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

$$X = x_E \boldsymbol{e_E} + x_B \boldsymbol{e_B} + x_k \boldsymbol{e_k} + t \boldsymbol{e_t}$$

$$K = k \boldsymbol{e_k} + \omega \boldsymbol{e_t}$$

$$K \cdot X = (e_B \cdot e_k)\, k x_B + (e_E \cdot e_k)\, k x_E - \omega t + k x_k$$

$$\begin{aligned} F = {} & (e_B \cdot e_k)\, B \sin\left((e_B \cdot e_k)\, k x_B + (e_E \cdot e_k)\, k x_E - \omega t + k x_k\right) \boldsymbol{e_E} \wedge \boldsymbol{e_B} \\ & - B \sin\left((e_B \cdot e_k)\, k x_B + (e_E \cdot e_k)\, k x_E - \omega t + k x_k\right) \boldsymbol{e_E} \wedge \boldsymbol{e_k} \\ & + E \sin\left((e_B \cdot e_k)\, k x_B + (e_E \cdot e_k)\, k x_E - \omega t + k x_k\right) \boldsymbol{e_E} \wedge \boldsymbol{e_t} \\ & + (e_E \cdot e_B)\, B \sin\left((e_B \cdot e_k)\, k x_B + (e_E \cdot e_k)\, k x_E - \omega t + k x_k\right) \boldsymbol{e_B} \wedge \boldsymbol{e_k} \end{aligned}$$

$$\begin{aligned} \boldsymbol{\nabla} F = 0 = {} & \left(-(e_B \cdot e_k)^2 Bk + Bk + E\omega\right) \cos\left((e_B \cdot e_k)\, k x_B + (e_E \cdot e_k)\, k x_E - \omega t + k x_k\right) \boldsymbol{e_E} \\ & + Bk\left((e_B \cdot e_k)(e_E \cdot e_k) - (e_E \cdot e_B)\right) \cos\left((e_B \cdot e_k)\, k x_B + (e_E \cdot e_k)\, k x_E - \omega t + k x_k\right) \boldsymbol{e_B} \\ & + Bk\left((e_B \cdot e_k)(e_E \cdot e_B) - (e_E \cdot e_k)\right) \cos\left((e_B \cdot e_k)\, k x_B + (e_E \cdot e_k)\, k x_E - \omega t + k x_k\right) \boldsymbol{e_k} \\ & + (e_E \cdot e_k)\, Ek \cos\left((e_B \cdot e_k)\, k x_B + (e_E \cdot e_k)\, k x_E - \omega t + k x_k\right) \boldsymbol{e_t} \\ & + (e_B \cdot e_k)\, Bk \cos\left((e_B \cdot e_k)\, k x_B + (e_E \cdot e_k)\, k x_E - \omega t + k x_k\right) \boldsymbol{e_E} \wedge \boldsymbol{e_B} \wedge \boldsymbol{e_k} \\ & + (e_B \cdot e_k)\, B\omega \cos\left((e_B \cdot e_k)\, k x_B + (e_E \cdot e_k)\, k x_E - \omega t + k x_k\right) \boldsymbol{e_E} \wedge \boldsymbol{e_B} \wedge \boldsymbol{e_t} \\ & + (-B\omega - Ek) \cos\left((e_B \cdot e_k)\, k x_B + (e_E \cdot e_k)\, k x_E - \omega t + k x_k\right) \boldsymbol{e_E} \wedge \boldsymbol{e_k} \wedge \boldsymbol{e_t} \\ & + (e_E \cdot e_B)\, B\omega \cos\left((e_B \cdot e_k)\, k x_B + (e_E \cdot e_k)\, k x_E - \omega t + k x_k\right) \boldsymbol{e_B} \wedge \boldsymbol{e_k} \wedge \boldsymbol{e_t} \end{aligned}$$

Substituting $e_E \cdot e_B = e_E \cdot e_k = e_B \cdot e_k = 0$

$$\begin{aligned} (\boldsymbol{\nabla} F) / (\cos(K \cdot X)) = 0 = {} & (Bk + E\omega)\, \boldsymbol{e_E} \\ & + (-B\omega - Ek)\, \boldsymbol{e_E} \wedge \boldsymbol{e_k} \wedge \boldsymbol{e_t} \end{aligned}$$