1 Power

When we say power we usually are talking about AVERAGE POWER. For DC circuits it is nothing but $P = VA$, for AC circuits average is an integral of instanteneous voltage $v(t)$ and $i(t)$:

$$P_{avg} = \frac{1}{T}\int_0^T v(t)i(t)\,dt. \tag{1}$$

Also, specifically for RLC circuit it can be shown

$$P_{avg} = (V_{rms} \times I_{rms})cos\phi \tag{2}$$

Here, ϕ is the angle between voltage and current phasor vectors(assumed constant). The product $(V_{rms} \times I_{rms})$ is the easily measurable quantity obtained by any DMM. On the other hand neither ϕ nor P_{avg} are easily measurable.

The term $VA = (V_{rms} \times I_{rms})$ is called APPARENT POWER.

The term $cos\phi$ is called POWER FACTOR(PF).

$$P_{avg} = VA \times PF \tag{3}$$

When we talk about *power factors*, we are assuming it can be represented by an equivalent RLC circuit(which may not always be realistic). IF WE DID KNOW WHAT RLC CIRCUIT IT WAS WE COULD CALCULATE POWER FACTOR DIRECTLY:

$$\phi = tan^{-1}\big(\frac{X_L - X_C}{R}\big), PF = cos\phi \tag{4}$$

Power factor relates easily "measurable" apparent power VA term to the less tangible P_{avg}.

Calculating power factor requires either computing integral from (1) or finding average power by some other means. Then

$$PF = \frac{P_{avg}}{VA} \tag{5}$$

P versus VA.

	VA	P
MEASURING	GREAT	OK
ESTIMATE TOTAL SYSTEM POWER	NOT GREAT	GREAT
PAY POWER BILLS	NOT GREAT	GREAT
ESTIMATE HEAT	NOT GREAT	GREAT
ESTIMATE DEVICE CURRENT DRAW	GREAT	NOT GREAT
ESTIMATE SYSTEM CURRENT DRAW	NOT GREAT	OK