Pseudo Scalar $I = \boldsymbol{\gamma}_t \wedge \boldsymbol{\gamma}_x \wedge \boldsymbol{\gamma}_y \wedge \boldsymbol{\gamma}_z$

$I_{xyz} = \boldsymbol{\gamma}_x \wedge \boldsymbol{\gamma}_y \wedge \boldsymbol{\gamma}_z$

Electromagnetic Field Bi-Vector $F = - E^x e^{-i(-\omega t + k_x x + k_y y + k_z z)} \boldsymbol{\gamma}_t \wedge \boldsymbol{\gamma}_x$
$- E^y e^{-i(-\omega t + k_x x + k_y y + k_z z)} \boldsymbol{\gamma}_t \wedge \boldsymbol{\gamma}_y$
$- E^z e^{-i(-\omega t + k_x x + k_y y + k_z z)} \boldsymbol{\gamma}_t \wedge \boldsymbol{\gamma}_z$
$- B^z e^{-i(-\omega t + k_x x + k_y y + k_z z)} \boldsymbol{\gamma}_x \wedge \boldsymbol{\gamma}_y$
$+ B^y e^{i(\omega t - k_x x - k_y y - k_z z)} \boldsymbol{\gamma}_x \wedge \boldsymbol{\gamma}_z$
$- B^x e^{-i(-\omega t + k_x x + k_y y + k_z z)} \boldsymbol{\gamma}_y \wedge \boldsymbol{\gamma}_z$

Geom Derivative of Electomagnetic Field Bi-Vector

$$\begin{aligned}
\boldsymbol{\nabla} F = 0 = & - i \left(E^x k_x + E^y k_y + E^z k_z\right) e^{-i(-\omega t + k_x x + k_y y + k_z z)} \boldsymbol{\gamma}_t \\
& + i \left(B^y k_z - B^z k_y - E^x \omega\right) e^{i(\omega t - k_x x - k_y y - k_z z)} \boldsymbol{\gamma}_x \\
& + i \left(-B^x k_z + B^z k_x - E^y \omega\right) e^{i(\omega t - k_x x - k_y y - k_z z)} \boldsymbol{\gamma}_y \\
& + i \left(B^x k_y - B^y k_x - E^z \omega\right) e^{i(\omega t - k_x x - k_y y - k_z z)} \boldsymbol{\gamma}_z \\
& + i \left(-B^z \omega - E^x k_y + E^y k_x\right) e^{i(\omega t - k_x x - k_y y - k_z z)} \boldsymbol{\gamma}_t \wedge \boldsymbol{\gamma}_x \wedge \boldsymbol{\gamma}_y \\
& + i \left(B^y \omega - E^x k_z + E^z k_x\right) e^{i(\omega t - k_x x - k_y y - k_z z)} \boldsymbol{\gamma}_t \wedge \boldsymbol{\gamma}_x \wedge \boldsymbol{\gamma}_z \\
& + i \left(-B^x \omega - E^y k_z + E^z k_y\right) e^{i(\omega t - k_x x - k_y y - k_z z)} \boldsymbol{\gamma}_t \wedge \boldsymbol{\gamma}_y \wedge \boldsymbol{\gamma}_z \\
& - i \left(B^x k_x + B^y k_y + B^z k_z\right) e^{-i(-\omega t + k_x x + k_y y + k_z z)} \boldsymbol{\gamma}_x \wedge \boldsymbol{\gamma}_y \wedge \boldsymbol{\gamma}_z
\end{aligned}$$

$$\begin{aligned}
\left(\boldsymbol{\nabla} F\right) / \left(i e^{iK \cdot X}\right) = 0 = & \left(-E^x k_x - E^y k_y - E^z k_z\right) \boldsymbol{\gamma}_t \\
& + \left(B^y k_z - B^z k_y - E^x \omega\right) \boldsymbol{\gamma}_x \\
& + \left(-B^x k_z + B^z k_x - E^y \omega\right) \boldsymbol{\gamma}_y \\
& + \left(B^x k_y - B^y k_x - E^z \omega\right) \boldsymbol{\gamma}_z \\
& + \left(-B^z \omega - E^x k_y + E^y k_x\right) \boldsymbol{\gamma}_t \wedge \boldsymbol{\gamma}_x \wedge \boldsymbol{\gamma}_y \\
& + \left(B^y \omega - E^x k_z + E^z k_x\right) \boldsymbol{\gamma}_t \wedge \boldsymbol{\gamma}_x \wedge \boldsymbol{\gamma}_z \\
& + \left(-B^x \omega - E^y k_z + E^z k_y\right) \boldsymbol{\gamma}_t \wedge \boldsymbol{\gamma}_y \wedge \boldsymbol{\gamma}_z \\
& + \left(-B^x k_x - B^y k_y - B^z k_z\right) \boldsymbol{\gamma}_x \wedge \boldsymbol{\gamma}_y \wedge \boldsymbol{\gamma}_z
\end{aligned}$$

set $e_E \cdot e_k = e_B \cdot e_k = 0$ and $e_E \cdot e_E = e_B \cdot e_B = e_k \cdot e_k = -e_t \cdot e_t = 1$

$$g = \begin{bmatrix} -1 & (e_E \cdot e_B) & 0 & 0 \\ (e_E \cdot e_B) & -1 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$K \cdot X = \omega t - k x_k$

$$\begin{aligned}
F = & - \frac{B e^{i(\omega t - k x_k)}}{\sqrt{-\left(e_E \cdot e_B\right)^2 + 1}} \boldsymbol{e}_E \wedge \boldsymbol{e}_k \\
& + E e^{i(\omega t - k x_k)} \boldsymbol{e}_E \wedge \boldsymbol{t} \\
& - \frac{\left(e_E \cdot e_B\right) B e^{i(\omega t - k x_k)}}{\sqrt{-\left(e_E \cdot e_B\right)^2 + 1}} \boldsymbol{e}_B \wedge \boldsymbol{e}_k
\end{aligned}$$

$$
\begin{aligned}
(\boldsymbol{\nabla} F)/\left(ie^{iK\cdot X}\right) = 0 = & \left(-\frac{Bk}{\sqrt{-\left(e_E\cdot e_B\right)^2+1}} - E\omega\right)\boldsymbol{e}_E \\
& - \frac{\left(e_E\cdot e_B\right)Bk}{\sqrt{-\left(e_E\cdot e_B\right)^2+1}}\boldsymbol{e}_B \\
& + \left(-\frac{B\omega}{\sqrt{-\left(e_E\cdot e_B\right)^2+1}} - Ek\right)\boldsymbol{e}_E\wedge\boldsymbol{e}_k\wedge\boldsymbol{t} \\
& - \frac{\left(e_E\cdot e_B\right)B\omega}{\sqrt{-\left(e_E\cdot e_B\right)^2+1}}\boldsymbol{e}_B\wedge\boldsymbol{e}_k\wedge\boldsymbol{t}
\end{aligned}
$$

Previous equation requires that: $e_E\cdot e_B = 0$ if $B \neq 0$ and $k \neq 0$

$$
\begin{aligned}
(\boldsymbol{\nabla} F)/\left(ie^{iK\cdot X}\right) = 0 = & \left(-Bk - E\omega\right)\boldsymbol{e}_E \\
& + \left(-B\omega - Ek\right)\boldsymbol{e}_E\wedge\boldsymbol{e}_k\wedge\boldsymbol{t}
\end{aligned}
$$

$0 = -Bk - E\omega$

$0 = -B\omega - Ek$

eq3 = eq1-eq2: $0 = -\frac{E\omega}{k} + \frac{Ek}{\omega}$

eq3 = (eq1-eq2)/E: $0 = -\frac{\omega}{k} + \frac{k}{\omega}$

$k = \begin{bmatrix} -\omega \\ \omega \end{bmatrix}$

$B = \begin{bmatrix} -E \\ E \end{bmatrix}$