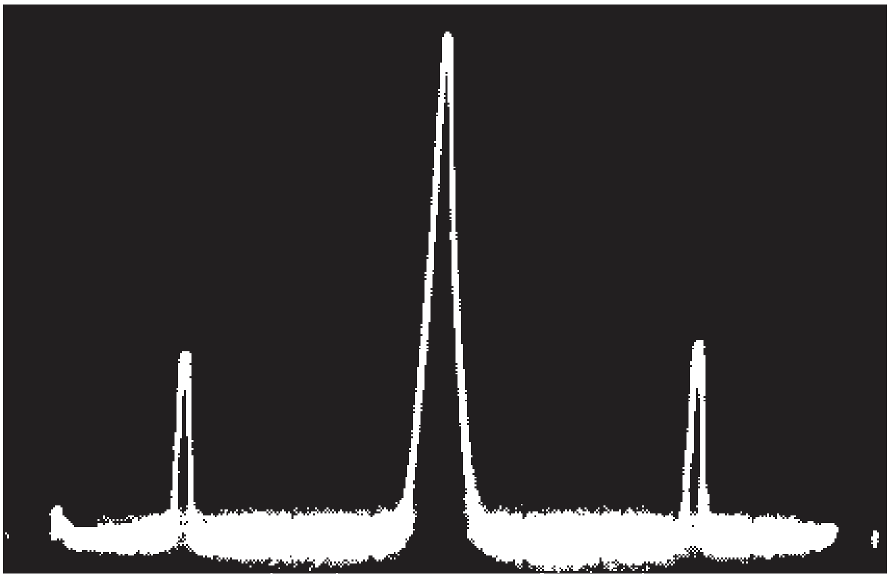
(Continued from page 3)

while wavelength is given in metres (m) or sub-multiples thereof. Using the above formula, therefore, we find that our v.h.f. f.m. signal at 96MHz has a wavelength of 300/96, which works out to 3.125m. The l/2 is thus close to 1.56m and the l/4 close to 0.78m. It is very important to remember that these apply to the radio signal in space.

When a radio signal travels through an antenna conductor or along a feeder then its velocity is reduced from the space value by factor v which is known as the velocity factor, more about which anon. Anyway, knowing either l or f we can easily find the other for example, f (MHz) = 300 /l (m)

Radio Wavebands

Table 1.1 Lists the various radio wavebands with their frequencies and wavelengths. For "entertainment" radio we are mostly interested in the f.m. v.h.f. part of the spectrum which so far extends from about 88 to 108MHz (3.4 to 2.7m). If we have a tuner with a.m. bands then we might



also be interested in the long waveband (L.W.) from about 150 to 285kHz (2000 to 1185m) and the medium waveband (c.w.) from about 535 to 1600kHz (560 to 187m).

Some tuners, especially those destined for overseas markets, are also equipped with an h.f. (high frequency) band or bands, the full scope of h.f. extending from 3 to 30MHz (100 to 10m), as shown in Table 1.1, and sometimes called the short waveband. The range of a radio signal is influenced both by its frequency or wavelength and the nature of the lower and upper atmospheres above the earth's surface; but before we delve into this let's get some clearance on modulation.

Modulation

The part of the radio signal, which carries the audio information, is, as we have seen, the electromagnetic carrier wave. The audio signal can be applied to this in various ways, but the two ways in which we are most interested are by varying the amplitude of the wave and by varying its frequency slightly either side of the mean carrier frequency. The first is called amplitude modulation (a.m.) and the second frequency modulation (f. m.).

Amplitude modulation is used on the signal in the long, medium and short wavebands, though there are a.m. stations transmitting in the higher frequency bands.

What happens is that after the carrier wave has been generated the audio information is super-imposed upon it in such a way that the amplitude of the wave is caused to alter in sympathy with the audio. Let's suppose that the audio is a pure tone represented by a sine wave, then the carrier plus the modulation gives rise to the nature of the signal shown in Fig. 1.3(a). When frequency modulated the amplitude of the carrier remains constant but this time the frequency of the carrier itself deviates slightly either side of its nominal value by an amount corresponding to the intensity of the sound being carried and at a rate corre-

(Continued on page 5)

Editors Comments

(Continued from page 2)

16 June Youth Day - Kids Day
21 - 22 June - All Asian DX CW Contest
28 June - Home Constructors Open Day at the West Rand Club
28 - 29 June - ARRL Field Day

RADIO LAW: N.J. MAY BAN "EVERYTHING" WHILE DRIVING

New Jersey state lawmakers are proposing a wide ranging law that would not only ban the use of cellular telephones in motion, it might also ban just about anything else a person might do while driving a car including sipping coffee or changing a radio station.

According to the May 11th Ocean County Observer, the state Assembly Transportation Committee has released a bill to better define what is and what is not considered to be reckless driving. Proponents of the measure call it an effort to reduce motor vehicle accidents caused by driver distraction.

The proposed legislation says distracting behaviour includes the use of communication technology such as cellular telephones, pagers, fax machines, locating devices, video players, two-way dispatch and citizen band radios.

Also on the list is the normal AM/FM radios found in most vehicles along with compact disc and tape players.

The bill also defines a variety of things that have been labelled as distracting behaviour. On this list are such activities as personal grooming, consuming food or beverages, reading and tending to unsecured pets. All would be considered as reckless driving.

State Representative John Wisniewski of Middlesex is

(Continued on page 9)

An Introduction to Antennas

(Continued from page 4)

sponding to its frequency. The rate of deviation is thus greater for a modulating signal of 10kHz than one of 1kHz, while the extent of the deviation is greater for a loud signal than a soft one. The modulation index, as it is called, is equal to the frequency of deviation divided by the frequency of the modulation or:

Modulation index
(M) = fd / fm

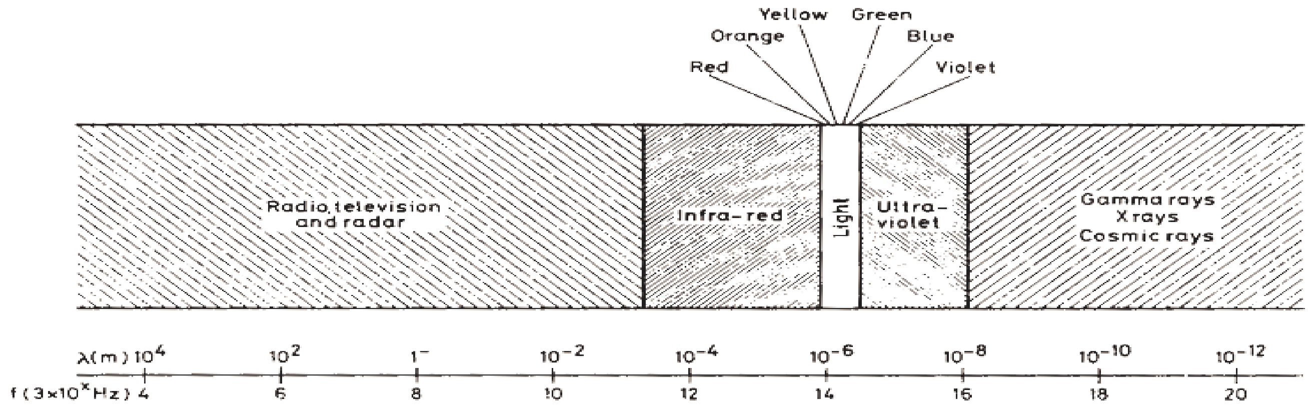
The fm. case is shown in Fig. 1.3(b) and it is the modulation index (M) which determines the sideband structure of the net signal in a somewhat complex mathematical manner. It is obviously outside the scope of this particular series of articles to delve deeply into the mathematics of modulation; but if we have a pure audio signal of say, 1kHz amplitude modulating a carrier wave of frequency f then the net signal can be analysed to reveal the carrier at f and two sidebands, the lower at f 1kHz and the upper at f + I kHz. Sideband amplitude depends on the modulation depth, each being half the amplitude of the carrier when the modulation is 100 per cent (when the troughs of the top and bottom modulation envelopes meet) and non-distorting. The maximum modulation on Band II is fixed at +75kHz deviation so that M would be around 5 assuming an upper frequency response at 15kHz, though this can be modified by pre-emphasis the quality of the programme material and by the stereo sub-channel components. However, instead of the one pair of a.m. sidebands, our 1kHz modulating frequency in the f.m. case produces multiple pairs of sidebands either side of f at + 1kHz, f+2kHz, f+3kHz etc (all spaced from each other by 1kHz, the modulating frequency). These spread quite a long way from f depending on the modulating signal itself (e.g. M), and their amplitudes are also influenced by M. Fig. 1.4 (a) shows a pair of a.m. sidebands, while (b) shows a lab

(Continued on page 6)

An Introduction to Antennas

(Continued from page 5)

spectrogram of the multiple sidebands of an f.m. stereo signal. The bandwidth required by an a.m. signal is thus less than that required by an f.m. signal when both are modulated with the same audio. If we modulate to, say, 15kHz on a.m. we can get away with a bandwidth of 2x 15kHz or 30kHz, while on f.m. for the same modulating frequency we require a band width of 200kHz or more at +75kHz deviation, especially in stereo mode, and even then we may not be fully embracing all the upper-order pairs of sidebands, but fortunately we do not need to bother too much only 9kHz a.m. so now you can also understand why it is impossible to achieve hi-fi results on the L.w. and m.w./a.m. system since 9kHz bandwidth implies an upper frequency audio response around 4.5kHz, which is hardly hi-fi! Frequency modulation also has other attributes, including enhanced signal/noise ratio and hence dynamic range, capture effect where the tuner is "captured" by the stronger of two signals on or near the same frequency when the wanted one is only slightly stronger than the unwanted one (on a.m. this would cause an annoying whistle) and, of haves more and more like light. That is, it is reflected, refracted, diffracted and has a tendency to cause shadows behind large objects—not visible ones, of course, but radio shadows as they are called where radio reception is cut off. To some extent these characteristics are demonstrated at v.h.f. which we use for f.m., they are demonstrated more dramatically at u.h.f. the frequencies we use for TV, and even more so at s.h.f. and e.h.f. (standing for ultra high frequency, super high frequency and extremely high frequency).



about the least significant sideband pairs as they do not contribute much to the audio quality, anyway.

You can appreciate now that it would be impossible to fit a viable number of f.m. stations into the l.w. and m.w. bands, which is the reason why v.h.f. is used for f.m. where there is much more elbow room. Channel spacing is 200kHz f.m. and course, the prevailing capability of stereo reproduction—though this is also possible on a.m.

It is useful to see where the "radio" bands reside in the overall electromagnetic wave spectrum and for this I have included the simplified diagram in Fig. 1.5. As a radio wave approaches the wavelength of light so it be-

Propagation

This, then, neatly brings us to the topic of propagation. This again is highly mathematical and somewhat abstract so I do hope the more knowledgeable readers will forgive my venture into simplification. A radio signal emanates from a transmitting antenna as an expanding sphere of electromagnetic en-

(Continued on page 7)

An Introduction to Antennas

(Continued from page 6)
ergy, though the design of the antenna may be such to concentrate the energy more in one direction than others round the compass, perhaps to elevate it skywards or to concentrate it in a "beam" more or less horizontal to the ground.

Our planet is protected (fortunately!) by a gaseous atmosphere extending to a height of about 1000km above its surface which has the highly desirable effect of filtering out excessive u.v. radiation. Sadly, so it is being inferred, we earth inhabitants are tending to destroy this filtration - by different kinds of pollution with the effect of a rise in u.v. emission at the surface of the earth, a change in the weather pattern and so I would forecast, a probable change in radio wave propagation which I can't help feeling I am beginning to detect already.

Just how the signal is propagated depends on its frequency and hence wavelength, the conductivity of the release of electrons by ionisation of the gases of the earth's outer atmosphere due to ultra-violet (u.v.) radiation from the sun and hence the conditions prevailing on the sun, time of day, time of year, and the earth's local atmosphere (troposphere) as dictated by the weather conditions.

The ionosphere

The u.v. emission from the sun alters over an 11-year cycle which is denoted by the so-called sun-spot number (though is now seems that the cycle is longer than this). When the sun-spot number is at its peak the u.v. emission strengthens the ionisation, the electron density and hence the degree by which the ionosphere, as it is called, returns radio signals back to earth. Sunspot cycles have been recorded for many years and the average number works out to about 120. ionisation is negligible in the earth's lower atmosphere but reaches a value sufficient to affect radio waves at a height approaching 100km.

The ionisation is brought about by the solar radiation—u.v. radiation and X-ray radiation—stripping the electrons from the atoms of the rarefied gases. A relatively high value of ionisation is maintained up to about 300 to 500km, the electron density then tapering off with increasing height.

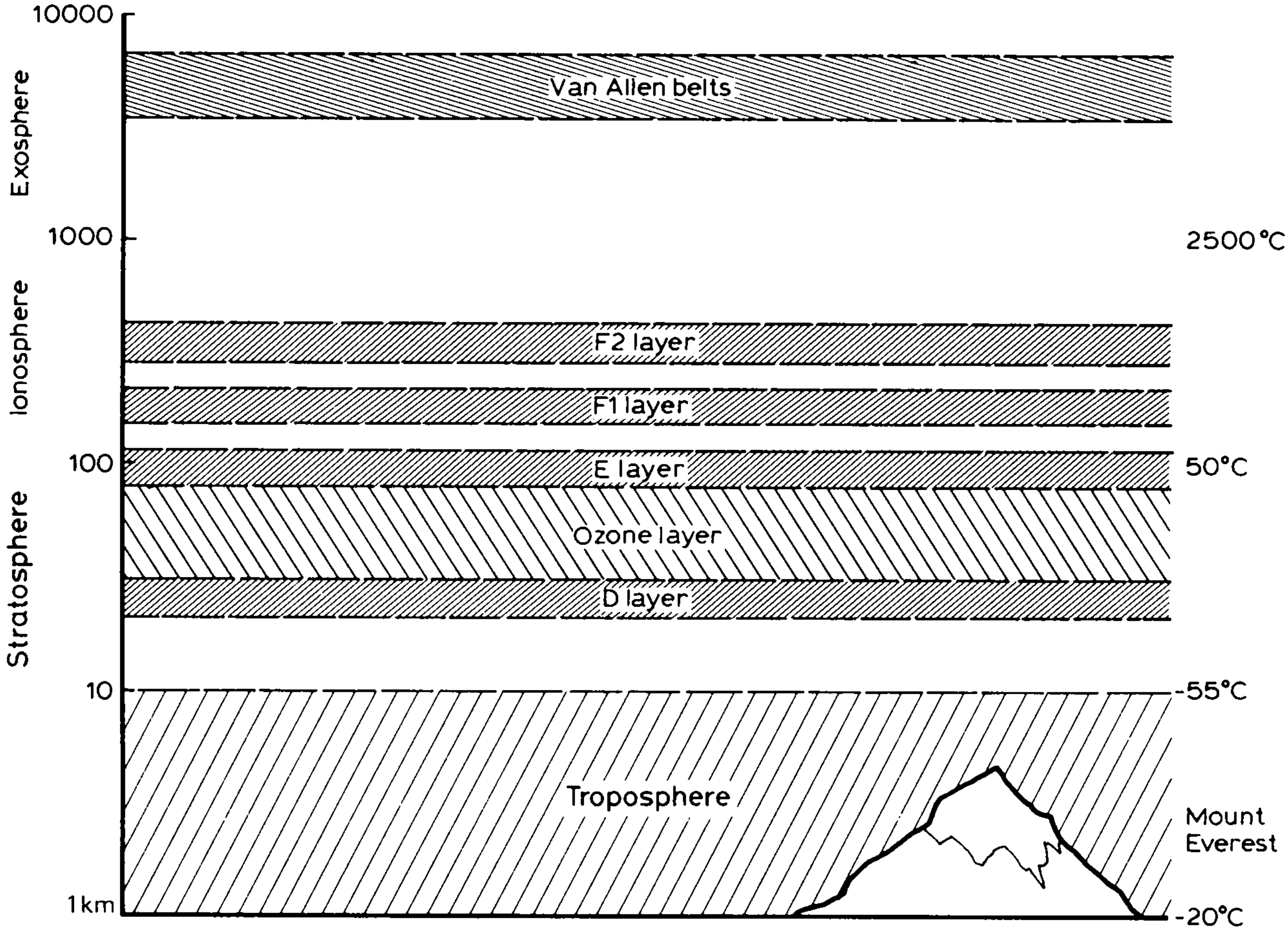
Rather than being held in a thick band, the ionisation separates into defined regions, called layers, at different heights. Each layer has a changing electron density whose most dense region is known as the peak of the layer. This maxima or peak may not be at the centre of the layer and neither does the ionisation vanish completely between the so-called layers. The degree of the ionisation is almost wholly governed by the intensity of the u.v. radiation from the sun, and different wavelengths of radiation ionise different gases. The u.v. radiation is progressively absorbed owing to energy lost in the production of the ionisation as the radiation passes down through the atmosphere so by the time it reaches the earth's surface it is almost completely filtered out. Recombination of the ions and free electrons is relatively slow at the higher reaches of the atmosphere owing to the scarcity of gas molecules, but closer to the earth's surface gas molecules are more abundant so here recombination happens quickly—the atoms soon being returned to neutrality. The layers are conventionally labelled D, E and F with increasing height. and during daylight hours the F region divides into two layers—the lower called Fl and the higher F2. The D layer, whose height is around 50km, is only present during daylight hours and this applies also essentially to the E layer, whose height falls around 100 to 150km, though less active E layer ionisation is also detected at night at m.f.; but in essence, because of fairly speedy recombination, the E layer can only hold a high level of ionisation when in sunlight, its effect on radio propagation tailing off quite significantly when the sun sets on the

(Continued on page 8)

An Introduction to Antennas

(Continued from page 7)

layer which, at 100km, is about 30 minutes after local sunset. Intermittent ionisation also occurs in thin layers of about 2km or less embedded in the E region. It is of an irregular and patchy makeup and can spread over a range to about 2000km. Its level of ionisation is greater than that of the normal E layer and it has the characteristic of being opaque to the lower h.f. waves while partially reflecting the upper h.f. waves—and sometimes v.h.f. waves as well. Because of its intermittent nature it is called sporadic E (E5 or sp-E). Although it can support night-time h.f. signals it is mostly active during the daylight hours of summer. The F layer is the highest of all the layers and extends from around 150km to 800km or more. It is present both during daylight and night-time hours but, as already noted, splits into two distinct layers during the daylight hours. The Fl layer has a nominal peak around 200km and holds fairly steady at this height summer and winter.



The Troposphere

The earth's lower atmosphere or troposphere as it is called also has an influence on the propagation of radio waves, especially at frequencies at upper h.f., v.h.f. and above. The temperature of the troposphere decreases with height at the rate of 6°C/km down to about—55° C. This is because the air near the earth is not heated by the sun but by convection currents from the heated earth.

(Continued on page 9)

An Introduction to Antennas

(Continued from page 8)

The drop in temperature results from the adiabatic expansion of the air as it moves into decreasing pressure with increasing height. The troposphere where our weather conditions develop extends to a ceiling of about 10km. Owing to the variation of temperature, pressure and moisture content with height upper h.f., v.h.f. and radio waves of higher frequency are refracted over a greater distance than explained by the geometric horizon distance between the transmitting and receiving aerials, which is equivalent to assuming that the earth's radius is increased by a factor k. The ionosphere itself becomes progressively more transparent to waves of these frequencies, which means that they pass through the layers into the outer space beyond so that propagation then becomes essentially tropospheric. Maximum possible distance (dm) for direct ray transmission can be expressed as:

$$dm = 3.565\ k(\sqrt{ht} + \sqrt{hr})$$

where dm is in km, ht and hr the heights of the transmitting and receiving antennas respectively in m and k the factor expressing the apparent increase in the earth's radius. For a homogeneous atmosphere k is around 1.33, but it can increase above this value under certain weather conditions thereby propagating the direct-ray signal further. For ex- ample, when the barometric pressure starts to fall after a spell of steady anticyclonic pressure the k factor can rise dramatically and bring in relatively long-distance signals.

Irregularities

Moreover, the temperature, pressure and moisture content can vary from point to point and with time thereby producing irregularities in the refractive index, which, especially when elevated, can scatter signals over large distances.

Another distance enhancing factor is a sudden discontinuity or, indeed, inversion in the normal temperature gradient. It is known that tropospheric stratification is more frequent than previously thought, and these sheets or layers of large vertical gradient can affect the propagation of signals quite substantially.

Ducting

Tropospheric variations of these kinds normally influence v.h.f., u.h.f. and higher frequency waves more than the lower frequency ones; but propagation tests at 27MHz have indicated that waves in this frequency range can also be distance enhanced by tropospheric propagation (in addition to ionospheric propagation!). Strong refraction over water and ducting of the waves through the troposphere are other mechanisms involved.

Some time ago G6DH noted the enhancement of signals as low as 3.5MHz arriving along a sea path during weather conditions producing tropospheric ducting at v.h.f. while more recently *Radio Science* carried a convincing paper supporting super refraction ducting over sea paths from 20MHz upwards. I have depicted in Fig. 1.6 the space immediately above the earth's surface, showing the troposphere and the ionised layers, which I have so far discussed.

Editor's Comments

(Continued from page 5)
chairman of the Transportation Committee and the primary sponsor of the bill. He says that giving the police a clear mandate to stop motorists who drive inattentively is logical way to stem the tide of roadway crashes and fatalities. And while Amateur Radio is not specifically mentioned it could easily fall under the two-way radio portion of the measure if it becomes state law. (W2CE)

Taken from the newsgroup.

JB 2003

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Bulletins (Sundays at …)
11h15 Start call in of stations
11h30 Main bulletin start

Frequencies
145,625 MHz (West Rand Repeater)
10,135 MHz (HF Relay)

Radio Amateurs do it with more frequency!

Chairman/Treasurer	Dave	ZR6AOC	475 0566 (H)	zr6aoc@mweb.co.za
Vice-Chairman/Events				
Secretary	John	ZS6FJ	672 4359 (A/H)	
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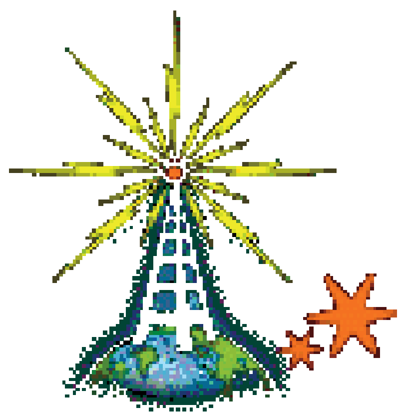
West Rand members input - we need your input!

To make this the best ham radio magazine in South Africa we need your input. Please submit articles, comments, suggestions etc.

Please send plain text with no formatting to the email address below.

In November 2001, we published an Anode Compendium on CD. It has the issues from July 2000 until November this year. This included IE5.5 and the new Adobe reader. It is soon to be updated, check with the vice-chairman for details.



We need your input! Email us articles, comments and suggestions please.
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