ONE OPTIMISED NETWORK EQUIPMENT

Common units of measure

Introduction

This note has been prepared to summarise some common units of measure used in the electrical engineering field and with specific reference to reactive power compensation. The aim is to remind readers of good engineering practice when preparing reports, specifications and other formal documentation in this field.

Reference

ISO/IEC 80000 is an international standard promulgated jointly by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC). It is a style guide for physical quantities and measurement, formulas involving them, and their corresponding units. IEC 80000-6:2008 lists the names, symbols, and definitions for quantities and units of electromagnetism, including conversion factors where relevant.

Electrical engineering quantities

The following quantities are ubiquitous in electrical engineering:

Current, I: The unit of measure is the ampere, abbreviated as A. It is the only quantity related to electrical engineering that is a base unit of the SI. The formal definition of an ampere is that constant current which, if maintained in two straight parallel conductors of infinite length, of negligible circular cross-section, and placed 1 metre apart in vacuum, would produce between these conductors a force equal to 2×10^{-7} newton per metre of length.

Example: The current I has a value of 5 amperes, or I = 5 A.

Voltage, V: It is strictly speaking incorrect to refer to voltage – the correct term is "electric tension" or "electrical potential difference". The unit of measure is the volt, abbreviated as V. Derived from other SI units, $1\ \text{V} = 1\ \text{W}\,\text{A}^{-1}$, and derived from SI base units $1\ \text{V} = 1\ \text{kg}\,\text{m}^2\,\text{s}^{-3}\,\text{A}^{-1}$.

Example: The electrical potential difference between the two busbars is 132 kilovolts, or V = 132 kV.

Active power, P: The unit of measure of active power is the watt, abbreviated as W. Derived from other SI units, $1\ \text{watt} = 1\ \text{J}\,\text{s}^{-1} = 1\ \text{V}\,\text{A}$. Derived from SI base units, $1\ \text{W} = 1\ \text{kg}\,\text{m}\,\text{s}^{-3}$.

Example: The power transfer capability of the transmission line is 720 megawatts, or P = 720 MW.

Apparent power, S: The unit of measure of apparent power is the volt ampere, abbreviated as V A. Derived from SI base units, $1\ \text{V}\,\text{A} = 1\ \text{kg}\,\text{m}\,\text{s}^{-3}$.

Example: The power rating of the transformer is 500 megavolt amperes, or S = 500 MV A.

Reactive power, Q: The IEC has adopted the name var (volt ampere reactive power), for the coherent SI unit of "volt ampere for reactive power". Derived from SI base units, $1\ \text{var} = 1\ \text{kg}\,\text{m}\,\text{s}^{-3}$. Note all lower case.

Example: The reactive power output of the capacitor bank is 50 megavolt amperes reactive, or Q = 50 Mvar.

The three above quantities: active, apparent and reactive power, are all obtained from the same base SI units and are all related to the product of voltage with current. What distinguishes them is only the treatment of the phase angle between the voltage and current vectors.

Active energy, W: The formal unit of measure for energy is the joule, and in electrical terms 1 J = 1 W s. Derived from SI base units, $1\ \text{J} = 1\ \text{kg}\,\text{m}\,\text{s}^{-2}$.

Example: The energy delivered by the battery system is 100 mega watt hours, or W = 100 MW h. Note that the symbol of energy is W (short for "work", not to be confused with the unit of measure of power: W (watt).

Capacitance, C: The unit of measurement of capacitance is the farad, abbreviated as F. $1\ \text{F} = 1\ \text{C}\,\text{V}^{-1} = 1\ \text{s}^4\,\text{A}^2\,\text{kg}^{-1}\,\text{m}^{-2}$.

Example: The capacitor unit has capacitance of 12.3 microfarad, C = 12.3 µF.

Resistance, R: The unit of measurement of resistance is the ohm, abbreviated as Ω. $1\ \Omega = 1\ \text{V}\,\text{A}^{-1} = 1\ \text{kg}\,\text{m}^2\,\text{s}^{-3}\,\text{A}^2$.

Example: The damping resistor unit has resistance of 500 ohms, $R = 500\ \Omega$.

Inductance, L: The unit of measurement of inductance is the henry, abbreviated as H. $1\ \text{H} = 1\ \text{V}\,\text{s}\,\text{A}^{-1} = 1\ \text{kg}\,\text{m}^2\,\text{s}^{-2}\,\text{A}^{-2}$.

Example: The reactor has inductance of 2.8 millihenries, L = 2.8 mH.

Magnetic flux density, B: The unit of measurement of magnetic flux density is the tesla, abbreviated as T. $1\ \text{T} = 1\ \text{V}\,\text{s}\,\text{m}^{-2} = 1\ \text{kg}\,\text{s}^{-2}\,\text{A}^{-1}$.

Example: The magnetic flux density at a distance of three metres from the reactor coil is 0.4 millitesla, B = 0.4 mT.

Conclusion

Using the correct terminology and units in formal documentation should be normal practice for professional electrical engineers. This document provides some information on this topic. Much more can be found at:

http://www.iec.ch/si/si
http://ukma.org.uk/docs/ukma-style-guide.pdf
http://physics.nist.gov/cuu/Units/checklist.html

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