Sinusoids, Frequency and Period

Sinusoids

A sinusoid is pictured in Figure 1. A sinusoid is just another name for a sine wave. When your radio control transmitter is communicating with the receiver on your robotic system, sine waves like the one in Figure 1 are created. By understanding these sinusoids, we can understand the relationship between the frequency of the crystal and the time needed to generate the signals between the crystals.

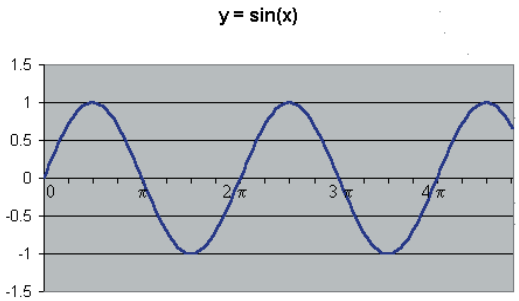

Figure 1

Period

A period (T) is defined as the interval taken to complete one cycle of a regularly repeating phenomenon. Periods are always measured in units of time.

EXAMPLE 1

What is the period of the Earth orbiting the Sun?

Solution:

The period of the Earth's rotation about the Sun is 365 days. Every 365 days, the Earth has come full circle around the Sun - back to where the Earth started. Every 365 days, the cycle of the Earth rotating once around the Sun repeats itself.

$T = 365 \text{ days}$

EXAMPLE 2

What is the period of the sine wave in Figure 1?

Solution:

Looking at Figure 1, we see that the sine wave is a repetition of a "mountain" and a "valley". One mountain starts at 0 and ends at π, while the valley starts at π and ends at $2 \times \pi$. Another mountain starts at $-2 \times \pi$ and ends at $-\pi$, while the valley starts at $-\pi$ and ends at 0.

The sine repeats this mountain/valley sequence forever. So to complete one cycle of this wave takes $2 \times \pi$ time units. So the period of the sine wave is $2 \times \pi$ time units.

$T = 2 \times \pi$

$$T = \frac{1}{f}$$

$$f = \frac{1}{T}$$

Frequency

Frequency (f) is the measurement of the number of times that a repeated event occurs per unit time. It is expressed in Hertz (1/second = 1 Hz). The relationship between frequencies and periods are displayed in the formulas at left.

EXAMPLE 3

What is the frequency of the Earth orbiting the Sun?

Solution:

The period of the Earth's rotation about the Sun is 365 days. Using the formula:

$$f = \frac{1}{365 \text{ days}} = \frac{1}{31536000 \text{ s}} = 3.17 \times 10^{-8} \text{ Hz} = 31.7 \times 10^{-9} \text{ Hz} = 31.7 \text{ nHz}$$

Sinusoids, Frequency and Period *continued*

$T = \frac{1}{f}$

$f = \frac{1}{T}$

EXAMPLE 4

What is the frequency of the sine wave in Figure 1?

Solution:

$$f = \frac{1}{2\pi \text{ s}} = 1.59 \times 10^{-1} \text{ Hz} = 159 \times 10^{-3} \text{ Hz} = 159 \text{ mHz}$$

Vex Crystals

So how do frequency, periods and sinusoidals relate to Vex crystals? The radio control transmitter sends signals by sending electrons up and down an antenna, which generates sine waves. If you know the crystal frequency, you can find the period of this sine wave. In addition, if you know the period of the sine wave, you can find the crystal frequency.

Refer to “Lessons / Multimedia / Vex Controller and Resonance” for more information about how the radio control transmitter communicates with the Vex receiver.

EXAMPLE 5

If your radio control transmitter has a 75.85 MHz crystal, what is the time period of the sine wave this crystal will generate?

Solution:

$$T = \frac{1}{75.85 \text{ MHz}} = \frac{1}{75.85 \times 10^{6} \text{ Hz}} = 1.318 \times 10^{-8} \text{ s} = 13.18 \times 10^{-9} \text{ s} = 13.18 \text{ ns}$$

EXAMPLE 6

If the time period of the sinusoid generated by your crystal is 3.0 microseconds, what is the frequency of the crystal?

Solution:

$$f = \frac{1}{3.0 \text{ ms}} = \frac{1}{3.0 \times 10^{-6} \text{ s}} = 3.3 \times 10^{5} \text{ Hz} = 333 \times 10^{3} \text{ Hz} = 333 \text{ kHz}$$