$5 junk-box circuit determines phase sequence

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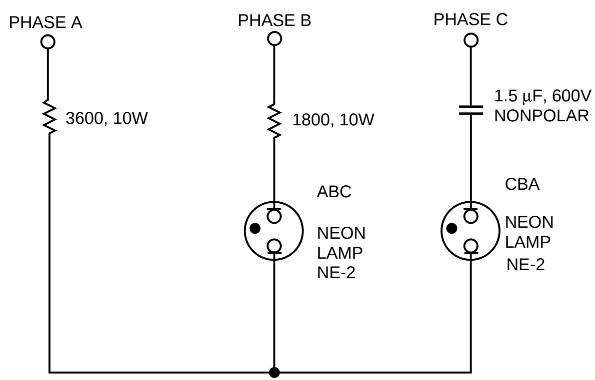
Have you ever wondered which way a blower motor is going to turn when you plug it into another socket, or have you ever inherited the task of modifying three-phase wiring in your plant? The circuit in **Figure 1** is a simple, approximately $5 phase sequencer that you can probably build from parts in your junk box and save approximately $50 to boot. The component values reflect 60-Hz operation, but the design equations in **Figures 2** and **3** allow you to select values for other frequencies. The equations are in MathCAD spread-

FIGURE 1



The brighter of the two neon lamps indicates the phase sequence, either ABC or CBA.

FIGURE 2

$$f=60$$
$$C=1.5\cdot10^{-6}$$
$$V=0$$
$$R1=3600 \quad R2=1800$$
$$x=\frac{1}{2\cdot\pi\cdot f\cdot C}$$
$$x=1.768\cdot10^{3}$$
$$IA=\frac{1}{R1}\cdot(120\cdot\cos(2\cdot\pi\cdot f)-V)$$
$$IB=\frac{1}{R2}\cdot\left(120\cdot\cos\left(2\cdot\pi\cdot f-2\cdot\frac{\pi}{3}\right)-V-90\right)$$
$$IC=\frac{1}{\left[\left(\frac{1}{2\cdot\pi\cdot f\cdot C}\right)^{2}\right]^{wQ}}\cdot\left(120\cdot\cos\left(2\cdot\pi\cdot f-4\cdot\frac{\pi}{3}-\frac{\pi}{4}\right)-V-90\right)$$

$IA=0.033$
$IB=-0.083$
$IC=-0.033$

MathCAD spreadsheet equations show a higher current in Phase B than in Phase C of the circuit in Figure 1; therefore, the phase sequence is ABC.

sheet format, but almost any other spreadsheet would do.

Referring to **Figure 1** and the equations, you can see that the neon bulb that glows brighter indicates the phase sequence, or phase-rotation order, ABC or CBA. The bulb glows brighter because it carries more current because of the phase shift the 1.5-μF capacitor provides. You can verify this assertion by examining the two sets of equations. Note that the two sets of equations have different expressions for I_B and I_C. In one, I_B lags I_A by $2\pi/3$; in the other, it lags by $4\pi/3$, and vice versa for I_C. The equations provide the mathematical way of reversing the phase sequence, and, as you can see, the two currents I_B and I_C reverse their relative magnitudes as the phase rotation reverses. (DI #2180) EDN

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FIGURE 3

$f=60$

$C=1.5\cdot 10^{-6}$

$V=0$

$R1=3600 \quad R2=1800$

$$x=\frac{1}{2\cdot\pi\cdot f\cdot C}$$

$$x=1.768\cdot 10^{3}$$

$$IA=\frac{1}{R1}\cdot(120\cdot\cos(2\cdot\pi\cdot f)-V)$$

$$IB=\frac{1}{R2}\left(120\cdot\cos\left(2\cdot\pi\cdot f-4\cdot\frac{\pi}{3}\right)-V-90\right)$$

$$IC=\frac{1}{\left[\left(\frac{1}{2\cdot\pi\cdot f\cdot C}\right)^{2}\right]^{wQ}}\cdot\left(120\cdot\cos 2\cdot\pi\cdot f-2\cdot\left(\frac{\pi}{3}-\frac{\pi}{4}\right)-V-90\right)$$

$IA=0.033$

$IB=-0.083$

$IC=-0.116$

A CBA phase sequence produces a higher current, thus a brighter neon lamp, in Phase C of the circuit in Figure 1.