## LESSON 0

Heat light and sound all trigger the human senses but this is not their only common factor.....They all have their place in the FREQUENCY SPECTRUM together with RADIO.

### WHAT IS FREQUENCY

If you hit a base drum its skin will vibrate. The number of completed vibrations that occur in each second is known as its frequency. Let us look at this in more detail.

The drum skin goes in when it is hit until it is so stretched that it can go no further. It the bounces back out, through its normal position and on to a point where it is bulging outwards. It is once again so stretched that it can go no further in this direction and goes back through its starting position having completed one vibration ( cycle ). In practice the drum skin would go through several such cycles ( complete vibrations ) before it comes to rest.

Frequency is the number of cycles in each second. The unit of frequency is Hertz ( Hz ) and is one cycle per second. Thus a frequency of 300 Hz is 300 cycles per second.

You may have already come across ' frequency ' in your day - to - day life. Here are a few examples:

The public electricity supply has a frequency of 50 Hz
The BBC transmits on 96 Million Hz ( 96 MHz )
Middle ' A ' on a piano is a frequency of 440 Hz
Your heart beats at a frequency of about 1 Hz
Your spin dryer rotates at a speed of 16.6 Hz

I expect the two last examples will surprise you ?. They appear rather slow. A typical spin dryer operates at 1000 revs ( cycles ) per MINUTE. You cannot call this 1000 Hz. Remember that HERTZ is CYCLES per SECOND and not cycles per minute. As there are 60 seconds in each minute the spin dryer frequency is 1000 / 60 = 16.6 Hz. In the same way a heart beating at a rate of 60 times each minute has a frequency of 60 / 60. i.e. 1 Hz.

### FREQUENCY SPECTRUM

Below is a diagram of the frequency spectrum. There are no clear cut divisions. For example, young human ears can hear sounds that have frequencies of up to about 20,000 Hz and yet there are radio transmissions at 16,000 Hz. There is an overlap. However, you will be pleased to know that the residents of Rugby cannot ' hear ' the 16 KHz as they take a country walk near the aerials. A similar overlap at the lower end of the ' Light ' part of the spectrum. As you know, if you make something red hot you can both see the glow and feel the heat.

FREQUENCY SPECTRUM

Sound RADIO Heat Infra-red Light Ultra-violet X - Ray

Increasing Frequency ⏩ ⏩ ⏩ ⏩

### BIG NUMBERS

Frequencies can be very large numbers. You may have noticed above it is convenient to use abbreviations.

K stands for 1 thousand. e.g. 20 KHz is 20000 Hz
M stands for 1 million. e.g. 96 MHz is 96000000 Hz
G stands for Giger which is 1 thousand million. e.g. 4 GHz is 4000000000 Hz.

 

.

We will now look in more detail at the radio frequency portion of the frequency spectrum. Useful radio frequencies range from about 10,000 Hz ( 10 KHz ) to beyond 30,000,000,000 Hz ( 30 GHz ). At first it would appear that with this enormous frequency range, there should never be a problem and it would be possible to hand out a frequency to all takers. This is not the case. The fact is, that each part of the radio frequency spectrum has its own characteristics and only a small range of frequencies are suitable for certain popular activities.

It is therefore vital that each frequency is put to its best use. It is also important that the frequencies that are capable of travelling around the world are subjected to world wide controls.

## THE RADIO FREQUENCY SPECTRUM

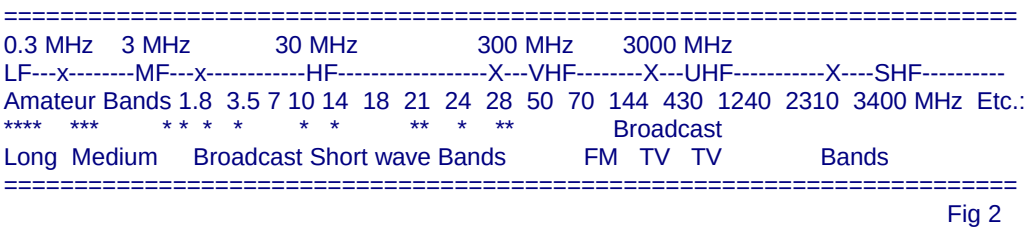


Fig 2

Fig 2 above, shows the most useful part of the spectrum. It indicates how the terms low frequency, **M**edium **F**requency, High **F**requency, **Very H**igh **F**requency, **U**ltra **H**igh **F**requency and **S**uper **H**igh **F**requency relate to the actual frequency. You will see that each is related to its neighbour by a factor of ten. The boundaries are all at decades of three. Now have another look, do you understand ?

The approximate lower band edge frequency of each amateur band up to 3400 MHz. If you now look at the schedule in the AMATEUR RADIO EXAMINATION MANUAL or HOW TO BECOME A RADIO AMATEUR you will see why I use the word approximate.
In order for you to get things in perspective. I have shown the radio and TV Broadcast Bands. This still leaves gaps in the diagram but in practise these are filled by numerous other services such as : Shipping, Aircraft, Military, Citizens Band, Navigation, Public Services, Telecommunications, Weather Services, Remote Control, Security Systems and Satellites et.
As mentioned earlier each frequency band has its own propagation characteristics. It is in the interests of the Radio Amateurs to have a broad selection of frequencies available.

Those of you owning short wave receivers will be able to listen to the amateur bands and broadcasting bands and will recognise that there is a predictable pattern.
You will discover that in order to hear a station on the west coast of the USA, Your selection of frequency will not only depend on the time of day ( light or dark ) but also the season of the year and the sunspot activity. This explains why it is necessary for the public broadcasting services to transmit the same programme several times on a selection of frequencies in order to obtain world wide coverage. As a short wave listener ( SWL ) you will also have the advantage of hearing amateur Radio procedures in action. This will give you a head start when you get round to studying licensing conditions, operating practices and amateur procedures as called for in the Radio Amateur Exam syllabus. You will notice that most radio amateurs refer to their bands in terms of wavelength, e.g. 20 meters. Official schedules will, however, quote actual frequencies. ( 14.0 - 14.35 MHz for this example ).

 

## METERS OR MEGAHERTZ

You may have noticed that some radio sets have their dial marked in Kilohertz and others have them graduated in Megahertz.

These are markings and as I will now show they are interrelated.

While a radio wave is travelling at the speed of light, it is possible to measure the distance between one cycle and the next. The distance, which will depend on the frequency, this is known as the wavelength ( i.e. The length of one wave or cycle ). Wavelength is measured in METERS.

WAVELENGTH versus FREQUENCY conversion ( i.e. changing from one to the other ).

$$\frac{\text{Speed of light ( in meters per second )}}{\text{Frequency ( in Hertz )}} = \text{WAVELENGTH ( in Meters )}$$

or putting it around the other way.

$$\frac{\text{Speed of light ( in meters per second )}}{\text{Wavelength (in Metres)}} = \text{FREQUENCY ( in Hertz )}$$

The speed of light is 186,000 Miles per second or 300 Million Meters per second. I think that the best way to help you with the two previous formula is to give a couple of examples :

EXAMPLE 1.

What is the wavelength of a Medium wave transmitter operating on 1 MHz ?

The wavelength would be : speed of light / frequency or 300,000,000 / 1000,000 = 300 Metres

EXAMPLE 2.

What is the frequency of BBC Droitwich on 1500 meters ?

The Frequency would be : speed of light / wavelength or 300,000,000 / 1500 = 200,000 Hz ( 200 KHz )

( In fact it is no longer on 1500 Meters as it has changed to 198 KHz )

As already mentioned abbreviations are usually used to avoid large numbers of Zero's :
K is short for 000 ( i.e. Thousand ), M is short 000,000 ( i.e. million ). But beware as there are some pitfalls - Read on .....

There are also abbreviations for very SMALL numbers. For example ' m ' stands for mill and is one THOUSANDTH whereas a MILLIONTH is denoted by ' μ ' ( pronounced " mue " ). Thus 1 mW is one THOUSANDTH of a Watt. And 1 MWatt is one million watts. The difference is very significant. This can be confusing so please be on your toes.

 

Now have a go at working out some frequency to wavelength and wavelength to frequency conversions for yourself.

If you choose ones used by the BBC you can check your answers by looking in the radio times ( But note that they quote the nearest whole meter ).

Now I would like you to have a go at the following questions.

Some of the questions relate to this lesson and others will require you to look at the TERMS, PROVISIONS AND LIMITATIONS OF USE ( BR68 ). You should also refer to the RADIO AMATEURS EXAMINATION MANUAL and the official publication HOW TO BECOME A RADIO AMATEUR. If you have any problems or do not understand any questions then please say so on your answer sheet.

Question 0.1 What frequency has a wavelength of 2 METERS

Question 0.2 What is the wavelength of a frequency 7.0 MHz

Question 0.3 List the upper and lower frequency of the Amateur Bands available to United Kingdom Amateurs, up to 500 MHz

Question 0.4 What is the maximum power that is permitted in the 3.5 to 3.8 MHz band

Question 0.5 Give the prefix of a call using that would be allocated to amateur living in Glasgow

Question 0.6 How long have you been interested in amateur radio

Question 0.7 What is the annual fee for an amateur transmitting licence

Question 0.8 How many Watts are their in half a Kilowatt

Question 0.9 How many microwatts are there in a milliwatt

Question 0.10 What is the maximum power permitted when transmitting on a frequency of 50.375 MHz

Please send your answers, on a separate sheet of paper ( or E'Mail ) to me not forgetting to enclose the following

This lesson and its questions ( if on loan )
Stamped self addressed envelope

Peter Pennington
( peter.pennington@btinternet.com )

 