Enigmas, etc.

Rectifier Efficiency

■ Takashi Ohira

A half-wave rectifier consists of a choking inductor *L*, an ideal diode, and a smoothing capacitor *C*, as shown in Figure 1. We assume for simplicity that *L* has infinite inductance, *C* has infinite capacitance, and there is no power dissipation in the diode. The rectifier is excited by a 50-Ω sinusoidal-wave source and produces dc power to a 50-Ω load. What is the RF-to-dc power conversion efficiency?

a) 50% b) 78% c) 81% d) 100%.

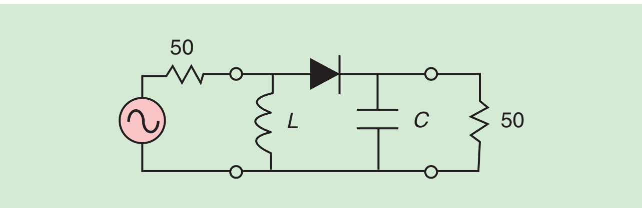

Figure 1. *A single-series diode rectifier working in a 50-Ω system.*

Solution to the September/October "Enigmas, etc."

The correct answer to the problem presented in the September/October 2017 installment of "Enigmas, etc." is b).

From the definitions of *k* and *Q*, it is straightforward to deduce

$$kQ = \frac{M}{L}\frac{\omega L}{R} = \frac{\omega M}{R} = \tan 2\theta.$$

This relation is projected on a persuasive chart in Figure 2. Answers to the July/August and September/October quizzes are summarized in a system of easy-to-remember equations,

$$\begin{cases} kQ = \tan 2\theta \\ \eta_{\max} = \tan^2\theta \end{cases},$$

by way of θ. For example, at least $kQ = 4\sqrt{5}$ is needed to achieve 80 % in efficiency.

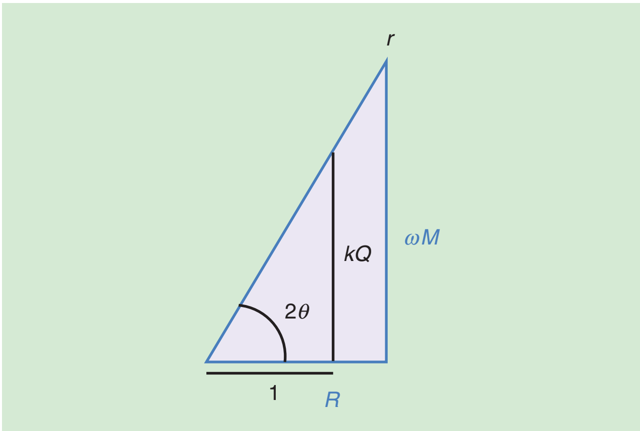

Figure 2. *A subtriangle created to visually demonstrate what kQ is.*

Reviewing this relation, one may notice that *k* and *Q* work together as a single quantity. That is exactly right. Actually, in many cases, they cannot be evaluated separately. Even in such situations, *kQ* still works as a figure of merit [1]. The *kQ* theory, first introduced in magnetic couplers, has been found applicable to any scheme of a reciprocal two-port network for diverse power-transfer systems.

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Reference

[1] T. Ohira, "The *kQ* product as viewed by an analog circuit engineer," *IEEE Circuits Syst. Mag.*, vol. 17, no. 1, pp. 27–32, Feb. 2017.