The Misinterpretation of Active Power

in the sinusoidal system

The instantaneous power is given by the product of the instantaneous voltage and current.

In a sinusoidal system, $I(t) = I_{max}\,\mathrm{Sin}(\omega t \pm \varphi)$

$$V(t) \cdot I(t) = V_{max}\,\mathrm{Sin}(\omega t) \cdot I_{max}\,\mathrm{Sin}(\omega t \pm \varphi)$$

$$V(t) \cdot I(t) = \underbrace{VI\cos\varphi\,\{1-\cos 2\omega t\} \pm VI\sin\varphi\sin(2\omega t)}_{\text{Existing equation for power}}$$

This equation is common and accepted by all power definitions in the sinusoidal system and consist of two parts. The interpretation of the first parts is the validity of a power definition.

Here, we compare two interpretations of the active power definition:

- The interpretation of IEEE 1459 Standard – 2010.
- Our interpretation – 2020.

$$V(t) \cdot I(t) = VI\cos\varphi\,\{1-\cos 2\omega t\} \pm VI\sin\varphi\sin(2\omega t)$$

Standard 1459`s Interpretation (2010)

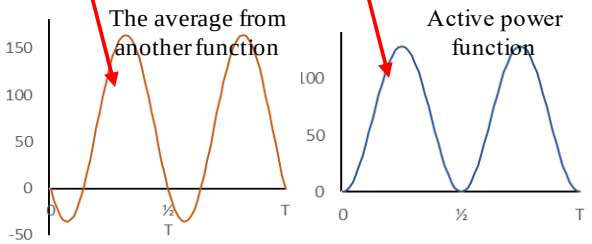
$$p = vi = \underbrace{VI\cos\varphi\,\{1-\cos(2\omega t)\}}_{pa} \pm \underbrace{VI\sin\varphi\sin(2\omega t)}_{pq}$$

p = pa + pq

The average of instantaneous power is active power

pa is the instantaneous active power

Instantaneous reactive power



Our Interpretation (2020)

$$V(t)\,.\,I(t) = VI\cos\varphi\,\{1-\cos(2\omega t)\} + VI\sin\varphi\sin(\pm 2\omega t)$$

$$V(t)\,.\,I(t) = \underbrace{2VI\cos\varphi\,\{\mathrm{Sin}^2(\omega t)\}}_{P(t)} + \underbrace{VI\sin\varphi\sin(\pm 2\omega t)}_{Q(t)}$$

$V(t)\,.\,I(t)$ = $P(t)$ + $Q(t)$

Instantaneous power

Instantaneous active power

Instantaneous reactive power

$\{$ **P** is amount of active power$\} = \frac{1}{2\pi}\int_0^{2\pi} P(t)$

{The average of a function} Must be $= \frac{1}{2\pi}\int_0^{2\pi}$ Same function

IEEE 1459 Standard (page 3): • The instantaneous power p is given by ($p = vi$).
• The component pa is the instantaneous active power.
• The active power P is the average value of the instantaneous power.

The active power P is addressed as the average value of another function.
It`s a deviation from the math principle.

IEEE 1459 Std`s interpretation (2010)	Our interpretation (2020)
$P = V.I \cos\varphi \{1 - \cos(2\omega t)\} + V.I \sin\varphi \sin(\pm 2\omega t)$	Instantaneous power = $V.I \cos\varphi \{1 - \cos(2\omega t)\} + V.I \sin\varphi \sin(\pm 2\omega t)$
$P = pa + pq$	Instantaneous power = (PART I) + (PART II)
Related to Active Power; Related to Active Power; Related to Reactive Power	Related to Instantaneous Power; Related to Active Power; Related to Reactive Power
Two power components are addressed.	There are three power components. Three equations, three waveforms, and three concepts.
The plus sign (+) between (pa) and (pq) have been ignored.	The plus sign (+) between Part 1 and Part 2 show that the active and reactive power are added algebraically not perpendicular.
IEEE 1459 Std. used only one character **P** (p, *P*, *p*, *pa*, *pq*) for different purposes. The amount and instantaneous of a parameter are not clearly separated. There isn`t <u>any</u> waveform concerning the power components on IEEE 1459 Std. These items would confuse the readers.	The instantaneous of a parameter is a function of time. We note it by using the upper-case character with the suffix (*t*), e.g., $P_{(t)}$, $Q_{(t)}$. The amount of a power component is an average of the same instantaneous function. We note it by using the same upper-case character without suffix, e.g., P, Q. We illustrate waveforms of power components frequently for clarification.