Euclidean Electromagnetic Units: The Basics

Abstract: The scientific community requires a set of standards to facilitate the exchange of scientific information. The mathematics of geometric relationships are well established and the characteristics of electromagnetic (EM) waves, their wavelength frequency relationships, can be expressed by a simple mathematical equation. By combining the mathematics of geometric relationships with those of EM waves a set of scientific base units can be mathematically defined. Euclidean Electromagnetic Units (EEU) establishes the basis for a set of scientific units of measure by mutually defining a unit of length, a unit of time and a numeric value for speed of light (SOL), all of which will be universal, permanent and invariant in time.

Conventional Geometric Relationships

The EEU process uses the geometric form of a right triangle and the mathematics that describe its relationships. Numeric values that represent EM wavelengths and frequencies can be used as elements of a right triangle. The basic right triangle is illustrated by Figure 1. When a unit wavelength is substituted for the values of x and y,the results will be as depicted in Figure 2. When a unit frequency, in its radian form, is substituted for x and y, the results will be as depicted in Figure 3. When wavelengths and frequencies are the elements that form the elements of a triangle, the angle itself then embodies a characteristic that defines one of the relationships between wavelengths and frequencies, the duration of the “unit of time”. Conventional geometric rules are applied to obtain the numeric value of the hypotenuse results.

EM wavelength frequency relationships are expressed by the equation set below.

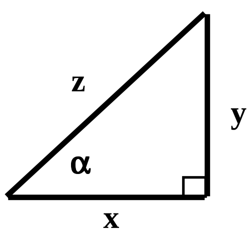

Figure 1.

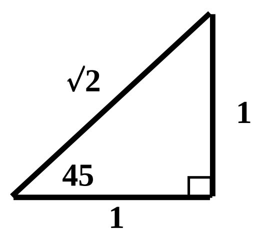

Figure 2.

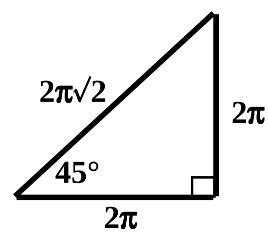

Figure 3.

$$f = c / \lambda \quad \text{or} \quad \lambda = c / f \quad \text{or} \quad c = f * \lambda \qquad (1)$$

The symbol f is for frequency, λ is for wavelength, and c represents the value for the SOL, typically espressed in SI units. When wavelengths and frequencies are used as elements of a triangle, the wavelength, frequency and SOL relationships are embedded in the geometric relationships. For right a triangle, when the value of the vertical leg is a unit value, the numeric value of the hypotenuse represents the cosecant of the angle. The trigonometric cosecant function can be used to determine the value of the hypotenuse when the vertical leg and the angle are known. The EEU process uses the cosecant function and the equation has the form shown below.

$$z = y \csc(\alpha) \qquad (2)$$

Trigonometric functions allow elements of a right triangle to be derived through angular relationships. Substituting a unit wavelength or a unit frequency for the value of y in equation (2) gives the following relationships,

$$\lambda_z = \lambda \cdot \csc(\alpha) \qquad (3)$$
$$f_z = f \cdot \csc(\alpha) \qquad (4)$$

where λ_z is the resultant wavelength and f_z the resultant frequency.

Using the third form of equation (1), combining and simplifying equations (3) and (4) gives,

$$C_E = (f_Z \cdot \lambda_Z) \qquad (5)$$

The value C_E is the EEU mathematical derivation of the SOL, but using Euclidean EM elements. The actual physical velocity of the SOL expressed by C_E and c are identical, the numeric difference being due to the method of derivation and different unit designators. Although C_E is exactly equivalent to that of c expressed in SI units, C_E can be calculated to near unlimited precision.

C_E is mathematically defined in the units of f_Z and λ_Z, which in the pure geometric case can be independent of any existing metrology system. Actual numeric values can be applied to f_Z and λ_Z, but the definition of EEU elements and their dimensions have to be established.

The EEU derivation will use the angle at 45°, it representing the simplest form of a right triangle and having symmetrical relationships. The duration of the unit of time varies as a function of the angle and will be denoted by the term Tau and will use the symbol τ. Tau has a unity value at 45°.

The value of λ in equation (3) will be defined as the Euclidean EM wavelength and will be represented by the symbol λ_E. The Euclidean EM wavelength has a unity value, one, and its length is represented by the symbol L_E. Equation (3) will have a numeric value of 1.4142... L_E.

The value of f in equation (4) will be defined as frequency with a numeric value of 6.2831...(10^8), the 10^8 multiplier is required to scale the value for electromagnetic waves. The value of equation (4) will have a value of 888.576587632 (10^6) cpτ (cycles per Tau).

Applying the values for the Euclidean EM wavelength, basic angular frequency, and the angle at 45 degrees gives the SOL, C_E, in EEUs.

$$\mathbf{C_E = ((628.31 * 10^6) * 1) \csc(45) = 888576587.632\ L_E\ \tau^{-1}} \qquad (6)$$

Constant Wavelength

The geometric EM relationships are retained when the angle is rotated. In metric, the value for the Euclidean EM wavelength, λ_E, was found to be 21.1061.... cm, which is the wavelength of the hyperfine transition emission of neutral hydrogen. The length 47.713... cm, a unique wavelength in SI units, at an angle of 26.25400 degrees illustrates the geometric relationships when expressed in SI units. The relationship between EEUs and their equivalent in SI units will exhibit the angular and corresponding hypotenuse differences shown in Figure 4, where the vertical leg is a constant wavelength. The wavelength of the hyperfine transition of neutral hydrogen is a natural unit of length.

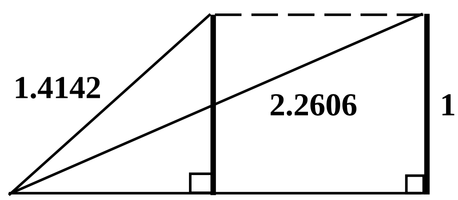

Figure 4. Constant Wavelength

Perspective

The duration of the SI second is ~ 1.598518 longer than the EEUs time duration, Tau.

The meter is ~ 4.737963 longer than the EEUs unit of length, L_E.

In EEUs, the SOL has the same numeric value as the frequency of the hydrogen hyperfine transition emission.

In SI units, the numeric value of the hydrogen hyperfine transition emission frequency, 1420405751.7667 cycles per second, differs from the SI SOL numeric value by a divisor of ~ 4.737963.

The duration of the EEU time unit Tau is a consequence of the geometric, wavelength and frequency relationships, a mathematical value.

The duration of the SI second is based upon the ephemeris second, an astronomical value.