Corrections to 'Practical Inductive Link Design for Biomedical Wireless Power Transfer: A Tutorial'

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THE original paper entitled 'Practical Inductive Link Design for Biomedical Wireless Power Transfer: A Tutorial' [1], aimed to provide an accessible review and guide, describing the necessary steps for designing effective biomedical inductive links, without the need for FEM software.

While the majority of the information in the paper is accurate and applicable, some errors in formulae have been brought to the attention of the authors, which could generate erroneous results if used in calculations. The aim of this manuscript is to highlight and correct these errors. It should be noted that the accompanying software for performing these calculations has also been corrected where necessary, in line with the corrections presented here [2].

The errors largely relate to the equations presented throughout, and are listed below:

Firstly, Equation (2) in [1], defining an approximation for Nagaoka's coefficient, contains erroneous squares and is missing a term in the fraction of the large denominator. The correct form is presented below:

$$\kappa = z_k \left(ln\left(1+\frac{1}{z_k}\right) \frac{1}{k_0 + k_1\left(\frac{l}{d}\right) + k_2\left(\frac{l}{d}\right)^2 + \frac{w_1}{(|w_2|+d/l)^v}} \right), \tag{1}$$

where $z_k = l/(\pi r)$, $k_0 = 2.30038$, $k_1 = 3.437$, $k_2 = 1.76356$, $w_1 = -0.47$, $w_2 = 0.755$, and $v = 1.44$.

Second, Equation (14) in [1] considers the AC losses of a Litz-wire coil. The original form contains errors of coefficients and signs. The correct formulation is given as follows:

$$R_{AC} \approx R_{DC}\frac{\gamma}{2}\left(A/n_s - 2\pi n_s\left(\zeta_1^2 + \zeta_2^2\frac{\psi}{2\pi n_s}\right)B\right) \quad ,$$
$$A = \frac{ber(\gamma)bei'(\gamma) - bei(\gamma)ber'(\gamma)}{ber'^2(\gamma) + bei'^2(\gamma)} \quad ,$$
$$B = \frac{ber_2(\gamma)ber'(\gamma) - bei_2(\gamma)bei'(\gamma)}{ber^2(\gamma) + bei^2(\gamma)} \quad , \tag{2}$$

where $R_{DC} = (4\rho l_c)/(n_s \pi d_s^2)$ is the DC loss, $\gamma = d_s/(\delta\sqrt{2})$, $\zeta_1 = (d_s/p)\sqrt{\pi/4}$ is an external porosity factor, $\zeta_2 = (d_s/p_s)\sqrt{\pi/4}$ is an internal porosity factor (p_s is the average strand pitch, and $\psi = (n\pi d_s^2)/(\pi d_0^2)$ is a packing factor.

Third, Equation (17) in [1] is missing a square. The correct form is as follows:

$$C_P = \left(\frac{1}{2\pi f_{SRF}\sqrt{L}}\right)^2 . \tag{3}$$

Fourth, Equation (26) in [1], that defines $\aleph_{ang}$, is missing a $\cos\alpha$ from the numerator of the top fraction under the square root. The correct form is given below:

$$\aleph_{ang} = \sqrt{\frac{\frac{4abcos\phi cos\alpha}{cos\lambda}}{a^2+b^2+D^2-2bDcos\phi sin\alpha + \frac{2abcos\phi cos\alpha}{cos\lambda}}} \quad , \tag{4}$$
$$\lambda = tan^{-1}\left(\frac{sin\phi}{cos\phi cos\alpha}\right) . \tag{5}$$

Finally, the caption of Fig. 17 in [1] is in error; it currently refers to coupling coefficient, while it shows Q-factor. It should read as follows:

'Changing Q-factor as winding pitch is modified, with respect to frequency.'.

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References

[1] M. Schormans, V. Valente, and A. Demosthenous, "Practical inductive link design for biomedical wireless power transfer: A tutorial," *IEEE Transactions on Biomedical Circuits and Systems*, vol. 12, no. 5, pp. 1112–1130, Oct 2018.

[2] (2018) CuCCo: The coupled coil configurator. [Online]. Available: https://github.com/schormans/CuCCo

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