# Enigmas, etc.

## Solution to Last Month's Quiz

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The rectifier circuit diagram is shown in Figure 1. The RF input power is expressed as the scalar product of voltage and current vectors

$$P_i = \frac{1}{2}\begin{bmatrix} V_P & V_Q \end{bmatrix}\begin{bmatrix} I_P \\ I_Q \end{bmatrix} \tag{1}$$

in the $P$–$Q$ domain [1]. The previous quiz [2] reminds us of the voltage and current formulas

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

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

for half-wave rectification. Substituting (2) and (3) into (1), we get

$$\begin{aligned} P_i &= \frac{1}{16}\begin{bmatrix} \pi & 2 \end{bmatrix}\begin{bmatrix} 2\pi \\ 8-\pi^2 \end{bmatrix} V_o I_o \\ &= V_o I_o \\ &= P_o. \end{aligned} \tag{4}$$

This result reveals that, despite the half-wave rectification, the RF input power is entirely converted into dc output. Therefore, the correct answer to last month's quiz is (d).

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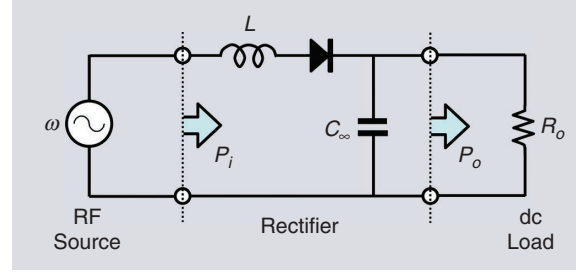


**Figure 1.** *Single-series diode rectifier.*

From the circuit topology shown in Figure 1, one may sense its possible relation to the class-E diode rectifier described in [1]. That is exactly right. We can consider the two circuit structures as a pair of counterparts from the viewpoint of duality. For more details, visit the January 2024 "Educator's Corner" column [3]. This concludes the diode rectifier story, and we hope you enjoyed it. Next month we will explore a new series of puzzles, so stay tuned to the "Enigmas, etc." corner.

## References

[1] T. Ohira, "Linear algebra elucidates class-E diode rectifiers [Educator's Corner]," *IEEE Microw. Mag.*, vol. 23, no. 12, pp. 113–122, Dec. 2022, doi: 10.1109/MMM.2022.3203947.
[2] T. Ohira, "Input impedance [Enigmas, etc.]," *IEEE Microw. Mag.*, vol. 25, no. 1, p. 95, Jan. 2024, doi: 10.1109/MMM.2023.3321553.
[3] T. Ohira, "Duality theorem juxtaposes class-E and inverse-class-E diode rectifiers," *IEEE Microw. Mag.*, vol. 25, no. 1, pp. 90–94, Jan. 2024, doi: 10.1109/MMM.2023.3321552.