PocketLab Voyager: Light Intensity of a #50 Lamp vs. a Slow Sine Wave Current

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In this investigation we study a slowly varying sine wave signal produced by a function generator and amplified by a power amplifier to light a small #50 lamp. We are specifically interested in seeing the relationship between the *light intensity* of the lamp and the *current* it is carrying at any given instant of time. PocketLab Voyager is a perfect laboratory for performing this investigation *even though Voyager does not have a current sensor*.

How is this possible? Ampère's Law deals with the production of a magnetic field by either a current carrying conductor or by moving charges. Put simply, Ampère's Law tells us that the magnetic field in the region surrounding an electric current is proportional to the electric current that is the source of the magnetic field. Therefore, we can use Voyager's *magnetic field sensor as a measure that is proportional to the current*. To amplify the magnetic field some, we wrap the wire carrying the current around an empty ribbon spool ten times. Figure 1 shows the electrical setup for the investigation—a simple series circuit with the #50 lamp.

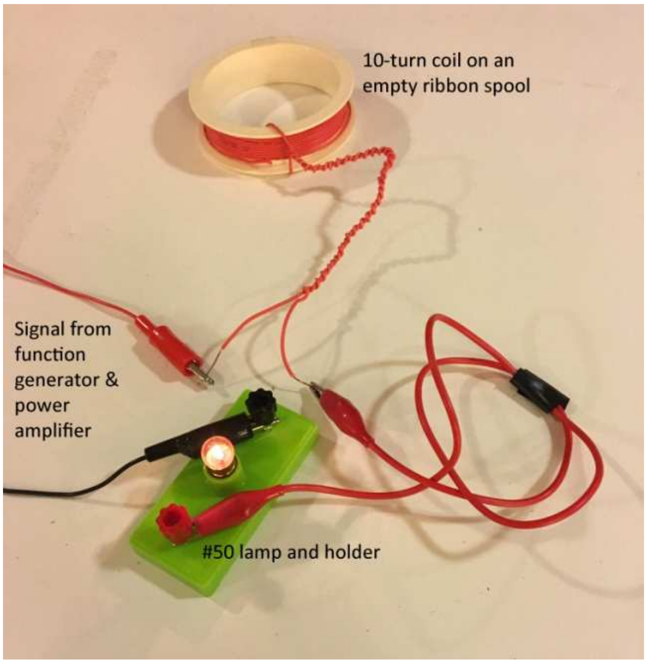

Figure 1

Although any appropriate function generator and power amplifier could be used, the sine wave signal used by the author was produced using Vernier Software & Technology's (vernier.com) LabQuest™ 2 (LABQ2) and Power Amplifier (PAMP). The sine wave was set to a frequency of 0.5 Hz, giving a period of 2 seconds.

Figure 2 shows a snapshot of the complete setup after collecting data (50 points/sec) and a video with the PocketLab app. A small translucent food storage container is placed upside-down over the #50 lamp. The wire coil is placed on the food storage container, and Voyager is placed on the container inside the wire spool.

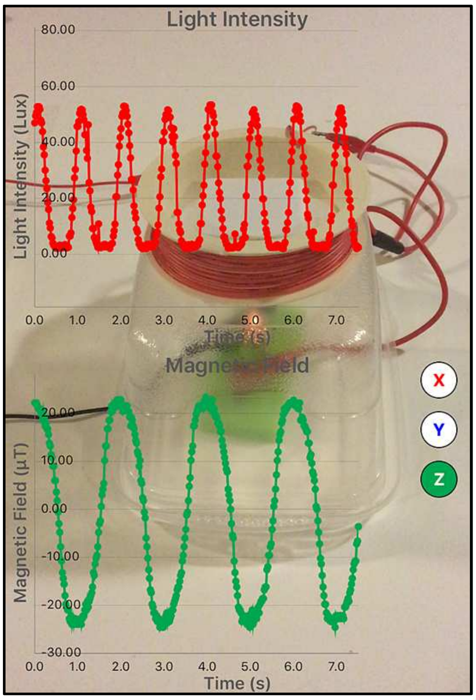

Figure 2

The light intensity and magnetic field graphs are sinusoidal in shape as we would expect, since the function generator was producing AC current with a sine shape. Recall that the magnetic field is also an indicator of current, as previously discussed. The frequency for the light intensity is twice that of the magnetic field, hence twice that of the current as well. This is also in line with what is to be expected, since the light intensity peaks twice for each AC current cycle, with peak intensity when the current is most negative or most positive. A combined video and data showing the blinking light accompanies this lesson. A must see.

Figure 3 shows a complete graph designed in Excel with the data recorded by the PocketLab app. It shows clearly that the period for the magnetic field (and AC sine current) was 2 seconds, as set on the function generator. The corresponding light intensity period is half that at 1 second.

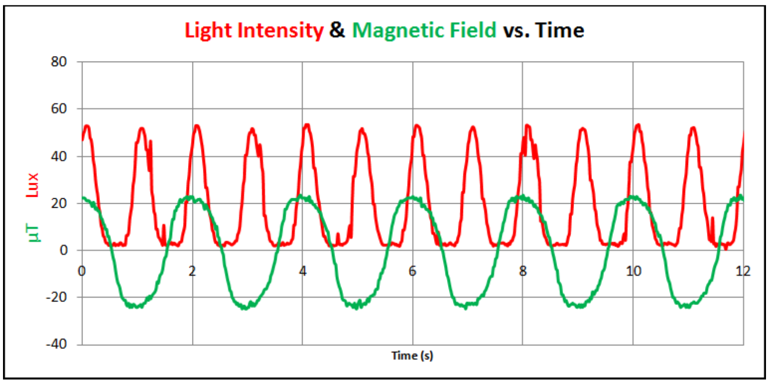

Figure 3