素子のQ値を用いた逆L型整合回路の損失の定式化と損失最小トポロジ

Jan. 26, 2015 – 山田 恭平

抄録

Development of WPT systems is one of the most practical and attractive fields of the day, and number of studies concerned with WPT have been reported [1, 2]. Although the systems proposed in previous works have some variations in design, they intrinsically make use of radio frequency energies in common, as well as they have the same goal of attempting high power transmission efficiency. These situations lead necessity of low loss matching circuits for all WPT systems.

For the simplest L-shaped two-element matching circuit between two purely resistive port impedances, the loss in the matching circuit in perfect matching condition is given by

$$\frac{\text{dissipative loss}}{\text{input power}} = \frac{1}{Q}\sqrt{\frac{r_1}{r_2} - 1}, \tag{1}$$

where r_1, r_2 are the port impedances ($r_1 > r_2$) and Q is the quality factor of the lumped elements, assumed sufficiently large [3]. Some interesting results can be derived from Eq. (1), e.g., for a high impedance ratio of r_1/r_2, multi-stage matching will lead better efficiency than single-stage one. While Eq. (1) may be of use in many situations, it is not wonder to doubt if it works for complex impedances. In general cases, we apply Ep. (1) after "tune out" the imaginary part. This procedure is simple but just a stopgap. Since the effect on the efficiency is not clarified, it makes the analysis obscure. In this work, we expand Ep. (1) for arbitrary complex impedances and establish a guideline for effective circuit design. Some analysis examples for particular situations are also given.

参考文献

[1] N. Shinohara, "Power without wires," IEEE Microw. Mag., vol.12, no. 7, pp. S64–S73, Dec. 2011.

[2] N. B. Carvalho *et al.*, "Wireless power transmission: R&D activities within Europe," IEEE Trans. Microw. Theory Techn., vol. 62, no. 4, pp. 1031–1045, Apr. 2014.

[3] A. M. Niknejad, "Resonance and impedance matching," in *Electromagnetics for High-Speed Analog and Digital Communication Circuits*, New York: Cambridge University Press, 2007, pp. 168–200.