In the electronic world, many forms of signals and waveforms are utilized. By displaying waveforms on the oscilloscope, such wave-forms properties as amplitude and time can be determined. There are occasions when the technician must know the frequency of a signal; the oscillioscope does not give the technician the frequency it is displaying. For this reason the technician must know how to calculate frequency. This lesson will teach you how to calculate the frequency of a signal if the period of the signal is known.

In this lesson the student will study four basic waveforms. These waveforms are symmetrical, that is, the positive and negative alternations have the same time or are equal. Study FIGURE 3.

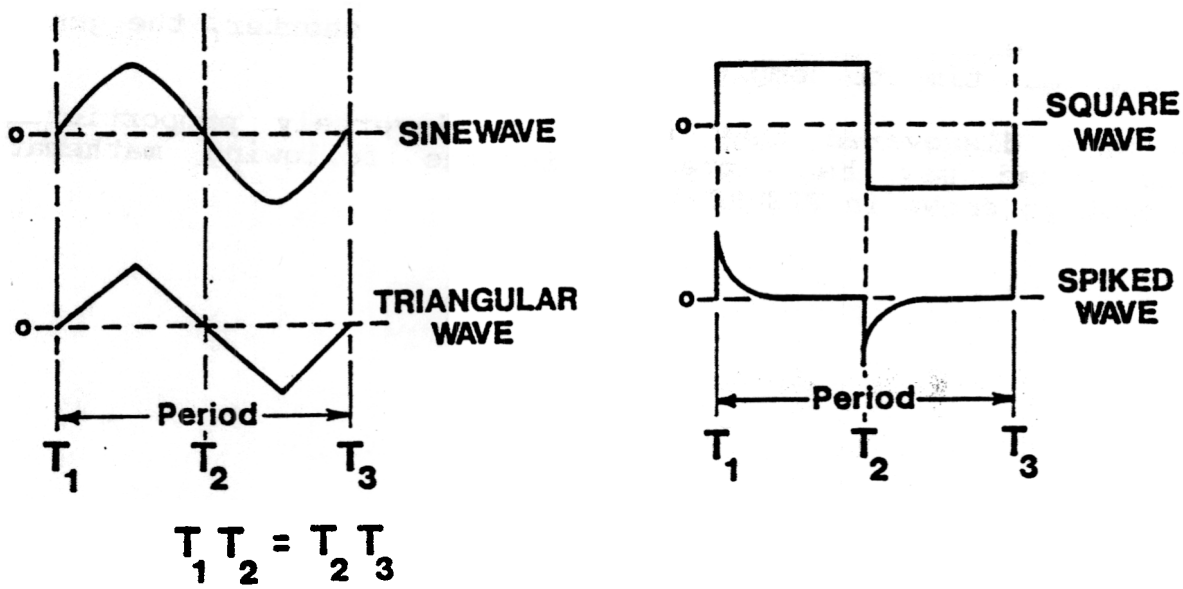

FIGURE 3

In FIGURE 3 there are four different waveforms. Some observa-tions of these waveforms will give the following:

First, each waveform will cross the zero (0) reference line in an positive direction at T_1.

Second, each waveform will cross the zero (0) reference going negative at T_2. This competes the first or positive alternation or one-half period.

Third, each waveform will cross the zero (0) reference going positive again at T_3. Thus completing the second alternation and completing one period.

The positive alternation comsumes the time from T_1 to T_2.
The negative alternation consumes the time from T_2 to T_3.

The time from T_1 to T3 is the period from one cylce or one Hertz. The statement may be made; the period of the waveform may be determined by measuring the time from the point where the waveform crosses the reference line going positive to the next point where the waveform

crossed the the reference line going positive, or repeats itself. When the frequency of the waveform is discussed the basic unit is the Hertz, thus one Hertz is equal to one cycle. The generator making the waveform has completed one revolution or one cycle. The length of time taken for the generator to complete one cycle is called the PERIOD.

The period is measured in TIME, that is, how long does it take for the generator to complete one cycle? The units of measurement of time are hours, minutes, seconds, milliseconds. Thus we may say that if the generator completes one cycle in one second it has a period of one second.

If PERIOD, is P, in seconds (Sec.) and frequency is F, in HERTZ, then as the period decreased or the time gets, shorter, the generator will take less time to complete one cycle.

We have discovered that period is inversely proportional to frequency and may be expressed in the following mathematical relationships shown in FIGURE 4.

$$F = \frac{1}{P}; \; P = \frac{1}{F}$$

FIGURE 4

From the sine wave in FIGURE 5, use the rules discussed in the above FIGURES 3 and 4 to calculate the frequency.

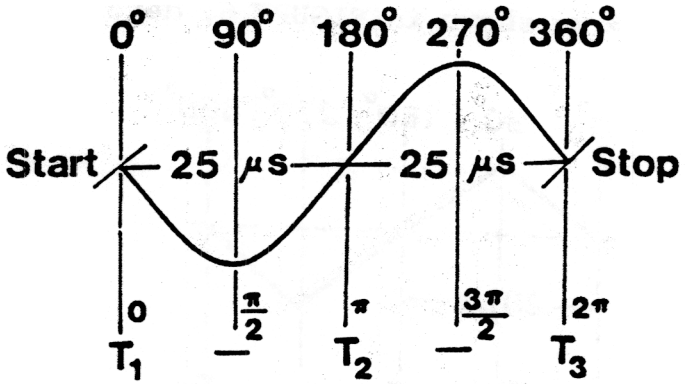

FIGURE 5

First, T_1 to T_3 = 50 microsec. = 1 Period (P)

50 microsec. = $50X10^{-6}$ sec.

Second, $F = \frac{1}{P} = \frac{1}{50X10^{-6}}$

0.02×10^6 Hertz

20×10^3 Hertz

20 Kilo Hertz

20 HKz

The 20 kilohertz meams the generator is turining at a rate of 20,000 times per second.

From FIGURE 4, the period is from T_1 to T_3, and is 50 microseconds. The time for the positive alternation is equal to the time from T_1 to T_2, and is called the PULSE WIDTH (PW). Thus we may express this mathematically.

$$PW = \frac{1}{2} P$$

$$PW = \frac{1}{2} (50X10^{-6})$$

$PW = 25X10^{-6}$ or 25 microseconds.

The time from T_1 to T_2 is equal to the time from T_2 to T_3. If T_1 to T_2, equals 25 microseconds, then T_2 to T_3 is also equal to 25 microseconds.

From the triangular wave shown in FIGURE 6, determine the period and the frequency.

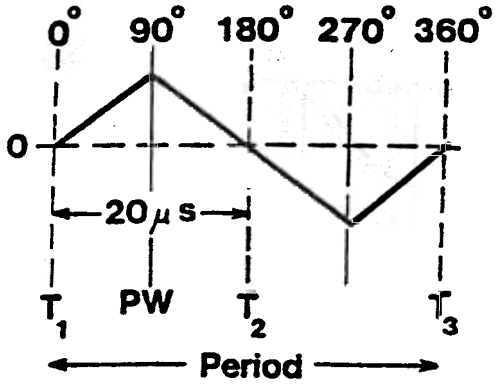

FIGURE 6

From FIGURE 6, T_1 to T_2 is equal to the PW, which is equal to 20 microseconds, thus;

$$PW = \frac{1}{2} P \text{ or } P = 2\ PW$$

$$P = 2\ (20X10^{-6})$$
$$P = 40X10^{-6}$$
PERIOD = 40 microsec.

$$F = \frac{1}{P} = \frac{1}{40X10^{-6}} = 0.025X10^{-6}$$

$$F = 25X10^{-3} = 25 \text{ Kilo Hertz (KHz)}$$

From FIGURE 7, calculate the period and the pulse width (PW) of the square wave.

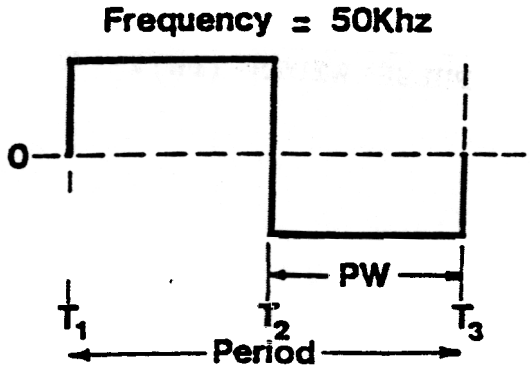

FIGURE 7

Given a frequency 50 KHz or $50X10^{-3} = 20X10^{-6}$ sec.

$$P = \frac{1}{F} = \frac{1}{50X10^{3}} = 0.02X10^{-3} = 20X10^{-6} \text{ sec}$$

P = 20 microsec or 20 sec.

$$PW = \frac{1}{2} P = \frac{1}{2} (20X10^{-6}) = 10X10^{-6} = 10 \text{ sec.}$$

PW = 10 sec.

From FIGURE 8, calculate the frequency and the pulse width of the spiked wave.

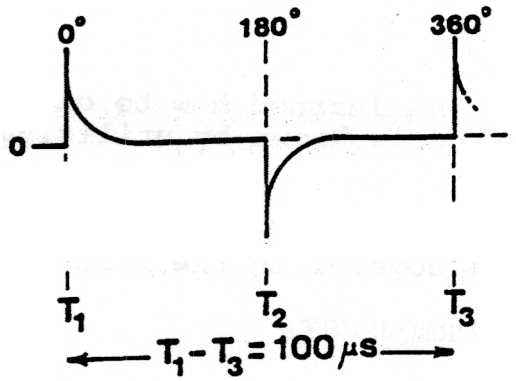

FIGURE 8

$$F = \frac{1}{P} = \frac{1}{T_1 \; T_3} = \frac{1}{100X10^{-6}} = 0.01X10^{-6}$$

$F = 10X10^3$ = 10Kilo Hertz or 10KHz

$$PW = \frac{1}{2} P = \frac{1}{2} (10X10^{-6}) = 50X10^{-6}$$

PW = 50 microsec = 50 sec.

Difficult calculations can sometimes be made by using powers of ten rather than numbers that contains several digitis. This view shows numbers and their equivalents to powers of ten. These numbers or powers of ten are used often in frequency calculations. FIGURE 9, shows show commonly used numbers and their powers of 10.

NUMBER		POWER OF TEN	NUMBER	POWER OF TEN
10	=	10^1	.1	
100	=	10^2	.01	
1,000	=	10^3	.001	
10,000	=	10^4	.0001	
100,000	=	10^5	.00001	
1,000,000	=	10^6	.000001	

FIGURE 9

Study the examples shown below.

To change 3KHz to Hz: 3 x 1000 = 3000 Hz
To change 2MHz to Hz: 2 x 1,000,000 = 2,000,000 Hz
To change 4KHz to MHz: 4 x .001 = .004 MHz
To change 400Hz to KHz: 400 x .001 = .4HHz

SUMMARY.

During this lesson you have learned how to calculate the frequency of a waveform when the period is known by utilizing the formula $F = \frac{1.}{P}$

The characteristics of a waveform can be determined by an oscilloscope, which will be covered in the next lesson.

HERTZ - BASIC UNIT OF FREQUENCY

SECOND - BASIC UNIT OF TIME

$F = \frac{1}{P}$ - FREQUENCY IS RECIPOCAL OF TIME