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Capacitive Current and Standby Loss

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Digital Phase Converter

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The formula for average power in an ideal AC system is:

$$P = V_m \cdot I_m \cdot \cos(\theta)$$

where m = magnitude
P = power
V= voltage
I = current
θ = phase angle (between voltage and current curves)

In this example circuit, there is always a phase angle of 90° because a purely reactive load (a load composed entirely of capacitors and/or inductors) causes a phase shift of 90°. If θ is always 90°, then cos(θ) will always be 0. Regardless of the voltage or current, the *average* power of an AC circuit in this configuration will always be 0W. However, as Figure 3 illustrates, even though the average power is 0, the instantaneous power does vary.

Phase Perfect Stand-By Power

The Phase Perfect systems are much more complex than the simple RC circuit explored up to this point. However, the same general concepts do apply. Due to the LC filtering in the Phase Perfect systems, the filter capacitors are alternately charging and discharging.

Table 1 calculates the expected currents when measuring a system in stand-by. The formula for calculating the current in a Phase Perfect system in stand-by is:

$$I = 2\pi \cdot V \cdot f \cdot C$$

where f = frequency
C = capacitance

Table 1 calculates this expected circulating current in stand-by mode for the various Phase Perfect models. These currents are not consumed, but reflected back to the source.

Table 1. Expected Circulating Current in Phase Perfect Systems

Model	**PT330**	**PT355**	**PT380**	**PT3110**	**PT3160**
Capacitance [C] (µF)	40	80	60	160	240
Voltage [V] (V)	240	240	240	240	240
Frequency [f] (Hz)	60	60	60	60	60
Current [I] (A)	**3.62**	**7.24**	**10.85**	**14.48**	**21.71**

Unlike the ideal circuit explored in the example, the Phase Perfect has losses, which means that the system is not 100% efficient. The system is consuming a nominal amount of energy, even in stand-by mode.

Utility meters only measure power consumed (i.e. currents that are greater than 0). In a Phase Perfect system, the utility meter will not register the circulating current (which averages to no net power consumption). The utility is measuring an average of the current flowing to the capacitors and being reflected back to the source. For a PT330 system, the current measured at the PT330 is approximately 4.06A in stand-by mode. Per Table 1, the circulating current is approximately 3.62A. Approximately 0.44A (the net difference) is consumed by the Phase Perfect. Thus, the stand-by power consumption for a Phase Perfect system is:

$$P = V \cdot (I_{converter} - I_{reflected})$$

where V = utility voltage
$I_{converter}$ = current measured at the Phase Perfect system
$I_{reflected}$ = circulating current reflected back to the source

For the PT330 system, the stand-by power consumption is:

$$P = 240V \cdot (4.06A - 3.62A) = 105.6W$$

Summary

Filter capacitors in Phase Perfect systems alternate between charging and discharging, creating a reactive load which consumes no power. The actual peak currents that may be measured at the source to a Phase Perfect unit will be much higher than what is actually being consumed. The actual power consumption is the difference between this current and the current that is reflected back to the source due to circulation.

Utility meters only measure current consumption, NOT circulation. Thus, though the amount of current passing through the Phase Perfect system may be significant, the utilities are only charging for the net power consumed, NOT the reactive current.

About Phase Technologies

Founded in 1999, Phase Technologies developed Phase Perfect® Digital Phase Converters, the first major advancement of phase conversion technology in decades. Recognized as the world's leading manufacturer of phase converter technologies, the company expanded its product offerings to include variable frequency drives (VFD's).

Specializing in VFD with Active Front End technology, Phase Technologies produces the only low harmonic, fully regenerative, phase-converting VFD that complies with IEEE 519, the international standard for allowable harmonic levels on utility mains. The company has an extensive product line-up of low harmonic, fully regenerative drives in both three-phase and phase-converting models.

Phase Technologies relies on a team of in-house power electronics and mechanical design engineers to develop innovative products, encompassing all aspects of hardware and firmware design. All products are manufactured at our facilities in the USA under exacting quality standards. In-house processes include printed circuit board population and custom magnetics fabrication.

The company operates a certified UL508A panel shop to integrate our drives into rugged outdoor panels with custom options for applications including irrigation, oil and gas production and general industrial control.

Integrity and honesty are the cornerstones of customer interaction at Phase Technologies. Knowledgeable sales experts are available to help customers select the right product to fit their needs, and we partner with the best distributors and dealers to make our products available with rapid delivery times and local service. Experts in our customer service department are standing by to answer technical questions and provide the support to keep your application up and running.

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