Voltage Unbalance: NEMA and Negative-Sequence (IEC) Methods

Voltage unbalance of a three-phase supply from the three line-to-line voltages, as NEMA maximum deviation from the average and as the negative-sequence ratio.

Method: NEMA MG 1 definition of voltage unbalance; IEC 61000-4-30 / IEC 61000-2-12 negative-sequence unbalance

Input parameters

Unit system: SI

Parameter	Value	Unit
Line-to-line voltage a–b	415.00	V
Line-to-line voltage b–c	410.00	V
Line-to-line voltage c–a	400.00	V

Calculated results

Parameter	Value	Unit
Average line voltage	408.33	V
Largest deviation from the average	8.3333	V
Unbalance, NEMA (largest deviation ÷ average)	2.0408	%
Unbalance factor, negative ÷ positive sequence	2.1540	%

Notes for this case

- Motor derating for unbalance comes from the motor standard or maker; this page gives the unbalance only.

Formula and method

$$V_{avg} = \frac{V_{ab} + V_{bc} + V_{ca}}{3}, \quad LVUR = \frac{\Delta V_{max}}{V_{avg}}$$

$$\beta = \frac{V_{ab}^4 + V_{bc}^4 + V_{ca}^4}{(V_{ab}^2 + V_{bc}^2 + V_{ca}^2)^2}, \quad VUF = \sqrt{\frac{1 - \sqrt{3 - 6\beta}}{1 + \sqrt{3 - 6\beta}}}$$

Variables

V_{ab}	Line-to-line voltage a–b	V
V_{bc}	Line-to-line voltage b–c	V
V_{ca}	Line-to-line voltage c–a	V
V_{avg}	Average line voltage	V
ΔV_{max}	Largest deviation from the average	V
$LVUR$	Unbalance, NEMA (largest deviation ÷ average)	-
VUF	Unbalance factor, negative ÷ positive sequence	-

Method and standards

The NEMA unbalance uses the line voltages directly. The negative-to-positive sequence ratio is computed from the three line-to-line magnitudes by the closed form above, which equals the symmetrical-component ratio (line voltages always form a closed triangle, so they have no zero sequence).

Assumptions and limits

- Fundamental-frequency rms magnitudes.
- Readings taken at the same moment.

References

- NEMA MG 1 definition of voltage unbalance
- IEC 61000-4-30 / IEC 61000-2-12 negative-sequence unbalance

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/electrical/power-quality/voltage-unbalance

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Reopens the calculator with the inputs of this report.