L V Sharma VU2LV
Mukalethu Matom
ADUR 691 523.

HOBBY ELECTRONICS
Part VI

Frequency, Velocity and Wavelength

In the previous lesson, we learnt about Alternating Current. The domestic power supply has a frequency of 50 cycles per second i.e., the dynamo produces 50 cycles in one second. Nowadays, instead of cycles we say Hertz(Hz) in honour of the German scientist who discovered electromagnetic waves. So we say that the frequency of domestic power supply is 50Hz per second. It has been found that both direct current and alternating current travel at an incredibly high speed of 300,000,000 metres per second. This velocity is so high that the electric current can encircle the globe in about one-seventh of a second.

Imagine a wire 300,000,000 metres long connected to a dynamo. When the dynamo starts rotating, cycles of alternating current produced by the dynamo will start travelling along the wire. Each cycle is called a wave on account of its shape. At the end of one second, the first wave produced by the dynamo would have travelled 300,000,000 metres and reached the other end of the wire. The second wave would be just behind the first wave, the third wave just behind the second wave and so on until the 50th wave will be just in front of the dynamo. So you can imagine a wire 300,000,000 metres long containing 50 waves on it. The length occupied by each wave will be 300,000,000/50, i.e., 6,000,000 metres. This length is called the wave-length of the alternating current. The wavelength is denoted by the Greek letter (inverted 'y'), pronounced 'lambda' and the frequency is denoted by the letter 'f'.

=300,000,000/f   f=300,000,000/

In the above paragraph, we have been talking about the domestic supply having a frequency of 50 Hz. In USA, the frequency of domestic power is 60 Hz and what has been said about 50 Hz will be equally true of 60 Hz. Here also the wavelength will be given by the above formula, only difference being that the wavelength of 60 Hz frequency will be somewhat shorter at 5,000,000 metres. You should not come to the conclusion that alternating current is used for domestic power supply alone. Alternating current has myraids of uses including radio communication. In short, electronics as we know of today would not exist if it were not for the alternating current. We will deal in detail with electric current of different frequencies.

1. Audio Frequencies
When we speak we are compressing and decompressing the air in front of us. This is achieved by the vocal cords inside the throat which vibrate at different frequencies to produce different sounds. If this sound is allowed to fall on a microphone the latter will convert the sound into electric current of different frequencies. It has been found that the frequencies of sound produced by human beings vary from 15 Hz to 16,000 Hz. In speech, we do not use all these frequencies but only upto 1500 Hz but when we are singing, we produce notes of higher frequencies. The male voice has more low frequencies while the female voice has more high frequencies. Musical instruments produce sounds of both low and high frequencies. In sound, the frequency is referred to by the term 'pitch'. So we say that drums produce sounds of low pitch while musical instruments like violin and flute produce sounds of high pitch. Low pitch is also known as bass and high pitch is known as treble. In your hi-fi tape-recorder, you must have seen the bass and treble controls. The bass control varies the strength of low frequencies and the treble control, the high frequencies.

2. Ultrasonic Frequencies
Frequencies from 16,000 to 30,000 Hz are called Ultrasonic Frequencies. Human beings are not capable of hearing sound of these frequencies. But bats have the ability to produce and hear these sounds. Currents of ultrasonic frequencies are used for cleaning and testing materials for cracks, flaws, etc.

3. Radio Frequencies
Frequencies in the range of 30,000 to 30,000,000,000 Hz are called radio frequencies and are most important for communication purposes. We use the following abbreviations for convenience:-

1000 Hz = 1 Kilohertz (KHz)
1000 KHz = 1 Megahertz (MHz)
1000 MHz = 1 Gigahertz (GHz)

This broad range of frequencies is further divided into different groups as follows:-

Very low frequencies (VLF) - Long waves
30 KHz to 300 KHz   10000 metres to 1000 metres

Medium Wave Frequences (MLF) - Medium Waves
300 KHz to 3 MHz   1000 metres to 100 metres

High Frequencies (HF) - Short Waves
3 MHz to 30 MHz   100 metres to 10 metres

Very High Frequencies (VHF)
30 MHz to 300 MHz   10 metres to 1 metre

Ultra High Frequencies (UHF)
300 MHz to 3 GHz   1 metre to 0.1 metre

Super High Frequencies (SHF)
3 GHz to 30 GHz   0.1 metre to 0.01 metre

(continued on page ...7)

L V Sharma VU2LV
Mukalethu Matom
ADUR 691 523.

HOBBY ELECTRONICS
Part V

Direct Current and Alternating Current

In a previous lesson we read that a battery has a positive terminal and a negative terminal. In a dry cell used in torches the carbon rod at the centre is the positive pole and the zinc container is the negative pole. Similarly the car battery has a positive terminal marked (+) and a negative terminal marked (-). We also learnt that current flows when electrons flow from negative terminal to the positive terminal. If we connect a torch bulb to the two terminals of a cell, electrons flow from the negative terminal zinc container to the bulb and from the bulb to the positive carbon rod. We know that if there is to be a current flow the circuit has to be completed. So the circuit is completed by the electrons flowing from the carbon rod (positive) to the zinc container (negative) inside the battery. So we come to the conclusion that electrons flow from negative to positive in the circuit and from positive to negative inside the battery. The chemicals inside the battery do the work of separating the electrons from the protons and pushing them towards the negative terminal. When the chemicals become exhausted this action does not take place and the battery becomes dead.

Before the electrons were discovered it was supposed that current flows from positive to negative and since it is very difficult to overcome a wrong habit we still say that current flows from positive to negative. To avoid confusion we say that current flows from positive to negative and electrons from negative to positive. Always remember this when reading the later sections of this course. When we speak of current we will consider it as flowing positive to negative and when we speak of electrons take it that it is flowing from negative to positive. Such a current which always flows in one direction is called direct current (DC).

When the polarity of the source is constantly changing ie the positive terminal becomes negative terminal and again changes to positive then the current flow will be constantly changing in direction. We call this alternating current (AC). Now you may very well ask why we should have alternating current when direct current will do the same work. Alternating current has many advantages which makes it vastly superior to direct current. For one thing alternating supply can be increased or decreased to any desired value which we cannot do with DC supply. Of course we cannot get alternating current from a battery because we cannot interchange the positive and negative terminals - but it is possible to convert direct current into alternating current with the help of electronic circuits called inverters about which we will learn later. But when we generate current through a dynamo it is possible to generate alternating current easily. We shall discuss how this is done in some detail.

In a dynamo, current is generated by rotating loops of wire inside a magnetic field. This works on the principle that when a wire cuts a magnetic field, current is induced in it. The loops of wire are mounted on a cylindrical former called armature, which rotates in a magnetic field. Current is drawn from the loops of wire by means of brushes which make contact with the loops. Look at the following figure which shows a section of the armature with the brushes making contact at points A & B.

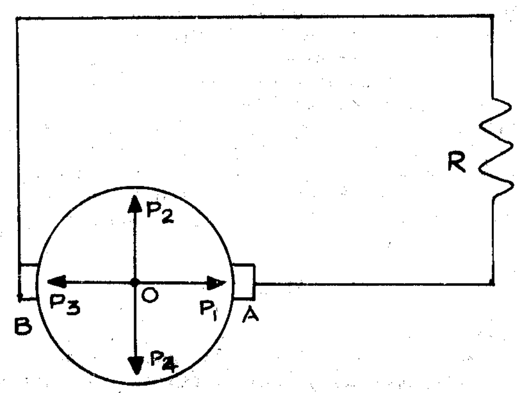

Figure 5-1

R is the load through which current passes. O is the centre & OP a radius. Let us suppose that the armature rotates in the anticlockwise direction and starts rotating from initial position OP1. Let us also suppose that in the starting position current is zero. When OP starts rotating from the initial position OP1 in the anticlockwise direction the current gradually increases from zero and reaches a maximum value when it reaches the position OP2. After reaching the maximum value at OP2 it gradually decreases and becomes zero at position OP3. From OP3 the current again increases and reaches a maximum value at position OP4. But now the current flows in the reverse direction. If the current is from A to B during the 1st half of rotation in the 2nd half it flows from B to A.

From the position OP4 to OP1 the current decreases and becomes zero when it reaches the original position OP1. During the 2nd rotation the current form is again repeated. If we were to measure the current at various positions of OP and plot it on a graph paper it would look like this.

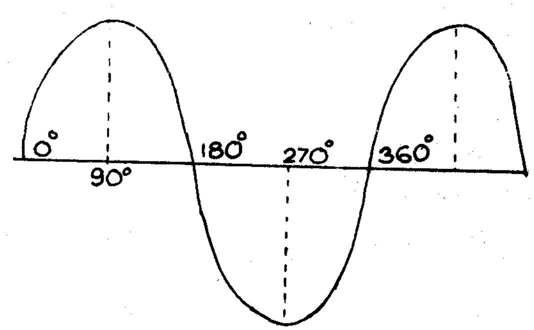

Figure 5-2

At 90° the current is maximum & is zero at 180°. At 270° it is again maximum but in the opposite direction and at 360° it is again zero. The wave form of the voltage will be the same as that of current ie. current and voltage will increase simultaneously, because zero simultaneously and change direction at the same time. The flow of current during the rotation of the dynamo is called one cycle. The domestic current supply is rated at 50 cycles per second ie the dynamo rotates 50 times in one second.

Peak Value RMS Value & Average Value

The domestic supply voltage is rated at 230 volts. What does this value denote? Is it the maximum value of the alternating voltage or an average value or some arbitrary value? Look at the curve once again. Mathematics students will at once recognise it as a Sine wave which is one of the most important curves in Mathematics. Most of the alternating current that we will come across in electronics will be of sine wave form. Any point on the voltage curve will give the value of the voltage at that instant. For example if we want to find out the voltage when the dynamo has rotated 45° on the horizontal line, draw a perpendicular through that point. Let this perpendicular line cut the curve at P. This point will give the voltage at 45°.

We have seen that the maximum voltage is reached at 90° and 270°. This is called the peak value. The peak value of domestic supply is 325 volts but this voltage is reached only for a brief instant during one cycle. So if we say that the line voltage is 325 volts it does not make any sense We can find the average value by measuring the voltage at different moments during one cycle & finding the average value. This will be about 206 volts for our domestic supply. For practical purpose however we use the RMS value (Root mean square value). This is done by finding the voltage at different instants in a cycle squaring it and finding the average and then finding its square root. In this way we arrive at the value 230 volts for our domestic supply. The RMS value

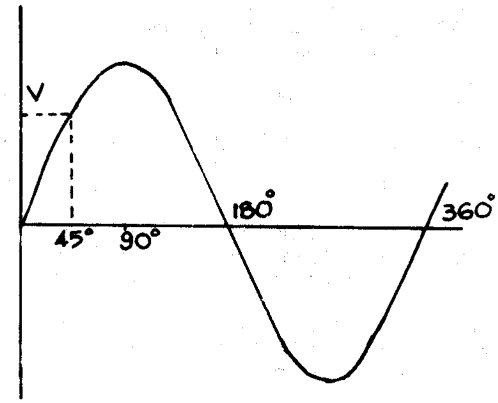

Figure 5-3

also called the effective value for a particular reason. AC current having RMS value of 230 volts will have the same effect as a DC supply of 230 volts. If we connect a heater to 230 volts RMS it will have the same heat as when connected to 230 volts DC. If we connect a bulb it will glow with the same brightness as a bulb connected to 230 volts DC What has been said about voltage applies equally to current also. For this reason instead of saying 230 volts RMS we simply say 230 volts.

We shall see what is the arithmatical relationship between the three values, Peak value, RMS value and Average Value.

Peak value x .636 = Average Value

Peak value x .707 = RMS value

RMS value x 1.414 = Peak value

(to be continued)

IN AUGUST 1987 ISSUE

SCOUTS JAMBOREE
Every year the third weekend of October is Jamboree day for Scouts and Hams. An article on the various features of this unique programme which brings Ham Radio closer to the younger generation.

A LOW-COST RECEIVER FOR 40-METERS
By the time the month is through atleast some of you would be in the final stages of putting together the transmitter described this month. For them and the SWLs, a low-cost receiver which can be built in a week-end.

R V Shenoy VU2VAS
37/1603 T D West
COCHIN 682 031.

GETTING STARTED ON THE BAND
Part V

Unlike a Communication Receiver which is rather difficult to homebrew, it is comparatively easy to build a transmitter for amateur use. A simple code transmitter will have one RF oscillator stage, or in addition, a power amplifier stage. The RF oscillator produces the required RF signal frequency and the key switches on and off the carrier frequency in acoordance with the code characters.

Crystal Controlled Transmitter

In a transmitter, the frequency stability is very important. While you are transmitting, the frequency of the transmitter should not drift up or down. The crystal ensures a high degree of stability. Such a transmitter is also easy to build. With only a few components like a transistor, one crystal, four capacitors, one resistor and an rf choke, you can build a low power transmitter and be on the air within an hour.

The crystal controlled transmitter has its share of disadvantage too. You will not be able to shift your frequency; you have work on the single frequency - that of the crystal. To overcome this, a Variable Frequency Oscillator(VFO) controlled transmitter has to be used. With a VFO you can change your transmitter to any desired frequency in the amateur band.

For voice operation, an Amplitude Modulator (for AM) or a SSB Generator (for SSB) is added to the transmitter. When you talk into the microphone, the audio is converted into electrical energy, amplified and mixed with the RF signal and then transmitted.

(to be concluded)

(HOBBY ELECTRONICS - continued from previous page)
The above terms are quite important as we will come across them very often. We use all the above frequencies for communication, each group having its own special features which make them suitable for some particular application. For example, medium frequencies are particularly suitable for transmission within a small region. Shortwaves are used for long distance communication while VHF is used for Television and FM transmissions. We shall soon learn about the nature of different frequencies in detail later.

If you look at the dial of your radio broadcast receiver, you will find that it can receive medium frequencies in one band (300 KHz to 3000 KHz) and shortwaves (3 MHz to 30 MHz) in one, two or more bands. (You may wonder about the frequencies above 3 GHz - Xrays, UVrays, light rays and infrared rays fall into this category).

If you look closely at the dial of your receiver, you can see that the dial gives frequencies in KHz and wavelength in metres for medium wave. The point on the dial marked 600 KHz will also be marked 500 metres. On shortwave, the dial will be marked in MHz and metres. Incidentally, the receiver that you are using is called a Broadcast Receiver as it is meant only for receiving broadcast stations. You might have noticed that in the medium wave band, broadcast stations are spread over throughout the band while in the shortwave band they are bunched at certain frequencies, leaving most of the other frequencies which produce a lot of unintelligble noise. Why is this so ?

Transmitting Stations on shortwaves operate around 50, 49, 30, 25, 19, 16 and 13 metres. Only a very small portion of the frequency spectrum is used for entertainment programmes. The rest are used for communication purposes by Governments, Airlines, Military, Police, Overseas Communication, etc., and of course Amateur Radio Station Operators called hams. Hams are permitted to transmit on certain frequencies in HF, VHF and UHF and communicate with other fellow hams.

Almost all the Governments the world over permit amateur radio operators because they were the first group to explore and the prove the possibility of transmission using short waves. In the earlier days of radio, transmission was confined to medium and long waves and it was believed that short waves were of no use for long distance communication. Hams have proved it to be otherwise.

Wireless communication has become such a vital link in modern life that the demand for more frequencies is being made by various agencies who use them. We should be thankful that no attempt to curtail the frequencies allotted to hams have been successful. We in India, are allowed to operate on the following frequencies:-

1820 KHz - 1860 KHz	known as 160 metres
3500 KHz - 3700 KHz	80 metres
3890 KHz - 3900 KHz	80 metres
7000 KHz - 7100 KHz	40 metres
14000 KHz - 14350 KHz	20 metres
18068 KHz - 18168 KHz	17 metres
21000 KHz - 21450 KHz	15 metres
24890 KHz - 24990 KHz	12 metres
28000 KHz - 29700 KHz	10 metres
144 MHz - 146 MHz	2 metres
434 MHz - 438 MHz	70 cms
1260 MHz - 1300 MHz	
3300 MHz - 3400 MHz	
5725 MHz - 5840 MHz	

Of the above frequencies, the 40-metre band, the 20-metre band, the 15-metre band and the 2-metre band are very popular among our hams. (to be continued)