NEMA C12.24 TR-2011

Definitions for Calculations of VA, VAh, VAR, and VARh for Poly-Phase Electricity Meters
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This Technical Report establishes definitions for calculations of VA, VAh, VAR, and VARh for poly-phase electricity meters. It is intended to ease identification of algorithms used in electricity meters and to facilitate accurate testing.

This technical report was processed and approved for submittal to ANSI by Accredited Standards Committee for Electricity Metering, C12. At the time the committee approved this technical report, the C12 Committee had the following members:

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Definitions for Calculations of VA, VAh, VAR, and VARh for Poly-Phase Electricity Meters

1 Scope

This technical report establishes names and mathematical definitions for the Volt-Ampere (VA), Volt-Ampere hours (VAh), Volt-Amperes Reactive (VAR), and Volt-Ampere Reactive hours (VARh) formulae used by poly-phase electricity meters. The mathematical definitions assume static waveforms.

2 Abbreviations and Letter Symbols

2.1 Abbreviations

- netVA: total meter Volt-Ampere
- netVAR: total meter Volt-Ampere reactive
- netWatt: total meter power
- RMS: root mean square
- VA: Volt-Ampere
- VAh: Volt-Ampere hours
- VAR: Volt-Ampere reactive
- VARh: Volt-Ampere reactive hours

2.2 Letter Symbols

- \( \alpha_{(h)\:i} \): phase angle of the potential for harmonic order \( h \) of phase \( i \)
- \( \beta_{(h)\:i} \): phase angle of the current for harmonic order \( h \) of phase \( i \)
- \( \theta_{i} \): phase angle between the fundamental potential and current of phase \( i \), \( \alpha_{(1)\:i} \) minus \( \beta_{(1)\:i} \)
- \( \tau \): start time of integration
- \( \omega \): fundamental angular frequency, \( 2\pi f_{0} \), where \( f_{0} \) is the fundamental frequency in Hertz
- \( bV_{i} \): Blondel’s theorem transformed voltages:

\[
\begin{align*}
    bV_{1} &= V_{1} - V_{2} \\
    bV_{2} &= 0 \\
    bV_{3} &= V_{3} - V_{2}
\end{align*}
\]

- \( \Delta t \): VARh and VAh integration interval measured in seconds
- \( h \): harmonic order (fundamental=1, second harmonic=2, etc.)
- \( i \): phase number in the poly-phase network
- \( I_{i} \): generalized current waveform of phase \( i \) (fundamental and all harmonics)