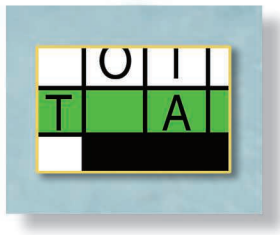

Enigmas, etc.

Solution to Last Month's Quiz

■ Takashi Ohira

The RF voltage source $v_s(t)$ has a sinusoidal waveform, which can be expressed as

$$v_s(t) = [V_P \;\; V_Q]\begin{bmatrix}\sin \omega t \\ \cos \omega t\end{bmatrix} \tag{1}$$

where V_P and V_Q are the in-phase and quadrature components, respectively. In terms of the voltages labeled on the elements in Figure 1, Kirchhoff's voltage law gives

$$v_s(t) + v_L(t) + v_D(t) = V_o. \tag{2}$$

The puzzle in the January 2023 issue of *IEEE Microwave Magazine* [1] reminds us of an important law on the inductor and diode (L + D). That is, a series L + D generally performs zero-voltage switching (ZVS) when D turns on. Defining the time origin $t = 0$ at that moment, the ZVS law can be expressed as

$$v_L(0) = v_D(0) = 0. \tag{3}$$

From (2) and (3), we quickly find

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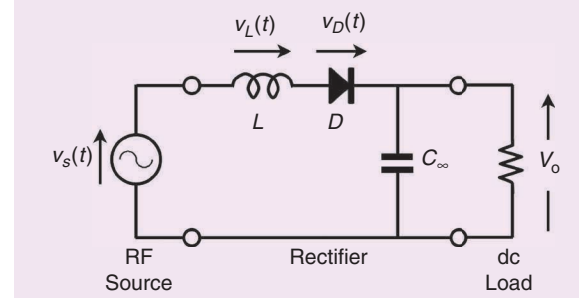

Figure 1. *The rectifier circuit diagram along with its internal voltages for time-domain analysis.*

$$v_s(0) = V_o. \tag{4}$$

For the waveform (1) to satisfy this initial condition, the quadrature component must meet

$$V_Q = V_o. \tag{5}$$

Therefore, the correct answer to last month's quiz is (b). Even though the circuit is so simple and thus equations are also as simple as (1) to (5), we could not reach the solution without knowing the ZVS law.

Reference

[1] T. Ohira, "Inductor and diode," *IEEE Microw. Mag.*, vol. 24, no. 1, pp. 89–90, Jan. 2023, doi: 10.1109/MMM.2022.3211596.