Enigmas, etc.

Solution to Last Month's Quiz

■ Takashi Ohira

The rectifier circuit diagram is shown in Figure 1. To achieve the half-wave rectification, the load resistance is given as

$$R_o = \pi\omega L \tag{1}$$

from [1]. Under this condition, we recall the RF input voltage and current

$$\begin{bmatrix} V_P \\ V_Q \end{bmatrix} = \frac{1}{2}\begin{bmatrix} \pi \\ 2 \end{bmatrix} V_o \tag{2}$$

$$\begin{bmatrix} I_P \\ I_Q \end{bmatrix} = \frac{1}{4}\begin{bmatrix} 2\pi \\ 8-\pi^2 \end{bmatrix} I_o \tag{3}$$

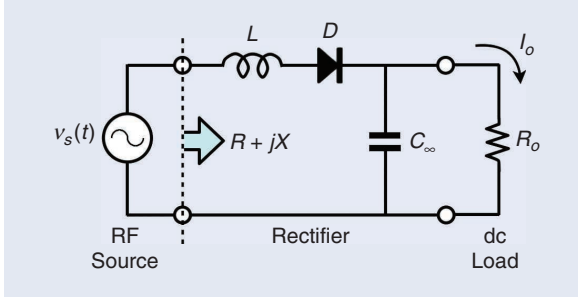

Figure 1. *The single-series diode rectifier.*

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from [2]. We also recall the general PQ-to-RX translator

$$\begin{bmatrix} R \\ X \end{bmatrix} = \begin{bmatrix} I_P & -I_Q \\ I_Q & I_P \end{bmatrix}^{-1} \begin{bmatrix} V_P \\ V_Q \end{bmatrix} \tag{4}$$

from [3]. Substituting (1), (2), (3), and Ohm's law $V_o = R_o I_o$ into (4), we obtain

$$\begin{aligned} \begin{bmatrix} R \\ X \end{bmatrix} &= \frac{2V_o}{I_o}\begin{bmatrix} 2\pi & \pi^2-8 \\ 8-\pi^2 & 2\pi \end{bmatrix}^{-1}\begin{bmatrix} \pi \\ 2 \end{bmatrix} \\ &= \frac{2R_o}{\pi^4 - 12\pi^2 + 64}\begin{bmatrix} 16 \\ \pi(\pi^2-4) \end{bmatrix} \\ &\approx \begin{bmatrix} 0.7446 \\ 0.8582 \end{bmatrix} R_o \\ &\approx \begin{bmatrix} 2.339 \\ 2.696 \end{bmatrix} \omega L. \end{aligned} \tag{5}$$

The bottom row of (5) finds $X > 2\omega L$. Therefore, the correct answer to last month's quiz is (d). The derived formula (5) is indispensable when we apply the rectifier to RF power electronics in good impedance matching.

References

[1] T. Ohira, "DC load pull [Enigmas, etc.]," *IEEE Microw. Mag.*, vol. 24, no. 7, p. 98, Jul. 2023, doi: 10.1109/MMM.2023.3265538.
[2] T. Ohira, "RF input current [Enigmas, etc.]," *IEEE Microw. Mag.*, vol. 24, no. 9, p. 80, Sep. 2023, doi: 10.1109/MMM.2023.3284796.
[3] T. Ohira, "Bridge between R-X and P-Q domains [Enigmas, etc.]," *IEEE Microw. Mag.*, vol. 24, no. 11, p. 98, Nov. 2023, doi: 10.1109/MMM.2023.3303688.